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Lausanne Summer School

Computational MR Brain Imaging Summer School at EPFL

In the context of TRABIT, EPFL organized a Computational Magnetic Resonance Brain Imaging Summer School. It took place from Monday June 24th until Friday June 28th.

The schedule of the summer school was quite diverse but was broadly focused on four different neuroimaging themes: human fetal brain imaging, diffusion MRI, machine learning & brain imaging biomarkers and statistics in imaging. In addition to the meticulous details of the imaging world, TRABIT ESRs also learned how important it is to communicate effectively, write persuasively and market ideas smartly.
One afternoon all ESRs discovered the beauty and history of Lausanne during a guided walking tour and enjoyed the perfect peak summer weather. When research meets nature's beauty - it would not be unfair to summarize the last summer school with this tagline.

https://trabit.eu/index.php/blog/536-lausanne-summer-school

Upcoming Event January 2020

TU/e Technische Universiteit Eindhoven University of Technology

Workshop in Eindhoven

The next TRABIT workshop will be held from 27th to 30th January 2020 at the TU/e, Eindhoven University. Four days with invited lectures, seminars and ESR progress reports are planned on topics like cloud computing, fetal brain image analysis, medical device approval process and morphometry & tractography, always focusing on translational brain imaging research.

https://trabit.eu/index.php/workshop-2-eindhoven

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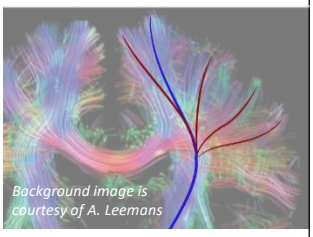
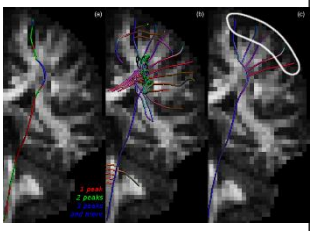
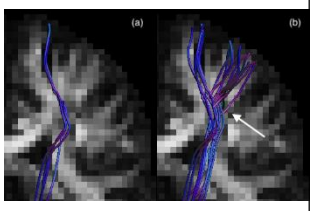
Short Report
ESR 9

Multi-level fiber tractography







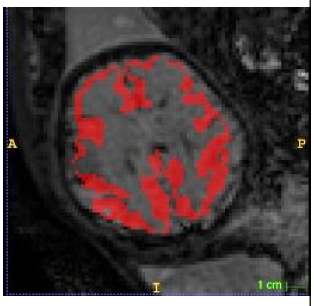
With diffusion MRI based fiber tractography, brain white matter fiber pathways can be reconstructed in vivo and noninvasively. Recent work has shown that reliable and consistent computation of these fiber trajectories is challenging as there are various algorithms with different user-defined settings. In particular, it is well known that probabilistic tractography approaches can produce more false positive reconstructions than the deterministic ones. On the other hand, while deterministic approaches can sample dominant peak orientations from the fiber orientation distribution in a robust way, they typically produce more false negative pathways.

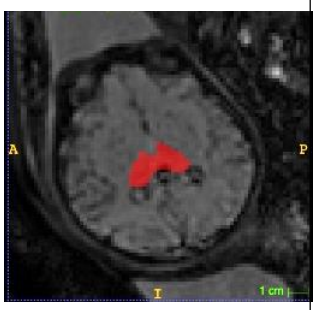
Andrey Zhylka is working on developing a tractography algorithm that is characterized by an improved sensitivity of the results while maintaining functional topology and pathway intercoherence. The concept addresses the notion of pathway branching. Details on the proof of concept can be found in the conference abstract.

https://doi.org/10.1007/978-3-030-05831-9_18

Short Report
ESR 6

Spatio-Temporal Signatures As Disease Markers in Fetal Brain Development of Morphology and Connectome





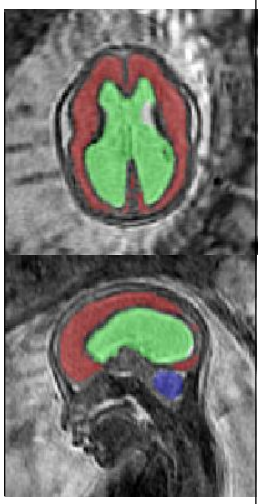
Brain development during fetal life provides a foundation for short and long term neurobehavioral outcomes, making the prenatal phase probably the most important period of our structural and functional growth and maturity. The study of brain development offer considerable potential for identifying periods of vulnerability during gestation, developing early diagnostic tools, early interventions, and generating strategies to ensure optimal prenatal development.

Athena Taymourtash is working on growth models of various brain structures, particularly the thalamus and the cerebral cortex, to construct a baseline for normal brain development of morphology and connectome. Her goal is to identify novel markers which can predict poor neurological maturation based on the deviation from baseline. She is also working on the quality assessment of fetal fMRI, as it is dominated by unpredictable fetal movements, to achieve a robust and reliable measure of functional connectivity.

https://doi.org/10.1007/978-3-030-32875-7_19

Short Report
ESR 4

Automatic parcellation of 3d fetal brain MRI



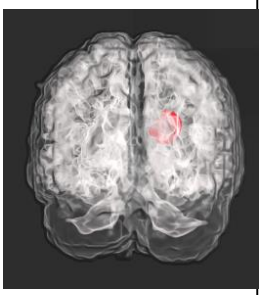
Congenital brain defects are disorders of the brain that appear during fetal development and are present at birth. Many congenital brain defects have a very poor prognosis, with little hope for definitive curative care. Some cases can nonetheless be prevented, while the severity of others can be reduced by fetal surgery. Automatic methods for fetal brain parcellation have the potential to improve our understanding of the disease, patient selection for in-utero surgery and parental counselling.

Lucas Fidon is working on robust deep learning methods for the automatic parecellation of 3d fetal brain MRI. The high variability of the anatomy of the fetal brain makes it challenging and current deep learning methods fail for some cases. The work of Lucas focuses on novel optimization methods that maximize the performance of the algorithms in the worst case. Lucas is also developing new methods that leverage biological constraints to guide the algorithms.

https://arxiv.org/abs/1907.01593

Short Report
ESR 7

Model-based optimization of treatment margins in the radio-treatment of glioma patients



Simulated glioblastoma courtesy of co-author Jana Lipkova

The glioblastoma is characterized by an infiltrative growth into the nearby healthy tissues, instead of forming a solid tumor with a well-defined boundary. Due to this, only a part of the glioma beyond a certain threshold of cancer cell concentration is visible on medical images. When using standard radiotherapy, the image volume of the tumor, which is extended by a uniform margin of a few centimeters, is irradiated by brief exposure to X-rays.

The objective of Ivan Ezhov's work is to develop and validate a new radio treatment approach that replaces the uniform safety margin, that is currently irradiated as a fix safety margin around the visible tumor, with a patient-specific margin that is adapted to anatomy, tumor location, and shape. This will include the following major aims: a) developing new inference schemes, integrating image information with biophysical model of tumor growth; b) testing the methods on various imaging modalities, such as FET PET, MRSI, perfusion, hypoxia MRI, c) comparing tumor model predictions against histology, e.g., MIB (cell proliferation marker), and follow up monitoring after radiotherapy.

https://arxiv.org/abs/1907.00973

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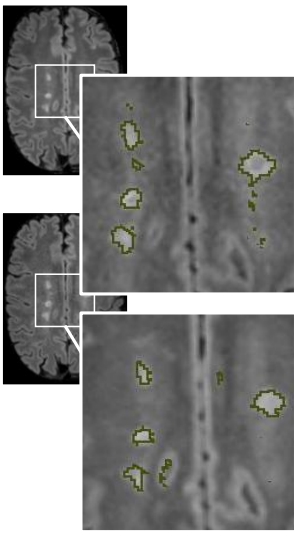
Short Report
ESR 1



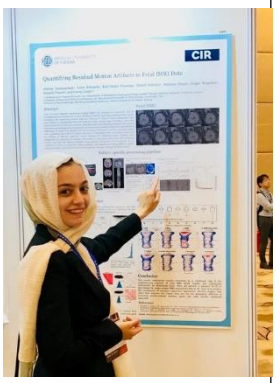
Robust evaluation of Multiple Sclerosis (MS) progression in multi-center/scanner settings

The follow-up of Multiple Sclerosis (MS) patients relies on the frequent acquisition of MR images to assess lesion progression of lesions and brain atrophy. However, this type of follow-up faces challenges due to hardware- or center-related variability. It is well known that scanner-factors such as manufacturer, magnetic field and gradient non-linearly influence volume measurements obtained from structural Magnetic Resonance Imaging (MRI). At the image level, these factors result in a high variability of intensities and other characteristics across patients and scanners, which can affect tasks like the segmentation of brain structures and lesions.

Maria Ines Meyer is working on improving the reliability of MS patient follow-up in multi-center/multi-scanner studies. Currently Ines is exploring the feasibility of using adversarial neural networks to enforce consistency on longitudinal patient data. Such an approach attempts to capture inter-scanner differences from delineations, under the assumption that the natural temporal variation in delineation shape can be distinguished from the variation caused by the different scanners.

https://arxiv.org/abs/1911.04289

Recent TRABIT
Publications



TRABIT Publications

The following publications are first-authored by an ESR of TRABIT.

L. Canalini et al. Segmentation-based registration of ultrasound volumes for glioma resection in image-guided neurosurgery. IJCARS, 2019

Meyer M.I. et al. Relevance Vector Machines for Harmonization of MRI Brain Volumes Using Image Descriptors. MLCN workshop, MICCAI 2019

A. Zhylka et al. On fiber orientation distribution peak selection for diffusion MRI fiber tractography. Magnetic Resonance Materials in Physics, 2019

I. Ezhov et al. Neural parameters estimation for brain tumor growth modeling. MICCAI 2019

L. Fidon et al. Incompressible image registration using divergence-conforming B-splines. MICCAI 2019.

L. Canalini et al. Registration of ultrasound volumes based on Euclidean distance transform. CuRIOUS Challenge, MICCAI 2019

https://trabit.eu/index.php/results