Undirected Graphical Model for Movie Rating Prediction

Data

- 10,000 movie ratings
- 943 users
- 1682 items

Model 1

- Age (5 age groups)
- Gender
- Occupation (19)
- Movie’s year
- Movie’s genre
- Rating

Structure Learning

$$p(x_1, x_2, \ldots, x_p) \triangleq \frac{1}{Z} \exp(\sum_{i=1}^{p} x_i b_i + \sum_{(i,j)\in E} x_i x_j w_{ij}).$$

$$\min_{W,\mathbf{b}} \sum_{m=1}^{n} [-\sum_{i=1}^{p} [-x_i^m b_i - \sum_{j=i+1}^{n} x_i^m x_j^m w_{ij}]] + n \log Z(W, \mathbf{b}) + \lambda \sum_{i=1}^{p} \sum_{j=i+1}^{p} |w_{ij}|.$$

Still dense. Group L1 & Pseudo likelihood

$$\underset{x \in \mathbb{R}^d}{\operatorname{argmin}} f(x) + \lambda \sum_{g \in G} \|x_g\|_2.$$

$$p(x_i | \mathbf{x}_{-i}, W, \mathbf{b}) = \frac{1}{Z_i} \exp(x_i b_i + \sum_{j \neq i} x_i x_j w_{ij}),$$

Weight Learning

$$\frac{\partial \ell}{\partial \boldsymbol{\theta}_c} = \left[\frac{1}{N} \sum_i \boldsymbol{\phi}_c(\mathbf{y}_i) \right] - \mathbb{E}\left[\boldsymbol{\phi}_c(\mathbf{y}) \right]$$

- Have to do inference

Weight Learning

- $P(X_c)_{MLE} = m(X_c)/N$

$$p(\mathbf{x}) = \frac{\prod_c \psi_c(\mathbf{x}_c)}{\prod_s \varphi_s(\mathbf{x}_s)}$$

Predicting

- Decoding

Model 2

- Age (5 age groups)
- Gender
- Occupation (19)
- Movie’s year
- Movie’s genre
- Rating
- Movie ID

Loopy Belief Propagation

$$KL(Q \| P) = \sum_X Q(X) \log(\frac{Q(X)}{P(X)})$$

$$F(P,Q) = -H_Q(X) - \sum_{f_a \in F} E_Q \log f_a(X_a)$$

$$F_{Betha} = \sum_a \sum_{\mathbf{x}_a} b_a(\mathbf{x}_a) \ln \frac{b_a(\mathbf{x}_a)}{f_a(\mathbf{x}_a)} + \sum_i (1 - d_i) \sum_{\mathbf{x}_i} b_i(\mathbf{x}_i) \ln b_i(\mathbf{x}_i)$$

Mean Field

$$KL(Q \| P) = \sum_X Q(X) \log(\frac{Q(X)}{P(X)})$$

$$q(\mathbf{x}) = \prod_i q_i(\mathbf{x}_i)$$

$$\log q_j(\mathbf{x}_j) = \mathbb{E}_{-q_j}\left[\log \tilde{p}(\mathbf{x})\right] + \text{const}$$