Portfolio Summary: Biocomputing and Advanced Computer Graphics Projects

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1 INTRODUCTION

This portfolio includes highlights from two graduate-level courses: CSE 568 Biocomputing and CSE 570 Advanced Computer Graphics. All projects in both courses were completed independently. The project selections reflect my interest in biologically inspired algorithms, modeling, and 3D geometric data processing.

2 OVERVIEW OF CSE 570 REPORT

This report summarizes four individual projects completed during the CSE 570 course on Advanced Computer Graphics, each addressing a core topic from geometric analysis to learning-based 3D processing. Combining theory, implementation, and analysis, these projects provide practical insight into the 3D data manipulation, rendering, and understanding pipeline. The projects reflect independent work and experimentation and collectively account for 50% of the final course grade.

The projects include constructing a Bézier Coons patch and computing Gaussian curvature through partial derivatives and numerical methods, with visualization of control grids and vector fields. The Loop subdivision project implemented mesh refinement on standard models, correctly computing new vertex positions, though it encountered challenges in generating subdivided faces beyond two iterations. The spherical conformal mapping project achieved folding-free, angle-preserving parameterization of a genus-0 brain surface onto a unit sphere by minimizing harmonic energy via gradient descent and Möbius transformations. Finally, the MeshCNN deep learning project explored feature modifications and pooling removal, maintaining 100% classification accuracy on 3D meshes. It also analyzed GPU usage and model parameters, demonstrating the model's robustness under architectural changes.

3 OVERVIEW OF CSE 568 REPORT

This report summarizes three individual projects completed during the CSE 568 Biocomputing course, which included six projects: Introduction to Graph Coloring, Extensions to Balanced Colorings and Neutral Landscapes, Introduction to Negative Selection, Anomaly Detection with Negative Selection, Modeling Collective Behavior in Ants, and Ant Colony Optimization for Network Route Repair, together comprising 60% of the final grade. For this portfolio, I selected Projects 1, 2, and 5—Introduction to Graph Coloring, Extensions to Balanced Colorings and Neutral Landscapes, and Modeling Collective Behavior in Ants—which together account for 30% of the coursework and best represent my individual contributions and understanding. Each was implemented independently using the course materials and Zybook platform.

The first project applied genetic algorithms using DEAP to solve the NP-hard graph coloring problem by minimizing color conflicts through parsing graph files, encoding individuals as binary strings, tuning parameters, and evaluating fitness, achieving convergence to valid colorings. The second project extended this by adding balanced coloring constraints and neutrality analysis, modifying the fitness function to penalize uneven color distribution and compute 1-step neutrality, demonstrating increasing fitness and successful neutrality computation on multiple graphs. The fifth project converted an ODE model into an agent-based model of ant foraging using Mesa, simulating exploration, recruitment, and commitment behaviors on a grid; the simulation results showed robust convergence on dominant food sources with stochastic recruitment dynamics, reflecting biologically-inspired positive feedback and emergent collective behavior. Together, these projects deepened my understanding of genetic algorithms, fitness design, neutrality, agent-based modeling, and biological system simulation.

4 KEY TAKEAWAYS

These projects enhanced my skills in modeling, algorithm development, and analysis. One of the main things I learned from these projects was the interconnectedness of different subjects, specifically the applications of NP-hard problems and bio-computing algorithms, as well as the 3D brain and conformal mapping projects and their relevance to real-world scenarios. The work I completed in these courses reflects a strong foundation in computational methods and an interest in interdisciplinary problem-solving.

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