C. Fundamentals of AIoT
Chapter #3: Introduction to AIoT and its Components

ET0743
5G and AIoT Applications

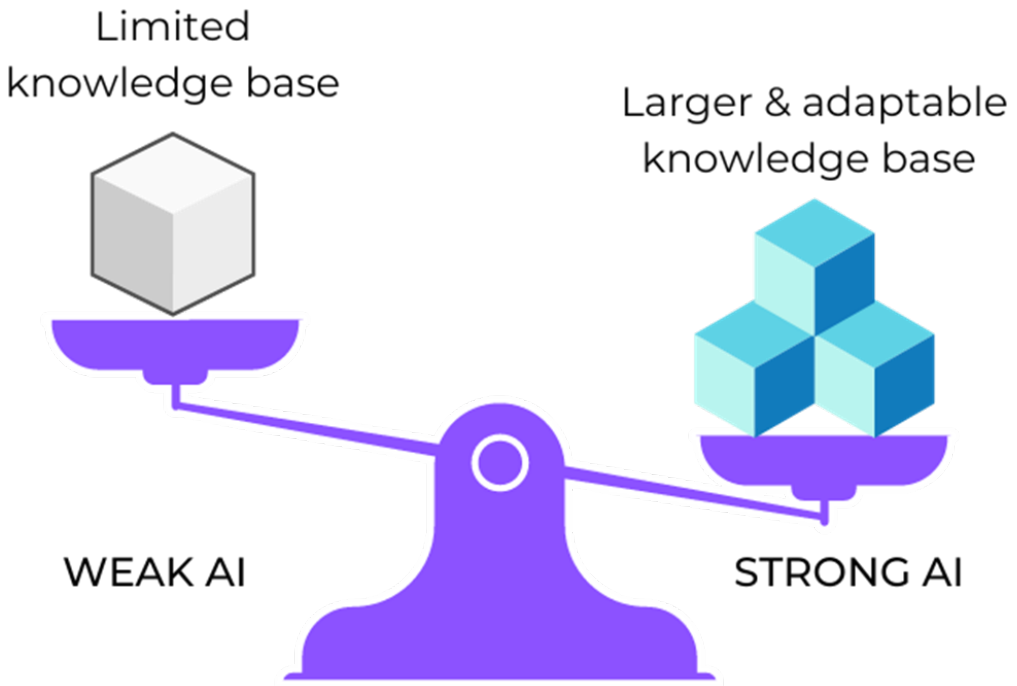
Week #4 – #5

Learning Objectives

At the end of instruction, the learner should be able to:

- Understand the basics of AI and Machine Learning.
- Understand AIoT architectures and integration of AI and IoT.
- Describe examples of AIoT applications.

3.1 Basics of Artificial Intelligence and Machine Learning – Road Map of AI



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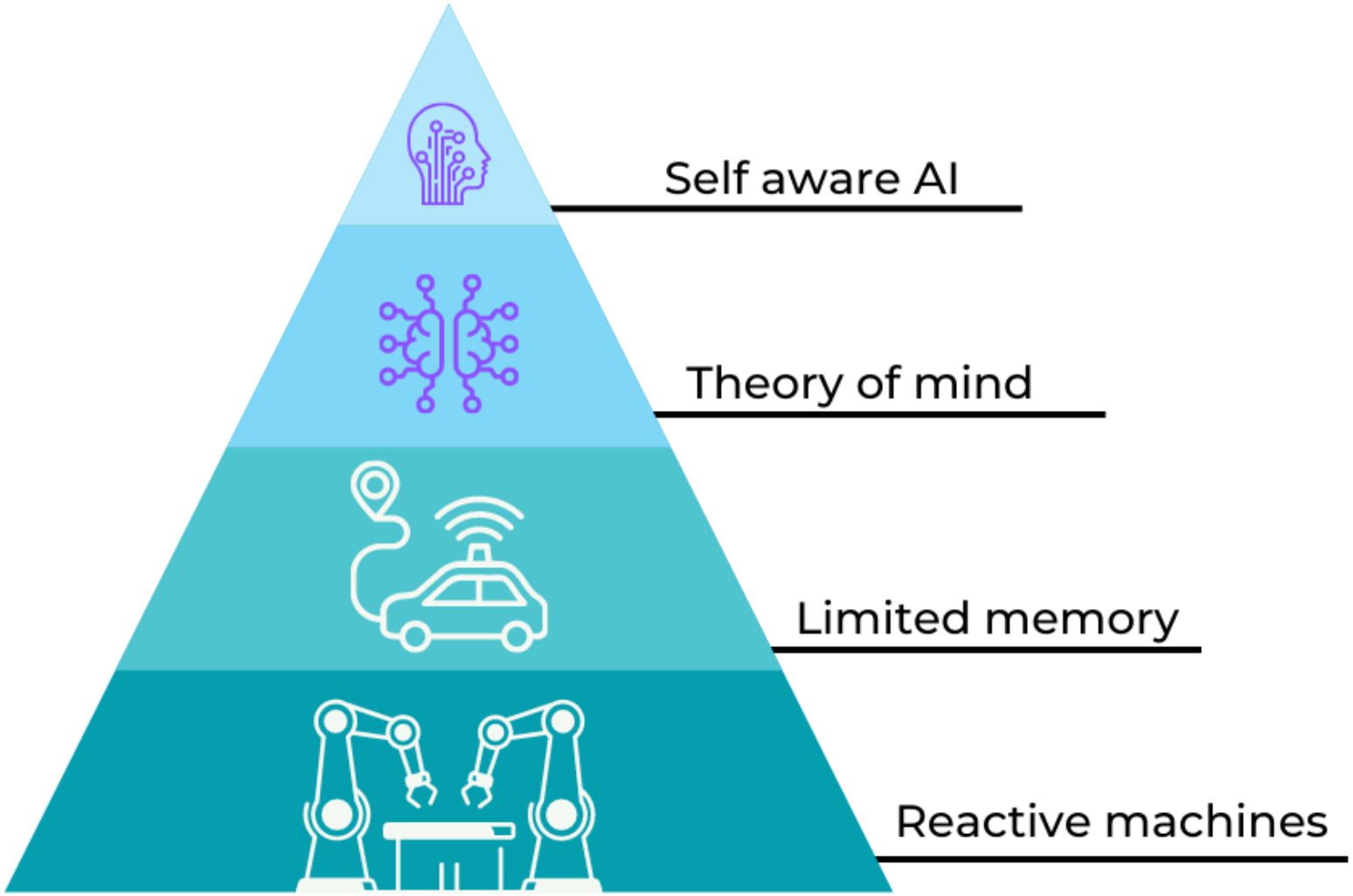
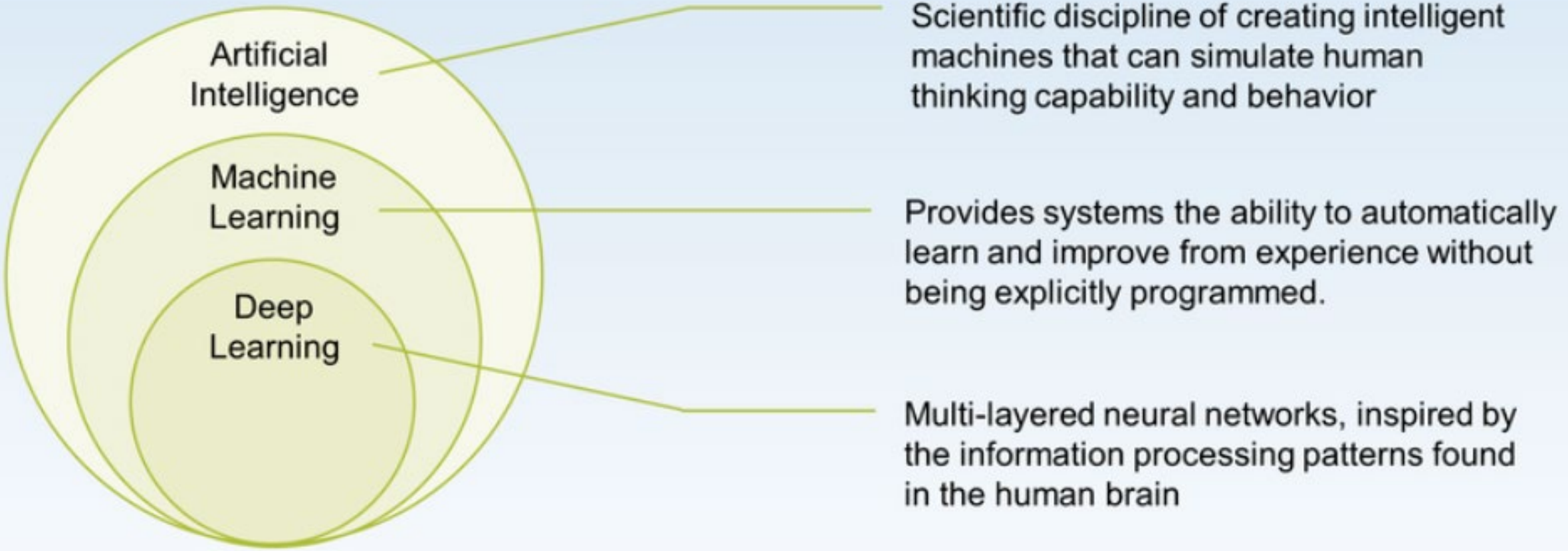


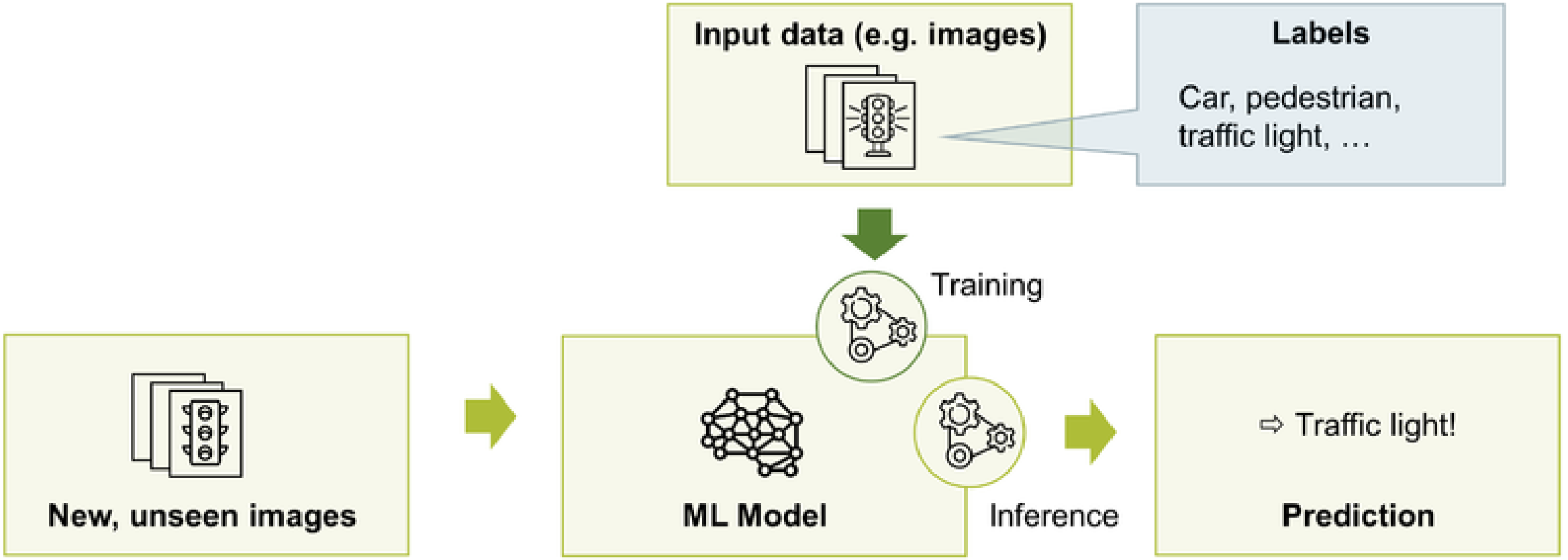
3.1 Basics of Artificial Intelligence and Machine Learning – Types of AI and relation between AI, ML & DL



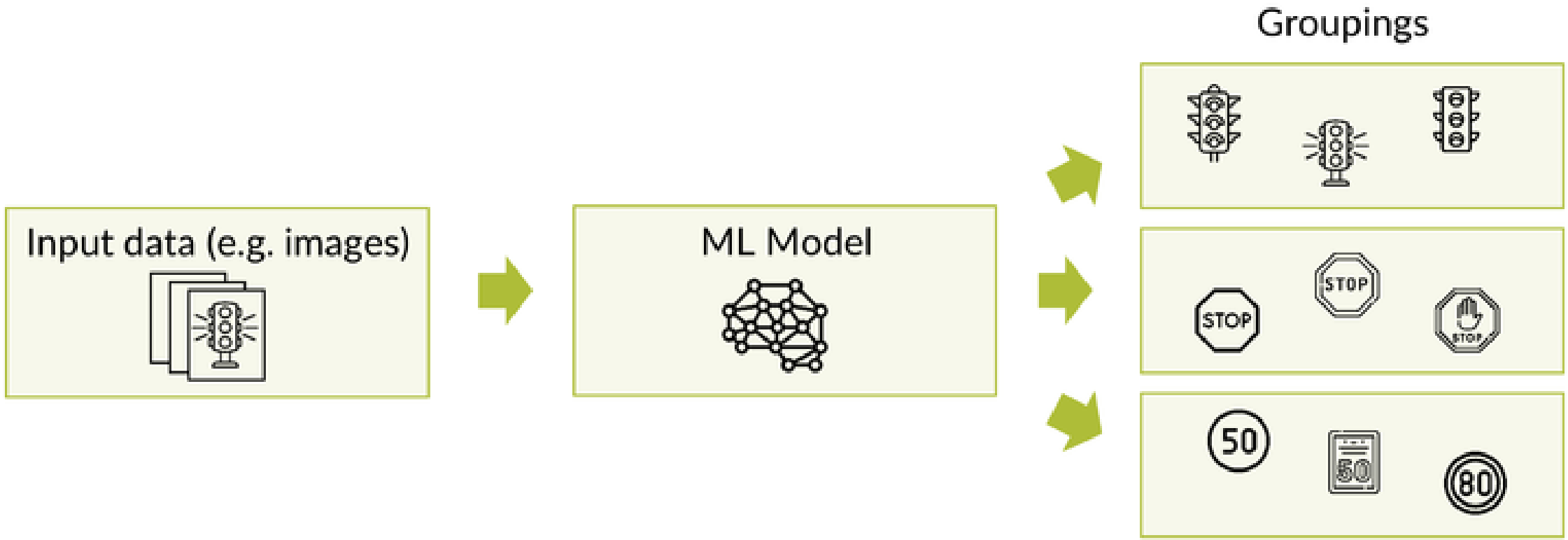
3.1 Basics of Artificial Intelligence and Machine Learning – Key AI Terms and Definitions

Term	Explanation	Example
Instance	The object about which the AI should make a prediction	An image from a vehicle front camera, which needs to be classified as „contains obstacle“ or not
Inference	The process of using a trained model to make predictions about an instance based on new data	Apply an ML model to a new image from the vehicle camera to identify potential obstacles
Label	The outcome of a prediction task (either supplied by the training data or by the AI)	Parts of an image labeled as „traffic light“, „pedestrian“, „speed limit“
Labeling	The process of manually (at least initially) detecting and tagging data samples as input for model training	Manually identify and tag potential obstacles on a large set of images
Training	Machine learning models are trained by using large, representative sets of data, e.g. labeled training data	Manually identify and tag potential obstacles on a large set of images
Feature	An measurable property or characteristic of an instance	Edges and objects in an image
Model	A statistical representation of a prediction task	A model to predict road traffic
Pipeline	The IT infrastructure for an AI/ML algorithm, including data and model management.	The pipline to manage data flows and prediction model definitions

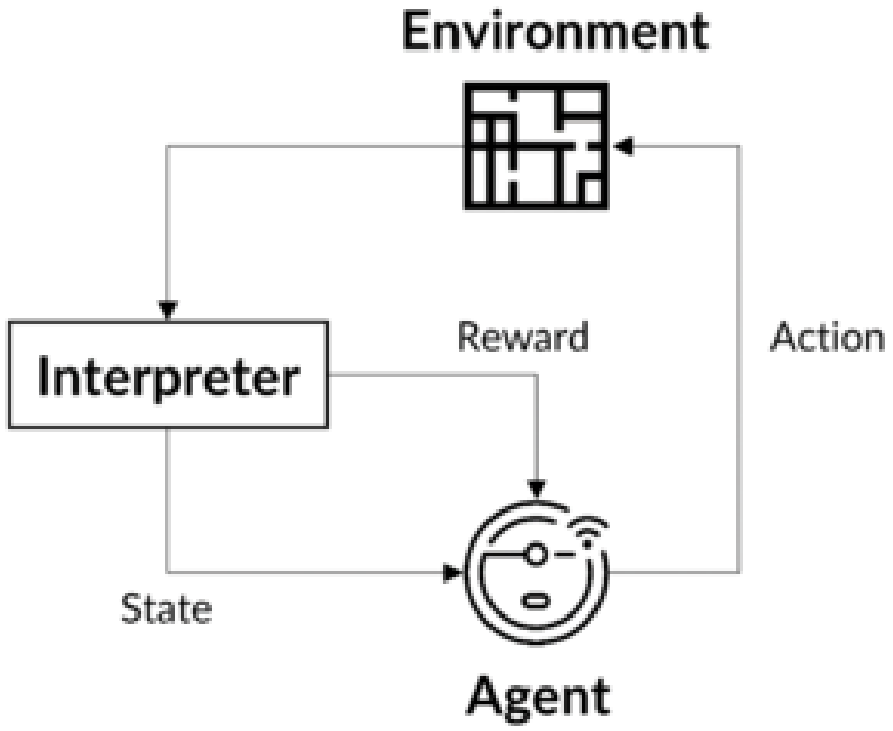
3.1 Basics of Artificial Intelligence and Machine Learning – Supervised Learning



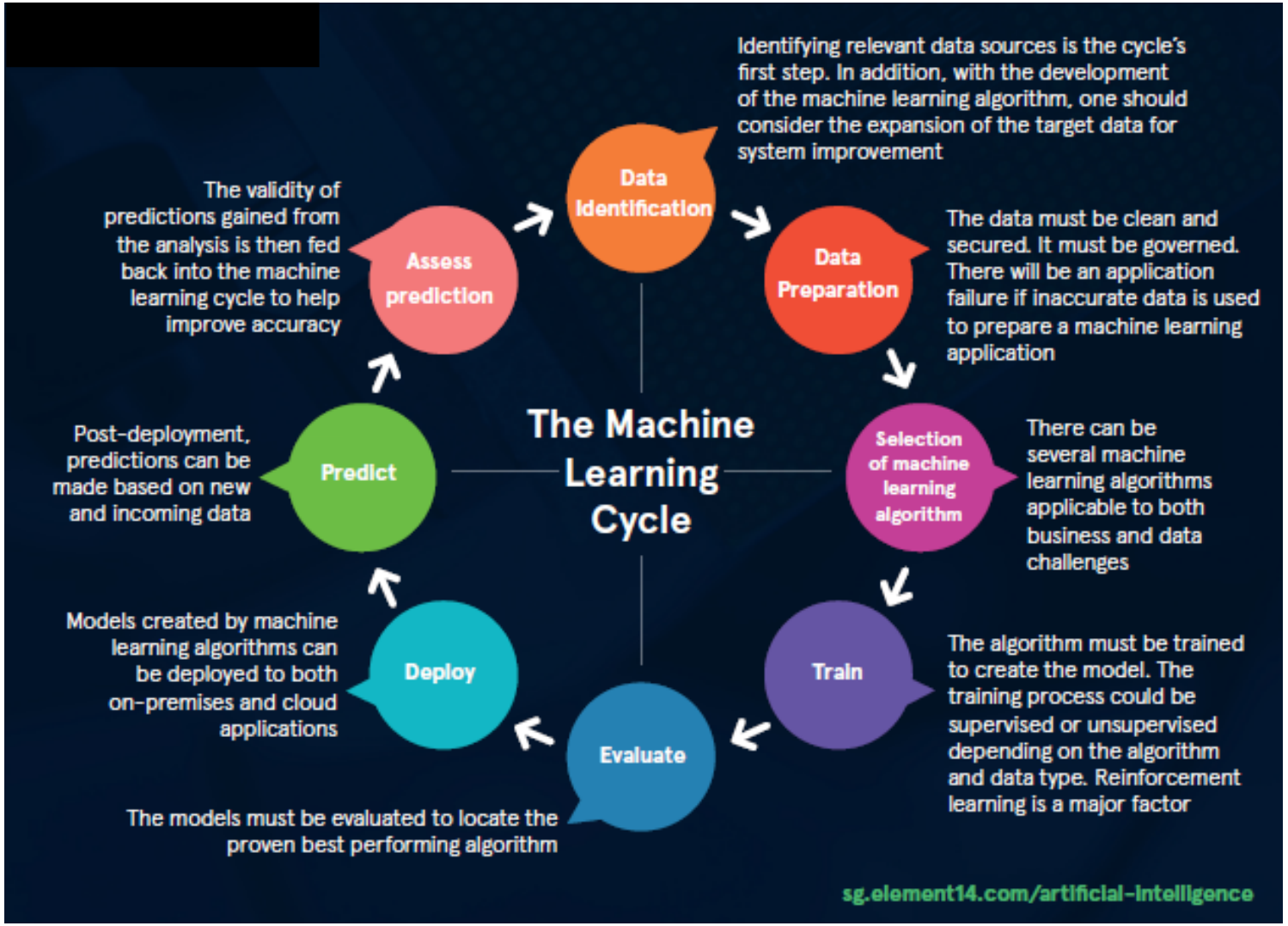
3.1 Basics of Artificial Intelligence and Machine Learning – Unsupervised Learning



3.1 Basics of Artificial Intelligence and Machine Learning – Reinforcement Learning



3.1 Basics of Artificial Intelligence and Machine Learning – The Machine Learning Cycle



Example: Lab #6 Use Case:

- To be added soon.

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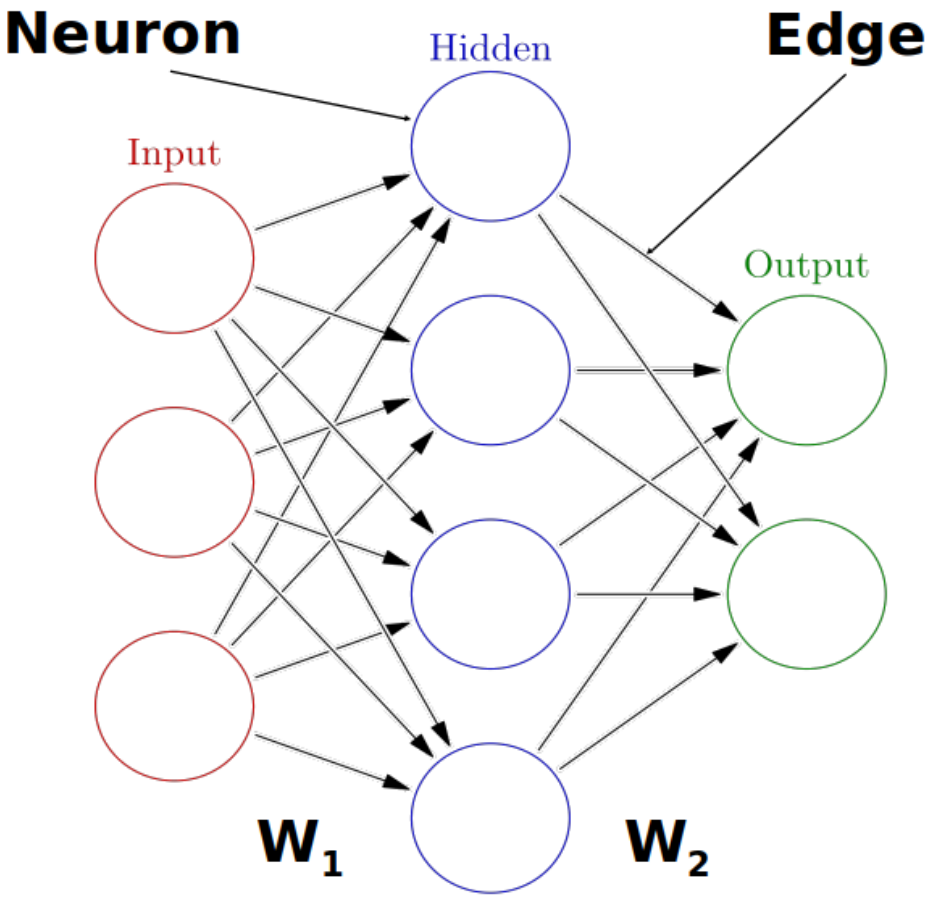
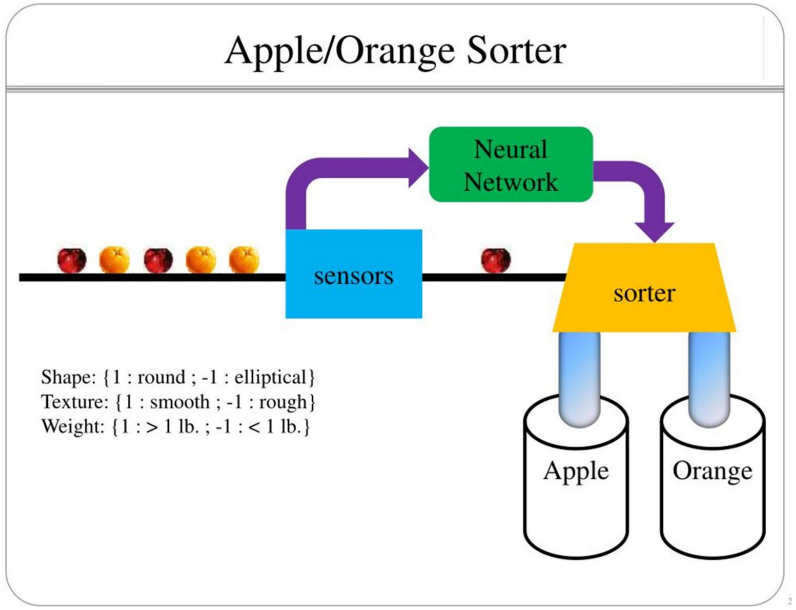
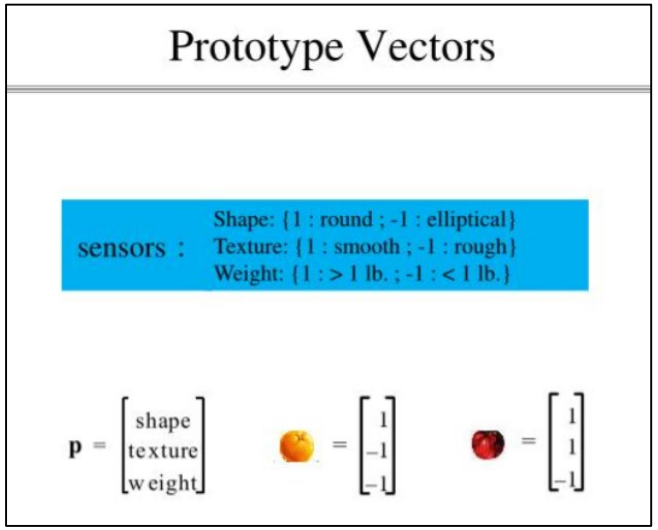
- To be added soon.

3.1 Basics of Artificial Intelligence and Machine Learning – Artificial Neural Networks and Deep Learning





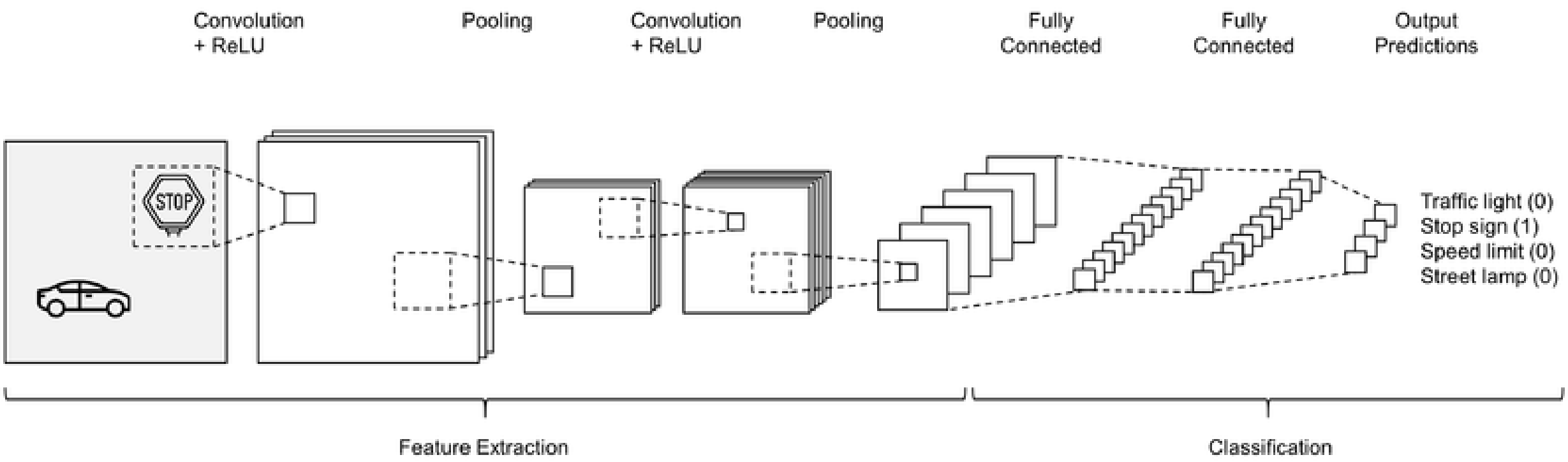


Pattern Recognition Example

- We can use a single-neuron perceptron with three inputs, because there are only two categories (**apple or orange**).

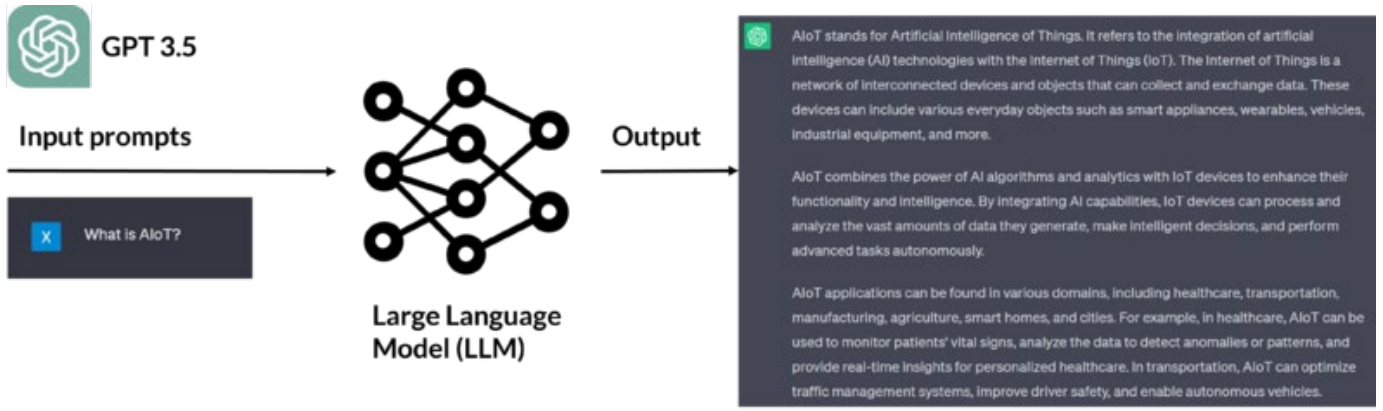
$$a = hardlims\left(\begin{bmatrix} w_{1,1} & w_{1,2} & w_{1,3} \end{bmatrix} \begin{bmatrix} p_1 \\ p_2 \\ p_3 \end{bmatrix} + b \right)$$

3.1 Basics of Artificial Intelligence and Machine Learning – Artificial Neural Networks and Deep Learning

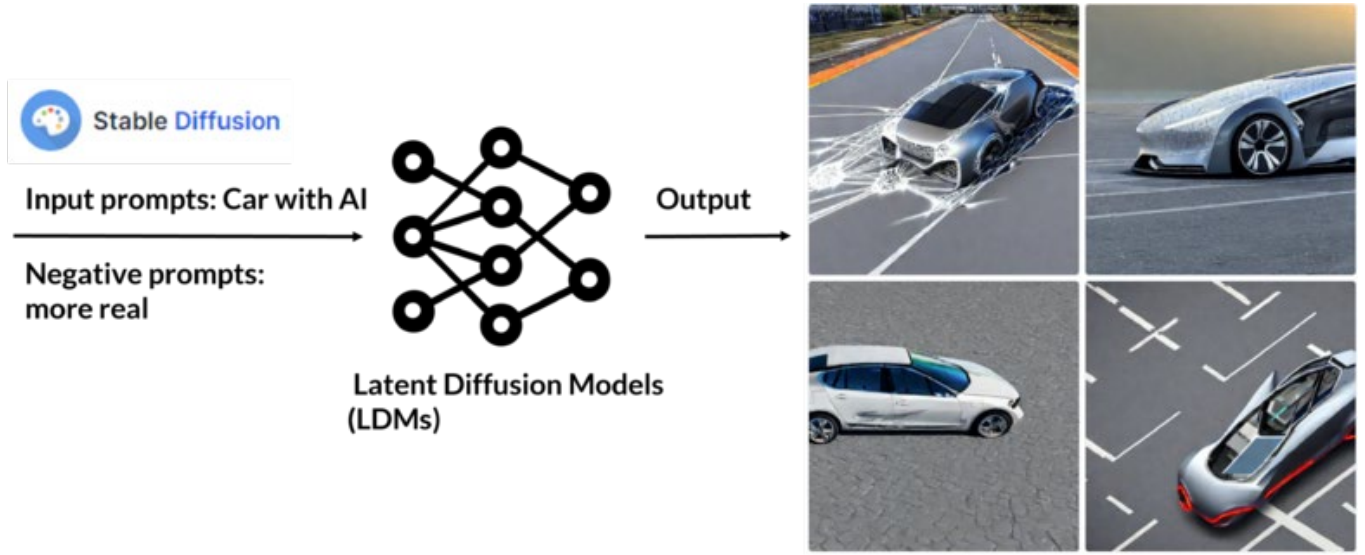


Identify visual features (e.g. edges, dark/light gradients) ⇨ combine visual features into patterns ⇨ learn how patterns combine to make signature forms ⇨ combine forms to recognize objects

3.1 Basics of Artificial Intelligence and Machine Learning – Generative AI



https://chat.openai.com/



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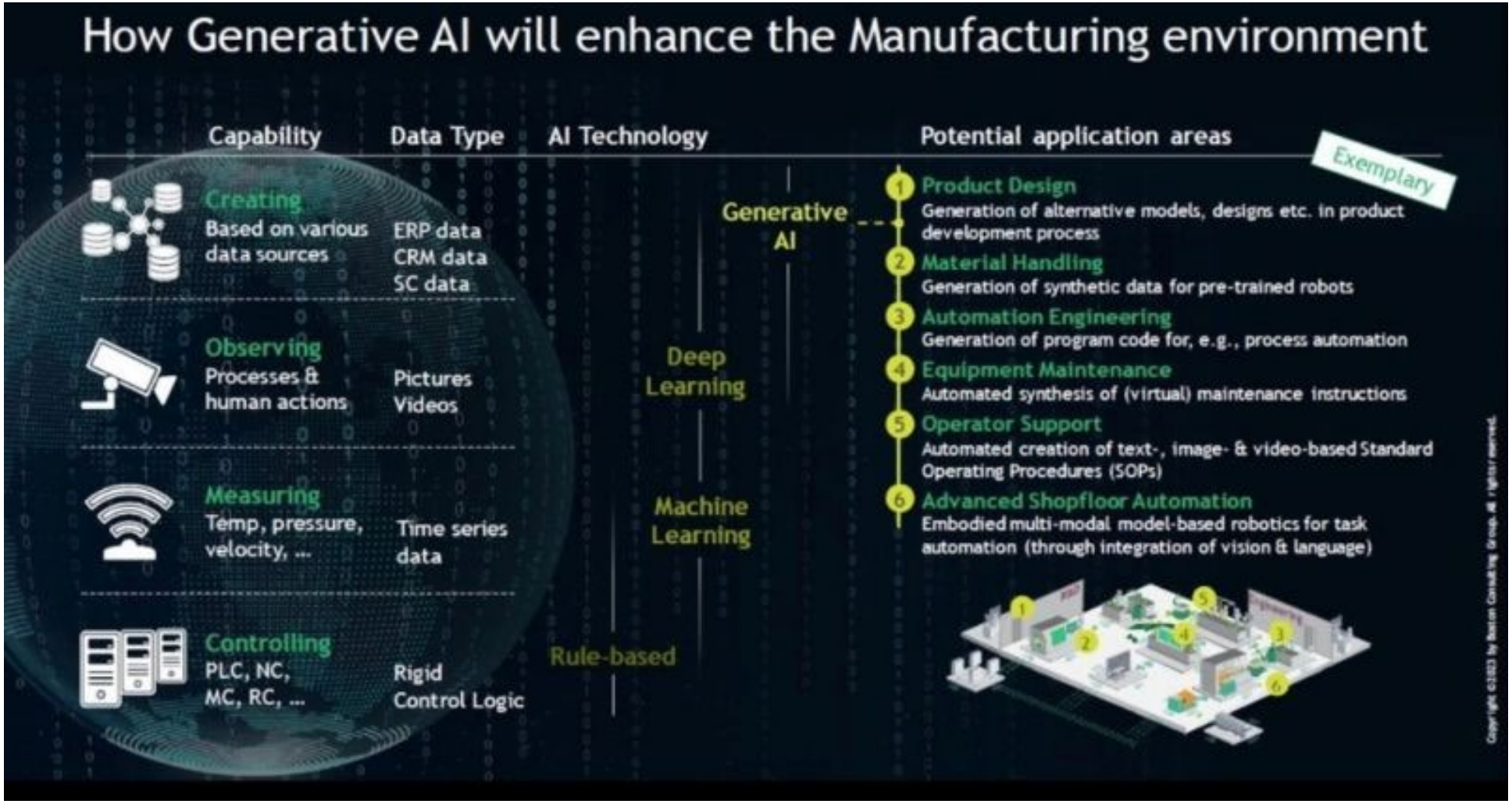
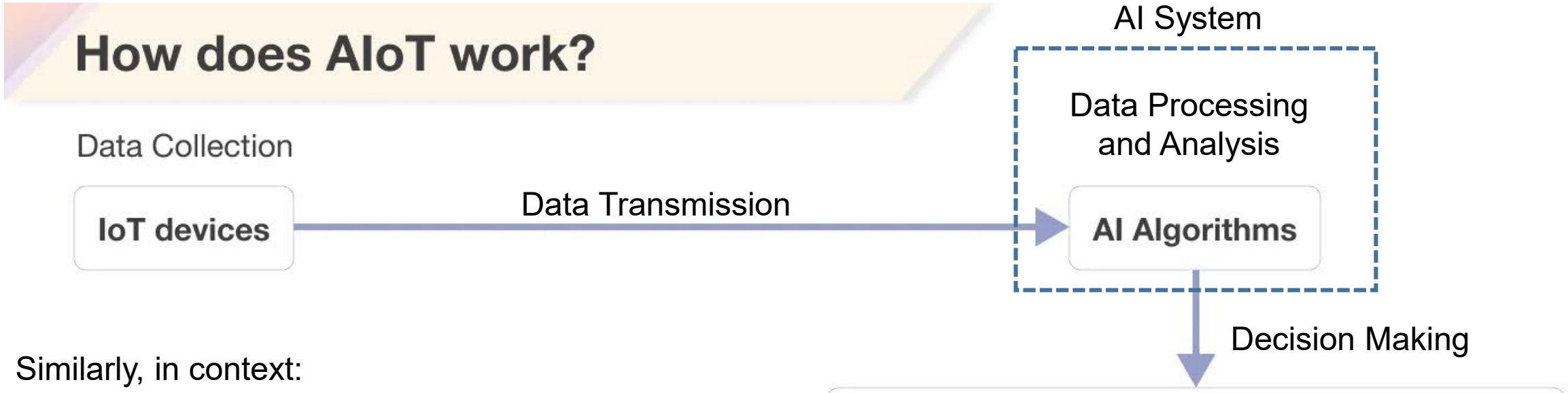
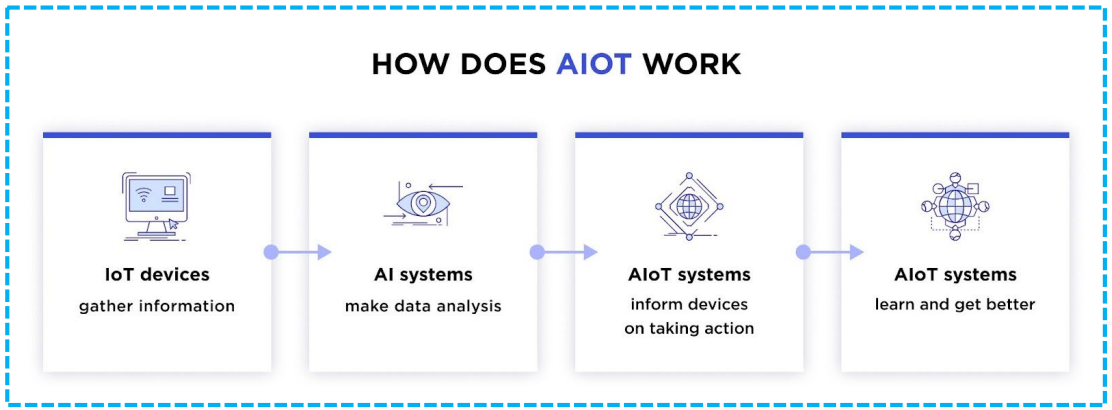


3.2 AIoT Architectures and Integration of AI and IoT



Similarly, in context:



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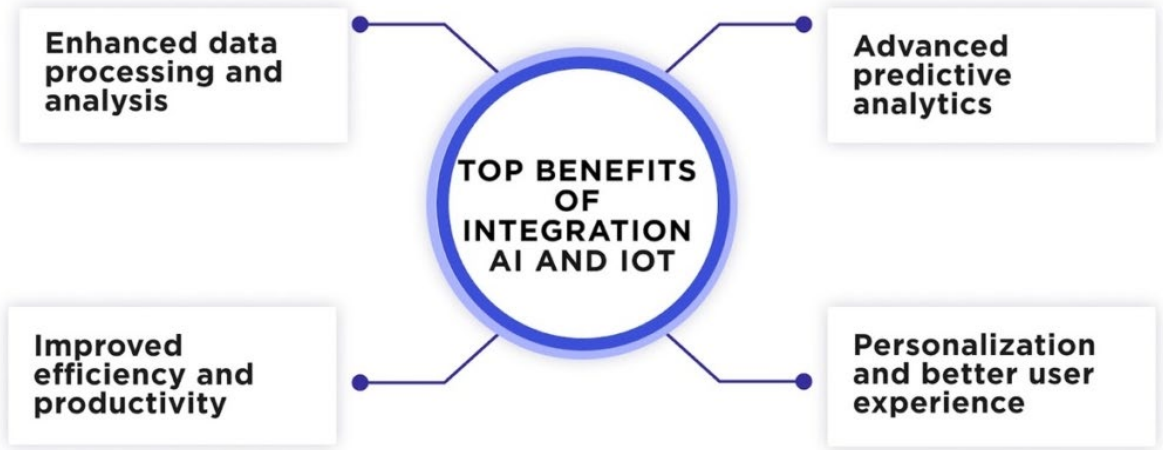

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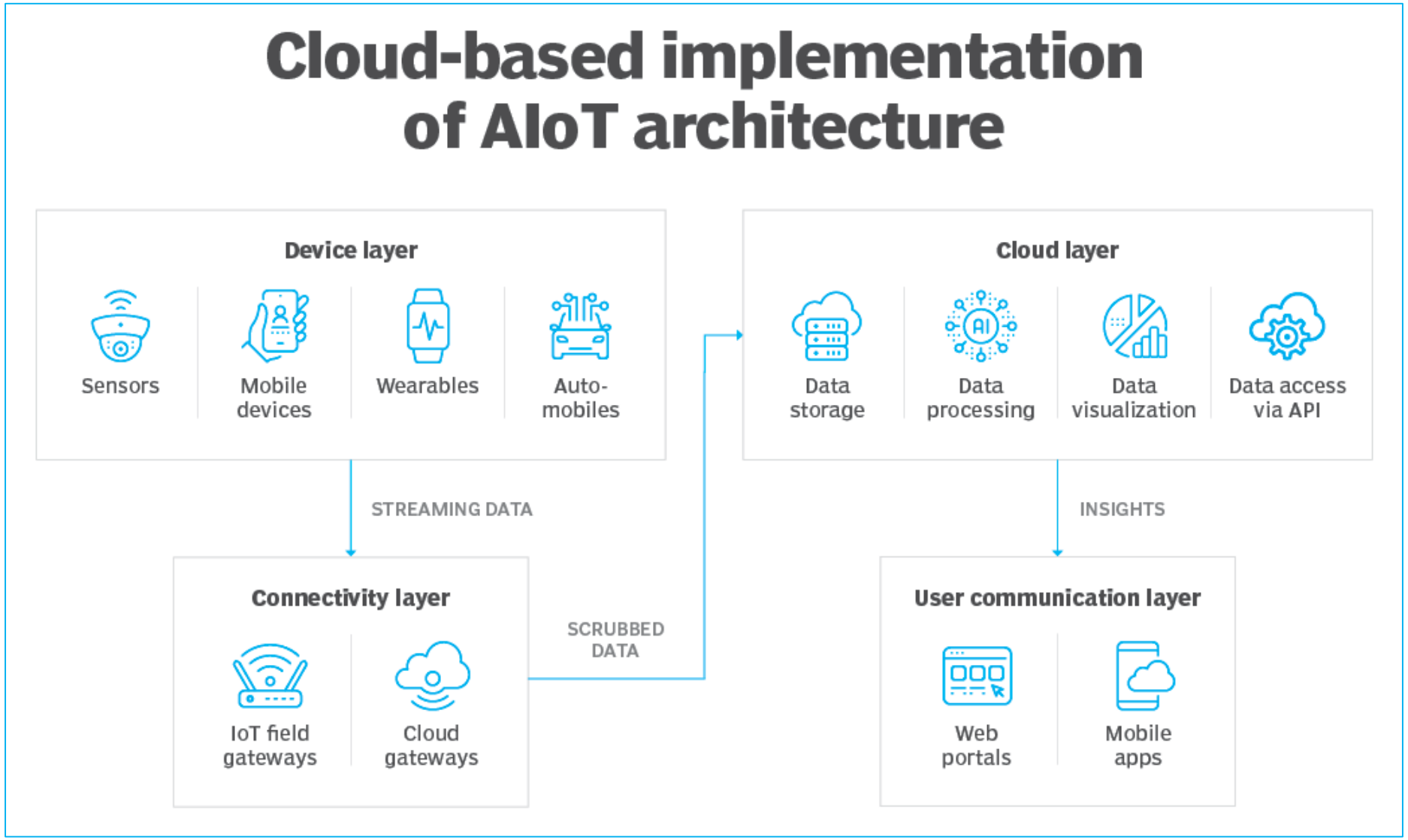

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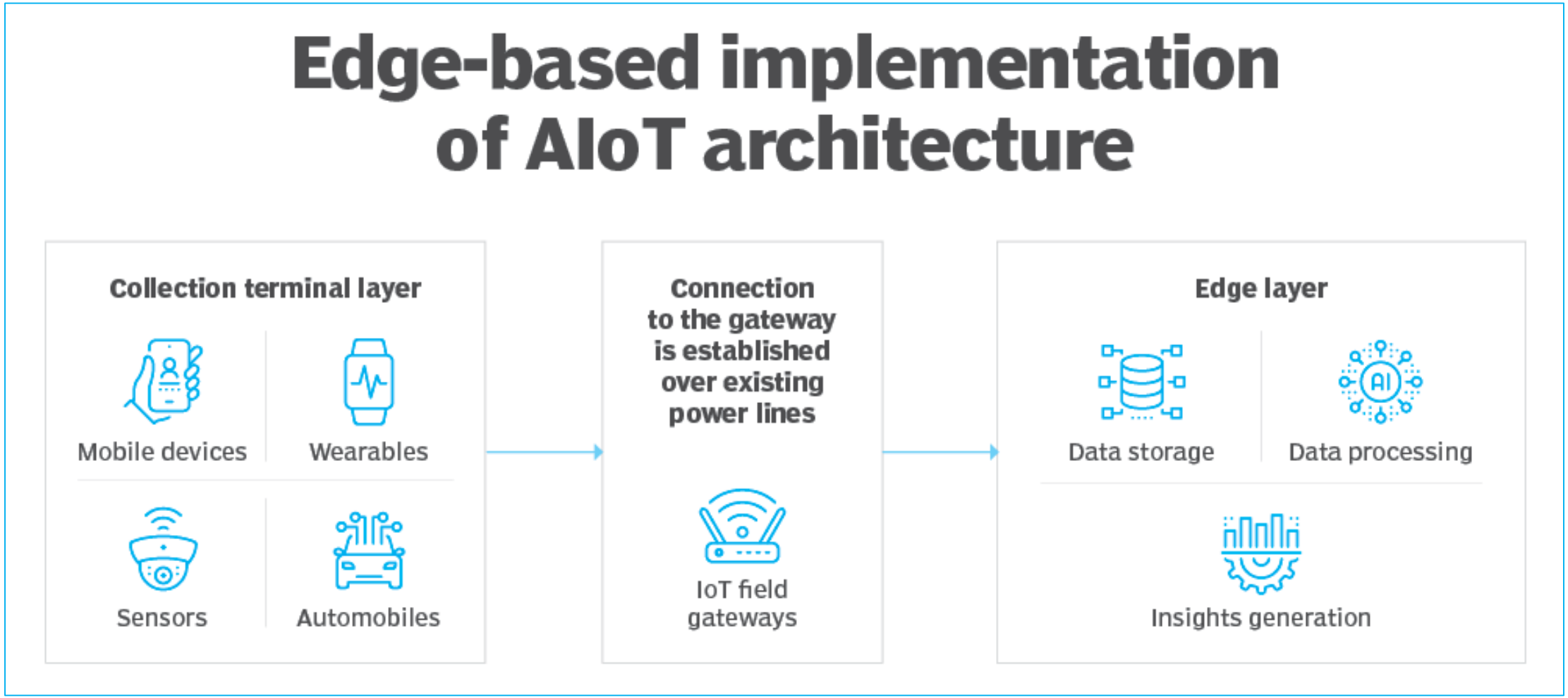
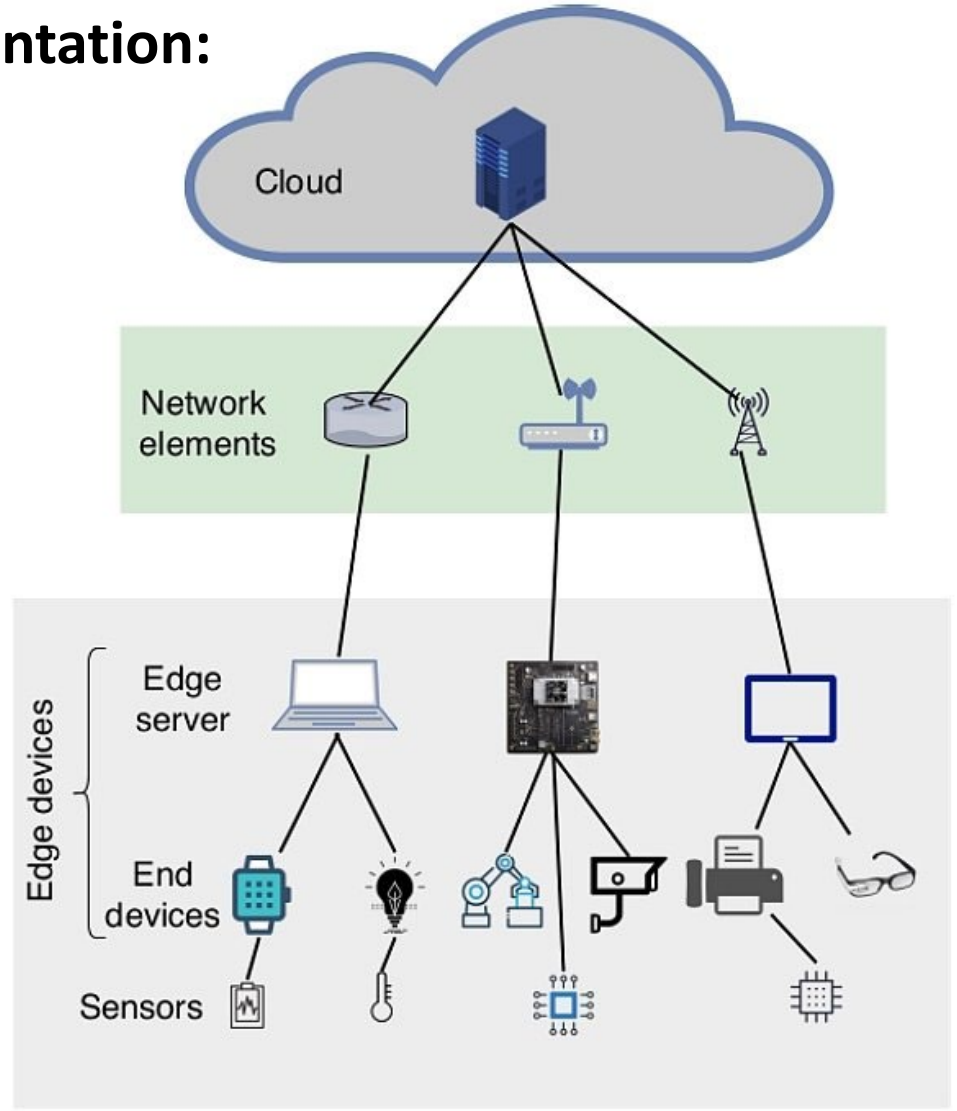
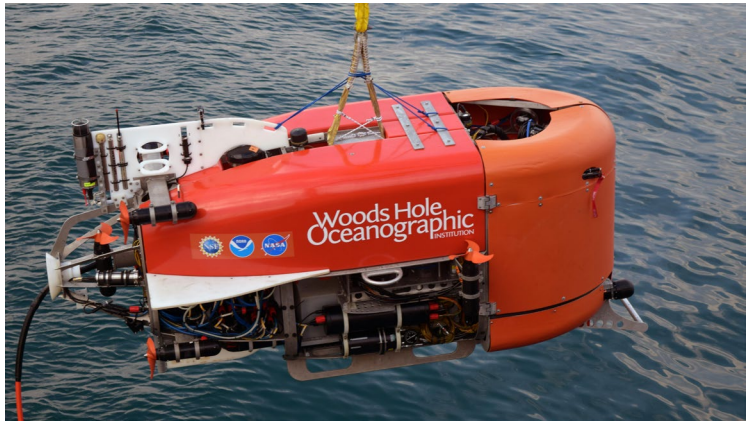


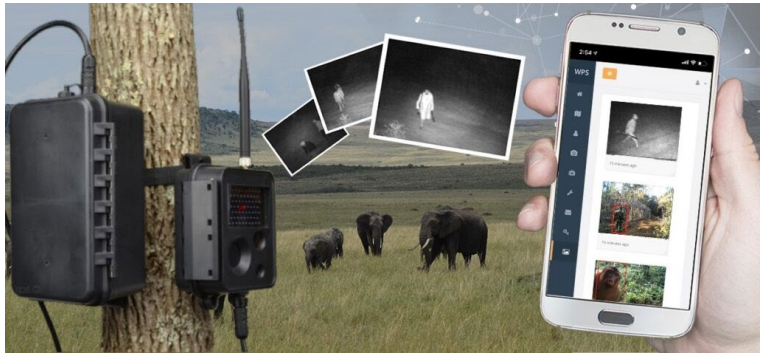
3.2 AIoT Architectures and Integration of AI and IoT

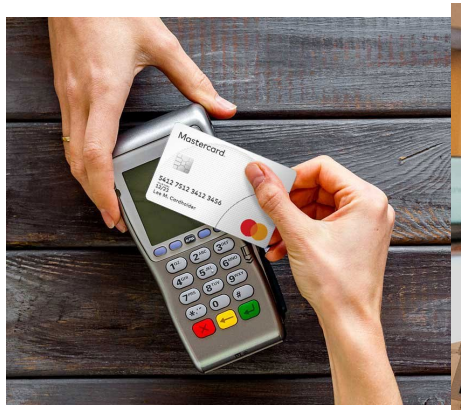
Edge Device Implementation:

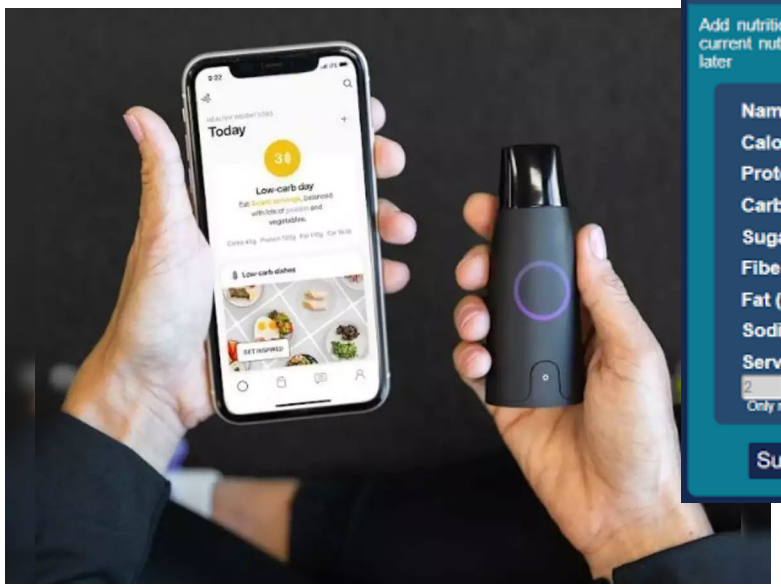


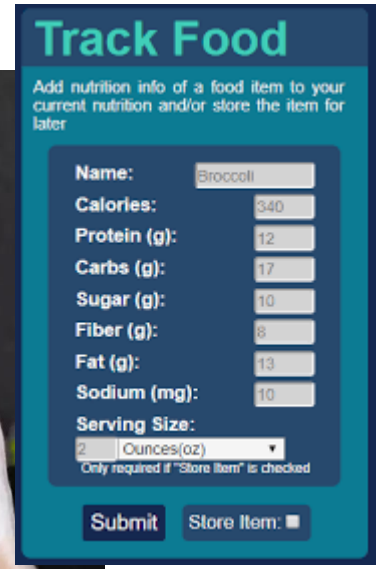
3.3 (Real-world) Examples of AIoT Applications





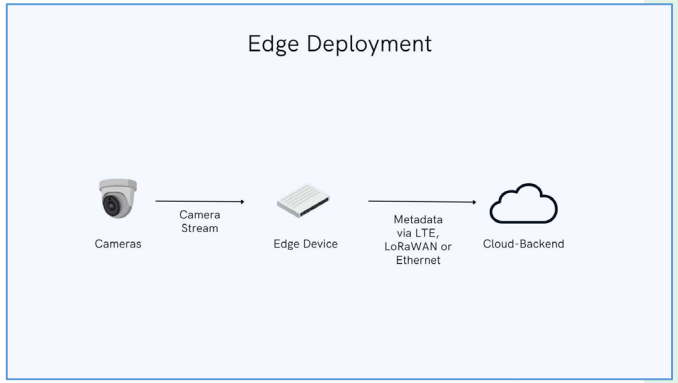






3.3 (Edge Device) Examples of AIoT Applications

A few notable applications of the edge devices are:



Surveillance and Monitoring

Deep Learning-enabled smart cameras can locally process captured images to identify and track multiple objects and people. The technology can detect suspicious activities directly on the Edge node.

Audio Event Detection

Distinguishing sounds like baby crying, glass breaking, or a gunshot can trigger an action, including notifications or location detection, via triangulation. Since understanding specific sound events in multisource conditions is a latency-critical task, AI at the Edge can be super-fast and effective. It can recognize an audio event among plentiful overlapping sound sources.

Body Monitoring

Wearable devices collect a lot of data about an individual's activity, location, and heart rate among others. This information can be correlated with health, stress levels, and diet. It can alert wearers to a potential health issue before it becomes critical.

Text To Speech (TTS) & Speech to Text (STT)

Two examples of complex tasks in which AI and DL are used to bring these functionalities on the Edge. Examples include hands-free text read and write functions in automotive, where the driver can keep attention on his main task (drive the car) while interacting with the infotainment system.