

LineageD: An Interactive Visual System for Plant Cell Lineage Assignments based on Correctable Machine Learning

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 Color Modes

 ● By District ○ By Normalized Shared Area ○ By Model Confidence
 ○ Randomized

Explosion Extent



0.0 1.0 2.0 3.0

Interactions

Confirm Wrong Children New Sister Supporting Cell

Predict One Level









Interactions

Confirm Wrong Children New Sister Supporting Cell

Predict One Level

Cell Lineage





Datasets



[1]



1. Julien, Moukhtar, et al. "Cell geometry determines symmetric and asymmetric division plane selection in Arabidopsis early embryos." PLOS Computational Biology 15.2 (2019): e1006771.

Datasets





Datasets





• 3D information

- Temporal Data
- Pair relationships

Cell Lineage





Current Software



[2] Fiji

x=253, y=127, z=47, value=0 16c_Col0_595.tif 48/86; 358x358 pixels; 8-bit; 11MB

[3] Avizo



J. Schindelin, I. Arganda-Carreras, E. Frise, V. Kaynig, M. Longair, T. Pietzsch, S. Preibisch, C. Rueden, S. Saalfeld, B. Schmid, J.-Y. Tinevez, D. J. White, V. Hartenstein, K. Eliceiri, P. Tomancak, and A. Cardona. Fiji: an open-source platform for biological-image analysis. Nature Methods , 9(7):676–682, July 2012.
 G. Trigui, L. Le Corre, D. Honoré and K. Boudehri-Giresse - 2D/3D Imaging - R&D team, GEVES. GEVES uses Avizo software to study and control plant seeds.

Current Software



/---- 50

\----- 30

/---- 38

\----- 17

/---- 135

\----- 134

/---- 132

\----- 131

--- 133

/----- 41

\---- 25

/----- 44

\----- 29

/---- 10

\----- 1

/---- 16

\----- 7

/---- 139

\---- 138

/---- 136

[4] TreeJ



Problem Description



When doing the cell lineage, biologists:

- Has no ultimate truth to the division
- Takes time in assigning big datasets
- Lack of 3D shape references













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Selections:





Interactions

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Predict One Level

3D Representations



Explosion

Target & Sister



Color Modes

By District O By Normalized Shared Area By Model Confidence O Randomized

Explosion Extent

b an	0.5	10	15	20
10.0	0.5	1.0	1.5	2.0

Peeling

0.0 1.0 2.0 3.0

Interactions

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Datasets 🛛 =

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0.0 1.0 2.0 3.0

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Selections:





Target & Sister





2D Abstract Visualizations



[4] TreeJ

























Interaction Process





Machine Learning Model



Binary Classification Problem:

Sisters / Non-sisters

93	47132	12	
embryos	pairs	features	

Sequential Neural Network





Trying out other neighbours for incorrect-assigned cells



Two-direction of building





Cell N									
	Cell N	Cell N-2							
Cell N-4		Cell N-3		Cell N-6		c			
Cell N-14	Cell N-13	Cell N-12	Cell N-11	Cell N-10	Cell N-9	Cell N-8			

.





Two-direction of building







Ν

N-1

N-2





Evaluation

G



5 Biologists









Biologists take time in learning the functionalities.

Biologists used both the 2D hierarchy and 3D views.

They valued the visual representations (3D and 2D).





 Biologists thought LineageD helps to better understand the embryo's development.

Experts would experience more to evaluate the machine learning experience.

Limitations and Future work



The actual shapes of cells in the higher generation is an approximative surface reconstruction.

We used one model for predicting assignments.

A longer-term evaluation could probably bring new insights on the tool usage.

Main Takeaways



- It is essential to combine 3D representations with 2D abstract representations to solve the lineage problem
- The biologists' traditional habits largely influence their behaviours in the evaluation study
- The two-direction assigning process helps biologists to control the interactions and gain confidence in the results



Thanks for watching!



Project Link



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