**Objective:**

Explore and implement vertical and horizontal partitioning of AI models, applying them to a wireless network optimization problem.

**Assignment Questions**

**Part 1: Theory and Concepts (10 Points)**

1. Define **vertical partitioning** and **horizontal partitioning** in the context of AI models.
2. Compare the advantages and disadvantages of these partitioning methods, focusing on computational efficiency, scalability, and real-world application in wireless networks (you can take any dataset).

**Part 2: Practical Implementation (60 Points)**

You are given a pre-trained model for predicting network latency and a dataset with the following attributes:

* **Tower ID**
* **Signal Strength (dBm)**
* **Network Traffic (MB)**
* **Latency (ms)**
* **User Count**
* **Device Type**

**Tasks:**

1. **Vertical Partitioning (30 Points)**
   * Split the original model into two sub-models:
     + **Model A**: Processes features related to the network (e.g., Signal Strength, Network Traffic).
     + **Model B**: Processes features related to user behavior (e.g., User Count, Device Type).
   * Combine the outputs of **Model A** and **Model B** to predict network latency.
   * Compare the performance of the partitioned model to the original monolithic model using metrics like accuracy and latency prediction error.
2. **Horizontal Partitioning (30 Points)**
   * Divide the dataset into two subsets based on geographic categories:
     + **Subset 1**: Urban cell towers.
     + **Subset 2**: Rural cell towers.
   * Train separate models for each subset and compare their performance to a single model trained on the entire dataset.
   * Provide insights into the benefits of horizontal partitioning in this scenario.

**Part 3: Industry-Oriented Analysis (30 Points)**

1. Based on your partitioning experiments:
   * Recommend scenarios where vertical partitioning is more effective.
   * Suggest situations better suited for horizontal partitioning.
2. Prepare a concise report or presentation for a potential Qualcomm use case:
   * How can these techniques improve scalability and performance in 5G network optimization?
   * What challenges might arise in deployment, and how would you address them?

**Submission Guidelines**

* Submit your answers as follows:
  + **Part 1**: A written document with your theoretical answers.
  + **Part 2**: Python scripts/notebooks for the partitioning experiments in ipnyb format with output cells.
  + **Part 3**: A detailed report (**in pdf format**) or a slide deck summarizing your analysis and recommendations.

**Evaluation Criteria**

* **Conceptual Clarity (20%)**
* **Implementation Accuracy and Code Quality (40%)**
* **Analysis and Insights (30%)**
* **Presentation of Recommendations (10%)**