Complex Systems Workflow

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December 10th, 2025

Outline

The Whole Point

Learn

- Memorize
- Categorize
- Synthesize
- Connect
- Expand

Create

- Literature
- Explore
- Hypothesize
- Test
- Replicate
- Analyze

Communicate

- Visualize
- Stabilize
- Consolidate
- Format
- Share

Find → Read → Notes → Ideas → Experiment Design → Code → Data → Figures → Writing → Publishing → Archiving

How to Get There

Complex Systems = Data Science + Physics + Epistemology

- **Modular**: Playful, expandable, iterable
- **Replicable**: Collaboration without subscription, fixing, expansion
- **Automated**: Systems require computation

Consolidated Pipeline of Open Source Local Software

Moral and Virtue Arguments

- **Moral Thought Experiment**: AI-assisted automation VS automation with AI. Consider environmental, social, personal ramifications. [3]
- **Virtue**: Better to understand the things you are using well.
- **Moral**: Better to live in world where skill and understanding are valuable and personal rather than auctioned off for false convenience.
- **Both**: How you do what you do should be a decision you make, not one that corporations make for you. [2]

Technical and Self-Interested Arguments

- **Venal Self Interest**: Pipelining as a skillset (the age of the ipynb is fading)
- **Version Control**
- **Regular Control**
- **Ongoing Access**
- ***Clearer opportunities for improvement***
- **Fun!**

Class Notes

- In Class: pen and paper
- Later: transferred, not transcribed, to Obsidian
- Clarified with wikipedia, textbooks, youtube, AI
- Categorize, Connect, Store, Label
- Importance of not being a freak about it.

Research Notes

- Zotero first
- Annotate and highlight digitally or on paper (if hard to focus on)
- Larger ideas and concepts in citation page in zotero
- Ideas integrated into conceptual 'evergreen' notes

Flash Cards

- Obsidian $\rightarrow$ ANKI
- Flashcards of formulas, phrases, ideas that I think will anchor my memory for things that are important to me
- Importance of not being a freak about it

Live Demo

Live Demo

Create

The Pipeline: experiment ideas in Obsidian turn into code in `src` uses data in `data` to make figures in `latex/figures` which `latex/project.tex`, possibly drafted in Obsidian, complies to share results.

Computational Experiments

A whole slide deck in itself....

Coding Practices

- **Mise en Place**: Clean Cutting Board, Clean Mind. Build a recipe, then prepare ingredients, then put together.
- **DRY**: Be kind to your future self! Like getting a glass of water after going out drinking.
- **Modular**: Organized functionality = iterable functionality
- **Paths**: Never raw strings, (python: Pathlib) and as limited absolute paths as possible
- **Reproducibility**: if in python, use conda/uv or at least a regularly pip list.
- Make stuff so that you can use it in later projects!
- Tests, Types, **Dataclasses**
- **Doing everything like you want to be better at doing it next time.**

Data Management

- Don’t put it on github
- Consider scale before you start
- Standardize, Log, and *save a record of all transformations*, ideally in a replicable script

Latex

- Local is better then overleaf: version control, directly piping in figures and results from code, potential for more automated writing.
- Write your own snippets and macros
- Latex extensions in vs code make it really easy
- Exporting full zotero bib allows for really quick citations.
- Live Demo!

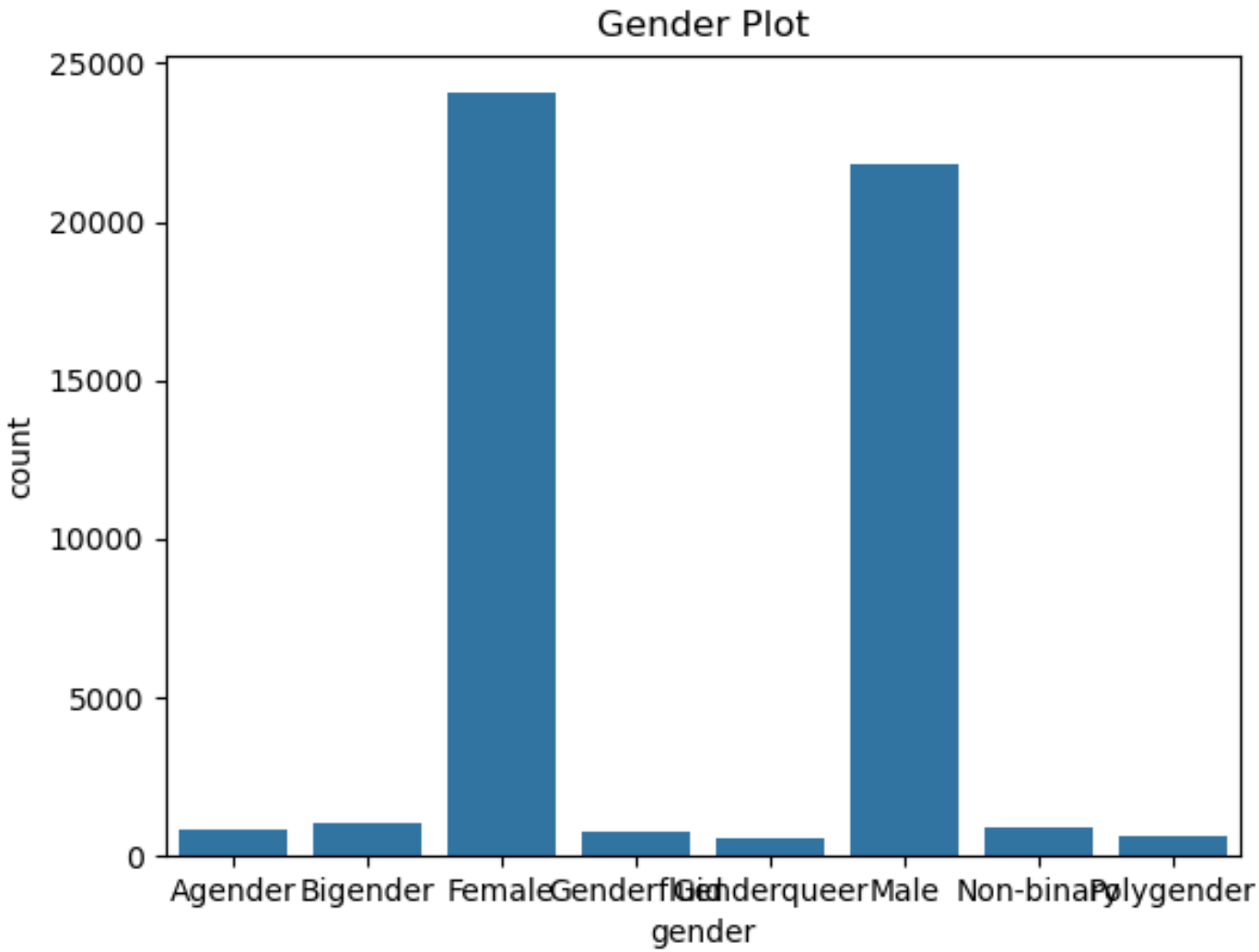

Figure: Gender distribution, which we will here claim has something to do with R^2 [1]

Version Control: GIT

- Commit when you might break something; push when you've changed or fixed something; PR when you've finished a defined subproject
- Easy to link an employer a cool github.
- Easy to bring in collaborators.
- Test: guess the GOODNESS levels of these three options:
  - VS Code extension
  - Terminal
  - Github GUI

References I

[1] Albert-László Barabási and Réka Albert. “Emergence of Scaling in Random Networks”. In: *Science* 286.5439 (Oct. 1999), pp. 509–512. ISSN: 0036-8075, 1095-9203. DOI: 10.1126/science.286.5439.509. (Visited on 01/29/2025).

[2] *How Google Took Over the Classroom - The New York Times*. https://www.nytimes.com/2017/05/13/technology/google-education-chromebooks-schools.html. (Visited on 12/07/2025).

[3] Laura Rodríguez Salamanca. *Microsoft, Google Say Their Data Centers Create Thousands of Jobs. Their Permit Filings Say Otherwise*. https://restofworld.org/2025/data-centers-jobs-microsoft-google-chile/. Nov. 2025. (Visited on 12/07/2025).