

**Teaching Computer Science at UVA**

(Technical Paper)

**Does Google Negatively Impact Our Cognitive Ability?**

(STS Paper)

A Thesis Prospectus Submitted to the  
Faculty of the School of Engineering and Applied Science  
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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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## **Introduction**

Search engines are extremely popular software programs that help people find the information that they are looking for online by using keywords or phrases (“What”, n.d.). Companies such as Google, Bing, Yahoo, and AOL have become household names due to the effectiveness and quality of their search engines. People use search engine services daily to find information on topics such as: current events, health concerns, products, government services, natural disasters, coworkers, peers, and a myriad of other topics of varying severity.

The process of online searching involves three steps: crawling, indexing, and ranking (Brin & Page, 1998). Crawling is used to download the web pages and to ensure that they are up to date. Indexing refers to the creation of a cataloged database for the crawled web pages. Ranking is the ordering of results based on both the importance to users and weighted calculations done on each individual page for the query. The ranking system is usually done by internal calculations predetermined by the company based on several factors of varying weights that are also determined by the company.

Through the creation of these ranking algorithms, search engines have become one of the most popular online activities, only slightly less popular than email use (“Type”, 2020). This popularity, caused by the optimization of research and sharing of information through the ranking system, has resulted in a “strong bias towards links higher in position even if the abstracts themselves were less relevant,” (Pan et al., 2007) for users when deciding which links to click.

Due to the nature of ranking systems, each search engine may display slightly different results based on the individual weights assigned by the company. For example, Google takes into

account over 200 factors before delivering their results to users (“Search,” 2021), while other companies could base their results on a completely different set of factors. These ranking algorithms have given search engines the role of primary gatekeeper of online information. And to some degree, “gatekeeping is a necessity when parsing through massive quantities of available information” (Granka, 2010).

While the efficiency of search engines is a technical issue, it is important to remember that the creation of the search engine has also resulted in a form of search politics. The design of search engines “systemically exclude (in some cases by design and in some accidentally) certain sites, and certain types of sites, in favor of others, systemically giving prominence to some at the expense of others” (Nissenbaum & Introna, 2006). For my technical project, I will recall my experience creating a web-based document search engine application programming interface (API) at my last internship and analyze how my education at the University of Virginia has prepared me for my role in creating a small scale application of one of the dominating software in the computing world. I will also provide recommendations that will benefit the curriculum in regards to preparing future students both for the workforce and similar projects. For the social aspect of this project, I will analyze the technological momentum of search engines with a focus on Google and the impacts that society had on it in its early stages of development, in comparison to the impact that Google has had on society and information sharing in the modern-day.

### **Technical Problem**

The one question that every computer science professor asks is “What is the best way to prepare my students for the workforce?” The University of Virginia’s Computer Science

department has asked this question as well; and as a result, they have given their students the option to share an internship experience and provide details on how their tenure as a student has prepared them for the task. As a fourth-year computer science student at the University of Virginia who participated in the 2019-2020 new curriculum, I have a unique perspective of being able to compare my internship experience and knowledge with peers who were either in the curriculum or on the traditional path of the Bachelor of Science in Computer Science (BSCS) track. During my most recent internship at Capital One, I was given the task of designing a document content search web API using javascript and leveraging several Amazon Web Services (AWS) platforms such as load balancers, simple queue services, lambda functions, databases, and elastic search in order to maximize efficiency. Throughout my experience, I had to become extremely familiar with javascript, learn all of the different AWS cloud platforms that were utilized, participate in an agile work environment, and craft presentations for both technical and non-technical coworkers.

Things that I had no prior experience with throughout my education at the University of Virginia were coding in javascript, presenting my codebase to both technical and non-technical peers, and working with agile software development. With a few adjustments, the restructuring of the computer science department could expose future students to these aspects so they experience less of a shock if asked during an internship. Adjusting the curriculum may also increase the likelihood of students receiving internship offers before the summer following their third year, which would give them an even larger advantage in the workforce.

Based on my experience, UVA should continue to infuse algorithms earlier in the computer science degree track in addition to teaching javascript and local cloud computing

structures and programs to assist in the exposure of students to rapidly growing fields and languages. Algorithms are a crucial concept in computer science. An algorithm refers to a “set of steps used in completing a certain task or to get [the] desired output” (How, 2021). They are applied to data structures, or an “orderly arrangement of data” (How, 2021) to optimize the performance of completing a task such as searching, addition, deletion, or sorting; and they are used to find the “best possible way of solving a problem” (Mulong, 2021). Cloud Computing is a term that refers to an area of information technology that touches the following areas: “hardware infrastructure, data center facilities, virtualization technologies, and software engineering concepts” (Bellasio, 2020). Most companies in the world utilize the cloud for managing their infrastructure (Bellasio, 2020).

Both algorithms and data structures are interrelated and complement each other, and how data structures are taught with the new computer science curriculum in the course Data Structures and Algorithms is very effective and needs little improvement. We spent about a week on every data structure which is enough to gain an in-depth understanding. However, even though we covered the different data structures and their respective methods in one semester, we did not make the connection between how each data structure’s methods relate to the common practice algorithms within computer science. Currently, the UVA student’s only avenue to learning cloud computing is when taking the introductory course CS4740: Cloud Computing, which is a well-designed course; but only having one course to reinforce the ideas of cloud computing is not sufficient for a field that is growing as rapidly as it is. If there are no changes made to the curriculum, students will not have the base knowledge of algorithms required to start

applying to internships and they will not know the necessary information to utilize cloud computing in a working environment.

My recommendation for the department is to change the Software Development Essentials course to utilize Javascript and its frameworks instead of Java. I would also recommend altering the final project so that incorporates cloud computing in its implementation. These changes would benefit UVA students entering the workforce because most applications have some sort of front-end service that uses javascript and cloud computing is an ever-growing field worth over \$200 billion with the expectation to triple by 2027 (Fortune Business Insights, 2021). To address these recommendations, I will consult with professors throughout the department to devise strategies to implement the changes outlined above. I will also look into the different course syllabi to find the best courses where these learning objectives could best be implemented throughout degree completion.

### **Research Project**

Arguably, no technology company is more responsible for shaping both the internet and modern life than Google (Verge, 2018). It started as a novel search engine and now manages eight products with more than 1 billion users each (Verge, 2018). Google has allowed students to incorporate information for research projects, allowed individuals to keep track of the stock market, and provided unique opportunities for people (Impact, n.d). The phrase “Google it” has become a common expression used when people either need to learn new information or cannot

remember something. Google has become a substitute for thinking and some may even say that it was designed specifically to think for us.

But if we continue to believe that it was always meant to think for us, we will not understand how its role and influence have evolved. Google was originally designed to be used as a resource to consolidate a conglomerate of information related to our search query (Brin & Page, 1998). It was meant to aid our thinking, but over time it has gained momentum and now has changed how we think. Nicholas Carr, an American writer who focuses on the intersectionality between technology, economics, and culture; states that Google and other search engines “supply the stuff of thought, but they also shape the process of thought” (2020). Studies have shown that the creation of search engines has reduced our “ability to read and absorb a longish article on the web or in print” (Carr, 2020). This is due to the skimming of headlines that usually accompany a search on Google. A developmental psychologist at Tufts University, Maryanne Wolf, believes that the style of reading promoted by the internet puts efficiency and immediacy as the highest priority, “weakening our capacity for the kind of deep reading that emerged when an earlier technology, the printing press, made long and complex works of prose commonplace” (Carr, 2020). Wolf claims that when we read online, we become “mere decoders of information” (Carr, 2020) and that our ability to interpret text and make the mental connections that form when we read deeply without distraction remains largely disengaged.

Not only has it changed the way we read, but because search engines use their ranking system to decide what information is presented to the user, “search engines are seen as wielding a great deal of power in what people know about a given topic” (Granka, 2010). Studies have revealed that the average Google user only “view and click the top two results returned”

(Granka, 2010) by the search. Users only paying attention to the top results is not an issue, but Google's ranking system, PageRank, is largely based on the popularity of the website and its traffic (Pan et al., 2007). This means that users are more likely to only view the top results which also tend to be the bigger companies essentially resulting in a "rich-get-richer loop" (Pan et al., 2007) and further marginalizing the voices that are not often heard. In this project, I will be using the Technological Momentum framework to discuss several ways in which Google has shaped our society throughout its lifetime. For example, the effect that Google had on the way society interprets long text and how our cognitive ability has been impacted. Technological Momentum states that as an artifact, or technological system, gains momentum, or popularity and influence, over time, the artifact becomes more the shaper of the society around it, rather than shaped by the society (Hughes, 2009). To support my argument, I will be using evidence drawn from multiple studies on the effects of Google on the way we read and think.

## **Conclusion**

The use of search engines has become one of the most popular online activities in the world. There is a low possibility of it losing its popularity any time soon, in fact, it is more likely that newer engines will be created in the future. With the chance of new engines being invented, developers need to know that the design of a search engine is socio-technical in nature. The deliverable for the technical problem discussed above will help UVA students to gather the background knowledge to implement a search engine while preparing them to enter the workforce. The research project will provide an analysis of the technological momentum of



Google over time. The combined results of this technical report will serve to address the deficiencies found in the CS curriculum at UVA and make the potential developers of the next big search engine aware of their ability to shape the way society thinks.

Word Count: 1980

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