Thesis Project Portfolio

Visualizing Complex-Valued Functions with GPU Computing

(Technical Report)

Infinite Controversy: Reactions to Cantor's Theory

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Elijah Maxwell Kin

Spring, 2024

Department of Computer Science

Table of Contents

Sociotechnical Synthesis

Visualizing Complex-Valued Functions with GPU Computing

Infinite Controversy: Reactions to Cantor's Theory

Prospectus

Sociotechnical Synthesis

The technical component of this thesis project discusses techniques for visualizing complex-valued functions, and their implementations on GPU hardware. Such visualizations hold pedagogical value for those trying to understand the behavior of a complex-valued function, for example, in identifying the locations of its zeros and poles. The benefit of a GPU implementation is that one can generate visualizations possibly hundreds of times faster than a traditional CPU implementation.

The STS component of this thesis project examines the reactions to Georg Cantor's theory of sets, particularly concerning infinity and his diagonal argument suggesting the distinction between countable and uncountable infinity. For background context, we first introduce Cantor's theory of sets, surjections, and cardinalities, and then outline his famous diagonal argument. While generally accepted today, Cantor's ideas were hotly debated by his late 19th century contemporaries. Bertrand Russell described Cantor as "one of the greatest intellects of the nineteenth century," while Henri Poincaré called his work "a grave mathematical malady, a perverse pathological illness that would one day be cured" (Dauben, 1990).

In general, the formalist school of mathematics responded favorably to Cantor's theory, while the pre-intuitionists staunchly rejected it. We discuss the historical reasons for these differing reactions including religion, the Aristotelian distinction between *potential* and *actual* infinity, objections to proof by contradiction, and opposing views on the nature and purpose of mathematics. Finally, we analyze how the sentiment towards Cantor's theory has evolved over time; set theory is a foundational pillar of mathematics today. We attempt to answer the question of how this came to be, and offer explanations including the rise of secularism, and a general trend toward the idea that mathematics need not be representative of reality.