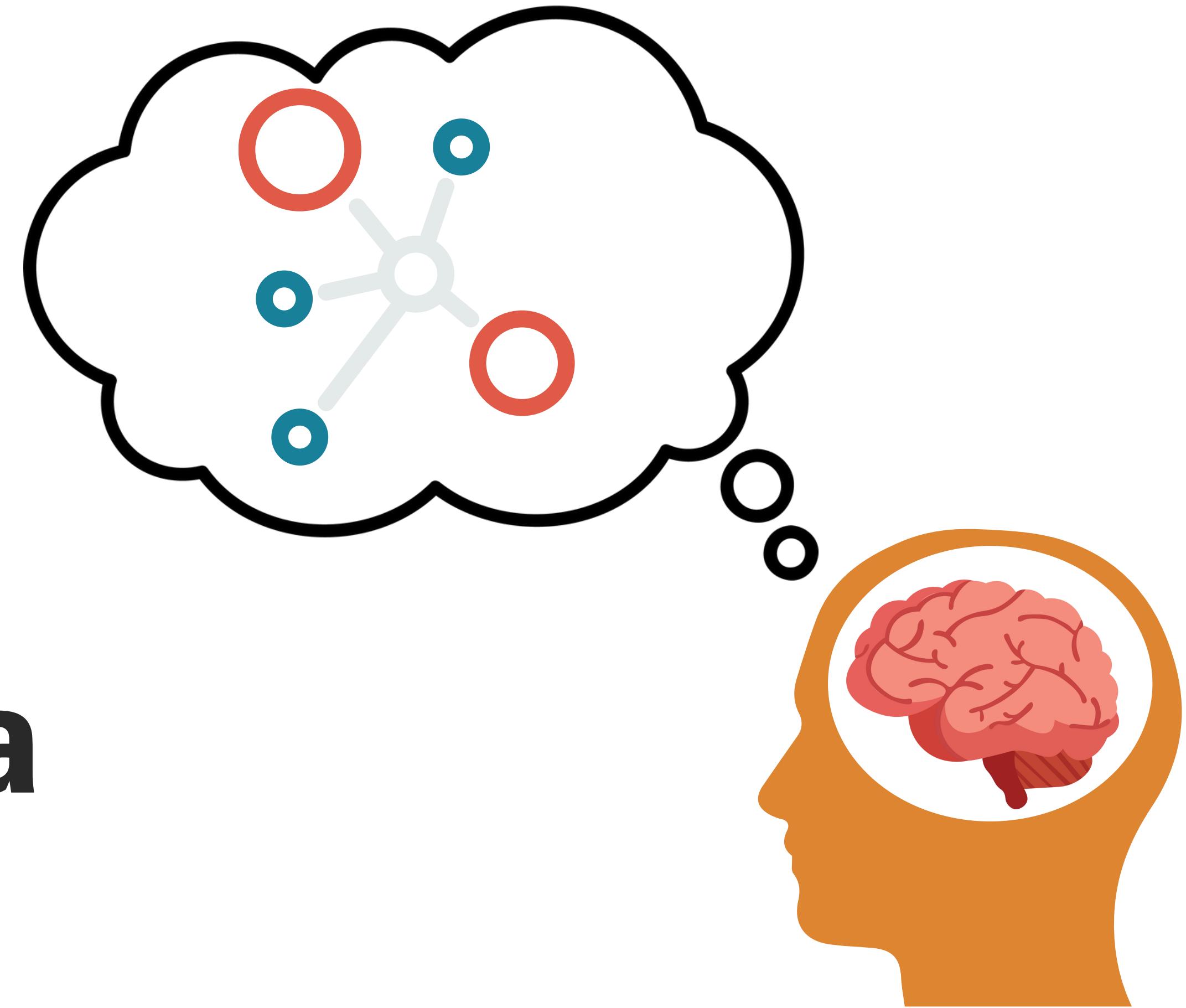
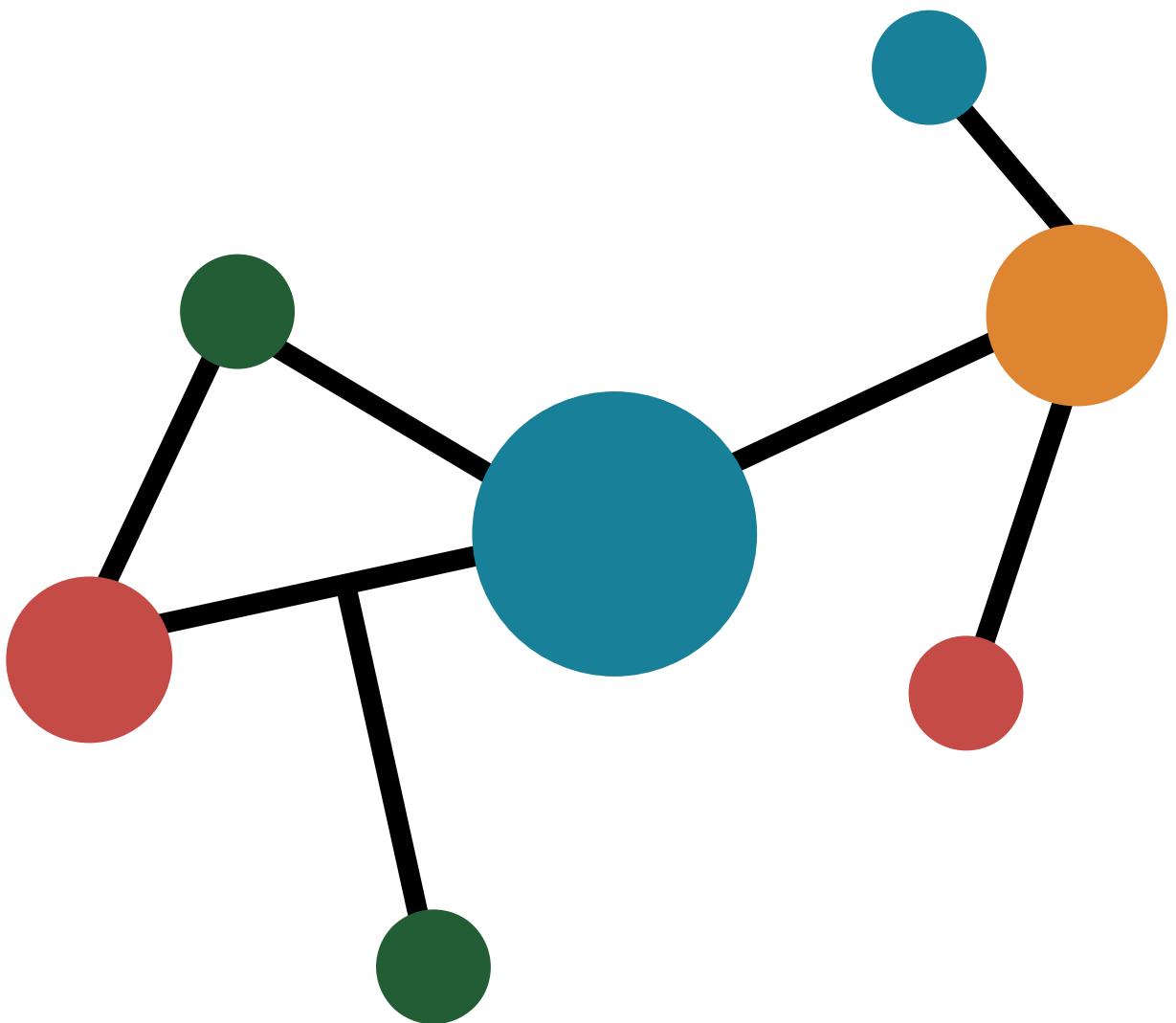


Lelia Ersco
Data Science 2023

Brain Area Proximity

Graph-Physical Distance





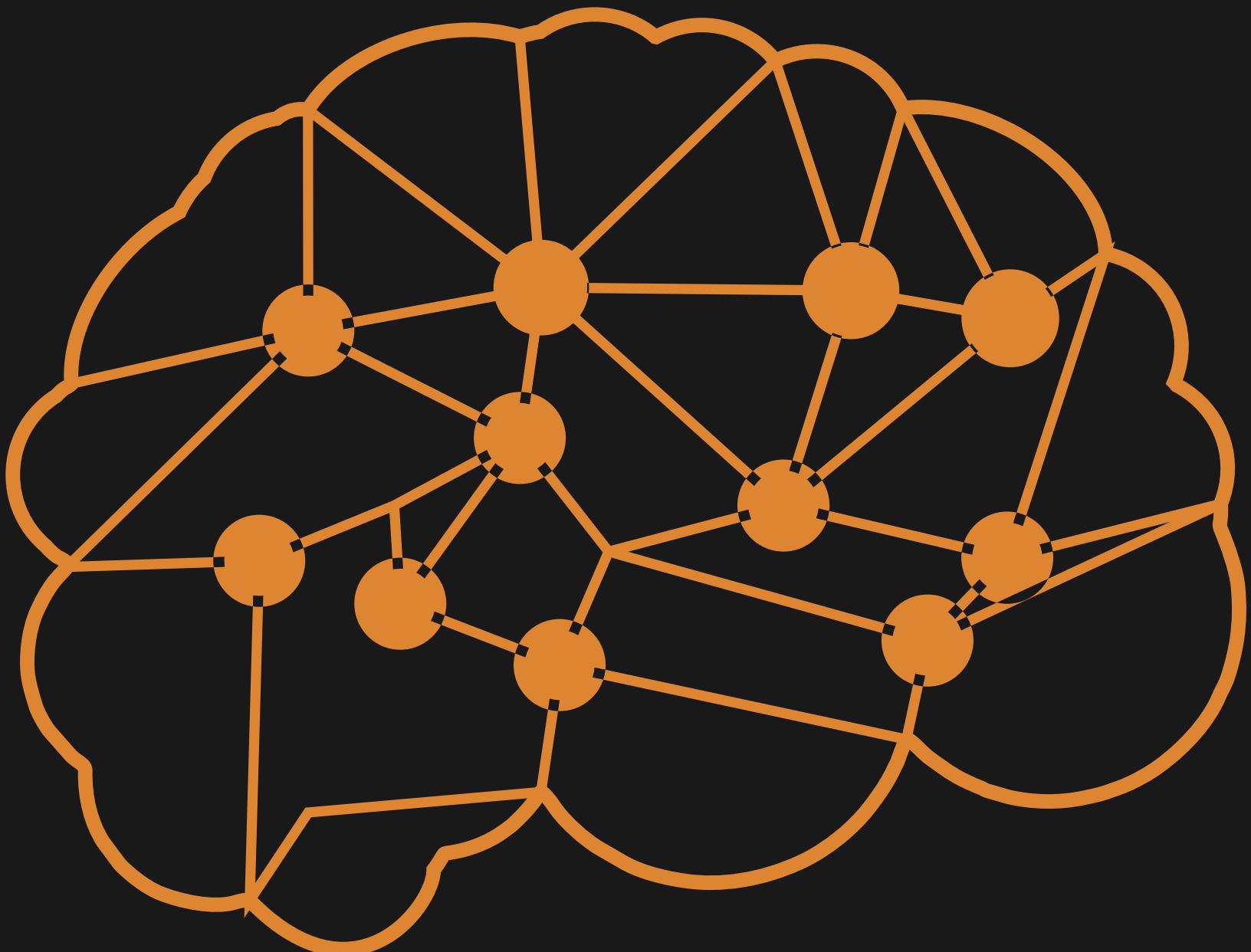
Research Question

Is there a **correlation** between the physical proximity of brain regions in the brain and their proximity in a connectome network created from those regions?

Why?

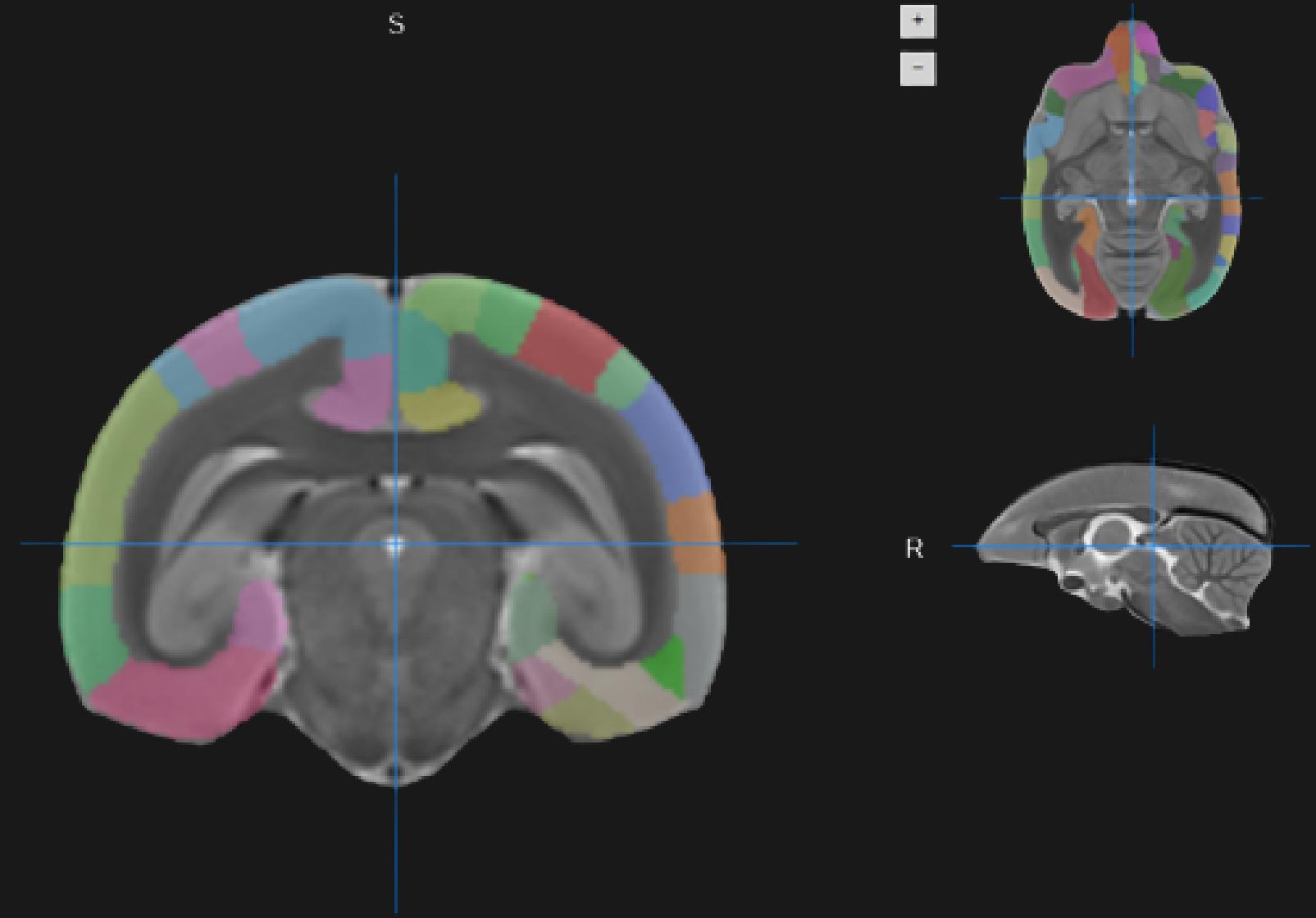
Examine the relationship
between **functionality**
and **topology**.

Easily build highly-
relevant **models**.

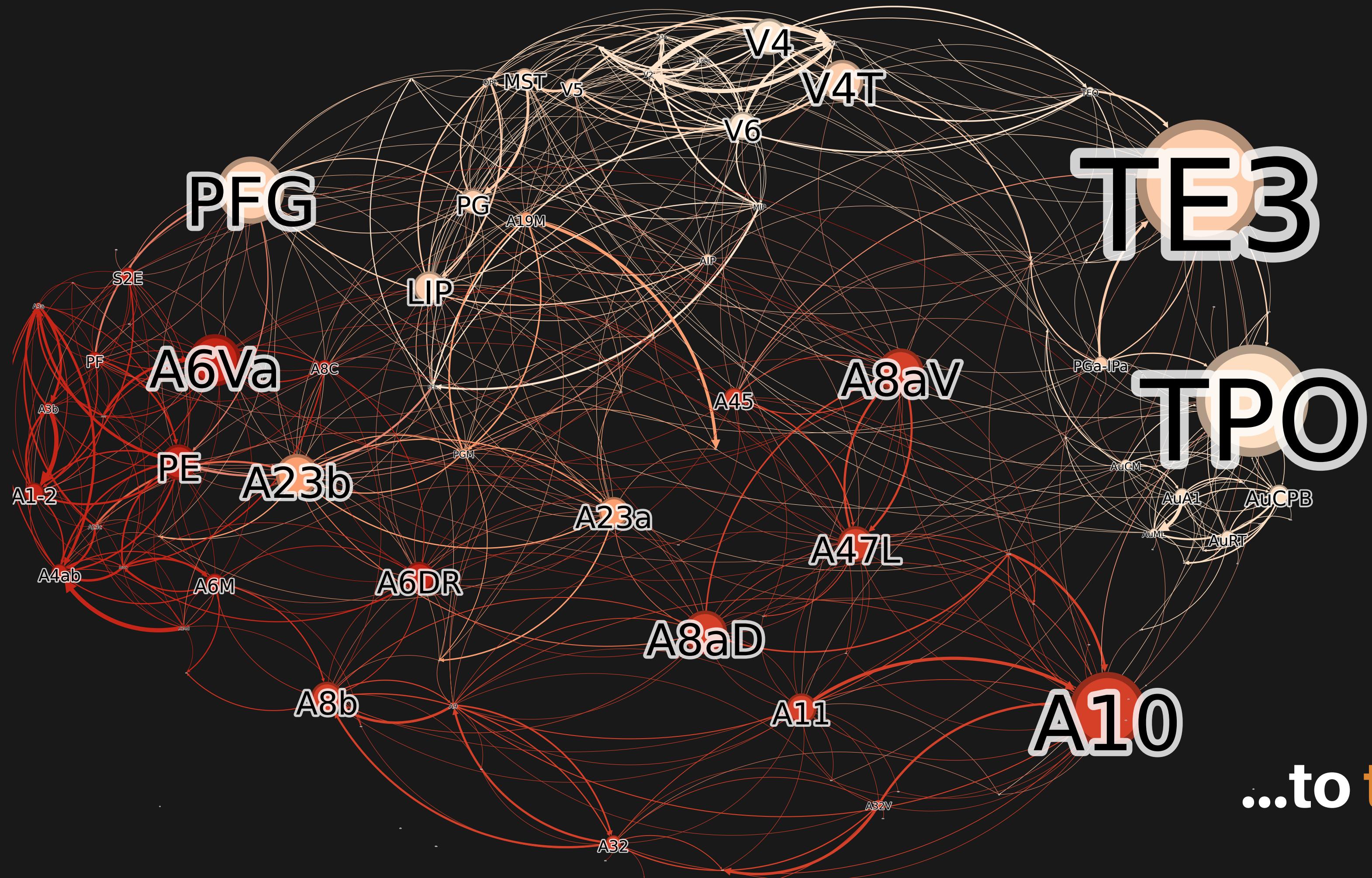


How?

From **this...**



...to this...



...to this!

2 Types of Data

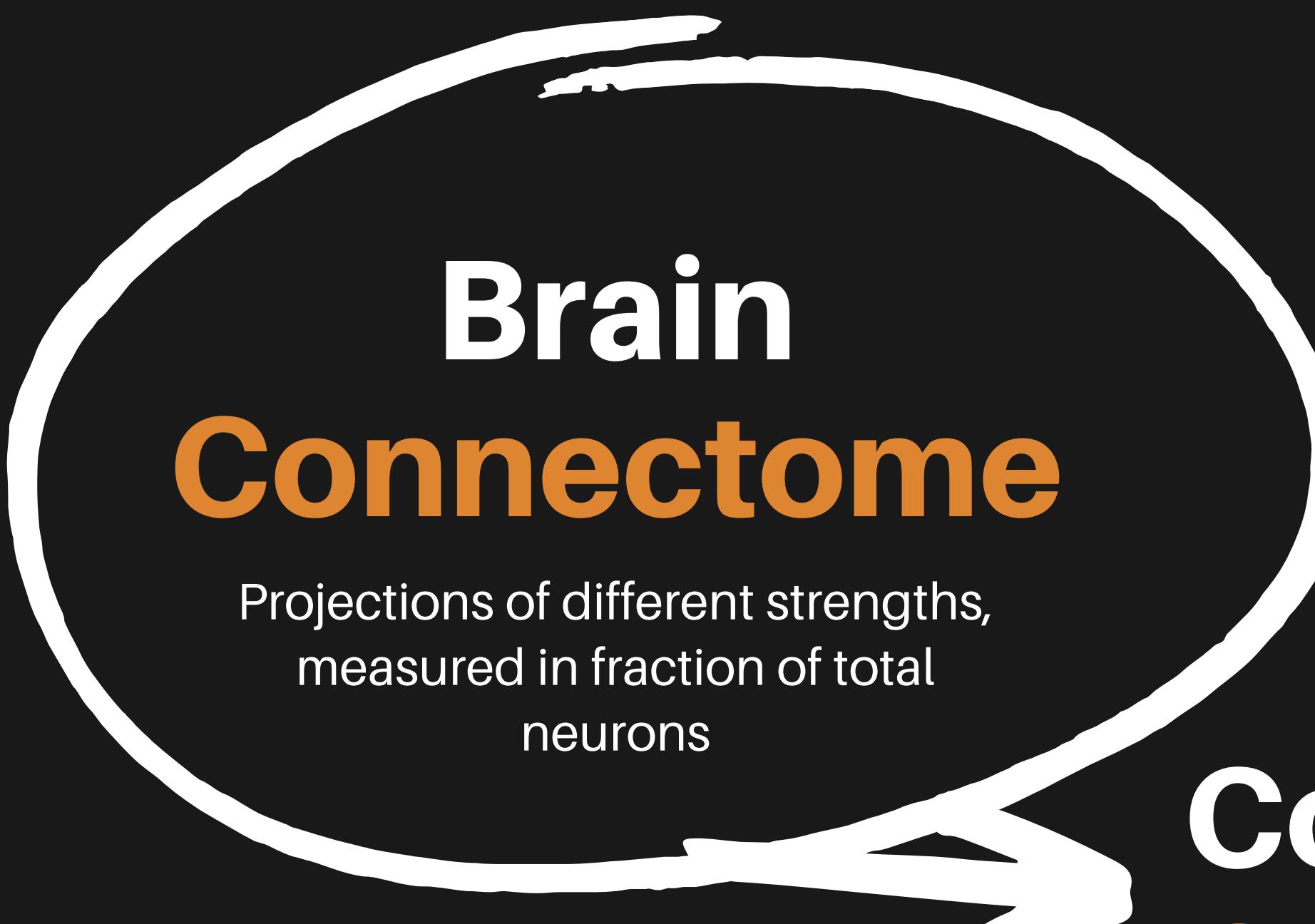
Brain Connectome

Projections of different strengths,
measured in fraction of total
neurons

Brain Area Distances

Physical distance , measured in micrometers

2 Types of Data



**Brain
Connectome**

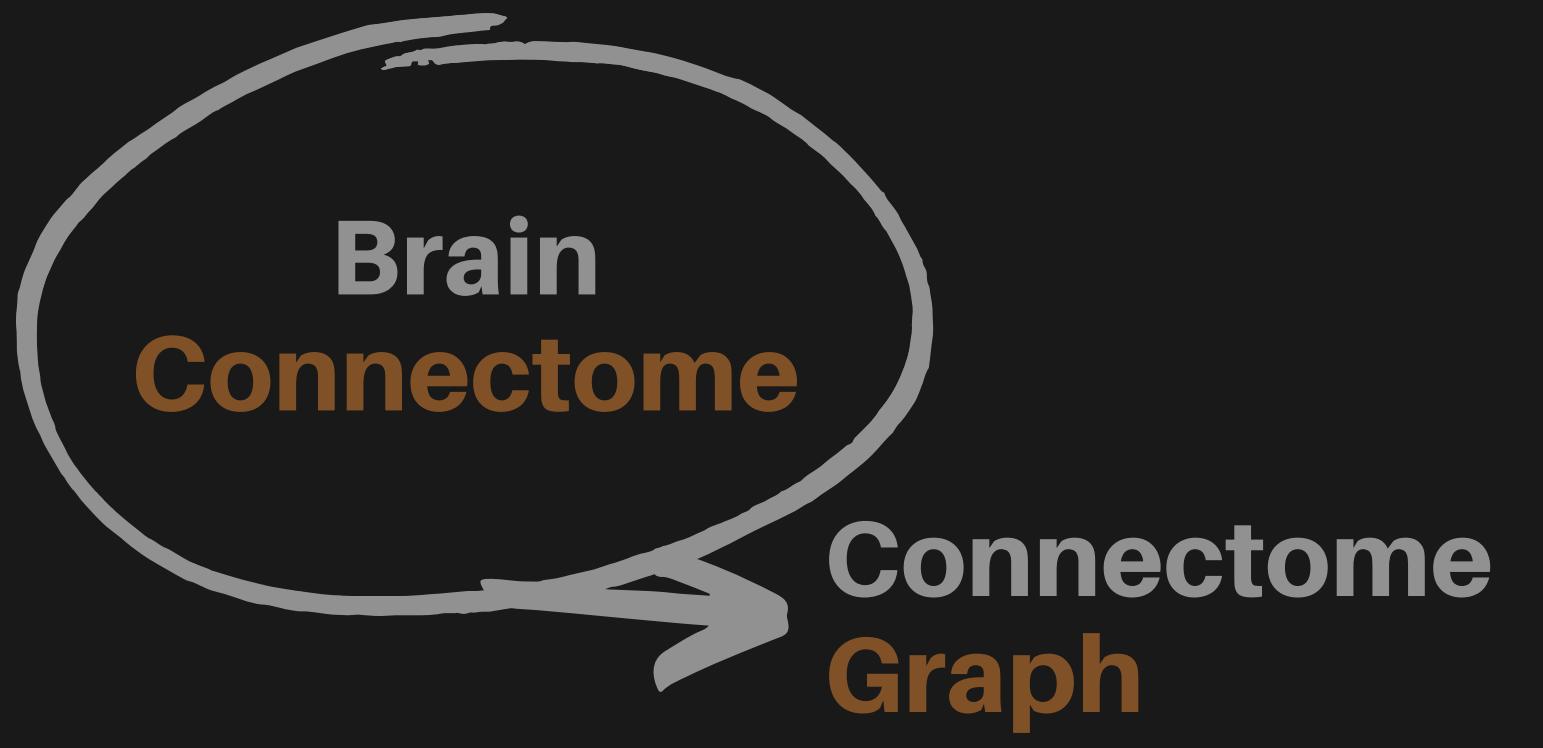
Projections of different strengths,
measured in fraction of total
neurons

**Brain Area
Distances**

Physical distance , measured in micrometers

**Connectome
Graph**

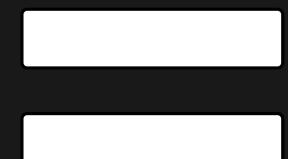
Network Graph Construction



Nodes
shortest
path



Edge
Weights



Graph
Distances

Connectome Graph Distances

Hypothesis

are strongly correlated to

Brain Area Distances

Brain measured distances

Mean: 12.43
Std: 5.3

Source	Target	Brain Distance
AuR	AURM	0.37
S2E	S2I	0.96
A24c	A24b	1.04
A36	A35	1.07
AuRTL	AuRTM	1.08

Closest brain areas in space
(not normalized)

Source	Target	Brain Distance
V1	APir	28.43
V1	A10	26.88
Ent	V1	26.58
V3	A10	26.35
A13b	V1	26.13

Furthest brain areas in space
(not normalized)

Density: 0.4

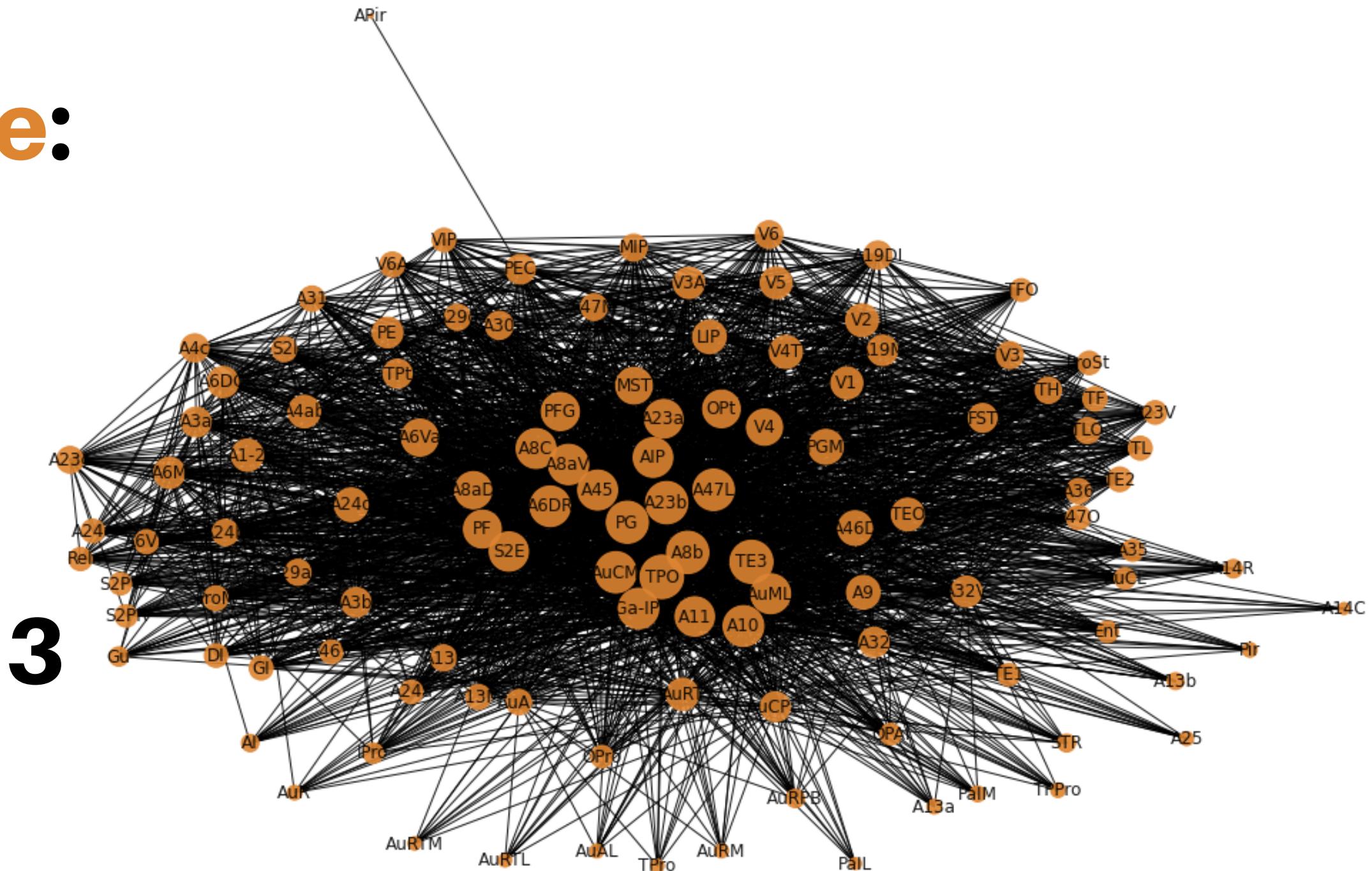
Transitivity: 0.59

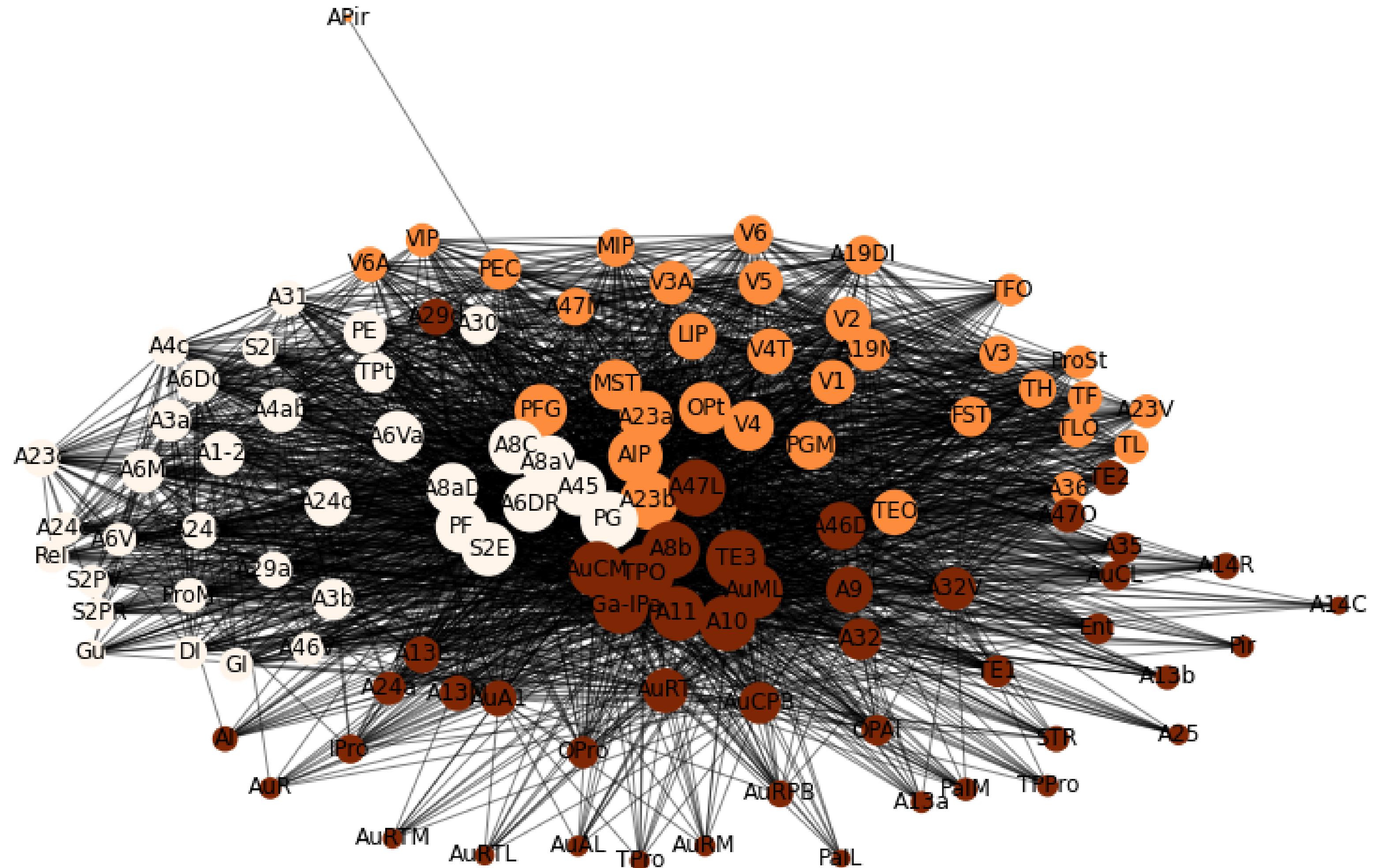
Top nodes by degree:

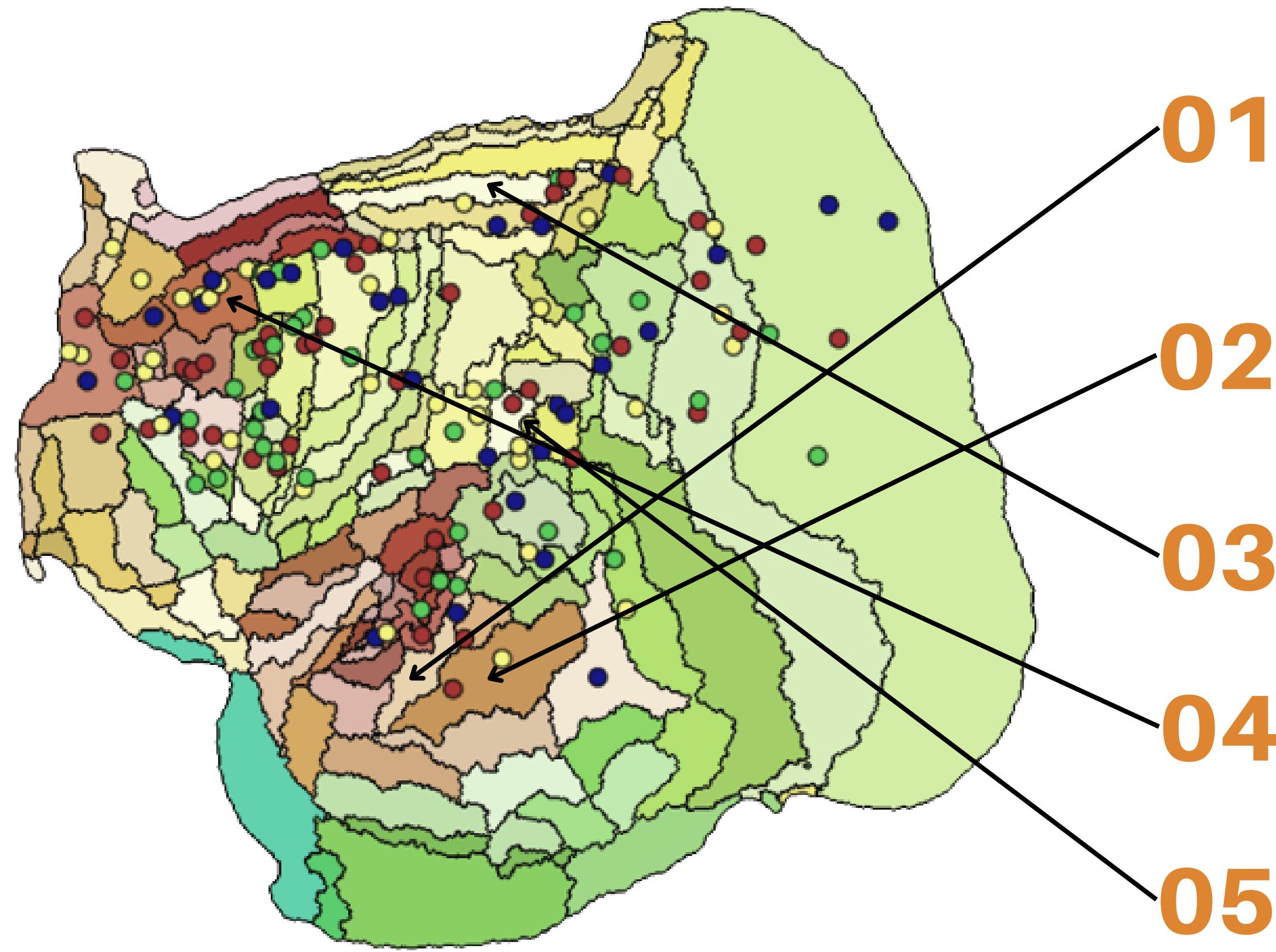
- TPO: 106
- TE3: 104
- A23b: 100
- A8b: 100
- PG: 90

Nr. of Communities: 3

- Comm 1: 36 areas
- Comm 2: 35 areas
- Comm 3: 45 areas







TPO : temporo-parieto-occipital
association area (superior temporal
polysensory cortex)

Community 2

TE3 : temporal area TE3 (inferior
temporal cortex)

Community 2

A23b : area 23b of cortex

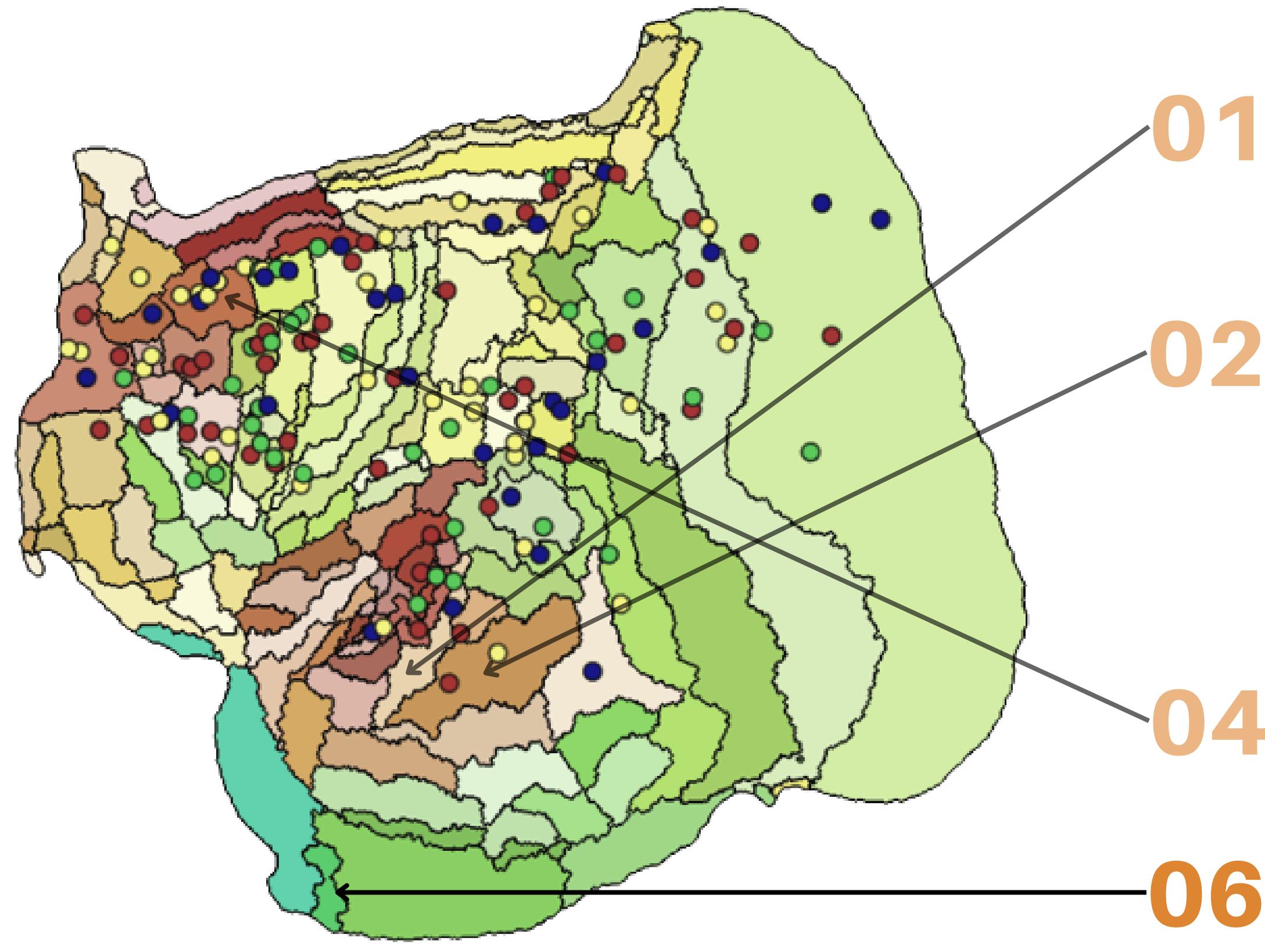
Community 1

A8b : area 8b of cortex

Community 2

PG : parietal area PG

Community 3



TPO : temporo-parieto-occipital
association area (superior temporal
polysensory cortex)

Community 2

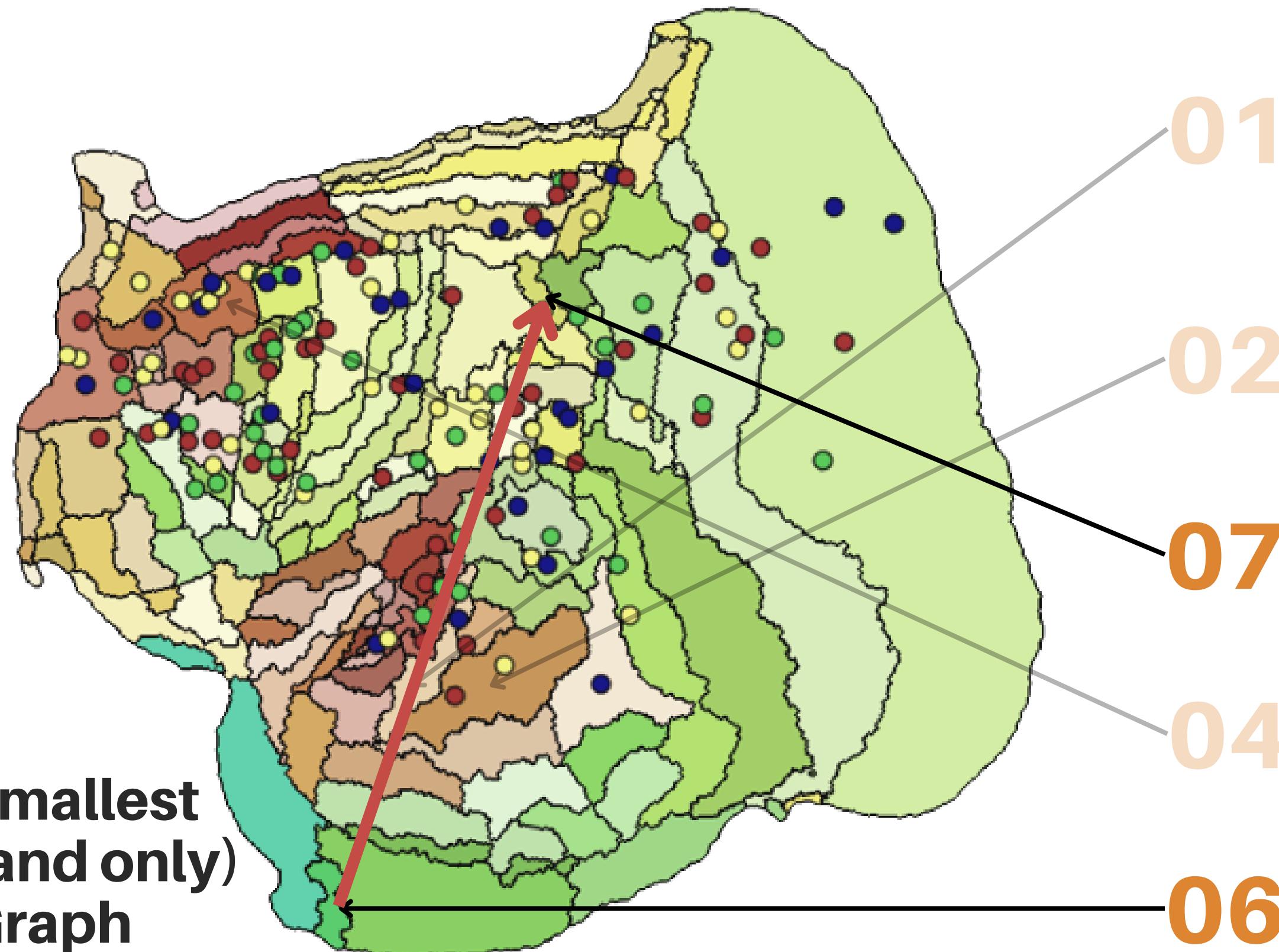
TE3 : temporal area TE3 (inferior
temporal cortex)

Community 2

A8b : area 8b of cortex
Community 2

APir : Amygdalopiriform
transition area
Community 2

**Smallest
(and only)
Graph
Distance**



01
TPO : temporo-parieto-occipital
association area (superior temporal
polysensory cortex)

Community 2

02
TE3 : temporal area TE3 (inferior
temporal cortex)

Community 2

07
PEC : Parietal area PE, caudal part

Community 2

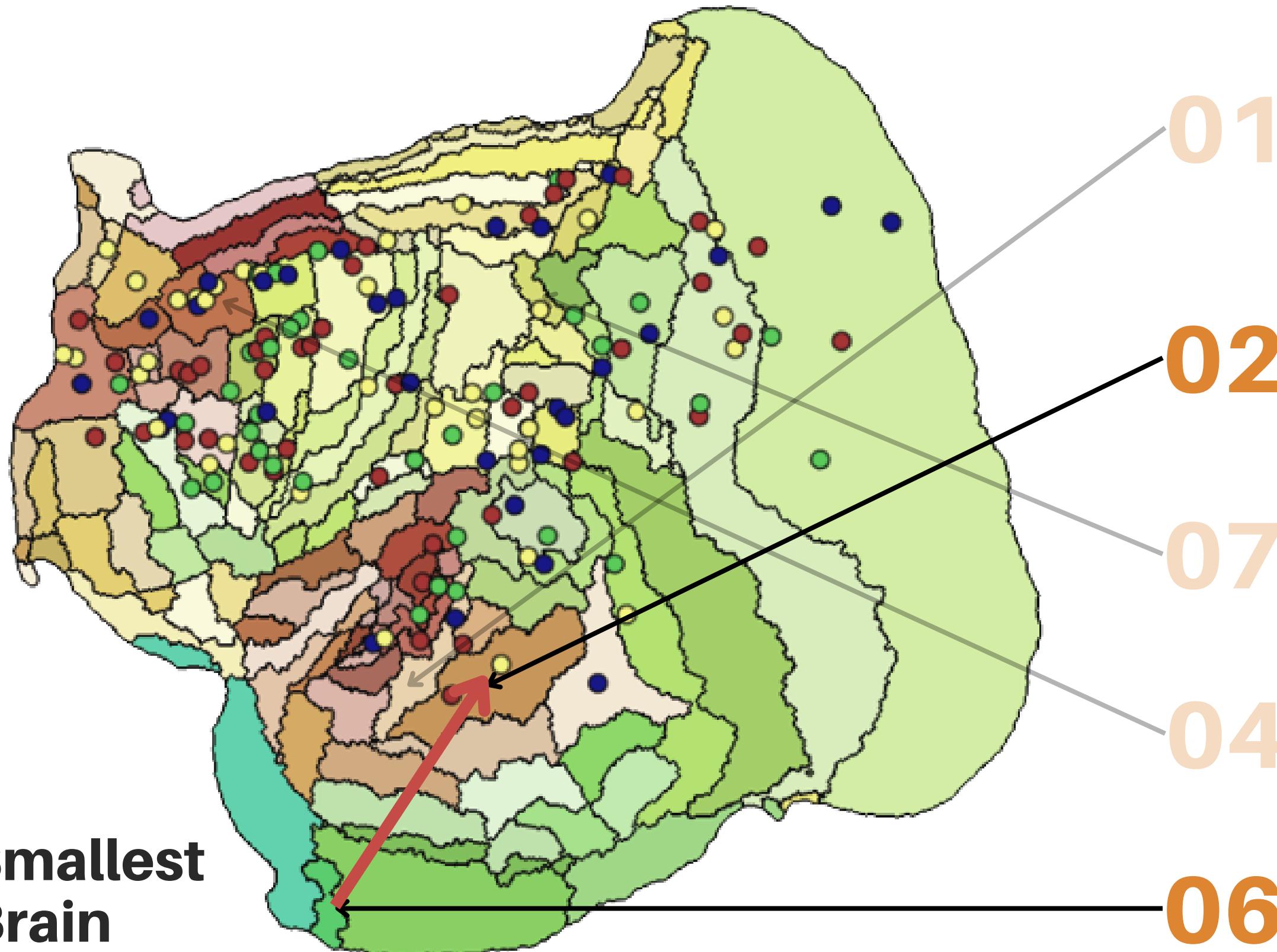
04
A8b : area 8b of cortex

Community 2

06
APir : Amygdalopiriform
transition area

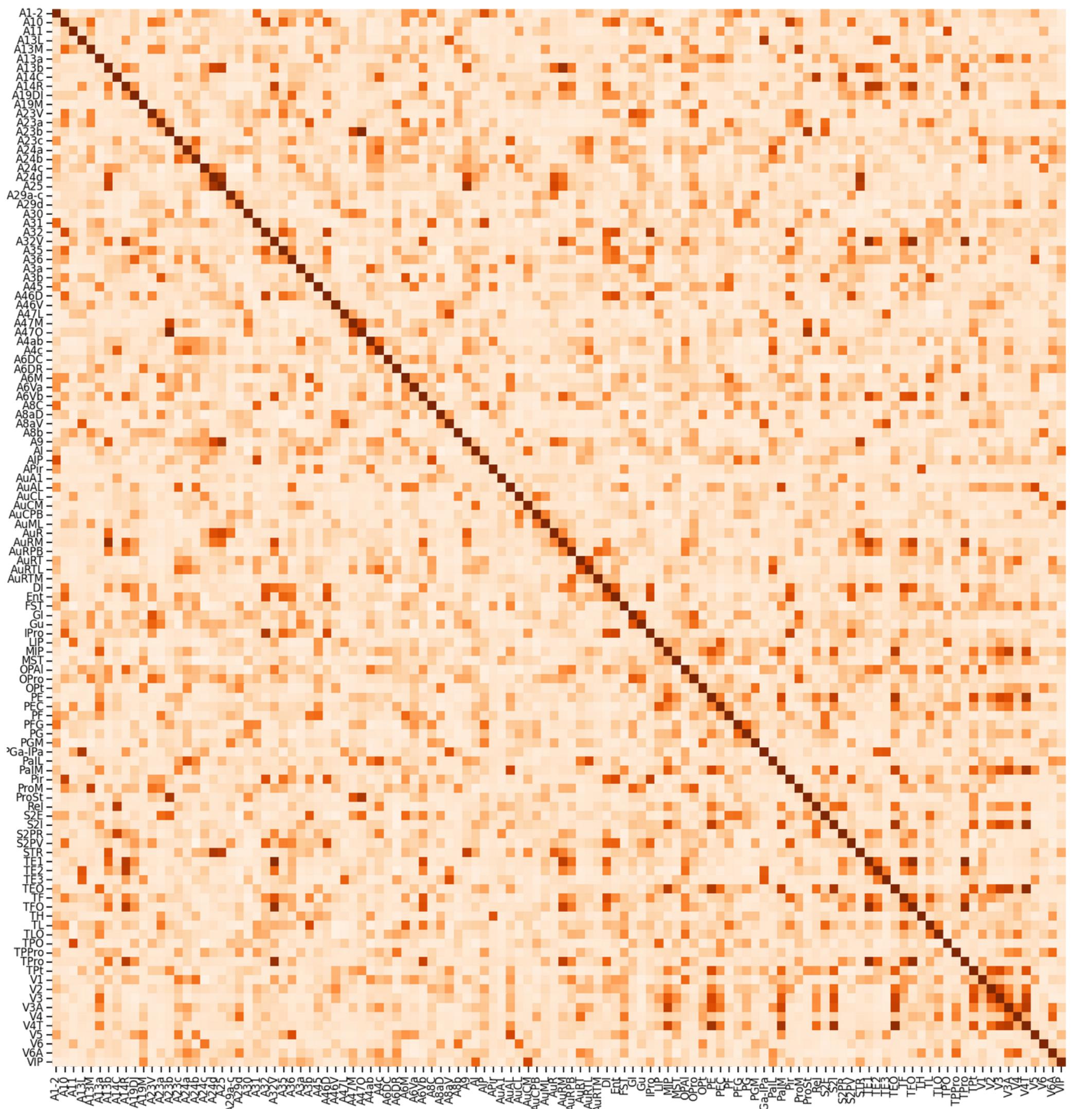
Community 2

Smallest Brain Distance

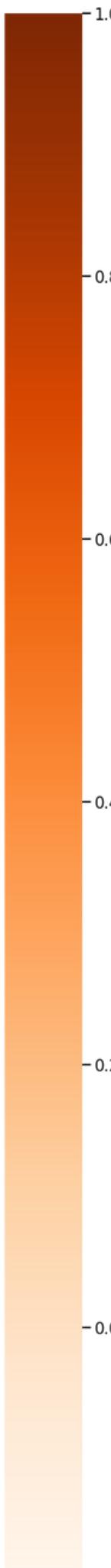
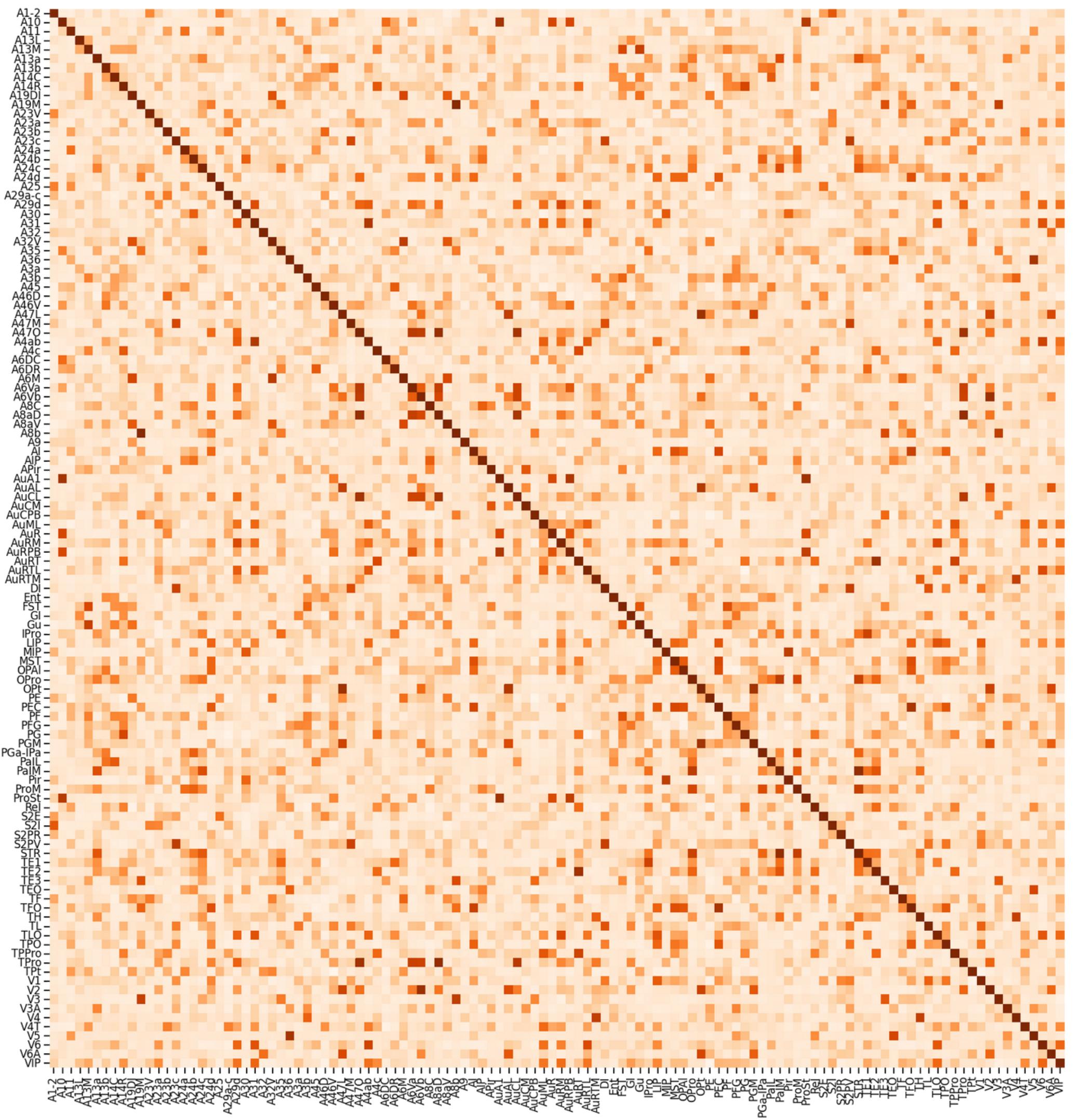


Case study: Amygdalopiriform transition area (APir)

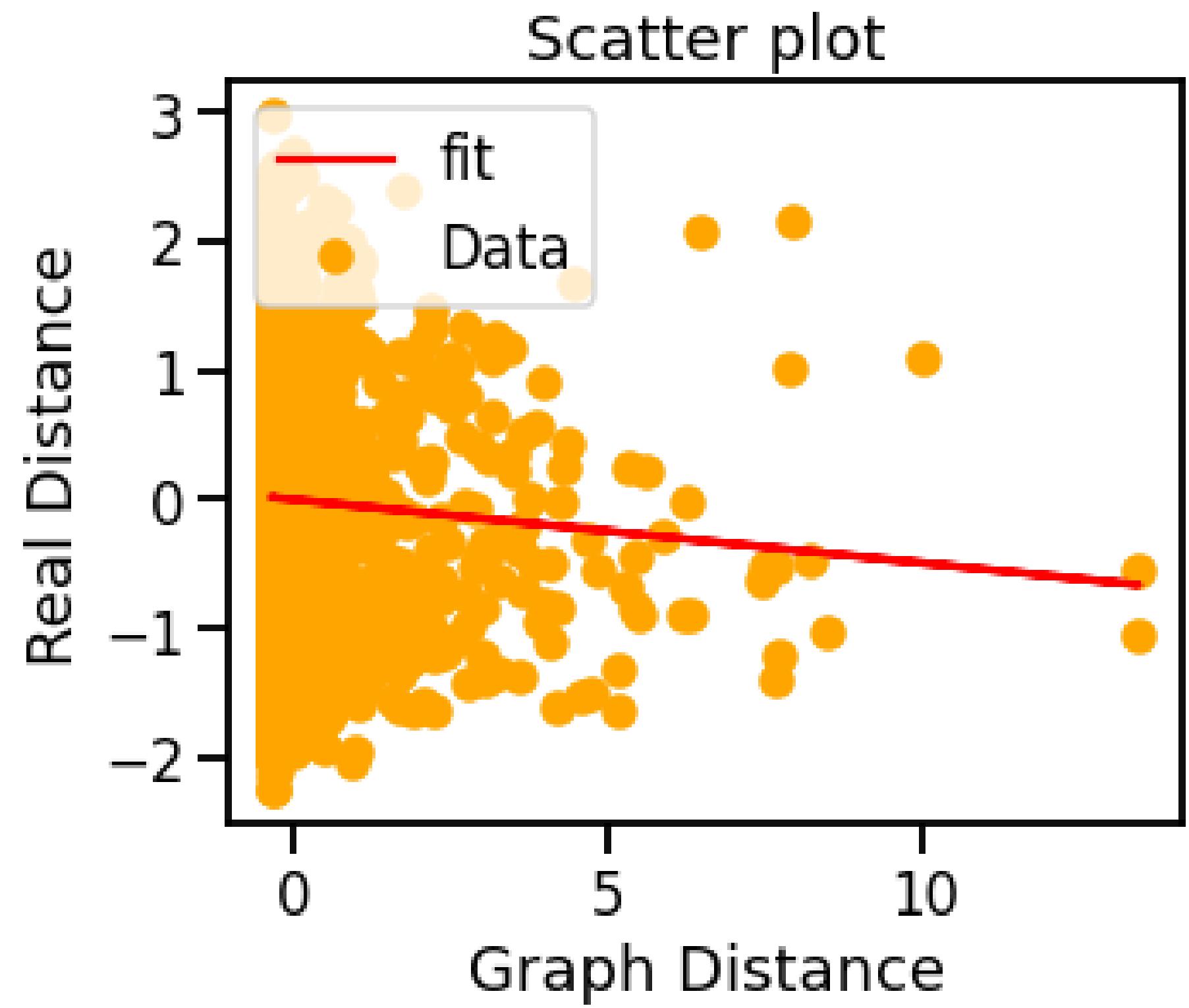
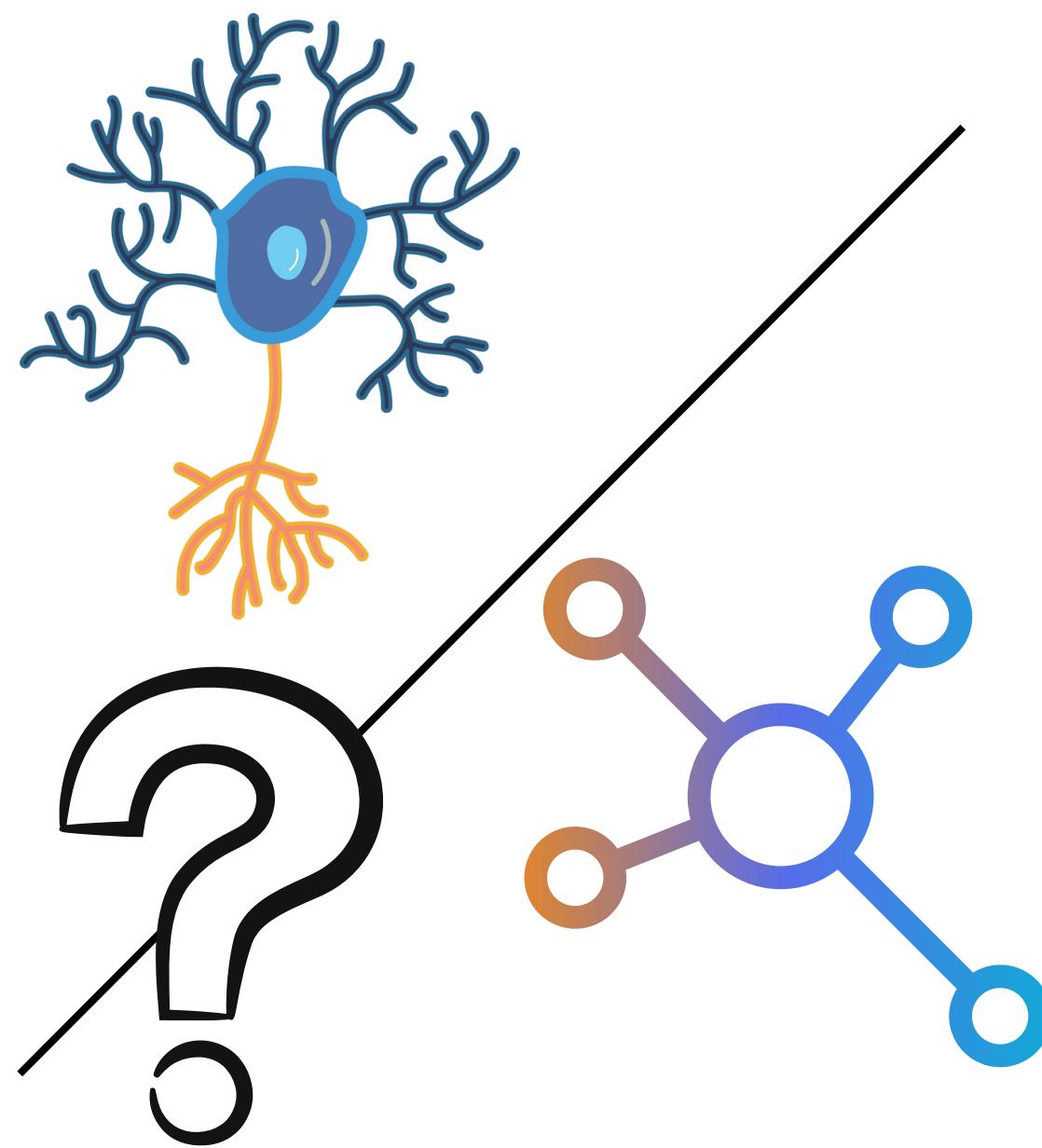
Id	Source	Target	Brain Distance	Graph Distance	Weight	Distance Difference
0	TE3	APir	-0.12	0.31	-	0.22
1	AuCM	APir	0.19	0.28	-	0.55
2	A6Va	APir	0.61	-7.92	-	0.96
3	A3a	APir	0.72	0.36	-	1.08
4	A8C	APir	0.73	-2.56	-	0.93
5	V4	APir	0.75	-3.81	-	1.22
...
25	V3A	APir	1.99	-2.55	-	2.13
26	PEC	APir	2.03	-2.52	0.11	1.81
27	PGM	APir	2.08	-2.66	-	2.37
28	V6	APir	2.38	-2.66	-	2.67
29	V2	APir	2.42	2.47	-	2.77
30	V1	APir	2.98	-6.53	-	3.33

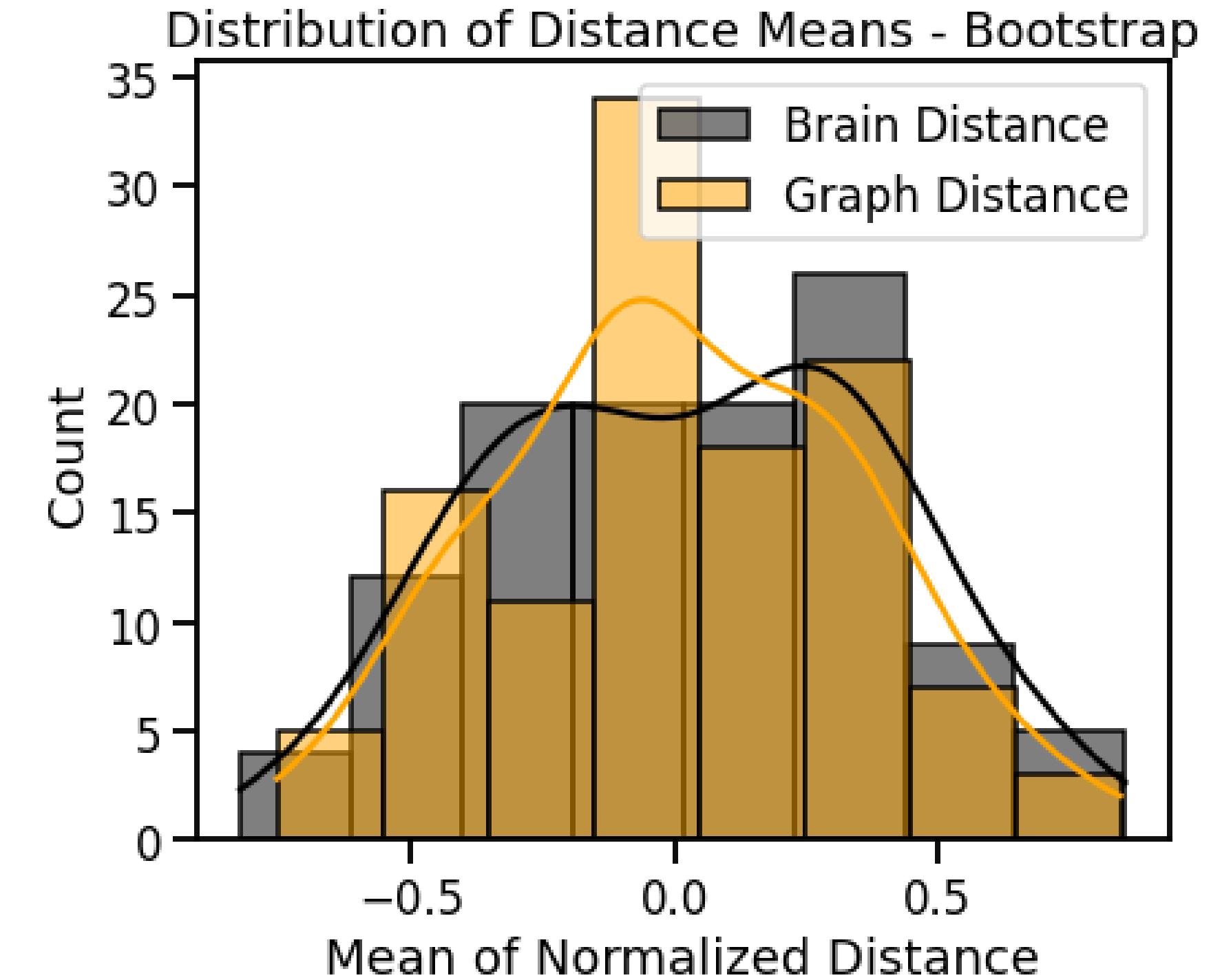
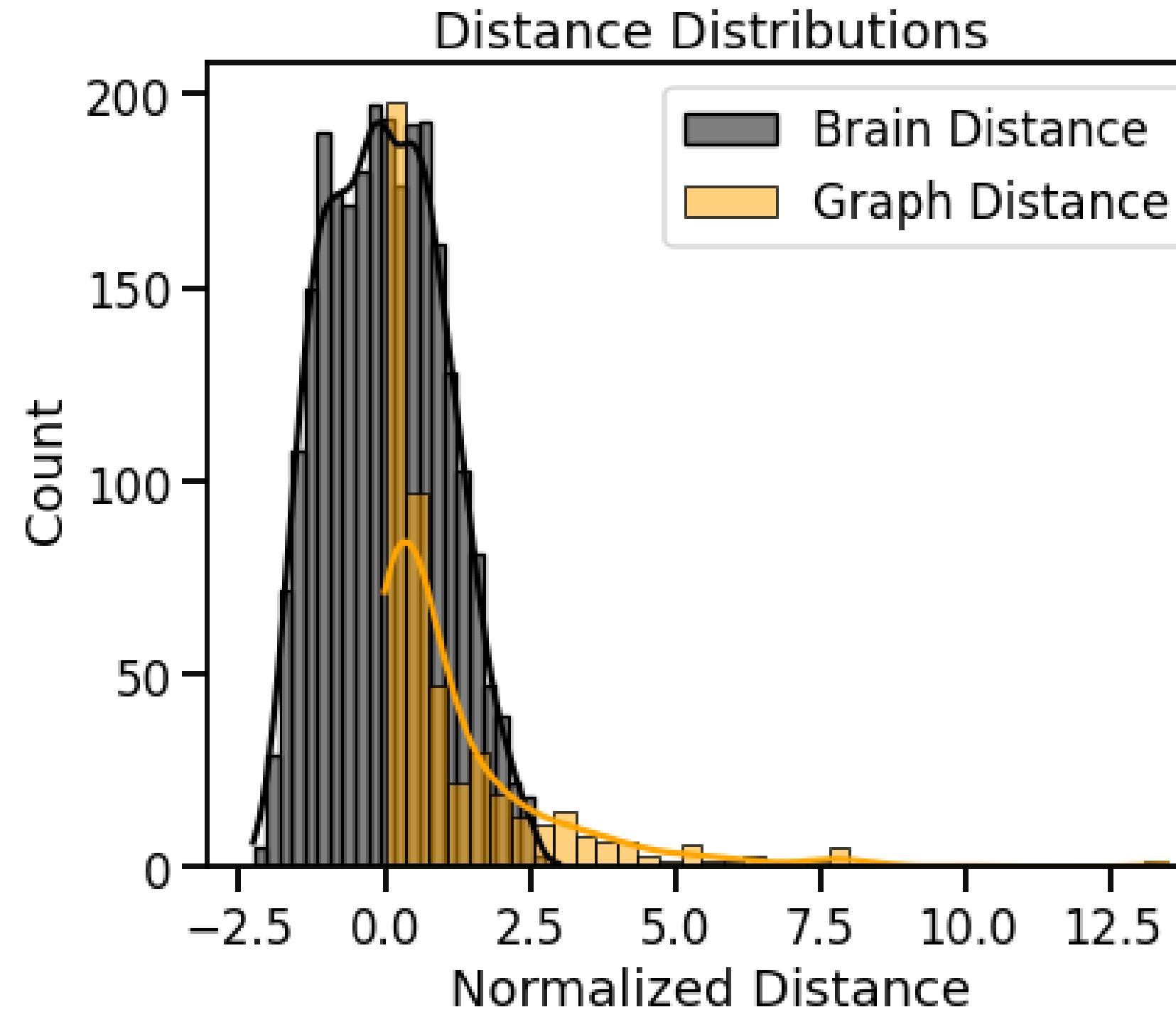


Brain Connectome (real distance)

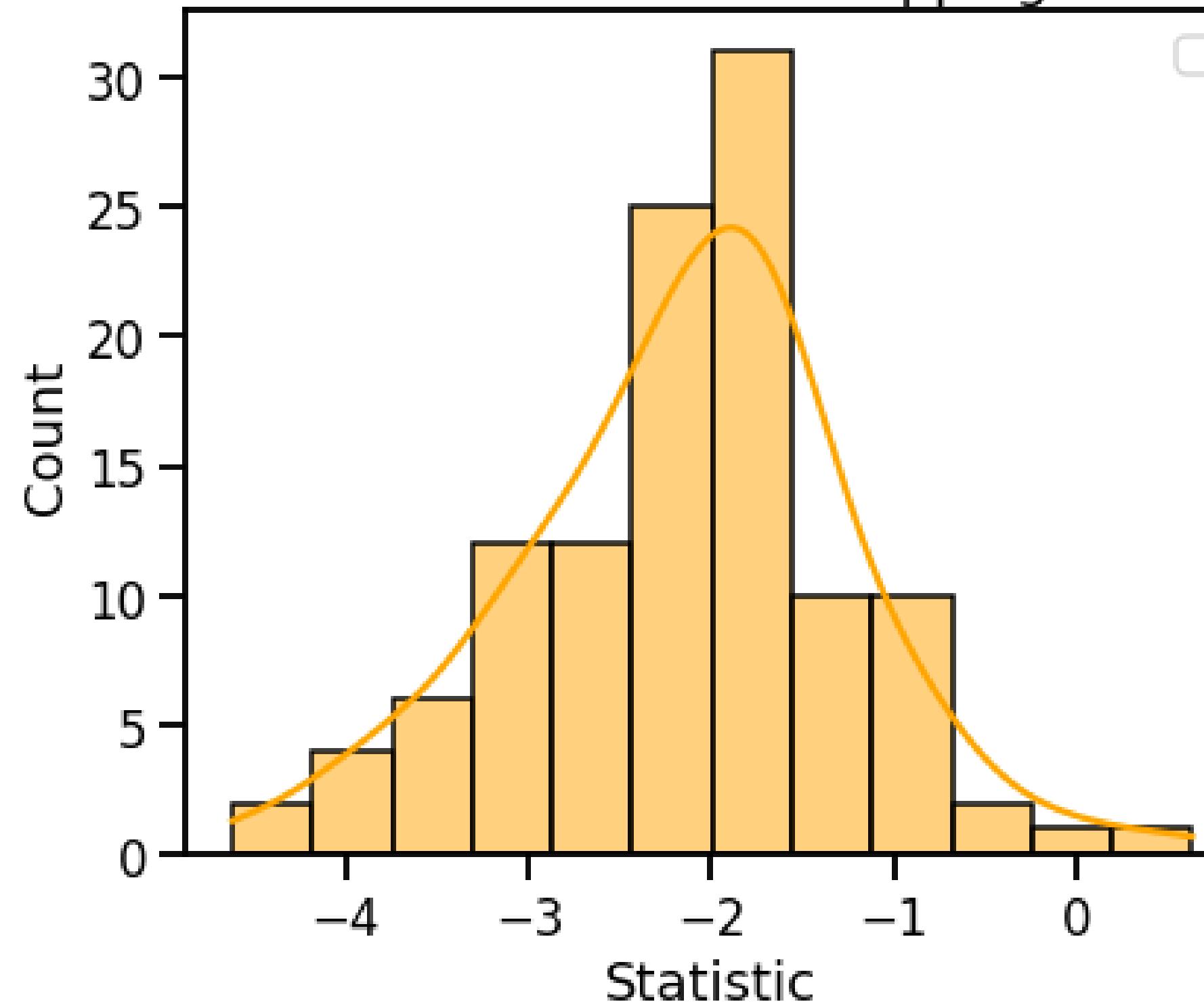


Graph Distances (calculated)





T-Test With Bootstrapping

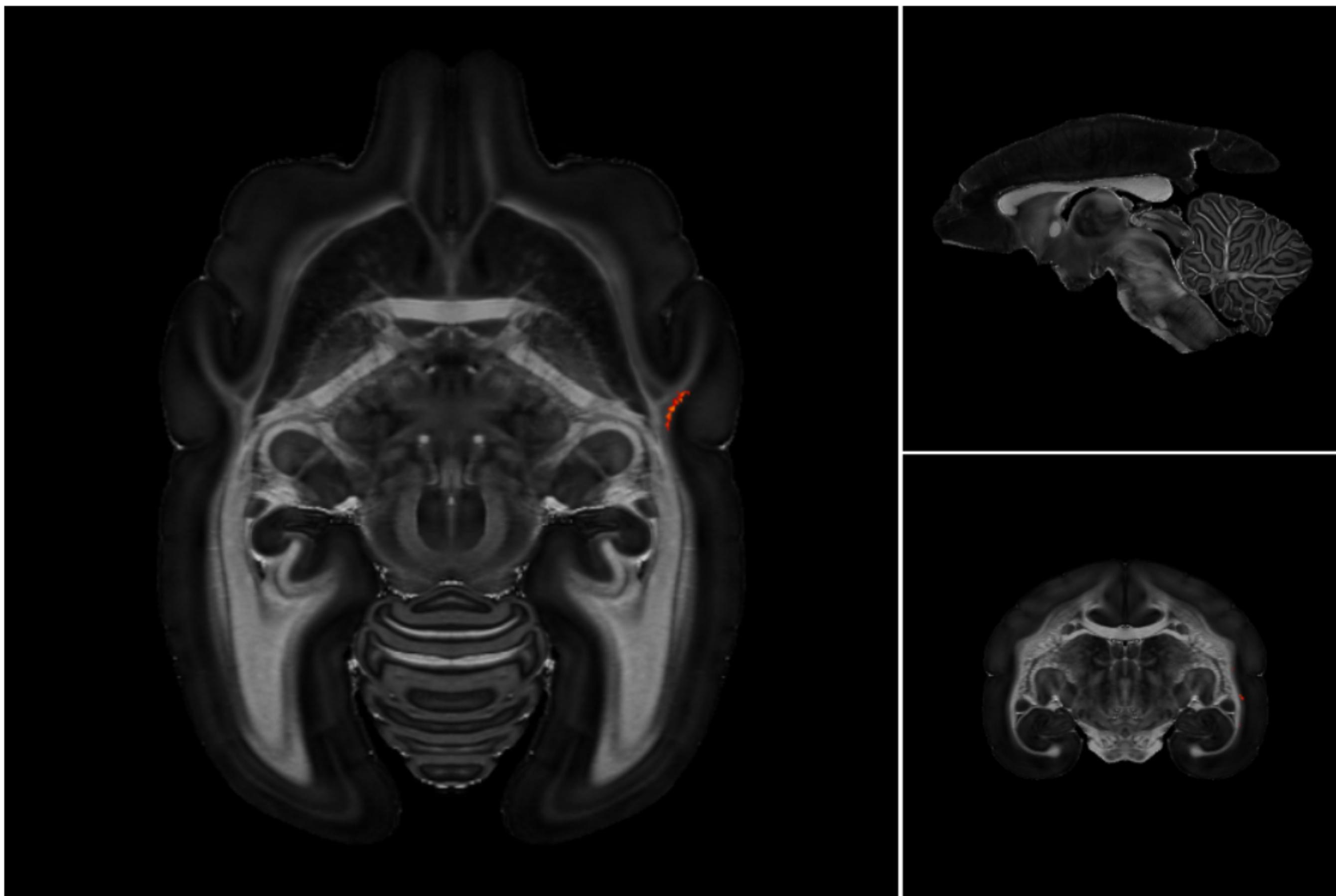


T-test statistic (all data) = -23
p_value = 0

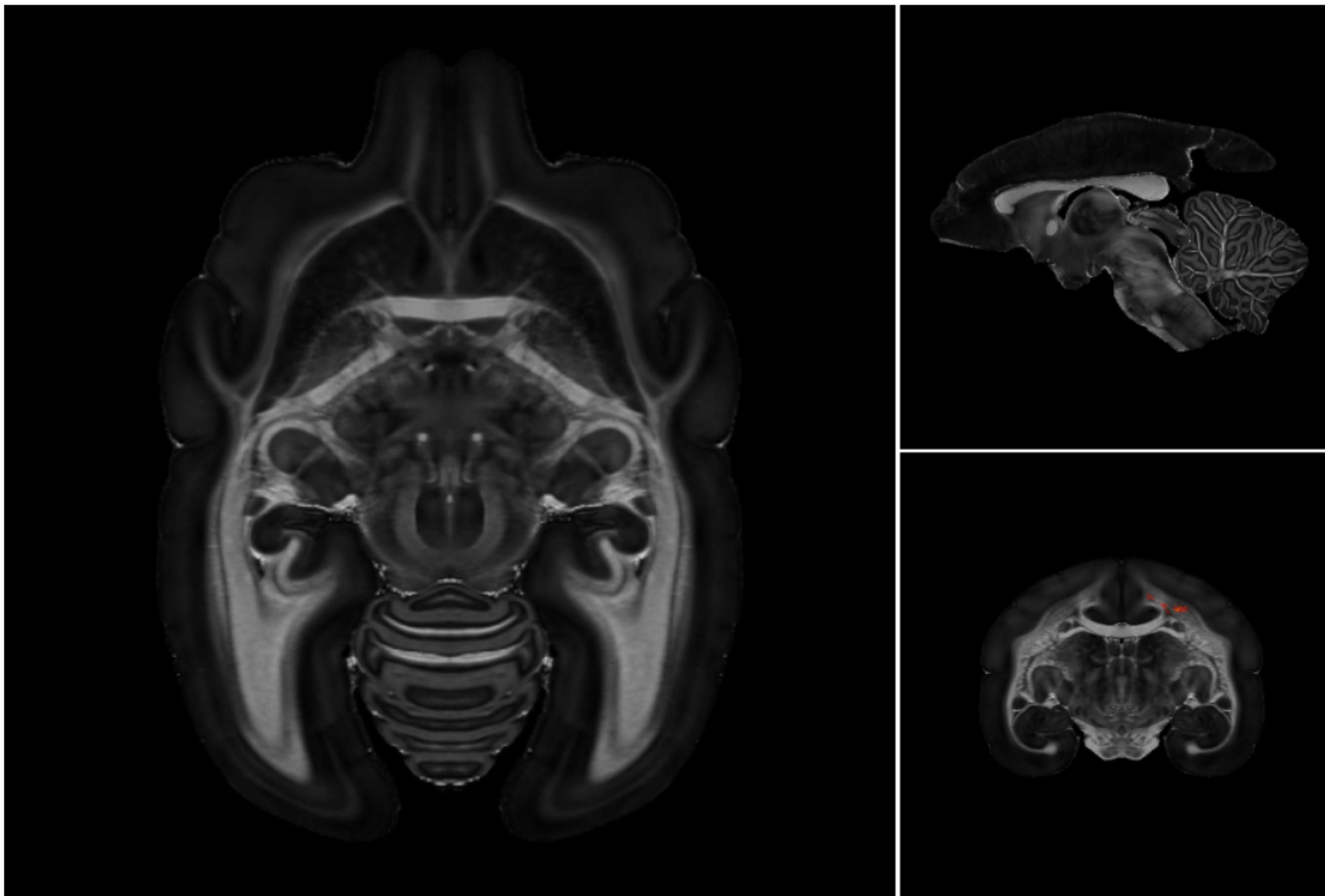
Area 1	Area 2	Connection (log(FLNe))	In the same Community	Shortest Path = 1
TPO	TE3	-1.3	Yes	Yes
A23b	PG	-1.62	No	Yes
TE3	PG	-1.66	No	Yes
A23b	A8b	-1.96	No	Yes
TPO	PG	-2.81	No	Yes
A8b	PG	-3.16	No	Yes
TPO	A8b	-3.26	Yes	Yes
TE3	A23b	-4.36	No	Yes
TPO	A23b	-	No	Yes
TE3	A8b	-	Yes	Yes

*

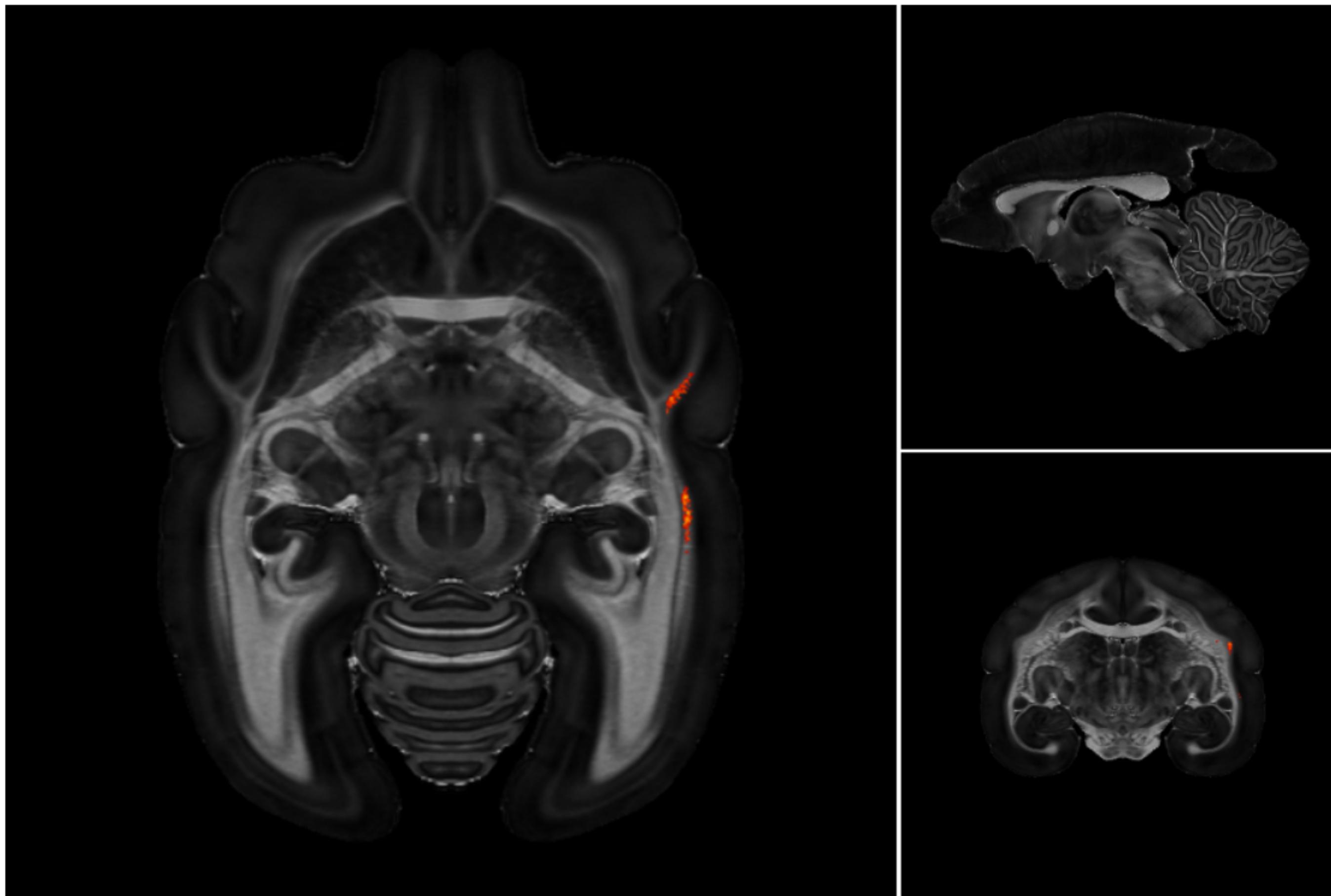
Avg path lenght: 1.6



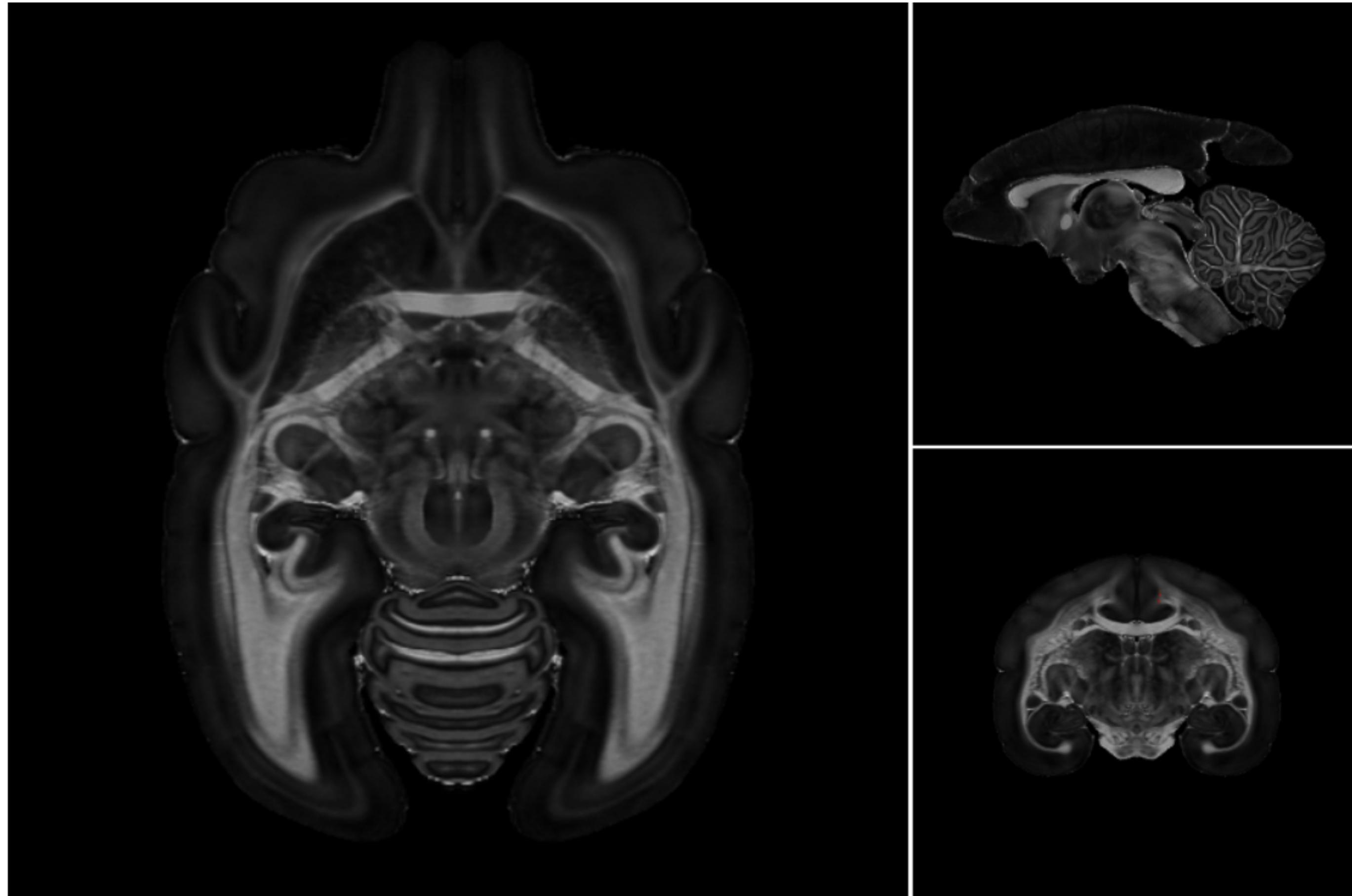
TPO-TE3



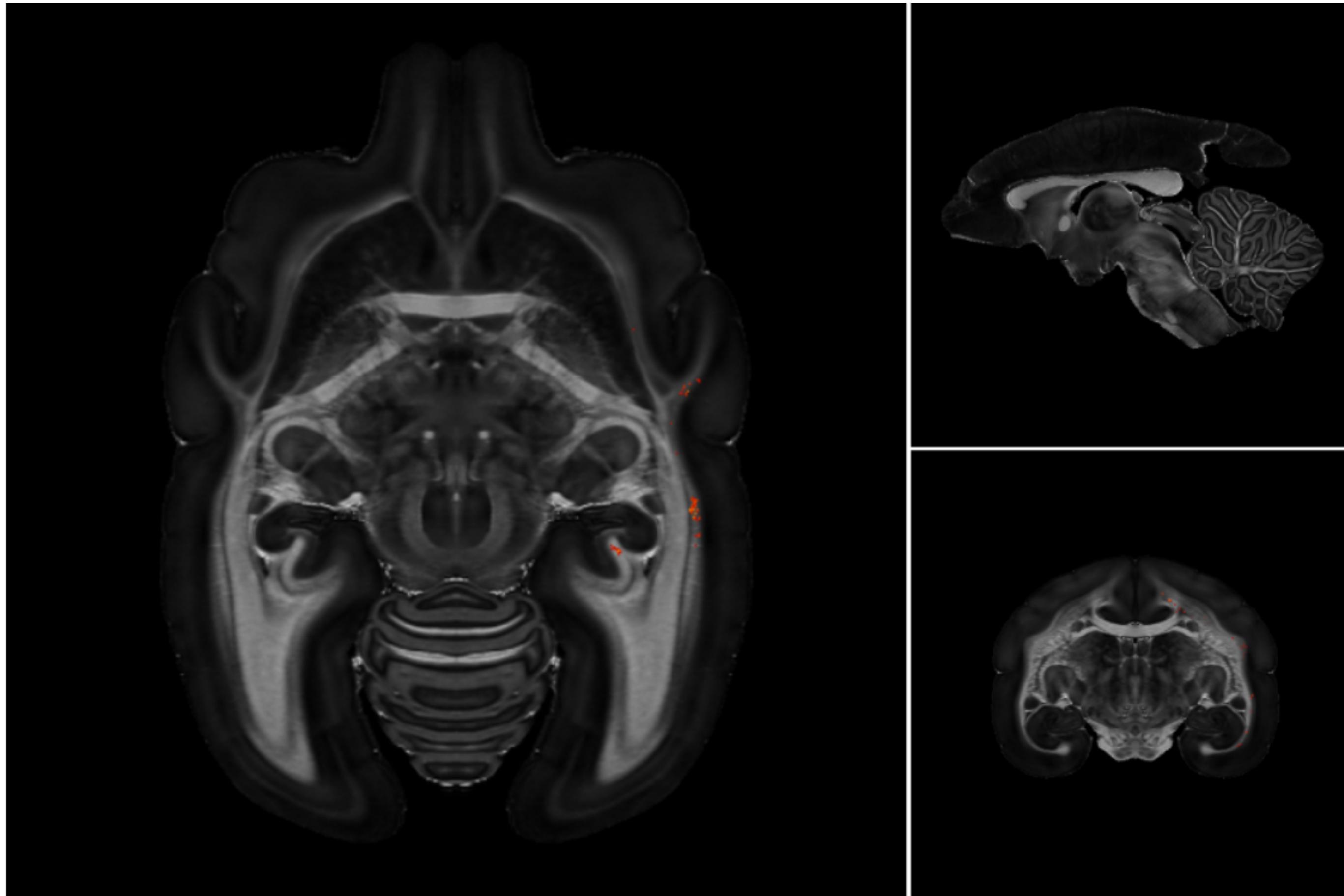
A23b-PG



TE3-PG



A23b-
A8b



A23b-
A8b



Conclusion

Constructing connectome network graphs is a close approximation of brain connectome.

Network graph puts slightly more emphasis on functionality than topology.

Limitations

Data accessibility.

Time to compare between-species.



That's all, folks!

Thank you!

Resources

1. Majka, P., Bai, S., Bakola, S., Bednarek, S., Chan, J. M., Jermakow, N., ... & Rosa, M. G. (2020). Open access resource for cellular-resolution analyses of corticocortical connectivity in the marmoset monkey. *Nature communications*, 11(1), 1-14.
2. Majka P., Chaplin T.A., Yu, H.-H., Tolpygo A., Mitra P.P., Wójcik D.K., & Rosa M.G.P. (2016). Towards a comprehensive atlas of cortical connections in a primate brain: Mapping tracer injection studies of the common marmoset into a reference digital template. *Journal of Comparative Neurology*, 524(11), 2161-2181. <http://doi.org/10.1002/cne.24023>
3. Liu, C., Ye, F.Q., Newman, J.D. et al. A resource for the detailed 3D mapping of white matter pathways in the marmoset brain. *Nat Neurosci* 23, 271–280 (2020). <https://doi.org/10.1038/s41593-019-0575-0>