Strategic IT management - 37E00200

Defining artificial intelligence

Esko Penttinen
Associate Professor, Information Systems Science, Aalto University School of Business
Chairman, XBRL Finland
Director, Real-Time Economy Competence Center

1

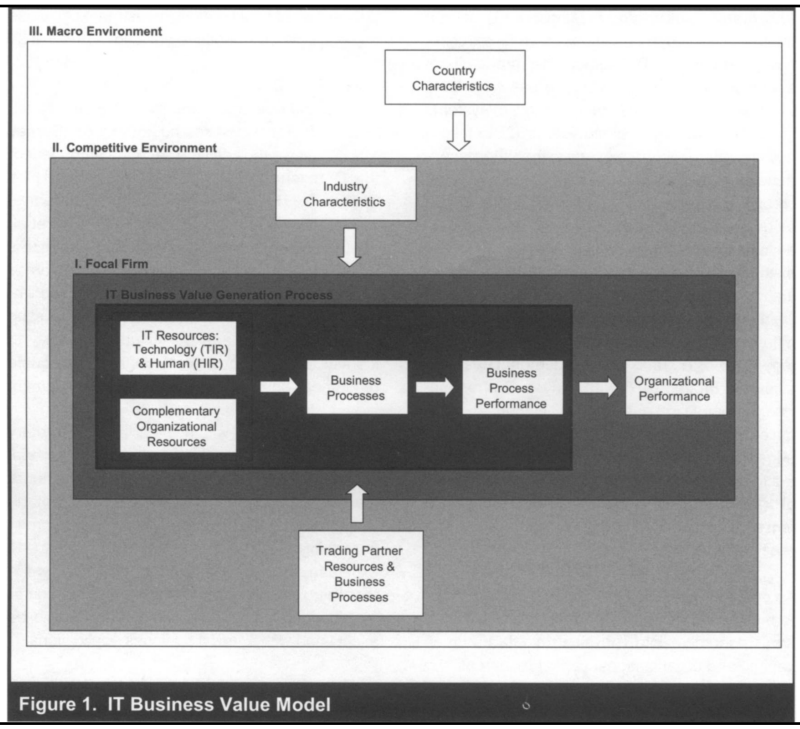


Figure 1. IT Business Value Model

Melville, Nigel, Kenneth Kraemer, and Vijay Gurbaxani. "Information technology and organizational performance: An integrative model of IT business value." *MIS quarterly* 28.2 (2004): 283-322.

2

Agenda…

… thus far

- Monday 23.10.
  - Introduction, assignments, IT business value
- Wednesday 25.10.
  - Technical debt
- Friday 27.10.
  - Legacy systems
- Monday 30.10.
  - Outsourcing
- Wednesday 1.11.
  - Virtual organizing and cloud
- Friday 3.11.
  - Case Kluuvin Apteekki
- Monday 6.11.
  - Information infrastructures
- Friday 10.11.
  - Case Tieto

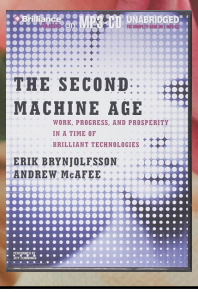
… for the remainder of the course

- Monday 20.11.
  - Defining artificial intelligence
- Wednesday 22.11.
  - Explainability
- Friday 24.11.
  - Case Nokia
- Monday 27.11.
  - Skills
- Wednesday 29.11.
  - Case presentations
- Friday 1.12.
  - Course synthesis

3

Amount of manual work decreases – more meaningful work for information workers

Complement - augmentation

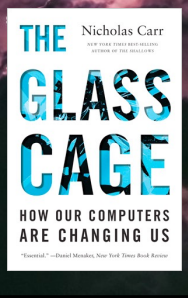


Moore's law (>32)

Technologies are building blocks (3 way matching)

Amount of manual work decreases – jobs are lost

Substitute - automation



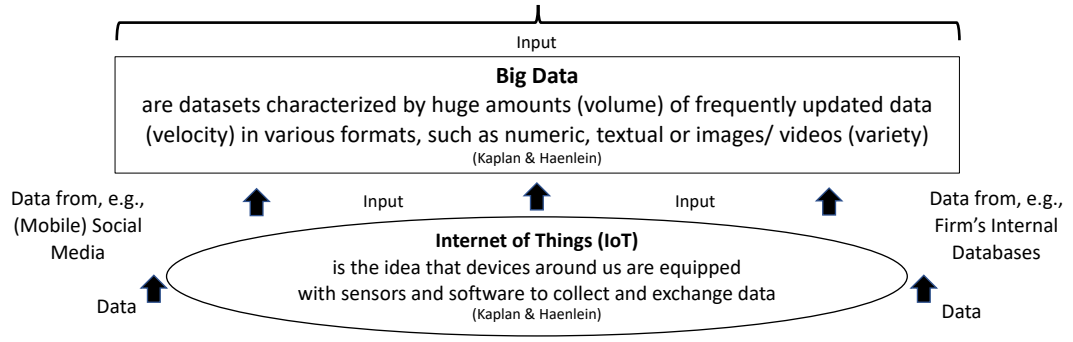
Navigation

Creativity(3D modeling)

4

Definition of Artificial Intelligence … and Related Concepts

Artificial Intelligence (AI)
is "a system's ability to correctly interpret external data,
to learn from such data, and to use those learnings
to achieve specific goals and tasks through flexible adaptation"
(Kaplan & Haenlein)



Kaplan A., Haenlein M. (2019) Siri, Siri in my hand, who 's the fairest in the land?
On the Interpretations, Illustrations and Implications of Artificial Intelligence, Business Horizons, 62(1)

5

Stages of Artificial Intelligence

Artificial Narrow Intelligence
ANI
(Weak, Below human-level AI)

- Applies AI only to specific areas
- Unable to autonomously solve problems in other areas
- Outperforms/ equals humans in the specific area

Siri can recognize your voice but cannot perform other tasks like driving a car

Artificial General Intelligence
AGI
(Strong, Human-level AI)

- Applies AI to several areas
- Able to autonomously solve problems in other areas
- Outperforms/equals humans in several areas

Siri evolves into a humanoid robot with wide capabilities including voice recognition, coffee preparation and writing skills

Artificial Super Intelligence
ASI
(Conscious/ Self-aware, Above human-level AI)

- Applies AI to any area
- Able to solve problems in other areas instantaneously
- Outperforms humans in all areas

Siri develops super-human capabilities such as solving complex mathematical problems instantaneously or writing a best seller in a heart (or clock) beat

Kaplan A., Haenlein M. (2019) Siri, Siri in my hand, who 's the fairest in the land?
On the Interpretations, Illustrations and Implications of Artificial Intelligence, Business Horizons, 62(1)

7

Levels of sophistication of IT

WHAT TODAY'S COGNITIVE TECHNOLOGIES CAN — AND CAN'T — DO

Mapping cognitive technologies by how autonomously they work and the tasks they perform shows the current state of smart machines — and anticipates how future technologies might unfold.

	LEVELS OF INTELLIGENCE			
TASK TYPE	SUPPORT FOR HUMANS	REPETITIVE TASK AUTOMATION	CONTEXT AWARENESS AND LEARNING	SELF-AWARENESS
Analyze Numbers	Business intelligence, data visualization, hypothesis-driven analytics	Operational analytics, scoring, model management	Machine learning, neural networks	Not yet
Analyze Words and Images	Character and speech recognition	Image recognition, machine vision	IBM Watson, natural language processing	Not yet
Perform Digital Tasks	Business process management	Rules engines, robotic process automation	Not yet	Not yet
Perform Physical Tasks	Remote operation of equipment	Industrial robotics, collaborative robotics	Autonomous robots, vehicles	Not yet

THE GREAT CONVERGENCE

Davenport & Kirby (2016), Just How Smart are Smart Machines, MIT Sloan Management Review

8

AI as a frontier

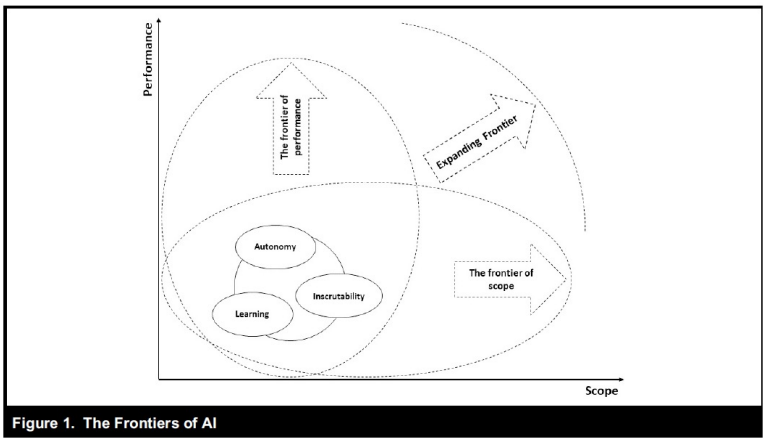


Figure 1. The Frontiers of AI

Table 1. Key Concepts of AI

Concept	Definition
Artificial Intelligence	The frontier of computational advancements that references human intelligence in addressing ever more complex decision-making problems
Dimensions of the AI Frontier	
Performance frontier	The ever-improving execution of tasks to which AI is applied
Scope frontier	The ever-expanding range of contexts to which AI is applied
Facets of AI	
Autonomy	Acting without human intervention
Learning	Improving through data and experience
Inscrutability	Being unintelligible to specific audiences

Berente, Nicholas, et al. "MANAGING ARTIFICIAL INTELLIGENCE." *MIS Quarterly* 45.3 (2021).

9

Types of AI Systems

Artificial Intelligence (AI)

	Expert Systems	Analytical AI	Human-Inspired AI	Humanized AI	Human Beings
Cognitive Intelligence	✘	✓	✓	✓	✓
Emotional Intelligence	✘	✘	✓	✓	✓
Social Intelligence	✘	✘	✘	✓	✓
Artistic Creativity	✘	✘	✘	✘	✓
		Supervised learning, Unsupervised learning, Reinforcement learning			

Kaplan A., Haenlein M. (2019) Siri, Siri in my hand, who 's the fairest in the land?
On the Interpretations, Illustrations and Implications of Artificial Intelligence, Business Horizons, 62(1)

10

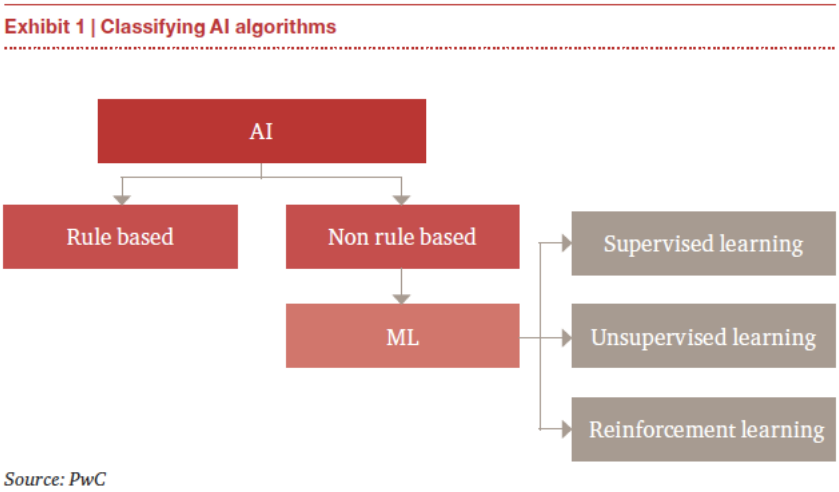
Illustrations of AI Applications within Specific Sectors

	Analytical AI	Human-Inspired AI	Humanized AI
Universities	Virtual teaching assistants able to answer student questions and tailor reactions to individual data	AI-based career services able to identify emotions to improve interview techniques of students	Robo-teachers animating a student group by acting as moderator and sparring partners
Corporations	Robo-advisors leveraging automation and AI algorithms to manage client portfolios	Stores identifying unhappy shoppers via facial recognition at checkouts to trigger remedial actions	Virtual agents dealing with customer complaints and addressing concerns of unhappy customers
Governments	Automation systems to set the brightness of streetlights based on traffic and pedestrian movements	Virtual army recruiters interviewing and selecting candidates based on emotional cues	AI systems able to psychologically train soldiers before entering a war zone

Kaplan A., Haenlein M. (2019) Siri, Siri in my hand, who 's the fairest in the land?
On the Interpretations, Illustrations and Implications of Artificial Intelligence, Business Horizons, 62(1)

11

Classifying AI algorithms



12

Supervised, Unsupervised, and Reinforcement Learning

Supervised Learning:
Mapping a given set of inputs to a given set of (labeled) outputs
(Linear regression, Classification trees, Neural networks)

Unsupervised Learning:
Only labeled inputs but unlabeled outputs
Algorithm needs to infer the underlying structure from the data itself (black box)
(Cluster analysis)

Reinforcement Learning:
System receives an output variable to be maximized
and a series of decisions that can be taken and which impact the output

Kaplan A., Haenlein M. (2019) Siri, Siri in my hand, who 's the fairest in the land?
On the Interpretations, Illustrations and Implications of Artificial Intelligence, Business Horizons, 62(1)

13

Dualities associated with AI

- Automate – informate
- Automation – augmentation
- Deskilling – reskilling – upskilling (28.11.)

duality
noun
du·al·i·ty dü-ˈa-lə-tē
also dyü-
plural dualities
: the quality or state of having two different or opposite parts or elements **:** dualism

Source: Merriam-Webster

15

Automate – informate

- Compared to the earlier generations of mechanization and automation designed to deskill jobs and substitute for human labor, information technology (IT) is characterized by a duality:
  - While automating operations (which might lead to deskilling), IT simultaneously generates information about the underlying processes and provides transparency to activities and thus translates its action into information
  - This is labeled as Informating in Zuboff 1988

Slide based on Shoshana Zuboff's "In the Age of the Smart Machine", 1988

16

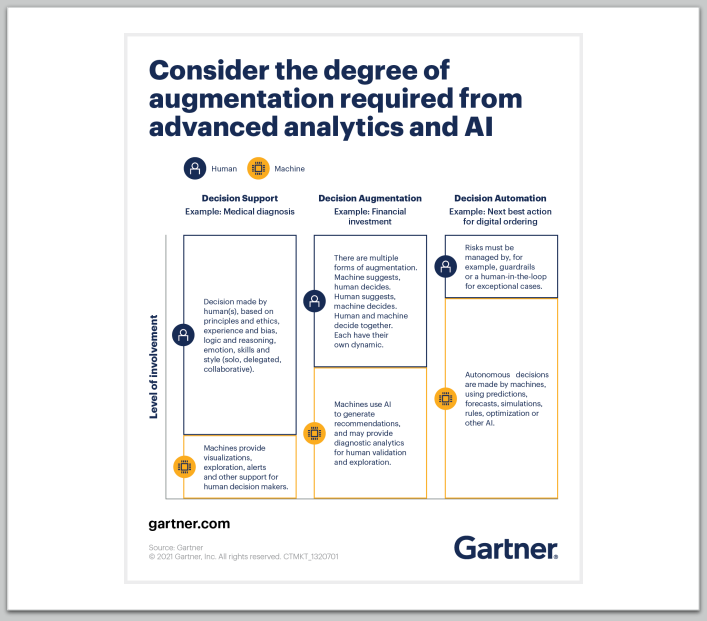
Informating through RPA

- Robotic Process Automation (RPA) has the potential to informate, if implemented correctly:
  - By articulating process steps into rule-based procedures to be followed by RPA, an organization may build a knowledge repository where both explicit information and tacit information about the organization's processes can be articulated and stored
  - Escalations (instances where RPA's capabilities do not meet with the requirements of the process) provide good analytical spots for process improvement
- Policy recommandation: careful when implementing automation in general and RPA in particular
  - Ensure upskilling of knowledge workers, avoid deskilling
  - Implement automation as a complement to human work, not merely as a substitute

17

Degrees of involvement

- Machines and humans are involved in task completion in differing degrees



18

Automation – augmentation

- Automation refers to replacing humans
  - Typical context: consistent patterns, routine tasks, rules-based processing, closed environments
  - Examples: warehouse logistics, factory automation, e-banking, transcription/translation
- Augmentation refers to supporting humans
  - Typical context: requirements for context-specific understanding, need for ability to reason, importance of assigning costs to false positives/false negatives, open environments
  - Types of augmentation
    - Triage: The AI makes a first pass at solving the problem, it is then passed onto a human specialist to take the final decision
      - Example: invoice processing in accounting, radiology in oncology
    - Decision support: The AI supports a human in making decisions in an interactive manner
      - Example: hiring decisions in human resources, credit decisions

19

Automation – augmentation
Paradoxical tensions

- While the contradiction automation-augmentation is real and companies do make either or choices when deploying AI, the two are also interdependent
- Increasing the temporal scale
  - Augmentation phase often leads to automation phase
  - Example: HR managers worked closely with an AI-based solution to identify reliable predictors of candidates' future work performance. It took a full year to make the system robust. After this augmentation phase, the firm removed humans from the initial screening process (automation) to avoid human biases. (Example from Raisch & Krakowski 2021)
- Increasing the spatial scale
  - Automation in one task might "spill over" enabling adjacent task's augmentation
  - Example: A fragrance firm automated the process of generating ideas for fragrance formulas from customer requirements. This led the the firm's master perfurmers to use the AI (augmentation) in the idea selection phase as well, for example, by experimenting with different dosages including hundreds of iterations. (Example from Raisch & Krakowski 2021)

Raisch, Sebastian, and Sebastian Krakowski. "Artificial intelligence and management: The automation–augmentation paradox." *Academy of Management Review* 46.1 (2021): 192-210.

20