Visualization of patent claims structure to improve their readability

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Abstract

Readability is considered as a important element in effective communication. The patent claims are regarded as typical bad example of readability since they are written in long sentences and the structure is complex among different claims. In one patent document, the several claims contain hierarchical structure within each other. In this project, we want to improve the patent claims readability via visualizing the hierarchical structure. To do this, we reviewed the-state-of-the-art researches including text readability, patent claim readability and improve the readability via visualization techniques. After that, we propose a improved method to visualizing the hierarchical structure claims. We also design a user-driven evaluation method to measure the performance and collect the feedback from users.
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People in significant numbers are enriching their knowledge by reading text from diverse sources and genres that include technical documents, contracts, blogs, etc. In addition, people nowadays would choose to read from different sources with various devices. As Legge and Bigelow (2011) point out in their paper, reading plays a fundamental significant role in our modern culture. In this case, it is essential for people especially laypeople to have a good experience when they are reading some texts that they are not familiar with such as technical documents. However, the current read experience would not satisfy every readers. Shaywitz and Shaywitz (2005) claim that roughly 5% to 17% of all people have difficulties with the current reading system. Schneps et al. (2013) agree with this point and point out that the new techniques such as e-reading would not provide a new way for readers now. Therefore, how to improve the reading experience for readers comes to be a vital topic nowadays. Schneps et al. (2013) point out that it is driving a fast-moving evolution in the social conventions for reading by the world wide adoption of e-readers. People would spend time on electronic devices such as computers, mobile phones as well as tablets. This brings us a thought that a new and better presentation of text on the digital screen may have a positive impact on readers’ reading experience, also a good presentation of texts would improve the experience in traditional reading method like newspapers and hard copy books. In fact, this idea is supported by Legge and Bigelow (2011), in their paper, they claim that on a page or a display screen, the size and shapes of strings of symbols would be crucial factors to determine the legibility of reading materia. In this case, visualization of texts seems to be a possible method to improve the reading experience.

Readability can be seeing as a kind of index to represent the reading experience. Kar-makar and Zhu (2010) define that a document readability could be regarded as an indicator of this document’s understandability to particular groups of readers. They add that the higher text readability would consist of improved readership, good comprehension, clear memorization, fast reading speed, and long reading persistence.

In this study, we focused on improving the readability of patent documents, more specifically, to improve the readability of the claims section of patent documents. We are interested in improving the patent readers experience because patents are known
as documents that are difficult to read and understand, and they possess a challenge, not only for laypeople, but also for experts users. Specially the claims sections are regarded as an example of poor readability since they consists in extremely long sentences with intricate syntax and vocabulary. Moreover, the claims are organized into a hierarchical structure that guides how the claims should be read, adding more complexity to the reader process.

Objectives

The main objective of this project is to improve the patent claim readability by offering a visual representation of the claim hierarchical structure. The objective of this thesis can be sub-divided into three sub-objectives, as follows:

- Revise the state-of-the-art literatures about text readability;
- Built a software application that visualize the patent claims hierarchical structure;
- Design a user study evaluation to assess whether the proposed software improves the reading experience.

Outlines

This thesis is organized with the following structure:

1. Chapter 2 talks about the materials and methods that we used in this project including the basic concepts and data exploration;
2. Chapter 3 present the state-of-the-art research in text readability improvements and the patent claim readability and improvement of patent claims he patent claim readability improvement through visualization methods;
3. In Chapter 4, we will present experiments and visualization demo that we have done according to the previous parts;
4. In Chapter 5, we will present the evaluation about the experiments and visualization demo that we have done;
5. In the last but not least chapter we would conclude our work. Finally, we present some directions for future work.
In this chapter, we introduce some basic concepts that would be useful to understand our study. First, we present what readability is. Second, we describe what patent claims. Finally, we present the data that we use in the experiments section.

2.1 The text readability

In order to improve the readability, the first thing is defining the readability. In this section, we give the definition of text readability and introduce some examples of the good readability and bad readability.

According to Karmakar and Zhu (2010), a document readability could be regarded as an indicator of this document’s understandability to particular groups of readers. In addition, the high readability include: improved readership, good comprehension, clear memorization, fast reading speed, and long reading persistence. In this definition, we can see that, the text readability could be different for different readers according to their understandability to the certain texts or documents. In another words, a same person would have different readability for different texts or documents. For example, some native English speaker may easily understand an adult novel that contains a bunch of lexicons so that a English learner may treat it as a big challenge. In fact, this definition has been supported by many researches, for example, McLaughlin (1969) stated the similar definition of the text readability as “the degree to which a given class of people find certain reading matter compelling and comprehensible.” In this definition, we can conclude that the two aspects would affect the readability, the human side and the text side. Because, as DuBay (2007) said, the reading is process of interaction between text and readers. In this case, DuBay (2007) claim that the some features could be helpful to improve the readability. For the reader part, DuBay (2007) point out that the features that could makes reading easy are:

- Prior knowledge;
- Reading skill;
- Interest;
- Motivation.

These features could be a requirement from the reader side to demonstrate the vital elements to have a good reading experience. On the other side, DuBay (2007) also show the key features from the text side that could makes reading easy:

- Content;
- Design;
- Style;
- Organization.

In this project, we focus on the the texts side because we think that the features from the human side are difficult to control since there are too many different readers in the world, but we can provide a better reading experience based on the reader’s current situation via improving the texts that are easier to digest.

### 2.2 Patent claims

In this section, in order to improve the readability, we introduce the patent and patent claims with the structure.

#### 2.2.1 Patent claim definition

According to Pressman (2012), a patent is a grant from the government aiming to protect the inventor’s rights via excluding others from making, using, selling or importing in a fixed period time. Patents documents are organized into several sections such as Title, Abstract, Background of the invention, Summary of the invention, Description of the Drawings and Claims. The claim section is the most important one, in which the legal boundaries of the invention protection are defined (Burgunder, 2010). Pressman (2012) defined patent claims as “Claims recite and define the structure or acts, of an invention in very precise, logical and exact term”. As mentioned before, in this research project, we focused on improving the readability of the claim section.

#### 2.2.2 The claim internal structure

Usually, patent claims are written with a defined internal structure that allows the claim to be decomposed into parts or text chunks. According to (Pressman, 2012),
there are three main parts in the claims, which are: the preamble, the transitional words or phrases and the body. These three parts are defined as follows:

- **Preamble**: is an introduction to the invention and states the general technical subject of the invention;
- **Transition phrase**: is used as a connection between the preamble and the other part of the claim;
- **Body**: compared with the previous two, the rest of the claim is the body which defines the details of the inventions.

**Example (1):**

1. [A boring tool] Preamble [comprising] TransitionPhrase [a body, a plurality of cutting blades supported by the body so as to be movable along paths equally incline at an acute angle to an axis of rotation of the body, outer ends of the blades having cutting edges and projecting beyond the body, characterised by a rotatable blade advancing member having a screwed shank within a threaded bore on the axis of rotation and a head abutting inner ends of the blades for advancing and retracting the blades on their paths consequent upon rotation of the shank within the bore, and means operable from the exterior of the body for causing rotation of the blade advancing member] Body.

In the example above, we can see that the Preamble is “A boring tool”, and the Transition phrase is “comprising” and the rest of the claim is the claim Body. Example (1) also illustrate that claims are rendered into a single long and complex sentence.

As recommended by Pressman (2012), it is a good practice to split the claims into its parts, in order to make it easier to understand.

### 2.2.3 Patent claims hierarchical structure

Each patent document contained at least one claim and in average 10 claims. The claims are organized into a hierarchical structure, where some claims are independent and some of them are dependent ones. Based on the hierarchical structure, the claim define the scope of the legal protection different ways, from general issues to details. Dependent and independent claims are defined as:

**Independent claims (IC)**: independent claims stands on their own. These kind of claims do not refer back to the previous claims (Pressman, 2012). Basically, they define the scope in a board and general way. The first claim of a patent is always an independent claim.

**Dependent claims (IC)**: dependent claims makes reference to the claim they dependent on (Pressman, 2012). They refer back to one or more than one claims from the
previous claims. Compared with the IC, dependent claims define the right protection in a narrow scope. The references to other claims are made explicit by textual references. An important characteristic of dependent claims is that they cannot be read in isolation, they should be read after understanding they claims they dependent on.

In what follows, we present a real patent example of a complete claims section.

to display the hierarchical structure:

1. A boring tool comprising a body, a plurality of cutting blades supported by the body so as to be movable along paths equally incline at an acute angle to an axis of rotation of the body, outer ends of the blades having cutting edges and projecting beyond the body, characterised by a rotatable blade advancing member having a screwed shank within a threaded bore on the axis of rotation and a head abutting inner ends of the blades for advancing and retracting the blades on their paths consequent upon rotation of the shank within the bore, and means operable from the exterior of the body for causing rotation of the blade advancing member.

2. A boring tool according to claim 1 characterised in that the means for causing rotation of the blade advancing member comprises a worm rotatable by a detachable handle or key and a meshingworm wheel secured to a shaft extending from the shank of the blade advancing member and co-axial therewith.

3. A boring tool according to claim 1 or 2 characterised in that the tool advancing member has a head with a conical surface abutting the inner ends of the cutting blades.

4. A boring tool according to claim 1 characterised in that the head lies within a cylindrical cavity extending inwardly from one end of the body member, the open end of the cavity being closed by a plug which backs a frusto-cuiucal pressure pad supporting the cutter blades.

5. A boring tool according to any of claims 1-4 characterised in that the cutter blades are guided by holes in the body which lie in planes radial to the axis of rotation.

6. A boring tool according to any of claims 1-5 characterised in that a serrated drive spigot co-axial with the axis of rotation of the tool is mounted on one end of the body remote from the cutting blades and for insertion within a corresponding socket in a drive adaptor, the tool being detachably securable to the adaptor by a ring nut engagesble with a screw threaded portion of the adaptor.

7. A boring tool according to claim 6 characterised in that the adaptor has a threaded hole to engage the screwed end of a power drill drive shaft.
As can be seen from the example above, the first claim is an independent claim since it define the invention in a board and general way and it does not refer to any other claims. The rest claims are all dependent claims since they refer back to other claims. The references to other claims are explicit made by using some key phrases like "according to claim 1" or "according to any of claims 1-5" (all the claim dependency relation expression are highlight in boldface).

Dependent claims do not stand by their own and must be read in the context of the claims they depend on in order to be fully understood (Pressman, 2012). Thus, having the claim hierarchical structure at hand could guide and, hopefully, improve the reading experience.

2.3 Example of our data

The data that was used in this project are claims, which are stored in json format. Please see the example file from the Figure 2.1.

As can be seen from the Figure 2.1, all the claims informations has been stored in this file with different levels. In this project, we just focus on the claim content so that we just care about the attribute called "claim" under its father node "claims". In the node of "claim", we see that each claim is represented with a claim number. For
example, “0” means the first claim, we can find basic attributes under “0” including the claim ID, number, the claim size, the claim type and the claim context. The first claim is an independent claim so it does have any previous claims to refer to. The second claim which is number with the attribute “1” also contained the attribute name “claimBackReference” which contains the textual reference that was used to express its dependency with other claims. For example, the second claim’s “claimBackReference” contains “of claim 1”, which means that the current claim is referring to the first one.

To conclude, in this chapter, we introduce some basic concepts that would be helpful for the rest of the report. We talked about the text readability and its definition, discussed the patent claims definition and their structure. In the end, we illustrate an example of structured patent claim that we used in our experiment part.
Chapter 3

Literature review

3.1 The Text readability and improvement

In the Chapter 2, we briefly talked about the text readability with its definition. Generally speaking, the text readability is an indicator for understandability for certain people. In this chapter, we introduce some reaches and approaches about text readability including its assessment, improvement and applications.

In order to improve the readability, people have proposed several methods to do the measurement. According to Callan and Eskenazi (2007), a system predicting reading difficulty that are based on both vocabulary and grammatical features has been evaluated by authors’ work. They consider two kinds of language learners, the first language (L1) learner and the second language (L2) learner. The main differences are the timeline and processes by which kind of language acquired. The authors described two models, language model, grammatical model, related to both two kind of learners. And then they did the experiments and concluded that using confidence scores for the grammar-based predictions showed improvement over both individual measures, and the grammatical model plays a more important role in second language readability than in first language readability.

Another work is from Crossley et al. (2011), they claims that readability measures could be used as a tool for authors to evaluate text comprehensibility. Authors aimed to determine which way can be the best way as classifiers for variety text levels, advanced, intermediate, beginner. The prediction related to text classification would measure text comprehensibility. To achieve that, authors compared the Coh-Metrix Second Language (L2) Reading Index with the traditional readability formulas on a large corpus in which texts has been simplified for language learners.

Furthermore, François and Miltsakaki (2012) pointed out that reading level could be matched by Readability formulas. In their paper, they want to see if the natural language processing (NLP) and machine learning (ML) approaches would improve the readability. To do this, they compared NLP-enabled features and machine learning techniques to Flesch formula (classical formula). In the end, they conclude that (1) method with NLP and ML techniques performs better than the classic formula; (2)
non-classic features were slightly more informative than classic features; (3) modern machine learning algorithms did not improve the explanatory power of our readability model, but allowed to better classify new observations; and (4) combining classic and non-classic features resulted in a significant gain in performance. With these examples of measurements, this project will focus on the readability improvement. As we said in the previous chapter, methods about readability improvement could be summarized into two groups using linguistic techniques and using visualization techniques. In this case, this chapter will review several work in these two fields. In addition, this chapter would also review some work related to the patent claims since this project is deal with the readability improvement of patent claims.

In this paper from Aluisio et al. (2010), the authors describes a readability assessment approach which is used to help poor literacy readers to access texts with the process of text simplification. The approach aims to predict the readability level with an input text. As we know, the readability occurs differently for different readers. This simplification process’s target are different according to the reader’s literacy level including rudimentary, basic or advanced. Using machine learning methods, namely classification, regression and ranking, they perform the experiments to assess the readability level with new features, and then they choose the best result model to embed in an authoring tool for Text Simplification.

Leykin and Tuceryan (2004) describe a pattern recognition approach to do the readability level assessment of text labels. Their approach aims to deal with the problem that information is placed over very busy and textured backgrounds compared with placing a text label to present the information to users. To identify the texts under certain conditions, they used texture properties and other visual features, which would be useful to judge the background where the texts are placed is suitable and if the texts is readable. They used the supervised machine learning to do the determination with these features, and the model was trained via more than 400 humans response to the over 50 text readability level. According to the result, the correct classification rate is over 85%, which seems reliable. The visualization part is vital element to readability level, and this approach is the way to consider this impact, which could be very useful in different areas such as web browsing. In the future, this experiment could consider the condition of the human subjects. For example, they could find people with reading difficulty and well-trained readers to do a comparison to see the performance of the approach.

Schwarm and Ostendorf (2005) state the significant of the reading ability especially in fundamental language education. It is a challenge, however, for teachers to find suitable texts for language learners such as foreigners or second language learners. In this paper, they use natural language processing technology to evaluate and assess the readability level. They claim that some traditional and existed measures of reading level seem not perform well in this task. However, according to their experience and previous work they find the possible value to solve the problem with the benefit of using statistical language models. Specifically, they propose to use support vector
machines (SVM) to combine features from traditional reading level measures, statistical language models, and other language processing tools to assess reading level. One of the challenge of the usage of SVM is feature extraction, which would be a obstacle for use this approach in different area. If we can apply a effective and information lose-less feature extraction method, this could apply in many areas.

Sato et al. (2008) proposed a approach to measure the readability level of the Japanese texts. Their data are the newly compiled textbook corpus consisting of 1478 sample passages extracted from 127 textbooks of elementary school, junior high school, high school, and university which have been divided into thirteen grade levels. Their readability measurement method determines the grade level to which the passage is the most similar by using character-unigram models. In their model, they did not consider the sentence-boundary analysis and word-boundary analysis, in other words the texts may include incomplete sentences and non-regular text fragments.

In the paper of Brooke et al. (2012), by supporting the difficult words in a document, the authors try to improve the readability. They want to develop a educational software so that they could help students to deal with the documents that contains some difficult words or lexicons that are beyond these readers vocabulary. However, their current recourses are coarse-grained and lacks coverage. Therefore, in this paper, they present an approach to automatically create readability lexicons with unannotated Corpora. To do that, they extract features from the corpus. In their work, they considered simple features, document readability and co-occurrence features, and as a result, they take a linear combination of these various features. In their work, they propose a method to build readability lexicons with unannounced corpora, this could be used as a proper method to improve the readability especially in legal domain since the patent claims may contain various words in the certain domain that laypeople may not be familiar with, the weakness of this work is lack of comparison with real circumstances since their work is based on and also compare with their previous work. But the consideration of feature extraction could be used in many different readability improvement job.

3.2 The patent claim readability and improvement

In the paper from Sheremetyeva (2003), they analysed patent claims by combining symbolic grammar formalisms and data intensive methods. The output of their work is a syntactic dependency tree. In one claim text, they claim that their analyzer is a shallow inter lingual representation which tried to capture both the structure and content. The disadvantages of their work are that first, they did not do a large-scale evaluation of their analysis module, second, the tool and the methodology did not generate a presentation to increase the readability.

According to Shinmori et al. (2003), they present some characteristics about Japanese patent claims, for example long sentence, complex description structure and technique
terms which need to be explained, that may be the obstacle for lay people and specialist in the viewpoint of readability. In their work, they analysed patent claims and their characteristics, then they presented their methodology to improve the readability. In their methodology, first they identified the discourse structures by recognizing, extracting and using the terms. Then, they paraphrase the discourse segment. According to their experiments and results, their results are robust and practical.

Bouayad-Agha et al. (2009) presented a method to do the claim summarization and paraphrase. The authors proposed a simplification method to summarize and paraphrase. The process of simplification includes claim segmentation in which authors compared two approaches in their work, rule-based and machine-learning-based approach, conference resolution and discourse tree derivation.

In the paper of Shinmori and Okumura (2004), they provided a method to align phrases in the claims with text spans from the description section. Specifically, first, they used structure analysis method to analyse patent claims. Then, they calculated the similarity scores between each core element in the claims by finding multiple local alignments. So that they were able to extract sentence from the detailed descriptions. In the end, they considered the existence of “effectiveness expressions” in the sentence to get the results.

In the work of Sang and Déjean (2001), they aimed to find the boundary in texts. They used different machine learning methods to evaluate the result. They named their work as clause identification. Generally, the work has three steps, recognizing clause starts, finding clause ends and identifying complete. According to Ferraro et al. (2014), the problem of this stratage is that the peculiar syntactic style of claims makes the phrase detection strategies not appropriate.

In the paper of Smith and Osborne (2006), they considered a method using gazetteers to do the natural language processing (NLP) and named entity recognition (NER) job. In their paper, they gave the reason about involving gazetteers into NLP and NER work and they also analysed the disadvantage and negative effects of using gazetteers features by proposing some examples. At the end, they gave their own solution that uses quarantining this kind of features and training them apart from other features.

3.3 The patent claim readability improvement through visualization

In the Chapter 3.1, we talked about the readability including the measurement, improvement and application. In this section, we will introduce some work and approaches to improve the readability using the visualization techniques. Visualization is a possible method to improve the readability with some successful applications in different areas.

In the paper from Karmakar and Zhu (2010), authors point out that we do have var-
ious metrics to evaluate a certain text document’s reading difficulty that is known as readability and all the metrics could be divided into two big groups, word complexity and sentence complexity. However, one single readability index is often assigned to illustrate the readability of a entire document, which is not a friendly method for people since this one-single index could not reflect the readability distribution in a certain document. In this case, they presented a method to visualizing the text readability metrics so that people could easily identify the distribution and also understand the difficulty of this certain document. To do that, they consider the two types of metrics, word complexity and sentence complexity, as the key elements. They represent a sentence as a bar, the length of bars could reflect the sentence complexity and one document may have many bars. One bar contains sections that are represent words and the diversity color would be used to represented the complexity. One disadvantage of this work is the word list that they used to identify the word complexity. Because different people may have their own vocabulary. For example, people may be more familiar with words in their own domains rather than some fresh field. In this case, people may need their own list to represent the word complexity.

Reading speed could be a method to reflect the the legibility of texts. The readability of a certain text for readers are effected by the size and shape of printed symbols. (Legge and Bigelow, 2011) In the paper of Legge and Bigelow (2011), they concentrate on the size of the font. In their opinion, the print sizes in historical and contemporary are related to a range in which text can be read at maximum speed and they provide some evidences to support their point from vision science and typography including providing the definition formula of Angular size in degrees. The view that font size would have impacts on reading speed is also supported by O’Brien et al. (2005). In the study, they claim that to maximum the reading speeds, larger critical print sizes would be needed by dyslexic readers. They use two groups of people to show the relation between reading speeds and font sizes. These two groups are children and they are separated based on children are with(aged 7 to 10 years) and without dyslexia (aged 6 to 8 years). The experiment illustrate that both dyslexic reading and skilled reading are following the same trend that the reading curve shape would have a sharp decline when the reading rates are below a critical font size and critical font sizes from the Readers with dyslexia are higher than the normal reader.

The presentation is not only about the characters or letters themselves, is also about the presentation of the entire text document. In the paper of Schneps et al. (2013), they claim that the length of the sentence would affect the readability. They use eye tracing to do a experiment on some high school students with struggle reading problems. To investigate the impact of the line length, they use two devices to perform the comparison, the Apple iPod Touch in portrait mode (5 cm × 7.5 cm) and the Apple iPad in landscape mode (19.7 cm × 14.8 cm). The result turns out that the device with small screen (iPod) would have a better readability. The performances including reading speeds, the number of fixations and the number of regressive saccade are better than the data from iPad. A weakness of this research is about the subjects. All the subject are high school students with dyslexia. The result would be useful if they can put a a
According to Rello et al. (2012), visual conceptual schemes may be helpful to improve the readability for poor readers like people with dyslexia. In their study, they investigate both text readability and the visual conceptual schemes. They thought that visual conceptual schemes may make the text more clear for these specific target readers. To support that, they considered a user study for Spanish native speakers through a group of twenty three dyslexic users, on the other hand they gave a control group of similar size. According to their result, graphical schemes may help to improve readability for dyslexic but are, unexpectedly, counterproductive for understandability.

Another work about improve the readability though the presentation modification is from Zorzi et al. (2012), in their work, 34 Italian and 40 French children aging from 8 to 14 with dyslexia are gathered to do an experiment. The experiment is about the spacing between each letters. Children are required to read 24 short meaningful sentences and each sentences are not related to each other so that it could prevent the informative problems. The only parameter changed in these texts is the spacing. The result shows that children would do a better job with the larger character spacing texts including a better reading accuracy and reading speed and this could be a example of readability improvement.

In fact, readability from certain source would be improved if some specific rules could be use to constrain the design of the certain field. Nielsen (2011) points out some typical mistake that web pages may have that would decrease the reading experience from end user. He focus on interaction and visualization of a web page and provides specific examples. For example, for most people over the age of 40, the fixed font size would importantly reduce the readability. Obviously, the his opinions are based on personal and career experience and preference, the lack of experience would be the disadvantage of this article.

Compared with Nielsen (2011), the work from de Santana et al. (2012) come to the actual guideline based on their research. In the paper of de Santana et al. (2012), they perform a survey focusing upon the art of web pages for the dyslexia and Web Accessibility. In the end, they propose 41 guideline for people who are involved in web design, development, and web content editing. After that, they make a tool call Firefixia based on their guideline(de Santana et al., 2013). Based on their guideline, they select some of the guidelines and invited four people with dyslexia to give the feedback about Firefixia. The Firefixia is a plug-in for Firefox browser and the main features are providing different visualization functions for page and allowing people to define their own features such as font size, font type, text alignment, space between lines, space between characters, background color, text color, link color, visited link color, line width, border of block elements, and eliminate italics.

Another tool work to improve the readability is called Seeworld. In the investigate stage, Gregor and Newell (2000) investigate the development situation of a word processing environment which is used to help people with dyslexic when they read and
produce texts and it aims to alleviate some of the visual problems. Then they describe a pragmatic, empirical approach to develop a partial aid to a partially understood problem. In the investigation stage, they do the research and clarify the problems that people with dyslexic may have, and then, to improve the readability, they propose a text environment with reading and editing. The environment aims to improve the readability through change the presentation of the texts including using and transferring different format documents and adopting personal configurations. In the following stage, Gregor et al. (2003) present a configurable word processing environment called Seeworld. They first built three prototypes and based on the feedback perform the improvements. In the end, the software would use visualization techniques to improve the readability. Specifically, the setting preference of the text colour and background colour, text font, text size and spacing between lines and between letters in each word could be used to modify the presentation so that improve the reading experience, for example, they are using different colors to deal with some confusing letters like “b” or “d”, they may label different color on “b” or “d”. The main disadvantage of Seeworld is that Gregor et al. (2003) only provide experiments on reading texts but no experiments on the text production which is another goal from Gregor and Newell (2000) in the initial stage.
In the previous chapters, we have reviewed various researches about texts readability, patent claims readability and their improvement, specifically, we have also reviewed works about improving the texts readability via visualization technology. With these knowledge, we decided to do the implementation and build a demo to improve the structured patent claims. The data that we used has been introduced in the Chapter 2.

4.1 Environment and Tools

In this section we will introduce the environment and tools that we used to build the demo. We build the system on a PC. The CPU is Intel Core 2 Duo (2.33GHz) and the RAM is 4 GB. The operation system is Windows 7 Service Pack 1 (64 Bit). The tools that we used to build is Processing. According to the introduction from Ben Fry (Ben Fry), “Processing is a programming language, development environment, and online community”. At the beginning, Processing is used to teach the computer language programming due to its clear structure and simplify grammar. With the development of Processing, the usage of Processing is ranging from education to art creation, it would be helpful for people to build a prototype. Since the processing contains strong techniques to draw and create animations, in this project, we have used Processing to develop a demo to visualize a structured patent claims.

4.2 Visualization demo

This section we show the three steps to improve the patent claim readability, the first is the raw text, the second stage is the approach that European Patent Office (EPO) takes, and finally we present our approach with the demo that we have built to illustrate the ideas and knowledge that we have reviewed from previous chapters.
1. A boring tool comprising a body, a plurality of cutting blades supported by the body so as to be movable along paths equally incline at an acute angle to an axis of rotation of the body, outer ends of the blades having cutting edges and projecting beyond the body, characterised by a rotatable blade advancing member having a screwed shank within a threaded bore on the axis of rotation and a head abutting inner ends of the blades for advancing and retracting the blades on their paths consequent upon rotation of the shank within the bore, and means operable from the exterior of the body for causing rotation of the blade advancing member.

2. A boring tool according to claim 1 characterised in that the means for causing rotation of the blade advancing member comprises a worm rotatable by a detachable handle or key and a meshing worm wheel secured to a shaft extending from the shank of the blade advancing member and co-axial therewith.

3. A boring tool according to claim 1 or 2 characterised in that the tool advancing member has a head with a conical surface abutting the inner ends of the cutting blades.

4. A boring tool according to claim 1 characterised in that the head lies within a cylindrical cavity extending inwardly from one end of the body member, the open end of the cavity being closed by a plug which backs a frusto-conical pressure pad supporting the cutter blades.

5. A boring tool according to any of claims 1-4 characterised in that the cutter blades are guided by holes in the body which lie in planes radial to the axis of rotation.

6. A boring tool according to any of claims 1-5 characterised in that a serrated drive spigot co-axial with the axis of rotation of the tool is mounted on one end of the body remote from the cutting blades and for insertion within a corresponding socket in a drive adaptor, the tool being detachably securable to the adaptor by a ring nut engagesble with a screw threaded portion of the adaptor.

7. A boring tool according to claim 6 characterised in that the adaptor has a threaded hole to engage the screwed end of a power drill drive shaft.

Test 1: raw texts

As can be seen from the Figure 4.1, this is the raw texts of the patent claims. As introduced from Pressman (2012), each claim is written in one long sentence due to the international regulation. Users cannot view the structure among claims. If the patent is complex with many claims, this raw texts could be a burden for readers to read and understand.

Test 2: EPO approach

According to official webpage, the European Patent Office (EPO) is the executive arm of the European Patent Organisation which offers inventors seeking patent protection in up to 40 European countries. The EPO provides a service that we can search and explore the claims with plot views shown in Figure 4.2.

In this approach, they successfully illustrate the hierarchical structure of patent claims. They used a tree view to demonstrate the relationships among each claim. As you can see from Figure 4.2, if users are interested in claim number 3, they could just click the circle with number 3. The selected claim would be highlight along with the different color of selected circle. Furthermore, the approach also highlight the previous patent that the sleeted claim is depend on. For example, users chose the number 3 claim by
1. in the EPO visualization tool, they do not distinguish between “and” and “or” relations;

2. the tree view could be confusing when the structure is complex;

For the first one, there are two relations related to dependency structure, “and” and “or”. This relationship is clearly stated in the reference part. For example, the claim number 3 states that “according to claim 1 or 2”, and this is an “or” relation. On the other hand, the claim number 5 states that “according to any of claims 1-4”, which could be regarded as an “and” relation. However, in the EPO visualization tool, they do not offer the possibility to distinguish between “and” and “or”. For the second one, we can see an example with more than 30 claim, then people used EPO approach to build a plot to demonstrate the hierarchical structure(Figure 4.3). As can be seen from Figure 4.3, the result is very confusing, because reader would be easily distracted due to the complex structure and difficult to concentrate on the claim that they real care.
Test 3: Our approach

With knowledge from the previous chapter, we could propose our own method to improve the readability. As can be seen from Figure 4.4, we propose a flat structure to put all the circle in one line and the arcs would show the relations if we click some circles that we are interested in. For example, in Figure 4.4, we click the number 3 circle, the number 3 claim texts would be highlight and the color of circle number would be red to show the selection. Compared with EPO approach, we decided to show the relations just related to the selected claim rather than display them all the time, which could be useful for users to concentrate on one claim. Another improvement from our approach is the demonstration of the “and” and “or” relations. As can be shown in Figure 4.5, the left picture shows the relation “or” with reference “according to claim 1 or 2”, and the right one shows the relation “and” with the reference “according to any of claims 1-4”. In this case, “1-4” means claim one, claim two, claim three and claim four. As you can see, we demonstrate the difference with different colored arcs. For the claims whose father claims are also depend claims, we decide to show the connections. For example, Figure 4.6 shows the different compared with EPO approach. The left picture shows the situation that user click the circle number 7, which just show that claim 7 is depend on claim 6. In our approach the right picture from Figure 4.6, user can not only see the dependency relation of claim 7, they can also see the connection for claim 6. We want to do this is because that claim 6 is the closest claim to claim 7, it would be helpful to demonstrate that to users. We would not show all the connections in the previous claims since that would be complex to see and understand.

Figure 4.7 shows the design of the demo via class diagram. As can be seen, the demo is designed to contained three main classes, main process, text and circle. Following the Modelviewcontroller (MVC) structure, the main process is the main interface and the way to do the interaction, and circle as well as text are the models used to create objects and restore data. The main class contains the main methods like create text to build a model, and also has the method like extract data to apply the data into the system. Another important duty of main process is the interaction, therefore, it has the methods to allow users to click. The class circle is used to display the structure of the claims. We use circle to represent the claims themselves and we add a class called line as a attribute to illustrate the relationship among different claims. The circle would contains the basic information about the claim such as the number and the father claims, also the class contains some information about the visualization like positions and color as well as the selected color which is different from the normal condition to
response the action from users. The color and the line would be different by choosing different circle(claim) based on the current claim’s information. The text class also contain the similar information, this class has to related to the circle by matching the claim number.

Figure 4.8 is the screen shot of the demo. As can be seen, the user interface has two parts, the above part shows the claims in order and the down side contains several circles. Each circle represents one claim with matching claim number. Among these circles, there are various arcs that represent the relationship among circles or claims. Users could check the relationship for a specific claim. For example, if users are checking a dependent claim like claim 3 in this case. They could simply click the circle with number 3, and the arcs would shows the relationship between claim number 3 with other claims. If users click a independent claim, then the circle just shown as selected and no lines are presented since the independent claims do not refer to any other claims.
3. A boring tool according to claim 1 or 2, characterised in that the tool advancing member has a head with a conical surface abutting the inner ends of the cutting blades.

5. A boring tool according to any of claims 1-4 characterised in that the cutter blades are guided by holes in the body which lie in planes radial to the axis of rotation.

Figure 4.5: Test three: “and” and “or” relations
1. A boring tool comprising a body, a plurality of cutting blades supported by the body so as to be movable along paths equally inclined at an angle to the axis of revolution of the body, each end of the blades having cutting edges and projecting inwardly thereby characterized by a rotatable blade advancing member having a screwed shank within a threaded bore on the axis of rotation and a head abutting inner ends of the blades for advancing the blades on the paths consequent upon rotation of the blade advancing member.

2. A boring tool according to claim 1 characterized in that the means for causing rotation of the blade advancing member comprises a worm rotatable by a detachable handle or key and a meshing worm wheel secured to a shaft extending from the shank of the blade advancing member and co-axial therewith.

3. A boring tool according to claim 1 or 2 characterized in that the tool advancing member has a head with a conical surface abutting the inner ends of the cutting blades.

4. A boring tool according to claim 1 characterized in that the head lies within a cylindrical cavity extending inwardly from one end of the body member, the open end of the cavity being closed by a frusto-conical pressure pad supporting the cutting blades.

5. A boring tool according to any of claims 1-4 characterized in that the cutter blades are guided by holes in the body which lie in planes radial to the axis of rotation.

6. A boring tool according to any of claims 1-5 characterized in that a serrated drive spigot co-axial with the axis of rotation of the tool is mounted on one end of the body remote from the cutting blades and for insertion within a corresponding socket in a drive adaptor, the tool being detachably securable to the adaptor by a ring nut engageable with a screw threaded portion of the adaptor.

7. A boring tool according to claim 6 characterized in that the adaptor has a threaded hole to engage the screwed end of a power drill drive shaft.

Figure 4.6: Test three: previous claims
Figure 4.7: Class Diagram
4.2 Visualization demo

Figure 4.8: The screen shot of the demo
Experiments and visualization demo
Evaluation

To evaluate if this system is truly improve the readability, we designed the user study and survey to perform a user-driven evaluation.

5.1 Theoretical Background

To do the evaluation and study survey, we consider three models, technology acceptance model (TAM) (Davis, 1989), task technology fit (TTF) (Goodhue, 1995) and website user satisfaction (WSUS) (Muylle et al., 2004). In this section, we would review these models and give the reasons we choose to use these.

Technology acceptance model (TAM) (Davis, 1989) attempts to understand why people accept or reject information technologies. It applies a very general model of human behaviour called the theory of reasoned action (TRA) (Fishbein and Ajzen, 1975) to the domain of user acceptance in the context of information technologies. In this model, external variables (e.g., user characteristics, political influences, organisational factors, and development process) are expected to influence technology acceptance indirectly by affecting people’s beliefs, attitudes, or intentions (Szajna, 1996). We chose this model, because TAM has been widely accepted among the research community as tools for evaluating technologies and predicting their use and are applicable to cases. TAM can be used to evaluate technologies very early on in their development or assess user reactions to technologies on a trial basis (Davis, 1989).

Task technology fit (TTF) (Goodhue, 1995) views technologies as means for a goal-directed person to perform tasks. It posits that technologies will be used if, and only if, their available functionalities support the users activities. Consequently, its focus is on the match between user task needs and available functionalities of a given technology. The match is measured by the extent that 1. technology functionalities or characteristics meet its 2. users abilities and 3. task requirements (Goodhue, 1995). In other words, the model is three dimensional. Rational, experienced users will choose to use technologies that enable them to complete their tasks with the greatest net benefit and not to use technologies that will not offer them a sufficient advantage. We
chose TTF because our goal is to assess which technologies/technology functionalities contribute to the readability of patent claims from laypersons perspective in the context of reading and searching tasks. We decided not to choose the integrated model but rather to consider both TAM and TTF separately, because this seems to be more common practice in the research community.

**Web site user satisfaction (WSUS)** (Muylle et al., 2004) is based on a two-step study. First, a pilot study was conducted in order to define which items contribute to user satisfaction if using a web interface to interact with technology users. The contributing items were along eleven dimensions (i.e., 1. information relevancy, 2. information accuracy, 3. information comprehensibility, 4. information comprehensiveness, 5. ease of use, 6. entry guidance, 7. website structure, 8. hyperlink connotation, 9. website speed, 10. layout, and 11. language customization). The dimensions 1-4 constitute the component of information, the dimensions 5-9 the component of connection, and the remaining components are layout (i.e., dimension 10) and language customisation (i.e., dimension 11). Second, a confirmatory factor analysis was performed for these items and its results demonstrated the adequate validity and reliability of the initial model. We chose to consider WSUS, because patent search is typically implemented on the Internet as a web search engine (e.g., The Lens (http://www.lens.org/lens/) a open public resource of this kind). It is also a contrasting approach to the supplementary models of TAM and TTF.

### 5.2 User study design

With the methodology and they we have mentioned above, we design the user study with several questions. First of all, we decide to have a wide range of participants because we want to improve the readability not just for well-trained experts. First, we want to expend the range of participants by having participants with different ages (like from 16 to 60). Second, we want to involve the participants with different occupations. Third, we want to have participants with different education levels. Though these three aspects, we have different people to test the study, and we could have the feedback to see the real performance about this project.

For each questions, we designed different levels of answers to reflect the user’s experience about the demo. The level that we designed are strongly agree, somewhat agree, neutral, somewhat disagree and strongly disagree from positive comment to the disagree.

1. In my opinion, it is important to improve the readability of patent documents
2. In my opinion, it is difficult to read patent documents
3. I do not find information I need easily from patent documents in this format

These two questions are trying to investigate the satisfaction about the patent document. We want to see the people’s attitude about patent claims from both trained
4. In my opinion, I prefer to read raw text

5. In my opinion, I prefer to read raw text with plot demonstration such as tree view about the document structure

6. In my opinion, I prefer to read raw text with notations such as font color, sentence spaces and underline

7. In my opinion, I have never tried texts with settings from Question 4 to 6, but I would like to try if these strategy is available

8. In my opinion, information provided in patent documents as they are is sufficient and further visualization is not needed. These questions are about the current condition that using the visualization strategies to improve the readability. We want to investigate that if the readers have already known these strategies and related products. If they have not used these kind of product, we want to the potential acceptance about these thing. We know that there are proven researches about this fields, but we still want to see people’s reaction about this strategies and techniques.

9. I feel easy to understand the UI and visualization result

10. I can easily see the structure of the patent claims in this form

11. I do not find information I need easily from patent documents as they are now

12. I can concentrate more in this form compared with raw text

13. I can concentrate more in this form compared with EOP method

14. I cannot understand the demonstration and plots at all

15. In my opinion, this settings and visualization form would contribute to information sufficiency

These questions are focusing on the demo itself including the operation, the information provide and the plot demonstration. We want to see if people could easily understand the UI and know the operation as the first step, then we want to see if they think they can get more informations about the patent claims such as the structure and the relations. The last thing we want to know from these questions is if our goal from the design stage has been achieved such as improve the readability and help the readers concentration about the claim that they really care.

16. In my opinion, it is difficult to use this kind of improvement option

17. In my opinion, the information and technology structures of this kind of improvement option are clear

18. In my opinion, this kind of improvement option was versatile enough

19. In my opinion, this kind of improvement option dose not perform as I expected,
but I still open to the visualization technique and I would like to try more products using this strategy

Thought these questions, we want to see the overall evaluation about this demo and about this project. We want to see if people think this project is truly useful and meaningful to improve the readability. Besides, we want to see their attitude about this project and the visualization strategy after they have see the demo. Do they think this is promising to improve the readability and if they really want to use some products with these strategies.
Conclusion and future work

In this project, we want to use visualization methods to improve the text readability especially the patent claim readability improvement. To do that, we start with reviewing some literatures with three topics: text readability, patent claim readability and visualization techniques. In this part, we reviewed the literatures to get the knowledge of concepts about readability and related improvement with different strategies such as linguistic improvement. Also, we study the patent claim including the patent documents, the claims text with its structure. Then we consider the state-of-the-art techniques to improve readability including change the font size, sentence space and applying specific rules. In this part, we focus on the patent claims readability improvement.

After reviewing the theoretical part, we would like to develop a demo to demonstrate our idea and improve the patent claim readability. Our method is improving the claims readability without changing the content but using visualization techniques. After we consider the previous researches as well as the current application, we propose several improvements to make the hierarchical structure more clear to readers and we aim to help readers having a better experience when they are reading the patent claims. Our goal for this demo is to let the readers being more concentration on the content, reading more fast and following the clear structure. To evaluate the performance, we propose to do the use study. We consider the three models including technology acceptance model (TAM), task technology fit (TTF), and web site user satisfaction (WSUS). By designing the use study, we could have the feedback from users about their use experience of the demo as well their attitude about the visualization techniques usage in these area to improve the readability.

As directions for future work, we could improve the project in several aspects. First, we could apply more methods to improve the readability such as visualizing the reference part in each claim; Then we could perform the user-driven evaluation. Although we design the study, we have not did the survey, we can finalize this part in the future by recruiting enough participants. This project is mainly about patent claim and its structure, we want to test this strategy in different domains to provide the better readability.
Conclusion and future work
Appendix A

Appendix
INDEPENDENT STUDY CONTRACT

Note: Enrolment is subject to approval by the projects co-ordinator

SECTION A (Students and Supervisors)

UniID: ______________________
SURNAME: Dong     FIRST NAMES: Shichao
PROJECT SUPERVISOR (may be external): Dr Gabriela Ferraro
COURSE SUPERVISOR (a RSCS academic): A/Prof Weifa Liang
COURSE CODE, TITLE AND UNIT:  COMP8740  Artificial Intelligence Project

SEMESTER  □ S1  □ S2  YEAR: 2014

PROJECT TITLE:
Visualization of patent claims structure to improve their readability

LEARNING OBJECTIVES:
1. Understanding of a research area: text readability
2. Acquisition of scientific literature review and writing skills
3. Discovery of Research direction
4. Development of an application which aim is to improve the readability of patent claims thought visualization techniques

PROJECT DESCRIPTION:

The main goal of this project is to study the state of the art techniques about text readability. Several topics about readability will be address. First, a detail description of the problem will be tracked. The description should include, for example, what is text readability and how it can be measure; which are the target users of readability studies? layman people? people with cognitive disabilities? web-users? all of them?.

Second, studies about how text readability can be improved are going to be discuss. The discussion will be focus in two main approaches: (i) Natural Processing Language based readability improvement, and (ii) Visualization based readability improvement. Finally, a critic review about the found literature would be presented and potential research directions would be outlined. Other goals about this study includes: the acquisition of fundamental research skills such as learn to discriminate relevant from irrelevant literature sources, develop the critical spirit, summarize and present a literature review, improve scientific writing skills.

Furthermore, this study include the development of a software tool to improve the readability of the patent claims, within the aim of improving also their understandability. The software tool should offer two different solutions for approaching the mentioned task.
ASSESSMENT (as per course’s project rules web page, with the differences noted below):

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MEETING DATES (IF KNOWN):

STUDENT DECLARATION: I agree to fulfil the above defined contract:

…………………………………………………..  ………………………..
Signature       Date

SECTION B (Supervisor):

I am willing to supervise and support this project. I have checked the student’s academic record and believe this student can complete the project.

…………………………………………………..  ………………………..
Signature       Date

REQUIRED DEPARTMENT RESOURCES:

SECTION C (Course coordinator approval)

…………………………………………………..  ………………………..
Signature       Date

SECTION D (Projects coordinator approval)

…………………………………………………..  ………………………..
Signature       Date


