# Some background for a discussion on less-centralized classrooms

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# Introduction

- Research shows that learners actively construct their knowledge
- Learning is seen as a collaborative social process
- Educators are turning toward inquiry, discussion, and group work, and away from lecture
- Outside the education field, interest is growing in decentralized systems and processes

## 1. Interest in decentralization

- Enterprises are using network structures of management
- The Internet is a decentralized system
- Web 2.0 has generated interest in decentralized user-generated content
- M. Resnick, "Decentralized Thinking," 1999
- J. Surowiecki, *The Wisdom of Crowds,* 2004
- D. Goleman, *Social intelligence,* 2007

## An era of decentralization

- Collapse of ultra-hierarchical states based on centrally-planned economies
- Shift in corporate organization toward less centralized management structures
- Distributed models of the human mind
- Theories of literary meaning as constructed by readers, not authors

(M. Resnick, 1999)

## Could the Internet have been designed?

- "There was no one we could have pointed to as charged with 'creating' the set of rules we now know as the Internet"
- "…only an 'authority-free' process … could have constructed this system…"

<div align="right">– D. Post</div>

## Wisdom of crowds

- *Necessary conditions:*
  - Diversity
  - Independence
  - A "certain kind" of decentralization
    <div align="right">(Surowiecki, 2004)</div>
- Decentralized communication requires support media for collective wisdom to develop; e.g., stock market

# Decentralization at work

- A fundamental change in work: "the individualization of labor in the labor process" (Castells)
- *Example:* flex time
- A reversal of the socialization of production
- Some management structures become less centralized, markets become customized, work segmented, and societies fragmented
- *Example:* Inter-departmental teams form to complete a project or solve a problem

# Organizational forms in industry

- Inter-firm networking
- Shift from vertical bureaucracies to the more horizontal corporation
    - flatter hierarchy
    - organization around process not task
    - team management
    - customer-satisfaction-driven
    - retraining of employees
    - decentralization

# Decentralized "design"

- *Example artifacts:*
  - The Internet
  - Natural language
  - Human society and culture
  - Evolution of life
- Are any *centralized* processes capable of producing equally good results as current *decentralized* processes?

# 2. Hierarchies and networks
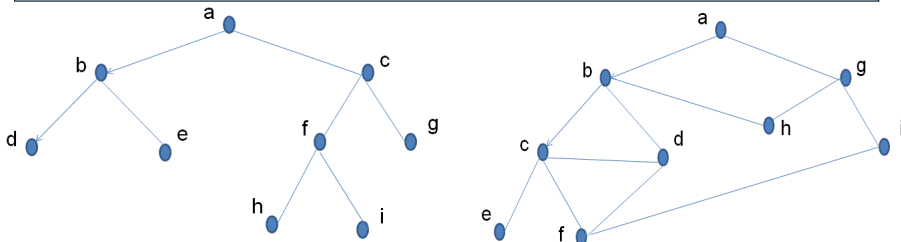


*Tree* (hierarchy) with vertical relationships: each node has *one* parent and possibly multiple children

*Graph* (network): horizontal connections may predominate

# Hierarchical structure

- Tree, with root at top

- Traditional military, corporate, or educational structure



- Supports clarity, decisiveness, plan-following

- Root emits commands and information, branches feed back information
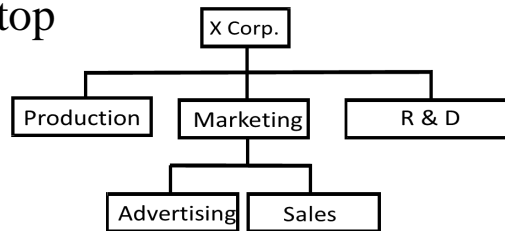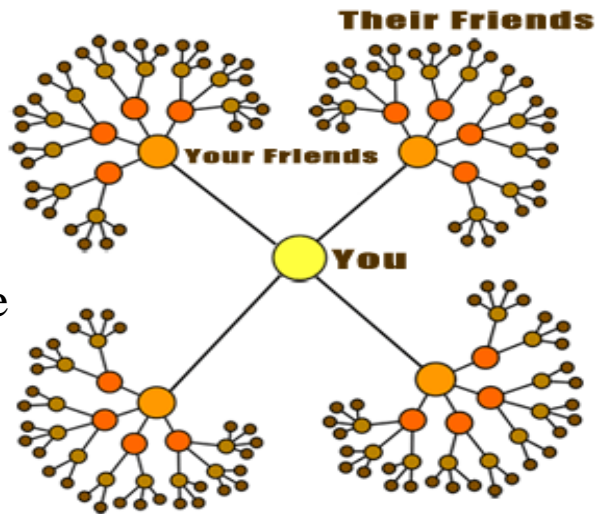
# Network structure
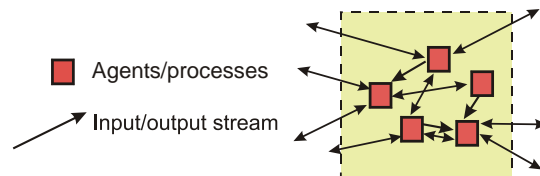


- Supports diversity, rich connection, choice, flexibility

- Some market economics reflect this

- Empowers those at lower levels

# Bottom-up view of network

This diagram represents a hierarchy of *connections*, centered at one network node, not *power*

# Neural networks

- Human brain: $10^{11}$ neurons, each connected by *axons* to average of $10^4$ others. Max. switching time: $10^{-3}$ sec

- Each neuron "fires" (output pulse) if summed inputs exceed a threshold

- Artificial NN ANVINN drove car at 70 mph, 1993

- Useful to solve problems with noisy, complex sensory information (cameras, microphones)

# Multi-layer neural network

- *Hidden layers* of neural nets are neither external inputs nor external outputs



Input layer  'Hidden' layer  Output layer
Input 1
Input 2  Output
Input 3
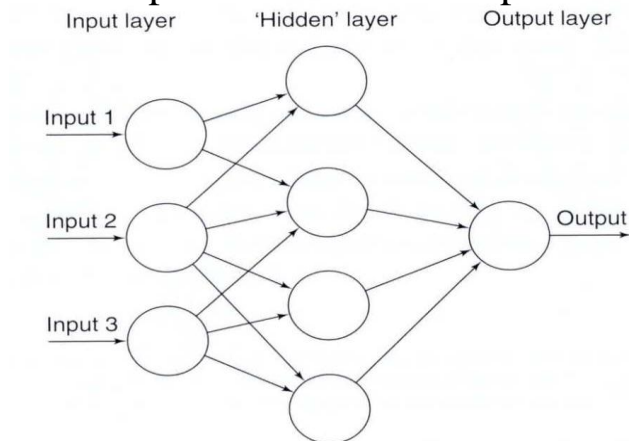
## 3. Information-processing problems

A. Functions
B. Services
C. Missions
Multi-stream interaction
Self-organizing systems
Emergent behavior
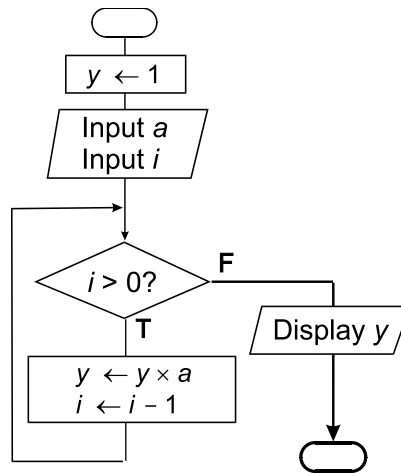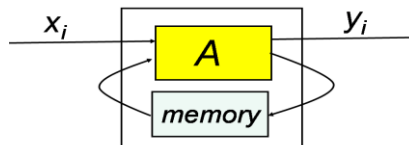
# A. Functions

$$x \xrightarrow{\hspace{2cm}} \boxed{f} \xrightarrow{\hspace{1cm} y \hspace{1cm}}$$
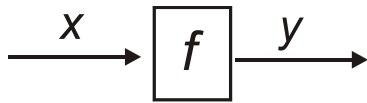
- Input *fixed* in advance
- *Solution:* an algorithm
- *Instance:* printing a
  student transcript

$y \leftarrow 1$

Input *a*
Input *i*

$i > 0?$　　F

T　　　Display *y*

$y \leftarrow y \times a$
$i \leftarrow i - 1$

# B. Services

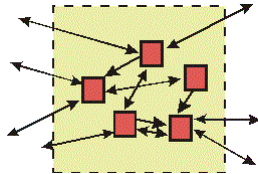$$x_i \xrightarrow{\hspace{1cm}} \boxed{\begin{array}{c} A \\ \textit{memory} \end{array}} \xrightarrow{\hspace{1cm} y_i}$$

- *Interaction,* in which input and output
  alternate, and system has *memory* between
  I/O steps
- *Solution:* sequential interactive process
- *Instance:* office application; web site that
  displays pages

# C. Missions



- *Multiple streams* of input and output
- *Solution:* multi-agent system that handles multiple streams
- *Instances:* social-network web sites, e.g., Facebook, Blackboard, Researchgate

# Self-organizing systems

*Three features:*

- Are open to environment
- Can create and maintain a structure in non-equilibrium conditions
- Are complex, in their large number of parts and in the network of feedback loops joining the parts

# Emergent behavior

- System behavior that is not the sum of component behaviors is called *emergent*
- It is typical of certain self-organized and decentralized systems
- *Example:* Ants forage for food and build nests without a blueprint or supervisor
- *Chaotic and complex systems* display emergent behavior

## Decentralized, self-organizing systems

- Lend themselves to flexibility and adaptiveness
- *Where required*: in dynamic, persistent, multi-agent, decentralized, and self-organizing environments

*Decentralized system:* a multi-agent system whose components do not respond to commands from an active director or manager component, and do not execute prespecified synchronized roles under a design or plan.

*Self-organizing system:* a multi-agent system with a coherent global structure or pattern shaped by local interactions among components, rather than by external forces.

## 4. Discussion

1.   What are our classrooms like?

2.   How do we manage them and help organize learning?

3.   What *decentralized* methods support learning?

4.   What *centralized* methods do we want to retain?

## References

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