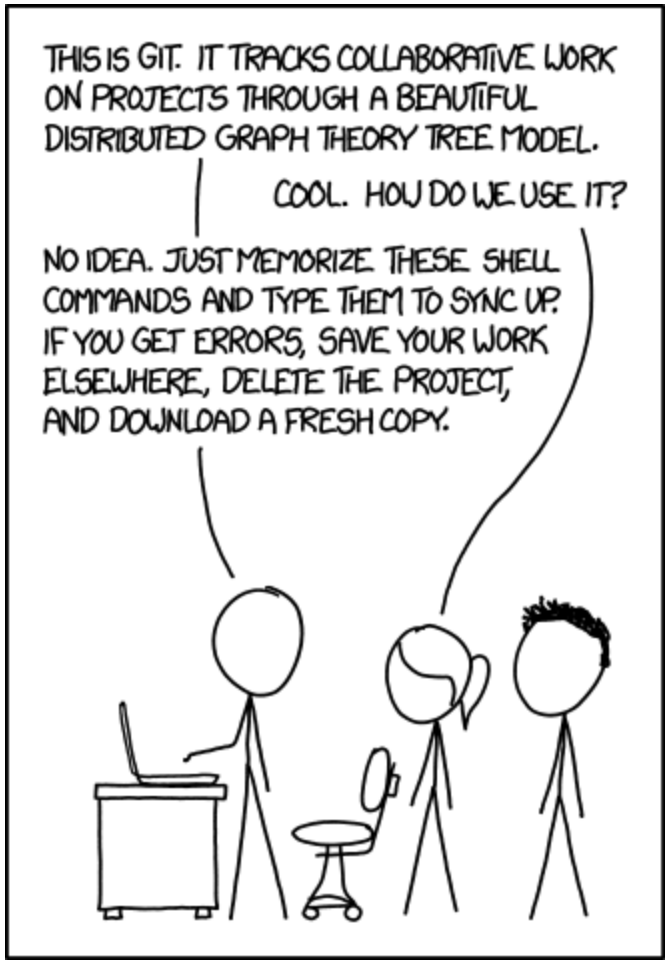
Version Control (Git)

Introduction to Version Control

- **Version Control Systems (VCSs)** track changes in files and folders.
- Useful for maintaining history and collaboration.
- Snapshot-based tracking of entire directory states.
- Metadata includes authorship, messages, and more.

Why Version Control?

- Track historical snapshots of a project.
- Log changes and reasoning behind them.
- Manage parallel branches of development.
- Resolve conflicts in concurrent development.
- Answer questions about code history.



https://missing.csail.mit.edu/

Understanding Git

- Git's interface can be confusing if approached top-down.
- Learning Git bottom-up, starting with its data model, leads to better understanding.
- Git commands manipulate the underlying data model.

Git's Data Model

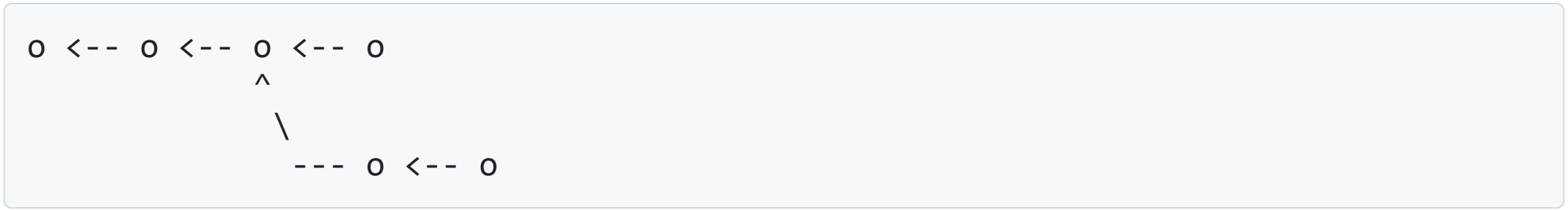
Snapshots

- **Blob**: A file.
- **Tree**: A directory mapping names to blobs or trees.
- **Commit**: A snapshot of the top-level tree with metadata.

```
<root> (tree)
|
+- foo (tree)
|  |
|  + bar.txt (blob, contents = "hello world")
|
+- baz.txt (blob, contents = "git is wonderful")
```

Modeling History: Relating Snapshots

- History in Git is a directed acyclic graph (DAG) of snapshots.
- Each commit refers to a set of parent snapshots.
- Commits are immutable; changes create new commits.



Objects and Content-Addressing

- Git stores blobs, trees, and commits as objects.
- Objects are content-addressed by their SHA-1 hash.

```
objects = map<string, object>

def store(object):
    id = sha1(object)
    objects[id] = object
```

References

- Human-readable names for SHA-1 hashes.
- Examples: `master`, `HEAD`.
- Mutable pointers to commits.

```
references = map<string, string>

def update_reference(name, id):
    references[name] = id
```

Repositories

- A Git *repository* is a collection of `objects` and `references`.
- Commands manipulate the commit DAG via objects and references.

Staging Area

- Intermediate area to specify modifications for the next commit.
- Allows for clean, selective snapshots.
- Not directly part of the data model, but essential for the interface.

Git Command-Line Interface

Basics

- `git init` : Create a new repo.
- `git status` : Current status.
- `git add <filename>` : Stage files.
- `git commit` : Create a commit.
- `git log` : Show history.

Branching and Merging

- `git branch` : List/create branches.
- `git checkout -b <name>` : Create/switch branches.
- `git merge <revision>` : Merge changes.

Remotes

- `git remote add <name> <url>` : Add remote repo.
- `git push/pull` : Send/receive changes.

Undo

- `git commit --amend` : Edit last commit.
- `git reset HEAD <file>` : Unstage file.
- `git checkout -- <file>` : Discard changes.

Advanced Git

- `git config`: Customize Git settings.
- `git add -p`: Interactive staging.
- `git rebase -i`: Interactive rebasing.
- `git blame`: Show last edit per line.
- `git stash`: Stash changes.
- `git bisect`: Binary search history.

Miscellaneous

- **GUIs**: There are many GUI clients for Git.
- **Shell integration**: Git status in shell prompt.
- **Editor integration**: Git features in text editors.
- **Workflows**: Different practices for using Git.
- **GitHub**: Git hosting with pull requests.
- **Other providers**: GitLab, BitBucket, etc.

Resources

- Pro Git Book
- Oh Shit, Git!?!
- Git for Computer Scientists
- Git from the Bottom Up
- Explain Git in Simple Words
- Learn Git Branching