1. Python and Python packages

Outline

Python

NumPy, JAX & PyTorch

Python

- a high-level, interpreted programming language
- known for its simplicity and readability
- widely used in scientific computing, data analysis, and ML
- a glue language for integrating different libraries and tools
- many numerical and scientific libraries available as Python packages
- has a large and active community

uv

- an extremely fast Python package and project manager
- `https://docs.astral.sh/uv`
- can install Python and Python packages and manage projects
- install uv on macOS or Linux
  `$ curl -LsSf https://astral.sh/uv/install.sh | sh`
- install uv on Windows:
  `$ powershell -c "irm https://astral.sh/uv/install.ps1 | iex"`
- after installation, run `uv` in the terminal to see the help message

Project management with uv

- `$ uv init myproject`
- `$ cd myproject`
- `$ uv run python`
- `$ uv add --dev notebook`
- `$ uv run ipython`
- `$ uv add numpy`

Interactive Python

- `$ uv run python`
- `$ uv run ipython`

```
Python 3.12.5 (main, Aug 14 2024, 04:32:18) [Clang 18.1.8 ]
Type 'copyright', 'credits' or 'license' for more information
IPython 8.31.0 -- An enhanced Interactive Python. Type '?' for help.

In [1]: 2 + 3
Out[1]: 5

In [2]: 3 * (9 - 8) / 4
Out[2]: 0.75

In [3]:
```

- `$ uv run jupyter notebook`

Python scripts

- create and edit a Python script file (e.g., `myscript.py`) with a text editor
- recommend using the Visual Studio Code editor
- run the script with `$ uv run python myscript.py`
- or run the script in an interactive IPython session, i.e.
  `$ uv run ipython`

```
Python 3.12.5 (main, Aug 14 2024, 04:32:18) [Clang 18.1.8 ]
Type 'copyright', 'credits' or 'license' for more information
IPython 8.31.0 -- An enhanced Interactive Python. Type '?' for help.

In [1]: %run myscript.py
```

Python basics

- variables and data types
- control flow
- functions
- classes and objects
- modules and packages
- tutorials

Outline

Python

NumPy, JAX & PyTorch

NumPy

- a Python package for numerical computing
- array as the fundamental data structure
- vectors and matrices are 1D and 2D arrays, respectively
- arrays can have any number of dimensions
- array manipulations and linear algebra operations
- vectorized operations for efficiency
- Numpy quickstart
- Numpy for absolute beginners

JAX

- similar to NumPy but with additional features
- automatic differentiation
- automatic vectorization
- just-in-time (JIT) compilation
- can run on CPU, GPU, and TPUs

PyTorch

- a popular deep learning library
- tensor as the fundamental data structure, similar to NumPy arrays
- implements various neural network layers
- automatic differentiation
- support for vectorization and parallelization
- GPU acceleration

NumPy, JAX, and PyTorch

- all are widely used in scientific computing and machine learning
- this course will mostly use NumPy and JAX
- but learn all three if you can
- all have good documentation and tutorials online