

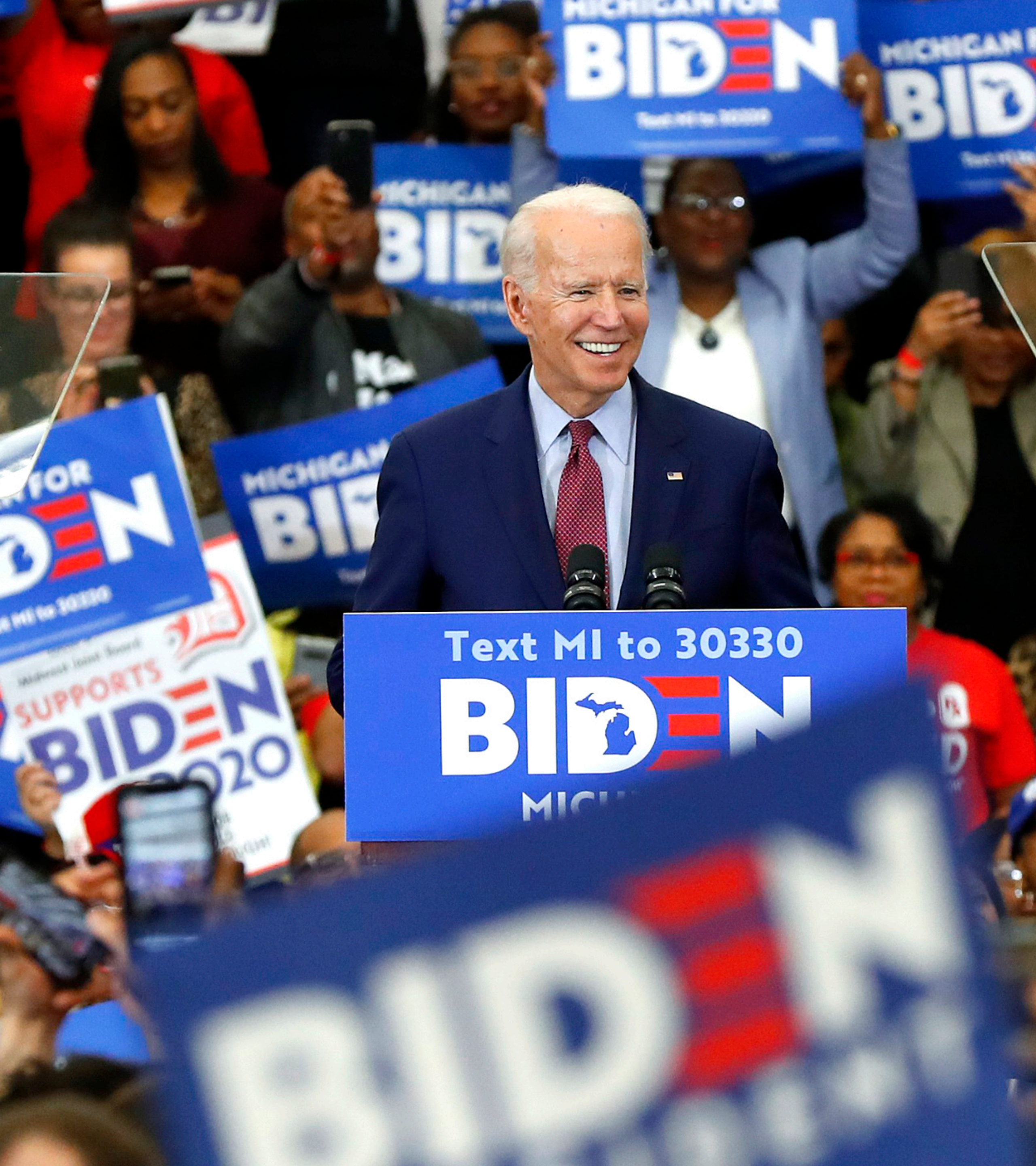
Sub-Matrix Factorization for Real-Time Vote Prediction

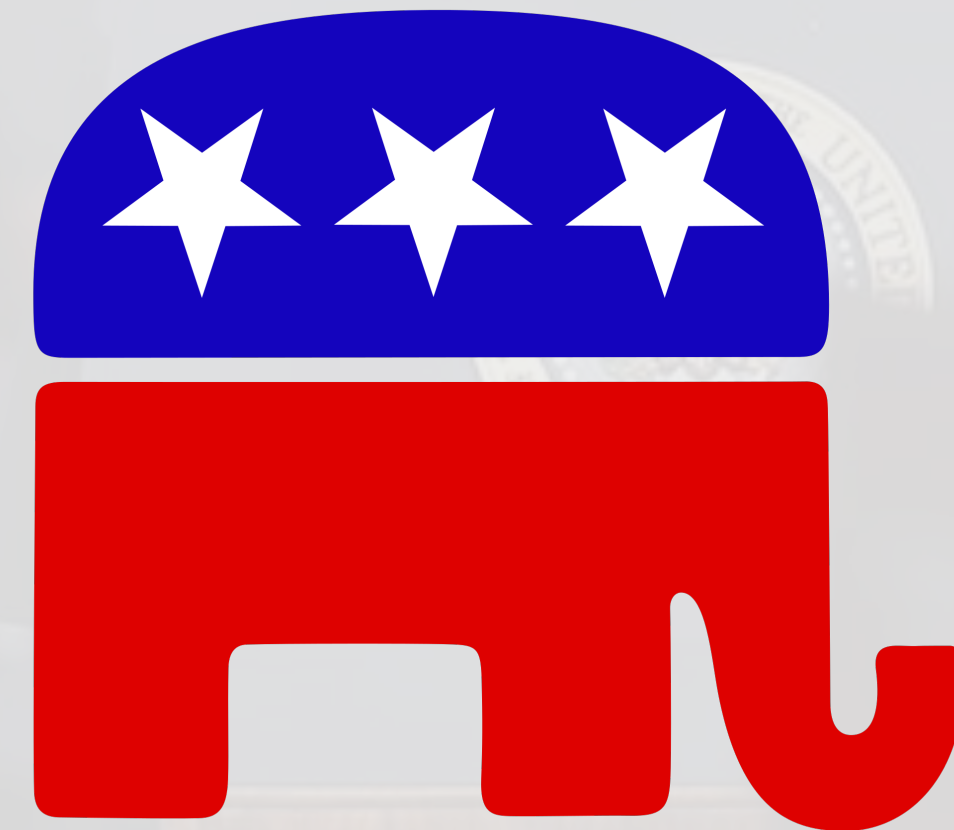
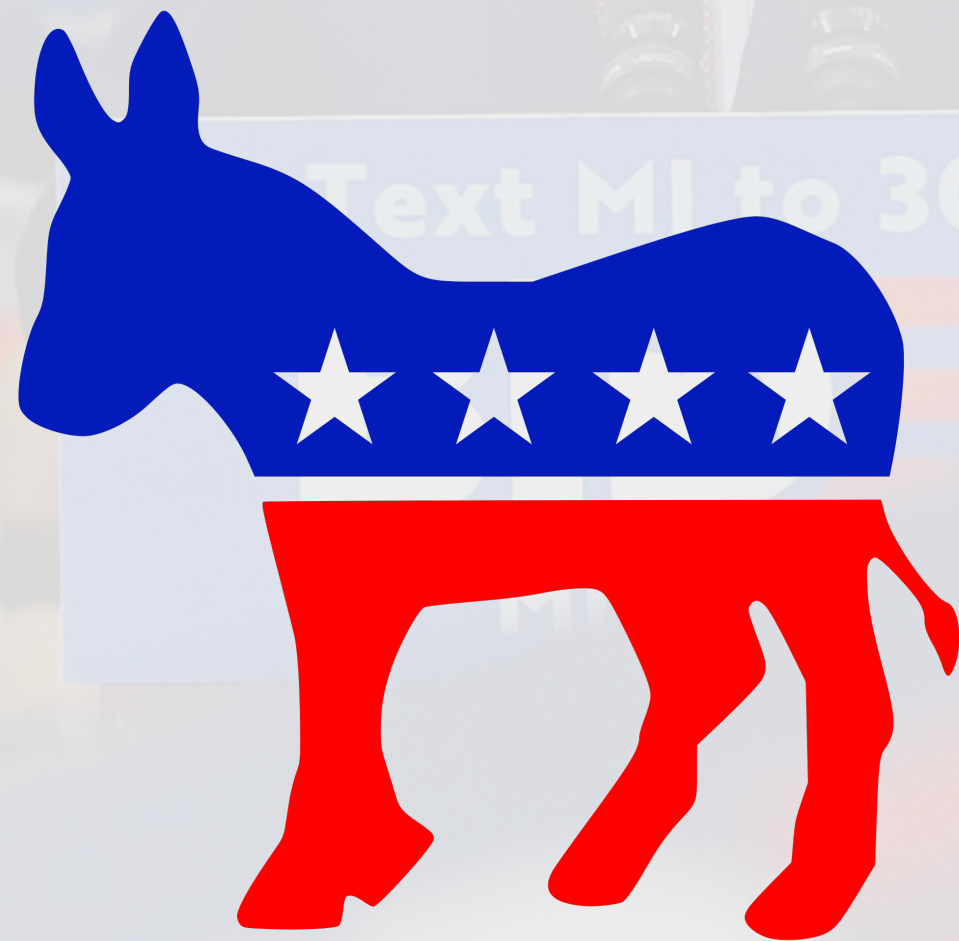
Alexander Immer*, **Victor Kristof***, Matthias Grossglauser, Patrick Thiran

`victor.kristof@epfl.ch`

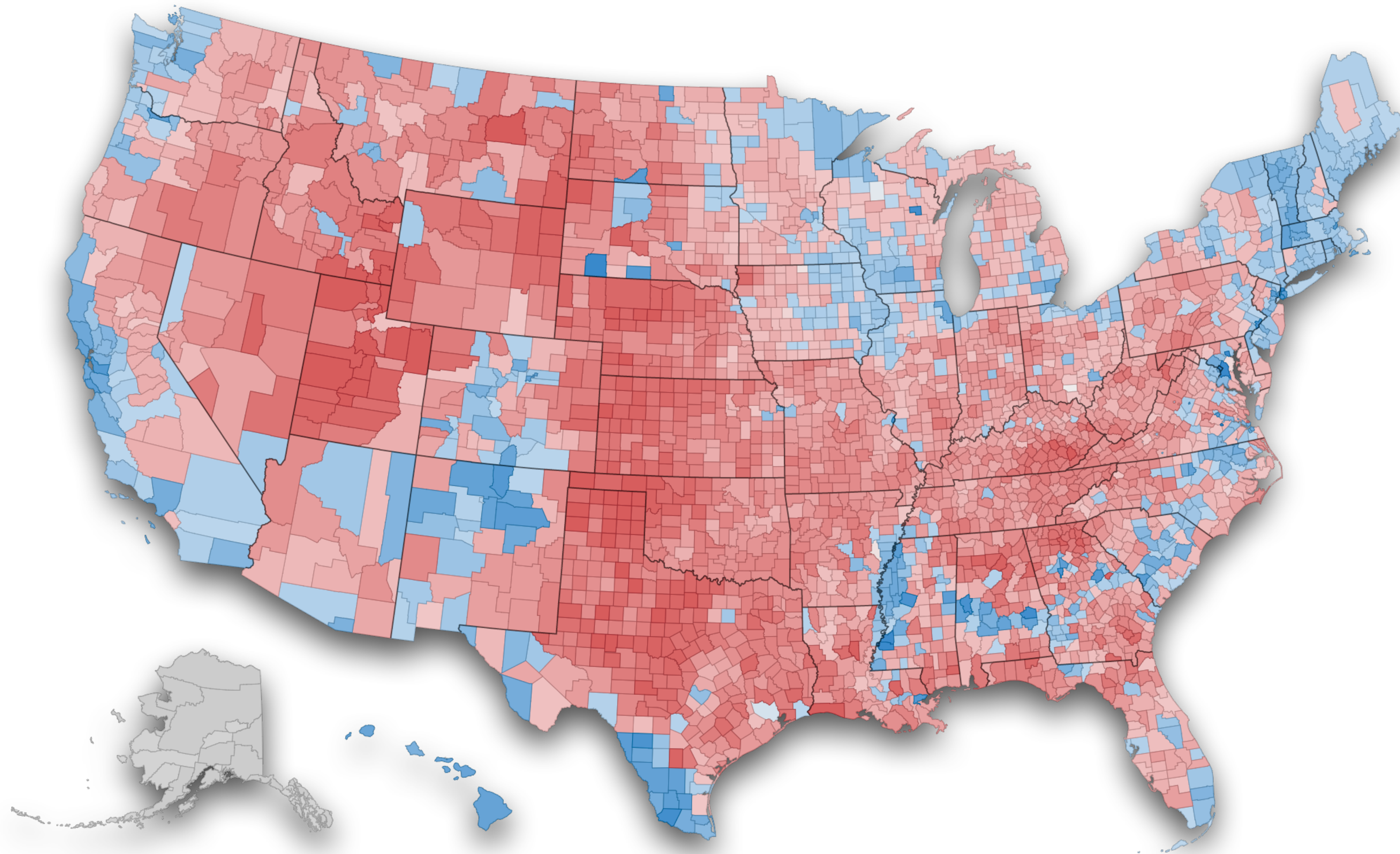
Information and **N**etwork **D**ynamics Lab (indy.epfl.ch) — Oral Presentation – KDD 2020



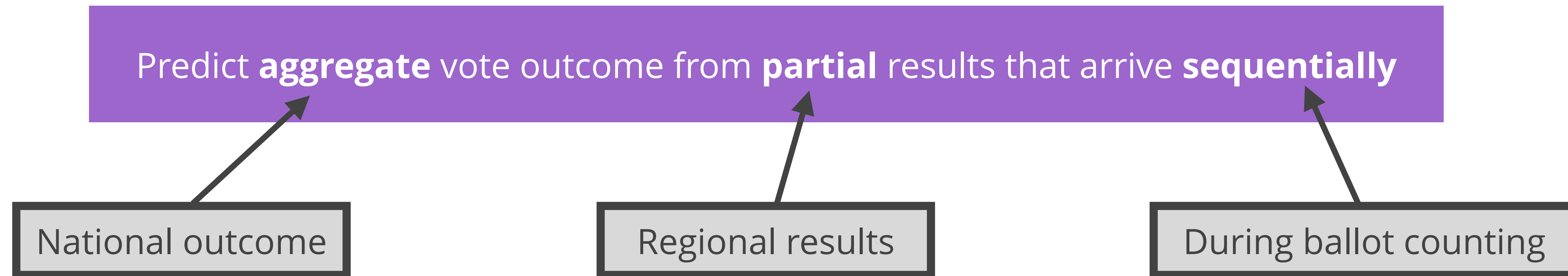




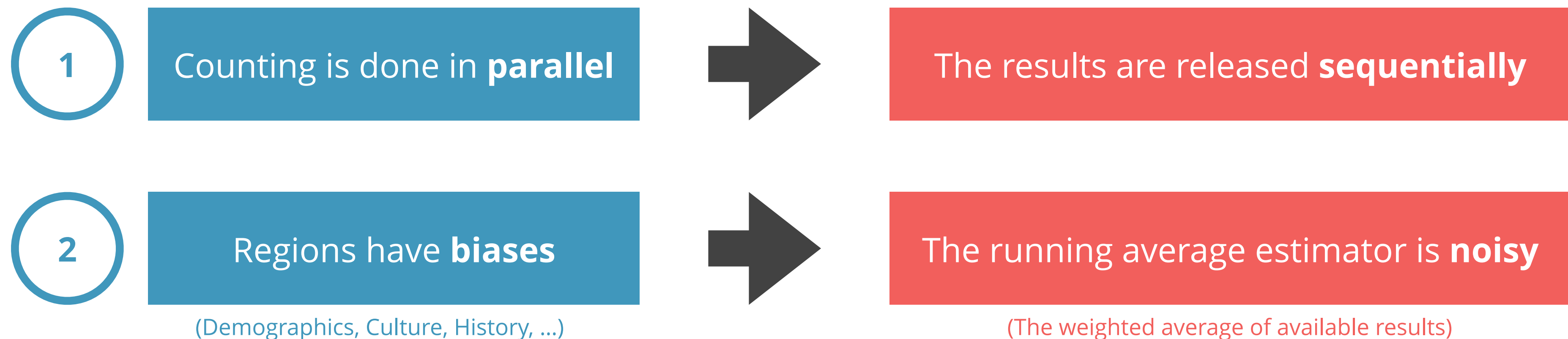
Voting Patterns



This Work

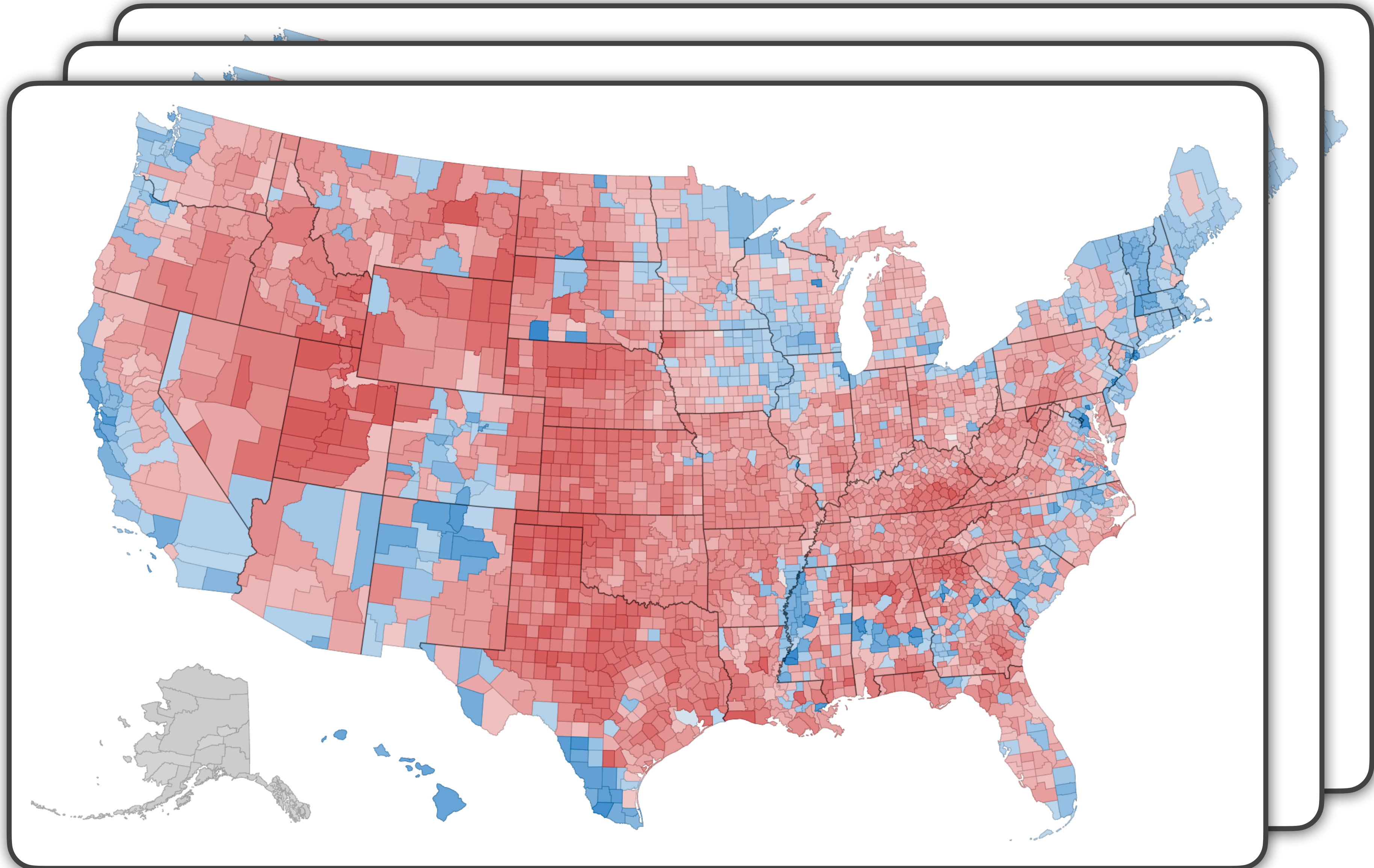


Two Assumptions:

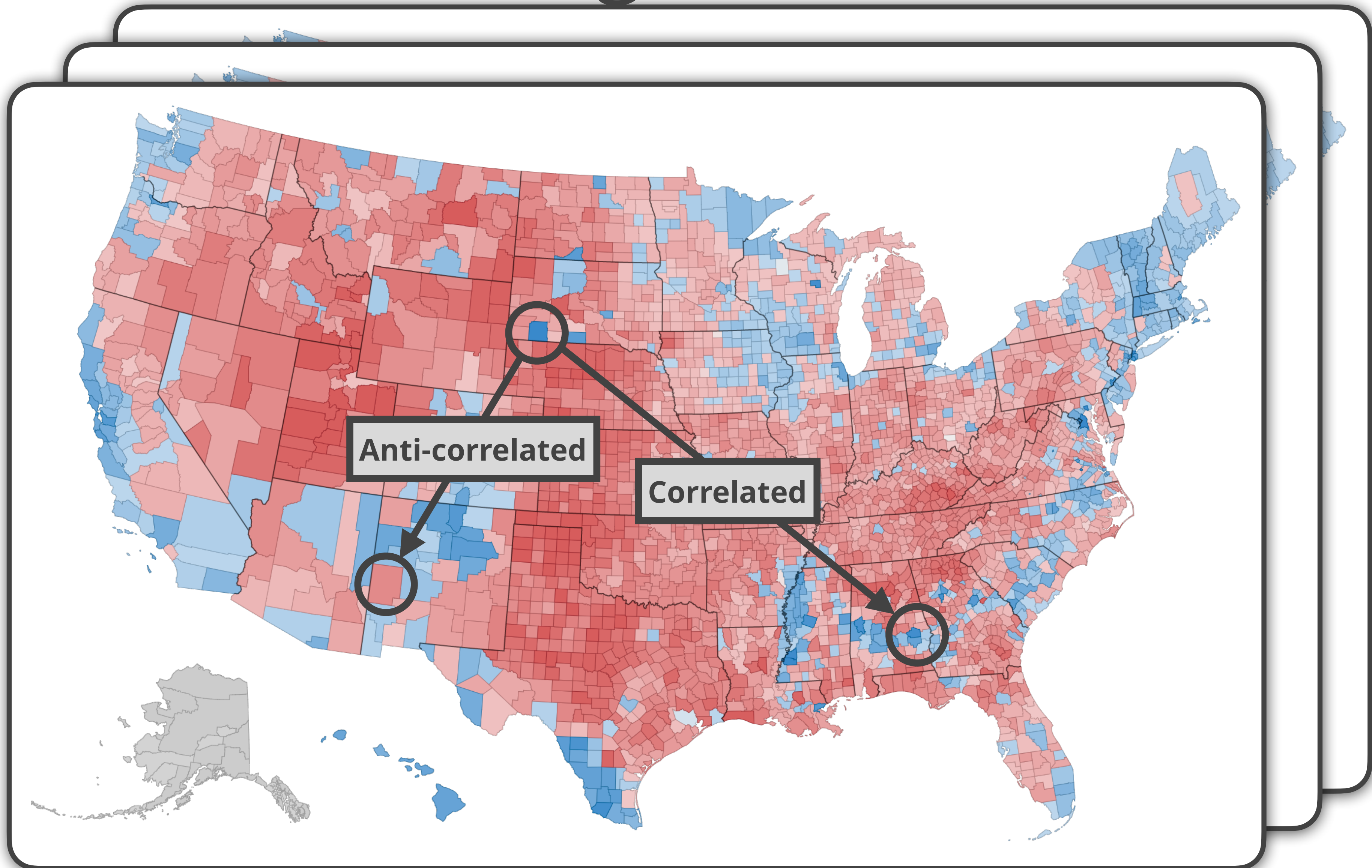


Exploit the **sequential results** in ① to **correct the bias** in ②!

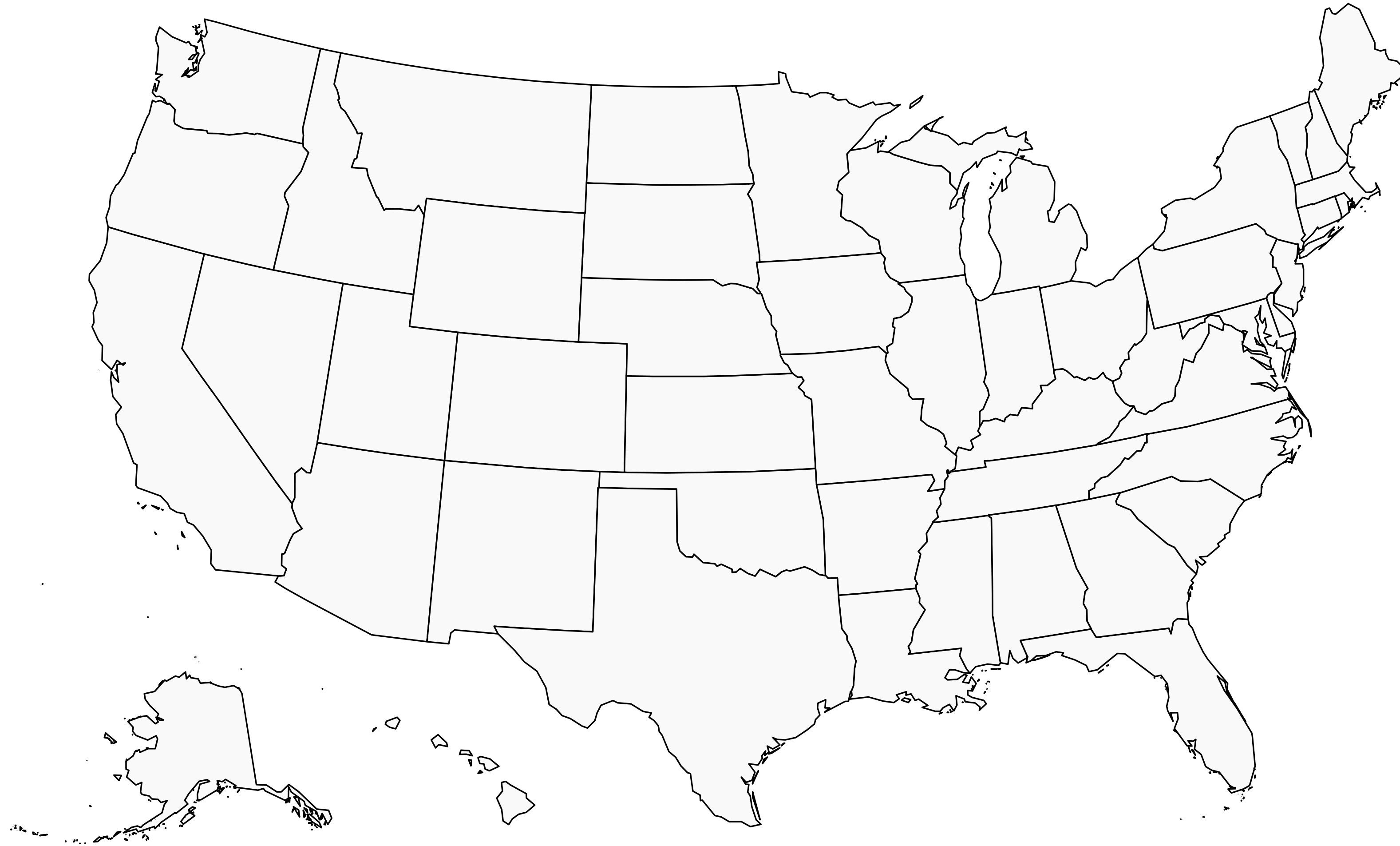
Correlation Between Votes..



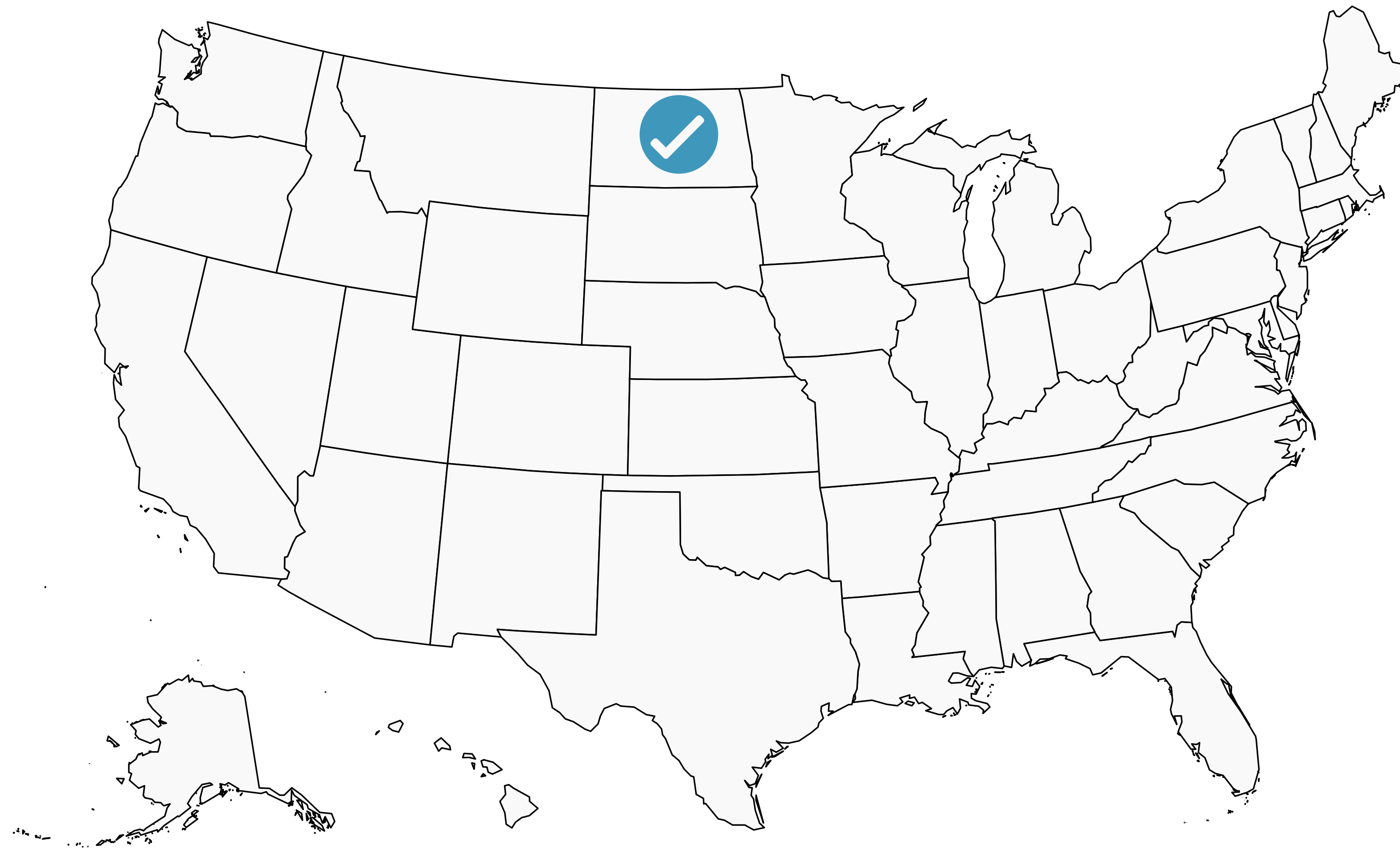
...and Between Regions



Making Real-Time Predictions



Making Real-Time Predictions



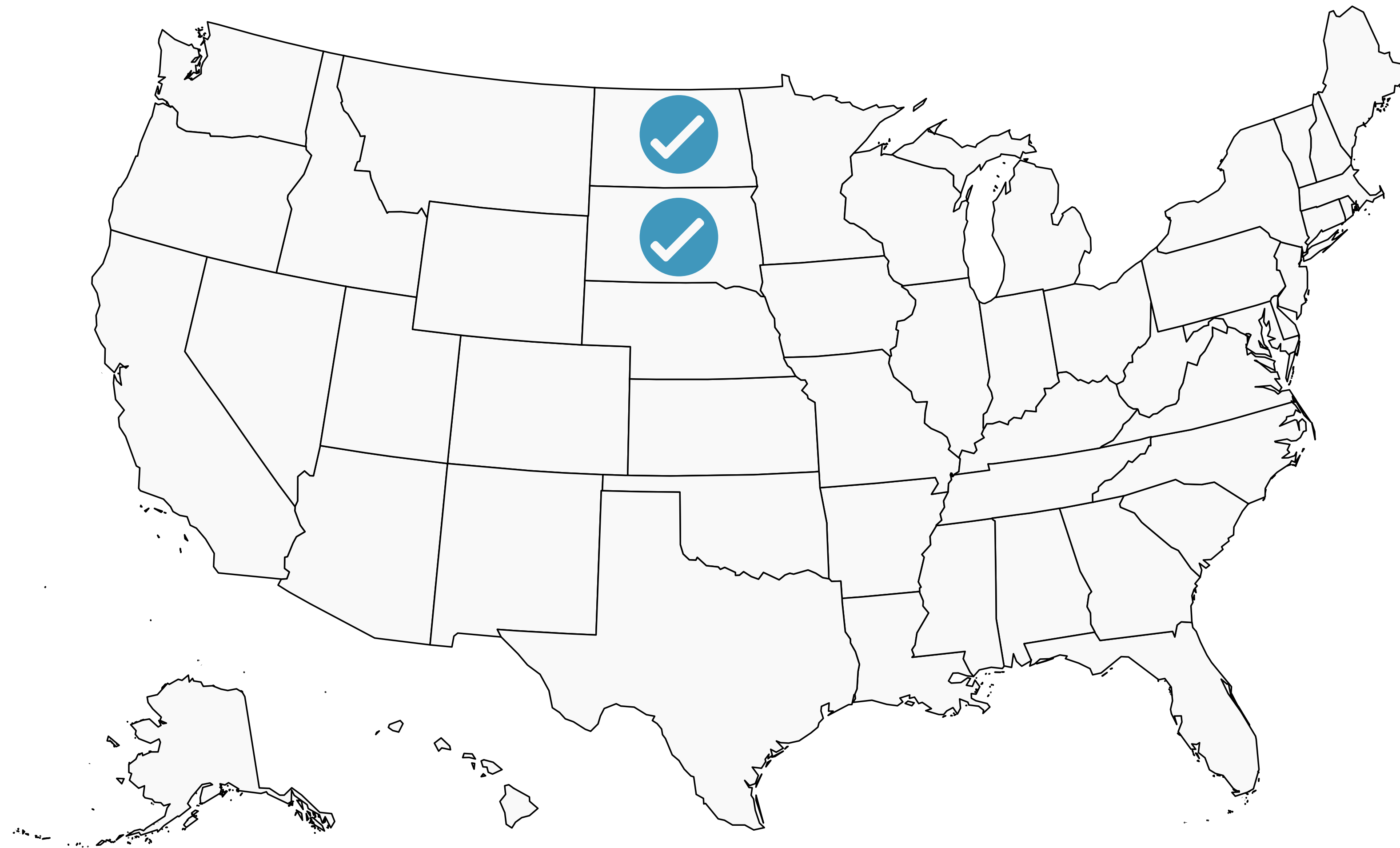
50%



50%



Making Real-Time Predictions



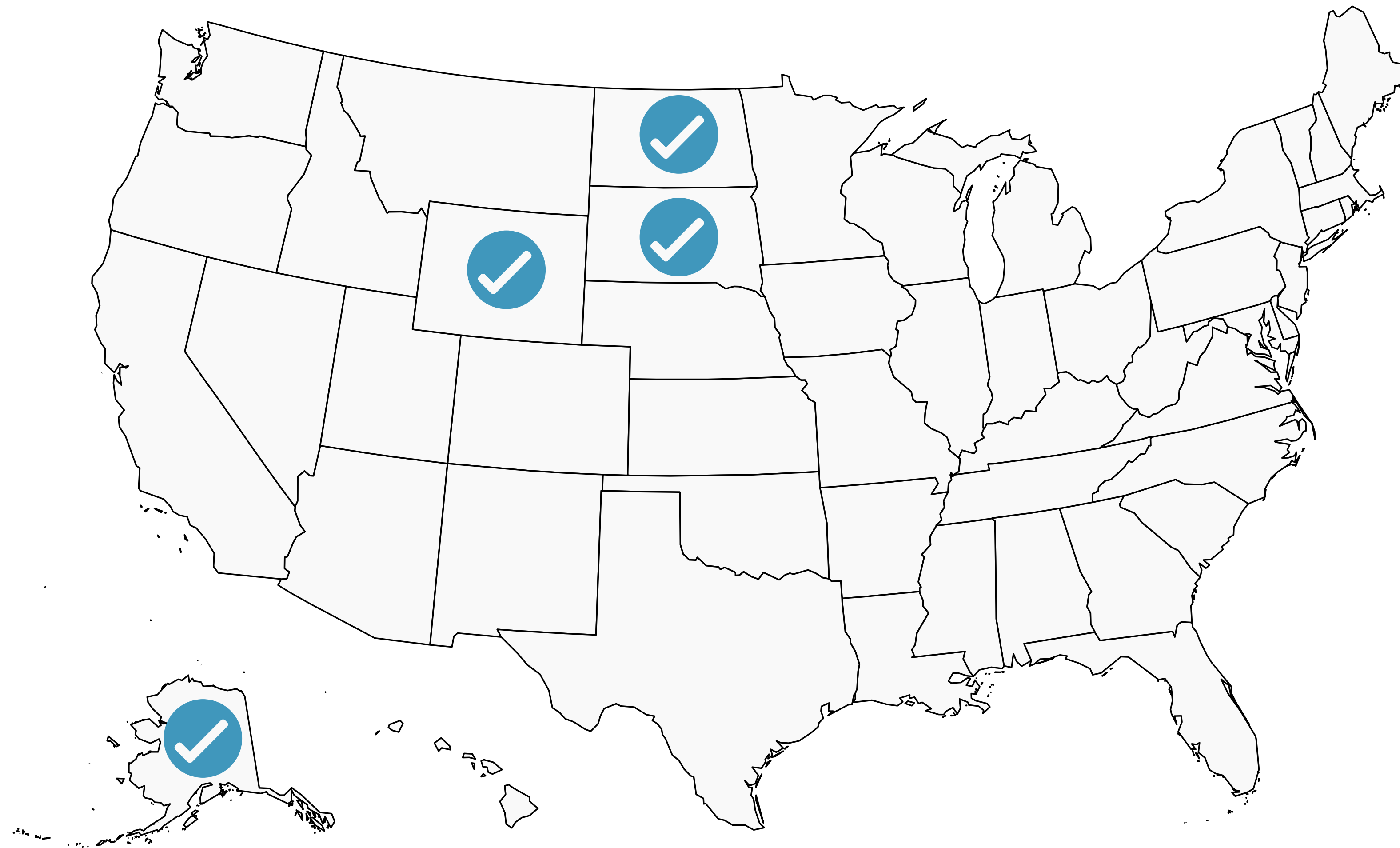
55%



45%



Making Real-Time Predictions



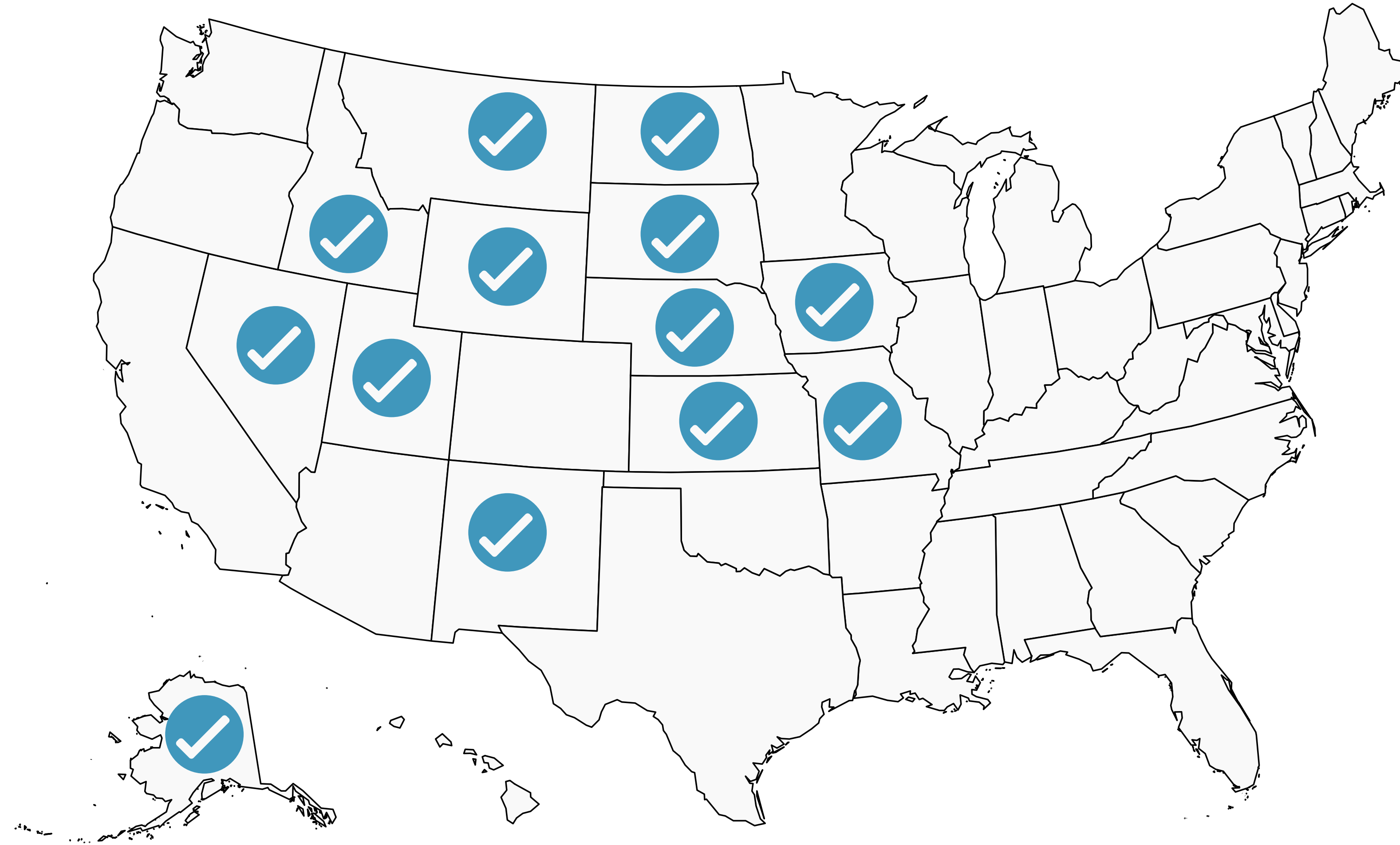
56%



44%



Making Real-Time Predictions



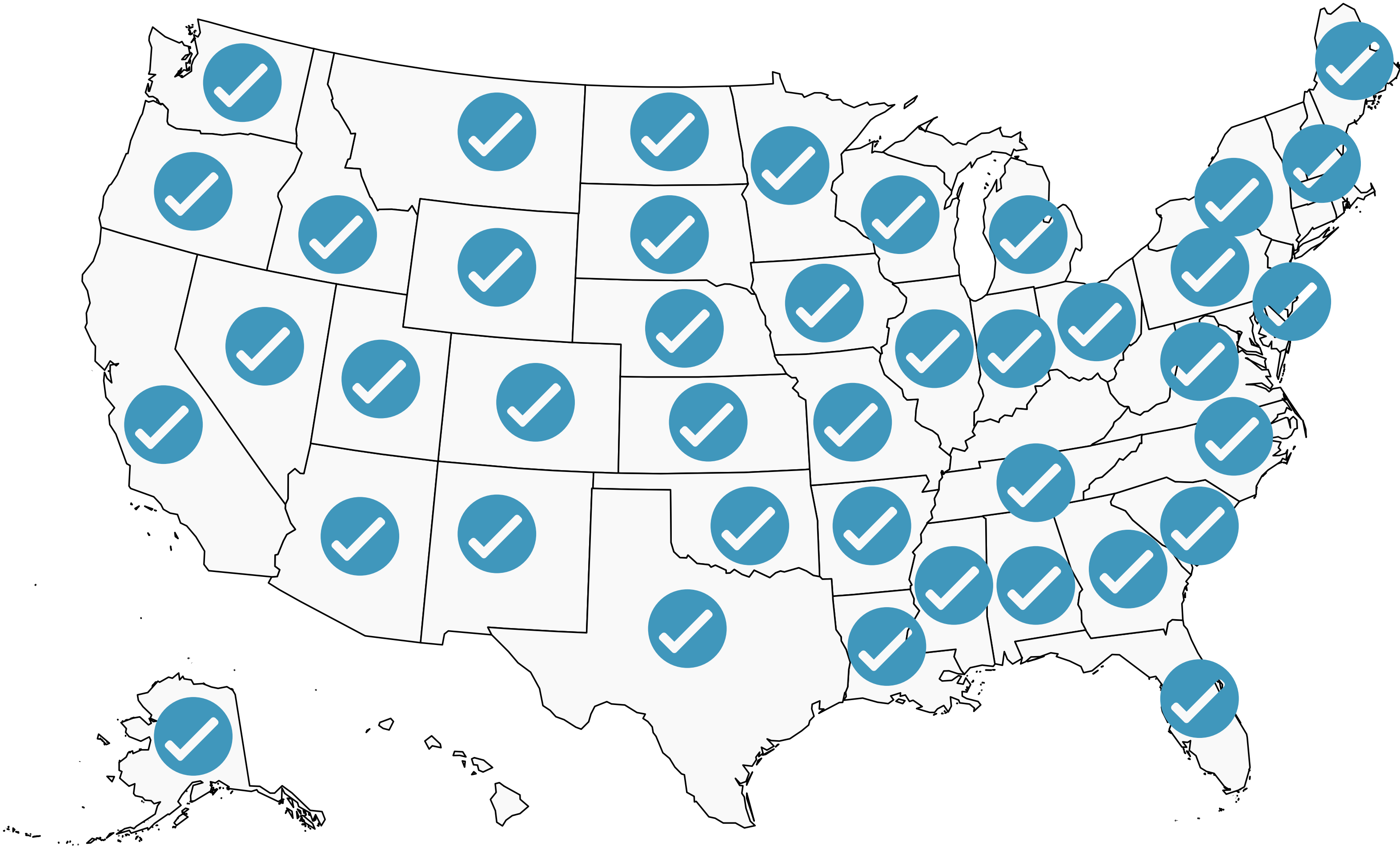
57%



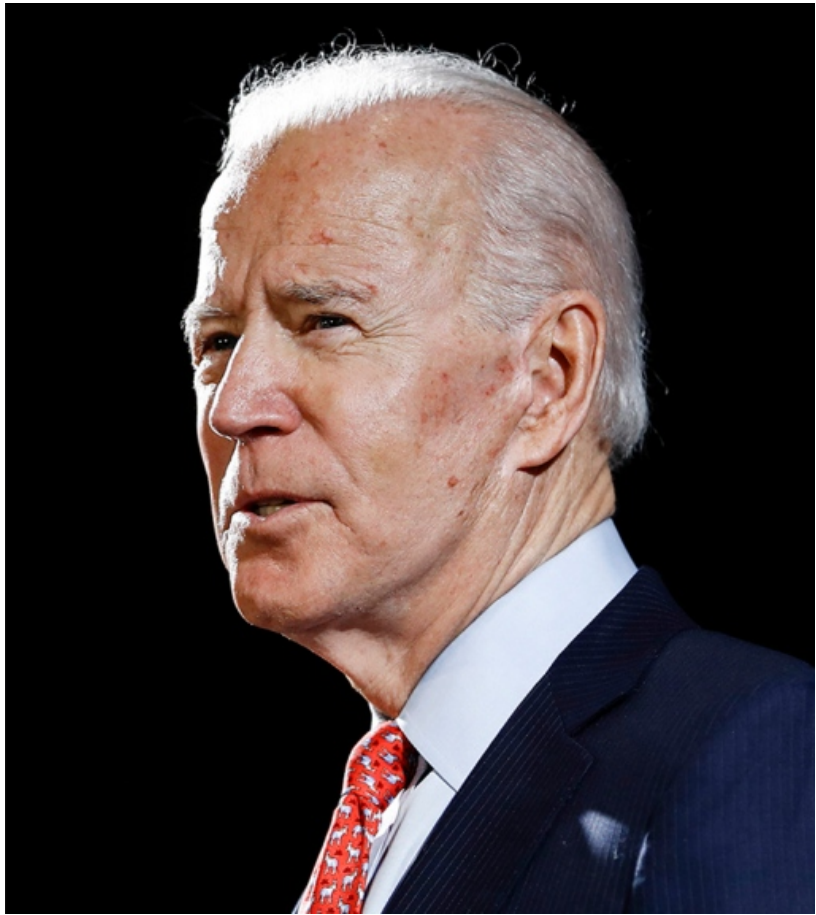
43%



Making Real-Time Predictions



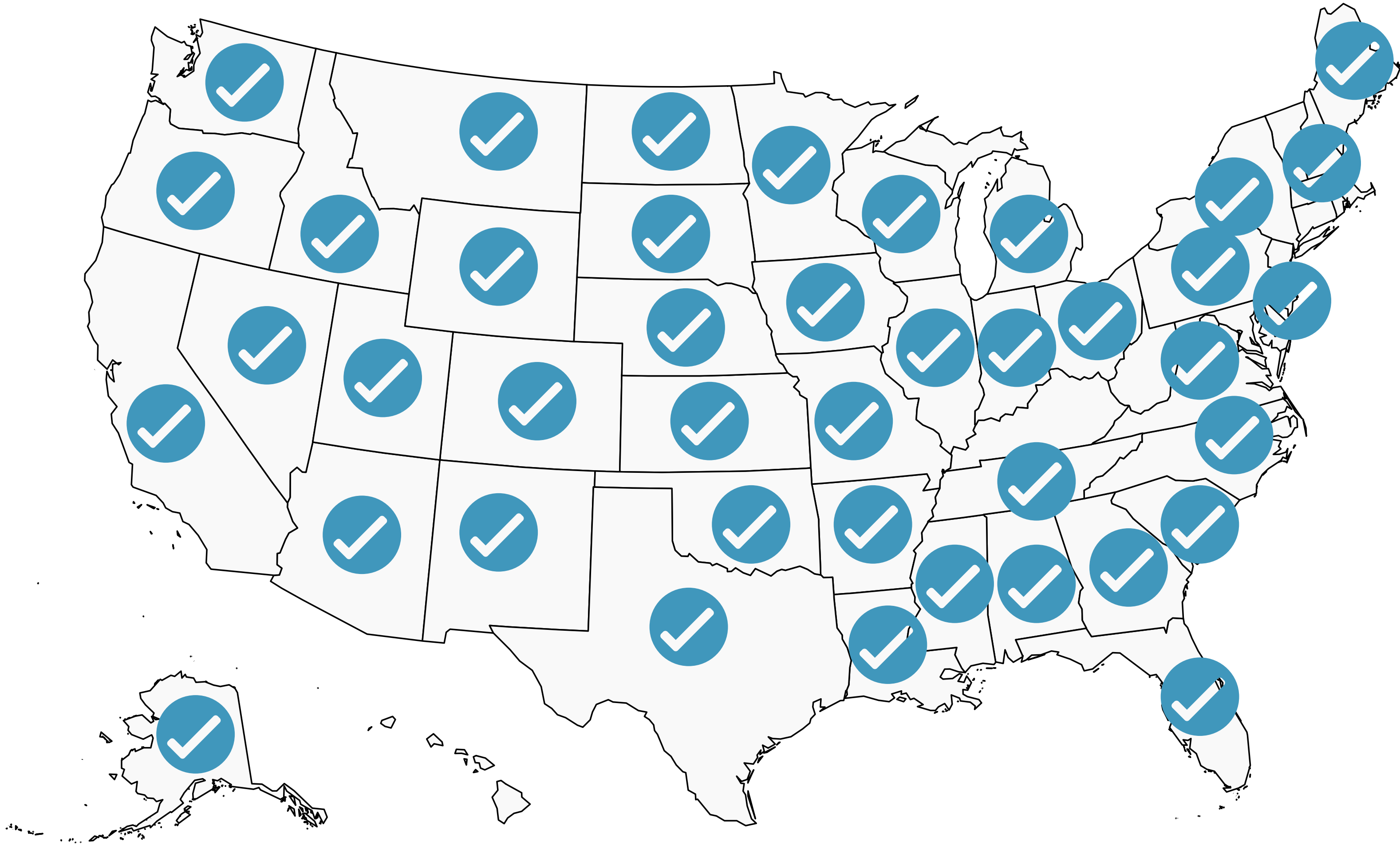
56%



44%



Making Real-Time Predictions



56%

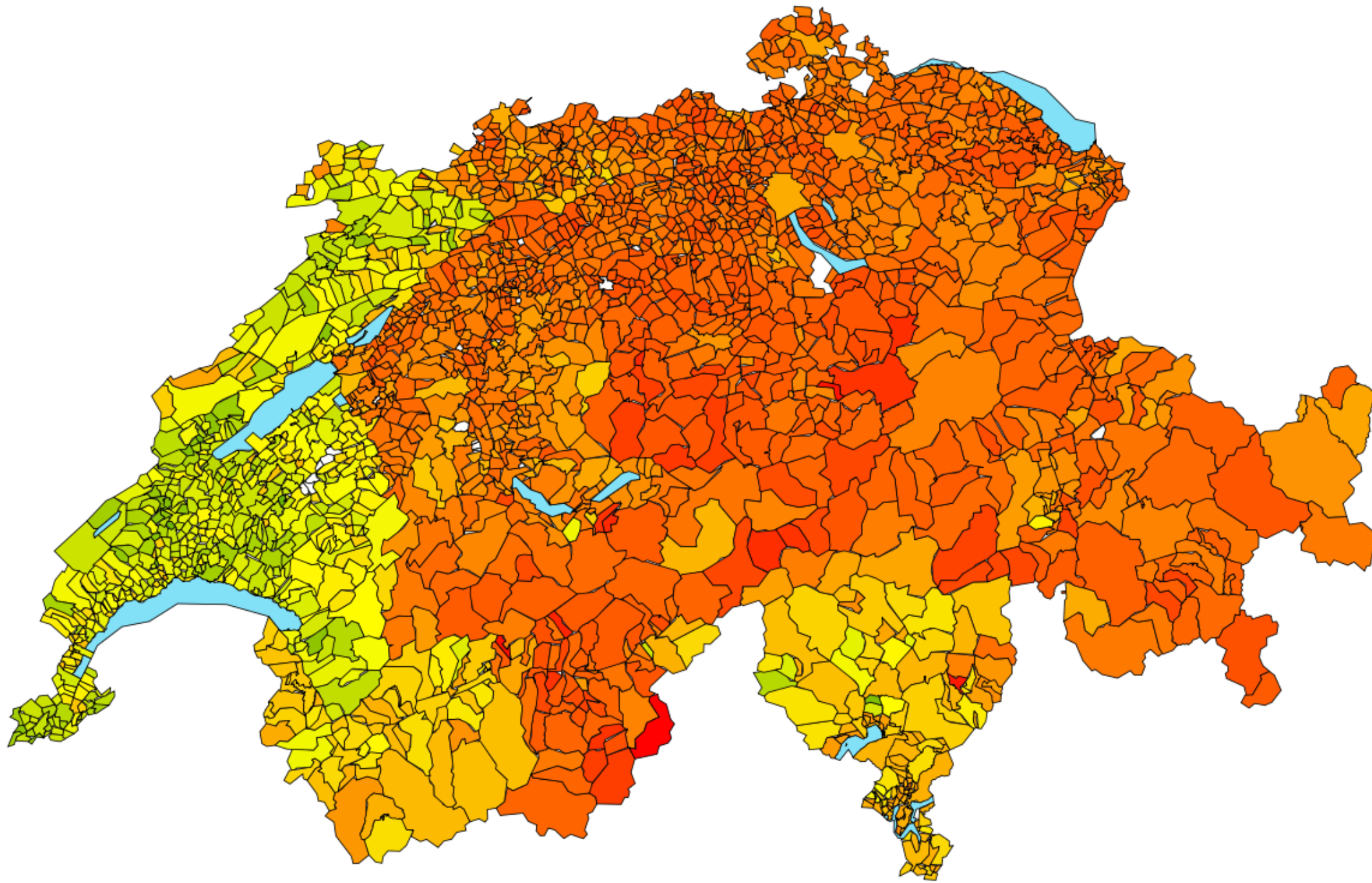


44%



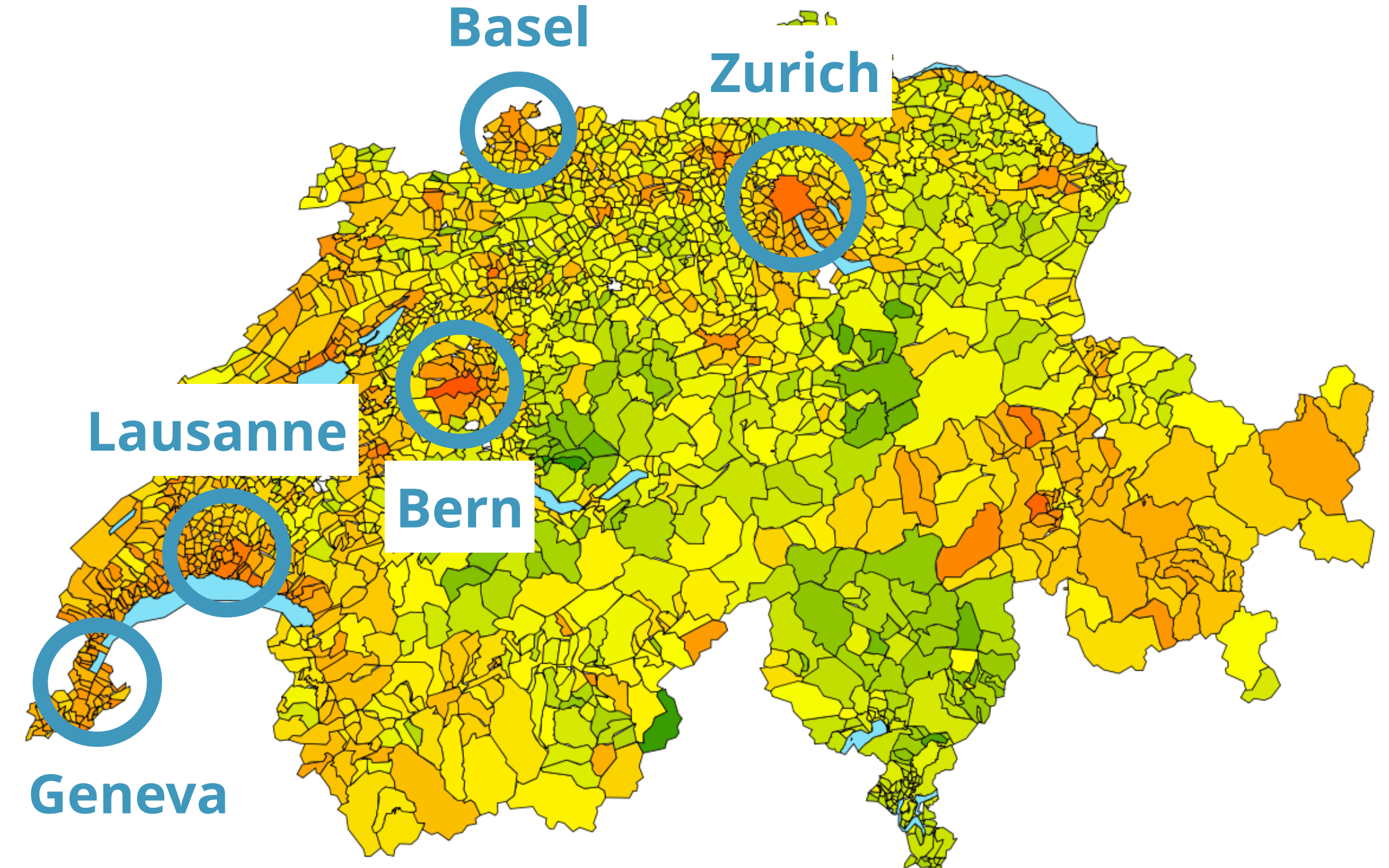
The World is Not Red and Blue

Food Sovereignty



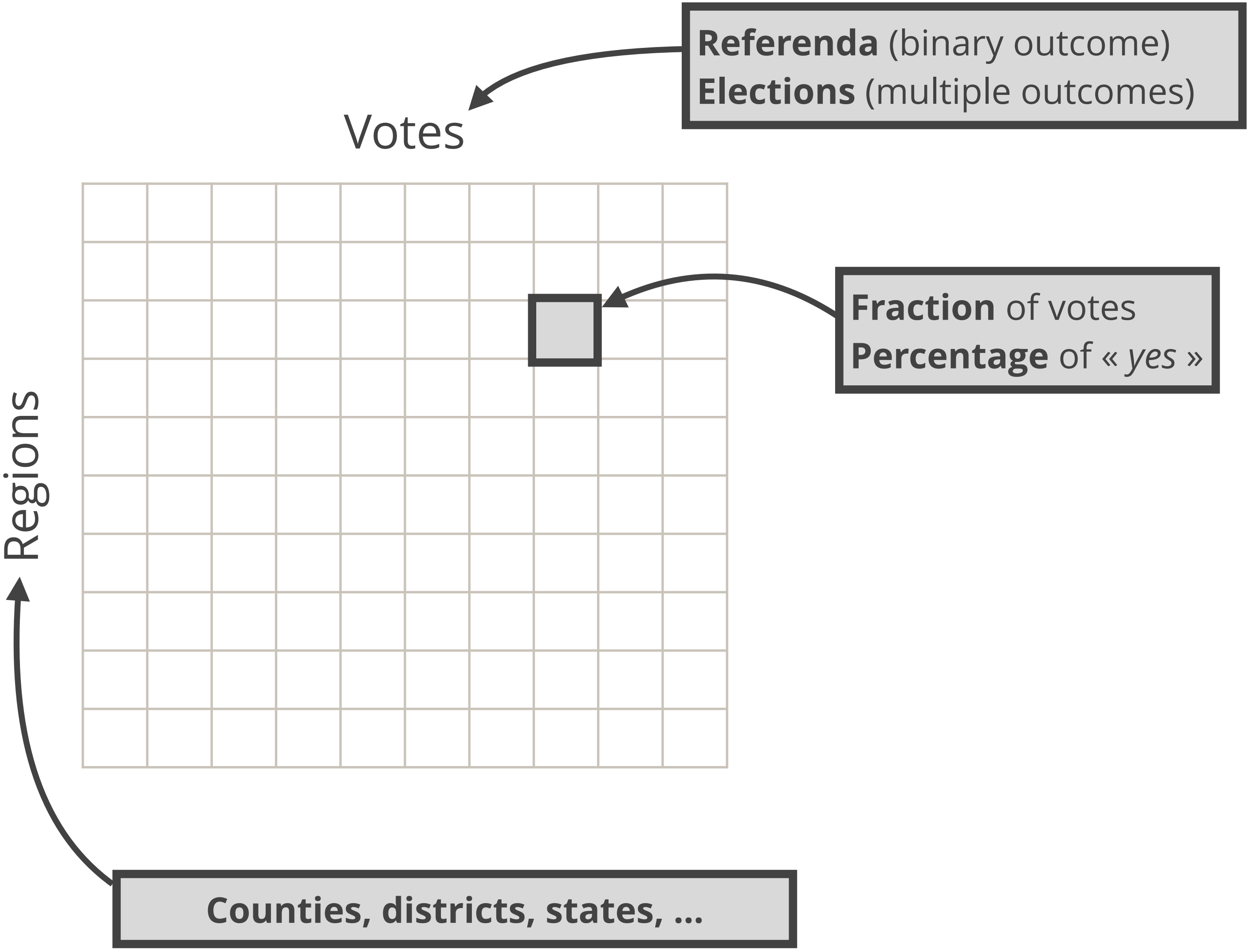
Voting « In favor » = **Left**-Leaning

Deportation of Criminal Foreigners



Voting « In favor » = **Right**-Leaning

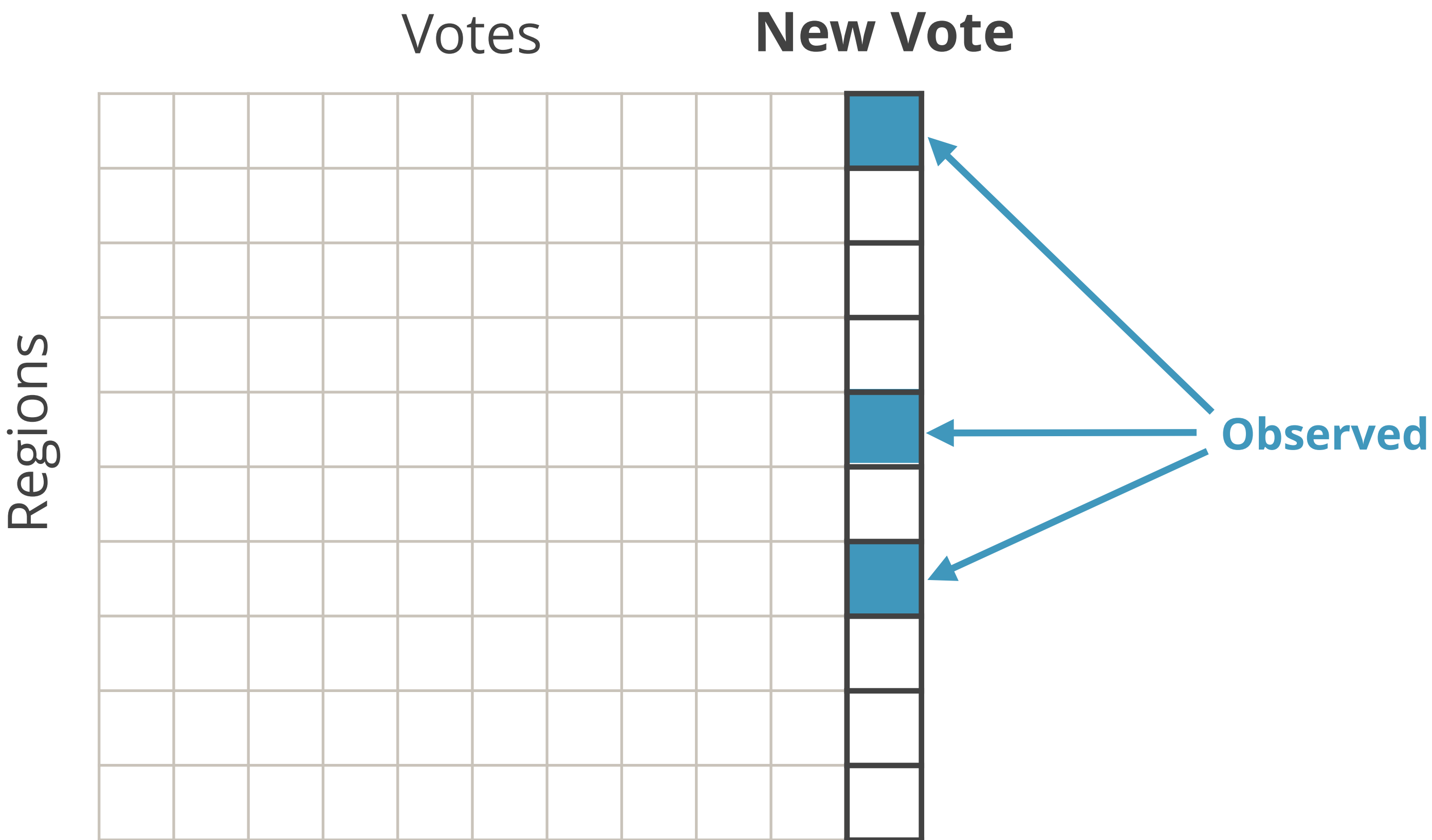
Vote Matrix



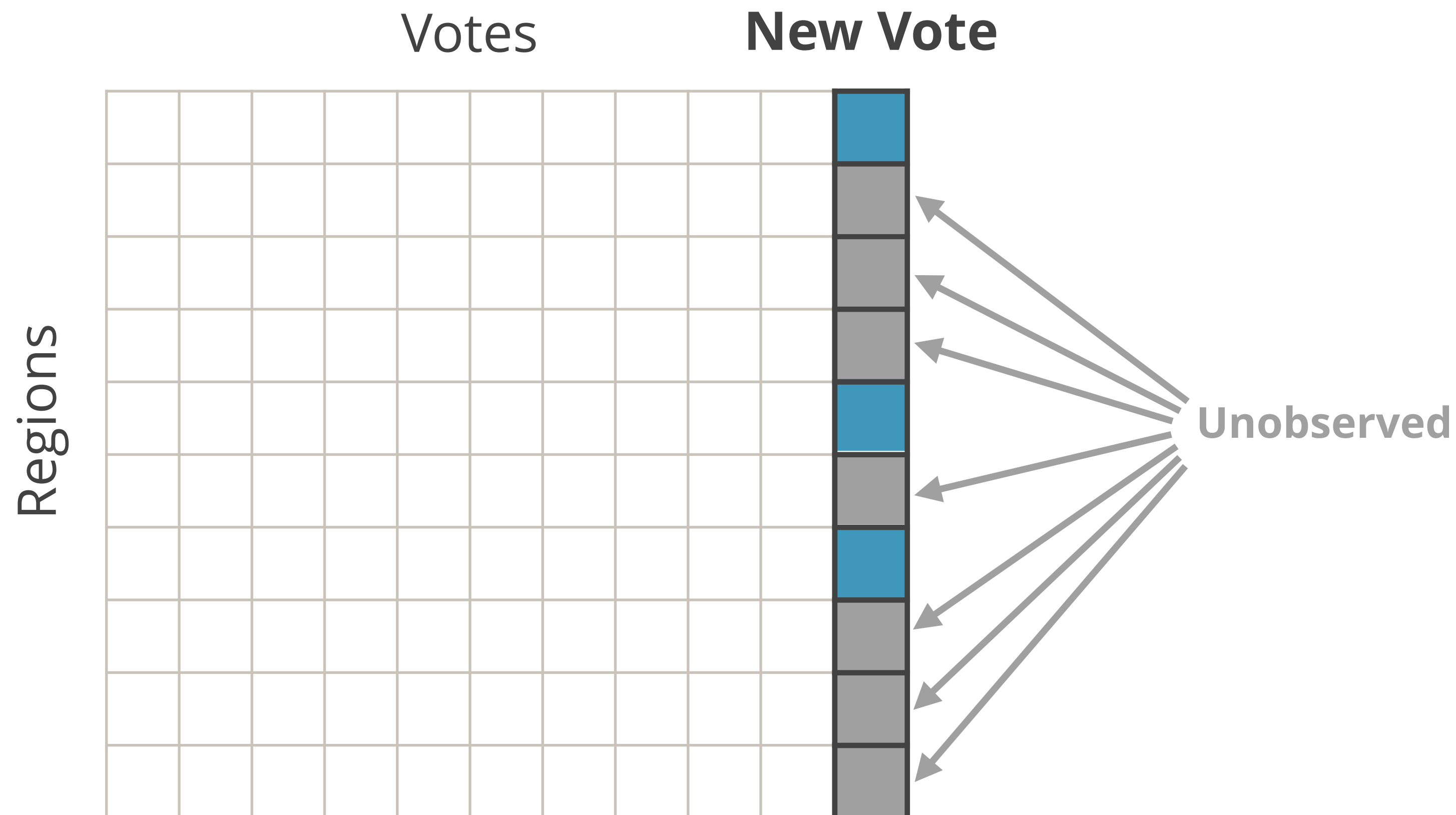
A Wild VOTE Appears!

Votes										New Vote
Regions										

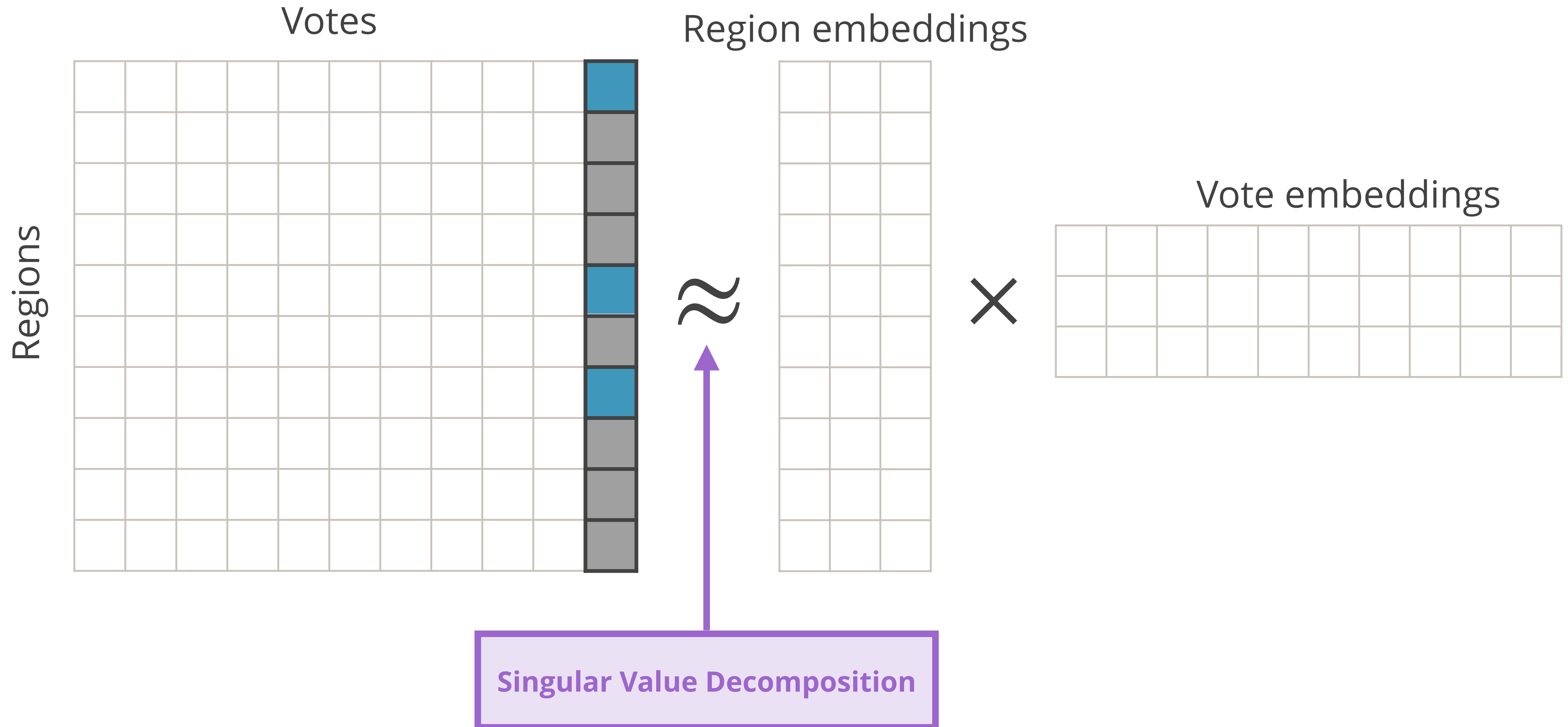
A Wild VOTE Appears!



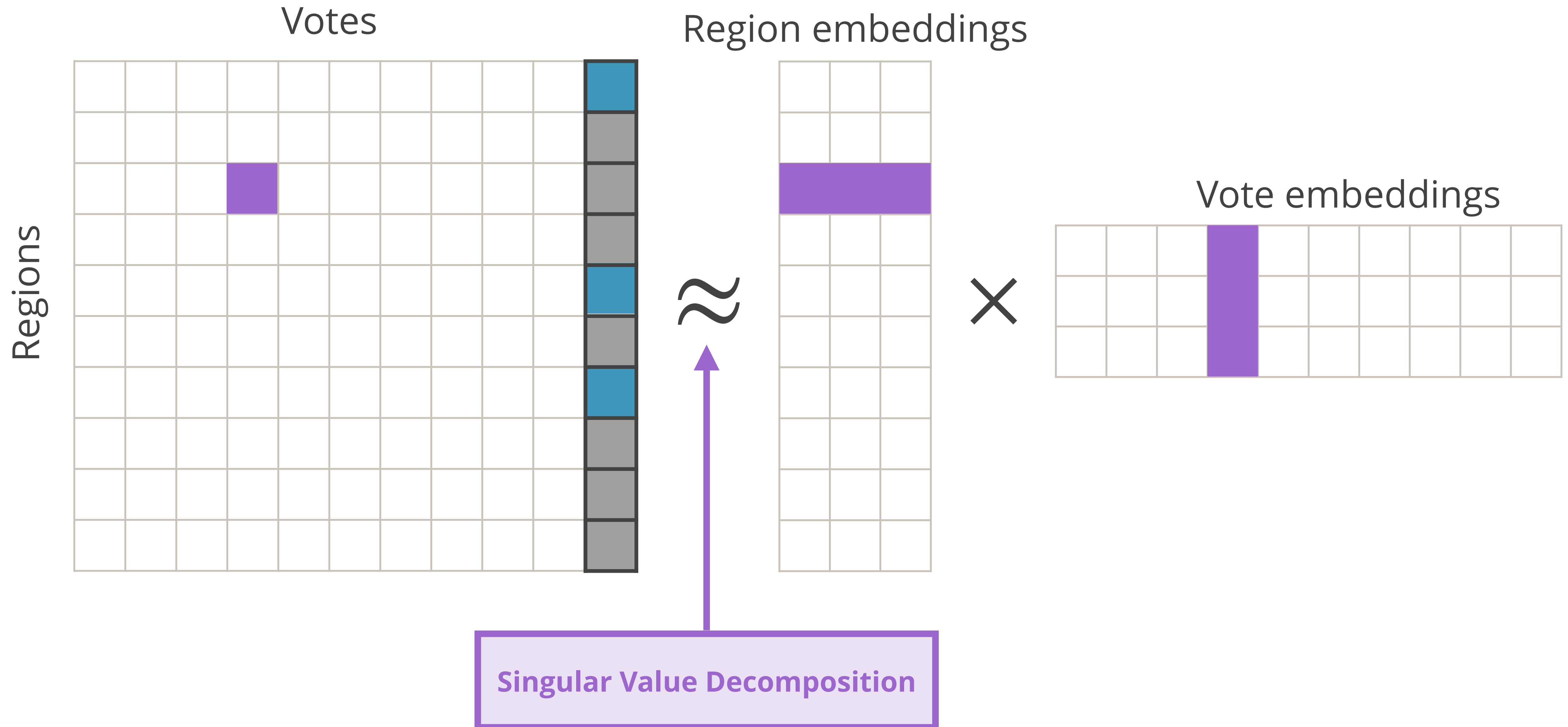
A Wild VOTE Appears!



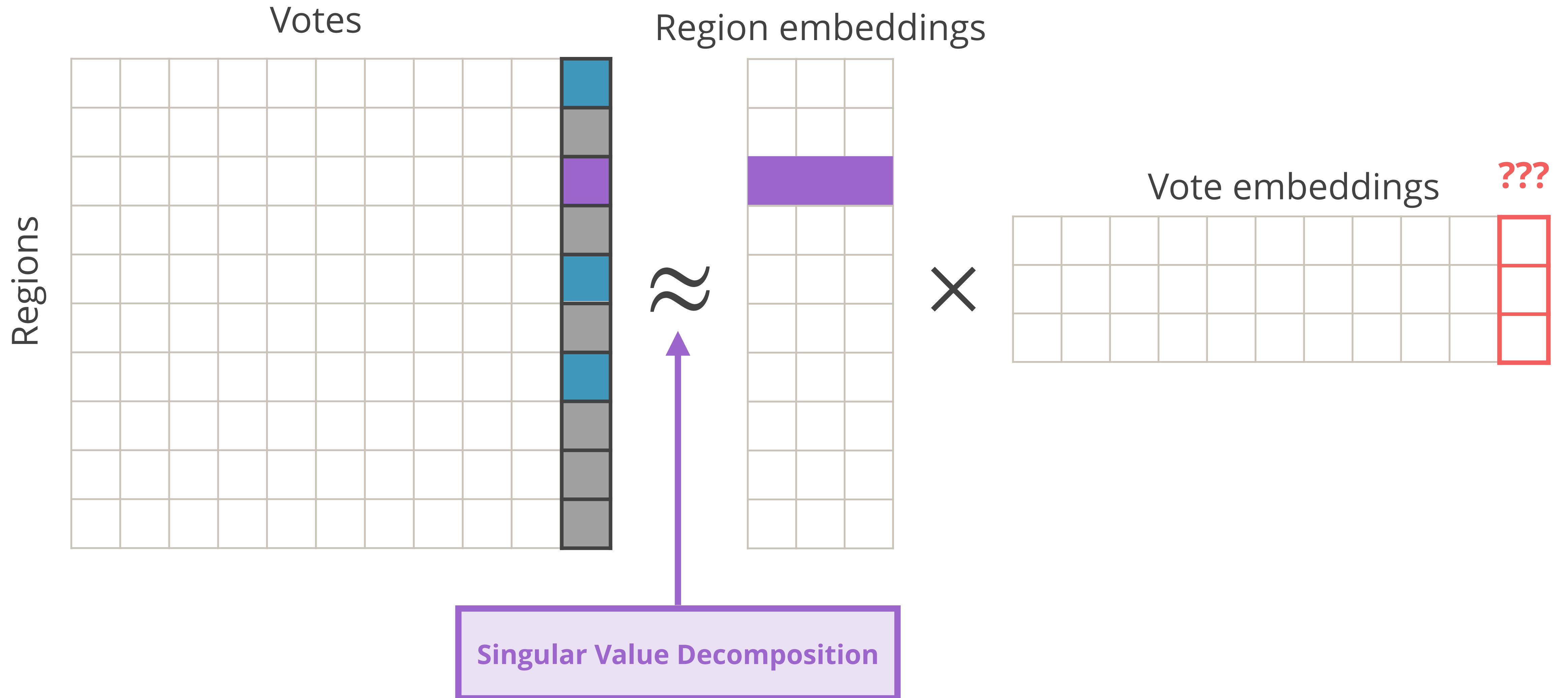
Sub-Matrix Factorization



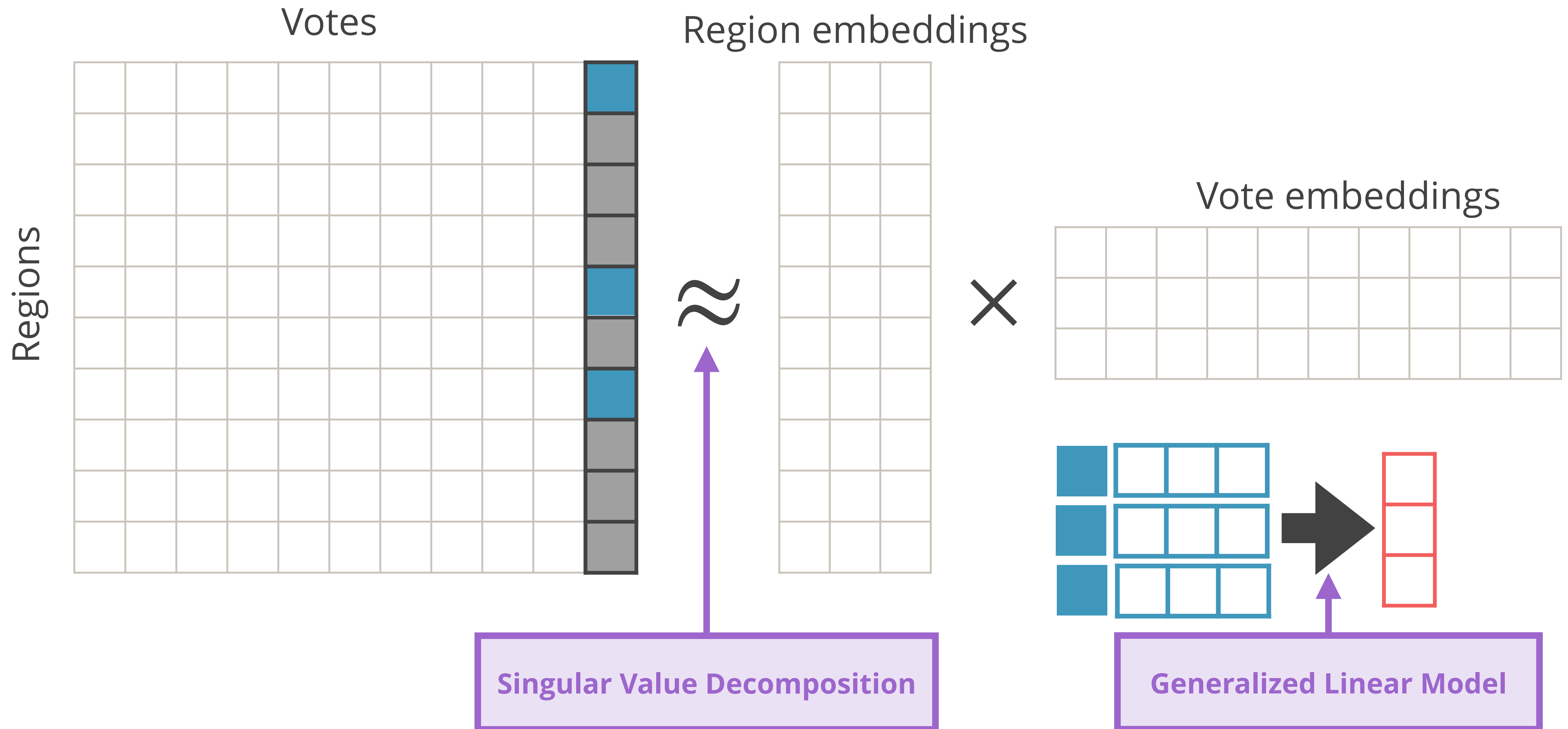
Sub-Matrix Factorization



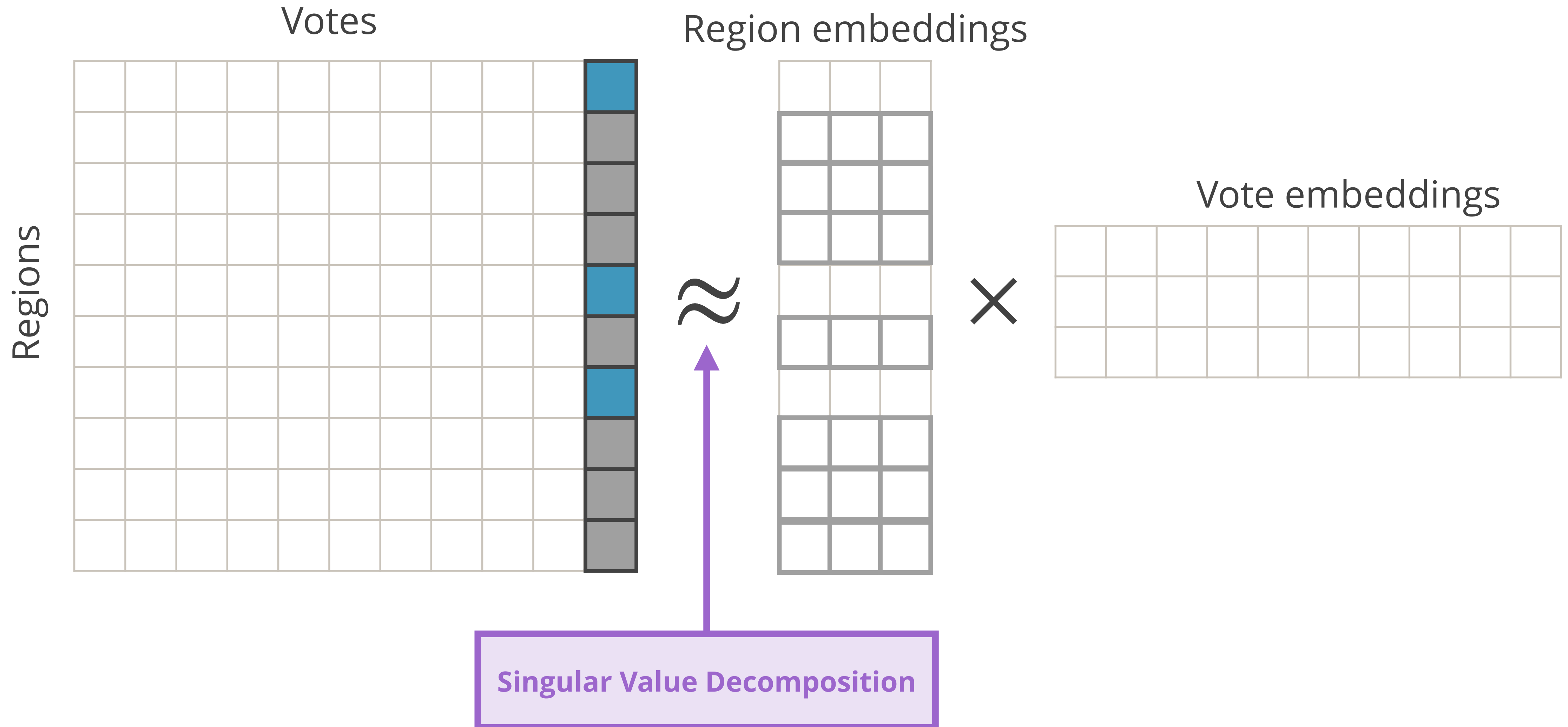
Sub-Matrix Factorization



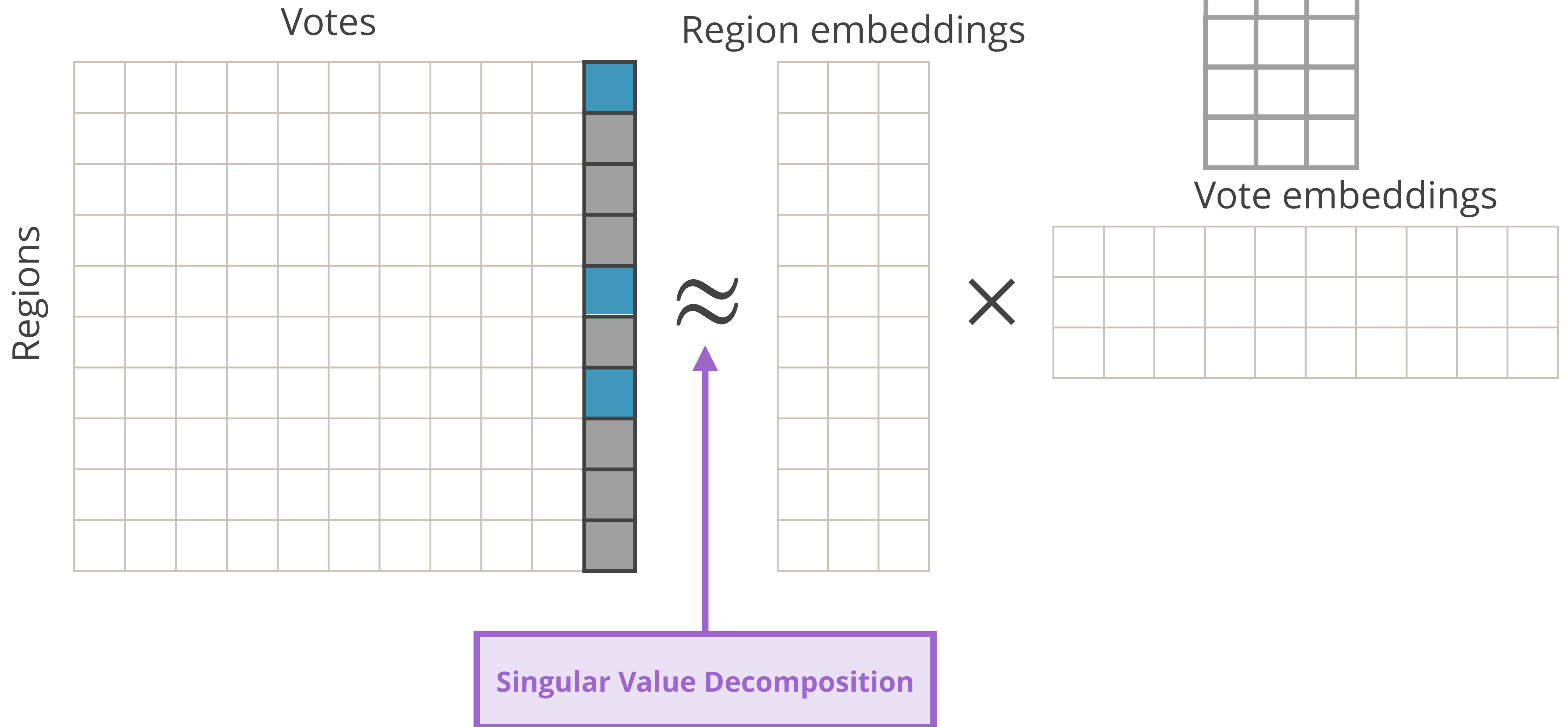
Embedding of the New Vote



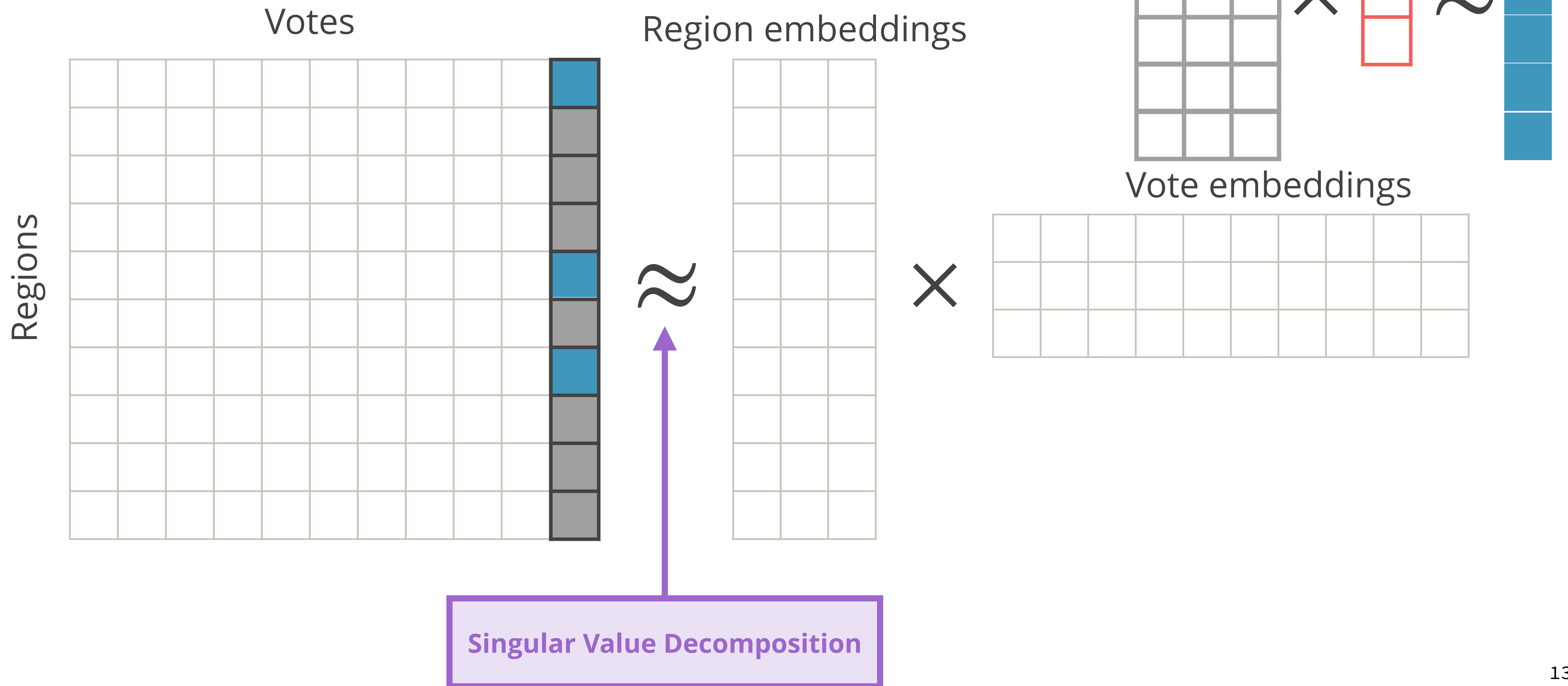
Predict Missing Entries



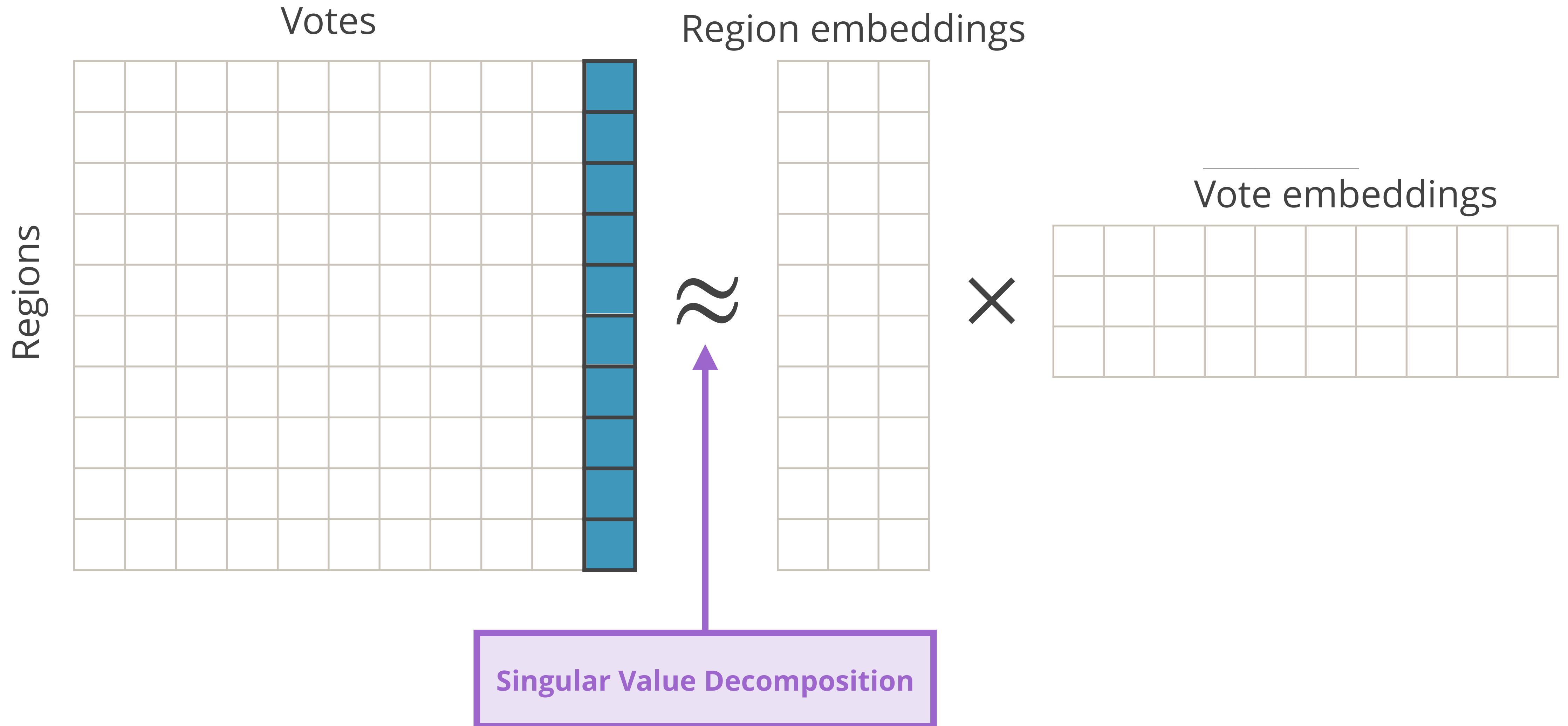
Predict Missing Entries



Predict Missing Entries



Predict Missing Entries



Experiment: Datasets

Country	Type	Region	# Regions	# Votes	# Parties	Period
Switzerland	Binary	Municipality	2 196	330	-	1981-2020
US	Binary	State	50	11	-	1976-2016
Germany	Categorical	State	16	6	5	1990-2009
Germany	Categorical	District	538	5	5	1990-2005

Experiment: Swiss Referenda

Prediction Task

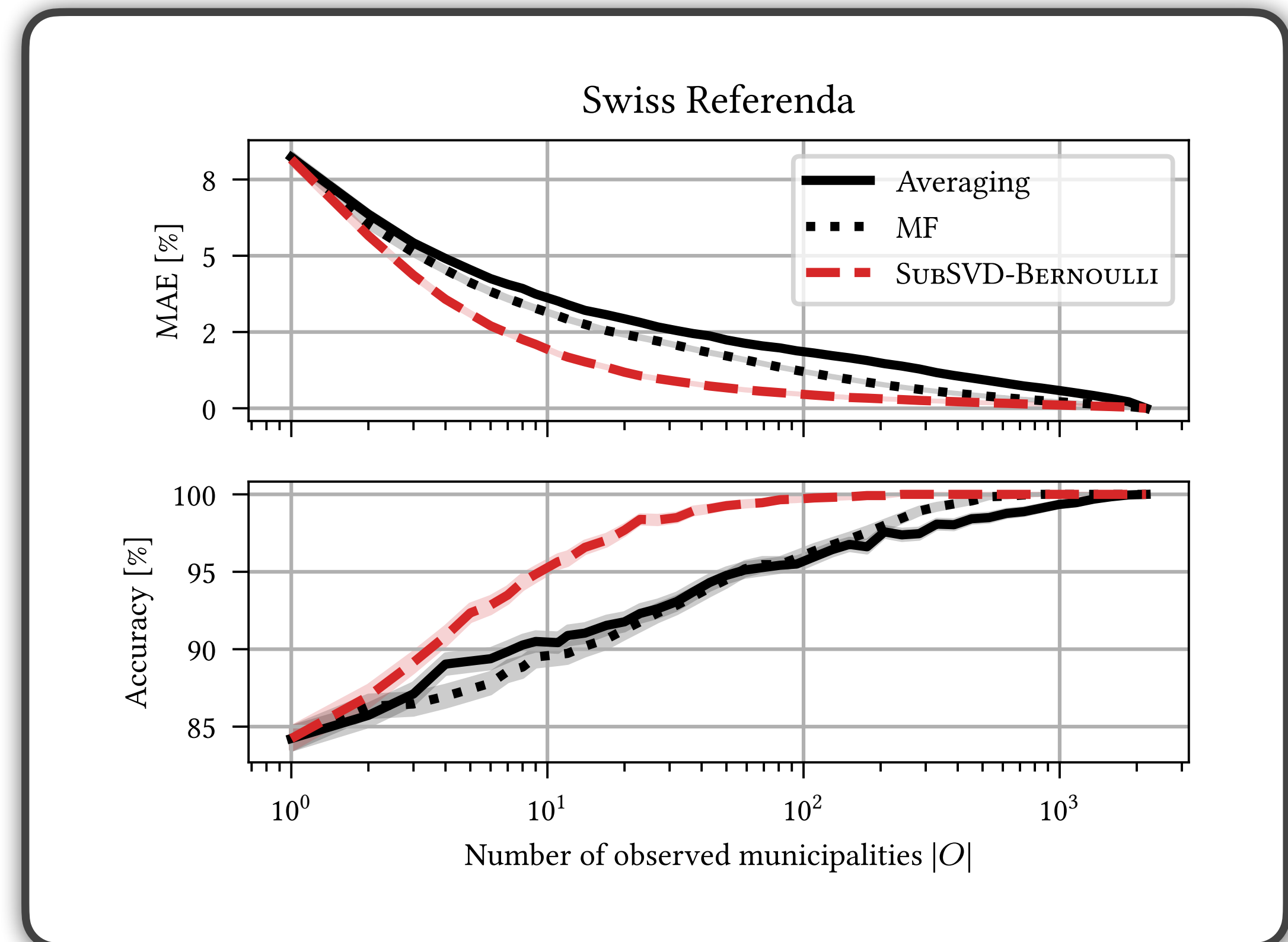
- Train on **300 votes** and **2196 regions**
- Test on **following vote** (26 test votes)
- Simulate **100 random reveal orders**
- Report averaged **MAE** and **accuracy**

Baselines

- **Running Average**
- **Standard Matrix Factorization** (ALS)

Our Algorithm

- **Gaussian** Likelihood (not reported)
- **Bernoulli** Likelihood



With 10 municipalities: MAE is less than 2% and accuracy is more than 95%

The performance of our algorithm will prove to be much better with **real data**!

Experiment: German Elections

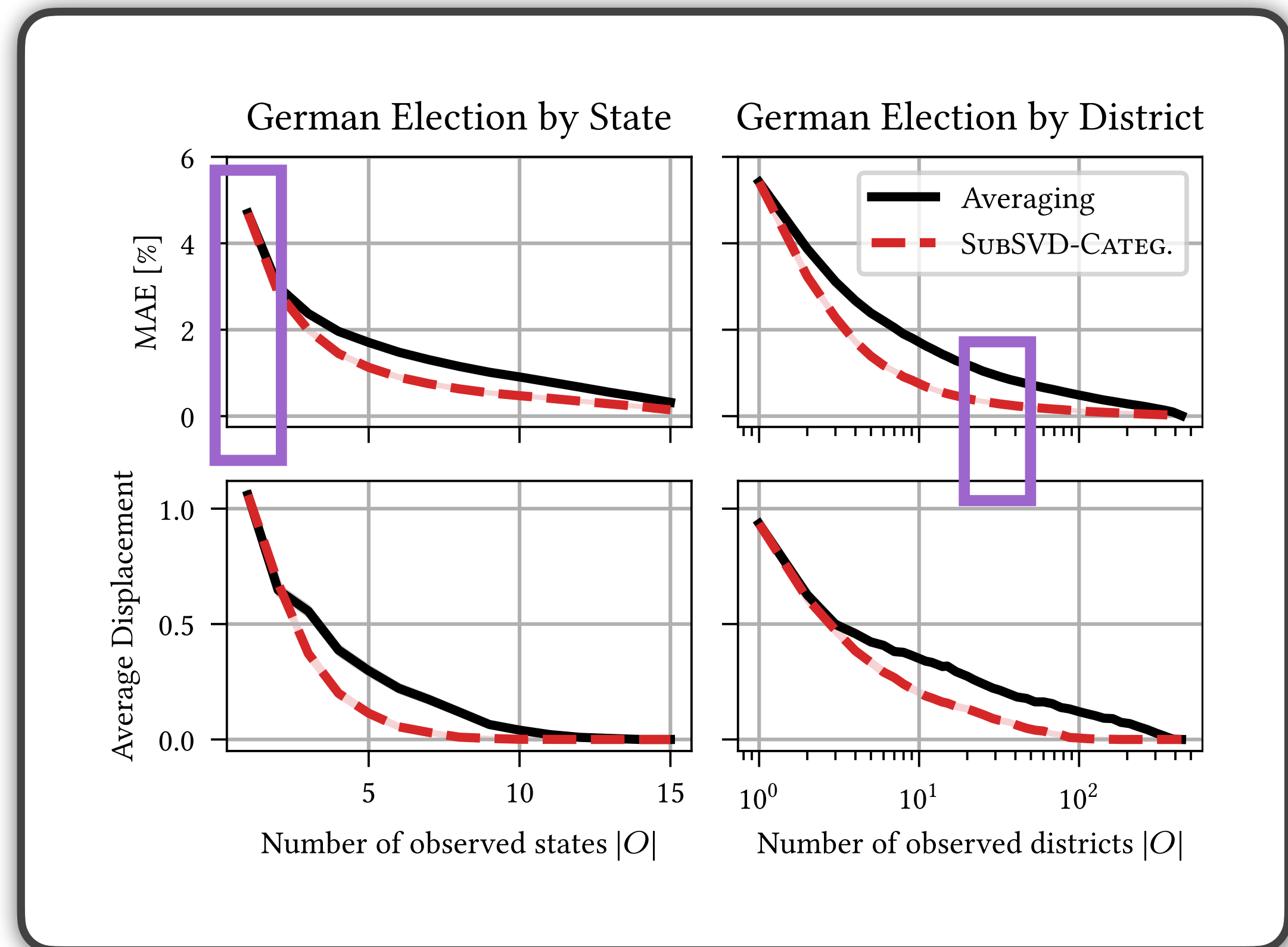
Prediction Task

- Elections with **5 political parties**
- Train on **5 votes** (**4 votes**, for districts)
- Test on **vote 6** (**vote 5**)
- Simulate **100 random reveal orders**
- Report **MAE** and **average displacement**

Baseline: Running Average

Our Algorithm

- **Gaussian** Likelihood (not reported)
- **Categorical** Likelihood

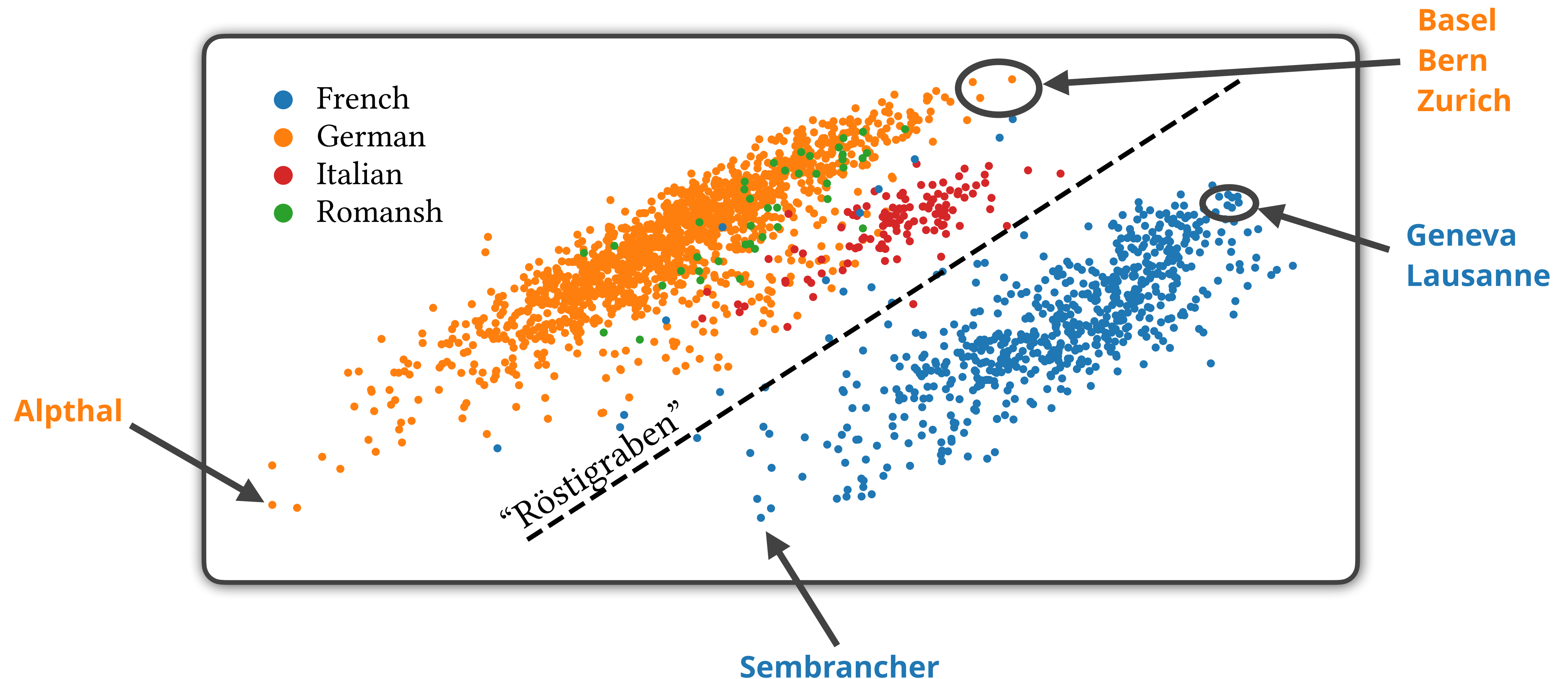


With 30 districts (average #districts per state): MAE is less than 0.5% (10x better than with 1 state)!

A **finer level of granularity** provides better performance, even if the number of voters is the **same**!

Ideological Space: Swiss Municipalities

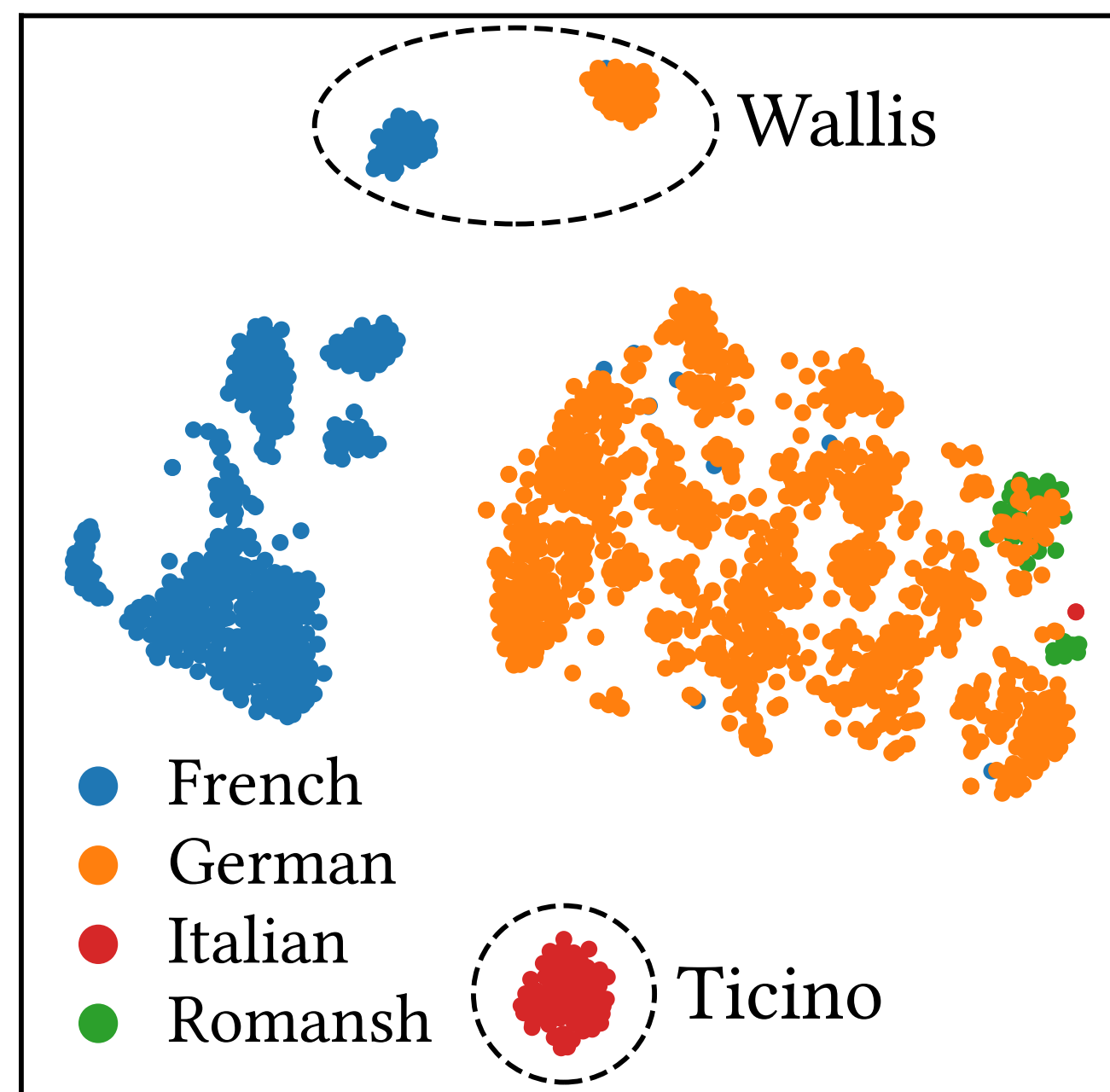
We project the **municipalities** onto the first two singular vectors of the **vote space**



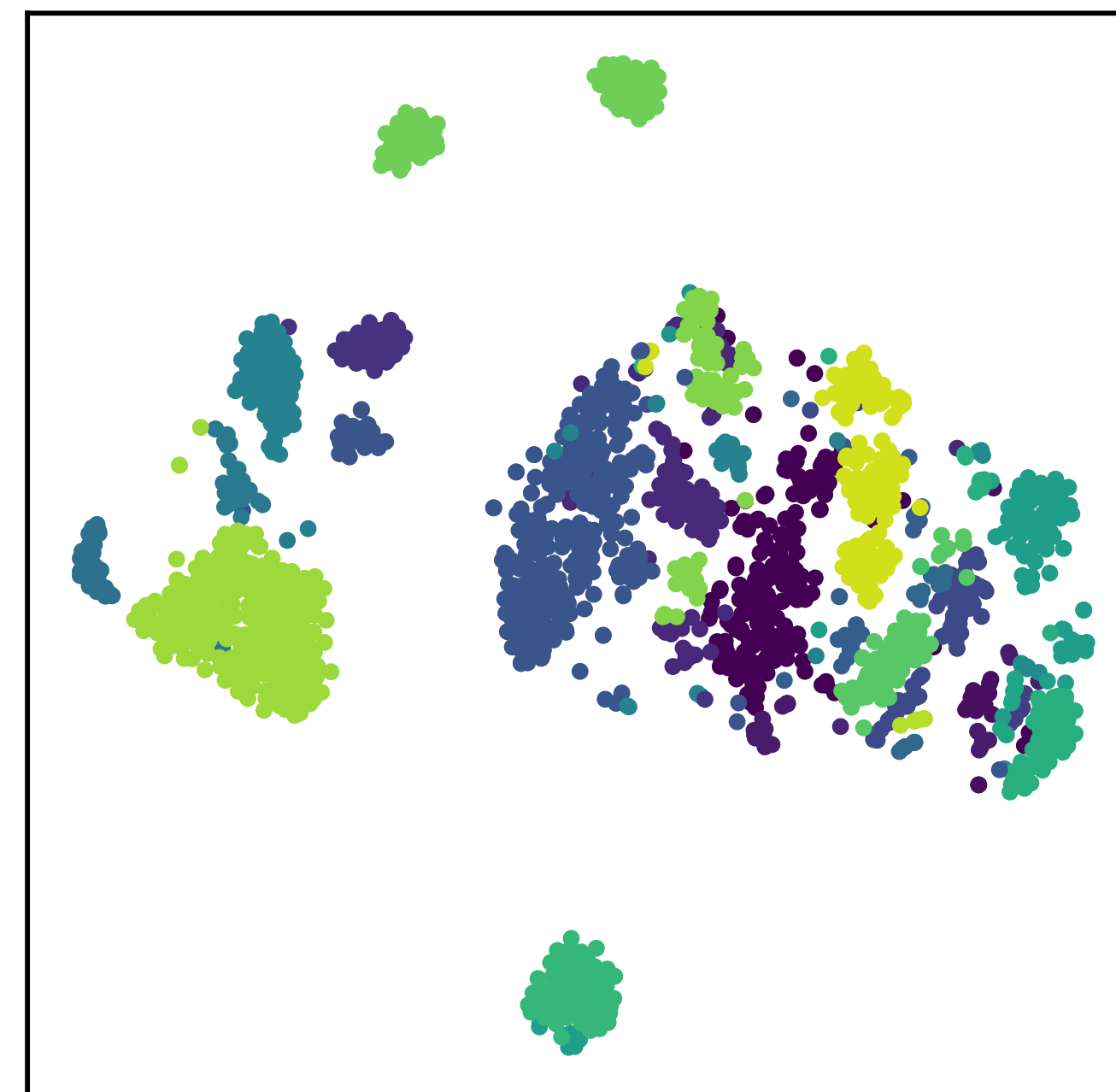
Ideological Space: Swiss Municipalities

We use **t-SNE** to visualize to **matrix** of all municipality embeddings

Coloring by Language

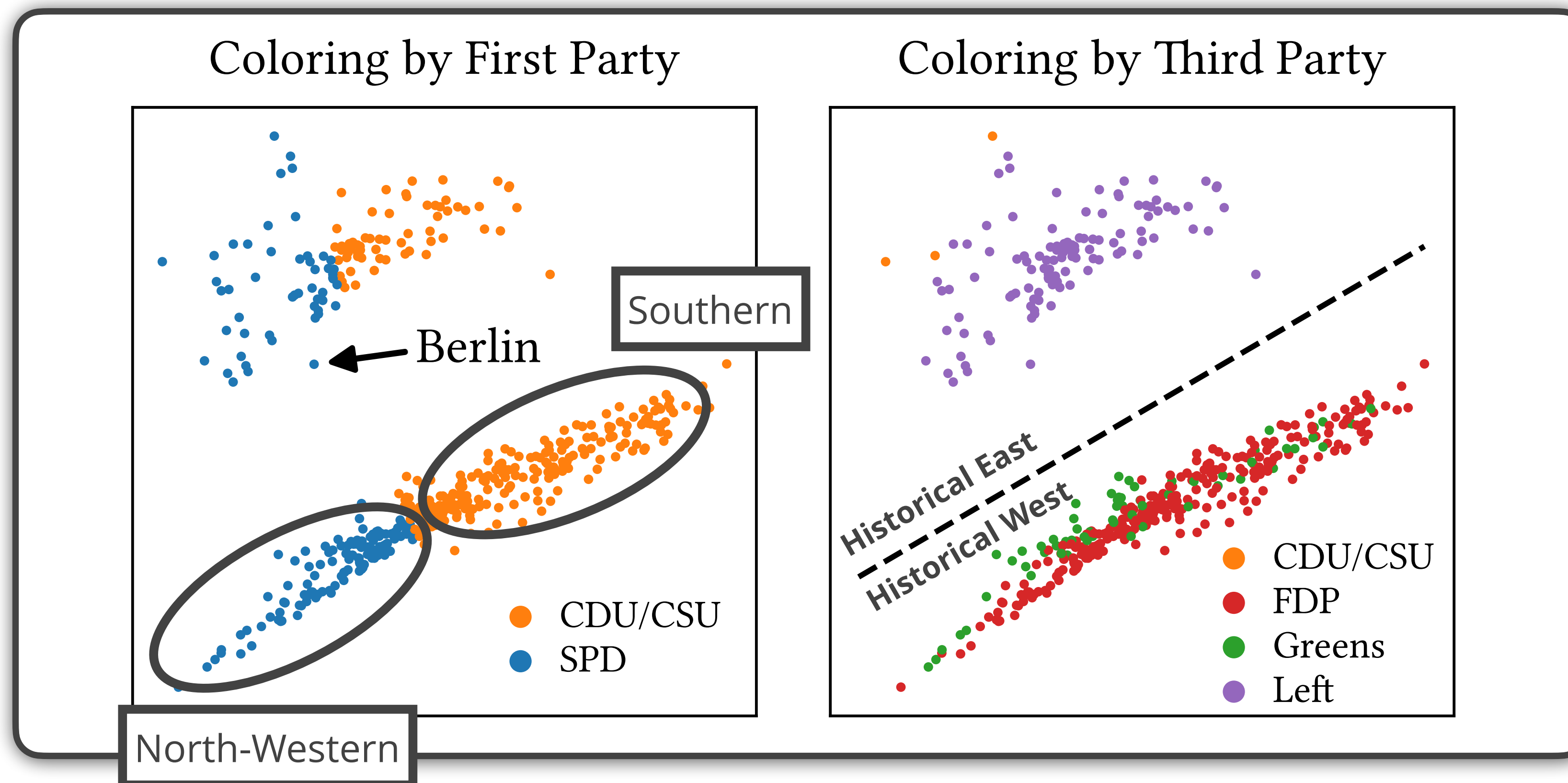


Coloring by Canton



Ideological Space: German Districts

We project the **district embeddings** onto the first two dimensions of the **vote space**

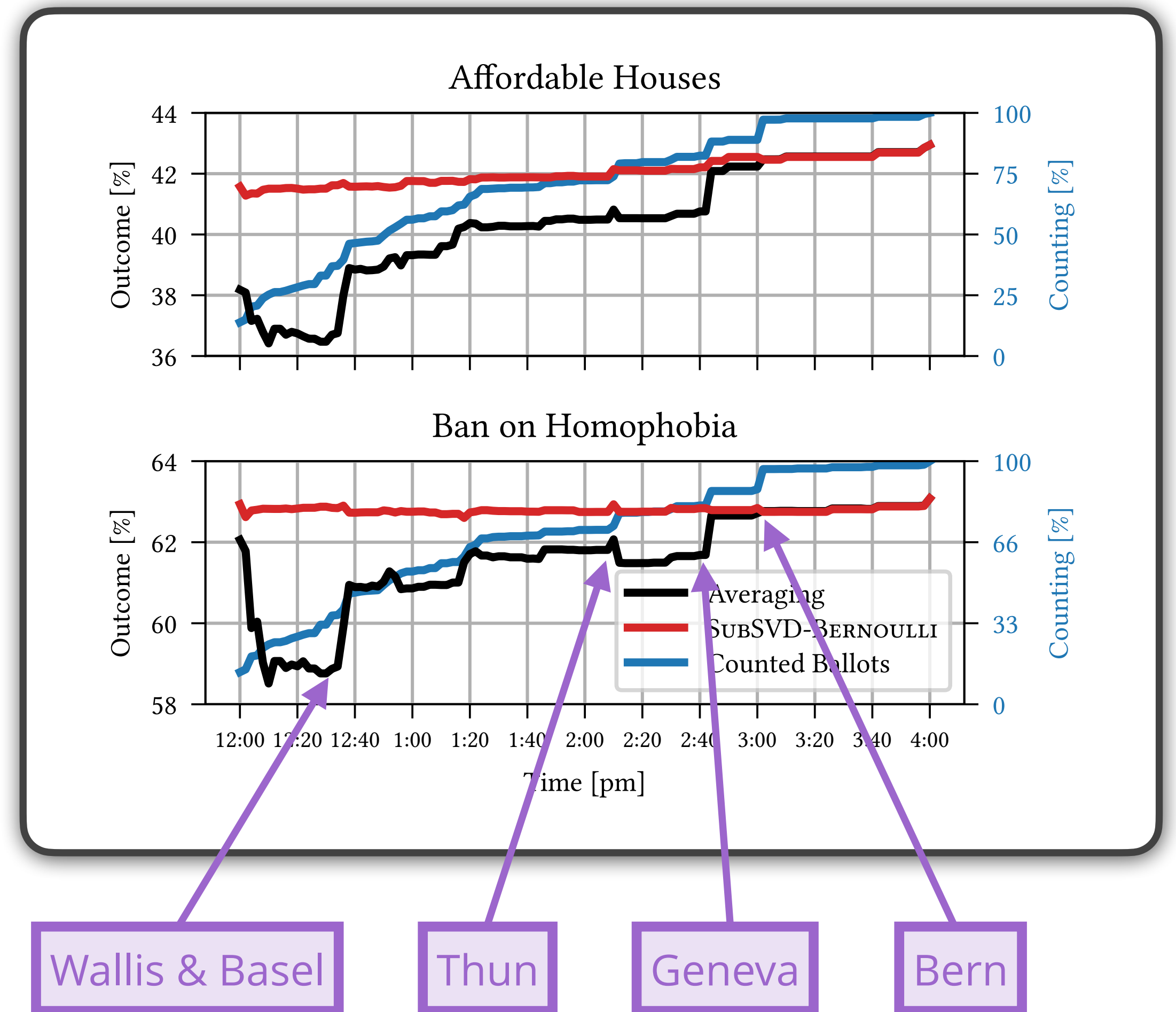


Real-Time Prediction

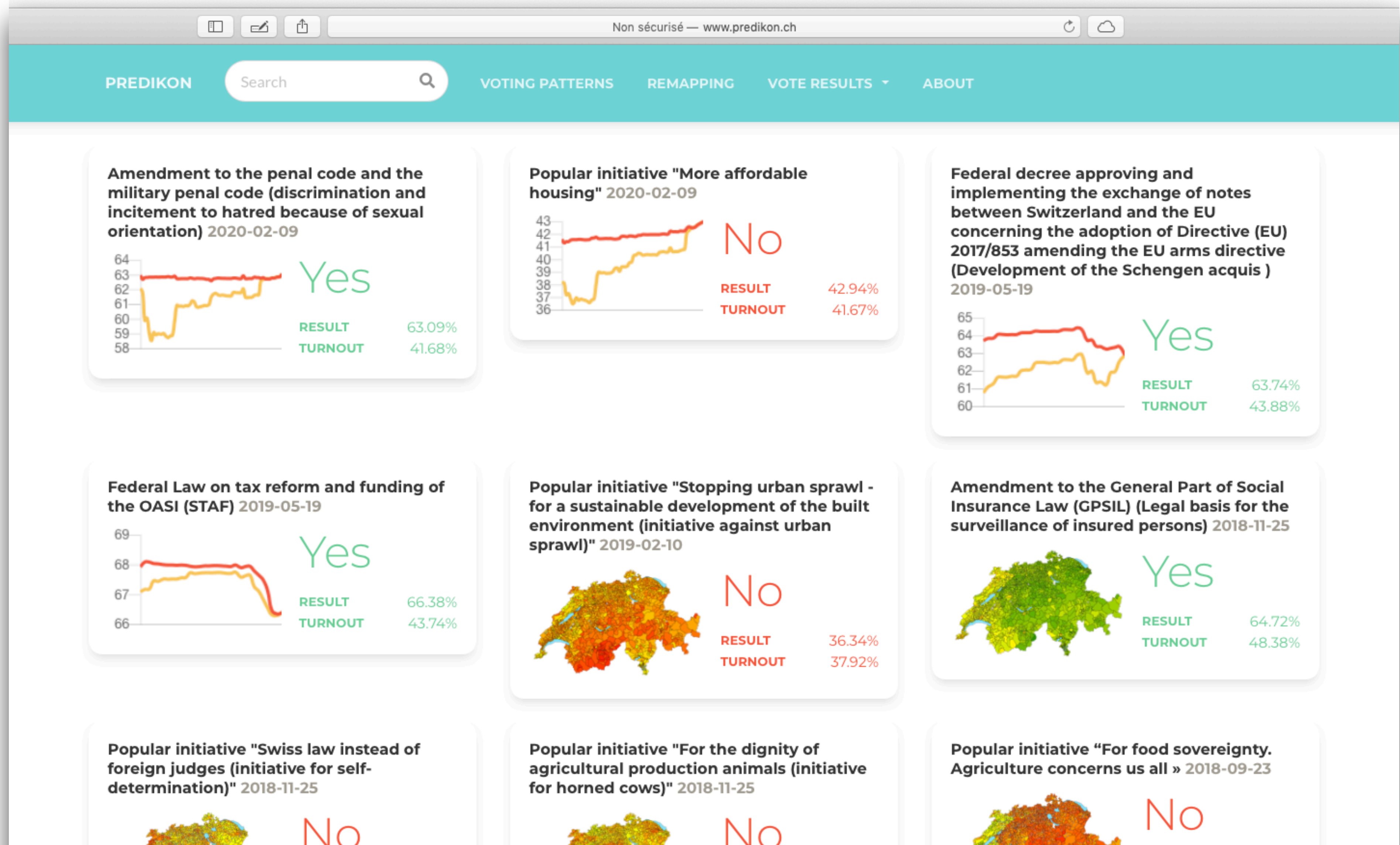
Actual Swiss Referenda in 2019 and 2020

Item	Outcome [%]	Prediction [%]	Difference
Tax Reform	66,38	67,90	1,52
Weapon Regulation	63,73	63,52	0,21
Affordable Houses	42,95	41,57	1,38
Ban on Homophobia	63,09	62,94	0,15

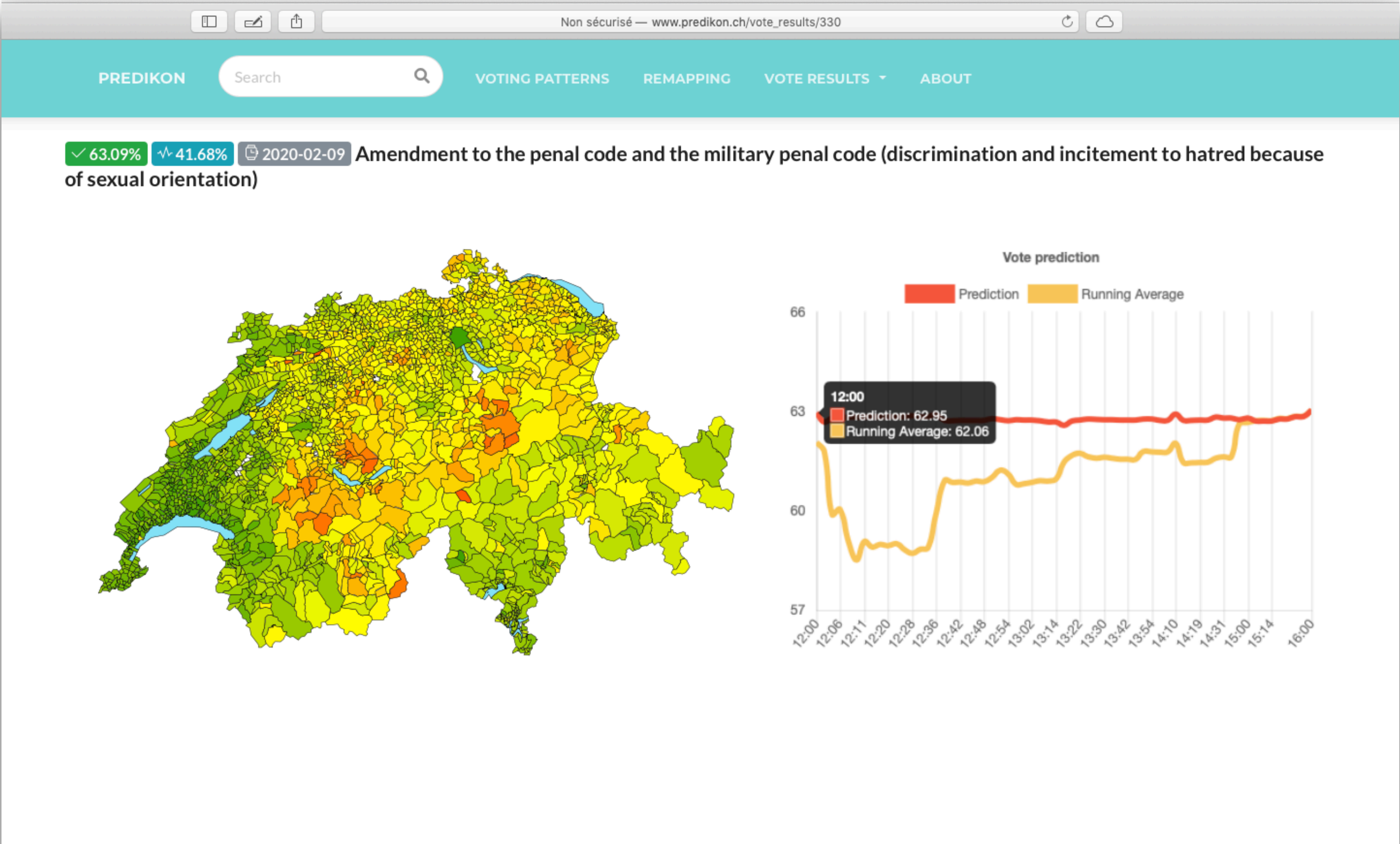
At 12pm: 13% of the results are available, prediction is 1% off



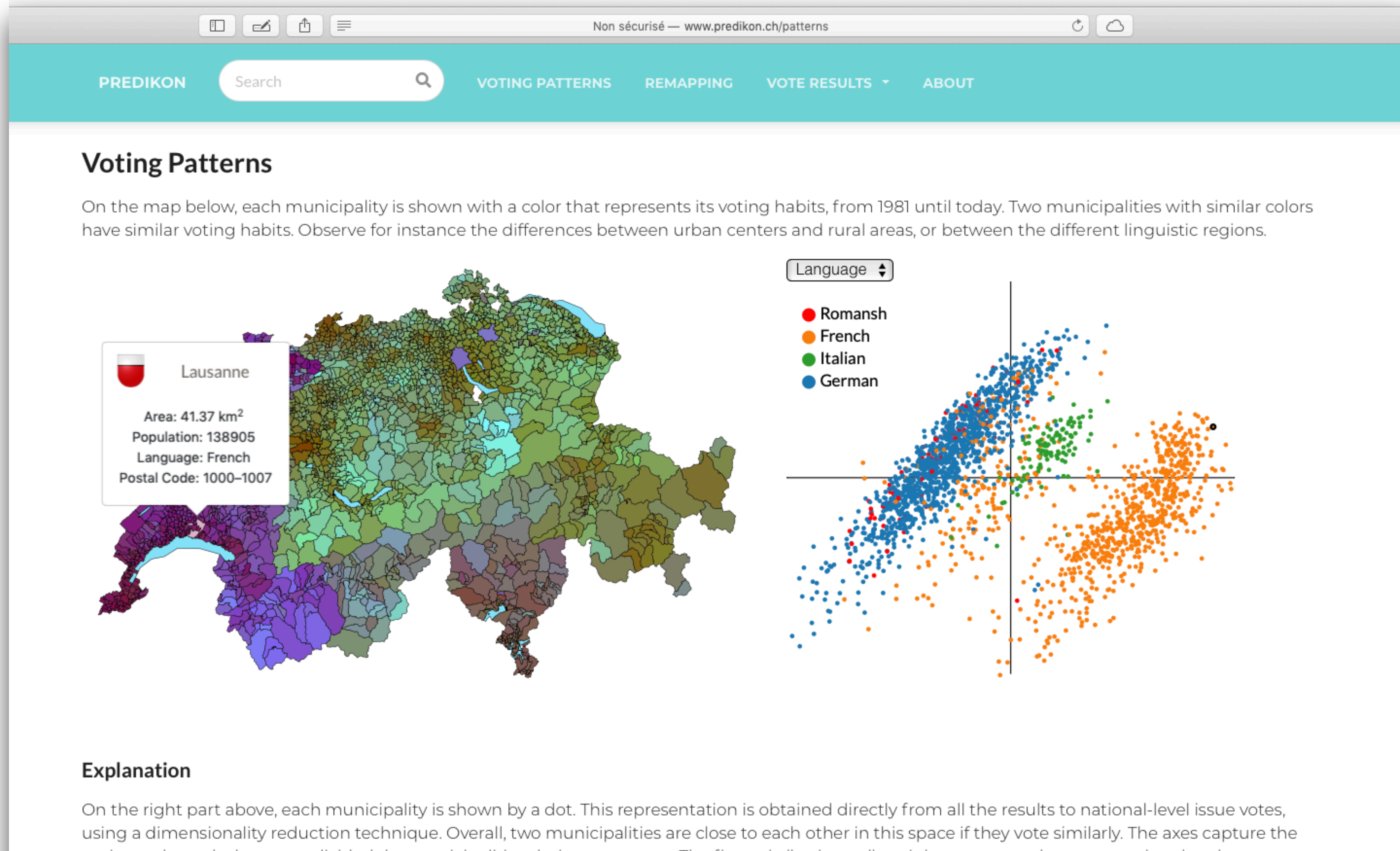
Web platform at <http://predikon.ch>



Web platform at <http://predikon.ch>



Web platform at <http://predikon.ch>



Thank you!

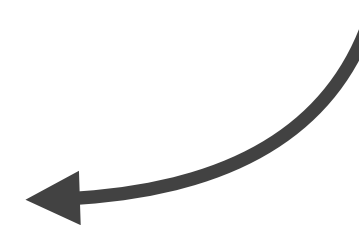
<http://predikon.ch>

Data, code, and Python library are on GitHub:

 [/indy-lab/submatrix-factorization](https://github.com/indy-lab/submatrix-factorization)



Or scan this code



Connect with me on Twitter!

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