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Translational Medicine: from bifurcations to epilepsy surgery

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Over the past decade we have demonstrated that constraining computational brain network models by structural information obtained from human brain imaging (anatomical MRI, diffusion tensor imaging (DTI)) allows patient specific predictions, beyond the explanatory power of neuroimaging alone. This fusion of an individual's brain structure with mathematical modelling allows creating one model per patient, systematically assessing the modeled parameters that relate to individual functional differences. The functions of the brain model are governed by realistic neuroelectric and neurovascular processes and allow executing dynamic neuroelectric simulation; further modeling features include refined geometry in 3D physical space; detailed personalized brain connectivity (Connectome); large repertoire of mathematical representations of brain region models, and a complete set of physical forward solutions mimicking commonly used in non-invasive brain mapping including functional Magnetic Resonance Imaging (fMRI), Magnetoencephalography (MEG) Electro-encephalography (EEG) and StereoElectroEncephalography (SEEG). So far our large-scale brain modeling approach has been successfully applied to the modeling of the resting state dynamics of individual human brains, as well as aging and clinical questions in stroke and epilepsy. In this talk I will focus on the example of epilepsy and systematically demonstrate the individual steps towards the creation of a personalized epileptic patient brain model.