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CS-499-19649-M01 Computer Science Capstone 2025

6-1 Journal: Emerging Technology and Artifact Update

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Part One:

What is the identification and description of each technology?

Thanks to today's technological advancements, progress and development can happen more quickly, thus accelerating the pace of change. In the current digital landscape, adopting digitalization has become a necessity rather than just an option. Digital trends and technologies are driving us to evolve at an unprecedented pace, marking the onset of a new era of development. With the help of new technologies, entire industries can undergo substantial changes, global issues can be addressed, and individuals can improve their living standards worldwide.

This journal entry explores two emerging trends representing disruptive, game-changing, or innovative technologies that are uniquely and significantly redefining the industry: quantum computing and natural language processing. Although quantum computing is still in its early stages, it holds the promise of transforming our approach to solving complex problems and performing computations. Simultaneously, natural language processing has reshaped the way machines understand and generate human language, enhancing the intuitiveness of interactions with technology. Although these trends are at varying stages of advancement, both are poised to redefine the boundaries of technology, influencing how we create, interact with, and rely on computers. I want to examine these two trends that broke down barriers to reaching people around the world and emphasize their importance and relevance to my prospective career in computer science.

**Quantum Computing:**

Quantum computing is an idea that has long been at the forefront of scientific research. It has seen breakthroughs over the past few years. This technology can produce computers that calculate at incredibly high speeds compared to typical machines. This technology will impact everything from cryptography to medicine to finance. Using quantum computing, which originates in quantum mechanics, we can compute in an entirely new way. The quantum computer utilizes multiple quantum states of bits (qubits) simultaneously to provide computational power that has never been achieved before.

In some cases, quantum computers can process information tenfold faster than conventional computers. Drug research, where quantum computing may accelerate the process by modeling molecular structures with precision, and cryptography, where it may break codes that are otherwise considered secure, are among the fields where quantum computing is being applied this year. By providing solutions to intricate issues that conventional computers are unable to address, technology has the potential to transform entire industries, even though it is in its infancy. The market for quantum computing is expected to reach USD 1.21 billion by 2023 and grow at a compound annual growth rate of 20.1% between 2024 and 2030, according to Grand View Research.

Several niche applications have already been found for quantum computing. A growing amount of funding is now available to take quantum circuits into new areas, including imaging, sensing, and measurement. Bringing quantum computing to many industries is a game-changer because it changes how computation is delivered. Computation is the most important factor in the world of Big Data.

**Natural Language Processing**:

Natural Language Processing has closed the gap between human communication and computer logic, serving as the backbone of our digital interactions today. Natural Language Processing (NLP) is an intriguing branch of artificial intelligence that enables machines to comprehend, interpret, and generate human language. It enables computers to analyze and make sense of extensive text and speech data. Furthermore, it allows machines not only to understand our spoken words but also to respond intelligently, making technological interactions feel more natural, personalized, and significant (Mahmood, 2025).

The demand for Natural Language Processing (NLP) is rapidly increasing. NLP has achieved a significant breakthrough with the emergence of large language models (LLMs). These models enable machines to understand and generate human language more intuitively, enhancing the user experience with technology. According to Statista, the market for Natural Language Processing is expected to reach US$156.80 billion by 2030. Leading AI models such as OpenAI's ChatGPT and Google's Bard are frequently in the news, demonstrating that these advancements represent not merely passing trends but the future of technology.

Q. What are the likely impacts on computer science or your career?

Quantum computing is revolutionizing the field of computer science by challenging traditional paradigms of computation. Classical computers struggle to solve complex problems, such as factoring large numbers, simulating quantum systems, or optimizing large datasets. To adapt to the exponential speedup in calculations that quantum computing offers, we will need to develop new algorithms, frameworks, and even programming languages.

Cryptography is one of the most profound impacts of quantum computing, which requires changes in computer science. Quantum computing introduces two notably powerful algorithms that impact cryptographic security: Shor's and Grover's. Shor's algorithm, developed by Peter Shor in 1994, leverages the Quantum Fourier Transform (QFT) to identify periodic structures within quantum states, enabling the factoring of large integers (Shor, 1997) (Seiler, 2024). Due to its ability to perform calculations that are impossible for classical computers, it poses a significant threat to current encryption methods, such as RSA, AES-128, and SHA-256. It is, therefore, imperative in the era of quantum computing that quantum-resistant cryptographic techniques be developed and adopted to secure sensitive information and digital communications. Researchers and developers can now explore and implement quantum solutions to complex problems through hybrid quantum systems, which integrate both classical and quantum computing models, paving the way for future discoveries in various fields.

Natural Language Processing:

Natural Language Processing (NLP) will significantly impact the field of computer science by enabling computers to understand, interpret, and generate human language. In the realm of computer science, there is a constant quest to bridge the gap between humans and machines.

NLP leverages algorithms and models to analyze the structure and meaning of language, enabling tasks such as text classification, sentiment analysis, speech recognition, and language translation. By breaking down language into its constituent parts, NLP algorithms can identify patterns, extract information, and generate responses that are contextually relevant and accurate (NLP: Revolutionizing How We Interact with Modern Technology, n.d.).

The development of NLP models that can understand and generate human language is a challenging task that requires significant expertise in computer science, linguistics, and machine learning. These Tasks are achieved through a combination of rule-based methods and machine-learning techniques. In recent years, deep learning models such as recurrent neural networks (RNNs) and transformers have significantly enhanced the performance of NLP applications. Models such as OpenAI's GPT (Generative Pre-trained Transformer) and Google's BERT (Bidirectional Encoder Representations from Transformers) are notable for their ability to comprehend context and generate text that resembles human language (Rathnasiri, 2024). To implement this NLP, significant research and development are required, as each language has its own unique characteristics and grammatical rules. Researchers must carefully design and train models to ensure they can handle the complexities of natural language. Each of these applications typically uses a combination of techniques that include preprocessing and either classic methods or deep learning.

Q. How might the two technologies impact humans, communities, or the world?

Quantum computing may not have an immediate impact on consumers; however, its long-term effects will be profoundly transformative. In the field of healthcare, for instance, quantum computing could revolutionize the discovery of drugs and materials by enabling the simulation of molecular and atomic interactions with unmatched precision. It can model energy-efficient technologies, such as improved batteries and solar panels. By simulating molecular structures, they can help identify new materials that enhance energy storage and conversion, thereby supporting a greener and more sustainable energy future. Professionals in tech fields will need to familiarize themselves with new quantum programming languages, such as Qiskit and Cirq, and cultivate a deep understanding of quantum mechanics and algorithms. Additionally, the potential for quantum computers to overcome encryption systems is driving companies to develop quantum-safe cryptography, leading to enhanced and more secure data protection (Azam et al., 2025).

Q. Which course outcomes have you achieved so far, and which ones remain?

At this point, I have accomplished multiple course goals. By working on three enhancement plans in the capstone project, I gained experience with different algorithmic design techniques, such as dynamic programming and algorithms, and learned how to use them to solve a wide range of problems. Additionally, I developed skills in logical, computational, and creative thinking, enabling me to identify and analyze issues, devise systematic solutions, and implement those solutions as computer programs. This involves breaking down problems, designing and evaluating potential solutions, and applying abstract concepts to address them.

As a result of this experience, I am capable of designing and evaluating computer solutions that solve a given problem based on algorithmic principles and computer science practices and standards appropriate to its solution while managing the trade-offs involved in design decisions.  I have also acquired experience implementing industry-specific computing solutions utilizing well-founded and innovative techniques, skills, and tools.

This week's journal provided me with a basic understanding of emerging technologies and their potential disruptions, along with the potential consequences for the future of computing. Furthermore, it highlighted the importance of examining the societal impacts of disruptive technologies, particularly in terms of data privacy and security.

The work still needs to be done. Gaining practical experience with NLP. While I studied NLP and deep learning in my last term, I also worked on several projects involving training robots or machines with pre-existing data and analyzing how long it took the machine to read the data and recognize images. I found it fascinating how quickly the system analyzed the data and provided results. It is crucial to have a solid foundation in both theoretical concepts and hands-on experience with programming, particularly in understanding machine learning algorithms and natural language processing (NLP) techniques, as they are considered game-changers and promising to revolutionize the field of computer science.

In summary, the future potential of quantum computing and NLP marks a new chapter in artificial intelligence, characterized by significant advancements in language understanding, enhanced processing speeds, and expanded applications across diverse sectors. Despite existing challenges, continuous research and progress in quantum computing and natural language processing are opening doors to a future in which machines can grasp and interact with human language in ways that were once thought impossible. These developments resonate with my enthusiasm for groundbreaking, influential technologies. By staying current with advancements and refining relevant skills, I aim to make a meaningful contribution to these exciting developments in the field.

Part Two:

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| **Checkpoint** | **Software Design and Engineering** | **Algorithms and Data Structures** | **Databases** |
| **Name of Artifact Used** | Weight Tracking App from CS 360 course  ( Mobile Architecture and Programming) | Animal\_main.py  Animal\_module.py (CS 340: Client/Server Development) | Animal Rescue Dashboard with MongoDB (CS 340: Client/Server Development) |
| **Status of Initial Enhancement** | Testing on Input validation on the account page and working on the data displayed in the chart, focusing on user-centric principles. | Testing indexing, sorting, and CRUD operations for faster lookups, demonstrating my capacity to improve the system's efficiency. | Testing indexing and aggregation techniques on large datasets and generating reports based on the search. |
| **Submission Status** | Once issues with the layouts are fixed, it will be ready for submission | Enhancement efforts are underway.. I have almost finished testing the code, , it will be ready for submission | Once finished with the unit testing, it will be ready for submission |
| **Status of Final Enhancement** | As of now, the project is still in progress. I have started focusing on User interface including the layout, design, typography, and overall aesthetics to make the user’s experience easy and intuitive. | Work is still in progress on testing. Using methods that also allows us to access individual elements directly. | Improvements are in progress. To enhanced with additional database features and a more efficient data access strategy. Utilizing aggregation pipelines more effectively and improving query speed. |
| **Uploaded to ePortfolio** | The file has not yet been uploaded. | There is still work to be done on the finalized ePortfolio. | There is still work to be done on the finalized ePortfolio. |
| **Status of Finalized ePortfolio** | Enhancements are ongoing, so the ePortfolio is not yet complete. | Enhancements are finishing so the ePortfolio will be uploaded soon | There is still work to be done on the finalized ePortfolio. |

**Status Checkpoints for All Categories**

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