Homework 5
IST 597
Physics-Informed Machine Learning

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Question 1

An implementation of the DeepONet to learn the solution operator for different Re. Here, choose a range of Re that coincides with varying sharpness of the advecting pulse.

Ans:

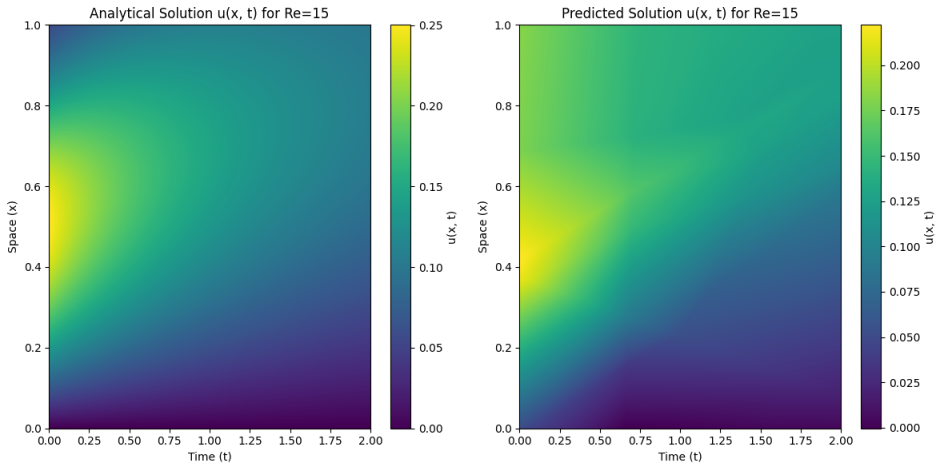

Figure 1: Prediction of DeepOnet

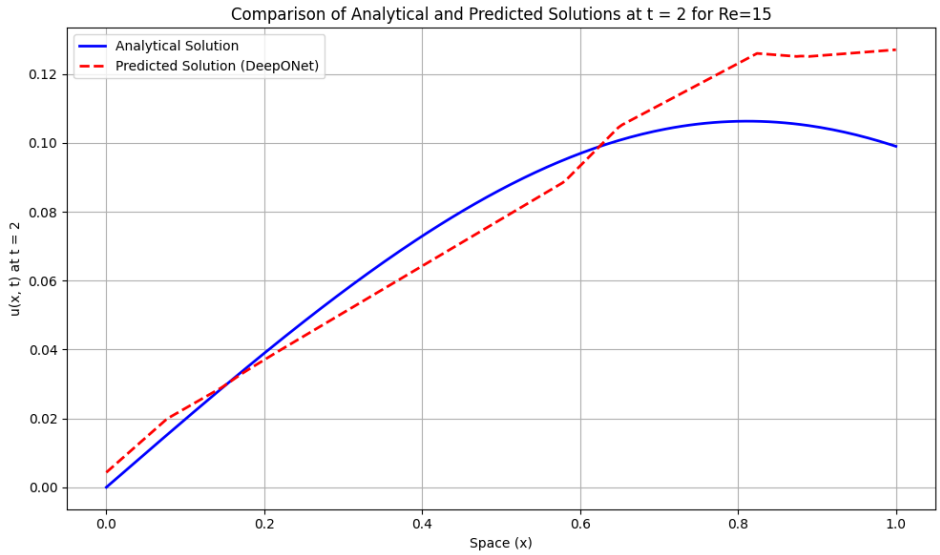

Figure 2: Comparison of Analytical and Predicted Solutions

Code: hw5.ipynb

Question 2

A study to see the effect of the amount of training data (in terms of Re, x , and t).

Ans:

Scenario	Re Values	x Points	t Points	MSE on Test Data	Comparison to Reference (0.0004)
Reference	10	200	200	**0.0004**	-
Fewer Spatial Points	10	100	200	0.0005	Slight increase
Fewer Time Points	10	200	100	0.0011	Significant increase
Fewer Reynolds Values	5	200	200	0.0007	Increase

Table 1: Comparison of MSE on Test Data Across Different Scenarios

Observations

- **Fewer Spatial Points:** Reducing the number of spatial points resulted in a slight increase in MSE (0.0005 vs. 0.0004). This suggests that spatial resolution has a minor impact on model performance.
- **Fewer Time Points:** Reducing the time points led to a significant increase in MSE (0.0011 vs. 0.0004), indicating that temporal resolution is crucial for capturing the dynamics of the data.
- **Fewer Reynolds Values:** Reducing the number of Reynolds values increased the MSE (0.0007 vs. 0.0004), suggesting that a broader range of Reynolds numbers improves model generalization.

Discussion

Maintaining high temporal resolution and a wide range of Reynolds numbers is crucial for optimal model performance, while spatial resolution has a comparatively smaller effect.
Code: hw5.ipynb

Question 3

A visualization for the changing adaptive basis functions as Re is changed

Ans:

Re = 10

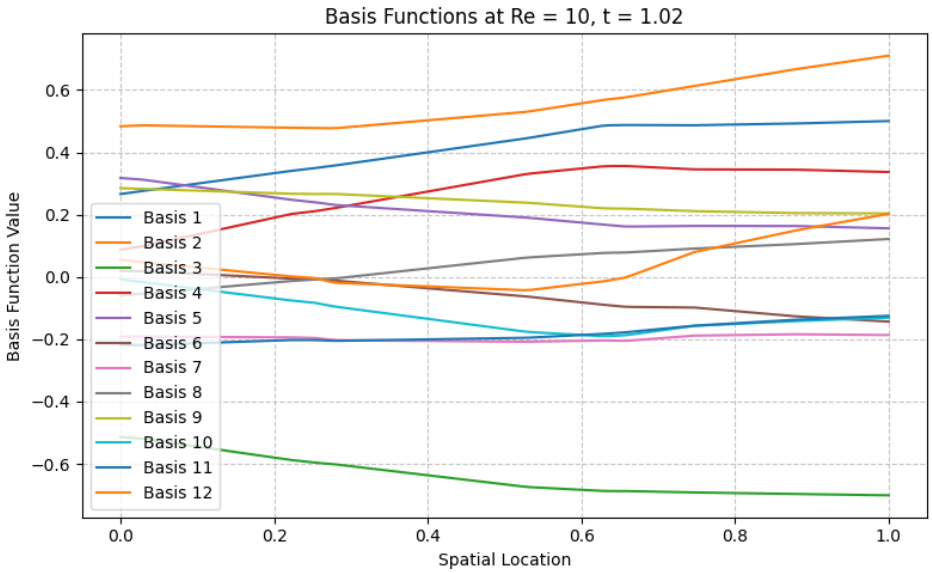

Figure 3: Basis Functions for Re = 10

Re = 50

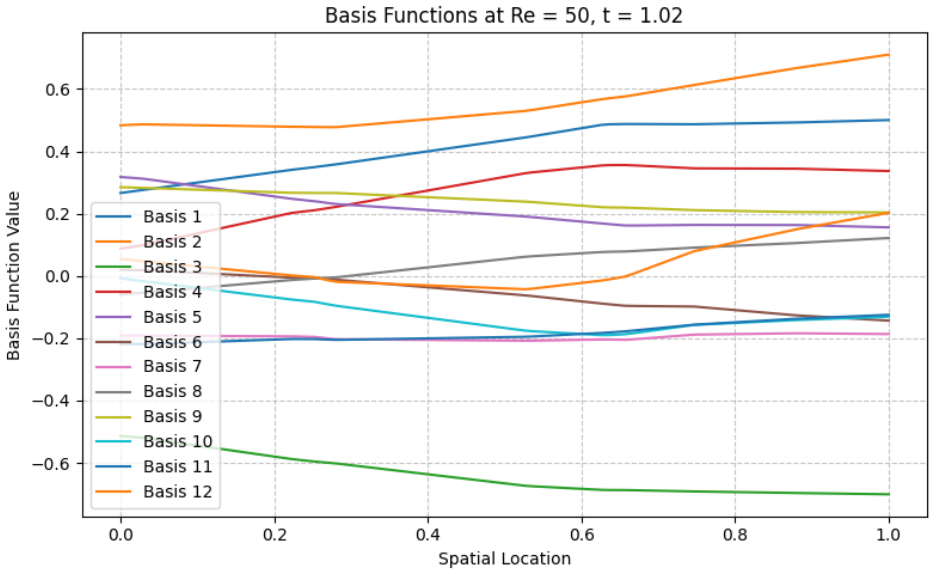

Figure 4: Basis Functions for Re = 50

Re = 100

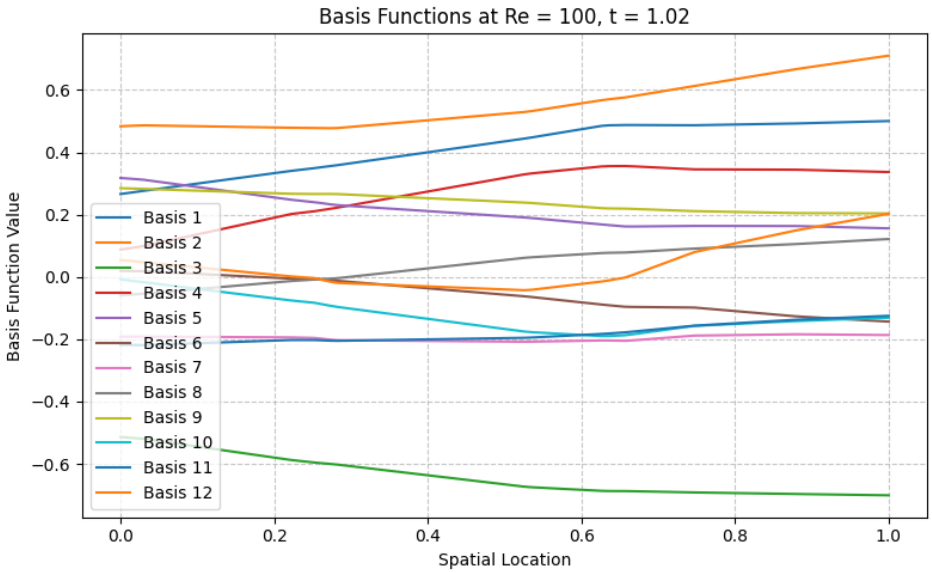

Figure 5: Basis Functions for Re = 100

Code: hw5.ipynb