

Building Software with Agentic Components

csci 7000-005
Mon/Wed @5:05pm

Danny Dig





Have you received the welcome email I sent yesterday?

- ⓘ The Slido app must be installed on every computer you're presenting from



What do you most want to get out of today's class?

- ⓘ The Slido app must be installed on every computer you're presenting from

Today's goals

Why learn how to build agents?

What is Agentic AI: practice and research examples

Discovery: learning about each other (Family Occupation Recreation Motivation), expectations

How can I be successful in CSCI 7000-005?

Why this course now?

LLMs are no longer just:

- Chatbots
- code generators

They are increasingly embedded as:

- Long running services
- Tool-using systems
- Autonomous components

Are we actually building software, or just demos?

Industry reality check

THE © AI
SUMMIT
NEW YORK



Industry reality check

THE © AI
SUMMIT
NEW YORK

When AIs Team Up: The Rise of the Multi-Agent Stack

📍 Next Generation Stage | 25 mins



The Enterprise Agent Factory: Building Scalable, Governed AI Systems

📍 Data Excellence Stage | 25 mins



Creating Delightful Customer Experiences with Voice AI Agents

📍 The AI Playground | 15 mins



From Assistants to Autonomy: The Rise of AI Workers

📍 AI at Scale Stage | 25 mins



Under the Hood of The World's Most Advanced AI Data Agent

📍 Data Excellence Stage | 25 mins



Panel: C-Suite Perspectives on Human-Centered Agentic AI

📍 Headliners Stage | 40 mins



Panel: Rise of the AgentOps Stack: Building for Autonomy at Scale

📍 Next Generation Stage | 40 mins



How to Build Trustworthy, High-Quality AI Agents with MLflow

📍 Workshop Room | 60 mins



Managing the Machines That Manage Themselves: Executive Perspectives on Agentic AI

📍 VisionAIres VIP Lounge | 40 mins



Building Smarter AI Agents with Azure Databases

📍 Data Excellence Stage | 25 mins



Lightweight, Heavy Impact: Leveraging Software Design Principles for Multi-Agent AI Systems

📍 Data Excellence Stage | 25 mins



Accelerating AI adoption in the enterprise: ensuring trust through governed agentic AI

📍 Headliners Stage | 25 mins



Precision Engagement: How Agentic AI and Predictive Models Cut Through the Pharma Noise

📍 The AI Playground | 15 mins



The Autonomous Advantage: Unleashing Your Agentic AI Future in Life Sciences & Healthcare

📍 Health & Pharma Stage | 25 mins



The Agentic Era: What's Really Driving Enterprise AI Adoption

📍 Headliners Stage | 25 mins



From Pilots to Production - Scaling AI Agents in Regulated Environment

📍 Finance Stage | 25 mins



Agentic Commerce and the Future of the AI Economy

📍 Data Excellence Stage | 20 mins

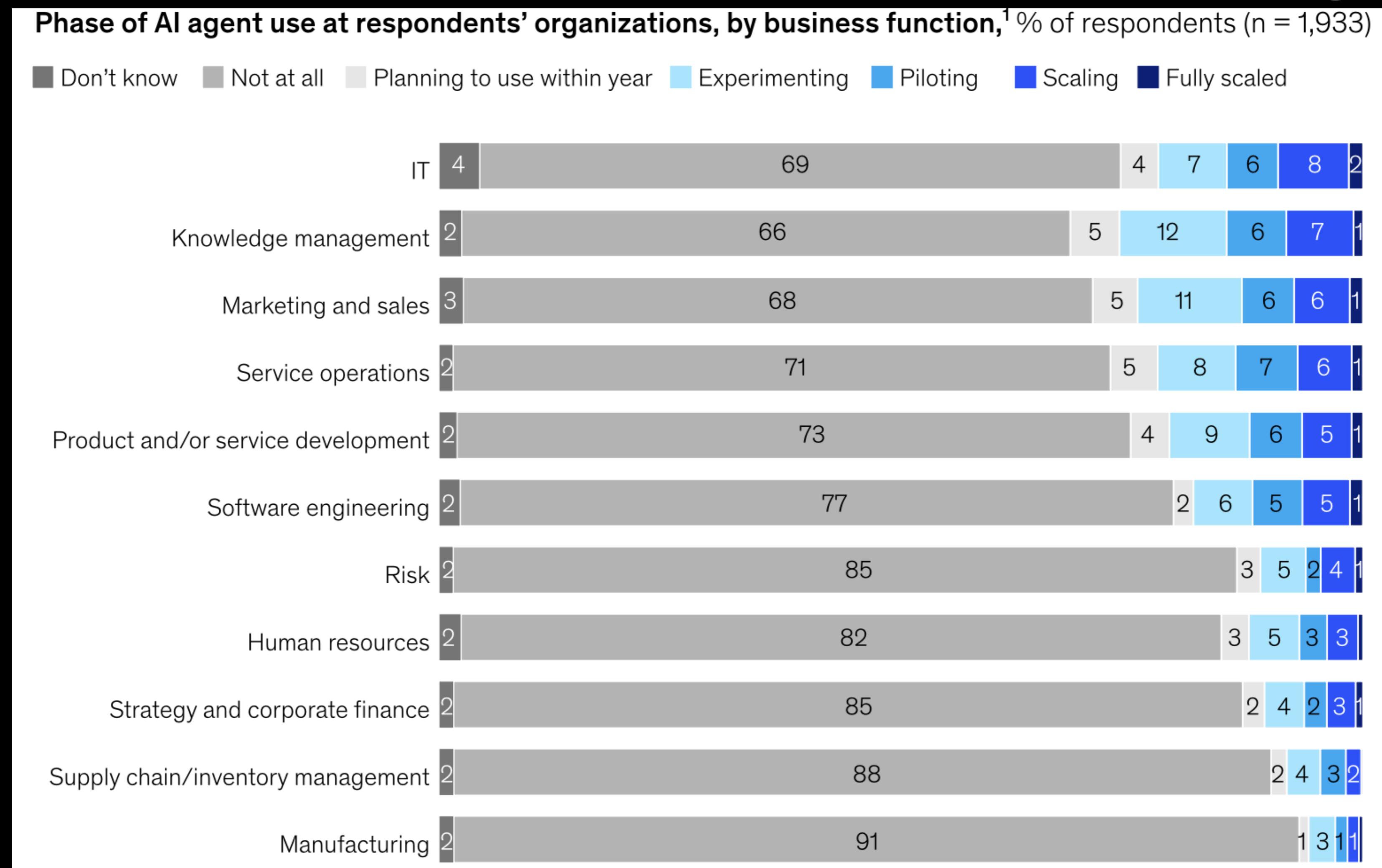


From Workflows to Agents: Transforming Financial Operations

📍 Finance Stage | 25 mins



Industry reality check: phase of AI agent use



Source: McKinsey Global Survey on the state of AI, 1,993 participants at all levels of the organization, June 25–July 29, 2025



Where have you personally seen agent-like systems in the wild?

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Have you used any AI-powered tools in your coding projects?

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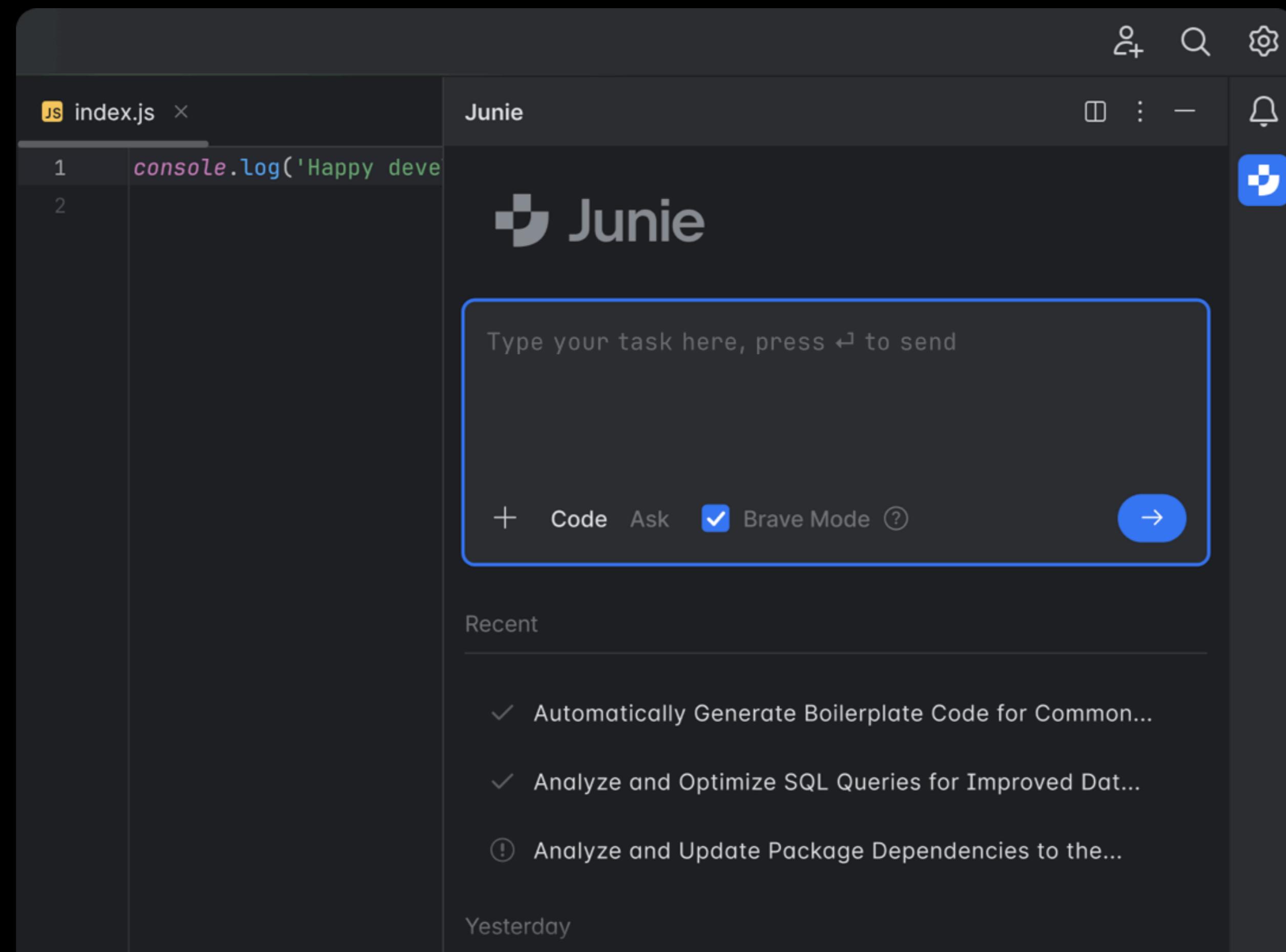
Which GenAI tools and services did you use for programming?

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Smart coding agent in the IDE

Lighten programmer's load





Code and ASK mode

Lighten programmer's load

The screenshot shows the Junie application interface. At the top, there's a dark header bar with a search icon, a gear icon, and a bell icon. Below the header, a navigation bar shows the path "M+ What_neural_network_model_works Junie". On the right side of the header, there's a blue Junie logo icon. The main content area has a dark background. On the left, there's a sidebar with the title "Neural Network | Low Light Conditions" and a snippet of code: "Based on the analysis of the project and current research in pose detection, here are the best neural network models for pose detection in low light conditions that are...". To the right of the sidebar, there's a "Response to Your Question" section with a blue checkmark icon and the heading "# Neural Network Models for Pose Detection in Low Light Conditions with TensorFlow.js". Below this, there's a snippet of code: "Based on the analysis of the project and current research in pose detection, here are the best neural network models for pose detection in low light conditions that are...". At the bottom of the screen, there's a footer bar with buttons for "Open in Editor" and a refresh icon, followed by a text input field labeled "Write follow up here", and finally a "Code Ask" button with a checked checkbox for "Brave Mode" and a right-pointing arrow icon.

Research Examples: Agentic AI for SE

AI Agents and Planning @JetBrains

Objective: advancing technologies around AI agents with the focus on locality

Infrastructure:

- Platform IDEFormer

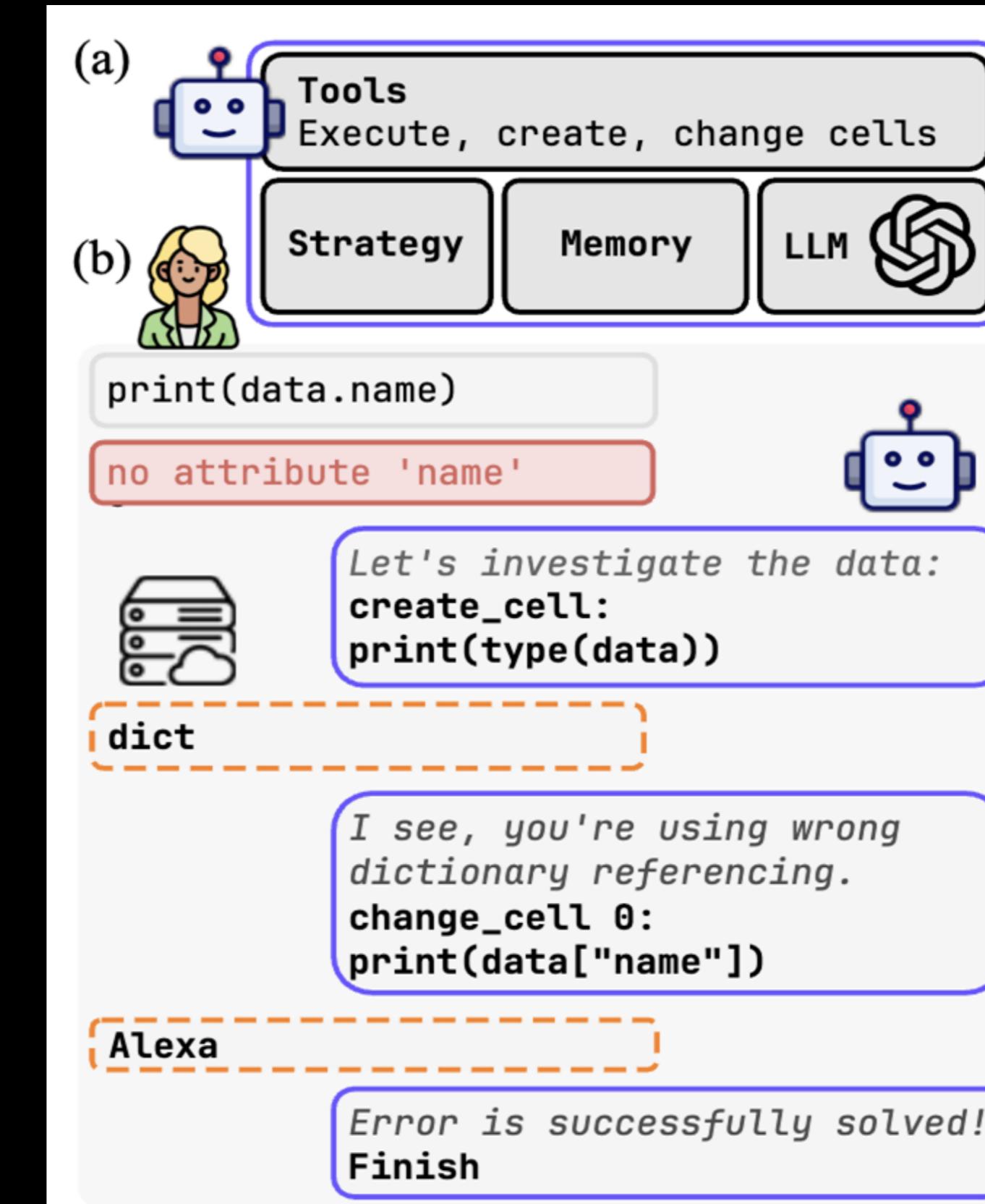
Agents:

- Debugging
- Environment Setup

Research:

- RL to tune models for Environment Setup
- Distillation for on-device models for SWE-agents

Notebook Debugging (Grotov et. al, 2024)

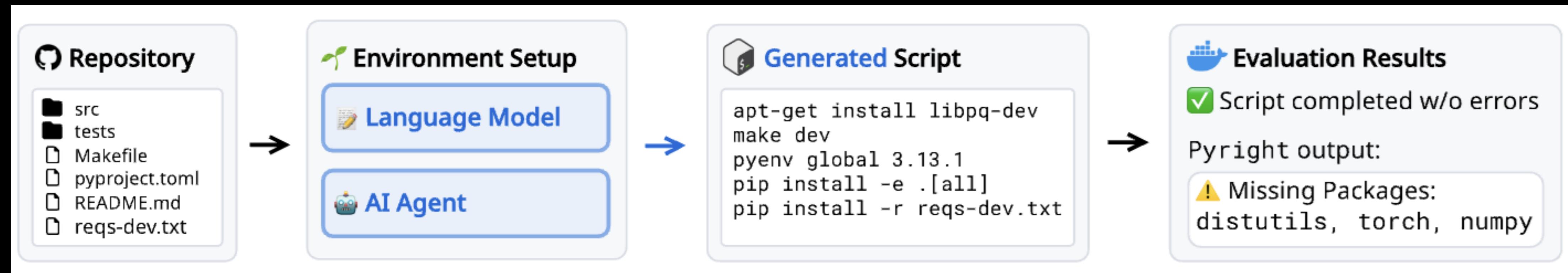


"Debug Smarter, Not Harder: AI Agents for Error Resolution in Computational Notebooks" EMNLP 2024



Setting up Environment (Eliseeva et. al, 2024)

EnvBench: A Benchmark for Autonomous Environment Setup



Coordinated Refactoring Agent (Bellur et al., 2025)

Developers perform more than 50% of refactorings in clusters:

- e.g., 243 renames in a single commit in Apache Flink
- time consuming: ~30 minutes to perform cluster rename

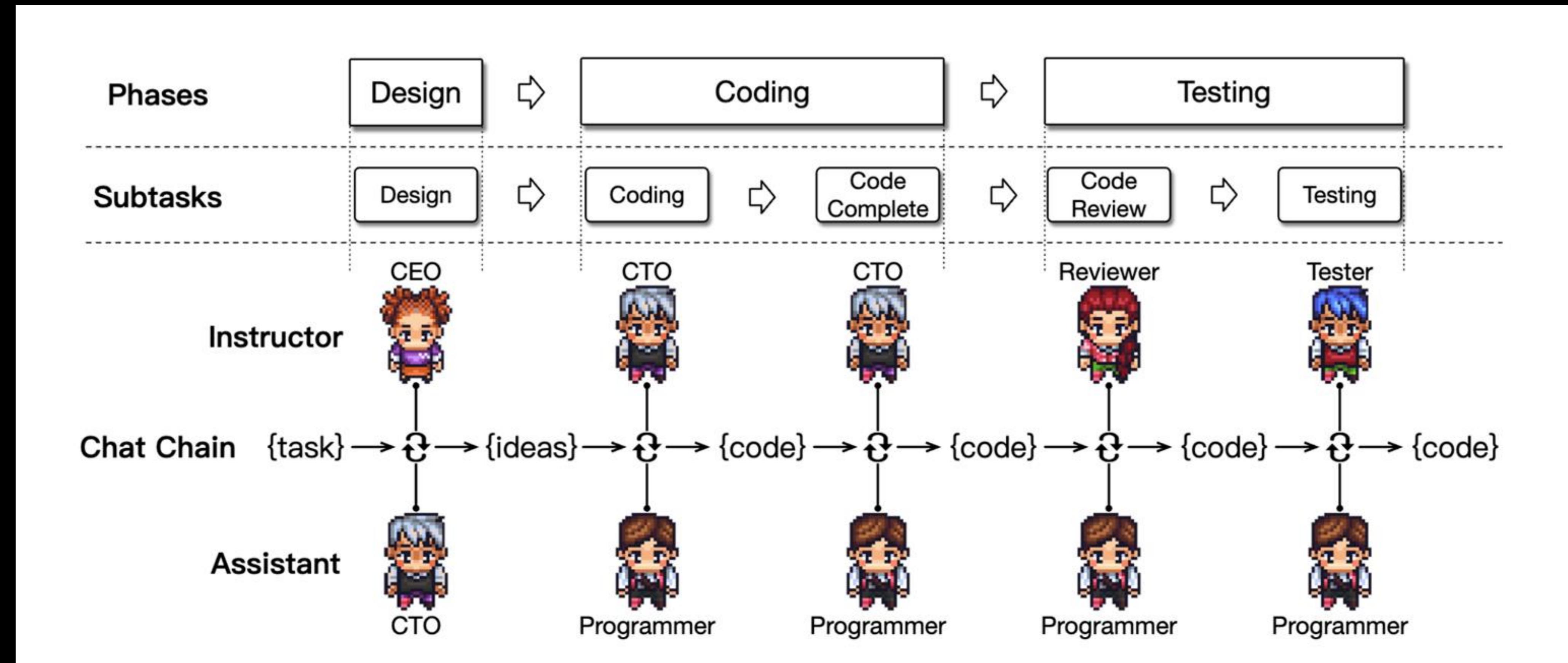
Multi-agent solution with **human in the loop**

Evaluating quality:

- Replicated 1500+ OSS refactorings, improvement over best baseline is **3x**
- **Patches** accepted in open-source projects
- **human in the loop** is crucial to reduce cascading errors by **4x**

ChatDev (*Chen et al., 2024*)

+ MetaGPT (*Hong et al., 2024*), AgileCoder (*Nguyen et al., 2024*), etc.

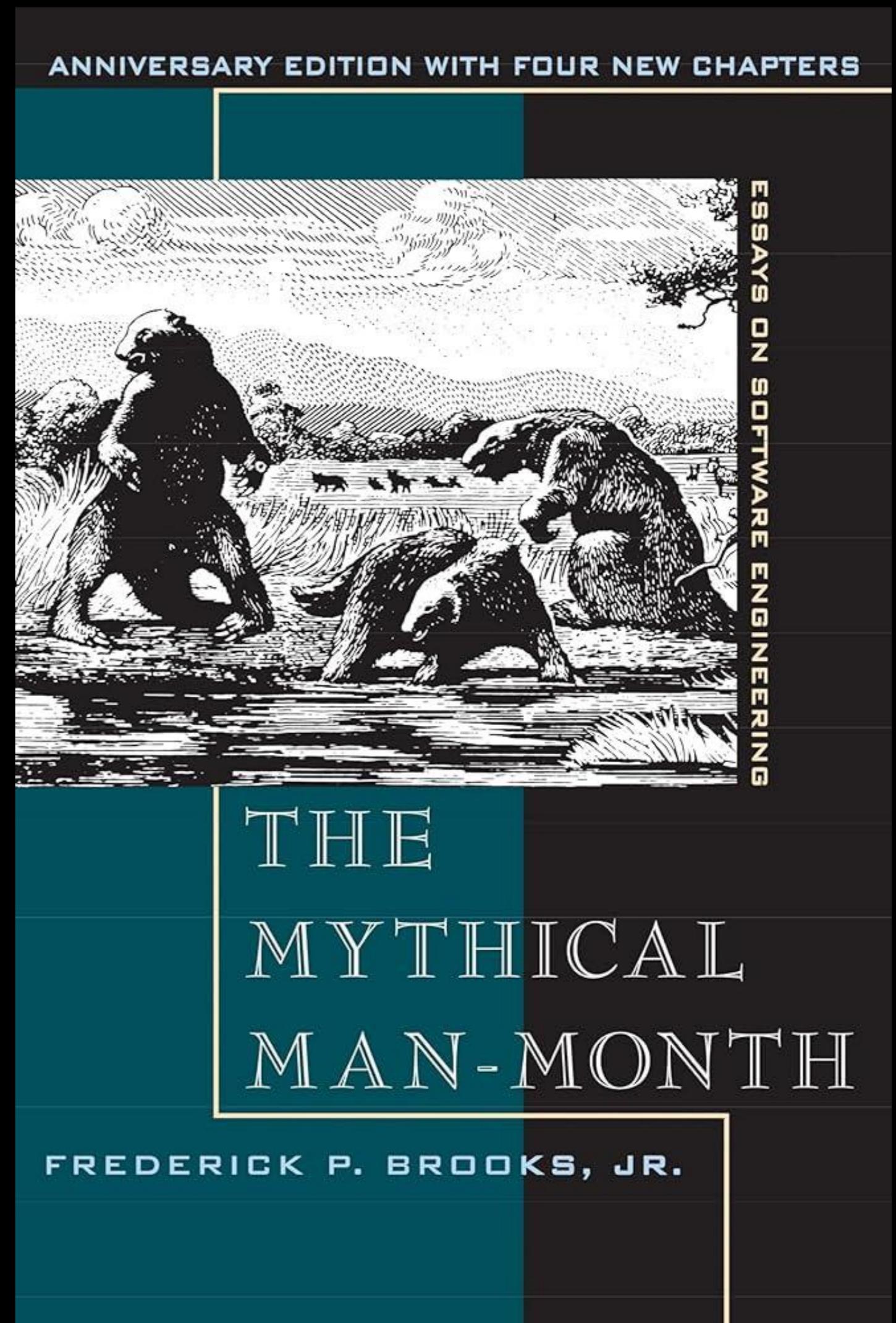


Why learn to Build AI Agents?

Essential vs accidental complexity

Because agents introduce new software problems

- Control flow you don't fully own
- State that evolves unpredictably
- Non-deterministic behavior
- Expensive failures at scale



Course Thesis

Agents are not prompts.

Agents are architectural commitments.

LLMs are components, not systems

Autonomy increases both power *and* risk

Robust agents require discipline

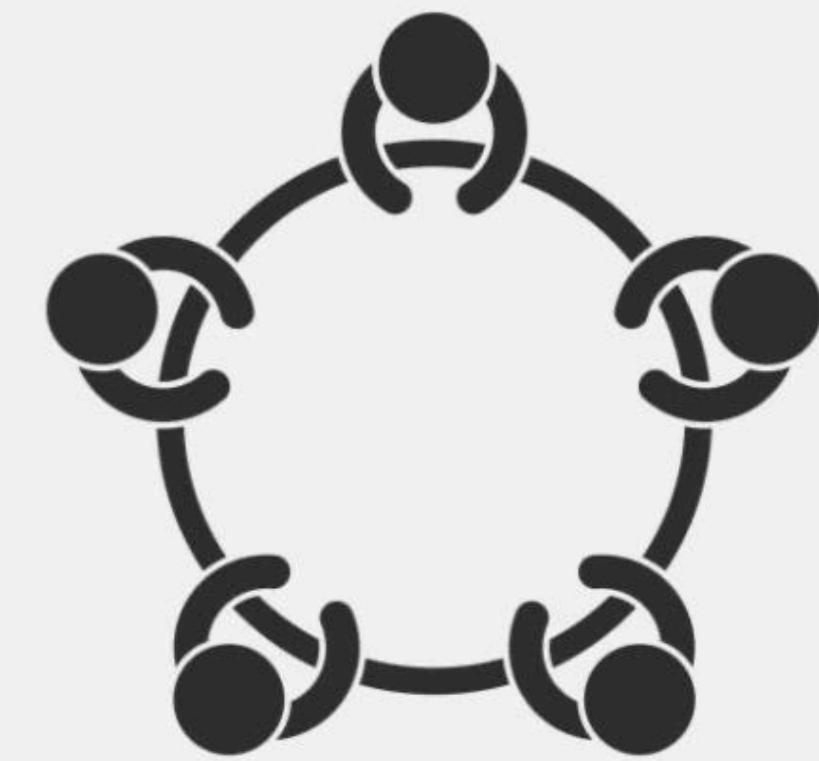
What is Agentic AI?

A system is agentic if it:

- Has goals
- Acts in an environment
- Uses tools
- Maintains state
- Operates over time
- Adapts based on feedback

Getting to know you

Quiz: About YOU



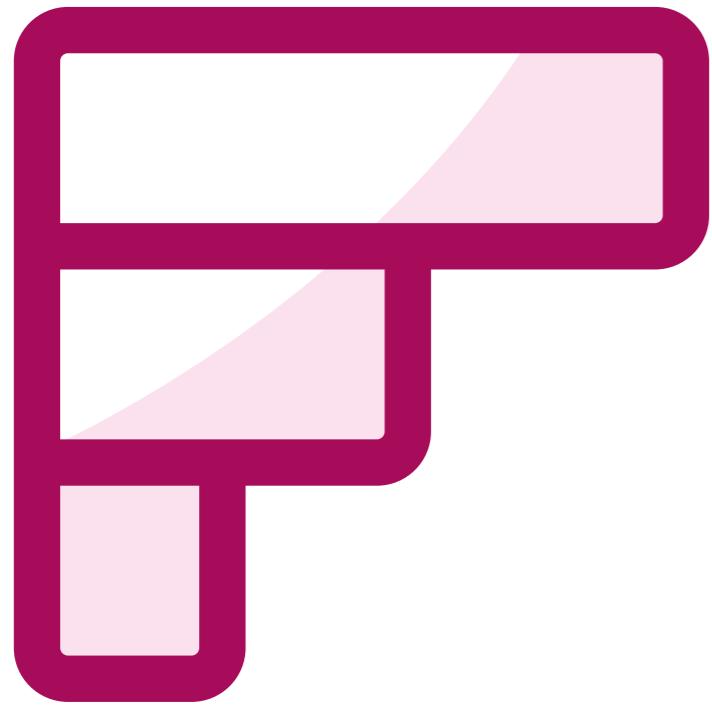
Your name

- **FORM** (family, occupation, recreation, motivation)
- **Grad Program** (e.g., CS PhD, MS, MSCP, etc.), year of study, who is your grad advisor
- Your **background** (e.g., industry experience, other CS background – such as strong SE, ML/AI, Systems, etc.)
- What is the ONE Thing that you **expect** to take out of CSCI 7000-005?

What are your plans **post graduation**?

What are your expectations from CSCI 7000-005: Building AI Agents?

- A. Do a cool Agentic Project that helps programmers/society
- B. Learn about exciting Agentic Applications for SE
- C. Exposure to research on Agentic AI for SE
- D. Learn about the Challenges in building Agentic software
- E. Learn how Agentic software differs from classical software
- F. How and when to build agentic systems
- G. Future-proof my SE career
- H. How to scale agentic systems
- I. Understand agents infrastructure
- J. How to integrate agents with existing applications



Rank these topics based on what you want to learn most in this course.

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Course Administration

Check webpage:

https://danny.cs.colorado.edu/courses/csci7000-005_Sp26

Work items due before next class Wed (01/14):

- Familiarize with class webpage
- sign up on Piazza (all communications through Piazza, no email after this week)
- Read and write critiques for two research papers (see template on webpage). Submit on Canvas before 12pm.

Check prerequisites: computing background (either practical experience or undergrad-level knowledge of SE, Systems, ML), please check with me after the class



Boulder

CS 7000-005 is Different!!!

This class is NOT:

- an introduction to Software Engineering (take instead CSCI 5828)
- a tutorial on GenAI APIs/tools (see free resources on the internet)
- a prompt-engineering class
- a LangChain/MCP tutorial
- a chatbot-building workshop
- an asynchronous course (you need to participate live each class)

This class IS:

- a grad level seminar on agentic software systems
- a place to build serious agentic prototypes
- a space for critique and experimentation

CS 7000-005 is Different!!!

Research-based course:

- at times it would feel it is not "organized"
- there are lots of choices, you need to select
- structure is fixed, but content is dynamic

Complete a research or industrial-novel project of your choice (teams of 4 students) [50% of grade]

- follow the iterative steps of open-ended/risky research (proposal, fit in literature, evaluate empirically)
- at the end of semester you produced a research paper that you can submit to conference, showcase portfolio
- WHY: equips you to lead **novel R&D**



Projects on Agentic AI

Showcase in your job application portfolio

For new grad student, project gives ideas for dissertation

For experienced grad student, project advances your research

Technological shifts/opportunities for Agentic SE:

- any process & tool we use in software development lifecycle (requirements, design, coding, testing, evolution)

Academic-research: generate new insights and knowledge

Industrial-innovation: application of established practices to produce a novel agentic software

CS 7000-005 is Different!!!

Participate in **live class discussion and activities. [10% of grade]**

Read 1-2 research papers for every class meeting (11 pages each, double column => total of 500+ research pages)

- later on, you choose papers that match your project

Paper Critiques: for each class meeting, for each research paper, submit before class (by 12pm) [20% of grade]

- WHY: equips you with **critical thinking**

Research presentation: you prepare and deliver for the selected research papers [20% of grade]

- WHY: equips you to **communicate** your ideas

What Happens Next

Next class:

- **What is an agent, really?**
- **Architectures vs prompts**
- **First research paper discussion**

Before next class:

- **Read the webpage, signup on Piazza**
- **Read two papers**
- **Submit Paper Critique + Questions in Canvas (by Wed at 12pm)**

Office hours: right after the class



Boulder

Testimonials

“The most effective aspects of this course are that Prof Dig challenged students to broaden their GenAI vocabulary and skillset. He used his strengths as a researcher and leader to facilitate great group conversations. I enjoyed the paper presentations where we got to lead class discussions and learn in depth about the topics. **The course workload felt very heavy at times; especially once the group project started.**

... Prof Dig was receptive to hearing feedback and make course adjustments to support our learning and wellbeing. The course content was great, and I am happy with my learnings from this semester.”

[student from GenAI for SE, Fall'25]



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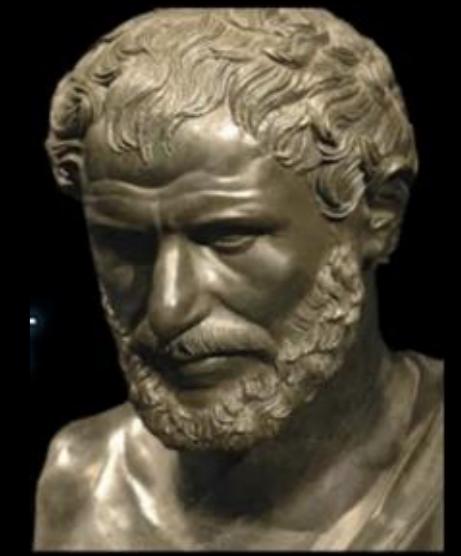
Executive Summary

Agentic AI + Human

"...Game changer! Enter the AI assistant, the great equalizer." -Lenovo CTO

"AI **will not** displace programmers. But programmers who use AI **will** displace programmers who do not use AI." – Prof Danny Dig

Change is the only guaranteed constant



Together We Go Further