

Modelling the effects of domestication in Wheat through novel computer-vision techniques

Nathan Hughes

March 14, 2018

Outline

- 1 Description of Topic
- 2 Materials and Image Capture Setup
- 3 Completed Work
- 4 Work in Progress
- 5 Additional Aims
- 6 References

What is the project?

The project is aiming to use computational methods to answer biologically significant questions on wheat grain morphology and domestication using μ CT images.

To do this, I will be using:

- Computer vision on 3D image sets
- Statistical analysis and data science
- Scientific theory to create reproducible results

Research Question:

Is it possible to use μ CT imaging to answer questions about Wheat domestication?

I hope so!

Null-Hypothesis

- H_0 = Domestication has no effect on the morphometric properties of wheat
- H_0 = Ploidy has no effect on the morphometric properties of wheat
- H_0 = There is no difference in hulled and non-hulled genotypes

**Hulling is a trait associated with domestication*

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Materials (Plant)

I have a wide range of Wheat genotypes, these are:

- Ranged between diploid, tetraploid and hexiploid
- 12 total genotypes
- Divided between domestication status



Figure 1: A Primitive Wheat Spike

Methods (Image Generation)

Capture Methods

In order to generate this data a μ CT100 scanner (ScancoMedical, Switzerland) was used Each spike was:

- ~1000 slices (51 slices per stack),
- 125 projections/ 180° were taken and a
- binning of 6 was used.
- Output images are a 0.2 megapixel (512×512) resolution ($68.8 \mu/\text{pixel}$)

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Data Gathering

MATLAB Software

Data has been extracted from the μ CT images using a method I previously developed at IBERS [1]. A lot of additions and novel augmentations have been added in order to work with the range of Wheat genotypes.

- This is done via separating non-grain from grain ROIs in the image data
- Measurements are taken on a per grain level
- Measurements are in mm, mm² and mm³ based on type
- Data is exported as CSV files

Improved Watershedding Algorithm

Algorithm

$$|x_1 - x_2| + (\sqrt{2} - 1), |x_1 - x_2| > |y_1 - y_2| (\sqrt{2} - 1) |x_1 - x_2|, \text{ otherwise} \quad (1)$$

Visual Example

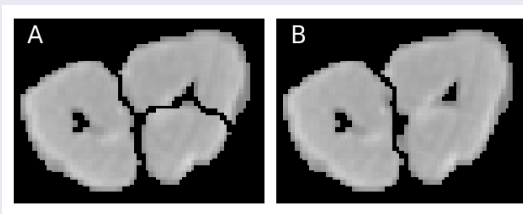


Figure 2: A showing the chessboard method, B improved quasi-euclidean method

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Data Analysis *WIP*

Statistical Methods to be implemented

These will be implemented in Python using the library *SciPy* [2]

- ANOVA
- MANOVA
- GLMs
- χ^2 Tests
- PCA
- T/F-Tests

Graphing Methods to be implemented

All Graphing is being implemented using Matplotlib [3]

- Box
- Violin
- Swarm
- Correlation Maps
- Scatter / LM
- Frequency/Histograms

Reproducible Analysis GUI - 1 *WIP*

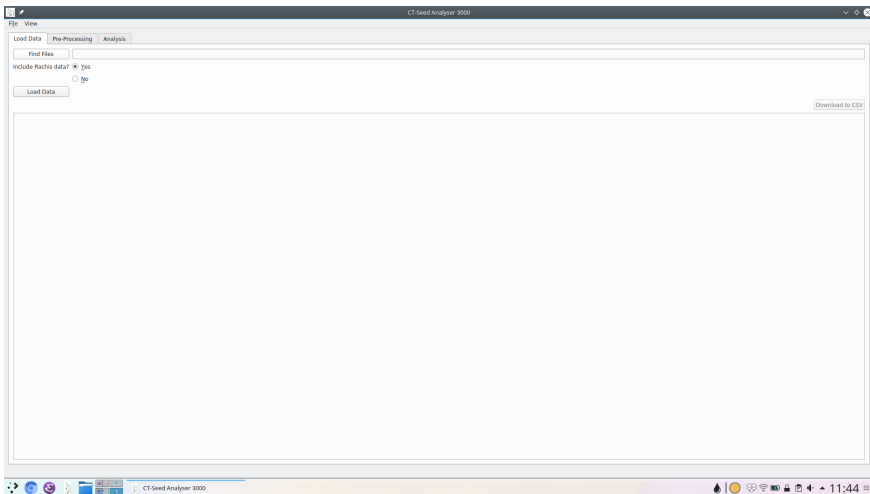


Figure 3: Initial GUI

Reproducible Analysis GUI - 2 *WIP*

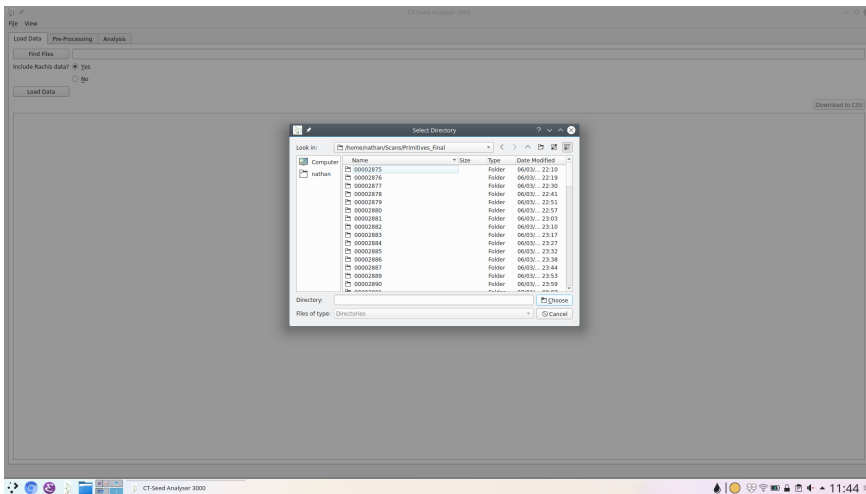


Figure 4: GUI select folders to search for data

Reproducible Analysis GUI - 3 WIP

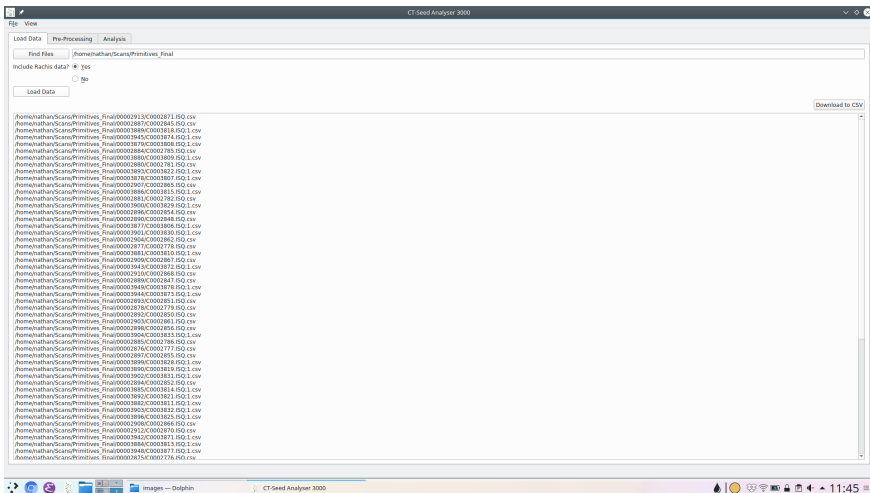


Figure 5: GUI with data loaded successfully

Reproducible Analysis GUI - 4 *WIP*

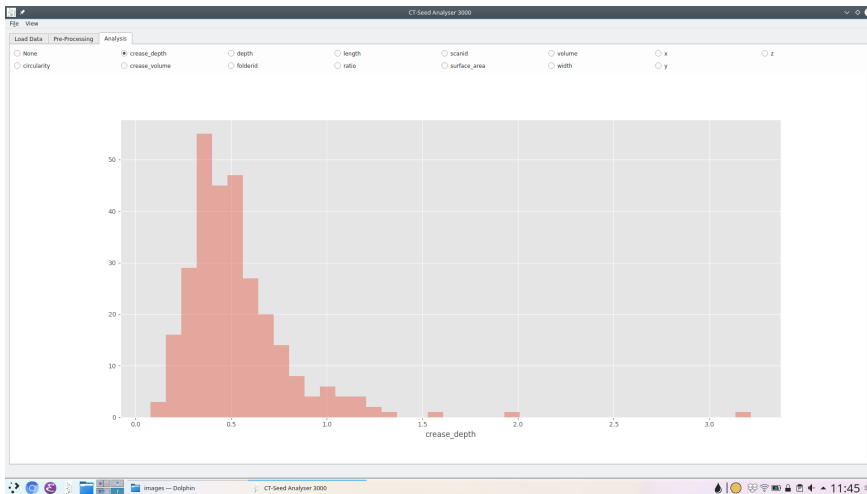


Figure 6: GUI dynamically graphing crease_depth

Reproducible Analysis GUI - 5 *WIP*



Figure 7: GUI dynamically graphing crease_volume

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Additional Aims

Not yet started, but would like to implement by end of project

- Automate error finding and identification
- Visually Display Errors in Data
- Write testing suite for software

Ideas for future work

- Test software library on other datasets
- Grow more plants and create more replicates for more robust study

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References

- [1] Nathan Hughes, Karen Askew, Callum P Scotson, Kevin Williams, Colin Sauze, Fiona Corke, John H Doonan, and Candida Nibau.
Non-destructive, high-content analysis of wheat grain traits using X-ray micro computed tomography.
Plant Methods, 13, 2017.
- [2] Eric Jones, Travis Oliphant, and Pearu Peterson.
{SciPy}: open source scientific tools for {Python}.
2014.
- [3] J. D. Hunter.
Matplotlib: A 2d graphics environment.
Computing In Science & Engineering, 9(3):90–95, 2007.