# Cognitive Robotics

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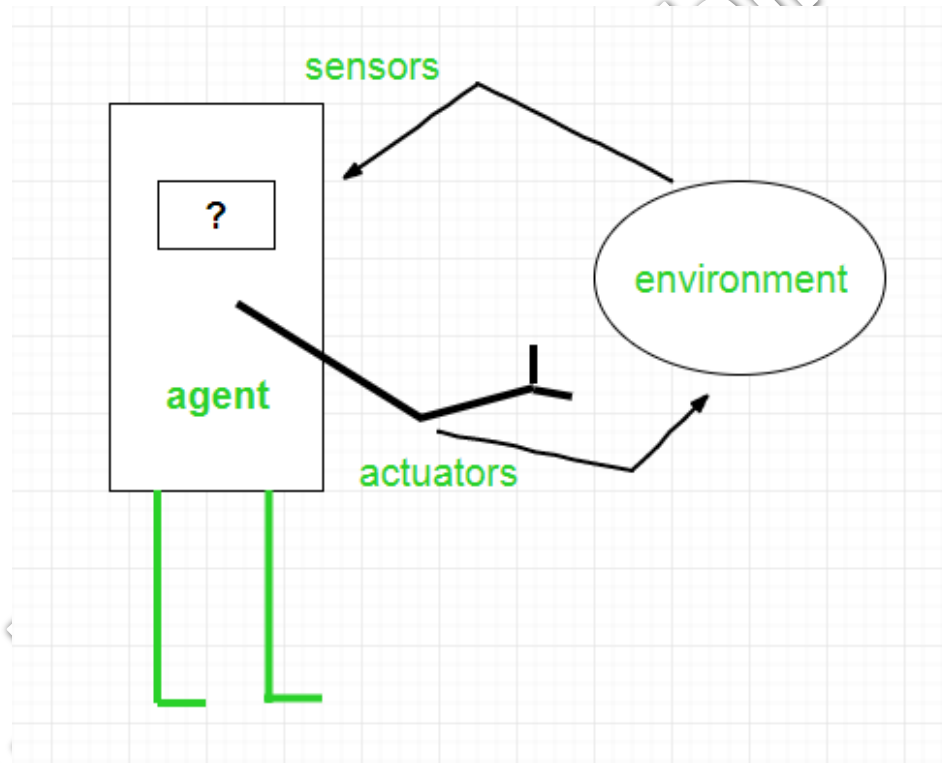
# Cognitive Robotics

**Cognitive robotics** is concerned with

- A robot with intelligent behavior



https://robotics.iiit.ac.in/roman-workshop/

# An architecture for Normal Robot



**Absence of decision making like humans in normal robots**

- Most of the <span style="color:red">work in robotics</span> emphasizes basic level tasks like
  - sensory processing,
  - path planning,
  - manipulator design and control,
  - reactive agents etc.

- <span style="color:cyan">Cognitive robotics</span> is concerned with the theory and the implementation of robots that is able to
  - reason, act and perceive in changing and, incompletely known and,
  - unpredictable environments.

**Cognitive robotics** is concerned with………

- Cognitive robots must have
  - higher level cognitive functions
  - reasoning,
  - for example, about goals, actions, when to perceive and what to look for,
  - the cognitive states of other agents and time,
  - collaborative task execution, etc.

# An architecture for learning and reasoning
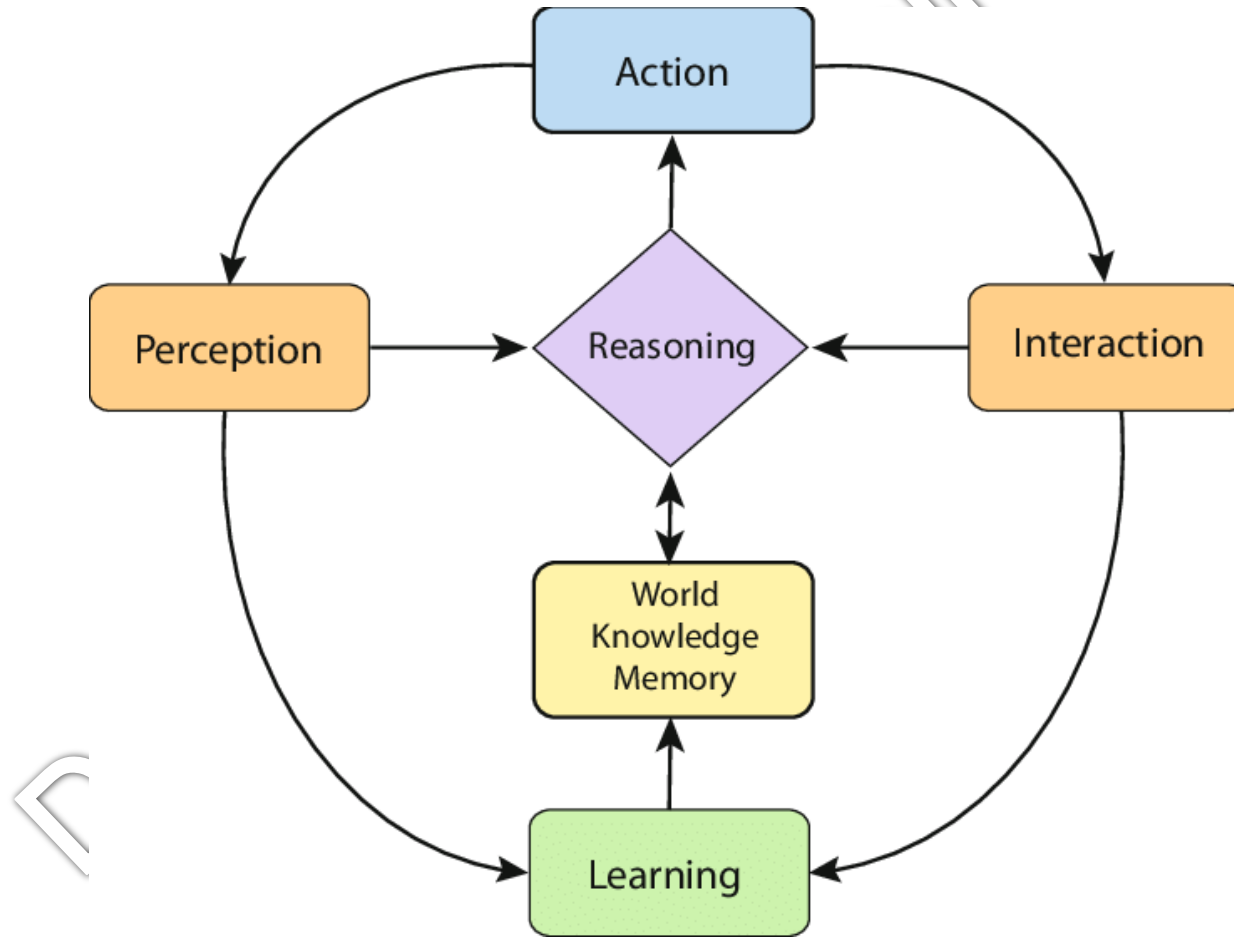
# Response to complex goals in a complex world



**A simple task of pattern matching**



**A series of tasks, dependent / independent to each other**

# Human Cognition

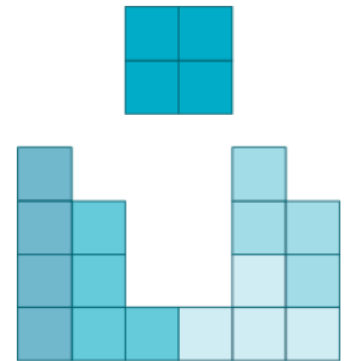Cognitive Functions

Attention

Executive Functions

Language

Memory

Social Cognition

Visuospatial Skills

# Cognitive Functions

**Perception**

- A process that transforms raw input into the system's internal representation for carrying out cognitive tasks.

**Attention**

- External or perceptual attention selects and modulates information incoming from various senses.

- Internal attention modulates internally generated information, such as the contents of working memory or possible behaviors in a given context.

# Cognitive Functions

**Memory**

- An essential part of any systems-level cognitive architecture for both studying human mind and solving engineering problems.

- Memory systems store intermediate results of computations, enable learning and adaptation to the changing environment.

**Learning**

- The capability of a system to improve its performance over time. Practically, any kind of learning is on the base of experience that is the knowledge.

# Cognitive robotics focus on **cognitive science** and embedding **cognition process** in robotics
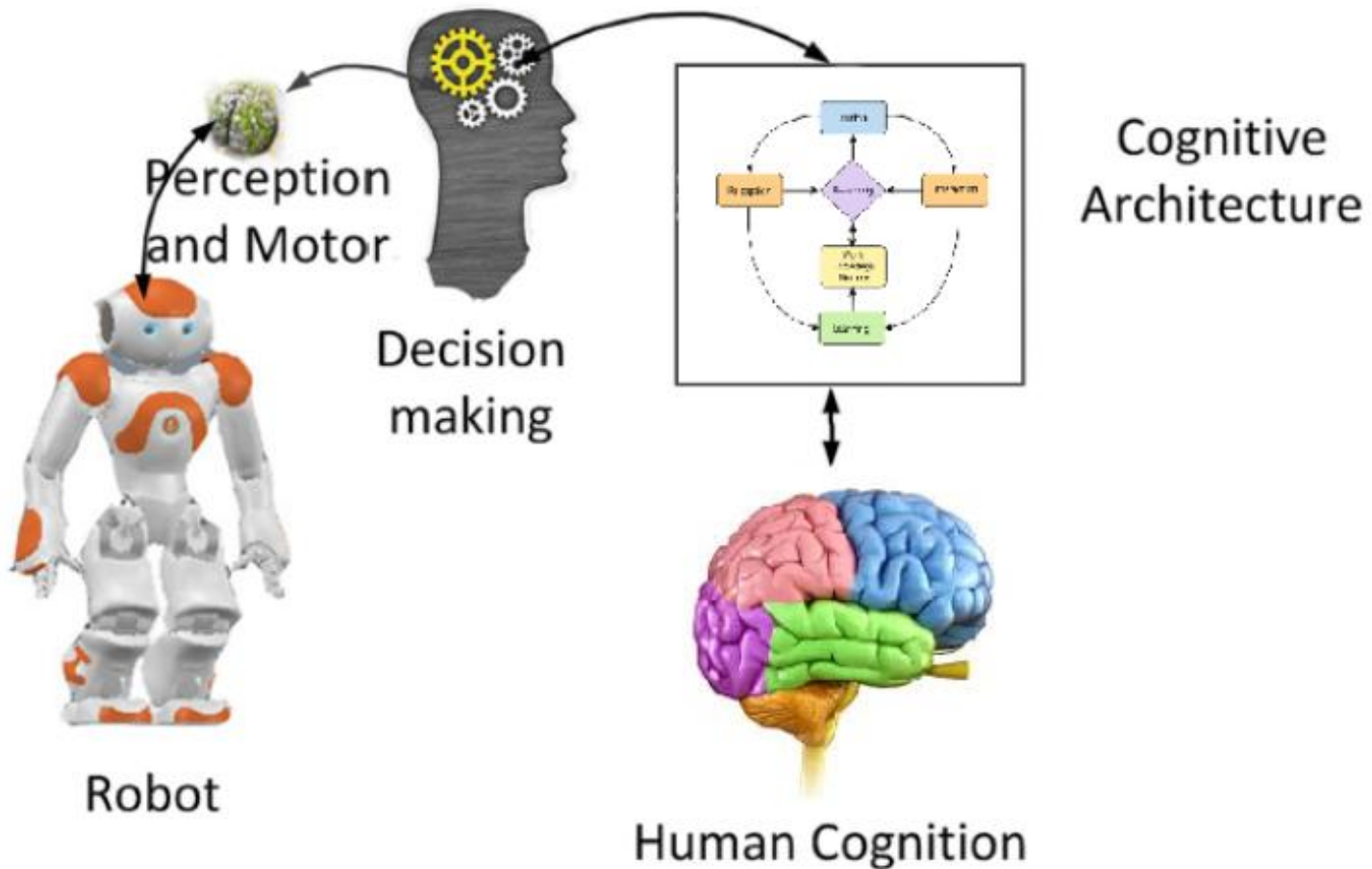


**Cognitive Robotics Framework**

# Cognitive Architecture for Robot

A cognitive architecture for robot (CAR) includes

- Perception,
- Information processing,
- Knowledge and learning,
- Decision-Making
- Motor module

# Principle of Cognitive Architecture for Robot
# (Similar to Human Cognition)
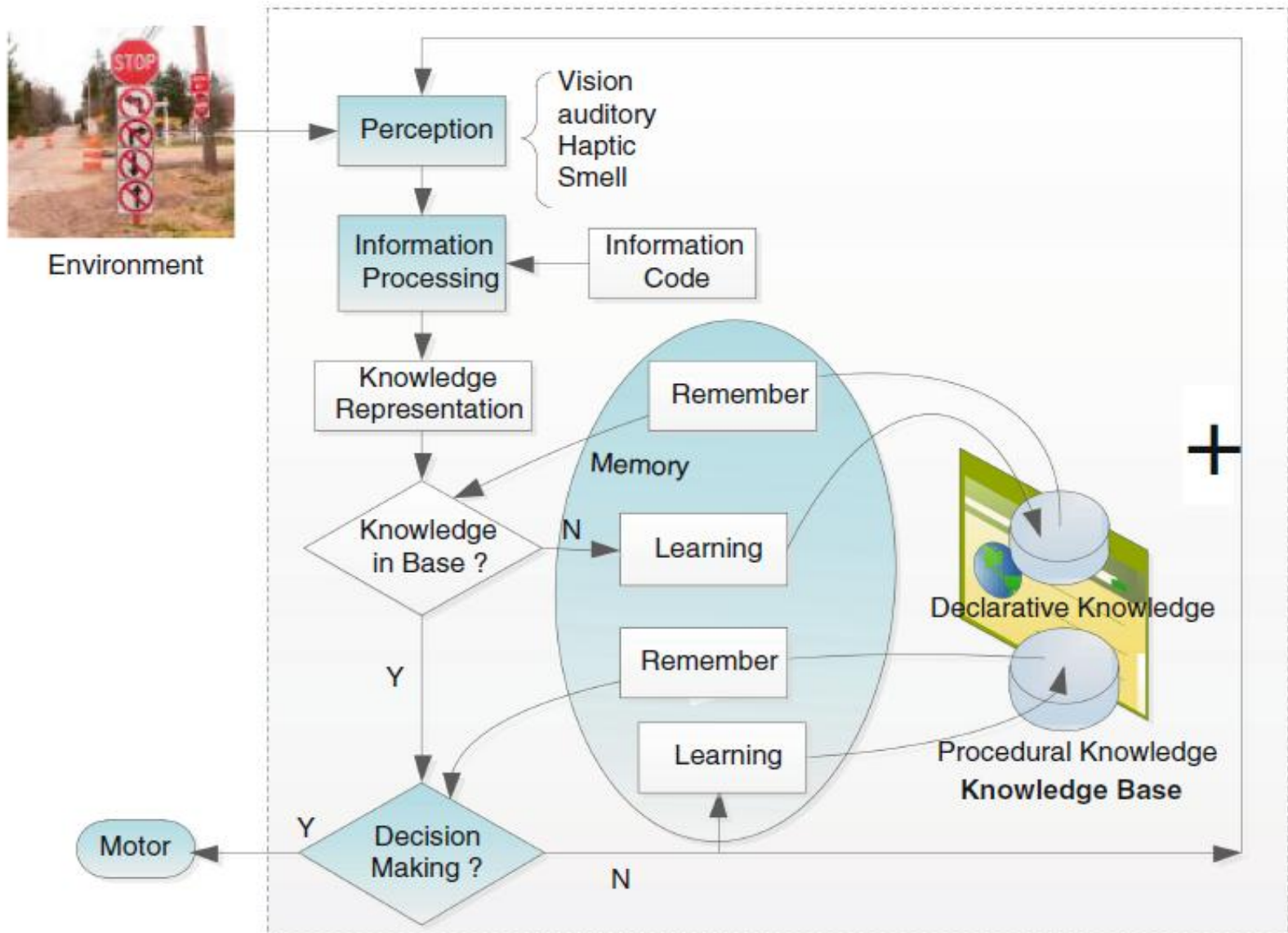
# NAO

- NAO is the world's leading and most widely used <span style="color:red">humanoid robot</span> for education, healthcare, and research

- Autonomous and fully programmable robot

- That can walk, talk, listen to human, and even recognize human's face.

- <span style="color:#00AEEF">Most important for research</span>, NAO is integrated in a sophisticated simulation platform v-rep

- <span style="color:#00AEEF">Virtual Robot Experimentation Platform</span> (V-REP)

# NAO

- ## NAO humanoid robot

- Face Learning/Recognition,
- Environment Detection/Navigation,
- Posture Awareness/Self-Balancing/Fall
- Protection/Self-Recovery from Falls,
- Fully Programmable,
- Internet Connectivity

# Mapping Cognitive Functions to Brain Lobes

- One of the main goals of a cognitive architecture is to summarize the various results of cognitive psychology in a comprehensive computer model.

- The studies have proved that different parts of the brain control different human behaviors.

- Beyond, the more important for the behavioral outcome is interaction between brain areas than the efficient processing of a single brain region.

# Human Decision-Making

## Factors affecting decision making process
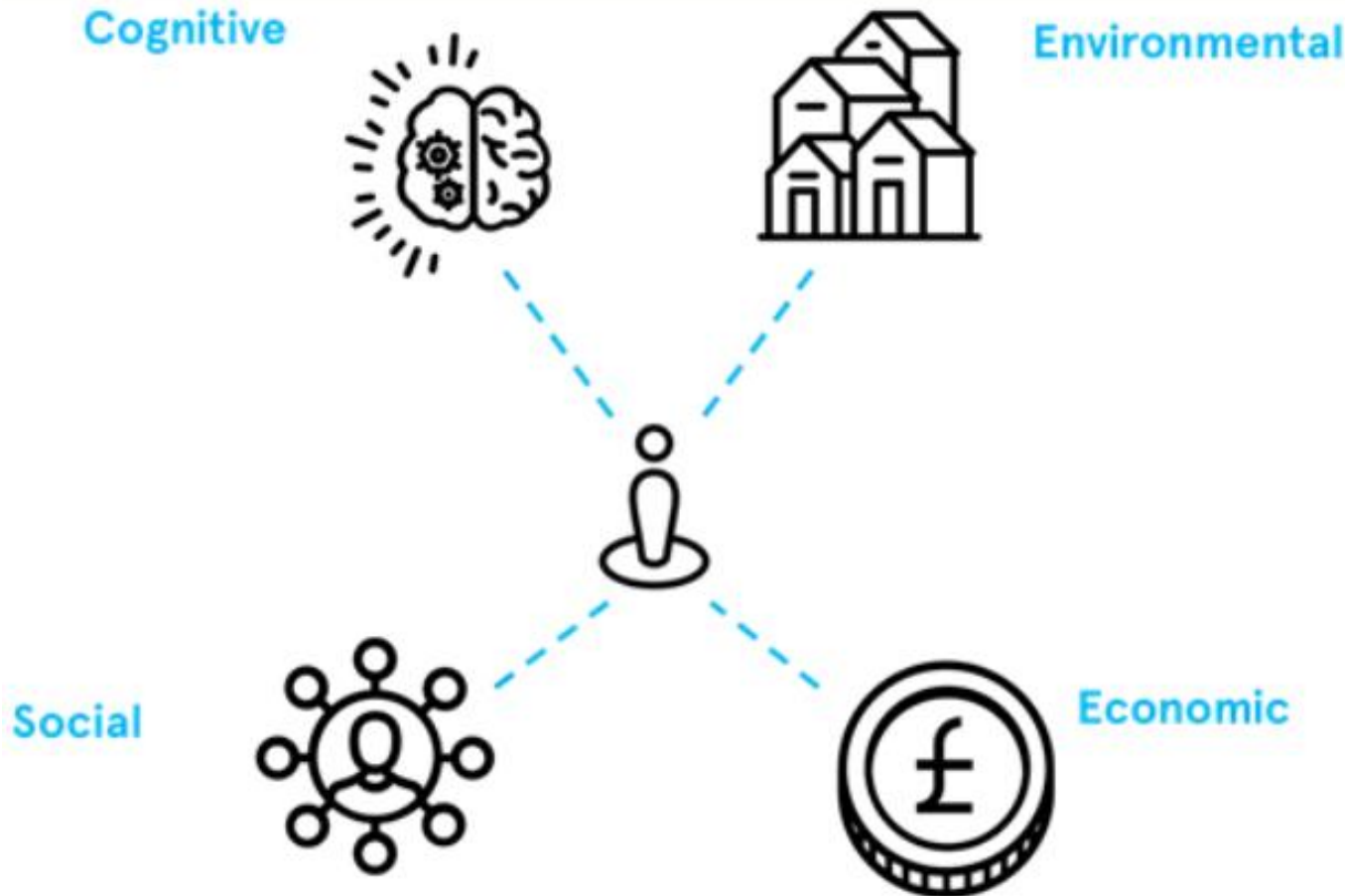
Human Decision-Making is very Complex process to model

How to model Human Decision-Making ?

# Refernces

- https://www.neuronup.com/en/areas/functions
- https://www.softbankrobotics.com/emea/en/nao
- Liu, Yanfei, et al. "Cognitive Architecture Based Simulation of Perception and Behavior Controls for Robot." *International Conference on Applied Human Factors and Ergonomics*. Springer, Cham, 2018.