CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
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Project Number
J1226

Project Title
How Does Particle Density Influence "Monte Carlo" Derivations of Pi?

Abstract

Objectives/Goals
The purpose of my project was to derive the value of PI using the Monte Carlo Effect with particles of different densities, and to determine whether or not the density of the particle affected the accuracy of the derivation. Monte Carlo methods use random numbers instead of predictable algorithms to simulate physical and mathematical relationships.

Methods/Materials
I made a large poster containing a circle (radius = 16 inches) inscribed within a square (side = 32 inches). I randomly distributed a small quantity of one of three particle types (rice, lentils or confetti) on to the circle and square. I then used a ratio of how many particles fell on the circle to how many fell on the whole square (including the circle), and substituted this ratio for what would normally be the ratio of the area of the circle to the area of the square in the formula [(4 x circle area)/square area = PI]. This allowed me to calculate an approximation for PI based on Monte Carlo methods. I repeated this process 45 times for each of the three particle types.

Results
My results showed that the trials performed with rice produced the closest average approximation to PI. Rice was the densest of the three particle types. One thing I noticed while I was filming the trials is that the more dense particles (lentils or rice) fell together and bounced and spread out when they hit the paper, whereas the confetti spread out in the air as it fell.

Conclusions/Discussion
My results somewhat supported my hypothesis because I stated that the more dense the particle is, the more accurate the approximation for PI would be. However, lentils are denser than confetti, and yet confetti produced a more accurate approximation for PI. If I would have performed more trials, my data may have produced a closer approximation for PI no matter what particle I used. The Law of Large Numbers states that the more trials you perform, the closer the experimental ratio will get to the theoretical ratio, which in my experiment was circle area/square area. However, the outcomes of Monte Carlo events in this project were somewhat dependent on particle density.

Summary Statement
In this project I used the Monte Carlo Effect to derive an approximation for PI.

Help Received
My teachers, Mr. Quintrell and Mr. Simonsen, helped edit my report.