Topic 1
Introduction to Artificial Intelligence (AI)

ST0249 (AIML) AI & MACHINE LEARNING

Learning Outcomes

❑ Understand what is AI and Machine Learning

- ▪ Explain the relationship between AI and machine learning
- ▪ Explain the problems machine learning can solve
- ▪ Explain the need to know your task and your data

❑ Machine Learning Algorithms

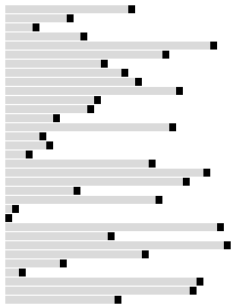- ▪ Understand how to choose an ML algorithm

What is AI?

Artificial Intelligence

Artificial intelligence (AI), the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings.
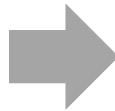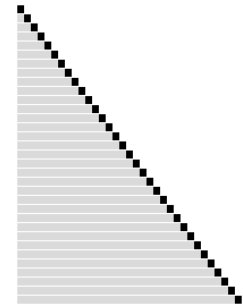
Source: https://www.britannica.com/technology/artificial-intelligence
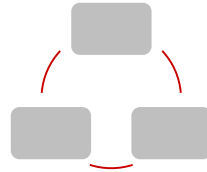
Algorithm

Input **Programmable Computer** **Output**
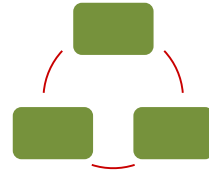
Algorithm

"Horse"

Input   **Programmable Computer**   **Output**

Search

?

Algorithm

Input

Human
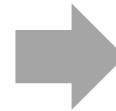
Output

Horse

Image Classification

?

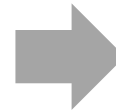**Algorithm**

Input   **Computer**   **Output**
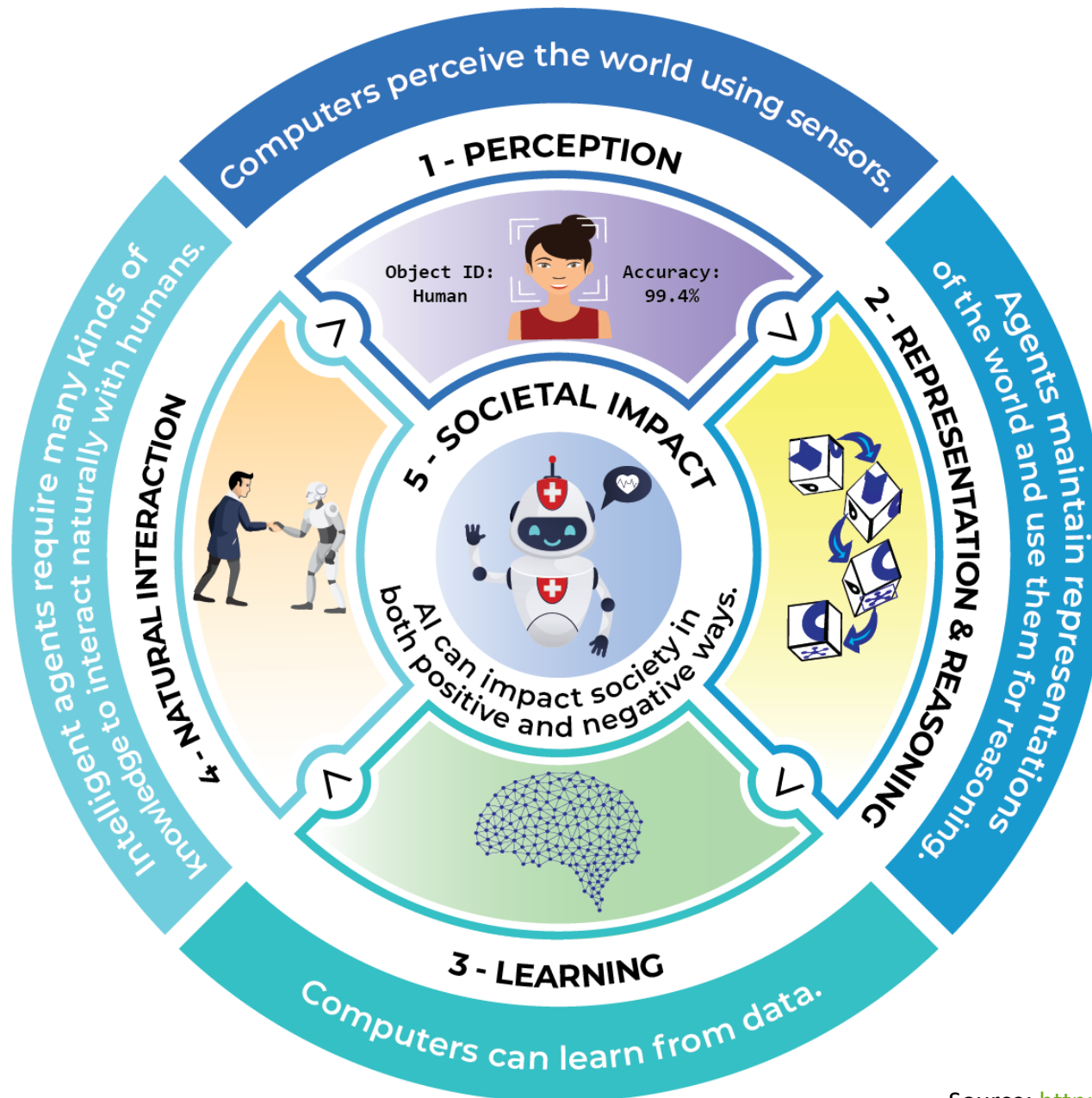
`Horse`

Image Classification

Tasks commonly associated with intelligent beings

Image understanding,

Natural language processing,

Knowledge acquisition,

Text understanding,

Planning,

Robotics,

Forecasting,

And many others.

Can a general system achieve all these tasks?

5

Big Ideas of AI

Source: http://ai4k12.org

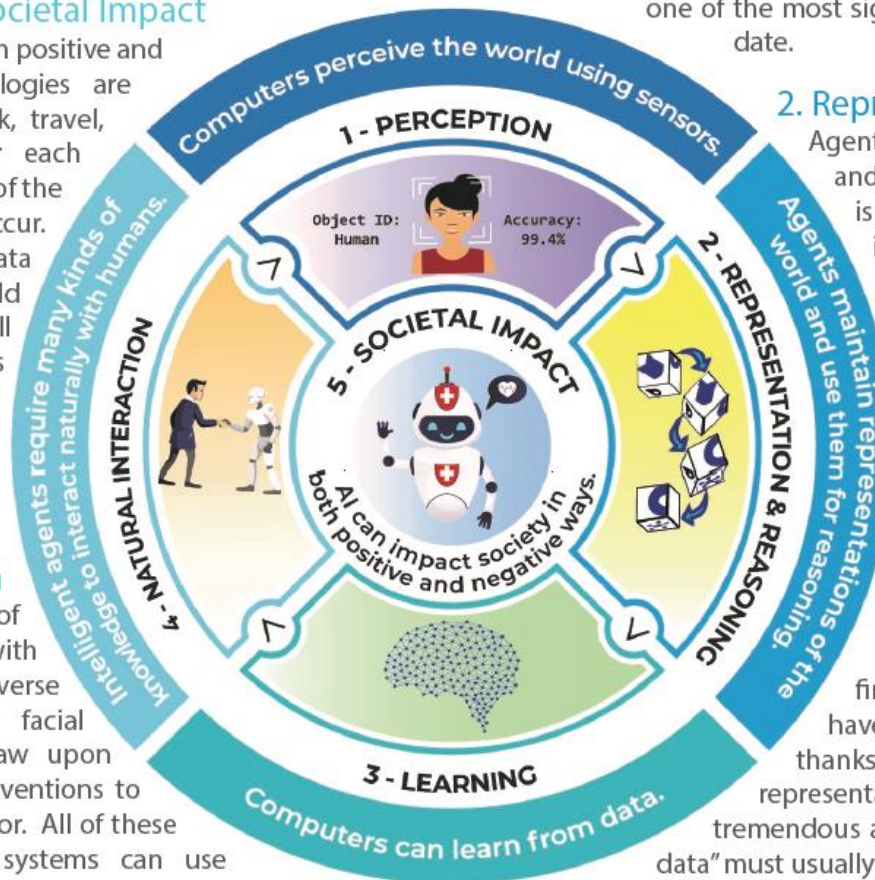# Five Big Ideas in Artificial Intelligence

1. Perception
Computers perceive the world using sensors. Perception is the process of extracting meaning from sensory signals. Making computers "see" and "hear" well enough for practical use is one of the most significant achievements of AI to date.

5. Societal Impact
AI can impact society in both positive and negative ways. AI technologies are changing the ways we work, travel, communicate, and care for each other. But we must be mindful of the harms that can potentially occur. For example, biases in the data used to train an AI system could lead to some people being less well served than others. Thus, it is important to discuss the impacts that AI is having on our society and develop criteria for the ethical design and deployment of AI-based systems.

2. Representation & Reasoning
Agents maintain representations of the world and use them for reasoning. Representation is one of the fundamental problems of intelligence, both natural and artificial. Computers construct representations using data structures, and these representations support reasoning algorithms that derive new information from what is already known. While AI agents can reason about very complex problems, they do not think the way a human does.
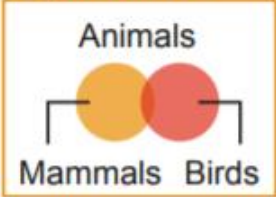
4. Natural Interaction
Intelligent agents require many kinds of knowlege to interact naturally with humans. Agents must be able to converse in human languages, recognize facial expressions and emotions, and draw upon knowledge of culture and social conventions to infer intentions from observed behavior. All of these are difficult problems. Today's AI systems can use language to a limited extent, but lack the general reasoning and conversational capabilities of even a child.
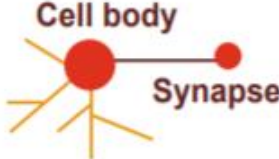
3. Learning
Computers can learn from data. Machine learning is a kind of statistical inference that finds patterns in data. Many areas of AI have progressed significantly in recent years thanks to learning algorithms that create new representations. For the approach to succeed, tremendous amounts of data are required. This "training data" must usually be supplied by people, but is sometimes acquired by the machine itself.

Circular diagram labels:
- Computers perceive the world using sensors. — 1 - PERCEPTION
  - Object ID: Human   Accuracy: 99.4%
- Agents maintain representations of the world and use them for reasoning. — 2 - REPRESENTATION & REASONING
- Computers can learn from data. — 3 - LEARNING
- Intelligent agents require many kinds of knowledge to interact naturally with humans. — 4 - NATURAL INTERACTION
- AI can impact society in both positive and negative ways. — 5 - SOCIETAL IMPACT

Source: http://ai4k12.org

Tribes of AI — Different Approaches to AI

Symbolists	Bayesians	Connectionists	Evolutionaries	Analogizers
Use symbols, rules, and logic to represent knowledge and draw logical inference	Assess the likelihood of occurrence for probabilistic inference	Recognize and generalize patterns dynamically with matrices of probabilistic, weighted neurons	Generate variations and then assess the fitness of each for a given purpose	Optimize a function in light of constraints ("going as high as you can while staying on the road")
Favored algorithm Rules and decision trees	**Favored algorithm** Naive Bayes or Markov	**Favored algorithm** Neural networks	**Favored algorithm** Genetic programs	**Favored algorithm** Support vectors

Source: Pedro Domingos, *The Master Algorithm*, 2015

Source: http://usblogs.pwc.com/emerging-technology/wp-content/uploads/2017/04/PwC_Next-in-Tech_Infographic_Machine-learning-evolution_2017.pdf
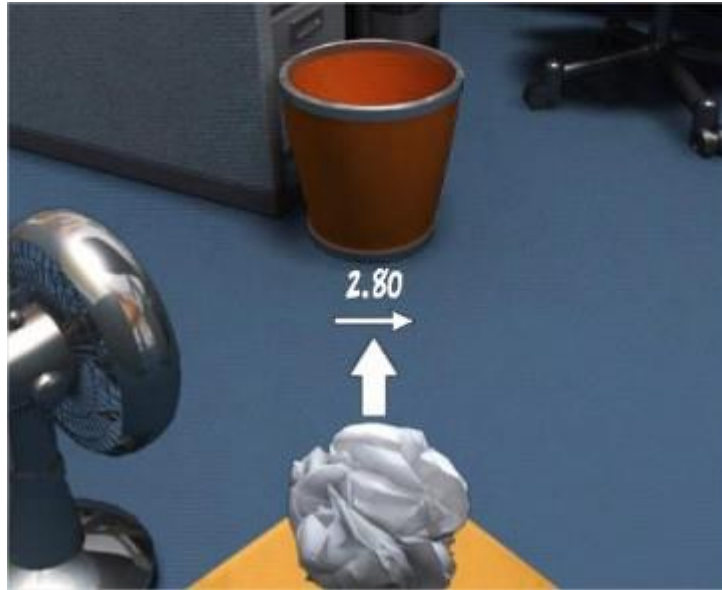
What is Machine Learning?

Machine Learning

Machine learning, in artificial intelligence, is a discipline concerned with the implementation of computer software that can learn autonomously.

source: https://www.britannica.com/technology/machine-learning

Machine Learning (in layman's term)

Non-machine learning way:
- Apply some pre-defined formula
- Need to reprogram for new conditions; such as wind

Machine learning way:
- Identify the relationship from repeated success/failures
- No need to reprogram for new conditions; just need more data

Machine Learning: in other words

Another more technical definition of Machine Learning is — A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P if its performance at tasks in T, as measured by P, improves with experience E.

This basically means in machine learning for any task a machine improves it's performance with its experience.

Machine Learning

PROS

Autonomous: learns automatically from the data

No need for human subject matter expert to determine the rules

Superhuman performance is possible for specific tasks (e.g. AlphaGo)
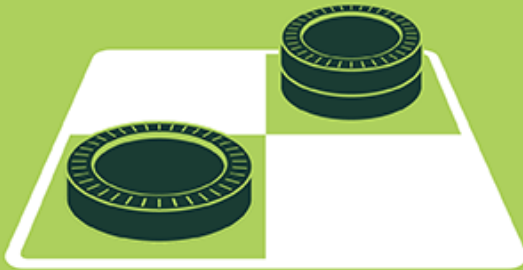
CONS

Need for data; lots of it

The relationship learnt is complex and is not easily explained

Can be easily fooled with "bad data"

What is Deep Learning?

ARTIFICIAL INTELLIGENCE
Early artificial intelligence stirs excitement.

MACHINE LEARNING
Machine learning begins to flourish.

DEEP LEARNING
Deep learning breakthroughs drive AI boom.

1950's 1960's 1970's 1980's 1990's 2000's 2010's

Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

Deep Learning

Deep Learning is a subfield of machine learning concerned with algorithms inspired by the structure and function of the brain called artificial neural networks.

Deep learning methods aim at learning feature hierarchies with features from higher levels of the hierarchy formed by the composition of lower level features. Automatically learning features at multiple levels of abstraction allow a system to learn complex functions mapping the input to the output directly from data, without depending completely on human-crafted features.

ML Methodology

Workflow

source https://upxacademy.com/introduction-machine-learning/
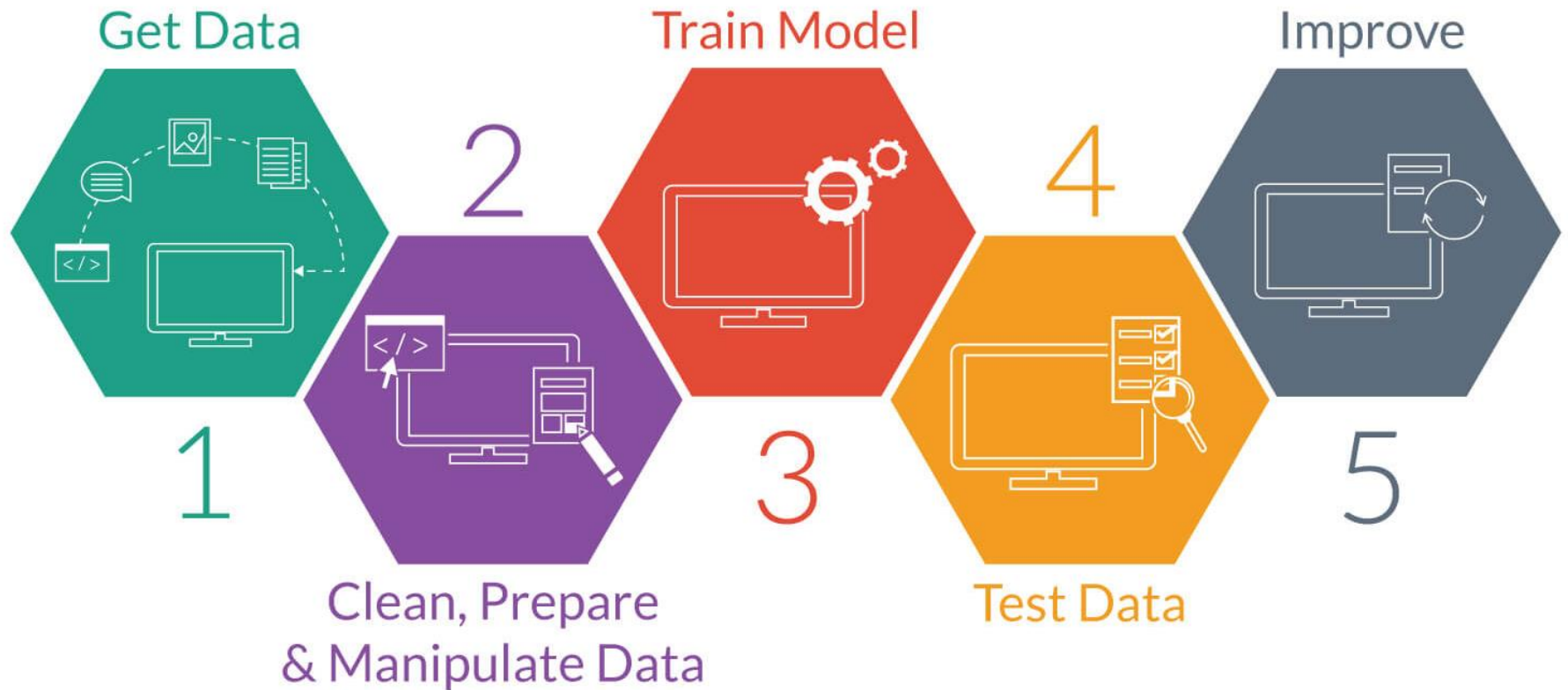
Machine Learning Algorithms

Types of Machine Learning
- At a glance

Supervised Learning

- Makes machine learn explicitly
- Data with clearly defined output is given
- Direct feedback is given
- Predicts outcome/ future
- Resolves classification & regression problems

Training
Inputs → [ ] → Outputs

Unsupervised Learning

- Machine understands the data (Identifies patterns/ structures)
- Evaluation is qualitative or indirect
- Does not predict / find anything specific

Inputs → [ ] → Outputs

Reinforcement Learning

- An approach to AI
- Reward based learning
- Learning from +ve & -ve reinforcement
- Machine learns how to act in a certain environment
- To maximize rewards

Rewards ←
Inputs → [ ] → Outputs

source: https://upxacademy.com/introduction-machine-learning/
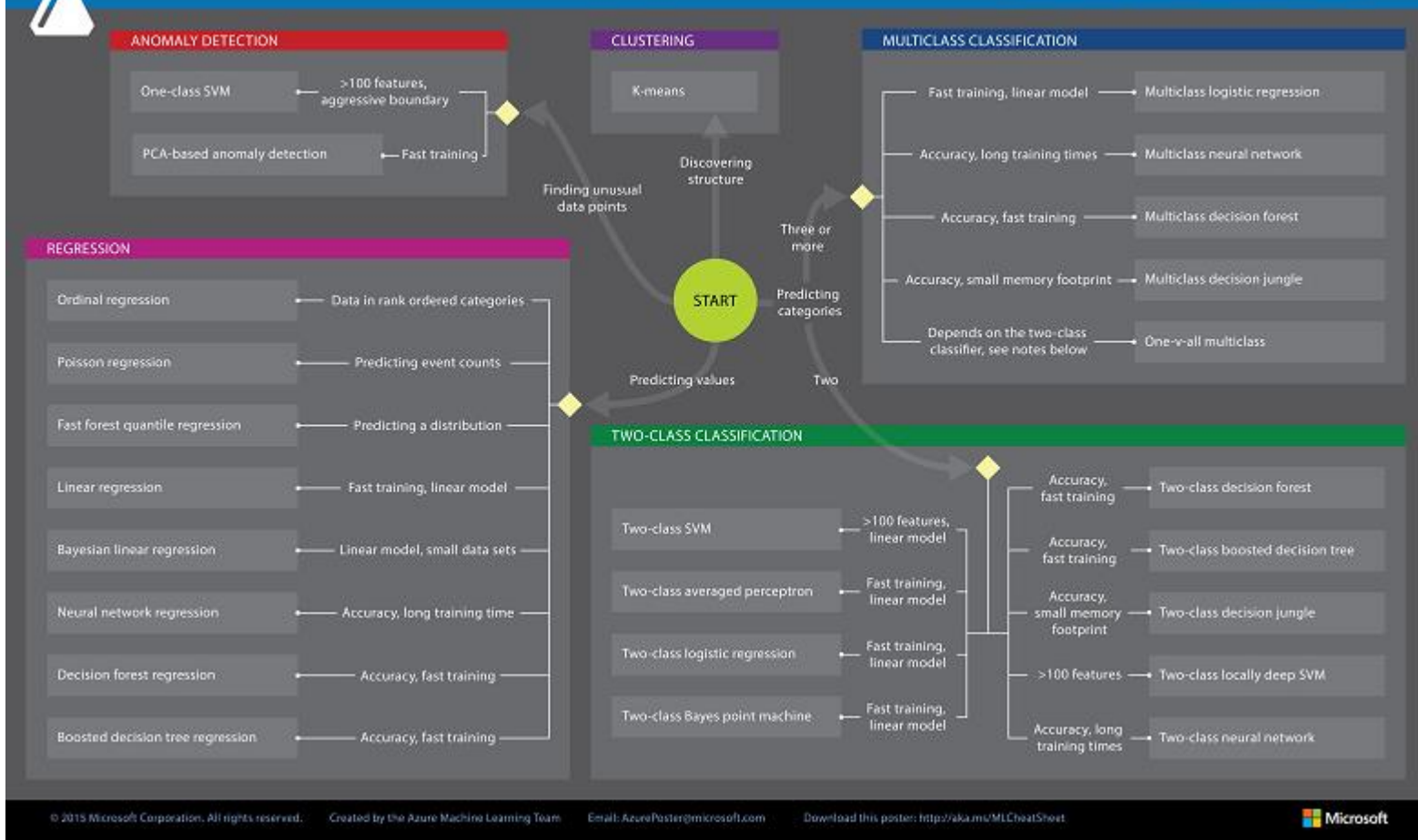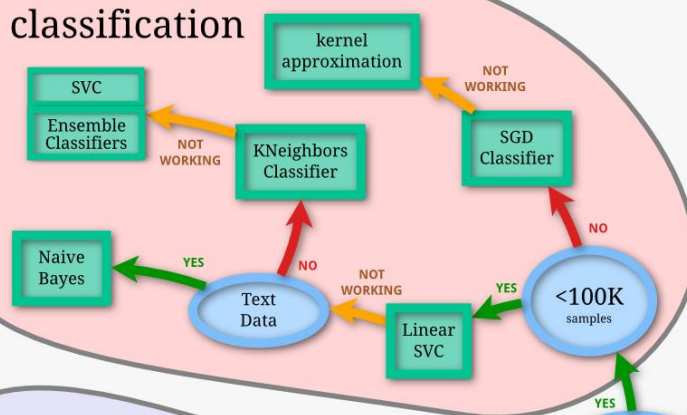
Microsoft Azure Machine Learning: Algorithm Cheat Sheet

This cheat sheet helps you choose the best Azure Machine Learning Studio algorithm for your predictive analytics solution. Your decision is driven by both the nature of your data and the question you're trying to answer.
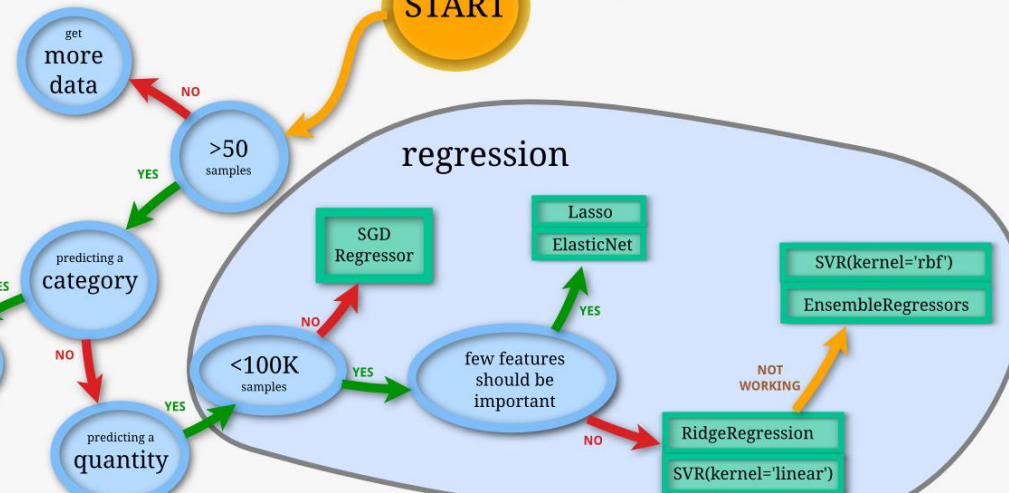
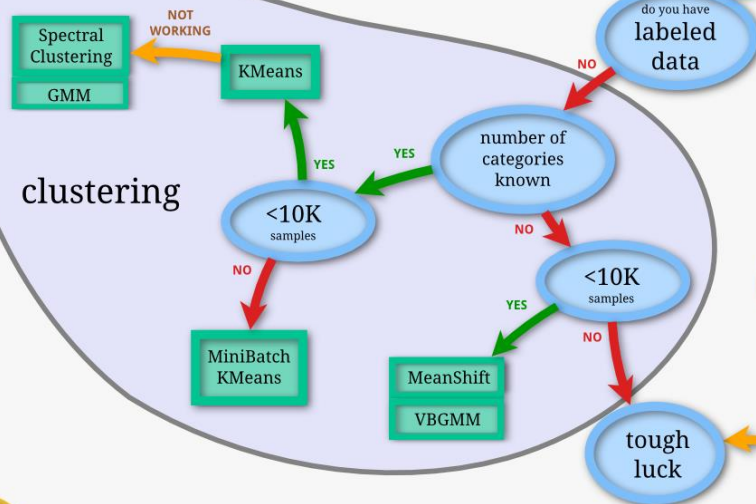source: https://docs.microsoft.com/en-us/azure/machine-learning/studio/algorithm-cheat-sheet
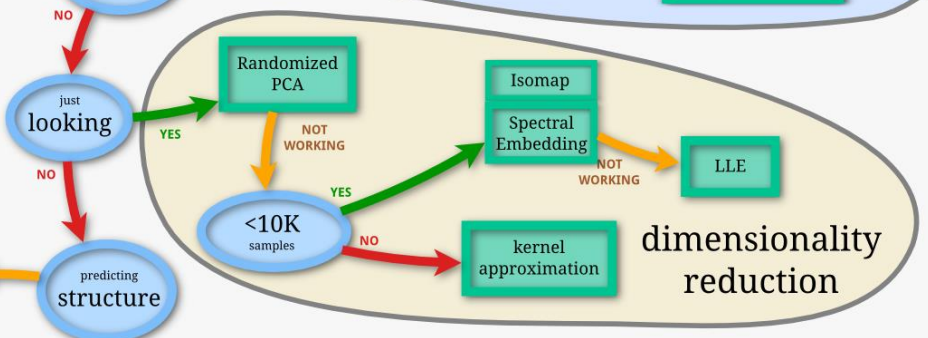   https://docs.microsoft.com/en-us/azure/machine-learning/studio/algorithm-choice

scikit-learn algorithm cheat-sheet

source: http://scikit-learn.org/stable/tutorial/machine_learning_map/index.html

References

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http://usblogs.pwc.com/emerging-technology/wp-content/uploads/2017/04/PwC_Next-in-Tech_Infographic_Machine-learning-evolution_2017.pdf

https://medium.com/intuitionmachine/the-many-tribes-problem-of-artificial-intelligence-ai-1300faba5b60

https://medium.com/intuitionmachine

Summary

We have learn that:

- AI != Human Intelligence

- There are many approaches to achieve AI

- AI includes Machine Learning, which includes Deep Learning

- Machine Learning enables automatic learning of the algorithm/function/rule from the data itself

- Machine Learning workflow is portable across tools

- You must apply suitable machine learning algorithms for the output that you want for a given set of data