This dissertation introduces two new algorithms that are steps towards the integration of gradient descent and neuroevolution for training neural networks. The first is the Limited Evaluation Evolutionary Algorithm (LEEA), which implements a novel form of evolution where individuals are partially evaluated, allowing rapid learning and enabling the evolutionary algorithm to behave more like gradient descent. This conception provides a critical stepping stone to future algorithms that more tightly couple evolutionary and gradient descent components. The second major algorithm is Divergent Discriminative Feature Accumulation (DDFA), which combines a neuroevolution phase, where features are collected in an unsupervised manner, with a gradient descent phase for fine tuning of the neural network weights. The neuroevolution phase of DDFA utilizes an indirect encoding and novelty search, which are sophisticated neuroevolution components rarely incorporated into gradient descent-based systems. Further contributions of this work that build on DDFA include an empirical analysis to identify an effective distance function for novelty search in high dimensions and the extension of DDFA for the purpose of discovering convolutional features. The results of these DDFA experiments together show that DDFA discovers features that are effective as a starting point for gradient descent, with significant improvement over gradient descent alone. Additionally, the method of collecting features in an unsupervised manner allows DDFA to be applied to domains with abundant unlabeled data and relatively sparse labeled data. This ability is highlighted in the STL-10 domain, where DDFA is shown to make effective use of unlabeled data.

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The public is welcome to attend.