Day-13

Speaker: Niloy Ganguly

Title: Fairness in Two Sided Market

Fairness in Two-Sided Platforms

Producers

Consumers

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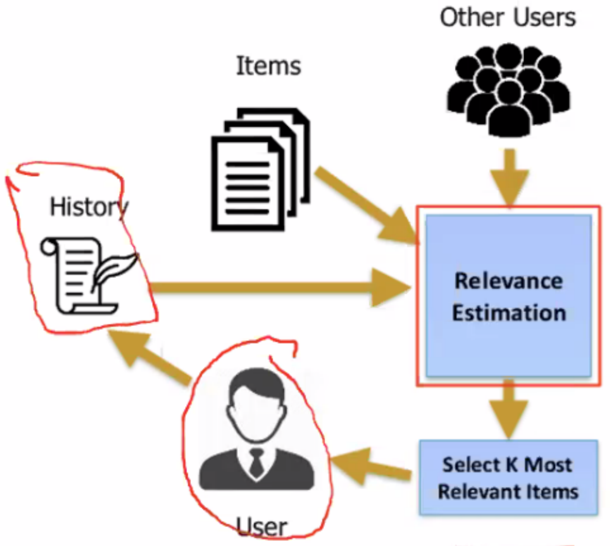
Hello

Personalized Recommendation



Learning Relevance Scores
1. Content-Based
2. Collaborative Filtering
3. Hybrid Approaches

Goal: Maximize customer satisfaction

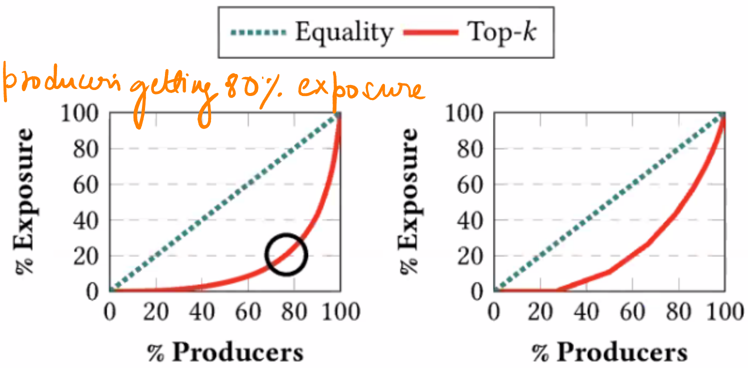
What is the effect of such customer-centric design on producers?

Datasets Used

- Google Local
  - Ratings of local businesses on Google Maps
  - 855 businesses in Manhattan
  - 11,172 customers based on New York City
  - 25,686 reviews and ratings
- Last.fm
  - No. of times different artists were played on last.fm
  - 1,892 listeners
  - 17,632 artists
  - 92,834 records of play counts

Effect on the Producers

Top 20% of producers getting 80% exposure



(a) Google Local, $k = 20$

(b) Last.fm, $k = 20$

Google Local: Top 20% artists got ~80% of total exposure

Last.fm: Bottom 60% artists got only ~20% of total exposure

Why to Care for Producers ?

Sellers like Cloudtail and WS Retail on Amazon, Flipkart scaling up to grab top slots

THE ECONOMIC TIMES

Small sellers fear being elbowed out in e-commerce festive sale

Business Today

As Softbank's Oyo booms, some Indian hotels cry foul and check out

ALJAZEERA

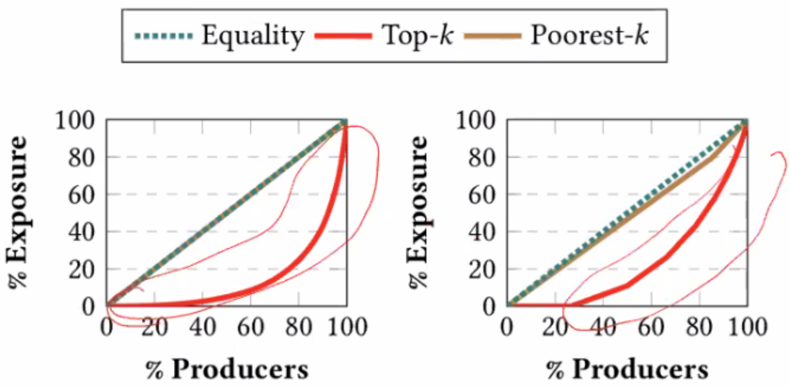
Heartbreak hotel: Is SoftBank's Oyo hurting Indian hoteliers?

REUTERS

Towards a Fair Marketplace

- Legal obligation
  - FDI Policy, Government of India
- Platforms' interest
  - Improved quality with higher competition
  - More choice for customers
- Voluntary commitment / Business requirement
  - To take new producers on board

Impact on Producers



(a) Google Local, $k = 20$ (b) Last.fm, $k = 20$

Huge Inequality in Top-k

Poorest-k achieves almost equality

Customer Utility

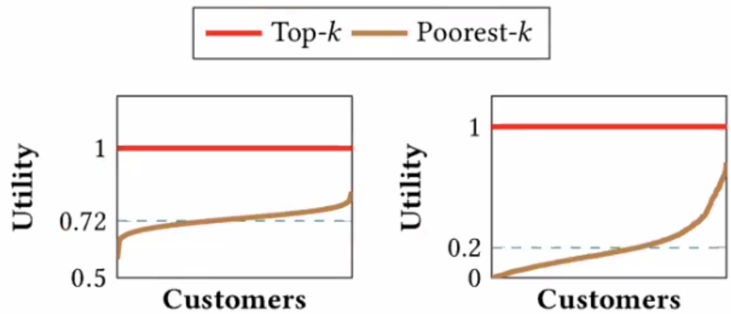
$$\text{Utility}_u = \sum_{p \in R_u} V(u,p) \Big/ \boxed{\max_{R_u} \sum_{p \in R_u} V(u,p)}$$

Relevance

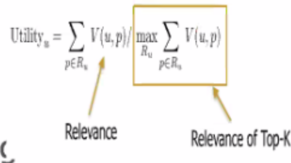
Relevance of Top-K

Best Customer

Impact on Customers



(a) **Google Local**, $k = 20$ (b) **Last.fm**, $k = 20$



- Utility for the customers decreases drastically
- Different customers can get affected to different deg

Bottom line: Need to consider fairness for both sides

Two-Sided Fairness in Recommendation

- Fairness for Producers
  - Ensure a minimum exposure guarantee for every producer
  - Comparable to the fairness of minimum wage guarantee
  - Minimum wage decreases income inequality
    [Brazil: Engbom et al. 2018, China: Lin et al. 2016]
  - What would be the guaranteed exposure?
- Fairness for Customers
  - Resultant loss in utility should fairly distributed among customers
  - What would be a fair distribution?

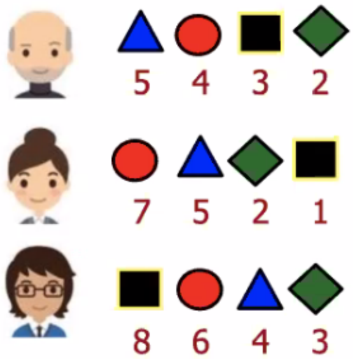
Reimagine Fair Recommendation as Fair Allocation

Fair Allocation of Indivisible Goods

Set of Goods $\mathcal{P}$

Set of Agents $\mathcal{U}$

A1 →
A2 →
A3 →



→ Utility in personalized.

$v_u(g) \geq 0; \quad \forall u \in \mathcal{U} \ \ \& \ \ \forall g \in \mathcal{P}$

Individual Valuations

Goal: Find a fair allocation $(A_1, ..., A_n)$

Fairness Notions

Classical notions of fairness for divisible goods

- Envy Freeness: Every agent values her bundle at least as much she values any other's bundle

Utility of bundle Ai → $\boxed{v_i(A_i)} \geq v_i(A_j), \quad \forall j$

- Proportional Fair Share: Every agent values her share to be at least 1/n times of her total value for all goods

$$v_i(A_i) \geq \frac{1}{|\mathcal{U}|} \sum_j v_i(A_j)$$

Indivisible goods

Envy-Freeness up to 1 good (EF1)

Maximin Share Guarantee (MMS)

Not always possible to achieve with indivisible goods

Envy-Freeness up to One Good (EF1)

An allocation $(A_1, A_2, \ldots, A_n)$ is said to be *envy free up to one good* (EF1) iff for every pair of agents i, j there exists a good $g \in A_j$ such that

$$v_i(A_i) \geq v_i(A_j \setminus \{g\}).$$

Budish 2011, Journal of Political Economy

A_1  A_2  But A_1  A_2 

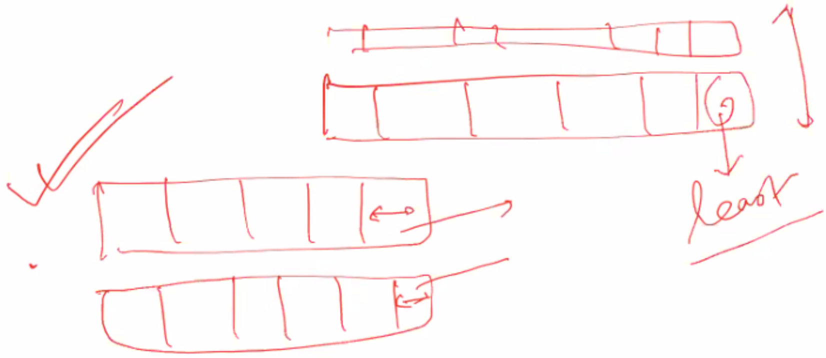
$v_1(A_1) < v_1(A_2)$ $\qquad$ $v_1(A_1) > v_1(A_2)$

Maxi Min Share Guarantee (MMS)

An allocation (A_1,.....,A_n) ensures MMS guarantee if

$$\forall i \in \mathcal{U}, \quad v_i(A_i) \geq \max_{(A_1,\ldots,A_n)} \min_{j \in \mathcal{U}} v_i(A_j)$$

Budish 2011, Journal of Political Economy



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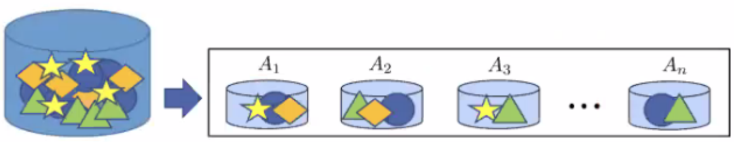
An agent i is asked to partition the goods into n parts



In worst case, i gets $\min_{j \in \mathcal{U}} v_i(A_j)$

Any rational agent would solve $\max_{(A_1,\ldots,A_n)} \min_{j \in \mathcal{U}} v_i(A_j)$

Fair Recommendation to Fair Allocation

Products as Goods

Relevance Scores as Valuations

Customers as Agents

Departure from existing fair allocation setup

- Gives guarantees only for the agents/customers
- Allocation terminates when no product left

Proposed a new algorithm FairRec

Required Properties for FairRec

Products as Goods

Relevance Scores as Valuations

Customers as Agents

(Producer Fairness)
Exposure Guarantee

- Each product is guaranteed a certain amount of exposure

(Customer Fairness)
EnvyFree upto 1 good

- The allocation must be envy-free upto 1 good

Cardinality constraint
from customer-side

- Each customer must be allocated with **k distinct** products

MMS Exposure Guarantee in FairRec

Products as Goods
#distinct_products=**n**

Relevance Scores as Valuations

Customers as Agents
#distinct_customers=**m**

Recommendation size **k**

Total Available Exposure
= **m** x **k**

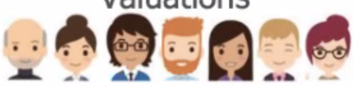
Maximum possible guarantee
for producers
MMS= $\lfloor$(**m** x **k**)/ **n**$\rfloor$

No guarantee above MMS is possible

Guaranteeing Two-Sided Fairness in FairRec

Products as Goods

Relevance Scores as Valuations



Customers as Agents

FairRec runs in two phases

1. Phase-1

- Ensures Minimum Exposure Guarantee
- Maintains EF1

2. Phase-2

- Completes allocation of exactly k products
- Continues to maintain EF1

* Could not cover the entire lecture

Will be adding soon