Code, Data, and Version Control: Best Practices for Economic Research

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Roadmap

How should economists organize empirical research?

I. Workflow
II. Code
III. Data
IV. Version control

Ecumenical audience:

- RAs, PhD students, faculty
- Language-agnostic
- Related disciplines

Ask questions!

Prologue: Motivation

Brueghel the Elder, *Sloth*

Why bother?

Easy to neglect best practices

- Looming deadlines
- "I'll fix it later . . ."

Good workflows do entail upfront costs

But they're dwarfed by the benefits

- Better research process
- Better research product

Good workflow improves the research *process* . . .

It saves time

- Less debugging
- Less duplication of effort

It facilitates analysis

- Rapid prototyping
- Ease of exploration
- Reversible choices

It feels good

- Less frustration
- Less panic
- More pleasure in the craft

. . . and the research *product*

It promotes good science
- More discoveries
- Fewer mistakes

It complements presentation
- Better figures and tables
- Ease of answering questions

It has positive spillovers
- Shareable code
- Replication packages

All of which confers professional credibility

Virtuous cycles

Rich complementarities

- Better organization $\Longrightarrow$ simpler code
- Simpler code $\Longrightarrow$ easier to improve
- Faster code $\Longrightarrow$ cheaper analysis
- Cheaper analysis $\Longrightarrow$ deeper dives
- Version control $\Longrightarrow$ safer experimentation

So we should think holistically

Part I: Workflow

Brueghel the Elder, *The Harvesters*

Roadmap

I. **Workflow**
   - Reproducibility
   - Project organization
   - Project life cycle
   - Collaboration
   - Computing

II. Code

III. Data

IV. Version control

A working definition

Research is reproducible to the extent that

> *source code and data are sufficient for an outside researcher to replicate results exactly in a supported computing environment*

Intrinsic motivation:

- "Why am I getting different results?"

Extrinsic motivation:

- Increasingly policed
- Prominent retractions
- Journal requirements

The road to reproducible research

Main principles:

- Do everything in scripts
- Make projects self-contained
- Execute them in one click
- Test in a clean environment

Many pitfalls:

- Revisions to source data
- External dependencies
- Artifacts from previous runs
- Different computer setups
- Ambiguous instructions

The project directory

Give each project its own directory

- Maximally self-contained
- No gratuitous dependencies
- Install packages internally

Organize it coherently

- Separate files by function
- Use clear and concise names
- Exploit parallel structure

Keep it clean

- Avoid redundancy
- Minimize clutter

A flexible project template

Four (or more) subdirectories:

- `code`
- `data`
- `logs`
- `output`

We can add a few more:

- `libraries`
- `models`
- `paper`

Primary script: `main.sh (.do, .r, .py, ...)`

- Defines the order of execution
- Runs everything in sequence

A flexible project template (continued)

Subdivide `code` by function

- `code/build` (data preparation)
- `code/check` (data validation)
- `code/learn` (exploratory analysis)
- `code/share` (public-facing analysis)

Subdivide `data` by provenance

- `data/raw` (data as provided to you)
- `data/derived` (anything you created)

Use parallel structure, recycle names

- `code/harmonize.do` $\Longrightarrow$ `logs/harmonize.log`
- `code/learn/emp.do` $\Longrightarrow$ `output/learn/emp.pdf`

Other organizational principles

Use good nomenclature

- Intelligible
- Concise
- Memorable

Avoid redundancy

- Declare settings/paths/scalars in just one place
- Store repeated code in separate callable scripts

Ensure traceability

- Distinct input files $\implies$ distinct outputs
- Should be obvious what generated what

No circularity—directed acyclic graph

The project life cycle

Typical progression:

- Early: understand data, probe viability
- Later: fine-tune analysis, create nice figures

Project structure should evolve over time

- Reorganize directories
- Revisit nomenclature
- Tie up loose ends

Hierarchy should scale with complexity

- Simple project $\implies$ flatter directory structure
- Complex project $\implies$ subdirs, subsubdirs, ...
- Start simple, elaborate as needed

Leave the campsite better than you found it

Entropy is a fact of life

- Code decays
- Clutter piles up
- Bugs creep in

Streamline as you go

- Clarifies the code logic
- Reminds you what you did
- Controls bug population

Avoid clutter—then declutter

- “But what if I need it later?”
- Stay tuned for version control

Plan for a replication package

Common mistake: defer replication to the end

- Waste time revamping
- Scramble to meet deadlines
- Discover mistakes

Keep the end goal in mind

- Will the code meet journal standards?
- Will the code be runnable by a replicator?
- Will the code be useful to others?
- Does it look professional?

Stringent standard: *American Economic Review*

Getting along (is hard to do)

Collaborative work $\Longrightarrow$ added challenges

- Code works for me, crashes for you
- I edit a script, it messes with your analysis
- I can't read your code, you can't read mine

Three viable approaches:

- Designated coder: one person touches the code
- Partnership: multiple equal coders
- Surgical team: primary coder + others

Which approach?

Tailor to team and project

- Coding ability, attention to detail
- Comparative advantage, bandwidth
- Access to data, computing resources
- Project complexity, optimal language
- Interpersonal dynamics

Multiple coders $\Longrightarrow$ all the more vital to

- Use version control
- Adopt uniform conventions and style
- Be mindful of computing environments

Research computing

Invest in a good primary language

- Stata: great for economics—but costly, narrow
- R: increasingly popular—but many dialects
- Python: versatile, all-purpose—but newer to econ

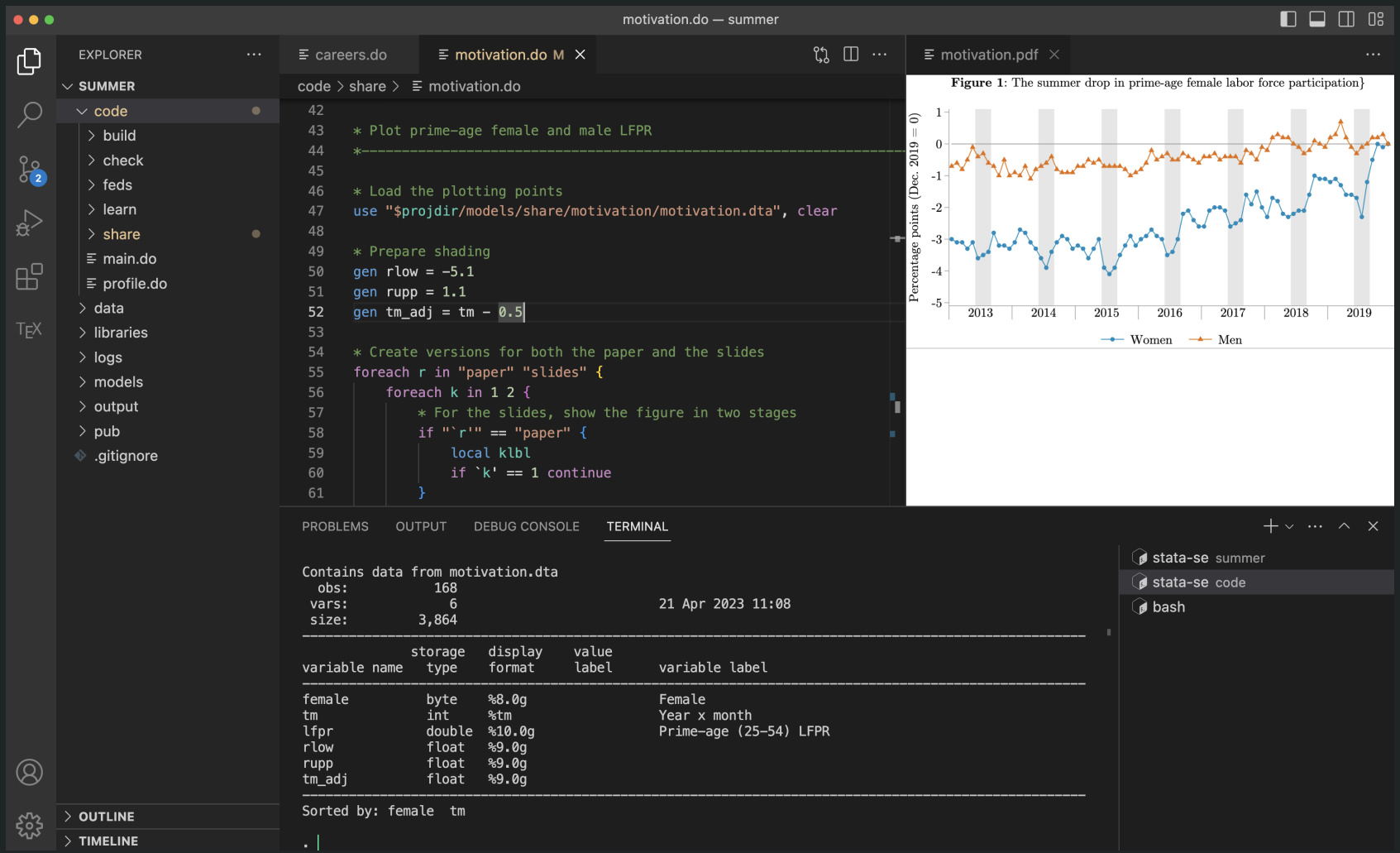
Supplement with the shell?

- Pro: useful lightweight utilities
  (preprocess text, scrape web, append pdfs)
- Con: reliance on OS impedes shareability

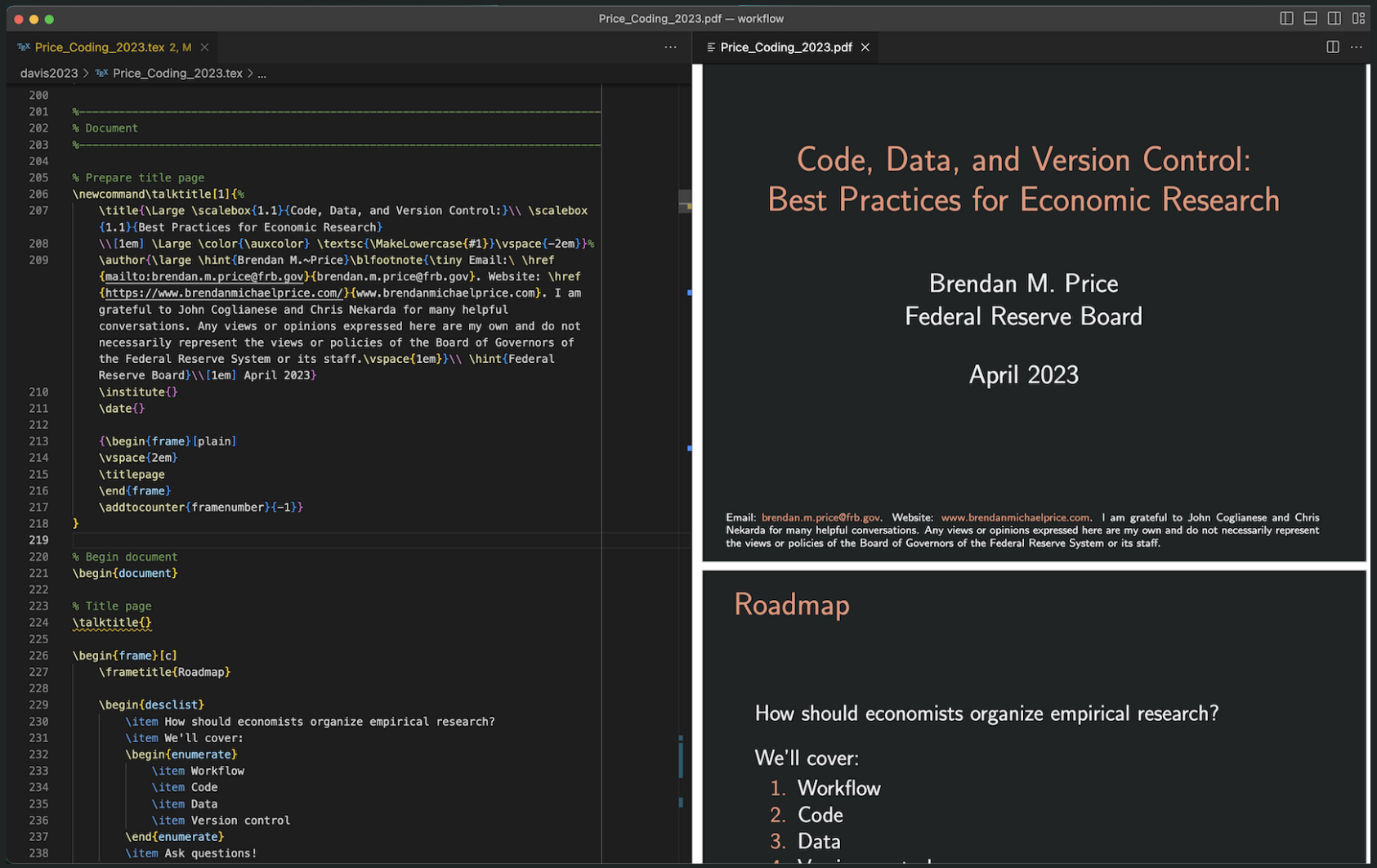
Highly recommended: Visual Studio Code

- Superb editing (syntax highlighting, multi-cursors)
- Integrated terminals, support for Git and LaTeX

VSCode: integrated terminal running Stata



VSCode: integrated LaTeX compilation



Go remote?

You may have access to a research server

Many pros . . .

- Faster processing
- Persistent sessions
- Shared access
- Regular backups

. . . but some cons

- Reliance on internet
- Server downtime
- Limited privileges
- May be harder to use GUIs

Learn a little Linux

Most servers run Linux*—so know the basics

- Navigation: `pwd`, `cd`, `ls`, `cp`, `mv`, `rm`, `mkdir`
- Permissions: `chmod`, `chown`, `chgrp`, `umask`
- Search and substitution: `find`, `grep`, `sed`
- Miscellaneous utilities: `cat`, `echo`, `head`, `less`
- Existential questions: `whoami`, `whatis man`

Powerful combos using pipes, I/O redirection, etc.

- Locate files containing a given string:

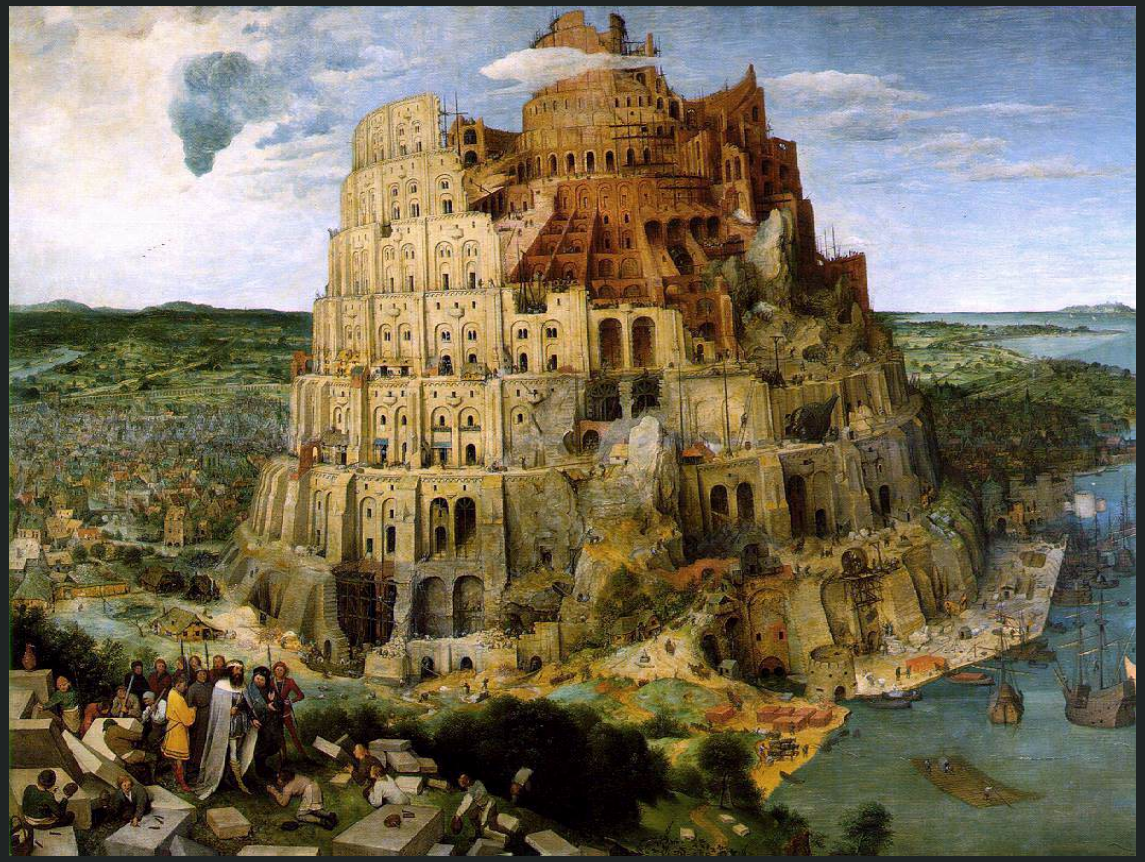
```
find haystack -name '*.py' -exec grep 'needle'
```

- Create a sorted list of lines containing a given string

```
cat counties.txt | grep 'Ohio' | sort > oh.txt
```

*MacOS is derived from Unix, so many Linux commands work here too.

Part II: Code



Brueghel the Elder, *The Tower of Babel*

Roadmap

I. Workflow

II. Code

- Desiderata
- Abstraction
- Readability
- Development
- Optimization

III. Data

IV. Version control

Desiderata

Good code is ...

- Concise
- Readable
- Robust
- Maintainable
- Extensible
- Efficient

These goals are often complementary

- Concise code runs faster
- Readable code is easier to maintain

Philosophy of continuous improvement

The root of all evil

The road to hell is paved with repetitive code

- Cut-and-paste within files
- Recycling across files

Curse of dimensionality

- Many groups (2 sexes $\times$ 3 age bins $\times$ ...)
- Many specs (raw, controls, FEs, more FEs ...)
- $\Longrightarrow$ Exponential growth

The horror, the horror

- Miserable to read, verify, debug
- Costly, error-prone to modify, extend

Automate repeated code

Abstract from repeated elements

- Encase repeated code blocks in loops
- Store repeated strings in macros
- Move repeated functionality into subroutines

Find the common threads

- Substantial overlap between `a`, `b`, `c`
- Loop over `a`, `b`, `c`
- Use conditionals to handle non-overlaps

Slimmer code, clearer logic

Abstraction in action

```
* Loop over sex
foreach f of numlist 0 1 {
    * Loop over outcome variables
    foreach yvar of varlist emp ump nlf lfe {
        * Specify controls and weights
        if "`yvar'" == "lfe" {
            local controls D.tmspline* D.weeks_elapsed
            local wtvar wtraked
        }
        else {
            local controls tmspline* weeks_elapsed
            local wtvar wtfinl
        }

        * Run the specification and save the estimates to disk
        quietly ivreg2 `yvar' ib5.month `controls' if female == `f' ///
            [aw = `wtvar'], bw($bandwidth) robust small
        process_estimates, path("share/overall") model("f`f'_`yvar'")
    }
}
```

Source: Price and Wasserman (2022).

Don't hardcode

Hardcoding = writing a literal instead of a variable

- User-specific filepaths
- Start/end of sample period
- Income thresholds

Main problem: multiple instances

- Annoying to change
- Hard to track down
- Hard to keep in sync

Obscures the logic, impedes readability

Instead: define variables in prominent places

- `main.do`, file header, `params.txt`

Write readable code

Readable code is easier to . . .

- Understand
- Debug
- Maintain
- Extend

The basic ingredients:

- Brevity balanced with clarity
- Good nomenclature
- Clear documentation
- Stylistic consistency

Be brief . . .

"Omit needless words."—Strunk and White

- Less to read, search, maintain, debug
- Better starting point for recycles

Tips for brevity:

- Automate extensively
- Look for one-liners
- Cut vestigial code

Fluency pays, as in this Stata example:

```
merge pid using cps.dta
assert _merge == 2 | _merge == 3
keep if _merge == 3
drop _merge
```

$\Longrightarrow$ `merge pid using cps.dta, assert(2 3) keep(3) nogen`

. . . but not overly brief

This is good:

```
gen sep_type = .
replace sep_type = 1 if sep == 1 & unemp == 1
replace sep_type = 2 if sep == 1 & nlf == 1
```

This is more compact, but harder to read:

```
gen sep_type = 1 if sep == 1 & unemp == 1
replace sep_type = 2 if sep == 1 & nlf == 1
```

And clever one-liners are not always best:

```
gen sep_type = unemp + 2 * nlf if sep == 1
```

Exploit visual parallels

Visually aligned code is easier to read:*

```
gen topcode = .
replace topcode =  999    if inrange(year, 1982, 1988)
replace topcode = 1923    if inrange(year, 1989, 1997)
replace topcode = 2884.61 if inrange(year, 1998, .)
```

Compare:

```
gen topcode = 999 if inrange(year, 1982, 1988)
replace topcode = 1923 if inrange(year, 1989, 1997)
replace topcode = 2884.61 if year >= 1998
```

Give related variables same prefixes, equal-length names

- Standardized prefixes $\Longrightarrow$ easy wildcard matching
- Standardized length $\Longrightarrow$ visual alignment

*Multiple spaces pair poorly with tab-indented code, since text editors expand tab indents to differing numbers of spaces.

Balance number vs. length of scripts

Each script should form a logical whole

- Unit of execution
- Locus of comprehension

More files or long files?

- Clutter vs. clarity
- Modular execution
- Ease of tracing version history

Rule of thumb: $>$500 lines feels long

A distribution of script lengths

Looked at a recent project . . .

```
find ./code -name '*.do' -exec wc -l {} | sort
```

Out of 39 code files:

- 12 files in `code/build`, 27 files in `code/share`
- 6 files under 100 lines, 2 files over 500 lines

My central tendency is 100–300 lines

Personal preference—but avoid bloat

Document for structure and clarity

Include a file header

- Purpose of the file
- Dependencies, caveats, known issues
- Version control handles author, date

Use section headers

- Breaks code into visually distinct units

Write informative comments

- Tautologous: `* Keep data from 1994 onward`
- Enlightening: `* Keep data post-CPS redesign`

Maintain comments as you would code

- Otherwise: code/comments contradict

Adopt a consistent style

Style encompasses:

- Naming conventions
- White space conventions
- Command abbreviations
- Preferred commands, approaches

No arguing about taste . . . but be consistent

- Easier to read own, others' code
- Easier to search for strings/patterns
- Easier to remember object names
- Easier to recycle across projects

Find a style guide for your language

Developing code

Sometimes makes sense to start rough . . .

- Ephemeral code
- Prototyping
- Time pressure
- Learning a new language

. . . but polish sooner rather than later

- Interactive $\rightarrow$ scripted
- Repetitive $\rightarrow$ automated
- Hardcoded $\rightarrow$ flexible
- Inefficient $\rightarrow$ optimized

Edit, edit, edit

Optimizing code

Two goals: efficient runtime, efficient storage

Theoretical trade-offs . . . but be on the Pareto frontier

- Space seldom binds
- But big files are slow and unwieldy

Locate and address bottlenecks

- Gentzkow and Shapiro: "profile slow code relentlessly"
- Develop a feel for fast and slow
- Use timers to record execution time

The need for speed

The sloth's excuse: "I'll only run it once"

Lots of reasons to rerun code:

- Ensuring it still works
- Incorporating new data
- Revisiting choices
- Purging artifacts
- Recycling across projects

Faster code $\implies$ quicker iteration

- Editing for readability
- Cleaning additional variables
- Modifying sample restrictions

Quicker code

Structure the data for speed

- Use minimal storage types
- Sort with an eye to future merges
- Operate on aggregates when you can

Leverage language

- Find faster commands, paradigms
- Farm out slow tasks to a faster language

Use intermediate files (judiciously)

- Store slow-to-build extracts
- Store regression estimates

Toggle slow code on/off (via flags, not comments)

Part III: Data

Brueghel the Elder, *Hunters in the Snow*

Roadmap

I. Workflow

II. Code

III. Data

- Provenance
- Data preparation
- Data validation
- Data analysis

IV. Version control

Provenance

Keep track of data provenance

- So you can re-download if needed
- So replicators can retrace your steps

Record where/how you got the source data

- Website linking to data extracts
- Exact URLs for direct downloads
- Instructions for navigating interface
- Accompanying documentation

Record *when* you got the data

- In case you later lose access
- In case data are revised over time

Protect the raw data

Keep the raw data pristine

- Store separately from derived files
- Never overwrite raw data(!)
- Limit and document file renames
  (but fine to store compressed)

Rare exception: prohibitively large files

- Retain subset of observations or variables
- Codify steps to downsize file
- Preprocess no more than necessary
- Save smaller file

Apart from that: clean only via code

Data preparation

Understand the data structure

- Unique identifiers
- Hierarchical relationships
- Completeness, missings
- Redundancies

Simplify and restructure

- Get rid of clutter
- Deal with inconsistencies
- Harmonize variables
- Improve nomenclature

Store cleaned extracts

Keep what you need

Raw data files contain lots of clutter

- Variables you'll never use
- Messy or gratuitous labels
- Early years with incomplete data

Keep what you need—and will bother to clean

- Economize on space (and speed)
- Retain what you can vouch for
- Can always reintroduce later

Eliminate redundancies

Raw data often contain redundant information

- Extra rows for state-wide totals
- Transformations of other variables

Verify redundancies, then eliminate them

- Make sure the data are internally consistent
- Drop anything you can recompute later

What if the data *aren't* internally consistent?

- Document any inconsistencies you find
- Deal with them on a case-by-case basis

Create clean extracts

Construct a minimal set of derived extracts

- Semi-cleaned extracts for data validation
- Fully cleaned extracts ready for estimation

Invest in high-quality extracts

- Unique identifiers
- Efficient data structures
- Clear, concise names and labels
- Sort by the unique IDs

Defer niche data processing further downstream

- Store `emp`—but compute `ln(emp)` on the fly

Data validation

It's (really) easy to make mistakes

- Raw data are wrong
- Raw data are right, but not what you think
- Typos, bad merges, floating-point issues ...

Solution: systematic data validation

- Reveals errors and false assumptions
- The sooner the better

Side benefits:

- Be better equipped to answer seminar questions
- Stumble on new ideas or identification strategies

Sweat the small stuff

Temptation: ignoring "small" bugs

- Issue only applies to a few observations
- Results make sense despite known bug

Most errors are canaries in coal mines

- Misunderstanding the data
- Misunderstanding the language

"Small" bugs often get amplified

Do not rest easy till you sort them out

Set tripwires

Data entail logical restrictions

- Additivities (population = sum across ages)
- Valid ranges ($0 \leq$ earnings $\leq$ income)
- Time invariance (birth state is fixed)

Set "tripwires": code crashes if an assertion fails

- Check your understanding of the data
- Document when identities do/don't hold
  (`assert popt == popm + popf if year >= 2003`)

Keep tripwires on—not commented out

- Old assumptions may cease to hold
- Add new data, redefine sample, update package ...

Know thy data

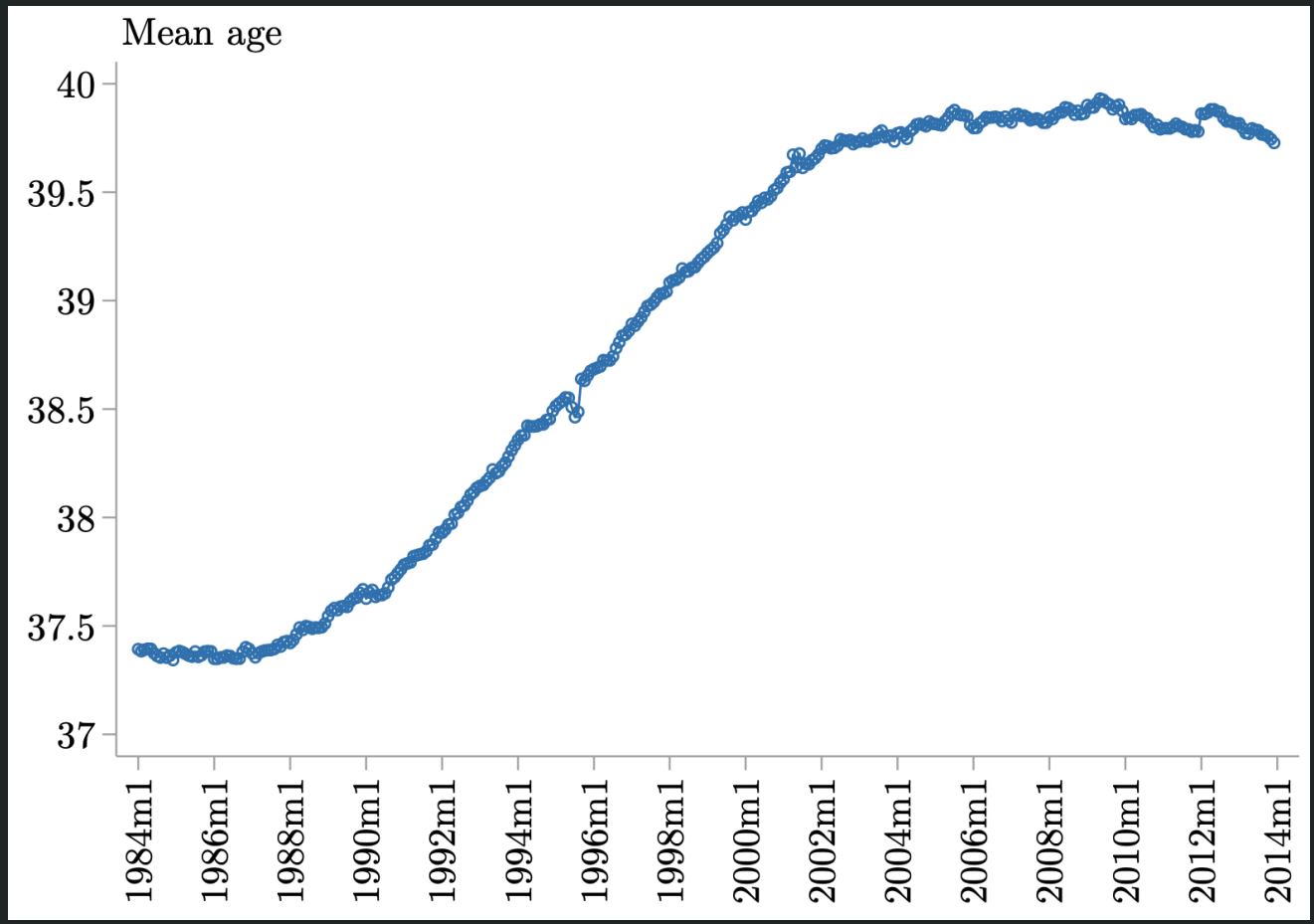
Look at the data!

- Browse individual observations
- Inspect means, SDs, correlations
- Plot the data over time

Ask yourself:

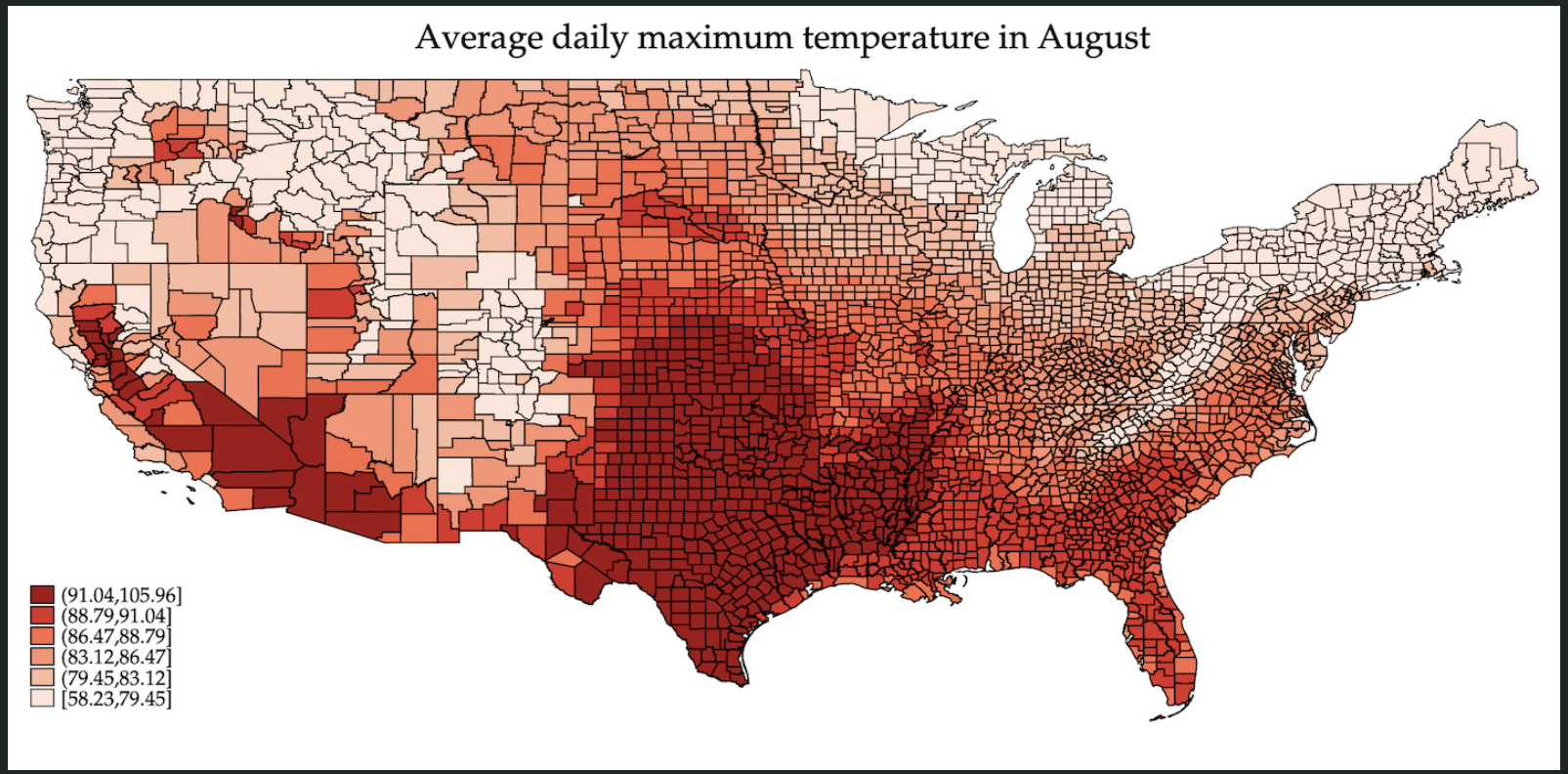
- Are the patterns plausible?
- Are there breaks in the data?
- Are there anomalies or outliers?
- Do expected features manifest?

Smooth series should evolve smoothly



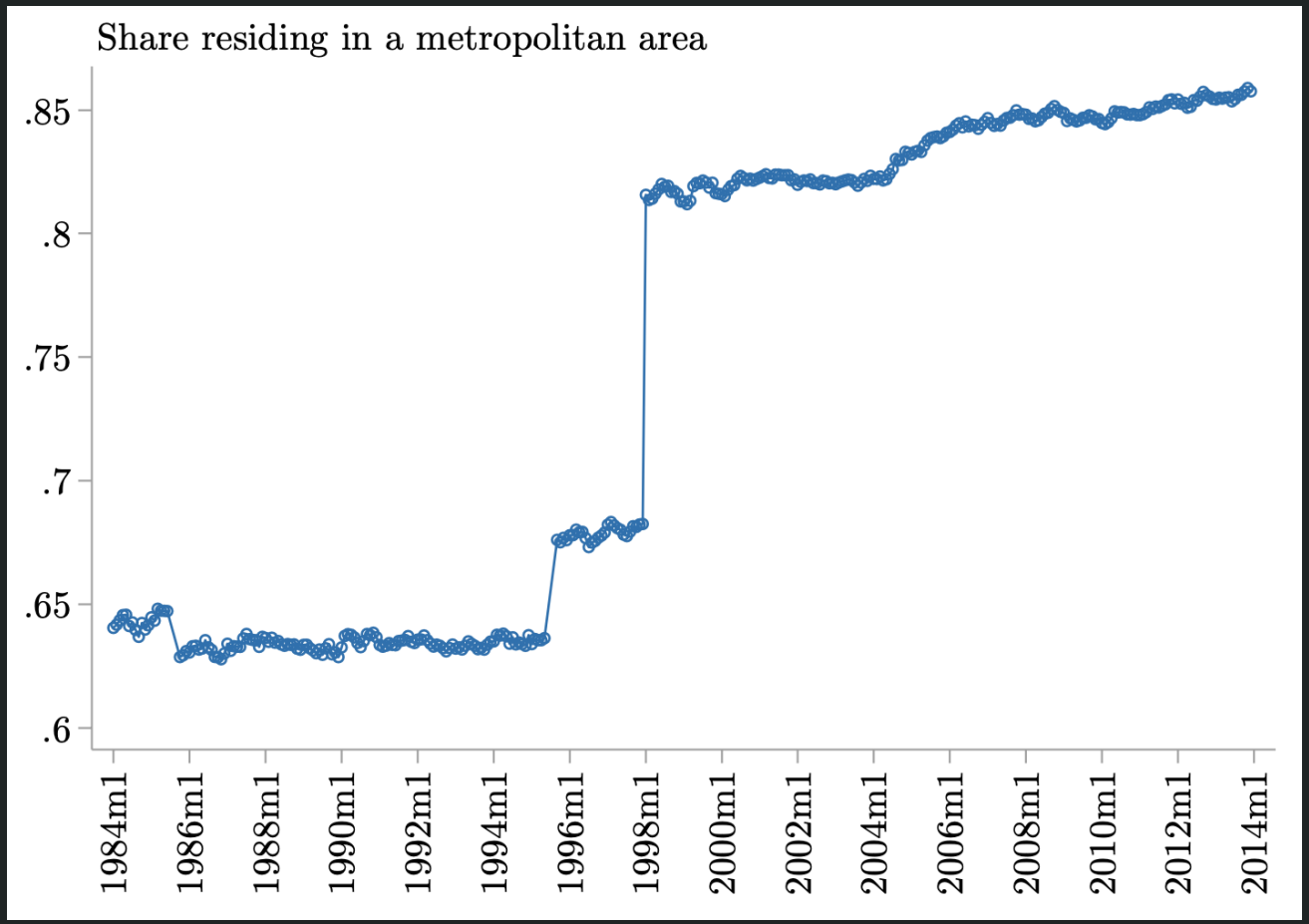
Source: IPUMS CPS data on prime-age US workers.

Hot places should be hot



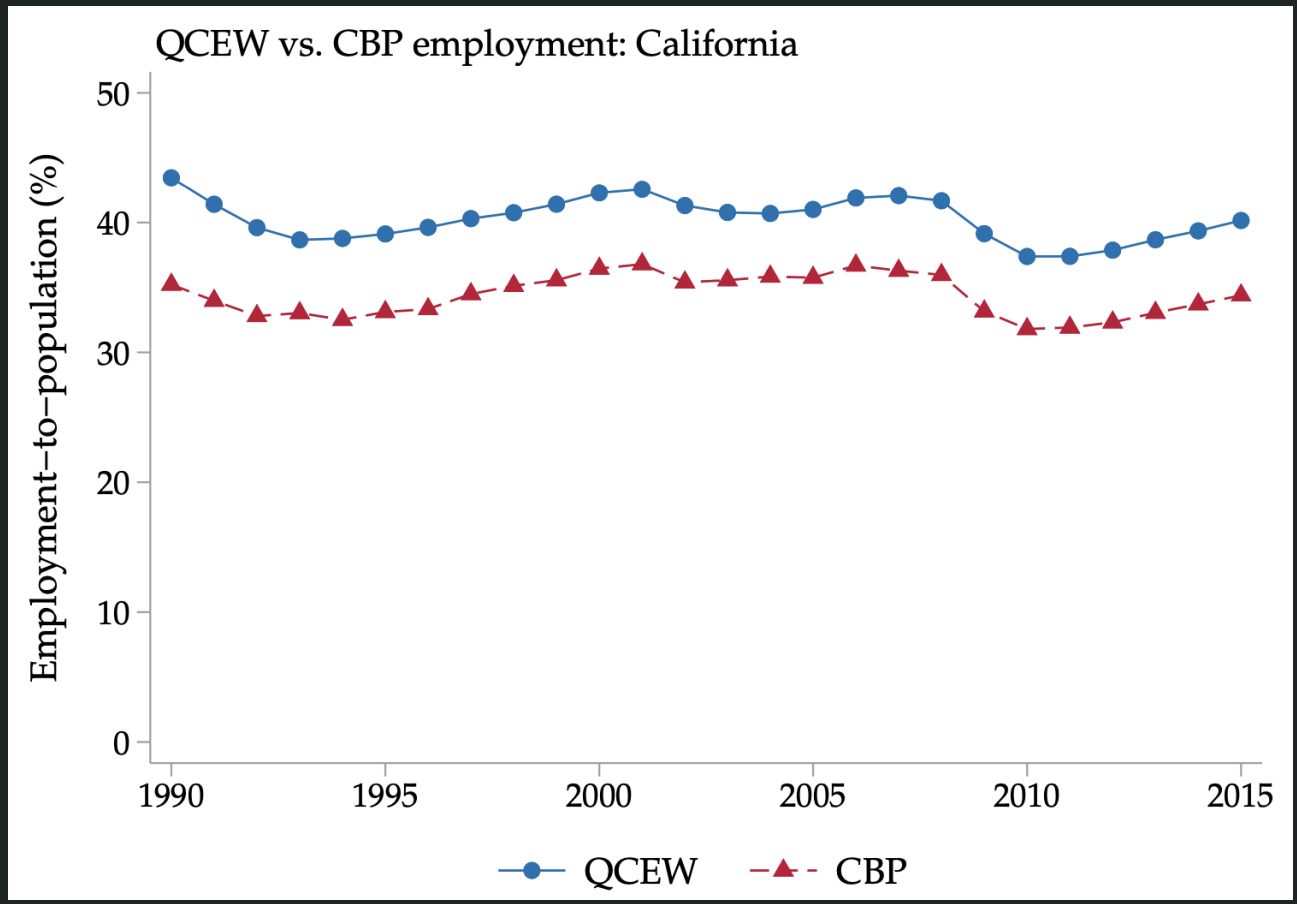
Source: North American Land Data Assimilation System, 1979–2011.

Plotting the data often reveals data seams



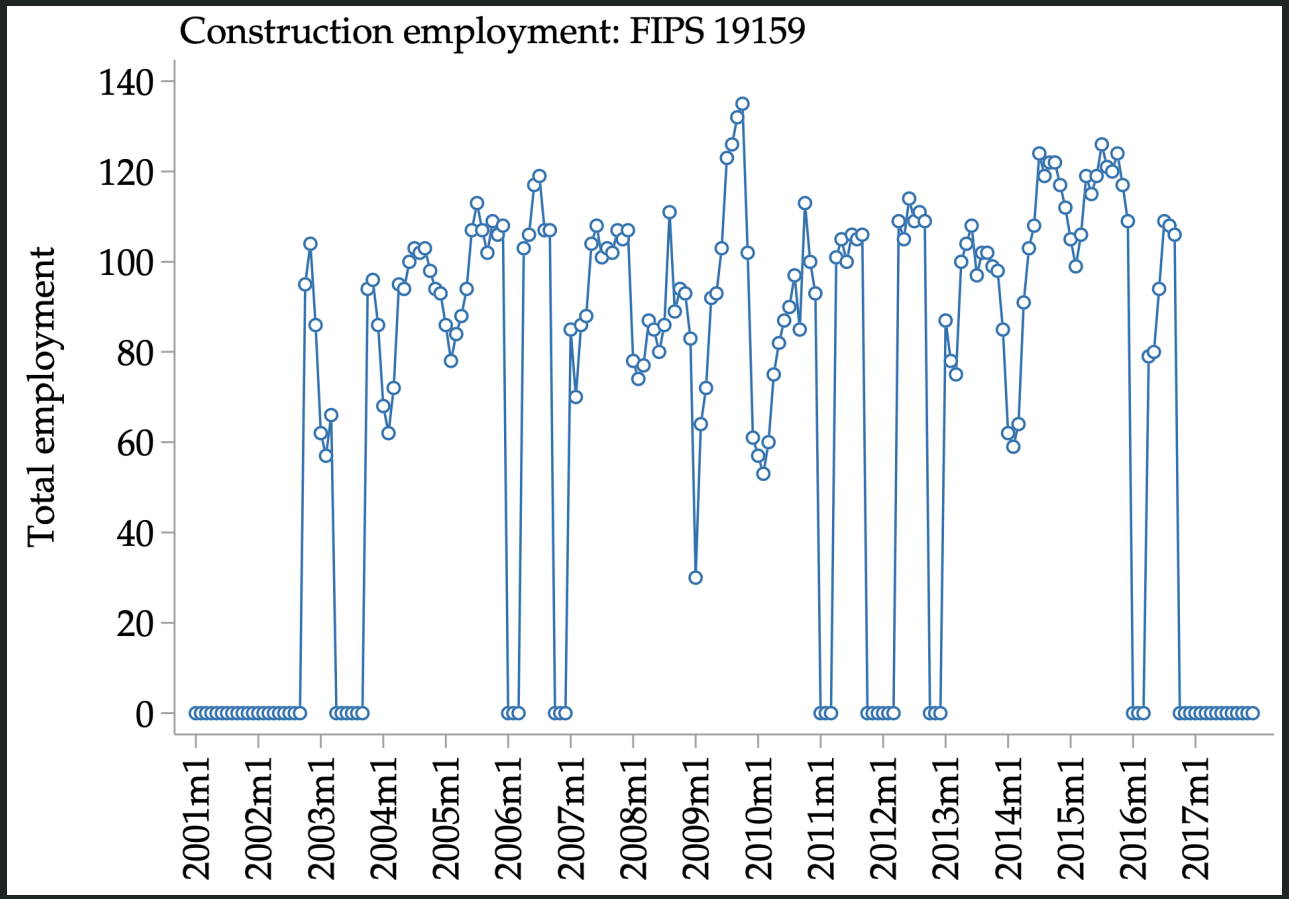
Source: IPUMS CPS data on prime-age US workers.

Validate one dataset against another



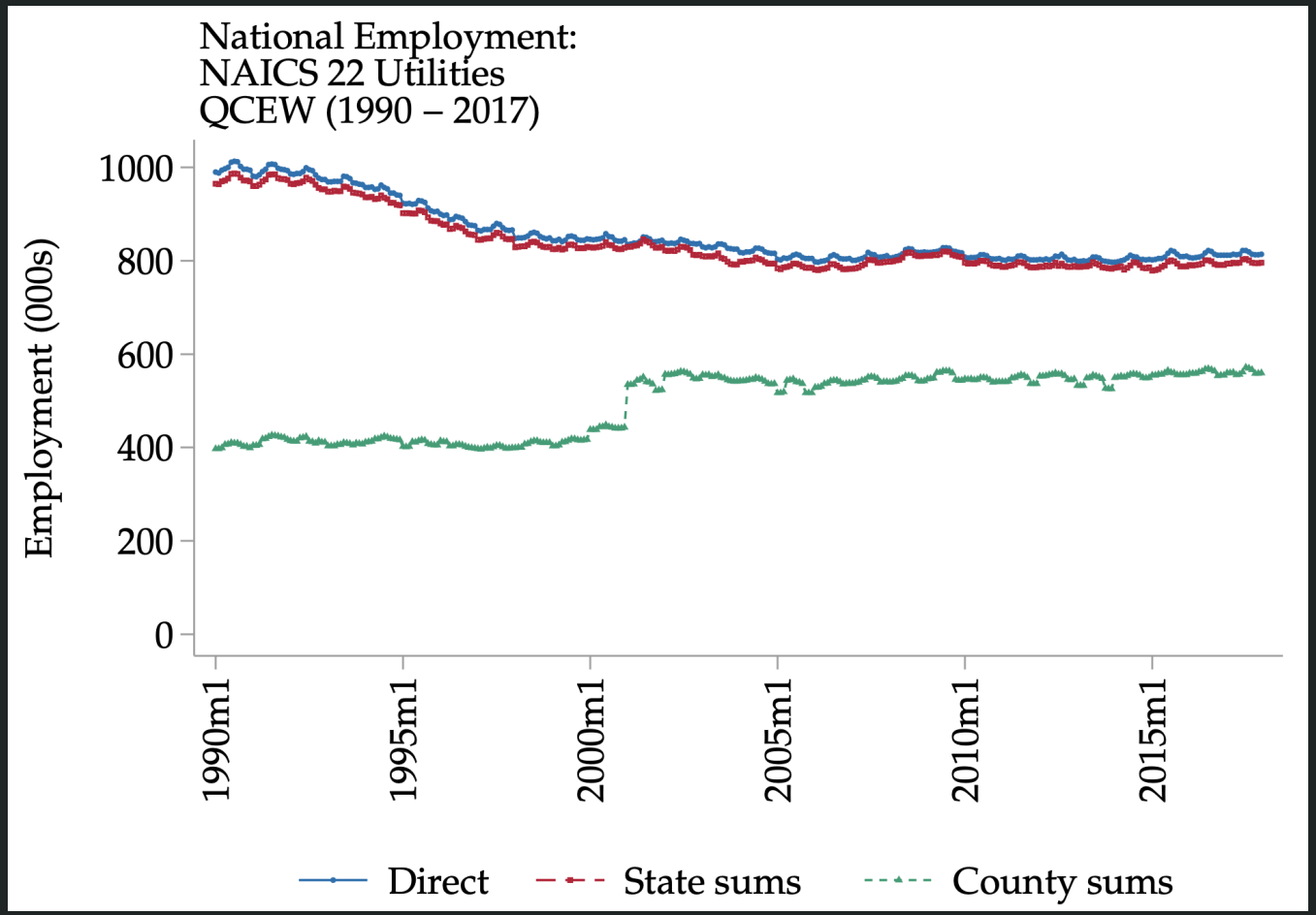
Source: Quarterly Census of Employment and Wages; County Business Patterns.

Visualize data suppressions



Source: Quarterly Census of Employment and Wages.

Examine data at different levels of aggregation



Source: Quarterly Census of Employment and Wages.

Lower the marginal cost of data analysis

Effective workflows yield . . .

- Quicker turnaround
- Fewer mistakes

Benefits scale with project complexity, duration

Quicker turnaround

Best practices save you time

- Automation $\Longrightarrow$ coding time
- Optimization $\Longrightarrow$ computational time
- Organization $\Longrightarrow$ search time

Faster turnaround means ...

- Cheaper data exploration
- Easier analytical modifications
- Less slog, more momentum
- Timelier feedback

Especially important with big, hard-to-access data

Fewer mistakes

Mistakes are costly if discovered . . .

- Backtracking, lost time
- Embarrassment, lost credibility
- Journal rejection, retraction

. . . but also if undiscovered

- Promising pilot flops at scale
- Measurement error attenuates result
- Erroneous science shapes the debate

Avoid unforced errors

Part IV: Version control

Brueghel the Elder, *Big Fish Eat Little Fish*

Roadmap

I. Workflow

II. Code

III. Data

IV. Version control

- Version chaos
- Version control in a nutshell
- Version control benefits
- Learning Git

Version chaos

We've all done it:

- `atus_v1.do`, `atus_v17.do`, `./v3/atus.do`
- `cps_bp.do`, `cps_FINAL_bp.do`, `cps_jul_bbag.do`

Confusion, error, terror, and strife

- Which version is authoritative?
- Who changed this? When?? WHY???
- How was the directory organized as of July?
- How does `v3` of one file relate to `v3` of another?
- When should I create a new version?
- Do I dare disturb the universe?

Even worse: multiple authors, machine migration

Poor man's version control

You might choose to go low-tech

- Git is unavailable
- Git is too hard(?!)
- Coauthors sharpening pitchforks

If you must: good organization helps

- Coherent, stable directory structure
- Readable, streamlined code

Archive the entire codebase at key junctures

- Rerun everything to ensure it's in sync
- Keep everything lightweight (`code`, `logs`, `output`)
- Apply a sortable date-stamp (`YYYYMMDD`)

Actual version control

Version control: a record of revisions to a set of files

- User saves snapshots of code and related files
- Easy to recover code from any given snapshot
- Easy to see how, when, by whom a file was edited
- Ideal for both solo and collaborative work

Everybody uses Git

- Versatile, reliable, fast, space-efficient

Usually paired with GitHub or GitLab

- Syncing across users, devices
- Discussion threads, project management

Some Git lingo

repository: a project containing version-controlled files

clone: a copy of the repo containing full project history

- Local clone on each coder's machine
- Remote clone on GitHub or GitLab

tracking: designating a (code) file for inclusion in the repo

commit: a snapshot of all tracked files at a particular time

pushing: uploading commits to GitHub/GitLab

pulling: downloading commits from GitHub/GitLab

The basic Git workflow

Initial configuration

- Set up a project directory as usual
- Initialize a Git repo (creates hidden `.git`)
- Link it to GitHub or GitLab

Commit and push an initial set of files

- Commit ID, author, timestamp, commit message

Further commits

- Create and edit files as usual
- Commit what/when you want to
- Tell Git what to ignore (derived files)

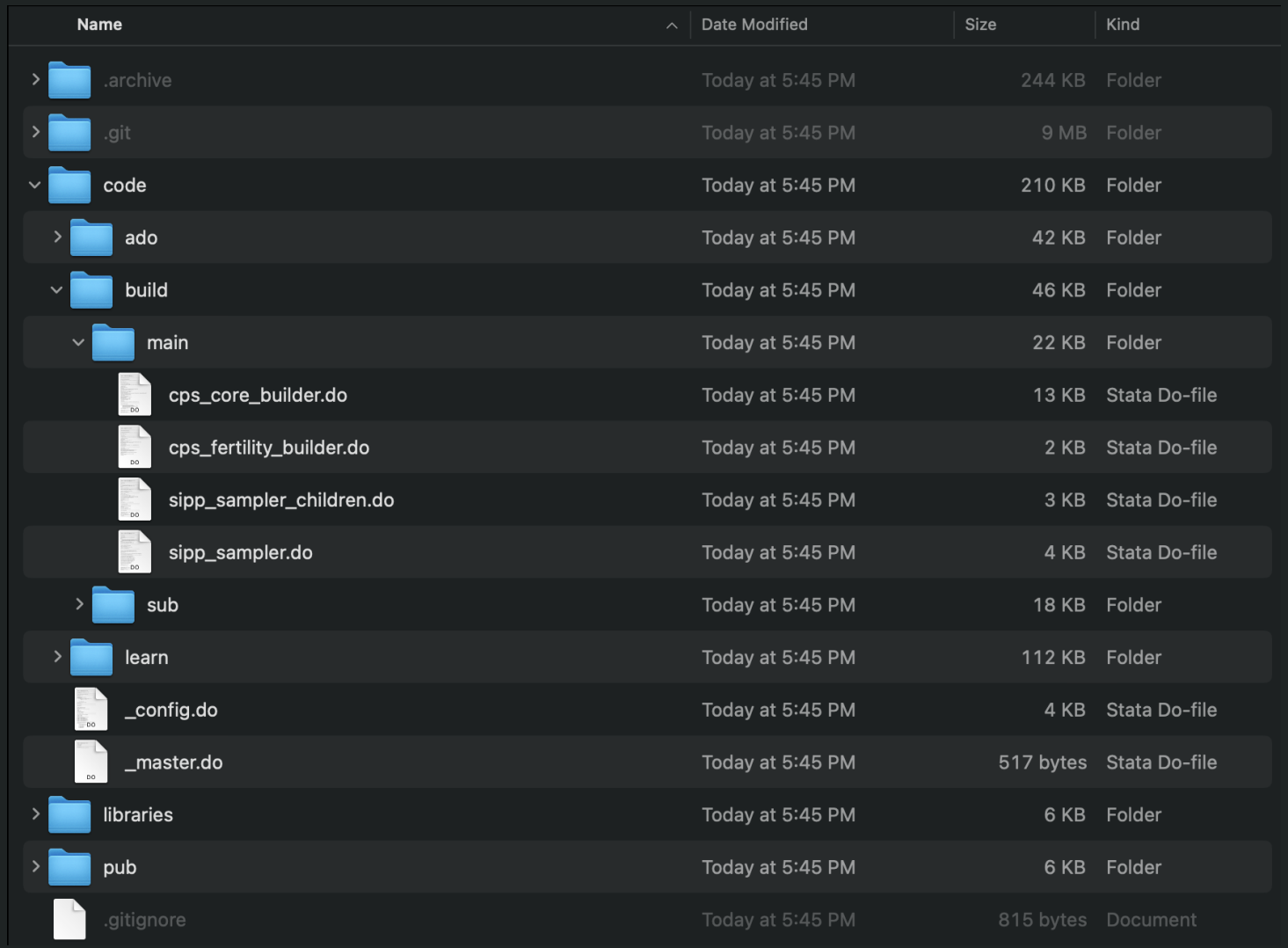
Inspect or revert to old versions as needed

A sample Git log

```
* | 6a4a6dc 2020-12-03 21:53:43 Merge branch 'develop'
|\|
| * 2199522 2020-12-03 21:41:20 Add analysis to guide our definition of mothers vs. non-mothers
| * 9bdcdba 2020-12-03 21:13:45 Update _main.do to execute additional .do files
| * 8897ac4 2020-12-03 21:10:06 Extend summer_drop.do sample period (1976-2019, instead of 1976-2017)
| * accbfe3 2020-12-03 20:32:52 Add code to construct our baseline, prime-age CPS estimation sample
* | 080cb98 2020-12-03 19:13:54 Merge branch 'develop' into 'master'
|\|
| * 082c567 2020-12-02 22:17:02 Assess detrending via restricted cubic splines
| * 0b22ab2 2020-12-02 18:29:32 Drop child observations with invalid personal identifiers
| * 8d80e66 2020-12-02 12:27:44 Fix bug in filepath for style files
* | d80bb5c 2020-12-02 16:44:34 Merge branch 'develop' into 'master'
|\|
| * b2d2382 2020-12-02 10:52:14 Add code to plot CPS variables over time
| * 549c090 2020-12-02 10:40:53 Add Stata style files
| * 9b62305 2020-12-01 22:31:34 Update cps_fertility_builder.do
| * 38f0e16 2020-12-01 22:16:19 Update _config.do to make code/ado/ssc/ if needed
| * 68f0379 2020-12-01 22:00:16 Update code to clean CPS basic monthly files
| * 19c6a23 2020-12-01 13:57:17 Incorporate updated CPS extracts
|/
* dd23431 2020-11-30 17:15:20 Change file nomenclature
* 44b9b49 2020-11-30 16:31:31 Add "replace" option to ssc install commands
* 81a4c0f 2020-09-25 20:55:45 (tag: v0.0) Incorporate Davis-era codebase
* 274d918 2020-06-14 22:20:21 Adapting old analyses to the new build
* ab72ae2 2020-06-14 20:37:45 Renaming folders, updating some files
* 071a6c1 2020-03-16 10:07:30 Updating CPS cleaning code (in progress)
* eded3e5 2020-03-07 22:59:38 Basic configuration
* 7d14d78 2020-03-07 21:40:22 Initial commit: utilities and file structure
```

Source: Price and Wasserman (2022).

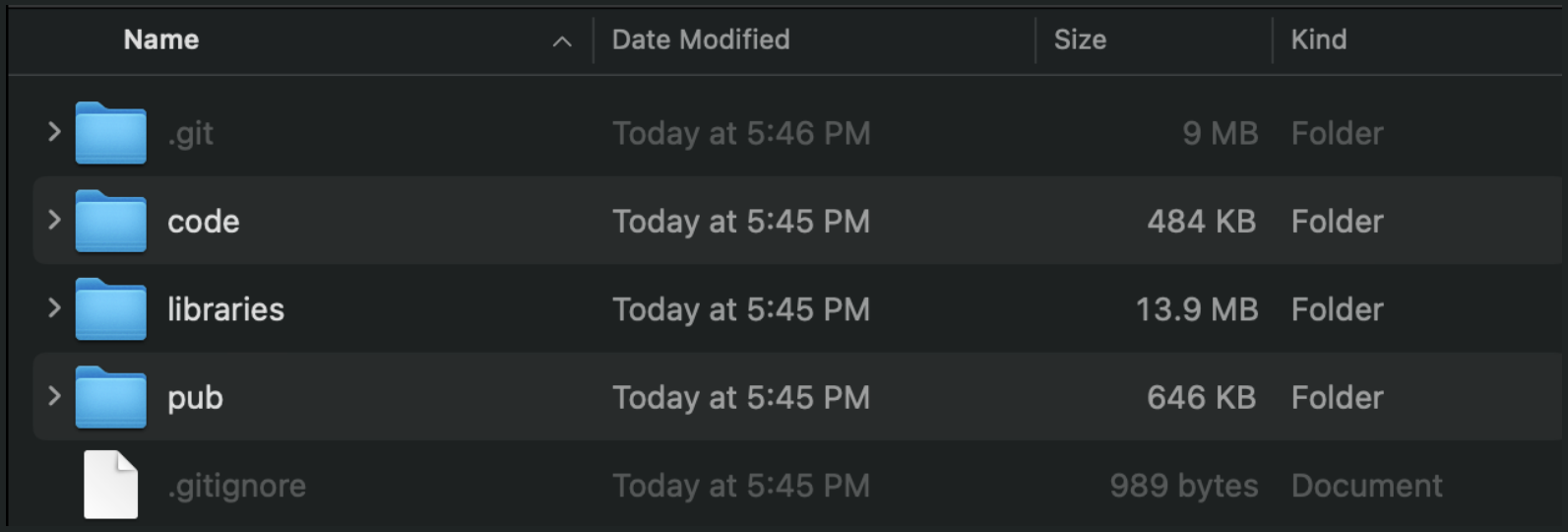
Meet Mr. 81a4c0f



Name	Date Modified	Size	Kind
.archive	Today at 5:45 PM	244 KB	Folder
.git	Today at 5:45 PM	9 MB	Folder
code	Today at 5:45 PM	210 KB	Folder
ado	Today at 5:45 PM	42 KB	Folder
build	Today at 5:45 PM	46 KB	Folder
main	Today at 5:45 PM	22 KB	Folder
cps_core_builder.do	Today at 5:45 PM	13 KB	Stata Do-file
cps_fertility_builder.do	Today at 5:45 PM	2 KB	Stata Do-file
sipp_sampler_children.do	Today at 5:45 PM	3 KB	Stata Do-file
sipp_sampler.do	Today at 5:45 PM	4 KB	Stata Do-file
sub	Today at 5:45 PM	18 KB	Folder
learn	Today at 5:45 PM	112 KB	Folder
_config.do	Today at 5:45 PM	4 KB	Stata Do-file
_master.do	Today at 5:45 PM	517 bytes	Stata Do-file
libraries	Today at 5:45 PM	6 KB	Folder
pub	Today at 5:45 PM	6 KB	Folder
.gitignore	Today at 5:45 PM	815 bytes	Document

Source: Price and Wasserman (2022).

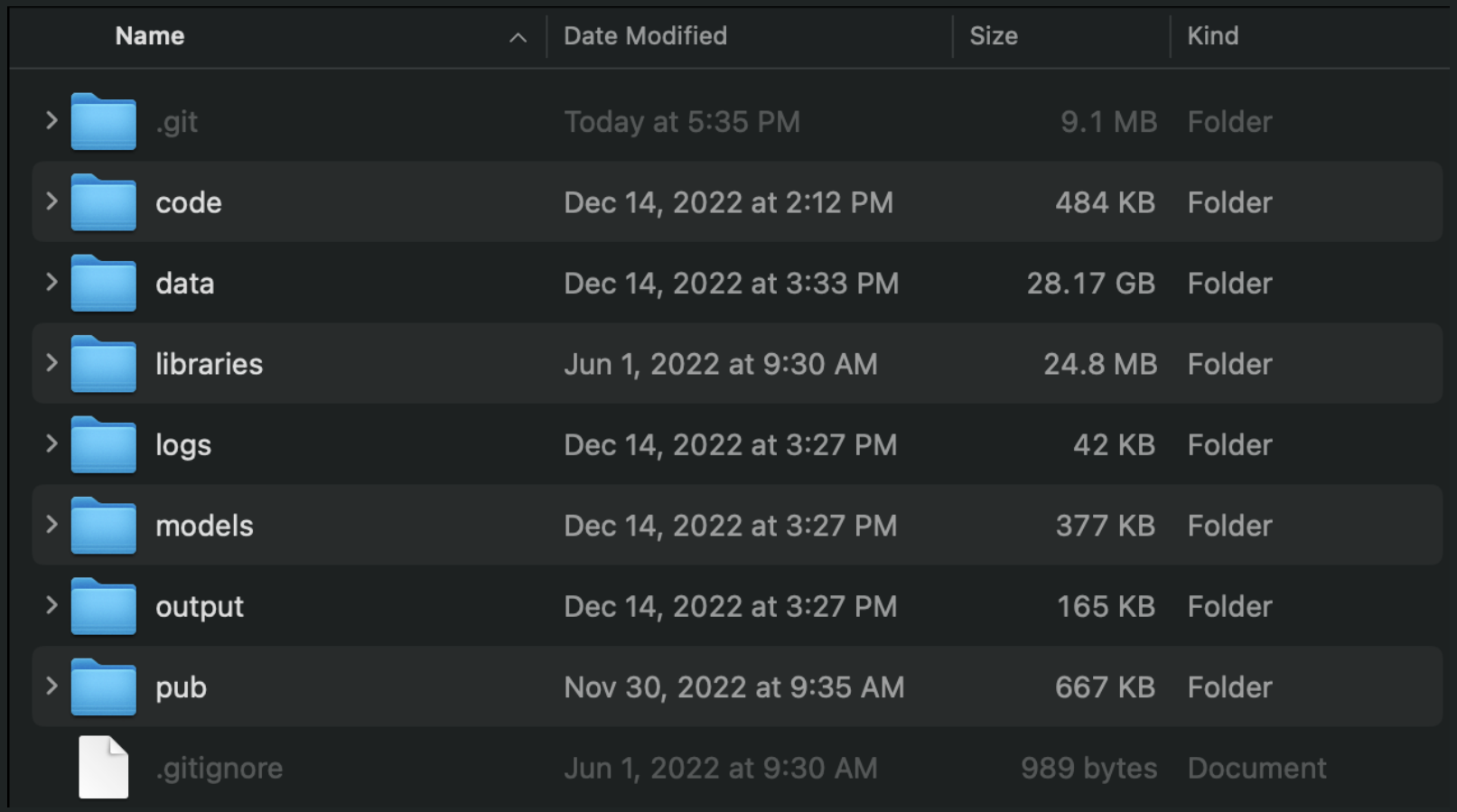
The latest version: tracked files only



Name	Date Modified	Size	Kind
.git	Today at 5:46 PM	9 MB	Folder
code	Today at 5:45 PM	484 KB	Folder
libraries	Today at 5:45 PM	13.9 MB	Folder
pub	Today at 5:45 PM	646 KB	Folder
.gitignore	Today at 5:45 PM	989 bytes	Document

Source: Price and Wasserman (2022).

The latest version: including derived files



Name	Date Modified	Size	Kind
.git	Today at 5:35 PM	9.1 MB	Folder
code	Dec 14, 2022 at 2:12 PM	484 KB	Folder
data	Dec 14, 2022 at 3:33 PM	28.17 GB	Folder
libraries	Jun 1, 2022 at 9:30 AM	24.8 MB	Folder
logs	Dec 14, 2022 at 3:27 PM	42 KB	Folder
models	Dec 14, 2022 at 3:27 PM	377 KB	Folder
output	Dec 14, 2022 at 3:27 PM	165 KB	Folder
pub	Nov 30, 2022 at 9:35 AM	667 KB	Folder
.gitignore	Jun 1, 2022 at 9:30 AM	989 bytes	Document

Source: Price and Wasserman (2022).

The perks of version control

Main benefit: code retrieval

- Organized archiving
- Convenient backups

Side benefit: lineage tracing

- Find all edits made to a given file
- Trace file, folder renames

Made for collaboration

- Work independently, merge together
- Link discussions to specific commits
- Share repos with the research community

Version control $\Longrightarrow$ better code

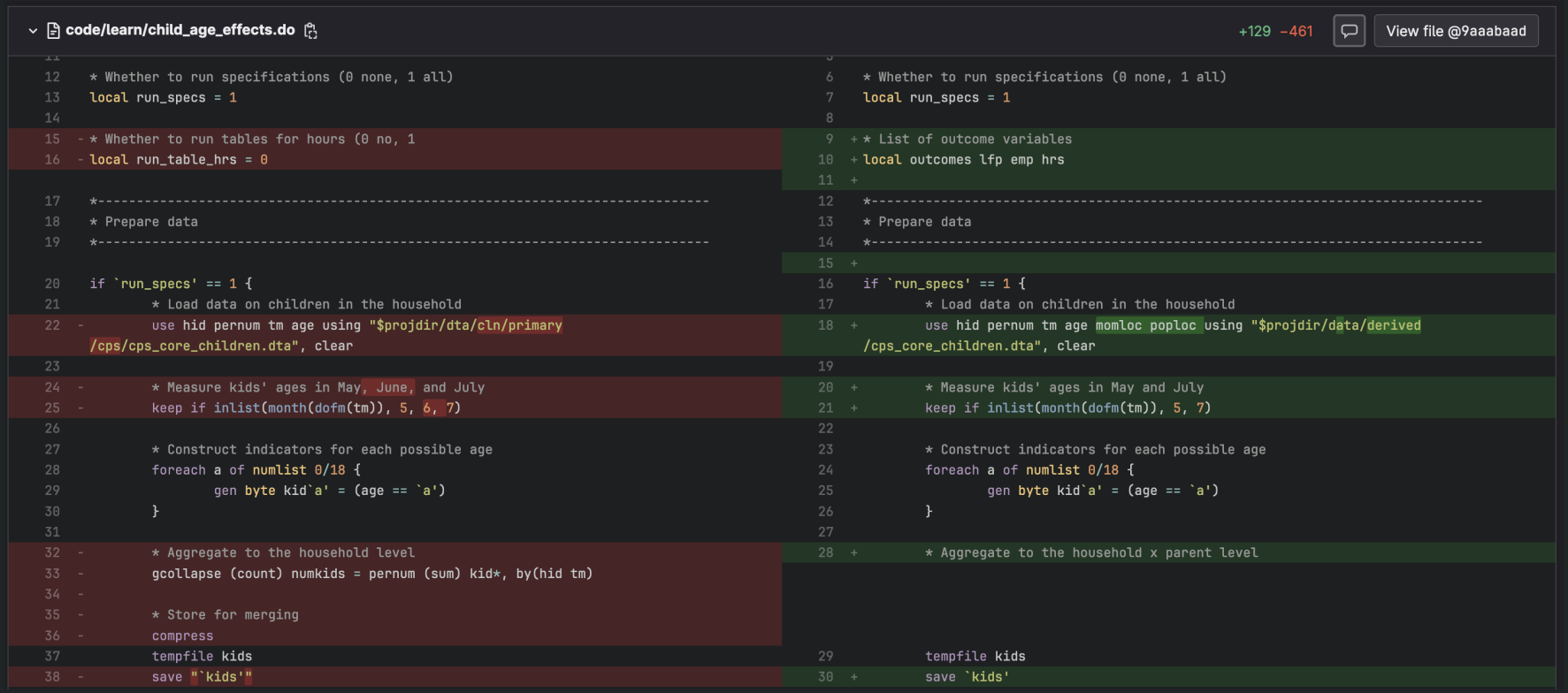
It promotes leanness

- Delete whatever you don't need now
- Easy to rerun code in a fresh clone

It disciplines your coding

- Workflow encourages modular thinking
- Easy to review edits before committing
- Easy to reverse mistakes

The power of the diff



code/learn/child_age_effects.do +129 −461 View file @9aaabaad

```
 * Whether to run specifications (0 none, 1 all)
local run_specs = 1

- * Whether to run tables for hours (0 no, 1
- local run_table_hrs = 0

*-------------------------------------------------------------------------------
* Prepare data
*-------------------------------------------------------------------------------

if `run_specs' == 1 {
        * Load data on children in the household
-       use hid pernum tm age using "$projdir/dta/cln/primary
/cps/cps_core_children.dta", clear

-       * Measure kids' ages in May, June, and July
-       keep if inlist(month(dofm(tm)), 5, 6, 7)

        * Construct indicators for each possible age
        foreach a of numlist 0/18 {
                gen byte kid`a' = (age == `a')
        }

-       * Aggregate to the household level
-       gcollapse (count) numkids = pernum (sum) kid*, by(hid tm)
-
-       * Store for merging
-       compress
        tempfile kids
-       save "`kids'"
```

```
 * Whether to run specifications (0 none, 1 all)
local run_specs = 1

+ * List of outcome variables
+ local outcomes lfp emp hrs
+
*-------------------------------------------------------------------------------
* Prepare data
*-------------------------------------------------------------------------------
+
if `run_specs' == 1 {
        * Load data on children in the household
+       use hid pernum tm age momloc poploc using "$projdir/data/derived
/cps_core_children.dta", clear

+       * Measure kids' ages in May and July
+       keep if inlist(month(dofm(tm)), 5, 7)

        * Construct indicators for each possible age
        foreach a of numlist 0/18 {
                gen byte kid`a' = (age == `a')
        }

+       * Aggregate to the household x parent level




        tempfile kids
+       save `kids'
```

Source: Price and Wasserman (2022).

How to learn Git

Git is well worth learning

- Hugely helpful for writing a dissertation
- Widely used in academia, policy, industry

Learning curve is a bit steep

- Start slow, stick with it
- Try it out in a solo project
- Over time: learn new tricks

Lots of good resources online

- But befriend an emergency contact

Postscript

Brueghel the Elder, *The Land of Cockaigne*

The big picture

Main message: think (hard) about workflow

Invest early in good habits

- Be organized
- Find ways to improve
- Figure out what works for you

Don't go it alone

- Talk to your classmates
- Read people's code
- Get the help you need

"Break any of these rules sooner than say anything outright barbarous."—George Orwell, *Politics and the English Language*

Further reading

Coding:

- Code and Data for the Social Sciences: A Practitioner's Guide, Matthew Gentzkow and Jesse Shapiro
- Coding for Economists, Ljubica Ristovska
- Coding Style Guide, Michael Stepner
- Best Practices for Computer Programming in Economics, Tal Gross

Version control:

- Git for Economists, Frank Pinter
- Pro Git, Scott Chacon and Ben Straub
- Version Control with Git, Jon Loeliger and Matthew McCullough

Plenty more at www.brendanmichaelprice.com