Optimization of RecoBundles for recognition of short white matter bundles

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Introduction

Although less studied than long-range connections, **superficial white matter** has been linked with **neurodegeneration** during ageing as well as to neurodegenerative diseases like Alzheimer's disease [1]. Most of the studies about **short-range connections** use small cohorts and a very small number of short-range bundles because the **available white matter bundles atlases contain mainly large connections** and the **tools used to study them are adapted for long connections**. Here, we optimize the RecoBundles method [3] for **automated recognition of short fibers** found in the short-range atlases developed by [4]. For each bundle in the atlas, this new method finds geometrical parameters describing the bundle and uses them to extract the bundle in a subject's tractogram. Hence, this method can be applied to big databases and different atlases with little parameter tuning.

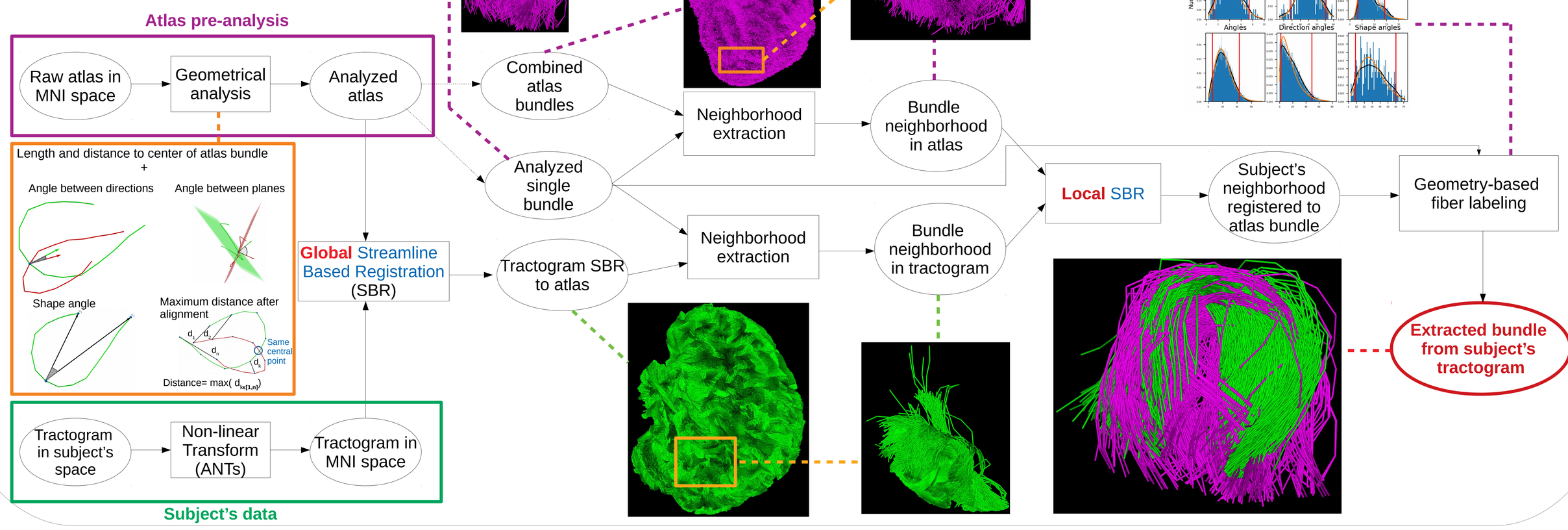
Figure 1 : Different shapes of short-range connections found in the superfical white matter (SWM) atlases developed by [ref] : U-shaped, C-shaped, open U-shaped, V-shaped, 6-shaped, straight and curved.

Materials and methods

Materials :

- **14 healthy subjects from the HCP** database that were among the 76 ones used by [4].
- Subjects registered to **MNI152** space using a non-linear transformation (ANTs).
- Tractograms computed using MRtrix's **multi-shell multi-tissue** model and its **probabilistic tractography** algorithm (10 000 000 fibers).
- Short-range connection atlas : ARCHI atlas with 486 short bundles [4]

Methods :



Results

Comparison of our method (geoLab : geometrical labeling) to MDF* (mean for the 14 subjects) :

	Affine		ANTs		Disco/Dartel		SBR (geoLab)
	MDF	geoLab	MDF	geoLab	MDF	geoLab	
% found out of 486 bundles	78	77	80	78	36	34	90
% in common to all subjects	62	60	69	65	15	13	83
Adjacency*	0,81	0.85	0,82	0.86	0,75	0.79	0,88
Coverage*	0,74	0.85	0,75	0.85	0,70	0.79	0,87
Overlap*	16.7	21.8	16.8	21.6	14,7	18.8	22.4

* Metrics defined in [2]

Figure 2 : Instances of extracted bundles using a geometrical approach. In green the extracted bundle and in purple the atlas bundle.

Conclusion

- Group level : **bigger adjacency, coverage and overlap** with SBR.
- Individual level : significant **improvement in the fiber labeling** when using a two-step SBR.
- Working directly in the space of streamlines seems to be **better** for the **extraction of short-range connections**.

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[2] Garyfallidis, Eleftherios, Matthew Brett, Marta Correia, Guy Williams, et Ian Nimmo-Smith. (2012), 'QuickBundles, a Method for Tractography Simplification'. Frontiers in Neuroscience 6
[3] Garyfallidis E., Côté M.A., Rheault F., Sidhu J., Hau J., Petit L., Fortin D., Cunanne S., Descoteaux M. (2017), 'Recognition of white matter bundles using local and global streamline-based registration and clustering'. Neuroimage. vol. 170, pp. 283-295.
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