

2. Can we compare and contrast the evolution of multiple users across forums?
3. Can we numerically describe forums in terms of temporal behavior of users?

To address the first question, we fit user paths with straight line. We find that the user path can fit with straight line reasonably well. This indicates that users indeed tend to exhibit consistent communication patterns over time. At the same time users can have variations from the straight line. We measure these variations, and thus the extent of consistency, with the root mean square error (RMSE) of the fit.

To address the second question, we superimpose paths for different users in a forum (Fig. 2). We find some properties common to all users. Specifically we find that there are dead zones in the feature space (i.e., areas where the probability of observing a user is low). A user found in these zones exhibits abnormal behavior with respect to the majority of users. Such a user, can be, for example, a spammer, and thus users with abnormal behavior might be of interest for forum administrators.

To address our last research question, we characterize forums with macro features, such as the mean length and the mean slope for the set of user paths. We validate the macro features with hierarchical clustering of forums (Fig. 3).

In summary, the main contributions of our work are as follows.

- A novel method for studying temporal evolution of individual users, measuring their behavior consistency, and scaling the method up to the levels of a forum and a forum board.
- Found patterns of consistent user engagement and dead zones.
- A method for an automated description and categorization of forums in terms of evolving user patterns.

In addition to our main results, we emphasize the flexibility and generality of our approach, since it can be applied to other domains, such as email or phone communications. Here the numbers of posts and replies can be replaced by the numbers of sent and received emails or outgoing and incoming calls respectively. Further, one can consider a user path in different feature spaces, for example, with posts and replies weighted as they are voted on by users, in cyberspaces such as Reddit and YouTube. Finally, our analysis can be performed on the collective evolution of communities rather than individual users, revealing community level patterns.

We suggest the following applications for our results: (i) predict whether a user is likely to be involved in conversations in future, based on past observations; (ii) identify users whose behavior significantly differs from the normative behavior for a given forum; (iii) categorize forums by their ability to elicit responses and apply different management policies for different categories of forums.

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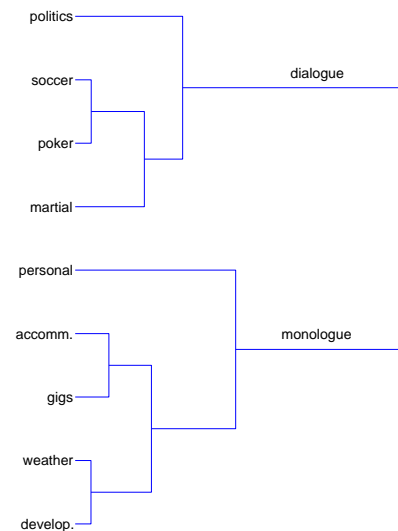


Figure 3: Hierarchical clustering of the forums based on macro features that characterize forum appearance. There are two prominent groups of forums. We label the first group as “dialogue”, because the forums in this group have relatively high reciprocity of communication (the average forum slope is closer to the 45 degree line). We label the second group as “monologue”, because of a lower reciprocity of communication (the average forum slope is closer to the x-axis).

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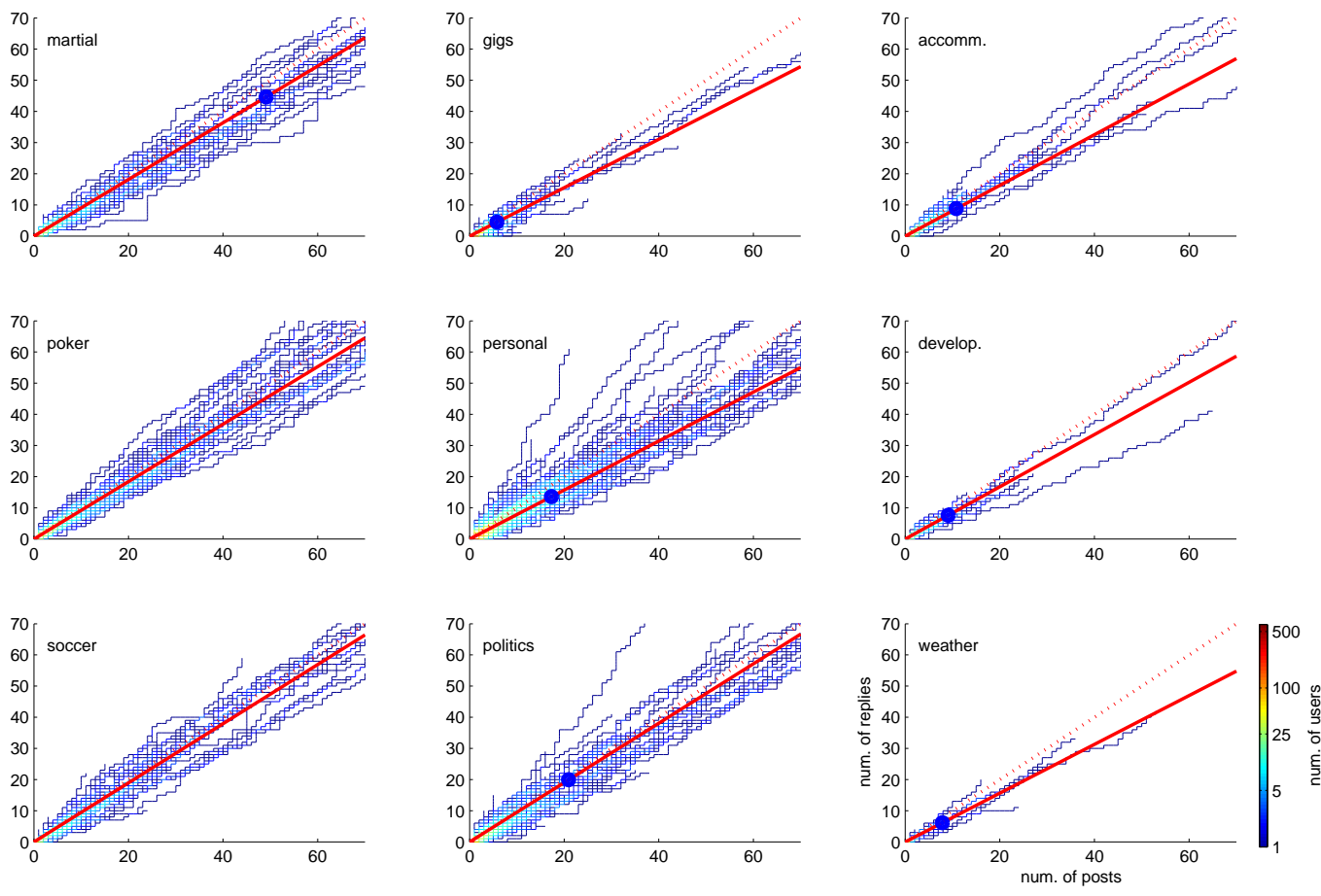


Figure 2: Visualization of nine forums from Boards.ie. For each forum, a random sample of all users registered in year 2006 was selected. Each user was tracked until January 2008. Each line is a path of one user. User paths can overlap, and color shows how many paths overlap at different points. Dashed red line is the 45 degree line, solid red line shows the average slope of the forum. Blue circle shows the average length of user path for the forum (for “soccer” and “poker” forums the average length is above 50).