Consultancy Project agreement with Dark Star Quantum Lab Inc., USA under the MoU with Acharya Prafulla Chandra College, West Bengal, India.

Project Title: Hybrid-Quantum toolkit for Epidemiological modeling and data analytics

1. Summary

Outbreak of contagious virus needs an intensive study and analysis for acquiring the knowledge necessary for epidemiological study of the respective. In the higher-level the purpose is to understand the spread of virus, predicting its trajectory over various constraints and suggesting a strategy to minimize its spreading. We develop a research and analysis toolkit for the study of the same. It comprises of classical-quantum algorithm based on epidemiological model and various optimization i.e. lockdown scheduling. Using this toolkit, user can achieve all of the necessary data to have a knowledge base of the spreading of virus.

2. Objective

1. To design a framework, an epidemiological toolkit which will provide to the user the detailed knowledge about SIR (Susceptible Infected Recovered), SEIR (Susceptible Exposed Infected Recovered), SEIRD (Susceptible Exposed Infected Recovered Dead), and SEIRDV (Susceptible Exposed Infected Recovered Dead Vaccinated) model. User will be able to utilize the toolkit for further development and research.

2. The toolkit will utilize a quantum algorithm to propose an optimal lockdown schedules during any pandemic outbreak. The policy maker will be benefited to take scientific lockdown and sustainable economic.

3. The toolkit will contain different modules of data analytics on epidemiology data. User will use these modules to analyze the outbreak with real set of data from any country.

3. Features of the toolkit:

1. The toolkit will support Epidemiology Model for the outspread of any contagiousvirus like - SIR, SEIR, SEIRD, and SEIRDV. User will have option to add custom compartmentinto the Model.
2. Perform simulation of the outspread.
3. Show virus reproductive rate.
4. Graphical representation of different compartment of the Model in the form of:
    a. Daily basis
    b. Monthly basis
    c. Yearly basis
5. Will support the following user defined object against the virus outspread rate,as part of

the optimization of scheduling process.
   6. Variable Lockdown strength.
   7. Variable Lockdown duration.
   8. Perform optimal lockdown based on the section 5.
   9. User will have the option to choose the lockdown simulation process to becomputed in classical and/or quantum computer for analysis.
   10.   Comparison between different outcomes among different models.
   11.   Option to print the chart sheet.

4. Analytical features of the toolkit:
   1. Statistical analysis of the data
   2. Using QSVM (Quantum Support Vector Machine), perform expert mechanism for distinguishing classifications among epidemiological data.
   3. Analysis of the rate of
        a. Incremental/ decremental growth of virus, infected, death, vaccinated people.
   4. Critical Analysis of simulation against real life data.

5. Dependencies of the toolkit:

   1. Python 3
   2. API of Quantum computing platform, Default: "D-Wave 2000Q". Optional: Any Quantum Computing API that support optimization problem solving computational power(AWS)

6. Time Schedules of activities:

Module	Module Name	Time frame
1	SIR validation and Implementation	1st Month
2	SEIR validation and Implementation	2nd Month
3	SEIRD validation and Implementation	3rd Month
4	Validation of Optimization module	4th -5th Month
5	Connecting Modules with AWS	5th – 6th Month
6	SEIRDV validation and Implementation	6th – 8th Month
7	Implementing other Analytical Modules associated with epidemiology	9th – 11th Month
8	Testing and Documentation	12th Month

3. Budget Estimation (to be paid by Dark Star Quantum Lab)

Items	Budget (In US Dollar)			
Quarters	**1st Quarter**	**2nd Quarter**	**3rd Quarter**	**Total**
A. *Recurring:* 1. *Remunerations/salaries of Manpower*	*$1361*	*$1361*	*$1361*	*$4083*
2. *Contingency*	*$205*	*$205*	*$205*	*$615*
B. *Non-recurring:* *Permanent equipment/ software* *	*$907**	*$907**	*$907**	*$2721**
Overhead costs (@ 10% of project cost)	*$681*	-	-	$681
Grand Total (A+B)	***$3154***	***$2473***	***$2473***	***$8100***

*Software cost will be equivalent to Access key of AWS or D-wave provided by Dark Star Quantum Lab Inc.

The Consultancy Project participants hereby confirm their agreement to its terms by the following signatures. Upon Signature, the project will commence on October 1st, 2021.

Dr. Kunal Das, APC College, New Barrackpore

Dr. Faisal Shah Khan, Founder and Chief Executive Officer, Dark Star Quantum Lab Inc.

Date: September 23, 2021___