

HOW DOES ARTIFICIAL INTELLIGENCE CHANGE THE WAY WE TEACH PROGRAMMING?

A trial lecture for a Doctor of Philosophy (Dr. Philos) degree

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THE DESIRE TO REPLICATE HUMAN COGNITIVE ABILITIES HAS DRIVEN THE DEVELOPMENT OF AI_[11]

HUMAN: THE PHYSICAL BODY AND THE NON-PHYSICAL MIND OR SOUL



SCIENCE & TECHNOLOGY: ROBOT'S PHYSICAL BODY AND ITS AI "MIND" (CONTROL SYSTEM)



HUMAN-LIKE ROBOTS

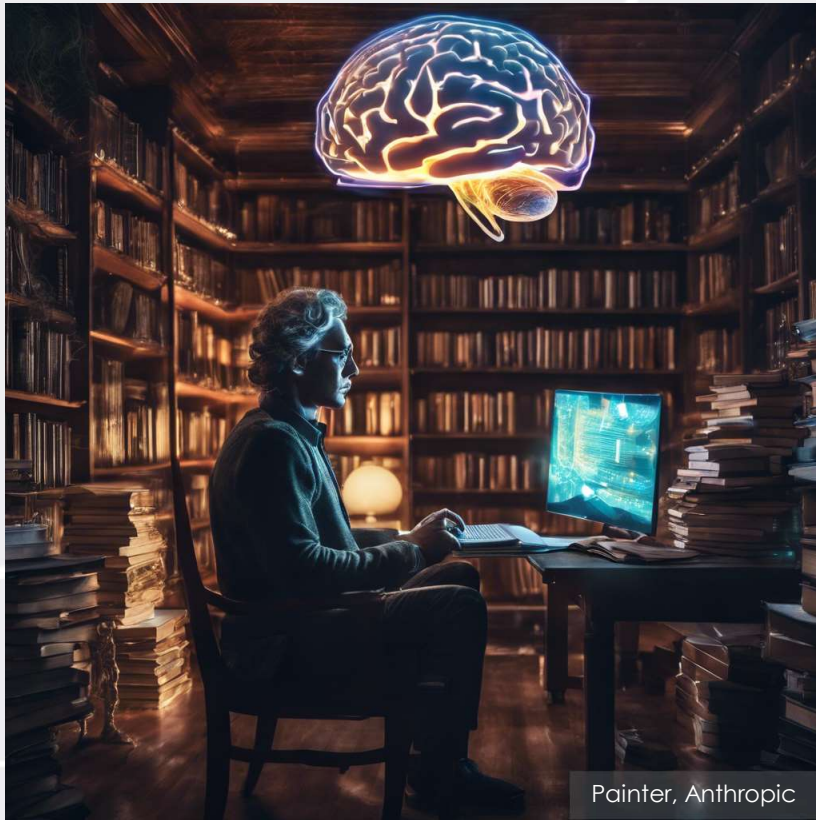


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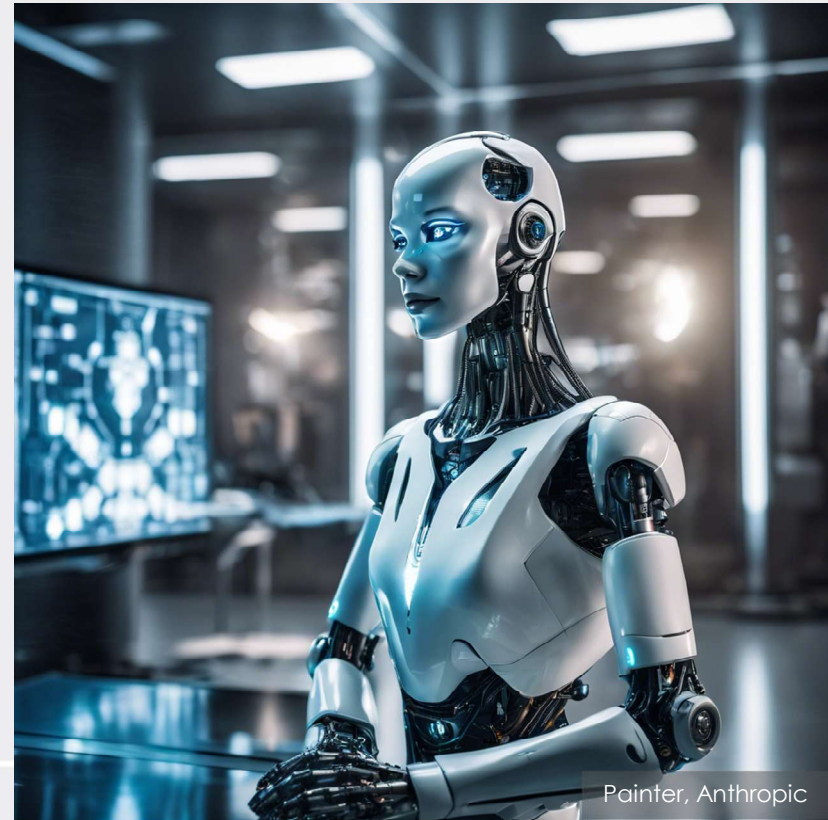


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THE QUEST FOR ARTIFICIAL INTELLIGENCE



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AGENDA



- Introduction
- AI in Programming Education
- Ethical Considerations & Regulations
- Conclusions & Future Directions

THE OBJECTIVES

- Explore AI's influence on programming education
- Highlight opportunities and challenges in integrating AI tools in programming courses
- Address ethical considerations in AI adoption for programming education

DEFINING KEY TERMS

- Artificial Intelligence (AI):
 - Systems that exhibit intelligent behavior using hardware, algorithms, and data
- Generative AI (GenAI):
 - AI models that can generate new original content like text, images, music, and code

AI IN EDUCATION: EMPHASIZING KEY CONSIDERATIONS

- Recent AI models surpass the human performance
- AI systems can produce irrelevant or false information (hallucination)
- Designing prompts to create the intended results



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EXAMPLE: THÉÂTRE D'OPÉRA SPATIAL^[8]



Jason Allen's A.I.-generated work, "Théâtre D'opéra Spatial," took first place in the digital category at the Colorado State Fair. via Jason Allen

THE ROLE OF TECHNOLOGY IN EDUCATION

"Teachers will not be replaced by technology, but teachers who do not use technology will be replaced by those who do." –Hari Krishna Arya [15]



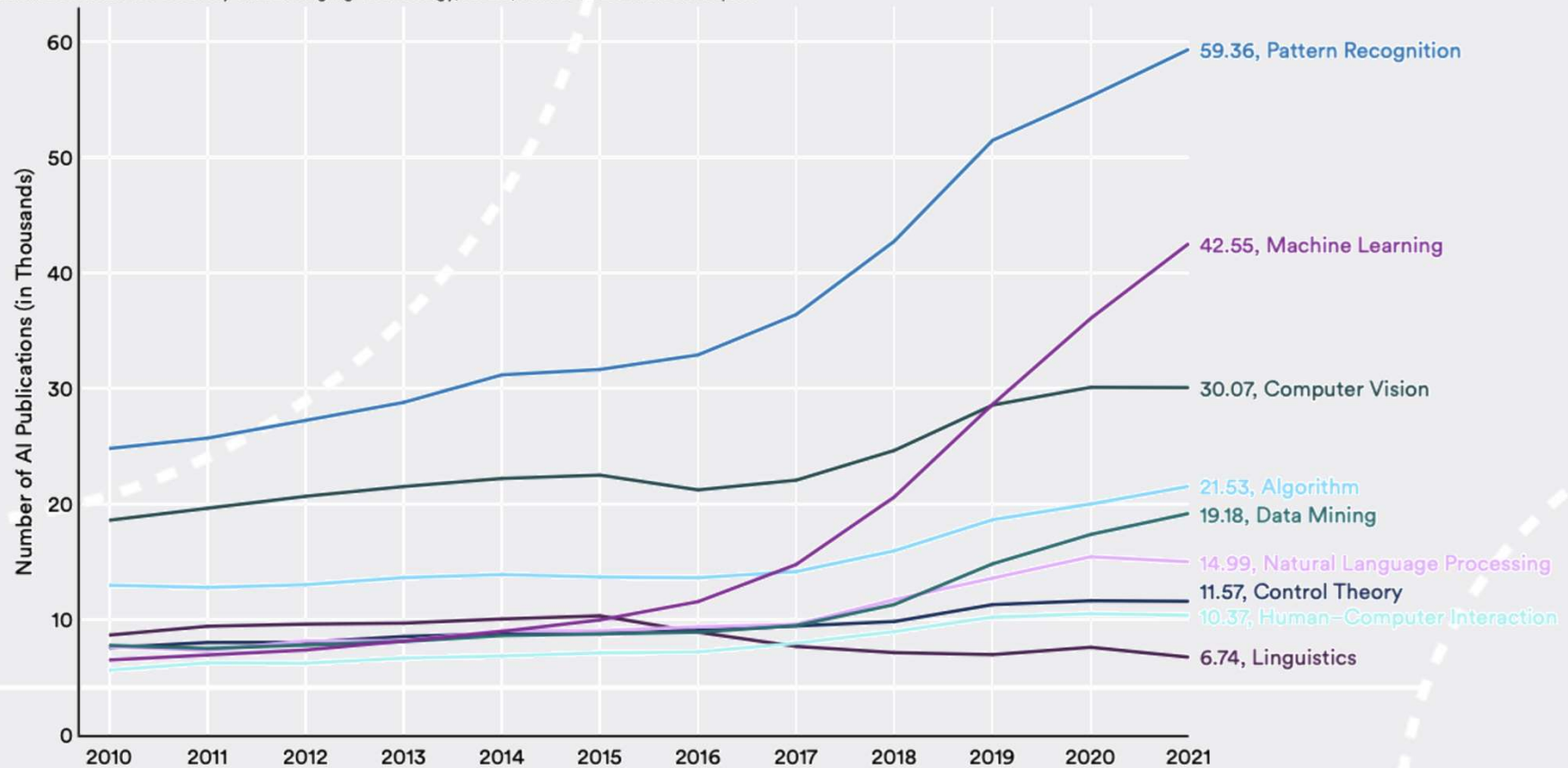
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RESEARCH ABOUT AI IS GROWING RAPIDLY.

CARDONA, M. A. ET AL (2023) [5]

Number of AI Publications by Field of Study (Excluding Other AI), 2010–21

Source: Center for Security and Emerging Technology, 2022 | Chart: 2023 AI Index Report



A TAXONOMY OF AIED SYSTEMS

HOLMES, W., & TUOMI, I. (2022), [12]

- **Student-focused**

- Intelligent Tutoring Systems (ITS)
- AI- assisted Apps
- AI- assisted Simulations
- AI to Support Learners with Disabilities
- Automatic Essay Writing (AEW)
- Chatbots
- Automatic Formative Assessment (AFA)
- Learning Network Orchestrators
- Dialogue-based Tutoring Systems (DBTS)
- Exploratory Learning Environments (ELE)
- AI-assisted Lifelong Learning Assistant

- **Teacher-focused**

- Plagiarism detection
- Smart Curation of Learning Materials
- Classroom Monitoring
- Automatic Summative Assessment
- AI Teaching Assistant (including assessment assistant)
- Classroom Orchestration

- **Institution-focused**

- Admissions (e.g. student selection)
- Course-planning Scheduling Timetabling
- School Security
- Identifying Dropouts and Students at risk
- e-Proctoring

AI TOOLS IN SOFTWARE DEVELOPMENT

As software development becomes increasingly reliant on AI-powered tools, it is crucial to examine how these advancements can enhance programming education.



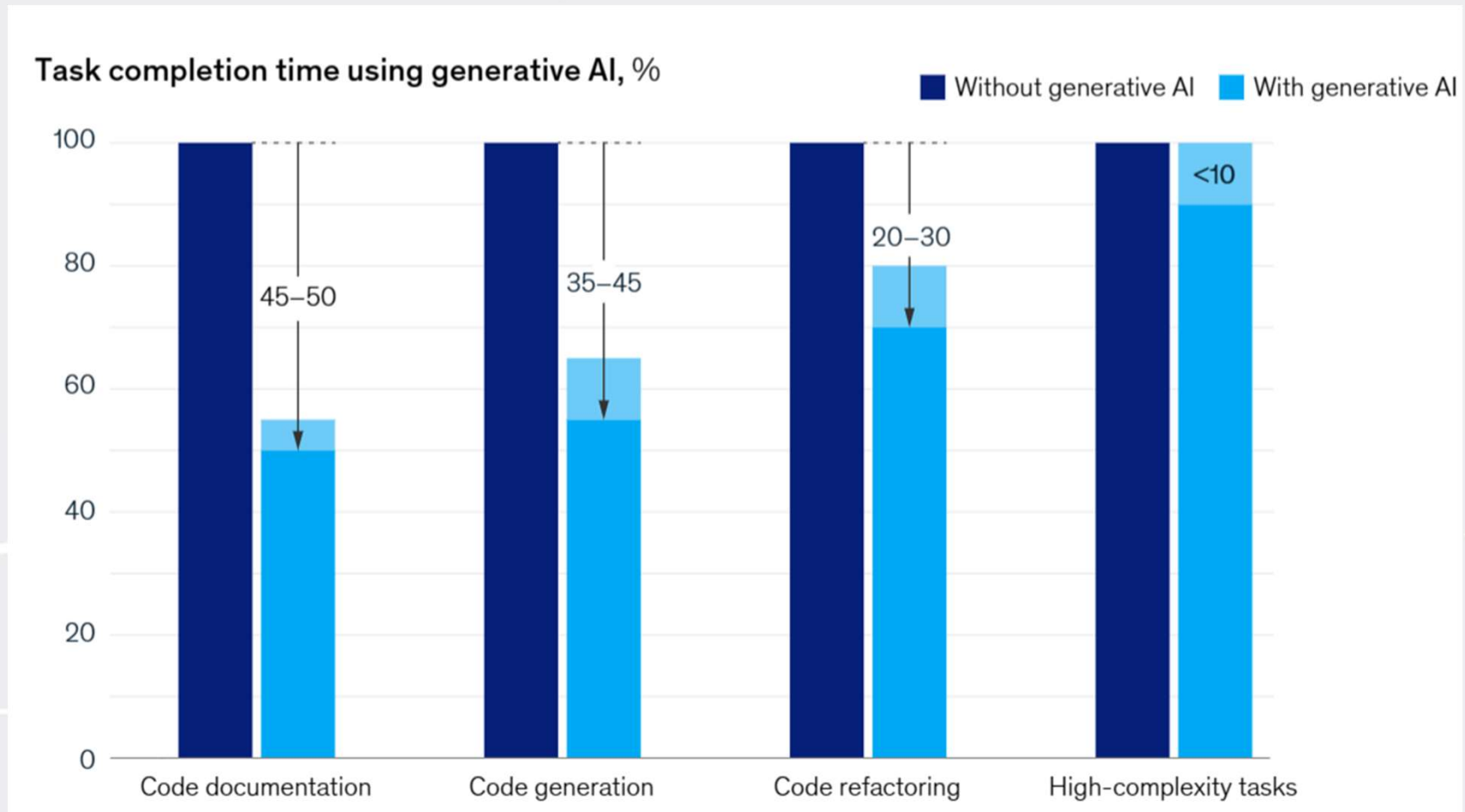
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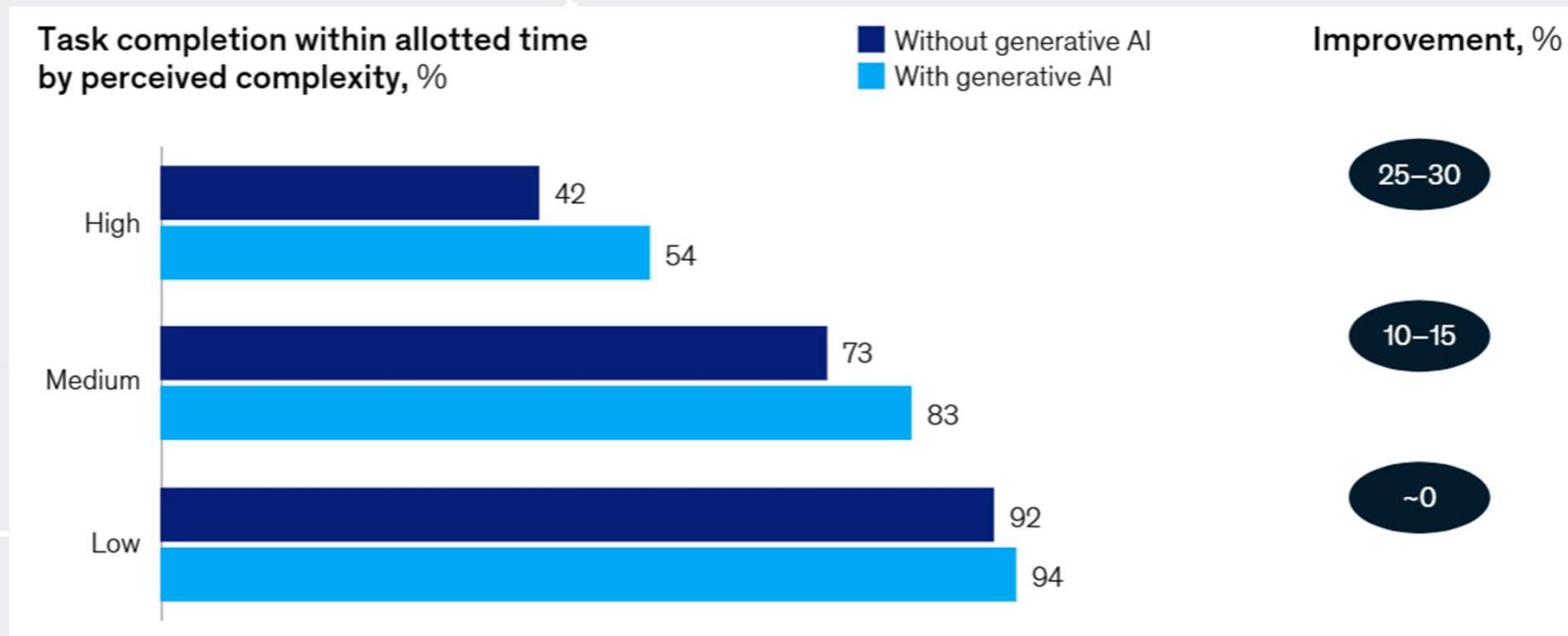
AI IN PROGRAMMING EDUCATION

RESEARCH ON EFFECTIVENESS OF GEN AI: CAN INCREASE DEVELOPER SPEED, BUT LESS SO FOR COMPLEX TASKS [10].



MORE LIKELY TO COMPLETE COMPLEX TASKS WITHIN A SET TIME FRAME

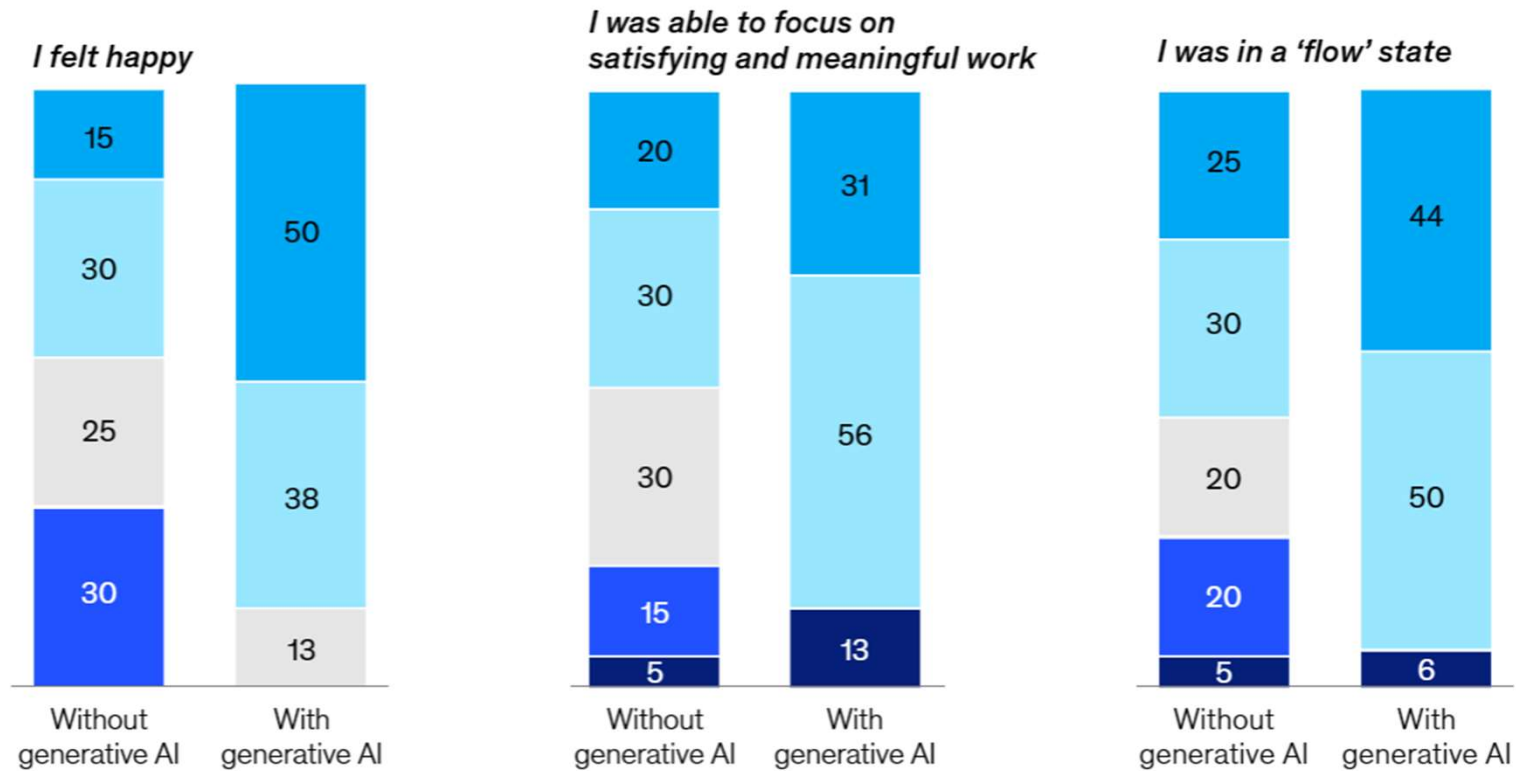
“Developers using generative AI to assist with complex tasks were more likely to complete those tasks within a given time frame” [10]



"GENERATIVE AI TOOLS HAVE POTENTIAL TO IMPROVE THE DEVELOPER EXPERIENCE" [10]

Agreement with statement,
% of respondents

Strongly disagree Somewhat disagree Neither agree or disagree Somewhat agree Strongly agree



Note: Figures may not sum to 100%, because of rounding.

TRANSLATION FROM PROBLEM TO CODE IN SEVEN STEPS (HILTON, A. D. ET AL., 2019, [9])

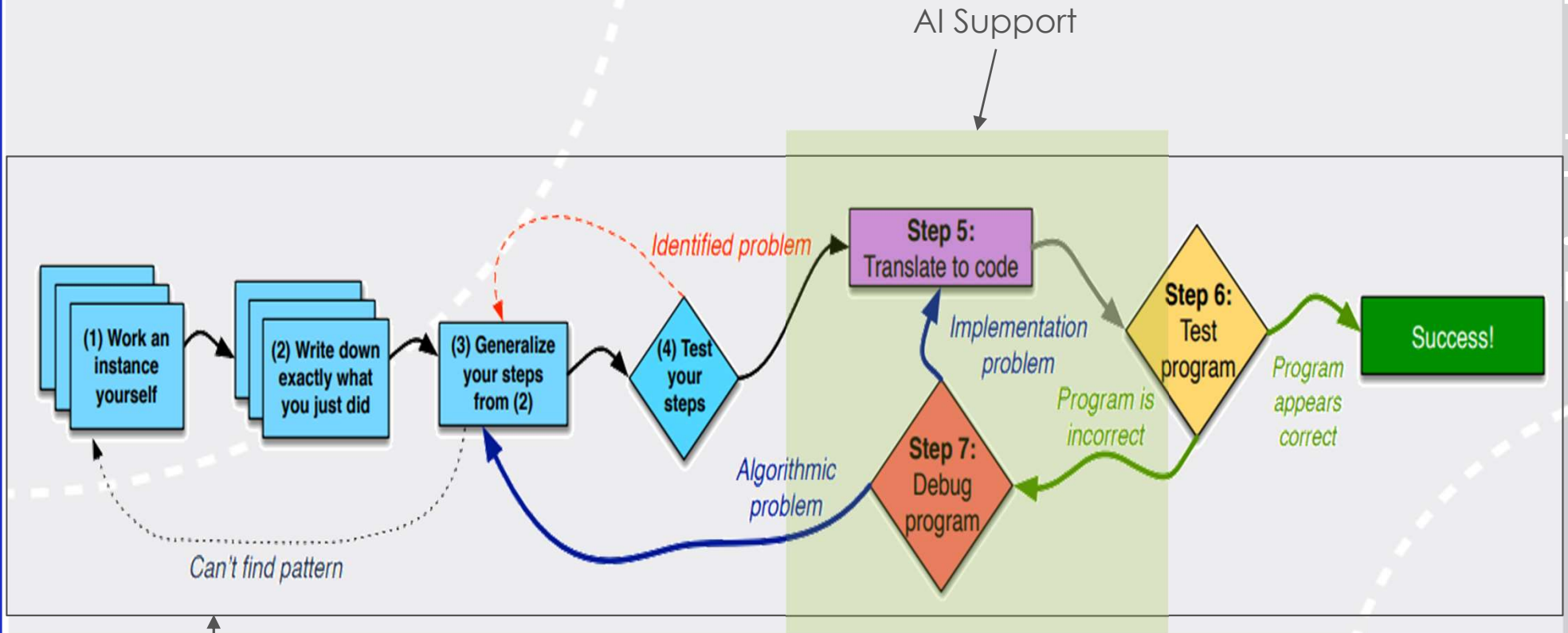


Figure 1: Diagram of The Seven Steps [9]

The responsibility of the programmer

A CHANGE IN PARADIGM

- Shifting Focus to Higher-Level Concepts
- Promoting Computational Thinking
- Students learn to think like software developer
 - approach problems systematically, leveraging AI tools as aids.



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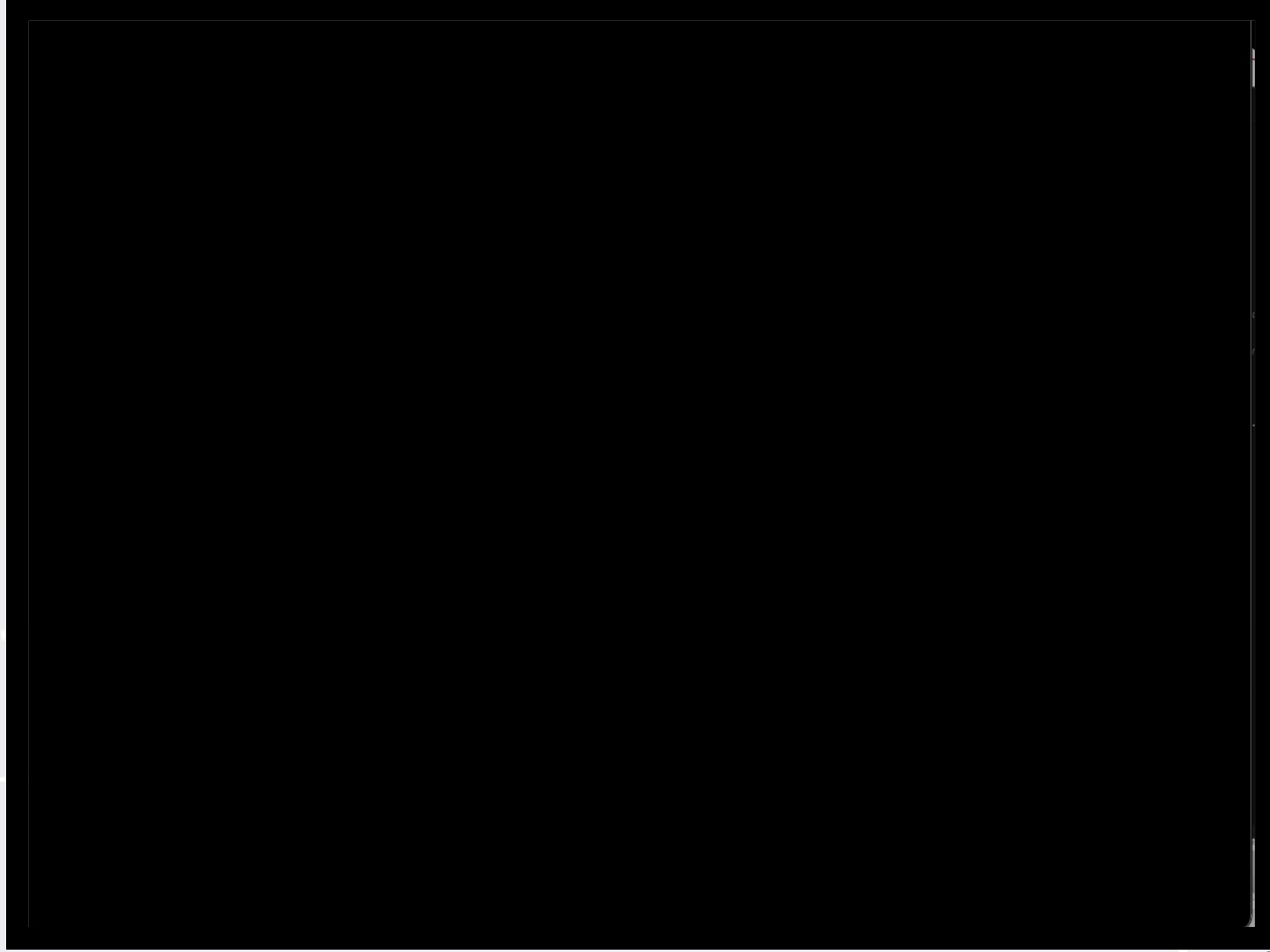
GENAI AS A 1:1 COACH FOR THE SELF-PACED ACQUISITION OF FOUNDATIONAL SKILLS IN LANGUAGES. HOLMES, W., & MIAO, F. (2023) [1]

- AI assistants as "practice students" allowing instructors to focus less on the mechanics of coding and more on pedagogy and student learning.
- GitHub Copilot, ChatGPT, Codeium, Codex, Cody



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GITHUB COPILOT: AI ASSISTANT



CHATGPT AS A PEER-REVIEWER


The image shows a chat interface with a white background and a black border. At the bottom, there is a text input field containing the text "Send a message" and a blue right-pointing arrow button. Above the input field are four rounded rectangular boxes, each containing a prompt. The prompts are arranged in two columns. The top-left prompt is "Explain this code:" followed by the code snippet `"cat config.yaml | awk NF"`. The top-right prompt is "Recommend a dish" followed by "to bring to a potluck". The bottom-left prompt is "Write a thank-you note" followed by "to our babysitter for the last-minute help". The bottom-right prompt is "Compare storytelling techniques" followed by "in novels and in films".

Explain this code:
`"cat config.yaml | awk NF"`

Recommend a dish
to bring to a potluck

Write a thank-you note
to our babysitter for the last-minute help

Compare storytelling techniques
in novels and in films

Send a message 

AUTOMATED CODE EVALUATION

The screenshot shows the Gradescope interface. On the left is a navigation sidebar with the Gradescope logo and a menu. The main content area is titled "8 Assignments" and displays a table of assignments. The table has columns for Name, Points Released, Due (CEST), Submissions, % Graded, and Published/Regrades. The assignments listed are:

Name	Points Released	Due (CEST)	Submissions	% Graded	Published/Regrades
<u>Online Assignment (Beta)</u>	18.0	Time Limit: 60 Minutes APR 24, 2024 7:37 AM - JUN 5, 2024 7:37 AM	9	60%	ON
<u>Computer Science - Python Programming Assignment</u>	30.0	APR 24, 2024 7:37 AM - MAY 8, 2024 7:37 AM	7	50%	ON
<u>Physics Exam</u>	15.0	Apr 24	20	0%	ON
<u>Mathematics</u>	25.0	Apr 24	20	0%	ON

Examples: Gradescope, Codio, Codegrade, and Vocareum

HANDLING ERRORS

The screenshot displays an IDE window with a chat interface on the left and code on the right. The chat interface shows a user asking for help with a compilation error. The error message is: "Exception in thread 'main' java.lang.Error: Unresolved compilation problem: The method chillingMethod() is undefined for the type ColdBrewedBeverage".

The chat interface provides a solution: "To fix this issue, you need to define the `chillingMethod()` in the `ColdBrewedBeverage` class. Here's how you can do it:"

```
abstract class ColdBrewedBeverage extends BrewedBeverage
// Other methods...

public void chillingMethod() {
// Implementation of chillingMethod
}
```

The code editor on the right shows the `ColdBrewedBeverage` class with the `chillingMethod()` method implemented. The terminal output shows the program running successfully, printing the following text:

```
Dripping Coffee through filter
Pouring into cup
Adding Sugar and Milk

Preparing Tea...
Boiling water
Steeping the tea
Pouring into cup
Adding Lemon
45)
45)
45)

at BeverageTemplateAbstract.prepareBeverages(BeverageTemplateAbstract.java
:159)
at BeverageTemplateAbstract.main(BeverageTemplateAbstract.java:166)
PS C:\Users\majid\github\drphilos\drphilos-trial-lecture-1>
```


CHATGPT DECREASES THE NUMBER OF QUESTIONS ASKED ON STACK OVERFLOW^[16]

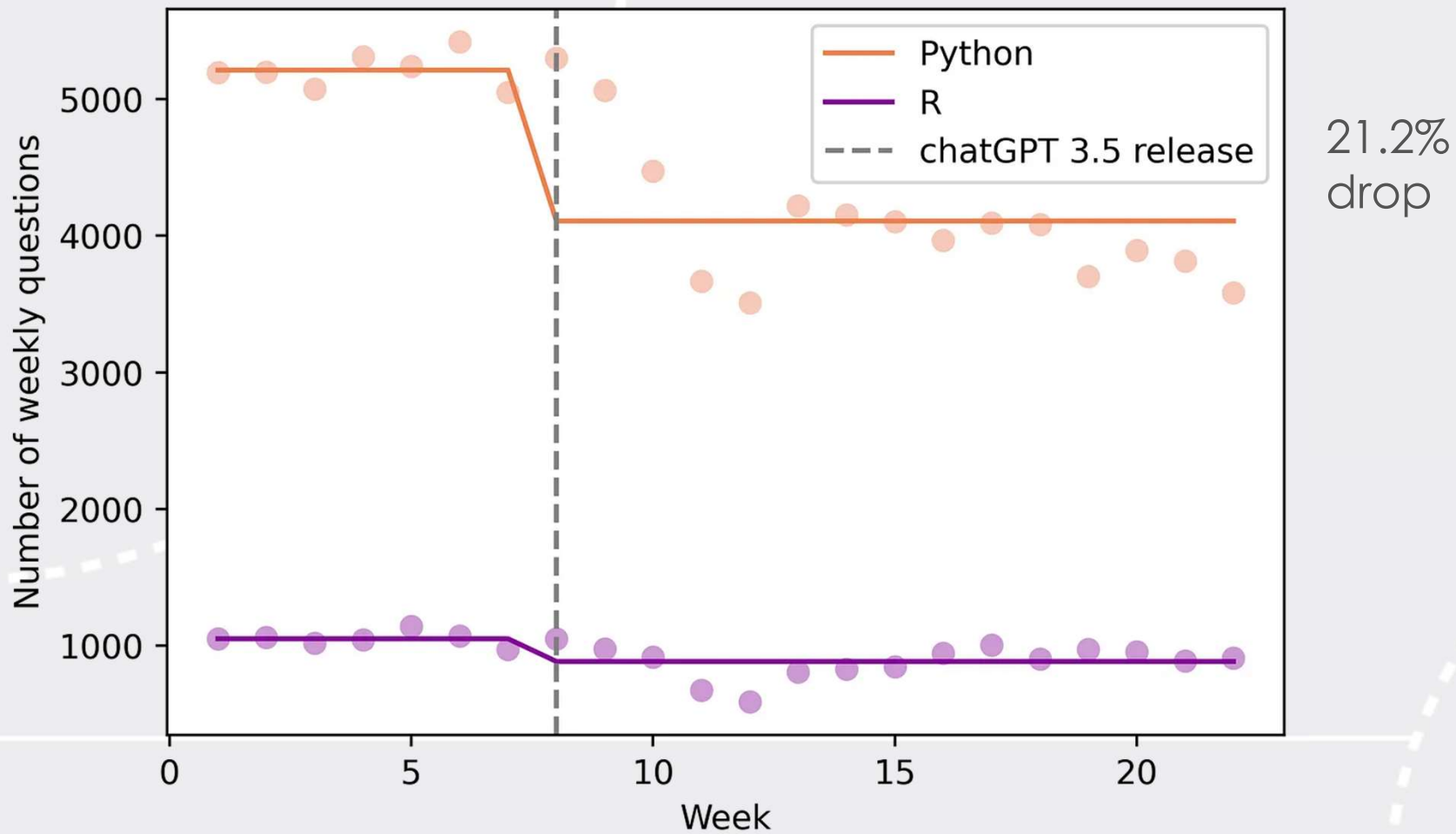


Figure 1: The effect of ChatGPT on weekly number of questions on Stack Overflow
Quentin G.(2023)[16]

HOW AI IS CHANGING THE WAY WE CODE

“These findings support the view that generative AI could revolutionize our work by taking care of routine questions, allowing us to focus on more complex problems requiring expertise while boosting our productivity”, Quentin Gallea (2023)[16] .

ETHICAL CONSIDERATIONS AND CONCERNS



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ETHICAL ISSUES & CONCERNS IN PROGRAMMING EDUCATION

OLSSON, E. ET AL.(2024) [14]

- Overreliance on AI-generated code by students
- Challenges in determining the boundary between authorized and unauthorized use of AI tools
- Potential negative impact on the credibility and reputation of programming education institutions if students become overly dependent on AI tools.
- Ethical considerations such as responsibility, integrity, security, transparency, explainability, and bias that should be considered when using AI in programming.

COPYRIGHT AND INTELLECTUAL PROPERTY

- Unauthorized use of copyrighted works violates exclusive rights.
- Determining ownership of generated works is increasingly challenging.
- Lack of traceability raises concerns about fair attribution.

RETHINKING ASSESSMENT AND LEARNING OUTCOMES

HOLMES, W., & MIAO, F. (2023)[1]

- Key learning outcomes to consider
 - Values for human-centered technology design
 - Foundational knowledge and skills
 - Higher-order thinking for human-AI collaboration
 - Vocational skills for working with AI

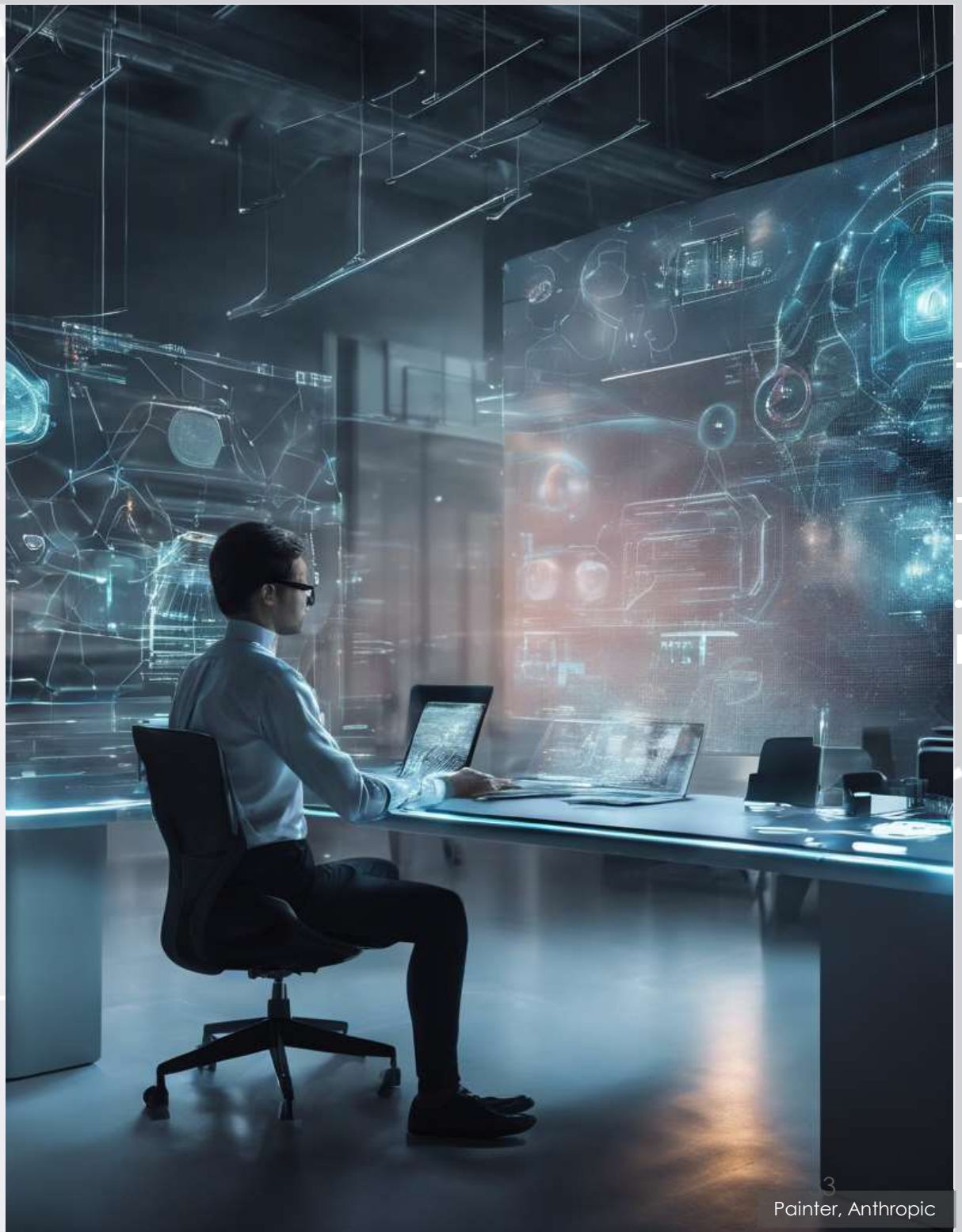
FUTURE DIRECTIONS: REGULATIONS & RECOMMENDATIONS

- US office of educational technologies
 - Building Ethical, Equitable Policies Together Cardona, M. A. et al. (2023), [5]
- UNESCO
 - Guidance for generative AI in education and research Holmes, W., & Miao, F. (2023), [1]

FUTURE DIRECTIONS: ADDRESSING ETHICAL AND SOCIETAL IMPACTS

- Courses addressing ethical AI, including biases, impacts, and responsible use.
- Students learn to critically examine (Critical thinking) AI-generated code and consider issues like data privacy, security, and inclusivity

GENERATIVE AI - A **COLLABORATOR**, NOT A **REPLACEMENT**



THE THREAT OF AI

"...I try to understand the challenge presented by the prospect of superintelligence, and how we might best respond. This is quite possibly the most important and most daunting challenge humanity has ever faced. And - whether we succeed or fail - it is probably the last challenge we will ever face." (Boston, 2014)



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“We can only see a short distance ahead, but we can see plenty that needs to be done.”

-Alan Turing

SUMMARY

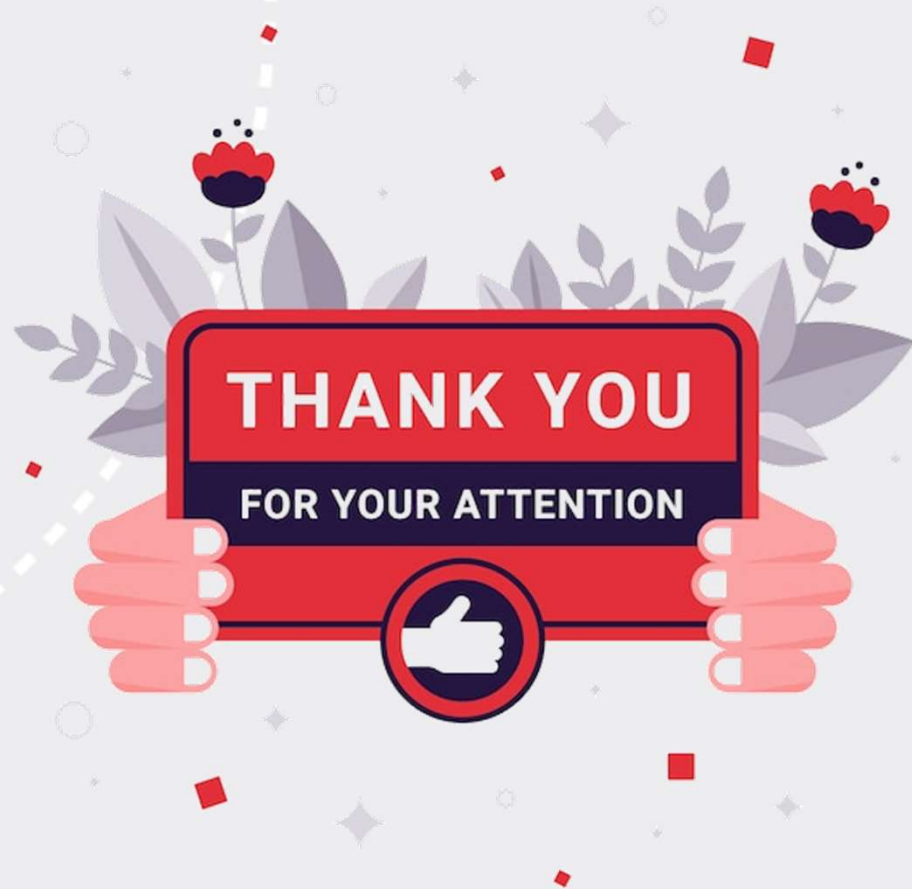
- Personalized learning and adaptive feedback
- Opportunities: AI-driven automation of grading and feedback
- Challenges: Ethical concerns around AI-generated code and the need for clear guidelines on intellectual property rights in programming.
- Rethinking assessment and learning outcomes
- Developing human-centered policies and regulations

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