

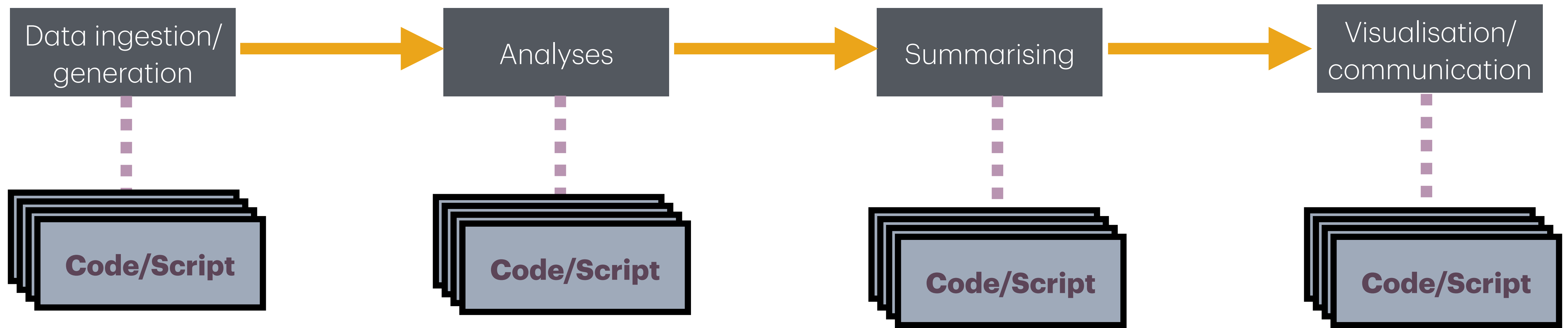
Workflow automation with GNU make

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Typical research software workflow



Questions:

- How do you keep track of what's changing and what needs to be regenerated?
 - Do you do it manually?
- How do you manage a workflow that uses > 1 programming language?

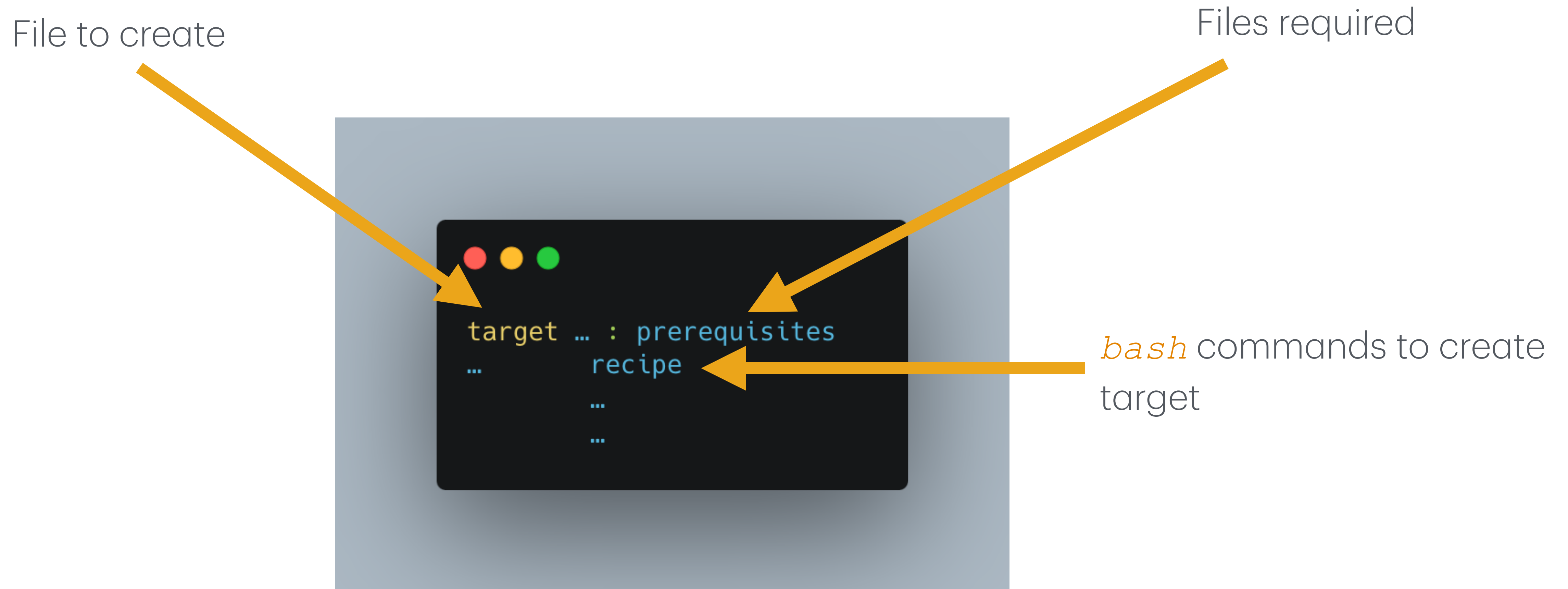
GNU make & makefiles

- *GNU make*:
 - Free open source tool for tracking/automating the generation of files from source files.
 - Ensures that all files are current.
 - Determines which files need to be updated/regenerated based on changes in source files, minimizing unnecessary rebuilds.
 - Main engine is the *makefile* (in the root directory).



Anatomy of a makefile


- *makefile*: contains rules and recipes for creating *targets* files.



makefile example

Create Figs/fig 1.pdf

Using R/fig1.R

A terminal window with a black background and three colored window control buttons (red, yellow, green) in the top-left corner. It contains two lines of text: 'Figs/fig1.pdf: R/fig1.R' and 'cd R;R CMD BATCH fig1.R'.

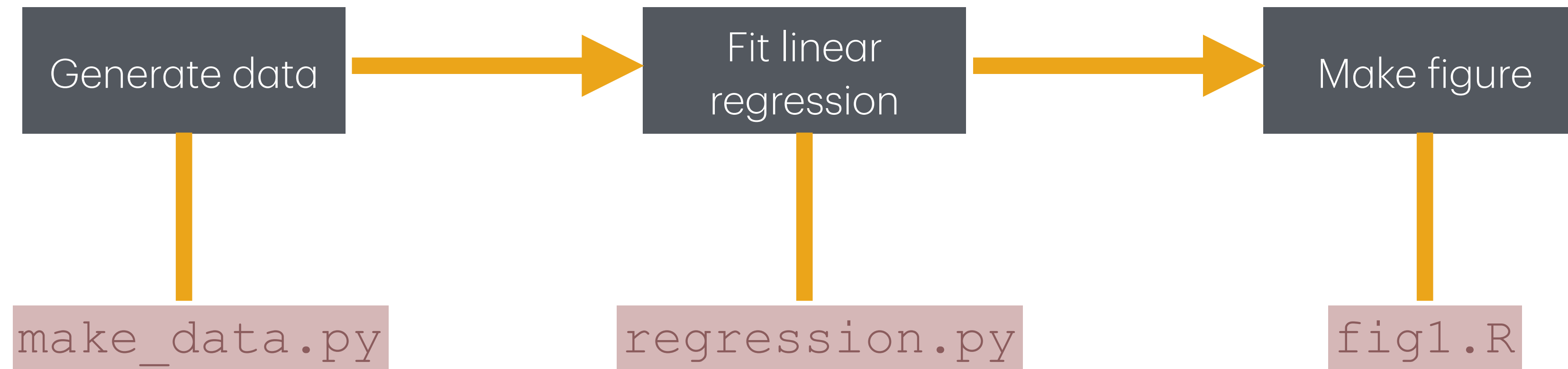
```
Figs/fig1.pdf: R/fig1.R  
cd R;R CMD BATCH fig1.R
```

By running these commands

Steps to use GNU make

- Install or check that you have *make* with `> make -version`
- Create an extension-less file in the root directory and name it *makefile*.
- Add the *make* rules
- Run `> make` in the terminal
 - **NB**: By default, the topmost rule is run, so place your main rule at the top but this can be changed.
 - You can also *make* specific targets with `> make target_name`

Demo



- Main commands in this demo:

- *> make*
- *> make -n*

GitHub repo at https://github.com/jamesmbaazam/gnumake_demo.

Immediately useful features

- Variables
- Automatic variables
- Pattern rules
- Phony targets

Similar tools

- {targets}: Only for R so doesn't handle multiple languages
- CMake: Strong alternative to GNU make but syntax and set up very different; choose your poison.

Resources to get started

- GNU Make manual
- Ode to GNU Make by Evan Mascitti
- Minimal make by Karl Broman
- AI/LLMs:
 - Co-pilot to refactor a whole codebase on GitHub
 - Ask Chatgpt | Claude | perplexity