

Future of a Crowd-sourced, AI-enabled knowledge resources:

Using the research on collective intelligence to predict the future of AI

Dr. N.L. Johnson research@collectivescience.com

Guide to the report

This report's goal is to capture the future of AI in the next stages of the Information Age in two phases:

1. Create a universal, innovative resource for individual and group problem-solving by *digitally capturing the full diversity of human experience at the individual level* within an online resource that is crowd-sourced and do-it-yourself. The AI captures and summarized the individuals contribution and aggregates over multiple individuals to find strongest recommendations.
2. *Advance the Age of AI by utilizing collective intelligence to solve humanity's most challenging problems* by processing the high-diversity data capture from Phase 1.

The report contains an extended introduction to motivate the proposed resources above. Introductory topics covered are 1) [Rethinking the Information Age to include AI](#), 2) [How influencers have changed marketing products](#), and 3) [How the future of commerce is the long-tail marketing of many diverse products for diverse consumers](#).

The above introductions are the foundation to discuss [how AI will provide a universal, problem-solving, online resource that addresses individual, community, and corporate needs](#). This discussion includes [how AI can address humanity's unmet needs](#).

The proposal for the two phases of investment is presented. [The first is technically straightforward and in my opinion will happen and may already be in development but not yet public](#).

[The second phase of developing an AI-enabled collective intelligent resource to solve humanity's most difficult challenges is likely but requires technical developments](#). Within this context, I discuss the technical questions about Collective Intelligence (CI) as a problem-solving resource: [Why an aggregation of diverse individual solutions solves simple problems](#), [What types of problems does CI work and not work](#), and [How AI can break the complexity barrier observed in prior CI methods](#). A full discussion of Phase 2 is not complete but thoughts are presented as a starting point for discussion.

To complete the discussion of the Age of AI, the report also contains: [A discussion on how AI will impact human jobs](#) (conclusion: ultimately, all current jobs will be impacted or replaced) and [a short discussion of how robotics plus AI will address the unique human niche of mobile manual labor](#) (conclusion: manual jobs are also not commonly identified as at risk by AI, because of processing demands and manual skills required; but these these are argued be replaced by AI robots, just as creative, innovative, and professional jobs will be replaced by AIs). Notable is that these conclusions are obvious in retrospect but are not commonly held by pundits on the future of AI.

I've included [an appendix on my thought process that resulted in this report](#): What motivated this analysis (a surprise) and the significant "ah-has" I had, particularly on the high likelihood of the two proposed phases and how AI applications (digital and robotics) will impact all occupations eventually.

Finally, [an extensive Appendix has supporting documentation for the report, provided in publications or pro-level queries to Perplexity](#). While many of Perplexity's inquiries are obvious questions generated in the scope of the report, each provides interesting reading about the Information Age and future of AI—only a few responses contained surprises.

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Introduction: Rethinking the Information Age to include AI

This report explores opportunities for future novel uses of AI and how these innovations will profoundly change society. To fulfill that goal, we first need to reexamine the Information Age over the last 50 years to provide context to the recent and future advances of AI. There are two extremes in which to analyze the rapid rise and integration of AI tools as part of the Information Age: short-term and long-term viewpoints.

Short-term view of the Information Age

Anytime a significant technology is developed, the short-term response is reactive to change, without preparation or planning (see [Appendix X for examples and trends](#)). This is essentially the zeitgeist of the current introduction of AI. This short-term viewpoint is that with the increase in AI capabilities in recent years, many human digital activities are impacted to the point of being improved (the good) or replaced by AI (the bad), creating significant uncertainty in the future (the ugly). These changes are followed by societal adaptations of the impacts of new technologies (see [App X](#)).

In the short term, some people see [AI as making their jobs and lives easier](#), while [others fear AI will replace their jobs because AI automation lowers costs or increases efficiency](#). The fear of AI replacing jobs spans the spectrum of employment. Lower-skilled workers see their jobs as noncompetitive and easily replaced by AI systems. While higher-skilled, creative professions are thought to be immune from automation ([see an analysis of jobs thought to be safe](#)), a recent exception is the [2023 scriptwriters' union strike](#). Because the AI revolution is still in its infancy, solid predictions are not possible without a historical long-view perspective on prior major employment shifts.

While the current impact of AI on jobs is rapidly changing and significant, it is just beginning by most estimates. Yet, few consider the impact of AI relative to historical times of rapid employment shifts. Will the impact of AI be as significant as the societal impact that occurred during the Industrial Revolution, when Western civilization went from a rural agrarian society to an urban industrial society? Definitely not.¹ How about the societal impact in the transition from an industrial society to a digital society in the last 50 years due to the advent of the Internet and widespread localized computing? This is a more difficult question because we are still experiencing these digital transitions, compounded now by AI. So, what can a historical perspective tell us about how AI will impact society in the long term, given the high uncertainty in the short term? (See [Appendix X for a brief summary of historical tech transformations](#).)

Long-term view of the Information Age

[Drucker's 1969 book, *The Age of Discontinuity: Guidelines to our changing society*](#), was remarkably written before the advent of the personal computer and the Internet. Yet, his predictions in 1969 were so accurate that in the next four reprints over 40 years, he stated in the preface simply “my predictions are right on track, and here are examples.”

Drucker's core prediction was the rise of the (Digital) Information Age, causing the replacement of the economic dominance of heavy industries by the economic dominance of service industries, driven by unique job knowledge. Here, service workers are broadly defined as teachers, accountants, doctors,... any professional or trade worker whose primary service is knowledge-based.

A key question arises: Is the increased use of AI an extension of Drucker's predictions, or is the Age of AI a qualitative change from Drucker's Information Age?

¹ The duration of the change must be considered. The [recent recipients of the 2024 Nobel prize for Economics](#), one of them in an interview on NPR noted that during the the Industrial Age (IA) in Northern England, politicians supporting the change argued that the IA would create higher paying jobs, which was true, but it didn't happen until 50 years and two generations later. While modern changes will happen faster, the same delay of better jobs is expected, due to time for retraining and coordination of change with other infrastructures and business models.

Even though the digital age had just begun around 1969 with main-frame computing, Drucker predicted that fundamental job changes, and hence the economy, would occur as information became the valued commodity driving the economy, resulting in what he called "[The Rise of the Knowledge Society](#)" (1993). As a consequence, the previously lifetime-employment occupations tied to large companies with significant capital investments were replaced by diverse knowledge workers who learn and market their services independently from large companies, vastly changing the fluidity of employment, society, and even companies.²

As a counterpoint, some claim that [AI adoption is creating new human jobs](#), as there are shortages of expertise to implement AI into current aspects of business and society.

Automation replacement of jobs missed by Drucker

Drucker did not predict which technology would bring about his Age of Discontinuity.³ The Information Age was primarily due to the growth and adoption of new knowledge infrastructures: the Internet and decentralized (personal) computing. The Information Age has profoundly changed jobs, businesses, personal life, and society. Notably, while many changes of the Information Age were resisted along the way, few now would question if the profound personal and societal changes were unnecessary.⁴ This observation sets the stage for considering the changes and impact of the *Age of AI*.

Will AI adoption continue Drucker's predicted Information Age transformations with more of the same but few qualitative changes? Or will the Age of AI be uniquely disruptive and transformative?⁵

The job-loss prediction from AI is not recent and was previously captured as the loss of jobs from workplace automation. For example, [automation of auto assembly](#) over the last three decades eliminated many jobs while creating new automation oversight jobs at a higher skill level. While the automation of tasks and the replacement of jobs by automation is the most significant change of the Information Age, all professions, jobs, and personal lives were impacted for good and bad by personal computing and the Internet. For example, using computers in classrooms is now a common experience by all students, and while beneficial, it has many risks ([see Appendix P](#)). Arguably, all aspects of society are impacted by the Information Age.

The age of AI meets the Information Age viewed through automation

One way to simplify the analysis of the impact of AI is to focus on the trend of increased automation. The increased use of AI in the workplace can be viewed as a continuation of automation over the last decades. Here is a popular list of [the most likely professions to be replaced by AI in the next decade](#): *Customer Service Representatives, Telemarketers, Receptionists, Bookkeeping Clerks, Proofreaders, Factory and Warehouse Workers, Car and Truck Drivers, Financial Traders, and Computer Programmers*. These are all service workers in Drucker's analysis. Current estimates are that by 2030 (in 6 years), 15-50% of current jobs will be automated by AI in developed countries ([see follow-up query](#)). Given these estimates, it's not surprising that there is already resistance to automation by AI in the workplace. One

² Drucker did not discuss how the information age would change family economics (that I remember), knowledge-based jobs likely enabled employment of both parents and single parents, worker types that had previously been excluded from the workforce. Also, the increased turnover in legacy corporations also occurred, as captured in [Creative Destruction by Foster and Kaplan](#) in 2001, arguably due to the more dynamic knowledge market and the inability of large corporations to adapt to changing markets.

³ Interestingly, Drucker did not predict what technologies would enable his predictions, only that his predictions were a necessary result of needs arising in society. He assumed new technologies would be discovered that would meet the needs he foresaw. This is a radically different type of prediction compared to technology predictions. He discussed his approach in detail in his first chapter on how to predict major societal and economic trends.

⁴ Compare the acceptance of changes of the Information Age to the growing opposition to the use of fossil fuels and the resulting climate change. Both have benefits and risks, yet the collective judgment about the resulting change for each is quite different.

⁵ While I think the prior question is likely, I'll present some thoughts and return to these questions at the end.

resistance had a potential national impact: dockworkers who struck in Oct 2024 to prevent and then chose to defer to resolve the [automation of handling shipping containers at dockside](#). While the deferment of automation by AI is possible, it is also inevitable.

Interestingly, the media largely ignores the most significant impact of AI based on salaries: the automation of high-paid professionals and technicians with extensive schooling and training. [While the collective references cited by Perplexity don't agree that professionals are at risk](#) (captured in the likely job loss list above), I think AI job replacement will ultimately include many high-paid knowledge-based professions, including lawyers, accountants, financial advisors, architects, medical doctors, cybersecurity experts, scientists, researchers, the list is long. It is worth noting that AI may offer less bias and discrimination in professions.

The above example of automation replacing professional jobs differs from Drucker's predictions, which focused on the growth of service industries, including education, training, personal services, etc. He predicted that professional (knowledge-based) jobs would become a greater part of the economy but didn't predict that they would be eliminated in the Knowledge Age. This observation illustrates how different the Age of AI is from the Information Age and possibly should be considered a unique "Age" that followed the Industrial, Information, and Knowledge Ages. Let's examine the extremes of how AI will impact employment.

There are two extremes of the impact of AI on all types of jobs. One is the rapid adoption of AI into existing jobs currently in progress, driven by improved efficiency and job satisfaction (e.g., eliminating repetitive tasks). The other extreme is eliminating jobs on a long-term scale because of required technological developments and employee/company coordination of the technologies. While Drucker's predictions captured the first extreme, [he did not predict the broad adoption of automation by the Information Age](#). This may be a significant historical oversight by the historian Drucker: the loss of jobs in specific sectors by the Information Age is similar to the extreme change and loss of jobs during the Industrial Age of the 1800s.

The Age of AI will eventually automate all jobs

Given the prior historical elimination and replacement of jobs, [human tasks, professions, and services that are thought to be exclusively human activities](#), now thought to be untouchable to AI replacement (because of their complexity and human intangibles), will follow past replacements by automation as AI develops greater capabilities. These include real estate transactions, financial services, human relations, military soldiers and campaigns, legal representation ([see Appendix N](#) for a complete list),... I conclude that any human activity or job can eventually be replaced by an AI system, with or without human oversight, as AI advances continue.

The Age of AI will exceed human performance

If all jobs can be replaced, then it's also likely that in many occupations, AI automation will exceed the performance of humans in the same job, both on average and beyond what the best humans can achieve. The metric of evaluation of the "best" is multidimensional. Still, AI will likely exceed in all of these: 1) cost per unit produced, 2) quality of performance, 3) speed of production, and 4) sustained production (no time off). AI will excel even in the performance area of creativity and complexity - the prior bastions of human uniqueness.

A prime example is [the design of integrated circuits](#) in the last decade, where modern computer designs optimize multiple variables (efficiency, speed, thermal control, etc.), complexity at scale, failure modes, preproduction simulation, and design testing and verification, all in a final design that is now too complex for human understanding. Other examples are generative design in architecture, genetic algorithms in urban planning, deep learning in IC design, or AI in video game strategy. In all examples, computer-driven designs outperform human-directed efforts by exploring larger solution spaces, optimizing multiple objectives simultaneously, and adapting dynamically to changing conditions ([From Perplexity](#)). As AI

technologies advance, we can expect even more areas where computer designs surpass what humans can achieve with traditional methods. And these examples were achieved before the maturing of the Age of AI. Hence, a reasonable conclusion is that AI automation will go beyond job replacement and accomplish performance previously thought unachievable by humans.

One dimension in which humans currently sustain their dominance over AI is in jobs that require mobility. Stationary robots have replaced humans in assembly lines - both in strength and dexterity. However, tasks that require mobile autonomy are more challenging due to energy storage restrictions, the bulk of robotic platforms, and maneuvering in complex environments. Examples are soldiers on missions, farm workers in the fields, nurses in hospitals, etc. – any situation requiring mobility in a complex environment with sustained activity.

Even these challenges are quickly being overcome by the recent development of robots that combine mobile AI with various human-like manual skills (see Appendix Q). A complete discussion of the Age of Robots is beyond this report, but the [recent developments in robots for mobile tasks](#) do not suggest that there are significant challenges. Also, see [this list of 5 new advances in robotics](#) by the International Federation of Robotics, which includes Collaborative Robots or [Cobots](#), that work with humans to address labor shortages.

Conclusion: Age of AI is the reinvention of Drucker's Information Age

Given the above discussion, the adoption and integration of AI is much more than a continuation of the Information Age. **The view here is that AI adoption is the beginning of achieving the full maturity of the Information Age, a deeper expression of Drucker's Knowledge Society that he did not envision, and because of its disruptive nature, deserves to be labeled the Age of AI.**

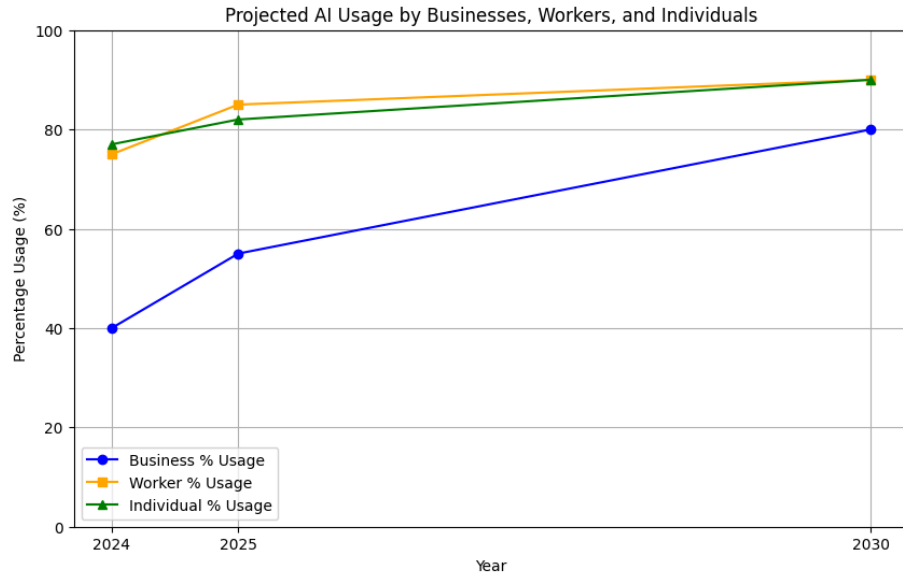
From the view of the ongoing Information Age, the integration and adoption of AI services are maturing the changes predicted by Drucker. A variation of this perspective is that the Information Age, as previously captured, is mainly complete (the shift to an information economy) and is now moving into Drucker's Knowledge Age, beyond the shift to digital information and online services, because *information is not actionable knowledge, let alone wisdom*. A core observation is that digitizing human experience, information, and knowledge is just beginning.

This report examines one niche of the next stage of the Information Age as the Age of AI, as a massive adoption of AI systems. Specifically, how individuals share and market their diverse expertise with customers with problems, no matter how specific or mundane. [I'll argue below](#) that digitization of the diversity of human experience is just getting started and is the next disruptive technology in the Age of AI.

Background in market factors influencing online services

1. Saturation of AI use, but not really

The initial use of AI in all aspects of business, workers' activities, and personal life is quickly becoming saturated. The initial [AI use is simplistic as a knowledge resource](#) and often a checkbox that AI is being used for market purposes. The AI tools' increased maturity (quality, efficiency, and integration) is next.



Citation: [perplexity 19 Sept 2024 see appendix B](#)

2. AI is built upon and requires human-produced digital data for AI training, quality control, and updating. This digital data is produced by online human activity, including chats, blogs, publications, market activity, purchases, ...

- Humans are dominant producers of digital data now. Soon, digital data will be AI-generated, which has an uncertain future: already AI-generated data causes undesirable feedback loops of inaccuracies. [See Appendix C: How AI data corrupts AI training](#) where AIs are used to create primary data posing as humans.

3. Data used for AI development and updating already raises privacy, proprietary rights, and copyright issues.

- These issues will increase as AI resources become more profitable (“I should get paid for the data I generate”). See prior citation on AI trends: [See Appendix D: “Is there a trend away from free digital data?”](#)

4. Optimal AI performance requires relevant and diverse training data, aligned with the desired application. [See Appendix E: The Advantages of diverse data and confederation of specialized AI tools.](#)

- For example, data on users playing online games will be noise to a medical-recommendation AI resource.
- A confederation of specialized AI resources achieved AI advances in efficiency, memory requirements, and accuracy, duplicating [the scientific discoveries of the last decades about how human diversity is essential in solving more challenging problems.](#)

5. The majority of current AI use is in its infancy. The next stage of AI development and applications is the increased maturity of AI resources, expansion of capability, and autonomous AI resources.

See [Appendix F: On the next stages of the development of AI tools.](#)

Conclusions

- The future of improvements in AI resources will require new sources of human activity and knowledge data — probably no longer free, with high diversity in narrow applications.

- While the use of AI is now almost universal across businesses, workers, and private use, the increased maturity of AI resources, expansion of capability, and autonomous AI resources are the next stage of AI development and applications.

The major market shift: best-sellers to long-tail consumerism

1. Long-tail marketing refers to replacing the profitability of massively selling a few best-sellers with the production and sales of individualized products provided by diverse providers to diverse buyers.

- The major shift in marketing was captured in a book by Chris Anderson⁶ in 2006 titled “[The Long Tail: Why the Future of Business Is Selling Less of More](#).” “the strategy of targeting a large number of niche markets rather than focusing solely on a few high-volume hits”
- The long-tail marketing shift significantly impacted the music industry, replacing hit music sales with diverse musicians offering their music to a few fans. This shift was made possible by the low-cost production of content and the delivery of digital music online, effectively changing the power of centralized music producers.
- As predicted in *The Long Tail*, the world’s consumer economy is now dominated by long-tail economics. The exceptions are those markets that require considerable investments for production, addressing government regulation, and/or costly delivery (e.g., petroleum fuels, pharmaceuticals, and real estate).

2. Online resources have exploded in the last 5-10 years, enabling individuals to sell their unique expertise to diverse consumers. Examples include:

- **EBay’s sellers - currently 13 million - with \$2.6 B in revenue and a net profit margin of 26%.** Originally, sellers were individuals selling personal items to the world, but large marketing companies now displace them on eBay. Esty.com's market model is similar, focusing on the appeal of art items.
 - “The [EBay] platform has increasingly become home to larger businesses and professional sellers. This shift is reflected in the tools and features that eBay provides to support high-volume sales typical of larger companies.” ([Perplexity link](#))
- **Individual Expert/Influencer Web Resources:** Diverse individuals with unique solutions offering their expertise to online services or personalized web pages. In all the following examples, an individual or small group is creating media content and using online services to distribute it, benefitting from direct or secondary advertising compensation.
 - The most respectable examples are individual contributions to Do-it-yourself online services ([Examples](#)), self-help guidance in YouTube posts, and online influencers with product recommendations.
 - Before the existence of these online resources, this knowledge to aid others was limited to published books, articles in specialized journals, or person-to-person social networks (before the internet).
 - Bloggers and social media influencers are profitable but arguably less respectable sources of long-tail service, with an estimated value of \$24B in 2024. Compensation includes gifts or rewards, sponsored and pay-per-post,

⁶ Chris was a researcher at [Los Alamos in the Center for Nonlinear Studies](#).

performance-based payments, fixed Rates, and bonuses. [See Appendix G: On the Economics of Influencers.](#)

- **OnlyFans has an extreme profit margin of 50% on revenue of \$1.3 B.** The most profitable online resource and content generators are those on OnlyFans ([see Appendix A: Business Insider article](#)).
 - “OnlyFans works by getting its [4 million creators to sell a variety of products](#) — some combination of videos, photos, and private messages — to some 300 million recurring users, who pay one-time fees or a recurring subscription to consume that stuff. Then OnlyFans takes a 20% cut.”
 - “Last year, the company [posted](#) operating [profits](#) of \$650 million, on revenue of \$1.3 billion.” Compare this to [“Meta \(35%\) and Google \(27%\) would love to have numbers like that.”](#)
 - “And at least for now, it has a lot of advantages over traditional user-generated content plays like [YouTube](#) or Instagram, which rely on the more fickle whims of the ad business.”

Future of the long-tail trends in consumerism and marketing

The new market of long-tail products and consumption. As [the book Long Tails describes](#): After centuries, markets of best-sellers are being replaced in the last decades of long-tail consumerism of highly diverse products to many individuals, exploiting the low cost of digital product delivery and, as in the case of music, social media, etc., the tools for individuals to offer their own creativity, either directly as a product or getting compensation as an influencer with advertising compensation.

The extreme profitability of web platforms that support long-tail markets. The flip side of the new long-tail markets (including social media) is that platforms that support long-tail consumerism have high if not the highest, profitability because the long-tail service platforms do not have to develop the content, only provide the platform for diverse individuals to offer, sell, market their creations.

How AI will change capabilities of the long-tail market and service platforms. What follows is one proposal on how AI resources will change the content production of the individual beyond the apparent use of AI as currently imagined: AI production of visual art, music, literature, etc, for consumption. And how this new AI-enabled content production will offer new problem-solving capabilities to the consumer (Phase I) and to society (Phase II).

Overview: Diverse AI resources utilizing long-tail marketing for universal problem-solving for the individual and society

The success of eBay, OnlyFans, and Influencers is built upon the tools enabling individuals to offer their products or content for compensation. These individuals' resources enable rapid, good quality, low-cost, and digital (cheap) product delivery. Finally, centralized website tools sustain the system's quality for the host, consumer, and content provider. *This is a decentralized system where the individual generates the products, and the online system provides an infrastructure to support the individual and consumer.* Note that these successes have occurred mainly before the heavy use of AI in content generation and marketing. So, AI in this long-tail game is still to come.

Requirements for long-tail marketing/consumer systems

1. Flexible, low-cost tools easily enable the individual to create a product (material or digital).
2. A marketing and sales system allows the individual to market, consummate, and deliver the product at a low cost and receive remuneration directly or indirectly.
3. A customer support system that promotes community monitoring and improvement.⁷

How AI can reinvent and expand the long-tail product offering

AI resources will take the past long-tail marketing to a new level of utility and functionality. *This change will happen either in the natural evolution of AI adoption or by entrepreneurs like [Pierre Omidyar](#) ([link to his nonprofit](#)).*

- **The next-gen AI resource for long-tail markets requires the holistic capture of an individual's uniqueness.**

AI tools are on the brink of capturing an individual's unique contributions to their niche of professional or personal life. The evolution of AI tools will enable every individual to offer a clone of an individual's unique profession, hobby, and/or experiences with minimal effort and make it available to other's benefit.⁸

- **How the holistic capture of an individual's (or group's) uniqueness will be the future of AI**

An AI-enabled platform offering AI-based content-creation tools and marketing will become a *de facto* standard for problem-solving on all topics. Just as Wikipedia - a community-generated resource - became the standard encyclopedia-like knowledge reference, AI-captured individual knowledge will become the solutions platform for all problem-solving. Problem-solving at this level is bounded by the expert complexity barrier (the level of complexity that the ideal human expert can solve a problem).

Phase 1 goal: A collectively intelligent AI resource will integrate all individual AI captures to create a resource that can break the expert complexity barrier.

While the initial focus will capture individual expertise and experiences, aggregating or integrating all individual resources will create a collective resource greater than the sum of the parts. This collective intelligence can address higher complexity problems than the parts can address.

Phase 2 goal: enabling a symbiotic AI to solve the most challenging societal problems, applying collective intelligence to the diverse data from Phase 1. In the same way that current human activity on digital systems becomes the training and updating data for current AI systems, this AI-enabled collection on a single platform provides future AI systems with functional solutions that can be integrated and repackaged for all humanity.

⁷ [eBay Founder Pierre Omidyar](#) argues that eBay was successful because the platform continually facilitated and created an infrastructure that supported a quality customer experience - capturing what is best in a community caring for itself. (Private communication - he's a major supporter of Santa Fe Institute.)

⁸ Morbid but quite close: [Companies offering AI generated clones of dead loved ones](#).

Unsolved Needs of Humanity and the AI Solution

Following Drucker's guidelines for prediction ([Age of Discontinuity](#), 1968), ask not what future technology can do for you, but ask what will be the future's unmet needs (apologies to President Kennedy), because some technology will always be developed to fulfill an unmet societal need.

Aside from the irrational conflicts between polarized groups, most futurists agree that the core challenge facing humanity is that the complexity of society at all levels has inhibited the ability of humanity to plan for the future. The result is a continual reaction to change without planning, where overreaction can lead to societal instability (this is a variation on [the singularity hypothesis](#) where change occurs so quickly that society fails, where most proponents hypothesize a superintelligent AI, dating back to the 1950s!)

Much of this increasing complexity is due to the interdependence of all aspects (systems) of society (personal, public, health, infrastructure, information systems, political, military, ecosystems... literally, there is not one independent system) and interdependence spatially (solutions to problems can't be just local, but are increasingly global). The discussion of this modern complexity barrier of problem-solving is beyond this report, but I and others have written about it ([Academia](#), [ResearchGate](#), [Website](#)). The higher societal complexity results in the failure of human resources (experts, politicians, scientists, religious, etc.) and, add to that list, artificial intelligence (AI) decision-making systems. The unanswered question is whether an AI superintelligence is the solution to the singularity dilemma or the downfall of humanity. (A question left to the reader, but this report takes a positive view.)

Because AI is rapidly advancing and [being adopted in almost all aspects of human activity](#), the goal in this section is to ask what are the unmet needs of AI in the role as resources for humanity (aka Drucker) and then propose how these needs might be met.

- **Currently, AI resources (like [ChatGPT](#)) are limited to knowledge resources for problem-solving or recognizing solutions via patterns from human solvers.**
 - Current AI resources can provide solutions to problems contained in the training database. Some advances occur because the AI resources can interpolate between solutions or chain multiple solutions together to create a broader solution that wasn't in the database.
 - Examples of AI in applying solutions of patterns to human-solved problems are AI applications in medical diagnosis, [AI evaluation of CT, and x-rays](#) being a prime example.
 - **However, current AI resources cannot innovate or extrapolate solutions beyond their knowledge domain (as argued above).**
- *Sidebar on hallucinations:* For AI resources to work best (not hallucinate), the training data must capture strong patterns on query topics. AI hallucinations could be viewed as inaccurate interpolations, making up for a lack of consensus (strong patterns) in the training data.
- **Can AIs replace expert performance?** While the current AI resources can improve the presentation of knowledge through better grammar, etc. (there is a strong consensus on proper grammar), they offer little beyond what can be achieved by a human skillfully using a search engine - *because the data for the search engines and current AI resources are essentially identical.* **Hence, AI resources can replace expert human researchers by better scaling with lower cost but can not go beyond the performance of experts because of the limitations of the capabilities within the current data sets, except as noted above.**
- **Conclusion on unmet AI needs:** The above conclusions imply two limitations or needs of current AI resources:
 - **1. There is a need to access diverse data that has yet to be previously digitized and made available for AI resources. What is missing data?**
 - **2. There is a need to move beyond AI as a knowledge resource to a creative, extrapolative problem-solving resource.**

- *Definition: Creative problem-solving* finds a solution to a problem that doesn't already exist in the data or is interpolated from the data (the combination of known steps to solve a more complex problem).
 - *Caveat: there is a significant difference between creative imaginings and selecting the best solution from a creative list of brainstorming ideas. There are many creative imaginings in training data, which, in turn, provides AI with some seemingly creative options.*
- These two unmet needs above are gradually being addressed in the evolving development of AI resources, but not within one online service offering or platform.
 - **The major limitation:** *The increased need for more diverse data is limited by the lack of access by individuals with no resources to capture their unique experiences in digital form. [Ben Horowitz, cofounder at a16z - a venture investment firm, recently stated that "We're running out of human knowledge" for AI systems.](#)*
 - *Caveat: AIs are achieving new levels of pure creativity - greater than humans, as a first stage of creative problem-solving: a recent *Nature* article suggests AI beats humans in pure creativity in some areas. [See Appendix H.](#)*
- **Where does the new AI training data come from?** *Only a small fraction of the world's humanity are digital content creators, even though every individual has knowledge to offer.*
- Currently, the barrier for these people to become digital content creators is an inexpensive and easy-to-use resource for creating digital content; *it is not the lack of knowledge.*
- *The assumption here is that future creative problem-solving AI resources require actionable knowledge from diverse individuals.⁹ Advances in AI tech are not sufficient to advance creative problem-solving.*

Phase 1: A “DIY” service resource with AI-enabled data collection for individual problem-solving

Building the infrastructure for the production of diverse content and integration into a new problem-solving resource

Of [the three necessary resources for long-tail marketing above](#), all are available in some form and only need integration, scaling for many users, packaging, and marketing for the basic AI expert resource aid (essentially funding and organization).

1. **AI-enabled experience-capture tool:** a flexible, low-cost AI tool that easily enables any individual to create a knowledge and problem-solving product based on their experiences. (See footnote 3 for the commercial capture of dead personalities using AI.)
 - AI resources that process any media type into structured, interrogatable resources are needed, probably with moderate computational processing needs but requiring ample data storage as more individuals contribute. Many companies are offering this content capture and integration in a resource as an in-house, proprietary LLM resource.
 - This AI-enabled resource would assimilate an individual's documents, videos, emails, conversations, etc., and answer questions like the individual, probably more concisely and with better grammar. Essentially, it is a clone of an individual's expert knowledge, problem-solving, and content generation in all aspects.

⁹ This is the core observation that [researchers at Los Alamos made in the 1990s in the Symbiotic Intelligence Project](#).

- This could even include personality type, as tied to problem-solving abilities (such as captured by [Myers-Briggs tests](#)).¹⁰ The subtlety of personality is an unappreciated aspect of problem-solving.
- [See Appendix M for how personality affects problem-solving and how the diversity of personalities leads to better and faster problem-solving.](#)
- Once captured within an AI system, a single individual's expertise can be aggregated with other individuals' contributions on the same topic to optimize the content via collective intelligence methods.¹¹
- Also, combining optimized collective solutions in a logical sequence can solve problems that any individual or group does not solve. (see [Phase 2](#) below)

Availability of this low-cost AI content-generation resource?

While not offered by AI/LLM resource companies, the current offerings to create internal LLMs for companies are similar.

- [See Appendix L for a summary of proprietary LLM offerings and their costs.](#)

What is proposed here is making the same available for individuals or groups - not just for proprietary use, but to market their offerings to the world.

- This model is similar to DIY websites and long-tail marketing ([described above](#)) but uses much higher tech support for creation, response, and scaling to mass markets (the AI can answer instead of the individual once the AI resource is created).
- 2. **A web platform for marketing and sales** allows individuals to market, consummate, and deliver products and receive remuneration directly or indirectly (such as content advertising).
 - There is nothing new here: software or web hosting is likely available for purchase.
- 3. **A customer support system** that promotes community monitoring and improvement (like [eBay's monitoring and recommender system](#)).
 - There is nothing new here: software or web hosting is likely available for purchase.

The end of Phase 1 provides a platform for data capture and marketing of any individual's or group's unique experiences and expertise, including better solutions derived from combined (aggregated) diverse contributions.

Funds for Phase 2 beyond Phase 1 service sales: The collected data (likely annotated, curated, and condensed) can be sold as a training set for other AI platforms, either en masse or by specialty area. Like other companies now use eBay and Amazon to sell their products, once a dominant supplier of diverse training data arises, other companies will want to use that data for their markets/resources.

¹⁰ The way humans perceive, analyze, solve, and communicate their solutions is a core aspect of diversity in problem solving. Solving a problem is not just having access to the requisite knowledge, but include perceiving the problem, articulating it, etc. A much longer discussion is needed about how AI could utilize this. The exploration of a collaboration between Referentia and Indesea a decade ago using their advanced network model included many of these aspects.

¹¹ It's my view that many of the surprising "ah-has" of current AI resources (advanced pattern recognition) can be explained by the understanding of collective intelligence acting on diverse but related data.

Phase 2: A “DIY” service resource for the most challenging problem-solving by building on AI-generated data from Phase 1

Building an AI-enabled resource that solves challenging and complex problems better than any human or groups of humans

Once Phase 1 develops a platform for data capture and marketing any individual’s or group’s unique experiences and expertise, Phase 2 develops the ability to combine the high-diversity, AI-captured experiences from Phase 1 (assuming sufficient participation) into a collective intelligent (CI) resource that can robustly outperform the best individual (expert) or group problem-solving ability.

The critical assumption or observation that motivates Phase 2 is that current AI resources cannot innovate beyond the content of the training data because, to function, identifiable patterns must exist in order to be captured. Without these strong aggregated patterns, the AI engine produces no results or random results, including hallucinations.

Two key questions arise from the above assumption:

- How can the training data be improved so that the current AI methods can produce higher quality results (but will still not be able to innovate)?
 - The answer to this question is covered in Phase 1 and is a foundation for Phase 2.
- What is “innovation” or creativity in AI? (Discussed in detail in [Appendix H](#).)
 - Indeed, AI can link together multiple patterns to provide “innovative” solutions to challenges (arguably, all the AI successes in science are of this type: protein folding, fusion reactor control, and math solutions [covered in Appendix I](#)).
 - As stated differently, if a sequence of steps doesn’t exist in the training data, but the individual steps do, this discovered sequence could be a weak form of innovation, yet significantly valuable in a complex world.
 - But can AI extrapolate and innovate outside the realm of the training data?¹²

These questions are the basis of current AI research, mainly in its infancy and primarily phenomenological by testing and observing AI systems ([see Appendix H](#)).

In order to discuss the future of AI in innovative problem solving, insight can be gained by applying the understanding developed in collective intelligence over the last 3 decades to AI systems (when viewed simplistically as an aggregation of diverse training data). As I have noted in emails before, the understanding achieved in collective intelligence research is one way to expose the strengths and weaknesses in current AI methods (although this is quickly changing, but out of the public’s eye within proprietary developments).

Before Phase 2 is presented, the context is set by discussing how collective intelligence works and doesn’t work.

¹² I would argue, likely not. This is in the realm of predictive extrapolation in idea space. It’s one challenge to extend time-resolved data to predict the future (largely a statistics exercise currently), as is done in weather prediction (see [successes in AI in Appendix I](#)). It’s a different class of challenge to extend concepts beyond the history of data or ideas. I argue this requires a different type of AI model... doable and likely a current thrust of AI development: AI built on logical reasoning ([Appendix T discusses](#) this topic).

Why does aggregation in collective intelligence work for simple challenges?

The success of a simple aggregation of diverse “situated”¹³ data has been studied and utilized for 2 ½ decades under the rubric of [collective intelligence](#) (CI).

- The earliest modern success of aggregation is now almost ubiquitous: Amazon’s product recommendation algorithm: “*People who bought this product also bought these products*” based on the purchases of diverse consumers. This CI method robustly provided the best product recommendation when applied to many diverse buyers, better than any other recommender algorithms.¹⁴ But this marketing aid fails for products with few purchases (which might explain why Amazon recommendations are starting to fail due to too many offerings).
- Other examples include [the weight of a bull in 1906 - the first published example of collective intelligence](#), the [classic county-fair challenge of the number of beans in a jar](#), and the Academy Awards winners [conducted by Scott Page](#) in his college classes yearly.
- A [theorem by Scott Page of collective intelligent performance for idealized problems guarantees that the CI solution with high individual diversity will match or exceed the average individual performance](#). Note that the theorem does not guarantee diverse performance is better than the best individual performer (the AI-generated link provides coding in over 20 programming languages... Fascinating). Still, many examples show it often outperforms the best individual solution. And relevant here: in complex problems, is more likely to succeed because the “best” solution is not knowable.¹⁵
- For a complete summary of general problems and science problems where collective intelligence excels, see [Appendix R](#) and [Appendix S](#), respectively. Notable is that current AI successes and failures track the same results, illustrating that CI has relevance to AI.

What is notable in these simple examples of collective intelligence (best or better solutions from the aggregation of diverse and situated experiences) is that the diversity contains two parts: 1) a weak signal found in most individuals that, when aggregated over high diversity groups, becomes the strongest signal and best solution and 2) individual differences, which are uncorrelated over the individuals and appear as noise, average out when aggregated. Note that the quality of the collective answer correlates with the group's diversity: higher diversity leads to better predictions.

There is a profound question that arises about individual diversity and the better CI aggregation: *Why should diversity correlate with a higher performance if the individual diversity cancels out?* Few researchers have addressed this question. The answer appears to be tied to level of complexity of the problem. For simple problems, all individuals can solve the problem, so the CI solution is identical to any individual (there is not CI advantage). For problems that are extremely complex, the individual solutions are random, with no weak signal that can be aggregated to provide a CI solutions. So there is a sweet

¹³ The adjectives *situated*, *localized*, or *embodied* capture viewpoints or knowledge that is localized in physical or mental space, such as from a unique perspective, viewpoint, or worldview (I define *worldview* in [my 1998 paper](#) as a shared view where all agree on the options, but not necessarily which option is the best choice). A localized understanding was historically dismissed as biased or limited, and often lacked objectivity ([bounded rationality](#)). Major advances in modeling intelligence occurred when researchers abandoned developing general intelligence from the 1950s on and focused on situated intelligence as captured by robots in domains ([Pfeifer, R. and C. Scheier \(1999\). Understanding Intelligence. Cambridge, MIT Press](#)). Collective intelligence goes one step further and says that the diversity of unique experiences are essential for a comprehensive understanding and ultimately a more robust and accurate problem solving.

¹⁴ This could also be characterized as *situated pattern recognition* and may be the reason AI LLMs have great success. I dive into this topic in [Appendix K: Higher intelligence requires situated data](#).

¹⁵ A deeper discussion of this is explored in my 1998 paper [Collective Problem Solving: Functionality Beyond the Individual](#), where the collective can solve an emergent problem that is not understandable by the individual. In emergent problem-solving, the “best” problem solver cannot be defined except from a global perspective that is not available to the individual. While this type of problem solving has relevance to the current discussion, it is an advanced topic and saved for future discussion. It suffices here to restrict the problem types to ones that can be understood by the individual.

spot of complexity, where the diversity of the individuals can explore the domain of solutions to the problem and provide pieces of the global problem that can be aggregated for a better CI solution. I discuss this in detail in my publication: *Applied Science of Collective Intelligence: Solving the grand challenges facing humanity*.¹⁶ I explore this question in the following sections.

When does collective intelligence work and not work?

Two questions arise from the above statements about CI: Why is the most common weak “signal” the best solution? Why does the quality of the collective solution correlate with higher diversity across the individuals in the collective?

- *CI Complexity barrier*: Similar to the individual or expert complexity barrier that prevents an individual from solving a problem, there is a CI complexity barrier that cannot be overcome with more extensive individual participation.
 - The reason for a CI complexity barrier is that when the problem becomes too difficult or complex for the individual, there is no weak “correct” signal can be aggregated to a “better” collective solution.
 - The information sampling by the group solution is the same for individuals with random choices (no intelligence) or some intelligence: the individual's contribution to the collective solution is random noise, though diverse, it averages out to a random solution.
- *A CI solution works with Individuals with correlated bias, uniform polarized views, etc.* Uncorrelated bias or diverse polarized views are just noise in the collective solution and do not prevent the collective solution from converging. I’ve demonstrated that random noise is not a detriment to CI: The collective solution is highly robust to noise where convergence still occurs, with over 90% of an individual’s valid experiential information being replaced with random information. BUT, correlated or uniform false information overrides the weak signal's aggregation, causing the collective solution to converge to the correlated biased or uniform polarized solution. (The same occurs in AI solutions if the training data has correlated biases.)
- *Different worldviews*, where disagreement on options available is a more severe form of misinformation than correlated biases. I’ve demonstrated that the convergence to a better CI solution with groups of differing worldviews requires more participants in the collective to converge to the CI solution, showing that differing worldviews on the same problem are not a fundamental barrier to CI, again, assuming that the diversity of worldviews is not correlated.

Does collective intelligence apply to more complex problems and how?

Realist problem domains that are not single prediction challenges (as listed above), but are decisions that are: 1) complicated by different worldviews (not agreeing on the available options), 2) a sequence of choices - i.e., not single choice, 3) choices with overlapping impacts, where decision steps have consequences, and 4) in an uncertain environment either in the understanding of the problem or in effectiveness of completing a decision. There are many other types of complications. ([Details in Appendix S.](#))

I published a paper on [The Applied Science of Collective Intelligence \(CI\)](#) that explores the advantages and limits of CI as complexity increases. This paper also gives examples of how the *expert complexity barrier* (when experts have fundamental disagreements because the complexity of the problem prevents the experts from robustly solving a problem) can be overcome by 1) program/project management methods of diverse teams and 2) diverse expert elicitation on fuzzy logic trees. What has not been done is using digital resources to exploit collective intelligence for complex problem-solving (although, arguably, current AI resources may be inadvertently developing this capability within LLMs).

¹⁶ “*Applied Science of Collective Intelligence: Solving the grand challenges facing humanity*,” Invited paper in Collective Intelligence issue of Spanda Journal 5 (2), 97-108, 2014. ([publication in Spanda](#))

- While advanced and general versions of AI-enabled problem-solving technology are not being used or do not currently exist, there are suggestions that specialized AI resources are solving some problems better than humans (e.g., image processing, math solutions, poker, etc.). Discussing what types of problems and methods are used is interesting and beyond this study, but [see Appendix I, List of examples of superior AI performance over humans](#)).
- Decomposition of high complexity into hierarchical levels that are each manageable - a solution approached evolved by nature to deal with biological complexity.

The science of collective intelligence is still in its infancy in more complex domains.

Advanced tech: integrating diverse individual contributions into a collective intelligence and problem-solving resource - Where the whole is greater than the sum of the parts.

-

Roadmap of the societal impact of the Age of AI

- Roadmap of the Age of AI, as extrapolated from the history of the Information Age

How the Age of AI follows the trends of the Information Age and the Industrial Age¹⁷

The transition from the Industrial Age to the Information Age, [captured in the Introduction](#), laid the foundation for the ongoing shift into the Age of AI. This evolution is marked by a profound transformation in the nature of human work, employment structures, and the skills required for success in the modern economy.

From Manufacturing to Knowledge Work

During the Industrial Age, employment was largely centered on manufacturing jobs in large companies. Workers were primarily engaged in manual labor, producing physical goods. However, as Drucker predicted, this began to change with the rise of the Information Age. The focus shifted towards service-based economies and knowledge work—jobs that require specialized expertise and intellectual capital rather than physical labor. This shift saw a decline in blue-collar manufacturing roles and a rise in professions such as doctors, lawyers, engineers, and technicians. [3,4](#)

Drucker coined the term *knowledge workers* to describe individuals who apply theoretical and analytical knowledge to their work. These professionals became increasingly valuable as economies grew more dependent on information and technology. Knowledge workers are characterized by their continuous learning and adaptability, traits that are essential in a rapidly changing technological and employment landscape. [3](#) The Information Age thus set the stage for a workforce where intellectual capabilities were prized over manual skills.

AI's Impact on Employment

As we move into the Age of AI, these trends continue to accelerate and are realized in different societal processes. AI is transforming jobs across all sectors by automating routine tasks and augmenting human capabilities. While AI is likely to displace some jobs—particularly those involving repetitive or low-skilled tasks—it is also expected to create new opportunities, especially in fields requiring higher education and expertise in technology. [1,2](#) For instance, AI will drive demand for professionals skilled in data science, machine learning, robotics engineering, and AI system maintenance. [1](#)

However, this transformation will not be uniform across all job types. Low-wage service jobs—such as those in food service or customer support—are particularly vulnerable to automation by AI technologies

¹⁷ [This section is generated by Perplexity \(see link for inquiry\)](#). It illustrates how an AI, while not innovative, can weave together multiple concepts to create composite view that hasn't been stated before.

like chatbots and kiosks. [5](#) This could exacerbate wage inequality as lower-income workers face higher risks of job displacement without alternatives compared to those in more specialized roles.

At the same time, AI is reshaping higher-wage professions by enhancing productivity rather than fully replacing workers. For example, AI can assist doctors by analyzing medical data more efficiently or help designers generate creative drafts faster. [5,7](#) In these cases, AI serves as a tool that augments human capabilities rather than replacing them outright.

AI and Robotics in Low-Paying Jobs

AI-driven robotics are also poised to address many low-paying manual labor jobs. Robots can perform tasks that were once done by humans—such as assembly line work or warehouse operations—more efficiently and without fatigue. [1](#) While this may reduce demand for certain types of manual labor, it also opens up new roles related to designing, programming, and maintaining these robotic systems. [1](#) This shift requires workers to develop new skills or risk being left behind by automation.

Cultural and Economic Adaptation

The Age of AI demands significant cultural and economic adaptation. As AI continues to transform industries, individuals must embrace lifelong learning and adaptability. Continuous education will be essential for workers to stay relevant as job requirements evolve. [6,7](#). Governments and organizations must also play a role by providing support through retraining programs, unemployment insurance for displaced workers, and policies that encourage job creation in emerging sectors. [7](#)

Culturally, society needs to redefine its relationship with work. As AI takes over routine tasks, humans will need to focus on roles that require creativity, empathy, emotional intelligence, and complex problem-solving—skills that machines cannot easily replicate. [6,9](#) This shift challenges us to rethink education systems so they emphasize critical thinking and emotional intelligence alongside technical skills.

Just as the Information Age followed from the Industrial Age with a shift towards knowledge work and intellectual capital, the Age of AI continues this trajectory by further automating routine tasks while creating new opportunities for specialized knowledge workers. However, this transition also presents challenges for low-skilled workers who may face displacement. To thrive in this new era, society must invest in continuous learning and foster adaptability both culturally and economically.

How the Age of AI requires new culture, ethics, and approach to AI¹⁸

As humanity enters the Age of AI, significant cultural and ethical shifts are required to ensure that AI technologies are developed and deployed in ways that benefit society equitably. These changes must address how AI systems interact with human values, avoid perpetuating biases, and maintain trust through transparency and accountability.

Ethical Principles for AI Development

To adapt to the Age of AI, human culture must embrace a set of core ethical principles that guide the design, deployment, and governance of AI systems. These principles include:

- *Fairness*: AI systems must be designed to treat all individuals equitably, avoiding discrimination based on race, gender, socioeconomic status, or other personal characteristics. This requires diverse data sets that represent the full spectrum of human experiences and contributions to prevent biased outcomes. [1,2](#) Ensuring fairness is critical because biased AI can reinforce societal inequalities rather than mitigate them.

¹⁸ [This section is generated by Perplexity \(see link for inquiry\)](#). Ditto.

- *Transparency*: The decision-making processes of AI systems must be understandable and open to scrutiny. This is particularly important for complex models like deep learning, which can function as "black boxes" where it is difficult to explain how decisions are made. [1,2](#) Transparent AI fosters trust by allowing users and stakeholders to understand how and why certain decisions are reached.
- *Accountability*: Developers, organizations, and governments must be accountable for the actions and impacts of AI systems. This includes establishing clear responsibility for addressing any harm caused by AI errors or biases. [1](#) Accountability mechanisms ensure that those who create and deploy AI are answerable for its ethical implications.
- *Inclusiveness*: AI should be designed with input from diverse communities to ensure that it serves everyone equitably. Inclusive design practices help identify potential exclusion barriers early in the development process, fostering innovation and ensuring that AI benefits a broad range of people. [2](#) Engaging stakeholders from different backgrounds helps align AI systems with societal values.
- *Trustworthiness*: Building trust in AI requires continuous monitoring and validation to ensure that systems operate reliably and safely under various conditions. [3](#) Trustworthy AI respects privacy, protects against security risks, and empowers users by supporting informed decision-making without manipulation or coercion. [5](#)

Addressing Bias in Data by Inclusion of all human experiences and contributions

For AI to function optimally and without bias, the data used to train these systems must reflect the diversity of human experiences. Bias in data can lead to discriminatory outcomes when AI systems are deployed in real-world scenarios. For example, if an AI system is trained on a dataset that underrepresents certain demographic groups, it may perform poorly or unfairly when applied to those groups. To mitigate this risk, developers must prioritize diverse data collection and use fairness-aware algorithms that are continuously evaluated for bias. [1,4](#)

Moreover, collaboration with diverse communities during the development process is essential. By involving stakeholders from various backgrounds, developers can better understand potential biases and create more inclusive solutions. [1,4](#) This approach ensures that the benefits of AI are distributed more equitably across society.

Cultural Adaptation: Rethinking Human-AI Relationships

Culturally, societies must adapt by redefining their relationship with technology. As AI becomes more integrated into daily life—shaping everything from healthcare to education—humans need to develop a deeper understanding of how these systems work and how they can impact individual lives. Education systems must evolve to teach not only technical skills but also critical thinking about the ethical implications of AI technology.

Additionally, there needs to be a cultural shift toward lifelong learning as workers across industries face job displacement due to AI automation. Governments and organizations must provide retraining programs that equip individuals with the skills needed for new roles in an AI-driven economy.

Economic Adaptation: Policies for an Equitable Future

Economically, policymakers must implement regulations that promote responsible AI use while protecting individuals from harm. This includes creating frameworks for data privacy, ensuring job security in the face of automation, and establishing guidelines for fair competition in industries increasingly dominated by AI technologies. [3,5](#) The EU's emerging regulatory frameworks around trustworthy AI provide an example of how governments can take proactive steps toward ensuring that these technologies serve the public good. [5](#)

In conclusion, adapting to the Age of AI requires both cultural and ethical transformations. By prioritizing fairness, transparency, accountability, inclusiveness, and trustworthiness in AI development—and ensuring that data reflects the full human diversity—society can harness the potential of AI while mitigating its risks. These changes will help create a future where AI acts as a force for good rather than exacerbating existing inequalities.

From Deep Dive Podcast

Provides roadmap

Phase 1: Anyone can contribute knowledge, skills, perspective - crowd sourcing on steroids. AI powered experts. Not just finding answers but solutions. All different experts on topic never before available.

Necessary for tackling hardest complicated problems. Not enough to have one answer, but many.

Phase 2: Where does CI come in? Use AI to synthesize Phase 1 to create a superintelligence: Patterns that no individual can see.. analogy of an ant colony to create emergent intelligence - from interaction of the parts. Wisdom of all humanity.

Amazing and utopian sounds.

How to build and make available to all?

Benefits are so huge, must try. There are big hurdles.

Where CI is already working: wikipedia, open source software, citizen science projects

AI can take existing models and supercharge best parts of human collaboration

Science, education, and personal lives.

What are potential downsides: Any tech like this must have risks.

- Develop and implement responsibly - not just a cool new AI, must use for good.
- Biggest concern bias: if the data is skewed or incomplete ⇒ discriminatory results, etc

Transparency is core: esp in data; identify biases before it gets into training data.

Building trust, has to be earned

Economic impact: If AI can solve problems that humans can do, what happens to all jobs?

Not just job loss, but also Provides opportunities for humans

Not about replacing human workers, but collaboration between AI and humans. (never said this). More optimistic than robots taking over.

Examples: healthcare: Ai help across all aspects, resulting in enhance human touch,

education: teachers mentor instead of detail teaching. This is essential for thriving in the Age of AI. AI for a human center approach to learning.

How to get ready for new reality - AI keeping the best of human existence.

Lifetime learning. Including Unlearn past.

AI can help with personalized learning pathways and access to knowledge, plus feedback - an AI tutor.

Must make available to everyone so everyone can succeed in this new world.

Who decides what knowledge get shared? Must think carefully how to design and govern these AI systems.

Must have these conversations now, to avoid unintended consequences.

Siberian pokerbot story: Potential of AI in unethical uses. Example for why we need ethical guidelines for AI. How to guarantee AI for good.

Need gov regulation, industry self-regulation and public education. All have a role to play. Not just preventing harm but using Ai to create a world that is more equitable and sustainable.

Summary: plan, examples, pros and cons. ⇒ on the verge of a great shift.

Can't be a passive Developing mindsets for AI: active consumer.

Advice: embrace curiosity, be open to learn new things, remember what makes us human: empathy, creativity, ability to connect with each other. What will make us successful in the Age of AI.

Only just seeing what is possible, embrace curiosity: More game changing tech in the future

Real world examples: How impt to develop skills and mindsets (caught in an idea loop)

Right on the edge of a major shift. Turning point. Get involved in development. Make sure it is aligned with human values.

Emph on diversity: is key for development and how to use effectively.

Biggest takeaway: How do we make sure diversity is included: fair algorithms inclusive and fair and cultural of inclusion. If not, then will limit what AI can do.

Make Ai less mysterious. Power to use it. Move beyond hype and fear of AI.

Doesn't pretend it's simple. Acknowledges the risks.

Demand AI should be used to benefit everyone.

Future of AI is not set in stone. It's up for use to decide.

(Curious: includes rambling and two false endings)

Appendix: On my process used in this report, with surprises

What initiated the proposed concept: [An article on the extreme profitability of OnlyFans](#).

While this is a very odd topic to be inspired by, reading the article made me realize that it was a perfect example of the ideas about the success of long-tail markets, I've talked about for the last two decades. And applied the ideas to new AI applications.

How the proposed AI concepts led to a broader understanding of the future of AI

After capturing the main concepts, the [Introduction of the ideas](#) grew longer than the proposal, particularly in analyzing how [Drucker's prediction of the Information Age in 1968](#) could be extended to include what I call the [Age of AI](#). I ended up unexpectedly believing that [AI resources will eventually \(shortly?\) be able to replace all human activities](#) and likely [exceed human performance](#) (a complicated topic).

I won't discuss the consequences of humankind from these conclusions. Still, my view is not dystopian: Just as the Industrial Revolution resulted in a higher quality of human life, I expect the same from the Age of AI. As I discussed, [there will be worker tensions from disruptions of traditional human jobs as society adjusts to new paradigms of human employment](#). I'm optimistic this will occur faster than in the 40-50 years it took during the Industrial Age.

How the role of robotics arose from the Age of AI

I never intended to discuss robotics. However, as I analyze AI's automation of human jobs, the missing piece is the packaging of AI into mobile systems that can replace human jobs requiring mobility with dexterity and adaptability. This includes more than manual laborers; it includes hospital workers and the military - in any situation where the work area can't come to the human/AI, the human/AI has to come to the work area. The future of robotics does not play a central role in current AI discussions and fears but certainly will in the next decade.

Using Perplexity sped up the analysis by 10 times and produced more comprehensive citations. Including adjusting my query by restating it with more popular phasing. With some glitches.

- A critical aspect of any broad inquiry requires casting the results in the most commonly used language. So many researchers create new words for old ideas just to claim novelty. Perplexity aids this process of finding the correct vocabulary for maximum assimilation.
- Almost all of these Perplexity queries produced conclusions or backgrounds that I expected. I knew what I was looking for, and I found it along with more depth and citations that would have taken me much longer to discover.
- Only in a few cases did Perplexity return a result contrary to my expectations. These fell into two types: #1) where my expectations were plain wrong and #2) where the popular aggregate patterns in the citations were wrong, typically accurate in areas that are rapidly evolving and where truth lags the majority consensus (popularly captured in: "Physics advances by the death of old professors."
 - An example of #1 is [how using computers would increase class sizes in schools](#).
 - An example of #2 is where I have expertise and disagree with the current zeitgeist: [Predictive challenges are best solved by collective intelligence](#).

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A. The extreme profitability of OnlyFans (Business Insider 8 Sept 2024)

Followup 9 Feb 2025: [How OnlyFans is finally dead](#) on Medium 8 Oct 2024.

NLJ: article give average income over time: few superstars. Worth asking why this change: was it just a fad finally died. Or was there something basically wrong with the individual marketing model? I would say it happened because many content providers came for the big win, rather than a livelihood. Too much hype.

Title: OnlyFans figured out the best porn business on the Internet

OnlyFans is an astonishingly big, and astonishingly profitable business. That's because it combines two longtime internet staples: porn and user-generated content. How come no one figured this out before?

You have probably heard of OnlyFans, the not-just-porn-but-definitely-a-lot-of-porn site. You may also know that [OnlyFans is a big business](#).

But you may still be shocked to see just how big a business OnlyFans has become: Last year, the company [posted](#) operating [profits](#) of \$650 million, on revenue of \$1.3 billion.

Maybe I'm missing something, but from what I can see, that makes OnlyFans the biggest and most profitable (mostly) porn operation in the world.

[MindGeek](#), for instance, the holding company that operates porn sites like Pornhub and Brazzers, [looks to be about half its size](#). Playboy, once the leading brand in porn, has just barely survived the internet era and is now [just a fraction of OnlyFans' size](#).

Not only that, but OnlyFans is simply an astonishing internet business, compared to other mega-successful internet businesses. Last year the company posted a 50% operating profit margin. [Meta \(35%\)](#) and Google [\(27%\)](#) would love to have numbers like that. Snap has [no operating profit](#) at all. And while we don't know if [Elon Musk](#) has managed to generate a profit at Twitter/X after laying off the majority of his employees, his [disappearing ad revenue](#) would make it quite hard to pull that off.

And the thing is, there's no secret to what OnlyFans has done: It has connected one of the internet's favorite things (porn), with one of its favorite content strategies (getting users to create all of its content, for free), and one of its favorite monetization strategies (payments and subscriptions).

In other words: OnlyFans works by getting its [4 million creators to sell a variety of products](#) — some combination of videos, photos, and private messages — to some 300 million recurring users, who pay one-time fees or a recurring subscription to consume that stuff. Then OnlyFans takes a 20% cut.

That's a super-simple, super-lucrative model. And it's way better than traditional porn companies, which have to pay people upfront to make videos. And at least for now, it has a lot of advantages over traditional user-generated content plays like [YouTube](#) or Instagram, which rely on the more fickle whims of the ad business.

So you can see why Twitter was [looking](#) at an OnlyFans clone before Elon Musk bought the company. And why people think Musk might still try to [build something similar](#).

OnlyFans isn't a flaw-free business. Banks and credit card companies can be skittish about working with its [customers and creators](#). Would-be investors have also [had qualms](#). Porn sites are magnets for [human traffickers](#), though OnlyFans [says](#) it tries to fight that. And some people simply don't want to have anything to do with porn, which is one reason OnlyFans doesn't have apps on Apple and Google's platforms (on the flip side, that means it doesn't have to give either company a cut of its sales).

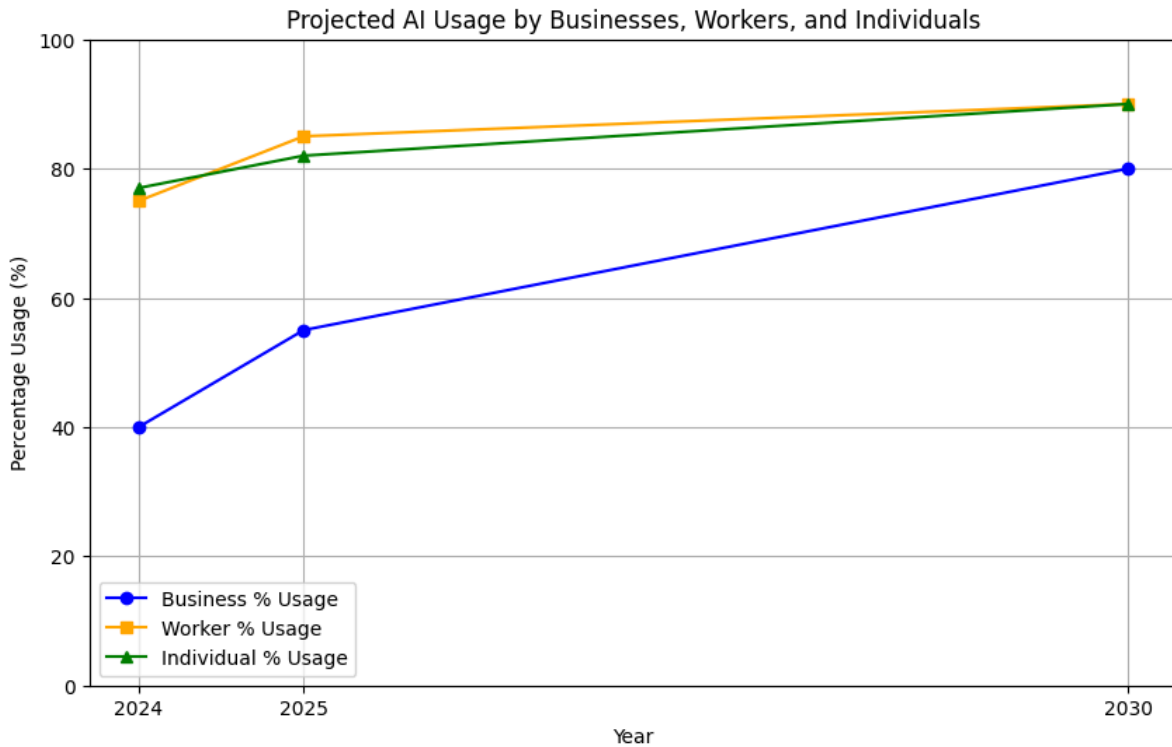
Still: Porn has been on the internet from the very start. User-generated content plays have been around for a couple of decades. It's kind of wild that no one figured out how to combine the two until a few years ago.

And now that everyone can see how lucrative this marriage is, expect to see more of them.

B. How much is AI used, now and in the future?

Query: “Estimate projected % use of AI by all businesses, by all workers, and by individual use, currently, in the next year, and the next five years. Plot the results.”

Note: [this Perplexity link provides citations.](#)



The use of Artificial Intelligence (AI) is rapidly expanding across various sectors, and projections indicate significant growth in the coming years. Here's an overview of the current and projected use of AI by businesses, workers, and individuals:

AI Use by Businesses

- **Current Use:** As of 2024, approximately 40% of global companies are using AI in their operations, with an additional 42% exploring its use. This means that over 82% of companies are engaged with AI in some capacity.
- **Next Year:** The adoption rate is expected to continue increasing as more companies recognize the competitive advantages offered by AI technologies. By 2025, it is projected that 55% of organizations worldwide will reach a stable stage in their AI maturity.
- **Next Five Years:** By 2030, the AI market is expected to grow significantly, reaching a value of \$1.85 trillion. This growth will likely lead to even higher adoption rates among businesses globally.

AI Use by Workers

- **Current Use:** In 2024, around 75% of knowledge workers are already using AI tools. This adoption has been largely driven by the benefits of generative AI, such as increased efficiency and creativity.
- **Next Year:** The trend of individual workers adopting AI tools is expected to continue growing as more employees independently integrate these technologies into their work routines.
- **Next Five Years:** As AI becomes more embedded in workplace processes, the number of workers using AI tools is likely to increase further. By 2025, it is anticipated that AI will have created new job opportunities while also displacing some existing roles.

Individual Use of AI

- **Current Use:** Currently, a significant portion of devices used by individuals feature some form of AI. For example, 77% of devices in use incorporate AI technologies.
- **Next Year:** The use of AI by individuals is set to rise as more consumer applications become available and accessible. Generative AI tools like ChatGPT have already seen rapid adoption among individual users.
- **Next Five Years:** By 2030, the number of users engaging with AI tools globally is expected to surpass 700 million, reflecting a substantial increase from previous years.

Overall, the integration and use of AI across businesses, workplaces, and individual applications are poised for significant growth. This expansion is driven by technological advancements and the increasing recognition of AI's potential to enhance productivity and innovation across various domains.

C. How training on synthetic AI-generated data corrupts AI systems

[Perplexity 19 Sept 2024](#)

Query: "How has AI-generated data caused problems with training and updating data for AI resources? For example, automated social media postings by AI create false trends."

AI-generated data has introduced several challenges in training and updating AI models, primarily due to the potential for creating misleading trends and biases. Here are some key issues:

Problems with AI-Generated Data

1. **Model Collapse:** When AI models are trained on data that includes AI-generated content, they can experience "model collapse." This degenerative process occurs when models lose information about the true data distribution, leading to outputs that lack diversity and accuracy. As AI-generated content becomes more prevalent online, it increasingly infiltrates training datasets, exacerbating this issue.
2. **Bias and Quality Concerns:** Synthetic data can introduce biases if not carefully managed. AI-generated content often lacks the nuance and variability of human-generated data, potentially leading to skewed or stereotypical outputs. This can perpetuate existing biases in AI systems, affecting their fairness and reliability.
3. **Misinformation and "Slop":** AI-generated content is often used to create misinformation or low-quality material, referred to as "slop." This content can flood social media platforms, creating false trends and misleading users. The ease of generating such content makes it challenging for platforms to maintain the integrity of information shared online.
4. **Training on Recursive Data:** Training AI models on outputs from other generative models can degrade performance over time. This recursive use of AI-generated data leads to a decline in model quality, as seen in studies where models trained on synthetic data produced less accurate and diverse results.

Implications for AI Development

- **Data Quality Management:** Ensuring high-quality training data is crucial. Organizations must implement robust data governance practices to prevent the inclusion of low-quality or biased synthetic data.
- **Ethical and Regulatory Considerations:** The use of synthetic data raises ethical concerns regarding privacy, transparency, and fairness. Establishing industry standards and guidelines is essential for mitigating these risks.
- **Balancing Synthetic and Real Data:** A hybrid approach that combines synthetic data with real-world data may offer a solution. This strategy can leverage the scalability of synthetic data while maintaining the diversity and authenticity provided by human-generated content.

Overall, while AI-generated data offers benefits such as scalability and privacy preservation, it also poses significant challenges that require careful management to ensure the development of reliable and unbiased AI systems.

D. On AI training data types and sources

Query: “What types of digital data are used to train and update AI resources? What's the relative percentage of the types? How much of this data is curated by tagging and error checks?” “How much is free?” “Is there a trend away from free data?”

The landscape of AI training data acquisition involves both purchased/licensed data and freely available datasets. The balance between these sources is influenced by various factors, including legal, ethical, and economic considerations.

Purchased or Licensed Data

- **Prevalence:** There is a significant trend towards purchasing or licensing high-quality datasets for AI training. This approach is often preferred by companies seeking to ensure data quality, avoid legal issues, and obtain domain-specific data that may not be readily available for free.
- **Reasons for Purchase:** Companies often purchase data to avoid the legal and ethical pitfalls associated with using freely available data, such as potential copyright infringements and privacy violations. Additionally, high-quality datasets can provide a competitive edge by offering more accurate and reliable training material.

Free Data

- **Availability:** Free datasets are widely used, especially by smaller organizations and individual researchers who may not have the resources to purchase data. These datasets are often sourced from open data platforms like Kaggle, UCI Machine Learning Repository, and government databases.
- **Challenges:** Free datasets may come with issues such as biases, lack of representativeness, and variable data quality. These challenges can affect the performance of AI models trained on such data.

Trends in Data Availability

- **Decreasing Availability of Free Data:** There is a growing concern about the decreasing availability of free data due to heightened awareness of privacy issues and the monetization of data by publishers and content creators. This trend is pushing more organizations towards purchasing or licensing data.
- **Legal and Ethical Considerations:** The use of free data raises significant legal and ethical concerns, including questions about data ownership, intellectual property rights, and privacy. As a result, there is an increasing emphasis on obtaining proper licenses for data use.

Overall, while free datasets remain an important resource for AI development, the trend towards purchasing or licensing data is likely to continue as organizations seek to mitigate risks and enhance the quality of their AI models.

Followup: “How much is free?” “Is there a trend away from free data?”

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E. On the diversity of training data and advantages of confederated specialized AI tools

[Link to Perplexity response.](#)

Query: “Examine the accuracy of the following statements:

- 1) Optimal AI performance closely aligns relevant (and diverse) training data with the desired application. For example, data from online game users will be noise to a medical-recommendation AI resource.
- 2) A confederation of specialized AI resources achieves advances in AI in efficiency, memory requirements, and accuracy, duplicating the scientific discoveries of the last two decades about how diversity is essential to address more challenging problems.”

The statements in the query address two key aspects of artificial intelligence (AI): the importance of relevant and diverse training data for optimal AI performance, and the benefits of a confederation of specialized AI resources. Let's examine the accuracy of each statement based on the provided search results.

1. Optimal AI performance closely aligns relevant (and diverse) training data with the desired application. For example, data from users playing online games will be noise to a medical-recommendation AI resource.

This statement is generally accurate. The performance of AI models heavily depends on the quality and relevance of the training data used. Diverse and representative training data allows models to generalize well, handle challenging scenarios, and reduce biases, leading to higher accuracy in real-world applications. Using irrelevant data, such as data from online games for a medical recommendation system, would indeed introduce noise and reduce the model's effectiveness. This is because AI models learn patterns from the input data, and irrelevant data can lead to incorrect or biased predictions.

2. A confederation of specialized AI resources achieves advances in AI in efficiency, memory requirements, and accuracy, duplicating the scientific discoveries of the last two decades about how diversity is essential to address more challenging problems.

This statement is also supported by evidence. The concept of using multiple specialized AI systems working together can enhance performance through diversity in problem-solving approaches. Cognitive diversity in AI development teams has been shown to improve innovation and robustness by incorporating different perspectives and expertise. Moreover, studies have demonstrated that diverse neural networks can outperform homogeneous ones in complex tasks due to their ability to adaptively learn efficient responses. The collaboration among multiple AI systems can improve reasoning abilities and factual accuracy by leveraging diverse insights and critiques from each system. This mirrors scientific findings that diversity is crucial for tackling complex problems effectively.

In summary, both statements reflect current understanding and practices in AI development. Diverse and relevant training data are crucial for optimal AI performance, while a confederation of specialized AI resources can enhance efficiency and accuracy by embracing diversity in problem-solving approaches.

F. Query: Evaluate the trends for the development of AI resources in the next 5 years

Query: "While the use of AI is now almost universal across businesses, workers and private use, the increased maturity of AI resources, expansion of capability, and autonomous AI resources are the next stage of AI development and applications."

[Link to Perplexity response](#). See the followup question.

Answer:

The statement regarding the trends for the development of AI resources in the next five years captures several key aspects of anticipated advancements in AI technology. Here's an evaluation based on the search results:

- 1. Increased Maturity of AI Resources:** The maturity of AI resources is expected to grow significantly, with advancements in machine learning, deep learning, and AI architectures. This includes improvements in self-supervised learning, which allows models to learn from unlabeled data, and the development of more efficient AI architectures like transformers and neuromorphic computing. These advancements will enhance the adaptability and efficiency of AI systems, making them more reliable and capable.
- 2. Expansion of Capability:** AI is expected to transform various industries by enhancing capabilities across different domains. For instance, AI-driven personalization will revolutionize user experiences by providing highly tailored interactions. In healthcare, AI will play a transformative role in diagnosis and treatment planning. Moreover, AI's integration with emerging technologies such as 5G, IoT, and blockchain will drive innovation and create new use cases in smart cities, autonomous vehicles, and personalized healthcare.
- 3. Autonomous AI Resources:** The development of autonomous AI agents is a significant trend. These agents can perform tasks independently by using memory and tools without direct human intervention. Autonomous systems are poised to revolutionize various sectors by improving efficiency, reducing labor costs, and enhancing safety. The concept of swarm intelligence, where multiple autonomous agents work collaboratively, is also gaining traction for its potential to solve complex problems efficiently.

Overall, these trends indicate that while AI is already widely used across businesses and personal applications, the next stage will focus on enhancing the sophistication and autonomy of AI systems. This will involve expanding their capabilities to handle more complex tasks independently and integrating them more deeply into various sectors to improve efficiency and productivity.

G: On the economics of influencers

[Link to Perplexity inquiry and response with citations.](#)

Economics of Influencers

Influencer marketing has become a significant component of digital marketing strategies, with the industry projected to be worth \$24 billion by the end of 2024. This growth highlights the increasing reliance on influencers to connect brands with their target audiences through various social media platforms.

How Influencers Obtain Compensation

Influencers receive compensation through several methods, each tailored to the nature of the campaign and the influencer's reach:

- **Gift or Rewards:** This is a cost-effective way for brands to compensate influencers by providing free products or services. It is often used in initial collaborations or when working with influencers who have smaller followings.
- **Sponsored and Pay-per-Post:** Influencers are paid for each piece of content they create. The payment varies based on factors such as follower count, engagement rates, and content type. High-profile influencers can command significant fees per post.
- **Performance-Based Payments:** Compensation is tied to the influencer's ability to drive specific actions, such as sales or sign-ups. This model aligns the influencer's success with the brand's goals and is popular due to its trackability and flexibility.
- **Fixed Rate and Bonus:** A combination of a base payment with additional bonuses for achieving certain performance metrics. This method provides security for influencers while incentivizing them to exceed expectations.

Platforms Used by Influencers

Influencers primarily operate on social media platforms where they can engage large audiences. Popular platforms include:

- **Instagram:** Known for its visual content, Instagram is a favorite among fashion, beauty, and lifestyle influencers.
- **YouTube:** Ideal for long-form video content, it attracts influencers in niches like gaming, education, and entertainment.
- **TikTok:** Rapidly growing in popularity, TikTok is favored for its short-form video content and younger demographic.
- **Facebook and Twitter:** Used for broader audience engagement and sharing diverse content types.

Types of Media Created

Influencers create various types of media to engage their audiences:

- **Photos and Stories:** Common on Instagram and Facebook, these are used for quick updates and promotions.
- **Videos:** YouTube and TikTok are platforms where influencers share detailed reviews, tutorials, or entertainment content.

- *Live Streams*: Platforms like Instagram Live or Twitch allow real-time interaction with followers.
- *Blogs and Articles*: Some influencers maintain blogs for in-depth content that complements their social media presence.

Market Size

The influencer marketing industry has experienced exponential growth from \$1.7 billion in 2016 to an estimated \$24 billion in 2024. This expansion reflects the increasing allocation of marketing budgets towards influencer partnerships, driven by their effectiveness in reaching targeted demographics.

Longevity of Influencer Careers

The longevity of an influencer's career depends on several factors:

- *Audience Engagement*: Maintaining a loyal and engaged audience is crucial for long-term success.
- *Relevance and Adaptability*: Influencers who expand into new categories or adapt to changing trends tend to have longer careers.
- *Brand Relationships*: Long-term partnerships with brands can provide stability and continuous opportunities.
- *Platform Evolution*: As platforms evolve, influencers must adapt their content strategies to remain relevant.

Overall, influencer marketing continues to grow as a vital part of digital marketing strategies. The industry's adaptability and diverse compensation models make it an attractive avenue for both brands and creators.

H: Testing creative AI - Nature article

NLJ: The problem with this article is that innovation or creativity in AI systems is not defined but left up to those reviewing the AI output. Innovation or creativity must be based on the current zeitgeist (human or AI), as a solution that doesn't currently exist.

1. This statement needs to be further refined to capture the difference between the accepted solution and a solution that is not accepted by the majority of scientists but does exist (many times, innovation occurs but isn't recognized until much later, as in my work on collective intelligence, and then becomes the collective wisdom). AI will not likely find fringe innovation because it is not a strong signal in the training data and is not captured in the training.
2. The other aspect that must be clarified is the difference between a) innovation by combining patterns that, when combined or sequenced, may not exist in the training data (I'd argue this is the current level of innovation by AI in all aspects, including science innovations) and b) innovation by creating concepts that don't exist in the training data (you can see how this difficult to define as different from #a).

I'd argue that most of the creativity below is type #2a. I need to examine the original article to prove, hopefully, if they defined the criteria for innovation.

The central point to be made here is that humans define creativity and innovation relative to some reference: the creative object cannot be judged isolated from context. This is not discussed in the following article. This statement implies that AI should be judged similarly: does the AI result exist in the training data or in the aggregate model (note that the result could exist in the training data as an outlier but not be captured in the aggregate model!)? Then, comparing AI creativity to humans should have a different creativity metric, with full recognition that "training data" for humans is different than for AI resources! The above discussion would be an excellent topic for a paper on creativity in AI systems.

Title: "Do AI models produce more original ideas than researchers?"

The concepts were judged by reviewers. They were not told who or what had created them.

By [Gemma Conroy](#) on 20 September 2024

Researchers built an artificial intelligence tool that came up with 4000 novel research ideas in a matter of hours.

An ideas generator powered by artificial intelligence (AI) came up with more original research ideas than did 50 scientists working independently, according to a preprint posted on arXiv this month¹.

The human and AI-generated ideas were evaluated by reviewers, who were not told who or what had created each idea (NLJ: this a variation on the Turing test if you can tell if the respondent is an AI or human). The reviewers scored AI-generated concepts as more exciting than those written by humans, although the AI's suggestions scored slightly lower on feasibility.

But scientists note the study, which has not been peer-reviewed, has limitations. It focused on one area of research and required human participants to come up with ideas on the fly, which probably hindered their ability to produce their best concepts.

AI in science

There are [burgeoning efforts](#) to explore how LLMs can be used to automate research tasks, including [writing papers](#), [generating code](#) and [searching literature](#). But it's been difficult to assess whether these AI tools can generate fresh research angles at a level similar to that of humans. That's because evaluating ideas is [highly subjective](#) and requires gathering researchers who have the expertise to assess them carefully, says study co-author, Chenglei Si. "The best way for us to contextualize such capabilities is to have a head-to-head comparison," says Si, a computer scientist at Stanford University in California.

The year-long project is one of the biggest efforts to assess whether large language models (LLMs) — the technology underlying tools such as [ChatGPT](#) — can produce innovative research ideas, says Tom Hope, a computer scientist at the Allen Institute for AI in Jerusalem. "More work like this needs to be done," he says.

The team recruited more than 100 researchers in natural language processing — a branch of computer science that focuses on communication between AI and humans. Forty-nine participants were tasked with developing and writing ideas, based on one of seven topics, within ten days. As an incentive, the researchers paid the participants US\$300 for each idea, with a \$1,000 bonus for the five top-scoring ideas.

Meanwhile, the researchers built an idea generator using Claude 3.5, an LLM developed by Anthropic in San Francisco, California. The researchers prompted their AI tool to find papers relevant to the seven research topics using Semantic Scholar, an AI-powered literature-search engine. On the basis of these papers, the researchers then prompted their AI agent to generate 4,000 ideas on each research topic and instructed it to rank the most original ones.

Human reviewers

Next, the researchers randomly assigned the human- and AI-generated ideas to 79 reviewers, who scored each idea on its novelty, excitement, feasibility and expected effectiveness. To ensure that the ideas' creators remained unknown to the reviewers, the researchers used another LLM to edit both types of text to standardize the writing style and tone without changing the ideas themselves.

On average, the reviewers scored the AI-generated ideas as more original and exciting than those written by human participants. However, when the team took a closer look at the 4,000 LLM-produced ideas, they found only around 200 that were **truly unique**, suggesting that the AI became less original as it churned out ideas.

When Si surveyed the participants, most admitted that their submitted ideas were average compared with those they had produced in the past.

The results suggest that LLMs might be able to produce ideas that are slightly more original than those in the existing literature, says Cong Lu, a machine-learning researcher at the University of British Columbia in Vancouver, Canada. But whether they can beat the most groundbreaking human ideas is an open question.

Another limitation is that the study compared written ideas that had been edited by an LLM, which altered the language and length of the submissions, says Jevin West, a computational social scientist at the University of Washington in Seattle. Such changes could have subtly influenced

how reviewers perceived novelty, he says. West adds that pitting researchers against an LLM that can generate thousands of ideas in hours might not make for a totally fair comparison. “You have to compare apples to apples,” he says.

Si and his colleagues are planning to compare AI-generated ideas with leading conference papers to gain a better understanding of how LLMs stack up against human creativity. “We are trying to push the community to think harder about how the future should look when AI can take on a more active role in the research process,” he says.

doi: <https://doi.org/10.1038/d41586-024-03070-5>

References: Si, C., Yang, D. & Hashimoto, T. Preprint at arXiv
<https://doi.org/10.48550/arXiv.2409.04109>(2024).

I: Examples of where AI systems outperform humans

[Link to perplexity with citations](#)

Query: What are examples where AI systems have performed significantly better than humans, for example, medical image processing and mathematics problems?

Artificial intelligence (AI) systems have demonstrated significant advancements in outperforming humans in various fields, including medical image processing and solving complex mathematics problems.

Medical Image Processing

AI has made substantial strides in the field of medical imaging, where it is often used to enhance diagnostic accuracy and efficiency. For instance, AI algorithms have been developed to screen chest X-rays for multiple diseases with performance comparable to or better than radiologists. A Stanford-led study highlighted an AI algorithm that could reliably evaluate X-rays for 14 pathologies, performing as well as radiologists in most cases and even surpassing them in some instances. Moreover, AI systems are increasingly used in radiology, pathology, and cardiology to detect abnormalities such as tumors and early signs of diseases like eye conditions. These capabilities allow for rapid and accurate detection, facilitating personalized treatment plans and improving patient outcomes.

Mathematics Problems

In the realm of mathematics, AI systems have shown remarkable progress in solving complex problems. A notable example is the GPT-4-based model that improved its performance on a dataset of challenging competition-level math problems from solving only 6.9% of problems in 2021 to 84.3% in 2023, approaching the human baseline of 90%. Additionally, AI systems like AlphaGeometry have been developed to solve complex geometry problems by combining language models with symbolic engines, demonstrating sophisticated reasoning skills that are essential for tackling intricate mathematical challenges.

These examples illustrate how AI is not only catching up with human capabilities but also surpassing them in specific domains, leading to transformative impacts across various sectors.

More examples

AI systems have demonstrated their ability to outperform humans in several domains beyond medical image processing and mathematics. Here are some notable examples:

Game Playing

- **Chess:** In 1997, IBM's Deep Blue defeated world chess champion Garry Kasparov, marking a significant milestone in AI's ability to outperform humans in strategic games.
- **Go:** Google's DeepMind developed AlphaGo, which defeated the world champion Lee Sedol in 2016. AlphaGo Zero, an improved version, used reinforcement learning without human input to surpass its predecessor's performance.
- **Jeopardy!:** IBM's Watson beat top human champions in the quiz show Jeopardy! in 2011, showcasing AI's capability in natural language processing and knowledge retrieval.

Autonomous Vehicles

AI systems have made significant advancements in autonomous driving. Companies like Waymo have deployed self-driving taxis, and AI-driven vehicles have successfully completed complex courses such as DARPA's Grand Challenge.

Natural Language Processing

AI has surpassed human performance in tasks such as reading comprehension and natural language inference. These capabilities allow AI to understand and generate human-like text, as seen with models like GPT-4.

Image Classification and Visual Reasoning

AI systems have excelled in image classification and visual reasoning. They can identify objects and deduce physical relationships between them more accurately than humans in many cases.

Speech Recognition

AI has achieved near-human or superior performance in speech-to-text conversion and speaker recognition, enhancing applications like virtual assistants and automated transcription services.

Summary: These examples illustrate the rapid progress of AI systems in outperforming humans across various specialized tasks, driven by advancements in machine learning algorithms and the availability of large datasets.

NLJ: Note that a major omission exists in a list of examples of profitable AI: [AI for gaming, like poker](#). [See the next article](#). (Also missing is the [recent claim AI has advanced fusion reactors](#).) I guess there are three reasons poker is not commonly included as an example of a successful AI application:

1. It's been going on for two decades (all current examples above are recent),
 2. It doesn't just use neural network training, which has become synonymous with AI (a significant mistake as AI evolved), and
 3. It's an application that people don't want to admit to.
-

J: The missing example: the Russian BotArmy for online poker and beyond - a \$2B market

NLJ: this is an essential article on the future of AI.

- Main point: rather than using LLM on massive training data, it uses a combination of stat math methods with logic trees and expert guidelines in order to deal with the chance nature of poker, the presence and use of bluffing, the need to not always win (non-Darwinian goal), ... essentially the nature of solving a problem with humans and repetitive games involved.
- Secondary point: Illustrates the many barriers over two decades to try to make AI profitable - it's more than having a winning AI, and includes keeping the community (the players here) engaged and returning. Many of the dynamics observed as online poker with AI bots evolved will likely be observed in other areas where AI is adopted - often competing with humans.
- Adopting AI will result in the same outcome: sustainability requires AIs to become part of the ecosystem rather than being disruptive or giving a few humans an advantage.

Title: The Russian Bot Army That Conquered Online Poker ([Bloomberg](#), [ForumServer](#), [Apple News](#))

How a card-playing Siberian AI outsmarted the world's brightest researchers and raked in millions.

By Kit Chellel

Illustrations by John Provencher

"Feruell" is near the top of poker's food chain. A professional from Russia, he makes a living gambling anonymously on GGPoker, Americas Cardroom and other sites, sometimes using Darth Vader as his avatar. Fellow sharks and smaller fish with money to lose are his prey. Feruell keeps his emotions in check during games, but he's outspoken in poker forums when he sees something he doesn't like.

In 2013 another player caught his eye. Vyacheslav Karpov, aka Performer, was posting lurid tales in a Russian-language chat room about prostitutes and card tricks he'd learned from "gypsies." To the cerebral Feruell, Karpov's boasting looked ridiculous. Even worse, he was charging young male acolytes for the privilege of receiving his advice, including how to cure anxiety with booze.

Feruell logged on to the chatroom and accused Performer of telling "fairy tales" to "collect \$50 an hour from suckers." He added that Karpov "doesn't know how to play poker."

Karpov threw down a gauntlet: "I challenge you to a fight."

The duel he proposed was in Limit Texas Hold 'em, a variant in which two cards are dealt to each player, then five more cards are dealt face up, interspersed with rounds of betting in which the maximum raise is capped. This happens to be Feruell's specialty—he's been called the "King of Limit." The match was set up on the PokerStars website. Bets would max out at \$200.

Feruell doesn't lose often. But when the game began, pot after pot went to Karpov. Some 400 hands later, the match was over, with the King of Limit down \$20,000. "His level of play was out of this world," Feruell later recalled.

He was suspicious right away. How could he have been outsmarted by a guy who ranted about homosexuals taking over the world? Although Feruell couldn't prove anything, he guessed Karpov had used software to direct his moves. Poker-playing programs—poker bots—had been around for decades,

but for most of that time they hadn't been good enough to beat top human competitors. (NLJ: I think this is an unexpressed suggestion that the AI is not potty trained - a tell that it's an AI.)

Feruell and Karpov both made their names in the boom era of online poker, which kicked off in 2003 after a Tennessee accountant with the improbable name of Chris MoneyMaker won the World Series of Poker in Las Vegas. MoneyMaker inspired millions around the world to try their luck, just as online poker sites emerged to make it easy to do so. These hobbyists were happy to pay good money to test their skills. Maybe they'd even win a little and then—why not?—make it to the World Series of Poker themselves.

Throughout this era, players could be reasonably confident that the people on the other side of the virtual table were, in fact, people. But Feruell had good reason to be suspicious. As researchers were using virtual poker to push the limits of artificial intelligence, machines were creeping into the online game. Some unscrupulous operators used software to cheat. Bots began to proliferate and contribute to the game's decline. By 2019, the same year a bot designed by researchers at Carnegie Mellon University humbled five pros in a mini-tournament, Morgan Stanley analysts warned that AI was an existential threat to the online poker market, still worth around \$3 billion today. The rise of "superhuman poker bots in the online ecosystem now appears to be a matter of when, not if," their report read.

That day has arrived. Advanced poker software is now widely available for a few hundred dollars. Forums are full of accusations about everyone from anonymous, low-stakes fish to sponsored professionals. All the big platforms promote a zero-tolerance policy, but no one seems to know how many bots are out there or where they come from. "It's a scourge," one gambling executive told me.

When I started investigating poker bots, I came across an obscure chatroom thread posted by a whistleblower describing an operation so large it resembled an international corporation. It had a board of directors, training programs and an HR department—everything, it seemed, but a water cooler. Allegedly based in Siberia, the group was said to have absorbed all potential rivals in the region, becoming known as BotFarm Corporation, or BF Corp. "You can't do anything about it," wrote the whistleblower, who seemed to have inside knowledge. "A machine is always stronger than a man."

I was intrigued but wary. The poker community, pumped up with testosterone and greed, is rife with conspiracy theories. One high-profile player had to go on camera with the website *PokerNews* to deny running a cheating cult fueled by hallucinogenic frog poison. The paranoia results, in part, from a lack of information. Neither professionals nor poker providers want to acknowledge the presence of intelligent machines for fear of deterring the new players whose money keeps the game afloat.

I decided to find out the truth about BF Corp., by following a trail of leaked internal emails and legal and corporate filings, and by conducting interviews with players, gambling executives, security consultants and botmakers. When I finally tracked down BF's Siberian creators, they reluctantly agreed to an interview. They turned out to be more deeply embedded in the poker industry than I could have imagined. And, far from ruining the game, they told me they wanted to save it.

Poker involves both luck and skill. That's key to its appeal. If I were to challenge the world's top golfer, Scottie Scheffler, there could be only one result. The contest would be pointless and embarrassing for all involved. But as a below-average participant in the occasional late-night card game with friends, I *might* have a chance against reigning World Series of Poker winner Jonathan Tamayo, at least for a few hands. I could fluke my way into four aces or play so incompetently that he struggled to interpret my strategy.

This sense of possibility is what draws in new blood, from frat-house amateurs to millionaires staking huge sums to take on elite players. A lot of people think they're smart enough to win online. Without these

players putting in money, the professionals wouldn't earn a profit, the websites wouldn't get a percentage of the action—the rake, in poker parlance—and the game's economy would collapse.

But over the long run, skill outweighs luck. **A key advantage is mathematical talent:** the ability to calculate the probability of winning a pot, based on variables such as hand strength, number of players and one's position at the table. (NLJ: This is a very simple reduction of the problem - and it's not purely about math talent. Shows the writer is naive.)

The students who founded BF Corp. were just this type of player. Hailing from Omsk, a city that serves as a gateway to the frozen wilderness of Siberia, **they were computer gamers who studied math, physics and economics.** With the digital poker boom in full swing, one of them convinced the others they could make serious money. (This and other details about the group were confirmed by early members, who, like many Russian sources for this article, asked not to be identified, citing the political situation in their home country.)

Poker collectives were springing up across former Soviet territories, where colleges were traditionally strong in science and technology, and wages were low enough to make gambling attractive. "Poker is about mathematics and self-discipline," Maxim Katz, who ran one such group from Moscow, told me. "That's two things Russians are good at."

The Omsk students borrowed money from their parents and began stalking other friends in return for a cut of their profits. They trained using pieces of dried pasta as chips. The winner got a meal; losers went hungry. A university lecturer came in to give off-books lessons in probability theory; others taught game theory. By a year or two in, about 50 students were coming to the dorm each evening to work the night shift.

The poker sites worked much like they do now. Players registered, deposited funds and joined a digitally rendered green felt table. The software shuffled and dealt. Participants could see their opponents' decisions—raise, call, fold—but not their cards. Anything from a few dollars to hundreds or thousands could be at stake, depending on the site and whether a tournament was running. Crucially, everyone was identified by only a first name or pseudonym, and normally by a cartoon avatar. That meant hapless Americans logging on after work had no idea they were playing against Russian kids trained in the mathematical dark arts.

One night a neighbor called the police, convinced terrorists were using the building, which was lit up at all hours with scruffy young men streaming in and out. The students invited officers inside to see banks of computer screens. There's no terrorism, they explained. Just games.

Soon, the group connected with a similar operation from another technical college in Siberia and agreed to merge. Greater scale meant bigger pots and bigger profits. They attracted external investors, including Svyatoslav Kapustin, a local real estate tycoon, according to records from Russian companies associated with the group and other sources. (Emails sent to companies affiliated with Kapustin went unanswered.) They also recruited professional players, including Petr "Rus" Vlasenko, who'd won the 2006 PartyPoker St. Petersburg Open and coached other pros for \$1,000 a session. Vlasenko had developed a mathematical approach to assess the odds in each hand. He came to Omsk, where one of the group's founders persuaded him to teach his method to a programmer in the hope of creating software that replicated his skills. Eventually, Vlasenko became a key member of the team.

Scientists had been trying to crack poker since at least the 1940s. That decade, researchers successfully trained 10-ton prototype computers to play checkers, creating arguably the first functioning AI. Chinook, a program designed at the University of Alberta, defeated the world checkers champion in 1994—a victory

that prompted a journalist from a Christian newspaper to ask its programmer, “Are you the devil?” Chess fell in 1997 to IBM Corp.’s Deep Blue machine, **which could review 200 million positions per second**, more than enough to beat grandmaster Garry Kasparov. (NLJ: the advances of DeepBlue went beyond deeper searches. Again, this shows the author’s poor understanding.)

Poker proved vastly more complicated. A game can have as many as 10 players, and each participant faces multiple decisions, from folding a hand to going all-in. **The number of potential scenarios in a single game of No-Limit Texas Hold ’em is greater than the number of atoms in the universe.** (NLJ: probably not true.) What’s more, poker involves guessing what type of hand an opponent is holding, taking cues from behavior (even online) and bluffing convincingly about your own hand—that is, lying. (NLJ: in a single game, lying probably isn’t different from chance. But over many games, winning requires beating a liar - which involves complex human behavior and “tells”.) Computers, designed to plow through huge datasets, aren’t good at this.

Around 2012, David Fairlamb, a former casino executive from Michigan, was mentoring at a business school in Moscow when he encountered a curious group of students from Siberia. They struck Fairlamb, who speaks fluent Russian, as introverted nerds who conversed in the mechanical language of computer programming. Their names didn’t stick with him, but their area of expertise did. They’d developed groundbreaking poker technology and were looking for ways to exploit it.

By then, several people in the Omsk group told me, they’d built probably the world’s most advanced poker-playing software and were deploying it profitably on every major poker website. In only a few years, they’d managed to substitute the human talent in their operation with an alternative that didn’t need to eat or sleep; that could connect automatically to a platform with minimal supervision by the founders and their friends; and that could sift through millions of potential scenarios to **find the best move from a 3-terabyte database of past games, right down to exploiting a given opponent’s tendencies based on their record of play.**

(NLJ: author’s weakness. A database with millions of games is marginally useful in a repeated game - where the outcome of a future game depends on the play in the current game.)

Fairlamb told me he didn’t know anything about the botting operation in Siberia. The deal he struck with the students was, to him, about their technology’s broad commercial potential. With his encouragement, the group decided to test their system against the world’s best bots, entering the [Annual Computer Poker Competition](#) in 2012 and 2013 under the name [Neo Poker Lab](#). They competed against two leading research hubs—Carnegie Mellon in Pittsburgh and the University of Alberta’s Computer Poker Research Group—as well as other assorted academics and tech hobbyists.

Organizers uploaded all the bots to a central server, then ran hundreds of millions of hands, pitting bot against bot as they folded, checked and raised over and over in the fraction of the time it takes a human to blink. **The system behind Neo, the group told competition planners, relied on “neural networks, regret minimization and gradient search equilibrium approximation, decision trees [and] recursive search methods as well as expert algorithms from [a] professional poker player.”** In plain English, that meant the software had played itself millions of times, learning from its mistakes and successes much the same way people do, except at mind-boggling scale.

NLJ: The above text is the most interesting statement in this article. Shows that using an LLM approach to a massive database is not enough.

The Neo bot was adapted to play other machines. **It was built on pure game theory**, a specialty at the students’ technical universities. **Applied to poker, game theory helps computers overcome their main**

weakness: lying. Its formulas calculate precisely when and how often to bluff to maximize the chances of victory, while minimizing “tells”—play patterns that can help opponents guess what someone is holding. Game theory can produce a poker strategy that’s as close to perfect as it’s possible to get.

NLJ: There's so much wrong with this paragraph. Guaranteed that more than pure game theory is required (I took classes from the prof who later won a Nobel prize on game theory). And while game theory has attempted to address lying and subversion, it definitely doesn't “calculate precisely” about bluffing behavior, either how to identify it or to use it. Likely the Neo bot crew told the author this and it was accepted, maybe to hide how they addressed bluffing in repeated games.

Academics were also tapping into its power, but the Russians had found an edge. Neo placed in several categories in 2013 and won a head-to-head Limit Texas Hold 'em contest, pushing the vaunted Alberta bot into second.

The victory gave Fairlamb something to promote back in the US alongside some prototype consumer software the Siberians had built: a poker-training program featuring cartoon characters from the TV show *Futurama*. The product won a startup award at the 2014 Global iGaming Summit and Expo in San Francisco. Fairlamb's wife attended the ceremony dressed as a glamorous robot.

Fairlamb persuaded other American gambling executives to join what was now a fledgling company. “Within nine months, we'll have a fully completed release of the game,” Neo's then-Chairman Rob Gallo told a journalist in Las Vegas. The same article touted [Chris Moneymaker](#), poker's most famous son, as an adviser to Neo's management team, a claim that also appeared on the company's website for years.

Moneymaker, however, told me he knew nothing about this. He said he'd never had any connection to Neo and didn't even know his name had been used. Gallo, who knew Moneymaker socially, said he wasn't sure who'd connected the poker champion's name to the project. (He also told me, like Fairlamb, that he knew nothing about a botting operation in Russia.)

Whoever was responsible, the attempt to inject some star power didn't help. The poker-training software never amounted to anything, failing to lure investors or paying customers. Fairlamb and Gallo parted ways with the effort, and both told me they didn't know what the Russians did next.

As Neo was winding down, in 2015, [University of Alberta scientists announced that they'd “solved” two-player Limit Hold 'em](#). Their [Cepheus](#) bot had run more hands against itself than the entire human race had played since the game's inception, they said. They claimed that, for all practical purposes, it was unbeatable. “It plays like God,” journalist [Oliver Roeder](#) wrote in his book *Seven Games: A Human History*. (NLJ: This is just silly: Running more “hands” does not create a smarter bot - otherwise, the team with the largest supercomputer would dominate all AI development. This is what I call the *collective complexity barrier*, where adding more data cannot solve harder problems, similar to how the *expert complexity barrier* limits the performance of an expert as problems get more complex.)

Cepheus was a landmark achievement in the history of machine intelligence. Reading the news from Russia, the Omsk crew were a little annoyed they'd never gotten a rematch, an associate told me. But they'd long since stopped bothering with scientific posturing. Poker isn't really poker without money at stake, and the Russian bot farmers knew that better than anyone.

Before Cepheus, poker websites didn't take botting that seriously. The technology wasn't good enough, and they had more serious problems. In 2011 [American authorities shut down](#) the three most popular sites, [Absolute Poker](#), [Full Tilt Poker](#) and [PokerStars](#), accusing them of breaching US gambling laws. The cases were eventually settled with no admission of wrongdoing by the companies, but the moves threw

online poker into a kind of legal limbo. Many operators kept going by fleeing to Costa Rica, Curaçao and other locations.

The industry persisted, though, and **by 2015 it was adopting security measures to detect and exclude bots.** (NLJ: this illustrates that the problem of determining bot vs. human is almost a decade old. Not a new problem with current AIs.) It wasn't that using software to play poker was illegal, apart from perhaps in casinos in Nevada, where a state law forbidding gambling devices already existed. It was, however, cheating. Players have always hated bots. The game is supposed to be a battle of wits, not of computing power. Virtually all poker sites now forbid bots in their terms of use and shutter the accounts and seize the funds of anyone suspected of employing them. (NLJ: There was a similar problem recently with online chess, where it appeared that a famous grandmaster was using chess software to play.)

The problem is, how do you spot a bot? The best pros can execute close to game-theory-optimal poker (NLJ: this should be gaming probability optimal, not game theory. You don't need game theory to predict how often a die will come up 1, only probability theory), so filtering for win rate or playing style isn't necessarily enough. Initially the sites tried methods such as **monitoring online chat boxes to see if players talked like humans and tracking cursor movements to see if they matched the way people use a mouse.** (NLJ: this goes back to the opening paragraphs that show an online player to be random and abusive. A tell.) To get around these defenses, the Siberians hired programmers **to tweak their software**, according to several people from the organization. (NLJ: More than tweaking, a new capability was added to mimic human behavior.) Soon their bots could simulate the jiggling mouse movements of a person at a desk, generate convincing chatter when prompted and even randomize the time they took to make a decision, imitating natural hesitation.

In response to such advances, **"game integrity" specialists learned to dig deeper into players' habits using analytics. A player's style is as individual as a fingerprint. Across hundreds of hands, no two people will make exactly the same choices. If websites detected two players folding, checking and raising at the same rate, they were bots. If they detected even more players doing so, that was a bot farm. Online vigilantes got in on the act, reviewing game data and flagging suspicious activity in poker forums.**

(NLJ: This illustrates two points. 1. A database of many games misses how games differ by individual style, and individual style is key to beating a player, so just having access to a huge game database is not enough. 2. How complex is it to identify an AI player. Here, the AI bot was found by observing the same "subtle" style at the same time over multiple games - which could only be a bot (is that true? Many grandmasters in chess play multiple games at a time.)

NLJ: The rest of the article captures how marketing a unique capability is more than a direct offering but requires evolving marketing in a responsive ecosystem, especially to mask the AI player as human.

This scrutiny posed a problem in Omsk. Accounts were now being banned, dozens at a time, after only a few days of play. Facing extinction, the group's leaders began outsourcing the operation of bot accounts to partners who paid for access to the software, which the group referred to internally as "the brain." It was around this time that the group earned the name [Bot Farm Corporation](#).

The partners who ran the farms acted like independent franchisees. Typically they'd rent office space and computers, hiring employees to operate the software. The partners also needed hundreds of real people to open "clean" accounts for the bots to use, supplying proof of ID if required. BF Corp. offered a menu of different brains, tailored to high- or low-stakes games, or to variants such as Omaha or five-card stud.

The software could run fully automated or with a human operator implementing decisions from a machine running in the background, to confound sites' bot detection systems. **Having a human face proved ideal for online tournaments where organizers were known to ask competitors to prove they were flesh and blood by recording a video of themselves playing.** If a partner's farm was caught and barred, they could just shut it down and start over with new accounts.

Internal chats from BF that were leaked on a Russian poker forum and Telegram show the operation's scale during this period, as well as the level of subterfuge it was deploying. In the transcripts, about 600 users with aliases such as Dallas and Zeon discuss overseeing accounts in Canada, China, India, Poland and Sweden, using virtual private networks or local SIM cards to disguise the operators' real location. Someone using the name **Musicant reported running so many bots that they ended up at the same online tables, playing against one another.**

Many of the first partners were Russian poker players or bloggers who'd heard about BF through word of mouth and had an online fan base to provide a steady supply of clean accounts. One of them was Feruell's nemesis, Vyacheslav Karpov. Karpov's farm was large enough that BF classified him as a "premium user," according to someone who saw the group's internal database. And he had access to the brain during his 2013 showdown against Feruell, another source confirmed. A few years later, in 2016, Karpov posted a message from PokerStars' security team saying he'd been kicked off the site for using prohibited software. He called the accusation "nonsense," saying, "This is normal for me. I just have this game strategy. I leave scorched earth. Until I win everything, I won't stop."

I got hold of Karpov's contact details and messaged him to say I'd be reporting on his use of poker bots and his links to BF Corp. He responded with a question: "How often do you think about suicide?" When I pushed him for a comment, he accused me of being unnatural "in a doggy style" and offered up some questionable views on the role of women in society before blocking my number. He signed off with these words: "Son, when I was 16 years old, I ate people like you for breakfast." (NLJ: ? I guess this is another attempt by the author to imply the contact was with an AI that's not potty trained?)

BF Corp. eventually concluded that it was too difficult and time-consuming to work directly with partners such as Karpov. **Starting around 2018, the founders decided to sell their software as a computer or smartphone app, leaving customers to decide how they used the technology.** This strategy meant the group didn't have to expend resources finding ways to avoid detection by websites and could spend more on developing the underlying AI. A new golden period began.

Some of the partners became distributors, spreading BF's bots far and wide. [N.Z.T. Poker](#), named after the superintelligence pill Bradley Cooper's character takes in the movie *Limitless*, had its own Facebook and Instagram pages, plus chat services on WhatsApp and Telegram. Its Russian-language website claimed to have 10,000 customers. "No more tough decisions or stressed burnouts. Just follow green hints and make money," its YouTube channel stated. NZT's software came from BF Corp., according to a source inside the Omsk group. (NZT didn't respond to messages seeking comment.)

The Russians were still digging for gold, only now they were "selling shovels," as they were referring to it in Siberia. At the group's peak, they were making more than \$10 million annually from selling access to their system, a BF member boasted to a friend in one of the conversations leaked online. **Some of those profits were spent experimenting with new, unexpected ways to exploit the AI, both inside and outside the poker economy.** Until now, the Siberians had approached poker sites like bandits, hiding in the shadows and plundering whatever they could. But what if they offered a service the industry actually wanted?

As I investigated what they did next, I stumbled across **online poker's dirty secret: Not all bots are unwelcome.** Alex Scott, president of the company that runs the [World Poker Tour](#), explained it to me.

Customers loathe bots and won't spend money playing them, he said. But **all accounts, including bots, generate revenue.** Poker sites make money from the rake, taking a small percentage of the pot in each hand. Even as they have rules forbidding bots, they have little incentive to care who wins or how. **Bots are also useful for keeping games running around the clock, providing what insiders call "liquidity," as customers prefer to join active tables rather than wait at empty ones.** "You can't run an online poker business without liquidity, and bots can provide that," Scott said. Companies he'd worked for hadn't used them, he noted, but he suspected smaller sites did.

BF Corp.'s founders spotted the opportunity early, opening offices in Novosibirsk and St. Petersburg, and recruiting marketing professionals to sell the product. In 2020 they created a company called Deeplay. Its mission was to "provide a comfortable environment for gamers," according to its website. "Our robots employ different strategies to maintain in-game balance."

Deeplay recruited hundreds of coders and analysts, some of whom didn't even know the core business was poker when they were hired. Its offices looked like those of any other tech startup, with massage chairs and Christmas parties with free steak and vodka, and no sign of playing cards or other gambling-themed décor. The company pitched itself not merely as a poker business but as an AI-powered data solutions provider for a range of corporate needs. Of the half-dozen ex-Deeplay staff I spoke with, only one knew about its origins in Siberia.

Many of Deeplay's clients were poker clubs. A relatively recent phenomenon in online poker, these privately run games could skirt legal prohibitions on gambling transactions by selling tokens or charging membership fees instead of taking rake directly. Clubs are popular in jurisdictions with restrictive betting laws, such as China and the US. Anyone can start one using off-the-shelf software, and the largest clubs rival mainstream poker websites in popularity. **Deeplay's bots could help club operators attract new members by making sure there were always active tables to join. The company also offered game analysis and, ironically, anti-bot security, to keep interlopers away.**

Some former Deeplay employees told me that **once its bots were operating at poker club tables, they could make money at the expense of real users. Others said the skill level could be adjusted down, allowing humans to win just enough so they stayed at tables longer, spending more money.** Deeplay would get a fee for providing this technology or take a share of the increased revenue. It's unclear whether any of Deeplay's clients knew they were in business with an offshoot of perhaps the largest cheating operation in the history of poker.

I couldn't find a single poker club or traditional website that openly admitted to running internal bots or having a relationship with Deeplay. "It's a complicated question," one gambling executive responded when I asked whether liquidity bots were ethical. "I know of other platforms that use bots." I asked the top five poker websites the same thing. They all either denied any connection to the practice, declined to comment or didn't respond. Messages sent to official channels at Deeplay went unreturned.

NLJ: the above paragraphs describe how bots encourage human gaming and sustain income. These methods probably will occur in other areas where 1) human participation depends on having other humans (but bots) present - both socially (as in social media) and competitively (as in poker), 2) bot support is not desirable, so bots must be more human-like, and 3) Companies using AI don't want to disclose their use, even though they are public, have AI laws limiting use, and are essential for operations.

The average poker enthusiast today can't really know whether their online opponent is a person or a machine. Game security isn't infallible, even on the big platforms. "This is an arms race against some very motivated individuals," PokerStars said in a 2023 blog post. At a recent tournament with a \$12.5 million prize pool, run by Winning Poker Network, a unit of Americas Cardroom, the second-place player was

disqualified mid event on suspicion of botting. “I believe there is no clean game online,” Vitaly Lunkin, a Russian professional, told me.

At the same time, most top players use software to train themselves to play with the efficiency of robots, in real life and online. The game is now less about psychology, spectacular bluffs or calls, and more about revealing as little as possible to opponents and grinding out the percentages. **Machines have taught us to play better, more boring poker.** (NLJ: Interesting and probably true. But illustrates how poker and chess differ: The best chess players don't make major mistakes (not a game of chance), but in poker, the game is all about the player assessing the odds well but still failing to a less experienced player. Very different games. That said, chess can have bluffs if a person can't see far enough into the game, so it's a matter of degree, rather than binary.)

This new reality made me think of bots as a virus, attacking the body of online poker. Over time, some viruses evolve to shed their predatory traits, and the host's biology absorbs them as they weave themselves permanently into the genome. Perhaps it's the same with poker, and online players should learn to live with bots. (NLJ: More apt is a comparison to ecosystem evolution: new species can initially be disruptive but soon develop dependencies and become part of the ecosystem's infrastructure. Diversity is always increasing while becoming more robust due to diversity. The virus analogy is not as rich.)

Or maybe the Morgan Stanley analysts were right in 2019 and the game is slowly destroying itself. There's no doubt the boom Chris MoneyMaker inspired is over. Traffic is down from its peak, apart from a spike during the Covid-19 pandemic, when half the world was stuck at home. **MoneyMaker himself told me AI and bots represent a massive threat to the industry he helped make.** “It might end up killing the whole online poker world eventually,” he said. (NLJ: Or maybe it kills the advantages of the expert players and their high incomes. Leveling the field.)

Earlier this year, after months spent interviewing anyone I could find connected to BF Corp., Neo or Deeplay, a new group chat popped up in the encrypted messaging service I was using. “Hi Kit. We hear uve been looking for neo core ppl for quite some time.”

They called themselves the “Neo pokerists” and said they were founding members. They were thinking about breaking their silence: “Weve decided that its better to have a conversation instead of sitting in the shadows.”

After a protracted negotiation, we arranged to meet in the Armenian capital of Yerevan. I agreed not to publish their full names. Doing so would put their safety at risk in Russia, they said. They'd planned a series of touristy activities so we could get to know each other better, and the morning after I landed, they pulled up in two SUVs with tinted windows.

I didn't know what to expect, but in person they seemed more worried about me and how my story might affect them than I was about them. There was Alex, a shaven-headed Muscovite with hip glasses and designer clothes. Vova and Valentin were both from Siberia. They'd been original members of the student poker collectives in Omsk. Vova, who had the distinctive sloping shoulders of someone who spends a lot of time in front of a computer, had been studying accounting at the time. Valentin, lean and twitchy, was the most gifted player of the three. In his youth, he said, he'd been able to run 17 online games simultaneously and still make money.

Seeking a quiet place for the interview, we drove to a vineyard in the shadow of Mount Ararat, still snow capped in the June sunshine. There, Alex, Valentin and Vova talked me through their poker careers and their vision for the future, speaking either in English or with Alex acting as interpreter.

BF Corp., Neo Poker Lab and Deeplay—it was all them, they confirmed, and all built around the technology they'd created in Siberia. They laughed heartily when I told them another name I'd heard, "Impertsy," Russian slang for "the Imperialists." It was because we grew so large, Alex said. He thought the people attacking them on internet forums were probably embittered poker professionals who couldn't compete against their bots. (NLJ: see my last comment about experts being threatened.) They detailed everything, including the police raiding their dorm in Omsk, their evolution into a service business, their sale of liquidity bots and their approach to the poker clubs.

After a couple of hours spent answering my questions, the three Russians asked to be left alone in the vineyard's dining room. I could hear raised voices inside. Then they summoned me back and began an impromptu presentation using a whiteboard from a meeting room, drawing in marker a single line representing their time in poker from about 2004 to the present. Online poker is built on a lie, Alex explained. He called it the "Moneymaker myth," saying the Tennessee accountant's unexpected success had created the misleading impression that anyone with skill and luck could rise to the top.

In truth, they said, online poker was a Darwinian contest. They called it "King of the Hill." The Siberians were very good at it, helped by their technology. The huge amount of data they'd gathered allowed them to see the game clearly. Alex drew another line on the whiteboard, slanting downward. It represented the average win rate and, by extension, the profit a skilled player could expect to make. Attracted by the steady flow of cash coming in after the Moneymaker boom began, pros and bots had flooded the field, all competing to take chips from the same limited pool of casual, unskilled players. The line suggested it had become much harder for anyone, even Siberian bot farmers, to make money sustainably.

Vova showed me a meme depicting what he called the average online table today, with one casual player being eyed hungrily by five pros. "King of the Hill is not a good game," he said. At first they'd responded by increasing the scale of their operations, initially with partners such as Karpov and then with downloadable software—"selling shovels." But by around 2018, the group's founders had reached the same conclusion as the Morgan Stanley analysts would a year later. Even selling liquidity bots couldn't change the equation. The Russians could see that about 80% of amateur players got sick of losing money and never made it to 1,000 hands. Unless the game got better at attracting and keeping players, they said, it was doomed.

Alex, Valentin and Vova told me they had plans to change this outcome. It was why they'd agreed to meet in Armenia. Their group was working on a model focused on the hobbyists, the 80% who were being driven away. Instead of milking them for chips, the world-beating Omsk poker machine would match players against other people with similar skills. "Like poker Tinder," Vova joked. Pro against pro. Amateur against amateur. A fair contest. A different revenue model that didn't depend on rake. "We need to make a new game," Alex said.

It was an ambitious idea, especially coming from botmakers. Could people reviled as pariahs by the rest of the poker community really be the ones to save the game?

We spent more time together that weekend, talking about life and poker. At one point we visited an underground monastery gouged into the hills outside Yerevan. Inside, five Armenian women in purple robes stood in a shaft of sunlight singing apostolic hymns, filling the cavern with the haunting sound of another era. The Siberians, eager for lunch, snuck out after a few minutes, but Alex seemed genuinely moved. He closed his eyes, leaning his head back against a stone pillar marked with a cross.

Later, in the vineyard, I put the question to him straight: Could they be both devils and angels? Alex sighed. "We do have good intentions," he said. "At the same time, we are in a capitalism game."

The poker entrepreneurs from Omsk continue to sell their shovels. They show little interest in how the bots are being used or who's using them. The “brain” they built is no longer only for poker. They said they've adapted the software to other challenges, analyzing baseball, cricket, fantasy sports and financial markets, teaching itself to spot patterns beyond human comprehension. There's even a research and development team in Siberia working on cracking the card game rummy, which has become popular among online gamblers.

As we said goodbye, Alex brought out a black T-shirt—a wry nod to all those who saw the group as a blight on poker. “The bad Russians” was printed on the front with “bad” crossed out. “GREAT” was scrawled above instead.

—*With Jake Rudnitsky and Katia Swarovskaya*

K: NLJ on Higher intelligence requires situated data

Comments by NLJ - taken from text as a sidebar to the main presentation. Note that all data (knowledge and intelligence) requires context, even mathematics. So the question is how much context or environment is needed to express or observe higher intelligence.

Why “situated” data? The adjectives situated, localized or embodied capture perceptions or knowledge localized in physical or mental space, such as from a unique perspective, viewpoint, or worldview. For decades, up until the 1990s, localized data or understanding was dismissed as biased, limited, and lacking objectivity.

Major advances in modeling intelligence occurred when researchers abandoned developing general intelligence (i.e., not having a situated viewpoint) in the 1950s and focused on situated intelligence as captured by robots in physical domains. This major “ah-ha” was documented in the book by [Pfeifer, R. and C. Scheier \(1999\), Understanding Intelligence. Cambridge, MIT Press.](#) I think they got it right.

The AI community seems to be rediscovering this conclusion again two decades later. The two papers below claim innovative advances by putting simple generative agents in “realistic” environments. A quote from the first paper: “...multi-agent self-play with simple game rules in sufficiently complex environments could lead to open-ended growth in complexity.” (Both papers were recommended to me by a colleague in Hawaii - Brian Laughlin <blaughlin777@gmail.com>.)

- OpenAI paper: “[EMERGENT TOOL USE FROM MULTI-AGENT AUTOCURRICULA](#)” [Video of the results](#).
 - Popular article on the research: *What if someone mixed The Sims with ChatGPT bots? It would look like this.* https://www.theregister.com/2023/04/11/sims_ai_generation/
 - [The code is available on GitHub.](#)
- Related paper: [Generative Agents: Interactive Simulacra of Human Behavior](#)

I think the AI papers claim innovative behavior (observed behavior not in the original model). Still, they are just discovering what was found in the 1990s: situated intelligence that is dumb outside the “situation.”

Collective intelligence goes one step further and says the diversity of unique experiences is essential for a comprehensive understanding and, ultimately, a more robust and accurate problem-solving.

Another point of context is that the [Artificial Life \(ALife\) community in the '90s](#) concluded that genetic algorithms (GAs) modifying model parameters cannot innovate; they can only optimize a model. A major effort within ALife was to demonstrate that an algorithm could create true innovation (some say emergent behavior, but the innovation doesn't have to be multiscale, like emergence). It wasn't until a project I led that used GA on logic trees that I think showed true innovation (Project *Automated Asynchronous Red Teaming* or AART for ONR 2008).

L: Services that offer proprietary, in-house LLMs to companies and enterprises

[Perplexity response](#)

Query: What services are provided by companies offering in-house, proprietary, secure LLMs? What media do these services support (audio, video, documents, etc.)? What is the range of costs for the service, including setup and maintenance?

Answer

Companies offering in-house, proprietary, secure Large Language Models (LLMs) provide a range of services and support various media types. Here are the key aspects of these services:

Services Provided

- API Integration: Companies offer APIs and platforms that allow developers to integrate LLMs into their applications easily¹.
- Customization and Fine-Tuning: LLMs can be customized using proprietary data to meet specific business needs, enhancing performance for particular tasks⁵.
- Security Enhancements: Solutions are designed to minimize data leaks and ensure data privacy, often through private cloud or on-premises deployments⁵. Security tools like LLM firewalls and monitoring systems are used to protect against cyber threats²⁶.
- Support and Documentation: Providers offer robust support and documentation to help developers utilize these models effectively¹.
- Regular Updates: Proprietary models are regularly updated with new features and improvements¹.

Supported Media

- Text: Primarily used for processing and generating text-based content.
- Audio/Voice: Some solutions include voice recognition capabilities, expanding applications to areas like call centers⁵.
- Documents: LLMs can process complex documents, which is crucial for tasks like data leak prevention⁶.
- Potential for Video: While not explicitly mentioned, the integration of audio and text suggests potential applications in video processing, especially with transcription services.

Cost Range

The costs associated with proprietary LLMs can vary significantly based on several factors:

- API Costs: Typically charged per token processed. Prices range from \$0.01 to \$0.10 per 1,000 tokens¹³.
- Subscription Plans: Monthly fees can range from \$0.20 to over \$500 for standard subscriptions, with enterprise solutions starting at \$10,000+ per month¹.

- **Setup and Maintenance:** Initial setup costs can be high, particularly if deploying on-premises with necessary hardware like GPUs. Maintenance costs include ongoing support and infrastructure management⁴⁷.
- **Custom Enterprise Agreements:** For large-scale deployments, custom pricing agreements can optimize costs but may require complex negotiations³.

Overall, while proprietary LLMs offer cutting-edge performance and security features, they come with significant costs that vary depending on the scale of deployment and specific use cases.

Query follow-up: What are the main advantages of using proprietary LLMs over open-source ones

[Proprietary vs. Open-Source LLMs: Best Choice for Enterprises](#)

[encora.com](#)

[Pros: · Innovation and Flexibility: Open-source LLMs encourage innovation, allowing enterprises to experiment and adapt the technology to their ...](#)

Answer

Proprietary Large Language Models (LLMs) offer several advantages over open-source alternatives, particularly for enterprises seeking robust, secure, and efficient AI solutions. Here are the main advantages:

Advantages of Proprietary LLMs

- **Security and Compliance:** Proprietary LLMs often come with enhanced security measures to protect sensitive data. They are designed to comply with industry standards and regulations, providing peace of mind for businesses handling confidential information¹⁵.
- **Performance and Scalability:** These models are typically trained on vast datasets using advanced infrastructure, offering superior performance and scalability compared to many open-source models. This makes them well-suited for handling large-scale enterprise applications²⁴.
- **Dedicated Support and Maintenance:** Proprietary LLMs are supported by dedicated teams that provide ongoing maintenance, updates, and customer support. This ensures that the models remain up-to-date with the latest advancements and can be tailored to evolving business needs¹³.
- **Ease of Integration:** Many proprietary LLMs offer user-friendly APIs and platforms that simplify the integration process into existing systems. This reduces the technical burden on in-house teams and accelerates deployment times³⁴.
- **Customization Options:** While proprietary models may not be as flexible as open-source ones in terms of modification, vendors often offer customization services to tailor the models to specific business requirements. This can include fine-tuning on proprietary data to enhance relevance and accuracy¹⁴.
- **Competitive Edge:** Using proprietary LLMs can provide a competitive advantage by leveraging unique features and capabilities that are not available with open-source models. This is particularly valuable for businesses looking to differentiate themselves in the market¹².

In summary, proprietary LLMs are particularly advantageous for enterprises that prioritize security, performance, and dedicated support. They offer a comprehensive package that includes robust security

features, scalability, ease of use, and vendor support, albeit often at a higher cost compared to open-source alternatives.

M: How does personality type affect problem solving?

[Perplexity response](#)

Query: How do personality types (such as for Myers-Briggs) affect problem-solving abilities? For a Type of problem, would there be a "best" personality type? And how can having a diversity of personalities solve a problem be better than just having one personality solve a problem?

Answer

Personality types, such as those identified by the Myers-Briggs Type Indicator (MBTI), can significantly influence problem-solving abilities. Each personality type has distinct preferences that shape how individuals approach and resolve problems.

Personality Types and Problem-Solving

The MBTI categorizes personalities into 16 types based on four dichotomies: Introversion vs. Extroversion, Sensing vs. Intuition, Thinking vs. Feeling, and Judging vs. Perceiving¹. Each combination of these traits affects problem-solving approaches:

- **Introverted types** might prefer working alone and focusing on internal thoughts, which can be beneficial for deep analysis but may miss collaborative insights.
- **Extroverted types** often thrive in group settings, bringing energy and diverse ideas but sometimes lacking depth in solitary analysis.
- **Sensing types** focus on concrete details and practical solutions, which are useful for immediate problem-solving but may overlook broader implications.
- **Intuitive types** look at the big picture and future possibilities, offering innovative solutions but potentially missing practical steps.
- **Thinking types** use logic and objective criteria, excelling in analytical tasks but possibly neglecting emotional aspects.
- **Feeling types** consider personal values and the impact on people, ensuring empathetic solutions but sometimes at the expense of objectivity.
- **Judging types** prefer structured approaches and decisive actions, which can lead to efficient solutions but may resist flexibility.
- **Perceiving types** are adaptable and open to new information, fostering creativity but sometimes lacking closure⁴⁵.

Is There a "Best" Personality Type for Problem Solving?

There is no universally "best" personality type for all problem-solving scenarios. Different problems may benefit from different personality traits. For instance:

- Technical problems might benefit from ISTJ or INTJ types due to their logical and systematic approaches⁴.
- Interpersonal conflicts might be better addressed by ENFJ or ESFJ types who are skilled at understanding emotions and maintaining harmony⁵.

Benefits of Diverse Personality Types in Problem Solving (NLJ: Better answer follows)

Having a diversity of personality types in problem-solving teams offers several advantages:

- **Broader Perspectives:** Diverse teams bring multiple viewpoints, leading to more comprehensive analyses and innovative solutions²³.
- **Enhanced Creativity:** Different cognitive styles stimulate creative thinking, allowing teams to explore unconventional solutions⁶.
- **Better Decision-Making:** Diversity encourages careful information processing, reducing biases and enhancing decision quality³⁸.
- **Improved Problem-Solving Speed:** Teams with varied cognitive approaches can solve problems faster by leveraging different strengths⁸.

In conclusion, while individual personality traits influence problem-solving abilities, a diverse team that includes a range of personalities often outperforms homogeneous groups. This diversity allows teams to approach problems from multiple angles, leading to more robust and innovative solutions.

Query follow-up: Can a diverse team with different personality types solve problems more efficiently

Answer

Yes, a diverse team with different personality types can solve problems more efficiently. The inclusion of varied personalities and cognitive styles within a team enhances problem-solving capabilities for several reasons:

1. **Broader Perspectives:** Diverse teams bring together a wide range of viewpoints and insights, which helps in understanding problems from multiple angles. This diversity in thought processes leads to more comprehensive analyses and innovative solutions¹⁴⁶.
2. **Enhanced Creativity and Innovation:** Teams with diverse personalities are more likely to generate creative ideas and develop unique solutions. Different cognitive approaches stimulate creative thinking, allowing teams to explore unconventional solutions that might not emerge in homogenous groups²⁴⁶.
3. **Improved Decision-Making:** Diverse teams tend to process information more carefully, ask more questions, and challenge assumptions, leading to better decision-making outcomes. This diversity of thought reduces the likelihood of groupthink and encourages a more thorough examination of potential solutions¹⁶.
4. **Psychological Safety and Collaboration:** When team members feel psychologically safe to express their unique viewpoints without fear of judgment, they are more likely to contribute creatively and innovatively. This environment fosters collaboration and ensures that all voices are heard, enhancing overall team performance¹³.
5. **Adaptability and Agility:** Diverse teams are better equipped to adapt to changing circumstances and respond to complex problems because they can draw on a wider array of skills and experiences. This adaptability is crucial in dynamic environments where quick and effective problem-solving is essential⁴⁶.

In summary, the integration of diverse personality types within a team not only improves problem-solving efficiency but also enhances creativity, decision-making, collaboration, and adaptability, ultimately leading to superior outcomes compared to homogenous teams.

N. AI replacement of jobs and professions

[Perplexity link](#)

Query: What human activities, jobs, and professions are not expected to be done by AI tools and robots in the next 10 years?

NLJ: Wow, this is a very myopic view of AI automation, possibly reflecting the extensive literature now to calm public fears about the threats of AI on jobs. Many examples cited below have success stories of AI systems accomplishing the same human activities. There is an anthropomorphic viewpoint that fails to recognize a simple extrapolation of AI abilities. A more nuanced response would be to distinguish between professions that require onsite presence (healthcare of patients, construction trades, etc.), which would require robotic solutions, versus professions that can be done remotely (almost all other jobs below) where a user may not know if it's an AI or human. The other dimensions of complexity, emotional intelligence, and creativity are covered below - all of which can be remote or onsite. Physical dexterity is inherently onsite and localized.

In the next decade, certain human activities, jobs, and professions are expected to remain largely unaffected by AI tools and robots due to the inherent human skills they require. These roles typically involve complex decision-making, emotional intelligence, creativity, and physical dexterity. Here are some key areas where human involvement is likely to persist:

Professions Requiring Emotional Intelligence and Human Interaction

- Healthcare: Roles such as doctors, nurses, and therapists require empathy, patient interaction, and complex decision-making that AI cannot replicate [5](#).
- Social Work: Social workers need to connect with clients on an emotional level, requiring empathy and understanding that AI lacks [4](#).
- Education: Teachers and educators play a crucial role in personalizing learning experiences and providing mentorship, which involves nuanced communication and emotional intelligence [1,5](#).

Creative and Artistic Fields

- Performing Arts: Activities like acting, singing, and dancing require creativity and a human touch that AI cannot emulate [4](#).
- Creative Professions: While AI can assist in generating content, it cannot replace the originality and creative intuition needed in fields like writing, graphic design, and music composition [5](#).

Skilled Trades and Manual Labor

- Construction and Skilled Trades: Jobs such as electricians, plumbers, carpenters, and other trades require physical dexterity and the ability to handle unpredictable situations on-site [3,4](#).
- Agriculture: Despite technological advancements, many agricultural roles still require human oversight and decision-making [1](#).

Leadership and Management Roles

- Human Resources Managers: These roles involve managing interpersonal relationships and resolving conflicts, requiring a deep understanding of human behavior [2](#).
- Sales and Marketing Managers: These positions demand high emotional intelligence for networking, motivating teams, and adapting strategies based on market changes [2](#).

- Chief Executives: Leadership roles require strategic thinking, vision-setting, and complex decision-making that go beyond AI's current capabilities [2,3](#).

Public Service Roles

- Emergency Services: Firefighters, paramedics, and police officers need to make quick decisions in high-pressure situations that require human judgment [3](#).
- Community Services: Roles such as social workers and community organizers involve direct interaction with people in diverse situations [3](#).

These professions highlight the areas where human skills remain indispensable. While AI continues to evolve and integrate into various sectors, the unique capabilities of humans in these roles ensure their continued relevance in the workforce.

Followup query: What tasks, jobs, and professions are most likely to be replaced by AI in the next 10 years?

In the next decade, several tasks, jobs, and professions are likely to be significantly impacted or replaced by AI due to advancements in automation and machine learning technologies. These include:

Jobs Most Likely to Be Replaced by AI

1. Customer Service Representatives: Many customer service roles involve handling repetitive queries that can be automated using AI chatbots and virtual assistants [2,4](#).
2. Telemarketers: The nature of telemarketing, which involves repetitive and predictable tasks, makes it highly susceptible to automation through AI-driven systems [2,6](#).
3. Receptionists: Automated phone and scheduling systems are increasingly replacing traditional receptionist roles, especially in tech companies [6](#).
4. Bookkeeping Clerks: The automation of financial processes through AI tools can handle bookkeeping tasks more efficiently than humans [6](#).
5. Proofreaders: Advanced proofreading software can perform grammar and spelling checks with high accuracy, reducing the need for human proofreaders [2](#).
6. Factory and Warehouse Workers: AI-powered robots are being used for tasks such as sorting, packing, and transporting goods in warehouses, leading to reduced demand for human labor in these roles [4,6](#).
7. Car and Truck Drivers: The development of autonomous vehicles is expected to reduce the need for human drivers in the transportation industry [2,4](#).
8. Financial Traders: AI algorithms can analyze market data faster and more accurately than humans, posing a threat to traditional trading roles [4,7](#).
9. Computer Programmers (Entry-Level): Generative AI tools can automate certain coding tasks, impacting entry-level programming jobs [7](#).

These changes highlight the growing influence of AI in automating routine and predictable tasks across various sectors. While some jobs may be replaced entirely, others will see a transformation in job roles, requiring workers to reskill or upskill to adapt to new technologies.

Follow-up query: What percentage of the workforce will likely lose their jobs to AI (as captured in the prior list) in the next decade?

The impact of AI on the workforce over the next decade is expected to be significant, with various estimates indicating a substantial number of jobs potentially being displaced. According to several studies and reports:

- 30% of the world's workforce could lose their jobs to AI by 2030, translating to between 400 and 800 million people globally¹.
- 14% of workers may need to change careers due to AI advancements by 2030, affecting around 375 million workers worldwide².
- In advanced economies, up to 60% of jobs are at risk of being replaced by AI, although this figure is lower in low-income countries².
- In the U.S., around 47% of workers are considered at risk of losing their jobs to automation over the coming decade².

These figures highlight the potential for widespread job displacement as AI technologies continue to evolve and integrate into various sectors. Jobs involving repetitive tasks, such as data entry, telemarketing, and certain roles in transportation and logistics, are particularly vulnerable. While new job opportunities may arise as a result of technological advancements, the transition could be challenging for many workers, necessitating retraining and adaptation to new roles.

O. Peter Drucker on automation replacing human jobs

[Link to Perplexity's response](#)

Query: Did Peter Drucker discuss the shift to automation in the Age of Discontinuity when he predicted the Information Age? Particularly how automation would replace or radically change human jobs.

Peter Drucker, in his seminal work *The Age of Discontinuity*, indeed addressed the transformative impact of technology and the advent of what he termed the "knowledge society." While he did not focus exclusively on automation, he discussed the broader implications of technological advancements on society and the economy.

Drucker identified a significant shift from manual labor to knowledge work, emphasizing that knowledge had become the central resource of the economy [2,4](#). This transition marked a move towards a society where intellectual capital and service sectors would dominate, suggesting that traditional jobs would be transformed or replaced by roles requiring specialized knowledge and skills [3,4](#). He foresaw that knowledge workers, who apply theoretical and analytical knowledge in their work, would become crucial to economic productivity and growth [5](#).

Although Drucker did not specifically predict the extent to which automation would replace human jobs, he acknowledged that technological change could be disruptive in the short term but was an integral part of societal evolution [3](#). He suggested that technology should be embraced as a tool for enhancing human capabilities rather than being viewed solely as a disruptive force. Drucker also highlighted the importance of continuous learning and adaptability in an era where many traditional jobs might be automated or augmented by new technologies [3](#).

In summary, while Peter Drucker did not explicitly predict the detailed impact of automation on employment in *The Age of Discontinuity*, he recognized the profound changes technology would bring to work and society, particularly through the rise of knowledge work. His insights laid the groundwork for understanding how technological advancements could reshape economic structures and labor markets.

NLJ: A good summary of Drucker's views on the impact on human occupation and life is captured in [The Rise of the Knowledge Society in 1993](#). He ends his essay with, "*But one thing is predictable: The greatest change will be in the form and content of knowledge, in its meaning and its responsibility, and in what it means to be an educated person.*" The essay and his ending statement capture his exclusive focus on the human experience, but not how the human experience might become symbiotic with other intelligences. Automation of human jobs is the most extreme form of how AI, the culmination of the Information Age, will impact human activities. In less extreme forms, humans and AI will redefine the "form and content of knowledge," as this report proposes.

P. How in-school computers have affected teaching and class size

[Link to Perplexity](#)

Query: Has using personal computers in teaching resulted in less demand for teachers per capita of students (resulting in larger class sizes)? What are the advantages of using personal computers in classrooms, such as tailoring teaching material to individual student's needs?

The integration of personal computers in education has not necessarily led to a reduced demand for teachers or larger class sizes. Instead, technology is being used to enhance the educational experience and support teachers in delivering personalized learning. Here are some insights into how computers are impacting teaching and learning:

Impact on Teacher Demand and Class Sizes

1. *Complementing Rather than Replacing Teachers:* Technology in classrooms is designed to complement the role of teachers, not replace them. Computers and educational technology enable teachers to deliver content more effectively and provide personalized support to students, allowing them to focus on individual needs rather than managing larger class sizes^{1,5}.
2. *Role of Teachers Remains Crucial:* Despite the increased use of technology, the role of teachers remains essential in guiding, mentoring, and facilitating student learning. Teachers use technology as a tool to enhance their teaching methods and engage students more effectively^{4,5}.

Advantages of Using Personal Computers in Classrooms

1. *Personalized Learning:* Computers enable personalized learning by allowing instruction to be tailored to individual students' needs, learning styles, and paces. Adaptive learning platforms can adjust the curriculum based on each student's progress, providing customized feedback and support^{3,4}.
2. *Increased Engagement:* The use of computers often increases student engagement by making lessons more interactive and enjoyable. Technology can transform traditional lesson plans into dynamic learning experiences that capture students' attention and interest^{2,4}.
3. *Access to Information and Resources:* Computers provide students with access to a vast array of information beyond traditional textbooks. This fosters independent learning and critical thinking as students explore topics of interest and engage with diverse perspectives⁴.
4. *Enhanced Learning Opportunities:* Technology facilitates expanded learning opportunities through virtual field trips, real-time communication with experts, and access to advanced coursework that might not be available locally^{2,5}.
5. *Preparation for the Future:* Integrating computers into education prepares students for a technology-rich future by developing essential digital skills needed in higher education and the workforce^{2,5}.

In summary, while personal computers have transformed educational practices by supporting personalized learning and increasing student engagement, they have not diminished the need for teachers or led to larger class sizes. Instead, they serve as valuable tools that enhance the educational experience for both students and educators.

NLJ: I think this is a weak example of where Perplexity (AI) comes to the wrong conclusion because of academics' massive amount of published literature on the utility of personal computers in school rooms. I don't disagree with any of the advantages or risks. Still, my experience is that typical public school classrooms can be larger due to personal computers and using media - because the teacher's time is less

in demand. Interestingly, even when prodded by a follow-up query below, the risks do not include my concern or others I mentioned. I'm sure there is research about the impact on class size, but it's buried in other more favorable studies.

Follow-up query: What are the negative aspects of personal computers in the classroom? For example, access to inappropriate content, not developing social skills necessary for human existence, the inability to accommodate more complex learning disabilities that a human teacher could diagnose and treat, ...

The use of personal computers in classrooms, while offering many benefits, also presents several negative aspects that educators and policymakers need to consider:

Negative Aspects of Personal Computers in Classrooms

1. **Distraction:** Personal computers can be a significant source of distraction for students. With access to social media, games, and other non-educational content, students may find it challenging to focus on their lessons. This distraction can lead to fragmented learning and reduced academic performance [1,2,3](#).
2. **Reduced Social Interaction:** The reliance on computers can diminish face-to-face interactions between students and teachers, which are crucial for developing social skills and building relationships. This lack of interaction can hinder the development of effective communication skills that are essential for personal and professional success [2,3](#).
3. **Over-Reliance on Technology:** Students may become overly dependent on technology for learning tasks, which can undermine the development of fundamental skills such as handwriting, mental math, and critical thinking. This reliance can also diminish problem-solving abilities as students may not engage deeply with the material [2,5](#).
4. **Equity and Access Issues:** Not all students have equal access to personal computers and the internet at home, which can exacerbate educational inequalities. This digital divide means that some students may not be able to fully participate in technology-enhanced learning experiences [2](#).
5. **Privacy and Security Concerns:** The use of technology in classrooms raises issues related to student privacy and data security. Schools need robust protocols to protect sensitive information and ensure online safety [2,8](#).
6. **Health Concerns:** Increased screen time associated with computer use can lead to negative health effects such as eye strain, headaches, and sleep disturbances. There is also concern about the impact of blue light exposure on students' health [4](#).
7. **Cheating and Academic Integrity:** The availability of information online makes it easier for students to engage in academic dishonesty during exams or assignments, posing challenges for maintaining academic integrity [5,6](#).
8. **Technical Issues:** Dependence on technology means that technical problems such as software glitches or connectivity issues can disrupt the learning process and cause frustration among both students and teachers [2,6](#).

These challenges highlight the need for careful integration of technology in education, ensuring that it complements rather than detracts from traditional teaching methods and learning experiences. Balancing digital tools with face-to-face interactions and providing adequate training for educators are critical steps in addressing these concerns.

Follow-up query: What is the data on teachers per student over the last 50 years in public schools?

Over the past 50 years, the pupil-teacher ratio in U.S. public schools has generally decreased, reflecting trends towards smaller class sizes and increased teacher hiring. Here is a summary of the data on pupil-teacher ratios over this period:

- 1970: The pupil-teacher ratio was approximately 22.3 in public schools¹.
- 1980: This ratio decreased to about 18.7¹.
- 1990: The ratio continued to decline to 17.2¹.
- 2000: By this year, the ratio had dropped further to 16.0¹.
- 2010: It remained relatively stable at around 16.0¹.
- 2021: The most recent data shows a pupil-teacher ratio of about 15.4 in public schools ¹.

Overall, the trend indicates a steady decrease in the number of students per teacher, suggesting efforts to improve educational quality by reducing class sizes. This trend is consistent across various data sources, which report an average student-teacher ratio of about 15 to 16 students per teacher in recent years^{2,3}. These changes reflect policy decisions aimed at enhancing educational outcomes by allowing for more individualized attention and support for students.

NLJ: Very interesting. I guess I'm wrong. I need to dig deeper into this. Decreasing class size is probably unrelated to in-school computing and reflects a trend to improve public schooling. So, there may be two competing trends: 1) Smaller classes from increased investment in schools and 2) larger classes from in-school computer resources. What needs to be asked: Is schooling improving, or are there problems with declining literacy (the basics), math skills, etc.?

Q. AI Robots: Addressing labor shortages and restrictive immigration

NLJ: This exploration started looking at a tech solution (robots) for the societal and business needs caused by the extreme reduction in birth rates in developed countries (initially Japan, but now China, EU, and USA). However, it became evident that robots will ultimately address the shortage of manual labor (currently caused by restrictive immigration policies). Robots will be a significant growth area as current AI methods are applied to using robots in all menial jobs.

Query: Describe the impact of the shortage of manual labor in developed countries due to low birth rates, leading to a future crisis. Particularly considering when coupled with limiting immigration or restrictive immigration policies.

[Link to Perplexity](#)

The shortage of manual labor in developed countries, driven by declining birth rates and restrictive immigration policies, is poised to create significant economic and social challenges. This issue is particularly pronounced in high-income countries where the birth rate has fallen below the replacement level needed to maintain population size over time^{2,3}.

Impact of Declining Birth Rates

- **Labor Shortages:** As birth rates decline, the working-age population shrinks, leading to labor shortages. This demographic shift results in fewer workers available to support economic growth and maintain public services like healthcare and social security^{2,4}. The ratio of working-age individuals to retirees is decreasing, which strains pension systems and increases the burden on the working population².
- **Economic Growth:** A reduced labor force can hinder economic growth by limiting the availability of workers needed for various industries. This could slow down productivity and innovation, especially in sectors that rely heavily on manual labor^{4,6}. Additionally, a smaller workforce can lead to increased wages as businesses compete for fewer available workers, potentially fueling inflation².
- **Social Security Systems:** With an aging population and fewer young people entering the workforce, social security systems face sustainability challenges. There will be increased pressure on public finances to provide for a growing number of retirees with a shrinking tax base⁴.

Role of Immigration

Immigration has historically played a crucial role in mitigating labor shortages in developed countries. Immigrants often fill gaps in the labor market, particularly in low-wage and manual labor sectors^{1,7}. However, restrictive immigration policies can exacerbate labor shortages by limiting the inflow of foreign workers who could otherwise help maintain economic stability⁵.

- **Economic Contributions:** Immigrants contribute significantly to the economy by increasing the labor supply and filling essential roles that native-born workers may not be available or willing to take⁷. They also contribute to entrepreneurship and innovation, with immigrants often more likely than natives to start new businesses⁵.
- **Policy Implications:** To address these challenges, countries may need to reconsider their immigration policies to allow for a more flexible and responsive system that can adapt to labor market needs^{1,5}. This could involve easing restrictions on visas and creating pathways for immigrants to enter sectors experiencing shortages.

Potential Solutions

- **Pro-Natal Policies:** Some countries are implementing policies to encourage higher birth rates, such as financial incentives for families, improved parental leave, and childcare support³. These measures aim to make it easier for families to have more children.
- **Gender Equality and Workforce Participation:** Increasing female participation in the workforce can help offset some of the labor shortages caused by declining birth rates. Policies that support gender equality and provide better access to childcare can encourage more women to enter and remain in the workforce⁸.
- **Technological Advancements:** Automation and technological innovations may help alleviate some of the pressures from labor shortages by increasing productivity with fewer workers. However, this also requires investment in education and training to equip workers with the necessary skills for a changing job market.

In summary, developed countries facing declining birth rates must navigate complex challenges related to labor shortages and economic sustainability. Balancing immigration policies with domestic initiatives aimed at boosting fertility rates and enhancing workforce participation will be critical in addressing these issues effectively.

How soon can AI in robotics address the labor shortage crisis?

AI and robotics are increasingly seen as viable solutions to address labor shortages in developed countries. The integration of AI in robotics offers several advantages that can help mitigate the impact of declining birth rates and restrictive immigration policies on the labor market.

Current and Future Impact of AI in Robotics

- **Automation of Repetitive Tasks:** AI-equipped robots are already being used to automate repetitive, hazardous, and physically demanding tasks across various industries, including manufacturing, logistics, and retail. These robots can work continuously without fatigue, significantly boosting productivity and efficiency^{1,4,5}.
- **Advanced Capabilities:** AI enhances the capabilities of robots by enabling them to perform complex tasks with precision and consistency. For example, AI-powered robots in manufacturing can handle high-variance tasks, optimize processes, and perform predictive maintenance⁸. In logistics, they can autonomously transport goods and manage inventory⁴.
- **Humanoid Robotics:** The development of humanoid robots is progressing and holds promise for filling gaps in manual labor. By 2030, humanoids could fill a portion of the labor shortage gap in sectors like manufacturing². However, achieving commercial viability for humanoids requires overcoming significant technological challenges related to motion, manipulation, perception, and energy efficiency².
- **Economic Impact:** By 2040, it is estimated that the U.S. could have 8 million working humanoid robots, with a substantial impact on wages and productivity⁷. This adoption could accelerate as industries facing labor shortages increasingly turn to automation solutions.

Timeline for Addressing Labor Shortages

While AI and robotics are making strides in addressing labor shortages, the timeline for fully resolving these issues depends on several factors:

- **Technological Advancements:** Continued innovation is required to enhance the capabilities of robots and reduce costs. AI technologies need to become more sophisticated to handle unstructured environments effectively^{2,7}.

- **Adoption Rates:** The speed at which industries adopt AI-powered robotics will influence how quickly labor shortages are alleviated. Current trends suggest that automation adoption is accelerating, with significant growth in industrial and service robot installations^{5,8}.
- **Regulatory and Social Acceptance:** The integration of robotics into the workforce will also depend on regulatory frameworks and societal acceptance. There may be resistance due to concerns about job displacement and the need for new skills training⁷.

Overall, while AI in robotics offers promising solutions to labor shortages, it is unlikely to fully address the crisis in the immediate future. Significant progress is expected by 2030, with further advancements anticipated by 2040 as technology matures and becomes more widely adopted across industries.

In what applications has robotics taken significant advances in the last 5 years? Why?

NLJ: Curious omissions in the following responses: Drone applications are not mentioned - both in public and military use (armed and unarmed drones have changed the battlefield). Nor military applications where robots are used for reconnaissance, equipment packing, and offense, including when armed. Why? Are these applications not being captured in the references of Perplexity? Swarming is mentioned in passing but is probably the greatest advancement in surveillance.

See [this list of 5 new advances in robotics](#), including Collaborative Robots or Cobots, that work with humans to address labor shortages.

In the past five years, robotics has advanced significantly across various applications:

- **Manufacturing and Automation:** Robotics has transformed production processes by increasing productivity, adaptability, and safety through AI integration and collaborative robots (cobots) that work alongside humans.
- **Healthcare:** Medical robotics have improved surgical precision and reduced recovery times, with robots performing intricate procedures like prostate cancer surgeries.
- **Logistics and Supply Chain:** Robots are used for stacking shelves, retrieving goods, and conducting deliveries, enhancing efficiency in logistics.
- **Agriculture:** Agricultural robots are optimizing yield and resource use, contributing to a third agricultural revolution.

These advancements are driven by labor shortages, technological innovations in AI and machine learning, and the need for efficiency and safety improvements across industries.

How has AI integration improved the capabilities of mobile robots in industries

AI integration has significantly enhanced the capabilities of mobile robots in various industries:

- **Autonomous Navigation:** AI enables mobile robots to navigate complex and dynamic environments autonomously, using technologies like deep reinforcement learning for efficient path planning and obstacle avoidance.
- **Process Automation:** AI-powered mobile robots can automate tasks such as sorting, quality assessment, and inventory management, improving efficiency and reducing errors in logistics and manufacturing.
- **Fleet Management:** AI enhances fleet management systems by optimizing robot deployment, managing traffic patterns, and ensuring continuous operation through automated recharging and maintenance.

These advancements are driven by the need for increased productivity, flexibility, and safety in industries facing labor shortages and rising demands.

How do AI-powered mobile robots handle unpredictable environments

AI-powered mobile robots handle unpredictable environments through several advanced capabilities:

- **Real-Time Environmental Understanding:** AI algorithms enable robots to perceive and interpret their surroundings using technologies like LIDAR, computer vision, and deep learning. This allows them to navigate complex terrains and adapt to changing conditions without relying on static maps. (NLJ: swarms of drones are the greatest advancement in area surveillance.)
- **Dynamic Path Planning:** AI facilitates real-time path planning, allowing robots to avoid obstacles and optimize routes as conditions change. Techniques like deep reinforcement learning enable robots to learn from their interactions and improve over time.
- **Collaborative Adaptation:** AI enhances fleet management by coordinating multiple robots, optimizing their tasks, and managing traffic patterns in dynamic environments, ensuring efficient operation even in high-traffic areas. (NLJ: a variation of swarming)

R. Predictive challenges best solved by collective intelligence

NLJ: This is a remarkably accurate response, given that the science of collective intelligence has been accepted as valid in the last two decades (some still criticize it).

There are inaccuracies, such as diversity is needed to reduce bias. While true, the better answer is that diversity is the engine of collective intelligence and is required even without bias. Otherwise, the collective aggregation will just reproduce the individual solution. A diversity of uncorrelated biases is required to eliminate bias if it exists (see my research on this). Hence, diversity occurs in multiple dimensions: unbiased solutions to the problem and biases in viewing the problem.

[Link to Perplexity response with references](#)

What type of prediction challenges (such as counting beans in a jar or the weight of a cow) does the aggregation of diverse guesses by people excel, commonly called collective intelligence?

The aggregation of diverse guesses by people, commonly referred to as collective intelligence or wisdom of the crowd, excels in prediction challenges where there is a correct answer that can be estimated from multiple independent judgments. This phenomenon works particularly well in tasks that involve:

1. Estimation Tasks (e.g., Counting Beans in a Jar, Weight of a Cow)

One of the most famous examples of collective intelligence comes from a 1906 experiment at a county fair, where participants were asked to guess the weight of an ox. The average guess of the crowd was remarkably close to the actual weight, outperforming most individual guesses. Similarly, tasks like estimating the number of beans in a jar or other numerical estimations benefit from the crowd's ability to cancel out individual errors, leading to an accurate collective estimate^{2,6}.

2. Prediction Markets

Collective intelligence is also highly effective in prediction markets, where participants predict future events such as election outcomes or product success. The aggregation of diverse opinions tends to produce highly accurate forecasts because it draws on varied knowledge and perspectives, reducing biases and errors^{2,5}. For example, prediction markets have been shown to outperform individual experts in forecasting political events and market trends.

3. General Numerical Estimations

Tasks that require estimating quantities, percentages, or dates (e.g., "What percentage of internet users connect from China?" or "When was electricity discovered?") also benefit from collective intelligence. By averaging independent guesses from a diverse group, random errors tend to cancel each other out, leading to more precise results⁴.

4. Complex Problem Solving

In more complex problems, such as predicting technological advancements or solving multidisciplinary challenges, collective intelligence thrives when the problem requires input from various fields of expertise. The diversity of knowledge and perspectives leads to more innovative solutions⁵.

Key Principles for Success

The success of collective intelligence in these tasks is based on several principles:

- Diversity of Perspectives: A wide range of backgrounds and experiences ensures that different viewpoints are considered, reducing bias².
- Independence: Individuals must make their judgments independently to avoid groupthink and herding behavior².
- Aggregation Mechanism: A reliable method for combining individual judgments (e.g., averaging) is crucial for producing an accurate collective estimate⁴.

Limitations of simple aggregation

While collective intelligence excels in estimation and prediction tasks with clear answers, it is less effective when:

- There is no definitive answer (e.g., subjective opinions).
- The crowd lacks diversity or independence.
- Systematic biases affect all participants similarly⁴.

In summary, collective intelligence is particularly powerful in tasks involving numerical estimations and predictions where diverse and independent inputs can be aggregated effectively.

S. Collective intelligence applied to solve complex scientific problems

[Link to Perplexity response with references](#)

Yes, collective intelligence can indeed be applied to solve complex scientific problems. This approach leverages the diverse knowledge, perspectives, and skills of large groups of people, often facilitated through technology, to address issues that are too challenging for individuals or small teams to solve alone. Here are some key ways collective intelligence is applied in scientific problem-solving:

1. Crowdsourcing in Scientific Research

Crowdsourcing allows researchers to gather and analyze large datasets, accelerating the research process and reducing costs. This method has been successfully used in fields such as astronomy, ecology, medicine, and history. For instance, citizen science projects enable non-experts to contribute to data collection and analysis, significantly expanding the scope and speed of research efforts^{1,2}. Examples include projects like classifying galaxies (e.g., Galaxy Zoo) or tracking animal migrations.

2. Multidisciplinary Collaboration

Complex scientific problems often require input from multiple disciplines. Collective intelligence thrives in such environments by bringing together experts from different fields to collaborate on solutions. This cross-disciplinary collaboration speeds up discovery and leads to more innovative solutions than isolated efforts^{6,9}. For example, tackling global challenges like climate change or pandemics requires expertise from biology, economics, social sciences, and technology.

3. Distributed Problem-Solving Platforms

Platforms that facilitate large-scale collaboration across geographic boundaries are increasingly used in science. These platforms allow scientists and non-scientists alike to contribute ideas, analyze data, or even develop new hypotheses. By aggregating diverse inputs, these platforms help solve problems that would be difficult for smaller groups to address^{2,9}. For instance, open-source software development or public contests for innovation are examples of how collective intelligence can generate creative solutions.

4. Collective Intelligence in Medical Decision-Making

In fields like medicine, collective intelligence has been shown to improve decision-making processes by pooling the knowledge of multiple experts. Studies have demonstrated that groups using collective intelligence can outperform individual experts in tasks such as diagnosis or treatment planning by synthesizing diverse opinions through technology platforms⁴. This approach is particularly useful when dealing with complex medical cases where no single expert has all the answers.

5. Predictive Modeling and Data Analysis

Collective intelligence is also applied in predictive modeling tasks where large datasets need to be interpreted or future events predicted. By combining human intuition with machine learning algorithms, crowdsourced data can be used to build more accurate models and forecasts⁹. This hybrid approach is especially useful in fields like epidemiology or environmental science where predictions must account for complex systems with many variables.

Key Benefits of Collective Intelligence in Science

- *Diverse Perspectives*: Collective intelligence brings together a wide range of viewpoints that can lead to more comprehensive solutions.
- *Scalability*: Crowdsourcing allows for large-scale data collection and analysis that would be impossible for small teams.
- *Cost Efficiency*: Utilizing the input of non-experts or volunteers reduces costs while still maintaining high-quality research outcomes.
- *Innovation*: Multidisciplinary teams foster creativity and innovation by combining knowledge from different fields.

In summary, collective intelligence is a powerful tool in solving complex scientific problems by leveraging the knowledge and skills of diverse groups through collaboration and technology^{1,2,6}.

T. Development of logic-based AI models and resources

[Link to perplexity response](#)

If prior AI resources largely perform by reproducing aggregate patterns found in training data, what successes have been made in developing AI resources that model logical reasoning, not just pattern matching? A past example might be chess-playing models.

While many AI systems have traditionally relied on pattern recognition and statistical models, significant advancements have been made in developing AI that can perform logical reasoning, moving beyond mere pattern matching.

Below are some key examples and approaches that showcase this evolution:

Chess-Playing Models as Early Examples

One of the earliest successes in AI reasoning was IBM's Deep Blue, which famously defeated world chess champion Garry Kasparov in 1997. This system used a combination of brute-force search and rule-based logic to evaluate millions of possible moves, leveraging predefined rules of chess to reason about optimal strategies. Deep Blue's success was not due to pattern matching but rather its ability to reason through a vast number of potential future game states⁵.

Neuro-Symbolic AI: Merging Learning with Logic

A major leap forward has been the development of neuro-symbolic AI, which integrates neural networks (good at learning from data) with symbolic reasoning (good at logical inference). This approach allows AI systems to learn from data while also using formal logic to reason about the world. For example, IBM's Project Debater combines data-driven insights with symbolic reasoning to debate complex topics, and Google DeepMind's AlphaGeometry uses neuro-symbolic techniques to solve complex geometry problems^{5,2}. These models are capable of handling ambiguity and smaller datasets more efficiently than traditional neural networks.

Reinforcement Learning and Logical Reasoning

Reinforcement learning (RL) has also been applied to logical reasoning tasks. For instance, Google DeepMind's AlphaZero used RL to master games like Go and chess without relying on human data. More recently, RL has been used in automated theorem proving, where agents learn to prove mathematical statements by reasoning through logical steps^{2,4}. This combination of RL with logical reasoning enables systems to tackle complex decision-making tasks that require hierarchical planning and backtracking.

Large Language Models (LLMs) and Reasoning

Although large language models (LLMs) like GPT-4 are primarily based on next-token prediction, recent research has focused on enhancing their reasoning capabilities. Techniques such as chain-of-thought prompting and least-to-most prompting help LLMs break down complex problems into simpler subproblems that they solve sequentially³. These methods improve the models' ability to handle tasks requiring logical planning, such as mathematical problem-solving or structured decision-making.

For example, DeepMind's AlphaProof demonstrated advanced reasoning by solving formal mathematical problems at the International Mathematical Olympiad level. This system translates informal math problems into formal logic statements, allowing it to reason through proofs using reinforcement learning techniques⁴.

Reasoning AI: A New Paradigm

A more recent development is the emergence of models like Reasoning AI, which explicitly mimic human logical thought processes. Unlike traditional machine learning models that rely on pattern recognition, Reasoning AI applies formal logic operators (such as AND, OR, NOT) to evaluate statements and draw

conclusions¹. This allows it to solve complex problems across various domains, including healthcare and finance, by reasoning through data rather than merely recognizing patterns.

Challenges and Future Directions

Despite these advancements, challenges remain in creating AI systems that can fully replicate human-like reasoning. For instance, LLMs still struggle with tasks like chess puzzles due to their reliance on token-based prediction rather than true understanding of game mechanics⁷. However, ongoing research in neuro-symbolic AI and reinforcement learning continues to push the boundaries of what is possible in terms of integrating logic with learning.

In summary:

- Early examples like Deep Blue used rule-based logic for reasoning.
- Neuro-symbolic AI combines neural networks with symbolic logic for more robust decision-making.
- Reinforcement learning has been applied to logical tasks like theorem proving.
 - NLJ: I'd argue that reinforcement learning is NOT a logic-based model. The training data is from logic-based problems. Not the same thing.
- LLMs are being enhanced with techniques like chain-of-thought prompting for better reasoning.
 - NLJ: a sequence of aggregated steps is not a logic-based model. But certainly one first step of more complex logic problems. Logic problems can be singular - requiring one solution or multiple steps, such as math proofs.
- Reasoning AI represents a new class of models designed specifically for logical deduction.

These developments suggest that while pattern recognition remains a foundational aspect of many AI systems, significant strides have been made in modeling logical reasoning within artificial intelligence.

U. How computer designs can outperform human abilities

How has computer design of integrated circuits achieved what is undoable by human computer-aided design? (Follow-up query has more examples)

[Link to Perplexity](#)

The design of integrated circuits (ICs) has reached a level of complexity that surpasses the capabilities of traditional human-driven computer-aided design (CAD). The introduction of computer-aided design (CAD) tools and electronic design automation (EDA) has enabled the achievement of tasks that are virtually impossible for humans to perform manually. These tools have transformed IC design by automating processes, reducing errors, and handling the immense scale and intricacies of modern chips.

Here are several key ways in which computer-aided IC design has surpassed what is achievable by human designers alone:

1. Handling Complexity at Scale

Modern integrated circuits contain billions of transistors, and the complexity of designing such systems is beyond what humans can manage without automation. CAD and EDA tools allow designers to work at higher levels of abstraction, such as the register-transfer level (RTL) or even at behavioral levels, where they can focus on system functionality rather than individual components like transistors or logic gates. These tools can automatically convert high-level descriptions into detailed designs, including logic gates and physical layouts^{1,2}.

2. Automation of Repetitive and Tedious Tasks

Many aspects of IC design involve repetitive tasks, such as placing components and routing connections between them. Manually performing these tasks would be time-consuming and error-prone. EDA tools automate these processes through place-and-route algorithms, which optimize the layout for performance, power consumption, and area (PPA). This automation significantly speeds up the design process while improving accuracy³.

3. Simulation and Error Detection

Before the physical chip is manufactured, CAD tools simulate its behavior under various conditions to detect potential errors. This includes both logic simulation (to verify that the circuit performs correctly) and transistor-level simulation (to ensure that the physical properties of transistors behave as expected). These simulations can account for variations in manufacturing processes, temperature fluctuations, and other real-world factors that would be difficult for human designers to predict^{1,4}.

4. Optimization Beyond Human Capability

IC design involves optimizing multiple parameters simultaneously, such as power consumption, performance, and area (PPA). Achieving an optimal balance among these parameters is a multi-dimensional problem that is extremely challenging for humans to solve manually. Advanced methodologies like deep learning are now being employed to optimize circuit layouts by learning from high-dimensional data representations. Deep learning models can predict performance metrics more accurately than traditional methods and handle complex interactions between design constraints⁸. These models can also identify optimization opportunities that human designers might overlook.

5. Design Verification and Testing

As IC designs grow more complex, verifying that a chip will function correctly becomes increasingly difficult. EDA tools provide extensive verification capabilities through techniques such as formal verification, which mathematically proves that a design adheres to its specifications. Additionally,

hardware emulation allows designers to test their designs in real-time environments before fabrication^{2,7}. These tools ensure higher reliability and reduce the likelihood of costly post-manufacturing errors.

6. Integration with Machine Learning

Recent advancements have integrated machine learning techniques into IC design workflows to further enhance optimization and decision-making processes. For example, deep reinforcement learning (DRL) has been applied to layout optimization problems, significantly improving the quality and efficiency of design decisions by continuously learning from simulated environments⁸. This represents a paradigm shift in how ICs are designed, moving towards more intelligent, adaptive systems that can handle increasingly complex challenges.

Conclusion

Computer-aided design tools have revolutionized integrated circuit design by automating tasks that are too complex or tedious for human designers. These tools enable designers to work at higher levels of abstraction, optimize designs more efficiently, simulate real-world conditions before manufacturing, and verify correctness with greater precision. As technology continues to evolve—**with the incorporation of machine learning techniques**—computer-driven IC design will continue to achieve what is undoable by traditional human methods alone.

Follow-up question: What are other examples of computer designs without human oversight or with minimal human oversight that outperform what a human can design? Human design can include computer support and use, such as simulations or analysis directed by a human.

NLJ: Note that most of these examples do not use the recent innovations in AI (massive LLM or collections of sub-LLMs), but standard decision methods available over the last 30 years. Yet, the Perplexity text identifies them as “AI-generated,” which illustrates my point that AI has subsumed all older statistical prediction methods, genetic algorithms, convergence algorithms in complex landscapes (like steepest ascent with randomness), neural networks, etc.

There are several areas where computer designs, with minimal or no human oversight, have outperformed human designs, even when humans use computer support such as simulations or analysis tools. These examples span various fields and demonstrate how AI and computational techniques can surpass human capabilities in terms of speed, complexity handling, and optimization.

1. Generative Design in Architecture

Generative design is a process where AI algorithms generate numerous design options based on predefined constraints and goals. In architecture, this approach allows for the creation of building layouts and structures that are optimized for factors like spatial efficiency, lighting, ventilation, and material use. AI can explore vast design spaces far beyond what a human architect could manually conceive. For example, AI-generated designs can optimize for environmental factors such as sunlight exposure or wind flow, producing structures that are more energy-efficient and sustainable than traditional designs. This process is already being used by companies like Voxel and Archilimetrics to develop optimized floor plans and window configurations¹.

2. Genetic Algorithms in Urban Planning

Genetic algorithms (GAs), inspired by natural selection, are used to optimize complex systems by iterating through generations of potential solutions. In urban planning and architecture, GAs can handle multi-objective optimization problems that involve conflicting requirements such as structural integrity, aesthetic appeal, sustainability, and cost. These algorithms simulate the evolutionary process by selecting the “fittest” designs from a pool of possibilities and combining their traits to produce new generations of solutions. This method has been shown to outperform traditional human-driven design processes by finding novel solutions that balance multiple competing factors more effectively².

3. Deep Learning in Integrated Circuit (IC) Design

Deep learning has revolutionized the design of integrated circuits by automating feature extraction and pattern recognition tasks that were previously handled manually. Neural networks can navigate vast design spaces to identify Pareto-optimal solutions that balance power consumption, performance, and area (PPA) considerations more efficiently than human designers using conventional methods. These models can predict critical design parameters early in the process, allowing for proactive adjustments that improve manufacturability and reduce errors⁴. The ability of deep learning models to generalize across diverse scenarios makes them superior to traditional rule-based or iterative optimization methods.

4. AI in Video Game Strategy

In video games, AI systems like Google's DeepMind have demonstrated superior performance over human players in games such as Atari Breakout and Go. These systems use deep reinforcement learning to learn game strategies without any predefined instructions or programming. Over time, they outperform even expert human players by discovering strategies that humans might not have considered. The AI's ability to play continuously without fatigue allows it to explore a much larger space of possible strategies than a human could³.

5. Automated Website Design

AI-driven website builders can analyze user interactions and conversion rates to automatically modify website designs for better performance. These systems use machine learning algorithms to identify patterns in user behavior and adjust site layouts accordingly—often producing more effective designs than those created by human designers working manually³. The AI's ability to continuously learn from data allows it to make real-time improvements based on user feedback.

6. Autonomous Vehicle Navigation

(NLJ: not really an example where it outperforms humans, but over time, some dimensions of higher performance are likely, e.g., fewer auto deaths because AI drivers don't drink or fall asleep at the wheel.)

Self-driving cars rely on AI systems that can adapt to complex environments far beyond what pre-programmed systems or human drivers could manage alone. While current autonomous vehicles depend on maps and sensors, future implementations of artificial general intelligence (AGI) could allow vehicles to make complex decisions in real time based on real-world conditions like traffic patterns or weather changes⁵. These systems would be able to learn from experience and adapt dynamically to new situations without requiring constant human oversight.

Conclusion

In each of these examples—whether it's generative design in architecture, genetic algorithms in urban planning, deep learning in IC design, or AI in video game strategy—**computer-driven designs outperform human-directed efforts by exploring larger solution spaces, optimizing multiple objectives simultaneously, and adapting dynamically to changing conditions.** As AI technologies continue to advance, we can expect even more areas where computer designs will surpass what humans can achieve with traditional methods. (NLJ: I'd say "adapting dynamically" is redundant: any adaptation is dynamic. Illustrates how AI is no better than its training data. I would have said "adapting rapidly.")

V. Creating LLM simulated (synthetic) individuals - report Nov 2024

[Link to report on arxiv](#) (from Brian Laughlin) [Perplexity summary of report and analysis](#)

Perplexity inquiry: *Summarize this paper. Does the study examine collective behavior or do they suggest the simulated individuals are now available in studies of collective behavior. For example, the introduction says: " When simulated individuals are combined into collectives, these simulations could help pilot interventions, develop complex theories capturing nuanced causal and contextual*

interactions, and expand our understanding of structures..." Did the study combine simulated individuals into collectives?

The paper titled "Generative Agent Simulations of 1,000 People" introduces a novel agent architecture that simulates the attitudes and behaviors of 1,052 real individuals. These generative agents are designed by applying large language models (LLMs) to qualitative interviews about the lives of the individuals they represent. The study evaluates how well these agents replicate the attitudes and behaviors of their human counterparts across various domains.

Key Findings

- The agents replicate participants' responses on the General Social Survey with 85% accuracy, comparable to how participants replicate their own answers two weeks later.
- The agents also perform well in predicting personality traits and outcomes in experimental replications.
- The architecture reduces biases in accuracy across racial and ideological groups compared to agents that rely solely on demographic descriptions.

Does the Study Examine Collective Behavior?

The paper explicitly states that it provides a foundation for tools to investigate both individual and collective behavior. However:

- The focus of the study is primarily on simulating individual attitudes and behaviors.
- While the introduction mentions the potential for combining simulated individuals into collectives to explore interventions or theories, there is no indication in the abstract or available details that this study actively combined agents into collectives or analyzed emergent collective behaviors.

In summary, this study focuses on validating the fidelity of individual-level simulations and highlights their potential for future applications in studying collective behavior. It does not appear to have directly simulated collectives or examined collective dynamics in this work.

NLJ summary: The report demonstrates that LLMs can synthesize human entities with unique opinions, belief, knowledge to 85% accuracy (I think this is largely meaningless - see my comments below). While the testing is narrow, the demonstration proves that synthetic individuals can be created using minimal data (short interviews). What I'm proposing is using much more detailed data. What isn't done by the authors is to assess the ability of the synthetic human to be a resource for specific expertise, such as knowledge to repair something or to solve a business problem.

My analysis follows.

I'd call this a study in synthetic person generation for individual behavior (not behavior in collectives). And not extrapolative, but interpolative (doesn't predict behavior outside of the training).

Their metric for success is: can a synthetic person reproduce similar responses from the human source? Yes, to a large degree (85%).

But I didn't see a discussion that includes how human responses show a variation of results. Few people will answer the same question identically if the prior answer was forgotten. Does the synthetic human show random variation? (It's possible the synthetic human doesn't show variation but the human does). Humans aren't deterministic in anything so why should AIs be?

The study says it contributes to collective behavior (not just individual behavior), but I don't see any modeling or tests of collective behavior (except statistical behavior a collective of individuals). So the simulations were NOT of 1000 people together, as suggested in the title, but 1000 individual simulations of 1000 individuals. Smells like a snake oil salesman.

What I'd be interested in: Use Meyers-Briggs to categorize each of the 1000 subjects into the 16 types. Then apply different M-B tests to the synthetic humans. Humans will reproduce their prior types within 2 weeks normally. My guess is that the synthetic human will not, because new questions will not have the same pattern matching to the AI. Have you ever taken M-B tests. Humans can duplicate behavior in different situations that trigger the same personality traits, but AI I'm sure can't. I think all AIs should take M-B tests to determine how likely they are to be social aggressive, creative, etc. Would make a great study and paper.

There are a huge number of questions that aren't addressed: While you can simulate an individual accurately, that says nothing about how individuals connect and interact with other individuals, how they form social groups or reject groups, etc. So, the suggestion that the study provides a foundation for investigating collective behavior is woefully poor.

X. How new technologies change society through history

[Link to Perplexity response.](#)

Perplexity query: Provide historical examples of how new technologies radically disrupted and transformed human societies, including how these technologies were integral to the greatest societal changes, such as nomadic to the formation of city-states, the Industrial Revolution, and the Information Age.

Throughout history, transformative technologies have disrupted and reshaped human societies, driving profound changes in social organization, economies, and daily life. Below are key historical examples of such disruptions:

1. The Neolithic Revolution: From Nomadic Life to Settled Societies

The Neolithic Revolution (circa 10,000 BCE) marked humanity's transition from hunting and gathering to agriculture and settlement. This shift was driven by technological innovations such as:

- **Agriculture:** The domestication of plants and animals enabled stable food supplies, fostering population growth and the establishment of permanent settlements.
- **Irrigation:** Techniques for managing water resources supported farming in arid regions like Mesopotamia and Egypt.
- **Specialized Tools:** Grinding stones, plows, and pottery improved food production and storage. These advancements led to the rise of social hierarchies, trade networks, and early city-states like Uruk in Mesopotamia. Societies became more complex as surpluses allowed for specialized labor, such as artisans and administrators [1,4](#).

2. The Industrial Revolution: Mechanization and Urbanization

Beginning in the late 18th century in Britain, the Industrial Revolution transformed agrarian economies into industrial powerhouses. Key technologies included:

- **Steam Engines:** Powered factories, transportation (trains and ships), and mechanized production.
- **Textile Machinery:** Innovations like the spinning jenny revolutionized fabric production.

- Iron and Steel: Enabled large-scale construction of railways, bridges, and machinery. This era saw mass migration to urban centers as factory jobs replaced agricultural work. While it increased productivity and lowered costs of goods, it also introduced challenges such as overcrowded cities, poor working conditions, and environmental pollution. It fundamentally altered social structures by creating a large industrial working class and a growing middle class [2,5,7](#).

3. The Information Age: Digital Transformation

The late 20th century witnessed the advent of the Information Age, driven by technologies like microprocessors, personal computers, and the internet:

- Computing Power: The 1971 introduction of microprocessors enabled rapid data processing.
- The Internet: By the 1990s, global connectivity revolutionized communication, commerce, and access to information.
- Artificial Intelligence (AI): Emerging in recent decades, AI is reshaping industries from healthcare to transportation. This era has democratized knowledge but also introduced challenges such as digital divides, privacy concerns, and economic disruptions due to automation. It has redefined work through remote collaboration tools and created entirely new industries [2,3,6](#).

4. Other Transformative Technological Disruptions

- Transportation Innovations: Canals (1790s), railroads (19th century), automobiles (20th century), and airplanes transformed trade, travel, and urban planning [2,5](#).
- Communication Advances: The telegraph (1830s), telephone (1870s), radio (early 20th century), and satellites revolutionized how information is shared globally [1,7](#).
- Energy Transitions: From wood to coal during the Industrial Revolution to oil in the 20th century and renewable energy today, energy sources have shaped economies and geopolitics.

Patterns of Technological Disruption

Technological disruptions often follow a predictable pattern:

1. A new technology emerges that is cheaper or more efficient than existing solutions.
2. Adoption accelerates as costs decline and performance improves.
3. Old systems are displaced rapidly (e.g., steam engines replacing manual labor or digital media replacing print).
4. Societal structures adapt over time to integrate new systems [6](#).

Conclusion

Technological revolutions have been integral to humanity's greatest societal transformations—shifting from nomadic lifestyles to settled civilizations during the Neolithic Revolution, industrializing economies in the 18th century, and digitizing global systems in the Information Age. These transitions have brought immense benefits but also significant societal challenges that require adaptation at individual, institutional, and global levels.

Y. Piaget's theory of cognitive development and AIs

[Link to Perplexity response](#)

NLJ: Note the interesting fact that only 30-60% of adults are found to be in Piaget's final stage of generalized reasoning. As an undergraduate at UCSD, I took an experimental psych class for majors where we did experiments on student volunteers to determine if they operated in Stage 3 or Stage 4, using simple physics tests. The class found that even college students are in the low range of 30%!! The prof was not surprised but the students were aghast at their peers. (I think I was in stage 4 very young maybe from my science interests.) Think about that next time you speak to an adult: It's likely that they can only think by applying observed patterns, but can't generalize those patterns to other applications.

Query: Summarize Piaget's theory of cognitive development in the transition from children to adults. Provide statistics on the percentages of adults in each stage by their 20s.

Jean Piaget's theory of cognitive development outlines four distinct stages through which individuals progress from infancy to adulthood. These stages reflect qualitative changes in how people think and understand the world as they mature biologically and interact with their environment.

Piaget's Four Stages of Cognitive Development

1. *Sensorimotor Stage* (Birth to ~2 years): Infants learn through sensory experiences and motor actions. Key milestones include developing object permanence—understanding that objects exist even when not seen.
2. *Preoperational Stage* (~2 to 7 years): Children begin using symbolic thought (e.g., language and pretend play) but are limited by egocentrism (difficulty seeing perspectives other than their own) and lack logical reasoning. They focus on centration, or concentrating on one aspect of a situation while ignoring others.
3. *Concrete Operational Stage* (~7 to 11 years): (NLJ: “Concrete” means pattern recognition without the ability to generalize to different situations.) Logical thinking emerges, particularly about concrete objects and events. Children master concepts such as conservation (understanding that quantity remains the same despite changes in shape) and develop inductive reasoning but struggle with abstract ideas.
4. *Formal Operational Stage* (12 years and older): Adolescents and adults develop the ability to think abstractly, reason systematically, and test hypotheses mentally. This stage supports scientific reasoning, problem-solving, and understanding complex concepts like justice or love.

Transition from Childhood to Adulthood

The transition from childhood to adulthood involves moving from the concrete operational stage into the formal operational stage. However, Piaget noted that not all individuals fully achieve formal operational thinking, even as adults.

Statistics on Adults in Cognitive Stages

- Research indicates that 30–60% of adults remain in the concrete operational stage during their 20s, relying on logical but concrete reasoning rather than abstract thought [2,3](#).
- The percentage of adults who consistently operate at the formal operational level is lower, with many demonstrating formal operational thinking only in specific areas where they have expertise or experience [2](#).

Implications

This variability suggests that cognitive development is influenced by both biological maturation and environmental factors, such as education and exposure to abstract reasoning tasks. While formal operational thinking enables advanced problem-solving and abstract reasoning, many adults function effectively in daily life using concrete operational thought.

Piaget's theory highlights that cognitive development is not uniform across individuals or domains of knowledge, emphasizing the importance of tailored educational approaches to foster higher-order thinking skills.

Query: Has Piaget's Four Stages of Cognitive Development been evaluated for AI systems, such as ChatGPT, etc.?

Piaget's *Four Stages of Cognitive Development* have been evaluated as a framework for understanding and designing artificial intelligence (AI) systems, particularly in the context of machine learning, reinforcement learning, and artificial general intelligence (AGI). Researchers and theorists have drawn parallels between Piaget's stages and the developmental processes of AI systems, exploring how concepts like schemas, assimilation, accommodation, and readiness can inform AI design.

Applications of Piaget's Theory in AI Systems

1. *Parallels Between Human and AI Learning:*

- Piaget's stages describe how humans progress from simple sensory-motor interactions to abstract reasoning. Similarly, AI systems evolve from basic data processing to more complex reasoning tasks as they are exposed to larger datasets and more sophisticated algorithms.
- For example, neural networks in AI mimic the strengthening of neural connections in human brains, akin to Piaget's concept of schema formation and adaptation through assimilation and accommodation [1,5](#).

2. *Reinforcement Learning Inspired by Piaget:*

- In reinforcement learning (RL), AI systems learn through trial-and-error interactions with their environment. Researchers have proposed computational frameworks that incorporate Piagetian principles, such as schema theory, to enhance the interpretability and adaptability of RL algorithms. These frameworks aim to emulate human-like cognitive processes such as systematicity and inferential coherence [4](#).

3. *Multi-Agent Systems for AGI:*

- A multi-agent system model based on Piaget's theory has been proposed to advance AGI. This approach uses positive reinforcement cycles to simulate cognitive development stages, enabling agents to acquire and organize knowledge in a manner analogous to human learning [2](#).

4. *Constructivist Approaches in AI:*

- Piaget's constructivism emphasizes active learning and readiness—concepts that align with iterative AI training processes like Q-learning or tree-of-thought prompting. These methods allow AI systems to refine their reasoning over time, paralleling the developmental progression seen in humans [5](#).

5. *Educational Tools and Simulations:*

- AI systems informed by Piaget's theory can simulate cognitive processes to predict outcomes or model developmental disorders. This application is particularly useful in educational contexts, where personalized learning systems can adapt to a student's developmental stage [1](#).

Limitations and Ethical Considerations

While Piaget's theory provides valuable insights for designing adaptive AI systems, there are challenges:

- *Abstract vs. Concrete Thinking*: Not all AI tasks require abstract reasoning akin to formal operational thought; many rely on concrete operational processes. (NLJ: Many? Probably All. This is severely understated.)
- *Ethical Concerns*: Applying human developmental models to AI raises questions about bias, fairness, and the ethical implications of creating systems that mimic human cognition [1](#), [3](#).

In conclusion, Piaget's cognitive development theory has influenced AI research by offering a structured framework for understanding learning processes. This approach not only enhances the interpretability of AI systems but also bridges human developmental psychology with artificial intelligence design principles.

NLJ:

While Perplexity's response is helpful for those who don't know about Piaget, above is a cursory treatment of Piaget's work and AI. There is much more that can be said. For example, in humans, Piaget's work describes a system that has evolved to have these stages. But in AI, humans are forcing the development of different stages. What is the difference between these approaches? For example: Evolutionary analysis would ask "what is the fitness criterion(s) that drives evolution?" Presumably, reproduction and passing on genes. But for AI systems, the fitness is strictly performance (accuracy, efficiency, and robustness with sprinkles of ethics), but no mechanism to capture survivability of the whole system or continuation of the coding. (Another way to express it: The [Selfish Gene argument](#) doesn't apply to programming!) Another example is that Piaget's theories for humans are simplified dimensions (wrote learning versus generalized abstraction) of extremely complex expressions of intelligence. For AI systems, the dimensions of intelligence are very narrow. What are the consequences of a narrowly defined evolution of intelligence vs broad intelligence?