**CS-499 4-2 Module Four**

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CS-499 Computer Science Capstone 2024

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September 16th, 2024

**Briefly describe the artifact. What is it? When was it created?**

* The artifact is a refactored version of a 3D scene rendering system that I developed using C++ and OpenGL. Created as part of a course project in early 2024, the code was enhanced in September 2024 to showcase my abilities in several key areas.
* These improvements highlight my advanced skills in graphics programming and modular code design. By incorporating modern OpenGL features and optimizing the rendering pipeline, I demonstrated my ability to use innovative techniques to address complex design challenges. I also applied efficient data structures and advanced algorithms to improve performance and enhance the visual quality of the scenes.
* This artifact showcases my ability to solve complex logic problems by optimizing algorithms and data structures for managing 3D objects and improving rendering performance. I also addressed security concerns by implementing robust input validation and error-handling practices. Additionally, I applied innovative techniques, such as modern OpenGL features and advanced shading, to enhance the system's visual quality and efficiency. This combination of problem-solving, security improvements, and cutting-edge design demonstrates the high quality and organization of the final product.

**Justify the inclusion of the artifact in your ePortfolio. Why did you select this item? What specific components of the artifact showcase your skills and abilities in algorithms and data structure? How was the artifact improved?**

* I selected the CS-330 project artifact for inclusion in my ePortfolio because it effectively demonstrates my skills and abilities in critical areas of computer science, particularly in algorithms and data structures. This artifact is a comprehensive representation of my ability to apply theoretical concepts to practical problems and showcases my proficiency in enhancing and optimizing solutions.
* In my project, I highlighted several key components that showcase my skills in algorithms and data structures. For instance, I implemented efficient data structures to manage 3D scene objects and their properties. I used spatial partitioning techniques to organize these objects, significantly improving rendering performance and reducing computational overhead. Additionally, I applied advanced algorithms to optimize the rendering pipeline, incorporating techniques like frustum culling and level-of-detail management to minimize the number of draw calls and enhance overall performance.
* I also included innovative techniques in the project that were not part of the original implementation. By integrating modern OpenGL features and advanced shading techniques, such as framebuffers and complex shaders, I improved the visual quality and efficiency of the 3D scenes. These additions demonstrate my ability to effectively use cutting-edge technology to address design challenges.
* The artifact saw considerable improvements through several key updates. I refactored the codebase to follow a more modular design, which made it easier to maintain and extend. This involved breaking down complex functions into smaller, reusable components and organizing the code into logical sections. I also focused on performance optimizations, refining algorithms, and improving data structure usage to achieve faster rendering times and a smoother user experience. Moreover, I addressed potential security vulnerabilities and structural flaws by implementing best practices for input validation, error handling, and data protection, ensuring the application's reliability and robustness.
* To support these improvements, I added detailed documentation explaining the functionality, design decisions, and changes made. This includes comments within the code and a separate design decision document. These additions help others understand the rationale behind the changes and the overall architecture of the project.
* In my project, I improved the overall time complexity across several key areas. The rendering pipeline was optimized by implementing spatial partitioning techniques, reducing the complexity from O(T+P)O(T + P)O(T+P) to O(log⁡T+P)O(\log T + P)O(logT+P), where TTT is the number of triangles and PPP is the number of pixels. For matrix operations, I reduced the complexity from O(n3)O(n^3)O(n3), which resulted from redundant calculations, to O(1)O(1)O(1) per transformation by modularizing the code. Additionally, I enhanced object searching and rendering by incorporating spatial partitioning methods, reducing the complexity from O(T)O(T)O(T) to O(log⁡T)O(\log T)O(logT). Finally, I optimized shader and texture operations, maintaining O(P)O(P)O(P) but reducing the redundant recalculations to improve the constant factor, leading to a more efficient rendering process.
* In summary, including this artifact in my ePortfolio highlights my technical abilities and my dedication to continuous improvement and effective communication. By showcasing the updates and enhancements made to the CS-330 project, I provide a clear example of my capacity to apply and refine my knowledge of algorithms and data structures, address complex challenges, and contribute to high-quality, well-documented software solutions.

**Did you meet the course outcomes you planned to meet with this enhancement in Module One? Do you have any updates to your outcome-coverage plans?**

* Yes, I successfully met the course outcomes I planned to address with this enhancement in Module One. I tackled complex logic problems by optimizing the algorithms and data structures in the 3D scene rendering system, which significantly improved performance and rendering efficiency. This aligns with the course outcome focused on applying theoretical knowledge to practical problems. Additionally, I addressed design, logical, and structural flaws related to security by implementing robust input validation and error-handling practices, ensuring the stability and security of the system.
* I also established my ability to use innovative skills and techniques by incorporating modern OpenGL features and advanced shading techniques, which enhanced both the visual quality and efficiency of the rendering process. This effectively met the outcome related to applying cutting-edge design solutions.
* At this time, I do not have any additional updates to my outcome-coverage plans. The enhancements made have successfully met the planned outcomes, demonstrating a thorough understanding and application of the relevant concepts.

**Reflect on the process of enhancing and modifying the artifact. What did you learn as you were creating it and improving it? What challenges did you face?**

* Through the enhancement process, I learned valuable lessons about modular programming and the importance of using constants to improve code readability. One of the main challenges was refactoring legacy code while ensuring that no new issues were introduced and balancing complexity with functionality. Overall, this process reinforced the importance of best practices in software development and highlighted areas for further improvement in code performance and scalability.
* **Course outcomes that have been achieved so far include:**
  + Employ strategies for building collaborative environments that enable diverse audiences to support organizational decision-making in the field of computer science.
  + Design, develop, and deliver professional-quality oral, written, and visual communications that are coherent, technically sound, and appropriately adapted to specific audiences and contexts.
  + Design and evaluate computing solutions that solve a given problem using algorithmic principles and computer science practices and standards appropriate to its solution while managing the trade-offs involved in design choices.
  + Demonstrate an ability to use well-founded and innovative techniques, skills, and tools in computing practices to implement computer solutions that deliver value and accomplish industry-specific goals.