Fairness and Transparency in IR

[DAT640] Information Retrieval and Text Mining

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In this module

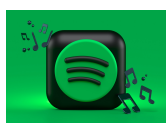
1. Sociotechnical system
2. Fairness in IR
3. Transparency in IR

Sociotechnical system

Applications of IR

- Search engines
- Product and items recommendation, *e.g.*, music, movies, books, news, etc.
- Candidate ranking, *e.g.*, hiring platform, college admission, etc.
- Etc.



Position of the people

- Where do the people intervene in IR applications?
  - Algorithms and systems design, implementation, and evaluation (*e.g.*, developers, annotators)
  - Consumers
  - Producers

Position of the people

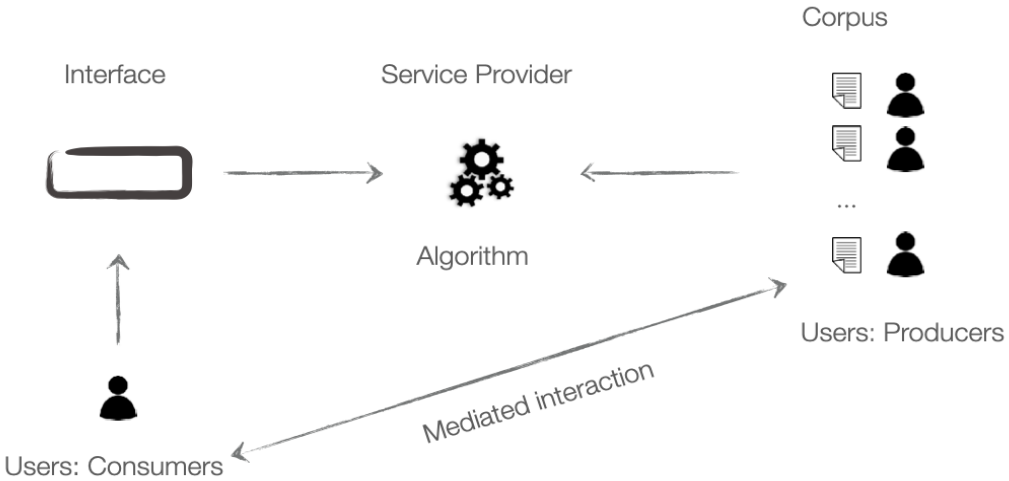


Figure: Information Retrieval system. Figure taken from Biega talk at ESSIR '22.

Sociotechnical system

- A IR system is a **sociotechnical system** due to the *omnipresence of people* in its ecosystem
  - It is used by producers and consumers
  - It learns from users behavior and feedback
  - It is designed and implemented by people
  - It can have an impact on the society, *e.g.*, consumption habits, political outcomes
  - Etc.

Negative impacts

- **Distributional harms**: unfair distribution of a resource to an individual or group of consumers, *e.g.*, unfair exposure of producers
- **Representation harms**: underrepresentation of a category of items from the corpus, *e.g.*, independent movies, women
- **Privacy loss**: collection of consumers personal data, disclosure of producers information

Fairness in IR

Question

What does it mean to be fair?

Common definition

Fairness: "the quality of treating people equally or in a way that is reasonable."[1]

- *Broad* definition which can be *interpreted differently* depending on the people
- It raises several questions such as:
  - What is the goal? → Definition
  - Is the goal completed? → Evaluation
  - How can we complete the goal? → Method, implementation
- Taxonomies have been proposed to formalize fairness

[1] `https://www.oxfordlearnersdictionaries.com`

Fairness taxonomy

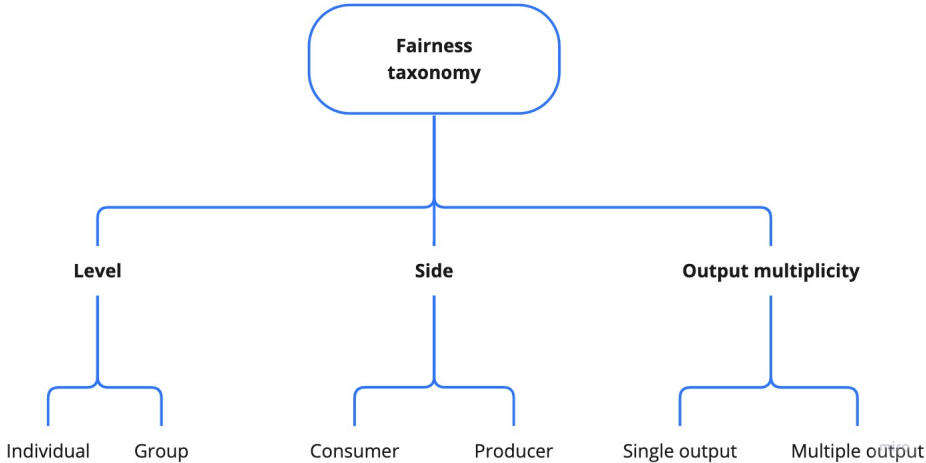


Figure: Fairness definition taxonomy (adapted from Pitoura et al., 2021)

Fairness dimensions

Level

- **Individual**: ensure consistent treatment of similar entities
- **Group**: ensure consistent treatment of entities belonging to a group

Example

Search Query	Work Experience	Education Experience	Candidate	Xing Ranking
Brand Strategist	146	57	male	1
Brand Strategist	327	0	female	2
Brand Strategist	502	74	male	3
Brand Strategist	444	56	female	4
Brand Strategist	139	25	male	5
Brand Strategist	110	65	female	6
Brand Strategist	12	73	male	7
Brand Strategist	99	41	male	8
Brand Strategist	42	51	female	9
Brand Strategist	220	102	female	10
		...		
Brand Strategist	3	107	female	20
Brand Strategist	123	56	female	30
Brand Strategist	3	3	male	40

TABLE I: Top k results on www.xing.com (Jan 2017) for an employer's job search query "Brand Strategist".

Figure: Example taken from Lahoti et al., 2019

- Group fairness is achieve in top-10
- Unfair to individuals with similar qualifications

Fairness dimensions

Side

- **Consumers**: ensure that similar users or group of users receive similar output
  - Example: democrats should have similar results when looking for information on gun regulations
- **Producers**: ensure that similar items or group of items are ranked/recommended in a similar way
  - Example: in candidate ranking, gender should not influence the final ranking

Fairness dimensions

Output multiplicity

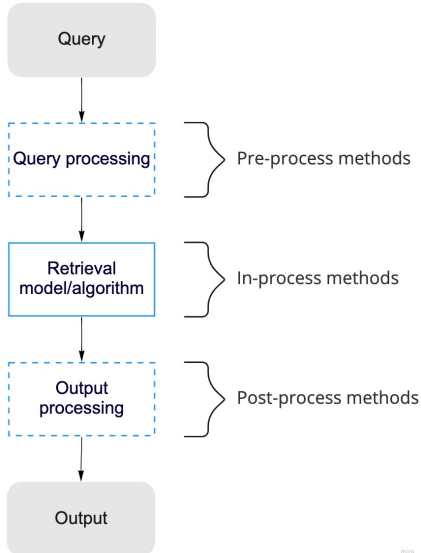
- **Single**: fairness is studied on only one output
- **Multiple**: fairness is studied on a sequence of outputs as a whole
  - Some rankings can be considered unfair in a fair system

Approach type

- Different types of solution exist to tackle the problem of fairness
  - **Model specific**: the approach does depend on the model used for information retrieval
  - **Model agnostic**: the approach does not depend on the model used for information retrieval

Approach position

- **Pre-process**: the approach is used before the retrieval process
- **In-process**: the approach modifies the retrieval process
- **Post-process**: the approach modifies the output of the retrieval process



Current trends

- Most of the literature focus on:
  - Group fairness
  - Single output
  - Item-side fairness
- Difficulty to establish state-of-art approach due to the number definitions
- A common approach is *post-process* and *model agnostic*

Exercise

E14-1 Measuring fairness in ranking

Transparency in IR

Common definition

Transparency: "the quality of something, such as a situation or an argument, that makes it easy to understand."[2]

- *Broad* definition which opens the door for many approaches
- Operationalization raises similar questions as for fairness

[2] https://www.oxfordlearnersdictionaries.com

Question

How can we make a system transparent?

Modality

Several modalities are possible to communicate with the users:

- **Article**: communication information in an article, or a blog post
  - Example: PubMed Best Match algorithm (Fiorini et al. 2018)
- **Open source**: build the system with open source resources
- **User Interface (UI)**: communicate with the user through the UI (*e.g.*, explanations, icons)

Example

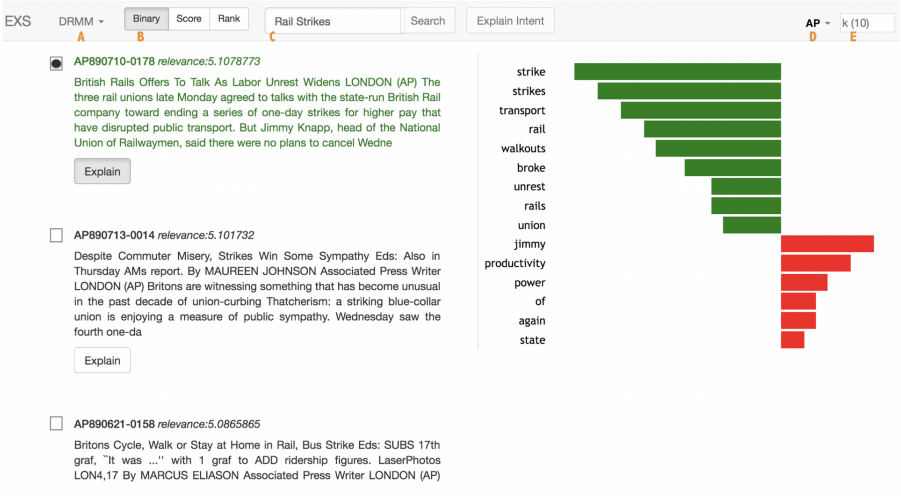


Figure: Example of the EXS user interface (Singh and Anand, 2019)

Challenges

There are many challenges related to transparency of the system, such as:

- How to be as transparent as possible without revealing business secrets to competitors?
- How to be transparent and prevent subsequent malicious behavior?
  - Example: search engine optimization, *i.e.*, website optimization to get a better ranking from the search algorithm
- Transparency of blackbox models
  - Example: explain a ranking produced by a transformer model

Transparency taxonomy

- Based on previous work and existing challenges, we identify two other dimensions for transparency:
  - Degree
  - Level

Degree of transparency

Degree

- **Full**: provide all the information necessary to make the entire system transparent
  - Example: description of the indexing and BM25 retrieval model for a search engine
- **Partial**: provide all the information necessary to make a part of system transparent
  - Example: description of the indexing, BM25 retrieval model, and transformer-based re-ranker for a search engine
  - The transformer-based re-ranker is not transparent yet

Level of transparency

Level

- **Global**: describe the inner-workings of the system
- **Local**: describe the relationship between a specific input and output
- **Causality**: describe the relationship between the inner-workings of a system (*i.e.*, the cause) and a specific output (*i.e.*, the effect)

Current trends

- A common approach is *post-process* and *model agnostic*
- Work in the literature tend to favor:
  - Local explanations
  - Communicate explanations through the UI

Exercise

E14-2 Ranking explanation

Summary

- IR systems are sociotechnical systems
  - Position of the people
  - Negative harms (incl. distributional and representational harms, privacy loss)
- Fairness in IR
  - Fairness taxonomy (incl. level, side, output multiplicity)
  - Fairness approach categorization
  - Current trends
- Transparency in IR
  - Transparency dimensions (incl. modality, degree, level)
  - Challenges
  - Current trends

Reading

- Pitoura et al. **Fairness in rankings and recommendations: an overview**. In: *The VLDB Journal (2021)*
  - `https://link.springer.com/article/10.1007/s00778-021-00697-y`
- Talk by Asia J. Biega at ESSIR '22. *Responsible Design of Information Access Systems*
  - Video: `https://www.youtube.com/watch?v=BnoiNTsUNZU`
  - Slides: `http://essir2022.org/slides/asia-biega.pdf`