The Art and Science of Transportation Research in the AI Era

Welcome to ASTRAI

Meng Cai

A stray
/ə streɪ/

Ashtray
/ˈæʃ treɪ/

Learning goals

#1 Understand what ASTRAI is about

#2 Understand what you need to do in ASTRAI

#3 Become familiar with git and GitHub

#4 Be able to clone (i.e., download) the course repo

Agenda

#1	ASTRAI
#2	git

Agenda

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Institut für Verkehrsplanung und Verkehrstechnik TU Darmstadt

#1 ASTRAI

#2 git

#1.1 The ASTRAI team

TECHNISCHE UNIVERSITÄT DARMSTADT

IVV Institut für Verkehrsplanung und Verkehrstechnik TU Darmstadt

Responsible professor

Prof. Eva Kaßens-Noor, Ph.D.

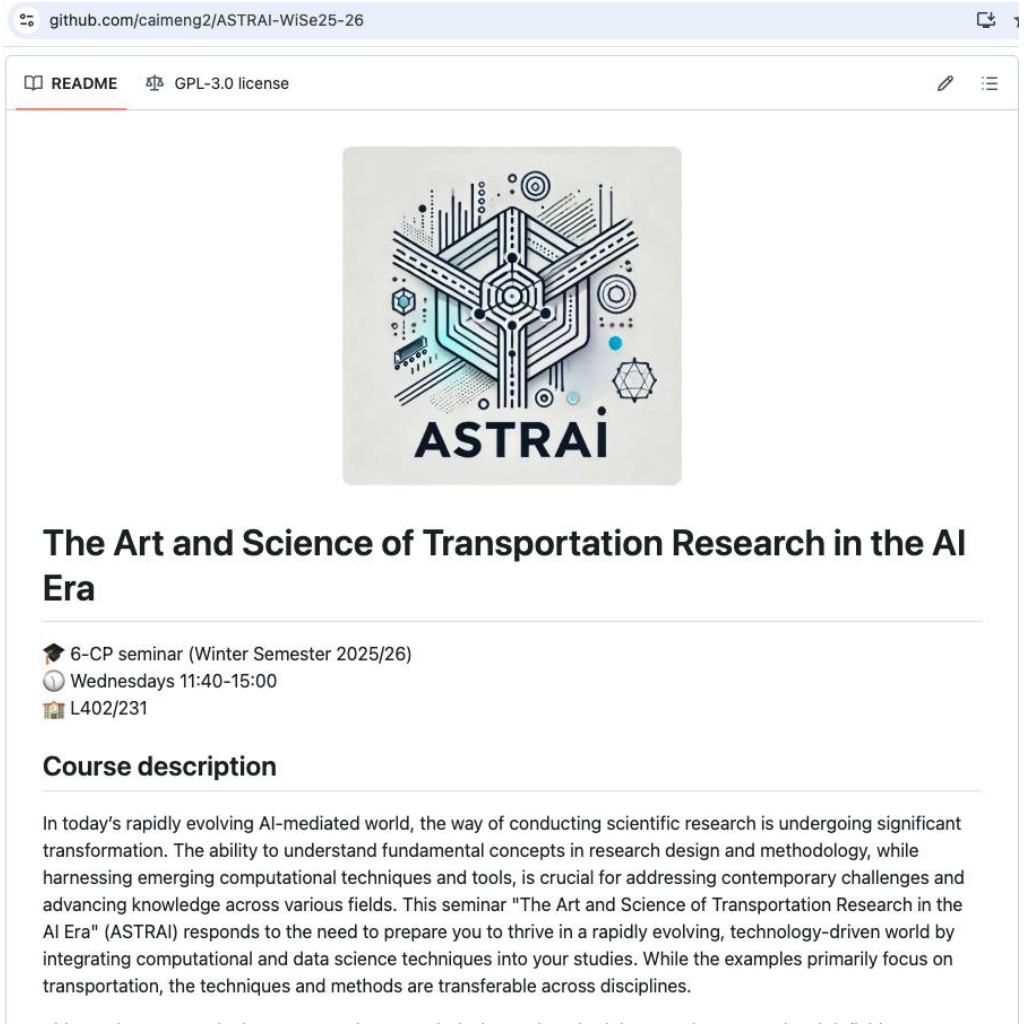
Contact person, instructor

Meng Cai, Ph.D.

Instructor

Hiba Karam, M.Sc.

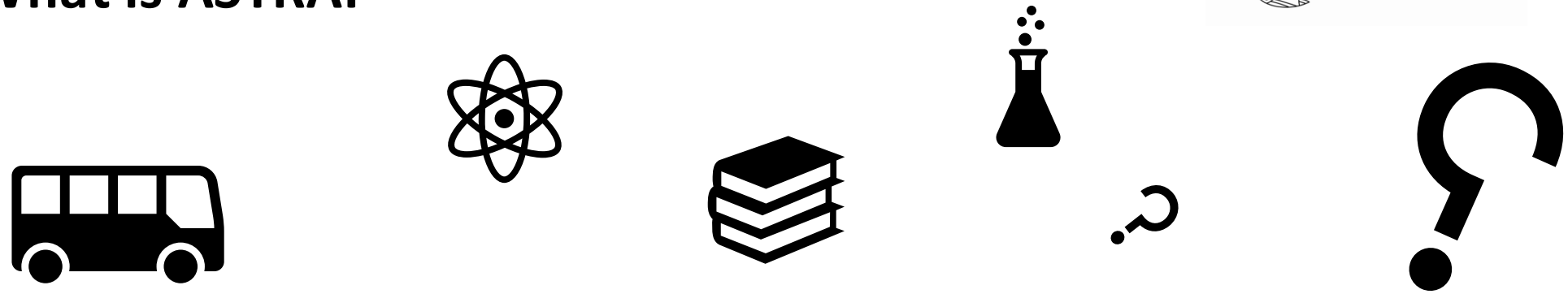
#1.2 Basic info



What: 6-CP seminar
When: Wednesdays 11:40-15:00
Where: L402/231
Contact: cai@verkehr.tu-darmstadt.de
Course website:
https://github.com/caimeng2/ASTRAI-WiSe25-26
Everything in the repo is freely and publicly available under the GPL-3.0 license.
No course Moodle page. We will send you messages through TUCaN.

Course contents in GitHub repo!

#1.3 What is ASTRAI



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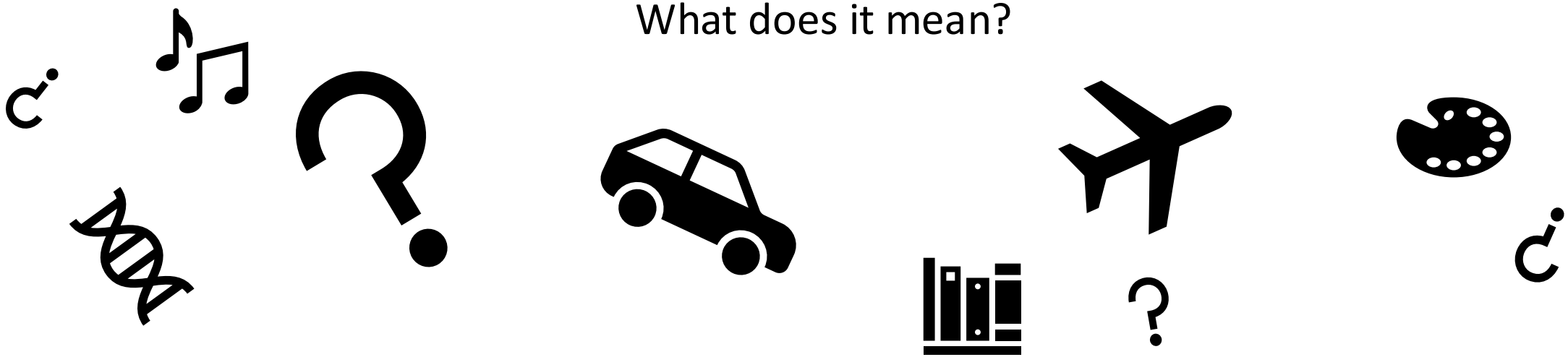
What does it mean?

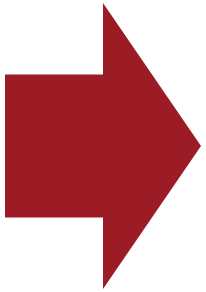


#1.3 What is ASTRAI

The Art and Science of Transportation **Research in the AI Era**

Research processes:

- Finding a research topic
- Defining a research question
- Conducting a literature review
- Designing a methodology
- Collecting data
- Analyzing data
- Interpreting results
- Report preparation and presentation of findings



- Interdisciplinary topics
- Data-driven
- AI-powered literature review
- New methods and tools
- New data sources, automated data collection, real-time data
- Easier and better visualization
- AI-assisted writing

#1.3 What is ASTRAI

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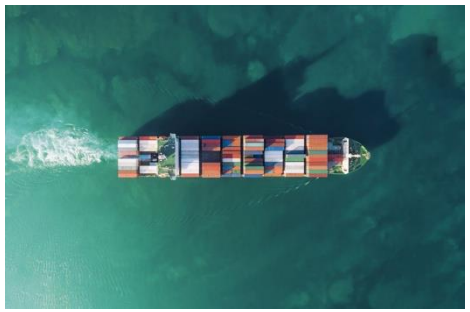
The Art and Science of **Transportation** Research in the AI Era

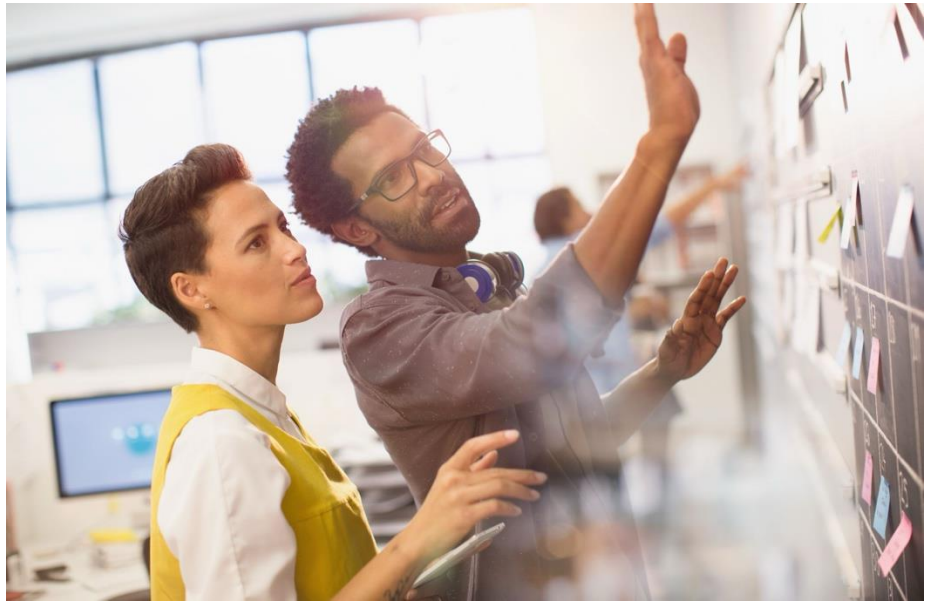
The examples are mostly transportation-related, but the techniques and methods are transferable across disciplines.



Picture sources: Microsoft stock images.

#1.3 What is ASTRAI

The **Art** and Science of Transportation Research in the AI Era



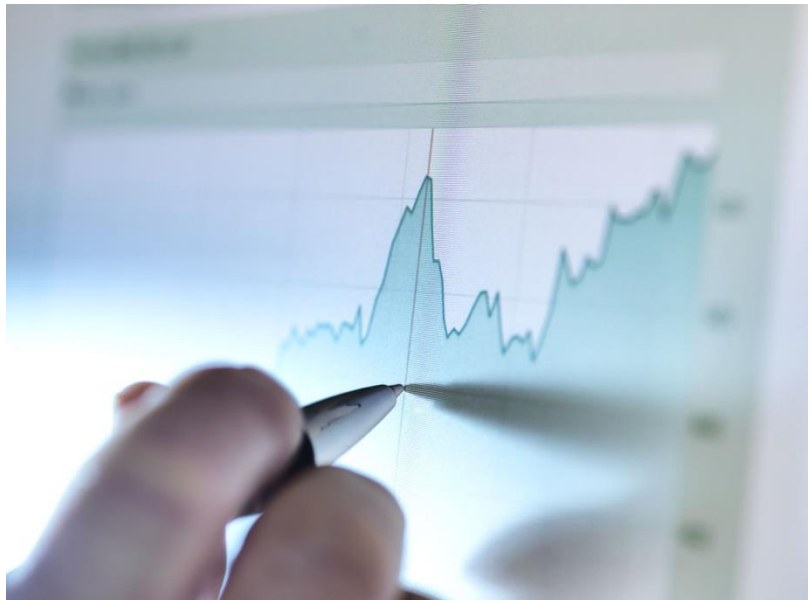
Picture sources: Microsoft stock images.

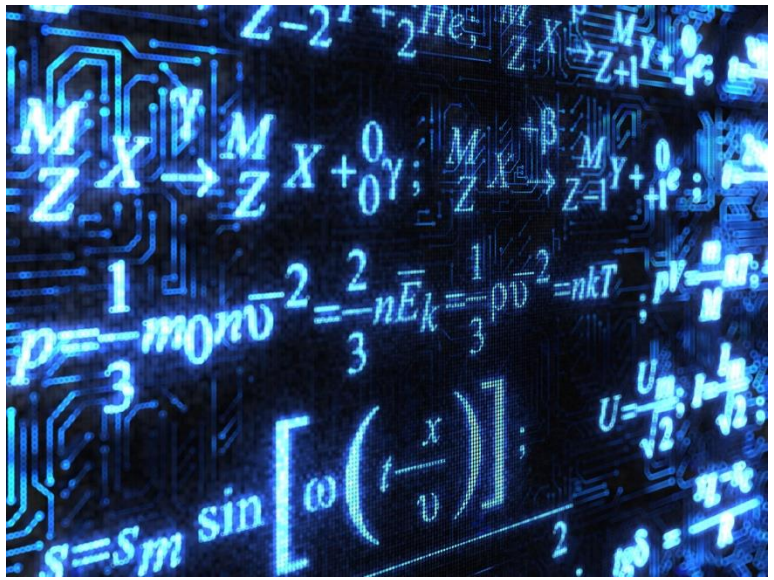
"Art" refers to the creative aspects of research

- Asking the right questions
- Developing novel approaches
- Finding innovative solutions
- Effectively communicating through compelling visuals

#1.3 What is ASTRAI

The Art and **Science** of Transportation Research in the AI Era





Picture sources: Microsoft stock images.

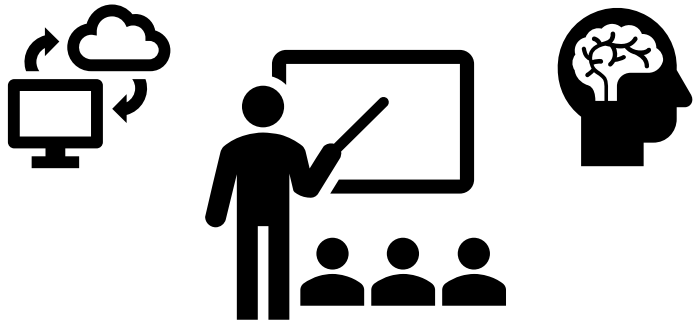
"Science" refers to the tools, techniques, and knowledge foundation for research

- Developing a good research design
- Having robust methodologies
- Leveraging advanced computational tools
- Be able to tell if the answers provided by AI are correct

#1.4 ASTRAI vision

To develop the right **mindset**:

- work across disciplines instead of domain-specific fields
- Stay updated
- Maintain a healthy skepticism of AI-generated results, recognizing limitations
- Address ethical issues proactively in research design and implementation
- Open science



To develop new **skillsets**:

- Programming proficiency
  - Understand and code in commonly used languages such as Python, R, and Git
- Big Data handling
  - Practice techniques for data cleaning, processing, and analyzing, using databases such as SQL
- Data visualization
  - Present data insights effectively via visualization tools like PowerBI

#1.5 What ASTRAI is NOT

- It is not a lecture.
- It is not a programming course.
- It is not aimed at making you a programmer, a computer scientist, or a computational engineer

Instead

- We act as supporters rather than traditional teachers
- Less lecturing, more doing
- Open dialogue is encouraged

Picture sources: Microsoft stock images.

#1.6 Learning outcomes

By the end of the course, you will:

- Understand the fundamental concepts in research design and methodology
- Effectively formulate research questions and design a study
- Develop proficiency in data science tools and techniques

Picture sources: Microsoft stock images.

#1.7 What you need to do

Participation	• Attend class every week • Bring your laptop and power cord
Pre-class requirement	From time to time, install software and/or setup accounts
In-class activities	Practice coding, debugging, etc
Student-led learning (YOU-lead)	Choose, study, and teach to your peers a computational tool/method (e.g., agent-based modeling) or a use case (e.g., simulating traffic congestion using agent-based modeling)
Final examination	Develop a one-page research proposal incorporating computational methods

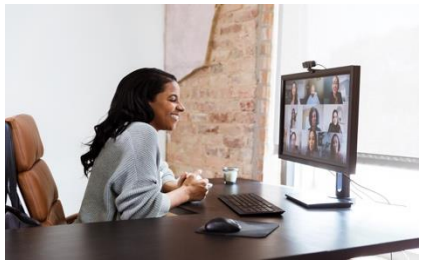
#1.8 YOU-lead ASTRAI

- The topics can be anything (within the scope of this course) that you find interesting or useful. They can be a use case of what you have learned from the class or a new tool

- Include what, why, how, and activities
- You don’t have to use slides

- Limited slots
- Improve your final grade by up to 0.4 points

- **Sign up in week 5**



#1.9 Final examination

A concise, one-page research proposal:

1. A brief literature review
2. Clear research questions
3. Methodology incorporating computational tools/techniques
4. Discussion of the limitations of methods

Grading:

- Literature review (20%)
- Research questions (20%)
- Methodology (20%)
- Limitations (20%)
- Writing (20%)

Deadline: Feb 20, 2026

Detailed instructions: https://github.com/caimeng2/ASTRAI-WiSe25-26/blob/master/examination.pdf

#1.10 Tentative schedule

- Week 1 (Oct 15, 2025): Welcome to ASTRAI, git
- Week 2 (Oct 22, 2025): Python basics
- Week 3 (Oct 29, 2025): Web scraping
- Week 4 (Nov 5, 2025): Data wrangling
- Week 5 (Nov 12, 2025): Open-source tools, signing up for YOU-lead
- Week 6 (Nov 19, 2025): Research design and methodology

- In 2026, YOU-lead

Agenda

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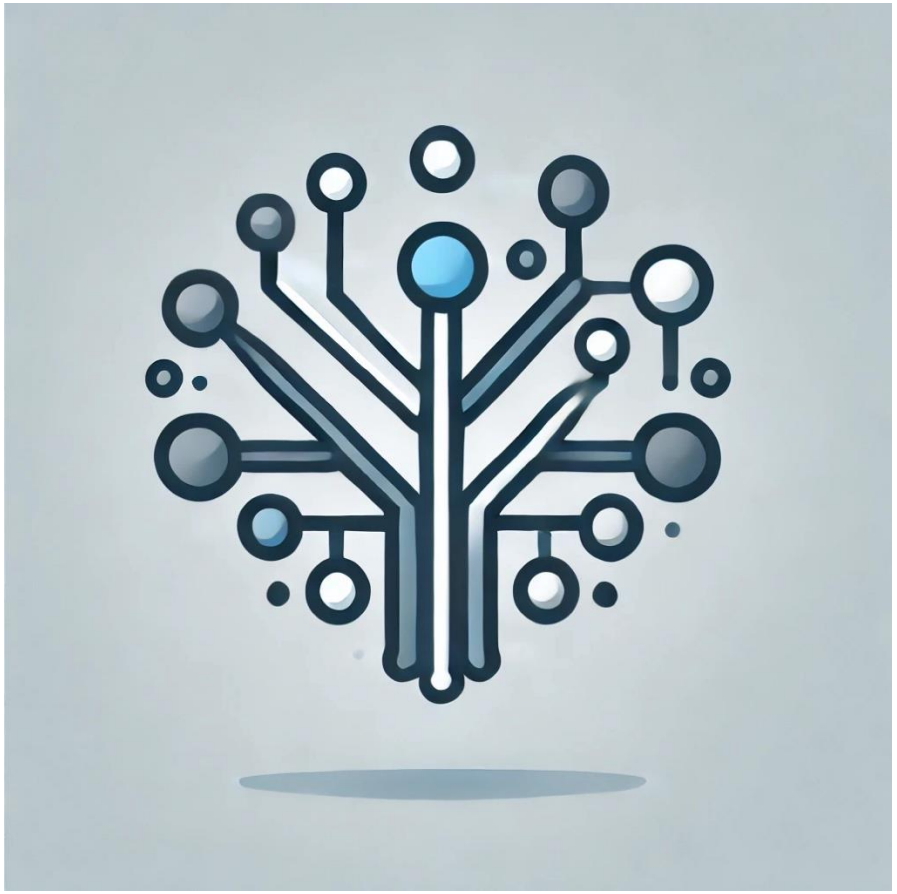
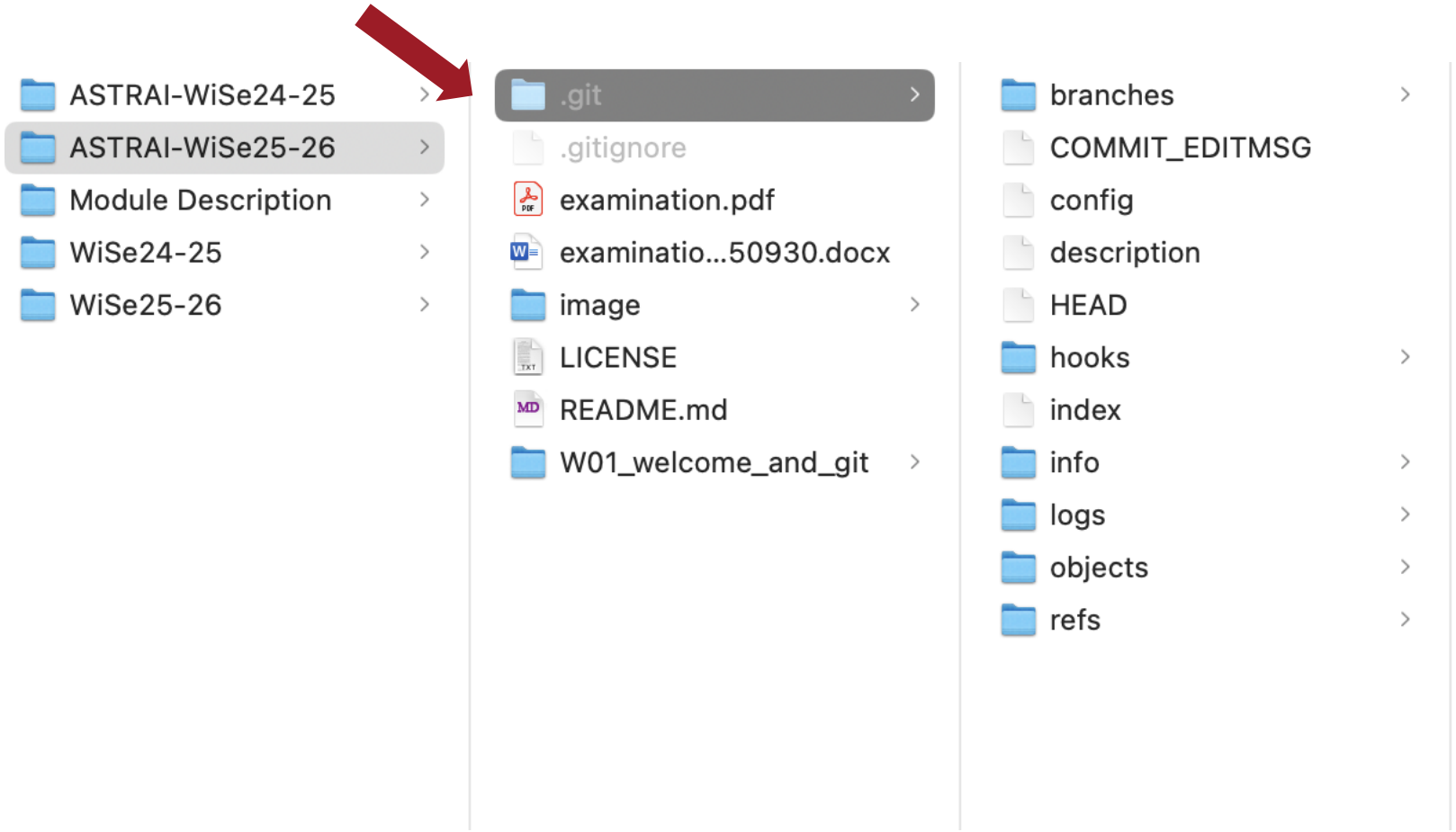
#1	ASTRAI
#2	git

#2.1 What is git



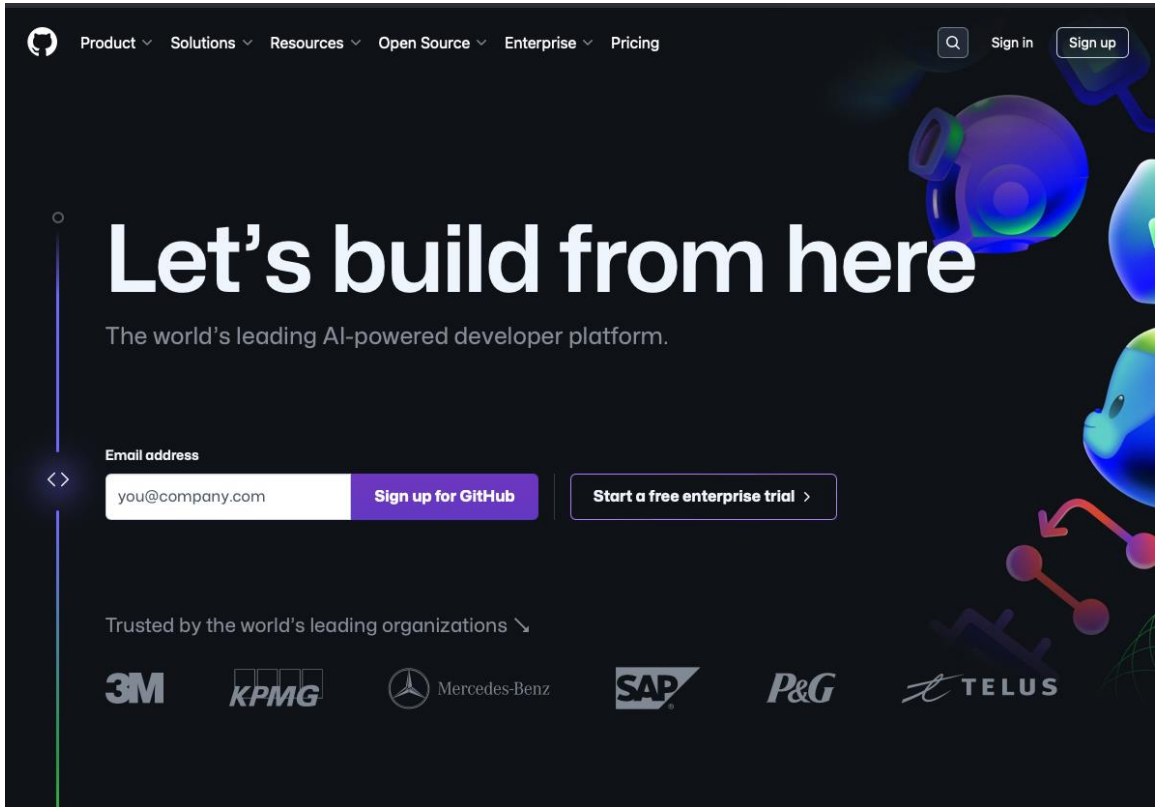
- Git is a version control system
- It is widely used in software development
- With Git, you can:
  - Track changes to files over time
  - Manage multiple versions of a project
  - Revert files to previous versions
  - Work simultaneously with others without overwriting each other's changes

#2.1 What is git



#2.2 What is GitHub

GitHub is a web-based platform for managing Git repositories



#2.2 What is GitHub

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2 files changed +1 -1 lines changed

README.md +1 -1

```
@@ -1,5 +1,5 @@
1  1    <p align="center">
2      -   <img src="logo_DALLE.jpeg" width="300"/>
   2  +   <img src="image/logo_DALLE.jpeg" width="300"/>
3  3    </p>
4  4
5  5    # The Art and Science of Transportation Research in the AI Era
```

Code | Issues | Pull requests | Actions | Projects | Wiki | Security | ...

Commits

main | All users | All time

Commits on Oct 10, 2024

change img path — caimeng2 committed 4 minutes ago — b1037fe

Commits on Sep 18, 2024

typo — caimeng2 committed 3 weeks ago — c98146a

Browse repository at this point

logo — caimeng2 committed 3 weeks ago — b5e55dd

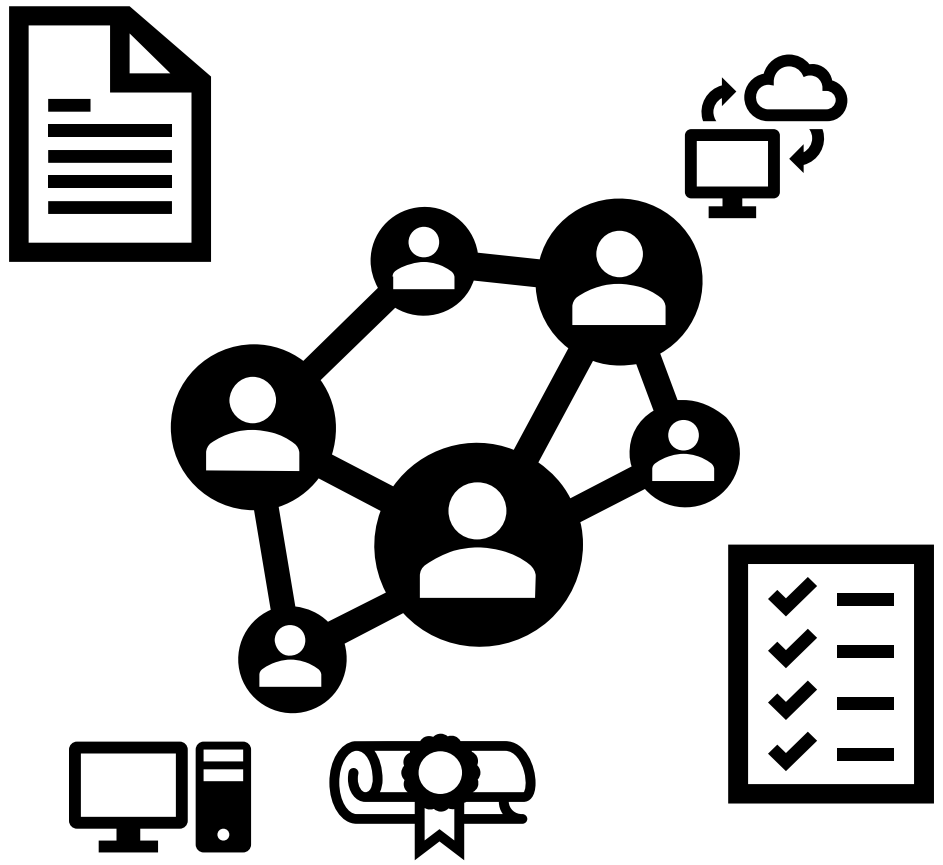
pix — caimeng2 committed 3 weeks ago — f495b48

Commits on Sep 10, 2024

replace md with pdf — caimeng2 committed last month — 7d8ab9d

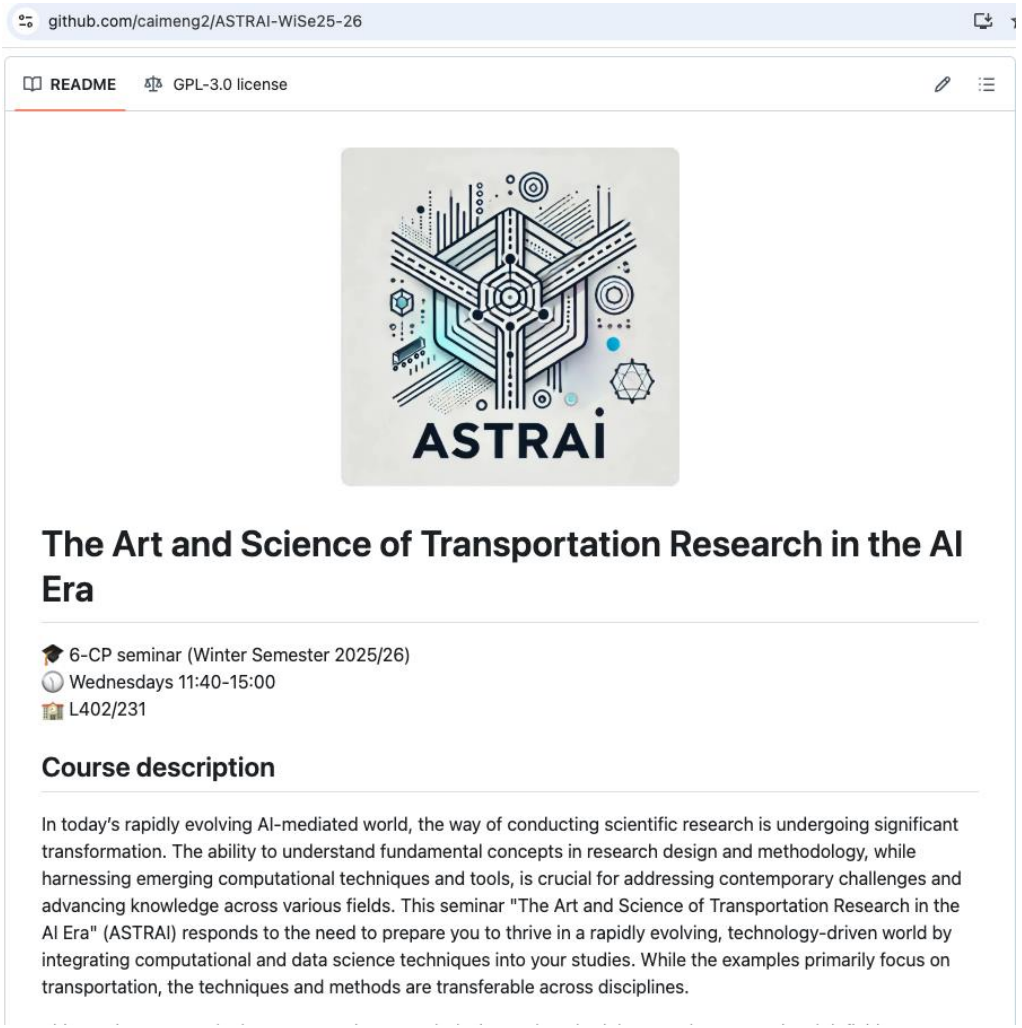
#2.3 Why use git/GitHub

- Collaboration: Enables users to collaborate more efficiently.
- Version history: Every change is recorded, and you can revert to previous versions if needed.
- Branching & merging: Allows users to create different branches for new features or bug fixes, without affecting the main codebase.
- Open source contributions: GitHub makes contributing to open-source projects simple and accessible.
- Backups: Code stored on GitHub acts as a backup and is accessible from anywhere.



#2.4 Why we use git/GitHub

- In the spirit of open science
- It is an invaluable tool for anyone working with code
- It keeps the course materials backed up and accessible from any device
- It might seem complicated at first, but it’s easier to learn than most people think
- It enables us to build the course together



#2.5 git terminology

Repo: A git repository is a folder or directory that contains all the files and the complete history of changes for a project. There can be a local repository (on your computer) and a remote repository (hosted on platforms like GitHub)

Clone: To create a copy of a remote repository on your local machine.

Fork: Forking creates a copy of a repository on a remote platform such as GitHub. This copy is independent of the original and you can make changes to it without affecting the original project.

Commit: A commit is a snapshot of the changes made to the files in a repository at a specific point in time.

Push: When you want to upload your local changes to the remote repository, you push them.

Pull: To update your local repository with changes from a remote repo, you pull those changes. This is typically done before pushing your own changes to ensure you have the latest update.

Pull request: In the context of GitHub, a pull request is a way to propose changes to a repository. It allows collaborators to review and discuss the proposed changes before merging them into the main branch.

Adapted from: https://medium.com/@unaware_harry/all-about-git-terminology-d9c91ea0a734
More info: https://git-scm.com/docs/gitglossary

#2.6 Common git commands

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Command	Function	Syntax
git init	starts a new repository	git init
git clone	duplicates a remote repository to your local machine	git clone <repository-url>
git status	shows the current status of the working directory and staging area	git status
git add	adds files to the staging area, preparing them for commit	git add <file-name> git add . # Add all files
git commit	commits changes in the staging area to the repository, recording a snapshot of the project history	git commit -m "commit message"

#2.6 Common git commands

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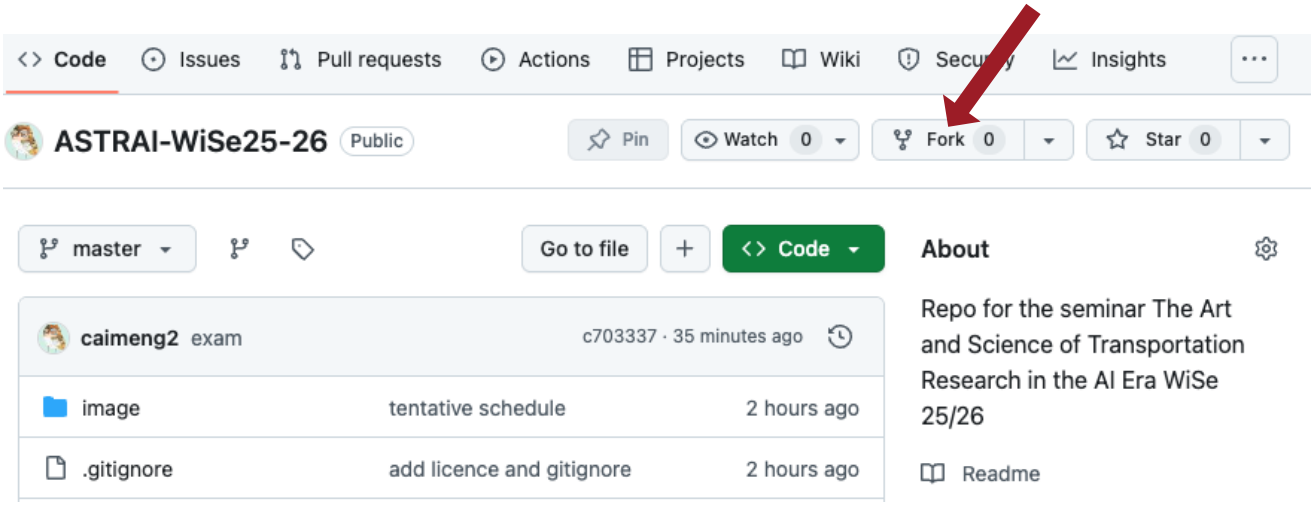
Command	Function	Syntax
git push	pushes changes to a remote repository	git push origin <branch-name>
git pull	fetches changes from a remote repository and merges them into the current branch	git push origin <branch-name>
git branch	lists all branches or creates a new branch	git branch # List all branches git branch <new-branch-name> # Create a new branch
git checkout	switches to another branch or commit	git checkout <branch-name>
git merge	merges a branch into the current branch	git merge <branch-name>

#2.7 Activity: fork ASTRAI repo

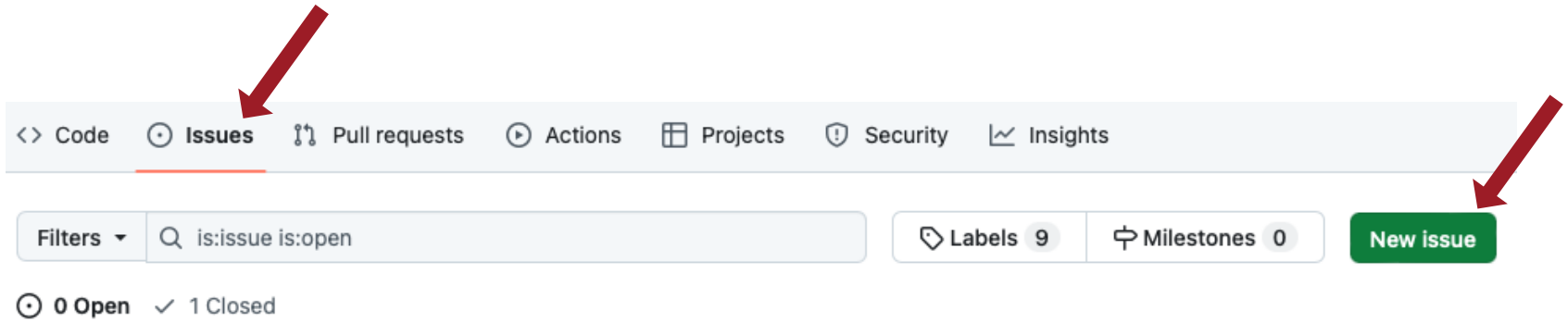
Step 1: Sign up for an account at https://github.com

Step 2: Sign in to your account

Step 3: Go to ASTRAI repo (https://github.com/caimeng2/ASTRAI-WiSe25-26) and click the "Fork" button



#2.7 Activity: submit an issue to ASTRAI



Step 1: Go to ASTRAI repo

Step 2: Click on “Issues”

Step 3: Click on the “New issue” button

Step 4: What do you wish to accomplish through ASTRAI? Share your thoughts and hit “Submit new issue.” Note: The issues are public. Do not share any sensitive information there.

#2.7 Activity: Install git

Instructions: https://github.com/git-guides/install-git

- **macOS/ Linux**:
  - Use the built-in **Terminal** application.
  - You can open the terminal by searching for “Terminal” in your applications menu.

- **Windows**:
  - You can use **Git Bash**, which comes with Git for Windows.
    - Download Git from https://git-scm.com/downloads
    - Install it. During installation, you'll be given the option to use Git Bash.
    - Git Bash provides a Unix-like terminal for Windows users, so the commands work the same as in Linux/macOS.

Type in “**git --version**” to check if you have git installed

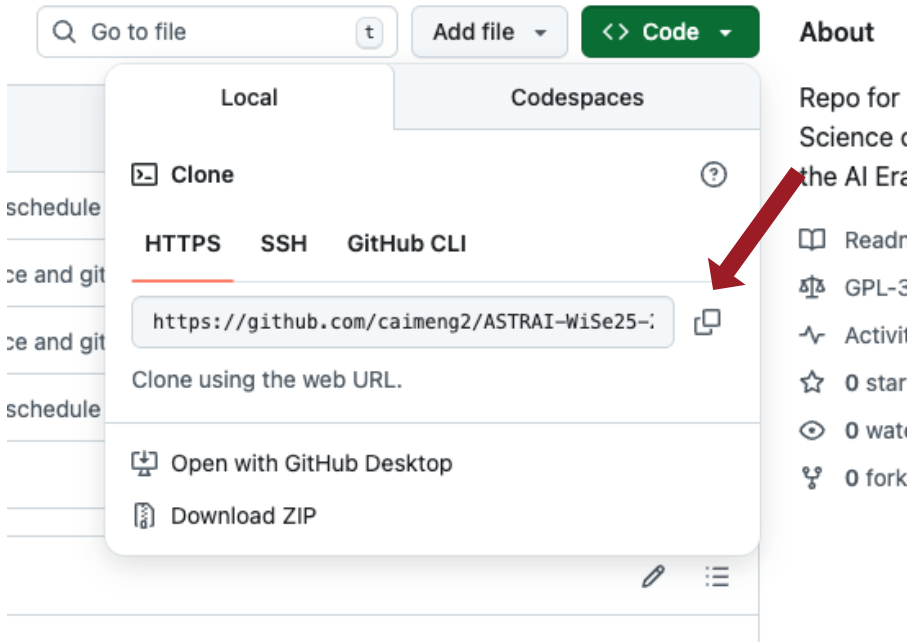
#2.7 Activity: clone ASTRAI repo

Step 1: Open Terminal or Git Bash

(Step 2: Change the directory: cd xx)

Step 3: Type in Terminal or Git Bash :

git clone https://github.com/caimeng2/ASTRAI-WiSe25-26.git



#2.8 Questions?

Take a moment to review the repo.

Do you have any questions or concerns?

Learning goals

#1 Understand what ASTRAI is about

#2 Understand what you need to do in ASTRAI

#3 Become familiar with git and GitHub

#4 Be able to clone (i.e., download) the course repo