



**CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY**

Name(s) Rachel M. Andrews	Project Number J1601
Project Title The Effect of RGB and CMYK Color Formats on the Number of Colors in Photographs	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective of this project is to determine if photographs in the RGB format demonstrate the same number of colors as photographs in the CMYK format.</p> <p>Methods/Materials Photographs of twelve subjects were taken with an 8 megapixel digital camera using manual settings at three specified F-stops. All 36 photographs were then entered into Adobe Photoshop CS on a laptop computer and each photograph was then converted to the CMYK format. The photographs were then saved to files identified by subject and format type, both RGB and CMYK versions. Each photograph was then analyzed for the total number of colors using Corel Paint Shop Pro X2 and then recorded.</p> <p>Results Ten out of twelve photographs demonstrated a greater number of colors in the CMYK format than the same photographs in the RGB format. The same results were repeated at all three F-stops. All 30 of the CMYK photographs (ten at each of 3 F-stops) had an average of 23-31% more colors. Two photographs at each F-stop did not follow the trend. No characteristics were identified in the two photographs that were different from the others used in this experiment.</p> <p>Conclusions/Discussion The CMYK photographs in this study often, but not always, demonstrated a significantly greater number of colors. It is unknown why there were two photographs that had more colors in the RGB format. The experimental results do not support my hypothesis. RGB color images are represented by 3 channels and CMYK images are represented by 4 channels, resulting in 16.7 million RGB and 4.4 billion CMYK color possibilities per pixel. It is possible that the CMYK images generally had a greater number of colors due to the difference in the number of color possibilities per pixel. The percentage difference in the number of colors counted for the RGB and CMYK photographs in this experiment was dramatically less than the difference in color possibilities per pixel for these formats. In the future, I would change the experiment to use the same shutter speed for all the photographs. I might also run a separate experiment to test what effect F-stop and shutter speed changes have on the number of colors in a photograph. This experiment did show the color counts dropped consistently as the F-stop was increased.</p>	
Summary Statement Photographs were taken, converted from the RGB to the CMYK format, and the number of colors in the photographs for both formats were counted and compared to determine which format displayed a greater number of colors.	
Help Received My dad showed me how to use manual functions on the camera. He helped to download the photographs to files and showed me how to convert the color format of the photographs. He also helped me search for a color counting program and download it.	



**CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY**

Name(s) Ryan M. Anielski	Project Number J1602
Project Title To Type or Not to Type: The Probability of Words Appearing in Randomly Generated Letter Sequences	
Abstract Objectives/Goals To determine the number of three, four, five and six letter words appearing in randomly generated letter sequences using both the 26 letters of the alphabet and the letter distribution from a standard Scrabble set. Methods/Materials Computer programs were written using "Phrogram" software to generate 10 sets of 10,000 random letters using the 26 letters of the alphabet, and 10 sets of 10,000 random letters using the letter distribution from a standard Scrabble game. The sets were checked and triple checked for 3, 4, 5 and 6 letter words, which were highlighted, verified using a Websters English Dictionary, and counted. Results The results of Test 1 (using 26 letters of the alphabet) produced approximately 50% less words than the expected outcome based on the statistical probability of finding words. Test 2 produced approximately twice the amount of 3, 4 and 5 letter words as Test 1, and 6 times more 6 letter words. Test 2 produced close to the statistical probability of 3,4 and 5 letter words and more than six times the expected probability of 6 letter words. Conclusions/Discussion The amount of words appearing in sequences of random letters is far less than the statistical probability would indicate. Most words that appear are 3 letters long, with the number of words decreasing as they get longer. When the Scrabble letters are used, far more words appear and their numbers generally are close to the statistical probabilities.	
Summary Statement This project compared words appearing in random letter sequences to statistical probabilities of words appearing.	
Help Received Math teacher at school helped explain statistical probability, uncle helped locate programming software, parents helped edit paper	



**CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY**

Name(s) Eduardo Cabrera	Project Number J1603
Project Title Statistical Reliability in a Marine Trapping System	
Abstract Objectives/Goals The objective of this statistical model was to examine if marine trapping systems frequently used along the coast line statistically represent the surrounding environment they are used in. Methods/Materials A mathematical model system was established by creating ten (10) five level #trapping models# and a randomly created environment to compare the smaller samples to. A t-Test was performed to see if data sets would meet statistical reliability at a 95% confidence level in the model. Results Generally, the trap models upon repeated tries did meet statistical reliability 90% of the time when t-Tested at a 95% confidence level. Conclusions/Discussion The statistical model in repeated samples did statistically support the methodology of the trapping system being currently used in many marine environments. Comparative real time data from several sources comes close to approximating the statistical model that was tested. This would indicate some degree of validity to the testing methodology being employed in surveying certain types of organisms in a marine environment.	
Summary Statement The purpose of this statistical modeling was to examine if marine trapping systems frequently used along the coast line statistically represent the surrounding environment they are used in.	
Help Received My teacher Dr. Morse helped prepare the display board and mentored me about the subject matter.	



**CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY**

Name(s) Dean Hathout	Project Number J1604
Project Title Tricky Triangles: A Probability Problem with Theoretical Solution and Monte Carlo Simulations	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective of this project is to study a challenging probability problem: if a stick is cut in two places at random to form three pieces, what is the probability that a triangle can be constructed from those pieces? This problem is solved theoretically using probability theory, and the solution is compared to empirical experiments and Monte Carlo simulations. The usefulness of Monte Carlo simulations is further explored using variants of the problem that do not have an easy theoretical solution.</p> <p>Methods/Materials Geometric probability theory is used to solve the problem. Sixteen 10 inch dowels and a paper cutter were used to conduct direct experimentation. A Dell PC with Matlab Software was used to program a Monte Carlo simulation of the problem (N=100,000) and was run four times. Simulations for problem variants were also programmed.</p> <p>Results The theoretical solution gives a probability of 25%. This showed an excellent match with both the experimental data and Monte Carlo simulations, which gave the same results. Monte Carlo simulation results of the problem variants are also obtained.</p> <p>Conclusions/Discussion This experiment explores the three ways to study a probability problem: theoretically using probability theory, empirically using repeated direct experiments, and using Monte Carlo simulations. For the problem posed above, there was excellent agreement between the theoretical, empirical, and simulation results. The project also shows the usefulness of Monte Carlo simulations for variants of the problem that do not have easy theoretical solutions.</p>	
Summary Statement This project explores a challenging probability problem using theoretical, empirical, and Monte Carlo simulation approaches; furthermore, it demonstrates the usefulness of Monte Carlo simulations in more complex problem variants.	
Help Received Mom helped with use of paper cutter. Dad helped load Matlab software on laptop for presentation.	



**CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY**

Name(s) Abraham P. Karplus	Project Number J1605
Project Title Find It Fast: Hash Tables and Collision Resolution	
Abstract Objectives/Goals Hash tables are an efficient method for data storage and access. They allow accessing data without extensive search. When two keys hash to the same location, a collision resolution algorithm is used to determine where the keys should be placed. I studied three collision resolution algorithms (CRAs): linear probing, linked list, and cellar. My hypothesis was that all three hash table CRAs would perform about equally well, and all much better than a simpler linear search method. Methods/Materials I measured time, memory usage, and number of string comparisons (as a more precise proxy for time) on 50 different inputs for these three hash methods and for linear search. Results As expected, hashing was a hundred times faster than linear search, taking 0.35-0.5 seconds to look up the approximately one million words of the Bible, instead of 45 seconds for linear search. Conclusions/Discussion The cellar and linked list CRAs always performed well. Contrary to my hypothesis, linear probing sometimes performed poorly when it didn't rehash until the table was full. Rehashing when the table was only 70% full allowed linear probing to perform on par with linked list and cellar.	
Summary Statement I programmed and measured the performance of three collision resolution algorithms for hash tables.	
Help Received Father taught me C, gave some help in debugging code, and helped create Makefile. Parents and teacher provided feedback on report.	



CALIFORNIA STATE SCIENCE FAIR 2009 PROJECT SUMMARY

Name(s) Sasha L. Langholz	Project Number J1606
Project Title The Fibonacci Sequence in Plants	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The Fibonacci sequence is a sequence where the sum of two preceding numbers is equal to the next number in the sequence. 1,1, 2, 3, 5, 8, 13, 21, 34, 55 ... Research suggests the Fibonacci sequence is in plants as an evolutionary growth strategy. Cells grow on the tip of stems and as the stem grows, the cells grow down and out in spiraling patterns. This project had two goals. One, study how often Fibonacci numbers occur in plants. Two, compare Fibonacci numbers between plant families.</p> <p>Methods/Materials The materials were Asteraceae and Myrtaceae flowers, Pinaceae cones, a camera and color copier to record samples, and a plant identification book. Visit plant stores, arboretum, florist, and gardens. Identify and sample Asteraceae and Myrtaceae flowers. Collect Pinaceae cones. Record genus species and count flower petals. For cones, write genus species and count clockwise and counterclockwise spirals. Count three of each. Copy or photograph samples and label with genus species.</p> <p>Results 2/3 or 66% of Asteraceae flowers had a Fibonacci number of petals. 12/13 or 92% of the Myrtaceae flowers had a Fibonacci number of petals. 8/8 or 100% of the cones of the Pinaceae family had Fibonacci numbers of spirals.</p> <p>Conclusions/Discussion The Pinaceae family had consistent Fibonacci numbers. The number of spirals clockwise and counterclockwise were consecutive Fibonacci numbers on each cone. The Fibonacci numbers relate to an evolutionary strategy of compacting seeds efficiently. The Asteraceae family had the least Fibonacci numbers. In books, the aster family is recognized as the family with the most Fibonacci numbers. For example, Ian Stewart in Nature's Numbers says "In nearly all flowers, the number of petals is one of the numbers that occur in the sequence 1, 1, 3, 5, 8, 13, 21, 34, 55, 89. For instance lilies have 3 petals, buttercups have 5, delphiniums have 8, marigolds have 13, asters have 21, and most daisies (asters) have 34, 55, or 89." This is not true. Aster petals show some Fibonacci numbers but aren't consistent. 93% of Myrtaceae flower petals are Fibonacci, but most had 3 or 5 petals. This does not show conclusively that Fibonacci numbers occur in myrtles, it could just be a plant characteristic. Fibonacci numbers appear in plants, more often in the Pinaceae family and less in Asteraceae and Myrtaceae.</p>	
Summary Statement My project tests how often Fibonacci numbers appear in the flowers or cones of the Asteraceae, Myrtaceae, or Pinaceae plant family.	
Help Received I acknowledge my uncle for introducing me to the Fibonacci sequence and my mom for helping me find reliable research and also for driving me around.	



**CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY**

Name(s) Paul H. Lego	Project Number J1607
Project Title Five of a Kind is Hard to Get	
Objectives/Goals The reason I chose this project is because I always wanted to know why it was so hard to roll a Yahtzee (five of a kind). My objective was to calculate and then test the probability of getting five of a kind with five dice on a single roll.	
Abstract	
Methods/Materials My materials included 5 regular six-sided dice, pencil, paper, and a personal computer with Microsoft Excel. I used mathematical probability to determine the chance of rolling five of a kind. I then rolled five dice 500 times physically to test the probability. I then used a Microsoft Excel spreadsheet to simulate 24,000 more random rolls. I repeated the 24,000 random rolls 42 more times for a total of 1,008,000 rolls. Finally, I compared the actual results to the predicted probability.	
Results The mathematical probability was 1 in 1,296, or 0.0772%. My actual results on over a million simulated rolls were 0.0773%, almost exactly the expected results.	
Conclusions/Discussion Five of a Kind turned out to be very hard to get on a single roll. I only got 779 of them in over a million rolls. Also, you shouldn't rely on data from small numbers of tests to test probabilities. I rolled one Yahtzee in 500 rolls or a 0.2% chance. My samples of 24,000 rolls varied from a low of 10 to a high of 27 Yahtzees, or a 2.7x difference. However, in 1,008,000 rolls the probability was 0.0773% or almost exactly the predicted probability.	
Summary Statement My project demonstrates how hard it is to get Five of a Kind on a single roll of five dice.	
Help Received My mother helped me roll the dice. My father taught me about probability and helped me make the Excel spreadsheet.	



**CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY**

Name(s) Isaac A. Loftus	Project Number J1608
Project Title Image Compression: Does It Really Matter?	
Abstract Objectives/Goals The objective of my science project is to determine which image compression method compresses the image to a smaller file size but still produces good image quality when printed. Methods/Materials I used a digital camera to take a picture, a compression program (irfanview) to compress the images into five different formats (JPEG, TIFF - lossy & lossless, PNG, and GIF. I used a Laser Printer and photo paper to print the images. I had 5 judges rate the quality of the images on a scale of one to five. I repeated this process five times and documented the results. Results The results of this experiment showed that pictures compressed using JPEG were chosen by the judges more often as having better image quality than pictures that were compressed using TIFF, PNG and GIF. Conclusions/Discussion In conclusion, through this experiment, I learned that the JPEG compression method results in the best image quality and should be used for the compression of an image when quality is important.	
Summary Statement I am investigating which compression method, (JPEG, PNG, TIFF, GIF) , compresses files and also produces the best image quality when printed.	
Help Received My Mother helped get judges for project and helped me figure out how to compile data for graphs.	



**CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY**

Name(s) Michael A. Metcalf, Jr.	Project Number J1609
Project Title Natural Human Interface for Technology	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals An easier way to interact with technology. A more natural interface for a user. Elimination of keyboard, mouse or remote control. Reduce amount of key commands needed to complete a task. Simple use of phone, computer or TV, etc.</p> <p>Methods/Materials Researched natural interfaces to technology including multi-touch, speech recognition and artificial intelligence. Researched multi-touch interfaces and how they worked. Found several different methods of multi-touch. Found multiple examples of speech technology and artificial intelligence on how to recognize speech. Decided to use a rear projection television and modify it to use multi-touch. Added microphones to recognize speech. Used lasers and IR camera to map touch points on the screen. Filtered out regular light except UV and IR light. Installed computer software to demonstrate ease of use.</p> <p>Results Successfully modified a rear projection TV with IR lasers, then modified my play station eyecam to recognize IR light. Configured and aligned lasers and cameras in order to map touch points on the screen. Created a touch interface on the screen. Physical touch deflects light which is then seen by the camera which causes an action. Created one touch option to connect with speech recognition using artificial intelligence to complete additional actions by voice command. Now I can touch, talk and see my results.</p> <p>Conclusions/Discussion Human touch is a much better way to interact with a computer, TV or phone. Speech recognition eliminates the need to memorize which buttons to push. Technology in the future should use a combination of multi-touch and speech to create a better interface. Reducing steps makes technology faster and fun.</p>	
Summary Statement The future of technology is the ability to touch, speak, and see.	
Help Received My dad help with purchasing the parts need. My mom helped with the presentation board.	



CALIFORNIA STATE SCIENCE FAIR 2009 PROJECT SUMMARY

Name(s) Michael L. Monaghan	Project Number J1610
Project Title Is the C or Assembly Programming Language Better for Programing PIC Microcontrollers?	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Microcontrollers are used to control almost everything electronic from game consoles, automobile airbags and life support systems. My project was devised to determine whether the C programming language is less than or equally efficient as the assembly programming language for programming PIC microcontrollers. My hypothesis is that assembly would be more efficient for very complex programs compared to the popular high level C language.</p> <p>Methods/Materials I first taught myself how to program PIC microcontrollers in C and assembly. I created 12 pairs of programs that performed identical functions for the PIC 16F887 in both C and assembly. Some programs were converted to work on the PIC 16F690 to ensure that the results were similar for different microcontrollers. I used Microchip's MPLAB IDE (integrated development environment) on a Windows XP computer to program the PIC 16F887 microcontroller with the PICKit 2 device programmer. The HI-TECH C compiler was used to translate C into machine code and the MPLAB IDE integrated assembler to translate assembly into machine code. The amount of program memory occupied would be measured in bytes for the matching C and assembly programs.</p> <p>Results The assembly programs used the least amount of memory on the microcontroller for all tests. C used more memory than the assembly programs for all of the tests. In complex programs, C occupied about twice the amount of memory compared to assembly. In simple programs, C used about 3 more instructions.</p> <p>Conclusions/Discussion In conclusion, assembly should be used for programming complex programs where memory is limited because the HI-TECH C compiler adds unneeded instructions and organizes the program in a less efficient way than assembly. C can be used but more money would be required to buy a microcontroller with a larger program memory. For small programs which needed to be prototyped or programed quickly, C could be used because the difference of program memory compared to assembly is very small. For devices requiring precise timing, without an external timer, assembly should be used because the C compiler adds extra instructions adding extra instruction cycles. For microcontrollers that control life support systems, the programmer might want the microcontroller to respond exactly as programmed so assembly would be used for programming the microcontroller.</p>	
Summary Statement My project was to determine whether the C programming language is less than or equally efficient compared to assembly language for programming 8bit PIC microcontrollers.	
Help Received Mother helped with the layout of display board. Father helped proof read papers.	



**CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY**

Name(s) Divya Siddarth	Project Number J1611
Project Title Global Shock: A Mathematical Model to Ascertain Correlation in Worldwide Stock Markets	
Abstract Objectives/Goals The purpose of my project is to determine the mathematical relationships between the stock market indices of several countries in 2000 and 2008 and to examine the change in these relationships with time. This analysis will show whether a global risk diversification strategy can be equally effective in 2000 and 2008. Methods/Materials I downloaded weekly closing prices of the stock market indices for ten countries, namely the U.S., China, India, Japan, Germany, England, France, Canada, Mexico, and Brazil for the years 2000 and 2008. Because the range of values of each stock market index is different, I standardized each country's weekly price by subtracting the mean and dividing by the standard deviation. In order to limit the number of comparisons for each country, c, I created a Global Index by averaging the standardized stock market indices of countries other than c for the same week. The relationship can be represented by the equation $SMI_{cw} = a_c + b_c * GI_{cw}$, where SMI_{cw} is the standardized value of the Stock Market Index of country c for week w and GI_{cw} is the Global Index created as above for the same week. I estimated the regression coefficients a_c and b_c for each country by the method of least squares. To examine the effect of the 2008 stock market meltdown, I also compared the estimation results from the first and second halves of 2008 for the U.S.-based Dow Jones Industrial Average. Results The stock market indices of all these countries were highly correlated with the global index in 2008. I obtained r-squared values between 0.88 and 0.98. In contrast, the correlations were lower in 2000, with r-squared values between 0.04 and 0.68. I also found that the correlation between the Dow Jones Industrial Average and the global index was noticeably higher in the second half of 2008 compared to the first half of 2008. Conclusions/Discussion These findings show an increase in the interdependence of global economies with time. One implication of these results is that a global risk diversification strategy would have been much less effective in 2008 compared to 2000. In addition, my analysis suggests that even the stock markets of the world's largest economies are not insulated from the markets of other, smaller, countries. Therefore, it is likely that countering the effects of a global recession would be more successful if the efforts to stimulate individual economies were globally coordinated.	
Summary Statement My project determines the mathematical relationships between stock market indices of several different countries and analyzes how these relationships have changed over time.	
Help Received My mother showed me where to download stock market data from the Web and showed me how to run a linear regression.	



**CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY**

Name(s) Thomas E. Swayze	Project Number J1612
Project Title Buy Bonds: Investment Algorithm Using an Inverted Linear Yield Curve	
Objectives/Goals Bonds are typically overlooked by investors, but I believe bonds can be a useful investment. Perhaps the bond market could predict economic conditions. To find out, I asked the following question: "If the yield curve of United States Treasury bonds is transformed to become linear, will certain parameters of this line predict future economic conditions such as interest rates, the stock market, and the Gross Domestic Product? If so, can an investment algorithm be developed to maximize profit?" I hypothesized that some predictions could be made, and that I could develop an investment algorithm using this information that might make significantly more money than investing only in stocks.	
Abstract	
Methods/Materials I found a model of the yield curve through research that transformed the yield curve into a line. I applied this model to every yield curve since 1953. I then examined the graphs of the slope and y-intercept. I plotted them against the graphs of the 30 Year Fixed Rate Mortgage, common stock indexes, and the Gross Domestic Product.	
Results I found that the graphs of the y-intercept and the 30 Year FRM almost coincided, but no prediction could be made, since movement was simultaneous. There was no obvious correlation between the stock indices and the parameters of the adjusted yield curve. However, every time the yield curve inverted, the percent change in GDP dipped below zero. This meant the inverted yield curves predicted recessions.	
Conclusions/Discussion Using this information, I created an investment algorithm. The investor buys stock, but when the yield curve inverts, he sells the stock and buys a one year bond. He only reinvests in the stock market once the yield curve returns to the median amount. I applied this method over time and found this strategy was five times as profitable as buying and holding stocks.	
Summary Statement The purpose of this project was to correlate economic parameters with the yield curve transformed into a line, and develop a profitable investment strategy based upon the findings.	
Help Received Thanks to my parents for motivating me to continue and complete my work. Thanks to my science teacher for helping to edit my report.	



**CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY**

Name(s) Prem M. Talwai	Project Number J1613
Project Title Sudoku Patterns	
Abstract Objectives/Goals The main goal of this project was to identify patterns in solved 9x9 Sudoku puzzles and then to use these patterns to create a new method to solve any standard 9x9 puzzle. This will provide Sudoku solvers a logical way to approach Sudoku puzzles that avoids long, intense calculations and guesswork. Methods/Materials The materials I used were empty 9x9 Sudoku grids, a large collection of Sudoku puzzles and their solutions (Super Colossal Book of Sudoku by William Shortz), and a pencil or pen. The first step of my procedure was creating a letter system to map Sudoku puzzles on the 9x9 grid. The letter systems consisted of the letters A through I, each letter consistently representing a number throughout each Sudoku grid. I mapped many puzzle solutions and found basic patterns that were evident in the bands and stacks of each puzzle. I then investigated how these patterns arise and came to the theory that certain #transformations# occur in a Sudoku puzzle. By examining these transformations on several Sudoku solutions, I discovered many more complex patterns. I used these patterns to configure a method to solve a Sudoku puzzle. I tested this method on many Sudoku puzzles. Results I successfully found patterns in solved Sudoku puzzles. I devised a repeating three step method, using band and stack patterns, which can be used to logically solve any 9x9 Sudoku puzzle without guesswork. Conclusions/Discussion I concluded that there are consistent patterns that arise in any Sudoku puzzle. I fulfilled my goal and created a method to solve Sudoku puzzles that uses these patterns.	
Summary Statement My project creates an easily understandable method to solve any 9x9 Sudoku puzzle.	
Help Received No help was received.	



**CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY**

Name(s) Jennie M. Werner	Project Number J1614
Project Title Fractals: The Geometry of Nature	
Abstract Objectives/Goals To analyze the following fractal patterns which are found in nature: 1. Tree: Based on the length of the first iteration, derive a formula to find the total length of all the branches based on the tree's fractal pattern 2. Koch Snowflake: Based on the length of the side of an equilateral triangle, derive the formula to find the perimeter and area, given the number of iterations. Methods/Materials 1. Geometer's Sketchpad software was used to generate two different fractals: Koch Snowflake and Tree. 2. The measuring functions in Geometer's Sketchpad were used to measure the first five iterations of the fractals. 3. The data was entered into a spreadsheet. 4. By looking for numeric patterns, formulas were created to calculate data for additional iterations. 5. To validate that the formulas were correct, the results from the formulas were compared with measuring function data taken from Geometer's Sketchpad. Results Calculations for the following were derived: Tree: Length of the branches Koch Snowflake: Total Area and Perimeter (See display board for the results as capital sigma notation can not be used in the abstract application.) Conclusions/Discussion It is possible to write a formula that calculates the total length of all the branches in a Tree fractal and to derive the formula to find the area and perimeter of a Koch Snowflake. Being able to estimate the measurement of objects in nature has many practical applications to solve real world problems. Because fractals are mathematical equations they can be used to measure objects in nature that seem rough and random. Calculating the length of the branches in a tree can help figure out the number of leaves on a tree and thus the amount of CO ₂ a whole forest takes in. Another use for fractals is for measuring a coastline. While the area of the Koch Snowflake is bounded, the perimeter continues to grow infinitely just like the coastline of an ocean.	
Summary Statement I derived an equation to measure the perimeter and area of a Koch Snowflake and the total length of all the branches in a fractal tree.	
Help Received My mother drove me to the store to buy a display board.	