DES203T:
Designing Intelligent Systems

Session 2 (Module 1)

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY,
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SESSION OUTLINE

- What is driving the trend of intelligent/smart systems/products?
- What do we mean by intelligence (for products/artificial systems)?
- How do we classify different types of intelligent products?

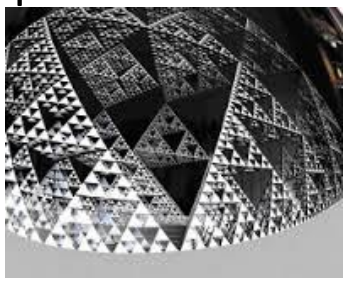
Trend of Increasing Information-intensity

Industrial Society – De-materialization in products (may not be at the whole economy)

Post-industrial / Network Society

1960s

LESS MATTER-INTENSITY: Use of less materials or substitute with better & cheaper materials



1980s onwards

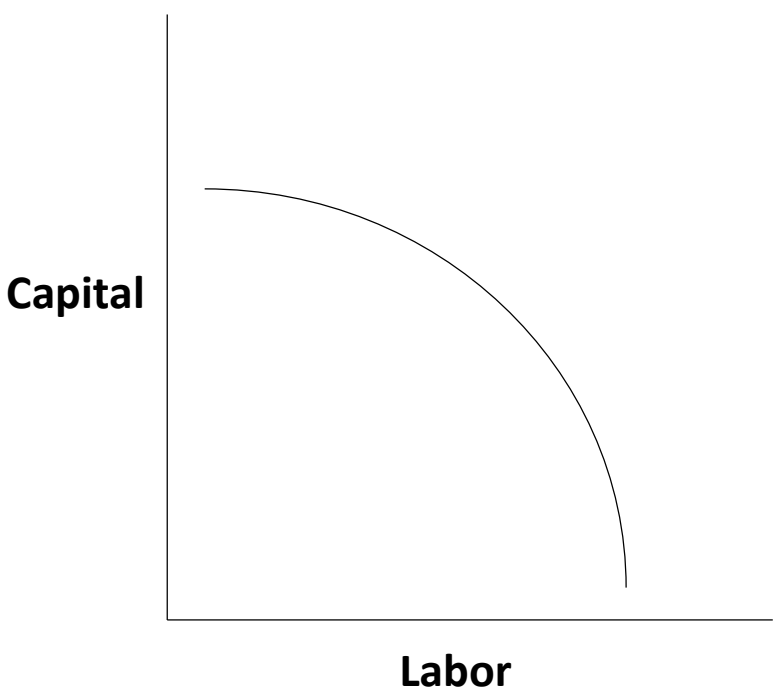
LESS ENERGY-INTENSIVE: Use of lesser energy, more efficiency in energy conversion with development of thermodynamics, alternative fuels

1990s onwards

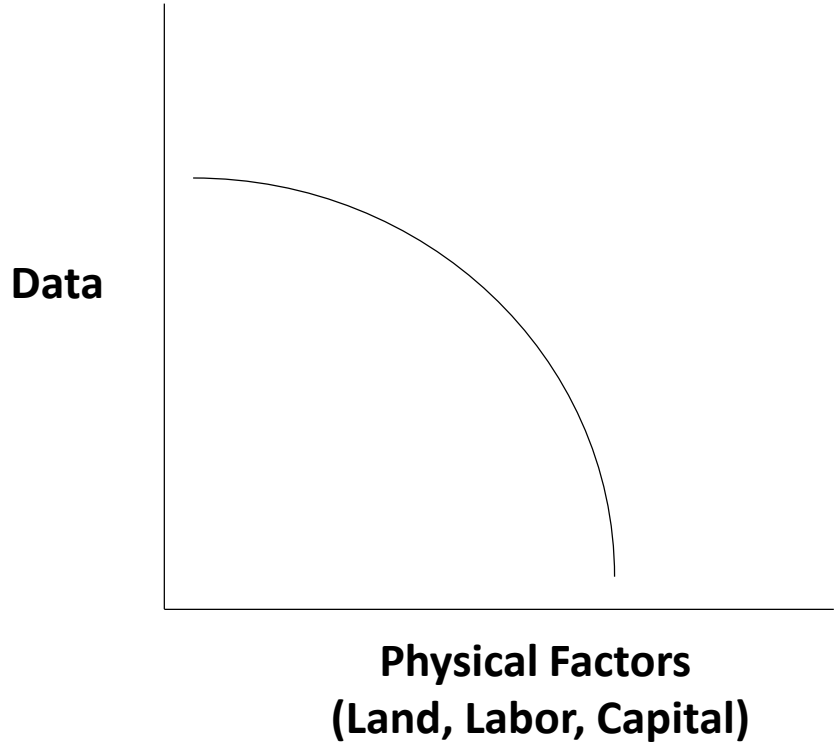
MORE INFORMATION-INTENSITY: Greater use of information to substitute matter and energy, with increasing computing power (Moore's Law)

Information-intensity in enterprises & products

Industrial Age

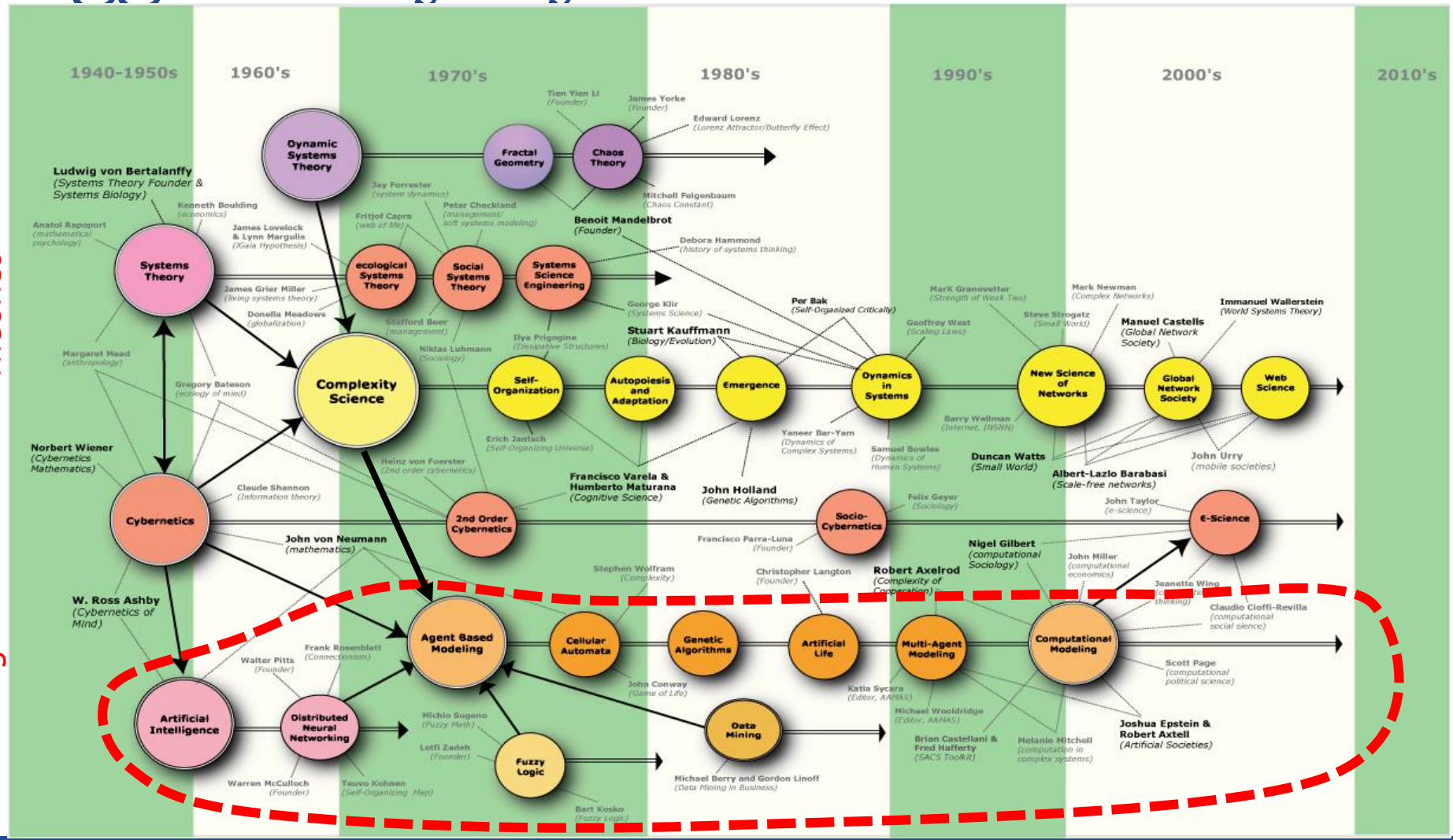


Post-industrial / Information Age



Labor-intensive -> Capital-intensive -> Information/Knowledge-intensive

Triggered by Cybernetics



Dominant Groups:

Control Systems Vs Computing

Systems Thinking and Intelligent Systems

	Systems Thinking for Design	Intelligent Systems Design
Systems Thinking & Complexity	Dealing with fuzziness, ambiguity, and uncertainty in FFE • Abstracting elements, Categorizing, Linking, Seeing Patterns, boundaries/purpose • Intelligent behavior as part of the FBS model (B influenced by both function and structure)	Principles of complex adaptive systems: • Cybernetics and Feedback Systems, Self-regulation, Self-organization, Self-referential, requisite variety, hierarchical systems • Reasoning with metaphors and analogies (biological, evolutionary) • Thinking in terms of system of systems (IoT)
Intelligent Systems Design		• Information processing techniques (Rule based Expert Systems, Fuzzy, Artificial Neural Networks, Evolutionary computation) • Cyber-Physical systems (control systems, embedded systems, robotics)

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- How do we classify different types of intelligent products?

Exercise 2a: Identify key elements & relations of intelligence from the given definitions (15 min)

- "The ability to learn, understand and make judgments or have opinions that are based on reason" Cambridge Advance Learner's Dictionary
- "Intelligence is a property of mind that encompasses many related mental abilities, such as the capacities to reason, plan, solve problems, think abstractly, comprehend ideas and language, and learn." Wikipedia
- "The ability to comprehend; to understand and profit from experience." Wordnet 2.1

- "We shall use the term 'intelligence' to mean the ability of an organism to solve new problems . . . " W. V. Bingham
- "Intelligence is not a single, unitary ability, but rather a composite of several functions. The term denotes that combination of abilities required for survival and advancement within a particular culture." A. Anastasi
- ". . . the ability to undertake activities that are characterized by (1) difficulty, (2) complexity, (3) abstractness, (4) economy, (5) adaptedness to goal, (6) social value, and (7) the emergence of originals, and to maintain such activities under conditions that demand a concentration of energy and a resistance to emotional forces." Stoddard

- ". . . the ability of a system to act appropriately in an uncertain environment, where appropriate action is that which increases the probability of success, and success is the achievement of behavioral sub-goals that support the system's ultimate goal." J. S. Albus
- ". . . the ability to solve hard problems." M. Minsky
- ". . . in any real situation behavior appropriate to the ends of the system and adaptive to the demands of the environment can occur, within some limits of speed and complexity." A. Newell and H. A. Simon

Common themes in the definitions

- Is a property that an individual agent has as it interacts with its environment
- Is related to the agent's ability to succeed or profit with respect to some goal
- Depends on how able the agent is to adapt to different goals and environments

"Intelligence measures an agent's ability to achieve goals in a wide range of environments." - S. Legg and M. Hutter

Source: Shane Legg and Marcus Hutter (2007), A Collection of Definitions of Intelligence, arXiv:0706.3639v1 [cs.AI]

Exercise 2b:

- Can this definition be applied to intelligent products or system of systems? What additional aspects will need to be covered?

The first examples of Intelligent Products apparently emerged in the after sales context, where computers running programs that tracked the configuration and performance, could request for service and maintenance … how does it fit with the definition?

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Definitions of Intelligent Products

McFarlane:

1. Has a unique identification
2. Is capable of communicating effectively with its environment
3. Can retain or store data about itself
4. Deploys a language to display its features, production requirements, etc
5. Is capable of participating in or making decisions relevant to its own destiny

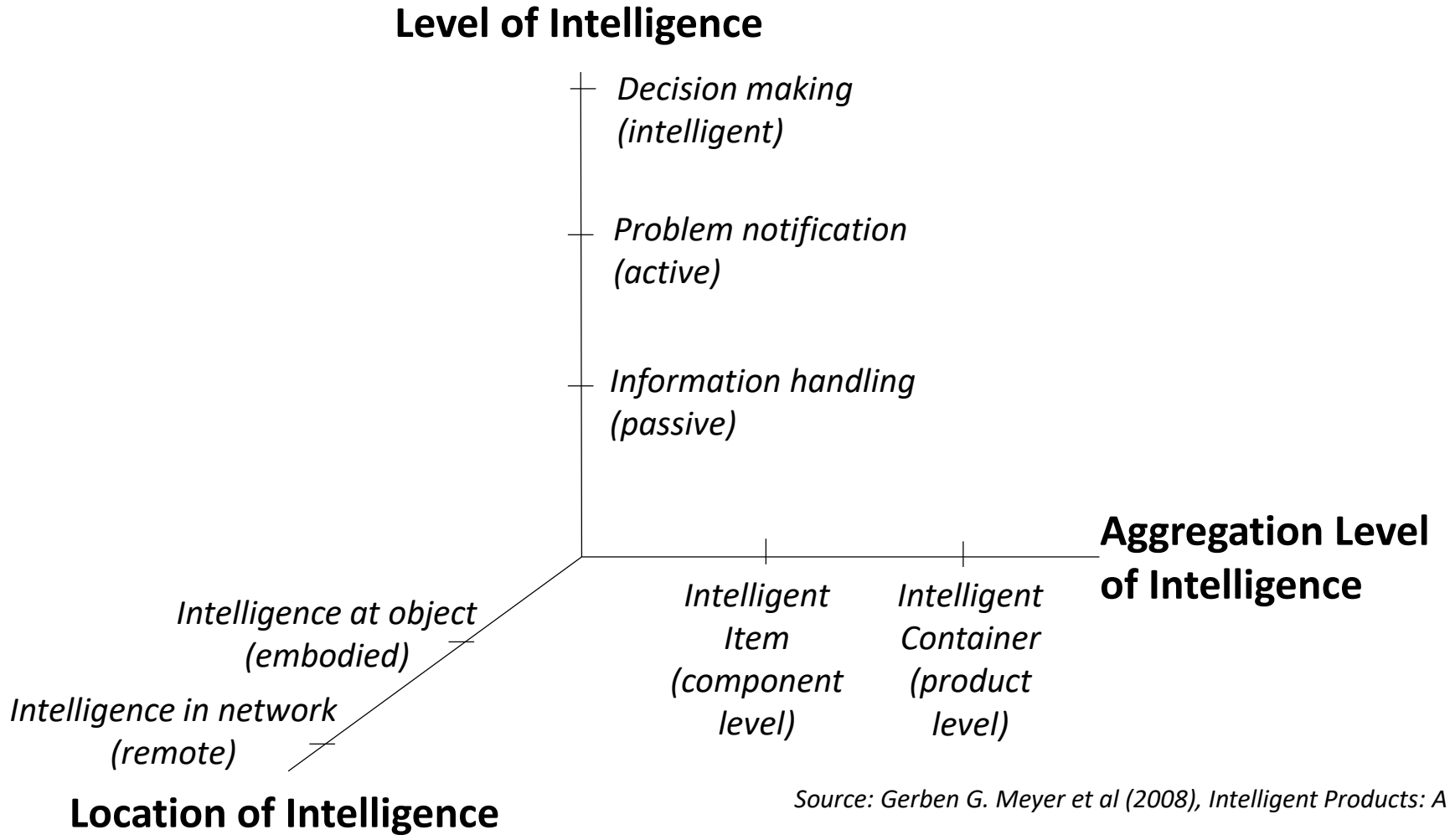
Kärkkäinen et al.:

1. Globally unique identification code
2. Links to information sources about the product across organizational borders, either included in the identification code itself or accessible by some look-up mechanism
3. Can communicate what needs to be done with them to information systems and users when needed (even pro-actively)

Ventä:

1. Continuously monitor their status and environment
2. React and adapt to environmental and operational conditions
3. Maintain optimal performance in variable circumstances, also in exception cases
4. Actively communicate with the user, environment or with other products and systems

Techno-centric classification of Intelligent Products



Source: Gerben G. Meyer et al (2008), Intelligent Products: A survey

Exercise 2c (30 min)

- List out different types of intelligent products using the classification model and provide one example for each from your everyday experience

- What type of intelligence is relevant for your product concept? What are the possible directions for your product concept?

Next session we will look at challenges in conceptualizing and developing intelligent products

Each individual may study

Chapter 18 in the Handbook of Product Development

or

Chapter 1 from Don Norman's book for discussion in class

Each group should have studied both chapters