# Generative AI Tools Experiences in Computer Science Capstone: Spring 2024

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Before the Spring 2024 semester started, I wrote about my experiences using Generative AI tools in my Fall 2023 capstone course in Computer Science. I alluded to some new ways we would explore using these tools during the spring semester.  In this article, I report on our experiences this past semester.  This article and three previous ones are available at https://maherou.github.io/Teaching/AI-Assisted-Research/

## Things that continue to work

First, here are some approaches that I have previously mentioned that continue to be effective.

1. **Topic selection:** Using generative AI tools to brainstorm topic selection continues to be effective. Every student finds a meaningful research topic. This is an excellent improvement over the past when one or two students struggled to find a good topic each semester.

2. **Dialogue-based assessment:** Dialogue is the foundation for grading. Throughout the semester, I meet individually with students and assess their levels of expertise on a scale from 1 to 10. While this approach is prone to subjectivity, its value as a means to reduce cheating and ensure student learning is essential.

3. **Generate-refine writing model**: I expect a complete draft submitted for every major written assignment, telling the students to submit a paper that they might have previously considered the final version of an assignment.  Then, a few days later, I have students submit the final version.  When I grade the assignment, I compare both versions with the expectation that the final version covers the same basic content as the draft but is of higher quality in our writing metrics.  By expecting all content to be present in the draft, I find that students can use generative AI tools more freely during content development of their draft and then transform the generated text into their own voice with refined arguments in the final paper.  This approach rewards the generate-refine writing model that I find effective for many AI-assisted activities.

4. **Virtual course instructor:** I continue to make a virtual course instructor available to my students. This special instance of ChatGPT is fine-tuned by incorporating the course

handbook. This approach is known in the literature as retrieval augmented generation (RAG). Several students this past semester made extensive use of this tool in preparing major assignments with good success.

5. **Demonstration prototype creation:** Student-developed prototypes continue to become more sophisticated as AI tools for software development become more prevalent and capable. Students can leverage software libraries and rapidly build a working software prototype in ways that would not have been possible in the past. As with writing papers, the generate-refine model is effective.

## New approaches used this semester

In my January 2024 article, I mentioned two ideas I planned to try during the Spring 2024 semester:

1. **Addressing depth of understanding:** Because generative AI tools can produce relevant content on a given topic from the beginning, some students read it and think they understand the topic when they don't. This semester, I required students to develop a thesis statement that included a description of the algorithm elements of their project. This statement was helpful as a description of the project and a diagnostic of student progress in acquiring depth of understanding: a shallow thesis statement indicated a shallow understanding of their topic. Adding a thesis statement as an explicit and early requirement significantly improved student depth of understanding.

2. **Integrating cross-discipline content:** We did not include additional cross-discipline content in our primary papers. Instead, we spent a lot of time outside of class reading, viewing, and listening to cross-discipline content and then discussing this content in class. This approach was a suitable adaptation to address the goal of integrating student liberal arts backgrounds.

## Emerging themes

Several cross-cutting themes have emerged this semester.

1. **Alignment:** A critical emerging concern in our generative AI tool-building activities is *alignment,* specifically, the alignment of what our computing tools do with our values. Computing capabilities have had practical applications for many decades, impacting our daily lives in ways we are both aware of and unaware of. However, with the emergence of generative AI capabilities, the potential impact of computing-based tools on our lives is increasing. We are becoming increasingly aware of the negative impacts of the past decade of social media tools, especially on young people. We see the rapid integration of generative AI tools into our information systems now, and we foresee even more generative AI tools becoming available.

   An important element of the course is independent reading, viewing, and listening to

computer science-related content on diverse topics chosen by the students for in-class discussions. Much of our discussion was focused on concerns of alignment. Generative AI tools have become so capable that we are always considering how to make them help us and not harm us. We regularly discussed ethical, cognitive, social, and other human-centric concerns. I pointed out to students that their liberal arts education at CSBSJU provides an excellent foundation for them as computer scientists since their future professional efforts will likely need to consider alignment issues in profound ways.

2. **Access to broad and deep expertise:** While there are many ways to misuse generative AI tools as a substitute for learning, the potential for using these tools to accelerate and complement learning is truly profound. Using tools like ChatGPT, we have an unprecedented knowledge resource for many academic disciplines. For my own area of computing—applying computational methods to mathematical problems in linear algebra—ChatGPT can correctly explain concepts of orthogonality, the challenges of finite-precision arithmetic, the opportunities for using fast, low-precision arithmetic available on today's modern processors, how to use a fused multiply-add hardware instruction to accelerate simulated high-precision arithmetic using fast low-precision arithmetic, and more. ChatGPT can even generate the computer code to execute the algorithms.

   One observation from the above experience is that the knowledge I had acquired over many years of study and work was now available on demand for anyone at any time.

3. **Summarizing content:** Generative AI tools are exceptionally good at summarizing content, and we learned some useful techniques to integrate this step in our learning process. Of particular value was uploading a potential resource to ChatGPT and asking for a summary. Students could more easily identify articles that would be most useful.

   During the semester, I use a conference management system called EasyChair to give students experience performing peer reviews. As part of their review of classmate papers, students were asked to summarize the paper first and then provide feedback. Some students took a shortcut in summarizing the paper by using ChatGPT and offered only minimal constructive feedback. I think there is value in using ChatGPT to help summarize, but relying solely on ChatGPT for this task is inadequate. Next semester, I will encourage students to summarize classmate papers using ChatGPT and also produce their own independent summaries. This approach should provide a holistic response to this challenge.

4. **The changing research enterprise:** I do not consider myself prone to making grandiose statements, but I cannot credibly tone down my opinion of how much generative AI tools are impacting how we learn, produce, and communicate information and knowledge. It is difficult for me to predict a long-term and stable outcome since the tools and our use of them are evolving so rapidly. Even so, the impact is already

apparent and will increase.

5. **Human-centric computing:** As the capabilities of computing-based tools and the rate at which we deliver them increase, and the effort to create them decreases,  more of our time and effort should be spent deciding what we want the computing field to produce and not produce.  I believe it is important for our academic community as a whole, and our computer science students specifically, to know and appreciate important concepts in human-centric computing.  Producing students who understand and appreciate both the human and technical concerns of generative AI tools is something CSBSJU can accomplish quite well.

## Summer reading suggestions

Much content is produced about generative AI, and much of it is interesting and relevant, exploring multiple viewpoints and concerns.  I read a lot of it.  Here are two sources I have found particularly good and that I think would be of interest to members of our community.

1. **The Alignment Problem: Machine Learning and Human Values by Brian Christian**
This book synthesizes a broad collection of research results, anecdotes, and quotes to discuss how machine learning technologies, including generative AI tools, reflect and influence our values. It is written with a general reading audience in mind, and I think many faculty members would find it interesting. It is available in print, Kindle, and audio format. I have enjoyed listening to the author read the audio version (on Audible).

Here is a link to the author's website: https://brianchristian.org/the-alignment-problem/

2. **One Useful Thing by Ethan Mollick**
This is a website containing a collection of articles. I find the content very interesting as it describes the status of and future trends in AI and its impact. The recent article, *Four Singularities for Research,* is particularly relevant to our community.

Articles on this website are freely available.  There is a prompt to subscribe (which also has a free option), or you can select "No Thanks" to go to the content.

Main site: https://www.oneusefulthing.org
Four Singularities article: https://www.oneusefulthing.org/p/four-singularities-for-research