## ML Challenge 5

Brought to you by the makers of such favorites as...ML Challenge 4, ML Challenge 3, and ML Challenge 2
Thomas Britton and David Lawrence

## Background

- This one is a bit different:
- 2 month timeframe
- To put us on cycle again
- Does not require any domain knowledge in physics
- Great for someone just starting out with ML
- Would be a really terrible idea to actually develop fully or employ
- Intrigued?......



## The Goal

- Make a 3 function calculator!
- Wait what?
- Yep 3 functions....all you need....



## The Goal

- Really the goal is to extend the MNIST dataset tutorials
- But without having to generate operator symbols



## How will we be judged?

- Sum of error squared over a set of problems (i)

$$
\sum_{i}\left(S_{u l}{ }^{2} \operatorname{mission}_{i}-\text { Correct }_{i}\right)^{2}
$$

- The winner will be the submission with the smallest score - In the event of a tie the winner will be the model with the fewest number of parameters



## What materials will we be given?

## - MNIST dataset and labels.....

- And problem specification:
$0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0, ~$ $0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,32,67,161,160,164,254,113,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,17,105,132,226,254,254,248,216,153,54,0,0,0,0,0,0,0,0,0,0,0,0,0,0,23,108,198,198,223,254,254,165,150,56,4$ $0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,73,244,254,254,211,171,85,85,13,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,107,151,254,131,8,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,174,249,47,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,2,2$ $7,0,0,0,0,0,10,54,110,179,179,179,179,179,147,67,0,0,0,0,0,0,0,0,0,0,0,226,59,0,0,0,19,113,232,250,254,203,193,103,103,103,134,229,113,0,0,0,0,0,0,0,0,0,32,239,56,0,16,147,229,247,134,37,37,4,0,0,0,0,0,65,235,78,0,0$ $0,0,136,225,18,157,225,247,128,51,0,0,0,0,0,0,0,0,0,0,217,229,0,0,0,0,0,0,0,0,161,254,254,235,136,53,0,0,0,0,0,0,0,0,0,0,0,0,124,255,0,0,0,0,0,0,0,0,160,254,182,20,0,0,0,0,0,0,0,0,0,0,0,0,0,0,123,254,0,0,0,0,0,0,0,0,12$ $0,0,0,0,0,0,0,0,0,0,0,0,0,3,162,250,0,0,0,0,0,0,0,0,22,120,19,0,0,0,0,0,0,0,0,0,0,0,0,0,0,57,254,131,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,161,254,66,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,16,144,252,1$ $, 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,26,137,212,254,150,11,0,0,0,0,0,0,0,0,0,0,0,0,0,172,32,0,0,0,0,15,57,130,216,254,221,72,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,91,232,217,126,133,217,227,254,254,207,114,21,0,0,0,0,0,0,0,0,0$ $0,0,0,0,0,0,0,0,0,0,0,0,06,13,212,24,10,11,0,0,0,0,0,0,0,0,0,0,0,0,1,32,0,0,0,0,1,5,130,210,254,221,7,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,91,232,217,126,133,21,227,254,254,207,114,21,0,0,0,0,0,0,0,0,0$
$1,191,254,218,183,160,111,66,22,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,+, 0,0,0,0,0,0,0,0,0,0,0$ $1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,39,121,148,253,253,253$, $, 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,39,121,148,253,253,253$,
$253,255,197,76,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,145,244,252,252,252,252,252,252,253,252,247,197,23,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,226,252,252,252,252,252,252,252,253,252,252,252,196,25,0,0,0,0,0,0,0,0,0,0,0,0,0,0,85,172,214$ $253,255,197,76,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,145,244,252,252,252,252,252,252,253,252,247,197,23,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,226,252,252,252,252,252,252,252,253,252,252,252,196,25,0,0,0,0,0,0,0,0,0,0,0,0,0,0,85,172,214$,
$172,172,172,172,172,173,248,252,252,252,195,26,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,28,0,0,0,0,0,0,50,172,242,252,252,115,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,185,252,252,212,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,81,2$ $172,172,172,172,172,173,248,252,252,252,195,26,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,28,0,0,0,0,0,0,50,172,242,252,252,115,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,185,252,252,212,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,81,2$
$52,252,212,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,10,168,252,252,212,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,171,252,252,252,134,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,226,252,252,224,38,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0$ $52,252,212,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,10,168,252,252,212,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,171,252,252,252,134,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,226,252,252,224,38,0,0,0,0,0,0,0,0,0,0,0,0,0,0$,
$0,0,0,0,0,0,0,0,170,253,253,253,66,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,170,251,252,252,224,38,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,75,94,79,50,5,164,253,252,252,252,136,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,111,244,252,246,234,215,2$ $0,0,0,0,0,0,0,170,253,253,253,66,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,170,251,252,252,224,38,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,75,94,79,50,5,164,253,252,252,252,136,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,111,244,252,246,234,215,2$ $52,253,252,252,252,116,81,68,0,0,0,0,0,0,0,0,0,0,0,0,0,25,223,252,252,252,252,252,252,253,252,252,252,252,252,244,179,0,0,0,0,0,0,0,0,0,0,0,0,94,252,252,252,252,252,252,252,253,252,252,252,252,212,177,59,0,0,0,0,0,0,0,0,0$ , $142,252,224,19,44,0,0,0,0,0,0$
$0,0,0,0,0,0,0,0,0,0,0,0,0,0,0$

The correct answer to the above is... 7

## Any restrictions?

- Only a couple:
- Your submission will be a jupyter notebook that we will run
- There can be no mathematical operations done after the model's output and the writing of the answer to the file
- E.g. you can not use built in operators on two numbers the AI determined a la MNIST
- You can do things like look up the label from a one hot output



## When/what is due

- A jupyter notebook compatible with jupyterhub.jlab.org's


## Spawner Options

Select a notebook image
ai-notebook (w/ slurm tools)

- The notebook must load your model and take in the problems (one problem per line), do any necessary preprocessing and produce a single numeric answer, writing that answer, in order, one answer per line, into a file to be judged


## This is all due August 5th at noon

## Go Here for the data/write-up

https://halldweb.jlab.org/talks/ML lunch/Jun2020/

