NTU ID: N0830182
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Module Code: COMP30151
Module Title: Project 202021 Full Year

COVID-19 Vaccine Degradation

[Project Synopsis]

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Abstract

The Covid-19 pandemic has caused havoc worldwide. It has led to the loss of millions of lives across the globe. In order to combat the SARS-CoV-2 virus there is a necessity to develop a vaccine which is not only fast effective but also can be distributed widely.

mRNA vaccines has been the most effective so far. However, they face their own limitations. RNA molecules have the tendency to spontaneously degrade. This is a serious limitation--a single cut can render the mRNA vaccine useless. Details of which part of the backbone of a given RNA is the most vulnerable is yet to be discovered. Unfortunately, due to the absence of this piece of information, the present mRNA vaccines needs to be shipped under extreme conditions. This approach is barely feasible as hardly a fraction of the affected population might receive the vaccine. So, there is an urgent need to fortify this process of vaccine creation.

The Eterna community, led by Professor Rhiju Das, a computational biochemist at Stanford's School of Medicine, brings together scientists and gamers to solve puzzles and invent medicine. Eterna is an online video game platform that challenges players to solve scientific problems such as mRNA design through puzzles. The solutions are synthesized and experimentally tested at Stanford by researchers to gain new insights about RNA molecules.

This project aims to develop models and design rules for RNA degradation. The primary objectives of this project are as follows:

- o Create a model that will predict likely degradation rates at each base of an RNA molecule.
- o The model will be trained on an Eterna dataset comprising over 3000 RNA molecules and their degradation rates at each position.
- o The models will then be scored on a second generation of RNA sequences that has been devised by Eterna players for COVID-19 mRNA vaccines.

The image below shows a mRNA molecule.
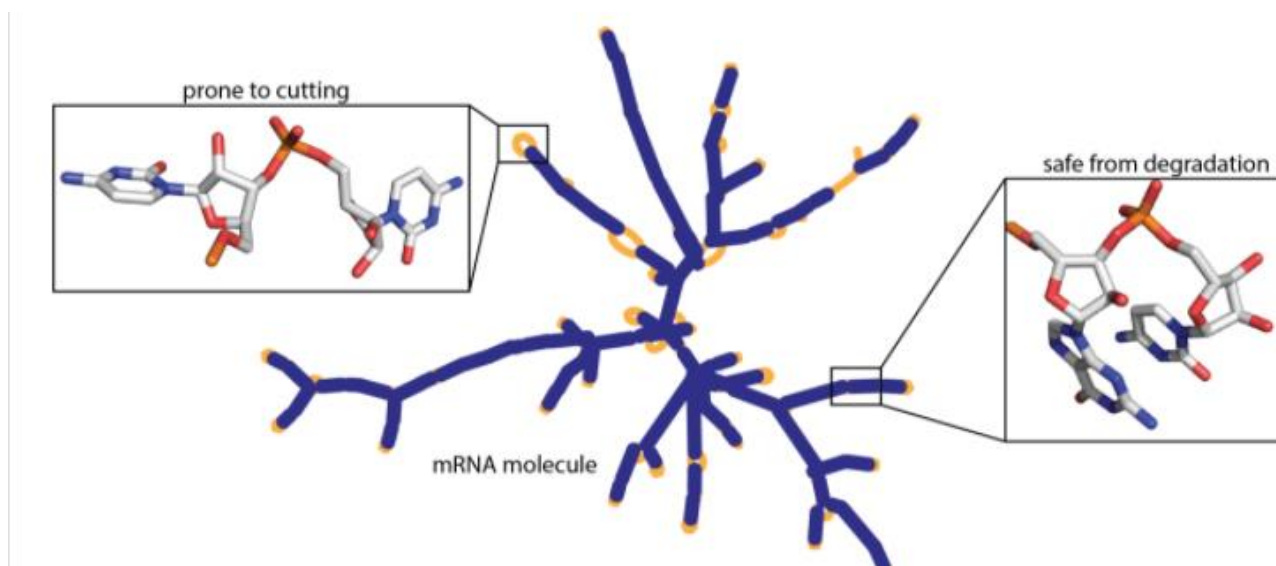
MoSCoW Analysis

Must haves:

- A model with a high accuracy score for predicting the RNA degradation rates.

Should haves:

- Good data visualizations from the training dataset.
- Efficient coding style depicting 'data cleaning' and 'data pruning' prior to data training.
- Efficient coding style depicting data training.

Could haves:

- An efficient user-friendly interface so that the model can be played around with non-coders as well.

Would haves:

Information To Explore:

- How RNA vaccines work, and their issues, featuring Dr. Rhiju Das [1].
- Launch of the OpenVaccine challenge [2].
- The impossibility of mass immunization with current RNA vaccines [3].
- CDC prepares for frozen mRNA vaccines [4].
- Eterna, the crowdsourcing platform for RNA design where OpenVaccine's RNA sequences are coming from [5].
- How to build a better vaccine from the comfort of your own web browser [6].

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[5] eternagame.org. (n.d.). Eterna. [online] Available at: https://eternagame.org [Accessed 28 Oct. 2020].

[6] Eternagame (2020). How to build a better vaccine from the comfort of your own web browser. [online] Medium. Available at: https://medium.com/eternaproject/how-to-build-a-better-vaccine-from-the-comfort-of-your-own-web-browser-233343e0210d [Accessed 28 Oct. 2020].

First Steps/ Tutorials/ Installations

- Watch tutorials to get familiar with Google Colab.
- Download and mount the Eterna training dataset to work with.
- Use the keras framework provided by Colab to implementing Deep Learning.
- Play around with the Eterna game to get an understanding of how the RNA molecules gets restructured.
- Check out the additional resources provided for the project on Kaggle here: https://www.kaggle.com/c/stanford-covid-vaccine/overview/additional-resources.
- Look at some projects that has been done and try to analyse the approach taken.