



# Informing Users of Corrections and Alterations in Online News while safeguarding Privacy

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zur Erlangung des akademischen Grades

**Diplom-Ingenieur**

im Rahmen des Studiums

**Media and Human-Centered Computing**

eingereicht von

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an der Fakultät für Informatik

der Technischen Universität Wien

Betreuung: Univ.Prof.in Geraldine Fitzpatrick, PhD

Wien, 4. Mai 2023

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Geraldine Fitzpatrick



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# Informing Users of Corrections and Alterations in Online News while safeguarding Privacy

DIPLOMA THESIS

submitted in partial fulfillment of the requirements for the degree of

**Diplom-Ingenieur**

in

**Media and Human-Centered Computing**

by

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Registration Number 00725416

to the Faculty of Informatics

at the TU Wien

Advisor: Univ.Prof.in Geraldine Fitzpatrick, PhD

Vienna, 4<sup>th</sup> May, 2023

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# Erklärung zur Verfassung der Arbeit

Markus Hametner

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Wien, 4. Mai 2023

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Thanks also go out to Peter Purgathofer, who pointed me to relevant research that helped me contextualize the interactions afforded by the prototype, as well as Chris Frauenberger, who offered valuable input on how to assess the ethics of the studies conducted in this thesis.

Without all the interviewees and other participants, this thesis would not have been possible. I appreciate everyone who took some time to provide expert opinions, to help me understand users' requirements and expectations, to submit surveys, to install and use my prototype or to give critical feedback on its usability. Thank you.

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Thank you also to my parents Vera and Christian for their support of my studies, their encouragement to finish this thesis, their last-minute help with copy-editing, but also for being good sports when I took on other projects.

Finally, of course, my thanks go out to my partner Maria for cheering this project on every step of the way, for providing constructive feedback, for rightfully questioning my section titles and capitalization, and for life-saving morning coffee after productive late-night writing sessions.



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# Kurzfassung

Online-Nachrichtenportale haben die Möglichkeit, Artikel nach ihrer Veröffentlichung zu verändern. Das ermöglicht nicht nur dynamische Nachrichtenformate sondern auch nachträgliche Korrekturen. Jedoch erfahren die Leserinnen und Leser, die die ursprünglichen Versionen gelesen haben und möglicherweise falsch informiert wurden, oft nicht von diesen Änderungen. Diese Arbeit beschäftigt sich mit dem Design, der Entwicklung und der Evaluierung einer Lösung, die Nachrichtenkonsument:innen über solche Änderungen informiert und gleichzeitig mittels Übernahme einer gut erprobten Lösung für das Problem des Widerrufs von Sicherheitszertifikaten die Privatsphäre der Nutzenden schützt. Sie beschäftigt sich auch mit den Einschätzungen von Expert:innen zu nachträglich vorgenommenen Änderungen in Onlinenachrichten sowie mit den Anforderungen von Nachrichtenkonsument:innen für ein solches Tool und ihrer Reaktion auf diese neu geschaffene Transparenz. Eine Evaluierung durch Interviews und gemessene Daten zu Benutzerinteraktionen bestätigen eine gute Nutzbarkeit dieser Lösung und ergeben, dass Nutzer:innen Interesse an solchen Informationen haben und diese auch interessant finden, obwohl sie nicht mit allen Benachrichtigung über Änderungen tatsächlich interagieren.



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# Abstract

Publishing news online has created the ability to modify pieces of news after they have been published. This allows for new, dynamic news formats, but also for post-publication corrections and other changes. However, these changes do not usually reach the people who consumed the piece of news before it was changed and who may have consumed later-corrected (and potentially untrue) information. This thesis documents the design, implementation and evaluation of a solution that informs news consumers about such changes while keeping users' data such as browsing habits private by adapting a well-tested solution for the problem of security certificate revocation to this different field. It documents experts' knowledge about changes in news as well as users' requirements for such tools and their reactions to this added transparency. An evaluation process based on interviews and analysis of user interaction data confirms the product's good usability and shows that users find this newly available information interesting, even when they do not interact with all messages that inform them about such changes.



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# CHAPTER 1

## Introduction

If you consume a piece of news online, there is no guarantee that someone who clicked the same headline a minute before you – or someone who clicked a minute later – read the same piece. You consume news using a dynamic medium. An article accessed by the same link may change drastically over time. Some outlets harness this opportunity explicitly by covering breaking news stories using dynamic formats like live tickers. Other outlets do not use special formats for live coverage, and edit news articles to reflect the latest developments, for example to update the story or correct errors. Changes are sometimes, but not always, made transparent to users. This often takes the form of a short sentence describing which parts were updated. The possibility to alter pieces of news is not restricted to developing stories, however, but applies to all published content. This is a stark difference to print newspapers, which cannot be altered after print and which are usually archived for future reference.

In online news, even if factual corrections are made transparent, it is likely they do not reach the news consumers that were originally misinformed, because very few people access the same piece of news twice.

This work aims to address the issue of factual corrections in online news not reaching the users that were initially misinformed. One major challenge in this is protecting news consumer's privacy. What news a user reads can indicate their political interests. Even the choice of medium may be correlated with political stances. Therefore, data on users' news consumption should be protected, while informing them about changes in news content they have personally encountered. Existing privacy-preserving solutions to technical problems like SSL certificate revocation and identity revocation can be adapted to this specific context. This thesis also sheds a light on online news consumers' behavior, especially concerning their reaction when confronted with differences between their mental model of how news is produced and reality.

According to the Reuters Digital News Report, 76 % [New18] of Austrian respondents consumed news online, hence using this dynamic medium. The project outcome is a prototype browser plugin that demonstrates using the Austrian news ecosystem a solution to the problems described above – notifying users when articles they consumed were later changed – is possible in a privacy-preserving manner.

This introduction chapter describes the context of the work, why it is relevant in a news ecosystem and the structure of the thesis.

### 1.1 Accuracy in Journalism

*Craig Silverman*, in his book *Regret the Error* [Sil09], notes that accuracy was an issue for newspaper publishers even in the seventeenth century:

*if no one believed and trusted their product enough to buy it again and again, their business would fail, so to cultivate a sense of trust they constantly trumpeted their dedication to truth and accuracy.* [Sil09, p. 21]

To reinforce these claims of journalistic quality, many print newspapers developed a practice of informing readers about material mistakes in a previous printed article:

*[...] the practice of correcting an erred report emerged [...] around the time newspapers began publishing with a set frequency* [Sil09, p. 227]

Publishers promised that material mistakes would be corrected in the next edition. Standardization followed in some papers, with some creating fixed spaces on a specific page, or at least specific headlines for corrections, should any occur. [Sil09, p. 228ff]

Online versions of newspapers vary in their practices much like their print counterparts. Their online format allows corrections to be placed with the original story. Some newspapers have strict standards for online corrections, such as indicating a story was corrected using correction notices and maintaining public lists of corrected stories. Others correct errors inside the story while not acknowledging the change. This avoids spreading information further and polluting search engine results with falsehoods, but avoids the step of acknowledging an error. [Sil09, p. 233f]

How do newspapers live up to their stated claims of accuracy? Researchers have found ways to measure newspapers' track record using accuracy studies, the first (according to Silverman) of which - Charnley's *Preliminary Notes on A Study of Newspaper Accuracy* [Cha36] - was conducted in 1936. Such studies ask the people cited as sources in a story to check stated facts contained in the story. A number of stories fitting the criteria of being "wholly objective" were clipped and sent to the persons mentioned in the story as sources of information, along with a questionnaire that allowed the sources to indicate



certain kinds of error in the story. Charnley sent 1000 questionnaires to sources, 591 were returned, slightly more than half of which indicated that the story contained no errors. Most often, sources indicated errors in meaning, names and titles. [Cha36]

These results were replicated by multiple sources in a number of news markets, with the rate of stories containing errors varying between 40 and 60 percent according to a 2005 meta-study by Scott R Maier [Mai05].

## 1.2 Issues with Online Corrections

In the print age, factual corrections were placed to reach readers who had been misinformed, within the limits of newspapers' logistics. A mistake in a previous article would be printed in the next edition [Sil09, p. 227]. Since subscribers would receive each paper automatically, this ensured best as possible that loyal readers would see a correction. However, Silverman also claims that *"the status quo of how to handle a mistake ensures that very few readers actually read the correct information"* [Sil09, p. 232]

Online, such corrections are generally made on the article page, on top or bottom of the page. This informs new readers that previous visitors to the article may have been misinformed. [Sil09, p. 233f]

However, in my personal experience, unless a drastic headline change occurred, readers are unlikely to access an article twice. This means that readers will likely not check articles for corrections that had previously misinformed them. This problem exists online despite the medium being much more dynamic.

Silverman argues that readers *"should have more options and tools to report and receive corrections"* and points to interest-specific Really Simple Syndication (RSS, a file format) feeds and e-mail alerts already being offered by news outlets. He notes: *"Readers should be able to be notified if a particular article they read has been corrected"*. [Sil09, p. 320]

## 1.3 Privacy Issues in naive Implementations

If one wanted to apply a fix to the issues in online news raised above and notify users of changes in articles they previously read, this would require tracking what news they consumed. A naive implementation would query a central source with a list of articles and the times they were accessed. If there was a change to the article after it was consumed, and the user was not previously informed of the change, a message informing the user that a change occurred could be displayed. Such an implementation would, however, allow the central source to know every user's behavior of news consumption. Ideally, a solution would allow the same kind of features without leaking private user data.

Similar privacy issues exist in computer science, for example in IT security, solutions to which can be adapted to avoid such information transfers.

### 1.4 Research Question

This thesis explores such a potential solution. It would allow people who previously accessed the news in question to be informed of changes in a privacy-preserving way. It also explores how to do this in a privacy-preserving manner by looking into how IT security methods can be adapted to the news ecosystem.

The research questions (RQs) answered in this thesis are twofold:

RQ1: *How do users react when notified about alterations in news they previously read?*

and

RQ2: *How can IT security methods be extended to preserve users' privacy when informing them about changes in news they consumed?*

### 1.5 Methodological Approach

To explore these overall Research Questions, I chose a variation of a user-centered design approach (section 3.1), which relies on gathering qualitative information from domain experts and news readers. The research was conducted in three phases. I first talked to experts – journalists – about corrections and quality issues in journalism, to identify design opportunities and to validate that the identified issues are relevant to local users. I held a focus group with journalists and users to talk through the identified issues and to find which requirements people had for using a potential solution. I then developed a prototype and recruited study participants who installed it and gave feedback after several months of usage.

Quantitative data was brought in to extend and validate the qualitative information. While talking to experts, I also gathered data on changes in news to validate their expertise. As part of a user study, I also tracked prototype users with their explicit permission and confronted them with the (anonymized) tracking data during feedback interviews, and additionally asked them to fill out a Systems Usability Scale form.

Every phase was conducted to answer Sub-Research Questions (Sub-RQs), which informed decisions in the later phases.

#### 1.5.1 Exploration

The purpose of this phase was to inform if the questions raised by the thesis were in fact worth exploring, and to clarify which questions could and should be answered by the work. It mostly concerns the news environment.

- Sub-RQ 1: *What kind of corrections occur in online news in Austria, and with which frequency?*
- Sub-RQ 2: *How do news outlets inform readers about corrections?*

- Sub-RQ 3: *What are journalists' experiences regarding corrections?*

As a first step, I investigated if the issue of corrections even exists in the Austrian news ecosystem. I set up software that watched Austrian news sites for changes in articles. The data showed that small changes to news pieces occur after publication often. I also interviewed experts – an Austrian journalist, a Swiss data journalist and a British journalist. The interviews confirmed that corrections do happen and that journalists themselves are aware that corrections policies could be improved, where they exist at all. Further Research Questions were a result of the literature review, expert interviews and data gathering steps.

This phase confirmed that corrections do occur in Austrian news and that journalism outlets could do better in informing the audience about changes. The data on the frequency of changes contributed to the requirements for the later phases.

### 1.5.2 Design and Prototyping

After confirming that the thesis topic is relevant in the Austrian news market, I gathered a focus group of news consumers and journalism professionals to find out how they produce and consume news and what they think of the usability and discoverability of corrections.

- Sub-RQ 4: *How do consumers perceive online news?*
- Sub-RQ 5: *What, if anything, do news consumers want to know if an article was changed after they consumed it?*

In the focus group, most news consumers mentioned being interested in getting notifications when news pieces change – within reason. Many pointed out that they would prefer to be notified of significant changes only. The focus group also provided insights in their requirements. The issue of online privacy was discussed, confirming that tracking is a concern for users. This requirement led to a further question:

- Sub-RQ 6: *How can identity revocation methods be adapted to the problem of news corrections?*

The result of which was a privacy-preserving design for solving the issue at hand.

The main contribution of this phase was the creation of a prototype solution, which was built according to the requirements surfaced in the Exploration and Design phases. This prototype takes the form of a plugin for the Chrome and Firefox browsers, which saves browsing data on news sites locally and notifies users of changes that happened in the news content after they accessed it.

### 1.5.3 Evaluation

The prototype was given to a number of participants to use for at least two months. I conducted Interviews with participants after that time, which allowed me to evaluate the prototype in terms of usability and changes to participants' opinions. Pseudonymized usage data, which I collected only with explicit permission, showed if they actively interacted with notifications when they got them.

- Sub-RQ 7: *What is news consumers experience when they are notified about changes in news they consume?*

While the extension was created with privacy in mind, I recruited test users who agreed to provide me with anonymized usage information. I asked them to install the extension for a few weeks and interviewed them about their experience after this period. Along with their answers to a Software Usability Scale questionnaire, the interviews were used to evaluate the prototype and document opportunities for future work.

Most participants thought being notified of changes was interesting, they did not necessarily look at the details of the changes. This may be related to most changes being small, and the change severity being prominently displayed in the notification. Most participants mentioned feeling more informed, but did not change their news consumption behavior or their opinion on the news in general.

This phase used user feedback, both from interviews and from usage data, finding that the prototype was generally regarded as positive and useful, but also showing that it did not generate a lot of interaction with its user interface.

## 1.6 Thesis Structure

This introduction has given an overview of the design problems this thesis aims to solve. Chapter 2 identifies related work both in news and other design spaces that face similar issues. Chapter 3 provides details about the methods used in the thesis. Chapter 4, chapter 5, and chapter 6 respectively cover the phases identified above. Chapter 7 relates the findings in previous chapters back to the questions identified in the introduction, argues which relevant contributions this thesis provides and shows open questions and research opportunities. Chapter 8 summarizes the findings and highlights the most relevant results.

## 1.7 Contribution

This thesis explores if, given the possibility of learning about corrections in stories they consumed, news consumers are interested in receiving these messages by measure of their words, but also their actions. News publishers may be interested in this outcome, and may consider providing such a feature as part of their regular service. The thesis also

shows that it is possible to create such a service both independent of news publishers and in a way that does not negatively impact news consumers' privacy. Its implementation, which draws on known privacy-preserving methods in other fields, may also serve as an inspiration to developers of other products or privacy researchers.



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## Related Work

Changes in online news specifically have not been a major focus of research so far, likely because they are rarely documented in detail. When projects covering the field exist, they usually take the form of services that make the occurrence of such changes visible. An exception to the aforementioned lack of research is Craig Silverman's book *Regret the Error* [Sil09], which explores the issue of corrections in print, broadcast and online news in great and sometimes hilarious detail. This chapter collects projects that made contributions to this space as well as an introduction to privacy-preserving solutions from the IT security field which serve as a basis for this thesis.

### 2.1 News Change Tracking

Change tracking and the archival of online news articles has been a concern in public debates since at least 2011, when the New York Times' then-*public editor* (an ombudsman-like role) Arthur S. Brisbane acknowledged in one of the last articles during his tenure at the paper.

*Unlike print, digital news is often updated throughout the day and night, sometimes many times. Versions evolve and sometimes morph into something quite different. Mistakes happen and are fixed. How The Times tracks and manages this can be very confusing. [...] You won't find that article anywhere on NYTimes.com now, though, because later the same day a completely different story, written with a different focus by a different reporter, replaced it online and eventually appeared in the paper. [Bri11]*

News sites sometimes make changes transparent in an informal manner, but outlets generally do not publish full version histories of their articles. Several initiatives have been launched to improve the transparency or visibility of such changes in pieces of news.

### 2.1.1 NewsDiffs

NewsDiffs [PLP12] is a website that was created by Eric Price, Jennifer 8. Lee and Greg Price on June 7, 2012. As of 2023, it tracks changes in articles on `nytimes.com`, `cnn.com`, `politico.com`, `washingtonpost.com`, and `bbc.co.uk` according to its website. The source code of this system is available as free software on GitHub.

Its website consists of a search function, which allows users to check if an article located at a certain URL (Uniform Resource Locator) was changed. It also provides a "browse" section showing recently observed changes. An article history page is available for each article covered by the service, which shows all its detected versions and "Compare with previous" links that lead to a separate page for each version, which highlights the exact differences to the previous version, as shown in Figure 2.1.

Since it is open-source, its technology was also available to be used as the basis for the server-side aspects of the prototype developed for this thesis. It uses a combination of a traditional database and git repositories for data storage and change tracking and provides a framework that allows for the easy creation and addition of parsers for different news sites. Its architecture and the additions that were made as part of this thesis will be covered later in section 5.2.1.

NewsDiffs enables users to see if an article has been modified. It does not allow readers to look up multiple articles, like those they have read, and does not contain a way to be informed about potential future changes in articles.

### 2.1.2 @nyt\_diff and similar

The Twitter account *@nyt\_diff* [nyt19], which also cites NewsDiffs as an inspiration, tweets changes to articles on the main page of the New York Times. The account's automated tweets are able to generate thousands of likes and retweets when headline changes are controversial. It was featured in a list of "7 of the best Twitter bots in journalism" [Fun17].

Its GitHub repository contains a list of additional twitter bots watching changes on other news outlets such as the BBC, CNN, Le Monde or The Guardian [git19].

As Twitter bots, their content does not vary depending on which pieces of news the reader has consumed – they merely provide a global feed of changes for the news sites they cover.

### 2.1.3 News Inspector

At least one design project concerning the topic has been published in a scientific journal. The paper authors John Fass and Angus Main [FM14] imagine a layer on top of an online news story, highlighting or otherwise representing changes. They describe it as a "design case in development that engages with various strains of thought within HCI". Notably,



NewsDiffs Home About Browse Highlights Press Subscribe Contact

## Comparing: President Obama's Dragnet

<http://www.nytimes.com/2013/06/07/opinion/president-obamas-dragnet.html>

- **Pink:** Archived June 06, 2013 at 4:35pm EDT
- **Green:** Archived June 06, 2013 at 7:09pm EDT

[<= Previous revision](#) | [All changes](#) | [Later revision =>](#)

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June 6, 2013  
 President Obama's Dragnet  
 By THE EDITORIAL BOARD

Within hours of the disclosure that the federal authorities routinely collect data on phone calls Americans make, regardless of whether they have any bearing on a counterterrorism investigation, the Obama administration issued the same platitude it has offered every time President Obama has been caught overreaching in the use of his powers: Terrorists are a real menace and you should just trust us to deal with them because we have internal mechanisms (that we are not going to tell you about) to make sure we do not violate your rights.

Those reassurances have never been persuasive — whether on secret warrants to scoop up a news agency's phone records or secret orders to kill an American suspected of terrorism — especially coming from a president who once promised transparency and accountability.

The administration has now lost all credibility **on this issue**. Mr. Obama is proving the truism that the executive will use any power it is given and very likely abuse it. That is one reason we have long argued that the Patriot Act, enacted in the heat of fear after the 9/11 attacks by members of Congress who mostly had not even read it, was reckless in its assignment of unnecessary and overbroad surveillance powers.

Based on an article in The Guardian published Wednesday night, we now know the Federal Bureau of Investigation and the National Security Agency used the Patriot Act to obtain a secret warrant to compel Verizon's business services division to turn over data on every single call that went through its system. We know that this particular order was a routine extension of surveillance that has been going on for years, and it seems very likely that it extends beyond Verizon's business division. There is every reason to believe the federal government has been collecting every bit of information about every American's phone calls except the words actually exchanged in those calls.

**Articles in The Washington Post and The Guardian described a process by which the N.S.A. is also able to capture Internet communications directly from the servers of nine leading American companies. The articles raised questions about whether the N.S.A. separated foreign communications from domestic ones.**

A senior administration official quoted in The Times **about the Verizon order** offered the lame observation that the information does not include the name of any caller, as though there would be the slightest difficulty

Figure 2.1: NewsDiffs page showing the difference between two versions of a New York Times article

## 2. RELATED WORK

their design includes a "timeline scrubber" embedded next to a news story, allowing users to surface old versions and the changes that have been made to them.

The concepts developed in the paper focus on extending the view of one article to make its past visible, but do not extend to future corrections or informing about changes in articles previously visited.

### 2.1.4 Transparent Metric

Transparent Metric was a browser plugin that indicated to users if the article they were currently reading has changed in the past. It also allowed users to see how and when the text was altered. Its user interface, shown in Figure 2.2, was accessible via a button in the browser's menu bar. When clicked, the times when edits were detected on the current page were displayed. Now (as of 2019) defunct, this service launched in 2016 [hac19].

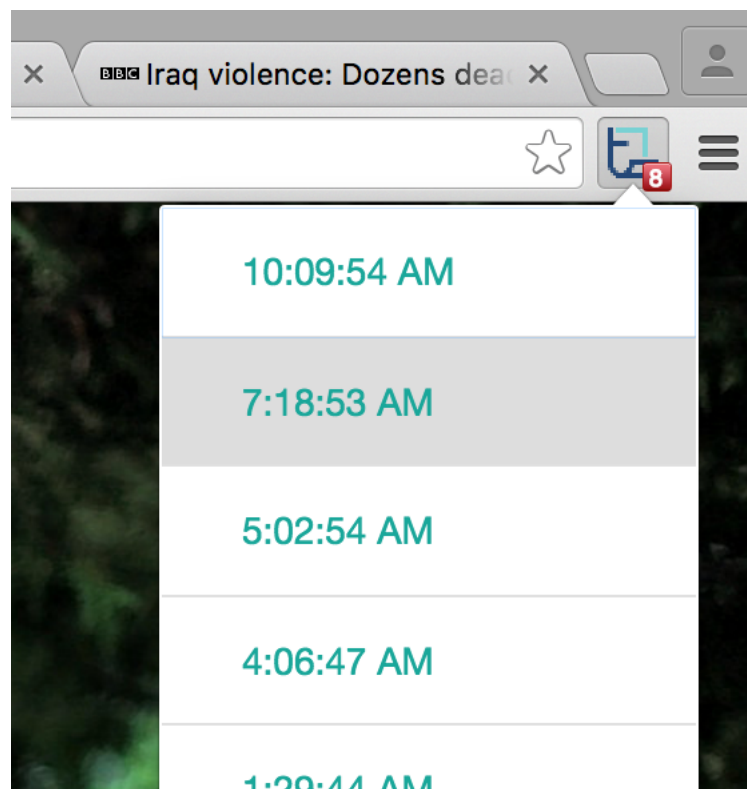


Figure 2.2: Screenshot of Transparent Metric browser plugin, obtained from the Internet Archive's WayBack Machine

The website associated with the project also provided a list of „Latest Changes” on the news sites it supported, which were the following: BBC, Aljazeera, the Guardian, New York Times, Die Zeit and Reuters.

Similar to NewsDiffs, this project enables users to discover previous changes in an article, but does not allow notifications about future changes.

### 2.1.5 WikiTribune

One exception to the aforementioned lack of transparency by news outlets was WikiTribune, a wiki-based collaborative news site active between 2017 and 2019 and founded by Jimmy Wales, who had previously co-founded Wikipedia. The project was funded by a crowdfunding campaign and institutional grants. A year after its launch, its journalistic staff was laid off in a move to focus on community-generated news. [Ing]

It provided a dynamic, automatically generated list of changes for every page and across the website, making its processes and internal discussions visible to news consumers and researchers, as shown in a screenshot of its global list of changes in Figure 2.3.

The screenshot shows the WikiTribune website interface. At the top, there is a navigation bar with the site name 'WikiTRIBUNE' and links for 'Recent changes', 'Help', 'Join', 'Sign in', 'Add new', and 'Support us'. Below the navigation bar, there is a search bar and a filter button labeled 'Filter: All'. The main content area is titled 'Recent changes' and displays a list of changes for two days: Sunday - 30 June 2019 and Saturday - 29 June 2019.

Timestamp	User	Description	Details
06:27 - Hist	Milne Klein	Milne Klein (talk   contribs)	Content: +336 Revised User Profile
05:48 - Hist	3104848609	Womble Haahr (talk   contribs)	File: 3104848609.jpg   Type: image/jpeg Attachment Uploaded
05:48 - Hist	Womble Haahr	Womble Haahr (talk   contribs)	Content: +319 Revised User Profile
01:50 - Diff   Hist	Political Violence in The United States	Csaba Szakolczal (talk   contribs)	Note: new incidents Content: +485 Revised Article
00:37 - Diff   Hist	Fact check: The 2019 live democratic debate!	Mohamed Salih (talk   contribs)	Note: minor Content: -149 Revised Article
00:36 - Diff   Hist	Fact check: The 2019 live democratic debate!	Mohamed Salih (talk   contribs)	Note: changed hero image Meta changes: 2 Revised Article
22:07 - Hist	Fact check: The 2019 live democratic debate!	Mohamed Salih (talk   contribs)	Comment: I want to add a source of the photo that includes all the candidates: I found that source here ... Posted a comment

Figure 2.3: Screenshot of WikiTribune recent changes site, obtained from web archive

The public nature of its editorial process allowed O’Riordan et al [OKEF19] to analyze all published content including changes after publication. An analysis of a sample of its content showed that the median article received 1 revision after publication, with values ranging from 1 to 59. The WikiTribune project was defunct as of late 2019, according to snapshots of its website `wikitribune.com` taken by the web archive.

While the transparency WikiTribune offered was a major difference to (and improvement over) other news organizations, receiving notifications about changes that occurred after consuming a piece of news was not a feature it offered.

### 2.2 Identity Revocation and Privacy

One challenge in the development of the prototype for this thesis in a privacy-preserving manner was creating a system that would allow a browser extension to check if articles were changed without leaking private information, such as articles users had viewed, to a central server. A naive implementation would check each article’s status with a centralized service, as noted in section 1.3, therefore enabling the service to infer the user’s news reading habits.

A similar issue can be found in the IT security field. It was described by Narasimha et al in *Privacy-preserving revocation checking* [NST09]: Browsers use SSL certificates to enable encrypted communication with servers and to confirm that a server is maintained by the organization – like a bank – users are expecting to communicate with. Such SSL certificates can be revoked. This may happen after an organization was hacked and or secret cryptographic data was compromised. When a browser contacts a server which provides it with a certificate, it can check with a third party if the certificate used to secure the connection is still valid. This allows such certificates that were compromised to be invalidated.

A naive implementation would query a central source (a verification authority, VA) every time a certificate is encountered – for example when opening an online banking system – to verify its continued validity. This is the case when using the On-line Certificate Status Protocol (OCSP). This method ensures that no invalid certificate is trusted. However, using this method can provide this authority with private information on users’ browsing behavior. [NST09]

Narasimha et al describe more privacy-preserving solutions to this issue. One such option is downloading a list of all revoked certificates (Certificate Revocation List, CRL) from a central source. This does not leak browsing data, but leads to larger download sizes and costly look-ups. Since certificate revocation is an internet-scale issue, this is an argument against using a CRL to solve this problem.

However, in the developed prototype’s case, only selected news sites are supported. Furthermore, since the news cycle moves fast, changes and notifications about them become less relevant the longer ago they happened. In addition, unlike in the case of revocation checking, the prototype does not need to check for a change when first

accessing a news site, since the changes most relevant to users are those which occur after initially reading the story. Since the prototype only needs to assess if any changes occurred since that initial access, and only a small quantity of changes are detected every day, a solution similar to CRL is a good model for discovering changes in news without leaking browsing data.

## 2.3 Summary

In this chapter I have also outlined a privacy-preserving technique from the field of IT security which can be adopted to the field at hand and the future prototype implementation. I have also outlined a number of projects which improved transparency around corrections in the field of online news. Informing users about past changes in an article provides improved transparency. However, these solutions rely on users putting in the work of looking for information explicitly (a "pull" model). They do not inform users who were potentially misinformed that corrections have taken place in the pieces of news they specifically accessed. In this, existing solutions differ from the user-centered design, which could be thought of as a "push" model, implemented in this thesis.



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The approved original version of this thesis is available in print at TU Wien Bibliothek.

# Methodology

This chapter describes the overall approach I took in designing the thesis, gathering information and evaluating my prototype. I also provide details on the methods that informed the thesis design.

## 3.1 User-Centered Design

Overall, I designed this thesis from a user-centered perspective. *User-Centered Design (UCD)* is "the process of building insights about users' experience through usability testing and other forms of user research into product development through an iterative design process" according to *Carol M Barnum* in the 2021 edition of *Usability Testing Essentials* [Bar21].

After I talked to experts to learn about the environment a solution would fit in (in Chapter 4), I similarly talked to potential users early on to establish if there is any interest or awareness of the issues raised in the thesis.

Barnum (in the 2011 edition of the same title [Bar11]) distinguishes between *formative* and *summative* usability studies. The former "reveal what users like" and allow researchers to understand users' goals and motivations. Summative studies are conducted when the product is finalized, are metrics-based and therefore require larger numbers of participants. The Design Workshop described in section 5.1 could be seen, in Barnums definitions, as an exploratory formative study using a "focus group" and a formative approach.

In Chapter 6, my focus is Usability testing, which is "the activity that focuses on observing users working with a product, performing tasks that are meaningful to them" (according to the same source). In it, section 6.3 uses a formative and section 6.4 uses a summative approach. The Usability testing definition can be (and needed to be, for the project tested in this thesis) stretched, which allows for remote or non-realtime observation. The



goal is to measure usability, which is comprised of users' efficiency and effectiveness in achieving a goal with a product as well as their satisfaction in doing so.

#### 3.1.1 A Rare Type of Interaction

Testing and evaluating the system was complicated by the relatively unusual interaction model, which had to be considered when deciding on an approach to take in usability testing. The prototype developed for this thesis notifies users of changes in articles they have read. Users' interactions can influence which kinds of changes they are informed about, but their actions neither cause nor influence the timing of notifications. Instead, such notifications pop up when users start using a web browser or at any time while they use the internet.

Of course, such a kind of interaction is not unprecedented. It can be, for example, thought of as a type of ambient awareness or incidental interaction, as defined by *Alan Dix* in his working paper *incidental interaction* [Dix02]. Dix' definition of *Incidental interaction* is

where actions performed for some other purpose or unconscious signs are interpreted in order to influence/improve/facilitate the actors' future interaction or day-to-day life

This is not a perfect fit for the interaction model of the prototype, since it's not the actor's actions that influence the interaction, but *other's* actions – such as corrections in news pieces – that lead, indirectly, to the interaction. However, the interaction happens when other actions are performed for other purposes, like using the computer or browsing the web. Dix alludes to a further category that does not sense the actor, but influences them. When the influence is accidental, not purposeful on part of the actor, the interaction falls in the categories *awareness or ambient*.

This is unlike the model of "instant messaging", where a message is sent purposefully and the generation of a notification is expected by the sender (though, like in this thesis' case, may not be expected by the recipient). To summarize, the interactions are not caused by the systems' user. They are not even purposefully caused by the users – journalists and editors – triggering the notifications. The choices made in the Evaluation chapter (6) reflect this issue.

#### 3.1.2 System Usability Scale

The System Usability Scale(SUS) is described by John Brooke in *SUS-A quick and dirty usability scale* [B<sup>+</sup>96] as "a reliable, low-cost usability scale that can be used for global assessments of systems usability". It is a form which asks users to declare how much they agree or disagree with 10 statements on a scale between "strongly disagree" (1) and "strongly agree" (5) – a *Likert* scale, as is pointed out in the paper. It also defines an associated scoring system, allowing a global result between 0 and 100 to be calculated from the individual answers. Brooke also points out that it is "generally used after the



respondent has had an opportunity to use the system being evaluated, but before any debriefing or discussion takes place".

Barnum recommends using this scale points out that *"it is common practice to substitute website, product, or interface for system"* when using the SUS. [Bar11, p. 182]

The SUS was used in section 6.4 of this thesis.

## 3.2 Privacy Concerns and Privacy by Design

Implementing a browser extension that can access users' browsing data comes with certain responsibilities and privacy implications. While browsing data in general is a privacy concern, news consumption data in particular may be even more sensitive. A study by Garrett suggests that news consumers choose news sources partially for reinforcement of political opinions [Gar09]. News consumption data may therefore allow inference of political opinions. Despite this, studies of US news sites, such as one by Hong et al [HMP<sup>+</sup>05] suggest that publishers do collect such data as part of their business models, creating and possibly marketing user profiles in exchange for free access to news content.

To handle this issue responsibly in my own prototype, and because privacy issues were mentioned in the design workshop, a „privacy by design“ approach was used. Canadian Information and Privacy Commissioner Ann Cavoukian formulated seven foundational principles of privacy by design in 2009 [C<sup>+</sup>09].

- Proactive not Reactive (anticipate and prevent invasive events before they happen)
- Privacy as the default setting
- Privacy Embedded into Design
- Full Functionality
- End-to-End Security - Full Lifecycle Protection
- Visibility and Transparency - Keep it Open (allow independent verification)
- Respect for User Privacy - Keep it User-Centric

The prototype was designed according to these principles. Following the (additional) principle of „data minimization“ [Sup], only those datapoints that are necessary to its functionality are collected. Furthermore, sensitive data is only held on users' computers and is deleted when it is no longer useful. The news ecosystem is conducive to such restrictions, since news pieces' importance generally fades quickly after the moment they are published.

To allow for data to be collected from study participants, an opt-in system was created, following the "Visibility and Transparency" principle. Next to the opt-in checkbox (shown

in the green box in Figure 5.3), I listed information on what kind of data would be sent, with a pseudonymous identifier, to my server. This data was used to discuss user behaviors with study participants, who could opt-out of data collection at any time or choose not to name their identity during their interview so there would be no way for me to connect the pseudonym to a real person.

### 3.3 Ethical Considerations

After deciding on this combination of methods, I evaluated the ethical aspects of the planned study using the working group's recommended self-assessment questionnaire then available at <http://igw.tuwien.ac.at/ethics/> (which is currently not accessible), reproduced in appendix section A.8.

All interviewed persons either signed a form noting their consent (some of which are reproduced in the appendix), or explicitly consented to being interviewed as part of filling out a survey form. I did agree to keep all users anonymous, in case of journalists so they could speak freely about their work and in other cases to allow unguarded discussions about how and when they consume news.

### 3.4 Summary

In summary, I used a User-Centered Design approach in designing and evaluating the prototype developed for this thesis. The interactions afforded by this system are relatively rare and hard to test, since they fall in the *awareness* or *ambient* categories of interactions as defined by Dix. I asked users to fill out a System Usability Scale form, among other methods, to help evaluate the usability of the prototype, which I implemented using a Privacy by Design approach.

In the next three chapters, I will detail how I confirmed that the problems described in the introduction also exist in the Austrian news environment, how I designed the prototype using the aforementioned user-centered approach and how I evaluated its usability.

# CHAPTER 4

## Exploration

In a first step, I wanted to explore the context in which a potential solution that would inform users about corrections in online news would exist. I gathered and analyzed data on news items and talked to experts to gain these initial insights.

### 4.1 Data Collection and initial Analysis

To inform Sub-RQ 1: *What kind of corrections occur in online news in Austria, and with which frequency?*, I set up an instance of NewsDiffs (cf 2.1.1) and – in a first step – added support for Austrian news sites *diepresse.com* and *derStandard.at*. These sites were selected because of their associated newspapers that are perceived as trustworthy by news consumers [New18] and because they are the two largest "quality newspapers" [Puc17].

To provide initial insights in corrections on the selected sites, this instance was used to collect article data between late August and early December 2015. The preliminary dataset contained all articles linked from the news sites' front pages in the selected time frame and their observed versions. The numbers shown in Table 4.1 were then obtained from the NewsDiffs system using a Python program which was again based on the NewsDiffs code. The number of articles and versions was then counted, grouped and summarised according to the severity of changes using a short R script, making use of the tidyverse set of libraries [WAB<sup>+</sup>19]. This data is contained in Table 4.1.

For a small fraction of articles, no changes were detected in the body text, which indicates that changes were detected elsewhere in the news content, for example in the title, date or byline. For about half (in case of *derStandard.at*) and a third (in case of *diePresse.com*) of articles, multiple versions were detected over time. Hence, a significant fraction of the encountered articles were indeed changed after publication, and users were not always

Measure	derStandard.at	diePresse.com
Articles	18 103	15 186
Multiple Versions	55.0 %	31.5 %
of those with multiple versions, the Articles' largest change was ...		
at least 1 Character changed	98.7 %	100 %
at least 1/5 of the Article text changed	23.4 %	40.5 %
at least half the Article text changed	15.5 %	27.2 %
marked by "update", "correction", or "korrektur"	0.2 %	-

Table 4.1: Data collected between August 25, 2015 and December 10, 2015

informed about that fact. The code used to obtain the data shown in Table 4.1 is included in Appendix A.1.

The modified articles were also categorized based on the magnitude of changes. This magnitude was estimated by counting the number of characters that were altered in each version in relation to the length of the complete text. A good portion of those articles – 23 and 40 percent, respectively – received large modifications covering at least a fifth of the article length. 15 and 27 percent saw even larger alterations, affecting over half the article's length. Changes that were explicitly marked as corrections or updates were only detected on derStandard.at in the analyzed data, and only in 0.2 percent of modified articles.

This confirms that articles are changed after publication in Austria and allowed a first insight into RQ1 – *What kind of corrections occur in Austrian online news, and with which frequency?*. It also shows that changes to published pieces do occur quite frequently, but that corrections and explicit updates either occur rarely or are seldom explicitly marked as such.

## 4.2 Expert Interviews

To inform Sub-RQ 2: *How do news outlets inform readers about corrections?* as well as Sub-RQ 3: *What are journalists' experiences regarding corrections?*, I interviewed three journalism professionals from different media outlets on the topic of changes and corrections in news.<sup>1</sup>

I contacted two of them, a data journalist working in Switzerland and an online journalist working at a British news organization's innovation division, at a journalism conference - the Journalism Festival in Perugia. The third interviewee was a journalist and responsible for working with readers at an Austrian newspaper. This person was also involved in handling corrections in the newspapers' print edition.

<sup>1</sup>Their identity will not be revealed in this thesis to ensure they could talk openly about industry practices. This is why gender-neutral pronouns are used in subsection 4.2.3.

### 4.2.1 Interviewee Selection

I selected the interviewees by looking over the Journalism Festival’s list of speakers and emailing people I thought would be familiar with online journalism and the topic of corrections. Since the two professionals I managed to interview work in foreign media settings, I also included a journalist at an Austrian paper to ensure that a professional perspective on the news ecosystem that I and potential users are familiar with was represented.

### 4.2.2 Questions and Analysis

I had initially planned to ask experts to answer a survey and first created a questionnaire referencing guides like *Designing a Survey* [sci]. However, I realized the conference would give me the option to gather in-depth knowledge, which I considered preferable in this early stage. Since the interviewees had very different roles and backgrounds, I modified the questions and conducted the interviews in a semi-structured fashion. The full list of questions I used to guide the interviews is reproduced in List 4.1. In summary, I asked the interviewees about their experience with corrections and reader feedback. I also confronted them with the findings summarized in section 1.1 and asked them about their professional opinions on the matter.

One interview was conducted directly at the conference. Another was scheduled there but held via Skype after the event had ended, since the busy conference schedule was not conducive to one-on-one conversations. The third interview took place in the offices of news outlet the interviewee worked at. They all took place in 2014 or 2015. They were recorded with explicit permission of the interviewees and all experts signed consent forms for their participation. The consent form is reproduced in Appendix section A.2. All of the interview recordings are 11 to 15 minutes in length.

To generate insights from the interviews, I listened to the interview recordings and partially transcribed sections most relevant to the above-mentioned Research Questions. I used the software ELAN [ela20] (and its sister tool Simple-ELAN) to annotate the audio files and to identify recurring themes and topics. I also looked for instances where their answers or perspectives differed.

### 4.2.3 Findings

The Austrian journalist shared their experience with handling reader feedback. They consider readers’ comments and letters one way for journalists to discover previously-published inaccuracies. However in their experience, most feedback does not concern factual inaccuracies. Complaints about opinion pieces or perceived editorial bias are more frequent, as are those about typos that made it in the paper despite the newsroom’s best effort, since readers consider these a nuisance. Feedback concerning gendered language being used (or not used), and authors using language perceived as insensitive were further examples.

- Who are you, where are you from and who do you write for?
- Does your outlet publish for print or online, or both?
- Do you have a print corrections policy?
  - Assume you've published something you now discover was false. What's the process towards a correction? Where and when will it be published, and who's responsible?
  - Do those corrections get reflected in the online version of the site too, and how?
- Do you have an online corrections policy?
  - Do print and online corrections work differently?
  - Same as with print: say you've discovered that something you published online was false - what's the process?
  - Can you access previously-published versions of articles in your CMS? Can your users access them as well?
- Are there any organisational, editorial or technical rules or processes we haven't touched on regarding corrections?
- What do you think about corrections, are they useful and what do they communicate?
- Do you think your readers actually read and/or notice the corrections?
- What are your thoughts on your outlet's - and your own - accuracy?
- Accuracy studies have, starting from the 30s, shown a pretty consistent 40% of tested articles contained at least one factual error, across the US and a few studies in Europe as well. What are your thoughts on this?

List 4.1: Expert Interview: prepared questions

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In this interviewee's newsroom, when readers do inform the editorial team about inaccurate information being published, the corrections process is as follows: the journalists who wrote the original piece are asked to recheck the facts. When a mistake is confirmed, it is generally made transparent by the relevant departments in the next print issue using a correction notice. The Swiss journalist mentioned similar, written policies being in place in their newsroom, for both print and online outlets. The British journalist pointed to an ombudsperson-like role („public editor“) being responsible for such issues and mentioned guidelines as well.

The Austrian journalist estimated that mistakes are discovered by the journalists themselves more often than by readers complaints. In comparison, the Swiss journalist did mention that reader "frequently" discover factual issues initially, often via the public comment section often available below articles in their online publication.

The Swiss journalist noted that how stringently their organization's policies are followed varies between departments. They consider this an implementation issue. In one of their projects, they published a large dataset they had collected manually and collaboratively, which due to its nature may have included mistakes or duplicate data points. The

publication contained a way to contact the team and report any issues as well as disclaimers explaining the issue of data quality. Generally, they advocate full transparency in case of mistakes, since „we’re all human, mistakes can happen“. The British journalist is also involved with creating new news products and formats. They did emphasize that the topics of changing content and corrections is interesting and challenging. Different platforms and products may also come with various difficulties, for example one can not edit a tweet after publication, which necessitates different rules for the platform than one would enact otherwise.

The British journalist mentioned rules being in place that, in their estimation, help prevent factual errors appearing in news coverage. One such rule is that anonymous information can only be published if it comes from two different sources, and hence can be considered verified. They also mentioned that content which was accurate when published may become outdated and therefore inaccurate. Their publication keeps articles online as a matter of record, but adds a note to inform reader about the age of an article, noting that their content is not actively maintained anymore. They mentioned an ongoing internal debate on how to best handle such issues.

The results discovered in accuracy studies (section 1.1) were met with some skepticism regarding their methodology, based on the Austrian journalists experience talking to readers and sources. They mentioned situations in which people who were cited as sources in a story believed they were misrepresented because certain sentences important to them did not make it in the final piece - when in fact journalists just had to abridge their comments to fit limited space. They argued that such situations may be mistaken for factual errors in some cases. The journalist responsible for working with readers mentioned a further study which analyzed how medical studies were covered by journalists, which they found more concerning. It found that a lot of the reporting that appeared in papers was limited to copies of press releases with few critical questions asked before publication.

The British journalist noted that different kinds of news articles may be associated with different reader expectations concerning accuracy. They reasoned that it seems to be generally understood that breaking news stories are still developing, are still being reported on, and as such may not paint the most accurate picture of reality. Such stories therefore may be refined as efforts are made to verify facts. Their news outlet does mark the such stories as developing, to communicate that expectation.

Asked about different versions being accessible in their publications’ Content Management System (CMS), the Swiss and British journalists mentioned that old versions are technically available, but the functionality may be hidden and some journalists may even be unaware of it. The British journalist mentioned liking the idea of showing differences between versions visually much like in software version control systems.

Both the Swiss and Austrian journalists agreed that transparent handling of corrections using correction notices („errata“) serve an important role. One noted: „We must be able to openly confront mistakes, and it’s a signal of quality when we do that.“ Online, the

Swiss journalist mentioned having replying to readers who had notified them of issues in the comment section, and thanking them for their help.

### 4.3 Summary of Exploration

The interviews and data analysis helped gain insights for several of the research questions:

Sub-RQ 1: *What kind of corrections occur in online news in Austria, and with which frequency?*: The two news sites analyzed initially do change articles after publication, though changes explicitly marked as corrections are a rarity even among articles that saw major changes. Small changes occur in many cases, but 15.5 percent of *Standard* and 27.2 percent of *Presse* pieces that were altered had major changes covering at least half the article. The Austrian journalist mentioned that standards for corrections are also in place in their Austrian outlet's print edition.

Sub-RQ 2: *How do news outlets inform readers about corrections?*: Print outlets inform readers of major factual errors in the following print edition. Explicit corrections and/or updates were observed in the online outlets as well, though not frequently, as seen in Table 4.1. When readers discover issues, they may report them in an article's comment section.

Sub-RQ 3: *What are journalists' experiences regarding corrections?*: The interviewed journalists seemed familiar with corrections processes and mentioned their importance to gaining and keeping audiences' trust. Transparency was heralded as especially relevant for trust. The Austrian journalist mentioned that journalists most often discover their factual mistakes while readers more often complain about simple typos.

With much input to answer these fundamental questions, I could continue developing a design and talking to potential users, as described in the next chapter.



# Design and Prototyping

In the Exploration chapter, I confirmed that pieces of news are sometimes indeed changed after publication at least in the two Austrian papers I analyzed and that professionals deem the issue of corrections worthy of further exploration. The next step was to design and develop a prototype solution for the issue of corrections not reaching the previously-misinformed readers.

Before starting development, I wanted to involve potential future users. I defined two target user groups: news consumers and journalists, who are often prolific readers of news at the same time. I then invited some potential users from both groups to a Design Workshop with the following goals: to gather feedback on the prototype idea itself and to gauge their interest in testing and giving feedback on the prototype itself later in the process. In this chapter, I describe the design workshop and the implementation of the prototype.

## 5.1 Design Workshop

This design and ideation workshop was held on *July 15, 2015* in the library of the Hackspace Metalab in Vienna, where I was a long-time member. It had the goal to provide insights into Sub-RQ 4: *How do consumers perceive online news?* and Sub-RQ 5: *What, if anything, do news consumers want to know if an article was changed after they consumed it?*

The issue at hand was introduced to participants as follows: *Can we do something to inform consumers of online news about news items that were corrected after they read them?*

### 5.1.1 Participants

The people who participated in the workshop were recruited partially by personal invitation after they expressed interest in the thesis topic in personal conversations, partially by an open invitation to the Hackspace’s member’s mailing list. This mailing list had roughly 100 subscribers at the time. The email to this mailing list is reproduced in Appendix section A.3. It included a Doodle meeting time coordination link which was also given to people who had previously expressed interest in participating or offered help with my thesis. The participants signed the consent forms provided in Appendix section A.4, which gave me permission to record the workshop.

Pseudonym	Gender	Job (optional)	Relationship to News
J1	male	Journalist	Producer of online news
J2	female	Journalist	Freelance radio Journalist
C1	female		Infrequent Consumer, reads daily news sites or papers roughly every three days
C2	male		Frequent Consumer of mainly technology and political news, the latter frequently at derStandard.at
C3	male	Designer	Consumer of political news directly at derStandard.at and of recommended articles via twitter
C4	male	Student	Consumer of political and critical news at spiegel.de and derStandard.at and articles via twitter

Table 5.1: Participants in the Design Workshop

Table 5.1 shows the participants’ Jobs, if they chose to name them in the introductory round, and their relationship to news as well as Pseudonyms I assigned to them <sup>1</sup>. Two journalists and four news consumers participated in the workshop. Two of the participants were women, four were men.

The workshop was facilitated and moderated by myself.

### 5.1.2 Process and Analysis

I had prepared an agenda for the workshop, which is reproduced in List 5.1.

The workshop was held in German and was audio recorded with a total runtime of almost two hours (1:46:40). In a method similar to the one followed in section 4.2, I listened through the recording multiple times and partially transcribed passages relevant to the research questions and concrete feedback, but left out personal identifying information

<sup>1</sup>Due to the chosen transcription process and privacy concerns, quotes will not be directly attributed to a participants’ pseudonyms

- Introduce myself and the thesis' problem description
- Introductory round for all participants: Name, Job and/or Calling, short description of news consumption habits (concrete question: last good article they read)
- Problem Discussion
  - Input: Corrections happen, how can they reach the misinformed?
  - Open Discussion
- Discussion of Accuracy Studies
  - Input: Accuracy Studies show high rates of mistakes, what do you think of this?
  - Open Discussion
- Prototype Discussion
  - Input: Short description of the planned prototype
  - Feedback on the prototype idea

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List 5.1: Design Workshop: prepared agenda

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and discussion tangents that were duplicates of earlier statements or clearly irrelevant to the research questions of the partial transcripts.

Based on the transcripts, I identified the following themes in the open discussion: *Current Practises in Journalism, Corrections in other Contexts, Perception of News and Corrections, Potential Solutions, Data Privacy*, and Differences in *Relevance of Changes*.

### 5.1.3 The Workshop

In the introductory round, all but one participants could name a good or interesting article they had recently read off the top of their head, the topics ranging from technology reporting to the portrait of a greek politician.

#### Problem Discussion

**Current Practises in Journalism** Early on, I asked the journalists if they themselves had experience with making a mistake and having to issue a correction. One of them mainly produced radio journalism and explained that corrections were, in their experience, only aired when ordered by courts, since time is very limited in radio news programs. The second journalist mainly published online and explained their practise to the non-journalist participants as follows: corrections are made transparent

when major factual errors are discovered. At his outlet this is done by appending a paragraph describing the correction to the article. Mere typos are corrected silently. In one case where there was a major oversight, the outlet issued an apology to the person the erroneous report had covered, reader reactions to this were positive.

A reader mentioned that they often see alterations to articles in breaking news contexts. Often the first pieces would be short and expanded over time. These are not corrections per-se, but extensions of the already-published pieces. A journalist shared that some media have special formats for such situations. They described a "special briefing" format, which has the sections "what we know", "what we believe" (or "what others believe"), and "what we know is wrong".

*I feel like journalists spend more time talking about than implementing ethics*  
A journalist

Later in the discussion, a journalist shared their feeling that journalists spend more time talking about ethics than implementing it.

One news consumer chimed in that corrections should ideally be made transparent above the article, since some readers only read the first paragraphs. Others disagreed, since the main body text is already corrected when the correction notice is issued, hence partial readers will not be misinformed. A compromise was also proposed: a short notice above stating that there had been corrections in the article combined with a more detailed correction notice below the text.

**Corrections in other Contexts** Practises around changes to content in other contexts were also mentioned: some online discussion forums and issue trackers on sourcecode-sharing websites such as GitHub allow edits to published content. On these sites, a participant noted that is common for authors to make transparent when they edit the text content of their contributions when they happen after the fact, for example when there are replies to the comment. Another participant noted that similar patterns can be found on the microblogging site Tumblr.

*On Github, when there is a discussion people also correct their posts and write below that they edited the post and what they changed.*

*Yes, or on Tumblr as well!* Two participants

One non-journalist mentioned they like to read scientific papers that correct (or answer to) other papers before reading the original versions and figuring out their stance.

Another participant mentioned that there is a proposal for an extension to the Hypertext Markup Language (HTML) to include a "version" tag [Dvo14].

**Perception of News and Corrections** The discussion frequently turned back to how participants perceive news and corrections, or how they think others perceive these topics.

One news consumer noted that he feels that audiences still associate newspapers with the truth and feel shocked when discovering mistakes. He attributed this to changes in the information economy, the speed of information sharing and information aging faster (provided it was even correct in the first place). He feels that it is true even when the audience knows that online news is created under more time pressure than print journalism was.

*Far too often, the paradigm is that newspapers announce the Truth – and then you're horrified when something wrong makes it into the paper.*

A news consumer

He also noted that he thinks of news pieces published on sites that have a comment section differently than on sites without. When user comments exist, the pieces feel more like a start of a discussion. The format or framing of news content also influences their expectations for accuracy – articles in breaking news situations and live tickers seem to make it clear that information may still change.

*If the news is covered as a live ticker or if the topic is an emergency situation it seems clear that information is still arriving, so one is still sceptical in receiving the information. It's different if the article is a result of a month-long investigation.*

A news consumer

Another consumer mentioned that false expectations may exist because of flawed media competency curriculums in schools, which in their perception promote dependency on authorities. They are also worried about falsehoods spreading faster than corrections or retractions.

*I generally don't find it very problematic when mistakes happen occasionally.*

A news consumer

**Potential Solutions** The participants also came up with a number of ideas for how to better inform readers of changes.

A participant first proposed a possible solution to the initial question: news media could log who accessed which pages and could show notifications about changes when they visit again. If the outlet has a paywall, users could be targeted with a high precision. Other technical suggestions were brought in by the participants, mainly regarding what news media could do to solve the problem: visible version tags in the article pages, or invisible information that users could choose to display using their browser; version information

in articles' URLs; correction notices on top and/or bottom of articles; RSS feeds that contain articles' changes.

*One concrete suggestion: the news site could add a meta tag to the article's html, specifying the version as version 1, version 1.1 and so on. And the browser could save [and then use] that information.* A news consumer

A further idea was to give users the option – using a button – to receive notifications when content is changed on a per-article or per-topic basis.

I brought up that most Content Management Systems (CMS) do save previous versions of content, but that implementing the features participants suggested, like adding additional RSS feeds, would require commitment from both technical and the editorial leadership of media institutions. The journalists agreed to this opinion.

Another news consumer proposed a tool that scrapes the pages a user has visited and looks for changes, highlighting the differences between versions, if any were found.

A journalist mentioned that it would be "really cool" if journalists could specify the kind of change they're making when editing articles, and if that was made transparent.

No particular solution seemed to be preferable to most participants. There was no clear consensus on the question if media should implement better infrastructure or merely provide more information which would enable better independent solutions. There was, however, a consensus that marking factual corrections explicitly and explaining such changes was a good thing, and that attention should be drawn to such changes.

**Data Privacy** The issue of privacy also came up. Participants noted that if media outlets wanted to solve the problem themselves, they would have to effectively track and save all users' reading habits. This would allow the site to create push notifications or to show a notice when users next visit any part of their site. Multiple participants voiced concerns about the behavior tracking this would imply and the tradeoffs with their privacy they would have to consider.

A journalist weighed in that different audiences may have different tradeoffs: financial managers reading industry press could be less interested in data privacy and more interested in knowing every change. They themselves mentioned that they would like to receive notifications for changes on pages they used in their research to ensure they're not working with outdated information.

A participant also mentioned that their behavior being tracked by an outlet they already trust and that may already have data on things like their comments on articles. If its use was made transparent and if asked, they might agree for data on their browsing behavior to also be saved.

*In my projects I'm a proponent of data privacy [and] I do believe, even as an opponent of cookies, that you can use technology for creative solutions. But it needs to be as transparent as possible.*

A news consumer

While discussing the prototype later, the idea of minimizing any tracking's impact by deleting such information regularly, therefore also minimize any risks to privacy, was also mentioned by one of the consumers.

**Relevance of Changes** Participants seemed to have two criteria for how relevant a change in a news article may be: one regarding the type of news article that was altered, one regarding the kind of change:

The journalists brought up the issue of journalists and users having different expectations for breaking news stories in contrast to non-breaking stories. For the latter, readers expect that the facts contained are well-researched, while readers of breaking news are often aware that the not everything is known about a situation, certain aspects and assessments may change as a situation develops. One consumer agreed and mentioned that certain formats such as live tickers or the "briefing" format described above may be used to support this (and manage reader expectations).

A further differentiation would be the kind of change, which as a participant noted, could be one of three categories: of an *Update*, an *Improvement* or a factual *Correction*. A correction of a typo could be considered a (small) *Improvement* as opposed to a *Correction*. Participants noted that small improvements may not be of interest to everybody (or anybody):

*If every site I visit during a day of research notified me whenever someone changed something – and that change would just have been a typo, I would be very angry.*

A journalist

Hence, potential solutions should try to weigh corrections and potentially give users options on what (not) to show.

### Accuracy Studies Discussion

I explained accuracy studies and their basic concepts. The first reaction by a participant was a methodological critique by a journalist, which centered on issues with asking just one expert source to check the factual basis for a whole article. The journalist worried that since they often cite experts which have different opinions on a topic in the same article, they might rate other experts' cited expertise as inaccurate in such a study scenario.

*Normally you include multiple sources and experts in a story. If they disagree they might count the others' expertise as inaccurate.*

A journalist

Other participants agreed that they are aware of similar issues in the scientific peer review process, where experts may disagree on methods but the discussion quickly turned back to participants' perception of user comments and never naturally returned to the topic of accuracy studies.

### Prototype Discussion

As a final input, about 80 minutes after the workshop started, I introduced the concept I had developed before the workshop: a concept for a browser plugin that would show notifications, and posed the question if any of the participants would be interested in using such a solution. I quickly outlined that the solution would automatically monitor news sites and save changes when they happened, and that the browser plugin would save the user's browsing history locally and compare it to a list of changes. I also explained the concept was mainly to show corrections and updates that were explicitly made transparent by the outlet and that I would work under the assumption that outlets would follow best practises.

A participant asked for clarification: this would not be a media outlet's project, but a third party scraping and tracking content? This was indeed the kind of solution envisioned for the prototype.

The first question a participant asked was how I would detect if any factual corrections occurred in a change. The prototype concept as I presented it was envisioned as just detecting explicitly marked corrections and/or updates. The participant was very clear that they wanted no notifications about fixed typos. However, others chimed in that also showing differences and notifying users of changes that were not explicitly marked may be interesting

A further question was also if I was proposing a solution that also tracked their behaviour on multiple devices, eg. not only a desktop or laptop computer, but also a phone or tablet. This participant stated they would prefer a unified solution that would cover (and provide notifications for) all their news reading. A further question was if they would have to create an user account at a centralized service.

A further input was that different users might want different settings for such a product: if a number changed, someone interested in economic news may be more interested in such a change than average readers.

Another participant chimed in that they would like to see a button under every article that would enable tracking on demand. One of the journalists, however, mentioned that in their experience, users would likely be too lazy to use such a feature.

Most participants claimed to be willing to install and test such a solution, especially if they could personalize what kind of changes they would be notified about.

In the end, I told participants that they were all invited to participate in the testing of the prototype as soon as it was implemented.



### 5.1.4 Summary and Implications for the Prototype

The workshop's discussions provided helpful insights into Sub-RQ 4: *How do consumers perceive online news?*, highlighting that news consumers are aware of some of their preconceptions concerning news when confronted with them, especially the connection of news with the truth. At least one user shared his feeling that the presence (or absence) of a discussion forum under the article influenced his perception of news either as a starting point for a discussion (or as something more authoritative). Some mentioned that they're not bothered by mistakes as long as they are handled ethically. Participants had encountered edited and/or corrected content online before, both in news context as well as in others.

One answer to Sub-RQ 5: *What, if anything, do news consumers want to know if an article was changed after they consumed it?* seems to be universal: in most cases, people would not want to be informed of changes that only fixed mistyped words. The participants also seemed to want some level of control. Some tended toward only wanting to be informed of corrections marked explicitly as such, others found information about general changes also to be potentially interesting, others would appreciate a button below an article, explicitly opting them in for receiving notifications. After this finding, I modified the prototype concept, which was originally developed under the assumption that it would only notify users of corrections and updates that were explicitly marked by the outlet. I added additional customization or personalization features to the prototype concept to enable this enhancements.

## 5.2 Prototype Development

In implementing the Prototype, I strived to fulfill user's requirements as previously collected in the Design Workshop. I also had the goal to show an answer to Sub-RQ 6: *How can identity revocation methods be adapted to the problem of news corrections?*

The prototype was implemented using a client-server architecture which preserves users' privacy as much as possible using techniques used for identity revocation (previously described in 2.2).

The server-side regularly reads a selection of news sites, checks articles for changes and provides data on those changes to the client-side.

The client is a plugin for the Google Chrome and Firefox web browsers which tracks visits to news sites locally, regularly queries the server for recent changes and displays notifications when certain changes were detected on articles the user has previously visited.

### 5.2.1 Server-Side

The Server-Side code is based on the open-source software backing the Website NewsDiffs [PLP12]. Its main function is to regularly check all current pieces of news linked on

supported news sites and check them for changes.

Such changes are then automatically classified by their severity or extent. Files listing all changes encountered in a day are generated that can be consumed by the Client-Side.

The Server-Side does not handle user data at all in the default case. However, I added special functionality for collecting data for this thesis on a purely opt-in basis.

### Gathering Data from News Sites

For every news site that should be supported, custom code (a so-called parser) is needed to enable the program to gather data from the page. This code needs to do two things. First of all, it needs to generate a list of links to articles, generally by visiting the home page of the news site and gathering all links matching a certain pattern. Secondly, it needs to obtain the article's content such as its title, body text, date and byline from a link in a clean, structured format. This is necessary because a news site's article page often does not only include the article itself but also navigation content, a comment section, links to further articles, adverts and other content. These parts of the page may change at any time without interfering with the content of the article itself, and NewsDiffs only strives to track changes to the article's content proper.

NewsDiffs includes such code for some United States-based and United Kingdom-based news sites as well as Tagesschau, a German site. I added parsers which cover Austrian news sites to support future testers' news habits, since most would be Austrian. This code also supported the initial analysis described in 4.1.

### NewsDiffs Architecture

NewsDiffs consists of an infrastructure supporting the regular extraction of content (scraping) from news sites, and a web interface showing detected changes. Both parts were modified to support the use cases explored in this thesis.

Figure 5.1 shows the architecture of the core parts of the system. The *Scraping* and *Find Changes* jobs are automatically called every thirty minutes using a cron [Pet09] job.

The *Scraping Job* is responsible for orchestrating the process of reading news sites and articles, comparing the detected content to previous versions and storing version information like the title and time of the change to the database whenever a change is detected. It is important to note that the article body text is not stored in the database, but in Git [git22] repositories, which simplifies the detection of changes. I altered this scraper code to allow for faster scraping of news sites. I achieved this by parallelizing the process of fetching news items' content. This was necessary to allow relatively frequent checks for new content. After these improvements, news sites could be checked every 30 minutes.

I also added a *"Find Changes"* process that was also regularly called after scraping was completed. This process reads recently-detected versions from the database and does

## NewsDiff Server-Side Architecture

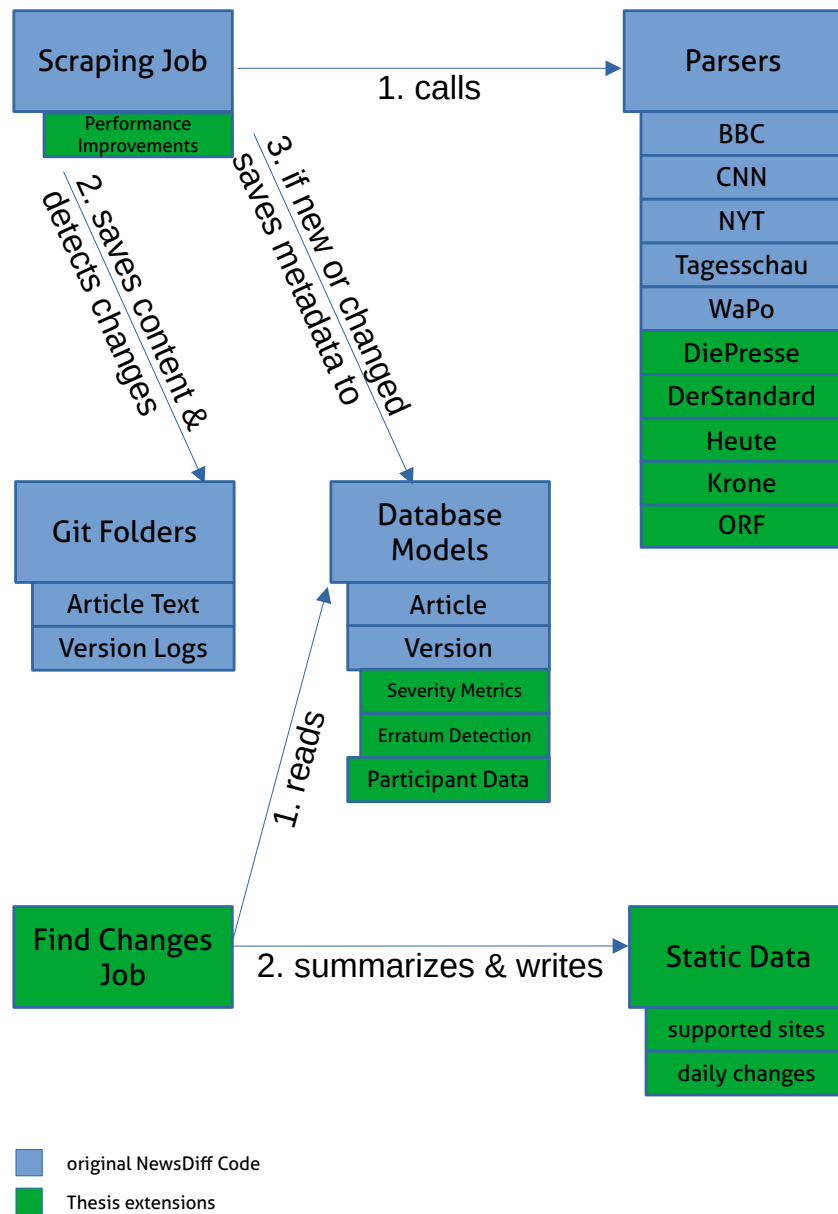


Figure 5.1: Server-side architecture for NewsDiffs

two things: it classifies the *Severity* of the changes (see below), then summarizes them into static files that can later be read by the client-side (subsection 5.2.2) portion of the software.

The original web interface to the data, which NewsDiffs provides, was also extended to display the severity metrics and to allow the download of the above-mentioned static files.

I also added some infrastructure for the collection of statistics (participant data) on the client-side, purely on an opt-in basis for the purpose of this thesis.

### Estimating the Severity a Change

A news article may be changed for a variety of reasons, as explored in the Design Workshop (section 5.1.3). Typos or deviations from style guides may be found and corrected after publication, new content may be added because stories developed or authors performed additional reporting, or errors may be found and corrected. On a technical level, these different styles of changes can look the same or very similar, unless the authors made the changes transparent by adding a correction notice. This is because none of the news sites publishes machine-readable information about such changes – only the latest version of the article.

To approximate if a change may interest the user, based on the requirements surfaced in the Design Workshop, I created a heuristic for determining the importance of a change. It currently categorizes changes in four levels of severity.

It is important that this categorization can be fully automated, since changes are frequently detected and human intervention would mean a lot of effort.

- The "official" severity level is triggered if text explaining the change is added. To help detecting this state, the program looks for words signifying such a change. Such words may be "Update", "Korrektur", or "Correction".
- The "moderate" severity level is reached if half the text of the news item was touched by the change.
- The "low" severity level is reached if a fifth of the text was touched.
- The "minimal" severity level indicates any change at all

The function used to calculate the severity of each change is provided in Appendix A.5. These categories can be used by the Client to allow for personalization of which kinds of changes should be displayed.

## Code Statistics

The extended NewsDiffs code is accessible in a GitHub repository at [https://github.com/fin/newsdiff-corrections/tree/merge\\_eprice](https://github.com/fin/newsdiff-corrections/tree/merge_eprice). A comparison with the original NewsDiffs repository using the git command-line tool (`git diff -stats`) yields the following result: *41 files changed, 1118 insertions(+), 157 deletions(-)*.

### 5.2.2 Client-Side: Browser Plugin

The user-facing part of the prototype is implemented as an extension for the Chrome and Firefox web browsers. This type of software was chosen because web browsers are typically used to read news content. Even links to news content encountered in other contexts like email will also open in a web browser.

An extension can be configured such that it gets notified whenever a new site is opened, therefore it can access information about which pages the user visits. The extension logs visits to news sites in a local database, which is never transmitted to another system. It can also regularly check files the server provides. These files describe changes that were detected by the server on all supported news sites.

Browser extensions can also notify users using small pop-up messages. When it is found that the server has registered a change in a piece of news the user has accessed before the change, and the change matches the users' preferences (section 5.2.2) for the kinds of changes to display, a notification is displayed to the user.

### Privacy-First Design

The Diagram Figure 5.2 shows the data flows between *Browser*, *Server* and the *Extension* which comprises the client-side user interface. Its implementation is based on the principles of Certificate Revocation Lists (CRL), a privacy-preserving identity revocation schemes as described in 2.2.

One major downside of the CRL approach is large file sizes. The list of revoked certificates will tend to grow over time, and the fact that a certain certificate has been revoked hardly diminishes in importance over time, leading to larger and larger file sizes.

The CRL-inspired implementation in this extension operates under the assumption that – unlike certificate or identity revocations – the interest in changes of news articles diminishes over time. Especially in the use case covered in this thesis, which is informing people who read an article about a change that occurred later. Therefore, the system does not need to maintain a full list of articles that were ever changed in one file, but can instead collect the changes detected on a certain day, and only regularly check the files for a number of recent days: currently the current day as well as yesterday and the day before yesterday.

### NewsDiff Privacy-first Design

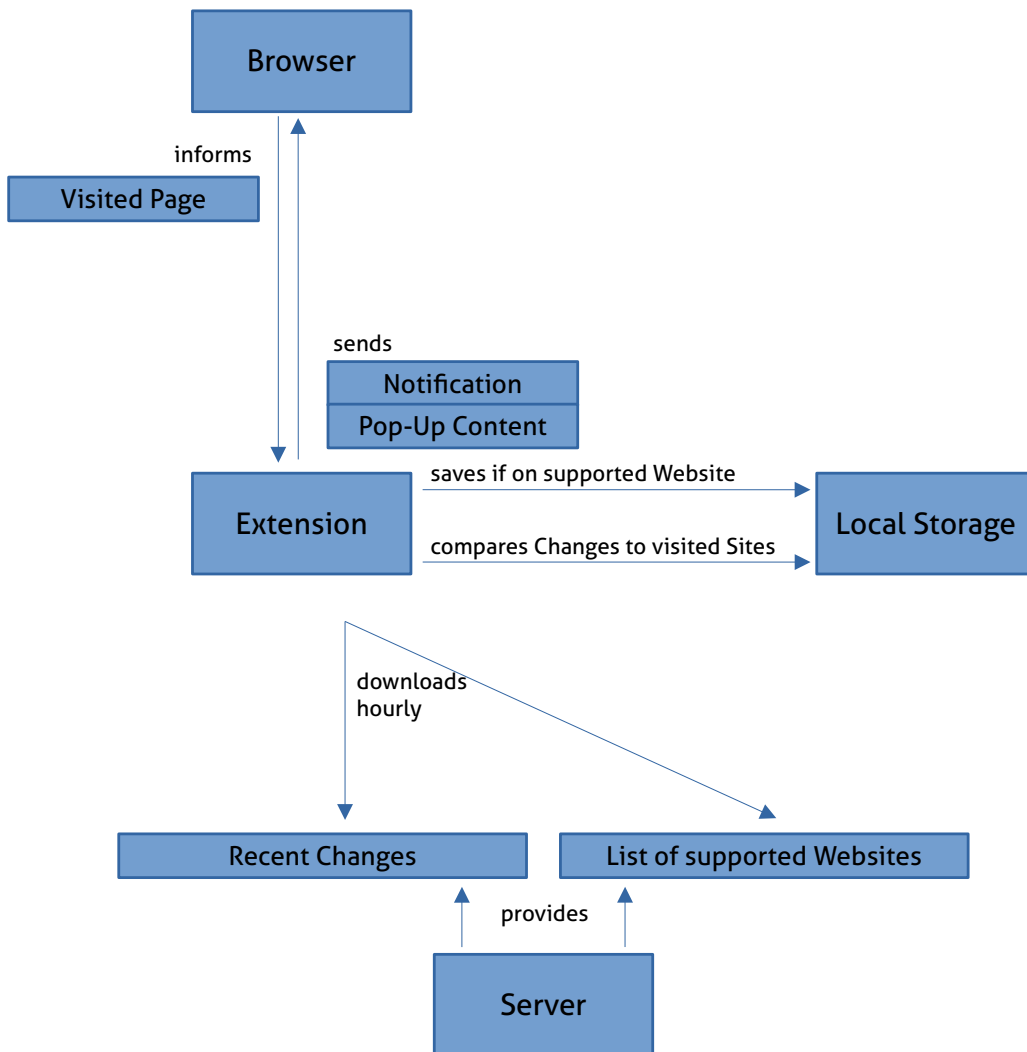


Figure 5.2: Privacy-first design: data flows between browser, extension and server

The Diagram shows that no personal data is sent to the server. Instead, the extension regularly downloads files provided by the server and compares the data they contain with a purely local database of news articles encountered by the user.

## Installation

For ease of distribution, the extension can be installed on the Chrome browser using the Google Chrome Web Store and on the Firefox browser using the Mozilla Add-Ons directory, to both of which I submitted the extension.

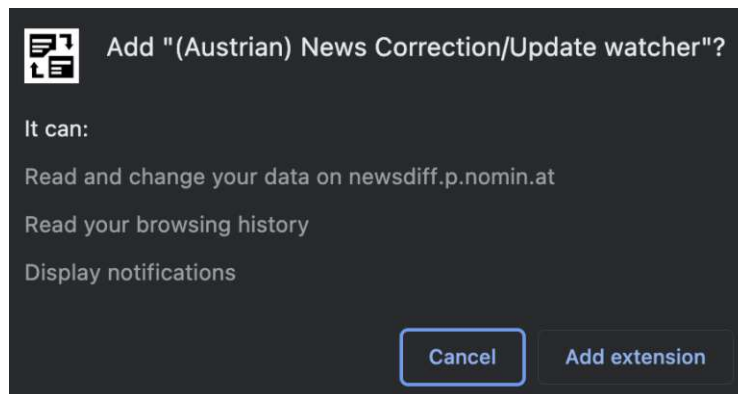


Figure 5.3: Screenshot of Permissions dialog during installation

Both distribution methods allow easy installation in each browser. In Chrome, when installing the Extension, the browser opens a dialog showing which information the extension will be able to access. A screenshot of this dialog is shown in Figure 5.3. After installation, the extension opens its Preferences screen.

## User Interface

The User Interface is normally invisible aside from the extension's icon, which is visible in the Browser's toolbar next to the address bar.

**Toolbar Pop-Up** Users can click this icon, which opens the Toolbar Pop-Up window, which is shown on the top-right of Figure 5.4. This pop-up includes a list of recently detected changes in articles the user has read. Clicking them opens a page showing the changes, same as clicking the notification window (described below). The titles of changes with a severity level of at least "moderate" are displayed in bold.

This list can be emptied using a button labeled "Discard all Notifications". A further cog icon allows access to the Preferences screen, which opens in a browser tab.

**Preferences** Since notification messages can be disruptive and distracting, and since the participants to the Design Workshop noted their desire to customize which changes they

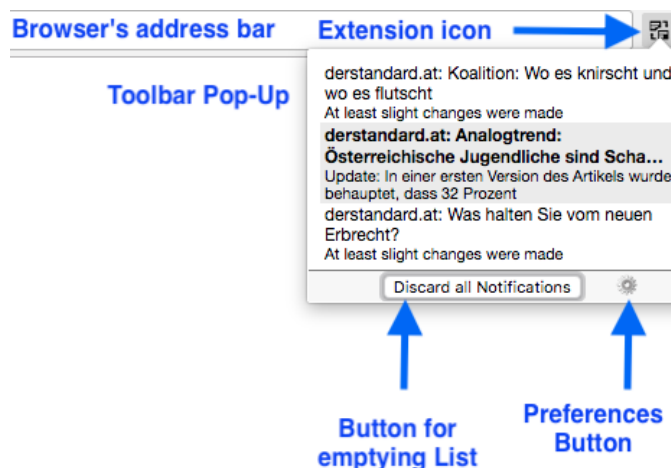


Figure 5.4: Annotated screenshot of the browser extension's interface elements in the Google Chrome browser

should be notified about, users can choose which kind of change warrants a notification in the Preference screen, which is depicted in Figure 5.5.

Some users may want to be informed of all changes, no matter how small. Others may only wish to be informed of the relatively rare "official" correction, which was made transparent by the author on the article page. To enable such different use cases, users can select the minimum severity (as described in section 5.2.1) of a change for two types of interaction: *Notification Severity* controls when a user is directly notified of a change by notification. *Display Severity* controls which changes are included in the pop-up window the user can manually open by clicking on the extension icon.

The Preference screen also allows the user to enable a tracking functionality developed specifically for this thesis, which sends pseudonymous, statistical data about their usage of the extension to the server roughly once a day. This gives me the opportunity to evaluate the plugin's performance and usability in the next chapter.

**Notifications** A typical Notification is shown in Figure 5.6. It is displayed when the extension has downloaded new changes which include a new change that is relevant to the user and fits the users' preferences. The Notification consists of a textual description of the severity of the change, the news site it was detected on and the title of the article in question. Since notifications are only shown for articles a user has previously visited using this browser, this should allow users to recognize the article and topic and to decide if the change is interesting to them at the time.

When clicking the Notification itself, the browser opens a page showing the differences between the article before and after the change. Deletions are highlighted in red, additions are shown in green. A screenshot of this page was included earlier (Figure 2.1)



## Settings for NewsDiff-Corrections Extension

This extension will track which pieces of news you read on the following websites:

- dastandard.at
- derstandard.at
- diepresse.com
- diestandard.at
- heute.at
- krone.at
- orf.at
- www.bbc.co.uk
- www.krone.at
- www.nytimes.com

Whenever an article changed after you read it, you will be notified. Changes will also be accessible via the extension's toolbar button.

By default, the extension only saves information about your behaviour locally, thus protecting your privacy. Only if you click on a notification, you will browse to a page on a public web server.

### When would you like to be notified (via popup) of a correction?

- Always, even when a tiny typo was corrected
  When at least slight changes were made
  When at least half the article was modified
  When a change was explicitly labeled Update or Correction

### When would you like a correction to show up in the extension's toolbar window?

- Always, even when a tiny typo was corrected
  When at least slight changes were made
  When at least half the article was modified
  When a change was explicitly labeled as Update or Correction

### Participate in a study by submitting statistics about my behaviour

The study is part of [fin's](#) master's thesis on Corrections in Online News. It explores how people react to being informed about changes in news they consumed. [More info on thesis & study](#)

**By participating in this study, I consent to the following information being logged and submitted to the server once a day:**

- Number of URLs (**not** the actual URLs) visited on the tracked news sites
- Number of changes that occurred after you visited the URLs
- Number of displayed changes "marked as read"
- Number of displayed notifications, per hour of day and per category (importance-level) of change
- Number of changes visited via the notification, per hour of day
- Number of notifications marked as read via the notification, per hour of day

Unique Identifier:

Submitted data will be linked to this ID, you can request your data - or the deletion thereof - by emailing [fin](#)

Changes are auto-saved, no worries  
Icon cc-by, by [Richard Wearn, GB on Nounproject](#)

Figure 5.5: Screenshot of the browser extension's Preferences page in the Firefox browser

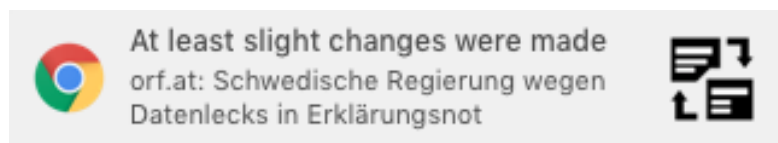


Figure 5.6: Screenshot of a Notification for a change in a orf.at news article.

in subsection 2.1.1. When hovering the notification, the browser also shows a button which closes or dismisses the notification without opening this page. Notifications also disappear after a number of seconds (5 seconds in current versions of Chrome).

### Optional Collection of Statistics

For the purpose of this thesis, users can enable a pseudonymous data collection feature which sends daily usage statistics to the server, which can be enabled by selecting a checkbox in the Preferences screen. The pseudonym consists of a number that is randomly selected when the extension is initially installed, which is sent with the usage statistics. No other identifying information is sent, and users could choose to reveal this number to me (or not to) when they were interviewed later in the process.

The following information is sent to the server on a daily basis if explicitly enabled by the user:

- the number of URLs (not the actual URLs!) visited on news sites
- the number of notifications shown, per day and per “severity” of the change
- the number of notifications dismissed, per day and per “severity” of the change
- the number of notifications interacted with, per day and per “severity” of the change

For further information on how this was used, see the following chapter.

### Code Statistics

All code for the Client-Side implementation is available at <https://github.com/fin/newsdiff-corrections-extension>. The repository contains 17 files, 323 blank lines, 2502 comment lines and 2359 lines of code according to the command-line tool `cloc` [Dan] (count lines of code).

## 5.3 Summary of Design and Prototyping

Based on initial ideas of user’s expectations, this chapter gave me a strong sense of the requirements for a prototype thanks to holding the Design Workshop. As noted in

subsection 5.1.4, users had varying degrees of interest in being notified about different kinds of alterations to the news they had read, leading to the requirement of providing options regarding which notifications a user would like to receive. On this basis, I implemented a prototype solution with a central focus on preserving users' privacy without compromising functionality. In doing this, I was able to gain insights into Sub-RQ 6: *How can identity revocation methods be adapted to the problem of news corrections?*. The solution based on CRL worked well on a technical level and led to notifications both in testing and for the test users, as shown in the next chapter, in which I determined if users found the prototype solution usable and useful.



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# Evaluation

After implementing the prototype, I assessed the quality of the system design and tried to find possible shortcomings. For this, I used a three-pronged approach. First, users were asked to rate their experience with the prototype using a Systems Usability Scale (SUS) [B<sup>+</sup>96] form. This standardized system enables an usability assessment that can be compared with other systems. Secondly, I conducted semi-structured interviews with the same participants to evaluate if the design goals had been reached and to find out how they rated both the systems' usability and its utility. Third, I asked participants to submit pseudonymous tracking data summarizing their interactions with the prototype. These approaches allowed me to gather answers to Sub-RQ 7: *What is news consumers experience when they are notified about changes in news they consume?*

All interviews and form submissions were conducted two months or more after users had installed the browser extension. They were conducted in German or English depending on the preference of the interviewees.

## 6.1 Choice of Evaluation Methods

Barnum [Bar11] provides three main options for testing the usability of a product: in the lab, in the field or remotely. Testing in the lab or in the field has the major advantage that the tester can perceive users while using the product. Special equipment that would enable eye tracking would also be available in a lab, offering potential for further insights. In the case of the prototype described previously, such types of tests would be costly and inefficient. This is because the timing of the interaction is not controlled by the user, but by a website being changed without the user's intervention. Watching users do their normal work and hoping for a notification to pop up (and therefore a relevant interaction to be observable) would be theoretically possible – but it would be as possible that days would go by without such an interaction.

Since one question for such a study is in which situations users would interact with the notification – if at all – even the measured interactions may have been influenced by a lab setting. Of course, I could have created a lab setup and have had users consume reproduction of news sites and do other tasks. But I judged it too difficult to impossible to "fake" a news context as engaging as real-world news sites.

Hence, I decided on the third option: a version of unmoderated (asynchronous) remote testing. I did not follow the recommendation to use an application to capture "the screen, keystrokes, mouse clicks, navigation path, drop-off rates and so forth" ([Bar11], p. 44), since the tested interactions would not be the main tasks users would be focused on during the time, and such a method would be unreasonably invasive to their privacy. Instead, I added basic, privacy-preserving tracking functionality to the extension and asked users to go through life normally while having the extension installed, do an interview afterward and fill out a System Usability Scale (subsection 3.1.2) score card.

## 6.2 Participant Recruitment

To find testers that would try the extension and be available for an interview about the experience, I set up a website at <https://fin.io/thesis> which I could refer to in my recruitment efforts, which is reproduced in section A.6. This page included links to install two versions of the extension as well as a link to a survey hosted on Google Forms, which asked basic questions like the user's email, if they used the Chrome browser for reading news online, if they interacted with news as a producer or consumer, their age and profession, and if they would be available for an interview about their experience using the extension (reproduced in Appendix section A.7).

I then told coworkers, family, the followers of my Twitter (Figure 6.1) and Facebook accounts as well as the Reddit community */r/alphaandbetausers* about my project and asked for their participation.

All in all, 25 people between the ages 22 and 62 submitted the above-mentioned survey, the average age was 32.5. Seven of the submissions came from Journalists or Reporters, six were students, five were IT professionals, two gave other professions and five did not state their profession.

A while later, I reached out to ten of the survey recipients. Two did not reply and two had uninstalled or switched computers in the meantime and felt unable to contribute due to a lack of recent memories of the experience. I ended up interviewing six users in-depth and asking them to fill out a System Usability Scale Survey.

## 6.3 In-Depth Interviews

The interviews were conducted between February and November 2019. They were audio recorded with a length between 13 and 28 minutes. For analysis I listened to the recordings and had them auto-transcribed using Microsoft Word so I could better find relevant

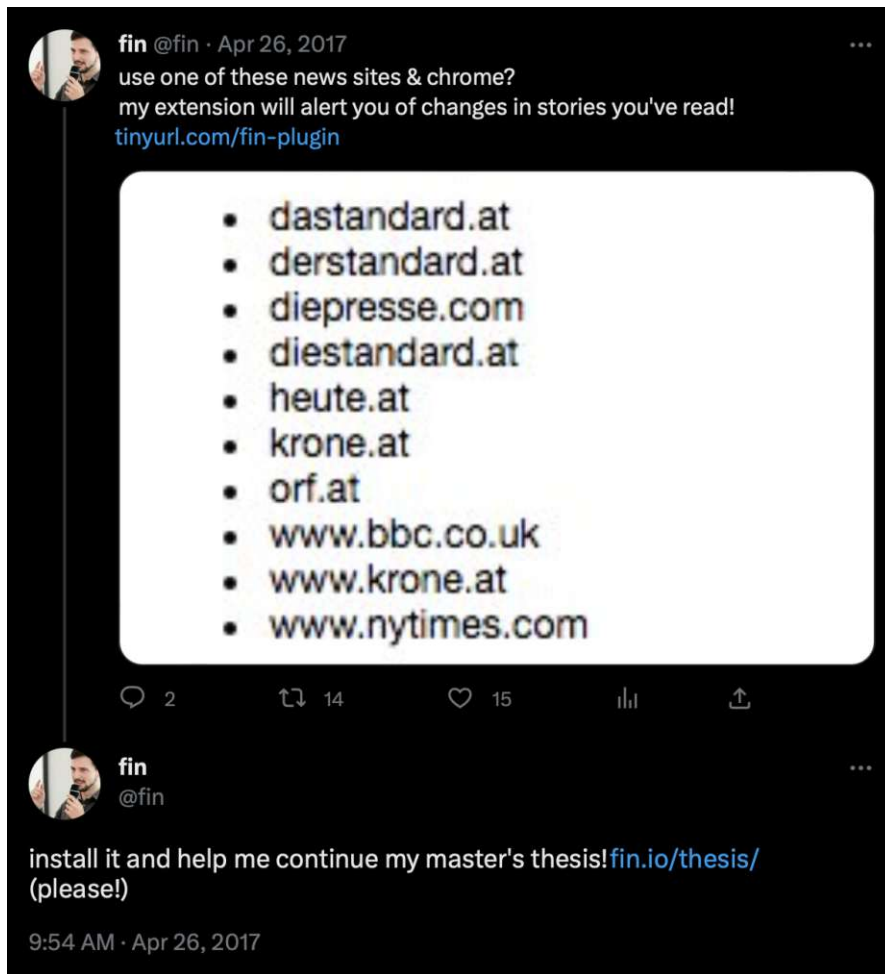


Figure 6.1: April 2017 Tweet which was used to find further participants

answers to the questions and insightful comments and tangents. I then went through my interview questions (see below) one by one, compared the answers and looked for additional examples or insights in the transcripts, confirming them with the recordings if quoting them directly. I also made sure to look for differences in the journalists' and consumers' answers and to point them out in the analysis, if I recognized any.

### 6.3.1 Participants

The participants I was able to schedule an interview are listed in Table 6.1. Only one of them had participated in the Design Workshop. Three of the participants were in their 20s at the time, two in their 30s and one in his 60s. Four were journalists, two were news consumers. Five interviews were held in German, one in English.

I promised participants anonymity to ensure open responses to the interview questions

Pseudonym	Gender	Age Range	Interview Language	Occupation	Relationship to News
A	Male	60s	German	Teacher	Consumer
B	Female	30s	German	Journalist	Producer & Consumer
C	Male	20s	German	Journalist	Producer & Consumer
D	Male	20s	German	Student	Consumer
E	Male	30s	English	Journalist	Producer & Consumer
F	Female	20s	German	Journalist	Producer & Consumer

Table 6.1: Participants in the Design Workshop

and am therefore leaving out personal details like their names and those of the news sites journalists work for or mentioned in their statements.<sup>1</sup>

### 6.3.2 Interview Questions

Before the first interview, I created a questionnaire which I followed closely during the interviews. The questions I asked are reproduced in List 6.1.

I used these questions as a guideline but also avoided interrupting interviewees when they offered opinions. I asked questions for clarification when it seemed like there were insights to be gained. Sometimes the questions were answered preemptively by the participants, so I did not explicitly have to ask them. Looking back, however, sometimes I had the impression that an answer had been given and moved on, but discovered while listening to the recording, that the question had not actually been fully answered. Hence, some questions were not fully answered by all participants.

### 6.3.3 News Habits

The first two questions focus on pre-existing habits of the users.

- How do you consume news, and how does news reach you?
- How do you use news sites? Do you consume or produce news?

Participant A was the only one who mentioned a daily newspaper subscription, he additionally regularly reads one to two Austrian news sites. Two participants, C and F, both journalists, mentioned using the morning radio news to stay up to date in addition to a selection of online news sites. The news site that was most mentioned was derStandard.at, though other sites such as kurier.at, diePresse.com, krone.at and orf.at were also mentioned by the (current or former) Austrian users. Participants B, C and D mentioned using their cellphones a lot, frequently in combination with social media sites

<sup>1</sup>This is why I am also not including transcripts in the appendix.



- How do you consume news, and how does news reach you?
- How do you use news sites? Do you consume or produce news?
- How did you find the tool?
- What kind of system did you use it on? Which operating system, which web browser?
- Can you remember the installation process? How did it feel?
- Did you receive notifications?
  - Did they bother you?
  - How many do you feel like you clicked?
  - Were the notifications interesting to you?
- Did you ever change the tool's preferences?
- Did you learn anything from using the tool?
- Do you see the news differently now, or was there anything that surprised you?
- Would you like a similar features to be implemented directly on news sites? For what kinds of changes?
- If you agreed to tracking during the thesis, would you like me to show you the information the tool has collected on your pseudonym?

List 6.1: Evaluation Interviews: Interview guide

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such as Twitter. E, the only participant who did not live in Austria in the testing period, mentioned international sites such as nytimes.com.

#### 6.3.4 Tool Discovery & Environment, Installation

The following questions focus on how the users discovered the browser extension, in which environment it was run, and on the installation process itself:

- How did you find the tool?
- What kind of system did you use it on? Which operating system, which web browser?
- Can you remember the installation process? How did it feel?

Of the participants, all users but B and E mentioned me talking to them personally (or their partner) as a reason for them discovering and installing the tool. B saw a post on Facebook in which I looked for participants. I seem to have skipped asking the question to E, though from context I infer that he installed the tool and submitted the survey after seeing my Twitter or Facebook post.

Regarding the environment the extension was running in, E mentioned using it in Firefox. A, C and F used it in Chrome.

The users remembered no issues with installation – if they remembered it at all, since the interviews were held at least 2 months after they started using the extension, sometimes longer. Participants C and D did not recall the process. Participant A called it "problem-free" (original: "problemlos"). He said: "I believe you sent me the link and that was it" ("Du hast mir glaube ich den Link geschickt und das war's"). Participant B chose the word "unproblematic" ("unproblematisch"), Participant E said "there was no problem at all", Participant F called it "pretty easy" ("ziemlich einfach").

While she had no issues with the installation itself, Participant B actively shared her thoughts about what should happen after the installation process while answering the question on how the installation process felt. I'll cover this feedback below in subsection 6.3.10.

### 6.3.5 Notifications

The next questions were related to notifications and how they were received. I had worried that users would find notifications distracting, since they're unpredictable and would by nature interrupt other activities on their computer. I prepared the following questions in my interview guide:

- Did you receive notifications?
  - Did they bother you?
  - How many do you feel like you clicked?
  - Were the notifications interesting to you?

All users received Notifications, though Participant E, who, only uses international sites (of those supported and monitored by my prototype), had warned me even when he agreed to be interviewed that he only received three of them. Participant E called his first notification "disappointing", since it was a space character that was removed in a New York Times article. He called the second one "interesting", since it was a developing story. He thought it was cool, since he "didn't remember browsing to the New York Times in particular, and it was really cool to have this reminder". He could not recall specifics about the third notification and summarized, that he did not find it valuable all-in-all in the test phase.

Participants A, B, C mentioned receiving notifications fairly regularly (A: "relatively regularly" ["relativ regelmäßig"]), D and F mentioned receiving notifications once in a while (D: "once in a while" ["öfter"], F: "a few" ["ein paar"]). A, B and D noted that it varied and they received more notifications when consuming news more often.

None of the participants mentioned being bothered or disturbed by the prototype's notifications. F mentioned that the notification looked like (messaging program) WhatsApp's notifications, which she found positive and not distracting. A appreciated having the article's title and the description of the severity of the change in the message, which allowed him to decide if he wanted to know more. He told me that, above all, he clicked notifications specifying "major changes" though he also interacted with notifications specifying "slight changes" if he was interested the specific article.

The number or proportion of interactions was the largest difference between users. As mentioned above, A only clicked notifications about larger changes or articles that were of particular interest to him, D described a very similar behavior, ignoring notifications "very often" ("sehr häufig") based on the the same criteria. D mentioned completely ("eigentlich komplett") ignoring those that specified small changes. B, however, described clicking all notifications she could see, and sometimes even checking the Toolbar Pop-Up (section 5.2.2) window to see if she missed any. C clicked many notifications early on, but fewer over time, since he noticed that notifications specifying "minor changes" often were just changes in headlines or subheadings, which he was not interested in. F mentioned clicking about half of the notifications, also depending on the notification message's contents.

### 6.3.6 User Preferences

The Preferences screen (section 5.2.2) is shown to users initially directly after installing the browser extension. Users can also reach it via an icon in the Toolbar Pop-Up (section 5.2.2). To find out if users ever changed these settings, I asked them: *Did you ever change the tool's preferences?* The answers I received raised many opportunities of improvement.

Participant E, for example, stated: "I didn't see at all that I could change that [to] not to be reminded when there was a typo". He remembered seeing the initial settings screen, but "when [he] had this disappointing experience, [he] had forgotten that". Participants A and D also stated that they did not realize that changing the threshold for when to be notified was possible until the interview.

Participants B and C mentioned changing the threshold once – B wanted to be notified about smaller changes, C set the threshold higher. Participant F stated that she would likely have changed the setting if she had felt like she was getting too many notifications.

The fact that *only three of six users were aware that they could change the thresholds for notifications* (though some of them remembered when reminded that the Preferences page was opened after installation) shows that usability of the prototype could be improved in this area.

### 6.3.7 Learnings & Perception Changes

The next questions in my interview guide were focused on the users' experience and learnings from using the tool:

- Did you learn anything from using the tool?
- Do you see the news differently now, or was there anything that surprised you?

Participant A noted that while he thought that seeing the changes was interesting, the number of notifications in relation to the number of articles he read (or of articles that are published) was minimal, and that they mainly related to articles that were related to current political developments. The other non-journalist, Participant D said similarly that it made him aware of how pieces of news have changed. He noted that he previously noticed that changes occurred when reading user comments under articles which on occasion referenced things that were not in the article, but he never knew before using the tool what exactly had changed. However, he said he also learned that the changes are for the most part not very exciting. ("... wie mir bewusst wird, wie sich Artikel eigentlich ändern – also etwas, was man sonst nur aus den Kommentaren herausliest – also wenn Kommentare etwas referenzieren was nicht mehr im Artikel ist. [...] Dass die Änderungen größtenteils nicht spannend waren, war das andere").

Of the journalists, Participant B mentioned learning that copy-editors at a news outlet had different policies on compound words. Participant C said that he previously thought that factual changes were generally made transparent (just like he does in his work) and was surprised that one news site often did not make such changes transparent. He also learned that articles seemed to only be copy-edited after he already read them more often than he expected, though he knew from his own work that such a situation sometimes happens. He was also surprised how much does get changed over all and noted that he had not understood the article as a "living object" before using the prototype ("... weil ich Artikel selbst bis dahin nicht so als lebendes Objekt verstanden hätte"). Participant F felt like she had relatively few notifications and that not much happened in the cases where there were changes.

### 6.3.8 Should News Sites support similar Features?

After asking about the prototype itself, I also asked users if they *would like a similar features to be implemented directly on news sites? For what kinds of changes?*

The idea of adding the plugin's functionality to news sites directly, instead of requiring users to install a plugin, was generally received favorably by the participants. Participant A mentioned it could be combined with showing what articles had changed or were added since the last time, which would make it easier to navigate to new articles as well. Participant C noted that with rising numbers of digital subscribers, such a solution would

"not be absurd" ("gar nicht so abwegig"), but pointed out that he liked the platform-independent solution that does not require every outlet do implement it for (just) itself. Participant F noted that one could argue that news sites offering such a functionality would be an improvement, since this would remove the necessity of running the extension in the background - but that it would not make a large difference for her in comparison with using the extension.

Participant B had a more ambivalent answer. She voiced her feelings that some readers are already paranoid towards journalists and news outlets, so she like integrating it prominently on a news site would "mean trouble". Therefore, she would not force this feature onto users. However, if news sites wanted to offer such functionality, she thinks it should be launched with an advertising campaign, since the outlet needs to explain itself and the upside of transparency to its readers. She thought this would be important, since this additional visibility also makes the journalists and the media outlet "vulnerable" and would make it necessary for outlets to more often explain their actions and processes to readers.

### 6.3.9 Pseudonymized Tracking Data Discussion

I gave the participants the option of giving me their pseudonym which is shown on the Preferences page (section 5.2.2). I used the script provided in appendix section A.10 to process the data into tables to discuss with the participants. Data collection for Participant E, who had only received three notifications, had apparently not worked at all. Participant C had forgotten to enable the opt-in checkbox on the Preferences screen, so no data was submitted by the extension. For Participant F, the data confirmed her intuition that she only received notifications about small changes and she confirmed that the time of day matched when she usually reads the news.

Participant A's also confirmed that he had received two notifications on the highest severity level (section 5.2.1), the other data I shared matched as well.

### 6.3.10 Further Feedback

Outside the questions in my interview guide, participants shared further relevant insights I am collecting here:

Participant A noted that a similar notification functionality would be helpful for all kinds of other pages as well, such as pages on websites of public bodies, Participant E also said he wished for this kind of functionality on every page.

Participant B criticized that she installed the extension, saw the settings page and then was not sure if anything was working and even ended up reinstalling the prototype because she was not sure if it was working. She expected a larger window to open when something happened, not a small notification on the top-right corner of her screen. She also expected more guidance such as a "manual" to be part of the installation process – or at least a message confirming that the prototype is active and what to expect.

Participant C noted that the categories (severities) of changes could potentially be improved by using better methods such as machine learning to categorize changes automatically and potentially differentiate between factual changes to articles and further developments being added to them. He also noticed one particular department of a news site frequently changing their articles after they read them without making those changes transparent, and that other departments of the same site were more transparent about such changes.

Participant D wanted a feature that would allow him to navigate to the original article from the screen that shows the difference between the versions (Figure 2.1).

Participant E suggested adding a functionality of showing an article's history for the curious.

Participant F pointed out that she would have liked to have a view showing her the notifications she had missed. This is already present in the Toolbar Pop-Up (section 5.2.2), but the fact that she did not realize this highlights the discoverability of this feature as a potential point of improvement.

### 6.4 System Usability Scale Evaluation

The Google Form reproduced in Appendix section A.9 was sent to all interviewees before their interview. In writing this chapter in 2023, I noticed that two participants did not submit their evaluation. I am therefore analyzing the data based on just four replies, knowing that a larger study would improve the validity of the results. <sup>2</sup>

I followed the scoring methodology outlined in *SUS-A quick and dirty usability scale* [B<sup>+</sup>96] (under "Scoring SUS") and calculating scores in the Google Sheet supplied by the Google Form I created the survey form with.

The average SUS score was 82.5, with scores ranging from 67.5 to 95. The scores seemed to reflect the participant's comments in the interviews reasonably well. Sauro provides a chart [Sau11] which maps a SUS score to a letter grade. According to this chart, the average score would be A to B grade, with the minimum score of 67.5 being a middle-of-the-road C.

### 6.5 Pseudonymous Data Collection

To supplement the interviews and SUS evaluation, I additionally looked at the data gathered between April 2017 and November 2019, which is the time frame from when I first looked for participants and until conducted the final interview.

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<sup>2</sup>Though Sauro states that "SUS can be used on very small sample sizes (as few as two users) and still generate reliable results" [Sau11]

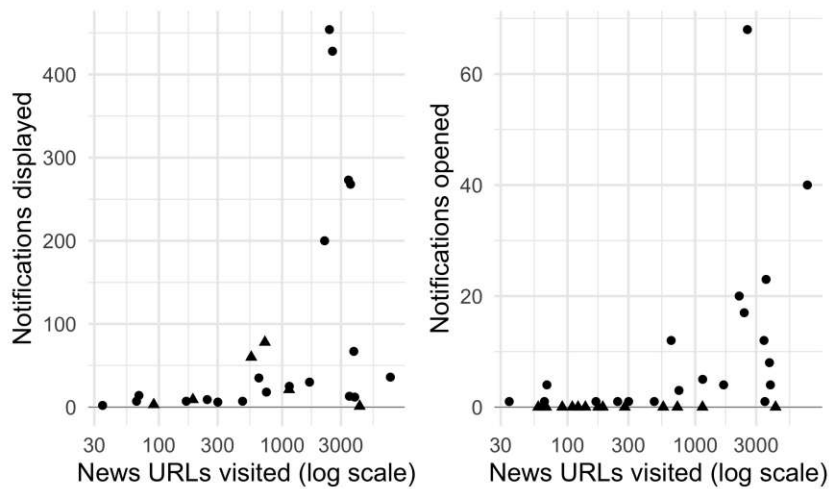


Figure 6.2: Notification interactions vs number of visits to news sites: *This chart shows how many notifications were displayed (left) and opened (right) depending on the number of news pages visited. Note the different scales on the y axis. Pseudonyms that opened zero notifications are shown as triangles.*

This data was only collected if explicitly enabled in the Preferences screen and sent by the plugin every 24 hours (or, if the 24 hours passed while the browser was closed, at the next opportunity).

Data was received for 48 pseudonyms, however, I only considered those which had sent data at least 15 times, and over at least 30 days. This left data for 34 pseudonyms to consider.

It is relevant to note that this is still more pseudonyms than number of users that filled out the survey described in section 6.2. However, users may have multiple browsers (and since the pseudonyms were auto-generated, multiple pseudonyms) or may have uninstalled and reinstalled the extension, which would delete data and cause a new pseudonym to be regenerated, or they may just not all have filled out the survey.

Figure 6.2 shows the relationship between the number of pages a pseudonym visited on news sites and the number of notifications which were displayed and opened, respectively. It shows that people who visited the same number of pages received vastly different numbers of notifications, which may be caused by differences in preferences or behavior. If a user browsed the news in the evening, it may be less likely that changes still occur on the next day versus a user checking the news during the working day.

It also shows that the pseudonym that received the most notifications only opened every 6th or 7th (roughly 400 vs 60). Since a triangle instead of a point is shown if a pseudonym never registered that a notification was opened, it is clear that even users who received 50 notifications or more may have never clicked any of them.



The rightmost point in Figure 6.2 is interesting, since it seems to show a user that visited many news sites, was shown relatively few notifications and opened more or less all of them.

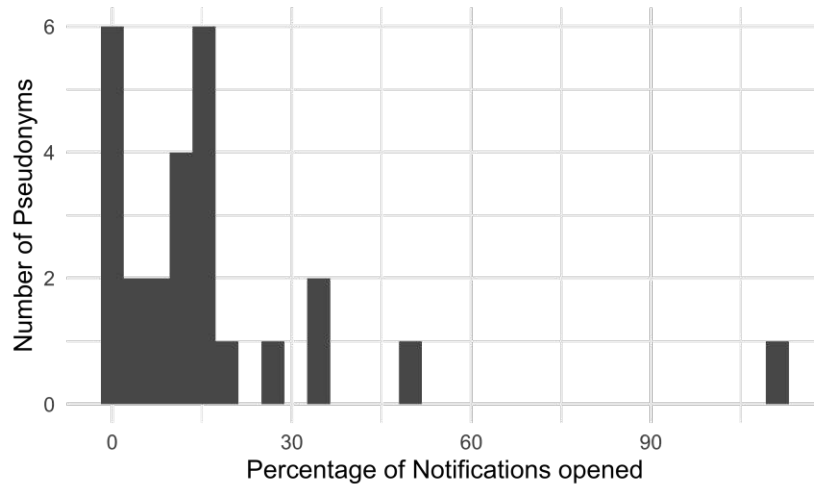


Figure 6.3: A histogram showing how many users opened how high of a share of notifications.

Directly comparing the number of Notifications with how many were opened, as in Figure 6.3, leads to the result that most users opened less than a third of notifications they received and some opened none of them. It also shows a user opening all notifications, confirming the point above.

## 6.6 Issues during the Implementation and Testing Phases

Since the evaluation was conducted during the period between 2017 and 2019, outside developments in the Austrian news industry created some issues. DerStandard.at was relaunched in July 2019 [sta19] and diePresse.com launched a payment model [pre17] in January 2017. Both changes necessitated adaptations to the code used for scraping the pages (section 5.2.1) and the latter change meant that more and more articles were not available in full. This introduced new kinds of changes, such as additional paragraphs of stories being shown or removed on diePresse.com – presumably without the content of the full article, which was hidden behind the paywall, ever changing. It also prevented finding changes in later paragraphs of articles, which were not accessible to the public and therefore the prototype.

Users noticed both these issues. Participant A referred to derStandard.at not working for a while in their interview while Participant B noted that she received notifications with paragraphs appearing or disappearing at the end of stories.



## 6.7 Evaluation Summary

In this chapter, I talked to users about their experiences using the prototype introduced in chapter 5 and set out to find answers to Sub-RQ 7: *What is news consumers experience when they are notified about changes in news they consume?*.

I found out that most users thought positively about their experience using the prototype, which is also reflected in the positive result given to the prototype on the System Usability Scale.

Most felt like they now know more about how the news they consume is created. However, the participants also identified areas that could be improved. This ranged from the fact that features were not discovered and a general lack of guidance for users to the potential for improvements to the categorization of changes.

Tracking data also shows that many notifications were not acted upon, hence users often did not click the notification to find out more about what specifically had changed.



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# Discussion

In this chapter, I will point out the different ways in which this thesis resulted in novel contributions to different fields. I will also relate my results from the previous chapters back to the questions I initially set out to answer.

## 7.1 Contributions

The contributions in thesis emerged as a result of trying to answer a series of questions. I have collected them in three threads: the first explores the news environment in which potential solutions would have to fit in, the second concerns users' requirements, preferences and reactions which together provide answers to RQ1, and the third concerns the technical approach that allowed a privacy-friendly solution to the challenge stated in RQ2.

### 7.1.1 The Austrian News Environment

In the Exploration chapter chapter 4, I validated that the problems pointed out by Craig Silverman [Sil09] and others exist in the Austrian news context. This was a prerequisite to continuing the work any further because the participants I could recruit would mainly be Austrian and therefore frequent primarily Austrian news outlets. I also preferred to test the developed solution in users' real news environment over creating laboratory scenarios, which required understanding this news environment.

To answer Sub-RQ 1: *What kind of corrections occur in online news in Austria, and with which frequency?* and Sub-RQ 2: *How do news outlets inform readers about corrections?* I conducted the - to my knowledge - only survey on alterations to online news articles in the Austrian news ecosystem. The study confirmed that changes in news articles do happen in Austria, and not too infrequently, which was the basis for continuing with the project itself. Since it was done early in my thesis, it only analyzed two outlets of the

five I ended up supporting in my prototype (see section 5.2.1) later during the evaluation phase.

The Exploration chapter also provides expert perspectives on multiple European news contexts regarding Sub-RQ 2: *How do news outlets inform readers about corrections?* and Sub-RQ 3: *What are journalists' experiences regarding corrections?* The interviewed experts noted that different outlets have distinct (and in one case multiple) policies for how to handle corrections and that even if there are policies, there may be differences in how closely they are adhered to between departments. How strictly they are followed or how accurately they are implemented may therefore vary with the position of the journalists and editors responsible for a text. Printed versions of newspapers seemed to have more established workflows around the publication of errata, when factual errors are discovered after the fact. Such are conducted in the next possible print edition. Online, changes may be made transparent by adding a correction notice to the article. Article's comment sections in which users can discuss the articles were noted as one way to learn about mistakes in a story. One interviewed journalist also stated that in their experience, most mistakes are discovered by the journalists themselves or their colleagues. Multiple experts also remarked that changes may occur for different reasons after an article was published: factual or textual corrections are one, updates with new developments or the addition of additional content are other potential reasons.

### 7.1.2 RQ1: *How do users react when notified about alterations in news they previously read?*

Talking to users before creating the prototype and asking users to test it in a real-life context contributes new knowledge about Austrian users' perceptions of news and their reactions both to hearing about news as a fluid medium and experiencing it in a new way through using the prototype.

The Design Workshop (Section 5.1) provided insights into to Sub-RQ 4: *How do consumers perceive online news?* and Sub-RQ 5: *What, if anything, do news consumers want to know if an article was changed after they consumed it?* It showed that some users had experienced changes to news before, in cases when news outlets made those changes transparent by adding a correction notice or when the comment section referred to content that was missing in the text. Users voiced some amount of understanding that changes - even factual corrections - happen, so long as the news organizations handle these alterations transparently. On the question of what information users want to receive when a changes occurs, the Design Workshop (Section 5.1) participants voiced interest in getting notified generally, but all agreed that receiving notifications for every typo that was corrected would not be in most users' interest. Opinions regarding which changes users would like to be notified about varied so much – including one participant mentioning that some users may actually want to be notified about even the smallest changes – that it led me to the decision to make the notification threshold configurable.

Finally, three methods were used to answer Sub-RQ 7: *What is news consumers experience*

*when they are notified about changes in news they consume?* Remote and asynchronous user tests with debriefing interviews in section 6.3, a System Usability Scale evaluation in section 6.4 and an analysis of pseudonymous tracking data (Section 6.5). Users reported interest in the notifications but some also spoke of disappointment when receiving notifications about minor changes. They also voiced an appreciation for the details included in the notifications, such as the article’s title and the severity of the change, which allow them to easily decide if they wanted to know what exactly was changed. However, many reported that they were unaware of the ability to customize what kinds of changes they would receive notifications for. Numerically, the analysis of SUS surveys suggested good usability overall.

A subset of the users interviewed were journalists who reported learning more about the specifics of how changes were handled, e.g. noting that apparently, a copy-editing often happened after they had already read the story. Some stated their surprise at how many changes occurred in their and other media, and at how many of them were not handled transparently by news outlets.

### 7.1.3 RQ2: *How can IT security methods be extended to preserve users’ privacy when informing them about changes in news they consumed?*

For checking if an article was altered after a user read it, this thesis used a pattern similar to Certification Revocation Lists (CRL), which are sometimes used by modern browsers for checking if security certificates were revoked. This solution has been criticized in [NST09] for the large file and download sizes required for storing all revocations that ever occurred.

File sizes were kept small by the prototype only supporting select news sites and by maintaining a list of changes discovered for each day, and checking the three most recent files listing the changes.

### 7.1.4 The Prototype

The fully-functional prototype, which was based on open-source software and is similarly published for everyone to use, inspect and develop further, is one more contribution this thesis. It may provide the basis for future projects which could further improve on it in a number of ways, independently host it, or just extend or alter it to support other news sites in other countries.

### 7.1.5 User Requirements for News Sites Transparency Efforts

Section 5.1.3 lists potential solutions which would require the cooperation of news sites. The Design Workshop participants noted that full transparency – as in the (machine-readable) accessibility of all previous versions of articles – would of course be one option. News organizations could also provide structured data on what changes were made for

which reason, by publishing the time and a categorization of each change. Both could be combined with asking journalists to categorize changes to published articles – especially if the change includes factual corrections – and also making this categorization public. A less involved variant would just include a version number for the article in the URL or source code. This would allow changes to be detectable, though not the reason for why they were performed. Alternatively, a heuristic could be implemented to automatically categorize changes and filter out simple grammatical or typographical alterations.

One journalist noted that any such transparency measures create a potential attack surface for journalists and would have to be actively communicated, explained and/or advertised as a good thing and a transparency initiative by the media outlet to outweigh the potential for critics undermining trust in news.

### 7.2 A Case Study for Usability Testing awareness/ambient Interactions

In subsection 3.1.1, I noted that the implemented system may fall in the *awareness/ambient* category according to Alan Dix' taxonomy of interactions. Such systems are relatively rare and potentially hard to test. This thesis can serve as an example for how to test such a system without resorting to simulations or laboratory experiments while giving participants agency regarding how much data is shared while usability testing and affording them the option of not having tracking data connected to their person.

Other studies testing systems using similar interactions, such as one recent paper in which the usability of Covid-19 tracking apps was evaluated [vKSvG<sup>+</sup>21], have used laboratory settings and methods like eye tracking, but have not focused on the notifications themselves and how they were received by users in a real-life environment.

Of course, this approach does have certain limitations. Since the pseudonym was not generally connected to the participant, questions about their behavior as suggested by the data could only be asked to participants available for (and invited to) interviews. Additionally, the code created for tracking users was hard to test, since it had to run in a diverse set of environments (Chrome, Firefox) and coexist with other extensions, which may have influenced the prototype's behavior.

### 7.3 Usability Challenges for Low-Intensity Applications

The user interviews suggested potential for improvements in the prototype's user experience. Most importantly, as noted in subsection 6.3.6, only half of the interviewed users were aware that they could personalize which notifications they would receive. Some remembered that it had been shown after the extension had been initially installed. The question remains: why did the users forget this page existed and why did they not go looking for it, since some of them did complain about receiving too many notifications?

The root cause could be that the prototype is a low-intensity application, meaning most users barely actively worked and interacted with it. Notifications are the main opportunities for interactions and are unpredictably, infrequently provided by the tool. It seems natural that users would therefore not think about further opportunities for interacting with the prototype.

## 7.4 A Case Study for Privacy by Design

This thesis also provides, in the implementation of the prototype, a case study for a tool which could be developed in a privacy-focused manner without being forced to make compromises. It shows that looking for similar patterns of data transfers in different context can lead to similar solutions and scientific research which provide good blueprints for other areas.

Unlike other privacy-preserving techniques recently published in scientific studies, such as Majeed and Hwangs recent review of Privacy Protections developed in the context of Covid-19 [MH21], the main solution the prototype employs fall in neither of the categories they identified (*Anonymization, Encryption/Cryptography, Obfuscation* or *Pseudonymization*). Instead, the privacy design was based on reversing the information flow, delivering a full list of observed changes in news, which were already public, to the user's computer. This avoids ever transferring personal data like users' browsing habits and preferences regarding which notifications outside of their control.

Server-side logging of requests would have exposed data on the activity of users on the network address the requests originate at. However, subsequent requests by the same user could not be connected to each other, so in moving from one network address to another, a user could not be tracked. Logging was disabled on the server-side anyhow, so no such data was ever collected.

This is likely a rare case in which simply re-engineering an information flow mitigates most relevant privacy issues, since many products do aim to store user data at a central service and therefore could not apply the same techniques.

## 7.5 Interpreting Tracking Data

In analyzing anonymous tracking data in section 6.5, I noted that while one pseudonymous user clicked all notifications, most interacted with less than a third of those they received, and some were apparently shown dozens of notifications and never interacted with a single one.

To interpret these numbers, it is important to note the limits of this data collection and which information is available to the user at which step. The tracking data includes the number of Notifications displayed and the number of Notifications that were clicked. Unlike in a laboratory setting, where eye tracking can reveal if and for long a notification

was looked at and what kind of information a user consumed, I cannot reliably measure if users looked at notifications using this method.

However, it is worth noting that a Notification (as shown in Figure 5.6) already includes the title of the article that was altered and the systems' assessment of the severity of the change. Clicking a Notification provides further information, since it opens a page showing what exactly was altered in the version that caused the Notification to be sent (as shown in Figure 2.1).

While the collected tracking data does not allow a clear conclusion, user interviews indicate that many users used the information already present in the notification to decide if they wanted to know more in this specific context. If they received a Notification stating a the change had a low severity, they may recall previous such Notifications which they investigated and not found interesting, leading to fewer interactions with similar Notifications. The decision whether to interact with a Notification at all may depend on what the user was trying to accomplish when confronted with the choice, as a lab study by Czerwinski et al showed that the time users take to interact with a Notification is related to how relevant its content is to the users' task at hand[CCH00].

As noted above, the tracking data does not include data on how many Notifications the user actually perceived.

### 7.6 Challenges working with Online News

Working in the context of news with its fast-moving, rapidly developing nature had advantages, since it allowed giving clear priorities to recent content (keeping file sizes relatively small by focusing on recent changes).

However, its idiosyncrasies led to difficulties as well. When news sites changed, such as when some were relaunched during the testing phase (section 6.6), they could not be supported by the prototype until code extracting the article text, title, author and byline were adapted to the new website's layout. In one case, this took a number of weeks, and participants noticed, as they remarked in the interviews.

In another case, a paywall was added and full-text versions of articles stopped being publicly available and therefore accessible to the tool in its current form. This paywall functionality apparently allowed editors to decide how many paragraphs were accessible to the public, and changes to this setting led to change notifications without (presumably) the underlying text being altered.

### 7.7 Limitations

Some methodological limitations need to be considered when interpreting or building on the above-mentioned results.



**User Experience Testing** While the methodology presented above is sound, some inconsistencies between tracking data and the interviews could be observed, most relevantly the question why users stated that the notifications were interesting and mentioned sometimes interacting with them to see details on the change while the data shows low rates of interaction.

**Participant Selection** Participants to the Design Workshop and Interviews did not amount to large sample sizes and were likely not representative of the average news consumer. Due to the recruitment methods (e.g. asking members of a hackspace to participate) applied in this thesis, they are likely to be more technically literate. While journalists are often heavy users of news themselves, they were clearly over-represented in both steps of the thesis. Conducting tests with a larger and more representative audience would likely lead to more stable conclusions as well as further insights.

## 7.8 Future Work

**User Tests** As noted earlier (in section 7.7), more representative user tests with a larger number of users could be conducted using the same methodology as used in this thesis. Such an approach could strengthen the findings discussed above and could result in findings on how users react to the prototype depending on how they consume news. One relatively simple improvement to the User Testing methodology could be to augment the methods used in chapter 6 with an in-person session covering the extension’s installation process, which could also be used for testing a variety of improvements to the on-boarding experience. Using a think-aloud process could shed some light on onboarding issues in particular.

### 7.8.1 Improvements to the Prototype

The contents of this thesis could provide the technological basis if a news site decided to implement similar functionality. It could re-use the privacy-preserving architecture even when integrating the functionality in its own website, allowing it to reasonably show that this new functionality does not require tracking users in more detail than before. However, independent projects like NewsDiffs could also be improved by adopting the improvements made for this thesis and further improving on them in the following areas:

**Cross-Device Tracking** For this thesis, the prototype only supported browsers on desktop or laptop computers. According to the Reuters Digital News Report [New18], news usage on smartphones had almost overtaken computer-based news users in 2018. Creating a solution that would be able to track user’s news habits across all their devices as well as enabling change notifications on all of them would likely be worthwhile.

**Better Guidance** Improvements could also be made in the area of usability based on the user feedback already covered in the thesis. Better guidance of new or existing users,

for example by providing a manual or tutorial as part of the extension, could mitigate some pain points. Further, since this is a long-running tool with large slices of time between interactions, users could be reminded of the settings and/or tour regularly. Even an indicator that the extension is working and active would have put one user at ease.

**Algorithmic Improvements** Further, there would be usability benefits from improving the heuristics implemented on the server-side. The algorithm which estimates the severity of a change (section 5.2.1) could be improved by more user testing or even machine-learning approaches involving manual coding of changes.

### 7.9 Summary

This chapter has shown how the Research Questions posed in this thesis were answered and which contributions were made in the process. The main research questions were answered. Users' reactions to seeing changes in news were mostly positive, though there were complaints about the specific implementation (as noted above). CRLs provided a good basis for implementing a privacy-preserving way to receive notifications about news changes.

Further, requirements for potential transparency efforts by news sites were identified, a methodology for testing a rare type of interaction was proposed and usability challenges for applications that are rarely interacted with were identified. I also differentiated the privacy approach taken in this thesis with other recently-published studies, noting that an established categorization system does not apply here. I also reflected on how to interpret remaining questions in tracking data and the challenges working on systems concerning online news.

I also noted which limitations apply to the results discussed in this section and extrapolated potential future work from these limitations and other remaining questions.

## Conclusion

This thesis aims to rise up to Craig Silverman's previously-cited challenge: "*Readers should be able to be notified if a particular article they read has been corrected*" in a way that best meets users' needs and in a privacy-preserving fashion. It presents a way for a news audience to better stay informed about the news they consumed and a possible way forward for news outlets to better inform users about how they generate news. While it only makes processes visible that already play out in the open, it shows them in a way neither intended nor expected by those who produce news.

This is a two-edged sword. It has clear benefits, since it does enable readers to realize that they were misinformed, that changes occurred which may reshape their perception or assessment of the events detailed in a news story in a way that current practices and policies arguably do not.

It also makes imperfections in the processes that shape the creation of online news visible to readers. These processes are often even more optimized for speed than they were in the era of 5PM print deadlines. Some of these imperfections were observed by users I interviewed. A journalist noted that it seemed like copy-editing processes often occurred after he read an article, but also that he was surprised about how many factual changes that were not noted in the new versions of the article he encountered using the prototype. This opens the journalistic and editorial processes up to outside scrutiny, and therefore to criticism. Such scrutiny and criticism, however, is only new to the Austrian news market. NewsDiffs, the system I extended for this thesis, has tracked global news outlets such as `nytimes.com` or `bbc.co.uk` for over a decade and enabled scrutiny of editorial decisions since then. What this thesis contributes is a previously-missing information flow to news consumers according to their individual behavior.

Technically, it would be comparatively easy for news outlets to bring the features this thesis explores to their audience. However, explaining the upside and the intentions of

this added transparency to users, but also to those whose work would be exposed to more scrutiny, would be a larger and more complex task.

This thesis also shows that additional features can be created without negatively impacting users' privacy and without collecting user data in a central location. All functionality was implemented by storing which news sites users visited on their own devices – which is less data than browsers save by default in their browsing history. That this aspect comes up late in the conclusion could be misinterpreted as privacy being an afterthought, a tangent. On the contrary: a privacy-first design and implementation process was at the center of this thesis, the Design Workshop confirmed that users were concerned about privacy even if some may disregard their privacy concern to gain functionality. But since few (if any) compromises were necessary, this leaves very little to say on the topic except to reinforce that critically analyzing data flows and looking for similar patterns in other fields worked for this issue and may work for different problems as well.

Deciding how to test a product such as the one developed in this thesis is challenging, since changes in a real news environment are hardly predictable. If one would want to run a user test in a laboratory setting, it would have to involve creating scenarios and therefore require "faking" a news environment for the duration of a user test. This would come too close to behaviors that detractors of independent journalism might call "fake news". Combining some data collection with user interviews brought interesting perspectives that one method may have missed. For example, the pseudonymous data revealed relatively low rates of interaction for some users. The interviews, however, showed that some users were happy just knowing that changes occurred in a story without investigating what exactly had changed – apparently deciding this based on the information included in the notification alone, depending on their level of interest.

Since news is a (often unreflected-on) part of many people's lives, further research into users' perception of news, especially in the area of corrections and informing users about them would surely be fruitful.

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# Appendix

## A.1 Exploration: Data analysis Scripts

Listing 1: Python script for extracting preliminary data from NewsDiffs database as CSV

```

1 import website.frontend.models
2
3 Article = website.frontend.models.Article
4
5
6 with open('articles_analysis.csv', 'w') as f:
7     for a in Article.objects.filter(initial_date__lt='2015-12-10'):
8         vs = a.versions()
9
10        if (len(vs)>0):
11            f.write(','.join(['{}'.format(a.id),
12                               a.publication(),
13                               '{}'.format(len(a.versions()))],
14                               '{}'.format(max(b.severity for b in a.
15                                             versions()))
16                               ])+'\n')

```

Listing 2: R script for summarising the Python scripts' output for use in Table 4.1

```

1 library(tidyverse)
2
3 articles_analysis <- read_csv('articles_analysis.csv', col_names=F)
4   %>%
5   rename(article_id=1,
6          publication=2,
7          num_versions=3,
8          max_severity=4)
9
10 articles_analysis %>%
11   group_by(publication) %>%
12   mutate(publication_articles=n()) %>%
13   filter(num_versions>1) %>%
14   mutate(publication_articles_multiple=n()) %>%

```

```
15   group_by(publication , max_severity , publication_articles ,
16           publication_articles_multiple) %>%
17   summarise(n=n()) %>%
18   group_by(publication) %>%
19   mutate(max_severity=as.numeric(max_severity)) %>%
20   arrange(desc(max_severity)) %>%
21   mutate(pct=n/publication_articles_multiple*100) %>%
22   select(-n) %>%
23   spread(max_severity , pct)
24
25 articles_analysis %>%
26   group_by(publication) %>%
27   mutate(publication_articles=n()) %>%
28   filter(num_versions>1) %>%
29   mutate(publication_articles_multiple=n()) %>%
30   group_by(publication , max_severity , publication_articles ,
31           publication_articles_multiple) %>%
32   summarise(n=n()) %>%
33   group_by(publication) %>%
34   mutate(max_severity=as.numeric(max_severity)) %>%
35   arrange(desc(max_severity)) %>%
36   mutate(pct=cumsum(n)/publication_articles_multiple*100) %>%
37   select(-n) %>%
38   spread(max_severity , pct)
```

---

## A.2 Exploration: Consent Form

Markus *fin* Hametner – MSc Thesis  
(Vienna University of Technology)  
Consent Form

April 2014

Dear Participant,

For my master's thesis, I'm researching editorial processes around breaking news, changing content, correction policies and errata.

One part of my research will be interviews with journalists. I'd like to interview you and create audio recordings of this interviews. This shouldn't take long, about 15-30 minutes. Please let me know if you have any further questions.

Thanks so much for your help,

*fin* / Markus Hametner

1) Participant's name: \_\_\_\_\_

2) Please tick as appropriate

a) I consent to me being (audio) recorded for the purpose of this research

Yes / No

b) I consent to anonymized quotes being drawn out of the recording

Yes / No

c) I consent to non-anonymized quotes being drawn out of the recording

Yes / No

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

### A.3 Design: Workshop Invitation Email

---

Liebes Metalab,

manche von euch erinnern sich vielleicht noch an mich (:

Ich arbeite gerade (endlich!) an meiner Masterarbeit zu Korrekturen in online-Artikeln und suche dazu für einen Design Workshop (mit potentiellen Usern über ein Problem reden & gemeinsam Lösungsvorschläge erarbeiten) Menschen die manchmal Nachrichten lesen.

Liest Du manchmal Nachrichten?

I WANT YOU an einem Abend irgendwann die nächsten Wochen  
[doodle link]

Was bekommst du?

Eine hoffentlich spannende Diskussion, und ich schau dass Bier und Wein existieren.

Danke vielmals  
-fin

---



## A.4 Design: Workshop Consent Form

Markus *fin* Hametner – MSc Thesis  
(Vienna University of Technology)  
Consent Form

July 2015

Dear Participant,

For my master's thesis, I'm researching editorial processes around breaking news, changing content, correction policies and errata.

One part of my research will be a design workshop - working together with a group of journalists and readers to create potential solutions to the problem of notifying readers of corrections.

Thanks so much for your help,

*fin* / Markus Hametner

- 1) Participant's name: \_\_\_\_\_
- 2) Please tick as appropriate
  - a) I consent to me being (audio) recorded for the purpose of this research  
Yes / No
  - b) I consent to anonymized quotes being drawn out of the recording  
Yes / No
  - c) I consent to non-anonymized quotes being drawn out of the recording  
Yes / No

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

## A.5 Design: Severity Estimation (Code Sample)

Listing 3: Python function for categorizing a change's severity

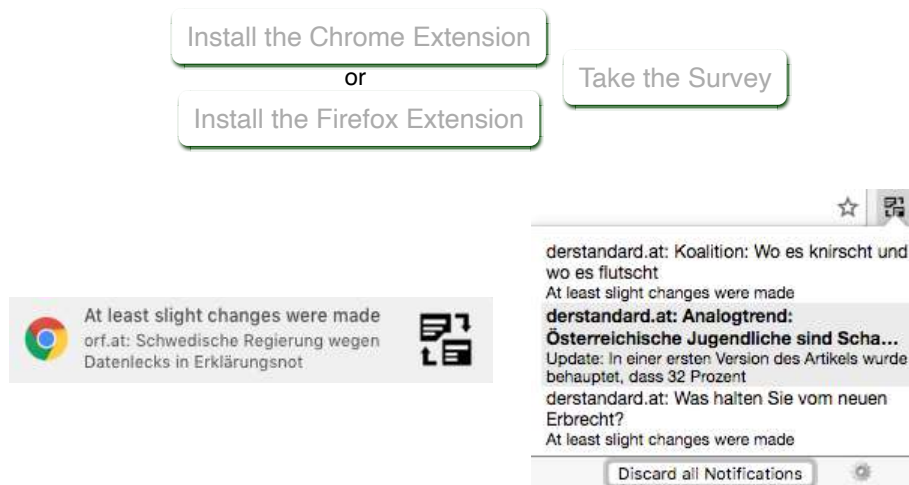
```
1 # in: newsdiff-corrections/website/frontend/models.py (class Version)
2
3 def update_severity(self, save=True):
4     severity = 0
5     severity_comment = None
6
7     if self.diff_info:
8         chars_changed = self.diff_info['chars_added'] + self.diff_info[
9             'chars_removed']
10        if chars_changed > 0:
11            severity = SEVERITY["MINIMAL"]
12            severity_comment = 'At least slight changes were made'
13
14        if chars_changed > len(self.text()) / 5:
15            severity = SEVERITY["LOW"]
16            severity_comment = 'At least a fifth of the length of the
17                article was changed'
18
19        if chars_changed > len(self.text()) / 2:
20            severity = SEVERITY["MODERATE"]
21            severity_comment = 'At least half of the article was
22                changed'
23
24        erratum = type(self).diff_is_erratum(self.diff_details())
25        if erratum and erratum.strip():
26            severity = SEVERITY["OFFICIAL"]
27            severity_comment = erratum
28
29        if severity != self.severity or severity_comment != self.
30            severity_comment:
31            self.severity = severity
32            self.severity_comment = severity_comment
33            if save:
34                self.save()
35
36    return self.severity, self.severity_comment
```

## A.6 Evaluation: fin.io/thesis

### Corrections in Online News

My (Markus »fin« Hametner's) Master's thesis at [Vienna University of Technology](#).

Advisor: [Geraldine Fitzpatrick](#), Professor of Technology Design and Assessment and head of the Institute of Design and Assessment of Technology.



Feature: Notifications on changes in news

Feature: all recent changes in the news you read

### The Study

The news is often perceived as a static medium. Online news articles, however, are often edited after publication. Some edits are minor, some add updates that happened during the day, some are complete rewrites or factual corrections.

For my master's thesis, I am exploring how people react to being notified about changes in news articles that happened after they read them. I am aiming for a duration of 6-8 weeks for this study, and I hope you'll participate.

### Privacy

Tracking what kind of news a person consumes may allow one to infer political opinions and potentially embarrassing information (if the only news someone browses are celebrity sites).

The extension you'll be evaluating is designed with privacy aspects in mind: the raw browsing data never leaves your computer. The server only serves lists of all changes that happened in the past few days, and is not asked for specific changes to stories, to prevent tracking by inference.

### Data Collection

The extension logs which urls you visit on a number of news sites and periodically checks for

changes in their content, by getting a list of changed articles from a server maintained by me. If you agree to participate in the survey – by checking a checkbox – once a day, the following information is then submitted for further analysis:

- the number of URLs (**not the actual URLs!**) visited on news sites
- the number of notifications shown, per day and per “severity” of the change
- the number of notifications dismissed, per day and per “severity” of the change
- the number of notifications interacted with, per day and per “severity” of the change

This helps me analyze how my tool is being used without having to track your exact browsing habits and actions.

Every data submission is tagged with an ID that is unique to your computer and is generated when the extension is installed. This information is only logged and submitted if a checkmark is checked on the options screen – it is off by default. Next to the checkmark, you'll also find details of what will be submitted.

I'm also asking all participants to complete a survey, which asks about your age, profession, and email. You'll also be asked if you'd be available to be interviewed about your experience. The responses to the survey are not linked to the ID contained in the data submissions. They are stored independently of the logging data, using a access-protected Google Form (which means they will only be accessible to me).

Generally, the extension was created with privacy aspects in mind. However, if you want to see details about changes to a story you were notified about, the extension opens a page on one of my servers, showing the before-after view for the change.

In theory, logging visits to the server could be used to help deanonymize users. However, this is non-trivial, and logging is not enabled.

### **Risks to Participants**

There is always a possibility of data breaches by hackers, either on the server the extension is accessing (and sending logs to), or on the user's browser. To mitigate against this, the server software is kept up to date and every effort is made to keep the data secure.

## A.7 Evaluation: Public Survey Form

### Corrections in Online News: Study

Thank you for agreeing to participate in my study. You hopefully have already installed the Chrome Extension and enabled your participation by checking the "Send Statistics for fin's trial & participate in study" checkmark. Please only fill in this form if you have done so!

For more information about this, go to <https://fin.io/thesis/>

The answers you give to this form will not be linked to the data submitted by the extension.

[In Google anmelden](#), um den Fortschritt zu speichern. [Weitere Informationen](#)

\* Gibt eine erforderliche Frage an

My email address: \*

Meine Antwort

When I read news online, I often use the Chrome Browser

- Yes
- No

I mostly interact with news as a \*

- producer
- consumer

My Age:  
(feel free to round to five)

Meine Antwort

My profession:  
(if you'd like to tell)

Meine Antwort

I'll be available for an interview about my experience using the extension: \*  
(If you answer "Yes", I will contact you via Email in April/May 2019)

Yes

No

Thank you for participating in my study!  
If you have any questions, feel free to email me at [fin+study@xbhd.org](mailto:fin+study@xbhd.org)

Senden

[Alle Eingaben löschen](#)

Geben Sie niemals Passwörter über Google Formulare weiter.

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Google Formulare



## A.8 Evaluation: Ethical Considerations Self-Assessment

### Ethical Considerations: “Corrections in Online News”

#### 1) Context

Provide information about your work / project / study to set the scene. Such information should include: funding, motivation, expected scientific outcomes, study design, methods used, reasons for this particular research being important...

For my master’s thesis on *corrections in online news*, I am exploring how users react to being notified about changes in news articles that happened after they read them. I am aiming for more than twenty users to participate over a duration of 6-8 weeks.

The news is often perceived as a static medium. Online news articles are however often edited after publication. Some edits are minor, some add updates that happened during the day, some are complete rewrites or factual corrections.

For this study, users install a browser extension that informs them of changes to news content they previously consumed.

#### 2) Overall Ethical Issues

Describe the ethical issues raised by the objectives of your research, its respective results or findings and the potential consequences of your research outcomes. Provide details about how the identified overall ethical issues will be addressed.

Tracking what kind of news a person consumes allows one to infer political opinions and potentially embarrassing information (if the only news someone browses are celebrity sites).

The extension the participants are evaluating is designed with privacy aspects in mind: the raw browsing data never leaves the users’ computers. The server is asked for all changes that happened in the past few days, not for specific changes to stories, to prevent tracking by inference.

#### 3) Participants

Who are your participants or in which way does your research impact on people. Provide details about how you will be recruiting participants (inclusion/exclusion criteria, sites of recruitment, process...) and how you will obtain informed consent (procedure for informing people, choices offered...). Example information sheets and consent forms are useful too, as appendices.

The following participants are expected to participate:

- Participants of a previous design workshop
- Other students recruited seminars
- Twitter followers, after a public announcement
- Journalists

**Participate in a study by submitting statistics about my behaviour**

The study is part of [fin's](#) master's thesis on Corrections in Online News. It explores how people react to being informed about changes in news they consumed. [More info on thesis & study](#)

**By participating in this study, I consent to the following information being logged and submitted to the server once a day:**

- Number of URLs (not the actual URLs) visited on the tracked news sites
- Number of changes that occurred after you visited the URLs
- Number of displayed changes "marked as read"
- Number of displayed notifications, per hour of day and per category (importance-level) of change
- Number of changes visited via the notification, per hour of day
- Number of notifications marked as read via the notification, per hour of day

[If you participate, please fill in this survey!](#)

Unique Identifier:

Submitted data will be linked to this ID, you can request your data - or the deletion thereof - by emailing [fin](#)

Informed consent is ensured by requiring study participants to opt-in to log collection and the sending of statistics using a checkbox on a "settings" screen which will auto-open after the participants manually installed the extension.

#### 4) Risks and Benefits to Stakeholders

Go through the list of all directly involved or indirectly affected groups of people discussing what the potential risks to them are (e.g., physical, psychological, financial...) and how they might benefit (e.g., reward, self-esteem, new skills, fun...).

Benefits:

- Participants will get insights in the news production process.
- Participants will be informed of updates and changes in the news that interests them

Risks:

- There is always a possibility of data breaches by hackers, either on the server the extension is accessing (and sending logs to), or on the user's browser.

#### 5) Data Collection and Privacy

Explain in detail which data you will be collecting, how you collect it, how it will be stored and secured and what measures will be taken to protect the privacy of people involved.

The extension logs which urls they visited on a number of news sites and periodically checks, if the content has changed, by getting a list of changed articles from a server maintained by me. Once a day, the following information is then submitted for further collection:

- the number of urls (not actual urls) visited on news sites
- the number of notifications shown, per day and per "severity" of the change
- the number of notifications dismissed, per day and per "severity" of the change
- the number of notifications interacted with, per day and per "severity" of the change

These submissions are tagged with a unique ID that was generated when the extension was installed. The information is only logged and submitted if a checkmark was checked on the options screen – it is off by default and accompanied with details of what will be submitted.

Participants are also asked to complete a survey, which asks about their age, profession, and for their email. They are also asked if they would be available to be interviewed about their



experience. The responses to the survey are not linked to the ID used for the data. This data is stored independently of the logging data, using a Google Form.

Generally, the extension was created with privacy aspects in mind. However, if a user wants to see details about changes to a story they were notified about, the extension opens a page on one of my servers, showing the before-after view for the change.

In theory, logging visits to the server could be used to help deanonymize users. However, this is non-trivial, and logging is not enabled.

## 6) Legal Boundaries and Guiding Documents

What relevant ethical and legal documents apply to the proposed research and/or what ethical guidance documents will be relied on? In which ways will these documents apply?

The Data Privacy Act (DSG2000) and the TU Wien Code of Ethics apply. I'm following the 08/2012 version of the AOIR Ethical Decision-Making and Internet Research recommendations.

## 7) Ethics Monitoring

Explain which structures or procedures you have in place to monitor ethics and to be able to react to ethical issues that were not foreseen in this document.

My advisor, Geraldine Fitzpatrick, will be informed of every step taken with regards to the study and data analysis.

Generally, steps are taken to ensure participants know what is happening with their data, why it is collected and who to contact for more information.

## 8) Conflict Resolution

What are the potential conflicts that may arise in the research (e.g., between stakeholders and researchers) and how are they to be solved?

Should stakeholders wish to retract their participation, their data will be deleted upon request.

## 9) Other Ethical Concerns

Are there other ethical concerns that need to be addressed (for example, unintended uses of an application, findings unrelated to the study goals etc.)

## A.9 Evaluation: System Usability Scale Form

### Newsdiff-Corrections: Usability Scale

\* Indicates required question

1. What's your name? \*

\_\_\_\_\_

2. 1 I think that I would like to use this system frequently

*Mark only one oval.*

1 2 3 4 5

Stro      Strongly agree

3. 2 I found the system unnecessarily complex

*Mark only one oval.*

1 2 3 4 5

Stro      Strongly agree

4. 3 I thought the system was easy to use

*Mark only one oval.*

1 2 3 4 5

Stro      Strongly agree

5. 4 I think that I would need the support of a technical person to be able to use this system

*Mark only one oval.*

1 2 3 4 5  
Stro      Strongly agree

6. 5 I found the various functions in this system were well integrated

*Mark only one oval.*

1 2 3 4 5  
Stro      Strongly agree

7. 6 I thought there was too much inconsistency in this system

*Mark only one oval.*

1 2 3 4 5  
Stro      Strongly agree

8. 7 I would imagine that most people would learn to use this system very quickly

*Mark only one oval.*

1 2 3 4 5  
Stro      Strongly agree

9. 8 I found the system very cumbersome to use

*Mark only one oval.*

1 2 3 4 5  
Stro      Strongly agree

10. 9 I felt very confident using the system

*Mark only one oval.*

1 2 3 4 5  
Stro      Strongly agree

11. 10 I needed to learn a lot of things before I could get going with this system

*Mark only one oval.*

1 2 3 4 5  
Stro      Strongly agree

---

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Google Forms

## A.10 Evaluation: Data analysis Scripts

Listing 4: R script for looking up user's pseudonymous data

```
1 library(tidyverse)
2 library(jsonlite)
3
4 PSEUDONYMOUS_IDENTIFIER <- 0 # IDENTIFIER HERE
5
6 raw <- fromJSON('~private/thesis_stats.json', flatten=T) %>%
7   rowwise() %>%
8   mutate(fields.data=list(fromJSON(fields.data)))
9
10 data <- raw
11 data$fd <- lapply(raw$fields.data, as.data.frame)
12 data <- data %>%
13   select(-fields.data) %>%
14   unnest() %>%
15   gather(key, value, -pk:-'fields.identifier') %>%
16   mutate(subkey=str_match(key, '^.*\\.([0-9]+)$')[,2],
17          key=gsub('\\.[0-9]+$',' ', key)) %>%
18   drop_na(value) %>%
19   select(pk:key, subkey, value)
20
21
22 data <- data %>%
23   mutate(month = unlist(lapply(str_split(fields.date, '-'),
24     function(x) { paste0(x[[1]], '-', x[[2]]) })))
25
26
27 selection <- data %>% filter(fields.identifier==PSEUDONYMOUS_
28   IDENTIFIER)
29
30 selection %>%
31   group_by(key) %>%
32   summarise(value=sum(value))
33
34
35 wie_viele_nachrichten_urls <- selection %>%
36   group_by(month, key) %>%
37   summarise(value=sum(value)) %>%
38   spread(month, value)
39
40 welche_popups <- selection %>%
41   filter(key=='notification.opened.details.severity') %>%
42   group_by(subkey) %>%
43   summarise(value=sum(value)) %>%
44   spread(subkey, value)
```

```
45
46
47 wann <- selection %>%
48   filter(key=='notification.opened.details.hour') %>%
49   group_by(subkey) %>%
50   summarise(value=sum(value)) %>%
51   spread(subkey, value)
```

---