QUANTUM BINARY CLASSIFIER FOR PARTICLE COLLISION EVENT DETECTION IN HIGH-ENERGY PHYSICS

INITIAL REPORT

- ## WHAT IS THIS PROJECT ABOUT?

This project classifies the data produced by particle collision experiment into background events and signal using quantum computer. The result is benchmarked and compared against classical computer.

- ## WHAT IS BACKGROUND AND SIGNAL?

After collision of particles, many events occurs this events are:

Signal:
These are the **rare, interesting events** that physicists are specifically looking for.
They often involve **new or important physics**, such as:

- The **Higgs boson**
- Evidence for **supersymmetry**, **dark matter**, or **new particles**

Signals usually match the predictions of specific theoretical models and are **not common** in standard interactions.
Example: A collision event that produces a Higgs boson decaying into two photons would be a signal event in a Higgs search.

Background:

- These are the **common, less interesting events** that happen much more frequently.
- They come from **known Standard Model processes.**
- Background events can **look similar to signal events**, making them harder to separate.

Example: Two high-energy photons from unrelated processes might mimic the signature of a Higgs boson decay, but they're just background.

- ## Dataset

1. Higgs Boson Machine Learning Challenge Dataset (from Kaggle)

    - Simulated data with 30 features.
    - Size around 36 MB.
    - 250,000 simulated events.
    - Only Higgs related data and events.

2. CERN Open Data Portal

    - Official open data released by CERN from actual LHC experiments.
    - Contains all types of events (Higgs, Mesons etc.).
    - Real data (Not simulated).
    - Size in TiBs.
    - Billions of events.

- ROLES
    - Quantum Machine Learning (QML) Developer. + Research stuffs
    - Classical ML & Benchmarking Lead.+ Deployment related stuffs
    - ~~Data Engineer~~.Development (Frontend for GUI and Backend if required)
    - Documentation Lead.+ QML and ML person 2

Hamein 2 log QML+ML ke liye chahiye aur 2 log deployment aur development. Jo ML+QML karega voh DE bhi kar lega kyunki ek hi dataset hai.

- WHAT TO LEARN ?

    It depends on role but here are some common topics:

    1) Basics of quantum computing.
    2) Quantum ml, Quiskit or PennyLane.
    3) Classical ml.
    4) For Data Preprocessing role only basics of particle physics.