

Order-of-Magnitude Estimation Colonizing the Galaxy (Level 3)

The Question

How long will it take an intelligent civilization to colonize the Galaxy?

Background

Our Galaxy is a disk made up of a few hundred billion stars, many of them like our Sun (roughly a “typical” star, but not quite). Many, if not most of these, have planetary systems of their own that might be colonized (or already host life!). If an intelligent species develops the means to travel at 10% of the speed of light, how long will it take to colonize systems on the other side of the Galactic disk?

We won’t do it here, but one can prove that the “root-mean-squared” distance traveled when taking random steps is proportional to the step size and the square-root of the number of steps. Mathematically, $d_{\text{tot}} \sim d_{\text{step}}\sqrt{N}$.

The Solution

Education Standards

This OoM Estimation problems meets the following standards in **bold**:
Next Generation Science Standards (NGSS):

- Physical Sciences
 - **Matter & Its Interactions**
 - Motion and Stability: Forces and Interactions
 - **Energy**
 - Waves and Their Applications in Technologies for Information Transfer
- Life Sciences
 - From Molecules to Organisms: Structures and Processes
 - **Ecosystems: Interactions, Energy, and Dynamics**
 - Heredity: Inheritance and Variation of Traits
 - Biological Evolution: Unity and Diversity
- Earth and Space Sciences
 - **Earth's Place in the Universe**
 - Earth's Systems
 - Earth and Human Activity
- Engineering, Technology, and Applications of Science
 - Engineering Design

Common Core Standards (CSS):

- **Counting & Cardinality**
- **Operations & Algebraic Thinking**
- **Numbers & Operations in Base Ten**
- **Number & Operations — Fractions**
- Measurement & Data
- **Geometry**
- **Ratios & Proportional Relationships**
- The Number System
- **Expressions & Equations**
- Functions
- **Statistics & Probability**