University of Petra

Faculty of Information Technology
Data Science & Artificial Intelligence

جامعة البترا

كلية تكنولوجيا المعلومات
علم البيانات والذكاء الاصطناعي

Course Syllabus

Year: 2023 - 2024　　　　　　　　　　　　　　　　　　　**Semester: (1)**

Course No.	Course Title	Prerequisite	Co-requisite	Credit Hours Lectures / Lab.
606465	Applications of AI		-	3:3:0 Lab

Instructor Name	E-mail	Office No.	Office ext.	Office Hours
Abdulkarim Albanna	abanna@uop.edu.jo	310	7310	9-10

Coordinator's Name:	Abdulkarim Albanna

Course Description	Applications of Artificial Intelligence course is designed to equip students with the knowledge and practical skills required to harness the power of AI to solve real-world problems. In this course, students will explore various AI applications, including natural language and speech processing. Through hands-on projects and in-depth discussions, students will understand how transformer-based models can be employed to make a meaningful impact in various industries.

Course Objectives

- Understand the core principles of transformer architectures and their role in revolutionizing AI, particularly in speech and NLP applications.
- Explore architectures and functioning of transformers, including attention mechanisms (self-attention,muli-head attention) and positional encodings.
- Develop student skills to employ transformers in various NLP tasks, such as text classification, multilingual named entity recognition, text generation, and question-answering.
- Explore the synergy between transformers and automatic speech recognition (ASR) systems, and how they enable highly accurate speech-to-text conversion.

Course Intended Learning Outcomes (ILOs) and their Alignment with Program ILOs, Teaching and Learning Methods, and Assessment Methods:

Upon successful completion of this course, students are expected to achieve the following learning outcomes:

Course ILOs	Program ILOs	Teaching and Learning Method	Assessment Method
Knowledge (K)			
K1-Understanding of transformer architectures and their applications in both speech processing and NLP.	G-DS&AI-7.2	Interactive Lectures	Final Exam
Intellectual (I)			

I1-Learn the inner workings and core components of transformer architectures to understand their role in AI applications.	G-DS&AI-2.1	nteractive Lectures	Mid Exam
Practical (P)				
P1-Learn to fine-tune pre-trained transformer models like BERT, GPT, WAV2VEC2 , and RoBERTa for domain-specific NLP and speech procesing tasks	DS&AI-6.1	Interactive Lectures	Project Evaluation Rubric
Transferable (T)				
T1-Develop competence in implementing speech processing and NLP solutions, including ASR, TTS, and NLP tasks, using transformer models.	G-DS&AI-1.3	Interactive Lectures	Mid Exam

Course Schedule:

Week	Topic	Topic Details	ILO number	Reference
1	Introduction to Transformers	The Encoder-Decoder Framework. Introduction to transformer architectures. The Hugging Face Ecosystem.	K1	Chapter 1
2	Fundamentals of Transformers	Understanding self-attention mechanisms. Transformer architecture components. Tokenization and embeddings.	K1	Chapter 3+Scientific Paper
3	NLP with Transformers	Token classification with BERT Text generation with GPT-2 Fine-tuning transformer models for NLP tasks	P1	Scientific Paper
4	NLP-APP1	Text Classification	P1 , T1	Chapter 2
5	NLP-APP2	Multilingual Named Entity Recognition	P1 , T1	Chapter 4
6	NLP-APP3	Text Generation	K1 , T1	Chapter 5
7	NLP-APP4	Question Answering	P1 , T1	Chapter 7
8-9	Introduction to Speech Signal Processing	Characteristics of Speech Signals.Speech Signal Preprocessing (Time domain).Speech Signal Segmentation. Introduction to MFCC, STFT, and Log-Mel Spectrum.	K1 , T1	Ref2- Lecture Notes
10	Feature Extraction using MFCC, STFT, and Mel-log Spectrum	Practical applications and feature extraction using MFCC, STFT, and the Log-Mel spectrum. Comparing the advantages and disadvantages of each technique.	K1 , P1	Lecture Notes
11	ASR with Transformer Models	Utilizing transformer models for Automatic Speech Recognition (ASR).	K1 , P1	Lecture Notes
12	Transformer Models for Speech Processing	An overview of transformer architectures and their role in speech processing.	P1	Lecture Notes
13	Student Project Proposals	Students propose project ideas focusing on transformer-based speech applications for the final project.	P1 , T1	-
14	Project Preparation and Planning	Students work on project proposals, refine their project objectives, and plan their project scope, including identifying datasets and resources required.	P1 , T1	-
15	Student Projects in Transformer-Based Speech Applications	Students work on their projects, applying what they've learned in the course to create and present real-world applications of transformer models in speech processing. This includes ASR, speaker recognition, speech synthesis, emotion analysis, or other innovative speech-related projects.	P1 , T1	-
16	Project Presentation and Evaluation	5: Students present their project outcomes. Each project presentation	P1 , T1	-

Assessment Methods and Grading System:

Assessment method	Grade	Comments
Final Exam	40%	
Mid Exam	20%	
Project Evaluation Rubric	20%	
Assignments	20%	

Total	**100%**	

Learning References:

1- Natural Language Processing with Transformers, Revised Edition 1st Edition by Lewis Tunstall, Leandro von Werra, Thomas Wolf.

2- Intelligent Speech Signal Processing 1st Edition by Nilanjan Dey.

3- https://towardsdatascience.com/

4- https://wiki.aalto.fi/display/ITSP/Introduction+to+Speech+Processing

5- https://arxiv.org/abs/1706.03762

Course Policies [1]

- Attendance Policy: University regulations apply to attendance.

- Academic Honesty: Academic dishonesty is an unacceptable mode of conduct, and will not be tolerated in any form at University of Petra. All persons involved in academic dishonesty and plagiarism in any form will be disciplined in accordance with University rules and regulations.

- Make-up Exams: Only students with valid excuses are allowed to have makeup exams. All excuses must be signed by the Faculty Dean. Student has the responsibility to arrange with his/her instructor for an exam date before the occurrence of the next regular exam.

- All assignment must be submitted at the specified due date. Marks will be deducted from late work (no later than 3 days).

- No makeup for quizzes under any circumstance.

Approved by	**Name**	**Date**	**Signature**
Head of Department			
Faculty Dean			

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[1] Additional information may be added in this section according to the nature of the course.