

CodeLabs - Scientific Machine Learning

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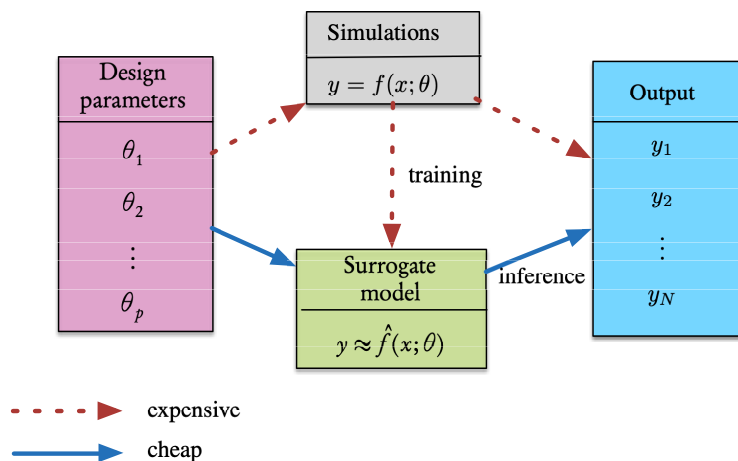
Program

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

SUMO

SUMO: Multiple, Nonlinear Regression

- Please recall the Surrogate Modelling principle:



- Multiple linear regression for predicting concrete strength

⇒ [02Examples/SUMO/mlreg_concrete.ipynb](#)

- SVM regression for LIDAR data

⇒ [01basic-course/02Examples/svm_reg/svm_reg.Rmd](#)

- Nonlinear regression for cyclical/periodic data using feature engineering

⇒ [02Examples/SUMO/cyclic_data.ipynb](#)

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

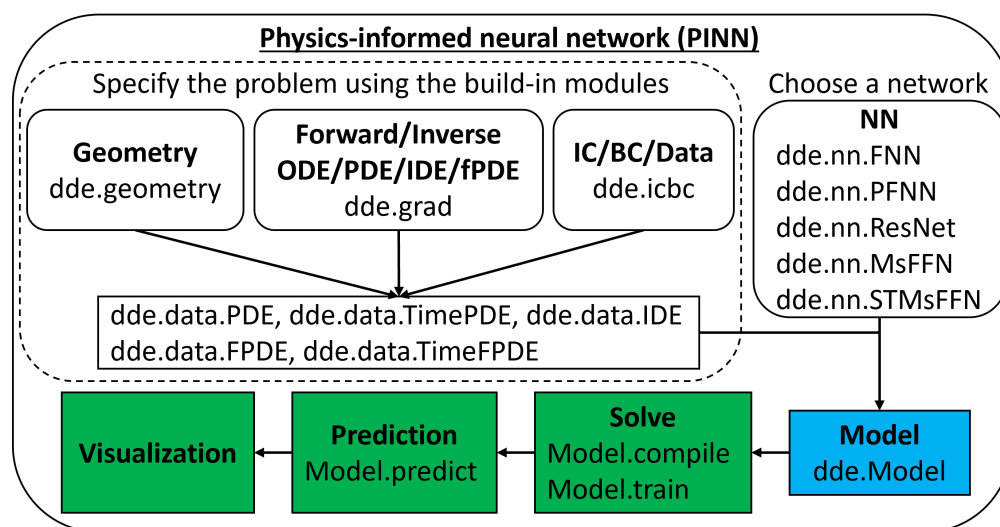
PINN for ODE

- 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](#)