

# User Taxonomy and Positional Dynamics in Online Innovation Networks: Evidence from Stack Overflow

*Keywords: Online Innovation Networks, Stack Overflow, Behavioral Taxonomy, Embeddedness, Network Analysis*

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## Extended Abstract

**Motivation.** Community Question and Answer (CQA) platforms such as Stack Overflow play an important role in large-scale knowledge sharing and collaborative problem solving. However, sustaining constructive user participation remains a challenge for many online communities. Prior research has identified different behavioral categories of users based on their activity patterns, highlighting the diversity of participation styles within such platforms. Despite these contributions, most studies treat behavioral roles as relatively static and provide limited insight into how these roles evolve over time.

In reality, participation in online communities is dynamic: users may shift between different behavioral roles as they gain experience, reputation, and connections within the interaction network. Understanding these transitions is important for explaining the mechanisms that sustain healthy knowledge-sharing ecosystems. This study therefore asks: **(1)** how users transition across behavioral categories over time and **(2)** how these behavioral roles relate to their structural positions within the interaction network.

**Approach and Methodology.** We analyze three years of activity data (2021–2023) from Stack Overflow comprising 59.8 million posts. Using question–answer relationships, we construct monthly directed and weighted user interaction networks, where nodes represent users and edges capture answering interactions between them.

Users are classified into five behavioral types based on an established taxonomy: Caretakers, Reputation Collectors, Noobs, Help Vampires, and an additional Uncategorized category. These roles represent varying levels of contribution and engagement in the community.

To capture users’ structural positions within the network, we compute several network measures including in-strength, out-strength, coreness, Burt’s constraint, betweenness centrality, HITS hub and authority scores, and clustering coefficient. Additional user attributes such as reputation, badges, and participation duration are also considered. Because the dependent variable represents an ordered behavioral ranking and the dataset forms an unbalanced panel, we estimate an ordinal logistic regression model to examine how network structure and user activity influence behavioral roles over time.

**Results.** Our findings show that network structural position strongly influences behavioral outcomes. Users with higher Burt’s constraint, reflecting more structurally closed network positions, are more likely to occupy lower-quality participation roles. In contrast, users with higher coreness, indicating stronger integration within the network core, tend to exhibit more constructive participation.

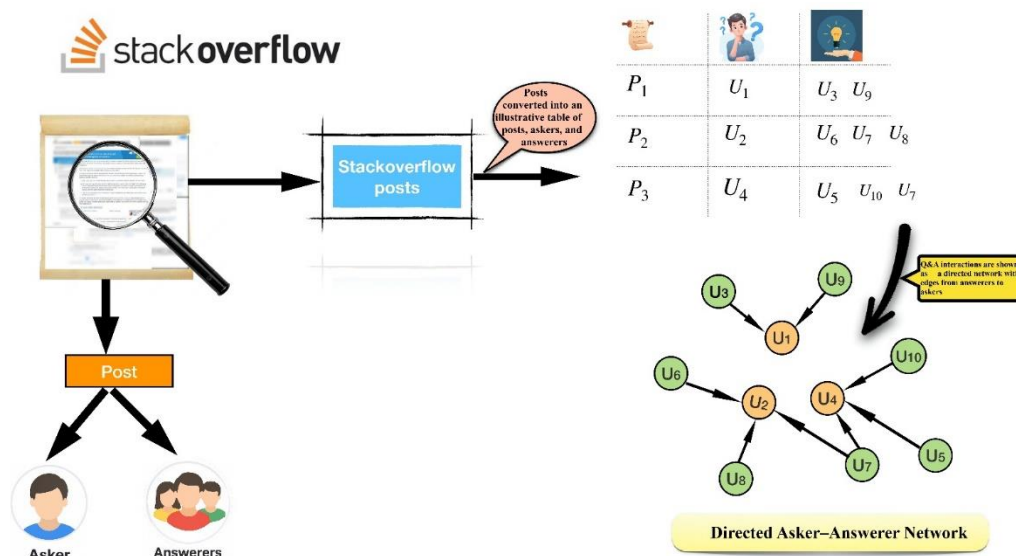
Activity-related factors also matter: sustained participation and higher total scores significantly improve a user’s behavioral rank. However, some commonly used indicators of expertise show limited explanatory power. In particular, gold badges and betweenness centrality contribute relatively little to explaining behavioral outcomes once network structure and activity variables are considered.

These results suggest that structural embeddedness within the interaction network plays a key role in shaping constructive participation in online communities.

**Conclusions and Outlook.** This study integrates behavioral taxonomy with network structural analysis to examine the evolution of user roles in a large CQA platform. The findings demonstrate that behavioral roles are closely linked to users’ positions within the interaction network and evolve over time. These insights can inform platform design by highlighting the importance of supporting structurally valuable contributors. Future work will incorporate topic modeling to examine topic diversity among users and its relationship with network embeddedness.

## References

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**Figure 1:** Construction of the Stack Overflow user interaction network from question–answer relationships.