# Artifact Narrative – Cartpole (Algorithms & Data Structures)

## Artifact Description

The artifact I selected for the Algorithms and Data Structures category is my Cartpole reinforcement learning project from CS 370: Current/Emerging Trends in Computer Science. This project originally implemented a reinforcement learning agent to balance a pole on a moving cart using trial-and-error learning. The base version demonstrated the fundamental idea but had limited efficiency and lacked modularity in how algorithms and data structures were applied.

## Justification for Inclusion

I chose this artifact because it demonstrates my ability to apply algorithmic principles and data structures to solve a real-world computational problem. The enhancements I implemented improved the efficiency, organization, and clarity of the project.  
  
Specifically, this artifact showcases:  
- Refactored Q-learning algorithm with more efficient state/action updates.  
- Improved data structures to handle state-action pairs, reducing redundancy.  
- Use of modular functions to separate the environment setup, training loop, and evaluation.  
- Visualization of learning performance to show algorithmic improvements more clearly.  
  
These enhancements highlight my growth in designing, analyzing, and applying algorithms with appropriate data structures.

## Reflection on the Enhancement Process

Enhancing the Cartpole project taught me the importance of algorithmic efficiency and modular design. One challenge was balancing exploration and exploitation within the Q-learning algorithm. By fine-tuning parameters and restructuring the update logic, I improved convergence speed while keeping the implementation readable.  
  
Another challenge was managing state representations efficiently. Initially, state-action pairs were not stored in a scalable way, which caused redundant lookups. I solved this by applying dictionary-based mappings that made updates faster and cleaner.  
  
This project also reminded me of the importance of visualization in algorithmic work. By graphing the reward over episodes, I could see the impact of my enhancements and verify the learning process.

## Course Outcomes Demonstrated

Through this enhancement, I demonstrated the following outcomes:  
- Algorithms and Data Structures: Applied efficient data structures to improve the performance of reinforcement learning.  
- Problem-Solving and Trade-offs: Balanced exploration vs. exploitation and improved the learning rate.  
- Tools and Techniques: Used modular programming and visualization tools to evaluate the performance of the algorithm.  
- Communication: Documented changes and explained results clearly for audiences who may not have deep algorithmic backgrounds.

## Conclusion

This enhanced Cartpole artifact represents my growth in applying algorithms and data structures to practical computational problems. By improving efficiency, modularity, and visualization, I demonstrated my ability to refine algorithmic solutions and present them in a professional, accessible way.