A Vertical Application Programming and Development Framework for Spike-Based Neuromorphic Computing Devices

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We have developed a software environment for programming applications on spike-based neuromorphic computing systems. The environment is vertical, from applications and programming methodologies at the top, to software support at the middle, to various neuromorphic computing models, simulators and devices at the bottom.

**Applications**
- Flappy Bird
- Pole Balancer
- Control
- 2D Nav
- Classification
- Microapplications

**Common Software Core**
- Implementation in C++

**Network Module**
- Create
- Serialize
- De-serialize
- Mutate
- Reproduce (Crossover)

**Device Module**
- Instantiate
- Load network
- Pull network
- Apply inputs
- Read outputs
- Run

**I/O Module**
- Transform inputs
  - numbers, strings
  - pulses, neurons, values
- Transform outputs
  - counts, neurons
  - numbers, decisions

**Job Module**
- Define job
- Batch multiple jobs
- (Support for GPU)
- (Support for threading)

**EO Module**
- Define complexity
- Fitness evaluation
- Sliding fitness window
- Reproduction
- Job support

**Neuromorphic Models**
- NIDA
  - 3D RISC model
  - Analog neurons & synapses
  - Simulator in C++
  - 3D Visualization
  - ASIC Design Completed
- DANNA
  - 2D grid of programmable elements
  - See our demo/poster on DANNA
  - FPGA Implementation
  - Simulator in C++
- MrDANNA
  - Memristive Synapses
  - See our poster on MrDANNA
  - GPU Simulator for batched runs
  - Hardware kit
  - Chip fabrication with SUNY Nanotech
- Others
  - Reservoir Biomimetic
  - Simulator in C++

**Programming**
- Evolutionary Optimization
  - Applications define fitness
  - Models define operations
  - Evolution of parameters and structure

**Exploiting Parallelism**
- Kernel Development

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