

# Directed Generative Nets

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# Topics in Deep Generative Models

- Boltzmann Machines
- Restricted Boltzmann Machines
- Deep Belief Networks
- Deep Boltzmann Machines
- Boltzmann Machines for Real-Valued Data
- Convolutional Boltzmann Machines
- Boltzmann Machines for Structured Sequential Objects
- Other Boltzmann Machines
- Back-Propagation through Random Operations
- **Directed Generative Nets**
- Drawing Samples from Autoencoders
- Generative Stochastic Networks
- Other Generation Schemes
- Evaluating Generative Models

# Topics in Directed Generative Nets

- What are deep, fully directed models
  1. Sigmoid belief nets
  2. Differentiable generator nets
  3. Variational autoencoders (VAE)
  4. Generative adversarial networks (GAN)
  5. Generative moment matching networks
  6. Convolutional generative networks
  7. Autoregressive networks
    8. Linear autoregressive networks
    9. Neural autoregressive networks
    10. Neural Autoregressive density estimators (NADE)

# Deep Generative Nets

- Directed models: an important class of PGMs
- But in Deep Learning community they have been overshadowed by undirected models
  - Note that DBNs are partially directed
  - Sparse coding models are shallow directed models
    - Used primarily for feature learners
    - Perform poorly in sample generation and density estimation
- Here we review directed PGMs associated with deep learning

# Sigmoid Belief Nets

- Has a vector of binary states  $\mathbf{s}$ , with each element influenced by its ancestors:

$$p(s_i) = \sigma \left( \sum_{j < i} W_{j,i} s_j + b_i \right)$$

- Structure:
  - Divided into many layers
  - Ancestral sampling proceeds through many hidden layers, finally generating the visible layer
  - Structure is similar to a DBN, except units at the beginning of the sampling process are independent of each other rather than sampled from an RBM