# Introduction to Deep Neural Networks

AIM3052-41

Prof. Hogun Park

성균관대학교
SUNG KYUN KWAN UNIVERSITY

# Course Overview

# Machine learning and Deep learning

- Machine learning (ML)
  - A type of artificial intelligence (AI) that allows software applications to become more accurate at predicting outcomes
  - Machine learning algorithms use historical data as input to predict new output values.
- Deep learning
  - A part of ML methods
  - Multi-layered Perceptrons and their variants such CNNs, LSTMs, and GANs
  - Deep learning leads the major advances in recent technology

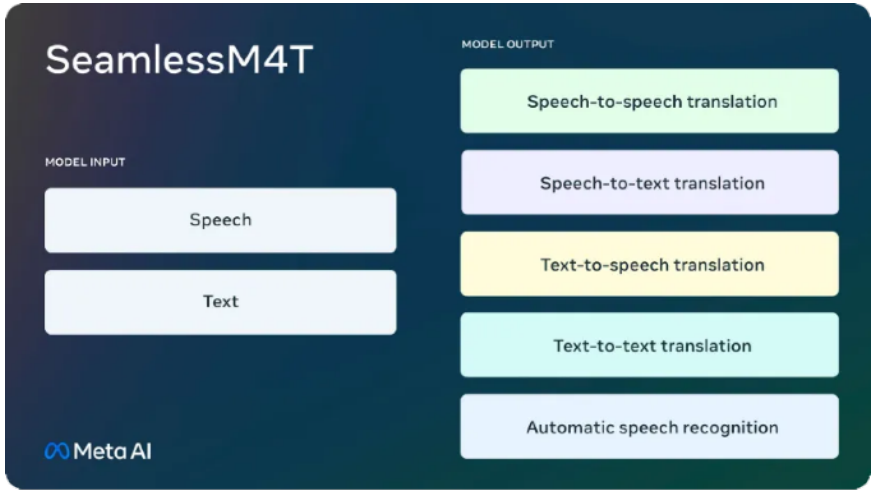
    Self-driving cars, Machine translation, ⋯

# Goals

- Deep Learning is one of the most highly sought after skills in AI. In this course, you will learn the foundations of Deep Learning, understand how to build neural networks, and learn how to lead successful machine learning projects. You will learn about Convolutional networks, RNNs, LSTM, Adam, Dropout and other recent techniques.
- Upon completing the course, students should be able to:
    - Learn about different supervised and unsupervised neural learning methods in the field of deep learning.
    - Implement some of those algorithms.
    - Learn the theory behind some algorithms.

# Why Deep learning Now?

# DL Today




- Speech recognition
  - Meta
    - ✓ Speech recognition for nearly 100 languages
    - ✓ Speech-to-text translation for nearly 100 input and output languages
    - ✓ Speech-to-speech translation, supporting nearly 100 input languages and 36 (including English) output languages
    - ✓ Text-to-text translation for nearly 100 languages
    - ✓ Text-to-speech translation, supporting nearly 100 input languages and 35 (including English) output languages


CNET
Hokkien
English
Highlights

# DL Today

- Computer Vision
  - Tesla

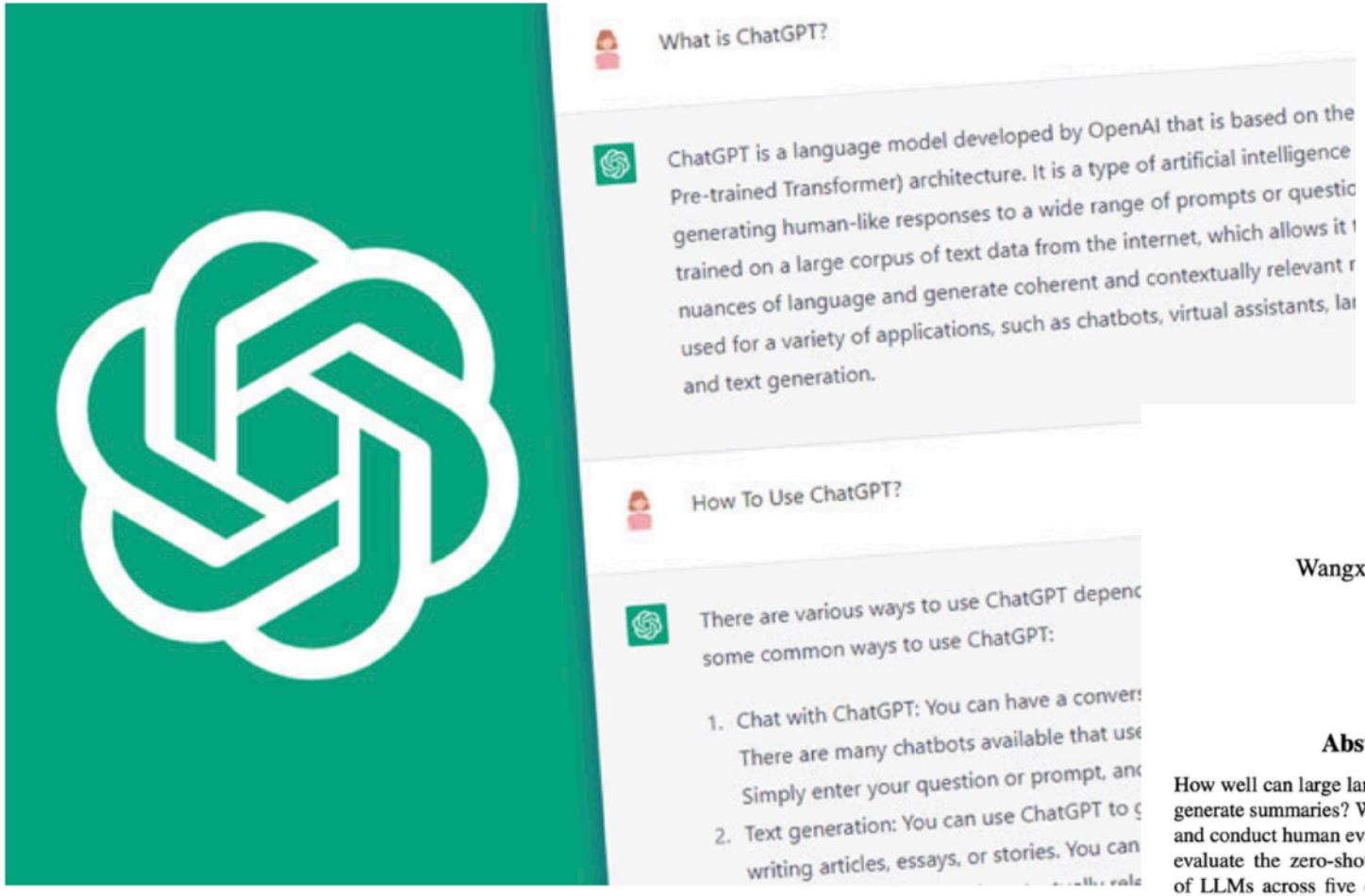
# DL Today

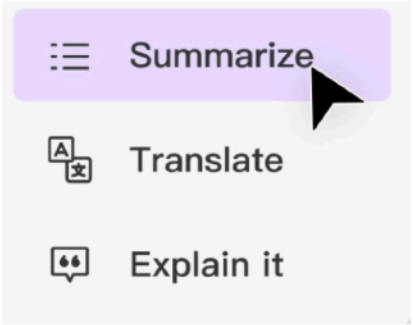
- Robot
  - Figure
    - ✓ Figure, a robotics startup based in Sunnyvale, California, has successfully secured $675 million in funding at a valuation of $2.6 billion. The early-stage funding round was backed by prominent tech companies including Nvidia, Microsoft, and Amazon.

# FIGURE 01
# AI COFFEE DEMO


Mobile ALOHA

# Text generation




**Summarization is (Almost) Dead**

**Xiao Pu***, **Mingqi Gao***, **Xiaojun Wan**
Wangxuan Institute of Computer Technology, Peking University
puxiao@stu.pku.edu.cn
{gaomingqi, wanxiaojun}@pku.edu.cn

**Abstract**

How well can large language models (LLMs) generate summaries? We develop new datasets and conduct human evaluation experiments to evaluate the zero-shot generation capability of LLMs across five distinct summarization

Our quantitative and qualitative comparisons between LLM-generated summaries, human-written summaries, and summaries generated by fine-tuned models revealed that **LLM summaries are significantly preferred by the human evaluators, which also demonstrate higher factuality**.

# Other tasks

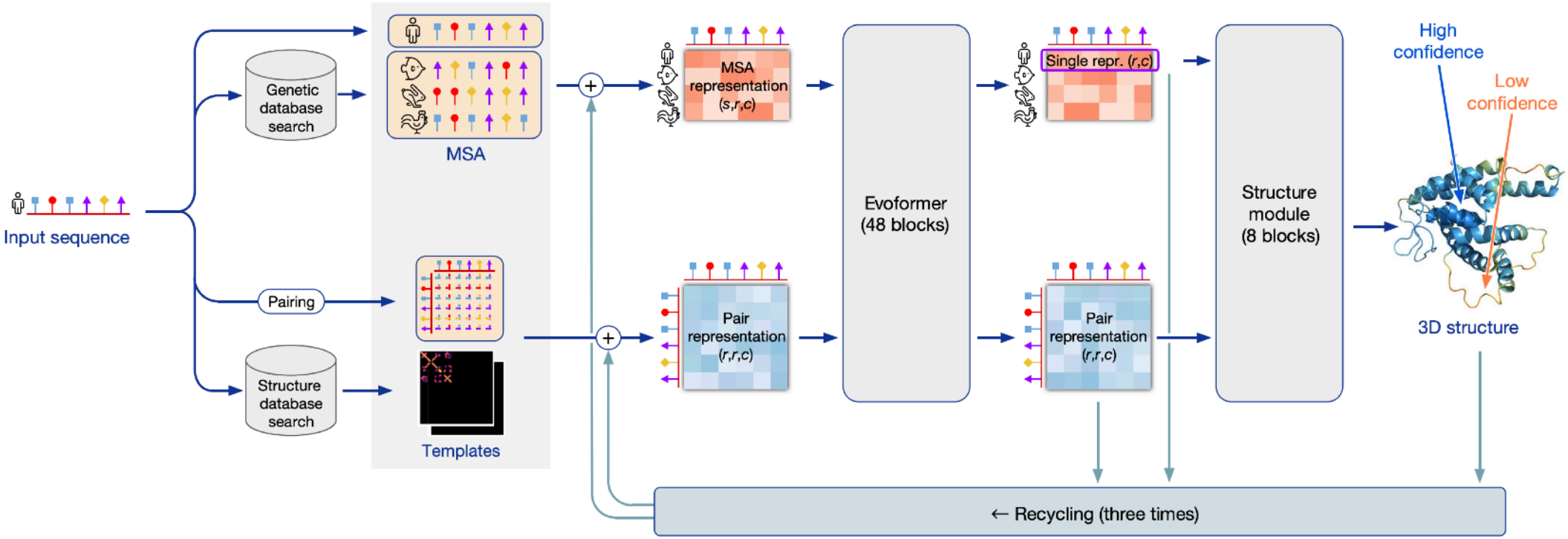
| | Claude 3 Opus | Claude 3 Sonnet | Claude 3 Haiku | GPT-4 | GPT-3.5 | Gemini 1.0 Ultra | Gemini 1.0 Pro |
|---|---|---|---|---|---|---|---|
| Undergraduate level knowledge *MMLU* | **86.8%** 5 shot | 79.0% 5-shot | 75.2% 5-shot | 86.4% 5-shot | 70.0% 5-shot | 83.7% 5-shot | 71.8% 5-shot |
| Graduate level reasoning *GPQA, Diamond* | **50.4%** 0-shot CoT | 40.4% 0-shot CoT | 33.3% 0-shot CoT | 35.7% 0-shot CoT | 28.1% 0-shot CoT | — | — |
| Grade school math *GSM8K* | **95.0%** 0-shot CoT | 92.3% 0-shot CoT | 88.9% 0-shot CoT | 92.0% 5-shot CoT | 57.1% 5-shot | 94.4% Maj1@32 | 86.5% Maj1@32 |
| Math problem-solving *MATH* | **60.1%** 0-shot CoT | 43.1% 0-shot CoT | 38.9% 0-shot CoT | 52.9% 4-shot | 34.1% 4-shot | 53.2% 4-shot | 32.6% 4-shot |
| Multilingual math *MGSM* | **90.7%** 0-shot | 83.5% 0-shot | 75.1% 0-shot | 74.5% 8-shot | — | 79.0% 8-shot | 63.5% 8-shot |
| Code *HumanEval* | **84.9%** 0-shot | 73.0% 0-shot | 75.9% 0-shot | 67.0% 0-shot | 48.1% 0-shot | 74.4% 0-shot | 67.7% 0-shot |
| Reasoning over text *DROP, F1 score* | **83.1** 3-shot | 78.9 3-shot | 78.4 3-shot | 80.9 3-shot | 64.1 3-shot | 82.4 Variable shots | 74.1 Variable shots |
| Mixed evaluations *BIG-Bench-Hard* | **86.8%** 3-shot CoT | 82.9% 3-shot CoT | 73.7% 3-shot CoT | 83.1% 3-shot CoT | 66.6% 3-shot CoT | 83.6% 3-shot CoT | 75.0% 3-shot CoT |
| Knowledge Q&A *ARC-Challenge* | **96.4%** 25-shot | 93.2% 25-shot | 89.2% 25-shot | 96.3% 25-shot | 85.2% 25-shot | — | — |
| Common Knowledge *HellaSwag* | **95.4%** 10-shot | 89.0% 10-shot | 85.9% 10-shot | 95.3% 10-shot | 85.5% 10-shot | 87.8% 10-shot | 84.7% 10-shot |

# Video generation

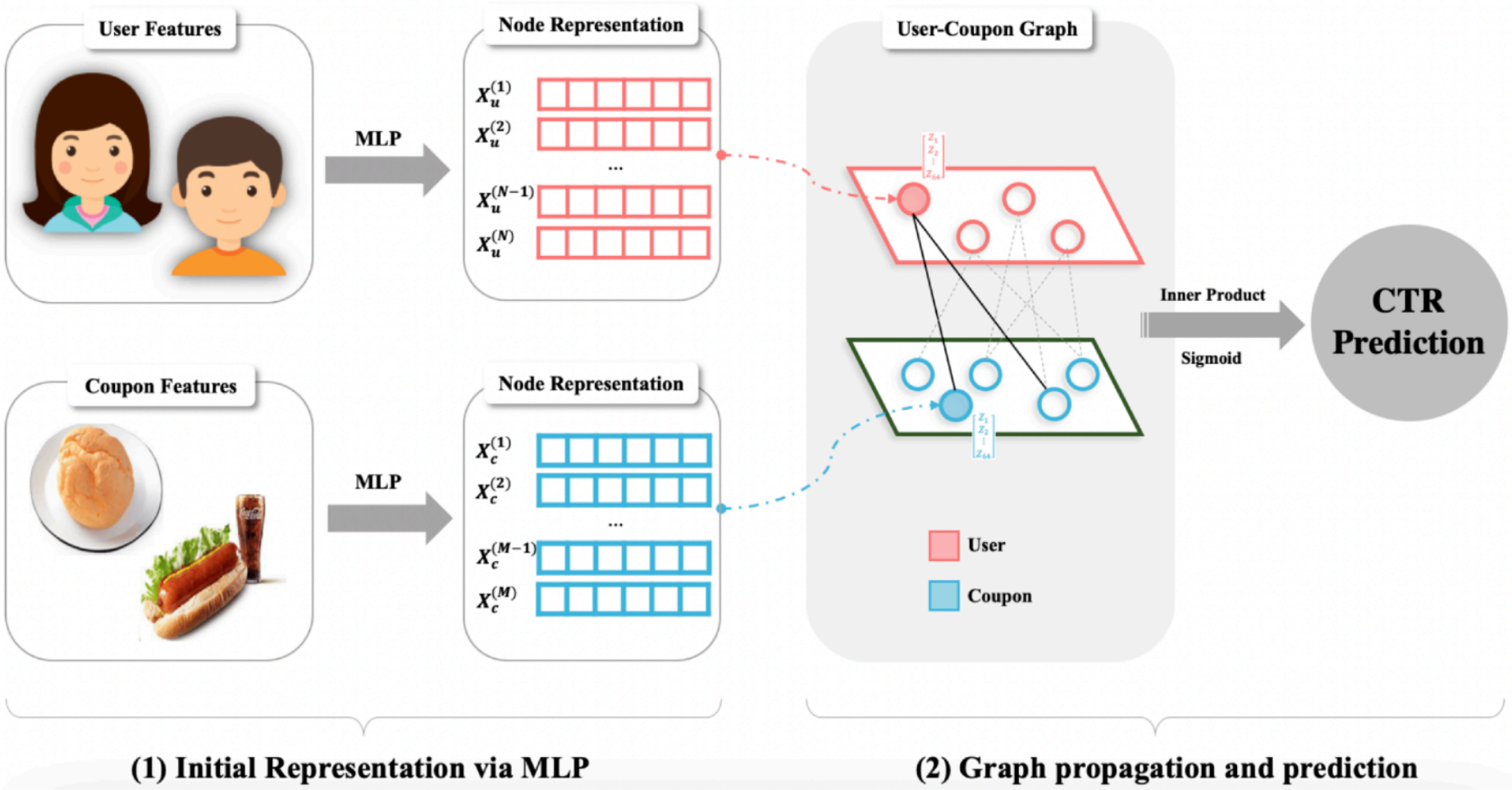
- SORA

# Biology

- Title: Highly accurate protein structure prediction with AlphaFold



# User-interaction




- User profiling
- Marketing

# After taking this class

- You can start
  - understanding their working draft or paper
  - reading and contributing the big projects

# (Tentative) Topics

- Deep feedforward networks
- Regularization for deep learning
- Optimization for training deep models
- Convolutional networks
- Sequence modeling: recurrent and recursive networks
- Autoencoders
- Foundational Representation learning models

# Logistics

- Time and location:
- Flipped learning: Recorded Lecture and OFFLINE Class (Every Tuesday 13:30-14:45)
- Instructor: Hogun Park
    - hogunpark@skku.edu, office hours: Wednesday14:00-15:00  by appointment
- Teaching assistant: TBD, office hours: TBD
- Webpage: iCampus  (Video)
- Prerequisites: 1 Programming class AND
  (1 Probability / Statistics OR 1 Linear Algebra)

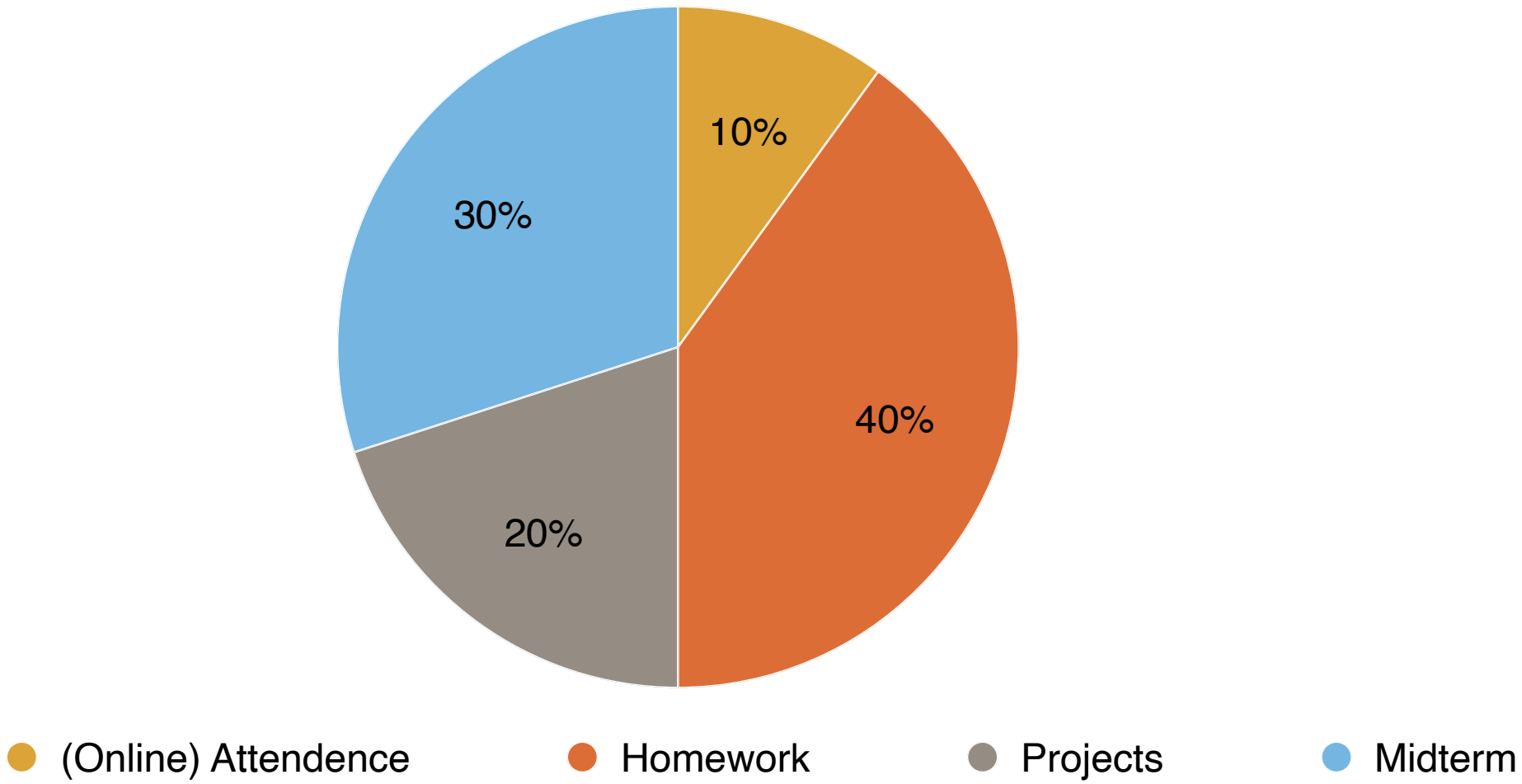
# Textbook (Not mandatory to buy)

- Goodfellow, Bengio, and Courville, (2016), Deep Learning
  - https://www.deeplearningbook.org/
- Lecture slides are from the textbook(https://www.deeplearningbook.org/lecture_slides.html)
  - UCB CS282A, and Stanford CS230

# Workload

- Homeworks/programming projects
    - Paper summary, Written/math exercises, Programming assignments in python/R
- Late policy: 15% off per day late, maximum of 5 days
  Four extension days can be applied anytime to homeworks/projects (no explanation needed)
    - The use of extension days must be stated explicitly at the time of submission.
    - Cannot be rearranged after they are applied to a submission
    - Cannot be used after the final day of classes
- Exams: Mid-term exam only

# Grading



# Honor Code (1/2)

- We strongly encourage students to form study groups.
- Students may discuss and work on homework problems in groups.
- However, each student must write down the solution independently, and without referring to written notes from the joint session.
- Each student must understand the solution well enough in order to reconstruct it by him/herself. It is an honor code violation to copy, refer to, or look at written or code solutions from a previous year, including but not limited to: official solutions from a previous year, solutions posted online, and solutions you or someone else may have written up in a previous year.
- Furthermore, it is an honor code violation to post your assignment/exam solutions online, such as on a public git repo.
- We run plagiarism-detection software on your code against past solutions or online materials.
- If the plagiarism is detected, the final grade will be immediately F.
    - (성균관대학교학칙 시행세칙(학사과정) 제25조, 시행세칙(대학원과정) 제31조)

# Honor Code (2/2)

- Example
  - If you copy codes and sentences, which are available online or in solutions, you will have zero points and get F grade immediately.
    - ✓ Exception: obvious api calls such as numpy or pytorch libraries

# Communication (1/2)

- We use the bulletin board (QnA board) and email communications.
  - Please specify the objective of your questions.
    - ✓ Good title: [HW#1] How to choose hyper-parameters in CNNs
    - ✓ Bad title: Questions about the lecture
- **However, we strongly recommend asking questions during our Webex live lectures.**

# Communication (2/2)

- Use only English for communication and all assignments
    - If you use Korean, you can expect to get zero points

# Thank you!