

# CSCE 478 - Project Proposal

## Solving Sudoku By Machine Learning

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### 1 Data Set

The data set contains one million Sudoku puzzles and solutions which can be obtained from Kaggle at <https://www.kaggle.com/bryanpark/sudoku>. Additional puzzles can also be found in UNL CSE Sudoku page <https://sudoku.unl.edu> or can be generated using a Sudoku generator, one of which can be found at this link <https://www.ocf.berkeley.edu/~arel/sudoku/main.html>.

### 2 Problem Description

We will apply and compare different Machine Learning techniques, especially Neural Network and its variations, on solving Sudoku puzzles.

### 3 Motivation

Sudoku can easily be solved using Constraint Programming by applying High Level Consistency and Search. We will do some experiments to see if Machine Learning can also be used to solve the same problem using a totally different approach. One of the inspirations comes from the fact that a Sudoku puzzle can be interpreted as a  $9 \times 9$  images which may encourage the usage of convolutional networks and its variations.

### 4 Project Plan

In our project, we will first analyze the data set obtained from all sources mentioned above to determine its complexity based on the puzzles' difficulty. Using that, we will decide whether the data is good enough for future experiments. Because all ideas mentioned in reference sources are all Neural Network based, we need to prepare a code base to help implementing different neural network models easier. We may utilize python's `Tensorflow` package to simplify the process to some extend. From there, we will study and implement different model ideas from the sources listed below in Section 5, try to get at least the first two models and spend as much time as we can on the third one. We will also apply grid search to find the best sets of hyper-parameters for each model. Finally, we will analyze and compare the obtained results as well as discuss the performances of those models.

### 5 References

- Can Convolutional Neural Networks Crack Sudoku Puzzles?  
<https://github.com/Kyubyong/sudoku>.
- Neural Networks As Sudoku Solvers  
<https://www.kaggle.com/dithyrambe/neural-nets-as-sudoku-solvers>.
- Recurrent Relational Networks by Palm, Paquet, and Winther (2017)  
<https://arxiv.org/pdf/1711.08028.pdf>