Using AI in Research Workflows

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How do I use AI?

- AI is part of pretty much everything I do on my laptop.
- Some use cases:
  - Getting a quick overview of papers I am unfamiliar with
  - Writing code, organizing project folders, updating results in a paper
  - Proof-checking that the code, the paper, and the slides are consistent
  - Discussing ideas and analyses when I am working on a project
  - Improving the clarity of my writing and presentations
- I use pen and paper when I need to fully understand something (e.g., theory, statistics) or for mental clarity (e.g., making a to-do list, planning ahead).

How do I not use AI?

- The one thing I do not do with AI: "Write me a full paper and a full slide set on this vague idea while I go play tennis."
- First, current AIs are just terrible at this when left unattended, so this is a very iterative process, and you need to be in the loop.
- Second, you will be ultimately presenting the paper and the results, so being in the loop allows you to *understand* what you are doing.

  $\rightarrow$ The journey is almost as important as the final destination in research.
- As mentioned above, AI can still help speed things up (and by a lot).

My setup

I connect the agent to 5 tools:

Dropbox	Project files and data
GitHub	Code history and repository
Overleaf	Paper and slides
HPC cluster	Heavy computation
Gmail	Co-author comments

The project folder

```
Dropbox/my-project/

   |-- overleaf/   Local paper copy, tables, and figures
   |-- code/       Code repository
   |-- data/       Raw and processed data
   |-- notes/      Working notes
```

Claude Code / Codex runs from the project folder; For Claude, I talk to it in the browser (`https://claude.ai/code/*`) so I can easily visualize PDFs and PNGs.

I always keep the local paper and the online Overleaf project in sync.

Principle 1: You are in charge.

- Agents can overproduce, expand the scope, and overreact to details.
- I don't let agents run unattended for long periods of time (e.g., overnight) unless the task is very well-defined (e.g., it has to monitor some jobs on the HPC and relaunch them if they fail).
- I have a hands-on approach to my sessions with AI. I stay in the loop and often have to correct course or make judgment calls.
- Being hands-on also ensures I still understand what I am doing, and that I can map it properly in my head though I am not doing the coding anymore.

Principle 2: Prioritize accuracy, not speed or cost-cutting.

- I run models at maximum reasoning. For EVERYTHING.
- A mistake in a paper can cost far more than extra tokens or waiting time, and the difference in IQ between reasoning levels is very large.
- More reasoning does not remove the need for verification (more on this after).

A typical loop

1. **I specify the task in Overleaf.**
   Sample, equation, estimator, clustering, and expected output. Just like I would in a detailed PAP or when writing a paper.

2. **A first agent implements it.**
   I ask it to flag ambiguities before coding. There is very high value in making sure the AI and you are on the same page.

3. **Other agents review it in a fresh context.**
   It reads the specification, code, and outputs; identifies discrepancies between the Overleaf and the implementation.
   A typical failure mode is AI making consequential decisions without asking (e.g., dropping some observations). I always ask the agents to check for this, too.

4. **I decide what to revise or accept.**
   I resolve issues, rerun, and repeat the review until I'm satisfied.

Two phases: prototyping, then sharpening

Prototyping phase:

- It is an exploratory phase.
- I do not review the code or the prose.
- I treat these outputs as probable but provisional.

Sharpening phase:

- If I think there is something there, I get involved in the writing and coding process.
- I audit the code, paying special attention to the number of rows in the dataset and results that "look weird". I have many independent agents check the code.
- I rewrite the Overleaf and work with AI to iterate on the visuals.
- I take responsibility for the results and claims.

Communication with co-authors

I keep three distinctions very explicit:

Origin	What the AI produced; what I produced.
Status	What is exploratory; what is polished.
Responsibility	What I have not checked; what I am ready to stand behind.

Your co-authors will not look at "exploratory" and "polished" results in the same way, and won't make the same comments.

AI use and understanding vary across co-authors. Though I think everyone will eventually use AI and that it greatly reduces coding mistakes and inconsistencies, it's important to be transparent and to take responsibility for your work.

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