



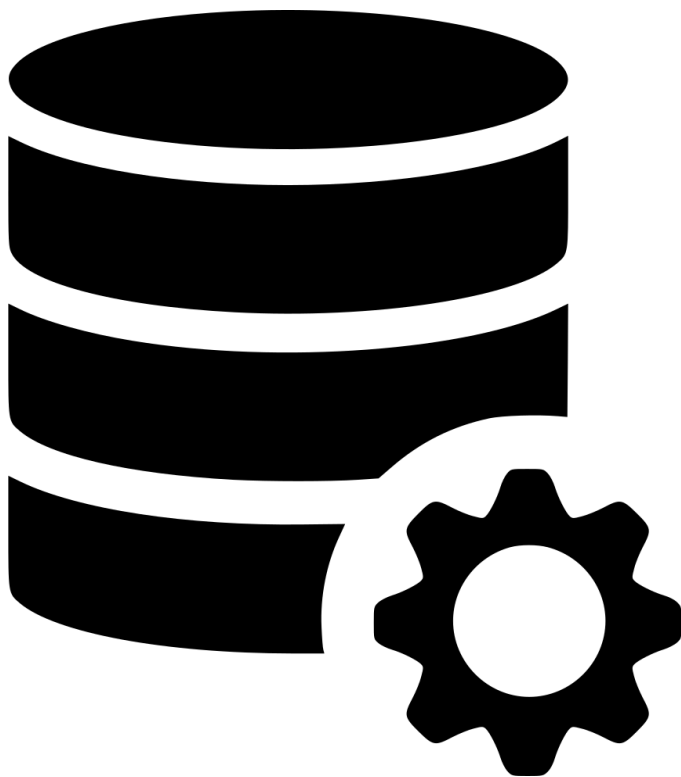
MOVIE RECOMMENDATIONS

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SWAPNIL ASAWA

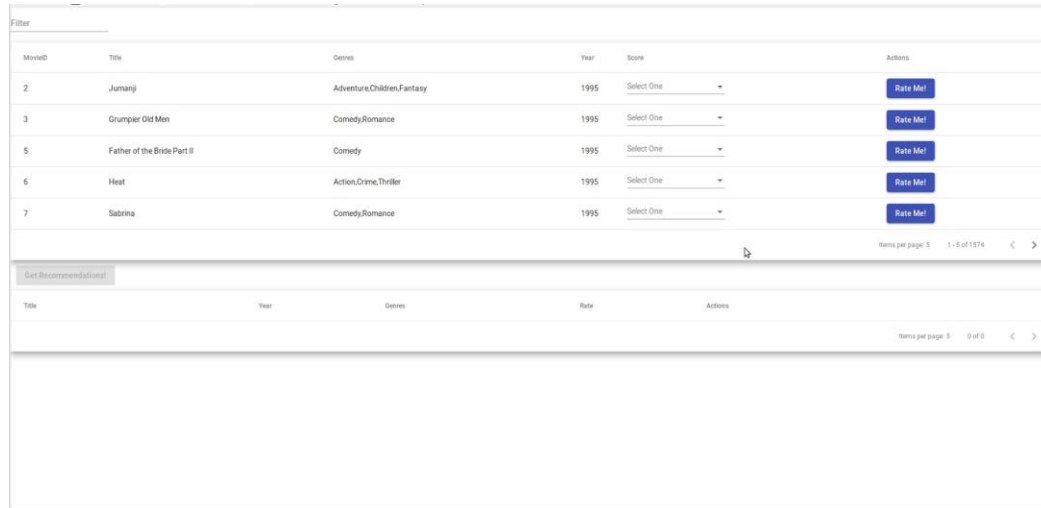
NISHCHAL NIGAM

OUR DATASET:



- Movie Lens Latest Dataset
- 58,000 movies
- 27 million ratings
- 280,000 users
- Last updated on 09/2018
- <http://grouplens.org/datasets/movielens/latest/>

TECHNOLOGIES USED



The screenshot displays a web application interface. At the top, there is a 'Filter' input field. Below it is a table with columns: MovieID, Title, Genes, Year, Score, and Actions. The table contains five rows of movie data. Each row has a 'Rate Me!' button in the Actions column. Below the table, there is a 'Get Recommendations' button. Underneath this button is another table with columns: Title, Year, Genes, Rate, and Actions. The bottom of the interface shows pagination information: 'Items per page: 5' and '1 - 5 of 1574'.

MovieID	Title	Genes	Year	Score	Actions
2	Jumanji	Adventure,Children,Fantasy	1995	Select One	Rate Me!
3	Grumpier Old Men	Comedy,Romance	1995	Select One	Rate Me!
5	Father of the Bride Part II	Comedy	1995	Select One	Rate Me!
6	Heat	Action,Crime,Thriller	1995	Select One	Rate Me!
7	Sabrina	Comedy,Romance	1995	Select One	Rate Me!

Items per page: 5 1 - 5 of 1574

Get Recommendations

Title	Year	Genes	Rate	Actions
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Items per page: 5 0 of 0

- Angular 2 for GUI
- Node and Express for Back-end
- CSV Database converted to MongoDB to make retrieval faster
- Python for running the actual recommendation algorithm

HOW TO USE IT:

Filter

ron man

MovielD	Title	Genres	Year	Score	Actions
59315	Iron Man	Action,Adventure,Sci-Fi	2008	Select One	<button>Rate Me!</button>
77561	Iron Man 2	Action,Adventure,Sci-Fi,Thriller,IMAX	2010	Select One	<button>Rate Me!</button>
102125	Iron Man 3	Action,Sci-Fi,Thriller,IMAX	2013	Select One	<button>Rate Me!</button>

Items per page: 5 1 - 3 of 3

10	GoldenEye	Action,Adventure,Thriller	1995	5	
11	American President, The	Comedy,Drama,Romance	1995	Select One	
12	Dracula: Dead and Loving It	Comedy,Horror	1995	Select One	
14	Nixon	Drama	1995	Select One	

Items per page: 5 6 - 10 of 1574 < >

Get Recommendations!

Title	Year	Genres	Rate	Actions
Sabrina	1995	Comedy,Romance	5	<button>Remove</button>
Heat	1995	Action,Crime,Thriller	5	<button>Remove</button>
Father of the Bride Part II	1995	Comedy	5	<button>Remove</button>
Jumanji	1995	Adventure,Children,Fantasy	5	<button>Remove</button>
Grumpier Old Men	1995	Comedy,Romance	4	<button>Remove</button>
Nixon	1995	Drama	5	<button>Remove</button>
Dracula: Dead and Loving It	1995	Comedy,Horror	5	<button>Remove</button>
American President, The	1995	Comedy,Drama,Romance	5	<button>Remove</button>
GoldenEye	1995	Action,Adventure,Thriller	5	<button>Remove</button>
Sudden Death	1995	Action	5	<button>Remove</button>

Items per page: 5 0 of 0 < >

- Select 10 or more movies or TV shows
- Rate them on a scale of 5
- Click on get recommendations
- Bazinga!

TECHNIQUE

- Pre-processing
- Collaborative Filtering
 - Main method SVD (Non-Probabilistic)
 - Also tested with KNN Item-Item, and User-User

USER-USER AND ITEM-ITEM SIMILARITY

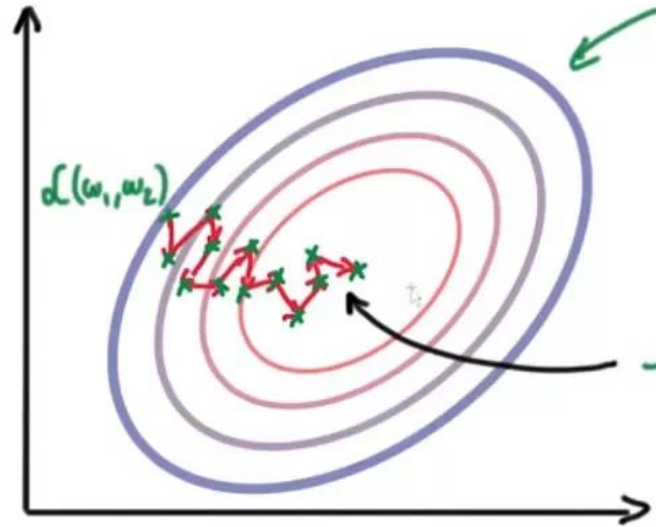
$$\hat{r}_{ui} = \mu_u + \frac{\sum_{v \in N_i^k(u)} \text{sim}(u, v) \cdot (r_{vi} - \mu_v)}{\sum_{v \in N_i^k(u)} \text{sim}(u, v)}$$

- KNNs with means
For user-user similarity,
Take k nearest neighbors of the user. Use their ratings to estimate yours. Add user bias.

Similarly, the test is performed for item-item matrix

- KNNs with z scores(normalizing) is performed for user-user and item-item.

SINGULAR VALUE DECOMPOSITION



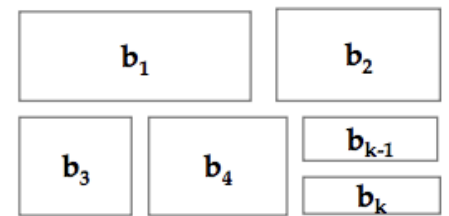
The prediction \hat{r}_{ui} is set as:

$$\hat{r}_{ui} = \mu + b_u + b_i + q_i^T p_u$$

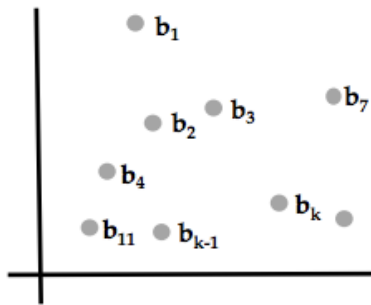
$$\sum_{r_{ui} \in R_{train}} (r_{ui} - \hat{r}_{ui})^2 + \lambda (b_i^2 + b_u^2 + \|q_i\|^2 + \|p_u\|^2)$$

$$\mathbf{R} \approx \mathbf{P} \times \mathbf{Q}^T = \hat{\mathbf{R}}$$

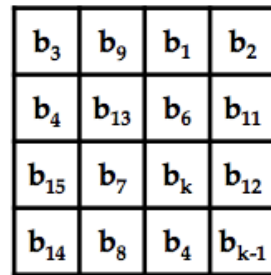
REINFORCEMENT LEARNING WITH BI-CLUSTERING



Biclusters from user-item matrix



Bicluster mapped to 2-D space



Bicluster remapped
n x n grid states

$\arg \max Q_\pi$

$$R(s_t, a_t, s_{t+1}) = \text{Jaccard_Distance}(U_{s_t}, U_{s_{t+1}})$$

$$= \frac{|U_{s_t} \cap U_{s_{t+1}}|}{|U_{s_t} \cup U_{s_{t+1}}|}$$

EXPERIMENTS

Results	KNN means User-Based	KNN means Item-Based	KNN Z-scores User-Based	KNN Z-scores Item-Based	SVD
RMSE	0.895	0.880	0.887	0.892	0.873
MAE	0.678	0.669	0.674	0.671	0.672
Fit Time	0.59	9.97	10.30	0.59	4.75
Test Time	1.37	6.65	11.56	1.40	0.17

TESTING WITH DIFFERENT GENRES OF MOVIE

```
raphael@raphael: ~/Documents/adaptiveSystems/finalProject
File Edit View Search Terminal Help
raphael@raphael:~/Documents/adaptiveSystems/finalProject$ time python finalProject.py
##### MOVIES SELECTED BY THE USER #####
Logan (2017) Action|Sci-Fi Rating: 5.0
Three Musketeers, The (1993) Action|Adventure|Comedy|Romance Rating: 5.0
Last of the Mohicans, The (1992) Action|Romance|War|Western Rating: 5.0
Goldfinger (1964) Action|Adventure|Thriller Rating: 5.0
Gladiator (2000) Action|Adventure|Drama Rating: 5.0
Scarface (1983) Action|Crime|Drama Rating: 4.0
Pearl Harbor (2001) Action|Drama|Romance|War Rating: 5.0
Lara Croft: Tomb Raider (2001) Action|Adventure Rating: 3.0
Fast and the Furious, The (2001) Action|Crime|Thriller Rating: 4.0
Planet of the Apes (2001) Action|Adventure|Drama|Sci-Fi Rating: 5.0
Minority Report (2002) Action|Crime|Mystery|Sci-Fi|Thriller Rating: 3.0
Men in Black II (a.k.a. MIB) (a.k.a. MIB 2) (2002) Action|Comedy|Sci-Fi Rating: 4.0
Jackass: The Movie (2002) Action|Comedy|Documentary Rating: 5.0
City of God (Cidade de Deus) (2002) Action|Adventure|Crime|Drama|Thriller Rating: 5.0
Dark Knight, The (2008) Action|Crime|Drama|IMAX Rating: 5.0
Matrix Reloaded, The (2003) Action|Adventure|Sci-Fi|Thriller|IMAX Rating: 5.0
Kung Fu Panda (2008) Action|Animation|Children|Comedy|IMAX Rating: 5.0
Avatar (2009) Action|Adventure|Sci-Fi|IMAX Rating: 5.0
Avengers, The (2012) Action|Adventure|Sci-Fi|IMAX Rating: 5.0
Man of Steel (2013) Action|Adventure|Fantasy|Sci-Fi|IMAX Rating: 3.0
How to Train Your Dragon 2 (2014) Action|Adventure|Animation Rating: 5.0
Deadpool (2016) Action|Adventure|Comedy|Sci-Fi Rating: 5.0
Guardians of the Galaxy 2 (2017) Action|Adventure|Sci-Fi Rating: 3.0
Doctor Strange (2016) Action|Adventure|Sci-Fi Rating: 5.0
Lion King, The (1994) Adventure|Animation|Children|Drama|Musical|IMAX Rating: 5.0
Mulan (1998) Adventure|Animation|Children|Comedy|Drama|Musical|Romance Rating: 5.0
Tarzan (1999) Adventure|Animation|Children|Drama Rating: 5.0
Incredibles, The (2004) Action|Adventure|Animation|Children|Comedy Rating: 5.0
##### RECOMMENDATION #####
# 1 - Intouchables (2011) - Comedy, Drama
# 2 - Inception (2010) - Action, Crime, Drama, Mystery, Sci-Fi, Thriller, IMAX
# 3 - WALL·E (2008) - Adventure, Animation, Children, Romance, Sci-Fi
# 4 - Finding Nemo (2003) - Adventure, Animation, Children, Comedy
# 5 - Batman Begins (2005) - Action, Crime, IMAX
# 6 - Good, the Bad and the Ugly, The (Buono, il brutto, il cattivo, Il) (1966) - Action, Adventure, Western
# 7 - Life Is Beautiful (La Vita è bella) (1997) - Comedy, Drama, Romance, War
# 8 - Green Mile, The (1999) - Crime, Drama
# 9 - Up (2009) - Adventure, Animation, Children, Drama
# 10 - Monsters, Inc. (2001) - Adventure, Animation, Children, Comedy, Fantasy

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user    5m50.028s
sys      0m4.046s
raphael@raphael:~/Documents/adaptiveSystems/finalProject$
```

TESTING WITH SUPER-HERO MOVIES

Items per page: 5

Get Recommendations!

1 - Avengers, The (2012) - Action, Adventure, Sci-Fi, IMAX
2 - Batman Begins (2005) - Action, Crime, IMAX
3 - Star Trek (2009) - Action, Adventure, Sci-Fi, IMAX
4 - X-Men: Days of Future Past (2014) - Action, Adventure, Sci-Fi
5 - Toy Story 3 (2010) - Adventure, Animation, Children, Comedy, Fantasy, IMAX
6 - Guardians of the Galaxy (2014) - Action, Adventure, Sci-Fi
7 - X2: X-Men United (2003) - Action, Adventure, Sci-Fi, Thriller
8 - X-Men: First Class (2011) - Action, Adventure, Sci-Fi, Thriller, War
9 - Dark Knight Rises, The (2012) - Action, Adventure, Crime, IMAX
10 - Captain America: The Winter Soldier (2014) - Action, Adventure, Sci-Fi, IMAX

Title	Year	Genres	Rate	Actions
Deadpool	2016	Action,Adventure,Comedy,Sci-Fi	5	<button>Remove</button>
Incredibles, The	2004	Action,Adventure,Animation,Children,Comedy	5	<button>Remove</button>
X-Men	2000	Action,Adventure,Sci-Fi	5	<button>Remove</button>
Dark Knight, The	2008	Action,Crime,Drama,IMAX	5	<button>Remove</button>
Avengers: Age of Ultron	2015	Action,Adventure,Sci-Fi	5	<button>Remove</button>
Iron Man	2008	Action,Adventure,Sci-Fi	5	<button>Remove</button>
Superman Returns	2006	Action,Adventure,Sci-Fi,IMAX	4	<button>Remove</button>
Amazing Spider-Man, The	2012	Action,Adventure,Sci-Fi,IMAX	5	<button>Remove</button>
Captain America: Civil War	2016	Action,Sci-Fi,Thriller	5	<button>Remove</button>
Despicable Me 2	2013	Animation,Children,Comedy,IMAX	5	<button>Remove</button>

Items per page: 5

FUTURE IMPROVEMENTS

Implement
Content Based
recommendation

Make the system
Hybrid

Filtering genre
and popularity

Save the user
preferences based
on genre

Complete the
Reinforcement
Learning approach