CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Jacob D. Andreas

Project Number
S1201

Project Title
The Optimum Aspect Ratio for Compressing Image Files of Text

Abstract

Objectives/Goals
This experiment measured whether non-square compressions were more effective than square ones at compressing image files of text. As digital storage of documents grows, a highly efficient image format specifically designed for text would be especially useful.

Methods/Materials
52 samples of letters in two different fonts, each 100*100 pixels, was prepared.
A Java scaling utility was used to compress these samples to various rectangles of the same area and then decompress them. An OCR (Optical Character Recognition) program was then used to measure the effectiveness of the compression by testing recognizeability of each sample.

Results
It was predicted that a non-square compression would be more effective than a square one. This was found to be false when first tested (reduction to 400 pixels), but then found to be true under a more extreme compression (reduction to 144 pixels). An 18*8 compression was most effective for the 144 pixel reduction, and a 20*20 compression was most effective for the 400 pixel reduction.

Conclusions/Discussion
Compressions reducing the image to 4% of its original size were found to be most effective when square; however, when the images were compressed to 1.44% of their original size several non-square compressions were more effective. This likely arises because rectangular compressions are better than square ones at preserving most of the vertical and horizontal strokes that make up letters. While the overall effectiveness of a compression depends in part on how the quality is judged, non-square compressions tend to be most effective when the degree of compression is extreme.
The success of this experiment in showing the effectiveness of non-square compressions suggests expanding research on this topic, including implementation of other OCR programs and samples in more fonts.

Summary Statement
This experiment tested whether the linear characteristics of letters can be exploited in image compressions that use non-square compressions instead of relying on averaging pixels in a square area, as most do now.

Help Received
Some help with analysis of data from Greg Andreas and Dr. Eric Neufeld.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Zarathustra E. Brady

Project Number
S1202

Project Title
Can a Computer Predict a Human's Decisions?

Abstract

Objectives/Goals
To show that a human's behavior, even when he/she is trying to act randomly, is predictable, and to create a program which can model and predict a human's reactions in certain situations.

Methods/Materials
I tested this out with the game Rock, Paper, Scissors. I used a Hidden Markov Model (HMM) to create predictions of the human's choices given previous choices. People would play it in four different ways: short games where they saw the computer's choices, long games where they saw the computers choices, short games where they didn't, and long games where they didn't.

Results
After testing it on one hundred people, I found that the computer always won if the game was long enough, and did much better when the human did not see the computer's choices.

Conclusions/Discussion
A computer can predict a human's decisions. This shows that human's are predictable (statistically), and it is possible to model them with a computer.

Summary Statement
I used a Hidden Markov Model to predict a human's choices in the game Rock, Paper, Scissors.

Help Received
My computer mentors told me about Hidden Markov Models.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)

Tyrone T. Chen

Project Number

S1203

Project Title

Mathematical Algorithms for Sensor Footprint Employment: Year 2 of an Ongoing Study

Abstract

Objectives/Goals

In the previous year project, it was shown through a field experiment that a large number of detection zones can be created by overlapping a small number of sensor footprints. If the number of detection zones can be larger than the number of sensors, then there is a mathematical algorithm to calculate the maximum number of detection zones given a number of sensors. An experiment was conducted to formulate this algorithm.

Methods/Materials

The experiment was carried out by experimental graphing of sensor configurations with overlapping footprints. The numbers of detection zones produced for each configuration was manually counted and tabulated. A heuristic approach was taken to help discover a pattern for the series of tabulated numbers. Patterns included ones based on n, n^2, n^3, n^4... where n is the number of sensors.

Results

It was discovered that the n2 type pattern applied. A combinatorial relationship was found for the maximum number of detection zones given n sensors: $f(n)= n(n-1)+1$.

Conclusions/Discussion

The results obtained through this experiment support the hypothesis that an algorithm that calculates the maximum number of detection zones given any number of sensors could be created. This could in turn help to reduce the number of sensors needed to cover a plot of land with a maximum number of detection zones. This enables low-cost motion sensors to replace high-tech infrared tracking cameras. This is particularly economical in cases where the area to be covered becomes larger, such as in many homeland security applications.

Summary Statement

This project's algorithmic conclusion helps to maximize the number of detection zones created through overlapping motion sensor footprints, thus enabling motion sensors to replace high-cost security items such as infrared tracking cameras.

Help Received

Father helped with charting values; Dr. Andrew Ho at Harbor UCLA helped with algorithmic visualization

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Eric Ford

Project Number
S1204

Project Title
Optimization of Cell Phone Service in Kern County

Abstract

Objectives/Goals
My objective was to determine the optimal arrangement of cell phone transmission towers in Kern County to generate the best service coverage and the most profit using a mathematical model.

Methods/Materials
I created a list of nodes that were representative of possible tower locations and assigned each a population density value, established points that corresponded to major highways using linear equalities, determined the total population and length of highway that was within the range of each tower, assigned an optimization value to represent the number of potential customers a tower could support, and allotted each highway node a value that represented the average traffic density for that location (2004 project). For my current project, based on the optimization value for a tower, a value was produced to represent the profits that could be generated by that tower#s customers. A representative cost for maintenance that increased with a potential tower#s distance from a city was also created. Using these profit and cost values, three models were generated: one representing the most profitable arrangement of cell phone towers; one representing the maximum service coverage to consumers without causing the service provider to lose money; and one that provided adequate coverage to consumers and also generated profit by using profit values of the first two models. The three models were recalculated with different population density values to represent population growth.

Results
The maximum profit models produced networks with relatively few towers positioned in key locations that would provide service to the most densely populated areas. The maximum coverage models produced networks that provided coverage to most population centers and major highways. The balanced models resembled the maximum service coverage models, but had fewer towers.

Conclusions/Discussion
The maximum profit model would be useful for a cell phone service provider that does not have adequate revenue to construct many towers. The maximum service coverage model would be applicable to a company unconcerned with current profits, but wanting to dominate the market. The average service provider would want to implement the balanced model because it produces profit and also provides enough service coverage to attract customers. All service providers would want to use the data that incorporate predicted population growth to sustain profitability.

Summary Statement
My project is a mathematical model that determines the arrangement of cell phone transmission towers in Kern County that is the most profitable and provides maximum service coverage.

Help Received
My parents assisted in editing and the assembly of my display.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Aaron P. Gallagher

Project Number
S1205

Project Title
The Effect of Threading and Optimization on the Framerate of a Python-Based Partlcle Engine

Abstract

Objectives/Goals
The objective of this project was to test threaded versus non-threaded and optimization techniques in a Python-based particle generator script.

Methods/Materials
This project used python version 2.3.3, TextWrangler, the pygame libraries, and an iBook G3/700. Different versions of a benchmarking script were used to test different optimizations and the use of threading.

Results
Non-threaded with dirty rectangle optimization was tested to produce the fastest benchmark, non-threaded unoptimized the next fastest, threaded with dirty rectangle optimization next fastest, and threaded unoptimized last.

Conclusions/Discussion
The results supported the hypothesis and the objective of the project was reach. These results and the code may be reused to produce quick particle generators for use in games or making aesthetically pleasing graphical patterns.

Summary Statement
This project is about making a Python-based particle engine with the highest framerate possible.

Help Received
George Feineman assisted in the concept and some of the math.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Carter E. Greenbaum

Project Number
S1206

Project Title
A Proven Mathematical System for Predicting Future Stock Market Fluctuations

Abstract

Objectives/Goals
The Objective of this project is to compute theoretical and mathematical data in regard to the Stock Market and other securities to accurately predict price fluctuations of such securities over the course of 3 months, 6 months, 1 year, 3 years and 5 years.

Methods/Materials
I used data from SEC filings of 108+ stocks of different sizes and industries to gather fundamental data regarding their earnings. Using such data, a value of -1 to +1 for each indicator was factored into the overall equation.

Results
The result of this project was a system which can predict the future fluctuations and trends of a security with less than a 5% error. Over a 1-year period my system resulted in a 64% return on the investment.

Conclusions/Discussion
A system using theoretical and mathematical ratios and data can predict future profitable stocks 95% of the time.

Summary Statement
My project involves creating a system of several equations that can predict future stock fluctuations for individual investors, short-term and long-term investors and retirement IRAs.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Ariana G. Haro

Project Number
S1207

Project Title
Statistical Validity of Environmentally Variable Small Population Data Bases

Abstract

Objectives/Goals
The goal was to determine whether a particular area surveyed statiscally represents the slightly larger area surrounding it (given the variability of the living data in the mathematical study model); utilizing real data derived from an alpine survey project as a model.

Methods/Materials
10m2 and 30m2 quadrant samples from an alpine data base were obtained for examination.The data was limited to one species of plant surveyed in this model study. T-values were determined and compared for each of the L1 and L2 ranges of the large and smaller population samples for statistical validity at a 0.95 confidence level.

Results
The smaller population frequency was 0.24. At the 0.95 confidence level the interval was L1= .3815 and L2= .3815 for the larger population. The smaller population sample did not fit within the t-test confidence interval of the larger population.

Conclusions/Discussion
To support my conclusion I examined all nine quadrants of the larger 30m2 quadrant study area. No individual 10m2 quadrant fit the 0.95 confidence interval limits for the 30m2 quadrant population. This would clearly support my hypothesis.

Summary Statement
Utilizing real research data I was able to confirm that using a small population sample does not accurately represent the larger population.

Help Received
Thanks to Dr.Guy Norton and Dr.Dawn Hawkins of Cambridge University, England, for support and information, and research data from the GLORIA project.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Elliot R. Kroo

Project Number
S1208

Project Title
Smart Soaring: Flocks of Autonomous Airplanes

Abstract

Objectives/Goals
Thermal updrafts are used by both birds and aircraft to improve flight performance. This project models the actions of a sailplane or soaring bird to enable an autonomous aircraft to improve its performance using thermals. The project also shows how higher performance can be gained through collaboration with other aircraft.

Methods/Materials
In the computer program used to model flight, all modules were developed by the author -- a three-dimensional flight simulation, thermal model, control laws, genetic optimizer, and graphics package. The 3D simulation uses vector geometry to model an aircraft#s flight in a ground-based coordinate system. Object-oriented programming techniques were also implemented, allowing for multiple planes to be easily included in the same simulation. The thermal model was based on a recent NASA paper, together with input from several sailplane pilots. Both single airplane and collaborative control laws, involving communication among several aircraft, were developed and tested in the simulation, and control variables were optimized using a genetic algorithm. The graphics package allowed solutions to be viewed in real time.

Results
Significant performance improvements were attained by optimizing both the single airplane and the collaborative control laws. Smaller aircraft were found to be able to take greater advantage of thermals and the multiple airplane system demonstrated much better performance than the single airplane heuristic models.

Conclusions/Discussion
The results suggest several exciting applications in which energy in thermals might be used to dramatically increase the endurance of unmanned civil or military aircraft.

Summary Statement
This project simulates robotic airplanes flying through updrafts. By communicating with each other, they are able to stay in the air for longer periods of time.

Help Received
Dad helped understand mathematics involved.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Olga V. Mandelshtam

Project Number
S1209

Project Title
A Study of the 3x+1 Transformation and Its Continuous Limit

Abstract

Objectives/Goals
My experiment is an application of a novel method to a century-old problem. The Collatz (or 3x+1) problem deals with a simple sequence of iterations of a function f(x)=3x+1 for odd x, and f(x)=x/2 for even x. The yet unproven Collatz conjecture states that any sequence of iterations of f(x) will eventually run to 1. In my project I developed a circle map that represents the Collatz transformation and investigated its properties to make progress in the problem. I expected that my method would have much potential in studies of the Collatz problem, and much of interest could be found in investigations such as this one.

Methods/Materials
I wrote numerous programs to explore various aspects of the problem I was investigating. Each of my programs stemmed from a particular aspect that interested me for further study.

Results
I studied and proved some properties of this map, and then related it to a continuous transformation. I then studied iterations for a family of continuous maps of this type, both numerically and analytically. My most interesting results are related to the pattern of the slopes of those iterations.

Conclusions/Discussion
I found that the pattern of slopes demonstrates a striking sequence of pseudoperiods that are related to my numerical calculation of an exact formula for the rotation number. I also related certain properties of iterations of this continuous transformation to the original Collatz problem. The maps discussed in this paper have potential to be of use in future work in the area.

Summary Statement
I developed a novel approach to the Collatz problem by representing the 3x+1 transformation as a circle map, and studying the properties of it and its continuous limit.

Help Received
Research done under the guidance of Prof. Svetlana Jitomirskaya

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Thomas W. Moulia

Project Number
S1211

Project Title
Cardiac Measurement and Analysis

Abstract

Objectives/Goals
Purpose of the Experiment: The goal of this project was to develop an expert system to screen for cardiac anomalies. The specific objectives were to 1) construct an electrocardiograph 2) create an expert system which will differentiate among different heart anomalies and 3) record and accurately analyze cardiac waveforms.

Methods/Materials
Methods: A one channel ECG was constructed to measure cardiac electric potential. Data was digitized using an analog to digital converter. An expert system was created using Java. It was designed to identify heart potential waveforms by using a set of trained neural networks. The training was based on digitized heart anomaly waveforms available over the WEB from MIT/BIH. In addition variants of these neural networks were designed to find distinct segments (P, QRS, PR complexes) of the cardiac waveform, allowing analysis of waveform features (peaks, duration and sequence). Actual ECGs were taken and analyzed for a number of subjects.

Results
Results/Conclusions: Initial attempts were made to train the system to recognize entire beats of various anomalies. Because of significant waveform variation even within a particular anomaly, this approach was abandoned in favor of training the networks to recognize various waveform complexes within each beat and then using their shape, duration and relative timing to diagnose anomalies. On this basis the system was able to distinguish a limited set of heart anomalies discernable on a single modified lead 2 channel with a high rate of success. These anomalies included tachycardias, bradycardias, escape and premature beats, and 1 deg AV and bundle blocks.

Summary Statement
Built an electrocardiograph and developed expert system software to diagnose heart anomalies.

Help Received
Ms Helms (teacher) advised on software issues, mother helped with board, father helped edit text

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Abhinav Prathivadi

Project Number
S1212

Project Title
Development of a 3D Search Engine for Mechanical and Geometrical Applications

Abstract

Objectives/Goals
The goal of this project was to build a 3D search engine that indexed and retrieved various geometric shapes, industrial models, and auxiliary industry parts by minimizing the time of exhaustive searching and maximizing the accuracy of the search results based on user queries.

Methods/Materials
1. A JAVA GUI was designed to accept a 3D file (.dwg (AUTOCAD) converted to .gif) and after a few verification factors, was immediately fed into the algorithmic phase.
2. The algorithm disintegrated each side (top, bottom, left, right, etc) of the model into individual miniature structures, thereby creating thousands of dots from a single model. It was then processed by a stream and passed on to the indexing phase.
3. The stream was compared to the 3D database (containing indexed streams) and matches were perfectly rearranged and presented to the user in a matrix format(3*3.)
4. To eliminate bugs, unit testing was used to test each module before being embedded into the main class.

Results
A successful 3D search model was developed and results were returned based on the pixel make up, density measured, and the number of hits found. To test the accuracy of the algorithm, a known model acted as a query only to return the same model. To accommodate deviations in accuracy, a distorted model of a known database model was prepared and uploaded. The search results were displayed as anticipated, and the distortion was removed (with moderate accuracy) to portray the exact model from the database.

Conclusions/Discussion
The development of a 3D search engine serves the primary purpose of retrieving accurate results based on varied query characteristics. Once, the results were generated, the algorithm had to integrate all these factors and eventually display the most efficient model in the database. It also has the capacity to evolve into a user-friendly interface where in users can draw an object (dog, cat, house, etc) and results are based on the drawing. The applications for the 3D search engine include deployment in automobile industries, industrial assembly lines and aeronautical hardware industries.

Summary Statement
This project utilizes an algorithm to index and retrieve 3D models based on geometrical and mathematical equations.

Help Received
I would like to thank Mr. McGaugh for his diligent guidance in terms of introducing me to some programming books and my parents for bearing the computer turbulences at nighttime.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Vinayak Ramesh

Project Number
S1213

Project Title
WiSeNet: A Software Simulator for Wireless Sensor Network Applications

Abstract

Objectives/Goals
My project is an investigation of the behavior of wireless sensor network applications. Factors like the spatial distribution of sensors and the wireless transmission range affect the overall behavior of the underlying application and the expected results. I have developed a software simulator that investigates these behaviors.

Methods/Materials
I am building the software simulator called #WiSeNet# that models the behavior of two applications:

1. Battle Field: remotely tracking the movement of enemy troops in a combat situation and
2. Forest Fire: remotely tracking the course of a forest fire.

WiSeNet is developed using the C# programming language and Microsoft .NET platform. The development tool used is the Microsoft Visual Studio .NET Integrated Development Environment (IDE).

Results
The behavior and performance of wireless sensor networks is influenced by many factors. The effectiveness of a wireless sensor network application depends on these factors and their interactions. A software simulator for wireless sensor network applications can be a very useful tool to carefully plan and select the right type of motes and sensors in a cost-effective manner.

Simulation Variables
1. WiSeNet simulates random distribution of sensors. Through repeated experimentation it is possible to arrive at an optimal spatial configuration of the sensors that is most effective for a given application.
2. WiSeNet also allows the wireless range of a sensor to be varied and study the effects on the application.

Conclusions/Discussion
My applications simulate a forest fire and a battle field, and how these wireless sensor networks can be used in tracking. In my other application, one can model a wireless sensor network before implementing one, making it cost efficient.
There are an infinite amount of applications in which wireless sensor networks can be used, but it will be at least five to ten years from now before the benefits are widely recognized, and the full potential discovered.

Summary Statement
The first application, someone is sitting in a control station can monitor what is happening in the area where the network is; in the second application, I see the relationship between different facts, such as distribution and sensor range.

Help Received
Father helped with programming.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Chase W. Raymond

Project Number
S1214

Project Title
The Origins of Pi

Abstract

Objectives/Goals
What are some of the different methods for calculating the irrational decimal place values of the constant, Pi (d)? Is any method more accurate or efficient than others?

Methods/Materials
Beaker Marble Yarn
Graphing Calculator Ruler Toothpicks

Procedure:
Methods to be Analyzed:
· Spherical Method
· Buffon#s Needle Experiment
· Monte Carlo Method (Quarter Circle)
· Arctangent Infinite Series
· Wallis# Formula
· Newtonian Fluxions

Calculate Percentage Error for the different methods and analyze which approaches the constant value of Pi (d) most rapidly and accurately.

Results
Wallis# Formula provided the most accurate calculation approaching the value of Pi (d). The real resultant from this data, however, is that no method or number can represent or calculate Pi#s (d) exact value, except Pi (d), itself.

Conclusions/Discussion
We, in the real world, must decide the amount of precision we are going to use on a given project (ie: the building of a bridge) in order to accept something as perfect 'enough' to accept its usage.

Summary Statement
I looked at different methods of calculating Pi's decimal places and tested which approached Pi's true value fastest.

Help Received

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.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Zach M. Rubin

Project Number
S1216

Project Title
Compu-Drive

Abstract

Objectives/Goals
Program a laptop so that it will interface with an R/C car wirelessly.

Methods/Materials
construct the interface. write the program (in C).
Hardware: # 1x 630E Thinkpad; # 1x bread board; # 8x relays 5vdc DPDT; # 2x parallel port cables; # 1x plastic enclosure; # 1xCard board box; # 2x R/C micro tanks with radio controller (49 and 27 Mhz).
Software: # Slackware Linux ; # gcc c compiler; # jed c development interface; # parapin package.
Tools: # Soldering iron; # Solder sucker; # Solder ; # Pliers; # Screwdrivers ; # Duct tape; # Digital multimeter; # LEDs; # Drill; # Dremel; # Wire and strippers.

Results
YES i was able to do this however i came accross many things that gave me trouble such as
linker errors
segmentation faults
null pins
bios settings
but with much time spent troubleshooting i was able to find the root of all theese problems to come to the conclustion i had hoped for.

Conclusions/Discussion
I was able to do what i had set out to do. I had constructed the interface, written the code and built a platform which two little cars drove around on, as they were programmed to, the only part to the problem that that was less than satasfying (to me at least) was the fact that i could not predict the cars path with much precision, this was because the cars speed is inconsistant, and they usally go increasingly slow as the battery dies.

Summary Statement
Compu-Drive focouses on robotics and the ability computers have to control hardware in the outside world.

Help Received
the following people helped me get my code running correctly , via email: Chuck White, Al Hooton

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Stephanie Salcedo

Project Number
S1217

Project Title
Morphing Circles

Abstract

Objectives/Goals
The purpose of my project is to see what would happen if a basic sine function is added to the graph of a circle or an ellipse. I believe that a pattern will be created according to how the circle "bumps" around the curve.

Methods/Materials
Using the computer software "Nucalc," I graphed a regular circle. I overlaid it with a circle with the same radius but with a sine function added to the equation of that circle. I noticed that adding a sine function to a circle creates bumps, so I defined a "bump" as a curve that is outside but still intersecting the original circle. I made t-charts to record the amount of bumps I saw as I increased the period of the sine function. I recorded the number of bumps up to the 25th period. I made t-charts using circles with radii of two through six. With ellipses, I followed the same procedures, and I used ellipses of different sizes for my t-charts.

Results
As I made my t-charts, I noticed that as the period increased, the number of bumps either stayed the same, increased by two, or increased by four. The number of bumps was always an odd number. When I overlaid the "morphed" circle with the sine curve graphed separately, I saw that the number of times the sine curve crossed the x-axis while inside the original circle was equal to the number of bumps the morphed circle has. In addition, when I increased the amplitude of the sine function that was added to the circle, the number of bumps stayed the same, but the morphed circle began to break apart.

Conclusions/Discussion
My data supports my hypothesis because numerical patterns did exist in my t-charts. I found out that the number of bumps on a circle uses the greatest integer function and 2rb/Pi, where r is the radius of the circle, and b is the period of the added sine function. With ellipses, the number of bumps uses the greatest integer function and 2cb/Pi, where c is the radius along the x-axis for the ellipse. Based on all the data and research I have gathered, I was able to see a relationship between the number of bumps a sine curve creates on a circle when added together and the period of the sine function.

Summary Statement
My project is about what would happen if a sine function is added to a circular graph.

Help Received
My mother helped cut out some of my work for my board, my project advisor, Diana Herrington, proofread my work and provided me with some necessary materials, and my father provided the transportation for me to go buy the needed materials for my project.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Carmel Schindelhaim

Project Number
S1218

Project Title
The Effect of Nominal Interest Rates, Real Interest Rates, and Trade Balance on the Exchange Rate of the US Dollar

Abstract

Objectives/Goals
The objective was to determine the effect of nominal interest rates, real interest rates (rates corrected for inflation measures) and trade balance (exports minus imports) on the exchange rate of the US dollar. The project also looked to determine the percentage correlation that each variable had with the exchange rate of the US dollar.

Methods/Materials
Data was gathered on nominal and real interest rates in the US and five other foreign countries (Canada, Mexico, UK, Japan and Germany), as well as export and import trade data between the US an each of these countries over the past 20 years. The gap in real and nominal interest rates between the US and each foreign country was calculated as well as the trade balance. Then each variable was compared to the exchange rate by deriving a correlation coefficient. The percent correlation between interest rates and exchange rates was calculated on a quarterly basis while percentage changes for trade balance were evaluated monthly.

Results
Nominal interest rates had the largest influence on the exchange rate, with a 64.54% correlation average for the two highest trading partners of the US. Other variables proved to be exchange rate determents while real interest rates had the lowest correlation with the exchange rate.

Conclusions/Discussion
Contrary to the hypothesis that real interest rates would have the strongest positive correlation with the value of the US dollar against foreign currencies, (which was based on the fact that real interest rates reflect the real return on the investment), nominal interest rates proved to be the strongest determinant. Changes in nominal interest rates cause quick and substantial movement of capital between countries, increasing or decreasing the demand for the US dollar and thus affecting the exchange rate. Trade balance, although proven to be an exchange rate determinant, was less influential because of the observed lag affect: the exchange rate values changed a few months after trade balance figures were released.

Summary Statement
This project tests the effect of different economic variables on the exchange rate of the US dollar.

Help Received
none

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Ivan Sergeev

Project Number
S1219

Project Title
Encryption Algorithm Performance on an AVR Microcontroller

Abstract

Objectives/Goals
Secure data transfer is important task of the today communications. Benchmarking several reputable encryption algorithms on an embedded micro-controller was the primary goal of this project. Obtained data illustrate the implementation of the security algorithms on an embedded platform that can be used successfully by business corporations and end-users.

Methods/Materials
Atmel AVR ATMega128 micro-controller was chosen for this project due to its popularity and because it meets the hardware requirements for an encryption application. Using the SRAM interface on the chip, external memory was added to the project. In addition, I/O communication was provided by using the micro-controller built-in UART serial interface. A software driver was developed to operate a LCD attached to the micro-controller and used for debugging. Open source encryption algorithms from libtomcrypt were ported and optimized with AVR-GCC, a GCC tool-chain ported to the AVR platform. A program was developed on the personal computer to perform benchmarks and tests. All board design and assembly were done by author.

Results
Using a benchmarking program developed and compiled on the personal computer, the key and data was sent to the micro-controller. The micro-controller then confirmed the acceptance of the key, and gave the signal to begin the timing. The program kept time, and stopped when the signal of completion from the micro-controller was sent. I/O communication was done over a RS232 serial interface. Encryption and decryption tests consisted of the encryption or decryption operations in sets of rounds with the same data and key that was sent initially. The time of round execution was measured, compared and presented for each algorithm, along with the compiled program, and key and data size.

Conclusions/Discussion
This project demonstrates that it is feasible to implement security solutions on inexpensive embedded devices. Such implementation is less vulnerable compared to a software only implementation because the encryption program itself is written to a read-only memory space. The program execution speed indicates that today's encryption algorithms can be practically used in embedded devices which can be efficiently utilized by the corporations, the government or the end-users. Future work can show that these inexpensive embedded devices with implemented security can be used as a secure data exchange connections between computers.

Summary Statement
Security solutions can be more safely implemented in embedded devices versus in a pure software solution where the security software itself is vulnerable.

Help Received
Dr. Andrei Sergeev dedicated time to brainstorming the initial project idea and project review.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Philip Q. Shao

Project Number
S1220

Project Title
Practical Use of Nyquist Sampling Theorem in Image Reduction

Abstract

Objectives/Goals
The objective of this experiment is to find out the minimum number of pixels of a digital picture necessary to maintain the basic features of an image. As an extension of my last years experiment in time domain, this is a study of practical application of Nyquist Sampling Theorem in 2-D space domain.

Methods/Materials
The first part of experiment analyzes the pixel reduction (or resolution reduction) of a periodically patterned checkerboard using Microsoft Excel¡#s cell merge and average functions. The model simulation results show that, with the correct starting point, the characteristics of the pattern can be maintained as long as a minimum of two samples per period is used. This means the Nyquist Criterion is applicable in 2-D space domain. It is also observed that when there is an offset in the starting point, the minimum sampling rate is considerably higher.
The second part of the experiment is to reduce the resolution on pictures of three former presidents using the same Excel cell merge method. Three pictures of well-known faces were downloaded. They were cut into similar pixel sizes and saved in the same format as starting pictures. Some basic research in facial recognition suggested nodal points on the face are used as ¡°periods.¡± As the resolution or the pixels, the independent variable, is reduced, the appearance, the dependent variable, of one president becomes more and more like the appearance of the others. Eventually, when the resolution drops below eight samples per nodal distance, the face becomes unrecognizable. This was explainable, because the nodal distances did not have a common pattern period and therefore were catastrophically off the ¡°correct¡± starting point.

Results
See Methods/Materials.

Conclusions/Discussion
In conclusion, this study clearly demonstrates the Sampling Theorem is applicable in 2-D space domain. It provides a numerical tool for digital picture resolution reduction. However, from the model simulation of periodic pattern reduction, it is observed that the selection of starting point affects the minimum sampling rate and real-life image reduction confirms this phenomenon. This has wide applications from more efficient missile targeting systems, to easier facial recognition #C and, buddy icons.

Summary Statement
The focus of this project is to use the Nyquist Criterion to determine the minimum resolution an image requires for facial recognition.

Help Received
Mother helped type report. Helped organize board and ideas.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Emily M. Stark

Project Number
S1221

Project Title
Virtualoso: An Artificial Intelligence Project in Computer-Based Music Composition

Abstract

Objectives/Goals
The objective of the project is to program a computer to compose original melodies using artificial intelligence and to learn from what it has previously composed.

Methods/Materials
I designed a computer program in Microsoft Visual Basic 6.0 that uses a genetic algorithm (an algorithm that mimics evolution to solve problems) and a neural network (a method of pattern recognition) to compose original melodies. The user rates each melody that the program composes for representation of style, representation of mood, and aural appeal, and all the previously composed melodies are stored in a database. To compose a new melody, the program selects two highly rated parent melodies from the database and analyzes their rhythms and intervals. This analysis is used to compose the new melody, which is then rated and entered into the database. The program was executed approximately 100 times and aural appeal ratings were graphed to determine if the program improves from what it has previously composed.

Results
In a sample of 35 melodies that the program composed, the aural appeal rating was graphed as a function of the number of melodies previously composed. The line of best fit had a slope of 0.0532, indicating an upward trend in composition. The average aural appeal rating is 6.16 (on a scale of 1 to 10, 10 being the highest). Based on the representation of style and mood ratings, the program is best at composing melodies rated as contemporary and sad, with average ratings of 8.29 and 8.00, respectively.

Conclusions/Discussion
The project achieved the objective of programming a computer to compose original melodies and learn from what it has previously composed. However, the melodies are still less aesthetically pleasing than most music composed by human intelligence. This program furthers the understanding of intelligence by designing a method to mathematically express a creative function of the human brain.

Summary Statement
My project is a computer program that uses artificial intelligence, specifically a genetic algorithm and a neural network, to compose original melodies and learn from what it has previously composed.

Help Received
My mother helped with cutting paper for the display and both of my parents proofread my written work.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Justin L. Stephens

Project Number
S1222

Project Title
Avencrypt

Abstract

Objectives/Goals
The objective of my project was to determine if a relatively effective encryption algorithm could be developed without the use of random numbers.

Methods/Materials
I brainstormed three different methods data could be encrypted without random numbers. The three I came up with were rearrange the binary, add or subtract from the values of the data or a process I call reversion, where the binary of a user-supplied password is matched up with the binary of the data being encrypted, then whenever the bit of the password is one, the corresponding bit of the data being encrypted is reversed. I took these ideas, tested them on paper, then, if they worked, put them into code.

Results
Rearranging the binary was too slow and wasn#t very secure because it wasn#t password protected. Adding or subtracting from the values of the data didn#t even work on paper because I couldn#t get it to decrypt correctly. Reversion worked was the method because it was relatively fast and secure.

Conclusions/Discussion
To conclude, I found that it is possible to create an encryption algorithm that doesn#t use random numbers.

Summary Statement
My project, Avencrypt is my attempt to create a relatively effective encryption algorithm that does not use random or semi-random values.

Help Received
My computer teacher Mrs. Kidwell suggested password protection.

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Alexander C. Trahan

Project Number
S1223

Project Title
When Does Randomness End?

Abstract

Objectives/Goals
The objective of this experiment is to determine whether multiplication, exponentiation, or addition will force a set of random numbers [0,1] to conform to Benford's Law (a most-significant-digit law for natural, social, or mathematically-manipulated numbers) with a statistical significance level of 0.05 by Chi-square testing.

Methods/Materials
Java was used to create random number sets [0,1] (proven not to conform to Benford's Law) then perform operations on this set with additional random number sets. The results from these programs were analyzed in Microsoft Excel and placed into charts and graphs. Error bars on these graphs were calculated using a poisson distribution. Chi-square values of each calculation were calculated and compared to the statistical significance level of 0.05.

Results
When multiplying with sets of random numbers, their conformity to Benford's Law becomes 0.05 significant after one multiplication and becomes much more significant with more multiplications. When random sets are added, the conformity is not significant. As the number of additions increases, the set becomes less significant. When random sets are used in exponentials their conformity is much better than 0.05 significance.

Conclusions/Discussion
Some mathematical operations on random number sets converge rapidly to a Benford's Law distribution. The number of operations can range from one to a few depending on the operation, but a general trend can often be detected after those first few operations. This rapid convergence can explain why numbers in calculations such as income tax returns can conform to Benford's Law.

Summary Statement
This project attempts to determine which operations (multiplication, addition, and/or exponentiation) used on a set of random numbers will cause that set to conform to Benford's law with a 0.05 (or lower) statistical significance level.

Help Received
Mr. Teachworth provided facilities to meet with mentor; Dr. Groce encouraged and provided guidance; Mr. Volger instructed on how to write the computer programs; Mother provided materials

CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
Kristen N. Uyemura

Project Number
S1224

Project Title
Variegation and Repeated Sequences on the Rubik's Cube

Abstract

Objectives/Goals
An investigation was conducted on the Rubik's cube to determine if a relationship exists between the order of a move sequence (the number of times the sequence must be performed on a solved cube for the cube to return to its original state) and the cube's average variegation (degree of disorder).

Methods/Materials
A computer program was written in QBASIC to simulate a Rubik's cube and compute average variegation. Using this program, data was collected, revealing the average variegation of a cube as various sequences were repeated on it.

Results
In sequences with orders small enough to be analyzed, it was discovered that when variegation was graphed against the number of repetitions of the sequence, the resulting points fit a 4th degree polynomial equation.

Conclusions/Discussion
Based on this and the appearance of the graphs of the remaining sequences, it is suggested that variegation during repetition of any given sequence may always change according to a polynomial expression of varying degree. The results also suggest that the larger the order of the sequence, the higher the degree of the polynomial, although further investigation must be carried out before this can be proven.

Summary Statement
This project explores the mathematics of how the average variegation of a Rubik's cube changes as sequences of moves are repeated on it.

Help Received
Fellow student helped debug QBASIC computer program.