



Figure 20.1: Examples of models that may be built with restricted Boltzmann machines. (a) The restricted Boltzmann machine itself is an undirected graphical model based on a bipartite graph, with visible units in one part of the graph and hidden units in the other part. There are no connections among the visible units, nor any connections among the hidden units. Typically every visible unit is connected to every hidden unit but it is possible to construct sparsely connected RBMs such as convolutional RBMs. (b) A deep belief network is a hybrid graphical model involving both directed and undirected connections. Like an RBM, it has no intralayer connections. However, a DBN has multiple hidden layers, and thus there are connections between hidden units that are in separate layers. All of the local conditional probability distributions needed by the deep belief network are copied directly from the local conditional probability distributions of its constituent RBMs. Alternatively, we could also represent the deep belief network with a completely undirected graph, but it would need intralayer connections to capture the dependencies between parents. (c) A deep Boltzmann machine is an undirected graphical model with several layers of latent variables. Like RBMs and DBNs, DBMs lack intralayer connections. DBMs are less closely tied to RBMs than DBNs are. When initializing a DBM from a stack of RBMs, it is necessary to modify the RBM parameters slightly. Some kinds of DBMs may be trained without first training a set of RBMs.