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Analyzing Cultural Differences in Collaborative Innovation Networks by Analyzing Editing Behavior in Different-Language Wikipedias

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Abstract

This paper aims to identify cultural differences in online collaborative innovation networks by comparing the English, German, Japanese, Korean, and Finish language Wikipedias. Towards this goal we analyze the process of article creation and communal interaction in different language Wikipedias through the lens of social network analysis.
Wikipedia exists in 273 languages (August 31, 2010), among them are languages like Finish, Korean, and Japanese which are not shared by other countries. Therefore Wikipedia offers a kind of microscope to analyze how people in these local cultures work together. As all the Wikipedians in the different languages ultimately share the same objectives and goals, this study is a first step to gain some insights from the editors' behavior on culturally influenced collaboration patterns in the real world. This is based on the premise that the editors reflect their own cultural norms and their way of collaboration in the real world back on the Wikipedia article creation process.

Keywords: Wikipedia, inter-cultural comparison, social network analysis, Japan, Finland

1. Introduction

This paper extends earlier work (Iba et. al 2009) analyzing the efficiency of collaboration in the English language Wikipedia through the lens of social network analysis to other-language Wikipedias. Our goal is to identify cultural differences in online collaborative innovation networks by comparing the English, German, Japanese, Korean, and Finish language Wikipedias.

Wikipedia exists in 273 languages (August 31, 2010). The English language Wikipedia is the largest by all statistics: number of articles, edits, editors, etc. It has 3,428,693 articles and 13,130,215 registered users (http://en.wikipedia.org/wiki/Special:Statistics). The second largest in terms of the number of articles is the German

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Wikipedia, which has 1,127,964 articles and 1,077,696 registered users (number of first-language speakers[2] of German: 90.3 million). The Wikipedia in Japanese (number of first-language speaker of Japanese: 122 million) is the sixth largest and has 706,580 articles and 456,937 registered users. The Korean (number of first-language speakers of Korean 66.3 million) Wikipedia has 144,313 articles and 127,970 registered users. The Finish (number of first-language speakers of Finish: 5 million) Wikipedia has 250,408 articles and 159,168 registered users. This is quite amazing, because both Finland and Korea are among the heaviest users of the Internet and both speak a language that is unique and not shared by any other country. However South Korea has 50 million inhabitants, while Finland has only 5 million. This means that Finland, a country with ten percent the population of Korea, maintains a Wikipedia with almost twice the number of articles as Korea. The German Wikipedia shows a similar disproportional size compared to the Japanese Wikipedia. Two very comparable countries in wealth and technology adaption, the German Wikipedia has a different article for every 80 inhabitants, while the Japanese Wikipedia only has one for every 173 inhabitants.

Why is it that countries with comparable levels of technical sophistication and wealth show such vast differences in Wikipedia creation and usage?

2. Hypothesis

In this paper we study cultural differences by analyzing the article writing collaboration and communication process of Wikipedia in the English, German, Japanese, Korean, and Finnish Wikipedias. We speculate that the pattern of article building and the form of community will be different in different-language Wikipedias. Particularly for languages like Finish and Korean which are not shared by other countries, their Wikipedia might offer a kind of microscope which shows how people of these local cultures work together.

In general, it is said that collaboration processes differ between Eastern and Western cultures. For instance, Eastern people are said to be collectivist, Westerners individualist (Hofstede 2005). Japanese, for example, tend to communicate with one another to develop a shared context and avoid conflict before collaboration (Obuchi and Takahashi 1994). On the other hand, in Western cultures strong leadership and open conflict resolution is preferred. We speculate that these cultural differences might lead to different patterns of collaborative innovation. We further assume that these different collaboration patterns will lead to different growth patterns in the different Wikipedias, and thus being one of the explanatory factors for the difference in the number of articles in the different Wikipedias. As all the Wikipedians in the different languages ultimately share the same objectives and goals, we hope to gain some insights from the editors' behavior on culturally influenced collaboration patterns in the real world. This is based on the premise that the editors reflect their own cultural norms and their way of collaboration in the real world back on the Wikipedia article creation process.

3. Measuring User Talk Network Growth

In our first analysis we compared the growth of communication networks among Wikipedians in the five different Wikipedias. We connected two editors A and B who exchanged at least 1 comment on their user talk page within the given period of time. The user talk page is the personal home page of an editor. This means that a user talk link between two editors represents a close collaborative relationship. We separate the user talk activities into 3-month sliding time windows (figure 1) over the entire duration of the analysis.

[2] http://www.ethnologue.org/ethno_docs/distribution.asp?by=size

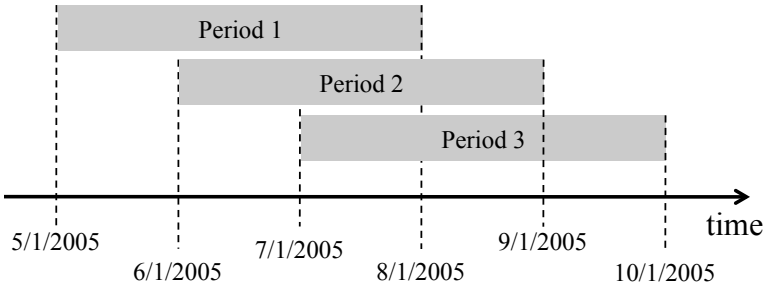

Figure 1. 3-month sliding time window networks

Figure 2 illustrates the growth of the number of nodes in the user talk network, i.e. the number of users active on the talk pages of other users (blue). It also shows the number of edges, i.e. the amount of interactions between two different editors (red), as well as the total number of interactions, as there can be many interactions between the same two editors (green).

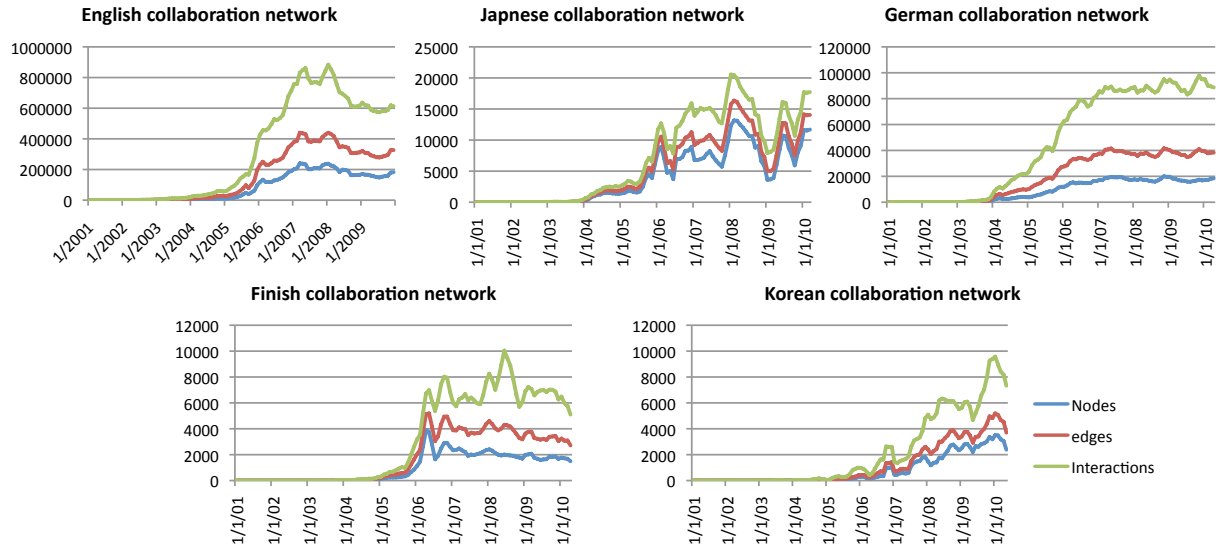

Figure 2. Collaboration Network Growth - Number of users, edges, and interactions on user talk pages

Overall, the English Wikipedia is almost 40 times bigger than the Japanese Wikipedia and 7.5 times bigger than the German Wikipedia in terms of interactions. The Finish and the Korean Wikipedia are almost the same size, 600 times smaller than the English one. The growth patterns of the collaboration network are very different among different language Wikipedias. Japanese growth fluctuated while German growth was quite steady and had consistent participants and interactions. One reason could be that the Japanese Wikipedians used the collaboration network associated with specific events (e.g. a so-called “editing war”) while German Wikipedians talk to each other on a more regular basis. The Finish and Korean user talk network are almost the same size; however the growth pattern is different. The Finish network grew exponentially at the beginning, and then had more or less a constant number of users and fluctuating interactions. On the other hand, the Korean network grew slowly and reached its peak on January 2010. In sum, once the collaboration network was formed, consistent numbers of Wikipedians communicate on the user talk pages in English, German, and Finish. On the other hand, the user talk network in the Japanese and Korean Wikipedias was very fluctuating, which suggests that they do have a much less stable collaboration network.

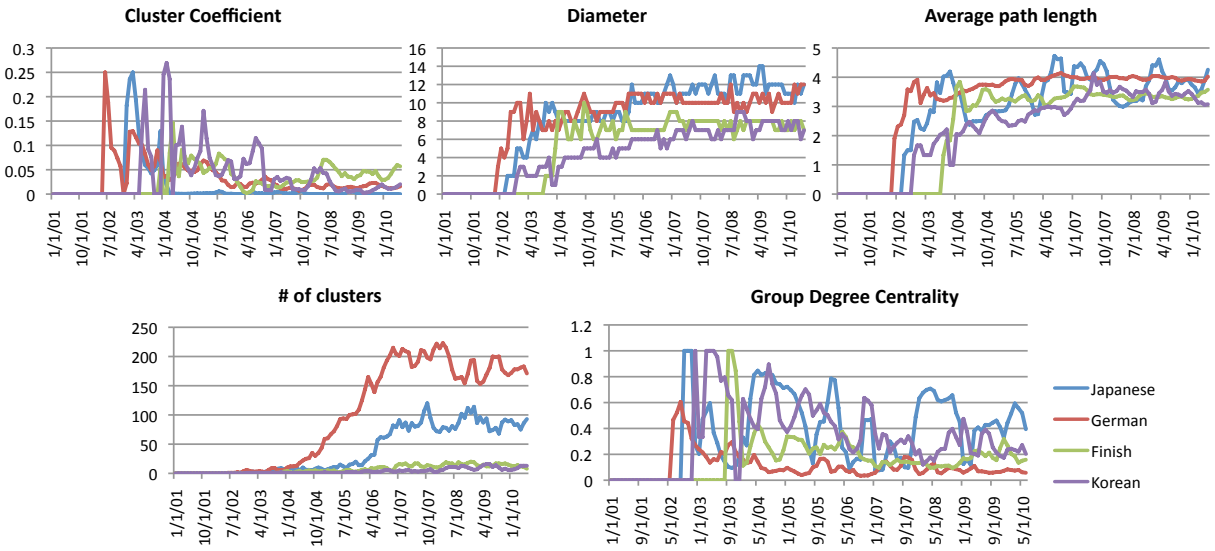

Figure 3. Cluster Coefficient, Diameter, Average path length, # of clusters, and Group Degree Centrality of the Japanese, German, Finish, Korean Wikipedia user talk collaboration network.

Figure 3 represents the longitudinal change of user talk network metrics. The size of the network is different among different languages Wikipedia; however, some network metrics show similar patterns.

Looking at the cluster coefficient, the Finish user talk network was highest (0.053) while the Japanese was lowest (0.00015), which means that Finish Wikipedians are connected and embedded in the network while Japanese are sparsely connected. Diameter and the number of clusters are associated with the size of the network. The Japanese and German networks are bigger than the Finish and Korean ones in both metrics. On the contrary, group degree centrality (GDC) in the Japanese user talk network was highest and German's was lowest, which means that the Japanese collaboration network was more centralized than the others. Overall, the user talk network of the German Wikipedia exhibits decreasing GDC. It seems therefore, that while more and more editors are joining Wikipedia, its collaboration network structure gets more and more decentralized.

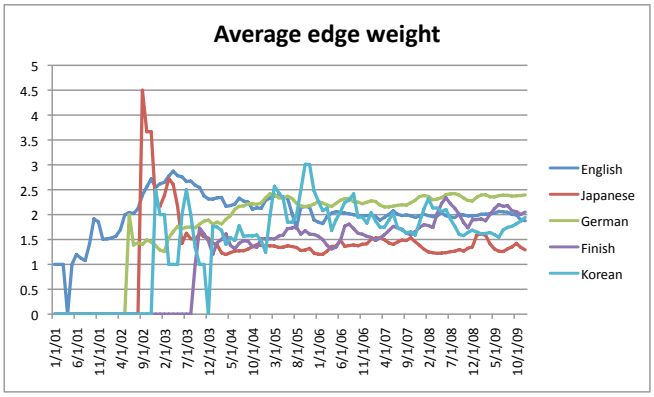

Figure 4. Amount of interaction per edge in the article talk page graph (y-axis)

Figure 4 illustrates the amount of interactions per edge in the user talk graph. It shows that not only is the communication network among German and English Wikipedians much denser (figure 2), but they also communicate more on their user talk pages with the same person.

4. Comparing Conflict Resolution in Five Different Wikipedias

In our second analysis, we compare in five different-language Wikipedias how Wikipedians resolve conflicts. We analyze two different metrics in the English, German, Japanese, Korean, and Finnish Wikipedia. First we look at the ratio of Wikipedia administrators to registered active users. Secondly we investigate the different ways how the five different-language Wikipedias deal with disagreements in documents.

According to Wikipedia[3] "*Administrators ... are Wikipedia editors who have been trusted with access to restricted technical features ("tools"). For example, administrators can protect, delete and restore pages, move pages over redirects, hide and delete page revisions, and block other editors.*

Administrators assume these responsibilities as volunteers; they are not acting as employees of the Wikimedia Foundation. They are never required to use their tools, and must never use them to gain an advantage in a dispute in which they are involved.

The English Wikipedia has 1,755 administrators as of September 9, 2010."

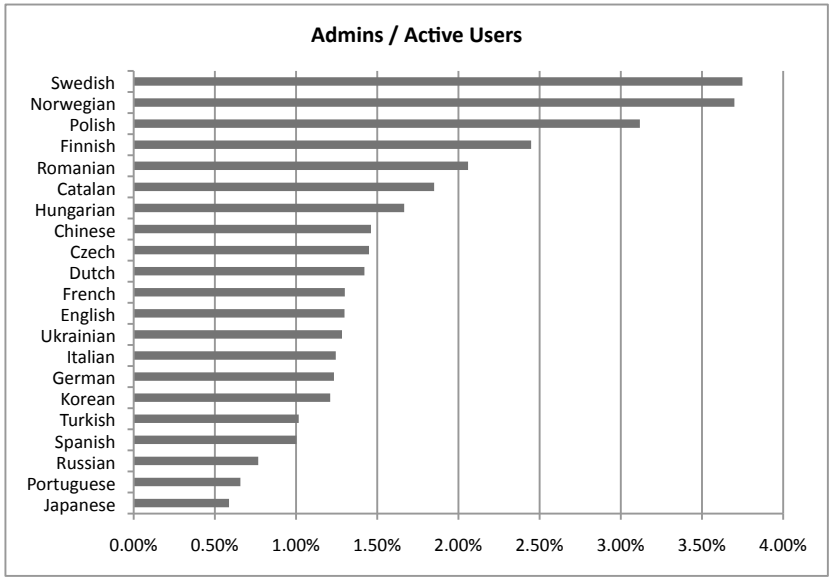

Figure 5. Percentage of Admins to ordinary registered editors in different Wikipedias

Figure 5 shows that the Swedish Wikipedia is the least hierarchical, with almost 4% of all registered users being admins. This is very different from the Japanese Wikipedia, where only slightly more then 0.5% of all registered users have admin privileges. The English Wikipedia is in the middle for the field, with about 1.3% of all registered Wikipedians being admins.

We subsequently explored the way how Wikipedians resolve conflict around what they call "Neutral Point of View" (NPOV). According to Wikipedia[4] *"...Neutral point of view (NPOV) is a fundamental Wikimedia principle and a cornerstone of Wikipedia. All Wikipedia articles and other encyclopedic content must be written from a*

[3] http://en.wikipedia.org/wiki/Wikipedia:Administrators
[4] http://en.wikipedia.org/wiki/Wikipedia:NPOV

neutral point of view. This means representing fairly, proportionately, and as far as possible without bias, all significant views that have been published by reliable sources."

Table 1. Basic statistics of articles of disputed NPOV

	NPOV			NPOV (talk)		Random			Random (talk)	
	N	Admin ratio	Admin edits ratio	Admin ratio	Admin edits ratio	N	Admin ratio	Admin edits ratio	Admin ratio	Admin edits ratio
English	9553	12.36%	10.17%	11.52%	10.92%	1000	12.95%	12.12%	14.49%	14.74%
Japanese	732	0.07%	0.04%	0.00%	0.00%	1000	0.01%	0.01%	0.00%	0.00%
Korean	217	1.64%	1.58%	0.22%	0.38%	1000	0.63%	0.44%	0.09%	0.09%
German	535	0.02%	0.01%	0.06%	0.04%	1000	0.01%	0.01%	0.00%	0.00%
Finish	0	N/A	N/A	N/A	N/A	1000	0.00%	0.00%	0.00%	0.00%

Table 1 lists the basic statistics of the articles with disputed NPOV[5]. Note that in the Finnish Wikipedia, this status does not even exist. It seems that the Finns are able to resolve their "editing wars" without having to resort to this formal mechanism. In table 1, the admin ratio is defined as the number of admins divided by the number of all editors per page. The admin edits ratio is defined as the number of edits done by an admin divided by all edits on a page. Basically, it seems that the English Wikipedia has far higher admin involvement than any other Wikipedia. Figure 7 compares the statistics from table 1 visually, normalized by the random articles. For the random articles, for each language Wikipedia, a thousand articles have been selected randomly, having at least ten edits.

Other statistics listed in figure 7 are the page age, i.e. the time from when the article was edited for the first time to Aug. 1, 2010; the page edits, i.e. the number of edits the article has; the number of unique editors (both named editors and IP editors) who made at least one edit on the article; and the named ratio, i.e. the number of named editors of the article over the number of all editors of the article. The Gini coefficient over all editors is a measure of the inequality of a distribution of the number of edits made by each editor. A value of 0 expresses total equality and a value of 1 maximal inequality, i.e. highly concentrated editing behavior.

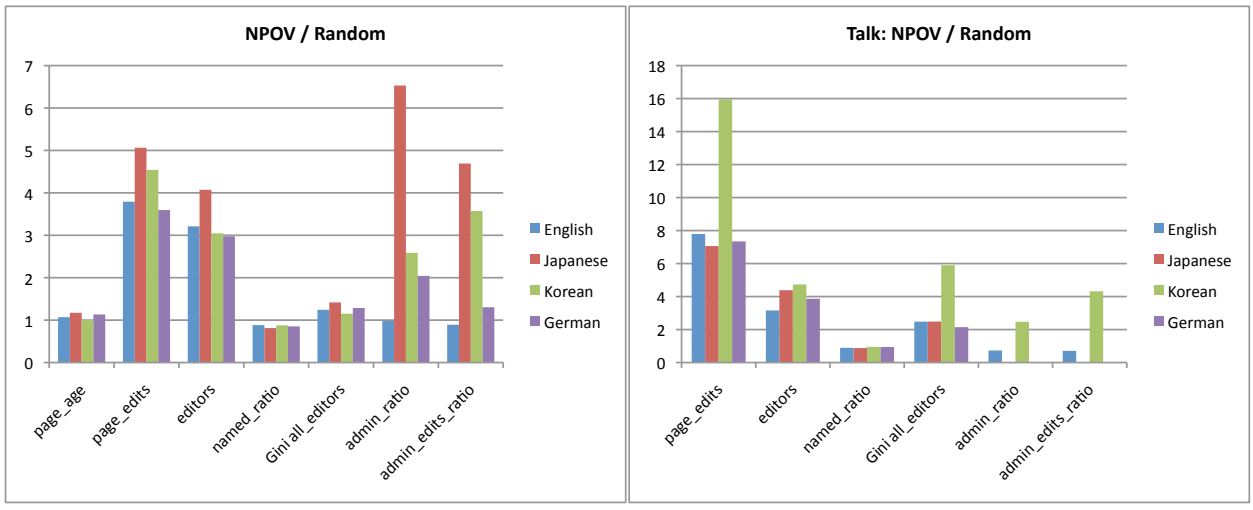

Figure 7. Statistics of NPOV articles normalized by Random articles, for both the article and the article talk pages

[5] http://en.wikipedia.org/wiki/Category:NPOV_disputes

As we can see, the Japanese Wikipedia has by far the highest admin ratio as well as the highest admin edits ratio. The Korean Wikipedia also scores quite high in that regard, while the English Wikipedia scores lowest. The Gini coefficient, on the other hand, seems to be constant across all Wikipedias. Interestingly, the talk pages show a very different pattern, with the Korean Wikpedia conflict resolution much more dominated by the admins. We speculate that the Korean language admins try to resolve conflicts on the talk page, while the Japanese admins "just do it" directly on the article pages.

5. Comparing featured article editing behavior in the five Wikipedias

In this section we investigate the different ways how the five different-language Wikipedias deal with the featured article (FA) editing process. Featured articles are regarded as the best articles by the Wikipedia community.

Figure 8 displays the basic statistics of FA articles normalized by the random articles (RA). The RA sample consists of a thousand articles selected randomly and having at least ten edits, for each of the five Wikipedias. The page age is slightly higher in FA than RA, while the number of page edits and editors are much larger in FA than RA in the five Wikipedias. In the English Wikipedia, the number of FA page edits is 13 times bigger and the number of FA editors is 10 times bigger than corresponding numbers for RA. The variance between FA and RA is biggest in the English Wikipedia. The editor concentration measured by the Gini coefficient is almost double in FA, which means that there are a few active editors in FAs and the FA editing behavior is more centralized in all five Wikipedias. The most remarkable difference is the admin ratio of FAs in the Japanese Wikipedia, which is 8 times bigger than for RA. This means that a small number of high status editors are dominant for FA creation in the Japanese Wikipedia; therefore the collaboration pattern is much more hierarchical.

Looking at the article talk analysis (figure 8 right side), the overall patterns are similar to the ones for the articles. The number of page edits and editors for article talk pages of FAs are much bigger than for RA. In contrast to the article statistics, there are fewer page edits and editors on the article talk pages of the Finish Wikipedia. The article talk page, in general, is used to discuss changes about its associated article, to resolve disagreements or conflict[6]. Fewer activities on the talk page suggest less explicit and more implicit coordination (Kittur and Kraut 2008). As we found that the Finish Wikipedia currently does not have disputed NPOV articles, Finns may be good at coordinating among editors implicitly.

On the contrary, the Korean Wikipedia has highest editor concentration on the FA article talk pages. As the article talk page is the place where explicit coordination happens, Koreans seem to need highly centralized coordination led by a small number of editors, while Finns are likely to use an entirely implicit, decentralized approach.

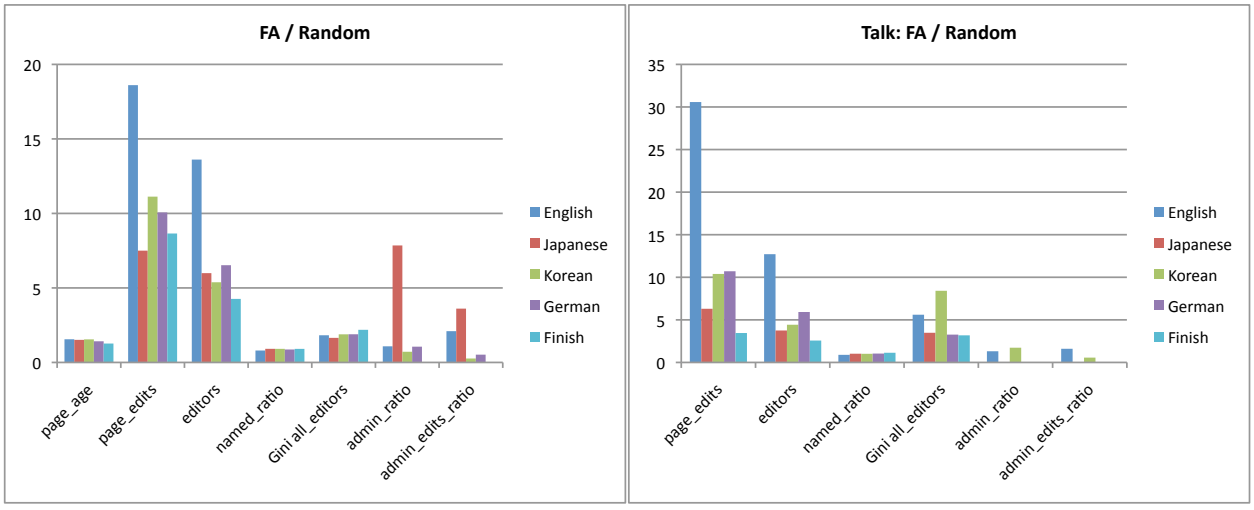

Figure 8 Statistics of FA articles normalized by Random articles, for both the article and the article talk pages

[6] http://en.wikipedia.org/wiki/Wikipedia:Talk_page_guidelines

In the next project, we constructed two primary social networks: an article network and a collaboration network. Following Itoh et al., we constructed the article network by inferring a relationship between two editors if editor B undertook an action (adding new text, deleting, or undoing) immediately after editor A within 7 days. This approach allowed us to categorize individual editing behavior for an article. To construct the collaboration network we utilized the user talk pages constructing a link between editors A and B if A and B worked on the same article, and editor A left a comment on the talk page of B (or vice versa). We assumed a like existed between two authors if they exchanged at least five messages on each other's user talk page.

To compare the network metrics of the two primary social networks among the different language Wikipedias, we normalized the metrics by random samples with comparable numbers of editors and edits, and age.

Figure 9 displays the size, group degree centrality (GDC), group betweenness centrality (GBC), density, and clustering coefficient (CC) in the article network and the collaboration network in the five Wikipedias. The normalized size is close to 1 because we chose random samples with size comparable to the featured articles. GDC and GBC for featured articles are higher than in the random sets, which means that a smaller number of editors actively intervene in the article building process. This is consistent with the editor concentration shown in Figure 8.

In the collaboration network (figure 9 right side), the size of the FA user talk network is bigger than the user talk network of the random articles, while the underlying article networks of featured and random networks are of same size. This means that the editors working on the same FAs are more likely to communicate with other editors, than the editors working on non-FAs. The clustering coefficient CC of the Japanese Wikipedia is much higher than for the other language Wikipedias. As shown in the NPOV analysis, the Japanese Wikipedia has the highest admin ratio in the article edit network but the lowest admin ratio in the user talk network. We therefore speculate that the behavior of editors of FAs in Japanese Wikipedia is characterized by a small number of admins, who are well embedded in the collaboration network. Hence their coordination takes place not on article talk pages, but in user talk pages (i.e. the collaboration network).

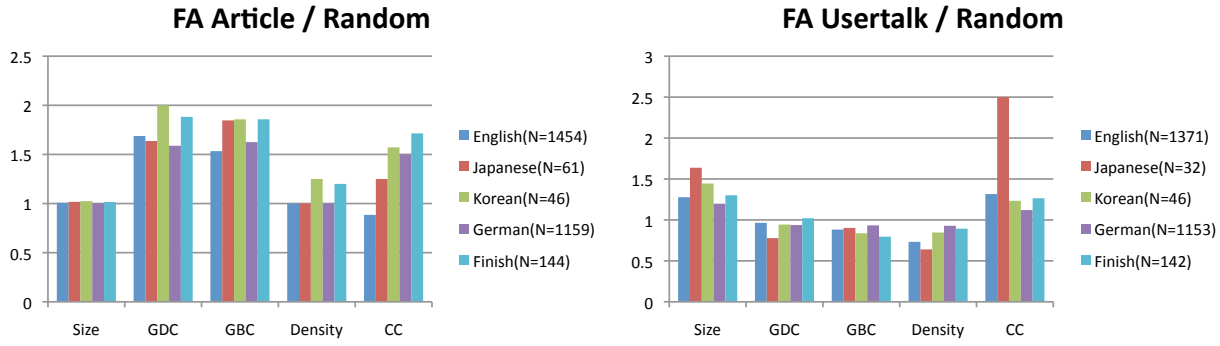

Figure 9. Network metrics of FA articles normalized by Random articles, for both the article and the user talk pages

In the final project, we look at the performance of the English and Japanese Wikipedians, measuring how long it took them to get an article to its highest level of quality.

6. Comparing Time to Featured Article for the English and Japanese Wikipedias

In this section, we again compare three types of networks for the two Wikipedias: (1) the article building network, (2) the article talk network, and (3) the user talk network.

(1) Following Itoh et al. (2009), we constructed the article network by inferring a tie between two editors if editor B undertook an action after editor A in the main Wikipedia article.

(2) To construct the article talk network, we infer a tie if editor B made an edit after editor A within the same section (thread) on the article talk page.

(3) To construct the user talk network, we connected two editors A and B who worked on the same article, and exchanged at least 5 comments on their user talk page from the beginning of the Wikipedia to the time an article was promoted (indicated by the dotted-line arrow in figure 10). The user talk page is the personal home page of an editor. This means that a user talk link between two editors represents a close collaborative relationship.

As our metric to compare the performance of Japanese and English Wikipedians we use "time to featured article" (FA time), that is the period of time between when an article is created to when the article is promoted to featured article status (indicated by the heavy-line arrow in figure 10).

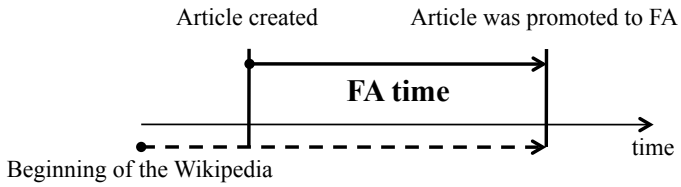

Figure 10 FAtime is the time from article creation to when it is promoted to featured article

For the English Wikipedia we collected the featured articles list on Dec. 15, 2009. The article network includes 2,206,753 edits from the featured articles, made by 91,880 named users. For the Japanese Wikipedia we collected the featured articles list on Feb. 23, 2010. The whole database was downloaded on July 11, 2009. The article network includes 9,013 edits from the featured articles, made by 1,206 named users. We also collected the number of named editors for each article (N_A in table 2), and the number of editors who also have placed an entry on the user talk page of another editor working on the same article (N_T in table 2).

Table 2. Correlations of basic editor article statistics with FAtime (*** $p<0.01$)

	English			Japanese		
N	2702			88	88	
	Mean	S.D.	Correlation	Mean	S.D.	Correlation
FAtime (days)	1101	738	-	752	577	-
# of edits	813	1370	.40***	145	181	.60***
N_A	121	207	.47***	26	26	.77***
N_T/N_A (%)	38	16	-.18***	14	14	.09

As table 2 illustrates, the more editors are working on an article, and the more edits they are making, the longer it takes for an article to reach FA status. This effect seems to be even stronger for the Japanese Wikipedia. This means that a small team that "gets it right" from the beginning is more effective than a large group of editors. On the other hand, if there is proportionally more activity on the talk page (N_T/N_A) the article gets promoted faster, at least in the English Wikipedia.

Table 3 lists our findings comparing social network statistics with FAtime. As an additional metric we identified the most active editor, i.e. the user making the most edits for each article, based on the number of edits they made on a particular article.

Our results in table 3 show that density, betweenness, and degree centrality are significantly negatively correlated with the time to be a featured article in the English Wikipedia. The same applies for the Japanese Wikipedia. The general insight for both Wikipedias is that the denser and the more centralized the collaboration network is, the faster an article reaches the "featured" status. It therefore seems that the more embedded Wikipedians are in a tight group of friends, the better the work they do.

Table 3. Correlation of Social Network Metrics with FAtime (* p<0.1 ** p<0.05 *** p<0.01)

		English			Japanese		
		Article	Article talk	User talk 5+	Article	Article talk	User talk 5+
Group Centrality	N	2693	1653	2566	88	45	42
	Degree	-.69***	-.31***	-.43***	-.27**	-.03	-.42***
	Betweenness	-.46***	-.28***	-.26***	-.05	-.08	-.33*
Density		-.65***	-.43***	-.64***	-.67***	-.38**	-.68***
Most active editor Centrality	N	2693	1246	1941	88	40	18
	Degree	-.71***	-.37***	-.56***	-.43***	-.21	-.65***
	Betweenness	-.50***	-.23***	-.32***	-.03	.06	-.36

This effect seems to be identical for both the Japanese and the English Wikipedia. At closer look, we speculate that this effect seems to be stronger for the – relatively more densely connected – English Wikipedia than for the – less densely connected – Japanese Wikipedia. This means that for the more communicative English Wikipedians, a strong leader or leadership team is even more important than for the more decentralized and less communicative Japanese Wikipedians.

7. Outlook

To compare different-language Wikipedias, we looked at some longitudinal changes in basic statistics from the beginning of each Wikipedia. Our main focus was on the evolution and changes in social network structure in edit and user talk networks of featured articles, applying the same methodology we used in prior work for the English Wikipedia. We found notable differences in the communication behavior among egalitarian cultures such as the Finnish, and quite hierarchical ones such as the Japanese. While the English language Wikipedia shows a distinctive pattern, most likely because it is by far the largest and frequently exploring new concepts copied by others, it seems to follow more the Finnish egalitarian, than the Japanese hierarchical style.

In future work, we will expand our preliminary results regarding what collaboration patterns make for more effective team performance in different cultural settings. Major challenges will be the article selection strategy for our analysis, what kind of metrics we will have to look at, and how we will be able to compare them even though the total size of the Wikipedias is quite different in each of the analyzed languages. Nevertheless, we hope that this very preliminary work has already shown how studying editing behavior in different language Wikipedias might open up a new window into the comparison of different cultural behavior, particularly in the open source online world.

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