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Invited talk: Deep learning image reconstruction for positron emission tomography (PET): present status and future perspectives

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Image reconstruction for positron emission tomography (PET) has been developed over many decades, starting out with filtered backprojection methods, with advances coming from improved modelling of the data statistics and improved modelling of the overall physics of the data acquisition / imaging process. However, high noise and limited spatial resolution have remained major issues in PET, and conventional state-of-the-art methods have exploited other medical imaging modalities (such as MRI) in order to assist in denoising and enhancing the spatial resolution for PET. Nonetheless, there is a drive towards not only improving image quality, but also to reducing the injected radiation dose and reducing scanning times. While the arrival of new PET scanners, such as total body PET (TB PET), is helping, there is still a need to improve the reconstruction of PET images in terms of quality and speed.

Deep learning methods are forming the new frontier of research for PET image reconstruction. They can learn the imaging physics and its inverse, learn the noise and also exploit databases of high-quality reference examples, to provide improvements in image quality. There are four main approaches: direct full data-driven learning of reconstruction operators, direct methods which incorporate known imaging physics, methods which integrate deep learning into existing iterative reconstruction algorithms (unrolled reconstruction) and methods which exploit deep learning as a means of representing the images to reconstruct (e.g. the deep image prior). This talk will cover a review of these methods, their advantages and disadvantages. The outlook of current and future directions for deep learning in PET reconstruction will then be considered, such as self-supervision, and quantifying uncertainty.

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Session Classification : Machine Learning in Medical Applications 2

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