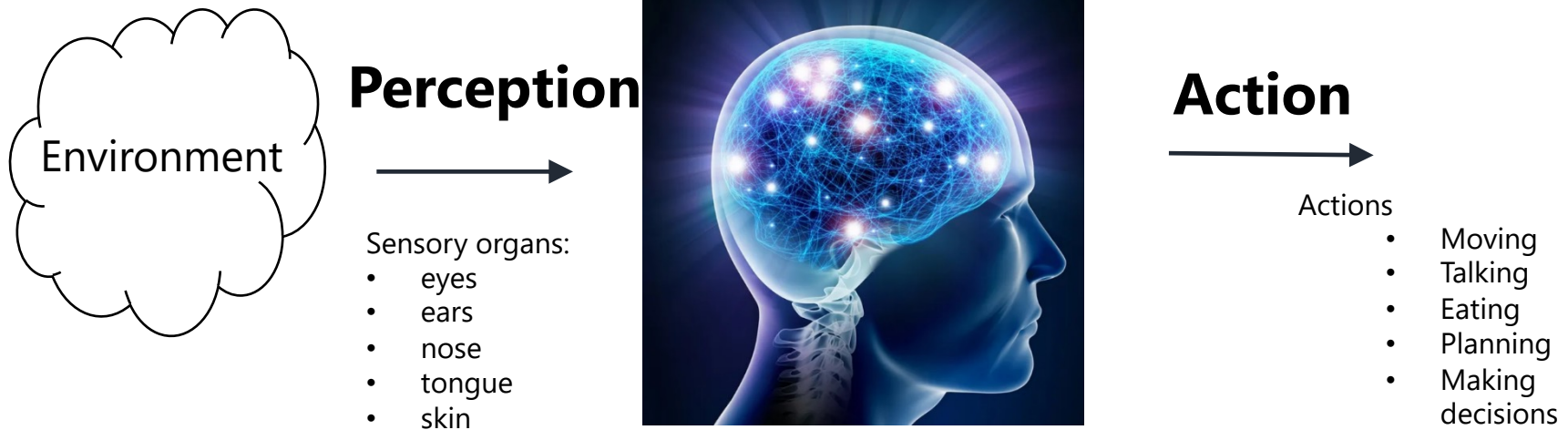# IT5005 Artificial Intelligence
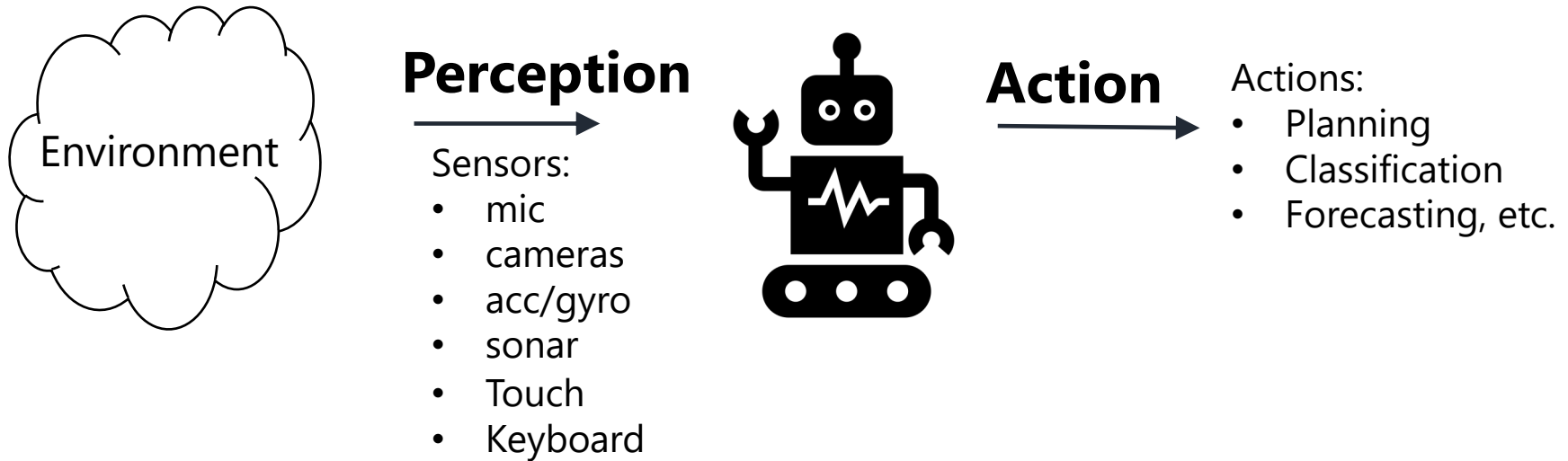
Introduction

Sirigina Rajendra Prasad
AY2025/2026: Semester 1

Intelligent Agents

Environment

Perception

Sensory organs:
- eyes
- ears
- nose
- tongue
- skin

Action

Actions
- Moving
- Talking
- Eating
- Planning
- Making decisions

Artificial Intelligent Agents

Environment

Perception

Sensors:
- mic
- cameras
- acc/gyro
- sonar
- Touch
- Keyboard

Action

Actions:
- Planning
- Classification
- Forecasting, etc.

A Simple Math Problem

- John has 4 bags, and each bag has 6 marbles. How many marbles does he have in total?
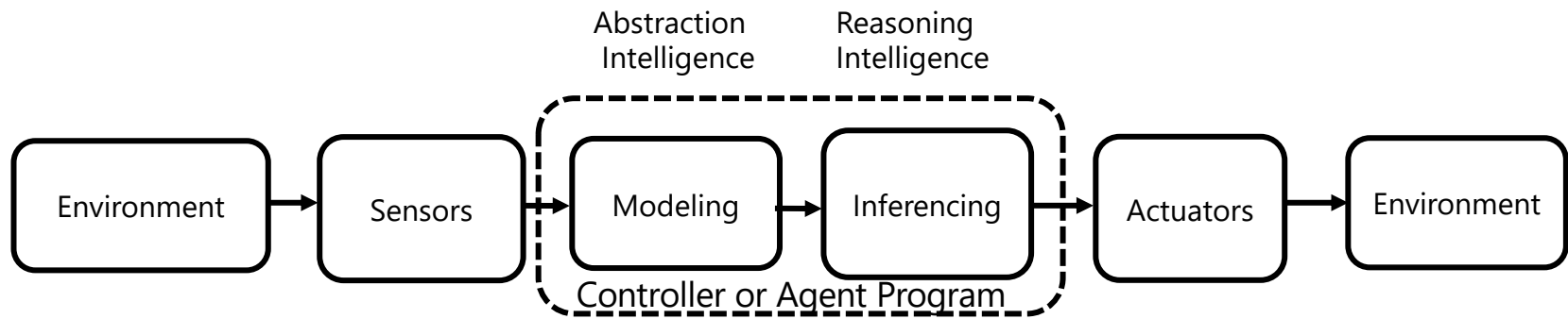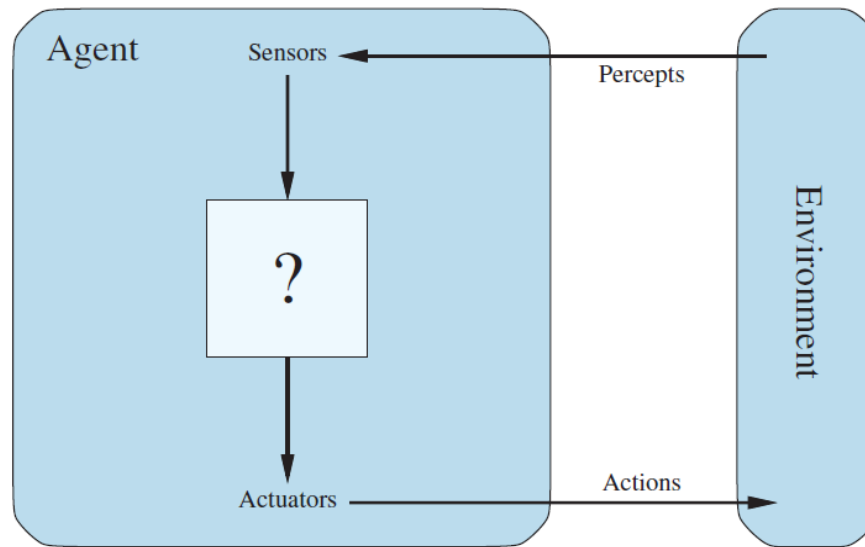
How do we solve it?

Read	Understand
Identify the Question	Plan a Solution
Solve	Communicate

AI Agent Architecture

Design Space

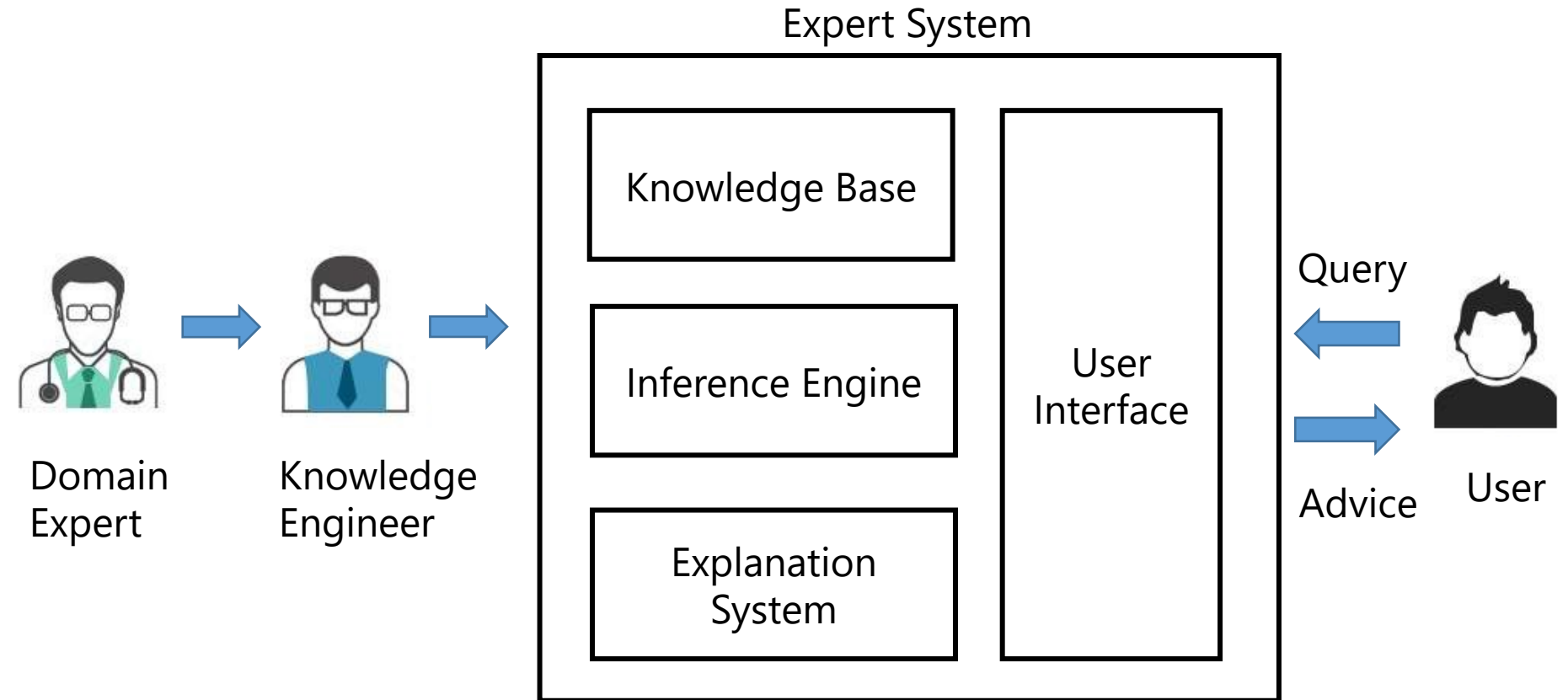| Dimension	Values
Environment	Static, Dynamic
Representation Scheme	States, Features, Relations
Observability	Fully Observable, Partially observable
Parameter Types	Discrete, Continuous
Uncertainty	Deterministic, Stochastic
Learning	Knowledge is given (known), knowledge is learned (unknown)
Number of Agents	Single Agent, Multiple Agent

Logic-based Systems

- Representation
  - ➢ Logical formalisms for knowledge representation
    - o Facts and Rules using propositional logic, First-order logic, etc.

- Reasoning
  - ➢ Search
    - o Systematic exploration of the knowledge base to derive new knowledge

Logic Theorist is a computer program written in 1956 by Allen Newell, Herbert A. Simon, and Cliff Shaw.[1] It was the first program deliberately engineered to perform automated reasoning and is called "the first artificial intelligence program".[1][a] *See § Philosophical implications* It would eventually prove 38 of the first 52 theorems in Whitehead and Russell's *Principia Mathematica* and find new and more elegant proofs for some.[3]

https://en.wikipedia.org/wiki/Logic_Theorist

Expert Systems

Expert Systems

RULE035

PREMISE: ($AND (SAME CNTXT GRAM GRAMNEG)
(SAME CNTXT MORPH ROD)
(SAME CNTXT AIR ANAEROBIC))
ACTION: (CONCLUDE CNTXT IDENTITY BACTEROIDES TALLY .6)

IF: 1) The gram stain of the organism is gramneg, and
2) The morphology of the organism is rod, and
3) The aerobicity of the organism is anaerobic
THEN: There is suggestive evidence (.6) that the identity
of the organism is bacteroides

FIGURE 4-3   A MYCIN rule, in both its internal (LISP) form and English translation. The term CNTXT appearing in every clause is a variable in MYCIN that is bound to the current context, in this case a specific organism (ORGANISM-2), to which the rule may be applied.

https://www.aaai.org/Papers/Buchanan/Buchanan06.pdf

Expert Systems: Handling Uncertainty

- Representation
  - ➢ Probabilistic graphical models
    - o Knowledge is encoded as a graph and conditional probabilities
- Reasoning
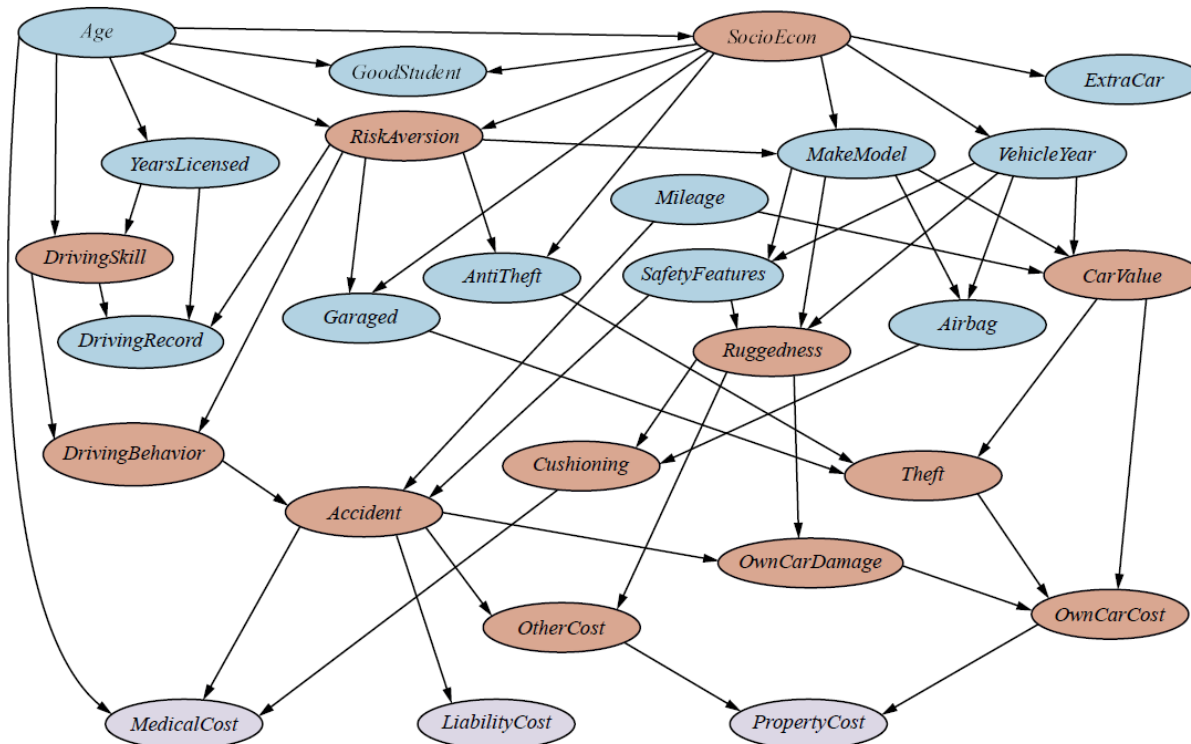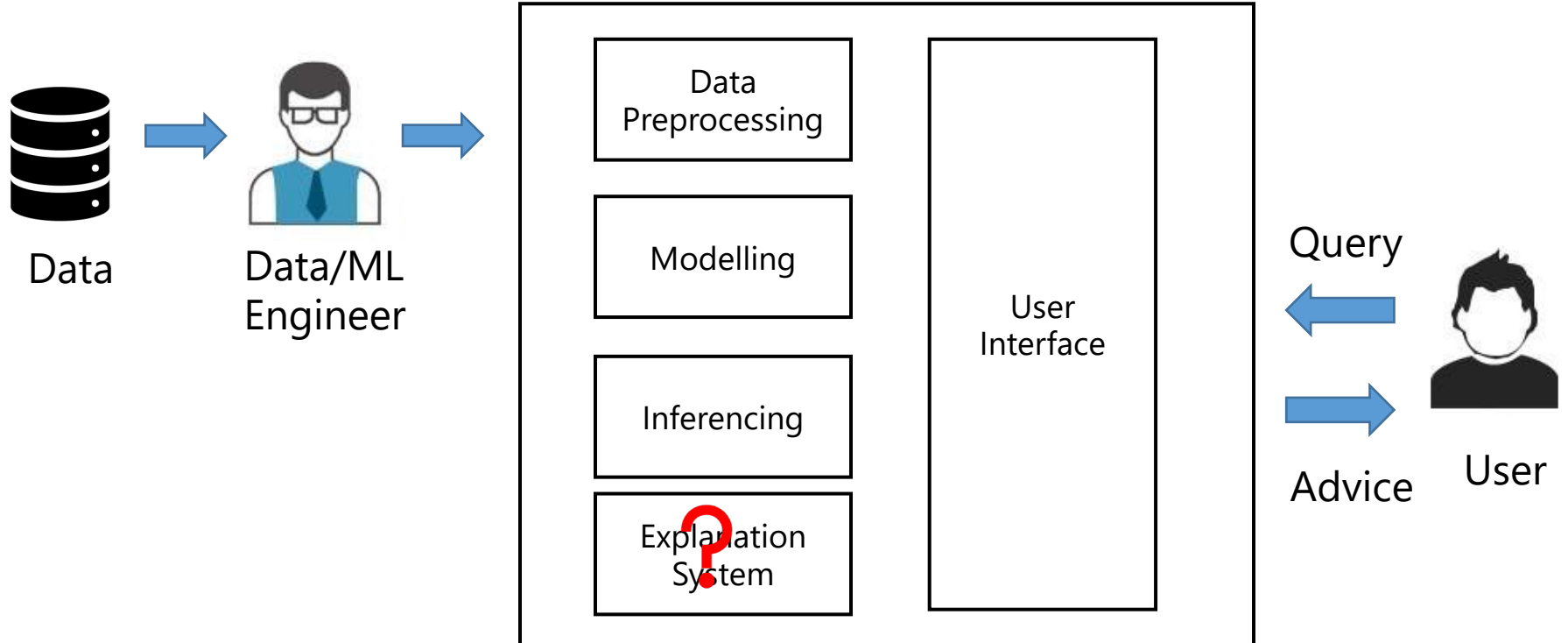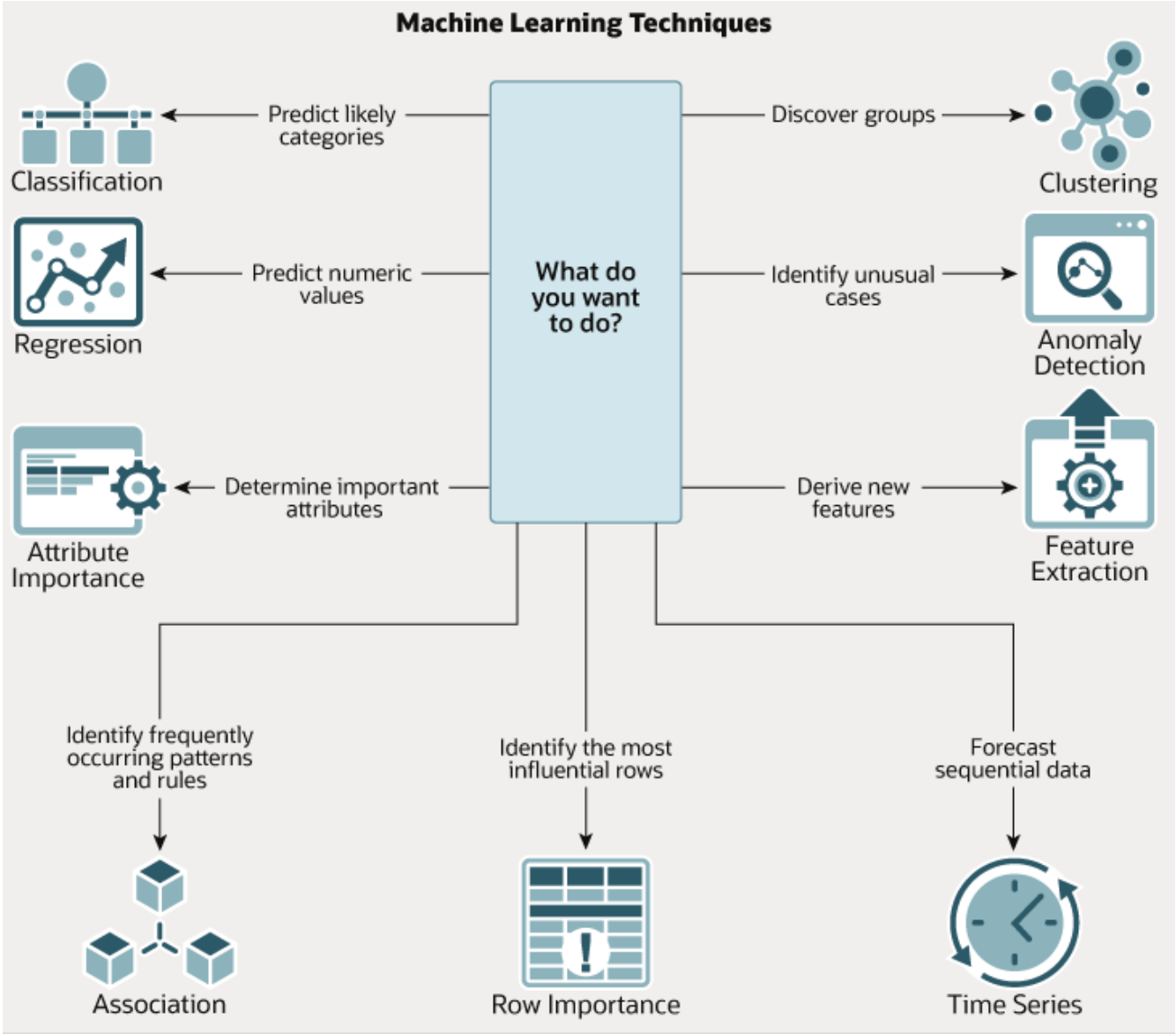 - ➢ Probabilistic inference

Figure 13.9 A Bayesian network for evaluating car insurance applications.
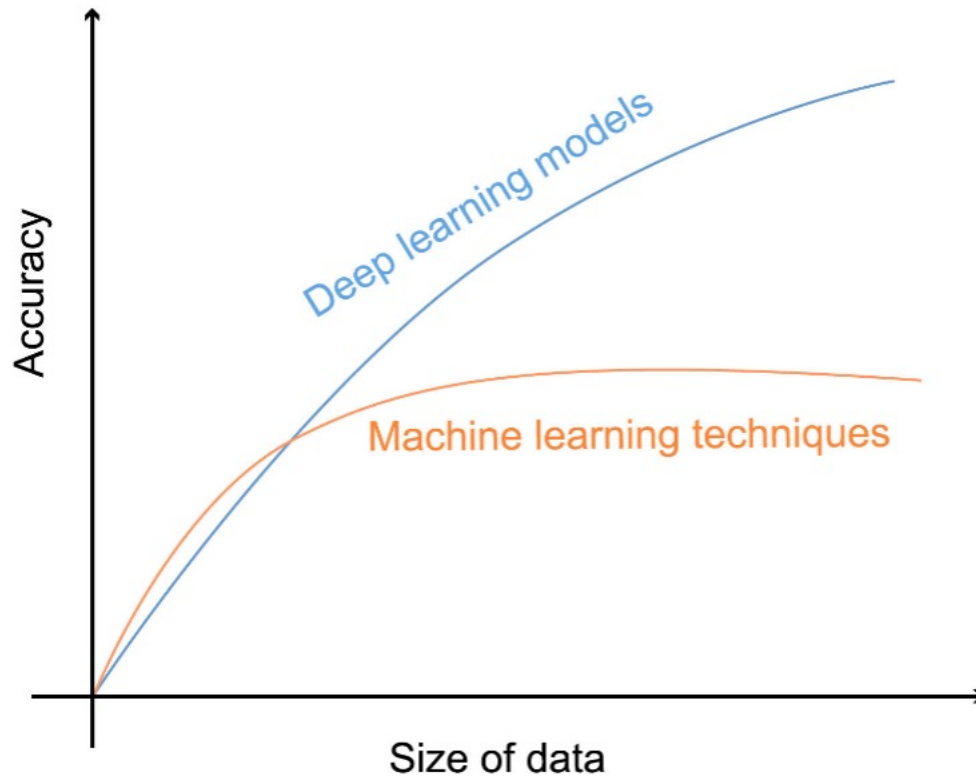
Machine Learning

Machine Learning

Machine Learning Techniques

https://docs.oracle.com/en/database/oracle/machine-learning/oml4sql/21/dmapi/oml4sql-basics.html#GUID-2BB02332-4824-4D04-BE04-4265C75BEAA9
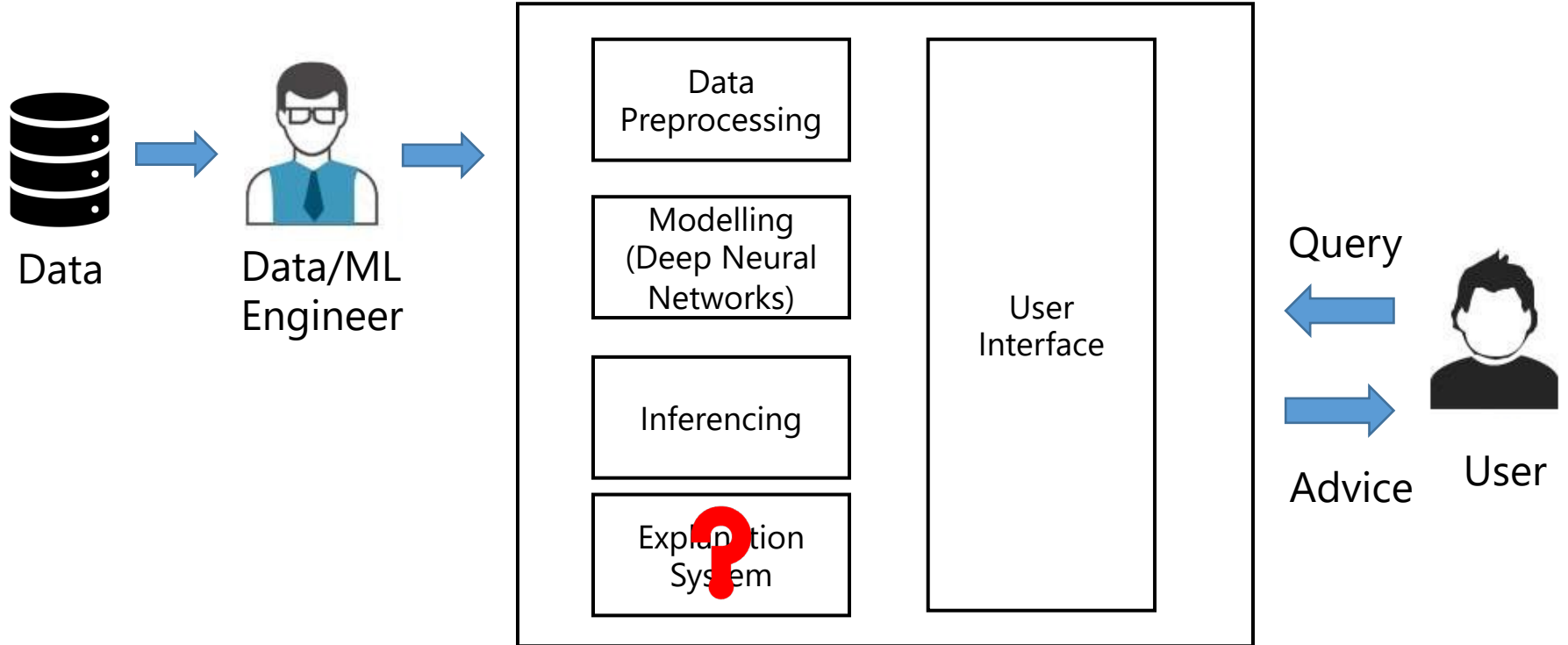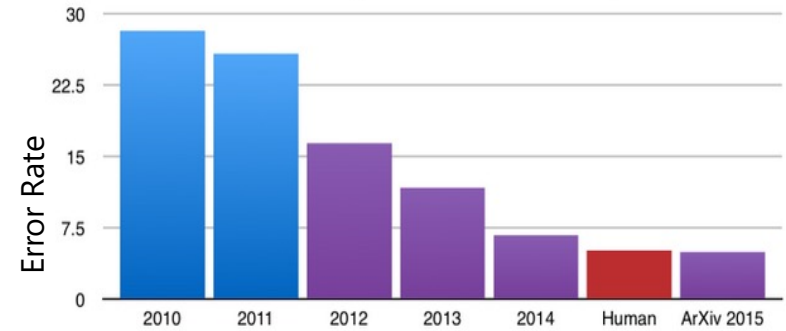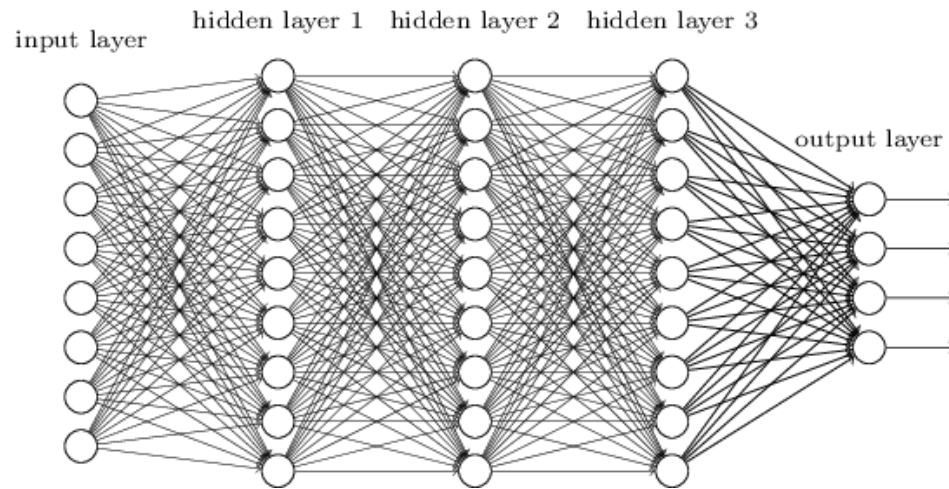
Deep Learning

Es-Sabery, Fatima, et al. "Sentence-level classification using parallel fuzzy deep learning classifier." *IEEE Access* (2021)

Deep Learning

Deep Learning

Starcraft 2: Deep Mind's AlphaStar [2019]

AI-generated art [2023]

https://developer.nvidia.com/blog/mocha-jl-deep-learning-julia/
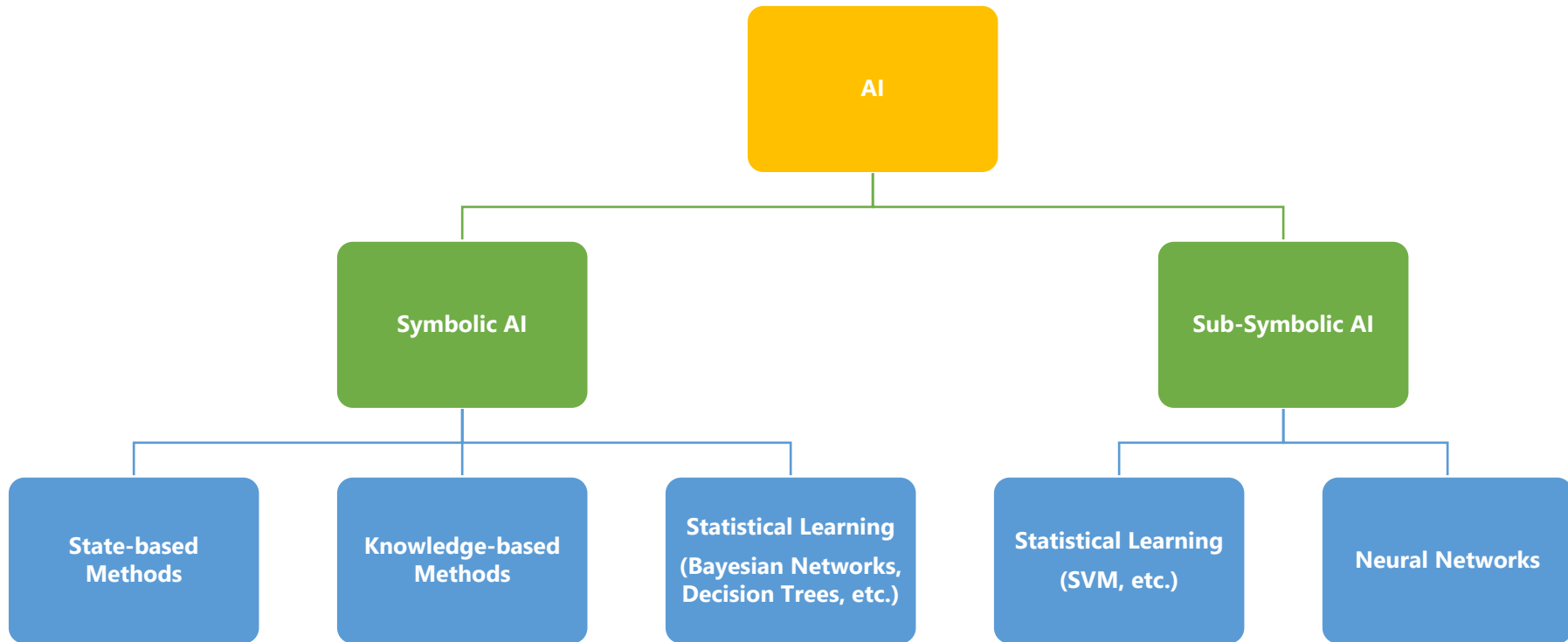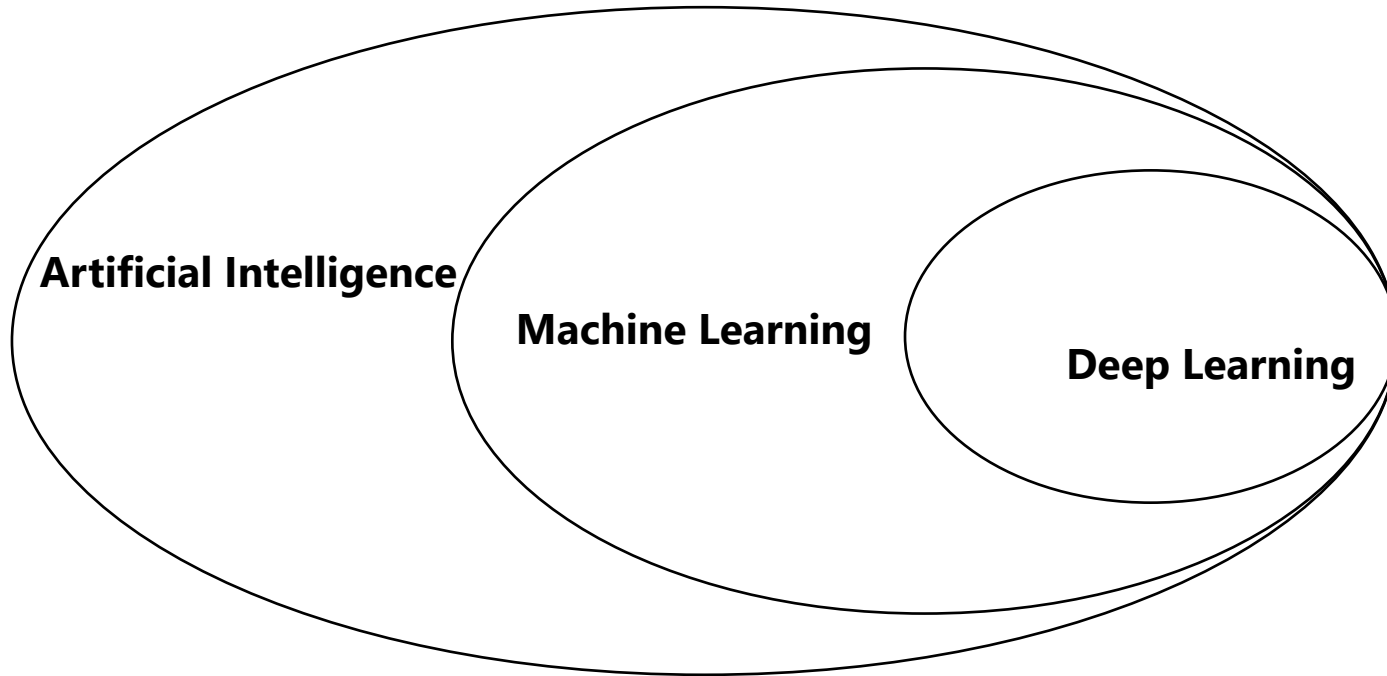https://www.deepmind.com/blog/alphastar-grandmaster-level-in-starcraft-ii-using-multi-agent-reinforcement-learning
https://hotpot.ai/gallery/8/ai-art-maker

16

Taxonomy of AI Techniques

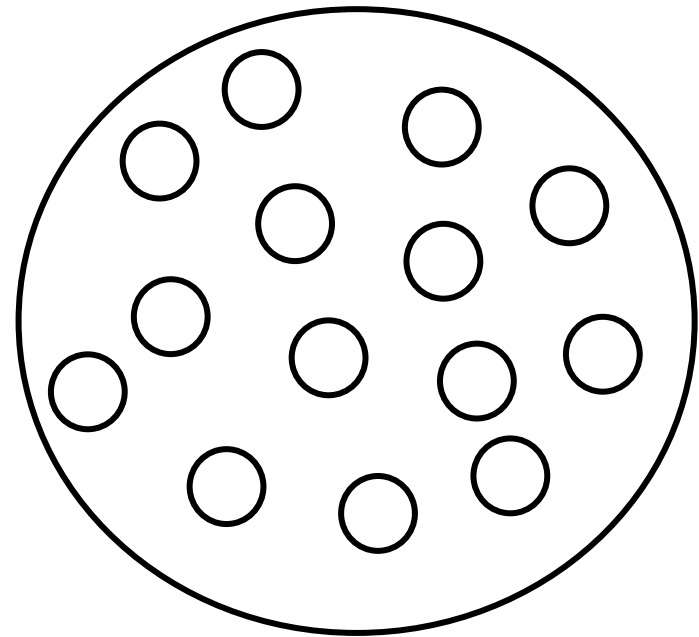# Artificial Intelligence, Machine Learning, and Deep Learning

Artificial Intelligence

Machine Learning
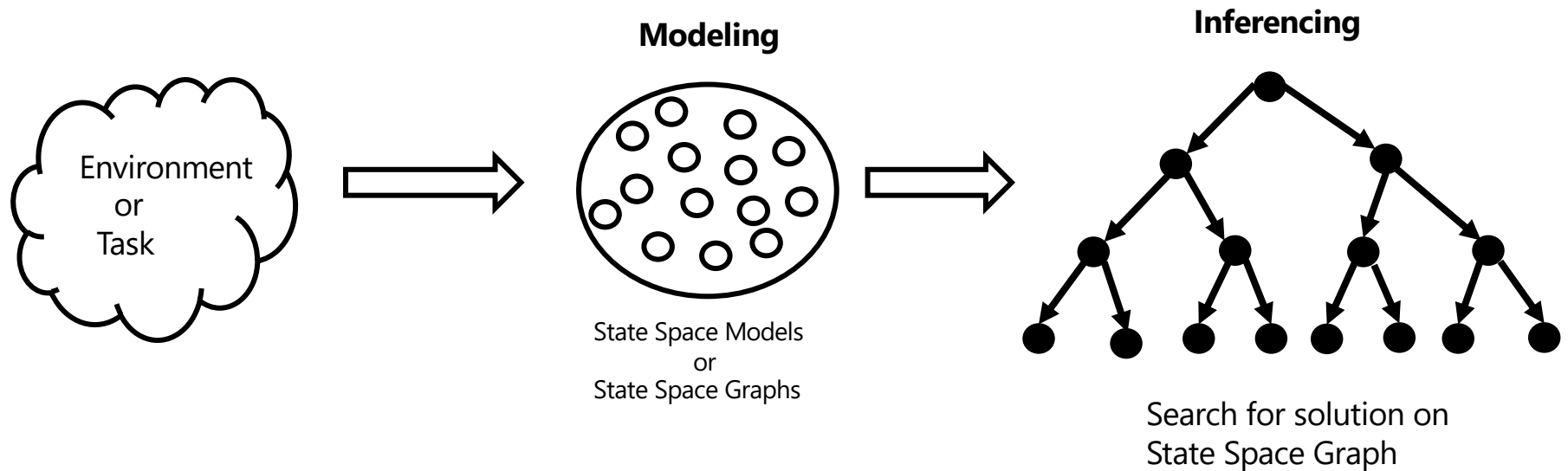
Deep Learning

Moving Forward

Modeling with Atomic (State) Representation

- Single Agent
  - ➢ Uninformed Search
    - o Goal is known
    - o **Objective**: find path to goal
  - ➢ Informed Search
    - o Goal is known
    - o Use heuristics
    - o **Objective**: find path to goal
  - ➢ Local Search
    - o Configuration Problem
    - o Path to goal is irrelevant
    - o **Objective**: find the optimal state
  - ➢ Markov Decision Processes
    - o Goal is known
    - o Action effects are uncertain
    - o **Objective**: Find an optimal policy

- Multiple Agents
  - ➢ Adversarial Search
    - o Two agents with competing objectives
    - o **Objective**: Maximize utility of an agent

State Space Model

Problem Solving by Search: Workflow

```
┌──────────────┐   ┌──────────────┐  ┌┄┄┄┄┄┄┄┄┄┄┄┄┄┄┄┄┄┄┄┄┄┄┄┄┄┐  ┌──────────────┐   ┌──────────────┐
│              │   │              │  ┊ ┌──────────┐ ┌──────────┐ ┊  │              │   │              │
│ Environment  │──▶│   Sensors    │──▶┊ │ Modeling │▶│Inferencing│┊──▶│  Actuators   │──▶│ Environment  │
│              │   │              │  ┊ └──────────┘ └──────────┘ ┊  │              │   │              │
└──────────────┘   └──────────────┘  └┄┄┄Controller or Agent Program┄┄┄┘  └──────────────┘   └──────────────┘
```

Modeling   **Inferencing**

Environment
or
Task

State Space Models
or
State Space Graphs

Search for solution on
State Space Graph

Problem Solving by Search: Applications

- Puzzles
  - ➤ Slide Puzzles,
  - ➤ N-Queens
  - ➤ Rubik's cube, etc.

- Games
  - ➤ Pacman
  - ➤ Tic-Tac-Toe
  - ➤ Chess
  - ➤ Black Gammon, etc.

- Real-World Applications
  - ➤ Route Planning
  - ➤ Robot Motion Planning
  - ➤ VLSI Layout Planning
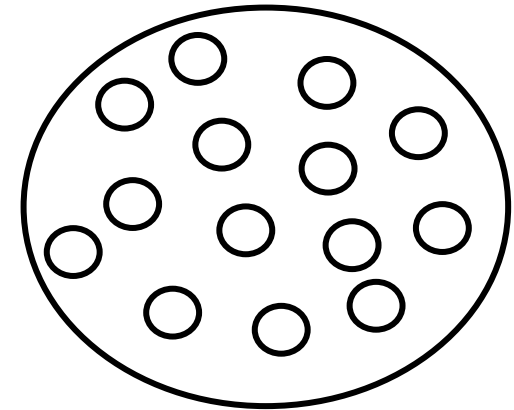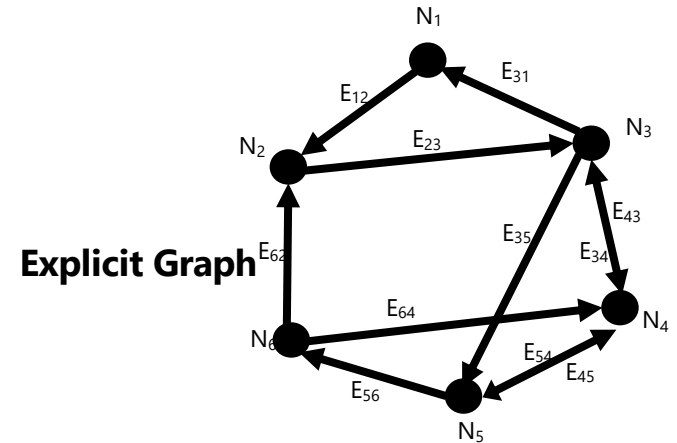 - ➤ Job Scheduling, etc.

Preliminaries: Graphs

- How to describe graphs?

  - ➢ Explicit Graphs
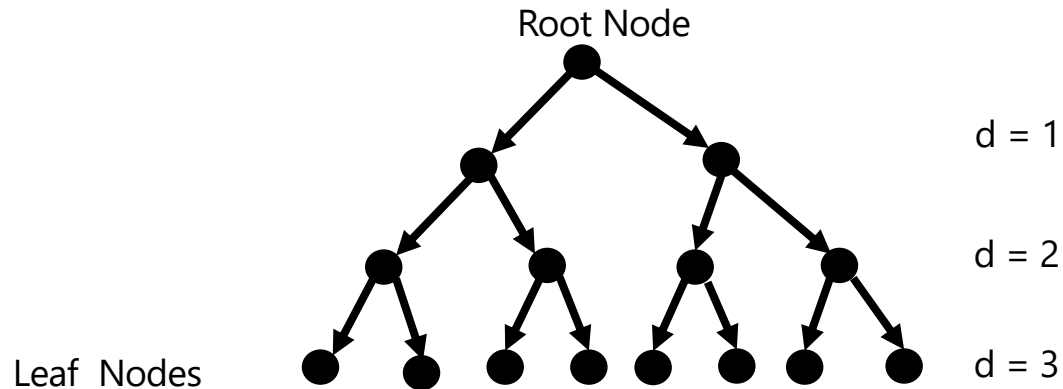   - o Adjacency Lists
    - o Linked Lists

  - ➢ Implicit Graphs
    - o Graph is not explicitly generated
    - o Obtained through modeling or problem formulation
    - o Can have infinite number of nodes

Explicit Graph

Implicit Graph

Preliminaries: Trees

Root Node

d = 1

d = 2

Leaf Nodes   d = 3

$$
\begin{aligned}
\text{Branching Factor} &= b \\
\text{Maximum Depth} &= m \\
\text{Number of Nodes at depth } d &= b^d \\
\text{Number of Leaf Nodes} &= b^m \\
\text{Number of Nodes} &= 1 + b + b^2 + \ldots b^d + \ldots + b^m
\end{aligned}
$$