



**CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY**

Name(s) Oliver C. Rickard	Project Number S1215
Project Title The Digital Life: Evolution on a Computer	
Abstract Objectives/Goals The objective is to find how complexity can be produced through Natural Selection and Evolution. It is thought that intermediate goals must be given to consistently reach a state of high complexity. It is also thought that higher mutation rates will allow for faster adaptation. Methods/Materials An application was written in the Java programming language where basic programs act as simple organisms. Rewards and punishments were set so that the organisms could evolve the ability to add two numbers given to them. Goals were first given for smaller steps towards addition, and then were only given for that ability. Communities were given 100 generations in which they could develop the ability to add two numbers before the experiment restarted itself. 1000 trials were run two times to establish validity. Results It was found that when smaller rewards were given for smaller goals, the populations developed the ability to add two numbers 75.52% of the time, and had an average development age of 68 generations. When rewards were only given for the development of addition, the percentage dropped to 0.75% of the time, and had an average development age of 68 generations. Increasing probability to mutate from 1/100 to 1/10 did not change the percentages within significant figures. Conclusions/Discussion Evolution is normally a very difficult thing to observe, however when modeled on a computer, it becomes very simple. It was found that complexity did arise in experiments where rewards were given for intermediate goals. The data shows that complexity is attainable through Evolution, but requires smaller steps, which must also be beneficial on their own. Mutation plays a big role in evolution, but when mutation rates rise too high, the reproduction rate drops dramatically. It is best for mutation rates to be at a minimum, while still allowing for change (1/100 in this experiment). This experiment shows that mutation can produce complexity when regulated by Natural Selection.	
Summary Statement The Digital Life models evolution through the use of small programs on a computer that mutate and are affected by Natural Selection in order to show how complexity can arise in nature.	
Help Received Nancy Rickard helped prepare backboard; Thomas Moulia suggested points of further investigation; Louis Armin-Hoiland introduced the topic; and the Avida program by Caltech Digital Life Lab provided inspiration.	