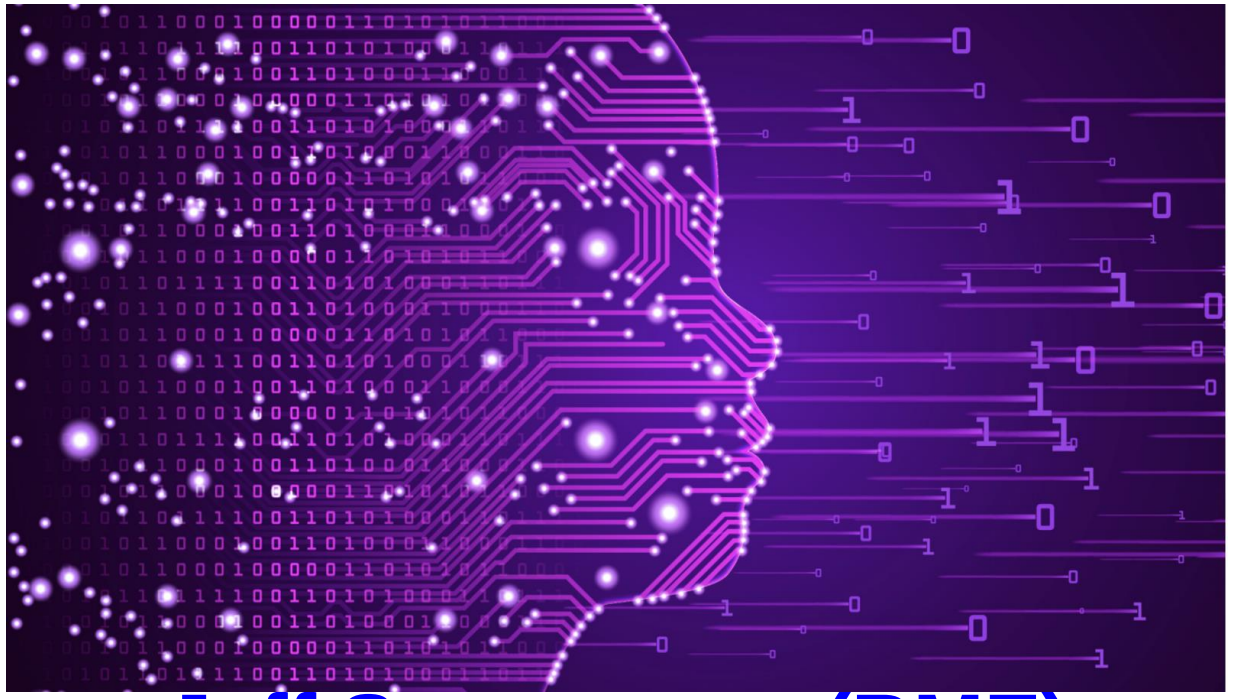
Does use of generative AI affect coding performance and confidence in BME 2315?



Jeff Saucerman (BME)

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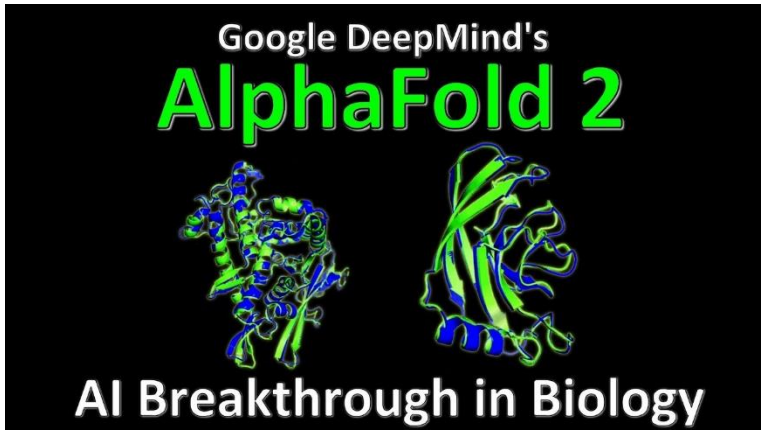
UNIVERSITY of VIRGINIA

Generative AI

Generative artificial intelligence (AI) is artificial intelligence capable of generating text, images, or other media, using generative models.
https://en.wikipedia.org/wiki/Generative_artificial_intelligence

ChatGPT



Text (2022, word prediction)
https://openai.com/chatgpt

Images (2022)
Midjourney DALL-E2
https://midjourney.com

Protein structure
AlphaFold2 (2021)
Jumper+ Nature 2021

Rationale for teaching and using generative AI in a BME course on numerical methods

- Teaching Generative AI for coding may:
  - Demonstrate how this course relates to modern developments in AI
  - Provide additional learning support and an example of continuous learning
  - Demonstrate the pitfalls of using AI for coding
  - **Alternatively, AI may be a crutch that hinders learning of how to code**
- Lecture provided on how large-language models work, hallucination
- Practical instruction on using generative AI to code: writing, commenting, explaining, debugging, translating, unit tests

https://www.pinterest.com/pin/246501779595085084

BME 2315 problem sets incorporating genAI

Problem Set	Topic
1	required
2	fibonacci
3	Pi estimate
4	diff and int
5	gaussian elim
6	interpolation
7	root finding
8	optimization
9	regression
10	ODEs
11	MATLAB

- Typical problem sets have 1/3 analytical calculations with numerical methods, **1/3 coding the numerical methods against unit tests**, and 1/3 application of the codes to analyze biomedical data or modeling a biological system.
- **Students were required to use generative AI for 1 assignment, then given the option to use generative AI for the remaining 10 assignments**
- After the course, a quiz was given to assess interest in engineering and medicine and to evaluate knowledge of core concepts.

Mixed student comments on generative AI during weekly surveys

Pro

- **“**ChatGPT use was very helpful for this problem**”**
- **“**This was my first time using generative AI and I thought it was really interesting.**”**
- **“People who know coding decently well can really harness chatgpt to its fullest.”**
- **“Using chatgpt definitely helps in doing the problems. There are a lot of halluciantions generated but logically working through is helps me learn the concepts and understanding the reasoning better.”**

Pro/Con

- “It was very interesting learning about ChatGpt and other AI tools and how they do not have very good computational skills.”
- **“**I was able to solve problem 1 with AI but I had to redo the problem with Bard instead of ChatGPT. The code ChatGPT came up with did not pass the unit tests ChatGPT came up with. **”**
- **“**Even though I used Chat GPT, I had to edit the code to make the test case work.**”**
- **“**ChatGPT gave very comprehensive code, but it wouldn't work so time was spent debugging the code.**”**
- **“**The code given from ChatGPT was not correct, had to edit and figure out myself for the code to work.**”**
- **“**It's interesting how one chat bot can do a problem correctly while another can’t.**”**
- **“I**t was difficult. I generated my own code and then used ChatGPT to debug it. **”**

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Student comments on course evaluations uniformly were positive

Pro-Inclusion of AI (5/5 comments)

- “time for questions and in class discussion about current topics and how they related to the class, such as AI, and allowed us all to each formulate our own opinion and talk about it, rather than just viewing one perspective.”
- “use of generative AI this semester opened up a lot of knowledge seeking opportunities and how AI can be both advantageous and disadvantageous.”
- “open ended questions like the ones referring to AI”
- “I enjoyed the applications of numerical methods to cardiac modeling, as well as the emphasis on AI.”
- “I also think the new content about ChatGPT and other generative AI was super informative and helpful for many contexts that will be applicable to our futures in BME.”

Notably, these end-of-course questions are reflective of the entire course experience, while weekly survey responses were more focused on an individual assignment.

Some of these perspectives on AI might be addressed through class discussion/reflection rather than practical use of ChatGPT

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Conclusions from teaching and use of generative AI for coding in BME 2315

- **Students were highly engaged in discussions on generative AI and *potential* for technical use**
- Overall, **most students found generative AI helpful.** But generative AI did not affect average completion or speed for coding problems (except hardest problems), or associate with performance on conceptual problems or career goals.
- **Proficient students saw the most benefit.** But most students that did not use generative AI still found that it was it helpful. *paradox?*
- Generative AI **shifted student effort** from drafting code to debugging and revising code, optimizing ChatGPT prompts. Students were sometimes disappointed that it was not even faster.

- ***Conclusion:* Generative AI in BME 2315 was engaging and helpful, but somewhat confuses some students without having marked educational benefit. Perhaps place generative AI at the end of BME 2315 as a more advanced application?**

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