Project Charter

Northrop Grumman, Quantum AI at the Edge

Prepared by the CU Boulder Northrop Grumman Capstone Team

October 03, 2021

1. Introduction

Executive Summary

- Northrop Grumman solves the toughest problems in space, aeronautics, defense, and cyberspace to meet the ever-evolving needs of their customers worldwide. Northrop Grumman defines what is possible every day using science, technology, and engineering to create and deliver advanced systems, products, and services.

- Northrop Grumman is a leading provider of full spectrum cyber across land, air, sea, and space. From preventing cyber-attacks to securing military communications and giving our customers a decisive advantage, our capabilities are second to none.

Opportunities

- The intersection between machine learning and quantum computing has attracted considerable attention in recent years. This has led to several recently proposed quantum algorithms.

- Current AI solutions require performance improvements in training, and these solutions are being deployed to new domains. Simple classifiers are starting to show promise on quantum processors, and these classifiers are deployable on edge processors for inference.

2. Objectives and Scope

Objectives

- Apply quantum AI to train a simple classifier network and then use that network for inference on an emulated embedded platform.

High Level Requirements

- SVM and MLP classifiers will be trained using OpenCV and/or TensorFlow to establish baselines.

- IBM Qiskit and Google Cirq will be used to implement SVM and MLP and compared with the baselines in terms of accuracy.

- Models should be run first in simulation and then on IBM and Google quantum processors.

- The classifiers should then be used for inference on a XILINX Vitis emulator to demonstrate similar performance to what was seen in training.

Project Scope

In Scope:
- Reviewing quantum computing techniques and necessary research papers

- Developing familiarity with the sponsor requested technology stack

- Reviewing appropriate tutorials for developing familiarity with novel quantum technology

- Translating quantum algorithms to utilize qubits in the Qiskit quantum simulator

- Developing familiarity with the constraints of the embedded and edge computing platforms

Out of Scope:
- Modifications to existing algorithms or creation of new algorithms

- Fundamental research on new quantum algorithmic techniques

- Building novel quantum AI, embedded, and edge computing toolkits

3. Project Approach

General Approach

- Develop familiarity with existing quantum and baseline technology stack via current research, documentation, and tutorials.

- Develop working code for the respective IBM and Google SDK's and libraries.

- Compare performance on the respective IBM and Google SDK's and libraries.

- After selecting the more performant SDK and library begin to develop working code for the embedded and edge platforms.

- Analyze and determine performance differences on the quantum versus baseline on the embedded and edge platforms.

Assumptions

- Since this is an R&D project that is fully exploratory by nature there is an underlying assumption that the project may not succeed.

Project Risks and Issues

- The sponsor has communicated that there is no guarantee that the project will necessarily work due to the R&D and fully exploratory nature of the project itself.

- During this project, as issues arise that put the success of the project at risk, the issues and risks will be documented in the *Project Log* and tracked through resolution.

Project Changes

- Changes to project scope and requirements will be reviewed by the project sponsor, manager, and engineering team. This group will assess the potential impact of the change on schedule and resources, then provide a decision for approval or disapproval. All scope and requirements changes will be documented in the *Project Log*.

4. Project Plan

Key Deliverables

1. Project Charter

2. Project Plan, containing:

- Detailed task list

- Revised milestones and target dates if needed

3. Requirements Definition, containing**:**

- Detailed description and documentation of each solution to be developed

- Clear, concise statements of what each solution must accomplish to be considered successful

4. Solution Design, containing

- An accurate description of each solution

- Change Management Plan for implementing each solution

5. Solution Construction and Testing, containing

- Analysis comparing baseline classifiers with quantum versions and libraries

- Datasets used for analysis

- Training Code

- Analysis of inference on emulated platform and code

6. Ongoing support and management procedures for each component of the KM Solution

- Support documentation

- Knowledge Management governance guidelines

Timeline

Deliverable	Due Date
Project Charter	October 03, 2021
Project Plan	October 15, 2021
Requirements Definition	November 01, 2021
High Level Solution Design	November 15, 2021
Detailed Solution Design	November 20, 2021
Solution Construction and Testing	November 25 , 2021
Governance Guidelines	November 25, 2021
Submit Written Report to Sponsor	December 01, 2021
Present Findings to Sponsor	December 05, 2021

Preliminary Cost Estimates

Labor Costs	Estimate
Development Time	$0

Hardware/Software Costs	Estimate
Open-Source Software	$0

5. Key Stakeholder Roles & Responsibilities

Stakeholder	Role/Responsibility
Dave Motta	Project Sponsor
Alec Carlisle	Project Sponsor
Alan Paradise	Capstone Instructor
Kirby Linvill	Project Mentor & TA
Jarek Reynolds	Project Manager
Adam Hoerger	Software Engineer
Alan Yu	Software Engineer
Cade Gorman	Software Engineer
Giovanni Visco	Software Engineer
John Ortiz	Software Engineer
Jorge Ortiz	Software Engineer
Noah Svensson	Software Engineer