# A User-Centric Approach to the Design and Consequences of Recommender Systems

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## Summary & Goals

Recommender systems have increasingly come under focus for negative social consequences:

- ***Filter Bubbles:*** Individuals consume increasingly similar goods and are isolated from diversity of content
- ***User Homogenization*:** Individuals consume increasingly similar goods to each other

We look at the extent to which these effects can be attributed to recommender systems as opposed to natural consequences of individual decision-making in markets where recommender systems are deployed.

## Model

**User Decision-Making**:

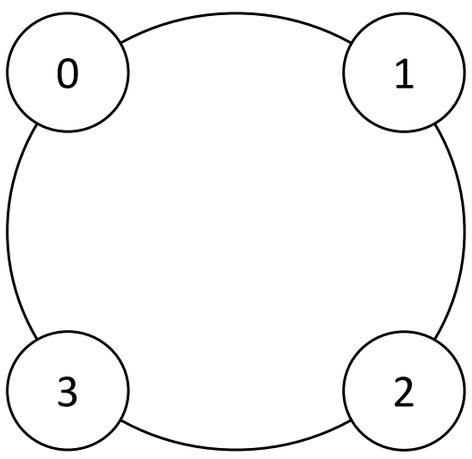
- $N$ items, users sequentially consume for $T$ periods, 1 item per period
- Realized value of items for consumer :

$$X_i = V_i + \beta V, V \sim N(0,\Sigma), V_i \sim N(\bar{V}_i, \Sigma_i)$$

- Value = Idiosyncratic component and common component
- Importance of common vs idiosyncratic component controlled by
- Users have beliefs over the realized utilities and can be risk-averse
- Assume myopic users: no purposeful exploration

**Product Space**:

Products are evenly spaced on a circle
$d(n,m) := \min\{|m-n|, N-|m-n|\} - m, n$ indices




**Learning**:

- Users employ *similarity-based generalization*
- Observe realized utilities directly after consumption
- Spillovers: Bayesian update beliefs about other items, but more strongly about value of similar items than about dissimilar items
- Strength of updating controlled by correlation coefficient

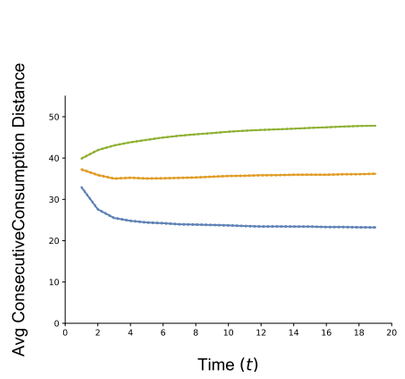
**Recommendation Regimes**:

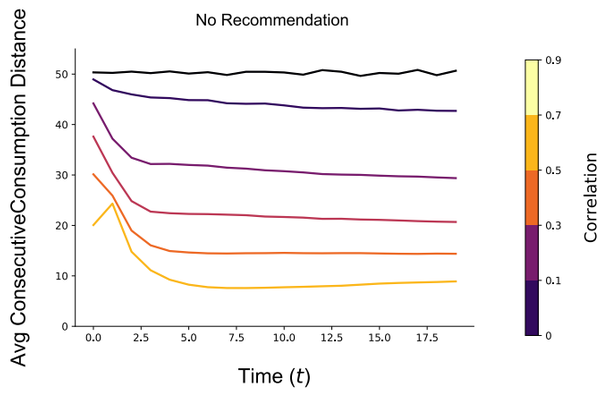
- No Recommendation: users get no information
- Recommendation: information on $V$ and combine with user beliefs
- Oracle: Ex-post (full information) optimal consumption path

**Evaluation**: Characterization via simulation over populations of users and a grid of relevant parameter values. Results here reported for $N$ = 200, $T$ = 20

## Filter Bubble Effect

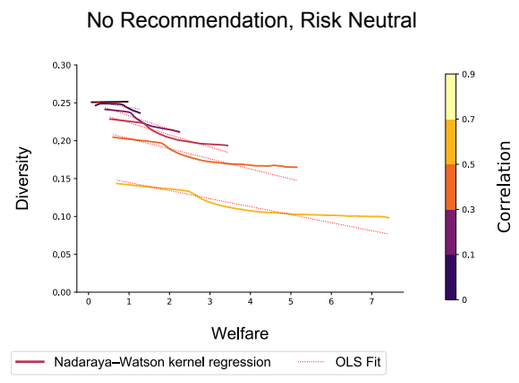
- Track average consumption distance across time
- Empirical work (Nguyen, et. al 2014 WWW) has found that filter bubble effects arise *without recommendation*
- Spillovers lead to a natural "narrowing" effect

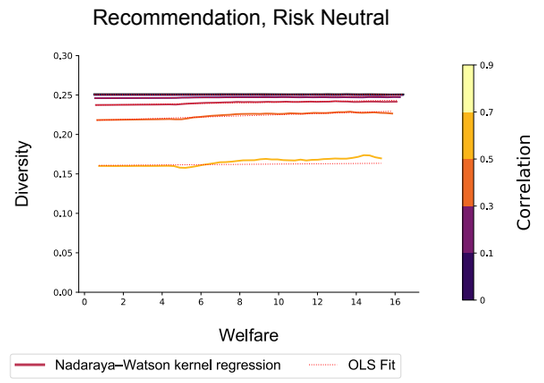



## Welfare and Content Diversity

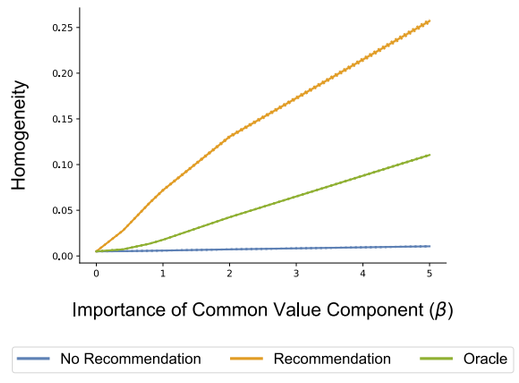
- Diversity = average normalized pairwise distance between consumed products
- Does higher "content diversity" imply higher welfare?
  - Low diversity may be due to consuming similar high value goods
  - High diversity may be due to consuming different low value goods
- Without Recommendation: Negatively correlated
- With Recommendation: Uncorrelated

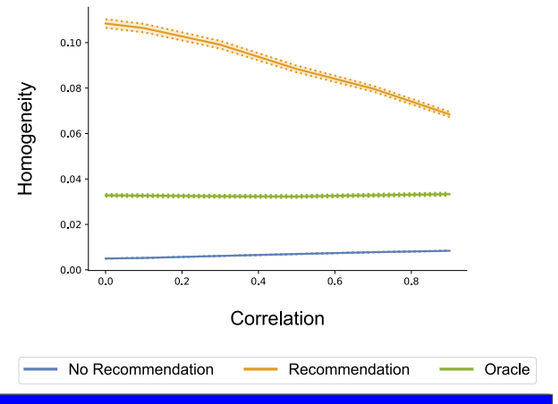



## User Homogeneity

- Homogeneity = Jaccard index across consumption sets
- Recommendation "coordinates" individuals in similar portions of the product space
- Without recommendation, no coordination leads to low homogeneity




## Conclusions

- Filter bubble effects can be generated by a natural model of user decision-making
- Homogeneity naturally arises in recommender systems by coordinating consumers in the product space
- Understanding user beliefs and user decision-making are important for evaluating recommender systems

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