Interim Report - Plan

<u>Outline of what Interim Report should include</u>
- 1000 words max length (11pt single line spacing, single column text, 2cm margins)
- Indicate progress made so far, preliminary results, indication of project aims, how these aims should be achieved
- No need to reiterate stuff mentioned in the project description

<u>Intro</u>
- Outline the project – NPE for GW – discuss current PEREGRINE code and the potential improvements that NPE has over TMNRE
- Potential extensions currently being considered beyond the implementation of NPE

<u>Section 1 – GW Theory</u>
- Discuss derivation of existence of gravitational waves, detection of them in LIGO
- Talk about inspiral of compact binaries (main type of detection we have)
- Power spectrum density, matched filtering and identifying noise from the signal
- Then talk about the statistical analysis of the data – Bayesian analysis, parameter estimation, matched filtering stats
- Effectively go through all written notes from Maggiore

<u>Section 2 – ML Theory</u>
- Overview of ML background, specifically focus in on important features of all models – hyperparameters, SGD, loss functions, supervised vs unsupervised
- Brief review of the simplest methodologies – linear regression, logistic regression, binary classification
- Neural networks – definition, some diagrams, architecture, backpropagation, examples – MLP, RNN, CNN
- Generative models – mention GANs, diffusion models, VAEs, but mostly focus in on normalizing flows
- Normalizing flows – definition, formula, Jacobian factor, types of flows etc.

<u>Section 3 – Tools and Implementation</u>
- Pytorch – overview of module, lightning
- Linear regression example – show some results, talk through how it works
- Normalizing flow examples – "   "
- Talk about monitoring loss on WandB, learning rate schedulers, early stopping,

<u>Section 4 – Next Steps</u>
- Put theory into practice essentially
- Work with LIGO data and understand the form of the data better, using the GW theory
- Build the NPE code based off NF examples
- Statistical comparison between the PEREGRINE results and the NPE code, comment on advantages and disadvantages of both
- Do extension (undecided for now)