#### Visualisation of cortical networks by Collaboration Spotting – Status Report

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#### Outline

#### Introduction

- Background
- The data
  - Original data
  - The cortical and the 2-hops graphs
  - Navigation
- The most relevant graphs
- Future work



#### Introduction - Background

- Using our visualisation and navigation tool on patents (PATSTAT EPO) and publications (Web of knowledge Thomson Reuters)
- Meeting in October in Wigner RCP (2016)
- The task: Try to visualise neuroscience data with our visualisation tool
- First data: the beginning of January 2017



# Anatomical and functional divisions of primate cortex



Source: A. Fülöp, L. Négyessy, "Interaction model of cortical networks", ECNP Seminar, 2016



#### Original data – inputs

													modularity_cl
id	vertex name	area name	modality	cerebral lobe	intra%	avg indeg	med indeg	outdegree	med clsns	betweeness	avg betw	med betw	ass
		visual area 1/											
		primery visual											
n0	V1	cortex	visual	occipital	59.66	17.5	15.5	8	0.29	1.4E+16	5283.28	5530.5	0
		visual area											
		2/secondary											
n1	V2	visual cortex	visual	occipital	48.47	15.81	15	21	0.28	7.16E+14	4538.12	3917.5	0

#### Nodes of cortical graph (g0) with attributes (top) – Nodes of 2-hops graph (g2) with attributes (bottom)

				modality of			type of	lobe of										
		vertex	area	processin	input	target	processin	processin		target	interactin				eccentricit		betweene	modularit
id	label	name	name	g area	modality	modality	g	g	input lobe	lobe	g lobes	indegree	outdegree	degree	у	closeness	SS	y_class
		V2/ V1/	visual area 1/ primery visual				intramoda											
n0	n0	V1/ V2/	cortex	visual	visual	visual	1	occipital	occipital	occipital	within	28	21	49	5	0.3	47142.01	3
		V3/V1/	visual area 1/ primery visual				intramoda											
n1	n1	V1/ V2/	cortex	visual	visual	visual	1	occipital	occipital	occipital	within	14	21	35	5	0.3	24722.67	3



#### The 2-hops graph – g2



Source: A. Fülöp, L. Négyessy, "Interaction model of cortical networks", ECNP Seminar, 2016

 2-hops graph (and 1-hop graph too) are generated by using g0 graph



## The navigation

- Reachability graph (on the right) of the current implementation is built
- Directed vs. Undirected: not supported (YET), but the cortical (g0 with Basic as reference) and the 2hops (g2 with g1 as reference) graphs are directed now
- Navigation opportunities: g0, Modality, Cerebral Lobe, g2, Lobe of processing and Type of processing
- 2 references: Basic and g1





## The cortical graph – g0

- Macaque brain contains 42 cortical areas (visual, multisensory, motor, etc.)
- There are 601 interactions between these areas.
- Modelled by using graphs
  - Areas → Nodes
  - Interactions → Edges





## The 2-hops graph – g2

- More than 9870

   nodes and 163147
   edges → Extremely
   Crowded
- Communities are generated, based on the result of Louvain algorithm (clustering)
- Edges between communities are not visualised either





#### Egocentric view on a community (2-hops graph)

- Left click action on nodes (originally) highlighted the selected node with its neighbour(s)
- We called it "egocentric view"
- In this graph, we show the full community (example: community 061, on the right)





#### Community as a subgraph

- By using the navigation, we can visualise the selected community (here, community 061) as a subgraph
- Clustering (Louvain) and graph layout (ForceAtlas) algorithms are executed on this subgraph
- The top two clusters represent part of the Ventral visual pathway (Important at categoric information)





Using 2-hops graph data as a filter on the cortical graph

- After selecting the community 061, we are able to navigate to the cortical graph (changing the reference from g1 to Basic and clicking on g0 navigation option)
- Only 33 nodes and 474 edges (g0: 42 nodes and 601 edges)





Using cortical graph nodes as a filter on the 2-hops graph

- Selecting V1 cortical area, we are able to navigate to 2-hops graph (changing the reference from Basic to g1 and clicking on g2 navigation option)
- Only 501 nodes and 5680 edges (full: more than 9800 nodes and 150000 edges)





#### More complex navigation

- Given the 2-hops graph
- Selecting the community 061 and visualise the subgraph
- Navigating from 2-hops graph to the cortical graph
- Selecting V2 node and navigating to 2-hops graph OR
- Selecting V4 node and navigating to 2-hops graph





#### Modality (left) and Cerebral Lobe (right) graphs



Non-filtered Modality and Cerebral Lobe graphs



#### Type (left) and Lobe (right) of processing graphs



Non-filtered Type of processing and Lobe of processing graphs



#### Future Work

- Database level:
  - Generalise the directed graph generator (now, the cortical and 2-hops graphs are supported)
  - Extend the navigation
- Data Processing Level:
  - NeuroScience-related algorithms
- Visualisation:
  - Colouring



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