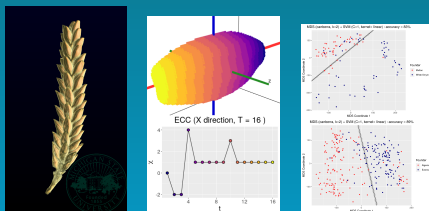


# Using topology to analyze the shape of barley

Check the **animated** version of my **poster!**

[bit.ly/barley\\_tda](http://bit.ly/barley_tda)



## Euler meets plant science

Erik Amézquita<sup>1</sup>

amezqui3@msu.edu

Michelle Quigley<sup>2</sup> Tim Ophelders<sup>1</sup> Elizabeth Munch<sup>1</sup> Daniel Chitwood<sup>2</sup> Jacob Landis<sup>3,4</sup> Daniel Koenig<sup>3</sup>

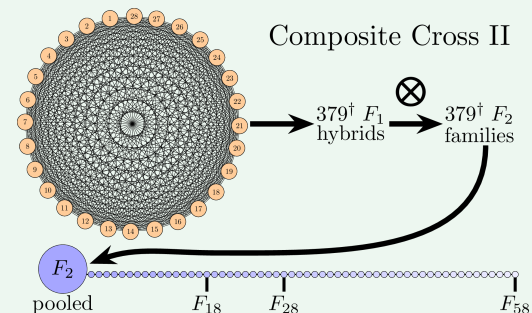
<sup>1</sup> Computational Math, Science & Engineering, Michigan State University

<sup>2</sup> Horticulture, Michigan State University

<sup>3</sup> Botany and Plant Sciences, University of California, Riverside

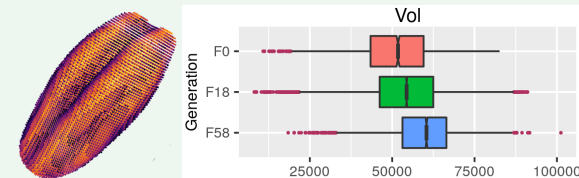
<sup>4</sup> Integrative Plant Science, Cornell University

### Experimental Design



- 28 founders (land races). 58 generations.

### Image processing to measure seeds



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

### SVM Classification Results

Shape descriptors	No. descriptors	Classification accuracy
Traditional	11	51.9% — 54.2%
Topological (ECT + KPCA)	12	43.2% — 45.7%
Combined (Trad + Topo)	23	69.2% — 71.9%

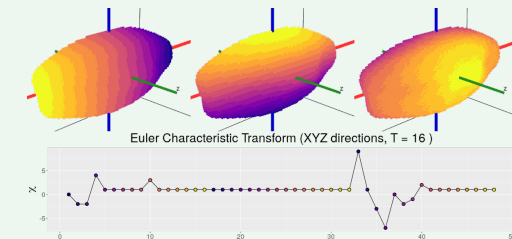
### Acknowledgements

This work is supported in part by Michigan State University and the National Science Foundation Research Traineeship Program (DGE-1828149).

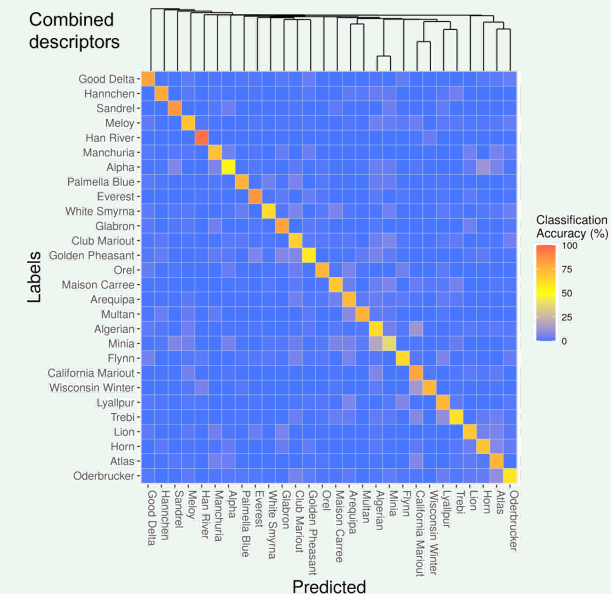
## Euler characteristic transform (ECT)

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

- 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].



## SVM: Traditional + ECT + KPCA



- SVM to classify 3,000 seeds from the 28 founders
- (80% training vs 20% testing) × 50 times
- **70% 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.