

# The Fall of the House of Experts



(The hidden role of diversity in innovative organizations)

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<http://ishi.lanl.gov>

# Themes of the Research Conference

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## How to influence the future...

### ? BIO + POLITICS

- Rational choice is dead

### ? Networks

### ? Emotional and Social life of Information

### ? Evolution

- Sexual politics
- Conflict
- Political communication
- *Health*

### ? *Drugs and the Brain*

# Themes of the Research Conference

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## **[?]** BIO + POLITICS

Many of our models are biologically motivated. Correct?

**[?]** Rational choice is dead

**[?]** Networks

**[?]** Emotional and Social life of information

**[?]** Drugs and the Brain

**[?]** Evolution

- Conflict
- Political communication

# Themes of the Research Conference

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**?** BIO + POLITICS

**?** Rational choice - of the individual - is dead  
Role of emergent properties in systems

**?** Networks

**?** Emotional and Social life of information

**?** Evolution

- Conflict
- Political communication

**?** Drugs and the Brain

# Themes of the Research Conference

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? BIO + POLITICS

? Rational choice (of the individual) is dead

? **Networks - Emotional and Social life of information**

Decentralized systems - How they work?

**What is the role of emotions in a complex system?**

? Evolution

- Conflict
- Political communication

? Drugs and the Brain

# Themes of the Research Conference

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❓ BIO + POLITICS

❓ Rational choice (of the individual) is dead

❓ Networks - Emotional and Social life of information

❓ **Evolution: Conflict - Communication - Cooperation**

A more realistic story of Nature (*and everything else*)

- Stages of evolution - by development
- Two roles of diversity
- Complexity and selection

# Questions to Follow

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- ❓ Answer them for your area.
- ❓ We'll come back to them as examples of the ideas.

# What is your Application area?

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1. Political systems
2. Organizational systems
3. Social systems
4. Economic Systems
5. Combination of the above



# Does your system evolve?

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1. Evolution is random and unpredictable
  - Evolution as dynamic and changing states, but with little prediction.
2. There is progress, but only over long times
  - The system does not make sense on the short term, but does on the long term.
3. Progress continually occurs, except for episodic failures

# Diversity?

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## *1. One homogenous system*

- Same behavior is observed uniformly.

## *2. Diverse, but tightly coupled*

- Different rules apply, but parts are highly interdependent.

## *3. Diverse and loosely coupled*

- Change in one part does not always affect other parts.

# Competitive or Cooperative or ?

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Is your system primarily driven by:

- 1. Competition - survival of the fittest?
- 2. Cooperation - Succeed by getting along
- 3. Methods of success change constantly
- 4. Other methods for success

# What is an Expert?

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- 1. Someone that tell you by what rules to make decisions?*
- 2. Someone that tells you what decisions to make right now (but his rules don't always work)?*

# Miracle of US Productivity/Expansion?

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*Miracle is due to:*

- 1. Lower inventory --> lower costs*
- 2. Banking coordination --> less failure*
- 3. Globalization*
- 4. Information revolution*

# Cause of the Presidential election tie?

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1. Random occurrence
  - Do the vote the next day, and it won't likely happen.
  
2. *Random occurrence this year*
  - Do the vote again and it will likely happen, but not in 4 years.
  
3. *Occurred because of strong processes*
  - It will happen again next year under similar circumstances.

# Natural Selection and Diversity

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Source of variety (mutation, migration, breeding)

**Increase  
Diversity**

Selection - Survival of the fittest

By 1900, 98% of the peppered moths were black

1900

1950

**Lower  
Diversity**

Inheritance of selection

# Disturbing Observations

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*A crisis being caused by timings for evolution based on DNA*

**?** *Lamarckian Evolution (experience is heritable )*

**?** *Experiments by David Wilson et al.*

- Hard selection on a complex population fails



# Competitive or Cooperative or ?

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Is your system primarily driven by:

1. Competition - survival of the fittest?
  - **Is there really failure?**
2. Cooperation - Succeed by getting along
  - Is cooperation fixed or changing?
3. Methods of success change constantly

# What Happens in Stable Environments?

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Source of variety (mutation, migration, breeding)

**Increase  
Diversity**

Selection of previous  
survivor's traits

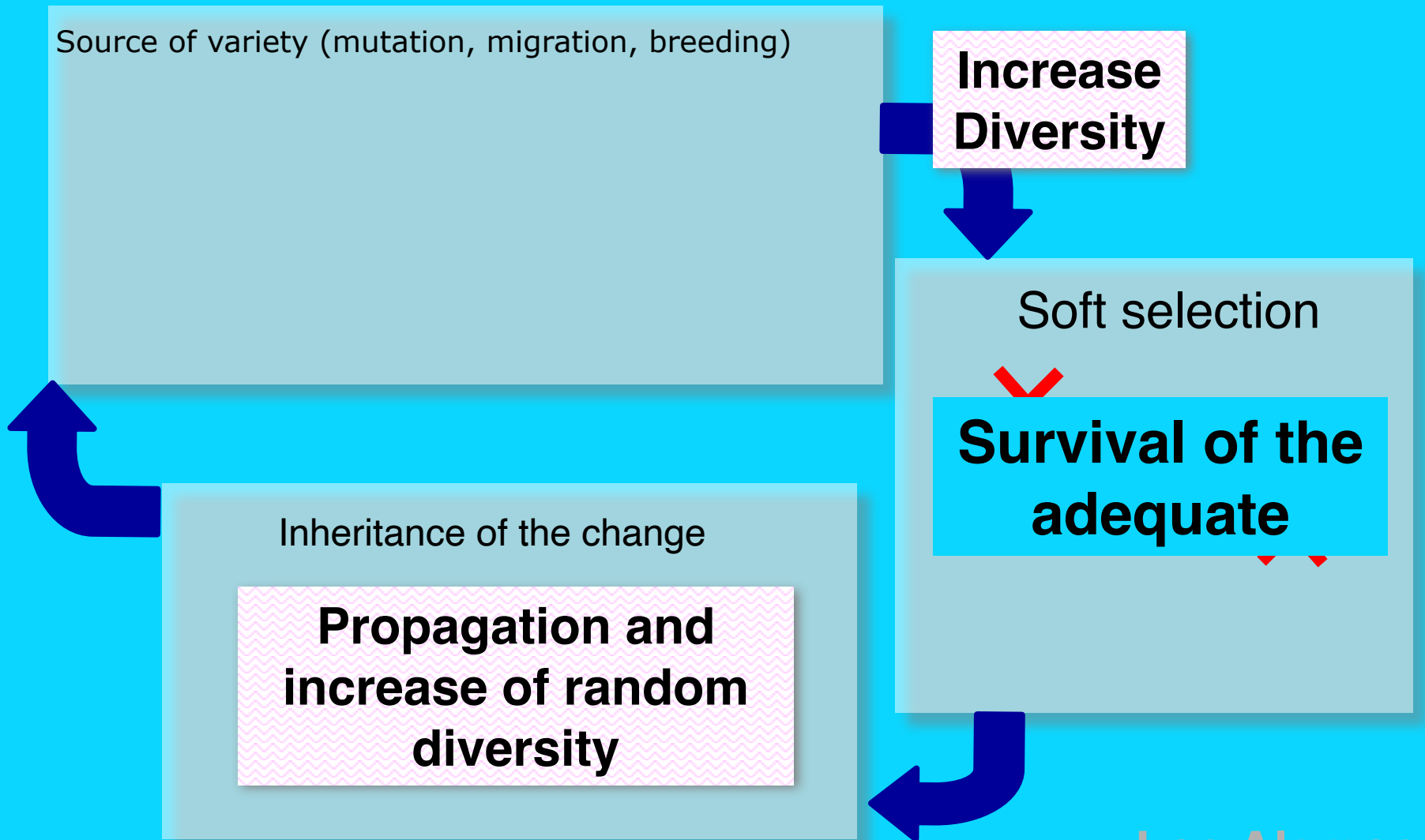


Inheritance of the change

**No change of gene  
pool - Retain the  
status quo**

# What Happens to the Survivors?

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# What Happens in Complex Environments?

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Source of variety (mutation, migration, breeding)

**Increase  
Diversity**

**Selection fails as a  
process for future  
population improvement**

that  
complex

**Genes are transferred  
by selection, but not  
traits**

# What is an Expert?

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- 1. Someone that tell you by what rules to make decisions?*
- 2. Someone that tells you what decisions to make right now (but his rules don't always work)?*

# Primer on Complexity “Theory”

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**Complexity:** *You know what it is when you see it, but you can't define it.*

## **Fundamental concepts**

- Chaotic behavior *or* non-linear response
- Emergent properties
- Structure in chaos

# Ants & Bees and Self-Organization

Most ants foraging for food find the shortest path.

- Highly decentralized - autonomous

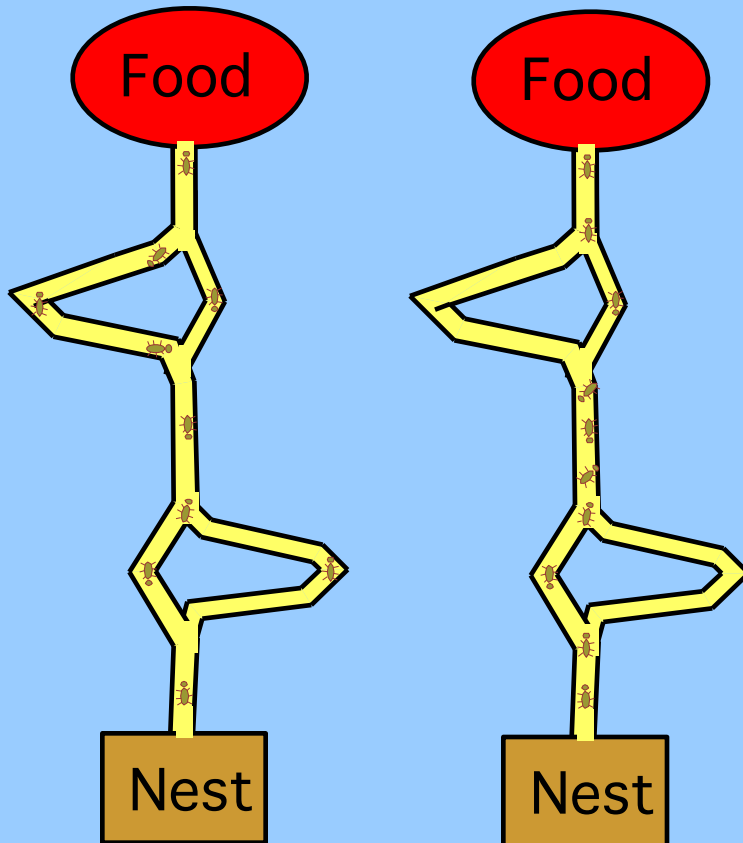
- Individual behavior is chaotic

- Shortest path is an Emergent property

## Structure in chaos

- How does it work? (next)

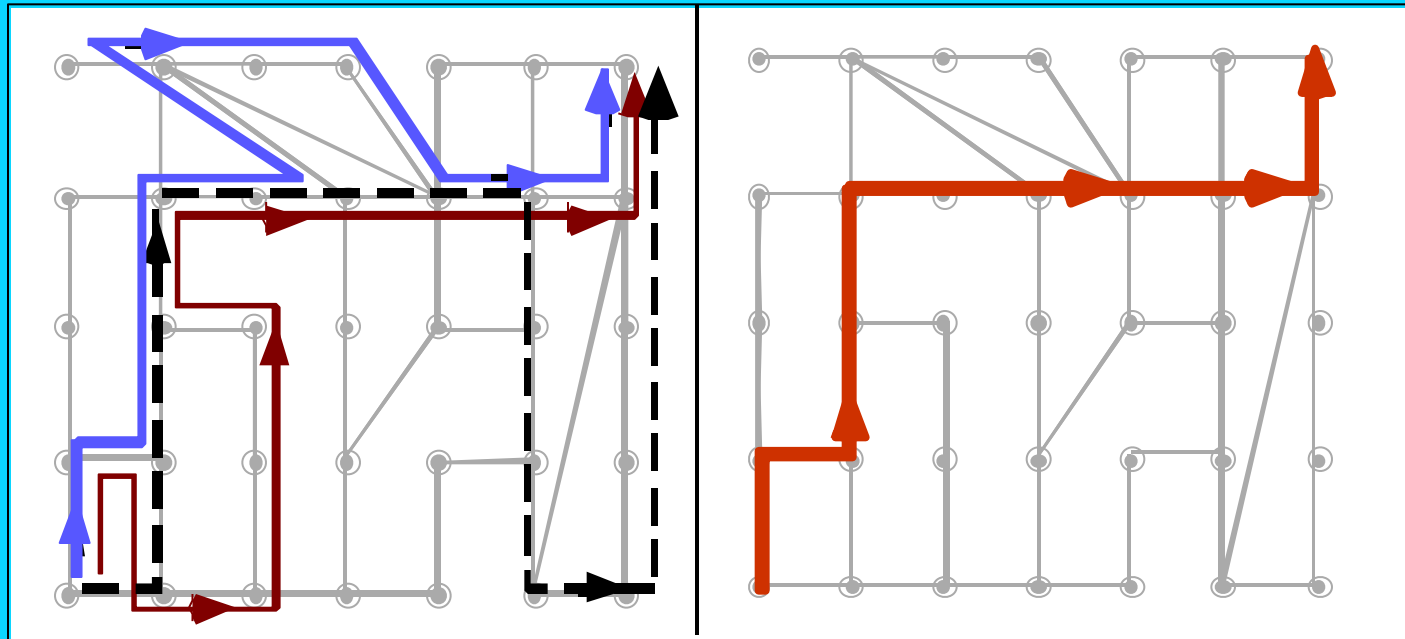
- Non-linear response (later)



(Goss, et al. 1989)

# How groups find the Shortest path

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Paths of three individuals

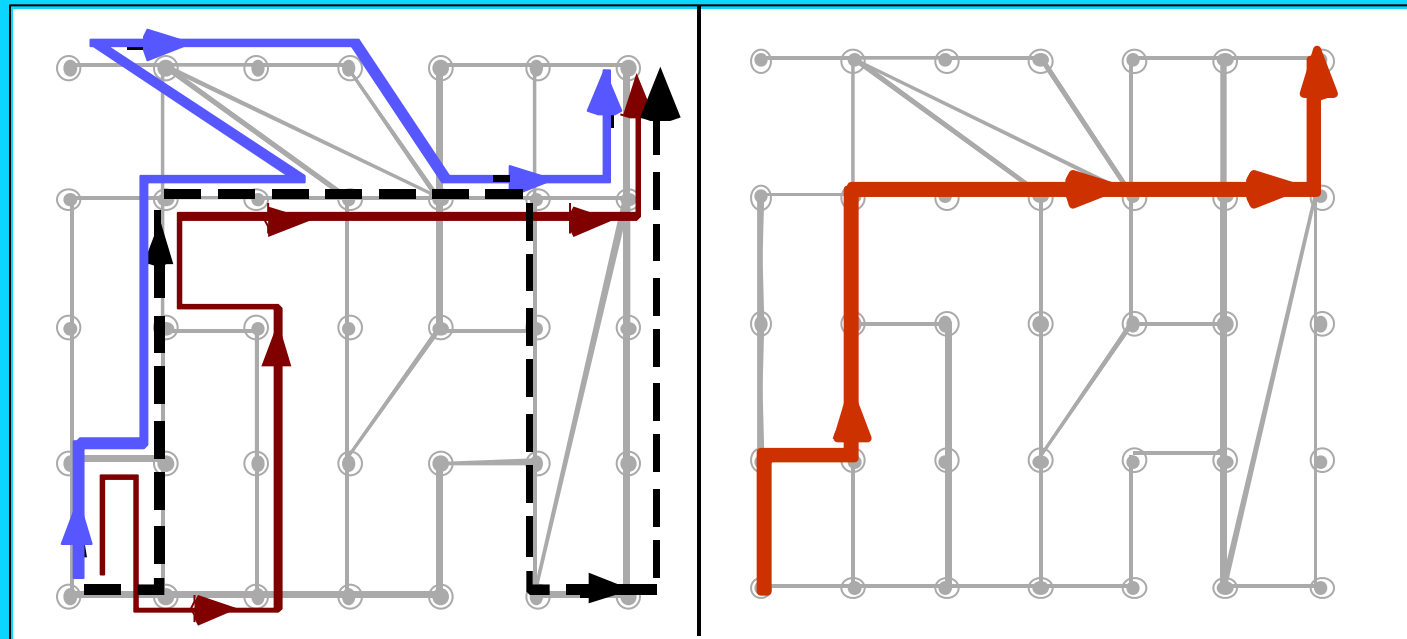
Collective path





# How groups find the Shortest path

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Paths of three individuals

Improved individual  
based on Collective path

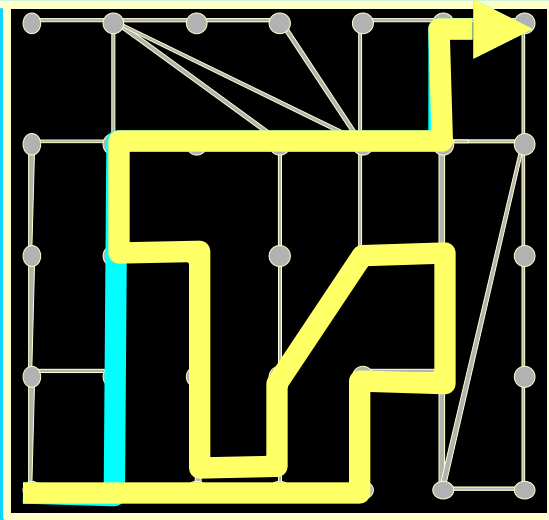
All a consequence of solving a problem in a complex environment

Los Alamos

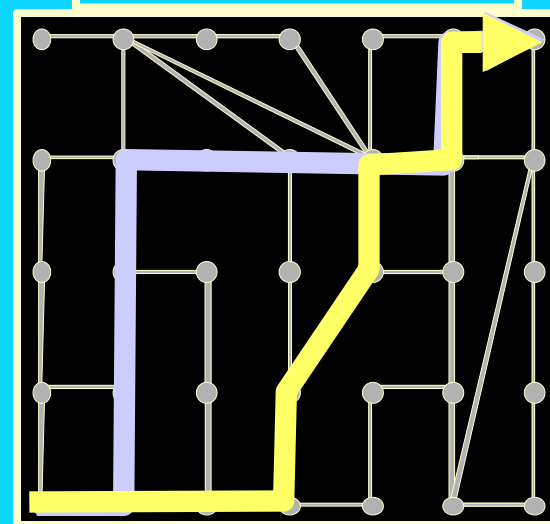
# Noise and Robustness

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An “expert” individual



A collective



- Individuals are very sensitive to noise

10 steps become 21 steps

Lack of experience

- Collectives are insensitive

10 steps become 9 steps

Contingency from diversity

# Collective Action & Natural Selection

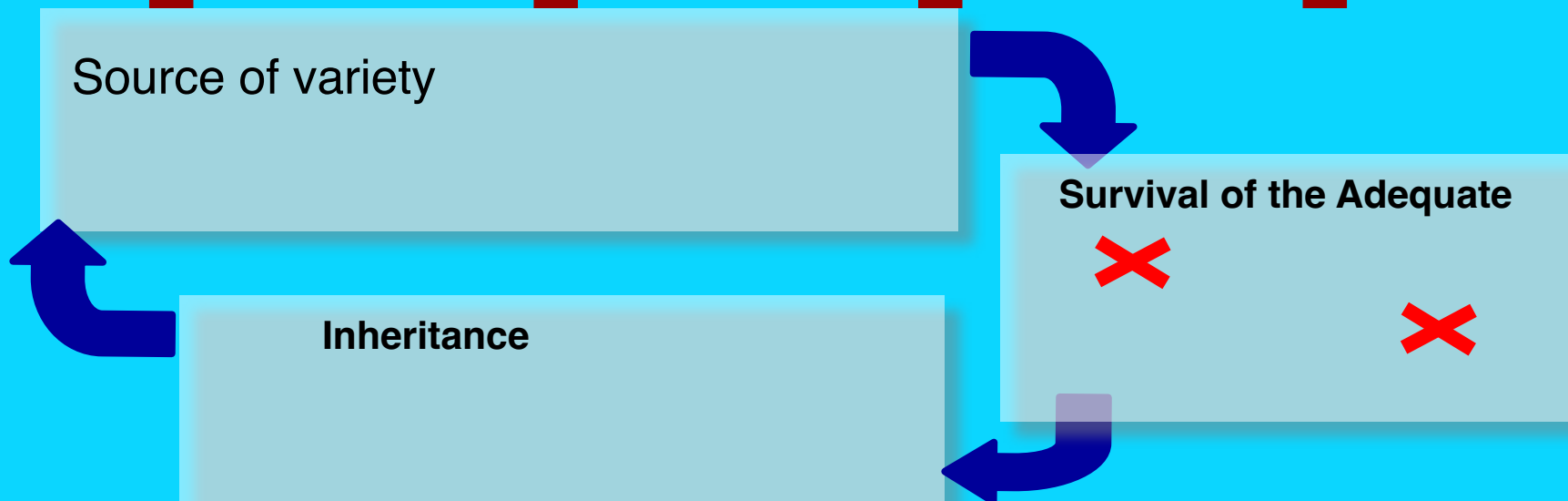
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## Collective or “Co-Operational” Effects

Higher Individual and Global Improvement

System Robustness

Higher individual performance + system complexity -> less selection



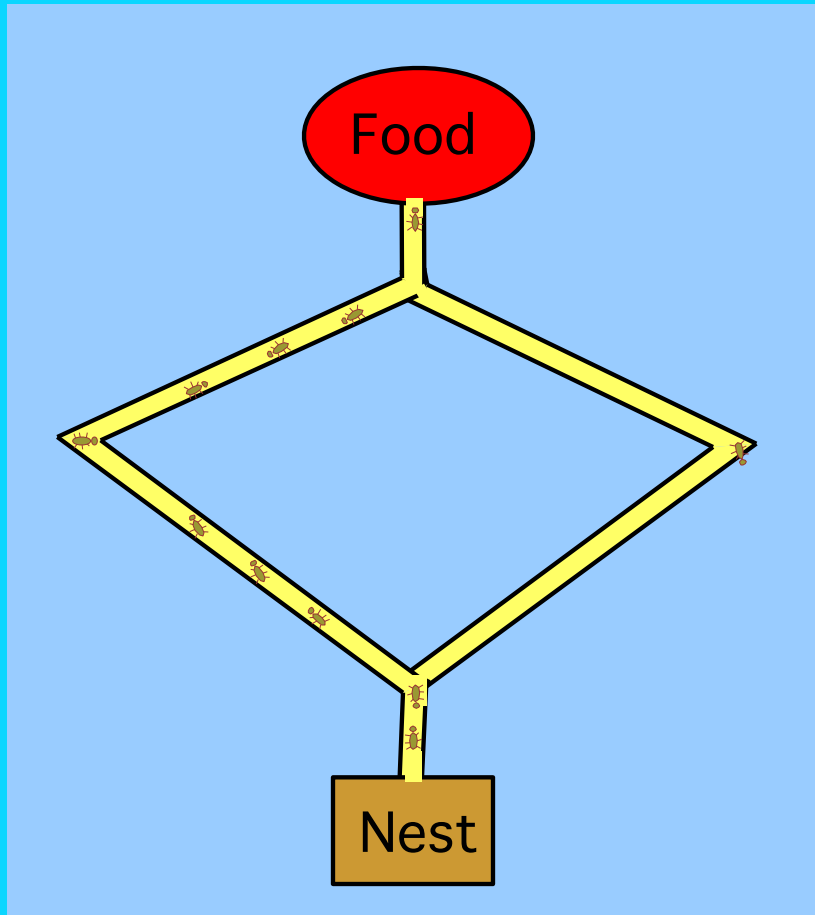
# Important Model Results for Independent Agents

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- ❑ Identical capability *still* leads to a diversity of experience.
- ❑ Specific paths are chaotic; the minimum path length is robust.
- ❑ Finding the shortest path is an **emergent property**, except for:
  - Groups of random individuals show no collective advantage.  
Hence, individual and collective performance are coupled.
- ❑ **Indecisive agents do not express the collective advantage.**
- ❑ Diversity - an essential property - from random processes:
  - Leads to responsive systems.
  - Leads to contingency information -> Robustness.
  - Leads to better global solutions - by collective closure of paths.
- ❑ What happens now if agents evolve and interact?

# The Problem with Collective Effects

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(Deneubourg et al. 1990)

Cooperation leads to exclusive behavior in stable environments.

Non-linear effects: Positive reinforcements can amplify small effects globally -> global chaos.

*(Does this happen in markets with the "herd effect" by mass-media?)*

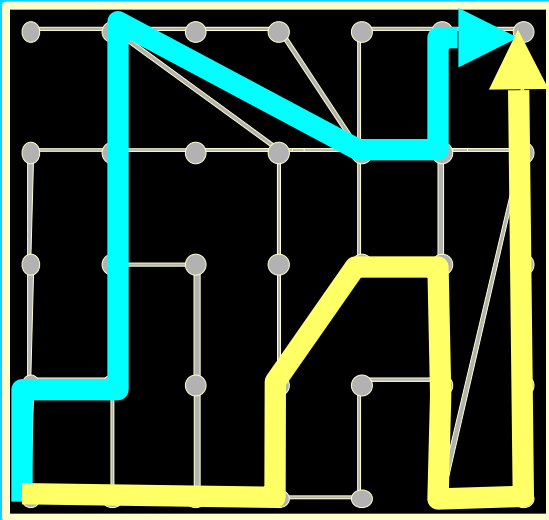
Randomness still required for global robustness.

# Three stages of development

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## Formative

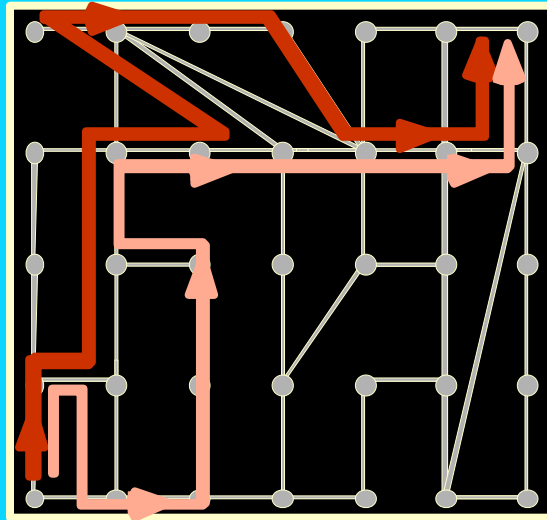
Individual development



Selection gives Agents capability, essential for the next stage.

## Co-Operational

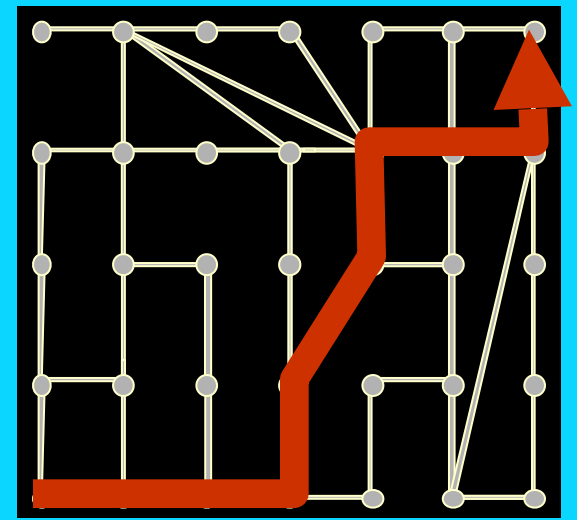
Collective improvement



Agents learn independently then share information during application

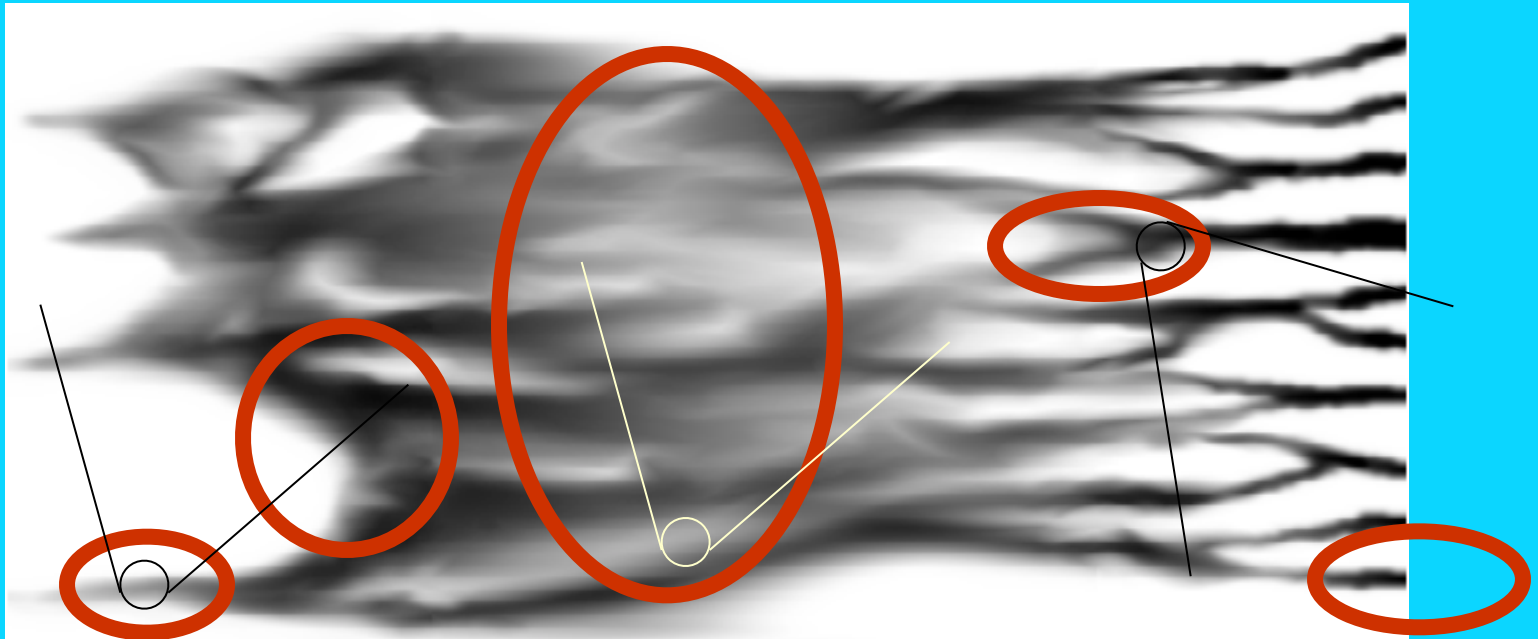
## Condensed

System “refinement”

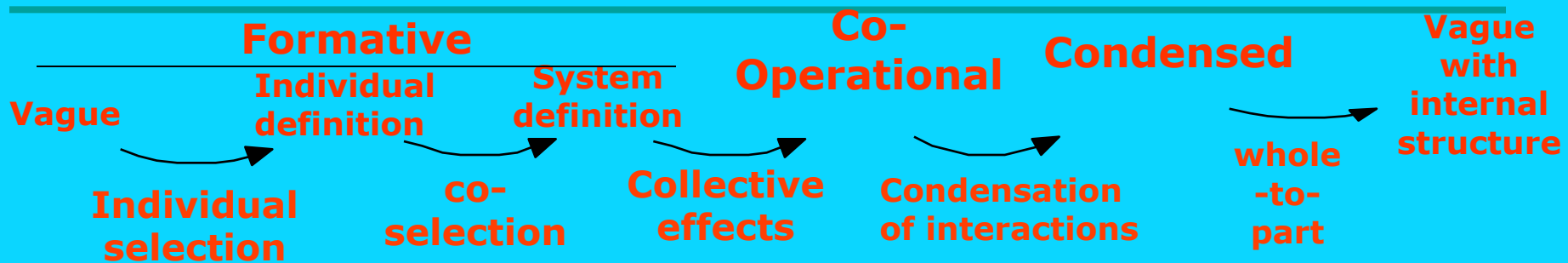


Agents share during learning in a stable environment

# Development of Interactions and Structure



States



Processes



# Diversity?

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## **Is your system:**

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# Examples of Each Stage

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## **Formative**

**Early Development of Life**  
**Life after Catastrophes**  
**Capital investment markets**  
**Artificial Life Studies**  
**Idea creation**

*Our perception is that many systems are competitive and selective.*

## **Co-Operational**

**Most ecosystems**  
**Large organizations**  
**Free economies**  
**Modern battlefields**  
**Power grids**  
**Optimal Brain function**  
**Social Evolution**

*This is the “sweet spot” of Life.*

## **Condensed**

**Old ecosystems**  
**Stagnant economies**  
**Old minds**  
**Centralized Political systems**

*Condensed systems may be “reborn” by universally adapting exclusive structures.*

# Does your system evolve?

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3. Progress continually occurs, except for episodic failures

# What caused the Presidential election to tie?

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## **?** 1. Random occurrence

- Do the vote the next day, and it won't likely happen.

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# Exit Polls from Nov. 7

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# Exit Polls

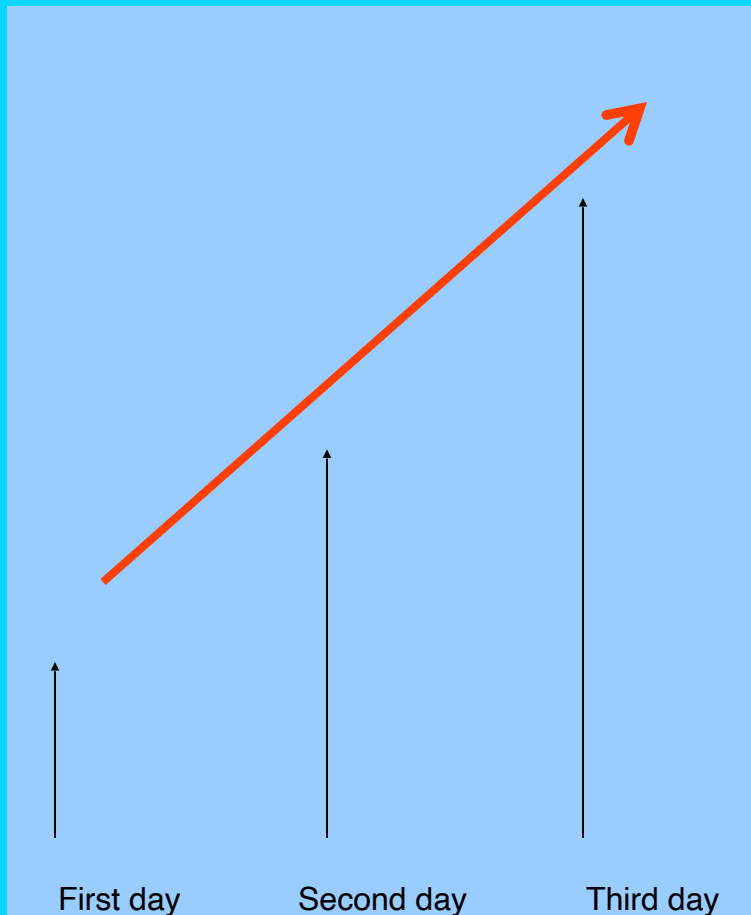
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Even though “my view” was not in agreement.

# Why care about Emergent properties?

## Researching Bee Talk

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Prediction is a useful capability for bees.  
But where is the prediction taking place?

Where is memory located?

Bee memory - 1 week

Bee life - 6 week.

Hive memory - 12 weeks.

Why are social insects so disturbing?

Who is (are) the Organism?

Higher performance without selection

Lack of understanding of the mechanisms

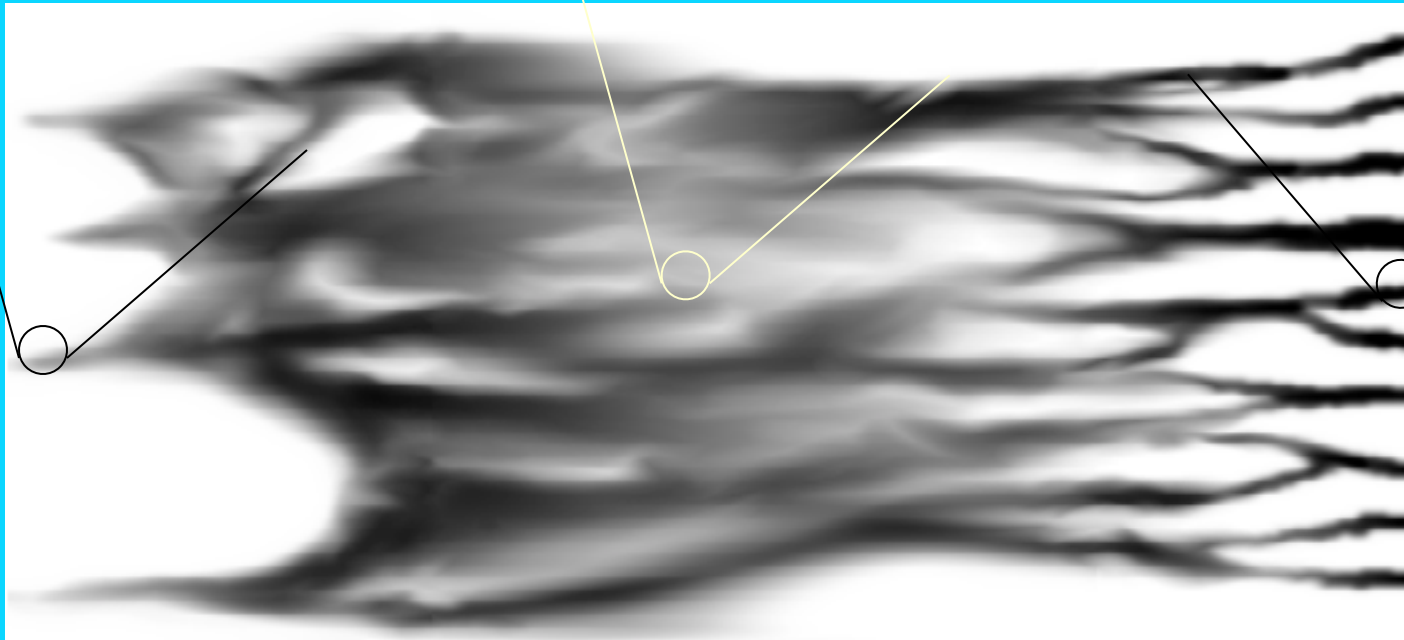
Do economies/market express the same mysteries?

# Miracle of US Productivity?

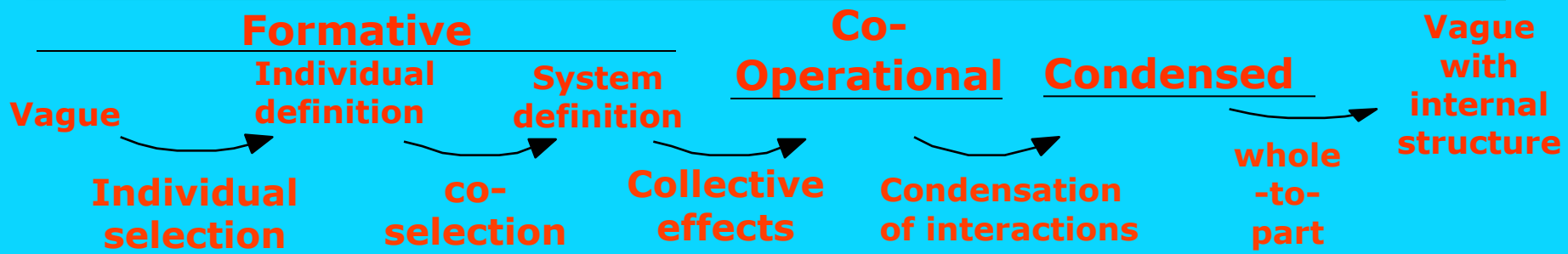
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- ? *Informal learning is the source of up to 70% of our work knowledge*
  - \$1.6 million DOL study of Motorola, Boeing, Ford, etc.
  - Even though \$30-50 billion a year is spent on formal training programs.
- ? *The US has the highest implementation of new information technology and is still growing. (Japan has the lowest implementation and is stagnating in the same global climate.)*
- ? *The Information Age activates Co-Operational processes - flexible information exchange and collective problem solving.*
- ? *Processes in Co-Operational stages are emergent and not easily measurable.*

# Visual Summary



States



Processes

# Examples of these ideas

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- ?** *Book referral at Amazon.com: "Others who bought this, also bought..."*  
*Best example of emergent knowledge creation by individuals doing their own thing (buying) for the benefit of all. It captures the unique capabilities of the Web (see <http://ishi.lanl.gov/symintel>). It captures weak signals of preferences across a very diverse population.*
- ?** *Many say the the Web is destructive to the social fabric.*
  - *But, the Web is an emergent solution to a social problem: individual isolation and lack of community.*
- ?** *Why weren't we better able to predict the REAL dangers of Y2K?*  
*Because we really don't know how society/economy works and how sensitive it is to local failure.*
- ?** *LTCM story (When Genius Failed by Roger Lowenstein)*  
*See New Yorker article on the Financial Page 10/6/00.*
- ?** *Knowledge management in the Intelligence community (IC)*  
*The IC was an early adopter of Information Technology. After about five years of poor returns on investment, they concluded that they had engineered out the most important component: people. (See <http://ishi.lanl.gov/Documents/coll-conf.summary.html>)*
- ?** *.Coms: In the future, we will view this time as an explosion of innovation*  
*Fueled by the information revolution, which was fueled by .Coms, which was fueled by the Info...*

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Many of our models are biologically motivated. Correct?

**[?]** Rational choice is dead

**[?]** Networks

**[?]** Emotional and Social life of information

**[?]** Drugs and the Brain

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❓ BIO + POLITICS

❓ Rational choice (of the individual) is dead

❓ Networks - Emotional and Social life of information

❓ **Evolution: Conflict - Communication - Cooperation**

A more realistic story of Nature (*and everything else*)

- Stages of evolution - by development
- Two roles of diversity
- Complexity and selection

# Summary

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- ❑ Thinks of systems as having stages, each with unique properties and processes.*
- ❑ Apply Co-operational processes to solve hard problems.*
- ❑ Consider emergent properties and processes.*

*Some of the “features” that you attribute to individuals may be global properties or global properties that have been captured in the individual.*

# *Weak-Signals - ishi.lanl.gov*

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- ?** *More information about the talk at <http://ishi.lanl.gov>*  
For a brief summary, see the paper at <http://ishi.lanl.gov/Documents1.html>:  
***Developmental Insights into Evolving Systems: Roles of Diversity, Non-Selection, Self-Organization, Symbiosis*** by N.L. Johnson (2000). In Artificial Life VII, M. Bedau et al., Eds. MIT Press, Cambridge.  
(A detailed paper will be posted about Nov. 2000.)
- ?** *General description of "Complexity" in economics.*  
See the introduction in: Arthur, W. B., S. N. Durlauf, et al., Eds. (1997). The Economy As an Evolving Complex System II. Boulder, Perseus Books.
- ?** *On revolution taking place in Artificial Intelligence:*  
Pfeifer, R. and C. Scheier (1999). Understanding Intelligence. Cambridge, MIT Press.
- ?** *Innovation in Industry, a case study:*  
Mandales, M. D. (1998). The Development of the B-52 and Jet Propulsion: A case study in organizational innovation. Maxwell Air Force Base, Air University Press.  
(Also see viewgraphs at <http://ishi.lanl.gov/Documents/coll-conf.summary.html>)
- ?** *Contact the author: [nlj@lanl.gov](mailto:nlj@lanl.gov)*