PROJECT3:MODEL ERROR CORRECTION IN ENSEMBLE DATA ASSIMILATION
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1. CODE FRAMEWORK EXPLANATION AND RESULT DISPLAY

The code `twoccale_ENKF_struct_addNN.py` can draw a picture to compare the filtering performance of ENKF with and without neural network correction.
`ENKF_class.py` implemented several different ENKFs, and be able to create realistic trajectories and observations using 4th-order Runge–Kutta.
`data_maker.py` is used to produce data by assimilating observations into the single-scale Lorenz96 using an ensemble Kalman filter in order to train the network.
`MLP.py` described the architecture of the network (just an MLP) and can be used to train the network.
`model_80_1500_8.pth` is the best network parameters I trained.
The result is figure 1
It can be found that compared with the observed trajectory, ENKF significantly reduces the error, and compared with ENKF, the ENKF using network correction further reduces the error.

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Observation vs True:
RMSE: 0.5322, MAE: 0.4504, Mean CRPS: 3.1714


EnKF Analysis vs True:
RMSE: 0.2072, MAE: 0.1669, Mean CRPS: 1.0355
EnKF with NN Analysis vs True:
RMSE: 0.2032, MAE: 0.1618, Mean CRPS: 0.9819
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2. AN ATTEMPT AT 2 ENSEMBLES ENKF

I found an article [1] mentioned that in order to avoid the rms spread in the ensemble being underestimated, two ensembles were used to calculate the covariance matrix and update each other's state, which achieved better results. I tried to use this method instead of the inflation mentioned in the lecture notes. Then I got the following results as figure 2.
It can be found that although the effect is not better than ENKF with inflation, it is at least better than the effect without inflation.
Perhaps when it is not possible to carefully select the inflation parameter, 2 ensembles EnKF would also be a possible option?

REFERENCES

[1] Houtekamer, P. L. and Mitchell, H. L. (1998). Data Assimilation Using an Ensemble Kalman Filter Technique. *Monthly Weather Review, 126*(3), 796–811. link.
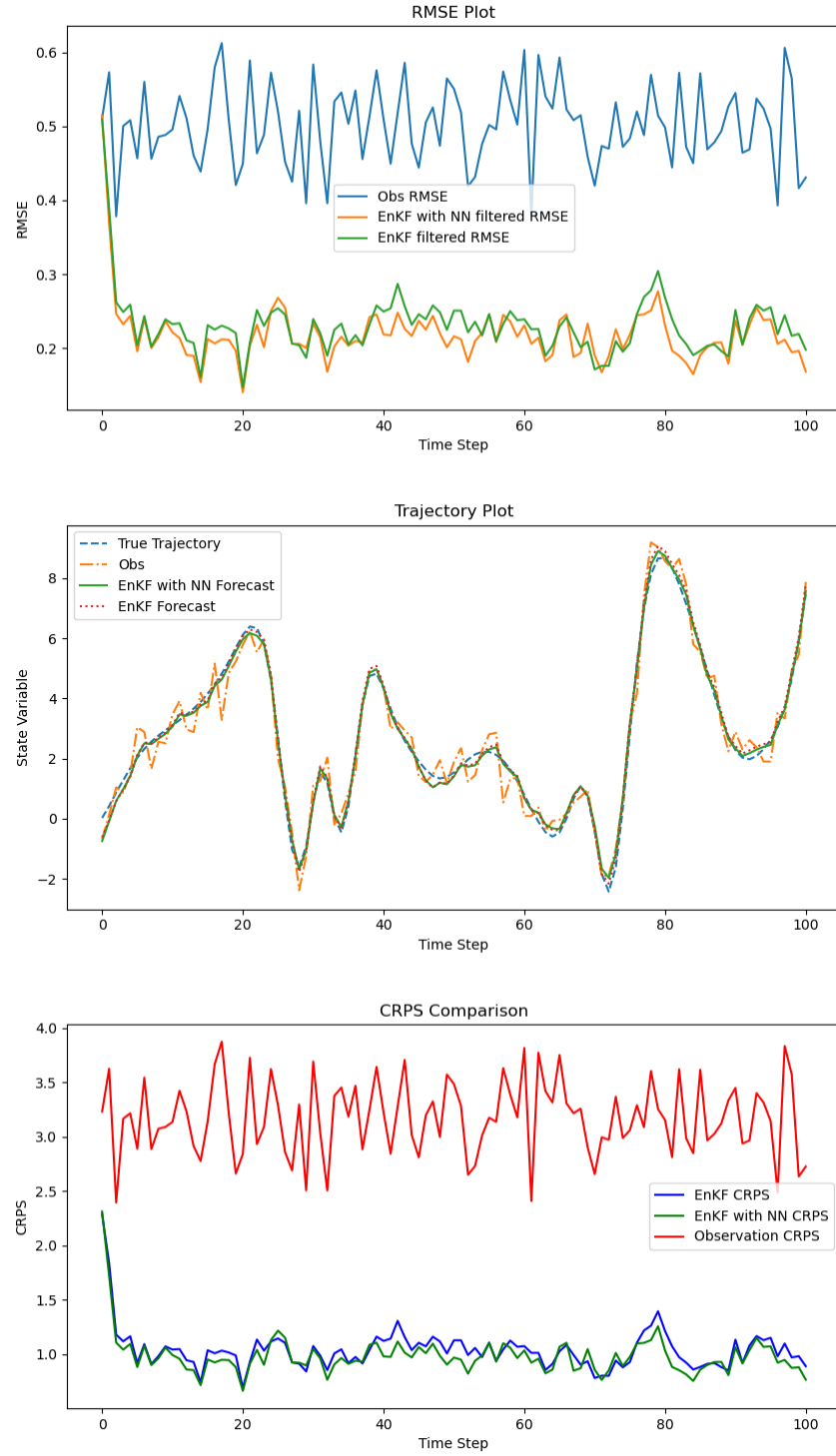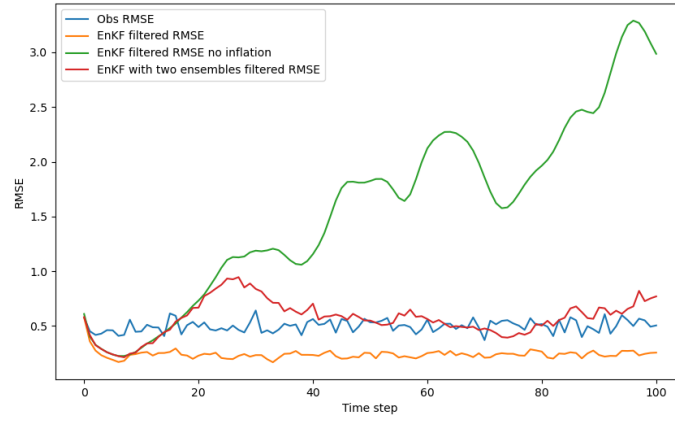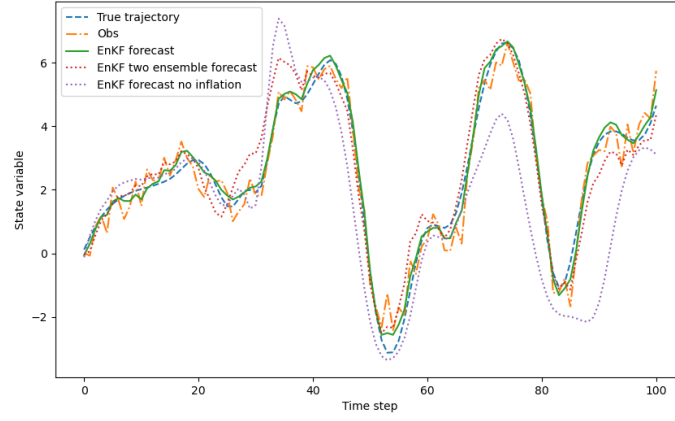
FIGURE 1. ENKFs result

(A) RMSE trend

(B) Dim 0 trend

FIGURE 2. 2 ensembles ENKF result