Artificial Intelligence

AI2002

Rushda Muneer

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Course Information

- Instructor: Rushda Muneer
- Email: rushda.muneer@lhr.nu.edu.pk
- Office: F-024 (CS Department)
- Office Hours: Tuesday & Thursday (1:00 -2:00 pm)
- Google Classroom Codes:

BCS 6B (1-2:30)

xrxxzajo

BCS 6C (10-11:30)

etdpf7gs

General Rules and Guidelines

- Attendance will be marked after 10 minutes in each class.
- Arriving after 10 minutes will be marked as Late.
- 80% attendance is required.
- The course will have Absolute Grading Scheme.
- Quizzes will be announced. No retakes.
- No late submissions.
- Cheating or plagiarism will result in Zero marks.
- Taking cross section classes and quizzes are not allowed.
- Four Assignments and Four Quizzes. No Best off policy.

Marks distribution

- Assignments + Homework (10 %)
- Project (5 %)
- Quizzes (10 %)
- Midterms (30 %)
- Final Exam (45 %)

Books

- Stuart Russell, Peter Norvig - Artificial Intelligence A Modern Approach - (3rd Edition)
- George F. Luger - Artificial Intelligence
- Additional Reference materials:
  - Tom Mitchell - Machine Learning

Course Outline

Week	Contents
1	Introduction Agent and Agent Architectures Knowledge Representation PEAS
2	Strategies for State Space Search: Blind/Uninformed/Brute-force Search • Depth First Search (DFS) • Breadth First Search (BFS)
3	• Iterative Deepening Search (IDS) • Uniform Cost Search (UCS) Direction of Search, Branching Factor
4	Heuristic/Informed Search • Best First Search • A* Search Informedness, Monotonicity, Admissibility, Optimality, Completeness
5	Adversarial Search Algorithms (Game Playing) • Minimax Search • Alpha-Beta Pruning Evaluation Functions
Mid 1	

Quiz 1

Quiz 2

Assignment 1

Course Outline

Week	Contents	
6	Local Search: Hill Climbing Search Evolutionary Search: Genetic Algorithm • Genetic Algorithm Introduction • Solution representation	Project Mid Evaluation
7	• Fitness evaluation function • Selection mechanism (Roulette wheel, Rank based, Tournament) • Genetic operators (Crossover, Mutation) • Replacement method • Generation gap, Elitism	
8	Supervised learning : Regression Simple Linear Regression	Quiz 3
9	Machine Learning Introduction, Supervised Learning, Classification (ANN) • Architecture: Feed-Forward Neural Network • Activation Functions (Linear,Sigmoid, Relu, tanh, Softamax)	
10	• Training Algorithms: Perceptron and common activation functions, Linear separability of a perceptron • Perceptron Learning Rule • Multilayer Perceptron	Assignment 2
Mid 2		

Course Outline

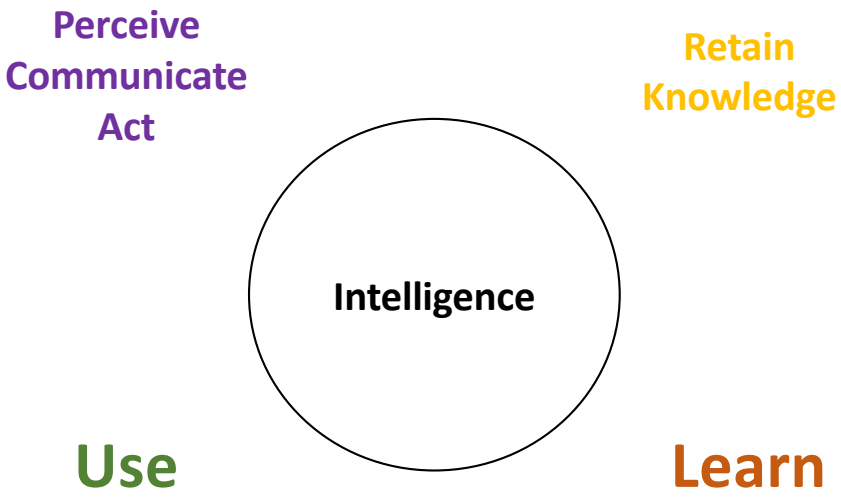
Week	Contents	
11	• Back propagation algorithm (Gradient Descent Learning) • Issues of ANN (Over-fitting, Under-fitting, Validation testing)	
12	• Performance measures: Confusion Matrix (Binary & Multi Class) • Evaluation metric: Accuracy, recall, Precision, F1 score Supervised learning • Decision Trees	Quiz 4
13	Convolutional Neural Network (fwd prop only) Unsupervised learning - Clustering and its application	Assignment 3
14	• K–means algorithm • K-medoids algorithm	Assignment 4
15	• Agglomerative clustering	Project Final Evaluation
Finals		

Introduction

Readings – Chapter 1

What is Intelligence?

- Intelligence is the ability to **acquire**, **understand** and **apply knowledge** and **skills** to **solve** problems, **adapt** to new situations, **reason** and **make** decisions.
- **Key aspects:**
  - Learning
  - Reasoning & Problem Solving
  - Adaptability
  - Memory
  - Creativity
  - Social Interactions
  - Self Awareness



Intelligence: the ability to acquire and apply knowledge and skills.

What is artificial intelligence?

Think Like a Human	Think Rationally
Act Like a Human	Act Rationally

- *The definitions on top are concerned with thought processes and reasoning,*
- *whereas the ones on the bottom address behavior.*
- *The definitions on the left measure success in terms of fidelity to human performance,*
- *Whereas the ones on the right measure against an ideal performance measure, called rationality.*

Thinking Humanly	**Thinking Rationally**
"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)
"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)	"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998)
"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Figure 1.1 Some definitions of artificial intelligence, organized into four categories.

Acting humanly: The Turing Test approach

- The Turing Test, proposed by Alan Turing (1950), was designed to provide a satisfactory operational definition of intelligence.
- A computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or from a computer.
- To pass the test, the computer would need to possess the following capabilities:
  - **natural language processing** to enable it to communicate successfully in English;
  - **knowledge representation** to store what it knows or hears;
  - **automated reasoning** to use the stored information to answer questions and to draw new conclusions;
  - **machine learning** to adapt to new circumstances and to detect and extrapolate patterns.
  - **computer vision** to perceive objects, and
  - **robotics** to manipulate objects and move about.

Thinking humanly: The cognitive modeling approach

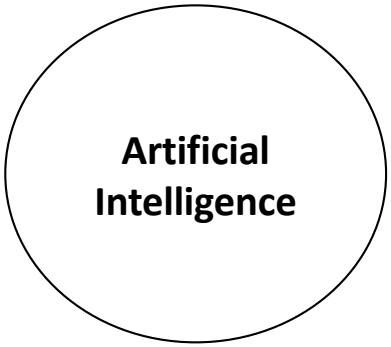
- There are three ways to do this:
  - through introspection—trying to catch our own thoughts as they go by;
  - through psychological experiments—observing a person in action;
  - and through brain imaging—observing the brain in action.
- The interdisciplinary field of cognitive science brings together computer models from AI and experimental techniques from psychology to construct precise and testable theories of the human mind.

Thinking rationally: The “laws of thought” approach

- The Greek philosopher Aristotle was one of the first to attempt to codify “right thinking,” that is, irrefutable reasoning processes.
- His syllogisms provided patterns for argument structures that always yielded correct conclusions when given correct premises
- For example,
  - “Socrates is a man; all men are mortal; therefore, Socrates is mortal.”
- Programs, in principle, solve any solvable problem described in logical notation.

Acting rationally: The rational agent approach

- An **agent** is just something that acts.
- All computer programs do something, but computer agents are expected to do more:
  - Operate autonomously,
  - Perceive their environment,
  - Persist over a prolonged time period,
  - Adapt to change,
  - And create and pursue goals.
- A **rational agent** is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome.



Sensors
Internet of Things
Cloud
Computer Vision
NLP
Robotics

Perceive
Communicate
Act

Knowledge Engineering
Knowledge Representation
How to Store, Link
information we have
Big Data

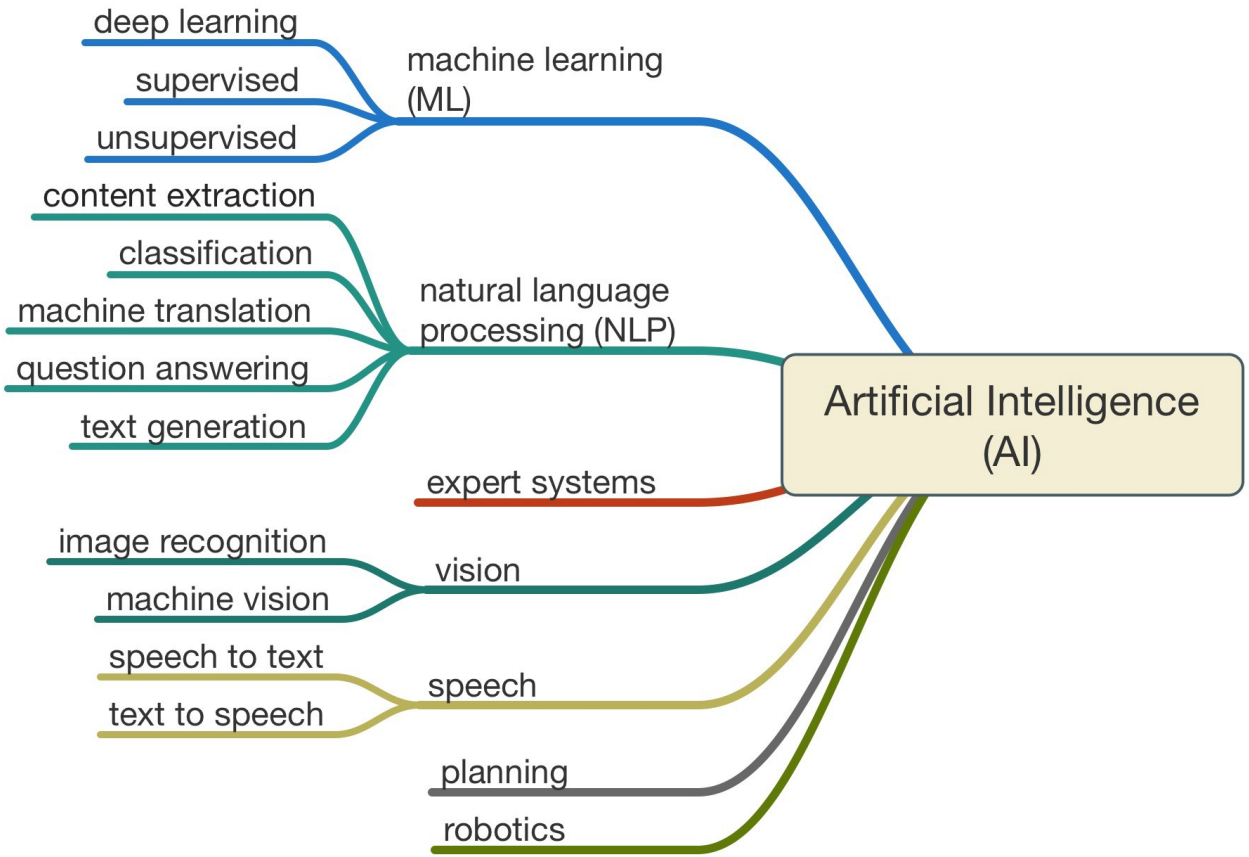
Retain
Knowledge

Planning
e.g., Scheduling
Problem Solving
Searching for solution e.g., game playing
Decision Making
Complex or simple
Uncertain and Certain situations
Data Mining
Data Science
Reasoning
use the stored information to answer questions and to draw new conclusions

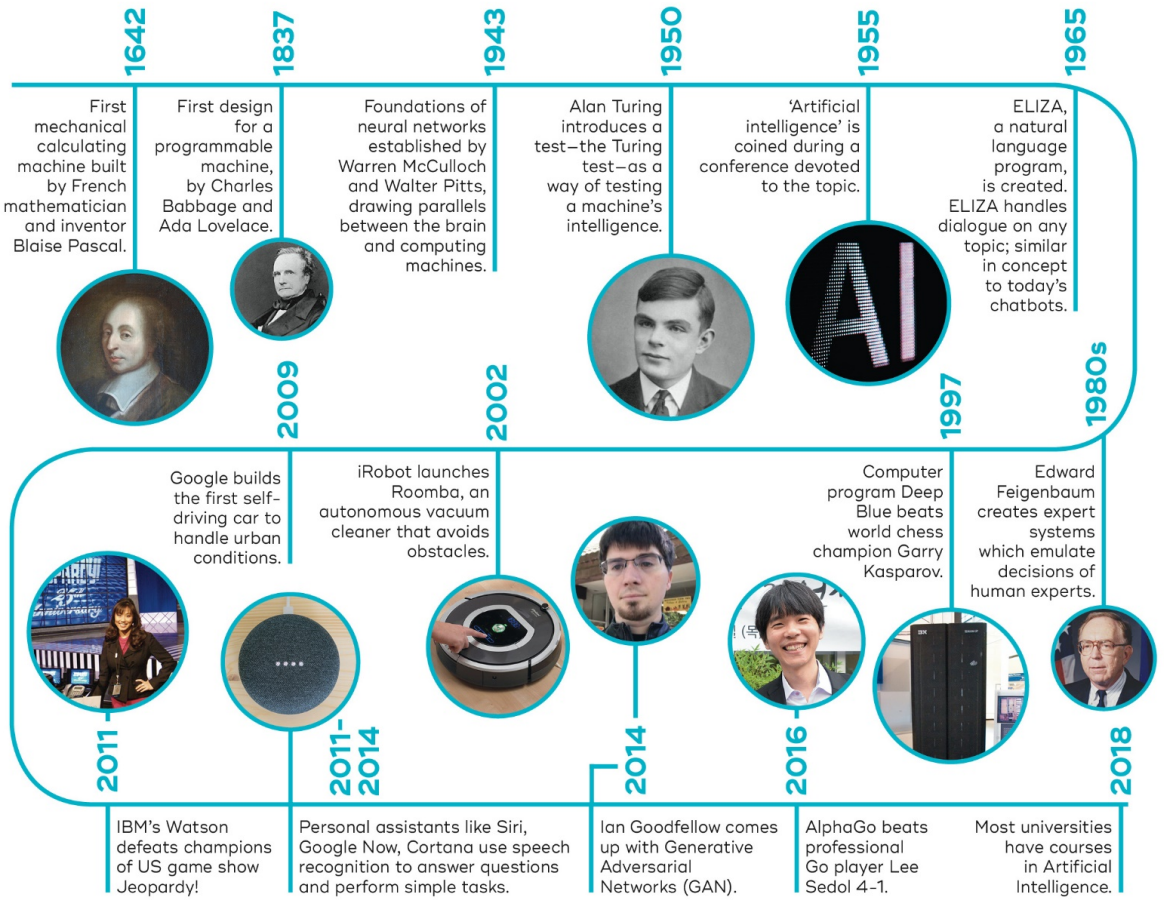
Use
Knowledge

Learn

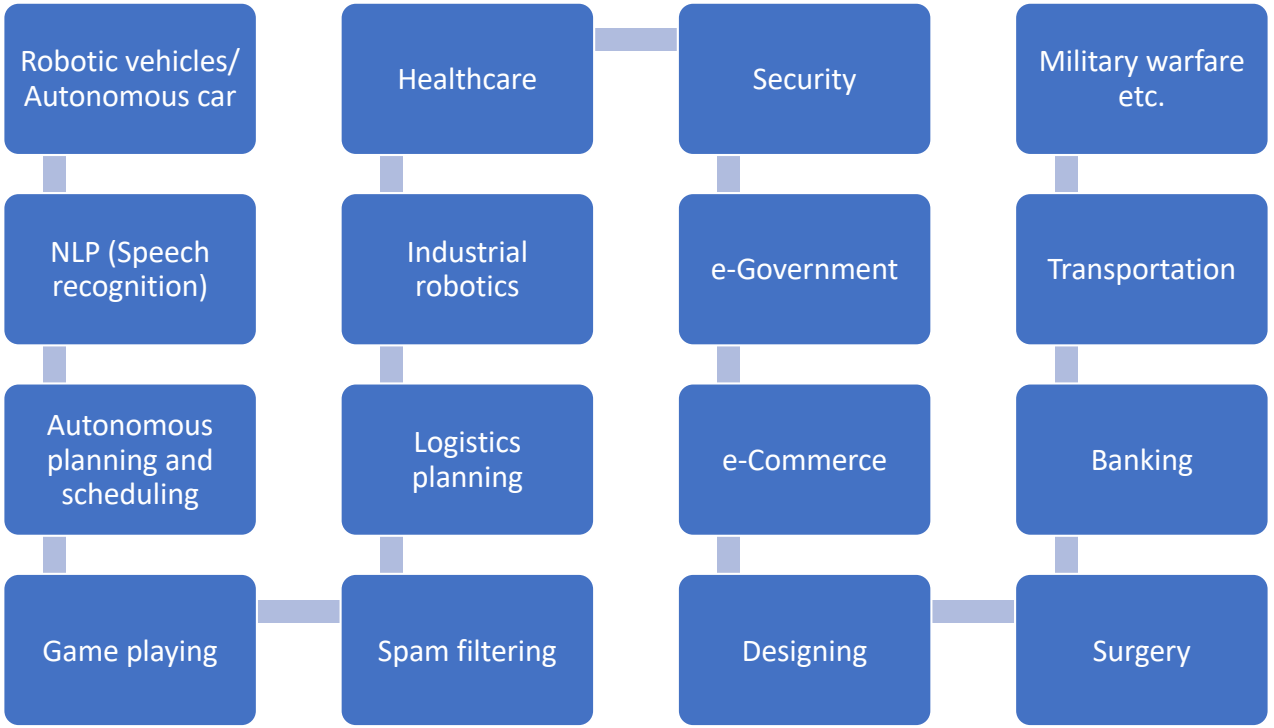
MACHINE LEARNING
Supervised Learning
Unsupervised Learning,
Semi-supervised Learning,
Reinforcement Learning
Deep Learning


Artificial Intelligence (AI)
machine learning (ML)
deep learning
supervised
unsupervised
natural language processing (NLP)
content extraction
classification
machine translation
question answering
text generation
expert systems
vision
image recognition
machine vision
speech
speech to text
text to speech
planning
robotics

History of AI



Applications of AI



Activity

- Divide into four groups.
- Think of applications of AI and link them to a definition of AI.
- Justify your argument in five minutes.

1. AI as Thinking Like a Human

- *(Cognitive modeling approach)*
  Focus: Mimicking human thought processes such as learning, reasoning, and problem-solving.
- **Applications:**
  - **Cognitive architectures** (e.g., ACT-R, SOAR) to model human thinking
  - **Intelligent tutoring systems** that adapt to a student's learning style
  - **Human memory and perception modeling** in psychology and neuroscience
  - **Brain–computer interaction systems**
  - **Simulation of human decision-making** in economics and behavioral studies

2. AI as Acting Like a Human

- *(Turing Test approach)*
  Focus: Machines that behave indistinguishably from humans.
- **Applications:**
  - **Chatbots and virtual assistants** (e.g., customer support bots)
  - **Social robots** (e.g., humanoid robots like Sophia)
  - **Speech recognition and synthesis systems**
  - **Facial expression and emotion recognition**
  - **Game characters and NPCs** that mimic human behavior

3. AI as Thinking Rationally

- *(Laws of thought approach)*
  Focus: Logical reasoning and correct inference using formal rules.
- **Applications:**
  - **Expert systems** (medical diagnosis, fault detection)
  - **Automated theorem proving**
  - **Knowledge-based systems using logic**
  - **Rule-based decision systems**
  - **Semantic reasoning and ontology-based systems**

4. AI as Acting Rationally

- *(Rational agent approach – most modern AI)*
  Focus: Taking actions that maximize goal achievement or performance.
- **Applications:**
  - **Autonomous vehicles** (self-driving cars)
  - **Robotics and automation systems**
  - **Recommendation systems** (Netflix, Amazon)
  - **AI in finance** (algorithmic trading, fraud detection)
  - **Game-playing AI** (Chess, Go, reinforcement learning agents)
  - **Smart systems** (smart homes, traffic control systems)

Homework

Read Chapter 1