MACHINE LEARNING & INDUSTRY

Review and trends

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UMEÅ UNIVERSITY

AGENDA

1. Introduction
2. Machine Learning and Industry, European and Swedish context
3. ML approaches (hands-on)
4. Industry 4.0
5. ML in two industrial sectors (cases)
6. Concluding remarks
7. Activity: co-analysis of ML+IND scenarios

DR. ESTEBAN GUERRERO

- Current position: Researcher
- Industrial experience:
  - 4 years R&D engineer in a Colombian telecommunications company. Role: support back-end services.
- Education:
  - Ph.D. in Computing Science, Umeå University. Sweden.
  - Ph. Licentiate in Computing Science, Umeå University.
  - M.Sc. Master’s degree in Computer Science, Malmö University. Sweden.
  - M.Sc. Master’s studies in Telematics Engineering, University of Cauca. Colombia.
  - B.Eng. Bachelor degree in Electronic and Telecommunications Engineering, University of Cauca. Colombia.

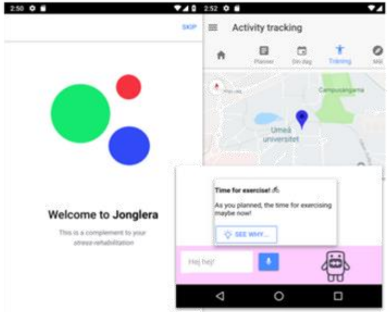
STAR-C: Sustainable behaviour change for health supported by person-Tailored, Adaptive, Risk-aware digital Coaching in a social context

Partners: **Department of Computing Science**, **Department of Epidemiology and Global Health**, **Department of Culture and Media Studies** and **Department of Social Work** Umeå University

SmartVib

en liten separat enhet med inbyggda sensorer som trådlöst sänder signaler till mobiltelefonen i vilken en applikation behandlar de uppmätta vibrationerna.

CVK Vibration & Noise VÄSTERBOTTENS LÄNS LANDSTING



Jonglera - an agent-b coaching system for s management

Partners: **Computing Science** dept. ar **Psychology**, Umeå Universit

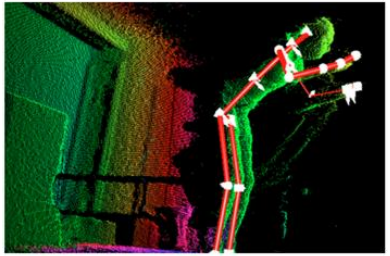
Key words: multi-agent system; argu theory; coalitions; stress; psych

2017-2019

Auton soft suppo

Partner Universit and Te

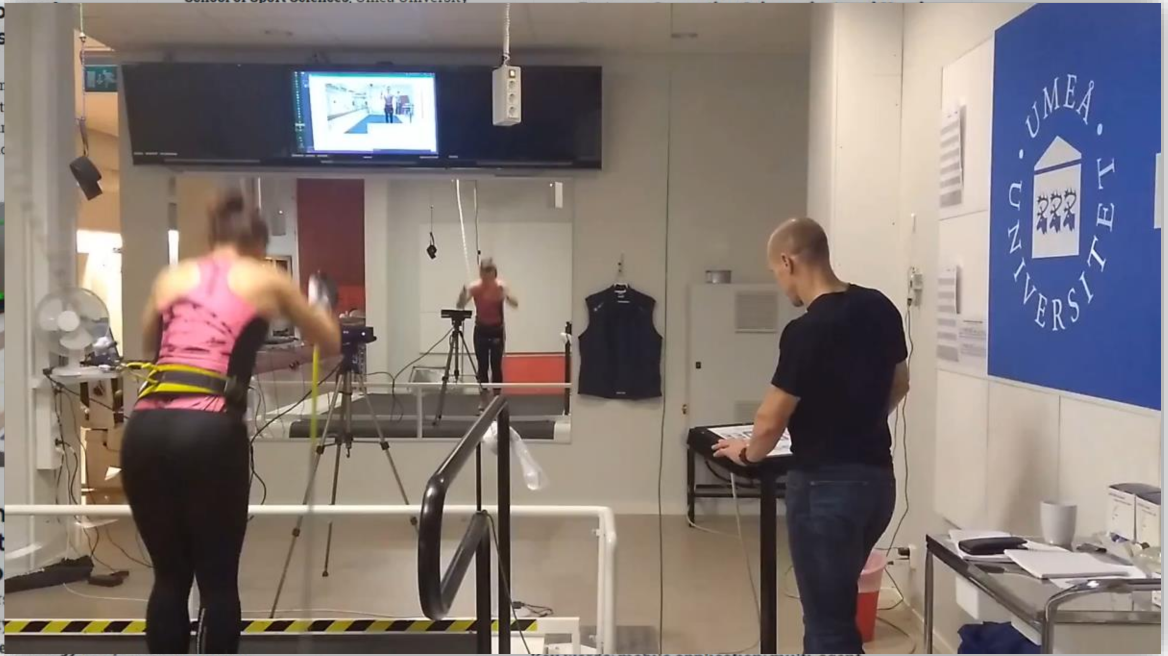
University, Taiwan



Intelligent skiing coach

Partners: **Computing Science** dept. and **Umeå School of Sport Sciences**, Umeå University

Towards a *trusted* intelligent coach



Key words: mobile application; multi-agent system; sensors;

2016-2017

https://people.cs.umu.se/esteban/

EUROPEAN CONTEXT

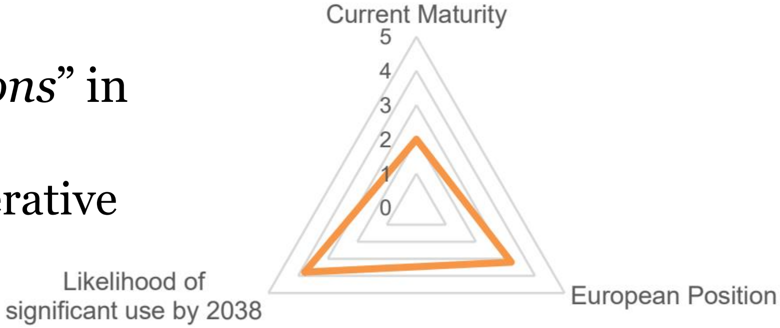
Main source:
https://ec.europa.eu/info/index_sv

Europeiska kommissionen

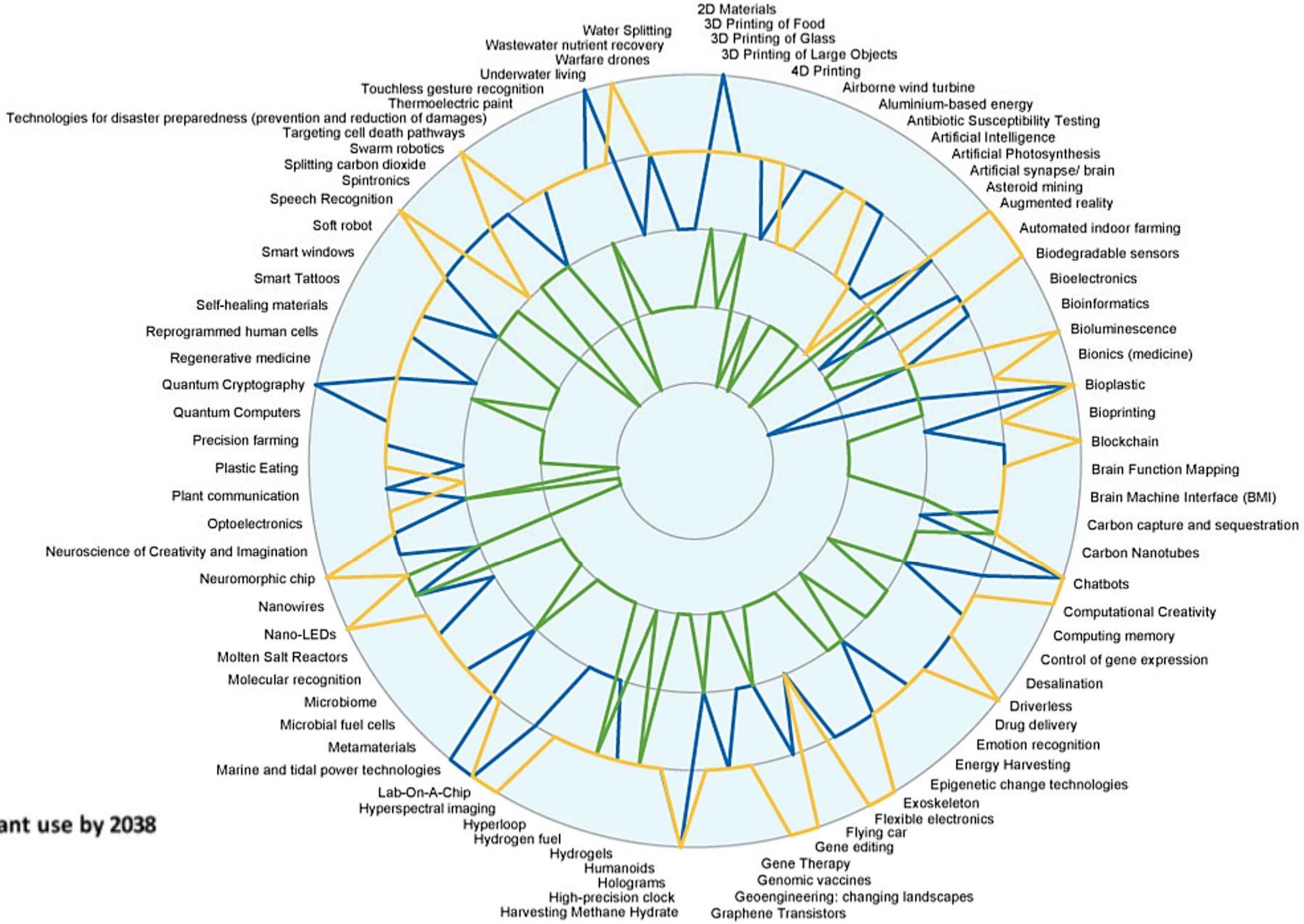
https://ec.europa.eu/info/sites/info/files/research_and_innovation/knowledge_publications_tools_and_data/documents/ec_rtd_radical-innovation-breakthrough_052019.pdf

Key in the report:

- Summary of “*recent progress directions*” in artificial intelligence:
  - Duelling networks, also called generative adversarial networks (GANs)
  - Capsule Networks
- Long term perspectives:
  “In the next decade and beyond, one can expect significant research around *one-shot* and *zero-shot learning models* involving knowledge transfer.”

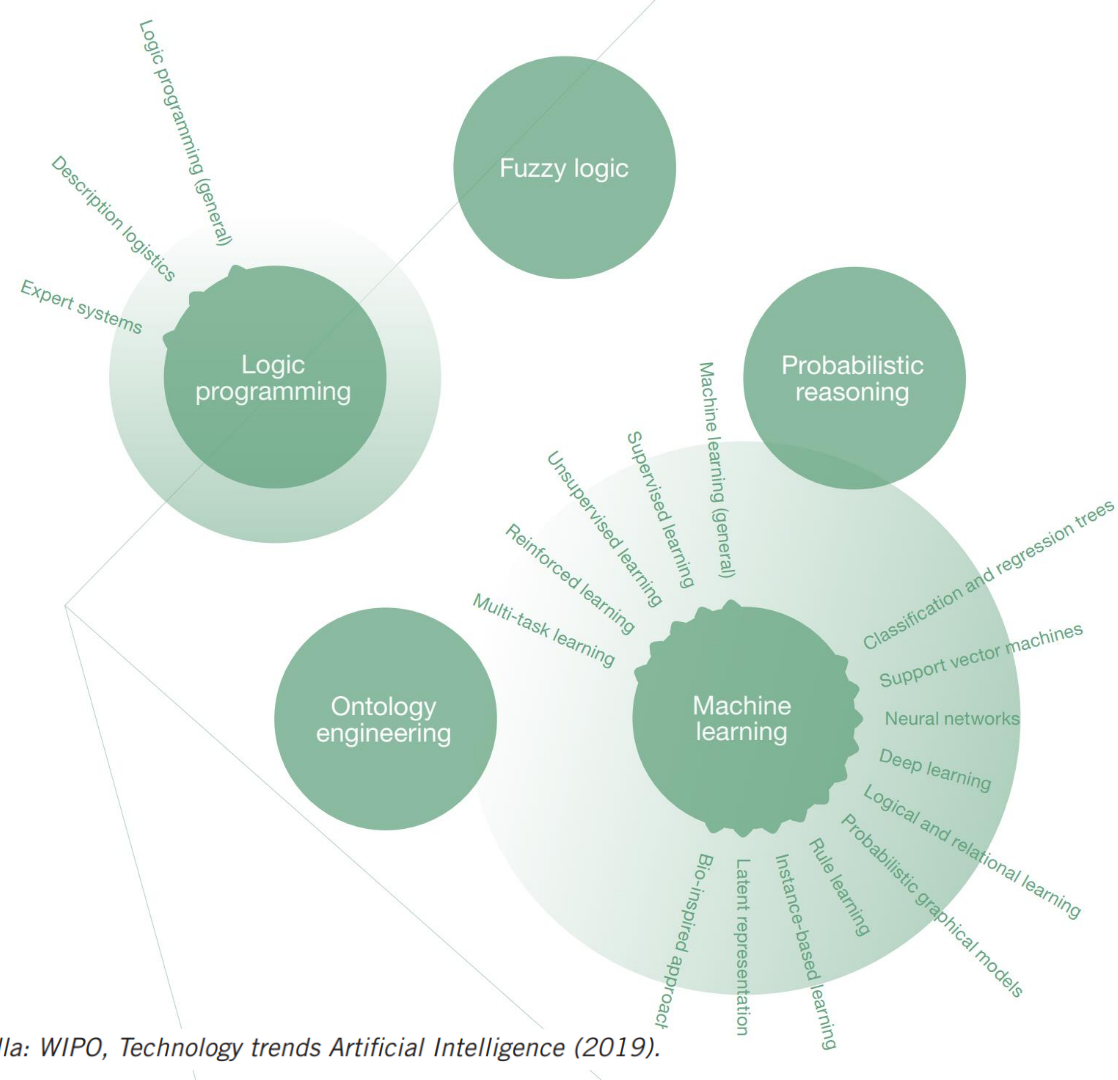


https://ec.europa.eu/info/sites/info/files/research_and_innovation/knowledge_publications_tools_and_data/documents/ec_rtd_radical-innovation-breakthrough_052019.pdf



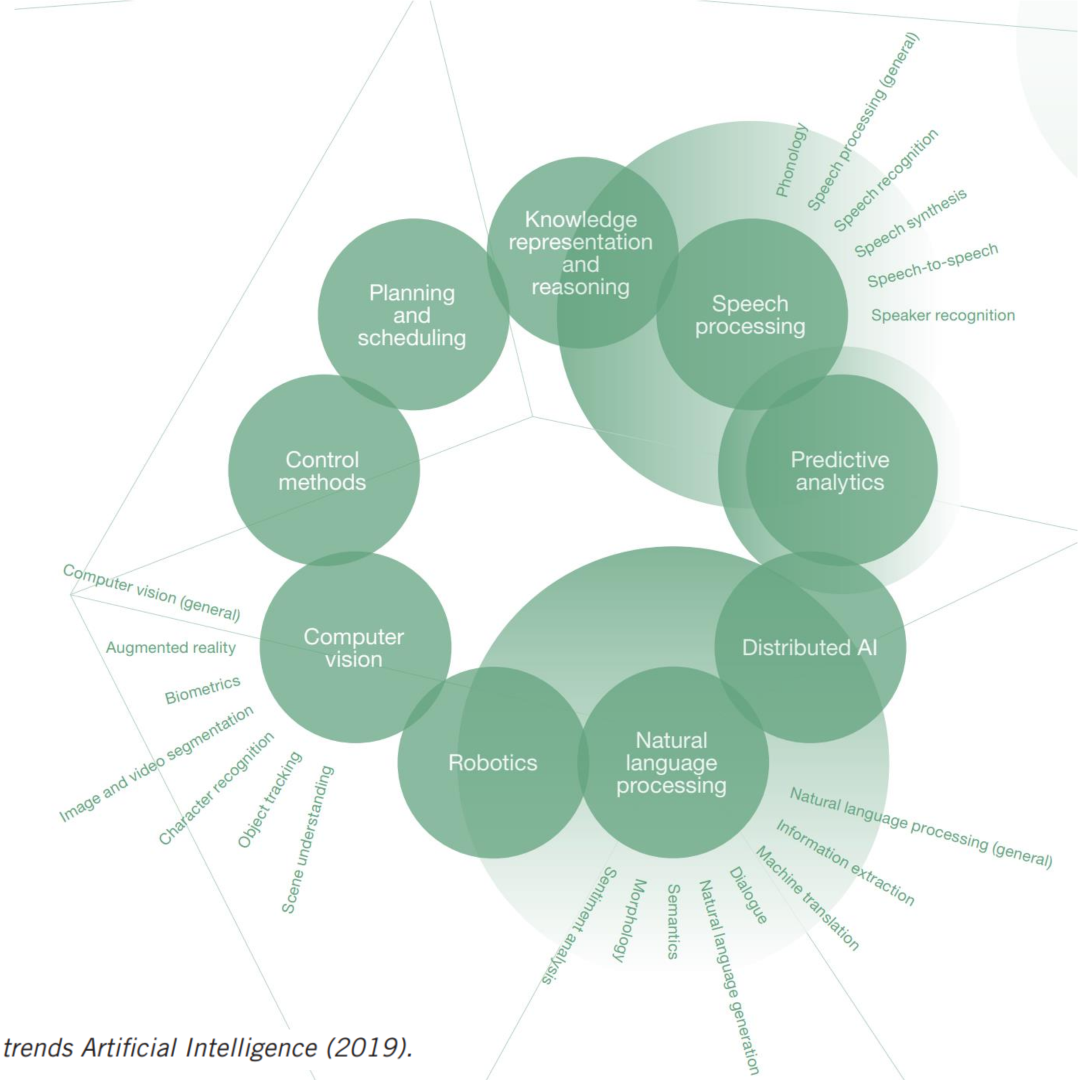
Current Maturity
European Position
Likelihood of significant use by 2038

AI techniques



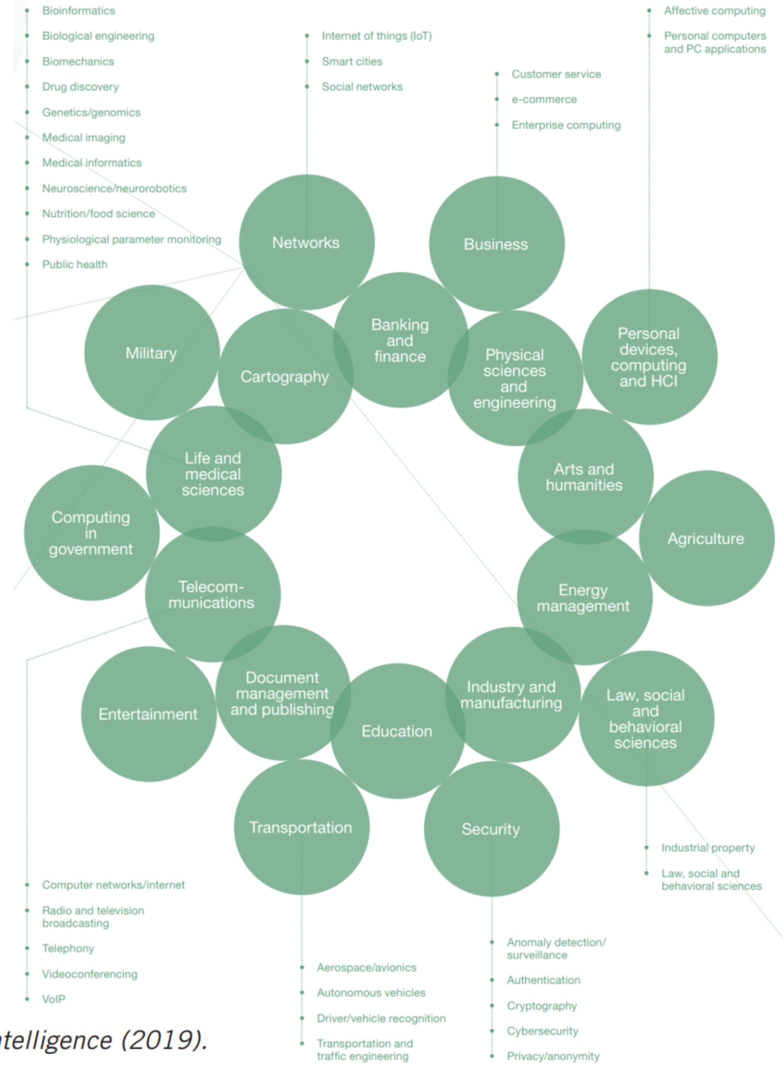
Källa: WIPO, Technology trends Artificial Intelligence (2019).

AI functional applications



Källa: WIPO, Technology trends Artificial Intelligence (2019).

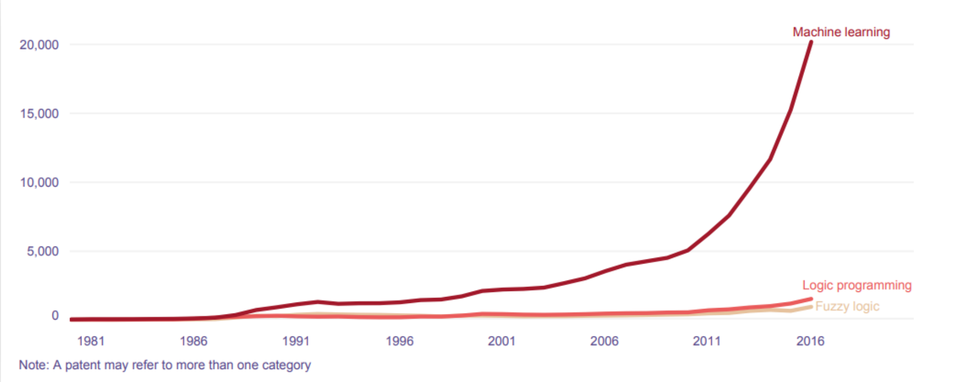
AI functional applications



Källa: WIPO, Technology trends Artificial Intelligence (2019).

PATENTS - GLOBAL

Patent families for top AI techniques by earliest priority year
Machine learning grew by an average of 26 percent annually between 2011 and 2016

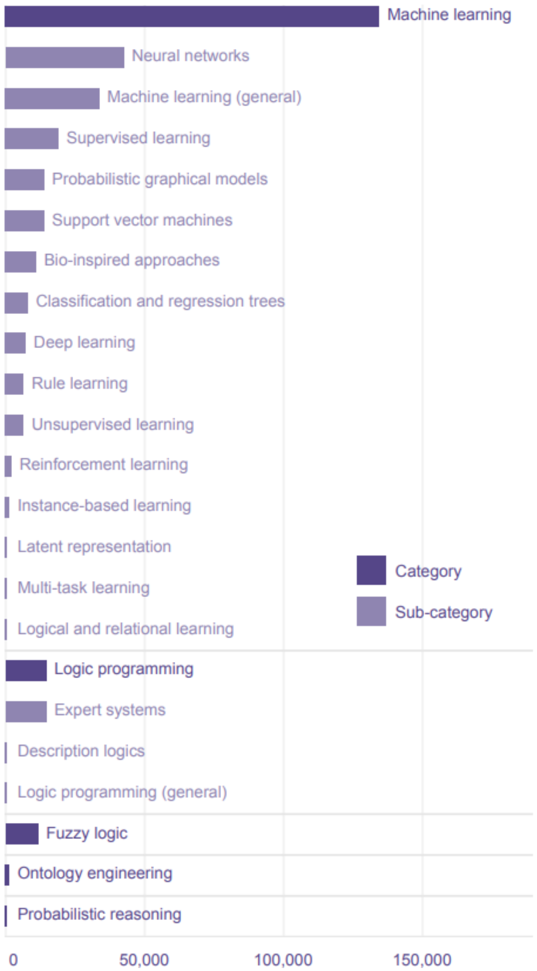


WIPO Technology Trends 2019: Artificial Intelligence

Additional info:

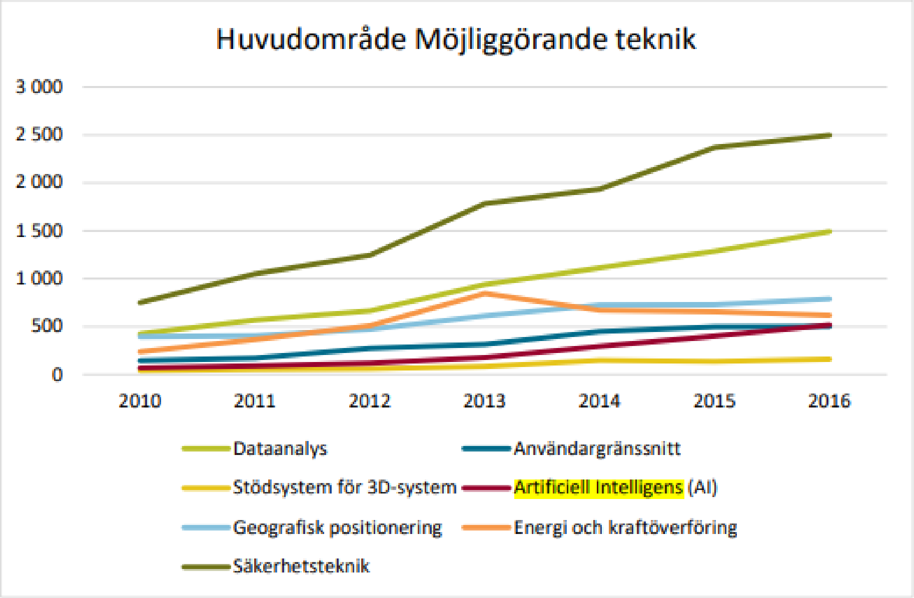
- G-II, 3.3.1 Artificial intelligence and machine learning - Guidelines for Examination (epo.org)

Machine learning is the dominant AI technique, representing 89 percent of patent families related to an AI technique

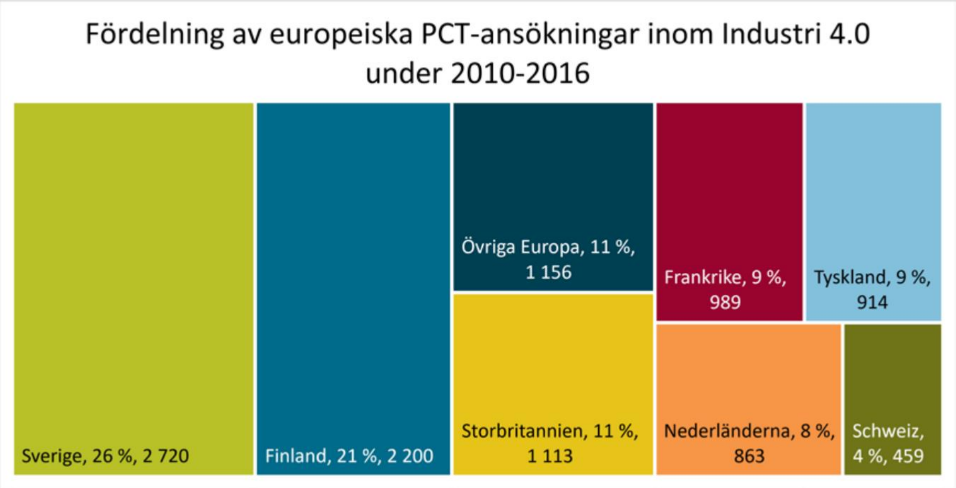


PATENTS - SWEDEN

Antal ansökningar per detaljområde 2010–2016
De tre huvudområdena låter sig delas in i underliggande detaljområden.



Patent- och registreringsverkets statistikårsbok 2018 (prv.se)



Under perioden 2010–2016 har antalet PCT-ansökningar inom Industri från svenska sökanden 4.0 en stark tillväxt. Faktum är att antalstillväxten i tidsperioden är dubbelt så stor för svenska ansökningar som för europeiska.

Additional info:

- https://www.prv.se/
- Documentation in Canvas

SWEDISH CONTEXT

Main sources: Vinnova, Regeringskansliet

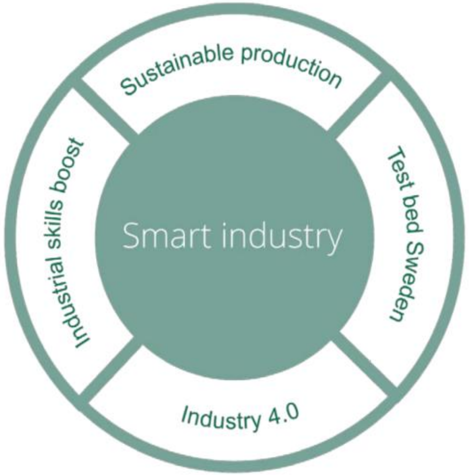
VINNOVA
Sveriges innovationsmyndighet

Regeringskansliet

SMART INDUSTRY - A STRATEGY FOR NEW INDUSTRIALISATION FOR SWEDEN

Four focus areas have been chosen:

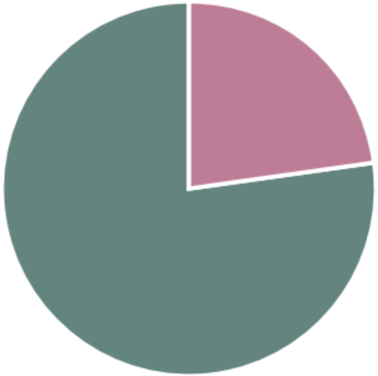
- Industry 4.0 – Exploit the potential of digitalisation
- Sustainable production – Improve the industrial sector's capacity for sustainable and resource-efficient production
- Industrial skills boost – Ensure the supply of skil to the industrial sector
- Test bed Sweden – Create attractive innovation environments



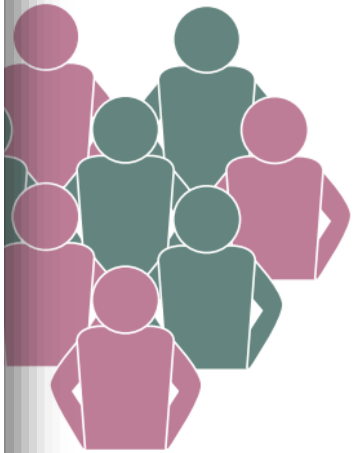
https://www.government.se/information-material/2016/04/smart-industry---a-strategy-for-new-industrialisation-for-sweden/

https://www.regeringen.se/

The industry sector
services sector acc



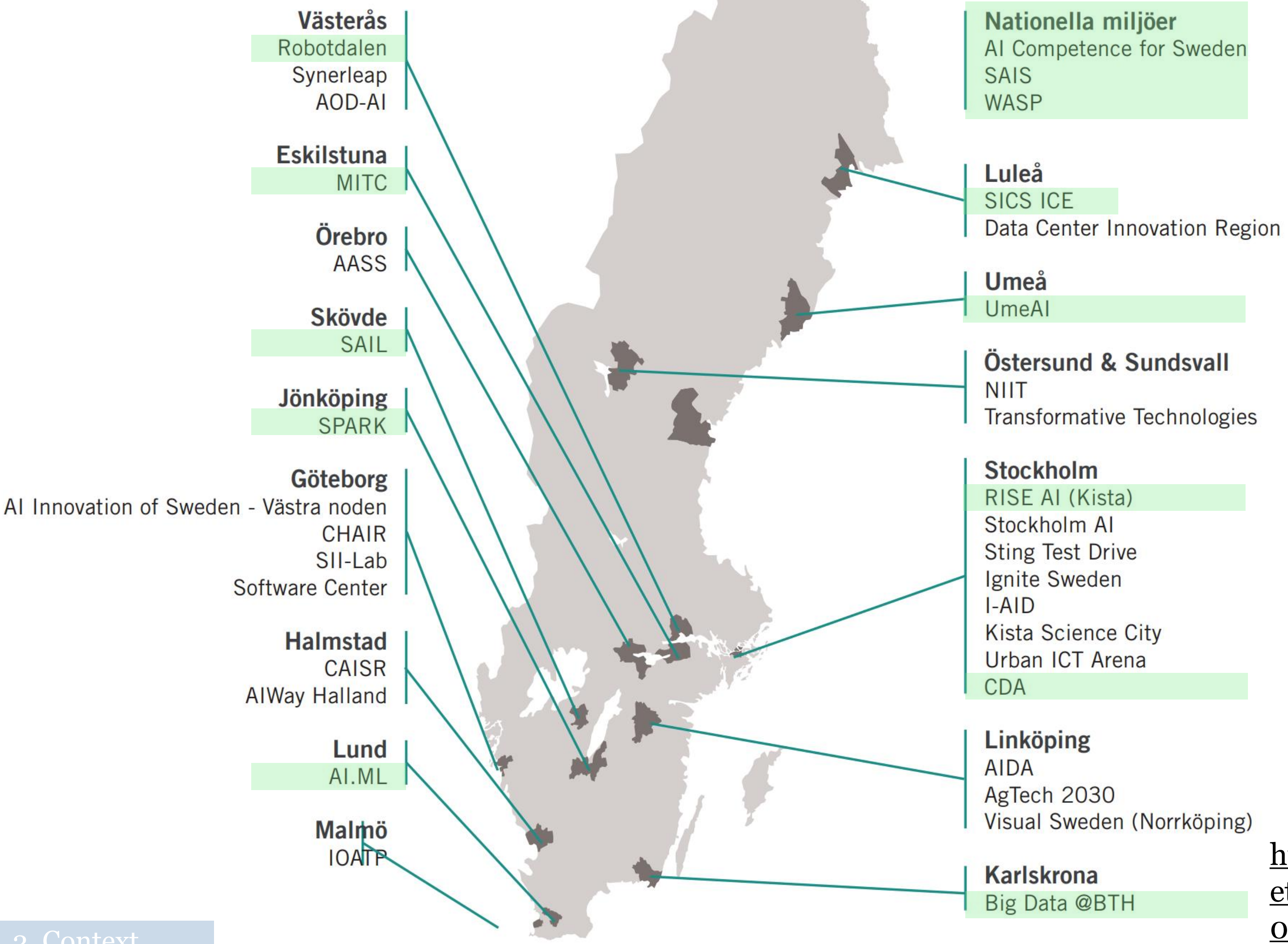
20 per cent of
Sweden's GDP



und 1 million jobs

https://www.government.se/4 e4a7ad75f2f54/nist_a4_faktablad_160701_eng_web.pdf

Svenska AI-miljöer med geografisk hemvist.



Centers with focus on Machine Learning

39 AI-miljöer som arbetar för utveckling av artifciell intelligens

https://www.vinnova.se/globalassets/mikrosajter/ai/vr_19-05_190704.pdf

INDUSTRY 4.0

INDUSTRI*E* 4.0

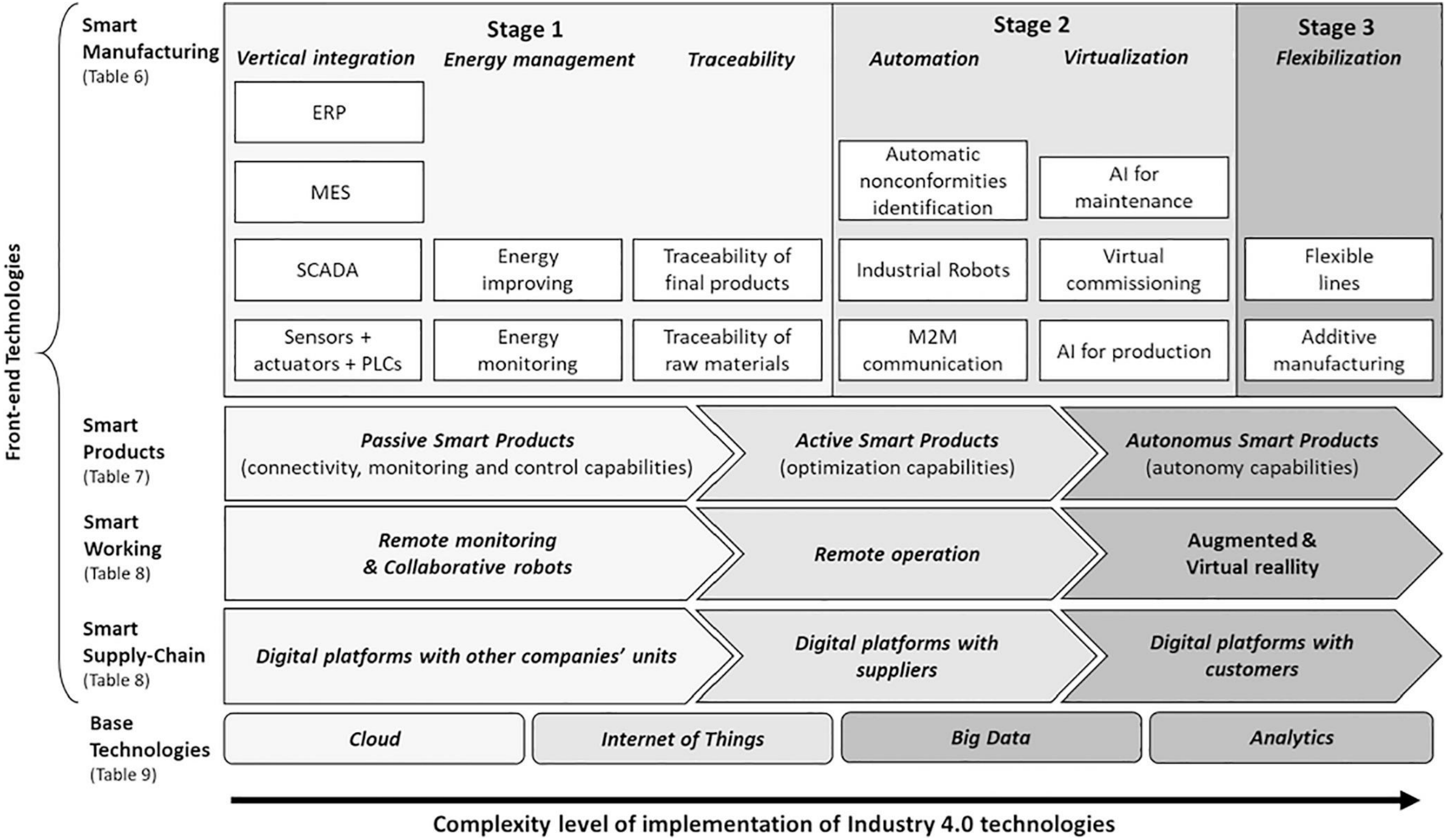
The Fourth Industrial Revolution aims to leverage differences between the physical, digital, and biological sphere. It integrates cyber-physical systems and the Internet of Things, big data_and cloud computing, robotics, artificial-intelligence based systems and additive manufacturing

Expected effects:

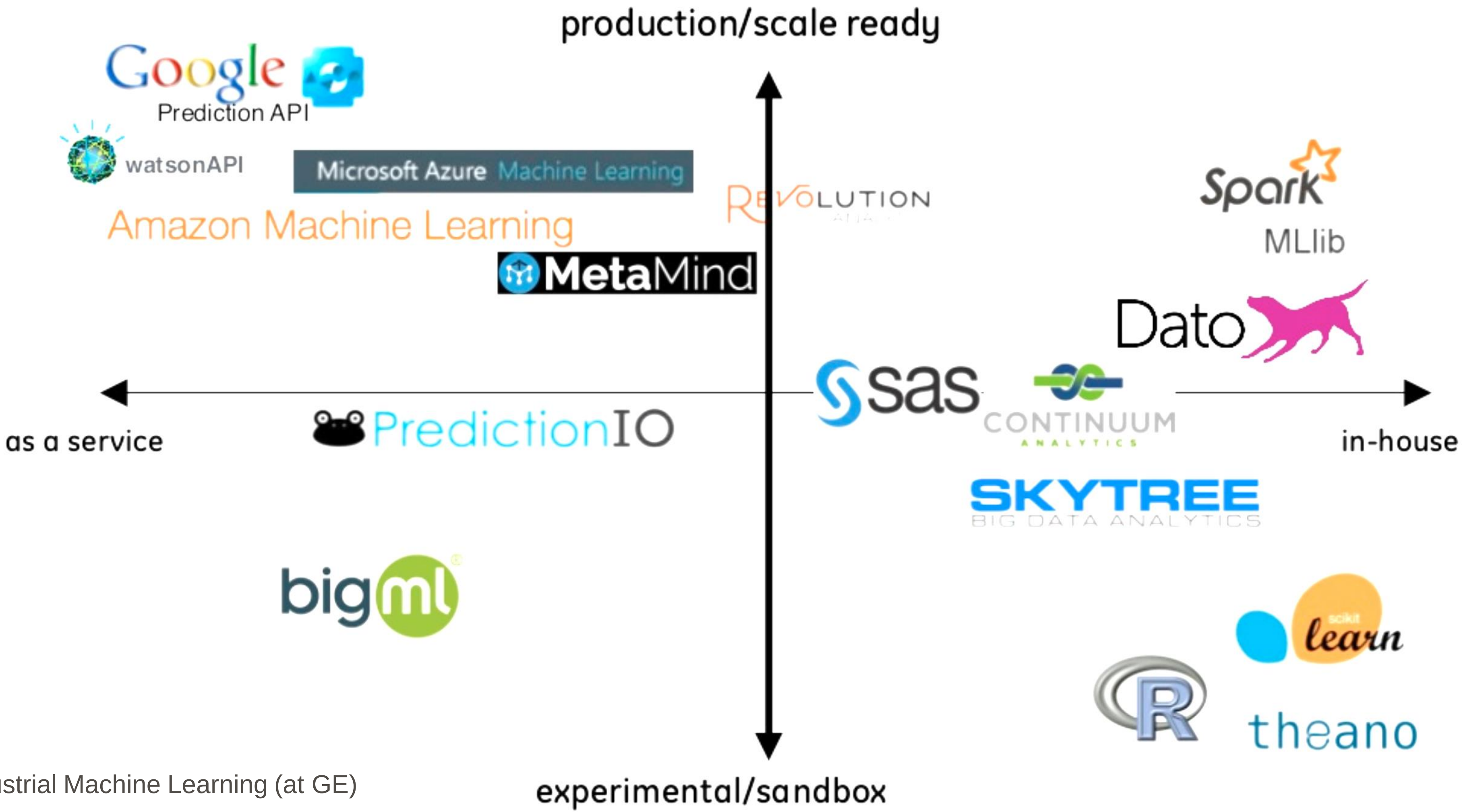
- On the business side: it drastically modifies customer expectations, product enhancement, collaborative innovation and organisational forms.
- On people: one of the greatest challenges is on privacy, on the notion of ownership, consumer patterns and how we devote time to develop skills.

European Commission, strategy on digitising the European industry.
https://ec.europa.eu/digital-single-market/en/fourth-industrial-revolution

INDUSTRIE 4.0



Frank, A. G., Dalenogare, L. S., & Ayala, N. F. (2019). Industry 4.0 technologies: Implementation patterns in manufacturing companies. *International Journal of Production Economics*, *210*, 15-26.



Industrial Machine Learning (at GE)

Joshua Bloom, Professor at UC Berkeley, CTO Wise/GE

Challenges in industrial cyber-physical systems

Area	Key Challenges	Difficulty	Priority	Maturity in
CPS Capabilities	Real-time control of CPS systems	High	High	4–7 years
	Real-time CPS SoS	High	Medium	3–5 years
	Optimization in CPS and their application	High	Medium	4–7 years
	On-CPS advanced analytics	Medium	High	3–5 years
	Modularization and servification of CPS	low	High	3–5 years
	Energy efficient CPS	Medium	Medium	3–5 years
CPS Management	Lifecycle management of CPS	Medium	Medium	5–8 years
	Management of (very) large scale CPS and CPS-SoS	High	High	5–8 years
	Security and trust management for heterogeneous CPS	High	High	5–8 years
CPS Engineering	Safe programming and validation of CPS SoS	High	High	5–10+ years
	Resilient risk-mitigating CPS	High	High	5–10+ years
	Methods and tools for CPS lifecycle support	High	High	3–7 years
	New operating systems and programming languages for CPS and CPS SoS	Medium	Low	3–6 years
	Simulation of CPS and of CPS-SoS	Medium	High	3–6 years
CPS Infrastructures	Interoperable CPS services	Medium	High	2–5 years
	Migration solutions to emerging CPS infrastructures	Medium	High	3–6 years
	Integration of heterogeneous/mobile hardware and software technologies in CPS	Low	Medium	2–4 years
	Provision of ubiquitous CPS services	Medium	Medium	3–5 years
	Economic impact of CPS Infrastructure	High	High	3–6 years
CPS Ecosystems	Autonomic and self-* CPS	High	Medium	7–10+ years
	Emergent behavior of CPS	High	Medium	7–10+ years
	CPS with humans in the loop	High	High	2–5 years
	Collaborative CPS	Medium	Medium	5–8 years
CPS Information Systems	Artificial intelligence in CPS	High	High	7–10+ years
	Cross-domain large-scale information integration to CPS infrastructures	Medium	Low	6–9 years
	Transformation of CPS data and information analytics to actionable knowledge	High	High	4–8 years
	Knowledge-driven decision making/management	High	Medium	6–10+ years

Leitão, P., Colombo, A. W., & Karnouskos, S. (2016). Industrial automation based on cyber-physical systems technologies: Prototype implementations and challenges. *Computers in Industry*, *81*, 11-25.

ML APPROACHES (BRIEF)
+
HANDS-ON

MACHINE LEARNING LANGUAGES

python™ C++ Java Swift

Go julia

C# Haskell R JS

SUPERVISED LEARNING

- What is: “Supervised learning is a learning model built to make prediction, given an unforeseen input instance.”

- How it works: “With supervised learning you use labelled data, which is a data set that has been classified, to infer a learning algorithm. The data set is used as the basis for predicting the classification of other unlabelled data” [Talabis,et.al.2014].

Talabis, M., McPherson, R., Miyamoto, I., & Martin, J. (2014). *Information Security Analytics: Finding Security Insights, Patterns, and Anomalies in Big Data*. Syngress.

SUPERVISED LEARNING

- Two important approaches (among many):
  - **Regression**: the goal is to predict a continuous measurement for an observation. That is, the responses variables are real numbers. Applications include forecasting stock prices, energy consumption, or disease incidence.
  - **Classification**: the goal is to assign a class (or *label*) from a finite set of classes to an observation. That is, responses are categorical variables. Applications include spam filters, advertisement recommendation systems, and image and speech recognition.

SUPERVISED LEARNING

$$\mathbf{y} = \begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{pmatrix} \quad X = \begin{pmatrix} \mathbf{x}_1^\mathsf{T} \\ \mathbf{x}_2^\mathsf{T} \\ \vdots \\ \mathbf{x}_n^\mathsf{T} \end{pmatrix} = \begin{pmatrix} 1 & x_{11} & \cdots & x_{1p} \\ 1 & x_{21} & \cdots & x_{2p} \\ \vdots & \vdots & \ddots & \vdots \\ 1 & x_{n1} & \cdots & x_{np} \end{pmatrix} \quad \boldsymbol{\beta} = \begin{pmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \\ \vdots \\ \beta_p \end{pmatrix}, \quad \boldsymbol{\varepsilon} = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{pmatrix}$$

- We assume the equation: $\boldsymbol{Y_e = \varepsilon + \beta X}$
- Y_e is the estimated or predicted value of Y based on our linear equation.

Goal: find statistically significant values of the **parameters *ε*** and ***β*** that minimize the difference between Y and Y_e.

If we are able to determine the optimum values of these two parameters, then we will have the **line of best fit** that we can use to predict the values of Y, given the value of X.

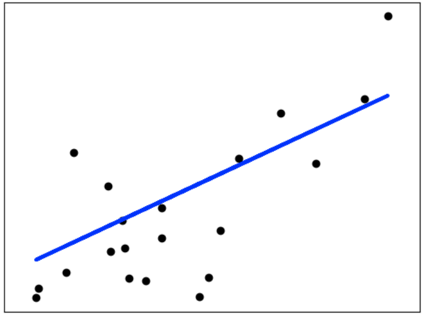
SUPERVISED LEARNING

- Example 0: Linear regression, a diabetes dataset with Python
  - Jupyter notebook using Python3, scikit-learn

https://colab.research.google.com/drive/1Ey0_E-fCtggCNxdd96v8gxbCnAKh7_ug

Patient	AGE x1	SEX x2	BMI x3	BP x4	··· Serum Measurements ··· x5	x6	x7	x8	x9	x10	Response y
1	59	2	32.1	101	157	93.2	38	4	4.9	87	151
2	48	1	21.6	87	183	103.2	70	3	3.9	69	75
3	72	2	30.5	93	156	93.6	41	4	4.7	85	141
4	24	1	25.3	84	198	131.4	40	5	4.9	89	206
5	50	1	23.0	101	192	125.4	52	4	4.3	80	135
6	23	1	22.6	89	139	64.8	61	2	4.2	68	97
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
441	36	1	30.0	95	201	125.2	42	5	5.1	85	220
442	36	1	19.6	71	250	133.2	97	3	4.6	92	57

Table 1. Diabetes study. 442 diabetes patients were measured on 10 baseline variables. A prediction model was desired for the response variable, a measure of disease progression one year after baseline.



https://web.stanford.edu/~hastie/Papers/LARS/LeastAngle_2002.pdf

https://www4.stat.ncsu.edu/~boos/var.select/diabetes.tab.txt

Out:
```
Coefficients:
 [938.23786125]
Mean squared error: 2548.07
Variance score: 0.47
```

SUPERVISED LEARNING

What the line means? → it represents a function

Patient x: age 35, sex 1,…

Output: diabetic 82%

	AGE	SEX	BMI	BP	⋯ Serum Measurements ⋯						Response
Patient	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	y
1	59	2	32.1	101	157	93.2	38	4	4.9	87	151
2	48	1	21.6	87	183	103.2	70	3	3.9	69	75
3	72	2	30.5	93	156	93.6	41	4	4.7	85	141
4	24	1	25.3	84	198	131.4	40	5	4.9	89	206
5	50	1	23.0	101	192	125.4	52	4	4.3	80	135
6	23	1	22.6	89	139	64.8	61	2	4.2	68	97
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
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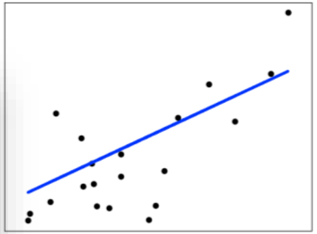


UNSUPERVISED LEARNING

- What is: “Unsupervised learning finds structures in the data.”

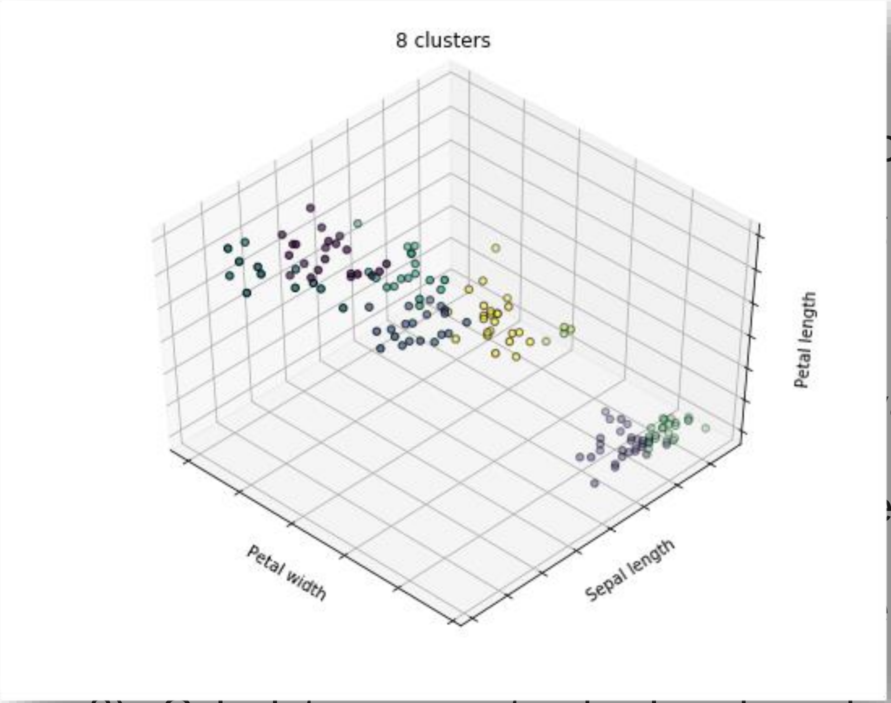
- How does it work?: “Labels for the data instances or other forms of guidance for training are not necessary. This makes unsupervised learning attractive in applications where data is cheap to obtain, but labels are either expensive or not available.” [Wittek. 2014].

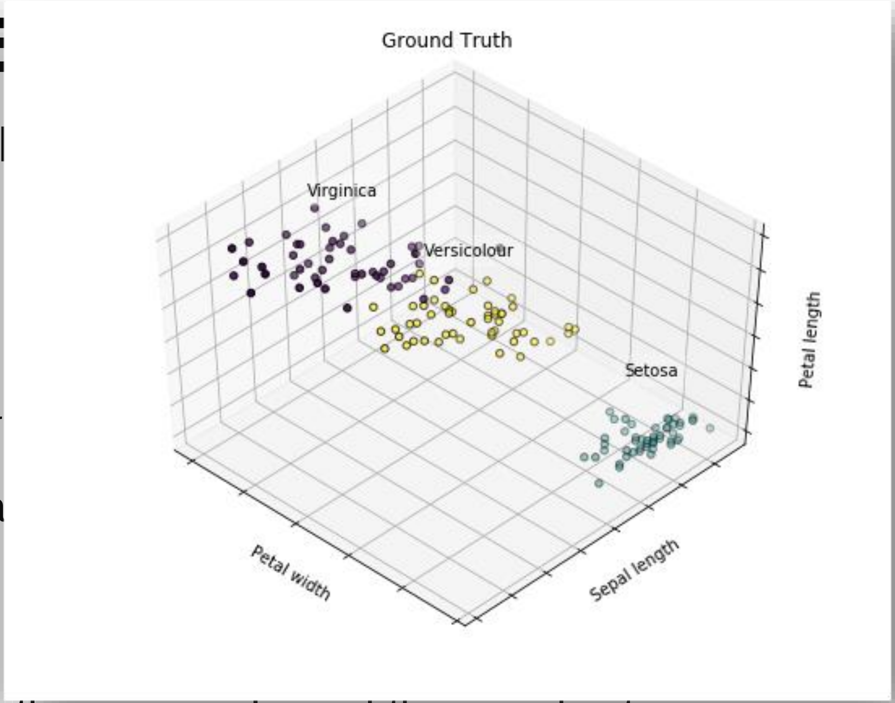
Wittek, P. (2014). *Quantum machine learning: what quantum computing means to data mining*. Academic Press.

UNSUPERVISED LEARNING

- Two important approaches (among many):
  - Clustering (many sub-mechanisms)
    - K-Means
    - Hierarchical clustering
    - Many others
  - Principal Components Analysis
    - used to preprocess and reduce the dimensionality of high-dimensional datasets, preserving the original structure

Wittek, P. (2014). *Quantum machine learning: what quantum computing means to data mining*. Academic Press.





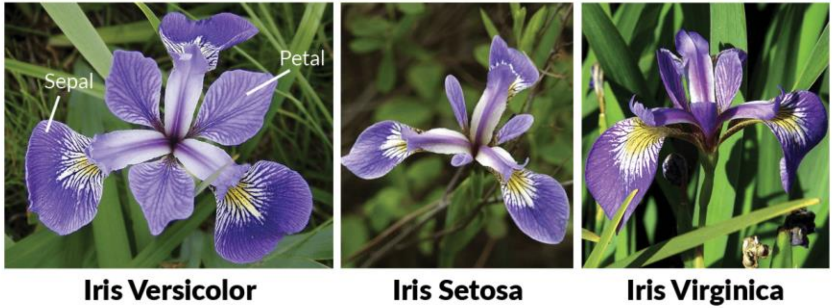
3) Calculate new centroid values based on the mean values of the coordinates of all the data instances from the corresponding cluster.

UNSUPERVISED LEARNING

Example 1: K-means with Python + Scikit-learn

Iris flower data set clustering

	Sepal length	Sepal width	Petal length	Petal width	Class
1	5.1	3.5	1.4	0.2	setosa
2	4.9	3.0	1.4	0.2	setosa
3	4.7	3.2	1.3	0.2	setosa
⋮	⋮	⋮	⋮	⋮	⋮
150	5.9	3.0	5.1	1.8	virginica



https://scikit-learn.org/stable/auto_examples/cluster/plot_cluster_iris.html#sphx-glr-auto-examples-cluster-plot-cluster-iris-py

UNSUPERVISED LEARNING

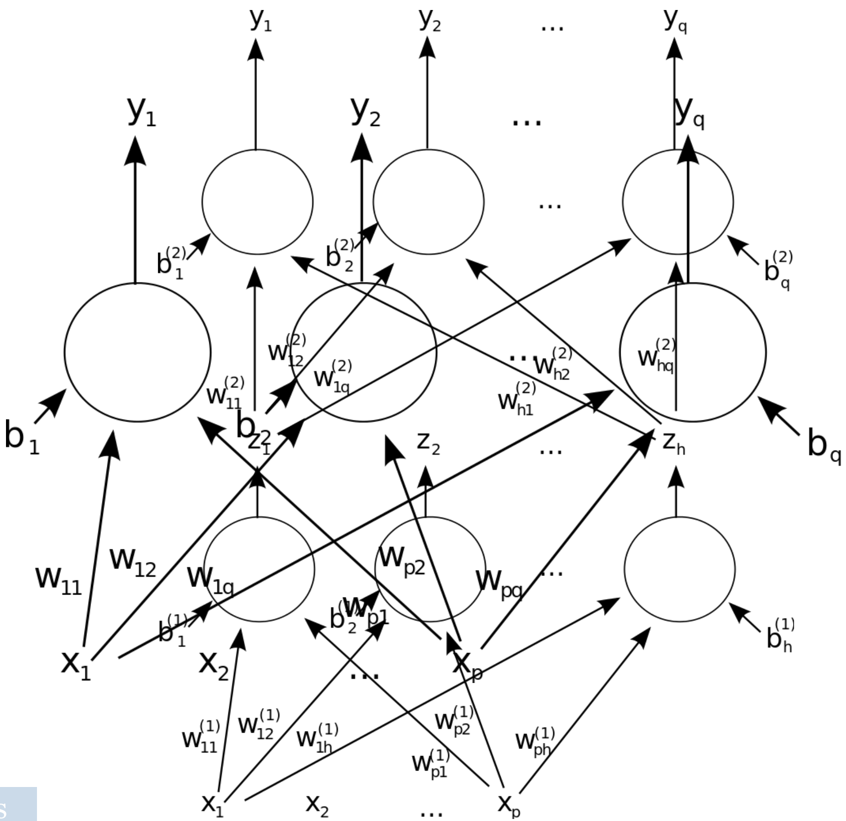
Example 1: K-means with Python + Scikit-learn

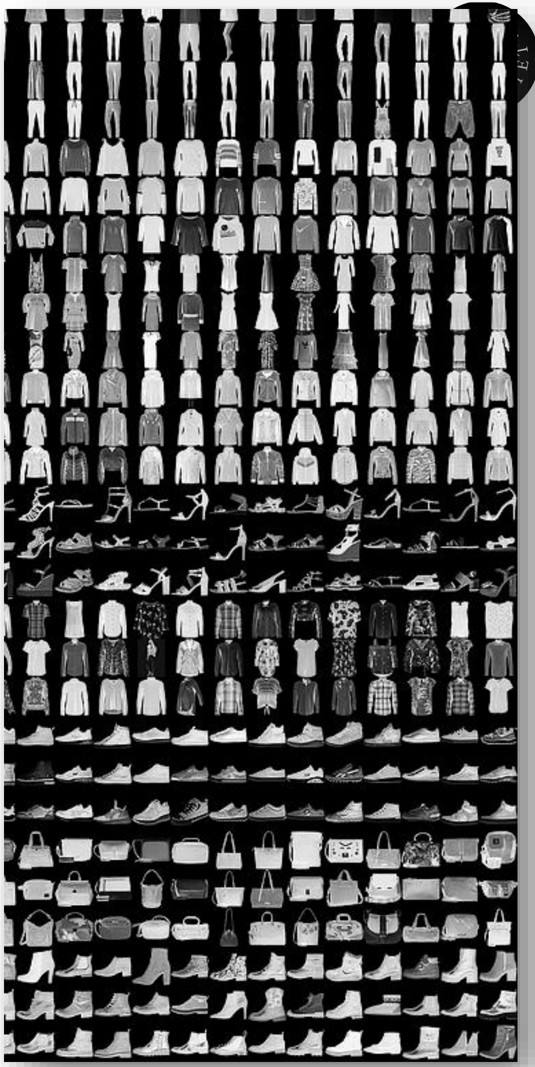
Jupyter notebook:

https://colab.research.google.com/drive/1dCb2q2ONQA3ge g2VBZ03bvxSdmGV_JF0

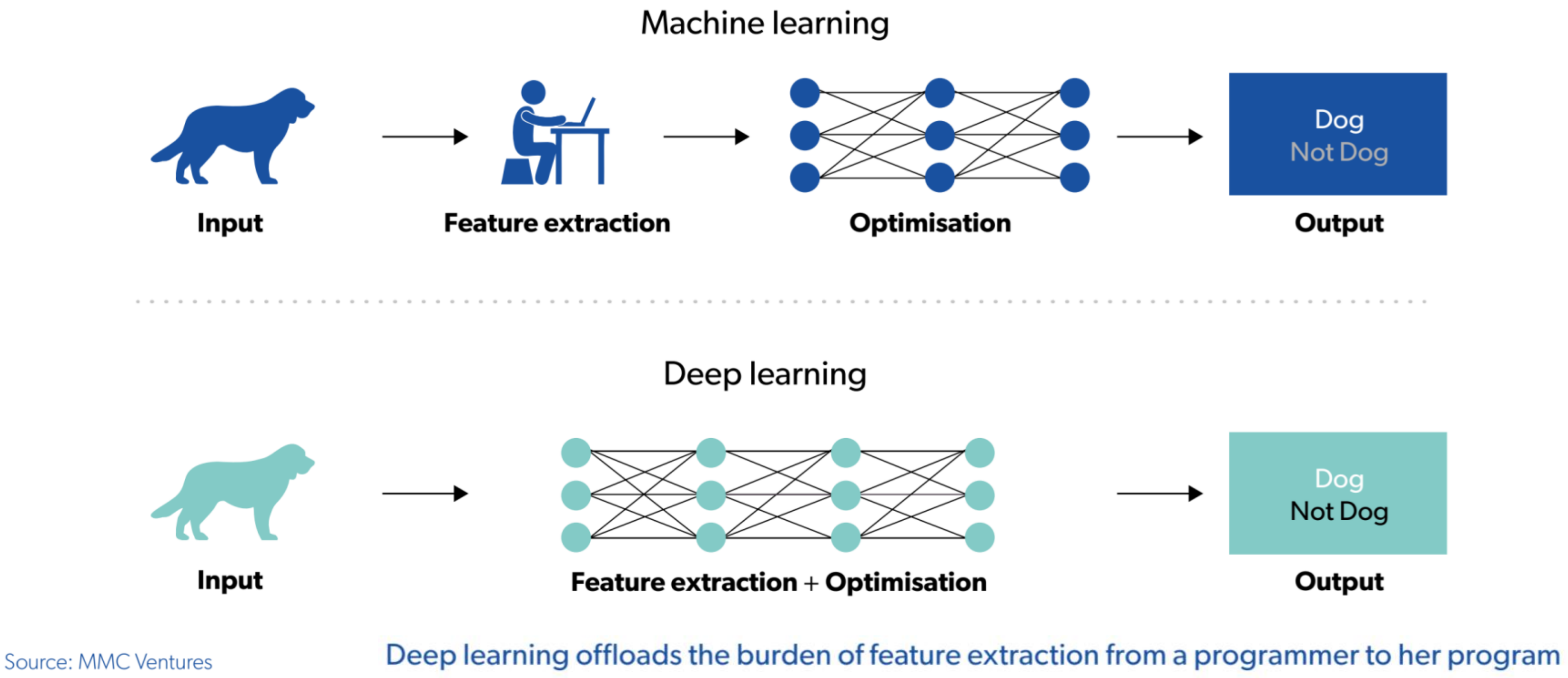
https://scikit-learn.org/stable/auto_examples/cluster/plot_cluster_iris.html#sphx-glr-auto-examples-cluster-plot-cluster-iris-py

DEEP LEARNING





DEEP LEARNING

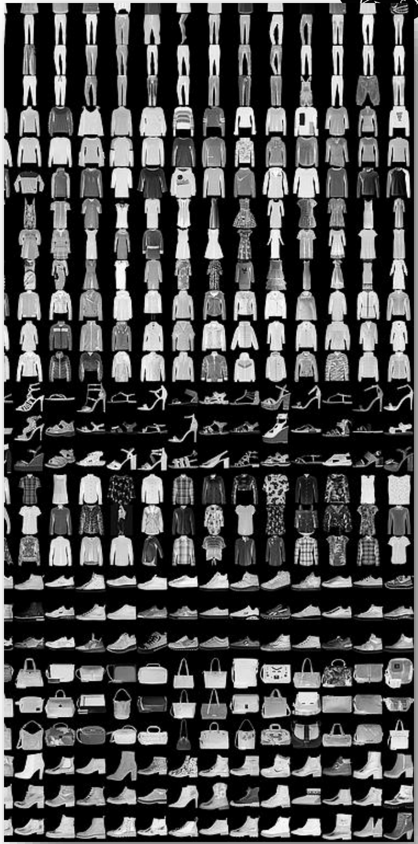


DEEP LEARNING

Example 2: Fashion MNIST dataset + TensorFlow + Python

Goal: Classify images.

How: Train a network with 60000 examples. Evaluate with 10000.



Reference: https://www.tensorflow.org/tensorboard/tensorboard_in_notebooks

DEEP LEARNING

Example 2: Fashion MNIST dataset + TensorFlow + Python

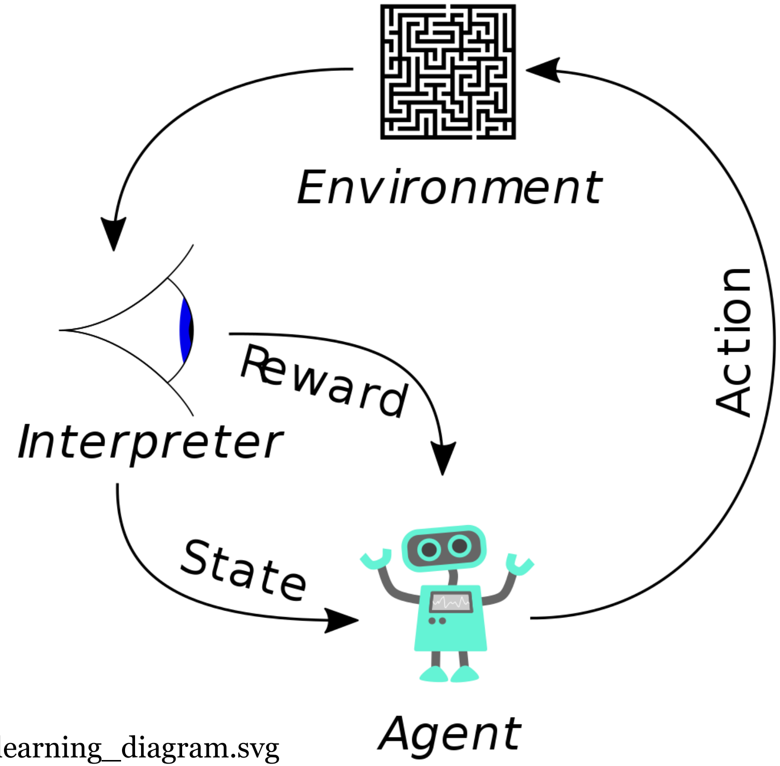
See Jupyter notebook:

https://colab.research.google.com/drive/13YG9iSbbDRDKPOrD4sE0G8w_Vd2Q-_sF

Reference: https://www.tensorflow.org/tensorboard/tensorboard_in_notebooks

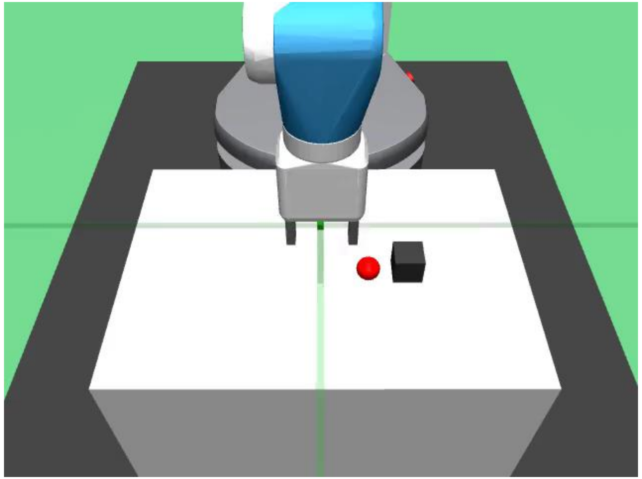
REINFORCEMENT LEARNING

- Basic idea:
  - Agent receives feedback in the form of rewards
  - Agent's utility is defined by the reward function
  - Must (learn to) act so as to maximize expected rewards
  - All learning is based on observed samples of outcomes



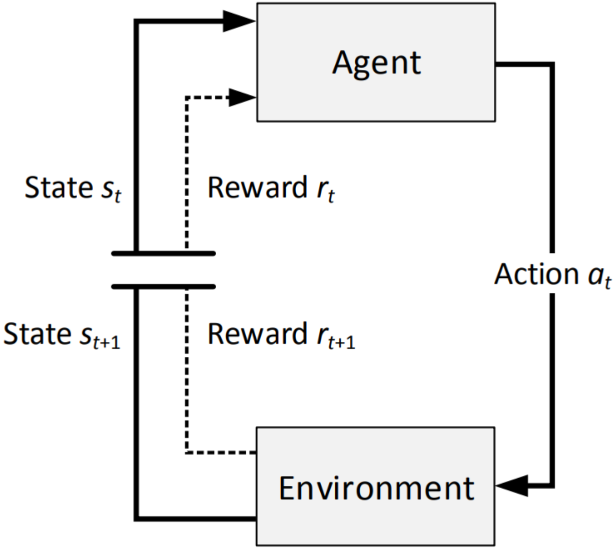
https://commons.wikimedia.org/wiki/File:Reinforcement_learning_diagram.svg

REINFORCEMENT LEARNING



https://gym.openai.com/envs/FetchPickAndPlace-v0/

https://deepmind.com/blog/article/deep-reinforcement-learning



At each step t, the agent:

- Executes action a_t
- Receives observation s_t
- Receives scalar reward r_t

The environment:

- Changes upon action a_t
- Emits observation s_{t+1}
- Emits scalar reward r_{t+1}

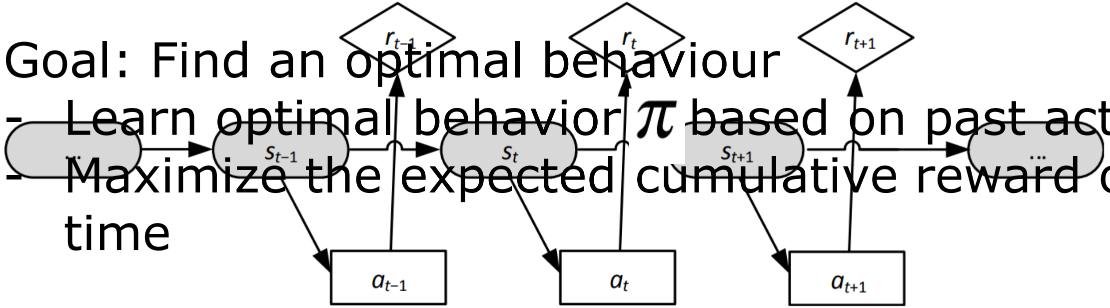
- Time step t is incremented after each iteration

REINFORCEMENT LEARNING

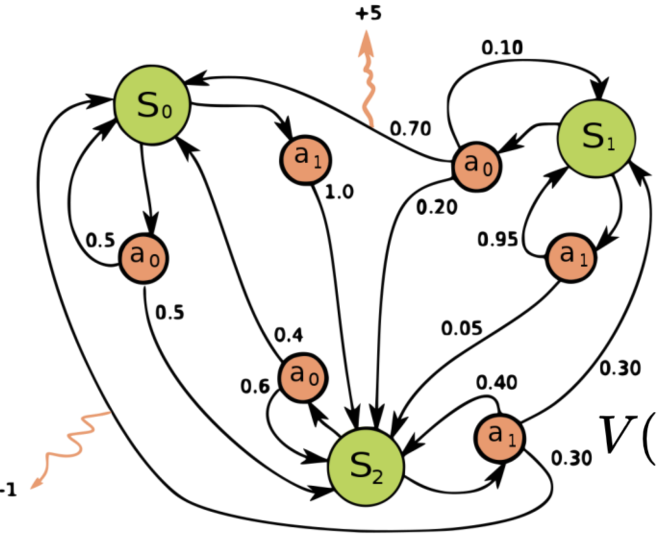
①	ENVIRONMENT	▸ You are in state 3 with 4 possible actions
②	AGENT	▸ I'll take action 2
③	ENVIRONMENT	▸ You received a reward of 5 units
		▸ You are in state 1 with 2 possible actions
⋮	⋮	⋮

Goal: Find an optimal behaviour

- Learn optimal behavior π based on past actions.
- Maximize the expected cumulative reward over time



REINFORCEMENT LEARNING



$$\Pr(s_{t+1} = s' \mid s_t = s, a_t = a)$$

..and we know that the action is determined by

$$\Pr(s_{t+1} = s' \mid s_t = s) \;\; \pi(s)$$

$$V(s) := \sum_{s'} P_{\pi(s)}(s, s') \left(R_{\pi(s)}(s, s') + \gamma V(s') \right)$$

Markov Decision Process

$$\pi(s) := \operatorname{argmax}_a \left\{ \sum_{s'} P(s' \mid s, a) \left(R(s' \mid s, a) + \gamma V(s') \right) \right\}$$

https://en.wikipedia.org/wiki/File:Markov_Decision_Process.svg

REINFORCEMENT LEARNING

- Example 3:OpenAI Gym
  https://gym.openai.com/

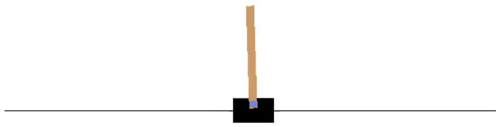
Gym

Gym is a toolkit for developing and comparing reinforcement learning algorithms. It supports teaching agents everything from walking to playing games like Pong or Pinball.

```python
import gym
env = gym.make("CartPole-v1")
observation = env.reset()
for _ in range(1000):
  env.render()
  action = env.action_space.sample() # your agent here (this takes random actions)
  observation, reward, done, info = env.step(action)

  if done:
    observation = env.reset()
env.close()
```

Lubuntu
Python 3.7



REVIEW OF ML IN TWO SPECIFIC SECTORS

Oil and Gas 4.0

Cybersecurity

SPECIFIC INDUSTRY AREAS

Case: Cybersecurity (1/3)

- Spam detection: "The detection of spam is based on the use of filters that analyse the content and decide whether or not they are spam or legitimate messages, blogs or websites" Two main strategies can be followed to detect spam: 1) textual analysis and 2) image-based analysis.

- Major technologies: Bayesian classifiers: Naive Bayes classifiers, Boolean Naive Bayes, etc.; Support vector machines (SVM), back-propagation neural networks, among others, Deep Belief Networks

Berman, D. S., Buczak, A. L., Chavis, J. S., & Corbett, C. L. (2019). A survey of deep learning methods for cyber security. *Information*, *10*(4), 122.

Torres, J. M., Comesaña, C. I., & García-Nieto, P. J. (2019). Machine learning techniques applied to cybersecurity. *International Journal of Machine Learning and Cybernetics*, 1-14.

SPECIFIC INDUSTRY AREAS

Case: Cybersecurity (2/3)

- Malware detection: “The detection of spam is based on the use of filters that analyse the content and decide whether or not they are spam or legitimate messages, blogs or websites” Two main strategies can be followed to detect spam: 1) textual analysis and 2) image-based analysis.

- Main technologies: Bayesian classifiers: Naive Bayes classifiers, Boolean Naive Bayes, etc.; Support vector machines (SVM), convolutional neural networks (CNNs) and recurrent neural networks (RNNs)

Berman, D. S., Buczak, A. L., Chavis, J. S., & Corbett, C. L. (2019). A survey of deep learning methods for cyber security. *Information*, *10*(4), 122.

Torres, J. M., Comesaña, C. I., & García-Nieto, P. J. (2019). Machine learning techniques applied to cybersecurity. *International Journal of Machine Learning and Cybernetics*, 1-14.

SPECIFIC INDUSTRY AREAS

Case: Cybersecurity (3/3)

- Phishing detection: "The detection of spam is based on the use of filters that analyse the content and decide whether or not they are spam or legitimate messages, blogs or websites" Two main strategies can be followed to detect spam: 1) textual analysis and 2) image-based analysis.

- Main technologies: Bayesian classifiers, SVMs, neural networks

Berman, D. S., Buczak, A. L., Chavis, J. S., & Corbett, C. L. (2019). A survey of deep learning methods for cyber security. *Information*, *10*(4), 122.

Torres, J. M., Comesaña, C. I., & García-Nieto, P. J. (2019). Machine learning techniques applied to cybersecurity. *International Journal of Machine Learning and Cybernetics*, 1-14.

SPECIFIC INDUSTRY AREAS

Datasets for cybersecurity:

- Knowledge Discovery and Dissemination (KDD) 1999 dataset: https://kdd.ics.uci.edu/databases/kddcup99/kddcup99.html
- NSL-KDD dataset: https://www.unb.ca/cic/datasets/nsl.html
- CTU-13 Dataset: https://www.stratosphereips.org/datasets-ctu13/
- Others: Contagio, Comodo, the Genome Project, Virus Share, VirusTotal, DREBIN, and Microsoft Malware Classification

Torres, J. M., Comesaña, C. I., & García-Nieto, P. J. (2019). Machine learning techniques applied to cybersecurity. *International Journal of Machine Learning and Cybernetics*, 1-14.

Application scenario		Benefit
Drilling		Reduce the safety risk an
Diagnosis and detection		With the help of unmann
Weather monitoring system		Automatic weather senso reduce construction risks ... vance,
Metering system		The intelligent sensor is ... tically according to the data.

Application scenarios of big data in the oil and gas industry (Mohammadpoor and Torabi, 2018).

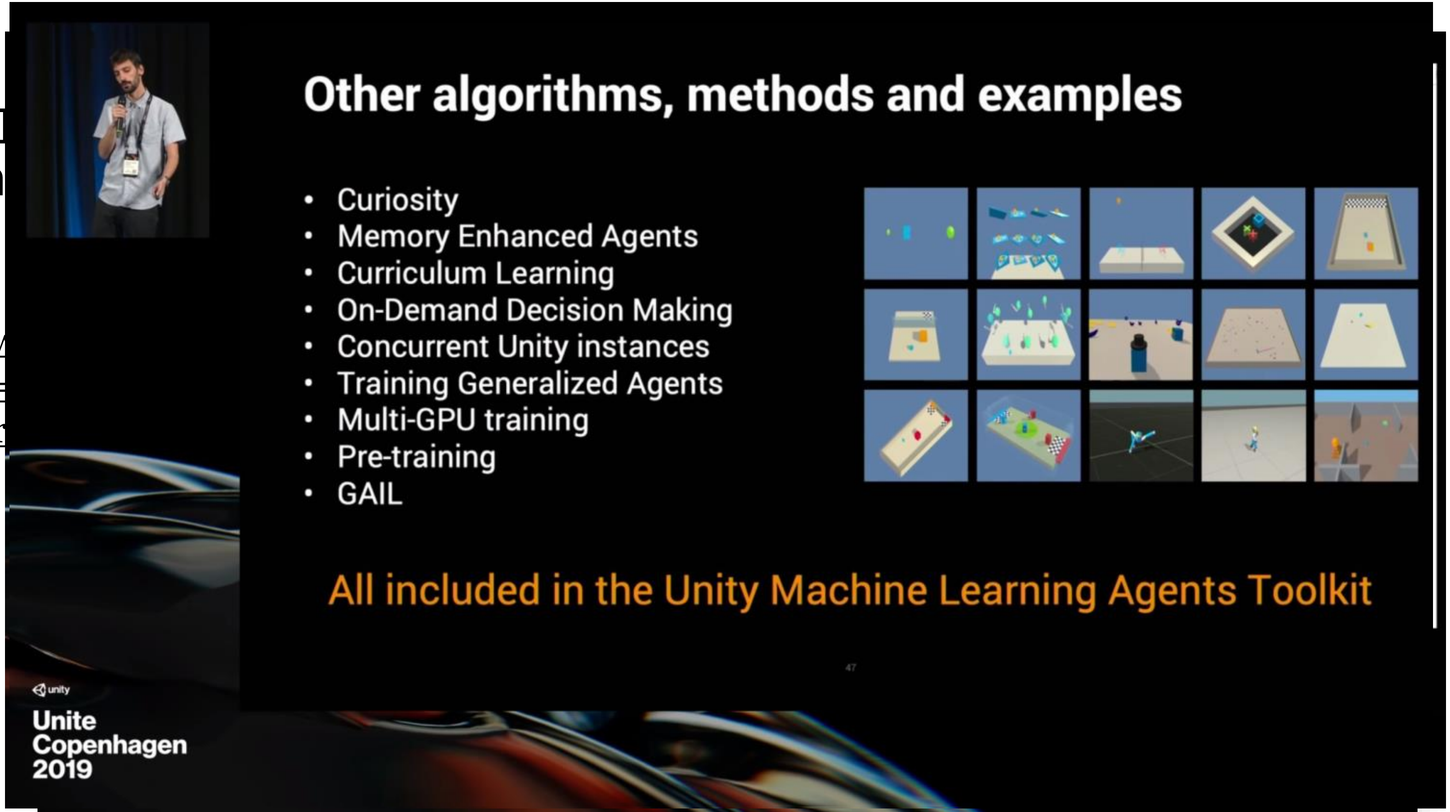
Domain	Application scenario
Exploration	Seismic data Micro-seismic data 1D, 2D, and 3D geological maps
Drilling	Drilling rig efficiency Drilling performance Invisible non-production time Reduce the risk of drilling operations Characterize the drill string dynamics
Reservoir engineering	Reservoir management application Closed-Loop Reservoir Management (CLRM) and Integrated Asset Modeling (IAM) Improve the CO_2 sequestration Optimization on heavy oil reservoirs Reservoir modeling for unconventional oil and gas resources Improve the modeling of hydraulically fractured reservoirs Optimize the application of EOR projects
Production engineering	Conduct automated decline analysis Production allocation technique Optimize the performance of electric submersible pumps (ESPs) Optimize the performance of rod pump wells Improve hydraulic fracturing projects Conduct field development
Refining	Petroleum asset management Management optimization of a comprehensive refinery in Spain Workflow to study the impact of well completion parameters on well productivity
Transportation	Improve shipping performance
Health and Safety Executive (HSE)	Develop an energy efficiency model during ship operations Improve the occupational safety of the oil and gas industry

Lu, H., Guo, L., Azimi, M., & Huang, K. (2019). Oil and Gas 4.0 era: A systematic review and outlook. *Computers in Industry*, *111*, 68-90.

GAMING INDUSTRY

• See AI Copen

https://www m/watch?v= LQQ&featur



CONCLUDING

WHY DO BUSINESSES FAIL AT MACHINE LEARNING?
CHECKLIST

- ❑ Know what business you're in.
- ❑ Do things in the right order. (don't start with the algorithms; solve: what business problem I am solving?)
- ❑ Don't reinvent the wheel
- ❑ Data is not the most important part (data not Data)
- ❑ To scale using ML in Industry, more humans are needed (more than data scientists / engineers; from: statistics, ethics, social work, etc.)
- ❑ Simplify where is possible
- ❑ Focus more in information ~~data~~ than the algorithms
- ❑ Design incentives that cannot be gamed (for reward functions in Reinforcement Learning: what you want the thing to learn?; and maybe for some Deep Learning approaches)

Cassie Kozyrkov
Head of Decision Intelligence, Google.

https://www.youtube.com/watch?v=dRJGyhS6gAo

Recommendations

Executives

- Familiarise yourself with the concepts of rules-based software, machine learning and deep learning.
- Explore why AI is important and its many applications
- Identify sources of AI expertise, and existing AI projects, within your organisation.

Entrepreneurs

- To identify opportunities for value creation, explore the many applications for AI
- Familiarise yourself with current developments in AI technology New approaches and novel techniques offer new possibilities.

https://www.ai-playbook.com/introduction

END

Questions?

UMEÅ UNIVERSITY

ACTIVITY

1. Individually or in group
2. Choose an industrial use case (it can be anonymized or hypothetical)
3. Simplify the case to I/ML/O
   1. Output: ? (key: think in business model)
   2. Input: data, human resources, infrastructure, etc.
   2. ML approach?
4. Take some minutes to reflect.
5. Group analysis

PROGRAMMING WITH PYTHON

Programming with Python

The best way to learn how to program is to do something useful, so this introduction to Python is built around a common scientific task: **data analysis**.

Arthritis Inflammation

We are studying **inflammation in patients** who have been given a new treatment for arthritis, and need to analyze the first dozen data sets of their daily inflammation. The data sets are stored in comma-separated values (CSV) format:

- each row holds information for a single patient,
- columns represent successive days.

The first three rows of our first file look like this:

Code

```
0,0,1,3,1,2,4,7,8,3,3,3,10,5,7,4,7,7,12,18,6,13,11,11,7,7,4,6,8,8,4,4,5,7,3,4,2,3,0,0
0,1,2,1,2,1,3,2,2,6,10,11,5,9,4,4,7,16,8,6,18,4,12,5,12,7,11,5,11,3,3,5,4,4,5,5,1,1,0,1
0,1,1,3,3,2,6,2,5,9,5,7,4,5,4,15,5,11,9,10,19,14,12,17,7,12,11,7,4,2,10,5,4,2,2,3,2,2,1,1
```

So, we want to:

1. Calculate the average inflammation per day across all patients.
2. Plot the result to discuss and share with colleagues.

To do all that, we'll have to learn a little bit about programming.

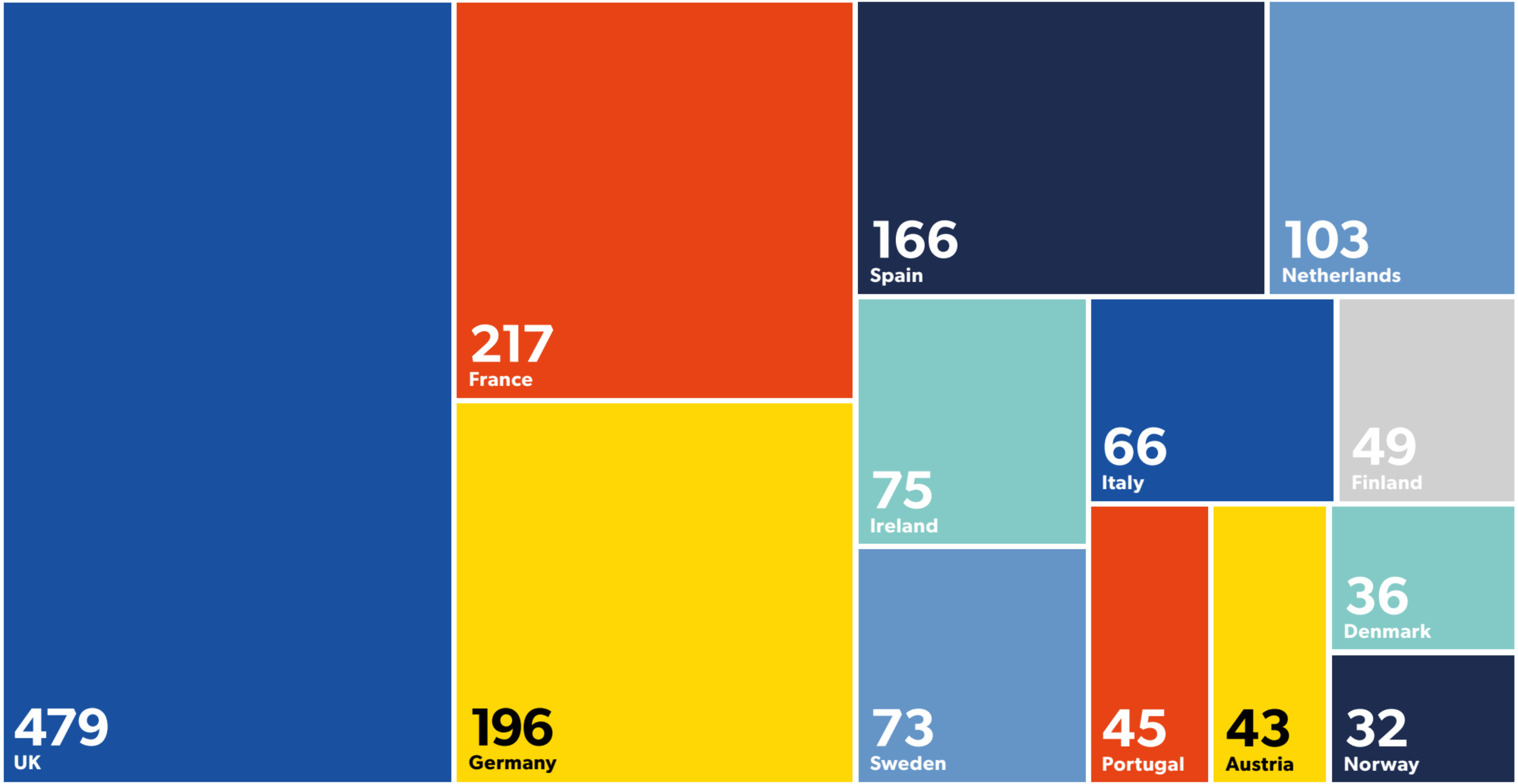
Prerequisites

You need to understand the concepts of **files** and **directories** and how to start a Python interpreter before tackling this lesson. This lesson sometimes references Jupyter Notebook although you can use any Python interpreter mentioned in the Setup.

The commands in this lesson pertain to **Python 3**.

https://www8.cs.umu.se/kursmaterial/ws-python-scientific-computing/

With twice as many AI startups as any other country, the UK is the powerhouse of European AI entrepreneurship



Source: MMC Ventures, Beauhurst, Crunchbase, Tracxn

https://www.mmcventures.com/wp-content/uploads/2019/02/The-State-of-AI-2019-Divergence.pdf

PiiA

Process Industrial IT and Automation

NEW REPORT (OCTOBER)

http://sip-piia.se/wp-content/uploads/2019/10/AI-rapport_2019-low.pdf