Unlocking Ancient Secrets with Modern Mathematics: The Vesuvius Challenge

Option for a Master Thesis

February 7, 2025

Introduction

In 79 CE, the eruption of Mount Vesuvius destroyed the city of Herculaneum. The Villa of the Papyri (considered to be one of the most luxurious houses in all the Roman world, was perhaps owned by Julius Caesar's father-in-law) with an extensive library of papyrus scrolls, was buried under a thick layer of ash and lava. The scrolls, charred and deformed by high temperatures, nevertheless survived, but for a long time they were inaccessible for study due to their fragility and the risk of destruction when physically unrolled. With the development of technology, it became possible to virtually unroll the scrolls and restore the texts they contain. Using computer tomography and special algorithms, a 3D model of the scroll is first created, and then it is unrolled layer by layer.

In this regard, in 2023, the **Vesuvius Challenge** competition was launched, the goal of which is to develop algorithms for recognizing texts on damaged and deformed scroll surfaces. Within a year, five percents of the text on 1 (out of 1800) of the scrolls was deciphered using machine learning methods. However, the competition continues with the goal of deciphering at least one scroll in its entirety.

As a student of **Ulm University**, you have the opportunity to explore cutting-edge methods and propose novel ideas, particularly from **stochastic geometry**, to contribute to this fascinating interdisciplinary field.

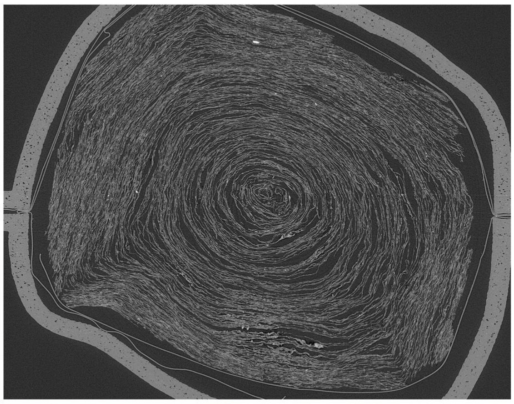

Figure 1: The carbonized Herculaneum Scrolls recovered from the 79 AD eruption of Mount Vesuvius [scrollprize.org].

Current Winning Methods

Recent breakthroughs have involved:

- "CT Scanning and Synchrotron Imaging" — High-resolution X-ray scans revealing hidden structures.
- "Machine Learning and AI" — Recognizing patterns in the scrolls using deep learning models.
- "Digital Unwrapping" — Computationally unfolding the scrolls without physically opening them.

How Stochastic Geometry Can Help

Stochastic Geometry (together with Machine Learning approaches) provides tools for modeling and analyzing "random spatial structures", such as, for example, cracks in concrete. Potential applications to the Vesuvius Challenge include:

- "Modeling Papyrus Fiber Patterns" — Identifying underlying geometries of rolled layers.
- "Probabilistic Ink Detection" — Developing statistical models to locate ink traces amidst noise.
- "3D Reconstruction Improvements" — Using geometric probability to enhance digital unwrapping techniques.

Join Us!

We invite interested students from Ulm University

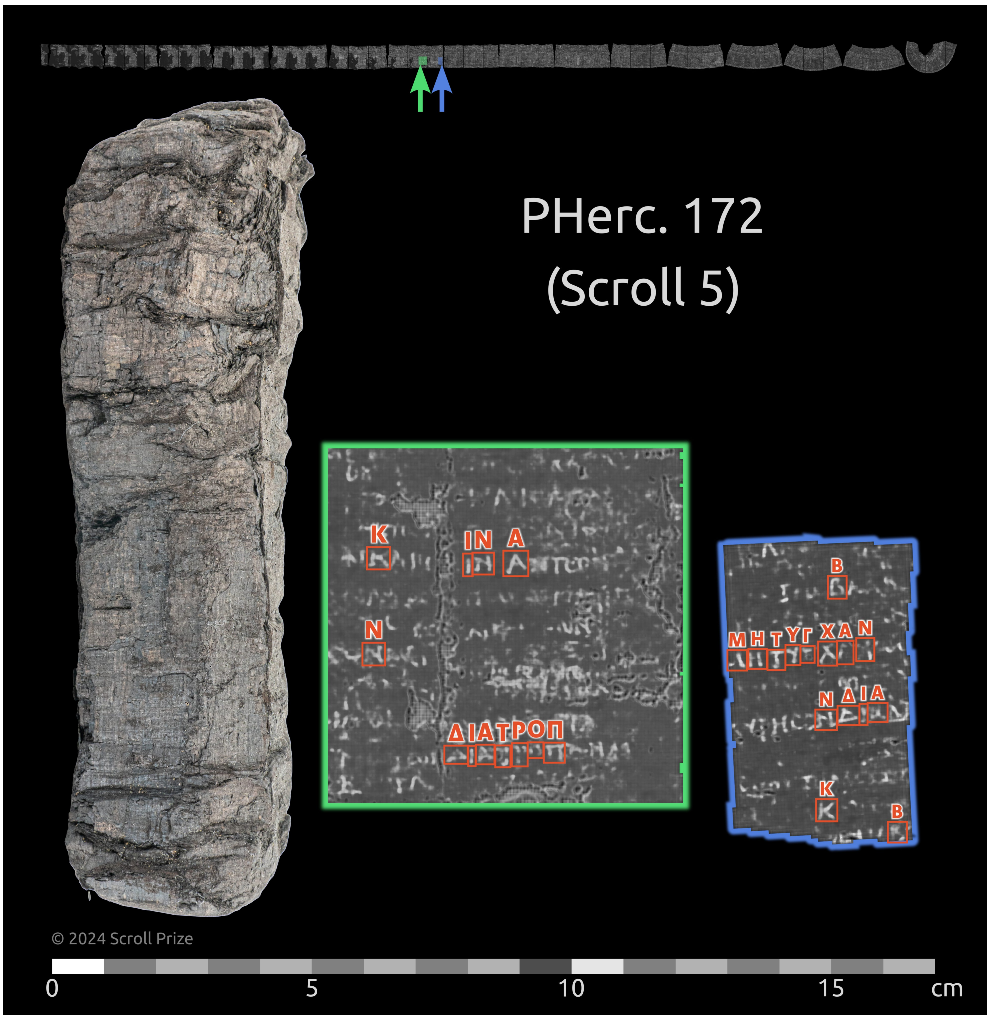

Figure 2: Example of a text extraction, [scrollprize.org].

Contacts and Further Information

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Let's unravel the past with the power of mathematics!