

Extracting Connectivity Profiles Using Diffusion MRI and Probabilistic Tractography for the Parcellation of IPL of Human Subjects

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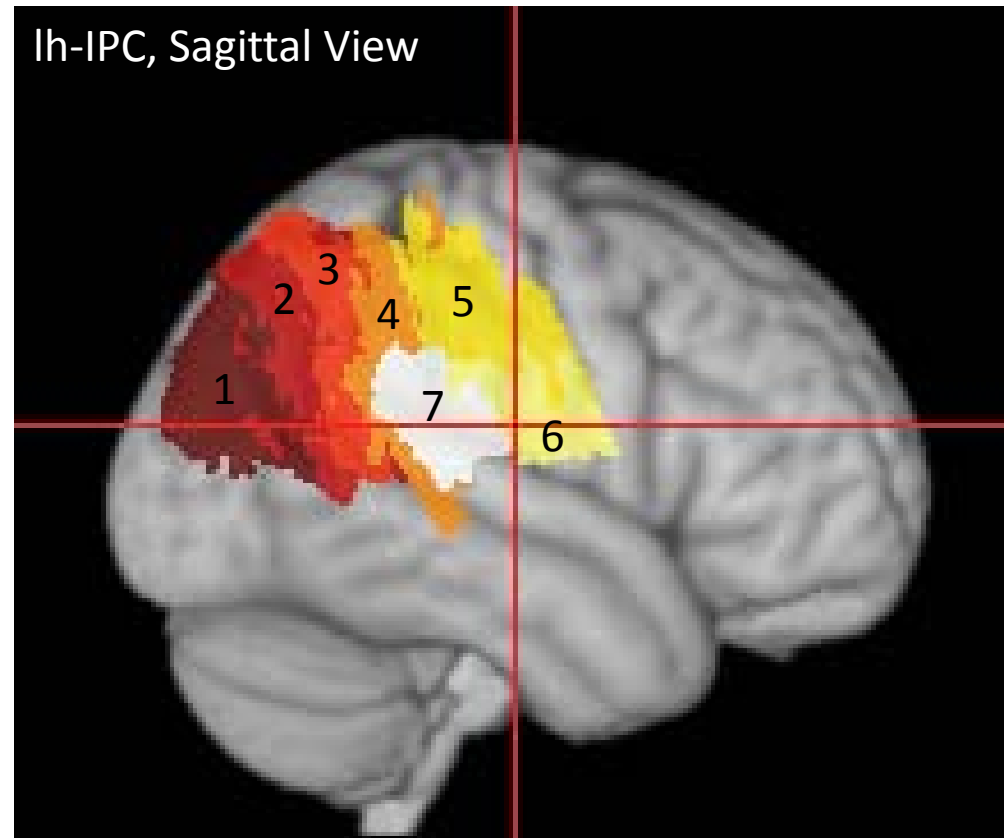
Motivation

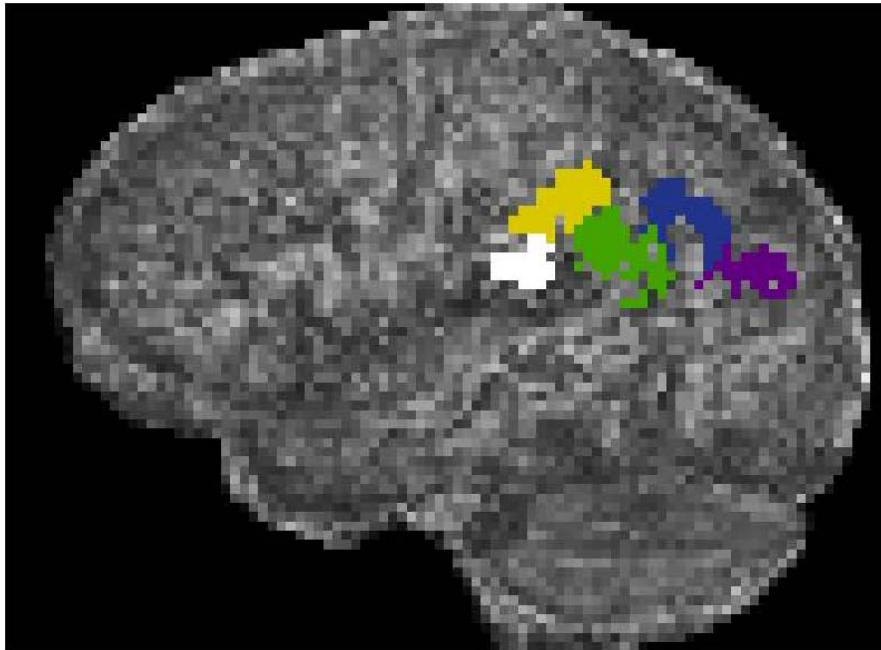
Analyzing different pre-processing pipelines while fixing the parcellation method.

Jülich Atlas

(Jülich histological (cyto- and myelo-architectonic) atlas)

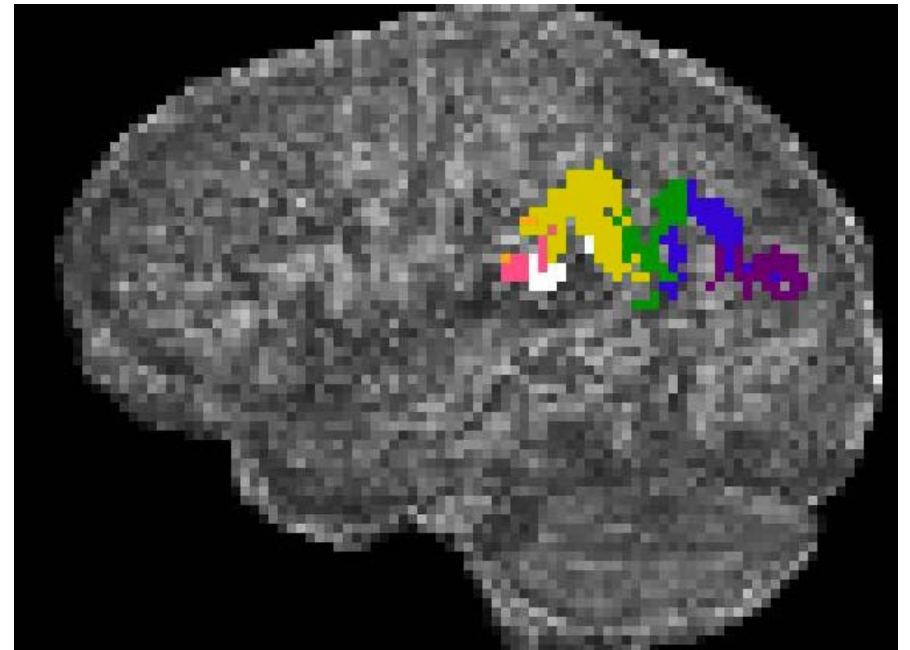
- Jülich atlas is a **probabilistic map** of each brain area.
- It's created based on the microscopic and quantitative histological examination of **ten human post-mortem brains**.





Example parcellation of a subject

Juliech Atlas in the subjects FA space



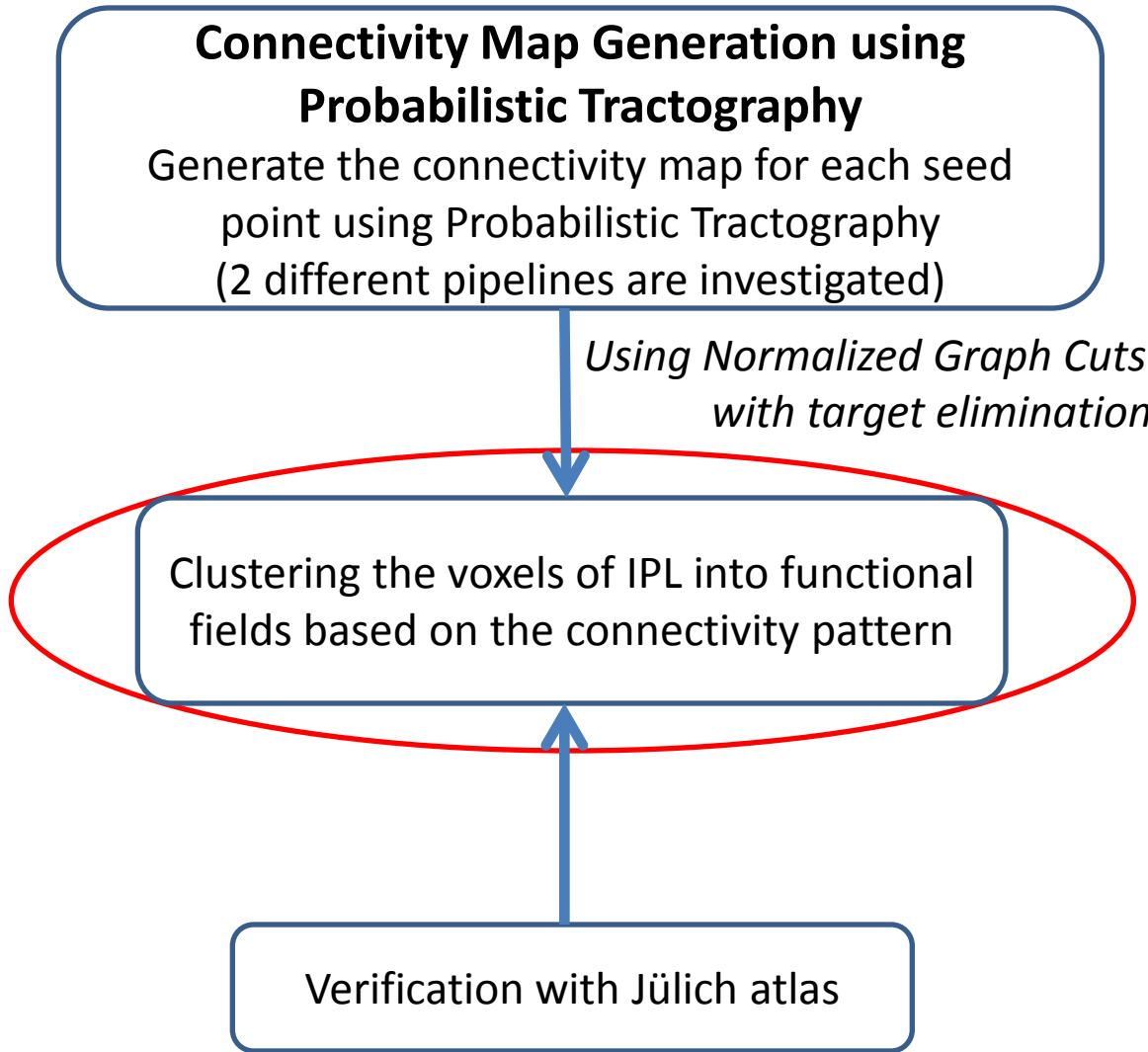
Connectivity Map Generation using Probabilistic Tractography

Generate the connectivity map for each seed point using Probabilistic Tractography (2 different pipelines are investigated)

Using Normalized Graph Cuts with target elimination

Clustering the voxels of IPL into functional fields based on the connectivity pattern

Verification with Jülich atlas



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Diffusion MRI

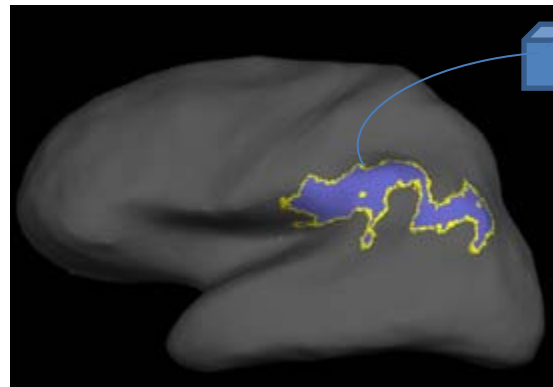
- Measures the **diffusion of water** molecules in biological tissues.

Tractography

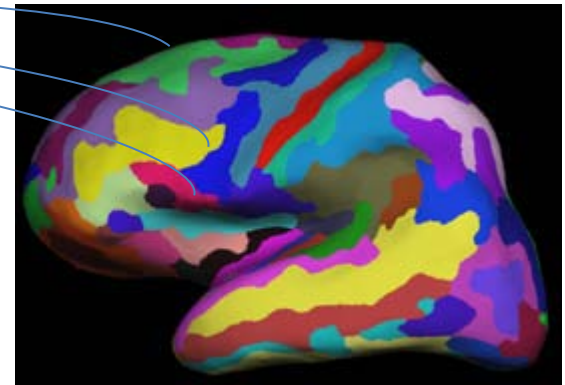
- Method for identifying **anatomical connections** in the **living** human brain.
- It offers an **overall view** of brain anatomy, including the degree of connectivity between different regions of the brain

Preprocessing

- Regions of interests (ROIs) were extracted.
- For each voxel in the IPL, connectivity profile is calculated using probabilistic tractography.



- 5000 Initiated from each seed voxel
- # of particles that reached to each target region counted.



Two pipelines for Extracting Connectivity Profiles

- Pipeline 1:
 - The target regions from both hemispheres
 - Freesurfer, BEDPOSTX, Probtrackx
- Pipeline 2:
 - Target regions from only related hemisphere
 - Freesurfer, Mrtrix

Experiments

Parameters we determined through experiments with the 10 training subjects' right hemispheres, using preprocessing **pipeline 1**:

Jaccard

$\alpha=0.7$

spatial affinity by Eq. 4

similarity matrix computation by Eq. 5

of clusters=5

Normalized Graph Cuts With Target Elimination

Subject	Left Hemisphere		Right Hemisphere	
	Preprocessing Pipeline 1	Preprocessing Pipeline 2	Preprocessing Pipeline 1	Preprocessing Pipeline 2
3211	0.64	0.64	0.61	0.60
3402	0.54	0.60	0.64	0.65
3407	0.64	0.59	0.65	0.61
3414	0.61	0.68	0.62	0.52
3422	0.57	0.69	0.61	0.69
3424	0.77	0.61	0.65	0.63
3425	0.57	0.61	0.68	0.67
3484	0.61	0.62	0.58	0.57
3485	0.67	0.64	0.59	0.58
3486	0.61	0.59	0.70	0.72
3487	0.60	0.62	0.66	0.63
3488	0.66	0.68	0.67	0.58
3496	0.67	0.66	0.65	0.67
3497	0.72	0.58	0.64	0.58
3498	0.59	0.74	0.65	0.68
3503	0.65	0.63	0.66	0.60
3504	0.68	0.70	0.72	0.58
3505	0.56	0.62	0.72	unacceptable
AVERAGE	0.63	0.64	0.65	0.59

Experiments

Parameters we determined through experiments with the 10 training subjects' right hemispheres, using preprocessing **pipeline 2**:

Jaccard

$\alpha=0.6$

spatial affinity by Eq. 3

similarity matrix computation by Eq. 6

of clusters=5

Normalized Graph Cuts With Target Elimination

Subject	Left Hemisphere		Right Hemisphere	
	Preprocessing Pipeline 1	Preprocessing Pipeline 2	Preprocessing Pipeline 1	Preprocessing Pipeline 2
3211	0.69	0.62	0.57	0.63
3402	0.60	0.61	0.65	0.75
3407	0.57	0.61	0.64	0.71
3414	0.61	0.67	0.65	0.57
3422	0.65	0.67	0.62	0.66
3424	0.63	0.71	0.65	0.65
3425	0.60	0.55	0.70	0.64
3484	0.65	0.60	0.61	0.60
3485	0.64	0.64	0.66	0.63
3486	0.67	0.56	0.69	0.68
3487	0.53	0.63	0.57	0.59
3488	0.63	0.64	0.65	0.62
3496	0.74	0.68	0.61	0.65
3497	0.71	0.59	0.61	0.67
3498	0.60	0.66	0.69	0.70
3503	0.68	0.64	0.62	0.60
3504	0.63	0.71	0.68	0.61
3505	0.55	0.64	0.58	0.67
AVERAGE	0.63	0.64	0.64	0.65

Discussion

- Possible reasons for similar performance:
 - the connection between the left IPL and the target regions in the right hemisphere could be weak compared to the same hemisphere target region connections (and vice versa for the right IPL), having lower impact on the parcellation.
 - the variance of connectivities between a seed voxel to a target region in the other hemisphere could have low variance, and therefore ignored by our target selection approach.

Conclusion

- investigation of different ways of obtaining connectivity profiles by using probabilistic tractography
- both pipelines showed similar performance.
 - *the connectivity patterns we obtained with these two different pre-processing methods are similar*
- Consistently obtained parameters during all experiments:
 - Number of clusters: 5
 - Alpha: 0.5 to 0.7
 - Connectivity Similarity metric: Jaccard