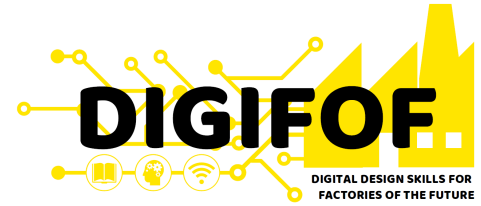


Artificial intelligence tools for Industry 4.0 transformation

Julia Siderska

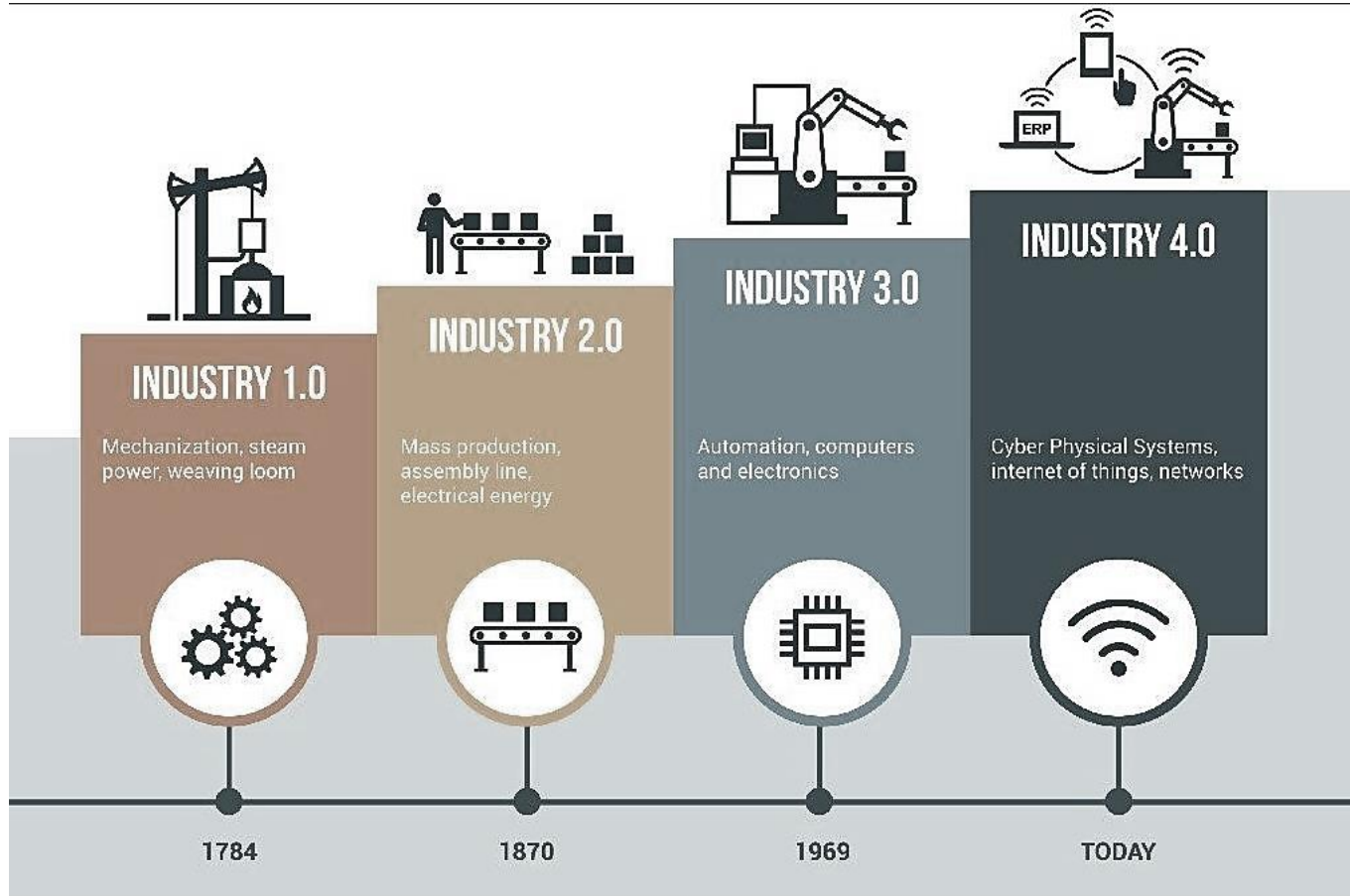


Agenda



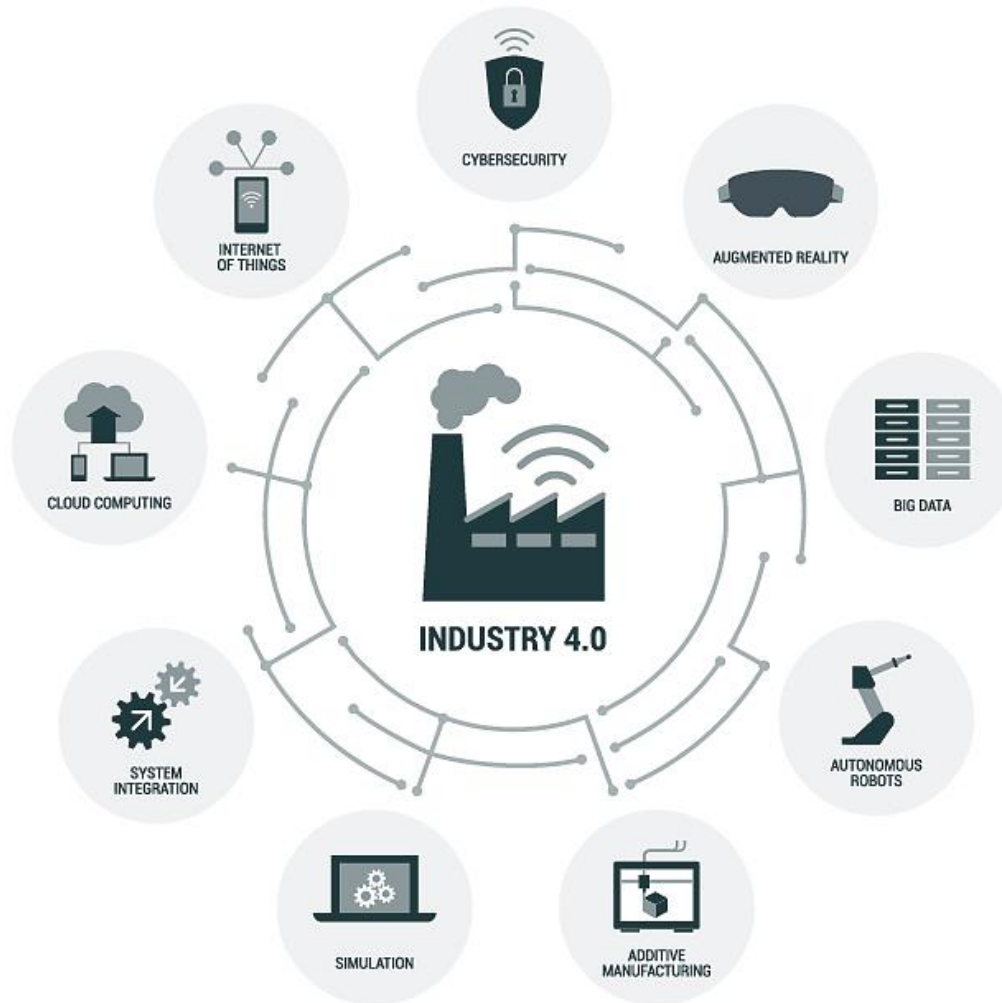
- ✓ Technologies transforming manufacturing sector
- ✓ Industry 4.0 – fundamental definitions
- ✓ Definitions of Artificial Intelligence
- ✓ Benefits of AI in manufacturing
- ✓ AI in the Factory of the Future
- ✓ Artificial neural networks
- ✓ Robotic Process Automation
- ✓ Exercises for participants

The four stages of industrial revolution



Source: <https://blogs.systemweak.com/are-we-ready-for-a-new-industrial-revolution/>

Technologies transforming industrial production



Source: <http://www.next-in.eu/2017/03/20/industry-4-0-the-fourth-industrial-revolution-of-cyber-physical-systems>

Technologies disrupting manufacturing sector



From...	Technology	To...
Data for improving internal operation	Big data	Use customer data to optimise product and pricing strategies
Security on internal network	Cybersecurity	Security on network and IoT devices
Workers operating machines based on information displayed on dials, gauges or screens	Augmented reality	Use sensors, cameras and motion sensors to accumulate information and display the images into real world during work
Leverage on human labour to operate	Autonomous robots	Bringing more effective use of human labour: channelling their energies on value-added activities
Managing hardware and software to operate the system	Cloud computing	Data driven proces with intelligence that change the role and function of system
Disjointed of data all over the system, making it difficult to obtain a real-time view of assets, people and transactions	Internet of Things	Enable real-time data sharing between all parts of the system, and all connected parties

Source: on the basis of: <https://www.myforesight.my/2018/02/26/industry-4-0-the-enabling-technologies-and-its-applications/>

Industry 4.0 – fundamental definitions



- ✓ Industry 4.0 refers to the intelligent networking of machines and processes for industry with the help of information and communication technology

<https://www.plattform-i40.de/PI40/Navigation/EN/Industrie40/WhatIsIndustrie40/what-is-industrie40.html>

- ✓ Industry 4.0 has been defined as “a name for the current trend of automation and data exchange in manufacturing technologies, including cyber-physical systems, the Internet of Things, cloud computing and cognitive computing and creating the smart factory”

<https://www.i-scoop.eu/industry-4-0/>

- ✓ Industry 4.0 is the evolution to cyber-physical systems, representing the fourth industrial revolution on the road to an end-to-end value chain with Industrial IoT and decentralized intelligence in manufacturing

<https://www.i-scoop.eu/industry-4-0/>

Towards Artificial Intelligence



Industry 4.0 principles

Interoperability

Decentralization

**Service
orientation**

Virtualization

**Modularity and
Scalability**

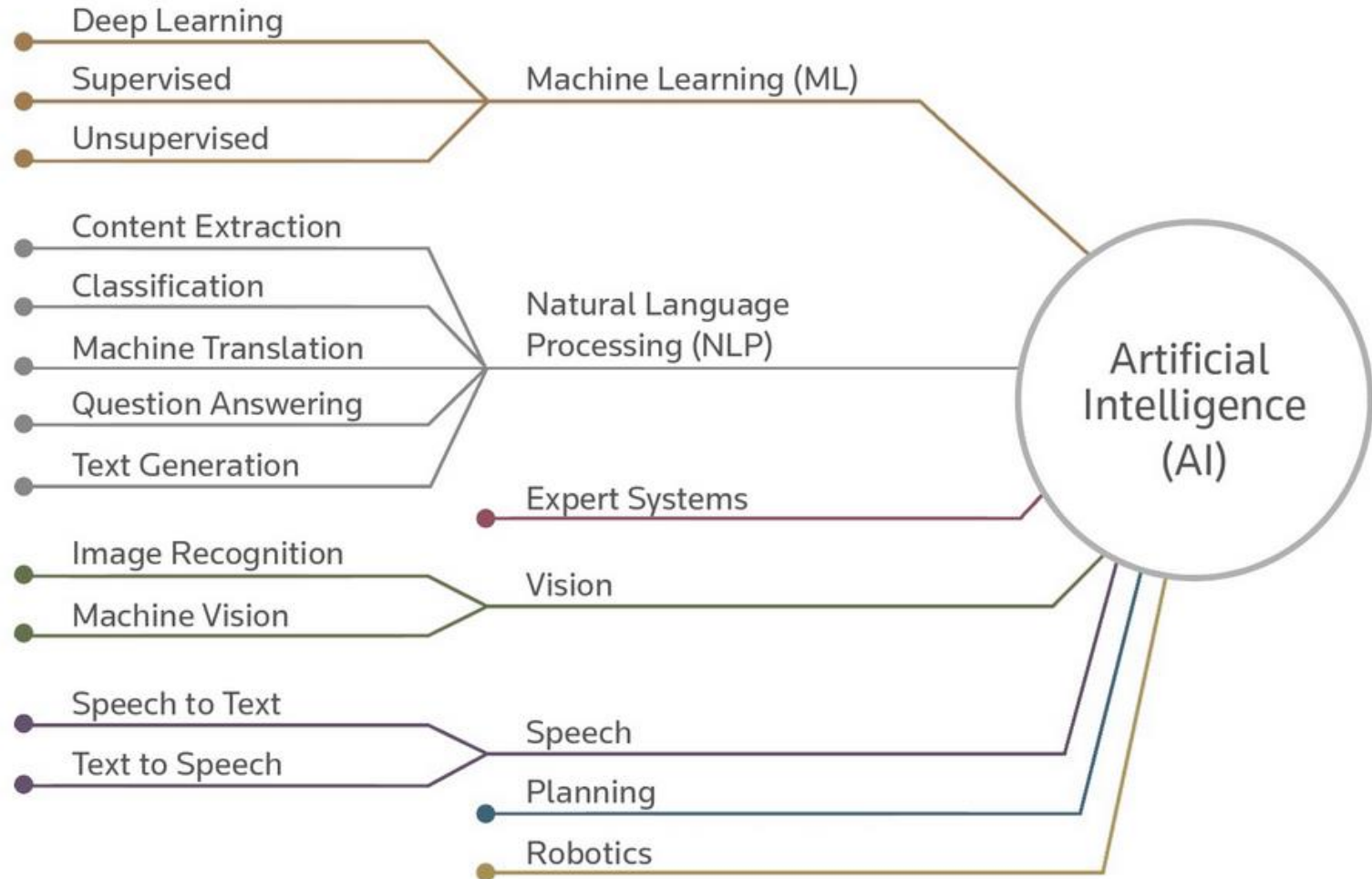
**Real-time
analytics**

Definitions of Artificial Intelligence



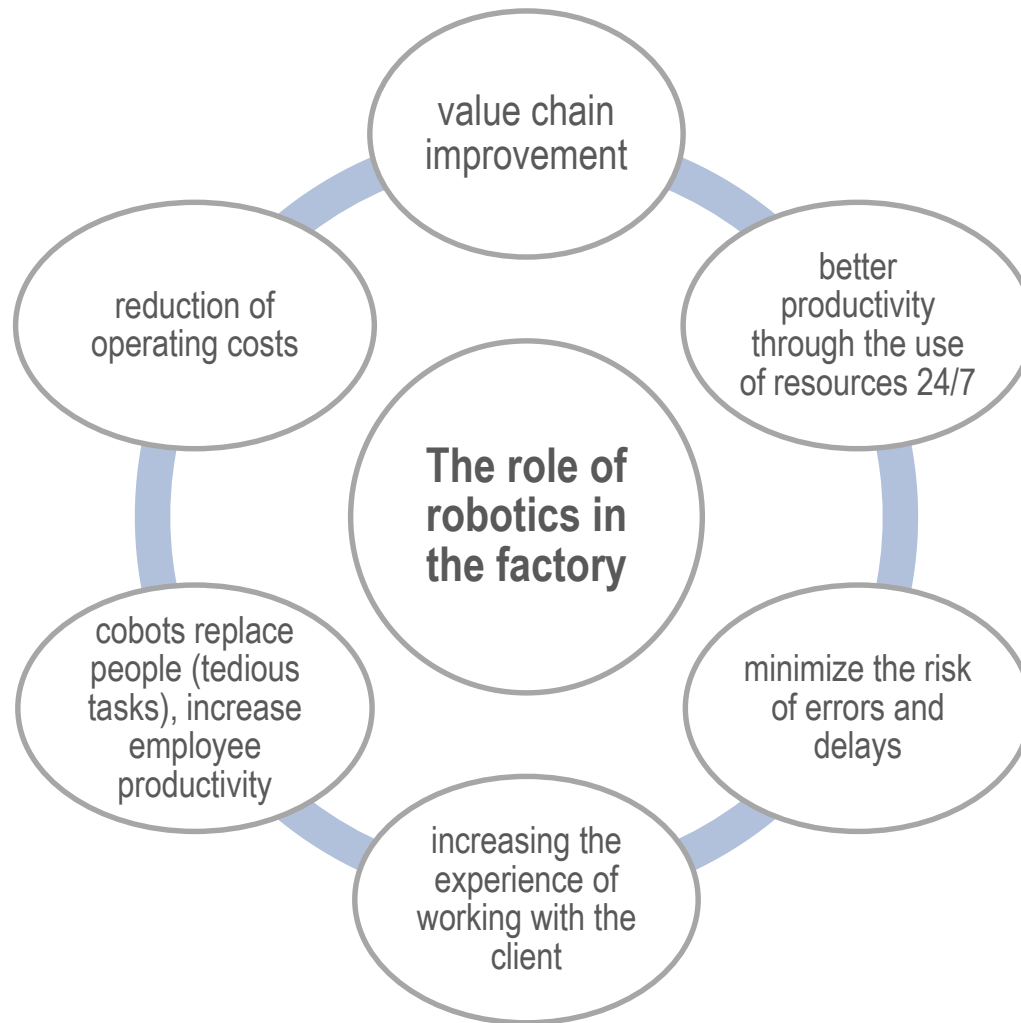
- ✓ “[The automation of] activities that we associate with human thinking, activities such as decision making, problem solving, learning” (Bellman, 1978)
- ✓ “The design and study of computer programs that behave intelligently. These programs are constructed to perform as would a human or an animal whose behavior we consider intelligent” (Dean et al., 1995)
- ✓ “The art of creating machines that perform functions that require intelligence when performed by people” (Kurzweil, 1990)
- ✓ “The branch of computer science that is concerned with the automation of intelligent behavior” (Luger & Stubblefield, 1993)

Main Artificial Intelligence streams



Source: <http://www.fullai.org/short-history-artificial-intelligence>

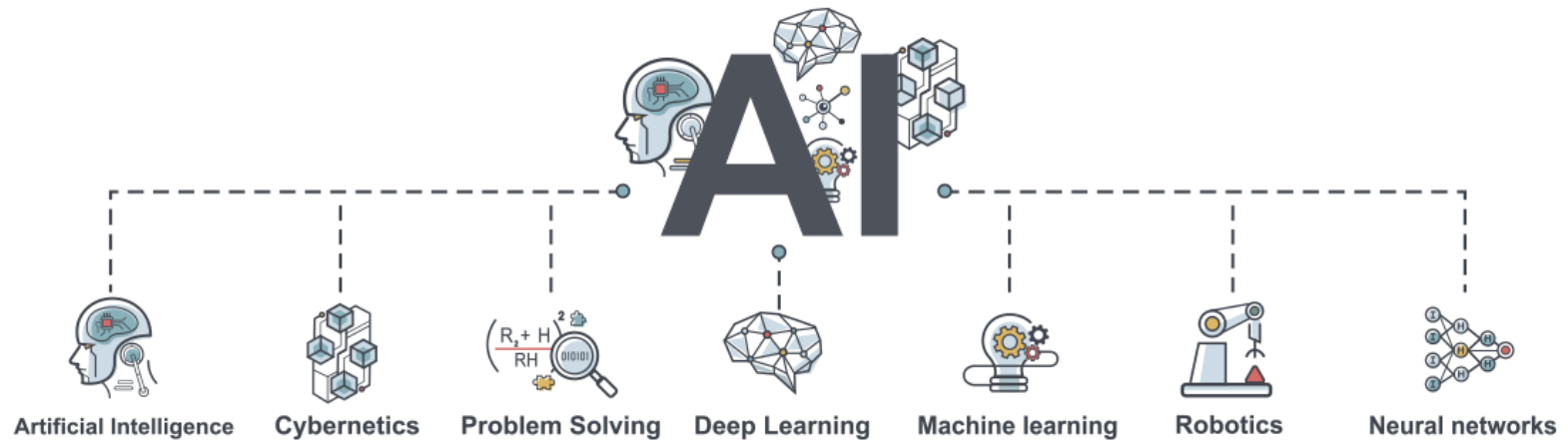
The use of AI in the factory



Source: own elaboration on the basis of: <https://www.controlengineering.pl/roboty-i-sztuczna-inteligencja-usprawnia-prace-fabryk-przyszlosci/>

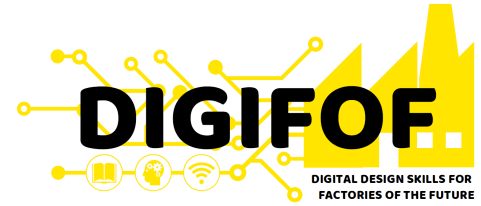
Benefits of AI in manufacturing

- ✓ Direct Automation
- ✓ 24/7 Production
- ✓ Lower Operational Costs
- ✓ Safety
- ✓ Greater Efficiency
- ✓ Quality control
- ✓ Quick decision making



Source: <https://www.rowse.co.uk/blog/post/7-manufacturing-ai-benefits>

AI in the Factory of the Future



AI as an umbrella term for *smart* technologies that are aware of and can learn from their environments, enabling them to subsequently take autonomous action

<https://www.pwc.com.au/pdf/essential-8-emerging-technologies-artificial-intelligence.pdf>

- ✓ Machine Learning
- ✓ Natural Language Processing
- ✓ Robotic Process Automation (RPA)
- ✓ Neural Networks

Robotic Process Automation

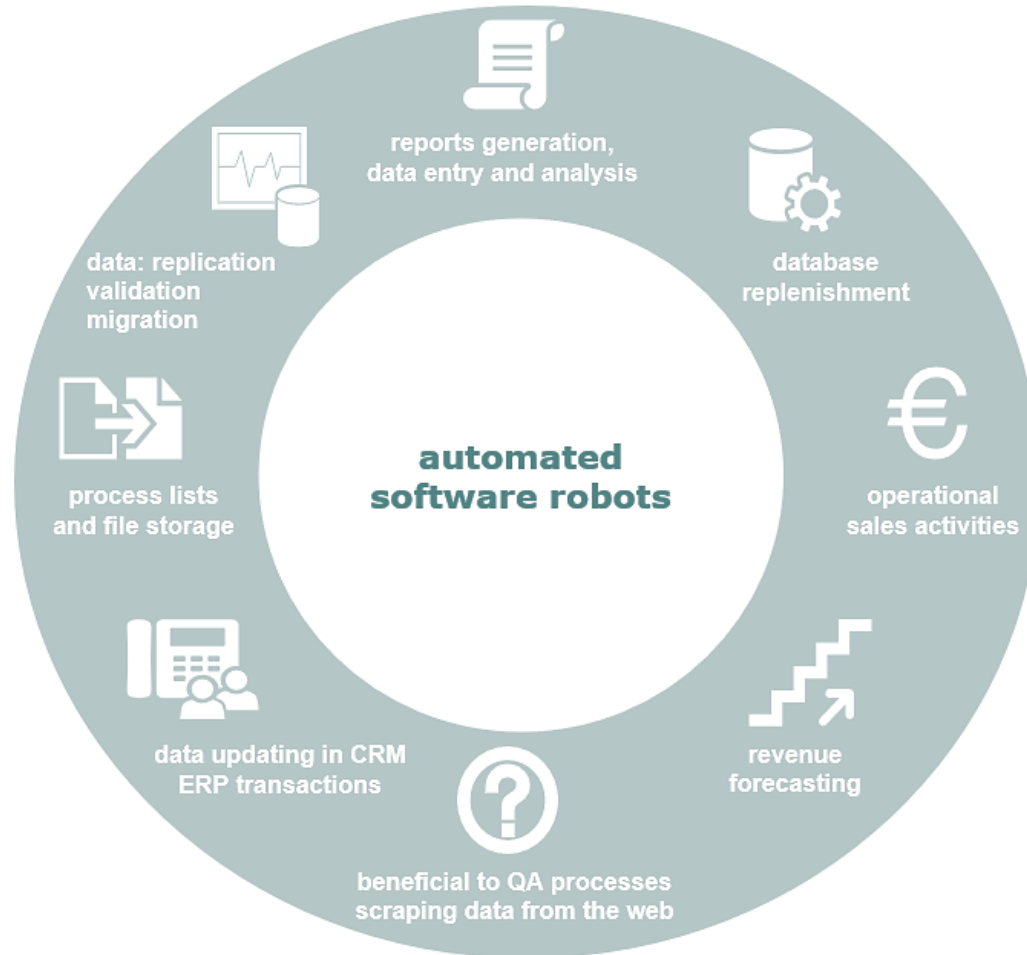
- ✓ „a fast-emerging process automation approach that uses software robots to replicate human tasks. After recording a process workflow, a virtual bot mimics the actions performed by humans in the application’s graphical user interface and automate their execution” (Quinn & Strauss, 2018)



<https://www.egospodarka.pl/146070,Automatyzacja-pracy-To-nie-roboty-wypelnia-wakaty,1,39,1.html>

- ✓ „RPA tools perform [if, then, else] statements on structured data, typically using a combination of user interface interactions (...) and operate by mapping a process in the RPA tool language for the software robot” (Gartner, 2017)

Leading applications of automated software robots

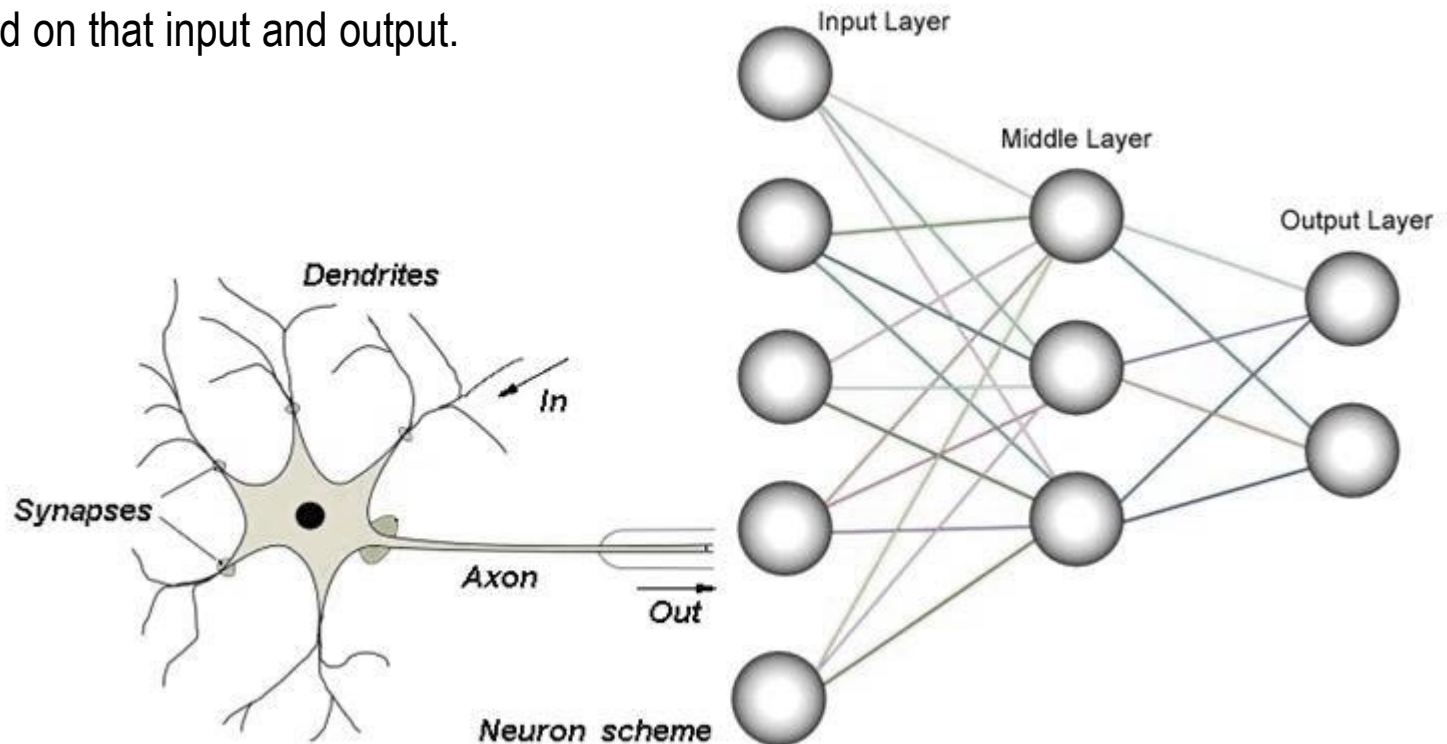


Source: J. Siderska, Robotic Process Automation – a driver of digital transformation?, Engineering Management in Production and Services, Vol. 12(2), 2020

Artificial neural network

An artificial neural network (ANN) is a computational model based on the structure and functions of biological neural networks.

Information that flows through the network affects the structure of the ANN because a neural network changes - or learns, in a sense - based on that input and output.



How to apply AI?

Four ways to apply AI, from simple to advanced:

- ✓ Automated intelligence
- ✓ Assisted intelligence
- ✓ Augmented intelligence
- ✓ Autonomous intelligence

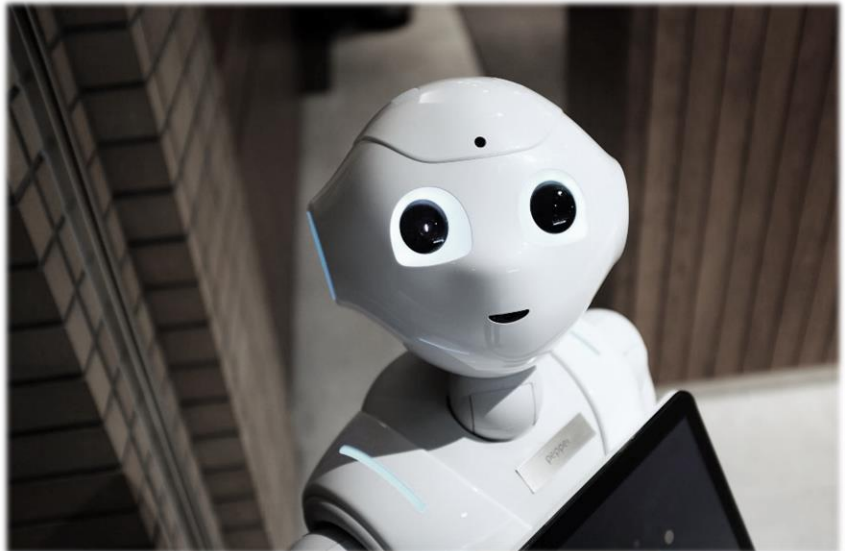


Photo by Alex Knight from Pexels

Opportunities? Risks?



- ✓ Have we considered how AI could transform our products or services and which aspects of our business could benefit from increased automation or machine learning?
- ✓ Have we considered the potential efficiency and productivity benefits that may come with adopting AI?
- ✓ How might AI fit with other emerging technologies we are investing in?
- ✓ Do we have the computing power and infrastructure to support the use of AI?
- ✓ Do we have the digital skills and talent to move forward?
- ✓ Have we thought about how we would use data collected by AI?
- ✓ Have we considered cyber risks and data privacy issues?

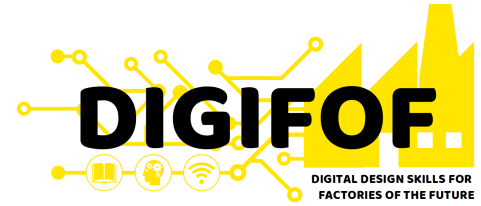
Adopted from: <https://www.pwc.com.au/pdf/essential-8-emerging-technologies-artificial-intelligence.pdf>

Practical exercises



Photo by PhotoMIX Company from Pexels

Regression



Regression is a statistical measure that attempts to determine the strength of the relationship between one dependent variable (usually denoted by Y) and a series of other changing variables (known as independent variables).

Linear Regression: $Y = a + bX + u$

Multiple Regression: $Y = a + b_1X_1 + b_2X_2 + b_3X_3 + \dots + b_tX_t + u$

Where:

Y = the variable to be predicted (dependent variable)

X = the variable used to predict Y (independent variable)

a = the intercept

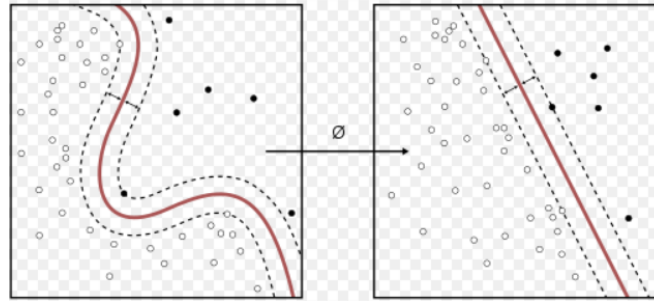
b = the slope

u = the regression residual

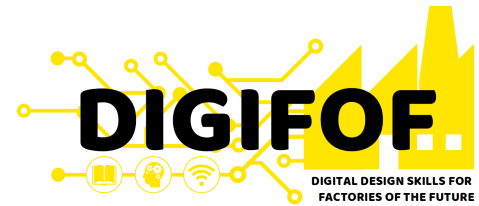
Classification

Classification is a general process related to categorization, the process in which ideas and objects are recognized, differentiated and understood.

In machine learning and statistics, classification is the problem of identifying to which of a set of categories a new observation belongs, on the basis of a training set of data containing observations whose category membership is known.



STATISTICA – Automated Neural Network



New analysis/Deployment

Deployment

Deploy models from previous analyses

Load network files

File name	Net. ID	Net. name	Hidden act.	Output act.

New analysis

New analysis

- Regression
- Classification
- Time series (regression)
- Time series (classification)
- Cluster analysis

Quick | MLP activation functions | Weight decay | Initialization

Network types

MLP:

Min. hidden units: 3

Max. hidden units: 11

RBF:

Min. hidden units: 21

Max. hidden units: 30

Train/Retain networks

Networks to train: 20

Networks to retain: 5

Error function

Sum of squares

Cross entropy

Train

Go to results

Save networks

Data statistics

Summary

Cancel

Options

Exercises for participants

Solving regression problem in STATISTICA software

- ✓ Task: In Statistica ANN software use the regression analysis to create a neural model.
- ✓ The model should determine the relations between the input and output variables.
- ✓ Test the trained model towards new data.
- ✓ To do this exercise please use the file: *regression.sta*

Exercises for participants

Solving classification problem in STATISTICA software

- ✓ Task: In Statistica ANN software use the classification analysis to create a neural model.
- ✓ The model should determine the relations between the input and output variables.
- ✓ Test the trained model towards new data.
- ✓ To do this exercise please use the file: *classification.sta*

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