Master's or Engineering Internship – 2025/2026

Medical imaging, Graphs, Artificial Intelligence

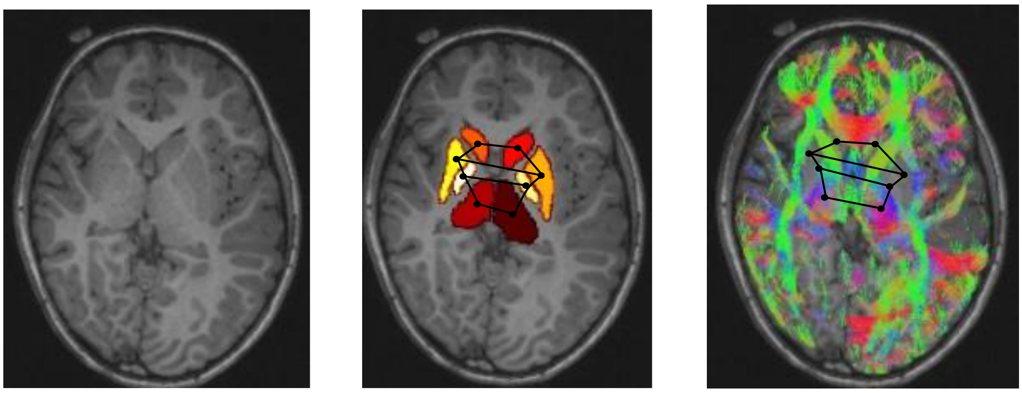

Figure A. Graph representation of the organisation of brain structures on T1 MRI (1st image) based on morphometric information (2nd image) or structural connectivity (3rd image).

Around 30% of children who suffered a neonatal ischaemic stroke develop permanent motor disorders known as cerebral palsy (Chabrier, et al. 2019). Studying key regions of the brain may help to better understand the manual motor impairments caused by (Craig, Carlson and Kirton 2019) (Hassett, et al. 2022) (Ilves, et al. 2022). Understanding the phenomena resulting from the presence of this early brain lesion can be based on imaging characterisation. While previous studies have highlighted a link between morphological information extracted from structural T1 MRI ((Coupeau, et al. 2024) -Figure A) and manual motor functions, additional information from other imaging modalities (e.g. diffusion IRM (Kirton, et al. 2016) - Figure A) could promote a better understanding of the mechanisms involved.
The recent rise of graph neural networks (GNNs) (Bacciu, et al. 2020) makes it possible to address multimodality and information complexity using graph-based architectures where nodes and edges carry features extracted from the image. GNNs have demonstrated their ability to effectively aggregate graph information and interactions between nodes, particularly for medical applications (Demirbilek et Rekik 2023).

The aim of this internship is to analyse diffusion MRI scans of a cohort of 7-year-old children (with and without neonatal stroke), extract relevant characteristics from this imaging modality to model them in a graph, and evaluate the effectiveness of GNNs in learning to predict the manual motor skills of these children based on this information.

The first part of the internship will focus on familiarising with diffusion data and automating the diffusion MRI (DWI) processing chain in the dataset: distortion correction, response function estimation, fibre orientation distribution estimation, tractography. This part will involve the use of the MRtrix (Tournier, et al. 2019) and FSL (Jenkinson, et al. 2012) libraries, operated in a Unix environment. This initial work has already been carried out on another cohort; all that remains is to transpose the pre-established processing chain.

In a second step, the intern will have to construct graphs modelling the nerve fibres connecting different regions of interest (primary motor area, thalamus, cerebral peduncle). This step will be carried out in Python using the PyTorch geometric library (Fey et Lenssen 2019) and codes from previous work of the team (Coupeau, et al. 2024).

The final task will be to train a GNN to attempt to predict children's motor skills based on diffusion information extracted and modelled in a graph.

During the internship, the intern will be invited to participate in monthly research meetings with medical researchers at Angers University Hospital.
If the results are conclusive, they may be presented in a journal article or conference paper.

The internship will take place at the **LARIS** laboratory for a period of **5-6 months** starting in February 2026.

The intern will receive a stipend of €4.35 per hour of actual attendance. The University of Angers may cover 75% of the cost of your transport pass, upon presentation of proof of purchase, up to a limit of €101.75 per month.

Contact :
Patty Coupeau (patty.coupeau@univ-angers.fr)

To apply for this internship, please provide:

- CV + cover letter
- Master's 1 transcripts
- Letter of recommendation (optional)

Références :

Bacciu, Davide, Federico Errica, Alessio Micheli, and Marco Podda. "A gentle introduction to deep learning for graphs." *Neural Networks* 129 (2020): 203-221.

Chabrier, Stéphane, et al. "From congenial paralysis to post-early brain injury developmental condition: Where does cerebral palsy actually stand?" *Annals of Physical and Rehabilitation Medicine* 63, no. 5 (2019): 431-438.

Coupeau, Patty, Josselin Démas, Jean-Baptiste Fasquel, Lucie Hertz-Pannier, Stéphane Chabrier, et Mickael Dinomais. «Hand function after neonatal stroke: a graph model based on basal ganglia and thalami structure.» *NeuroImage: Clinical* 41 (2024): 103568.

Craig, Brandon T, Helen L Carlson, and Adam Kirton. "Thalamic diaschisis following perinatal stroke is associated with clinical disability." *Neuroimage Clinical* 21 (2019): 101660.

Demirbilek, Oytun, et Islem Rekik. «Predicting the evolution trajectory of population-driven connectional brain.» *Medical Image Analysis* 83 (2023): 102649.

Fey, Matthias, et Jan E Lenssen. «Fast Graph Representation Learning with PyTorch Geometric.» *ICLR Workshop on Representation Learning on Graphs and Manifolds*, 2019.

Hassett, Jordan, Helen Carlson, Ali Babwani, and Adam Kirton. "Bihemispheric developmental alterations in basal ganglia volumes following unilateral perinatal stroke." *Neuroimage Clinical* 35 (2022): 103143.

Ilves, Nigul, et al. "Ipsilesional volume loss of basal ganglia and thalamus is associated with poor hand function after ischemic perinatal stroke." *BMC Neurology* 22, no. 1 (2022): 23.

Jenkinson, Mark, Christian F Beckmann, Timothy E.J. Behrens, Mark W Woolrich, et Stephen M Smith. «FSL.» *NeuroImage* 62 (2012): 782-790.

Kirton, Adam, et al. "Diffusion imaging of cerebral diaschisis in childhood arterial ischemic stroke." *International Journal of Stroke* 11, no. 9 (2016): 1028-1035.

Tournier, J-Donald, et al. «MRtrix3: A fast, flexible and open software framework for medical image processing and visualisation.» *NeuroImage* 202 (2019): 116137.