



Spatial Data Mining II: A Deep Dive Into Space-Time Analysis

Ankita Bakshi

Lauren Bennett

Alberto Nieto

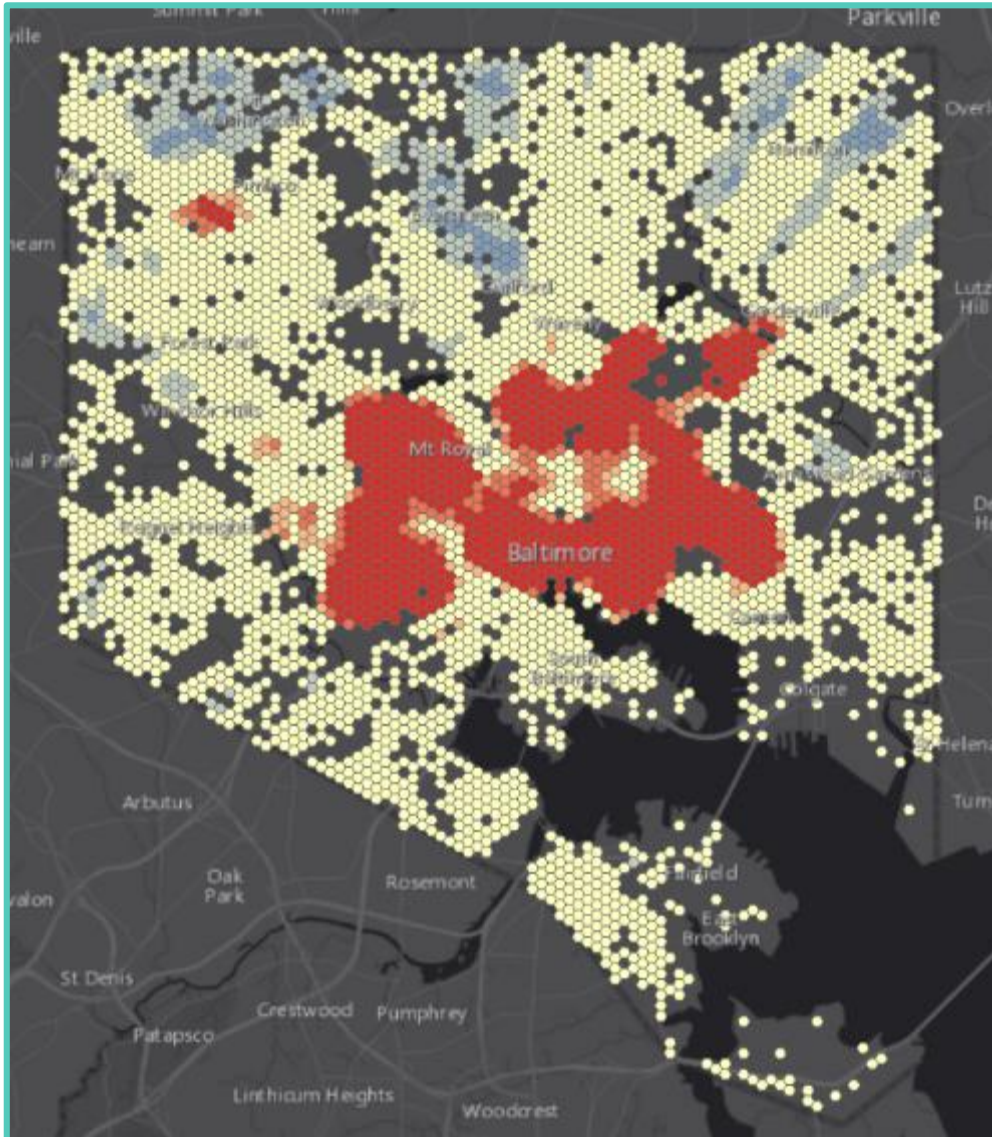
Flora Vale

esriurl.com/spatialstats

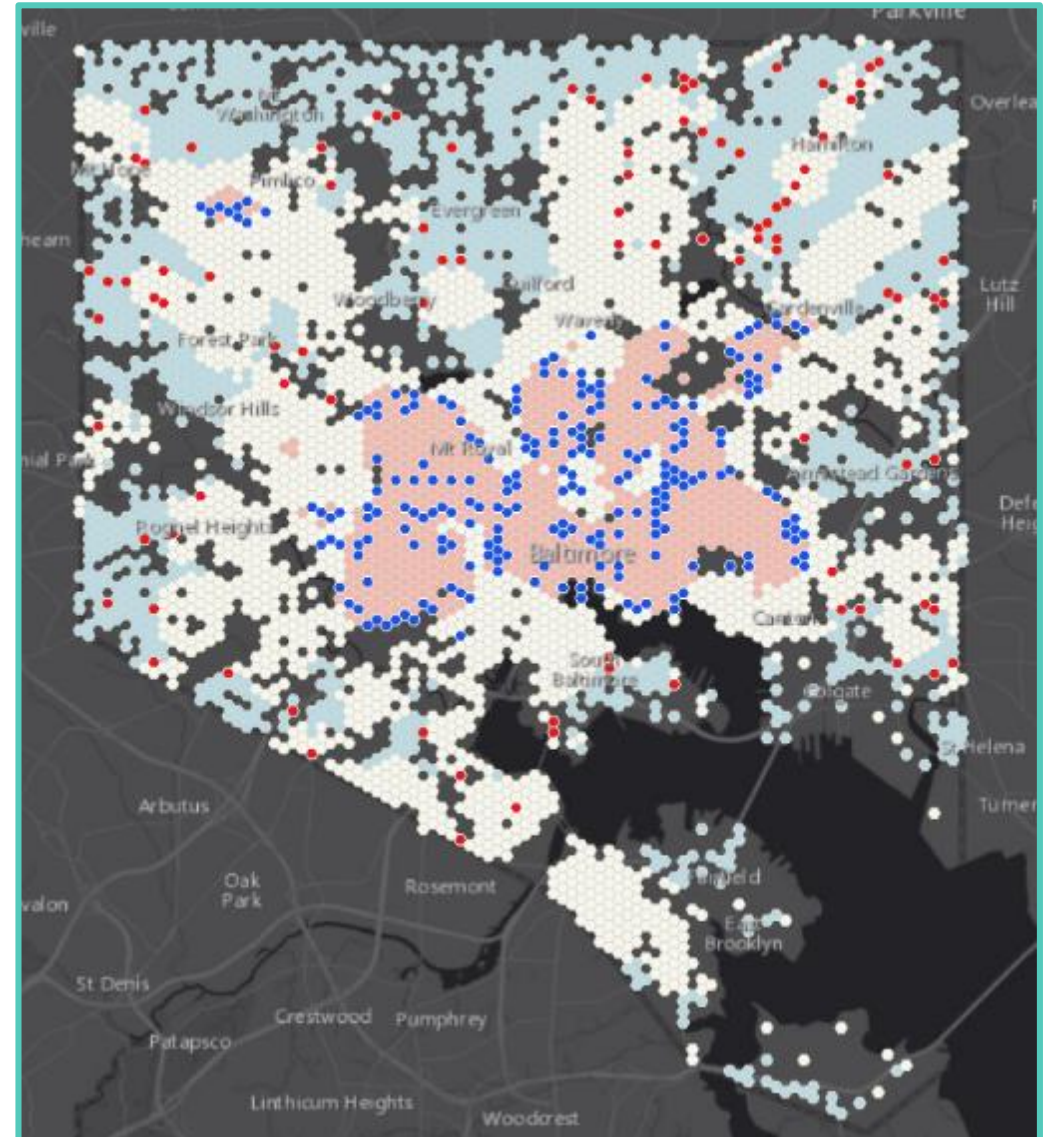
SEE
WHAT
OTHERS
CAN'T



Quantifying Spatial Clusters

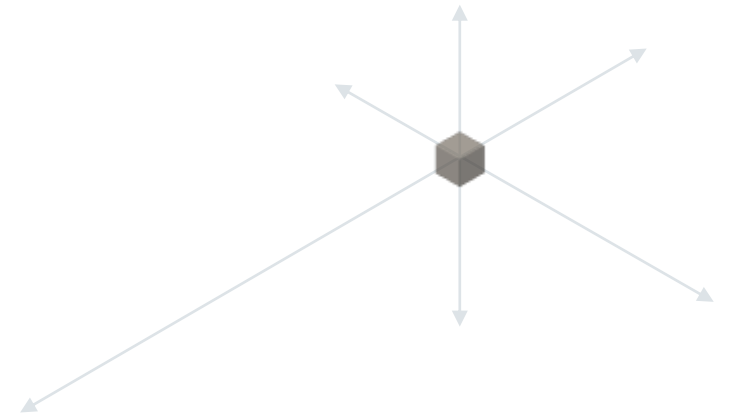


Hot Spot Analysis



Cluster and Outlier Analysis

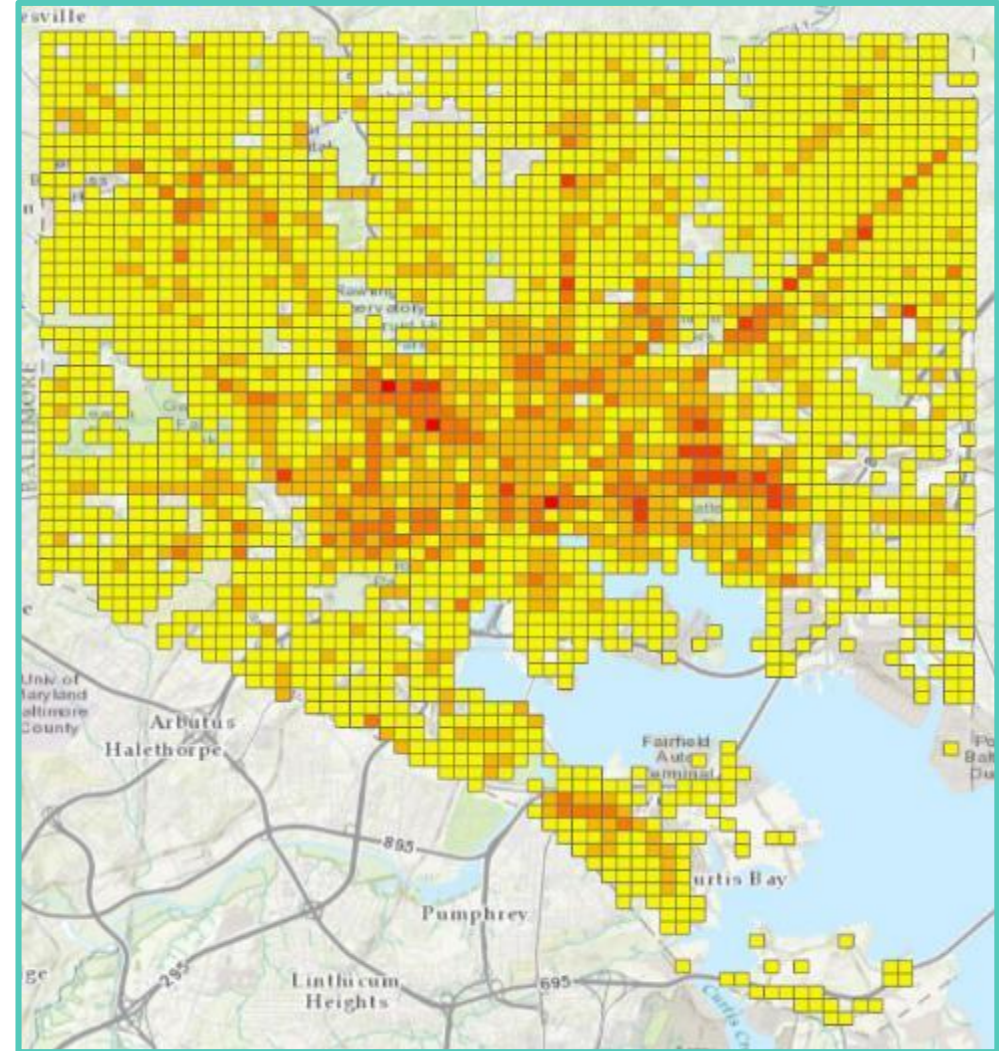
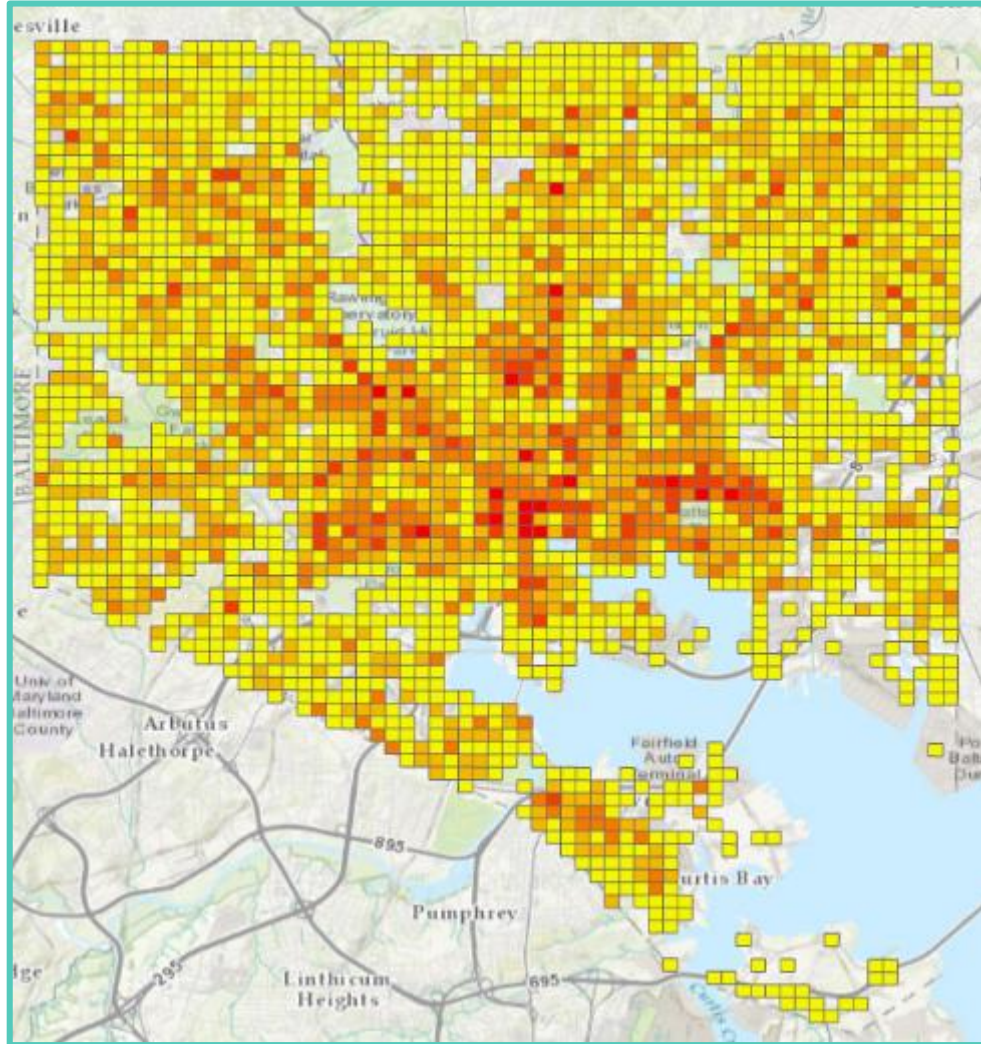
What about **time**?



911 Calls

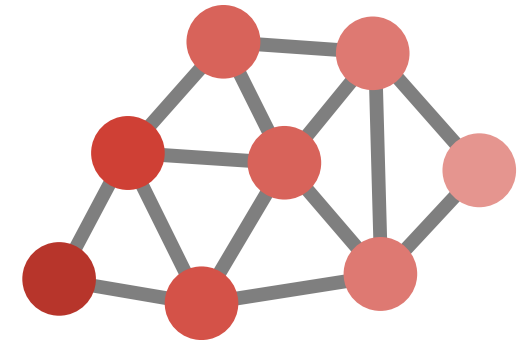
January 2015

January 2016

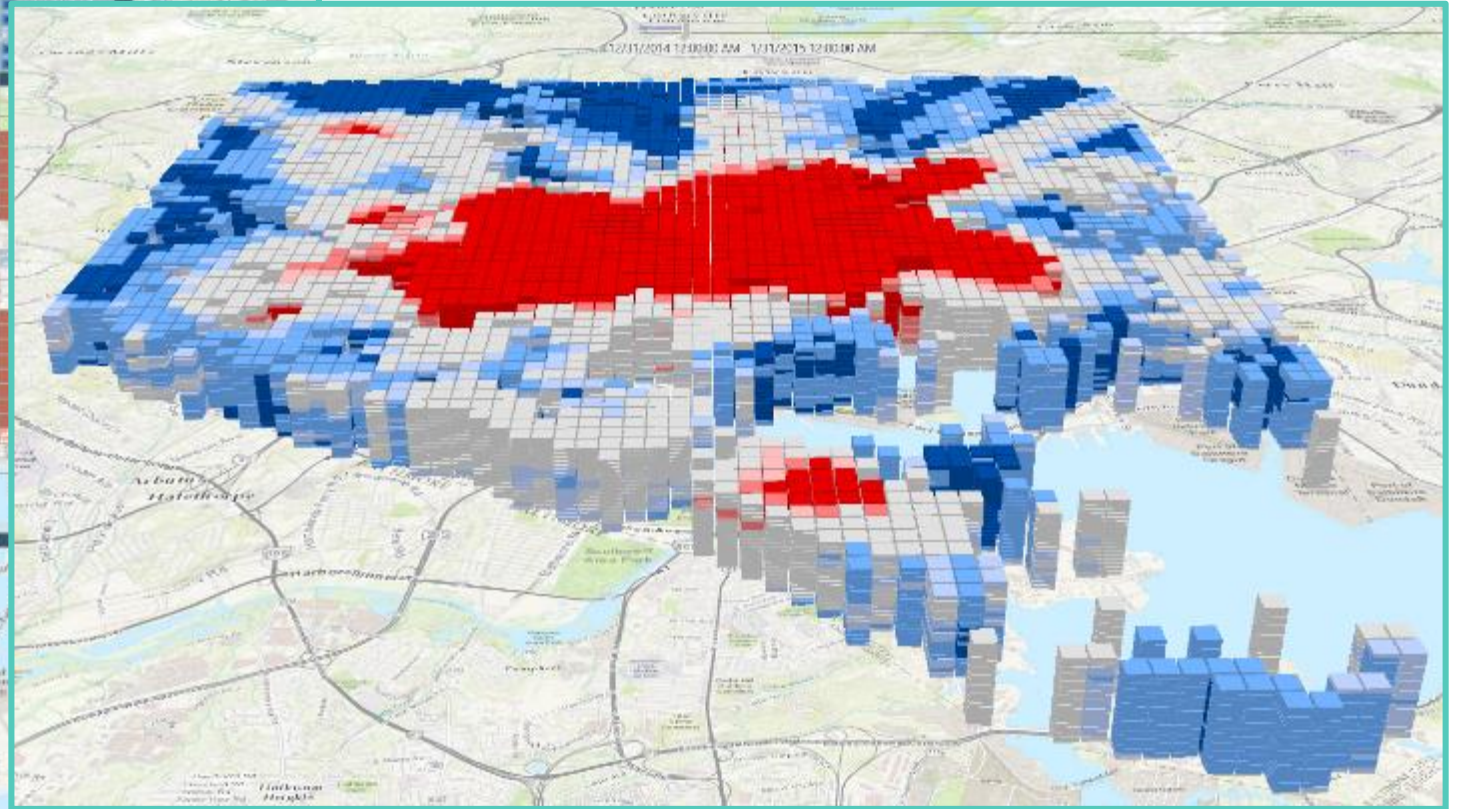
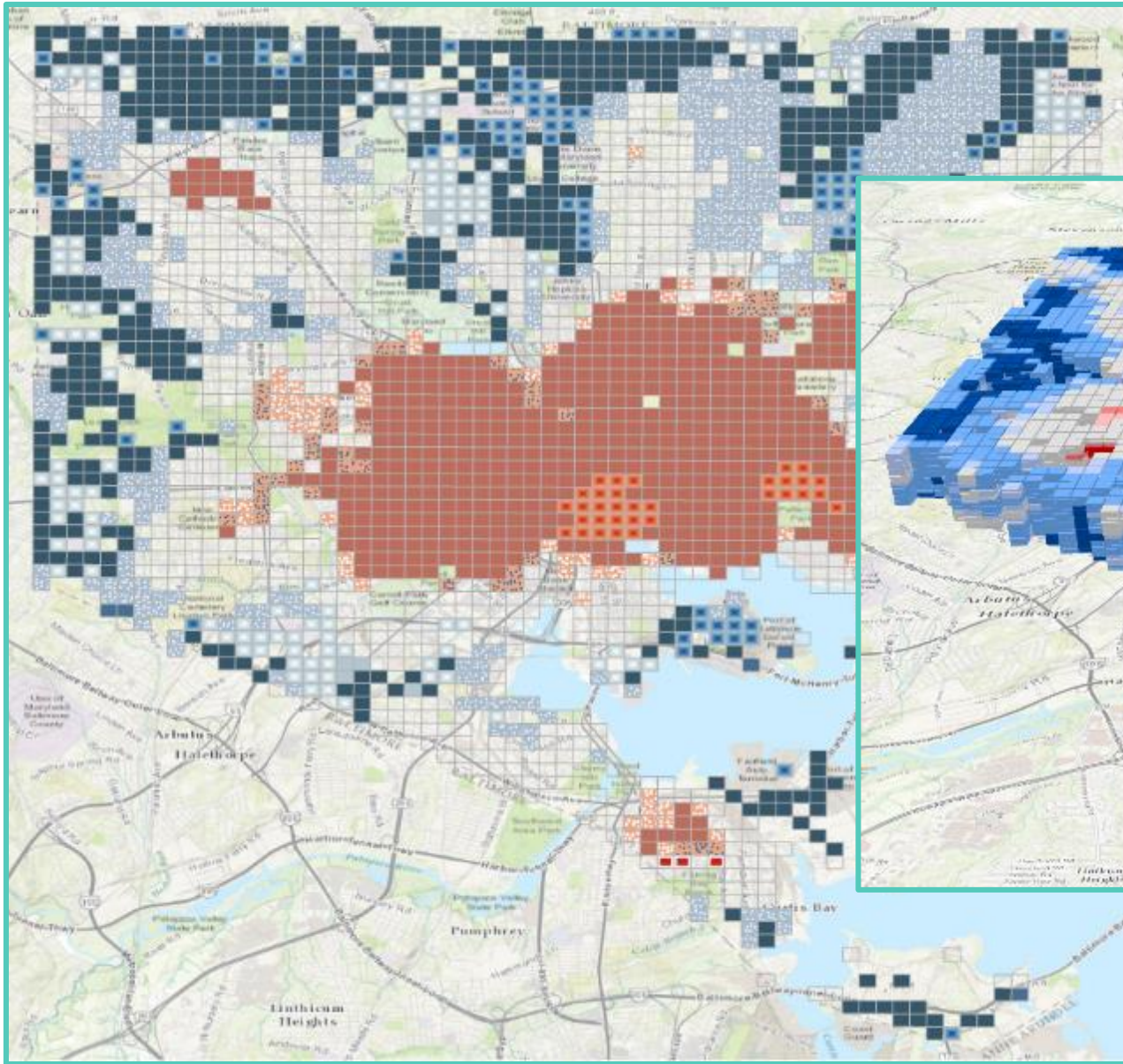


Where have things changed? Is it meaningful?

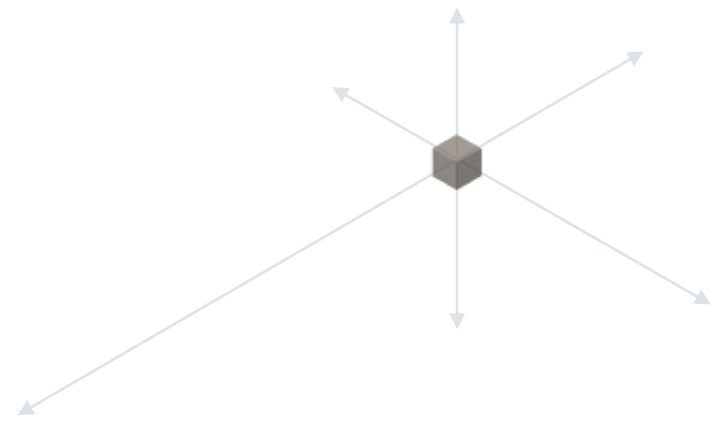
“...everything is related to everything else, but **near and recent** things are more related than **distant** things.”



Quantifying Spatiotemporal Clusters



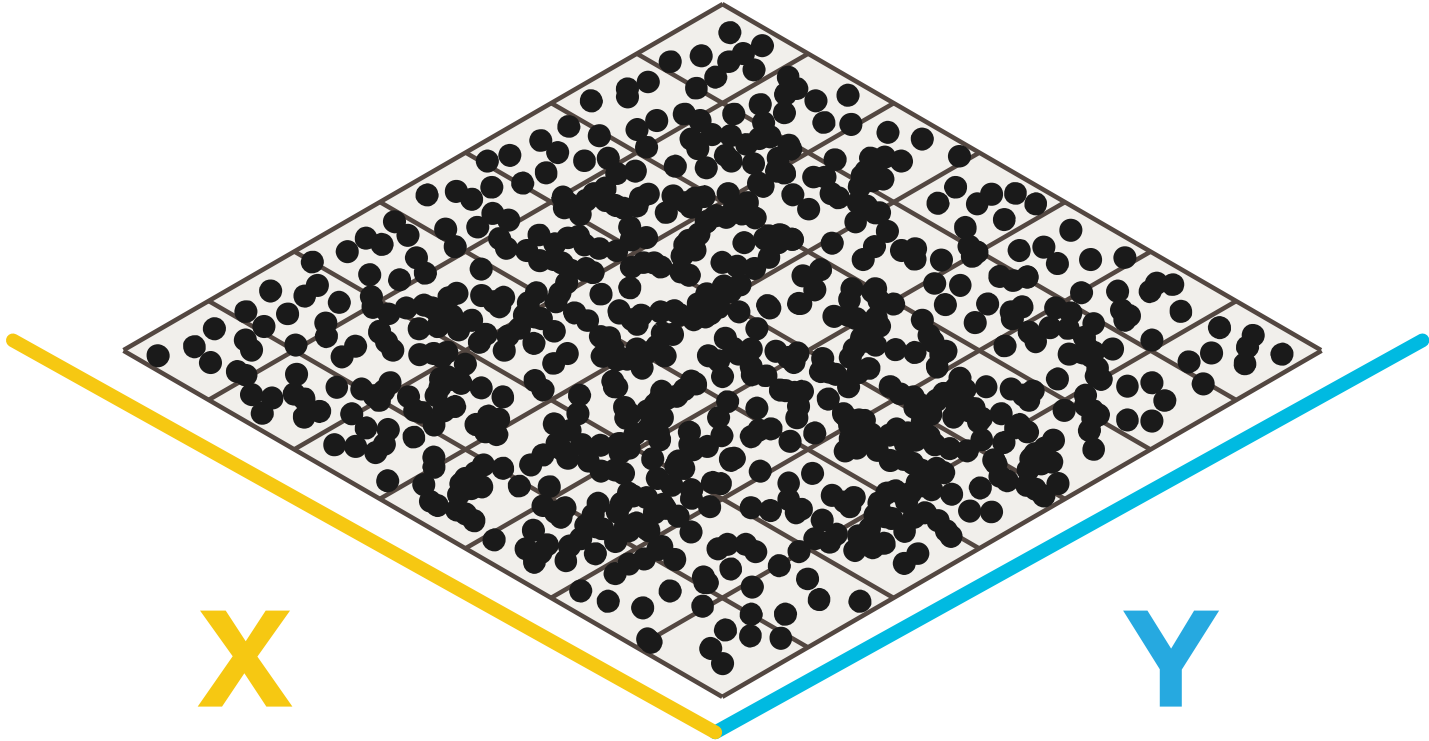
The Space Time Pattern Mining Tools

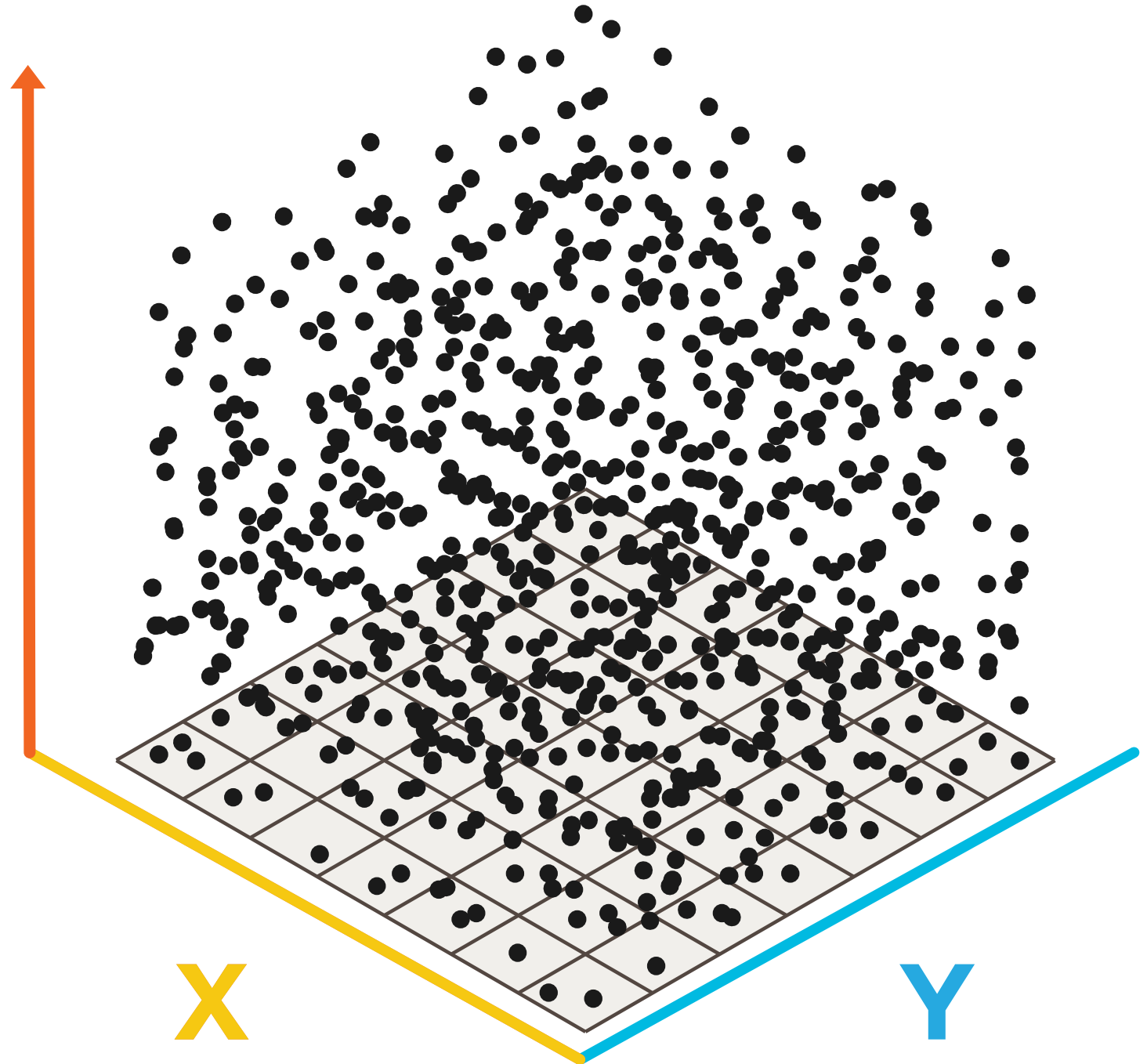


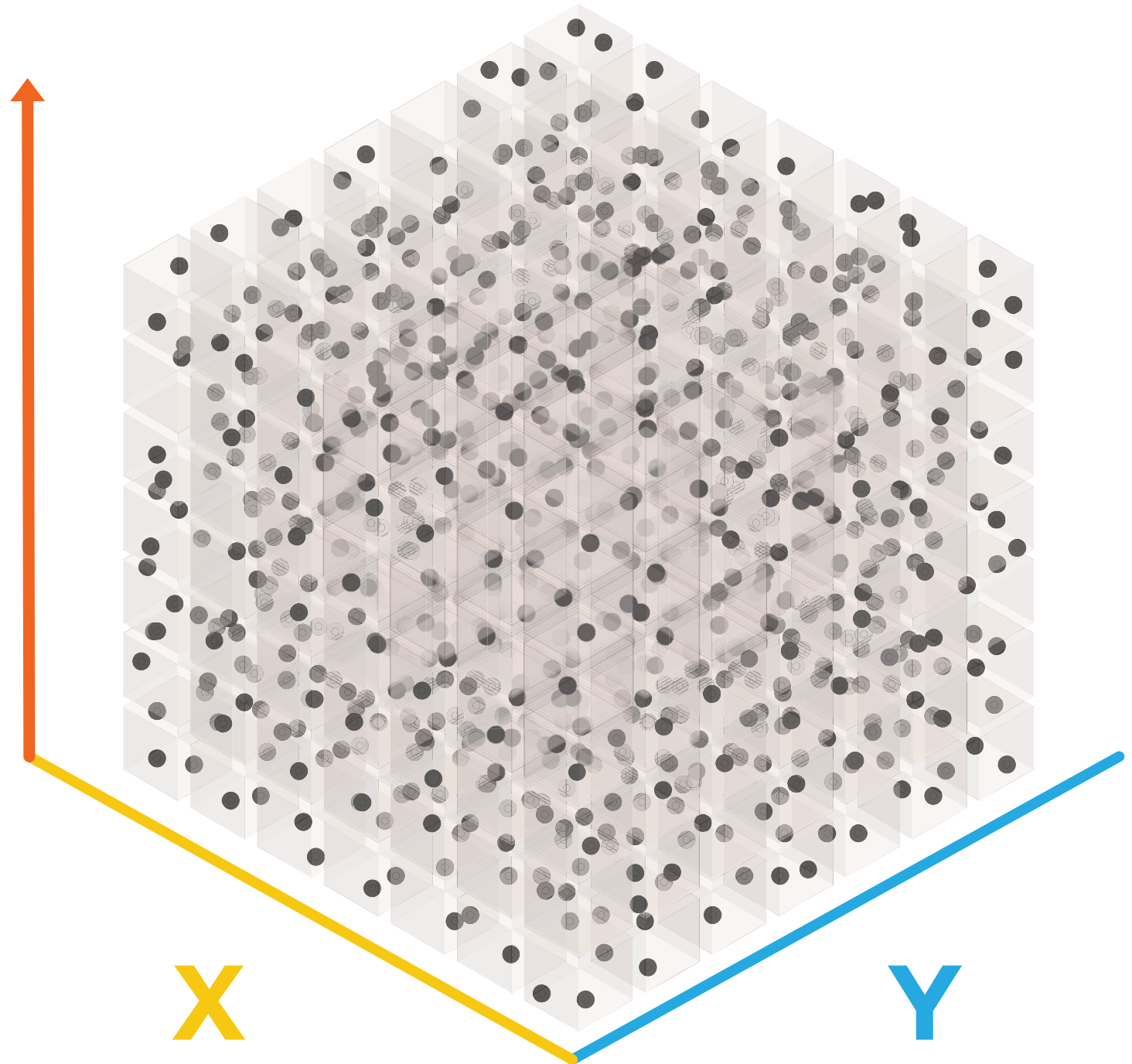
Create Space Time Cube By Aggregating Points

aggregates a set of points into space-time bins, counting the number of points and optionally calculating statistics for attributes



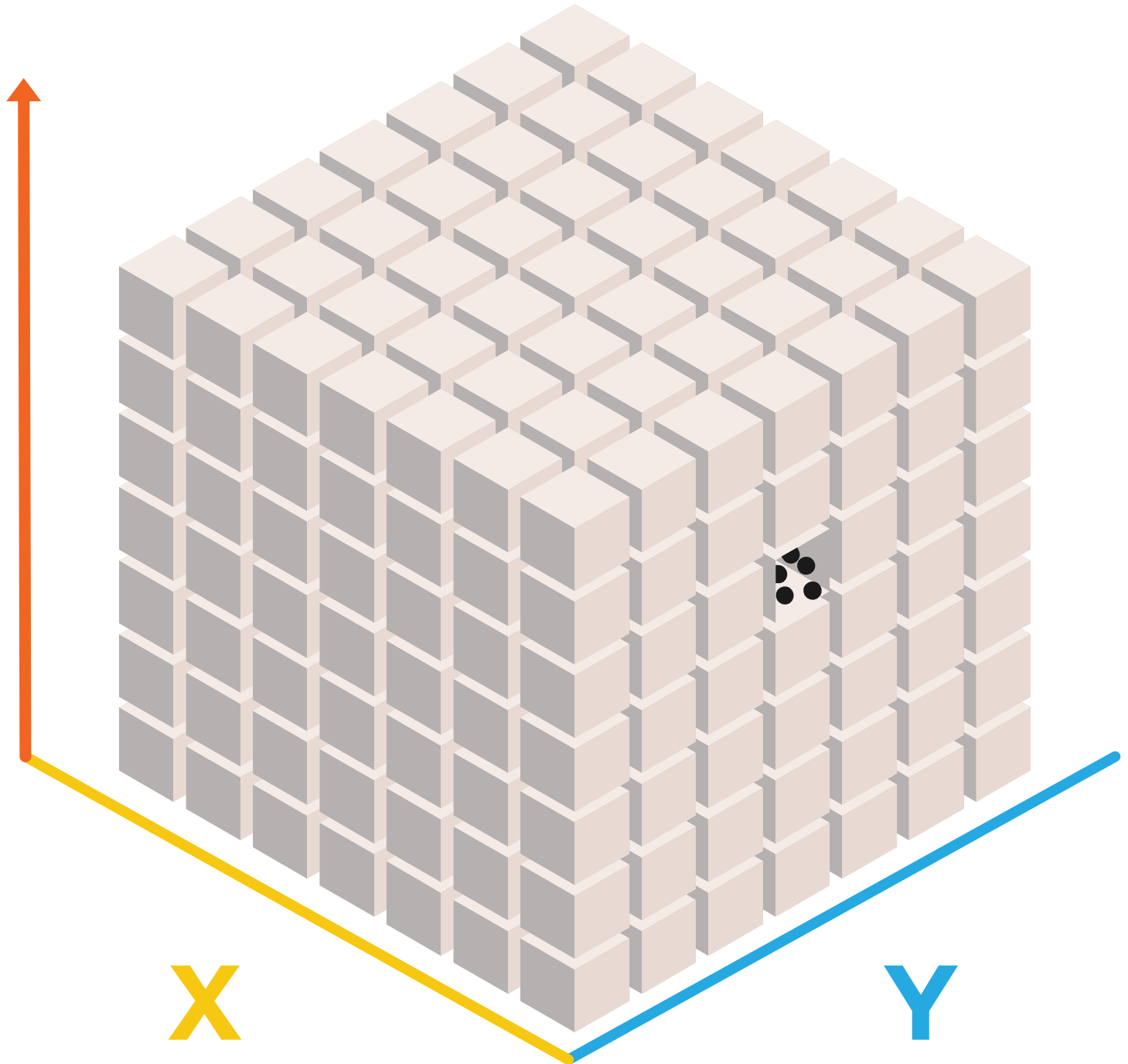






X

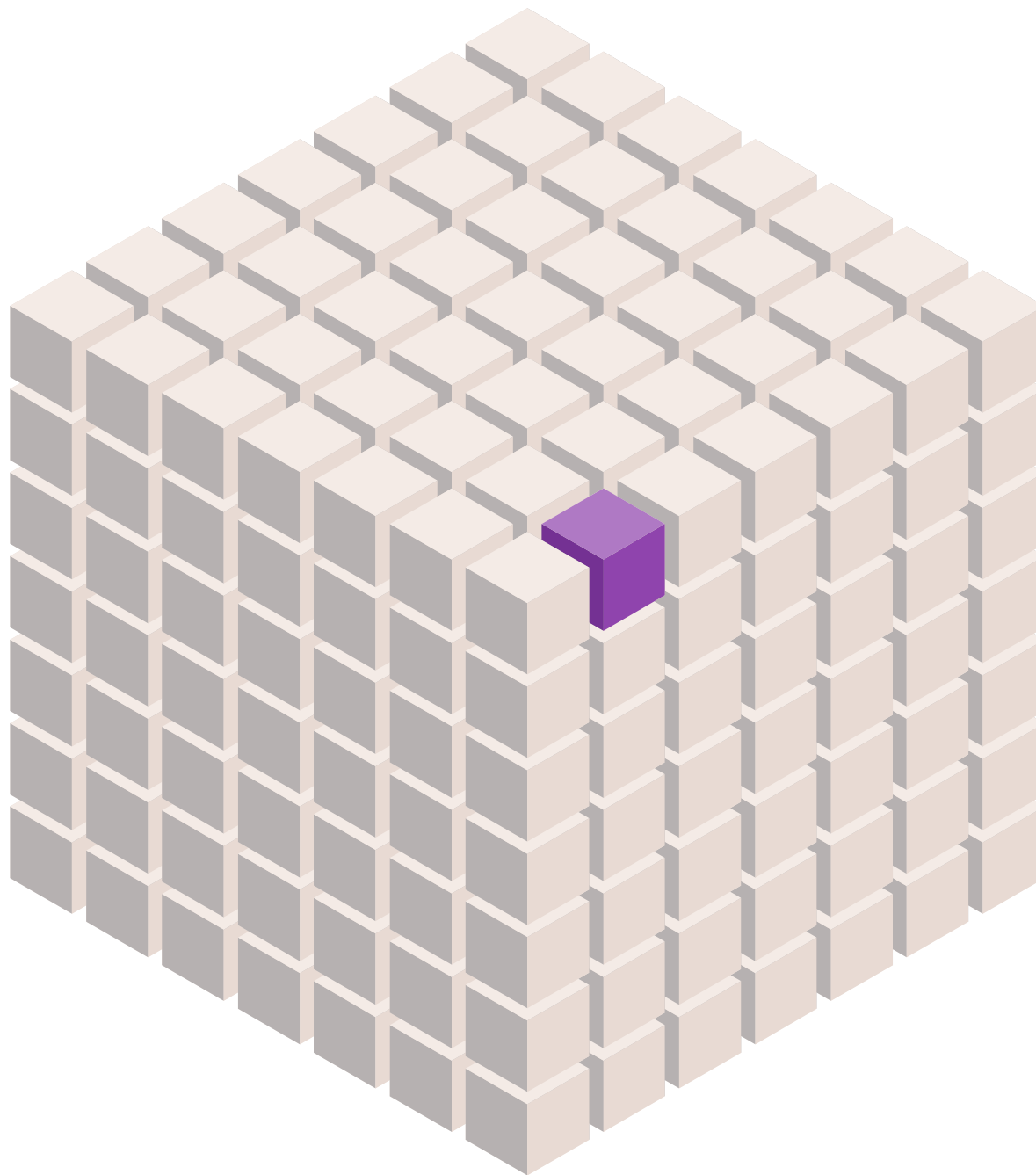
Y



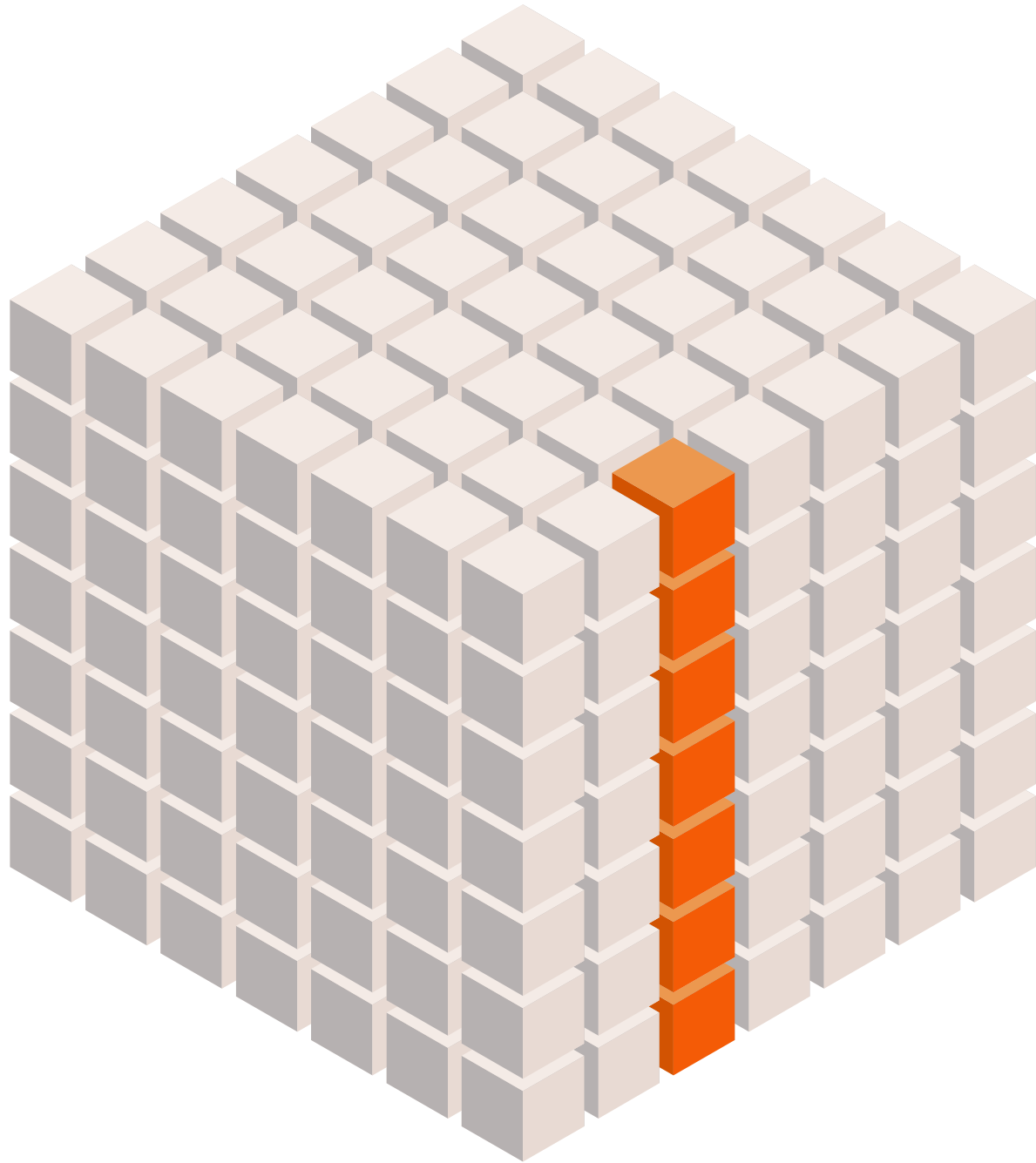
X

Y

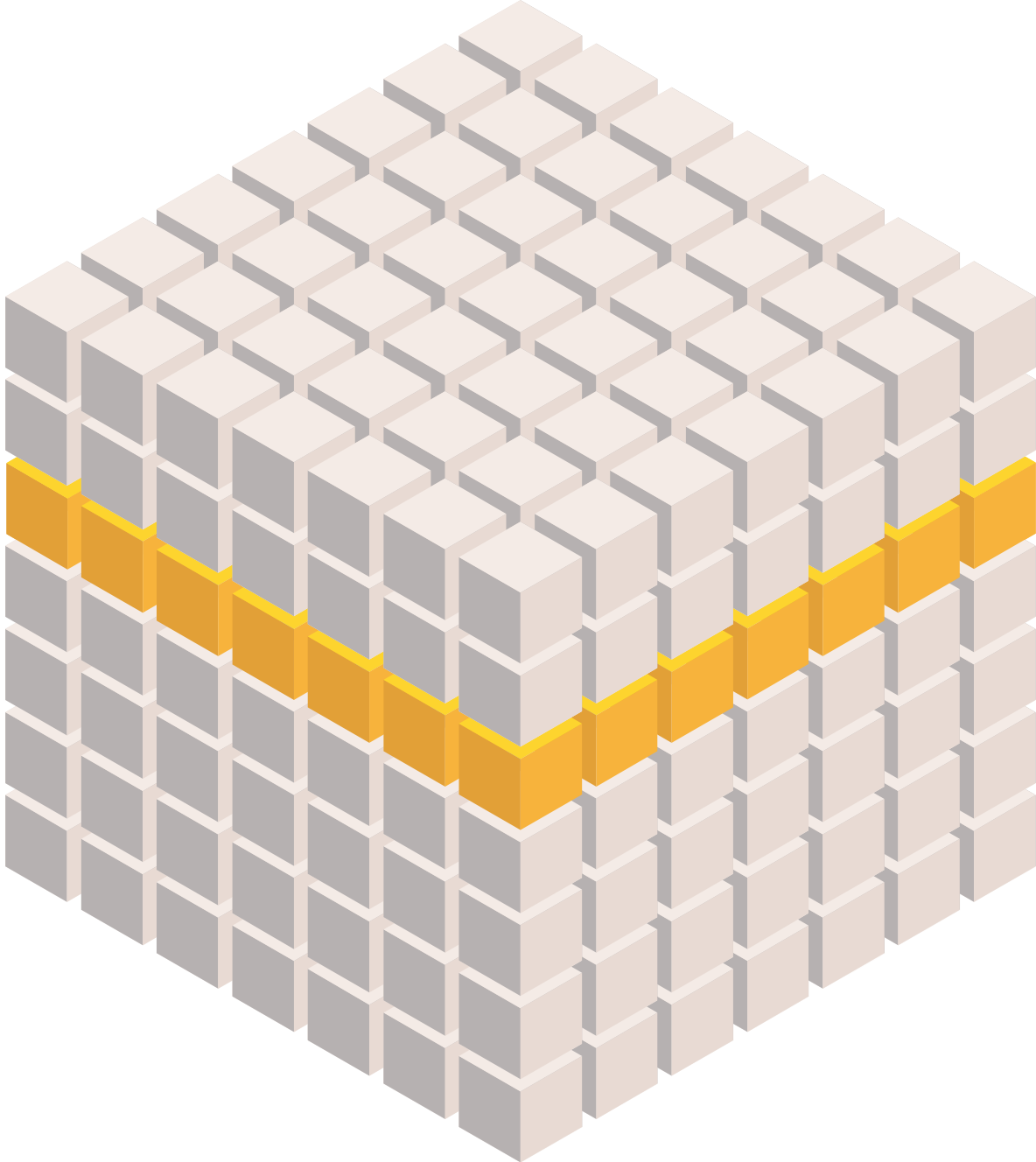
bin



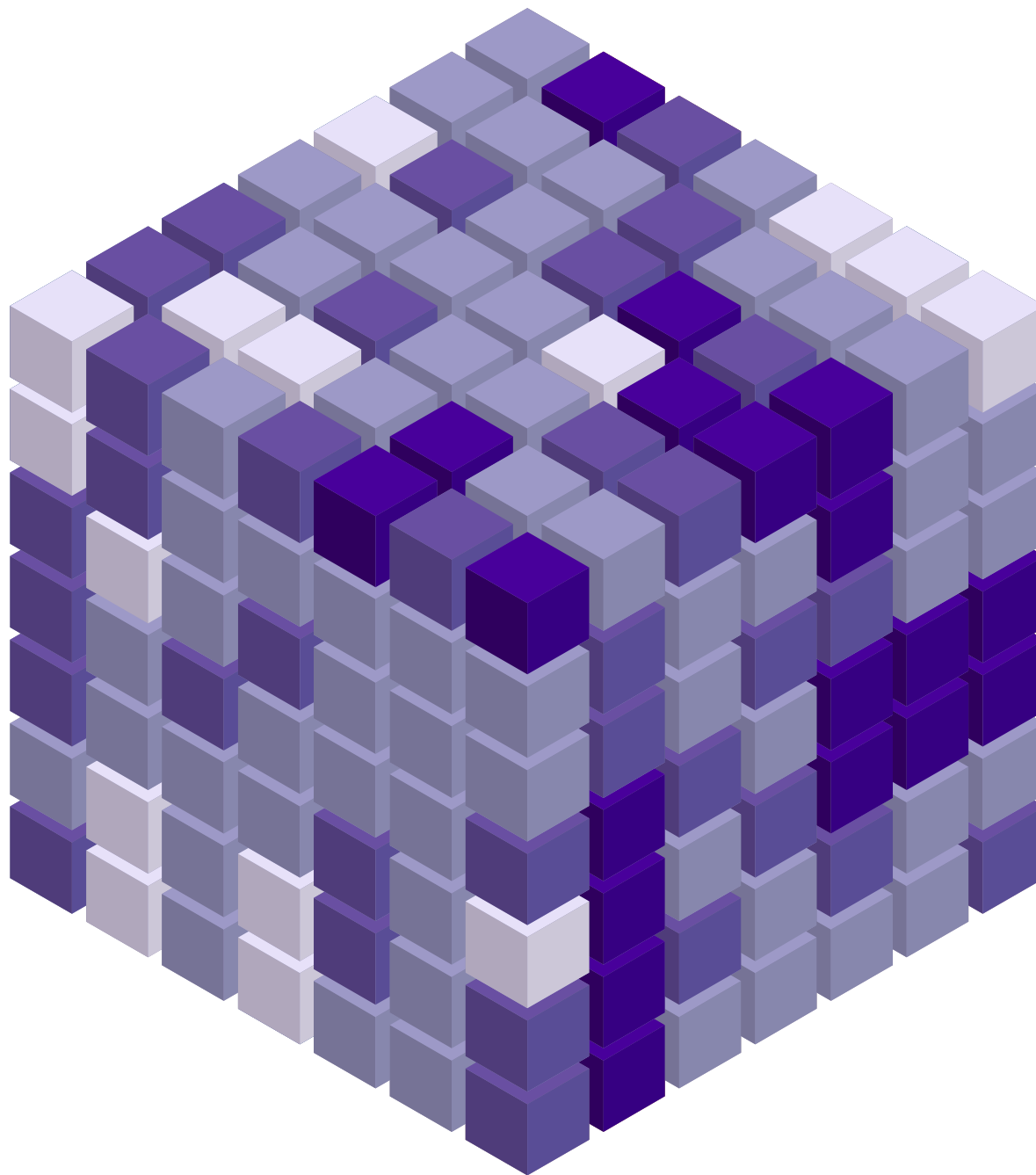
location



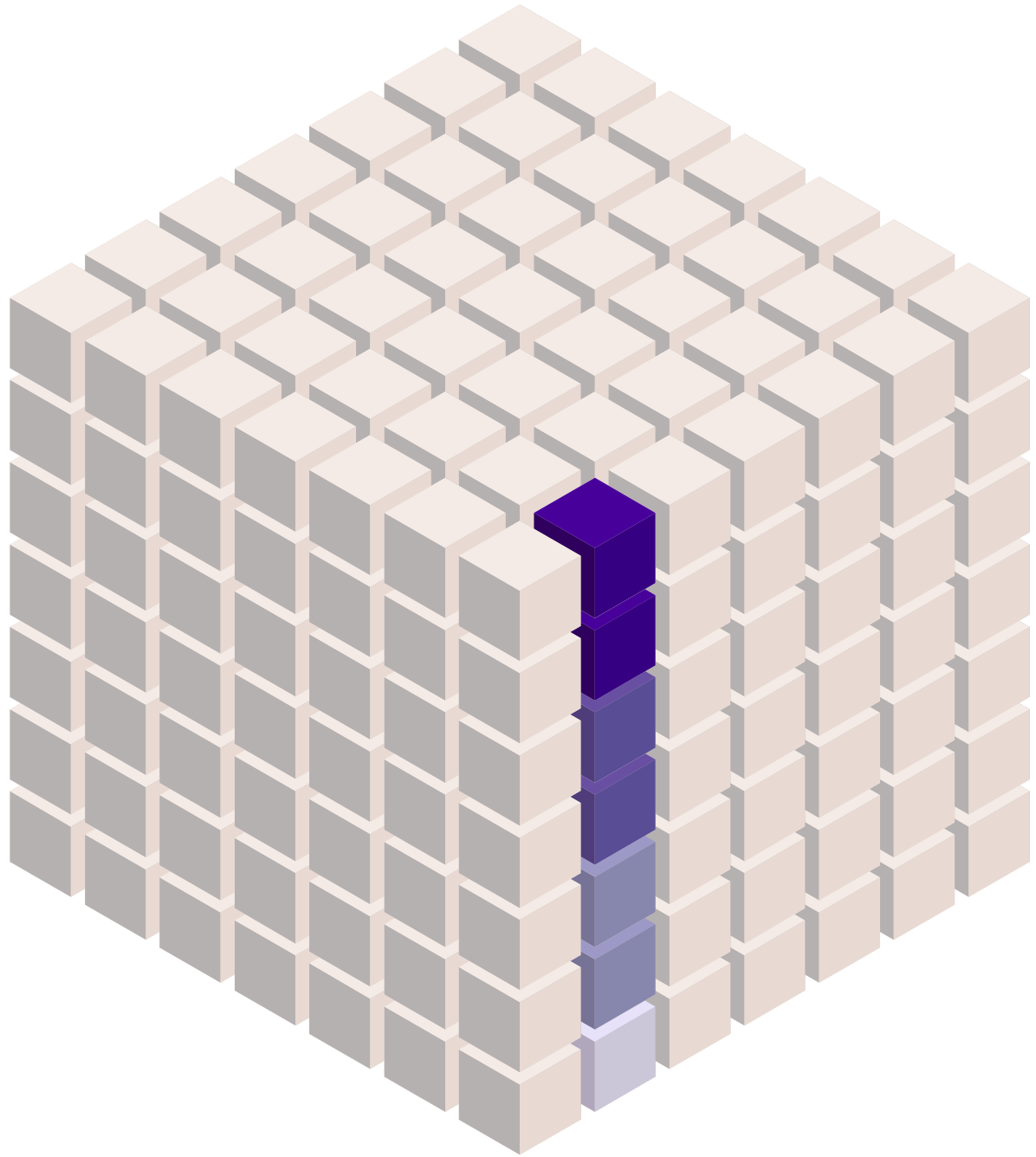
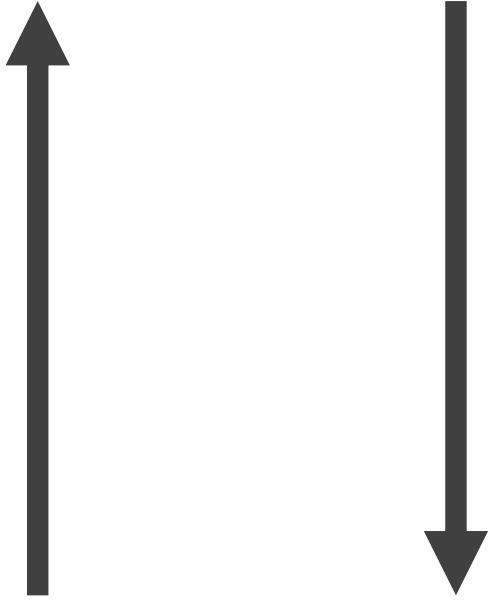
time
slice



counts



trend analysis



summary fields

sum

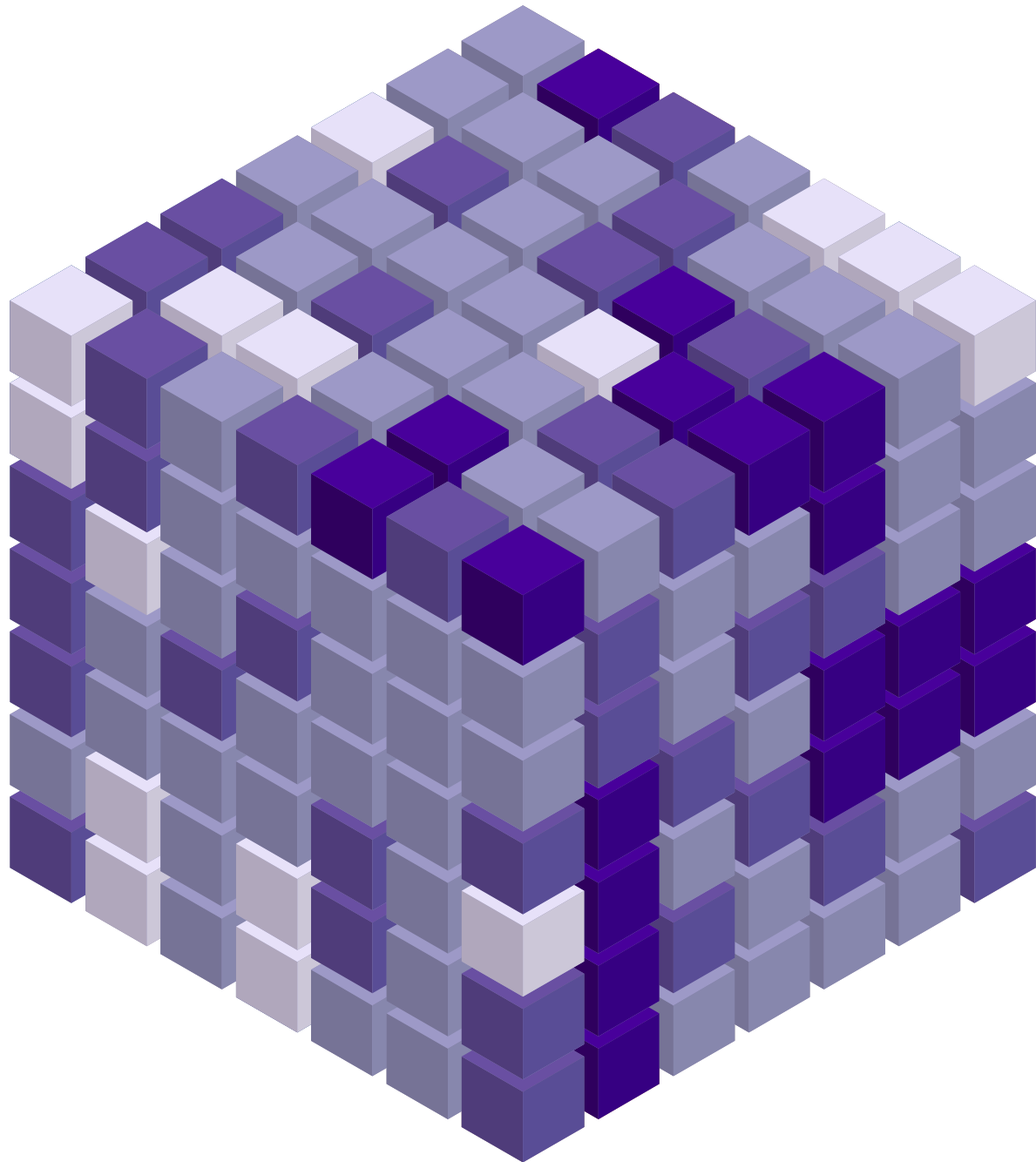
mean

median

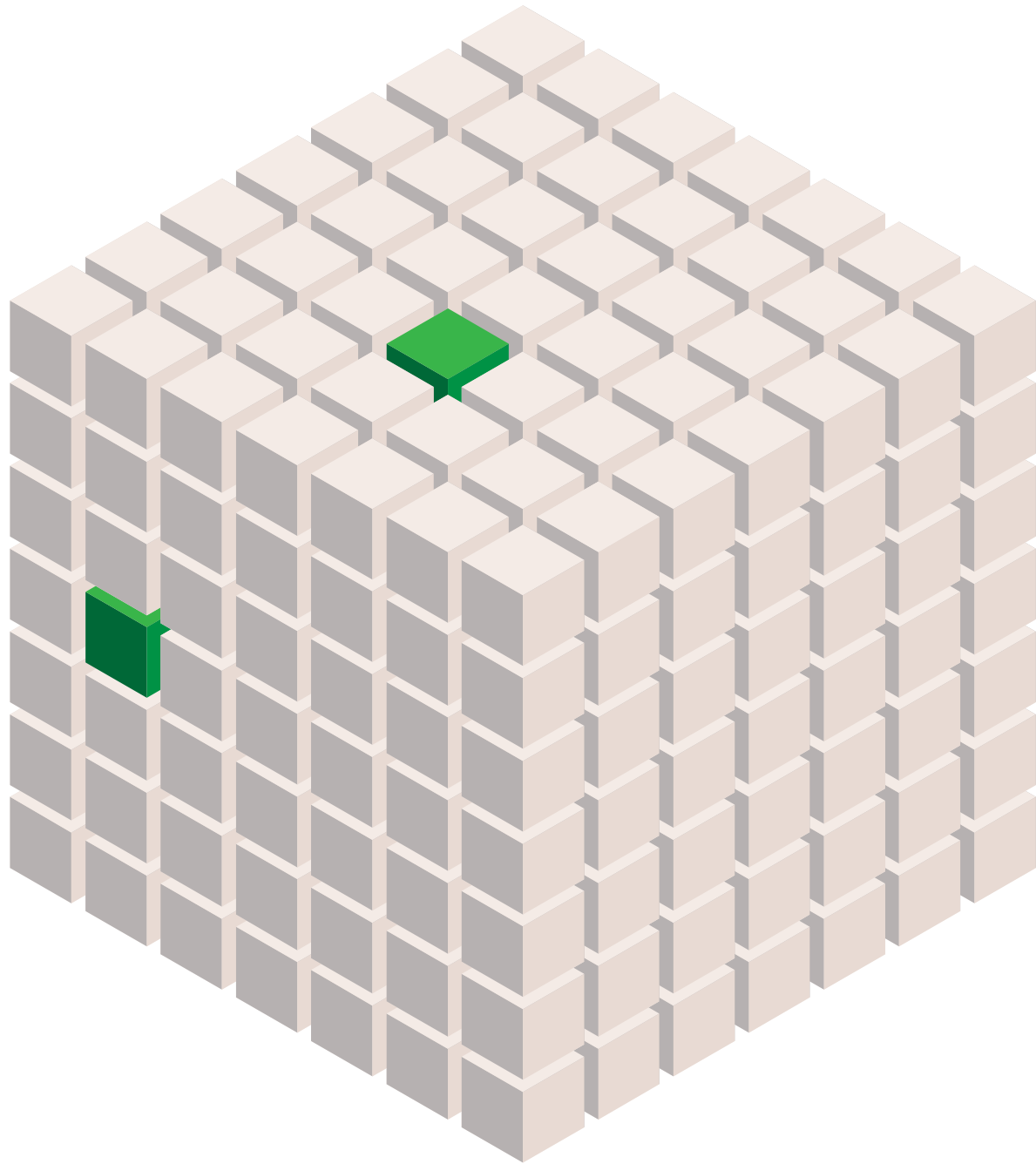
min

max

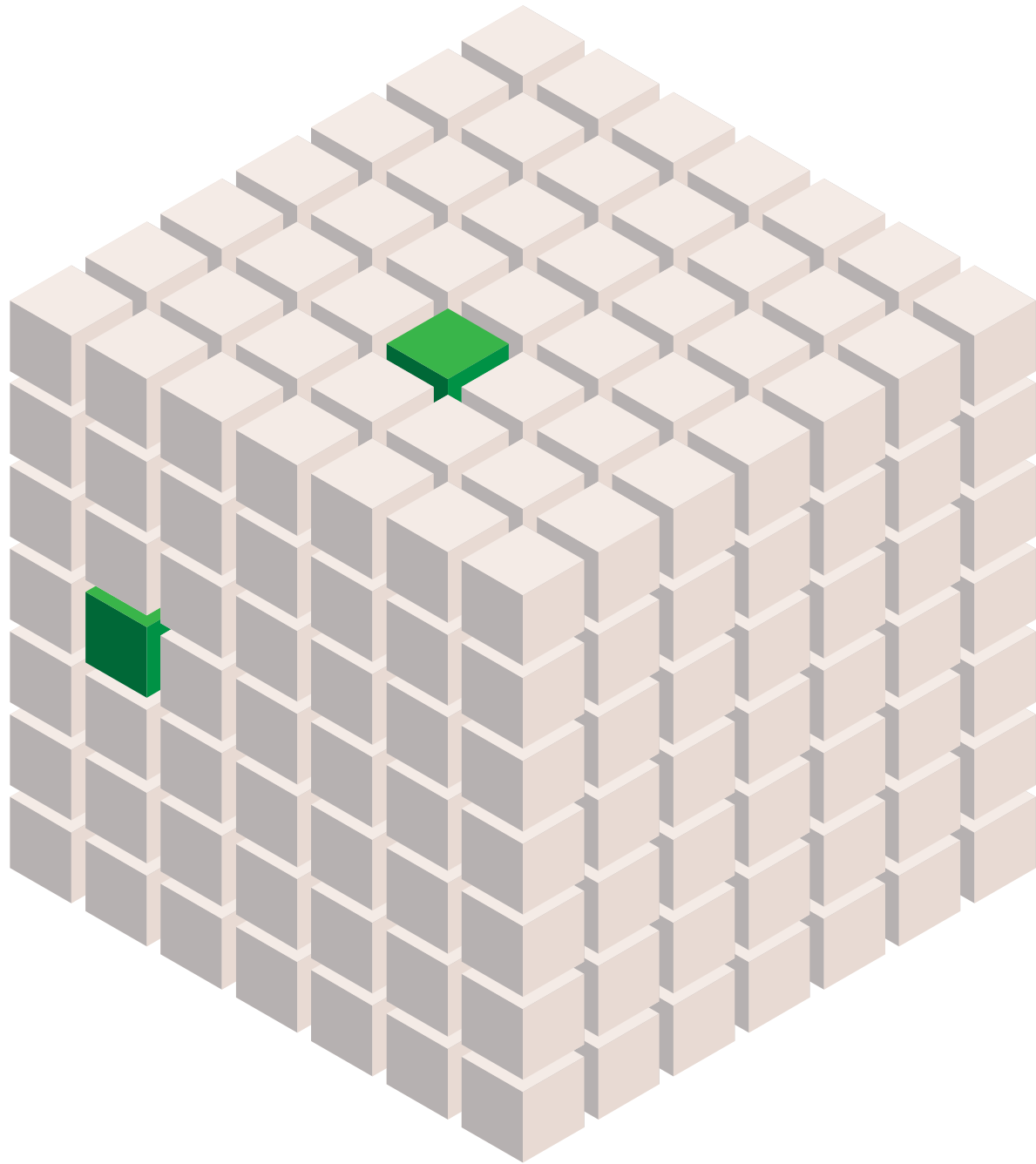
standard deviation



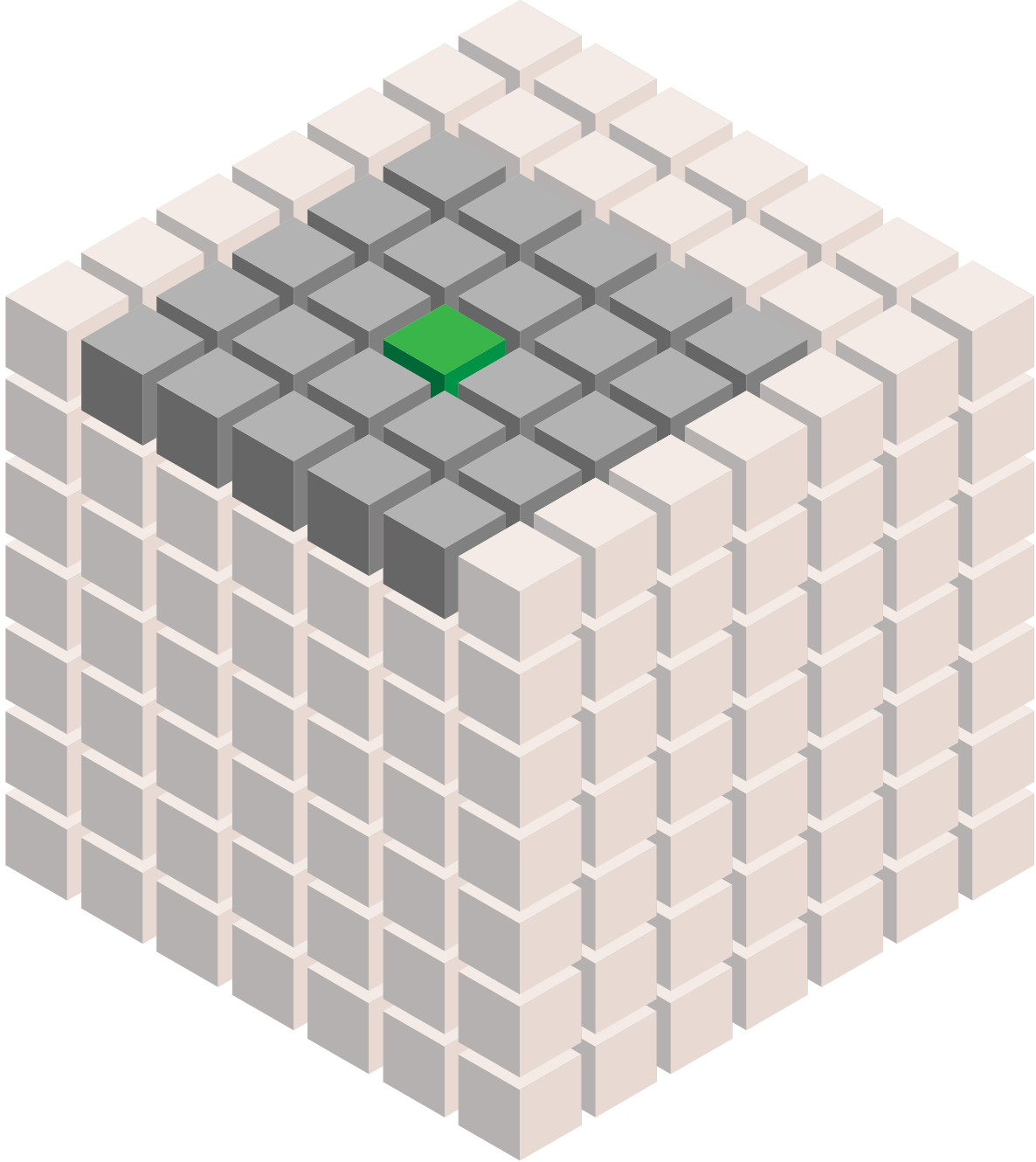
filling
empty
bins



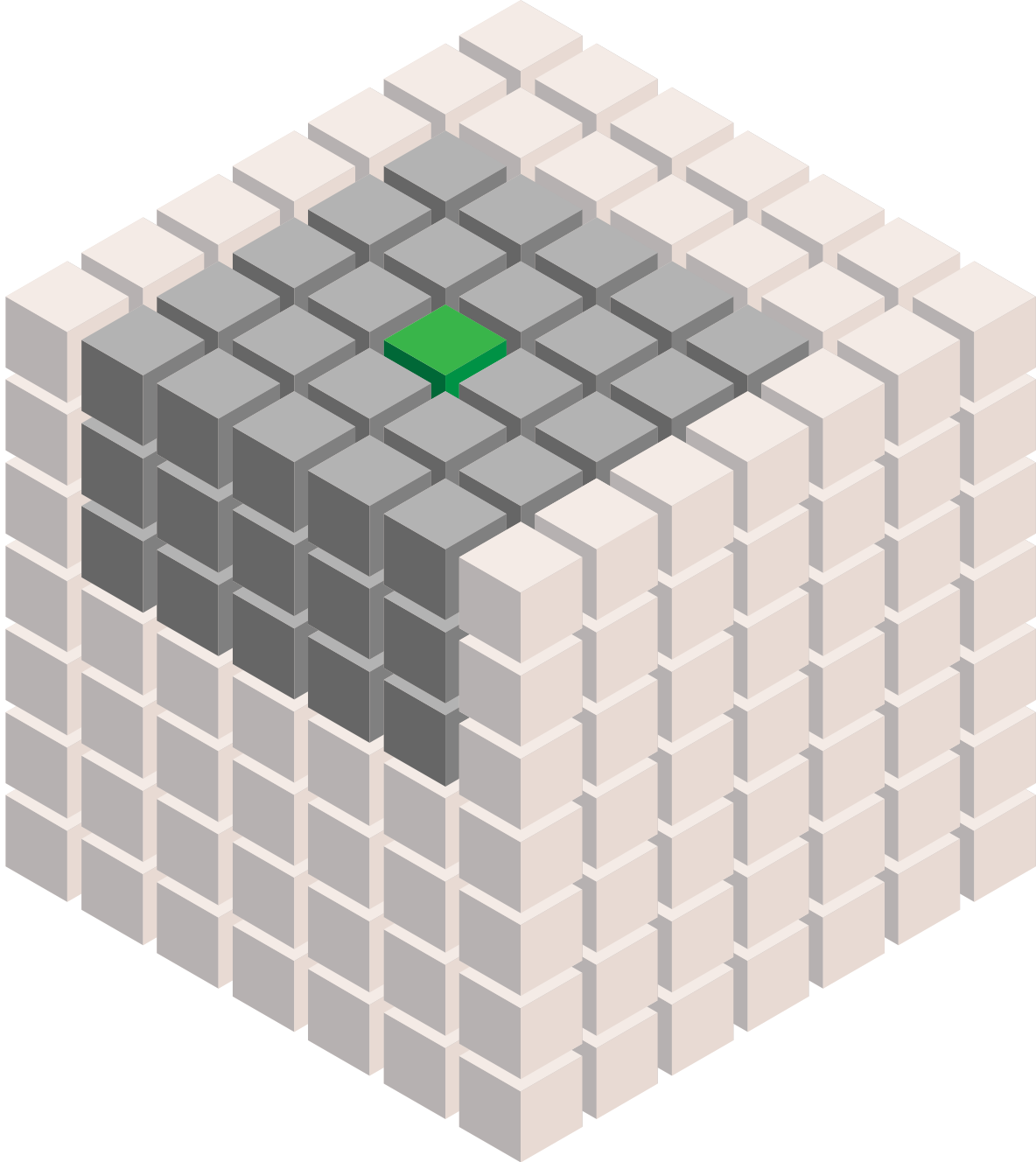
zeros



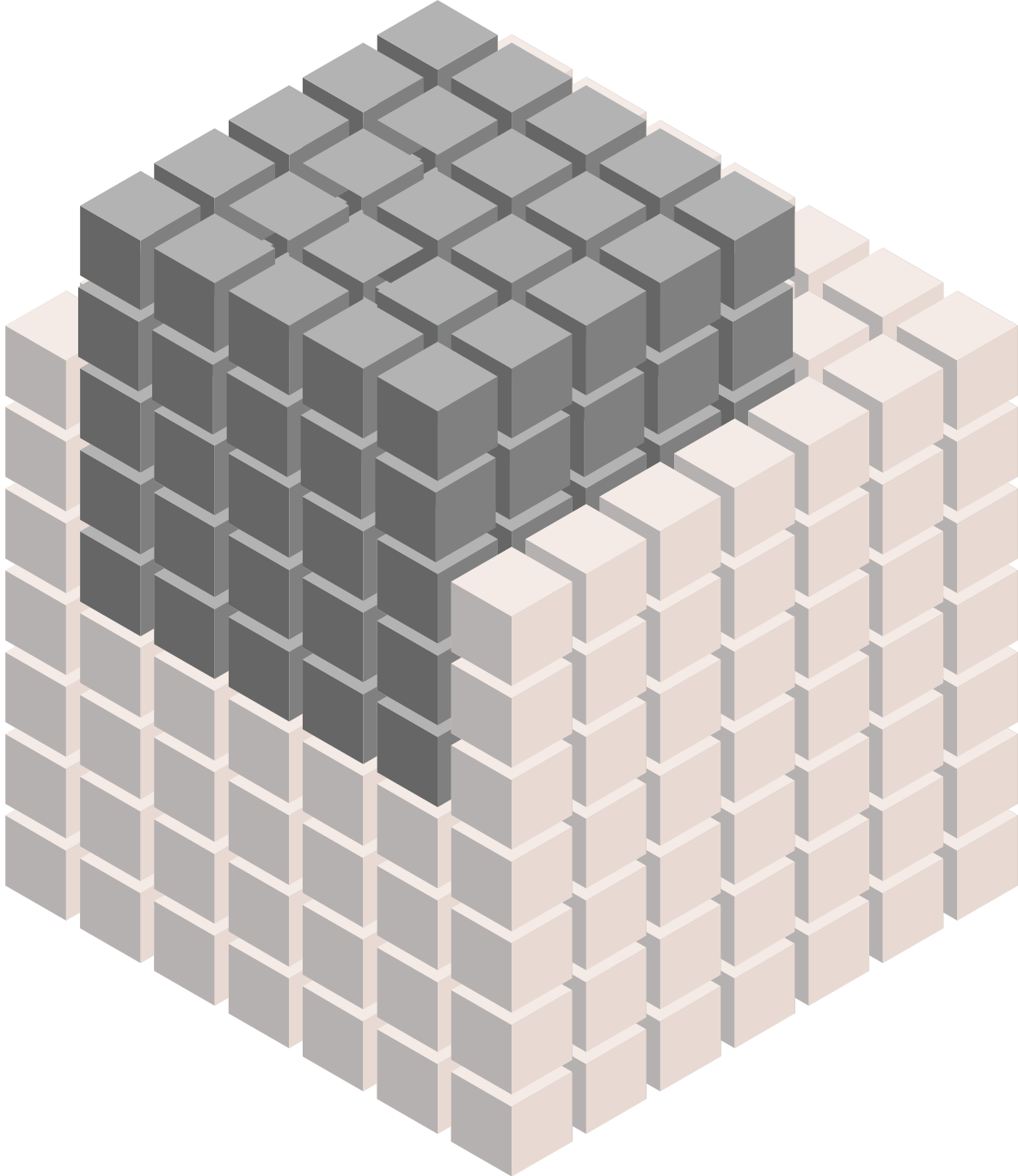
spatial neighbors



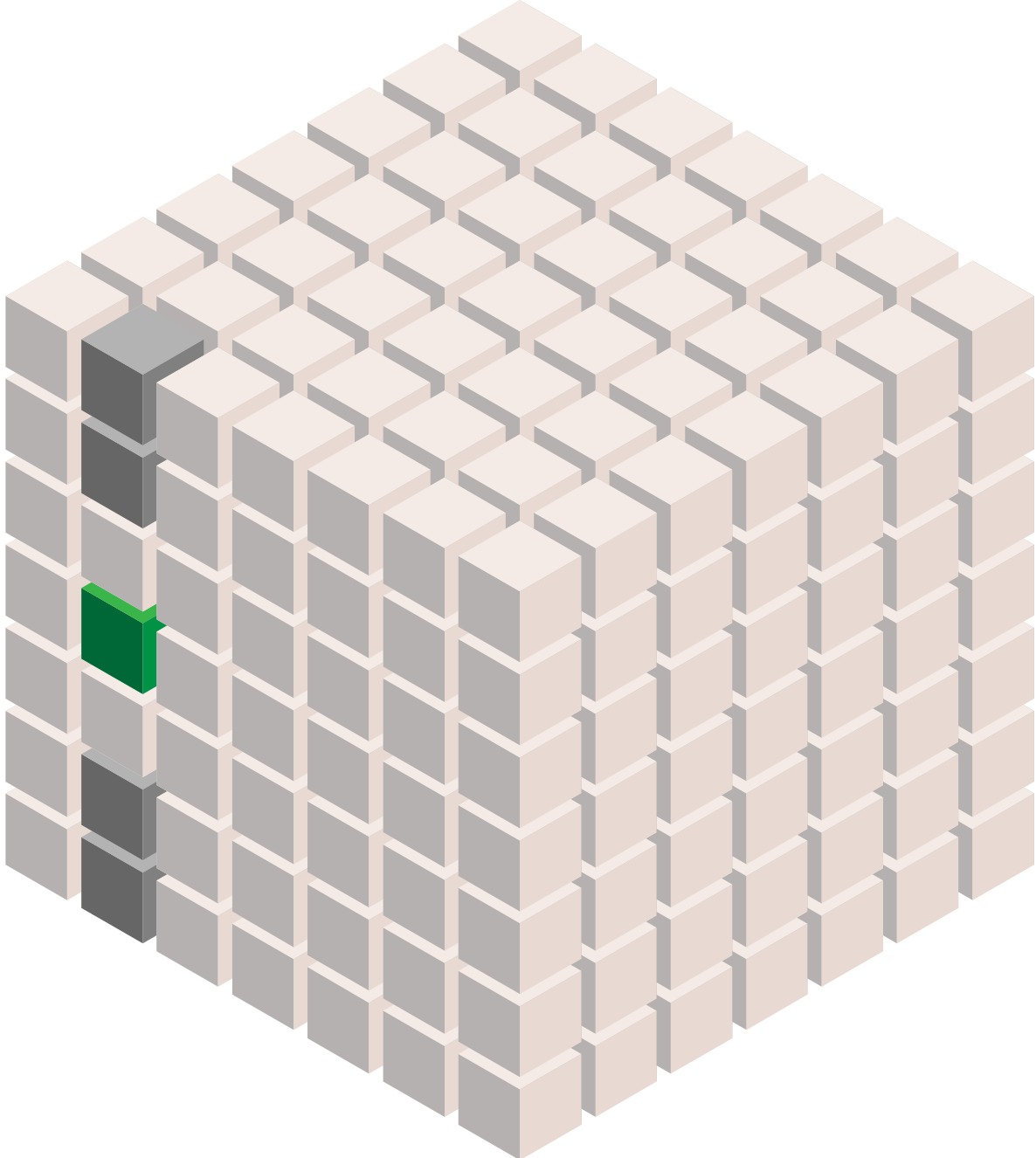
space time
neighbors



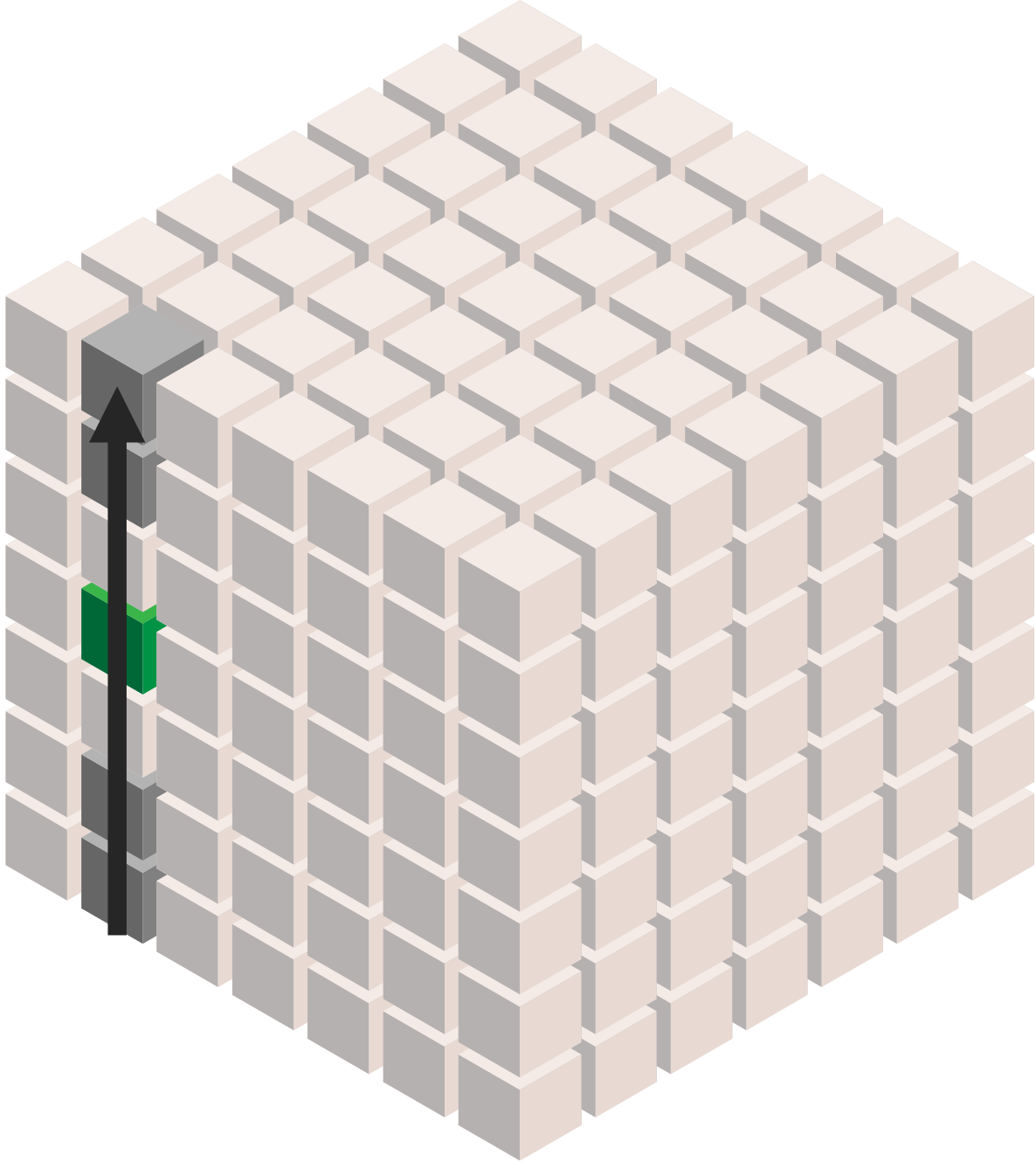
space time
neighbors

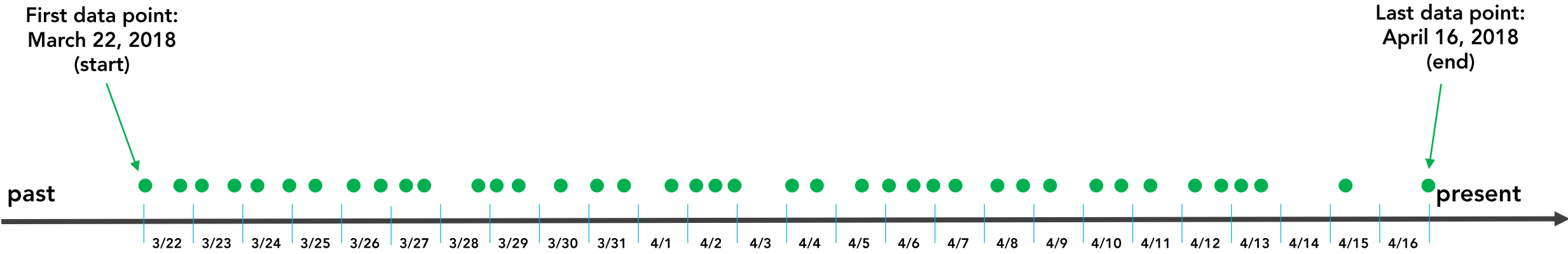


temporal neighbors

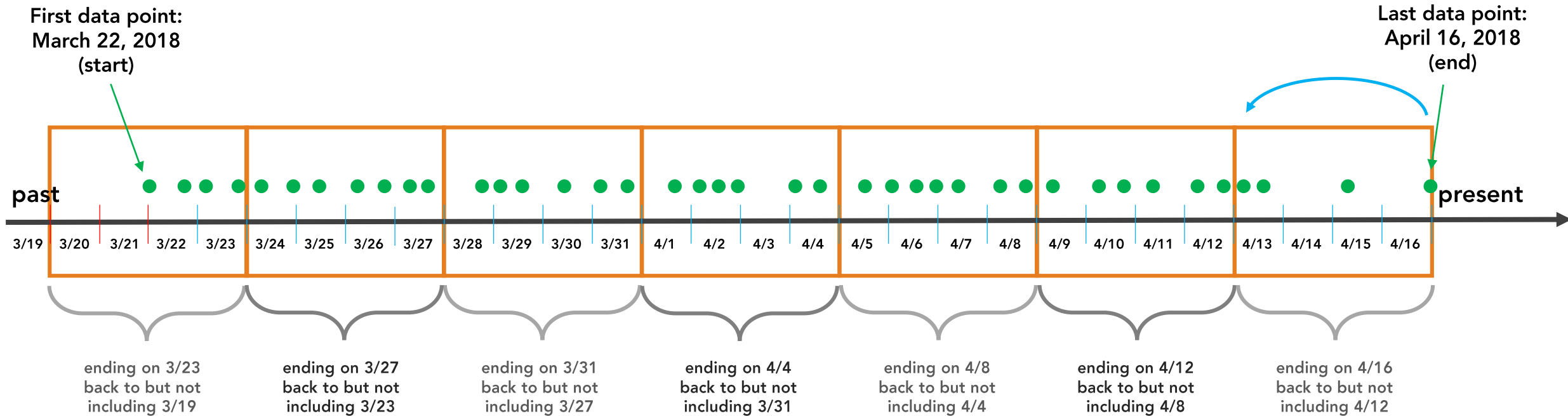


temporal
neighbors

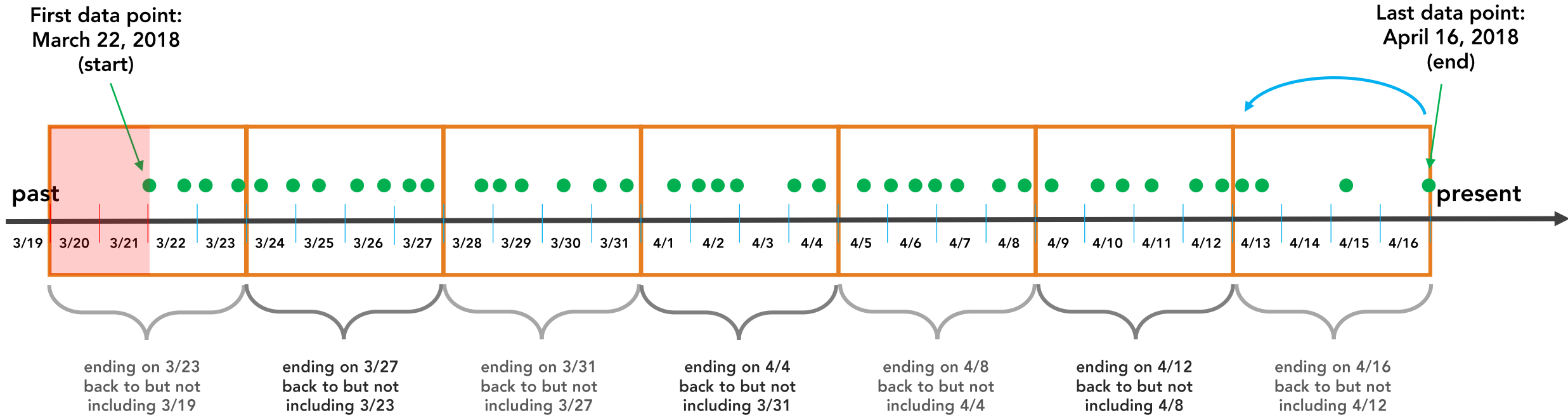




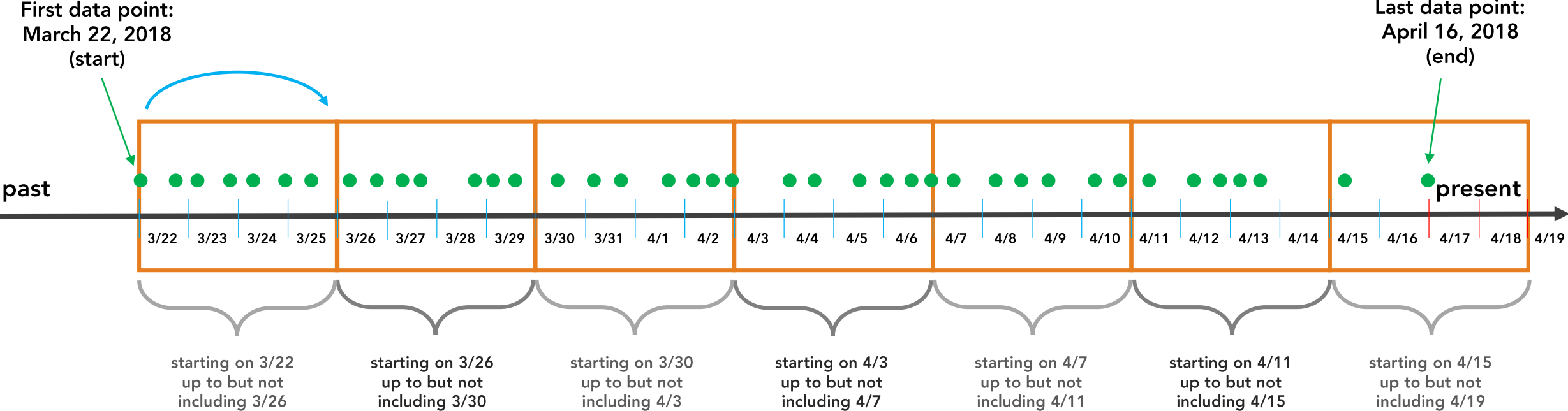
End Time



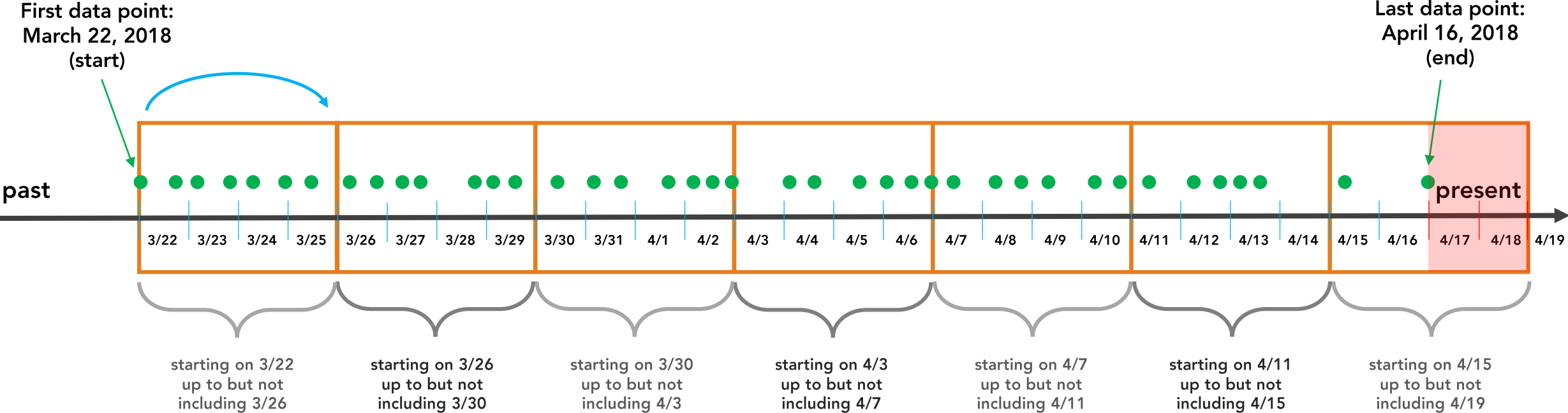
End Time



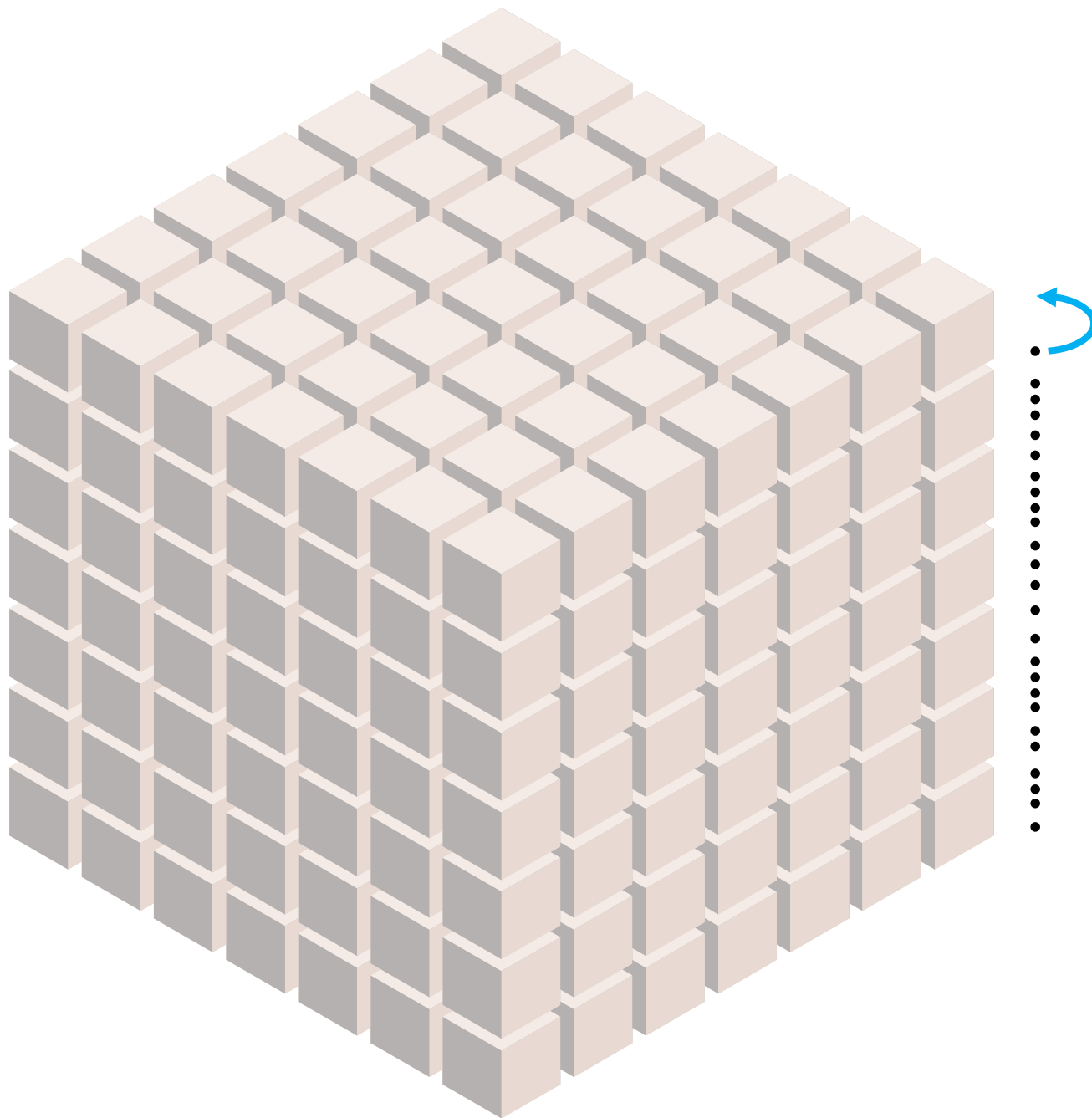
Start Time



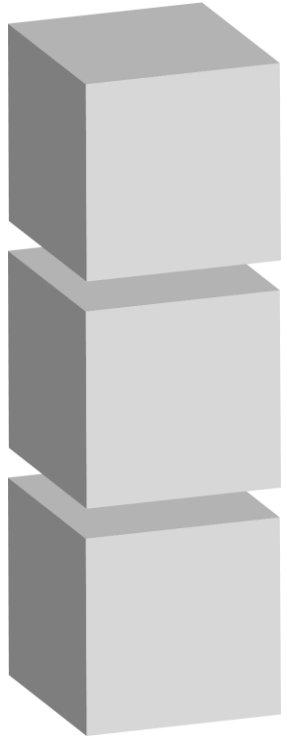
Start Time



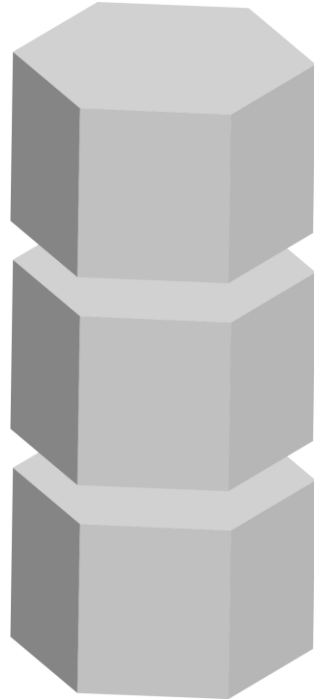
Temporal Bias



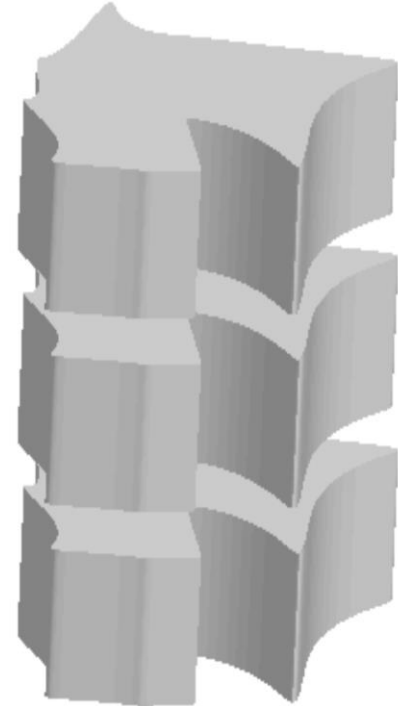
Aggregation Options



**fishnet
grid**



**hexagon
grid**



**defined
locations**

Create Space Time Cube From Defined Locations

structures panel data or station data where geography does not change but attributes change over time into space-time bins

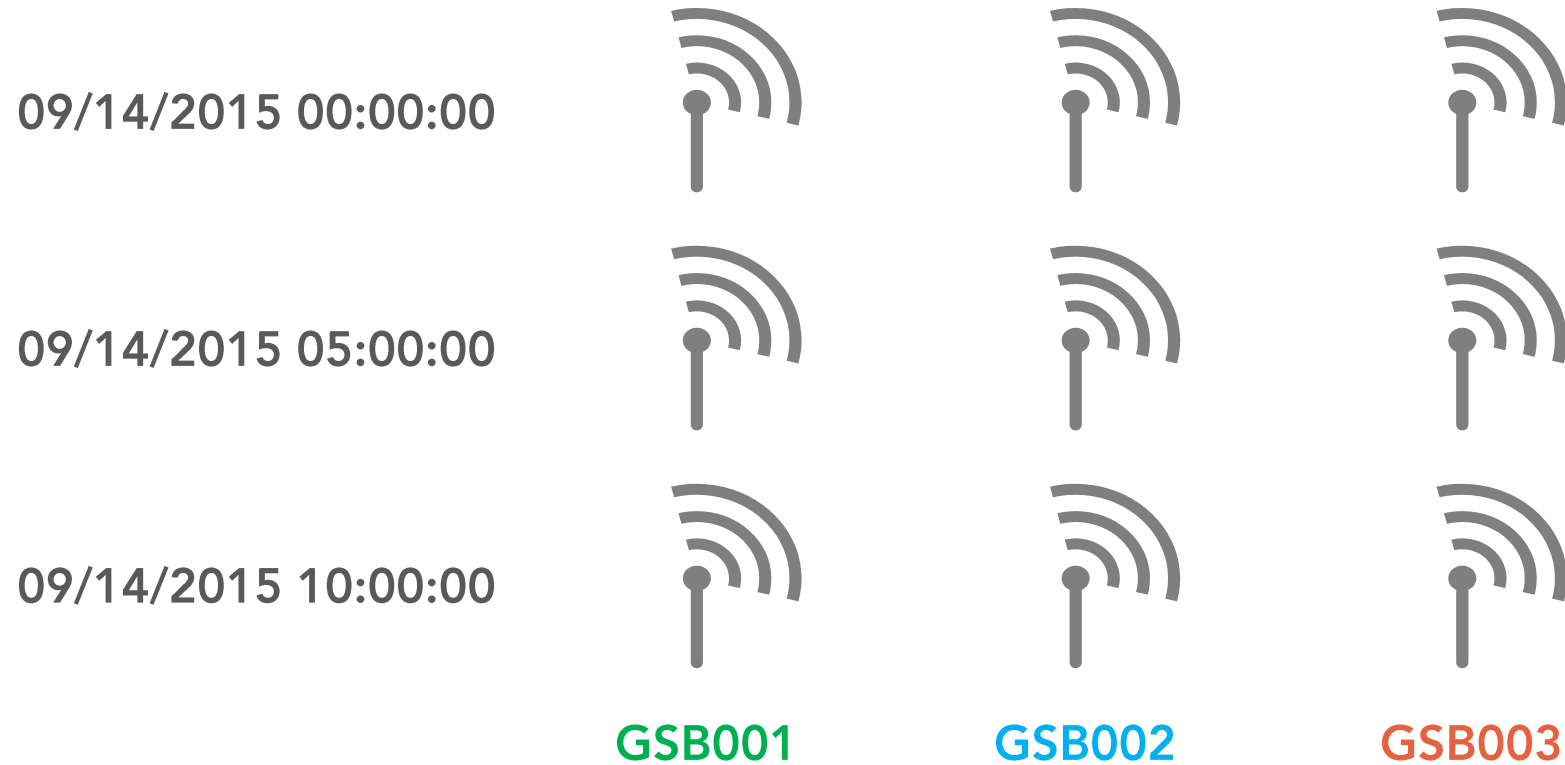


Data can be one set of features with a related table containing attributes over time

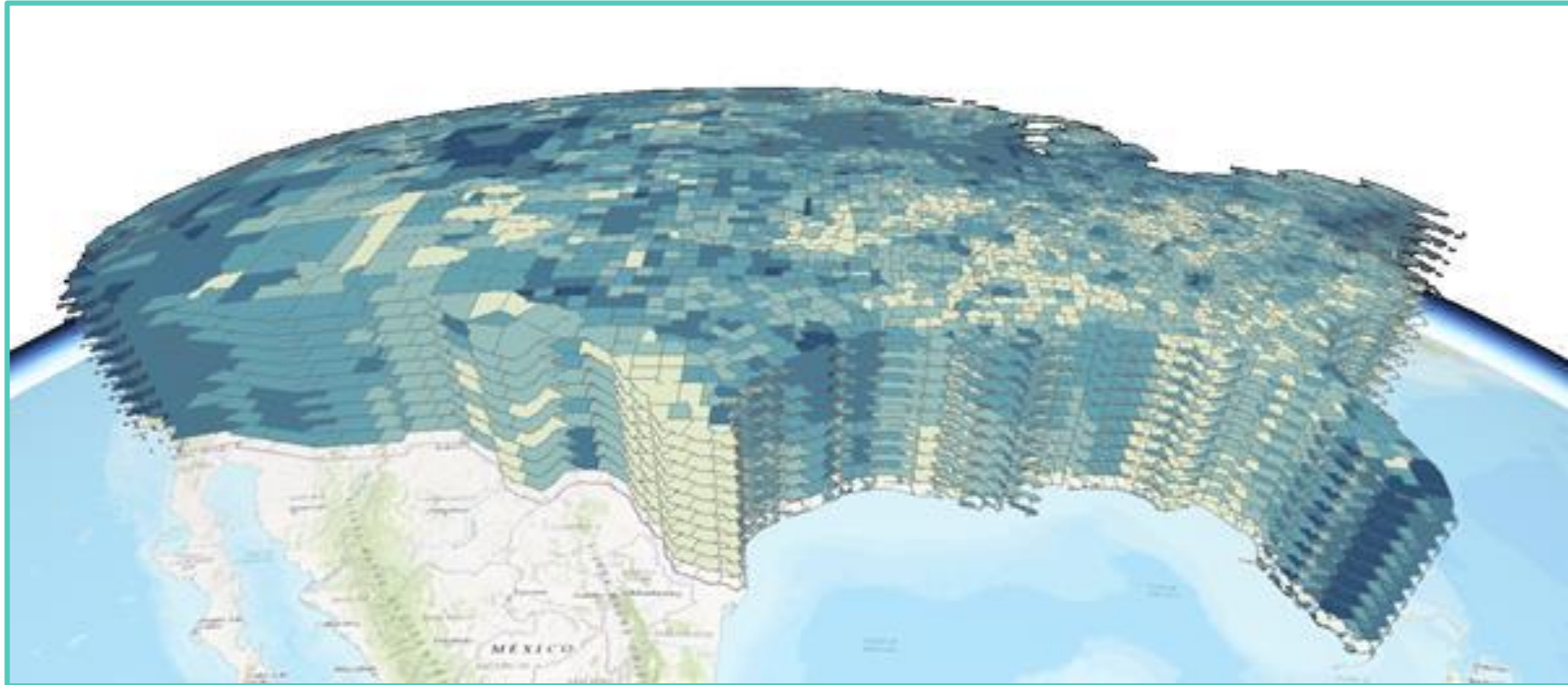


ID	DateTime	Reading
GSB001	09/14/2015 00:00:00	03.14
GSB001	09/14/2015 05:00:00	15.92
GSB001	09/14/2015 10:00:00	69.35
GSB002	09/14/2015 00:00:00	89.79
GSB002	09/14/2015 05:00:00	32.38
GSB002	09/14/2015 10:00:00	46.26
GSB003	09/14/2015 00:00:00	43.38

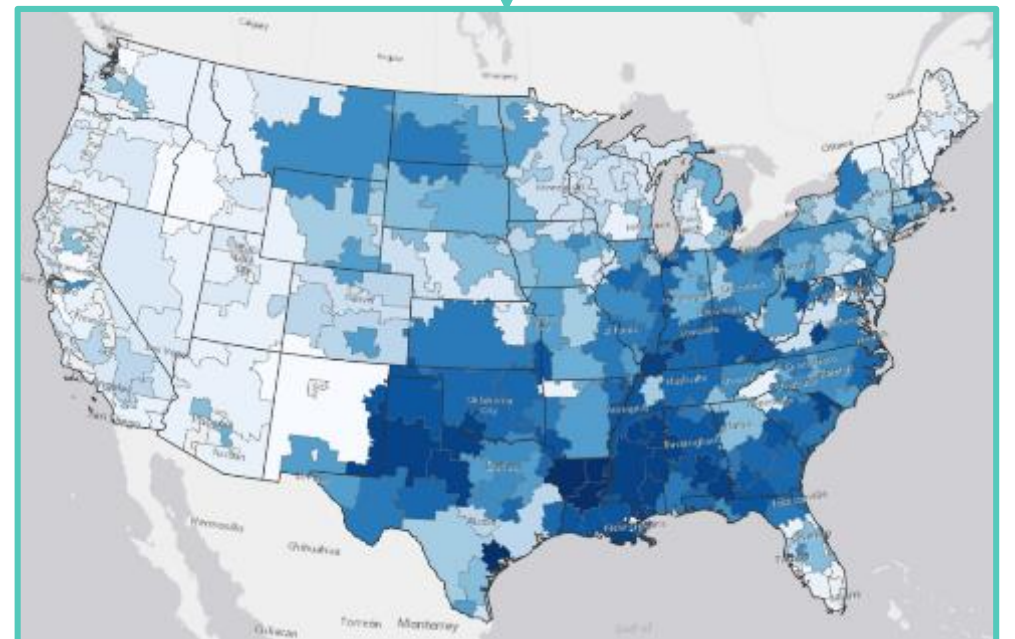
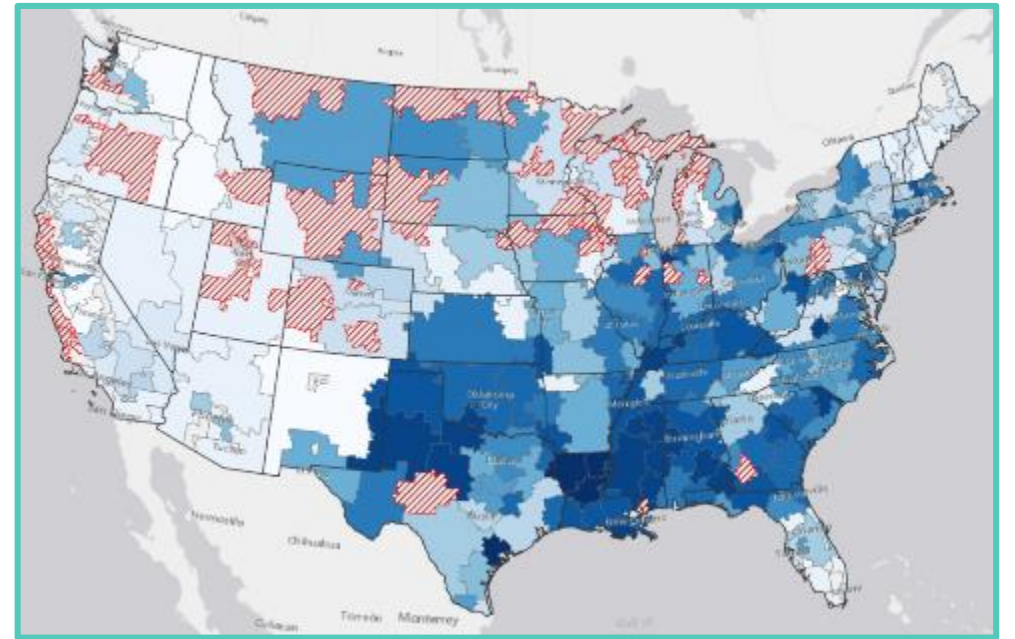
or repeating shapes
contained within the
same feature class



or repeating shapes
contained within the
same feature class

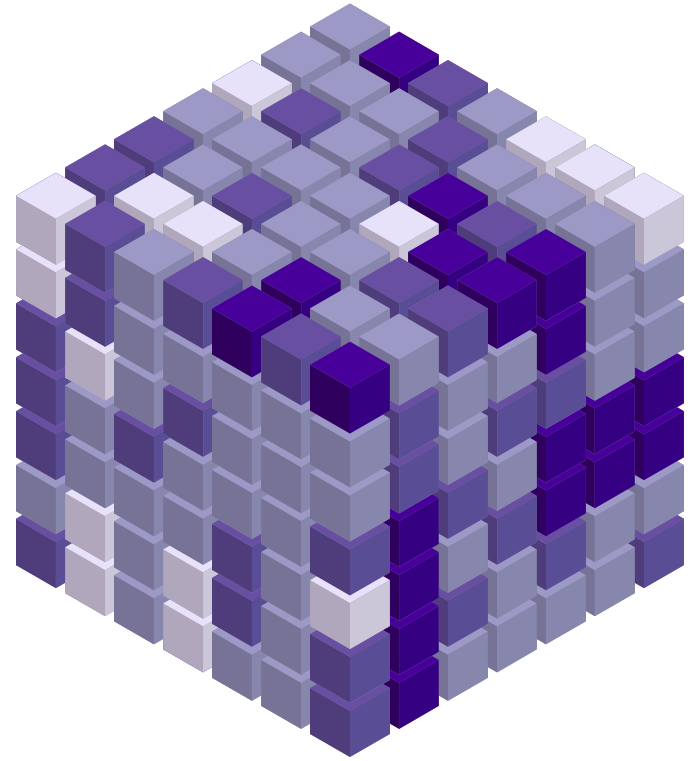


Fill Missing Values



8447.86	1.129	0.1746	176.081215
9576.94	1.146	0.1679	189.160293
6494.61	0.96	0.1291	-99
7792	1.062	0.1667	238.410596
6350.27	0.897	0.1279	-99
6936.38	0.994	0.1482	-99
7200.04	1.037	0.1602	180.940893
7113.31	1.107	0.1742	156.364278
8270.93	1.118	0.1294	-99
9919.04	1.304	0.201	214.627011
10980.52	1.261	0.2125	272.243164
9126.52	1.161	0.1838	279.776179
11150.28	1.236	0.1869	228.033214
6689.43	1.006	0.1433	-99
0633.46	1.222	0.2030	224.204226

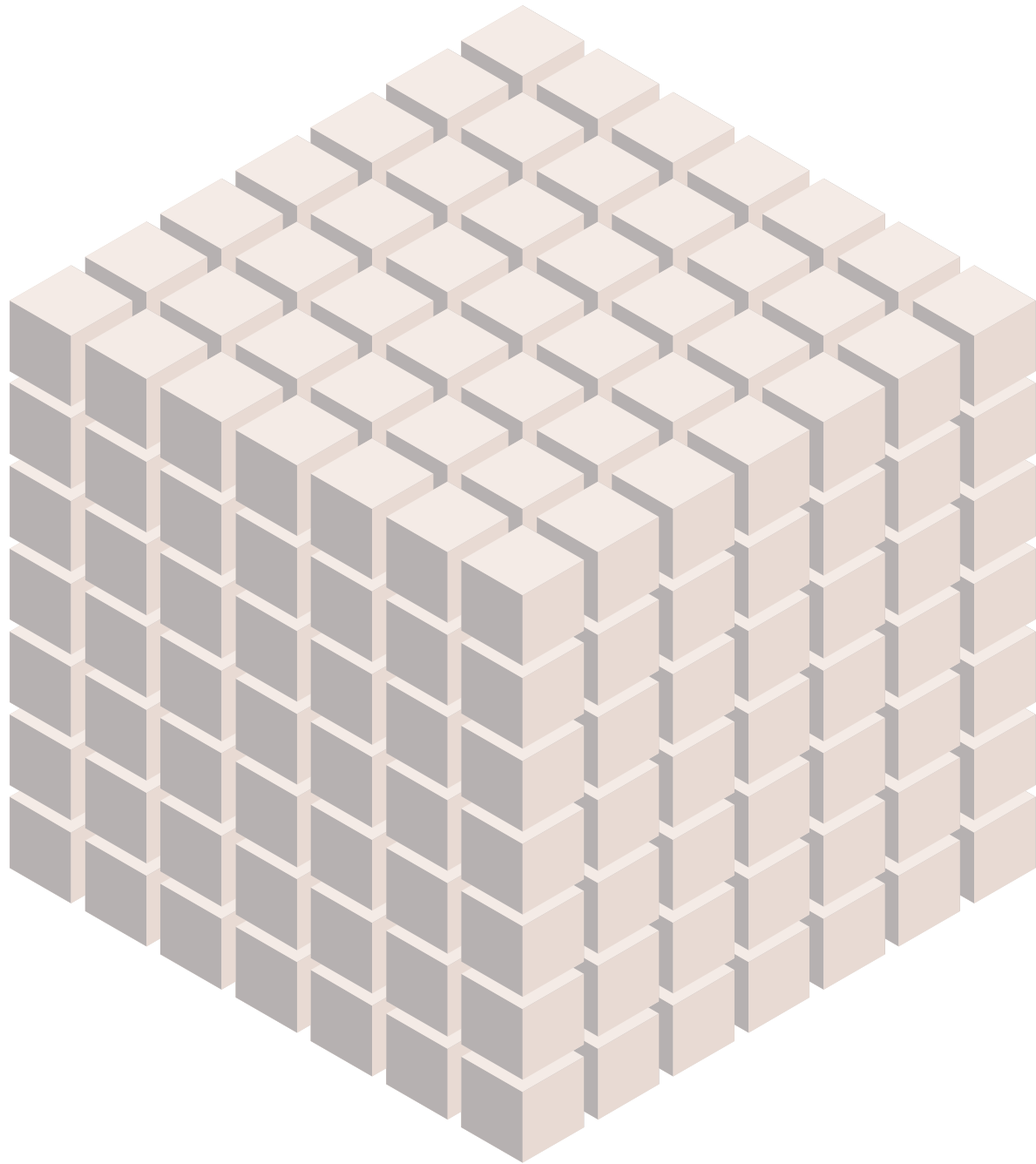
demo

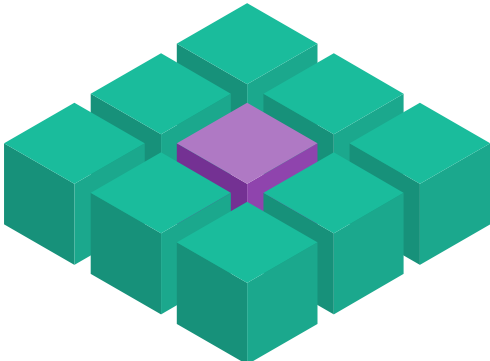


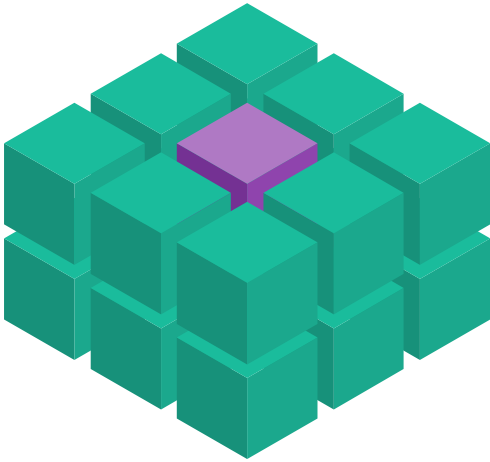
Emerging Hot Spot Analysis

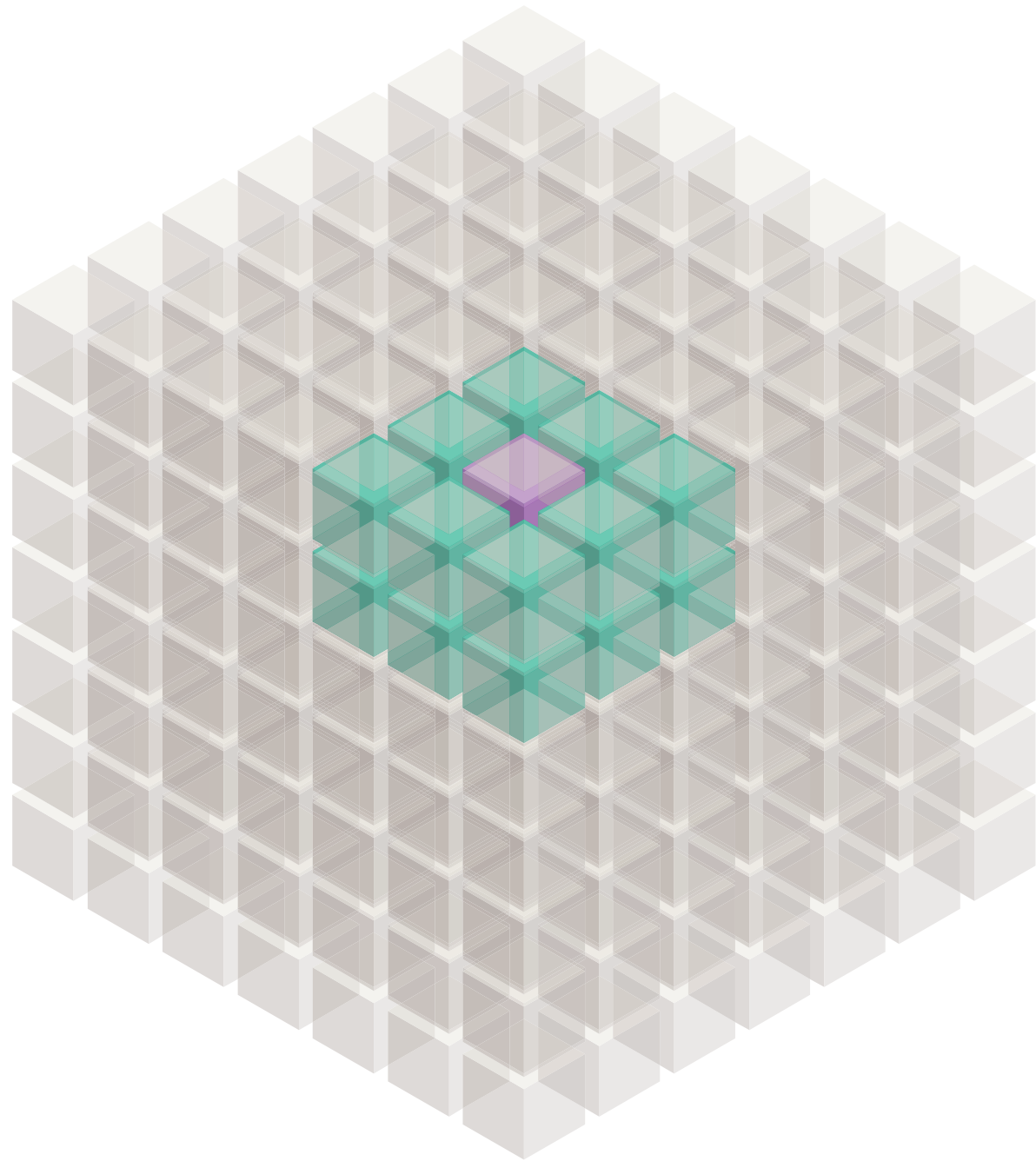
identifies trends in the clustering of counts
or summary fields in a space time cube

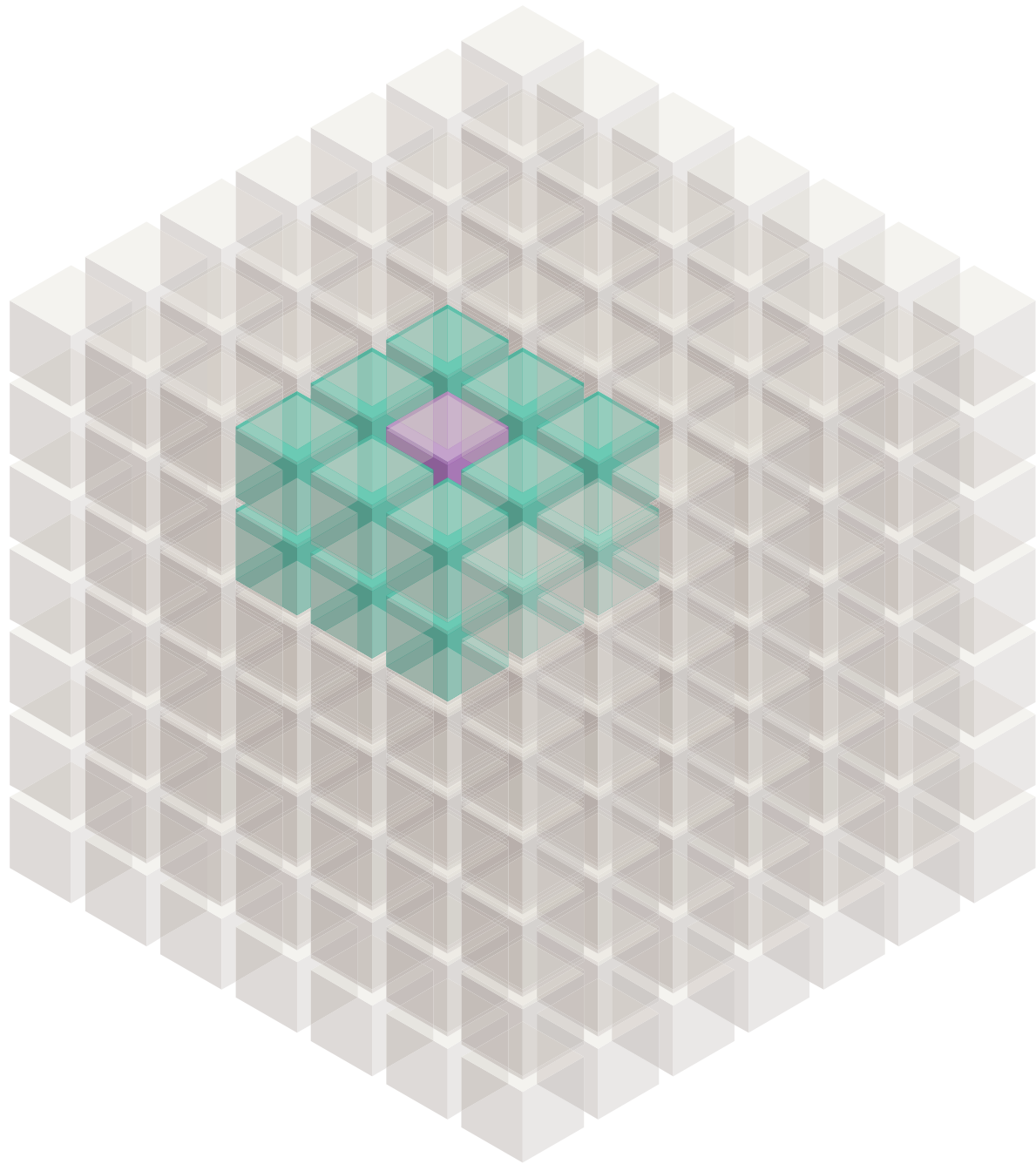


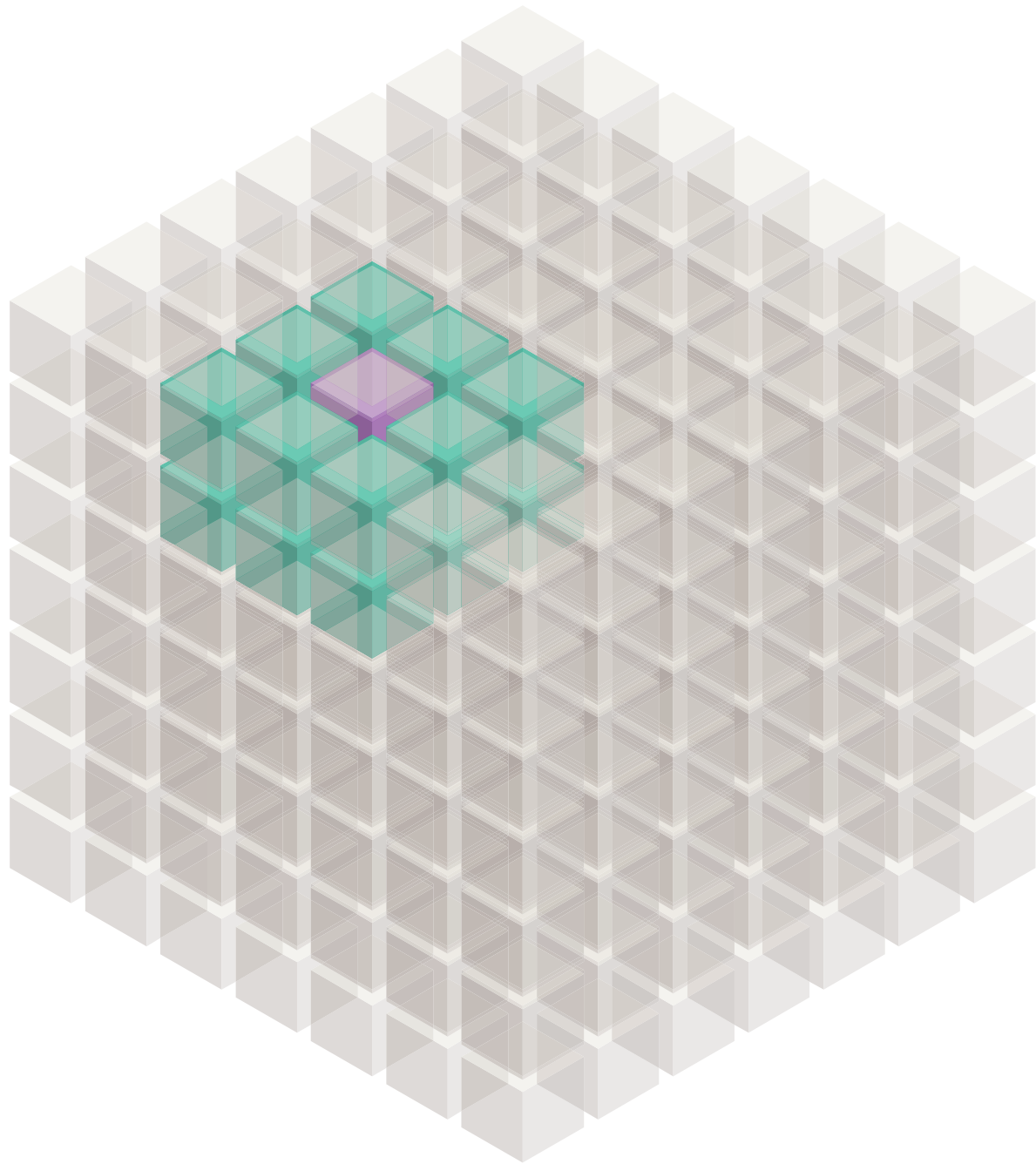




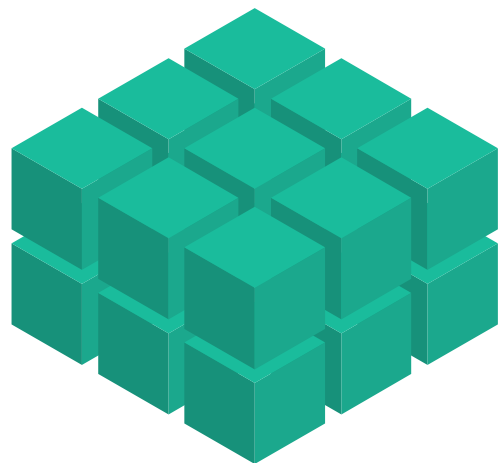




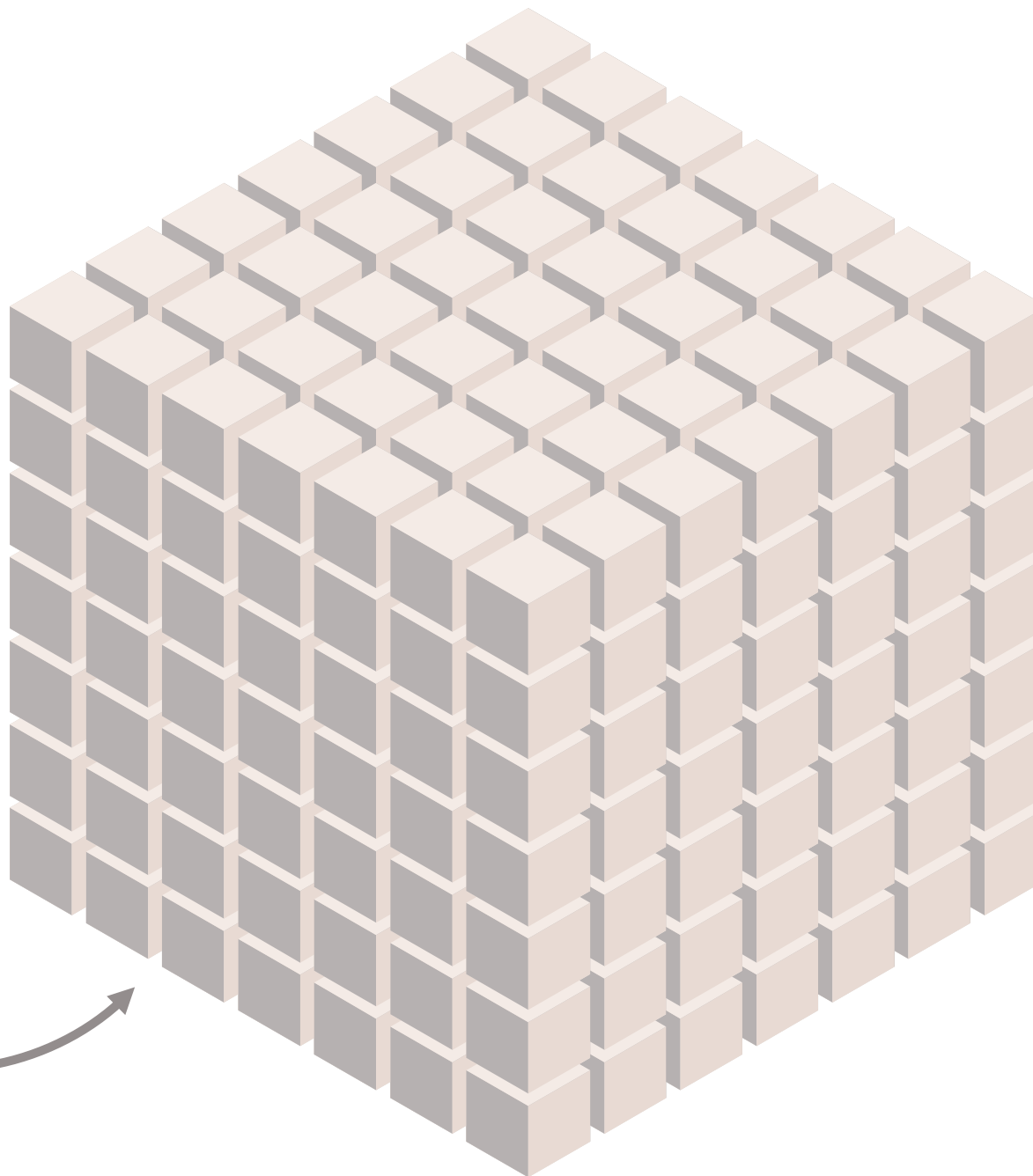




is this

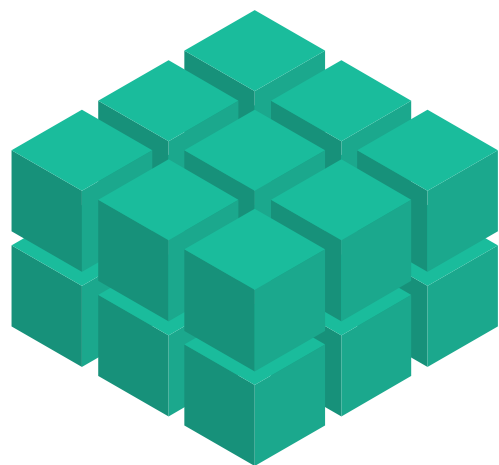


significantly
different from this?

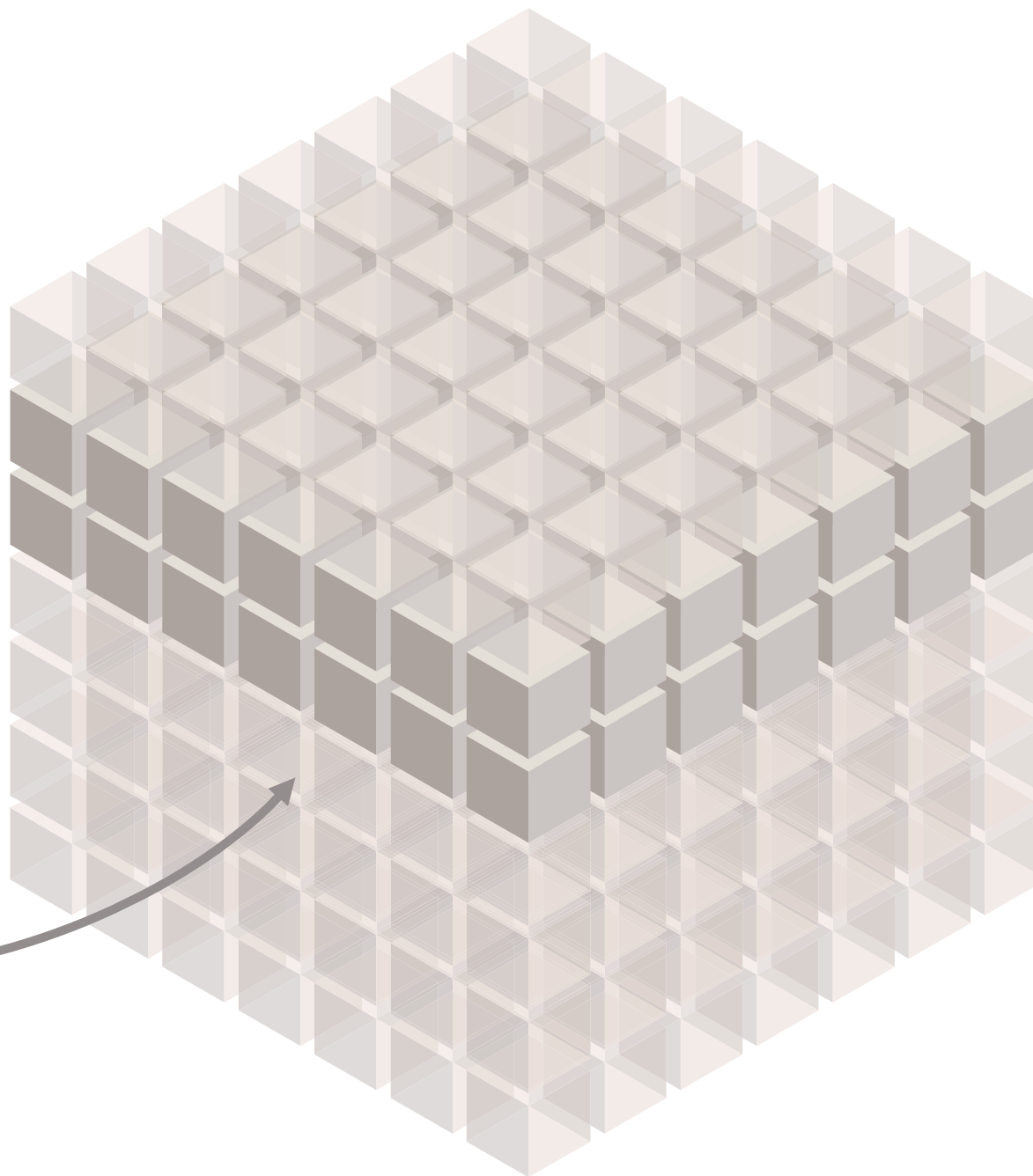


Entire Cube

is this

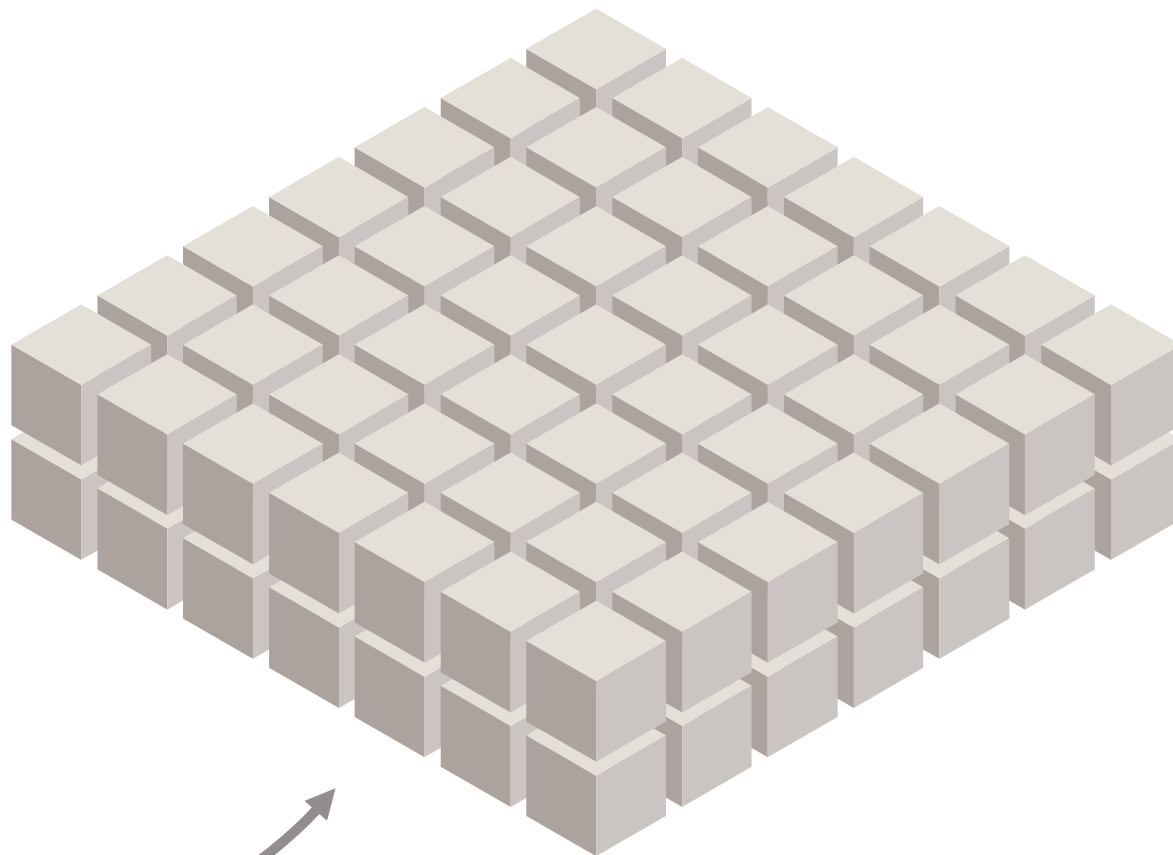
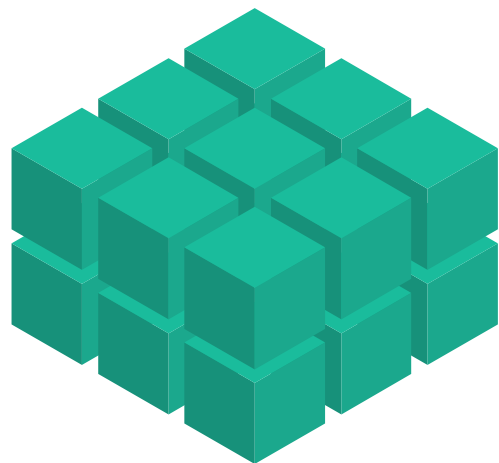


significantly
different from this?

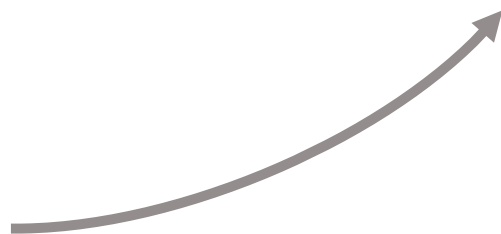


Neighborhood Time Step

is this

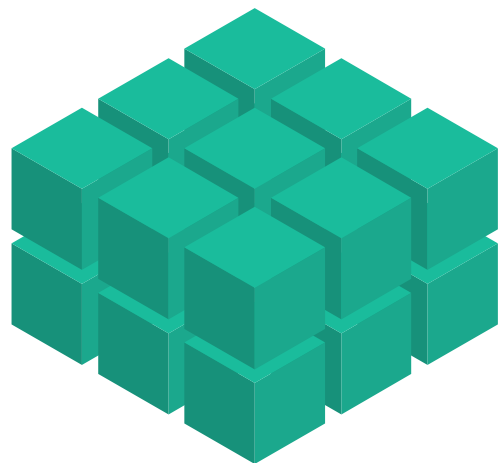


significantly
different from this?

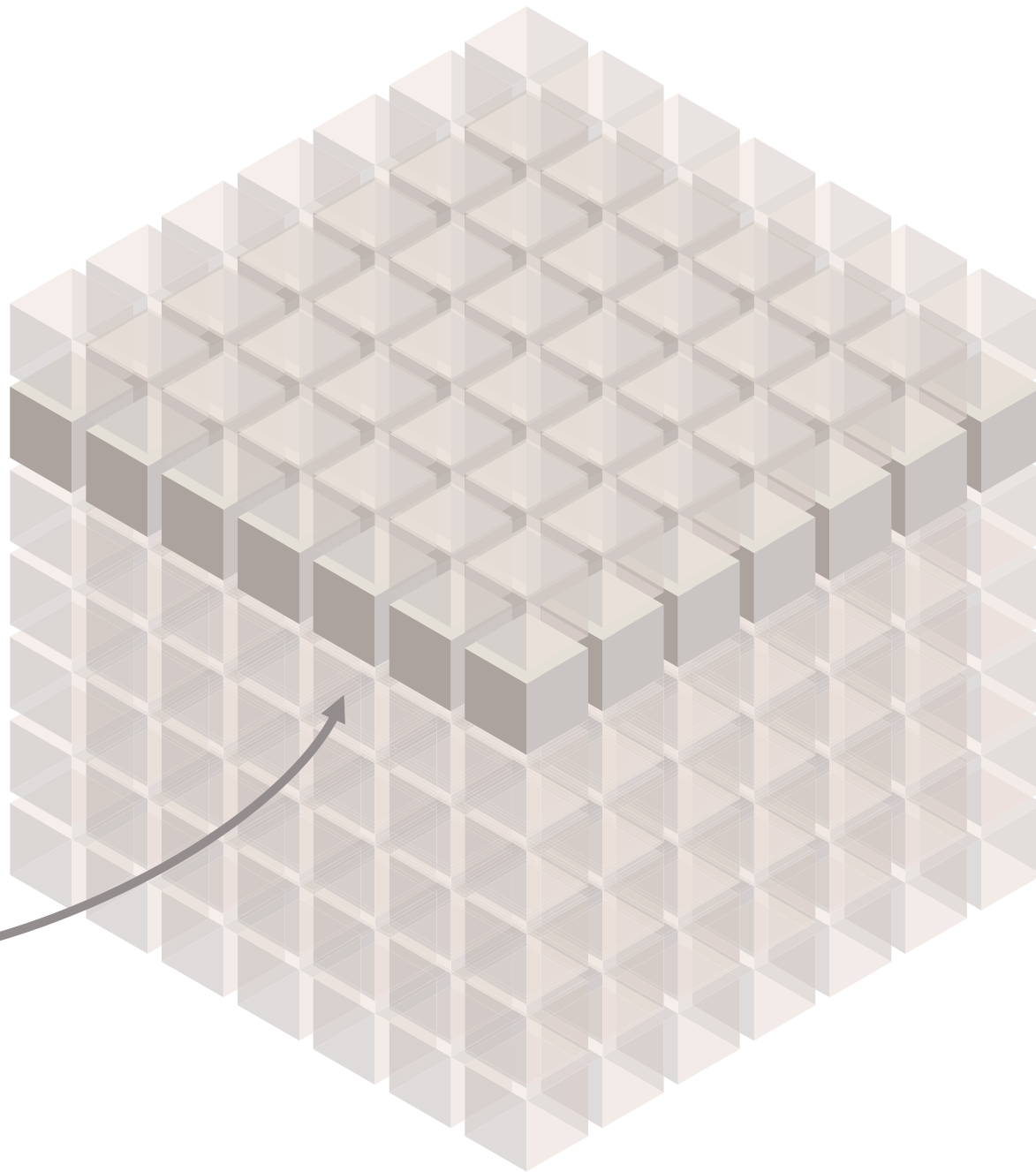


Neighborhood Time Step

is this

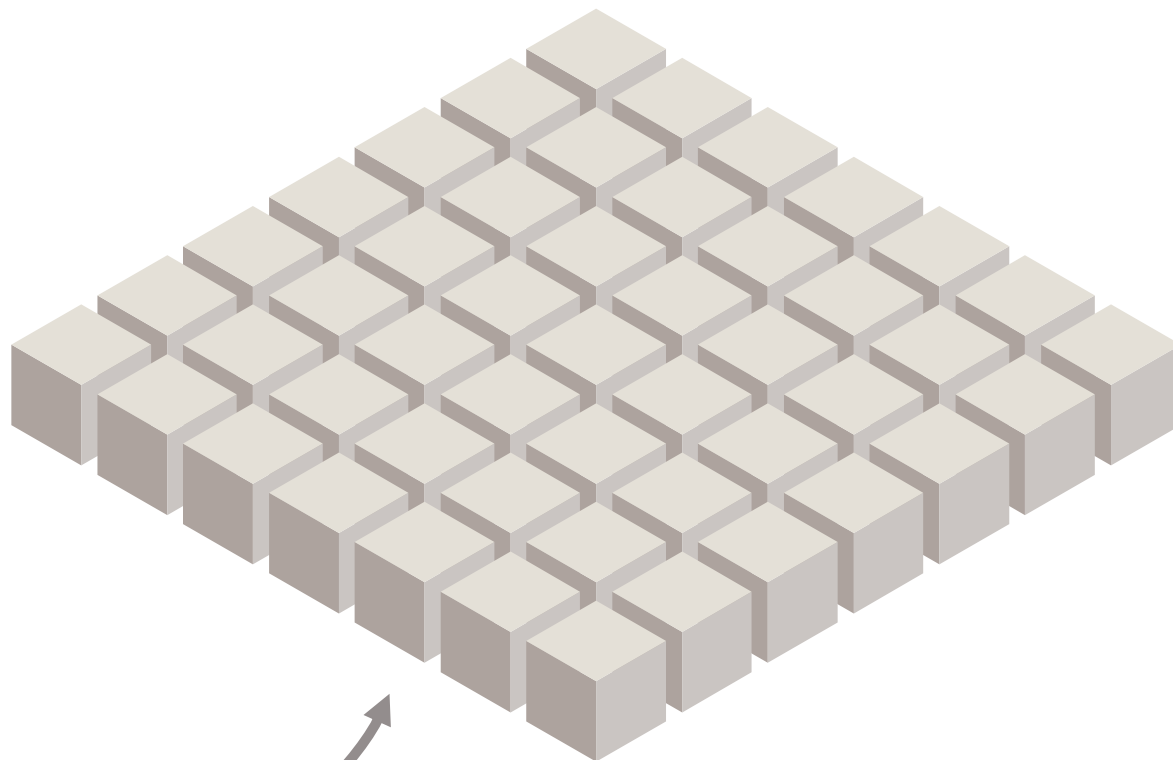
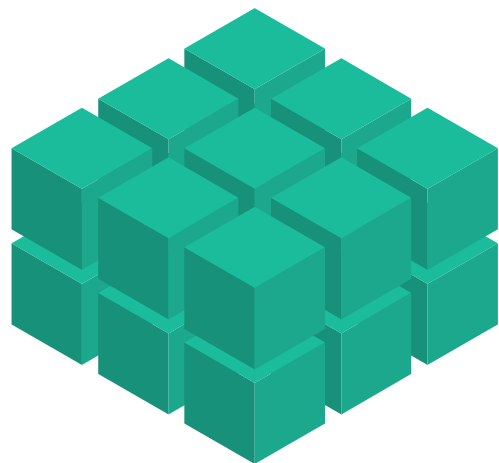


significantly
different from this?

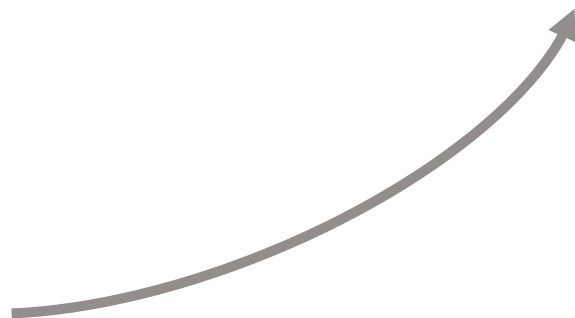


Individual Time Step

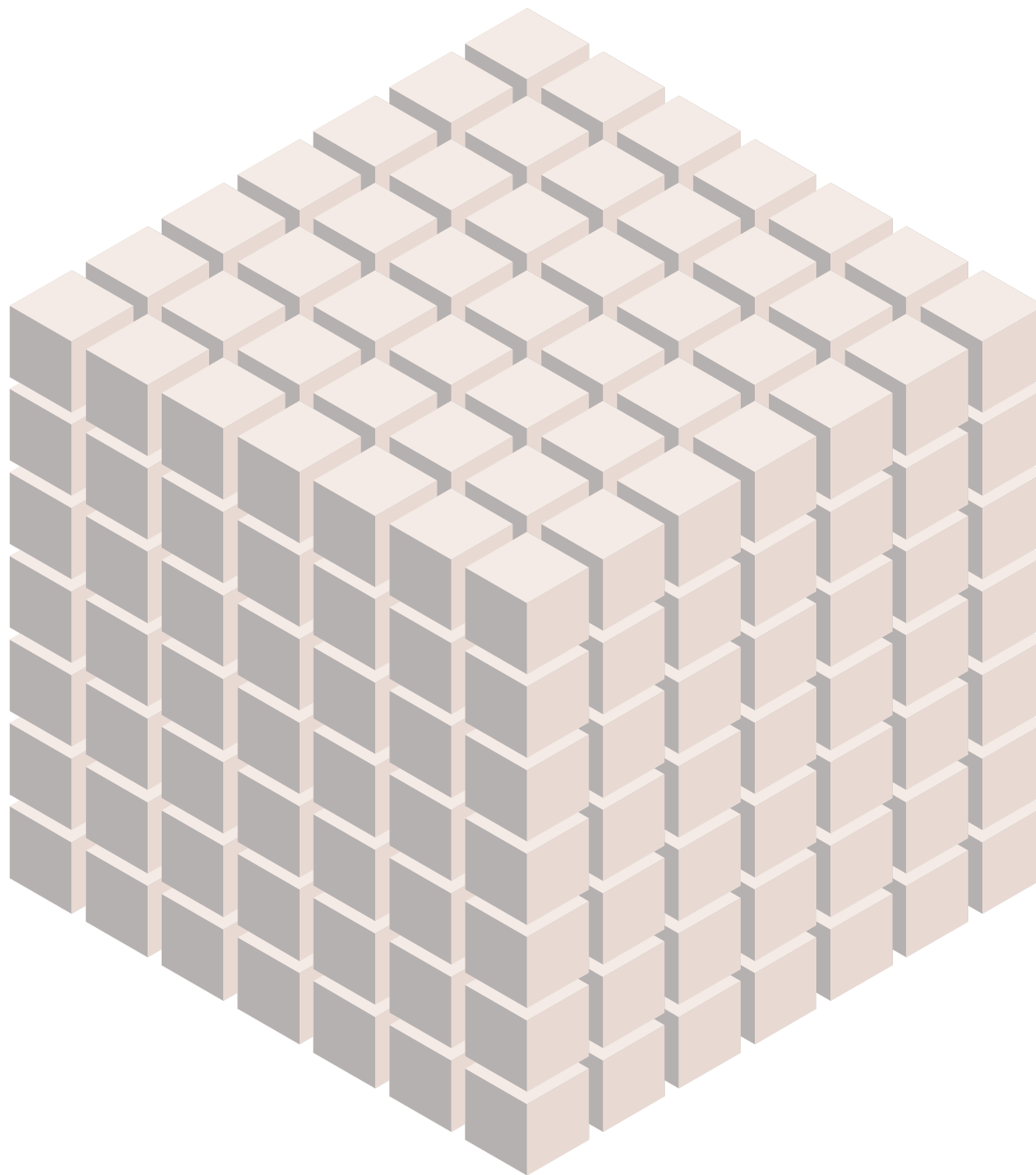
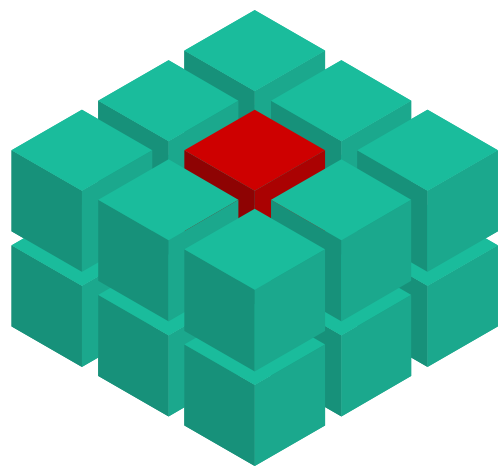
is this

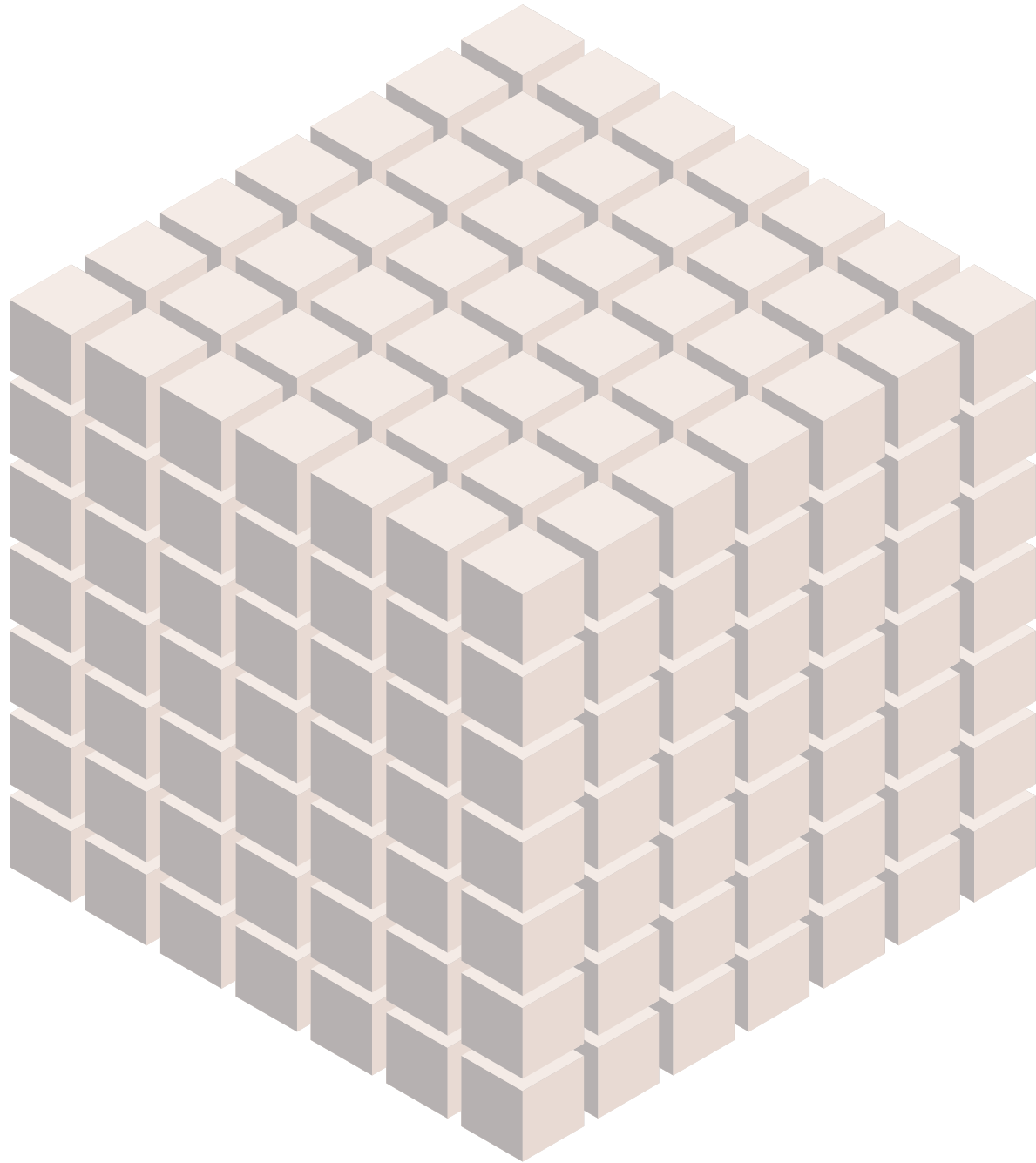
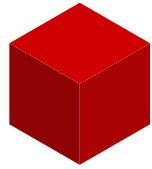


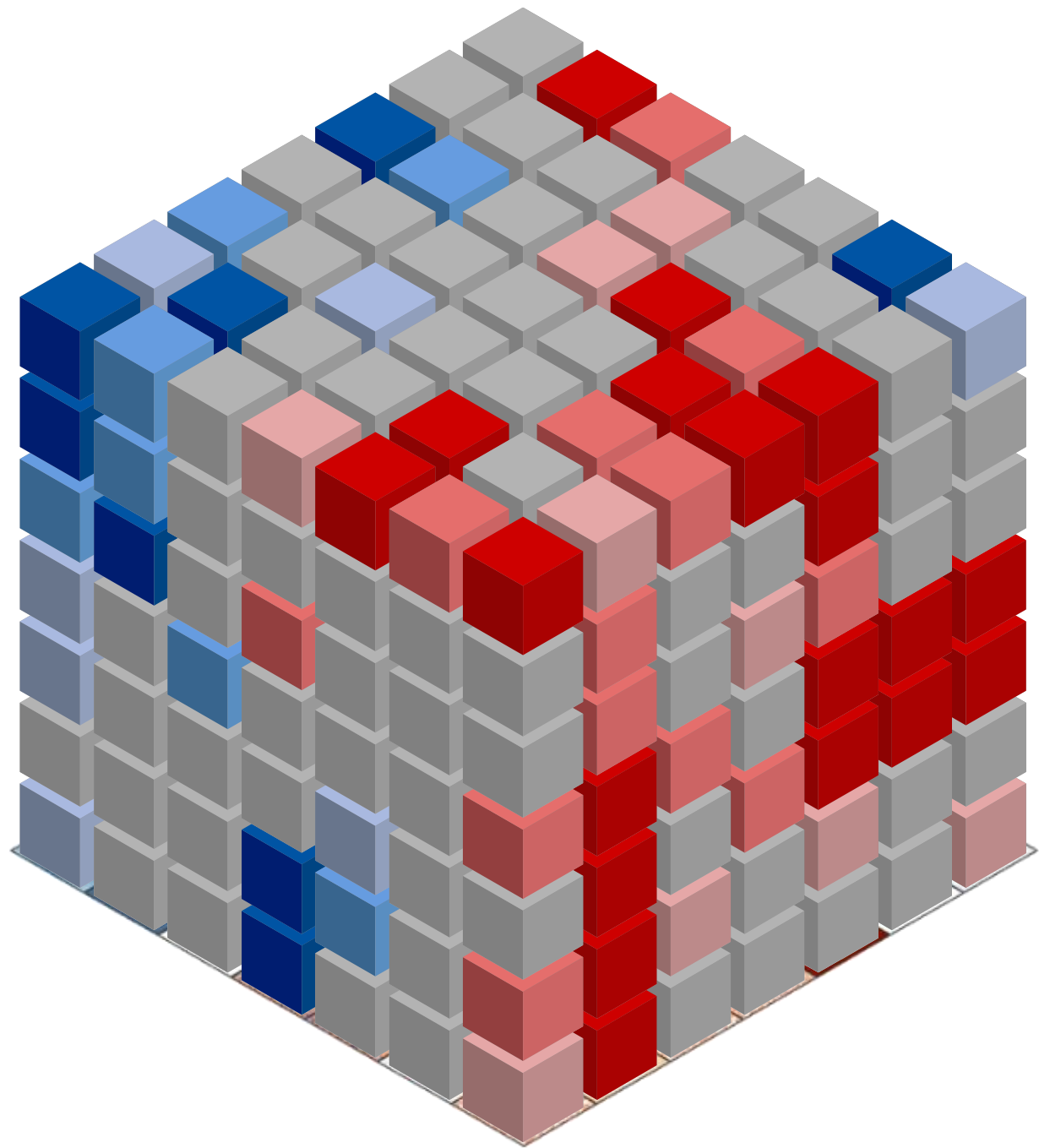
significantly
different from this?











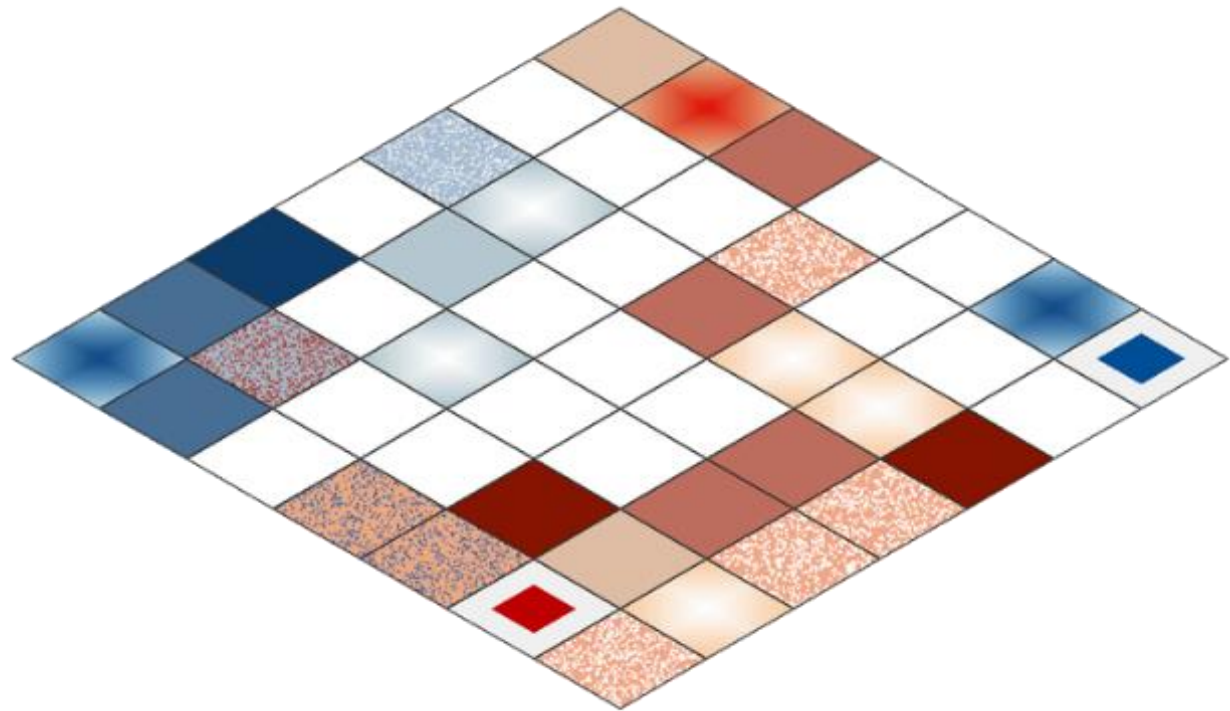
Individual Time Step












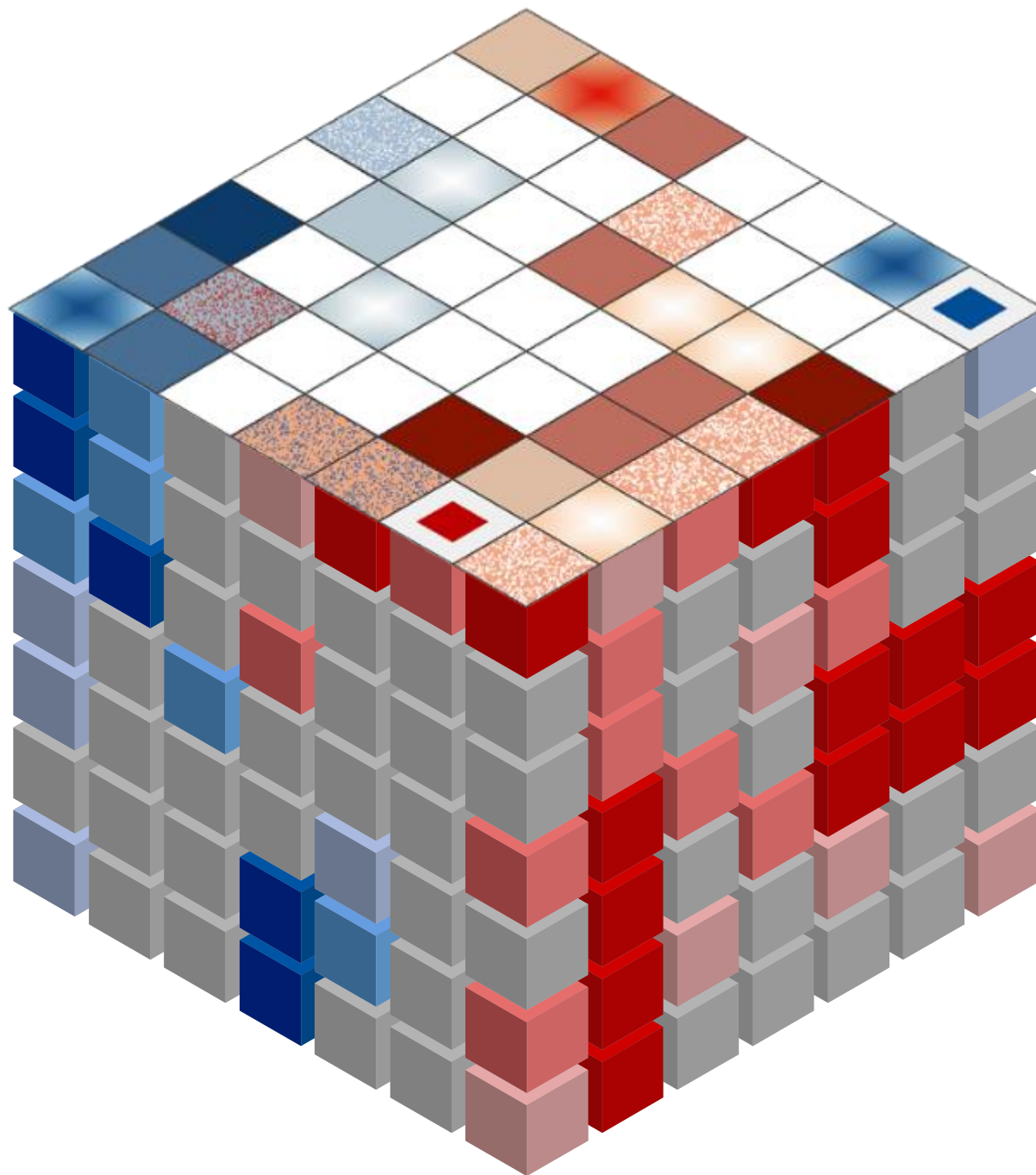




















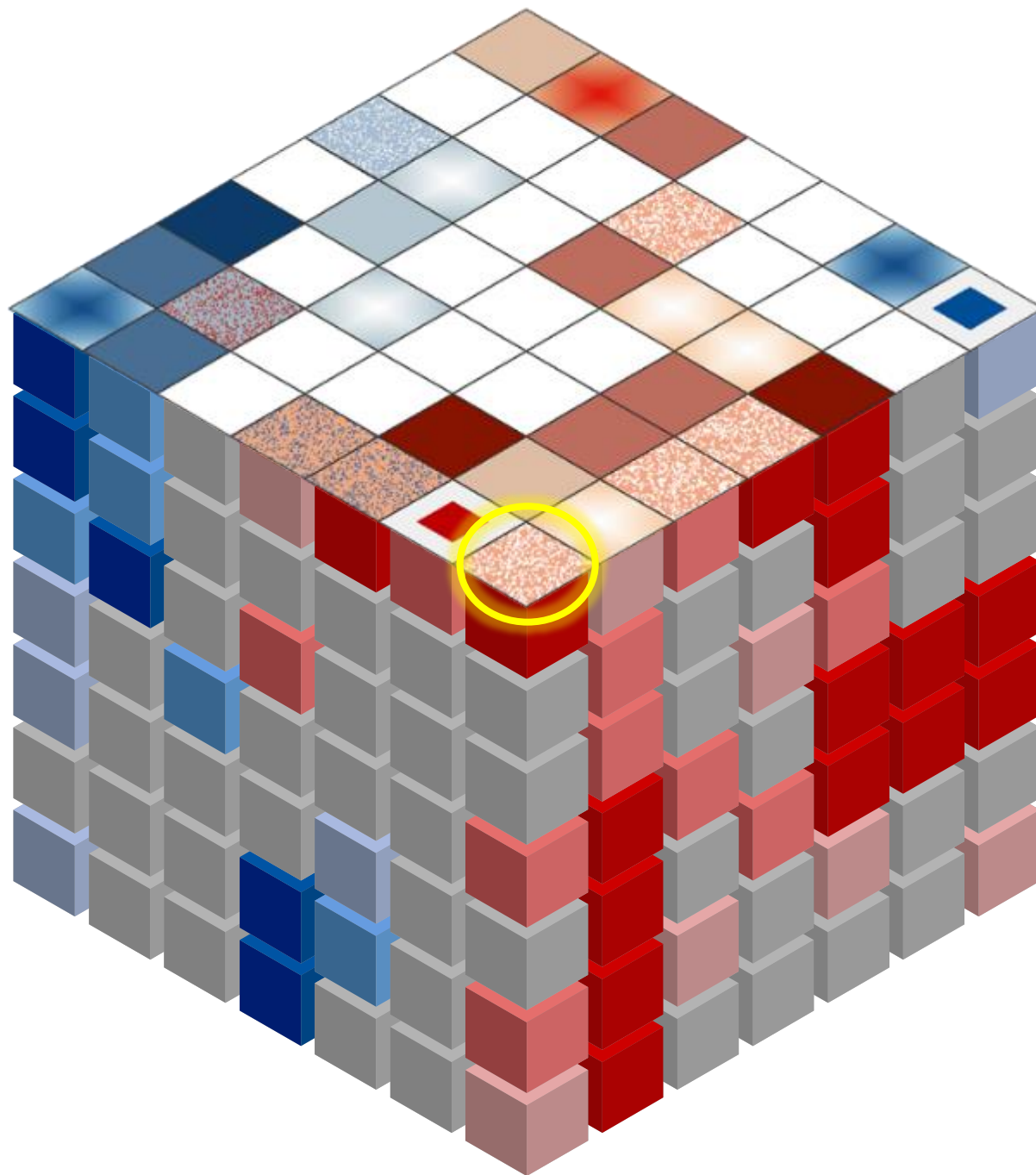
-  New Hot Spot
-  Consecutive Hot Spot
-  Intensifying Hot Spot
-  Persistent Hot Spot
-  Diminishing Hot Spot
-  Sporadic Hot Spot
-  Oscillating Hot Spot
-  Historical Hot Spot
-  New Cold Spot
-  Consecutive Cold Spot
-  Intensifying Cold Spot
-  Persistent Cold Spot
-  Diminishing Cold Spot
-  Sporadic Cold Spot
-  Oscillating Cold Spot
-  Historical Cold Spot
-  No trend detected




















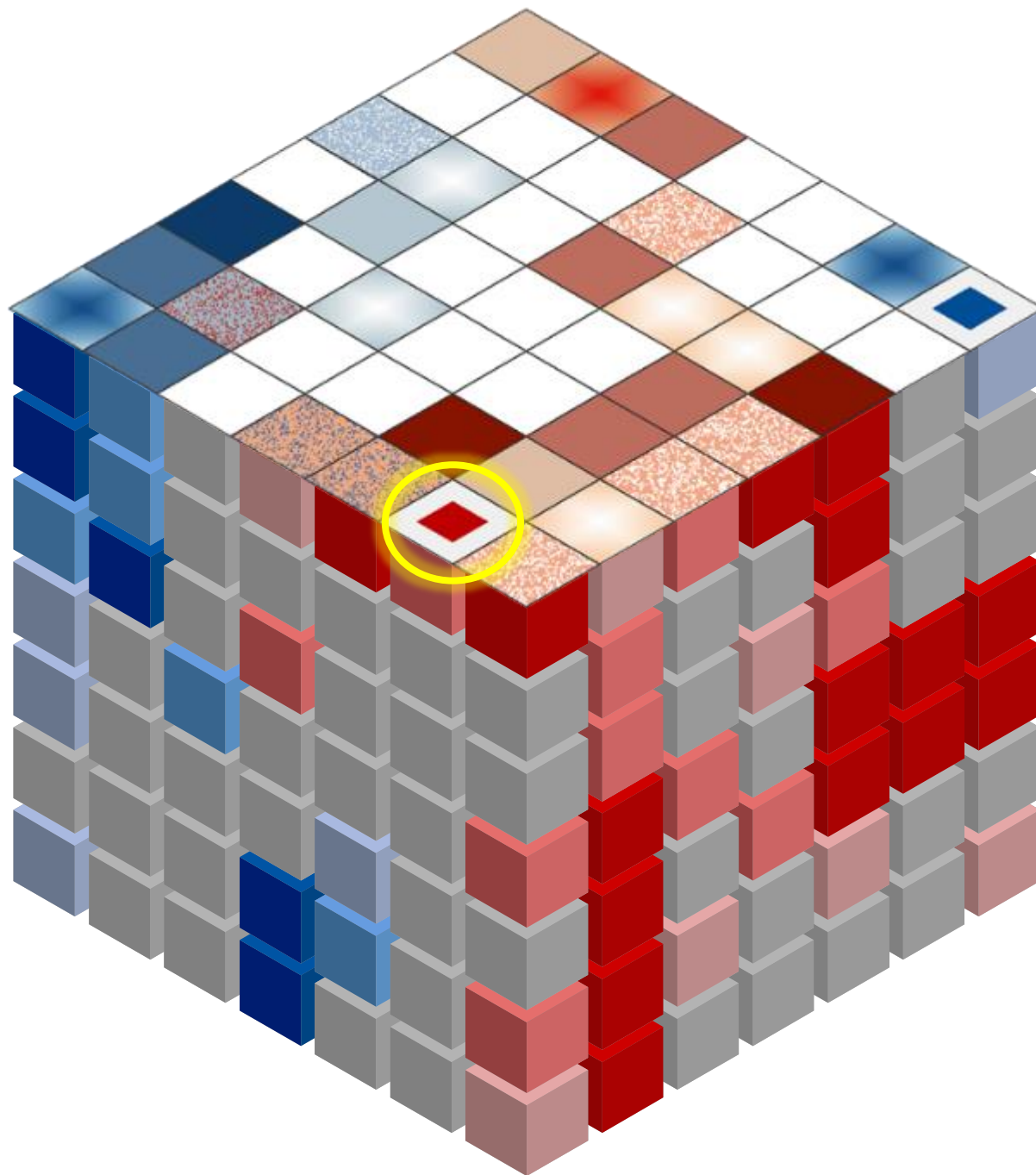
-  New Hot Spot
-  Consecutive Hot Spot
-  Intensifying Hot Spot
-  Persistent Hot Spot
-  Diminishing Hot Spot
-  Sporadic Hot Spot
-  Oscillating Hot Spot
-  Historical Hot Spot
-  New Cold Spot
-  Consecutive Cold Spot
-  Intensifying Cold Spot
-  Persistent Cold Spot
-  Diminishing Cold Spot
-  Sporadic Cold Spot
-  Oscillating Cold Spot
-  Historical Cold Spot
-  No trend detected



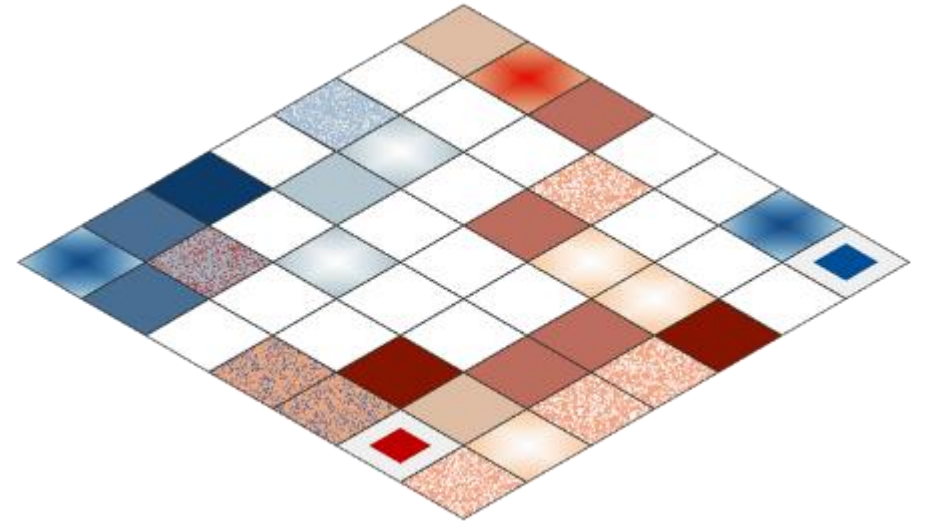
-  New Hot Spot
-  Consecutive Hot Spot
-  Intensifying Hot Spot
-  Persistent Hot Spot
-  Diminishing Hot Spot
-  Sporadic Hot Spot
-  Oscillating Hot Spot
-  Historical Hot Spot
-  New Cold Spot
-  Consecutive Cold Spot
-  Intensifying Cold Spot
-  Persistent Cold Spot
-  Diminishing Cold Spot
-  Sporadic Cold Spot
-  Oscillating Cold Spot
-  Historical Cold Spot
-  No trend detected



-  New Hot Spot
-  Consecutive Hot Spot
-  Intensifying Hot Spot
-  Persistent Hot Spot
-  Diminishing Hot Spot
-  Sporadic Hot Spot
-  Oscillating Hot Spot
-  Historical Hot Spot
-  New Cold Spot
-  Consecutive Cold Spot
-  Intensifying Cold Spot
-  Persistent Cold Spot
-  Diminishing Cold Spot
-  Sporadic Cold Spot
-  Oscillating Cold Spot
-  Historical Cold Spot
-  No trend detected



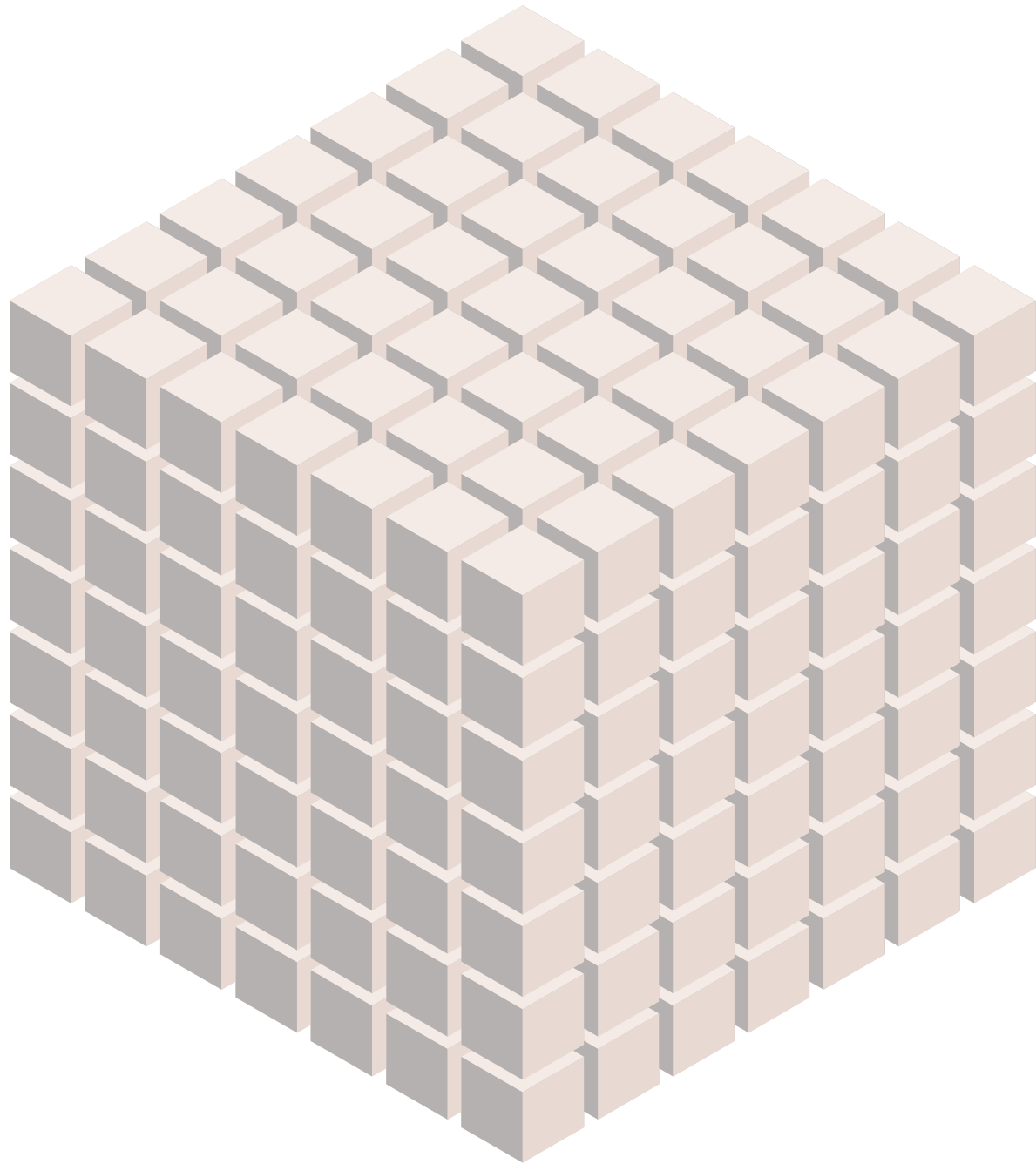
demo



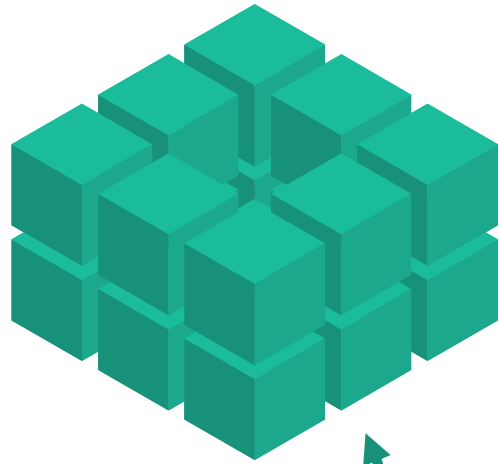
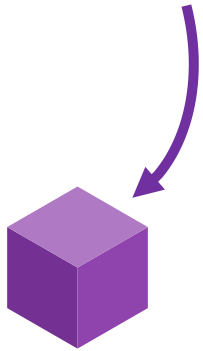
Local Outlier Analysis

identifies statistically significant clusters and outliers in the context of both space and time

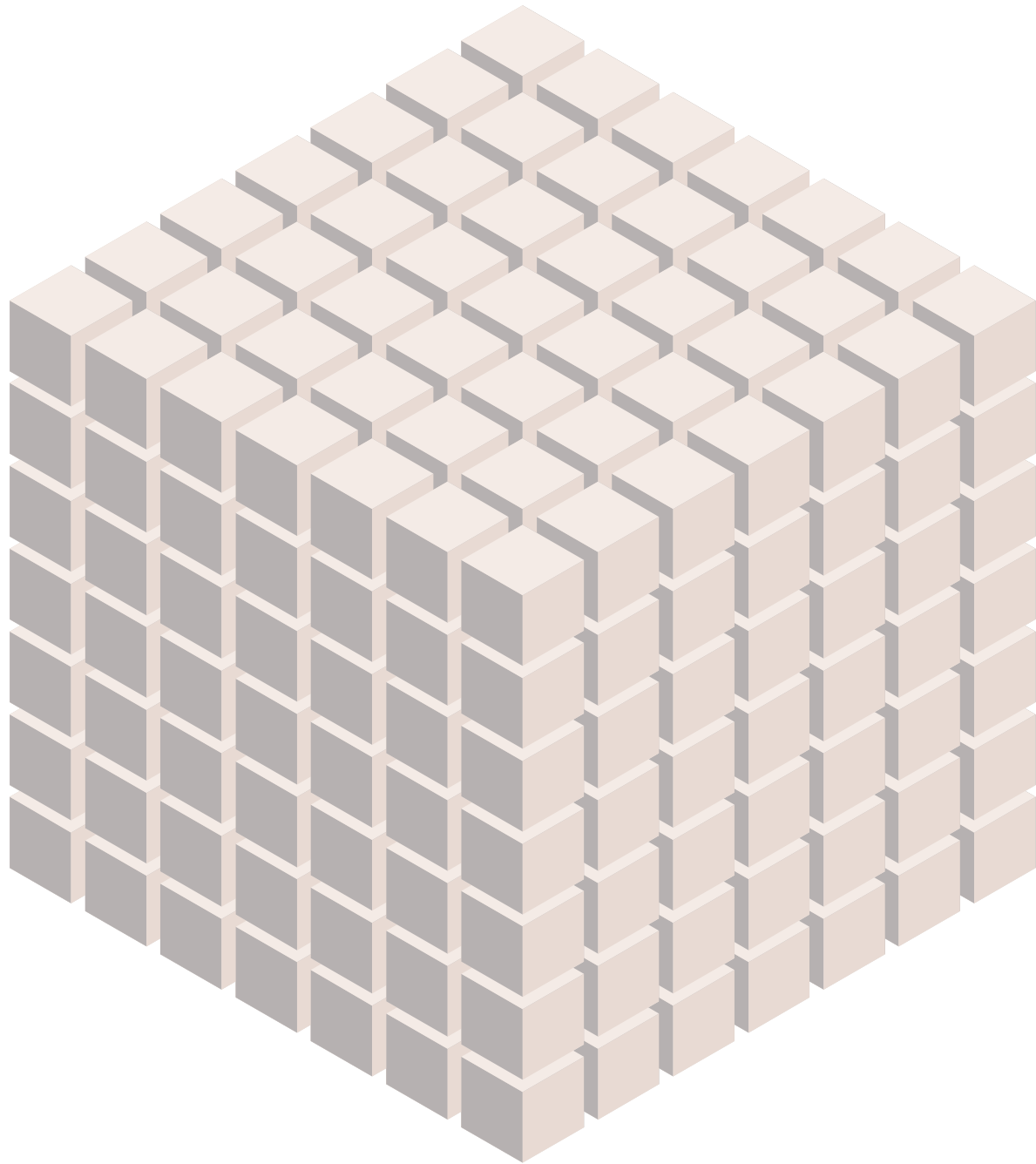


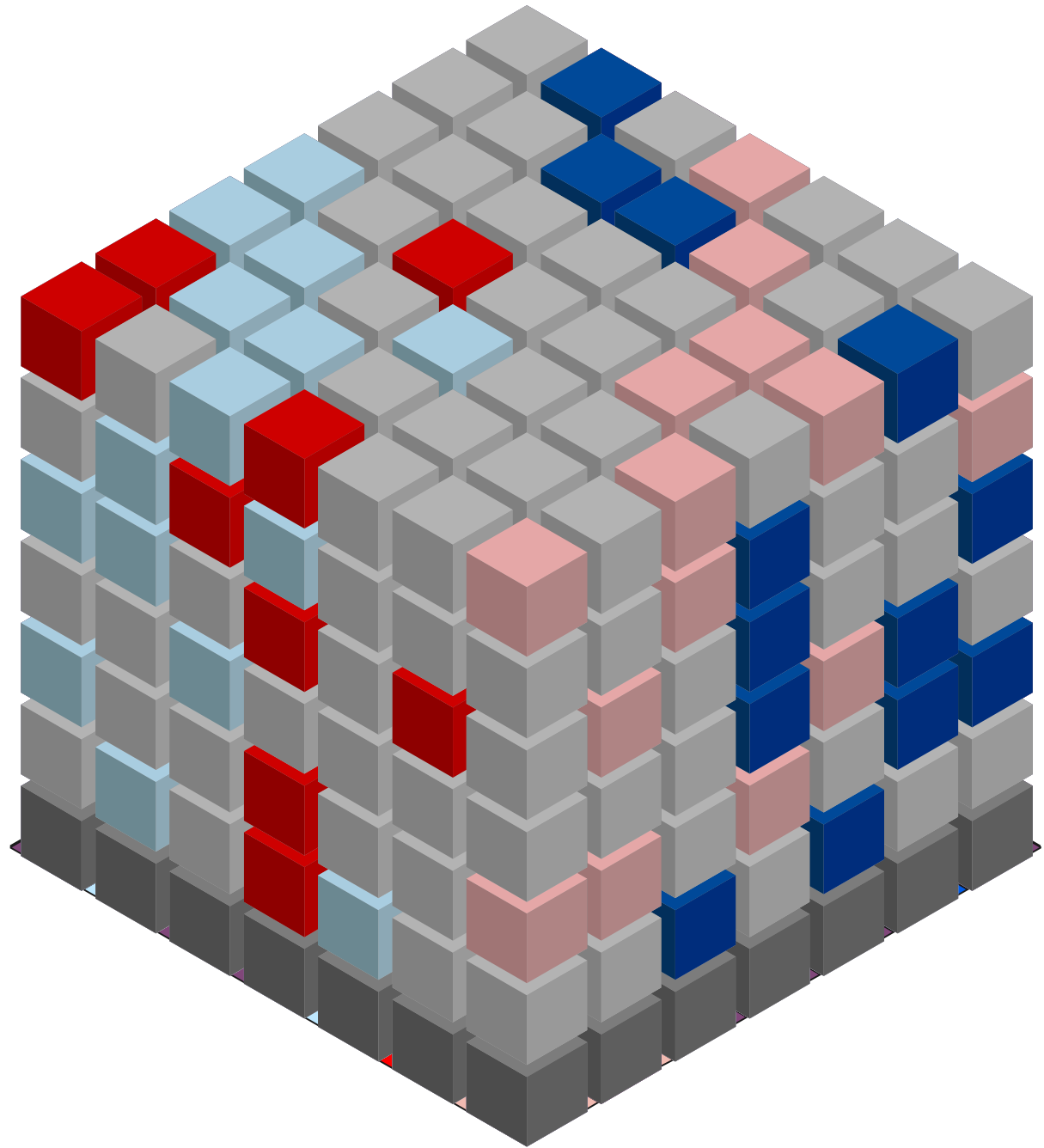


is the bin
significantly
different from all
other bins?



is the neighborhood
significantly different
from all other
neighborhoods?





bin is **higher** than other bins,
neighborhood is **lower** than other neighborhoods



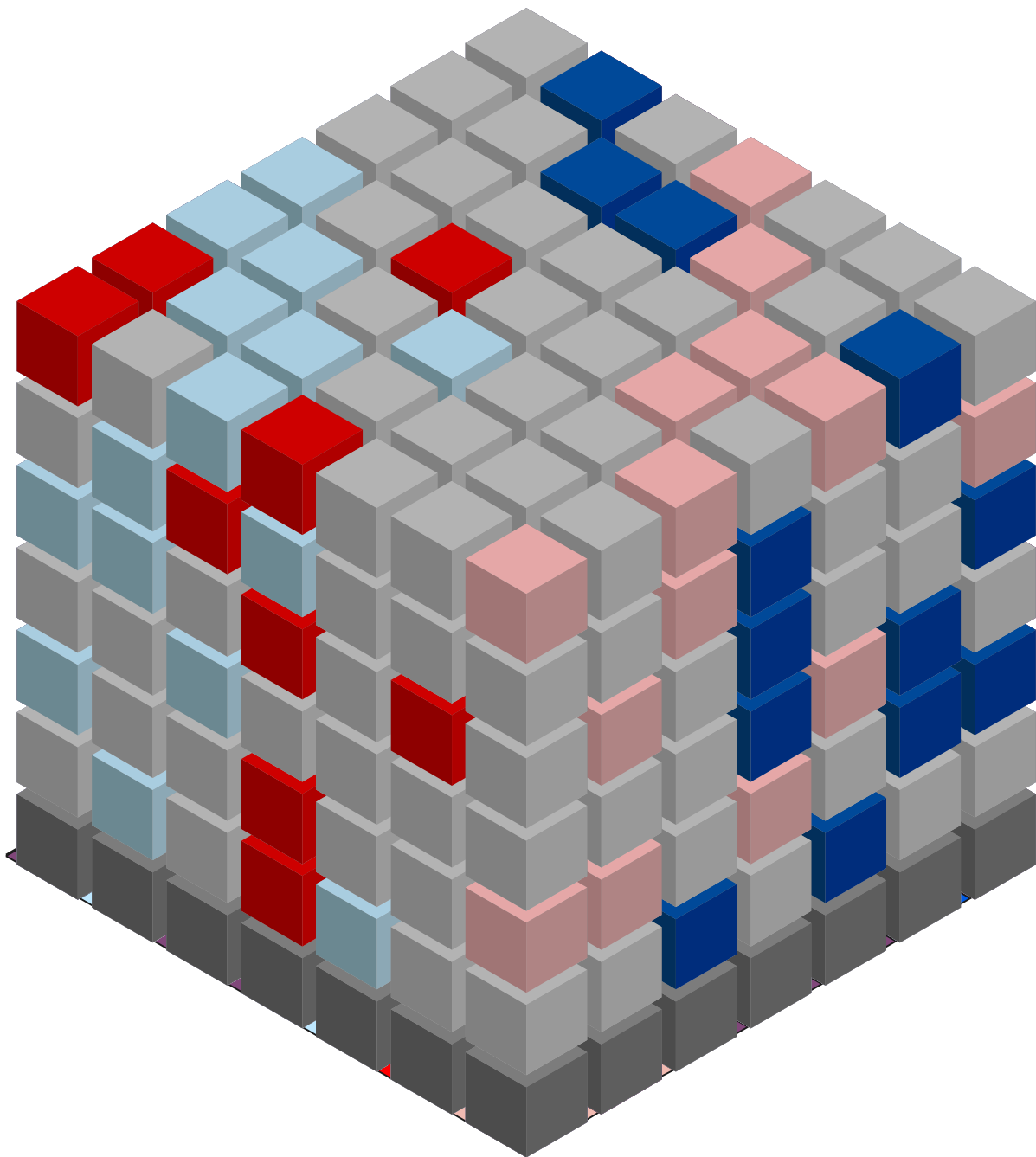
bin is **higher** than other bins,
neighborhood is **higher** than other neighborhoods



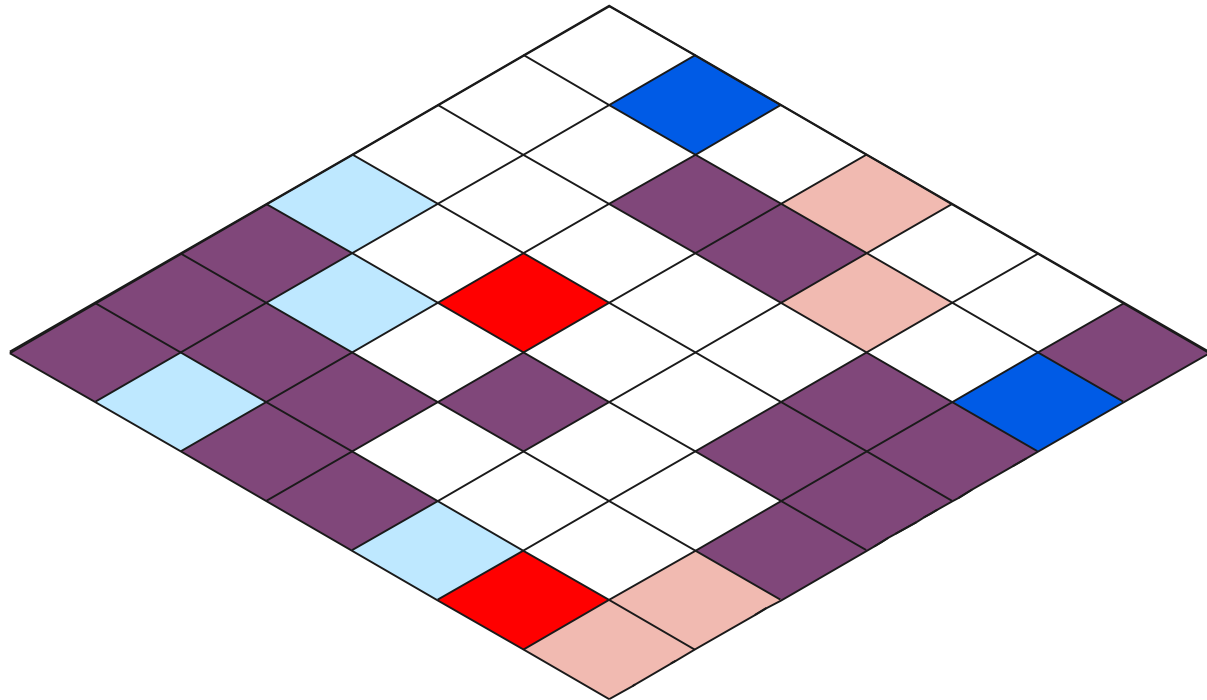
bin is **lower** than other bins,
neighborhood is **lower** than other neighborhoods



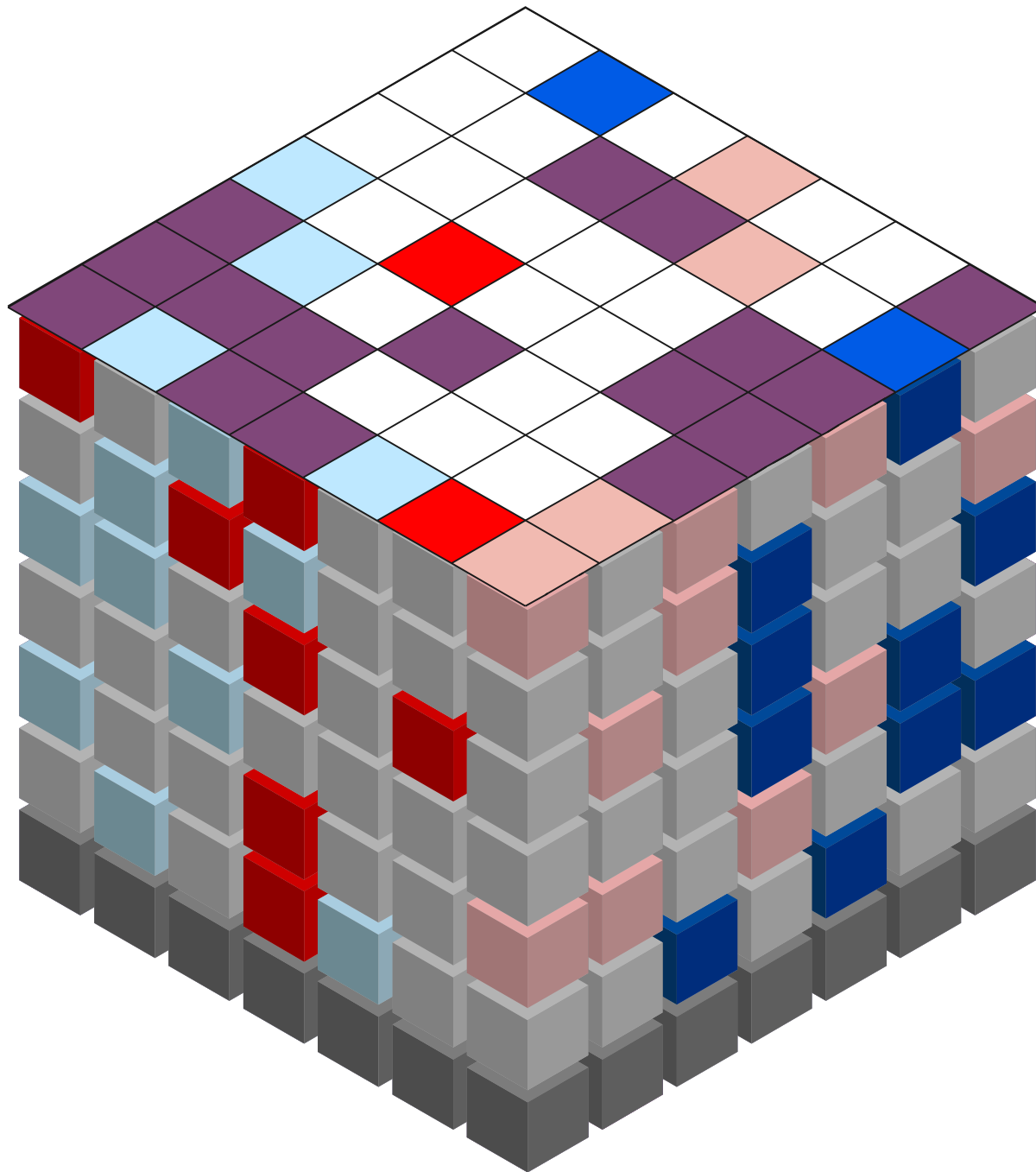
bin is **lower** than other bins,
neighborhood is **higher** than other neighborhoods



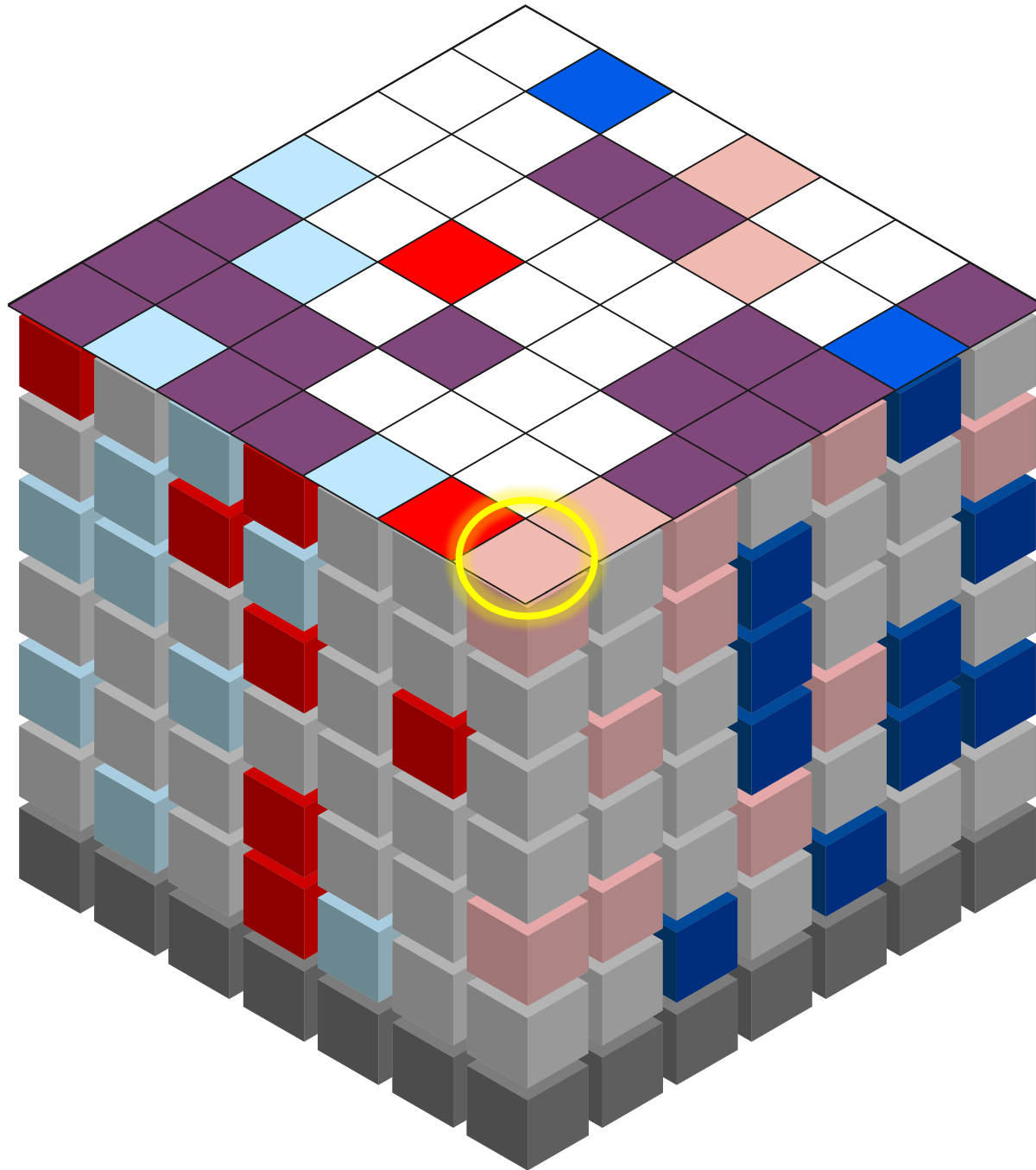
- Never Significant
- Only High-High Cluster
- Only High-Low Outlier
- Only Low-High Outlier
- Only Low-Low Cluster
- Multiple Types



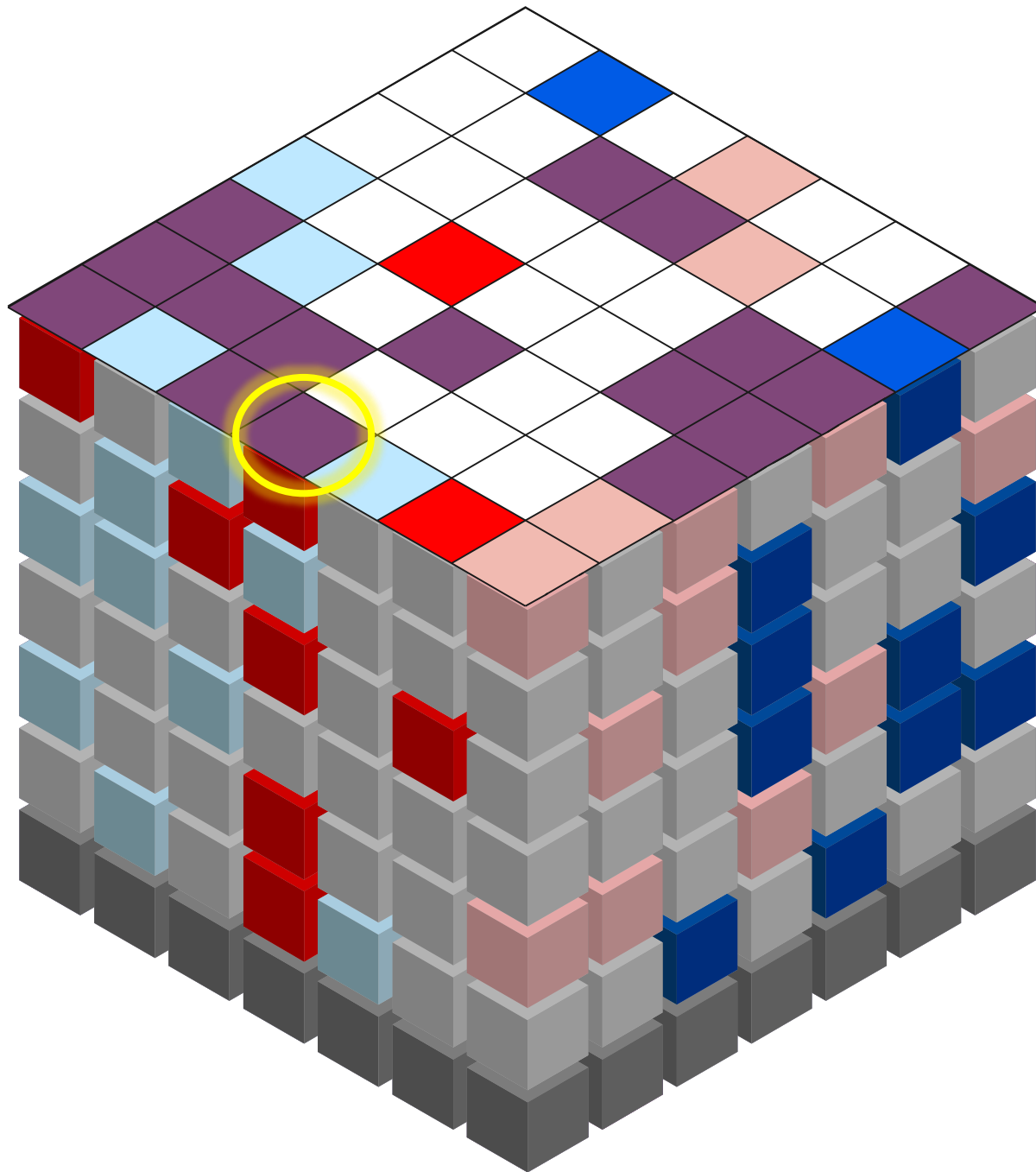
- Never Significant
- Only High-High Cluster
- Only High-Low Outlier
- Only Low-High Outlier
- Only Low-Low Cluster
- Multiple Types



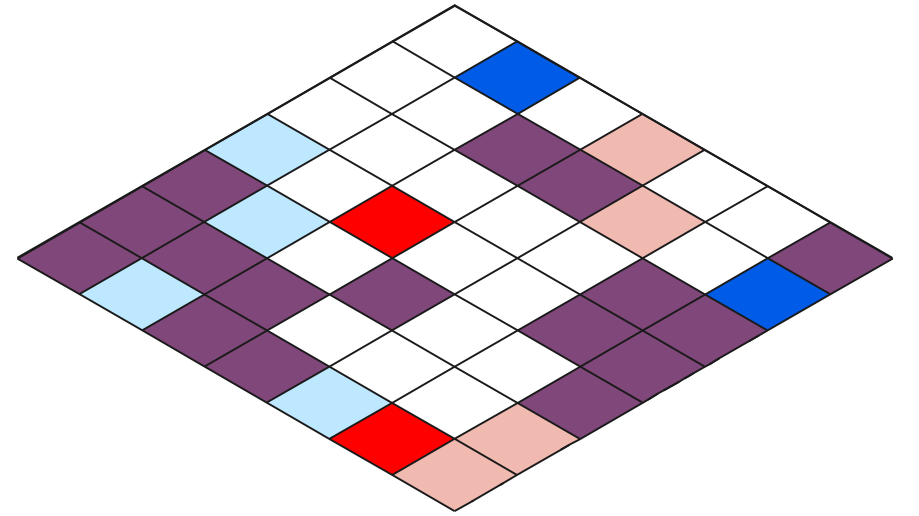
- Never Significant
- Only High-High Cluster
- Only High-Low Outlier
- Only Low-High Outlier
- Only Low-Low Cluster
- Multiple Types



- Never Significant
- Only High-High Cluster
- Only High-Low Outlier
- Only Low-High Outlier
- Only Low-Low Cluster
- Multiple Types



demo





esriurl.com/spatialstats