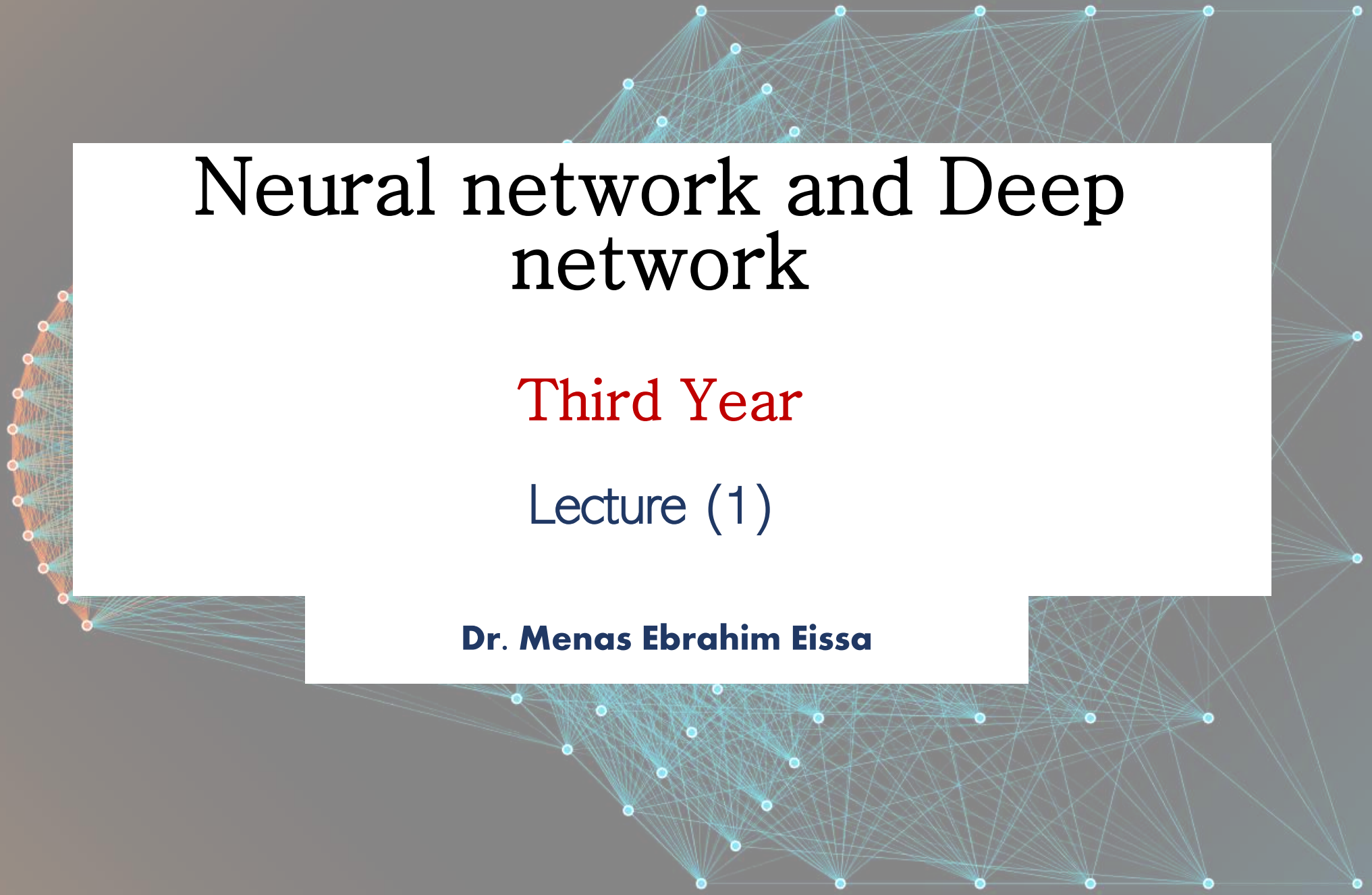
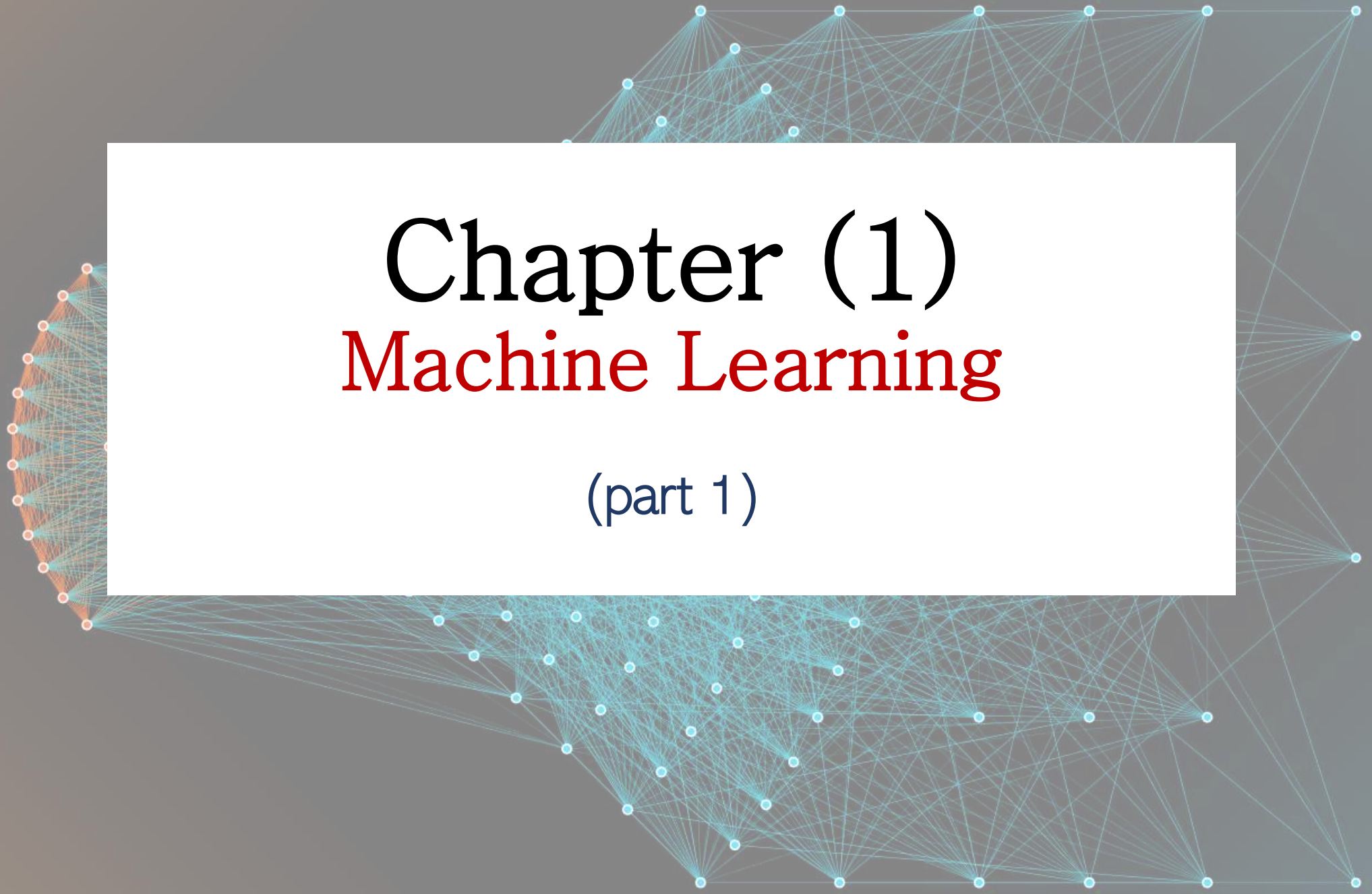


# Neural network and Deep network

## Third Year

Lecture (1)

**Dr. Menas Ebrahim Eissa**

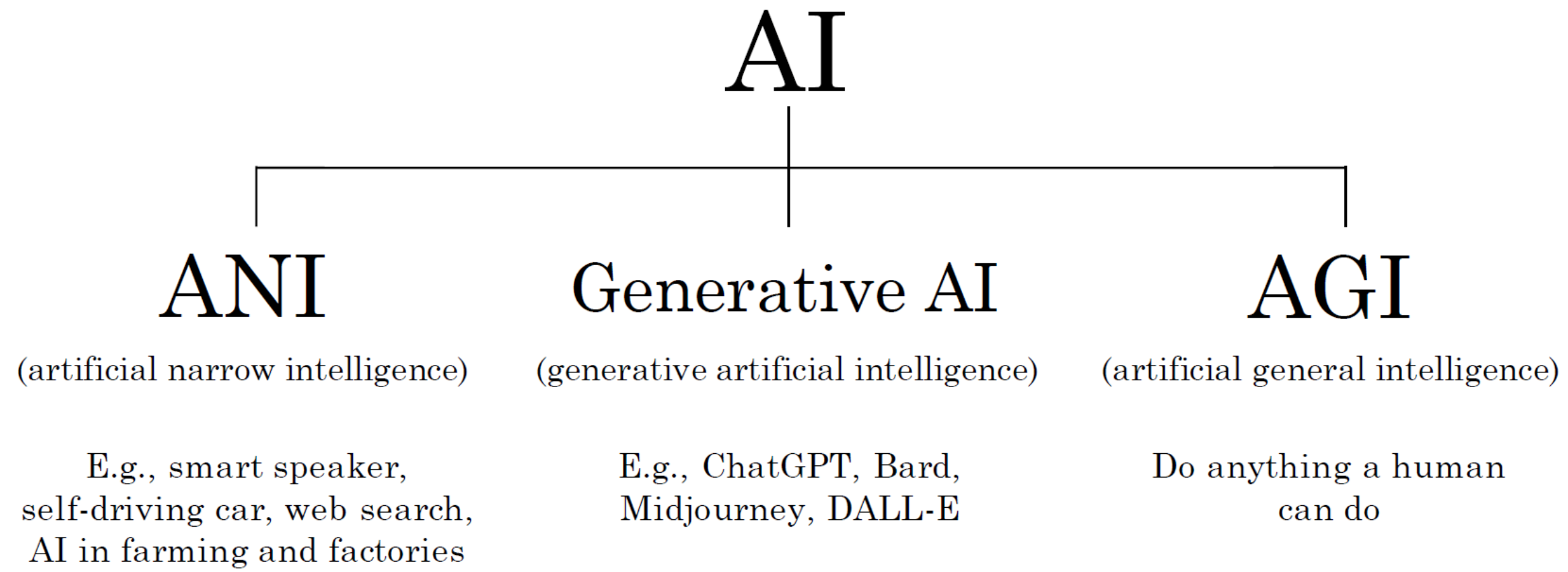


# Chapter (1)

## Machine Learning

(part 1)

# Demystifying AI

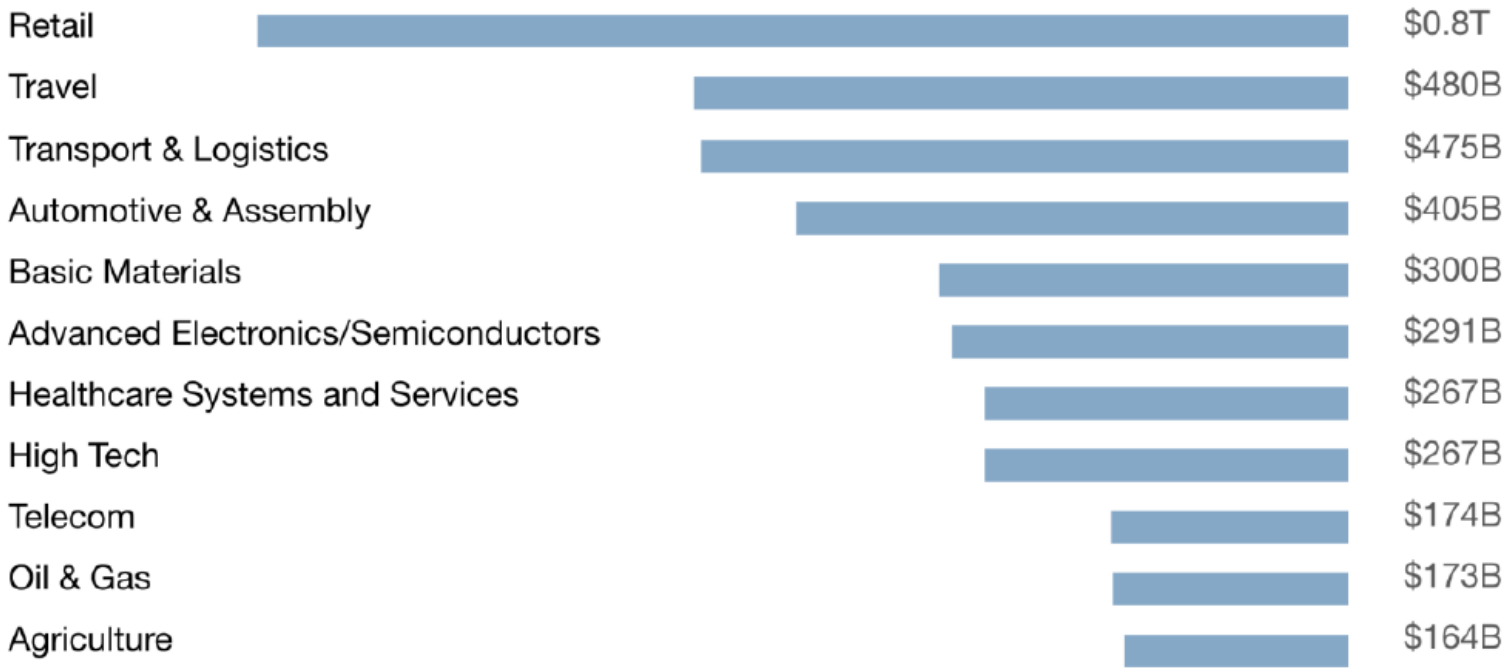


# Introduction

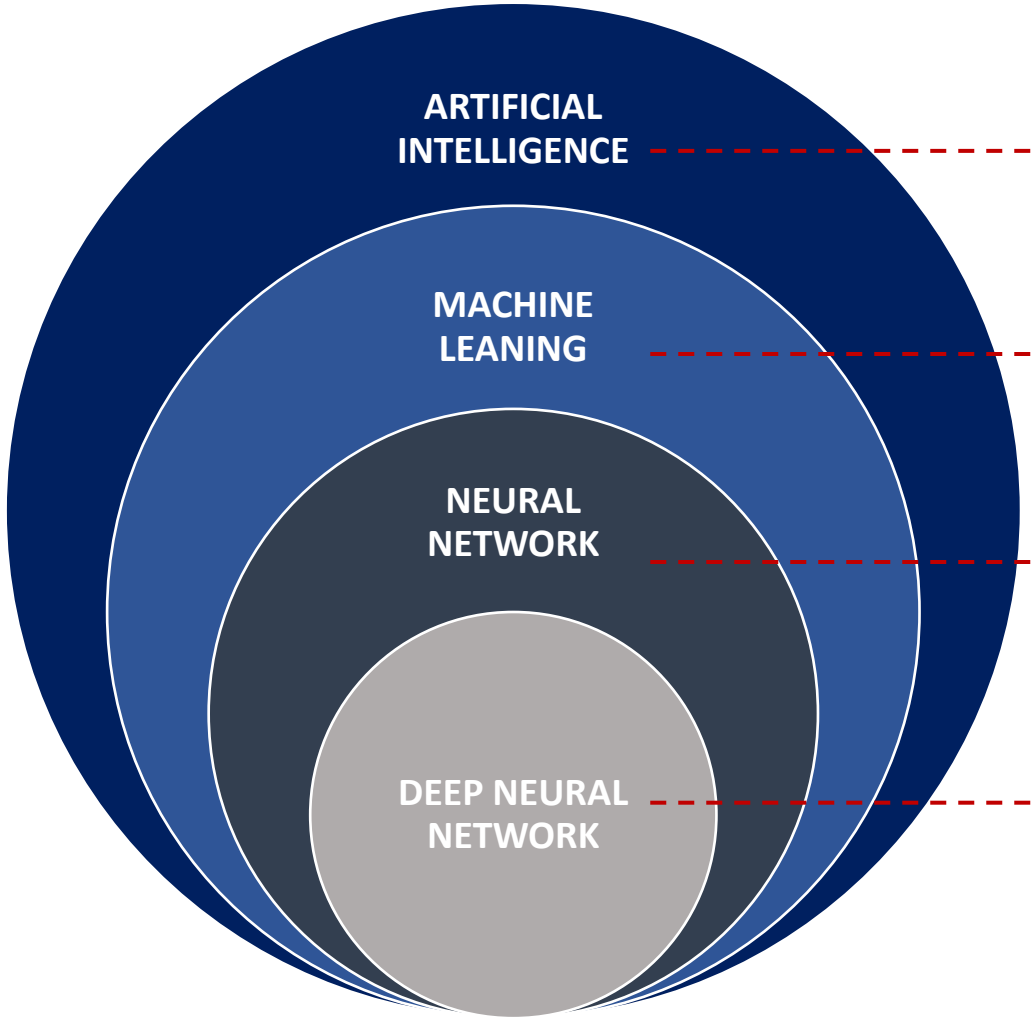
AI value creation by 2033

**$13-22 trillion**

(includes $3-4 trillion from generative AI)




[Source: McKinsey]




**Artificial intelligence (AI)**

A program that can sense, reason, act, and adapt

**Machine learning (ML)**

field of study that gives computers the ability to learn without being explicitly programmed

**Artificial neural networks (ANN)**

Brain-inspired machine learning models

**Deep learning (DL)**

A subset of ML which uses deep artificial neural networks as models and automatically builds a hierarchy of data representations

Machine learning is a subfield of artificial intelligence. Deep learning is a subfield of machine learning, and neural networks make up the backbone of deep learning algorithms.

# Why Use Machine Learning?

1. First you would look at what spam typically looks like. You might notice that some words or phrases (such as “4U,” “credit card,” “free,” and “amazing”) tend to come up a lot in the subject. Perhaps you would also notice a few other patterns in the sender’s name, the email’s body, and so on.

2. You would write a detection algorithm for each of the patterns that you noticed, and your program would flag emails as spam if a number of these patterns are detected.

3. You would test your program, and repeat steps 1 and 2 until it is good enough.

Since the problem is not trivial, your program will likely become a long list of complex rules—pretty hard to maintain.

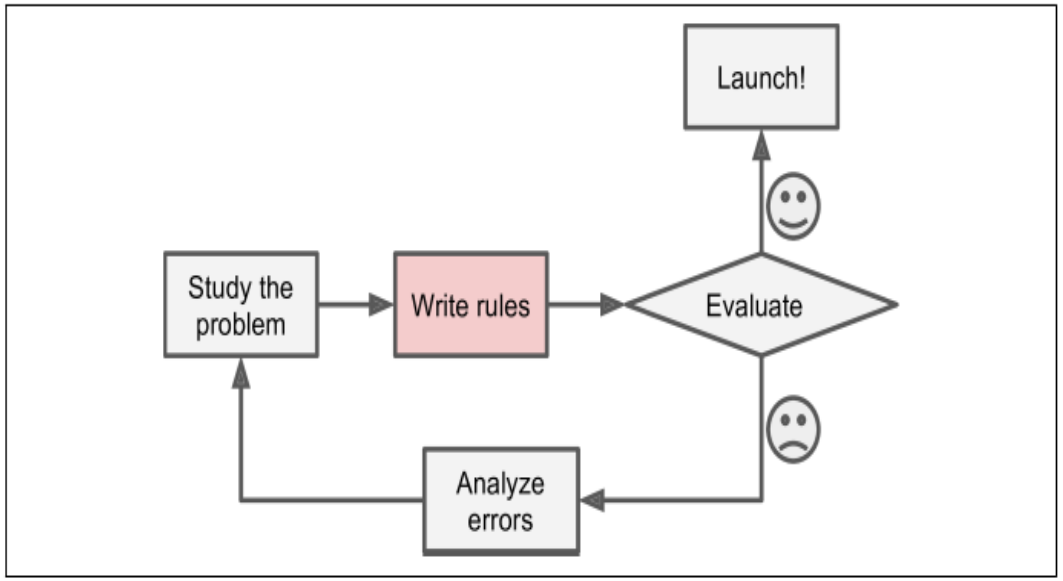



*Figure 1-1. The traditional approach*

# Why Use Machine Learning?

- In contrast, a spam filter based on Machine Learning techniques automatically learns which words and phrases are good predictors of spam by detecting unusually frequent patterns of words in the spam examples compared to the ham examples. The program is **much shorter, easier to maintain, and most likely more accurate**.
- Moreover, if spammers notice that all their emails containing "4U" are blocked, they might start writing "For U" instead. A spam filter using traditional programming techniques would need to be updated to flag "For U" emails. If spammers keep working around your spam filter, you will need to keep writing new rules forever.
- In contrast, a spam filter based on Machine Learning techniques automatically notices that "For U" has become unusually frequent in spam flagged by users, and it starts flagging them without your intervention.

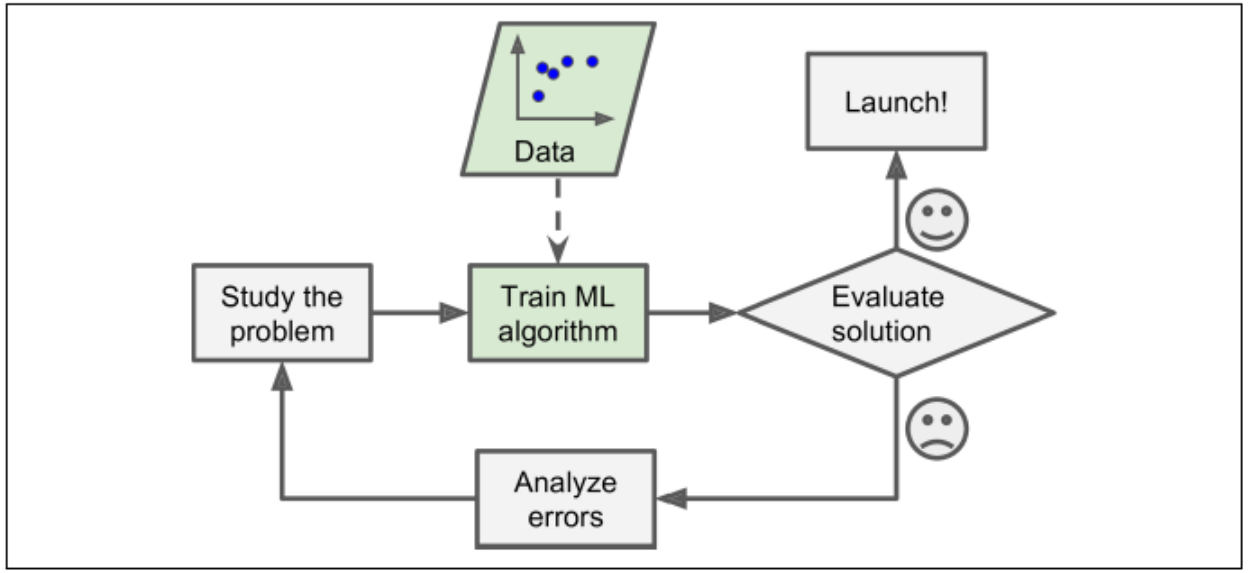



*Figure 1-2. Machine Learning approach*

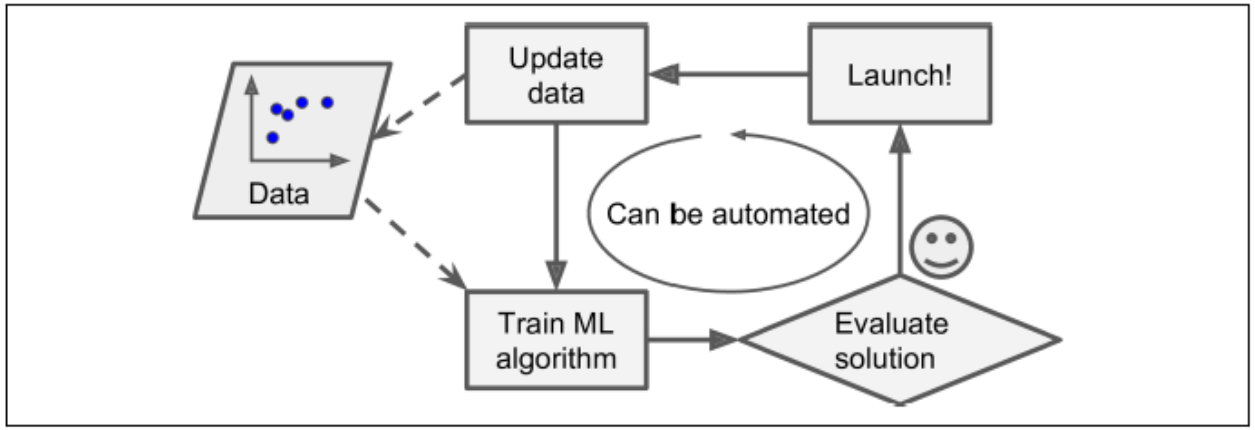



*Figure 1-3. Automatically adapting to change*

# When to Use Machine Learning?

Machine Learning is great for:

- Problems for which existing solutions require a lot of hand-tuning or long lists of rules: one Machine Learning algorithm can often simplify code and perform better.
- Complex problems for which there is no good solution at all using a traditional approach: the best Machine Learning techniques can find a solution.
- Fluctuating environments: a Machine Learning system can adapt to new data.
- Getting insights about complex problems and large amounts of data.

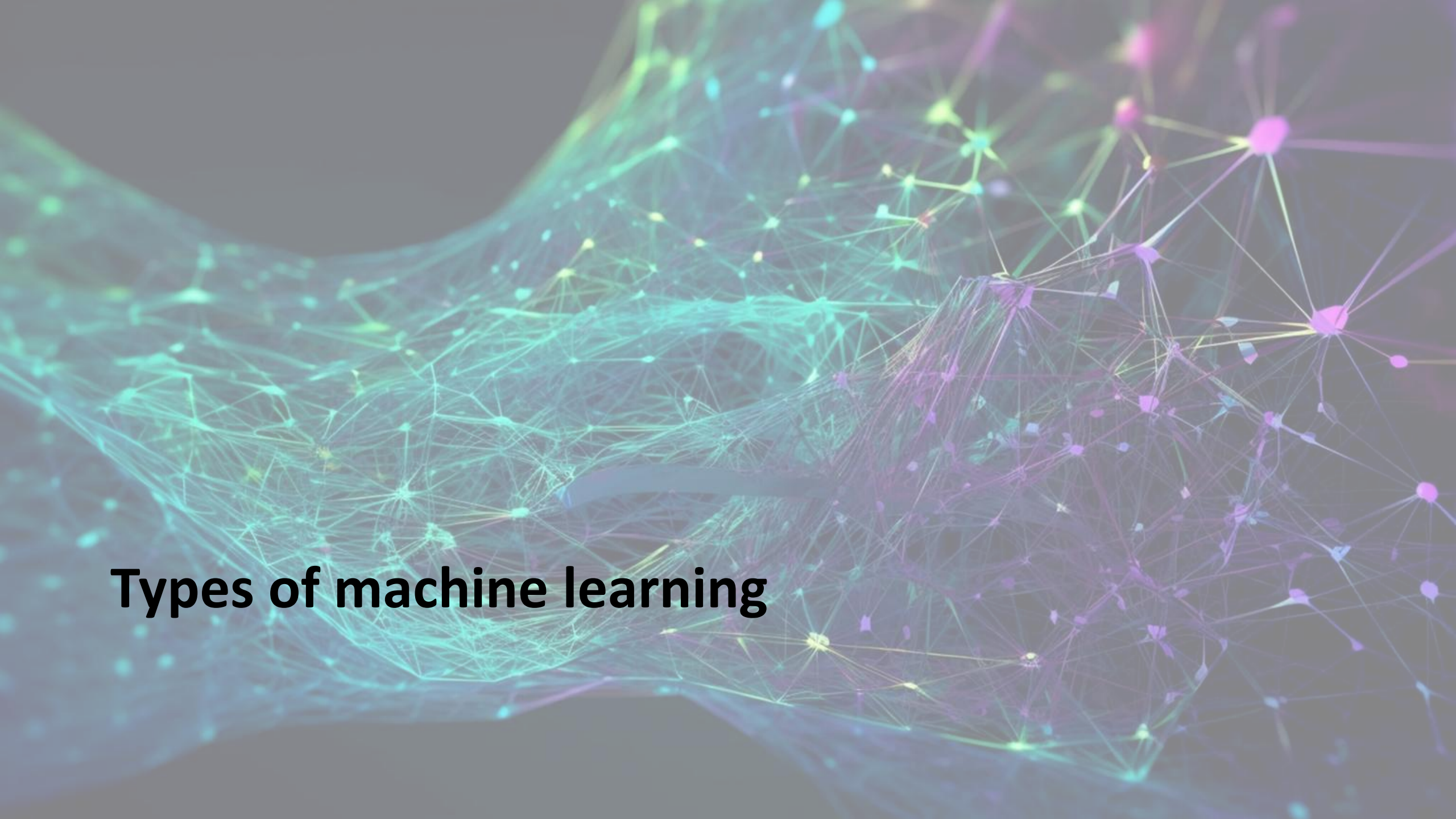
# How can machines learn?

In order to “educate” the machine, you need these 3 components:

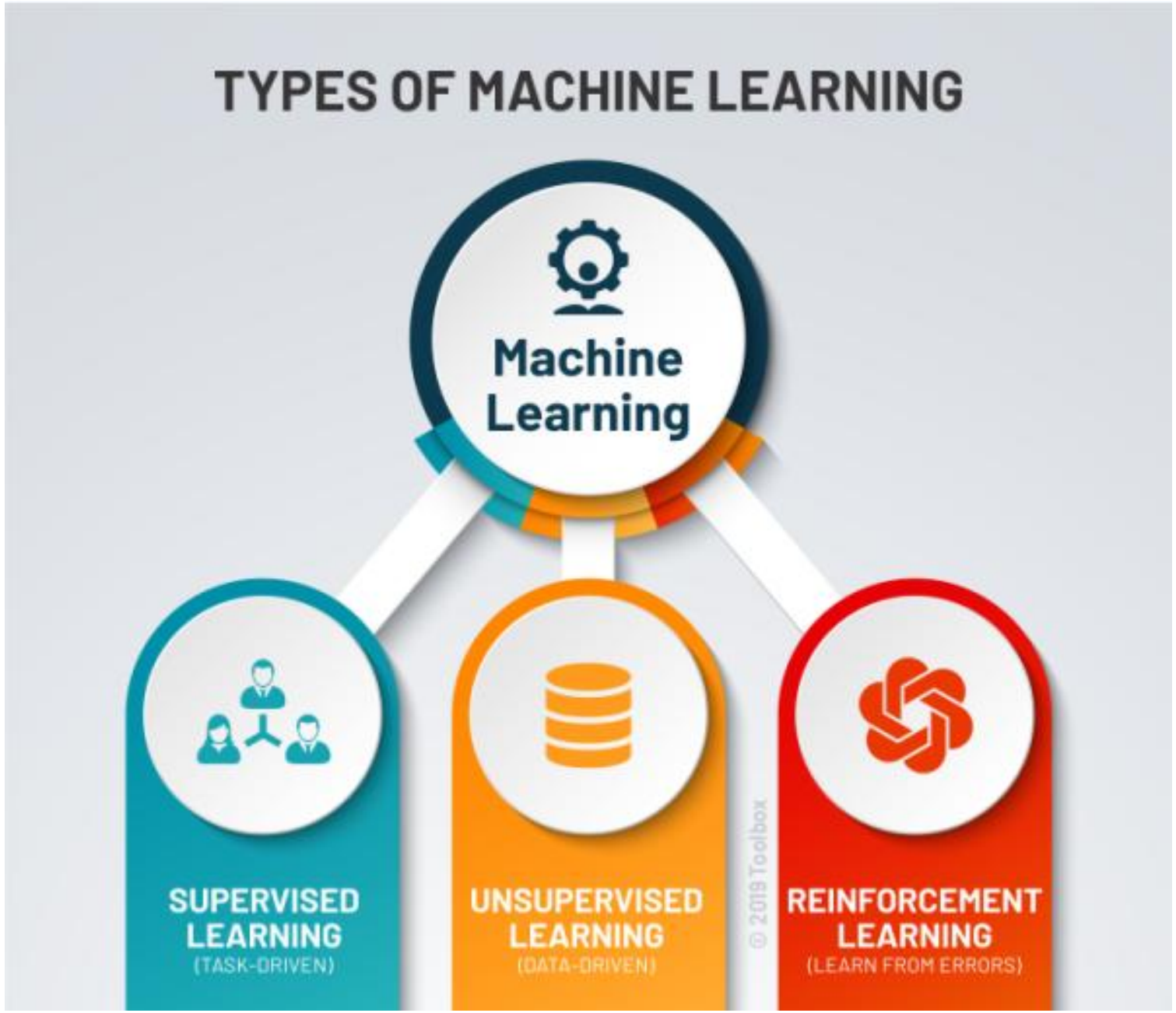
1. Datasets.
   - Machine learning systems are trained on special collections of samples called datasets . The samples can include numbers, images, texts or any other kind of data.
2. Features.
   - Features are important pieces of data that work as the key to the solution of the task . They demonstrate to the machine what to pay attention to.
3. Algorithm.
   - It is possible to solve the same task using different algorithms . Depending on the algorithm, the accuracy or speed of getting the results can be different

# General machine learning steps


- A machine learning model learns from the historical data fed to it and then builds prediction algorithms to predict the output for the new set of data that comes in as input to the system.
- The accuracy of these models would depend on the quality and amount of input data. A large amount of data will help build a better model which predicts the output more accurately.



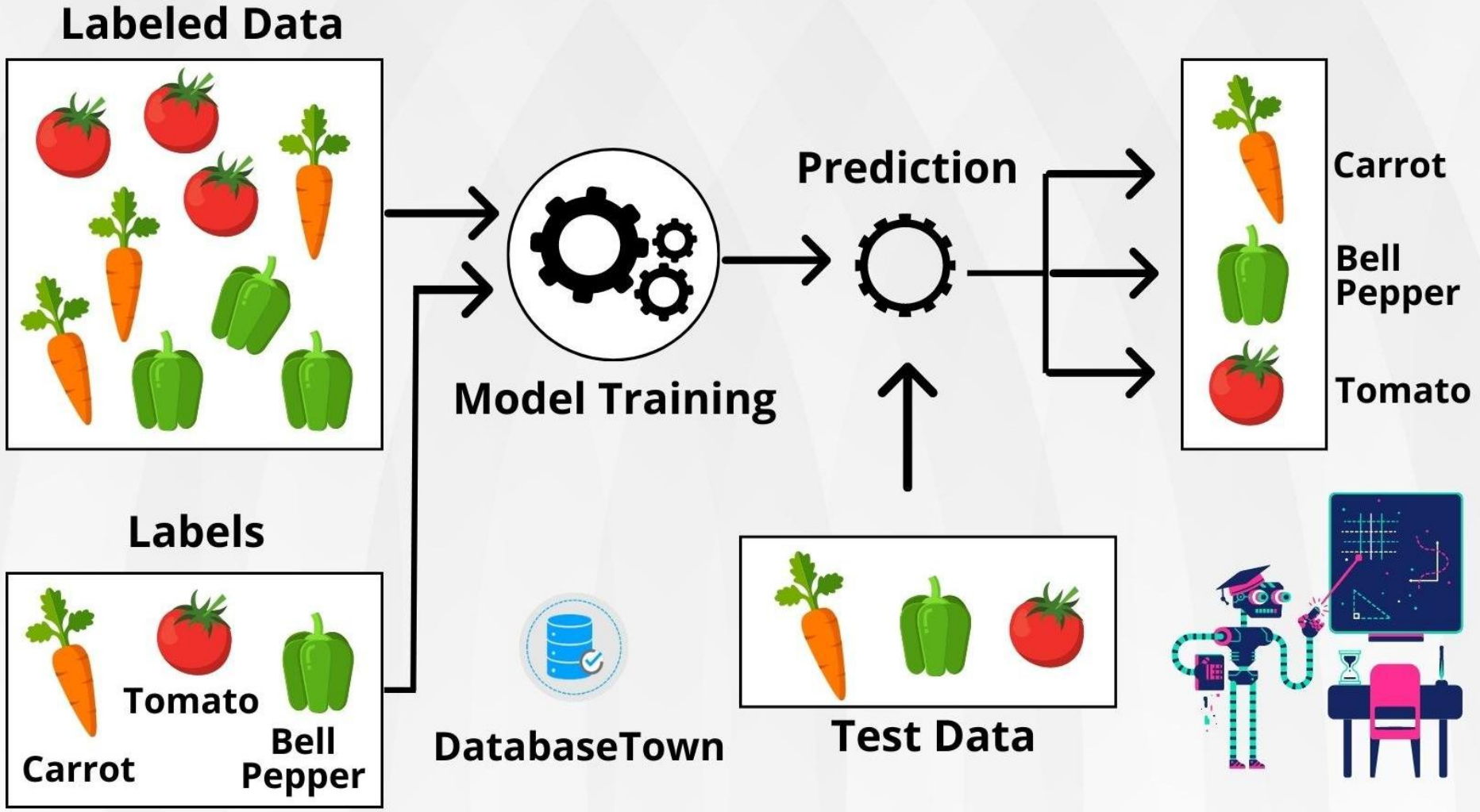
# Types of machine learning


TYPES OF MACHINE LEARNING
Machine Learning
SUPERVISED LEARNING
(TASK-DRIVEN)
UNSUPERVISED LEARNING
(DATA-DRIVEN)
REINFORCEMENT LEARNING
(LEARN FROM ERRORS)
© 2018 Toolbox

Types of Machine Learning cont.

# SUPERVISED LEARNING

Supervised machine learning is a branch of artificial intelligence that focuses on training models to make predictions or decisions based on labeled training data.



# Supervised learning cont.

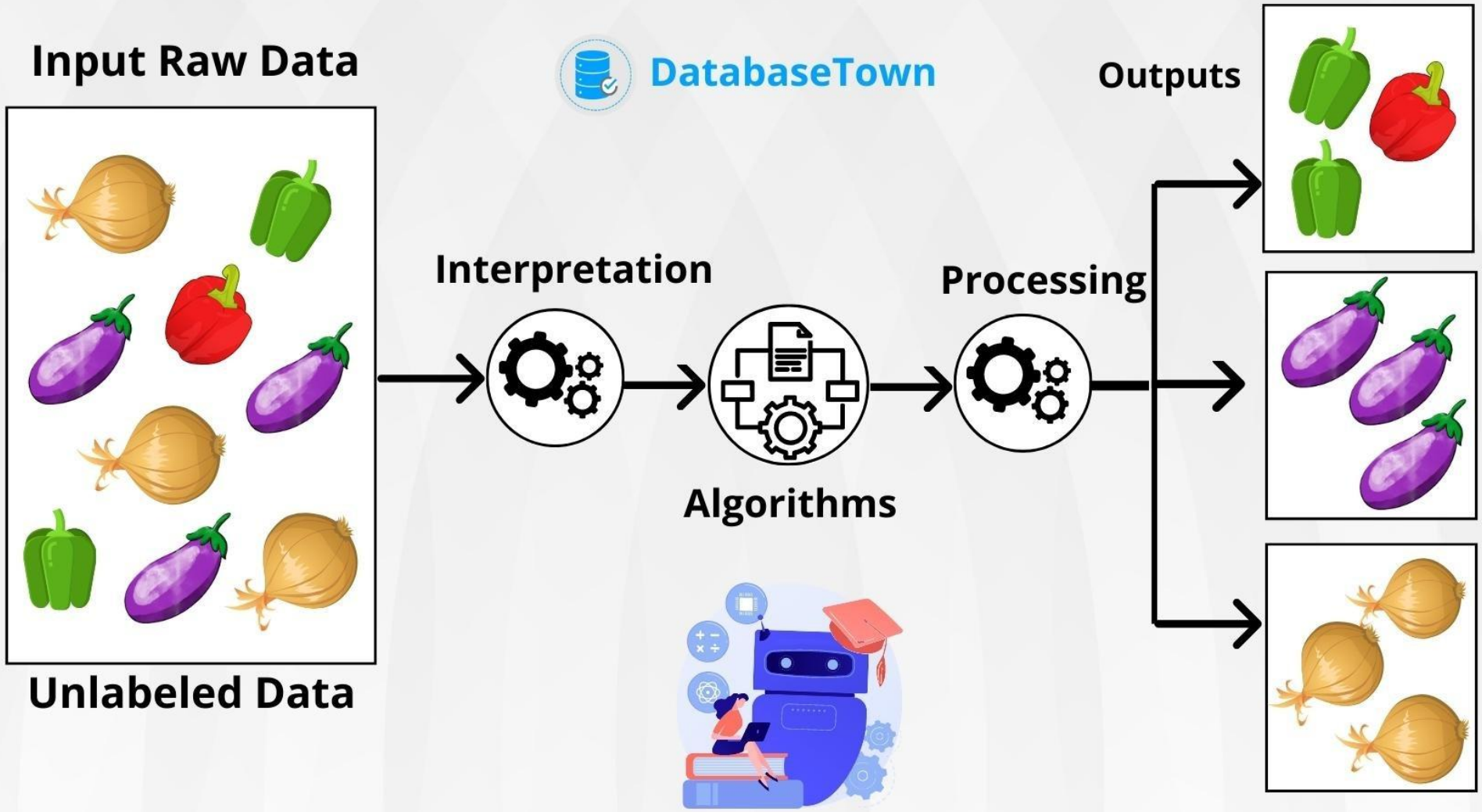
There are two types of problems in supervised learning Classification problems and regression problems

- Classification problems ask the algorithm to predict a discrete value that can identify the input data as a member of a particular class or group Taking up the animal photos dataset, each photo has been labeled as a dog, a cat, etc and then the algorithm must classify the new images into any of these labeled categories
- Regression problems are responsible for continuous data e g for predicting the price of a piece of land in a city, given the area, location, etc Here, the input is sent to the machine for predicting the price according to previous instances And the machine determines a function that would map the pairs If it is unable to provide accurate results, backward propagation is used to repeat the whole function until it receives satisfactory results.

Types of Machine Learning cont.

# UNSUPERVISED LEARNING

Unsupervised learning is a type of machine learning where the algorithm learns from unlabeled data without any predefined outputs or target variables.

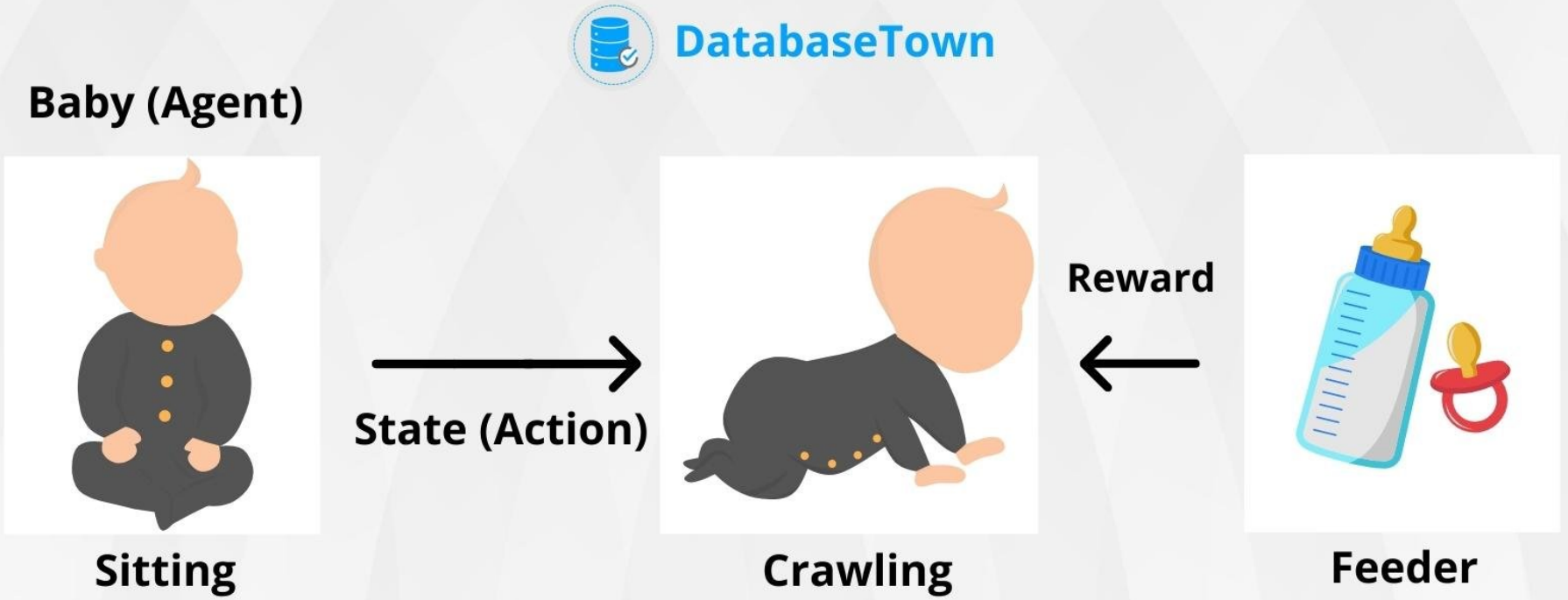


Types of Machine Learning cont.

# REINFORCEMENT LEARNING

Reinforcement learning is a machine learning paradigm that focuses on how agents learn to interact with an environment to maximize cumulative rewards.

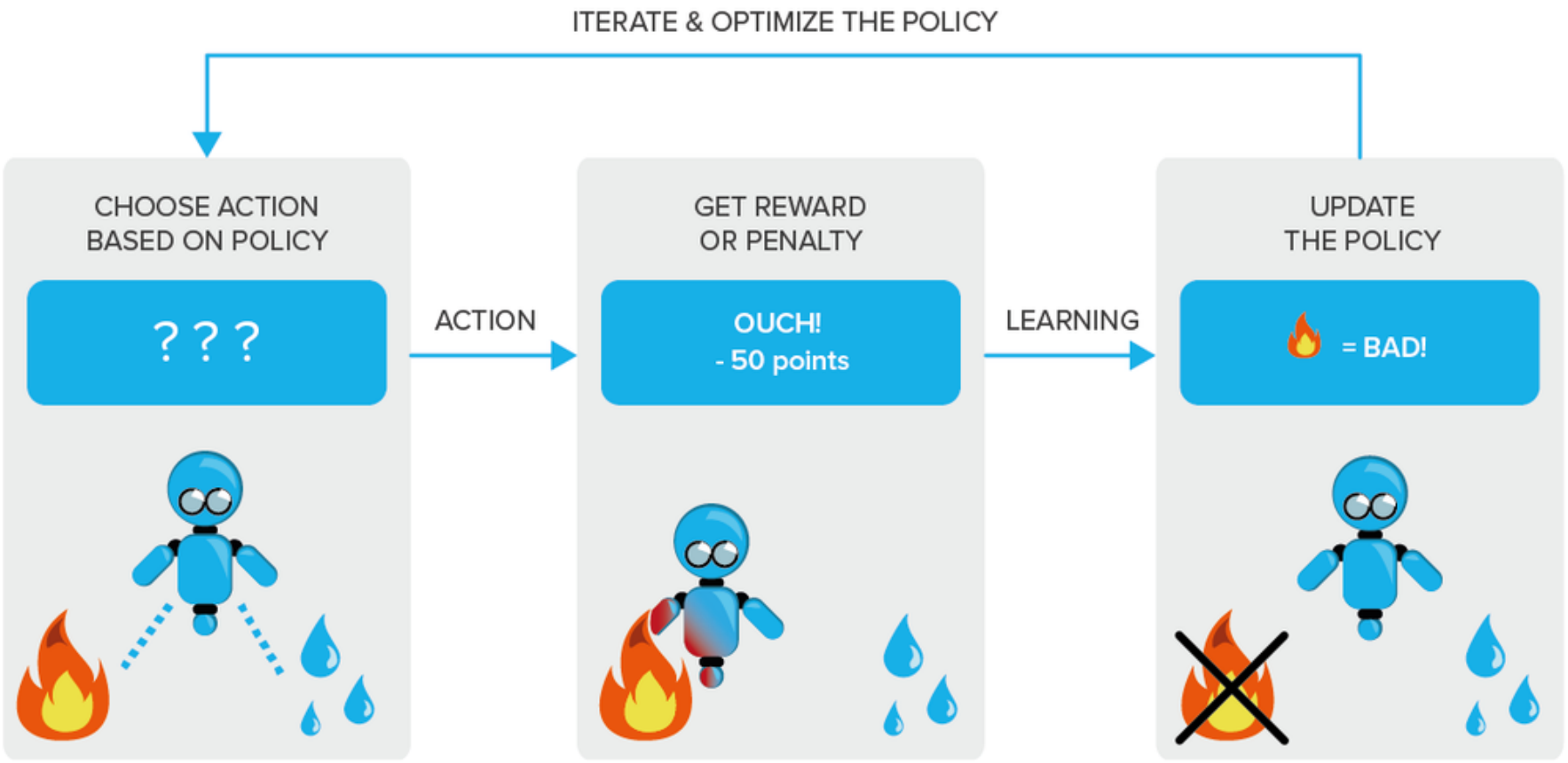
DatabaseTown




## Algorithms and Approaches in Reinforcement Learning

- Q-learning
- Deep Q-networks (DQN)
- Policy Gradients Methods
- Proximal Policy Optimization (PPO)

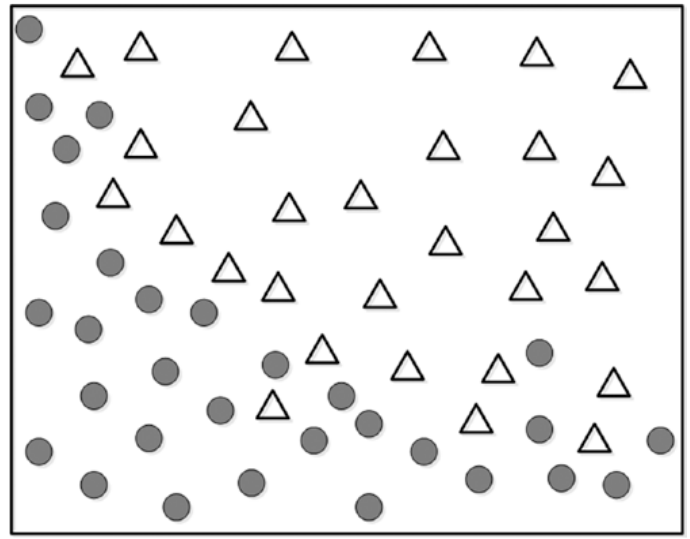
# How reinforcement learning works??



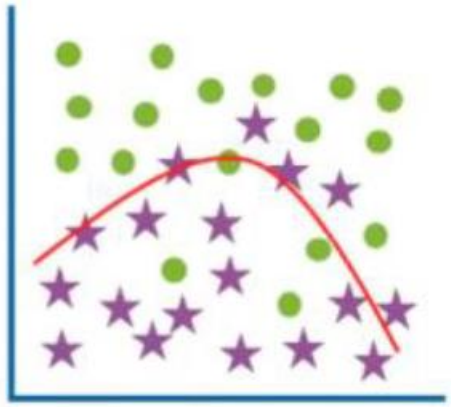

- The learning system, called an agent , can observe the environment, select and perform actions, and get rewards in return (or penalties in the form of negative rewards)
- It must then learn by itself what is the best strategy, called a policy to get the most reward over time
- A policy defines what action the agent should choose when it is in a given situation

# Main Challenges of Machine Learning

- Insufficient Quantity of Training Data
- Nonrepresentative Training Data
- Poor-Quality Data
- Irrelevant Features
- **Overfitting the Training Data**
- **Underfitting the Training Data**

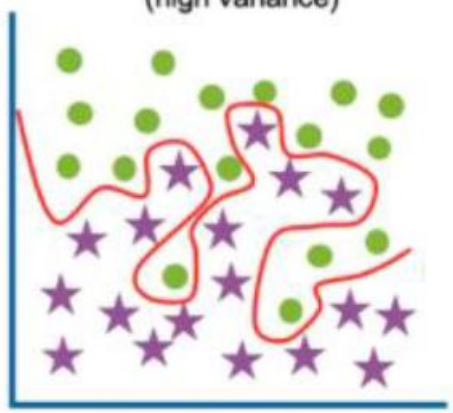


Optimum



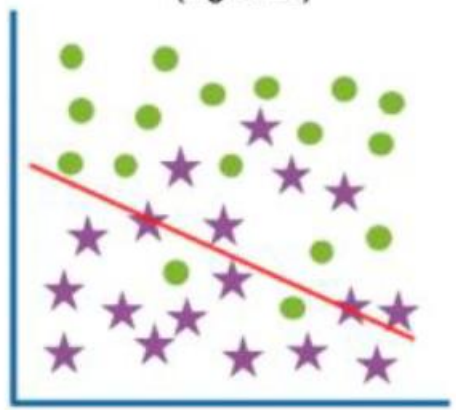
Low training error
Low test error

Overfit
(high variance)



Low training error
High test error

Underfit
(high bias)



High training error
High test error

# How to avoid underfitting

- By adding complexity and variation to the model, allowing for successful training of the model.
- Increase the duration of training
- Feature selection
  - With any model, specific features are used to determine a given outcome. If there are not enough predictive features present, then more features or features with greater importance, should be introduced.

Ex.

add more hidden neurons in neural network

# How to avoid overfitting

- Simplifying The Model
  - The first step when dealing with overfitting is to decrease the complexity of the model To decrease the complexity, we can simply remove layers or reduce the number of neurons to make the network smaller
- Early Stopping
  - Early stopping is a form of regularization while training a model with an iterative method, such as gradient descent Since all the neural networks learn exclusively by using gradient descent, early stopping is a technique applicable to all the problems
- Use Regularization
  - Regularization is a technique to reduce the complexity of the model. It does so by adding a penalty term to the loss function. The most common techniques are known as L1 and L2 regularization.

# Machine learning applications cont.

**6. Email Spam and Malware Filtering:**

- Whenever we receive a new email, it is filtered automatically as important, normal, and spam. We always receive an important mail in our inbox with the important symbol and spam emails in our spam box, and the technology behind this is Machine learning. Below are some spam filters used by Gmail:
  - Content Filter
  - Header filter
  - General blacklists filter
  - Rules-based filters
  - Permission filters

**7. Virtual Personal Assistant**

- We have various virtual personal assistants such as Google assistant, Alexa, Cortana, Siri As the name suggests, they help us in finding the information using our voice instruction These assistants can help us in various ways just by our voice instructions such as Play music, call someone, open an email, Scheduling an appointment etc.

# Machine learning applications cont.

**8. Online Fraud Detection**

- Machine learning is making our online transaction safe and secure by detecting fraud transaction. Whenever we perform some online transaction, there may be various ways that a fraudulent احتيالي transaction can take place such as fake accounts, fake ids, and steal money in the middle of a transaction So, to detect this, **Feed Forward Neural network** helps us by checking whether it is a genuine transaction or a fraud transaction

**9. Stock Market trading تداول الأوراق المالية ف البورصة**

- Machine learning is widely used in stock market trading In the stock market, there is always a risk of up and downs in shares, so for this machine learning's long short term memory neural network is used for the prediction of stock market trends.