

moms: measuring occupancy in multidimensional space

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Acknowledgements



Robin Beck

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Natalie Cooper

Thomas Halliday

Ariel Marcy

Matt Phillips

Mark Puttick

Vera Weisbecker

SAVE YOURSELF, MAMMAL!

A SATURDAY MORNING BREAKFAST CEREAL COLLECTION

BY ZACH WEINER





Cenozoic

Paleogene

Mesozoic

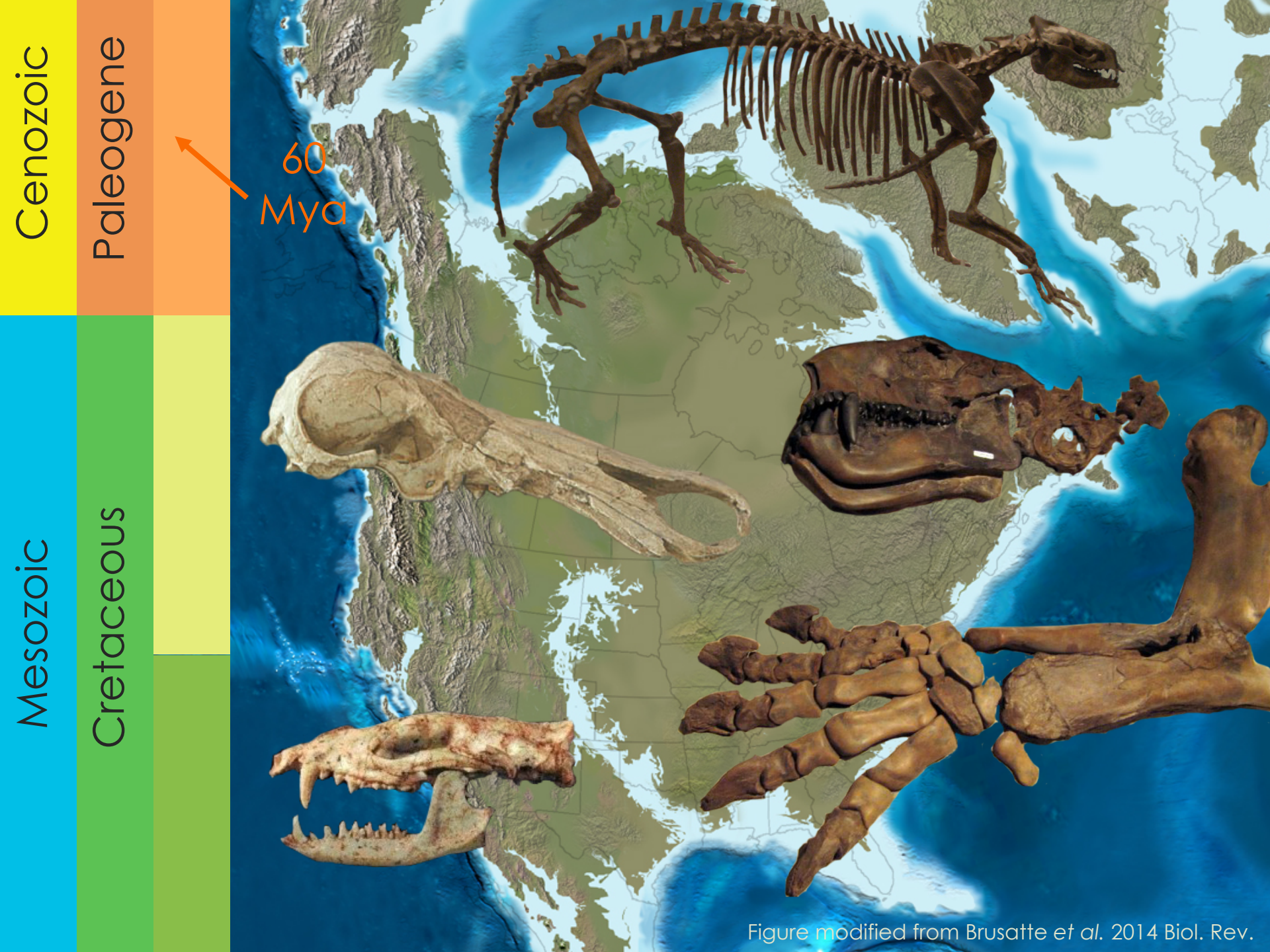
Cretaceous

80
Mya



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





Cenozoic

Paleogene

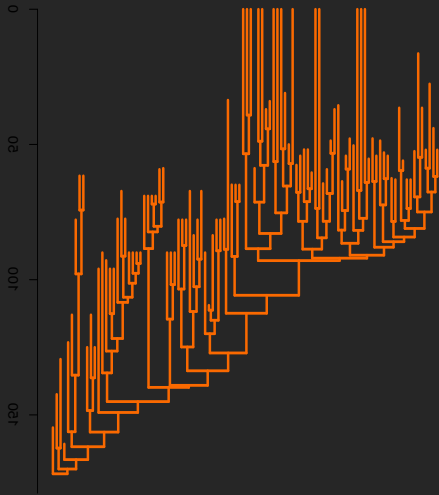
Mesozoic

Cretaceous

60
Mya

Mammalian morphospace

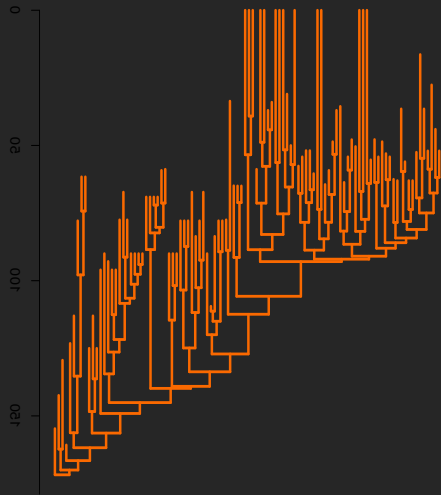
443 species



Mammalian morphospace

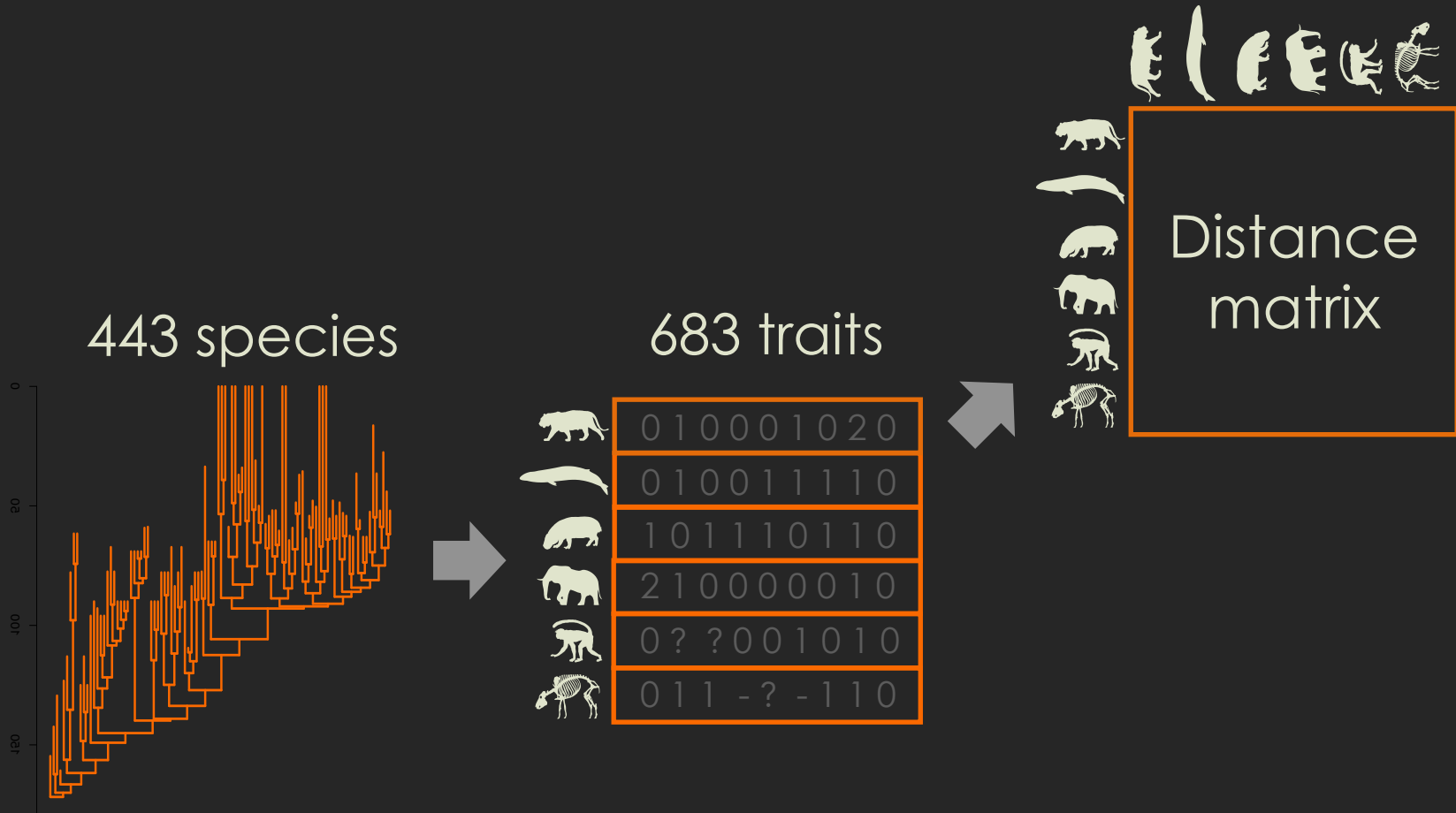
443 species

683 traits

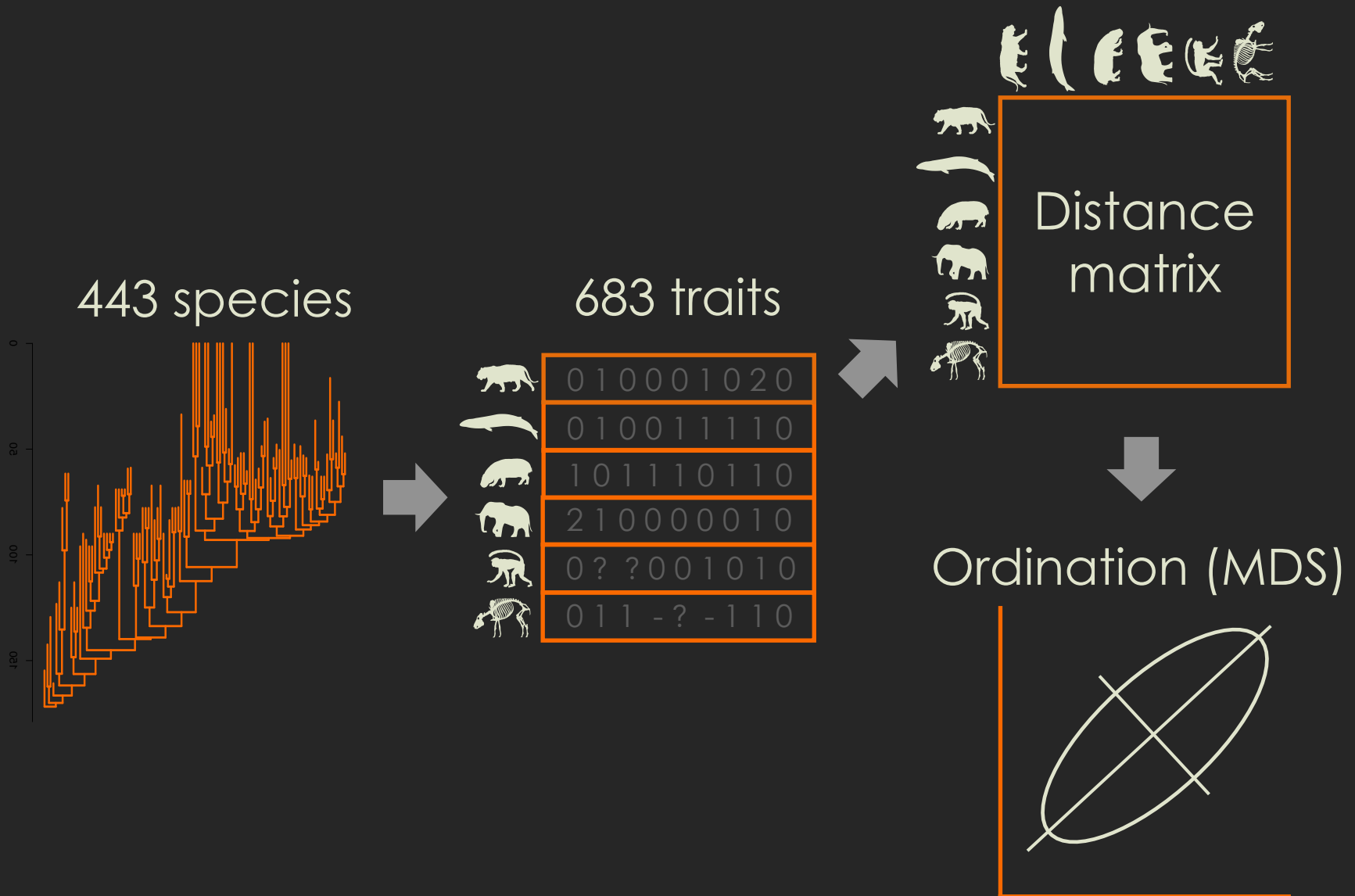


0	1	0	0	0	1	0	2	0
0	1	0	0	1	1	1	1	0
1	0	1	1	1	0	1	1	0
2	1	0	0	0	0	0	1	0
0	?	?	0	0	1	0	1	0
0	1	1	-	?	-	1	1	0

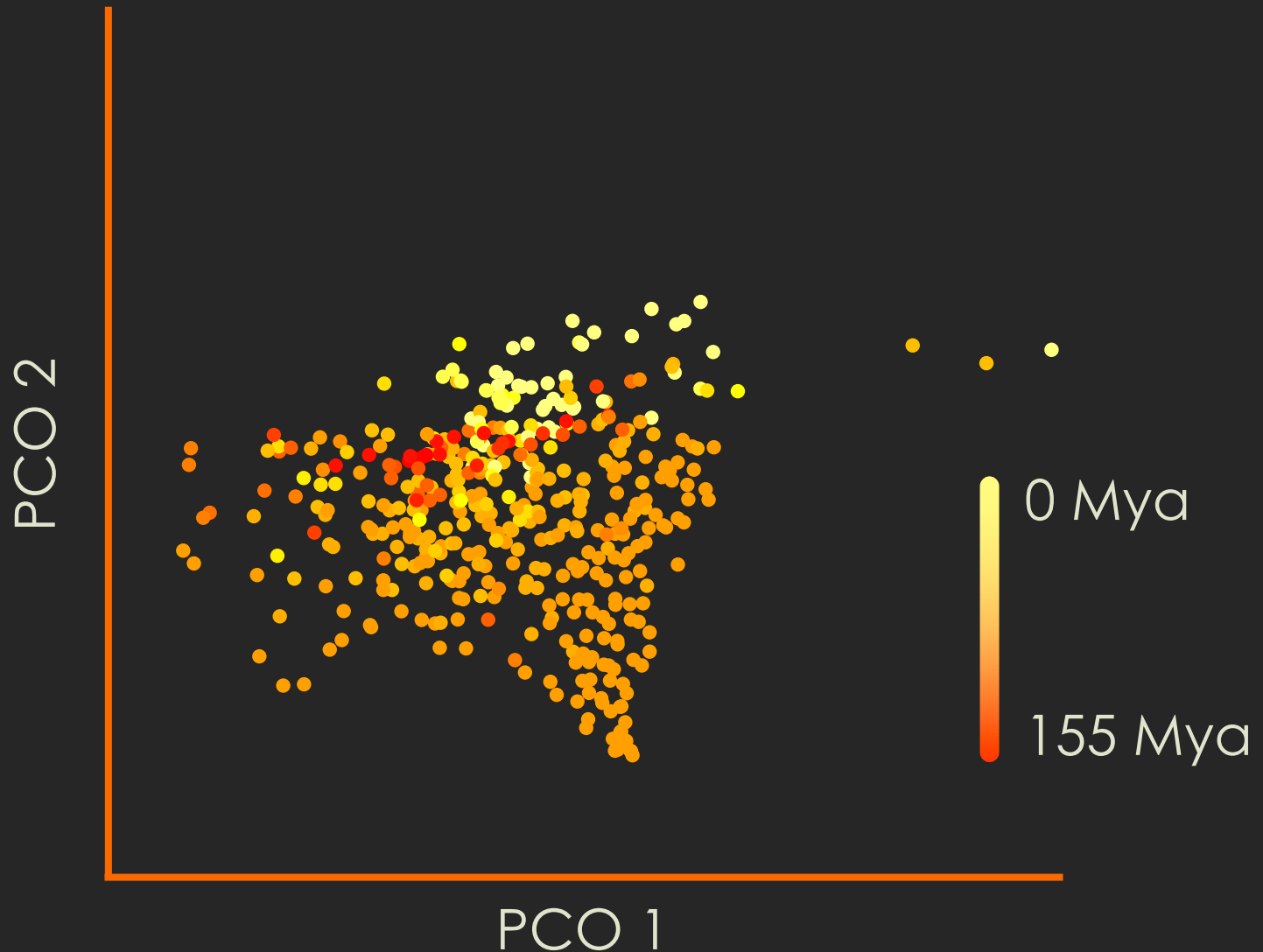
Mammalian morphospace



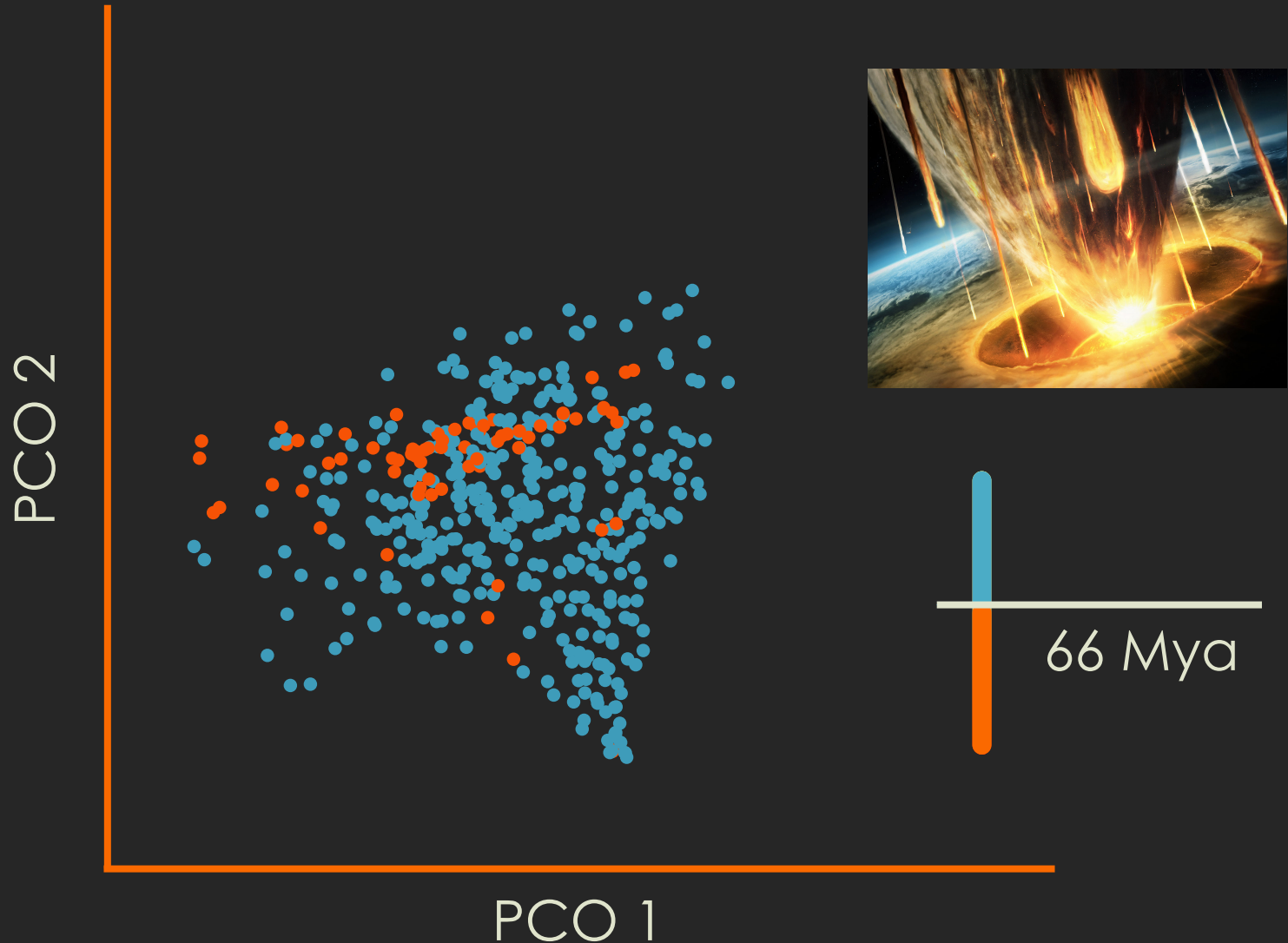
Mammalian morphospace



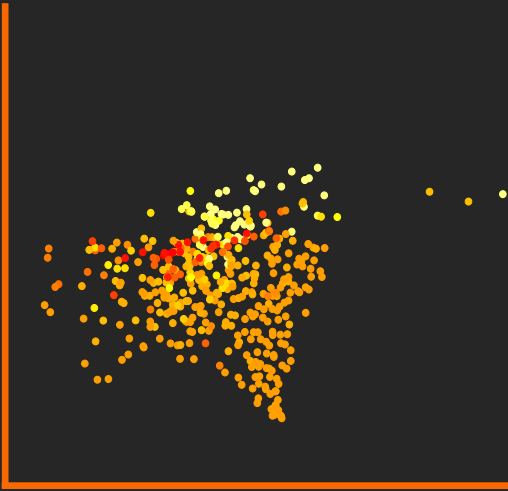
Mammalian morphospace



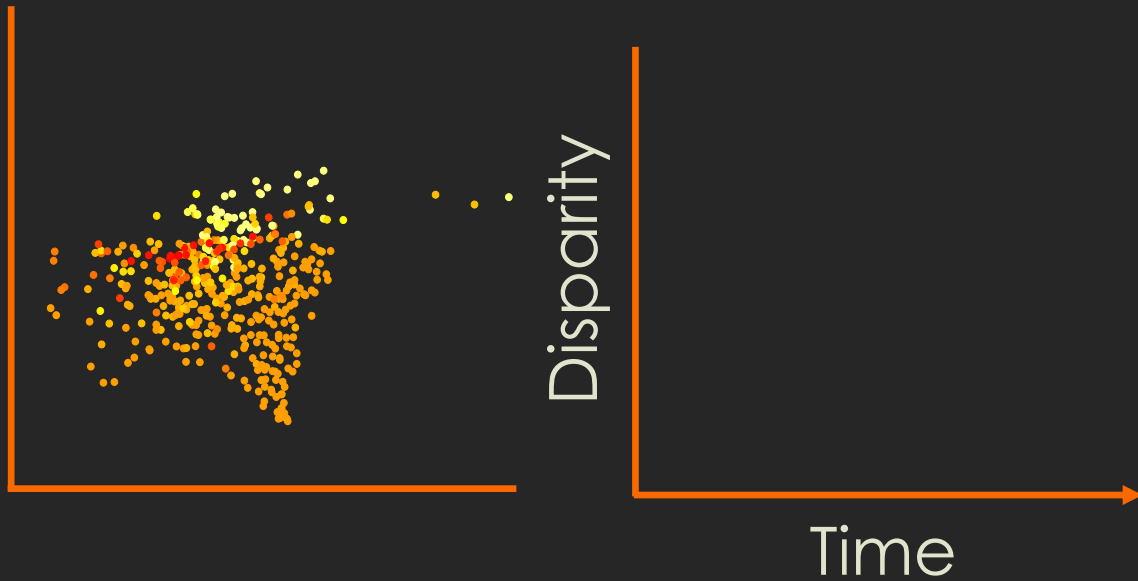
Mammalian morphospace



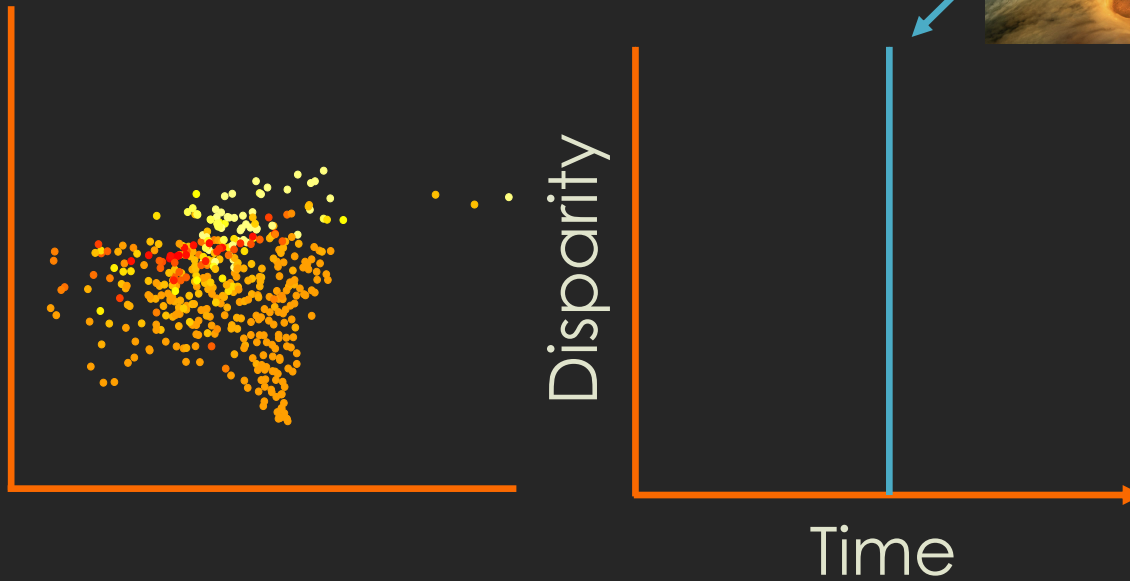
Disparity-through-time



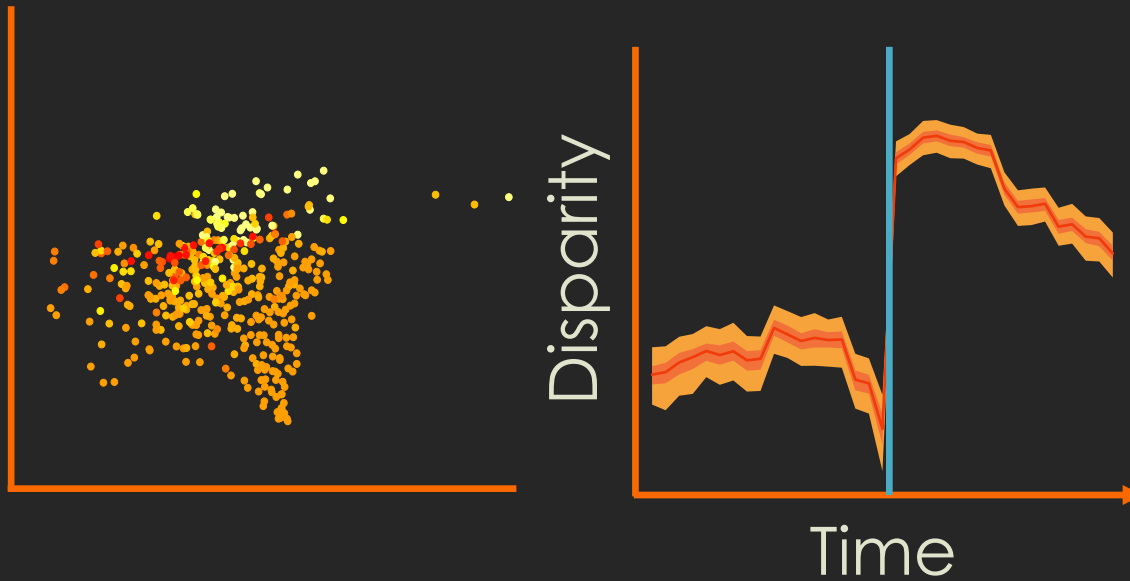
Disparity-through-time



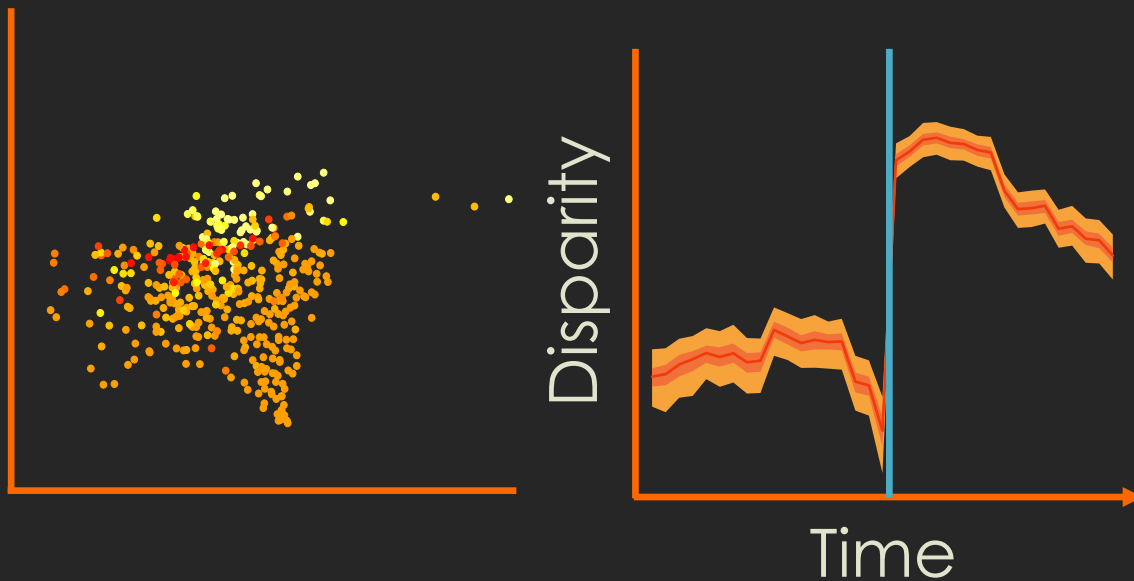
Disparity-through-time



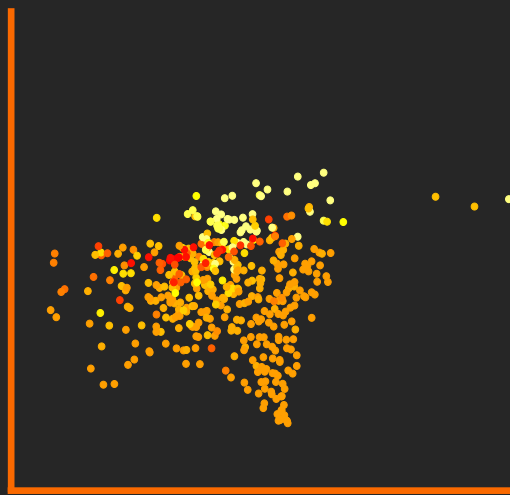
Disparity-through-time



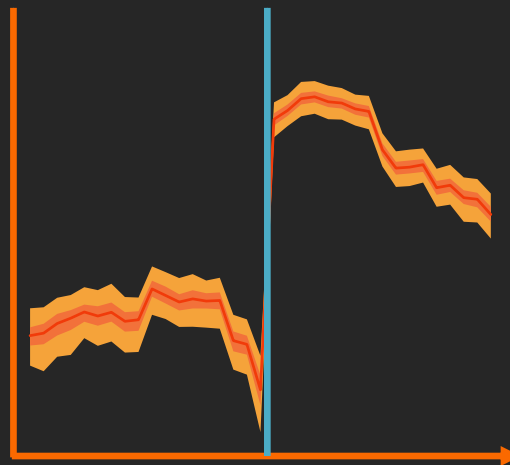
Effect of K-Pg on mammal evolution?



Effect of K-Pg on mammal evolution?

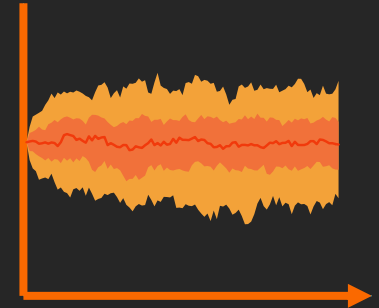


Disparity

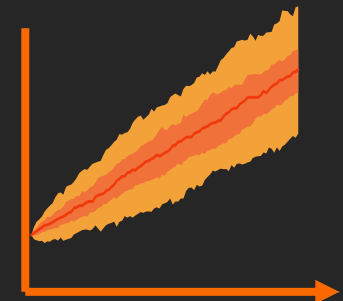


Time

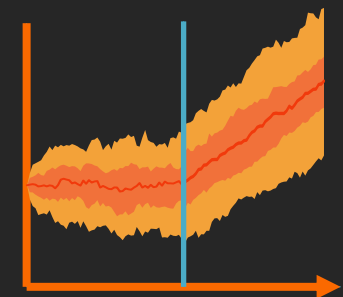
?



OU?

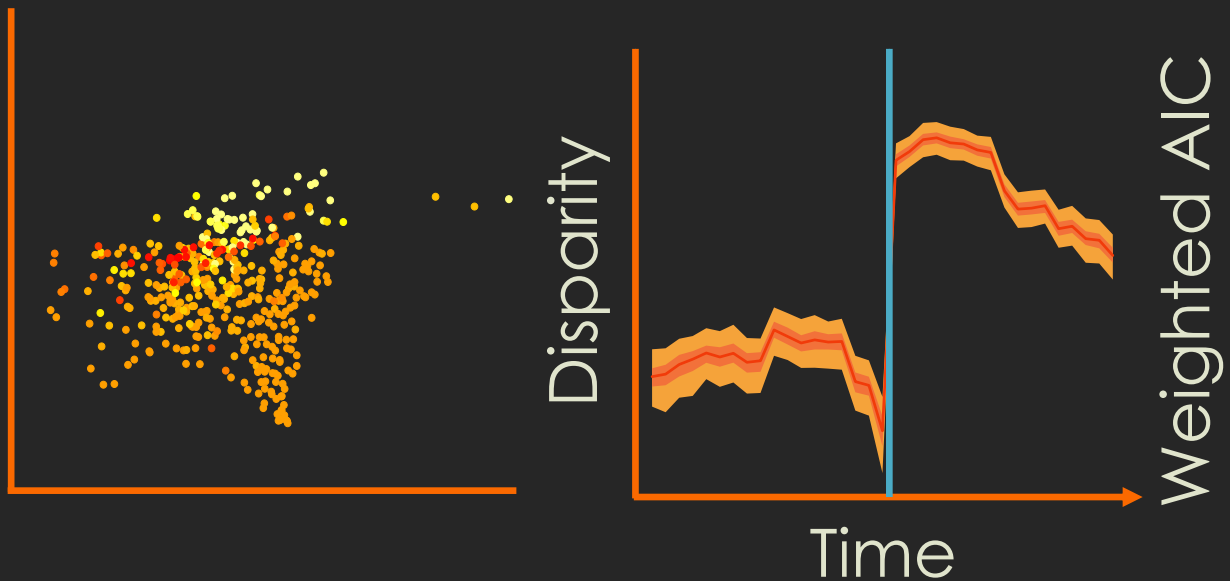


Trend?



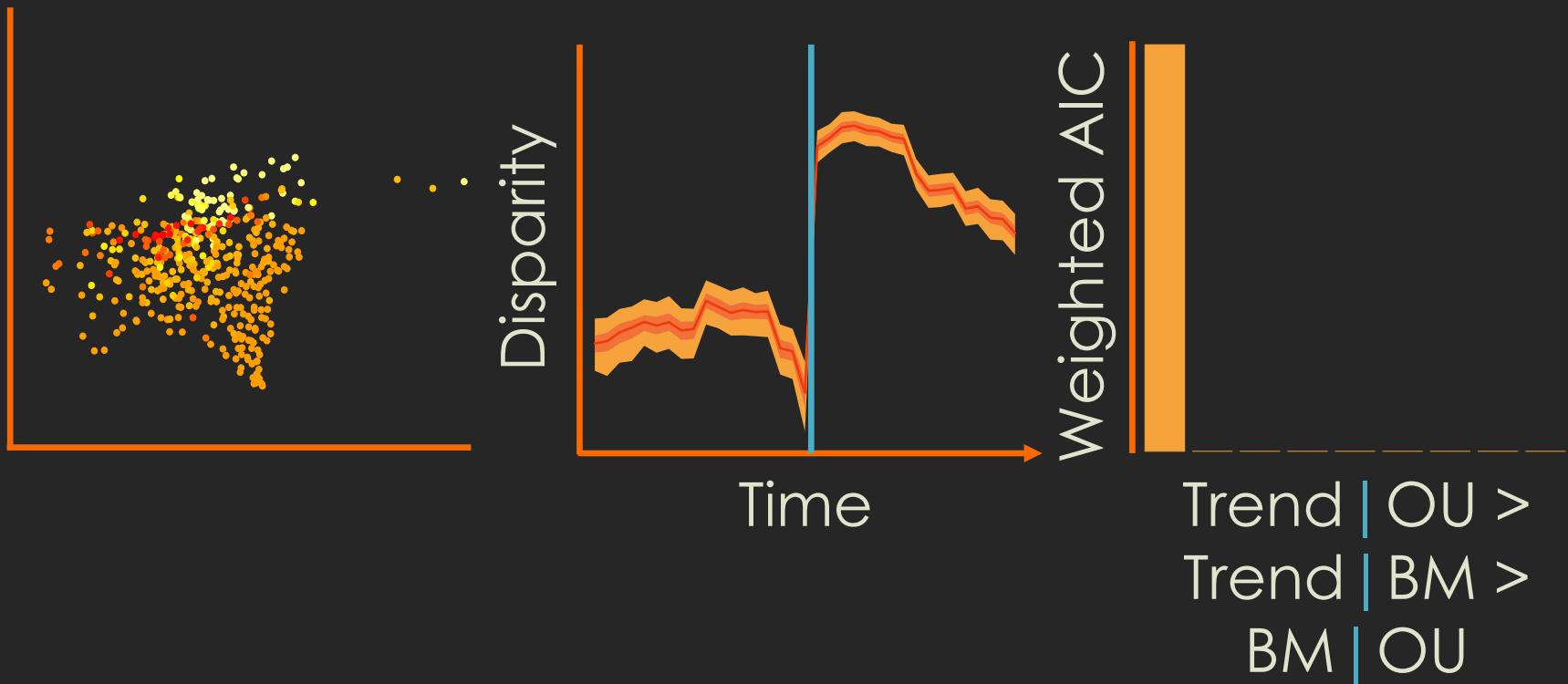
BM | Trend?

Effect of K-Pg on mammal evolution?



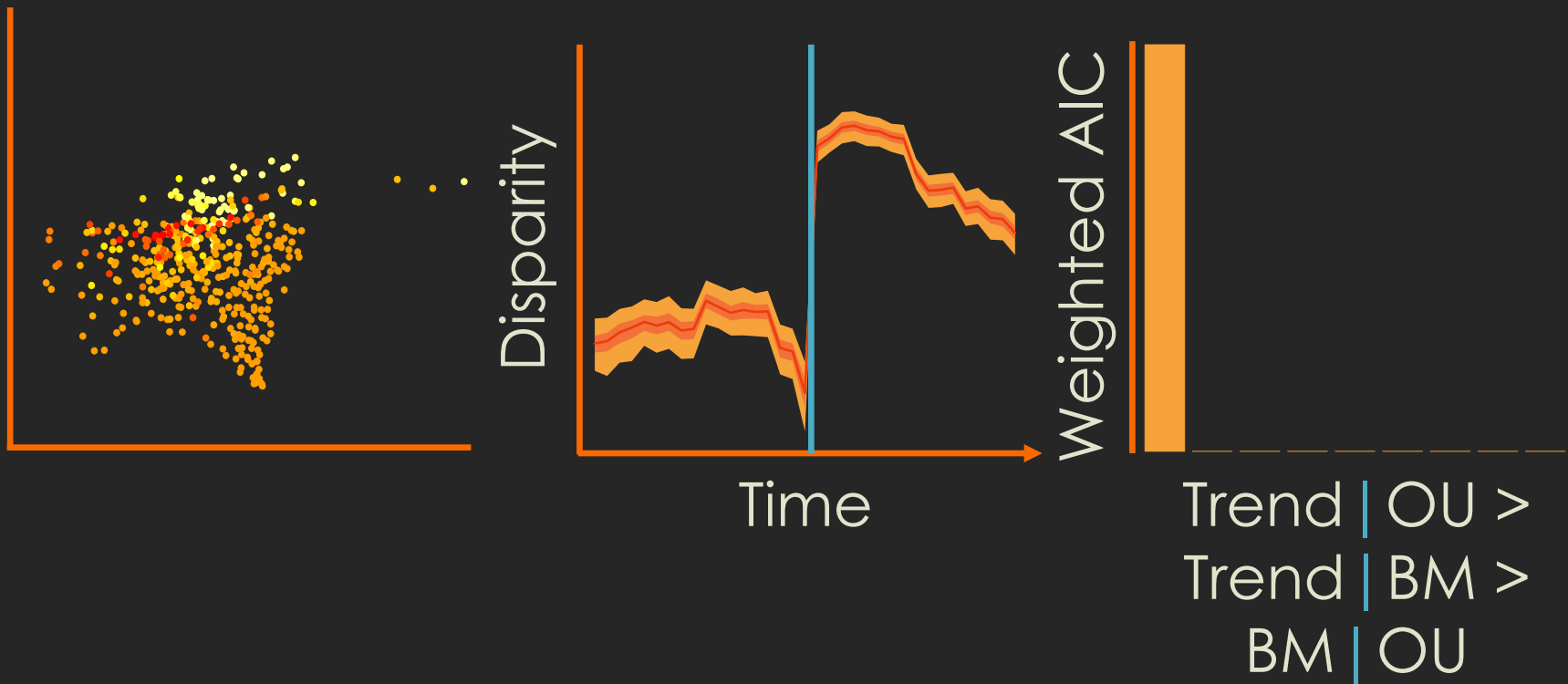
Model 1 >
Model 2 >
Model 3

Effect of K-Pg on mammal evolution?



Effect of K-Pg on mammal evolution?

Yes.



SAVE YOURSELF, MAMMAL!

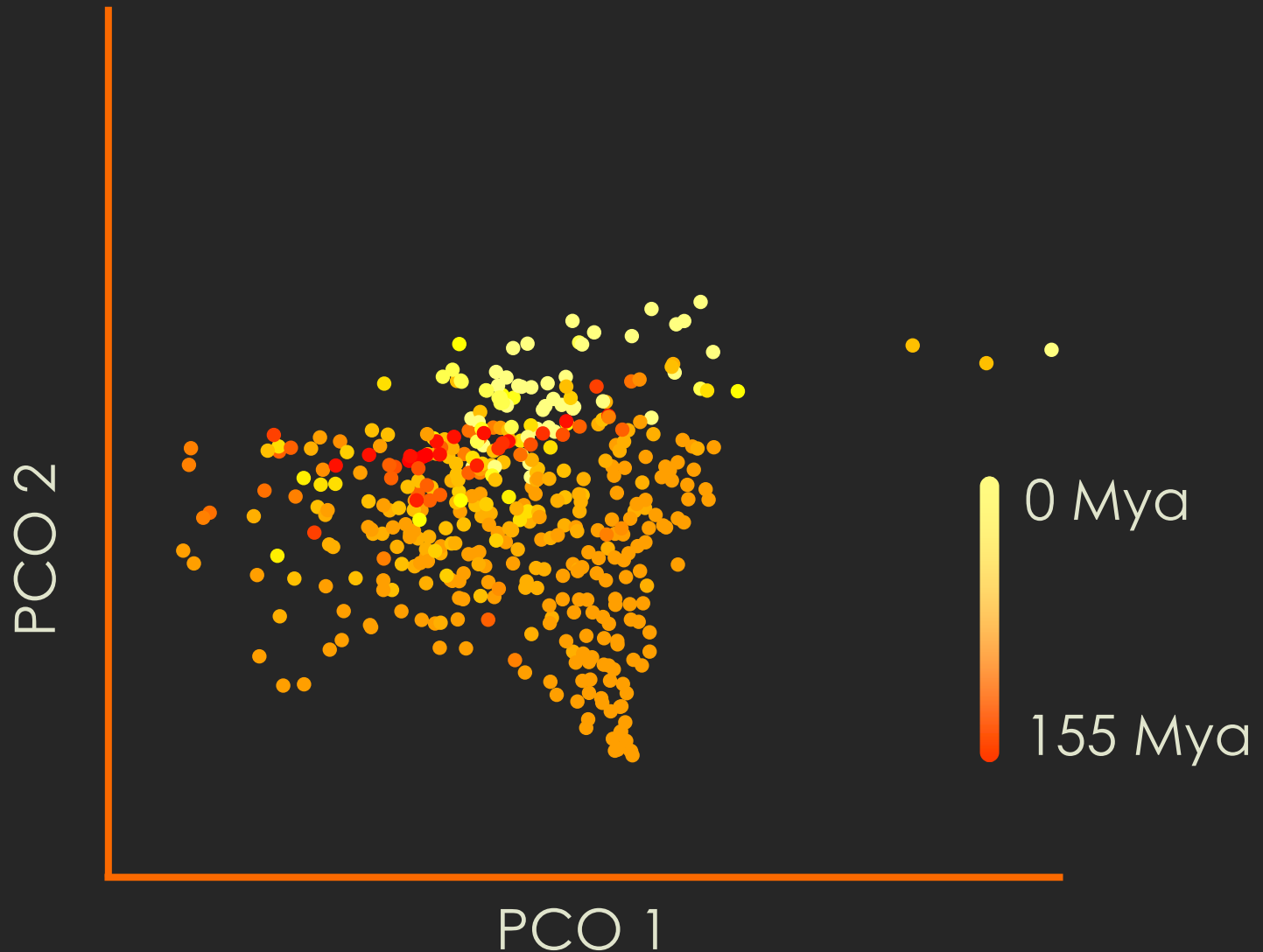
A SATURDAY MORNING BREAKFAST CEREAL COLLECTION

BY ZACH WEINER

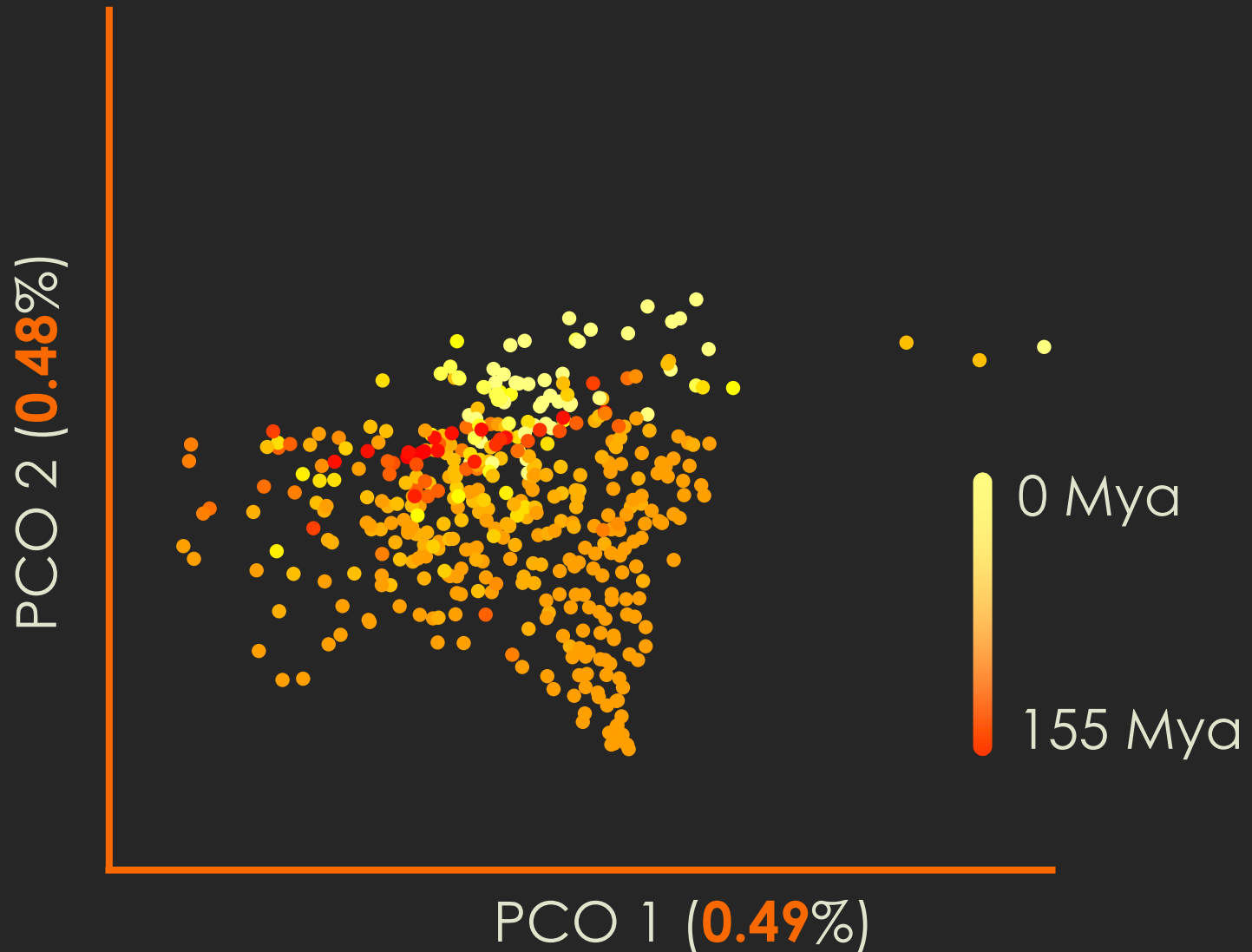
Cheers!



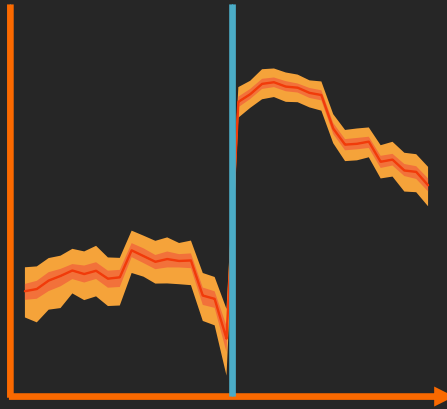
Mammalian trait-space



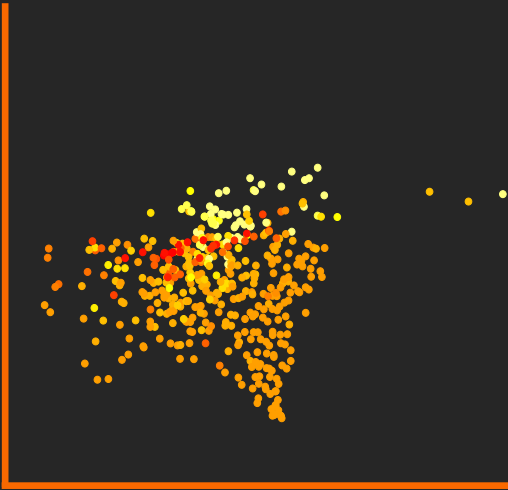
A **441 dimensions** trait-space!



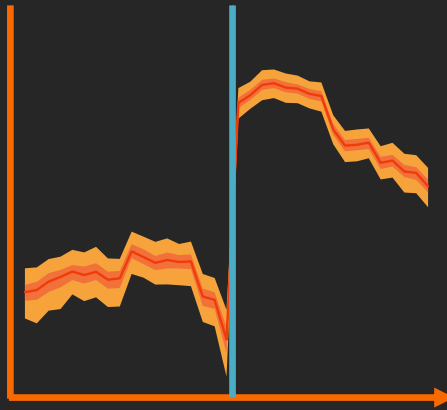
Sum of
ranges



Trend | OU >
Trend | BM >
BM | OU

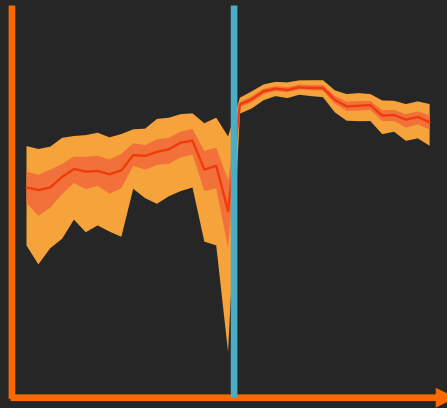
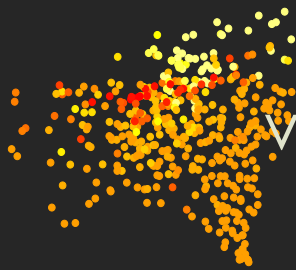


Sum of
ranges

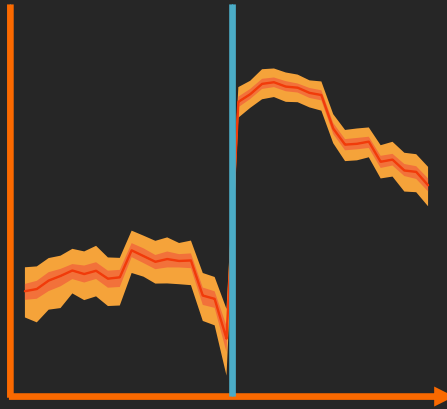


Trend | OU >
Trend | BM >
BM | OU

Sum of
variances



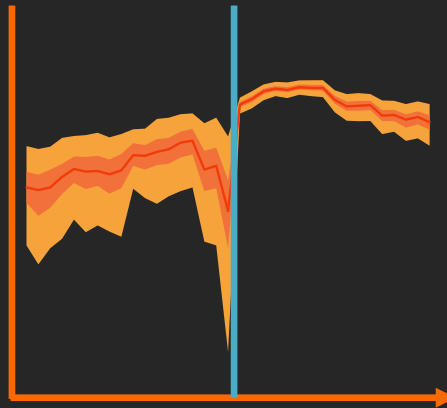
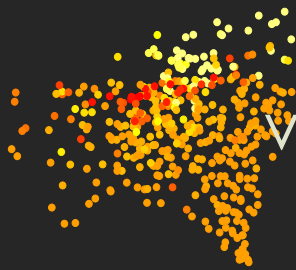
Sum of
ranges



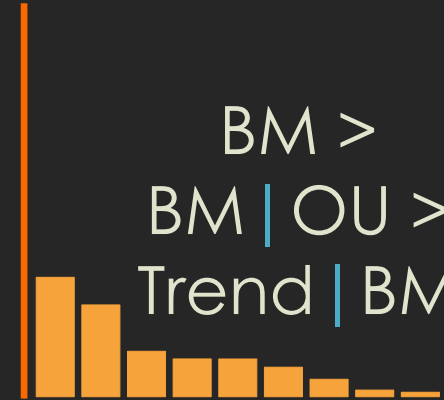
Trend | OU >
Trend | BM >
BM | OU



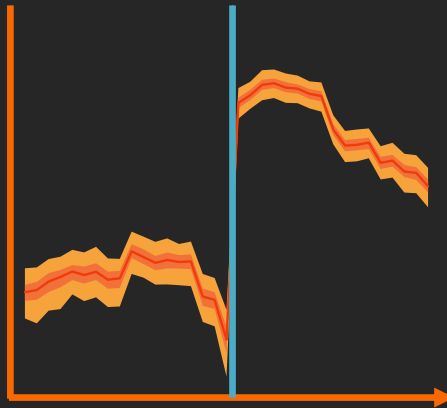
Sum of
variances



BM >
BM | OU >
Trend | BM



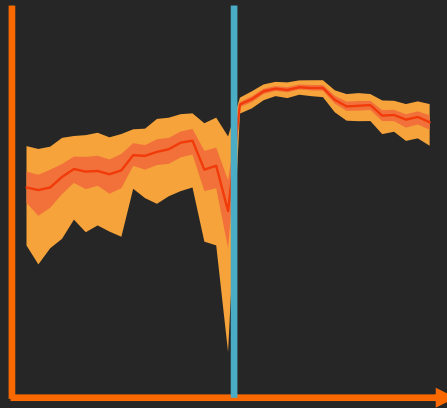
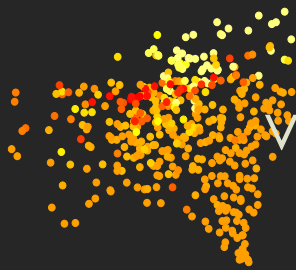
Sum of
ranges



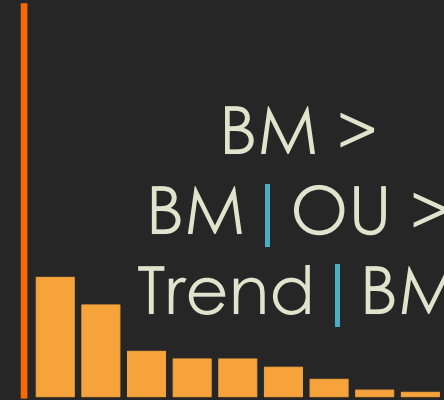
Trend | OU >
Trend | BM >
BM | OU



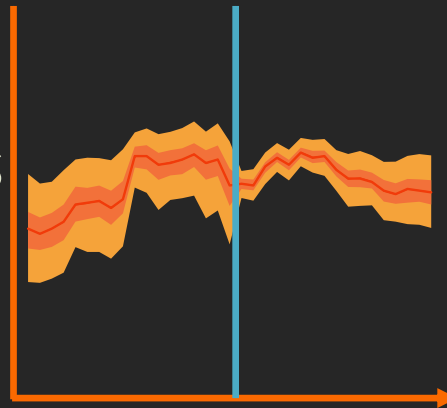
Sum of
variances



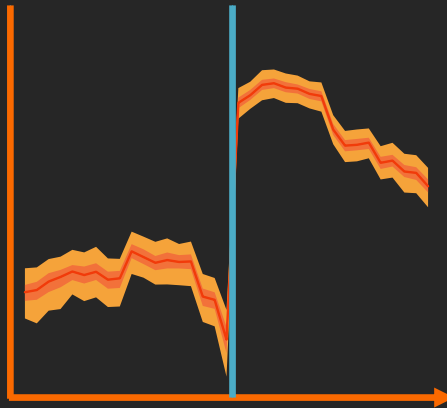
BM >
BM | OU >
Trend | BM



Procrustes
variance



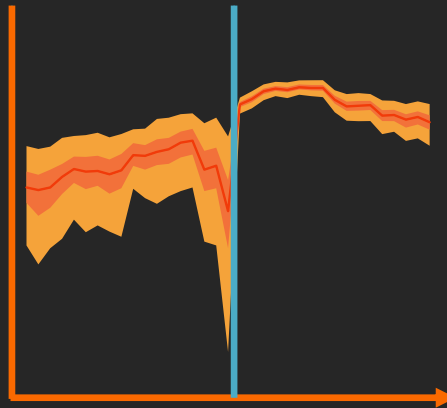
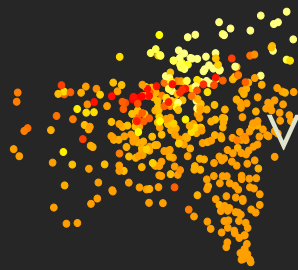
Sum of
ranges



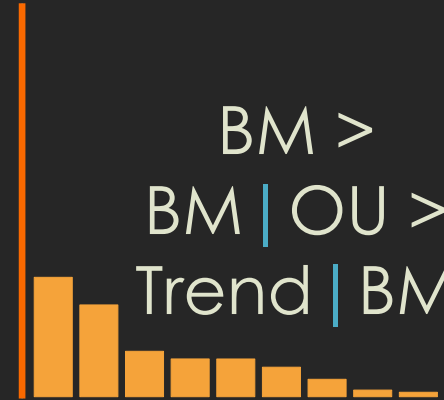
Trend | OU >
Trend | BM >
BM | OU



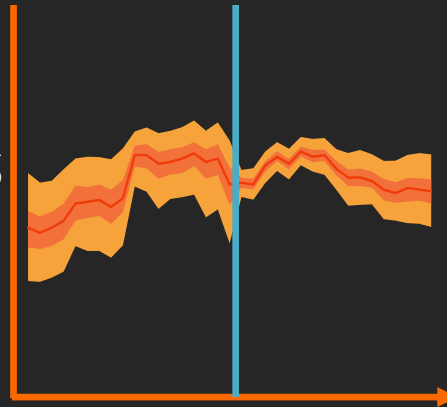
Sum of
variances



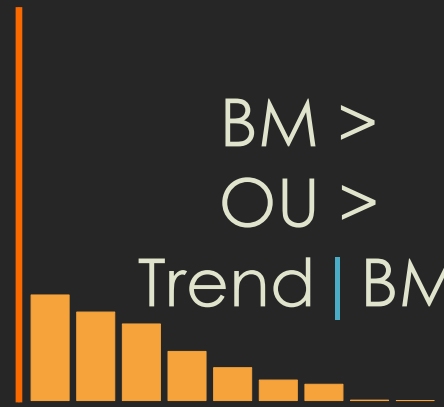
BM >
BM | OU >
Trend | BM



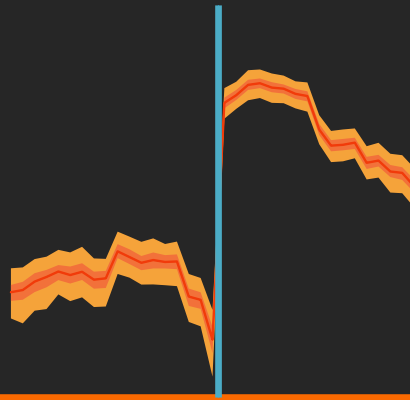
Procrustes
variance



BM >
OU >
Trend | BM

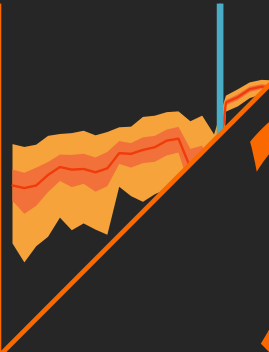
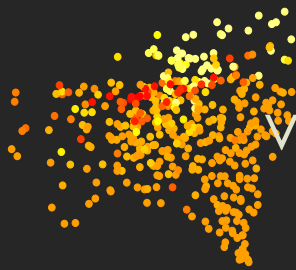


Sum of
ranges



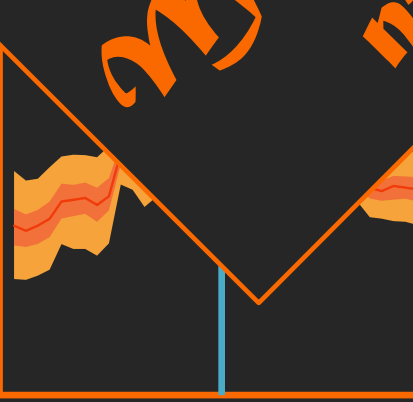
Trend | OU >
Trend | BM >
M | OU

Sum of
variances



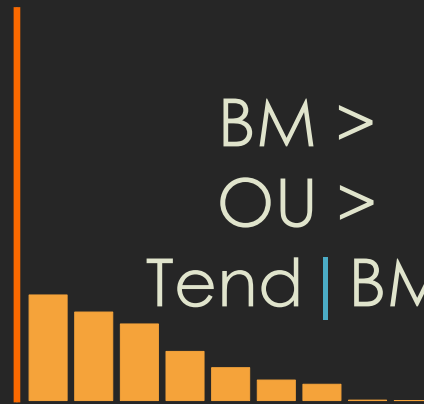
A >
A | OU >
Trend | BM

Procrustes
variance

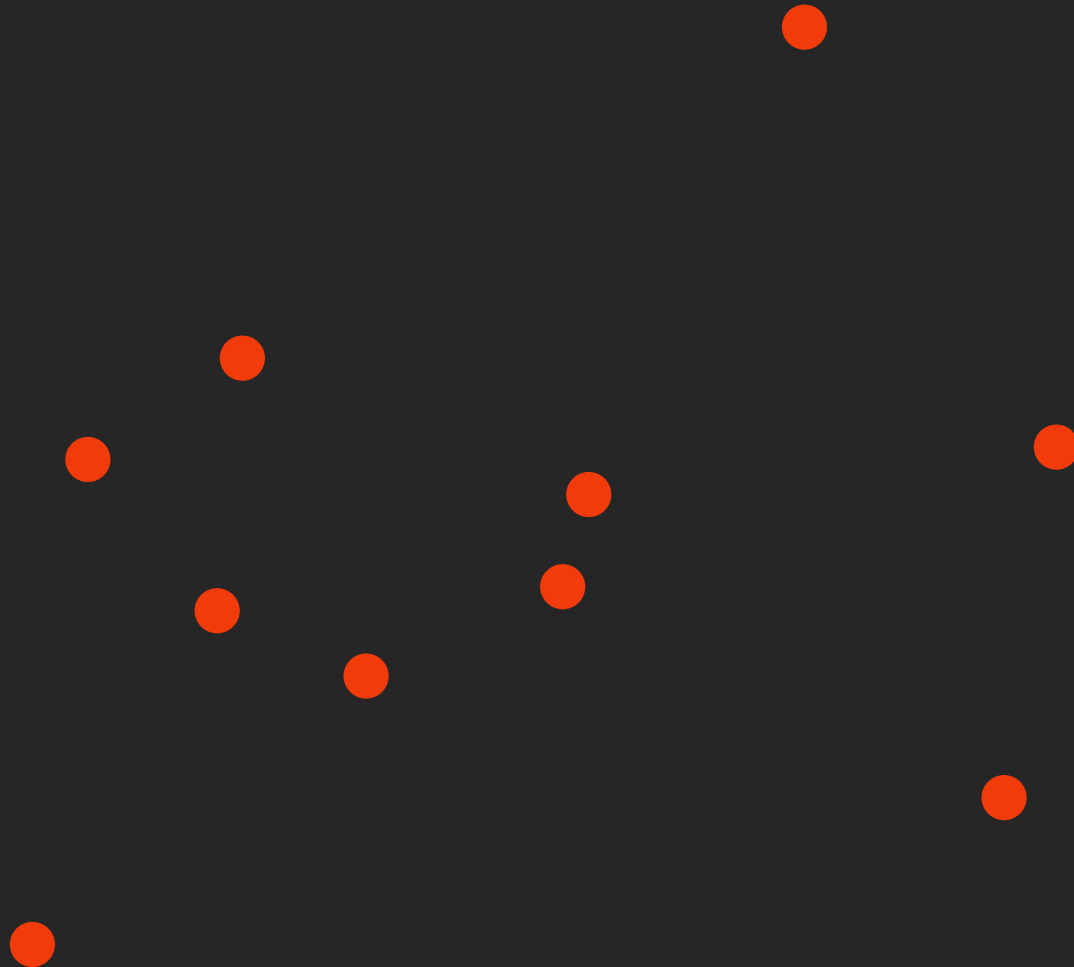


BM >
OU >
Tend | BM

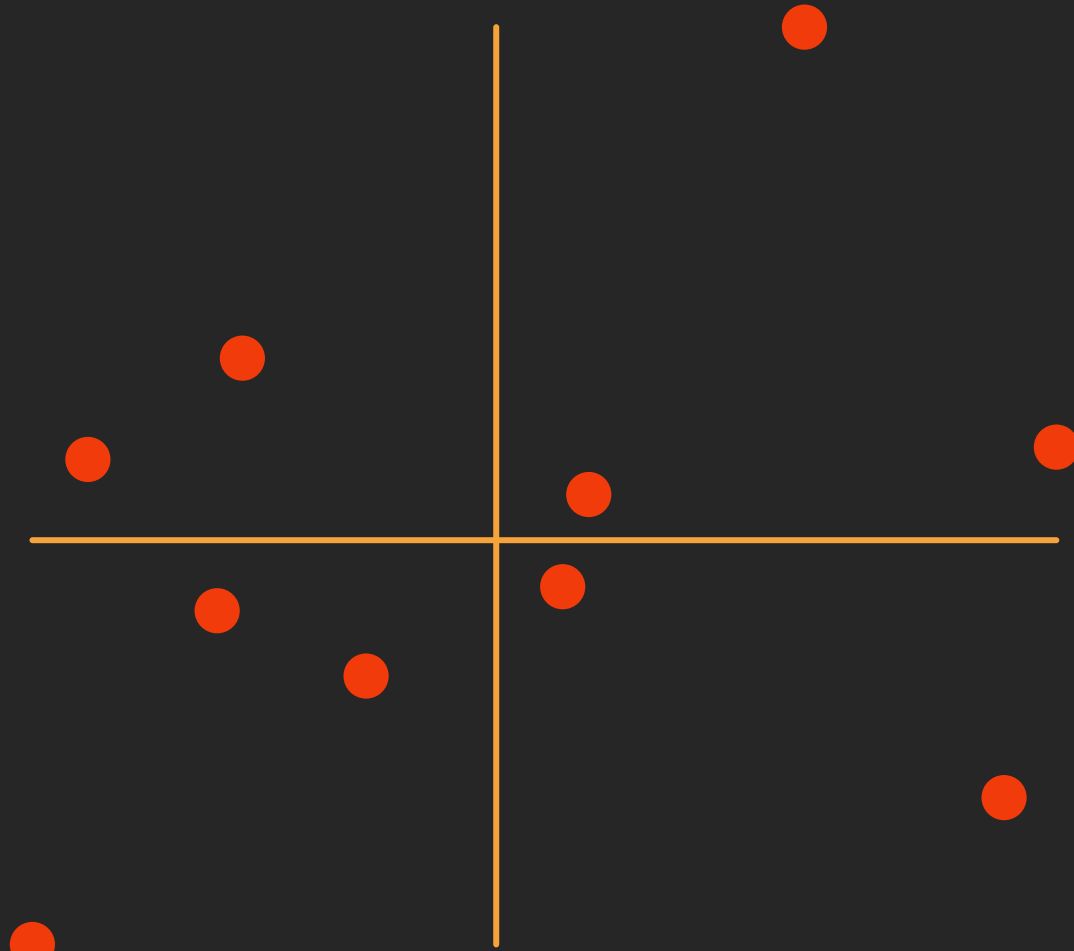
The
Multidimensional
nightmare!



What to measure in trait-space?

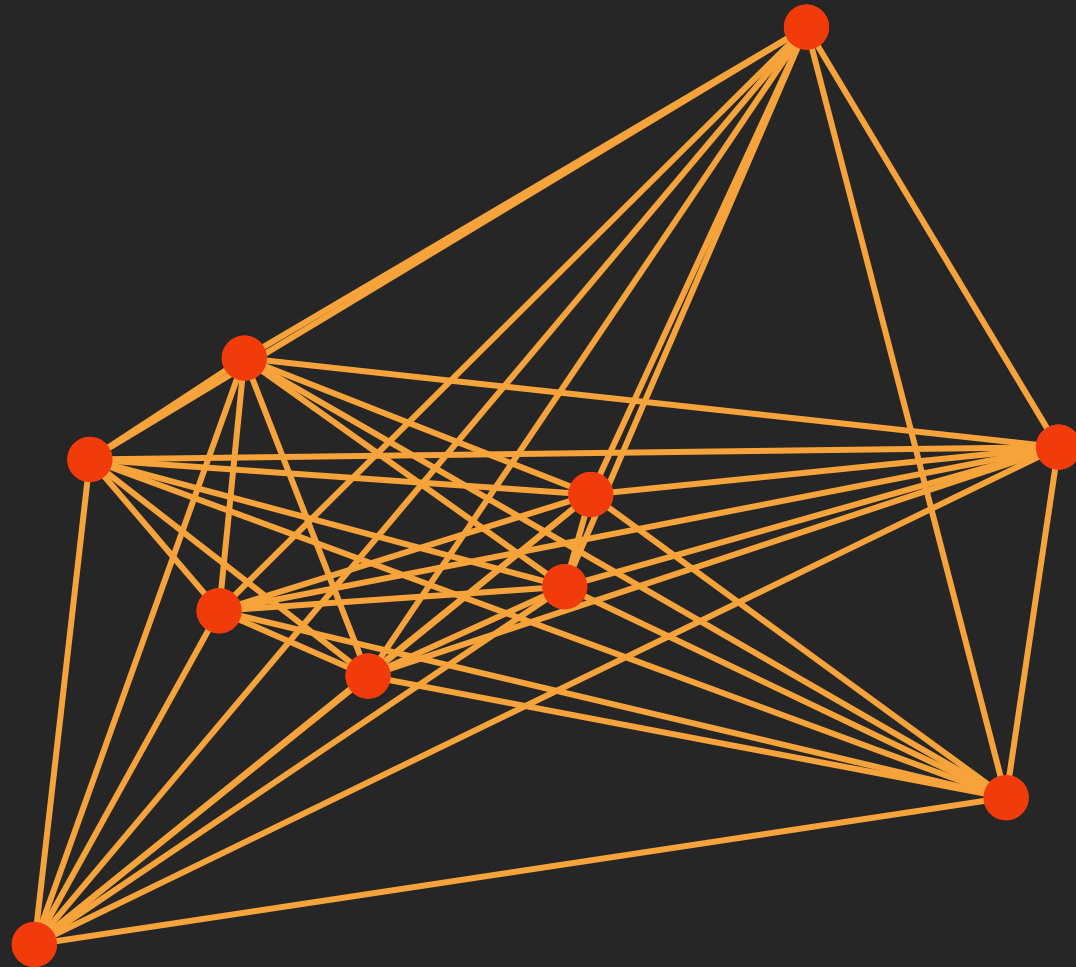


What to measure in trait-space?



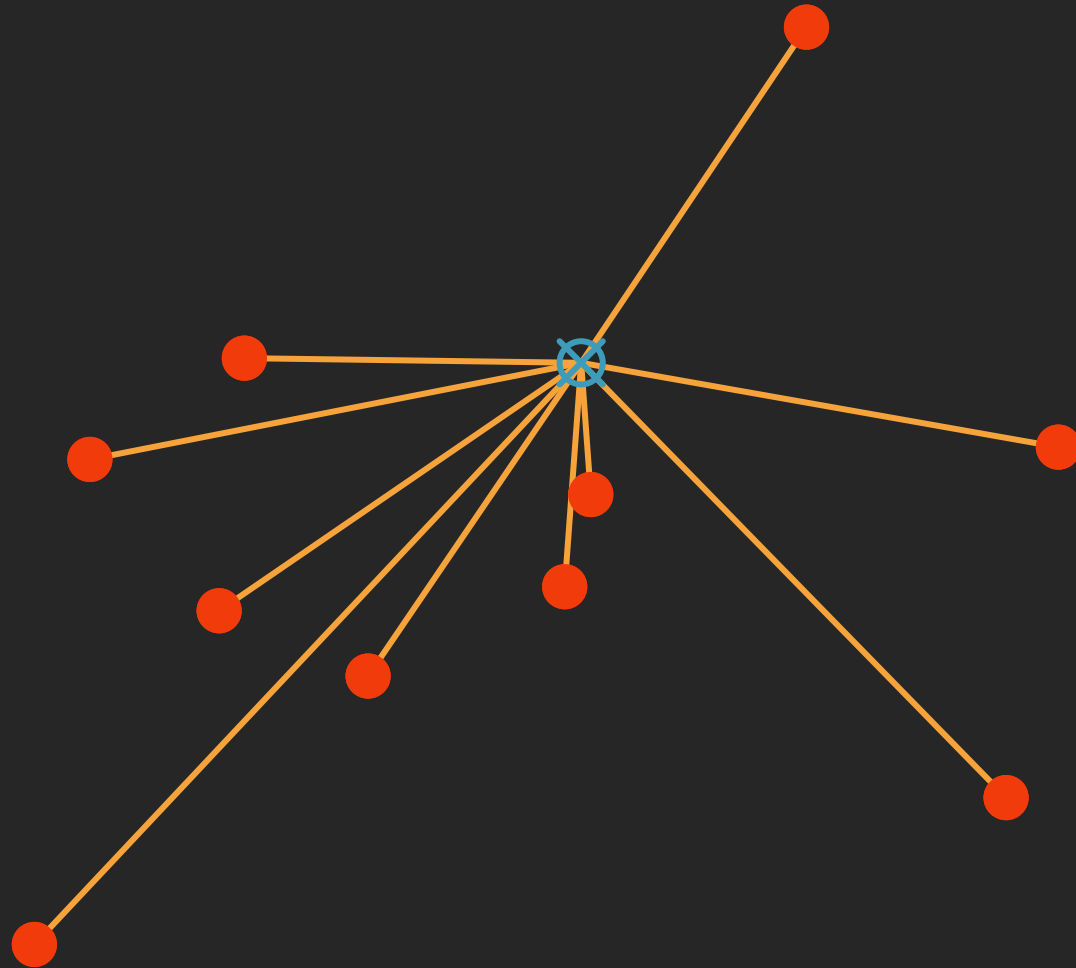
Volume (e.g. product of ranges)

What to measure in trait-space?



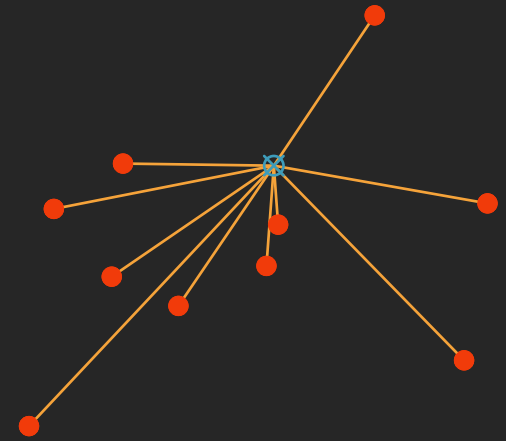
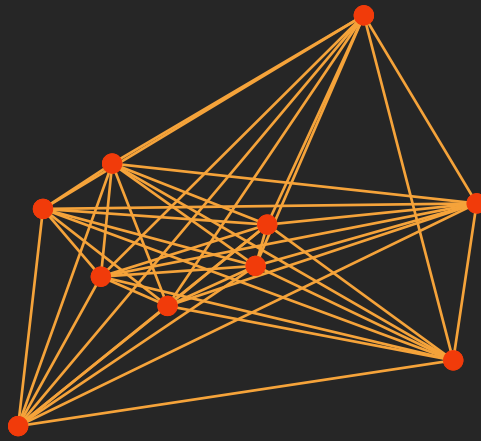
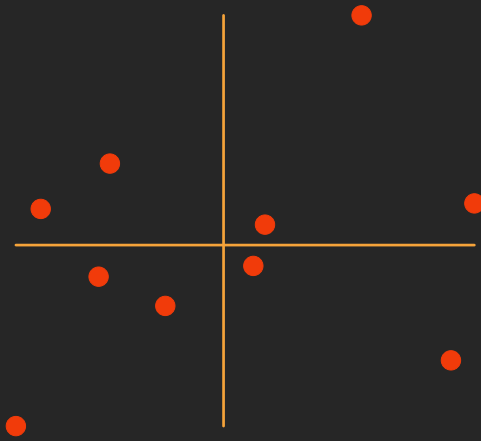
Density (e.g. pairwise distances)

What to measure in trait-space?



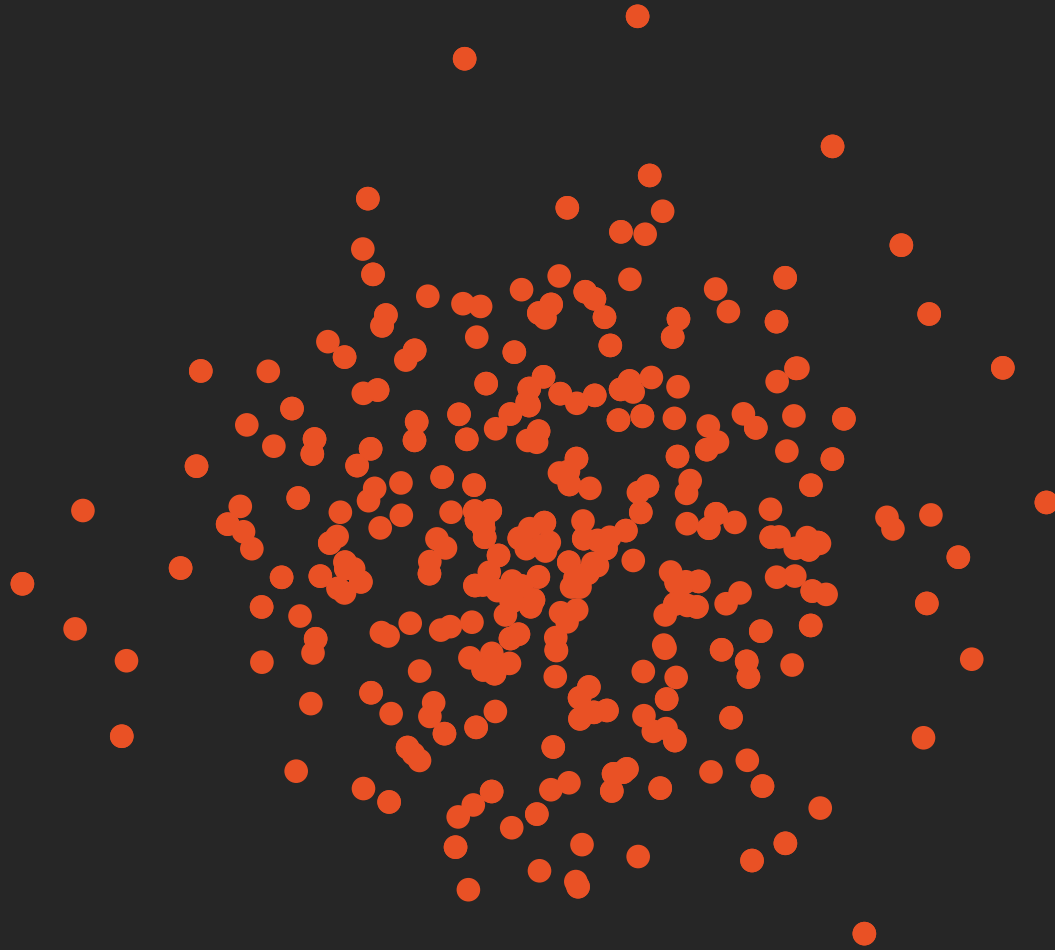
Position (e.g. distance from center)

What to measure in trait-space?

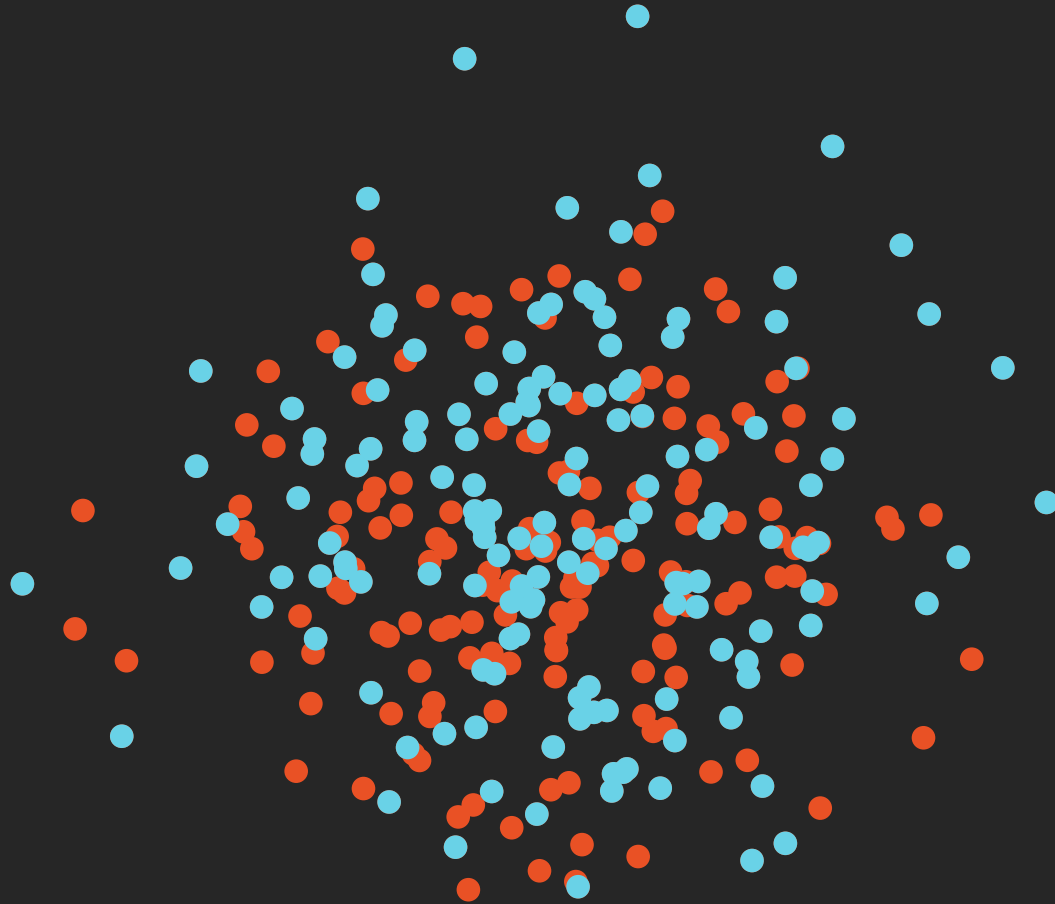


Volume & density & position?

How does the metric works in multidimensional space?

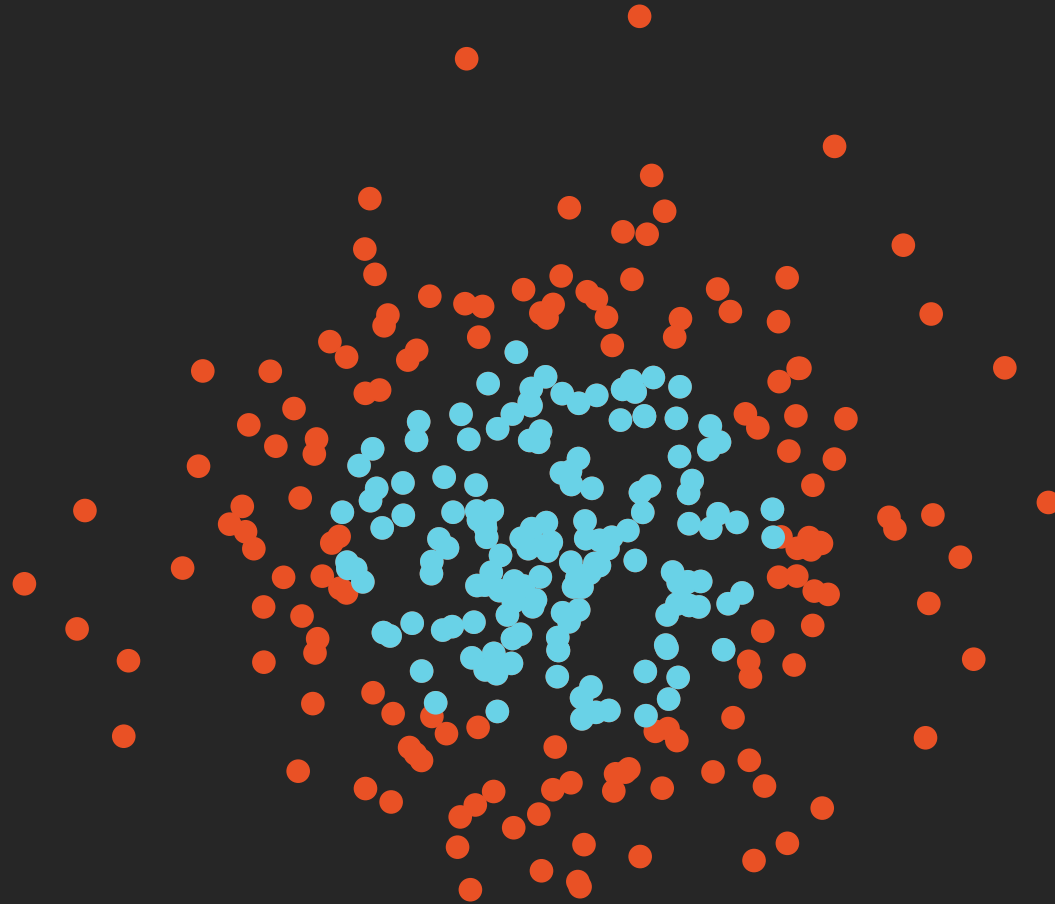


How does the metric works in multidimensional space?



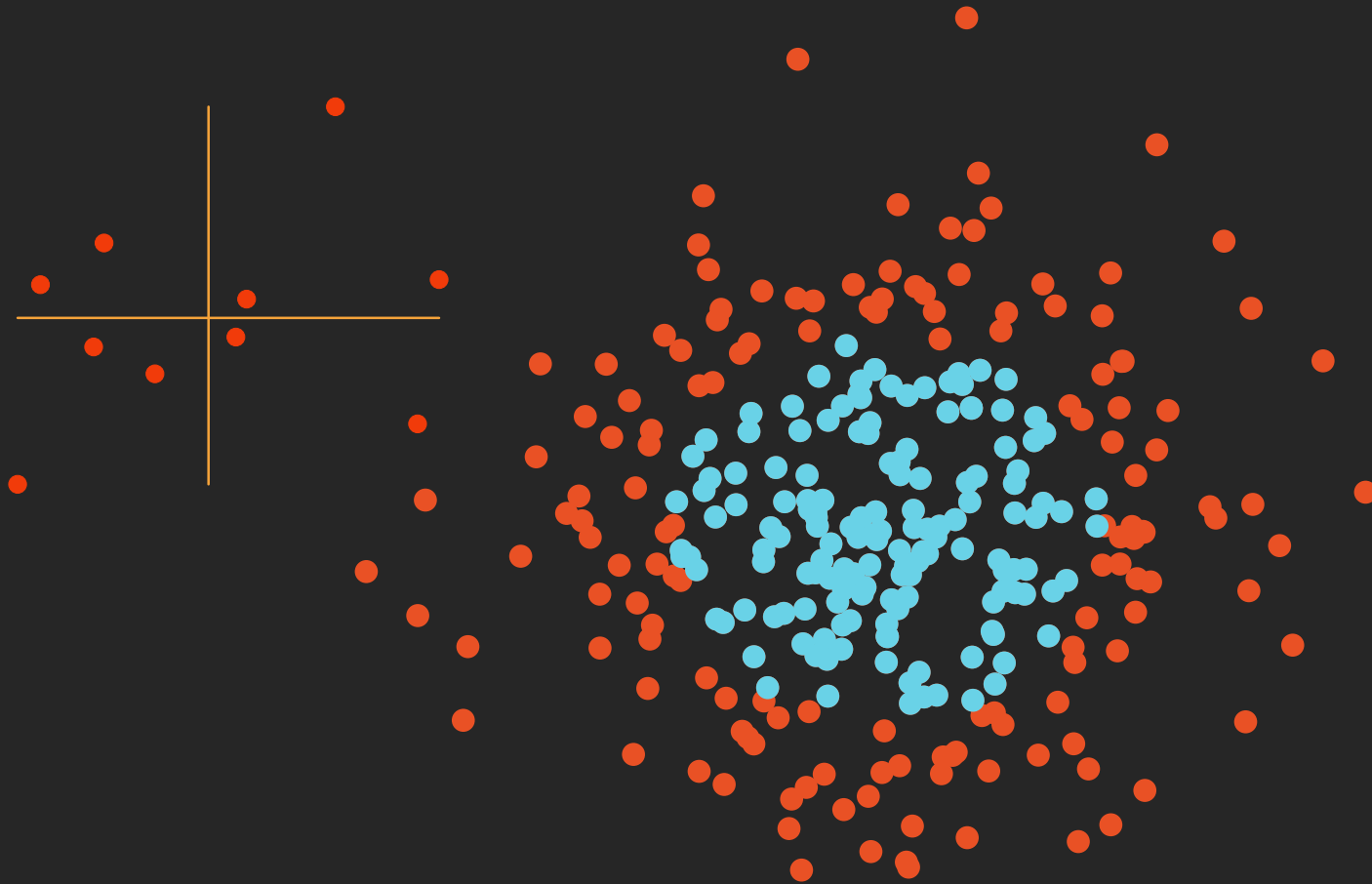
Random change (null)

How does the metric works in multidimensional space?



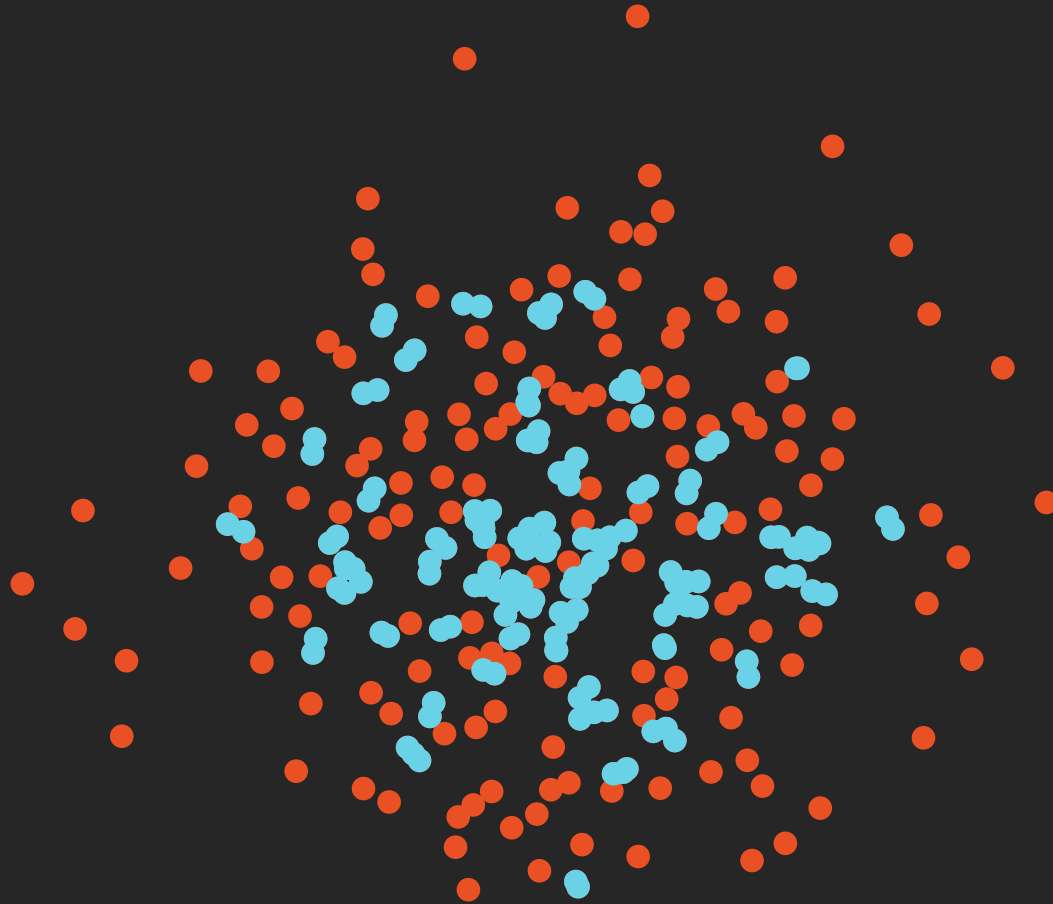
Volume change

How does the metric works in multidimensional space?



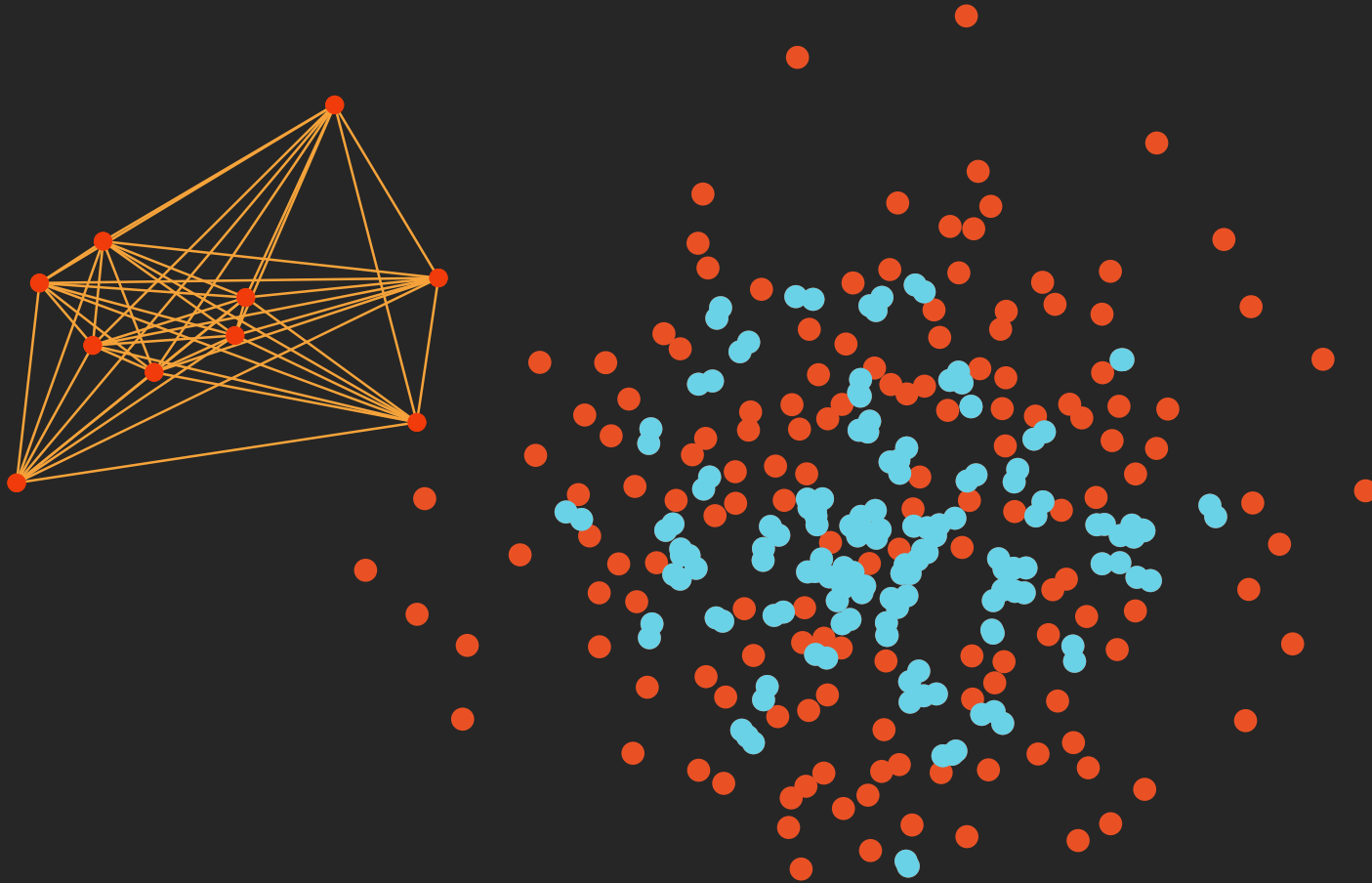
Volume change

How does the metric works in multidimensional space?



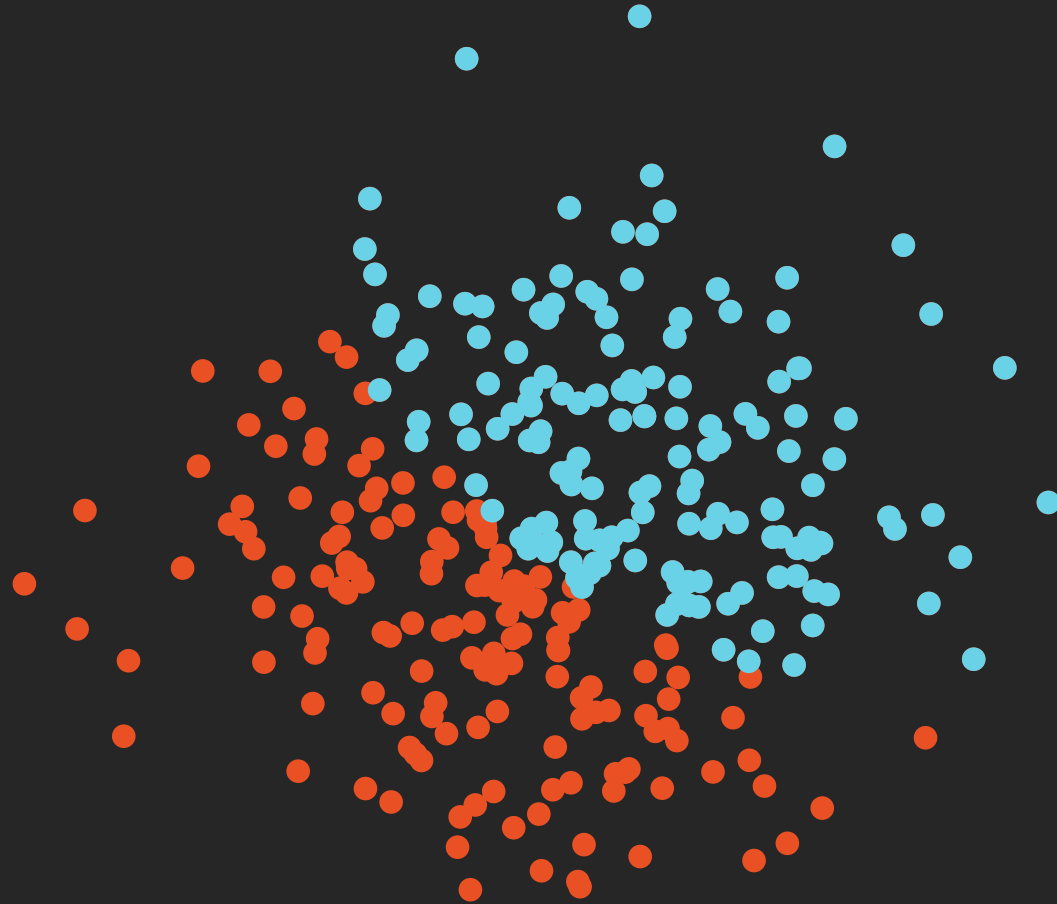
Density change

How does the metric works in multidimensional space?



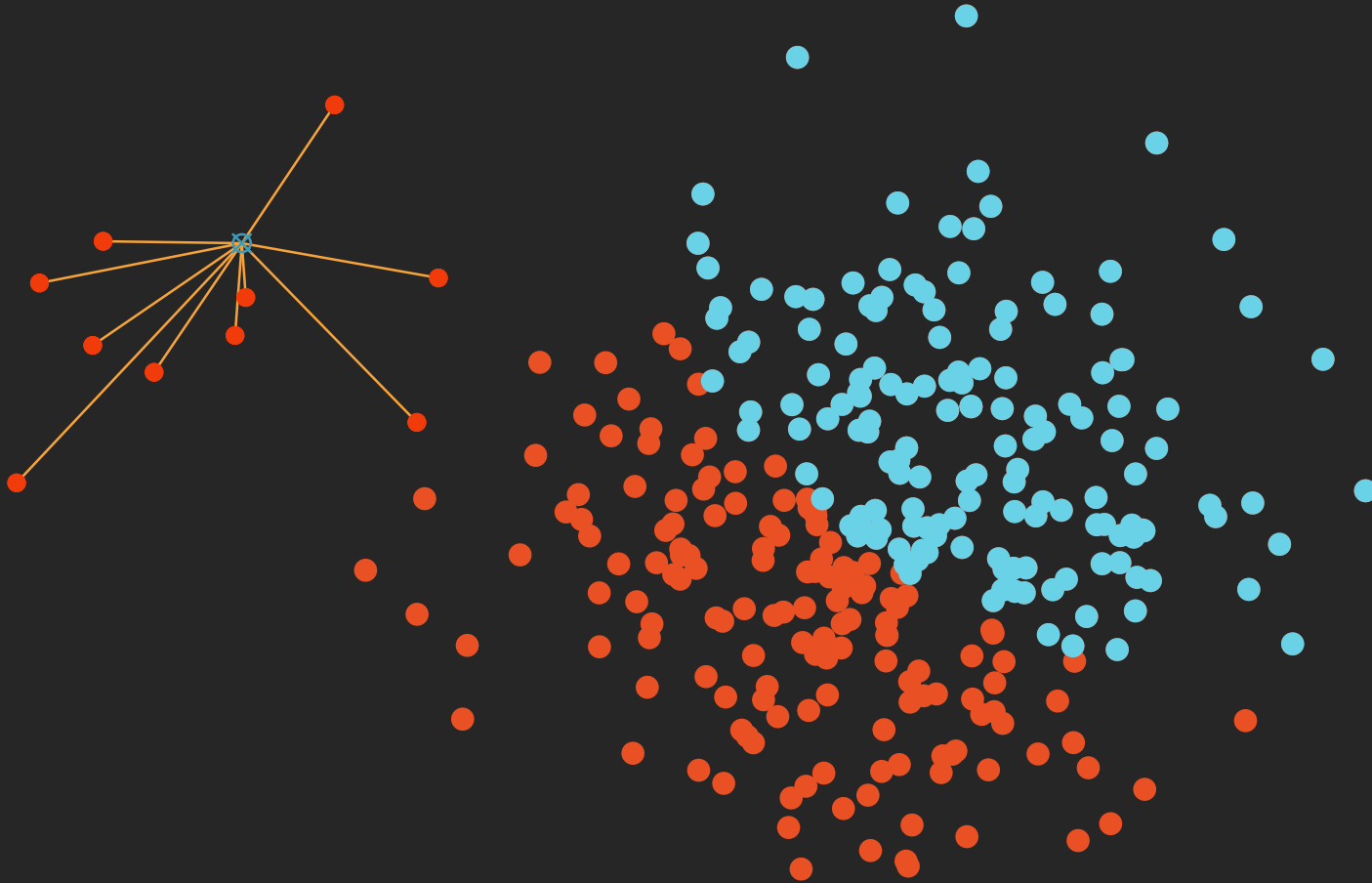
Density change

How does the metric works in multidimensional space?

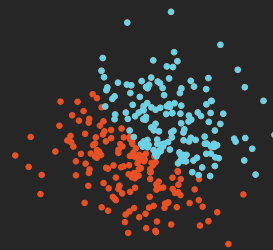
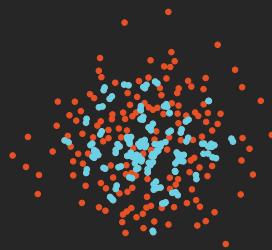
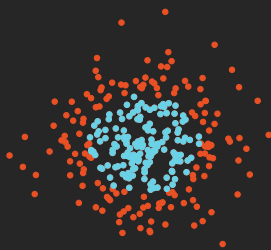
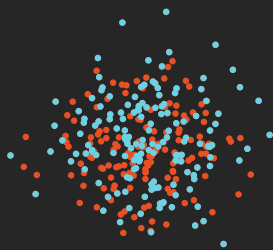


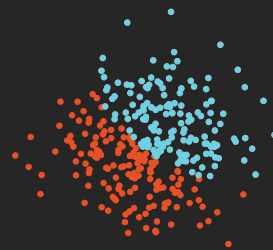
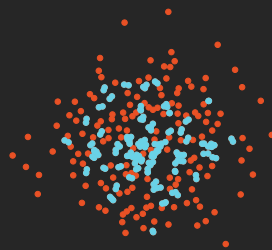
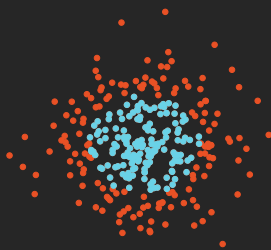
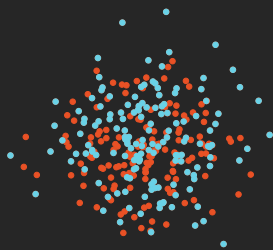
Position change

How does the metric works in multidimensional space?

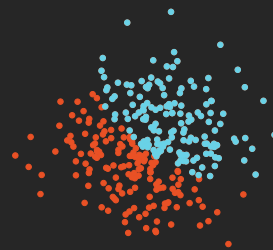
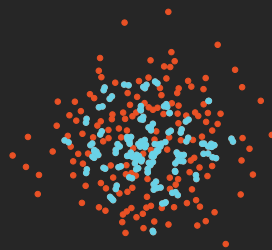
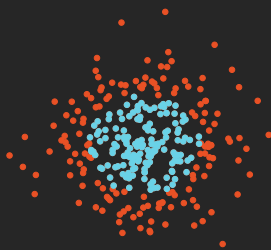
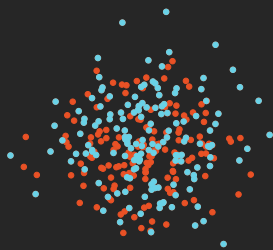


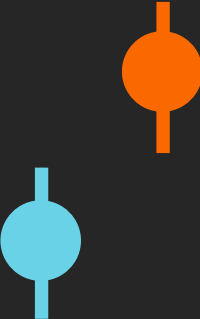
Position change

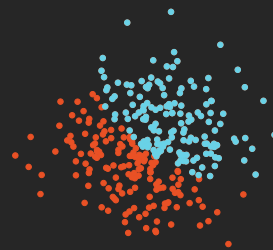
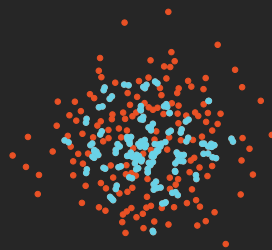
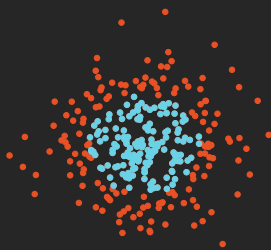
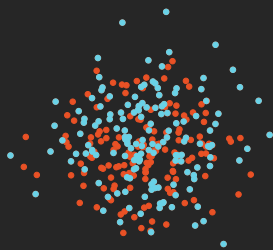




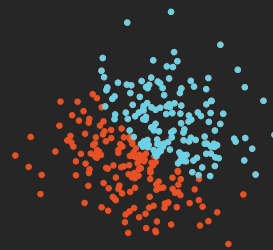
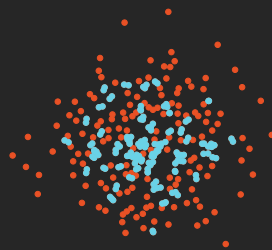
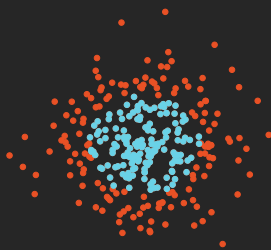
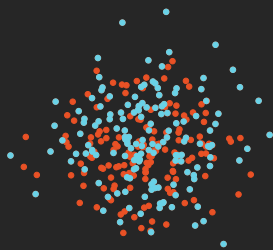
			



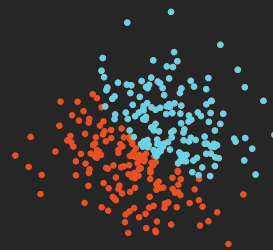
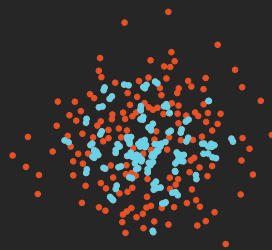
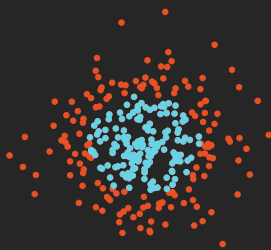
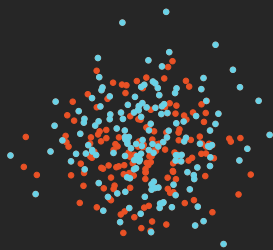
			





$=$	$\neq$	$=$	$=$
$=$	$=$	$\neq$	$=$



$=$	$\neq$	$=$	$=$
$=$	$=$	$\neq$	$=$
$=$	$=$	$=$	$\neq$

*The
Multidimensional
nightmare!*

VS.



momS: measuring
occupancy in
multidimensional space

moms: Measuring Occupancy in Multidimensional Spaces

Guillermo 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:

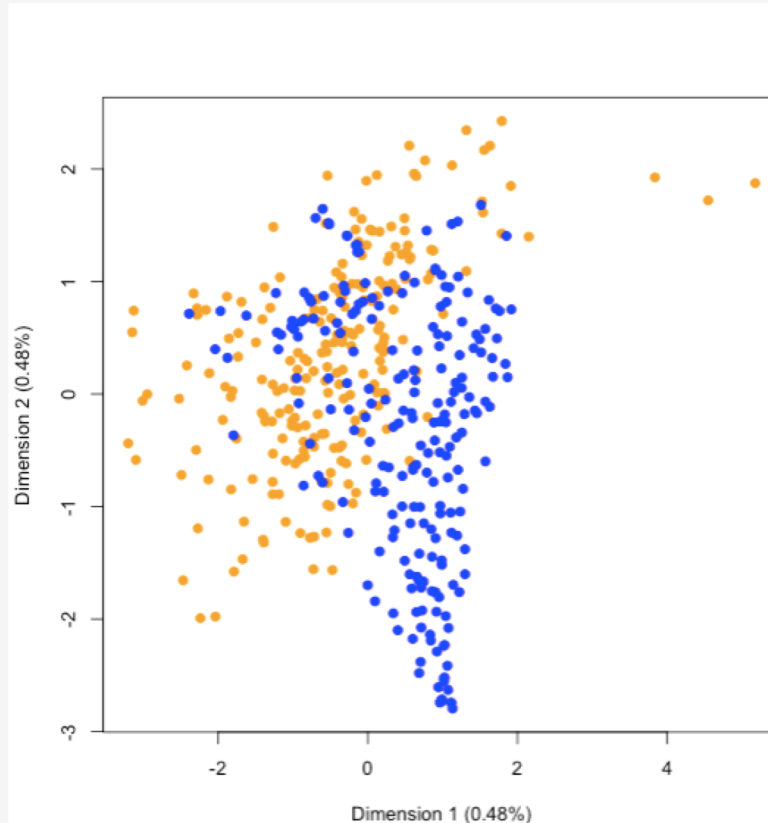
0.1

0.5

0.9

0.1 0.18 0.26 0.34 0.42 0.5 0.58 0.66 0.74 0.82 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

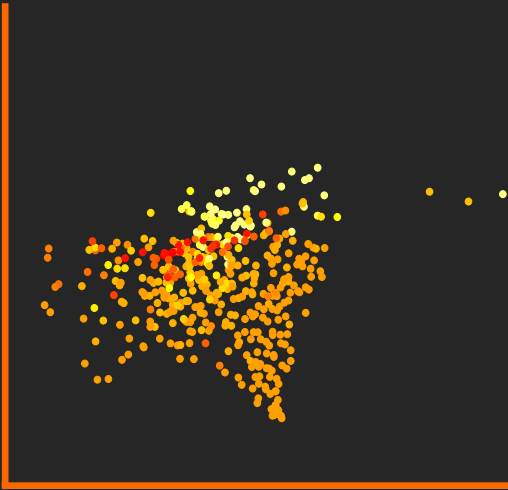
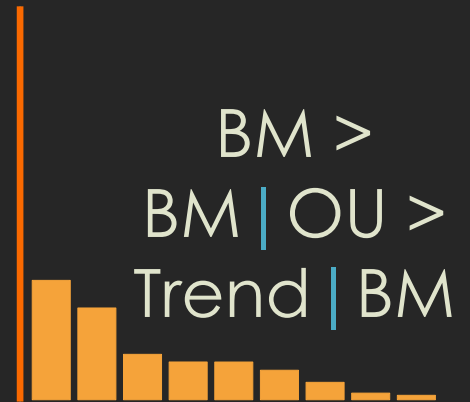
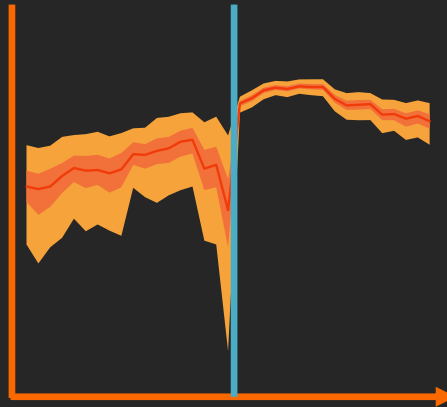
2

Colours

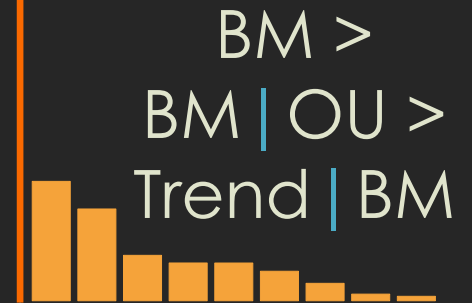
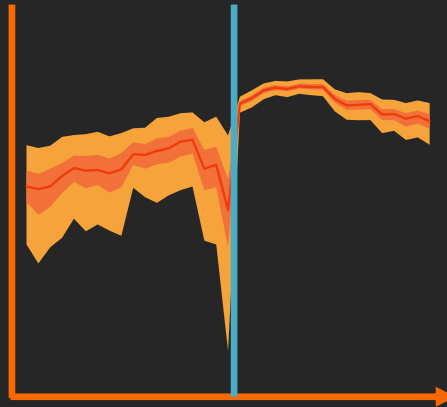
Contrast

☐ Axis with the same scale

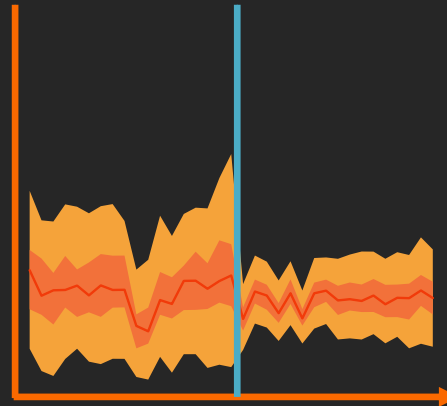
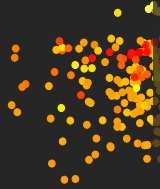
Volume:
Sum of
variances



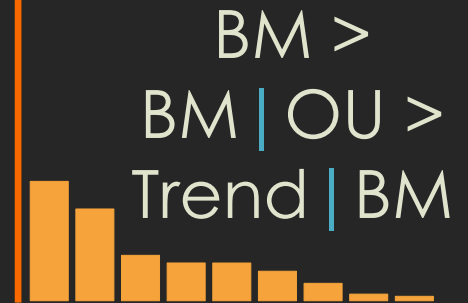
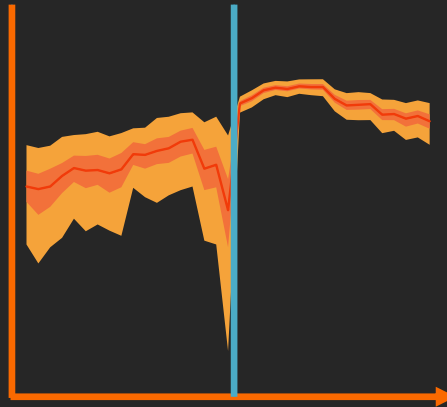
Volume:
Sum of
variances



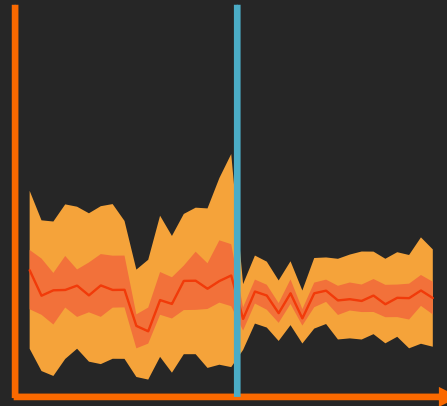
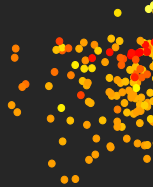
Density:
Average
nearest
neighbour
distance



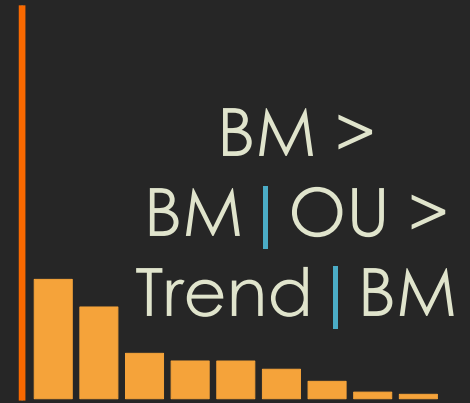
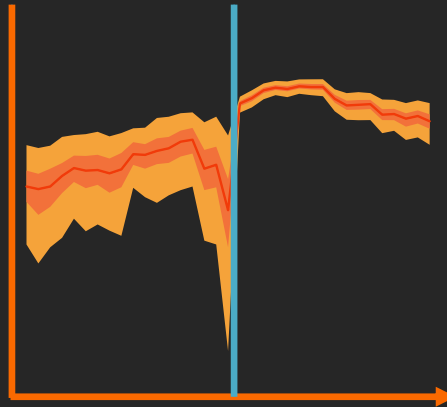
Volume:
Sum of
variances



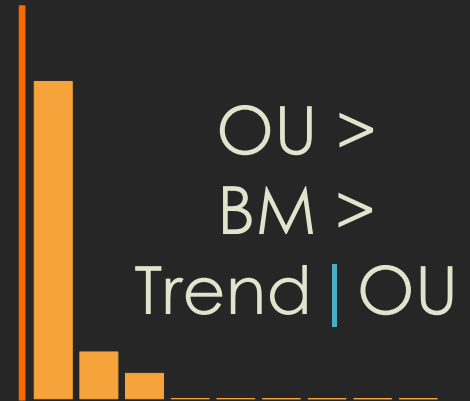
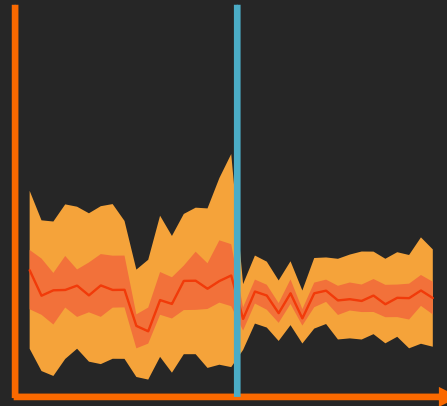
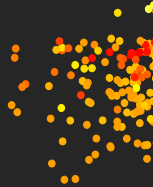
Density:
Average
nearest
neighbour
distance



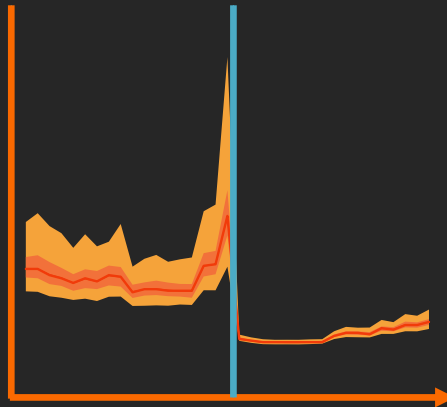
Volume:
Sum of
variances



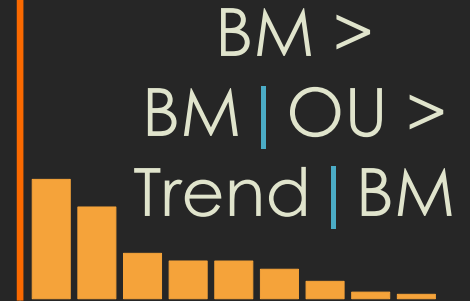
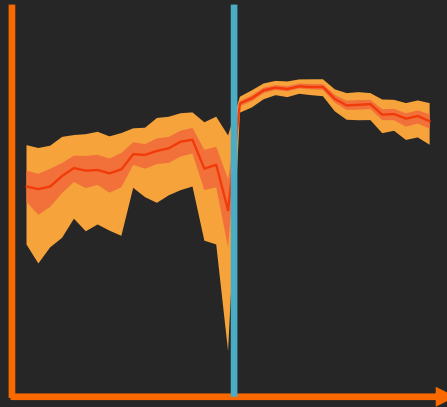
Density:
Average
nearest
neighbour
distance



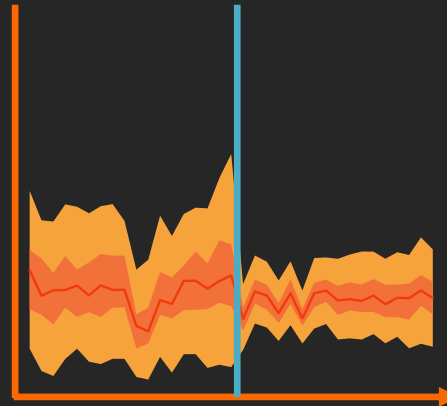
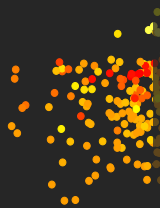
Position:
Average
displacement



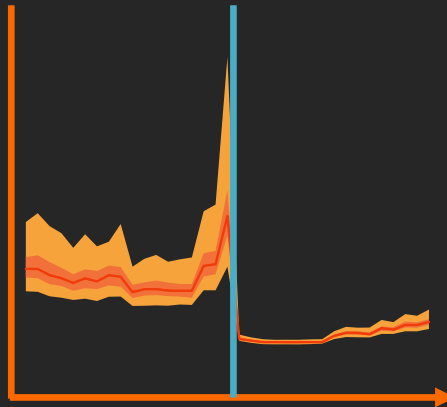
Volume:
Sum of
variances



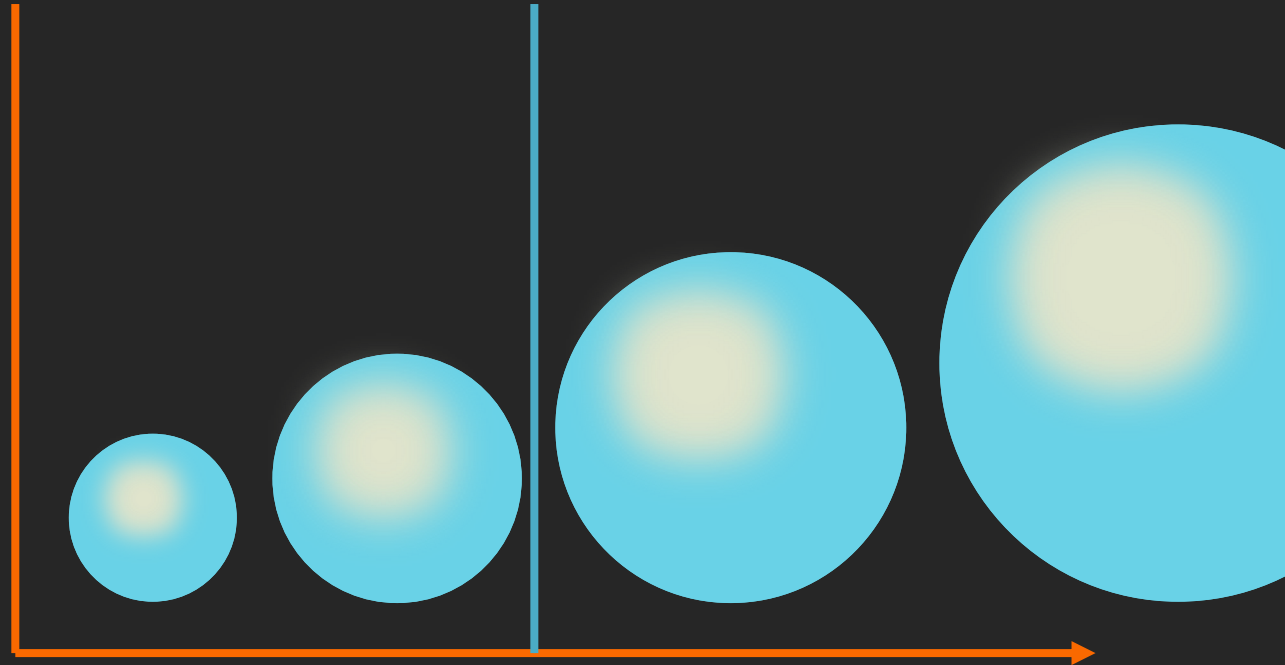
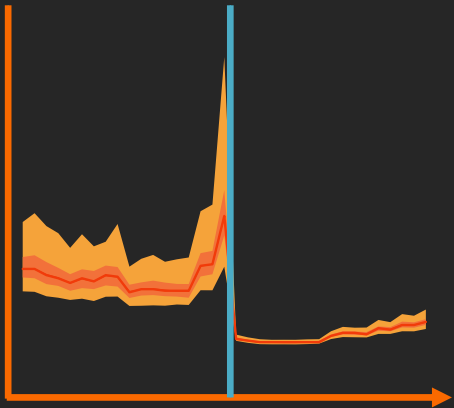
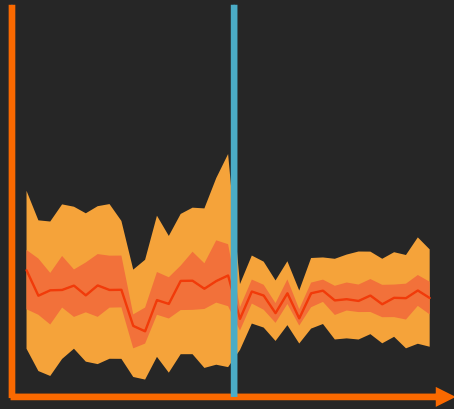
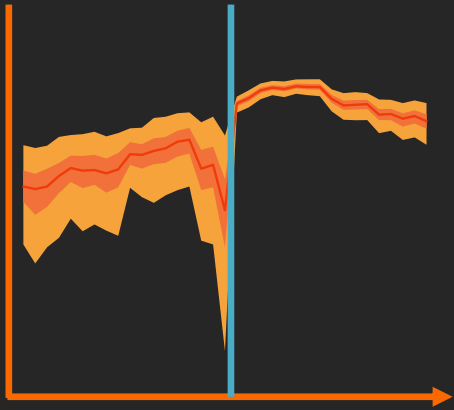
Density:
Average
nearest
neighbour
distance



Position:
Average
displacement



Effect of K-Pg on mammal evolution?



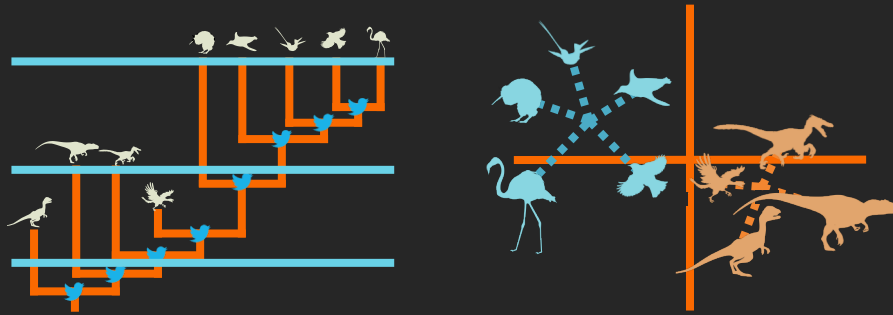
Volume: constant increase/constraint?
Density: constraint/ constant increase?
Position: constant change/ trend?



Thanks!



github.com/TGuillerme/disprity



github.com/TGuillerme/moms

