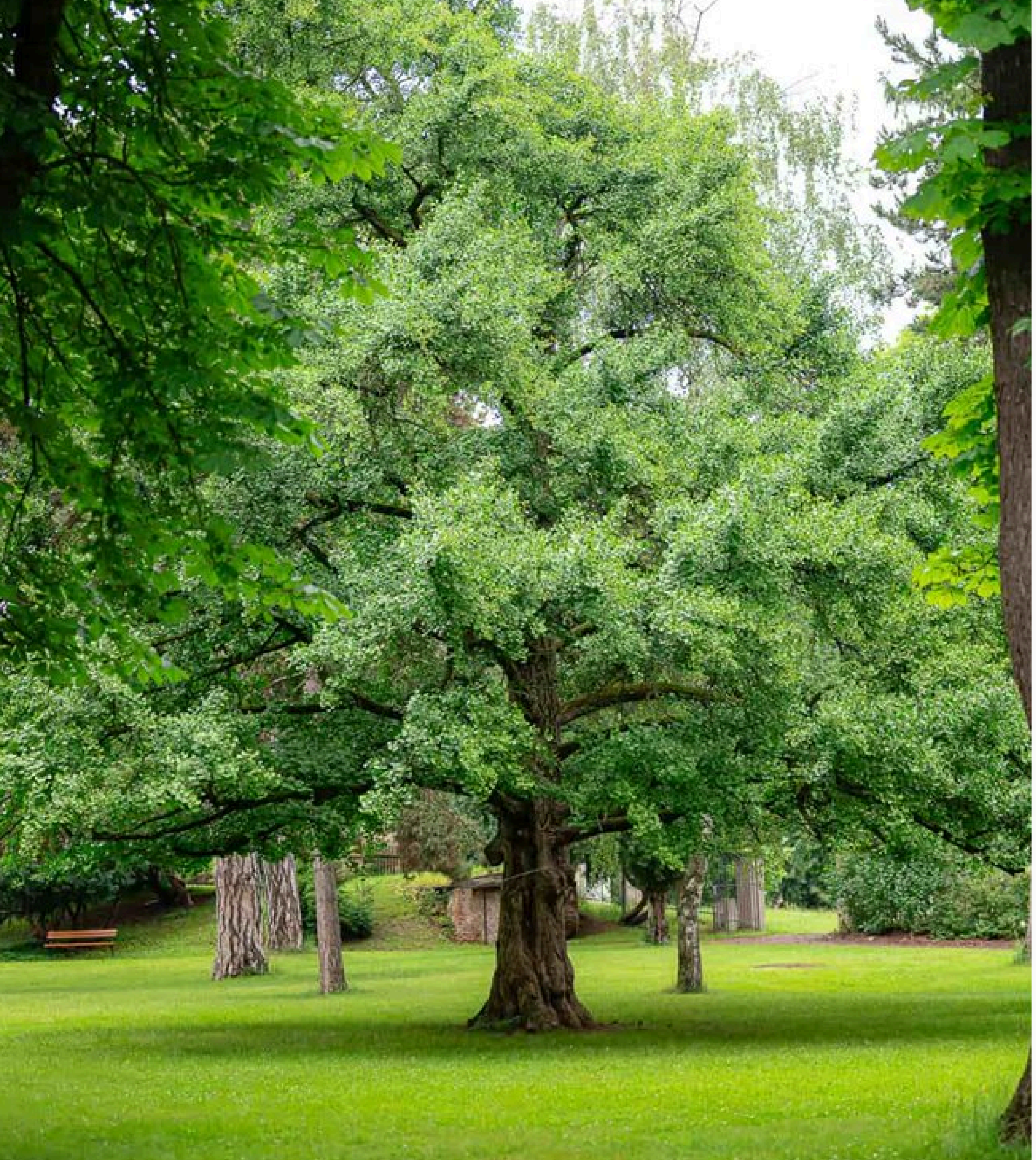

When acoustic tomography meets resistograph

Robert Mařík & Valentino Cristini

Mendel University in Brno

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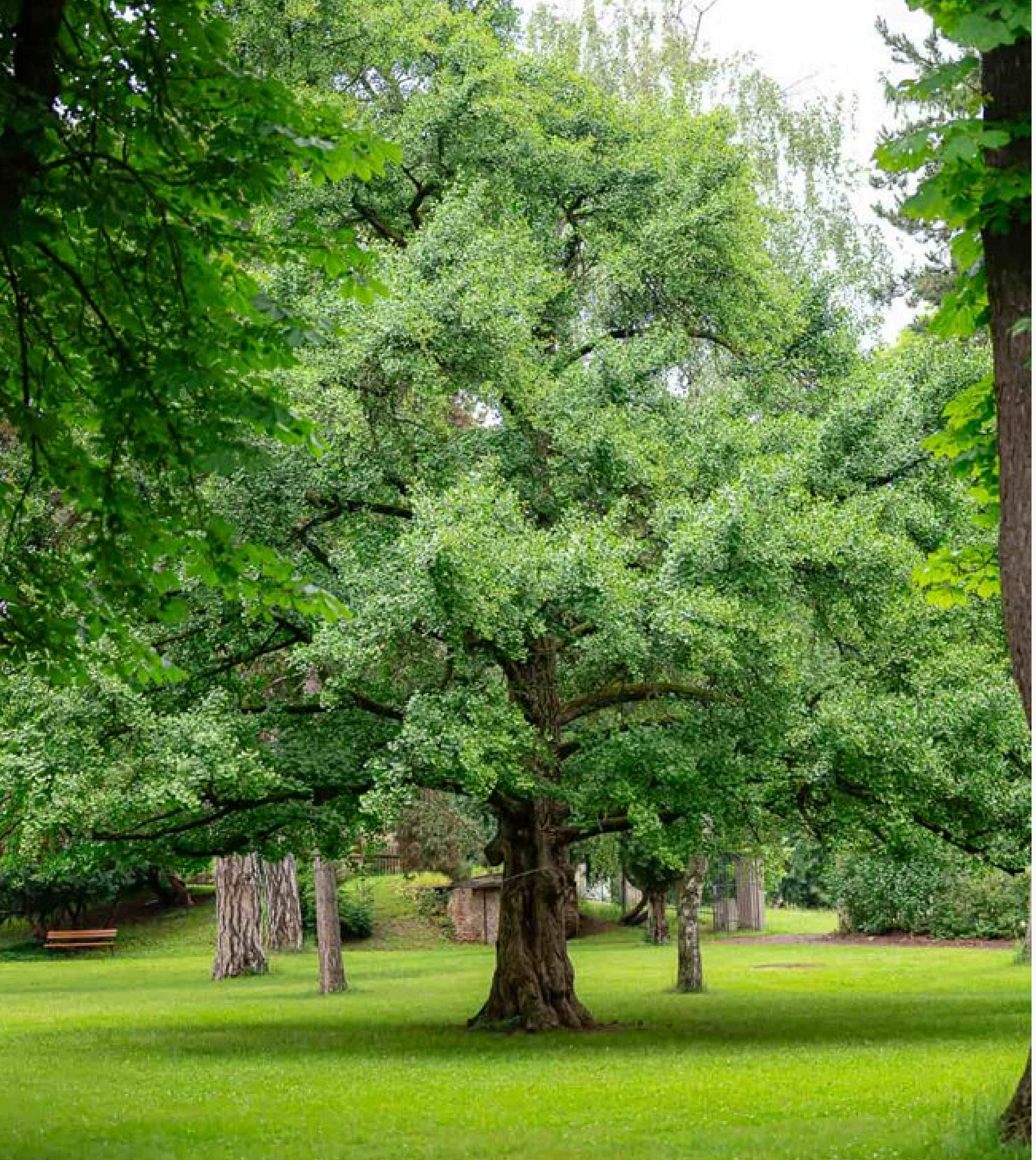
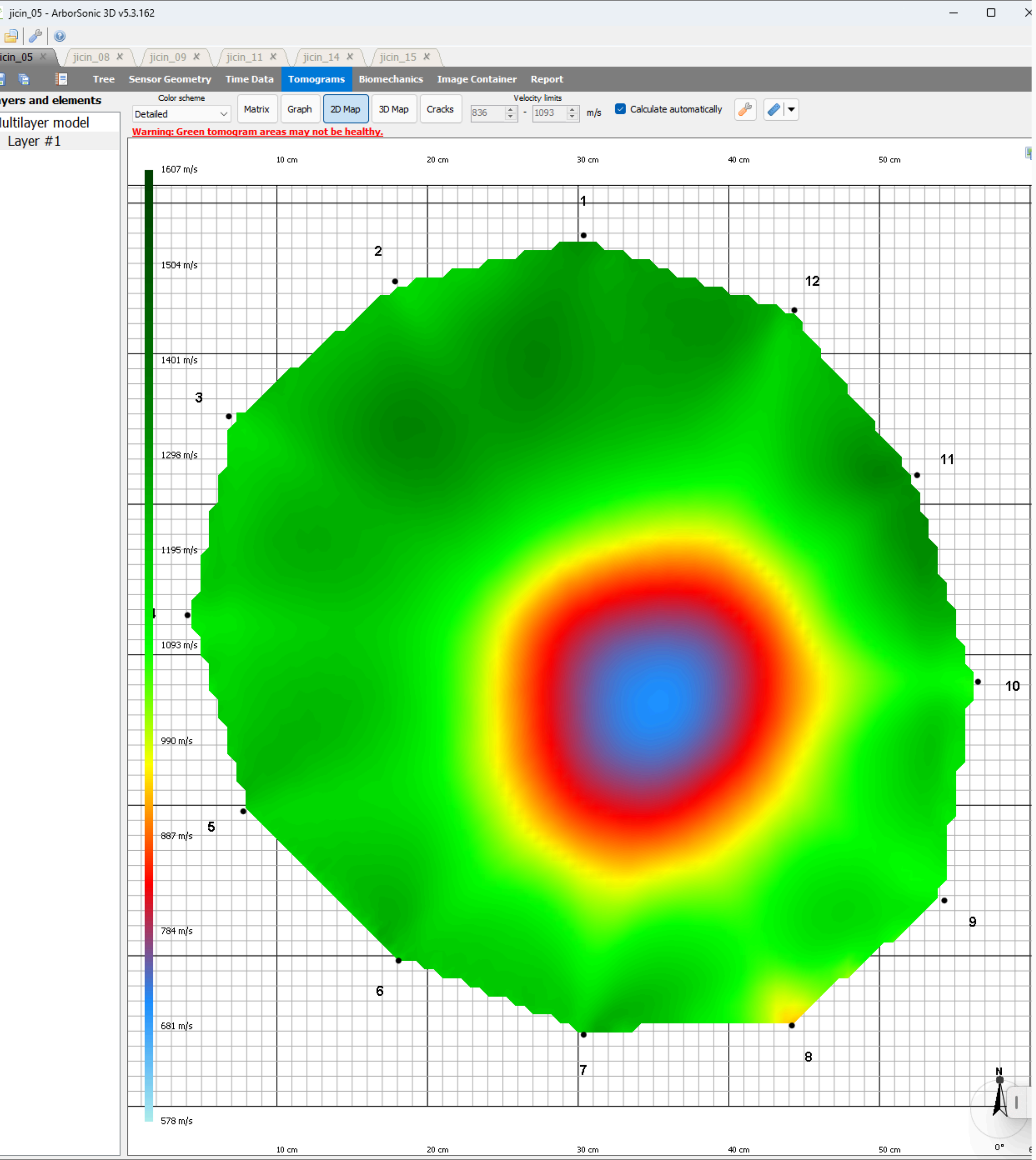


Content of the talk

- Tomograph and resistograph: strengths and limitations
- Combined approach: a Python library for simultaneous interpretation
- Vibe coding (ChatGPT)
- Code containerization (Docker)



Acoustic tomograph

- Tool for fast stem inspection
- Provides **global information** across the whole cross section
- Green part - high sound speed value - sound wood
- Shows size and shape of internal defects

- Limited by long wavelength and small number of rays for reconstruction
- Cracks are reported as cavities

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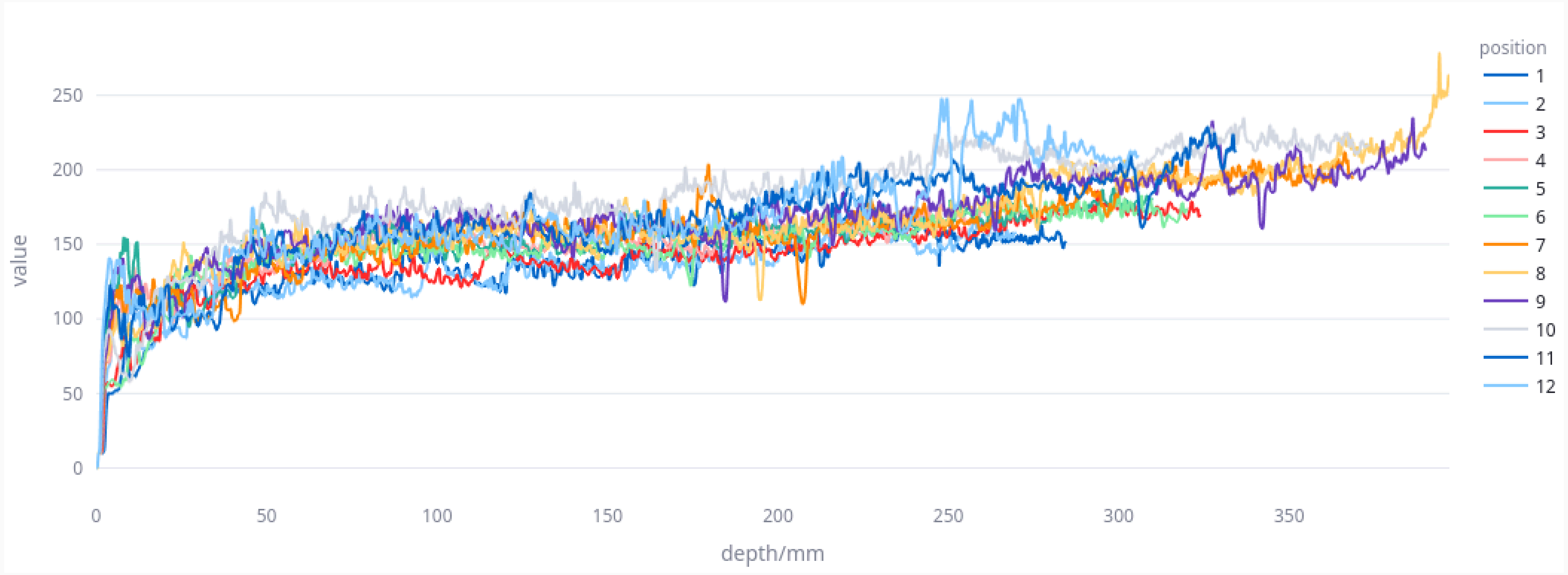
Resistograph

- Measures the power required for microdrilling at a fixed speed
- Provides **local** mechanical properties of the material
- Note short(!) valleys: the central cavity hypotheses is not accepted
- Projection of the data to the stem cross section would reveal details of the defect



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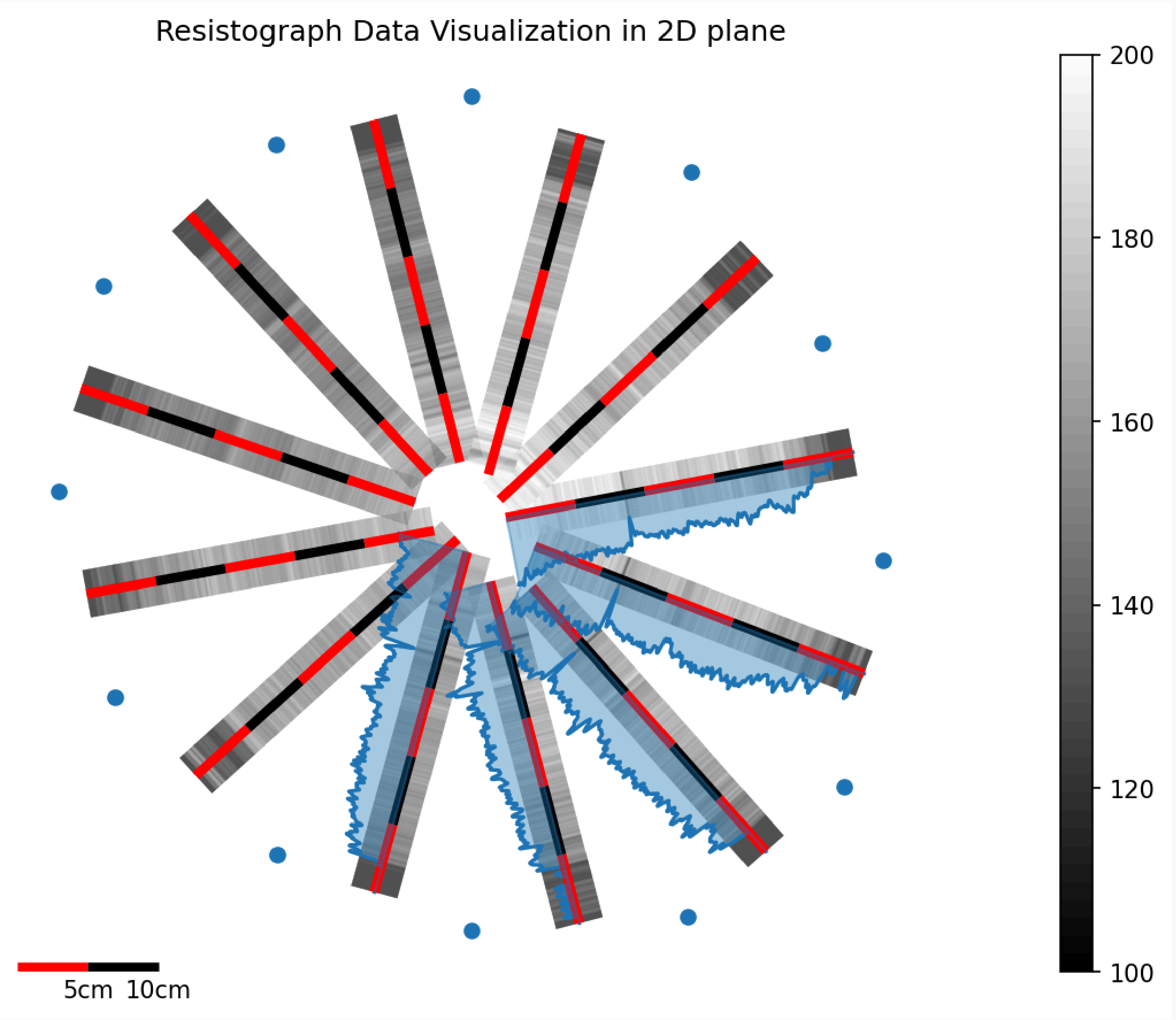

Data in cross section geometry

- Transform resistograph data into 2D cross-section geometry
- Two types of visualization
  - curves
  - color scale
- Written as Python library
- Published on GitHub

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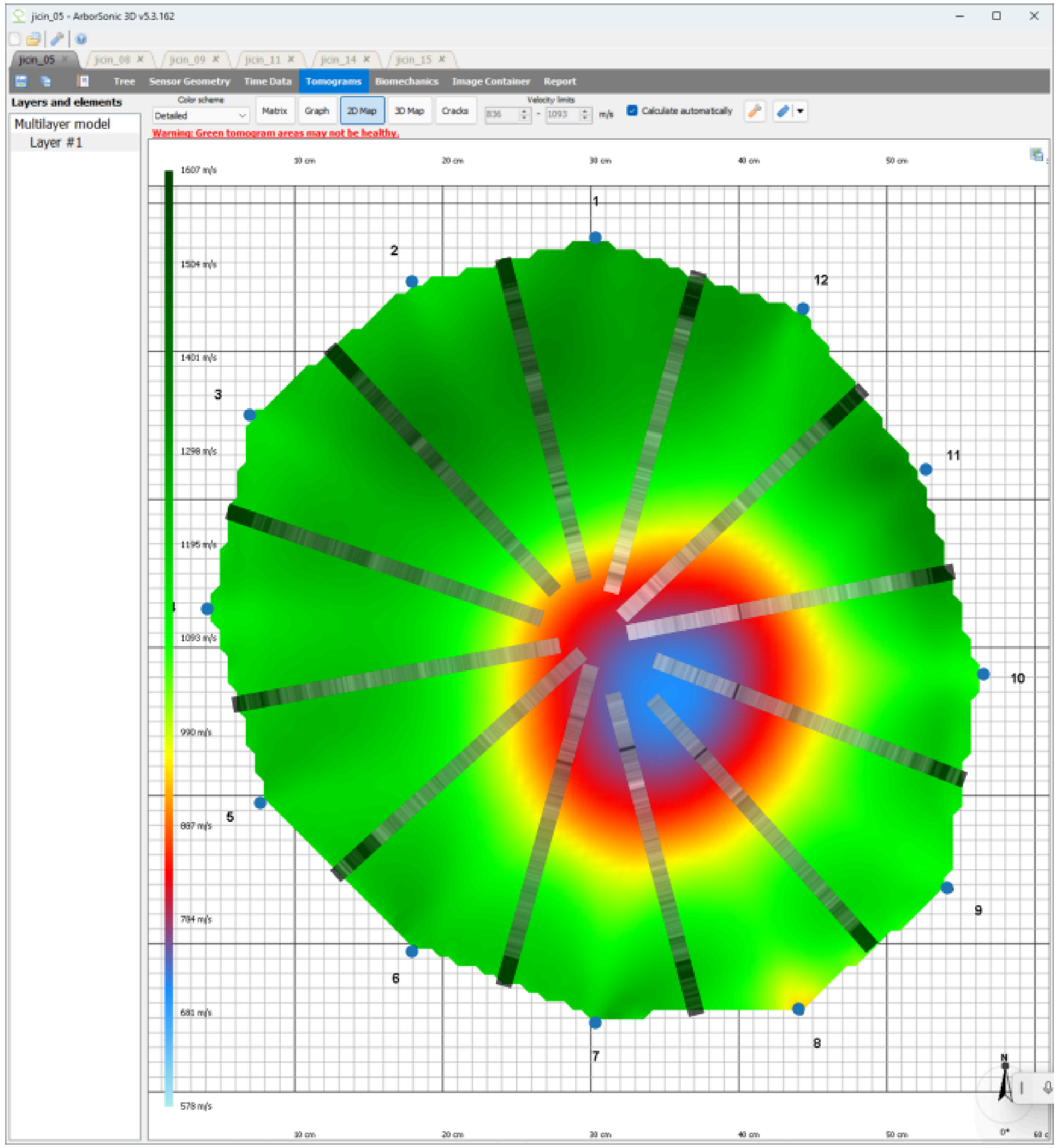

Color scheme: Detailed
Velocity limits: 836 - 1093 m/s
☑ Calculate automatically

Warning: Green tomogram areas may not be healthy.

Merge data

- Resistograph data in a tomogram
- Increases the accuracy of data interpretation
- The dark strips allow to localize the defect
- In our case the hypotheses have been confirmed by detailed inspection after felling the tree

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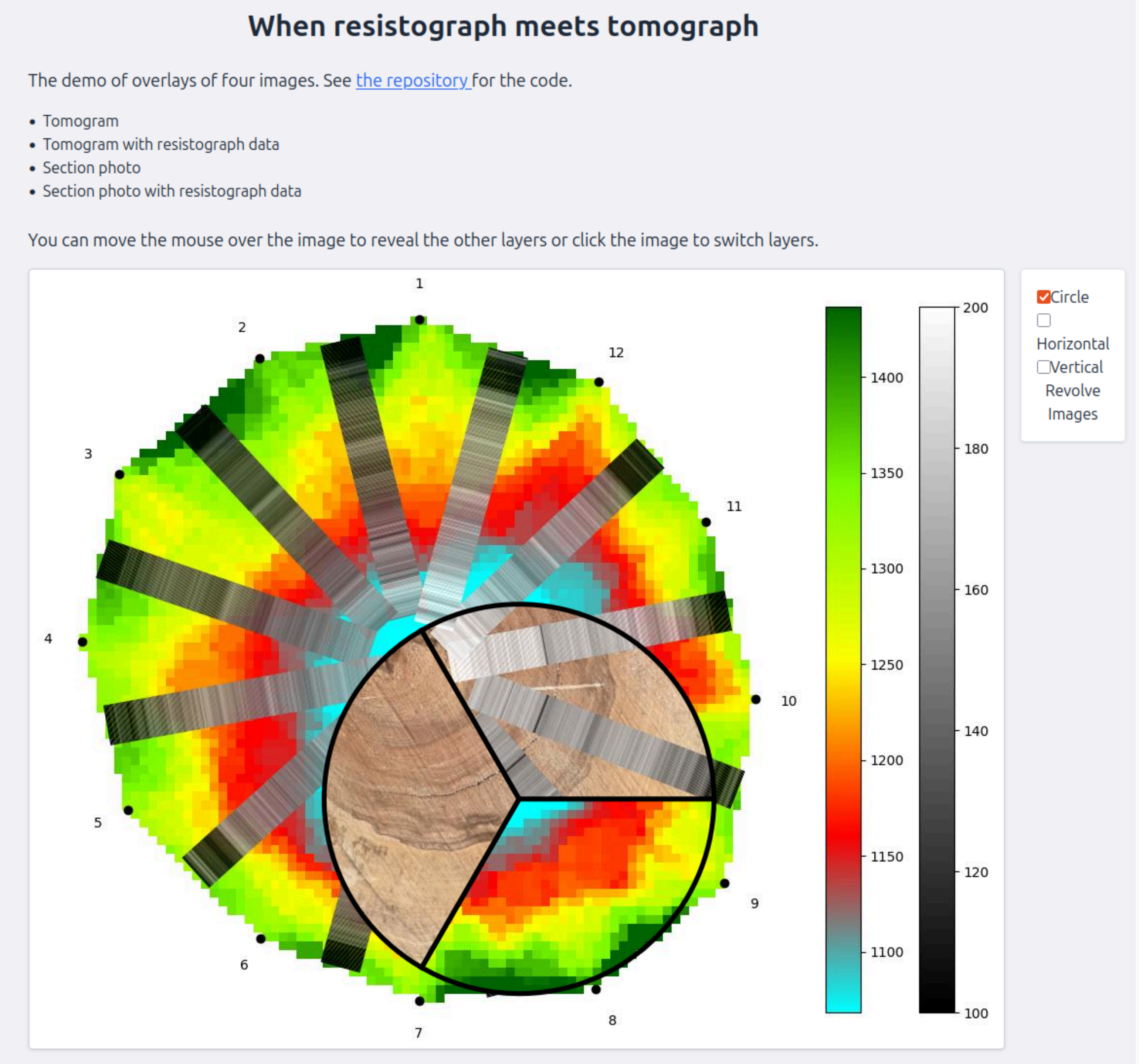

When resistograph meets tomograph

The demo of overlays of four images. See the repository for the code.

- Tomogram
- Tomogram with resistograph data
- Section photo
- Section photo with resistograph data

You can move the mouse over the image to reveal the other layers or click the image to switch layers.

Python library

Advantages

- Python is widely used in scientific data processing
- Easy automation, scaling, modification, sharing, and reuse
- Simple integration with other tools

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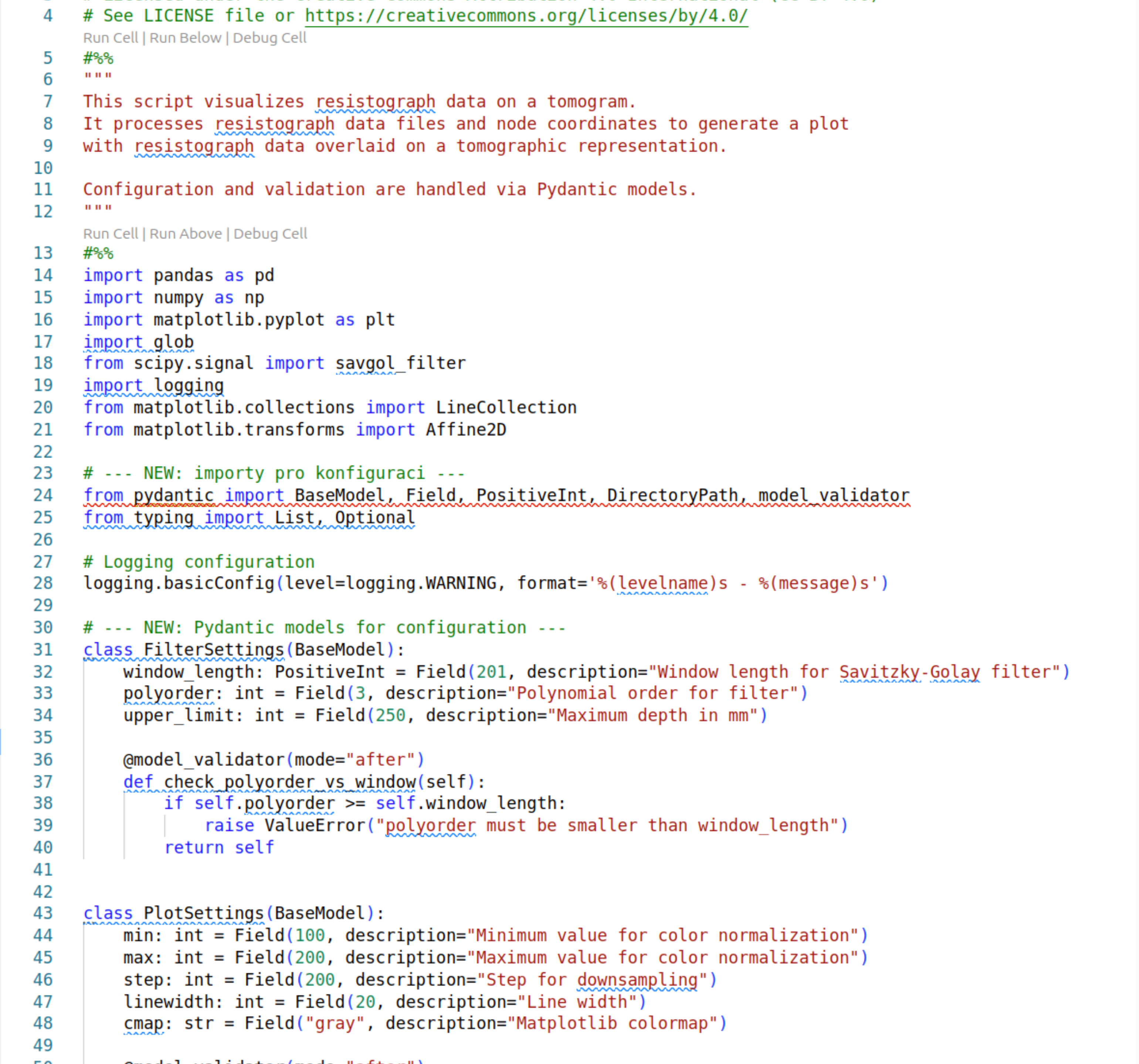
Run Cell | Run Below | Debug Cell
Run Cell | Run Above | Debug Cell

```python
# See LICENSE file or https://creativecommons.org/licenses/by/4.0/
#%%
"""
This script visualizes resistograph data on a tomogram.
It processes resistograph data files and node coordinates to generate a plot
with resistograph data overlaid on a tomographic representation.

Configuration and validation are handled via Pydantic models.
"""
#%%
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import glob
from scipy.signal import savgol_filter
import logging
from matplotlib.collections import LineCollection
from matplotlib.transforms import Affine2D

# --- NEW: importy pro konfiguraci ---
from pydantic import BaseModel, Field, PositiveInt, DirectoryPath, model_validator
from typing import List, Optional

# Logging configuration
logging.basicConfig(level=logging.WARNING, format='%(levelname)s - %(message)s')

# --- NEW: Pydantic models for configuration ---
class FilterSettings(BaseModel):
    window_length: PositiveInt = Field(201, description="Window length for Savitzky-Golay filter")
    polyorder: int = Field(3, description="Polynomial order for filter")
    upper_limit: int = Field(250, description="Maximum depth in mm")

    @model_validator(mode="after")
    def check_polyorder_vs_window(self):
        if self.polyorder >= self.window_length:
            raise ValueError("polyorder must be smaller than window_length")
        return self


class PlotSettings(BaseModel):
    min: int = Field(100, description="Minimum value for color normalization")
    max: int = Field(200, description="Maximum value for color normalization")
    step: int = Field(200, description="Step for downsampling")
    linewidth: int = Field(20, description="Line width")
    cmap: str = Field("gray", description="Matplotlib colormap")
```

Python library

Limitations

- Needs installation of Python ecosystem
- Requires programming skills
- No graphical user interface

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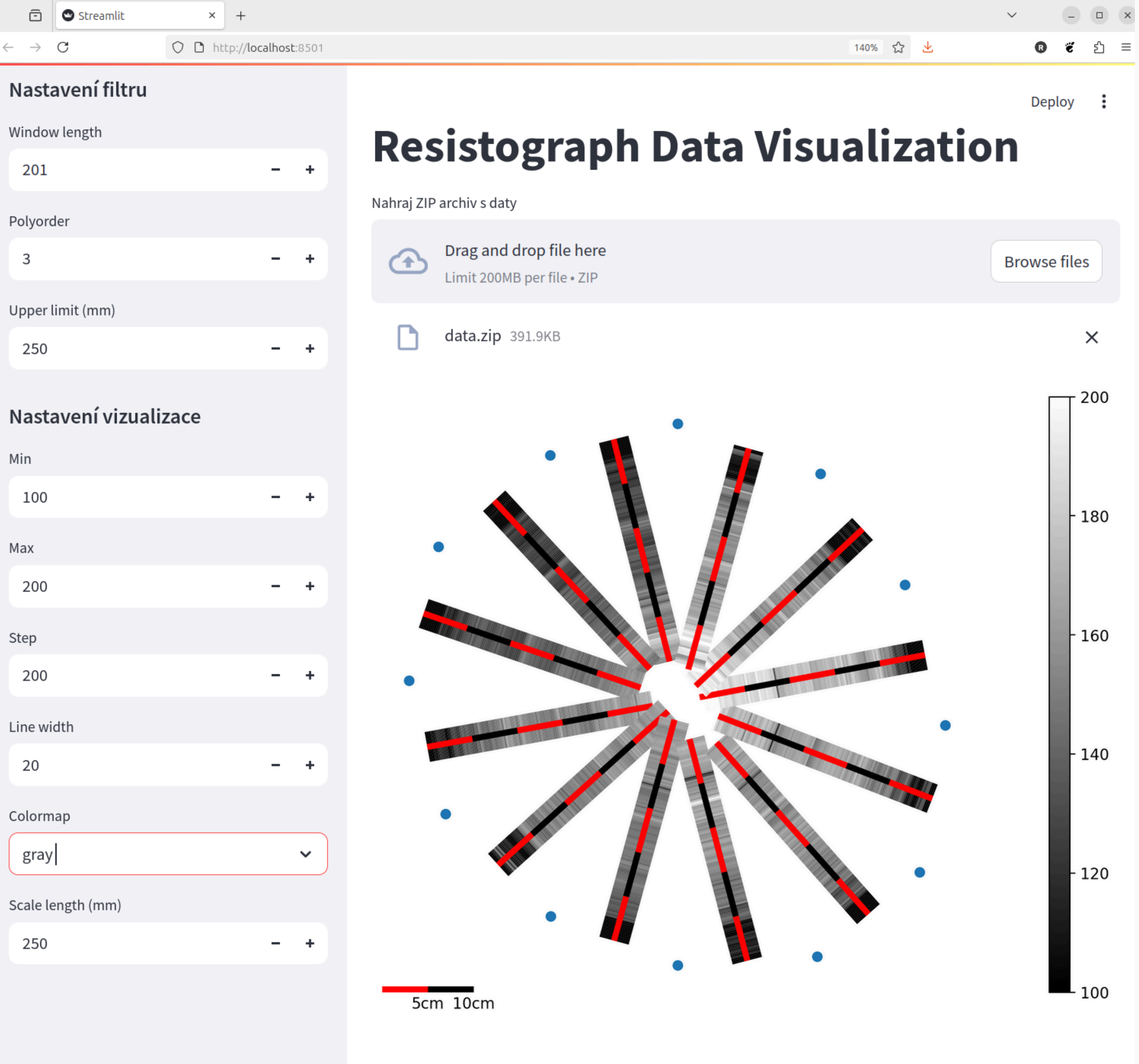

Nastavení filtru

Window length 201

Polyorder 3

Upper limit (mm) 250

Nastavení vizualizace

Min 100

Max 200

Step 200

Line width 20

Colormap gray

Scale length (mm) 250

Resistograph Data Visualization

Nahraj ZIP archiv s daty

Drag and drop file here
Limit 200MB per file • ZIP

data.zip 391.9KB

Streamlit

- Library for building interactive web apps
- GUI in web browser
- Widely used in industry and academia
- Requires minimal code

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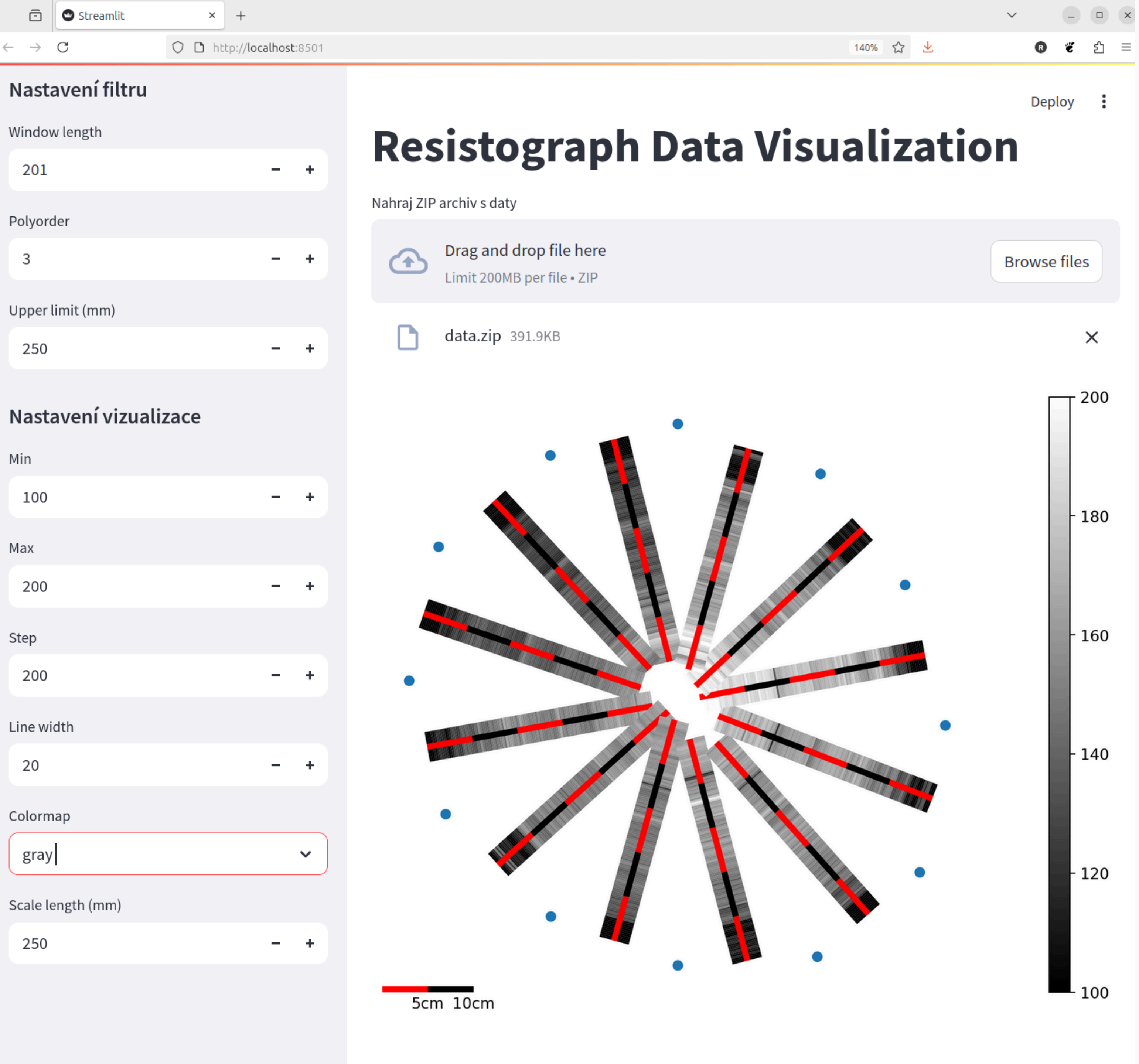

Nastavení filtru

Window length: 201

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Min: 100

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Step: 200

Line width: 20

Colormap: gray

Scale length (mm): 250

Resistograph Data Visualization

Nahraj ZIP archiv s daty

Drag and drop file here

Limit 200MB per file • ZIP

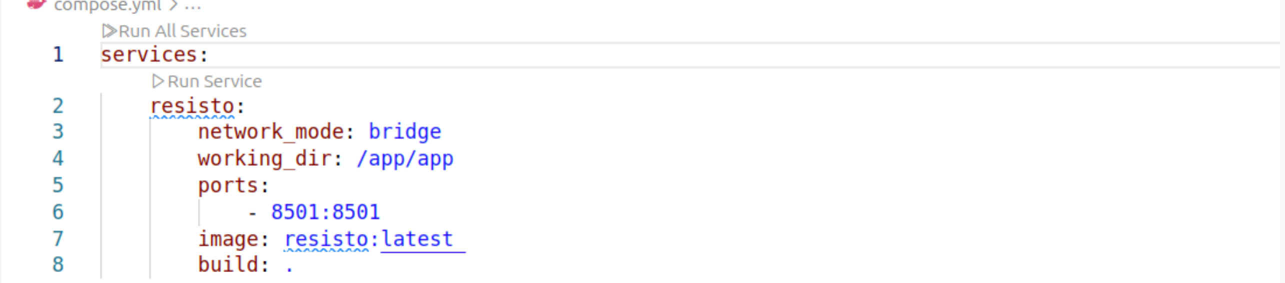
data.zip 391.9KB

Vibe coding

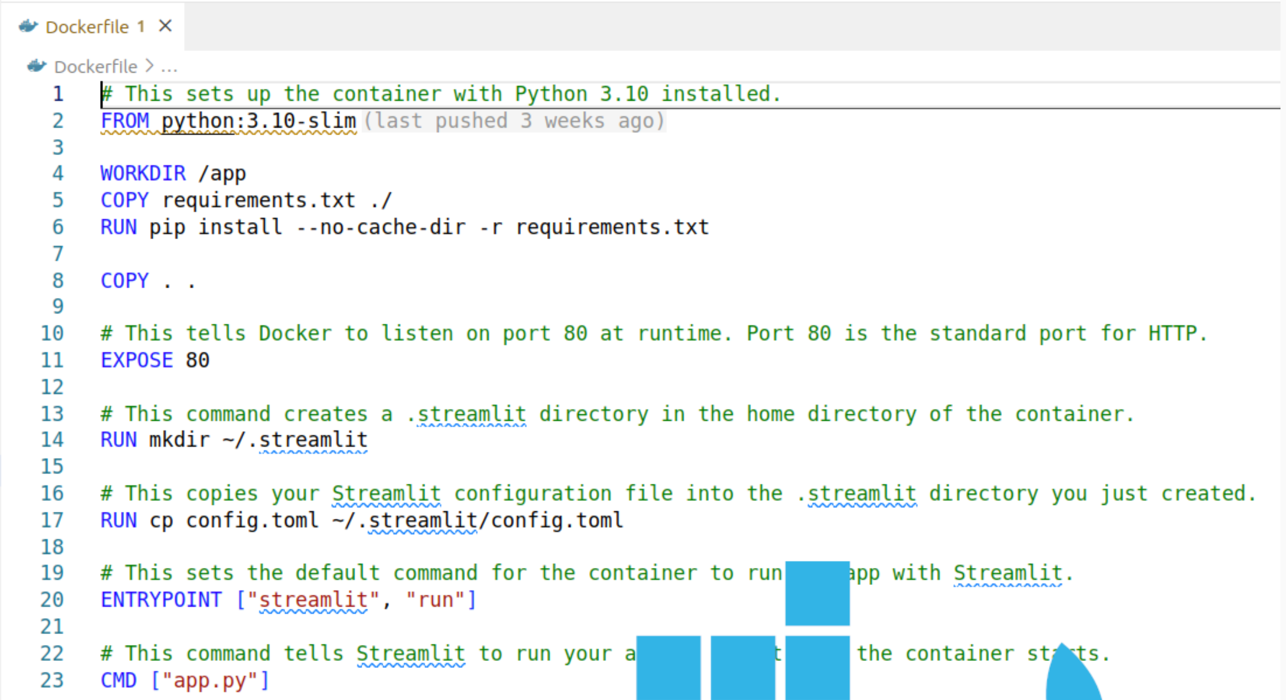
- Code written by AI (LLM)
- ChatGPT 5 in August 2025
- Web app produced in two prompts

```
I have the following library. Write
a streamlit program that allows you
to upload a zipped directory with data
and run commands corresponding to
the main function on it.
The output will be displayed.
```

```
OK. I want to be able to change
the preset options in the left panel.
```



```yaml
services:
    resisto:
        network_mode: bridge
        working_dir: /app/app
        ports:
            - 8501:8501
        image: resisto:latest
        build: .
```



```dockerfile
# This sets up the container with Python 3.10 installed.
FROM python:3.10-slim (last pushed 3 weeks ago)

WORKDIR /app
COPY requirements.txt ./
RUN pip install --no-cache-dir -r requirements.txt

COPY . .

# This tells Docker to listen on port 80 at runtime. Port 80 is the standard port for HTTP.
EXPOSE 80

# This command creates a .streamlit directory in the home directory of the container.
RUN mkdir ~/.streamlit

# This copies your Streamlit configuration file into the .streamlit directory you just created.
RUN cp config.toml ~/.streamlit/config.toml

# This sets the default command for the container to run [illegible] app with Streamlit.
ENTRYPOINT ["streamlit", "run"]

# This command tells Streamlit to run your a[illegible]t[illegible] the container st[illegible]ts.
CMD ["app.py"]
```

Docker

- Packages app and dependencies into a single container
- Ensures consistency across environments - ideal for **transparent and repeatable data processing**
- Widely used in industry and academia

- In some fields, the "compute capsule" is submitted together with the manuscript (Code Ocean).

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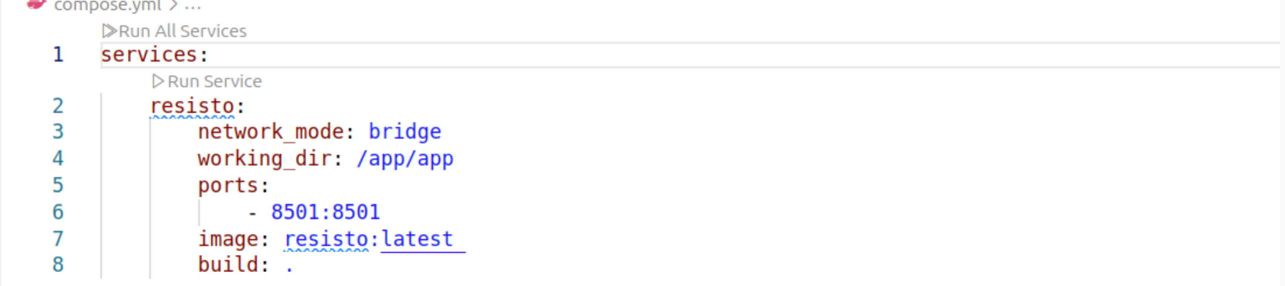

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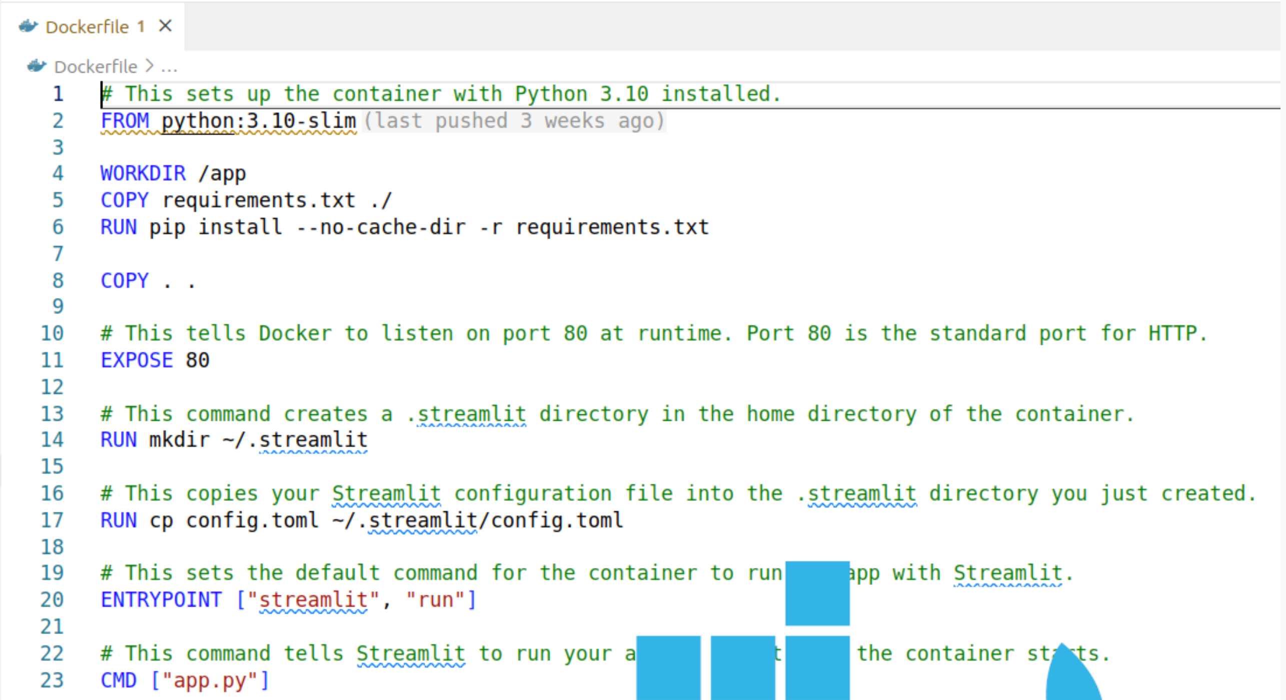

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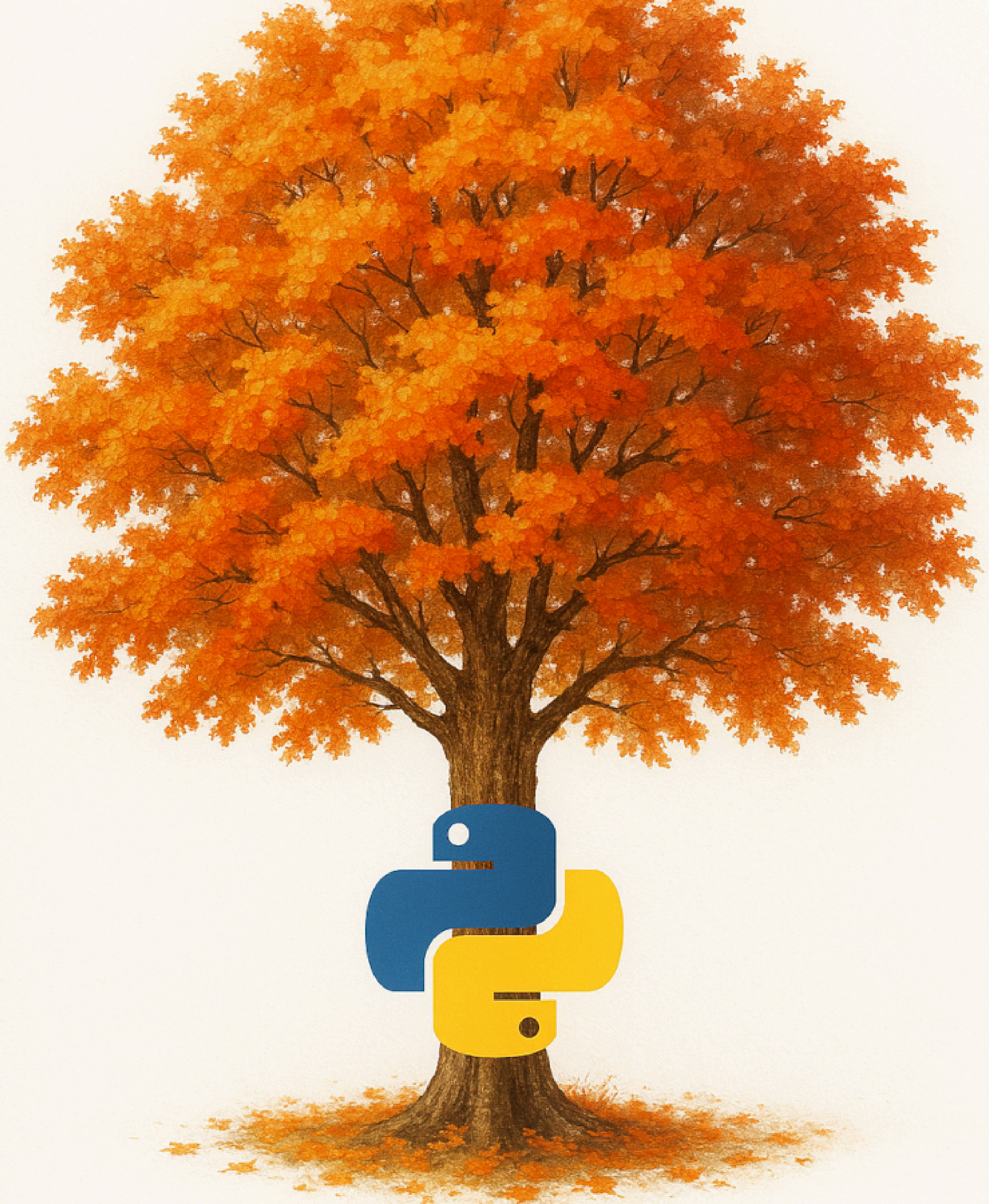
CMD ["app.py"]
```

Run dockerized app

```
docker compose up
```

- First run takes minutes, later runs take ms
- No Python install required
- No dependency issues
- Works on Win / Mac / Linux



Summary

- Resistograph and tomograph are complementary tools for tree inspection

- A Python library was developed to enhance data interpretation
- GUI is possible with Streamlit
- Coding can be done with AI support
- Installation can be simplified and repeated with Docker

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