The Intricacies of Time in News Recommendation

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ABSTRACT

It is commonly accepted that time is a critical issue in news recommendation. As opposed to book or movie recommendations, news articles have extremely short life spans and should normally not be recommended after a few days. Most current news recommender systems use time as a decaying factor in ratings or just cut off older articles according to some simple mechanism. An experiment done on four different newspapers in Norway reveal that the time issue is somewhat more complicated. The life span of articles varies substantially from one newspaper to another, and from one category to another. Social media like Facebook may affect articles' life span, though the influence of social media is highly category-dependent.

CCS Concepts

 Information systems→Database management system engines
World Wide Web→Traffic analysis,
Information Retrieval→Recommender systems

Keywords

News recommendation; log analysis; temporal mining; news analytics.

1. INTRODUCTION

News recommender systems are online solutions that monitor news streams and recommend news to individual readers or groups of readers. They often aggregate news from numerous sources, though there are also recommender systems employed by a particular media house for their news articles only. The systems observe reader behavior and use collaborative filtering, contentbased filtering or hybrid approaches in real-time to generate ranked lists of relevant news articles.

Recommender systems are today common in many domains, among others in e-commerce, movies and music sites, financial services, tourism, real estate and job search. Overall the news domain's characteristics are not very different from e-commerce sites and general web page recommendation solutions [1]. There is no particular risk if recommendations are bad, except that readers may leave the news site and not come back. News stories are not of the heterogeneous type, though the textual nature of them still make it difficult to analyze and recommend the content. The news domain probably has the highest churn rate of all recommendation domains. New articles are checked in continually, and as the analysis below shows, most articles can be discarded after a few days. Like in many other domains, news recommender systems cannot expect any explicit rating that indicates user's appreciation of the news story. Instead, implicit signals like click patterns and reading times are used as indications of interest or satisfaction.

An unclear issue is the stability of user preferences. There are longterm preferences that seem to be fairly stable, though research shows that many users follow short-term interests as well that typically reflect what is going on right now or particular events that are unfolding [2].

News recommendation displays some particular challenges that separate them from other well-known types of recommender systems [3]:

- articles have short life-cycles, and freshness and location may often be as important to the user as the article's content relevance,
- news articles are unstructured and more complex to analyze than objects with structured properties like product reviews or networks of friends,
- the volatility and unlimited reach of news lead to rapid changes of both terminologies and topics over time,
- serendipities or the need for variety and unexpected news have to be addressed, and
- cold-start problems linked to users that have no history and news that have not yet been discovered by enough users are notorious.

This paper deals with the first challenge, i.e. the perceived short life spans of news articles. As opposed to testing a running news recommender system with different strategies for boosting fresh news stories, we have analyzed the real traffic of four national newspapers that operate independently of each other and have different manual and automatic procedures for publishing news articles. The goal is to identify and analyze reader behavior patterns that shed light on this surge for fresh news and investigate to what extent these patterns or tendencies are satisfactorily considered in current news recommender systems. The experiment is part of the SmartMedia research program at NTNU in Trondheim. Apart from developing new semantic methods for the analysis of news content, SmartMedia is also evaluating different recommendation strategies in a full-fledged mobile news recommender system [4].

The paper is structured as follows. Whereas we discuss current approaches for dealing with time in news recommender systems in Section 2, Section 3 explains our user log analysis experiment with the four newspapers. In Section 4 we present our overall analysis of news articles' life spans and compare the results of the four newspapers. Going into some more detail, we break down the analysis by category for one newspaper in Section 5, before we analyze the effect of Facebook traffic on these user logs in Section 6. The conclusions are found in Section 7.

2. RELATED WORK

Context-aware recommender systems are recommender systems that exploit various contextual features to improve the quality or relevance of their recommended items. As seen from Figure 1, these contextual features may describe aspects of the items themselves, but also of the individual user or the social groups of which he may be a member. For news recommendation solutions contextual knowledge of news items like *location* and *time* are of particular interest. A news event takes place at a particular location at a particular time, and both variables can normally be identified from the news text.

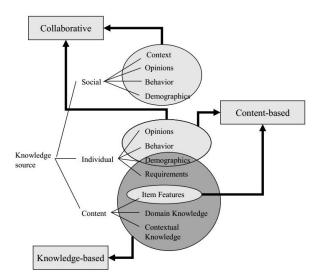


Figure 1. Context in recommender systems (from [1])

There are two aspects of time that may need to be addressed by a recommender system: (i) are the user ratings, on which the recommendations are based, old and outdated, or (ii) are the items themselves old and outdated? Whereas domains like online bookstores and movie rental sites are concerned with possibly old user ratings [basile], the domain of news recommendation is normally left with only implicit user feedback and need to deal with news articles – items – that may emerge, change or disappear within minutes. A news recommender system that recommends last week's news will normally not be received favorably even if the news articles match the reader's interest profile to perfection.

Within news recommendation a common strategy has been to use time as a decaying factor in news article ratings [6, 7, 8]. In [7], for example, the time dimension is one of three dimensions (the other are location and interests) that is used to produce a ranked list of news recommendations. Implementationally, there is a time function that boosts fresh news using an exponential decay curve that emphasized brand new articles and give very little weight to articles more than two-three days old. Comparable approaches are reported in [9] for Yahoo news personalization and in [10] for the SCENE news recommender prototype.

An interesting and simple strategy called *Most popular* is described in [11]. The idea is simply to choose a particular time frame and recommend unread news articles according to their popularity in this time frame. The idea is that people may quite likely be interested in reading a particular article if it is currently of interest to sufficiently many other readers. The strategy does not need a particular way of dealing with article age, as it can be assumed that the popular articles tend to be found among the most recent news. A limitation of this strategy is that all readers will basically get the same recommendations independently of their individual preferences and interests.

Simple cut-off strategies are often used in combination with other recommendation strategies. In [12], for example, a hybrid recommendation strategy is employed, though only news articles that are less than six hours old are included in the final list.

In spite of these efforts in context-aware recommender systems in general and news recommender systems in particular, the time dimension is still treated as a factor fairly independent of other contextual factors. For example, even though news recommender systems incorporate news from numerous sources of different quality and focus, the assumption is that the life spans of news articles are constant across these sources. Also, current systems tend to ignore the possibility that certain news categories may be more time-independent or have greater life spans from social media traffic. The issue is whether these simplifications are reasonable or not in the news recommendation domain.

3. NEWSPAPER USER LOGS

In our experiment we wanted to assess the importance of recency among newspaper readers. We wanted to investigate under what circumstances readers may consider old news articles relevant, and to what extent there are any particular behavioral patterns that are shared across the newspapers and can be used to personalize the news experience. Since so many recommender systems use decay factors to lower the weights of older news, we also wanted to check if real news traffic provides any evidence in support of this approach.

The experiment included four Norwegian newspapers of different circulations and different target groups. Whereas two of the newspapers are among the top 5 most popular newspapers in Norway, the other two are rather small with a particular political and religious target group. All four newspapers cover daily news events, though the two large ones have a stronger presence of breaking news. Neither of them make substantial use of recommender systems at the moment, which means that the user logs mostly reflect the readers' own ability to browse the papers and retrieve interesting news stories.

User logs from all four newspapers were collected from 1 August to 1 November 2014. Since the log formats varied somewhat from one paper to the other, not all the analyses could be carried out for all newspapers. Two general problems for all newspapers were that users could not be followed across reading sessions and reading times were unavailable. Every published article was followed for 8 weeks from publication, and clicks after these 8 weeks were not considered. We ignored articles that were published less than 8 weeks before the end of the experiment, since all articles in the analysis should be followed for exactly 8 weeks. If the publication date was not known, we assumed that the date of publication was the same date as the date when the article was first read. We also removed data that were not related to proper news articles, like commentaries on news stories, or were referring to empty URLs.

All the original four user logs were first converted into a harmonized TSV log format, before three separate tables were generated for analysis (see Figure 2):

- *Artread.* Basic statistics for each article published, like URL of article, time stamp, number of clicks, average age of article when clicked, category and referral traffic.
- Clicklog. Click data for the news articles in Artread, including click ID, associated user session ID, the age of the article when it was clicked, and the referring page URL.
- *Usercat*. Linking a user session to the number of clicks for each news category in this session.

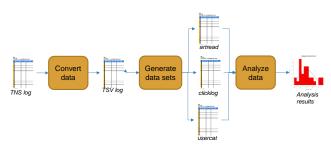


Figure 2. Log analysis process

After cleaning up the data sets and generating the three separate tables, we ended up with a total of 10,000 articles and a bit more than 40 million articles views. As Figure 3 shows, the number of clicks (views) vary substantially among the four newspapers, ranging from only 187,000 clicks for paper #3 and #4 together to 31 million clicks for paper #2. The two small newspapers also have a very small production of news articles, with only 400 published news articles available for analysis for this period.

Newspaper	Compressed logs	Processed logs
#1	12 GB/121 M views	3.400 articles/9,7 M views
#2	44 GB/794 M views	6.200 articles/31 M views
#3 and #4	7 GB/9 M views	400 articles/187 K views
TOTAL	63 GB/931 M views	10,000 articles/40.887 M views
Figure 3. Log data sets		

All four newspapers present their news material using a traditional online newspaper design. Breaking news or very popular stories are published on the front page. Users may click on particular news categories to browse articles of these categories only. Incorporated with the presentation of an article are other article links that are either manually added or to some extent generated as recommendations to the readers.

Three types of analyses were conducted on the final data sets:

- Click rates for all four newspapers as a function of the articles' age
- Life span of articles by news category
- Contribution from Facebook by news category

In the following we discuss the results of each of these analyses.

4. SOURCE IMPACT

In the first analysis we analyzed the popularity of articles over time independent of associated news categories. The intention was to identify the average age of all articles viewed during the experiment.

The *age of an article view or click* is related to one particular reader's viewing of that article and is defined as the difference between the time of viewing the article and the time of its publication. Different people may of course view the article at different points of time, and each viewing generates one entry in the statistics. This means that popular articles have much more impact on this analysis than articles that are read just a few times.

Figures 4 through 7 show the age distribution of all article views for the four different newspapers. Even though the overall graphs are quite comparable, there are some significant differences among the newspapers:



Figure 4. Newspaper #1's total click rates

- Newspaper #1 and #2 have considerably more traffic than #3 and #4.
- The traffic on the two biggest newspapers (#1 and #2) is heavily dominated by articles that are less than two days old. Clicks on articles that are more than five days old are almost ignorable.
- Newspaper #3 have almost all their traffic within the first 5 days, whereas newspaper #4 also have some signifant traffic up to 10 days after publication.

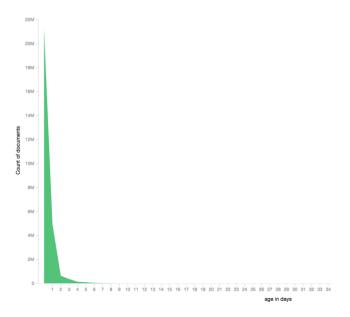


Figure 5. Newspaper #2's total click rates

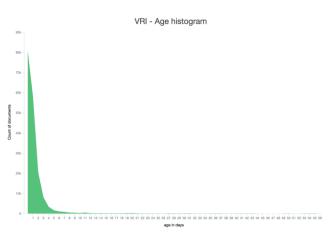


Figure 6. Newspaper #3's total click rates

It seems like a decay function for news recommendation may be able to capture such a general pattern of reader behavior. The graphs are similar in shape, and clearly indicate that readers across newspapers have a preference for recently published news stories.

However, the graphs suggest that these decay functions will not be identical from one newspaper to another. The degree of decay differ substantially and should be set for each individual newspaper after comprehensive experimentation.

It may not be surprising that the two biggest newspapers have the largest share of traffic within the first two days. These are newspapers that have the resources to focus on breaking news and be present as new stories unfold, and they both target readers from all social, political and religious backgrounds. However, the analysis does not reveal whether circulation or size is enough to successfully configure a decay function for efficient news recommendation.

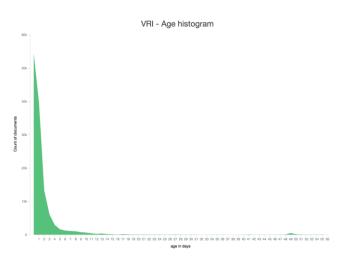


Figure 7. Newspaper #4's total click rates

It is worth noting that even though the overall shape of these graphs seem to support the idea that users quickly lose interest in old news, we should be careful about being too conclusive. The logs confirm that most readers access news articles through the newspapers' front page. Since the front pages tend to emphasize breaking news and change continually throughout the day, readers notice the most recent news articles very easy and may end up viewing a moderately interesting new article rather than an older and more interesting one that requires the user to search or navigate to a particular category section. If this is the case, introducing proper recommender systems on these news sites may alter these graphs and revitalize older material that is not easily found by the readers.

5. CATEGORY IMPACT

The second analysis breaks down the results from the previous section according to news categories.

Figure 8 shows the average age of article views of different categories in newspaper #1. From left to right the categories are Health, Wine, Consumer, Opinions, Fitness, Sports, Plus (paid content), Home, Student, Economy, Digital, adressa.no, Family, Culture, Ongoing events, Front page, News and Trondheim. Not surprisingly, articles of the category News ("nyheter" in Norwegian) are read very quickly, with an average age of article views at 0.6 days. We see that news from the local town ("Trondheim") also viewed right after publication. On the other end of the scale, there are categories that live much longer in readers' eyes. The average click on a health-related news article ("helse") comes almost 2.2 days after publication. The categories Wine ("vin") and Consumer ("forbruker") also contain long-lived articles that are perceived relevant days after publication. On the average wine articles and consumer articles are viewed 2 days and 1.9 days after publication, respectively.

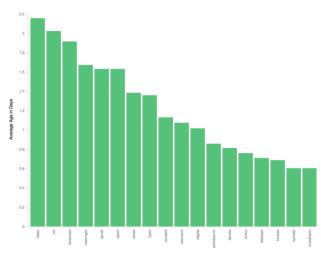


Figure 8. Life spans of news categories

The results of this experiment severely questions the simplistic use of decay functions or other similar mechanisms. Since some news categories's articles are considered relevant 3-4 times longer than other categories', it is hard to see how a simple decay factor can successfully work across categories. One can of course configure the decay factor according to the most popular category, which is News for newspaper #1, or alternatively set different factors for each individual category, but this requires a thorough analysis of each newspaper's categories over time. And this analysis also needs to assess whether the decisive factor is the category itself and not some underlying difference, like that different categories are read by different people or in different contexts.

6. IMPACT FROM SOCIAL MEDIA

Over the last few years social media like Facebook and Twitter have become more important in news distribution. Users share and recommend news articles to friends, and a substantial share of a newspaper's traffic now comes from social media platforms. This means that readers click on news links on these social platforms that take them directly to the relevant article without stopping by the newspaper's own front page.

The impact of this traffic from social media varies from one newspaper to another. For newspaper #1 there is substantial traffic from Facebook when the articles are 2-7 days old. In our experiment Facebook generated almost 30% of the traffic to four days old news articles.

Figure 9 shows the average age of article clicks per category divided into two groups. The clicks coming from Facebook are shown in dark blue bars, while the non-Facebook traffic are shown in light green bars. The categories are the same as discussed in Section 5. For most categories we see that the light green bars are somewhat higher than the dark blue ones. This means that the traffic generated from Facebook tends to come a little bit earlier than the average traffic through the front page or other sites for these categories, though the difference is not substantial.

However, there are some noticeable exceptions. Whereas the consumer articles are normally viewed about two days after publication, the clicks on consumer articles that originate from Facebook come after 5-6 days, on average. Similarly, Facebook-generated traffic to family-oriented articles come 2-3 days after publication, while family-oriented articles otherwise are viewed after one day. Facebook, thus, helps the newspaper extend the life

spans of news articles about consumers and families. These are articles that are suitable for discussions and debates, and are often not linked to particular recent events. Interestingly, Facebook also extends to some extent the life spans of typical breaking news articles from the categories News and Trondheim.

These results seem to suggest that Facebook and other social sites may affect the reading patterns of both breaking news categories and time-independent news categories, though the largest effect seem to be on selected time-independent categories like Consumer, Family and Wine.

In general there is little traffic from Facebook after 6-7 days. Even though Facebook does contribute to the total traffic to these news sites, the impact so far is limited, temporary and does little to revitalize old relevant news articles. But if the traffic from Facebook is to increase, it may be wise to pay attention to which categories have most appeal on Facebook and modify the recommendation strategies to extend these categories' life spans.

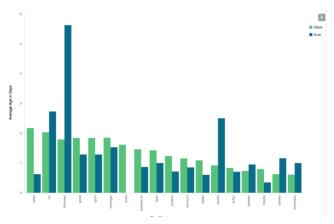


Figure 9. Effect of Facebook by category

7. CONCLUSIONS

In this paper we have discussed the findings of a user log analysis project that involved four different Norwegian newspapers. These newspapers vary in size and focus, though all cover basic national and international news in addition to some more newspaperspecific themes.

The analysis confirms the importance of recency in news recommender systems. In all four newspapers the articles have short life spans and should normally not be recommended after a few days. A traditional method like a decay function seems like a good approximation for ranking news articles according to recency. However, there are substantial differences between the newspapers, and even more between the different news categories, that call for more complex approaches to incorporating time in news recommendation strategies.

First of all, even though all four newspapers have most of their traffic the first two days after publication, it seems that the two smaller newspapers – with their focus on particular political and religious reader groups – have a larger share of long-lived articles than the two big papers. Moreover, the life spans of articles depend heavily on their news category, as does the effect of social media like Facebook. Any strategy for incorporating time in news recommendation, it seems, need to take the news category into account.

Our initial experiment was carried out with limited data over a limited time period. We are now in the process of collecting more comprehensive user log data for longer time periods. We will analyze the temporal issues in more detail to see if more complex approximations than simple decay factors can be used to boost recent news articles. Together with our industrial partners in SmartMedia we will develop and deploy new recommendation strategies in a living lab system with real users. The expectation is that this will shed more light on the importance of time in news recommendation and how it can be dealt with in full-fledged news recommender systems.

Currently, we use semantic information from Wikidata to disambiguate news entities. In the future we will also investigate how other contextual factors than time can be integrated semantically in news recommendation, following ideas from recent semantic search approaches [13].

8. ACKNOWLEDGMENTS

Thanks to VRI Trøndelag for partially funding this research.

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