Excursion: Fair Clustering

Katrin Casel

Hasso Plattner Institute
Universität Potsdam

What is Fairness?

That is a tough question...

Why does it come up for learning from data?

- We have gathered so much personal data...
- It is tempting to base decisions on it (especially difficult ones):

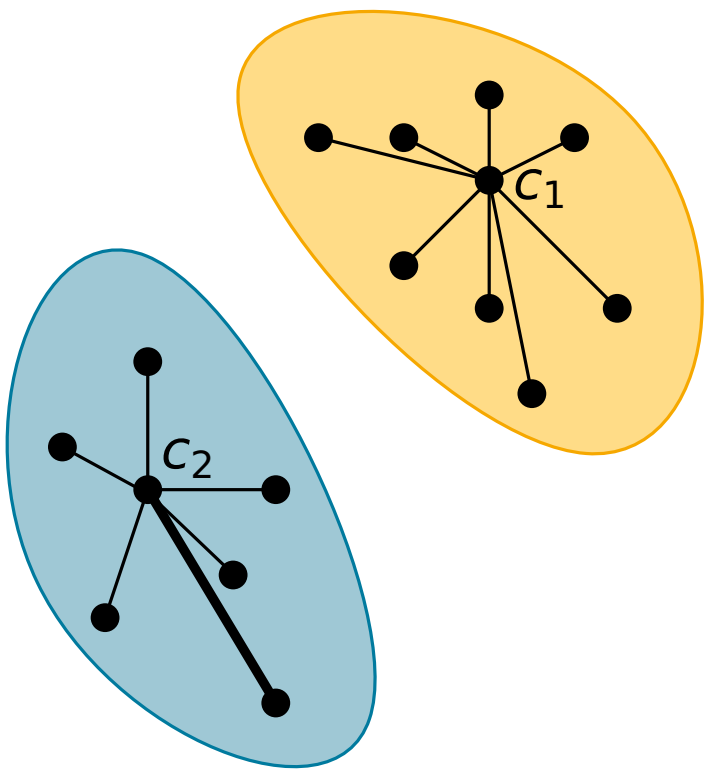
  Who gets bank loan / job offer / medical treatment / insurance /... ?
- race, gender, religion, ... should NOT play a role for such decisions

Simply deleting these attributes is not enough!

- Algorithms that learn from our data also learn our bias.

Clustering: (basic idea)

Find a partition $S_1, \ldots, S_k$ of a given set S of objects that represents similarity, i.e. similar objects lie in the same set, dissimilar objects lie in different sets.



Objectives:

a) Centroid-based clustering

For distance $d: S \times S \to \mathbb{R}$, find $S_1, \ldots, S_k$ and pick $c_i \in S_i$, $1 \leq i \leq k$ that minimize:

$$\sum_{i=1}^{k} \sum_{x \in S_i} d(c_i, x)$$ *k-median*

sum all distances

$$\max_{1 \leq i \leq k} \max_{x \in S_i} d(c_i, x)$$ *k-center*

maximum radius

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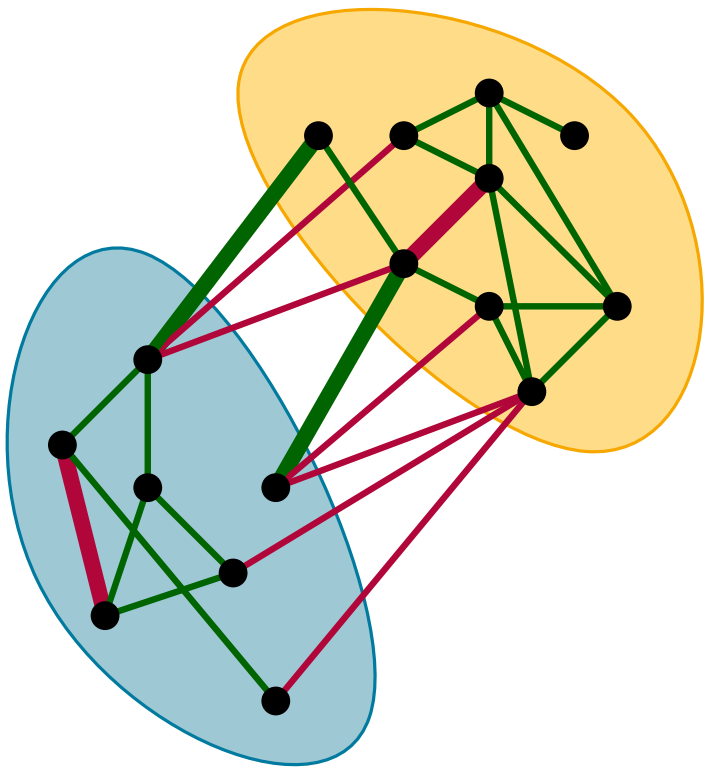


Objectives:

b) Correlation Clustering

For S with $d\colon S \times S \to \{\text{-}1, 0, 1\}$
1 = similar, 0=neutral, -1 = different

red edges in cluster

$$\sum_{i=1}^{k} |\{(u,v) \in S_i \times S_i \mid d(u,v) = \text{-}1\}| \quad +$$

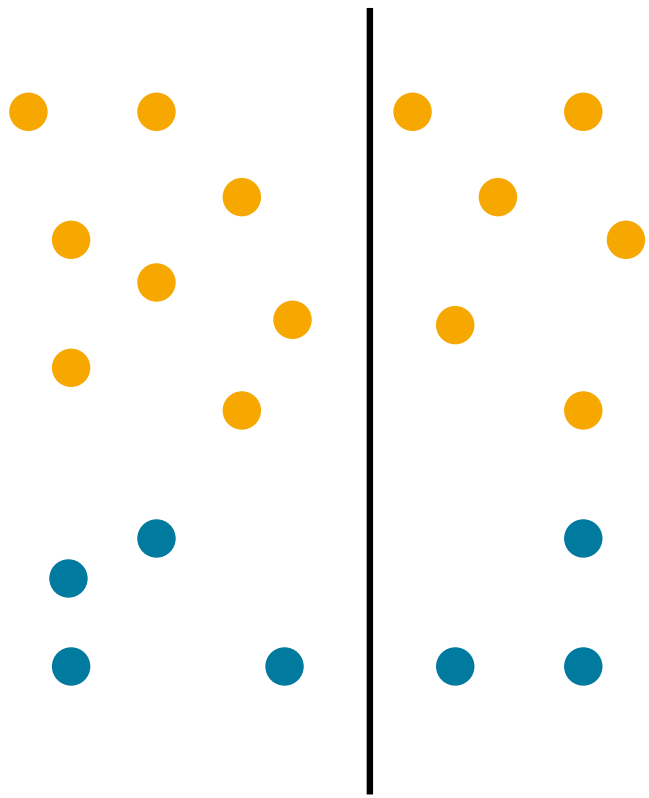
$$\sum_{i \neq j} |\{(u,v) \in S_i \times S_j \mid d(u,v) = 1\}|$$

green edges across clusters

Same distribution of sensitive attribute (race, gender,...) in every cluster.

→ Every cluster has same distribution of sensitive attribute as input set.

sensitive attribute = coloring



Formal Fairness Condition:

Partition S into $S_1, \ldots, S_k$ such that:

$$\frac{|\{\bullet \in S\}|}{|S|} = \frac{|\{\bullet \in S_i\}|}{|S_i|}$$

% of ● in ground set = % of ● in cluster

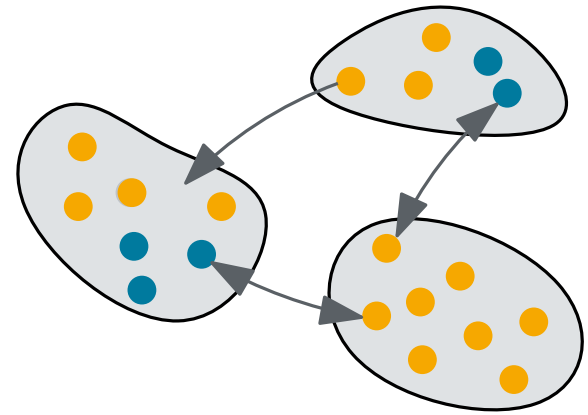
- for all clusters S_i, $1 \leq i \leq k$

- for all colors ● ●

Methods for Fair Clustering

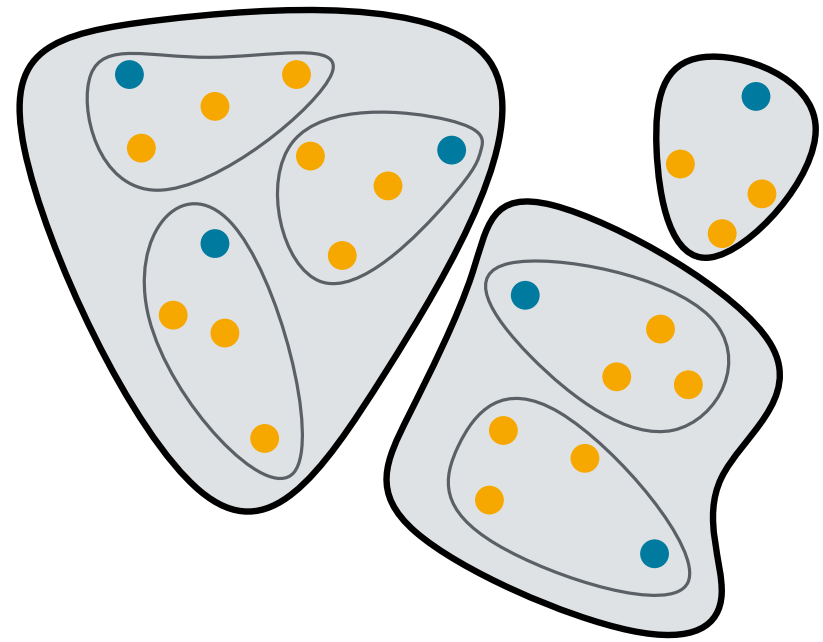
Postprocessing:

- Cluster without fairness constraints
- Make partition fair with as little change as possible



Preprocessing:

- Build many small fair clusters
- Treat small clusters as objects of unfair clustering algorithm



Inprocessing:

- Alter unfair clustering algorithm

Bias in data-driven artificial intelligence systems - An introductory survey

Eirini Ntoutsi, Pavlos Fafalios, Ujwal Gadiraju, Vasileios Iosifidis, Wolfgang Nejdl, Maria-Esther Vidal, Salvatore Ruggieri, Franco Turini, Symeon Papadopoulos, Emmanouil Krasanakis, Ioannis Kompatsiaris, Katharina Kinder-Kurlanda, Claudia Wagner, Fariba Karimi, Miriam Fernández, Harith Alani, Bettina Berendt, Tina Kruegel, Christian Heinze, Klaus Broelemann, Gjergji Kasneci, Thanassis Tiropanis, Steffen Staab

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