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SOFIA UNIVERSITY
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ICT-TEX course on Digital skills

Topic 7: Introduction to Artificial Intelligence and Machine Learning

The course is developed under Erasmus+ Program Key Action 2:
Cooperation for innovation and the exchange of good practices [Knowledge Alliance](#)

ICT IN TEXTILE AND CLOTHING HIGHER EDUCATION AND BUSINESS

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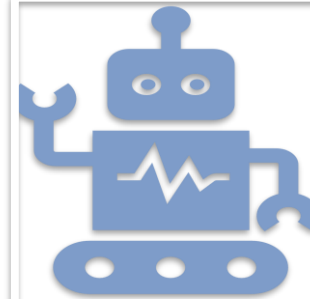


Outline



What is AI?

Where it can
be applied?



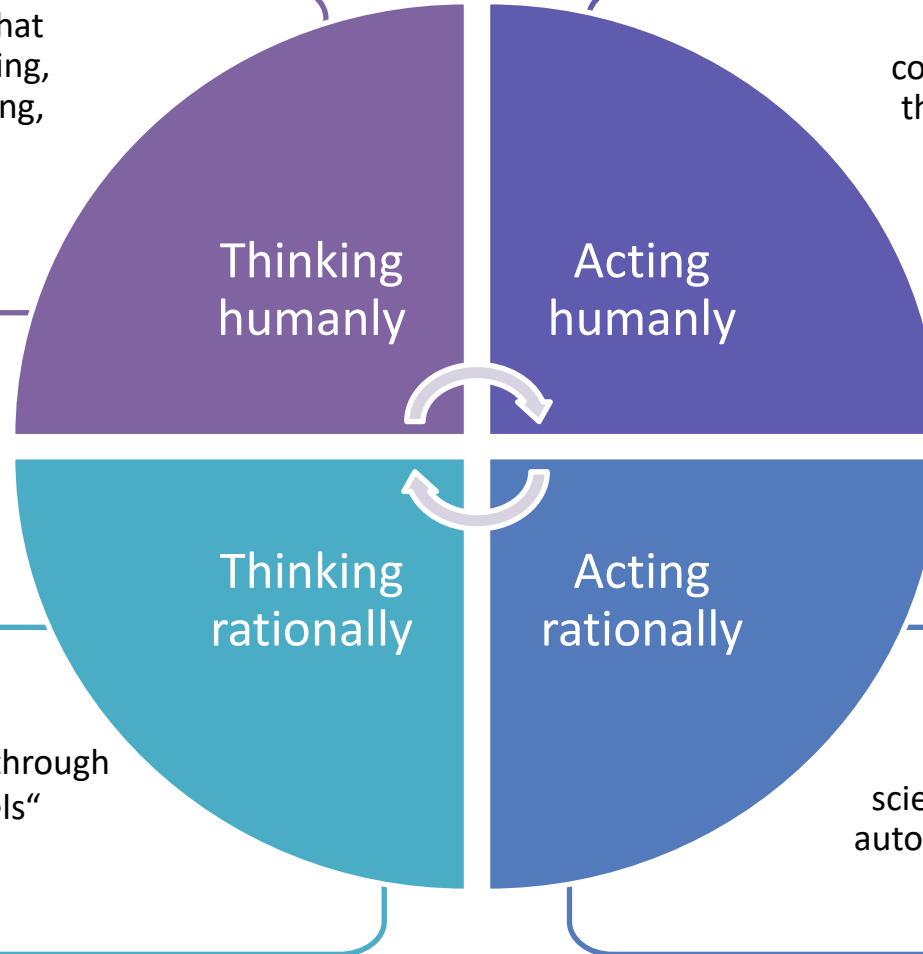
How does it
work?



Strong AI

[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning ..."
(Richard Bellman , 1978))

"The study of how to make computers do things at which, at the moment, people are better"
(Rich+Knight, 1991)



What is AI?

"The study of mental faculties through the use of computational models"
(Charniak+McDermott, 1985)

"The branch of computer science that is concerned with the automation of intelligent behavior"
(Luger+Stubbleeld, 1993)

Weak AI

Strong AI

Strong AI refers to AI that exhibits human-level intelligence. So, it can understand, think, and act the same way a human might in any given situation. This is when a machine truly understands what is happening. There may even be emotions and creativity. For the most part, it is what we see in science fiction movies. This type of AI is also known as **Artificial General Intelligence (AGI)**. In theory, then, anything a human can do, a strong AI can do too.

Note that there are only a handful of companies that focus on this category, such as Google's [DeepMind](#), the [Human Brain Project](#) and [OpenAI](#).



Weak AI

Weak AI is both the most limited and the most common of the three types of AI. It's also known as narrow AI or **artificial narrow intelligence (ANI)**. With this, a machine is pattern matching and usually focused on narrow tasks. The idea behind weak AI isn't to mimic or replicate human intelligence. Rather, it's to simulate human behavior.

Examples of this include [Apple's Siri](#) and [Amazon's Alexa](#).





Super AI

Super AI is AI that surpasses human intelligence and ability. It's also known as **artificial superintelligence (ASI)** or superintelligence. It's the best at everything — maths, science, medicine, hobbies, you name it. Even the brightest human minds cannot come close to the abilities of super AI.



*Of the types of AI, super AI is the one most people mean when they talk about **robots taking over the world.***



Acting humanly: The Turing Test

- The Turing Test, proposed by Alan Turing was designed to provide a satisfactory operational definition of intelligence. Turing defined intelligent behavior as the ability to achieve human-level performance in all cognitive tasks, sufficient to fool an interrogator. Roughly speaking, the test he proposed is that the computer should be interrogated by a human via a teletype, and passes the test if the interrogator cannot tell if there is a computer or a human at the other end.

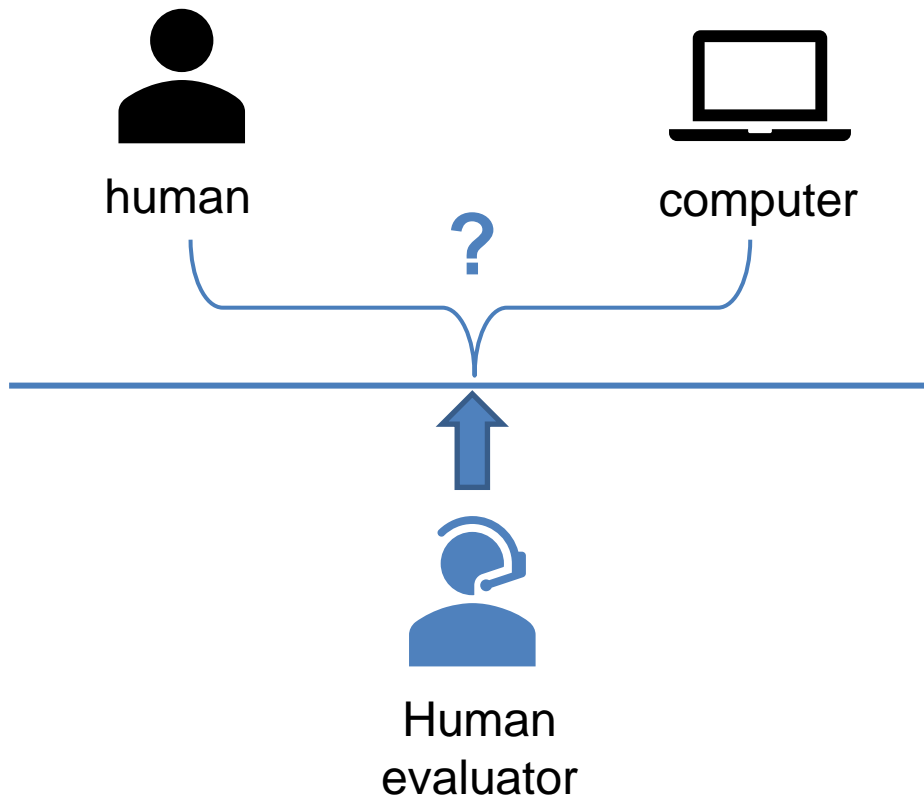


Alan Turing (1912 – 1954)

Source: https://en.wikipedia.org/wiki/Alan_Turing#/media/File:Alan_Turing_Aged_16.jpg (Public domain)



Turing Test



- “Turing Test” is essentially a game with three players: two that are human and one that is a computer.
- The evaluator, a human, asks open-ended questions of the other two (one human, one computer) with the goal of determining which one is the human.
- If the evaluator cannot make a determination, then it is presumed that the computer is intelligent.

The Turing Test

- For now, programming a computer to pass the test provides plenty to work on. The computer would need to possess the following capabilities:
 - **natural language processing** to enable it to communicate successfully in English (or some other human language);
 - **knowledge representation** to store information provided before or during the interrogation;
 - **automated reasoning** to use the stored information to answer questions and to draw new conclusions;
 - **machine learning** to adapt to new circumstances and to detect and extrapolate patterns.



The Turing Test

- Turing's test deliberately avoided direct physical interaction between the interrogator and the computer, because physical simulation of a person is unnecessary for intelligence. However, the so-called total Turing Test includes a video signal so that the interrogator can test the subject's perceptual abilities, as well as the opportunity for the interrogator to pass physical objects “through the hatch.” To pass the total Turing Test, the computer will need:
 - **computer vision** to perceive objects, and
 - **robotics** to move them about.

Thinking humanly: The cognitive modelling approach

- Requires scientific theories of internal activities of the brain
- We need to get *inside* the actual workings of human minds.
- There are two ways to do this:
 - through introspection--trying to catch our own thoughts as they go by
 - through psychological experiments
- The interdisciplinary field of **cognitive science** brings together computer models from AI and experimental techniques from psychology to try to construct precise and testable theories of the workings of the human mind.



Thinking rationally: The laws of thought approach

- Normative (or prescriptive) rather than descriptive
- Aristotle: what are correct arguments/thought processes?
- Several Greek schools developed various forms of logic:
 - notation and rules of derivation for thoughts;
 - may or may not have proceeded to the idea of mechanization



Acting rationally

- Rational behavior means doing *the right thing*
- The right thing: that which is expected to maximize goal achievement, given the available information
- Doesn't necessarily involve thinking, but should be in the service of rational action



A visual History of AI

<p>1943</p> <p>First mathematical model of a neuron.</p> <p>$\Phi(x) = \begin{cases} 1 & \text{if } x \geq \theta \\ -1 & \text{otherwise} \end{cases}$</p> <p>Electronic Brain by McCulloch & Pitts</p>	<p>1950</p> <p>Turing test is proposed.</p> <p>Turing Test by Alan Turing</p>	<p>1952</p> <p>One of the first computer board game.</p> <p>Checkers Program by Arthur Samuel</p>	<p>1957</p> <p>Weights automatically learned.</p> <p>$y = \sum_{i=1}^n w_i x_i + w_0 = \mathbf{w}^T \mathbf{x}$</p> <p>Perceptron by Frank Rosenblatt</p>	<p>1960</p> <p>The first cost function.</p> <p>$E(\mathbf{w}) = \frac{1}{2} \sum_i (y_i - \Phi(z_i))^2$</p> <p>ADALINE by Widrow & Hoff</p>	<p>1969</p> <p>Perceptron cannot learn XOR.</p> <p>XOR Problem by Minsky & Papert</p>
AI Winter (1974-1980)			AI Winter (1987-1993)		
<p>1970</p> <p>Backpropagation & automatic differentiation.</p> <p>$\frac{\partial y}{\partial x} = \frac{\partial y}{\partial w_1} \frac{\partial w_1}{\partial x}$</p> <p>Automatic differentiation by Seppo Linnainmaa</p>	<p>1979</p> <p>The first convolutional neural network (CNN).</p> <p>Neocognitron by Kunihiko Fukushima</p>	<p>1982</p> <p>Foundation of graphical probabilistic models.</p> <p>Bayesian Networks by Judea Pearl</p>	<p>1986</p> <p>Backpropagation is popularized.</p> <p>Backpropagation in MLP by Rumelhart, Hinton, Williams</p>	<p>1989</p> <p>Convolutional neural networks (CNN) used for recognizing handwriting.</p> <p>LeNet by Yann LeCun</p>	<p>1992</p> <p>Almost champion-level backgammon, using reinforcement learning.</p> <p>TD-Gammon by Gerald Tesauro</p>
<p>1995</p> <p>Soft-margin SVM is introduced.</p> <p>Support Vector Machines by S. Vapnik & Cortes</p>	<p>1995</p> <p>NIST MNIST is born.</p> <p>MNIST by NIST</p>	<p>1996</p> <p>DeepBlue beats Kasparov in chess.</p> <p>DeepBlue by IBM</p>	<p>1997</p> <p>LSTM for addressing vanishing gradients.</p> <p>Long Short-Term Memory (LSTM) by Schmidhuber.</p>	<p>2006</p> <p>Deep learning is possible.</p> <p>Deep Boltzman Machine by Ruslan & Hinton</p>	<p>2009</p> <p>ImageNet, a large-scale image dataset is introduced.</p> <p>ImageNet by Fei-Fei Li</p>
<p>2012</p> <p>First significant results in deep learning.</p> <p>AlexNet by Krizhevsky & Hinton</p>	<p>2013</p> <p>Word embeddings become popular.</p> <p>Word2Vec by Tomas Mikolov</p>	<p>2014</p> <p>Generative Adversarial Network (GAN) introduced.</p> <p>GAN by Ian Goodfellow</p>	<p>2016</p> <p>DeepMind The first program to beat a professional Go player.</p> <p>AlphaGo by DeepMind</p>	<p>2018</p> <p>Google AI Pretrained language models.</p> <p>BERT by Google AI</p>	<p>2019</p> <p>DeepMind Grandmaster level in Starcraft II.</p> <p>AlphaStar by DeepMind</p>

Parisa Rashidi, May 2020. CC BY 4.0

Source: https://twitter.com/Parisa_Rashidi/status/1264724313560592385/photo/1



Symbolic AI

- Rule-Based Systems



Connectionist AI

- Neural Networks



Evolutionary AI

- Genetic Algorithms



Molecular AI

- DNA Computing



Big Data

Capability to process massive amount of structured and unstructured data which can change constantly

Reasoning

Ability to reason (deductive or inductive) and to draw inferences based to the situation. Context driven awareness of the system



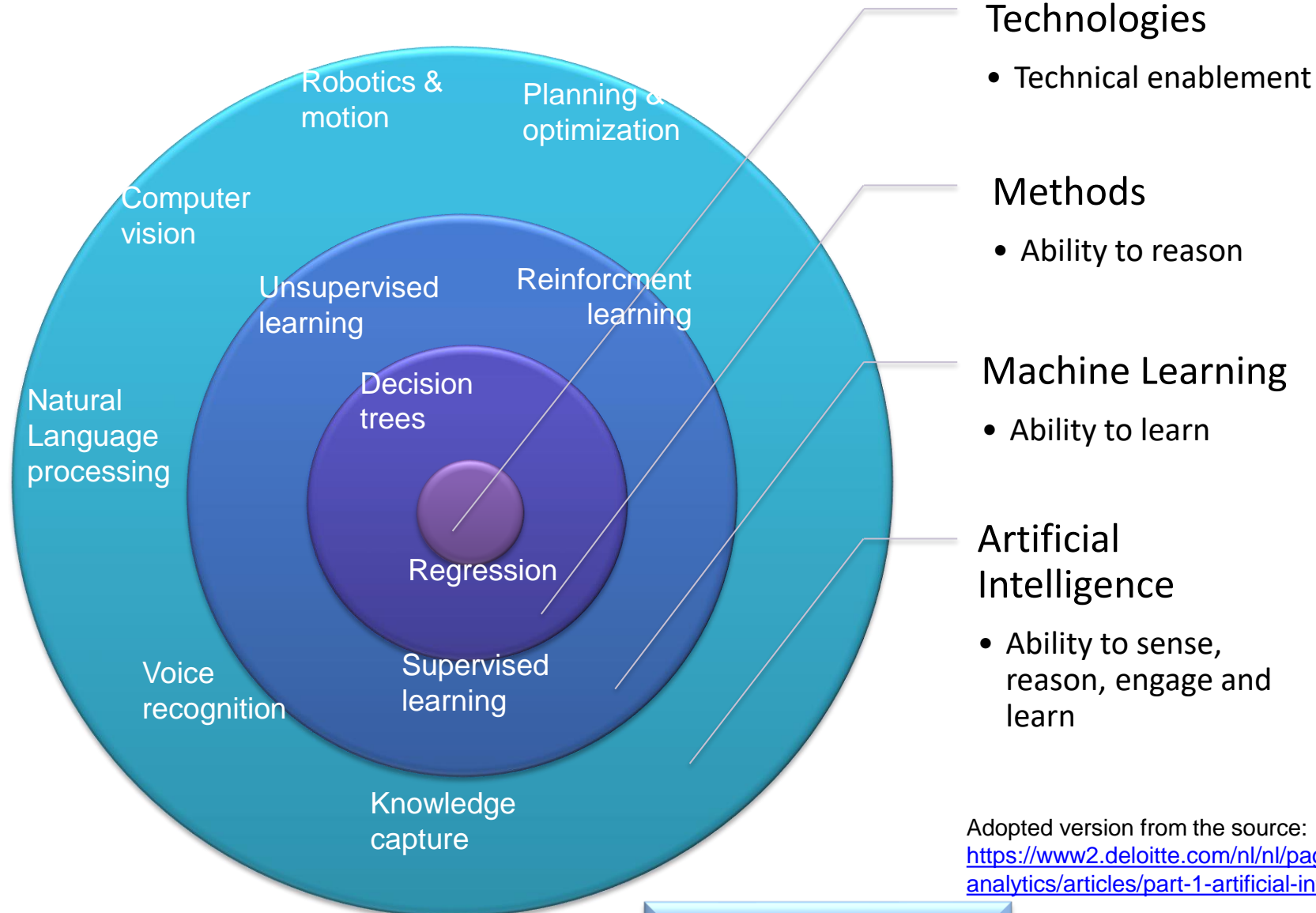
Ability to learn, based on historical patterns, expert input and feedback loop

Learning

Capability to analyze and solve complex problems to special purpose and general-purpose domain

Problem solving

Adopted version from the source: <https://www2.deloitte.com/nl/nl/pages/data-analytics/articles/part-1-artificial-intelligence-defined.html>





Essential techniques

Problem-solving

Searching in the
State Space

Constraint
Satisfaction
Problem

Genetic
Algorithms

Knowledge, reasoning, and planning

Knowledge
Representation

First Order Logic

Planning

Uncertain knowledge and reasoning

Probabilistic
Reasoning

Decision Support
Systems

Machine Learning

Unsupervised
Learning

Supervised
Learning

Reinforcement
Learning

Communicating, perceiving, and acting

Natural Language
Processing

Deep Learning

Computer Vision

Robotics



For the best experience with this topic, it is also recommended to go through the hands-on case studies, included in the “Additional resources” section in the course page on ICT-TEX platform.



References

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- Types of AI: distinguishing between weak, strong, and super AI, <https://www.thinkautomation.com/bots-and-ai/types-of-ai-distinguishing-between-weak-strong-and-super-ai/>

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