Git, GitHub, and VS Code

Agentic AI for Project Management and Research Productivity

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Workshop Overview

1. Introduction
2. VS Code: Your Research Environment
   - Project Structure
3. Git: Version Control Fundamentals
4. GitHub: Collaboration Platform
5. Agentic AI for Research
6. Putting It All Together

Why This Workshop?

- Modern research requires computational reproducibility
- Collaboration demands version control and project management
- AI tools are transforming how we write code and documents
- Integration of these tools creates powerful workflows

Goal: Learn to combine VS Code, Git/GitHub, and AI assistants for efficient, reproducible research.

"We'll let the AI roam free... but set up proper guardrails."

The “Jur-AI-ssic Park” Approach to Research

The Park

(VS Code)

The island where everything lives

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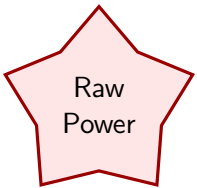
The Dinosaurs

(AI Agents)



Powerful, fast, but chaotic

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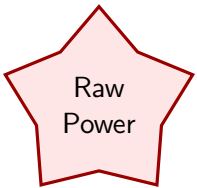

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The Guardrails

(Git & GitHub)

Keeps the chaos contained

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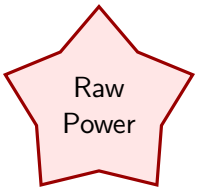

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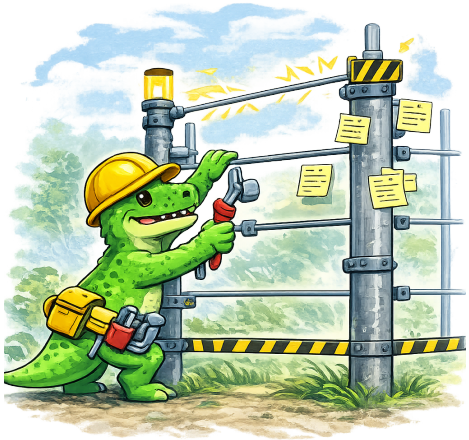
Keeps the chaos contained

"Your scientists were so preoccupied with whether or not they could, they didn't stop to think if they should... **Git lets you undo if they shouldn't.**"

The Symbiosis: Agents as Builders



From Safety to Superpowers:

- **VS Code → Capability**
  Agents gain *hands*. They can execute tests, debug, and browse the web.
- **Git/GitHub → Memory**
  Issues & PRs provide persistent context ("Pseudo-Memory") and documentation.
- **Agents → Mastery**
  They lower the cost of learning the tools.
  "How do I cherry-pick this commit?"

What You'll Learn

Module I: Foundations

- VS Code as integrated development environment
- Git fundamentals: commits, branches, merges
- GitHub workflows: issues, pull requests, project boards

Module II: Agentic AI

- VS Code Chat: Ask, Edit, and Agent modes
- GitHub Copilot: local and cloud workflows
- AI-assisted code review and refactoring
- Complementary tools: Refine, NotebookLM, Elicit

Workshop Materials

- **Template Repository**: Complete research project structure
- **Sample Data**: CSV files for demonstration
- **Python Scripts**: Analysis, plotting, table generation
- **LaTeX Templates**: Paper and slides
- **Makefile**: Automated workflow
- **Documentation**: README, agent instructions

Repository available at: `https://github.com/tlarroucau/AI_workshop`

Workshop Prerequisites

1. **Accounts**
   - **GitHub Account**: Create at `github.com`
   - **Education Benefits**: Apply for student/educator pack at `education.github.com` (Upgrade to Pro!)
2. **Software**
   - **VS Code**: Download from `code.visualstudio.com`
   - **Git**: Install from `git-scm.com`
   - *Optional*: Python & LaTeX distribution
3. **Extensions & Setup**
   - **Link GitHub**: Sign in to GitHub within VS Code (Accounts menu)
   - **Copilot**: Install "GitHub Copilot" extension (Required for Module I & II)
   - **MCP Server**: Will be configured in Module II (Agentic AI)

Note on Access

GitHub Copilot is now free! However, upgrading to Copilot Pro (via Education pack) offers better models and limits. Verification can take a few days.

Module I

Foundations: VS Code, Git & GitHub

1. VS Code as integrated development environment
2. Git fundamentals: commits, branches, merges
3. GitHub workflows: issues, pull requests, project boards

What is VS Code?

Visual Studio Code

- Free, open-source editor by Microsoft
- Cross-platform (Windows, Mac, Linux)
- Extensible via marketplace
- Integrated terminal
- Built-in Git support
- AI assistant integration

Why VS Code for Research?

- Write code *and* papers in one place
- Manage entire project lifecycle
- Collaborate seamlessly
- Automate repetitive tasks
- Leverage AI for productivity

Essential VS Code Features

Navigation & Interface:

- **Ctrl/Cmd+Shift+P**: Command Palette
- **Ctrl/Cmd+P**: Quick file open
- **Ctrl+‘**: Toggle terminal
- **F5**: Start debugger

Multi-Cursor Magic:

- **Ctrl/Cmd+D**: Select next occurrence
- **Alt+Click**: Add cursor anywhere
- **Ctrl/Cmd+Shift+L**: Select all occurrences

Code Editing:

- **Alt+↑/↓**: Move line up/down
- **Ctrl/Cmd+/**: Toggle comment
- **Ctrl/Cmd+Shift+K**: Delete line
- **Ctrl/Cmd+Shift+D**: Duplicate line

Code Navigation:

- **Ctrl/Cmd+Click**: Go to definition
- **Alt+←/→**: Navigate back/forward

Pro tip: Multi-cursor editing (Ctrl+D) is a game changer for renaming variables!

Essential Extensions for Research & Productivity

Extension	Purpose
AI & Productivity	
GitHub Copilot	AI code assistant
Copilot Chat	AI chat interface
Codex	Cloud AI coding agent
Continue	Local AI assistant
Cline	Autonomous AI agent
Prompt Flow	MCP integration
VS Code Speech	Speech-to-text input
Data Science	
Python	Language support
Pylance	IntelliSense, type check
Jupyter	Notebook support
R	R language support
Stata Enhanced	Stata syntax
Documentation	
LaTeX Workshop	Compile LaTeX
LTeX	Grammar/spell check
Markdown All in One	Markdown preview

Extension	Purpose
Project Management	
GitHub PR & Issues	Manage PRs/issues
GitLens	Git visualization
Git History	View git log
Project Manager	Organize projects
Todo Tree	Track TODOs
Data & Utilities	
Rainbow CSV	CSV colorization
Excel Viewer	View Excel files
PDF Viewer	Preview PDFs
Code Snap	Code screenshots
Auto Align	Align code formatting
Development Tools	
Remote SSH	Remote development
Docker	Container support
Error Lens	Inline diagnostics
Live Server	Local web server

VS Code Workspace Setup

Recommended Workspace Structure:

- Open entire project folder as workspace
- Use multi-root workspaces for complex projects
- Configure settings per workspace (Python path, linters, etc.)
- Save workspace file (.code-workspace) for team sharing

Settings Sync:

- Sync extensions and settings across machines
- Use GitHub or Microsoft account
- Maintain consistency in team environments

Real-Time Collaboration:

- **Live Share extension**: Co-edit files with co-authors in real-time
- Share terminals, debuggers, and servers
- Great for remote pair programming and debugging sessions

Common Frictions in Academic Research

Integration Challenges:

Statistical Software

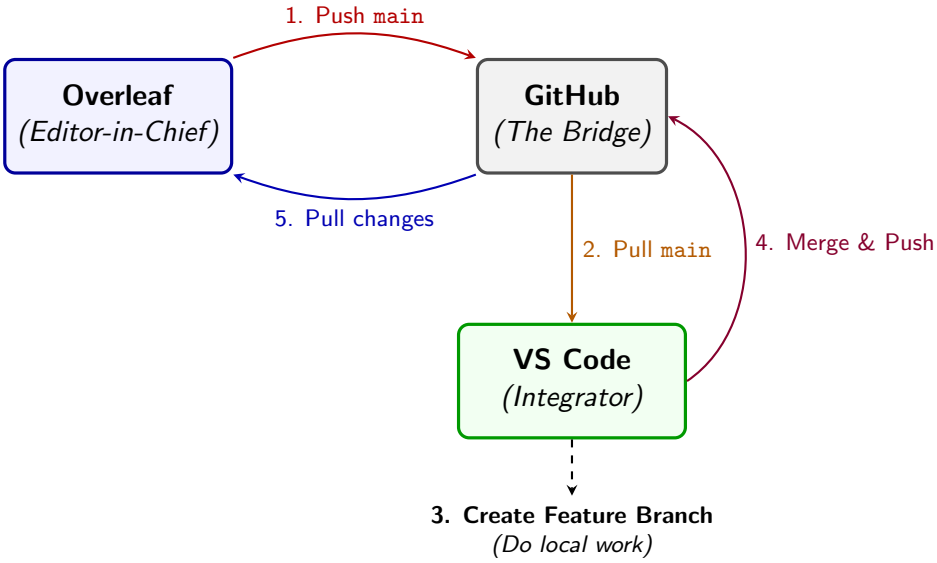
- **Stata/MATLAB**: Not natively integrated in VS Code
- **Solution**: Run through integrated terminal with commands
- Extensions available for syntax highlighting
- Execute code blocks via terminal shortcuts

Overleaf Integration

- **Via Dropbox**: Sync local folder with Overleaf project (some lag)
- **Via Git**: Clone Overleaf project, push/pull changes (more control)
- **Via GitHub**: Sync Overleaf project with GitHub repository (requires Premium)
- **Alternative**: Use LaTeX Workshop extension in VS Code directly and Copy/Paste files

Bottom line: Not perfect, but workable with some adjustments!

Optimum Workflow: Overleaf + VS Code



Reproducible Research Template

Repository Structure:

- `data/`: Raw and processed data
- `scripts/`: Analysis code
- `output/`: Generated figures and tables
- `tex/`: LaTeX documents (paper, slides)
- `Makefile`: Automation workflow
- `README.md`: Project documentation
- `.gitignore`: Excluded files

Key Principle: Everything generated from scripts, nothing manual!

The Makefile Approach

Why Makefile?

- Automate entire workflow
- Document dependencies
- One command rebuilds everything
- Reproducibility guarantee

Example Targets

```
make all      # Run complete pipeline
make data     # Generate/process data
make analysis # Run statistical analysis
make figures  # Create plots
make tables   # Generate LaTeX tables
make paper    # Compile PDF
make clean    # Remove generated files
```

Demo: Running the complete workflow

Data Management

Raw Data

- Store in `data/raw/`
- Never modify original files
- Commit to Git (if reasonable size)

Processed Data

- Save to `data/processed/`
- Generate from scripts
- Add to .gitignore (reproducible)

Output Files

- Figures: PDF + PNG in `output/figures/`
- Tables: LaTeX in `output/tables/`
- Rebuild via Makefile

Code Organization

Python Scripts Best Practices:

- **Modular**: Separate utility functions from main analysis
- **Documented**: Docstrings for all functions
- **Typed**: Use type hints for clarity
- **Styled**: Follow PEP 8 conventions
- **Tested**: Include basic validation

Example Structure:

- `utils.py`: Helper functions, plotting utilities
- `analysis.py`: Main analysis script
- `requirements.txt`: Python dependencies

Demo: Code structure in template repository

LaTeX Integration

Automated Table Generation:

- Python scripts create .tex files
- Use `pandas.DataFrame.to_latex()`
- Format with booktabs package
- Include via `\input{}` in main document

Figure Inclusion:

- Save plots as PDF (vector) and PNG (preview)
- Use `\includegraphics{}`
- Relative paths from tex directory
- Captions and labels for cross-reference

Benefits:

- No manual copy-paste errors
- Update data $\rightarrow$ regenerate everything
- Always in sync with analysis

VS Code Chat Modes

1. **Ask Mode (Chat Panel)** 
   - Answer questions about code
   - Explain complex functions
   - Suggest best practices
2. **Edit Mode (Inline)** 
   - Modify existing code
   - Refactor functions
   - Apply changes directly
3. **Agent Mode (@workspace)** 
   - Multi-file operations
   - Workspace-wide changes
   - Project scaffolding
4. **Plan Mode (New!)** 
   - High-level reasoning
   - Break down complex tasks
   - Create implementation plans

Advanced Feature: *Agent Sessions* maintain context across multiple interactions, allowing for iterative refinement of complex tasks without losing history.

Demo: Using different chat modes

VS Code Custom Context

Tailoring Copilot to your Project:

- **Custom Instructions** (`.github/copilot-instructions.md`):
  - High-level context: project architecture, coding patterns, tech stack.
  - Always appended to the system prompt.
- **Prompt Files** (`.github/prompts/*.prompt.md`):
  - Reusable, pre-defined prompts for specific tasks (e.g., "Summarize", "Refactor").
  - Can specify a particular model (e.g., GPT-4o, Claude 3.5 Sonnet).
  - Added to the user prompt when invoked.
- **Custom Agents** (Configured in settings):
  - Define specific personas or workflows (e.g., "Planner", "Implementer").
  - Augment or override default agent behavior.

Advanced Agent Capabilities: Skills

Agent Skills (`.github/skills/`)

- Bundle scripts, templates, and instructions into a modular "skill".
- Enables the agent to perform complex actions (e.g., fetching data, running analysis).
- **Progressively loaded:** Only loaded into context when the agent decides to use them.

Demo: Custom Context in Action

1. Reviewing `.github/copilot-instructions.md` (Project Standards)
2. Using `.github/prompts/summarize.prompt.md` (Reusable Prompt)
3. Triggering `.github/skills/youtube-transcript/` (fetching a video transcript)

AI-Assisted Workflows: Local

Local AI Agent Workflow:

1. Open repository in VS Code
2. Use Copilot Chat to understand codebase
3. Generate code with suggestions
4. Refactor existing code
5. Write tests and documentation

Example Tasks:

- "Add a function to compute standard errors"
- "Write docstrings for all functions in this file"
- "Explain what this regression model does"

Demo: Live coding with Copilot

What is Git?

- **Distributed version control system**
- Tracks changes to files over time
- Enables collaboration without conflicts
- Essential for reproducible research

Why Git for Research?

- Complete history of your work
- Experiment safely with branches
- Collaborate with co-authors
- Publish code alongside papers
- Recover from mistakes

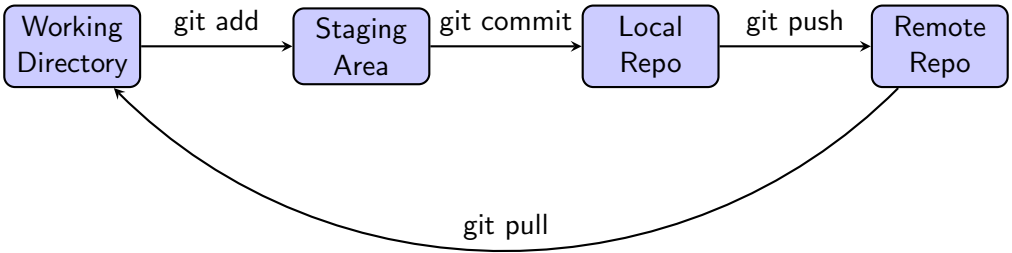
Git Core Concepts

1. **Repository (repo)**: Project folder tracked by Git
2. **Commit**: Snapshot of your project at a point in time
3. **Branch**: Parallel version of your repository
4. **Merge**: Combine changes from different branches
5. **Remote**: Repository hosted online (e.g., GitHub)

Basic Workflow

```
git add file.py          # Stage changes
git commit -m "message"  # Save snapshot
git push                 # Upload to remote
```

The Git Workflow



- Edit files in working directory
- Stage changes you want to commit
- Commit creates permanent snapshot
- Push shares with collaborators

Essential Git Commands

Repository Setup

```
git init                    # Initialize new repo
git clone <url>             # Copy remote repo
```

Daily Workflow

```
git status                  # Check current state
git add <file>              # Stage specific file
git add .                   # Stage all changes
git commit -m "msg"         # Commit with message
git fetch                   # Download remote changes
git pull                    # Fetch + merge changes
git push origin main        # Push to remote
git log                     # View commit history
git diff                    # See unstaged changes
```

Branching Strategy

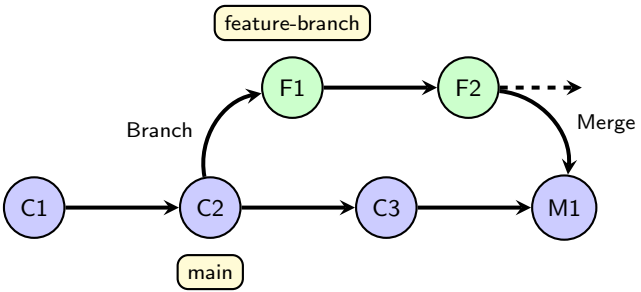
Why branches?

- Isolate experimental work
- Develop features independently
- Keep main branch stable

Common workflow:

1. Create branch for new feature: `git checkout -b feature-name`
2. Make changes and commit
3. Push branch: `git push -u origin feature-name`
4. Create pull request on GitHub
5. Review and merge
6. Delete branch after merge

Visualizing Branches



- **Branch**: Create a parallel timeline (`git checkout -b`)
- **Commit**: Work on the feature branch (F1, F2)
- **Merge**: Combine feature history back into main (`git merge`)
- *Note: The branch remains open after merging unless deleted*

Git Best Practices

Commit Messages

- Be descriptive: "Add regression analysis for Model 2"
- Use imperative mood: "Fix data loading bug"
- Reference issues: "Closes #42"

What to Commit

- DO: Source code, scripts, documentation
- DO: Raw data (if reasonable size)
- DON'T: Generated outputs (rebuild from scripts)
- DON'T: Large binary files (use Git LFS if needed)
- DON'T: Passwords or API keys

The .gitignore File

What is .gitignore?

- Tells Git which files to ignore (never commit)
- Prevents committing generated files, credentials, or large binaries
- One per repository (in root directory)

Example .gitignore for Research Projects:

```
# Python
__pycache__/
*.pyc
.ipynb_checkpoints/
*.egg-info/

# R
.Rhistory
.RData
.Rproj.user/

# Stata
*.dta~
*.log

# LaTeX
*.aux
*.bbl
*.blg
*.log
*.out
*.fls
*.synctex.gz

# Generated outputs
output/
*.pdf
*.png
```

What is GitHub?

GitHub is...

- Web-based Git hosting
- Social coding platform
- Project management tools
- Collaboration infrastructure
- Portfolio for researchers

Key Features:

- Remote repository hosting
- Pull requests
- Issues and project boards
- Actions (CI/CD)
- Pages (documentation)
- Copilot (AI assistant)

Free for academic use! (github.com/education)

GitHub Workflow: Issues

What are Issues?

- Track tasks, bugs, feature requests
- Organize work with labels and milestones
- Assign to team members
- Reference in commits and PRs

Issue-Driven Development:

1. Create issue: "Add robustness checks"
2. Create branch: `git checkout -b issue-42-robustness`
3. Work on feature, commit with "Addresses #42"
4. Create pull request
5. Merge and close: "Closes #42"

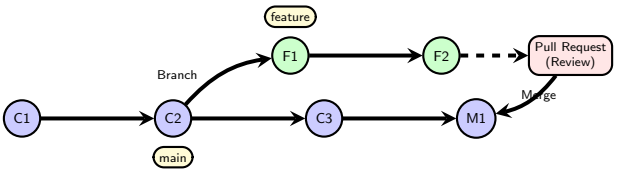
Demo: Creating and managing issues

GitHub Workflow: Pull Requests

What are Pull Requests (PRs)?

- Propose changes to repository
- Enable code review before merging
- Discuss implementation details
- Run automated tests

PR Workflow:



1. Create and push feature branch
2. Open Pull Request on GitHub
3. Review, discuss, and fix
4. Merge when approved

Demo: Creating and reviewing pull requests

GitHub Project Boards

Organize Research Projects:

- Kanban-style boards
- Columns: To Do, In Progress, Done
- Link to issues and PRs
- Automate card movement

Example Workflow:

1. Create project board for paper
2. Add columns for analysis, writing, revisions
3. Create issues for each task
4. Move cards as work progresses
5. Track progress visually

Demo: Setting up a project board

Collaboration Best Practices

Repository Setup

- Clear README with setup instructions
- .gitignore for generated files

Team Workflow

- Never commit directly to main
- All changes via pull requests
- Require reviews before merging

Communication

- Issues for tasks and discussions
- PR comments for code feedback
- Wiki for documentation

Module II

Agentic AI for Research Productivity

1. VS Code Chat: Ask, Edit, and Agent modes
2. GitHub Copilot: local and cloud workflows
3. AI-assisted code review and refactoring
4. MCP: Connecting AI to external tools

What is Agentic AI?

Traditional AI Assistants

- Respond to queries
- Generate code snippets
- Provide suggestions

Agentic AI

- Autonomous task completion
- Multi-step reasoning
- Context-aware assistance

Key Tools:

- GitHub Copilot (local & cloud)
- VS Code Chat modes
- Cline + Continue (offline capable!)
- Cursor, Windsurf

GitHub Copilot Overview

Copilot Features:

- Code completion
- Chat interface
- Inline suggestions
- Whole function generation
- Documentation writing
- Code explanation

Use Cases:

- Write boilerplate code
- Debug errors
- Refactor functions
- Generate tests
- Write docstrings
- Translate code

Free for students and educators!
Apply at: `education.github.com`

AI-Assisted Workflows: Cloud

GitHub Copilot Workspace / Claude Code / Codex / Jules (Cloud):

- Work on issues directly in browser
- AI proposes implementation plan
- Review and refine suggestions
- Create PR automatically
- Collaborate asynchronously!

Use Cases:

- Quick fixes from mobile/tablet
- Delegate tasks to AI agent
- Review AI-generated solutions

Demo: Creating issue and using Copilot Workspace and Codex

Complementary Research Tools

Tool	Purpose
Refine (refine.ink)	AI-powered writing revision and style improvement Interactive editing with suggestions
NotebookLM (Google)	Structured reading and note-taking Create study guides from papers Create academic podcasts!
Elicit	Literature discovery and synthesis Extract data from papers
GPT/Claude/Gemini	General research assistance Draft writing, brainstorming

Integration: Use alongside Git/GitHub workflow for complete research pipeline

AI Best Practices

DO:

- Review all AI-generated code
- Test suggestions before committing
- Understand what the code does
- Use AI to learn new techniques
- Iterate on prompts for better results

DON'T:

- Blindly accept all suggestions
- Share sensitive data with AI
- Rely on AI for critical decisions
- Use AI to write entire papers

Remember: AI is a tool, not a replacement for thinking!

Data Privacy & Security Considerations

Follow Your Institution's Guidelines:

- Always comply with ASU (or your institution's) data security policies
- Review AI tool terms of service for data retention policies!
- Be cautious with sensitive, proprietary, or confidential data

When Cloud AI is Not an Option:

- If data privacy or code confidentiality is a major concern
- If institutional policies prohibit cloud-based AI tools
- If working with regulated data (HIPAA, FERPA, etc.)

Fully Local AI Solutions:

- **Continue** + **Ollama**: Run local LLMs (Llama, CodeLlama, etc.)
- **Cline** + local models: Autonomous agent without cloud
- Complete offline workflow: No data leaves your machine
- Trade-off: Lower performance than cloud models, but complete privacy

Using AI APIs in Your Code

When to Use AI APIs Directly:

- Automate repetitive data processing tasks (classify text, extract entities)
- Generate synthetic data for testing or augmentation
- Create automated reports or summaries from analysis results

Example: OpenAI API

- Text generation/completion
- Code generation
- Data classification
- Embeddings for similarity

Example: Anthropic Claude

- Long document analysis
- Complex reasoning tasks
- JSON mode for structured output
- Vision for image analysis

Best Practice: Store API keys in environment variables, never commit them to Git!

MCP: Model Context Protocol

What is MCP?

- Protocol that gives AI agents access to external tools and services
- Enables *direct interaction* with APIs (not just generating code for you)

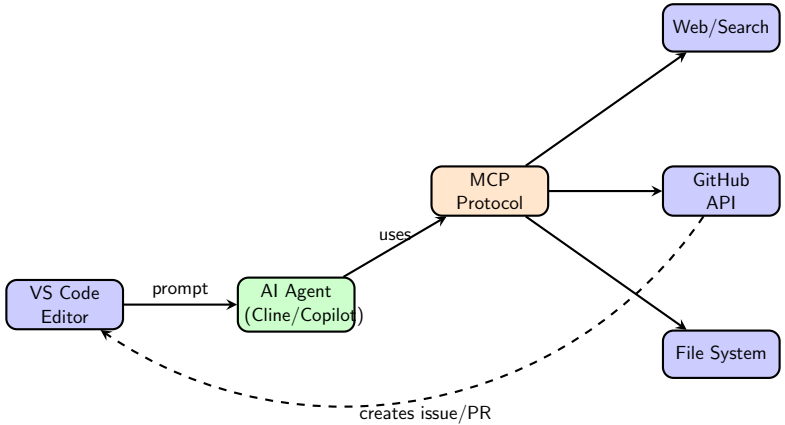
Key MCP Servers:

- **GitHub**: Create issues, PRs, manage boards
- **Filesystem**: Access external files/folders
- **Brave Search**: Web search with sources
- **Fetch**: Download/parse web content

Setup (GitHub MCP):

1. Install MCP server (npx)
2. Get GitHub token
3. Configure in Copilot settings
4. Done!

How AI Tools Connect: The Big Picture



Example Flow:

1. You: "Create issue for clustered SE analysis and add to project board"
2. AI Agent → MCP → GitHub API → Issue created + added to board
3. VS Code shows notification with issue link
4. Agent can then create branch, write code, commit, create PR automatically!

Complete Research Workflow

1. **Setup**
   - Clone template repository
   - Set up Python environment
   - Configure VS Code
2. **Development**
   - Create issues for tasks
   - Work in feature branches
   - Use AI for code generation
   - Commit regularly
3. **Collaboration**
   - Push branches to GitHub
   - Create pull requests
   - Review code
   - Merge to main
4. **Publication**
   - Run `make all`
   - Compile paper and slides
   - Share repository with paper

Live Demo: End-to-End Example

Scenario: Add a new robustness check using MCP-enabled AI agent

1. Ask AI agent: "Create issue for adding clustered SE robustness check"
2. Agent uses GitHub MCP to create issue and add to project board
3. Agent creates branch: `feature/clustered-se`
4. Agent uses Copilot to generate implementation code
5. Update analysis script with AI assistance
6. Run `make all` to regenerate outputs
7. Agent commits changes with descriptive message
8. Agent creates PR linking to original issue
9. Review PR and merge to main

We'll work through this together - from idea to merged code in minutes!

Common Challenges & Solutions

Understanding Merge Conflicts:

- Occur when Git cannot automatically determine which version to keep
- Happen when the same lines of code/text are edited in different branches
- VS Code highlights conflicts and lets you choose which version to keep
- AI agents can suggest the best resolution strategy!

Backing Up Your Work:

- You can keep your local repo in Dropbox for automatic backup
- **WARNING:** Do not share that Dropbox folder with co-authors!

Challenge	Solution
Merge conflicts	Use VS Code conflict resolver, ask AI agent for help
Large files	Use .gitignore, Git LFS if needed
Slow Git operations	Use .gitignore for generated files
Lost work	Commit often, use branches
Unclear AI output	Refine prompts, add context
Reproducibility	Use Makefile, document dependencies

Next Steps

First:

1. Fork/clone workshop template repository
2. Install VS Code and extensions
3. Set up GitHub account (education benefits)
4. Practice basic Git commands
5. Run `make all` to build template
6. Ask your favorite AI agent to explain any concepts from the slides you don't understand

Second:

- Apply workflow to a small project
- Create repository for current research
- Experiment with Copilot
- Set up project board

Resources

Documentation

- Git: `git-scm.com/doc`
- GitHub: `docs.github.com`
- VS Code: `code.visualstudio.com/docs`

Learning

- GitHub Skills: `skills.github.com`
- Software Carpentry: `software-carpentry.org`

Workshop Materials

- Template: `github.com/tlarroucau/AI_workshop`
- Slides: `tex/slides/`

Behind the Scenes: Meta Moment

This ENTIRE workshop was created with ONE prompt and FOUR hours of edits!

Questions?

Thank you for attending!

Contact: Tomas.Larroucau@asu.edu

Template Repository:
`github.com/tlarroucau/AI_workshop`