**Advanced Programming in Python – MiniProject #1**

**Due till 15/12/24**

**Part 1 – Object Oriented programming (15pts):**

Consider the following hierarchy that represents different types of neurons and their roles in the nervous system:

1. General Neuron: Represents a generic neuron with basic properties and functions common to all neuron types.

- Attributes: firing_rate: A numerical value representing how frequently the neuron "fires" in response to a stimulus.

- Functionality: Activate: Receives a stimulus and calculates a firing rate based on the strength of that stimulus.

2. Sensory Neuron: A neuron that detects and responds to external stimuli. Each sensory neuron is sensitive to a specific type of stimulus, such as light or pressure.

- Attributes: receptor_type: Indicates the type of stimulus the neuron detects (e.g., "light" for photoreceptors or "pressure" for mechanoreceptors).

- Functionality: Sense Stimulus: Processes the specific stimulus it is sensitive to and activates the neuron based on the strength or type of that stimulus.

3. Motor Neuron: A neuron responsible for initiating muscle movement by sending activation signals to a target muscle.

- Attributes: target_muscle: Specifies the muscle controlled by the motor neuron (e.g., "skeletal muscle" or "muscle spindle").

- Functionality: Control Muscle: Triggers a response in the target muscle based on the neuron's activation level.

4. Photoreceptor: A sensory neuron specifically sensitive to light.

- Attributes: receptor_type: Fixed as "light" to represent its sensitivity.

- Functionality: Light Detection: Receives light intensity as input and activates according to light levels.

- Unique Response to Light: Exhibits a behaviour specific to light detection, such as increasing firing rate with higher light intensity.

5. Mechanoreceptor: A sensory neuron that responds to pressure.

- Attributes: receptor_type: Fixed as "pressure" to represent its sensitivity.
- Functionality: Pressure Detection: Receives pressure as input and activates in response to the strength of the applied pressure.
- Unique Response to Pressure: Produces a response based on the pressure level, potentially changing firing rate or triggering other effects.

6. Alpha Motor Neuron: A motor neuron that controls skeletal muscles.

- Attributes: target_muscle: Set to "skeletal muscle" to specify its control function.
- Functionality: Skeletal Muscle Control: Initiates muscle contraction or movement in response to its activation level.
- Response Specific to Skeletal Muscle: Exhibits control mechanisms appropriate for skeletal muscles, such as strong, rapid contractions.

7. Gamma Motor Neuron: A motor neuron that controls muscle spindles, helping regulate muscle tone.

- Attributes: target_muscle: Set to "muscle spindle" to specify its control function.
- Functionality: Muscle Spindle Control: Adjusts muscle spindle tension in response to activation, affecting muscle tone.
- Unique Control Mechanism: Exhibits a response specific to muscle spindles, often slower and more gradual than the rapid activation of skeletal muscles.

Tasks:

A. Design the class hierarchy:

  a. Identify the classes

  b. Determine the relationships between them

  c. Plot a suitable diagram (free style for non CS student)

B. Define the classes (no need to implement the functions themselves)

  a. Define base, intermediate and leaf classes

  b. Define base class attributes and methods

  c. Add any unique attributes or method required by the intermediate classes if needed

  d. Add any unique attributes or method required by the leaf classes if needed

e. Override methods if needed

The output should be a diagram (A) and class definitions in Python (B).

** No need to implement the functions **

**Part 2 – NumPy, Pandas, MatPlotLib:**

The purpose of this part is to practice using libraries that were introduced in lecture. These libraries include pandas, numpy and matplotlib.

Please use the git commands that you were taught while completing this project and upload this project to your github account.

When submitting the assignment, please include the code file as well as the URL to your git account to show us you understand navigating projects using git.

**Q1 (20pts):** Write a function that samples a sinusoidal signal while preserving all maximum and minimum points.

**Input to function**: a NumPy array representing a sinusoidal signal with a frequency of 5Hz, sampled every 0.01 seconds.

**Output**: a new numpy array representing the same signal. The length of the new array should be approximately 20% of the original one.

**Requirements:**

1.Use NumPy 2. Ensure the downsampled signal maintains the key characteristics (maxima and minima) of the original signal. 3. Write a short script to verify the functionality of your implementation.

**Hints:**

Find the Maxima and Minima: Identify the indices of the maximum and minimum points in the sinusoidal signal.

Downsample the Signal: Create a downsampled version of the signal by selecting every 5th data point. Ensure that all identified maxima and minima are preserved in the downsampled signal.

**Q2 (65pts):** For this question you will use the dataset titled "laptop-price – dataset.csv".

Import the libraries mentioned above and import the dataset from your filesystem into the code.

Please write code to complete the following tasks with this dataset:

- Plot the price of all the laptops
- Which company has on average the most expensive laptop? What is the average laptop price for each company?
- Find the different types of Operating systems present in the data - under the column name "OpSys".
    - Please note - there are operating systems that are the same systems and just written differently in the column - please fix them to be uniform.
- Plot for each of the operating system types the distribution of the prices, so that the number of plots equals to the number of unique operating systems.
- What is the relationship between RAM and computer price? add an adequate plot to support your findings.
- Create a new column for the dataframe called "Storage type" that extracts the storage type from the column "Memory".
    - For example, in the first row in the column "Memory" it states "128GB SSD", the new column will have just "SSD" in its first row.

All plots must be plotted with axes titles and units as well as plot titles.

**Bonus question (10pts):** Think of additional questions related to this data. What types of analyses and visualizations would you use to address them? Select two questions from your list and implement. Submit your list of questions, suggested analyses and visualization and the implementation.

**Submission:** your submission will include one jupyter notebook file for the code (including comments in the code), a diagram of the class hierarchy, and the URL to your github page (where we will find your uploaded project).

**Grading criteria:**

Correctness: 60%

Structure and readability: 10%

Explanation and documentation: 15%

Adherence to guidelines and submission requirements: 10%

Innovation and creativity: 5%