Group 4

Collaborative Filtering Algorithms

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Data Set Info

Data Set 1: Anonymous Microsoft Web Data

Data Set 2: Movies Grading Data

Binary (0 for not visited & 1 for visited)

User: User indices range from 10010 to 42708

Feature (web): Site indices ranging from 1000 to 1295

Train: 4151* 85

Test: 665 * 85

6 Categories (movie rating from 1 to 6)

User: User indices range from 1 to 74418

Feature(Movie): Movie indices range from 1 to 1648

Train: 5055 * 1619

Test: 5055 * 1597

Implementation: Variants being tested

Algorithm	Component	Variants	Data
Memory-based Algorithm	Similarity Weight	Pearson Correlation	1,2
		Mean Square Difference	1,2
		SimRank	1
	Variance Weighting	No	1,2
	Selecting Neighbors	Weight Threshold	1,2
		Best-n-estimator	1,2
		Combined	1,2
	Rating Normalization	Deviation for Mean	1,2
		Z-score	1,2
Model-based Algorithm	Cluster Models		1

Similarity Weight:

Weight all users with respect to similarity with the active user:

Pearson Correlation

Measures the degree to which a linear relationship exists between two variables

$$w_{a,u} = \frac{\sum_{i=1}^{m} (r_{a,i} - \overline{r}_a) * (r_{u,i} - \overline{r}_u)}{\sigma_a * \sigma_u}$$

Mean Square Difference

$$MSD_{a,u} = \frac{\sum_{h} (r_a - r_u)^2}{n}$$

$$w_{a,u} = \frac{max(MSD_{a,u}) - MSD_{a,u}}{max(MSD_{a,u})}$$

SimRank

For the algorithm of SimRank, we mainly implement these two equations below

$$s(c,d) = \frac{C_2}{|I(c)||I(d)|} \sum_{i=1}^{|I(c)|} \sum_{j=1}^{|I(d)|} s(I_i(c), I_j(d))$$

$$s(A,B) = \frac{C_1}{|O(A)||O(B)|} \sum_{i=1}^{|O(A)|} \sum_{j=1}^{|O(B)|} s(O_i(A), O_j(B))$$

The way to compute SimRank is the naïve method:

$$R_0(a,b) = \begin{cases} 0 & \text{(if } a \neq b) \\ 1 & \text{(if } a = b) \end{cases} \qquad R_{k+1}(a,b) = \frac{C}{|I(a)||I(b)|} \sum_{i=1}^{|I(a)|} \sum_{j=1}^{|I(a)|} R_k(I_i(a), I_j(b))$$

Model Based Algorithm – Cluster Model

• Step 1: Take initial guess for all the parameters $\hat{\mu}, \hat{\gamma}$. One choice is start with uniform values, that is to say

$$\hat{\mu}_c = \frac{1}{C}, \quad \forall c$$

$$\hat{\gamma}_{c,j}^{(k)} = \frac{1}{6}, \quad \forall c, j, k.$$
(9)

• Step 2: Expectation.

Compute the responsibilities for each user i

$$\hat{\pi_i^c} = \frac{\hat{\mu_c} \cdot \hat{\phi_c}(D(i))}{\sum_{c=1}^C \hat{\mu_c} \cdot \hat{\phi_c}(D(i))}$$
(10)

for c = 1, ..., C and i = 1, ..., N.

In the above equation, $\hat{\phi}_c(D(i)) = \prod_{j \in I(i)} \hat{P}(V_j^{(i)} = v_j^{(i)} | \Delta_i = c)$, where $\hat{P}(V_j^{(i)} = k | \Delta_i = c) = \hat{\gamma}_{c,j}^{(k)}$.

• Step 3: Maximization.
Update the parameters

$$\hat{\mu}_{c} = \frac{\sum_{i=1}^{N} \hat{\pi}_{i}^{c}}{N}, \quad \text{for} \quad c = 1, ..., C$$

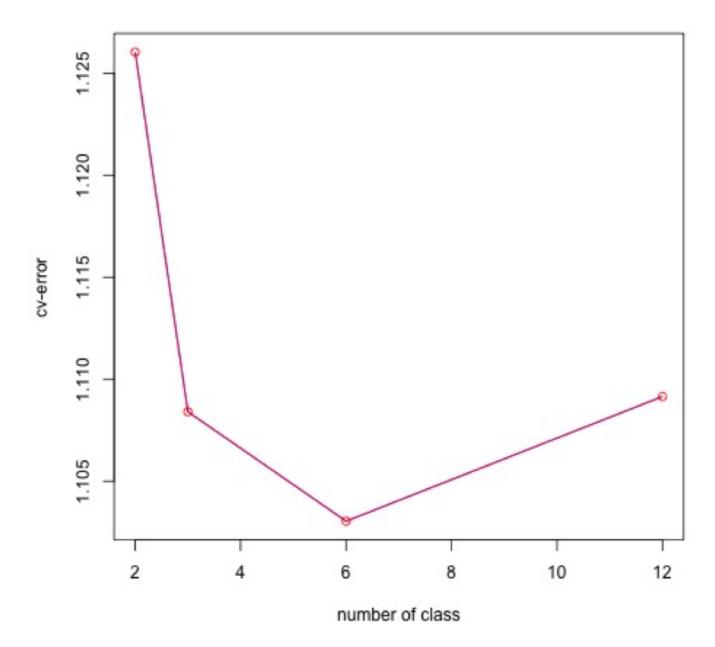
$$\hat{\gamma}_{c,j}^{(k)} = \frac{\sum_{i:j \in I(i)} \hat{\pi}_{i}^{c} \cdot \mathbb{I}(v_{j}^{(i)} = k)}{\sum_{i:j \in I(i)} \hat{\pi}_{i}^{c}}, \quad \text{for} \quad \forall c, j, k$$
(11)

For initialization, Set parameter γ random variable which sum by class is 1.

For iteration,

We set the iteration as 100; There is also another stop sign which is

$$|\pi_i - \pi_{i-1}| \le 0.05$$



Rating Normalization

Deviation for mean

$$p_{a,i} = \overline{r}_a + \frac{\sum_{u=1}^{n} (r_{u,i} - \overline{r}_u) * w_{a,u}}{\sum_{u=1}^{n} w_{a,u}}$$

• Z-score:

$$p_{a,i} = \overline{r}_a + \sigma_a * \frac{\sum_{u=1}^{n} \frac{r_{u,i} - r_u}{\sigma_u} * w_{a,u}}{\sum_{u=1}^{n} w_{a,u}}$$

Evaluation

For this part, we applied three evaluation methods to compare the results:

For dataset 1 – Rank Score

- Rank Score
- ❖ It measures the expected utility of a ranked recommendation list Ra and normalized by the maximum achievable utility Ra_max.
- The expected utility of a list is simply the probability of viewing a recommanded item times its utility.

For dataset 2 – MAE

- MAE
- * MAE is simply to calculate the average absolute deviation for a user :

$$S_a = \frac{1}{m_a} \sum_{j \in P_a} |p_{a,j} - v_{a,j}|$$

Results Analysis

Dataset 1: Ranked Scoring								
Selecting Nbors Similarity Weight	Weight Threshold		Best-N-Estimator		Combined			
	0.05	0.2	20	40	0.05 + 40			
Pearson Correlation	45.7274	44.05147	32.68916	34.62473	33.7009			
Mean-Squared- Difference	47.77998	47.77998	33.38771	35.12559	35.04042			
SimRank	45.985	32.1453	32.3775	33.39524	35.0523			

Dataset 2: MAE

Selecting Nbors Similarity Weight	Weight Threshold		Best-N-Estimator		Combined
	0.05	0.2	20	40	0.05 + 40
Pearson Correlation	1.187658	1.185793	1.167949	1.167326	1.183761
Mean-Squared- Difference	1.168654	1.168654	1.170718	1.169313	1.166298

THANK YOU