

Topic 1

Introduction to Artificial Intelligence (AI)

IT8302 APPLIED MACHINE LEARNING

Learning Outcomes

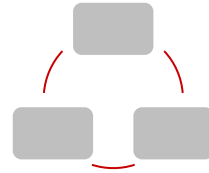
- ❑ Understand what is AI and Machine Learning
 - Explain the relationship between AI and machine learning
 - Explain the problems machine learning can solve
 - Explain the need to know your task and your data
- ❑ Machine Learning Algorithms
 - Understand how to choose an ML algorithm

What is AI?

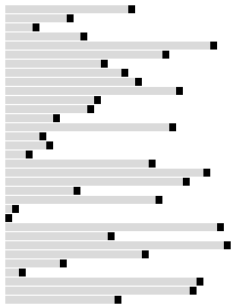
Artificial Intelligence

Artificial intelligence (AI), the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings.

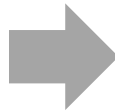
Source: <https://www.britannica.com/technology/artificial-intelligence>



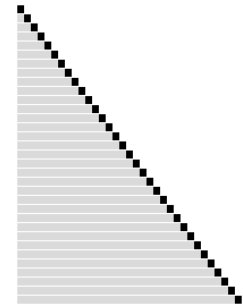
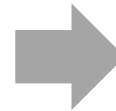
Algorithm



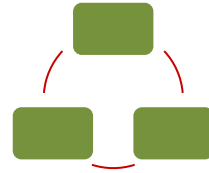
Input



**Programmable
Computer**



Output



Algorithm



“Horse”



Input



**Programmable
Computer**



Output

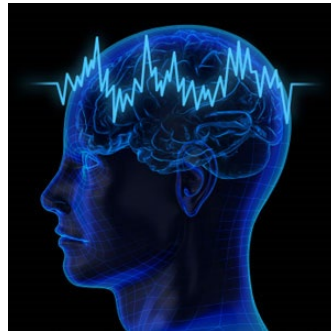
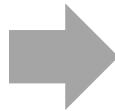
Search



Algorithm



Input



Human



Horse

Output

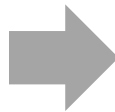
Image Classification



Algorithm



Input



Computer



Horse

Output

Image Classification

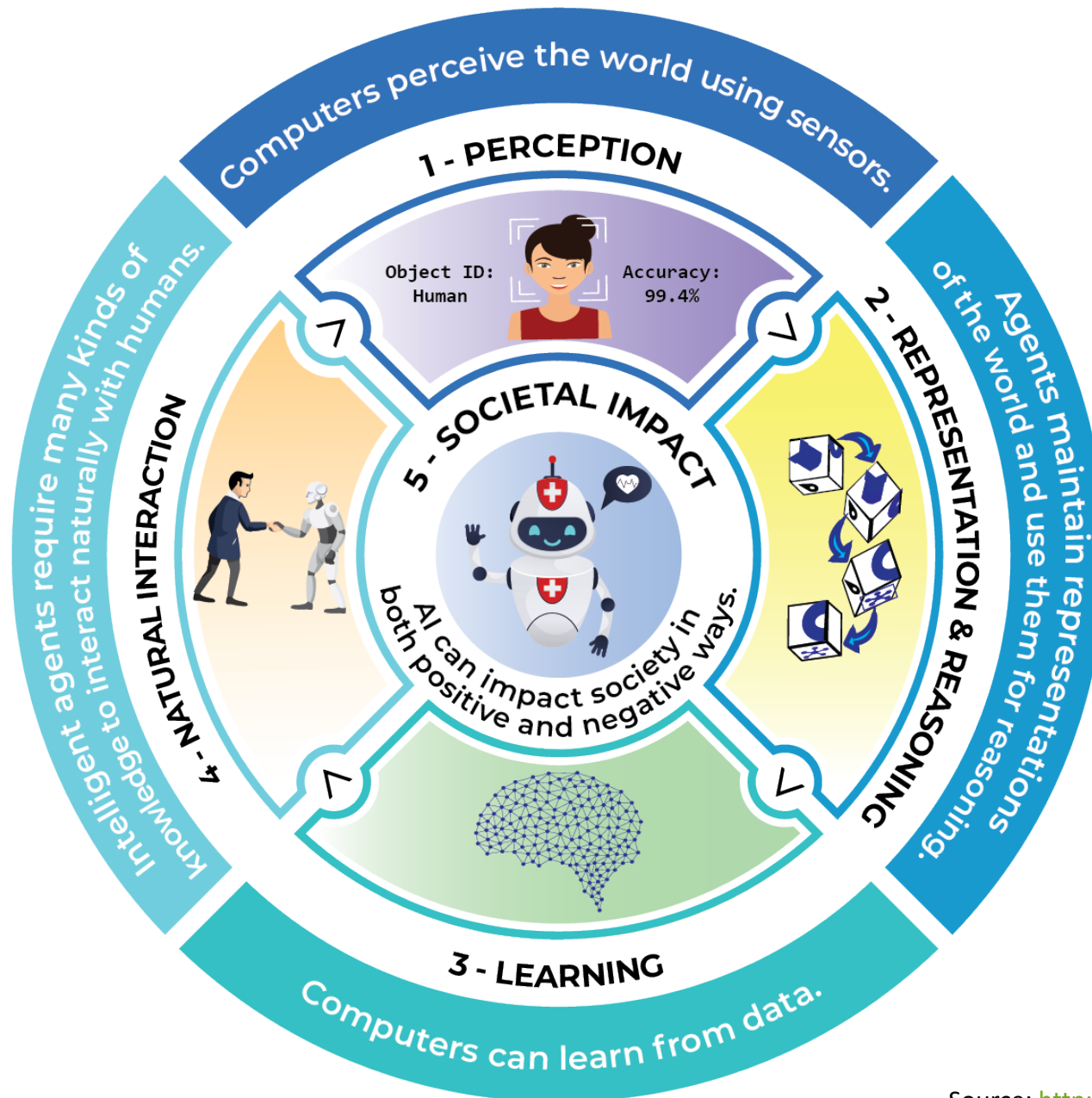
Tasks commonly associated with intelligent beings

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

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.

4. Natural Interaction

Intelligent agents require many kinds of knowledge 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.

1. Perception

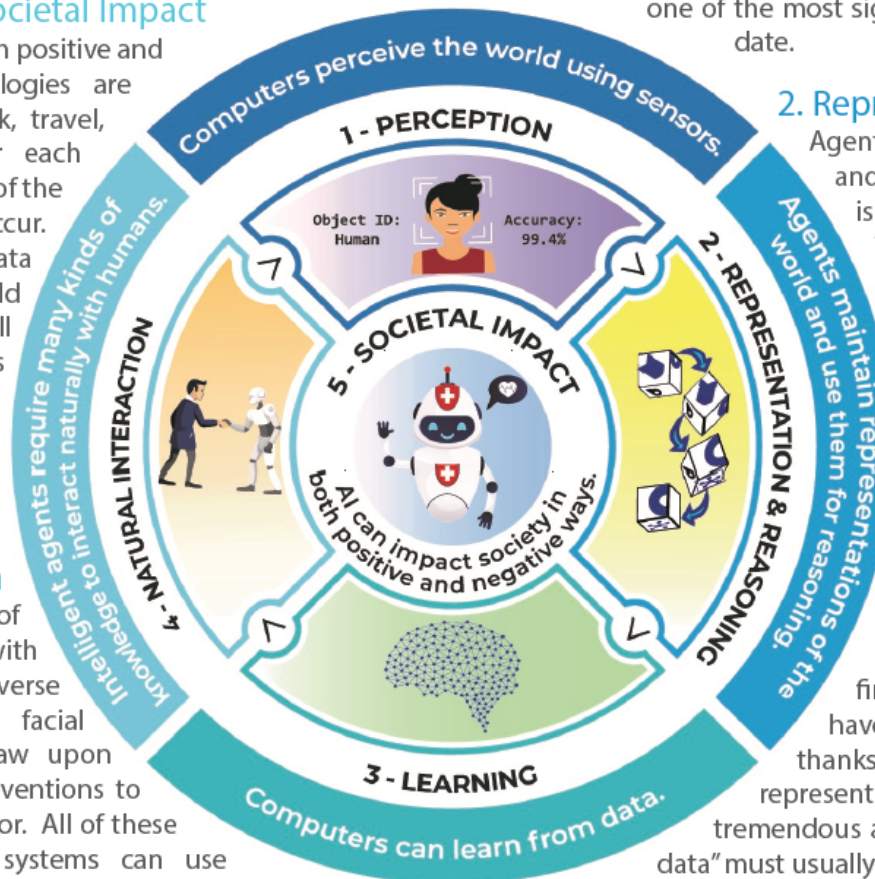
Computers perceive the world using sensors. Perception is the process of extracting meaning from sensory signals. Making computers "see" and "hear" well enough for practical use is one of the most significant achievements of AI to date.

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.

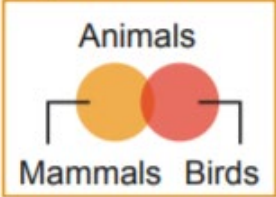

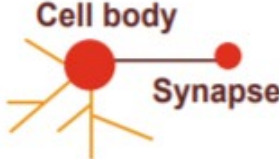


3. Learning

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.



Source: <http://ai4k12.org>

Tribes of AI — Different Approaches to AI

Symbolists	Bayesians	Connectionists	Evolutionaries	Analogizers
 <p>A Venn diagram with two overlapping circles. The left circle is labeled 'Mammals' and the right circle is labeled 'Birds'. The intersection of the two circles is labeled 'Animals'.</p>	 <p>A diagram representing Bayesian inference. It shows a vertical line divided into four sections. The top section is labeled 'Likelihood', the bottom section is labeled 'Posterior', the left side is labeled 'Prior', and the right side is labeled 'Margin'.</p>	 <p>A diagram of a neuron. It features a central 'Cell body' with several lines extending from it, and a 'Synapse' represented by a small circle connected to the cell body.</p>	 <p>A diagram of a neural network. It shows a hierarchy of nodes (circles) connected by lines. The nodes are colored in various shades of red, orange, and grey.</p>	 <p>A diagram of a support vector machine (SVM). It shows a circle with several points inside and outside. A black dot is located in the center of the circle.</p>
<p>Use symbols, rules, and logic to represent knowledge and draw logical inference</p>	<p>Assess the likelihood of occurrence for probabilistic inference</p>	<p>Recognize and generalize patterns dynamically with matrices of probabilistic, weighted neurons</p>	<p>Generate variations and then assess the fitness of each for a given purpose</p>	<p>Optimize a function in light of constraints ("going as high as you can while staying on the road")</p>
<p>Favored algorithm Rules and decision trees</p>	<p>Favored algorithm Naive Bayes or Markov</p>	<p>Favored algorithm Neural networks</p>	<p>Favored algorithm Genetic programs</p>	<p>Favored algorithm Support vectors</p>

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

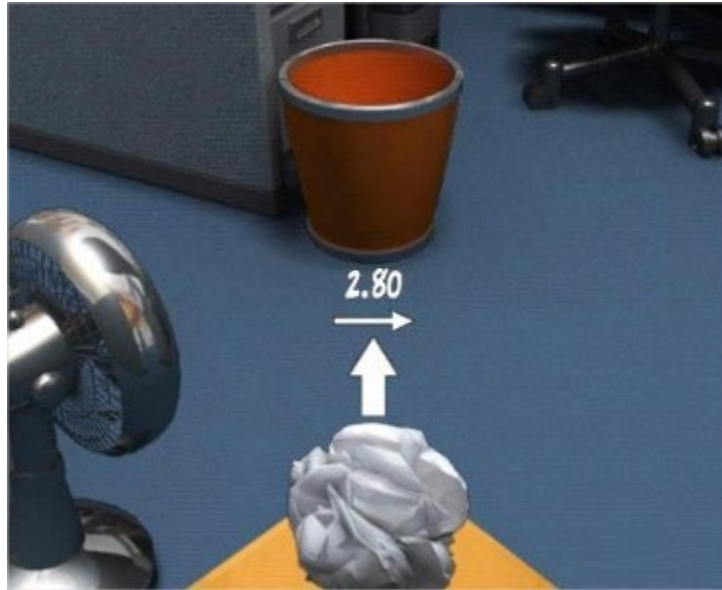
What is Machine Learning?

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 its 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.

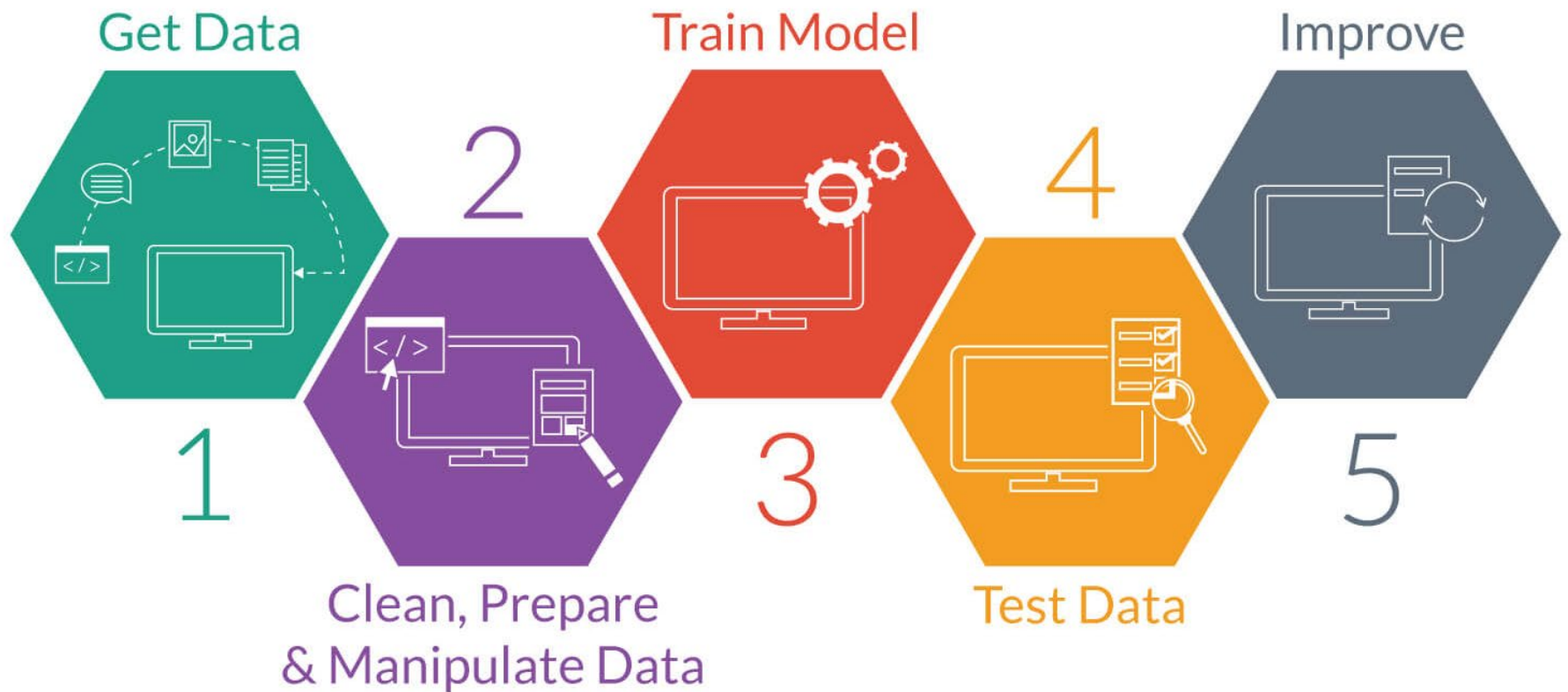
Deep Learning

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



Unsupervised Learning

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



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

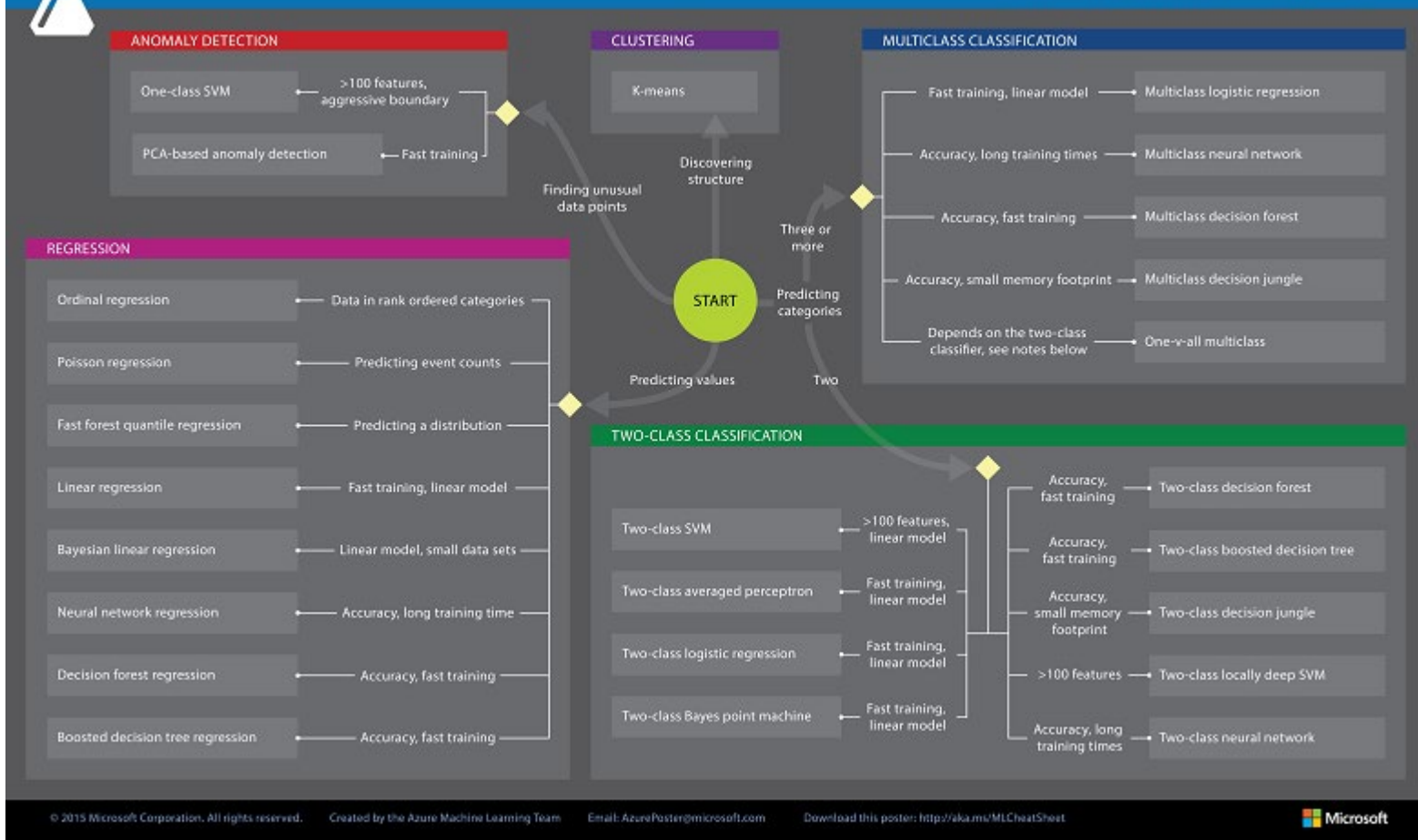


source: <https://upxacademy.com/introduction-machine-learning/>



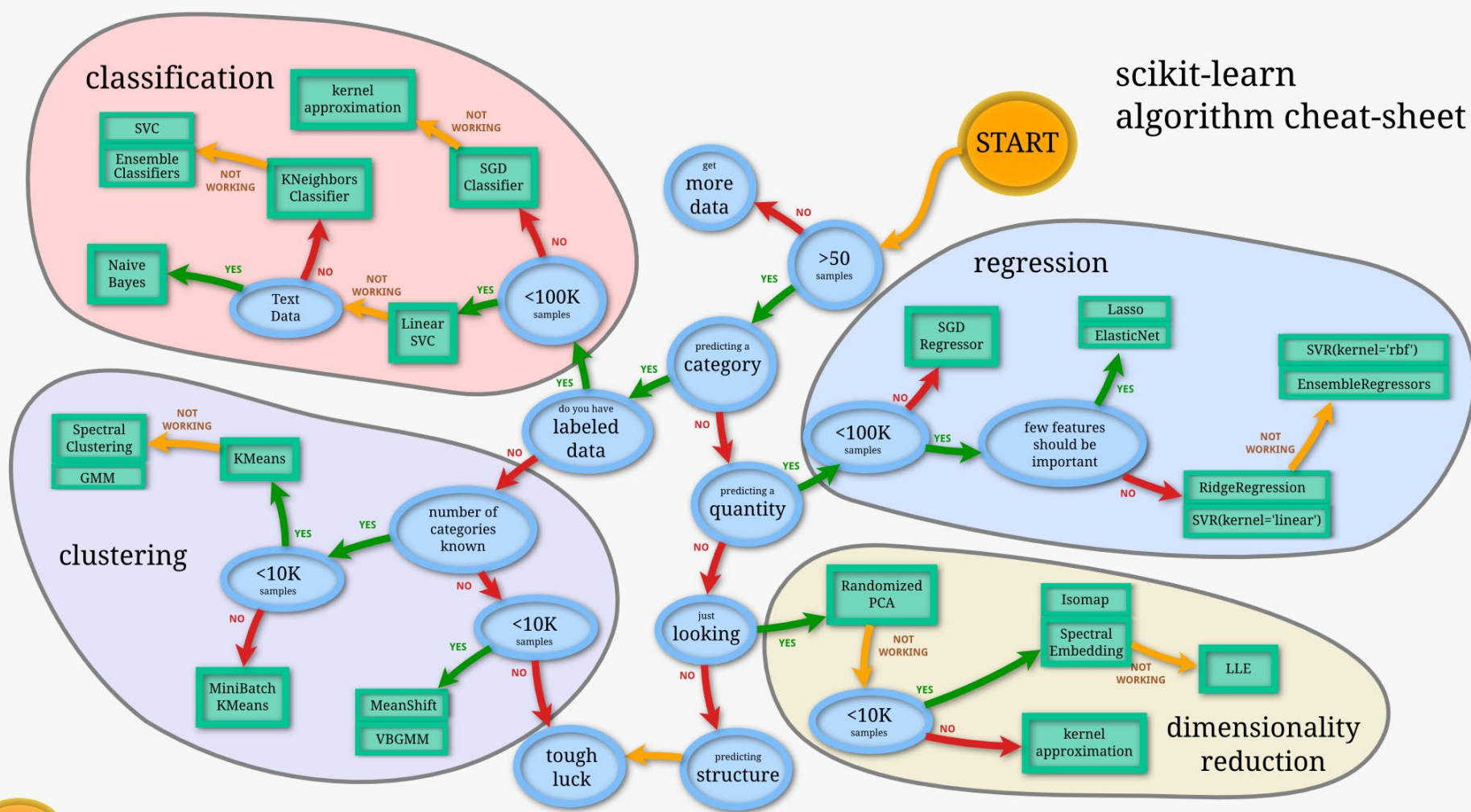
Microsoft Azure Machine Learning: Algorithm Cheat Sheet

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