Evaluating the Impact of Recommeder Systems to society

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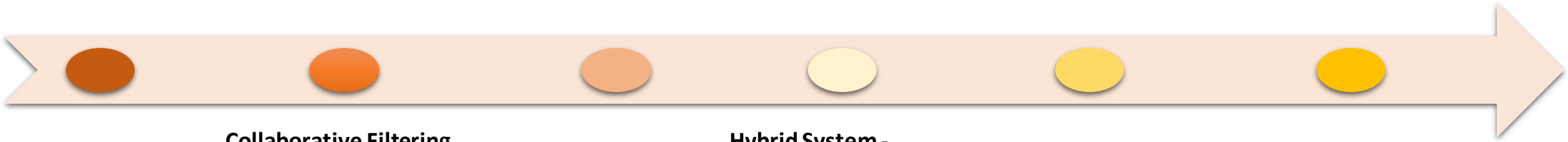
Overview Recommender Systems

•Recommender systems are tools for interacting with large and complex information spaces. They provide a personalized view of such spaces, prioritizing items likely to be of interest to the user.

Collaborative Filtering, user – user similarity
People like you who bought milk also bought bread

Content Based Filtering -
You like action movie, starring Clint Eastwood, you might also like *Good, Bad and the Ugly*

Deep Learning based RS-
Use of ML techniques to integrate traditional methods or solely model based

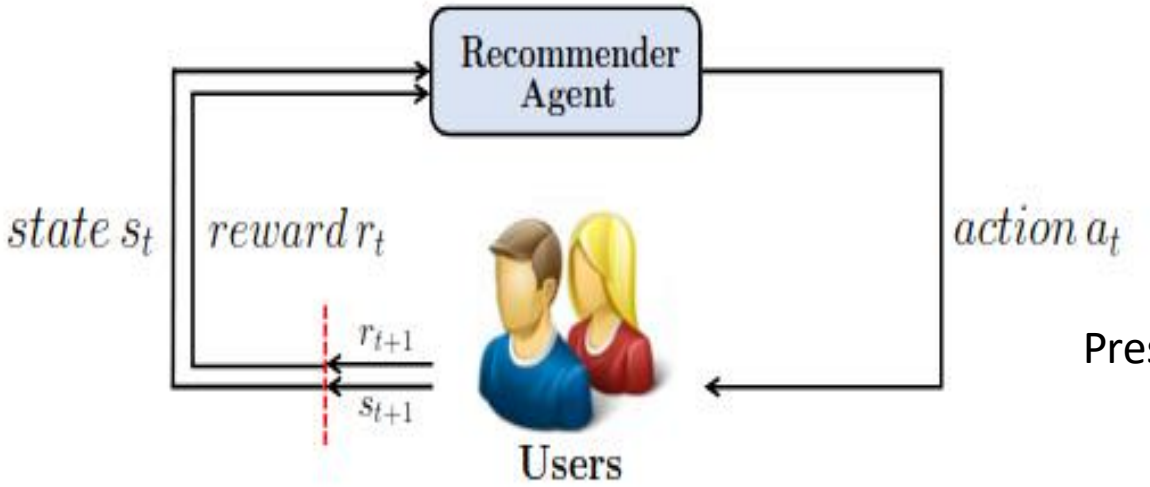


Collaborative Filtering, item– item similarity
You like Superman so you will also like Spiderman

Hybrid System -
The Godfather, Donnie Brasco and Peaky blinders are considered similar; people like you who enjoyed *The Godfather,* also liked *Peaky Blinders*

Reinforcement Learning based RS -
The recommendation problem is considered as a sequential decision-making process

Reinforcement Learning - based RS



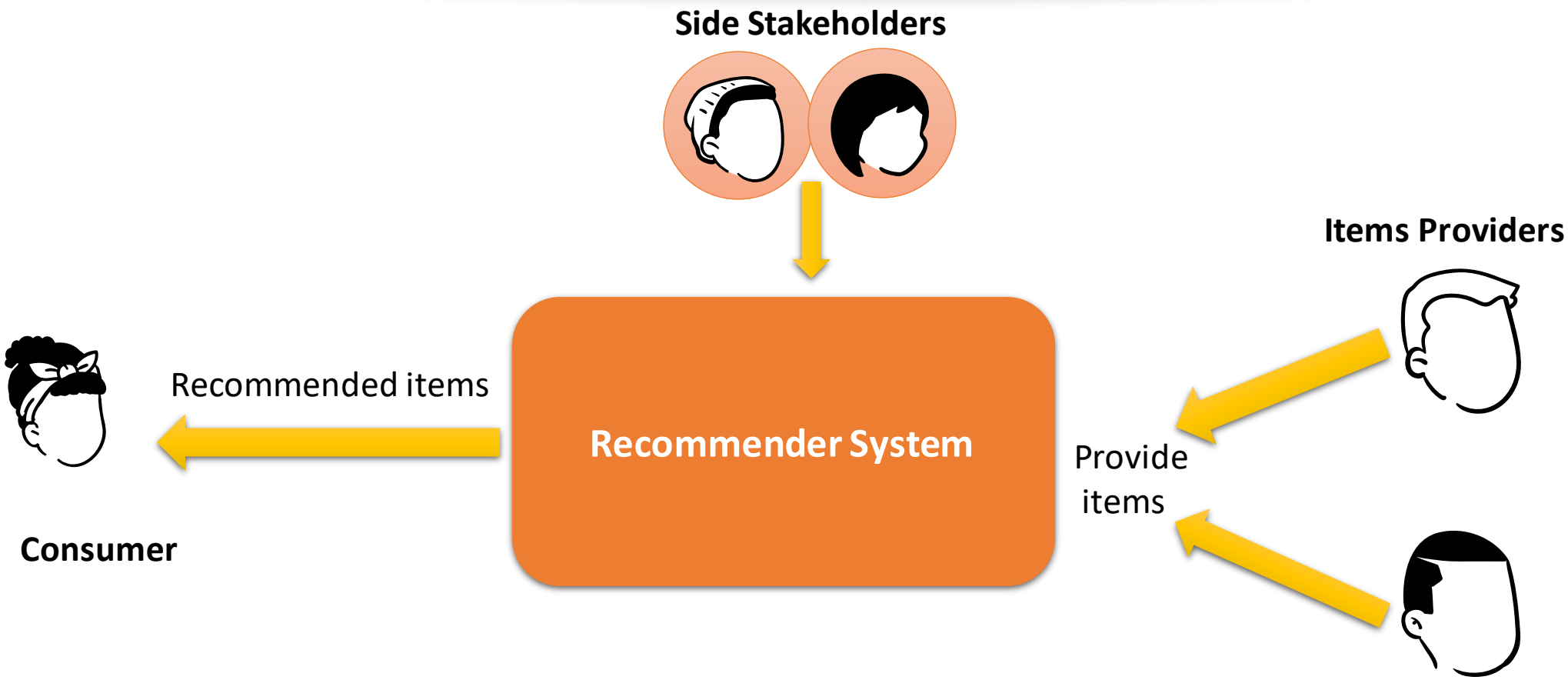
The **recommendation problem** suits the **RL problem,** since:

- There is a decision-maker – the **agent** – that learns from direct interaction with the **environment** to make good sequences of decision in order to maximize a numerical **reward**;
- the problem is closed-loop
- the learner does not have a tutor and learns by trial and error
- actions influence not only the short-term results, but also the long-term ones

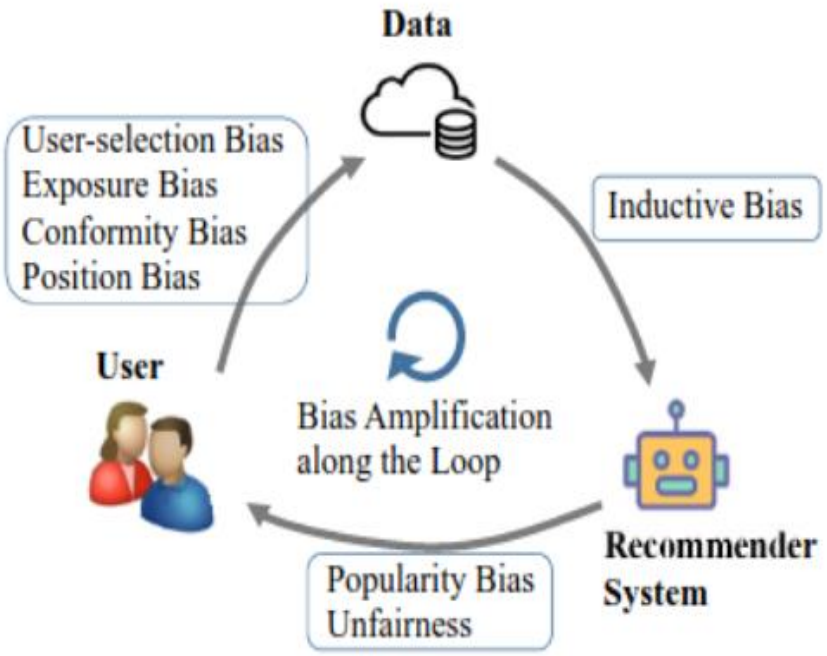
Presents the main sub-elements of a RL system:

- **Policy:** mapping from state to action
- **Reward:** immediate desiderability
- **Value Function**: how good the state or action is in long-term
- **Model:** provides dynamics about the behavior of the environment

Multi-Stakeholders Recommender Systems



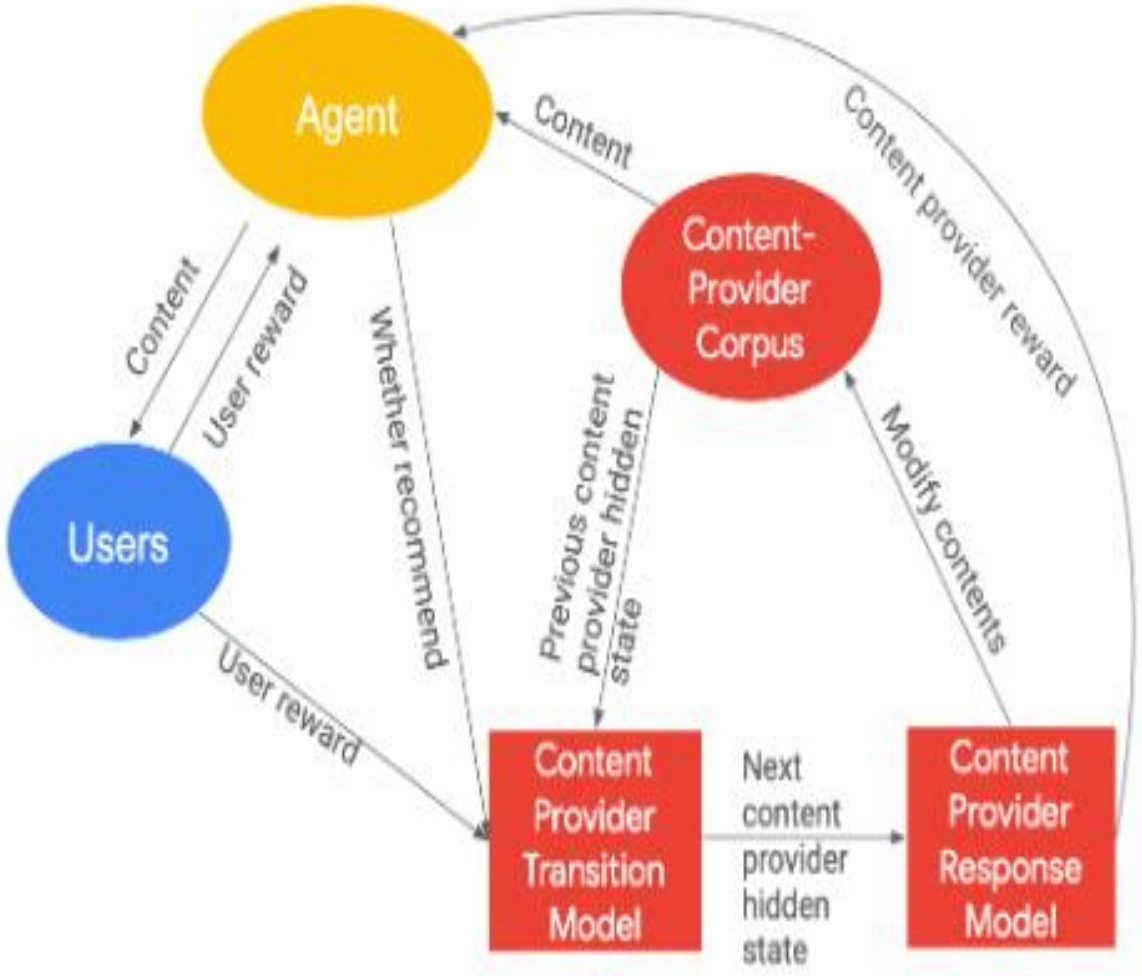
From RS Biases to Undesired Effects to Society



- **Filter Bubbles**: personalized environment for users where are removed the key elements that trigger the users' necessity to see something different
- **Echo chambers:** particular case of the filter bubble, users' environment is also polarized, meaning that only certain viewpoints, information, and beliefs the users agree with are available
- User behavior **homogenization** due to popularity bias that push users consuming mainstream items
- User behavior **manipulation** to foster providers' interest in environments where the market is dominated by a few suppliers, mostly due to the presence of unfairness towards providers

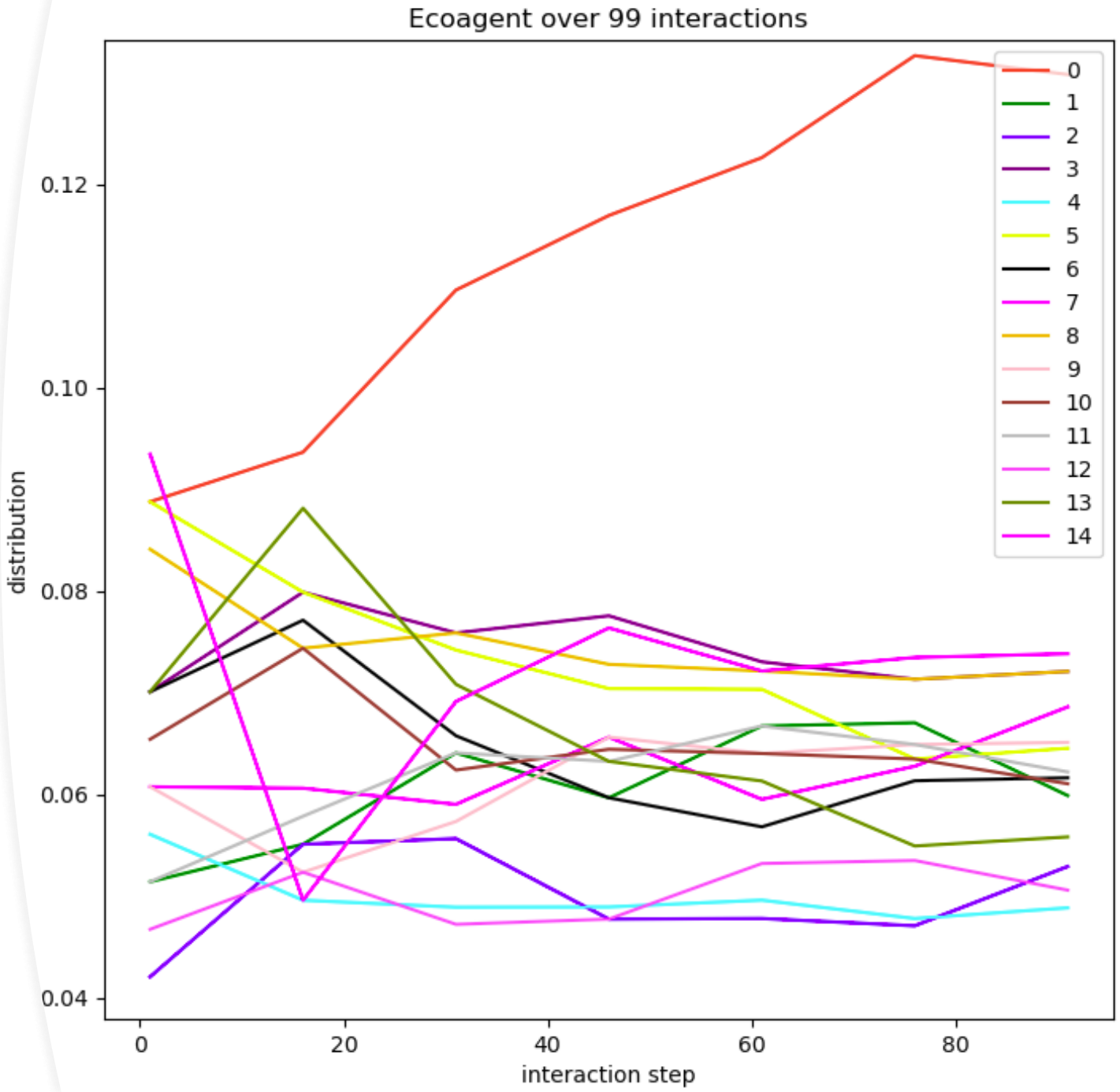
EcoAgent: a Simulation Study

- **Environment setup:**
  - 50 users, 10 providers (each initialized with 20 content on 15 possible topics), new comers not allowed
  - Users update their content preferences based on recommendation
  - Providers rewards depend on #recommendation & associated users rewards
  - Providers update their content creation preferences based on user and RS feedbacks
  - Providers leave the platform if their satisfaction drop below a certain threshold
  - Considers long-tem user and provider utility



Simulation Analysis

- Content providers leave the platform due to unsatisfaction;
- The environment presents a popularity bias over topics available on the platform;
- EcoAgent's unfair behavior towards content providers;
- Most documents on the biased topic are created by the content provider preferred by the system
- **Risks**: *diversity reduction* and high risks of *echo chambers* creation, *manipulation* of user's behavior



Post-Processing Methods

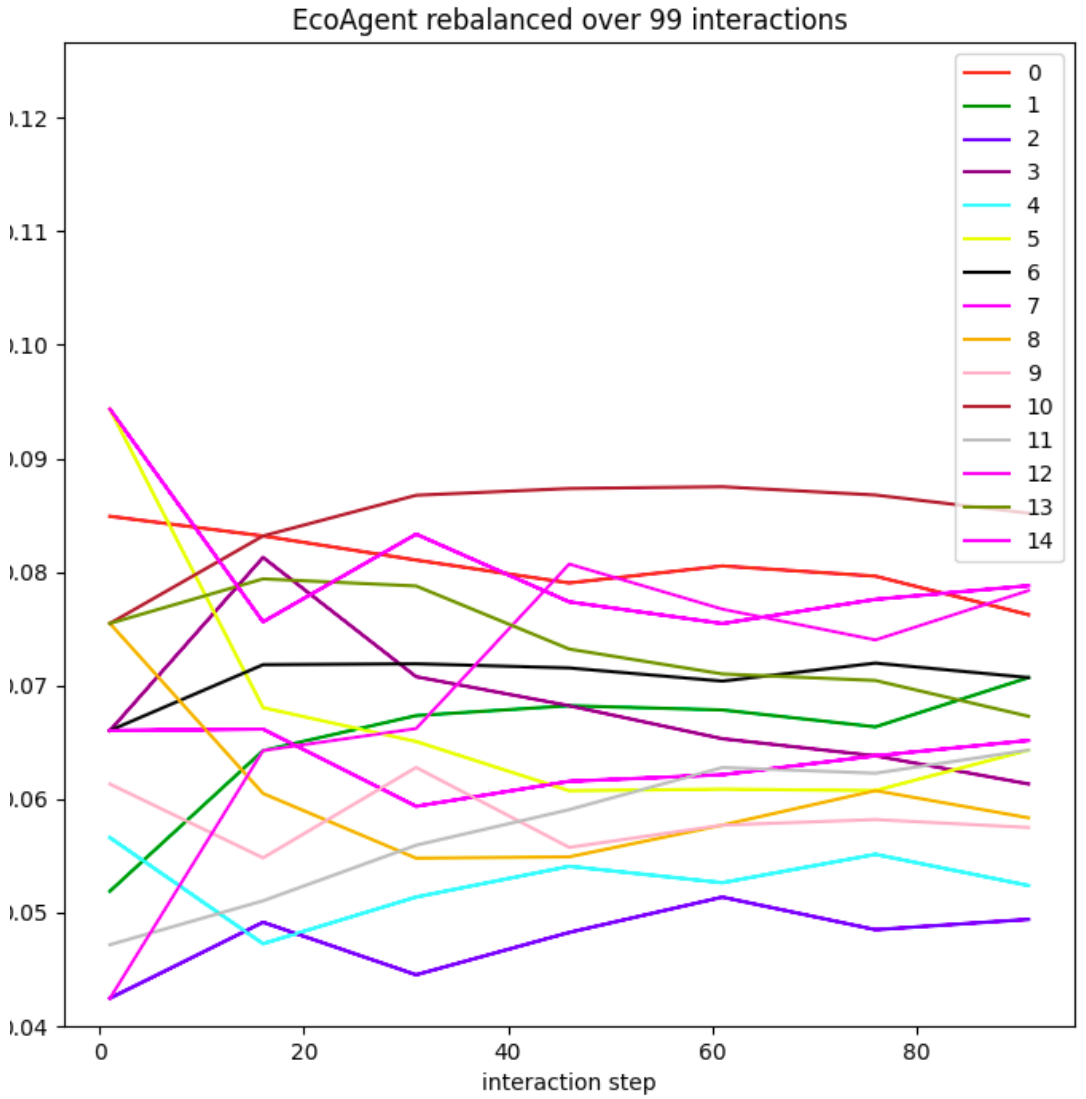
- **Question**: How does the number of providers and the system fairness reflects in the creation of biases?

To answer the question we apply on EcoAgent two post-processing techniques to obtain:

- **reactive** EcoAgent, able to maximize the number of content providers available, but with a low degree of fairness towards them.
- **proactive** EcoAgent, able to maximize the number of content providers available while acting almost perfectly fairly towards them.

Post-processing methods

- ***Reactive*** EcoAgent' s behavior was very similar to EcoAgent, so it was concluded that the number of providers does not particularly impact the environment
- **Proactive** EcoAgent**,** instead, proved that fairness towards content providers mitigates the popularity bias. In addition, the contribution of many content providers on the same topic was observed, meaning different viewpoints that reduce the risk of users being trapped in echo chambers.



Conclusion and Future Work

- Implement an RS able to meet some requirements on the diversity of the elements present in a slate of recommendation and study how this would affect the satisfaction of users and suppliers.

Thanks for your attention!