

# Artificial Intelligence

- What is Artificial Intelligence (AI),
- Why Study AI?,
- What is the definition of AI?
- AI Paradigms and Hypothesis,
  - Knowledge medium,
  - Manipulation,
  - Calculate, logic, store, retrieve,
  - Translate, sort, edit, Make decision,
  - Monitor, control,
- How AI differs from Conventional Computing,
  - AI Computing,
- Objective and Scope of AI,
  - Acting Humanly,
  - Thinking Humanly,
  - Thinking Rationally,
  - Acting Rationally.
- Foundations of AI,
- History of AI,
- AI Questions,
- Applications of Artificial Intelligence.
- Explore: Topics based Research Areas:

# Course Grading Evaluation

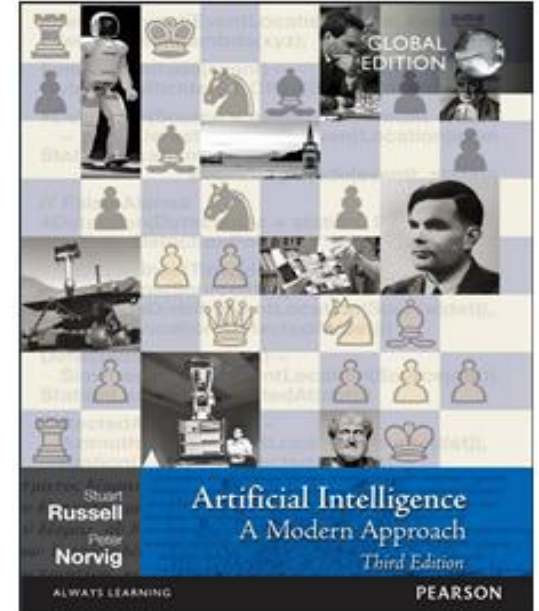
- Course Activities (Grading Criteria)
  - Class Participation:
  - Assignment/Quizzes:
  - Semester Project:
  - Research Article implementation/ demo:
  - Mid Term Exam:
  - Final Term Exam:

# Course Books (for Reference)

## ➤ Artificial Intelligence:

A Modern Approach

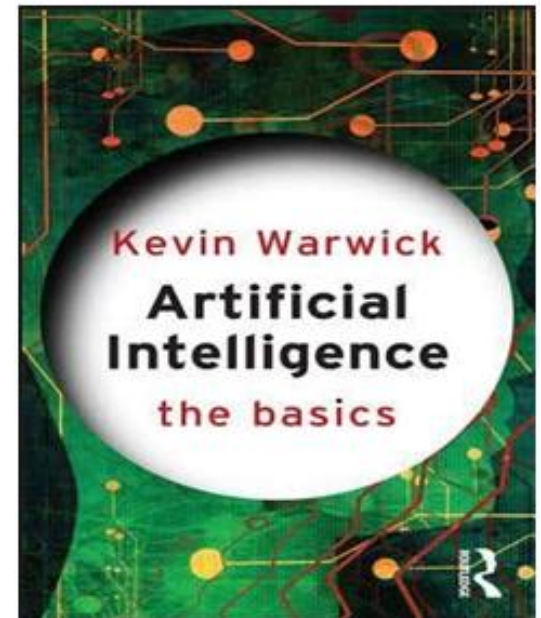
- By: Stuart J. Russel and Peter Norvig
- Published by Prentice Hall.



## ➤ Artificial Intelligence:

The Basics

- By: Kevin Warwick



# Course contents

- Objective and Scope of AI,
- Intelligent Agents, What is Intelligent agent (IA),
  - Components of an AI system,
  - Tasks Parameters for Agents,
- Agent Types,
  - Simple Reflex Agent,
  - Reflex Agent With State,
  - Goal-based Agents
- What is Problem-solving,
  - State and Search Space,
  - Game Trees, Greedy searching,
- Knowledge Representation,
- Knowledge & Reasoning (As Schemes),
- Reasoning and Uncertainty,
  - Combined Probability,
  - Utility Theory,
- Game Playing,
  - Game theory,
- What is Planning,
  - Partial-Order Planning (POP),
  - Clobbering (Promotion / Demotion),
- Natural Language Processing,
  - Syntactic processing,
  - Semantic and pragmatic analysis,
- Robotics with AI,

# 1. What is Artificial Intelligence (AI)

- Artificial Intelligence;
  - is a subdivision of computer science devoted to creating computer software and hardware that imitates the human mind.
- Main goal of AI;
  - is to make computers smarter by creating software.
  - allow a computer to mimic some of the functions of the human brain in selected applications.
  - idea is not to replace human beings, but to provide us a more powerful tool to assist us in our work.
- Computers already emulate some of the simpler activities of the human mind.
  - perform mathematical calculations.
  - manipulate numbers and letters.
  - make simple decision.
  - perform various storage and retrieval functions.

# 1. What is Artificial Intelligence (AI)

(Con...)

- Exceeds the human mind in performance.
  - computer can calculate larger values.
  - more complex problems faster than the human mind.
  - they can store huge quantities of data that can be accessed easily.
  - computers greatly speed up.
  - simplify human thought process.
  
- As a result, they greatly improve our ability to accomplish work.

## 2. Why Study AI?

- Intelligent computer would have huge impact on civilization.
- Computer is a good metaphor for talking and thinking about intelligence.
- Turning theory into working programs forces us to work out the details.
- AI yields good results for Computer Science.
- Personal motivation: mystery.
- AI makes computers more useful.

### 3. What is the definition of AI?

Systems that think like humans	Systems that think rationally
Systems that act like humans	Systems that act rationally

➤ **Bellman, 1978;**

- “[The automation of] activities that we associate with human thinking, activities such as decision making, problem solving, learning”.

➤ **Dean et al., 1995;**

- “The design and study of computer programs that behave intelligently. These programs are constructed to perform as would a human or an animal whose behavior we consider intelligent”.

➤ **Nilsson, 1998;**

- “Many human mental activities such as writing computer programs, doing mathematics, engaging in common sense reasoning, understanding language, and even driving an automobile, are said to demand intelligence. We might say that [these systems] exhibit artificial intelligence”.

# 4. AI Paradigms and Hypothesis

- Artificial Intelligence;
  - gives computer extra features of added computing capability.
  - allowing them to exhibit intelligent behavior.
  
- Intelligence, the ability of a human being to;
  - to acquire knowledge and apply it.
  - the capability of thinking and reasoning.
  
- To a limited degree;
  - AI permits computers to accept knowledge from human input;
  - then use that knowledge through simulated thought.
  - reasoning processes to solve problems.

# 4. AI Paradigms and Hypothesis

(Cont...)

- A key part of any AI application is;
  - knowledge.
  - an understanding of some subject area obtained through education or experience.
  
- Computer cannot have ability, experiences or study and learn as the human mind;
  - it can acquire knowledge given to it by human experts.
  - knowledge consists of facts, concepts, theories, procedures and relationship.
  
- Knowledge is also information that;
  - has been organized and analyzed to make it understandable and applicable to problem solving or decision making.
  - Most knowledge bases are limited and focus on specific subject area.

# 4. AI Paradigms and Hypothesis (Class Participation)

➤ Detect Uncertain-events “OR” Figure-Prints :-

❖ Facts =

❖ Concepts =

❖ Theories =

❖ Procedures =

❖ Relationship =

# 4. AI Paradigms and Hypothesis

(Cont...)

- Once a knowledge base is built;
  - AI techniques are used to give the computer thought and reasoning capability.
- The computer will be able to think, reason, and
  - make inferences and judgements based on the knowledge.
- **Figure illustrates** the concepts of a computer using AI in an application.
  - by searching the knowledge base for relevant facts and relationships,
  - the computer can reach one or more alternative solutions to the given problems.

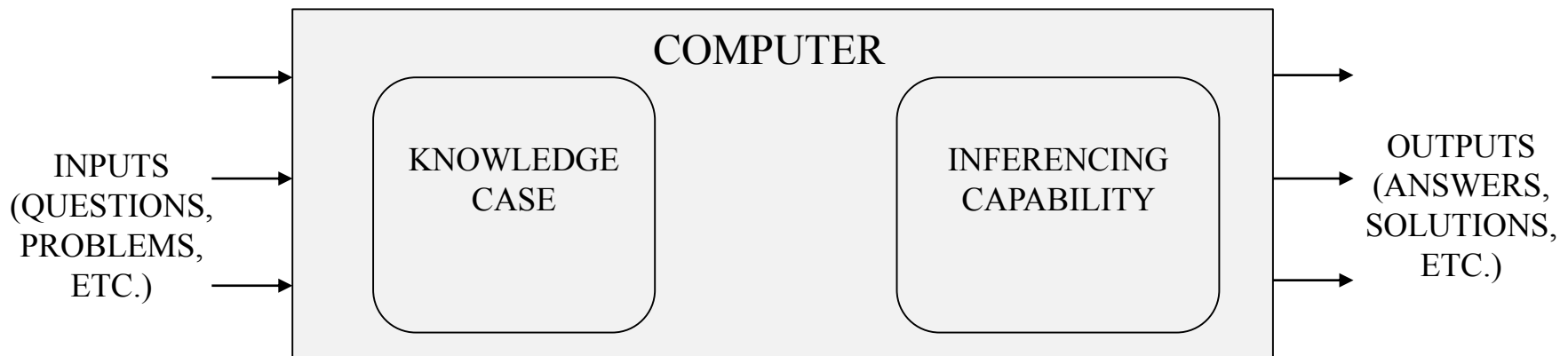


Figure: Applying AI concepts with a computer.

# 4. AI Paradigms and Hypothesis

- AI gives a computer the ability;
  - to solve a wider range of problems than calculation, data storage and retrieval or simple control.

Table : How AI techniques merge with computer

The Process	The MANIPULATION
1. Calculate	Perform mathematical operations such as add, subtract, multiply, divide, etc. Solve formulas.
2. Logic	Perform logical operations such as AND, OR, invert, etc.
3. Store	Remember facts and figures.
4. Retrieve	Access data stored in files as required.
5. Translate	Convert data from one form to another.
6. Sort	Examine data and put it into some desired order or format.
7. Edit	Make changes, additions and deletions to data and change its sequences.
8. Make Decision	Reach simple conclusions based on internal or external conditions.
9. Monitor	Observe external or internal events and take action if certain conditions are met.
10. Control	Take charge of or operate external devices.

# 5. How AI differs from Conventional Computing

- Artificial intelligence is software that;
  - permits virtually any digital computer to duplicate some functions of the human brain in a limited way.
- ✓ In conventional software, we tell the computer how to solve the problem.
- ✓ In AI, we tell the computer what the problem is but not how to solve it.

## Conventional Computing:-

- Here, the computer is given data in the form of “algorithms”,
- and a step-by-step program specifies “how the data is to be used to reach an answer”.
- It also consists of mathematically formulas or a clearly defined sequential procedures that will lead to a solution.
- The algorithm is converted into a computer program;
  - a sequential list of instructions or commands that **lead to exact problem’s solution.**

# 5. How AI differs from Conventional Computing (Cont...)

## **AI Computing:-**

➤ In AI computing;

- the computer is given knowledge about the problem subject area.
- plus some inferencing capability.

➤ We don't tell the computer specifically "how to solve the problem".

- Instead, the computer and software determine the method of arriving at a solution.

## **Requirements:-**

➤ AI software is not based on an exact algorithmic process.

➤ Instead, it is based on

- symbolic representation and manipulation.

- In AI, a symbol is a letter, word, or number that is used to represent objects, processes, and their relationships.

➤ Objects can be people, things, ideas, concepts, events, or statements of facts.

# 5. How AI differs from Conventional Computing (Cont...)

## AI Computing:-

### **Requirements:-**

➤ By using symbols,

- it is possible to create a knowledge base that states facts, concepts, and the relationships between them.

✓ Example and basic techniques are search and pattern matching.

✓ Figure shows block representation of both conventional and AI operations.

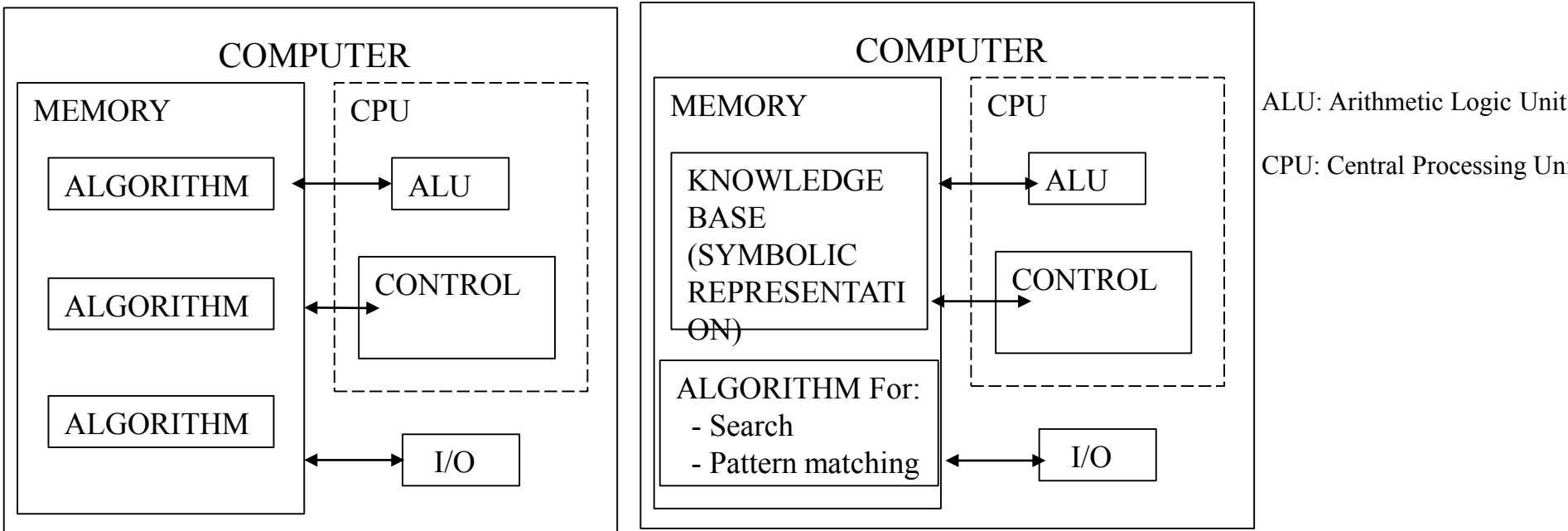


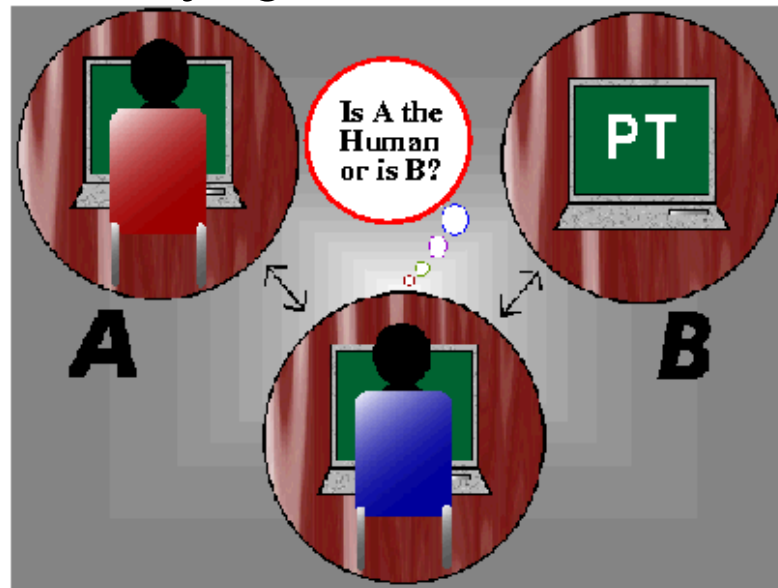
Figure: CONVENTIONAL AI Copyrights Advanced Artificial Intelligence Organized by Figure: AI (http://portals.au.edu.pk/imc/)

# 6. Objective and Scope of AI

- AI deals with strong objectives and scopes in real-world implementation.

## Approach 1: Acting Humanly

- Turing test: ultimate test for acting humanly
  - Computer and human both interrogated by judge
  - Computer passes test if judge can't tell the difference



**Figure:** Acting Humanly; **Subject A** includes human limited information, **Subject B** includes search and pattern matching.

# 6. Objective and Scope of AI

(Cont...)

## Approach 1: Acting Humanly (How effective is this test?)

- Agent must:

- Have command of language.
- Have wide range of knowledge.
- Demonstrate human traits (humor, emotion).
- Be able to reason.
- Be able to learn.

✓ **Agent:** An intelligent agent is an autonomous entity which observes through sensors and acts upon an environment using actuators (i.e., it is an agent).

✓ **Example:** Alice (Artificial Linguistic Internet Computer Entity); is a NLP chatterbot. It's a knowledge-based program that engages in conversation with a human by applying some heuristical pattern matching.

# 6. Objective and Scope of AI

(Cont...)

## Approach 1: Acting Humanly ( Another Example)

### Chinese Room Arguments:

Imagine you are sitting in a room with a library of rule books, a bunch of blank exercise books, and a lot of writing utensils. Your only contact with the external world is through two slots in the wall labeled ``input'' and ``output''. Occasionally, pieces of paper with Chinese characters come into your room through the ``input'' slot. Each time a piece of paper comes in through the input slot your task is to find the section in the rule books that matches the pattern of Chinese characters on the piece of paper. The rule book will tell you which pattern of characters to inscribe the appropriate pattern on a blank piece of paper. Once you have inscribed the appropriate pattern according to the rule book your task is simply to push it out the output slot.

By the way, you don't understand Chinese, nor are you aware that the symbols that you are manipulating are Chinese symbols.

In fact, the Chinese characters which you have been receiving as input have been questions about a story and the output you have been producing has been the appropriate, perhaps even "insightful," responses to the questions asked.

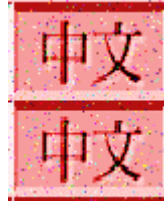
Indeed, to the outside questioners your output has been so good that they are convinced that whoever (or whatever) has been producing the responses to their queries must be a [native speaker](#) of, or [at least extremely fluent in, Chinese](#).

# 6. Objective and Scope of AI

(Cont...)

## Approach 1: Acting Humanly ( Another Example)

Chinese Room Arguments:



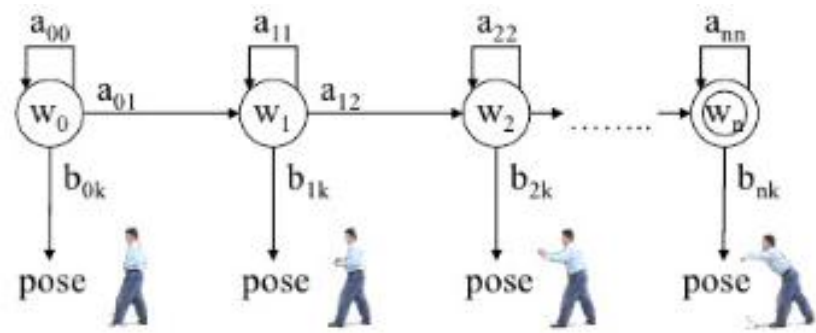
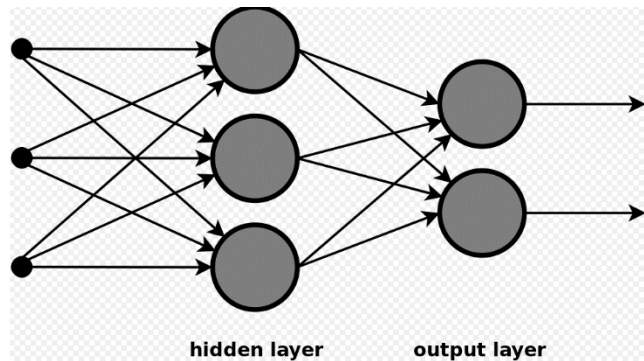
- Searle says NO
- What do you think?
- Is this a refutation of the possibility of AI?
- The Systems Reply
  - The individual is just part of the overall system, which does understand Chinese
- The Robot Reply
  - Put same capabilities in a robot along with perceiving, talking, etc. This agent would seem to have genuine understanding and mental states.

# 6. Objective and Scope of AI

(Cont...)

## Approach 2: Thinking Humanly

- Requires knowledge of brain function.
- What level of abstraction?
- How can we validate this?
  - based on training/pre-testing, evaluation, Testing phase.
- This is the focus of Cognitive Science.
  - includes representation, language, perception, memory, attention, reasoning and emotion.



**Figure:** Examples of thinking humanly based on nodes concepts.

# 6. Objective and Scope of AI

(Cont...)

## Approach 3: Thinking Rationally

➤ Aristotle attempted this.

### *Quotes:*

*“We are what we repeatedly do. Excellence, then, is not an act, but a habit”.*

*“It is the mark of an educated mind to be able to entertain a thought without accepting it”.*

➤ What are correct arguments or thought processes?

➤ Provided foundation of much of AI.

➤ Not all intelligent behavior controlled by logic.

➤ What is our goal? What is the purpose of thinking?

*For Example*, it is **rational** to **think** that the earth revolves around the sun.

- There are some tools like Bayesian probability theory that can help to promote **rational thinking**.

# Bayesian probability theory

## ❖ Examples [Drug testing]

Suppose that a test for using a particular drug is 99% sensitive and 99% specific.

That is, the test will produce 99% true positive results for drug users and 99% true negative results for non-drug users.

Suppose that 0.5% of people are users of the drug. What is the probability that a randomly selected individual with a positive test is a user?

$$\begin{aligned}P(\text{User} \mid +) &= \frac{P(+ \mid \text{User})P(\text{User})}{P(+)} \\&= \frac{P(+ \mid \text{User})P(\text{User})}{P(+ \mid \text{User})P(\text{User}) + P(+ \mid \text{Non-user})P(\text{Non-user})} \\&= \frac{0.99 \times 0.005}{0.99 \times 0.005 + 0.01 \times 0.995} \\&\approx 33.2\%\end{aligned}$$

- **Even if an individual tests positive, it is more likely that they do *not* use the drug than that they do.**
- To use concrete numbers, if 1000 individuals are tested, there are expected to be 995 non-users and 5 users. From the 995 non-users,  $0.01 \times 995 \approx 10$  false positives are expected. From the 5 users,  $0.99 \times 5 \approx 5$  true positives are expected. Out of 15 positive results, only 5, about 33%, are genuine.
- The importance of specificity in this example can be seen by calculating that even if sensitivity is raised to 100% and specificity remains at 99% then the **probability of the person being a drug user only rises from 33.2% to 33.4%**, but if the sensitivity is held at 99% and the specificity is increased to 99.5% then the **probability of the person being a drug user rises to about 49.9%**.

# 6. Objective and Scope of AI

(Cont...)

## **Approach 4: Acting Rationally**

- Act to achieve goals, given set of beliefs.
- What Rational behavior is doing the “right thing”.
  - Thing which expects to maximize goal achievement.

Example; Rules/Conditions for fudge factors:

Sprinkler -> 0.99 WetGrass	Or	Heavy-Cloud -> 0.99 WetGrass
WetGrass -> 0.7 Rain	Or	WetGrass -> 0.7 Rain

Issues: e.g., does Sprinkler cause Rain?? Or does heavy clouds cause Rain?

# 7. Foundations of AI

## ➤ Philosophy

- 450 BC, Socrates asked for algorithm to distinguish pious from non-pious individuals.
- Aristotle developed laws for reasoning.

## ➤ Mathematics

- 1847, Boole introduced formal language for making logical inference.

## ➤ Economics

- 1776, Smith views economies as consisting of agents maximizing their own well being (payoff).

## ➤ Neuroscience

- 1861, Study how brains process information.

## ➤ Psychology

- 1879, Cognitive psychology initiated.

## ➤ Linguistics

- 1957, Skinner studied behaviorist approach to language learning.

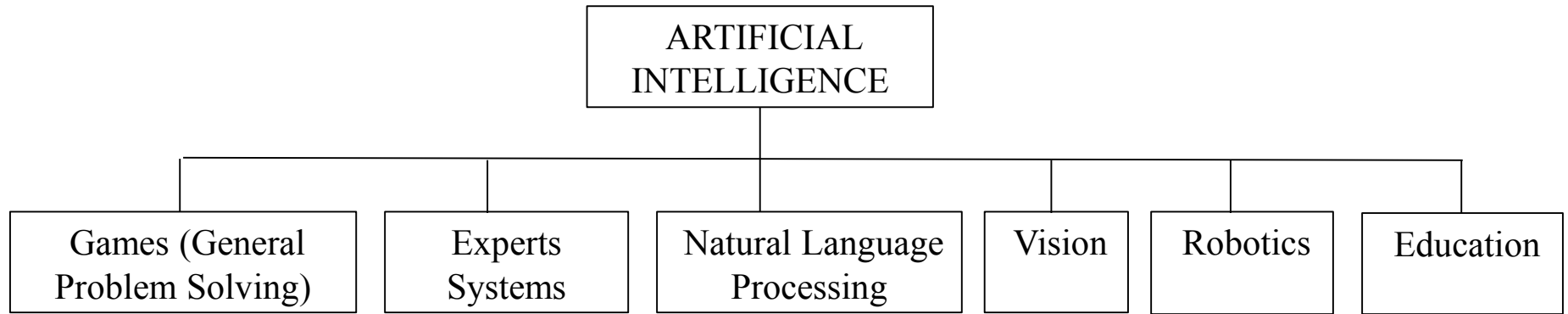
# 8. History of AI

- CS-based AI started with “Dartmouth Conference” in 1956.
- Attendees
  - John McCarthy
    - LISP, application of logic to reasoning.
  - Marvin Minsky
    - Popularized neural networks.
    - Slots and frames.
    - The Society of the Mind.
  - Claude Shannon
    - Computer checkers.
    - Information theory.
  - Allen Newell and Herb Simon
    - General Problem Solver.

# 9. AI Questions

- Can we make something that is as intelligent as a human?
- Can we make something that is evolutionary, self improving, autonomous, and flexible?
- Can we save this plant \$20M/year by pattern recognition?
- Can we save this bank \$50M/year by automatic fraud detection?
- Can we start a new industry of handwriting recognition agents?

# 10. Applications of Artificial Intelligence



**Figure:** The major application area of AI.

## i) Games:-

- The first applications of AI were game playing and puzzle solving.
- Researchers felt that;
  - ability of a computer to play a game was an excellent demonstration of human intelligence.
- AI programs to play;
  - chess, checkers, tic-tac-toe and many other examples.
- This application proved that;
  - symbolic processing concepts of AI.

# 10. Applications of Artificial Intelligence (Cont...)

## ii) Expert Systems:-

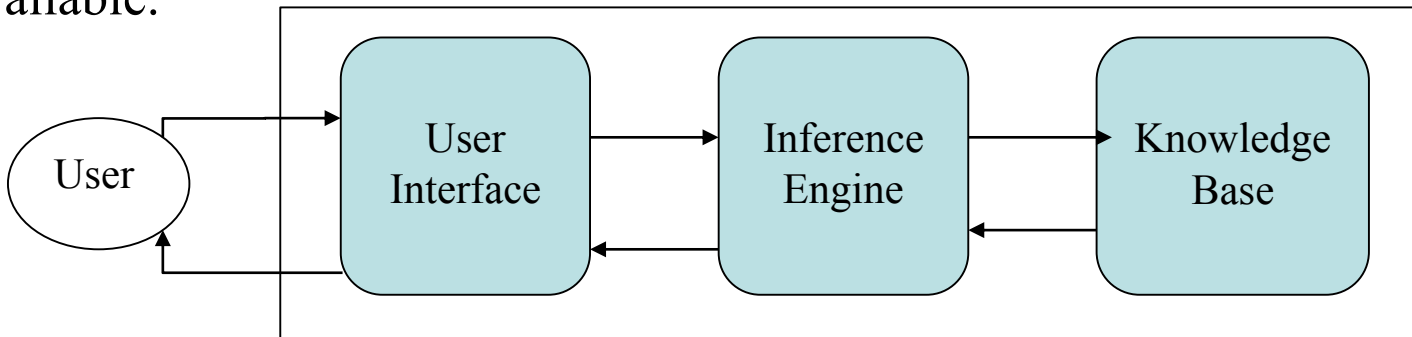
➤ An expert system permits;

- the knowledge and experience of one or more experts and stored in computers.

➤ The purpose of an expert system is not to replace the experts but;

- simply to make their knowledge and experience more valuable and widely used.

➤ Expert die, retire, get sick, move on to other fields and otherwise become unavailable.



**Figure:** General block diagram of an expert system.

➤ An expert system consists of 3 major components;

**a) Knowledge base** contains all the facts, ideas, relationships and interaction.

**b) Interface engine** analyzes the knowledge and draw conclusions.

**c) User interface** software permits new knowledge to be entered into the **knowledge base** and implements communication with the user.

# 10. Applications of Artificial Intelligence (Cont...)

## iii) Natural Language Processing:-

### ➤ Natural language processing programs;

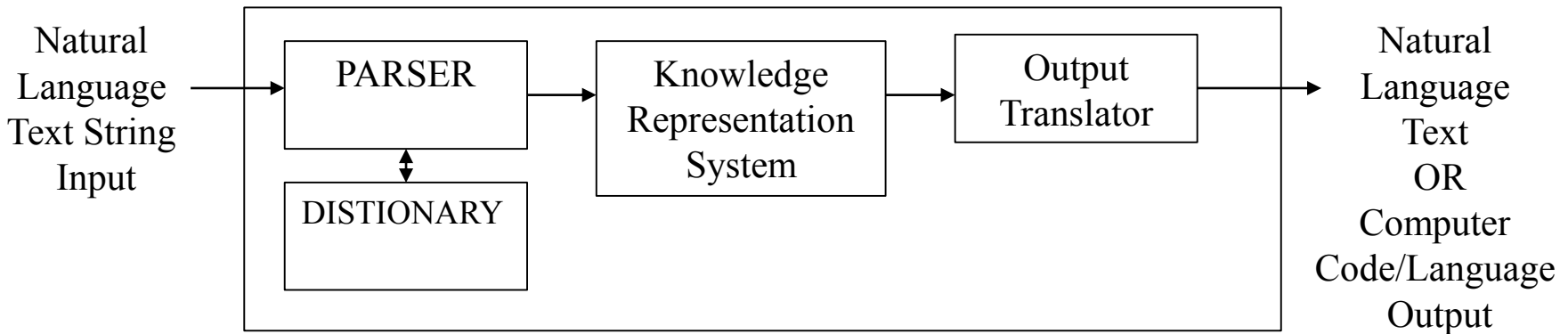
- use AI techniques to permit a computer to understand and generate natural language.

➤ Key to intelligence is the understanding of language.

### ➤ Natural language understanding programs;

- used for language translation.

Example; Such a program might read the Spanish language, understand it, and produce an accurate English translation.



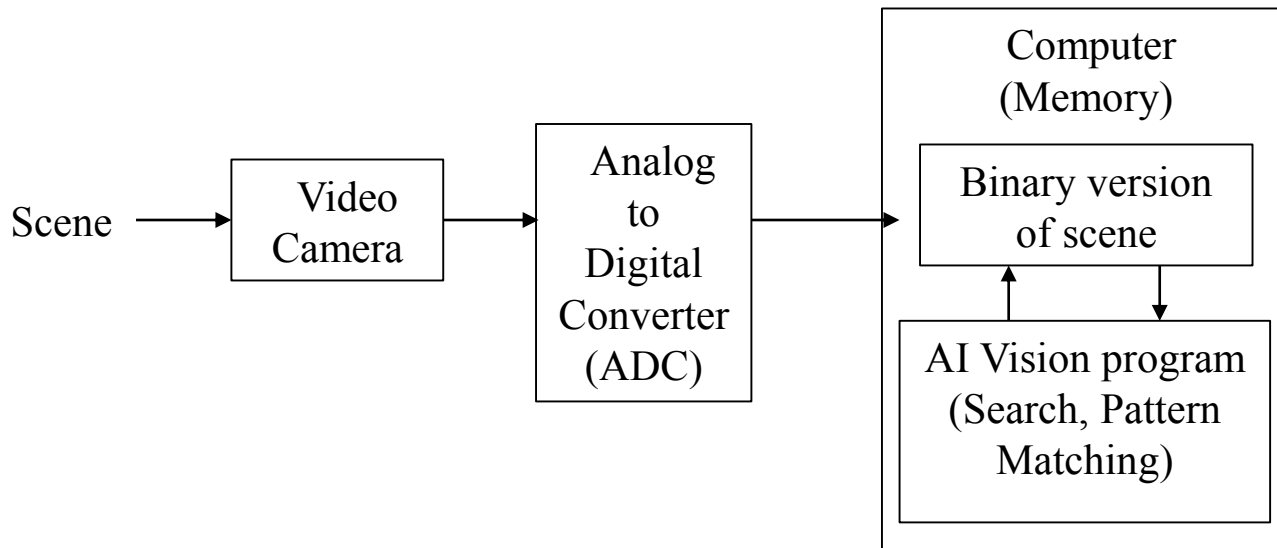
**Figure:** The major components of an NLP system.

➤ **The parser** breaks it down into the various parts of grammar (nouns, verbs, adjective, etc.).

# 10. Applications of Artificial Intelligence (Cont...)

## iv) Computer Vision:-

- to analyze and evaluate visual information.
- allow the computer to examine a picture or real-life scene to identify particular objects, features, or patterns.
- By using search and pattern-matching techniques;
  - computer can pick out key features.
  - search and identify information that a human eye may miss.



**Figure:** A computer vision system.

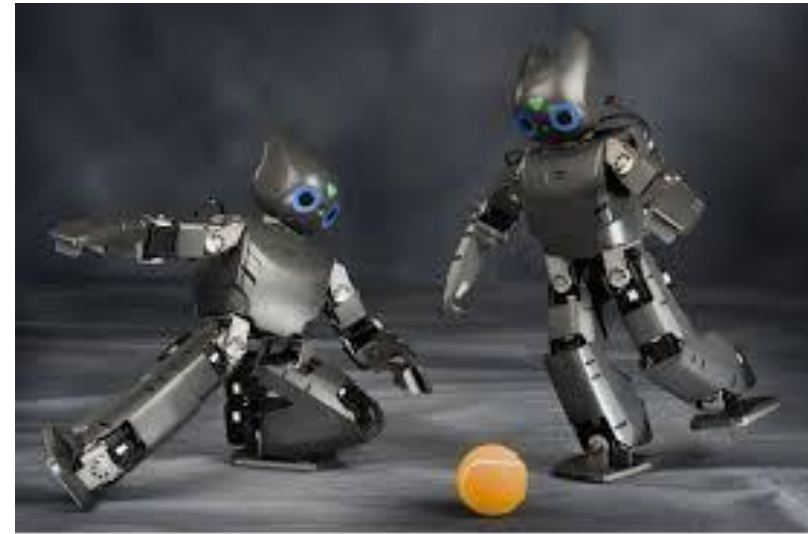
# 10. Applications of Artificial Intelligence (Cont...)

## v) Robotics:-

➤ Robotics is that field of engineering;

- devoted to duplicating the physical capabilities of human beings.
- field of AI which attempts to mimic human mental abilities.

*Example;* typical robot is a manipulators arm that can be used to pick up and place parts in a manufacturing operation.



**Figure:** An “intelligent” robot.

# 10. Applications of Artificial Intelligence (Cont...)

## vi) Education:-

- AI can also be used in education and training.
- Computer-based training (CBT) software;
  - to act as an intelligent tutor.
- In some cases,
  - education or training may not even be necessary if the knowledge in an expert system is available.

# 10. Applications of Artificial Intelligence (Cont...)

Categories following application (Class Evaluation):-

- Play a decent game of table tennis.
- Drive autonomously along a curving mountain road.
- Drive autonomously in the center of Cairo.
- Play a decent game of bridge.
- Discover and prove a new mathematical theorem.
- Write an intentionally funny story.
- Give competent legal advice in a specialized area of law.
- Translate spoken English into spoken Swedish in real time.
- Plan schedule of operations for a NASA spacecraft.
- Defeat the world champion in chess.

# Class Assignment

Categories following application (Class Assignment):-

- You beat somebody at chess.
- You prove a mathematical theorem using a set of known axioms.
- You need to buy some supplies, meet three different colleagues, return books to the library, and exercise. You plan your day in such a way that everything is achieved in an efficient manner.
- You are a lawyer who is asked to defend someone. You recall three similar cases in which the defendant was guilty, and you turn down the potential client.
- A stranger passing you on the street notices your watch and asks, “Can you tell me the time?” You say, “It is 3:00.”
- You are told to find a large Phillips screwdriver in a cluttered workroom. You enter the room (you have never been there before), search without falling over objects, and eventually find the screwdriver.

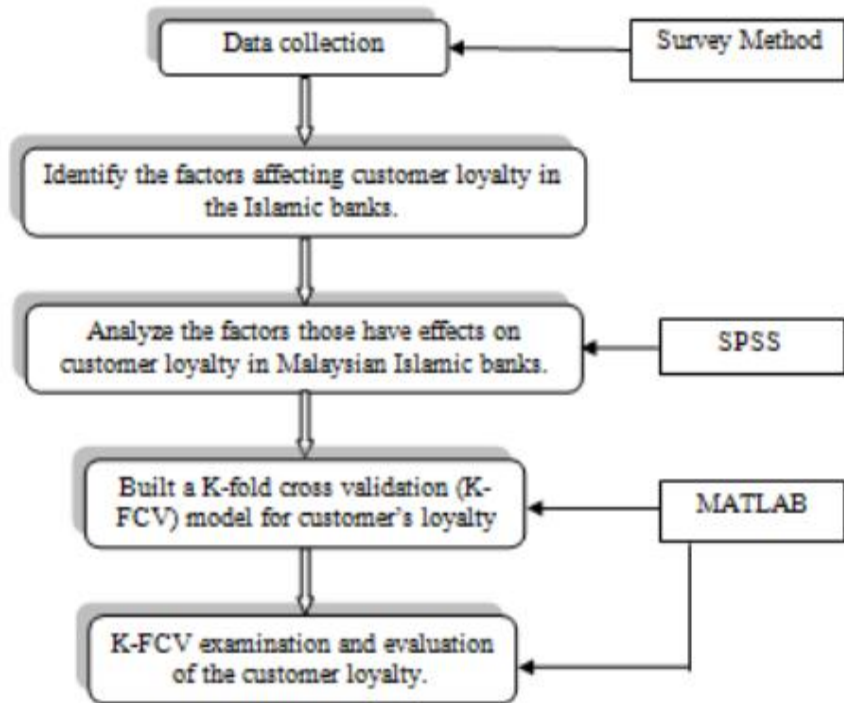
# Class Assignment

## Categories following application (Class Assignment):-

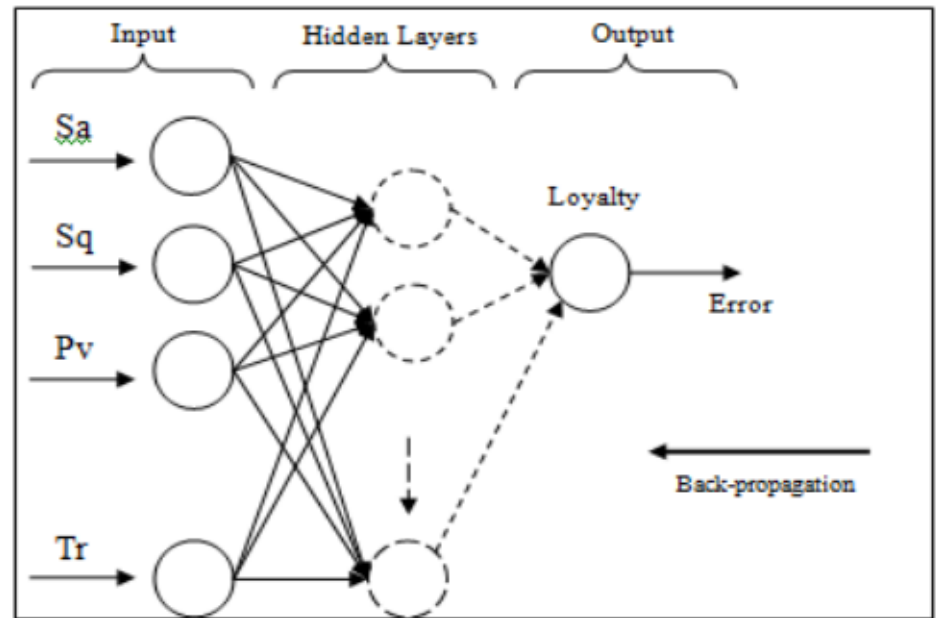
- You are a six-month-old infant. You can produce sounds with your vocal organs, and you can hear speech sounds around you, but you do not know how to make the sounds you are hearing. In the next year, you figure out what the sounds of your parents' language are and how to make them.
- You are a one-year-old child learning Arabic. You hear strings of sounds and figure out that they are associated with particular meanings in the world. Within two years, you learn how to segment the strings into meaningful parts and produce your own words and sentences.
- Someone taps a rhythm, and you are able to beat along with it and to continue it even after it stops.
- You are some sort of primitive invertebrate. You know nothing about how to move about in your world, only that you need to find food and keep from bumping into walls. After lots of reinforcement and punishment, you get around just fine.

# 11. Explore: Topics based Research Areas

(1) Intelligent methods to analyze customer loyalty assessment :-



Proposed architecture of Model



Schematic of the Proposed Neural Network

## Factor Analysis of Variables

Factors	Lo	Sa	Sq	Pv	Tr
Cronbach's $\alpha$	0.862	0.848	0.916	0.881	0.875

Implemented results

Scale validation is another step experienced using Cronbach's  $\alpha$  to measure the reliability of loyalty (Lo), satisfaction (Sa), service quality (Sq), perceived value (Pv) and trust (Tr), as indicated in Table 1. The summarized results from table indicate, reliability based Cronbach's  $\alpha$  is greater than Nunnally's threshold of 0.70 [16].

# 11. Explore: Topics based Research Areas

(2) Smart cars as autonomous intelligent agents (A\* algorithm):-

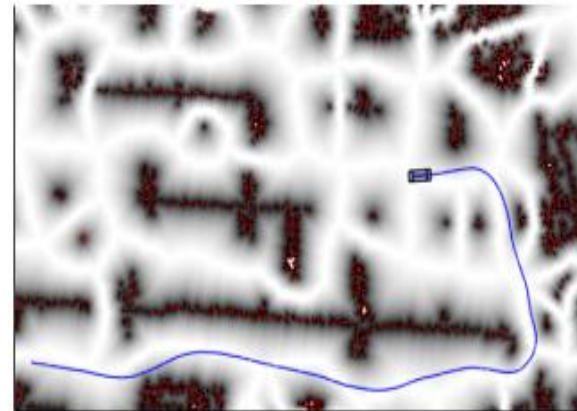
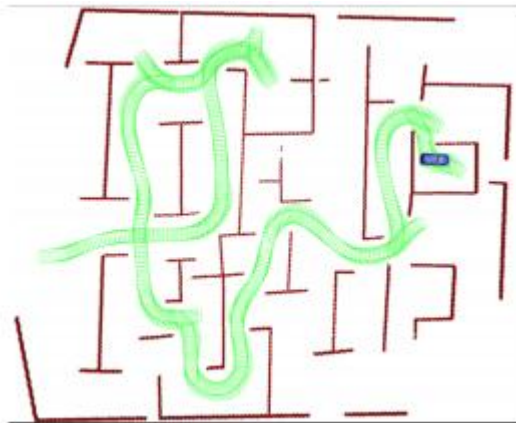
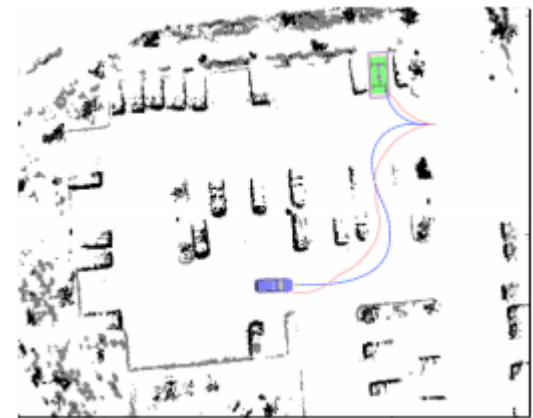
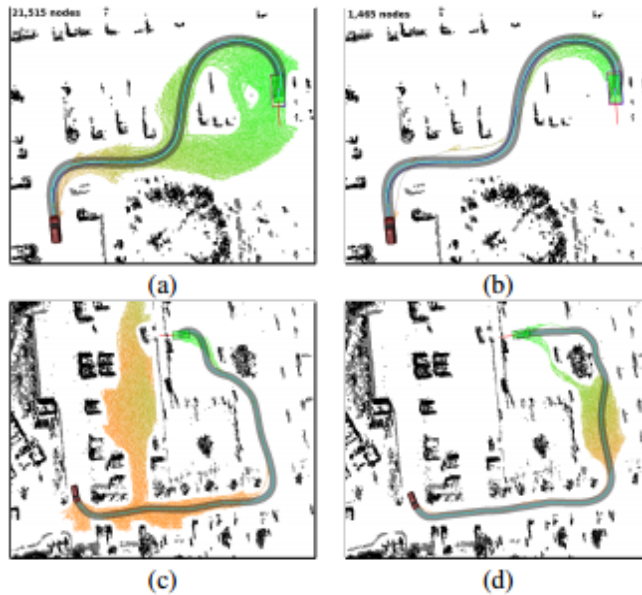
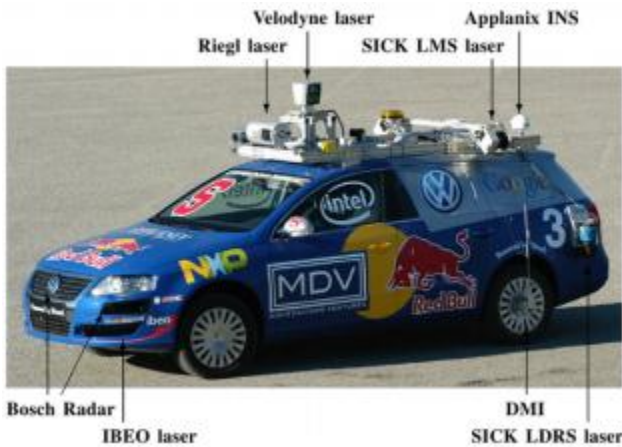


Figure A\* heuristics. Euclidean distance in 2D expands 21,515 nodes (a). The non-holonomic-without-obstacles heuristic is a significant improvement: it expands 1,465 nodes in (b), but can lead to wasteful exploration of dead-ends in more complex settings: 68,730 nodes in (c). This is rectified by using the latter in conjunction with the holonomic-with-obstacles heuristic: 10,588 nodes in (d).

Proposed architecture of Model

Implemented results