# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**
Kunal Agarwal

**Project Number**
**S1601**

**Project Title**
## Project Zier: Innovating Credit Card Security

**Abstract**

**Objectives/Goals**
Credit card purchases are fraught with vulnerabilities, and identity theft can and does result from everyday activities. Project Zier unveils a new identity verification system.

**Methods/Materials**
Zier comprises of ZierStation, ZierCard, and ZierServer. First, the customer enters a code displayed on ZierCard into ZierStation at POS. Second, ZierStation uses this number to connect to ZierServer and retrieve the customer#s voiceprint. ZierStation records the customer#s name live and attempts to match it with voiceprint on record. Finally, if the match is made, ZierServer sends text message to the customer which is then entered into ZierStation to complete the transaction. Current prototype system utilizes a computer and an iPhone (ZierCard substitute).

**Results**
Zier has delivered promising results. Any attempt to breach the system requires three barriers to be broken: physical possession of ZierCard, matching voiceprint, and the customer#s cell phone. This creates a far more secure system than the present-day solution.

**Conclusions/Discussion**
R&D concludes that Zier can effectively deter fraud. Hopefully, credit card companies will consider implementing this prototype to bolster industry standards. In production, ZierCard will consist of an EPaper screen and Paper Battery. The physical system#s processes will remain the same, but a user-friendly GUI will be programmed. Last, while Zier provides three levels of security, these levels can be scaled down as appropriate for the transaction.

**Summary Statement**
Project Zier is the basis of an innovative credit security system that will include dynamic card number generation, speaker identification, and cellular text verification.

**Help Received**
Help from Scott Lubbs in simplification; Help from ZiHan Lin in proofreading;

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**
Sundeep Bekal

**Project Number**
**S1602**

**Project Title**
## A Study of Dandelin Spheres: A Second Year Investigation

**Abstract**

**Objectives/Goals**
The purpose of this investigation is to see if there is a relationship that forms between the radius of the smaller dandelin sphere to the tangent of the angle RLM and distances that form inside the ellipse.

**Methods/Materials**
I investigated a conic section of an ellipse that contained two Dandelin Spheres to determine if there was such a relationship. I used the same program as last year, Geometer's Sketchpad, to generate measurements of last year's 2D model of the conic section so that I could better investigate the relationship. After slicing the spheres along the central pole, I looked to see if there were any patterns or relationships. To do this I set the radius of the smaller circle (sphere in 3-D) to 1.09 cm. I changed the radius by .05 cm every time while also noting how the other segments changed or did not change.

Materials
-Geometer's Sketchpad
-Calculator
-Computer
-Paper
-Pencil

**Results**
After looking through the data tables I noticed that the radius had the same exact values as (a+c)(tan(1/2) angleRLM), where (a+c) is the distance located in the ellipse. I also noticed that the ratio of the (radius)/(a+c) had the same values as tan((1/2 angleRLM)). I figured that this would be true because the tan (theta)=(opposite)/(adjacent) which in this case, would be tan ((1/2 angleRLM)) = (radius)/(a+c).

**Conclusions/Discussion**
Based on my research with previous experiments involving the spheres I proved that the radius of the sphere r(s) will equal (1/2tan)(a+c), where (a+c) is the distance located in the ellipse. This is only true when the ratio of r(s)/(a+c) equals (1/2tan).

r(s)=tan(1/2theta)(a+c) which is only true when tan(1/2theta)=(r(s))/(a+c).

**Summary Statement**
To find the relationship that forms between a dandelin sphere's radius to an angle formed by an ellipse.

**Help Received**
Teacher proofread my project

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**
Samantha Darryanto; Karyne Yakupoglu

**Project Number**
**S1603**

**Project Title**
## Biometrics: A Study of Algorithm-Based Facial Recognition Systems

**Abstract**

**Objectives/Goals**
Does the application of lighting, gender, ethnicity, facial distortion, and facial obstructions, on the detection of algorithm-based facial recognition softwares affect its accuracy?
The overall objective of this experiment is to use the application of independent and dependent variables to test the overall accuracy of the detection of facial recognition softwares based on a test group of 55 subjects. The application to all softwares, emerge from the experimental results of Veriface, a facial recognition software, in which the variables are applied to.

**Methods/Materials**
Veriface Lenovo Software, Survey with variables to be tested, 11 students with glasses, 11 male students, 11 female students, 11 students who can test for facial expression, 11 students testing for lighting, Compaq Laptop, Acer Webcam, Chair, Digital Camera, Stopwatch
The subject remains expressionless throughout the process. The system is then exited, and logged out; the program reappears in the log in page and again, takes a series of photographs of the subject. These recent photographs are then compared to the series of photographs already registered in the system. If the recognition occurs, the subject is logged back into the homepage. The process is repeated, when a variable of light, facial expression or facial obstructions is applied. Gender and ethnicity, are based with time as a control.

**Results**
Ethnicity & Facial Expression changes were the factors that created the most difference in time and pictures taken between the control and the variable testing. Males had a faster recognition time than females. Lastly, lighting had the least discrepency between control and variable.

**Conclusions/Discussion**
The hypothesis claimed that lighting and facial expression would take much longer to identify within the system, which proved to be true. Facial recognition affected the softwares concise measurement of the nodule points on the subjects face to be measured. Ethnicity also proved to be a common source of error, the system favoring caucasian subjects for their light skin and large eyes, in comparison to the longer identification of dark-skinned AfricanAmericans and smaller-eyed Asians. Males were the quickest to be identified, rather than females. Glasses, as an obstruction also had an impact, not as much as ethnicity and facial expression, but affecting the distance between the nodule points previously recorded within the system.

**Summary Statement**
The purpose of our project is to inform the public and biometrics manufacturers/providers about the most common source of error in this specific algorithm-based facial recognition system.

**Help Received**
Parents supplied us money for board supplies, Blessing Information Technology provided our LCD monitor, Friend supplied Lenovo Veriface

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**

**Ryan Dempsey; John Templeman**

**Project Number**

**S1604**

**Project Title**

## Honey Cluster Computing vs. Distributed Denial of Service Attacks

**Abstract**

**Objectives/Goals**

The objective of the project is to show the effect of the utilization of a single system image (SSI) cluster computing platform as a centralized management, action, and deployment point for distributed honeypot systems on the number of captured, repelled, and countered hacker attacks, in order to better enhance computer network security.

**Methods/Materials**

Four computers were set up as a simulated DDoS attack group, four computers were set up as the Honey Cluster, and two computers were set up as the Nmap Scanner Cluster. The four DDoS computers first attacked the control group, made up of the same computers as the Honey Cluster. After this control attack, the DDoS computers attacked the experimental Honey Cluster computers. The data collected from the attacks was the ratio of outgoing to incoming packets, measured on the control group computers and the Honey Cluster.

**Results**

This was chosen because DDoS attacks are dangerous in nature, potentially affecting hundreds of computers on a given network. After a simulated DDoS attack on the Honey Cluster, the Honey Cluster#s response to the attack was shown to be a statistically significant DDoS countermeasure relative to the control computer systems. The LaBrea Honey Cluster enacted a reactive-defense counter to the DDoS attack, fully repelling and redirecting 160% of the packet flood back to the DDoS group. When the control computer systems were attacked by way of a simulated DDoS, the control computers sent 0% of the original attack packets back to the DDoS group. The ultimate result of the DDoS redirection was a total stoppage of services and exploits in the simulated DDoS Group.

**Conclusions/Discussion**

By analyzing the results, experimentation has shown that cluster computing in regards to honeypot technology, specifically known as a Honey Cluster, can provide statistically significant protection against DDoS attacks. Hackers have been statistically shown to be dangerous people, with dangerous motives and dangerous intentions. Protecting against hackers by means of Honey Cluster technology is the main goal of this project. This endeavor has shown the potential to provide greater levels of security to the public. The success of this endeavor shows that defense against such prolific and prevalent threats as DDoS attacks is possible, probable, and ultimately achievable.

**Summary Statement**

This project is about the enhancement of computer and network security through the marriage of honeypots (an emerging security technology) and compute clusters in such a way that provides the end user a safer, more secure computer network.

**Help Received**

Recieved a donation of ten computers from the ZGallerie, Inc. IT Department - this was made possible by Mr. Howard Kolodny, the Director of the IT Department for ZGallerie; Mr. Lindbergh Atkins of CAMS High School helped the project through his donation of hard drives.

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**
Dylan Freedman

**Project Number**
**S1605**

**Project Title**
## Efficient True Random Number Generation

**Abstract**

**Objectives/Goals**
Through this project, I investigated algorithms that efficiently generated true high quality random numbers from a source of entropy. My objective was to create a random number generator that would produce high quality, cryptographically secure random numbers in large quantities.

**Methods/Materials**
First, I created a basic framework to implement methods in Java. I used a public online webcam focused on Times Square, New York as a source of entropy and wrote a simple class to process these pixel values. Then, I created five control methods based on preexisting algorithms or data sources. I constructed twelve of my own methods, six of which applied pseudorandom algorithms to my true source of entropy. For each of my methods, I computed the average processing time taken in bits per millisecond and the average data produced in bits per image. The quality of the random numbers outputted was evaluated with the NIST Statistical Test Suite. All of these quantities were measured with the same sample sizes.

**Results**
The final method I created was by far the most efficient. It strategically applied true random numbers to reseed the famous Mersenne Twister algorithm. To further obfuscate the data, it used an xor operation on the results of one iteration and the seeding values of the previous iteration. This method quickly and efficiently produced a high quantity of high quality, cryptographically secure, true random numbers.

**Conclusions/Discussion**
Most of the methods I created had various failures and shortcomings; however, all my methods were insightful and led to many small observations about the properties of various statistical tests for randomness. My final method fulfilled all of my project's objectives. Compared to the random number generating algorithms I have researched, this method appears to be the most effective in quantity, quality, and cryptographic security of random numbers produced.

**Summary Statement**
My project establishes a method that overcomes the difficulty of efficiently generating high quantities of true random numbers.

**Help Received**
Parents helped proofread report; Upon completion of project, received professional review from a computer scientist, a mathematics professor, and a social scientist

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**
Christian Hahn

**Project Number**
**S1606**

**Project Title**
## Camera Recognition Based American Sign Language Translator

**Abstract**

**Objectives/Goals**
The design and construction of an American Sign Language-to-text translator for sign language users to communicate to anyone. My approach to this conundrum is to use a relative inexpensive camera, take a picture of the user#s hand, map the position of the fingertips and then determine the distances in between the fingertips. These distance values can then be correlated to values stored in a database and assigned an alphabet character. The software in questions is written in C# with a clear and concise visual GUI to allow for fine-tuning at a testing level and future expansion towards an end-user application.

**Methods/Materials**
The goal behind this project was to maintain a definitive ease of use and simplicity of the implementation. This was done by using an extremely affordable PC webcam and (besides the computer /w software) no other physical components.
The software#s approach maintains simplicity to allow it to be hosted by low-power, handheld platforms. After the camera took a picture of the end-user#s hand, the software determined the relative distances in-between the user#s fingertips. This was done so regardless of how the user rotated his hand (relative to the camera) the relative distances between the user#s fingertips remained constant.

**Results**
Through several trial runs of the system, the camera and software were successfully able to read-in and output the matching hand-sign alphabet. However, it is to be noted that these trials were conducted in a controlled environment (with controlled lightning and background) and not out in the field.

**Conclusions/Discussion**
Along with creating an effective end-user product, this project has opened many possibilities for future development and expansion. For example, making the software adaptive to the end-user#s physical limitations (i.e. hand size) and perhaps making it aware of the hand-signers individual style and technique.

**Summary Statement**
The design and construction of an American Sign Language-to-text translator for sign language users to communicate to anyone.

**Help Received**

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**

**Kaavya Jayram**

**Project Number**

**S1607**

**Project Title**

## Number Theory Meets Algebra: Walking the Path of Fermat, Euler, and Gauss

**Abstract**

**Objectives/Goals**

A (binary) quadratic form is a polynomial f(x,y) = ax^2 + bxy + cy^2, where a, b, and c are integers. A number n is represented by a quadratic form f(x,y) if n = f(x,y) for some integers x, y. The investigations of Fermat, Euler, Gauss, and many other great mathematicians led them to discover the patterns governing the multiplication of two numbers represented by the same quadratic form.

My objective is to discover a method to multiply two numbers represented by the same quadratic form f.

**Methods/Materials**

To demonstrate the process, I will play a card game called the Quad game which contains some big squares, small squares and rectangles. The game is a pictorial representation of a quadratic form in which the big square is x^2, the small square is y^2, and the rectangle is xy. The object of the game, given a particular hand, is to create one square of some large size plus optionally several squares of a single smaller size. The game is subject to certain rules which I will also explain. The winning strategies for this game provide the necessary clues to derive the multiplication formula for quadratic forms.

**Results**

Using the Quad Game, I showed how to multiply two numbers represented by the same quadratic form f. My main result is that their product is also represented by some quadratic form g. In some cases g is different than f, and in some cases g is the same as f.

**Summary Statement**

A method to multiply numbers represented by quadratic form(s) and derive a general formula for the same.

**Help Received**

I discussed my methods with Dr. Laurens Gunnarsen

# CALIFORNIA STATE SCIENCE FAIR
## 2009 PROJECT SUMMARY

**Name(s)**
Shuhee Kim

**Project Number**
**S1608**

**Project Title**
# Computer Generated Simulation of the Migration Path of Ancient Native Americans into North America

**Abstract**

**Objectives/Goals**
The migration path of the ancient Native Americans has long been a much sought for, yet abstract concept. The present method of determining the ancient Native Americans# migration route into North America relies heavily upon the discoveries of fossils and other ancient artifacts that scientists can use to locate the assumed settlements of ancient Native American tribes. The object of this project is to produce a realistic computer simulation of the migration path of the ancient Native Americans.

**Methods/Materials**
The migration path is simulated using inputted data, which are the factors of living conditions, such as land formations and climate, which must have played a significant role in the migration of ancient Native Americans. The inputted data are then translated in the program into configurable values which are used to set the parameters of the harshness of living conditions. The migration is realistically portrayed, significantly affected by the migration hindrances (mountain ranges, etc), which further enhances the accuracy of the simulated migration path.

**Results**
The accuracy of the resulting simulated migration path was determined by comparing the computer generated migration path with the migration path determined by professional researchers using paleontological and archaeological information.

**Conclusions/Discussion**
The simulation proved highly compatible, and it could ultimately become a major source of data and reference for researchers in the future.

**Summary Statement**
By using simple living condition factors (such as land formations and climate), the migration path of the ancient Native Americans can be determined by a computer generated simulation.

**Help Received**
Paleontological map used to verfiy simulation provided by Dr. David Glenn Smith from University of California Davis.

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**
Brian S. Lee

**Project Number**
**S1609**

**Project Title**
## Mathematical Approaches to a Neat Problem

**Abstract**

**Objectives/Goals**
This project introduces a neat problem in two different settings that are mathematically the same. The first setting has two cylindrical tanks where the tank on the right is filled with water and the tank on the left is empty. The two tanks are connected by a pipe at the bottom and the right tank has an outlet pipe at bottom. The second setting involves an electrical circuit with two capacitors, two resistors, and a battery. The capacitor on the right is initially charged while the capacitor on the left has no charge at all. The question is: will the water level on the left (L) tank always be lower than the water level on the right (R) tank? Or, will the charge on the left capacitor always be lower than the charge on the right capacitor? The objective of this project is to use a mathematical model of differential equations to answer the question algebraically and numerically and verify with an experiment.

**Methods/Materials**
Algebraic method - Given a mathematical model of differential equations, solve it for the ratio of R/L at equilibrium under various constants. Numerical method - Use TI-89 calculator program and functions to find numerical solutions of the differential equations at different constants. Experimental method - build a circuit using two capacitors, two resistors, and a 6 volts battery. Use DataMate software and TI-89 for collecting data. Vary the resistor values to see the effects on the ratio of R/L. With the two voltage probes on the two capacitors, the CBL 2 will take the measurements and transfer them to the TI-89 for graphs and data storage.

**Results**
All of the graphs with any pair of resistors in the experiment show that the charges in the left capacitor exceed the charges in the capacitor on the right after they intersect with each other. Also, as for the algebraic and numerical methods, any combination of constants a, b, and c gave us the R/L ratio of less than one at equilibrium, which indicates that the water level or charges on the left tank or capacitor becomes greater than those on the right after a while.

**Conclusions/Discussion**
The results from all three approaches concur that the water level or charge on the left water tank or capacitor is greater than the one on the right. Thus, I conclude that the experiment correctly verified the results of algebraic and numerical approaches and that my hypothesis was partially correct.

**Summary Statement**
The purpose of this project is to solve a neat problem algebraically and numerically using a mathematical model of differential equations and to verify them with an experiment.

**Help Received**
My AP Calculus teacher Mr. Jacotin helped me with understanding of the equilibrium points in differential equations.

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**

**Kenny Lei**

**Project Number**

**S1610**

**Project Title**

## Improving Elevator Scheduling Efficiency by Implementing a Smarter Controller

**Abstract**

**Objectives/Goals**

This research considers how efficiently elevators can deliver passengers to their intended destinations. The director behind this process is the elevator controller, which evaluates many possible delivery scenarios and decides the most efficient plan. The problem becomes more complex and the possible plans grow tremendously when the scale of operation is increased. This project's objective is to create a smarter elevator controller designed to reduce the average waiting time (AWT), based on the Empty the System Algorithm (ESA), which calculates and minimizes expected waiting times over all passengers using a system of elevators.

**Methods/Materials**

Due to the complex and costly nature of using and testing real elevator systems, this controller was implemented in an elevator simulator program. This project was conducted on a computer, which can be running on one of many operation system platforms since all software used are cross-platform. Software was developed by integrating the smarter controller into an existing simulator called ElevatorSim, which was written in the Java programming language. The smarter controller, called ESA, was written with five Java methods expected by the simulator. The most important Java method determines the best car for each car request using an AWT formula created in this project.

**Results**

Over 10,000 elevator simulation trials were performed with ElevatorSim, and the AWT for the ESA controller was compared against the AWT for ElevatorSim's Default controller. Observations show that the smarter elevator controller outperforms ElevatorSim's Default controller by an average of 12 percent, significantly reducing passenger waiting time.

**Conclusions/Discussion**

The ESA controller significantly surpasses the Default controller. The ESA controller can be applied to real elevator systems and improve elevator efficiency. More efficient operation can contribute to reducing energy consumption and operational costs. By including these new elevator scheduling strategies used in creating this project's controller, elevator efficiency will continue to improve and progress.

**Summary Statement**

Create a smarter elevator controller within an elevator simulator program using the Java programming language.

**Help Received**

Research guidance provided by mentor Dr. Craig Rich of California State Polytechnic University, Pomona.

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**
David C. Liu

**Project Number**
**S1611**

**Project Title**
## Semantic Image Retrieval: Learning Gaussian Mixture Models of Semantic Concepts using Expectation-Maximization

**Abstract**

**Objectives/Goals**
The proliferation of digital photos has made efficient automation of image search more challenging than ever. Current image retrieval methods directly compare images by low-level perceptual characteristics such as color and texture. However, humans understand images by describing them with concepts, such as "building," "sky," and "people." This project employs artificial intelligence to identify semantic concepts in images using probabilistic models. No manual annotation of photos is required#images are found using content recognition.

**Methods/Materials**
In this research, the visual feature distribution of each concept was modeled with a Gaussian Mixture Model learned using the Expectation-Maximization algorithm. The models captured the dominant colors and textures of the concepts. During retrieval, the models were used to determine the probability of each concept occurring in the images, producing a probability vector called a semantic multinomial (SMN). Images were retrieved by finding the most similar SMNs.

**Results**
This research has shown that by linking images with their underlying semantic meaning, the system understood the images and significantly improved retrieval accuracy. It was also shown that a feature set consisting of YCbCr color values and Gabor texture filter responses had consistently better retrieval performance than Discrete Cosine Transform features.

A novel dynamic browser was also developed for exploring image collections based on semantic similarity. It uses an animated spring graph layout algorithm to create self-organizing clusters of semantic concepts. This provides a unique way to visualize the inherent semantic relationships in the image database, as well as to search for images by concepts.

**Conclusions/Discussion**
This technology has far reaching applications beyond organizing family albums. In the medical profession, the ability to quickly correlate unknown MRI images with that of known medical disorders is now within reach. In the area of natural resource exploration for oil, gas, and coal, remotely-sensed images can now be automatically related to images of known natural reserves.

**Summary Statement**
I used artificial intelligence models to associate visual features (color and texture) with images' underlying meaning, automatically annotating them with concepts like "buildings" and "water." I also created a unique dynamic image browser.

**Help Received**
Dr. Gustavo Carneiro answered questions via e-mail; Mr. Rob Reis reviewed my abstract and board.

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**

**Akshay J. Maheshwari**

**Project Number**

**S1612**

**Project Title**

## Zergling: An Optimizing Expert System for High Speed Detection of Chimeras Formed during PCR Amplification of 16S rRNA

**Abstract**

**Objectives/Goals**

16s rRNA is a region of highly conserved RNA found in ribosomes that is extremely important in the identification of organisms. Through the process of PCR amplification, RNA from this region can be sequenced and analyzed. Although PCR is a common and frequently used technique, the process is not perfect - the genes from different organisms are often accidentally spliced together to make Chimeras. Chimeras are artificial artifacts of PCR and the RNA does not exist in any extant organism. The current most common way to get rid of the Chimeras from databases is to have scientists manually check each of the hundreds of thousands of sequences for chimeric qualities. The goal of this project was to create a program, Zergling, which could efficiently and accurately identify and eliminate these chimeras from the data set.

**Methods/Materials**

Zergling solves the problem of Chimeras through a linear algorithm rather than the quadratic algorithms advocated by other chimera checkers. It does so by utilizing a reference database of 2000 known sequences and a percent composition dual-bagging algorithm. The base Reference Database was created by manually going through RNA databases and collecting mean representations of different taxa; as new sequences are processed, the database can learn and grow. The Percent composition and Dual-bagging algorithm compute 5 numbers from each 12,000 index input sequence enabling efficient and accurate comparison against each reference database sequence. This results in an O(n) speed with an insignificant constant k, unlike programs such as Mallard that run at O(n2) speed and with extremely high constants.

**Results**

The speed and accuracy benchmarks of Zergling were compared against those of Mallard and the manual checking by phylogeneticists. Zergling consistently processed sequences more than 100x faster than Mallard and more than 500x faster than manual checking. Zergling was highly accurate and found within 95% of the chimeras found by manual checking while Mallard averaged under 75%.

**Conclusions/Discussion**

Zergling greatly increased the speed and accuracy of chimera identification. Because of this, it has the capability to process PCR sequences in real time as well as screen millions of sequences from past databases in a batch process. Zergling can learn from new sequences and will be used to validate past and future databases. It will soon be released for use by scientists worldwide.

**Summary Statement**

This project identifies erroneously spliced genes formed during PCR. A novel learning algorithm is utilized which makes batch processing of RNA feasible in real time.

**Help Received**

My Mother and Father helped design poster; Bioinformatics Research Associate Elisabeth Bik assisted in the validation of my project

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**

**Zachary J. Michaels**

**Project Number**

**S1613**

**Project Title**

## Choice Based on Past Knowledge using Multi-Layered Neural Networks in Tic-Tac-Toe

**Abstract**

**Objectives/Goals**

The objective of the experiment was to test the learning capabilities of a neural network by teaching it how to play Tic-Tac-Toe. According to the research, neural networks learn by the assigning of a set of weights attached to valid choices. The weight of that choice signifies how much that move is valued. So if it was an effective move, then its weight is assigned a greater value from knowledge gained through past experiences.

**Methods/Materials**

The materials required for the experiment were: a computer that supports the Java Virtual Machine as well as the Java Run Time Environment. In order to perform the experiment, the Java Run Time Environment was installed. Once all of the required software was accessible, a program of the network was written. Several revisions were completed in order to debug all of the features of the system. This required creating graphical user interfaces to display data as well as to show the steps that the program was executing at that time.

After completion of the application, the experiment was executed. A total of seventy-four trials were performed with each trial consisting of one-hundred games that the network played against a pre-written artificial intelligence. The data was taken directly from the output and input into graphs.

**Results**

Generally, the network had a net win percent change and a net tie percent change that were both greater than 0 and a net loss percent change of less than 0. It was not until trial thirty that any of the results passed the mean. It was observed that the average deviation showed slight differences between ties and its mean and wins and its mean. The average for wins was close to the result of evaluating the function of the power regression line for wins. (6.24% obtained by input 74 for f(x) = 5.73x^0.02 and 6.59%).

**Conclusions/Discussion**

Although the results showed that learning had occurred through the course of the experiment, they did not support the hypothesis because the program was never able to win against a human player. It instead learned how to tie with the computer player due to a flaw within the programming that overvalued the weight of a tie. This exaggerated value had the potential to increase the weight of a tie favorably by 166% more than the weight of an actual win.

**Summary Statement**

The game of Tic-Tac-Toe was used in order to test the learning capabilities of a Neural Network.

**Help Received**

none

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**

Aarthi Ravi; Shruthi Ravi

**Project Number**

**S1614**

**Project Title**

## To Go or Not to Go: That Is the Calculation

**Abstract**

**Objectives/Goals**

The objective is to develop a geometrical algorithm to estimate car travel distance to a traffic light using digital camera and inclinometer. The goal is to estimate the distance with <10% error, while the car is at a distance of >200 feet from the light. Our motivation is to prevent accidents when drivers approach an intersection with traffic light, and make the wrong decision to continue after it turns yellow.

**Methods/Materials**

Digital camera, Laptop, GPS, incline meter, distance meter, laser level, ImageJ software

A digital camera and inclinometer was securely attached to tripod and placed in the car. At an arbitrary distance from the intersection: take photo of traffic light, and record road incline and GPS distance reading. As car moves towards the intersection, repeat the steps three times at different distances, and also record the GPS reading under the traffic light. Use ImageJ to read the image file, and measure the image length in pixels. The change in image length, as the car moves closer to the light, is proportional to the distance moved. Use triangle theorems to estimate distance to traffic light. Perform the experiments during day, night, and for different traffic light types.

**Results**

Overall we collected and analyzed 35 images from control experiments, 72 day-time images, and 56 night-time images from Cupertino road intersection experiments. We failed to meet our initial goal of <10% error because we got CHI-2 = 14.8 with this criteria. We could not analyze the night-time images at all, since the images had too much glare from the lights, so image length measurement was not repeatable.

**Conclusions/Discussion**

Our original goal was too ambitious for the equipment we were using and the sources of errors. However, by changing our goal to <15% error, we got CHI-2 = 0.099. Hence, we conclude that with the equipment we were using, we should have set a goal of <15% error. Using ImageJ software for traffic light recognition and measurement did not work successfully for all images.

**Summary Statement**

To accurately estimate car travel distance to traffic light at an intersection, using a digital camera, inclinometer and geometrical algorithms.

**Help Received**

We would like to thank our science teacher, Mrs. Renee Fallon, for statistics help. Our Dad helped make sense of digital camera and the mathematics in our references.

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**
Jessica A. Richeri

**Project Number**
**S1615**

**Project Title**
## Autonomous Robotic Vehicle: Designing the Auto Matrix

**Abstract**

**Objectives/Goals**
My goal was to formulate different algorithms so I can create an autonomous car. My first phase consisted of mainly constructing the actual car, and create the speed and steering control algorithms.

**Methods/Materials**
I took a remote controlled car, removed the transmitter that had the remote capability and connected an array of infra-red sensors to a Phidgets interface kit. The servo and ESC were connected to a Phidgets advance servo controller. All the hardware was connected to a Tablet PC, running XP Pro, via USB cable. The algorithms that I formulated were written on Microsoft Visual Studios 2008. C# was chosen for the need of a high level programming language. The two main algorithms that I used were Speed Control and Path Prediction. I modified the standard Pure Pursuit algorithm to create a novel approach for my Path Prediction algorithm . These algorithms were used to control and test the car around a series of turns and curves in a customized track. A HP Laptop was used to track and remote control of the car. The laptop was connected to the car with Microsoft Remote Control, thru a wireless connection. In case of wireless failure or car erroneous behaviors, a E-Stop system was implemented to stop the vehicle immediately.

**Results**
The long and short distance sensors overlapped with each other so I had to install an opto-relay switching system, depending how far the car was from the wall. I began to test the capabilities of my autonomous car by initiating with straight paths followed by low degree left and right turns and increasing the degree of difficulty until I reached a sharp 180 degree turn. As the degree of difficulty increased, I adjusted my algorithms to accomplish a superior performance.

**Conclusions/Discussion**
The curvature and proximity of the wall had an effect on how the car will find its way around the track, but the steering needed to be proactive, adjusting the direction of the car before it arrived to the curve. Subsequent to adding a safe zone and distance calculation algorithms, my car was able to travel seamlessly around the track. After 2,000 lines of programming and, hours and hours of trial and error, I was continually successful at making the car go around the track autonomously.

**Summary Statement**
The design of different algorithms to create an autonomous robotic vehicle.

**Help Received**
Dad helped record and edit the videos

# CALIFORNIA STATE SCIENCE FAIR
## 2009 PROJECT SUMMARY

**Name(s)**
Joyce L. Rushton

**Project Number**
**S1616**

**Project Title**
## Fun with Fibonacci

**Abstract**

**Objectives/Goals**
The objective is to determine whether there is a ratio between the areas under curves with Fibonacci number intervals.

**Methods/Materials**
I used a graphing calculator and a ruler to do my project. I decided to test my question with several different types of equations- linear, parabolic, x-cubed, and logarithmic/exponential. I found the areas under the curves between the Fibonacci intervals. I also found the areas under curves between the Lucas numbers for a control group. I used these areas to try to find a ratio. I divided the first area by the second area, then the second area by the third, and the third by the fourth, continuing in this fashion until I'd divided all of the numbers into a ratio.

**Results**
The areas under parabolic curves with intervals of Lucas Numbers and Fibonacci Numbers had a ratio (but not perfectly.) X-cubed graphs and linear equations also had a ratio, which was more consistent than the ratio between the areas under parabolic curves. One of the most interesting things about this was that the areas under the curves using Lucas Numbers or Fibonacci Numbers led to the same ratio.

**Conclusions/Discussion**
There could be a #golden area# for areas under curves.

**Summary Statement**
My project analyzes Fibonacci numbers and the golden ratio.

**Help Received**

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**
Hannah B. Sarver

**Project Number**
**S1617**

**Project Title**
## Yes We Can: Optimizing the Chicken Soup Can

**Abstract**

**Objectives/Goals**
Optimize for cost the production and shipment of cans of 450 mL of uncondensed chicken noodle soup, looking at each step of the process to minimize cost with respect to several shapes (circular cylinder, rectangular prism, hexagonal prism, and triangular prism) and dimensions of cans and geometries of their placement in shipping crates.

**Methods/Materials**
Calculate the dimensions at which surface area will be a minimum for the given volume employing single- and multivariable applications of the Extreme Value Theorem. Analyze the two-dimensional geometry of aligning each shape into rectangular units, and derive formulas for their dimensions and wasted space. Measure the density of chicken soup as well as rough weight per square cm of steel using beaker and postal scale, then determine feasible configurations of cans for each shape into cartons. Divide shipping cost by maximum number of cans contained in one truckload to find approximate shipping cost per can for each shape. Combine results from production and shipping optimization to determine an overall most efficient can design (also considering structural stability based on force testing).

**Results**
Net cost advantage analysis (net cost = production + shipping, to 3 significant figures):
- cylinder: $.0553/can (surface area per can: 325 cm^2 ; # shipped per truck: 162,000)
- rectangular prism: $.0532/can (surface area per can: 352 cm^2 ; # shipped per truck: 211,968)
- hexagonal prism: $.0548/can (surface area per can: 336 cm^2 ; # shipped per truck: 176,640)
- triangular prism: $.0616/can (surface area per can: 384 cm^2 ; # shipped per truck: 160,650)

**Conclusions/Discussion**
The rectangular prism (cube) design is the most cost effective overall, although the circular cylinder and hexagonal prism are more efficient in the production stage. The structural stabilities of the cylinder and rectangular and hexagonal prisms were all similar, while the triangular prism was weaker, as well as being less efficient for both production and shipping. Other factors to consider if actually implementing the results of this project would include the cost and effort of modifying manufacturing machinery to accommodate new can designs, as well as marketing and supermarket perspectives.

**Summary Statement**
This project aimed to determine the optimal shape and dimensions of the chicken soup can based on the prices of production and shipping for various can shapes and packing configurations.

**Help Received**
Mother assisted in structural stability test process and measurements.

# CALIFORNIA STATE SCIENCE FAIR
## 2009 PROJECT SUMMARY

**Name(s)**
Arjun B. Sharma

**Project Number**
**S1618**

**Project Title**
# A Computational Analysis of the Topological Property of the Human Transcription Factors Protein-Protein Networks

**Abstract**

**Objectives/Goals**
Are Mammalian Transcription Regulatory Networks (TRNs) scale-free?

**Methods/Materials**
I got the data of Human transcriptions factors protein-protein interaction measurements generated by a Yeast Two Hybrid analysis in a text file with two columns. Then using Matlab, I applied the equations of topology analysis (see Glossary). The result of these equations was plotted using Matlab. I plotted a graph to show what would happen if several nodes were taken away from the network. In addition, also the network and an example of network hubs have been visualized using software Cytoscape.

**Results**
The result of the equation on the network measurements produced a discrete value for each of the three parameters. k= 7.3; s=3.6; power law coefficient = -1.5. These values were compared with classical scale-free parameters, the k fit the range from 5 to 8, characteristic of a scale-free network. The s is in the range of 3 to 8, also characteristic of scale-free network. And the power law coefficient is negative, which is strong evidence that the degree fit to a power law distribution.
To further test my hypothesis, I did a test similar to the tests in the literature to see if this network displayed scale-free characteristics when under attack. As shown in figure 4, when I sequentially took out hubs from the network, the average path length increased substantially, which lead to a severe decrease in productivity. My results are similar as described in the literature, so this is another strong piece of evidence pointing to the fact that this network is scale-free.

**Conclusions/Discussion**
After my analysis, I concluded that human transcription factors protein-protein network have a scale-free property, which means the network is dominated by hubs, proteins with more interactions than a random node. These hubs are the most important players of the network; therefore, they are important in biological pathways. All the properties of a scale-free network were shown through my experiment. The path length chart showed that all path lengths were close, unlike a random network in which the path lengths between different nodes would greatly vary. In addition, when this network was #attacked#, when nodes were taken away sequentially, the efficiency of this network drastically declined. It declined to a point to where the network became isolated clumps of nodes with no practicality.

**Summary Statement**
I computationally analyzed with the use of MATLAB the dynamics, and topological properties of a human transcription factors network, and tested whether it exhibited scale-free properties.

**Help Received**
The data was provided through Dr. Timothy Ravasi at UCSD, also MATLAB was provided.

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**

Jeongmin Shin

**Project Number**

**S1619**

**Project Title**

## Biophysical Studies of Cytotoxic Effect of TiO(2) Nanoparticles on Human Cervical Carcinoma in vitro: Computational Stud

**Abstract**

**Objectives/Goals**

The main objective is to demonstrate how deterministic mathematical modeling and Monte-Carlo stochastic technique can be used to model the dynamics of the growth and response to titanium dioxide nanoparticles of human cervical carcinomaIn Vitro.

**Methods/Materials**

Implementing the monte carlo model and the cellular automaton method, the computer model was coded by using MATLAB. The algoithm itself involves seven kinds of species, six sets of equations, and various parameters.

**Results**

The simulation results match those of the experiment as they both show the correlation between the titanium dioxide percentage and the quantitative and qualitative measures. Using data from the experiment, the model is highly reliable and presents an effective algorithm that models the phenomenon. The radius of the cell colony agrees with the observation obtained from the previous experiment and the roughness of the tumor cell shows the quality of the cell being reduced.

**Conclusions/Discussion**

An interesting approach to cancer research, the particular model can be used for investigating the nature of titanium dioxide nanoparticles and cancer cells. The model is applicable for future use as it presents the experiment in a macroscopic scale, making it more attainable. Future research can be made by adjusting the parameters to illustrate another phenomenon that is similar to the model presented. Research can also be led on to derive specific mathematical formulas from the model presented. The works of this project are expected to show substantial impact in cancer research.

**Summary Statement**

The project focuses on constructing a computer model from the results of an experiment that examines the anti-cancerous nature of titanium dioxide nanoparticles.

**Help Received**

Used lab at Mahidol University under the supervision of Dr. Wannapong Triampo; Participant in Knowledge Exchange Institute Program; Learned MATLAB under the supervision of the Biophysics group of Mahidol University

# CALIFORNIA STATE SCIENCE FAIR
## 2009 PROJECT SUMMARY

**Name(s)**
Kaitlyn M. Sims

**Project Number**
**S1620**

**Project Title**
## What's the Deal or No Deal?

**Abstract**

**Objectives/Goals**
The objective of my project was to assess the modern game show, "Deal or No Deal", and to create offers like those given on the live game show to contestants. If I was successful in creating these offers, I would compare the predicted offers to those actually given on the live show in order to determine whether or not the game show is fair.

**Methods/Materials**
In this project I used the online game show on the NBC web site, Microsoft Excel, Microsoft Word, Digital Video Recording (DVR), pencils, paper, and the live game show on NBC.

**Results**
In the online game, I found that consistently there were visible formulas used in the ninth offer to create the offers dependent upon which amount was dominant and which formula applied. I was able to create formulas for offers when the dominant, or larger, amount of the two remaining in the game was $1,000,000; $750,000; $500,000; $400,000; $300,000; $200,000; $100,000; and $1,000.

**Conclusions/Discussion**
For Offer 9, I was able to create formulas for eight out of the twenty-five possible dominant amounts (discluding $.01, which cannot be a dominant amount). However, I was not able to create formulas for the other seventeen possible dominant amounts because of limits in my data. I also only was able to create formulas for Offer 9. By examining the dominant and subdominant amounts within the live game shows, I was able to create and examine five predicted offers on the live show. None of the five offers were close to those predicted using my formula. However, I was unable to create more than that because of the limited amount of data I had collected. Still, this suggests that with more testing, data may show that the offers do deviate heavily from those predicted using the online game show#s formulas based upon the offers. This would suggest that the Banker does know what is in the case. My results are overall inconclusive. With more data from the online game show, more formulas can be created, and with more data from the live show, more predicted offers can be created and a better, more definitive conclusion can be reached.

**Summary Statement**
My project tests the game show, "Deal or No Deal", and uses mathematics to create formulas to create offers like those on the live game show in order to assess whether or not the game is fair.

**Help Received**
Mother helepd to build board

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**
Andrew C. Stanek

**Project Number**
**S1621**

**Project Title**
## A Suite of Software Tools for Raman Spectroscopy

**Abstract**

**Objectives/Goals**
The goal of this project was to create a suite of tools to facilitate Raman spectroscopy. This suite consists of two programs: the Nanoscanner, used for scanning a sample, and the Nanoanalyzer, used for interpreting the results.

**Methods/Materials**
Labview was used to program the Nanoscanner, while Matlab was used to program the Nanoanalyzer. Both the Nanoscanner and the Nanoanalyzer were tested with the Raman spectrometer and real spectroscopy data sets, and potential users reviewed both programs for utility and user-friendliness. A NI Data Acquisition Unit and a standard PCI card were necessary to operate the Raman spectrometer itself.

**Results**
Two versions of the Nanoanalyzer were released, and the final version included a variety of tools for analyzing spectroscopy data sets and a customizable interface. The Nanoanalyzer was able to load and handle large datasets extremely quickly with a minimum of system resources used. During numerous trials, the Nanoscanner approached the theoretical minimum time to complete a scan (median within 15% of the minimum) and completed scans of actual samples on the Raman spectrometer.

**Conclusions/Discussion**
The Nanoanalyzer and the Nanoscanner, the two main components of the suite of tools, fulfill their design requirements and are extremely useful in the process of Raman spectroscopy. The suite of tools may be expanded in the future to further simplify and streamline data collection and analysis.

**Summary Statement**
The purpose of this project was to create a suite of software tools to facilitate scientists' and researchers' use of Raman spectroscopy and to otherwise aid experimentation.

**Help Received**
My project was mentored and all equipment provided by Dr. P. James Schuck, Staff Scientist, Molecular Foundry, Lawrence Berkeley National Laboratory, under its Center for Science Research and Engineering Education's High School Summer Research Participation Program.

# CALIFORNIA STATE SCIENCE FAIR
## 2009 PROJECT SUMMARY

**Name(s)**
Eli N. Weinstein

**Project Number**
**S1622**

**Project Title**
# Are Colonies Superior? Pheromone Following Traits as a Measure of the Evolutionary Efficiency of Eusociality

**Abstract**

**Objectives/Goals**
The objective was to use a computer simulation to determine the efficiency of two types of evolution with regards to highly social and altruistic species (eusocial species) such as ants. The two types were individual direct selection, in which individuals reproduce, and the other was group selection, in which a single entity, who passes on their genes to an entire group (a queen), reproduces. Therefore, the question was whether individual selection or group selection working on eusocial species produced better traits, and how quickly.

**Methods/Materials**
To test this, the trait evolved was the attraction to trails of pheromone (chemical markers) to which there must be some ideal attraction to maximize efficiency. To test this, first groups of colonies were evolved, and the level of attraction of the next generation was determined by that of the most successful previous colonies (based on amount of food gathered). For individuals, it worked much the same way; there was no break between colonies, and data was gathered as a function of each individual ant#s lifespan. These two experiments were each run 10 times, and total food gathered was recorded.

**Results**
The results were that the ants following group selection gathered significantly more food (on average per unit time) than those following individual selection. The amount of food gathered in each generation did not improve over the course of individual selection, nor did it improve during generational selection. The average chance of following a pheromone did not change over the course of individual direct selection, but, importantly, it did for group selection. Not only that, but it moved towards a value which, on further analysis of the data, was found to produce more food on average in both individual direct selection and group selection.

**Conclusions/Discussion**
Based on this simulation, there is significant evidence for group selection being just as efficient (if not more so) than individual selection for eusocial species. This has important implications with regards to the evolution of eusocial species. It means that species which made the jump from mere high levels of organization to having the vast majority of their individuals being unable to reproduce were able to keep pace in a computational evolutionary sense with their cousins who did not.

**Summary Statement**
This project is about the evolutionary efficiency of selection working on groups with regards to the origin of ants, as modeled using a system of artificial intelligence-based foraging behavior.

**Help Received**
My father gave me access to the programming system MATLAB through his work as a professor at Caltech.

# CALIFORNIA STATE SCIENCE FAIR
## 2009 PROJECT SUMMARY

**Name(s)**
Caroline M. White

**Project Number**
**S1623**

**Project Title**
## Automatic Die-rolling Machine for Defect Determination

**Abstract**

**Objectives/Goals**
The goal of this project was to design and construct a die-rolling machine used to determine if a die is defective or not by compiling the statistics of the numbers rolled by the dice.

**Methods/Materials**
I first built the dice tumbler, and then attached the dice tumbler to a stepper motor. I also mounted a light source (LED board) and a web cam above the dice tumbler to allow the machine to take pictures of the die being testd. After I built the machine, I programmed an application that basically spins the dice tumbler, takes an image of the die, and then processes the image. The image is processed by converting the image to black and white, negating the image, and then using connectivity analysis to determine the number of "blobs", or dark spots, on the die. These blobs are filtered out based on their areas and how circular they are, and the blobs that aren't filtered out are considered indents, are counted, and the number of indents is displayed on the user interface.

**Results**
I tested 21 dice of varying colors. Of the 21 dice, 16 were tested without error on the machine's part. Of those 16 dice, I deemed four of them, or 25% of them, defective based on a +/-10% defective threshold that I set. This means that if a die rolls a number with a probability 10% above or below the ideal probability (1/6), I considered it defective.

**Conclusions/Discussion**
Overall, the machine was a success. The only dice the machine had trouble reading were some of the colored ones, due to the glare from the lighting blending in with the indents on the dice while the image was being processed. However, the tumbler ended up being extremely efficient and precise, and the image quality from the web cam was satisfactory. The lighting, while not perfectly uniform works, well enough for my algorithm to work, and the algorithm itself works quite well. With a few minor adjustments, this machine could be put out for commercial use.

**Summary Statement**
My project is a system capable of gathering and displaying the statistics of a dice.

**Help Received**
Advisor helped supply equipment and material, and helped with program

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**
Angela Y. Yeung

**Project Number**
**S1624**

**Project Title**
## Sharing Spectrum the Smart Way: Cognitive Radio for Relieving Overcrowding on the Airwaves

**Abstract**

**Objectives/Goals**
While the over-crowdedness of the radio frequency spectrum has become an increasingly noted problem, potential solutions lie in the fact that up to 70% of the licensed spectrum is actually idle at any given time. Cognitive radio is an emerging technology that enables primary and secondary users in a hierarchical access structure to interoperate and use radio spectrum efficiently. One of the most pressing issues in such systems, however, is the complex interaction between distributed secondary users: each user must rely solely on its own observations to optimize the tradeoff between selecting idle channels temporarily unoccupied by primary users and avoiding collisions with other secondary users. The objective of this research was to gain insights into the interaction between distributed secondary users and to use this information to design high performance networking policies with low complexity.

**Methods/Materials**
In this project, a class of distributed randomized policies was investigated. Using a Partially Observable Markov Decision Process (POMDP) to formulate the problem, MATLAB was employed to simulate a proposed multi-user policy in various network settings. Simulation data were then analyzed to draw conclusions about the policy, and subsequently to improve its performance.

**Results**
From analysis of simulation data, a theorem was derived in which the optimum percentage of channels to normalize in any given system could be determined given the ratio of users to channels and the packet arrival probability. In addition, the causes of the relationship between this optimum percentage of channels and the temporal correlation of spectrum opportunity # a system-determining property # were investigated.

**Conclusions/Discussion**
The policy developed in this project improves implementation efficiency by up to 90% while maintaining the optimal average throughput of the original policy. This is significant because it is necessary for users to be able to make good decisions quickly and efficiently in time slots that last only fractions of a second. The policy detailed in this research can have a wide range of applications including cell phone networks, portable devices, and wireless internet.

**Summary Statement**
My research focuses on developing high performance networking policies that will enable users to efficiently share radio frequency spectrum without interfering with one another.

**Help Received**
I did this research at the University of California at Davis under the supervision of Professor Qing Zhao.

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**
Leo Zhou

**Project Number**
**S1625**

**Project Title**
## The Effects of Inverse Fourier Transform on Gaussian Random Fields

**Abstract**

**Objectives/Goals**
This project seeks a correlation between deterministic functions of standard deviation used to generate Gaussian random fields and the functions or surfaces generated by inverse Fourier transforming the fields.

**Methods/Materials**
I employed a personal laptop with Matlab for computation and Microsoft Excel for data processing. I experimented with various functions of standard deviation and graphed them, their inverse Fourier transforms, the Gaussian random fields generated, and the functions or surfaces generated. The number of crests is determined by scanning every point on the function or surface and check if adjacent points have lower values. Linear regression analysis at the crests of two functions or surfaces is used for quantitative analysis of the correlation.

**Results**
It is observed that the generated functions or surfaces exhibit predictable patterns given a function of standard deviation, and these functions or surfaces resemble the inverse Fourier transform of the standard deviation function considerably at their extrema. Further testing and analysis demonstrate a linear correlation between the two near their extrema with high statistical significance. They correlate very significantly ($|r|>=0.9$) in high frequencies, typically 90%, in cases of smooth or oscillating waves. However, the frequencies of highly significant correlations can be less than 10% for cases of chaotic waves, but fairly significant correlations ($|r|>=0.7$) are still common. Besides, the frequency of significant correlations depends on the predictive range; and for individual extremum, sometimes $|r|>=0.99$ despite low frequencies.

**Conclusions/Discussion**
As supported by my results, there indeed exist a strong correlation between deterministic functions of standard deviation and the generated functions and surfaces via the inverse Fourier transform of the standard deviation function. This correlation is very significant in applicable cases and can be used to effectively classify and to predict the behaviors of arbitrary functions and surfaces, especially those in error control, signal analysis, geophysics and ocean science.

**Summary Statement**
My project analyzes behaviors of waves and surfaces via examining the consequences of inverse Fourier transforming Gaussian random fields, and concludes with a scheme to classify and predict arbitrary waves and surfaces.

**Help Received**
My 2009 Canada/USA Mathcamp advisor answered some of my questions.

# CALIFORNIA STATE SCIENCE FAIR
# 2009 PROJECT SUMMARY

**Name(s)**
Zhejun Zhou

**Project Number**
**S1626**

**Project Title**
## Motion Detection Algorithm with Hardware Realization

**Abstract**

**Objectives/Goals**
In my project, my objective was to write an algorithm that utilizes a more cost-effective method of detecting motion in image sequences, and then realize this algorithm in FPGA so that the result can be viewed on TV.

**Methods/Materials**
In order to detect the area of motion, I will accumulate all the pixel values of each row and column, storing only the summated values. Then, I will compare the summated data of each row and column for the current frame with the previous frame's data by taking the absolute value of the difference between the two values for each row and column. Differences in these values will ultimately allow me to determine where motion has occurred in the image sequence.

To complete this project, I need the following programs: Debussy, Modelsim, and Simplify Pro. Other materials include a Xilinx FPGA Chip, Xilinx FPGA tools, an Electronic circuit board with video input/output, a video camera, and a TV.

**Results**
When the video camera was connected to the FPGA Development Board after my algorithm had been downloaded into the chip, the output on the TV screen showed white lines surrounding the area in motion, indicating that my algorithm was successful.

**Conclusions/Discussion**
My results prove that my algorithm functions, and compared with the original memory sizes needed to store one video frame (from about 338Kbyte of memory to 2Mbyte of memory), the memory required when using my algorithm is small. After summating the pixel values for each frame, I only have 80 rows of data (about 1Kbyte), and 720 columns of data (about 1.5Kbyte) for a 720x480 format.

Using my algorithm, the total memory space needed for storage is a mere 2.5 KBytes for 720x480 format, and 7 Kbytes for a 1920x1080 HD video format, a clear cut back in the memory space.

**Summary Statement**
My project is about a more cost-effective method of detecting the area of motion in image sequences.

**Help Received**
Father helped buy FPGA Development Board and briefly assisted with reviewing the algorithm for errors.