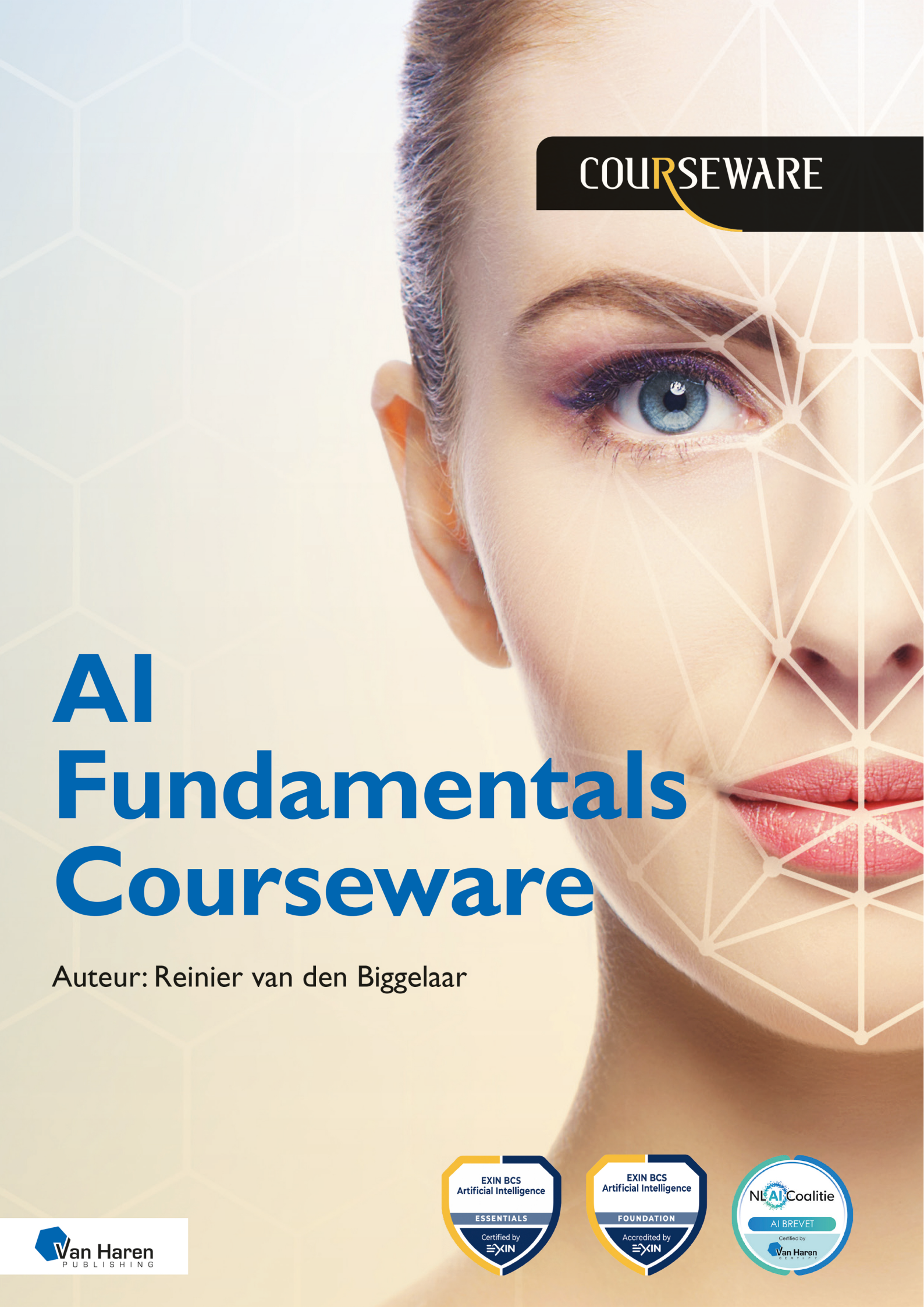

COURSEWARE

AI Fundamentals Courseware

Auteur: Reinier van den Biggelaar

EXIN BCS Artificial Intelligence ESSENTIALS Certified by EXIN

EXIN BCS Artificial Intelligence FOUNDATION Accredited by EXIN

NL AI Coalitie AI BREVET Certified by Van Haren

Van Haren PUBLISHING

AI Fundamentals
Courseware

Colophon

Title:	AI Fundamentals Courseware
Authors:	Reinier van den Biggelaar
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Design:	Van Haren Publishing, ‘s-Hertogenbosch

For further information about Van Haren Publishing please e-mail us at: info@vanharen.net or visit our website: www.vanharen.net

Publisher about the Courseware

The Courseware was created by experts from the industry who served as the author(s) for this publication. The input for the material is based on existing publications and the experience and expertise of the author(s). The material has been revised by trainers who also have experience working with the material. Close attention was also paid to the key learning points to ensure what needs to be mastered.

The objective of the courseware is to provide maximum support to the trainer and to the student, during his or her training. The material has a modular structure and according to the author(s) has the highest success rate should the student opt for examination. The Courseware is also accredited for this reason, wherever applicable.

In order to satisfy the requirements for accreditation the material must meet certain quality standards. The structure, the use of certain terms, diagrams and references are all part of this accreditation. Additionally, the material must be made available to each student in order to obtain full accreditation. To optimally support the trainer and the participant of the training assignments, practice exams and results are provided with the material.

Direct reference to advised literature is also regularly covered in the sheets so that students can find additional information concerning a particular topic. The decision to leave out notes pages from the Courseware was to encourage students to take notes throughout the material.

Although the courseware is complete, the possibility that the trainer deviates from the structure of the sheets or chooses to not refer to all the sheets or commands does exist. The student always has the possibility to cover these topics and go through them on their own time. It is recommended to follow the structure of the courseware and publications for maximum exam preparation.

The courseware and the recommended literature are the perfect combination to learn and understand the theory.

-- Van Haren Publishing

Other publications by Van Haren Publishing

Van Haren Publishing (VHP) specializes in titles on Best Practices, methods and standards within four domains:

- IT and IT Management
- Architecture (Enterprise and IT)
- Business Management and
- Project Management

Van Haren Publishing is also publishing on behalf of leading organizations and companies: ASLBiSL Foundation, BRMI, CA, Centre Henri Tudor, Gaming Works, IACCM, IAOP, IFDC, Innovation Value Institute, IPMA-NL, ITSqc, NAF, KNVI, PMI-NL, PON, The Open Group, The SOX Institute.

Topics are (per domain):

IT and IT Management

ABC of ICT
ASL®
CATS CM®
CMMI®
COBIT®
e-CF
ISO/IEC 20000
ISO/IEC 27001/27002
ISPL
IT4IT®
IT-CMF™
IT Service CMM
ITIL®
MOF
MSF
SABSA
SAF
SIAM™
TRIM
VeriSM™

Enterprise Architecture

ArchiMate®
GEA®
Novius Architectuur
Methode
TOGAF®

Business Management

BABOK® Guide
BiSL® and BiSL® Next
BRMBOK™
BTF
EFQM
eSCM
IACCM
ISA-95
ISO 9000/9001
OPBOK
SixSigma
SOX
SqEME®

Project Management

A4-Projectmanagement
DSDM/Atern
ICB / NCB
ISO 21500
MINCE®
M_o_R®
MSP®
P3O®
PMBOK® Guide
Praxis®
PRINCE2®

For the latest information on VHP publications, visit our website: www.vanharen.net.

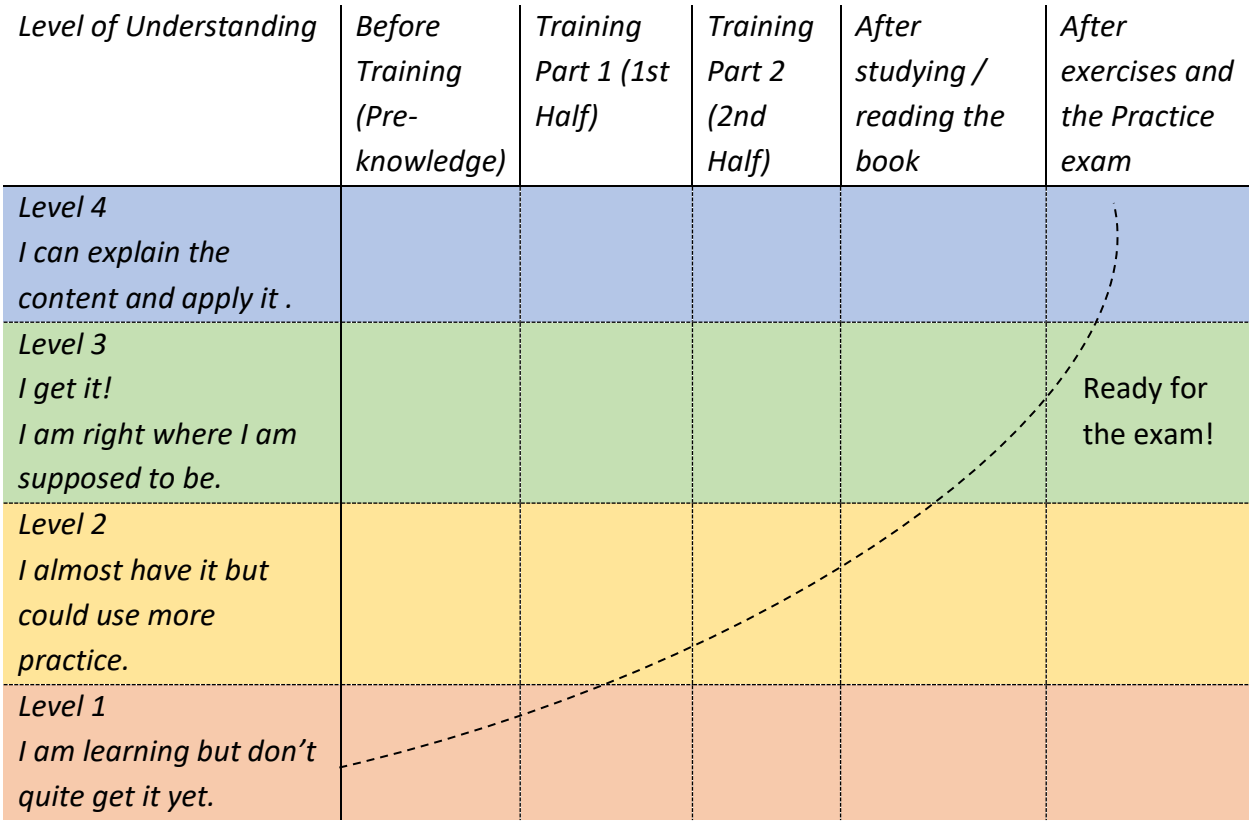
Table of content

Self-Reflection of understanding Diagram

'*What you do not measure, you cannot control*.'' – Tom Peters

Fill in this diagram to self-evaluate your understanding of the material. This is an evaluation of how well you know the material and how well you understand it. In order to pass the exam successfully you should be aiming to reach the higher end of Level 3. If you really want to become a pro, then you should be aiming for Level 4. Your overall level of understanding will naturally follow the learning curve. So, it's important to keep track of where you are at each point of the training and address any areas of difficulty.

Based on where you are within the Self-Reflection of Understanding diagram you can evaluate the progress of your own training.



(Self-Reflection of Understanding Diagram)

Write down the problem areas that you are still having difficulty with so that you can consolidate them yourself, or with your trainer. After you have had a look at these, then you should evaluate to see if you now have a better understanding of where you actually are on the learning curve.

Troubleshooting

Problem areas:	*Topic:*
Part 1	
Part 2	
You have gone through the book and studied.	
You have answered the questions and done the practice exam.	

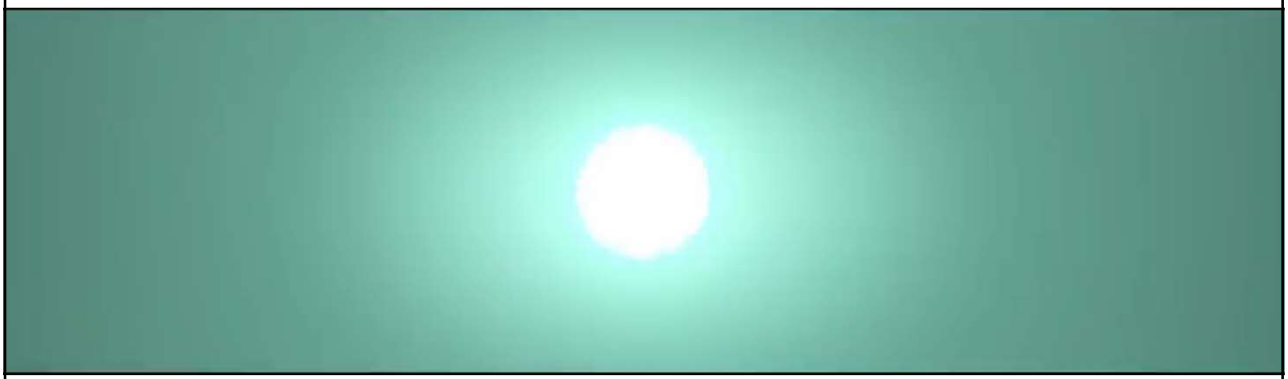
Timetable AI Fundamentals

Time table	Module	AI essentials EXIN BCS	AI Brevet Dutch AI Coalition AI for Business & Gov.	AI – Foundation EXIN BCS
Day 1 - part 1	Introduction and Agenda	✓	✓	✓
	Some history	✓	✓	✓
	Intelligence IQ and EQ	✓	✓	✓
	What is AI?	✓	✓	✓
	Heuristics and learning	✓	✓	✓
	Algorithms	✓	✓	✓
	Examples of AI	✓	✓	✓
Day 1 - part 2	Agents and Robotics	✓	✓	✓
	Starting with AI, what to do?	✓	✓	✓
	Future of AI	✓	✓	✓
Day 2 - part 1	Business Intelligence - Advanced analytics		✓	✓
	Use cases of AI, enablers			✓
	Finding AI use case		✓	✓
	AI Opportunity matrix and journey		✓	✓
	AI canvas exercise		✓	✓
Day 2 - part 2	Running AI projects		✓	✓
	Basic statistics for ML		✓	✓
	Data and Big data		✓	✓
	Data management and governance		✓	✓
	Ethics – Trustworthy AI		✓	✓
	Requirements for ethical and trustworthy AI		✓	✓

Day 3 - part 1				
	Organisational aspects		✓	✓
	Data engineering		✓	✓
	AI and sustainability			✓
	What is a Robot?		✓	✓
	Risks TRL			✓
	what do we need?			✓
	Types of Machine Learning			✓
	Building a Machine Learning Toolbox – Visualising Data			✓
Day 3 - part 2	A Simple Neural Network Schematic			✓
	Open Source ML and Robotic Systems			✓
	Machine Learning and Consciousness			✓
	Enabling capabilities		✓	✓
	Agile Projects		✓	✓
	Skills and competencies		✓	✓
	Center of excellence		✓	✓
	Make or buy		✓	✓
	The Future of Artificial Intelligence – The Human + Machine		✓	✓
	Conclusion & reading list		✓	✓

Day 1
Artificial Intelligence Foundation

COURSEWARE



Let’s get to knows each other

- Name
- Organisation
- Title/Role
- Experience
- Your objectives:
  - for the day
  - and beyond
- And one fun fact, but only if you want to share

Course approach

- Presentation, as the structure
- Exercises

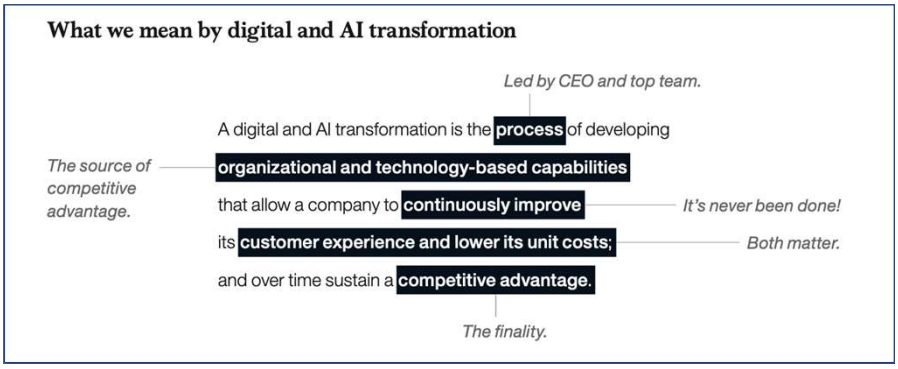
And very much stimulated and appreciated:

- Interactions
- Questions
- Discussions
- Experiences

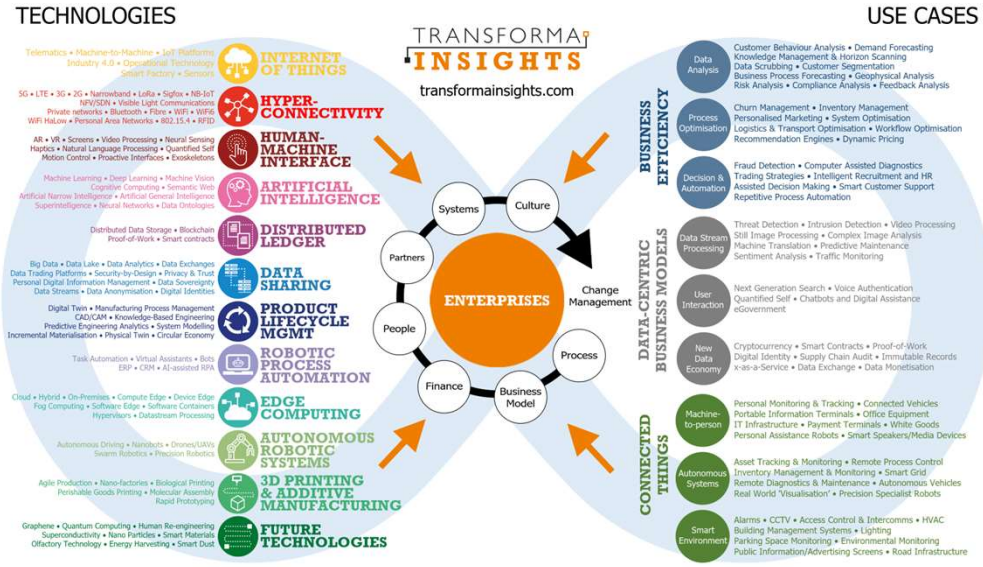
The WHY of AI

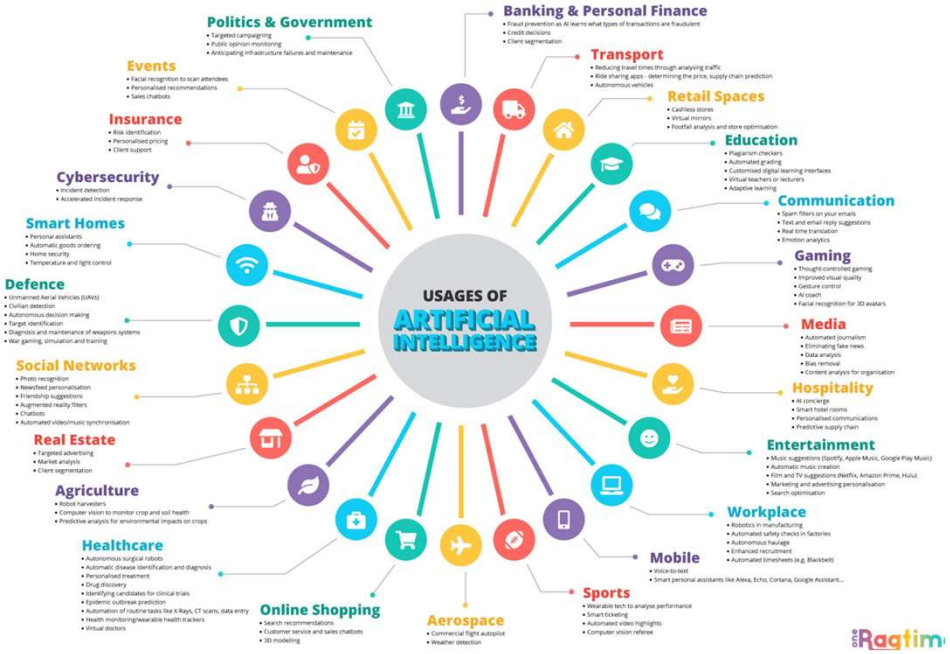
Digital transformation is the fundamental rewiring of how an organization operates. The goal of a digital transformation should be to build a competitive advantage by continuously deploying tech at scale to improve customer experience and lower costs.

(as outlined in the new McKinsey book *Rewired: A McKinsey Guide to Outcompeting in the Age of Digital and AI* (Wiley, June 20, 2023)

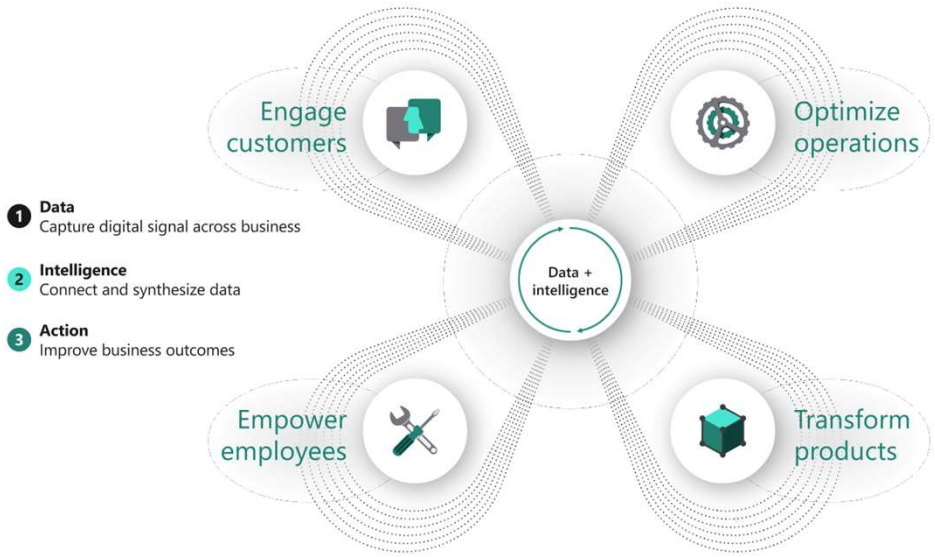


Digital transformation

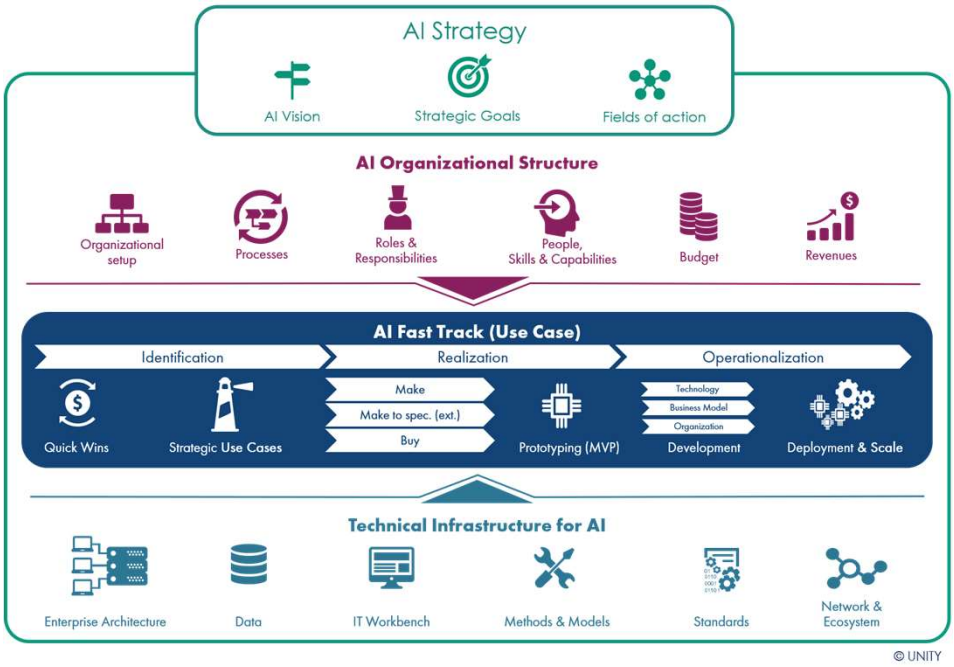




Digital feedback loop



Source Microsoft



Value expected over sectors and functions

Function	Consumer	Education	Energy	Financial Services	Government	Health Care Pharma	IG	Professional Services	Tech/IT	Telco/ Media
Strategy	21%	21%	13%	18%	22%	26%	11%	27%	17%	15%
R&D or Product Development	26%	33%	15%	32%	24%	38%	34%	35%	56%	44%
Supply Chain Management	48%	14%	46%	8%	20%	29%	44%	15%	12%	17%
Operations, Manufacturing	33%	32%	69%	31%	37%	42%	56%	35%	34%	53%
Sales	40%	16%	12%	32%	3%	12%	21%	27%	22%	15%
Customer Service	38%	32%	19%	54%	40%	37%	33%	34%	43%	47%
Marketing	40%	30%	15%	24%	2%	17%	19%	29%	22%	35%
Communication	4%	15%	2%	7%	10%	4%	7%	9%	4%	13%
Legal or Compliance	3%	5%	6%	13%	14%	4%	3%	5%	5%	3%
Finance, Accounting, or Risk	14%	12%	23%	34%	19%	22%	19%	20%	13%	8%
Information Technology	11%	34%	23%	31%	40%	31%	19%	27%	43%	32%
Procurement	10%	4%	25%	3%	7%	6%	12%	4%	4%	4%
Human Resources	7%	18%	13%	3%	17%	9%	9%	15%	12%	4%

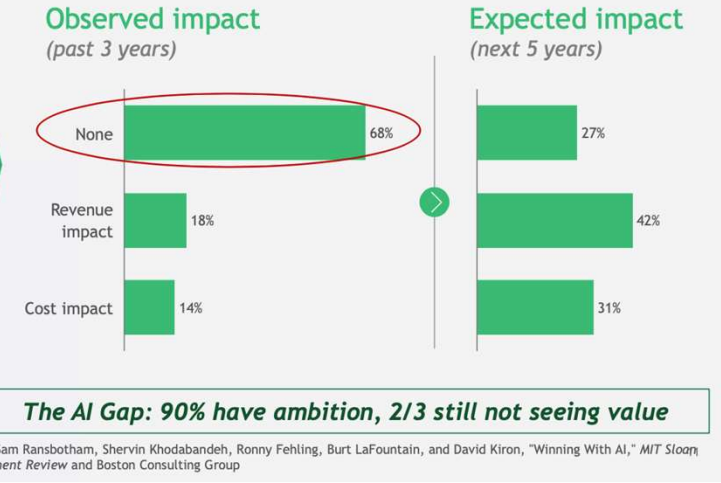
Source: Sam Ransbotham, Shervin Khodabandeh, Ronny Fehling, Burt LaFountain, and David Kiron, "Winning With AI," *MIT Sloan Management Review*

AI is everywhere, in % of case studies

Business domain	NLP	NLG	Vision	Machine learning	VA	Advanced robotics
Research and development	27%	20%	33%	32%	22%	30%
Customer service	26%	29%	26%	24%	47%	28%
Supply chain management	26%	25%	19%	24%	26%	27%
Operations	23%	31%	29%	36%	23%	50%
Distribution	20%	20%	24%	21%	29%	24%
Sales and marketing	19%	28%	23%	27%	36%	18%
Human resources	17%	14%	14%	17%	14%	14%
Financial and risk management	11%	9%	11%	22%	12%	12%
Executive management	10%	13%	12%	14%	11%	12%

BUT…

Most are struggling despite motivation, effort, and investments



The AI Gap: 90% have ambition, 2/3 still not seeing value

Source: Sam Ransbotham, Shervin Khodabandeh, Ronny Fehling, Burt LaFountain, and David Kiron, "Winning With AI," *MIT Sloan Management Review* and Boston Consulting Group

Some history

History of Artificial Intelligence: Notable Milestones

- 18th century : Mathematical development of statistics (Bayes' Theorem) and the first computer description and algorithm – Ada Lovelace
- 19th century: myth and legend AI became a regular topic of science fiction (Samuel Butler's "Darwin among the Machines" or Edgar Allan Poe's "Maelzel's Chess Player")
- 1940s: Walter Pitts and Warren McCulloch analyze networks of artificial neurons that can perform simple logical functions (neural networks)
- 1950: Alan Turing publishes an important paper : a test of a machine's ability to exhibit intelligent behavior that is indistinguishable from that of a human.
- 1951: Christopher Strachey writes a checkers program that eventually achieved sufficient skill to defeat a respectable amateur
- 1951: Marvin Minsky, student of Pitts and McCulloch, builds the first neural net machine
- 1972: Karen Spärck Jones – IDF (inverse document frequency is a numerical statistic that is intended to reflect how important a word is to a document in a collection or corpus) weighting underpins most search engines
- 1973: Resources withdrawn from AI research – Sir James Lighthill's report
  www.youtube.com/watch?v=03p2CADwGF8
- 1980: David Rumelhart and James McClelland Parallel Distributed Processing and Neural Network Models

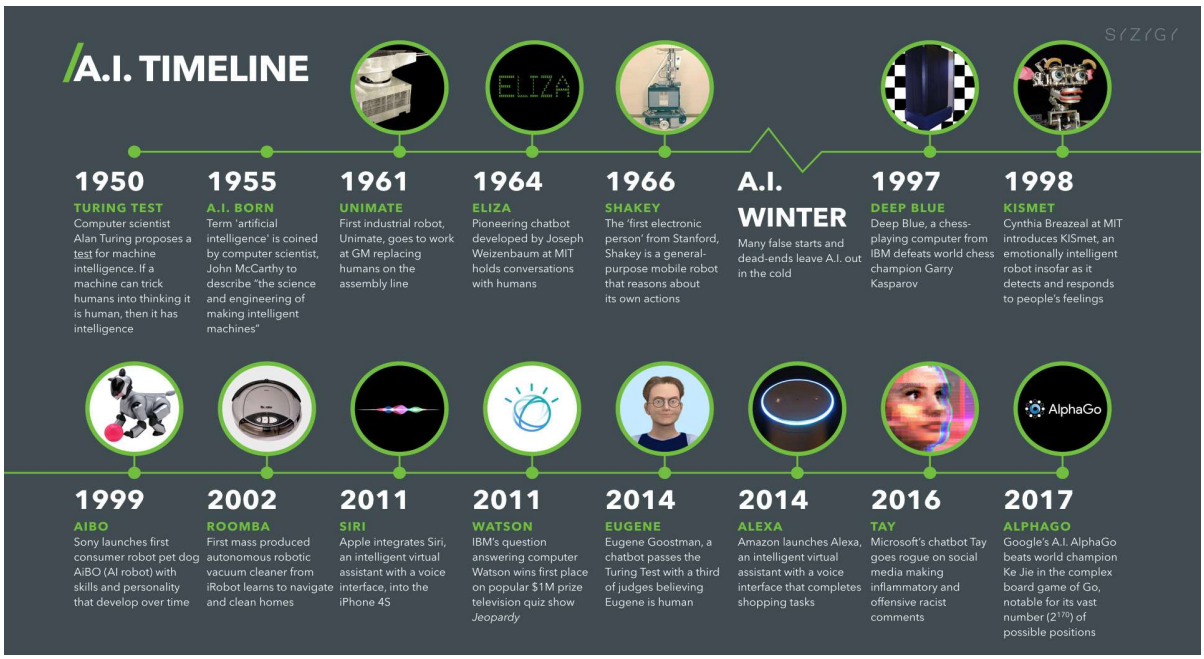
Birth of Artificial Intelligence: Dartmouth Workshop

In 1956 Marvin Minsky and John McCarthy organize the 'Dartmouth Workshop of 1956'

This workshop was attended by many scientists who would later go on to contribute significantly to the field of AI research

This is the moment that AI gained its name and mission, and it is widely considered as the birth of the separate field of artificial intelligence research ☑

Dartmouth Workshop of 1956



Garry Kasparov vs Deep Blue, 1997

History of Artificial Intelligence: Notable Milestones

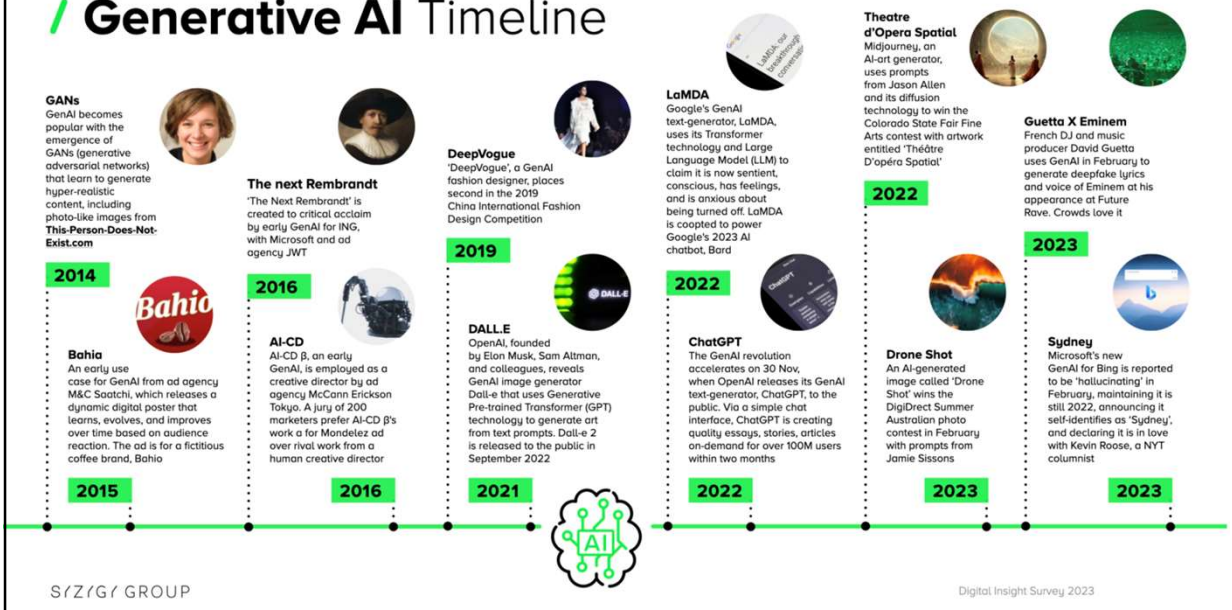
- 1997: Deep Blue (11.4 GFLOPS) beats world chess champion – won by searching 200,000,000 moves per second. (iPhone 7 - 400 GFLOPS)
- 2005: Five autonomous vehicles complete the DARPA Grand Challenge
- 2011: Apple launches SIRI
- 2017: AlphaGo, created by Deep Mind, beats the world's Go champion
- 2017: Attention is all you need, Google Research paper
- 2018: Facebook starts using AI to filter out explicit visual content
- 2019: AI outperforms radiologist in diagnosing lung cancer
- 2021: Researchers at Howard Hughes Medical Institute use brain signals to enable a paralyzed person to write
- 2022: Large language model GPT by OpenAI
- 2023: Anthropic Claude, Meta Llama 2,

Lee Sedol vs AlpaGo, 20 years later

Generative AI developments

- GPT-2: In 2019, OpenAI released the language model GPT-2 (Generative Pre-trained Transformer 2), which was trained on a massive dataset of text and could generate human-like language with remarkable coherence and fluency.
- AlphaFold: In 2020, DeepMind announced the development of AlphaFold, a neural network that can accurately predict the 3D structure of proteins, which is a long-standing challenge in biochemistry. AlphaFold has the potential to accelerate the discovery of new drugs and treatments for diseases.
- GPT-3: In 2020, OpenAI released GPT-3, a language model with 175 billion parameters, making it one of the largest language models ever created.
- MuZero: In 2020, DeepMind announced the development of MuZero, a neural network that can learn how to play games without any knowledge of the game rules or any human input.
- DALL-E: In 2021, OpenAI released DALL-E, a neural network that can generate images from textual descriptions. For example, given the prompt "an armchair in the shape of an avocado," DALL-E can produce a unique, photorealistic image that matches the description.
- ChatGPT: in Januari 2023 OpenAI released ChatGPT, which reached 100 million users within 3 weeks

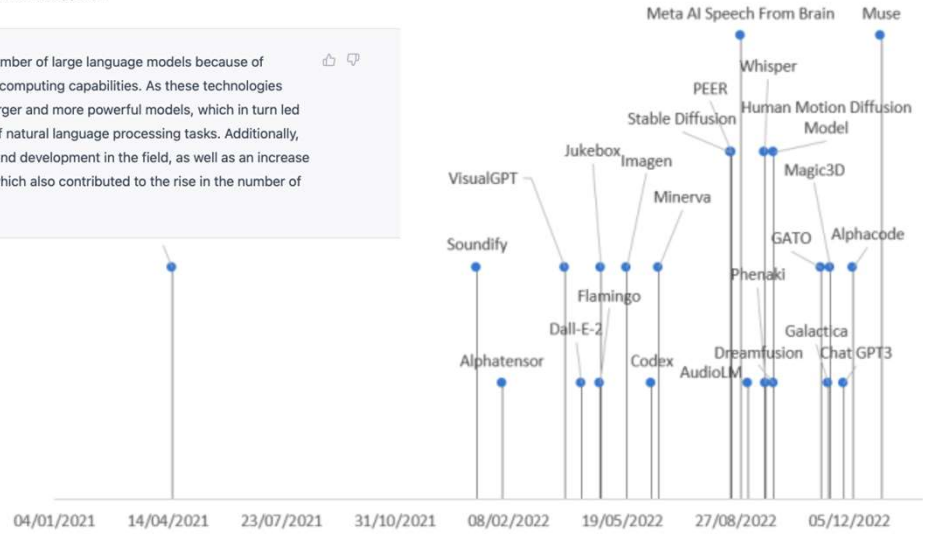
/ Generative AI Timeline



Storm of LLM's

RE why did in 2022 so many large language models appear?

In 2022, there was an increase in the number of large language models because of advancements in machine learning and computing capabilities. As these technologies improved, it became possible to train larger and more powerful models, which in turn led to improved performance on a variety of natural language processing tasks. Additionally, there was also an increase in research and development in the field, as well as an increase in funding and investment in the area, which also contributed to the rise in the number of large language models.



A (r)evolution?

Machine learning: Analysis and prediction phase

Deep learning: Vision and speech phase

Generative AI: Enter the language-mastery phase

Source: Accenture

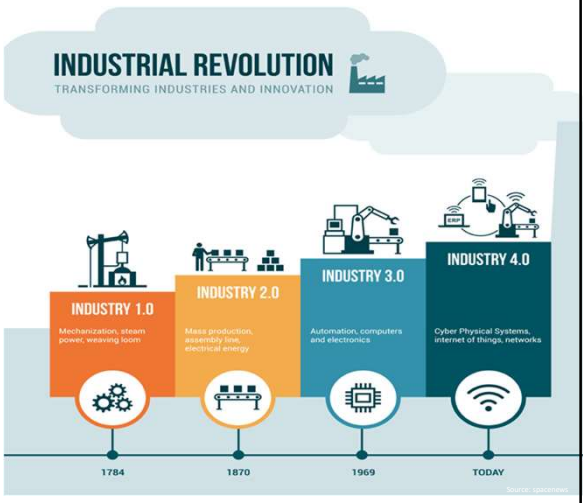
The industrial revolutions

- First: 18th and 19th centuries
  - Europe and US – steam engine, rural societies became urban and industrial.
- Second: 1870 to 1914
  - Electricity allowed mass production and technological advances such as the internal combustion engine, telephone and light bulb. *(combustion engine can be seen as third)*
- Third: 1980s
  - Digital and ICT (information and communications technology) are embedded into society; personal computers, internet and automation.
- Fourth: Today
  - Exploits the digital revolution and is disruptive, driven by AI, robotics, IoT (Internet of Things), plastic printing, nano-technology, bio-engineering.

Named by Klaus Schwab – Founder of the World Economic Forum.
The Fourth Industrial Revolution is changing every area of our lives. ☑

AI in an acceleration phase

- Klaus Schwab, founder and executive chairman of the **World Economic Forum** (WEF), author of The Fourth Industrial Revolution:
  - "**The convergence of the physical, digital and biological worlds** that is at the heart of the fourth industrial revolution offers significant opportunities for the world to achieve huge gains in resource use and efficiency." - Developments in various fields have enabled us to make significant technological progress
- The progress that AI has made is driven by **increases in computing power,** by the availability of **vast amounts of data, fast networks** and powerful **programming languages** as R and Python



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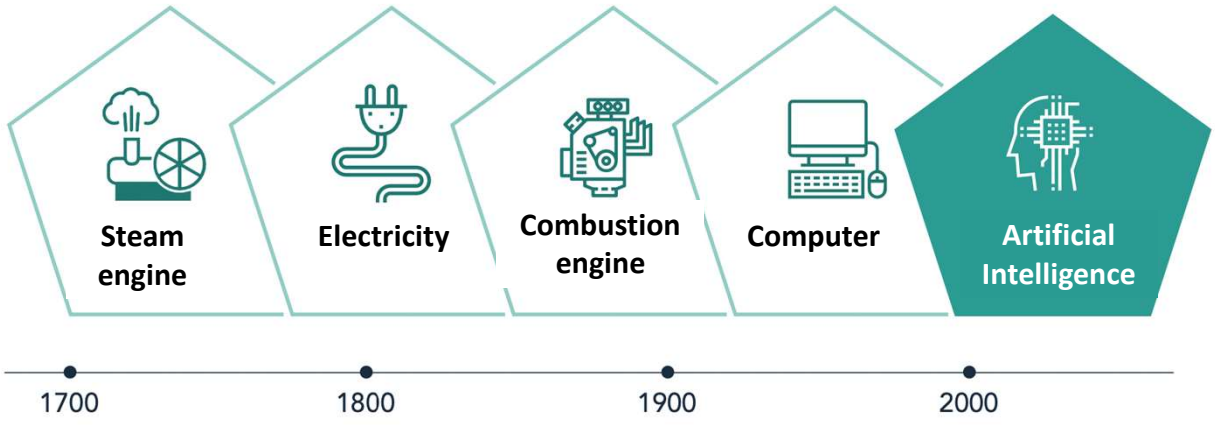
AI as system technology



Source: WRR

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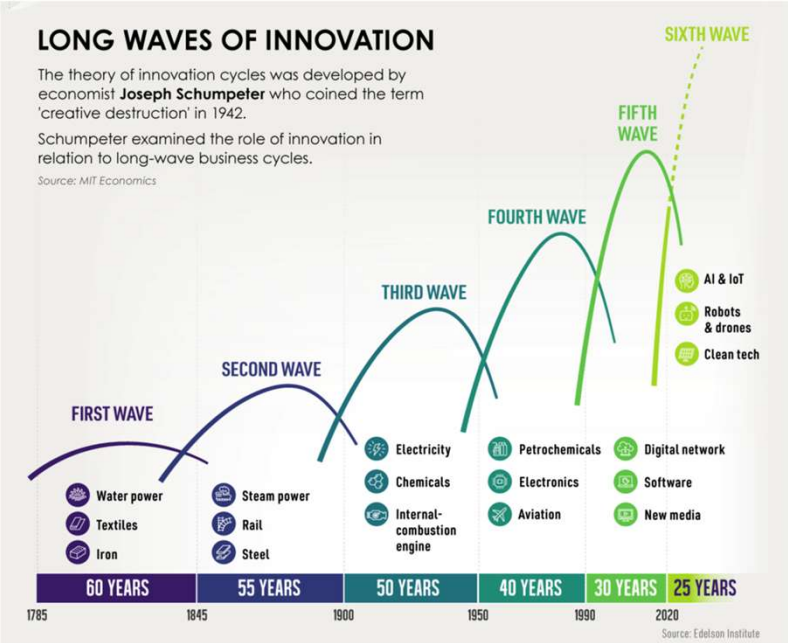
Schumpeter on Innovation and Creative Destruction



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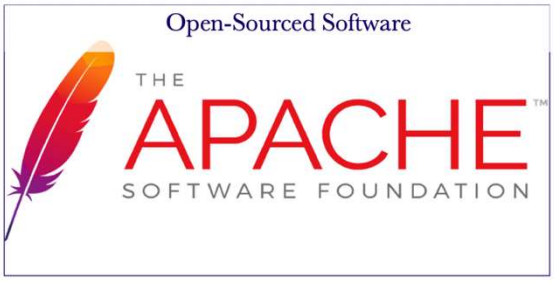
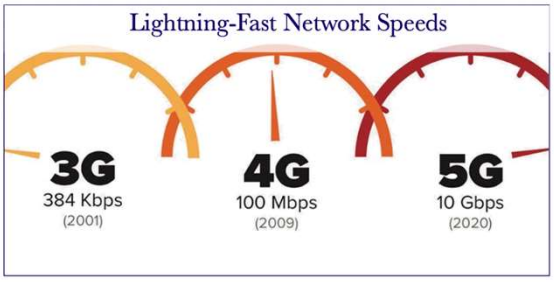
Drivers of AI





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So far, so good?
Any questions?

Intelligence:
- Human and artificial
- IQ and EQ

COURSEWARE

Aristotle

364BC to 322BC – Father of Western Philosophy

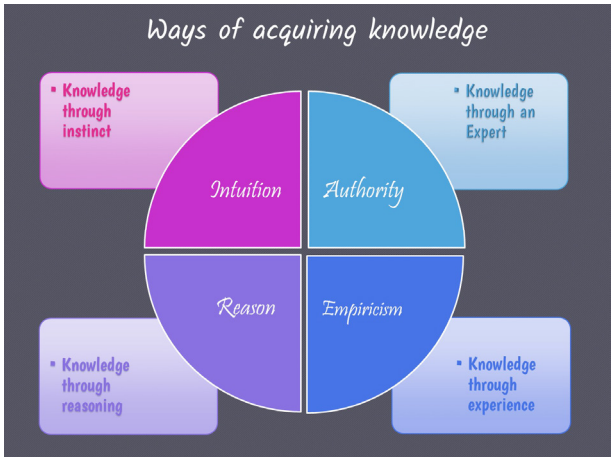
First to write about objects and laid the foundations of:

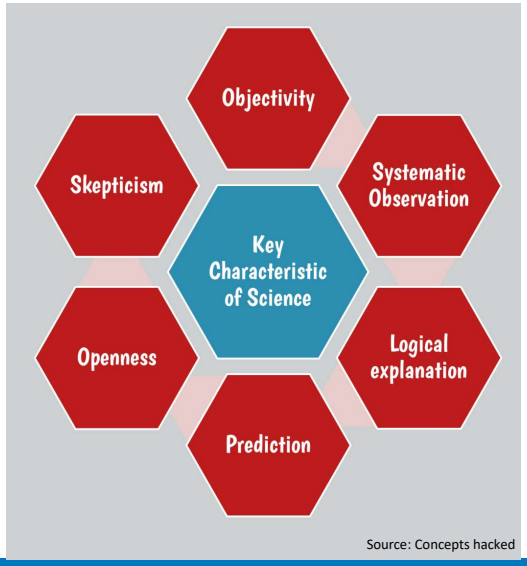
- Ontology – the nature of being, knowledge, engineering;
- The scientific method.

Today, we teach:

- Natural science;
- Data science;
- Computer science;
- Social science;
- Artificial intelligence – a universal subject?

Knowledge and Science





Source: Concepts hacked

The scientific method – objective

The empirical approach to acquiring knowledge involves a systematic process that includes

- careful observation,
- rigorous skepticism,
- formulating hypotheses,
- testing through experiments,
- refining those hypotheses.

This method is iterative and cyclical, as we continually build upon and learn from our experiences. To ensure credibility, researchers publish their results for peer review, emphasizing transparency and reproducibility.

The scientific method and experiential learning have paved the way for machine learning (ML), which now benefits us in our everyday lives.

For more information, visit: https://en.wikipedia.org/wiki/Scientific_method

Emotional intelligence – EQ – subjective

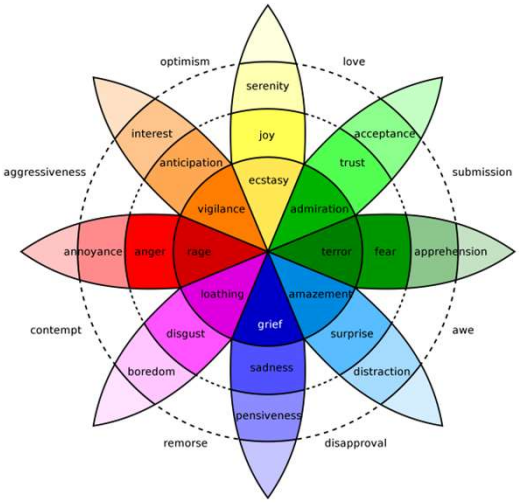
Our capacity to comprehend our emotions and the emotions of others enables us to adapt to and modify our surroundings.

By leveraging this understanding, we can empathize and make informed decisions.

Consciousness remains the most challenging aspect of artificial intelligence.

Ongoing scientific research is steadily expanding our knowledge in this area.

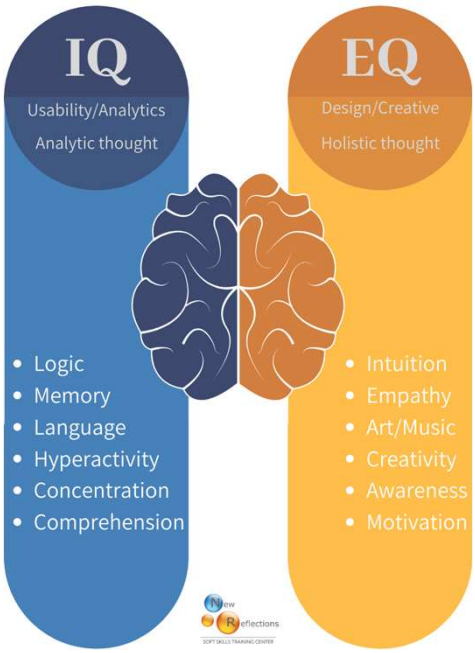
Meanwhile, the scientific method is being employed across various social science disciplines, including economics, politics, geography, health, sociology, psychology, and marketing.



EQ versus IQ

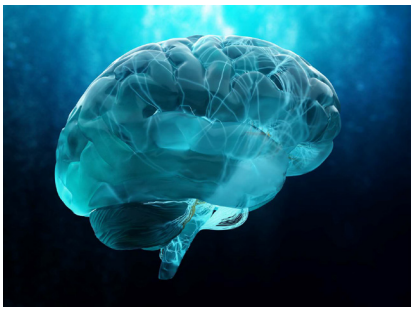
IQ tests measure your ability to solve problems, use logic, and grasp or communicate complex ideas.

EQ tests measure your ability to recognize emotion in yourself and others, and to use that awareness to guide your decisions.



Tech definition of Intelligence

Intelligence can be defined as the ability to perceive or infer **information**, and to retain it as **knowledge** to be applied towards adaptive **behaviors** within an environment or context.



In computer science we call something that has this ability an **intelligent agent**.

- We will talk more about intelligent agents in Topic 2.

Dictionary definition of intelligence

Human intelligence
is a mental quality that consists of the abilities to learn from experience, adapt to new situations, understand and handle abstract concepts, and use ☑ knowledge to manipulate one's environment.

- The Concise Oxford Dictionary: *"quickness of understanding; wisdom. The collection of information."*
- Cambridge International Dictionary of English: *"the ability to understand and learn and make judgements or have opinions that are based on reason."*
- Wikipedia: *Problem Solving, Reasoning, Self-Awareness, Creativity, Emotional Knowledge*
- Encyclopeadia Britannica: Learn from experience, understand and handle abstract concepts, manipulate our environment.

Evaluating Intelligence

- How do we evaluate levels of intelligence?

Robert Dilts:

Six logical levels of thinking or situation

NLP origin

Also as change mngt model

Psychologist definition of intelligence

This is a big, ambiguous question to which there is no settled answer. But here's one answer, offered by a group of 52 psychologists in 1994:

"Intelligence is a very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience."

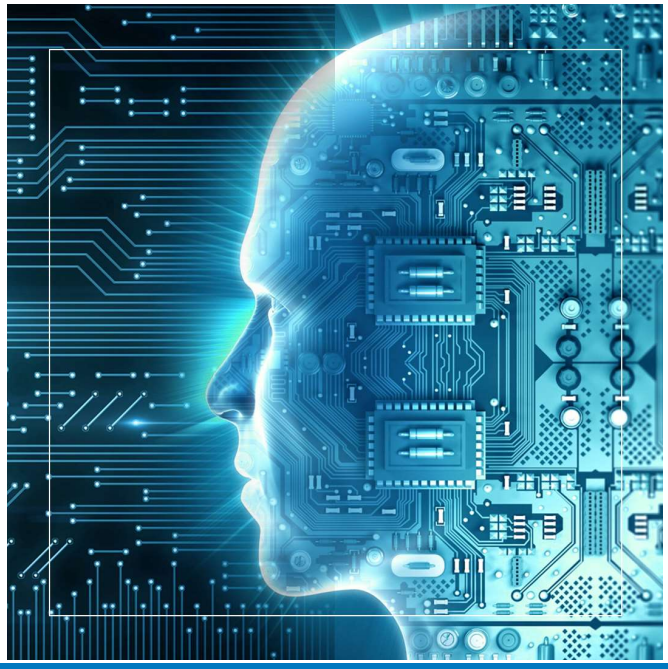
It is not merely book learning, a narrow academic skill, or test-taking smarts.
Rather, it reflects a broader and deeper capability for comprehending our surroundings
"catching on," "making sense" of things, or "figuring out" what to do.

Source:
Mainstream Science on Intelligence: An Editorial With 52 Signatories, History, and Bibliography
LINDA S. GOTTFREDSON
University of Delaware

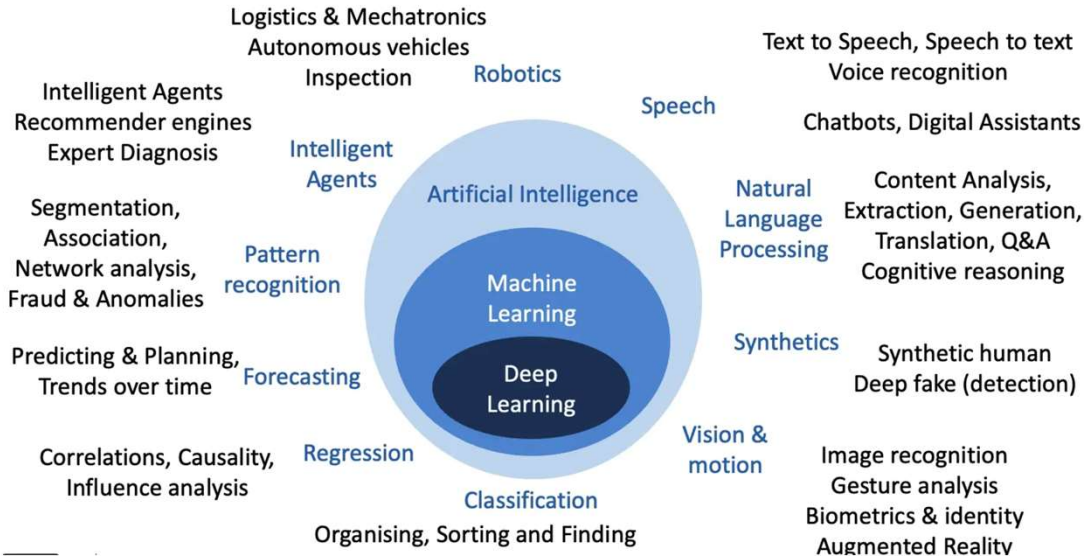
Artificial Intelligence vs Human Intelligence

Artificial Intelligence	Human Intelligence
Created by human intelligence	Created by Divine intelligence
Process information faster	Process information slower
Highly objective	May be subjective
More accurate	May be less accurate
Uses 2 watts	Uses 25 watts
Cannot adapt to changes well	Can easily adapt to changes
Cannot multitask that well	Can easily multitask
Below average social skills	Excellent social skills
Still working towards self-awareness	Has self-awareness
Optimization	Innovation

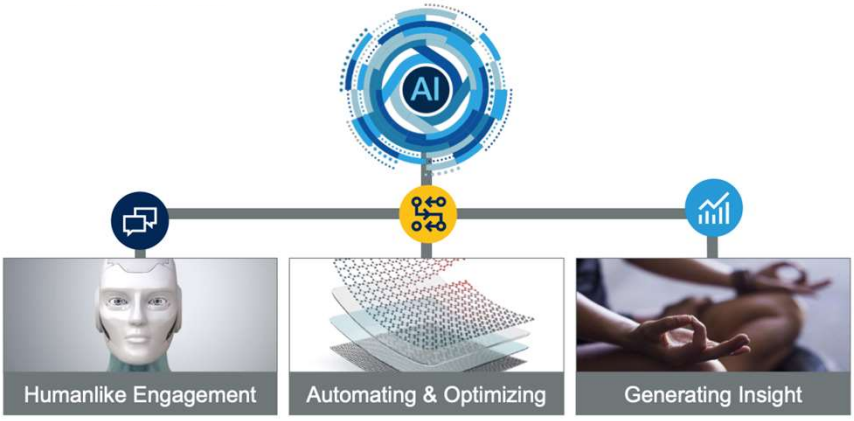
What is AI?



AI : Collection of many different applications



AI : Types of solutions



- Chatbots, Virtual Assistants
- Natural Language Processing
- Computer Vision

- Process Optimization
- Automating Tasks

- Forecasting
- Classification
- Find and Interpret Patterns

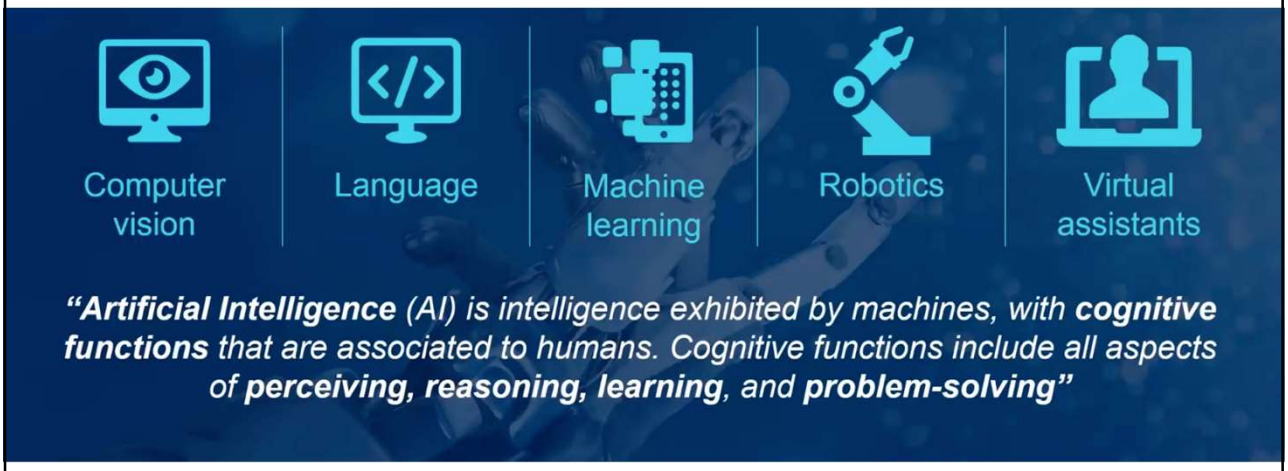
Source Gartner

AI : Taxonomy

	AI taxonomy	
	AI domain	**AI subdomain**
Core	**Reasoning**	Knowledge representation
		Automated reasoning
		Common sense reasoning
	Planning	Planning and Scheduling
		Searching
		Optimisation
	Learning	Machine learning
	Communication	Natural language processing
	Perception	Computer vision
		Audio processing
Transversal	**Integration and Interaction**	Multi-agent systems
		Robotics and Automation
		Connected and Automated vehicles
	Services	AI Services
	Ethics and Philosophy	AI Ethics
		Philosophy of AI

JRC TECHNICAL REPORTS
Source EU AI Watch:
Defining Artificial Intelligence 2.0

AI definition



More definitions

The term "artificial intelligence" means a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations, or decisions influencing real or virtual environments

Field of study that gives computers the abilty to learn without being explicitly programmed. (Arthur Samuel, IBM 1959)

- Intelligence demonstrated by machines.
- *"Intelligent agents"* perceiving their environment, learning from experience and taking actions to achieve a goal. (Computer science view)
- Some traditional goals are sometimes called narrow or weak AI:
  - Reasoning, planning, learning, natural language processing, image recognition…
- Artificial general intelligence (AGI), sometimes called strong AI:
  - Performs a full range of human abilities
  - Some predict it will be 2050 before we can achieve this
  - Large Language models are a big step forward

Even more definitions

Artificial Intelligence is the science of training machines to perform human tasks

AI is the simulation of human intelligence in machines
AI is autonomous and adaptive systems

An AI system is a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations, or decisions influencing real or virtual environments. AI systems are designed to operate with varying levels of autonomy. (OECD)

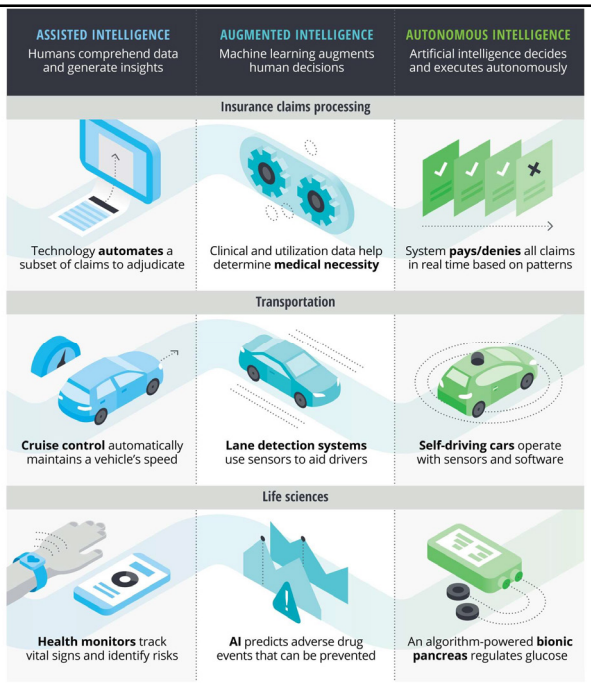
Artificial Intelligence is a concept, a term for all those situations where a computer does things that seem human, like perceive, reason, learn and act

Common features

Multiple definitions exist but common features in AI definitions are:

- **Perception of the environment**, including the consideration of the real world complexity
- **Information processing**: collecting and interpreting inputs (in form of data)
- **Decision making** (including reasoning and learning): taking actions, performance of tasks (including adaptation, reaction to changes in the environment) with certain level of autonomy
- **Achievement of specific goals**: this is considered as the ultimate reason of AI systems

AI : 3 variations



Source McKinsey