Abstract of the Dissertation

Unsupervised Feature Learning for Computer Vision

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Much of computer vision has been devoted to the question of representation through feature extraction. Ideal features transform raw pixel intensity values to a representation in which common problems such as object identification, tracking, and segmentation are easier to solve. Recently, deep feature hierarchies have proven to be immensely successful at solving many problems in computer vision. In the supervised setting, these hierarchies are trained to solve specific problems by minimizing an objective function of the data and problem specific label information. Recent findings suggest that despite being trained on a specific task, the learned features can be transferred across multiple visual tasks. These findings suggests that there exists a generically useful feature representation for natural visual data.

This work aims to uncover the principles that lead to these generic feature representations in the unsupervised setting, which does not require problem specific label information. We begin by reviewing relevant prior work, particularly the literature on auto-encoder networks and energy based learning. We introduce a new regularizer for auto-encoders that plays an analogous role to the partition function in probabilistic graphical models. Next we explore the role of specialized encoder architectures for sparse inference. The remainder of the thesis explores visual feature learning from video. We establish a connection between slow-feature learning and metric learning, and experimentally demonstrate that semantically coherent metrics can be learned from natural videos. Finally, we posit that useful features linearize natural image transformations in video. To this end, we introduce

a new architecture and loss for training deep feature hierarchies that linearize the transformations observed in unlabeled natural video sequences by learning to predict future frames in the presence of uncertainty.