

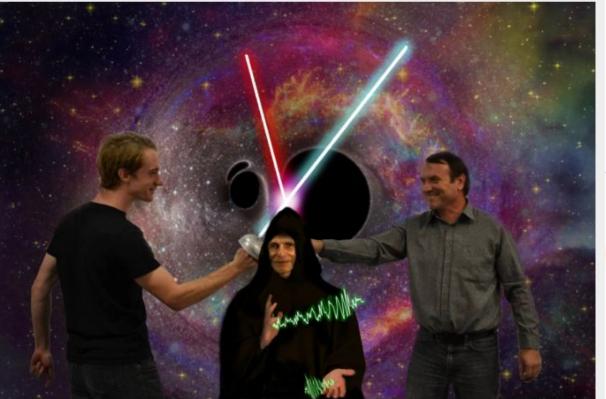
Classical and

PAPER

Spectral C gravitation

Casey J Handmer Published 21 Octob Classical and Quant

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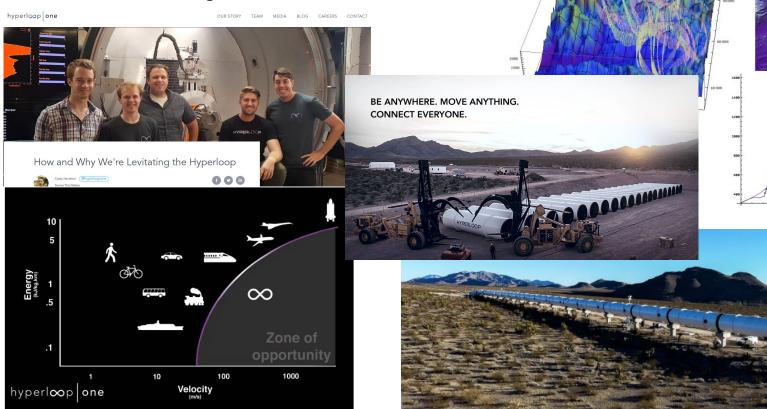


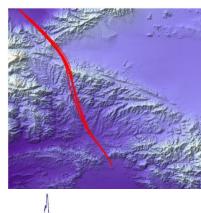
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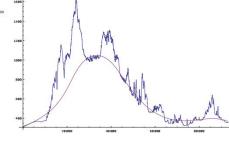
Casey Handmer (Caltech), Bela Szilagyi (JPL) and Jeffrey Winicour (Pittsburg) reprise their former stance discussing asymptotically time-like inertial scri+ foliations, now with even better CGI. Image credit: Photo manipulation by Annie Handmer, background image by SXS Collaboration: Andy Bohn *et al* 2015 Class. Quantum Grav. **32** 065002.

Hyperloop One

Levitation Engineer

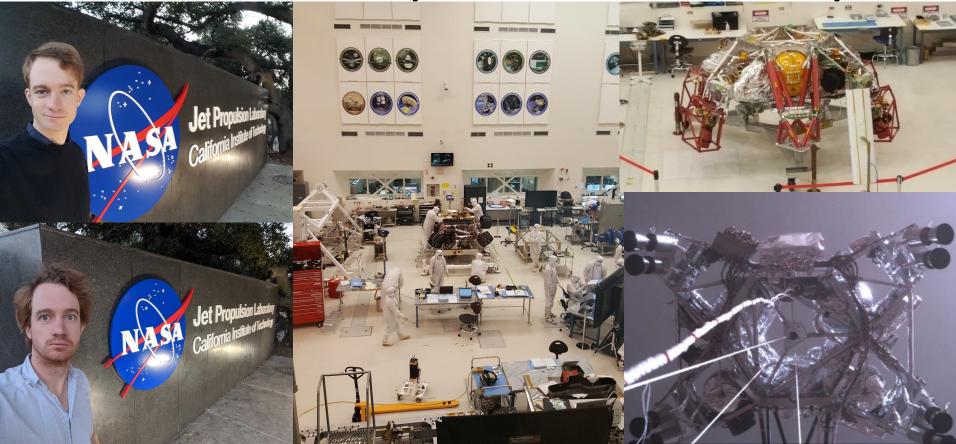




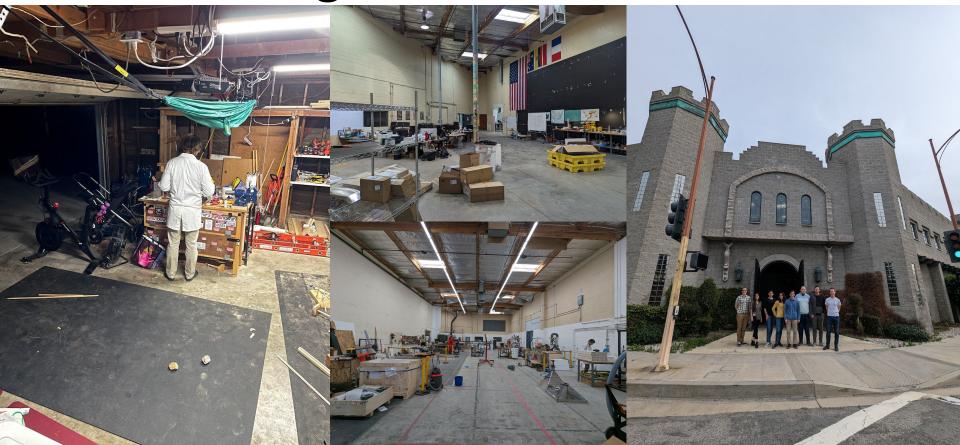




NASA Jet Propulsion Laboratory



Founding Terraform Industries







Vesuvius Challenge

Background

2023 Grand Prize Awarded

Overview

2024 Prizes

The Master Plan

Prize Winners

Community Projects

Data

Scrolls

Fragments

Segments

Tutorials

- 1. Technical Overview
- 2. Scanning
- 3. Segmentation and Flattening
- 4. Ink Detection

FAQ

History

Livestreams

Resurrect an ancient library from the ashes of a volcano.

Win Prizes. Make History.

The Vesuvius Challenge is a machine learning and computer vision competition that in 2023 cracked the riddle of the Herculaneum Papyri & awarded over \$1,000,000 in prizes.

2024's challenge is to go from reading a few passages to entire scrolls.

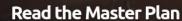
\$500,000+ in New Prizes

MORE INFORMATION →

Not a ser tall Trust 201

TEINGUNITUM CAMPON



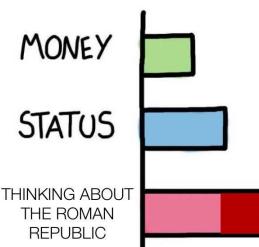






WHAT GIVES PEOPLE FEELINGS OF POWER

@iamnotan



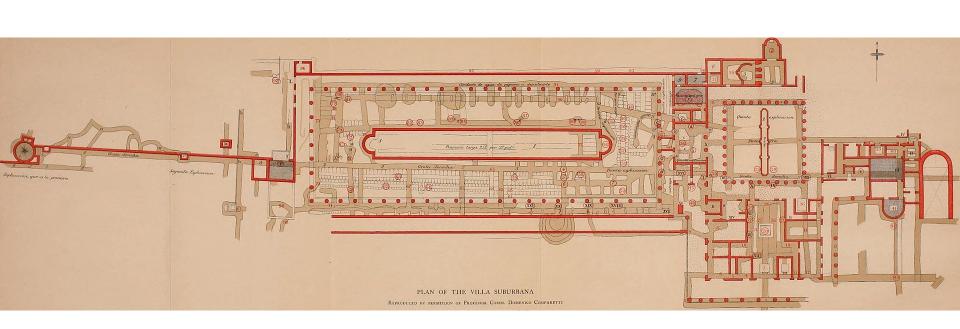












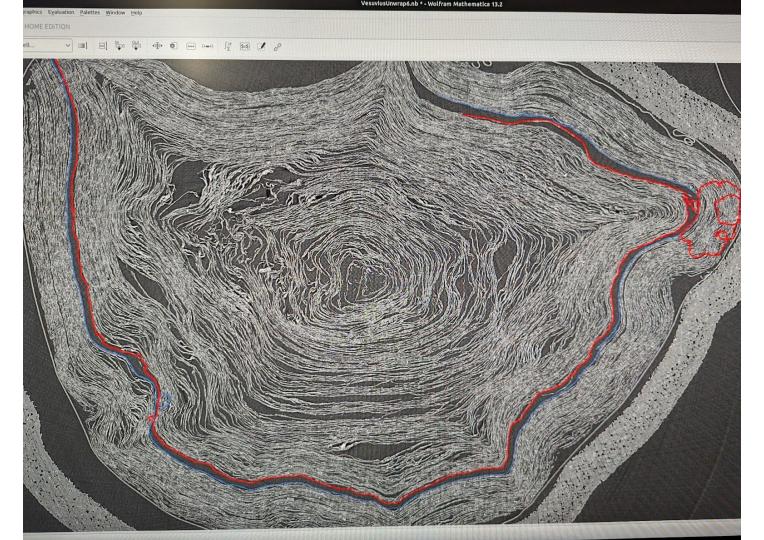












Businessweek Can Al Unlock the Secrets of the Ancient World? Almost 2,000 years ago, a volcano preserved Herculaneum's vast library of scrolls but left them unreadable. A volunteer army of nerds has been racing to decipher them. By Ashlee Vance and Ellen Huet February 5, 2024, 9:00 AM UTC The early months were a slog of splotchy images. Then Casey Handmer, an Australian mathematician, physicist and polymath, scored a point for humankind by beating the computers to the first major breakthrough. Handmer took a few stabs at writing scroll-reading code, but he soon concluded he might have better luck if he just stared at the images for a really long time. Eventually he began to notice what he and the other contestants have come to call "crackle," a faint pattern of cracks and lines on the page that resembles what you might see in the mud of a dried-out lakebed. To Handmer's eyes, the crackle seemed to have the shape of Greek letters and the blobs and strokes that accompany handwritten ink. He says he believes it to be dried-out ink that's lifted up from the surface of the page.

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Youssef Nader Luke Farritor

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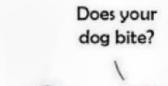
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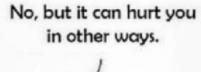


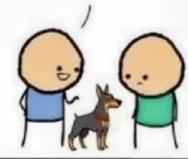


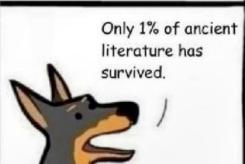


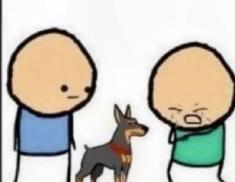






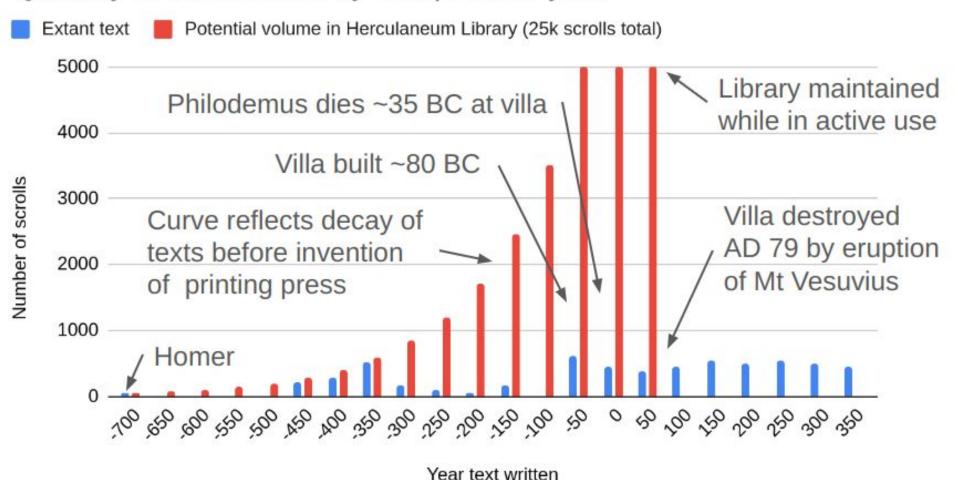








Quantity of ancient text by composition year







Vesuvius Challenge Grand Prize







Youssef Nader, Luke Farritor, and Julian Schilliger



ETH ZUrich Robotics X35L Robotic Systems Lab

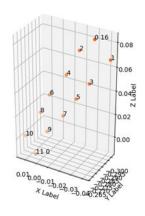


















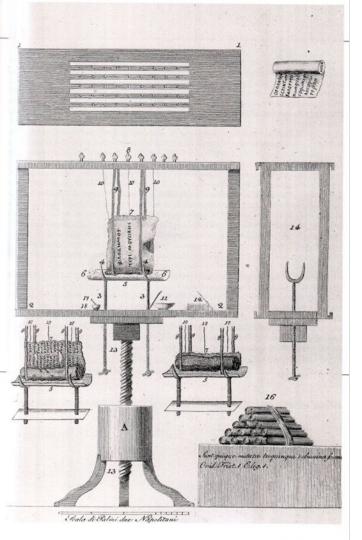
www.floatingrobotics.com



Technical Challenges

Unroll Scroll

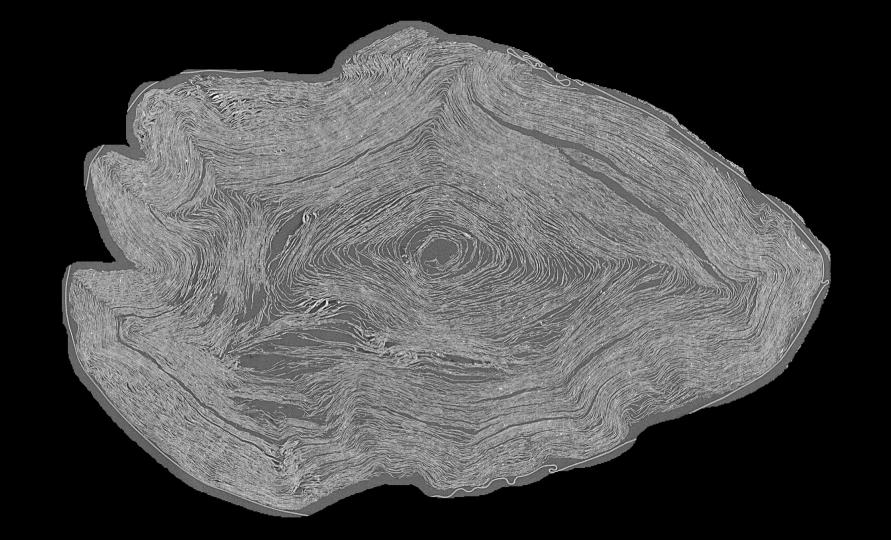
Ink Detection

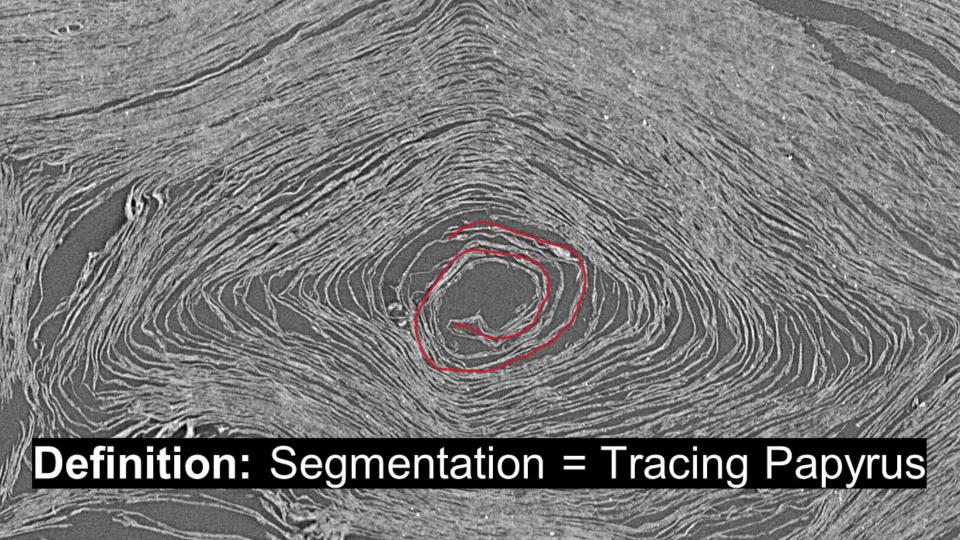


Piaggio's Machine

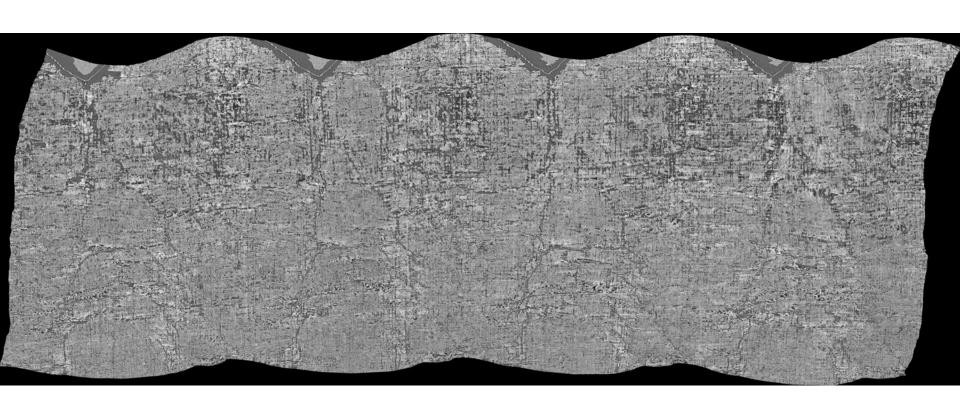








Rendering

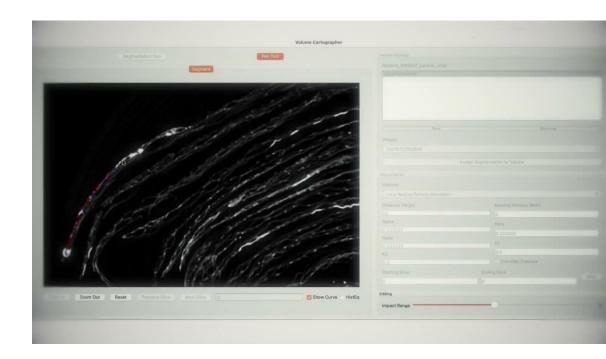




Previous Tool

Volume Cartographer (VC)

- Clunky
- Slow
- Crashed often
- Extremely small segments



Optical Flow Segmentation (OFS)

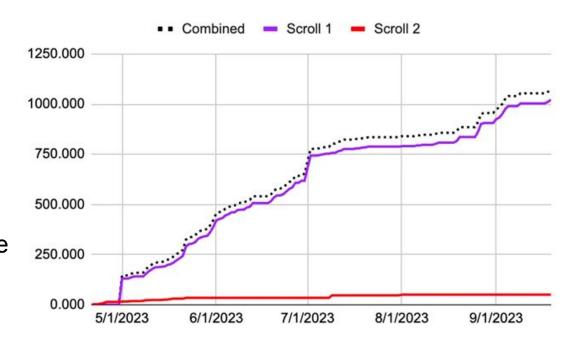
- Video = 3D Scroll Volume
- Movement of pixels = sheet
- "Magic" Sauce
- Testing, testing, testing ...



PHerc.Paris. 4

Reason for VC+OFS Success

- Interesting Problem
- VC was used before
- Developed in the open
- Feedback from users
- Fast iteration cycles
- Area Segmented = Performance



Result: 10'000x Improvement

Segmentation

- Tracing the papyrus cost ~\$100/ sqcm in 2023
- \$2-3M per scroll
- We have 400-800 scrolls
- Estimated cost: 3 Colosseums



Where did the money come from to finance the building

...

Good question. It has been estimated that the building took about \$670 million to build. Take that estimate with a grain of salt, ...



ThaumatoAnakalyptor

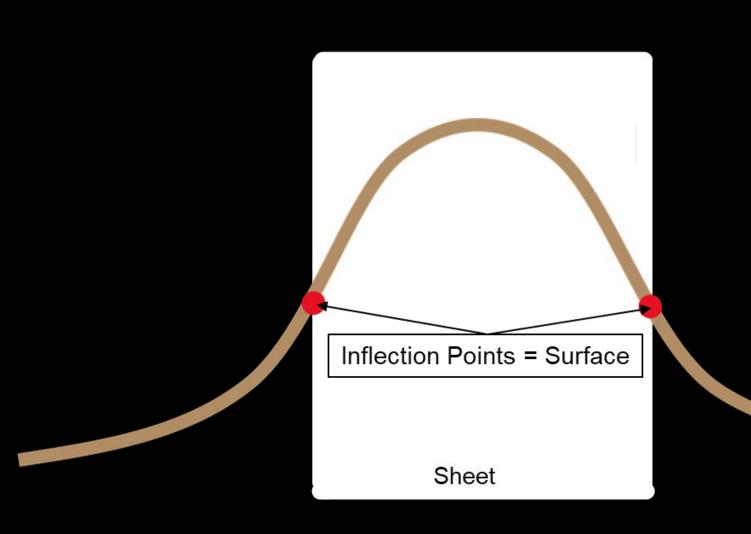
- Goal: Segmentation at scale
- Define smaller subproblems
- Focus on
 - Generalization
 - Abstraction
 - Automation



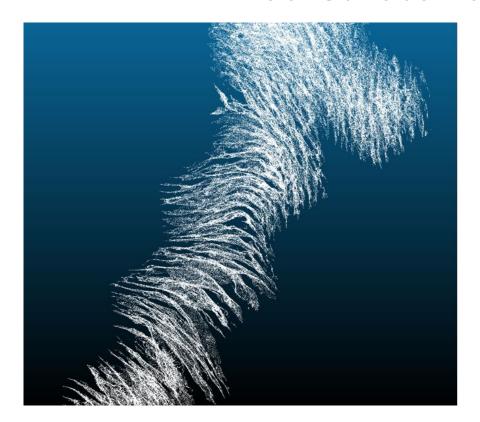
Pipeline Steps

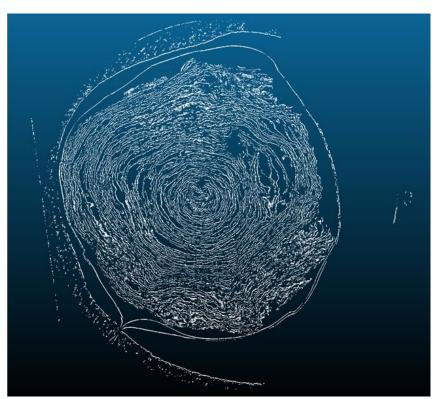
- Extract 3D Surface Points
- Point Connectivity
- Meshing + Flattening



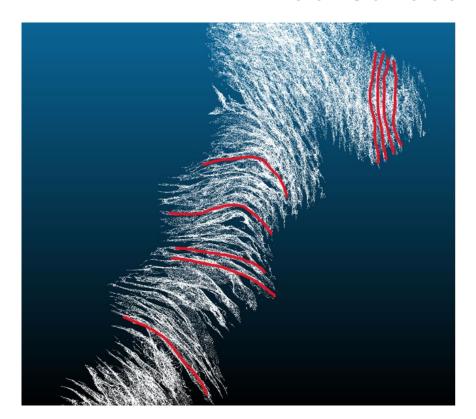


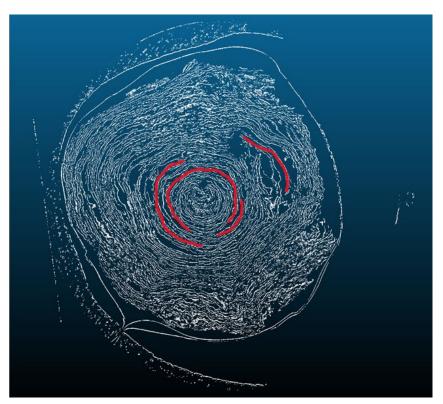
Extract Surface Points - PointCloud



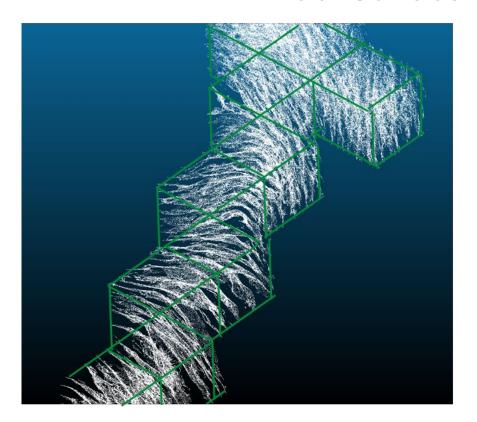


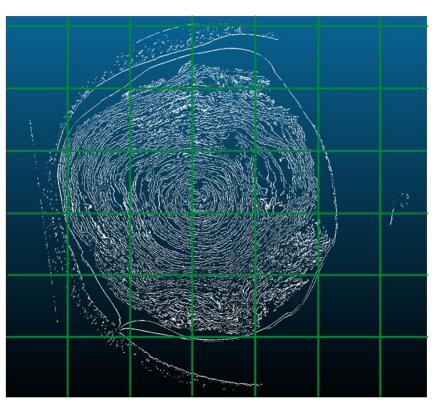
Extract Surface Points - Sheets





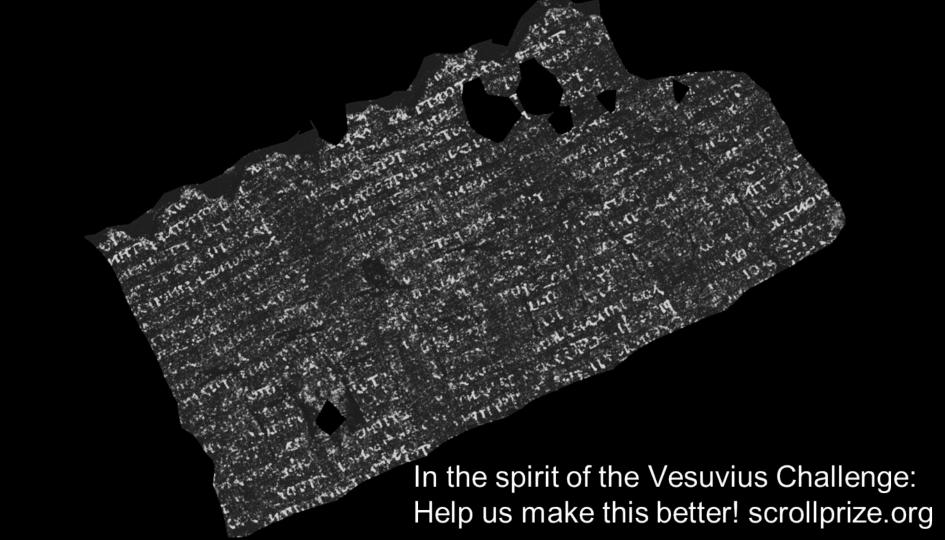
Extract Surface Points - Blocks





PointCloud Connectivity

- First: PointCloud Instance Segmentation
- Second: Stitch Instances to Sheet
- Minimum Feedback Arc Set Problem
- General NP hard
- Our case???
- Randomized Algorithms



Introduction

Youssef Nader

Bsc Communication and Computer Engineering Cairo University

Msc Data Science Freie Universitaet

Currently PhD student at Prof. Tim Landgraf's Lab



Work Interests: Machine learning|XAI and interpretability|Self-supervised Learning

How I got involved?



Vesuvius Challenge - Ink Detection

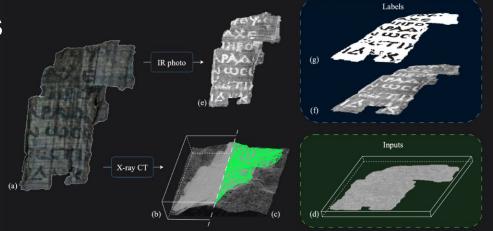
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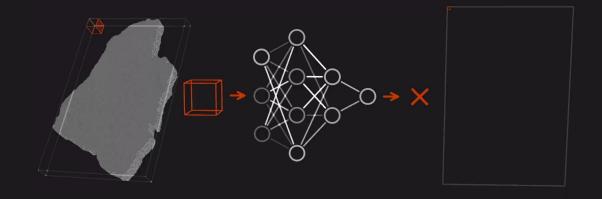
Reward: **\$1,000,000**

1,249 teams

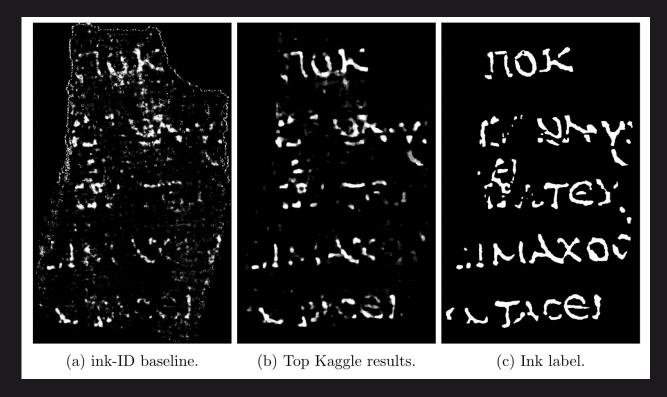
Ink Detection in 3d Images

The flattened and unwrapped segment is turned into a stack of 2D images where ink detection is possible





Kaggle ink detection Progress

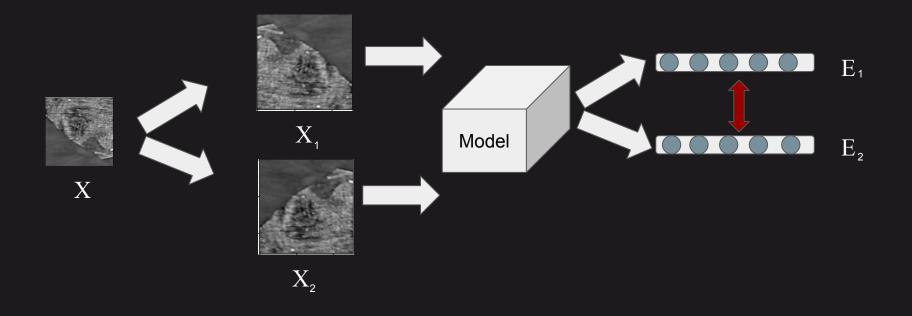


Hard-Hearted Scrolls: A Noninvasive Method for Reading the Herculaneum Papyri https://uknowledge.uky.edu/cs_etds/138/

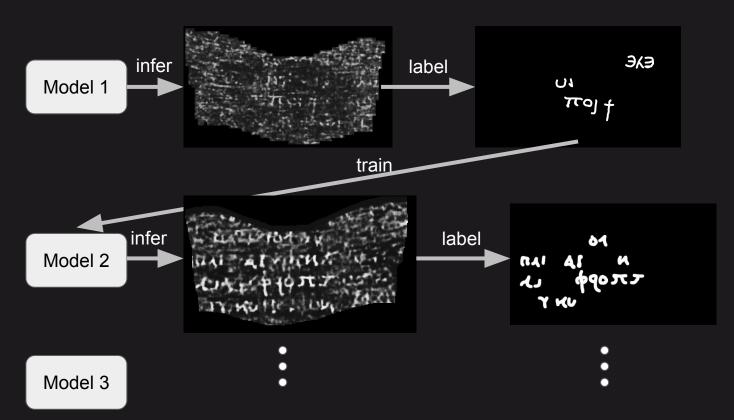
Ink Detection Follow Up Solution



Self-Supervised Learning on Scrolls



Pseudo-labeling Process



How to prevent overfitting?

- 1- Smaller models
- 2- High Label Smoothing
- 3- Balancing the dataset
- 4- heavy augmentations

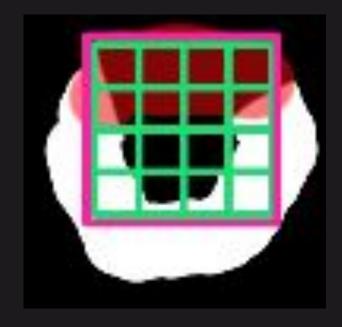
Give the model some wiggle room to make mistakes

High Label Smoothing

Mistakes can happen during labeling (false positives/negatives)

Models should not be heavily penalized when they make a mistake

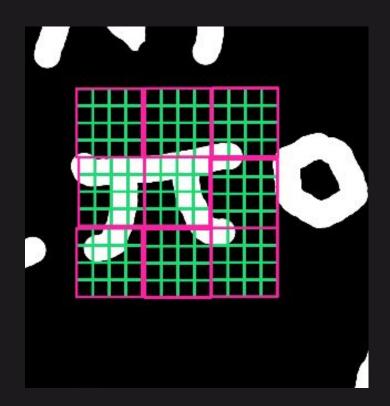
Label smoothing: turn 1-0 probabilities into softer probabilities eg. 0.875-0.125



Balancing the dataset

Sample windows around the letter

Balance the dataset with negative samples

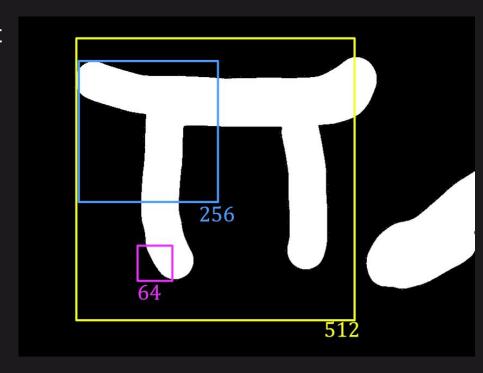


Choosing The Window Size

Larger window sizes have the full context of the letter

The model learns and is able to match the label stroke

Smaller windows mitigate hallucination and preserve stroke shape



First Letters Prize



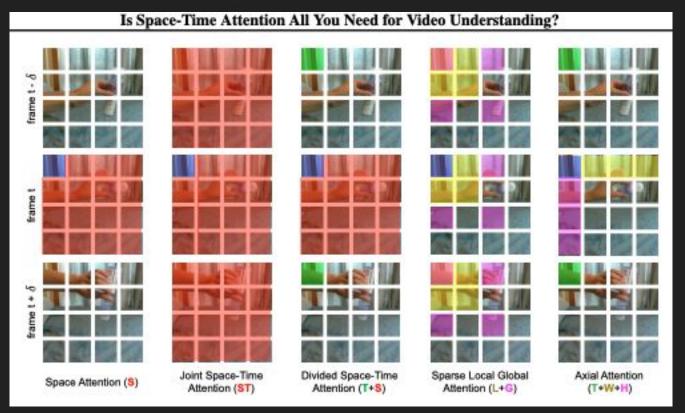
Scaling up to the Grand Prize

- The Grand Prize solution was about perfecting the First Letters approach
- Explores two main fronts:
 - 1- How to get as much quality data as possible?
 - 2- How to train models to make the most out of the available data?

Scaling up the Data

- More than 15 pseudo-labeling rounds between first letters and Grand Prize
- Exploring labeling techniques, data quality effects
- Conclusion: Quality and Diversity >>> Quantity

Scaling the models, Why timesformer?



Source: Is Space-Time Attention All You Need For Video Understanding? https://arxiv.org/pdf/2102.05095.pdf



"...have nothing to say about pleasure, either in general or in particular, when it is a question of definition." -Philodemus

Thank You!