Robust Boltzmann Machines for Recognition and Denoising

Introduction

- Allows Boltzmann Machines to be robust to noise and occlusions
- Multiplicative gating allows for the presence of novel occluders with exotic appearances
- The structure of occluders and noise statistics can be learned from the data in an unsupervised fashion
- Completely automated image inpainting and denoising correspond to posterior inference in the model

Gibbs Iterations

Initial 1 3 5 7 9 11

Ground truth Partially occluded RoBM RBM PCA Wiener Nearest Neighbor

Face Recognition - Yale Database

Idea

Model Diagram

Inference using Gibbs Sampling:

1) Sample from $p(s | h, g, v)$
2) Sample from $p(v | s, h, g)$
3) Sample from $p(h | v, s)$

Face Recognition - Yale Database

AR faces - Inference

AR faces - Recognition

Learning Epochs

1 3 5 7 10 20 30 40 50

(a) Inferred

(b) Inferred

Learning Noise Structure

- A binary RBM component within the RoBM learns the structure of the occluders
- A learned occluder model allows for improved denoising and recognition

Gaussian Restricted Boltzmann Machine

Hidden nodes

Visible nodes

$E_{\text{RoBM}}(v, h) = \frac{1}{2} \sum_i \left( \alpha_i | v_i |^2 + \beta_i | h_i |^2 \right) + \sum_{ij} W_{ij} v_i h_j$

Multiplicative gating allows for the presence of novel occluders with exotic appearances

Allows Boltzmann Machines to be robust to noise and occlusions for Recognition and Denoising

Salt and Pepper Denoising

Removing Sunglasses

Block Occlusion Denoising

Denoising

Ground truth Partially occluded RoBM RBM PCA Wiener Nearest Neighbor

Removing Sunglasses