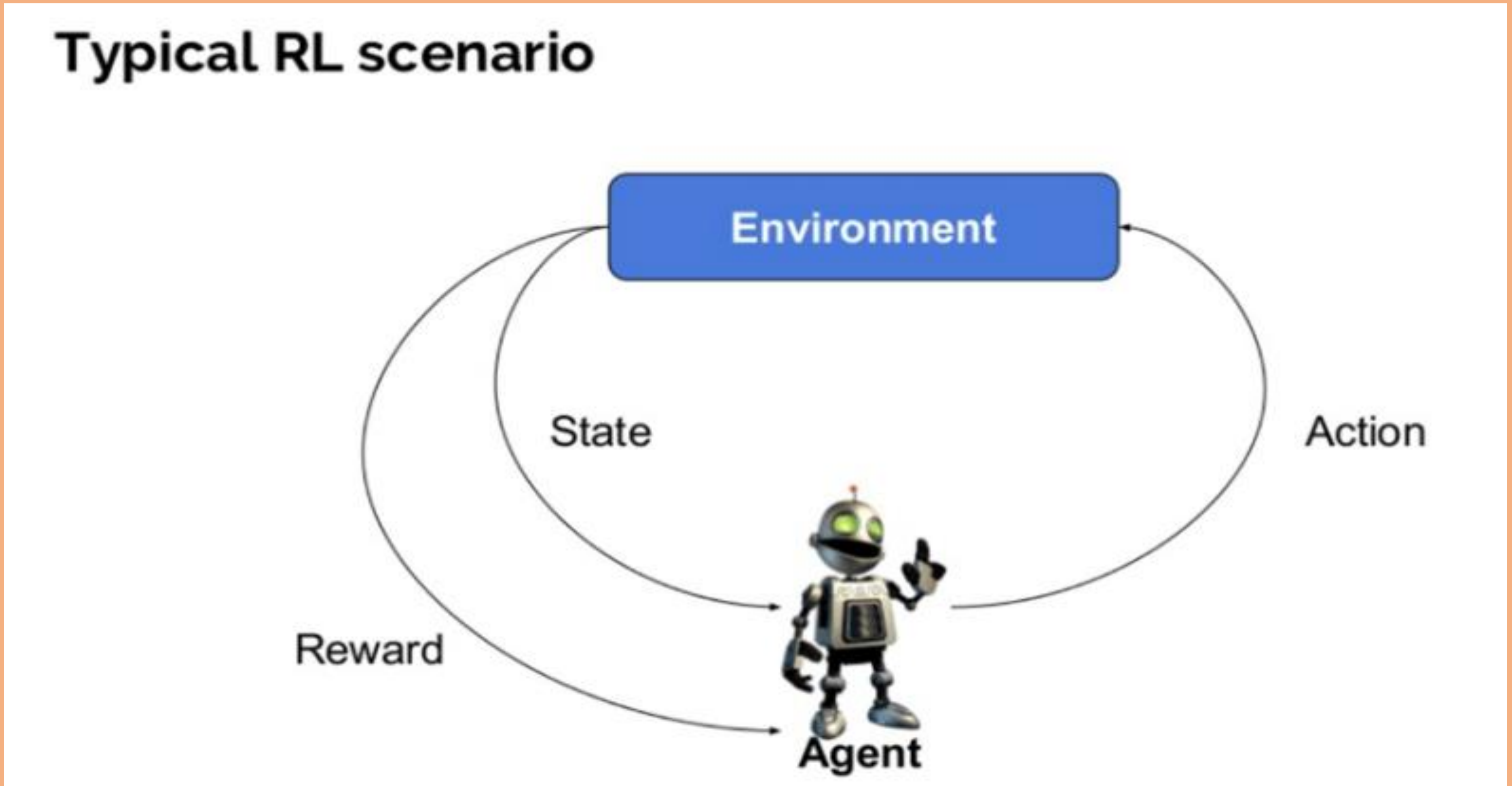
ML Internship Day_5

Reinforcement Learning

What is Reinforcement Learning?

- Reinforcement Learning is defined as a Machine Learning method that is concerned with how software agents should take actions in an environment.
- Reinforcement Learning is a part of the deep learning method that helps you to maximize some portion of the cumulative reward.
- This neural network learning method helps you to learn how to attain a complex objective or maximize a specific dimension over many steps.



Important terms used in Reinforcement AI:

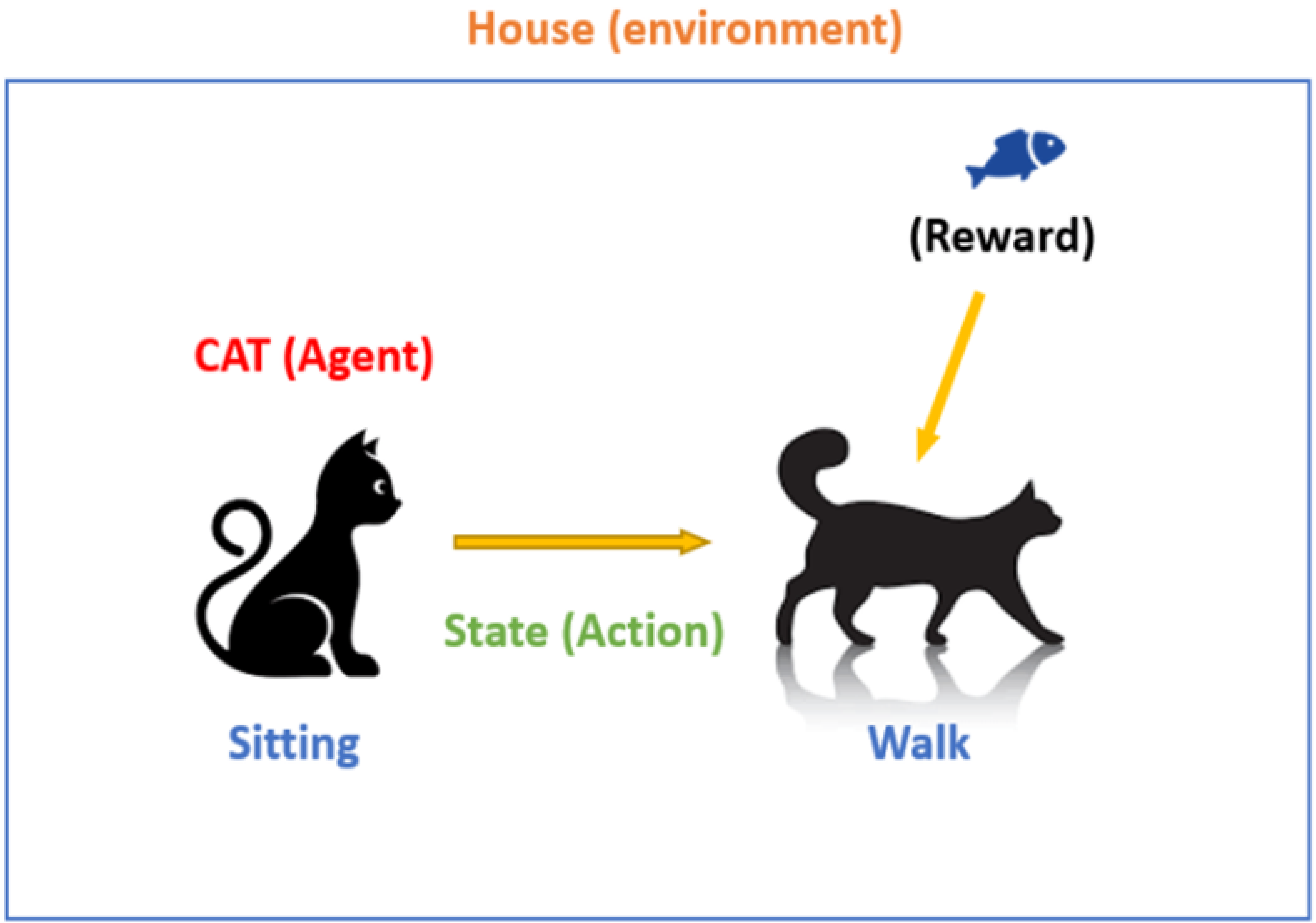
- **Agent:** It is an assumed entity which performs actions in an environment to gain some reward.
- **Environment (e):** A scenario that an agent has to face.
- **Reward (R):** An immediate return given to an agent when he or she performs specific action or task.
- **State (s):** State refers to the current situation returned by the environment.
- **Policy (π):** It is a strategy which applies by the agent to decide the next action based on the current state.
- **Value (V):** It is expected long-term return with discount, as compared to the short-term reward.
- **Value Function:** It specifies the value of a state that is the total amount of reward. It is an agent which should be expected beginning from that state.
- **Model of the environment:** This mimics the behavior of the environment. It helps you to make inferences to be made and also determine how the environment will behave.
- **Model based methods:** It is a method for solving reinforcement learning problems which use model-based methods.
- **Q value or action value (Q):** Q value is quite similar to value. The only difference between the two is that it takes an additional parameter as a current action.

How Reinforcement Learning works?

Let's see some simple example which helps you to illustrate the reinforcement learning mechanism.

Consider the scenario of teaching new tricks to your cat

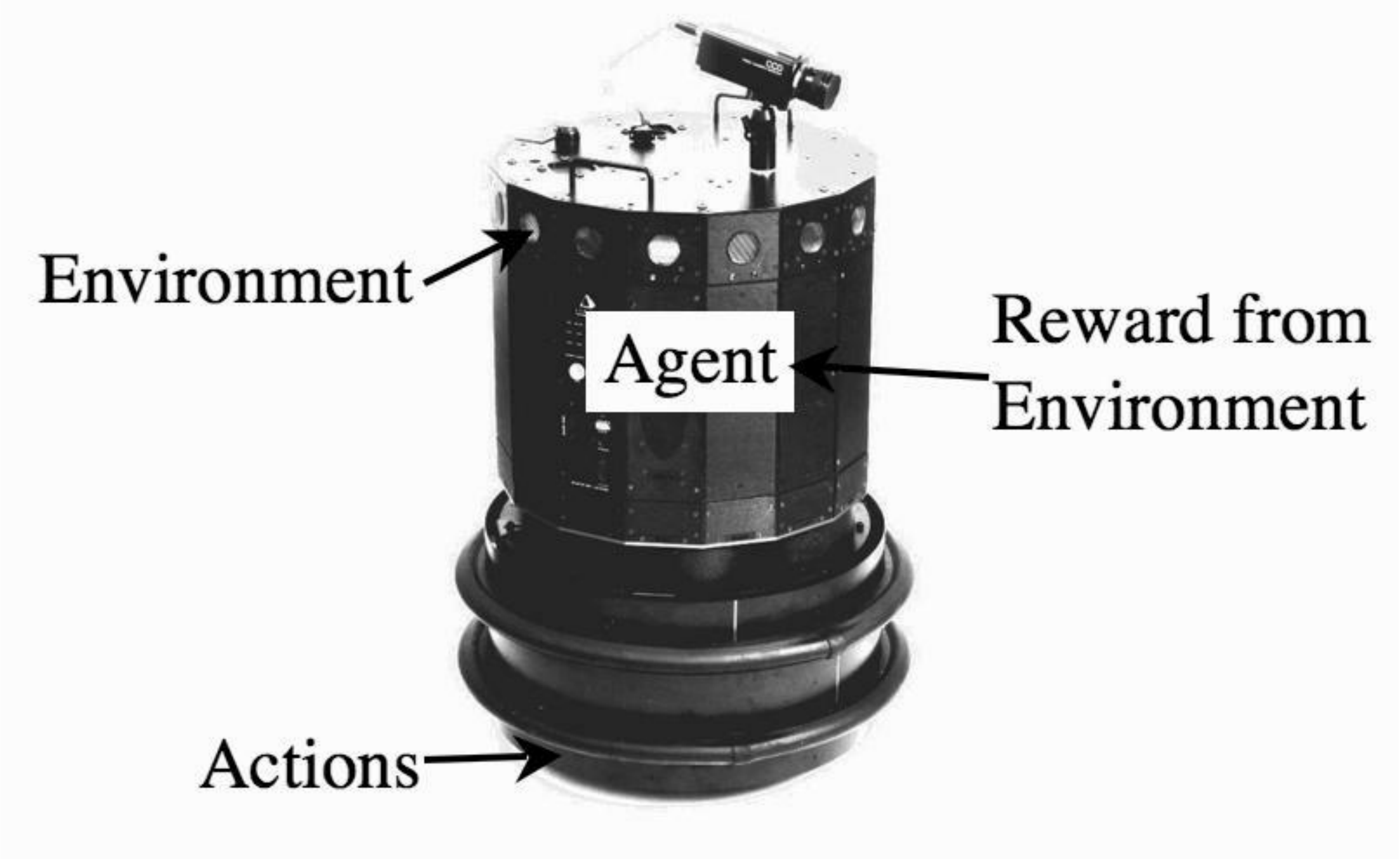
- As cat doesn't understand English or any other human language, we can't tell her directly what to do. Instead, we follow a different strategy.
- We emulate a situation, and the cat tries to respond in many different ways. If the cat's response is the desired way, we will give her fish.
- Now whenever the cat is exposed to the same situation, the cat executes a similar action with even more enthusiastically in expectation of getting more reward(food).
- That's like learning that cat gets from "what to do" from positive experiences.
- At the same time, the cat also learns what not do when faced with negative experiences.



How Reinforcement Learning works

In this case,

- Your cat is an **agent** that is exposed to the environment(**your house)**.
- An example of a state could be your cat sitting, and
- You use a specific word in for cat to **walk.**
- Our agent reacts by performing an action transition from one "state" to another "state."
- For example, your cat goes from sitting to walking.
- The reaction of an agent is an action, and the policy is a method of selecting an action given a state in expectation of better outcomes.
- After the transition, they may get a **reward or penalty** in return.



A robot perceives the current state of its environment through its sensors,
and performs actions by moving its motors. The reinforcement learner (agent) within the
robot tries to predict the next state and reward.

Reinforcement Learning Algorithms

There are three approaches to implement a Reinforcement Learning algorithm.

1. Value-Based:

In a value-based Reinforcement Learning method, you should try to maximize a value function **V(s)**. In this method, the agent is expecting a long-term return of the current states under policy **π**.

2. Policy-based:

In a policy-based RL method, you try to come up with such a policy that the action performed in every state helps you to gain maximum reward in the future.

Two types of policy-based methods are:

- Deterministic: For any state, the same action is produced by the policy π.
- Stochastic: Every action has a certain probability

3. Model-Based:

In this Reinforcement Learning method, you need to create a virtual model for each environment. The agent learns to perform in that specific environment.

Characteristics of Reinforcement Learning

- There is no supervisor, only a real number or reward signal
- Sequential decision making
- Time plays a crucial role
- Feedback is always delayed, not instantaneous
- Agent's actions determine the subsequent data it receives

Types of Reinforcement Learning

Two kinds of reinforcement learning methods are:

Positive:

- Defined as an event, that occurs because of specific behavior.
- It increases the strength and the frequency of the behavior and impacts positively on the action taken by the agent.
- Helps you to maximize performance and sustain change for a more extended period.
- However, too much Reinforcement may lead to over-optimization of state, which can affect the results.

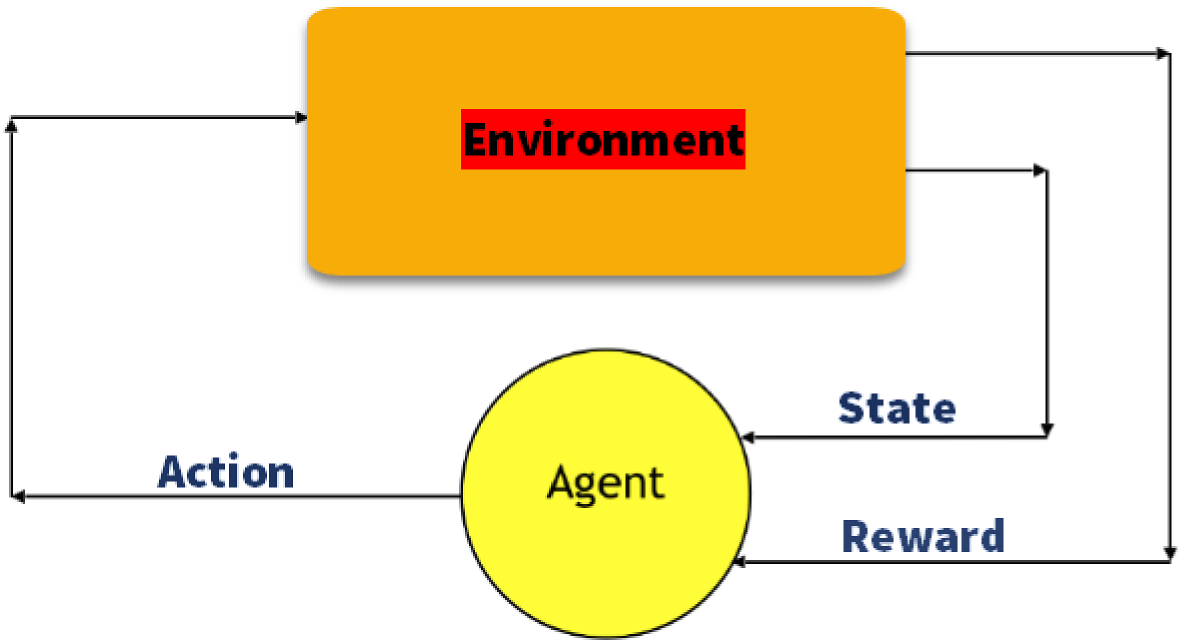
Negative:

- Negative Reinforcement is defined as strengthening of behavior that occurs because of a negative condition which should have stopped or avoided.
- It helps you to define the minimum stand of performance.

Learning Models of Reinforcement

There are two important learning models in reinforcement learning:

- Markov Decision Process
- Q learning



Markov Decision Process

The following parameters are used to get a solution:

- Set of actions- A
- Set of states -S
- Reward- R
- Policy- n
- Value- V

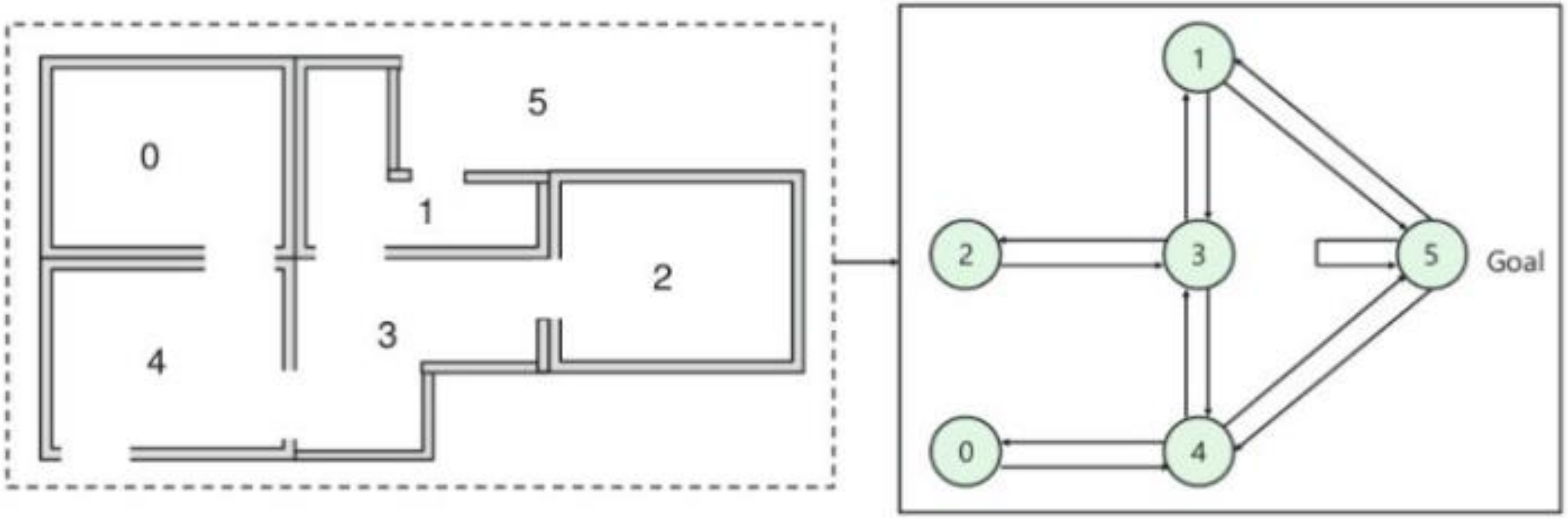
The mathematical approach for mapping a solution in reinforcement Learning is recon as a Markov Decision Process or (MDP).

Q-Learning

Q learning is a value-based method of supplying information to inform which action an agent should take.

Let's understand this method by the following example:

- There are five rooms in a building which are connected by doors.
- Each room is numbered 0 to 4
- The outside of the building can be one big outside area (5)
- Doors number 1 and 4 lead into the building from room 5



Next, you need to associate a reward value to each door:

- Doors which lead directly to the goal have a reward of 100
- Doors which is not directly connected to the target room gives zero reward
- As doors are two-way, and two arrows are assigned for each room
- Every arrow in the above image contains an instant reward value

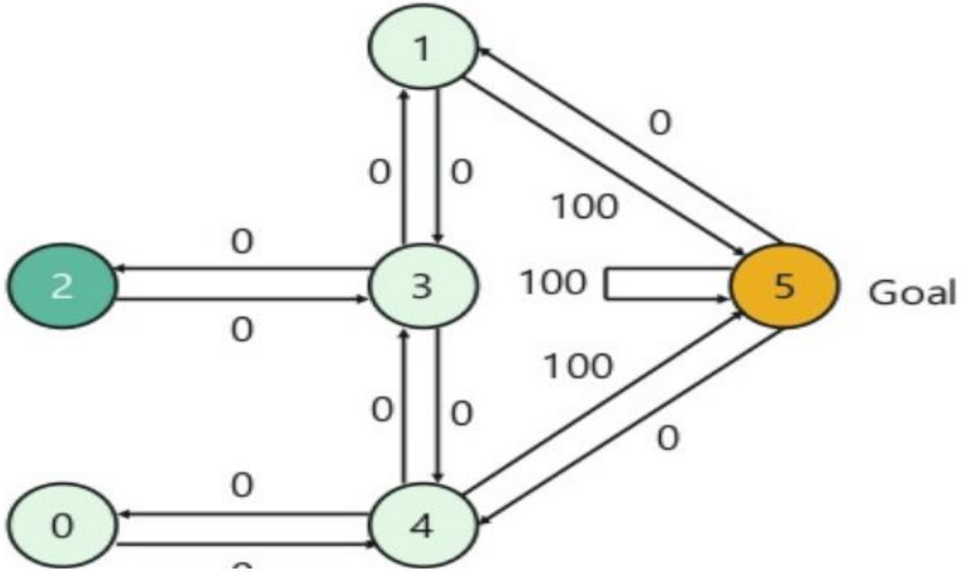
Explanation:

In this image, you can view that room represents a state Agent's movement from one room to another represents an action

In the below-given image, a state is described as a node, while the arrows show the action.

For example, an agent traverse from room number 2 to 5

- Initial state = state 2
- State 2-> state 3
- State 3 -> state (2,1,4)
- State 4-> state (0,5,3)
- State 1-> state (5,3)
- State 0-> state 4



For example, an agent traverse from room number 2 to 5

Reinforcement Learning vs. Supervised Learning

Parameters	Reinforcement Learning	Supervised Learning
Decision style	reinforcement learning helps you to take your decisions sequentially.	In this method, a decision is made on the input given at the beginning.
Works on	Works on interacting with the environment.	Works on examples or given sample data.
Dependency on decision	In RL method learning decision is dependent. Therefore, you should give labels to all the dependent decisions.	Supervised learning the decisions which are independent of each other, so labels are given for every decision.
Best suited	Supports and work better in AI, where human interaction is prevalent.	It is mostly operated with an interactive software system or applications.
Example	Chess game	Object recognition

Applications of Reinforcement Learning

- Robotics for industrial automation.
- Business strategy planning
- Machine learning and data processing
- It helps you to create training systems that provide custom instruction and materials according to the requirement of students.
- Aircraft control and robot motion control

Robot learning

- **Robot learning** is a research field at the intersection of machine learning and robotics.
- It studies techniques allowing a robot to acquire novel skills or adapt to its environment through learning algorithms.
- The embodiment of the robot, situated in a physical embedding, provides at the same time specific difficulties (e.g. high-dimensionality, real time constraints for collecting data and learning) and opportunities for guiding the learning process (e.g. sensorimotor synergies, motor primitives).

  Example of skills that are targeted by learning algorithms include

- Sensorimotor skills such as locomotion, grasping, active object categorization
- Interactive skills such as joint manipulation of an object with a human peer such as the grounded and situated meaning of human language.

  Learning can happen either through autonomous self-exploration or through guidance from a human teacher, like for example in robot learning by imitation

Robot learning

- In Tellex's "Million Object Challenge," the goal is robots that learn how to spot and handle simple items and upload their data to the cloud to allow other robots to analyze and use the information.
- RoboBrain is a knowledge engine for robots which can be freely accessed by any device wishing to carry out a task. The database gathers new information about tasks as robots perform them, by searching the Internet, interpreting natural language text, images, and videos, object recognition as well as interaction. The project is led by Ashutosh Saxena at Stanford University.
- RoboEarth is a project that has been described as a "World Wide Web for robots" − it is a network and database repository where robots can share information and learn from each other and a cloud for outsourcing heavy computation tasks. The project brings together researchers from five major universities in Germany, the Netherlands and Spain and is backed by the European Union.
- Google Research, DeepMind, and Google X have decided to allow their robots share their experiences

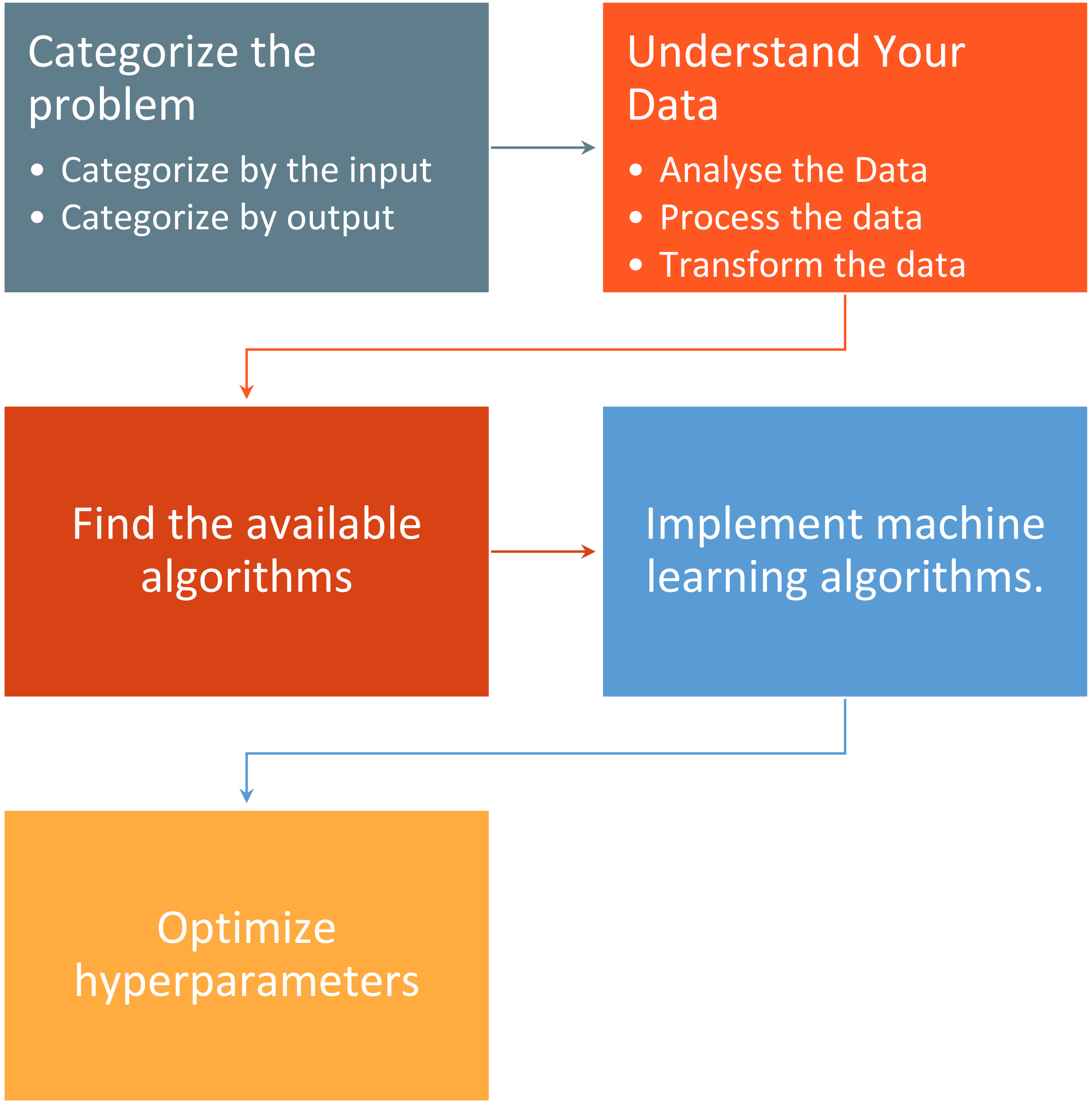
5 Current Machine Learning Applications in Robotics

- Computer Vision
- Imitation Learning
- Self-Supervised Learning
- Assistive and Medical Technologies
- Multi-Agent Learning

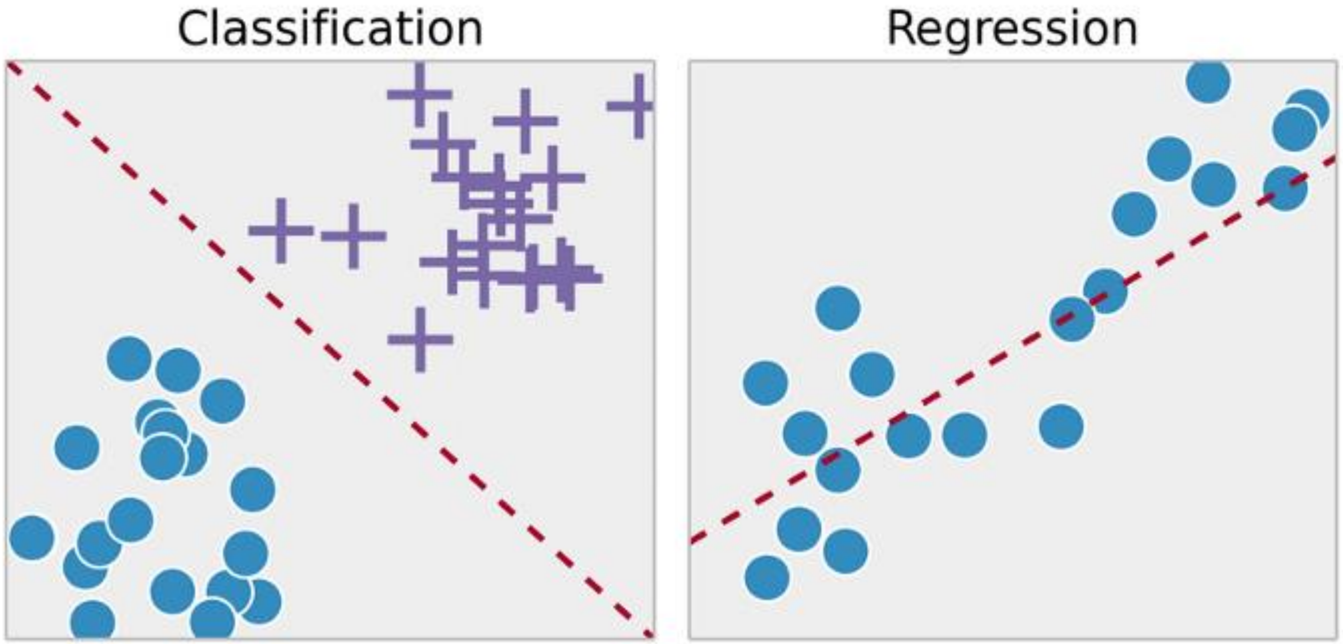
How AI and Machine Learning Can Improve Robotics

- Industrial Robots With AI Become More Aware of People and Surroundings
- AI robotics companies make manufacturing more efficient
- AI and machine learning applications give robots greater potential

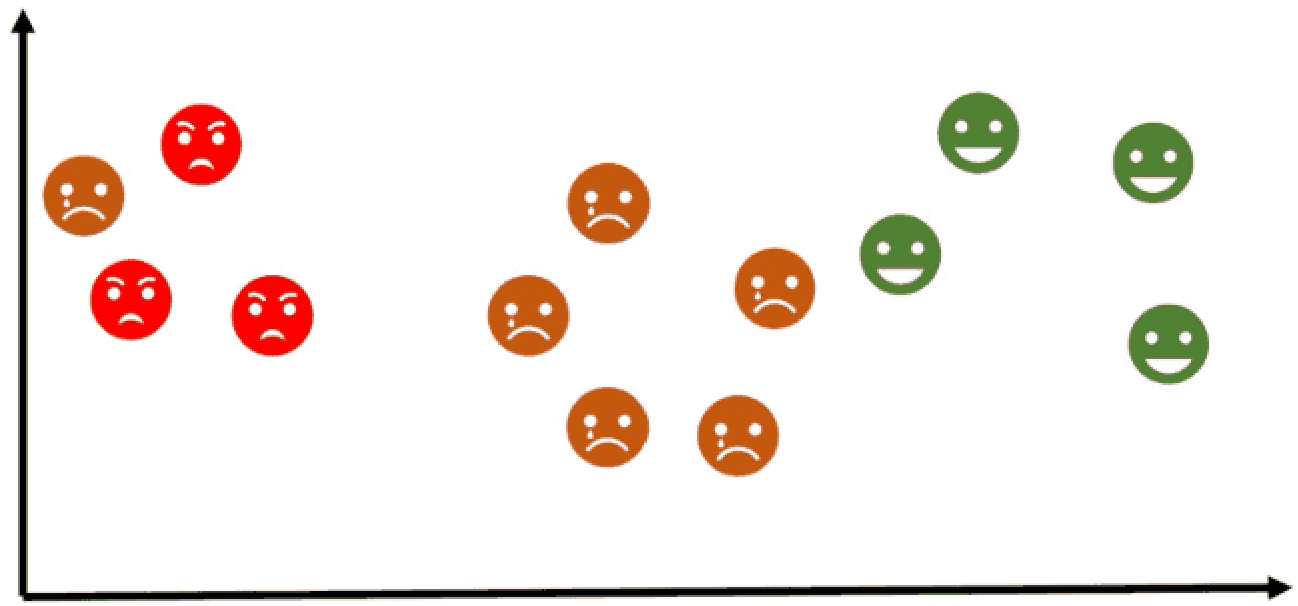
How to choose the right machine learning algorithm

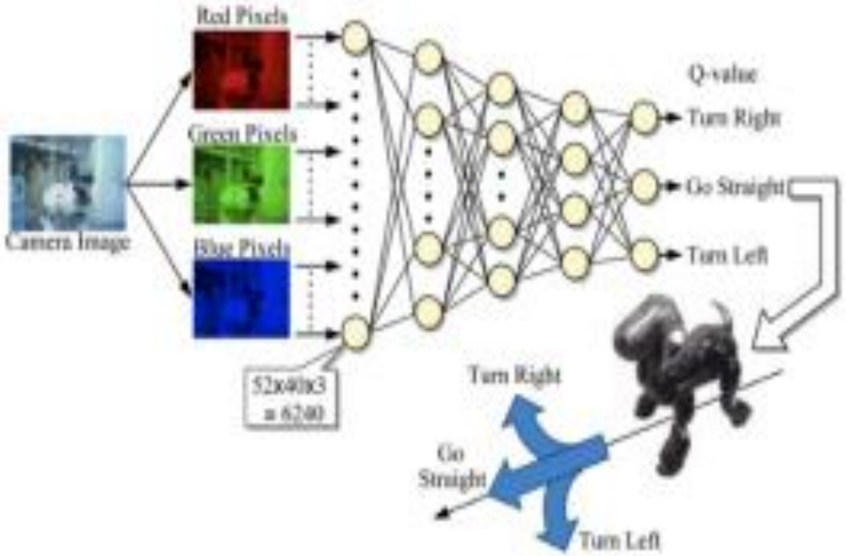


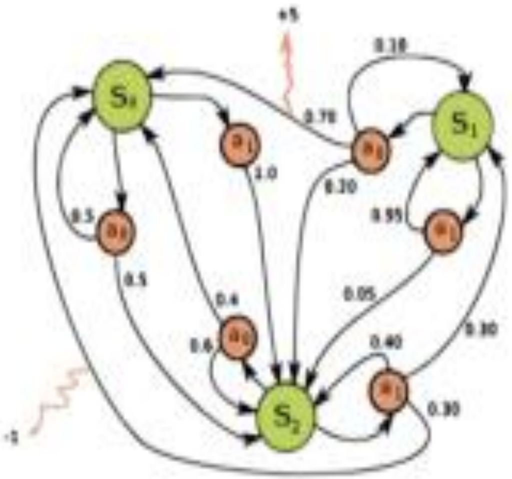
Supervised

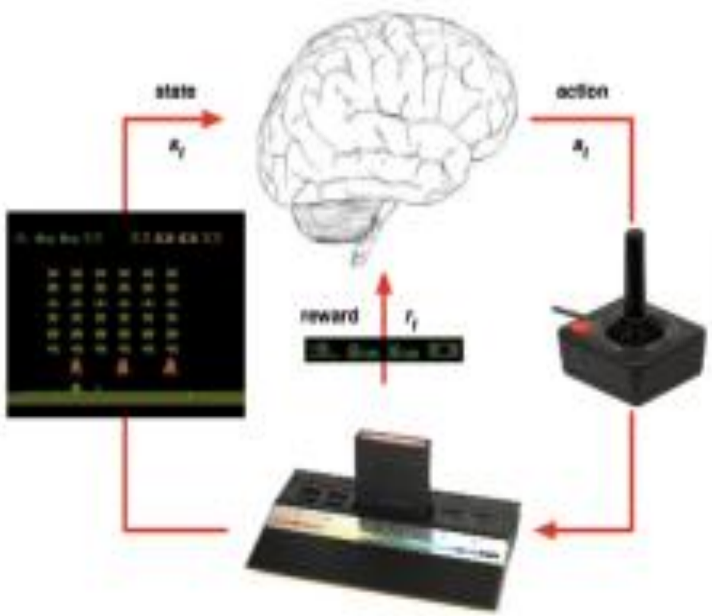


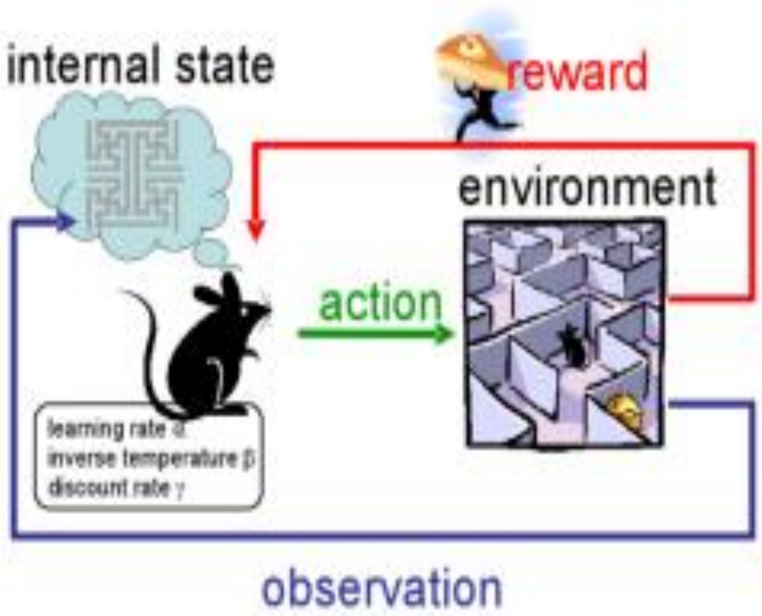
Unsupervised

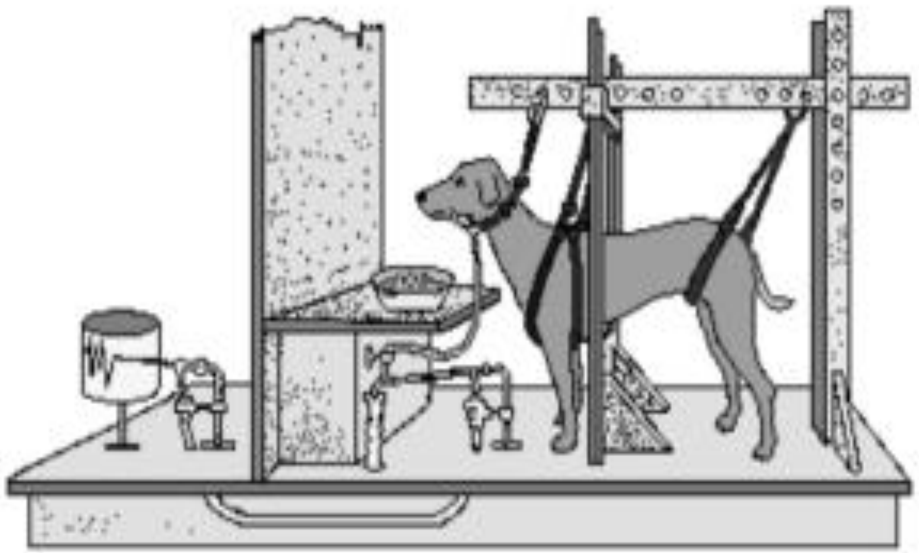



Red Pixels
Green Pixels
Blue Pixels
Camera Image
52x40x3
= 6240
Q-value
Turn Right
Go Straight
Turn Left
Turn Right
Go Straight
Turn Left

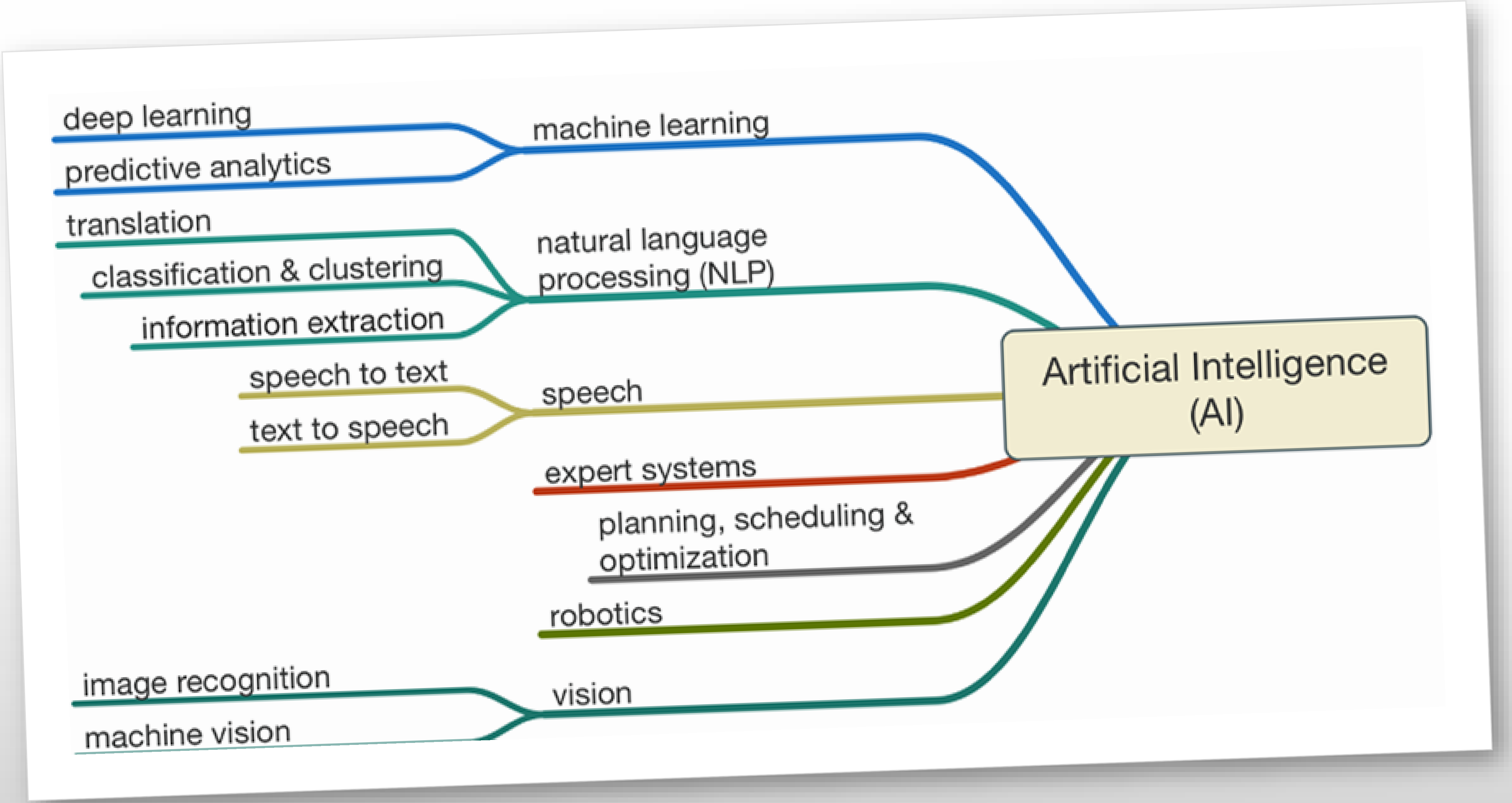



state
action
reward


internal state
reward
environment
action
learning rate α
inverse temperature β
discount rate γ
observation




Regression
Forecast the future by estimating the relationship between variables.
Predict Values
Estimate product demand
Predict sales figures
Analyze marketing returns
Predict credit risk
Detect fraud
Catch abnormal equipment readings
Find Unusual Occurrences
Anomaly Detection
Identify and predict rare or unusual data points.
Clustering
Separate similar data points into intuitive groups.
Discover Structure
Perform customer segmentation
Predict customer tastes
Determine market price
Predict Categories
Classification
Identify what category new information belongs in.


deep learning
predictive analytics
machine learning
translation
classification & clustering
information extraction
natural language processing (NLP)
speech to text
text to speech
speech
Artificial Intelligence (AI)
expert systems
planning, scheduling & optimization
robotics
image recognition
machine vision
vision

Project

Generate a .CSV file of 5 dimensions, analyse it statistically,split it for testing and training. Test with the following algorithms:

a. Linear Regression
b. Logistic Regression
c. SVM
d. K-means Clustering
e. KNN
f. PCA
g. Naive Bayes &
h. AdaBoost Classifier

Visualise your results using a suitable plot.


ANNOUNCEMENT!

Please Note:

- You have to fill the feedback form
- Access for the files shared as part of this internship will be up to 03.11.2020 5 pm
- Last date of the project submission : 03-11-2020 5pm
- Complete the assignments and fill the feedback forms before that.


WHAT
HAVE YOU
LEARNED?
Learning
Training
Content
Courses
System
Delivery
Framework
Analysis
Reporting
Management
Courses
Delivery
System
Content
Training
Analysis
Courses


NEXT STEP ?
YOUR
WHATS


LOOK
WHAT I
CAN DO!

Contact

- Email id : sakthiprasad221914@gmail.com
- WhatsApp: 8086673701


Thank
You