Using Neural Network-based Approximation to improve HPC Application

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*Abstract*—Our project is about replacing the time-consuming part of the OpenFuelCell which is the simulation software for the SOFC (Solid Oxide Fuel Cell) by using a neural network. For that we produced the datapoints with the help of OpenFuelCell and used them as the labeled datapoints to train our neural network to predict. The model we trained in this project gives the 87% accurate result in predicting the output current and voltage.

Keywords—component, formatting, style, styling, insert (key words)

# Introduction (*Heading 1*)

Fuel cell is the electrochemical conversion device that changes the chemical energy of fuel and oxidizing agent into electrical energy. Unlike the normal batteries, the fuel cell doesn’t require recharging. They will produce electricity if they will get a continuous supply of fuel to keep working. A fuel cell consists of three main parts cathode, anode and electrolyte. Fuel cells are generally classified based on electrolyte type. This classification determines the kind of electro-chemical reactions that take place in the cell, the kind of catalysts required, the temperature range in which the cell operates, the fuel required, and other factors. There are several types of fuel cells currently under development, each with its own advantages, limitations, and potential applications.

Fuel cells are better compared to traditional power sources like batteries and engines because of their high efficiency and they eliminate the pollution caused by engines using fossil fuels. Hydrogen fuel cells emit only water, so they produce no pollutant like carbon dioxide or carbon monoxide. The fuel cells are quite during operation as there are fewer moving parts that makes them suitable to be used at noise-sensitive areas and operating time of fuel cell is more than double that of traditional batteries. As fuel cell doesn’t depend on traditional fuels like oil and gas and can reduce the dependency of non-oil producing countries economical dependency on oil producing countries. Different fuel cells come in different sizes and can work at variety of temperatures, which increases the areas of application for fuel cells.

Solid oxide fuel cell, also known as SOFC for short uses a non-porous ceramic compound as electrolyte. SOFC works at very high temperature like 1000 degree Celsius and due to which it doesn’t require costly metal catalyst, which reduces the cost. When it comes to efficiency solid oxide fuel cell can provide 60% accuracy and because it works at very high temperature the utilization of that heat further increases its efficiency. But due to high temperature operation the startup is slow and thermal shielding is required to retain its heat. This also restrict the areas in which solid oxide fuel cell can be used and this will restrict the elements that can be used in this type of fuel cell.

OpenFuelCell is open source computational fluid dynamics software to model solid oxide fuel cell using Hydrogen and water as fuel and dry air as oxidant.

# Ease of Use

## Traditional Method of SOFC simulation

There are existing locally and commercially developed simulation for Solid Oxide Fuel Cell. The model under consideration is openFuelCell simulation with OpenFoam 6 environment, which is C++ software developed to run solid oxide fuel cell simulation.

(ref: <https://openfuelcell.sourceforge.net/books/export/html/1>)

This model considers parameters like global temperature, fluid region, air and fuel, includes calculation on fluid density, pressure, momentum, mass diffusivity, mass fraction, electrochemistry, regional velocity, thermophysical data, energy equation in repetition until convergence.

## SOFC simulation Vs Neural Network

Neural network is the set of algorithms to recognizing the relationship between the data by mimicking the way the brain would process it. SOFC simulation works by predicting the results by converging on with carrying out complex equation and calculation.

Identify applicable funding agency here. If none, delete this text box.

# Our Proposed Model

The proposed neural network model to simulate the solid oxide fuel cell is multi-layer perceptron which consists of 4 hidden dense layers with activation functions of relu, tanh, elu, relu respectively. The optimizer used is adam, adaptive learning optimizing algorithm, with mean squared error as the loss function. The data is split into 80% for training and 20% for testing.

## Abbreviations and Acronyms

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*a**b* 

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An excellent style manual for science writers is [7].

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