Visualizing RNA velocity

Genomic Data Visualization

Lyla Atta

03/07/2022

Visualizing RNA Velocity

RNA velocity recap

Visualizing RNA velocity - previous approaches

VeloViz: RNA velocity-informed low dimensional embeddings

Try it out!

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- Visualizing RNA velocity - previous approaches
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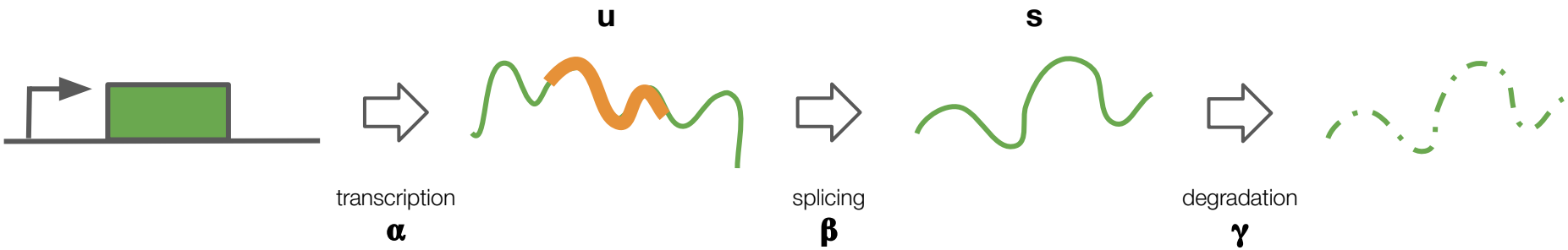
RNA velocity recap

Assign directionality to transcriptomic states

Relative quantities of spliced and unspliced

Rate at which genes are being expressed

RNA velocity: spliced and unspliced RNA levels indicate changing gene expression



La Manno, et. al. Nature 2018

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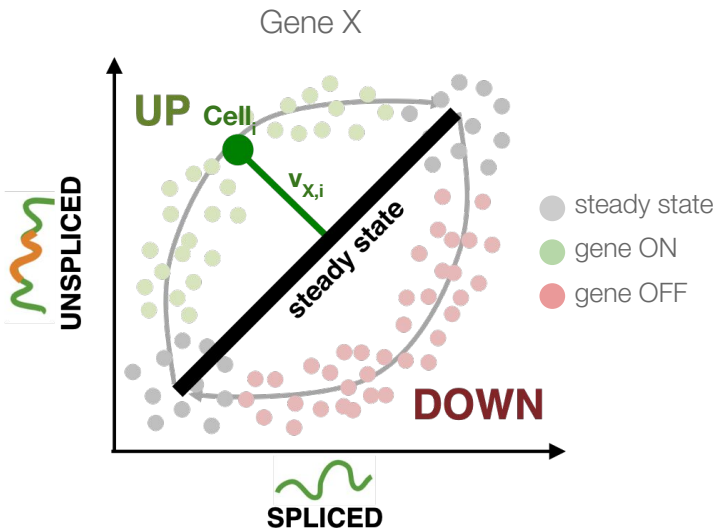

$v_{X,i}$ = **velocity** for gene X in cell i

RNA velocity estimation: Bergen et. al. Nat. Biotechnol. 2020

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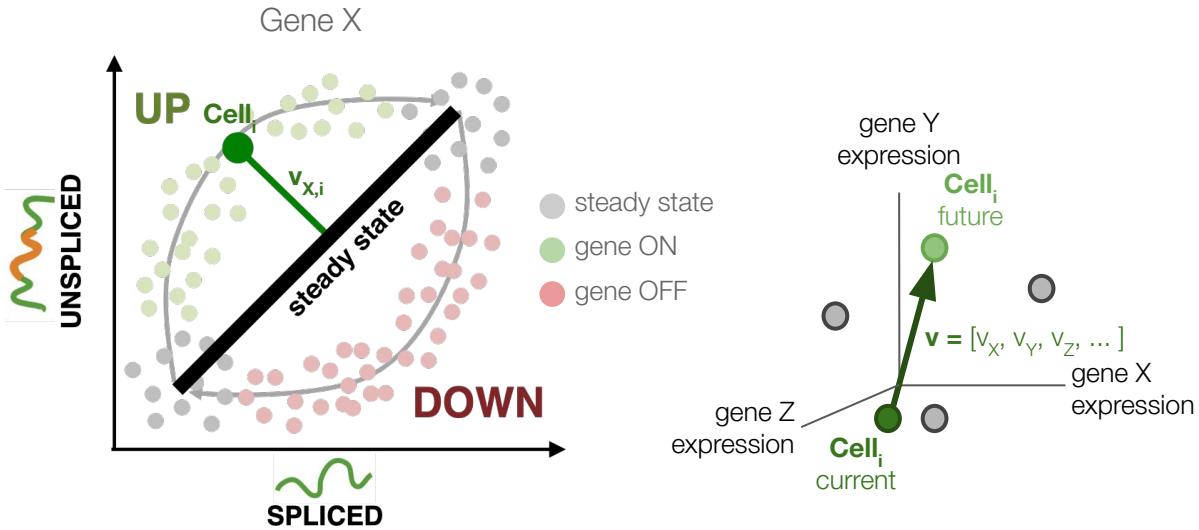

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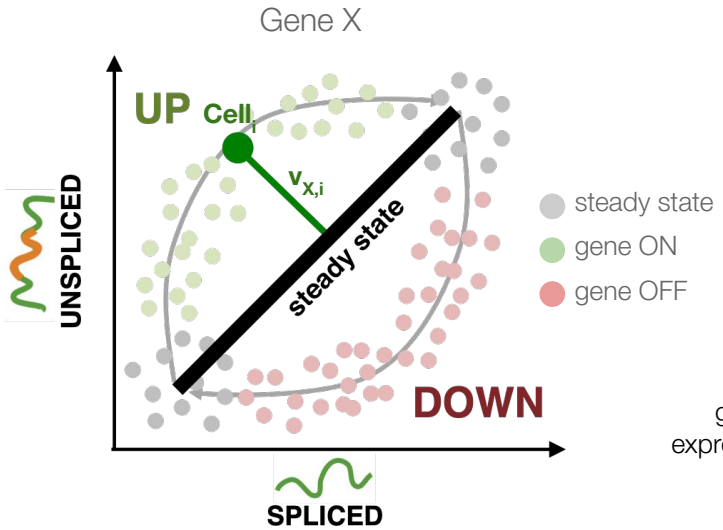

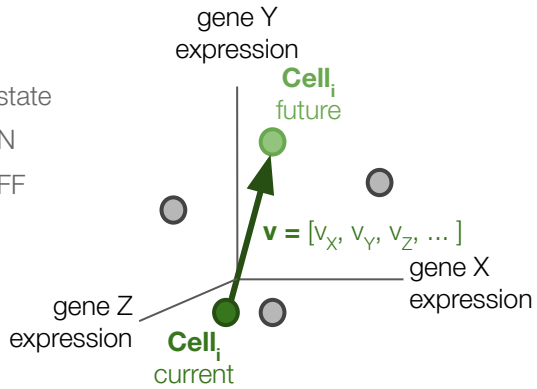

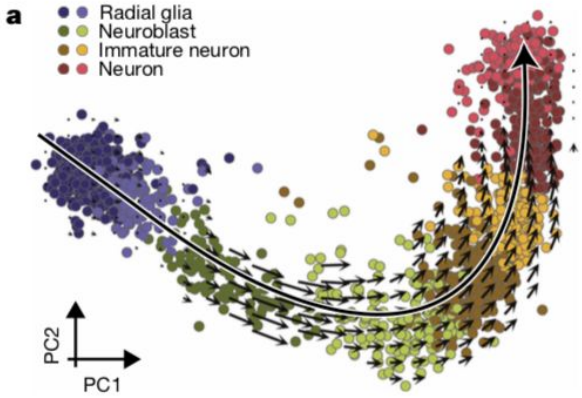

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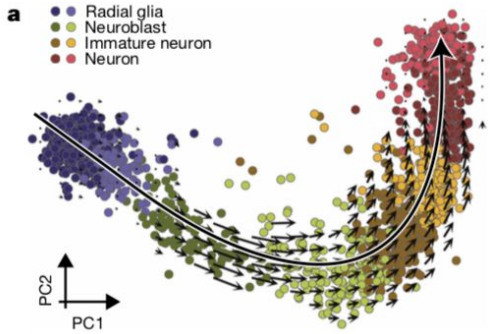
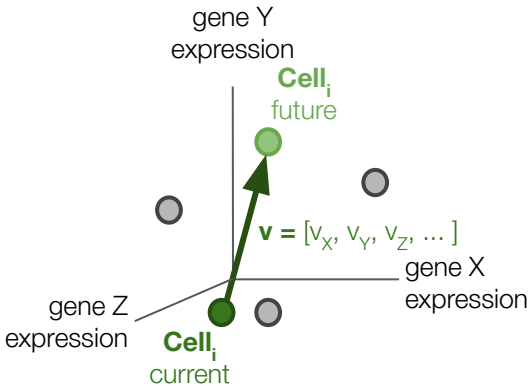
Visualizing RNA velocity trends

Goals:

- Encode direction, predicted states
- Differentiation, general cell state transitions, origin of rare cell types

Visualizing RNA velocity trends - PCA





PC1 = 3X - 7Y
PC2 = 0.5X + 5Y

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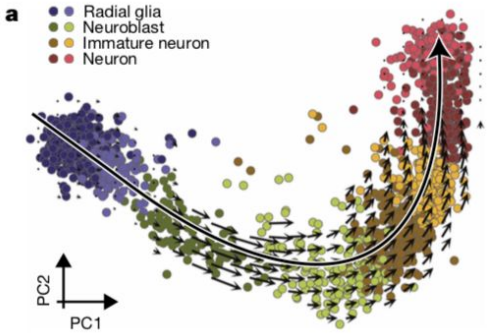

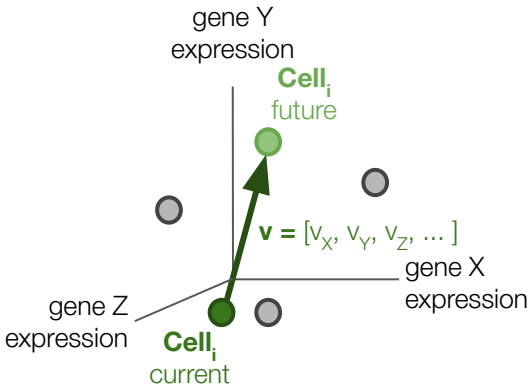

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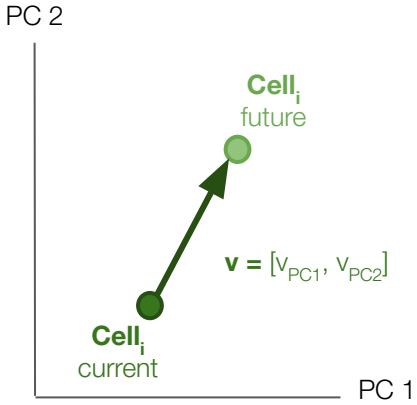
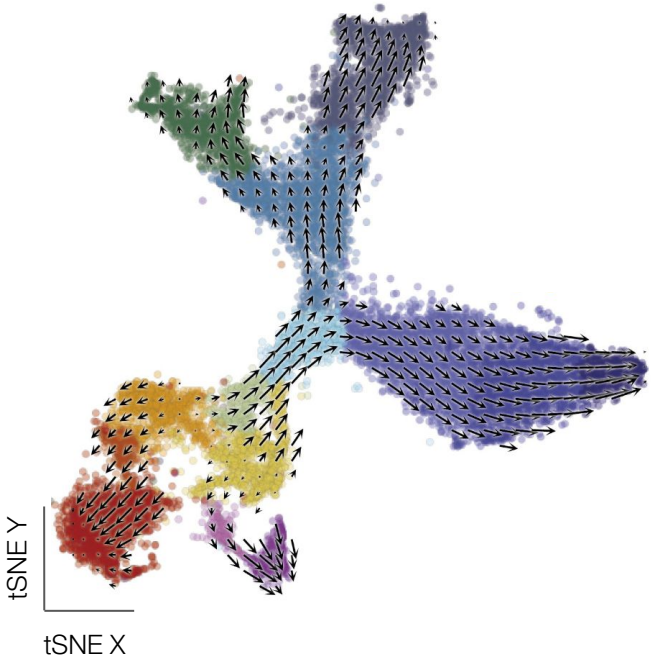


$V_{PC1} = 3V_X - 7V_Y$

$V_{PC2} = 0.5V_X - 5V_Y$

Visualizing RNA velocity trends - non-linear embeddings



La Manno, et. al. Nature 2018

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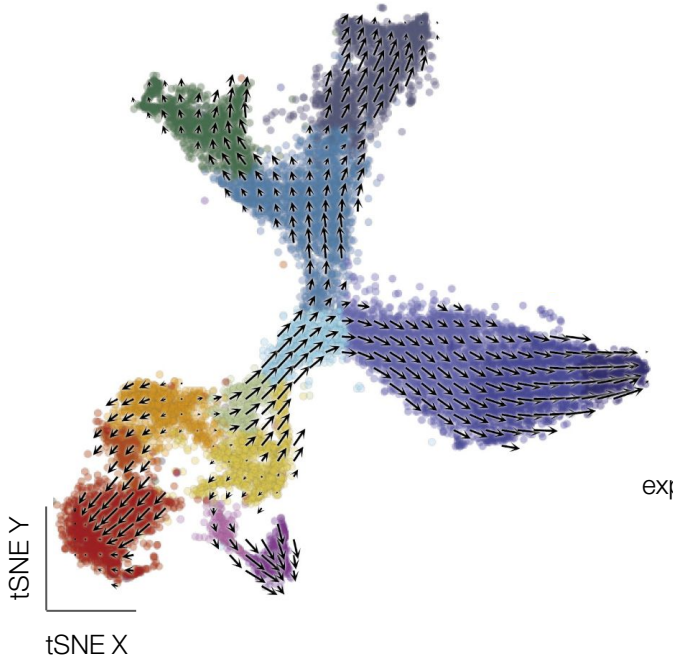

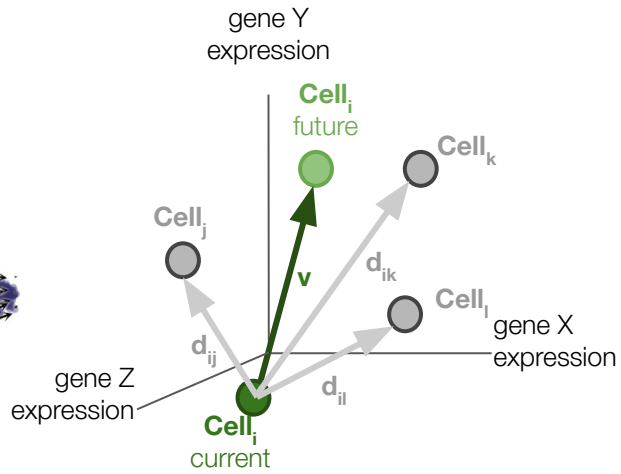

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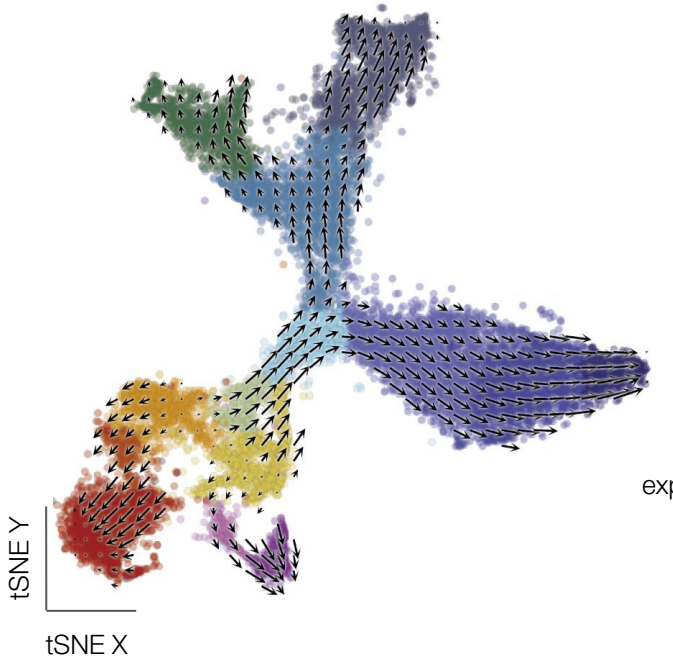

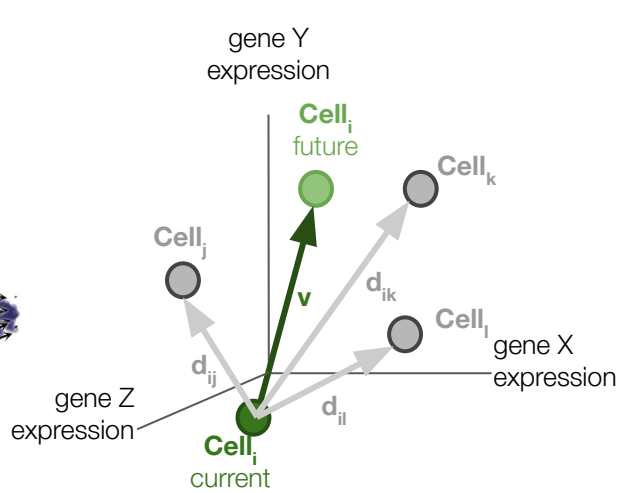

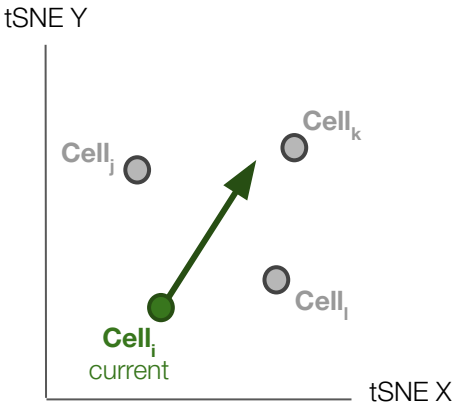

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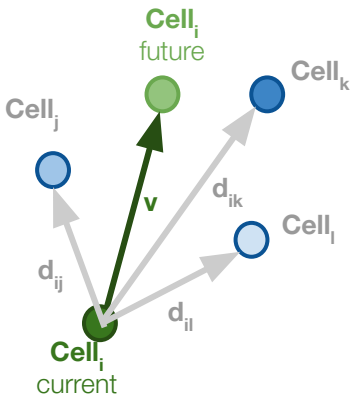
Visualizing RNA velocity trends - non-linear embeddings

Transition probability:

$$P_{ix} \sim corr(v_{ix}, d_{ix})$$



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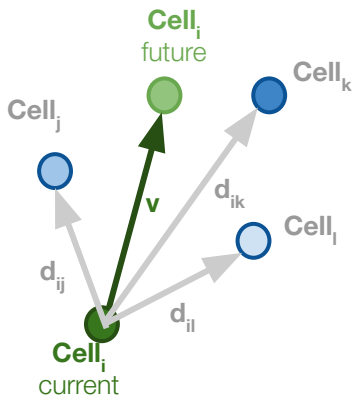

Given an embedding $\boldsymbol{X}$ of n cells:

$$X = [x_1, x_2, \ldots, x_{n-1}, x_n]$$

Velocity displacement of a cell in embedding:

$$v_{tSNE} \sim \Sigma_j P_{ij} \frac{(x_j - x_i)}{\|x_j - x_i\|}$$

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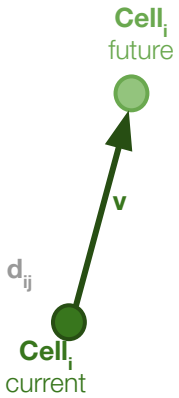

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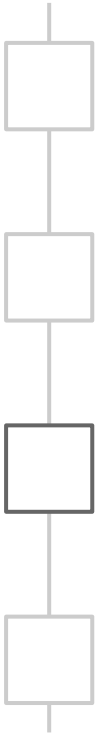

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VeloViz: RNA velocity-informed low dimensional embeddings

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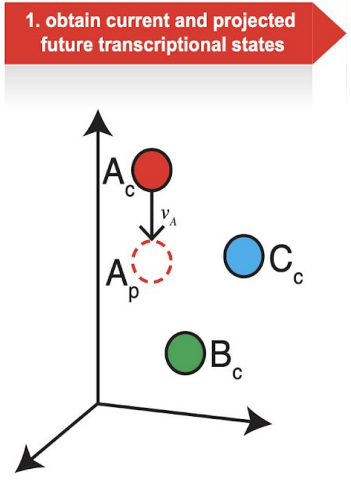

X_c = observed current transcriptional state
X_p = predicted future transcriptional state
v_X = RNA velocity for cell X

Bioinformatics, 2021: **tinyurl.com/veloviz**
Software + tutorials: **jef.works/veloviz**

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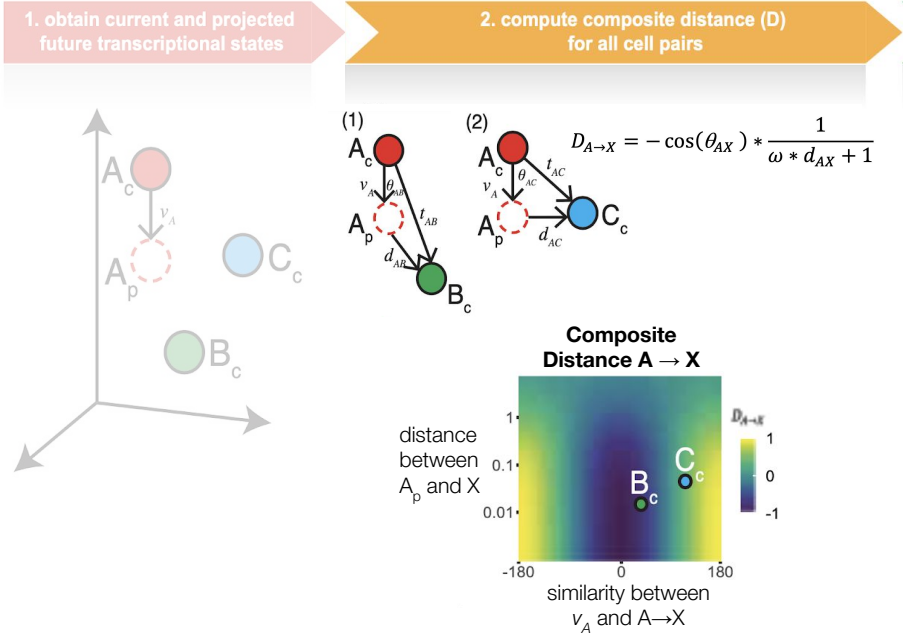

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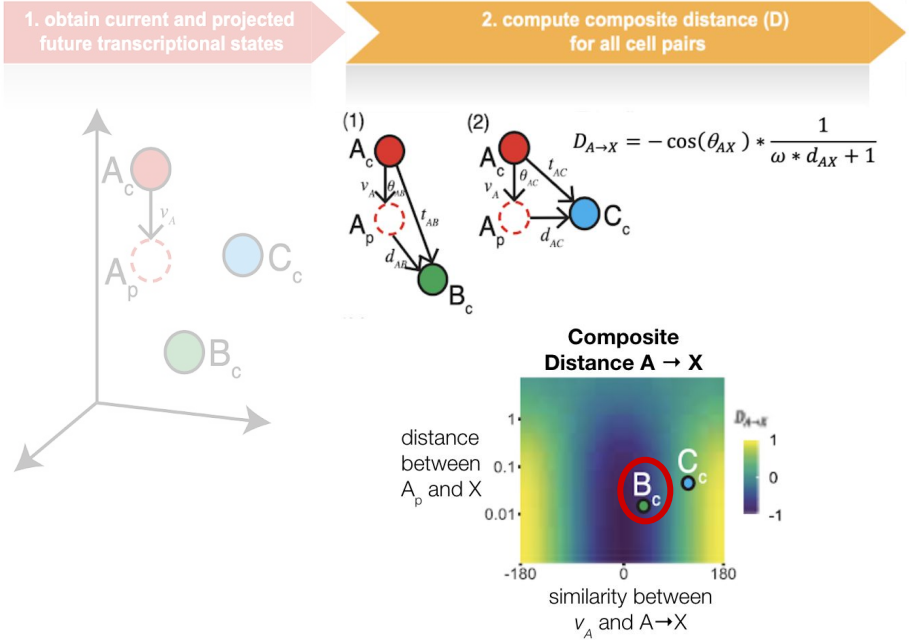

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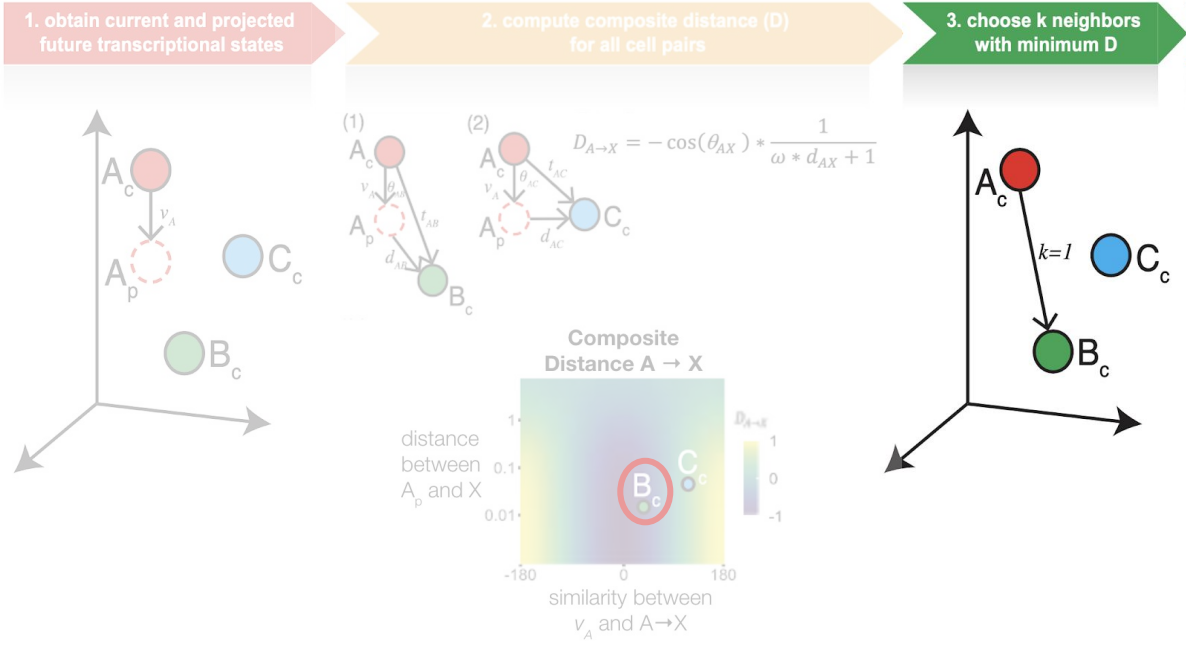

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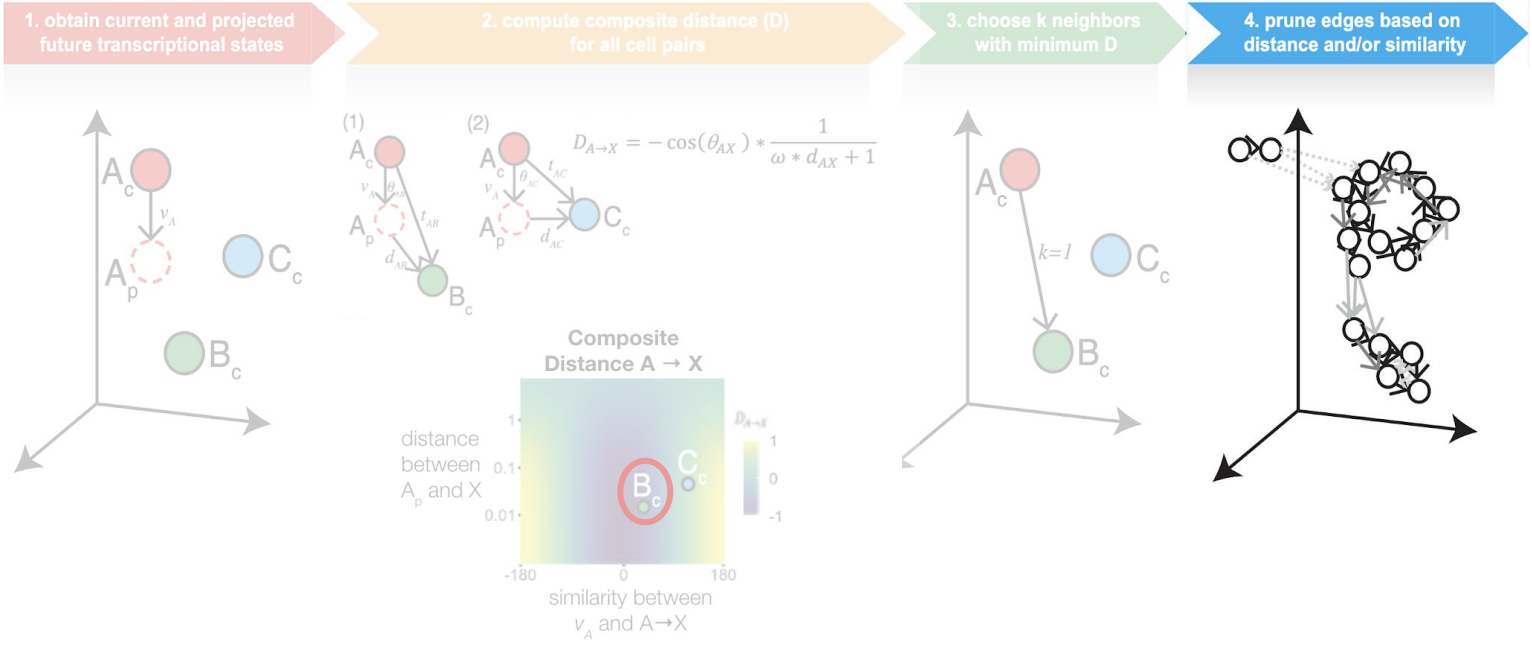

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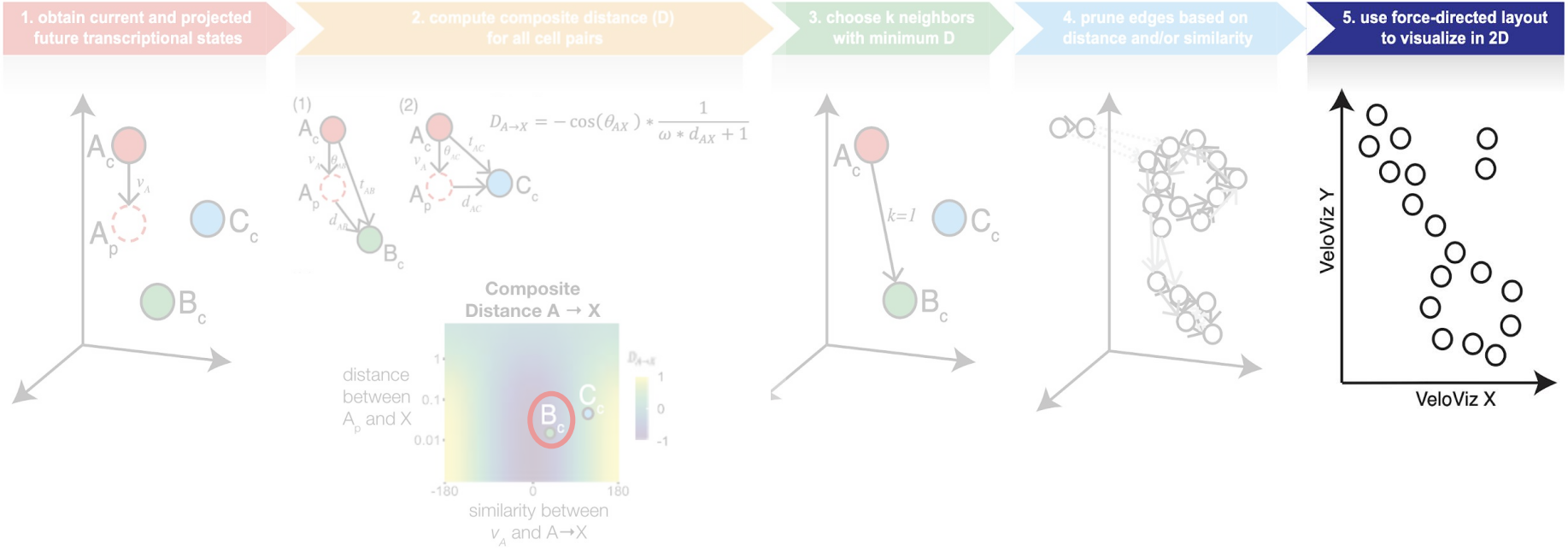

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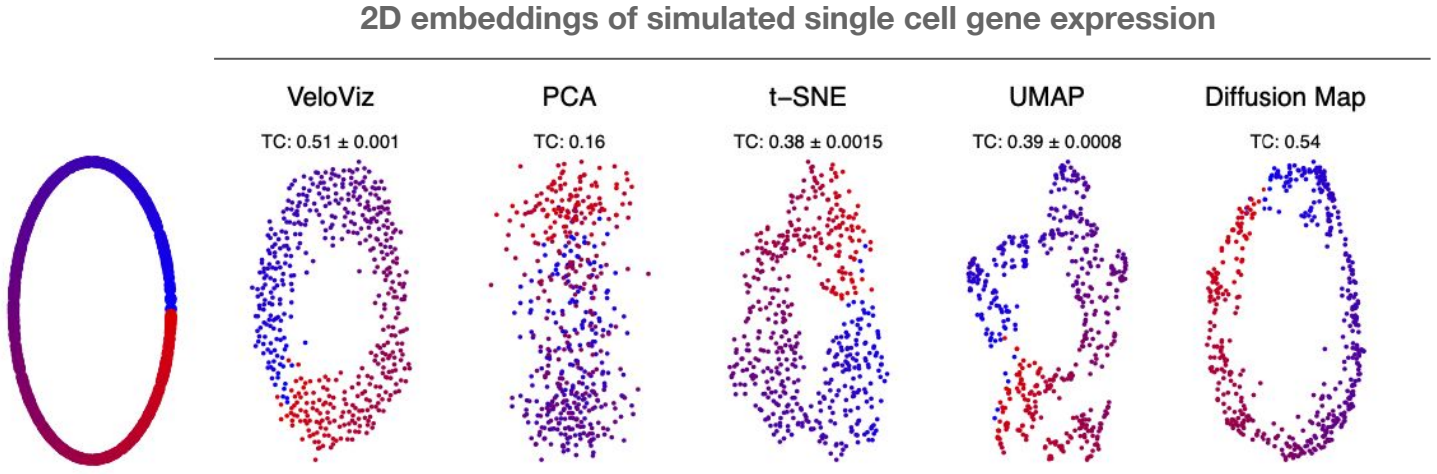
VeloViz embeddings: simulated cycling and branching trajectories



TC: Trajectory Consistency

TC = 1: perfect representation of ground truth trajectory

error over random seeds

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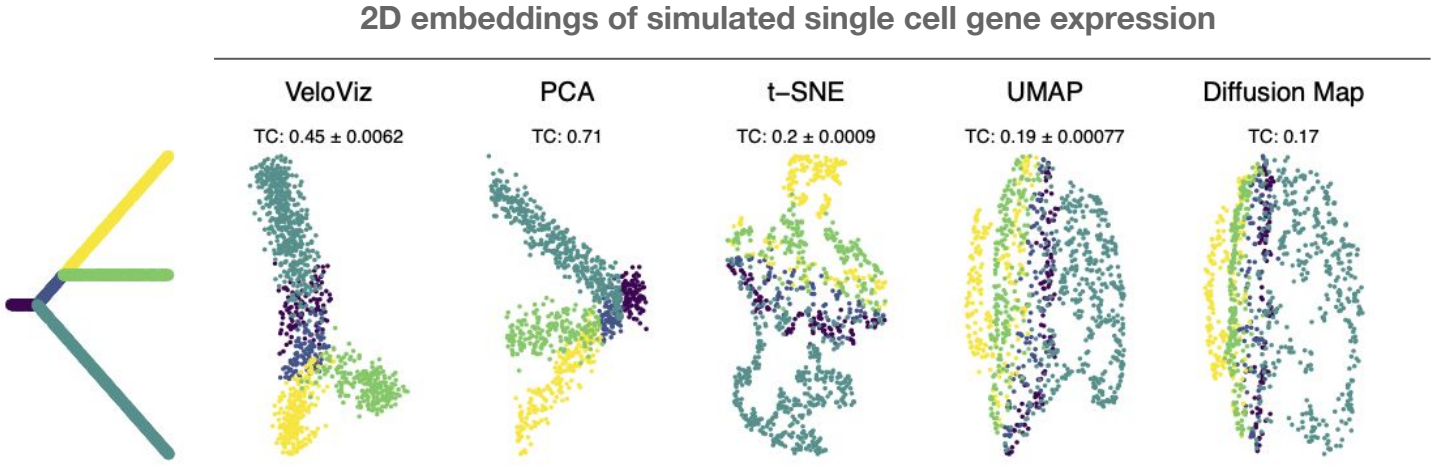

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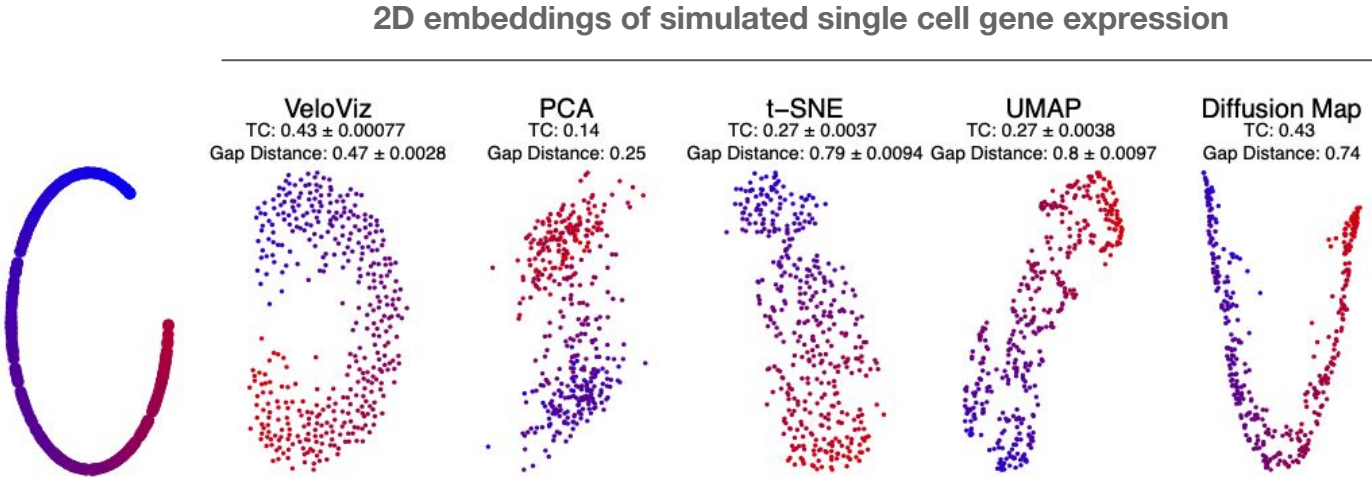

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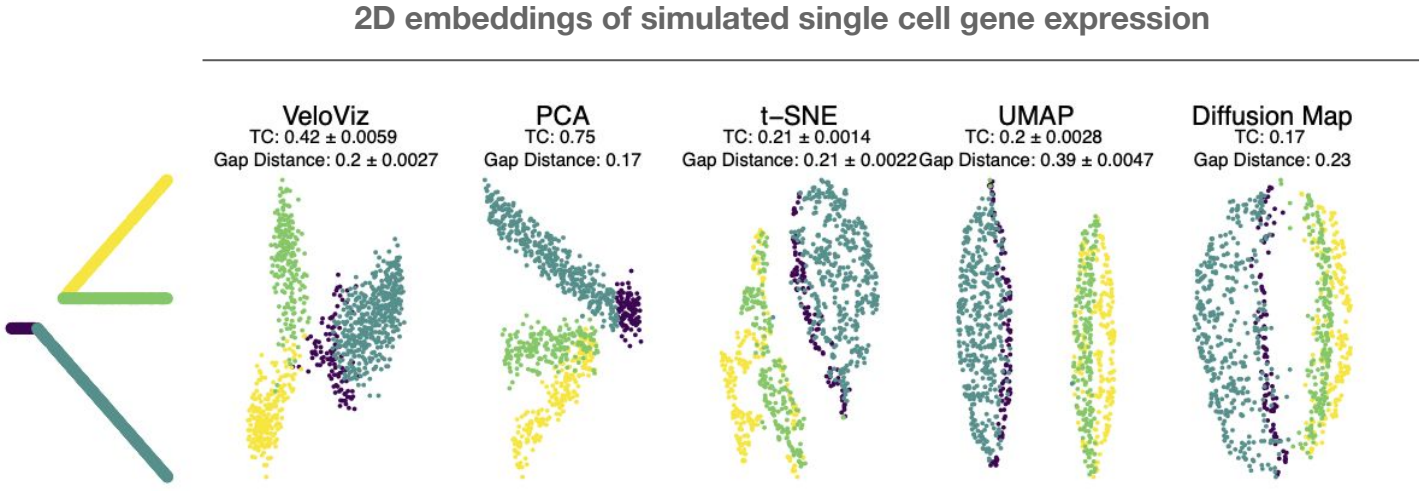

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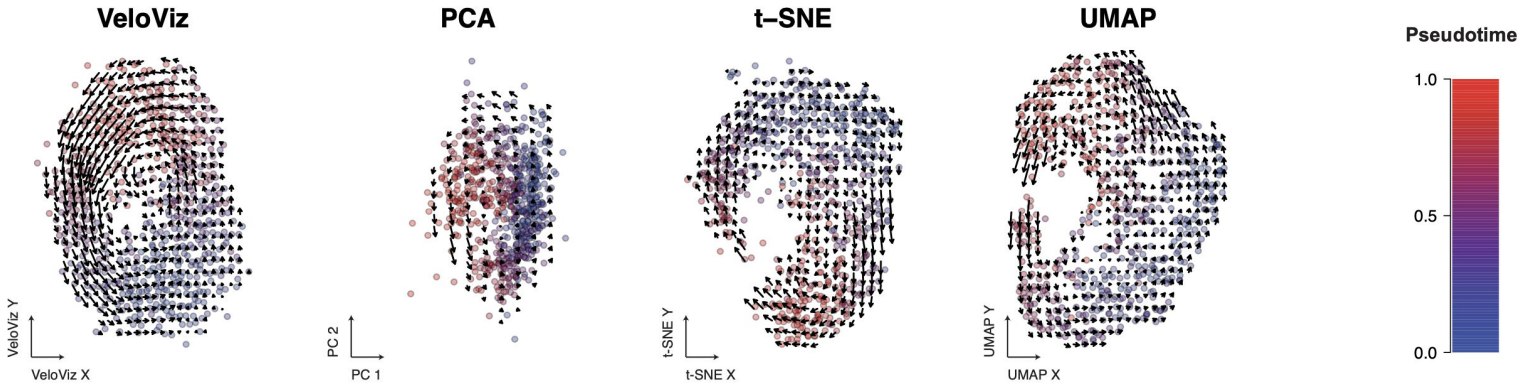
VeloViz embeddings: spatial single-cell transcriptomics cycling cultured cells



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MERFISH Data: Xia et. al. PNAS 2019

Questions?

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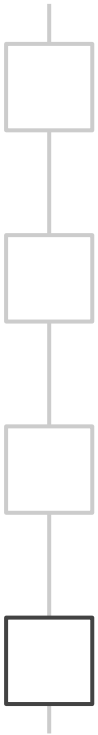

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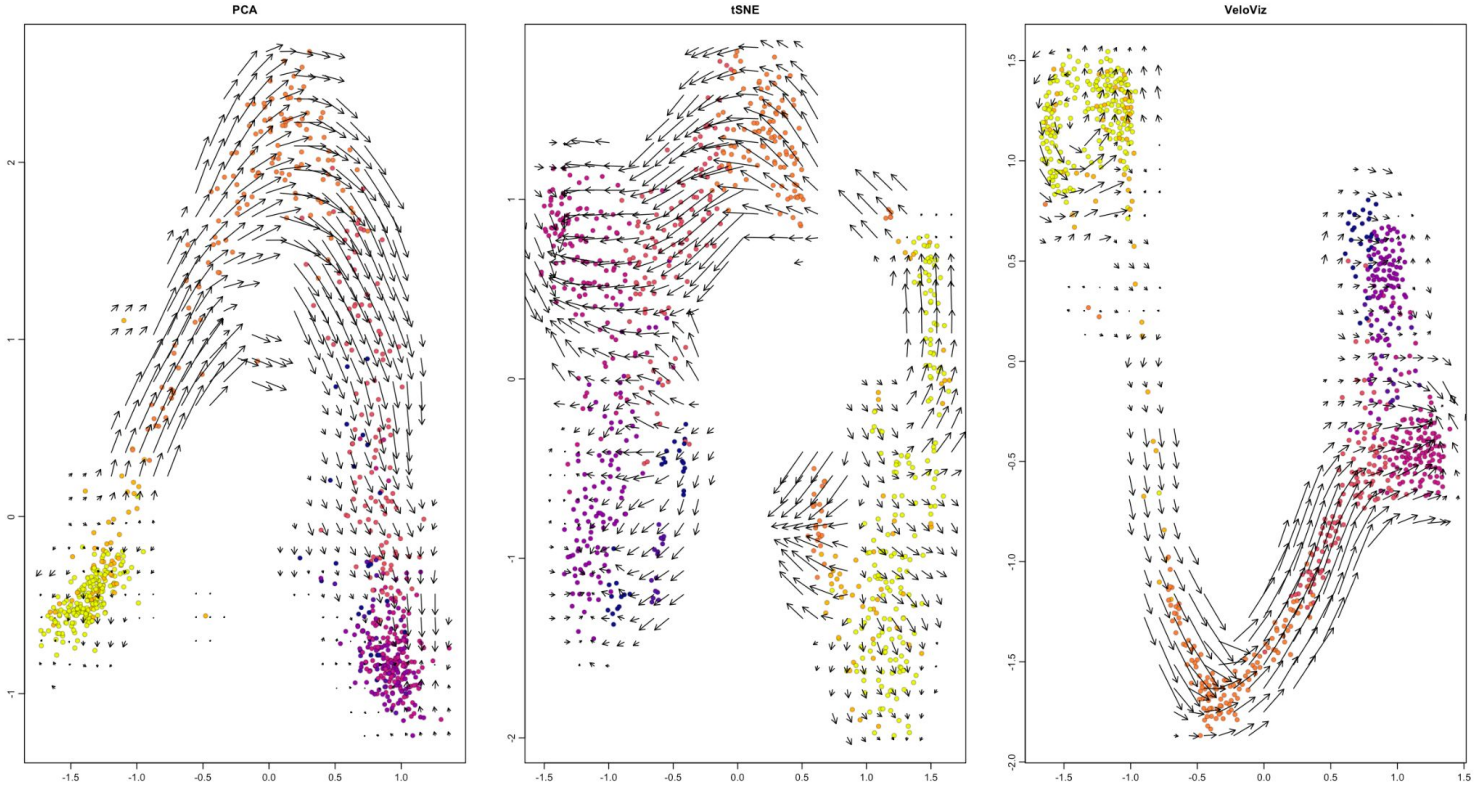

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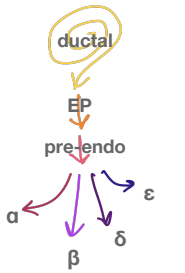
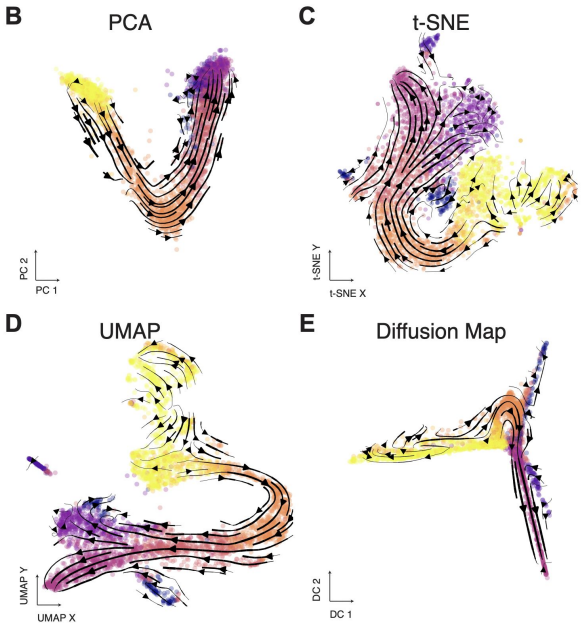
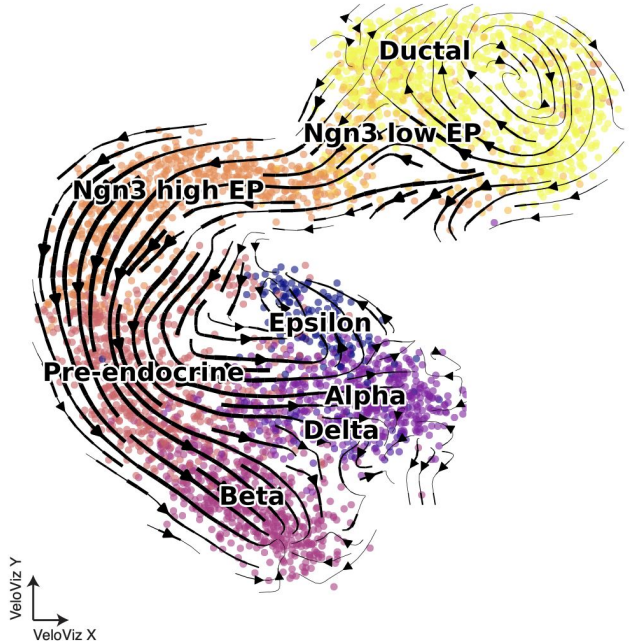


- Ductal
- Ngn3 low EP
- Ngn3 high EP
- Pre-endocrine
- Beta
- Alpha
- Delta
- Epsilon





Atta et. al. Bioinformatics, 2021.
Pancreas data: Bastidas-Ponce et. al. via scVelo package, Bergen et. al. Nat. Biotechnol. 2020