

## ASSIGNMENT BRIEF

<b>HTU Course No:</b> 10204450	<b>HTU Course Name:</b> Deep Learning
<b>BTEC Unit Code:</b>	<b>BTEC UNIT Name:</b>

**Version: 3**



<b>Student Name/ID Number/Section</b>	
<b>HTU Course Number and Title</b>	10204450 Deep Learning
<b>BTEC Unit Code and Title</b>	
<b>Academic Year</b>	2023-2024 Spring
<b>Assignment Author</b>	Ala'a Al-Habashna
<b>Course Tutor</b>	Ala'a Al-Habashna
<b>Assignment Title</b>	Developing a deep learning-based system
<b>Assignment Ref No</b>	1
<b>Issue Date</b>	01/05/2024
<b>Formative Assessment dates</b>	From 01/05/2024 to 30/05/2024
<b>Submission Date</b>	13/06/2024
<b>IV Name &amp; Date</b>	Raneem Qaddoura 30/04/2024

#### Submission Format

The submission is in the form of a soft copy to be submitted through the university's E-learning system within the deadline specified above from the following link: <https://elearning.htu.edu.jo>.

#### Submission for this assignment is expected to be as follows:

1. An individual written report that follows the below guidelines, and contains the parts described in the assignment brief (**.docx**).
2. The source code and model files of the project (e.g., **.py**, **ipynb**, **.pt**, **.pth**, etc.).
3. Student declaration form filled out and signed properly (**.docx**).

#### Report guidelines:

In a report, you should make use of headings, paragraphs, and subsections as appropriate. The expected word limit is 5000-10000 words, although you will not be penalized for exceeding the total word limit, do your best to be within the word limit. Your report should be:

1. In a word form of a soft copy submitted to the instructor.
2. Written in a formal business style using single spacing and font size 12.
3. Must be supported with research and referenced using the Harvard referencing system.

#### Further instructions:

1. You must show up to the final oral exam on time, or you will fail.
2. In addition to discussing your submission (code, report, etc.), the oral exam will include questions from the course material.

## Unit Learning Outcomes

**LO1** Understand the theoretical foundation of deep learning and how deep neural networks work.

**LO2** Investigate the different types of neural networks (e.g., DNN, CNN, RNN) and their modern architectures, and choose/compare the ones prevalently used to solve a specific problem.

**LO3** Develop deep learning model(s) (to solve a real-world problem) and embed it in an application using an appropriate programming language and deep learning tools.

**LO4** Evaluate the outcome or the result of the developed application to determine the effectiveness of the developed deep learning model(s) used in the application.

## Assignment Brief and Guidance

You have just joined a company specializing in commercial deep learning applications as a deep learning algorithms engineer (intern). Your *first project* is to develop a Neural Network from scratch (with the appropriate programming language) that can be used to train models to be used in commercial capacity.

Your *second project* is to use an appropriate programming language and deep learning package (e.g., PyTorch) to develop a deep learning-based system. Initially, you must identify the desired application. Subsequently, you should research existing papers on the chosen application to understand the prevalent neural networks and architectures utilized. Once you have finalized the application concept and selected the architectures, your next step is to either locate and prepare a dataset for training and testing your deep-learning models. It is essential to thoroughly train and test these models (with the appropriate programming language and packages), conducting comprehensive assessments to attain optimal accuracy (using proper evaluation metrics). You need to create a simple interface to use the developed deep learning modes. Upon completing your assigned duties, you must submit a detailed report to your manager outlining the final product and the developmental process. Clarity is crucial in this report, as it will later serve as a reference for junior developers within the company. You must be proficient in developing, optimizing, testing, and documenting all stages of the process.

Below you find a detailed description of the assignment mapped to the different assessment criteria:

### **Part-1: Neural Network Implementation**

1. Design and construct a neural network **from scratch** using an appropriate programming language. Use proper Object-Oriented (OO) design for your implementation. **(Project)**
2. Provide a thorough description of your implementation for the neural network, encompassing its architecture, neuron components, training procedure, and other pertinent details. **(Report)**
3. Test your implementation by using it to train an actual benchmarking dataset and use a test set to evaluate the accuracy of the trained model(s) with appropriate metrics. **(Project)**
4. Discuss the accuracy and effectiveness of your implementation and how it can be improved. **(Report)**

### **Part-2: Problem Statement**

1. Provide a well-defined problem statement with a clear set of requirements. **(Report)**
2. Search the literature to find the best deep neural network architectures used to train models for the problem under consideration. **(Report)**
3. Investigate the modern architectures used for the problem under consideration. **(Report)**
4. Compare the popular modern architectures used to solve this problem and make a summary of their advantages/disadvantages. Use this to justify your choice of architectures to use. **(Report)**

### **Part-3: Model Development**

1. Find a dataset to train model(s) for the problem under consideration. Describe the dataset's source, collection method, attributes, size, and domain. **(Project and Report)**
2. Prepare training and test data for model training. **(Project and Report)**
3. Train models to be used to make inference to solve the problem under consideration. **(Project)**
4. Describe in detail, the training process, hyper-parameters considered and their values, the architecture(s) to be employed, etc. **(Report)**

#### **Part-4: Model Evaluation**

1. Discuss the performance measures you choose to evaluate the effectiveness of your models and why you choose these metrics. **(Report)**
2. Use the three-way split approach to select the best models and test them on a test set. **(Project)**
3. When training/testing is finished, wrap your models in an interface that selects a model, takes an input and produces an output/prediction. **(Project)**
4. Describe how, based on the performance measures, you were able to enhance the models. **(Report)**
5. Discuss the reliability of your results and whether they are balanced, overfitting, or underfitting. **(Report)**
6. Analyse the results of the models to determine the effectiveness of the selected architectures. **(Report)**
7. Draw conclusions regarding the strengths and weaknesses of the different architectures. **(Report)**
8. Identify further enhancements which can be made in the future? Discuss any limitations and future improvements of your project. **(Report)**

Learning Outcomes and Assessment Criteria			
Learning Outcome	Pass	Merit	Distinction
<b>LO1</b> Understand the theoretical foundation of deep learning and how deep neural networks work.	<b>P1</b> Design a neural network with at least one hidden layer.  <b>P2</b> Implement the neural network from scratch without the use of existing packages such as nn package.	<b>M1</b> Train and evaluate your neural network implementation on a benchmarking dataset.	<b>D1</b> Evaluate the effectiveness of the design and implementation of the neural network and suggest improvements.
<b>LO2</b> Investigate the different types of neural networks (e.g., DNN, CNN, RNN) and their modern architectures, and choose/compare the ones prevalently used to solve a specific problem.	<b>P3</b> Define a problem to solve using deep learning.  <b>P4</b> Investigate the type of neural networks usually used to solve this problem.	<b>M2</b> Investigate the popular modern architectures used in research/industry to solve the problem under consideration.	<b>D2</b> Compare the popular modern architectures used to solve this problem and make a summary of their advantages/disadvantages. Use this to justify your choice of architectures to use.
<b>LO3</b> Develop deep learning model(s) (to solve a real-world problem) and embed it in an application using an appropriate programming language and deep learning tools.	<b>P5</b> Find and prepare the training and test data sets in order to implement the deep learning solution.  <b>P6</b> Train deep learning models with suitable deep learning architectures and demonstrate the outcomes.	<b>M3</b> Test the deep learning models using a range of test data and explain each stage of this activity.	<b>D3</b> Critically evaluate the implemented learning solution and its effectiveness in meeting end user requirements and suggest future improvements.
<b>LO4</b> Evaluate the outcome or the result of the developed application to determine the effectiveness of the developed deep learning model(s) used in the application.	<b>P7</b> Discuss whether the results are balanced, under-fitting or over-fitting.  <b>P8</b> Analyse the results of the models to determine the effectiveness of the architectures used.	<b>M4</b> Evaluate the effectiveness of the used architectures used in the application.  <b>M5</b> Wrap your model in an interface that selects a model, takes an input and produces an output (prediction).	