

moms: measuring occupancy in multidimensional space

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Acknowledgements



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Vera Weisbecker

SAVE YOURSELF, MAMMAL!

A SATURDAY MORNING BREAKFAST CEREAL COLLECTION

BY ZACH WEINER



Cenozoic
Paleogene
Mesozoic
Cretaceous



Figure modified from Brusatte et al. 2014 Biol. Rev.

Cenozoic

Paleogene

Mesozoic

Cretaceous

70
Mya



Figure modified from Brusatte et al. 2014 Biol. Rev.



taenaron.deviantart.com
EARTH 2049

 L

Mesozoic Cretaceous

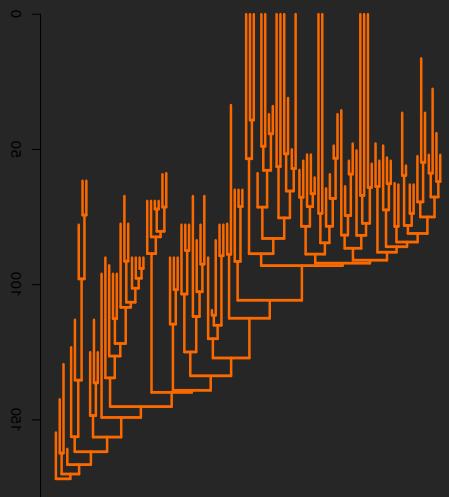
Paleogene



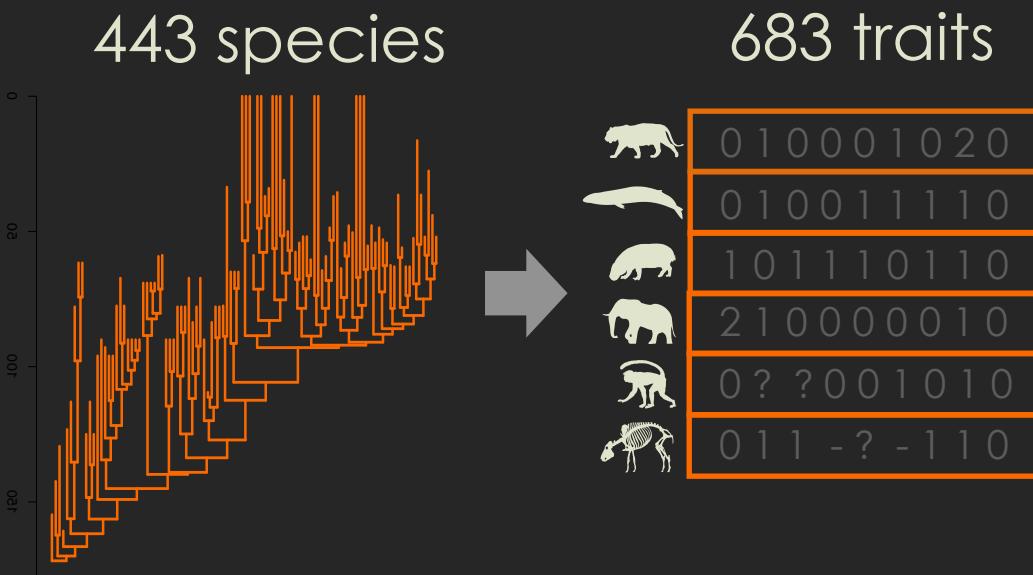
Figure modified from Brusatte et al. 2014 Biol. Rev.

Mammalian morphospace

443 species

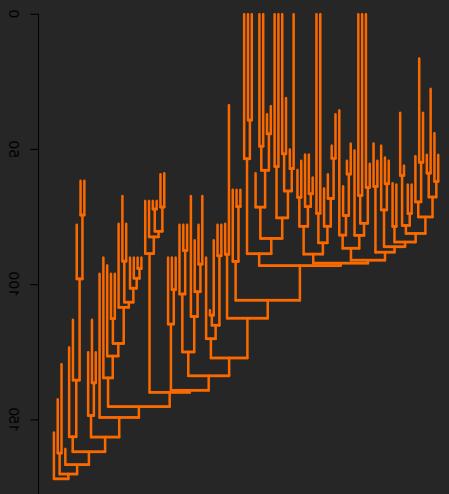


Mammalian morphospace



Mammalian morphospace

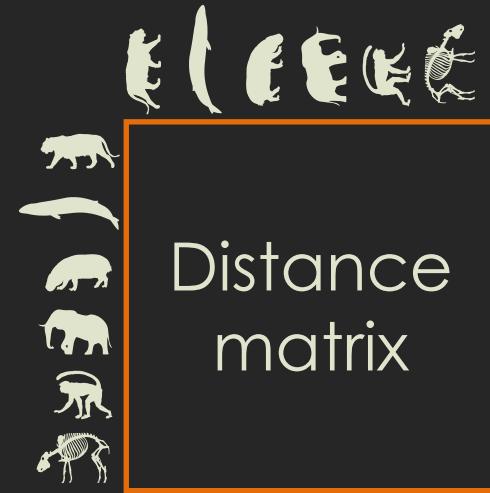
443 species



683 traits

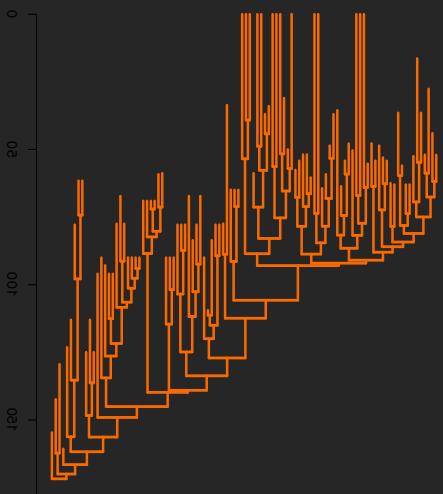
A diagram illustrating the trait matrix. On the left, there is a vertical list of seven mammals with their corresponding skeletal icons. To the right of this list is a large orange arrow pointing right, indicating the direction of transformation from the phylogenetic tree to the trait matrix. Below the arrow is a table consisting of seven rows, each representing a trait for one of the seven mammals. The first six rows have binary values (0 or 1), while the seventh row contains question marks and dashes. The table is enclosed in a red border.

	0 1 0 0 0 1 0 2 0
	0 1 0 0 1 1 1 1 0
	1 0 1 1 1 0 1 1 0
	2 1 0 0 0 0 0 1 0
	0 ? ? 0 0 1 0 1 0
	0 1 1 - ? - 1 1 0



Mammalian morphospace

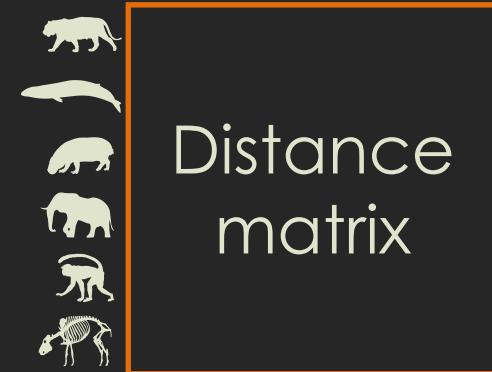
443 species



683 traits

A diagram illustrating the trait matrix. On the left, six small icons represent different mammals: a tiger, a whale, a mouse, an elephant, a monkey, and a dog skeleton. An arrow points from the phylogenetic tree to a grid of binary trait values. The grid has the same six rows as the icons. The columns represent 683 traits. The first few columns have specific values (e.g., 010001020), while later columns contain question marks or dashes, indicating missing data.

Tiger	0	1	0	0	0	1	0	2	0
Whale	0	1	0	0	1	1	1	0	0
Mouse	1	0	1	1	0	1	1	0	0
Elephant	2	1	0	0	0	0	0	1	0
Monkey	0	?	?	0	0	1	0	1	0
Dog skeleton	0	1	1	-	?	-	-	1	0

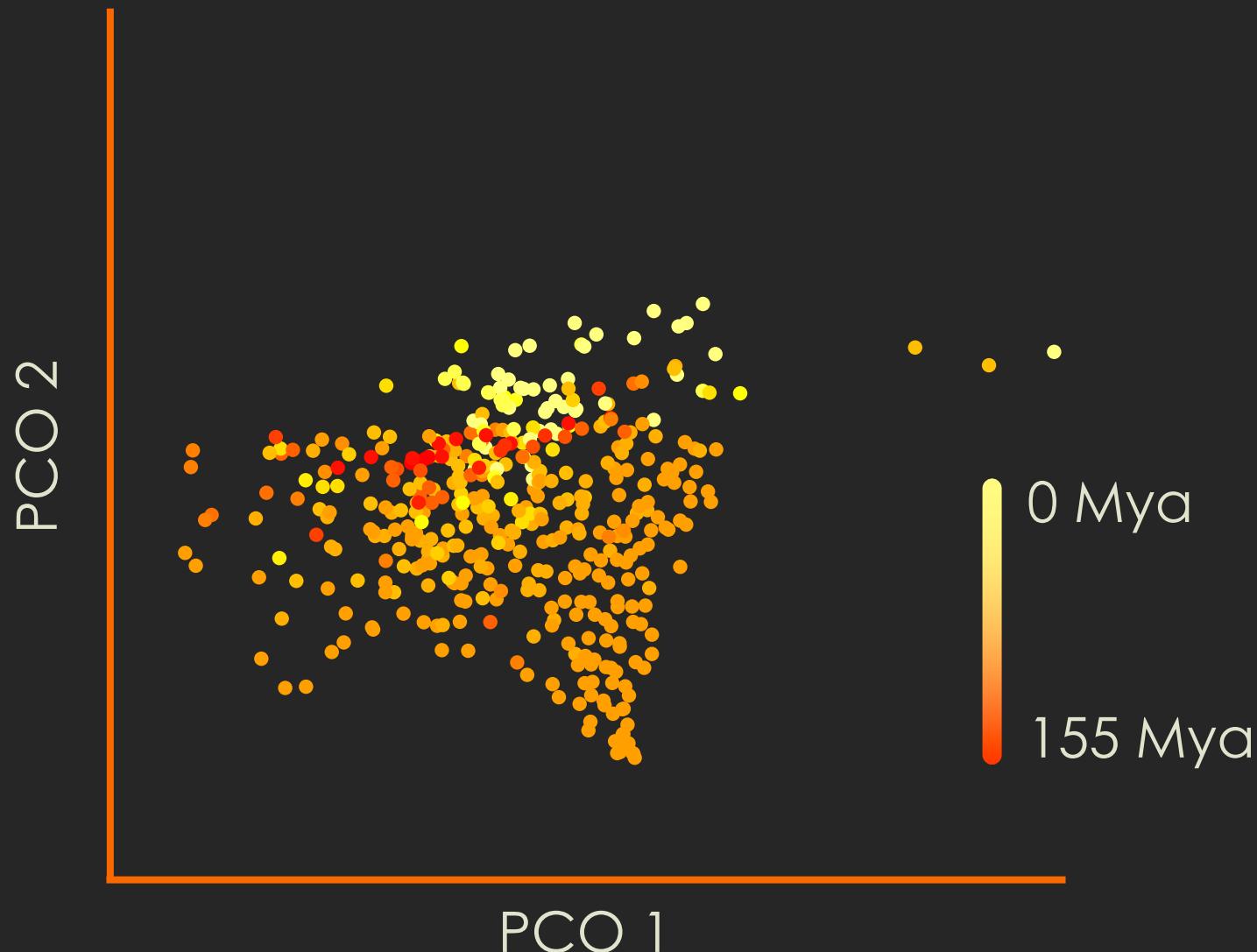


Distance
matrix

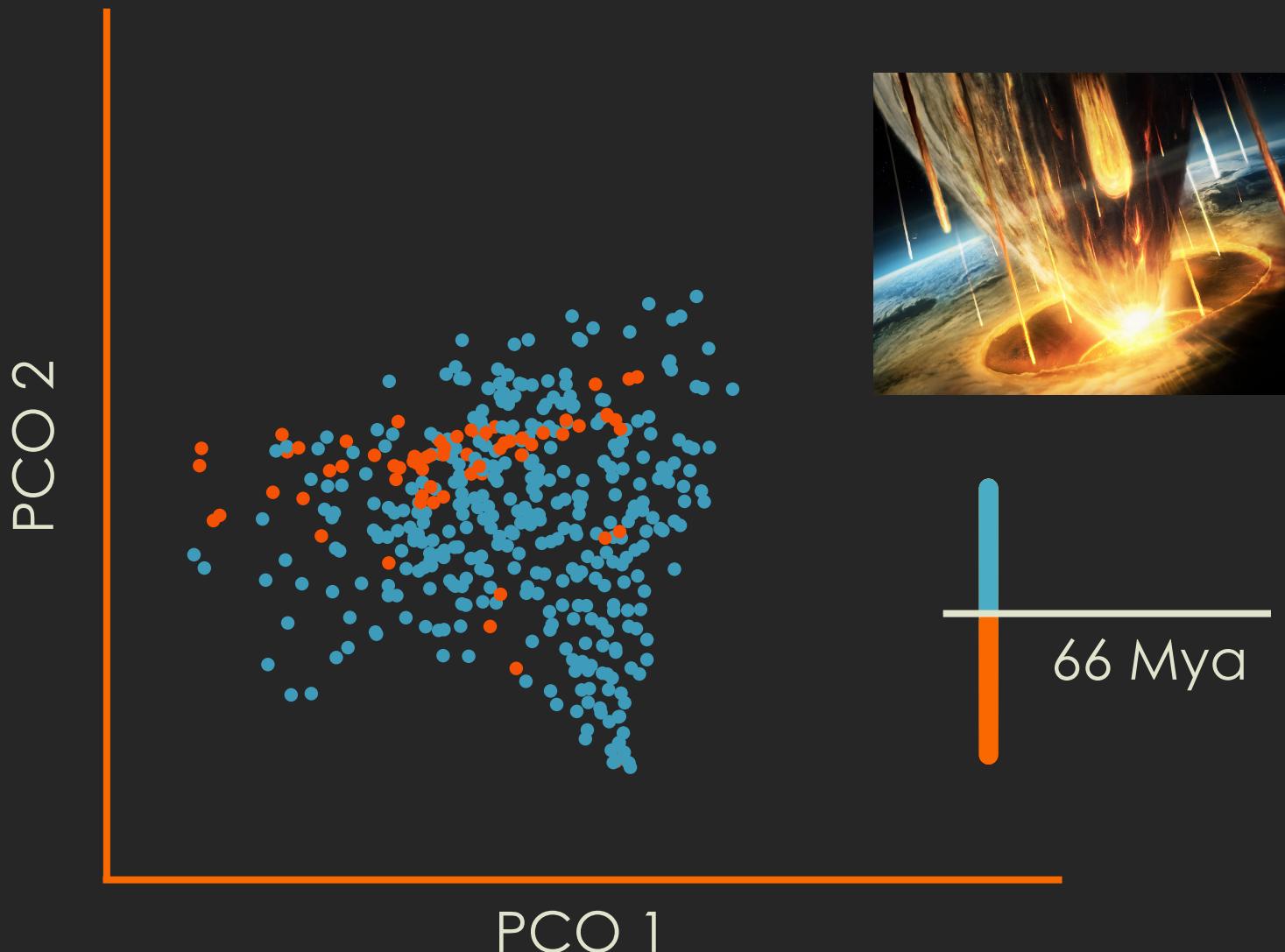
Ordination (MDS)



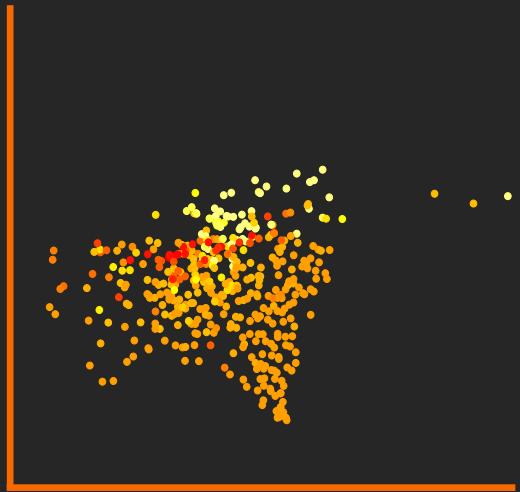
Mammalian morphospace



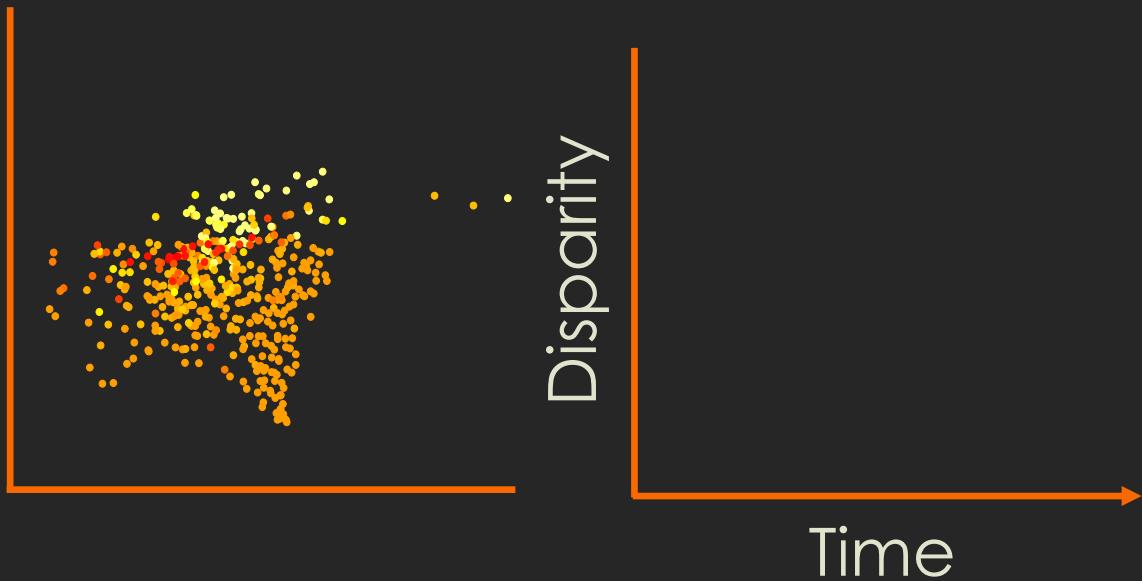
Mammalian morphospace



Disparity-through-time



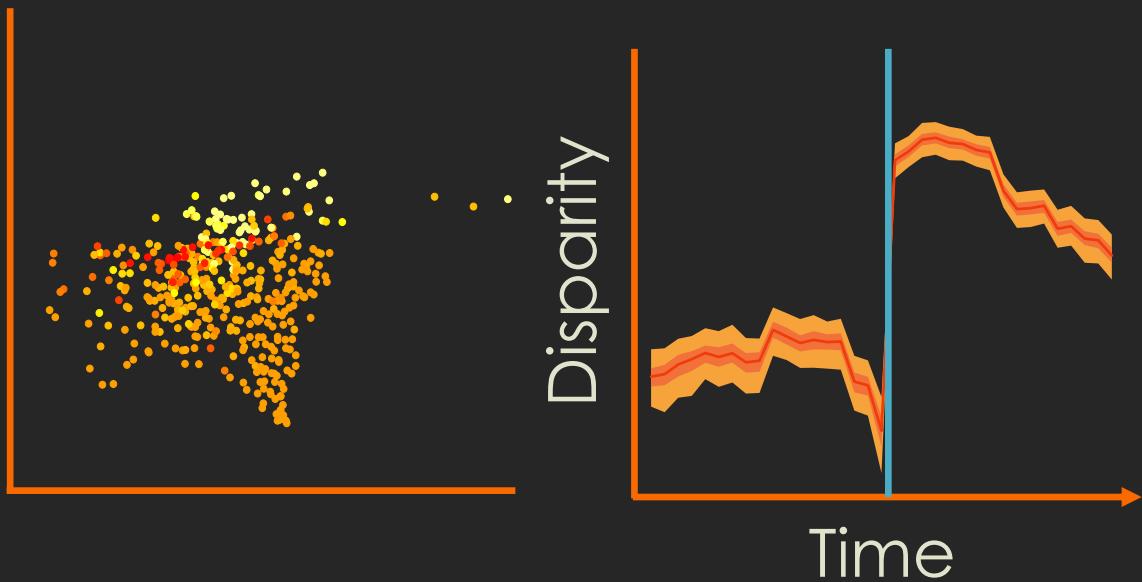
Disparity-through-time



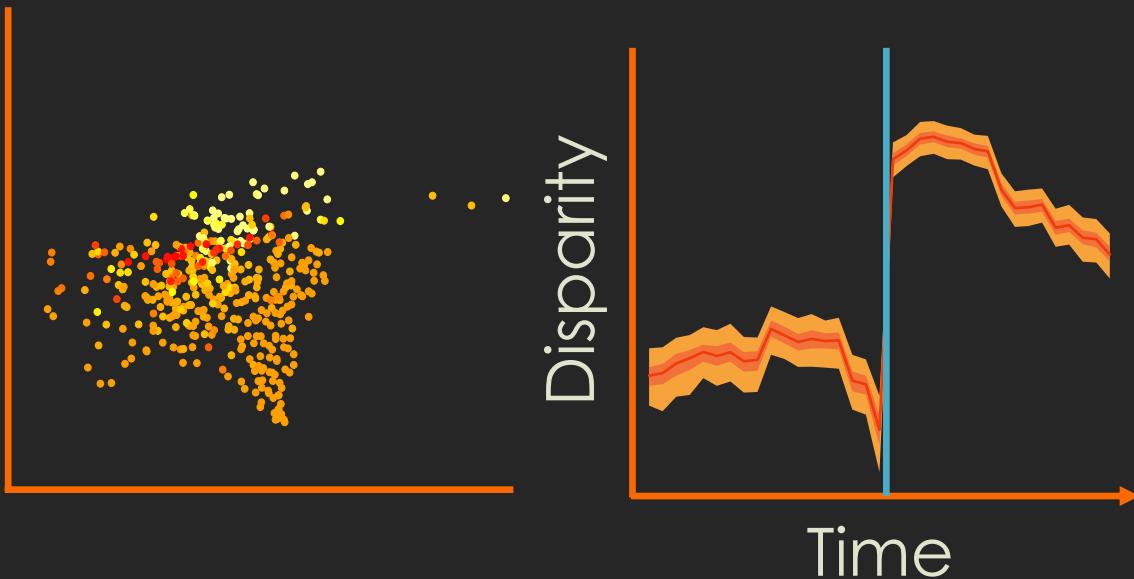
Disparity-through-time



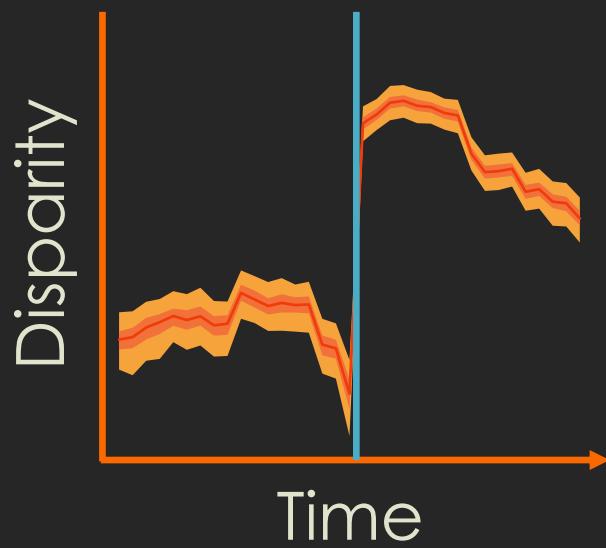
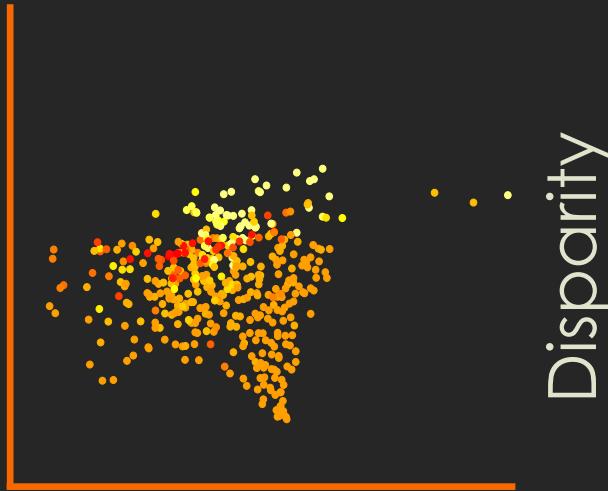
Disparity-through-time



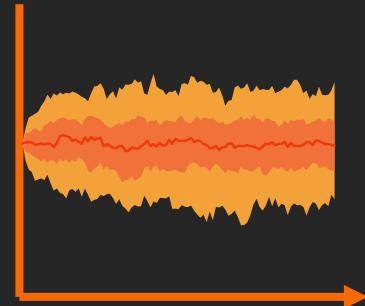
Effect of K-Pg on mammal evolution?



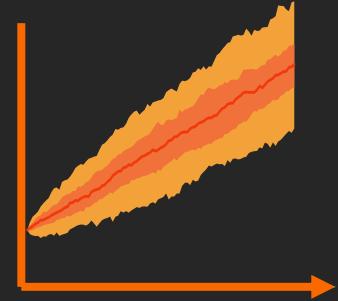
Effect of K-Pg on mammal evolution?



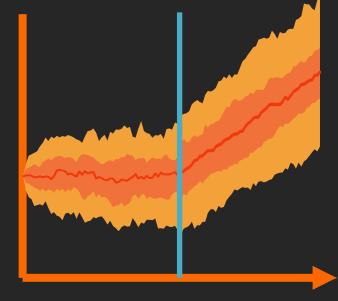
?



OU?

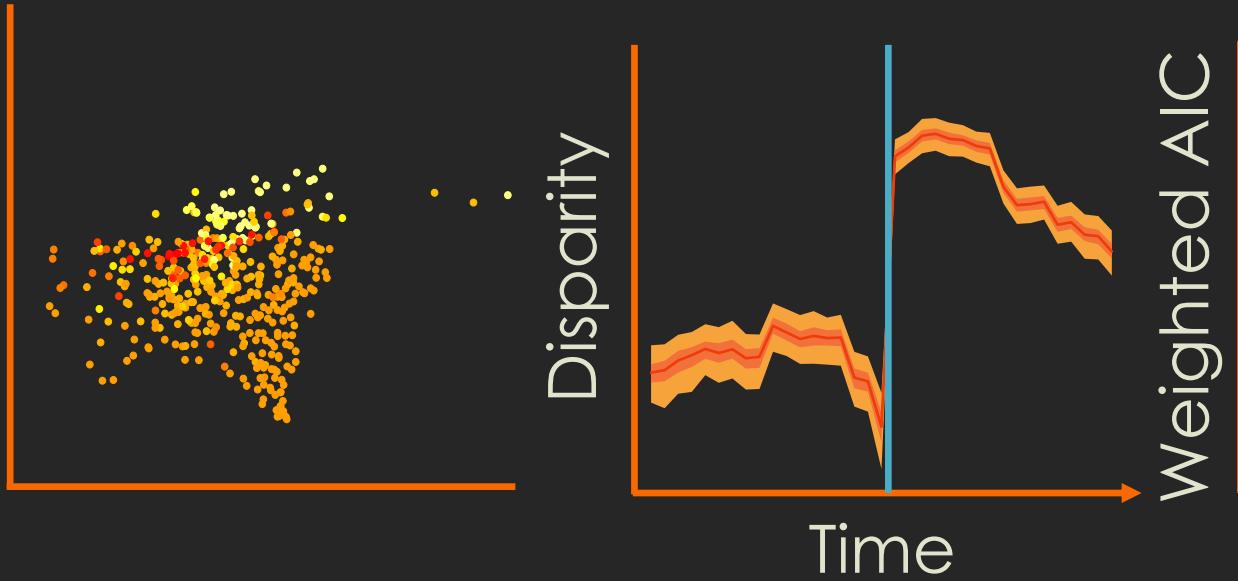


Trend?



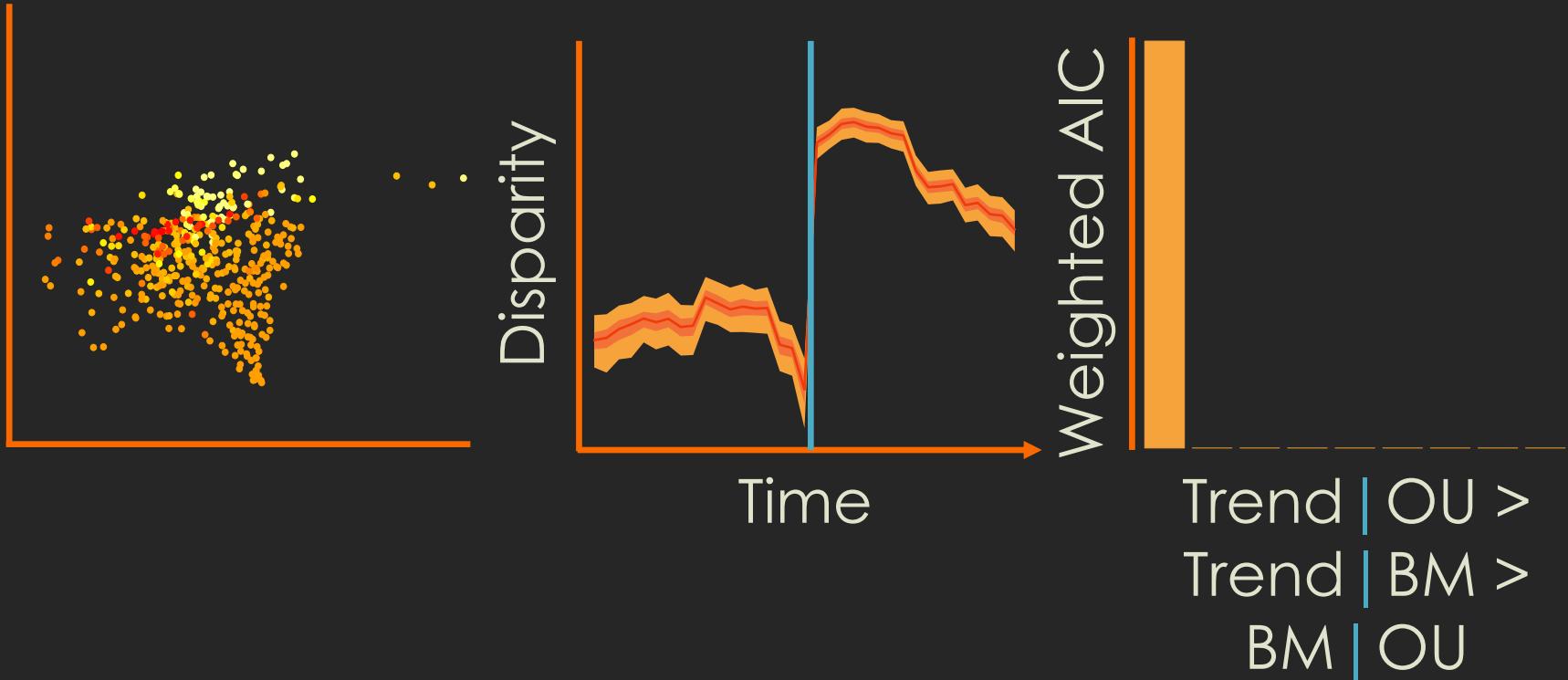
BM | Trend?

Effect of K-Pg on mammal evolution?



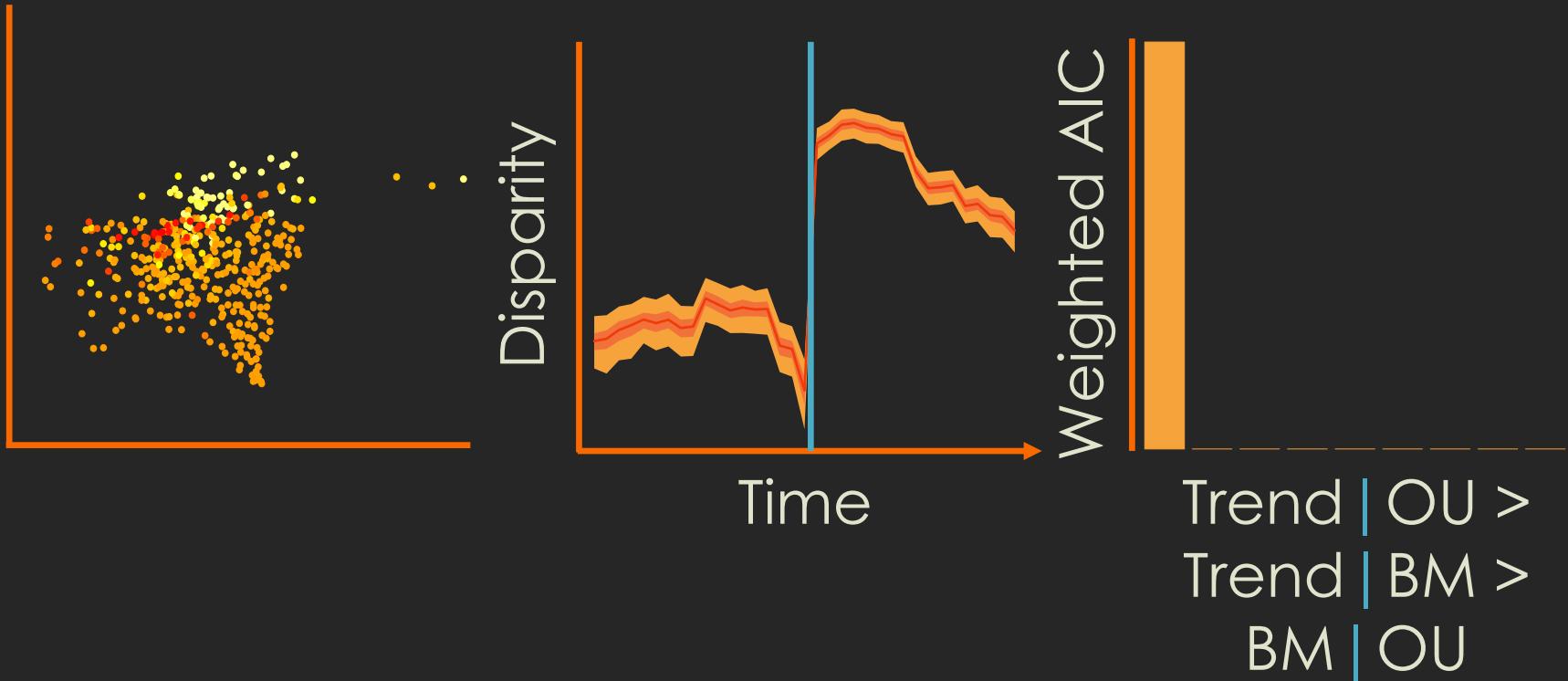
Model 1 >
Model 2 >
Model 3

Effect of K-Pg on mammal evolution?



Effect of K-Pg on mammal evolution?

Yes.



SAVE YOURSELF, MAMMAL!

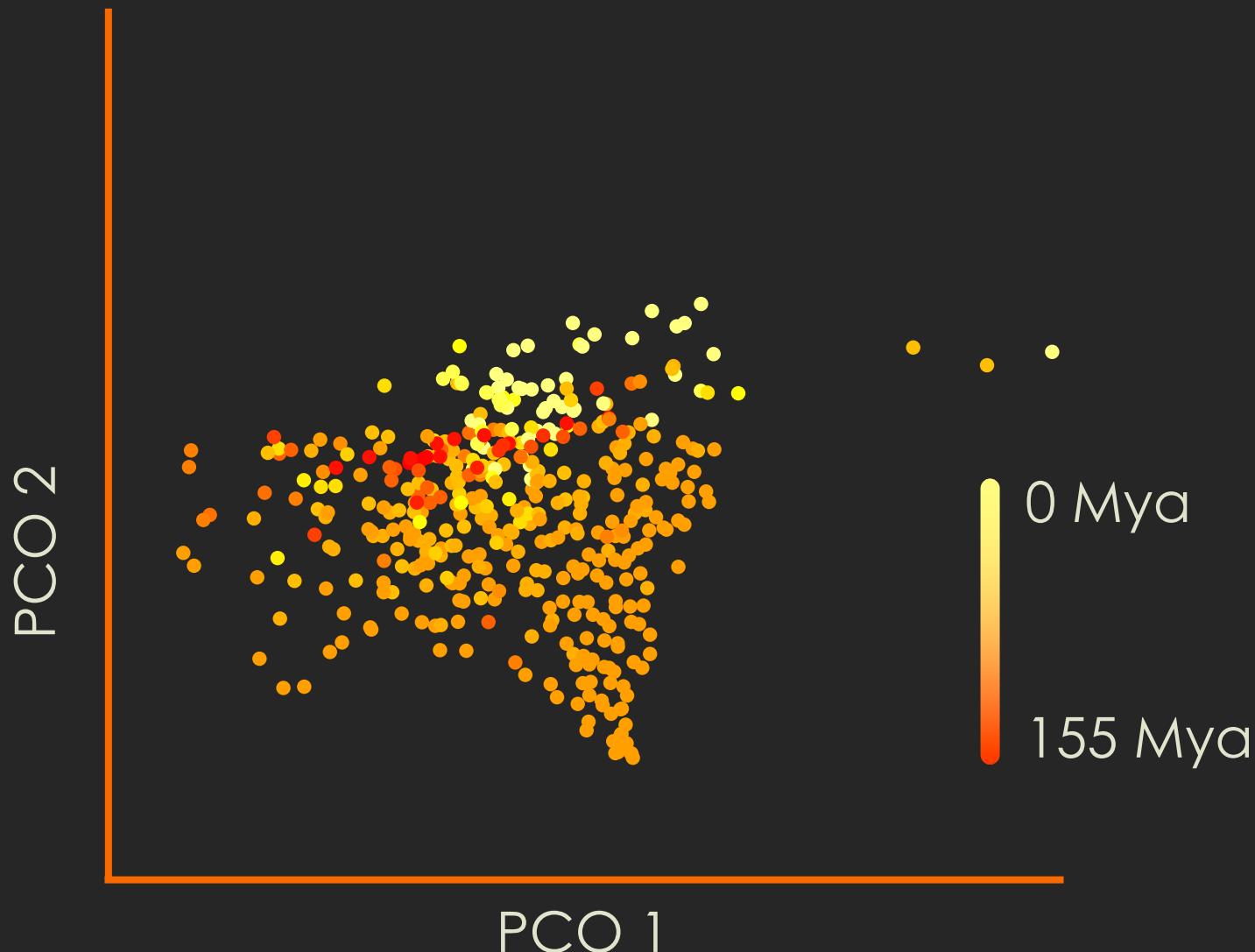
A SATURDAY MORNING BREAKFAST CEREAL COLLECTION

BY ZACH WEINER

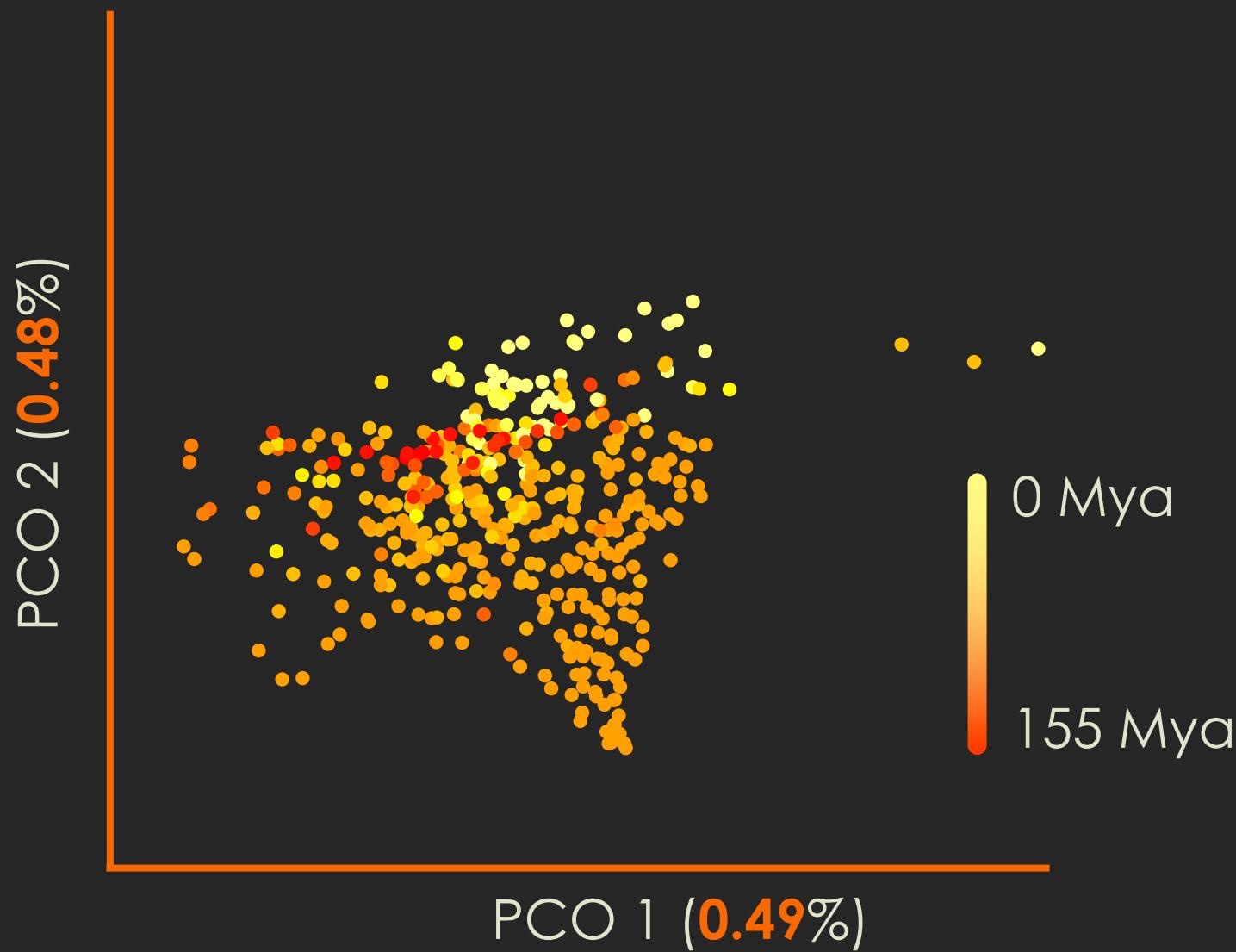
Cheers!

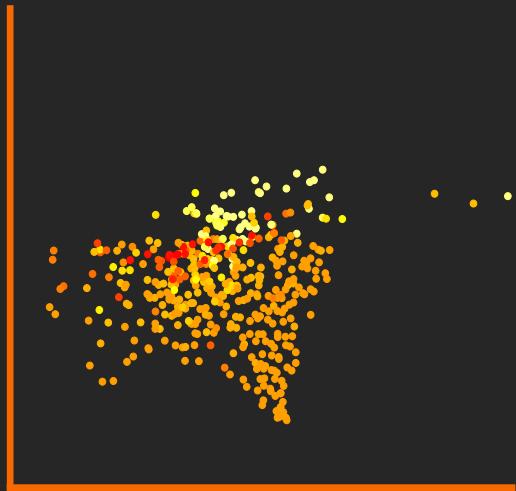


Mammalian trait-space

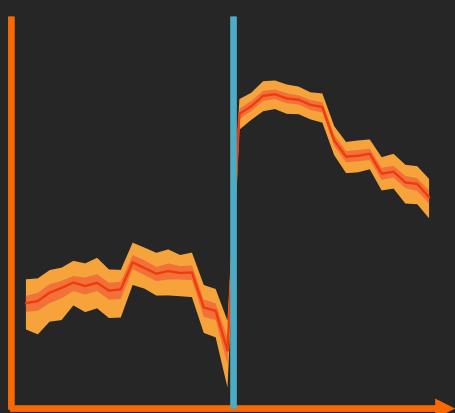


A 441 dimensions trait-space!



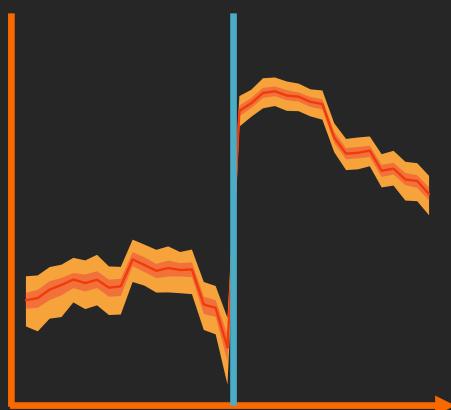


Sum of
ranges

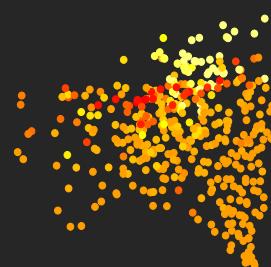
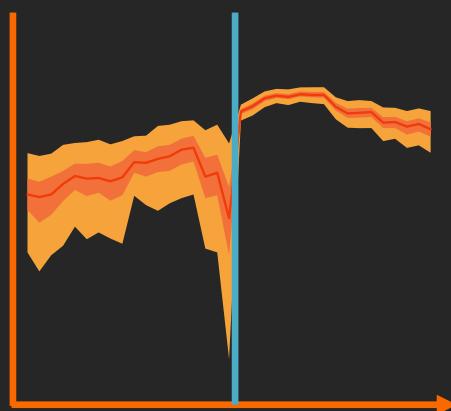


Trend | OU >
Trend | BM >
BM | OU

Sum of
ranges

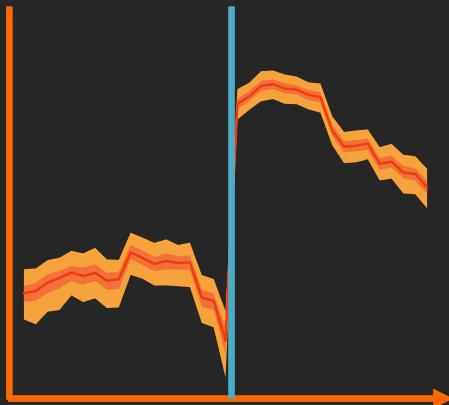


Sum of
variances

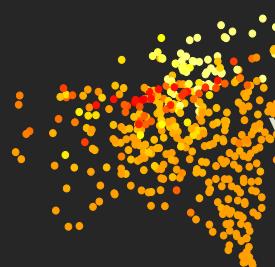
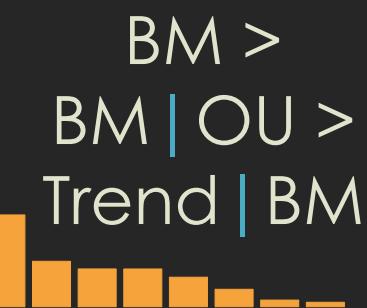
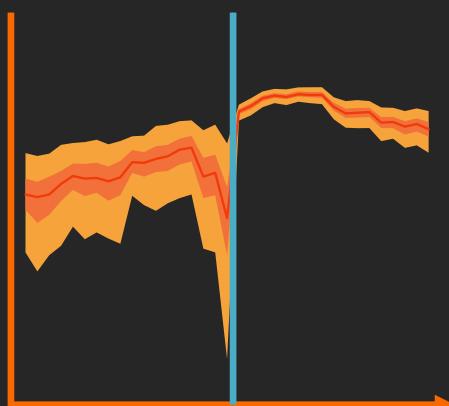




Sum of
ranges

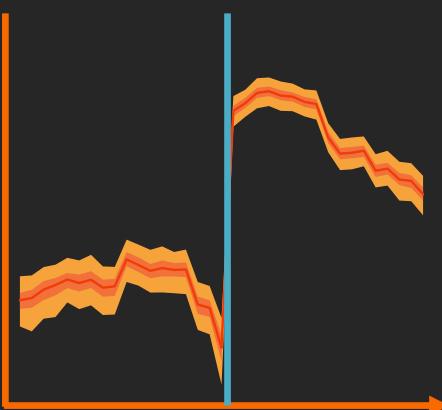


Sum of
variances

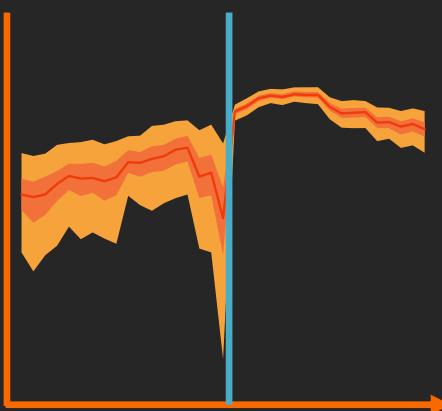


Trend | OU >
Trend | BM >
BM | OU

Sum of
ranges

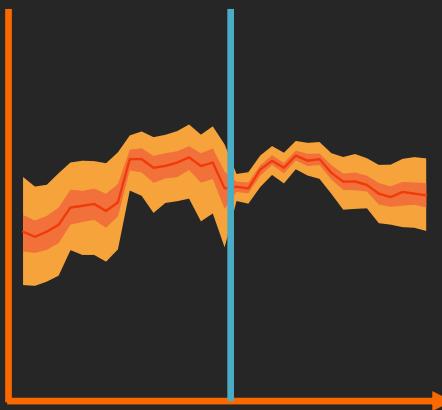


Sum of
variances

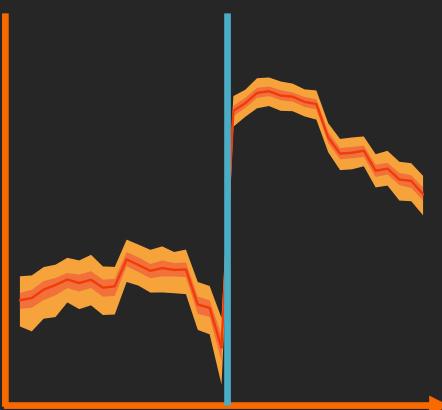


BM >
BM | OU >
Trend | BM

Procrustes
variance

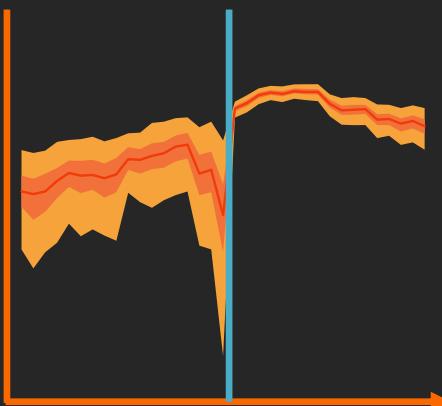


Sum of
ranges



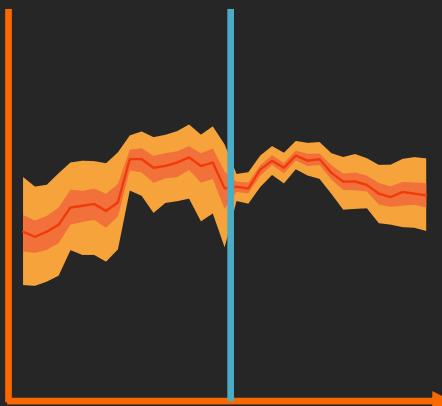
Trend | OU >
Trend | BM >
BM | OU

Sum of
variances

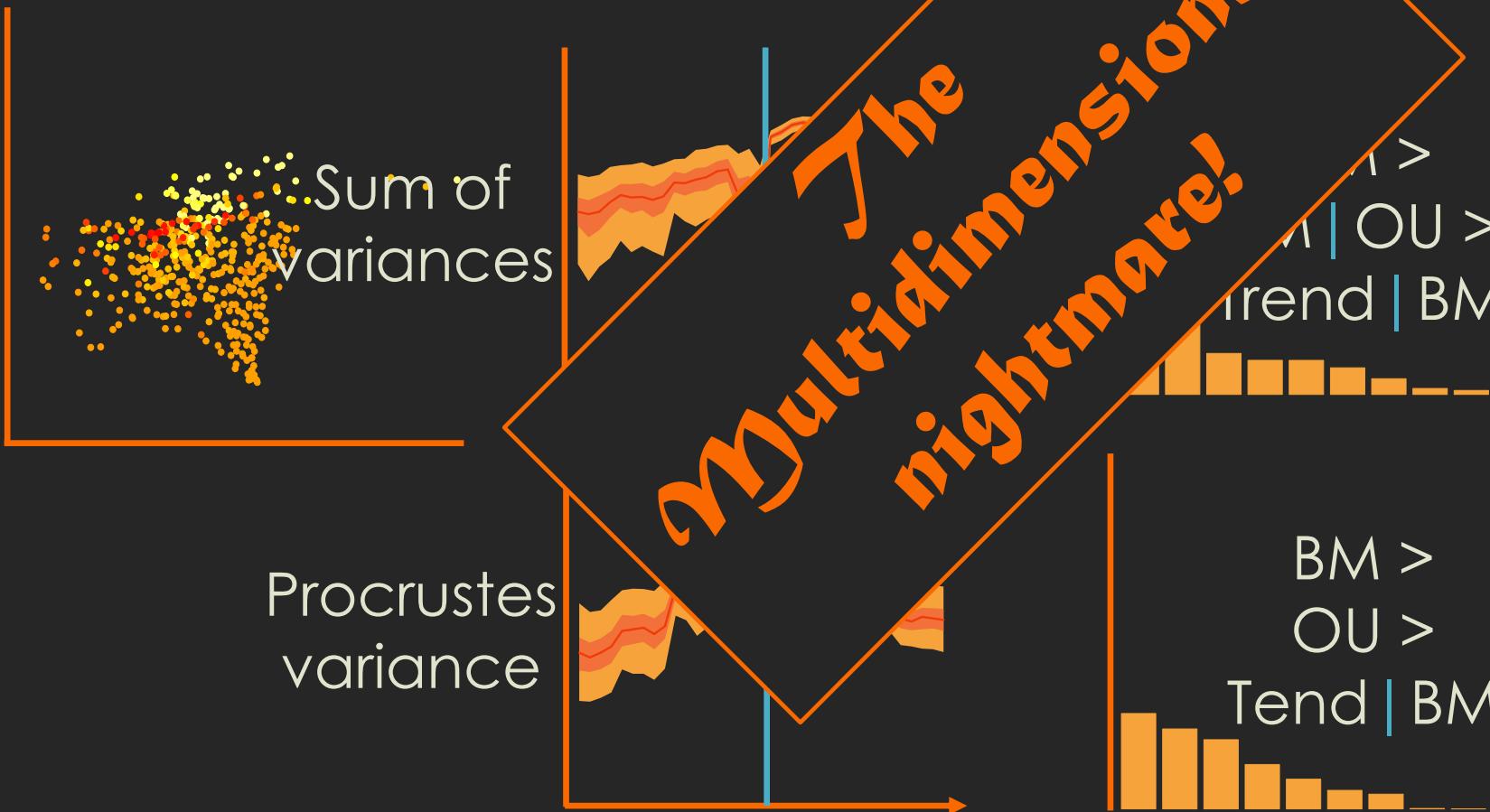


BM >
BM | OU >
Trend | BM

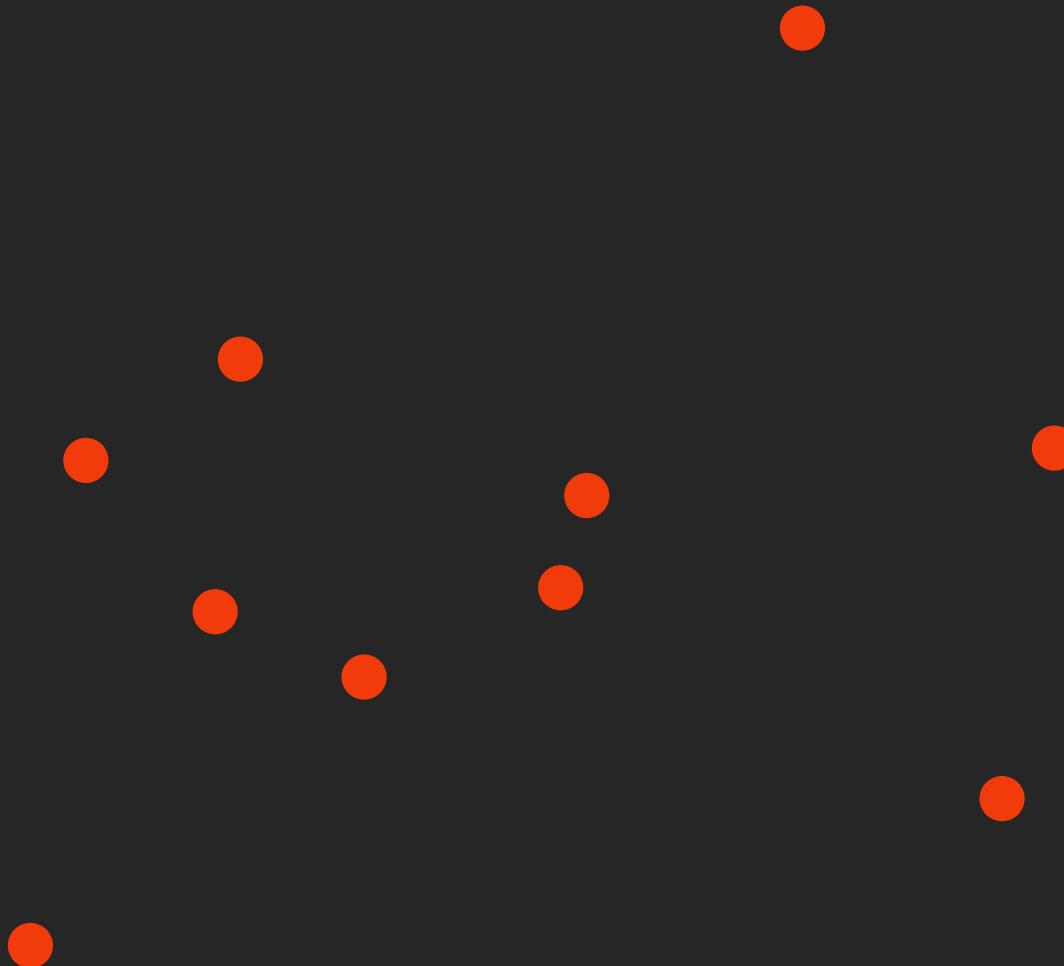
Procrustes
variance



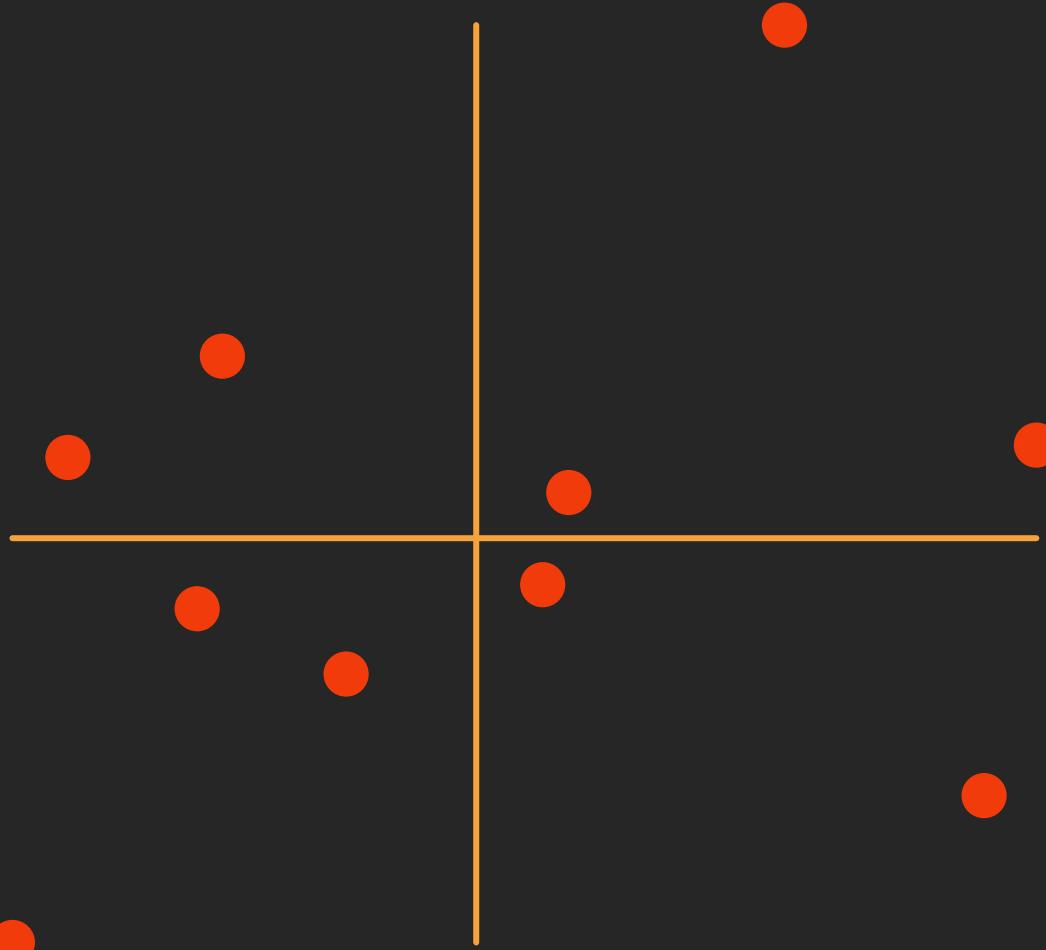
BM >
OU >
Trend | BM



What to measure in trait-space?

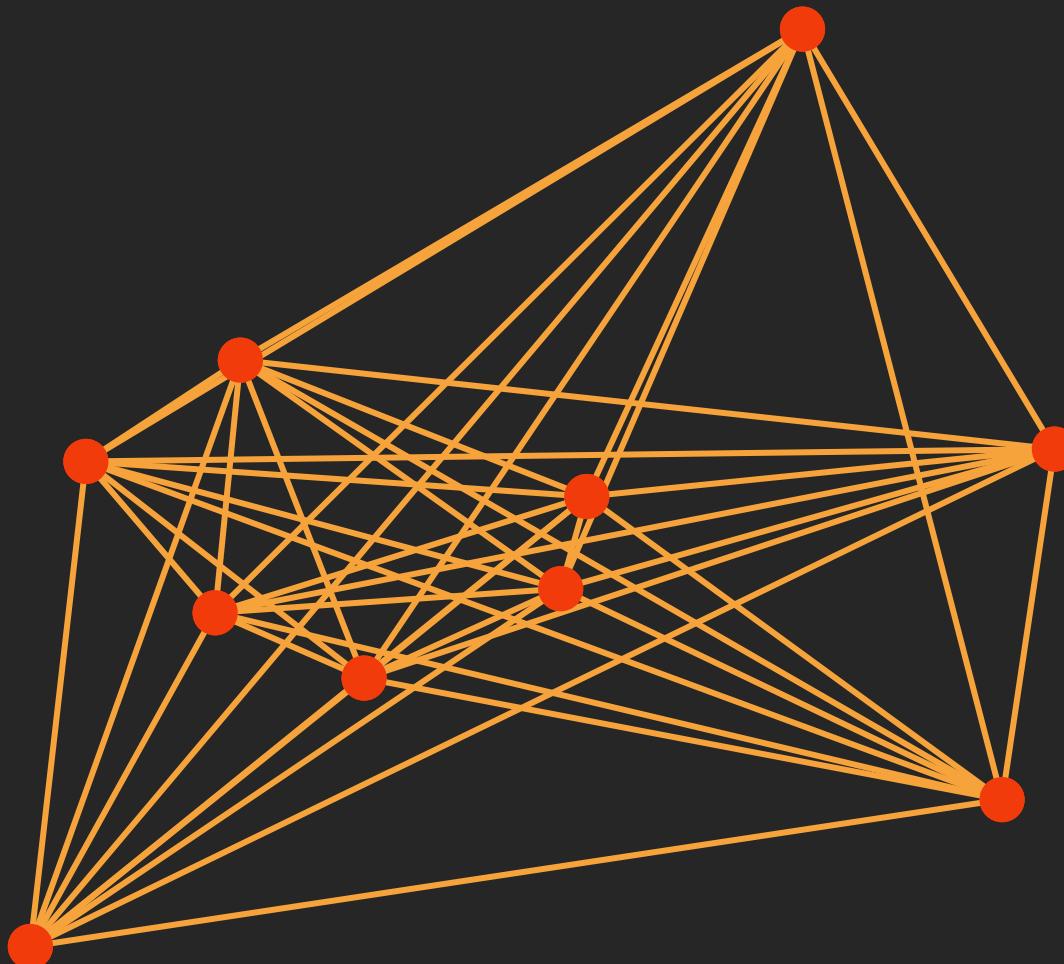


What to measure in trait-space?



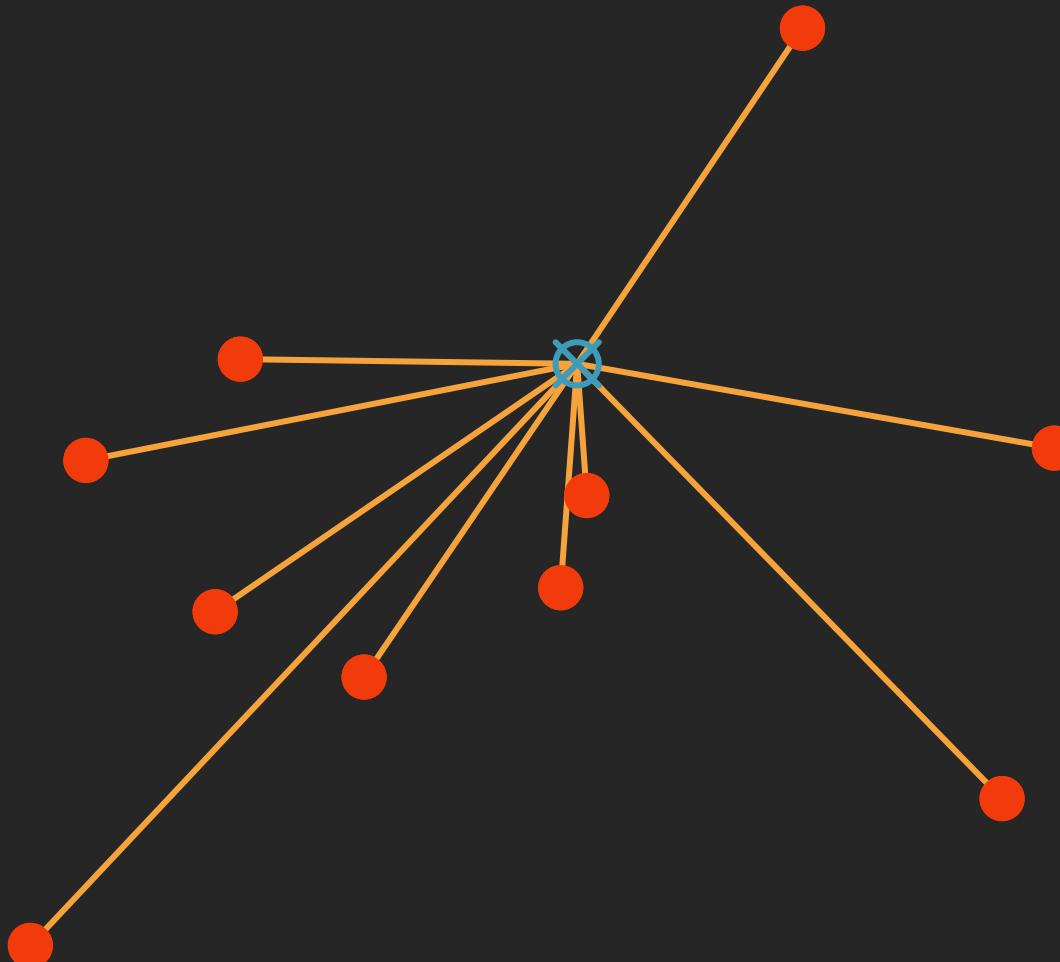
Volume (e.g. product of ranges)

What to measure in trait-space?



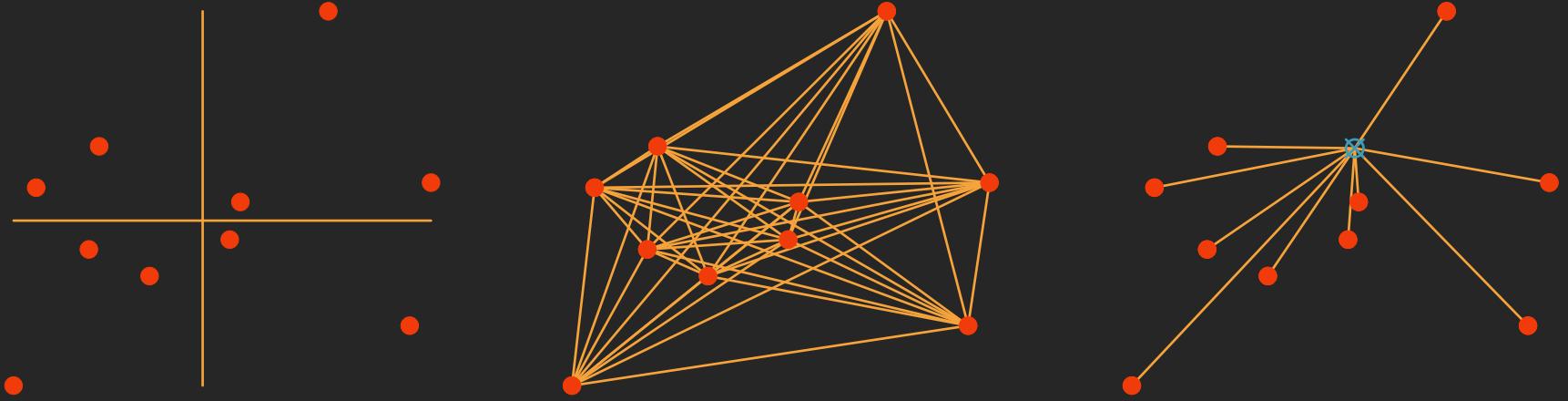
Density (e.g. pairwise distances)

What to measure in trait-space?



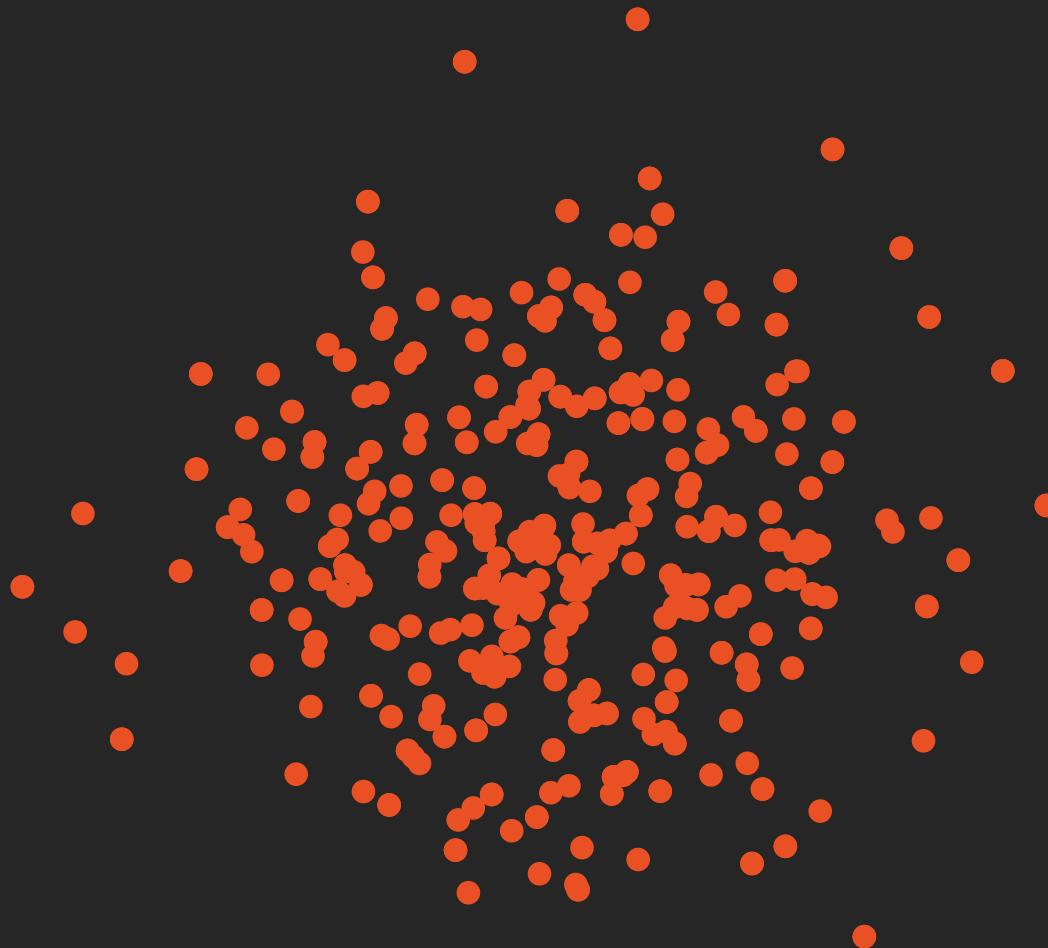
Position (e.g. distance from center)

What to measure in trait-space?

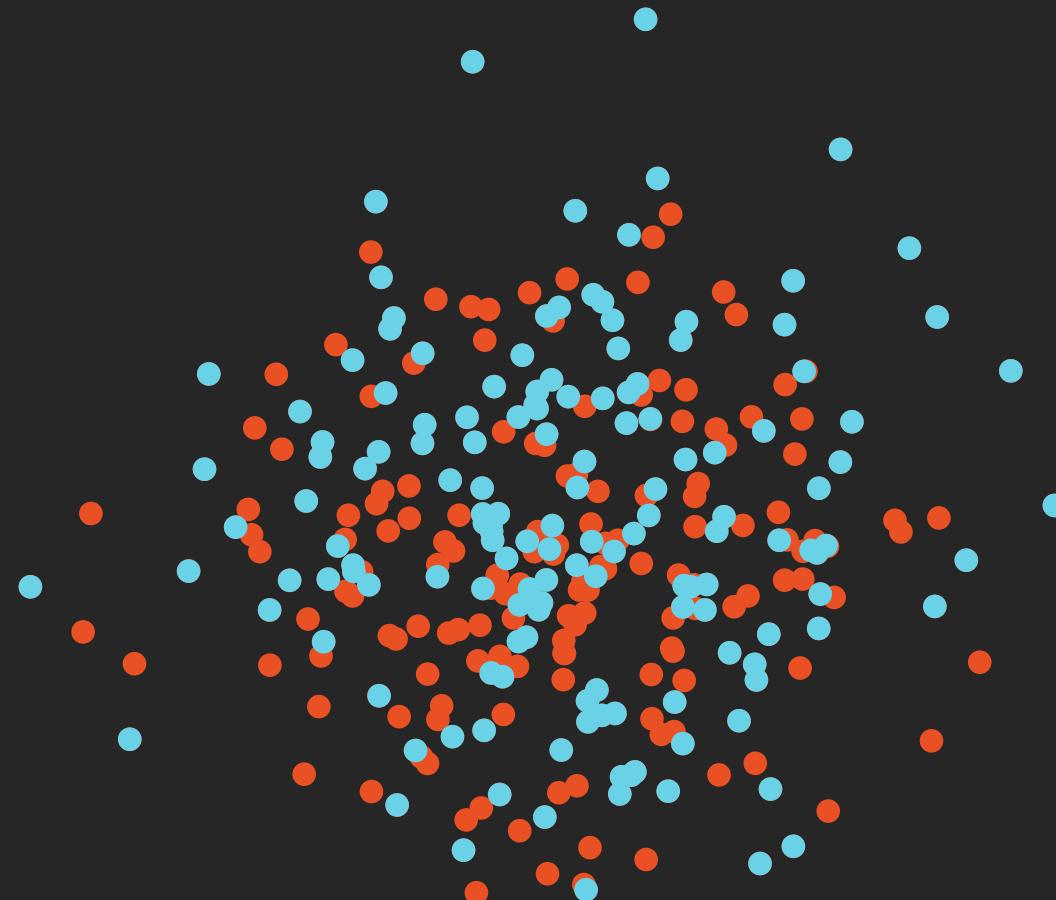


Volume & density & position?

How does the metric works in multidimensional space?

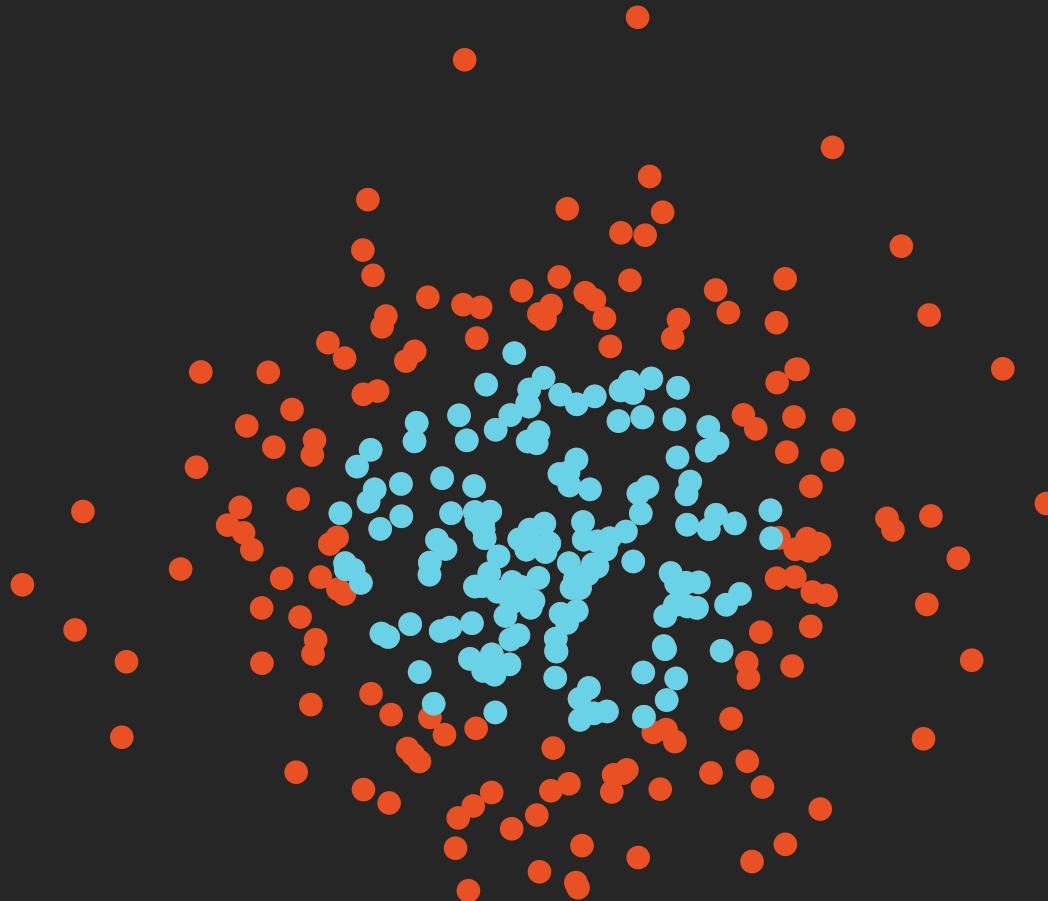


How does the metric works in multidimensional space?



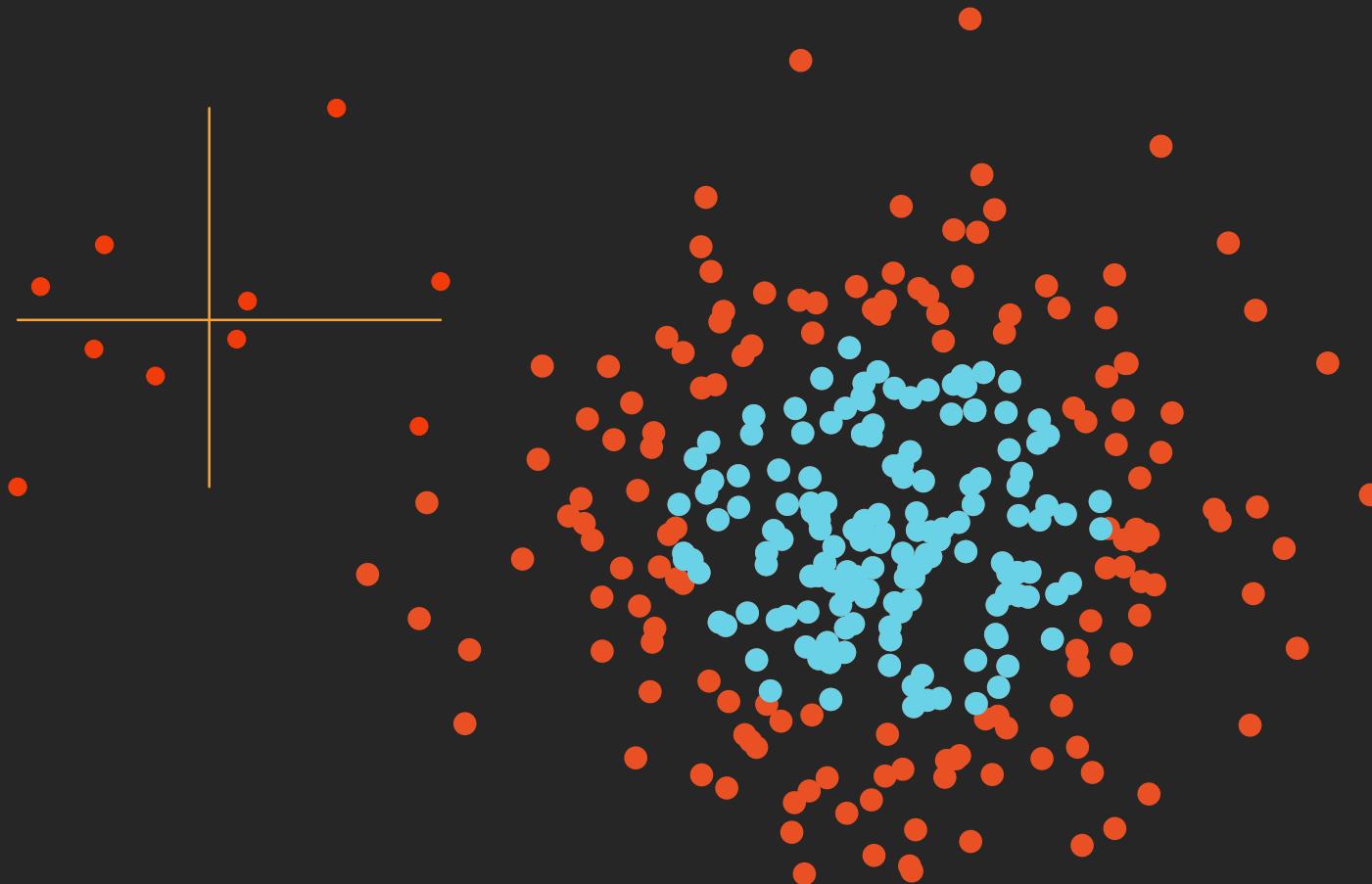
Random change (null)

How does the metric works in multidimensional space?



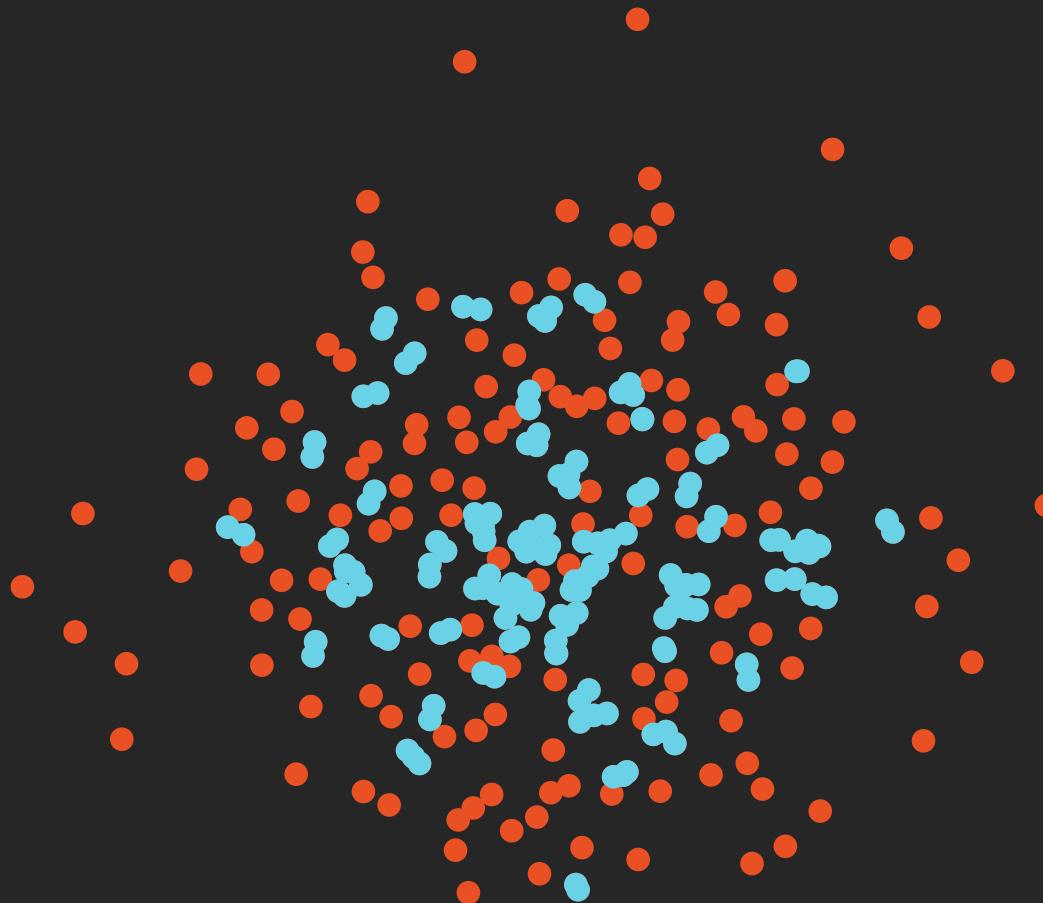
Volume change

How does the metric works in multidimensional space?



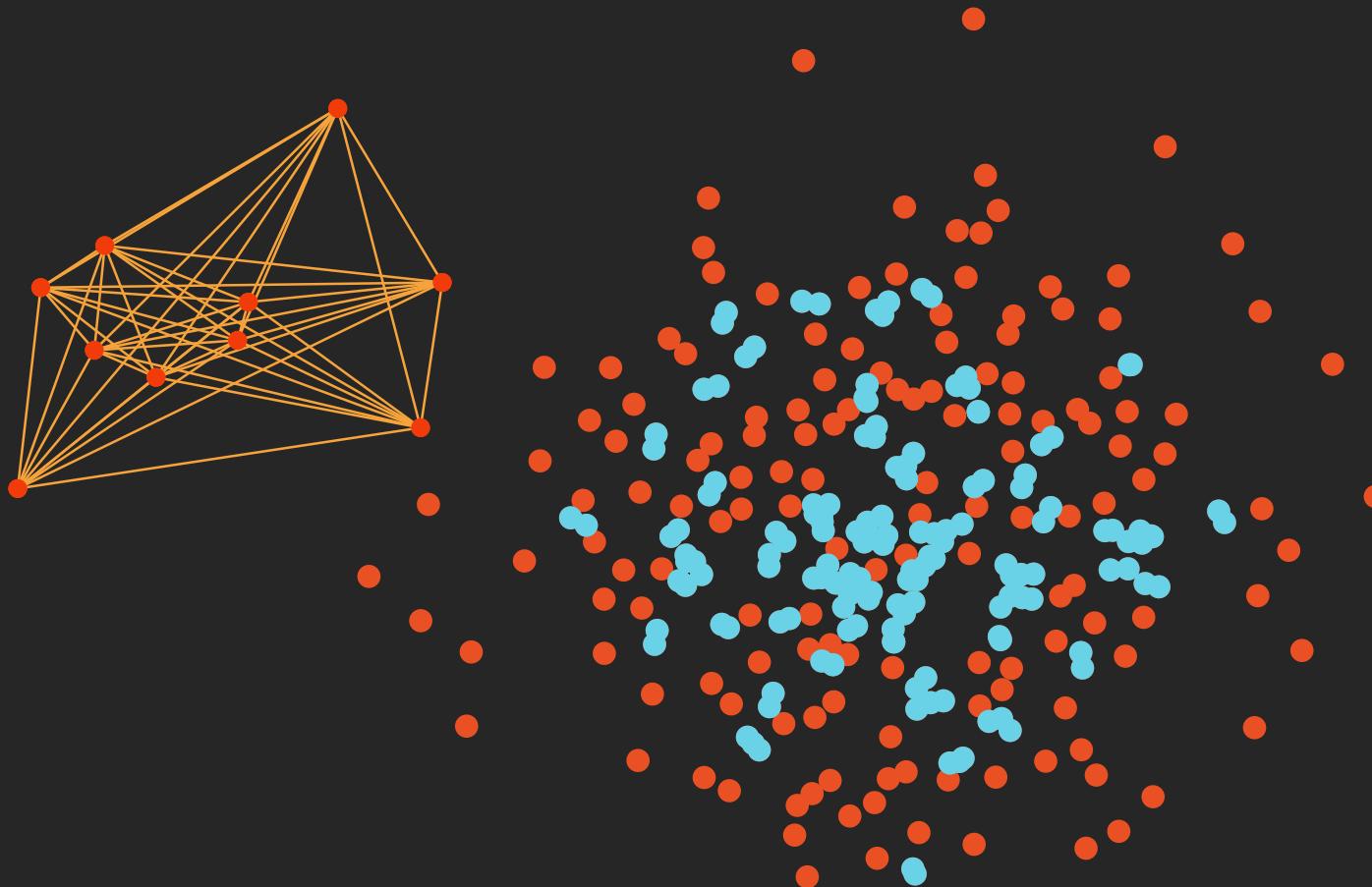
Volume change

How does the metric works in multidimensional space?



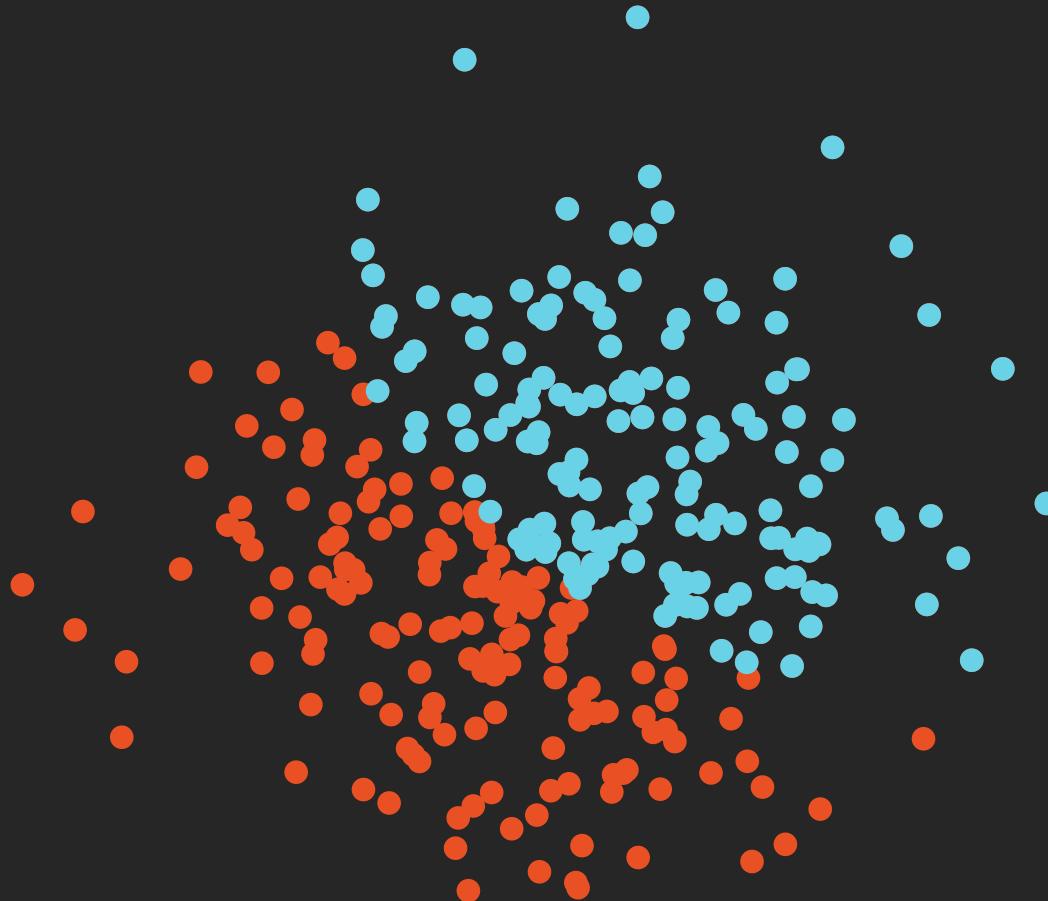
Density change

How does the metric works in multidimensional space?



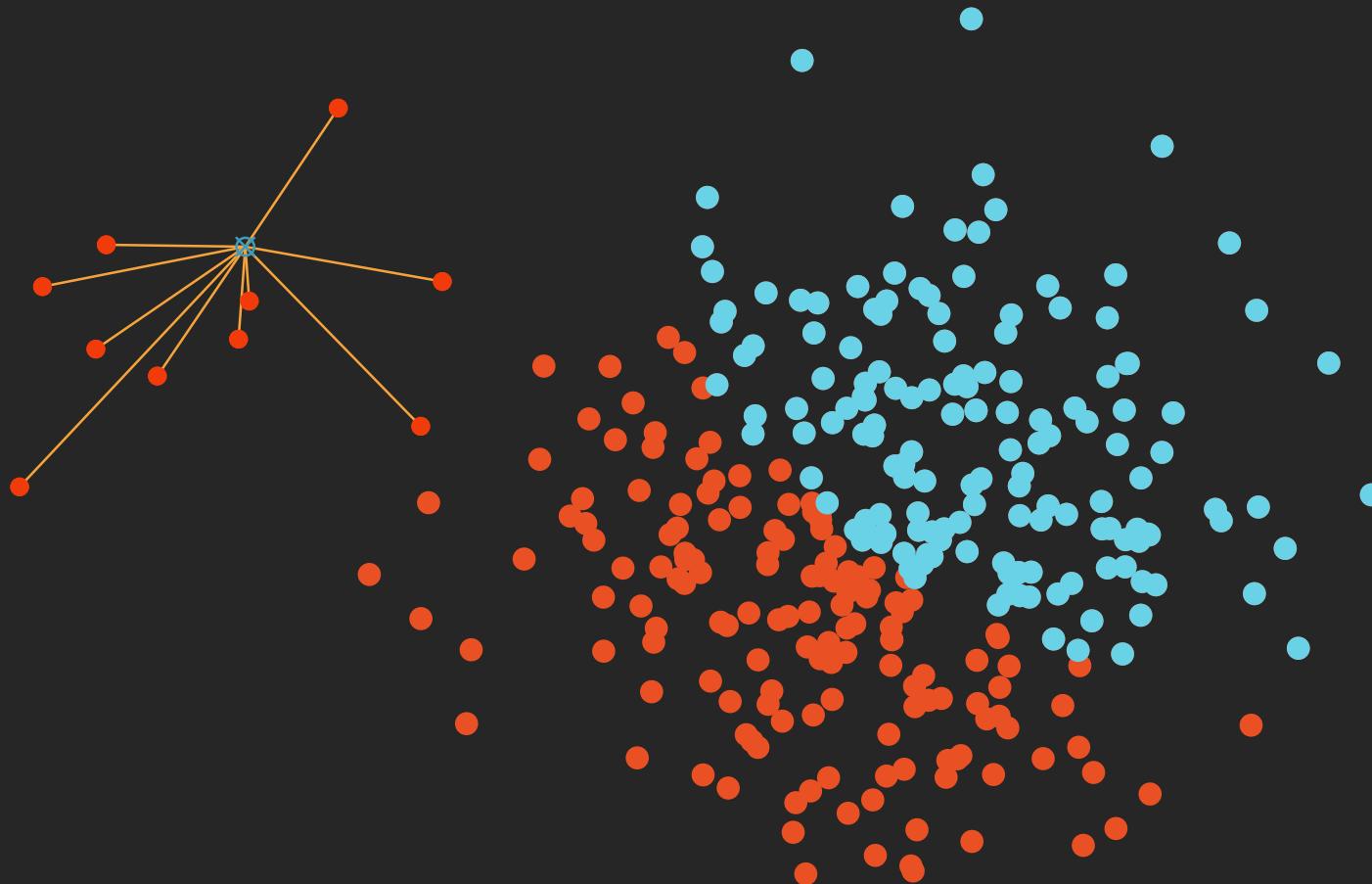
Density change

How does the metric works in multidimensional space?

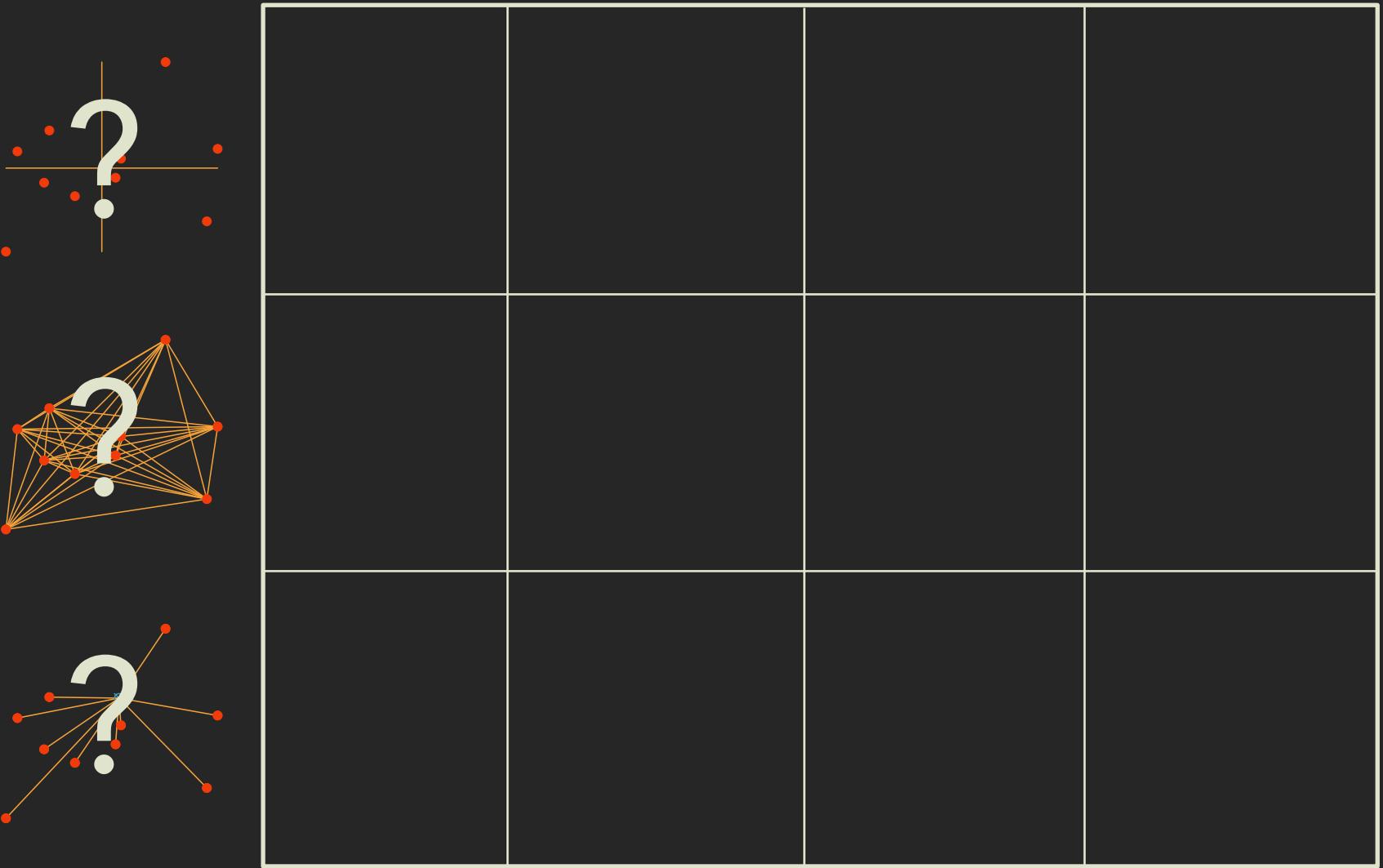
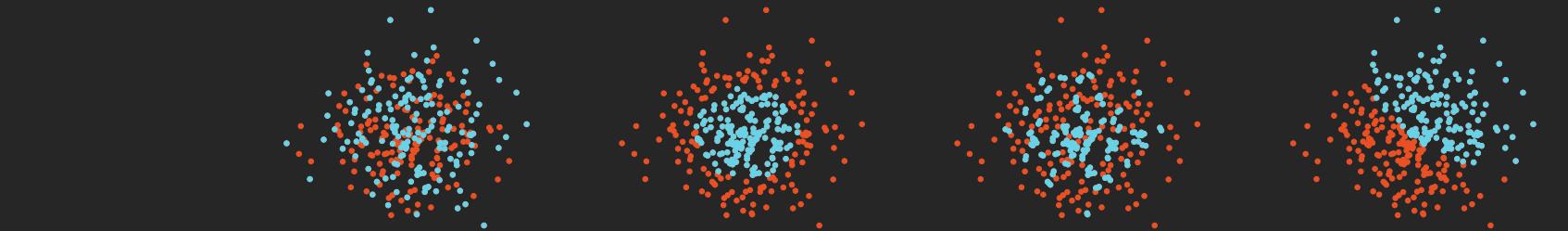


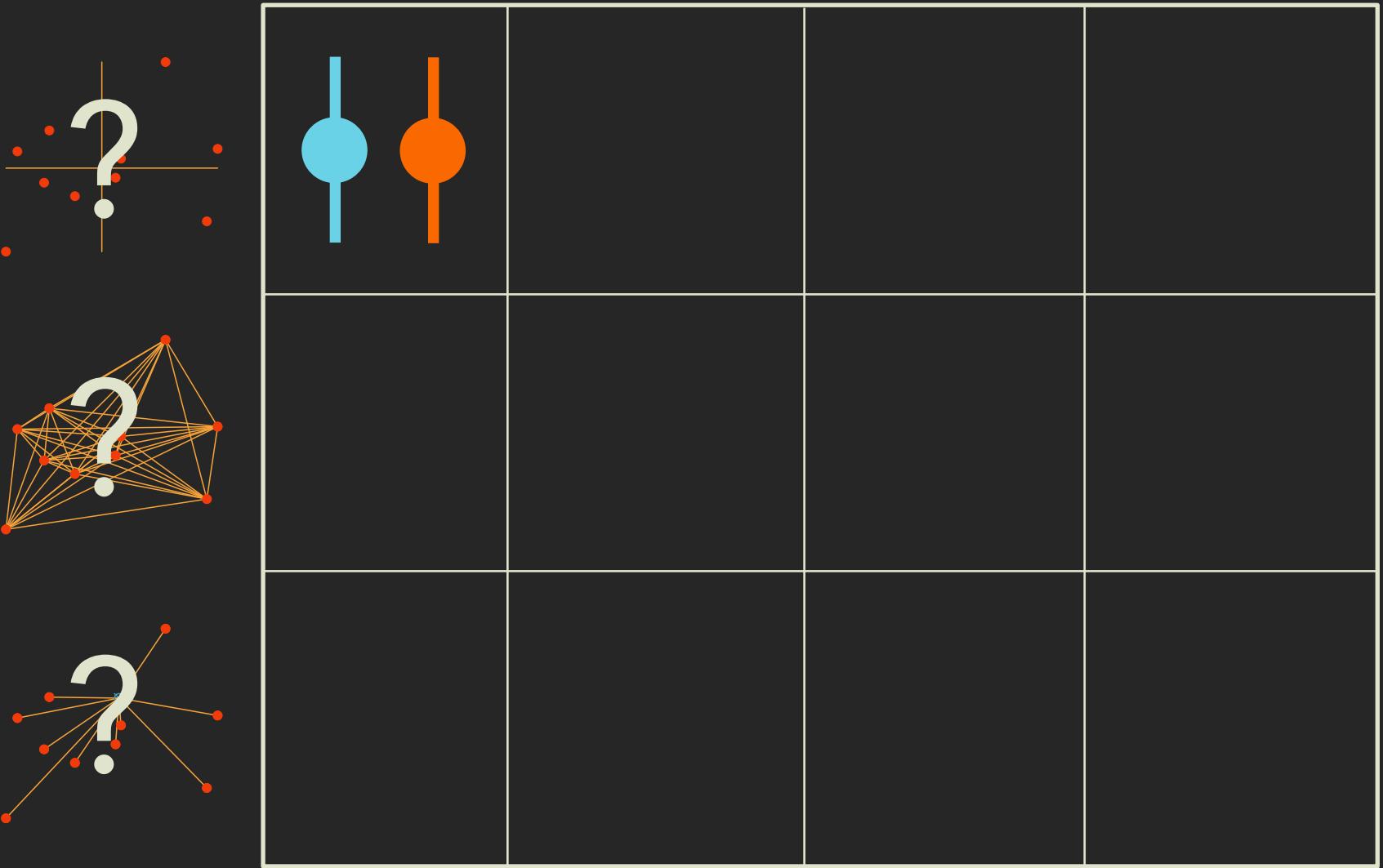
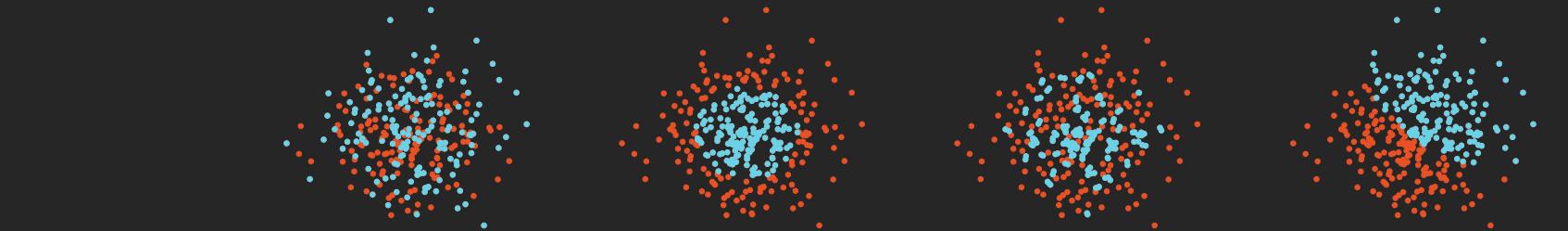
Position change

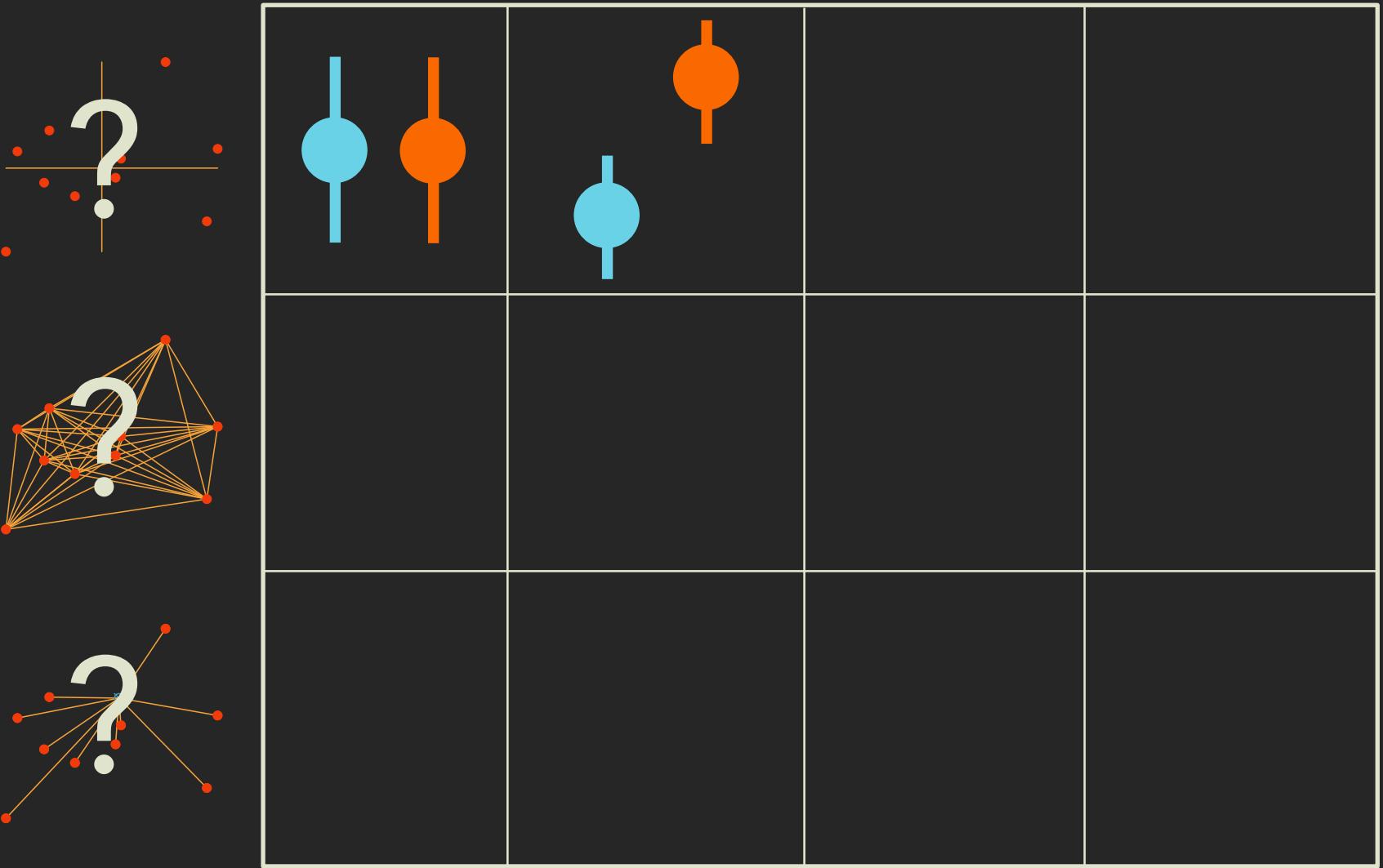
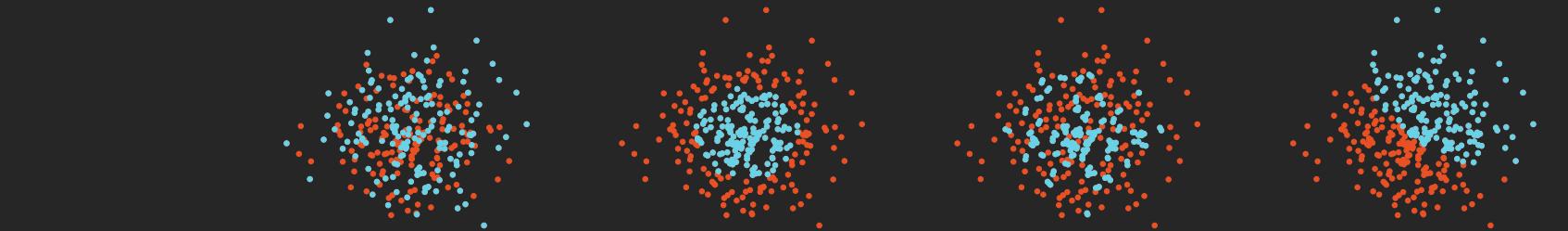
How does the metric works in multidimensional space?

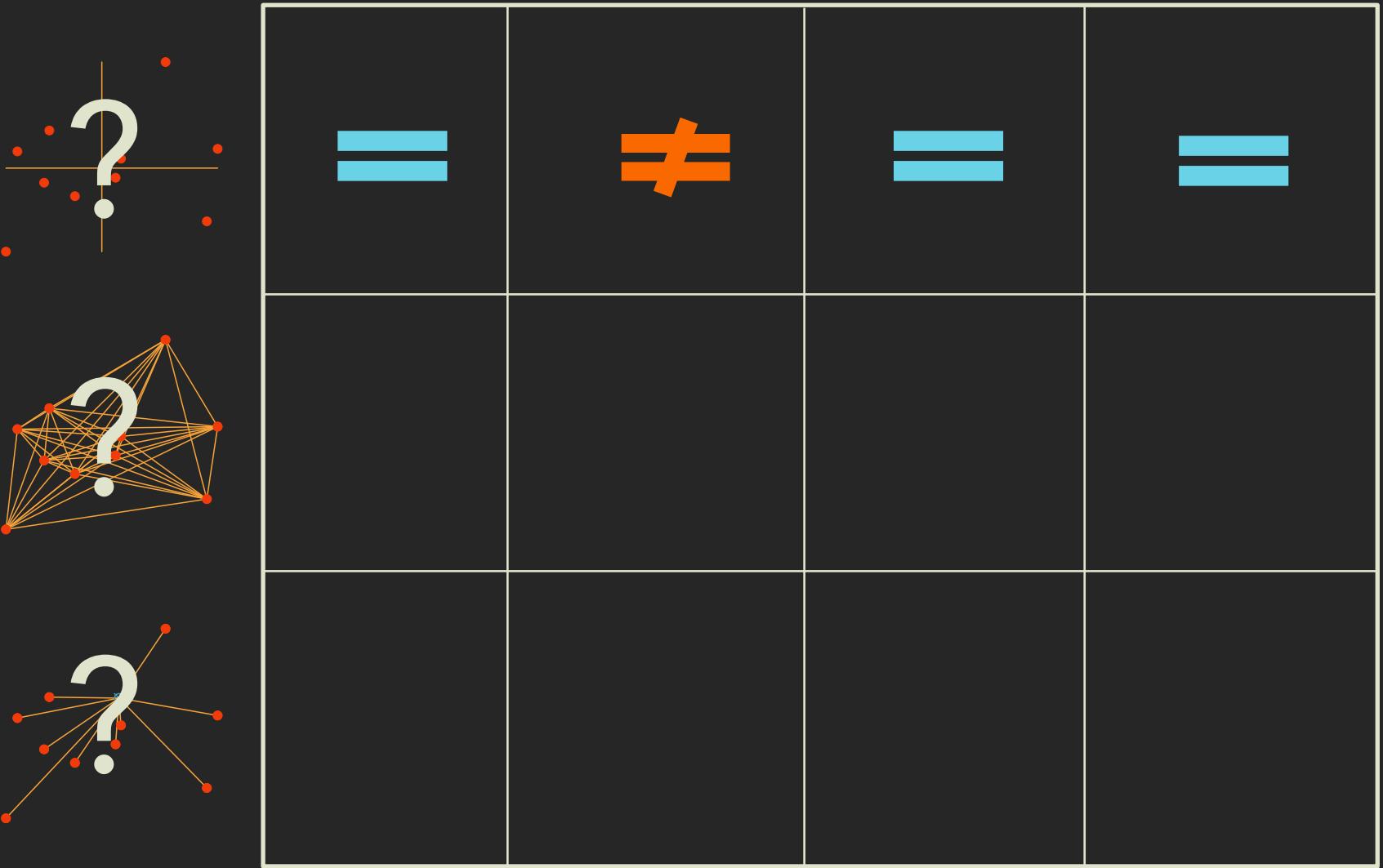
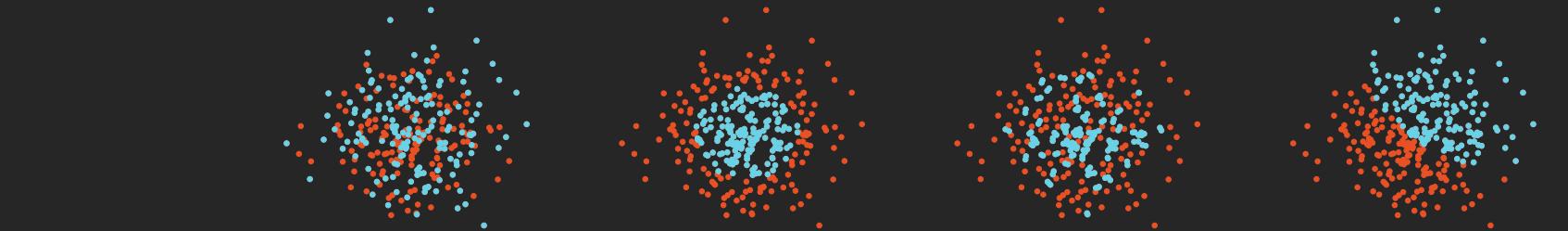


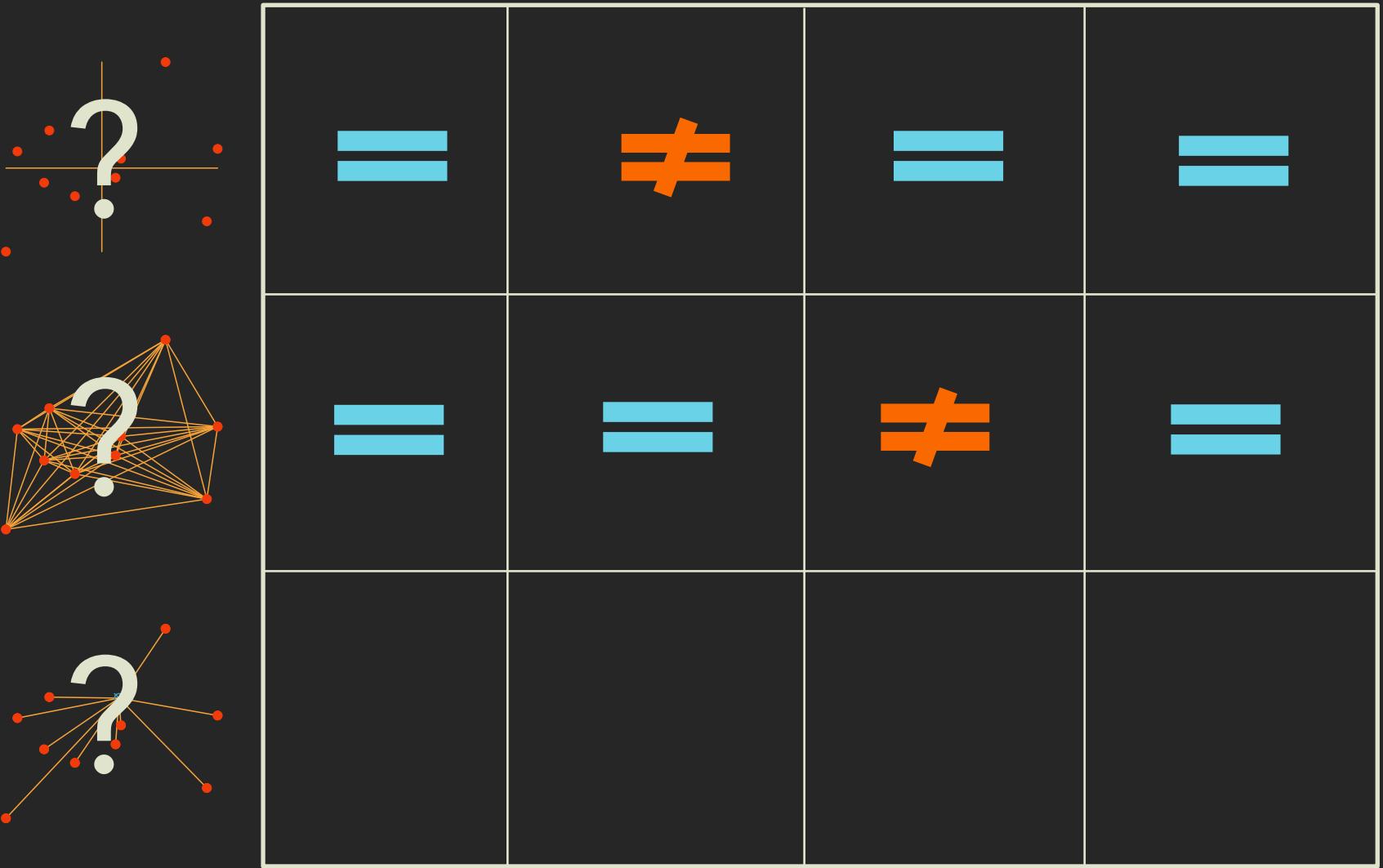
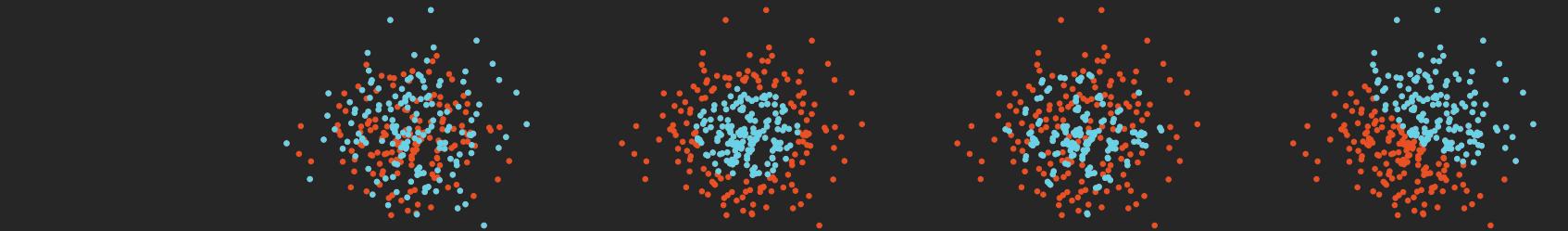
Position change

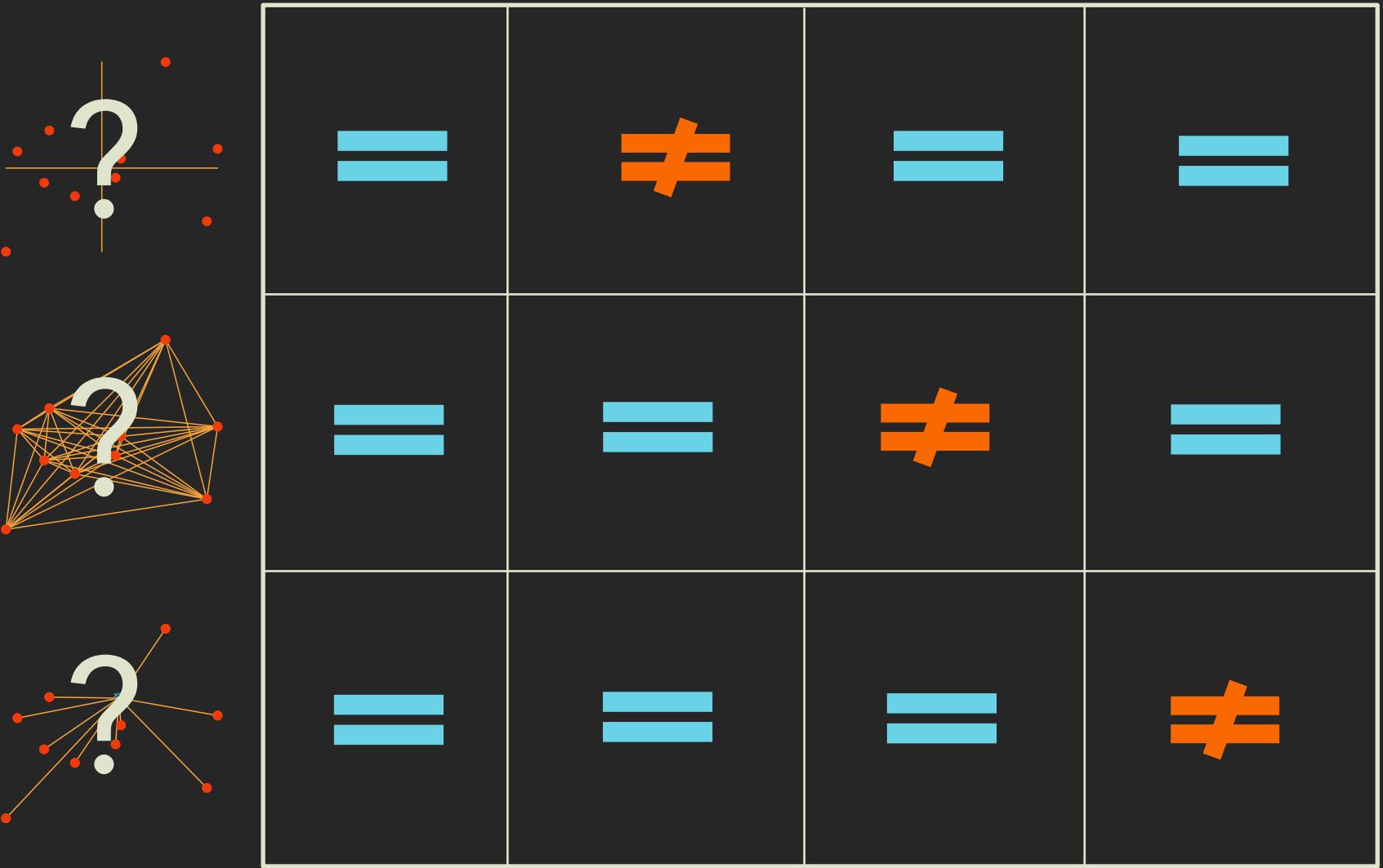
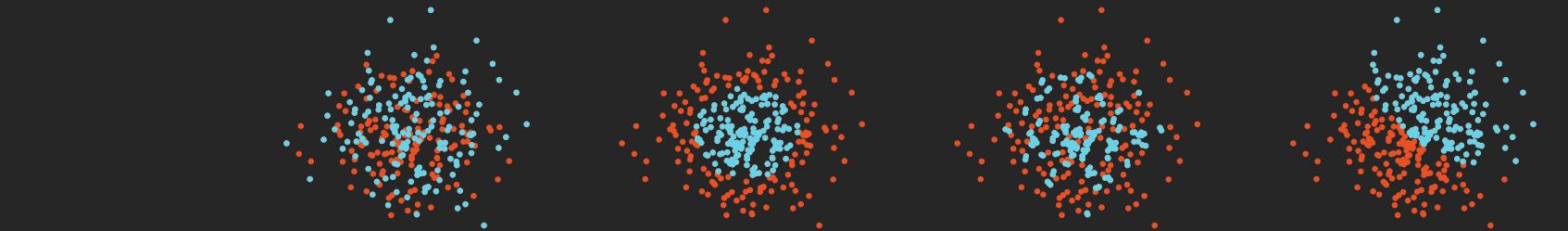












The
Multidimensional
nightmare!

VS.



moms: measuring
occupancy in
multidimensional space

github.com/TGuillermo/moms

moms: Measuring Occupancy in Multidimensional Spaces

Guillerme T, Puttick M, Marcy A, and Weisbecker V (2019). Moms: an exploratory tool for multidimensional space analyses. Some journal. doi: some DOI .

USER MANUAL

Multidimensional space parameters

Select the type of space to use:

Input

Select a multidimensional matrix in csv format.

Browse...

trait_space_full.csv

Upload complete

Upload your own multidimensional matrix! The matrix must be in .csv format, with numeric values no NAs.

Space modification

Limit

Proportion to remove:

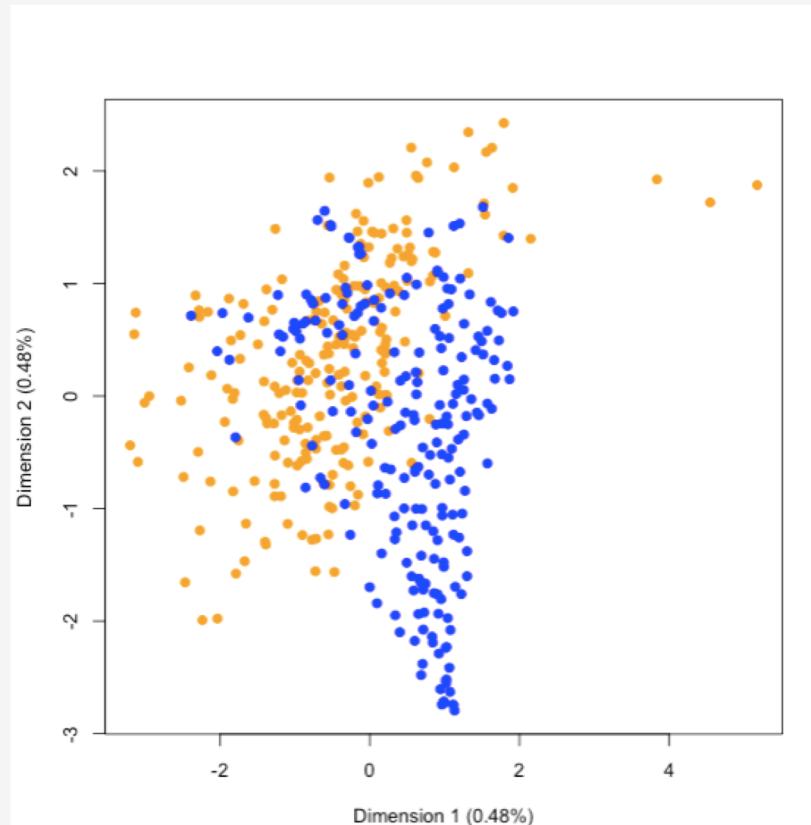
0.1

0.5

0.9



Inverse removal



Multidimensional space occupancy (disparity):

n	Sum of variances	change
443	264.30	
221	259.90	-1.66 %

Space occupancy metric (disparity)

Metric type

Volume

Volume metric

Sum of variances

Show metric code

You can find more informations about the metric types in the [dispRity manual](#).

Display

Horizontal axis

1

Vertical axis

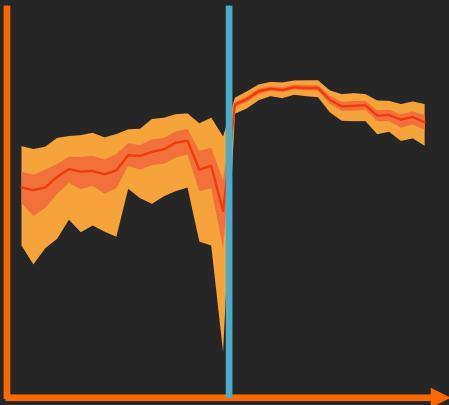
2

Colours

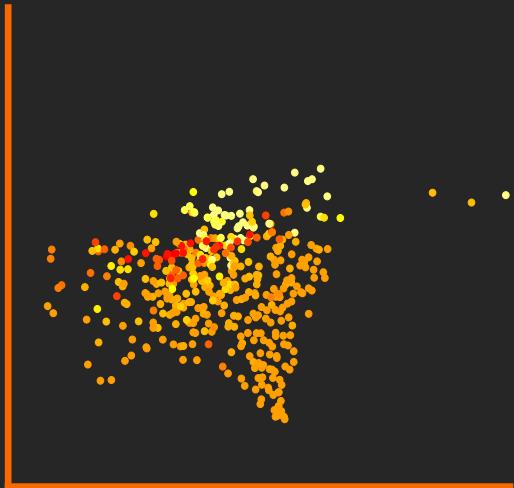
Contrast

Axis with the same scale

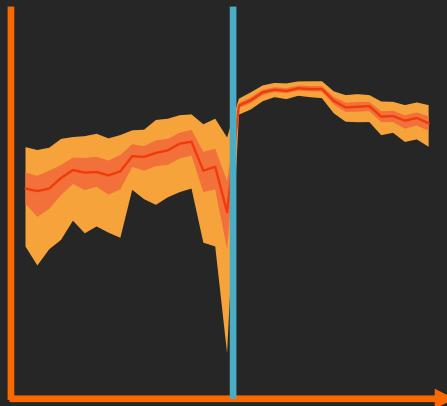
Volume:
Sum of
variances



BM >
BM | OU >
Trend | BM

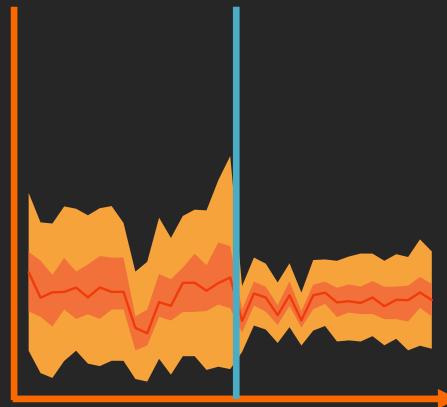


Volume:
Sum of
variances

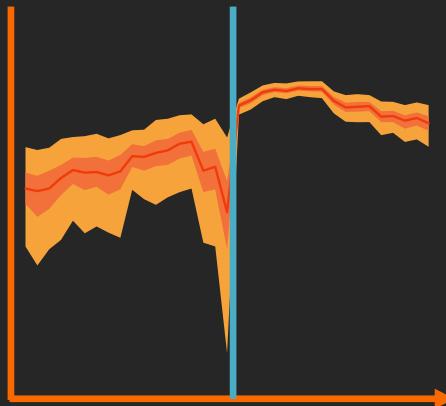


BM >
BM | OU >
Trend | BM

Density:
Average
nearest
neighbour
distance

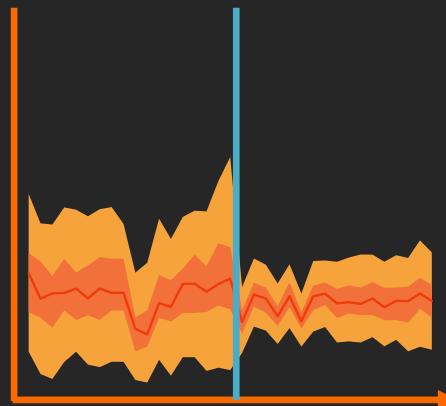


Volume:
Sum of
variances



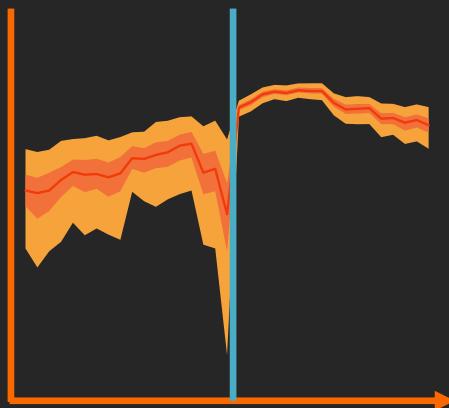
BM >
BM | OU >
Trend | BM

Density:
Average
nearest
neighbour
distance



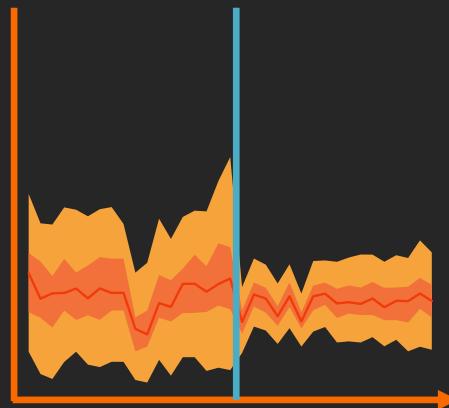
OU >
BM >
Trend | OU

Volume:
Sum of
variances



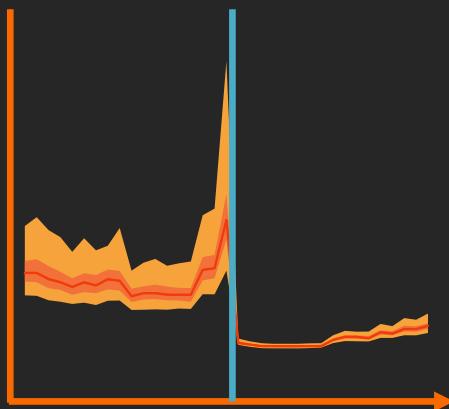
BM >
BM | OU >
Trend | BM

Density:
Average
nearest
neighbour
distance

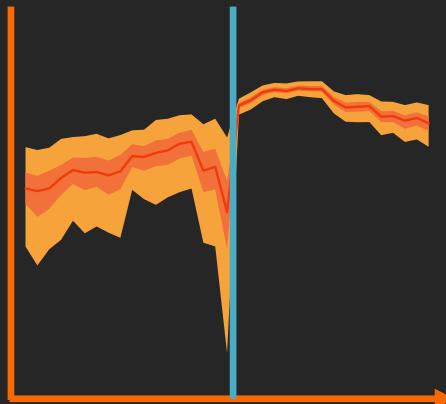


OU >
BM >
Trend | OU

Position:
Average
displacement

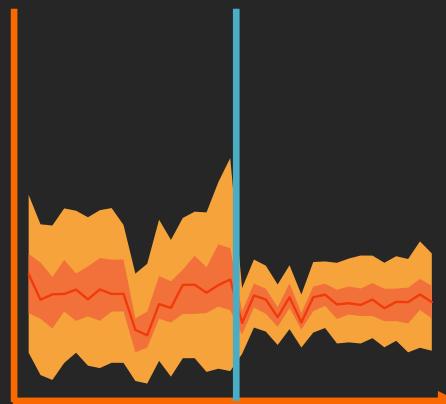


Volume:
Sum of
variances



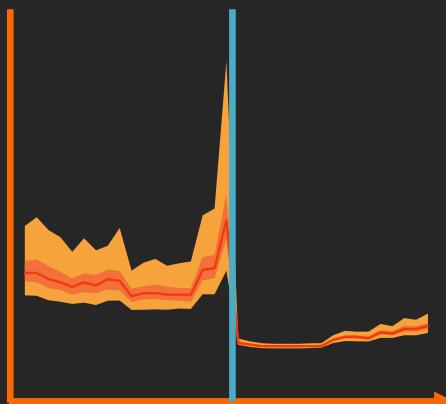
BM >
BM | OU >
Trend | BM

Density:
Average
nearest
neighbour
distance



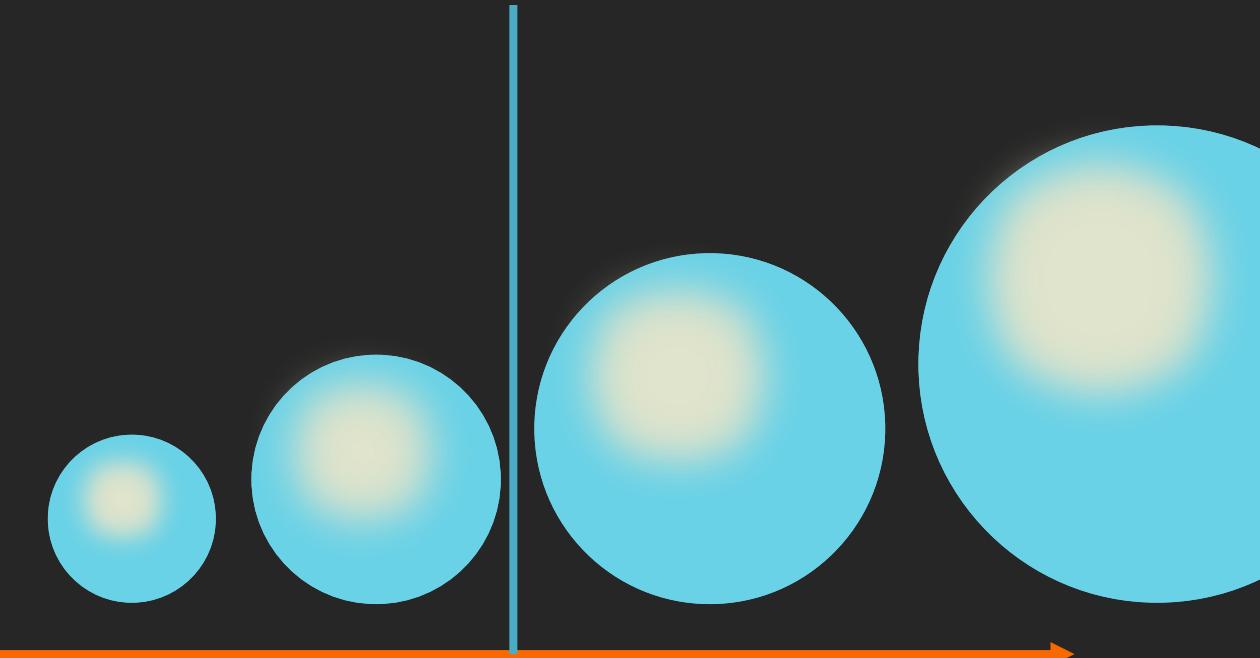
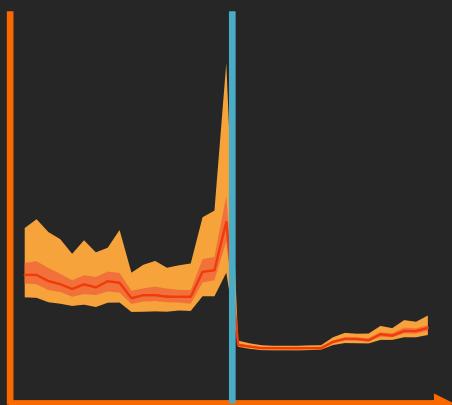
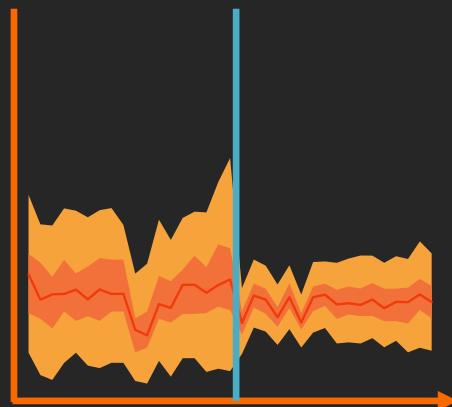
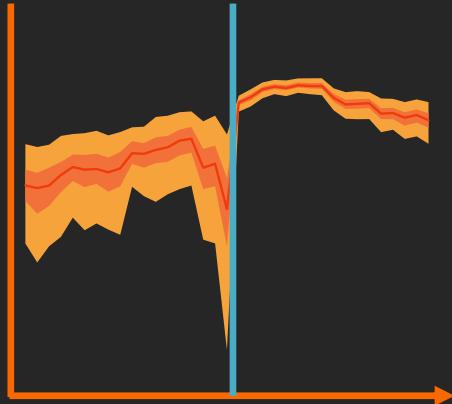
OU >
BM >
Trend | OU

Position:
Average
displacement



BM >
Trend | BM >
Trend

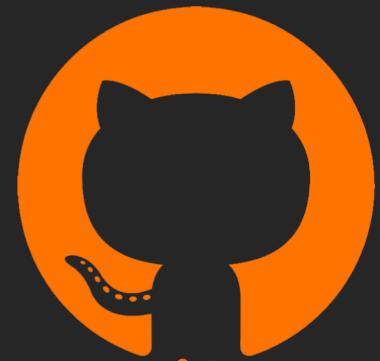
Effect of K-Pg on mammal evolution?



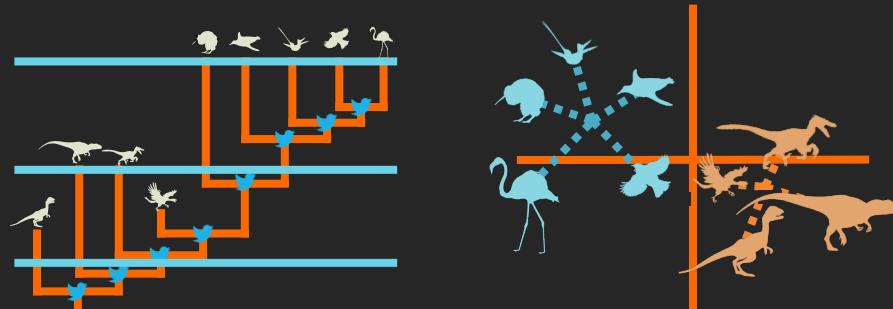
Volume: constant increase/constraint?
Density: constraint/ constant increase?
Position: constant change/ trend?



Thanks!



github.com/TGuillerme/dispRity



github.com/TGuillerme/moms

