Detecting Communities among COVID-19 Patients with a Quantum-Ready Method

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We are quickly getting strong results from community detection for COVID-relevant use cases and will shortly add quantum execution.

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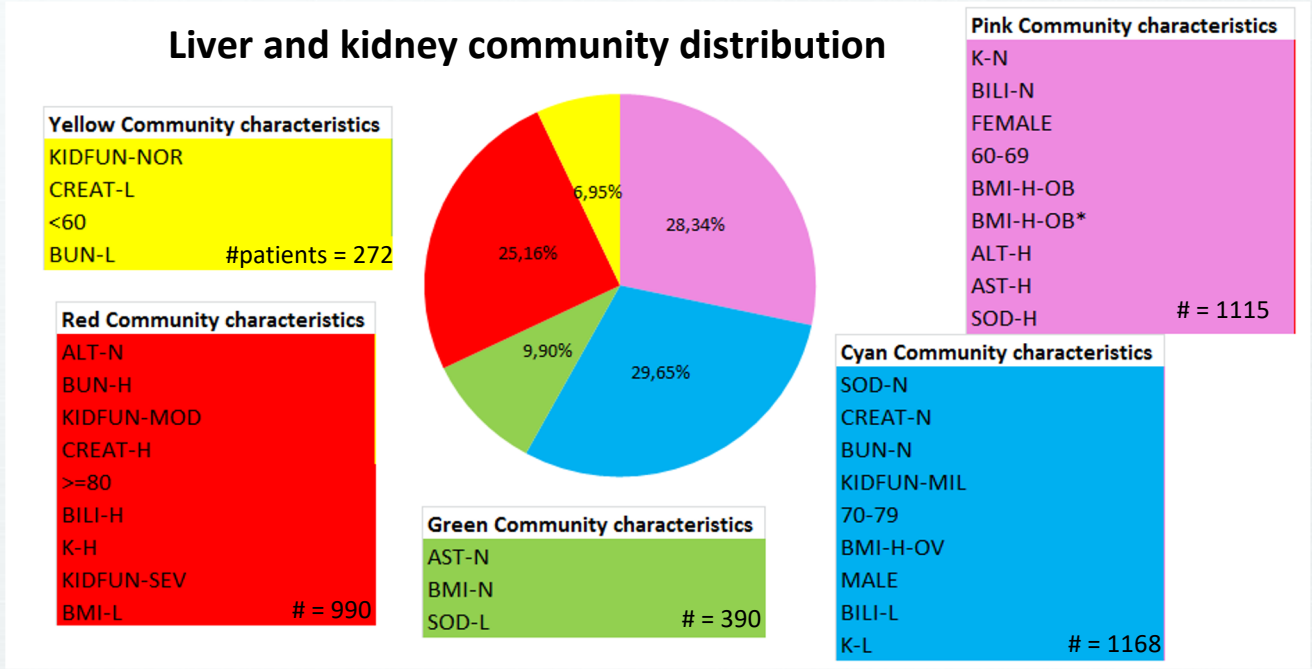
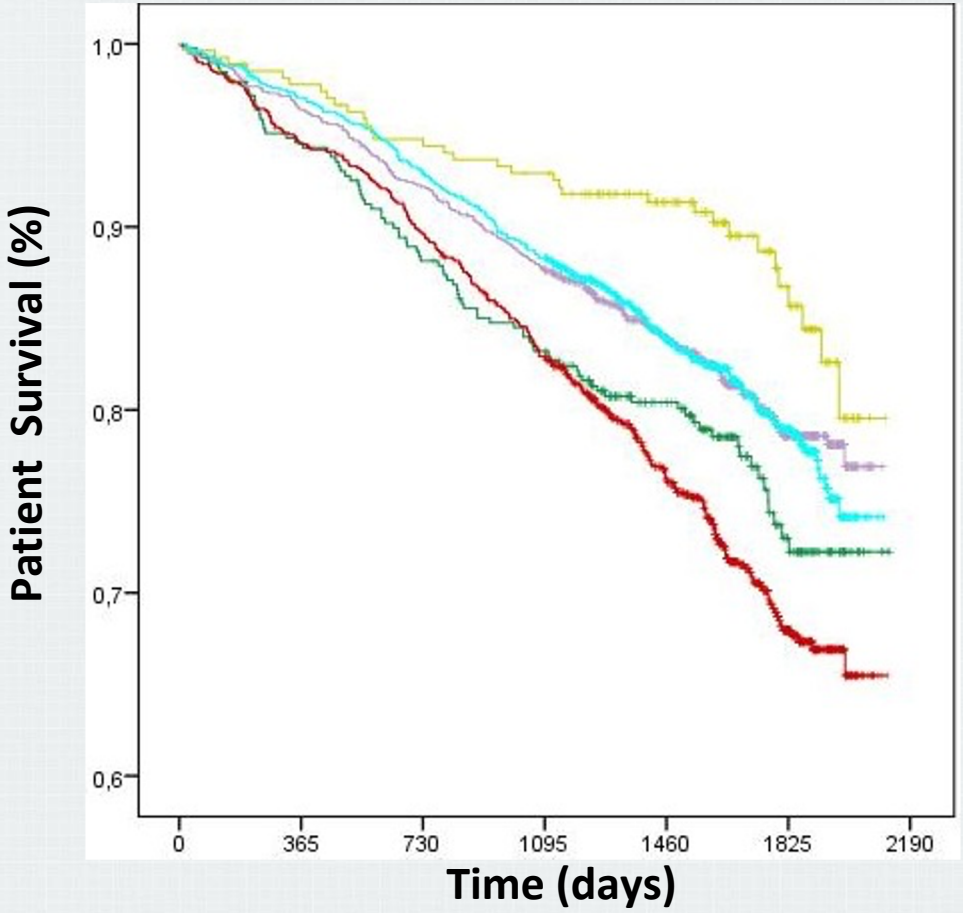
Motivation: Unsuccessful Trial of Heart-failure Drug

- Trial with 4,000 patients over 6 years
- Total development+trial cost close to $1B
- No benefit found so drug not approved
- Community Detection identified sub-groups of patients that benefitted, where statistical clustering failed





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Implementation/Use of Community Detection

- Need good community assignments quickly for problems with many more dimensions
- Implemented Girvan-Newman modularity-maximizing algorithm, in quantum-ready form due to Negre et al.*, in QCI NetworkX
- Solves via classical sampler (for now)
- Computation grows as f(#medical variables), not f(#patients)
- Validate results with earlier heart-failure analysis
- Tweak modularity calculation to reflect bipartite graph representation
- Tweak algorithm to support medical variables not in a community

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*Negre et al., “Detecting multiple communities using quantum annealing on the D-Wave system”, PLOS1, 2020.

Results

Heart-failure data

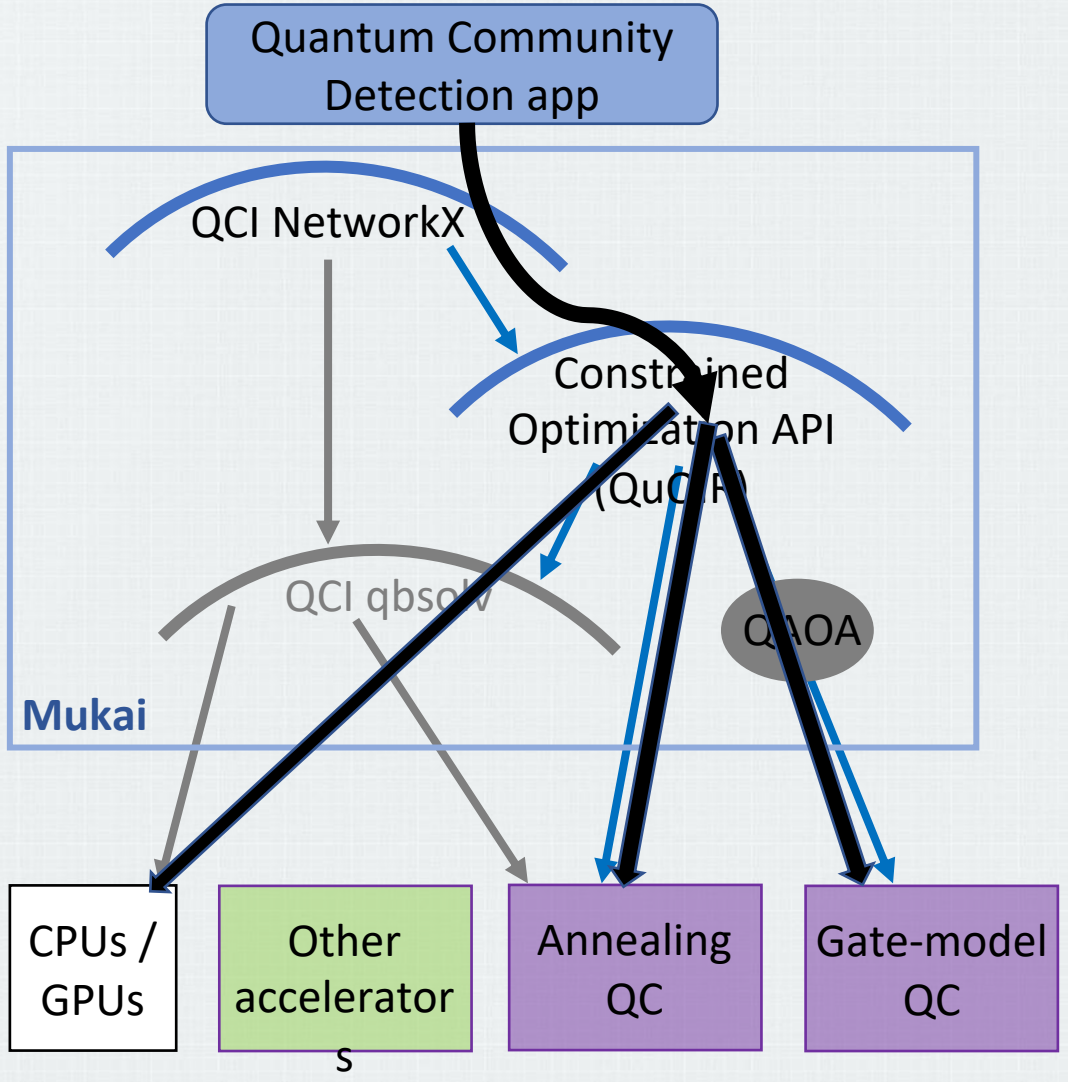
- Comparing with 2015 Gephi-generated results
- Two measures
  - Bipartite modularity: Gephi 0.086, QCI NetworkX 0.141
  - Percent of patients properly assigned, given medical variables: Gephi 51.6%, QCI NetworkX 98.2%
- QNX chose 3 communities
- Runtime: <10 minutes
- Potential impact: improve patient management, enhance drug development, and improve clinical trial success and efficiency

VHA COVID data

- Data for 118K patients; diagnoses, treatments, medications, expenses, and outcomes (e.g., ventilator- and ICU-days)
- So far, ~40 of 300 medications are relevant to COVID and their effects need to be modeled
- Work in progress

Implications

- Community detection (CD) can work in an unsupervised way to select the number of communities and which dimensions of data are most useful
- Starting from a knowledge graph, CD can help identify missing but valuable dimensions of data from the top down
- Want to use on bigger graphs; the computational cost of CD grows exponentially / NP-hard
- Hybrid quantum/classical execution coming soon. Quantum acceleration when? Mukai enables simple comparison of QPUs for high-level task.
- Other graph kernels: partitioning, clique cover, maximum independent set, …



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