



PHENOME 2020

TUCSON, AZ FEBRUARY 24-27

Semantic Segmentation of Sorghum Using Hyperspectral Data Identifies Genetic Associations

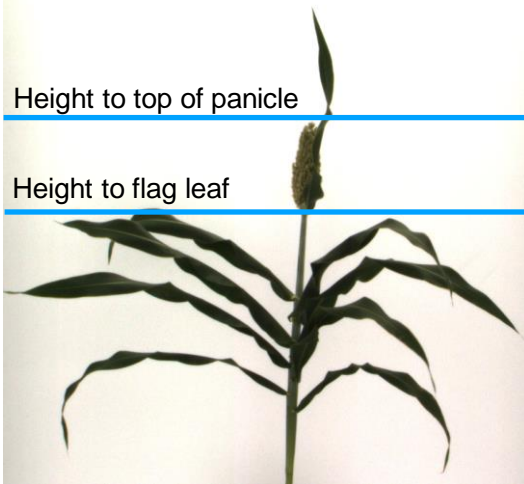
Chenyong Miao
February 26, 2020

When I talk about this topic, people ask

- What is the semantic segmentation
- What do you use it for

Introduction

- Whole plant segmentation in RGB images
- The limitations of using RGB images
- Semantic segmentation = pixel classification to plant organs



Height to tallest point of the plant

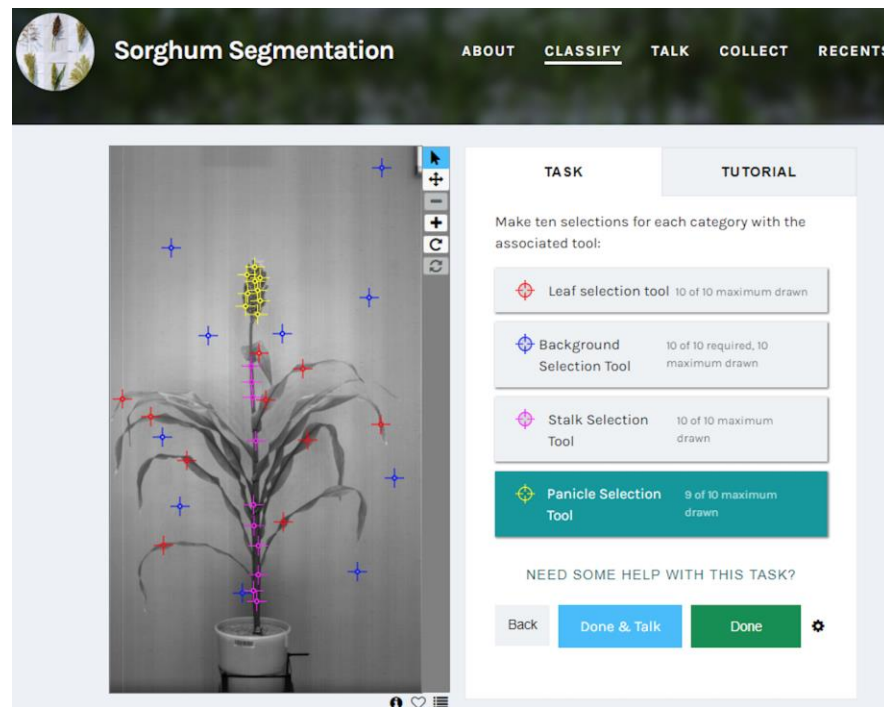
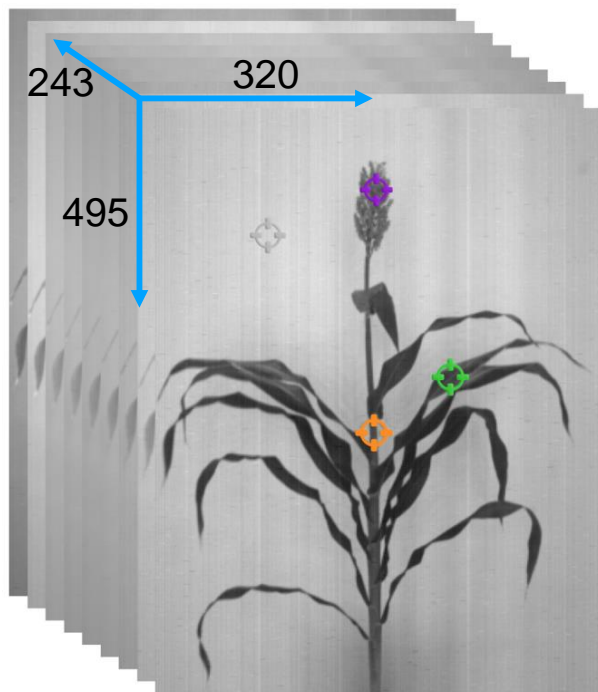


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Hyperspectral Signatures of Sorghum Organs

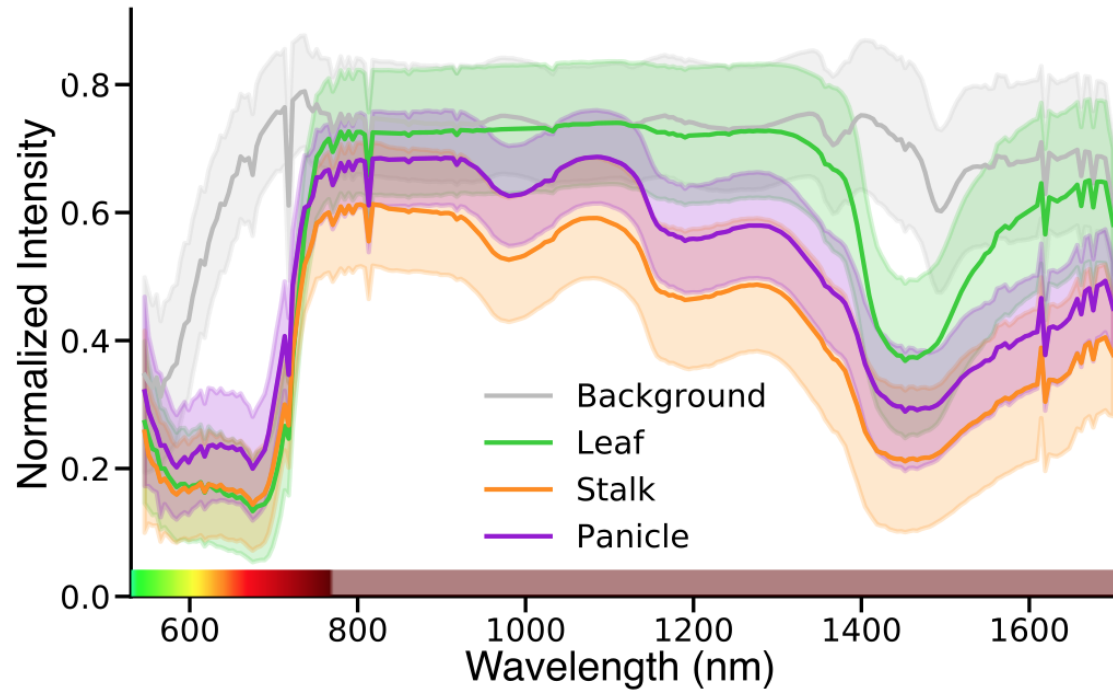
A



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Hyperspectral Signatures of Sorghum Organs



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Performance of Classification Algorithms

Methods	Background	Leaf	Stalk	Panicle	Average
LDA	1.000	0.969	0.946	0.974	0.972
PLS-DA	1.000	0.973	0.911	0.976	0.965
ANN	0.997	0.974	0.923	0.958	0.963
MLR	0.983	0.970	0.934	0.959	0.962
SVM	0.999	0.978	0.920	0.948	0.961
RF	0.999	0.964	0.830	0.931	0.931
LASSO	1.000	0.962	0.754	0.956	0.918
QDA	0.987	0.986	0.657	0.865	0.874

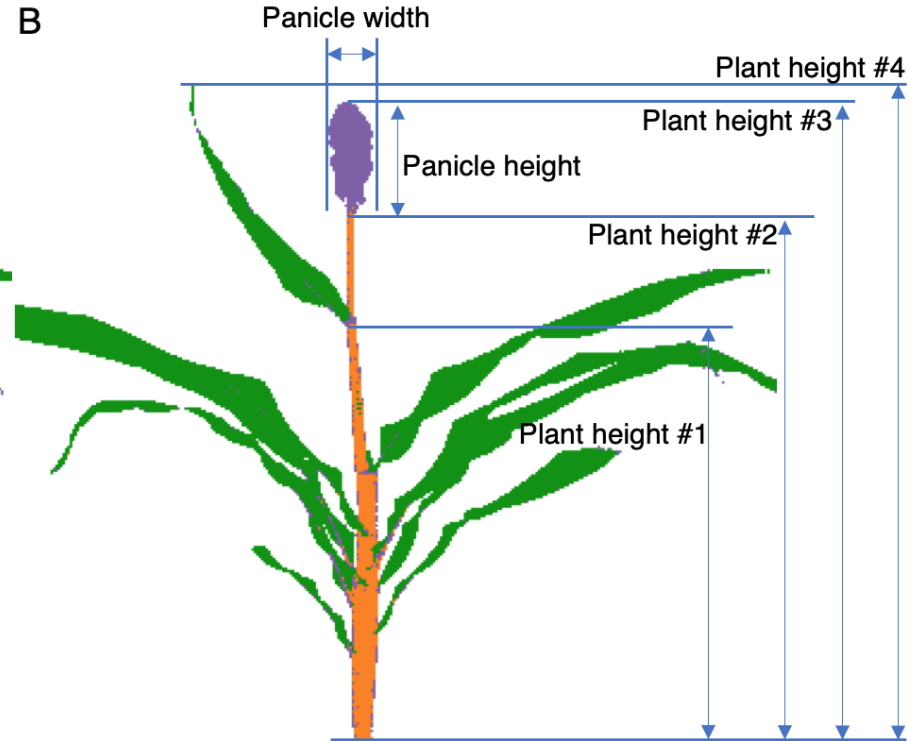
LDA: linear discriminant analysis; **MLR**: multinomial logistic regression;
ANN: artificial neural network; **SVM**: support vector machine;
PLS-DA: partial least squares discriminant analysis; **RF**: random forest;
QDA: quadratic discriminant analysis; **LASSO**: least absolute shrinkage and selection operator.

Whole image prediction using LDA

A



B



Quantitative Genetics of Semantic Segmentation Traits

- Hyperspectral images for 300 lines in SAP were collected
- A wide range of traits were measured
- A SNP dataset for SAP

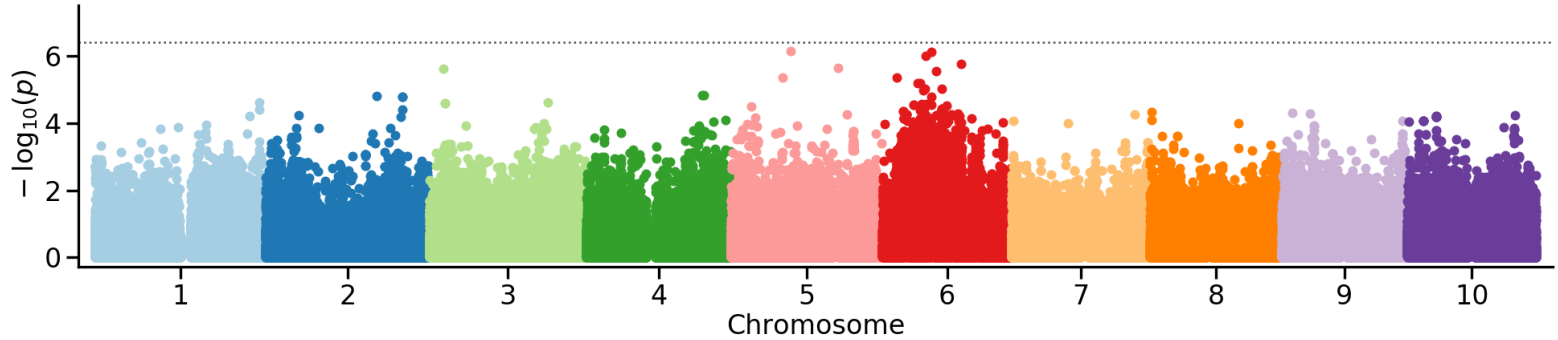


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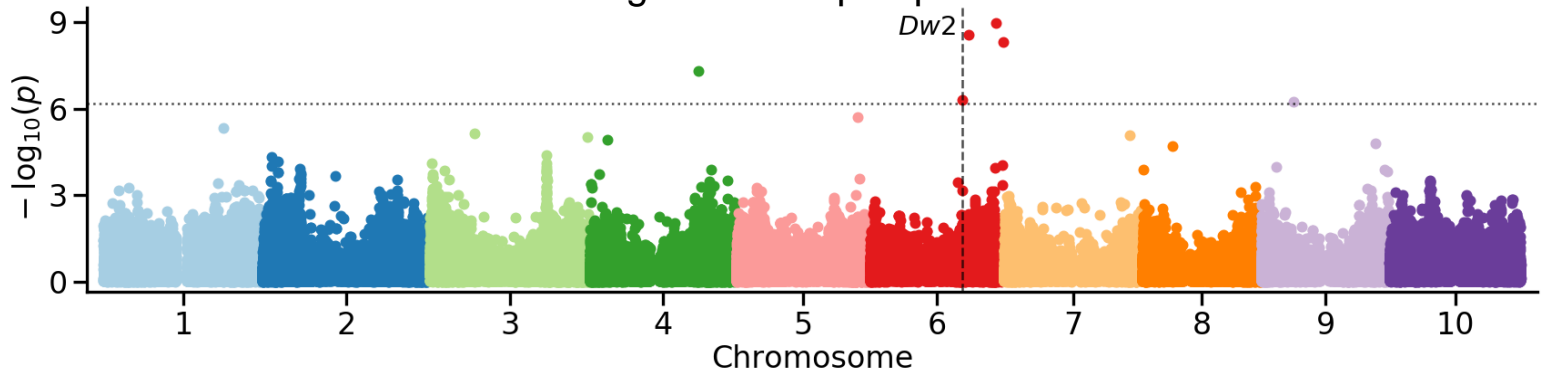
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Quantitative Genetics of Semantic Segmentation Traits

Height to the tallest point of plant

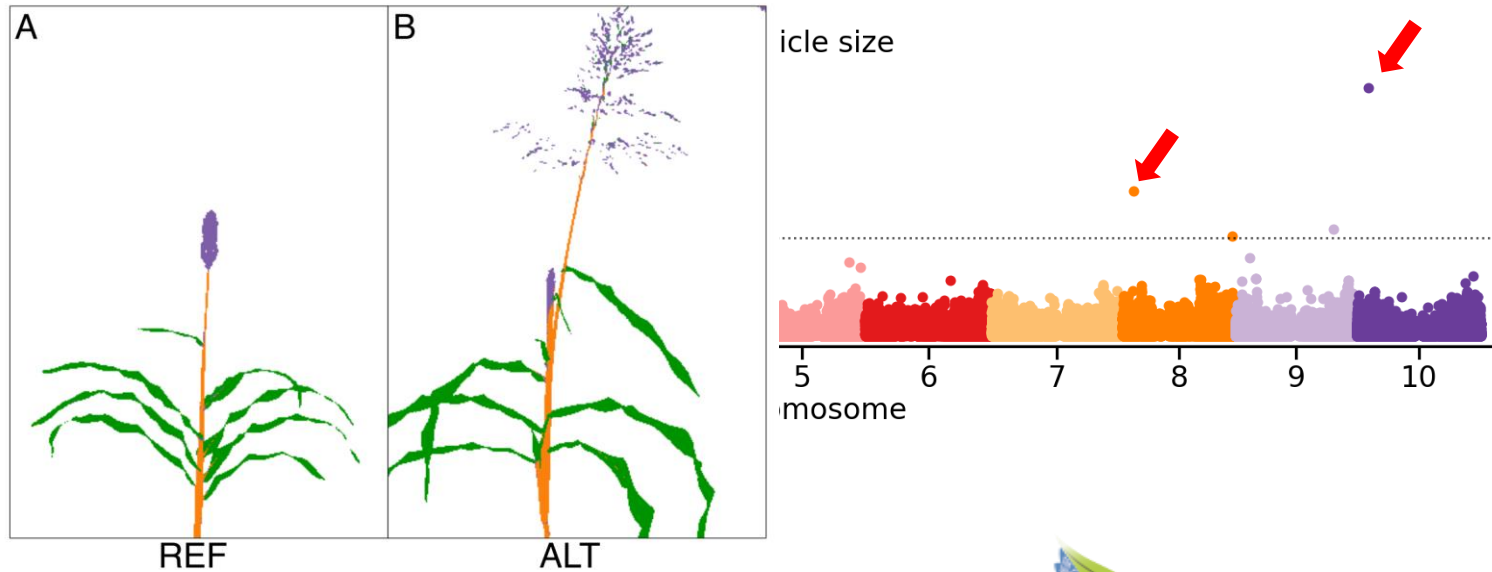


Height to the top of panicle



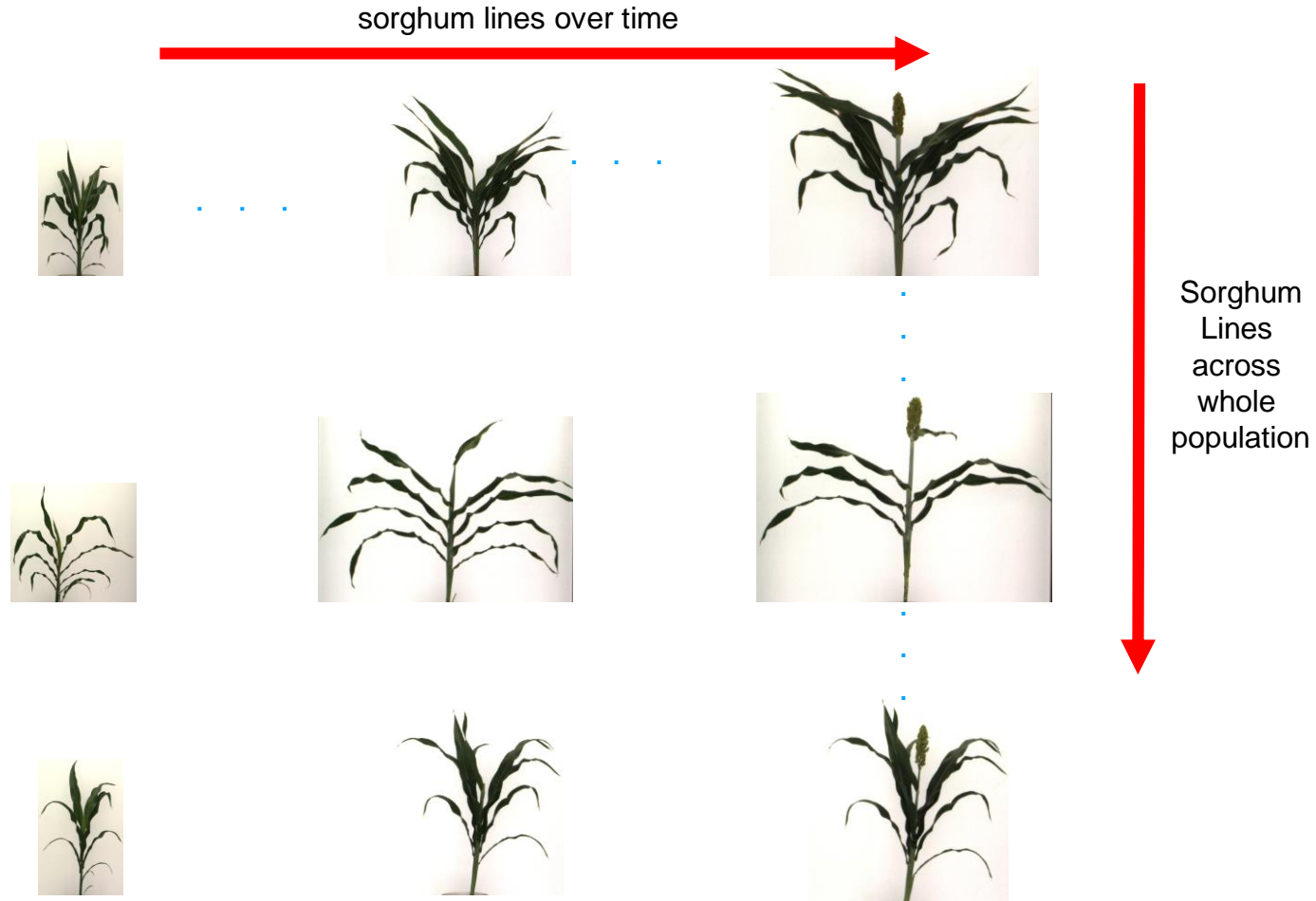
Quantitative Genetics of Semantic Segmentation Traits

- GWAS on panicle size in SAP

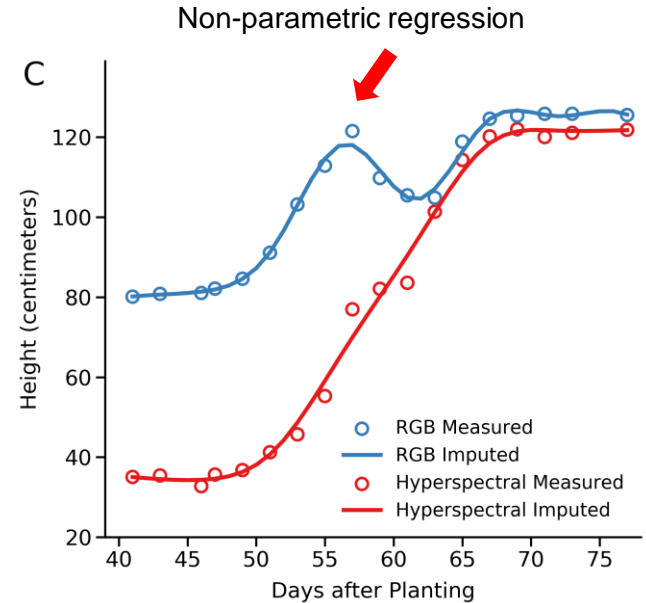
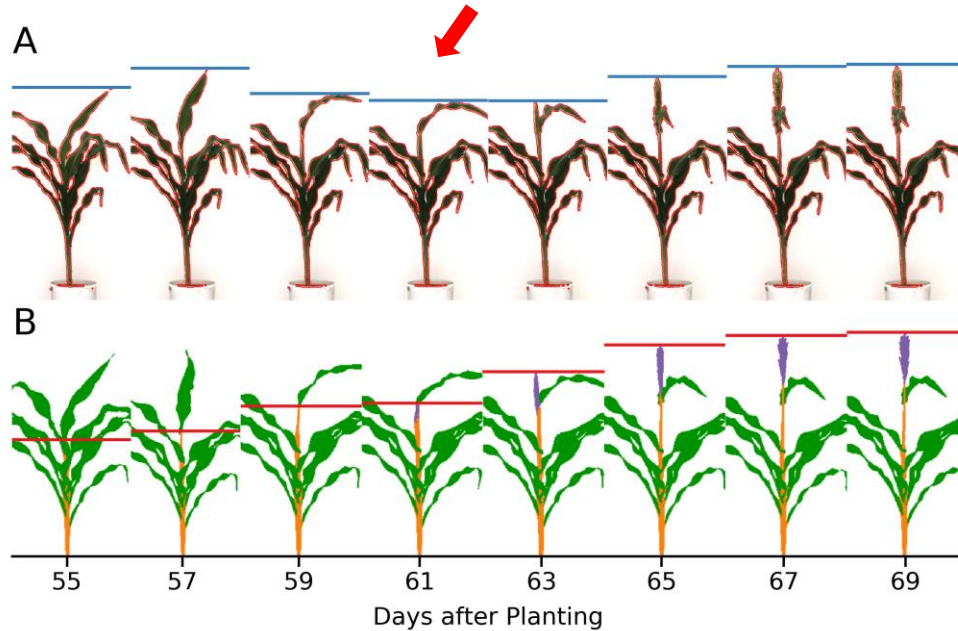


Miao et al, plant phenomics, doi: 10.34133/2020/4216373

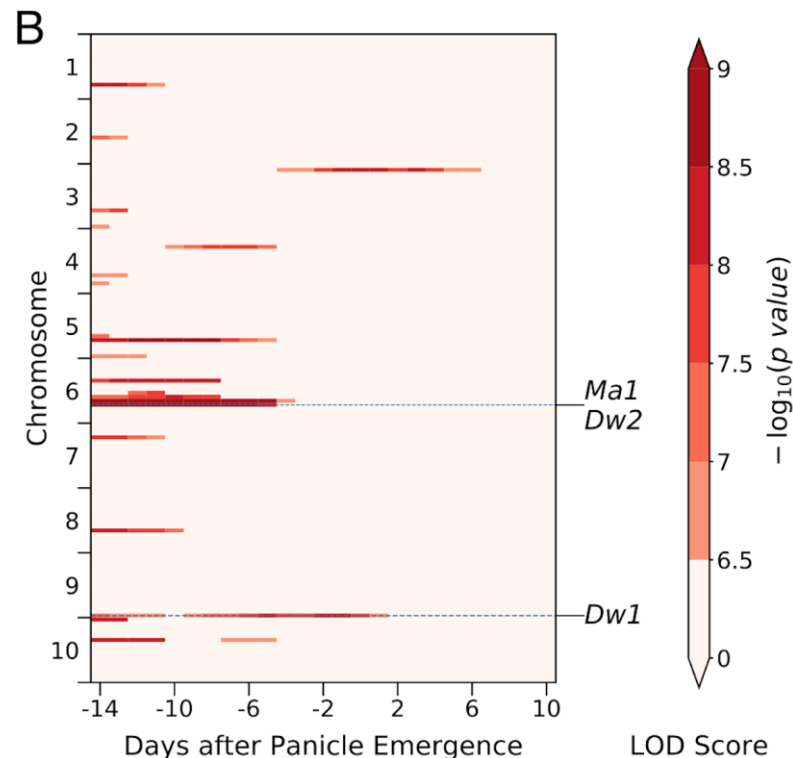
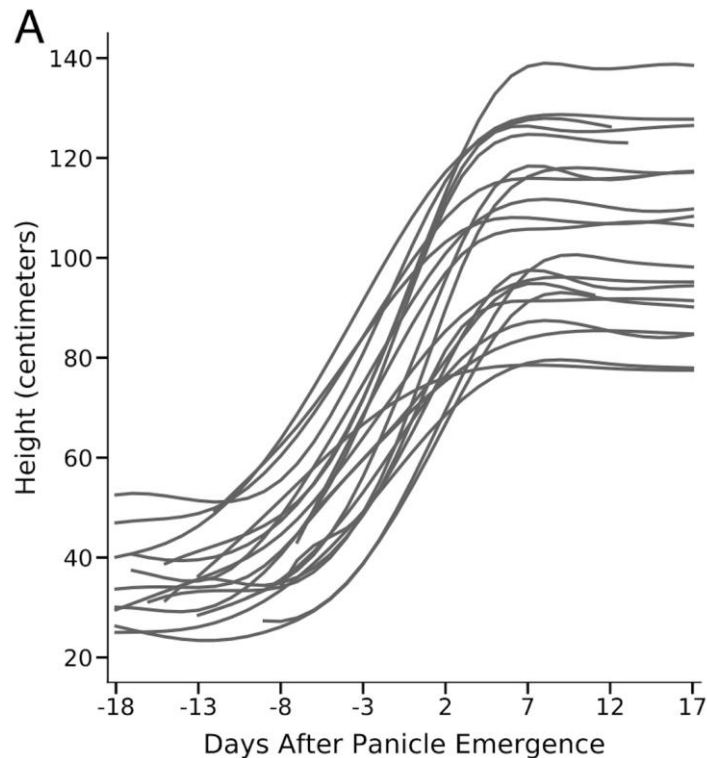
We can do more



Apply semantic segmentation in plant dynamic traits



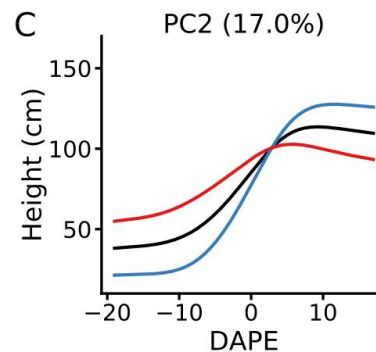
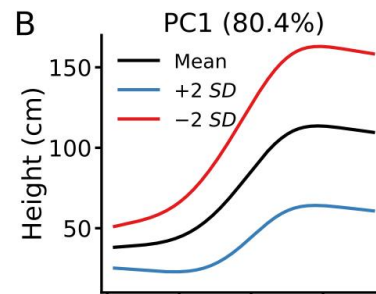
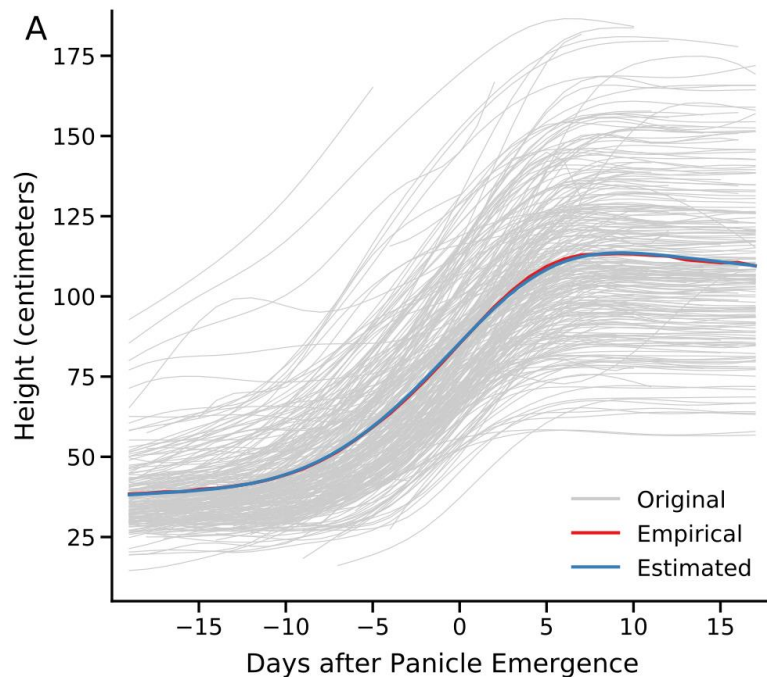
Mapping plant growth curves using sequential GWAS



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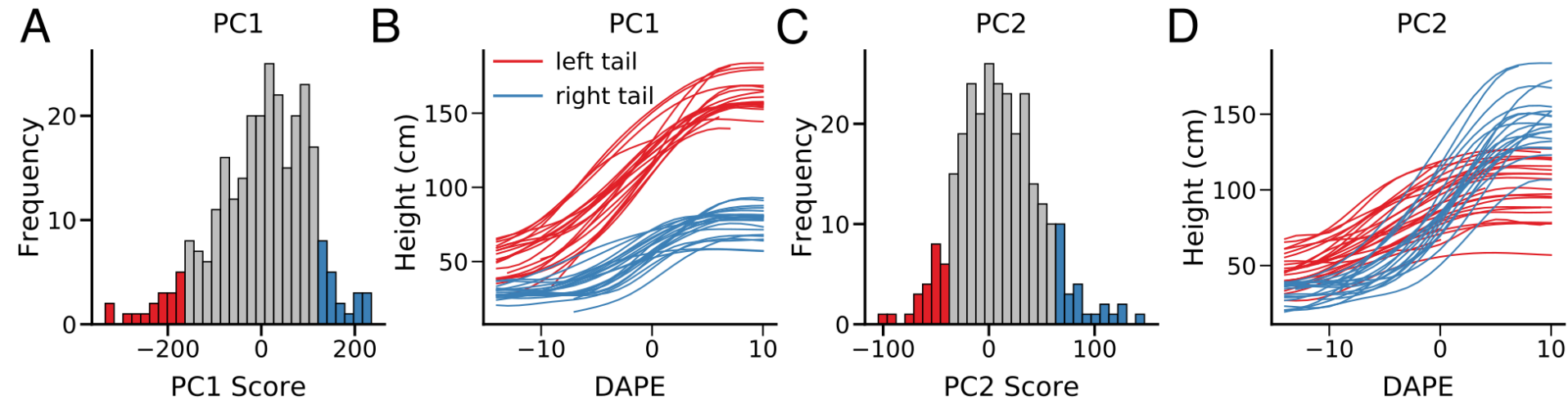
Using FPCA to extract growth patterns (statistics)



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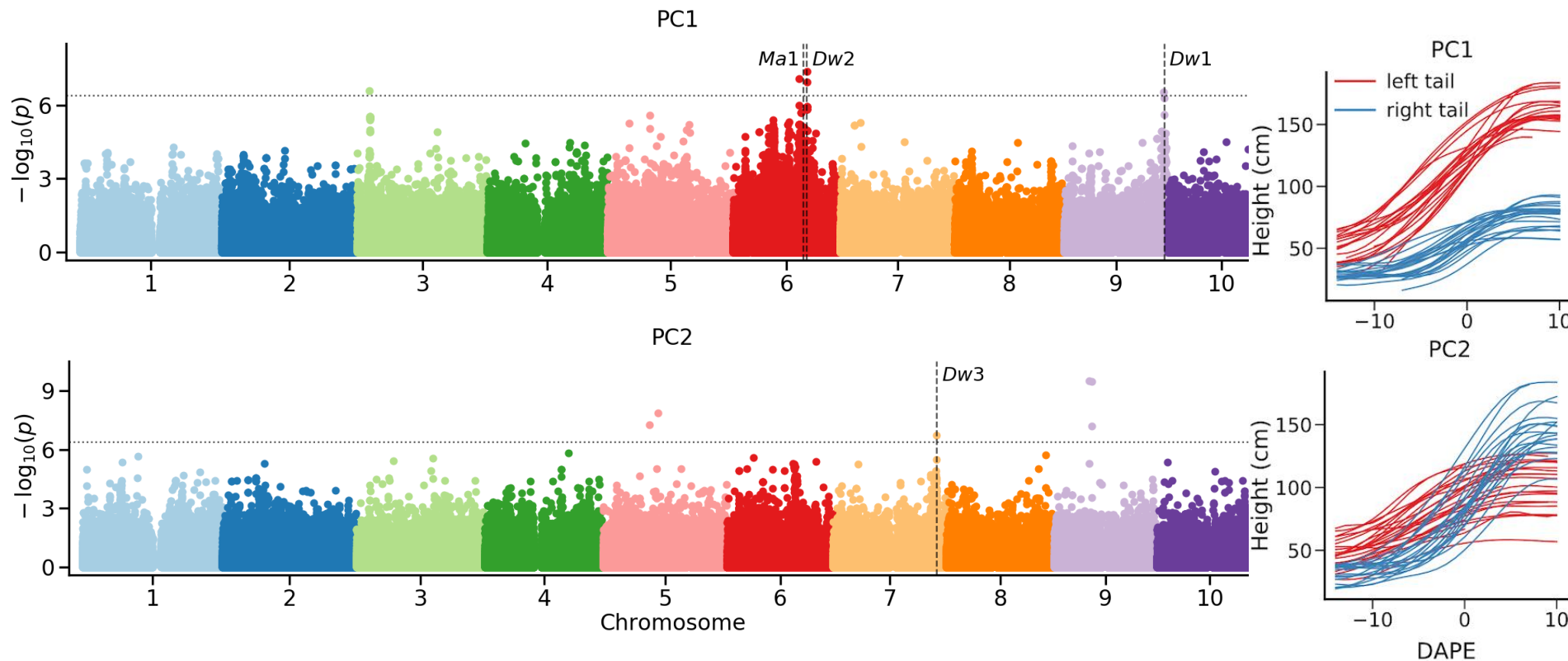
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Using FPCA to extract growth patterns (biology)



Miao et al, bioRxiv, doi: 10.1101/2020.02.16.951467

Map growth patterns using GWAS



Summary

- 1. Organ level segmentation provides opportunities to quantify a wide range of plant traits
- 2. The results from semantic segmentation can be used to map genes controlling the variations
- 3. Time-series data can increase the power and accuracy of GWAS analyses

Thank You



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