Mathematical modelling and large-scale computational optimisation elucidates the link between C. Elegans neural circuit morphology and worms behaviour.

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Caenorhabditis Elegans is undoubtfully one of the most studied living organism. It is the only animal for which its neural connectome has been fully resolved. However, its functional link to the behaviour and cognitive capabilities remains obscure. Adequate mathematical models of the of the electrophysiological properties of neural cells were successfully developed in recent decades[1]. But still, a large number of unknown parameter values and the complexity of the whole neural circuits require the employment of the large-scale computations to explore the space of all possible dynamical states of the network. The particular solutions were verified against behavioural experimental data, and the most likely parameter values and activity states were indicated. Among the others, crucial for further understanding the worm neurobiology, morphological and physiological features were described: neural polarities, average membrane potentials and intrinsic calcium concentrations. The parameter optimisation was carried out using genetic algorithm approach implemented in the Parallel Computation in Java library, and performed on a massively parallel computational architecture [2], employing about one thousand CPU's in a single run.

1. Rakowski, F.; Srinivasan, J.; Sternberg, P.W.; Karbowski, J.; Synaptic polarity of the interneuron circuit controlling C. Elegans locomotion, Frontiers in Computational Neuroscience, 2013, Vol 7, 128
2. Górski Ł., Rakowski F., Bała P. Parallel differential evolution in the PGAS programming model implemented with PCJ Java library, Lecture Notes in Computer Science. 2016