# Task Specialization in Social Production Communities: The Case of Geographic Volunteer Work

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**Abstract**

In social production communities, users' individual and collective efforts lead to the creation of valuable resources – cf. Wikipedia, Open Street Map, and Reddit. Contributors to such communities often *specialize* in the tasks they choose to do. We found evidence for specialization by *work type* in Cyclopath, a geographic wiki for bicyclists – most users edit a single type of map feature, such as points of interest or roads and trails. We also saw a user lifecycle effect: as users gain experience, they specialize in editing roads and trails. Our findings suggest more effective ways to organize social production interfaces, compose units of work, and match them to users who want to help.

## Introduction

Social production communities – where large numbers of users collaborate on tasks, and anyone can be a contributor – have recently emerged as a powerful method for creating and maintaining *artifacts of lasting value* (Cosley et al. 2006). For example, Wikipedia has produced over ten million encyclopedia articles in dozens of languages, and Yahoo! Answers has received over one billion answers.

Contributors to such systems often specialize in the work they choose to do, whether by *topic* (e.g., some users answer questions about cats while others address cooking) or by *work type* (e.g., some Wikipedia users prefer to patrol for vandalism while others fix typos). Understanding these patterns is important because it has implications for designing both the user experience and policies of open content communities.

We studied specialization in the context of *geographic volunteer work* (Priedhorsky, Masli, and Terveen 2010) done by users of Cyclopath (`http://cyclopath.org`). Cyclopath is a geographic wiki (or *geowiki*) offering route-finding services for bicyclists in the metropolitan area of Minneapolis-St. Paul, Minnesota, USA, an area of roughly 8,000 square kilometers and 2.3 million people.

The general specialization dimensions noted above have direct analogues in a geographic context. *Topic* translates to *geographic location and extent*: users can specialize in different geographic areas (e.g., one user might edit in the Cedar-Riverside neighborhood, while another might focus on the suburb of Richfield) as well as the shape of the areas they edit (e.g., one user might focus his or her edits in the area near home, while another might edit along a favorite bike path). Similarly, *work type* corresponds to the *type of map feature* edited. In Cyclopath, users can edit roads and trails (the *blocks* that form the transportation network), points, and regions as well as the notes and tags that can be attached to these features. In this paper, we study the latter, i.e. specialization by work type by framing the following research questions:

**RQ1. Specialization of Contributions**. *Considered in the aggregate, are revisions in Cyclopath – also the units of work in other wikis – biased toward any particular type of work?* Yes. We found that despite the freedom available, a majority (80%) of revisions consist of a single work type, with byway editing being the most popular. In those that do not, we see a definite object+annotation combination.

**RQ2. Specialization of Contributors**. *Do individual Cyclopath users specialize by work type?* Yes. A majority (65%) of users specialized in one specific type of work. Block editing was by far the most common specialization, even though this is the most difficult editing task.

**RQ3. Change in Specialization**. *Does specialization by work type change as users gain experience?* Yes and no. We saw interesting changes as users gained experience: although a majority of users (65%) did not change their specialization, a large minority (35%) did, and they tended to either transition to specializing in the important but difficult task of block editing or to diversify their editing and become generalists.

The remainder of the paper is arranged as follows. We first survey related work, then detail the data sets we analyzed. We then address our three research questions in turn. We conclude with design implications for geographic and general social production systems and areas for future research.

## Related Work

### Social production

Social production communities (Benkler 2006; Gilbert and Karahalios 2009) let loosely connected users work together to produce information and artifacts of value (Cosley et al. 2006). Collaborative filtering systems like MovieLens and Amazon leverage users' ratings of items (movies, consumer products, etc.) to enable personalized recommendations. Q&A sites like Yahoo! Answers and Stack Overflow form knowledge economies, where users spend points to ask or boost the priority of questions and earn them for answering. Wikis take user-provided content to its logical end: anyone can add, edit, or delete anything. Wikipedia is among the top 10 most popular sites on the Web, and smaller wikis are ubiquitous. Scholarly interest in this form of interaction is intense, encompassing both, studies of current sites and techniques (Harper et al. 2008; Lampe and Resnick 2004), and efforts to develop novel and better ones (Beenen et al. 2004; Cosley et al. 2007; Sen et al. 2006).

### Geographic social production systems

Many web sites combine a map-based interface with an open content model. Community-focused sites such as FixMyStreet and SeeClickFix let locals plot the location of potholes and similar problems on a map. Open Street Map is a large ongoing effort to build a worldwide street map using the wiki model, and Google Map Maker lets users directly edit Google Maps data (in some countries) and submit those changes for inclusion in the public map.

There is a growing body of scholarly work on geographic open content systems, including description of the Cyclopath design and rationale (Priedhorsky, Jordan, and Terveen 2007), evaluation of the effectiveness of the Cyclopath geowiki model (Priedhorsky and Terveen 2008), and analysis of the effectiveness of FixMyStreet as a vehicle for citizen-government interaction (King and Brown 2007).

### Task specialization

Much research has analyzed the different roles of users in online communities, and in social production systems specifically. A fundamental finding is that participation is highly unequal: a very low proportion of "power" or "elite" users accounts for a very high proportion of participation (Kittur et al. 2007; Priedhorsky et al. 2007). However, users specialize in ways other than simply the amount of work they do, and prior work has addressed the same dimensions of specialization that we do: topic and work type.

The basic organization of online communities reflects the obvious fact that different people are interested in different topics. For example, Usenet groups were defined for particular hobbies, television shows, and rock bands. However, even within a particular community, different users are interested in and knowledgeable about different topics. For example, Demartini observed that Wikipedia editors specialize in certain topics, then developed algorithms that analyze user edits to create topic expertise profiles (Demartini 2007), and Cosley et al. developed algorithms to match users with tasks in topics with which they were familiar (Cosley et al. 2006; 2007).

Research in a variety of communities has found that users specialize in their participation. In online discussion forums, Turner et al. (2005) and Welser et al. (2007) identify different roles that users assume, notably "Question Person" and "Answer Person" and try to build models to predict them using users' patterns of communication. In the context of Wikipedia, Welser et al. 2008 mapped out various social roles that contributors can play, such as technical editors, substantive experts, vandal fighters, and social networkers. Bryant, Forte, and Bruckman (2005) found that Wikipedia editors shifted concerns as they became more experienced, evolving from a focus on topics about which they had some personal expertise to taking on different types of "community maintenance" tasks, e.g. monitoring for vandalism and enforcing policies like "Neutral Point of View."

### This research

This paper investigates the nature of work type specialization in Cyclopath and extends prior work in several ways. First, in an attempt to move towards generality, we study the concept of specialization in a context that is qualitatively different and at a scale that is more real-world than an edge case like Wikipedia, which is the platform for most prior work. Second, we extend prior research on task specialization by studying work type specialization in a wiki context and how it varies over users' lifecycles. Third, we map our findings to clear implications for designers of commonly found social production communities.

## Study Design

Cyclopath went live in the summer of 2008. The database was populated initially with road and bicycle trail data from the Minnesota Department of Transportation (Mn/DOT). The initial release supported the map features blocks, points, and notes. Tags were added in April 2009, and regions were added in November 2009. In this research, we analyzed usage data from the initial release through September 9, 2010. At this time, there were 2,184 registered users, and the system had been visited from 59,433 distinct IP addresses.

Users contribute to Cyclopath by editing (any number and any type of) map features, then clicking "Save Changes." This sends the set of edits to the Cyclopath server, which saves it as a *revision*. The Cyclopath server logs various information about each revision, including who did it (username if available and IP address) and a timestamp. The results of the revision are immediately visible to all Cyclopath users. Also, since Cyclopath is a wiki, all prior map states are retained; users can monitor the Recent Changes List for revisions of interest and revert any that are problematic.

Our dataset contains a total of 12,311 revisions. Of these, 10,777 were made by 544 registered users, and the remaining 1,534 were made anonymously. Figure 1 shows an example of a fairly complex revision.

Cyclopath also logs information about other user activities, such as viewing the map, asking for routes, and entering bikeability ratings for blocks. This paper focuses on

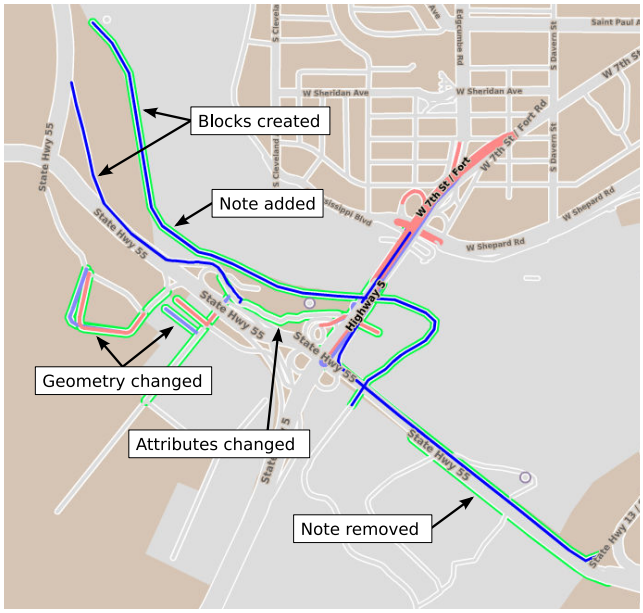


Figure 1: Changes in one revision, with some highlights indicated. New blocks are shown in dark blue; changed geometry is indicated with light red (old geometry) and light blue (new geometry); and changes to non-geometric attributes and notes are indicated with a green outline. This revision added 7 blocks and changed 19 (7 geometrically, 6 in non-geometric attributes, and 6 in both), added 5 notes to 5 blocks, and removed 4 notes from 3 blocks. Figure from (Priedhorsky 2010).

publically visible contributions, so we do not consider ratings (which are private contributions) or viewing activity and route requests (which are private and not contributions).

Recall that we interpret *work type* as editing different types of map features. Specifically, we consider the following five feature types:

- *Blocks* – 154,858 atomic segments of the roads and trails that make up the transportation network, e.g., the block of Union St. between Beacon St. and Washington Ave.
- *Points* – 3,138 points of interest, e.g., TCF Bank Stadium.
- *Regions* – 396 cities, neighborhoods, and other defined geographic regions, e.g., Marcy-Holmes, a Minneapolis neighborhood.
- *Notes* – 2,603 text notes attached to 8,355 blocks, e.g. "icy during the winter".
- *Tags* – 324 brief text labels attached to 26,646 blocks, points, and regions, e.g., "bumpy" (attached to a block).

Our analyses are organized by our research questions. For each question, we describe the procedures used and the results found.

## RQ1: Specialization of Contributions

**Procedure**. As shown in Figure 1, a Cyclopath revision can consist of edits to multiple map features of different types.

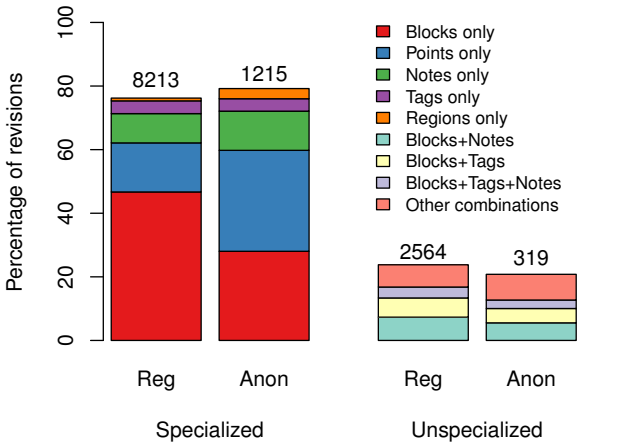


Figure 2: Specialization of revisions by registered (*Reg*) and anonymous (*Anon*) users. Note that bar height is normalized between the two classes of users; the actual revision counts are above the bars.

In this section, we examine the types of map features that actually are edited together in revisions. We count a revision as a block revision if it edited only blocks. Similar terminology also holds for revisions editing other types of map features, like point, region, note, and tag. We also count revisions of mixed types, e.g., block+note revisions.

For this analysis, we ignore the number of map features edited in a revision. For example, a revision modifying 10 blocks and another modifying 2 blocks both count as block revisions. A revision with 1 block edit and 5 note edits and a revision with 5 block edits and 1 note edits both count as block+note revisions. We ignored the number of edited features in this analysis because we are concerned only with co-occurrence, not frequency.

We also consider revisions by registered and anonymous users separately. While prior work on Cyclopath shows that some revisions done by anonymous users can be attributed to registered users (Panciera et al. 2010), the number of such revisions is low, and thus we do not apply that attribution process here.

**Results**. Figure 2 shows the number of revisions modifying particular map features and combinations of features. The results for registered and anonymous users are presented separately. Tags and regions were introduced about 9 months and 14 months, respectively, after Cyclopath was released, which explains in part their lower usage. So few revisions modify regions that they are not visible in Figure 2, and we therefore exclude regions from further analysis. Our observations concerning the results are as follows:

1. *Most revisions consist of a single type of work.* Although no Cyclopath norm dictates this, 78% of revisions made by registered users, and 80% made by anonymous users ($p < 0.001$ in both cases[1]) consist of edits to a single type

[1]In each case, we compared the proportion of specialized revisions to unspecialized ones using a 2-sample test for equality of proportions using continuity correction.

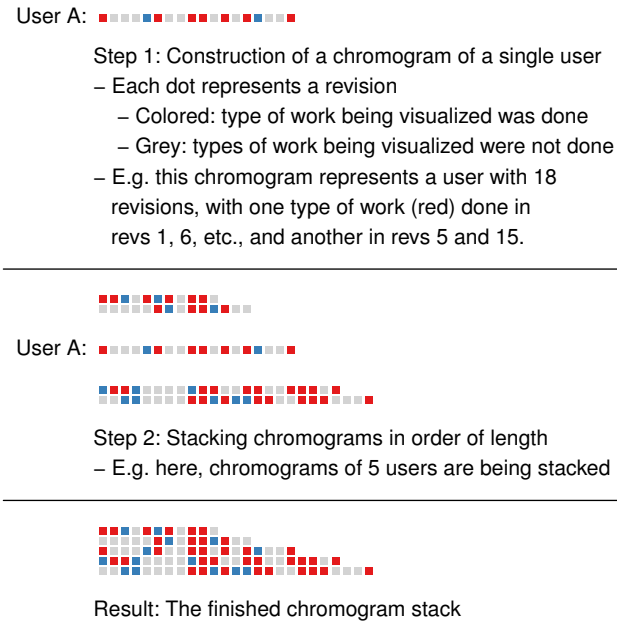


Figure 3: Construction of a chromogram stack.

of map feature. We call such revisions *specialized* in the relevant map feature.

2. *Block edits are the most common work type.* We believe there are several reasons for this. First, there are two orders of magnitude more blocks in Cyclopath than other types of features. Second, blocks are the crucial unit in Cyclopath, as they form the basis of routing. Without blocks – and without accurate connections among blocks – routing would be impossible. The other features add useful information but are not strictly necessary.

3. *There are clear differences in the editing behaviors of registered and anonymous users.* Specifically, block editing accounts for a much lower proportion of revisions made by anonymous users ($\chi^2 = 152.64, df = 1, p < 0.001$). We think that this is because while editing blocks is very important, it also is difficult (due to intrinsic properties of the task – block editing involves checking connectivity to neighboring blocks, shape, alignment etc.) As noted later in this paper, users apparently need time to learn and understand block editing; indeed, revisions made by registered users early in their careers have a work type distribution quite similar to anonymous users.

4. *Certain combinations of work types are most common.* Blocks+tags and blocks+notes (in general, object+annotation) are the most popular combinations ($\chi^2 = 30.44, df = 1, p < 0.001$). Since tags and notes let users provide additional information about blocks (as well as points), it makes sense that users would add information to explain their edits to blocks.

Our results show a strong degree of specialization in the entire set of revisions, nearly 80%. A natural issue to investigate next is whether individual users specialize.

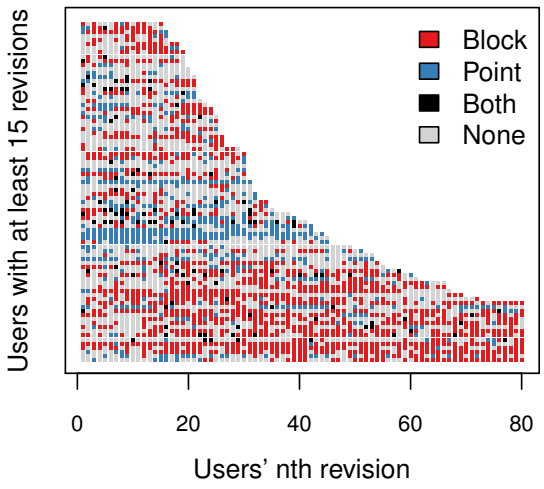


Figure 4: A section of the chromogram stack for edits to points and blocks: There are some blue rows, indicating specialization in points, and many red rows, indicating specialization in blocks.

## RQ2: Specialization of Contributors

### Identifying specialists

**Procedure**. We began by developing exploratory visualizations of the data to help us identify major patterns and guide quantitative analysis. We chose the chromogram technique because it has been used in the past to discover patterns in Wikipedia revisions (Wattenberg, Viégas, and Hollenbach 2007). Since there is a separate chromogram for each user's revisions, it is hard to identify patterns across a set of users; one has to study the chromograms of different users separately and consolidate observations externally. We overcame this difficulty by "stacking" chromograms of multiple users one above the other; this lets us observe cross-user patterns. We call this extension a *chromogram stack*.

Figure 3 explains how to construct a chromogram stack. We use colors to indicate work of a particular type in a revision and grey to indicate that no work type of analytic interest was present. Due to their use of colors, chromogram stacks are best read on a color screen or color printout.

**Results**. Figure 4 shows a part of the chromogram stack for edits to blocks and points. Red indicates a block revision, blue a point revision, black a block+point revision, and grey neither. We limited the chromogram stack to include only users with at least 15 revisions, and we truncated the display at 80 revisions. The figure reveals several patterns, including a few rows that are mostly blue and many more rows that are predominantly red. This suggests the existence of work type specialists and that there are more block specialists than point specialists. To confirm these suggestions, we next formally define what it means for a user to be a specialist and quantify their distribution in the Cyclopath user population.

| Work type | Number of specialists among | |
|---|---|---|
| | Study users | Experienced users |
| Block | 38 | 20 |
| Point | 10 | 2 |
| Note | 5 | 0 |
| Tag | 2 | 0 |
| *none* | 29 | 5 |
| Total | 84 | 27 |

Table 1: Specialists by work type, using our supermajority specialization metric: There are many more block specialists than other types of specialists.

### Counting specialists

**Procedure**. We define a user as *specialized in a map feature* if more than 60% of the total number of that user's revisions are specialized in that map feature. For example, a user who has made 40 revisions, of which 30 are point specialized, is a point specialist. We chose 60% because it is a common supermajority threshold; further, this definition guarantees that a user specialized in a particular work type makes revisions specialized in that work type at least 50% more often than all other work types combined. As before, we consider only registered users with at least 15 revisions in our analysis.

This metric assumes that the "value" of each revision, as a unit of work, is the same. Clearly, this will not be true for any given pair of revisions; for example, a revision with edits to 5 blocks does not represent the same amount of work as a revision with edits to 2 points. However, in the aggregate, such differences balance out, because the probabilistic expected value of a revision equals the mean value of all revisions.[2]

**Results**. Table 1 shows the results of computing our user specialization metric. We count the number of specialists by work type among all our study users (users with 15 revisions or more), as well as within experienced users only (top 5% of all contributors, as defined by Panciera et al. (2010)). Using the Fisher-Exact test for equality of proportions, we found that the proportions of the different types of specialists were not all identical ($p < 0.001$). Post-hoc pairwise tests showed that the proportion of block specialists is significantly more than those of point, note and tag specialists ($p < 0.001$ in all cases). The results confirm the patterns suggested in the chromogram stack: 55 out of 84 (65%) or about two thirds of the users in our study are specialists, with the greatest number (nearly half) specializing in block edits. Further, we see that experienced users are predominantly block specialists (also using Fisher-Exact, $p = 0.005$).

[2]We compared this metric to one using *an atomic map feature edit* (e.g. changing the geometry of one block, or creating a new point) as the unit of work. Using this alternative, a user would be defined as specialized in a map feature if more that 60% of the total number of map features the user has edited are of one type (e.g., block). We found no differences in the trends, and the overall pattern of results was the same. We chose revisions as they are more clearly parallel with other wiki work.

### Summary of results

Bringing together the results noted above, we make three key observations:

1. *Most users specialize in editing one type of map feature.* Various factors might lead users to specialize, including different knowledge, different perceptions of what feature types are most important to the community, and different preferences for and understanding of the various Cyclopath editing tools.
2. *There are many more block specialists than any other type of specialist.* In the previous section, we saw that more revisions are specialized in blocks than in any other type of map feature. The same reasons we offered to explain specialization at the revision level apply here: more opportunities and greater importance. In addition, users may also find performing block edits most interesting, since this is a rare and thus potentially appealing feature in map-based interfaces.
3. *Experienced users devote a higher proportion of their effort to editing blocks than do anonymous and less experienced users.* Since blocks play a central role in the key public Cyclopath service – route finding – this finding is consistent with prior research showing that experienced users are more committed to their communities (Bryant, Forte, and Bruckman 2005; Panciera, Halfaker, and Terveen 2009). Further, block editing is one of the most difficult types of work in Cyclopath, and thus takes time to learn and commitment to master.

Thus far, we have quantified the nature of work type specialization among users. However, we also have uncovered hints that users may change specializations as they gain experience. We explore this question next.

## RQ3: Change in Specialization

### Specialists at different experience levels

**Procedure**. To investigate the distribution of user specialization at different user experience levels, we segmented revisions into buckets constituting progressively larger portions of users' revision histories (the first 15, 30, 60, 120, 240, and 480 revisions each user made). We then counted the specialists of each type of work (using the procedure in the previous section) after each interval.

**Results**. Figure 5 shows our results. The clearest pattern is that the proportion of block specialists increases for more experienced users. If we consider only the first 15 revisions of registered users (including those who went on to make many more revisions), the proportion of block specialists resembles the proportion of block specialized revisions made by anonymous users. This supports the conjecture that block specialization evolves over time, due (we speculate) to increased commitment to the community and increased mastery of complicated editing tools. This gives rise to the following questions: What happens to the users who do not specialize in editing blocks early in their careers? Do they drop out at a higher rate than block specialists? Or do they change their specialization to block editing as they gain experience? We address these questions next.

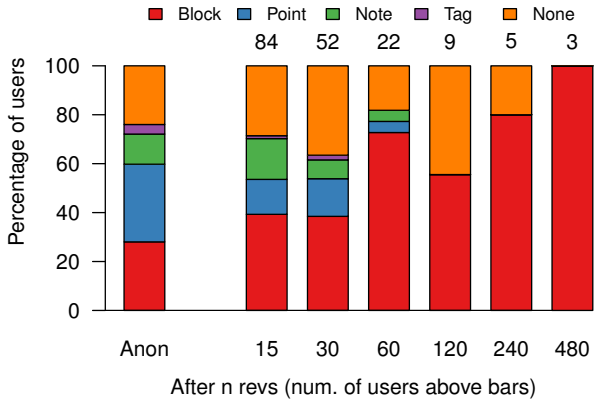


Figure 5: Distribution of specialization in different types of map features at various stages in users' editing careers. At low experience levels, the distribution of specialists resembles the distribution of specializations in anonymous revisions (*Anon*). At higher experience, only block specialists remain.

| Initial | Now | | | | |
|---|---|---|---|---|---|
| | Blocks | Points | Notes | Tags | *none* |
| Blocks | **18** | 0 | 0 | 0 | 2 |
| Points | 0 | **6** | 0 | 0 | 3 |
| Notes | 4 | 0 | **2** | 0 | 2 |
| Tags | 0 | 0 | 0 | **0** | 0 |
| *none* | 4 | 2 | 0 | 1 | **8** |

Table 2: Change in specialization. *Initial* is the users' first 15 revisions, while *now* is the full revision history. 34 out of the 52 users (in bold) examined did not change specializations, whereas 18 did.

## Change in user specialization

**Procedure**. To find out whether users change specializations and become block specialists, we took the subset of users who had the opportunity to change specializations – the 52 users who had made at least 30 revisions – and compared each's specialization at two points: (a) their first 15 revisions to (b) their entire revision history.

**Results**. The results of this analysis are tabulated in Table 2. First, a solid majority (65%) of users do not change specialization over their editing careers ($\chi^2 = 64.14, df = 1, p < 0.001$). However, this leaves a large minority (35%) who do change. The two most notable patterns are: eight (15%) users develop into block specialists, and seven (13%) other users turn into generalists.

## Effect of habituation

**Procedure**. To measure the extent to which users became habituated in their editing patterns, we did an analysis based on one by Sen et al. concerning tagging behavior (Sen et al. 2006). For each user, we computed the cosine similarity of his or her $n^{th}$ revision to the previous $n-1$ revisions, for all values of $n$. Cosine similarity values range from 0 (complete dissimilarity) to 1 (identity).

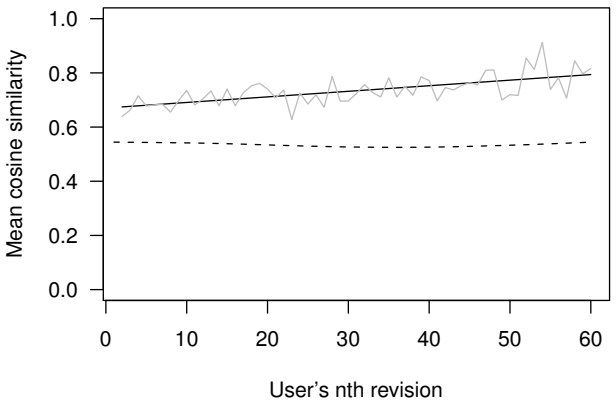


Figure 6: Mean cosine similarity of a user's $n^{th}$ revision with his or her prior revisions (solid line). Similarities to a uniform distribution is also shown (dotted line). Users increasingly "become set in their own ways" as they contribute more.

At the computational level, a single revision is represented as a vector with one component for each type of map feature: block, point, region, note, and tag (in this order). The value for a given component represents the proportion of features in the revision that were of that type. To clarify how to interpret differences between two cosine similarity values, we again follow Sen et al. and provide a frame of reference by computing the similarity between any revision and a vector [0.2, 0.2, 0.2, 0.2, 0.2] representing a uniform distribution of work.[3]

**Results**. The results of the habituation analysis are shown in Figure 6. Notice that there is a clear increase in similarity of a user's current revision to previous revisions over time, beginning at about 0.6 and rising to about 0.8 after 60 revisions.

Unlike Sen et al., we did not study the effect of community influence on user's editing behavior. In their case, community influence was direct (and experimentally manipulated): namely, it consisted of what community-applied tags were displayed to a user in the tag application interface. In Cyclopath, there is no correspondingly direct exposure to the nature of revisions made by the community as a whole: the Recent Changes list and Geographic Diff mode (to view what exactly changed in one or more revisions) interfaces only allow scanning of individual revisions.

## Summary of results

Bringing together the results noted above, we make the following key observations:

1. *Most users did not change their specialization over their lifecycles; however, those who did generally turned*

[3] As tagging and regions were added during the analytic time frame we cover, we used a uniform vector of [0.33, 0.33, 0.33] prior to the release of tagging and regions, and [0.25, 0.25, 0.25, 0.25] after tagging was released but before regions were added.

*into block specialists or generalists.* Based on prior work (Bryant, Forte, and Bruckman 2005), taking on more core and complicated tasks, like block editing, could be interpreted as an indication of higher commitment to being a Cyclopath contributor. One interesting example is that one of the most prolific Cyclopath users began as a note specialist, then transitioned into a block specialist at their 83rd revision. By the end of the data analyzed, 72% of the user's revisions were block specialized. There are several possible reasons for the transition to becoming a generalist, including users wanting to diversify and try out new types of work and being in the process of transitioning to block specialization. Qualitative analyses can help us answer these questions.

2. *Users tended to get habituated to their editing patterns.* Is this degree of habituation ("becoming set in one's ways") inevitable? Or could we intervene to try to change these patterns? Prior work suggests that interventions may nudge users to new patterns (Priedhorsky, Masli, and Terveen 2010). However, once the intervention was discontinued, users went back to their old patterns of work.

## Implications and Future Work

**Generality of methodology and findings**. In this paper, we have studied one aspect of users' behavior. Since Cyclopath is both a wiki and a geographic crowd-sourced system, our methodology could be generalized to both these classes of applications. Further, the scale of Cyclopath is closer to what is typically found in the wild, not an edge case like Wikipedia which draws most of the research in this domain. Thus, our findings have implications not only for the design of geographic volunteer communities, but also for social production systems in general, and for future research.

**Is specialization desirable?** Recall that users can specialize by topic (geographic location and extent) and work type. Topic specialization certainly is desirable. Just like Yahoo! Answers needs people who know about cats, cars, and quarks, Cyclopath needs users who know about Minneapolis, St. Paul, and the Minnesota River Bottoms trail.

Whether work type specialization is desirable is a more subtle issue. Do we really need about half of all users and a majority of all revisions to be specialized in blocks? Our hypothesis is that the distribution of specializations reflects the relative importance of the different types of work. Further, when we consider user lifecycles, we see that casual and new users of the system contribute a healthy number of non-critical work types – points and annotations (notes and tags) – while experienced and power users account for a large proportion of the critical task of block editing. There is a steady stream of new and casual users, for whom doing simpler tasks like editing points, notes, and tags is an easy entry to the system.

**Modal interfaces**. Most Cyclopath users view the map and request routes, but do not edit. Therefore, segregating "view mode" from "edit mode" (like Wikipedia) would almost certainly make the user interface significantly easier to use. Further, because most Cyclopath revisions consist of edits to a single type of map feature, redesigning the interface tools to support single-feature editing also has potential to ease users' editing work. This doesn't require strict modal separation; instead, modifications that make it easier to make multiple edits of the same type (for example) is one promising idea. This has possible extensions in other social production communities as well; for example, Wikipedia could have a separate "wikifying" mode.

**Composition of coherent work units**. Prior work on Cyclopath showed that presenting work opportunities to users in a visually comprehensible format elicited a significant increase in participation (Priedhorsky, Masli, and Terveen 2010). Our current findings can help designers of social production communities construct these work opportunities more intelligently: offer tasks that involve common, meaningful combinations of work types, like editing objects+annotations, e.g., in Cyclopath, adding points only, or editing some blocks and then adding notes about them.

**Intelligent task routing**. Intelligent task routing is the process of automatically recommending tasks to users who are likely to have the interest and ability to perform them (Cosley et al. 2006). It has been tested and shown effective in Cyclopath (Priedhorsky, Masli, and Terveen 2010), MovieLens (Cosley et al. 2006), and Wikipedia (Cosley et al. 2007). Our findings here suggest that work type also would be effective for task routing. For example, in Cyclopath, we could recommend tasks involving fixing connectivity at intersections to block specialists, and work in Wikipedia (Cosley et al. 2007) can be refined to recommend tasks involving wikifying, and ensuring neutral point of view to corresponding specialists. If the community needs specialists for a new type of task (e.g. for monitoring map edits), we could also devise methods to cultivate new specializations (intelligent recruiting).

Development campaigns are a particularly interesting application of intelligent task routing. Wikipedia has "WikiProjects", domain-specific collaborative efforts to organize volunteer work. Contributors to WikiProjects specialize, e.g., some people add new content, whereas some others fix links and typos. In geographic crowd-sourced communitiest, there could be map-wide development campaigns organized by map feature work, like fixing intersections and bridges or adding all sports-related points of interest. Of course, a campaign might recruit on both dimensions: "the Uptown neighborhood needs a tag specialist!"

**Specialization by topic**. Along with work type, topic is an important dimension of tasks. In a geographic context, we can operationalize topic in two ways:

- **Geographic shape**. There are two obvious types of *geographic shapes* that could delimit a cyclist's knowledge: *area* – editing is focused on areas (e.g., the neighborhood surrounding one's home) – and *route* – editing is focused in a "linear" way, e.g., along portions of a work commute or favorite recreational trails.

  Do users specialize by geographic shape? Preliminary studies indicate that there are users whose edits are mostly area-shaped and others whose edits are mostly route-shaped. However, more exploration and analyses (using spatial statistical tools like the SANET (Okabe, Okunuki,

and Shiode 2006)) are necessary to confirm and extend these observations.

- **Geographic extent**. Research on Wikipedia has shown that people diversify their edits as they become more experienced (Bryant, Forte, and Bruckman 2005). This leads to the question whether the *geographic extent* of users' contributions grew as they gained experience: did they edit across a broader portion of the map as they contributed more? Metrics like the Ripley's K (Ripley 1979) from spatial statistics can be used to address this question.

**Qualititative follow-ups**. The quantitative methods we used in this work do not provide the "whys" behind specialization. Do people intend to specialize? Do people care if there are specialists available in the community? Do people notice when they change their specialization? Can they explain why they change? Surveys, interviews, and other qualitative methods are needed to answer these questions.

## Summary

We studied specialization of users and their contributions in a geographic wiki, Cyclopath, exploring the well-known dimension of work type. We found clear specialization by work type, with block specialists most numerous. We also saw user lifecycle effects: Experienced users either took on more difficult tasks (becoming block specialists) or more diverse tasks (becoming generalists). These shifts suggest an evolution from *my neighborhood* to *my community*.

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