

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) $O(\log(n))$

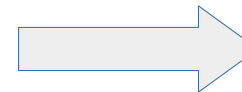
$$F(n) = \frac{\phi^n - (1-\phi)^n}{\sqrt{5}}$$

$$\phi = \frac{1 + \sqrt{5}}{2}$$

- **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)
```

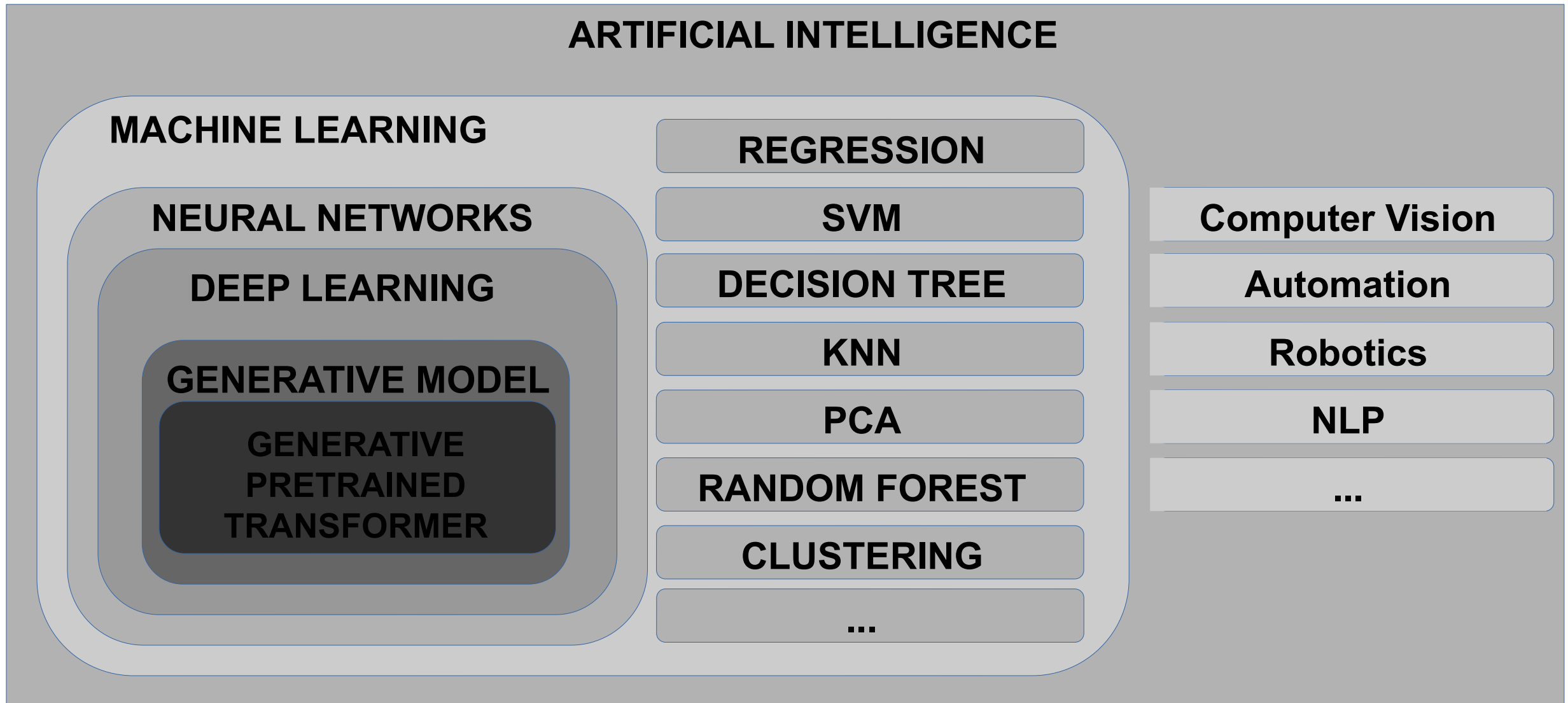
$O(n)$

- **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

PROBLEM DEFINITION

DATA COLLECTION

DATA CLEANING

FEATURE EXTRACTION

TRAINING

VALIDATION

TESTING

DATA VISUALIZATION

REPORT GENERATION

Quick Notes : IMPLEMENTATION OF AI TASKS

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 expected 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

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)

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

```
## https://ubuntu.com/desktop/wsl
```

```
## In powershell :
```

```
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

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