Opportunity for Programmers: An Educational Tool based on NETMORPH

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About NETMORPH

- **Purpose/Functionality**: Simulate the simultaneous outgrowth of a large number (hundreds/thousands) of neurons in terms of their detailed 3D morphology in a manner closely resembling the development of biological neurons. Simulated development includes the generation of synaptic connections between axons and dendrites of different neurons, so that realistic neuronal networks are formed.
- **Algorithmic approach**: Outgrowth is simulated by updating simulated activity at the growth cones at the ends of each dendrite or axon. Activities include elongation of the axon or dendrite, changes in the direction of growth and branching (bifurcation). Actions are simulated in a phenomenological manner, meaning that the resulting structures at each stage of development are a statistically correct representation of natural development. (A mechanistic implementation based on neurophysiological processes is a possible extension, but at this stage has been used only to enable directed growth toward target neurons.)
- **Validation**: Satisfactory simulated development of typical neuron morphologies has been validated by comparison with data from a database of manually reconstructed neuron morphologies. NETMORPH has been published in the journal Neuroinformatics: **Koene, R.A., et al. (2009). NETMORPH: A Framework for the Stochastic Generation of Large Scale Neuronal Networks With Realistic Neuron Morphologies, *Neuroinformatics*, 7(3), pp.195-210, doi: 10.1007/s12021-009-9052-3.** (Download PDF.)
- **Platform**: C++, natively on Linux/Unix and Mac OS, Windows with the Cygwin libraries.
- **Examples**: A descriptive site is located at http://www.netmorph.org and animated examples of results achieved with NETMORPH are provided on the Examples (http://www.netmorph.org/Home/examples) page of that site.

http://sites.google.com/site/netmorphorg/documents-1/koene.NETMORPH.Neuroinformatics-7-2009-195-210.pdf?attredirects=0&d=1

About the Educational Tool

- Intended functions/aims:
  - Easy-to-use and appealing 3D visualization and exploration of resulting cell structures and networks, as well as visualization of the process of development.
  - Easily run any of a number of preset scenarios that demonstrate specific types of cell or network development, function or dysfunction.
  - Lab tutorials/exercises capability that allows students and teachers to prepare their own simulations. A subset of parameters should be easily configurable and should include explanations of their meaning that are shown graphically when possible.
  - Observe cell and network growth, and the effect of intrinsic parameters as well as external effects (e.g. environmental constraints).
  - Identify an evaluate resulting network connectivity, its causes and dependencies.
  - Depict the propagation of action potentials, the transmission at synapses.
  - Showing neuroscience methods such as the patch-clamp method.
  - *...Many more interesting and more complex possibilities exist, but should be considered after the simplest implementation is delivered as a first version of the educational tool.*

- *...If we can create scenarios that accompany and clearly demonstate important aspects of each chapter of a popular neuroscience text (e.g. Mark F. Bear's Neuroscience textbook) then it may also be possible to sell the product as an addition to the book.*

- Important features:
  - Primary design as an AJAX web application that interfaces with server-based NETMORPH, focusing on universality and simplicity of the interface tool, and centralized maintenance.
  - Output in formats usable in presentations and reports by students.
  - 3D graphical visualization of progress during the simulation of neuronal development.
  - Learn about the basic morphological aspects of neurons. What are their parts?
  - *...A future stand-alone version of the tool can have performance benefits, which are interesting mostly for use in an advanced research setting.*

About the Business Model

Technologically, this is a low-risk project, because the greatest part of that task has already been completed during the period from 2004-2008 in the creation and validation of the NETMORPH framework.

Production resources are low cost, because the product is a software package. When implemented as a web application risks and costs in production are further decreased.

The target market – neuroscience teaching – exists in universities world-wide (>>25,000, new classes each year) and is developing at the high-school level. The product can be sold bundled with existing teaching materials, through individually purchased licenses, or at the departmental/institutional level. The initial product has a development path both in terms of improvements to the core product, but also through the addition of add-ons in a product suite that range from teacher tools, lab and exam/test materials, companion guides, expanded capabilities for advanced use in research and stand-alone versions for high-performance use.

This product is not in itself something that neuroscience courses cannot do without, but that problem may be overcome by seeking bundling with required teaching materials and appeal through the product's ability to greatly reduce the effort to achieve clear understanding of course materials.

I am seeking 1 or 2 persons to carry out the development of an easy-to-use interface to the software (**HCI skills**) and its implementation (probably using **AJAX web application** principles). The work-load is anticipated to be between 10-20 hours per week per person. Remuneration is in the form of a **work-for-equity** deal.

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