Quantum Algorithm for Classical Data Classification

Objective:
Develop a **Variational Quantum Classifier (VQC)** with a **customized feature map** and a **customized parametric quantum circuit (ansatz)** to classify the given dataset. You have the freedom to use any of the available SDKs.
Additionally, create and upload a **5–7 minute video presentation** explaining the implementation. The video must be uploaded to a cloud platform (e.g., Google Drive) with open access.

Dataset Link: Dataset

Evaluation Criteria:
Total: 100 points
1. Technical Implementation (40 points):
- **Algorithm Complexity:**
  - Design an efficient quantum (VQC) model that results in better performance.
  - Evaluate the model's performance on a Fake backend or noisy simulators.
- Scalability:
  - Design the ansatz with the potential to scale efficiently to higher qubit systems without compromising performance.
- Metrics Calculation:
  - Assess quantum-specific metrics such as:
  - Expressibility
  - Entangling Capacity
  - Circuit Depth Reduction
  - Effective Dimensions
  - Compute machine learning metrics such as accuracy, precision recall, etc. to validate performance
- Exploration:
  - Compare the performance of the customized feature map and ansatz with default (standard) feature maps and ansatz available in respective SDK's.

2. Uniqueness (30 points):
- Novelty:
  - Ensure the implementation is distinct and demonstrates creativity in design
- Originality:
  - Minimize or avoid the use of pre-built functions and classes, opting instead for custom-built components wherever possible.

3. Presentation (20 points):
- Technical Explanation:
  - Provide a clear and well-structured explanation of the implementation and highlight key technical aspects.
- Creative Storytelling:
  - Maintain a concise, engaging, and easy-to-understand narrative throughout the

presentation.

4. Bonus Criteria (10 points):
    - Noise Model Comparison:
        - Analyze and compare results using different noise models to simulate realistic quantum environments.
    - Classical Machine Learning Benchmarking:
    - Evaluate and compare the performance of the quantum classifier with classical machine learning models to demonstrate effectiveness.

Final Deliverables:

1. Code Implementation:
    - Implementation with clear documentation (including data preprocessing).
2. Video Presentation:
    - Duration: 5–7 minutes.
    - Upload to a cloud platform with open access.
3. Report/Documentation:
    - Explain your Quantum (VQC) model by specifically justifying the ansatz selection by using the metrics, results, and comparisons with supporting graphs and tables. Also report the model performance with classical ML metrics.