Introduction to Programming for AI

Wigner Summer Camp
Data and Compute Intensive Sciences Research Group

Balázs, Paszkál, Vince, Levente, Antal
Éva, Hajni

7-11 July 2025

Course Overview

This course will cover essential programming tools for AI:

- Core Python programming
- Numerical computing with NumPy
- Data manipulation with pandas
- Data visualization with matplotlib
- Deep learning basics with PyTorch

Each topic has:

- Lecture notebook (e.g., python_basics.ipynb)
- Solution notebook (e.g., python_basics_solutions.ipynb)

Why Python for AI?

- **Readability:** Simple syntax similar to pseudocode
- **Ecosystem:** Rich collection of libraries for scientific computing
- **Community:** Large user base and extensive documentation
- **Flexibility:** Supports both prototyping and production

Example (Simple Python Example)

```
# Calculate factorial
def factorial(n):
return 1 if n == 0 else n *
    factorial(n-1)
```

Python Basics

Core concepts you'll learn:

- Variables and data types (int, float, str, bool)
- Control flow (if-else, for/while loops)
- Functions and lambda expressions
- Lists, tuples, dictionaries, sets
- Object-oriented programming basics

Example (List Comprehension Example)

```
1  squares = [x**2 for x in range(10)]
```

NumPy: Numerical Computing

- **What:** Fundamental package for scientific computing
- **Why:** Efficient array operations and linear algebra
- **Key features:**
  - N-dimensional array object
  - Broadcasting functions
  - Linear algebra, Fourier transform, random number capabilities

Example (NumPy array)

```
import numpy as np
a = np.array([[1, 2], [3, 4]])
b = np.ones((2,2))
c = a + b  # Element-wise addition
```

pandas: Data Analysis

- **What:** Powerful data manipulation library
- **Why:** Essential for data cleaning and preprocessing
- **Key features:**
  - DataFrame object (like Excel tables)
  - Handling missing data
  - Merging and joining datasets
  - Time series functionality

Example (pandas DataFrame)

```
import pandas as pd
data = {'Name': ['Alice', 'Bob'],
    'Age': [25, 30]}
df = pd.DataFrame(data)
```

matplotlib: Data Visualization

- **What:** Comprehensive 2D plotting library
- **Why:** Visualize data and model results
- **Key features:**
  - Publication-quality figures
  - Various plot types (line, bar, scatter, histogram)
  - Customizable styling

Example (Simple plot)

```
import matplotlib.pyplot as plt
plt.plot([1, 2, 3], [1, 4, 9])
plt.xlabel('X axis')
plt.ylabel('Y axis')
```

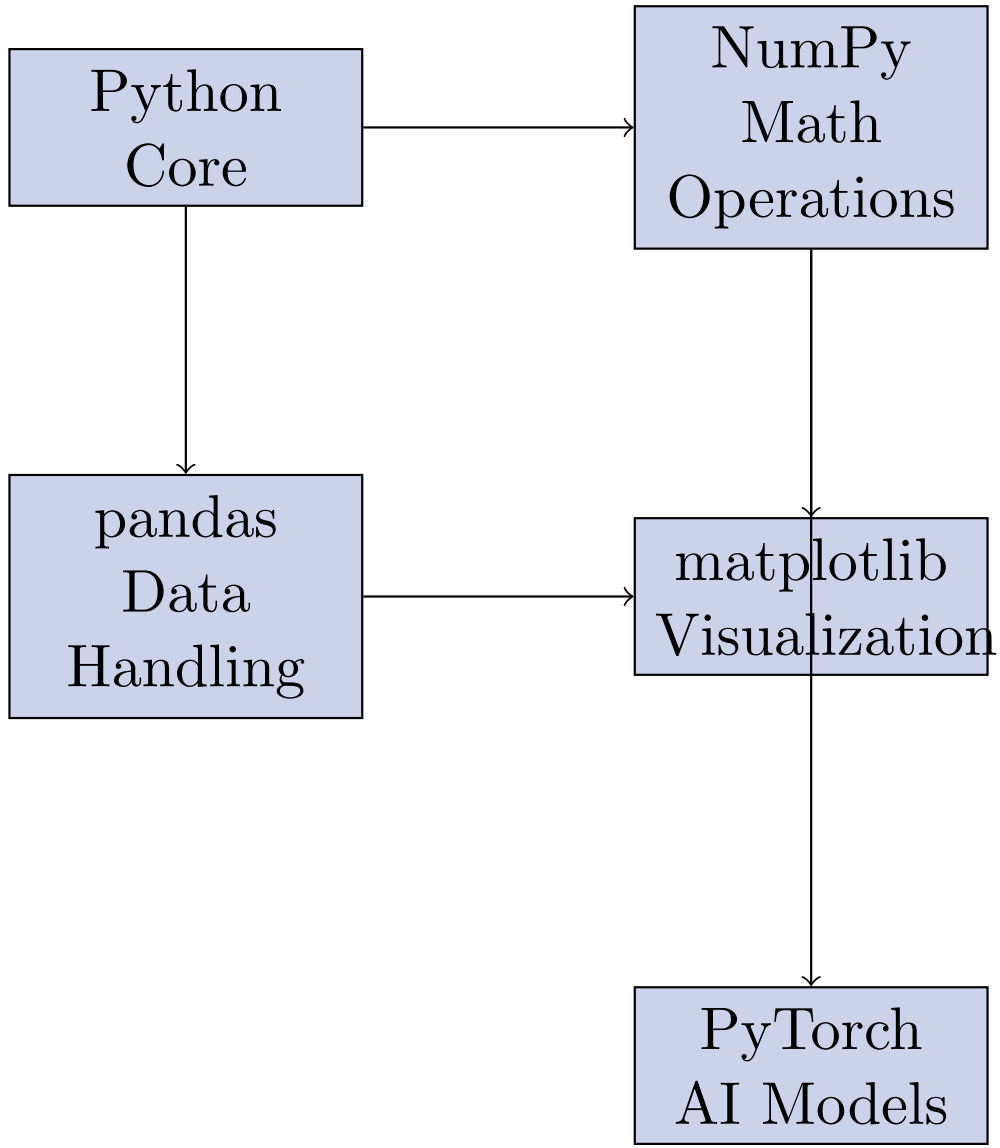
PyTorch: Deep Learning

- **What:** Open-source machine learning library
- **Why:** Flexible architecture for research and production
- **Key features:**
  - Tensor computation with GPU acceleration
  - Automatic differentiation
  - Neural network building blocks

Example (Simple tensor operation)

```
import torch
x = torch.tensor([[1, 2], [3, 4.]])
y = torch.matmul(x, x)  # Matrix
    multiplication
```

How These Tools Work Together



Practical Workflow Example

1. Load and clean data with pandas
2. Perform numerical operations with NumPy
3. Visualize results with matplotlib
4. Build and train models with PyTorch
5. Analyze results and iterate

Example (AI workflow)

```
# 1. Load data
data = pd.read_csv('dataset.csv')

# 2. Preprocess
X = data[['feature1',
    'feature2']].values
y = data['target'].values

# 3. Build model
model = torch.nn.Linear(2, 1)
```

Getting Started

- Install Python (recommend Anaconda distribution)
- Jupyter Notebook for interactive coding
- Course materials available on GitHub
- Exercises with solutions for practice

Next Steps

- Start with python_basics.ipynb
- Progress through each module
- Ask questions and experiment!