Advanced Data Science

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How Data Science Research Should Be Reported

Why reproducible reporting matters

- Scientific credibility depends on **transparency and reproducibility**
- Data, code, and methodology should be **openly accessible**
- Enables **validation, reuse**, and further research

Where modern research is shared

- Research paper hubs (e.g., Hugging Face Papers trending section)
- Public **GitHub repositories** accompanying publications
- Increasing expectation of **open science practices**

How Data Science Research Should Be Reported

Core reproducibility principles

- Share datasets whenever **legally/ethically** possible
- Provide **clean, executable code** and **documentation**
- Ensure computational **environments** can be recreated
- Maintain clear project structure and reporting standards

Development Environments in Data Science

Why use an **IDE**?

- Improves productivity with **debugging**, **linting***, and **code navigation**
- Facilitates project **organization** and **version control** integration
- Common choices: VS Code, PyCharm, Jupyter-based workflows

Best practices

- Create one **environment per project**
- Document dependencies (**requirements.txt** / environment.yml)

*https://peps.python.org/pep-0008/

Development Environments in Data Science

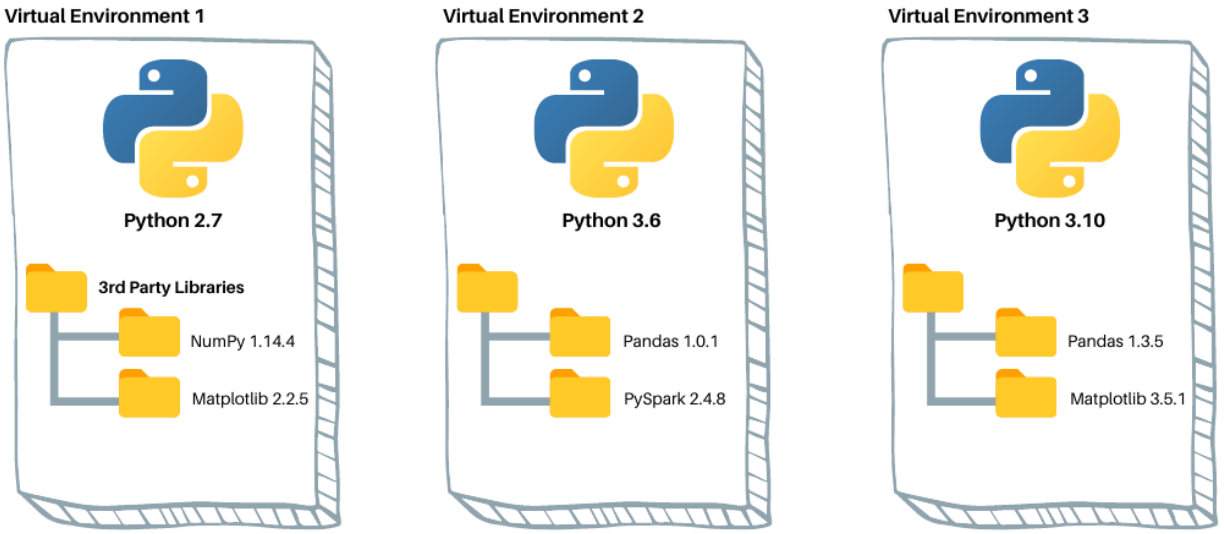
Environment management is essential

- **Avoids** dependency **conflicts** across projects
- Ensures **reproducibility** of experiments

Common tools

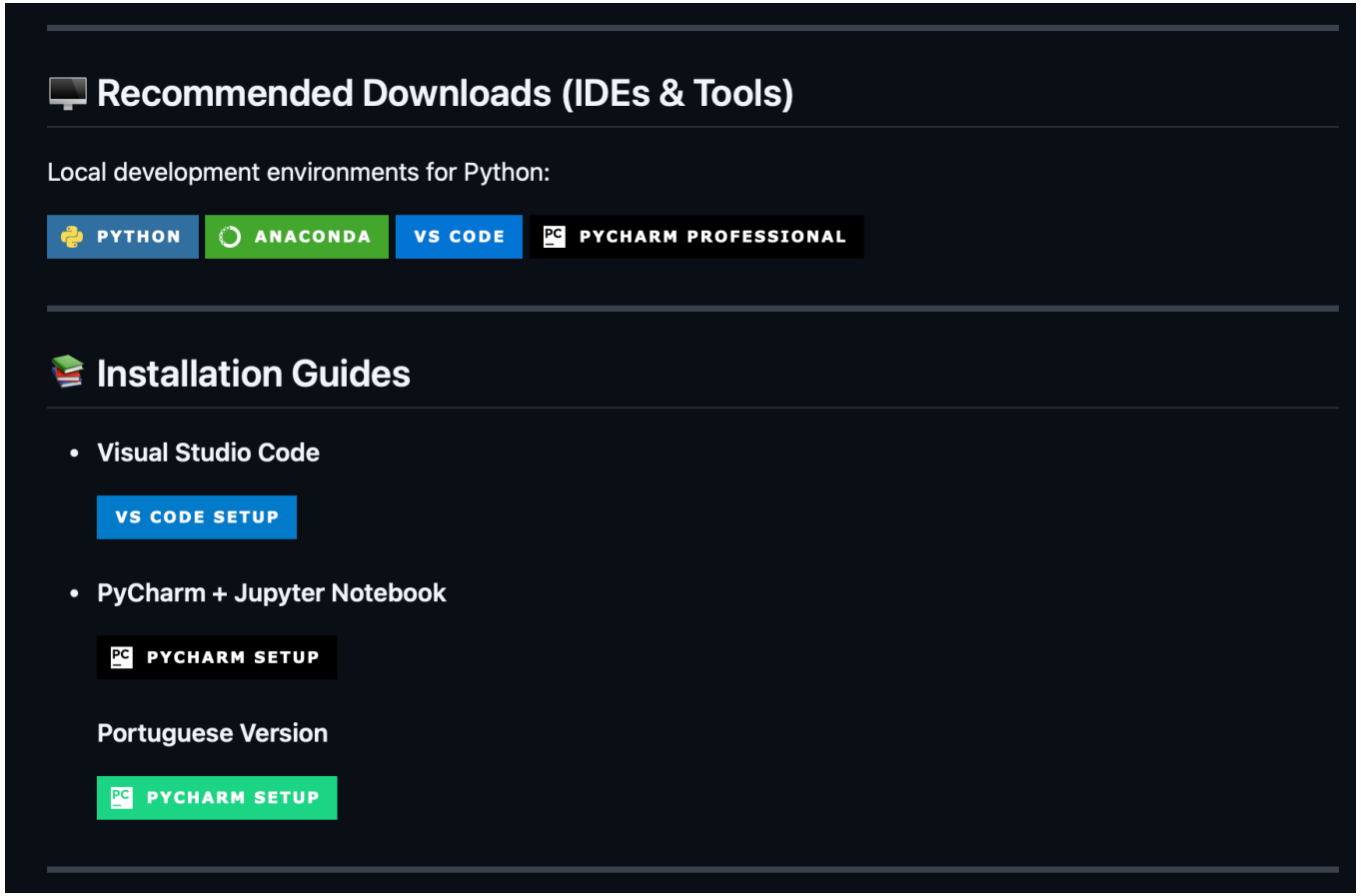
- **venv** → lightweight built-in Python virtual environments
- **conda** → environment + package manager widely used in data science

Configuration

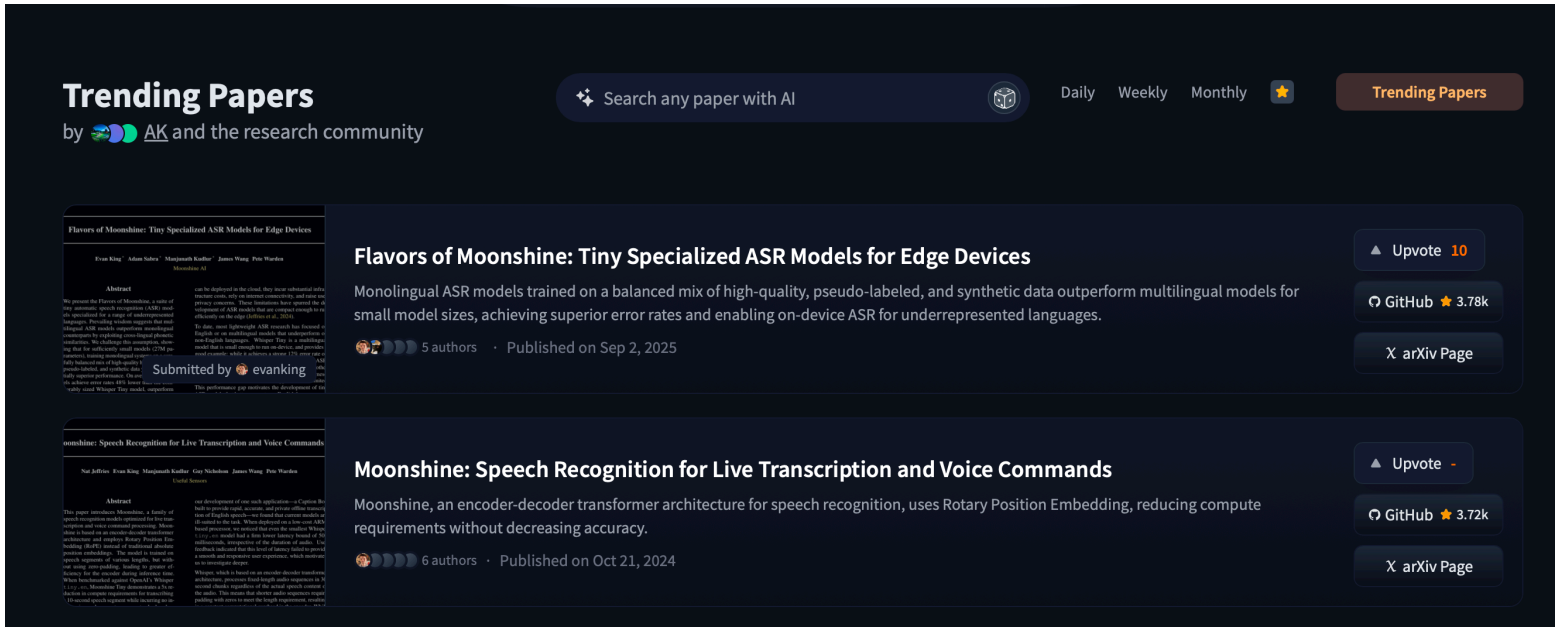


https://www.dataquest.io/blog/a-complete-guide-to-python-virtual-environments/

Configuration



Example



https://huggingface.co/papers/trending

Hands-On Practice: Building a Reproducible Repository (Ames Housing Dataset)

Objective

- Apply reproducibility principles by **creating a structured GitHub repository**
- Work with the **Ames** Housing dataset as a real Data Science **case study**

Dataset

- Ames Housing Dataset (Kaggle)
- Focus on **data loading, initial exploration**, and **reporting** findings

Hands-On Practice: Building a Reproducible Repository (Ames Housing Dataset)

```
# ames-project/
# │
# ├── data/
# │   ├── raw/
# │   └── processed/
# │
# ├── notebooks/
# ├── src/
# ├── reports/
# │   └── figures/
# │
# ├── README.md
# ├── requirements.txt
# └── .gitignore
```

Expected Outcome

- A shared GitHub repository as a course **assignment**
- Clear organization, reproducible environment, and documented insights

The folder descriptions shown in the tree above are available in the Python notebook.

Hands-On Practice: Building a Reproducible Repository (Ames Housing Dataset)

Goal

- Carefully review the dataset features before any modeling step
- **Develop** a clear **understanding** of what **each variable** represents

Your Task

- Briefly describe each column in the dataset (1–2 lines per feature)
- Identify the **variable type** for each feature.

Hands-On Practice: Building a Reproducible Repository (Ames Housing Dataset)

Why This Matters

- **Prevents misinterpretation** of variables
- Helps **detect** inconsistencies or data **quality issues**
- **Guides** preprocessing, visualization, and modeling decisions

Deliverable

- A summarized **feature description** documented in your GitHub repository (README or reports)

Feature Types in Data Science

Numerical Variables

- Continuous: Real-valued measurements (e.g., price, height, temperature)
- Discrete: Countable integers (e.g., number of rooms, transactions)

Categorical Variables

- Nominal: Categories without intrinsic order (e.g., neighborhood, color)
- Ordinal: Ordered categories (e.g., quality rating, education level)

Binary Variables

- Two possible states (0/1, yes/no, true/false)
- Often treated as categorical but sometimes numeric for modeling

Feature Types in Data Science

Temporal Variables

- Dates, timestamps, durations
- Important for trends, seasonality, and time series analysis

Text / Unstructured Variables

- Free text, documents, comments
- Require NLP preprocessing (tokenization, embeddings, etc.)

Spatial / Geographical Variables

- Coordinates, regions, spatial relationships
- Used in geospatial and environmental analysis

Preliminary Data Quality Check

Start Evaluating Data Consistency

- Are there missing values in the dataset?
- Are they random, systematic, or meaningful?

Validate Data Types

- Check if stored types match expected semantics:
  - Dates → proper datetime format
  - Age, price, counts → numeric (int/float)
  - Categories → consistent categorical encoding

Preliminary Data Quality Check

Look for Incompatibilities

- Unexpected strings in numeric fields
- Incorrect formats (e.g., dates as text)
- Mixed data types within the same feature

Why This Step Matters

- Prevents modeling errors and biased conclusions
- Improves data cleaning and preprocessing decisions
- Strengthens reproducibility and reporting quality

Obrigado!