Evaluating a Faceted Search Approach for Efficient News Event Filtering

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Abstract

This master thesis presents the process of developing and evaluation of three search interface prototypes of high fidelity. Applying Design Science research for problem-solving, meeting with experts within the news domain to ensure the best possible development of the prototypes as possible.

The aim is to investigate the user's behavior from the three types of search interface and compare the effectiveness of the user's point of view. The goal of the thesis is to find out to what extent the faceted search approach developed is efficient. To do so, I compare to other baseline approaches typically found on the Web to search for news content.

User evaluation was conducted through one experiment to delve into the behavior of the users and the performance of these three interfaces. A baseline search interface includes a search only option. The second search interface shows the summary and which category each article is entitled to. The last search interface (faceted filtering) uses the same establishment as the latter one with addition facets functions. The three prototypes were evaluated with quantitative and qualitative methods for data gathering. *Semi-structured interview*, *questionnaires*, *observation* and *System Usability Scale*(SUS). The feedback was valuable, as a result, indicate a significant difference between the search interfaces from user performance, where the faceted filtering search interface is more efficient compared to the other two baseline approaches search interfaces. The faceted filtering search interface exceeds the baseline and the text summary search interface in performance and outperforms the other two baselines in terms of user satisfaction.

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Chapter 1

Introduction

1.1 Motivation

Printed newspaper and watching television was a traditional way of finding information about news, but as the years passed by these traditional ways has been overtaken by online sources. In order to find the news online, the user has to write a query into a search engine that will give the user several results based on the query. Although it is not that easy to retrieve relevant information which the user is looking after with only a query. In the early days of the Internet, this technique worked quite smoothly as the result of the resources was limited.

The first generation of search engines were concentrating on retrieving text documents through links and analyzing them. Meaning that it did not include interaction with the user to the system. As the Internet expanded, the resource of sharing information had no boundaries. Thus the phase of the second generation of search engines came across.

This growth lead in the direction of developing an automatic way of ranking the resources on the Internet. Not only ranking the result from the query but also how to manage the social network. With the ranking, the need for being in the top-n search resulted in a motivation that leaned towards the business world Pan [2015]. As of displaying its resources on the ranking list, many competitors got on and wanted their resources on the web. This way of trying to have their resources on the top list affected the user and influenced the purpose of the user query. The result from each query became massive and, as a consequence, became exhausting for the one searching. They had to find the result they wanted from – in some cases – millions of hits, comparable to finding a needle in a haystack. This issue started the encouragement of a new angle of the problem with the rank of the relevant content from the user query instead of ranking by personal resources Sudhakar et al. [2012].

A search engine is always changing and trying to be in the favored position, which results in continuous development in technologies. However, nowadays, it is common to have a system that consists of a ranking structure and filtering technology by customary searches Pan [2015]. However, nowadays, it is common to have a system that consists of a ranking structure and filtering technology by customary searches Pan [2015]. The user might become frustrated if he/she has to go through several pages of irrelevant information due to the result of the query having a low precision by the relevancy.

Too much information is hard to be found. In order to overcome the problem of information overload, this thesis will investigate the facets filtering of events in the news domain by implementing three search interfaces and evaluating users' approaches for efficient news events with filtering functions. Nowadays, nearly all the big e-commerce companies have a facets interface implemented on their websites. The facets functionality on these e-commerce sites is to make the discovery and navigation from the user as accessible as possible. This is not a new field of researching; however, it looks like in the news domain. It is not well established yet with the usage of facets.

1.2 Objective

The purpose of this thesis is to find out if a facet filtering search system in the field of news will have better performance and effectiveness in finding the desired information. Even though it exists, the usage is greatly presented in e-commerce companies to enhance their user experience. It is not well adapted yet in the news domain. For instance, the *HuffPost* Huffpost [2019] does not have a facets filtering approach implemented in their news website, nor does the *Yahoo! News* Yahoo [2019] which are ranked 1 in popular news websites Ebizmba [2019]. Thus, it is valuable to find out if facets in the news domain are efficient and investigate if any detectable differences can be found in performance in contrast to the developed search interface.

The essential aim of this thesis is to delve into the aspects of search engine technologies used within the news domain to research if useful information can be extracted and visualized into a display useful for retrieving useful data in the news domain. These aspects consist of retrieving and facets of filtering techniques. To look into this matter, the thesis is based on the data from *Kaggle.com*, a dataset that contains 202,372 records of public news articles, which has been obtained through the American news website *HuffPost* Huffpost [2019] from 2012 to 2018. The different search interfaces that will be developed throughout this thesis will be made up of this data dump from Kaggle. Since the dataset contains other domains than news, the portion of the dataset will be reduced significantly. In order to detect the effectiveness and performance, this thesis will analyze the behavior of the user who was used in this research. Through log analyzing, it is within reach to examine the user's interaction through clicks on the different search interfaces.

This thesis investigates the following research question(RQ):

(1) *RQ1*: In the context of a faceted filtering search interface in the domain of news, is there any detectable differences in performance amongst the developed search interfaces?

(2) *RQ2*: If yes, to what extent does the difference vary?

1.3 Contribution

Three prototypes were developed for this thesis in order to investigate the research questions. The prototypes are a search interface system, where each interface extracts information using different search and facets filtering functions. This thesis explores the development of three search interfaces that retrieves articles in the news domain. In order to explore the performance and effectiveness of user behavior and the search interfaces, a within-subject study was conducted, where each participant evaluated all three search interfaces throughout one study session. Figure 1.1 is an overview of the different steps the evaluation takes in order to tackle the awareness around retrieving relevant information from a support system. Although, in this thesis, the news domain was used, this approach is undoubtedly applicable in other domains. The reason for choosing news articles was that an association with the DNB risk assessment department, who was interested in news about companies. Besides, the adaption of facets functions in the news domain has still not been established related to the big e-commerce sites. In order to validate the quality of the search interface, a dataset from Kaggle.com was used. The use of search interfaces with facets functions in text context for personal and non-personal use can be found in the majority of domains, but not yet adopted in the news domain. It is, therefore, interesting to see if the function of the faceted is a viable aid in finding news articles.

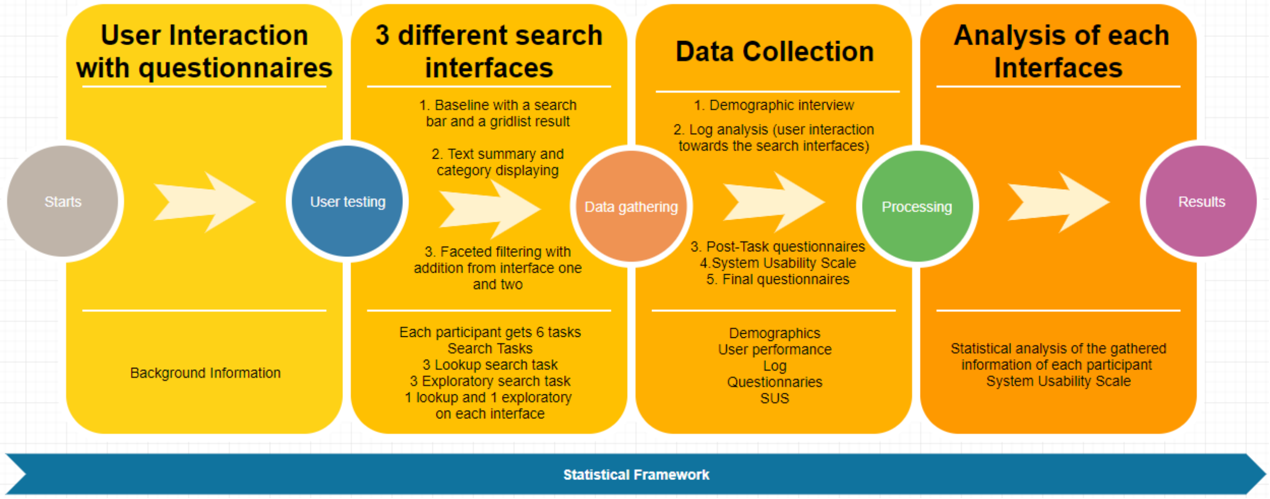

User Interaction with questionnaires
3 different search interfaces
Data Collection
Analysis of each Interfaces
1. Baseline with a search bar and a gridlist result
2. Text summary and category displaying
3. Faceted filtering with addition from interface one and two
1. Demographic interview
2. Log analysis (user interaction towards the search interfaces)
3. Post-Task questionnaires
4.System Usability Scale
5. Final questionnaires
Starts
User testing
Data gathering
Processing
Results
Background Information
Each participant gets 6 tasks
Search Tasks
3 Lookup search task
3 Exploratory search task
1 lookup and 1 exploratory
on each interface
Demographics
User performance
Log
Questionnaries
SUS
Statistical analysis of the gathered information of each participant
System Usability Scale
Statistical Framework

Figure 1.1: Conceptual Model of the process of User Study Design

1.4 Thesis Outline

The master thesis has the following general outline.

Chapter 2: Background and Related Work: This chapter presents the background theory towards this thesis and the related work regarding it.

Chapter 3: Methodology: That has been developed in the research of this thesis, as well as the evaluation of the prototype produced.

Chapter 4: Prototype Implementation: Showing the different iteration of the development that has been carried out.

Chapter 5: Results: This chapter consists of the result from the user feedback and how the system usability evaluation was managed.

Chapter 6: Discussion: This chapter presents discussion evolves throughout methods, methodologies, prototyping, evaluation, and justification for the research question.

Chapter 7: Summary and Future Work: Discusses the conclusion and future work regarding the findings in this thesis and recommendations towards the future development of the system.

Chapter 2

Background and Related Work

This chapter introduces an important concept in *search engines* and presents a review of research that is relevant to this study.

2.1 Search Engines

2.1.1 Search Engines in General

At present, the technologies around us provide a significant amount of data that is expanding faster than our ability to deal with it. All the information can be overwhelming, especially on the Internet, where we can get the feeling of being overrun by the number of data points that are displayed every day, such as news, new books, movies, music, articles, all sort of data that is displayed every day. The Internet has effectively reduced the boundaries of storing and sharing information and thus making it challenging to locate the relevant documents. There is therefore a need for technologies that can help reduce this information overflow Berry and Browne [2005].

In order to handle this overflow of information, a search engine has been developed capable of adding an efficient approach to the accessible data on the Internet Schmidt et al. [2016]. This improvement involves different approaches that will be identified in the next sections. Using a search engine on the Internet, it enables the user to access the desired information with a keywords-searching, called a query. How can we access such information with a query?

A huge part of how to retrieve the desired information lies in how to prepare the vast documents to search in. Namely indexing. With the help of technologies, we can reduce this overwhelming barrier with information overflow. These so-called query statements have to be put into the system of information retrieval by the user. A search engine is a system for document retrieval to help the user find the desired information they are seeking that are stored, for instance, inside a corpus. Furthermore, by using indexing, the search engine operates efficiently and quickly.

2.1.2 Indexing

The reason behind using indexing in a search engine is that if the user does not use it, they will have to search the user query through the whole database of the document and not just the indexing. Thus, it will consult in time-consuming and computer power. By preparing the document, the user has to be careful with their query since a search engine searches through the world wide web with an index of the user's keywords. It is considering that the search engine makes the decisions over the query from the user Kok Yew [2019]. Hence too many keywords will get the user displayed with no result, as in too few keywords will leave the result too many. This means that indexing all the documents needs a high requirement for processing for the document reliably Schmidt et al. [2016]. For a search engine is finding out what the user is after with keyword-searching, it will scan the index of the document in the vast of the Internet for content that is related to the user query keyword-searching. To build an index it requires two detailed steps: Berry and Browne [2005]

- *Document analyzing*: Through analyzing each document in various databases, it is structured in terms of the layout of the document by the title, body, source, and in what way the information is displayed. Through how critically the information in a document is or displayed in another format such as image, table, or graphics. Furthermore, this information, the decision will be based on what part of the document will be indexed and what not.

- *Term extraction or token analysis*: As stated above, the user has to vary of which keyword to use to get the most accurate meaning of the document.

In order to analyze these documents, it is critical that the *Hypertext Markup Language* (HTML) document HTML [2019], that is represented by dozen of tags and labels, such as <title>, <body>, <meta>, heading, paragraph, table, so on, are in editable format. In contrast, tags present how the document is structured and shown on the Internet since a web browser reads these *HTML* documents. Hence the web browser uses these tags to resolve how the document is displayed. A critical point here is that the *HTML* document is valid, meaning that it does not lack the consistency of tagging.

These steps are the act for organizing the web-document with its indexing terms, namely identifying the content of each document. Those behind indexing must have in mind what is essential and how many terms should include. Hence a more judgment of indexing, when we look at the old-fashioned way. The indexer considers the segmentation from the term since it has influenced by the knowledge and experience it has, which means that different indexers will have a different segmentation of the term that will influence the retrieval of information. By using a computer program to analyze the terms and compare the result with other web-document, it is called the automatic indexing. It is used with databases with a vast amount of documents in it. Comparison to the manual indexing, it consists of a so-called web-crawler that searches through the Internet for collecting web-documents and indexing term such as keyword from its text Berry and Browne [2005]. As of manual indexing focus on the summary, title and get a depth of understanding the text while analyzing it, web-crawler takes away the time-consuming limit and open up with analyzing the whole document.

The second step that Berry and Browne [2005] mention is the term extraction. This process involves that the words from the document get extracted directly, sliced, and diced before being stored again. This process involves getting rid of all the formatting of an *HTML* document, leaving only the text. All documents have to be normalized into a standard format for it to simplify the process of normalization. The first to look after in token extraction is the language of the document. After the language has got identified, then the text will be put into UNICODE. Unicode is an industry-standard for handling the representation of text. Unicode has over 130.000 characters and has the essential language mapped into a subset of Unicode character. UTF-8 is the most used one on the world wide web Kowalski.

2.1.3 Processing Token

After the item gets chosen for indexing, the next step is to *zone* the normalized document, which now only is a lump of text and classify the token for indexing. Afterward, the lump of text gets parsed, and each term gets divided within *logical sub-divisions*, making it easier for the user to understand the process. On the point of it gives users an overview, addition to expand the precision of a query and enhance the display of the query. Such term gets divided into a *zone* that can overlay each other, for instance, title, all the way down to bibliography. The information from the *zone* gets moved through the process of classification to store the location of the *zone* Kowalski. It is granting the query from a user to be in the controlled *zone*. Hence if the user is fascinated by an article based on *Stephen King*, for instance, then the search through the text will conclude the desired *zones* and not check the body *zone*. Thus, leaving the *zoning* process to be an effective way to enhance the precision of the search.

When the *normalization* and *zoning* get refined, the dull text character gets divided into processing tokens. Considering that the word is reinvented as symbols, containing numbers and letters between words such as a blank space. Hence the searching part must also manage punctuation, letters, and words. When identifying each processed token, we also eliminate the plain text to the lower character, which means that "t" and "T" will be the same. The next step for identifying the process token is the classifying of the clear-cut word characteristics. In consideration of that, characteristics determine the value as understanding the meaning of a specific word at the same time study of the word. When this part gets done processing, the possible list of processing tokens gets determined.

Furthermore, we can start the next phase with a *stop-list algorithm*. The function of this algorithm takes on the task of eliminating tokens from the possible list to which token that has low value to the user. The following phase is the stemming procedure, which reduces the word to its *root*, for instance, fishing, fished, fisher would be the *root* word fish Kowalski. The reason behind *tokenization* is that the computer does not understand the meaning behind the words like us humans. The structure and recognizing sentence and words are complicated for a program to do since it does not "know" the essence from it. Meaning, by normalization of the text, this process converts the text document into a *bag of word*, whereas the text gets turned into lowercase. Removing terms with no value behind it, for instance, *and*. Also, the text adjusts the words into their base.

Also, nowadays, the author behind web pages can create content, meaning that the web content may contain lies, truth, or contradictions. Thus leaving the question, which web pages are telling the truth or are trustworthy. Although, it depends on each person to whether the content on the web pages are trustworthy or not. Thus, making it challenges to search engines to return reliable data to the user.

2.1.4 Inverted File Structure

A database system is a basic idea to store vast documents on the Internet. The structure in these systems is often an *inverted file structure* (IFS). IFS has a sequence of three fundamentals that follow which web-document consists of which index terms. As mention above, the indexing in the database gives us a more time-saving alternative in the process of searching. The IFS coordinates the entire information into a list of abbreviated terms, built on the query from the user, can reference a collection of documents Berry and Browne [2005]. As stated above, the three fundamentals are: Berry and Browne [2005]

- Document file: Each document has an accustomed number classifier, and all the processing tokens from the document are classified as well.
- Dictionary file: A sorted list with particular processing tokens in the assortment along with pointer from the processing tokens to the inversion list.

- Inversion list: This list concludes the pointer from the dictionary file, meaning the terms pointer to which document containing that term Nakamura et al. [2019].

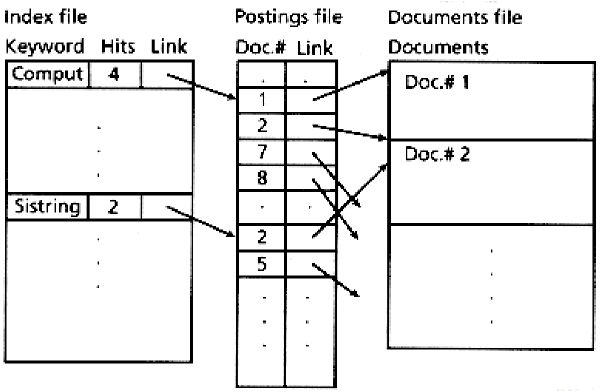


Figure 2.1: An inverted file implemented using a sorted array.
Donna Harman [2019]

2.1.5 Web-Crawling

As mention above, web-crawler is for automatics indexing where the corpus is containing a high number of documents. However, before the documents can be indexed, the web-crawler has to find it. Web-crawling means to follow the links by "crawling" around the websites Introna and Nissenbaum [2000]. When a crawler comes to a web page, it will follow other links that are one that website. Furthermore, the reason for following the links is because it can get a more in-depth look at the website. Another factor for the crawler is going by the links, is that it can show if the website is more trustworthy than another one.

The reason why search engines manage to retrieve some paper from the vast documents in a corpus is the sake of web-crawlers. As stated above, the crawler "reads" everything that they discover. They scan the wide world web of web pages to examine what words the different document contains and where they are used. The "finding" of word from the crawler gets turned into major indexing, hence the automatic indexing. In essence, it is a giant list of the words the crawler has "found", addition to its document. In that way, users can give a query to the search engines and ask for "trump". The search engine will then check only the indexed documents, not the whole corpus itself, and give the user a list of pages that contains the term "trump" in it.

The crawler also crawls the web frequently, so the problem with the web-pages that keep updating is not a problem, so the crawler consistently has indexing that's up to date of the web. Many factors can alter the crawling; as of unfairness, people might say why their web-pages are not one of them that are indexed. Below is a list of some of them to understand:

- *Domain name:* Domain should consist of value keywords, those domains that do that receive importance. Hence the higher rate of importance to the one who has active traffic on it.
- *Internal Links:* Deep linking on a web-page that links to another web-page or resource, as of a document or image.
- *Backlinks:* The more backlinks to the web-page, the more *trustworthy* will the web-page been in the eye of a search engine. However, if the web-page has a good ranking, although the backlinks are low, the search engine can consider that the web-page has low-quality content on it.
- *Duplicate Content:* When the web-page has repeated content, spread all over the web-page, and in the worst case, it will ban the site.
- *XML Sitemap:* By setting up an XML sitemap, Google will be informed, and their crawler can visit that web-page also.
- *Meta tags:* To have unique meta tags on the web-page, will ensure that to get a higher chance to be on a high place in the ranking list in the search engines.

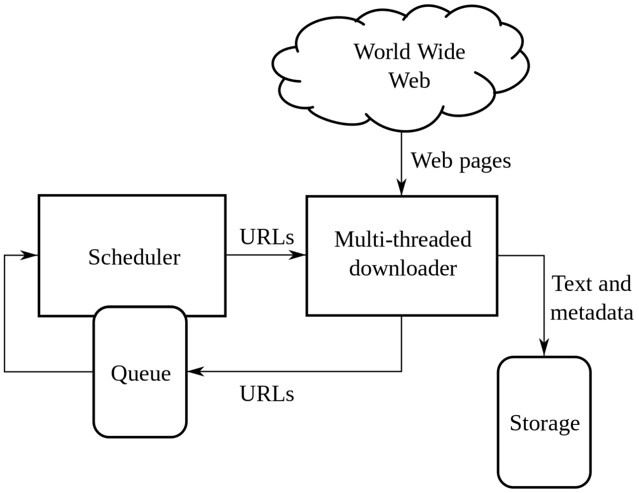


Figure 2.2: The architecture of a web-crawler.

Web-Crawler [2019]

2.1.6 Page Ranking TF-IDF

With indexing a large number of documents in a corpus, the task for retrieving that document from a user query has become natural to everyone using the Internet, that people do not even think about it when doing it. Thus, this increasing use of retrieve data from a query, have started research for generating enchantments solutions to the query retrieval problem. One approach for dealing with indexing is the support of *Boolean* queries Nakamura et al. [2019]. These queries check whether or not the query itself is a match with a document. The problem with this approach is that when a corpus has a vast of documents in it, the result that will be retrieved can overrun the ability for a human to inspect. Thus making it important for a search engine to have something called *rank-order* or *page ranking* Behnert and Lewandowski [2015], to match documents with the user queries.

From indexing making document retrieve by metadata, for instance, that way for retrieving document allows us to be straightforward a mean of scoring of each tokens *(words)*. We are thereby ranking the documents by the reply to a query as the user wants the “best” result back from their searching. Thus making the ranking method the core of the system. One popular approach is the *term frequency-inverse document frequency* (TF-IDF) weighing Wu et al. [2008]. However, before putting the TF-IDF together for scoring tokens, we have to understand what TF and IDF exactly is. In the short term, weighing (word weighing) is determined by the action to estimate and appoint value to each term (word) for the sake of emphasizing its commit in separate a specific document against other documents.

Term Frequency Term weighting is a process to compute and assign a numeric value to each term to weight its contribution in distinguishing a particular document from other Wu et al. [2008]. The most popular approach is the TF-IDF weighting scheme, i.e., term frequency (TF) times inverse document frequency (IDF) Wu et al. [2008]. The next step to make it possible for each token to have its score, because of a document that possesses a term (token) more frequently, must have a higher value, accordingly should grant a higher score. Term frequency is just exactly what it implies: The frequency of each term (in a text-document that would be a word), appear in that specific document. For instance: In a document d that’s 600 words long, that is consisting of 15 times of the term t *“trump”*. The TF for the word *“trump”* would be.

$$tf_{t,d} = TFtrump = 15/600 = 0.025 \tag{2.1}$$

If the “trump” is more frequently in the document, *higher*, the weight of that particular term will be, thus, making it more valuable than the other terms. Through weighing each term in a document, the most straightforward way is to appoint the score which each term has gotten from the TF. Leaving us with the weighing schemes of $tf_{t,d}$.

Inverse Document Frequency As good as it sounds, the TF might face a crucial problem. Because all terms are somewhat treated evenly noteworthy during the time to appraise the applicability on a query. Although some term has light judgment ability in concluding importance. An illustration of that would be an assortment of documents on the IT industry. The term “IT” would presumably have a high chance of being in nearly all of them. To solve this problem, we can suggest an approach for reducing the effectiveness of terms that appear more frequently in that assortment of documents to be essential for applicability importance. This suggestion is to use the frequency of a document df_t, characterized to consider the number of documents in the assortment that consist of the term t Wu et al. [2008]. The calculation of document frequency df of a term, stand for the total number of the document in a corpus (collection of documents) N, we then can define IDF of a term t as:

$$idf_f = \log \frac{N}{df_t} \tag{2.2}$$

Hence, the IDF of an infrequent term will have a high score, although the IDF of a common term is reasonable to have a low score. Let us continue with the example above with the term *trump*. That term appears n times in a collection of documents with a size of 8,000,000 million. Supposedly there are 0.18 million documents that consist of the term *trump*. Thus, IDF is prone by the total of documents divided by the document consisting of the term *trump*.

$$IDFtrump = \log \frac{8,000,000}{180,000} = 1.64 \tag{2.3}$$

To combine these two terms for a TF-IDF weigh scheme, we multiply them together as follows: whereas W is the weighed scheme.

$$Wtrump = (TF * IDF)trump = 0.025 * 1.64 = 0.041 \tag{2.4}$$

This number we get from the weighing scheme is the “value” of that term in our example, which means that we can now get a higher understanding of how valuable a term is within a document in a corpus.

The extraction of keywords is the abbreviated model of the document, and these keywords are broadly used to determine the query among *information retrieval* (IR). From the above, we introduced one of the methods for extracting keywords or entities. By modifying the TF-IDF method, we can get the *top-n words*. By using this approach, we sort the score from the TF-IDF in descending order and extract the top words from that list. With the *top-n words* Datta et al. [2017], we get to see the relevance that each keyword has. Furthermore, we can use this descending list for ranking.

The reason why it is important to extract keywords can be because of judging a sentence in a document that catches the users' interest, that might be worth reading. We also create the decision to either that sentence is worth the time to read. Also, we can classify the sentence or keywords to any category. For instance, a particular sentence is referring to let us say the word "cyber" or "screen". The entire objective for keyword extraction is to retrieve relevant terms in a document, so that special term can be scored up against other terms. As mention above, a higher score points out that this particular term is more applicatory in that document. Thus in this manner, it adds an interest analytical to determine other keywords that are assumable worthy of being a keyword.

2.1.7 User Query Categories

The query that the user types into the search engine can get categorized into three groups; nevertheless, some queries will appear in more than one category.

- *Informational:* Explore the broad information on an immense topic, as in cancer or fashion. Usually, on the web, all the information about the topics is not on one web page, so in queries like informational, the user will try to comprehend information from different web pages.
- *Navigational:* Explore not multiple web pages but instead want to find one entity, such as SAS (airline). Thus leaving the assumption that the user would want the first search will contain the home page of SAS. However, the reason for the user is not curious or interested in other web pages that consist of the term SAS.
- *Transactional:* A user is looking for the use for carrying out a transaction. Meaning that a user wants to purchase something, make a reservation, for instance, on a restaurant or download a file. A user that is in this category should get returned a list that provides such transaction information they are looking for.

2.1.8 Current State-of-the-Art in Search Engines

The exponential increase with the data online is getting out of hand. This ongoing increase of data has transferred a new hindrance to obtaining and analyzing the data Nakamura et al. [2019]. Before this growth, the first generation of the search engine was about searching through a relative small directory, as it was not that much data. The second generation, which based on a keyword that is corresponding to each other, and link analysis for essential ranking consideration, nevertheless, determine the trustworthiness behind a web page. Meaning that the search engine takes the structure of each web-page into account Andrei Broder [2002].

The third generation of search engine introduced universal searching, as a search can include multiple information types, from books to an image. Also, a fresher result for events that are currently ongoing, hot topics, to be more relevant to the users who are searching. This change alters the ranking algorithm for a more freshness update. Also, a new algorithm arrived for *over-optimization*, meaning that it punishes for aggressive use of web-spam, unnatural linking the web page overall. A search engine in this generation looked at the problem from understanding and returning the most identical result towards the growth of voice searching. This conversational search can use *natural language processing* (NLP) and semantic search into account, with how humans are functioning as of thinking and searching.

Also, the use of a machine-learning algorithm to help the search engine to filter all the result from a search to give the best result back to the user. Meaning that the search engine is using machine learning to teach itself on how to rank web-pages, in preference to getting taught by humans. Also more on-wards to quality on the Internet. Algorithm to check whether it has high or low-quality content. The purpose is to weed out the lowest quality content web pages in the ranking system. The content has to be accurate, trustworthy, and authentic and not fake. This is resolving the user's getting a better result from their query.

2.1.9 Framework

Elasticsearch (ES) Elasticsearch [2019] is a search engine framework and scalable to search vast documents of text data with tremendous speed. It is open-source and used for developing a search application. It offers application program interfaces (APIs) and works with JSON (JavaScript Object Notation) documents files to store data, which means that it is possible to appeal to servers with multiple programming languages. Not only that, but addition ES support real-time search on the data Meaning that every data that gets uploaded is searchable the minute it gets added.

The structure of ES is based on documents, and not by tables or schema. As in, the ES index is very much alike tables in *Relation Database Management System* known as RDBMS. In the act of each table is like a selection of rows, just like each index is a selection of documents in ES. This means, rather than storing the data in rows of columnar, and the data gets stored in documents with a JSON format. The way the data gets indexed is the same approaches, as mentioned in Section 2.1.4. It offers recovery, distributed indexing, load-balancing query, replication, and automated recovery, which means that if its manage well, it will become remarkably scalable, reliable, and fault-tolerant for a search engine.

The difference between RDBMS and ES structure is:

Table 2.1: The comparison between RDBMS and ES systems.

RDBMS	**ES**
Database	Cluster
Shard	Shard
Table	Index
Column	Field
Row	Document

The following notion are key concepts in the ES, and they are:

- *Node:* Relates to an instance when ES is running. It is a server that stores the data. When ES is starting, the user starts with a single node; therefore, the user also has a cluster of one node.
- *Cluster:* A collection of one or more nodes that are connected is called a cluster. Since the nodes have to be connected, they also associate with each other in that event can forward the client request of the other nodes in the cluster. This cluster holds together the entire user data.
- *Index:* An enhanced collection of different types of documents, where each document is a selection of fields. Inside this selection, the data get contained by a key-value pair. In other words, ES index data in every field, and each of these fields has a committed data structure additionally. For instance, the text field structure is an inverted file structure.
- *Document:* It is a collection of fields that represents in a JSON format. Nonetheless, all documents do reside to a type and exist inside an index. In order to identify each document, they get correlated with a unique identifier called $_{i}d$ field.
- *Shard:* The problem with storing an extensive amount of data, the data can surpass the limit of the storing places of an individual node. ES supports a piece called shard. Shard provides an approach that subdivides the index into numerous properties of documents. In itself, a shard is a fully operating index. When the index gets subdivided into these so-called shards, the representing is a horizontal scale of the data. The logic behind it is that each document consists of all properties of each document, although the number of JSON objects is less than the index.

- *Replicas:* With all different nodes and shards, which gets uploaded and stored in a cloud environment since the size of the data is enormous. The possibility of a malfunction can be expected to be happening. In this scenario, it would be quite valuable and not least recommended to have a backup operational mode mechanism in the event of one or more shards of nodes disconnect or worst case disappear. Replicas allow the user to clone one or more index shard's which then are called replicas (replica shards).

2.1.10 Text Similarity

For comparing two documents to each other in *information retrieval*, similarity functions can be used for comparison — also, weighted schemes. In the term IR or data mining, this function is measuring the distance between each feature of the object in a dimension. If the distance of the vectors is close to each other, the object will have a higher similarity than if the distance of the vector is broader, meaning lower degree based on similarity. The similarity is mostly dependent on the domain itself because two *fruits*, for instance, will have similarities between taste, color, shape, or size. Meaning that one should take into consideration the troublesome situation when calculating distance from features across an unrelated dimension. For shielding that erroneous from unrelated features, the values of each element are required to be *normalized*, considering that one feature could wind up dominating the calculation of the feature.

Aforementioned, this function gets measured in the range between 0 and 1. The main factors in similarity are:

Where A and B are two objects.

Similarity = $0\ if\ A \neq B$

Similarity = $1\ if\ A = B$

Three functions that are widely used for text similarity to determine the scores in IR are:

- Dice

$$Dice(A, B) = \frac{2|A \cup B|}{|A| + |B|} \tag{2.5}$$

The dice coefficient is for measuring the similarity between sets A and B. In our case, between two documents. If the two sets of documents are equal, meaning if the element in them contains the same, then the coefficient is measured to 1.0. On the other hand, if document A and B have no elements that are comparative to each other, the measure is 0.0. If, in different circumstances, the measuring will get ranged between 0.0 and 1.0. Below is a demonstration of the formula.

Table 2.2: Two documents with a set of terms where one term is shared.

Set A	**Set B**
Table	Soap
Soap	Chair

$$Dice(A,B) = \frac{2|soap|}{|table, soap| + |chair, soap|} \tag{2.6}$$

$$Dice(A,B) = 2 * 1/(2+2) = 2/4 = 1/2 \tag{2.7}$$

- Jaccard

$$Jaccard(A,B) = \frac{|A \cap B|}{|A \cup B|} \tag{2.8}$$

Jaccard gets used for comparing the similarity of characteristics for finding the similarity between the set of data. Shown above is the formula by the Jaccard index. It is theoretically a proportion of how many characteristics in two sets get compared to each other out of the total number of characters the two sets have together.

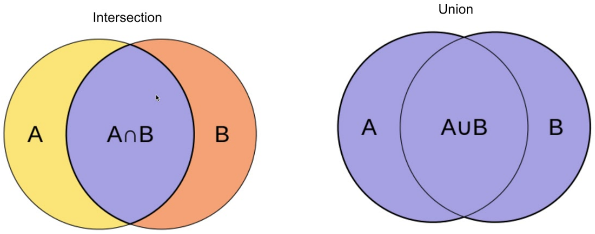


Figure 2.3: Jaccard Index

- Cosine

$$Similarity(A,B) = \frac{A * B}{||A||\ ||B||} \tag{2.9}$$

Cosine similarity gets used to determine to what degree the similarity between documents is regardless of the size of the documents. In order words, this metric measures the cosine of each vectors angle in an n-dimensional space. Moreover, these vectors are containing the word counts of the documents.

These tree similarity functions are for measuring importing keywords and the importance of it, as stated in Section 2.1.6; the weighting schemes refer to the term TF-IDF. By using one of these three approaches with the weighting schemes for a scoring approach, these function uses the TF and IDF. In contrast, the importance of a word in a document may not be that important if it has lots of repetition in a document.

2.1.11 Features in finding similarity

If we look at the fundamental of unstructured data of text, such as the body or abstract in an article, user reviews from an electronic component or even critics, finding features in this domain for similarity can be of *meta-data* in the structure of attributes. Meaning that the attributes can have a different symbol in them. To mention a few, the attributes can be of a *brand*, *sales item* or *price*.

Another popular feature can consist of *labels* as *tags*. Usually, a label is a representation of an item, serving as a word or phase of words. As mention in Section 2.1.3, the *bag-of-words* is a model representation of the *labels*. In content-based similarity uses quite simple yet powerful methods for information retrieval such as *TF-IDF* in Section 2.1.6, or the *TF-IDF weighted model*. Finding similarities is not restricted to one domain.

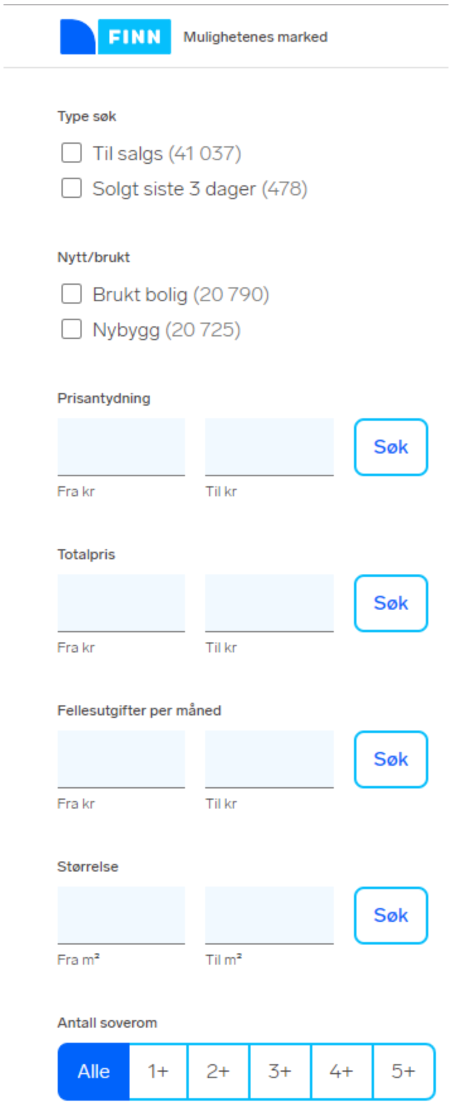
There are broad approaches for computing similarity between information entities. These entities can be of above mention, wholesome features in the music domain such as artists, musicians, genre, length, melody, instrumental — an alternative in the movie domain, for instance, genre, actors, director, a language so forth. There are many more domains than only these three, but stated in Section 2.1.10, one must be careful about computing various features.

2.1.12 Navigation Search

The section until now has been about general usage of how a search engine works. For a search engine to be even more advantageous for helping people to find what they are after, a technique that focuses the search even further, a so-called *facets navigational search* Vandic et al. [2017]. The term *facets* means in the field of information science, has been used as representing the properties and its value of elements, in order words, organize the information. The information that gets organized can be, for instance, topic, category, brand, color, price, weight, etc. Thus is making e-commerce sites a perfect area for using navigation search Teevan et al. [2008].

The support of the faceted search can filter out different data for narrowing the search even further when it is necessary to refine their query. For instance, at the website *Finn.no*, the user wants to look for a house. The user can choose from which type they want to look at location, area, price, how many bedrooms, and so on. The usage of faceted navigation to filter the product's properties and its value will help the user to discover their interest much faster than searching through every house in Norway.

Furthermore, as one can see in this example, a faceted search can be concatenated for a more in-depth search. Thus leaving for a faster keyword search. Figure 2.4 shows a portion of the different facets of *Finn* is using. The website uses different approaches to the filtering methods; a user can either type or use the check function for narrowing down the search. How the faceted navigation search was used in Figure 2.4, which integrates with the query search and the properties and its value of the information, has been profitably in many fields. As briefly discussed in e-commerce sites, but also a digital library and desktop search. Their information is well organized with metadata.



FINN Mulighetenes marked

Type søk

□ Til salgs (41 037)

□ Solgt siste 3 dager (478)

Nytt/brukt

□ Brukt bolig (20 790)

□ Nybygg (20 725)

Prisantydning

Fra kr Til kr Søk

Totalpris

Fra kr Til kr Søk

Fellesutgifter per måned

Fra kr Til kr Søk

Størrelse

Fra m² Til m² Søk

Antall soverom

Alle 1+ 2+ 3+ 4+ 5+

Figure 2.4: Different facets of the website Finn.no

Finn [2019]

2.1.13 Summary

One of the essential measures in the search engine is the quality of the result from a user query. How to extract and find the critical data that the user is looking for has been discussed in Section 2.1.6 and Section 2.1.10. In addition to navigating the search in Section 2.1.12. The process of automated indexing the documents with a web-crawler and tokenize the text into a normalized document. This way will help the document to analyze it further. This process gets called for parsing the data as a result of breaking down the sentences into bits and describe each bits' role. Indexing is quite an essential aspect in retrieving data, whereas it shortens the time significantly if the corpus is composed of millions of documents. As seen above, measuring the similarity between text has more than only one approach, considering that finding data that correlates, similarity approaches use different kinds of methods to measure the density of a word.

As seen in Section 3.2, the basic concept with dealing with unstructured, storage, and representation of data, is *IR*. Because on the web, the web pages include text multimedia content. Hence processing this data is a tedious task. This process makes a user able to search through a dozen of documents with just a user query. *IR's* aim is for searching after information that a user is looking to find. Within this process, we have two forms:

- *Browse*: Common searching for information.
- *Retrieval*: Looking for the desired information that a user is searching after. Instead of commonly looking for information, this information is focused and purposeful.

The state that the web is in now is a time with information overload, hence the state of making a decision or continually be informed by a specific topic is limited. As discussed in the previous section, various tools can help the user in retrieving information or look up content on the Internet.

2.2 Related Studies

As briefly discussed, there are many different approaches and combinations toward a system that can be extracted and retrieve information — this section presents previous studies in a research field of search engines. As stated above, the development within this *sub-field* has not stopped moving; existing tools continue to improve; new approaches are always under development and are proliferating. We will be focusing on exploratory support systems, such as faceted search and similarity searches retrieval in text documents.

2.2.1 Keyword Identification in Text Documents

As Nakamura et al. [2019] stated, the most central way of an *IR* task would be the *ad-hoc* search task. This indicates that it is essential for returning a ranked list that contains the most relevant documents from the desired information the user is looking after. That is the goal for the searcher. One way to look at it is that the searcher is looking for discovering new information or looking for information about a subject. Hence, the searcher is relying on the search engine that presents the relevant documents Silva et al. [2015], Antonio Mouriño García et al. [2018] points out a common technique for representing text in a document. Namely *Bag of Word*. This BOW model was represented in Section 2.1.11. This model lets one arrange the frequency of each word in a document. Hence a list of the relevant document can be made. For a system to be favorable, it has to be capable of ranking search results Behnert and Lewandowski [2015]. However, Sciascio and Gmbh [2018] mention that only having a ranked list of relevant documents is still favorable in their popular format but loses value if the technique is left alone. Because of how much clarity the searcher has of the domain or understanding of the information they are looking Diriye et al. [2010]. However, the problem regarding the BOW model appears when highly frequent words begin to stand out in the document.

The paper Behnert and Lewandowski [2015] investigate six different groups of importance ability factors for the ranking search result and giving a better solution to the text matching, namely TF-IDF. As stated above, the intuition behind this approach makes “rare” words more essential and universal term wordless. This approach can be seen as an extended version of the Boolean model Nakamura et al. [2019]. Which represents a simply easy model that states whether or not the user query is matching the text document. The approaches that have been discussed so far is one of the most effective search techniques — especially looking from meaningful information from a large corpus of text documents. One of the significant steps with any dealing with the text model is pre-processing, as discussed in Section 2.1.3. Although, searching through a full-text document may give some problems as the variables can get out of hand. To be able for all these variables to become apparent, the data we are looking for have to get put into features. Moreover, from here, it can be extracted. These features are characteristic of the text document.

2.2.2 Support System

Despite only returning a ranked list of relevant text documents, we have seen that this standard approach alone is opaque and under-informative Hearst [1995]. Alternatively, a search engine should display more attributes that are associated with the relation between the text document and the query Hearst [1995]. To improve a general-purpose search system interface with a ranked list displayed, we have to explore the support of the *Exploratory search systems*.

ESSs go beyond the standard search system and target to help the user in creating awareness and understanding in supporting their decision making. Hence this support system helps the user to amplify their rate of gaining rich information. Diverge from a simple; however, a powerful search interface, the exploratory search interface has been studied on with different functions towards investigating, learning, and synthesize the information user gets from their queries. These functions consist of different suggestions towards user query, a preview of the queries, detailed knowledge and interest, and more for tuning a support system into helping users finding their information and also decision making. This activity for seeking valued information to the users is in a continuous stage, which keeps developing every time modern systems make an appearance Palagi et al. [2017].

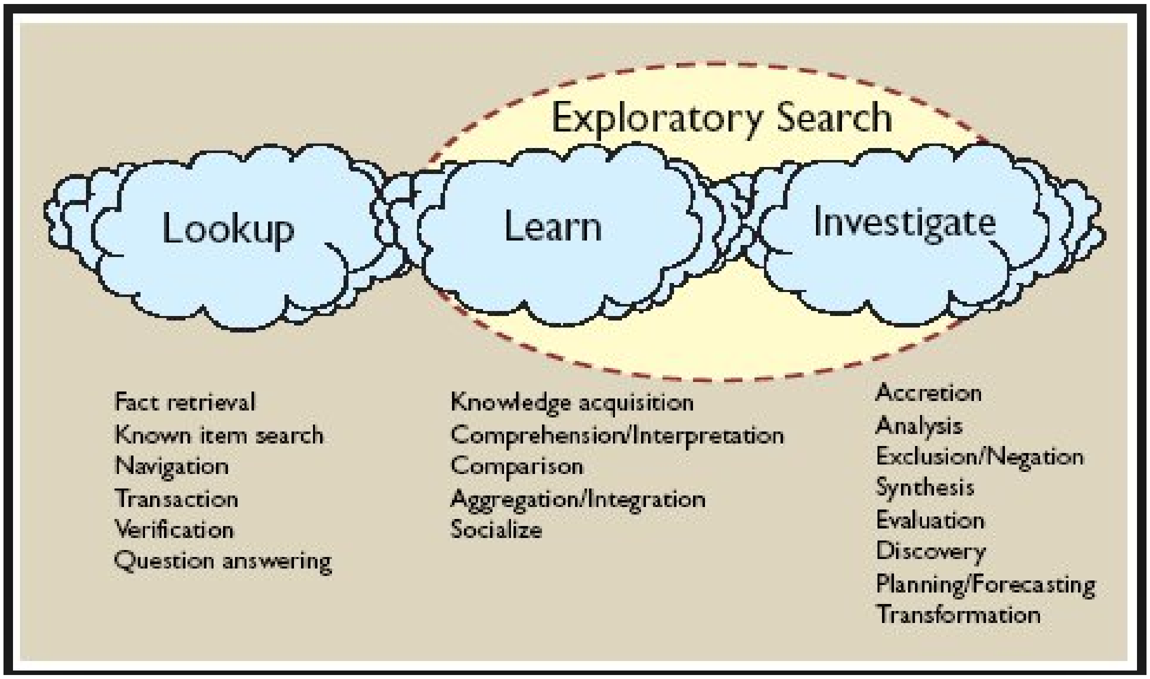
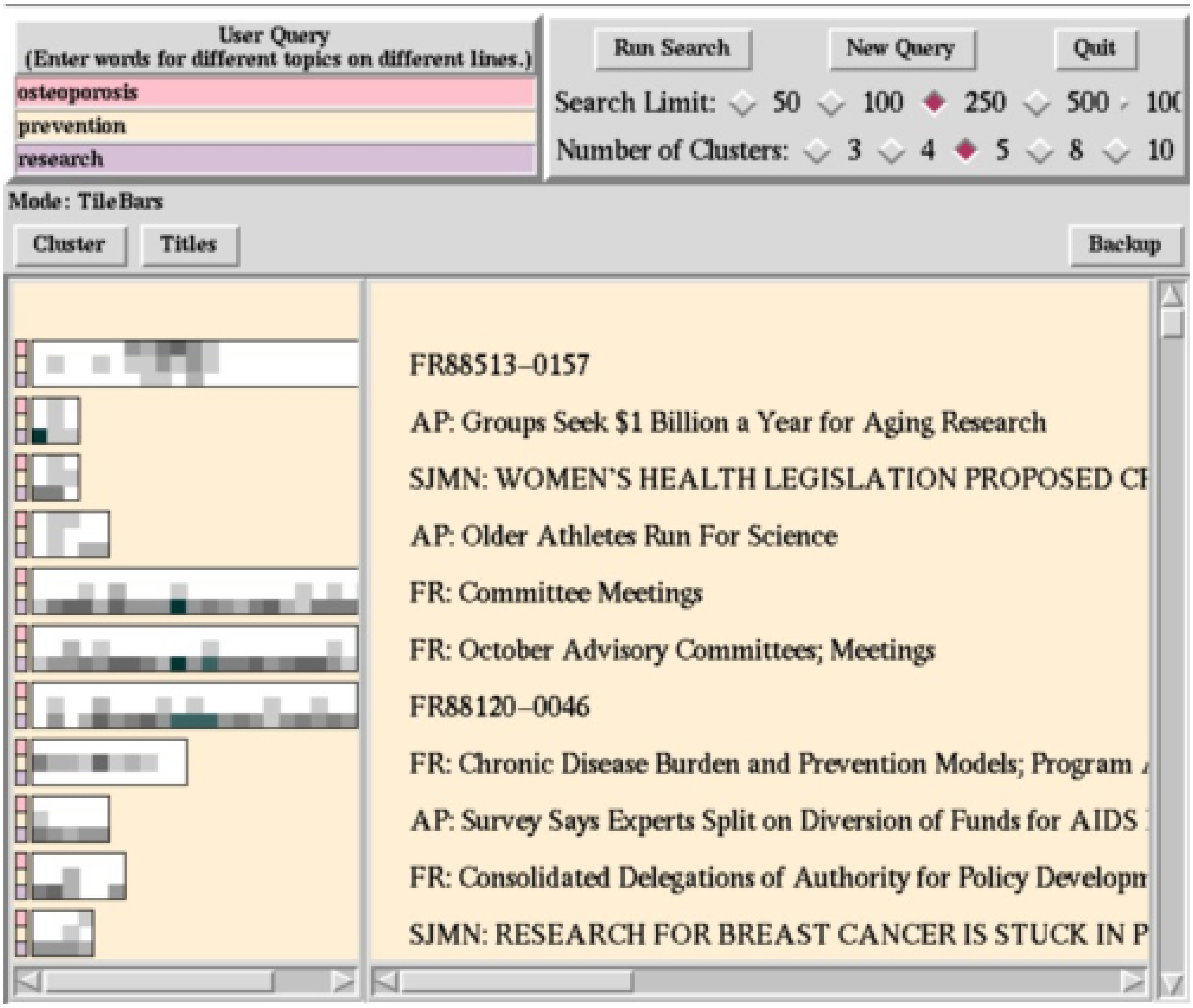


Figure 2.5: Search activities.
Marchionini [2014]

As shown in Figure 2.5, it demonstrates three kinds of labels of searching activities, lookup, learns, and investigate. Exploratory search focus on the learn and investigate labels.

There have been many developments of support systems in the past, such as TileBars Hearst [1995], which is a display paradigm that grants the user to concurrently view the relative frequency of a query term, the relative document length which has been retrieved and also marketing possessions. In order words, a visualized system that focuses and represents information term distribution in a full-text access system. In Figure 2.6, the representation of the TileBar is shown. In order to assist the user, the system can be sorted or filtered corresponding to users' routine and frequency of the query term's.



User Query
(Enter words for different topics on different lines.)

osteoporosis
prevention
research

Search Limit: ○ 50 ○ 100 ● 250 ○ 500 ○ 10(

Number of Clusters: ○ 3 ○ 4 ● 5 ○ 8 ○ 10

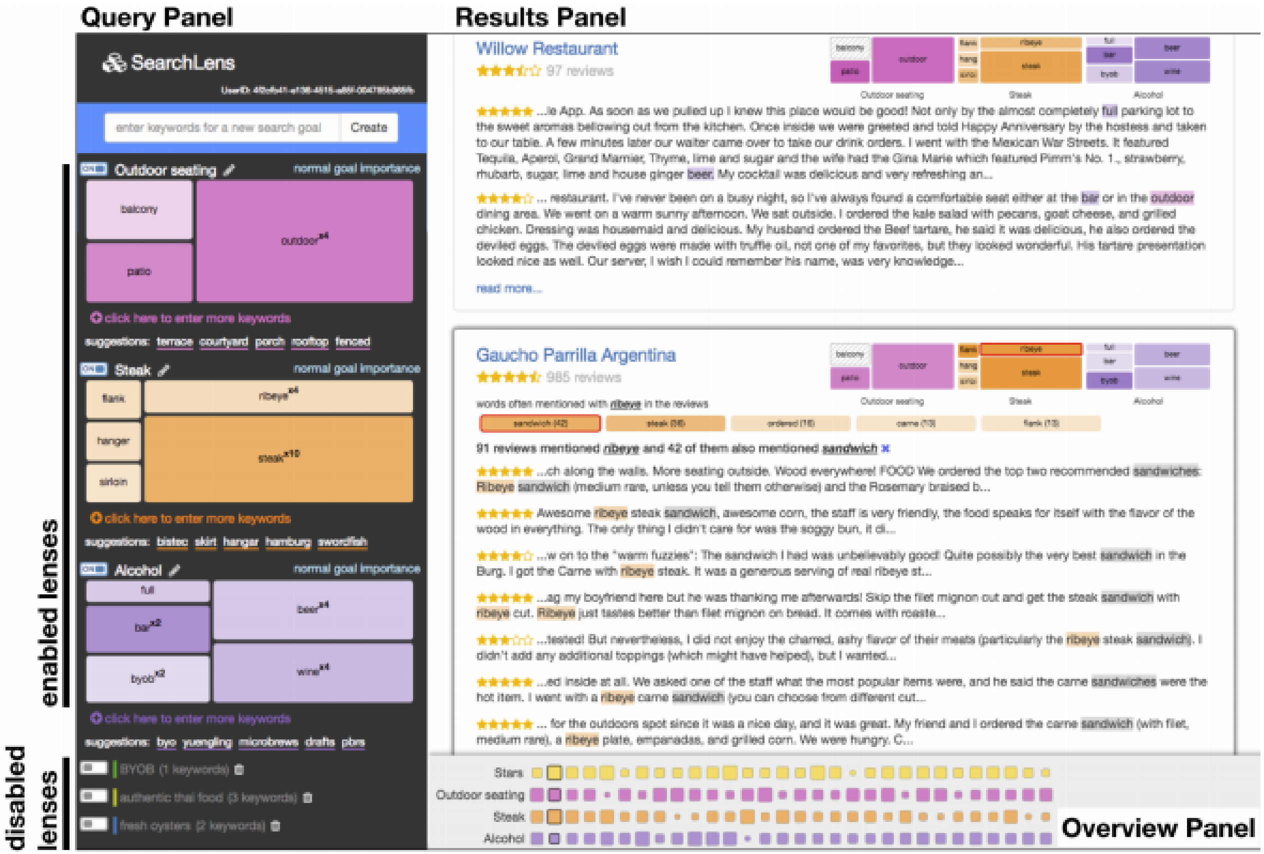
Mode: TileBars

FR88513–0157
AP: Groups Seek $1 Billion a Year for Aging Research
SJMN: WOMEN'S HEALTH LEGISLATION PROPOSED CI
AP: Older Athletes Run For Science
FR: Committee Meetings
FR: October Advisory Committees; Meetings
FR88120–0046
FR: Chronic Disease Burden and Prevention Models; Program
AP: Survey Says Experts Split on Diversion of Funds for AIDS
FR: Consolidated Delegations of Authority for Policy Developm
SJMN: RESEARCH FOR BREAST CANCER IS STUCK IN P

Figure 2.6: Tilebar UI. The rectangles correlate to documents length, and the square correlates to text pieces. The dimness of a square illustrates the frequency of the terms while titles and original words are shown on the right, next to the rectangles.

Hearst [1995]

Similar to the studies above, Chang et al. [2019] are tackling the problem by capturing the desired information with a tool that lets the user construct a representation. This representation is of their interest as what they describe as a “Lenses”. These lenses influence an exploratory tool, which grants the user a way to quickly understand and make a decision based on the ample reviews of data. An example of their tool is shown in Figure 2.7.



★★★★★ ...le App. As soon as we pulled up I knew this place would be good! Not only by the almost completely full parking lot to the sweet aromas bellowing out from the kitchen. Once inside we were greeted and told Happy Anniversary by the hostess and taken to our table. A few minutes later our waiter came over to take our drink orders. I went with the Mexican War Streets. It featured Tequila, Aperol, Grand Marnier, Thyme, lime and sugar and the wife had the Gina Marie which featured Pimm's No. 1., strawberry, rhubarb, sugar, lime and house ginger beer. My cocktail was delicious and very refreshing an...

★★★★☆ ... restaurant. I've never been on a busy night, so I've always found a comfortable seat either at the bar or in the outdoor dining area. We went on a warm sunny afternoon. We sat outside. I ordered the kale salad with pecans, goat cheese, and grilled chicken. Dressing was housemaid and delicious. My husband ordered the Beef tartare, he said it was delicious, he also ordered the deviled eggs. The deviled eggs were made with truffle oil, not one of my favorites, but they looked wonderful. His tartare presentation looked nice as well. Our server, I wish I could remember his name, was very knowledge...

read more...

words often mentioned with ribeye in the reviews

91 reviews mentioned ribeye and 42 of them also mentioned sandwich ✖

★★★★★ ...ch along the walls. More seating outside. Wood everywhere! FOOD We ordered the top two recommended sandwiches: Ribeye sandwich (medium rare, unless you tell them otherwise) and the Rosemary braised b...

★★★★★ Awesome ribeye steak sandwich, awesome corn, the staff is very friendly, the food speaks for itself with the flavor of the wood in everything. The only thing I didn't care for was the soggy bun, it di...

★★★★☆ ...w on to the "warm fuzzies": The sandwich I had was unbelievably good! Quite possibly the very best sandwich in the Burg. I got the Carne with ribeye steak. It was a generous serving of real ribeye st...

★★★★★ ...ag my boyfriend here but he was thanking me afterwards! Skip the filet mignon out and get the steak sandwich with ribeye cut. Ribeye just tastes better than filet mignon on bread. It comes with roaste...

★★★☆☆ ...tested! But nevertheless, I did not enjoy the charred, ashy flavor of their meats (particularly the ribeye steak sandwich). I didn't add any additional toppings (which might have helped), but I wanted...

★★★★★ ...ed inside at all. We asked one of the staff what the most popular items were, and he said the carne sandwiches were the hot item. I went with a ribeye carne sandwich (you can choose from different cut...

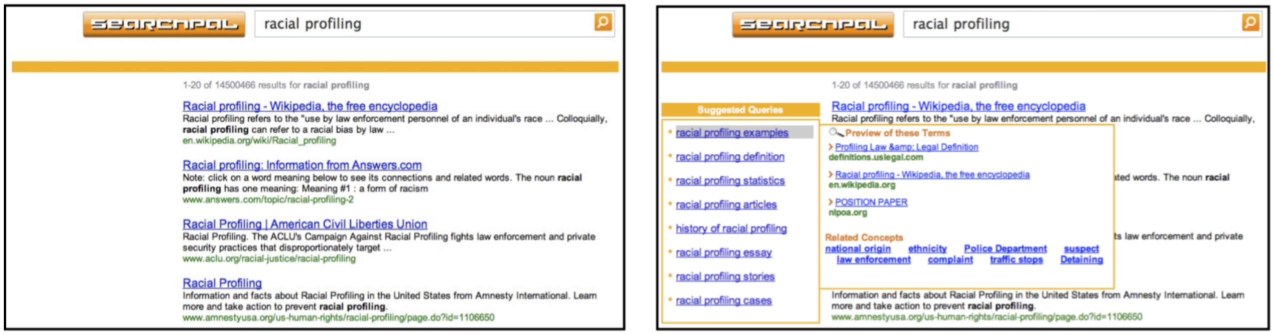
★★★★★ ... for the outdoors spot since it was a nice day, and it was great. My friend and I ordered the carne sandwich (with filet, medium rare), a ribeye plate, empanadas, and grilled corn. We were hungry. C...

Figure 2.7: The display of the system SearchLens.
Chang et al. [2019]

The paper from Diriye et al. [2010], tackle the problem with search tasks and search interfaces and investigate the relation between them. By answering the question, they are using a user study to explore the effects each interface has regarding search tasks. In the domain of Information Science and Retrieval, search tasks can get categorized into Known-items and exploratory tasks. The difference between them is in the brightness of what the information they seek, how knowledgeable they are in the domain, and analyzing the information. Their user study consisted of known-item and exploratory tasks. This user study demonstrated two interfaces where one had a baseline, and the other interface supported exploratory search. The baseline interfaced mirrored the trendy layout of the search engines that Google uses. The function of this baseline presents a search box and a result of the top 20 searches from the user's query.

The study design did conduct with a repeated-measures 2X2 within-participant. The data that were collected contained both qualitative and quantitative data to analyze the relationship between the two interfaces deeply. They used the standard measuring, such as task-completion time, precision with interactive, and the usage of the system overall. This was along with the qualitative methods such as screen-recording of how the user where behavior fronting the search tasks, questionnaires, and interviews.

Their findings in this project were that the system support is more effective only when its enabling search activities that are convenient to the task the user is doing. Also, the level of knowledge regarding the search system seems to play a massive role in finding the desired information. They found out that a search interface that enables support to the user activity that gets correlated to the search task; this way, the system helps the user to address their problem efficiently. Differently, overdone and unrelated support can restrict the user's progress and mislead the searcher. Figure 2.8 demonstrates the two interface that was used in their research.



1-20 of 14500466 results for **racial profiling**

Racial profiling - Wikipedia, the free encyclopedia
Racial profiling refers to the "use by law enforcement personnel of an individual's race ... Colloquially, **racial profiling** can refer to a racial bias by law ...
en.wikipedia.org/wiki/Racial_profiling

Racial profiling: Information from Answers.com
Note: click on a word meaning below to see its connections and related words. The noun **racial profiling** has one meaning: Meaning #1 : a form of racism
www.answers.com/topic/racial-profiling-2

Racial Profiling | American Civil Liberties Union
Racial Profiling. The ACLU's Campaign Against Racial Profiling fights law enforcement and private security practices that disproportionately target ...
www.aclu.org/racial-justice/racial-profiling

Racial Profiling
Information and facts about Racial Profiling in the United States from Amnesty International. Learn more and take action to prevent **racial profiling**.
www.amnestyusa.org/us-human-rights/racial-profiling/page.do?id=1106650

1-20 of 14500466 results for **racial profiling**

Suggested Queries
- racial profiling examples
- racial profiling definition
- racial profiling statistics
- racial profiling articles
- history of racial profiling
- racial profiling essay
- racial profiling stories
- racial profiling cases

Racial profiling - Wikipedia, the free encyclopedia
Racial profiling refers to the "use by law enforcement personnel of an individual's race ... Colloquially,

Preview of these Terms
> Profiling Law &amp; Legal Definition
definitions.uslegal.com
> Racial profiling - Wikipedia, the free encyclopedia
en.wikipedia.org
> POSITION PAPER
nlpoa.org

Related Concepts
national origin ethnicity Police Department suspect
law enforcement complaint traffic stops Detaining

ted words. The noun **racial**

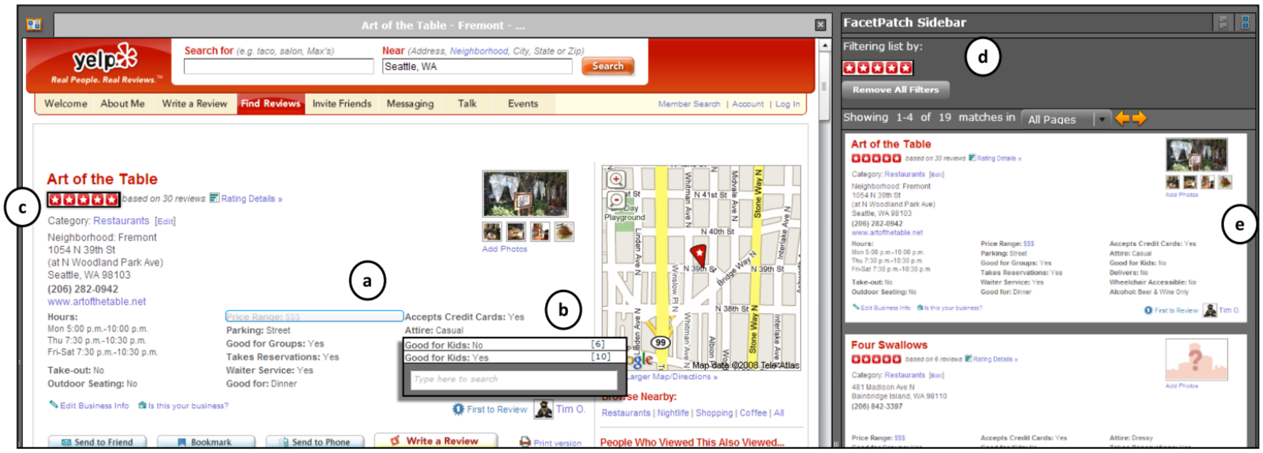
ts law enforcement and private

Information and facts about Racial Profiling in the United States from Amnesty International. Learn more and take action to prevent **racial profiling**.
www.amnestyusa.org/us-human-rights/racial-profiling/page.do?id=1106650

Figure 2.8: The baseline(left), and the exploratory search(right) system. Diriye et al. [2010]

2.2.3 Faceted Search

When users are uncertain about looking for information, searching through using only keywords may not be efficient as it appears. Thus an ample researcher has been researched in a field that supports to navigate the user through information. One of these techniques is faceted browsing Wei et al. [2013]. Furthermore, these techniques assist the user in an excelling understanding in a domain filled with information. Medynskiy et al. [2009], for instance, presented a technique called *contextual facets* for facets browsing. The essence is that this technique alters the static elements in a webpage, into user interface components. However, it does not separate the query interface. They developed a prototype called *FacePatch*, which explores their techniques, which enhance the faceted navigation system. The prototype function like a normal web browser, including a sidebar from view the *contextual faceted*, which comes from the user query, which is shown in Figure 2.9.



Near: Seattle, WA

Art of the Table

based on 30 reviews

Category: Restaurants [Edit]
Neighborhood: Fremont
1054 N 39th St
(at N Woodland Park Ave)
Seattle, WA 98103
(206) 282-0942
www.artofthetable.net

Hours:
Mon 5:00 p.m.-10:00 p.m.
Thu 7:30 p.m.-10:30 p.m.
Fri-Sat 7:30 p.m.-10:30 p.m.

Take-out: No
Outdoor Seating: No

Price Range: $$$
Parking: Street
Good for Groups: Yes
Takes Reservations: Yes
Waiter Service: Yes
Good for: Dinner

Accepts Credit Cards: Yes
Attire: Casual

Good for Kids: No [6]
Good for Kids: Yes [10]
Type here to search

Showing 1-4 of 19 matches in All Pages

Art of the Table

based on 30 reviews

Category: Restaurants [Edit]
Neighborhood: Fremont
1054 N 39th St
(at N Woodland Park Ave)
Seattle, WA 98103
(206) 282-0942
www.artofthetable.net

Hours:
Mon 5:00 p.m.-10:00 p.m.
Thu 7:30 p.m.-10:30 p.m.
Fri-Sat 7:30 p.m.-10:30 p.m.

Take-out: No
Outdoor Seating: No

Price Range: $$$
Parking: Street
Good for Groups: Yes
Takes Reservations: Yes
Waiter Service: Yes
Good for: Dinner

Accepts Credit Cards: Yes
Attire: Casual
Good for Kids: No
Delivers: No
Wheelchair Accessible: No
Alcohol: Beer & Wine Only

Four Swallows

based on 6 reviews

Category: Restaurants [Edit]
481 Madison Ave N
Bainbridge Island, WA 98110
(206) 842-3397

Price Range: $$$
Accepts Credit Cards: Yes
Attire: Dressy

Figure 2.9: FacetPatch interface with contextual facets.
Medynskiy et al. [2009]

Among other domains, we see that it is a great quantity of research such as image Trattner et al. [2012], digital library Bogaard et al. [2019], Wilson and Schraefel [2008], movies Koren et al. [2008] and desktop search Cutrell et al. [2006]. We see in e-commerce sites that the elements of a product have the same values, such as price, brand, size, or category, which provide clear navigation to the user. These benefits are exceedingly well with faceted navigational searches. Nevertheless, the problem of this navigational search is not yet well adapted in the news domain, which can be that the elements nature are assorted and broad as we see that these e-commerce sites have limited their assortment of user tasks Koren et al. [2008].

As mentioned earlier in a commercial application, the use of facets search on e-commerce sites is the leading way of searching. Figure 2.4 shows a straightforward faceted search interface used in Finn [2019]. From the demonstration shown from *Finn*, we can see that the faceted search easily corresponds to the exploratory items in the search task, in this example, the products. Also that the use of accessing their content.

2.2.4 Summary

In this chapter background, search engine techniques get introduced, an overview of related studies, and that different techniques improve the overall performance and are greater than separated tools effects. We also see that *IR* approaches manage to perform satisfactorily in more than one domain. Although, when it comes to the similarity of text, the *IR* methods such as *Cosine Similarity*. With this approach, it is needed to convert sentences from the text into vectors. One way to do this is the famous method *TF-IDF*. As discussed in Section 2.1.10, we have, for instance, *Jaccard*. The matter with this method is taking in only the unique word in a text; on the other hand, the *Cosine* measures the total length of the vector. Thus leaving *Jaccard* in a favorable choice for using when duplicated words do not matter and the length of the size documents in the corpus. We also see that the supporting of faceted function in a specific domain, whether it is personalized or non-personalized (e.g., images, movies, actors, or e-commerce sites), the news domain is not well adopted yet for faceted functions.

Every paper lands on the same conclusion, that the fundamental way of finding information that the user needs, gets outperformed with the support of search techniques. However, adding too many functions to the support can hurt the overall performance and give the user disorientation and discontent. With this in mind, the importance of feedback from the user plays a significant role and also the level of knowledge in searching for information for developing this type of system. Nevertheless, the usage of faceted function in e-commerce websites is quite normal these days and is adapted well in navigating users in discovery information. However, this feature is not well adapt yet in the news domain.

Chapter 3

Methodology

This chapter will take you through methods and the research methodology, Design Science, which have been used throughout this research project. Along with displaying the methods for data collection for evaluation.

3.1 Similarity in Text Fields

In this thesis, the similarity algorithm used in matching the articles is called *TF-IDF*. The Okapi BM25 algorithm is the default algorithm that Elastichsearch and Lucene is using. From release five and below in Elastichsearch, the default similarity algorithm for text fields uses the classic *TF-IDF*, which are briefly discussed in section 2.1.6. The current version in the three prototypes are using, is of the release of five, as stated in the beginning. This similarity algorithm is *TF-IDF*, which gets the relevance of each document. Meaning that each document gets a score that gets represented to them, and that score is a positive float number. When the score of the document is higher than the other, that means the document is more relevant than other documents. With this score, we can rank each result into a ranking-list of displaying the most relevant documents. *TF-IDF* will be a base algorithm in the three search interface because the several technologies used with Elasticsearch and Appbase are not compatibility with the newest release.

3.2 Design Science

This study adopts the framework of Design Science. Design science research is an approach that initiates and operationalizes research along with expanding the boundaries from organizational and human capability through constructing innovative artifacts or a recommendation Esearch et al. [2004] — thus forming this method into a solution-oriented discipline on problem-solving. Also, to be a process which accordingly deals with analytic of design of an object, it provides an establishment of evaluations for that object, or rather exchange the information the results and perceive the artifact Esearch et al. [2004]. Although the process is oriented to solve problems, the solution that arises from this process can achieve as an adequate solution towards the situation yet if it is not optimal Esearch et al. [2004]. In that account, the developed artifact does not have to be a finish solution, but rather a prototype that can display proof of concept, which means that this central approach factor is to adapt to problem-solving.

It concerns to understand a given problem fully. The Design Science approach can get managed by developing and evaluate artifacts that permit a new production of the assets through differing the link to an improved level Esearch et al. [2004]. With the assorted action, this method benefits from continuous design and evaluation with the iterative process. The evaluation phase, contribute feedback which helps to understand the given problem of the situation and improve the overall quality of the artifact Esearch et al. [2004].

3.2.1 Design Cycle

An insight towards the method Design Science gives the awareness to three main concepts in design cycles, when considering to design an artifact, correspondingly in Design Science. As shown in Figure 3.1, the three cycles are *relevance cycles*, *rigor cycle* ,and *design cycle*

These are essentials factors. The first cycle, which is the relevance cycle, is linked to the environment surrounding the proposed artifact. As for the rigor cycle, it connects to the Design Science process by utilizing prior knowledge of various skills, which are essential for the construction of an artifact. The last cycle is the design cycle. The design cycle is a bridge between relevance and rigor cycle. It links them together, making it iterating among options and evaluation of design, to provide a release of the artifact. Hence, the progress of each process can be able to contribute brand-new awareness to the knowledge base, which can contribute a new application in the surrounding environment.

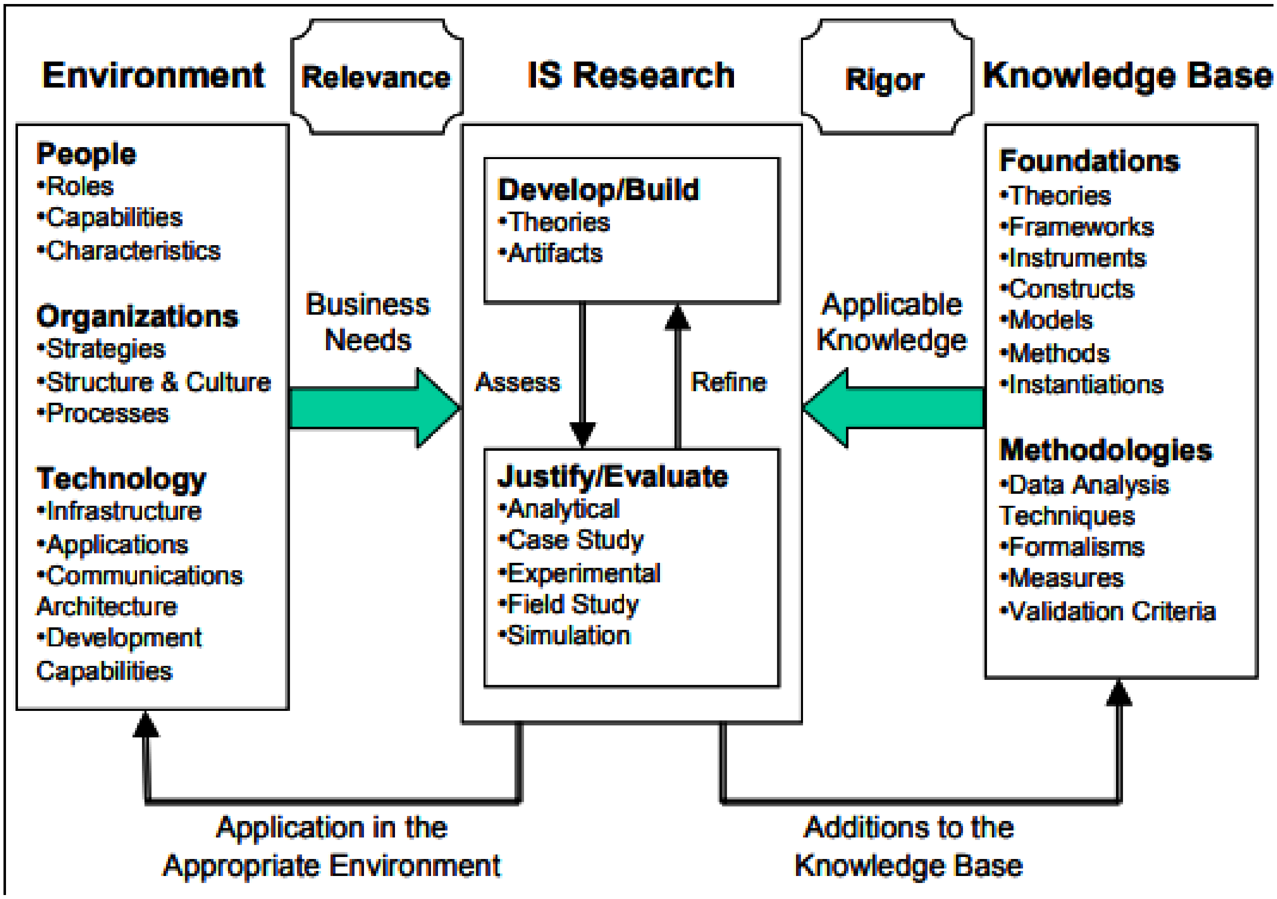


Figure 3.1: Design Science Research Cycles.
Esearch et al. [2004]

3.2.2 Guidelines

In a way to help with conducting the research, Esearch et al. [2004] has presented seven guidelines for implementing and evaluating of Design Science. The different guidelines are concentrating on the meaningfulness and modernization of the design from the artifact in a stated problem domain, where it gets regular evaluated. As the artifact have to be innovative, it must be able to solve a known problem or an unsolved problem in a better adequate way. Nevertheless, one of the seven guidelines also indicates the importance of a rigorous structure that represents which also adapts the artifact along with the matter at hand. With this in mind, the artifact can then be used in new research for studying or implement the outcome of the artifact. The seven guidelines are shown in Figure 3.2, with a brief explanation for each guideline. This thesis has been followed these guidelines as close as possible for achieving a good result in Design Science.

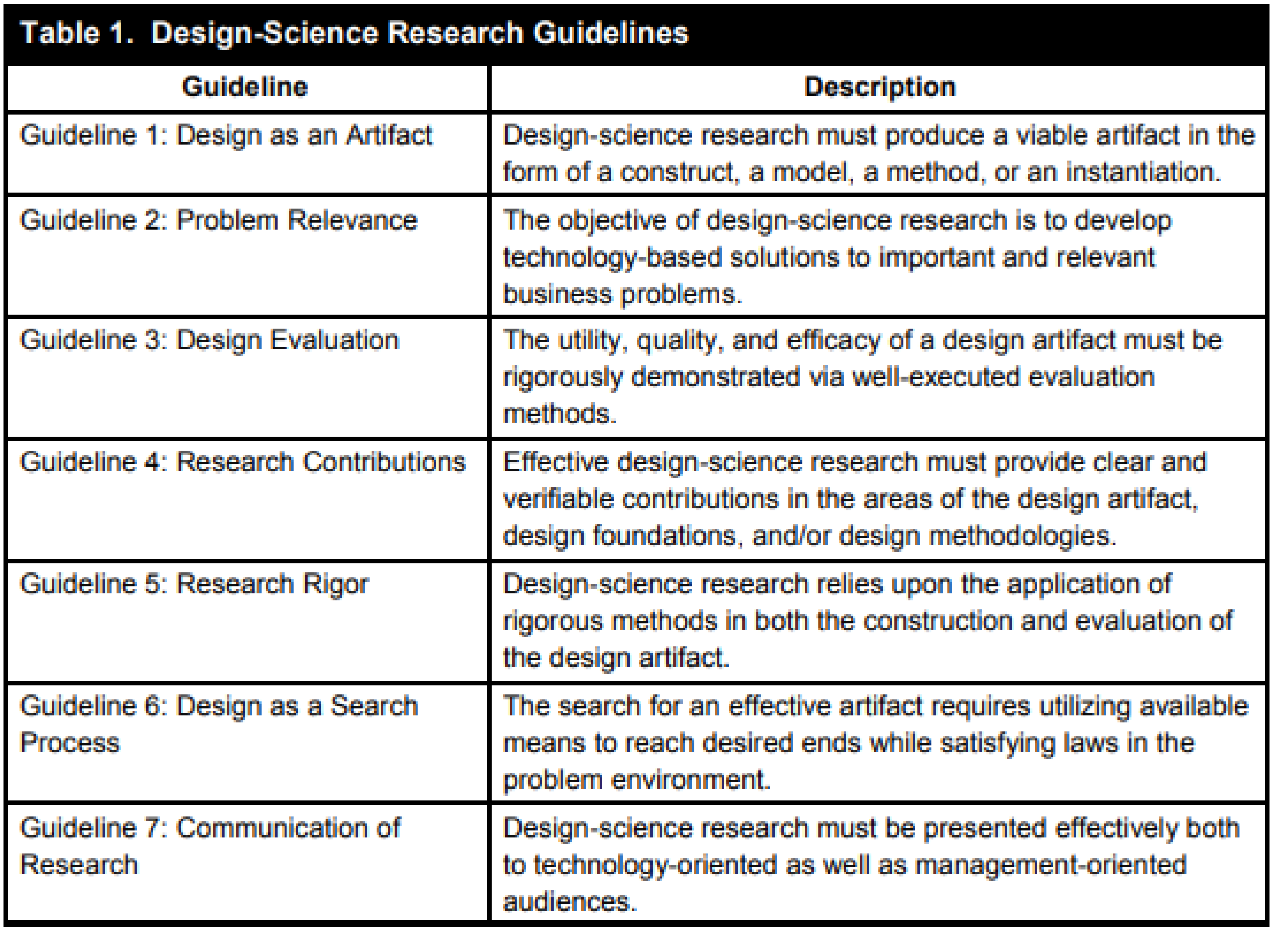


Table 1. Design-Science Research Guidelines

Guideline	Description
Guideline 1: Design as an Artifact	Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.
Guideline 4: Research Contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Guideline 5: Research Rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
Guideline 6: Design as a Search Process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of Research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

Figure 3.2: Seven guidelines for Design Science.
Esearch et al. [2004]

3.2.3 Artifact

Esearch et al. [2004] points out that IT artifacts can identify not only by instantiation but also construct models and method, which means that it has a broader, but also a narrower definition. By narrow, it means that elements such as organizations or people do not involve the definition by Esearch et al. [2004]. The artifacts that are accompanied by Design Science focus on solving known or unsolved problems, along with rigorously represented via evaluation. This is important as of the crucial feedback in the evaluation phase, will provide utility, efficacy, and quality of the instrument, which is still in the developing phase. Those four backbones that were just briefly discussed is listed as follows:

- *Constructs:* Are contributing to vocabulary and symbols. Meaning that language is a core role for characterizing and communicate problems and how to solve them.
- *Models:* With the help of using the construct, it forms a real word representation of a situation concerning the problem and solution space. Hence, the model aids in clarifying the answer, which lies behind the problem but also with the solution, which means that the representation is usually a link between them.
- *Methods:* Are describing the different processes. In other words, guidelines to search and figure out problems.
- *Instantiation:* By the implementation of constructs, models, or methods, instantiation present that it can be done in a working system.

As of the artifact that will be implemented in this research, the central core is the back end of the information retrieval system, which determines the activity and the different approaches used in the different interfaces based on the collected data. Hence this is an instantiation.

3.2.4 Prototyping

A *Prototype* is a demonstration of design, which gives the people of interest a way of interacting with it and examine its properties Rogers et al. [2011]. A prototype is only a demonstration, which means that it has limited properties and tends to show important properties rather than less important ones Rogers et al. [2011]. This means that a prototype can be of any construction from paper-based to an advanced prototype in Adobe. *Low-Fidelity* to *High-Fidelity Prototype*. Meaning that *Low-Fidelity* on the scale of prototyping is the most basic way of constructing design. This can be of materials like paper or cardboard. As it is the basis of the two fidelities, it often provides handwritten drafts Rogers et al. [2011].

On the other side of the scale, we have a *High-Fidelity Prototype*. How this prototype gets constructed, is that they are using a more advanced material that looks more like the final product in contrast to the *Low-Fidelity* ones. However, this comes with a prize. The problems that come out from developing a *High-Fidelity Prototype* are that it takes time to build, a bug can alter the time for testing the prototype, as well as developers can hesitate to change the prototype, which they have been developed in an over a long period. Least but not last, when the *High-Fidelity Prototype* is presented, testing and review can influence testers into losing focus of aspects rather than content Rogers et al. [2011]. As of the *Low-Fidelity Prototype*, it is valuable since construction one is a lot cheaper, not to mention less time-consuming and quick to make and add a modification to it Rogers et al. [2011].

In this research, prototyping has been used in the development of the final product. The prototypes which were developed were a *High-Fidelity Prototype*, which was used in the evaluation part, and also in gathering data. The prototypes were made of a single web-page with several tools behind designing it. The objective of this thesis is to evaluate three search interfaces that focus on reducing the time and efficiency to find and extract relevant information to the user. To find out if it is more efficient for that task, the idea behind it is to make three interfaces that build on top of each other with different techniques.

3.3 System Development Methods

An edition of scrum Scrum [2019] is used in this study for developing the artifact. This edition is a personal Scrum, and the idea behind it is to develop this thesis in continuous steps in mind that each step will show something of use. The central idea around this method is that the person will see around himself with regular recognition and also prevent obstacles from continue and let himself cross the right path or moment in the next days or weeks.

Moreover, from that reasoning, I have chosen personal scrum. With a continued step, you work with that you have at that moment and more steady forward to the goal. Not only that but also to get a constant reflection of oneself, from daily to weekly-reflection.

An excellent approach to clarify what has to be done and also to come up with attainable solutions throughout the project were problems arise. If one cannot see a solution there and then, the problem can be forward to the scrum board for a next checkup. Another reason for choosing a personal scrum, it lets people work their way up to fixed, precise goals of the project. Therefore it is essential to work evenly throughout the project, with feasible goals that are great to reach each milestone.

With this edition, sprint does not work. The reason is: a single person has several roles in adapting every day. Leading to if a person is fixated on one case, with narrowing the sight of the other assignments, will it be problematic in the long run. To fix this problem, to make the problem into smaller problems and use some hours every day to focus on that particular assignment. The below Figure 3.3 shows the framework of the scrum.

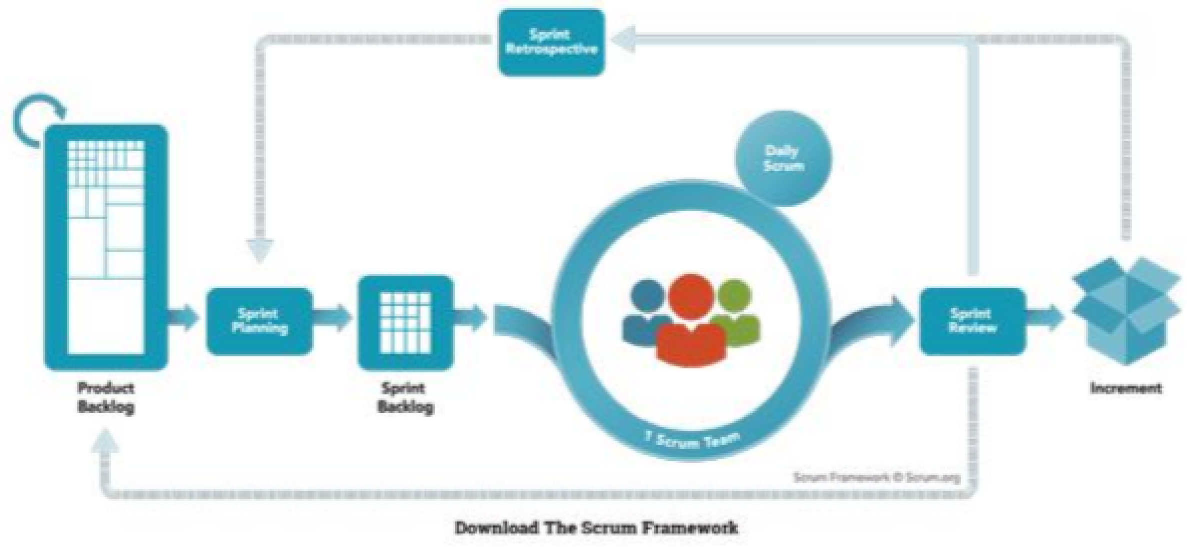


Figure 3.3: Scrum Framework.
Scrum-Framework [2019]

3.4 Data Gathering

Gathering data is a crucial role part of the research process, thus choosing the right methods is critical as well. There are lots of different techniques for collecting data. These techniques are within the three main approaches in collecting data, which are observation, questionnaires, and interviews Rogers et al. [2011].

3.4.1 Observation

The first primary technique in gathering data is observation. This approach was used to see how the interviewee was responding and acts towards how they behaved and how they were doing it. In other words, their performance in their activity Rogers et al. [2011]. Observation can observe either directly or recorded observation, which also can take place in a controlled environment or in the field. In this thesis, data gathering will be conducted in a controlled environment.

Controlled Environment. When doing an observation in a controlled observation, the basic recording of the user is the same for controlled or in the field observation, such as collection audio or notes. However, how it is used is different from another. Meaning that in a controlled environment, it is strongly focused on the details from the user, and during the field, the focus is mainly on the context of how people interacting with the surrounding field as each other or technologies Rogers et al. [2011].

One of the techniques to help the observer in observing the user is called the *Think-Aloud* technique, as the observer does not know what the user is thinking and by that can only take guesses from what the observer sees Rogers et al. [2011], which means that in a controlled environment, the observer can ask the user to use this technique when performing the task of the experiment.

3.4.2 Semi-Structured Interview

The second primary technique in gathering data is interviews. An interview is a communication technique where the purpose is to have a conversation with the interviewee to gather data Rogers et al. [2011]. Within the interview, several different techniques can be used. Such as group, semi-structured, structured, and open-ended interviews. This thesis will use the semi-structured type, because it combines most of the structured and open-ended features, such as opening and closing questions. First of the researcher makes necessary guidance in which cover the same topic in all interviewee and starting quite straightforward in the beginning and continue to dig deeper into the conversation until no more relevant information is needed Rogers et al. [2011]. Furthermore, the body language to the interviewer can inflict bias results in the interviewee, such as when the interviewer shows emotion as smiling, looks disappointed, or agree with the answer from the interview. These behaviors can influence the interviewee and get inaccurate answers.

3.4.3 Questionnaires

The third primary technique in gathering data is close to the first-second one and is called a questionnaire. This technique is firmly focused on the interviewee's opinions Rogers et al. [2011]. It is close to interviewing because it contains the same open and closed questions. This thesis is using two questionnaires, which will help the researcher to clarify the understanding even further. The setup to a questionnaire is necessary to have specified questions, whenever the researcher has to possibility, the use of closed questions should be used, and the option to answering the question should have a range of options. The first method was used in the post and final questionnaires evaluation, and the and the second one was the System Usability Scale (SUS), which is covered in Section 3.5.

3.5 Evaluation Methods

Evaluate the artifact is one of the crucial roles in the development, as it collects information from the participant's experience when interacting with a prototype Rogers et al. [2011]. Hence its focus on the user's experience and the usability of the prototype. It consists of several different evaluation methods, and the intention behind the evaluation is to help to decide which method to use. During different phases throughout the project, the developers can check whether or not the design is still meeting the requirement. While evaluating that it is called *formative evaluations*. In the last phase of the development of a product in order to check the achievements is called *summative evaluations* Rogers et al. [2011].

Depending on the environment around the product, an evaluation often implicate observation in a controlled environment. The reason behind this is that it gives targets of characteristics which can get systematically investigated Rogers et al. [2011]. If the participant is evaluated in a natural environment, the evaluator is losing a lot of control of the situation as of the participant's activities, which is revolving around the products but can demonstrate in a real-life situation. Although this way of evaluating is quite expensive and more difficult to set up Rogers et al. [2011].

The evaluation conducted in this research project had one goal. Moreover, as of the design was not the most crucial in the development of the product, a summative evaluation was used to get an explanation if the prototype was a success in retrieving relevant information to the user.

3.5.1 System Usability Scale

System Usability Scale (SUS), which Brooke [1996] set in motion, is a dependable scale that supports measuring the usability of a system. SUS is a Likert scale which consists of 10 questionnaires for measuring intuitive assessment for the usability of the system Brooke [1996]. The questionnaires changes between positive and negative and the scale is ranging from fives marks from "strongly agree" to "strongly disagree" Brooke [1996].

These positive and negative charged questionnaires are five each, where participants have to be careful when selecting one of the points on the Likert scale. Because the techniques Brooke have used is to identify elements which introduce to profound statements of mindset being secured Brooke [1996]. The selected statements in SUS coincide with a variety of visible features connected to system usability. These visible features are complexity, training, and support. Hence the SUS validity for being a reliable tool for measuring usability in a system is therefore high Brooke [1996].

In order to measure the usability of the three search interfaces, SUS was used in all three prototypes. The use of SUS in the evaluation provided a quick, yet an efficient response according to their experience towards the three search interfaces.

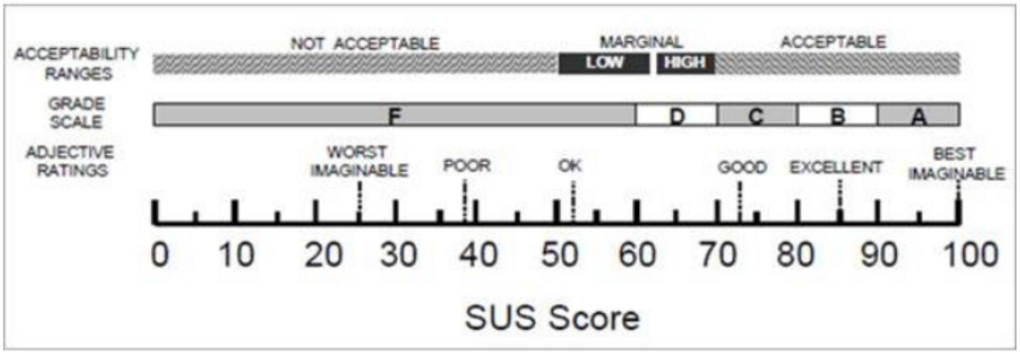


Figure 3.4: A comparison of the SUS score and how they can be interpreted. Brooke [1996]

It crucial to not mix up the SUS score to percentages, considering that the SUS score is a percentile ranking. As seen in Figure 3.4, the score goes from 0 to 100, where 0 is the lowest attainable score Brooke [1996]. In order to compute the score of a participant, each score from each questionnaire has to be added first. Each questionnaire can get a score between 0 and 4 Brooke [1996]. The odd number questionnaires get the score of their position of the questionnaire scale, which is between 1 and 5, but subtract by 1 Brooke [1996]. The even number questionnaires get a score where they take five and subtract the placement from the scale Brooke [1996]. Then the total sum of the questionnaires gets multiplied by 2,5. As shown in Figure 3.4, a score of 70 and above, can be seen as acceptable products.

3.5.2 Pilot Studies

Before executing the evaluation procedure, a pilot study was conducted. A pilot study is a small-scale testing of the evaluation procedure. The goal of the pilot study is to verify that the suggested approach is feasible before commence the main study Rogers et al. [2011]. In this research, a pilot study was used with a professor to get an answer if the suggested approach was feasible, or changes to be made in order to enhance the approach.

3.5.3 User's Characteristics

Although evaluating an interface through a list of measuring usability, it is also essential to focus on the result of the users. As of it is for the user himself to grasp whether or not the result from the query is relevant and prefer a further lookup or reformulate the query in which then check if its worth continue the search for the relevant information. Hence, the user needs to evaluate the relevance of the document that is retrieved. As it goes, the more relevant documents that get retrieved, the better is the system that retrieves them.

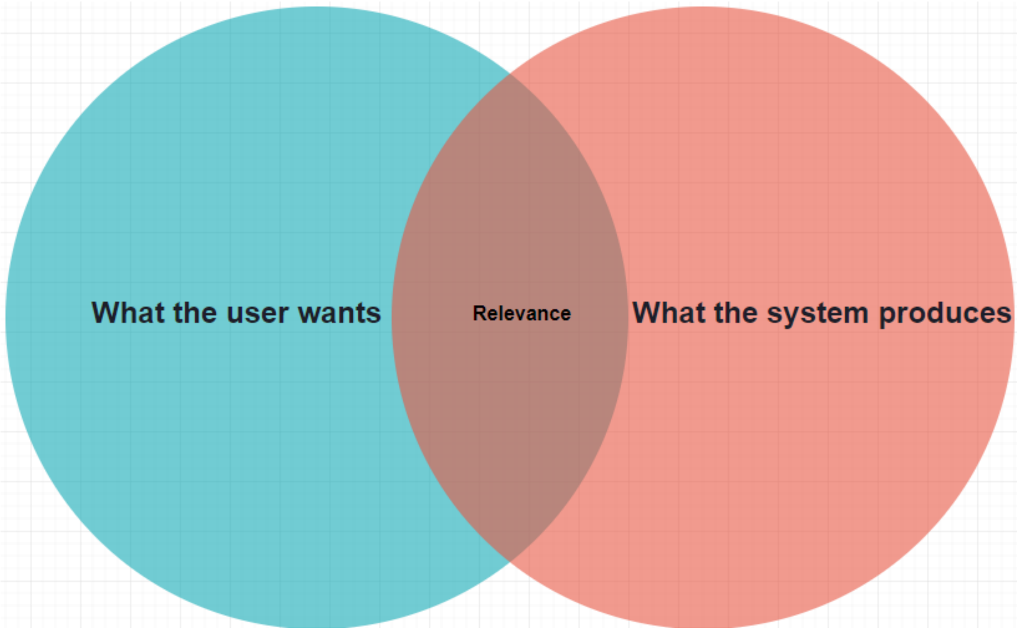


Figure 3.5: Venn Diagram of relevancy.

As stated in Section 2.1.6, the relevance for a document is a perception of whether a document is relevant or not relevant. By all means, if a document covers the topic of the search, e.g., "Computer Interaction", the document is acknowledged as relevant. Although the results might not trigger user satisfaction, in Figure 3.5, one can see the overlap between the relevant documents of an IR system, and what the user is looking after. This overlapping is what we are looking for, the relevance. The blue circle consists of the desired information of what the user is seeking, and it is not simple to find out what the user is genuinely interested in. The feedback from the user's action is needed for finding the results relevancy. Meaning that the time for finding information, visiting documents, go through a document, or showing expression that implies that the user is interested or not.

3.5.4 Statistical Analysis

In order to prove what degree various elements like log analysis, user performance, user perceptions, and search tasks have on various search systems, statistical analyses can be applied. Initially, to determine the performance of the subjects, we inspected the search time and the total number of the interaction of each interface.

By request log, we got information about each action that had been done on the different search interfaces. The next elements to get data of was the post-questionnaires, which had a Likert scale from 1 to 5, where a higher value indicates higher recognition with the statement. The final questionnaires had the same was build the same as the post-questionnaires. The data that was collected through these steps were analyzed with a method called *t-test*, where additional analysis can be distinguished.

From these different methods of gathering information. The metrics that this thesis will be focused on will be the measurements of the following:

1. Difficult level from the search task, the lookup, and the exploratory search task from the participants.
2. Log analysis which involves:
   (a) Action Search.
   (b) Remove Term.
   (c) Click Link.
   (d) Author Function.
   (e) Date Range Function.
   (f) Category Function.
   (g) Total Actions.
3. Post-Task questionnaires will analyze the participant's perceptions of each interface.
4. Final questionnaires that will support the participant's preferences of each interface.

As of finding out whether or not the performance of a support system has better effectiveness and performance from a conventional search system, these metrics stated above will be focused on. After obtaining these data as mention, the data will then be analyzed with the method *t-test*, where the statistical analysis will be conducted, which will be the focal point in answering the research questions.

In order to analyze the data for uncovering *statistics significant*, a required measurement is needed. This measurements is called *p-value* Thisted [2010]. He also writes that "*p-values exceeding 0.05 (one in twenty) just aren't strong enough to be the sole evidence that two treatments being studied really differ in their effect*" - Thisted [2010]. Thus, the use of a *p-value of 0.05* in this thesis is being utilized with all the statistical tests being performed. The use of drawing out statistically significant in this thesis is for layout the results about the detectable patterns of the participants that went through with the study session. On behalf of the volume of the data being drawn from the experiment, it grants the data to be determined with statistically significant.

3.6 Research Ethics

Throughout the process of gathering data, all kinds of approaches should comply with ethical guidelines, as it is of utmost importance that the participants have the right to privacy, and this data is treated with absolute respect. Research projects that include gathering personal data are required to inform the Norwegian Centre for Research(Norsk Senter for Forskningsdata - NSD). This includes a detailed description of the research process and methods of how the gathering of data is conducted as well as how the data is being processed and stored.

It is ensuring that this research project is gathering personal data in the way of evaluations and interviews. It has been approved by the NSD, which means that this research project has been taken proper measurements in the process of data collection and securely storing the data. All personal data will be destroyed or to be edited out if any of the participants decide to withdraw their consent to maintain the anonymity of the participants. In Appendix 7.1.1 can be read about the approval from the NSD. The consent information to the participant and the interview guide form can be read in Appendix 7.1.1.

3.7 Dataset

The dataset Misra [2018] that is used in this thesis is from Kaggle.com, a dataset of 202,372 records. This dump was downloaded in *07.09.2019* at Kaggle [2019]. The format of the dataset is JSON, and store this vast data into Elasticsearch, which is a search engine framework. From this dataset, the corresponding articles have a category, and this dataset contains 41 categories in which only five categories were used in this thesis. From a news domain point of view, those categories went under that domain.

After extracting these categories, each record was checked to see whether missing data or duplicate records were in the dataset. If any was found, they were deleted from the record. This process went over each index of the dataset. Later on, the dataset decreased to 3197 records, whereas the categories are as follow:

Table 3.1: The different categories of the records used in this thesis.

Category	Records
Business	1037
Media	837
World News	811
Money	473
Worldpost	39
Total	3197

This dataset has six fields of the index, which will be used for searching through the news articles. By indexing these fields, the framework Elasticsearch with the help of Appbaseio and Dejavu. The reason for using this dataset and not Norwegian articles is frankly because of tools not support the Norwegian language, as well as the different dialects. A simple solution could be translating all the Norwegian articles into English and then pre-process the raw data. Nevertheless, that would be a tedious and higher chance of getting a mistake in the language. Another reason for not choosing Norwegian articles is because it will need a subscription on most of the web service that publishes those articles. Table 3.2 shows an overview of the dataset.

Table 3.2: Structure of the Dataset.

Index	Definition
Category	Classification type
Headline	Title
Authors	Authors
Link	Link to the article
Short description	Abstract
Date	When it is published

3.8 Context

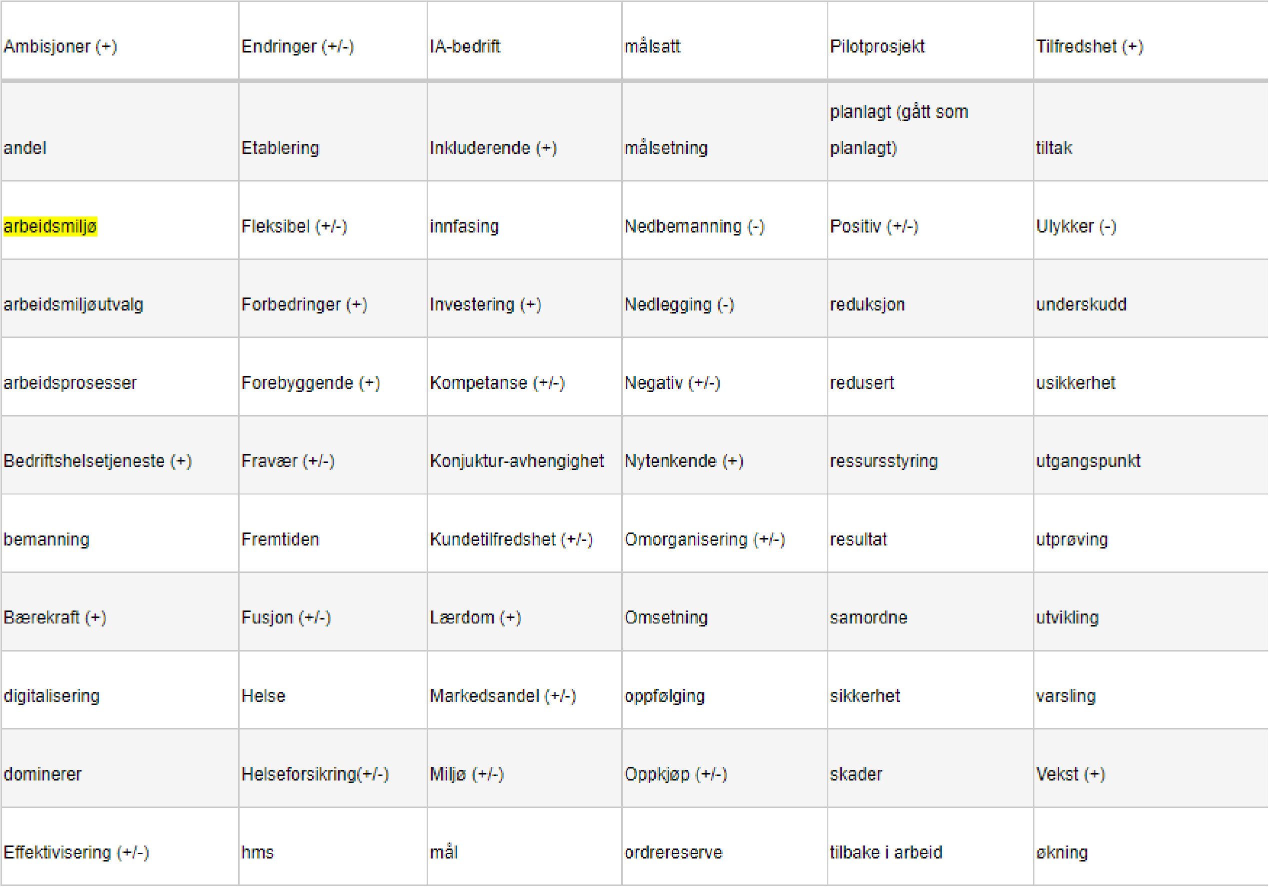
By developing and evaluating three search user interfaces, whereas two of them are an exploratory search interface for searching through articles in the domain of news. The company, DNB Livsforsikring AS (life insurance), which is a part of the Finance Innovation cluster. Moreover, as they are interested in looking into the opportunities for information retrieval, the concept fell on evaluating three search user interfaces that use different techniques to retrieve information. From the meetings, one concept came to mind when they presented what they were looking after. When they were asked about how they were checking the information from Annual reports, media from the news, news article, or social media. The answer was that they search for a company name in and find articles or annual reports from that company. In other words, time-consuming work for finding relevant information.

In the meetings, they have stated that the information which they are interested in is from many factors, though one factor is the media, especially articles which will be focused on in this thesis. The information inside the media, they are looking for all sorts of information that can help them with decision making on the final result. This information can be, for example, about how it is going with the company in general, the employees who work there, but can base this information on to the information they already have and see if the result can be adjusted.

Different trending in companies, in how they change from one to another. Such as Redundancies are relevant information to companies as of cornerstone companies in the rural areas, for instance. Here the majority of employers have a middle to lower payroll, which means that the disability for pension benefits is higher. Also that workers often do not get a new job close to their home, therefore try to get a disability pension. This can be because of the illness of a moderate nature, but workers have managed to carry out the workload as long as the job was in reach of their home. Another example is to check whether or not the contracts in industrial companies have long or short contracts. If the economy is considered good or not. Therefore it is valuable information to check if the industrial companies have been merged, demerged, or acquisitions. The downsizing of companies can consist of several reasons. Such as the lousy timing supply and oil industry in recent years in Norway has had the reason for reducing their work. In other cases, the technology takes over like self-register cashier in food stores. Not only the reduction of the worker but also the environment in the workplace is relevant to look after.

Therefore DNB Liv has provided an overview of keywords that they classify as an essential term for checking out the information of the companies. They have factored them as positive + and negative -. Because their primary goal from this vast data of information is to shift out the text, which will then be studied more in detail. By cause of reading through the whole annual reports or articles are tedious work and time-consuming.

Figure 3.6 shows the keywords that they consider to be important in their research on life insurance. The keywords from Table 3.6 are disordered. Hence the words have equally weight behind them. Some of the keywords are labeled with + and -, considering that how the context of the keyword is labeled in the sentence is also important. By presenting the idea of the thesis to DNB Livsforsikring AS, they were intrigued by how the filtering should be done. They wanted the filtering feature to manage the weighing value to the words from Figure 3.6. These are the key factors they look after to determine whether a company is having a tough time or not.



Ambisjoner (+)	Endringer (+/-)	IA-bedrift	målsatt	Pilotprosjekt	Tilfredshet (+)
andel	Etablering	Inkluderende (+)	målsetning	planlagt (gått som planlagt)	tiltak
arbeidsmiljø	Fleksibel (+/-)	innfasing	Nedbemanning (-)	Positiv (+/-)	Ulykker (-)
arbeidsmiljøutvalg	Forbedringer (+)	Investering (+)	Nedlegging (-)	reduksjon	underskudd
arbeidsprosesser	Forebyggende (+)	Kompetanse (+/-)	Negativ (+/-)	redusert	usikkerhet
Bedriftshelsetjeneste (+)	Fravær (+/-)	Konjuktur-avhengighet	Nytenkende (+)	ressursstyring	utgangspunkt
bemanning	Fremtiden	Kundetilfredshet (+/-)	Omorganisering (+/-)	resultat	utprøving
Bærekraft (+)	Fusjon (+/-)	Lærdom (+)	Omsetning	samordne	utvikling
digitalisering	Helse	Markedsandel (+/-)	oppfølging	sikkerhet	varsling
dominerer	Helseforsikring(+/-)	Miljø (+/-)	Oppkjøp (+/-)	skader	Vekst (+)
Effektivisering (+/-)	hms	mål	ordrereserve	tilbake i arbeid	økning

Figure 3.6: A table with keywords labeling positive + and negative -.

3.9 Prototype

For this thesis, I will be implementing three search interfaces (two is exploratory search) to search the collecting of articles in the news domain. The first interface will be a general-purpose ”search box¨ interface, which the result is a ranked list of articles. The other two search interfaces will build upon the first interface and support both exploratory and filtering browsing. These three prototypes will be in high-fidelity.

3.9.1 The Baseline Search Interface

The first interface will be the baseline and groundwork from the other two search interfaces. The display will be a standard search interface that returns a list of relevant documents from the user's query, where the top document is the most relevant. The length of the list will be returning six results. As of the design, the fact that the display is a standard search interface, the first interface has the design of the second and last interface. The reason behind this is during the evaluation phase; the participant will not spend ineffective time learning the different interfaces and can alter the evaluation from getting distracted by learning the different interfaces.

3.9.2 Text Summary Search Interface

The second search interface will use the same display as the baseline but also add a summarizing and a category tag to the relevant result. The abstract of the article will be shown under the title. The return result will consist of a header, category, and an abstract of the article.

3.9.3 Faceted Filtering Search Interface

The third search interface is built on top of the second interface. In addition to the summary and the categorizing of the articles is showing, also filtering facets are also implemented. These facets are based on author, date, and category. All facets also interact with each other, which means that if a user uses one facet, the other facets will also change from the output from that facet.

3.10 Set up Description

In order to compare the three search interfaces and to investigate the connection between the two search tasks, a within-subject study was designed. Each participant evaluated all three search interfaces in the course of one study session. In order to conclude if exploratory support will have better effectiveness and performance, the context of each search interface was evaluated with two different search tasks. The lookup (n = 3) and the exploratory tasks (n = 3), which are explained in the following section. Figure 3.7 presents an overview of the user testing process.

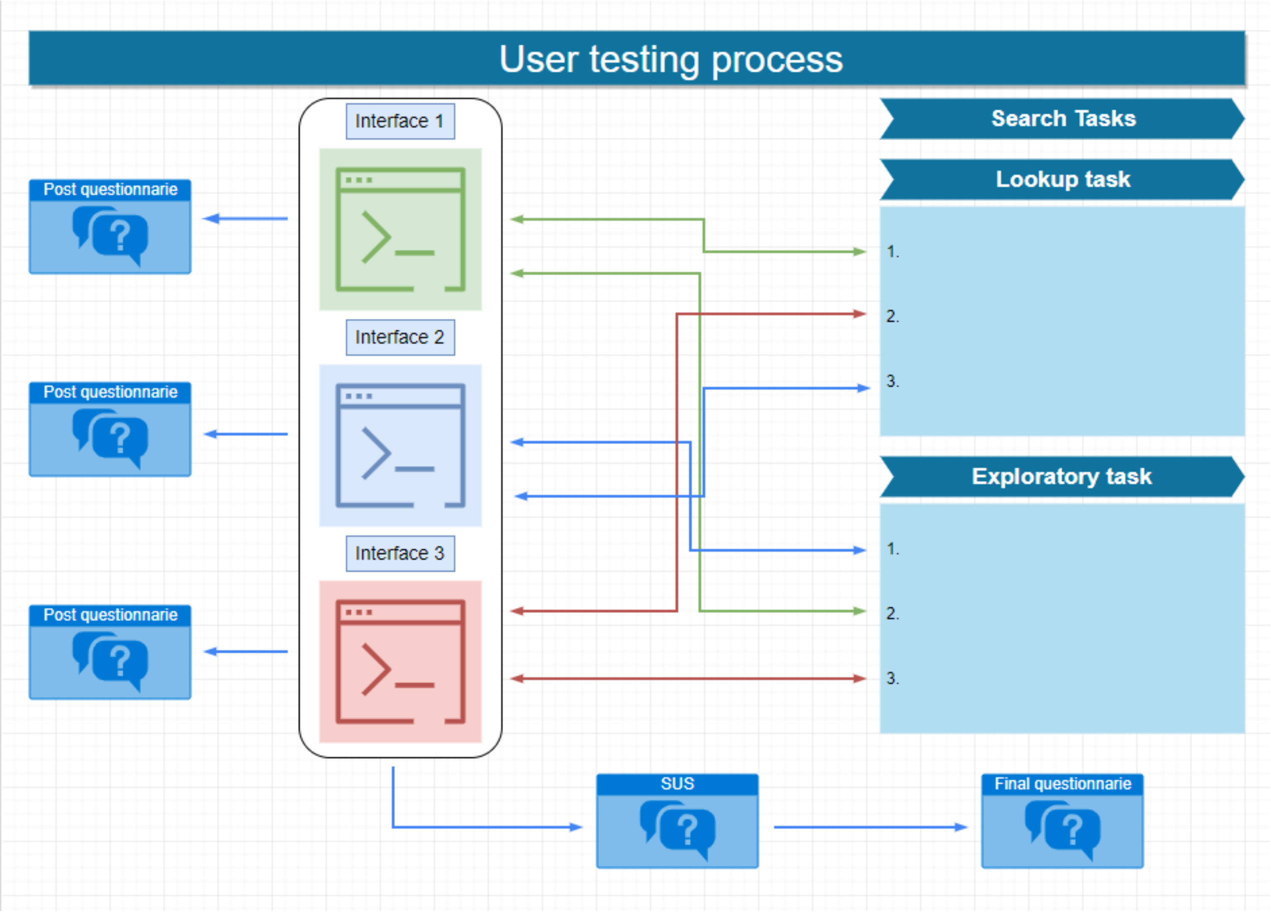


Figure 3.7: User testing process

3.10.1 Search Tasks

Previous research has found out that the search task attributes do affect information-seeking behavior Vakkari et al. [2003], Diriye et al. [2010], Trattner et al. [2012]. A search task has many factors in it, such as difficulty, clarity, complexity, and familiarity Diriye et al. [2010]. These factors appear to influence how the user is searching, uses the information, and also browsing Trattner et al. [2012]. To take into consideration of these factors in evaluating the three search interfaces for simplicity, this study used two types of search tasks commonly recognized as lookup and exploratory tasks. These search tasks was briefly discussed in Section 2.2.

The most basic search is the lookup search task. As its name implies, a lookup search is to find well-structured and specific information and is typically associated with the standard search interface Marchionini [2014]. The selection of the lookup search task was picked out for finding facts that answered the specific search tasks. The later of the two search tasks is the exploratory type. This task is on another level of difficulty in terms of searching. It goes further than only finding specific information.

Exploratory tasks assume that the user requires a piece of more in-depth information that cannot get access to a mere ’relevant” information object, such as number, names, or shorts descriptions. Which are similar to the information user are seeking with lookup searching. The tasks used in this study are shown in Table 3.3. We selected three search tasks from the lookup searching and three from the exploratory category, which results in six search tasks in total.

Table 3.3: Search tasks and descriptions.

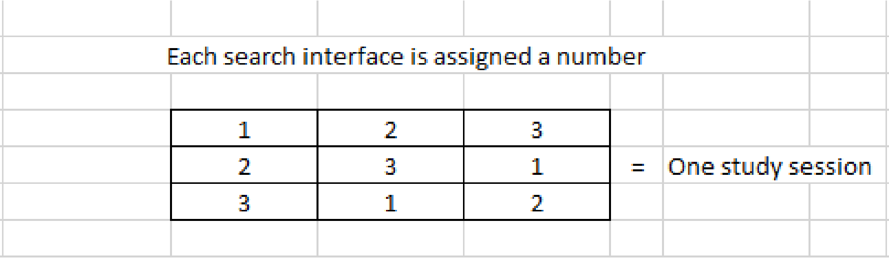
Search Tasks	**Search Task Descriptions**
Lookup	1. Find one article related to war, which has been written by Reuters.
	2. Find one article talking about fake news on social media platforms.
	3. An app in 2018 got much focus as it published ”sensitive” data that involve the military. Find that article.
Exploratory	1. Find at least five articles that talk about climate change that have occurred around the world.
	2. Find five articles that involve politic elections in different countries.
	3. Find five articles that involve social network media, where each article includes different social network media.

3.10.2 Evaluation Process

In the opening chapter, we briefly discussed that the subjects which were used in this study had to undergo two selection of search tasks while testing three different kinds of search interfaces for the period of one user study session. Throughout the study session, the subject was appointed three different lookups and three different exploratory search tasks which they had to carry out. Overall it was anticipated that all participants were to carry out the search tasks.

In order to withstand the influence of learning and tiredness, the arrange of the different search interfaces and search tasks were used, were following the Latin square design. This design is demonstrated in Figure 3.8, which shows the rotating of the different search interfaces. As mentioned, the search task was also rotated using Latin square design, but also got randomized with the purpose of making sure that each search task was tested under different search interfaces settings.

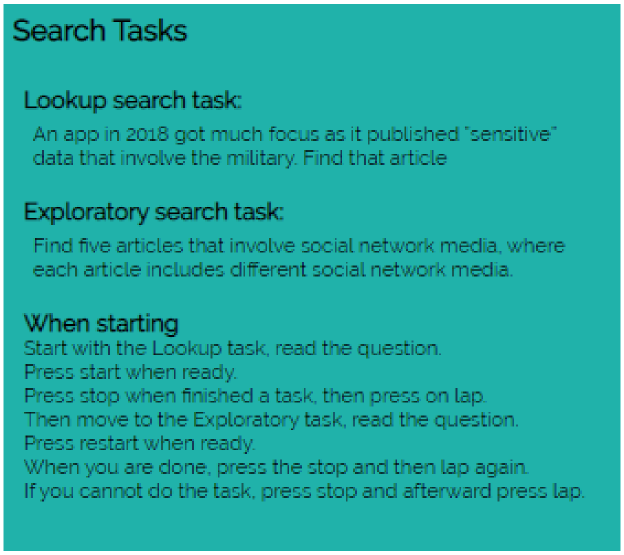
About support the participants in this session with their work on the search tasks, each search interface was enhanced with a *support panel*, which includes a help field and task description. Furthermore, the search interfaces have a start, stop, and a lap(used for tracking each search task) for tracking the duration of each search task from the participants. The Figure shown in 3.9 and 3.10, demonstrates the look of these panels. While Figure 3.11 shows the support panel in the search interface.



Each search interface is assigned a number

1	2	3		
2	3	1	=	One study session
3	1	2		

Figure 3.8: Latin square design.



Search Tasks

Lookup search task:

An app in 2018 got much focus as it published "sensitive" data that involve the military. Find that article

Exploratory search task:

Find five articles that involve social network media, where each article includes different social network media.

When starting

Start with the Lookup task, read the question.
Press start when ready.
Press stop when finished a task, then press on lap.
Then move to the Exploratory task, read the question.
Press restart when ready.
When you are done, press the stop and then lap again.
If you cannot do the task, press stop and afterward press lap.

Figure 3.9: Search task description and guidance.

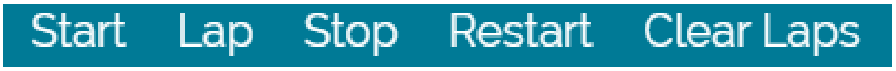


Figure 3.10: Stopwatch displayed in the different search interfaces.

The following procedure was carried out in the user study:

1. Each participant was greeted, seated, and informed of the experiment. After that, they got asked to read and sign a consent form.

2. The participant was asked to complete a short questionnaire eliciting demographic information.

3. For each interface, a demonstration was given so that each participant would get familiar with the interfaces. The given time was plentiful, roughly 10 minutes.

4. For each interface, the participant was assigned one lookup task and one exploratory search task.

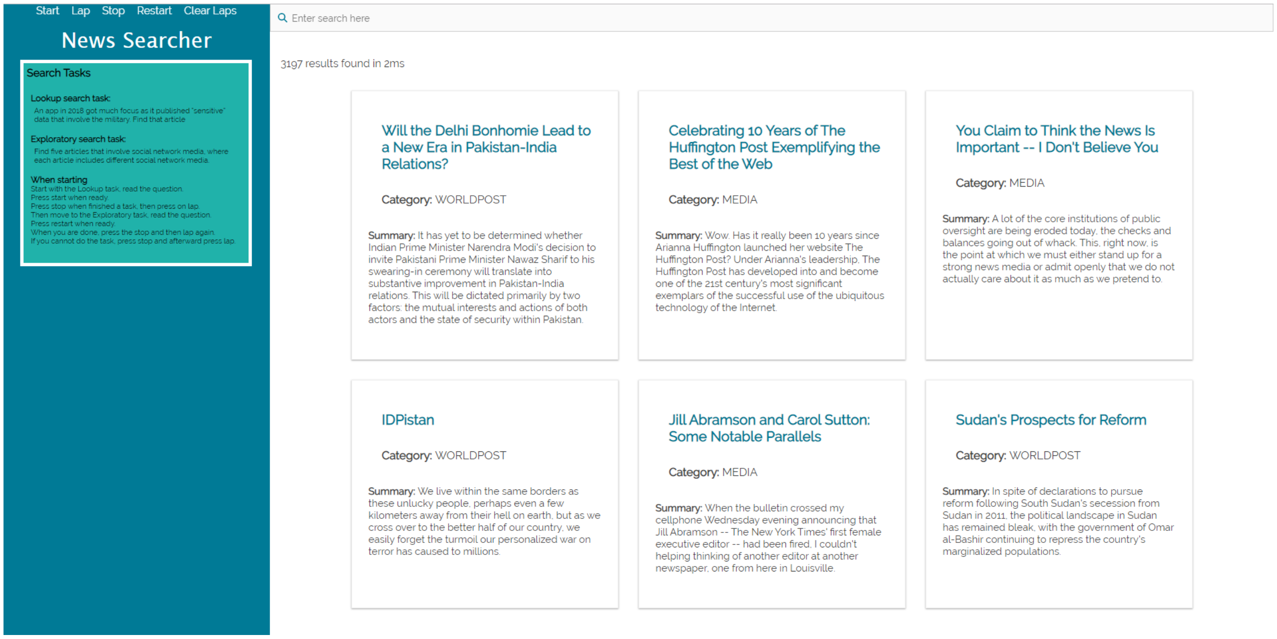
   (a) Lookup task: A description of the task was handed out to the participant where the time limit of completing the task was 3 minutes, + 30 seconds for reading the description.

   (b) Exploratory task: A description of the task was handed out to the participant were the time limit of completing the task was 10 minutes, + 1 minute for reading the description.

   (c) After each task, a post-search questionnaire was laid out to the participants.

5. When the search task part was done, a system usability scale form was handed out to the participant for evaluating the distinctness between the three search interfaces.

6. After the SUS form was handed out, the participants had final questionnaires according to the observation of the study.



News Searcher

Search Tasks

Lookup search task:
An app in 2018 got much focus as it published "sensitive" data that involve the military. Find that article

Exploratory search task:
Find five articles that involve social network media, where each article includes different social network media.

When starting
Start with the Lookup task, read the question.
Press start when ready.
Press stop when finished a task, then press on lap.
Then move to the Exploratory task, read the question.
Press restart when ready.
When you are done, press the stop and then lap again.
If you cannot do the task, press stop and afterward press lap.

3197 results found in 2ms

Will the Delhi Bonhomie Lead to a New Era in Pakistan-India Relations?

Category: WORLDPOST

Summary: It has yet to be determined whether Indian Prime Minister Narendra Modi's decision to invite Pakistani Prime Minister Nawaz Sharif to his swearing-in ceremony will translate into substantive improvement in Pakistan-India relations. This will be dictated primarily by two factors: the mutual interests and actions of both actors and the state of security within Pakistan.

Celebrating 10 Years of The Huffington Post Exemplifying the Best of the Web

Category: MEDIA

Summary: Wow. Has it really been 10 years since Arianna Huffington launched her website The Huffington Post? Under Arianna's leadership, The Huffington Post has developed into and become one of the 21st century's most significant exemplars of the successful use of the ubiquitous technology of the Internet.

You Claim to Think the News Is Important -- I Don't Believe You

Category: MEDIA

Summary: A lot of the core institutions of public oversight are being eroded today, the checks and balances going out of whack. This, right now, is the point at which we must either stand up for a strong news media or admit openly that we do not actually care about it as much as we pretend to.

IDPistan

Category: WORLDPOST

Summary: We live within the same borders as these unlucky people, perhaps even a few kilometers away from their hell on earth, but as we cross over to the better half of our country, we easily forget the turmoil our personalized war on terror has caused to millions.

Jill Abramson and Carol Sutton: Some Notable Parallels

Category: MEDIA

Summary: When the bulletin crossed my cellphone Wednesday evening announcing that Jill Abramson -- The New York Times' first female executive editor -- had been fired, I couldn't helping thinking of another editor at another newspaper, one from here in Louisville.

Sudan's Prospects for Reform

Category: WORLDPOST

Summary: In spite of declarations to pursue reform following South Sudan's secession from Sudan in 2011, the political landscape in Sudan has remained bleak, with the government of Omar al-Bashir continuing to repress the country's marginalized populations.

Figure 3.11: The support panel displayed on the text summary search interface.

3.10.3 Search Interface Logging

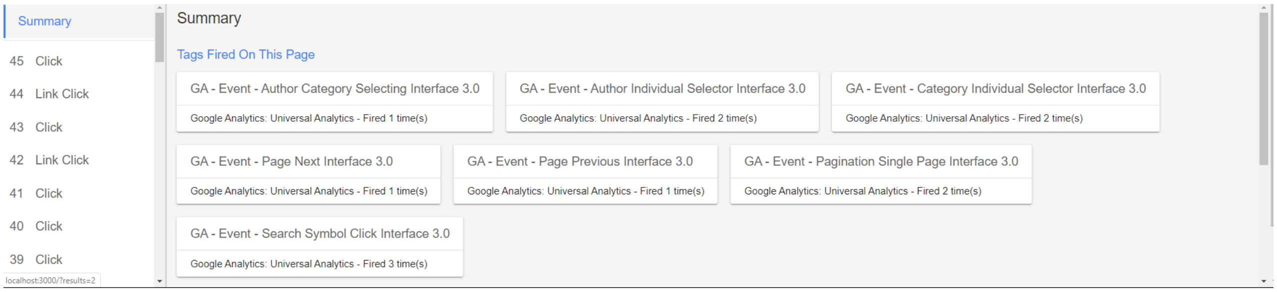
In order to assist the participants when undertaking different search tasks, as shown in Figure 3.11, each search interface was enhanced with a *supporting panel* on the top left. This *support panel* consists of the task description, guidance through the search tasks. At the top of each search interface, a stopwatch was also implemented for tracking the time during the different search tasks, which is shown in Figure 3.10. Also, each interaction of elements of the different search interfaces was tracked using *Google Tag Manager* (GTM) GTM [2019]. Moreover, these elements are:

Table 3.4: The elements that are being tracked with Google Tag Manager.

	Interface		
	Baseline	**Text Summary**	**Faceted Filtering**
Search	✓	✓	✓
Remove Term	✓	✓	✓
Click Link	✓	✓	✓
Author Function	x	x	✓
Date Range Function	x	x	✓
Category Function	x	x	✓
Total Actions	✓	✓	✓

In Figure 3.12, demonstrates the tracking of interaction on the filtering search interface. Each search interface has its workspace with its tracking measurements, which makes it easier to examine the action of each participant.

How the GTM is working, is that when an event on the search interface has happened, meaning when a trigger has been enabled, GTM immediately looks for that particular interaction. For instance, when the *Link Click* is enabled, this trigger is standing by until an interaction happens when a user clicks any link on the website. During the time that particular interaction appears, that event shows up in the GTM Event Timeline, as presented in Figure 3.12.



Summary

45 Click
44 Link Click
43 Click
42 Link Click
41 Click
40 Click
39 Click

localhost:3000/?results=2

Summary

Tags Fired On This Page

GA - Event - Author Category Selecting Interface 3.0
Google Analytics: Universal Analytics - Fired 1 time(s)

GA - Event - Author Individual Selector Interface 3.0
Google Analytics: Universal Analytics - Fired 2 time(s)

GA - Event - Category Individual Selector Interface 3.0
Google Analytics: Universal Analytics - Fired 2 time(s)

GA - Event - Page Next Interface 3.0
Google Analytics: Universal Analytics - Fired 1 time(s)

GA - Event - Page Previous Interface 3.0
Google Analytics: Universal Analytics - Fired 1 time(s)

GA - Event - Pagination Single Page Interface 3.0
Google Analytics: Universal Analytics - Fired 2 time(s)

GA - Event - Search Symbol Click Interface 3.0
Google Analytics: Universal Analytics - Fired 3 time(s)

Figure 3.12: Overview of tracking interaction on the filtering search interface.

Chapter 4

Prototype Implementation

This chapter is two-fold. The first section consists of the descriptions of the different tools used in this thesis. The last section gives an in-depth view of the implementation of the prototype of the three different search interfaces.

4.1 Tools

In this study, the tools can be put into two categories. These two are front-end and back-end development. Front-end is visually and what the user interacts with, while the back-end is everything behind the scene. As the difference between these two is quite subtle, the functionally of a web page relies on each of them as a unit for interacting with one another. Both are crucial as front-end commits to the client-side, while back-end commits to the server-side of any application that requires it.

4.1.1 Front-End Technologies

HTML As briefly discussed in Section 2.1.3, the HTML stands for HyperText Markup Language HTML [2019], which is a markup language for structuring the documents online. HTML is the first core for starting with wed development. Inside these documents, we have something called HTML elements; these elements or tags can be used for describing the content on a document, such as its structure, type of data to put the information. The HTML is the skeleton of the document as it describes the online document.

CSS In order to style the HTML page, a stylesheet language can be used. CSS is a style sheet language CSS [2019] that can be used to style the information in an HTML page. The second core is CSS, which tells how each of the HTML elements and properties will be displayed.

Javascript JavaScript JavaScript [2019] is to make the elements of the page programmable or adding dynamic components. By dynamic components means anything from moving elements, animation refreshing, content can be hidden or shown. A technology called JavaScript can be used, which is the last core of this triad. Since its a programming language, it is equivalent to the other programming language, such as C or Java.

4.1.2 Back-End Technologies

Elasticsearch Elasticsearch Elasticsearch [2019] is a search and analytics engine, where indexing, analyzing, and searching for the data is happening. Furthermore, it can provide these features in real-time. The feature of this NoSQL database is offering is a full-text search on all document stored data.

React React React [2019] is a library for JavaScript for implementing user interfaces. React can render the right components when the data changes or wants to display the returned data from the input data.

ReactiveSearch ReactiveSearch is a react user interface (UI) components library for React and React Native, which works great with Appbase.io as backends Reactivesearch [2019]. This library's specialty is building search user interfaces.

4.1.3 Development Tools

Visual Studio Code Visual Studio Code Code [2019] is an Integrated Development Environment (IDE), it is a tool for writing, debugging, and compile code supporting almost every programming language, but also JavaScript, which was used in this thesis. One key feature of this IDE is that it can open up one or more directories, meaning that they can be saved in something called a workspace. The workspace is where the project is held.

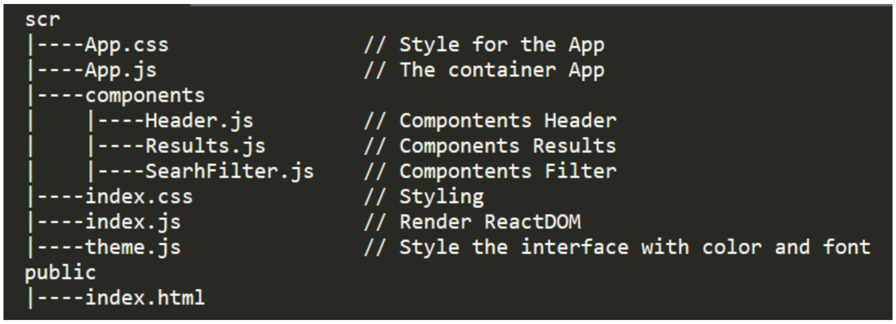
Dejavu In order to import the data into Elasticsearch, the tool used in this study was Dejavu Dejavu [2019]. Dejavu is a web UI for Elasticsearch that supports data importing such as CSV and JSON files. Dejvavu can also define field mapping from the data from its graphical user interface (GUI). This tool lets one import the data directly and is available as an extension in the browser.

Appbase.io This tool provides a hosted Elasticsearch as a service, with abundant analytic for the data, visually testing the search relevancy Appbase [2019].

4.1.4 Architecture

The figures below show the structure of the directory, index, and dataset structure. All three search interfaces are using these structures as their central structure.

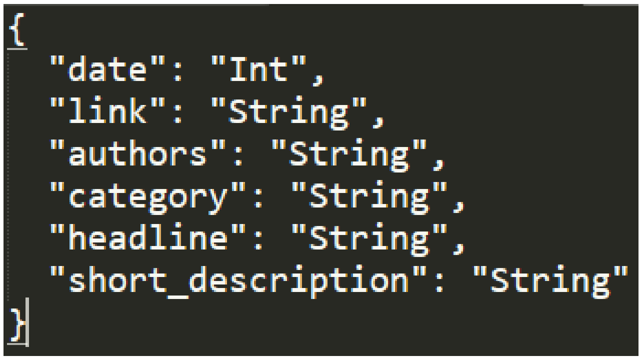
The directory structure of the search interfaces followed a simple, yet a clear path. As shown in Figure 4.1, this structure is used in all three search interfaces.



```
scr
|----App.css                 // Style for the App
|----App.js                  // The container App
|----components
|    |----Header.js          // Compontents Header
|    |----Results.js         // Components Results
|    |----SearhFilter.js     // Compontents Filter
|----index.css               // Styling
|----index.js                // Render ReactDOM
|----theme.js                // Style the interface with color and font
public
|----index.html
```

Figure 4.1: Directory structure of the application.

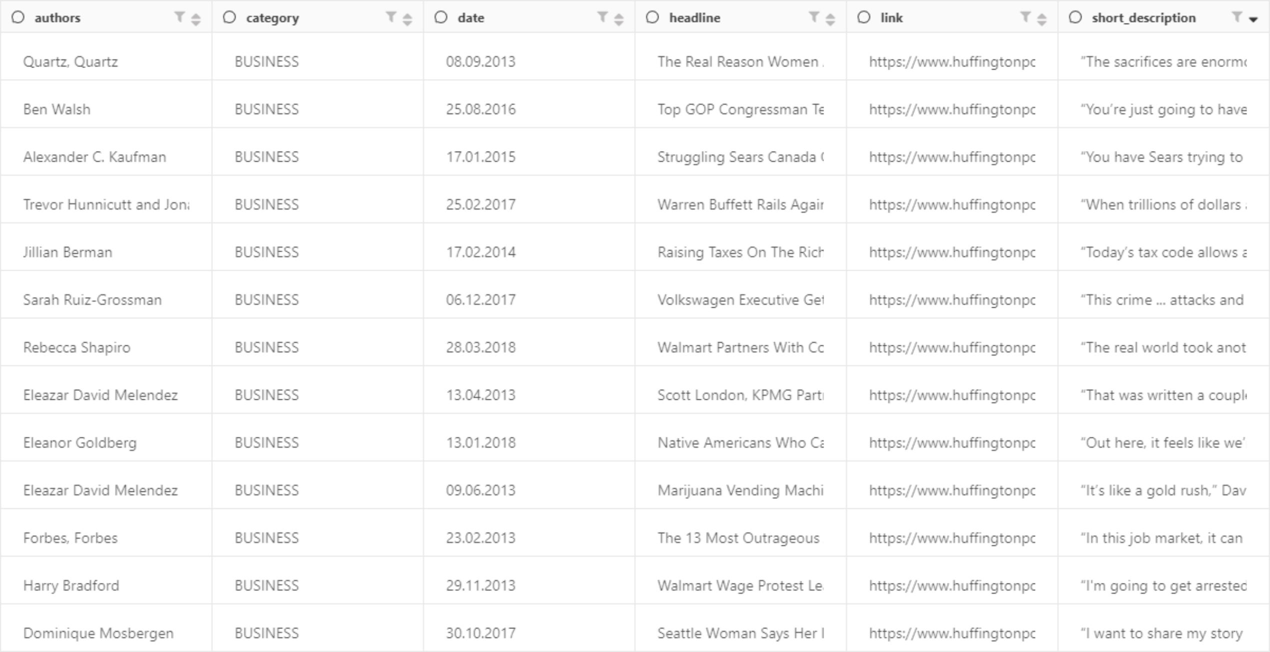
The structure of the dataset, which has been downloaded as a JSON file from Kaggle.com, was cleaned before getting uploaded to Appbase.io. The uploading was through the web UI Dejavu to Elasticsearch. When it was importing, the dataset was imported into an index. This way of importing the data is compatibility with JSON and CSV files. The index structure is shown in Figure 4.2.



```
{
  "date": "Int",
  "link": "String",
  "authors": "String",
  "category": "String",
  "headline": "String",
  "short_description": "String"
}
```

Figure 4.2: Index structure.

Moreover, the dataset is shown in Figure 4.3 is from dejavu's user interface.



○ authors	○ category	○ date	○ headline	○ link	○ short_description
Quartz, Quartz	BUSINESS	08.09.2013	The Real Reason Women .	https://www.huffingtonpc	"The sacrifices are enorm
Ben Walsh	BUSINESS	25.08.2016	Top GOP Congressman Te	https://www.huffingtonpc	"You're just going to have
Alexander C. Kaufman	BUSINESS	17.01.2015	Struggling Sears Canada (	https://www.huffingtonpc	"You have Sears trying to
Trevor Hunnicutt and Jon	BUSINESS	25.02.2017	Warren Buffett Rails Agair	https://www.huffingtonpc	"When trillions of dollars .
Jillian Berman	BUSINESS	17.02.2014	Raising Taxes On The Rich	https://www.huffingtonpc	"Today's tax code allows a
Sarah Ruiz-Grossman	BUSINESS	06.12.2017	Volkswagen Executive Get	https://www.huffingtonpc	"This crime ... attacks and
Rebecca Shapiro	BUSINESS	28.03.2018	Walmart Partners With Cc	https://www.huffingtonpc	"The real world took anot
Eleazar David Melendez	BUSINESS	13.04.2013	Scott London, KPMG Part	https://www.huffingtonpc	"That was written a coupl
Eleanor Goldberg	BUSINESS	13.01.2018	Native Americans Who Ca	https://www.huffingtonpc	"Out here, it feels like we'
Eleazar David Melendez	BUSINESS	09.06.2013	Marijuana Vending Machi	https://www.huffingtonpc	"It's like a gold rush," Dav
Forbes, Forbes	BUSINESS	23.02.2013	The 13 Most Outrageous	https://www.huffingtonpc	"In this job market, it can
Harry Bradford	BUSINESS	29.11.2013	Walmart Wage Protest Le	https://www.huffingtonpc	"I'm going to get arrested
Dominique Mosbergen	BUSINESS	30.10.2017	Seattle Woman Says Her I	https://www.huffingtonpc	"I want to share my story

Figure 4.3: Dejavu index structure.

For the reason of using Dejavu for indexing the dataset than Appbase itself, the Appbase could not upload an index of over 3k records. At the start, the dataset only consisted of 100 records, which was excellent for Appbase; however, when I started to input more records into the database, it stopped indexing the dataset. One reason can be that it does not handle an upload consisting of 3k records in one go, such as Dejavu. Moreover, Dejavu has a more unobstructed view of the process when importing the records.

4.1.5 Baseline Interface

The first search interface, as mentioned, follows a simple search interface. At the top, it has a search bar that returns a size of 6 results. Because the implementation of returning a list made the ratio of the web-page uneven and confusing, therefore the result list is displayed in a grid of 2*3 where the title is displayed in each of these containers, which can be shown in Figure 4.5. This way, the user does not have to scroll down for the pagination function. The left side of the search bar is where the search filters are established.

In order to minimize the design for all three search interfaces, the first one will have the same design as the other two search interfaces with more functions on them. The color is a combination of blue and green, whereas the color dark cyan. The result shows the title of each article in the corpus. At the bottom of the page, it has a pagination system that the user can use for searching further if necessary than the top results. Although the pagination system has no more than five pages for checking the results, the ”page’ the user is on is shown with a dark cyan color surrounding the ”page’ number, which can be seen in Figure 4.5. Also, under the search bar, it shows the number of articles in the corpus.

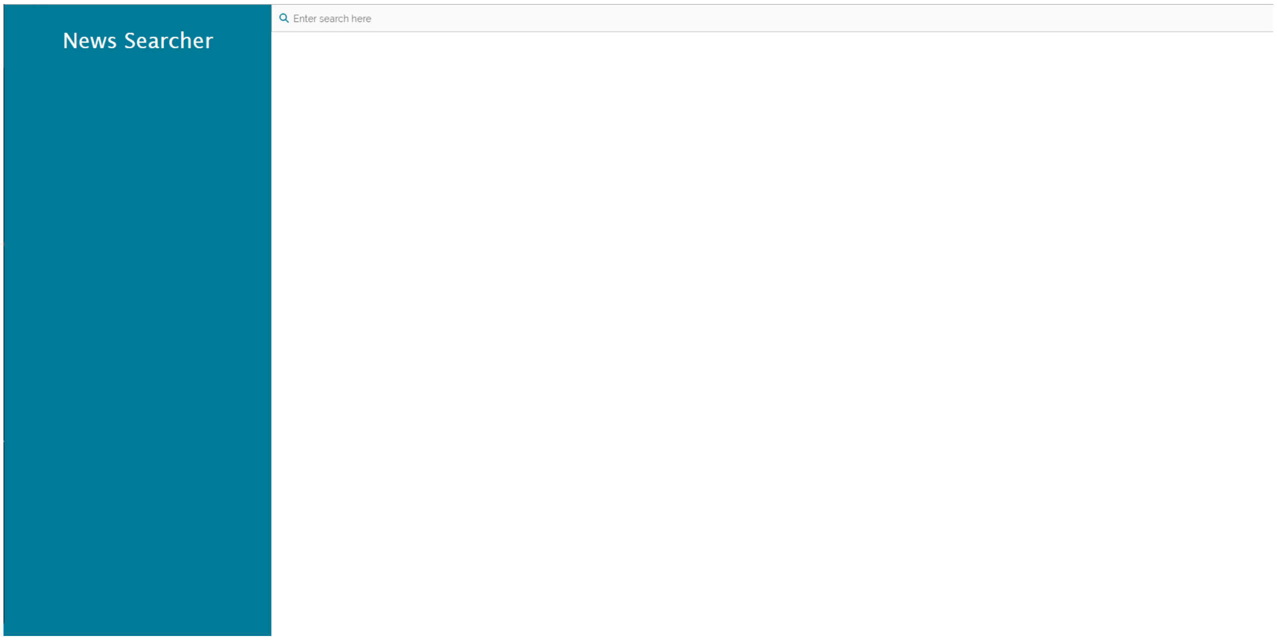
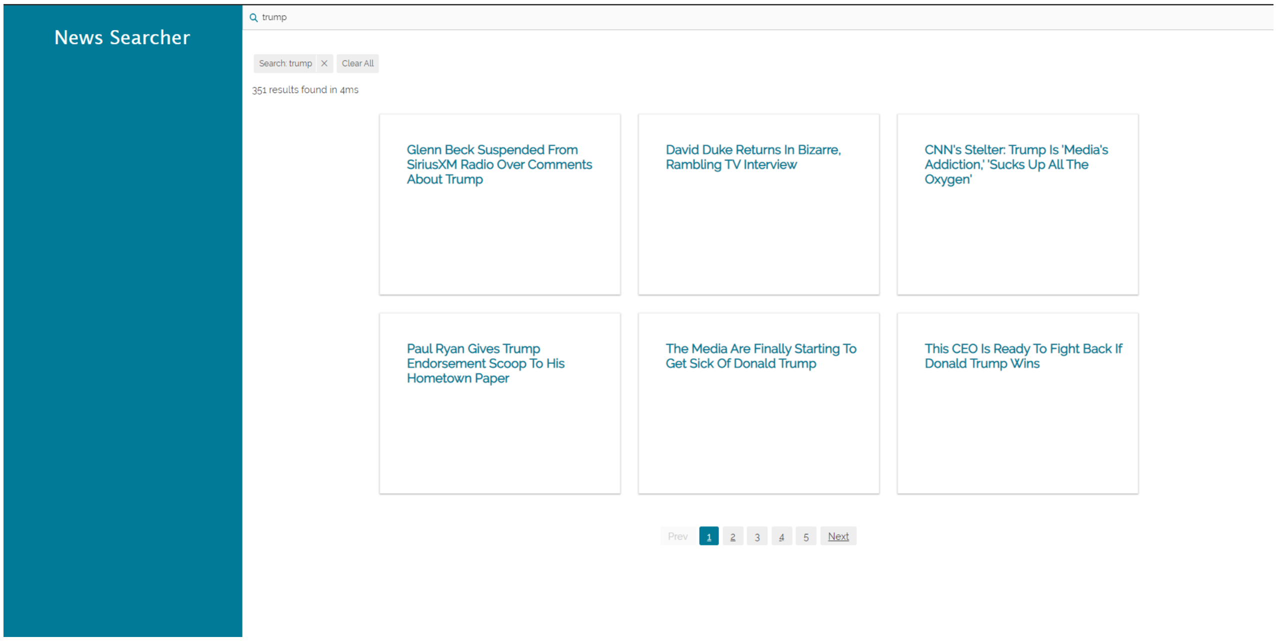


Figure 4.4: Baseline interface.

The critical component is the DataSearch component used in the ReactiveSearch library for searching through the medium of articles. As of the component form, a search user interface that lets users search for one or more data fields that are connected to the database fields, directly. The DataSearch component is shown in Figure 4.6.



351 results found in 4ms

Glenn Beck Suspended From SiriusXM Radio Over Comments About Trump

David Duke Returns In Bizarre, Rambling TV Interview

CNN's Stelter: Trump Is 'Media's Addiction,' 'Sucks Up All The Oxygen'

Paul Ryan Gives Trump Endorsement Scoop To His Hometown Paper

The Media Are Finally Starting To Get Sick Of Donald Trump

This CEO Is Ready To Fight Back If Donald Trump Wins

Figure 4.5: Baseline search interface displaying the result from a user query.

The format from a query that is used in this prototype has the value of *and*. The results that match the words “chair” and table will both of them be returned. The other value which can be used is *or*. This tells us that any of the query text will be returned. Using the same example, “chair” or “table” will return all the results from the chair or results from the table.

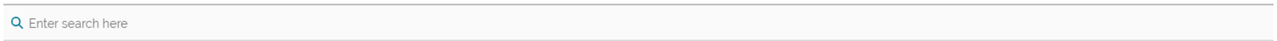
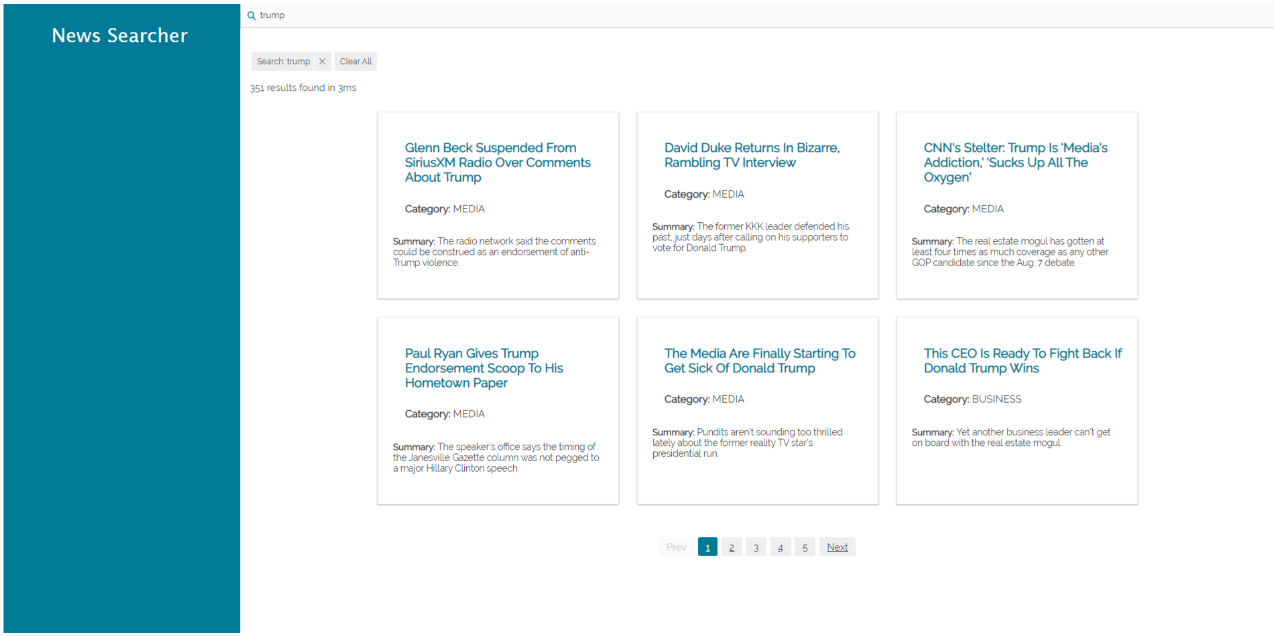


Figure 4.6: DataSearch component.

4.1.6 Text Summary

The second search interface in this thesis is referred to as an exploratory interface. As mentioned in Section 2.2, exploratory is to help the users to go beyond a standard search interface, such as the baseline used in this thesis. Moreover, it helps the users to gain more insight into information to make a better decision to achieve the information they are looking for. This search interface extends the baseline with setting a categorization of the article and gives a short description of the article, which is shown from the results.

The category is put below the title and gives the user an overview of which field the articles consist of, which allows the user to narrow the search further down. The short description gives the user a more understanding of the article from only the header. Moreover, it helps to understand the context better and gives the user a better judgment of whether a further discovering of the article is worth it. As discussed earlier in this chapter, the indexing consists of six fields, and three of them are the category, header, and short description. The exploratory interface it used for being displayed by the user queries. This search interface is presented in Figure 4.7.



351 results found in 3ms

Glenn Beck Suspended From SiriusXM Radio Over Comments About Trump

Category: MEDIA

Summary: The radio network said the comments could be construed as an endorsement of anti-Trump violence.

David Duke Returns In Bizarre, Rambling TV Interview

Category: MEDIA

Summary: The former KKK leader defended his past, just days after calling on his supporters to vote for Donald Trump.

CNN's Stelter: Trump Is 'Media's Addiction,' 'Sucks Up All The Oxygen'

Category: MEDIA

Summary: The real estate mogul has gotten at least four times as much coverage as any other GOP candidate since the Aug. 7 debate.

Paul Ryan Gives Trump Endorsement Scoop To His Hometown Paper

Category: MEDIA

Summary: The speaker's office says the timing of the Janesville Gazette column was not pegged to a major Hillary Clinton speech.

The Media Are Finally Starting To Get Sick Of Donald Trump

Category: MEDIA

Summary: Pundits aren't sounding too thrilled lately about the former reality TV star's presidential run.

This CEO Is Ready To Fight Back If Donald Trump Wins

Category: BUSINESS

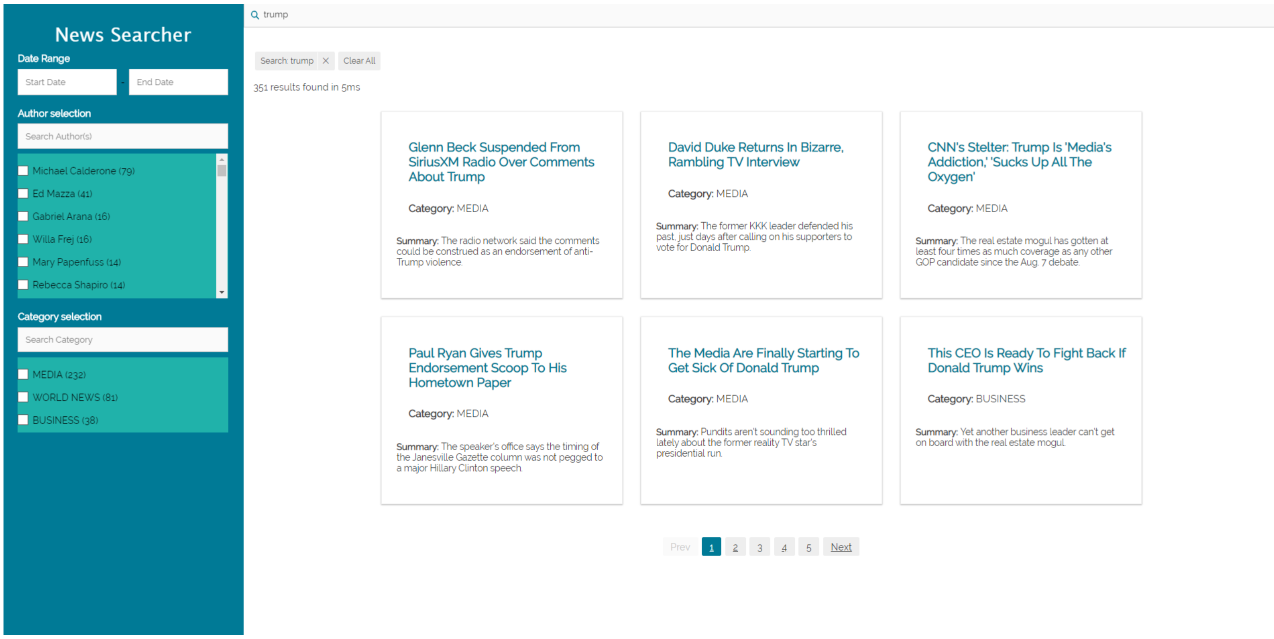
Summary: Yet another business leader can't get on board with the real estate mogul.

Figure 4.7: Text summary search interface.

4.1.7 Faceted Filtering Search Interface

The third search interface that was developed in this thesis for evaluating is referred to as an exploratory filtering search interface. It is similar to the second interface as it enhances it with filtering facets. These filter facets consist of a date-range, filtering authors ,and a category filter facets. Date-range has been implemented as it is vital to know when the article was published as the time is essential to know when looking for information about a certain situation. The author filter got assigned as the user wants to know which publisher has published it and prefer articles that are true and have meaningful information in it. The order of the author filtering functions is displayed in a count-based list, where the one with the most article published is on top.

The query format used in the different filtering facets is using *and*. The category filtering facet is used to separate other fields in the news domain that is unnecessary or the other way around to refine the search even further. As each user is looking for different news articles that they think are meaningful to them and thus making this function a valuable filter facet, which helps the user to limit their search.



351 results found in 5ms

Glenn Beck Suspended From SiriusXM Radio Over Comments About Trump

Category: MEDIA

Summary: The radio network said the comments could be construed as an endorsement of anti-Trump violence.

David Duke Returns In Bizarre, Rambling TV Interview

Category: MEDIA

Summary: The former KKK leader defended his past, just days after calling on his supporters to vote for Donald Trump.

CNN's Stelter: Trump Is 'Media's Addiction,' 'Sucks Up All The Oxygen'

Category: MEDIA

Summary: The real estate mogul has gotten at least four times as much coverage as any other GOP candidate since the Aug. 7 debate.

Paul Ryan Gives Trump Endorsement Scoop To His Hometown Paper

Category: MEDIA

Summary: The speaker's office says the timing of the Janesville Gazette column was not pegged to a major Hillary Clinton speech.

The Media Are Finally Starting To Get Sick Of Donald Trump

Category: MEDIA

Summary: Pundits aren't sounding too thrilled lately about the former reality TV star's presidential run.

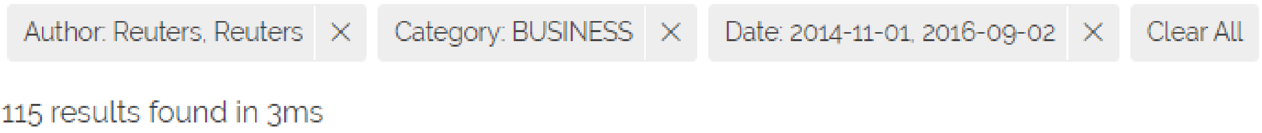
This CEO Is Ready To Fight Back If Donald Trump Wins

Category: BUSINESS

Summary: Yet another business leader can't get on board with the real estate mogul.

Figure 4.8: Faceted filtering search interface.

All facets can be used at the same time, as beneath the search bar, the filter facet that is in used gets displayed there. Not only displayed, but also the user can undo the filtering if the user has selected the wrong author, date, category, or query. A close look at this function is shown below. Not only the filter facet can be removed, but also the user query. If the query and the filtering give zero results, instead of starting a new search, the user can modify the ongoing search.


Author: Reuters, Reuters ×

Category: BUSINESS ×

Date: 2014-11-01, 2016-09-02 ×

Clear All

115 results found in 3ms

Figure 4.9: Clearing out from the faceted filtering search interface.

4.1.8 Popularity

The perception of the factor popularity is established around the “wisdom of crowds” principle. Rather than following the wisdom of people with expertise, the knowledge of many is recognized as more sufficient Surowiecki [2005]. By that, the three facets were implemented and sorted.

- *Popularity by the author* - The more published articles an author has published, a higher indication of popularity, but also in the ¨knowledge-area”, which can influence the ratio of “trust”.
- *Freshness* - Quite important as people commonly explore present information, as of information can have value today but have lost its value the next day.
- *Category* - Get an overview of which articles is under each category, which makes it easier to separate articles in other categories that the user is not interested in.

Chapter 5

Results

This chapter presents the results from the evaluation, which is from the performance (quantitative and qualitative) and usability. We start by describing the participants, then by matching the user performance with the various search interfaces. From there, we investigate the log analysis that clarifies to what degree the different interfaces were used. After that, we present the outcomes from the post and final questionnaires. In the end, the reports the findings from the SUS from the participants' opinion regarding the different interfaces.

5.1 Participants in Evaluation

Table 5.1 is an overview of the subjects, which participated in SUS, and individual user evaluation. The population of participants for this study span over a variety of disciplines ranging from business management to land surveying. A total of 12 participants were involved, which were recruited via flyers in Bergen. All the participants fully completed the user study. The average age of the participants was 27.5 years, (min = 21, max = 38 and SD = 4.56 years)

All of the participants stated that they were familiar with the news domains and had a high basis in using the computer weekly (except 1 participant) reported the usage of 3-5 days in a week of using the computer. Three participants using the computer daily. This outcome was also with experience in online searching. Most of the allocation of participants stated that they frequency used a search engine, and nearly all (except 1 using stated using Safari) primarily used Google as their search engine. Every participant stated that they were accustomed to filtering facets and has used search filtering interfaces before, especially in e-commerce sites.

As discussed in Section 3.10, they engage in questionnaires throughout the whole study session, which utilized detailed log documentation (see Section 5.2), which is the lead approach of collection data. Each user study session carried on for average at 60 minutes.

Table 5.1: Participant evaluators.

Participant ID	**Age**	**Gender**	**Computer experience**	**Familiar with searching**
P1	27	Male	✓	✓
P2	28	Male	✓	✓
P3	32	Female	✓	✓
P4	21	Male	✓	✓
P5	27	Female	✓	✓
P6	22	Female	✓	✓
P7	27	Male	✓	✓
P8	38	Female	✓	✓
P9	28	Female	✓	✓
P10	25	Male	✓	✓
P11	29	Male	✓	✓
P12	34	Male	✓	✓

5.1.1 Pilot Study

Before the study session, which involved the evaluation procedure, a pilot study was conducted (see Section 3.5.2), in order to foreseen possible errors or missing elements. The participant of the pilot study was a professor from the *University of Bergen* (UiB). The trial was convenient as it pointed out that it was a chance to improve around the evaluation method, like the interview, questionnaires, the search tasks part. A few of the questions in the interview and questionnaire part were rather hard to understand, which required an explanation of the questions. Thus those questions that were afflicted with complexity were paraphrased into straightforward and comprehensible questions. Also, some question was removed or combined for lessening the time for the participants. Since the study session (see Section 3.7), the participants underwent a great extend of questions.

5.1.2 Participant Performance Analysis

The objective of this study was to find out if a support system will have better performance and effectiveness in finding the desired information in the news domain. In order to find that out, the user search performance was conducted with two types of search tasks, namely lookup and exploratory search tasks. Together with these types, they were tested on three different search interfaces. Such as a baseline interface which has the function of a general-purpose search bar and a grid list of results. A search interface that is displaying a summary and category of the article. The last search interface is displaying the mention above with filtering facets for determining user performance and efficiency. All participants finished the search task successfully.

Table 5.2: Summary of the average time in seconds on the search tasks of the different search interfaces.

	Action				
Action	**Baseline**	**Text Summary**	**Faceted Filtering**	**Lookup**	**Exploratory**
	72	90	49	-	-
	150	154	99	-	-
Total Action	222	244	148	211	403

Table 5.3: Summary of the total actions on each search interface and total action on the two search tasks.

	Search Interface		
Time	**Baseline**	**Text Summary**	**Faceted Filtering**
Lookup	679	652	318
Exploratory	1149	839	537
Total Time	1828	1491	855

5.2 Log Analysis

To appraise the efficiency and performance distinctness enclosed by the three search interfaces, we inspected and analyzed the action of search time. The total number of clicks of each user-click was done to each search interface. Table 5.4 shows a summary of the average time and total actions on lookup and exploratory tasks. Fewer action and shorter time should contain information about an excellent efficiency search interface towards the articles.

Table 5.4: Summary of mean and SE of search time and total clicks in each search interface.

Task	Measure	Baseline	Text Summary	Faceted Filtering
Lookup	Total Clicks	6 $\pm 0,52$	7.5 ± 0.66	4.08 ± 0.39
	Search Time	56.58 ± 7.31	54.33 ± 8.36	26.5 ± 1.93
Exploratory	Total Clicks	12.5 ± 0.43	12.83 ± 0.86	8.25 ± 0.42
	Search Time	95.75 ± 4.82	69.91 ± 4.15	44.75 ± 3.10

As all participants successfully finished all the search tasks, the overall performance is not tempered with. Table 5.4 reports the performance of the various search task with total action and total time. Moreover, from the participants' performance, we can see that the difference between the two search tasks is crucial. As one would expect, the exploratory search tasks used the longest time for completing search tasks, additionally with total action. In order to determine the significant difference between the performance on the different search interfaces, the method *t-test* was performed. The method of analysis was applied isolated to each other (total action and search time). Since all the participants completed the search task, an evaluation of the total (12) cases was also evaluated.

Despite the efficiency from the log analyses from the average, which exposes crucial distinctions between the three search interfaces from the search tasks. No matter how one sees it, these results do not show how these accustomed various are collected from other kinds of actions. In order to throw a spotlight on this matter, a more in-depth analysis of the user log, which was about each interaction the user did and the tasks, was conducted. In other words, these actions are the search button from a user query, clicking on links that take them to the initial article, clicking on the various filtering functions, and last, remove button of a query. While some action is accessible on all three search interfaces, other functions are only feasible in the search interface with the faceted filtering search interface. These actions that can be compared on all three search interfaces are action on search, remove term, click a link, and pagination, while the action of the other is only displayed on the search interface with the faceted filtering.

By conducting a statistic analyzation with the *t-test* method on the search time, a significant difference was found between the lookup, the exploratory search tasks, and the search time on the different search interfaces. The difference between the baseline and the faceted filtering search interface demonstrated significant differences t(12) = 3.97, p = .001. Whereas with the baseline and the text summary search interface, there was no sign of significant difference, t(12) = .20, p = .42. Concerning the exploratory search time, a significant difference was found from all the search interfaces. Between the baseline and the text summary, the significant difference was t(12) = 4.05, p = .001. Furthermore, a significant difference was found among the baseline and the faceted filtering search interface, t(12) = 8.88, p = .001.

By performing a t-test on the total action on each search interface on the lookup and exploratory search task, a significant difference was discovered among the search interfaces with the lookup task. Between the baseline and the faceted filtering search interface, there was a significant difference, t(12) = 2.91, p = .003. For the baseline and text summary, there was also a significant difference, t(12) = 1.76, p = .045. In addition to also discovering a significant difference between the search interface on behalf of the exploratory search tasks. Among baseline and faceted filtering search interface, a significant difference was identified, t(12) = 6.95, p = .001. However, no significant difference were revealed between the baseline and the text summary, t(12) = 0.34, p = .36.

Through analyzing the total action on all three search interface regarding both search tasks, a significant difference was uncovered among the search interfaces as well. The total action between the baseline and the faceted filtering searching was found a significant difference, t(12) = 6.32, p = .001. Despite that, no significant difference was found between the baseline and the test summary search interface, t(12) = 1.69, p = .051.

Some types of the tables do not substantiate, or straightforward make it challenging to demonstrate the differences among the search interface, regarding the search time concerning the two search tasks. The following Figure 5.1 is meant to shed light on the statistic analyzing in the previous section in connection with the search time.

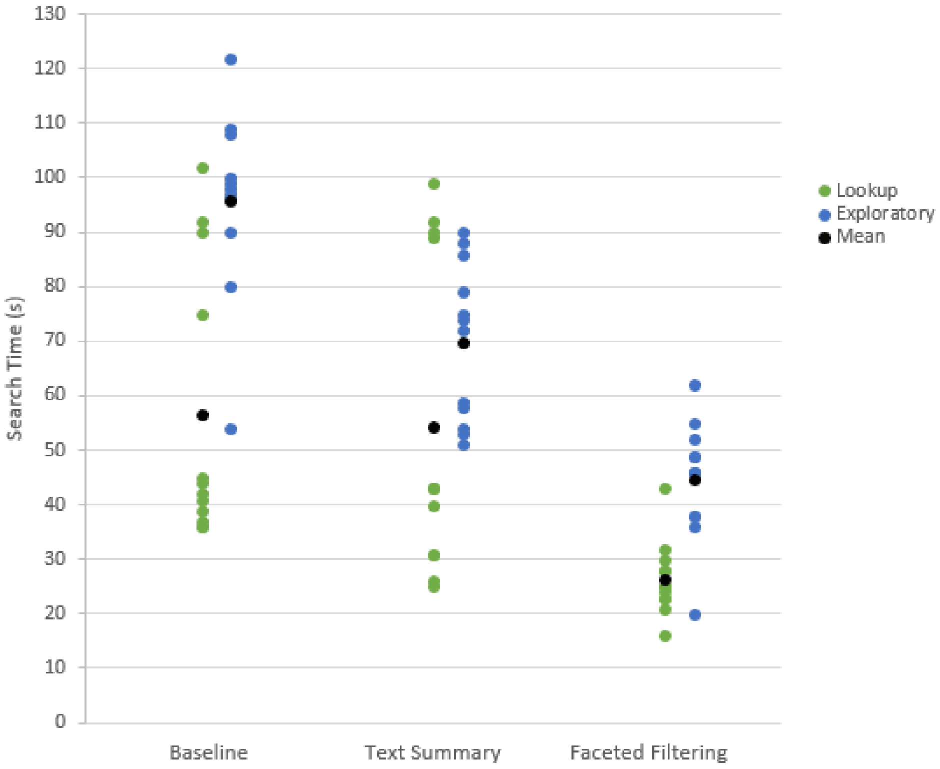


Figure 5.1: Lookup and Exploratory search task complete-time among the difference search interfaces.

Table 5.5: Summary of actions based on each search task in the different search interfaces.

	Search Interface			Task			
	Baseline	Text Summary	Faceted Filtering	Lookup	%	Exploratory	%
Search	4.66 ±0.37	6.08 ±0.67	2.50 ±0.15	6.25 ±0.61	35.55%	7 0.44	20.84%
Remove Term	2.5 ±0.26	3.25 ±0.55	-	2 ±0.27	11.37%	3.75 0.46	11.17%
Click Link	6.25 ±0.25	7 ±0.49	6.58 ±0.28	3.83 ±0.27	21.80%	16 0.55	47.64%
Author Function	-	-	1.00 ±0.00	1.00 ±0.00	5.69%	-	0%
Date Range Function	-	-	0.33 ±0.14	0.33 0.14	1.9%	-	0%
Category Function	-	-	1.25 ±0.13	0.25 ±0.13	1.42%	1 .0	2.98%
Pagination Function	5.08 ±0.22	4 ±0.42	0.66 ±0.25	3.91 ±0.45	22.27%	5.83 0.44	17.37%
Total Actions	18.5 ±0.73	20.79 ±0.86	12.33 ±0.64	17.25 ±0.84	100%	33.58 0.62	100%

Conventionally, investigating the time and click-log, these factors certified crucial efficiency and performance among the various search interfaces. The faceted filtering search interface appears to have, on average, more exceptional performance on both search tasks in terms of time. As shown in Figure 5.1.

5.3 Post-Task Questionnaires: Participants Awareness of the Different Search Interfaces

Table 5.6: Response to the post questionnaires with a Likert scale from 1-5, where 5 is higher values, expressing a higher recognition.

	Lookup Task			Exploratory Task		
Question	Baseline	Text Summary	Faceted Filtering	Baseline	Text Summary	Faceted Filtering
1. Did the interface give enough support for the task?	3.08 ±0.33	3.41 ±0.28	4.66 ±0.14	2.75 ±0.35	3.41 ±0.25	4.74 0.13
2. Were some function unnecessary in the interface for the task?	2.16 ±0.16	2.33 ±0.22	2.33 ±0.25	2.25 ±0.21	2.16 ±0.16	1.91 ±0.19
3. Did the function help you to find the relevant information on the topic?	3.41 ±0.22	3.27 ±0.27	4.75 ±0.13	3 ±0.27	3.75 0.13	4.8 ±0.11
4. Did you find the interface without baseline helpful to find relevant information?	-	4.33 ±0.18	4.75 ±0.13	-	4.58 ±0.14	4.8 0.11
5. Was it helpful with having the filtering function listing the result in a count-based ranking?	-	-	4.75 ±0.13	-	-	4.8 0.11
6. Was the x useful for removing terms to the query?	2.41 ±0.43	2.58 ±0.46	-	3.58 ±0.19	3.91 ±0.22	-

After each participant finished their two search tasks on a search interface, they were asked to complete a series of questions, and analyzing the feedback about the user's perception of the usefulness, helped with establishing differences among the search interfaces. As shown in Table 5.6, the average user's perception of the questions.

5.3.1 Post Questionnaires: Participants Preference on Search Interfaces and Comments

A practical groundwork of user feedback was from the event with the post questionnaire, from Figure 3.7, we see that it was executed after each participant were finished with the entire study. The indicated questionnaire provided a favorable chance to request the participants for their impressions of the various search interfaces. From this point of view, the participants had achieved functional knowledge with the various search interface along with the two types of search tasks. Table 5.7 shows the participant's preferences of the various search interfaces.

When asking the participant a reflective question, "*Which one of the search interfaces did you prefer?*" All participants (12) appointed the faceted filtering search interface over the other two (baseline and text summary search interface). From knowing this, it associated with their action and searched time on the search tasks. As for questions two and three, which involved the two types of tasks, the feedback from the participant was one-sided in both questions. Like "*Which one of the search interfaces do you prefer for lookup search?*". All those who participated (12) favored the faceted filtering search interface in the lookup and exploratory search task. In additional to find the search interface the participant favor, a question was asked to determine which search interface required more work with the search tasks. "*Which one of the search interfaces did you feel that required more effort to find relevant information?*". The entire group (12) reported that the baseline (search only) was the one that needed the most effort in doing the search task. This finding points out that the faceted filtering search interface was measured to be more robust and more favored than the baseline.

The information from these questions reveals the significant difference from the participants' visions within the enhanced search interfaces (text summary and the faceted filtering) and the baseline. The faceted filtering search interface was favored from all the participants (12), while everyone stated that their dissatisfaction with the baseline search interface. Besides, these participant perceptions, a more justified estimation regarding the tree search interface were applied for supporting these differences. In examining their rating on a Likert scale, which goes from 1 to 5, where a higher number is indicating a higher agreement of the statement.

Table 5.8 shows that the average rating of the baseline search interface is 1.66, 3.5 for the text summary search interface, and 4.91 for the faceted filtering search interface. Taking this into consideration, the result from the prefer question correlates strongly with the baseline search interface, that it was rated considerably lower than the text summary search interface, and the faceted filtering search interface. Despite that, from the participant perception, all subjects (12) stated that they preferred the faceted filtering search interface, and none stated the text summary search interface.

The explicit rating did discover that the text summary search interface was fairly well rated. The reason behind why the statistic of the participant perception only showing 100% preferably on the faceted filtering and 0% on the text summary search interface is the cause of only one option to choose on. Nevertheless, the explicit rating did cover how each participant rated the different search interfaces.

Table 5.7: Precentages and frequencies(freq) from the final questionnaries.

	Search Interface					
Question	**Baseline**	**Freq**	**Text Summary**	**Freq**	**Faceted Filtering**	**Freq**
1. Which one of the search interfaces did you prefer?	-	(-)	-	(-)	**100%**	**(12)**
2. Which one of the search interfaces do you prefer for lookup search?	-	(-)	-	(-)	**100%**	**(12)**
3. Which one of the search interfaces do you prefer for exploratory search?	-	(-)	-	(-)	**100%**	**(12)**
4. Which of the search interface did you feel that required more effort in order to find relevant information?	**100%**	**(12)**	-	(-)	-	(-)

5.4 Comment Analysis

In order to explain the various distinctness between the participants' awareness from the different search interfaces, another source of analysis were examined. The meticulous feedback, such as comments originating from the post questionnaire time of the study session. The following sections are from the participants' comments on which type of search interface they sided with:

5.4.1 *Preferred the Baseline Search Interface*

In compliance with the participant, none of the users preferred the baseline search interface. From the various comments, the reason was apparent. Since all subjects did rate the baseline poorly and stated roughly the same, a sample of the comments as following are selected:

“The baseline, no doubt. With only a search box and a showing only the headline of the articles. It gave more time to check the results” - P1

“Too less information displayed, which made me read more headlines and checking more pages” - P2

“Baseline only showing the headline of each article gave a little nuisance. It was more effort in searching that the other two interfaces” - P3

“It lacked displaying information and faceted for a more structured way of searching. In some cases, its enough for only showing the headline, but in today’s society, it is a lot of click-baiting of the headline, which made me more alert when reading the headlines” - P6

“Baseline, because you need to click on the different to read what the article is about. On the other interfaces, you could at least read the summary and get a thought on what the article is about” - P9

“Simply, too less information is showing. Luckily the search tasks were not that hard, so it was easy to do them. My opinion is that this interface does require more effort on using it.” - P11

Nearly all the participant specified too less information showing, which seems like the major role for rating the search interface as poorly as the subjects did.

5.4.2 *Preferred the Text Summary Search Interface*

While everyone selected the faceted filtering search interface, they also mention the text summary search interface as the information displayed is the same, without the faceted.

“The text summary gave decent information, but lacked facets to organize the different properties of the article” - P6

“Text summary gave lots of information, the same as the faceted interface. In addition to the filtering function, which was a huge help in the search tasks” - P10

The subjects that mention the text summary search interface seem to criticize the interface for not having filter facets as the faceted filtering search interface has.

5.4.3 *Preferred the Faceted Filtering Search Interface*

Since every subject preferred the faceted filtering search interface from the comments, it appears that the reason is mainly three angles on that matter. The first side is their opinion on selecting this search interface, which presents them in an organizes view of the information.

“Faceted filtering, as the filtering made a better view and keeping the data organized.” - P1

“Using the faceted filtering interface, it was good to see a summary of all the articles and which category, but I liked the structured way of the information when you have the option to refine your search with facets, like these” - P3

“Faceted filtering is the most effective and helpful search interface” - P7

“The information looked more organized and was easy to do the search task” - P10

“The faceted filtering interface made it easier to navigate towards the information” - P6

The second side in which the subject shaped their opinion on the search interface is that the faceted filtering search interface was making it easier for supporting their search.

“the interface with filter option provided me with more information that helped me with the search tasks” - P2

“It was easier and faster to use a faceted filtering interface to searching for information. Other interfaces were not accurate in searching. It took more time to search for information” - P5

While the last aspect from the subject was that the faceted filtering provided support with searching which required less effort in focusing on the query.

“Less focus on the query, which the facets were a huge help to find the right information” - P10

“Helped with searching, less focus on the query itself” - P12

“I like the way with the facets, less thinking, and makes it easier to navigate through products” - P4

Table 5.8: Summary of the final questionnaires.

Question	**Rating**
Overall how would you rate the Baseline search interface?	1.66 ± 0.11
Overall how would you rate the Text Summary search interface?	3.50 ± 0.15
Overall how would you rate the Faceted Filtering search interface?	4.91 ± 0.08

5.5 System Usability Testing

The project was conducted in a controlled environment with a laptop and with a second monitor, mouse, and keyboard, which provides the tools for conducting the tasks. As shown in Table 5.1, the participants are labels as unique IDs.

5.5.1 System Usability Scale

The score and the results from conducting the SUS questionnaires from the end of the study session are presented in this section. For more information about the SUS, it can be read in Section 3.5.1. The usage of this evaluation method aimed at resolving the usability of the different search interfaces. The sample of the usability testing included all participants that completed the study session. After computing the SUS score of the different search interfaces, the average SUS score of the baseline search interface was 47.1. The search interface with text summary and category was 72.1, and the last search interface with the filtering functions was 88.3.

As discussed in Section 3.5.1, an average score of 70 and above is expressed as good usability for prototypes. As shown in 5.9, the text summary and faceted filtering search interface were both over a score of 70, with an average SUS score of text summary (72.1), and the faceted filtering (88.3) does mean that it can be characterized as satisfactory results, although these SUS scores from the participants do indicate that the faceted filtering search interface will be more feasible to recommend to others over the other two. The lowest score is 67.5, and also see that three participants gave the faceted filtering search interface a score of 100. The majority gave a score of over 90. As of the baseline, it got a mere average score of 47.1, meaning that it is not suited in usability.

We see that the highest score of the baseline search interface is 70, and the lowest is 32.5. Nearly all of the participants gave a score under 55. The text summary search interface had the lowest score of 60 and the highest at 82.5, and the majority think that it is considered a reasonable search interface. But not nearly as good as the faceted filtering system. Table 5.8 shows the explicit rating on the three search interfaces. From the explicit user rating of which search interface they preferred, a significant difference was revealing the search interfaces. Among the baseline and faceted filtering search interface, it showed a significant difference, t(12) = 28,72 p = .001. Addition to also show significant difference between the baseline and the text summary search interface, t(12) = 11,28 p = .001.

Table 5.9: SUS scores on the different search interfaces with average and difference between them.

	Search Interface		
System Usability Scale	**Baseline**	**Text Summary**	**Faceted Filtering**
P1	52.2	67.5	**77.5**
P2	32.5	60.0	**72.5**
P3	45.0	65.0	**67.5**
P4	47.5	67.5	**80.0**
P5	57.5	75.0	**100.0**
P6	52.5	72.5	**82.5**
P7	40.0	67.5	**100.0**
P8	42.5	75.0	**100.0**
P9	70.0	80.0	**92.5**
P10	40.0	75.0	**92.5**
P11	50.0	77.5	**97.5**
P12	35.5	82.5	**97.5**
Average	47.1	72.1	**88.3**

Table 5.10: Task completion time.

	Search Interface					
	Baseline		**Text Summary**		**Faceted Filtering**	
Participant	**Lookup**	**Exploratory**	**Lookup**	**Exploratory**	**Lookup**	**Exploratory**
P1	39	98	89	59	28	49
P2	90	99	40	58	30	46
P3	45	122	26	75	32	55
P4	41	54	92	86	43	62
P5	75	96	43	90	28	20
P6	44	97	43	51	23	38
P7	36	80	99	54	21	52
P8	102	100	31	88	16	38
P9	42	109	43	53	25	46
P10	36	108	90	72	23	49
P11	92	90	25	79	25	36
P12	37	96	24	74	24	46
Total Time	679	1149	652	839	318	537

5.5.2 Users tasks for evaluation

Each participant went through search tasks on the different search interfaces (see Section 3.10). The same tasks were used in all three search interfaces. The rotating of the different interfaces and search tasks were used with the Latin square design (see Section 3.10.2). Furthermore, the search tasks were arranged, such as one lookup task and one exploratory search task on each interface. Besides, the search task was also randomized.

Table 5.10 shows each participant individual time used on the various search tasks, while Table 5.3 shows the average time on each search interfaces, but also of the two types of search tasks. The lookup and the exploratory search tasks correlate well that the assumption that the exploratory search task uses more time than the lookup search tasks. The difference between the search types in the baseline search interface, is 19.38%, 16.18% in the text summary search interface, and 22.64% in the faceted filtering search interface. The distinction between the two types can also be seen with the total action on the different search interfaces, which is shown in table 5.2. The difference action between the two search types is 50% in the baseline, 37.7% in the text summary, and 37.5% in the faceted filtering search interface.

Chapter 6

Discussion

In this chapter, the different methods, methodologies, and prototypes, which were used in this study are discussed. Furthermore, it will end with answering the research question from Section 1.2.

6.1 Methodologies

6.1.1 Design Science

Throughout the study, the framework Design Science was used in order to accommodate the different methods. Within Design Science we gain insight into three key factors along with determining seven guidelines in the interest of an efficient utilization for research.

Design as an Artifact as the first guideline means that *"research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation."* Esearch et al. [2004]. Viable artifacts have been developed, three search interface with different functions.

Problem Relevance, which is the second guideline means that *"The objective of design-science research is to develop technology-based solutions to important and relevant business problems"* Esearch et al. [2004]. The three search interfaces were used to delve into identifying if a search interface supporting functions will have better effectiveness and performance in finding the relevant information, in which this thesis uses a dataset in the news domain. This research has fulfilled the second guideline through uncover that the majority of the user prefer a support system through searching.

Design Evaluation, the third guideline, means that *"The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods"* Esearch et al. [2004]. In Chapter 5, this guideline gets satisfied by evaluating the three high-fidelity prototypes.

Research Contributions the fourth guide means that *"Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies"* Esearch et al. [2004]. In this research, these three search interfaces have contributed to the finding of user characteristics from two search tasks, namely lookup and exploratory search tasks. This demonstration enabled us to find a difference in performance and efficiency towards the different search interfaces.

Research Rigor, the fifth guideline, means that *"Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact"* Esearch et al. [2004]. All three search interface is of high-fidelity that was evaluated through various methods, such as observation, usage of questionnaires, semi-interviews, and usability evaluation. The procedure of evaluation is described in Section 3.10.2.

Design as a Search Process is the six guidelines, which means that *"The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment"* Esearch et al. [2004]. Knowledge within the domain of news, in the concept of requirement and constraints, can be a critical point towards the usability but also the utility of the design. Throughout the research, regular meetings with professionals from DNB, the risk assessment department, has given awareness within this domain, which has helped to establish the requirements for the different search interfaces. This has been an iterative process with an in-depth evaluation at the end.

Communication of Research, which is the last guideline, means that *"Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences"* Esearch et al. [2004]. The three search interface prototypes will be presented to the professionals from DNB. The thesis will be published at bora.uib.no, where it would be accessed to the public. Thus all information presented in this can be used for further research.

6.1.2 Data Gathering

Observation During the evaluation process, observation (see Section3.10.2), were used in a controlled environment (see Section 3.4.1) for quantitative and qualitative data surrounding the three search interface prototypes. The benefit of using this method is that it amplifies the information gathered from the interview phase. Not only that but observing in a closed environment could have affected the whole experiment in a relaxing way for the participants. All the participants finished the study session. With the usage of one laptop and two monitors, making it easier to observe when answering questions and doing the search tasks.

Semi-Structured Interview Semi-structured interviews (see Section 3.4.2) were used in the beginning, within, and at the end of the study session (see Section 3.10.2). This method was used for getting eliciting information about the participants, their performance, and preference on the different search interfaces, which worked quite right for gathering information, which would be difficult with the use of other methods. This method provided essential feedback between the three search interfaces. As the objective of gathering data with these interviews was to appraise the required information, the semi-structured interview's granted this information to be gathered. As discussed in Section 3.10.2, the study session involved different data gathering techniques, and the average time of one session took with a participant was 60 minutes. Thus made it quite time-consuming as each session was done at different times in one week. Nevertheless, these techniques were profitable and suited for the study session.

Evaluation This thesis uses acknowledged and proven methods for evaluation. Participants from the different domains were used in order to evaluate the three search interfaces. As discussed in Section 3.5 a summative evaluation with the aid of SUS, which are discussed in Section 3.5.1, Semi-structured interviews, which are discussed in Section 3.4.2 supporting the questionnaires, which are discussed in Section 3.4.3, and last statistical analyses, which are discussed in Section 3.5.4 was used towards the finding the results from the gathered data. The different methods presented positive and also negatively elements in the different search interfaces.

Since the participants had to undergo two different search tasks, six in total, which were the lookup (three tasks) and the exploratory (three tasks) search tasks. Furthermore, each of the search tasks was appointed to a search interface. Thus, the best approach was to include the full evaluation in one session, as it will reduce the tiredness and learning ability of each user.

In Figure 3.7, the study session is presented, and when a user was finished with the search task in one search interface, a post-questionnaire was used. In order to do statistical analyses on the data, it has to be collected in a unit of the mathematical system; in other words, a number. These post-questionnaires were in the form of a Likert scale arranged to measure usability through the user's preferences. The Likert scale from 1 to 5 was used throughout the session. In the interest of statistical analysis, every search interfaces were tracked from the log, every interaction of elements of the different search interface was registered using the *Google Tag Manager*. In Section 3.10.3 discussed tracking each interaction of each of the search interfaces. These measurements make it possible for analyzing the user pattern in the different search interfaces. The Table shown in 3.4, presents each element that was tracked during the study session, while Table 5.5 shows the complete interaction of each search interface.

6.1.3 Prototype

The three search interface prototypes were developed using the Design cycle, which is discussed in Section 3.2.1 from the framework of Design Science and an edition of Scrum, which is called personal Scrum, which is discussed in Section 3.3. Combining these two methods has worked quite well. In the process of personal Scrum has been used for keeping an overview of the different tasks throughout the research in detail steps, whereas the Design cycle was used for a way of looking at the overall structure of the development of the different prototypes.

Each search interface used the same records. Although to make it easier to separate and analyze the log of each search interface, each one had its database, which made it straightforward for analyzing the different logs, but also a more significant total overview of each search interface.

Pilot Study (see Section 3.5.2) was useful before the main study session. The use of a pilot study made it possible to find mistakes through the different approached that were used in the main study session. As the consequences of the pilot study, questionnaires were adjusted and shorten down. The interview question was simplified for more understandable towards the participants. The search tasks were also simplified adjusted in for the sake of the participants. As discussed in Section 3.5.2, a professor from UiB did undergo the pilot study.

6.2 Dataset Restrictions

The records that were used in this thesis were originally 202,372 records. Since this vast records of articles, what can be considered in the news domain were just a small portion of the records. After cleaning this sample of records, the sample had shrunk into a fraction of the organically size to 3197 records, which are discussed in Section 3.7. The objective was to use an ample size of records in this thesis; however, after encounter *Error Values* in the vast dataset, the priority of a cleaned dataset stood higher. Hence, the size of the records used in this thesis is 3197.

6.3 Technical

The three different prototypes which have been developed in this research are a result of the usage of various tools and frameworks. Each component and implementation of the different prototypes have been through Javascript, React, and ReactiveSearch. The usage and what they are is discussed in Section 4.1. These tools made it feasible for making different search interfaces for computer and laptop users.

The different prototypes are also responsive, meaning that mobile users can use it to some extent. However, for the sake of simplicity of this research, the evaluation was executed via a laptop. Since the prototypes also operate on smaller devices to some extent, it makes it easier to work further with an available launch.

6.4 Limitations

The research does have some limitations. It could be more beneficial for including more participants in the evaluation. It was not enabled to get more participants as the timeframe was not in scope in this thesis. It is thus resulting in a limited evaluation by statistic analyzing. Also, doing the evaluation process earlier in the process, for enhancing the final prototypes. Regardless of the feedback from the questionnaires, interview and SUS-questions, which was valuable and, quite detailed, the research could be in favor of introducing formative evaluation as well and the summative evaluation within usability.

As of the timeframe, the scope of the prototypes was limited in order to focus on the concept itself, which is the reason not all facets were included in the evaluation. Considering the time for this research, the implementation of the different prototypes does not have more facets. The idea was also to use a sample of the words from the list given by DNB. However, the result of the facet returned a max of two articles, which would result in an inconclusive result. Therefore, the facets were removed in the evaluation. The reason behind this is the time. Building three different prototype is time-consuming work, even though there are built on top of each other. That is the reason why the prototype with the filtering facets has been limited to focus on some aspects, which show a perception of it. Excluded requirements and further development is therefore suggested as further work, which is discussed in Section 7.1.1.

As briefly discussed the limitation towards the research is by the time of implementing the prototypes, and the process of evaluation.

6.5 Research Questions

The research question, which is discussed in Section 1.2, which, through evaluation and analyzing the developed prototypes, will be attempt answered below.

RQ1: In the context of a faceted filtering search interface in the domain of news, is there any detectable differences in performance amongst the developed search interfaces?

Yes. In order to measure the difference amongst the search interfaces, the investigation of the interaction through clicking, and the search time for each participant was used. Nevertheless, the result from the total action and search time of the different search interfaces concludes that they reveal a significant difference in user performance. Whereas, the data of these two features from the various search tasks (lookup and exploratory task). The one standing out is the faceted filtering search interface. The total time used in both search tasks in the different search interfaces shows that faceted filtering has the lowest time of them all. With a total time of *823* seconds, while the baseline had the longest total time of *1831* seconds, and text summary search interface had *1499* seconds.

The baseline and text summary search interface have a close range of total clicks with a differ of 9.02%. Whereas the faceted filtering search interface has around four times less total action than the text summary (39.34%) and 33.33% from the baseline. As shown in Table 5.2, the participant searched nearly half as much as the faceted filtering search interface, baseline (46.43%), and text summary (58.90%). Apart from this, the pagination action was substantially lower than from the faceted filtering search interface than the other two. Among the text summary and the faceted, the difference was 83.33%, while 86.89% from the baseline and the faceted filtering search interface.

Every subject also preferred the faceted filtering search interface with a rating of *Very Good* (12), additionally to rate the baseline *Very Bad* (10) and *Bad* (3). The text summary rating got above the average rating with 6 subjects rating it *Good*, and the rest subjects (6) rated it *Average*.

RQ2: If yes, to what extent does the difference vary

The difference varies from the total action of the filter facets, searching, pagination, and clearing the query from the two search tasks. The faceted filtering search interface used merely 20.27% of the total click on searching, 29.92% on the text summary, and 25.23% on the baseline. While checking the action towards the remove term, an interesting result was discovered. From the text summary, it was used 15.95%, 13.51% on the baseline; however, on the faceted filtering search interface, the remove term was used 0%. This correlates with the % usage of the searching, which indicates with facets, the total action gradually reduces, which exposes to view that the faceted filtering search interface is the superior one. With less total action, the total time also reduced. Analyzing the difference search tasks between the different search interfaces from the total time, a significant difference was revealed. Between the lookup tasks, it was found a significant difference between the baseline and the faceted filtering search interface, while between the baseline and the text summary search interface, there was none significant difference. However, from the exploratory tasks, it showed a significant difference among all the three search interfaces.

It is also important to note that a significant difference was revealed by the total action among the different search interfaces, even though 20.95% was used on the facets action. Between the baseline and the faceted filtering search interface, unveiled a significant difference. Although there was none significant difference between the baseline and the text summary interface, these actions made it feasible to discover the extent of the difference in the search interfaces.

This result indicates that the subject used less time with primary using the search bar, and also used the filter to refine their search more. Each facet was used regarding the two searching tasks.

The results of the evaluation done through the usage of SUS (see Section 3.5.1, and Section 5.5.1) show that the participant gave the faceted filtering search interface the highest average score. This indicates that the faceted filtering search interface, related research, and this research that it is feasible that a finished search interface would have a higher performance and efficiency with faceted filtering in the news domain. However, the issue towards a faceted filtering system is the properties and values of each news article that is the crucial challenge to make it work in the news domain Teevan et al. [2008]. The faceted properties which were used in this research were author, date, and category. It was suggested to use a faceted feature around the usage of positive and negative words (see Section 3.8; however, that faceted was not used in the evaluation.

Chapter 7

Summary and Future Work

7.1 Conclusion

In this thesis, we explored the behavior patterns of the user through search task time, a total of clicks, and the number of actions done towards different elements on the various search interfaces. This was from the log analyses of these search interfaces. Also, we were eliciting demographic information of the participants, which involved familiar with a search engine, age, usage of a computer. The last investigating we underwent was with participant's preference and comments toward the different search interface, and a SUS evaluation in the end. The Design Science framework was applied for developing the three prototypes of search interfaces for verifying if a faceted filtering search interface has better performance than the developed search interfaces (the baseline and the text summary). Based on the outcome of the user evaluation, the results show a significant difference between the search interface, from the total time used, and from the users' total action interaction with the different search interfaces.

As foreseen, from the collected results, the search interface with the facets had exceptional better performance than the baseline and the text summary search interface. From the users' explicit rating, the text summary and the faceted filtering search interface detected to be outstanding than the baseline. In terms of the log analyzing the participant, the faceted filtering revealed significant difference used in both of the search tasks (lookup and exploratory search tasks). The faceted filtering search interface was proved to be substantially more effective regarding the time and the action towards the search interface. A more in-depth investigation of the action done to the different search interfaces exposed additional performance, which supports the users preferred the faceted filtering search interface. The "pagination" were used substantially less from the other two search interfaces. This demonstrates that the faceted filtering search interface likely provided the participant with beneficial results. This also correlates to the finding of "clear". Where the difference between the faceted filtering search interface was significantly lower than the other two search interfaces.

The usability evaluation also correlates greatly from the result of the task and search time. The participant scored the highest with the faceted filtering search interface, while the baseline got the lowest scored. The average scoring the subject graded was 88.3, which indicates that the system describes good usability of the prototype.

This research is based on a literature review from using different faceted systems in various domains. From the expertise of domain experts along with applying elements for problem-solving from the Design Science framework to get the greater feasible solution to a problem. The finding shows that in the news domain, it is not well adapted, but exist in other domain, which in commerce sites uses it a lot.

7.1.1 Future Work

The next move would be to implement the right solution, which includes facets that were not implemented in the prototype, such as a feature for navigating trough negative and positive articles by weighing the corresponding keywords that were introduced in Section 3.8. The user would be able to do the weighing in the interface.

A method regarding the similarity of a given article, depending on the properties of the article. The properties would be the other facets, alternatively, by the content of the article. Furthermore, the corpus would expand with multiple news sites.

Further evaluation regarding finding valuable properties and values a given news article has, would be essential to check if an article has that. That would be essential to check the efficiency of a search system in the news domain. It would also be appreciated to make a proper responsive search interface that works on other platforms as well. There is always space for improvement.

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Approval from NSD

Det innsendte meldeskjemaet med referansekode 302457 er nå vurdert av NSD.

Følgende vurdering er gitt:

Det er vår vurdering at behandlingen av personopplysninger i prosjektet vil være i samsvar med personvernlovgivningen så fremt den gjennomføres i tråd med det som er dokumentert i meldeskjemaet med vedlegg den 01.08.2019, samt i meldingsdialogen mellom innmelder og NSD. Behandlingen kan starte.

MELD ENDRINGER

Dersom behandlingen av personopplysninger endrer seg, kan det være nødvendig å melde dette til NSD ved å oppdatere meldeskjemaet. På våre nettsider informerer vi om hvilke endringer som må meldes. Vent på svar før endringer gjennomføres.

TYPE OPPLYSNINGER OG VARIGHET

Prosjektet vil behandle alminnelige kategorier av personopplysninger frem til 02.12.2019.

LOVLIG GRUNNLAG

Prosjektet vil innhente samtykke fra de registrerte til behandlingen av personopplysninger. Vår vurdering er at prosjektet legger opp til et samtykke i samsvar med kravene i art. 4 og 7, ved at det er en frivillig, spesifikk, informert og utvetydig bekreftelse som kan dokumenteres, og som den registrerte kan trekke tilbake. Lovlig grunnlag for behandlingen vil dermed være den registrertes samtykke, jf. personvernforordningen art. 6 nr. 1 bokstav a.

PERSONVERNPRINSIPPER

NSD vurderer at den planlagte behandlingen av personopplysninger vil følge prinsippene i personvernforordningen om:

- lovlighet, rettferdighet og åpenhet (art. 5.1 a), ved at de registrerte får tilfredsstillende informasjon om og samtykker til behandlingen

- formålsbegrensning (art. 5.1 b), ved at personopplysninger samles inn for spesifikke, uttrykkelig angitte og berettigede formål, og ikke behandles til nye, uforenlige formål
- dataminimering (art. 5.1 c), ved at det kun behandles opplysninger som er adekvate, relevante og nødvendige for formålet med prosjektet
- lagringsbegrensning (art. 5.1 e), ved at personopplysningene ikke lagres lengre enn nødvendig for å oppfylle formålet

DE REGISTRERTES RETTIGHETER

Så lenge de registrerte kan identifiseres i datamaterialet vil de ha følgende rettigheter: åpenhet (art. 12), informasjon (art. 13), innsyn (art. 15), retting (art. 16), sletting (art. 17), begrensning (art. 18), underretning (art. 19), dataportabilitet (art. 20).

NSD vurderer at informasjonen om behandlingen som de registrerte vil motta oppfyller lovens krav til form og innhold, jf. art. 12.1 og art. 13.

Vi minner om at hvis en registrert tar kontakt om sine rettigheter, har behandlingsansvarlig institusjon plikt til å svare innen en måned.

FØLG DIN INSTITUSJONS RETNINGSLINJER

NSD legger til grunn at behandlingen oppfyller kravene i personvernforordningen om riktighet (art. 5.1 d), integritet og konfidensialitet (art. 5.1. f) og sikkerhet (art. 32).

SurveyXact er databehandler i prosjektet. NSD legger til grunn at behandlingen oppfyller kravene til bruk av databehandler, jf. art 28 og 29.

For å forsikre dere om at kravene oppfylles, må dere følge interne retningslinjer og/eller rådføre dere med behandlingsansvarlig institusjon.

OPPFØLGING AV PROSJEKTET

NSD vil følge opp ved planlagt avslutning for å avklare om behandlingen av personopplysningene er avsluttet.

Lykke til med prosjektet!

Kontaktperson hos NSD: Elizabeth Blomstervik Tlf. Personverntjenester: 55 58 21 17 (tast 1)

Informal Consent Form in Norwegain

Vil du delta i forskningsprosjektet

"[Evaluating a Faceted Search Approach for Efficient News Event Filtering]"?

Bakgrunn og formål

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å se om et søkesystem kan effektivisere måten brukere finner informasjon på. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål

Dette forskningsprosjektet er tilknyttet en masteroppgave ved Institutt for informasjons- og medievitenskap ved Universitet i Bergen. Formålet går ut på å se om forskjellige brukergrensesnitt vil ha en bedre effektivitet på å utvinne informasjon som brukere ser etter. Dette prosjektet har tre brukergrensesnitt som deltager skal evaluere. Fokuset på å delta i dette forskningsprosjektet vil være å observere deltakernes oppførsel og håndtering av de tre brukergrensesnittene.

Hva innebærer det for deg å delta?

Å være en deltager innebærer det å teste ut tre forskjellige brukergrensesnitt for å uthente informasjon. Testingen vil skje på i et lukket miljø som vil være et rom uten forstyrrelser. Gjennom forskningsprosjektet vil deltakeren bli observert om hvordan deltakeren bruker de forskjellige brukergrensesnittene. Dette vil være av click-rate, bruken av funksjoner og hvordan å søke etter informasjon. Når testingen er ferdig vil det være noen enkle spørsmål om brukergrensesnittene. Dette vil ta omtrent 45 -maks 60 minutter totalt. Det vil føres notater underveis i testingen.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger

Alle personopplysninger vil bli behandlet konfidensielt. Det er kun masterstudenten og veilederen for prosjektet som har tilgang til personopplysningene. Personopplysningene blir ikke lagret ved navn, men bli anonymisert av et referansenummer. Navnelisten med kodenøkkelen vil bli oppbevart separat fra oppgaven og annet materiale, slit at det ikke er mulig å identifisere deltakerne. Deltakere i denne studien vil ikke bli gjenkjent i publikasjonen. Prosjektet skal etter planen avsluttes 1. desember 2019. Ved prosjektslutt kommer all personopplysning av deltakerne til å bli slettes.

Dine rettigheter

Så lenge du kan identifiseres i datamaterialet, har du rett til: - innsyn i hvilke personopplysninger som er registrert om deg, - å få rettet personopplysninger om deg, - få slettet personopplysninger om deg, - få utlevert en kopi av dine personopplysninger (dataportabilitet), og - å sende klage til personvernombudet eller Datatilsynet om behandlingen av dine personopplysninger.

Hva gir oss rett til å behandle personopplysninger om deg?

Vi behandler opplysninger om deg basert på ditt samtykke.

Det er frivillig å delta

Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykke tilbake. Hvis du har spørsmål til studien ,ta kontakt med:

- Masterstudent Tim Soltvedt Aadland 94 36 53 08 tim.s.aadland@gmail.com
- Veileder Christoph Trattner 453 96 180 christoph.trattner@uib.no
- Personvernombundet NSD 55 58 21 17 personverntjenester@nsd.no

Samtykkeerklæring Jeg har mottatt og forstått informasjon om prosjektet, og har fått anledning til å stille spørsmål. Jeg samtykker til:

- Å delta i intervju
- Å delta å bli observert gjennom deltakelsen
- Å delta på spørreskjema
- At mine personopplysninger behandles frem til prosjektet er avsluttet. 1 desember 2019.

——————————————————————— (Signert av prosjektdeltaker, dato)

Informantnummer (fylles ut av masterstudenten):——————

Interview guide

Interview guide for the research project - Establishment of requirements

Evaluating a Faceted Search Approach for Efficient News Event Filtering

Overall plan and questions for the interviews:

- Informal talk with an introduction of interviews (approx. 5 min)
- Interview information (approx. 5 min)
- Information on the theme, background, and purpose.
- Explanation of what the interview should be used for, with information for anonymizing participants.
- Information on notes throughout the project process, if possible, to read over which is taken along the way before publication.
- Information about the project end and what will happen to the collected data after the end of the project.

Gender

- □ Male
- □ Female

Age

(Number field)

Computer experience. On a weekly basis, how many days do you use the computer?

- □ 1-3 days a week

- □ 3-5 days a week
- □ Daily
- □ Other

Web search experience On a weekly basis, how many days do you search online for information?

- □ 1-3 days a week
- □ 3-5 days a week
- □ Daily
- □ Other

Which search engine do you primarily use?

(Text field)

Do you use the same search engine to search for different data (image, text, song etc.)

- □ Yes
- □ No
- □ I dont know
- □ Other

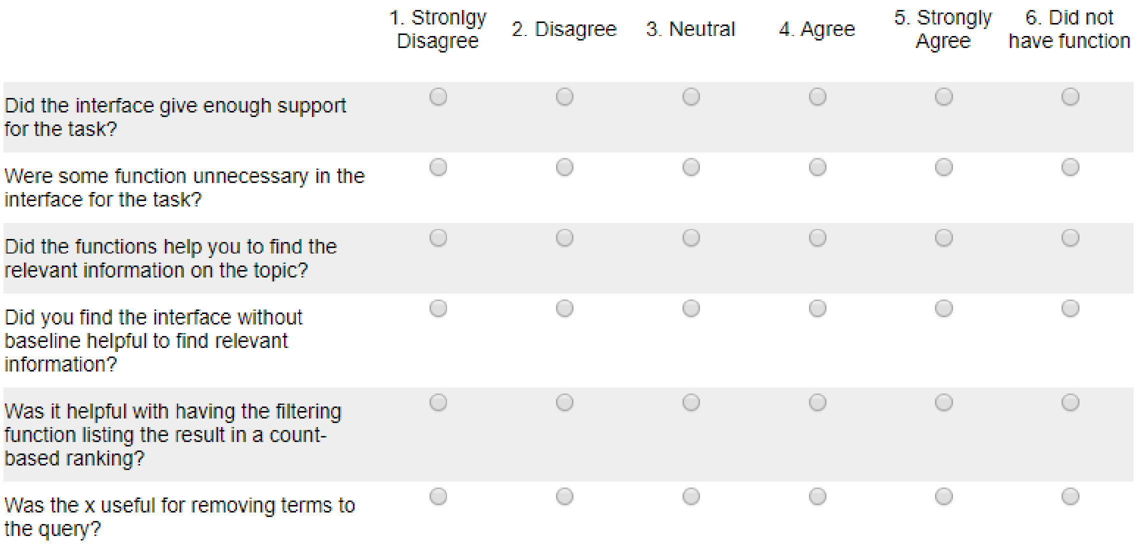
When searching for information, do you use advanced features in your search? (Boolean or, and, «», filtering, image).

- □ Yes
- □ No
- □ I dont know
- □ Other

Thank you!

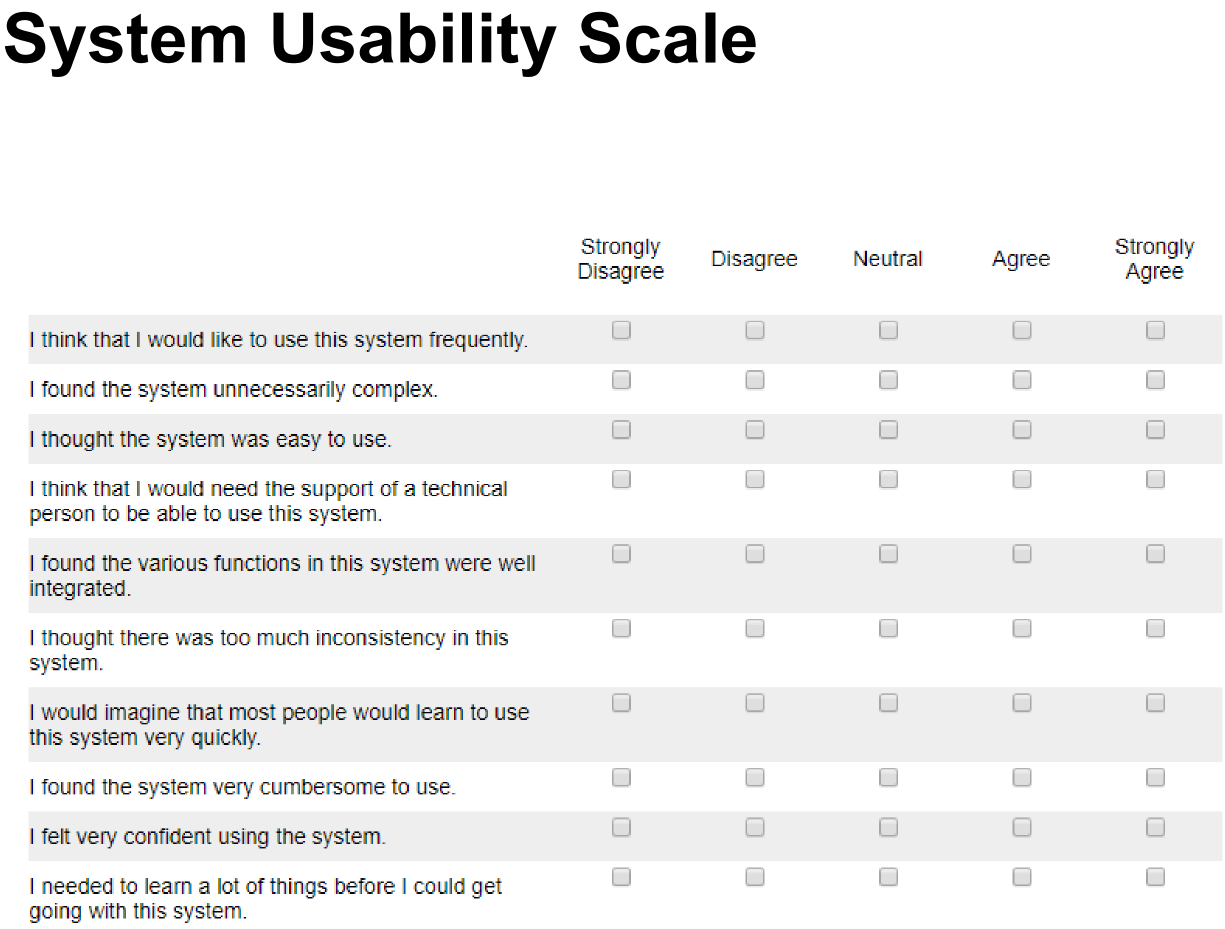
Post Questionnaires

Post-Task Questionnaires: Participants' Perceptions of the Interfaces For each task, please fill this post-task questionnaire.



	1. Stronlgy Disagree	2. Disagree	3. Neutral	4. Agree	5. Strongly Agree	6. Did not have function
Did the interface give enough support for the task?	○	○	○	○	○	○
Were some function unnecessary in the interface for the task?	○	○	○	○	○	○
Did the functions help you to find the relevant information on the topic?	○	○	○	○	○	○
Did you find the interface without baseline helpful to find relevant information?	○	○	○	○	○	○
Was it helpful with having the filtering function listing the result in a count-based ranking?	○	○	○	○	○	○
Was the x useful for removing terms to the query?	○	○	○	○	○	○

Figure 1: Post Questionnaries



System Usability Scale

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I think that I would like to use this system frequently.	□	□	□	□	□
I found the system unnecessarily complex.	□	□	□	□	□
I thought the system was easy to use.	□	□	□	□	□
I think that I would need the support of a technical person to be able to use this system.	□	□	□	□	□
I found the various functions in this system were well integrated.	□	□	□	□	□
I thought there was too much inconsistency in this system.	□	□	□	□	□
I would imagine that most people would learn to use this system very quickly.	□	□	□	□	□
I found the system very cumbersome to use.	□	□	□	□	□
I felt very confident using the system.	□	□	□	□	□
I needed to learn a lot of things before I could get going with this system.	□	□	□	□	□

Figure 2: System Usability Scale - Questionnaries

Post Questionnaires

Which one of the interfaces did you prefer?

- □ Basic Search
- □ Text Summary
- □ Filtering Function
- □ Please elaborate your answer

Which one of the interfaces do you prefer for lookup search?

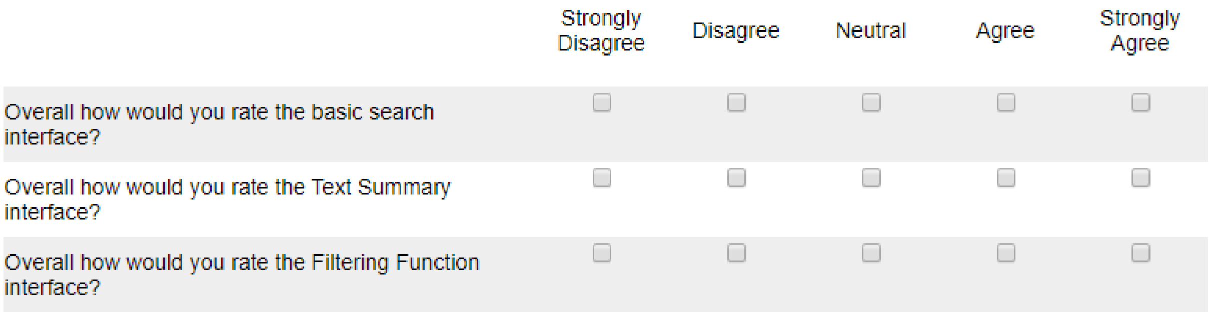
- □ Basic Search
- □ Text Summary
- □ Filtering Function
- □ Please elaborate your answer

Which one of the interfaces do you prefer exploratory search?

- □ Basic Search
- □ Text Summary
- □ Filtering Function
- □ Please elaborate your answer

Which of the interface did you feel that required more effort in order to find relevant information?

- □ Basic Search
- □ Text Summary
- □ Filtering Function
- □ Please elaborate your answer



	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Overall how would you rate the basic search interface?	□	□	□	□	□
Overall how would you rate the Text Summary interface?	□	□	□	□	□
Overall how would you rate the Filtering Function interface?	□	□	□	□	□

Figure 3: Final - Questionnaries