CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

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Project Number

S1519

Project Title

What Factors Determine an Eulerian Polygon? A Computer-Inspired Analysis

Abstract

Objectives/Goals

Generalize the Euler Line to non-triangular polygons.

Invent a method to find the special points (while confirming collinearity and 2:1 ratio).

Determine which polygons contain the Euler Line.

Methods/Materials

As an initial platform for gaining insight, we began drawing simple sketches to discover possible ways of defining the special points. After realizing the inaccuracy and inefficiency of this approach, we decided to implement the method of computer inspiration. We wrote a program in Java, and simulated random convex polygons using JavaFX and StdDraw (Standard GUIs in Java). In addition, we used the Java Topology Suite (an open source java software library that assists with computational geometry) to calculate the location and ratio of the special points. This allowed us to maintain precision and efficiently gain insight for analyzing an Eulerian Polygon.

Results

Our new method to find the special points of an Eulerian Polygon resulted in three unique points derived from recursively decomposing the polygon into triangles. Using our induction-based recursive formula, we were able to illustrate which polygons were Eulerian.

Conclusions/Discussion

Ultimately, we were able to find the defining criteria of an Eulerian Polygon. Through recursive decomposition into triangles, we could pinpoint the three unique special points of certain polygons. This inductive proof was inspired and not assisted by the use of a computer program, since the program provided insight into developing a mathematical proof and did not offer parts of the proof itself. Upon developing the Euler sequence, we noticed deep isomorphisms to renowned mathematical wonders such as the Collatz conjecture and Fibonacci Sequence, since both rely on a recursive approach to determine the next element. Though already explored to a certain extent, we also wish to extend our novel ideas into the third dimension and explore its practical relation to origami. We are currently working towards publishing a joint arXiv paper explaining our generalizations and contributions.

Summary Statement

Using computer simulations to provide insight, we generalized the Euler Line to all polygons, and discovered a recursive method based on inductive reasoning to determine which polygons are Eulerian.

Help Received

No outside help. From developing our research idea to making our conclusion, all work was collaboratively accomplished between us. During our research, however, we reviewed several online mathematical articles to comprehend existing work.