Courses & Labs

Aomar OSMANI

Courses : 16 hours, **Labs : 15h**, **Eval Lab : 3h**

- 3 hours :
  - General introduction to AI and Industry
  - General Introduction to ML (and IoT)
  - Labs context (colab, github, drive) + configuration
  - Evaluation (Presentations of two applications + UCI datasets)
- 3h
  - Summary to know to carry out Labs (NN principle, basic concepts, architecture, tuning, ...)
  - General Introduction to IoT
  - Evaluation process (if not presented in course 1
- 10h
  - ML General principles
  - Specificity of Machine Learning in IoT
  - Information on the evaluation (web link to datasets, data visualisation, process)

Courses & Labs

Same sequence and hours number for all groups. However, this slide show only labs sequence for one group.

Labs : 9h, **Eval Lab : 3h**

- 3h :
  - Preparation of the environment (colab, git, drive)
  - HAR Application presentation (site SHL) or our work : Data Generation Process Modeling for Activity Recognition
  - Data preparation (data loading / generation and visualization)
- 6h
  - Part 1/2 of the HAR Lab
- 6h
  - Part 2/2 of the HAR Lab
- 3h
  - Evaluation 1/2 : guided lab
- homework (finish the last guided lab)

Artificial Intelligence and Industry 4.0

Machine Learning and Internet of Things

Aomar OSMANI

Almost all the links in the slides are clickable. They allow you to access sources and download reports

2021

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The changing role of technology in the workplace

From the Pega 2020 future of work report [1]

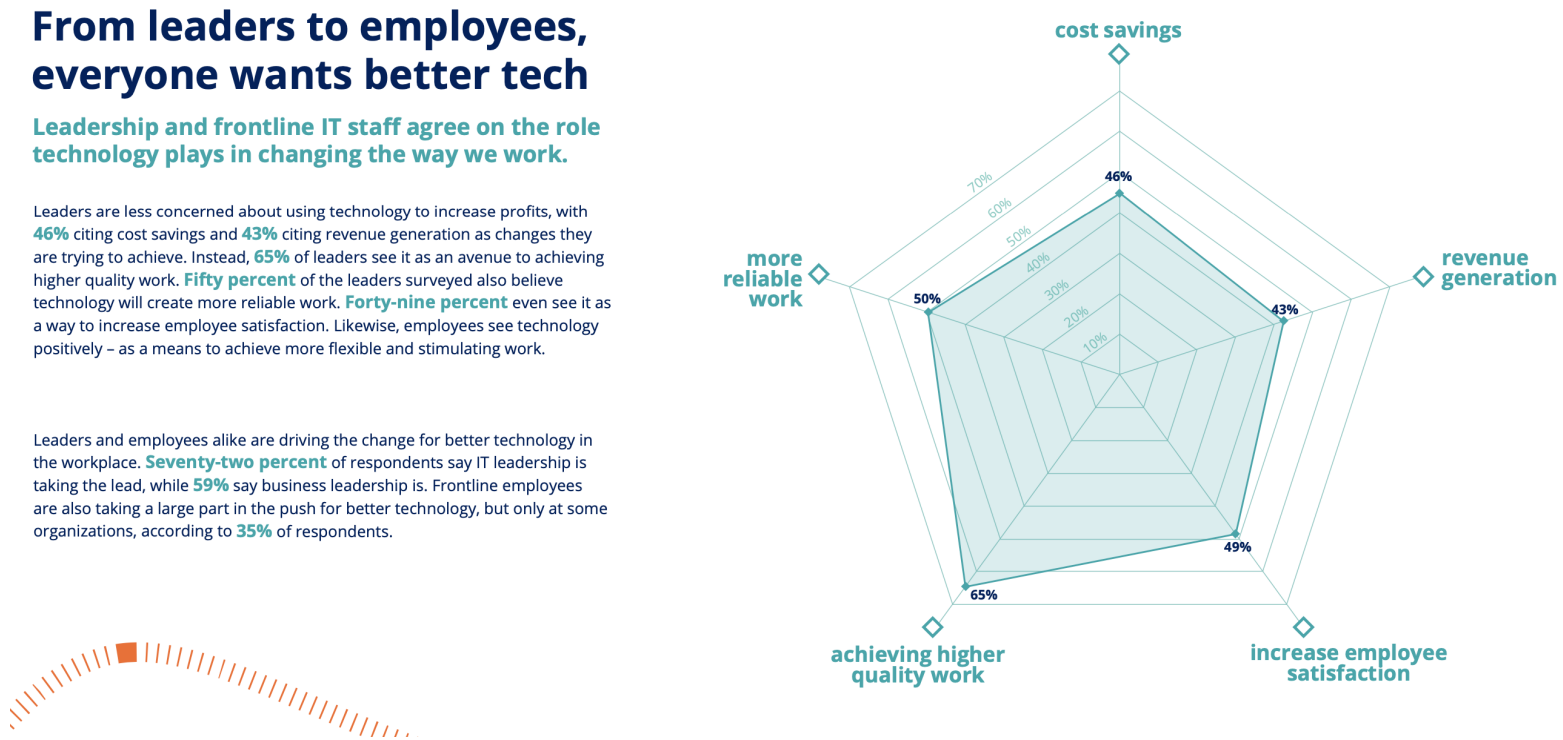

FIGURE – A 2020 research study on the changing role of technology in the workplace

1. https ://www.pega.com/

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Key technologies in Industry [2]

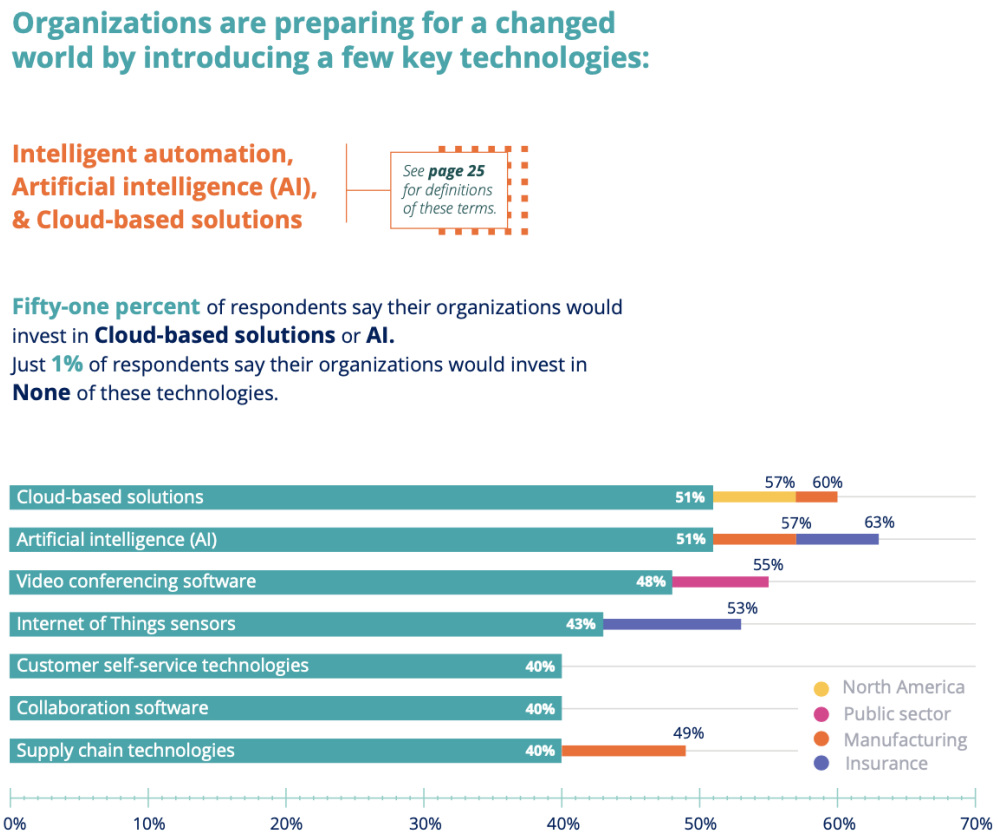

FIGURE – A 2020 key technologies

2. https ://www.pega.com/

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Technology and Industry [3]

SECTION 3

From disruption to transformation

Today's investments in technology aim to improve efficiency, reduce costs, and benefit employees. Two-thirds of our respondents say employees are asking for better technology to improve how they work.

To meet this need, companies are investing in a range of technologies, including the following:

Business process management (BPM) software
Deep learning
Machine learning
Robotic process automation (RPA)

*See **page 25** for definitions of these terms.*

What percentage of companies are investing in these technologies?

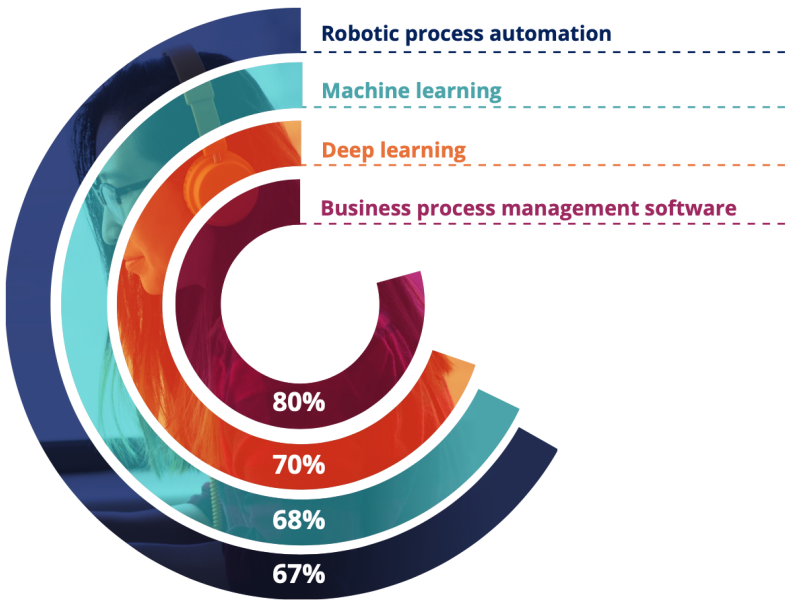
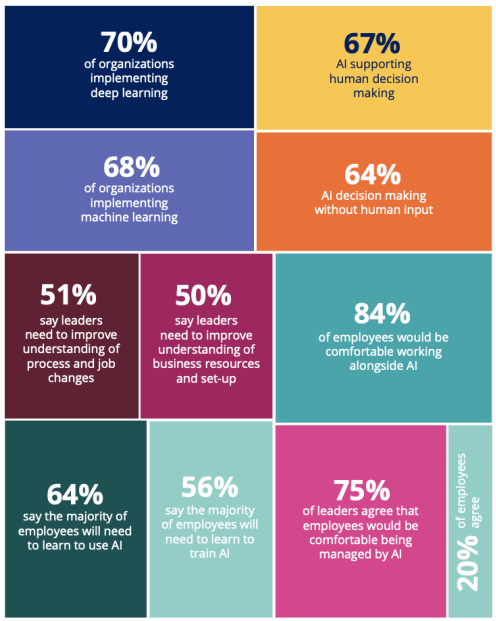


FIGURE – Technology to improve how we work

3. https ://www.pega.com/

Technology and Industry [4]

Changing the workforce with AI



AI already plays a major role in the workplace.

This is evident in the widespread deployment of AI technologies, with **70%** of organizations deploying deep learning and **68%** deploying machine learning. **Sixty-seven percent** of organizations are also using AI to support decision making and **64%** are using AI to reach decisions without human input.

Some further questions our study explored include:

How are business leaders responding to AI?

Business leaders are eager to explore the opportunities that AI can deliver, but they still have a lot to learn. **Fifty-one percent** of respondents think senior leaders need to improve their understanding of how AI changes processes and affects jobs. And **50%** of respondents think senior leaders need to improve their understanding of the business resources and set-up needed to make new technology work well.

How will AI affect frontline staff?

Ultimately, all employees will need to become more familiar with AI solutions. **Sixty-four percent** of respondents think the majority of employees will need to know how to use AI within the next five years. **Fifty-six percent** think they will also need to learn how to train AI.

How do employees feel about AI managers?

Intelligent machines are increasingly being used for managing tasks and supervising productivity. **Eighty-four percent** of workers say they're comfortable working alongside intelligent machines. However, being managed by them is another story.

Seventy-five percent of C-suite leaders think workers would be "quite" or "completely" comfortable being managed by a machine. Frontline employees, however, don't share this view. We asked employees this question in our 2017 study. **Four out of five** respondents said they would not be comfortable with an intelligent machine managing them.[5]

[5] *The Future of Work: A Report from Marketforce and Pegasystems. 2017.* https://www.pega.com/insights/resources/future-work-report-marketforce-and-pegasystems

FIGURE – Changing workforce with Artificial Intelligence

4. https ://www.pega.com/

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Pluralsight industrie 4.0 previsions [5]

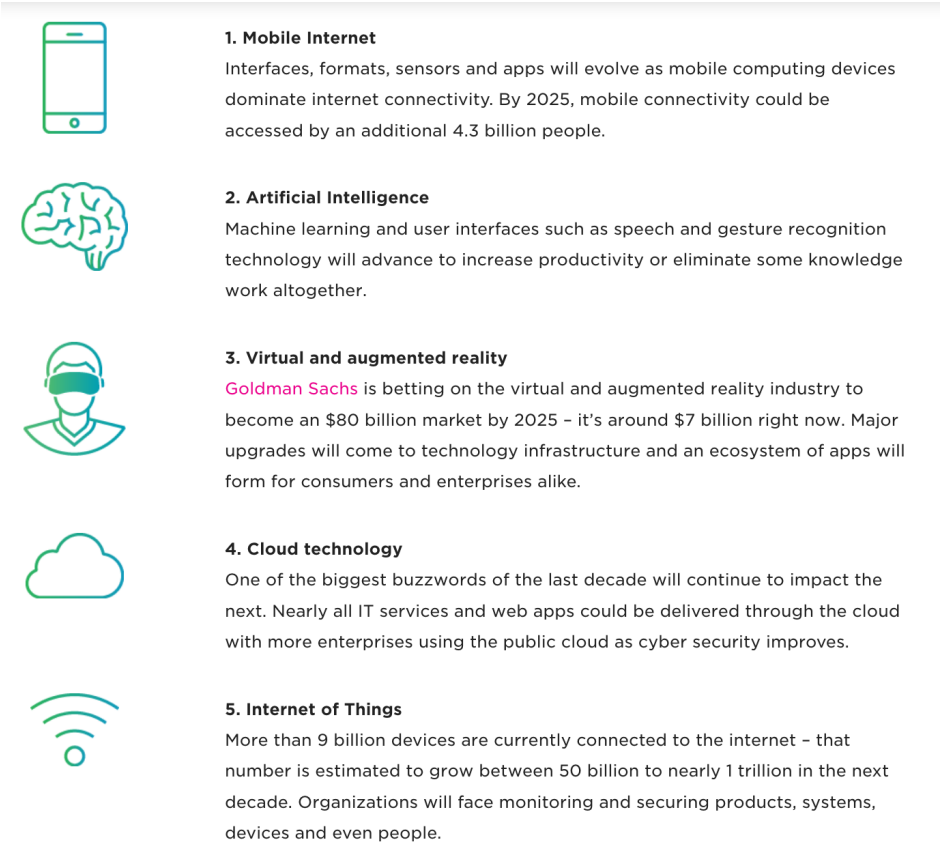
This report introduces the 2025 main technologies preparing industrie 4.0.

An extract : “

With so many technologies emerging on so many fronts, it's a challenge to keep up. Every advance is billed as “the next big thing.” Combining a report by The McKinsey Global Institute and knowledge of Pluralsight's subject-matter experts, we've compiled a list of 10 technologies that will lead the fourth industrial revolution. As the Institute notes, “Not every emerging technology will alter the business or social landscape – but some truly do have the potential to disrupt the status quo, alter the way people live and work, and rearrange value pools.“”

5. https ://www.pluralsight.com/blog/career/tech-in-2025

technologies that will transform the economy by 2025 [6]



1. Mobile Internet
Interfaces, formats, sensors and apps will evolve as mobile computing devices dominate internet connectivity. By 2025, mobile connectivity could be accessed by an additional 4.3 billion people.

2. Artificial Intelligence
Machine learning and user interfaces such as speech and gesture recognition technology will advance to increase productivity or eliminate some knowledge work altogether.

3. Virtual and augmented reality
Goldman Sachs is betting on the virtual and augmented reality industry to become an $80 billion market by 2025 – it's around $7 billion right now. Major upgrades will come to technology infrastructure and an ecosystem of apps will form for consumers and enterprises alike.

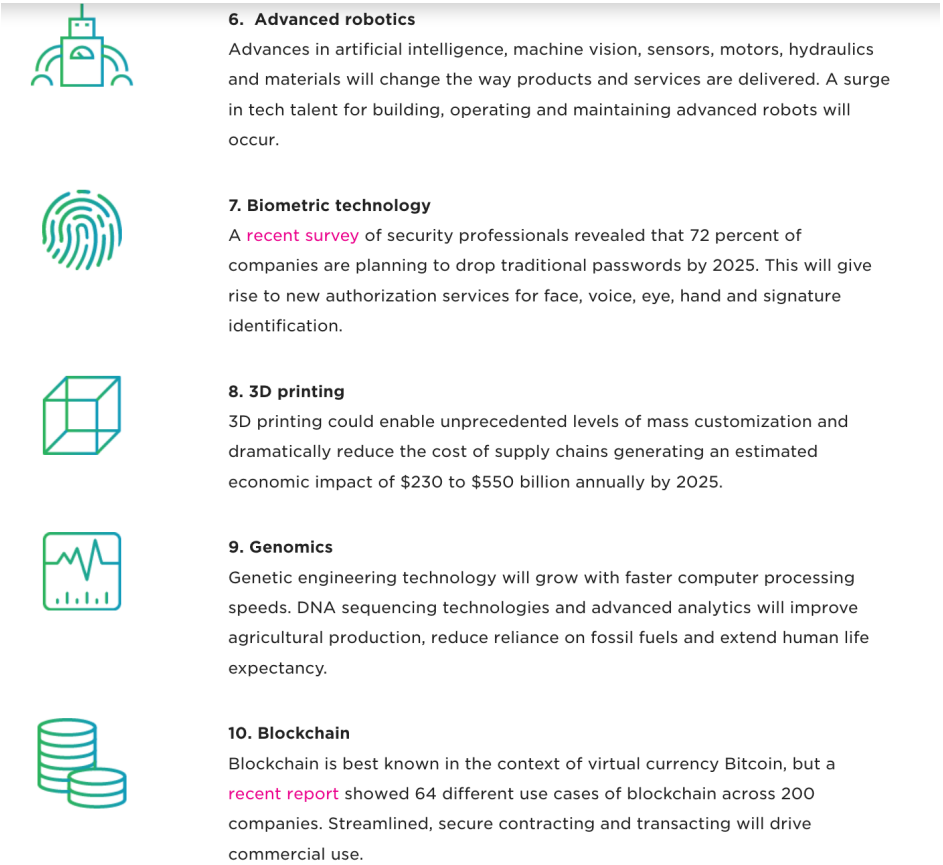
4. Cloud technology
One of the biggest buzzwords of the last decade will continue to impact the next. Nearly all IT services and web apps could be delivered through the cloud with more enterprises using the public cloud as cyber security improves.

5. Internet of Things
More than 9 billion devices are currently connected to the internet – that number is estimated to grow between 50 billion to nearly 1 trillion in the next decade. Organizations will face monitoring and securing products, systems, devices and even people.

FIGURE – 10 technologies that will transform the global economy by 2025

6. https ://www.pluralsight.com/blog/career/tech-in-2025

technologies that will transform the economy by 2025 [7]



6. Advanced robotics
Advances in artificial intelligence, machine vision, sensors, motors, hydraulics and materials will change the way products and services are delivered. A surge in tech talent for building, operating and maintaining advanced robots will occur.

7. Biometric technology
A recent survey of security professionals revealed that 72 percent of companies are planning to drop traditional passwords by 2025. This will give rise to new authorization services for face, voice, eye, hand and signature identification.

8. 3D printing
3D printing could enable unprecedented levels of mass customization and dramatically reduce the cost of supply chains generating an estimated economic impact of $230 to $550 billion annually by 2025.

9. Genomics
Genetic engineering technology will grow with faster computer processing speeds. DNA sequencing technologies and advanced analytics will improve agricultural production, reduce reliance on fossil fuels and extend human life expectancy.

10. Blockchain
Blockchain is best known in the context of virtual currency Bitcoin, but a recent report showed 64 different use cases of blockchain across 200 companies. Streamlined, secure contracting and transacting will drive commercial use.

FIGURE – 10 technologies that will transform the global economy by 2025

7. https ://www.pluralsight.com/blog/career/tech-in-2025

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Report to read

Documentation is abundant on the net. However, that established by certain large firms constitutes good general references. Among these, I suggest :

- The real-world potential and limitations of AI, McKinsey 2018
- 2020 McKinsey collection including conversation with Stuart Russell
- Bain & Compagny 2020 : The impact of covid on the AI adoption, AI customer experience tools,
- BCG 2020 : AI has entered business world: what happens next?
- Gartner ressources
- Audit big four : Deloitte, KPMG, PwC et EY.

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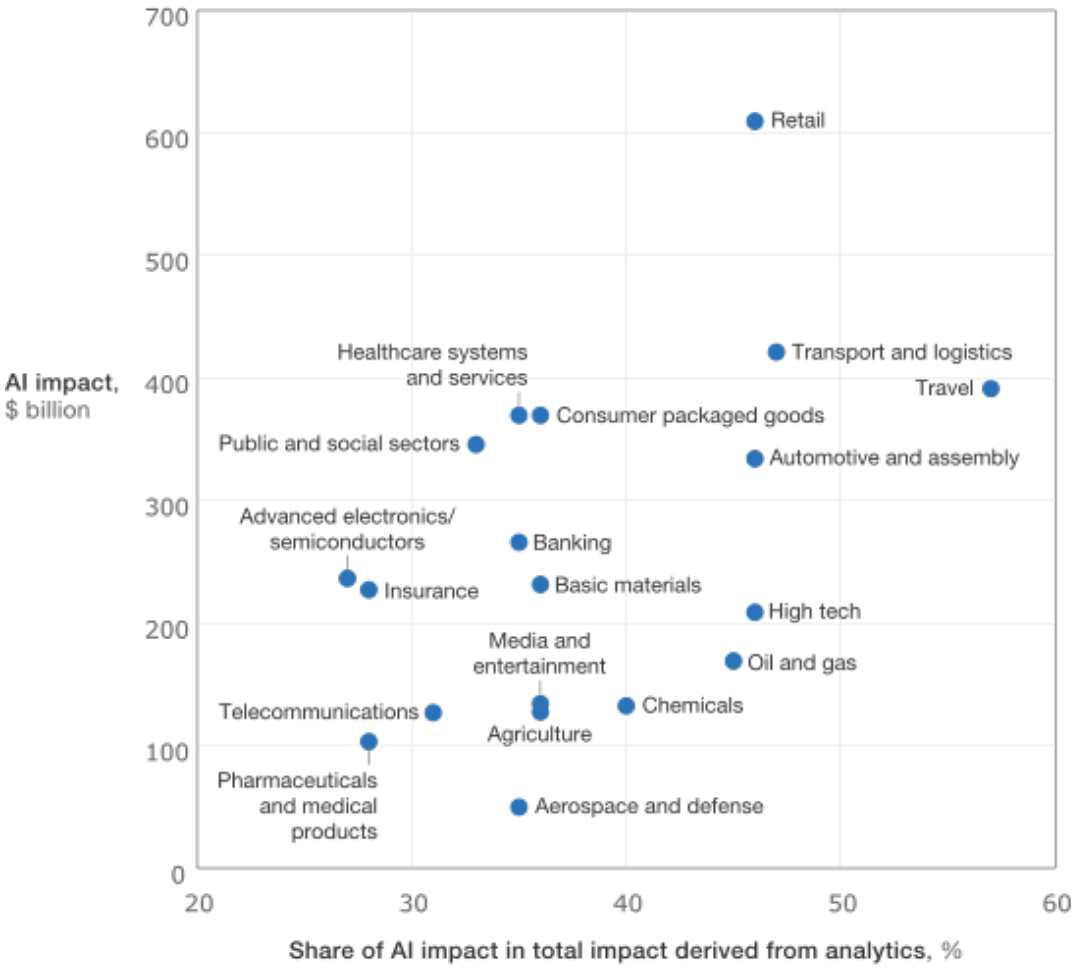
AI potential in Industry

Artificial intelligence (AI) has the potential to create value across sectors.



McKinsey&Company | **Source:** McKinsey Global Institute analysis

Figure

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Artificial Intelligence Definition

Définition

AI is a set of computer theories and technics used to perform tasks usually requiring human intelligence. It's a collection of technologies that can enable machines or systems to perceive, understand, solve problems, act and learn.

Main AI domains :

- Knowledge representation and reasoning
- Automated Planning
- Natural language processing
- Machine Perception (vision, haring, touch,...) .
- Intelligent Robots (eg. Boston Dynamics).
- Problem Solving
- Machine learning

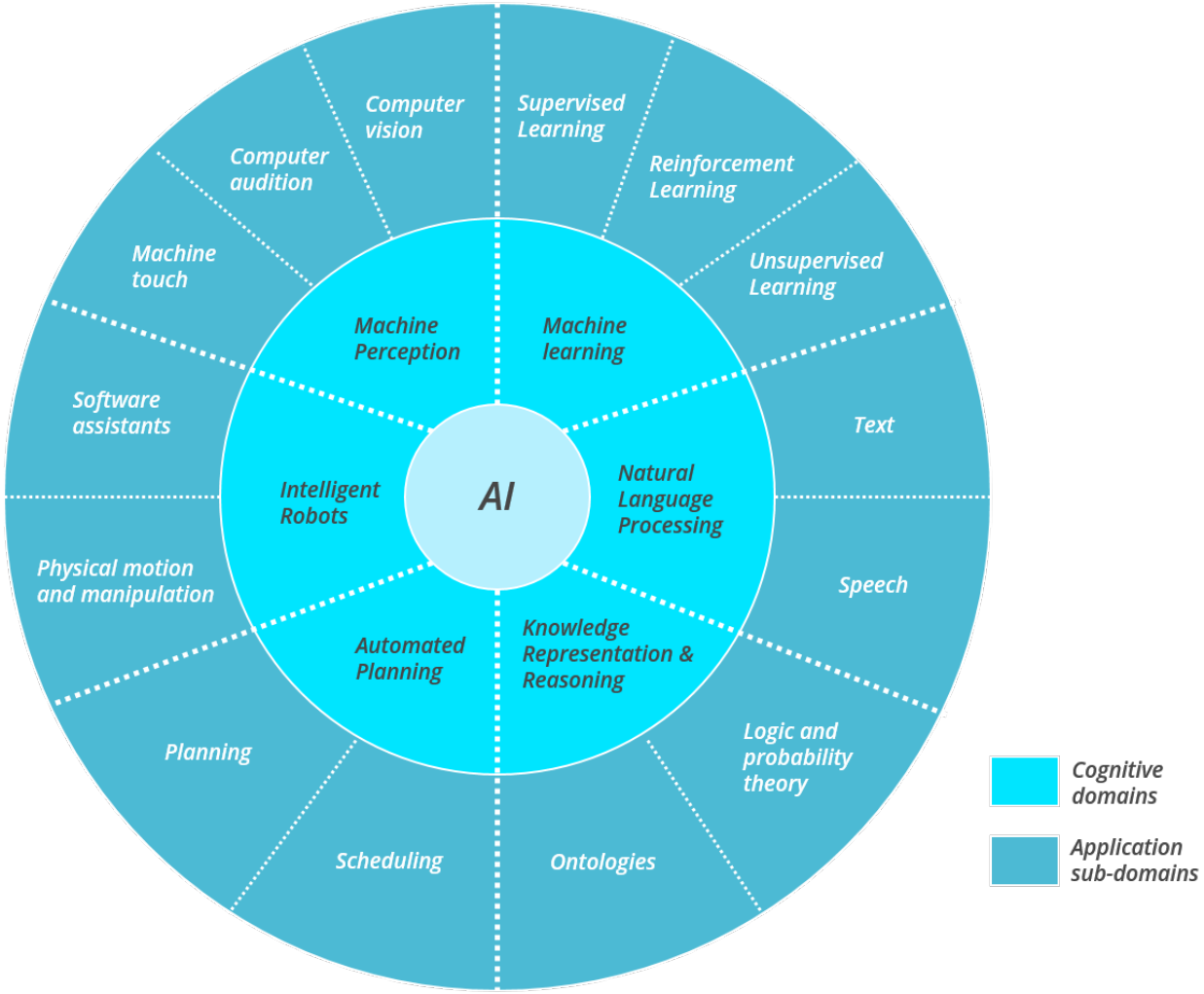

FIGURE – AI domains

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Machine Learning Algorithms

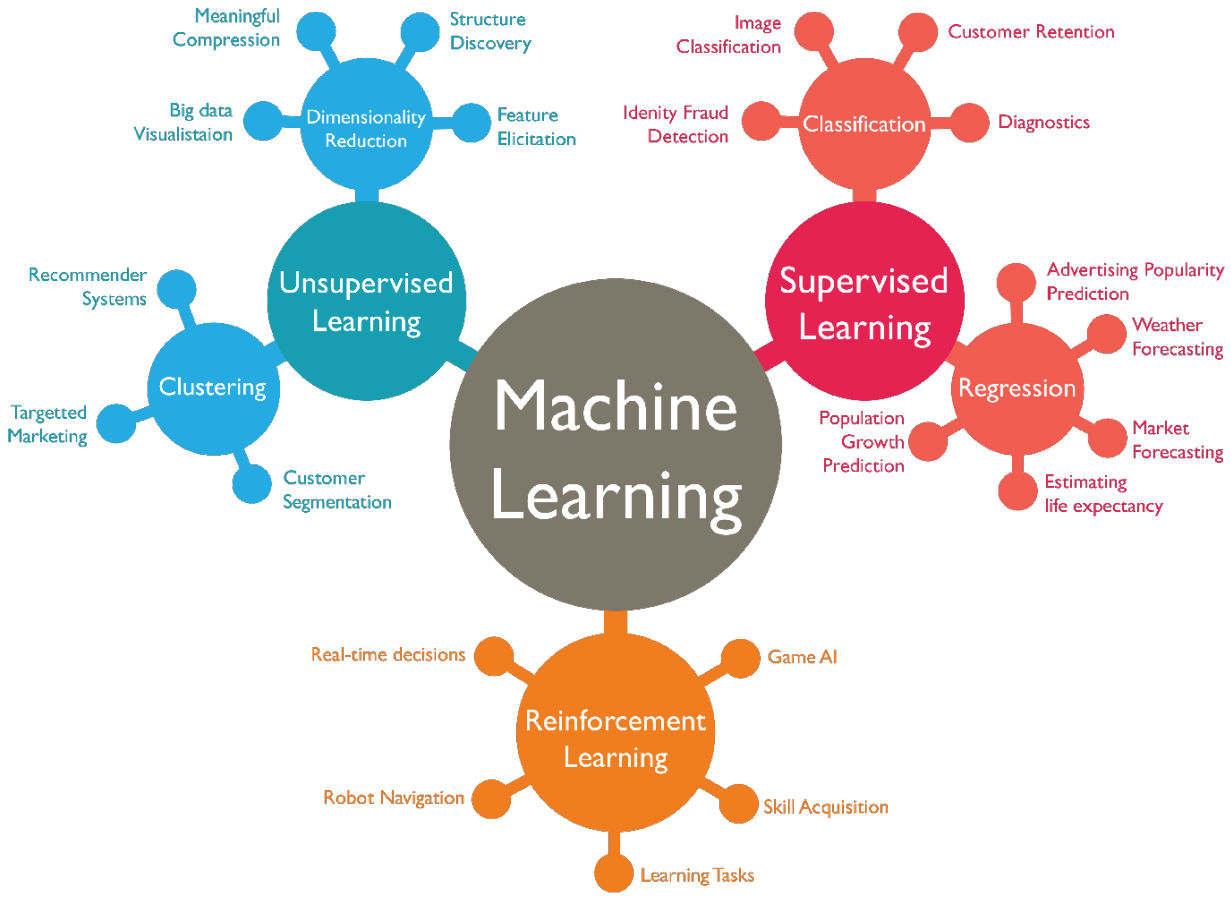

FIGURE – Machine Learning Algorithms

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Machine Learning Applications

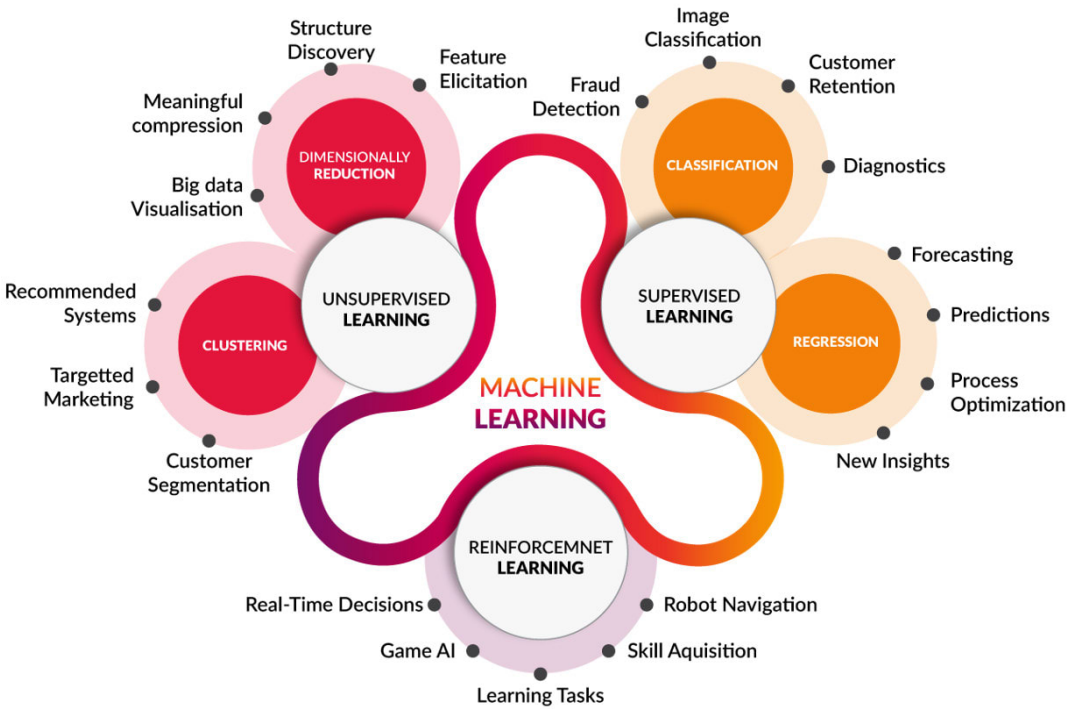

FIGURE – Machine Learning Applications

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Machine Learning in manufacturing

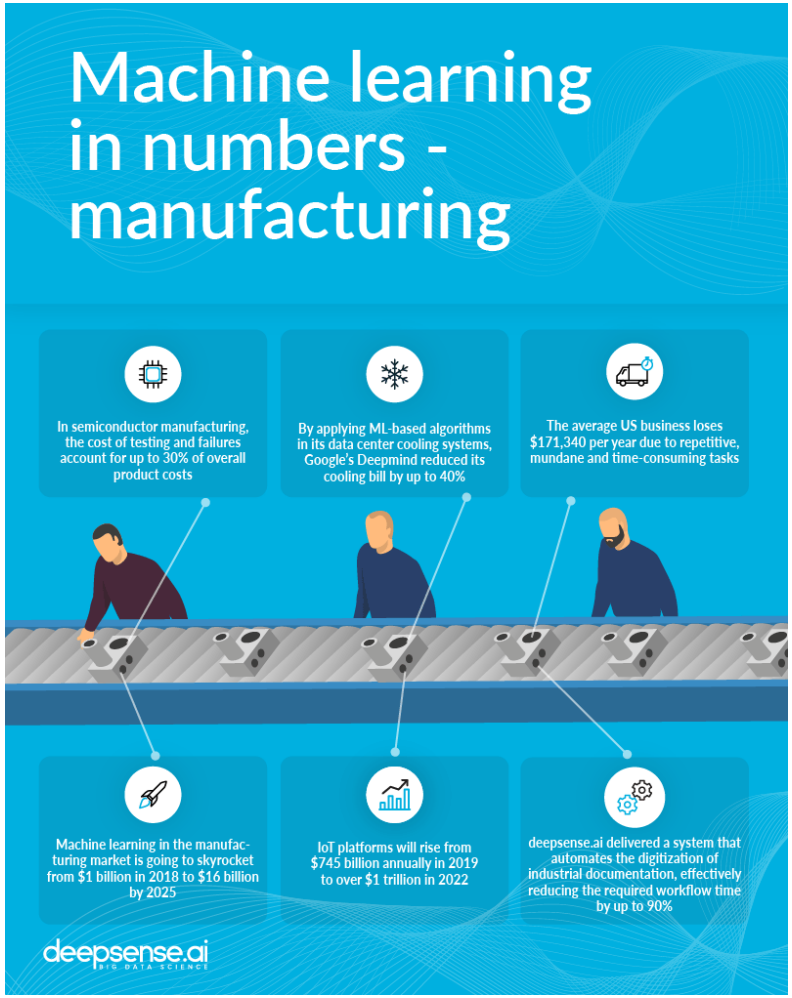

FIGURE – Machine Learning for Applications in Manufacturing

Machine Learning in manufacturing

To read

- Industry 4.0 and the Impacts of Machine Learning on the Manufacturing Industry
- How is Machine Learning Reshaping Manufacturing Industry?
- How Machine Learning is Transforming Industrial Production
- MACHINE LEARNING AND AI IN MANUFACTURING, A quick guide to the fundamentals

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Machine Learning types

The main ML categories are :

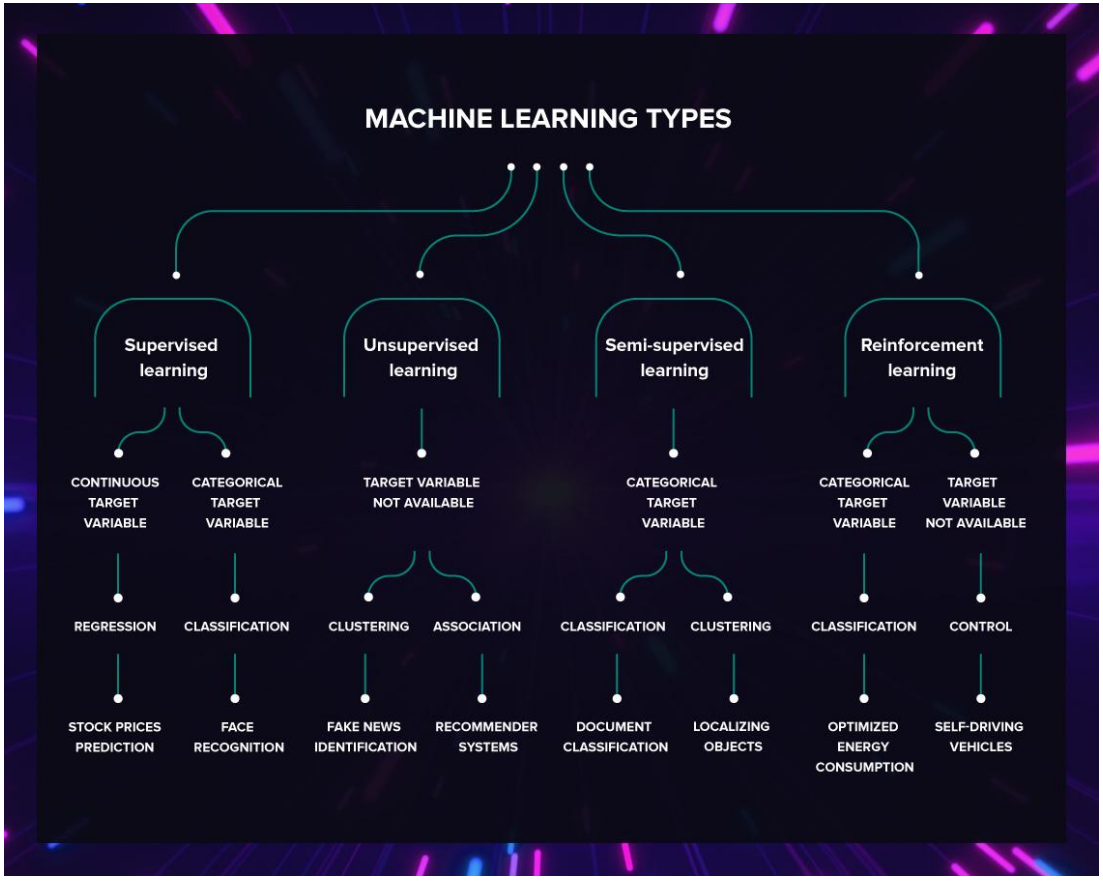

FIGURE – Machine Learning types

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Machine Learning algorithms

One classification of ML algorithms :

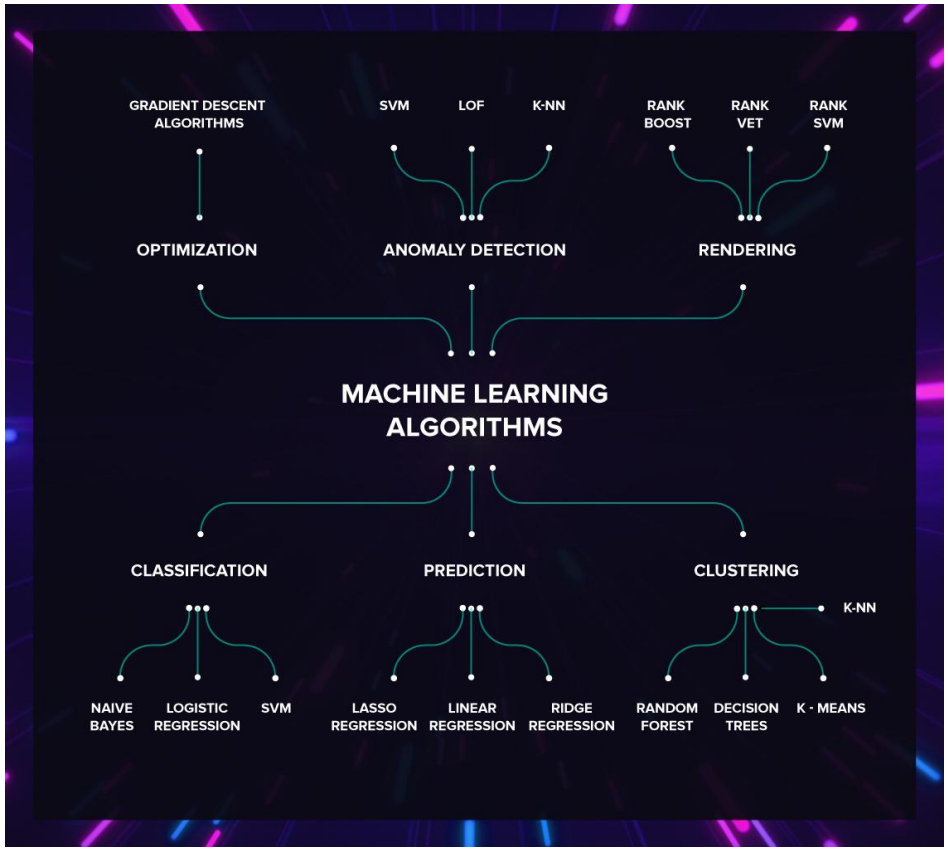

FIGURE – Machine Learning algorithms

Machine Learning algorithms

Another classification of ML algorithms :

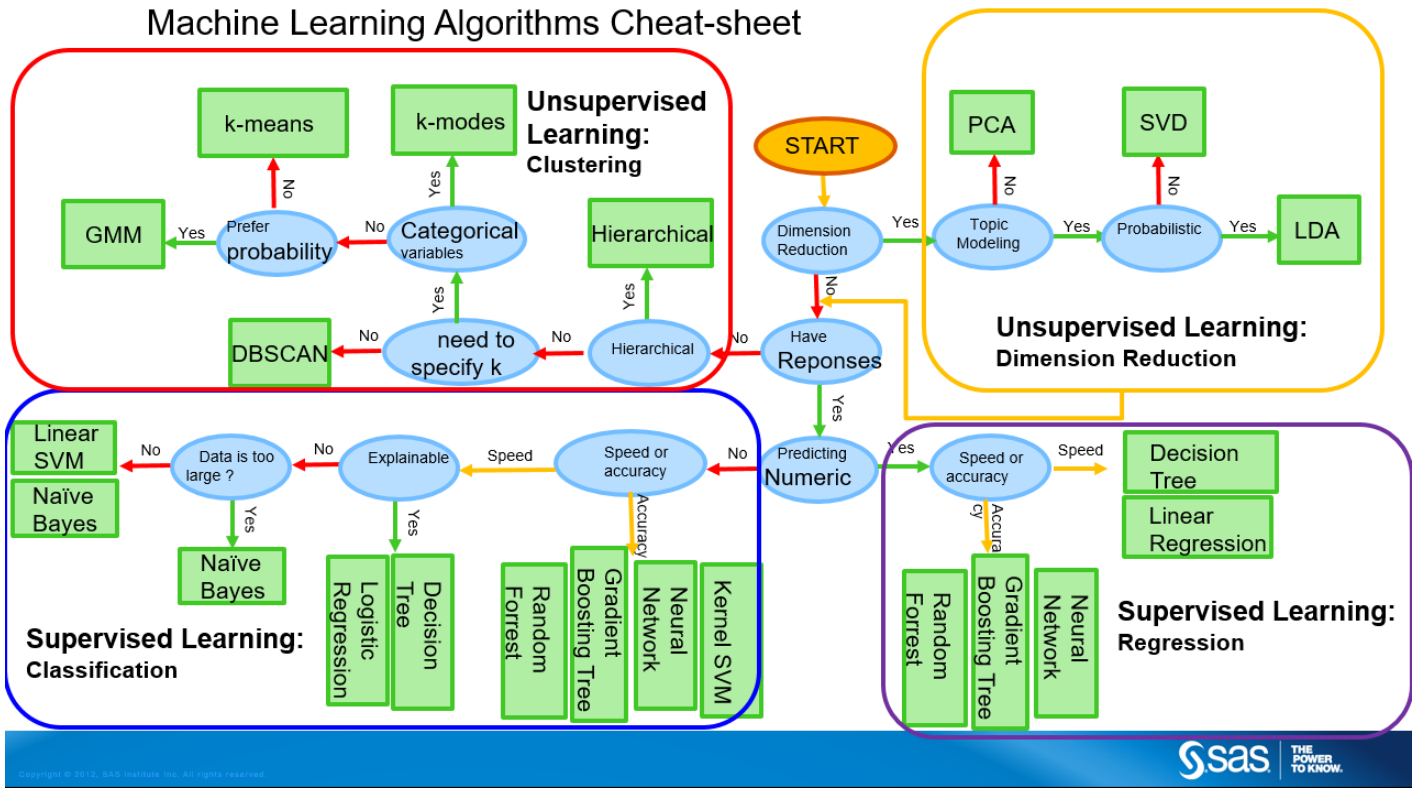

FIGURE – Machine Learning algorithms 2

Machine Learning algorithms

Some references to read :

- Classification Algorithms in Machine Learning: How They Work (logistic regression, naive bayes classifier,Knn, decision tree (random forest),svn)
  Example : decision tree
- 4 Types of Classification Tasks in Machine Learning with Python
- Machine Learning Classification – 8 Algorithms for Data Science Aspirants
- Machine learning algorithms overview

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Machine Learning Definition

Machine Learning is the study of computer algorithms that improve automatically through experience. Applications range from datamining programs that discover general rules in large data sets, to information filtering systems that automatically learn users' interests. (Tom Mitchell)

Définition

Machine Learning (Tom Mitchell 1998) is a computer program learning from experience E with respect to some task T and some performance measure P, if its performance on T as measured by P, improves with E.

Labs context (Colab,github,drive)

- Labs configuration: follow the link
- Applications for the the evaluation
  - Application 1 : **Monitoring of a Dynamic System Based on Autoencoders** (OsmaniHamidi IJCAI 2019)
  - Application 2 : **Augmented Experiments in Material Engineering Using Machine Learning** (OsmaniHamidi AAAI 2021)
  - **UCI bank**
  - **kaggle bank**

Natural Learning

Can be defined as a change in behavior resulting from repeated interaction with the environment. Some basic notions in experimental psychology :

- Rote learning and conditioning
- Reinforcement learning (punishment-reward)
- Learning concepts
- Generalization / specialization
- The need for biases
- The simplicity bias (or Occam's razor)

Natural Learning

Question :
What is the number that extends the sequence 1 2 3 5. . . ?

Answers :
(1) **6 :** integers except 4 (2) **7 :** sequence of prime numbers
(3) **8 :** Fibonacci sequence (F(0)=0, F(1)=1, F(i)=F(i-1)+F(i-2))

In general, it is easy to show that any number can be a possible extension of any finite sequence of numbers $\Longrightarrow$ One solution is to choose the simplest answer. This strategy is known as the Occam's razor principle : "for equal explanatory value choose the simplest solution"

It is therefore necessary to establish a family of concepts within which we will seek the best explanation of the data $\Longrightarrow$ learning bias

Machine Learning

Among the questions that arise :

- What should we learn ? in what language ?
- How to describe the experiments (examples) ? in what language ?
- What are the algorithms that best approximate the functions to be learned ?
- How is the learning system designed to approach the solution to the problem ?
  - By playing on the number of learning examples
  - By making the representation assumptions more complex
- How problem modeling influences the accuracy of learning
  - Noisy data
  - Multiple data sources
- What are the theoretical limits of learnability ?
- How can prior knowledge help learning ?

Machine Learning

Artificial learning is at the crossroads of several disciplines including

- statistics : Hypothesis test, ...
- artificial intelligence : symbolic representation, ...
- philosophy : generalization induction, ...
- information theory : entropy
- biology : regulatory networks, ...
- cognitive sciences : language learning, ...
- the theory of complexity : PAC, ...
- etc.

According to Tom Mitchell : The best way to approach machine learning is to see it through these different perspectives.

Supervised Machine Learning

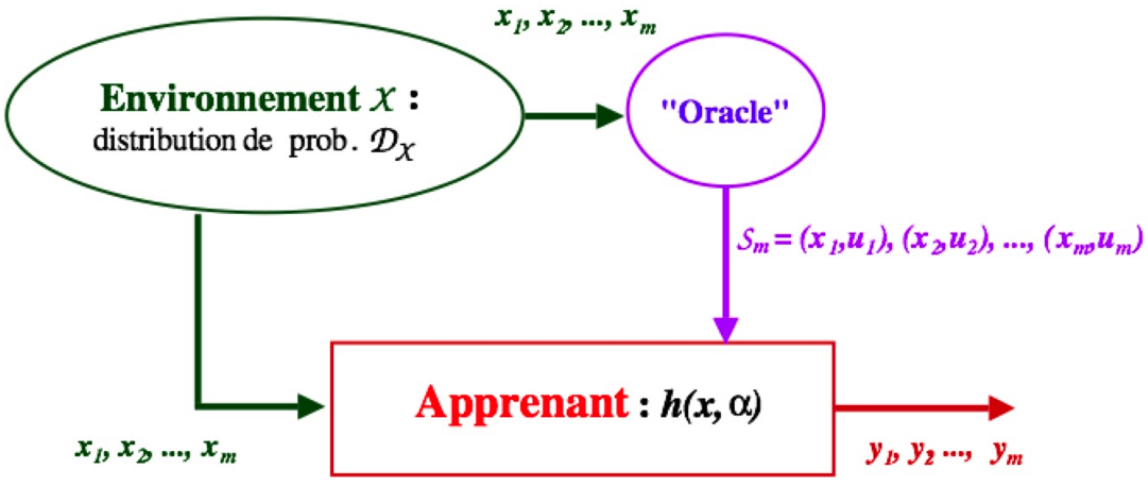

FIGURE – Supervised Machine Learning

Supervised Machine Learning

Given $S = \{(x_1, y_1), \ldots, (x_m, y_m)\}$ with functional dependency between $x_i \in X$ and $y_j \in Y$

Problem : find hypothesis $h \in H$ such that $\forall i, h(x_i) = y_i$

- Y :
  - continuous $\Longrightarrow$ regression problem
  - discrete $\Longrightarrow$ classification or concept learning
- X : example or instances space
  - Vector in $\mathscr{R}^n \Longrightarrow$ "numerical" machine learning
  - Logic representations (order 0, order 1, etc) $\Longrightarrow$ symbolical machine learning
  - ...
- H : is defined in accordance with X
  - numerical learning : SVM, neural networks, k-NN, ...
  - symbolical learning : decision tree, rule set, ILP, graphical representations, ...
  - ...