AM160 HW2 Problem1

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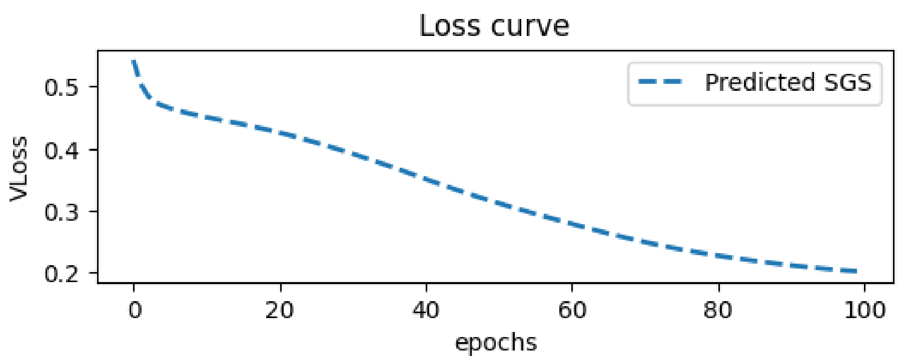
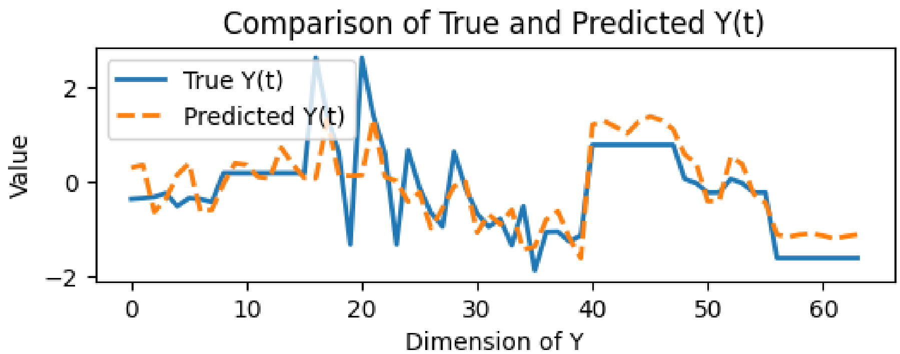
All code for this assignment can be found here

a Training the neural net

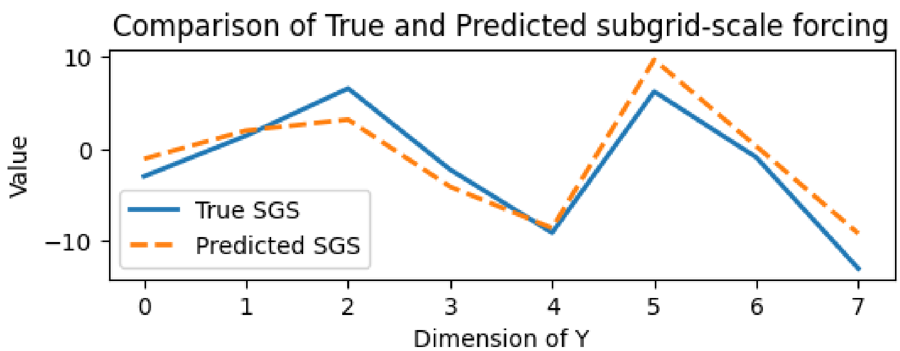
Following the procedure in class (and the sample code given in Canvas), I trained a neural net with a linear input layer going from 8 to 128 features, 3 hidden linear layers of 128 features each, and a linear output layer going from 128 to 64 features. This neural net was trained on 10,000 training inputs.
The loss is as expected:



We can see for a test point, the neural net does pretty OK:

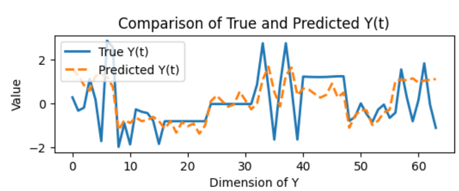


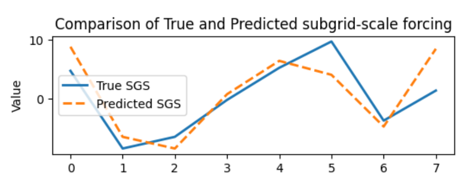
And its SGS is reasonable.



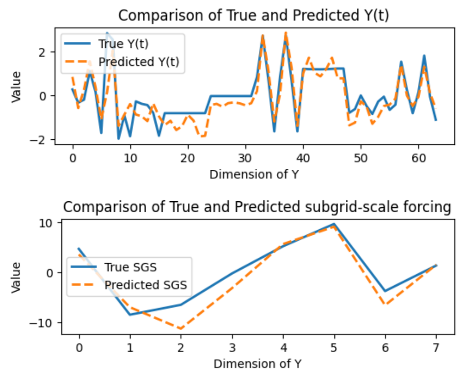
b Fine tuning for different physics

As expected, trying to use this neural net to predict physics of a different problem does slightly better than random, but still not the best.





So I train the network on the new physics data and get some slightly better results:

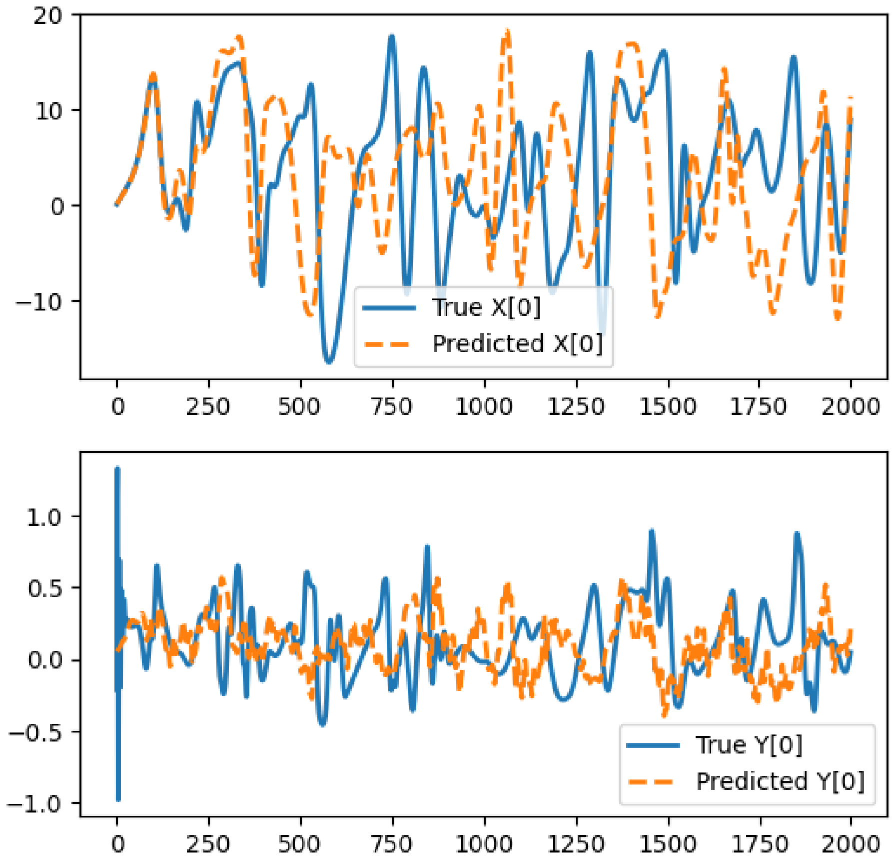


c Simulating using original model

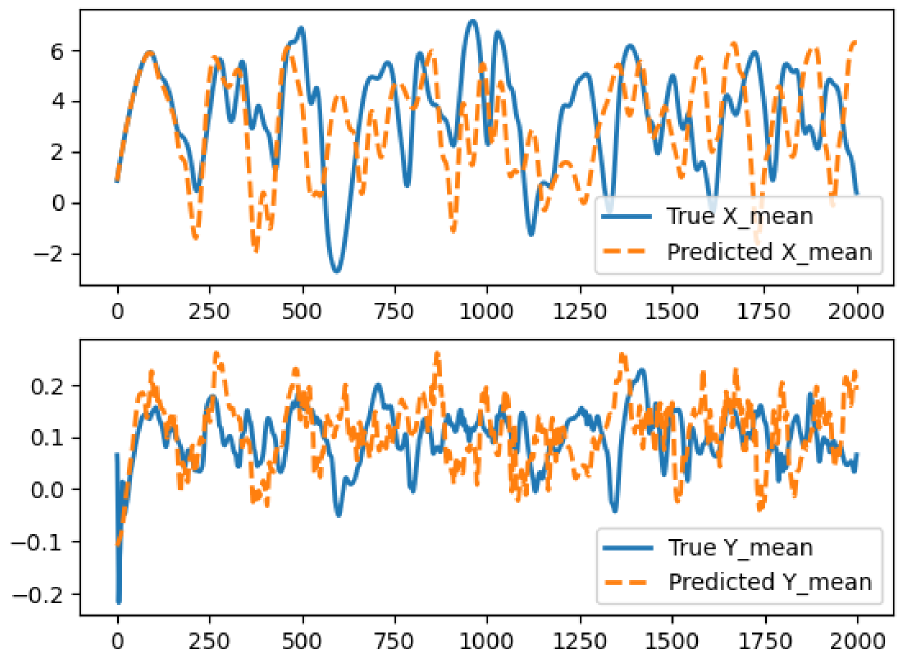
This was pretty hard. The method I used to increment x is newton's method using the output of the neural net to compute $\Sigma_j Y_{jk}$:

$$X^{t+1} = X^t + dt[X^t_{K-1}(X^t_{K+1} - X^t_{K+2}) - X^t_K + F + \frac{hc}{b}\Sigma_j(M_1(X^t))]$$

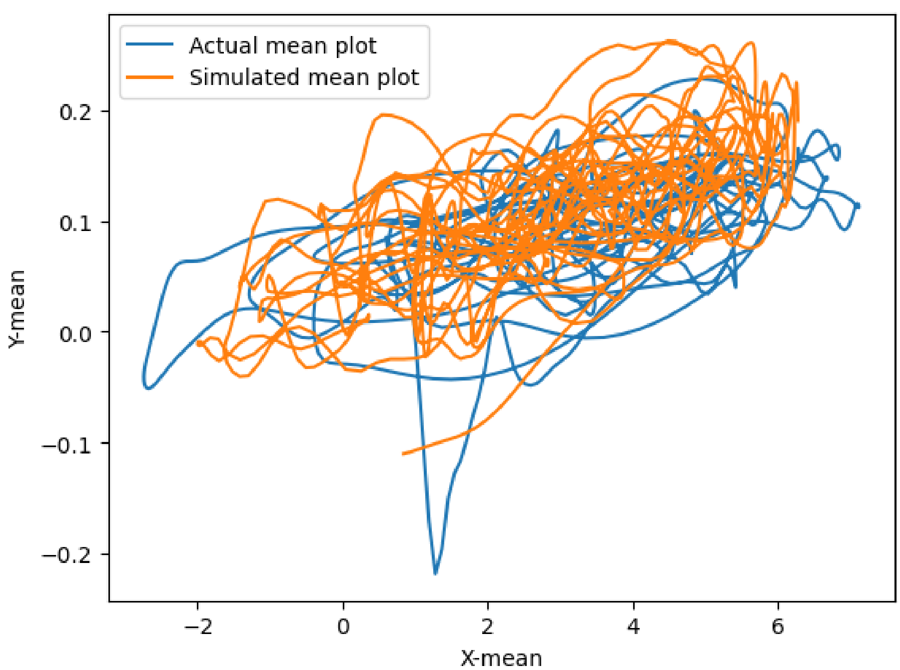
and normalizing after to compare to the Comparing the 0th entry of the X vector and Y vector, we see that the X vector is starts off pretty accurate, capturing the physics pretty well. Also the Y starts off decently well as well. After a short time, however, the solution diverges pretty considerably.



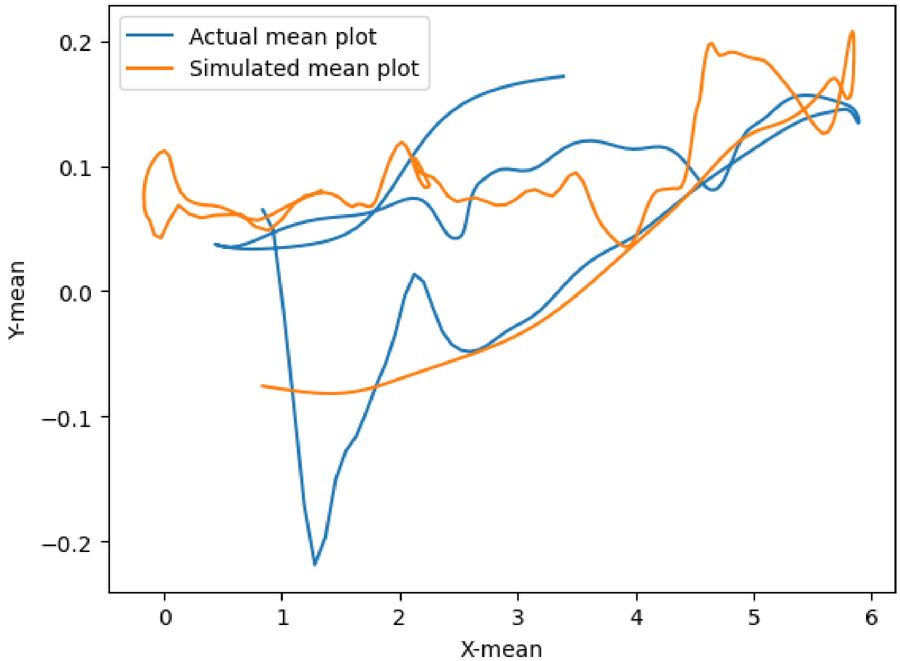
Comparing the mean values of the X and Y vectors, we see similar results:



Finally, plotting the mean values of X vs Y, the physics is pretty strange:



I would say for this model we are accurate to about 250 timesteps (around 12 seconds), after which the model diverges pretty considerably. In fact, if you look at the mean x-y plot of the first 250 timesteps, and squint really hard, it almost looks like the same thing!



If I were to try and make this better, I would try to use an RK4 step instead of a Euler step.