Probabilistic Deep Learning

for Fast Radio Bursts Project Proposal

UNIVERSITY OF TORONTO

遠馬印驤

Introduction

What is the Problem?

We wish to tackle two issues:

1. There exists a large dataset of classified FRBs done by the a community however there hasn't been any real statistics done to quantify the performance.

2. We want to eventually build an automatic detection process where we can reliably rely on the system to classify potential FRB candidates.

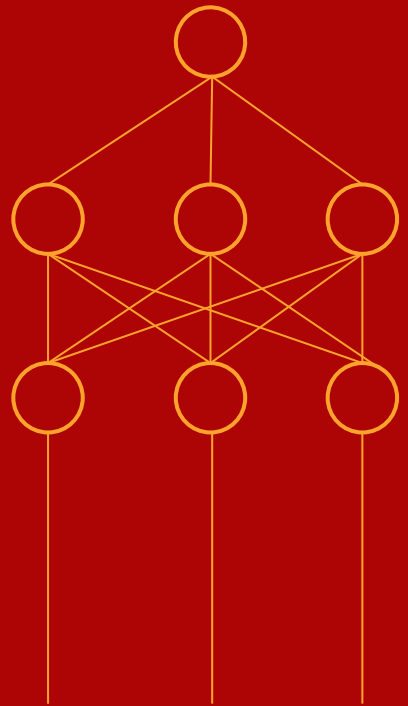
Introduction

But Why Deep Learning?

Not all problems are good fits for deep learning. So what does DL bring to the table?

Deep learning has always presented itself as a solution to replace simple image recognition tasks and has a track record in mimicking and at times out performing human performance.

We expect the flow of data to eventually one day overwhelm the manual efforts in verifying FRB candidates.



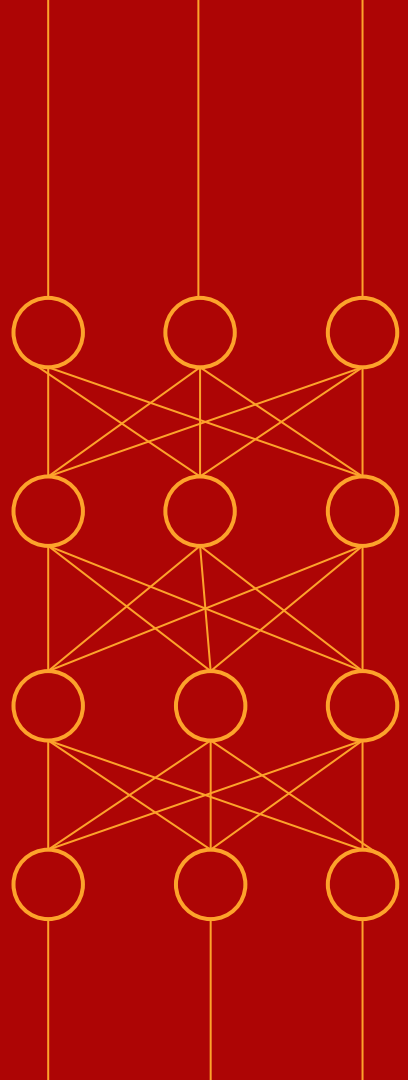
Building Intuition

Why are Probabilistic/Bayesian models powerful?

Bayesian/probabilistic models are designed to learn distributions rather than “point” weights. In a typical neural network, the feedforward is completely deterministic. In a Bayesian neural network the outputs are stochastic. This means that the outputs are samples from distributions rather than discrete values thus the model can output both a classification AND an uncertainty associated to the classification.

Furthermore, Bayesian neural nets are more robust and are designed to prevent overfitting especially dealing small data samples. This presents itself as an interesting detection method to search for transients where data could be disproportionately filled with negative samples in respect to positive ones, or vice versa.

Paper Reference **https://arxiv.org/pdf/1806.05978.pdf**



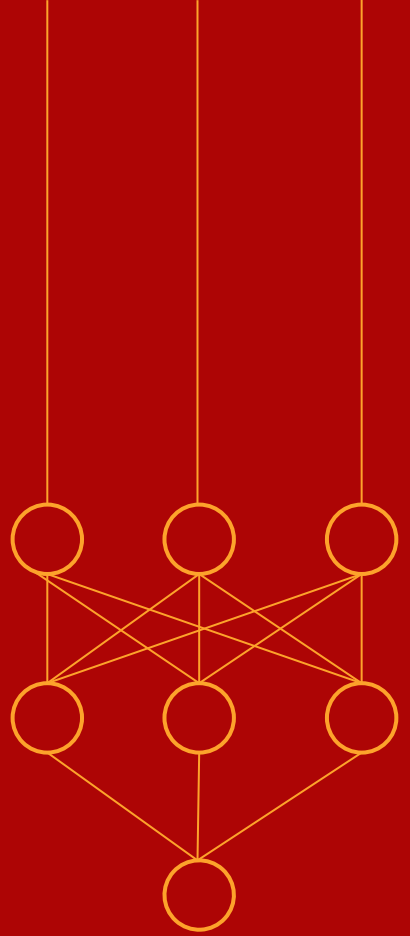
Timeline

Research Questions

1. Can deep learning models approximate the performance of a community based effort in classifying FRBs?

2. Can this model then suggest anything about human level performance? If so, what does it suggest? If not, why?

3. Can we use this technique in the future for automated detection? If so, how? If not, why?



Timeline?

Scope of Project

Project involves three main components:
Simulation, Model Development and
Performance Assessments

Simulation: We need to design a “ground truth” in which we can test the model and test the model on after training it on volunteer data.

Model Development: Dedicated time to engineering the model. [1 month]

Assessment : we then use the simulations and run diagnostics on the model and conclude statistics. [1 month]

Timeline?

How will this be done?

Step 1: Build simulation data

This will take the most amount of time

Step 2: Build CBNN on community data

Step 3: Evaluate model on community data to verify model is a good approx.

Step 4: Evaluate model on simulated data

These take the least amount of time

Results

Deliverables

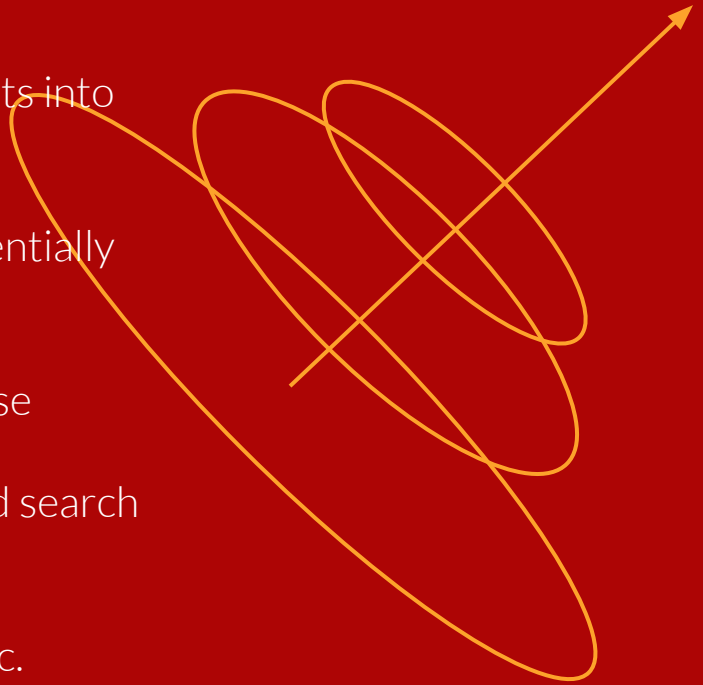
A number of results from the project:

1. Python based FRB simulation that can inject bursts into existing filterbank or HDF5 files?

2. Model based on CBNN technique which can potentially be used for automated detection strategies.

3. We can then characterize the false positive or false negative rate of the model and conclude some approximated results about the community based search efforts!

4. Course work deliverables, presentation, paper etc.



Find me at…

Personal Website: Peterma.ca
Email: Peterxy.ma@gmail.com
Twitter: @peterma02
Github: @Petchma

UNIVERSITY OF TORONTO

遠馬印驤