Brain Connectome and ageing

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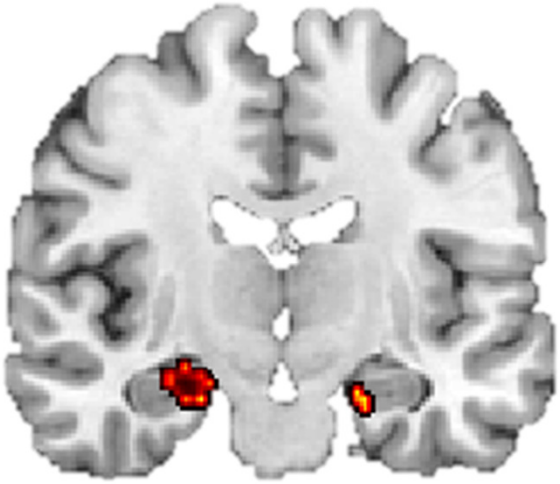
BAW 2016

Yaniv: "Playing computer games help to increase the connections in your brain. It's good for you – tell your parents!"

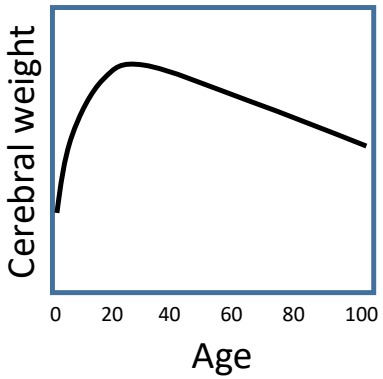
11 yo kid: "Increase the connections? Won't the brain explode at some time?"

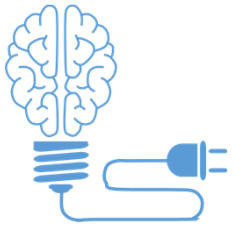
Yaniv: "ah….. Eh…. Well? Its complicated"



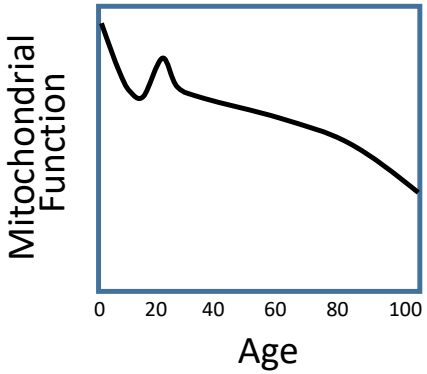
Physics & Brain Ageing

Conservation of mass





Conservation of energy

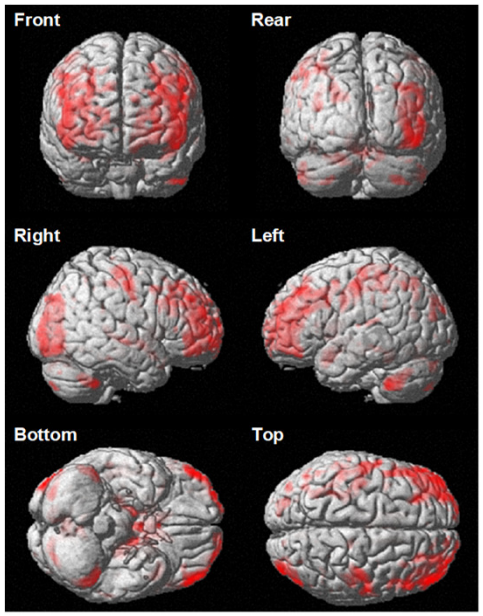


Santiago Ramon y Cajal, 1909, Histology of the nervous system of man and vertebrates
(Translation by N & LW Swanson, Oxford university press, 1995, p. 116)

"We realized that all of the various conformations of the neuron and its various components are simply morphological adaptations governed by **laws of conservation for time, space and material**"

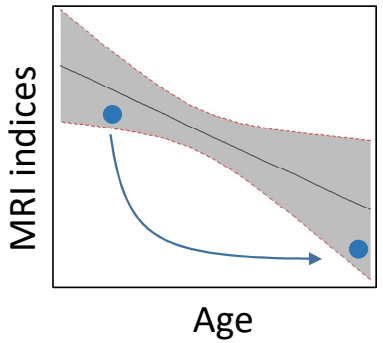
Brain & Ageing

Correlation with age over 100 subjects (age range 21-92 y)



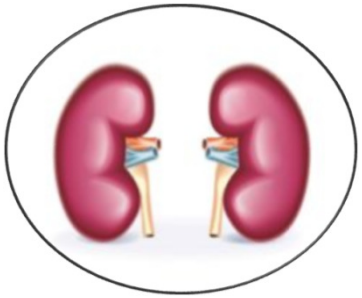
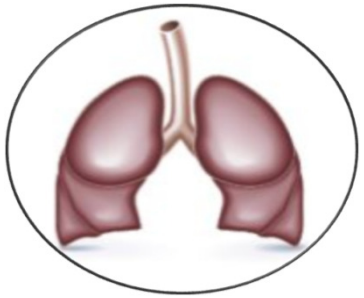
Aging = f (genetics) + f (heredity) + f (Environment) + f (Life habits)

No control	No control	Minimal control	Some control



Hypothesis:
Brain Imaging can provide better understanding of the ageing process, its interactions with well-being and other individual factors

Eat healthy
Don't eat fat
Eat good fat
Don't eat carbohydrates
Don't drink alcohol
Drink Alcohol moderately
Don't smoke
Don't use cannabis
Cannabis is good for the elderly
Solve puzzles, Sudoko
Do sports
Don't overdo sports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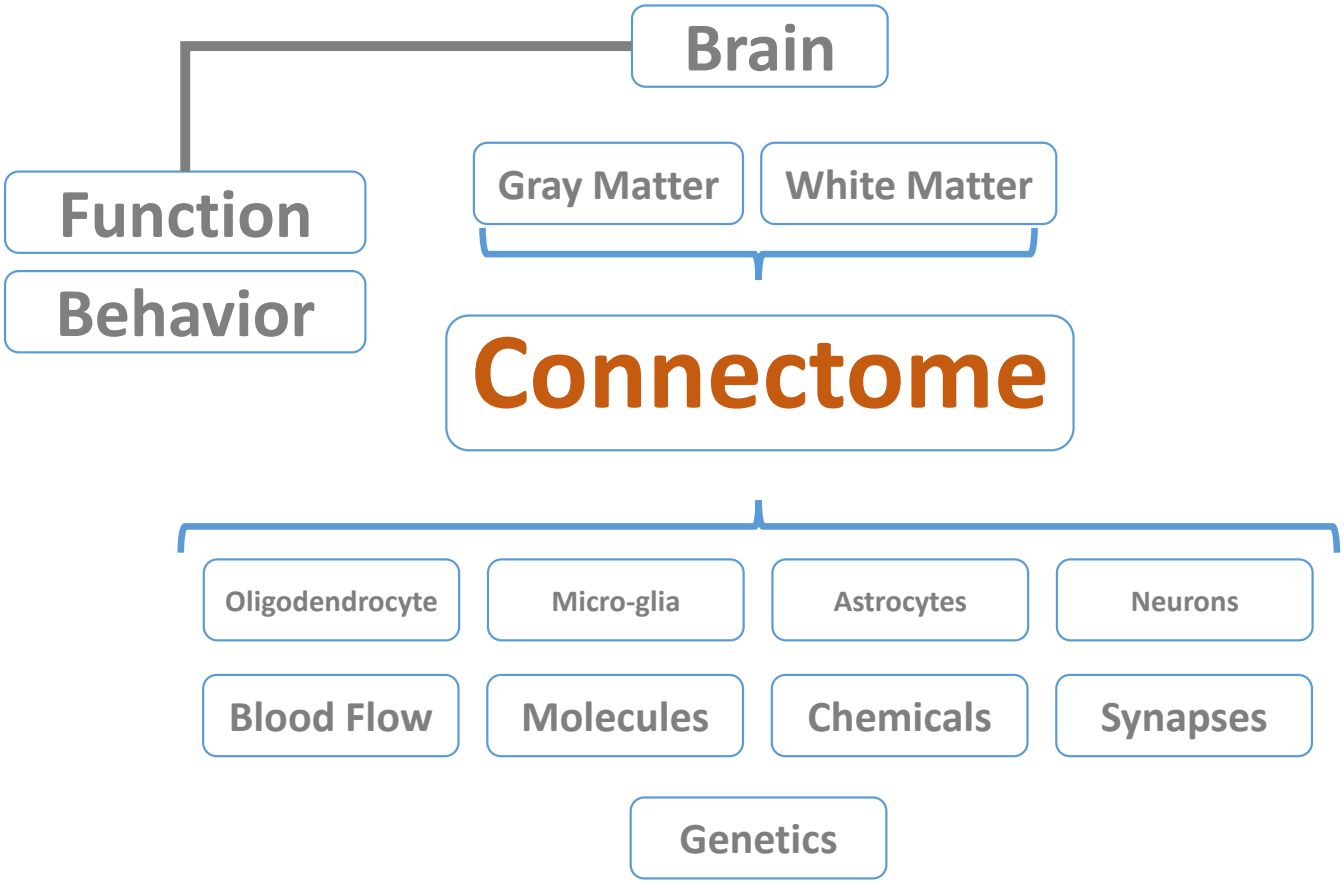
Brain Connectome



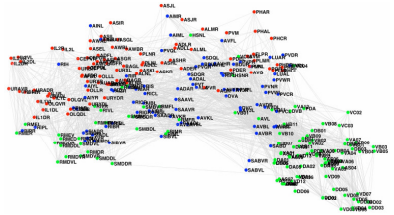
Brain Connectome

The mass array of neural connections that forms the dense network between all components of the nervous system

- The connectome spans over many dimensions
- The connectome is a map/graph
- The connectome affects our cognition and behavior
- As genes encode our body, the connectome encodes our mind

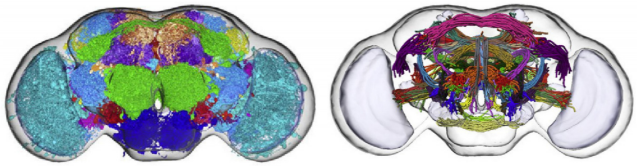
Connectome Research

302 neurons



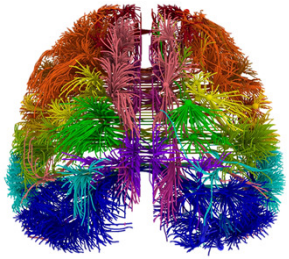
Varshney, L.R., et-al.
PLoS Comput. Biol. **7**, e1001066 (2011).

25,000 neurons



Current Biology, 21(1):1–11, January 2011.

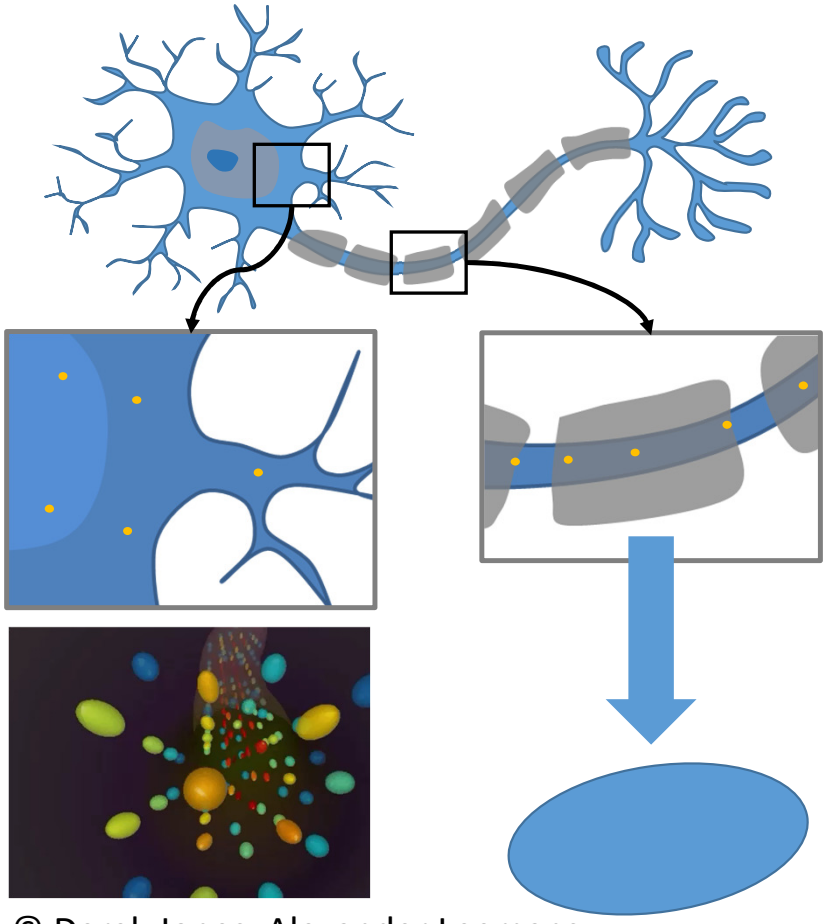
70 million neurons



The Allen Brain Institute
Wook Oh et al.
Nature, 508, 207-217, 2014

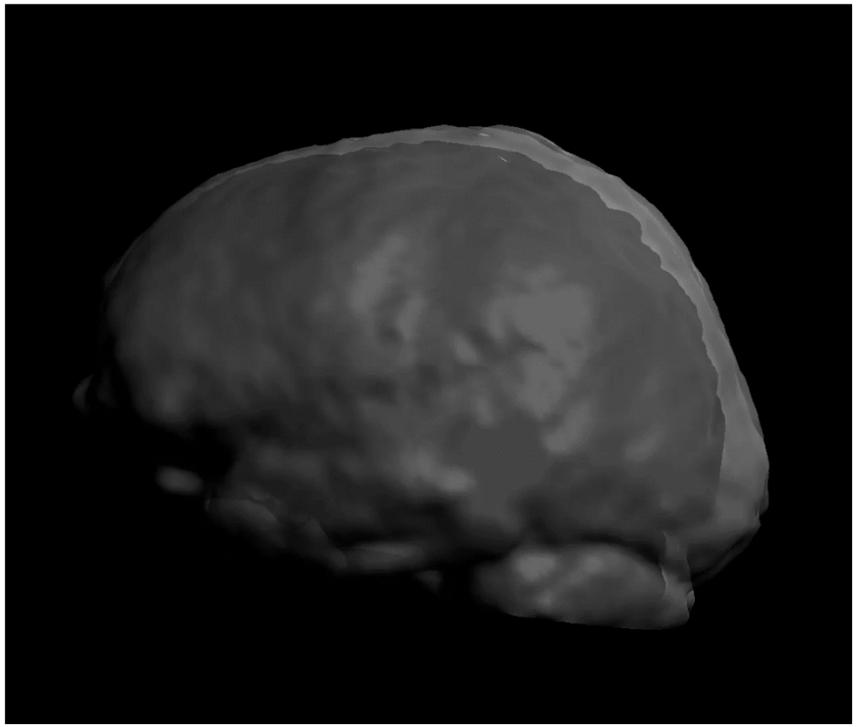
100 billion neurons

Connectome Research



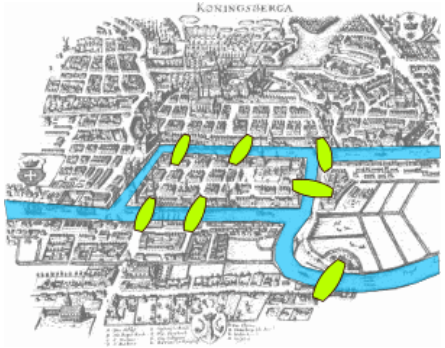
© Derek Jones, Alexander Leemans

Diffusion MRI

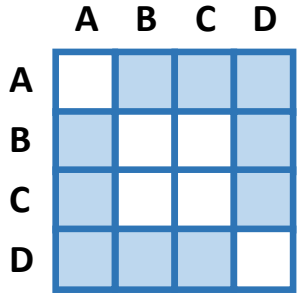


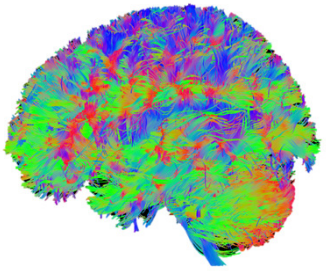
Connectome & Graphs

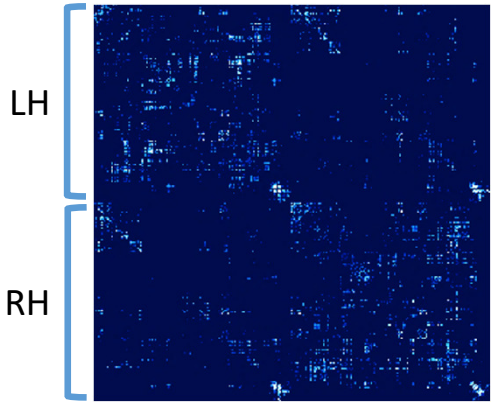
Graph Theory

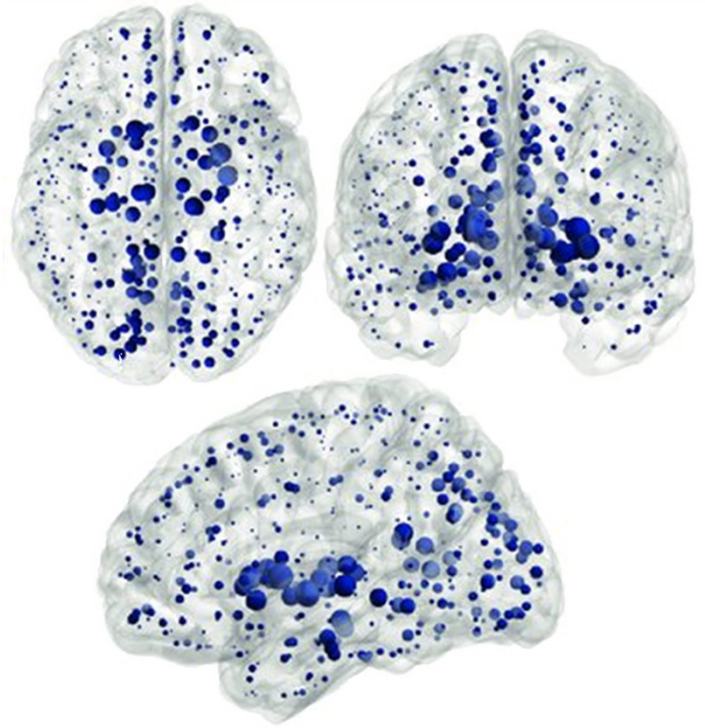


Leonhard Euler



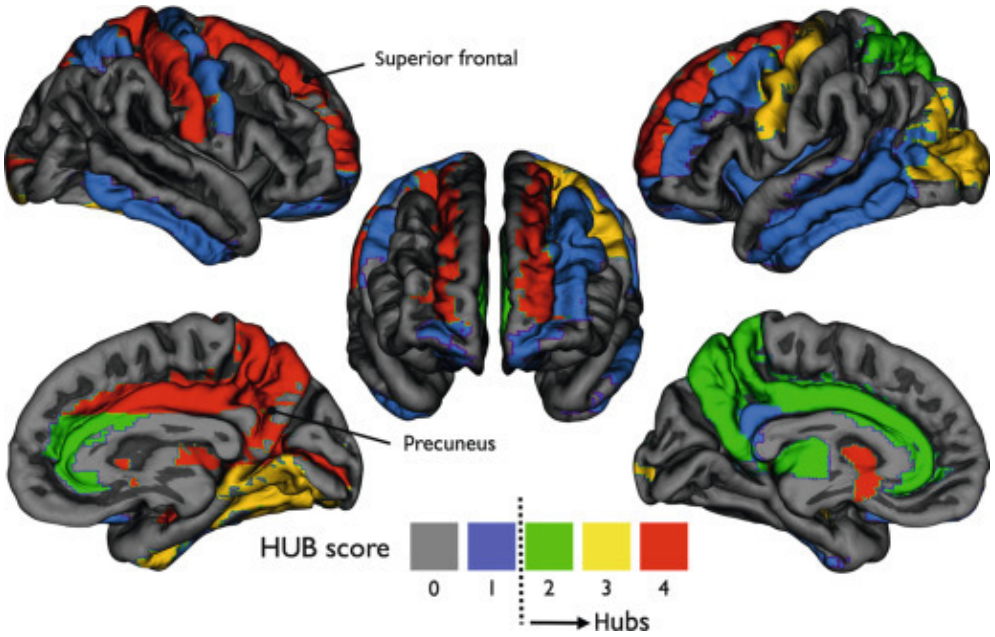






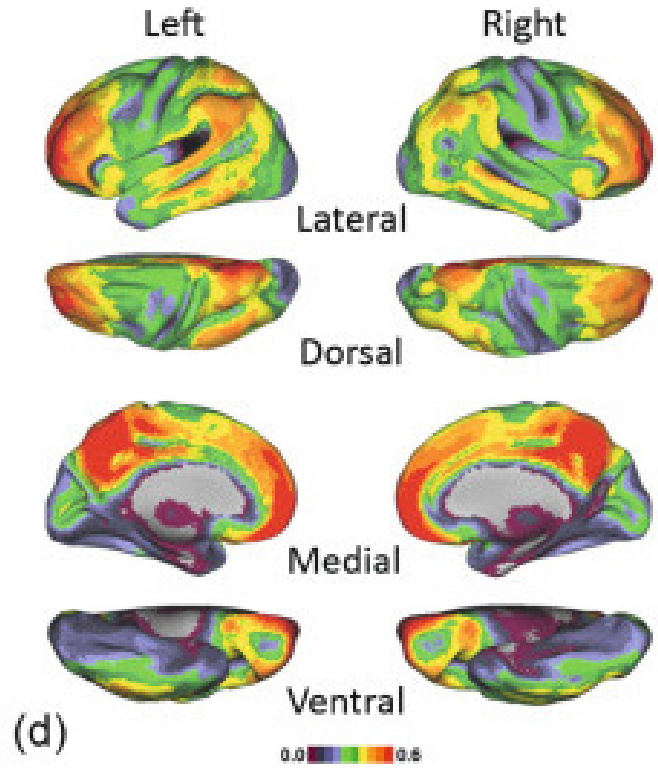
Crossley N.A., Mechelli A., Scott J., Carletti F., Fox P.T. McGuire P., Bullmore E.T.
The hubs of the human connectome are generally implicated in the anatomy of brain disorders.
Brain 137; 2382-2395 (2014)

Brain Hubs



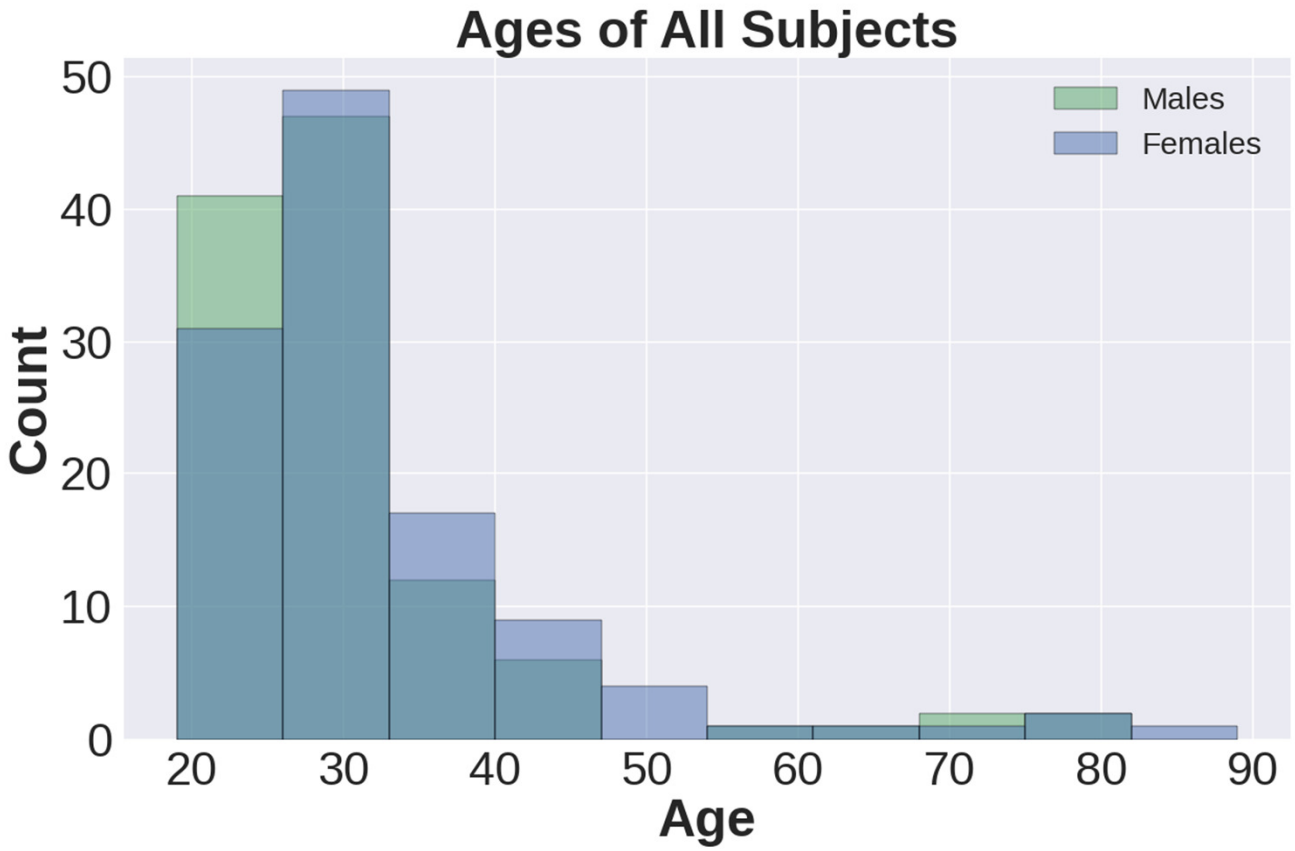
Fornito A., Zalesky A., Bullmore E.
Fundamental of brain networks

Amyloid deposition



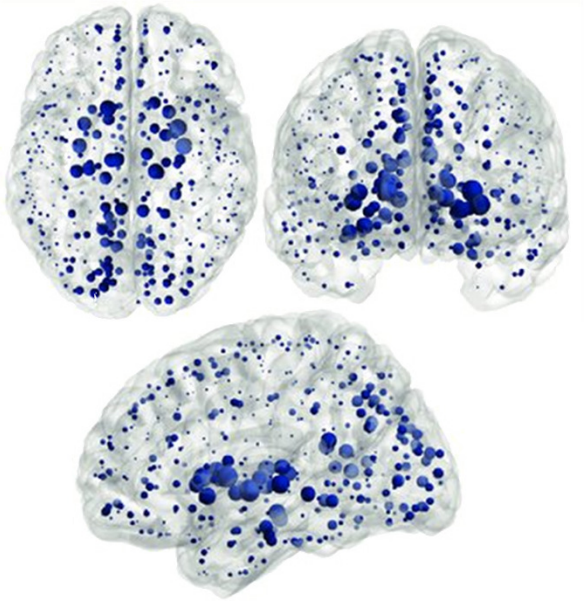
Buckner 2009

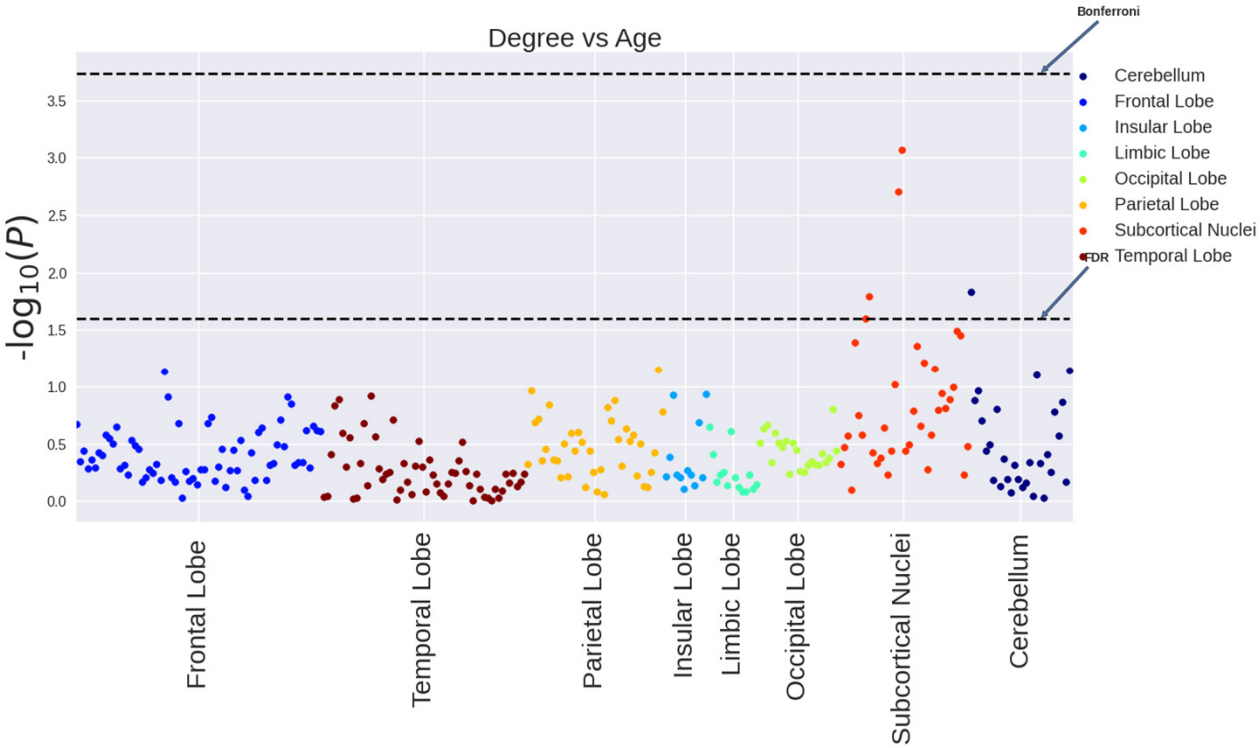
TAU Brain Bank



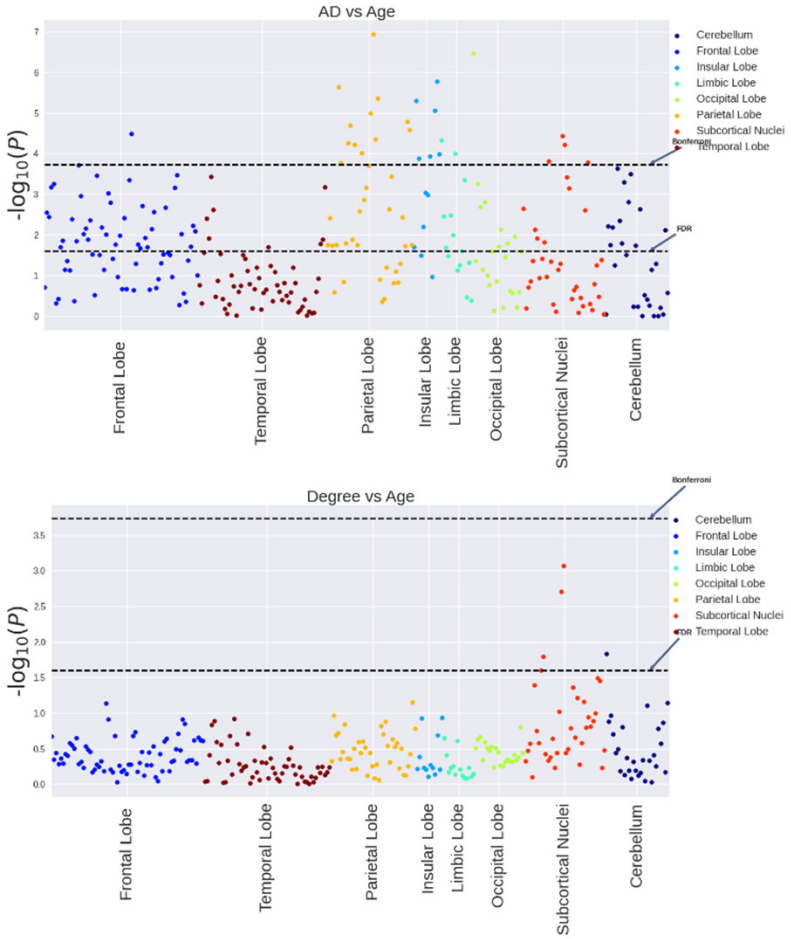
400 subjects
(+10/week)

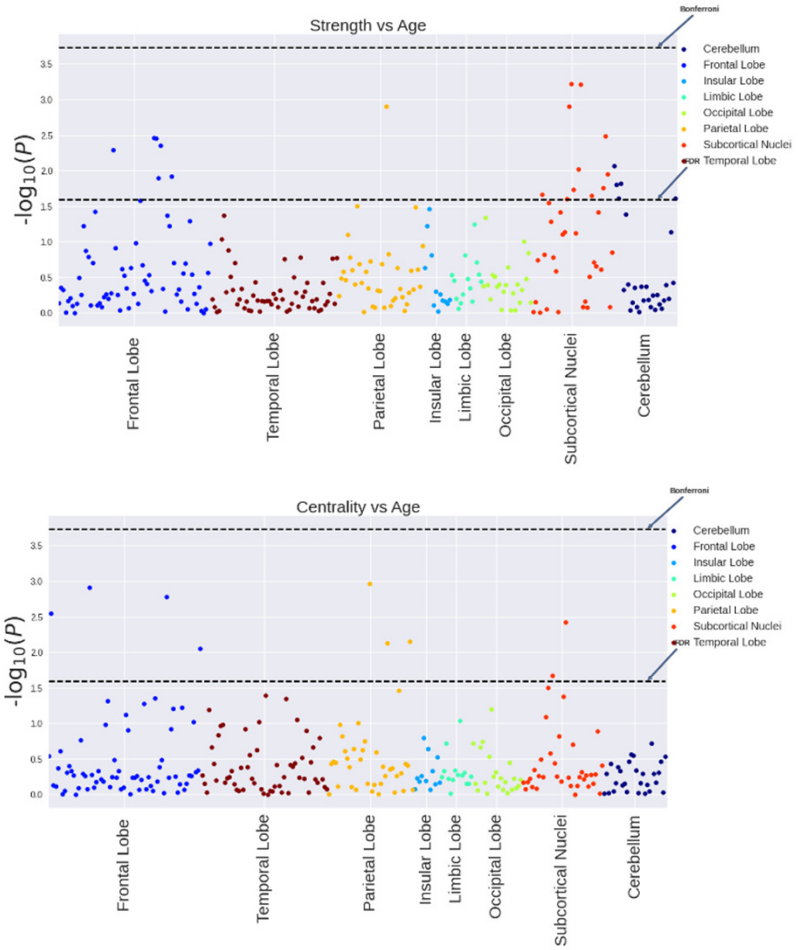
Brain Hubs & Ageing



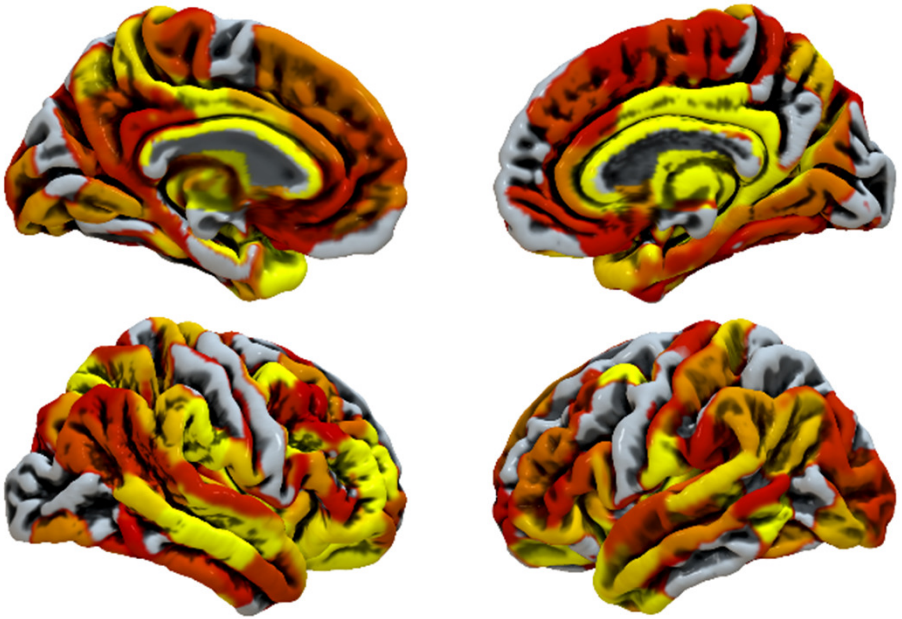


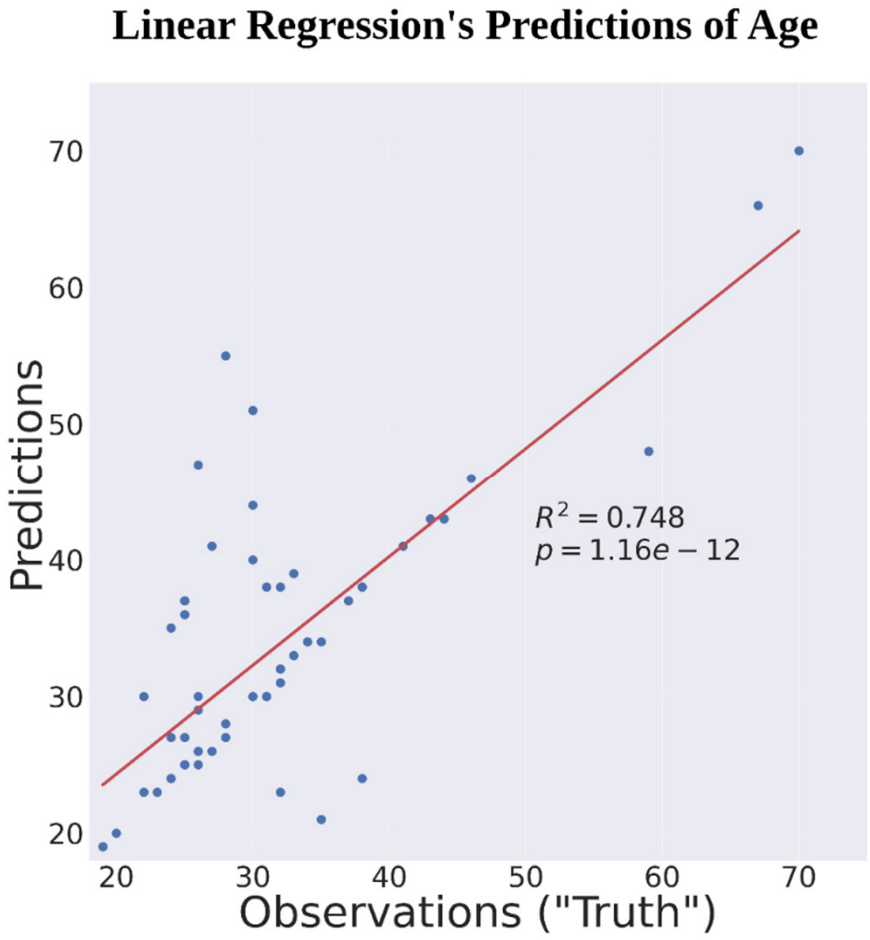
Graph Analysis & Ageing





Prediction Model





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