LMU KLINIKUM
Department of Nuclear Medicine

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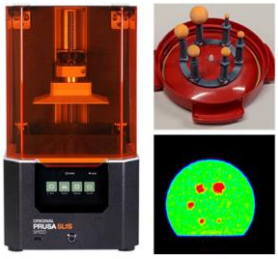
Bachelor/Master thesis projects in PET Image Analysis in Neuro-Oncology (PIANO) group

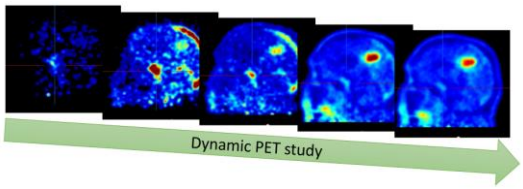
We are looking for highly motivated students **(physics/statistics/informatics)** who would like to join **PIANO** and work with us on challenging projects in the **Department of Nuclear Medicine at the University Hospital, LMU Munich**. The bachelor/master thesis can be started any time. Below you can find three major projects, within which the thesis projects can be defined. The exact content of each thesis will be agreed upon together with you and your department.

Background: In nuclear medicine pharmaceuticals are labelled with a radionuclide for diagnostic or therapeutic purposes. For positron emission tomography (PET) positron emitting radionuclides are used to deduce the spatial and temporal distribution of an injected radiopharmaceutical within the body. Depending on the specific radiopharmaceutical and clinical task, either static or dynamic PET data are measured and analyzed. With the help of pharmacokinetic modelling, tissue properties can be quantified. Pharmacokinetic properties or radiomic features derived from PET data may aid with diagnosis or prognosis or guide therapy decisions. **Project 1** deals with verification of PET quantification using phantom measurements and PET simulations. **Project 2** is dedicated to improving non-invasive pharmacokinetic modelling using an image derived blood input function. **Project 3** tackles the issue that image properties can vary among different scanners. Here, image harmonization techniques will be explored to enable data pooling and model application to data from different centers.

1. Establish and validate PET data simulations for two different scanning devices using phantom measurements (**3D printed radioactive objects**)
   - Simulation methods:
     - **Monte Carlo** (GATE)
     - Convolution-based
   - Evaluate influence of imaging process and scanning device on:
     - Tumor segmentation (standard and deep learning-based)
     - Radiomic features (volume- and voxel-based)
     - Pharmacokinetic modelling (volume- and voxel-based)



2. Establish and compare different methods for the generation of an image derived input function (IDIF) for **pharmacokinetic modelling** of dynamic PET images
   - Validation using "ground truth" from simulations of dynamic PET studies
   - Establish **deep learning**-based method for the extraction of an IDIF
     - Whole-blood IDIF from an image section (dynamic PET) around carotids and/or sinus sagittalis
     - Metabolite corrected IDIF from larger image section or separate time-activity curves
   - Compare to established methods such as simultaneous estimation



3. Establish and validate **deep learning**-based **image harmonization**
   - Application of generative adversarial networks (GANs) for supervised (e.g. conditional GAN with additional loss function) and unsupervised image transformation (e.g. CycleGAN)
   - Comparison to ComBat method for harmonization of radiomic features
   - Assess improved generalizability for clinical prediction when data from two different scanning devices are used

If you are interested, please contact us with some personal information (short CV, transcript of records, software development skills etc.). Lena.Kaiser@med.uni-muenchen.de