



CALIFORNIA STATE SCIENCE FAIR 2006 PROJECT SUMMARY

Name(s) Ish B. Bhanu	Project Number S1201
Project Title 2D and 3D Biometric: Recognizing Humans by Their Ears	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The human ear is known to be a stable structure from childhood to the age over 75. My project is to determine if humans can be distinguished by their ears imaged in 2D and 3D. In particular, since so many pixels in images do not contain unique information I believe a more compact representation other than the original image can be used to distinguish ears.</p> <p>Methods/Materials The principal component analysis is used to recognize humans by their ears both in 2D and 3D. It consists of computing mean vector and covariance matrix, finding eigen-values and eigen-vectors, normalization of eigen vectors and computing the transformation matrix to provide the principal axes and the transformation.</p> <p>The data on human ears are collected using a 3D laser range finder that provides both a 2D intensity image and a 3D range image. The eigen-ear compact representation is used to describe ears. Experiments are carried out on the available data by training on all images (intensity or range) and testing on the remaining image and finally averaging the results over the entire dataset. The nearest neighbor algorithm is used to recognize ears of different people. Cross-validation is performed by repeating experiments twice and averaging the results. Programs are implemented using the Matlab image processing toolbox.</p> <p>Results Experiments are carried out on ear databases of 26 subjects with 86 intensity images and 22 subjects with 68 range images. They show that eigen-ear representation is useful for recognizing humans by their ears. It can provide data reduction by a factor of 100.</p> <p>Conclusions/Discussion 1. Eigen-ear representation has a good discrimination capability for distinguishing people based on their ears. 2. The results on intensity images are better than on range images. 3. It may be possible to use shape features and use information from both the range and intensity images to further improve the results. Moreover, these results can be combined with side face (or frontal face) recognition results to improve the performance of human recognition. Thus, ear recognition can help against the crimes and the war on terrorism.</p>	
Summary Statement Humans can be distinguished by the computer based on their ears and eigen-ear representation can be very useful.	
Help Received Ms. Xiaolin Zhou and Mr. Hui Chen at UC Riverside. Ms. Zhou helped me with Matlab and Mr.Chen helped with the data.	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) George Chen; Frank Fu-Han Chuang; Victor Andrew Shia	Project Number S1202
Project Title Paladin: A New Fast and Secure Symmetric Block Cipher	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The advanced encryption standard, AES, is the standard for encryption in the United States. However, AES carries with it some flaws that may jeopardize its security. This project serves the purpose of developing a new cipher that addresses these issues while inheriting the good aspects of many cipher designs.</p> <p>Methods/Materials Utilizing and improving upon past research and existing cipher designs, various functions of a cipher were coded to maximize security and efficiency. After compiling all of the functions into the overall cipher, several programs were coded to compare the encryption and decryption speeds of AES and Paladin and to test Paladin's resistance to certain attacks.</p> <p>Results On the Athlon, Sempron, Athlon 64, and Pentium 4 processors, Paladin encrypts and decrypts at a faster speed than several optimized software implementations of the full 14-round AES. Differential cryptanalysis and linear cryptanalysis both have complexities that make them less feasible than an exhaustive key search. Several other attacks are prevented due to Paladin's design.</p> <p>Conclusions/Discussion Paladin is faster than AES on modern systems while addressing security issues brought up with AES and various other ciphers. However, further work needs to be done in the area of cryptanalysis before Paladin can be used in a commercial environment.</p>	
Summary Statement Paladin is a computer encryption program that protects sensitive data from unauthorized users.	
Help Received none	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Tyrone T. Chen	Project Number S1203
Project Title Combinatorial Design Criteria to Optimize Sensor Footprint Configurations (Year 3 of an Ongoing Study)	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The effect of spacing between motion sensors on the number of detection zones will be determined by programming a computer simulation. Sensor spacing can be expressed as a fraction of the sensor footprint radius, r, thus providing a non-dimensional parameter that can be applied to any real sensor footprint size. The sensor spacing will be from $2r$, resulting in n detection zones for n sensors, to a spacing less than $2r$ that provides the maximum number of detection zones, $n(n-1)+1$. The simulation will determine the range of sensor spacing less than $2r$ that provides this maximum number of detection zones. This project provides quantified guidelines for designing optimum configurations for large sensor fields.</p> <p>Methods/Materials The computer program implements the following: 1) Input the number of sensors, n, the footprint radius, and the radius of the reference circle on which the sensors are placed. 2) Calculate the maximum number of overlapping zones produced through the formula $n(n-1)+1$ for n sensors. 3) Equidistantly space the number of sensors around a reference circle by dividing 360 degrees by n, and use polar coordinate to rectangular coordinate calculations to determine the x and y values of each sensor location. 4) Calculate the sensor spacing using the mathematical distance formula between two points on a plane. 5) Create a display for the sensor footprint configuration. 6) Display the inputted values as well as the calculated spacing between sensors and the number of zones produced.</p> <p>Results Using this program, it was found that the original hypothesis that the maximum number of zones, $n(n-1)+1$ is achieved by a spacing, d, between a lower and upper bound fraction of the sensor footprint radius r, where the bounds may depend on the number of sensors, was found to be mathematically trivial in that the lower bound was always $d=0$ and the upper bound was always $d=2r$ so that $0 < d < 2r$ always achieved the maximum number of zones.</p> <p>Conclusions/Discussion This discovery indicates that optimal sensor configuration should not be based on the number of detection zones but, instead, should be based on the usable area of each zone since sensor spacing within $0 < d < 2r$ can significantly alter the relative size of resulting zones. The computer program developed in this project is helpful in quickly plotting various configurations enabling the user to rapidly visualize and decide on a useful sensor configuration.</p>	
Summary Statement This project continues the two previous ones to define the design criteria needed to optimize a sensor footprint configuration, thus reducing the number of motion sensors used to cover a given area and lowering the cost of security.	
Help Received Father guided me through topic selection and assisted me in the conceptual engineering background.	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Anna K. Dewey	Project Number S1204
Project Title Predictive Analysis using Linear Regression	
Abstract Objectives/Goals To determine if linear regression can be used to accurately predict results of a given experiment. Methods/Materials All you need for this project is microsoft word to be used in conjunction with excel, to calculate linear regression using existing data. Results I found that if the data is linear, than the accuracy of the formula is superb. Good data is required to accurately predict endpoints using mathematical equations. Conclusions/Discussion The key to using probability is to accurately model formula to known results.	
Summary Statement Using linear regression equations to predict end results of data.	
Help Received	



CALIFORNIA STATE SCIENCE FAIR 2006 PROJECT SUMMARY

Name(s) Frederick C. Dopfel	Project Number S1205
Project Title The Effect of a Low Precision Computational Environment on Comparative Algorithm Speed for Calculating the Value of Pi	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective is to determine the performance of advanced algorithms for calculating the value of pi (such as the Borwein Quartic Convergence (BQC) algorithm) in a low-precision environment typical of modern personal computing applications. I suspect that such advanced algorithms designed for supercomputers at high precision may underperform simpler algorithms in a low-precision environment.</p> <p>Methods/Materials The algorithms that I chose to calculate pi were: Borwein Quartic Convergence algorithm (an advanced algorithm that is used in supercomputers at high precision); the arctangent formula; Viete's formula; Wallis's formula; and Monte Carlo approximation. I used C++ to code these algorithms and to constrain the precision to 14 digits. The program output included number of algorithm loops completed, the elapsed computation time and the estimated value of pi (error). Before running the programs, I stopped all background programs. The experiment was replicated numerous times to control for any aberrations in the performance of the computer. The computer itself was designed and home-built by me, and runs with a 3.0 GHz processor and 1.5 GB of RAM.</p> <p>Results The significant conclusion is that BQC, the fastest known algorithm at high precision, underperforms in a typical lower-precision computational environment, and "choked" at 12-digit accuracy, never converging to pi at 14-digit accuracy. The Viete algorithm, invented in the 16th century, outperformed BQC and other algorithms at 12-digits or more accuracy. Wallis' formula and the arctangent formula were very close in efficiency and the Monte Carlo was the slowest algorithm, as expected.</p> <p>Conclusions/Discussion BQC relies on repeated high-precision calculations of fourth roots and powers while the other algorithms tested rely more on multiplication and addition of simple fractions. Although BQC takes very few loops to converge, each loop is very costly in computational time and resources (82x more time per loop than the Viete algorithm). For these reasons, the BQC algorithm, while known to be the fastest in a high-precision computing environment, underperformed relative to simpler algorithms in a low-precision computing environment. Algorithms and software designed for supercomputers may not always perform well in typical computing environments. Software designers need to account for the computing environment when choosing the algorithms to code for complex tasks.</p>	
Summary Statement My project tests how complex algorithms (such as those for calculating the value of pi) designed for high-precision computing environments perform in comparison to simpler algorithms in a low-precision computing environment.	
Help Received My school provided a free copy of Microsoft Visual Studio.	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Justin Feng; Alexander Kayfetz-Gaum	Project Number S1206
Project Title What's So Great about Sex?	
Abstract Objectives/Goals To determine whether the rate of evolution towards an optimal genome is greater among a sexually reproducing population (SRP) or an asexually reproducing population (ARP). Methods/Materials Construct two separate computer programs using the programming language Python. One simulates evolution among a SRP and the other simulates evolution among an ARP. Each individual strives to become more fit, which is defined as the distance between an individual's genome and the target and reach a target genome. Adjusting certain values, such as genome size, average mutation rate, etc., makes it possible to compare average evolutionary efficiency under different conditions to acquire the most accurate results possible. Results The sexually reproducing population achieved a higher level of fitness at a faster rate than the asexually reproducing population. Changing the values of the parameters created both favorable conditions and extreme conditions in which the populations were to evolve, and only when the average mutation size was extremely high was asexual reproduction advantageous in the evolutionary process. Conclusions/Discussion The results we acquired are further proof of why more species in real-life reproduce sexually rather than asexually. We surmise that genetic recombination and variability account for the superiority of sexual reproduction. Because an offspring's genome in a SRP takes beneficial genes from two parents, it will become more fit at a faster rate while also increasing genetic variability within the entire gene pool. Because of the close similarity between a parent and an offspring's genomes in an ARP, genetic variability is low and the population as a whole does not evolve at as fast of a rate as the SRP.	
Summary Statement This project explores whether sexual reproduction or asexual reproduction is more efficient in the evolutionary process of a population.	
Help Received Stefan Karpinski helped with improving and looking over the programs.	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Eric A. Ford	Project Number S1207
Project Title Target Acquired: A Comparison of the Effectiveness of Search Patterns Executed by Autonomous Robotic Vehicles	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals My objective was to determine the most effective of four search patterns I developed for an autonomous robotic vehicle.</p> <p>Methods/Materials I assembled wheeled robots equipped with ultrasonic sensors for obstacle detection, infrared sensors for target detection, and infrared wheel encoders for determining distance traveled. I programmed a series of tasks to control the low-level sensor and movement functions of the robots. The data from the repeating sensor tasks was then stored in a class where it could be accessed by the high-level obstacle-avoidance and searching behavior functions of the robot. I compared the amount of time the robot took to locate an infrared target with different search patterns. The first was a raster search pattern where a robot searches in incrementing lines of travel parallel to the walls of the room. A second random search pattern was utilized where a robot travels in a straight line until encountering an obstacle, at which point it pivots a random number of degrees away from the obstacle and begins another straight line movement. In the third pattern, a robot completes a movement of random length, pivots a random angle, and then begins another random movement. A fourth pattern was like the third, but used movement values determined by a Levy distribution. This results in a long movement followed by a series of short movements in the area. The fourth pattern mimics the search patterns of predatory animals where they choose a location and then check the vicinity for signs of prey.</p> <p>Results The raster search pattern yielded a faster mean search time and lower standard deviation than the other searches. The Levy search had the slowest mean search time and the greatest deviation, although it had the fastest mean search time for the target positions that were farthest from the searcher's starting position.</p> <p>Conclusions/Discussion The data suggests a relationship between fast search times and deviation from the mean. The searches that were able to find targets the fastest were also the ones that could potentially take a very long time to find a target as a result of redundancy caused by their shorter movements. Refining the rules governing the search patterns by increasing the maximum movement lengths would dramatically improve the effectiveness of the random search patterns. However, random search patterns will have greater potential for deviation than a raster search.</p>	
Summary Statement My project is a comparison of the effectiveness of several search patterns executed by autonomous robotic vehicles.	
Help Received Alan Van Nevel of the Naval Air Warfare Center at China Lake provided me the internship that made my project possible. Duane Schwartzwald assisted me with Java programming and wiring. He, along with Rodney Heil and Jim Bobinchak, secured funding for the robotics lab and hardware.	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Carter E. Greenbaum; Leah A. Greenbaum	Project Number S1208
Project Title An Algorithm for Predicting Future Stock Market Fluctuations by Volatility and Arccosine Analysis	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective of this research project is to determine the most accurate techniques in predicting short-term stock market fluctuations by identifying recurring patterns in the stock market.</p> <p>Methods/Materials After observing and recording patterns to predict price changes, an algorithm for computing volatility as a means of determining the risk factor of buying a stock must be created. The same must be done for the reward. Finally, a pattern must be established for predicting an uptrend and a downtrend, which is common and recurring among the great majority of heavily, traded stocks. Stocks were bought and sold based on these patterns and the gain per transaction was recorded.</p> <p>Results After 10 Weeks and 500 transactions, I returned 54% on my original investment. That is an average of .108% per transactions. This was a 10-week simulation (with 50 trading days and a maximum of 10 transactions per day). My portfolio placed first in the entire state of California because of the technical analysis techniques I used. Meanwhile, the stocks in my control group lost a total of 3% on the same amount of transactions. My second trial reaffirmed the results of my first trial.</p> <p>Conclusions/Discussion The technique that returned the most on my original investment was Parabolic (SAR) Analysis, a commonly used and applied technique. On average, the pattern materializes 5 to 6 times a day in a single stock. However 7 out of 8 times, according to my algorithm, the possible risk is greater than the reward. The next highest performer was my own modified theory, the Fibonacci Cap Sequence. Rounding out the top three was the Elliot Wave Analysis. The most commonly occurring pattern is the arccosine pattern. Even though the Parabolic SAR is the most profitable pattern, it does not occur as often as the arccosine pattern. The Fibonacci Cap Sequence was the second most profitable pattern. In a close third was the Elliot Wave pattern. The best analyses for short-term investments are the Parabolic SAR, Fibonacci Cap Sequence, Elliot Wave Pattern and the Arccosine Pattern.</p>	
Summary Statement Determining which type of short-term analysis is most accurate in predicting short term Stock Market fluctuations?	
Help Received Dr. Taylor helped with software development	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Ariana Haro	Project Number S1209
Project Title The Utilization of Empirical Math Modeling in a Predator-Prey Relationship	
Abstract Objectives/Goals In this study it is my goal to examine whether a mathematical model can accurately represent a predator-prey relationship that includes dynamics not within the populations# control. Methods/Materials First, a classic predator-prey mathematical model was constructed for comparison purposes. Then data from a thirty-year study conducted in Serengeti National Park, Tanzania was converted into spreadsheets. Using these spreadsheets graphs were made for each predator and prey. With the graphs polynomial fit lines were constructed. Then the classic mathematical model was compared to the various graphs to check for compliance. Results The data bases and graphs in conjunction with research showed that in the years prior to the indicated canine distemper virus (CDV) outbreak a classic predator-prey model will portray the proper trends. However, the classic model no longer could accurately represent the Serengeti data as exemplified by the canine distemper virus. Conclusions/Discussion Utilizing real research data I was able to confirm that classic predator-prey models fail to include dynamics that influence population size.	
Summary Statement This project examines whether a mathematical model can accurately represent a predator-prey relationship that includes dynamics not within the populations# control.	
Help Received Some minimal data consultation was provided by Dr. Guy Norton, Mikumi National Park Tanzania, and Dr. Randall Swift, California State Polytechnic University, Pomona	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Kalvin Huang	Project Number S1210
Project Title Will You Be the Next Millionaire?	
Abstract Objectives/Goals My objective was to see if the lottery numbers are predictable. Methods/Materials The material I used for my project was the computer program QBASIC, that I used to create my programs, and Microsoft Exell, used to create my graphs. My first program is designed to compare the numbers that the computer draws with the numbers that I pick. My second program is designed to run a lottery program a certain amount of time and display the accumulated total of each number#s appearance. Results The results for my project was that the lottery numbers are not predictable. The frequency for each numbers appearance is not predictable. Different psychologist gave different response to why people gamble with chances so small. Conclusions/Discussion My hypothesis was correct, "The lottery numberse are not predictable." Hopefully, this project will benefit all the people that buy lottery tickets.	
Summary Statement Are the lottery numbers predictable?	
Help Received My dad proofread all my work and helped my glue everything on my board; Mrs. T-R taught my how to write programs in QBASIC.	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Brad J. Jensen	Project Number S1211
Project Title Charting the Unknown: The 4th Operator	
Abstract Objectives/Goals My objective with this project is to define the once unknown operators and create a basic #road map# for the topic. My goal is to lead the way into a new field of mathematics. The purpose of this project is to help redefine math, and the way we think of it, starting with the most basic part of it: The standard operators. Methods/Materials In order to create additional operators that succeed exponents and multiplication we must establish a connecting pattern between these standard operators, once this pattern is established we can proceed to invent additional operators that have never existed. Results After establishing the pattern of the operators I began calculating the 4th operator and beyond. I did several calculations and discovered some basic rules that apply to all operators. Conclusions/Discussion My primary objective now that I have completed my project is to have it examined and discussed. I desperately need input on the project pertaining to how to proceed with the project, and where to go next.	
Summary Statement The purpose of this project is to calculate the undefined operators that exist but have never been considered.	
Help Received Conceptual discussion (which helped point me in my current direction) from my brother, 2 different math teachers, and various other people.	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Sarah Knight; Amanda Whitney	Project Number S1212
Project Title A Simulation of Optic Flow in a Predator Prey Relationship	
Abstract Objectives/Goals The objective of this project was to design a computer program that could accurately simulate Optic Flow and its effects on a predator/prey relationship. Methods/Materials A mobile robot with simple vision capabilities was used to run short optical flow algorithms that simulated the tracking of mobile #prey# in an artificial environment: a darkly colored arena with contrasting white paper insects that a simple linear camera could detect. The computer programming language, Python, was used to program the robot to take pictures with the linear camera until #prey# was visualized. The program was then designed to do contrast stretching, pixel thresholding, grouping of continuous blocks of light (blobbing) and blob tacking (Optic Flow). The contrast stretching improved the visual image, and the thresholding served to eliminate all unnecessary visual information like an organism#s brain eliminates all visual noise. The robot was programmed to find and characterize contiguous image features (find the best #prey#) and simulate an organism#s neuro-muscle network by determining a correct direction of travel to the image feature of interest. Results The program accurately provided the robot with reactions comparable to organisms in their natural environments, and therefore, an Optic Flow model is plausible and merits further research. Conclusions/Discussion Further experiments with colored cameras also deserve research to more accurately simulate Optic Flow of organisms that see in color.	
Summary Statement The purpose of this project was to determine how Optic Flow in a predator/prey relationship could be plausibly explained through a simulation of behaviors applied to a Hemisson robot by a computer programming language, Python.	
Help Received Phill Whitney helped build arena; Robin Knight provided robot and framework programming	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Brian S. Lee	Project Number S1213
Project Title What Makes a Team Win More or Fewer than Pythagorean Expectation?	
Abstract Objectives/Goals The objective of this project is to determine why baseball teams win more or fewer games than they are expected by the Pythagorean expectation, which is based on runs scored and allowed. Methods/Materials I researched the database, stats, and references of the Major League Baseball teams in 2004 and 2005. I also researched the Pythagorean expectation, Pythagorean Theorem, and Bill James who invented the Pythagorean expectation formula. Then the expected winning percentage for each team was calculated and I identified the teams whose actual winning percentages were deviated most from their expected percentages. Next, I gathered more details on those teams and analyzed to find out what they did that resulted in more or fewer wins than predicted. Finally, I tried to determine what the teams had in common. Results 2005 Arizona Diamondbacks (won 13 more games): getting good players (infusion of veteran talents) and good chemistry 2005 Toronto Blue Jays (won 9 fewer games): mismanagement - sent best players without improving the team and chopped payroll (team salaries ranked 25th - difficult to attract quality veteran players) 2004 Cincinnati Reds (won 10 more games): young starting pitching was the biggest reason 2004 Detroit Tigers (won 7 fewer games): poor bullpen and weak team chemistry (lost their motivation and intensity toward the end) Conclusions/Discussion I conclude that my hypothesis was partially correct. Poor bullpen was the main reason why the Tigers won seven fewer games than expected. But it was good players, good veteran players for the Diamondbacks and young starting pitchers for the Reds, that they earned more victories. Also, team chemistry was a critical factor for both the Diamondbacks and the Tigers; it helped the Diamondbacks to win more games while the Tigers saw their team to break apart due to lack of motivation and intensity. I observed that teams that suffered worst records in the MLB came back close to their norm the next year. I also noticed that teams need to invest more money to attract quality players and to win more games. For further research I would like to repeat my project using 1.82 as an ideal exponent instead of 2 that I used and compare the accuracy of the Pythagorean expectation using 1.82 versus 2. Furthermore, I would like to analyze the results to see my hypothesis will be more or less correct than now.	
Summary Statement My project explored what makes a team's winning percentage deviate from the Pythagorean expectation, which is based on runs scored and allowed.	
Help Received My dad helped me searching for numerous baseball related websites to find teams and players stats and any relevant information that I needed. He also showed me how to enter functions to calculate Pythagorean expectation easily using Microsoft Excel.	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Bryan Lin	Project Number S1214
Project Title The Modeling of the Human Spherical Retina through Binocular Vision	
Abstract Objectives/Goals The purpose of this project is to derive a more precise and realistic retinal representation in monocular as well as binocular vision based on its optical and geometrical properties. Methods/Materials Based on a #flat# shaped retinal model (used extensively in most of the visual servo controls), a new retinal model has been formulated based on the spherical shape of the human retina in monocular vision. Spherical model parameters, such as retinal arc length 'l' and angle 'alpha', have been carefully chosen so that they uniquely represent the projected location on the retinal surface. The uniqueness of this new model is that it establishes a differential relationship between an observed point in one#s visual space and the projected spot on the spherical retinal surface. Furthermore, the model of differential relationship in monocular vision is being extended to the binocular vision case. Results A novel and more precise differential model of the human spherical retina has been derived. The importance of this new model has two folds: (1) From mathematical and geometrical point of view, it solves a projection problem that a point in 3-dimensional space is projected onto a spherical surface via an optical pinhole; (2) From bio-engineering point of view, precise motion behavior of the projected spot on the retinal surface resulting from an observed point in one#s visual space can be predicted by the model. Conclusions/Discussion The model can readily be applied in scientific research, such as the human binocular visual servo computational study. Also, the idea of establishing a visual model based on a spherical retina can be extended to model other shaped retinas, such as parabolic or elliptical shaped retinas in other animals# ocular systems.	
Summary Statement A new retinal model for monocular and binocular vision for the human ocular system has been established.	
Help Received Ms. Amanda Day, my science teacher, was available for consultation. Mother helped to buy materials for project display.	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Rocio Mercado	Project Number S1216
Project Title The Pappus Chain Theorem: A Proof	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The Pappus Chain Theorem, a type of Euclidean geometry, was discovered and proven by Pappus of Alexandria in the third century. In the 1800's, Jacob Steiner, a Swiss mathematician, found a simpler proof for the theorem which used the method of circle inversion. The objective of this project is to research the Pappus Chain Theorem and circle inversion to use the new knowledge and proof the theorem myself.</p> <p>Methods/Materials 1 drawing compass; 1 12" long straightedge; a protractor; color pencils; a computer w/ internet access (for research); library access/encyclopedias (for research)</p> <p>Results After applying the concept of circle inversion to the Pappus Chain, it was plainly visible that hidden between all the lines were similar triangles. The "triangles" are similar because of certain angles I found: $x(n)$, $y(n)$, $z(n)$, $x(n)$, $Y(n)$, $Z(n)$. The proof is much simpler than it appears, and the two triangles, along with circle inversion, have a big part in proving that $hn=n*d(Cn)$.</p> <p>Conclusions/Discussion From carrying out this experiment/proof, I conclude that the line creating a right angle from line AC to the center of inscribed circle n is equal to the diameter of circle n multiplied by n, $hn=n*d(Cn)$. I know this is true because the philosophy of circle inversion doesn't change when using it to corroborate with the Pappus Chain Theorem. During experimentation, I learned that this theorem is even true for $n=0$ and $n=(\text{forever})$, since the chain is a sort of fractal. At $n=(\text{forever})$, it will never touch line AC, therefore it will never touch point A and every circle has a centerpoint. If I was to carry out this project again, I would improve it by constructing better visuals with less human error in the constructions so that it will be easier for people to see the process and all the little details. That is also why I would make it bigger, but big compasses are hard to find. I would also use a computer program to make the constructions because by hand there is too much human error and it is very time consuming.</p>	
Summary Statement The Pappus Chain Theorem, $hn=n*d(Cn)$, is an infinite chain of tangent circles inscribed inside an arbelos and can be proven using Jacob Steiner's method, circle inversion.	
Help Received Mr. Delaby (mentor)	



CALIFORNIA STATE SCIENCE FAIR 2006 PROJECT SUMMARY

Name(s) Thomas Moulia; Oliver Rickard	Project Number S1217
Project Title Clockwork Evolution	
Abstract Objectives/Goals The purpose of this project is to create a digital model for evolution in the Java programming language. The simulation attempts to emulate the natural allowance for infinite variability in surmounting environmental obstacles. Methods/Materials The program's digitized creatures have a structure similar to that of simple organic organisms; each of which will contain homologous pairs of chromosomes and neural networks which produce their behavior. The chromosomes follow standard programming syntax so that many dynamic aspects of the computational model can be utilized. The combination of genetic rules and computational structures creates a system in which solutions to complex problems may be found. The creatures are contained within an environment of data that produces stimuli to which the creatures react. Results Within the simulation, certain social behaviors were observed such as herding and an outwards circular propagation. The simulation successfully demonstrated evolutionary theory including Hardy-Weinberg, genetic drift, founder effect, and population bottlenecks. With these basic principles confirmed, further experimentation showed that the environment could shape the organisms' behavior and structure. Conclusions/Discussion It was found that the simulation could produce complex behavior and structure in response to problems created by the environment. This system models organic structures and processes and exhibits adaptation of populations seen in nature. Due to the open-ended genetic algorithm that the simulation employs, the program can be used to create solutions for computational and analytical problems. As a model for the evolutionary process, this project can be used to test hypotheses that are difficult to examine with natural populations.	
Summary Statement The Clockwork Evolution Project developed a digitized model of organic systems, which demonstrated basic principles of evolution and can be expanded to test evolutionary theory.	
Help Received Louis Armin-Hoiland and Joan Williams edited our papers; Our mothers helped construct backboard; The Digital Life Lab at CalTech gave inspiration for the project idea.	



CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s) Stephanie Salcedo	Project Number S1218
Project Title Morphing Circles with Trig	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The purpose of this year's investigation was to see if there was a way to verify mathematically the patterns I noticed last year when I added a sine function to a circular graph. Last year, when I added a sine function to the graph of a circle, the sine curve would create "bumps" on the morphed circle, and the number of bumps would change depending on the period of the added sine function. My hypothesis was that there is a mathematical formula to verify the effect that the sine function has on the circle.</p> <p>Methods/Materials To test my hypothesis, I looked at all of last year's work, like the t-charts and graphs I created, and I looked at why the bumps on the morphed circle were occurring. I made tables showing the relationship between the circle, the number of bumps, and the period of the added sine function. I also tried calculating where the morphed circle and regular circle intersect, in hopes of figuring out a formula to the number of bumps. I did not see any new patterns, so I decided to observe the graphs of the morphed circles.</p> <p>Results When I observed various graphs of morphed circles, I noticed that wherever the sine curve was at -a for the given domain, the circle would curve out directly above. I noticed this when I worked with phase shifts as well. I also saw that depending on the amplitude of the sine function, the morphed circle would curve in and out of the original circle at a constant distance. When the morphed circle would break apart, I realized that this was because some areas of the graph became undefined due to the added sine function.</p> <p>Conclusions/Discussion My results support my hypothesis because based on my observations and all of my data, I was able to see why adding a sine function to a circular graph creates bumps on the circle. Every time $a \sin bx$ is at -a for the given domain, a bump occurs on the circle. When you have a morphed circle with the equation $x^2 + y^2 + a \sin bx = r^2$, r^2 has to remain constant. When $a \sin bx$ is at -a, $x^2 + y^2$ has to increase in value in order to keep r^2 constant. When $a \sin bx$ is at a, $x^2 + y^2$ has to decrease in value in order to keep r^2 constant. This is why the morphed circle goes inside and outside the original circle.</p>	
Summary Statement My project is about investigating mathematically the affect the sine function has on a circular graph when they are added together and to see if there is a verification for the patterns I noticed last year when investigating this.	
Help Received My mother helped cut everything out to put on my board, my project advisor, Diana Herrington, proofread my work, and my father provided the transportation for me to go purchase the materials that I needed.	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Philip Q. Shao	Project Number S1219
Project Title Density-Based Color Subtraction for Noise Reduction in Motion Detection	
Abstract Objectives/Goals The goal of this experiment was to determine a new way of extracting and tracking a moving object from an inferior movie sequence generated by an inexpensive commercial web-camera. Methods/Materials The project studied extraction of moving objects in front of two types of background scenes. 1) Stable background is a white plain scene; 2) Unstable background is a colored scene, strong color variation is considered unstable in the space domain. A Computer algorithm was developed to extract the moving object from a mixed scene, to reduce background noise and to output the location of the moving object. Results In order to accurately track the moving object using the low quality, high noise web-camera, the noise reduction methods were established and their effectiveness was studied based on the output tracking accuracy. a) Pixel by pixel Intensity Subtraction Threshold (T-PIS) method used the difference in gray scale intensity as noise threshold scale. The threshold could be adjusted based on the background/object intensities. This method effectively removed most of the random noises due to the low camera quality. b) Threshold applied to Density-based Color Filtration (T-DCF) counted the number of flagged (as moving object) pixels in the area adjacent to a given pixel producing a Flagged Pixel Density percentage (FPD). A threshold could be set to eliminate the noise since the FPD around a noise pixel would be much lower than a moving object. c) The signal to noise ratios resulting from these two filters were plotted and analyzed to illustrate the effect of each threshold on the noise reduction. Conclusions/Discussion Using a combination of T-PIS and T-DCF, the experiment was able to produce the low-noise environment necessary for tracking the moving object. The output enables further algorithms for security tracking system and/or data analysis . With this image processing capability, an inexpensive image-capture device can be used in a wide range of Homeland Security applications.	
Summary Statement A study of noise reduction for object isolation and tracking applications	
Help Received Parents purchased camera. Mother proofread report.	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Emily M. Stark	Project Number S1220
Project Title An Autopicking Algorithm for the Detection of Seismic Event Arrivals	
Abstract Objectives/Goals This project aims to solve the problem in computational seismology of automatically picking the arrival of an earthquake from data points that represent a seismogram. The algorithm developed in this project uses a neural network to refine an approximate pick calculated from the quadratic mean of the data. Methods/Materials An algorithm was written and programmed that uses the quadratic means (also known as the root-mean-squares) of two sections of a seismogram to calculate an approximate pick, and then inputs the approximate pick into a neural network for refinement. Using the backpropagation algorithm, the neural net was trained four times with a set of fifty data files, and different parameters of the network were changed between each training. Throughout each training, the neural network picks for a data file selected from a testing set of ten data files were recorded, and the difference from these picks to the manual picks for the data file were graphed as a function of the number of files with which the network had been trained. Results A combination of network parameters was found that produced two trainings with negative slopes for the graph of distance from neural net pick to manual pick versus files with which the network had been trained. Without thorough and repetitive training, however, the approximate picks calculated from the quadratic means are more consistently accurate than those produced by the neural network. Conclusions/Discussion These results suggest that with thorough and repetitive training, the neural network can produce accurate results. Areas of further study for this project include changes in the design and structure of the network, minimization of human error caused by inconsistent manual picks, and minimization of error caused by computer rounding.	
Summary Statement An algorithm was developed to automatically pick the arrival of an earthquake on a seismogram.	
Help Received Father helped find data sources; Mother helped cut paper for display	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Caroline Suen	Project Number S1221
Project Title Triangular Discoveries: A Look into Heron's Formula and Beyond	
Abstract Objectives/Goals This project aims to find properties other than those involving matrices and determinants to prove Heron's Formula and Brahmagupta's Formulas. Methods/Materials Various strategies were used to do so: plotting triangles with their circumcenters at the origin, plotting triangles with their vertices on the two axes, simply drawing triangles on a plane, and expanding Heron's and Brahmagupta's formulas. Results A comparison between my new proofs and the official proofs of the Formulas shows that the concepts used in my proofs were more accessible, thus proving my hypothesis correct. Additionally, the discovered properties provided algebraical insights into understanding the concepts underlying Heron's Formula. Conclusions/Discussion These properties can be used in mathematical drills, contests, research, and other related areas. Additionally, the similarity of the proofs for Heron's Formula, Brahmagupta's Formula, and its extension might be implemented to develop a formula for a polygon with greater than four sides, and perhaps eventually a general formula for any n-gon!	
Summary Statement This project finds properties other than those involving matrices and determinants to prove Heron's Formula and Brahmagupta's Formulas.	
Help Received Biology teacher submitted project application; Mother bought materials.	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Yi Sun	Project Number S1222
Project Title On the Expected Winding Number of a Random Walk on the Unit Lattice	
Abstract Objectives/Goals Some recent studies have focused on the winding number of a random walk. Given a random walk s starting at $(1,1)$ on the unit lattice, the winding number w of s is the number of signed complete rotations the walk has made about $(1/2,1/2)$. Despite the known results on the continuous winding number, the discrete version appears to be unstudied. This project investigates the root mean square expectation of the winding number. Methods/Materials We rephrase the problem in terms of a diagonal lattice and determine the winding number as a function of two variables counting steps beginning and ending on the positive x -axis. We then condition on the values of these variables and examine the change in expectation created by each additional step in the walk to express the desired expectation as a summation of only two smaller expectations. A symmetry that yields a bijection between types of these random walks allows us to determine these unknowns and thus reach our final result. Conclusions/Discussion We have found an explicit expression for the RMS expected winding number after n steps of a random walk beginning at $(1,0)$ on the unit lattice. This expression is in terms of a binomial sum; we first find the expectation recursively and then exploit a symmetry of random walks to solve the recursion. This result gives us a better understanding of the rotational properties of random walks and thus may be useful in further investigations into this field.	
Summary Statement My project determined the exact value of the expected value of the winding number, the number of rotations that a random walk, or a random path, on the unit lattice makes around a point.	
Help Received Was mentored by Mr. David Pritchard, a graduate student at MIT.	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Michael A. Viscardi	Project Number S1223
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Project Title The Solution of the Dirichlet Problem with Rational Boundary Data
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<p style="text-align: center;">Abstract</p> <p>Objectives/Goals I study the Dirichlet problem for the Laplace operator on arbitrary simply connected bounded domains in the plane with rational holomorphic boundary data. My first goal is to answer the following question: When are all solutions rational? My second goal is to find an explicit formula for the solution.</p> <p>Methods/Materials I form and prove several theorems related to my question, and combine them into a single theorem, which among other things, completely answers my question. By extending the proof of my theorem, I obtain an explicit formula for the solution on any simply connected bounded domain in the plane.</p> <p>Results My main results include the following:</p> <ol style="list-style-type: none">1. The solution to every Dirichlet problem with rational holomorphic data is rational if and only if a Riemann map is rational.2. The solution to every Dirichlet problem with rational holomorphic data is rational if and only if the Bergman kernel of the domain is rational.3. The solutions to the above Dirichlet problems are rational if and only if the solution is rational for a single, relatively 'simple' data function, namely, the function $1/(z-a)$, where a is a point in the domain.4. The Bergman kernel $K(z,w)$ is rational if and only if $K(z,a_1)$ and $K(z,a_2)$ are rational, where a_1 and a_2 are any two points in the domain. <p>Furthermore, I state and prove an explicit formula for the solution to any such Dirichlet problem in terms of only two functions: a Riemann map of the domain and the boundary data function.</p> <p>Conclusions/Discussion My theorem completely answers my question both geometrically and algebraically; namely, in terms of a Riemann map and in terms of the Bergman kernel of the domain. My theorem also connects the concepts of the Dirichlet problem, the Riemann map, the Bergman kernel, and rational functions in a simple way. Furthermore, my formula is the first explicit solution to the Dirichlet problem on arbitrary simply connected bounded domains in the plane.</p>
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Summary Statement I completely characterize, both geometrically and algebraically, all domains in the plane in which the solution of every Dirichlet problem with rational holomorphic data is rational, and obtain the first explicit formula for the solution.
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Help Received My mentor, Prof. Peter Ebenfelt of UCSD, was available to answer my questions as I worked through proofs. I completely wrote the paper on my own, and Prof. Ebenfelt looked over it and made suggestions for improvement.



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Maria Yefimova	Project Number S1224
Project Title Bionformatics-based Prediction of Novel Caspase Substrates	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Many diseases have been linked to apoptosis, but the advance of new treatments is halted due to the limited knowledge of it. An identification of proteins involved in the process will provide insights on the relationship between caspases, the executors of the apoptosis, their targets, and cell's ultimate death. The objectives of this project are to build a model for the prediction of proteins cleaved by caspases, and provide the results to be tested in laboratory.</p> <p>Methods/Materials A mathematical model of amino acid sequence (pattern) has been created using the combination of the caspase cleavage motif and the nuclear localization signal sequence. The protein databases have been scanned in order to obtain results containing the pattern. The results have been sorted and proteins with most potential to be cleaved by caspases have been selected.</p> <p>Results Four families of proteins containing monopartite nuclear localization signals and twenty-seven families of proteins with bipartite nuclear localization signals have been determined to be potential caspase targets. The next step in the research is the actual experimentation with the proposed proteins that will validate the results of this work.</p> <p>Conclusions/Discussion Currently the rather accidental and rare cases of discovering the proteins cleaved by caspases provide new insights on the cell's regulatory processes and its death. New potential caspase substrates are identified methodologically in this project. If tested positive, they will help to obtain more knowledge of the core participants of the apoptotic process.</p>	
Summary Statement This project utilizes bioinformatics methods of manipulating available data and creates a model for the prediction of potential proteins cleaved by caspases during apoptosis.	
Help Received Mr. Kevin Karplus gave advice on using bioinformatics software;	



**CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY**

Name(s) Noah P. Young	Project Number S1225
Project Title Finding Efficiencies of 2 and 1-way Road Networks of Various City Block Sizes and Traffic Levels using Computer Modeling	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals This experiment will attempt to determine what kind of street configuration will best remedy traffic problems in dense cities by comparing one-way and two-way street systems.</p> <p>Methods/Materials Materials included a Compaq laptop and Macromedia Flash MX 2004. The simulation to test the hypothesis works by creating a grid network with either one or two-way streets spaced at a set distance (called the city block size). A set number of vehicles are created which use simplified path-finding algorithms to reach a random destination from a random starting point. When a vehicle reaches a destination, a counter is incremented and the vehicle is regenerated. Thus, there is always the same number of vehicles in a simulation as when the simulation began. The simulation will continue until the counter value is four times the number of vehicles in the simulation, meaning that, on average, every vehicle has reached its destination four times (generating hundreds of theoretically perfectly random numbers in the process).</p> <p>Results After conducting experiments in varying block sizes and vehicle volumes on the road network, the data was found to support the hypothesis. The raw quantitative data produced from the tests exhibited a strong quadratic relationship which made it possible to create regression models.</p> <p>Conclusions/Discussion After examining the movements of the vehicles in finding their destinations, an explanation was found that resembled the explanation behind the original hypothesis. Intersections in the two-way network allowed cars to turn in any direction, but time waiting for the lights to change was longer. The one-way system, where 50% of the traffic signal phases allowed a given car through, proved more efficient when vehicles encountered intersections more frequently. As the space between intersections grew, however, this advantage was overshadowed by the fact that vehicles would frequently find themselves needing to turn a certain direction at an intersection that would not allow it. This was not a problem for the two-way street system because all turns are allowed at a two-way street intersection. The regression models produced from the test results can be used to determine the optimum street configuration for real cities.</p>	
Summary Statement A computer model simulates a simple grid road network to test how different types of street configurations (1or 2-way), different city block lengths, and different traffic volumes effect the efficiency of the network.	
Help Received	