ENG 346
Data Structures and Algorithms for Artificial Intelligence
Course Overview

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https://github.com/mehmetpekmezci/GTU-ENG-346

Quick Notes : PROGRAM – ALGORITHM – MATH RELATION

- A Computer Program is based on an Algorithm.
- Algorithm (Webster Dict.) :

  An algorithm is a finite sequence of **mathematically** rigorous instructions, typically used to solve a class of specific problems or to perform a computation.

Quick Notes : MATH. > ALGO. > PROG. LANGUAGE

- Example : Fibonacci Numbers : $a_n=a_{n-1}+a_{n-2}$
- a_{100000}=?
- **Math** : Binet's Formula (Generating Functions) **O(log(n))**

$$F(n) = \frac{\phi^n - (1-\phi)^n}{\sqrt{5}} \qquad \phi = \frac{1+\sqrt{5}}{2}$$

- **Algorithm** : Find an algorithm that calculates faster with less resource :

```
def nth_fibonacci(n):
    if n <= 1: return n
    return nth_fibonacci(n - 1) + nth_fibonacci(n - 2)

print(nth_fibonacci(5))
```

O(2^n)

```
F_n=0 ; F_n_1=2; F_n_2=1
n=5
for  in range(n):
  F_n =  F_n_1 + F_n_2
  F_n_2=F_n_1
  F_n_1=F_n
print(F_n)
```

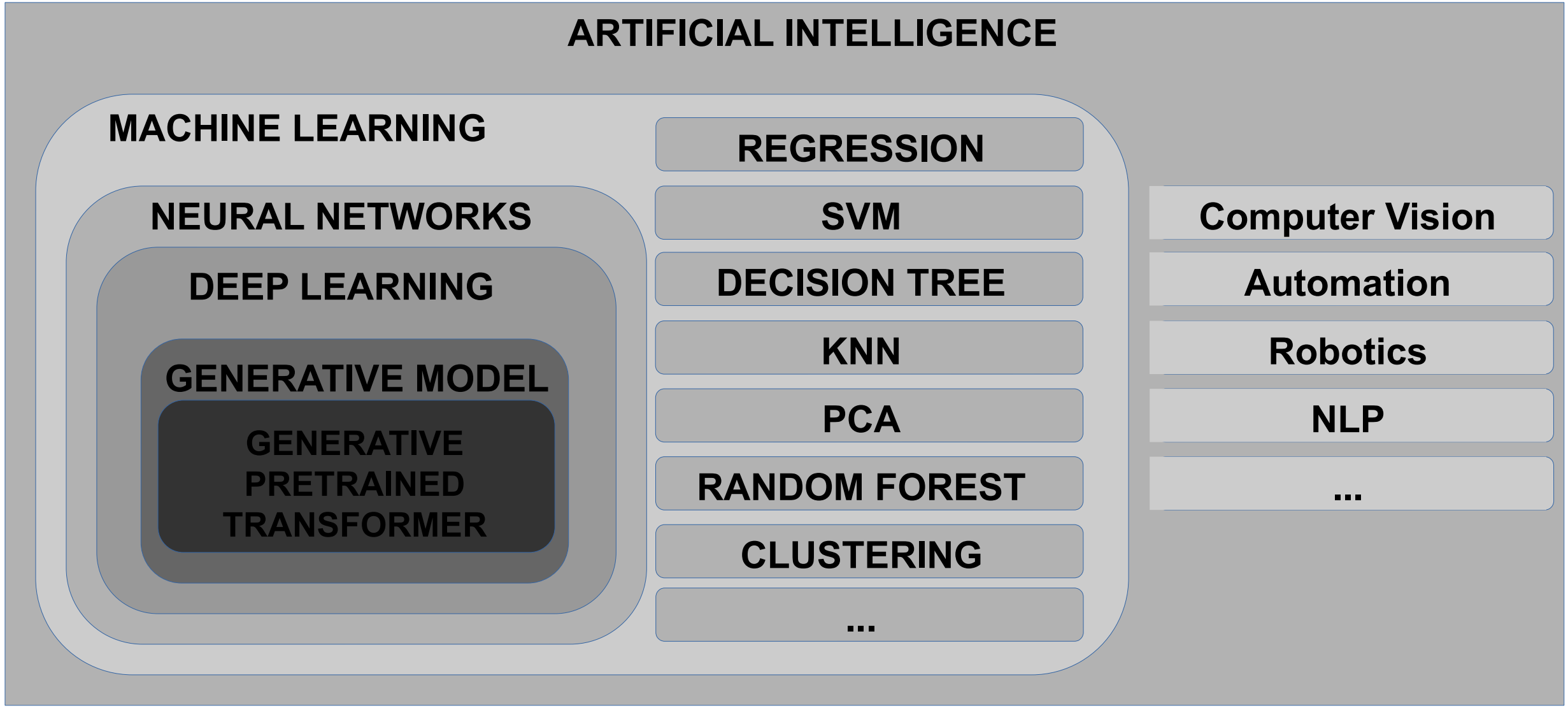
O(n)

- **Programming Language** : C/Rust programs run definitely faster than java/python programs **(for the same algorithm)**

Quick Notes : ARTIFICIAL INTELLIGENCE

- Artificial intelligence (AI) is the capability of computational systems to perform tasks typically associated with human intelligence, such as learning, reasoning, problem-solving, perception, and decision-making. (Wikipedia)

Quick Notes : ARTIFICIAL INTELLIGENCE



Quick Notes : MACHINE LEARNING

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PROBLEM DEFINITION

DATA COLLECTION

DATA CLEANING

FEATURE EXTRACTION

TRAINING

VALIDATION

TESTING

DATA VISUALIZATION

REPORT GENERATION

Quick Notes : IMPLEMENTATION OF AI TASKS

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- PYTHON
- R
- MATLAB
- JAVA
- C++
- RUST
- ...

Homework and Project will be implemented in Python.

Python has large set of Machine Learning libraries that wraps native (C) libraries.

Python is easy to learn.

- MEHMET PEKMEZCİ :

- ACADEMY :
- 2003 - BSc, Galatasaray University, Computer Engineering
- 2011 - MSc, Maltepe University, Computer Engineering
- 2025 - PhD, Gebze Technical University, Computer Engineering

- WORK :
- 2003 – 32BIT LTD. – Java Developer
- 2008 – HAVELSAN - Unix/Linux System Admin
- 2011 - HAVELSAN - Development Environment Admin
- 2017 – HAVELSAN - System Admin Team Leader
- 2019 – HAVELSAN - Infrastructure Group Leader (Sysops, Devops, Infra Teams)

Introduce yourself

- Your name
- Your department
- Your expectations from the course
- Your skill of AI knowledge

Course Overview

Why Data Structures and Algorithms

- Data structures are vital in handling and manipulating large datasets in fields like machine learning and data science.
- Algorithms are used for data analysis, pattern recognition, and more.
- Code efficiency, e.g., optimizations in searching and sorting, which is critical for software performance.
- Structural approach to problem solving.
- Critical Thinking and Problem-Solving Skills: Encourages to break down complex problems into manageable components.
- Resource management, i.e., efficient use of system resources like memory and processing power.

Purpose and Outcomes

Purpose of the course	This is a course designed to *enhance advanced Python programming*, *data structures*, *and algorithm skills* necessary for developing software, coding, and conducting group work in the field of data science and artificial intelligence
Learning outcomes	• Ability to perform basic data structures and algorithm design and analysis • Ability to collaborate in software development • Possessing skills in current software development technologies

Methodology

- Face-to-face lectures,
- Active participation expected,
- Hands-on coding,
- Homeworks: Individual work expected. **A pdf report and a python file is expected to be delivered.**
- Project: May be group project based on the project idea. **A pdf report is excepted after each phase, and a python code tar ball is expected at the end of the semester.** Phases are indicated in “Project Phases” , report dates are indicated in “Schedule” pages.
- Two quizzes,
- One midterm exam,
- One final exam.

Project Phases

- Data Collection
- Data Extraction (Standardized Format)
- Data Cleaning
- Find and replace missing value
- Normalize data
- Data Visualization
- Feature Extraction
- Training
- Validation
- Testing

Project Report Templates

- https://github.com/mehmetpekmezci/GTU-ENG-346/tree/main/Reports

Project - Possible Receivers/Transmitters

- Receivers
  - Webcam (image receiver)
  - Microphone (sound receiver)
  - Sensors in mobile phone (Accelerometers/Gyros/GPS, ... etc.)
  - Bluetooth temperature/humidity sensors
- Transmitters
  - Loud-Speaker (sound transmitter)

Example Scenario : Transmit various sound frequencies and take photo of the leaves of a tree. Try to find a relation between the growth speed of the leaves and the sound frequencies they are applied.

Grading

Homework	20
Quiz	20
Midterm Exam	20
Project	30
Final Exam	30
Total	130

Schedule

Week #	Topic	Assessment
Week 1	Basic Python Concepts with GUI	
Week 2	Matrix Operations and Numpy	HW1
Week 3	Basic Bash Concepts	**Project proposals**
Week 4	Data Analysis and Visualization	HW2 / **Project-Data-Collection-Report**
Week 5	Object-Oriented Programming	QUIZ1 / **Project-Data-Extraction-Report**
Week 6	Complexity	**Project-Data-Cleaning-And-Missing-Value-Report**
Week 7	Arrays, Linked Lists, Maps,	HW3 / **Project-Data-Normalization-Visualization-Report**
Week 8	Recursion	Midterm exam
Week 9	Stacks and Queues	HW4 - **Project-Feature-Extraction-And-Training-Report**
Week 10	Linked Lists, Trees	**Project-Validation-And-Testing-Report**
Week 11	Graphs and NetworkX	HW5
Week 12	Graphs and NetworkX	QUIZ2
Week 13		HW6
Week 14	Final Projects	
Week 15	-	
Week 16	Final exam	Final project presentations

Windows Subsystem for Linux (WSL)

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```
## https://learn.microsoft.com/en-us/windows/wsl/install
## https://ubuntu.com/desktop/wsl

## In poweshell :

Wsl --list --online

Wsl --install Ubuntu-24.04

Wsl -d Ubuntu-24.04


## Linux Shell Starts Here

sudo apt update
sudo apt install python3-pip
pip3 install matplotlib numpy pandas

## The first time you run code from Ubuntu, it will trigger a download of the necessary
dependencies:
code .
```

Textbooks and Other Resources

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Textbooks

- Goodrich, Michael T., Roberto Tamassia, and Michael H. Goldwasser, *Data structures and algorithms in Python*, John Wiley & Sons Ltd, 2013.

- Grus, Joel, *Data science from scratch: first principles with python*, O'Reilly Media, 2019.

Recommended

- https://www.kaggle.com/learn
- https://www.coursera.org/learn/python-data
- https://www.coursera.org/learn/python-data-analysis

Office Hours and Communication

- No office. We can talk between and after the lectures.

- Reach me at mpekmezci@gtu.edu.tr