Machine learning techniques for inverse problems on brain cell migration in neurogenesis

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Abstract: Neurogenesis is the process of formation of new neurons in the brain from precursor cells called neuroblasts. This process, where new born neuroblasts migrate in the adult brain before maturng into neurons, has been widely described in the literature. However, few models have been developed for that, and as far as we know, the only one in realistic meshes of the brain is the one proposed in [1]. In this model, the route of migration is determined by PDEs that depend on several parameters and describe the chemoattraction forces and the heterogeneous mobility of neuroblasts in different regions of the rodent brain.

In our current study, we delve into the use of Physics-Informed Neural Networks [2] for neurogenesis modeling. Our primary objective is, above all, to refine the parameters of the governing PDEs that dictate the migration pathways of neuroblasts. The target is to improve the accuracy of the predictions with respect to the experimental data from real rodent brains provided by our collaborating neurobiology researchers. Through a series of tests, we compare the efficacy of our Physics-Informed Neural Network approach with other L-BFGS-B minimizing techniques.

References:

[1] Acosta-Soba, Daniel and Castro-González, Carmen and Geribaldi-Doldán, Noelia and Guillén-González, Francisco and Núñez-Abades, Pedro and Ortega-Román, Noelia and Pérez-García, Patricia and Rodríguez-Galván, J Rafael. *Mathematical Modelling of Neuroblast Chemotaxis Migration towards the Olfactory Bulb*. ArXiv preprint 2211.06166, 2023.

[2] Raissi, Maziar and Perdikaris, Paris and Karniadakis, George E, *Physics-informed neural networks: A deep learning framework for solving forward and inverse problems involving nonlinear partial differential equations*, Journal of Computational physics, 378, 686–707, 2019.