Learning Multiple-Question Decision Trees for Cold-Start Recommendation

Mingxuan Sun   Fuxin Li   Joonseok Lee   Ke Zhou
Guy Lebanon   Hongyuan Zha

College of Computing
Georgia Institute of Technology

02/07/2013

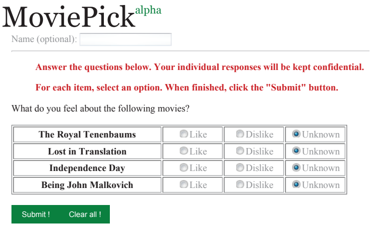
Recommendation Systems

Cold-start Recommendation

Challenge: rapid profiling of new users

Interview: learn preferences for new users

- Static: ask questions about selected items [Rashid2002,Golbandi2010]

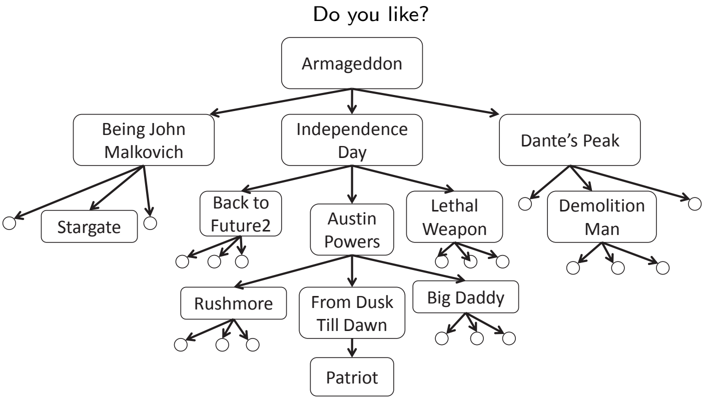


- Previous answers not used to improve question selection!

Cold-start Recommendation

Interview: learn preferences for new users

- Adaptive: query according to previous answers [Rashid2008,Golbandi2011,Zhou2011]



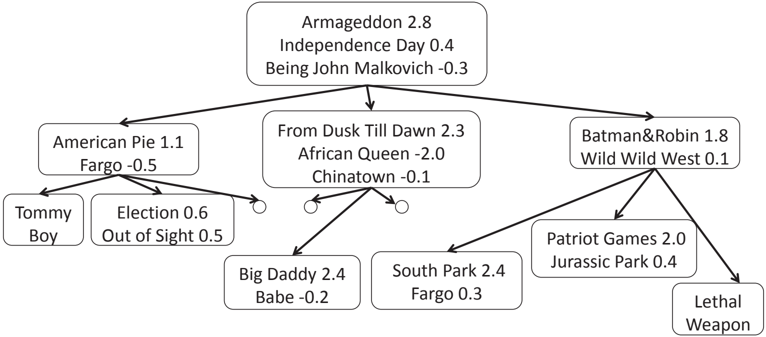
- Users repeatedly select "Unknown" before locating familiar items. Considerable amounts of user interaction!

Ours: Decision Tree with Multi-questions

- Higher recommendation accuracy
- Less user interaction

Challenges

- Search all splits: infeasible
- Learn an uniform user profile: inefficient



Learning Framework - Learn to Split at Each Node

w: weight for movies, x_i: answer of user i, l: max questions

Probabilities assigned to the left and right branches:

$$p_i = \frac{1}{1 + c\exp(-x_i^\top w)} \quad q_i = \frac{1}{1 + c\exp(x_i^\top w)}$$

Three branches:

$$L(w) = \{i|p_i \text{ max}\}, D(w) = \{i|q_i \text{ max}\}, U(w) = \{i|otherwise\}$$

Objective: to minimize the prediction loss:

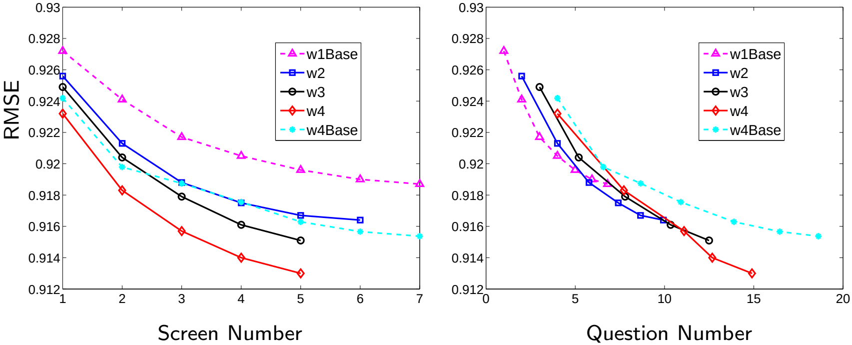
$\bar{x}_i$: answers user already submitted
r_{ij}: observed rating of user i for movie j
v_j: movie profiles

$$\min_{w, Z_L, Z_D, Z_U} \sum_{i \in L(w)} \sum_{j \in O_i} (r_{ij} - (Z_L \bar{x}_i)^\top v_j)^2 + \sum_{i \in D(w)} \sum_{j \in O_i} (r_{ij} - (Z_D \bar{x}_i)^\top v_j)^2 + \sum_{i \in U(w)} \sum_{j \in O_i} (r_{ij} - (Z_U \bar{x}_i)^\top v_j)^2 \text{ s.t. } \|w\|_0 \leq l$$

where Z_L,Z_D,Z_U are linear regressors

Prediction Accuracy: Netflix

- w1Base: single question
- w4Base: linear combination of 4 single-question trees



- Multi-questions: better prediction
- Ours: better prediction with fewer questions
- More results in the poster!