CURCA Proposal Cover Sheet

Title of Project: Mathematical Modeling and Simulation of Strategy-based Games

Faculty Members:

Brad Bailey John Holliday Dianna Spence bbailey

Research participants will use graph theory and probability to build mathematical models to analyze these games and seek optimal team and individual strategies for each game. Furthermore, student researchers will work with faculty to develop computer simulations for the games. These simulations will be used to compute both theoretical and empirical probabilities associated with the game and thereby determine optimal strategies. To develop the simulations, the student researchers will learn to use a cutting-edge parallel-processing language called CUDA in a Graphics Processing Unit (GPU) programming environment.

Significance:

The significance of this project is three-fold, involving 1) ap1(1)1Td [mi12 >>BDd m

Since one of the games is a relatively new yet commercially available game that is growing in popularity, there may be widespread interest among mathematicians and game theorists in understanding the strategic principles underlying the game. The other game has potential applications in military and other strategic settings and may be of interest in such fields as military science, law enforcement, and political science. In both cases, graph theoretic models provide an appropriate and relevant mechanism to analyze the games. This project seeks to leverage developments in the area of graph theoretic models, as well as to make further contributions in this evolving area of mathematics research.

Third, parallel processing, and in particular parallel programming in a GPU environment, is one of the most significant current developments in the the field of computer science. This area of computing, known as General Purpose GPU (GPGPU) programming, is advancing to the forefront of the computing industry. One of the most pervasive uses for this kind of programming is to conduct simulations, because a simulation is computationally intensive, entailing many different processing paths for which results need to be determined. GPU environments allow the programmer to compute many outcomes simultaneously, thereby maximizing the number of different simulation results that can be obtained in a limited amount of time. This allows far more complex simulation scenarios than were previously possible. Finally, graph theoretic applications are particularly well suited to computer-programmed representations and simulations. Graph theory and computing are often jointly researched because data structures in computer science provide a very useful way to represent the elements and structure of the graphs.

Thus, the proposed project is highly inter-disciplinary, with applications relevant to many fields, and with the planned research having a direct impact on significant lines of inquiry in both mathematics and computer science.

Goals and Products:

We will model these games to determine probabilities of different outcomes given specified sets of conditions then use the data to determine optimal strategies.

The deliverables for this project include: code for computer simulations, mathematical analysis of the outcomes of each game and computations of theoretical/empirical probabilities of victory under various conditions. In addition, each of the students will write a brief

Student Stipends: Each of the 4 participating students will be paid a

certain hardware, memory, and power supply specifications beyond those found in computers available in the Math/CS Department or in campus computer labs. An economical platform that will meet the needs of the project has been specified with the components below. These will be combined with a mouse and a monitor available in the Math/CS Department and already secured for the project.

Component	Cost
Motherboard - ASUS P8H61-M LE/CSM	75.00
CPU - Intel Core i17-2600	300.00
GPU Card - EVGA 570 GTX 1.25 GB	325.00
Memory - 2 x Kingston DDR3 1333 4GB	50.00
Hard Drive - WD5002AALX 500GB	70.00
Power Supply - Corsair TX650 V2 650Watt	100.00
Keyboard - Logitech K200	20.00
CD/DVD - LG GH24LS70	25.00
OS/Software Configuration	160.00
Windows 7 Professional 64Bit OEM	
Visual Studio 2008 Compiler	
Total	1125.00

This computer will be placed in the NOC 211 lab where our research students will have access. This lab is locked at night and whenever the department is closed for business.

Timeline:

Early October	Meet with students to introduce the game(s). Set up weekly meetings.
October- Early February	Regular weekly meetings with the student researchers and faculty mentor.
Early-February-Early March	Students prepare to present results; continue to meet with faculty for guidance.
Mid-March	Students present at SICCGTC.
March-April	Students project summaries suitable for publication;

continue to meet with faculty for guidance.