**Title: Variation Principle using Machine Learning and Neural Networks with Mathematica**

Variation principle aims to solve the Schrodinger Equation (SE) by finding a suitable wavefunction for a particular quantum state which gives us the lowest expectation value for the energy. We can assume the wavefunction to be a linear combination of some weights times some trial functions. By changing the weights and functions we can achieve the exact solution provided by experiments. I aim to use the in-built tools in the Wolfram Language (Machine Learning and Neural Networks) to perform a demonstration this procedure in quantum mechanics. The model can then be visualised using neural networks. It can also be evaluated using literature values of different atoms or molecules (eg H2+, H2, etc). The project itself can help link Machine Learning and Quantum Mechanics together and make both easier and more accessible at the same time for future students.

**Title: Spin Statistics using Hypergraphs**

The goal will be to map out the “spins” of electrons using Hypergraphs. With some of the remakable works by Dr. Wolfram, hypergraphs can map out the “rules” of relativity and quantum mechanics. As spin is the consequence of the both combined, as from the work of Paul Dirac, it is hypothesised that the intrinsic properties of electrons or other fermions can be visualised and mapped out using hypergraphs. This can shed new insights on how to understand the difficult concept of spin also how to visualise it computationally. At first, the case will be the simplest (1 electron), then the system can increase in complexity, from a 2electron system to a very large molecule such as a protein. The respective spin statistics will all be described and mapped out by hypergraphs.

**Title: Exploring ATLAS data with Mathematica**

The project idea is inspired by the following: https://community.wolfram.com/groups/-/m/t/1137265

Using Mathematica, some of the open data provided by the following link will be explored: <https://atlas.cern/resources/opendata>. The data will then be processed via some machine learning methods provided by the wolfram language. The goal will be to understand the implications behind the patterns of the data, i.e. what the different interactions and behaviors of the different subatomic particles detected are. The project will make the ATLAS data and its implications more accessible. It will also be a good demonstration of the data analysis process within particle physics, as well as introducing different particles from the standard model.