

# CodeLabs - Scientific Machine Learning

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# Program

1. Function approximation
2. Function learning
3. Parameter identification in a (P)DE
4. PINN for harmonic oscillator
5. DeepXDE tutorial and examples

# FUNCTIONS

# Approximating and Learning Functions

- Learn a sine function

⇒ [02Examples/PINN/pytorch\\_NN\\_fct\\_approx.ipynb](#)

- Learn a stepwise function

⇒ [02Examples/PINN/pytorch\\_NN\\_single\\_layer.ipynb](#)

# PHYSICS CONSTRAINED LEARNING

# Parameter Identification

- Constant parameter identification inverse problem for a (P)DE

⇒ [02Examples/PINN/PCL\\_1D\\_param\\_const.ipynb](#)

# PHYSICS INSPIRED NEURAL NETWORKS

# PINN for ODE

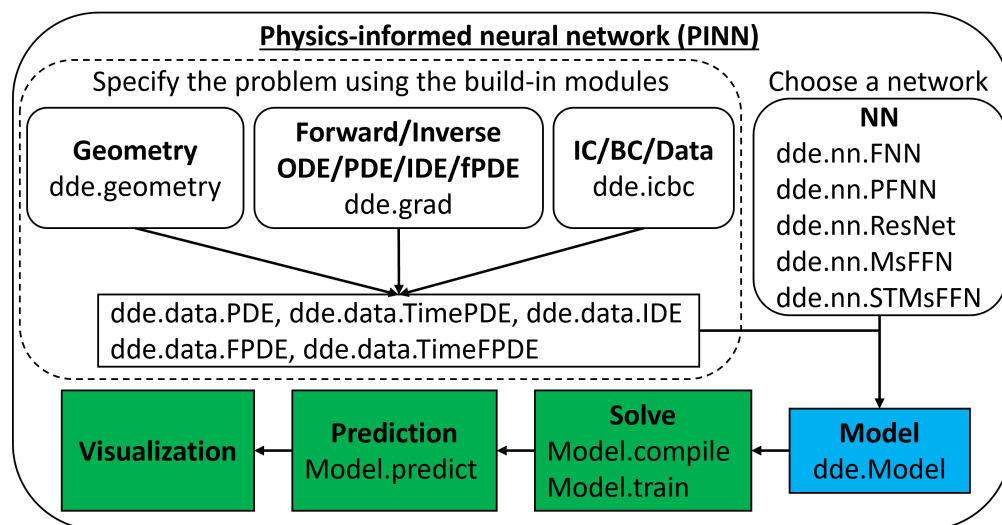
- PINN for harmonic oscillator

⇒ [02Examples/PINN/PINN\\_harmonic.ipynb](#)



# PINN for PDEs with DeepXDE

- **DeepXDE** is a library for scientific machine learning and physics-informed learning. DeepXDE includes the following approaches:
  - ⇒ physics-informed neural network (PINN)
  - ⇒ (physics-informed) deep operator network (DeepONet)
  - ⇒ multifidelity neural network (MFNN)
- In this course, we will concentrate on PINN



- Installation is described on this [page](#) - we will be using the PyTorch backend, which we have already installed...
- ⇒ We recommend to create a new conda environment for DeepXDE and to install it, together with all its dependencies in this env

```
conda create -n deepxde23 python=3
```

```
conda activate deepxde23
```

```
conda install jupyter numpy matplotlib scipy
```

```
conda install scikit-learn scikit-optimize
```

```
conda install pytorch torchvision -c pytorch
```

```
conda install -c conda-forge deepxde
```

# DDE Examples

- Learn a sine function

⇒ [02Examples/DDE/dde\\_fct\\_learning.ipynb](#)

- Learn solution to a very simple system of ODEs

⇒ [02Examples/DDE/dde\\_simpleODE.ipynb](#)

- Learn solution to the Lotka-Volterra system of ODEs

⇒ [02Examples/DDE/dde\\_LK.ipynb](#)

- Learn solution to the 1D Poisson equation with Dirichlet and Robin BCs

⇒ [02Examples/DDE/dde\\_Poisson1D.ipynb](#)

- Learn solution to the 2D Poisson equation on an L-shaped domain

⇒ [02Examples/DDE/dde\\_Poisson2D..ipynb](#)

# References

1. Please consult the list provided on the website:  
[CODE REFERENCES](#)