USING QUANTUM COMPUTERS AND SUPERCOMPUTERS TO ADDRESS COVID-19 IN EGYPT (QUAN-COV-EG)

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QuanCovEg Project Outline

- Motivation: COVID-19 has caused major negative impact on human life, and on economic, travel and most basic everyday life activities, locally and worldwide.

- Project Objective:
  - Building the capacity for computational drug discovery and computer-assisted epidemiological data analysis in Egypt.
    - Using the powerful computational capabilities of quantum computers (including quantum simulation) and of supercomputers (including parallel and high-performance computing).

QuanCovEg

- Two Subprojects (Components):
  Drug Discovery and **Epidemiological Analysis**
- Drug Discovery: Simulate the chemical interaction of potential drugs with the novel coronavirus (Sars-Cov-2).
- Epidemiological Analysis: Search for factors that may speedup or slowdown the spread of the virus and the disease, and develop a model for its spread specific to Egypt.
  - Factors such as diet, weather, lockdown measures, prior vaccinations, … etc.
  - Consider Egypt-specific factors as well as generic ones.
  - Attempt to predict the future diffusion of the virus (and disease) in Egypt.
- Both components will use the power of quantum and supercomputers, combined with that of the most recent mathematical models.
- Both components will employ artificial intelligence (AI) and machine learning (ML) methods and technologies.

QuanCovEg Motivating Efforts

- In the US, sixteen (16) supercomputers are working in tandem to discover a drug for COVID-19.
  - Effort involves the US government, as well as several companies (e.g., IBM, Microsoft, Intel, and others).
  - These supercomputers are usually tasked with military research (e.g., simulations of nuclear weapons) and weather forecasting.
- In Canada, D-Wave Co. is offering **free** cloud-based access to its latest quantum computer (Leap 2.0) for COVID-19-related research.
  - D-Wave's quantum computers are specialized for performing optimization and searching algorithms. They are based on 'quantum annealing', a quantum formulation of standard simulated annealing (SA).
  - May be used also in *quantum predictive analysis*.
- The standard epidemiological model SIR, next to other models, is widely used by epidemiologists, locally and worldwide, to analyze the current spread of the pandemic and predict its future diffusion.

QuanCovEg Tentative Team

- Myself (PI, Quantum Computing)
- Senior members:
  - Emer. Prof. Ali Hasab (Epidemiology, HIPH)
  - Emer. Prof. Muhammad Elbarrawy (Microbiology, HIPH)
  - Prof. Amr Elmasry (Algorithms, CSE Chair, Fac. of Eng.)
  - Prof. Layla AbuHadeed (Parallel/Supercomputing, CSE, Fac. of Eng.)
  - Dr. Muhammad Umar (Data Science, Visiting Scholar, EJUST-CSE)
- Junior members:
  - Eng. Ahmad Badie (Sen. SW Dev., Inova)
  - Eng. Muhammad Saad (Sen. SW Dev., Inova)
  - Eng. Amira Muhammad (Sen. SW Dev., Inova)
  - Eng. Ahmad Helmy (SW Dev., Incorta)
- (Related) Project Budget: Can it be significantly increased?
  - Discuss LATER.

QuanCovEg Required Equipment

- All main required resources are **freely** accessible, including:
  - Supercomputers.
    - Alex. Univ.
    - Informatics Research Institute, SRTA-City.
    - Arab Academy of Science and Technology (AAST).
    - All located in Alexandria governorate.
  - D-Wave's *Leap 2.0* quantum computers.
    - Via cloud (i.e., Internet).

Project Management and Plan

- Two teams (roughly 5 members each); a team for each component.
  - Senior members (seniors) will supervise junior members (juniors).
  - Juniors will learn and implement quantum and classical AI and ML methods and techniques suggested by the seniors.
  - PI duties:
    - In addition to active participation in the activities of each team, the PI will coordinate and facilitate communication and cooperation between members of each team.
- Two main phases:
  - Phase 1: Planning and Preparation (3-4 months).
  - Phase 2: Software Implementation and Testing (4-5 months).

QuanCovEg Expected Outcomes

- Tried and tested knowledge and expertise among team members on how to use quantum computers and supercomputers in addressing epidemics.

- Significant findings may be patented and/or published in international journals.
  - IF any findings are reached in this short-term project.

QuanCovEg Project Impact

- Discovering a drug for COVID-19 will have a huge impact, nationally and internationally.
- Similarly, predicting the future diffusion of the pandemic can save lives and save economies.
- Expertise in computational drug discovery and in epidemiological data analysis are valuable assets.
  - A nation that has such expertise is better equipped to deal with any current epidemics, as well as better prepared for the onset — may God forbid! — of any future ones.

QuanCovEg Project Budget

- Currently asking for 60,000 EGP.
  - Max. allowed budget is 2,000,000 EGP in call-for-proposals announced by STIFA.
  - Project plus: Required equipment cost = 0 EGP.

- Polite request: Can incentives budget get significantly increased?
  - Still, NO salary for PI (Yes, 0 EGP!).
  - Better salaries for junior and senior members (other than PI).
    - Better dedicated; juniors will offer much more time; seniors will feel appreciation.
  - Can allow **adding** other team members.
    - E.g., ones from fac. of medicine, fac. of pharmacology, and fac. of engineering.
  - Increment decision is totally left to STIFA discretion.
    - Would rather NOT specify an exact figure. If pressed for some figure, then a budget of 1,000,000 EGP is definitely more than enough for all purposes.
    - If a significant increment in incentives budget is not possible, that is OK too.
      - Likely, effort will be downsized.

Thank You