Towards Training the Extended Voltage Manifold Computer (EVMC) using Particle Swarm Optimization

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Extended Analog Computers (EAC) have been explored as a substrate for unconventional computing techniques since the early 1990s. A particular strength of the technique is the near instantaneous speed it solves computational problems. However, application of the EAC and specific EAC classes, as the Extended Voltage Manifold Computer (EVMC), to real-world problems await the development of methods to program EACs. A property of the EVMC is that each output voltage can be described by a class of radial basis functions (RBF). Linking multiple EVMCs, a neural network called a radial basis function network (RBFN) can be implemented. The specific aim of this work is to develop the means to train EVMCs and networks of EVMC based RBFNs.

The strategy employed in the present work is to develop a method using EVMCs implemented as finite element method (FEM) simulations to define the error state-space and error gradient of the untrained EVMC manifold. Once defined the EVMC simulation can be recursively configured to reduce the error in a Hebbian sense. Furthermore, particle swarm optimization (PSO) is being explored to improve the speed of convergence.

FEM simulations were constructed using COMSOL Multiphysics to model EVMC manifolds in different states. In parallel, a particle swarm optimizer was altered to demonstrate training of simple RBF manifolds. Examination of FEM simulations verified the kernel function as hyperbolic and radially based. These preliminary findings indicated that the EVMC can be accurately modeled and manipulated using COMSOL, and PSO can be used once the error manifold is defined. From this we can take the possibility of improving the speed of training the EVMC via PSO. The next step to verify this possibility is to combine the COMSOL and Python codes to confirm the EVMC can be trained.

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