CALIFORNIA STATE SCIENCE FAIR
2001 PROJECT SUMMARY

Your Name (List all student names if multiple authors.)
Katherine E. Barnett

S1101

Project Title (Limit: 120 characters. Those beyond 120 will be ignored. See pg. 9)
Discovering Zones of Cooperation Through the Emergent Behavior of Autonomous Agents

Division
_ **Junior (6-8)** X **Senior (9-12)**

Preferred Category (See page 5 for descriptions.)
11 - Mathematics & Software

Abstract (Include Objective, Methods, Results, Conclusion. See samples on page 14.)
Use no attachments. Only text inside these boxes will be used for category assignment or given to your judges.

Objective: The purpose of this experiment is to study the emergent behavior of autonomous agents using fixed Prisoner#s Dilemma strategies to cooperate or defect. The model attempts to answer the question: "How can cooperation evolve in populations whose bilateral interactions are governed by the Prisoner's Dilemma."

Materials and Methods: The experiment uses a computer model developed in StarLogo. StarLogo is a programmable modeling environment for exploring the behavior of decentralized systems. Populations of autonomous agents move to random sites on a grid and play Prisoner's Dilemma strategies of cooperate or defect against neighbors. Agents are indistinguishable from one another. Positive and negative payoffs are accumulated. If accumulated payoffs exceed a specified threshold, the agent clones itself. If accumulated payoffs are negative, the agent dies and is removed. In time, spatial zones of cooperation emerge (i.e., areas of the grid dominated by cooperating agents). Research into the subject included autonomous agent modeling and emergent behavior. Based on an idea proposed by Joshua M. Epstein.

Results: The experiments confirmed that cooperation could emerge and endure in the absence of any centralized control or mutual awareness of the agents. This outcome is contrary to what might be predicted by the assumptions resulting from other types of Prisoner's Dilemma modeling. It was possible to confirm this behavior under varying combinations of the model#s parameters.

Conclusion: My hypothesis was confirmed. My experiments showed that cooperation could emerge and endure without a centralized control or mutual awareness of agents. Other types of Prisoner's Dilemma modeling require memory and adaptive strategies in order to show these results. Some researchers have suggested that cooperation zones could not emerge under this model#s conditions. It was possible to confirm this behavior under varying combinations of the model#s parameters.

Summary Statement (In one sentence, state what your project is about.)
The model attempts to answer the question: "How can cooperation evolve in populations whose bilateral interactions are governed by the Prisoner's Dilemma."

Help Received in Doing Project (e.g. Mother helped type report; Neighbor helped wire board; Used lab equipment at university X under the supervision of Dr. Y; Participant in NSF Young Scholars Program) See Display Regulation #8 on page 4.
My father instructed me in the use of the StarLogo programming language, and I consulted him on simulation procedures and analysis.