Using **topology** to **analyze** the **shape** of barley

ECC (X direction, T = 16)

MDS (canberra, k=2) + SVM (C=1, kernel= linear) : accuracy = 83%

Founder
- Multan
- White Smyrna

MDS (canberra, k=2) + SVM (C=1, kernel= linear) : accuracy = 89%

Founder
- Algerian
- Everest
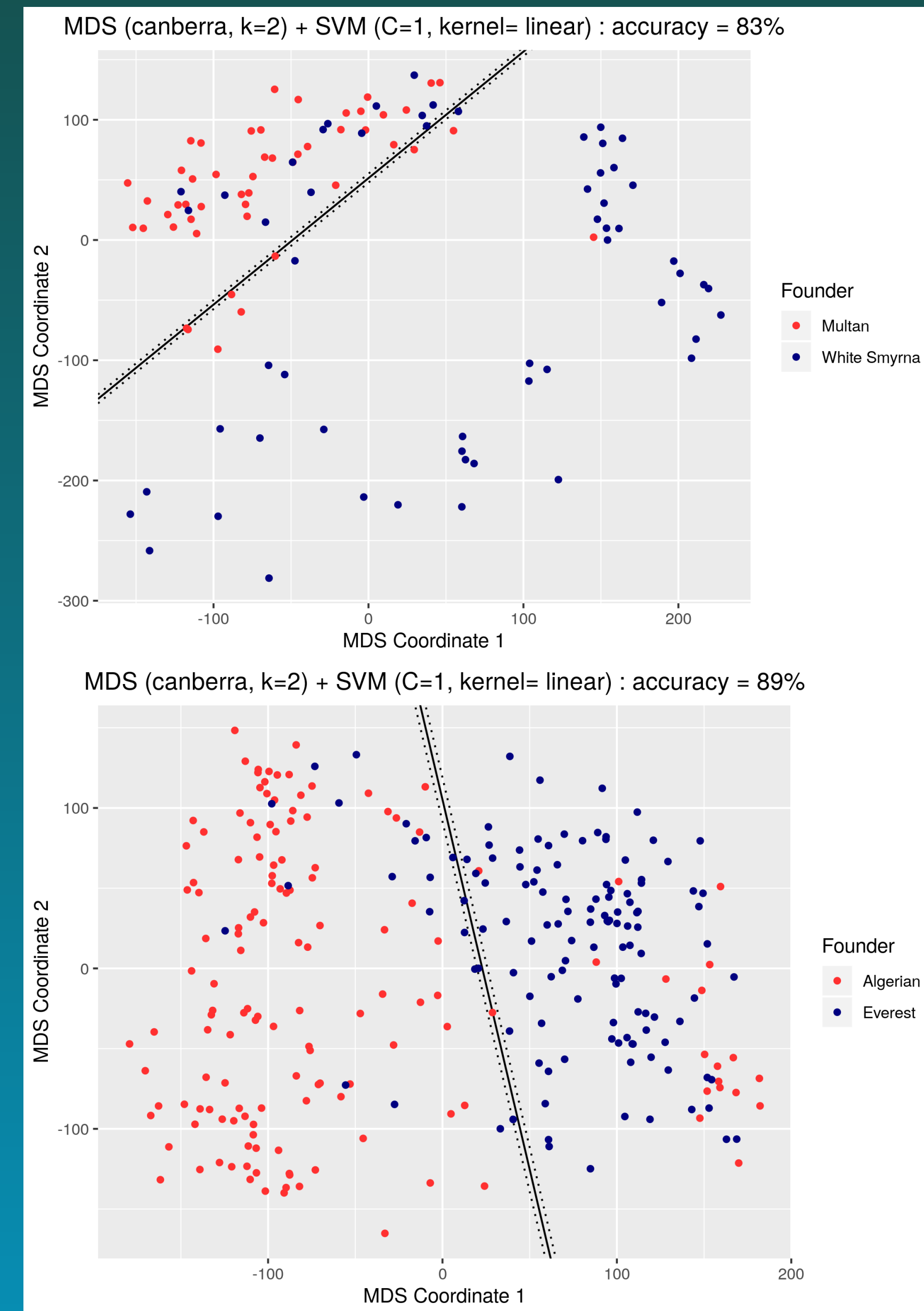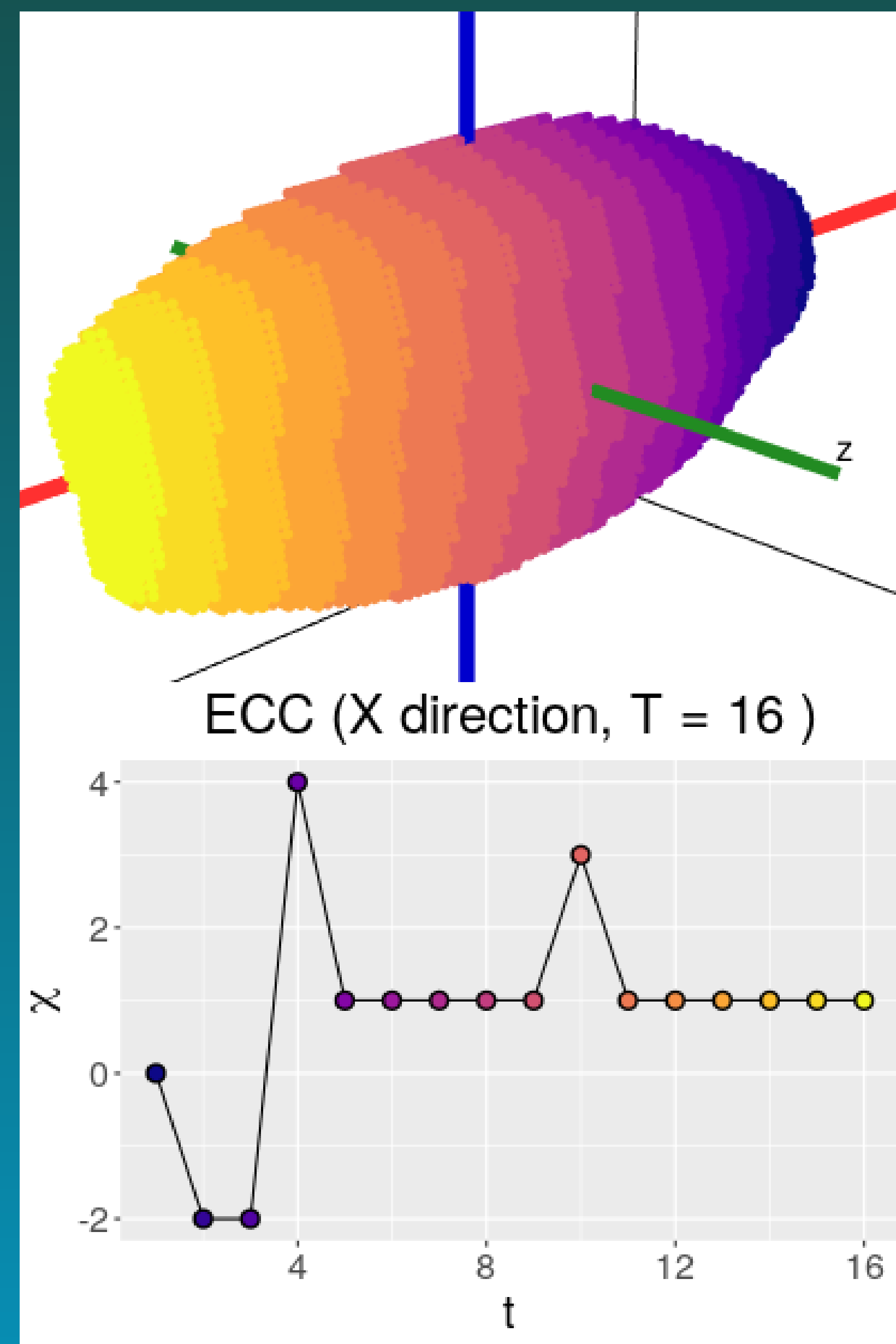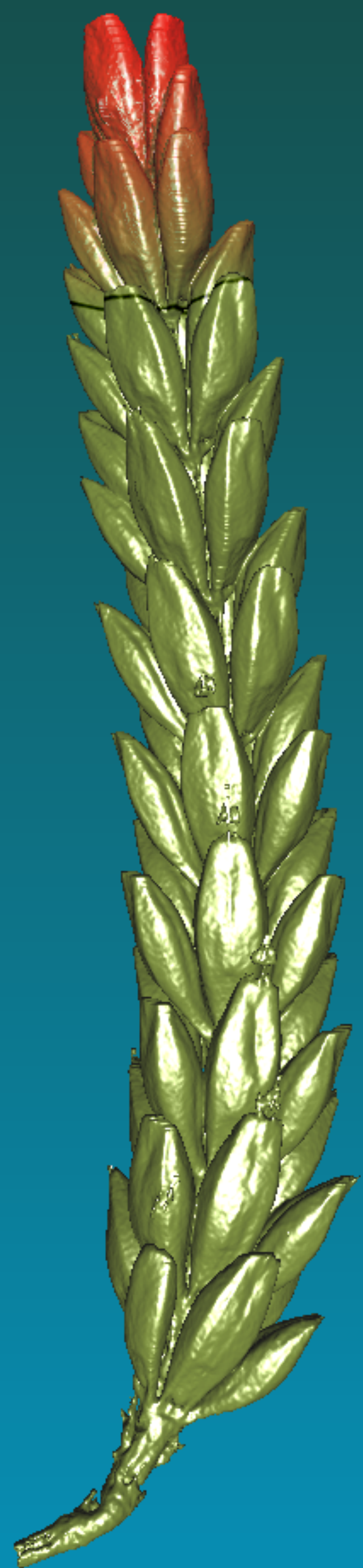
Euler meets plant science

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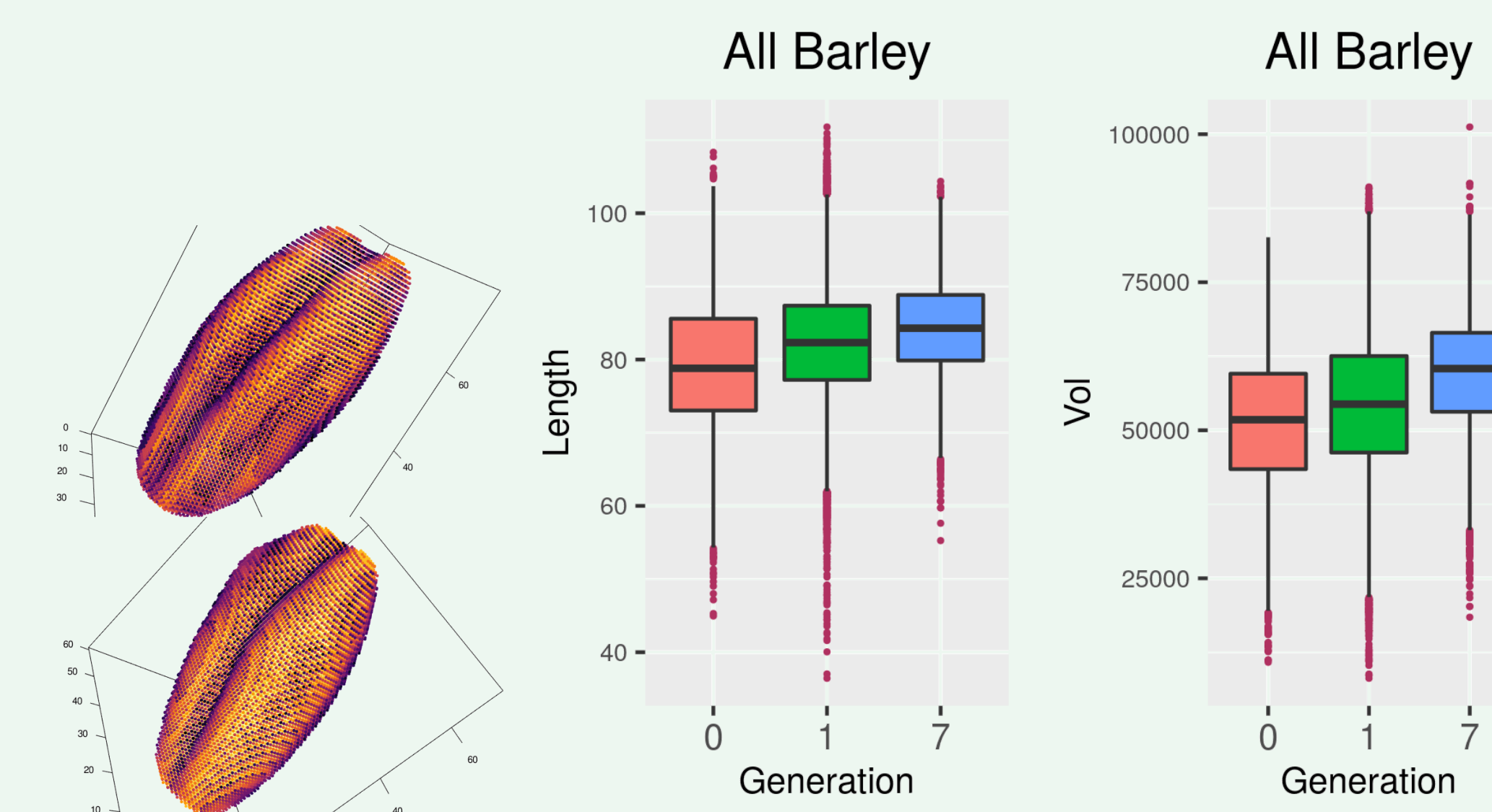[2] *Horticulture, Michigan State University*
[3] *Botany and Plant Sciences, University of California, Riverside*

Experimental Design

Pooled F$_2$

F_{18}

F_{28}

379 F$_1$

$\otimes$

379 F$_2$ families

F_{58}
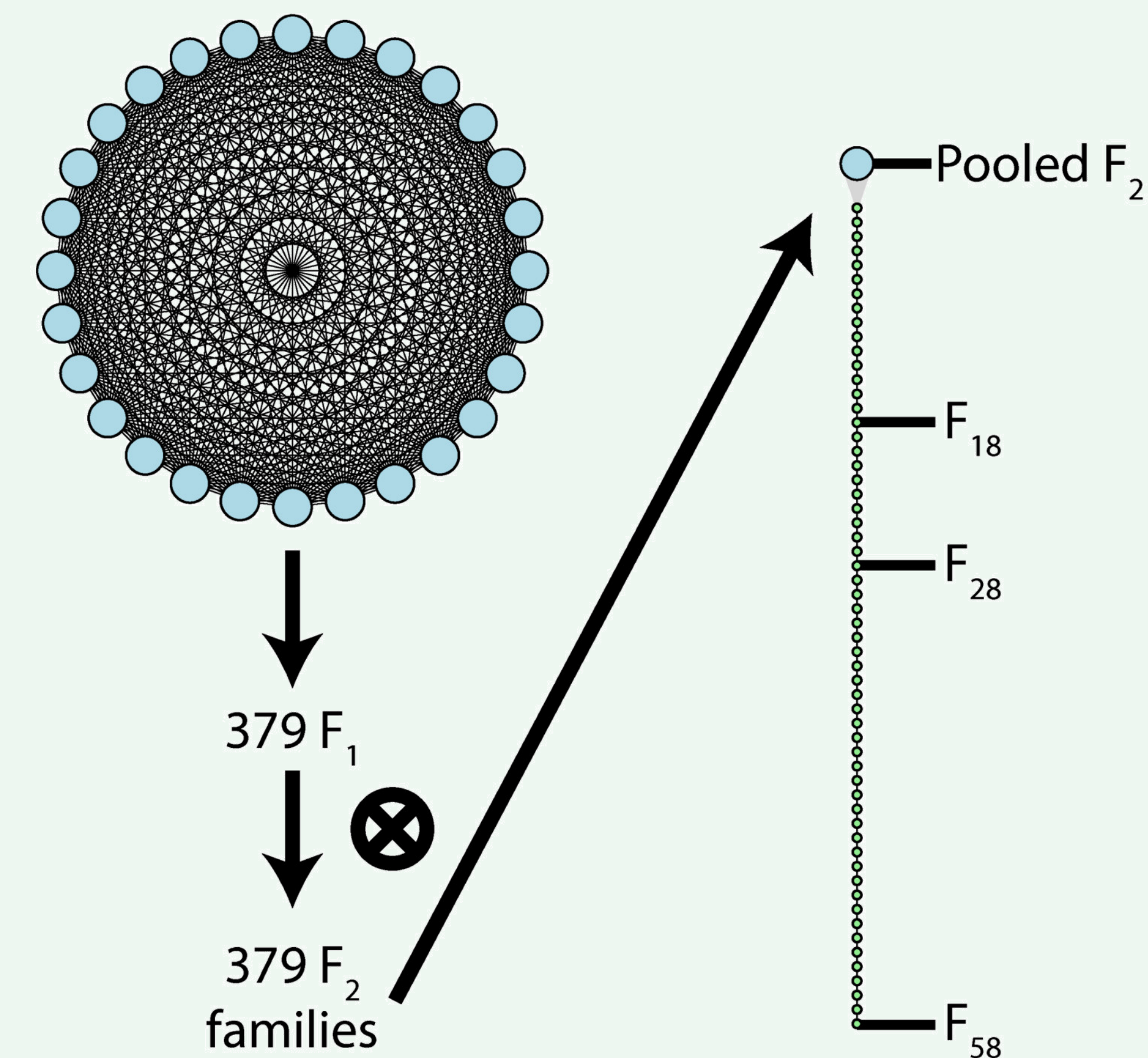
- Composite cross. 28 founders. 58 generations.

## Image processing to measure seeds

All Barley

All Barley

- 3D X-ray CT scan data: 875 barley spikes.
- 38,000 seeds: generations F0, F18, and F58.
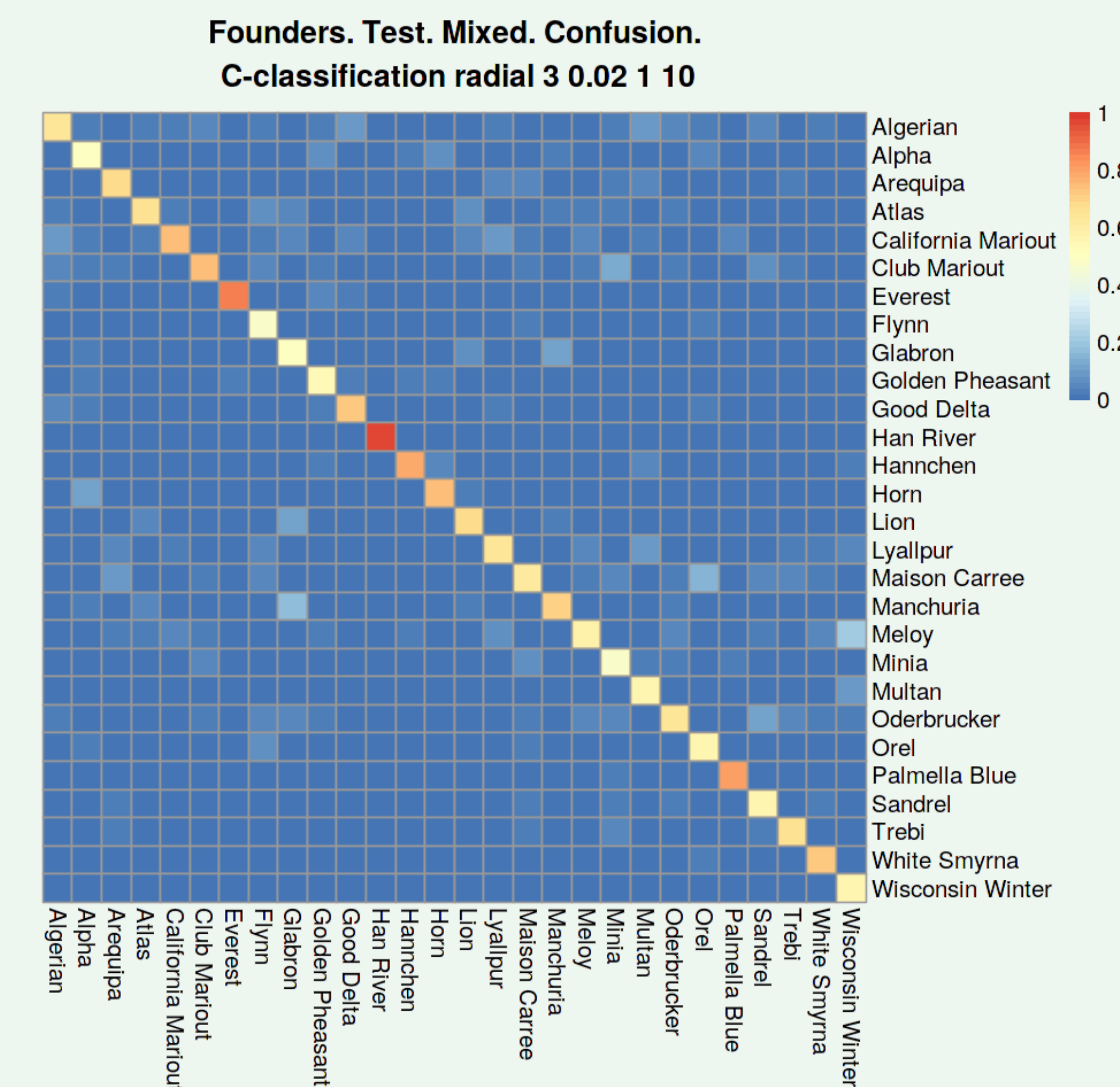- Distribution of length, height, width, volume, etc.

Euler characteristic transform (ECT)

$$\chi = \#(\text{Vertices}) - \#(\text{Edges}) + \#(\text{Faces})$$

- ECT is the record of how the EC changes as we reconstruct a given object in all possible directions.
- The ECT summarizes all shape information [1].

Euler Characteristic Transform (XYZ directions, T = 16)
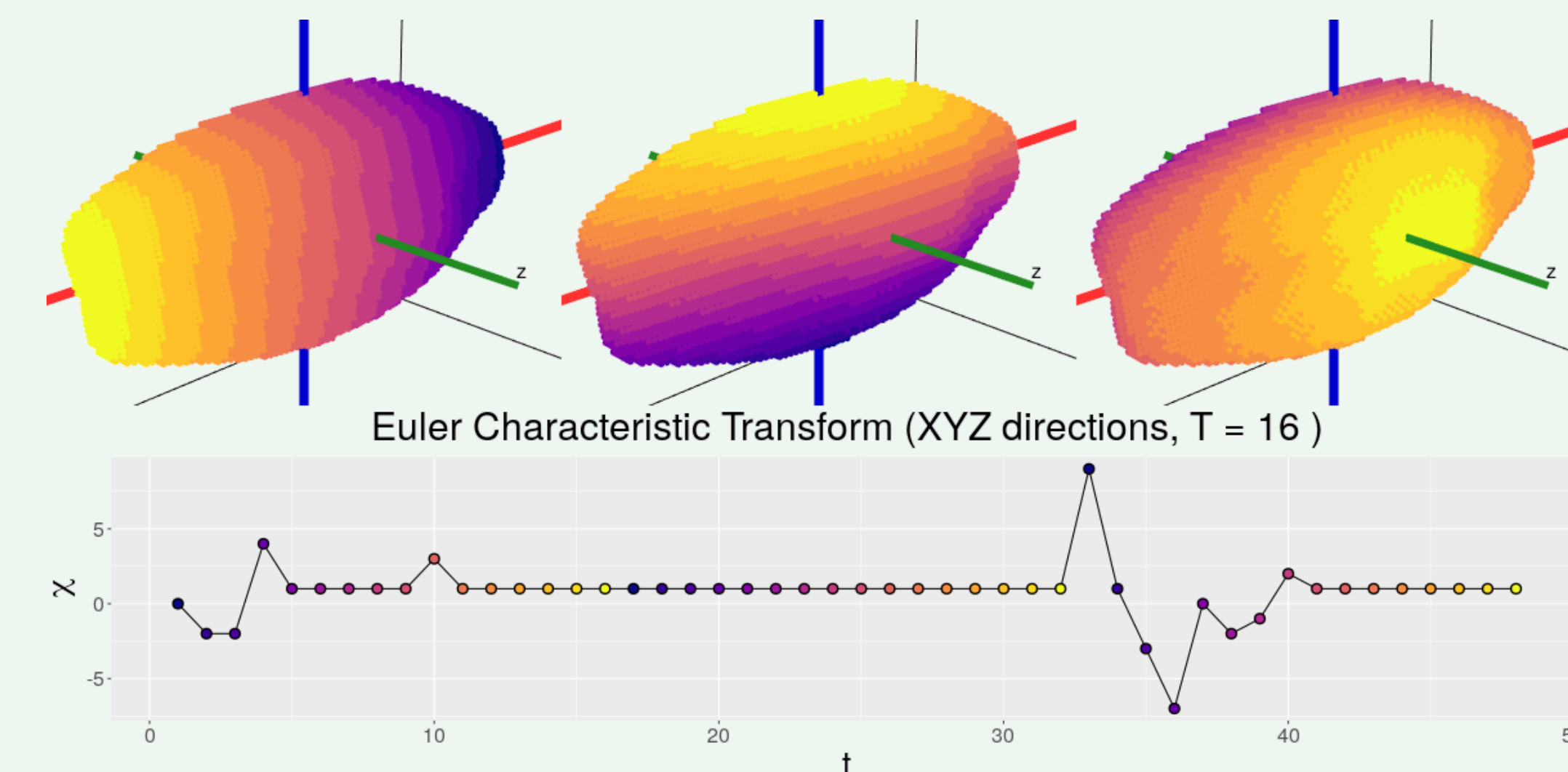
SVM Results: Traditional + ECT

Founders. Test. Mixed. Confusion.
C-classification radial 3 0.02 1 10

- SVM to classify the seeds from the 28 founders
- (80% training vs 20% testing) × 50 times
- **66% classification accuracy**

References
[1] K. Turner, S. Mukherjee, and D. M. Boyer, "Persistent homology transform for modeling shapes and surfaces," *Information and Inference*, vol. 3, no. 4, pp. 310–344, Dec. 2014.