How a Personalized Geowiki Can Help Bicyclists Share Information More Effectively

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ABSTRACT
The bicycling community is focused around a real-world activity – navigating a bicycle – which requires planning within a complex and ever-changing space. While all the knowledge needed to find suitable routes exists, much of it is distributed across different individuals. We show, using the results of surveys and interviews, that cyclists need a comprehensive, up-to-date, and personalized information resource that offers automated route finding. We introduce the personalized geowiki, a new type of wiki which meets these requirements, and we formalize the notion of geowiki. Finally, we state some general prerequisites for wiki contribution and show that they are met by cyclists.

Categories and Subject Descriptors
H.5.3 [Group and Organization Interfaces]: Collaborative computing.

Keywords
Wiki, geowiki, geography, personalization

1. INTRODUCTION
1.1 Bicycling and the Personalized Geowiki
The bicycling community is focused around doing: navigating a bicycle in the physical world. This activity raises interesting challenges. First, it is inherently geographic and typically local (i.e., people mostly ride in the area where they live). Second, the planning task – deciding where to go, and how to get there – is hard. It is hard because cyclists must navigate a transportation network largely designed for another purpose, driving motor vehicles, and because they must do so under constantly changing conditions (weather, automobile traffic, road construction, etc.). Third, cyclists have significant individual differences in purpose, attitude, and abilities.

Many related domains exist. One is shopping in a mall: this is geographic and local, focused around real-world doing, and requires planning in a complex, changing space. Another is finding one’s way around a new city or neighborhood: this too is geographic, local, and occurs in a complex, changing space. A third is natural resource management, for example monitoring off-road vehicle activity. In other words, the personalized geowiki has many applications beyond cycling.

The complexity of bicyclists’ tasks result in complex information needs. Cyclists have a strong tradition of sharing information, but their existing practices are relatively inefficient. Unfortunately, there is no comprehensive, up-to-date information resource that helps users find routes that meet their personal preferences. This is true even today, when at least four major vendors offer geographic web search and automated motor vehicle route finding1 and there are hundreds of Google Maps “mashups”, covering everything from where to find an apartment2 to where crimes have occurred3 to “If the Earth Were a Sandwich”4 [8]. Why is there no Google Bicycle?

First, the cycling community is relatively small. In the United States, cycling is two or three orders of magnitude less frequent than driving, whether measured by number of trips or number of miles traveled per person [14]. Second, cyclists require detailed and constantly changing information to plan their routes. Together, these two factors make the problem too hard for hobbyists and economically unattractive for businesses.

However, wikis change the equation. While it’s still hard to gather and maintain the information, this work is distributed across many motivated users, rather than being the responsibility of the system builder.

To meet the needs of the cycling community, we propose a new type of wiki: a personalized geowiki, which is a geowiki with personalized planning features. We have designed the user interface of our personalized geowiki and are currently implementing it; Figure 1 is a screenshot of our application at the time of this writing.

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2http://www.housingmaps.com/
3http://www.chicagocrime.org/
4http://www.zefrank.com/sandwich/tool.html
1.2 The Geowiki

Our personalized geowiki concept is an extension of the geowiki, which is itself an extension of the wiki. Geowiki is already a well-established term and is generally considered to mean a geographically contextualized wiki. However, we argue that, in a true geowiki, the geographic context itself as well as links between geographic context and non-geographic data also enjoy wiki editing features – in other words, the structure of the map itself can be edited, not just items on the map – and this is the notion of geowiki that we extend.

Specifically, a geowiki is a geographically contextualized wiki which implements the following features:

1. Graphical web-map interface with standard web-map navigation operations.
2. On-line map editability, i.e. if geographic data or links involving geographic data are reasonably editable at all, they can be edited in the browser. For example, the names of lakes and the locations and connectivity of streets are editable, but aerial imagery is not, because aerial images, once loaded, typically are not edited by anyone. (Additional non-browser-based editing tools may be available, but they are not required.)
3. WYSIWYG editing for geographic data, with a reasonably complete set of editing operations. While wiki-text markup works reasonably well for textual data, geographic data is too complex to visualize from text markup.
4. Robust linking to geographic data. For example, text which describes a street must be linked to the street itself rather than to a region which is co-located with the street. Colocation links are weak, breaking down both when geodata moves and when multiple geographic objects are themselves co-located.
5. Holistic data monitoring, i.e. revision history browsing and automatic watching of geographic data, non-geographic data, and links between data. We introduce the watch region, a generalization of the watch list feature standard in traditional text wikis: users graphically indicate regions (or byways) they care about.

When editing changes data within a watch region, the system then notifies the user who defined it.

We are not aware of any currently existing true geowikis, though numerous partial implementations exist, which we discuss further in Section 2 below. However, as we show, this holistic editability is key to the success of wiki as a cycling resource.

In the remainder of the paper, we sketch related work, present the design of an empirical study of cyclists, identify their unmet needs, show how they can be met with a personalized geowiki, and explain why we believe cyclists will contribute to the wiki. We also illustrate the key features of our personalized geowiki.

2. RELATED WORK

The wiki model, where any random visitor can make unreviewed changes to a website, is a relatively new method of collective work. The Wikipedia online encyclopedia is the most famous and successful example and has attracted considerable research. Viegas et. al. [15] found that certain types of vandalism were repaired in a median of three minutes or less. Giles found that the accuracy of Wikipedia and Encyclopedia Britannica were roughly equivalent [6]. (This surprising finding generated a vigorous rebuttal from Britannica [5], but we are convinced by Nature’s refutation [11] that the original result is sound.) Cosley et. al. reported two compelling non-Wikipedia results: that users are as effective as experts in reviewing other users’ work [3], and that the wiki model and traditional review-before-publication result in the same quality, but wiki achieves it faster [4].

Partial implementations of the geowiki concept exist. For example, PlaceOpedia maps Wikipedia articles to locations, Opendiagrams[7] is a wiki travel guide, WikiMapia allows users to tag places and rectangles with wiki-editable information, and there are numerous other similar sites. However, these sites implement only geographically contextualized wiki information without offering any editability of the geographic context (i.e., they implement only the first of our five geowiki features).

Other sites allow sharing of WYSIWYG-edited geographic and geographically contextualized data but do not have any wiki features. Gmaps Pedometer allows sharing of routes, and Google My Maps allows sharing of points, paths, and polygons which can be annotated with text, images, and videos. In both cases, information is geographically contextualized using co-location only, though because routes sometimes deviate from known geography, this is necessary in an unchangable-geography system.

Open Street Map[11] is a wiki effort to build street maps. This project is a fuller geowiki, implementing four of our five features.

geowiki features: a web-map interface, on-line map editability\(^{12}\), WYSIWYG editing, and (to some degree) robust linking. Geographic data is robustly linked with itself, but there is no non-geographic data at all, making the issue of robust linking between geographic data and non-geographic data within OSM moot. OSM’s programmatic interface would permit such robust linking and could be used in the construction of geowikis, though we are not aware of any which make use of this feature. Similarly, while the programmatic interface makes available the revision history of geographic data, this is not exposed in the Web interface, and no automatic watching is available.

The geographic information systems (GIS) community has also proposed various types of collaboration in mapmaking: among GIS experts \([10]\), between GIS experts and experts in other fields \([2]\), and between GIS experts and laypeople \([7, 12]\). However, GIS researchers have not considered the open editing that is the essence of the wiki model.

Finally, there are many websites dedicated to bicycle navigation. Bikely\(^{13}\) allows users to create and share routes. TopoRoute\(^{14}\) does this and also offers automated route finding, but this is of limited help because it uses motor vehicle routing data. byCycle\(^{15}\) offers cyclist-oriented automated route finding but offers only the route choices “Normal” and “Safer”, which does not fully meet the routing needs of cyclists, as we show below.

3. RESEARCH DESIGN

To understand the cycling community, we studied cyclists using surveys and interviews. We recruited subjects from the Minneapolis-St. Paul metropolitan area. We sent invitations to three local cyclists’ discussion lists with about 950 total members and also encouraged recipients to forward the invitation. Participation was limited to people over 18 who had spent at least 200 miles or 25 hours cycling within the local area over the past year.

We offered monetary incentives to subjects: for each survey completed, we donated $3US to the Lance Armstrong Foundation (a charity well-known in cycling circles), and for each interview, we donated $10, for a total donation of $409. We also paid for parking for some interview subjects.

73 respondents finished the survey, and most questions had about 75 responses. 68% of survey respondents were male and 32% female; most were between 18 and 64 years of age with a roughly uniform distribution. Survey questions focused on attitudes regarding map errors and existing planning and navigation methods. We also used the survey to recruit for interviews.

We completed 19 semi-structured interviews lasting 60 to 90 minutes each; 13 subjects were men and 6 women. Some questions elaborated on issues touched on by the survey; others explored topics more suitable to an interview setting, such as attitudes toward the wiki model and privacy concerns. We also presented lo-fi paper mockups of three core personalized geowiki features – the wiki geodatabase, bike-ability ratings, and monitoring of edits. Finally, each subject sketched a map of a familiar route to provide non-verbal ability ratings, and monitoring of edits. Finally, each subject sketched a map of a familiar route to provide non-verbal

4. UNMET NEEDS

We identify three key unmet needs: no comprehensive and up-to-date information resource, no automated route finding, and no personalized ratings of byway bikeability. Resource in this context means anything bicyclists use to plan routes, common examples being bicycle maps or guidebooks. We use byway to mean the smallest identifiable segment of a bike route, e.g. a section of bike path between intersections with roads or other paths.

4.1 No Comprehensive, Up-To-Date Resource

To plan a route, cyclists need to know how they can travel through geographic space now and what they will find within the space now. Some of this information isn’t recorded at all, and the rest is distributed across various electronic and non-electronic resources. For example, some bike trails and bike lanes are mapped by the state department of transportation, while others are mapped by individual municipalities, and water sources are mapped by various park management organizations.

Bicycle travel is accomplished using byways. Cyclists need to know: where are byways, and how do they connect? Byways clearly include dedicated bike trails and many (but not all) roads. However, subjects suggested several additional classes of surfaces that are sometimes byways: alleys, sidewalks, unofficial paths through fields, parking lots, etc. More classes certainly exist, and it is difficult to enumerate them even if all possible cycling routes were known. Regardless, current information resources do not include these types of byways. Furthermore, only true byways should be included, in order to avoid overwhelming the resource and users with unimportant information. For example, it would not be necessary to include all or even most sidewalks, but some sidewalks, such as pedestrian highway overpasses, are key byways. Cyclists know the locations and properties of byways because they themselves travel upon them.

The locations of landmarks, resources, and obstacles are also important to bicyclists. 16 out of 19 subjects mentioned landmarks. These, in addition to street names, are used for orientation and navigation, and subjects cited objects like businesses, highways, and water bodies, i.e. both point and non-point landmarks. Resources are things helpful to cyclists in some way: 11 subjects cited a wide variety of resources including restrooms, water sources, and restaurants. Obstacles cause cyclists difficulty or frustration. 12 subjects mentioned a variety of obstacles, including construction and traffic lights. A few of these items are found on current information resources – e.g., water bodies – but most are typically not. It is also time-consuming to identify which landmarks, resources, and obstacles are important; for example, members of the local cycling club frequently use Dairy Queen restaurants as landmarks. However, cyclists know which of

12 On-line editing uses a Java applet, which somewhat limits its accessibility.
13 http://www.bikely.com
14 http://toporoute.com
15 http://bycycle.org
these things are important and where they are located because they themselves use or avoid them.

These things change, both in location and other properties. Construction begins and ends, byways close and new ones open, and businesses close or move. A useful resource must be up-to-date. However, current (typically centrally-maintained) resources go stale. 11 subjects mentioned this or its consequences as a problem. 

People who notice problems can fix them or at least point them out.

These observations – that existing information repositories are widely scattered and incomplete, and that cyclists themselves know the important information – motivate the distributed editing approach of wikis.

4.2 No Automated Route Finding

Cyclists told us that they want automated route finding, i.e. “find me a good route from point A to point B”: 4 of 19 subjects mentioned this desire specifically, 5 described a problem that could be solved with such a tool, and 5 expressed dissatisfaction using motor vehicle route-finders for cycling (11 total). No such tool is available.

Tools for automated motor vehicle route finding are very successful, but our interviews reveal that they are unsuitable for cyclists because they do not know about all byways and they do not take into account the complexity of cyclists’ routing needs. While a handful of bicycle-specific routing tools exist, most notably byCycle, they suffer from the same basic problems of incomplete coverage and simplistic routes.

Automated bicycle route finding can use the same basic approach as motor vehicle routing: the network of byways is represented as a weighted graph, and a minimum-weight path is calculated. However, while motor vehicle routing uses simple factors like distance and travel time to calculate edge weights, effective bicycle weights are based on many more additional factors. Subjects cited factors both objective and subjective, including the locations of hills, presence and quality of pavement, motor vehicle traffic levels, motorist attitude, and numerous others.

4.3 No Personalized Bikeability

Furthermore, people’s ratings of and preferences for any given byway are a matter of personal taste: cyclists do not agree on which quality factors should be considered and what their relative importance should be. This led 8 of 19 subjects to question the utility of existing generic bikeability ratings (in the cases where they are available), expressing either a general concern that their own notion of what made for a good trail might differ or else that they had actually encountered ratings they disagreed with. Additionally, existing resources offer bikeability ratings for only a subset of byways. What cyclists really wanted was a way to get personalized ratings for any byway.

5. THE PERSONALIZED GEOWIKI

A personalized geowiki can meet these three unmet needs. In the context of cycling, a personalized geowiki has four core features, the first two forming the geowiki and the latter two adding the necessary personalization:

1. Wiki map. A user-maintained geographic information system (GIS) storing the byway network. Editing byways is done with a simple interface analogous to standard vector drawing programs. High-resolution aerial photos help orient users. Also, precise positioning of byways is not as important as connectivity, which is easier to edit.

This component is closely related to Open Street Map. While OSM builds street maps from scratch in order to avoid the great cost of base maps in Europe, in our locale, high-quality base maps of both streets and cycling infrastructure are available for free and 0.3-meter-resolution color aerial photography for a nominal fee. We therefore use these as a starting point for our wiki map.

2. Wiki geodatabase. A user-maintained database of geographic objects important to cyclists: the locations and details of landmarks, resources, and obstacles. These are contextualized using the wiki map and robustly linked to geographic objects in the map and to one another.

Monitoring of both the wiki map and wiki geodatabase is achieved using watch regions. When editing occurs inside the geographic boundary of a watch region, whoever defined the region is notified, regardless of whether or not the edit was geographic.

3. Route finding. Automatic generation of routes through the byway network based on personal preference and immediate needs. Figure 2 shows our current route finding interface design.

As noted above, there is strong personal variation on what makes a good byway. Our approach is to isolate a few objective weighting metrics generally considered useful – for example, distance and hilliness – and address the rest with a purely subjective “bikeability” metric, as discussed below.

A few subjects noted that they already use aerial photos to plan.
Relying on cyclists themselves to enter and maintain data seems plausible and attractive. They know what information is important to cyclists and why it is important, because they use it (or wish they had it) on every ride. Therefore, a comprehensive, up-to-date personalized geowiki is possible – but only if cyclists are willing to contribute.

6. WILL CYCLISTS CONTRIBUTE?
A wiki is successful only if users do the necessary work: creating, editing, and monitoring the data. We discuss four prerequisites for getting work done: propensity to share, trust, propensity to monitor, and privacy.

Our subjects expressed a strong propensity to share what they knew with other cyclists. 83% of survey respondents reported asking other cyclists for route planning help. They were also willing to spend substantial effort correcting map errors, especially if their work was made available to others immediately; see Table 1. Furthermore, some cyclists are already spending considerable effort on helping one another. In 2006, the local recreational cycling club’s 100 volunteer ride leaders led over 1,400 rides [1]. The duties of a ride leader are to obtain or create a route, scout the route regularly, maintain and distribute maps and turn lists, and lead rides along the route – many hours of effort on behalf of other cyclists.

<table>
<thead>
<tr>
<th>Willing to spend</th>
<th>If other users saw corrections...</th>
</tr>
</thead>
<tbody>
<tr>
<td>in six months</td>
<td>immediately</td>
</tr>
<tr>
<td>1 minute or more</td>
<td>67%</td>
</tr>
<tr>
<td>5 minutes or more</td>
<td>44%</td>
</tr>
<tr>
<td>10 minutes or more</td>
<td>21%</td>
</tr>
</tbody>
</table>

Table 1: Willingness to correct map errors.

In our interviews, we asked subjects if they would share routes with the general public; 17 of 19 subjects said yes. 14 mentioned textual information they would share. When asked if they would rate the bikeability of byways to help other cyclists, 13 subjects said yes. When asked if they believed that they knew how to correct map errors they had encountered themselves, 14 said yes, and when asked why they would fix map errors, 7 gave helping others as a reason.

We also observe cyclists using existing collaborative technology, however cumbersome, to share information. For example, the following routing help request recently appeared on a local cycling web forum:

How do I get to Khan’s in Roseville, from the St. Paul campus [of the University of Minnesota], without being killed in traffic?
Khan’s Mongolian Barbeque
2720 Snelling Ave N
Roseville, MN 55113

It generated 8 responses, including (a) a detailed Gmaps Pedometer route posted 7 minutes later, (b) a different Gmaps Pedometer route recommended for use on the way home after dark, (c) an endorsement of the second route, and (d) a warning that a specific byway contained many potholes. Another thread began with a warning that a particular bridge was closed and a third, titled “streets to avoid”, had 24 posts.

These results reflect the tradition of information sharing within the bicycling community. We expect the geowiki initially to benefit from this tradition and subsequently to allow for even more effective sharing.

6 interview subjects hesitated to trust the wiki model, noting its vulnerability to vandalism and misinformation. These concerns are valid. However, as we have noted, successful and trusted wikis have emerged. When they do, wikis work because of the motivation of users to correct mistakes and vandalism, aided by mechanisms to help notice and fix the damage. Subjects were enthusiastic about using watch regions to monitor areas they knew and cared about: 16 identified specific geographic regions the would want to watch, typically near their homes or on routes they rode frequently.

We asked subjects about any privacy concerns they had with the wiki information sharing model. 10 subjects mentioned various concerns. Most of these are easily handled through standard techniques – e.g., using pseudonyms instead of real names – or though selective information withholding – e.g., by not sharing a few revealing routes, such as used for commuting. 7 subjects told us that they wanted to keep the location of their homes private; however, most were willing to reveal nearby locations, e.g., “If some creepy guy wants to come to the corner of my block, more power to him”.

Traditional wikis expose editing history, labeling each action with the pseudonym of the user who performed it; if geowikis do this as well, it might be possible to infer the location of user’s home, areas they’re likely to be found, or other potentially sensitive locations. Research into what is and is not acceptable to users, specific information that can be inferred, and techniques to minimize potential risks must be explored.

7. STATUS AND NEXT STEPS
The results of our study, including subjects’ positive response to our interface design, support the potential of the personalized geowiki approach. Our planned design is illustrated in Figure 3. It features a zoomable, pannable map...
with different layers of information that can be viewed or hidden, and (in most cases) edited.

However, to realize the potential of a personalized geowiki, we must complete our implementation and deploy it for use by cyclists. This is challenging, as existing web mapping APIs like Google Maps\(^{17}\) do not provide sufficient functionality, offering only manipulation of data co-located with an unchangeable transportation network controlled by the vendor. Our study shows that we must implement not only deep access to the connectivity and properties of byways, but all of this must be editable as well.

Therefore, we are implementing our design using lower-level APIs. The client is written using the Adobe Flex\(^{18}\) framework and runs in the browser on the widely deployed Flash Player 9 virtual machine\(^{19}\). It communicates over HTTP with custom mapping and route-finding servers written in Python\(^{20}\). Data is stored using the industry-standard Post-GIS spatial database manager\(^{21}\).

In summary, we show that cyclists need a comprehensive resource that contains all information relevant to planning a route and enables personalized route finding through the network of byways. While cyclists have a strong tradition of sharing information, their existing methods are limited; a wiki builds on the tradition of sharing and promises much greater coverage and reach, allowing individual cyclists to efficiently share with many others. We look forward to deploying our personalized geowiki and meeting this promise.

8. ACKNOWLEDGEMENTS
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