QUANTUM FOR CONSUMERS

Quantum Computing Services for Consumers

QUANTUM REALM COMPUTING

Offshoot of a small defense contractor focusing on quantum image processing (QImP) including quantum image representation and image retrieval. Its primary work deals with implementing current QImP methods or working to design new, novel methods based on current methods or combinations of existing and/or new methods. Targets are gate number reduction (circuit size) and gate depth reduction (critical path).

- Compression
- Edge Detection
- Image Classification
- Object detection
- Scene interpretation
- Gait analysis
- Machine Learning using QCNN
- Watermarking
- Fingerprinting

BILL GONZALEZ

- Software Engineer working primarily on systems for various defense agencies. I operate in many aspects from typical coding to architecting systems and implementing scalable software factories.
- I also perform research on quantum image processing based on some of the work I have performed on some of the afore mentioned contracts.
- I have received certifications from MIT's xPRO programs in fundamentals in Quantum Computing Fundamentals and Algorithms for Cybersecurity, Chemistry and Optimization. In addition, I have completed courses provided by QWorld including a graduate research course working on an independent project in quantum image processing.
- Current Master's Degree student at the University of Texas at San Antonio with a concentration in Data Science.

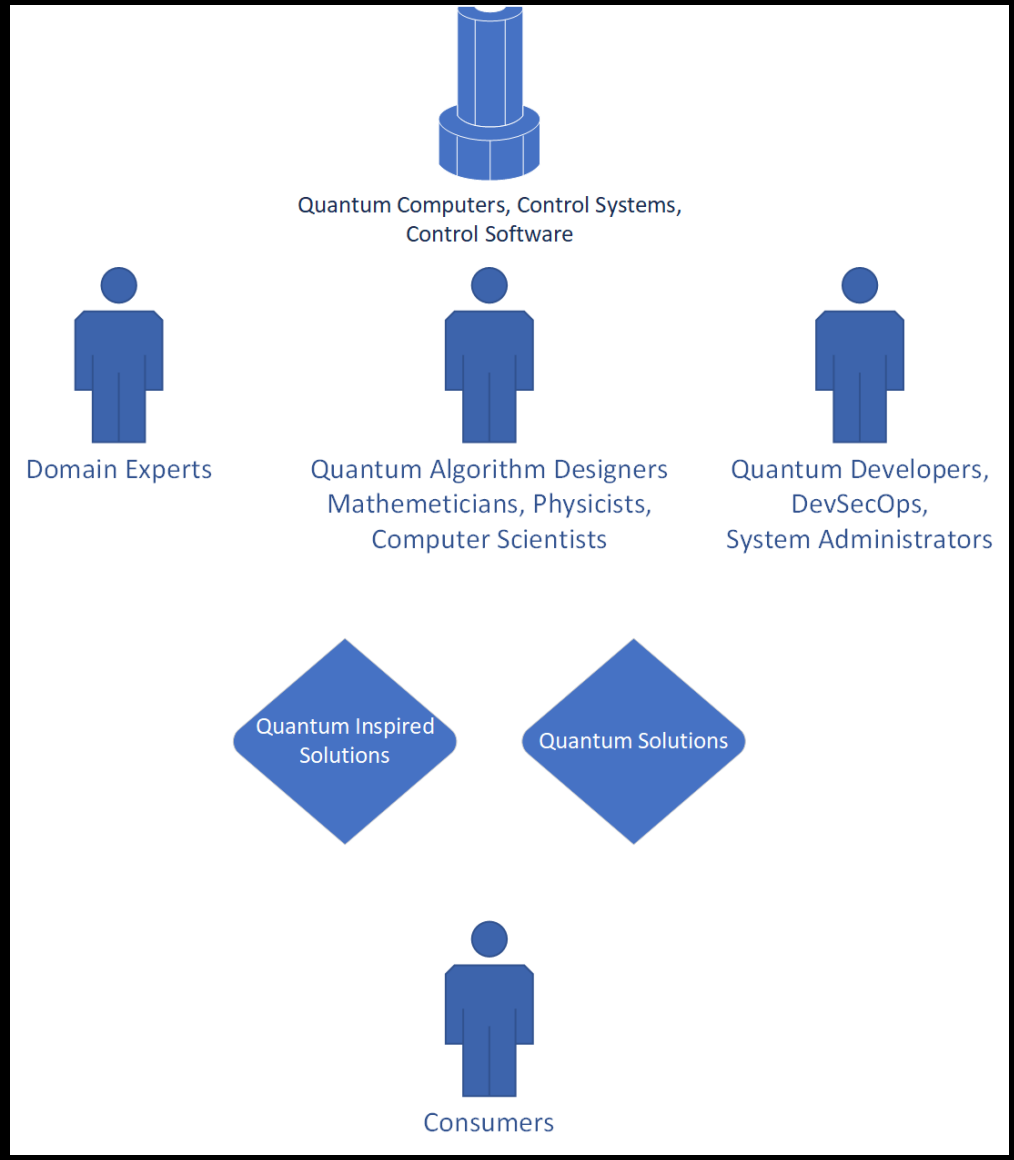
AREAS OF IMPACT

Impact areas are the same for standard image processing, but the hopes are that processing can become more efficient, faster, more accurate.

- Autonomous Vehicles
- Medical: cancer detection, birth defect identification
- Automation – packaging, cargo loading optimization, robotics, image recognition
- Logistics, e.g., robotic systems used to process product, production lines
- Defense – facial recognition, gait analysis, biometrics
- Space – future space operations, debris detection, collision avoidance, resource extraction, astronomical imagery, ground imagery

BENEFIT CHAIN

Because of NISQ, Consumers cannot currently take any benefit from quantum technology as advertised.



SERVICE PROVISION

Compute Time
- On-prem software accessing cloud offerings
- Methods available via a public or private APIs
- Free for now in research mode, pay to play for those with financial resources
- On-prem installation or build your own – large providers, e.g., federal government

Resources
- Internal team
- Outsource to large quantum service provider

Offerings
- Buy a solution, buy services

SECURE SOFTWARE FACTORY

In addition to work on quantum image processing another goal is to overlay a software factory mentality to our quantum computing environments.

- Containers for environments
- GitLab/GitHub repositories
- Python library scanning using tools like OSS Index, Snyk, etc.
- Locally controlled image environments, e.g. Nexus
- Agile development

Tools

- NumPy, SciPy, OpenCV, PIL, Keras, Mahotas
- Qiskit and the IBM Q Experience
- Cirq from Google
- Pennylane
- Tensor-Flow Quantum (TFQ)

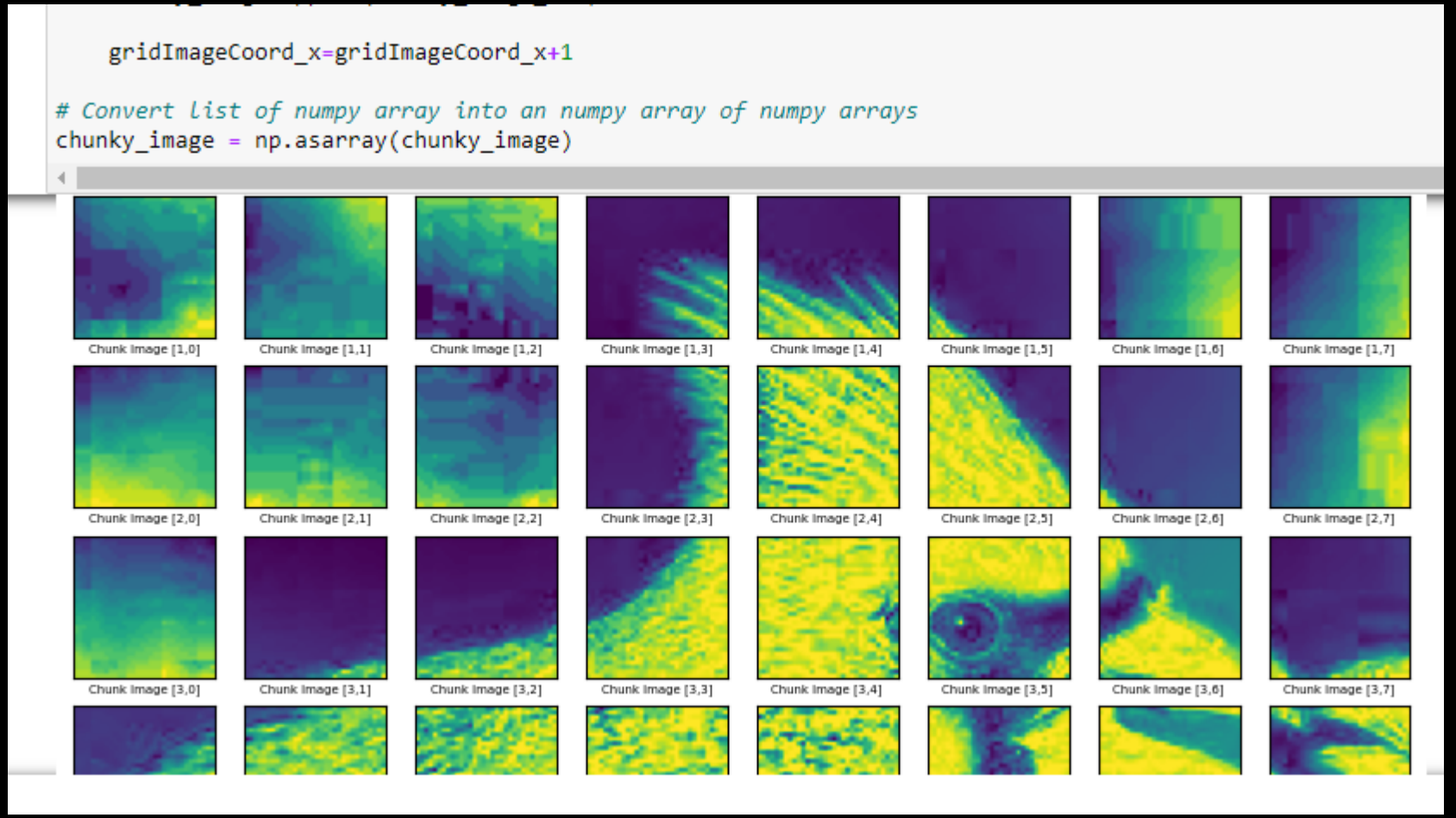
- Classiq
- Covalent by Aqnostiq (Toronto) – Python components

BLOCKERS AND INHIBITORS

- NISQ
- Error mitigation is a vastly growing field, something Shor worked on early on, but hardware also advances, and faster gates may provide for higher gate fidelity, longer coherence times and minimization of effects of the environment.
- Changing and advancing technologies, e.g., new modality discovery and development
- Availability of systems with more qubits

THE STRUGGLE IS REAL

- Pre-processing
- Compression
- Circuit design (reduce gates, gate depth)
- CBS – Computational Base States – 0 or 1 e.g. MSB – most significant bits
- Slicing/chunking
- Normalizing
- Thresholding
- Binarizing
- Slow run times
- Queuing



PATH FORWARD

- What we are hoping the hardware developers do is create a quantum computer that can fit in my pocket, or at least on an externally deployable device.
- Just like CPUs gave way to GPUs and now TPUs and NPUs, in the future we should probably see continued advancements in the development of QPUs, quantum processing units, e.g. Pasqal et al.
- Discovery of modalities that are affected less by the environment
- Adaptation by current providers of semiconductor devices as they already have the money and the means to produce (NVIDIA, Intel)
- Combination of components on the same chip, e.g. SEECQ
- Greater qubit fidelity, or as mentioned in yesterday's closing keynote, use of qutrits and ququarts
- At least some minimal alignment of frameworks and tools for different devices