Recommender system for science: A basic Taxonomy

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Outline

- Introduction
- Methodology
- Analysis
- Conclusion and Future works

Introduction

- The volume of **science** doubles every 10 to 15 years [1].
- It becomes **difficult** for researchers to **discover relevant scientific artefacts**.
- **Recommender systems** are software systems devised to recommend items to users based on their observed interests.
- No systematic literature survey has been performed to document the state of the art of recommender systems in science settings.
- We provided a **taxonomy** regarding the **scientific artefacts recommender systems** stemming from a systematic mapping study of the current literature.

1- Bornmann, Lutz, and Rüdiger Mutz. "Growth rates of modern science: A bibliometric analysis based on the number of publications and cited references." *Journal of the Association for Information Science and Technology* 66.11 (2015): 2215-2222.

Methodology

- This research was carried out as a **Systematic Mapping Study** (SMS).

- The goal of the study is reflected in these **research questions**:

    1. How are users (and their interests) represented?
    2. What are the items of interest, and how are these items characterised?
    3. Which recommender algorithms have been used?
    4. Which evaluation methods have been used?

Methodology

Conducting search:

- Selecting keywords and creating query

Keyword	Synonym and related concepts
Recommender	Recommendation
Scientific products and Science	Scientific - Researcher - Science - Articles - Papers - Datasets

Methodology

- Conduct search on scientific repositories

  1. ACM
  2. IEEEXplore
  3. ScienceDirect
  4. Springer
  5. Scopus

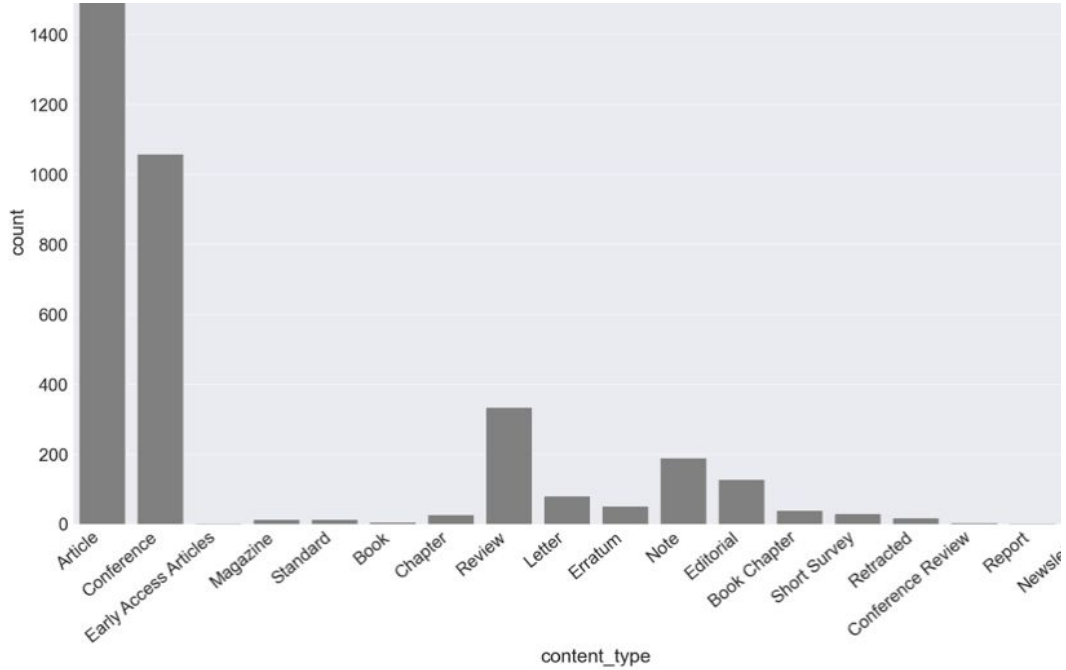
- We identified **3787** primary papers.

- **Papers Screening:**

- After removing the duplications, we explore the papers in terms of **publication type and year** to find the inclusion and exclusion **criteria**.

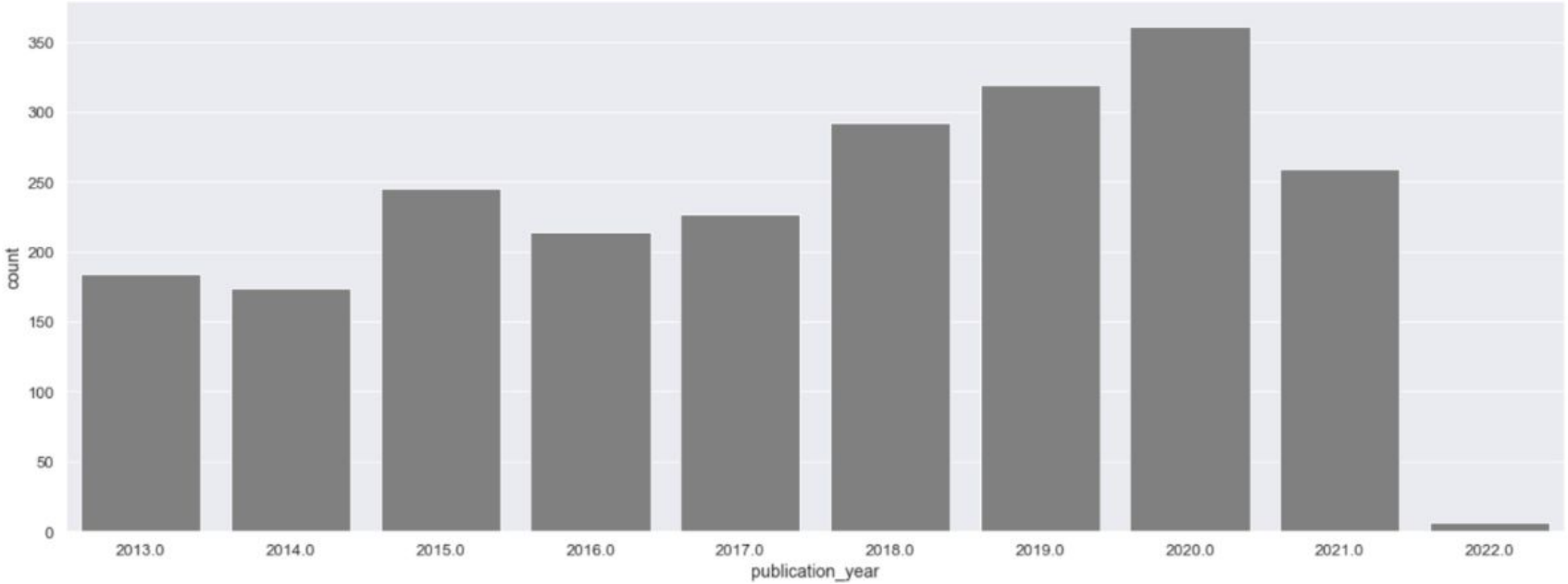
Methodology

- **Journal articles** and **Conferences proceedings** are considered as **inclusion criteria**.



Methodology

- Published papers between **2015** and **2022** are considered as **inclusion criteria**.

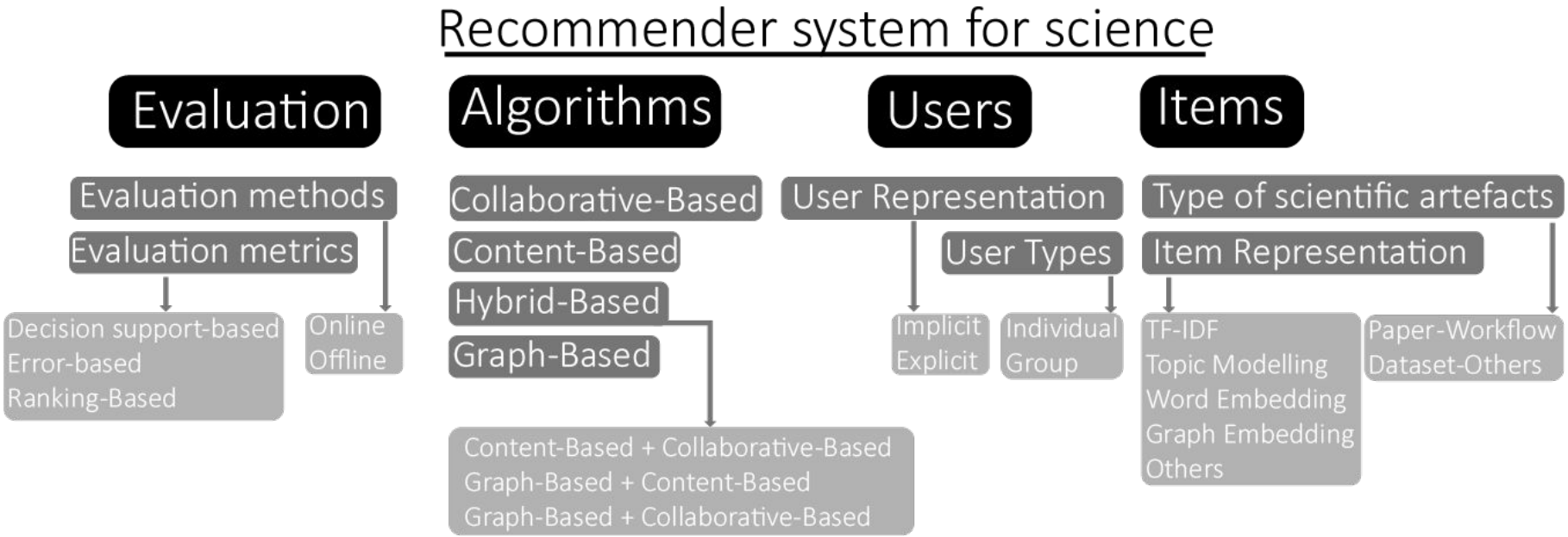


Methodology

- After reviewing the papers we reached the final dataset which contains **209** papers.

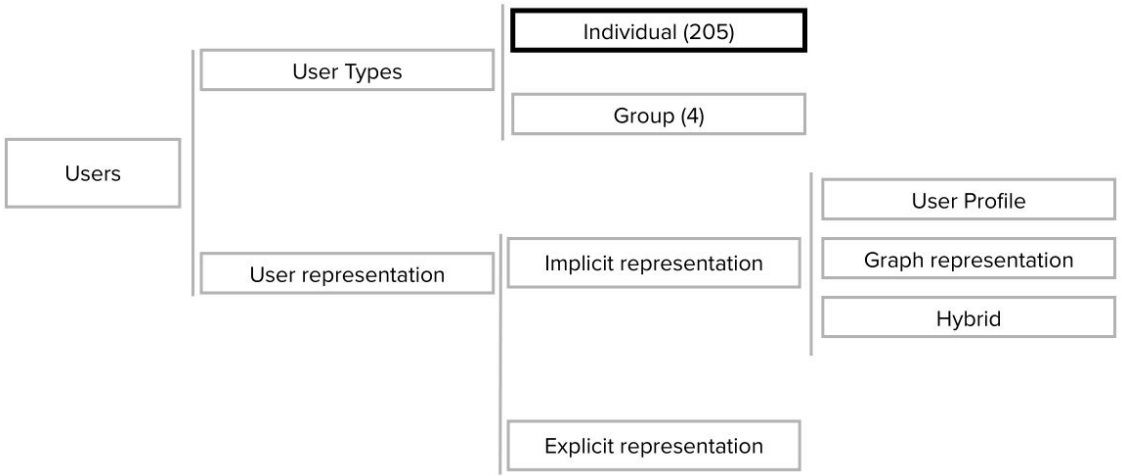
Repository:	ACM	IEEEXplore	ScienceDirect	Springer	Scopus	Total
After removing duplicates:	114	64	152	40	2205	**2575**
After applying criteria:	64	6	53	11	853	**987**
After reviewing:	8	3	0	6	192	**209**

Analysis - Classification scheme



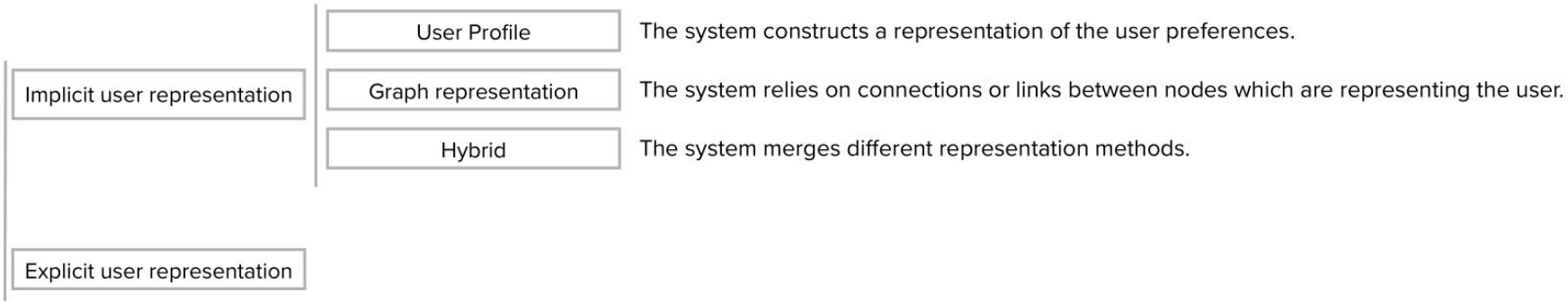
Analysis - User types and representation

- Only **4** papers are identified where the target is a **group of researchers**.
- **205** papers out of 209 papers are focused on **individual users**.



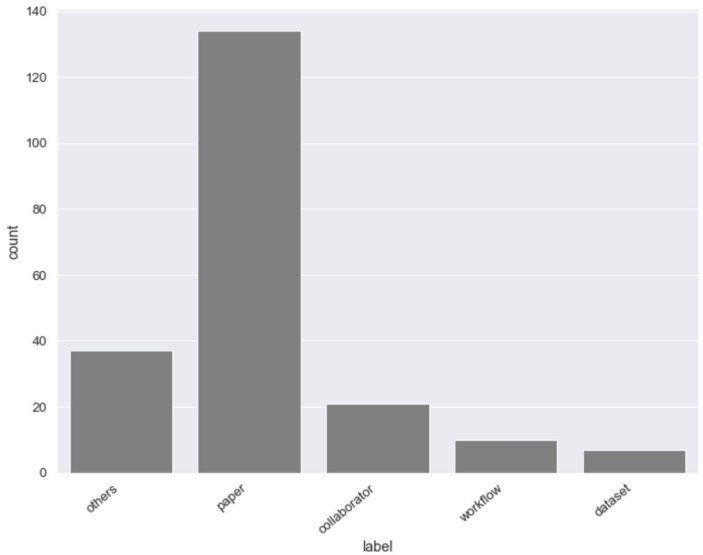
Analysis - User types and representation

- Implicit representation: The system captures users' interests **indirectly**.
- Explicit representation: The system relies on the **user's input** which could be a query, paper, dataset, etc.



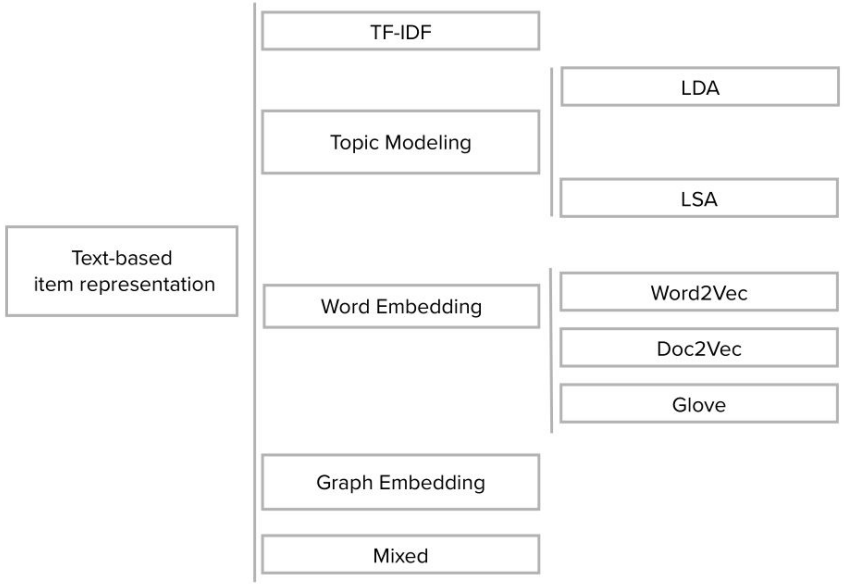
Analysis - Item types and representation

- **16** heterogeneous typologies of **artefacts** are identified.
- **Paper recommender system** are proposed in 134 of the 209 papers reviewed.
- **Software recommender system** is unprecedented.
- Others: Keyword, Tag, Research area, Paper submission, etc.



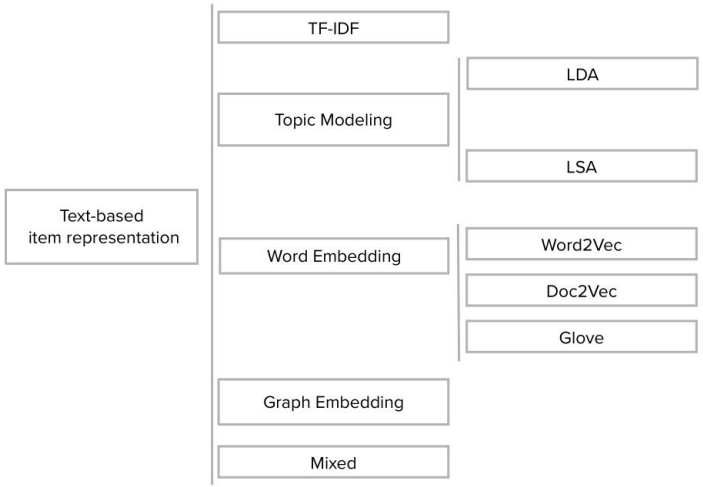
Analysis - Item types and representation

- For almost all of the scientific artefacts it is possible to have a **text-based characterization**.
- We analysed and classified text-based representations methods.



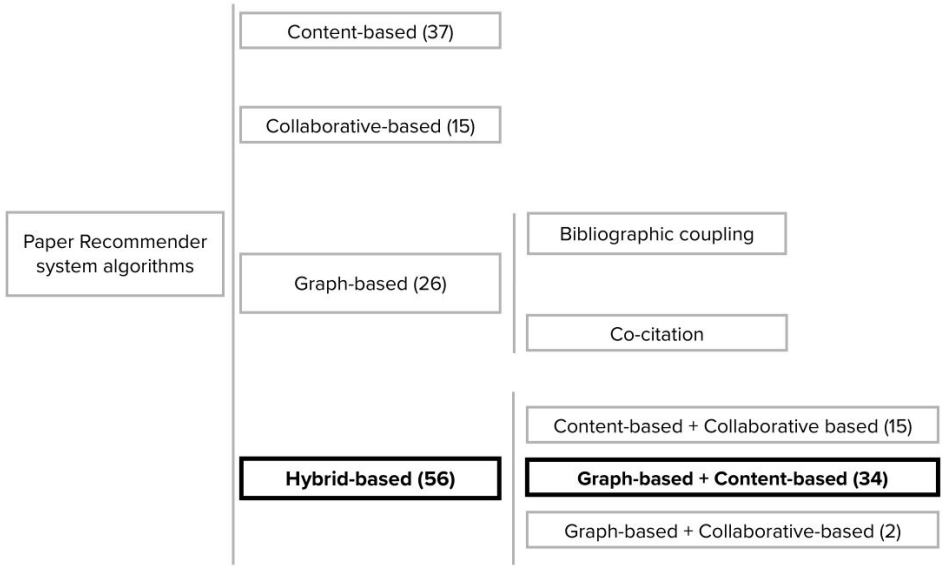
Analysis - Item types and representation

- TF-IDF, Topic Modeling and Word embedding are applied in the case of Content-based Filtering.
- The goal of **word embedding method** is to capture semantic and syntactic regularities.
- Graph embedding can be used in Graph-based algorithms like **citation network**.



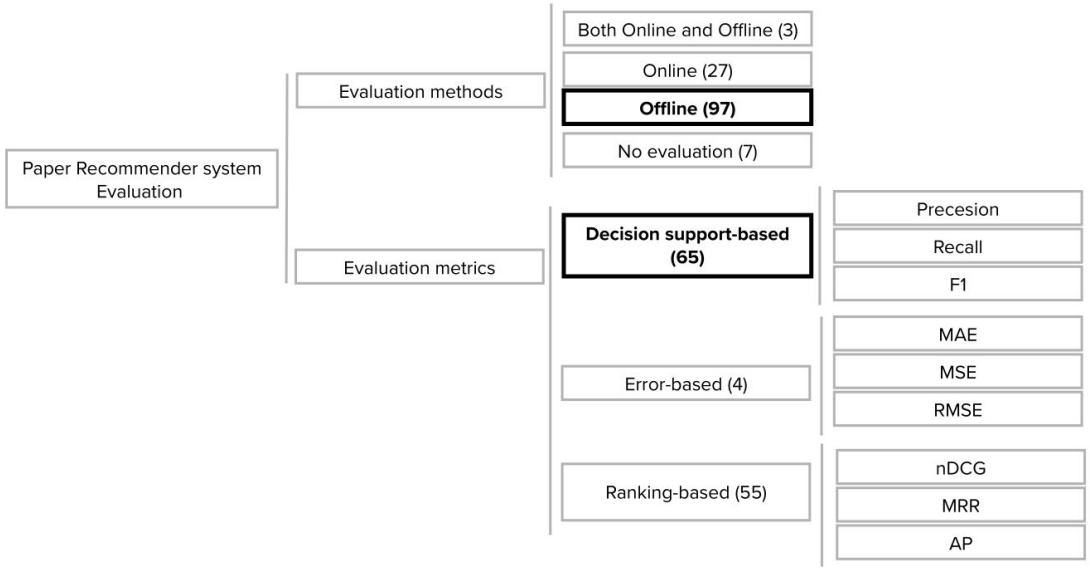
Analysis - Algorithms

- **56** of the **134** paper recommender systems used **hybrid approaches**, while **37** of them used **content-based algorithm**.
- The most used combination in Hybrid-based is **Graph-based + Content-based.**



Analysis - Evaluation

- Online evaluation method: observe the **user interactions** regarding the given recommendations.
- Offline evaluation method: test the effectiveness of recommender system algorithms on a **certain dataset.**



Conclusion and Future works

- We had a **Systematic Mapping Approach** on the **recommender system for science**.
- **209** papers of interest have been published between 2015 and 2022 are reviewed.
- A **taxonomy** of recommender system for science is presented.
- The **paper recommender system** is the predominant recommendation class and there is a huge gap in recommending other scientific artifacts like **datasets** and **softwares**.
- Lack of recommending scientific artefacts to the **group of researchers**.
- Most of the scientific artefacts recommendation systems relied on the **offline evaluation**.
- **Diversity** and **serendipity** of the recommended items can be taken into account.

Next Step..

- Exploiting OpenAIRE graph to compare effectiveness of different Dataset Recommender system approaches.

Thank you for your attention.

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