An ambitious long-term goal for neuroevolution, which studies how artificial evolutionary processes can be driven to produce brain-like structures, is to evolve neurocontrollers with a high density of neurons and connections that can adapt and learn from past experience. Yet while neuroevolution has produced successful results in a variety of domains, the scale of natural brains remains far beyond reach. In this dissertation two extensions to the recently introduced Hypercube-based NeuroEvolution of Augmenting Topologies (HyperNEAT) approach are presented that are a step towards more brain-like artificial neural networks (ANNs). First, HyperNEAT is extended to evolve plastic ANNs that can learn from past experience. This new approach, called adaptive HyperNEAT, allows not only patterns of weights across the connectivity of an ANN to be generated by a function of its geometry, but also patterns of arbitrary local learning rules. Second, evolvable-substrate HyperNEAT (ES-HyperNEAT) is introduced, which relieves the user from deciding where the hidden nodes should be placed in a geometry that is potentially infinitely dense. This approach not only can evolve the location of every neuron in the network, but also can represent regions of varying density, which means resolution can increase holistically over evolution. The combined approach, adaptive ES-HyperNEAT, unifies for the first time in neuroevolution the abilities to indirectly encode connectivity through geometry, generate patterns of heterogeneous plasticity, and simultaneously encode the density and placement of nodes in space. The dissertation culminates in a major application domain that takes a step towards the general goal of adaptive neurocontrollers for legged locomotion.

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The public is welcome to attend.