CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Bryan D. Ardron

Project Number
J1401

Project Title
Hit or Miss: The Effect of the Number of Trials on the Experimental Value of Pi in Buffon's Needle (Dropping) Experiment

Abstract

Objectives/Goals
The objective is to determine if the experimental value of pi obtained using Buffon#s Needle Experiment approaches the actual value of pi in a consistent and speedy way over the first 1000 trials.

Methods/Materials
Three sets of equally spaced parallel lines were drawn on a large piece of paper. The line spacings were 6.5 cm (green), 8 cm (black), and 10 cm (red). Ten 6.5 cm toothpicks were dropped on the paper, picked up and dropped again until 1000 toothpicks had been dropped. The number of toothpicks out of 10 that crossed a line of each color was recorded. Buffon's formula, which includes pi, as well as toothpick length and line spacing as constants was used to obtain an experimental value for pi on the basis of the first 100 trials, the first 200, etc. up to 1000 cumulative trials. The expected value for the number of crossings is simply replaced with the experimental ratio obtained from the trials. For each line spacing the values for pi, as well as the errors were graphed using an Excel spreadsheet.

Results
The average error (= positive difference between pi and experimental pi) for all three line spacings did improve from 100 trials (E = 0.1616) to 1000 trials (0.1354), but this convergence was not consistent. The average error decreased over only 4 of the 100 trial intervals, while it increased over 5 of them. The average error for 1000 trials was in fact significantly greater than for 200, 300, 400, and marginally greater than for 900 trials. Despite this variability, the variations in the error were much smaller over the later trials than at first.

Conclusions/Discussion
I discovered that after about 50 trials the experimental value for pi converges rather slowly to the actual value using Buffon#s Needle Method. Some physical and human limitations that may have affected the outcome were: 1) the possible misjudgment of whether a toothpick crossed a line or not, 2) the thickness of the lines that made these judgments more difficult, 3) the possibility that some toothpicks were not exactly 6.5 cm long, 4) the possibility that not all lines were perfectly parallel, and therefore not precisely 6.5, 8, or 10 cm apart. Despite these limitations, the numbers I obtained were pretty consistent for the 3 different line spacings. In addition, given the direction my results seemed to be heading, I am confident that doing more trials would have led to a better estimate for pi.

Summary Statement
This project compares estimates of pi obtained using Buffon's Needle Experiment formula for up to 1000 trials.

Help Received
My dad served as my mentor. He also helped me with the Excel spreadsheet and special symbols.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Benjamin A. Baraad

Project Number

J1402

Project Title

ReMYnder Binder

Abstract

Objectives/Goals

The integration of technology into the classroom is beginning to impact schools across the country. The load on a student's back is being significantly lightened by e-readers and computers allow for the rapid sharing and editing of documents. However, one area of the classroom process that received less re-invention than necessary is the assigning and management of homework. At some schools (mine, for example), each teacher has a class webpage to which they can upload assignments and relevant content as they see fit. To a teacher, the largest problem is that the process is unintuitive. There is no simple "Add Assignment" functionality, nor is there a simple way to easily upload a document linked to the assignment. For a student, the largest problem is fragmentation. With a physical assignment book, a student can see all of their assignments at once and prioritize. On these websites, however, a student must load several teacher's pages to view all of their assignments. Thus, the goal of ReMYnder Binder is to create a homework program that both students and teachers will find easy to use.

Methods/Materials

ReMYnder Binder's creation required few materials. To build the product, I used XAMPP as a package for both hosting my own Apache server (for testing PHP) and using mySQL (server-side data organization), Notepad ++ to write HTML, PHP, Javascript, and AJAX, and tested my work on the Chrome browser. The work was conducted on a laptop running Windows XP. There was little rigid schedule for production of ReMYnder Binder. I mainly simply sat for long periods of time and wrote code. I also learned AJAX from a book specifically for the project.

Results

I believe I have created a simple, intuitive portal for students to easily view upcoming assignments, as well as a simple method for teachers to upload new assignments that will be automatically pushed to their students. I am in the process of adding new features, so I hope the product will soon have even greater functionality for both both teacher and student organization.

Conclusions/Discussion

ReMYnder Binder is still in pre-alpha. While the service is not yet finished, I believe I have already created a useful product that allows for the painless and unified assignment and checking of homework and look forward to building upon my current foundation to build an even better product.

Summary Statement

The goal of ReMYnder Binder is to create a simple, unified interface for students to check their homework on.

Help Received

None

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Tyler Boyd; Spencer Song

Project Number

J1403

Project Title

Artificial Intelligence: Teaching a Computer to Play Tic-Tac-Toe

Abstract

Objectives/Goals

Our purpose was to create a computer program that can learn to play tic-tac-toe. We were interested in how artificial intelligence works and wanted to see if we could create a program, teach it to play tic-tac-toe, and make it unbeatable.

Methods/Materials

The initial step was to learn the basics of JavaScript, HTML, and computer programming. Then, we created a web page to draw the square images to create a tic-tac-toe board. Functions were set up for the computer to pick the computers next move, such as being able to 'win and block if given the option' and 'picking the most popular move'. Test subjects were asked to play the game on various settings, and data was collected regarding wins, losses, and ties.

Results

Before we created a function that chose the 'most popular winning move' and saved a lot of game data, we could beat the computer almost every time. With plenty of data and the 'most popular winning move' function complete, the computer can never lose. The computer now only wins or ties. This has been demonstrated with several test subjects.

Conclusions/Discussion

The computer, after loading all previous game data files, cannot be beat, but it can be tied. This approach of computer learning can be applied to other fields such as medicine, engineering and manufacturing.

Summary Statement

We programmed a computer to learn from human behaviors and play tic-tac-toe, showing that with limited learning data the computer didn't play as well as it did with total access to all recorded game data.

Help Received

Mr. Boyd helped teach us JavaScript and HTML. He also helped us set up the beginning of the program. We also took the online HTML and JavaScript course at www.w3school.com.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Isaiah J. Campbell

Project Number
J1404

Project Title
By Random Chance or By Design?

Abstract

Objectives/Goals
Can Something that is designed be recreated by random chance? What is the probability if the materials needed were present? I believe that none of the designed things that I will test will be able to be recreated by random chance.

Methods/Materials
Test 1PATTERN TEST Mat. used:10 blocks, 2 of ea.-yellow sq.,blue rect.,red rt tri.,tan rt tri.,green eq lat tri.,a box PROCEDURE:I made a pattern using the 10 blks.I took picture of the pattern.I put the blks in the box.I mixed them up with my hand.I randomly drew them out. I picked the first one I touched.I laid them in a straight line.I recorded what order they were in to see if any matched the original design.I repeated the process 50x's.
Test 2 PLACEMENT TEST Mat. used:8 blocks, 2 of ea.- eq. lat. Tri., sq. rect., rt. Tri., piece of paper PROCEDURE: Lay 8 blocks in a design. Draw around the blks to make a template. Hold blks 1 ft. above paper. Drop them. Record if any land in correct places. I also recorded if any had the correct orientation or touched the correct place. I repeated the process 50x's.

Results
Test 1 THE PATTERN TEST, was an easy test for showing random order. I got enough data by running the test 50 x#s to show good results. My test showed that it is very unlikely for patterns to be remade by random chance. The mathematical probability of recreating the same pattern I had by random choice is 1 out of 113,400. Test 2 THE PLACEMENT TEST was more complicated for showing random placement. There#s no way to conduct the test accurately enough from my home with the tools I have. There are too many factors at play.

Conclusions/Discussion
Test 1 THE PATTERN TEST, it was pretty obvious to see that recreating even a simple pattern by randomly choosing objects, is very unlikely. I got the results I expected. Test 2 THE PLACEMENT TEST, was more difficult to accurately test because there were more factors involved when I dropped the blocks. In order for something to be created that is 3-D or has structural placement there are physics involved. It#s not only the random order but the placement of the objects that matters. This makes the testing process more complicated. Because you have gravity, velocity and other forces, it is not possible to get completely accurate results at my house. I did get the results I thought I would get because the design was never recreated.

Summary Statement
Can something that's been designed by recreated by random chance?

Help Received
Mother reviewed project for clarity.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Caleb Clements; Chase Clements

Project Number

J1405

Project Title

Creating a Global Positioning System: Determining Latitude and Longitude Based Upon Solar Azimuth and Elevation

Abstract

Objectives/Goals

Our project was to create a global positioning system (GPS) by building a device to measure the azimuth and elevation of the Sun and creating an algorithm to calculate the latitude and longitude of the observer.

Methods/Materials

We built a device similar to a horizontal sundial to measure the azimuth and elevation of the Sun based upon the length and direction of the shadow cast by the gnomon. We also developed an algorithm to calculate the latitude and longitude based upon the date, time, solar azimuth, and solar elevation.

The algorithm had to account for Earth's orbital mechanics, including but not limited to: eccentricity of orbit, uneven days in year, axial rotation, and variable speed of orbit (Kepler's second law).

In order to test our hypothesis, we measured the solar azimuth and elevation for 10 different dates and times in our backyard and used our algorithm to estimate our latitude and longitude. We also obtained date, time, solar azimuth, and solar elevation data for 30 significant events in world history in the last 1,000 years and used our algorithm to estimate the latitude and longitude of the event.

Results

For the 10 tests performed in our back yard our errors ranged from 16.5KM to 143.8KM, with an average of 40.2KM. For the 30 worldwide events we were given for our experiment, our errors ranged from 0.4KM to 92.1KM, with an average error of 24.2KM.

Conclusions/Discussion

Our conclusion is that we can create a GPS by noting the date and time, measuring the azimuth and elevation of the Sun and calculating our latitude and longitude on Earth. This project greatly increased our knowledge of Earth's orbital mechanics.

Summary Statement

We created a global positioning system by building a device to measure the azimuth and elevation of the Sun and developing an algorithm to calculate the latitude and longitude based upon the date, time, solar azimuth, and solar elevation.

Help Received

Mother helped us prepare the board; Father operated the drill press during the construction of our device; Dr. Fiona Vincent (astronomer at St. Andrews University) and Dr. Robert Kellog (with the North American Sundial Society) both answered questions and explained certain concepts.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Katarina A. Cohen

Project Number
J1406

Project Title
Mathematical Properties Found in Nature

Abstract

Objectives/Goals
My objective was to discover if patterns in Pascal's triangle could be found and identified in nature.

Methods/Materials
To begin my exploration I needed many Blank Pascal#s Triangle sheets, graph paper, original Pascal#s Triangle on paper, calculator (if necessary), graph of the digital roots of Pascal#s Triangle by row, graph of EKG readings, graph of a seismogram reading of an earthquake and graph of sound waves. I graphed the digital roots in Pascal's Triangle. I then compared this graph to the graphs on EKG readings, seismogram readings of an earthquake, and sound wave graphs. I looked for the similarities between each graph. I then used the blank triangles and shaded in specific numbers like all odd numbers, all even numbers, and multiples of 2,3,4, and so on.

Results
My results showed that my graph of digit roots had a correlation between the rates of increase and decrease with the EKG graphs, sound wave graphs, and seismogram readings of earthquake graphs. One of the most useful patterns in my findings was the Fibonacci Numbers. These numbers can form a swirl that is found almost every in nature. A common pattern I found was one of symmetry.

Conclusions/Discussion
I figured out that Fibonacci Numbers are also a pattern within Pascal#s Triangle. I came to learn that these numbers form a pattern, a swirling line, which can be found in nature. I printed out Pascal#s Triangle multiple times and colored in different number patterns. I saw that the patterns that emerged when I did this and noticed the symmetry in them. I also realized that symmetry is found in nature.
I had found two ways in which patterns in Pascal#s Triangle can be related to nature, thus supporting my hypothesis.

Summary Statement
My project is about discovering patterns in Pascal's Triangle that can be found and related to patterns in nature.

Help Received
My mother encouraged me to do a project about mathematics because she knows it is one of my passions.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Ian M. Gallagher

Project Number
J1407

Project Title
Scouting vs. Sabremetrics

Abstract

Objectives/Goals
I got the idea for my project from the movie Moneyball. I chose it because I wanted to learn a little more about baseball and have fun doing it. Scouting is where they look at a player#s abilities on site and write a report on it. Teams are usually comprised of one to two good players and a few less than average players. Teams with bigger salaries are usually better than others because they can field a team of all good players. They also mainly use the players hitting when evaluating offensive ability.
In sabermetrics people look at the raw data on players and field a team of all average players. Also the teams look more at the ability to get on base (OBP) instead of hitting. The teams with bigger salaries now field a team of all good players based on sabermetrics which defeats the ability of teams with smaller salaries to use sabermetrics to compete with the larger teams salaries. Even though this happened, sabermetrics still leveled out the playing field in baseball for a while.

Methods/Materials
Materials: Computer, Internet, Word Processing
Procedure: Collect data on team salaries, Organize into graphs, Collect data on teams average and teams OBP, Organize data into graphs, Write conclusion and introduction, Make poster.

Results
My results showed that teams use an even mix of scouting and sabremetrics determined by the coach or general manager

Conclusions/Discussion
Teams use a little bit of scouting and a little bit of sabermetrics in a balance. As shown in my data the teams were very close to each other, in hitting and getting on base, but teams with more money were generally a little better. The Phillies, the New York Yankees, the Boston Red Sox, most of The AL Central, the Texas Rangers, and the St. Louis Cardinals all seemed to have the best percentages. When calculating the percentages I got rid of players who did not play more than fifteen games on that team. I also got rid of players who did not have at least thirty at bats which consisted mostly of closing pitchers in the national league. I could improve the data gathered by finding a different and better medium for figuring out who uses what.

Summary Statement
My project is about baseball and how teams evaluate players

Help Received

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Zachary J. Haupt

Project Number
J1408

Project Title
Does Cosmic Dust Have an Effect on Space Travel?

Abstract

Objectives/Goals
The goal of my project was to determine whether or not cosmic dust in space will slow a spacecraft down, and if so, how long it would take.

Methods/Materials
Since real-world experiments were not practical, a way of simulating outer space was sought. A mathematical model was tested using air-drag formulas to create a computer program simulation. The simulation was run with different starting conditions approximating the density of the medium in which the test object was "flown". Sea-level conditions were used to calibrate the model's output with published values. Additional runs were made testing thinner atmospheres such as the top of Mount Everest and the orbit of the International Space Station (ISS). Each simulation was run until either the object slowed to a preset velocity or a fixed number of iterations had been reached.

Results
The simulation illustrated that the less dense the material through which the object traveled, the longer it would take to slow down. The simulation run using values similar to those at the altitude of the ISS ran a very long time and while the object slowed down, it would not be noticeable to an observer.

Conclusions/Discussion
Cosmic dust, air molecules, and even small bits of rock can influence the flight of an object in space, but other factors (like gravity) are likely to have a larger effect. Learning more advanced math and physics techniques will allow greater accuracy and ability to calculate these relationships.

Summary Statement
A computer simulation is used to determine the effects of cosmic dust on objects traveling in space.

Help Received
Father helped with computer program, learning math and physics

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Samantha Huerta

Project Number
J1409

Project Title
A Comparison of Small Population Transect and Radial Sampling Methods with Larger Whole Populations Sampling

Abstract

Objectives/Goals
My project was to determine if radial and transect sampling methods will represent a whole population statistically and at what sample size. It is obviously not practical for Forestry personnel to count all trees in large areas, so representative samples are taken with transect and radial sampling methods when aerial methods are not practical. The location of the sampling and the methods may be greatly influenced by the density over which the survey takes place.

Methods/Materials
To test this I made a representative scale math model where 520 hectares were laid out in a grid. Trees were simulated in a random distribution which produced areas of sparse and great density that might be found in nature. I then randomly produced numerous transect and radial survey samples of one hectare each. My hypothesis was that the whole population would be represented statistically at a 15% area sample size. I did a statistical analysis and performed a t-test at a 95% confidence level at differing sampling sizes with the two methods.

Results
I found out that my hypothesis was wrong. My calculations indicated that both sampling methods at a 15% sample or less did not adequately represent the whole population, nor did they work well at much larger sampling percentages.

Conclusions/Discussion
My conclusion is that neither radial or transects sampling in the model methods I employed worked well enough to be employed in the field. Either the sampling size needs to be increased greatly, or the methodology changed.

Summary Statement
My project is to determine if radial and transect sampling methods will represent a whole population statistically and at what size.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

George H. Hutchinson

Project Number

J1410

Project Title

Sudoku.exe

Abstract

Objectives/Goals

Sudoku is an NP-complete puzzle, meaning that it is in a group of puzzles of great importance to mankind. So, I pose the question, "What heuristics are most efficient in helping to solve a Sudoku puzzle?" There are many heuristics to use: I tested a specific four: the Single-Possibility Rule (SPR), Apparent Twin Rule (ATR), Hidden Twin Rule (HTR), the Sub-Group Exclusion Rule (SGXR). I saw the HTR occurring in many situations in puzzles, thus I saw it eliminating many possible values for each spot in a puzzle. Hence, I hypothesized that if I test all those heuristics with a depth-first search as control, then the hidden twin rule would be most efficient.

Methods/Materials

For a test group, I used a list of 1000 randomly generated puzzles. I had two different computers, one cutting-edge, one nearly antique, both solve all 1000 puzzles with first no heuristics then each one, one at a time. The program cataloged times as it proceeded, and then computed some summary statistics.

Results

The heuristics ranked in a clear order by average time: SPR (0.01 sec), ATR (0.07), none (control) (0.24), SGXR (0.30), HTR (35.75).

Conclusions/Discussion

HTR was clearly the least efficient, so I reject my hypothesis. I attribute this to the amount of looping that was required to implement it. However, there are better implementations. It would be interesting to extend the project and re-try it with better implementations.

Summary Statement

I studied different ways of efficently solving Sudoku puzzles, with the hope of applying that knowledge to similiar, but much more important conundrums .

Help Received

Parents helped in board design and report; Dr. Turk (see advisor section) advised me in all aspects of the project.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Abe N. Jellinek

Project Number
J1411

Project Title
The Three Little Pigs and the Big Bad Navigation Device

Abstract

Objectives/Goals
To investigate, out of three techniques, which method of navigating in a 3D world is the most efficient for users.

Methods/Materials
Materials
MacBook 13" computer; Minecraft 1.1 3D game software; IntelliJ 11, a Java IDE.
Java libraries: LWJGL, Batik, a Scalable Vector Graphics (SVG) library, SoundSystem/3DSound.
Methods
1.Wrote a program in Java for the Minecraft game, that allows a player to see 3D lines in the game world, pointing at other players. 3.Refined my idea to test efficiency of three modifications, one of which was the line. 4.Wrote code for compass. 5.Found map modification for Minecraft and adapted. 6.Wrote a program to time a person as they navigated in the world, and write their position to a file. 7.Decided to use pigs as points. 8.Created start for the test, and placed three pigs at equal distances from the start. 9.Randomized which pig, and which navigation technique, was used during the test. 10.At each pig, I placed a pressure plate for teleporting. 11.Created questionnaire program to run at the end. 12.Wrote script to read so that they would receive the same instructions. 13.Tested 12 people, all of whom said they were experienced MC users. 15.Created program to draw the path that people took when finding the pigs. 17.Decided to throw out ones that exceeded two standard deviations from the mean. 18.Figured out a way to compare time results. 19.Calculated mean time for all of each user's results, and expressed times per navigation device as a function of the mean. 20.Analyzed and compared the results. 21.Created graphs of correlations.

Results
More than 2400 characters of data from path images, raw times, deviation from mean, typical users, & perceptions of users.

Conclusions/Discussion
Analyzing the paths:
#line was most intuitive
#compass had a steep learning curve
#map was slowest and hardest to use
Analyzing raw times, I could see the effectiveness of each tool.
Analyzing deviation, I could see that data as well as how well the tool worked for that person.

Summary Statement
This project analyzes the effectiveness of three virtual navigation devices in a virtual 3D world.

Help Received
Father consulted on programming questions and suggested analysis techniques; mother helped organize tests.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

J. Tyler Jones

Project Number

J1412

Project Title

Demonstrating the Birthday Paradox Using a Computer Simulation

Abstract

Objectives/Goals

The objective is to determine if a computer program be used to demonstrate the birthday paradox where in a group of 23 people there is a 50.5% probability that two people have the same birthday. The experimenter thought that the birthday paradox could be simulated by a computer program because a computer program can be written to mimic a real life experiment and can run numerous trials quickly and easily.

Methods/Materials

A Java intermediate programming platform called BlueJ was used in developing the program. For a set number of groups of people with randomly generated birthdays the program determines how many of the groups had matching birthdays. The program does this for a set number of trials and outputs the number of groups with matching birthdays for each set of groups. The program was run with different combinations of the number of groups and the number of trials. To analyze the results, the averages, standard deviations, maximums, and minimums were calculated.

Results

With 12 different tests, the birthday paradox simulation correlated very closely to the calculated 50.5% probability of a match. While conducting the experiment, the experimenter found that the combination 500 trials and 100 groups did the best in terms of most accurate average, which was 50.424%. The second closest was 100 trials and 100 groups, with an average of 50.61%. The average for all "100 groups" sets of data was 50.4695%, which is very similar to the calculated probability.

Conclusions/Discussion

Based on the results, it seems that the birthday paradox can be demonstrated accurately by a computer simulation. Computer simulations are powerful because they can be made to resemble a live test, run large numbers of trials with different inputs, and do it all quickly.

Summary Statement

This project simulated the birthday paradox, a complex probability, with a Java computer program.

Help Received

Father helped me to learn Java and develop the computer program; Mother assisted in assembling the backboard.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Janet M.S. Liu

Project Number
J1413

Project Title
The Center of Gravity

Abstract

Objectives/Goals
To define which crucial triangle point (incenter, centroid, orthocenter, circumcenter) is also the triangle#s center of balance or gravity.

Methods/Materials
I tested my theories with a scalene triangle, and plotted the four crucial triangle points necessary for my experiment by means of geometric construction methods. I tested my point which seemed to best balance the triangle by performing a balance test, then did the test again on paper versions of all four triangles.

Results
The crucial triangle point, the centroid, is the center of gravity for all four types of triangles.

Conclusions/Discussion
After I pondered my conclusion further, I was also able to better validate the conclusion mathematically and logically, not to mention the physical test I performed in this experiment. I believe I am fully convinced that the centroid is indeed the triangle#s center of balance. If I had to redo this experiment, I would also attempt to test and make certain the fact that the other three triangle points do not balance any of the other types of triangles.

Summary Statement
My project is about validating the triangle's centroid as its center of gravity.

Help Received
Father helped prepare heavy cardboard for project

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Jett D. Liu

Project Number
J1414

Project Title
Investigating Properties of Computer Generated Holograms

Abstract

Objectives/Goals
Last year, when I was in sixth grade, I created holograms by capturing interference fringes onto a holographic plate using a laser. This year I wanted to find out if it was possible to create holograms without using an object or a plate. I decided to try to generate and print hologram patterns using a mathematical computer program. I tested the distributive property of holograms and the effect of print resolution on these holograms, measured in dots per square inch (dpi).

Methods/Materials
I tested a total of seventeen holograms, ten at 300 dpi, seven at 600 dpi. I used a computer program to create these holograms. The program uses a mathematical method called the Fourier transform to calculate the depth of the hologram and create the interference pattern of the hologram. I printed out the holograms I created onto transparency film. I then used a laser to view the holograms. This project required a HeNe laser, and transparency sheets.

Results
Of the seventeen holograms I created and tested, the 600 dpi images were considerably more detailed when viewed and the shapes were clearer. I also tested the distributive property of holograms. I tested what 50% of the hologram covered would produce, and I also tested the image at 95% concealment. There were no obvious differences between the two tests and the original hologram.

Conclusions/Discussion
As I conducted my experiments I realized that the holographic patterns were similar to Quick Response codes (QR codes), which are being used instead of UPC barcodes for some products. I believe that computer generated holograms can be used as a replacement for QR codes. Not only because holograms can be read faster, but because they contain more information, and can be read even if the hologram is damaged. Holographic computer storage is also something that I believe should be the trend for the future. Currently the prototypes can hold up to 1.6 terabytes of data, which no existing computer can compare to, and not only that, all 1.6 terabytes can be read in less than 0.5 seconds. Also, due to the distributive property, if the storage medium is damaged the data is not lost, and can still be read. Holographic storage, I believe, will be the hard drive of computers of the future.

Summary Statement
I investigated the properties of holograms and the interference patterns that were generated by a computer program, using the Fourier transform.

Help Received
Thanks to my father for purchasing the test materials and supervising me during the experiments. Thanks to my science teacher for loaning me lasers. Finally, thanks to my math teacher who taught me the Fourier transform.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Anna J. Lou

Project Number
J1415

Project Title
Computer vs. Human: Exploring AI in the Game Blokus

Abstract

Objectives/Goals
AI researchers have always been interested in abstract strategy games because they involve complex human thought process and a clean environment with clear criteria for success. My objective is to explore AI in a new strategy game Blokus. I hypothesize that, by using my newly created and optimized strategies based on last year's research, my Blokus AI program could defeat human players, represented in my project by doctors and professors.

Methods/Materials
(1) With my own C# program, I simulated and analyzed a total of 5 million Blokus games in 500 strategy tests (with 100 trials in each test) in Experiments 1, 2, 3, and 4. I created 4 new versions of increasingly effective strategies by developing a new Form (F) Strategy, enhancing the Piece (P) and Location (L) strategies, and adding a deep search algorithm. I tested 30 parameter values for P, L, and F, and investigated hundreds of different combinations in order to achieve the best winning chance. (2) In Experiment 5, Computer vs. Human, I developed new functions to allow my best strategy to play against 5 PhDs and 4 professors in a total of 72 games for human-level AI testing. (3) In a Side Experiment, I had my program play against both commercial Blokus AI products I was able to find.

Results
(1) This year's best strategy achieved a 99.8% winning chance against random and an 89.5% against P/L, last year's best strategy. The optimal parameter values were determined as P12, L9, and F0.8587 by using polynomial regression analyses and calculus techniques of finding the extrema. (2) In Exp. 5, my AI program defeated all 9 human players. (3) In the Side Exp., my program won against both commercial Blokus AI products.

Conclusions/Discussion
(1) The results support my hypothesis that my Blokus AI could defeat human players, represented here by doctors and professors. (2) I created my AI program by not only copying the way the human brain thinks, but also taking advantage of the computer's calculation power in order to handle the search tree's large branching factors and to run 5 million games for parameter optimization. (3) My project is very significant because it shows AI's great potential to win humans in Blokus and provides a good test-bed for studying Blokus and other similar games. More importantly, with a newly studied game Blokus, my project contributes to the challenging field of game-related AI research.

Summary Statement
By developing new strategies, adding a deep search algorithm, and simulating 5 million games, I created a Blokus AI program which defeated human players, including 9 doctors and professors, and also defeated commercial Blokus AI products.

Help Received
Dr. L. FitzGerald, Dr. H. Huang, Prof. L. Lazarus, Dr. L. Song, Dr. X. Song, Prof. L. Waldman, Dr. W. Wei, Prof. J. Xue, and Prof. Z. Yang helped with human-level AI testing. Prof. Xue advised on calculus and statistics topics. Thanks also to my parents for their great support.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Alastair C. Macmillan

Project Number
J1416

Project Title
Solving Polynomials: A Multifaceted Approach by Computer

Abstract

Objectives/Goals
The purpose of my experiment was to create a computer program that uses various processes for solving the roots of first through fifth order polynomials. The results are limited to real numbers rounded to three decimal places.

Methods/Materials
I started by looking into ways of solving polynomials, and the method used differed for each order. I found formulas in a number of locations, such as an Algebra 2 text and others on websites. I then worked out how they functioned, and developed flowcharts to model step-by-step instructions of how to solve the polynomial equations. From there I created subroutines that solved each section of the flowchart and combined them to create the program #solving polynomials.sb# that solves for the roots of the polynomials and graphs the results. I needed to test my program out to make sure it worked for all the equations within my parameters. I was able to create control graphs using Grapher, an Apple program, and also used www.solvemymath to generate polynomials from the roots given. With these two controls, I was able to check my answers against known results.

Results
My program successfully solves first through fifth order polynomials with integer coefficients, gives real numbers and also produces graphs of the equation. If non-integer coefficients are entered, the program also uses the bracket method to generate roots to three decimal places.

Conclusions/Discussion
The #Solving Polynomials.sb# program is unique in that it can successfully solve almost all quintic and lower polynomial equations except ones containing imaginary numbers as roots, and roots that are less than 240 and greater than -240. It could be used to generate quick solutions to engineering problems, like space flight and modeling geometric solids in a variety of situations.

Summary Statement
My project a computer program that uses various processes for solving the roots of first through fifth order polynomials.

Help Received
I used my Dad as a beta tester. Mom helped glue up the board.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Robert L. Mummery

Project Number

J1417

Project Title

NBA Prime Time: Determining the Age When NBA Players Reach Their Peak

Abstract

Objectives/Goals

The goal of my science project was to determine the age at which NBA players peak. I believed that the average NBA player would peak around the ages of twenty-four and twenty-five.

Methods/Materials

I used retired NBA players who had a career lasting at least 950 games, starting after 1949 and before they turned twenty-six. I used Player Efficiency Rating, Basketball Win Shares, and Basketball Defensive Win Shares to draw conclusions.

I collected the PER, Win Shares, Games Played, Age, and Defensive Win Shares statistics for each player from basketball-reference.com. I separated the players by position into categories, and divided each category into two groups. One group used two-thirds of the players, and the other group used the remaining third. I then sorted their seasons by their age on February 1 of that season, and I calculated the means, medians, and bivariate correlations.

Results

According to PER, the overall peak was between the ages of twenty-four and thirty-one,. and both Win Shares and Defensive Win Shares stated that they peaked between the ages of twenty-five and twenty-nine.

Conclusions/Discussion

My hypothesis was incorrect; NBA players peak between the ages of twenty-five and twenty-nine. There was little difference between my two groups. I noticed that centers typically play longer and sometimes peak earlier than guards. I believe they have longer careers because they are harder to replace, and they peak earlier because they are more predisposed to injury. I also noticed something I call the Wave Effect, where players' statistics tend fluctuate in alternate directions for at least three years. The Wave Effect is a very common phenomenon amongst guards. If I were to further this experiment, I would probably expand my analysis and study the Wave Effect more closely.

Summary Statement

The goal of my experiment was to determine the average age at which NBA players peak.

Help Received

My mom proofread my work and helped me with my project display assembly (She cut; I glued). My science teacher leant me SPSS and answered my questions.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Ken Noh

Project Number
J1418

Project Title
A Mathematical Analysis of Animal Food Chains in Serengeti National Park, Africa: A Computer Simulation Program

Abstract

Objectives/Goals
Computer languages such as Java can be used to code programs which simulate future generations of data based on a solid mathematical model, such as in the case of generating data for large population counts. This study aimed to create a simulation that could help show how different levels in the Serengeti ecosystem would react to changes in the population. The research hypothesis was: If a change is made in one animal population within a food chain, (1) the level of the food chain that is most directly related to the manipulated population will experience the most population change; and (2) the level of the food chain that is least directly connected or neutral will experience the least change.

Methods/Materials
The materials used in this project were one HP Touch Smart 310 PC (w/ Mouse and Keyboard) along with a Java 6.0 Eclipse IDE running on Windows 7.
A linear regression model was built with four parameters:
P(t+1)=P(t)*a+P(t-1)*b+P(t-2)*c+1*d. P(t) represents the population at time t; a,b,c represent change rate coefficients; and d is the adjustment factor. In order to find a, b, c, d to minimize errors, matrix manipulations in the Normal Equation were done. After this model was completed, the starting populations of animals were manipulated to test the effectiveness of this model.

Results
The results showed the linear regression model was successful in simulating possible ecosystem changes. When the population of lions was increased, this resulted in a rapid decline in the populations of various herbivores. When the population of lions was decreased, this resulted in an increase of herbivore populations. For example, when the population of zebras was increased, the population of lions also increased. When the population of zebras decreased, the population of lions also decreased. These results supported the actual data.

Conclusions/Discussion
The hypothesis was supported by the data generated in the simulation. It was found that vultures and elephants (both neutral animals) were barely affected by the manipulation. On the other hand, the levels of the food chain directly connected to each other, such as carnivores and herbivores showed the most change in each population. To improve this project, the simulation would need to include all species to be more realistic. With this, the next step would be to create a program which could find a ratio to create an equilibrium within the ecosystem.

Summary Statement
A computer simulation program coded with Java, used to represent animal populations in future generations, was created with a linear regressive model and was tested with manipulated populations.

Help Received
Mother helped glue together project and buy materials.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Ayesha M. Rashed

Project Number
J1419

Project Title
Security through Obscurity (Steganography)

Abstract

Objectives/Goals
The goal of this project is to determine (a) how much color variation in a digital image is noticeable by average human eyes, (b) how can digital images hold covert information within the un-noticeable band of color variation, and finally (c) how the covert information embedded in a digital image can be kept secure?

Methods/Materials
(1) Standard images, used in Digital Signal Processing (DSP), were downloaded from the USC (SIPI) website. (2) Python and Python Image Library (PIL) was setup on my computer. (3) An electronic survey was conducted to determine the human ability to detect the pixel color variation of different levels by different group of people based on their ages, gender and geographical disposition. (4) A python steganography program was written to merge digital information into an uncompressed digital image. (5) To extract the information out of the impregnated image, a decoder program was written in python to test the integrity of the data. (6) To make the covert digital information embedded into the uncompressed image, secure and unbreakable without the knowledge of the original pass-phrase or encoding seed, different methods like seeded pseudo random functions and pass-phrase based 2D location function were used to distribute the data.

Results
(1) The survey results show that in normal portrait picture about 70% people do not find 3 bit color variation detectable. (2) In high contrast pictures 70% people do not detect variation as high as 5-bits. (3) Variation of RGB color channels in the solid colors is more observable. (4) The color variation is less observable in low intensity regions of a digital picture. (5) Security of the covert data is virtually unbreakable by distributing it in two dimensional (2D) pixels space.

Conclusions/Discussion
Through this project it is proved that up to 3 lower bits of the each of the RGB color channels of the pixels of common digital images can safely be changed, without losing noticeable colors and texture details. This available bit space can be used to compress the digital images or hold covert digital information. It is shown that the pictures of high contrast and dynamic range can hold more covert information. The steganography techniques proposed in this project can be used in applications like copyright, watermarking of intellectual property, and keeping personal data secured through obscurity on unsecure mediums like USB drives, CDs, etc.

Summary Statement
Securely embedding covert digital information in an un-compressed digital picture.

Help Received
Dr. Rashed Z. Bhatti supervised and helped in Python programing.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Parker A. Snipes

Project Number
J1420

Project Title
Probability and Risk

Abstract

Objectives/Goals
My objective was to find out whether, in the board game Risk, the attacker or the defender has a better chance of winning in combat. My hypothesis was that, because of the rule that ties go to the defender, in general the defender would have a less than 50% chance of losing a man in each combat, and thus a slight advantage in the game.

Methods/Materials
I needed to find the probability that the defender would lose a man for each possible roll of the die and number of dice rolled (1, 2, or 3). So I used Excel on my laptop to create tables showing various combinations that the attacker and defender could roll and showing in each case the number of men lost by the defender. I then calculated the odds that the defender will lose a man in each scenario.

Results
The defender's odds of losing a man vary depending on how many dice the attacker and defender roll. When the attacker rolls only 1 die, the defender#s odds of losing a man are always less than 50%. When the attacker rolls 2 dice, the defender#s odds of losing a man are greater than 50% in 2/3 of the cases. When the attacker rolls 3 dice, the defender#s odds of losing a man are greater than 50% in at least 2 out of 3 cases.

Conclusions/Discussion
My hypothesis was correct as to some scenarios, but not as to others. In nearly every case, the defender has a less than 50% chance of losing a man unless the attacker is rolling a greater number of dice than the defender. Thus, a likely winning strategy in Risk would be to attack a territory only if the attacker can roll more dice than the defender in the attack.

Summary Statement
My project is about whether the odds favor the attacker or defender in the board game Risk.

Help Received
My mom helped me format and glue the board, and my dad helped me describe my results and conclusions.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Dennis van Ee

Project Number

J1421

Project Title

Cashier Strategies

Abstract

Objectives/Goals

Determine which cashier strategy is most efficient. In this case, the strategy that results in the shortest average waiting time in the queue is the most efficient. I considered two cashier strategies: single-line and multi-line; the single-line strategy uses a single queue for all registers, and the multi-line strategy uses a single queue per register.

Methods/Materials

The experiment is performed by simulating a shop. To be able to do this, you need a computer and a C# development environment (I used Microsoft Visual Studio 2008). You also need the react.NET library for C# which provides basic functions for discrete simulations.

I created three different classes: Shop, Customer, and Register. A single instance (object) of the Shop class creates instances of both the Register and the Customer class. A Register object is created for each simulated register at the start of the simulation and Customer objects are created with a delay from an exponential distribution to simulate the arrival of customers in the simulated shop. For each Customer object, the simulation waits the browsing time (from a uniform distribution) before putting the Customer object in a queue where it waits for an available Register object. Register objects wait the serving time (from a uniform distribution) for each customer before releasing that customer. The Customer object then records its browsing time, waiting time and serving time. Each Register object records its idle time.

Results

In all 12 trials that I have conducted, the single-line method had a lower average waiting time than the multi-line method. These differences were sometimes very subtle, but some showed a large difference in average waiting time. The register idle time for the single-line method turned out to be lower than for the multi-line method; except in two of the trials.

Conclusions/Discussion

By observing the data, I conclude that the single-line method triumphs over the multi-line method in efficiency because the single-line method has a smaller average waiting time (a reduced average waiting time does not imply the waiting time using the single-line method is less for each individual simulated customer). Moreover, I conclude that the reduced average waiting time is caused by a reduced average register idle time with the single-line method. Further study is required to determine why the idle time was longer for the single-line method in two of the trials.

Summary Statement

Using a computer simulation, determine which cashier strategy, the multi-line or the single-line method, is more efficient.

Help Received

My father helped with the C# program.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Trevor C. Williams

Project Number
J1422

Project Title
Which Web Browser Is the Fastest?

Abstract

Objectives/Goals
My goal is to recommend the web browser that will change your Internet experience by testing Safari, Google Chrome, and Firefox using online webpage stopwatch to find out which is fastest. This is all tested on the same Internet connection and the same computer to ensure a consistent measurement.

Methods/Materials
I pulled up a website loading timer and typed in the following websites: Google, MSN, New York Times, ESPN, Ebay, Yahoo, Facebook, Twitter, Netflix and Gamefly. Then I opened up Safari, Google Chrome, and Firefox. I tested each of these websites 10 times on each web browser. Then, taking all of the data, I discovered a mean.

Results
The fastest browser was Safari. The second fastest was Google Chrome, then Firefox. My hypothesis that Firefox would be the fastest was not supported based on my test results.

Conclusions/Discussion
All of these browsers have their pros and cons. Google Chrome separates each tab into its own process, making your system safe, but also takes a long time to refresh if you leave a tab idle for too long. Firefox is a speedy browser and has unique features, but does not offer any thumbnail previews or mouse gesture compatibility. Safari has a fast start up and navigation speed, but this browser does not have anti-phishing. Phishing is the activity of defrauding an online account holder of financial information by posing as a legitimate company, so some of the things you might click on might infect your computer. Although an important factor to the browsing experience, I did not test any security related aspects.

Summary Statement
My project is to determine which web browser is fastest by testing Safari, Google Chrome, and Firefox using an online webpage stopwatch and ten different websites.

Help Received
My mom helped with some cutting and gluing on my display board and my dad double checked my data results to make sure they were right (he made no changes).