DSAIE– CEGM2003

BEAM project

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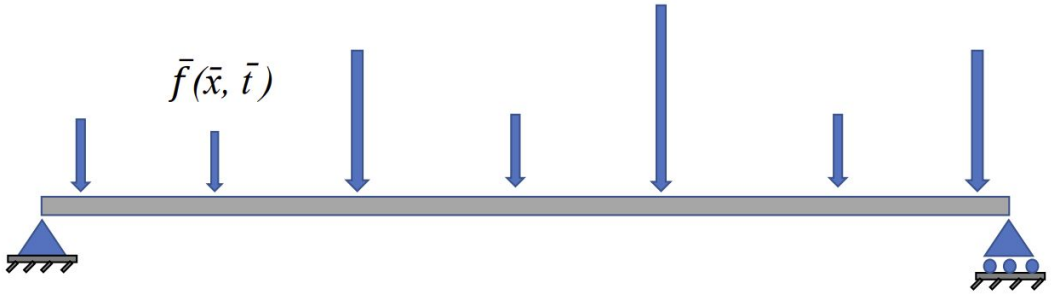
Introduction

- **Project: AI for beams**
- **Apply PINN Until now without PI**
- **Regression problem**
- **Data generation with analytical solution**

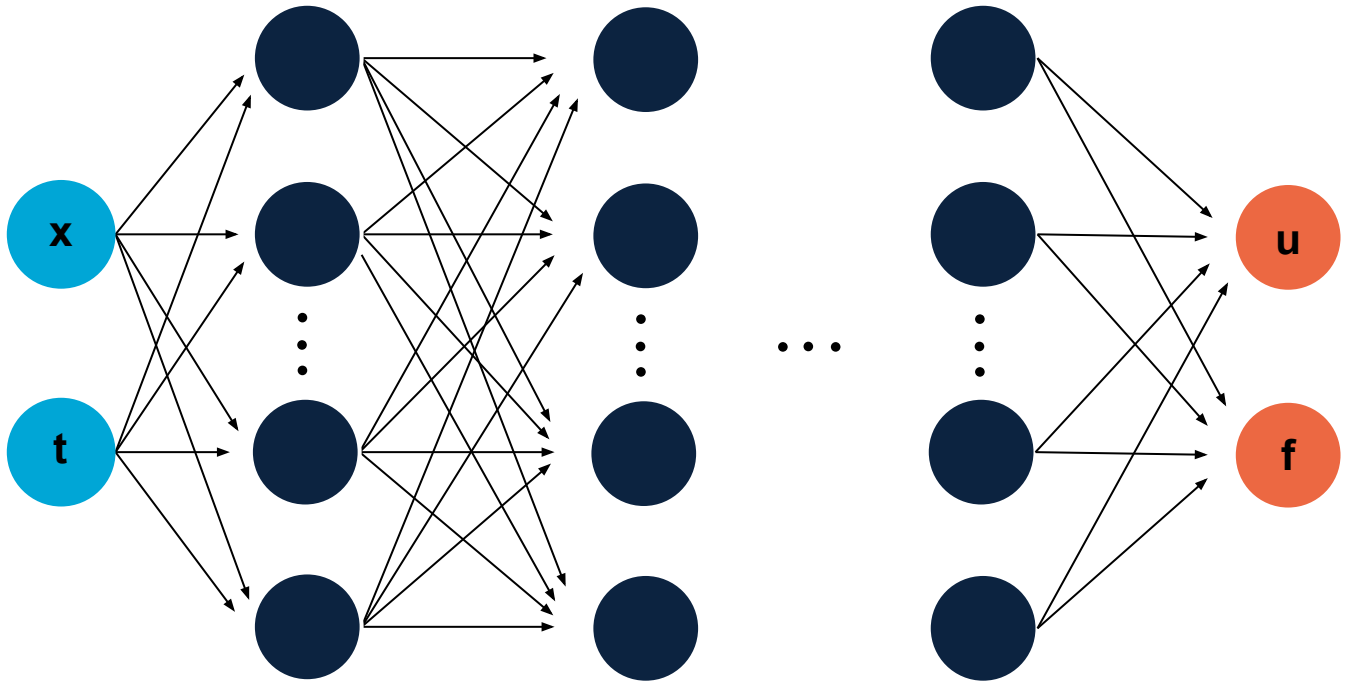


$$f(x,t) = (1 - 16\pi^2)\sin(x)\cos(4\pi t)$$

$$u(x,t) = \sin(x)\cos(4\pi t)$$

Neural network architecture

- Inputs : **x** (position along the beam) and **t** (time)
- Outputs : **u** (displacement profiles) and **f** (force function)



Hyperparameters

Hyperparameters to analyse:

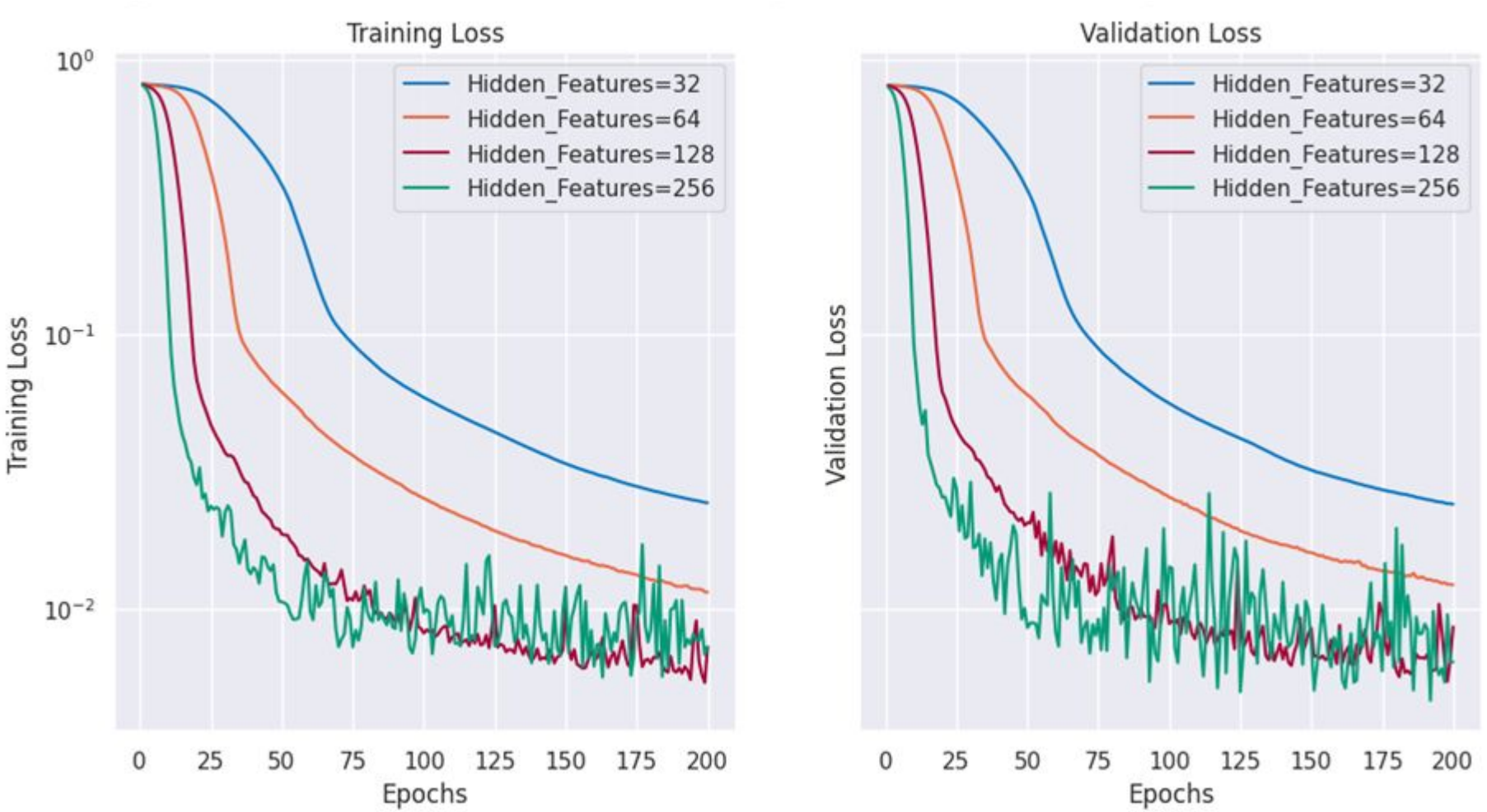
- **Learning rate**
- **Loss function**
- **Optimizer**
- **Activation function**
- **Number of layers**
- **Number of hidden features**

Results

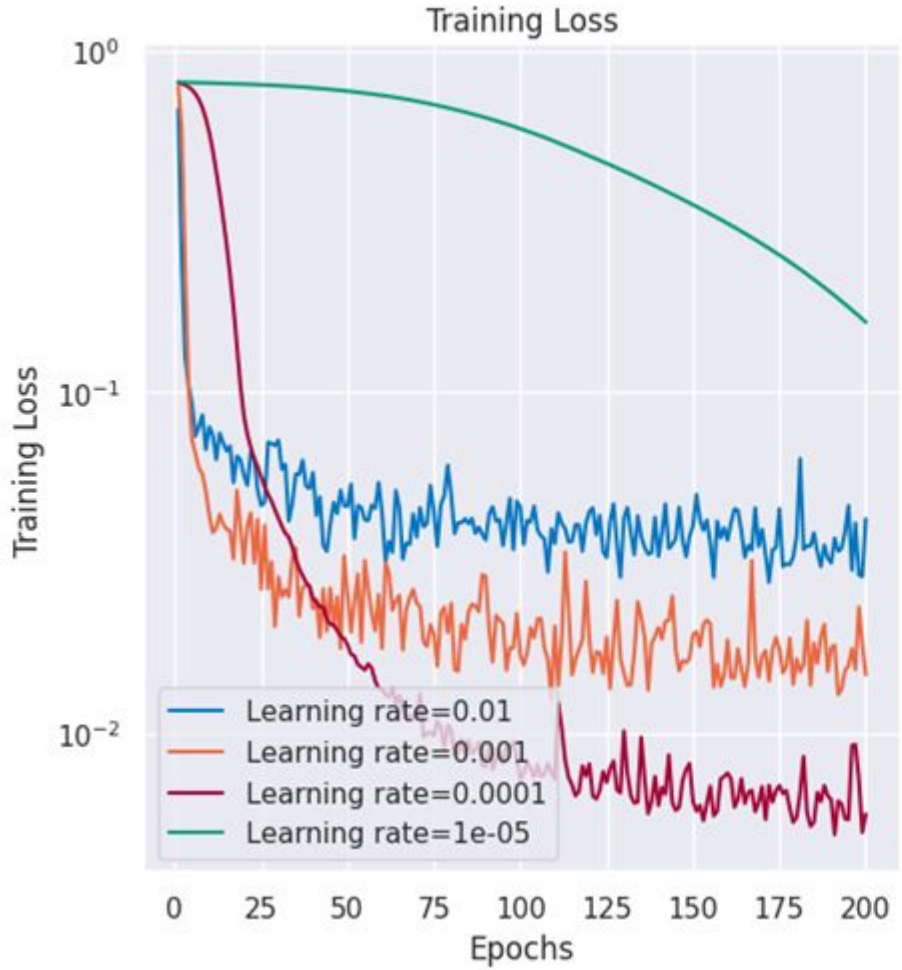
Final network architecture:

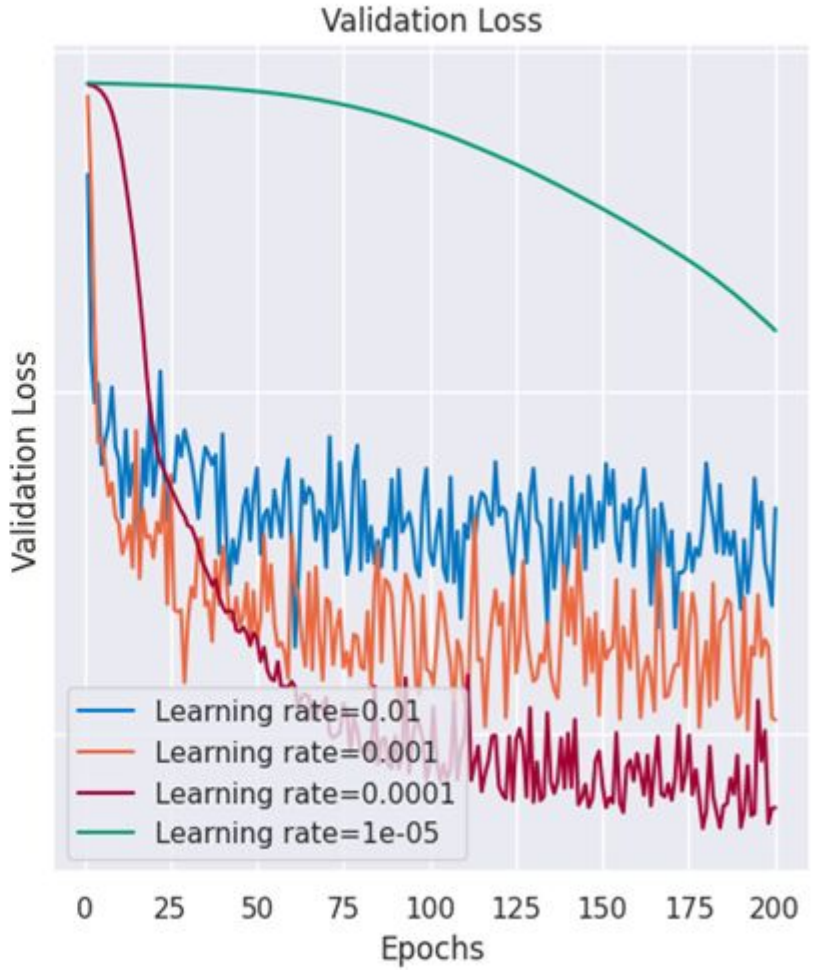
- **Learning rate: 0.0001**
- **L1 Loss function**
- **AdamW optimizer**
- **ReLU activation function**
- **4 hidden layers**
- **128 neurons per layer**

Results - varying number of hidden features

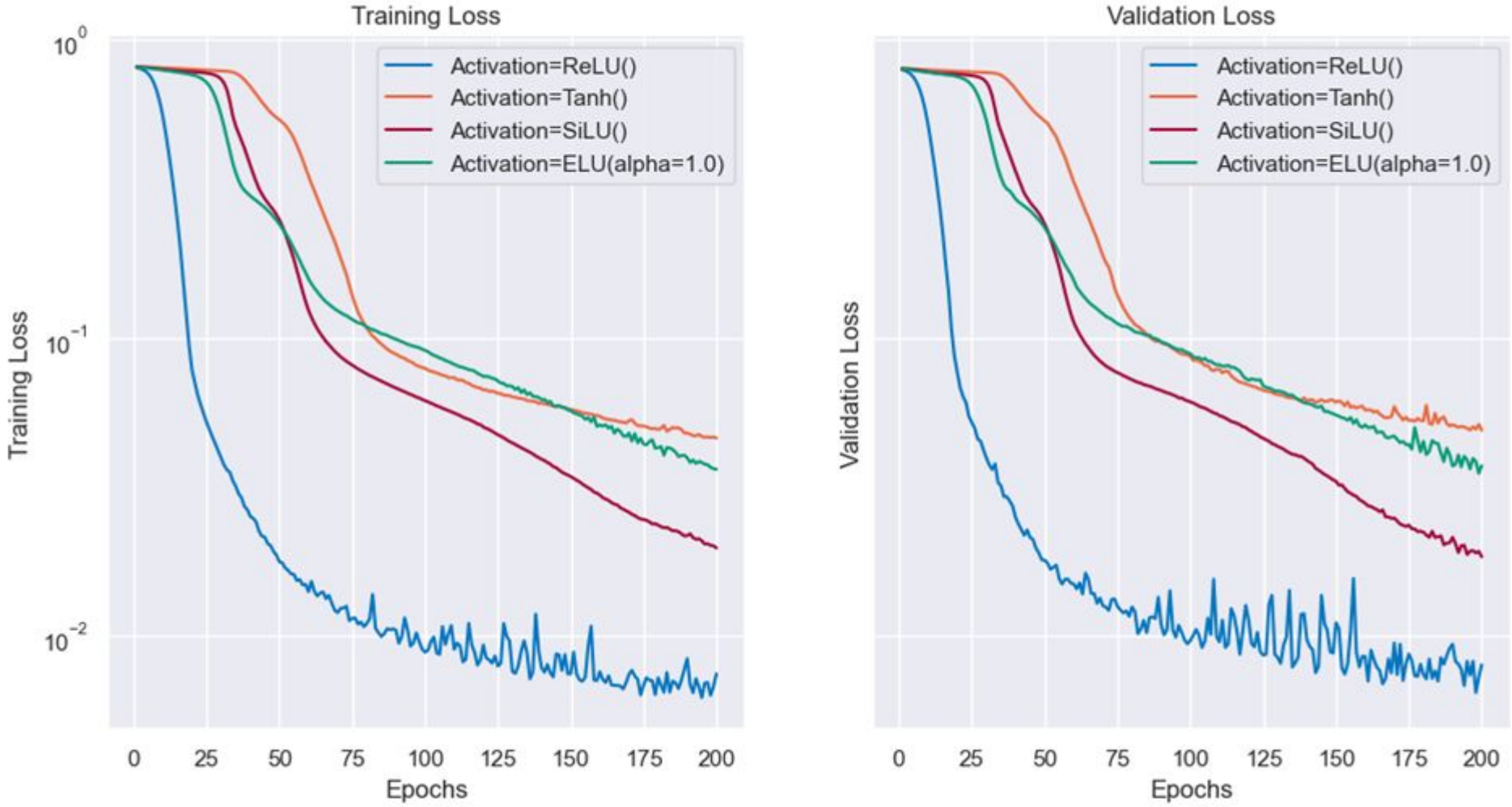


Results - varying learning rate

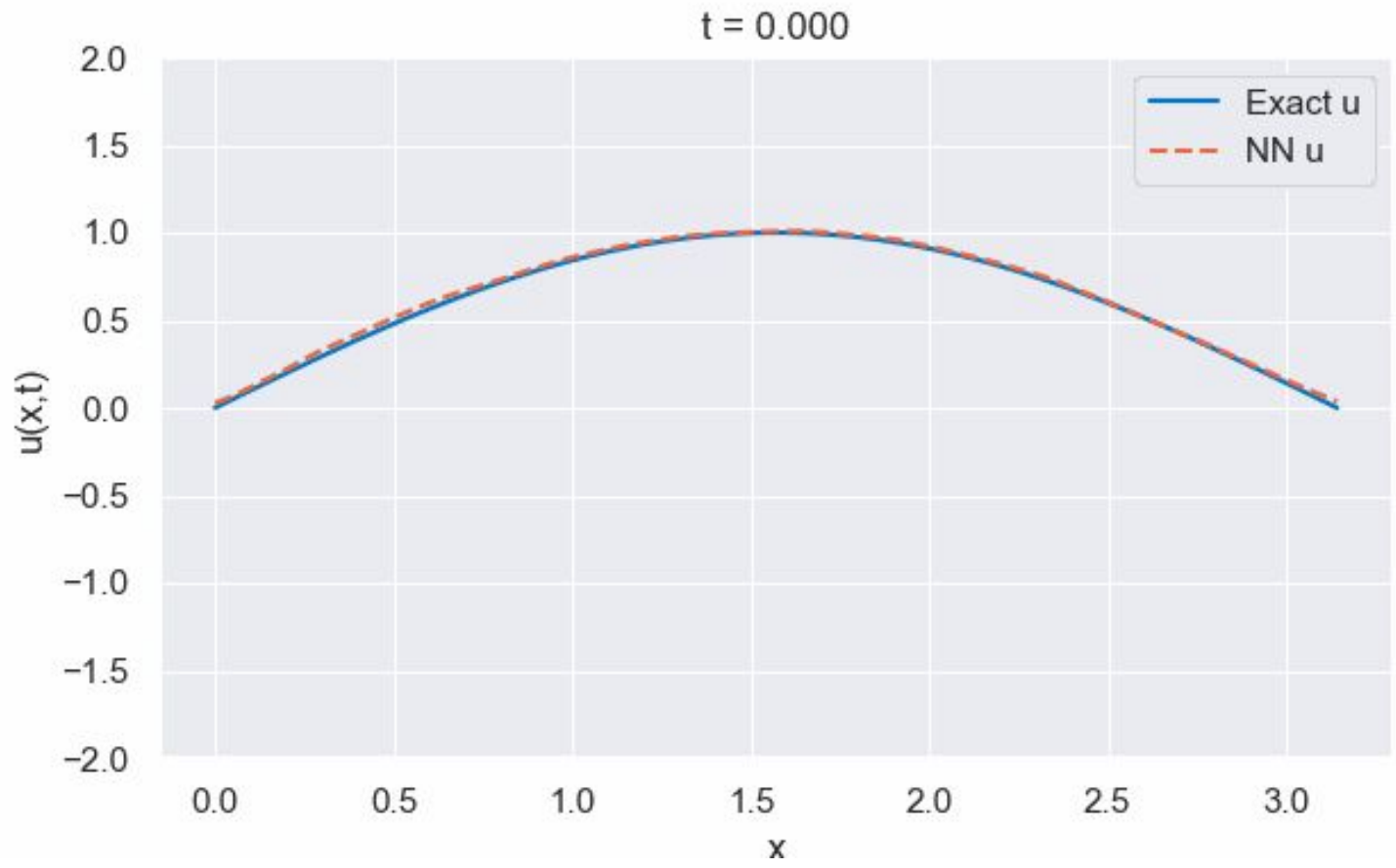




Results - varying activation functions



Results


t = 0.000
Exact u
NN u
u(x,t)
x
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0

Limitations and next steps

Limitations:

- **Lots of data needed**
- **Hyperparameter selection**
- **No extrapolation in time or space**
- **Stability (inputs)**

Next steps:

- **PINN**
  - **Incorporates physical laws**
  - **Improved performance and stability**
  - **Extrapolation**

The End