



**CALIFORNIA STATE SCIENCE FAIR
2002 PROJECT SUMMARY**

Name(s) Eli E. Friedman	Project Number 22191
Project Title A Controlled Look at Chaos: The Varying Effects of Precision on Iterative Processes	
Abstract Objectives/Goals This experiment was designed to examine chaos under controlled conditions. This experiment looks at chaos and how it appears in iterative processes that differ by a constant and are computed using different levels of precision. The experiment tests how varying levels of precision affect outcomes with processes with different constants. Methods/Materials The experimenter compared outcomes for different values of the constant r and different levels of precision for the iterative process $x(n+1) = rx(n)(1-x(n))$. Each process was repeated for 26 iterations, starting with $x(0) = 0.5$. Microsoft Excel was used to calculate the iterations. The experiment tested different values of r , from 2.70 to 3.70 in increments of .02. The experiment also tested the effects of precision on sequences, using precision levels of 2, 3, 4, and 15 digits past the decimal point for each value of r . Results The experimenter found that the constant used had a great effect on the type of sequence that resulted: convergent (repeating a single number), bifurcating (alternating between two numbers), and chaotic (never settling down or tending toward any number). The experimenter also found that, for some constants, changing the level of rounding had such a strong effect that the same sequence would either bifurcate (alternate between two numbers) or converge (repeat a single number), depending on the precision. For example, with constant 2.92, sequences with lower levels of precision bifurcate while higher ones converge. The rounding, however, had a much smaller effect than expected for chaotic sequences that have no apparent attractors. Conclusions/Discussion Overall, the constants are an important part of the iterative process. Precision has a distinct effect, although it does not affect certain chaotic sequences as much as expected.	
Summary Statement This experiment reveals how chaos appears in iterative processes with differing levels of precision.	
Help Received Parents and teachers proofread report; I learned about chaos theory by reading books myself.	