

BeamEquation: Physics-Informed Neural Network (PINN) for Euler-Bernoulli Beam

This repository implements a Physics-Informed Neural Network (PINN) to solve the Euler-Bernoulli beam equation. It combines machine learning (LibTorch/C++) with physical constraints to estimate the deflection of a beam on the domain $[0, 1]$.

Contents

- `main.cpp` : Training and inference routine
- `Beam.h/cpp` : PINN model definition and loss logic
- `Global.h` : Global constants and options
- `Timer.h` : Runtime measurement helper
- `plot.py` : Python script to visualize model output
- `test_beam.cpp` : Unit tests with Catch2

Getting Started

Requirements

- Visual Studio 2022
- CMake 3.20+
- vcpkg for dependencies (see below)
- LibTorch (installed via vcpkg)

Setup

1. Clone Repository

```
git clone https://github.com/yourusername/BeamEquation.git
```

1. Install Dependencies

```
# Optional: set VCPKG_ROOT if not global
git clone https://github.com/microsoft/vcpkg.git
./vcpkg/bootstrap-vcpkg.sh
./vcpkg/vcpkg install libtorch catch2
```

1. Build Project

```
mkdir build && cd build
cmake .. -DCMAKE_TOOLCHAIN_FILE=C:/Users/haasr/vcpkg/scripts/buildsystems/
vcpkg.cmake
cmake --build . --config Release
```

Training

Run the executable (in Release mode):

```
./BeamEquation.exe > result.txt
```

The model will:

- Train using Adam (coarse fit)
- Refine with LBFGS
- Output deflection $u(x)$ over $[0, 1]$

Plotting Results

Requirements

- Python 3.8+
- matplotlib

```
pip install matplotlib
```

Usage

```
python plot.py result.txt
```

This script plots the predicted beam deflection over $[0, 1]$.

Testing

We use [Catch2](#) for unit testing.

Build Tests

```
cmake .. -DBUILD_TESTING=ON
cmake --build . --config Debug
ctest
```

Or run directly:

```
./test_beam
```

License

MIT License

Acknowledgments

- LibTorch (PyTorch C++ API)
- Microsoft vcpkg
- Catch2 Testing Framework