**CS 499 Milestone Three: Algorithms and Data Structure Enhancement**

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The selected artifact is a 2D OpenGL-based simulation demonstrating brick collision mechanics. Originally developed in the CS-330 Computational Graphics and Visualization course, this project features circles moving randomly within a defined space, reflective bricks that change the direction of circles upon collision, and destructible bricks that fade over time and disappear after multiple hits. Basic collision detection between circles and bricks, as well as simple rendering mechanics using OpenGL, were implemented. This project was chosen for enhancement because it demonstrates my algorithmic problem-solving skills, particularly in movement optimization, collision detection, and rendering techniques.

This artifact was selected because it aligns with the Algorithms and Data Structures category, demonstrating my ability to design, optimize, and implement efficient algorithms. The key skills showcased in this enhancement include optimized collision detection, improved performance by reducing complexity, enhanced movement algorithms with efficient boundary checks, and an improved shading technique that applies a Phong-like shading model for smoother visual transitions. Additionally, the refactored code structure allows for better maintainability and readability, aligning with industry standards in graphics programming, algorithm optimization, and object-oriented design.

The enhancement aligns with the CS 499 course outcome that requires designing and evaluating computing solutions using algorithmic principles while managing trade-offs in design choices. To meet this outcome, I refactored inefficient movement logic to optimize boundary constraints and reduce redundant computations. I also separated collision detection into a dedicated function (mergeCircles()) to improve efficiency and maintainability while applying spatial partitioning principles for better execution time. The introduction of a shading improvement using color transition logic enhances visual feedback in destructible bricks. These enhancements showcase my ability to identify inefficiencies, apply algorithmic optimizations, and implement data structures effectively.

Throughout this process, I learned the importance of performance optimization, particularly how modular function separation and reducing redundant operations significantly improve execution speed. Implementing optimized movement and collision detection strengthened my understanding of the trade-offs between computational complexity and real-time performance. Furthermore, introducing a Phong-like shading model required a deeper understanding of color interpolation, fragment shading, and OpenGL rendering techniques. Despite these advancements, challenges arose in maintaining code readability while optimizing performance, ensuring accuracy in collision detection while minimizing computational overhead, and fine-tuning shading parameters for smooth fading effects.

The milestone significantly improved my understanding of algorithm optimization and data structure implementation in graphical applications. The refinements made the program more efficient, readable, and scalable, demonstrating my growth as a software developer. The submission includes the enhanced code files in a ZIP archive, an updated README file describing the enhancements and improvements, and this narrative document explaining the enhancement process and reflections.

In conclusion, this milestone successfully demonstrates my ability to optimize algorithms and refine data structures in a real-world graphical application. The enhancements provide substantial improvements in efficiency, maintainability, and functionality, making this an excellent artifact for my professional ePortfolio. These refinements solidify my skills in computational graphics, algorithm optimization, and software design, preparing me for future challenges in the field of computer science.