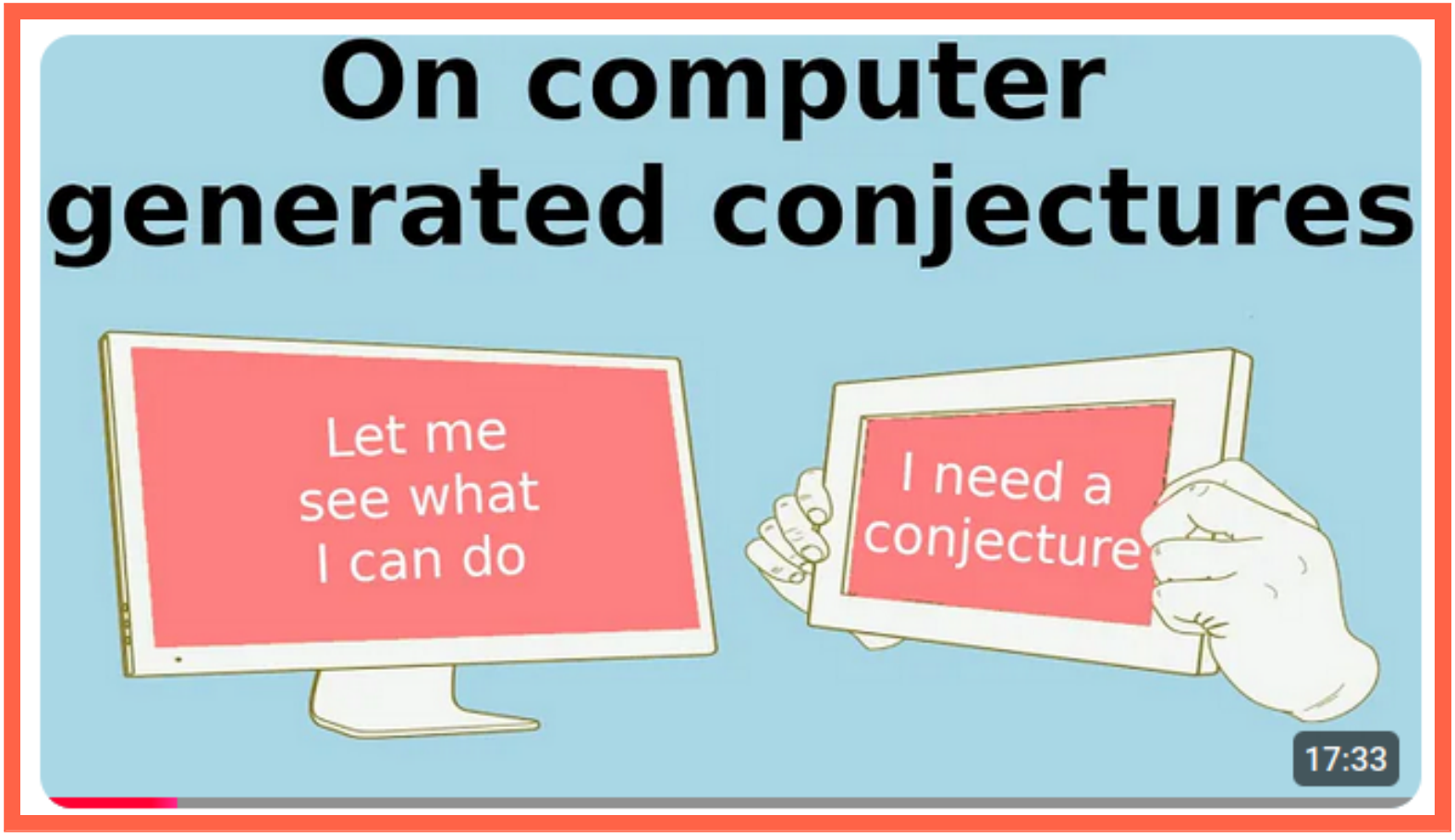
AI for the working mathematician - part 3?

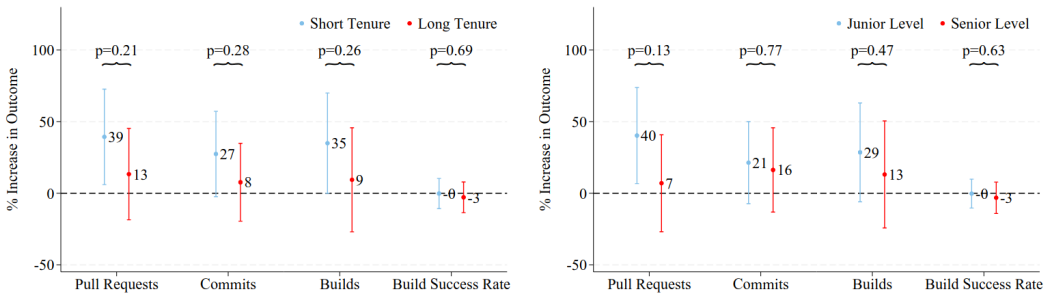
Or: What is...coding with AI?

The mantra: AI improves your coding and then your math



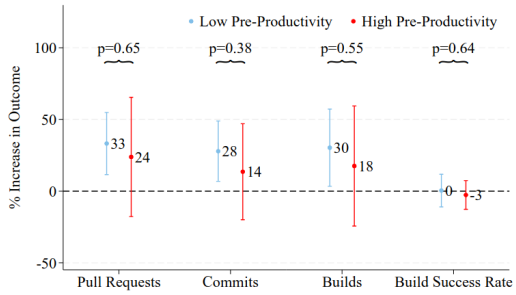
- Strategy Turn a math idea into code with AI doing the scaffolding
- Example You have a conjecture and want some evidence that it holds $\Rightarrow$ use code to generate plenty of examples
- Today I show how I code with AI: fast, auditable, and under human control

Research on the slogan



(a) Treatment Effects by Tenure

(b) Treatment Effects by Level

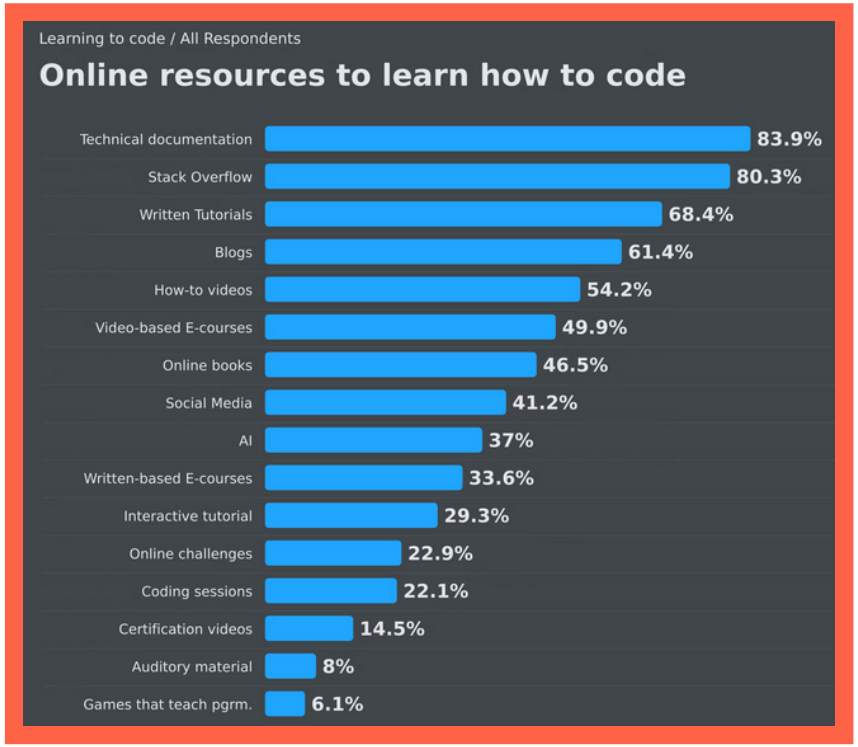


(c) Treatment Effects by Pre-Productivity

Figure 6: Heterogeneity of Copilot Effect (Weighted IV)

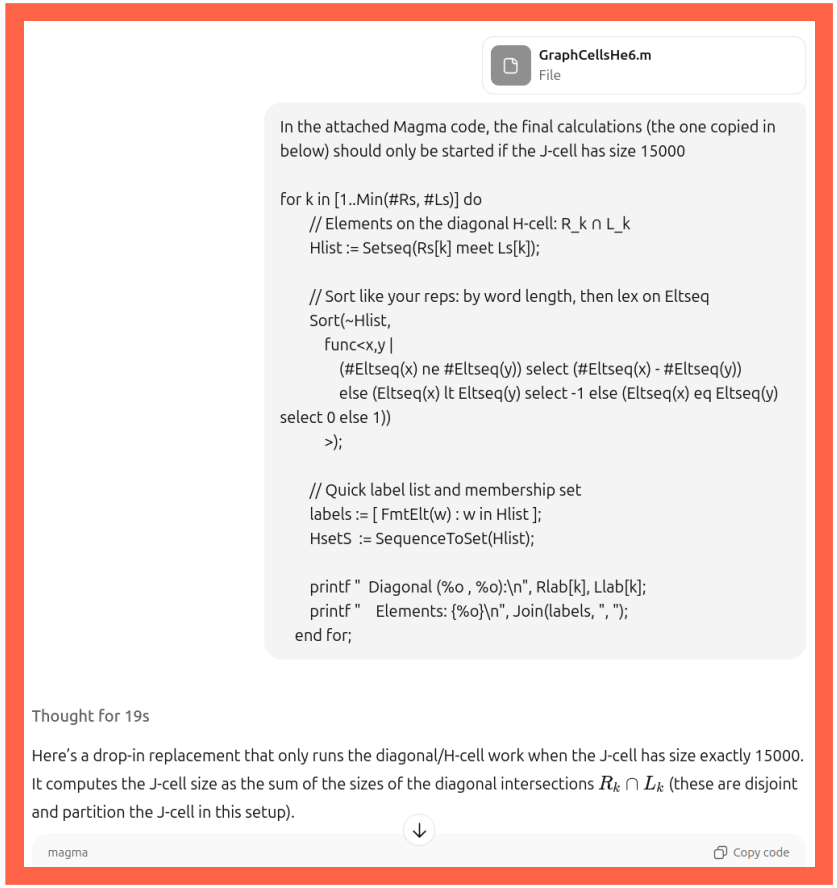
- Why? Controlled experiments report substantial time savings on standard programming tasks $\Rightarrow$ use this in math!
- Above (example research) The Effects of Generative AI on High-Skilled Work
- Quote "our analysis reveals a 26.08% increase (SE: 10.3%) in completed tasks among developers using the AI tool"

Why are LLMs so good at this?



- Code repeats Most programs reuse the same patterns (read a file, loop, call a library, plot); LLMs have seen millions of these
- Easy to check Code either runs or it doesn't; tests and error messages give instant feedback, so you nudge the model and it quickly fixes the draft
- Why is this great? You describe the goal in plain language; the model lays down the boring bits, leaving you to focus on ideas

An example from my own research



GraphCellsHe6.m
File

In the attached Magma code, the final calculations (the one copied in below) should only be started if the J-cell has size 15000

```
for k in [1..Min(#Rs, #Ls)] do
    // Elements on the diagonal H-cell: R_k ∩ L_k
    Hlist := Setseq(Rs[k] meet Ls[k]);

    // Sort like your reps: by word length, then lex on Eltseq
    Sort(~Hlist,
      func<x,y |
        (#Eltseq(x) ne #Eltseq(y)) select (#Eltseq(x) - #Eltseq(y))
        else (Eltseq(x) lt Eltseq(y) select -1 else (Eltseq(x) eq Eltseq(y)
select 0 else 1))
      >);

    // Quick label list and membership set
    labels := [ FmtElt(w) : w in Hlist ];
    HsetS  := SequenceToSet(Hlist);

    printf "  Diagonal (%o , %o):\n", Rlab[k], Llab[k];
    printf "    Elements: {%o}\n", Join(labels, ", ");
  end for;
```

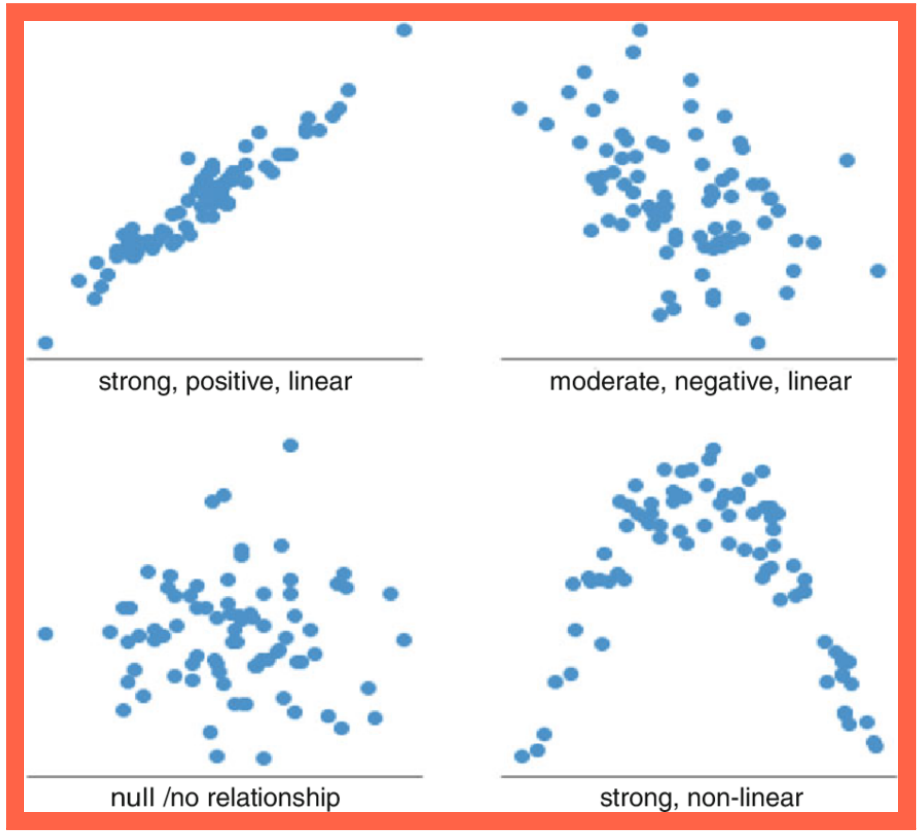
Thought for 19s

Here's a drop-in replacement that only runs the diagonal/H-cell work when the J-cell has size exactly 15000. It computes the J-cell size as the sum of the sizes of the diagonal intersections $R_k \cap L_k$ (these are disjoint and partition the J-cell in this setup).

magma Copy code

- Above I asked ChatGPT to create Magma code for a very-pure-math-problem
- How this goes I know where to go, ask for code snippets (where I explain the problem) and we keep on adding and polishing together
- Now A live toy problem, show failures, and keep an audit trail you can rerun

Summary & what to try next



- The loop Say what you want → get a draft → run it → fix it → repeat
- Why this helps a working mathematician It gives quick evidence (or a counterexample) and even new ideas/conjectures, makes clean plots, and lets you spend time on the idea while the machine does the setup
- Try this next Pick a small claim you care about and make lots of examples

Thank you for your attention!

I hope that was of some help.