

Project presentation

Machine Learning and Big Data Processing(ELEC–Y591)

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Outline

- 1 Context
- 2 Approach
- 3 Results

Objective: challenge the anonymization of published data. Mainly two methods exist.

- Graph matching: social network attacks. Example: link Flickr and Twitter accounts.
- Similarity matching: use similar features between target and auxiliary information. Example: link tweets to resumes.

This project tackles the **Netflix prize dataset** attack.

Similarity matching:

$$Sim(r_1, r_2) = \frac{\sum Sim_{\cos}(r_{1i}, r_{2i})}{|supp(r_1) \cup supp(r_2)|}$$

Adapted to the dataset: rating ρ and timestamp d , giving more value to statistically rare elements.

$$Score(r, aux) = \sum_{i \in supp(aux)} \frac{1}{\log|supp(i)|} \left(e^{-\frac{|\rho_i - \rho'_i|}{\rho_0}} + e^{-\frac{|d_i - d'_i|}{d_0}} \right)$$

Matching

```
1: for each record  $r_i$  in  $R$  do
2:   for each entry  $aux_i$  in  $aux$  do
3:     Compute  $Score(r_i, aux_i)$ 
4:   end for
5:   Compute  $\sigma_S = \text{stdev}(Score)$ 
6:   Find  $S_1 = \max(Score(r_i, aux))$ 
7:   Find  $S_2 = \max(Score(r_i, aux) \setminus \{S_1\})$ 
8:   Compute  $\phi = (S_1 - S_2) / \sigma_S$ 
9:   if  $\phi > 1.5$  then
10:    Match found !
11:   end if
12: end for
```

$$\phi = \frac{S_1 - S_2}{\sigma_S}$$

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The Netflix dataset

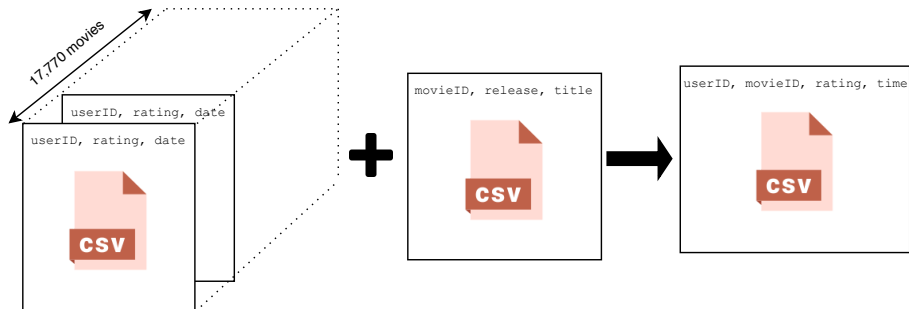
- 5.5 GB of data
- 17,770 movies
- 480,000 users
- \simeq 100 million ratings

against

The MovieLens dataset

- 875.6 MB of data
- 27,278 movies
- 138,493 users
- \simeq 20 million ratings

Netflix data reshaping



- 1 Discard MovieLens entries based on timestamps.
- 2 Discard all movies not present on both datasets. A movie was uniquely identified by its title and release date.
⚠ "Lord of the Rings, The" and "The Lord of the Rings (2001)"
- 3 Recast timestamps: from YYYY-MM-DD and elapsed seconds to common reference.
- 4 Rounded MovieLens ratings.

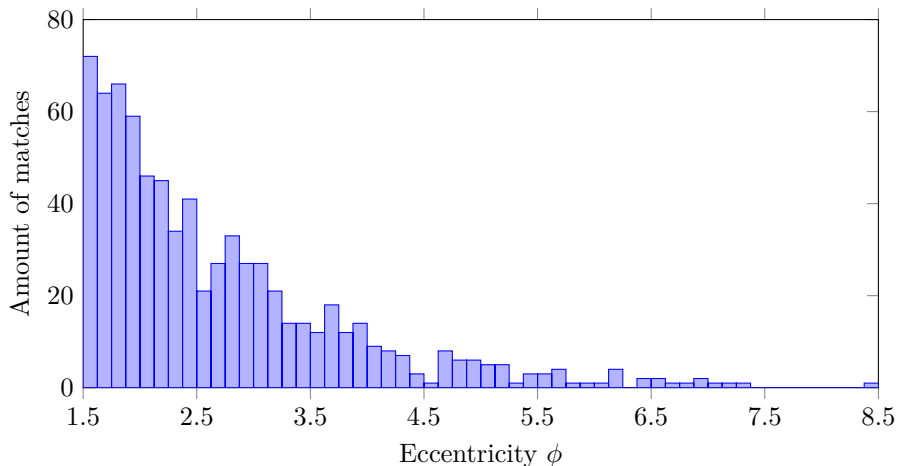
⇒ 5800 common movies, 52,875 users
remaining in ML and 478,756 in Netflix.

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Matches

- 3600 Netflix and 3000 MovieLens users
- a few more than 800 matches, 5 with $\phi > 7$

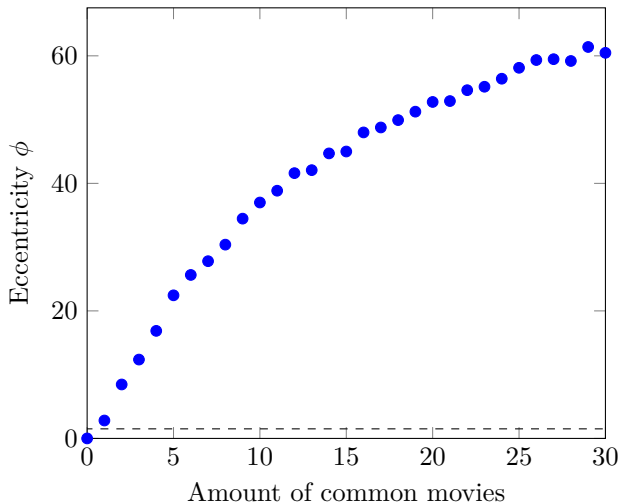


How to validate the results?

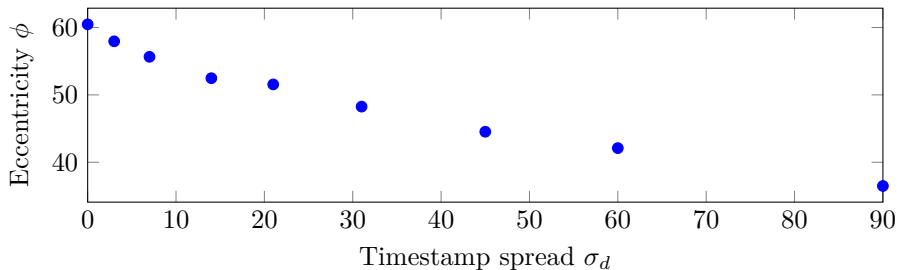
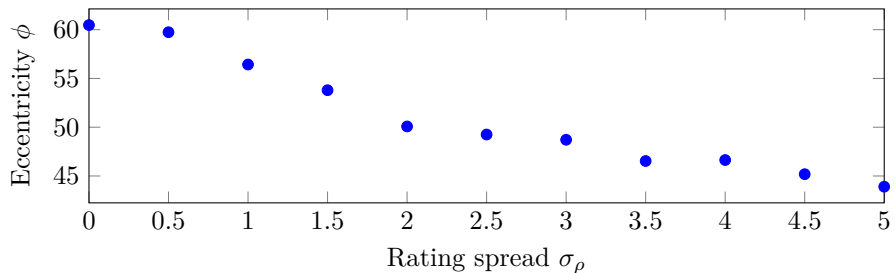
- No knowledge of the ground truth of matching users

Validation procedure

- Put a dummy user in both datasets
- Vary the number of common movies
- Perturb the rating and the timestamp with uniform distributed noise



Robustness



Conclusion

- $\phi_{\max} \approx 8.5$ while the validation process showed $\phi > 30$
- The original Netflix attack: $\phi_{\text{match}} = \{18, 25\}$

⇒ cannot conclude statistical quasi-certainty of de-anonymization

Possible improvements

- Use more than 0.04 % of the possible user combinations
- Tuning of the parameters ϕ, d_0, ρ_0
- Add more features (e.g. movie genres)
- Increase the errors impact on the scoring