**CS-499 Computer Science Capstone**

**(Narrative)**

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**Enhancement One: Software Design/Engineering of the Secure Authentication System**

The artifact I selected for this milestone is the *Secure Authentication System* developed during my CS 405: Secure Coding course. This project was initially created on September 29, 2024, as a foundational piece for learning secure coding practices. The primary functionality of this system is to safeguard user data through encryption and secure authentication mechanisms. It includes features for encrypting and decrypting sensitive data, validating user inputs, and securely handling user credentials to prevent unauthorized access. This artifact is particularly significant in the context of my capstone project as it serves as a practical demonstration of my ability to apply secure coding practices and software engineering principles in a real-world scenario.

This artifact was included in my ePortfolio because it showcases my ability to implement robust software engineering and secure design principles and demonstrates significant growth. The project highlights my proficiency in developing secure authentication mechanisms, implementing encryption algorithms, and managing sensitive data. The enhancements to this artifact are a testament to my growth as a developer, especially in applying advanced security measures and optimizing software design to align with industry standards.

The artifact was improved through the following enhancements:

1. **Integration of Enhanced Encryption**: The original XOR-based encryption was replaced with a more secure algorithm (bcrypt). Salting was also added to protect against rainbow table attacks.
2. **Implementation of Input Validation**: A dedicated input validation function was added to sanitize user inputs, ensuring they meet security requirements and are free of malicious content.
3. **Improved File I/O Management**: The file reading and writing processes were optimized to handle errors better and store sensitive data more securely.
4. **Code Quality Enhancements**: Inline comments and detailed documentation were added to improve code readability and maintainability.

The planned enhancements align with several course outcomes:

* **Outcome 3**: The enhancements demonstrate my ability to design and evaluate solutions using algorithmic principles and secure coding standards. For example, replacing XOR encryption with bcrypt improves security and adheres to modern standards for password hashing.
* **Outcome 4**: By incorporating well-founded techniques such as advanced encryption and input validation, the artifact showcases innovative methods for building secure systems.
* **Outcome 5**: Adding input validation and encryption demonstrates a security mindset by proactively mitigating vulnerabilities, ensuring data privacy, and enhancing the software's security.

The enhancements I planned in Module One were successfully implemented, meeting the outlined objectives. These updates ensure the artifact reflects my skill level and adheres to the best software development and security practices, marking a significant accomplishment in my journey.

Reflecting on these and enhancing this artifact provided valuable learning opportunities. Through the process, I deepened my understanding of secure coding practices and advanced encryption techniques. Implementing bcrypt and salting taught me how to balance security with computational efficiency. Developing input validation mechanisms also reinforced the importance of preventing common vulnerabilities such as SQL injection and buffer overflows.

One of the primary challenges was integrating bcrypt into the existing system without disrupting its core functionality. This required a deep understanding of the system's architecture and the encryption process. Another obstacle was designing a flexible input validation function that could accommodate various scenarios while maintaining simplicity and security. Overcoming these challenges required extensive research, testing, and iteration, which ultimately improved my problem-solving and debugging skills. These challenges also provided valuable learning opportunities, reinforcing the importance of adaptability and resilience in software development.

The enhancements made to the Secure Authentication System significantly improved its functionality, security, and maintainability. These changes demonstrate my ability to address design flaws, implement innovative techniques, and build secure software systems. Including this artifact in my ePortfolio proves my software design and engineering skills, aligning with the Computer Science program's overarching outcomes. As I continue refining this artifact based on instructor feedback, I am confident it will vigorously represent my capabilities and achievements. Moreover, I see great potential for this artifact to serve as a foundation for future projects and a testament to my commitment to continuous improvement and growth in computer science.