



Visualizing and Comparing Machine Learning Predictions to Improve Human-AI Teaming on the Example of Cell Lineage



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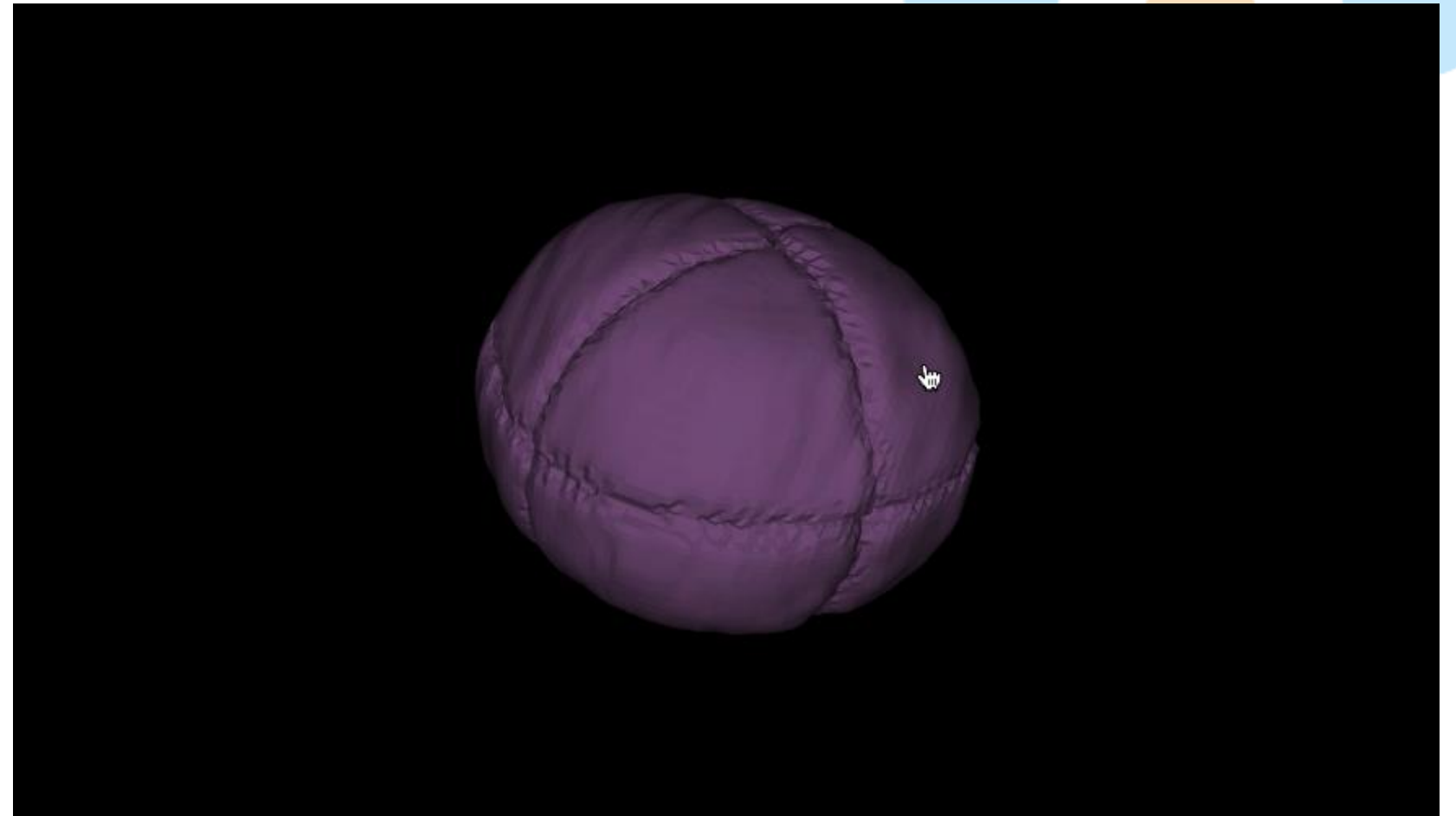
Alain Trubuil, Université Paris-Saclay, InraE, France

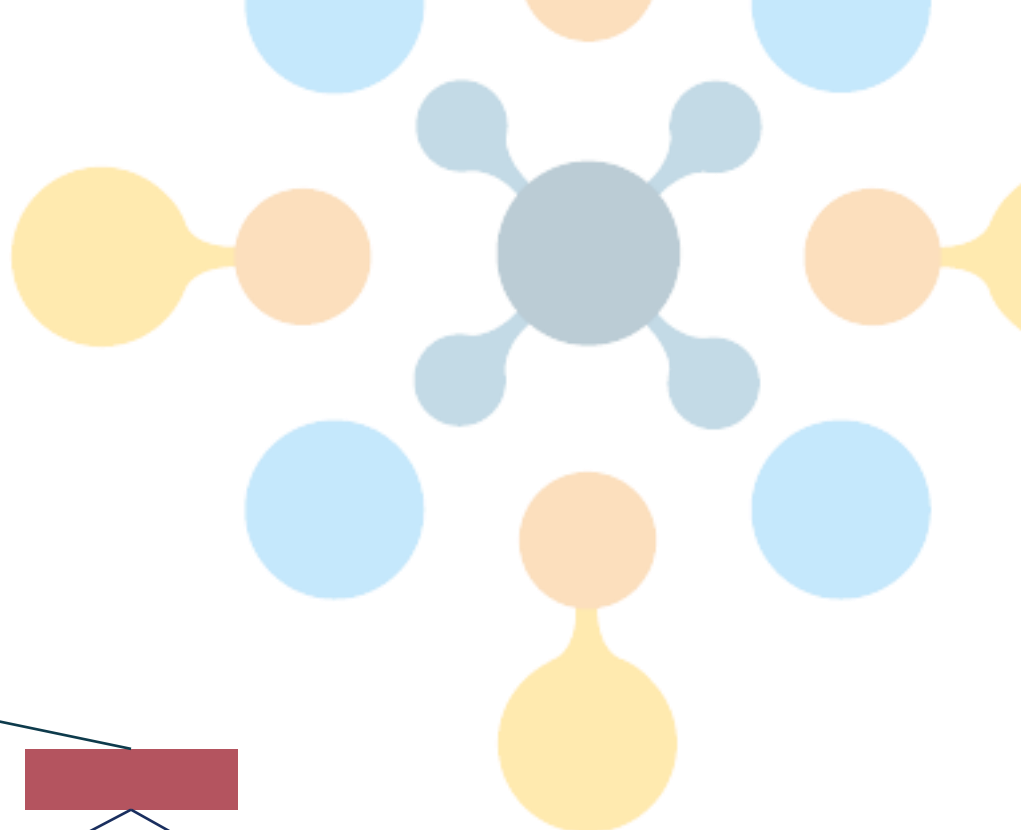
Tobias Isenberg, Université Paris-Saclay, CNRS, Inria, France

Background Introduction

Plant Cell Lineage

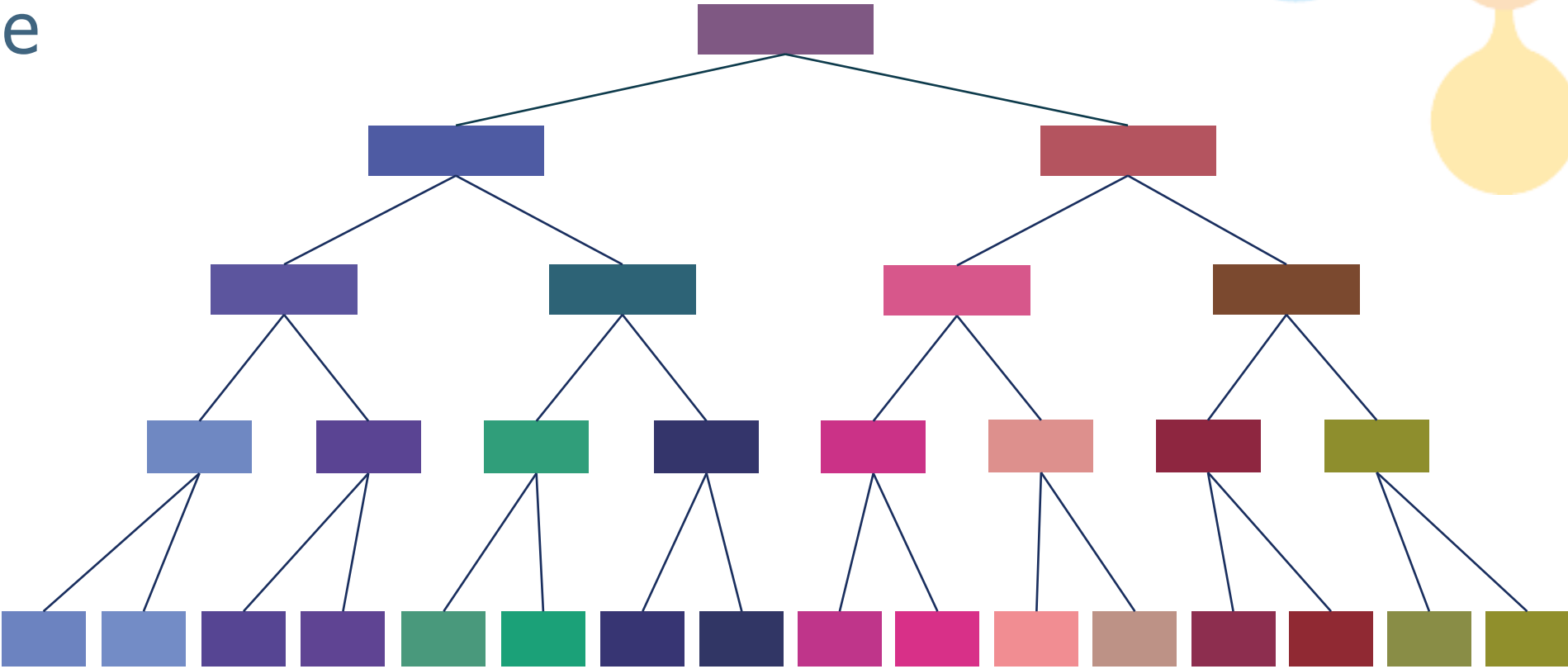
The development history of plant embryos.

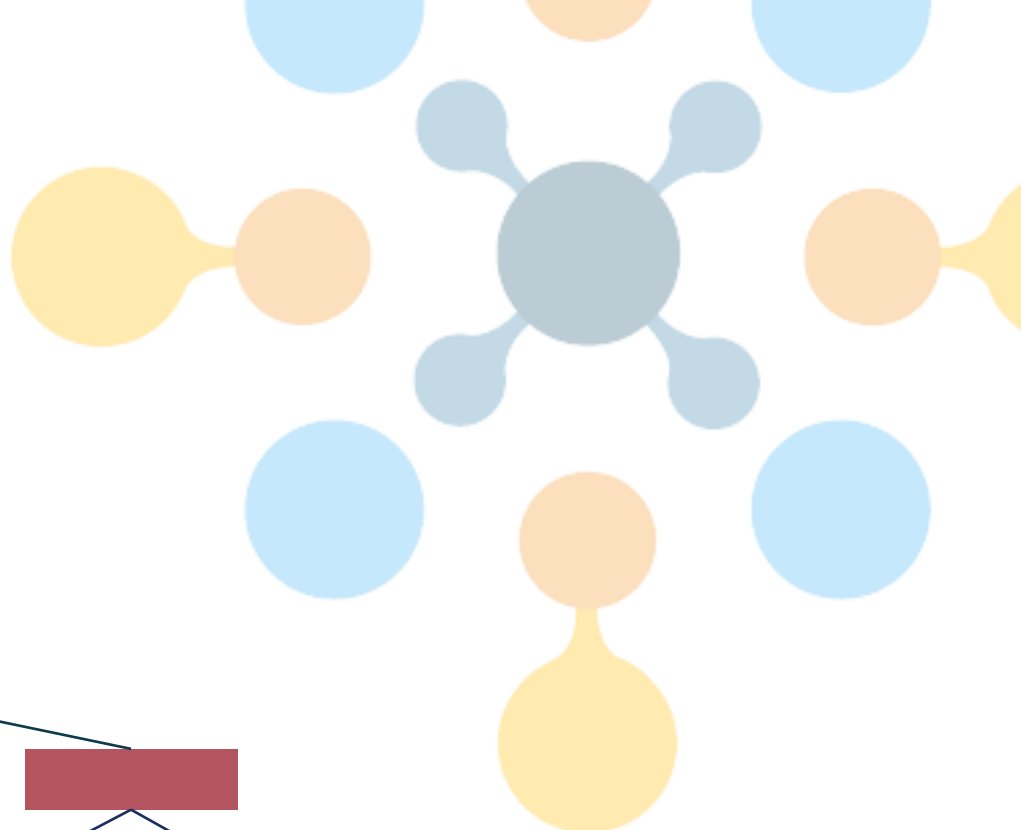




Background Introduction

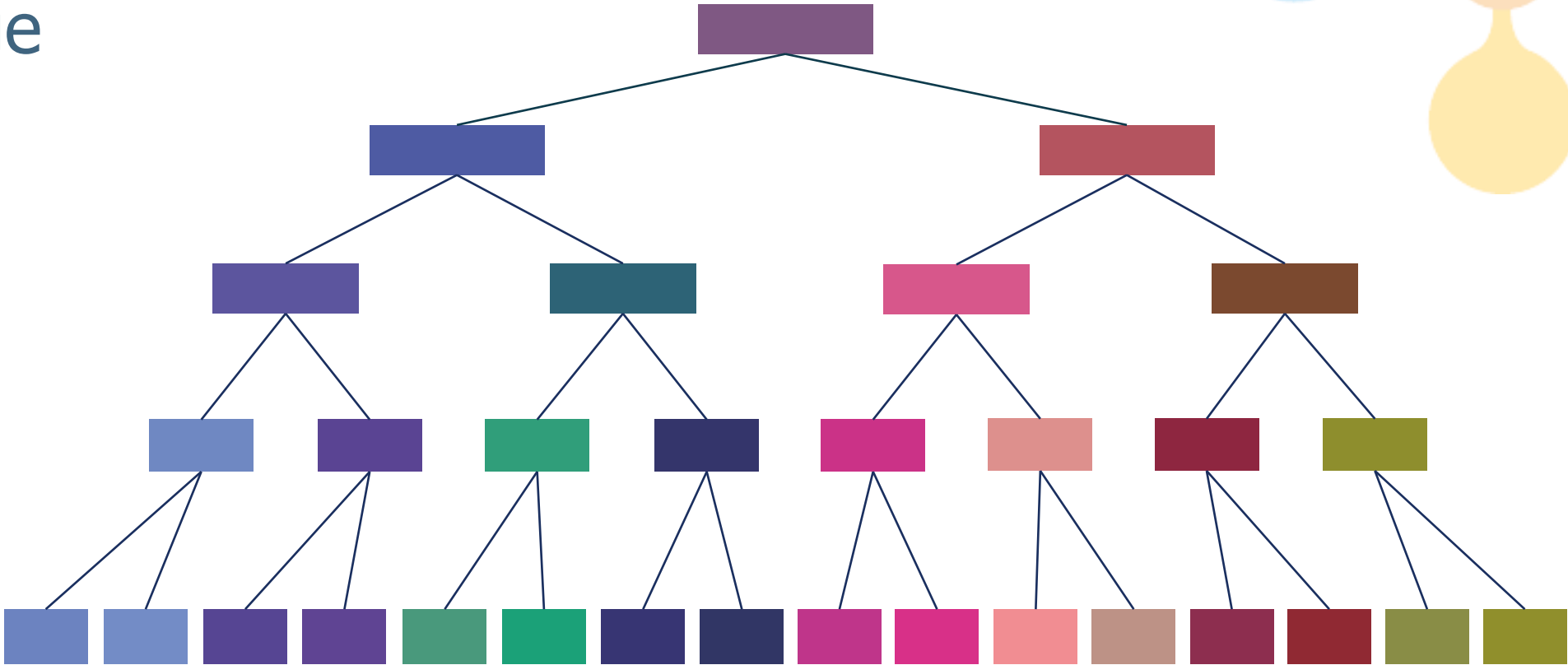
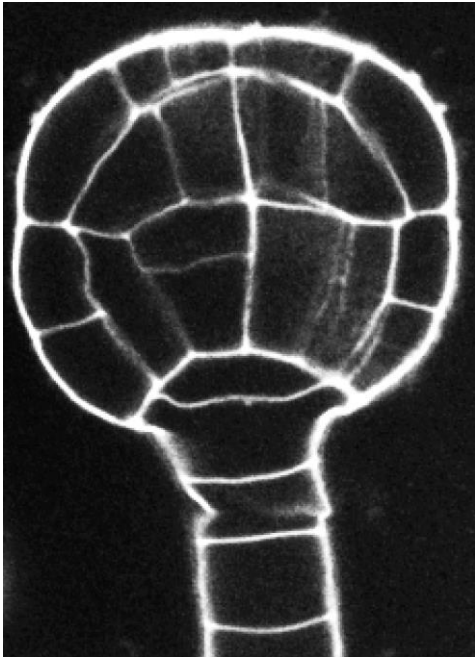
Plant Cell Lineage





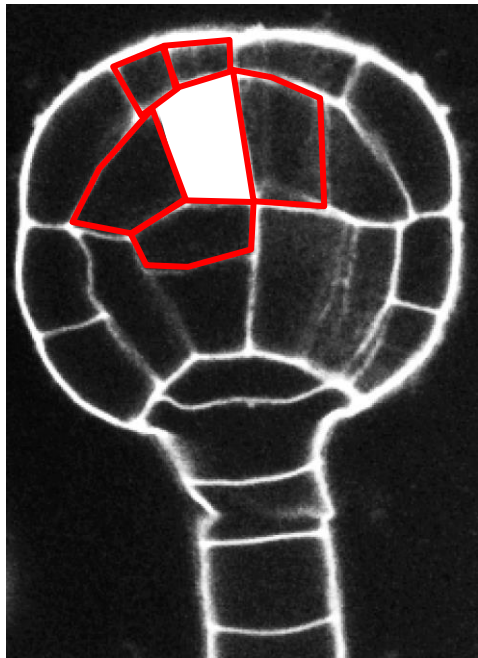
Background Introduction

Plant Cell Lineage



Background Introduction

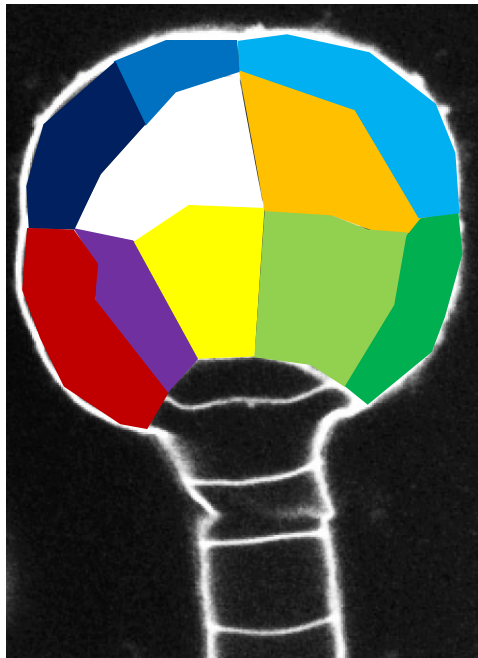
How to do cell lineage manually?



- Biologists need to find the right sister cell for every cell in an embryo.

Background Introduction

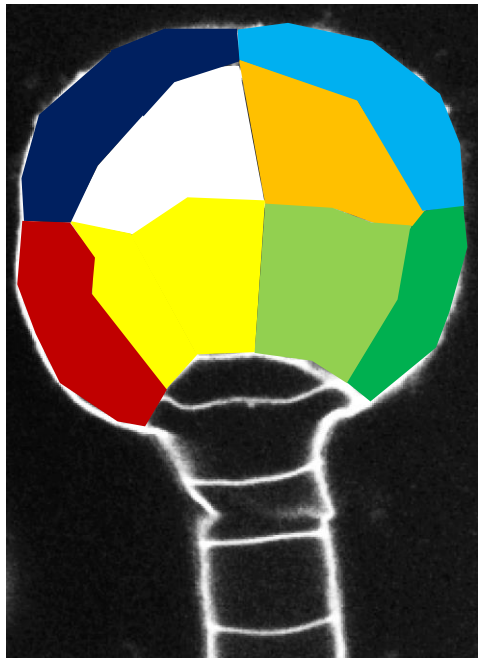
How to do cell lineage manually?



- Once decided, they would merge cells and continue assigning the remaining cells.

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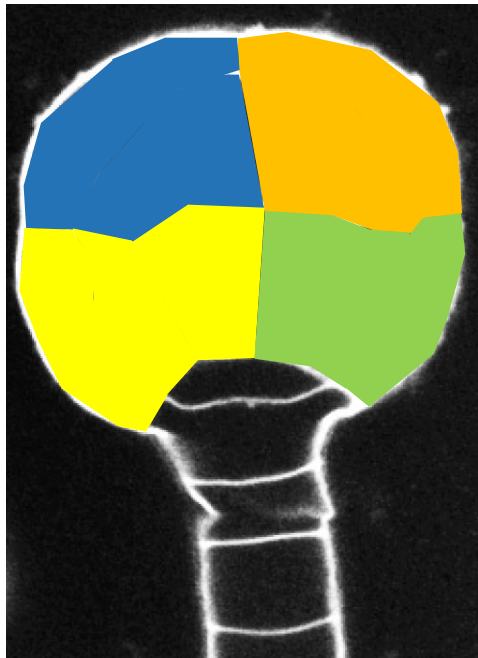
How to do cell lineage manually?



- Biologists will continue this process to the new generation until there is only one cell left.

Background Introduction

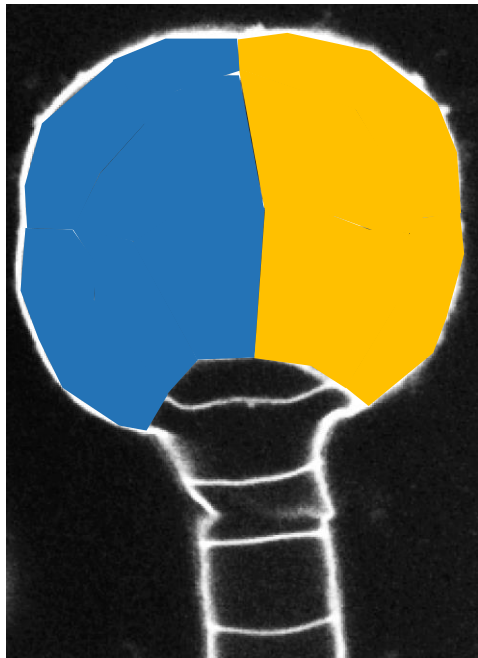
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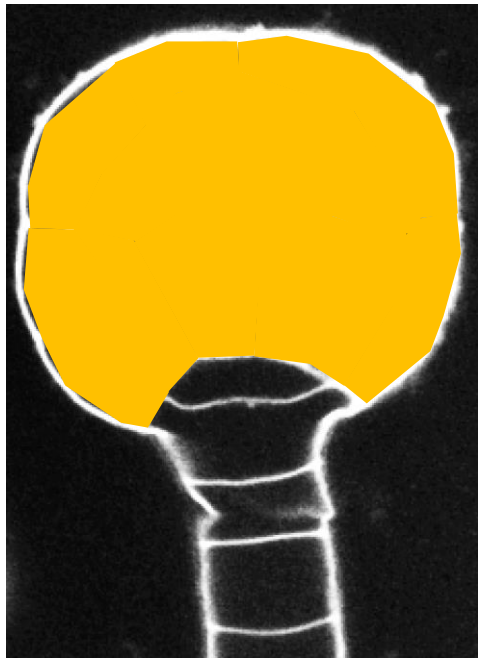
How to do cell lineage manually?



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Background Introduction

How to do cell lineage manually?



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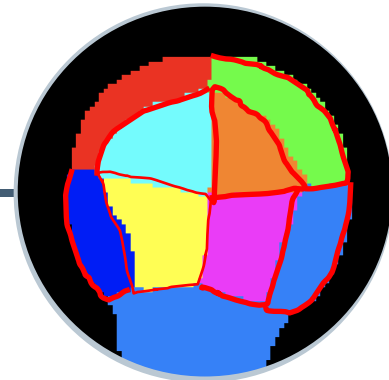
Background Introduction

Traditional workflow

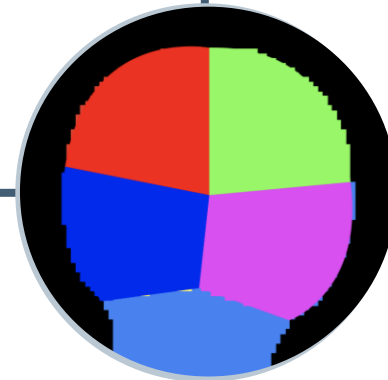
Get segmented
2D slices



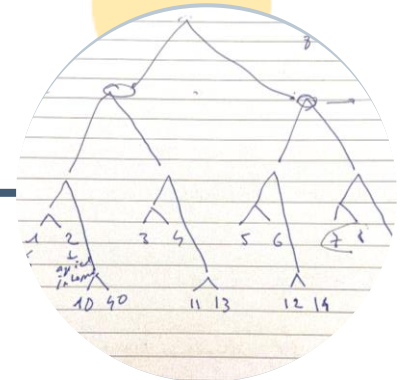
Check every cell



Manually find the
sister for each cell



Write down the
hierarchy on paper



Background Introduction

Challenges

- **Time-consuming**
An embryo can be large.
- **Tedious**
The cell assignment is repetitive.

Machine Learning

Limited Training Datasets



Create the
"best" model



Enable users to
make choices

Approach

Human-AI Teaming



Make use of
machine learning

We need to try our best
to improve ML
performances.



Allow people to
control the results

Human beings should
have full control over
the final decisions.

Approach

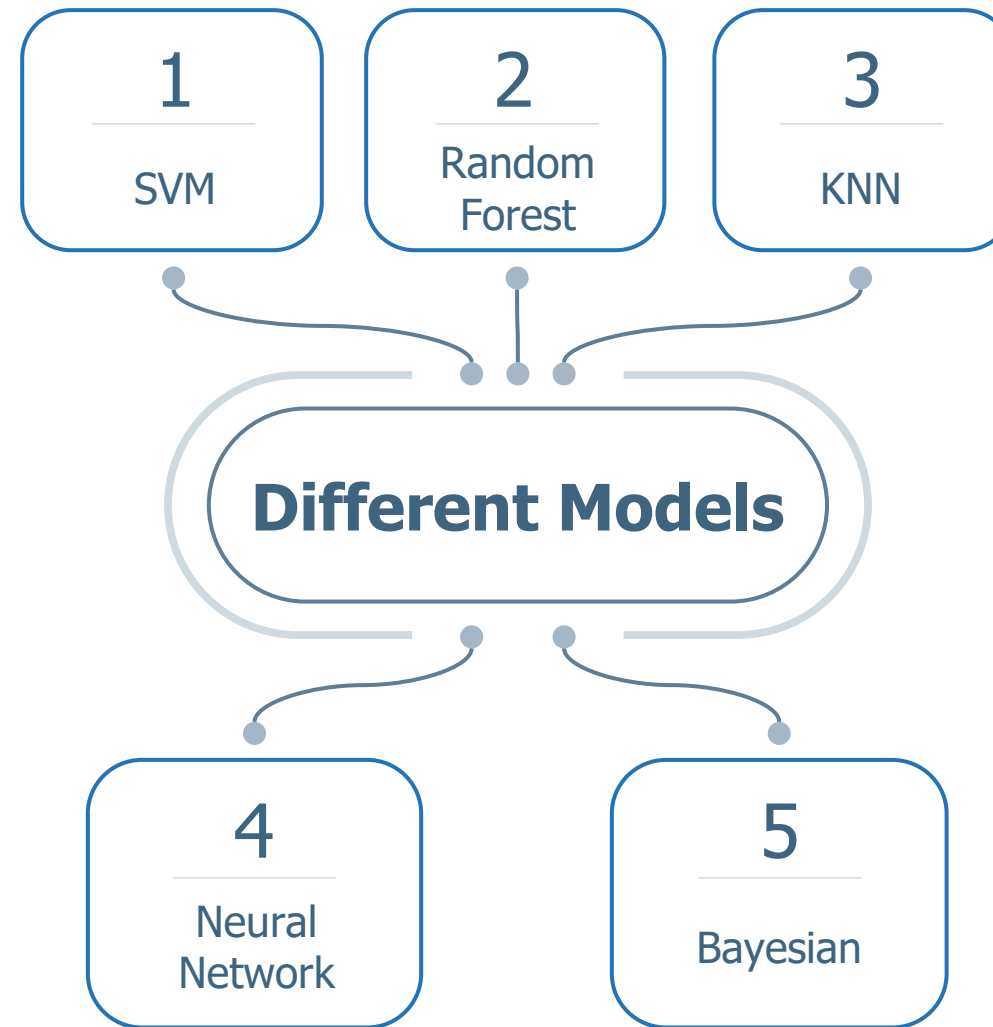
Human-AI Teaming



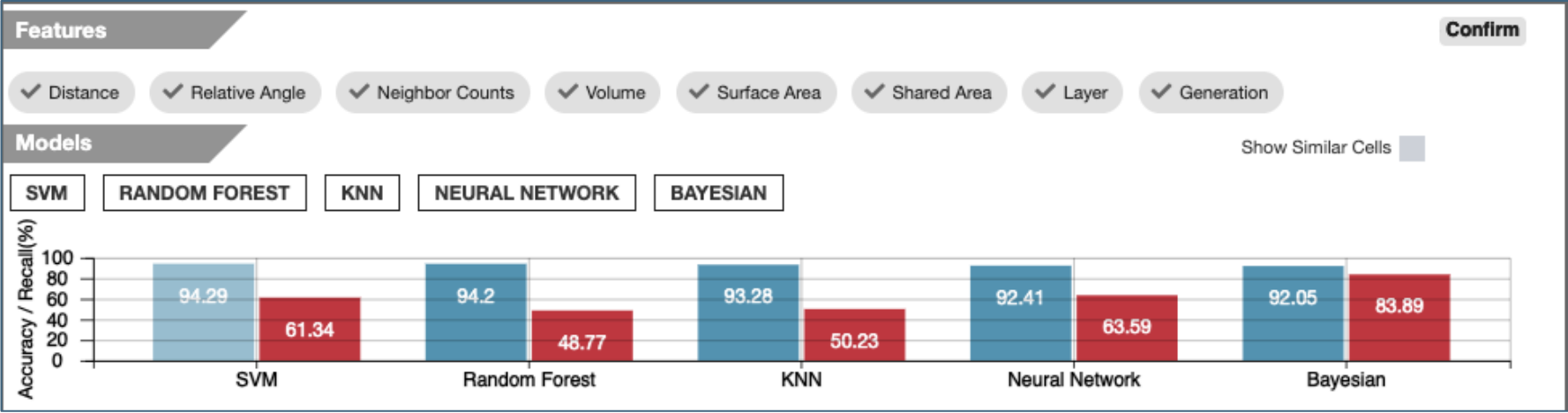
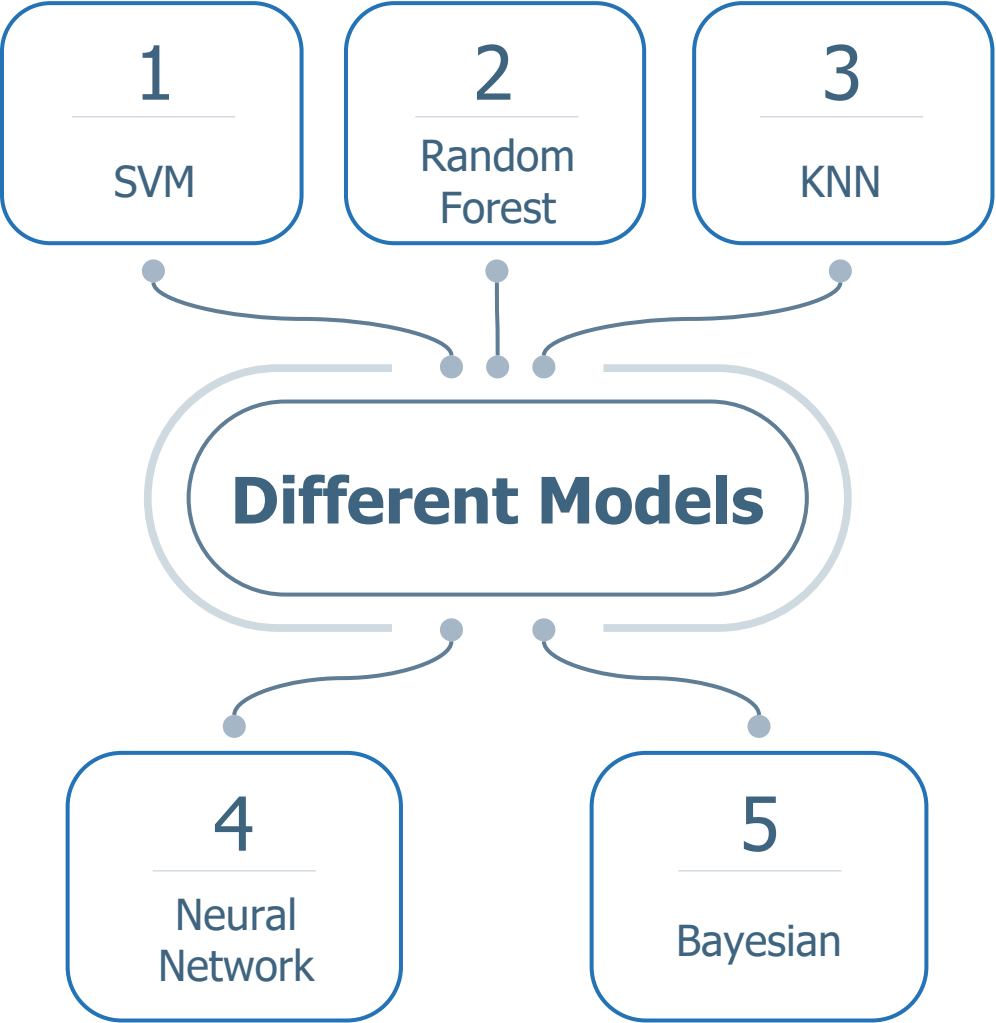
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Model Training



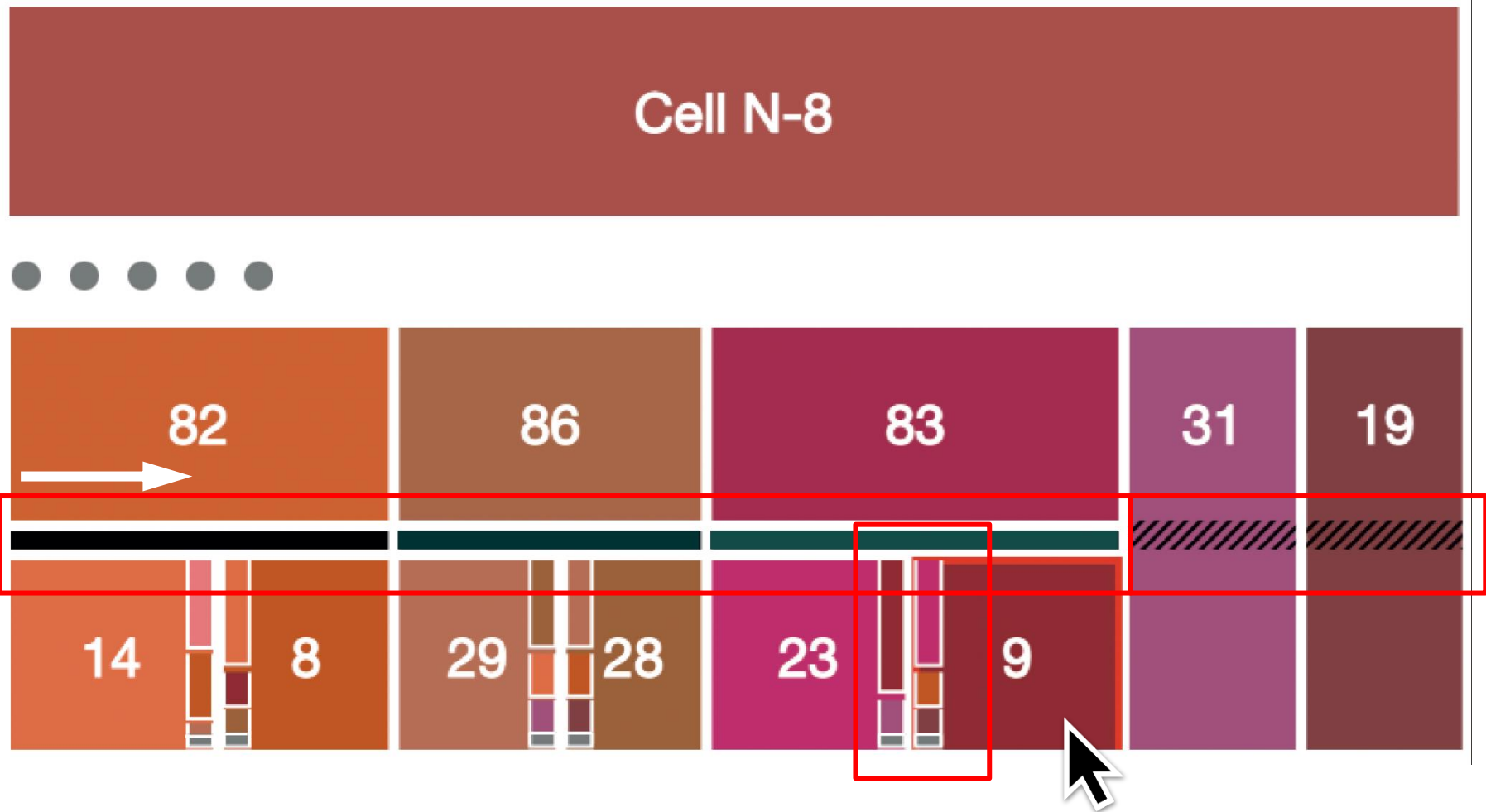
Model Training



Accuracy

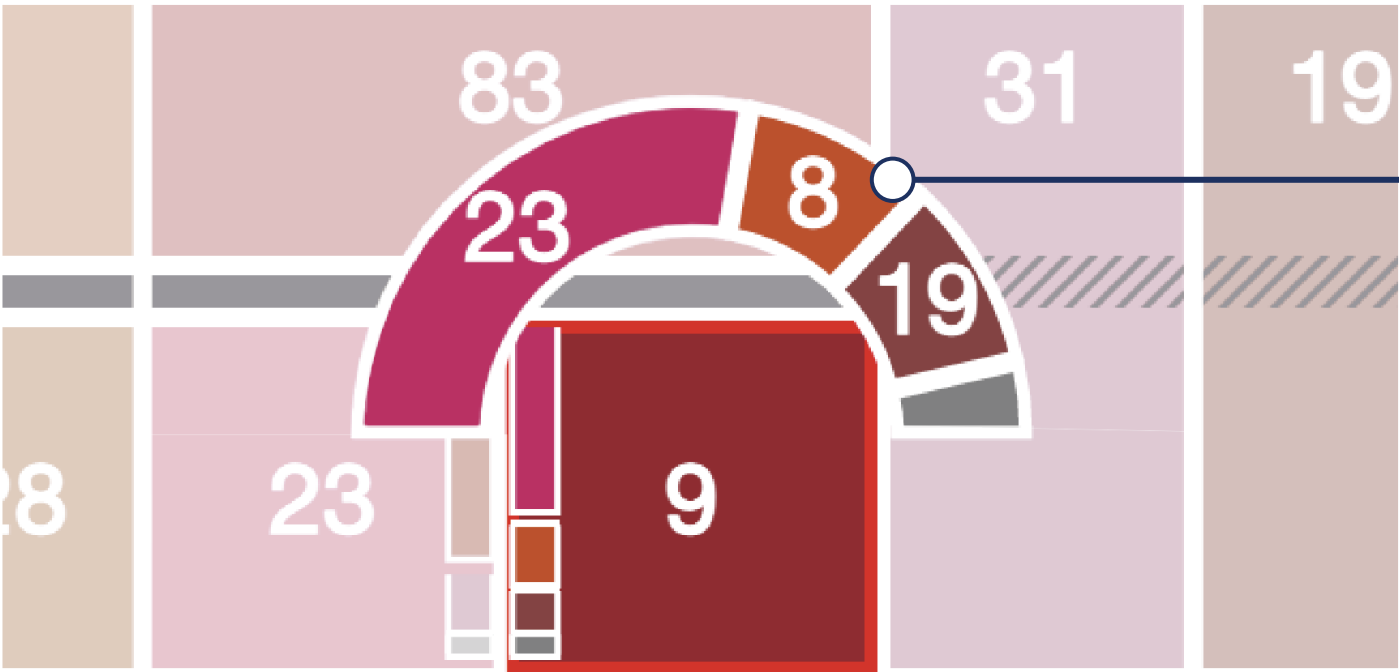
Recall

Prediction Visualization



Combining the prediction results from five models, we visualized them with stacked bar charts on each node.

Prediction Visualization



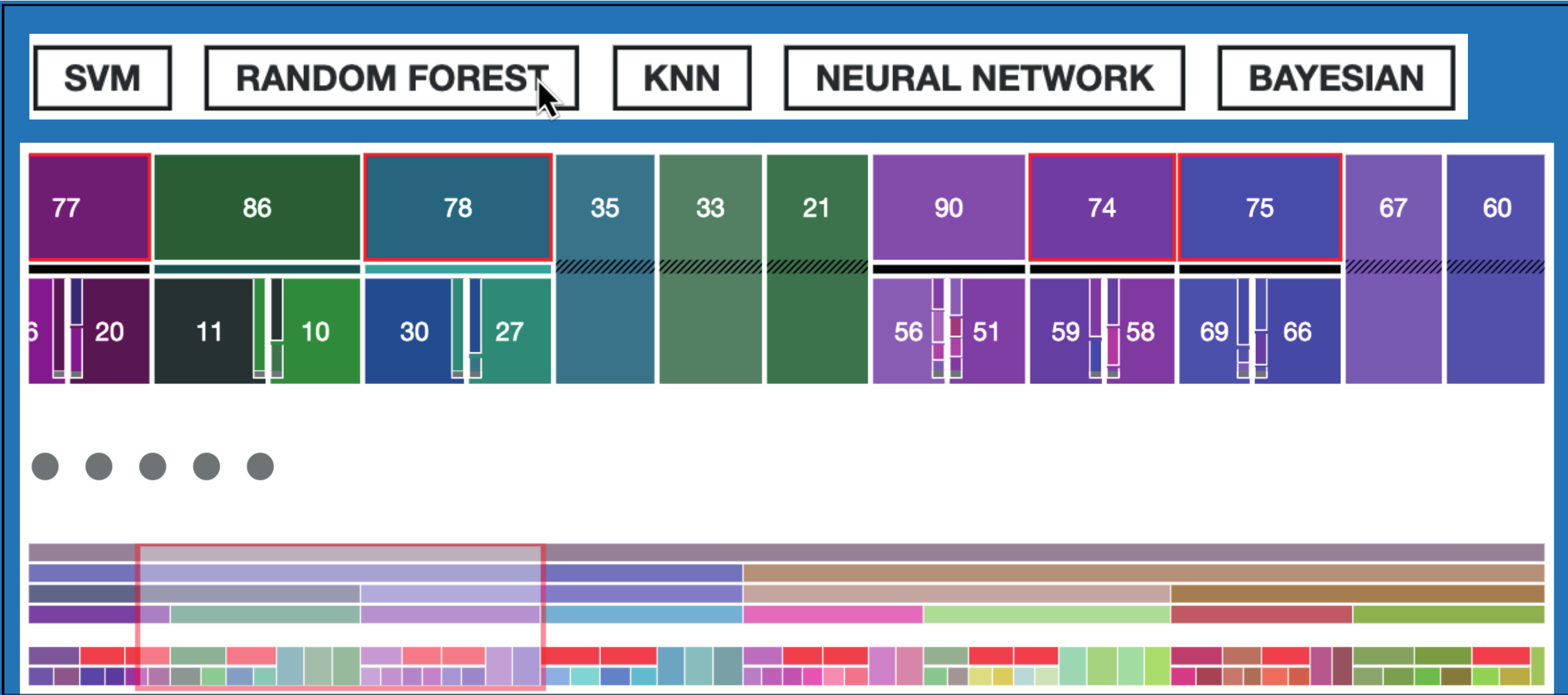
All predicted sisters

Vertical thumbnail of all predictions



All the other neighboring cells

Individual Model Prediction



Approach

Human-AI Teaming



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Allow people to
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Human beings should
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Approach

Human-AI Teaming

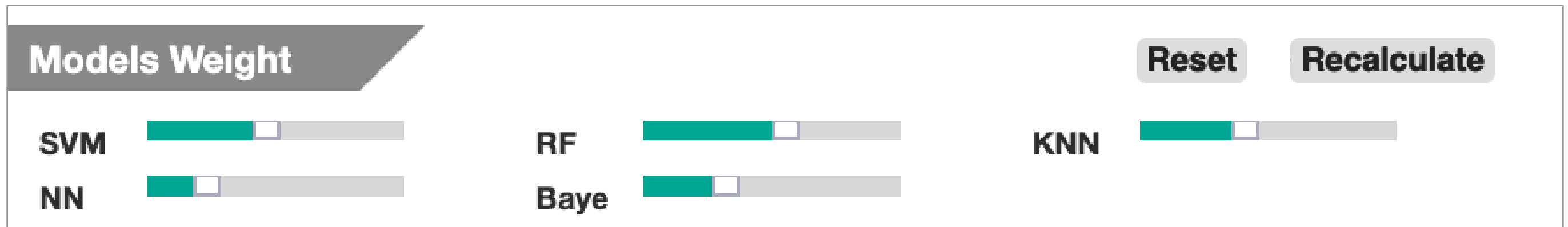


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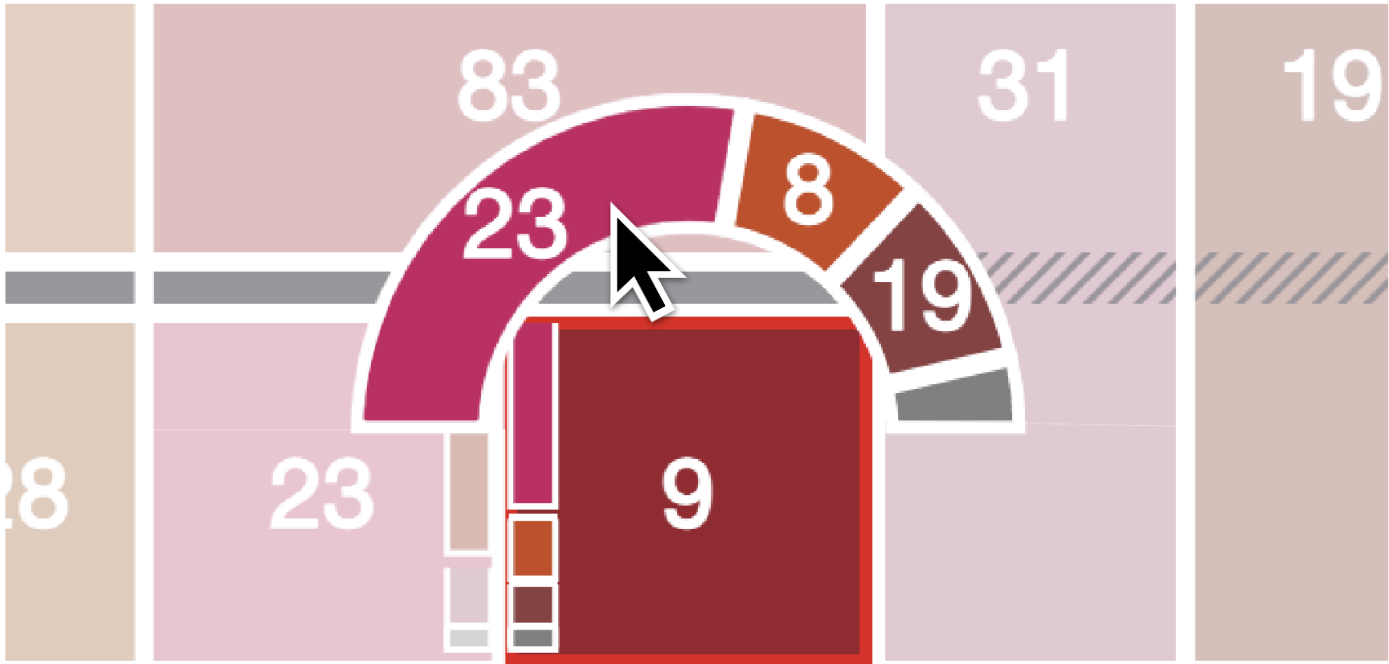
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Models Weight

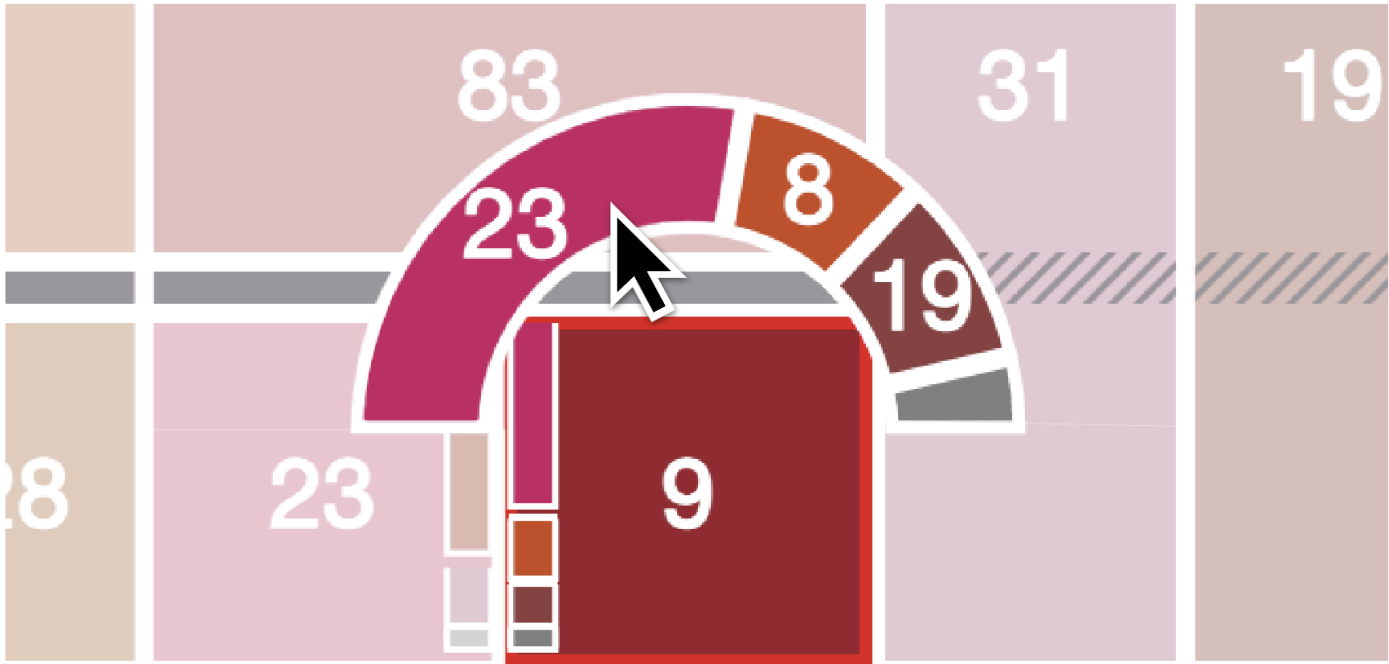
- The overall predictions for each cell.
- The visualization of model prediction confidence.



Prediction Visualization



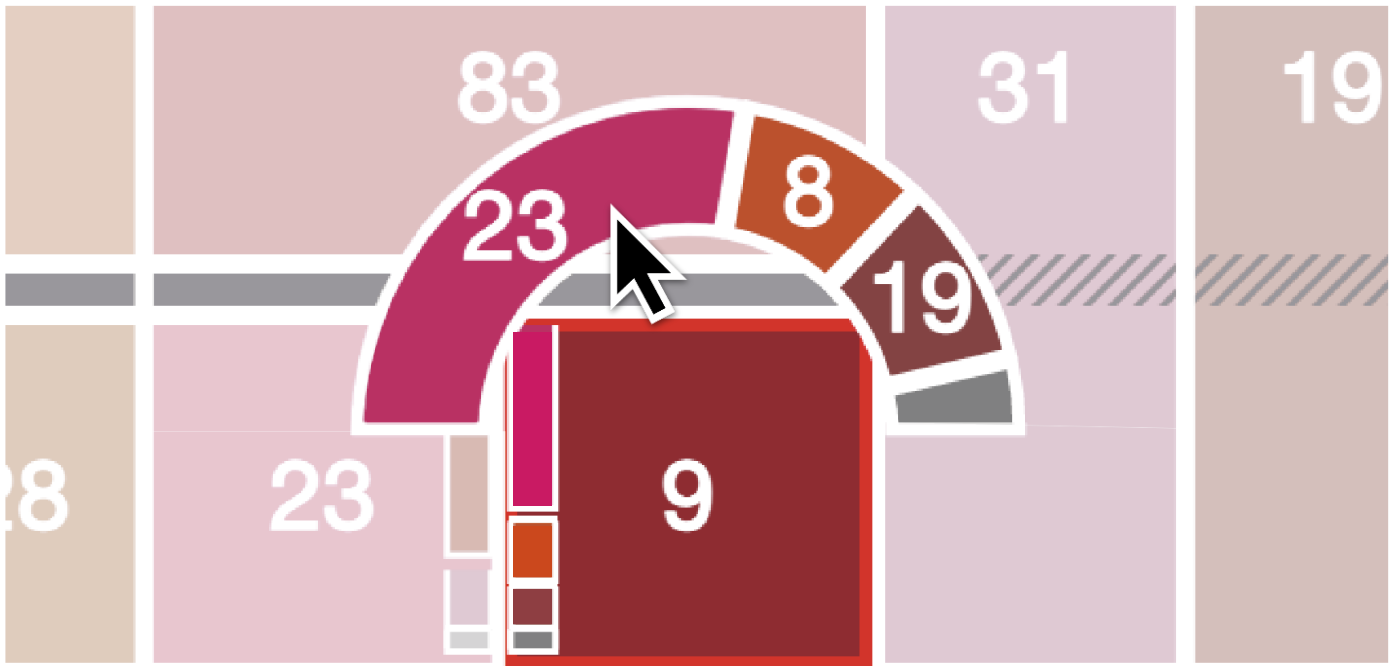
Prediction Visualization



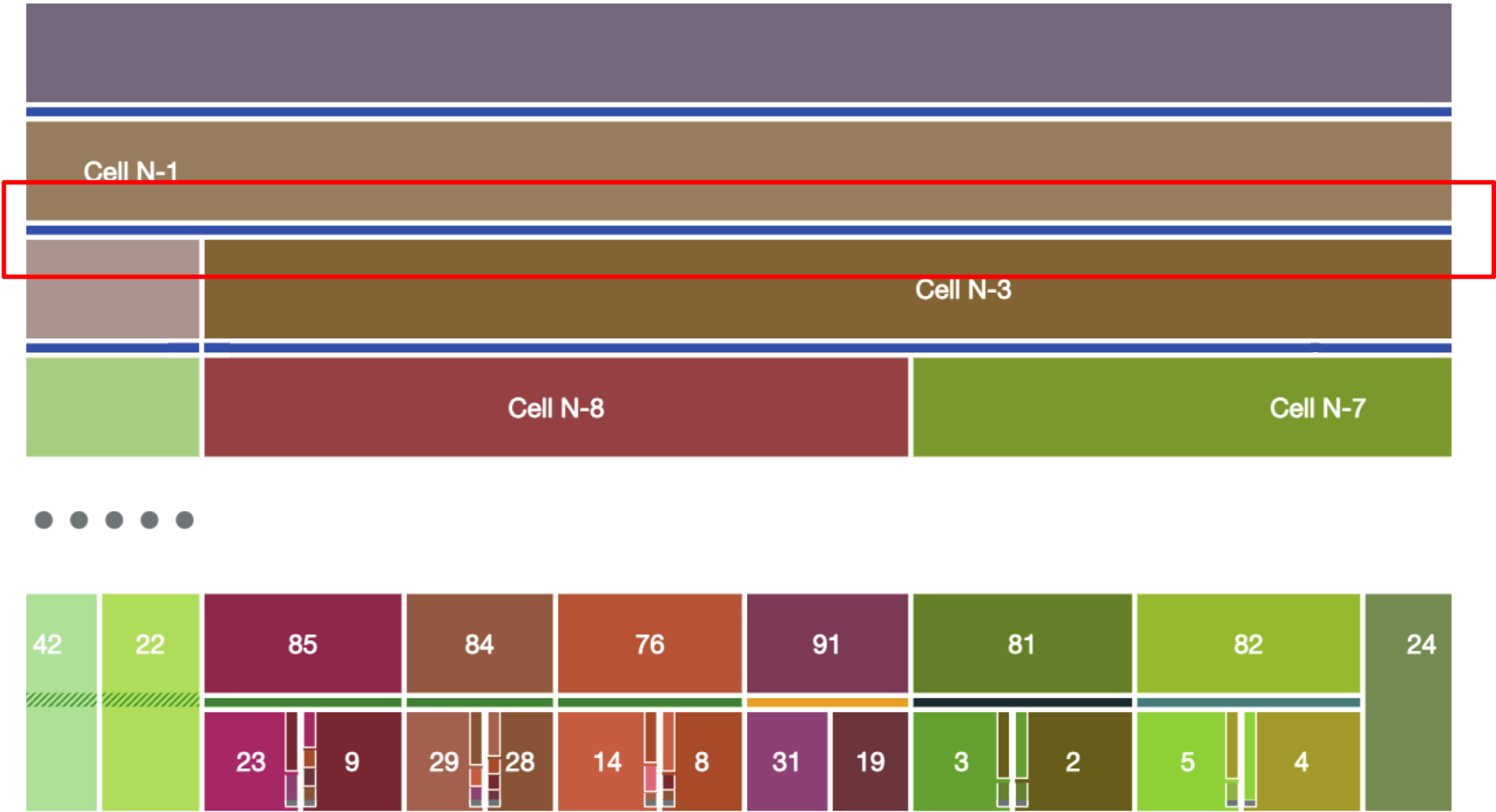
neuralNetwork	
knn	
bayesian	
svm	
randomForest	



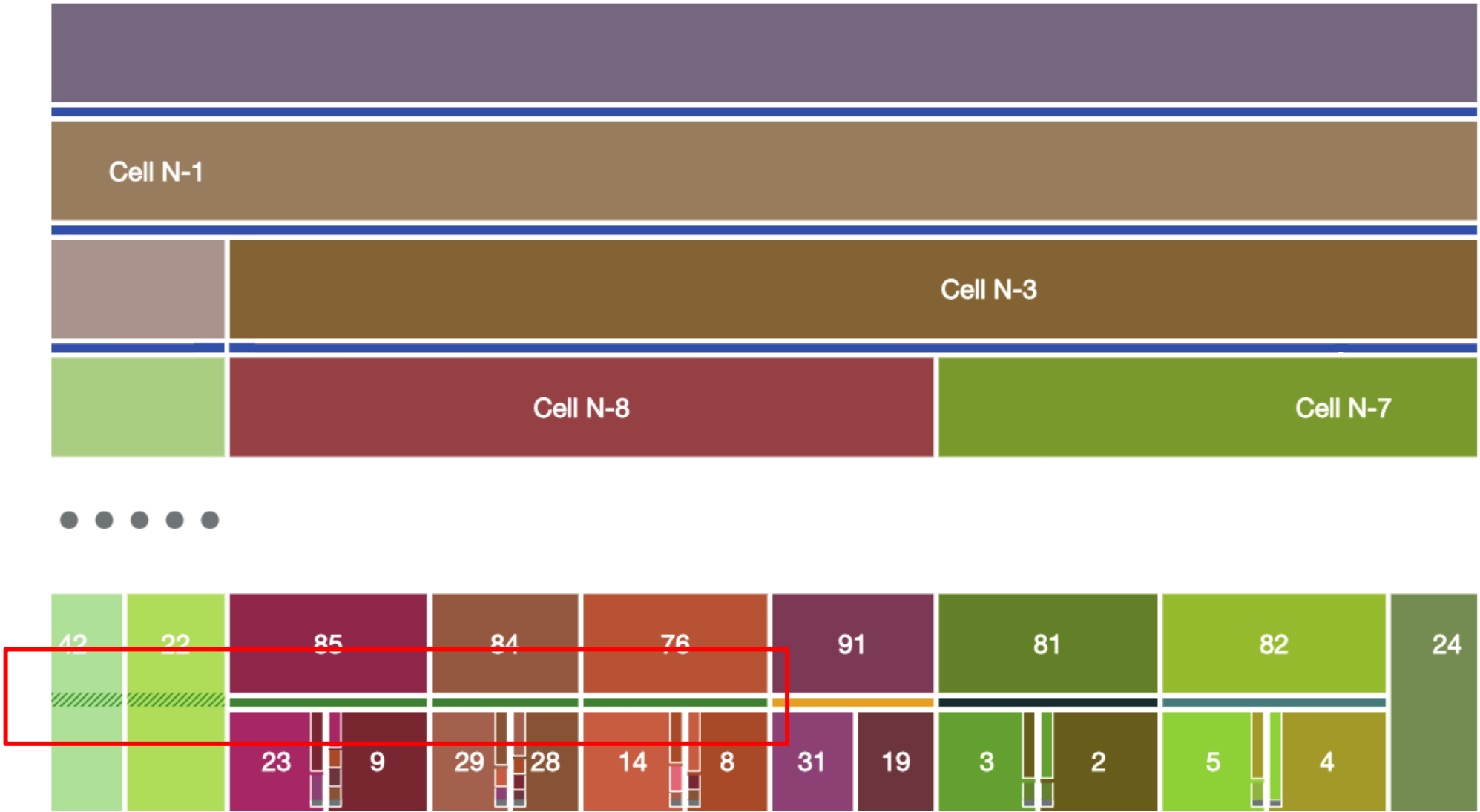
Prediction Visualization



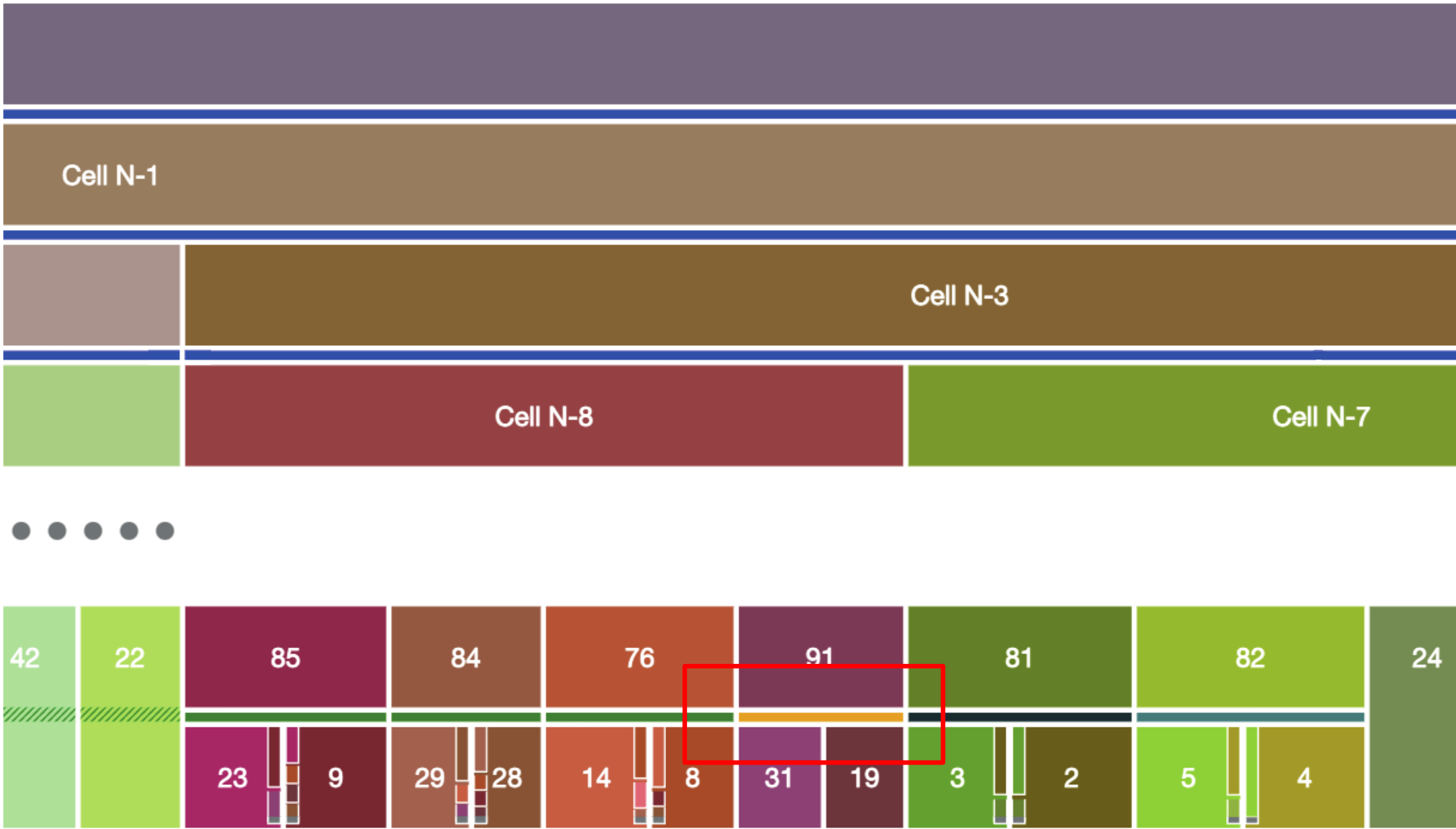
Differentiate Manual Assignments



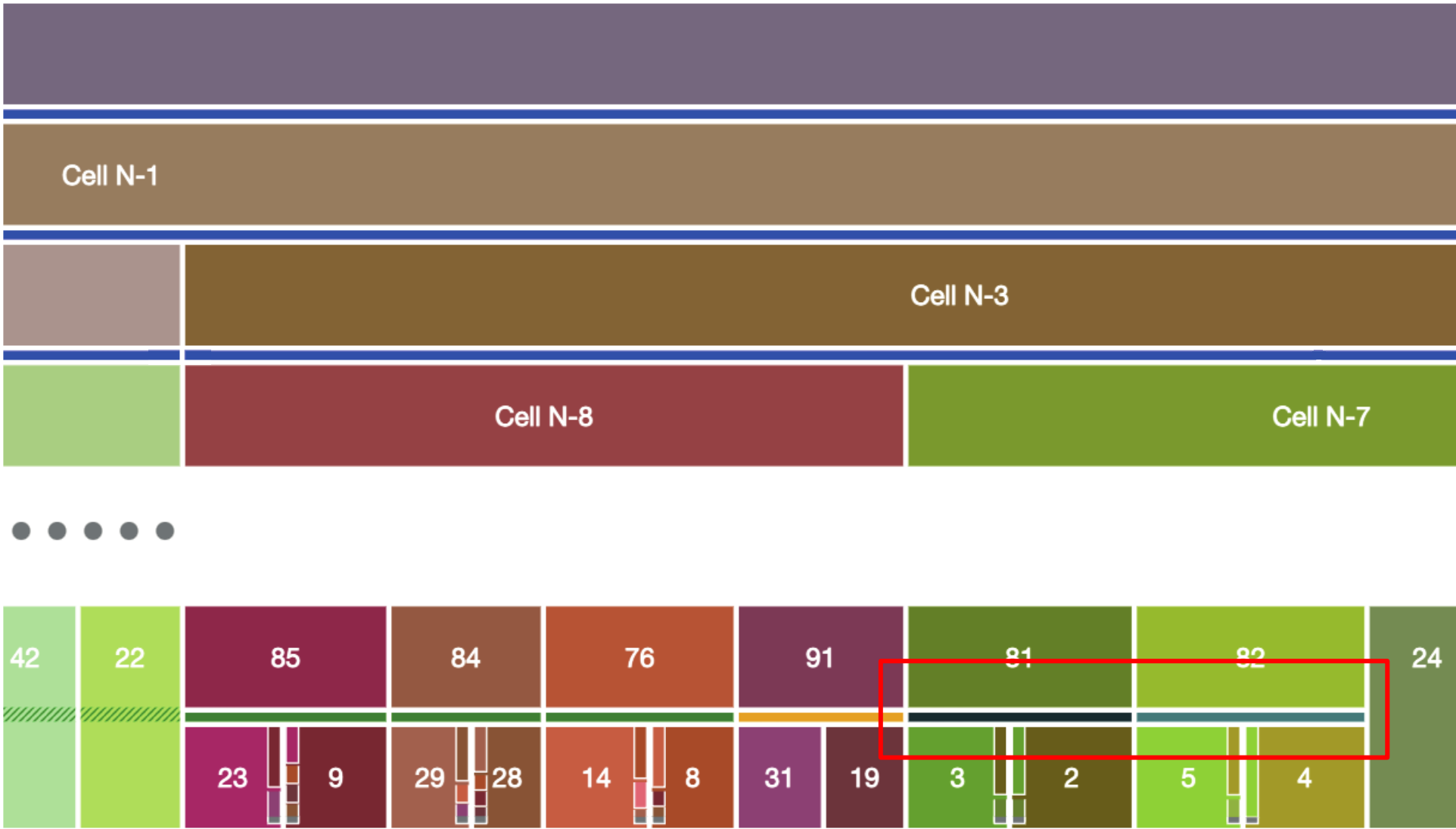
Differentiate Manual Assignments



Differentiate Manual Assignments



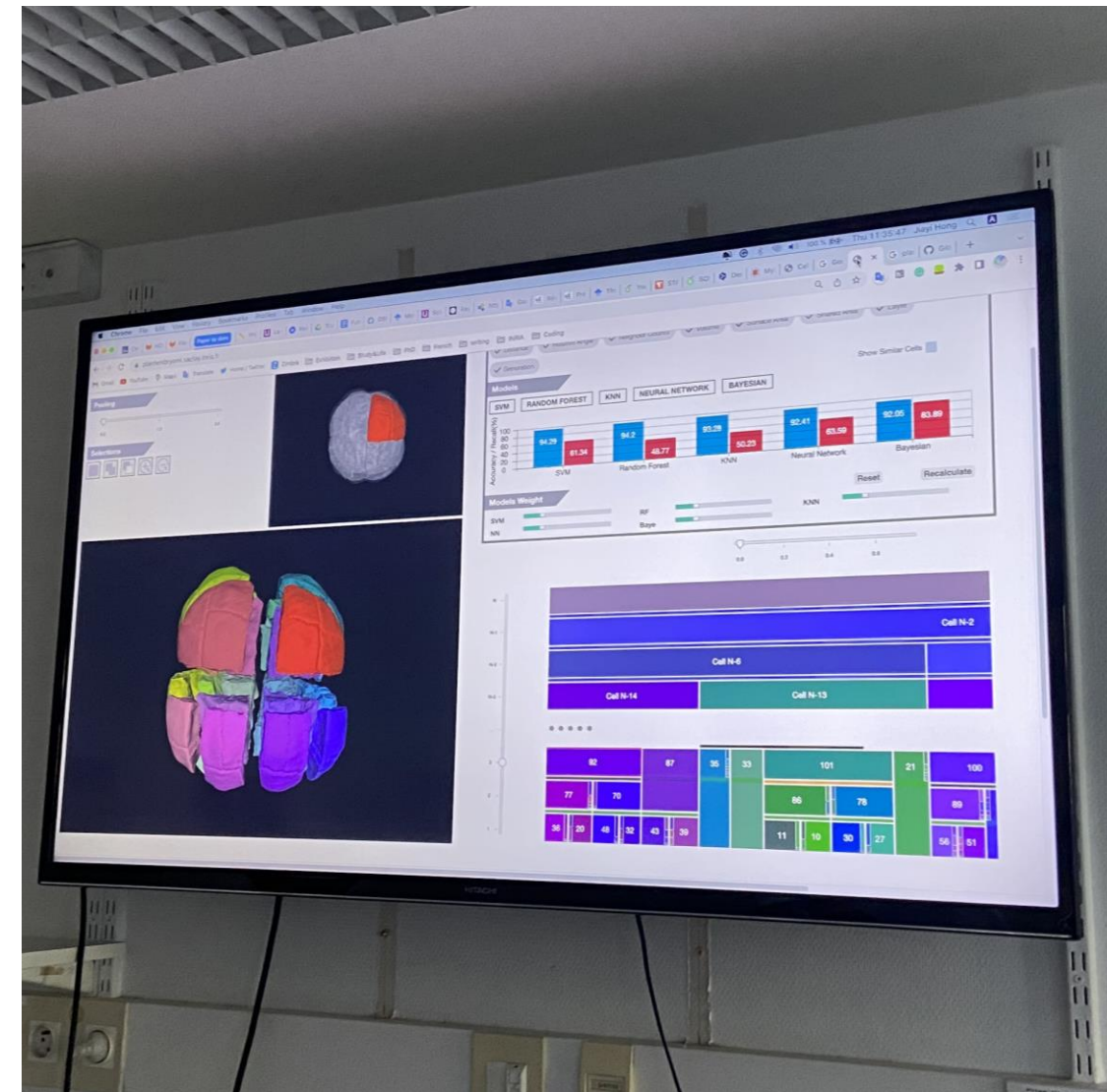
Differentiate Manual Assignments



Evaluation Study

Study Design: Six Biologists

- Training session using a 16-cell embryo
- Observational Study using a 64-cell embryo
- Post-study Interview

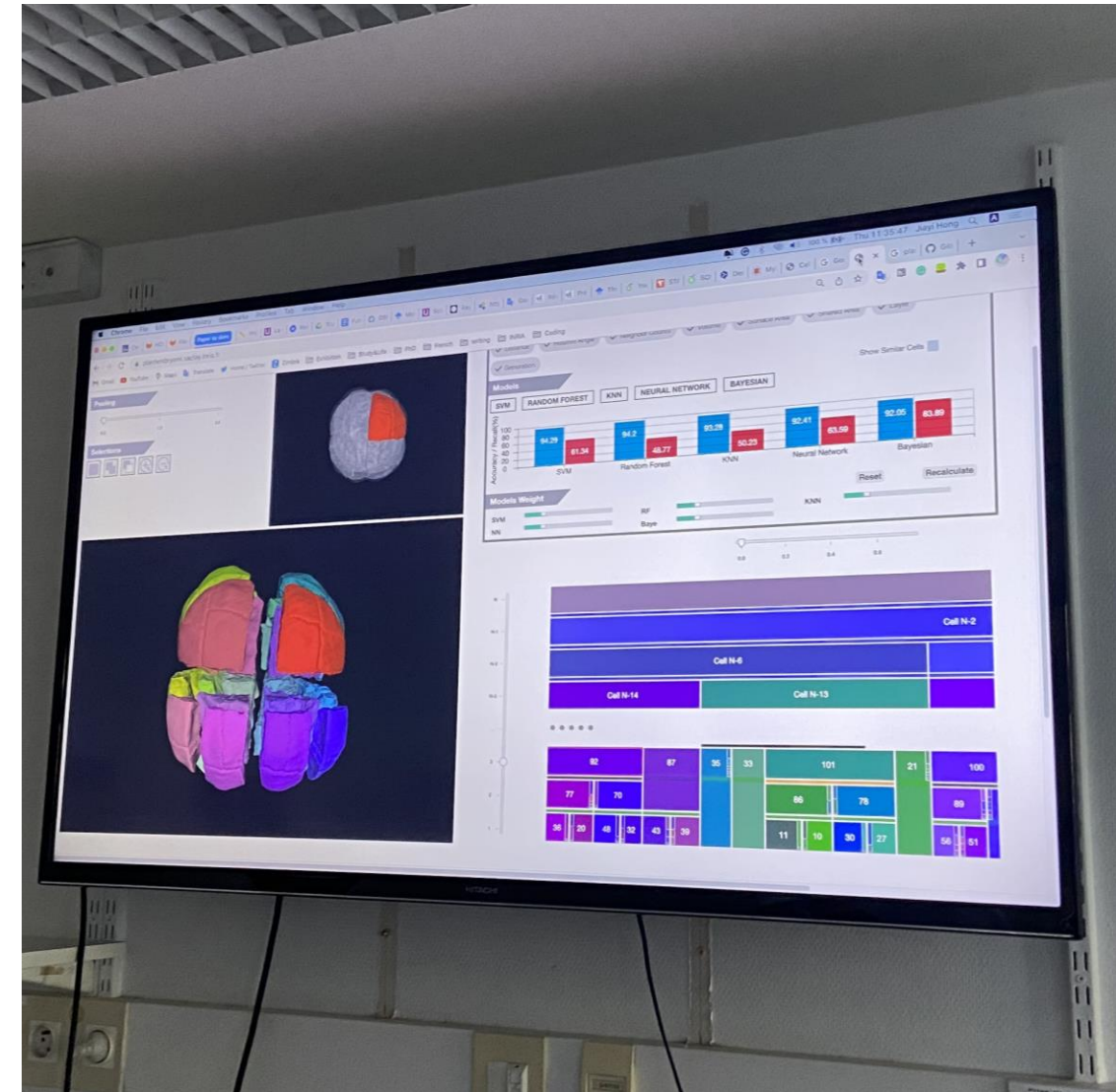


Evaluation Study

Six Biologists

Results

- Biologists appreciated the prediction results and their visualization.
- They thought LineageD+ could help save time and change the traditional approach they used in the assignment process.
- One biologist expressed that interacting with ML made her feel like she was discussing with the computer in making decisions.





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[Thank you for watching!](#)

