HOCHSCHULE LUZERN

PAWI

Evaluation of different content extraction algorithms

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A thesis submitted in fulfilment of the requirements for the degree of some HSLU degree

in the

Research Group Name
Department or School Name

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Declaration of Authorship

I, Joel Rolli, declare that this thesis titled, 'Evaluation of different content extraction algorithms' and the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

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Abstract

Faculty Name
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Evaluation of different content extraction algorithms

by Joel Rolli

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Acknowledgements

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Abbreviations

HTML	**H**yper **T**ext **M**arkup **L**anguage

For/Dedicated to/To my…

Chapter 1

Problem statement

This chapter describes the problem statement, as well as the topical environment in which the project takes place.

1.1 Introduction

This project is done on behalf of the company Layzapp. Layzapp is specialized in second-screen solutions. It is currently working on a mobile application which brings relevant data to a second screen during a TV show. The Internet is crawled to find relevant information about a certain topic. The outcome of this search is a certain number of web pages. The content of these web pages is made usable by removing irrelevant data, such as navigation elements, advertisement and login pages. Removing the HTML content is not a very hard task. But after this first process of removal there is still much irrelevant content left, for instance descriptions of further articles or advertisements. Removing this part is much more complicated.

1.2 Task

As described in the introduction, irrelevant content, which is also called boilerplate, needs to be removed from a web page. There are already several algorithms which fulfill this task. To compare the performance of the known algorithms and contrast them to possible new algorithms, a test environment is required. The test environment needs to classify the quality of a text extraction performed by the different algorithms. For this purpose, each algorithm is fed with a certain amount of HTML content. The outcome is then inspected for its quality.

1.3 Text extraction and algorithms

This chapter is a description of the text extraction subject and the known algorithms.

1.3.1 Text extraction

Text extraction or content extraction of web pages is a widely discussed field in research. There are several approaches to this field. The two main approaches are page segmentation via visual and DOM features and boilerplate removal. The main drawback of visual page segmentation is that at some point the web page needs to be rendered and processed as image. This task is very time-consuming and many resources are necessary to fulfill it. This project focuses on algorithms which work with boilerplate removal. The basic idea of boilerplate removal was first introduced with the BTE (Body Text Extraction) algorithm. The assumptions are that the relevant part of the HTML content is usually a continuous text where the density of HTML tags is lower than in boilerplate content. Hence, by breaking up the HTML page in single sections and counting the HTML tags, there is an area where the number of HTML tags do not increase. It is quite simple to define an objective function. One can expect that this is the article text. Unfortunately, BTE's performance is very limited, but it is still used to compare different extraction algorithms to each other. The two algorithms Boilerpipe and Justext improve the performance of BTE.

1.3.2 Boilerpipe

The Boilerpipe algorithm is based on the concept described in Kohlschütter's paper "Boilerplate Detection using Shallow Text Features". It uses a variate of HTML tags to divide the HTML document into blocks. Each block is classified according to its shallow text features and to the classification of the previous and the next blocks. Some examples for shallow text features are average word length, average sentence length or the absolute number of words. The features are described more closely in the paper.

1.3.3 Justext

Justext uses similar features as Boilerplate but inspects the data for the presence of stop words as well. Some examples for stop words are "a", "and", "but", "how", "or", and "what". An article contains more stop words than boilerplate. Based on this information, a better classification can be achieved.

1.3.4 Classification

The main task of the application is to somehow classify the performance of the algorithms. The performance can be defined as how much of relevant text is classified as relevant and how much is classified as boilerplate. In information retrieval, these performances can be described in a confusion matrix.

	Classified as content	**Classified as boilerplate**
Actual content	True positive (TP)	False negative(FN)
Actual boilerplate	False positive (FP)	True negative (TN)

- True positive is the amount of text which is relevant content and classified as content by the algorithm
- False positive is the amount of text which is relevant content but classified as boilerplate by the algorithm
- True negative is the amount of text which is boilerplate and is classified as boilerplate by the algorithm
- False negative is the amount of text which is boilerplate but is classified as content by the algorithm

These values are the basis for calculating both the recall (also known as sensitivity) which is the fraction of relevant text that is retrieved and the precision which is the fraction of retrieved text that is relevant. These values, their dependencies and some more values are described more closely in the software requirement specification (C.4.4).

1.4 Conclusion

An application is needed which can be fed with HTML documents. These documents are then processed by text extraction algorithms. The outcome is then compared with the relevant content and classification values are calculated. Based on these values the performance of the algorithms can be compared. Possible strengths and weaknesses can be determined in this comparison.

Chapter 2

Solution Development

This chapter describes the approach developing the application and the outcomes.

2.1 Approach

2.1.1 Planning

The planning of this project was a very straight forward task. Since it is a small one man project and the start and end dates were clearly defined there was not a lot of margins. However I am working part time for Layzapp and this project was not the only task during the period of time and the project needed to be coordinated somehow with other tasks. My solution was to work about one to two weeks for on this project and switch to other tasks for the next one to two weeks. Switching between multiple projects within one week is not very effective because one needs always some hours to get back into the topic. A project plan was done for the whole time line of the project. Several milestones and its delivery objects were defined. As I was working with scrum a milestone was defined as sprint and the delivery objects were divided into stories on the start of each sprint. Since it was a one man team no weekly scrum meetings were. However on the end of each sprint there was a sprint meeting and the delivery objects were presented to the supervisors and the tasks for the next sprint were defined or adjusted. During the project, the tool toggl [1] was used as a time tracker and task manager. The whole planning as well as the time tracking can be found in the abbreviations under A.

[1] see A.10 for more information about toggl

2.1.2 Programming

As a first step a data model and a first approach of a software architecture was developed. This first approach was then implemented so that the basic functionality of the application is working. With this working version the data model and the software architecture could be approved. The next step was elimination the biggest risk which were the integration of the two algorithms Justext and Boilerpipe into the application. Prototypes for each algorithm were programmed. Implementing the Boilerpipe algorithm was an easy task since it is implemented in Java and could be used without the need of any modification. Implementing the Justext algorithm was a more difficult task since it is implemented in Python. The final solution was then to call the python application with system calls from the java application and read the output text file generated by the python program. The second big risk was the approach comparing the text with the actual content and the outcome of the algorithms and find the classification numbers (True positive, false positive, true negative, false negative). The different approaches are described on following example.

Content file

```
I am an interesting text.  My content is about advertisement.
```

Outcome algorithm

```
I am an interesting text.  And i am advertisement about socks.
```

In the example above, the algorithm classified the first sentence correct but classified another sentence from an advertisement block as content as well. If these text would be compared with the approche described above, the word "advertisement" would be defined as classified correctly (True positive) but it is not. In a second approach, the comparison was done by not only comparing a single word but as well as the word before and after the word of interest. For the example above, for each word, a group of three words is built and this group is then compared with the second text. The word "advertisement" would be defined as the word group "is about advertisement" and the second text was searched for this pattern. Since there is not such a group, the word advertisement would be defined as classified wrong (False positive). With this approach the results were already a lot better. But there were still situations where this approach was not working. Instead of implementing an elaborated text comparison algorithm I decided to fall back on existing solutions. Merging tools like diff [2] or meld [3] are performing exaclty the task I was looking for. I decided to use the Java open source

[2] http://en.wikipedia.org/wiki/Diff_utility
[3] http://en.wikipedia.org/wiki/Meld_(software)

implementation merge-diff-patch [4] from google. The outcome of the comparison are all the words of the input text grouped in 'EQUAL', 'DELETE' and 'INSERT' which can be easy transferred into the needed values True Positive ('EQUAL'), False Positive ('INSERT'), True Negative ('DELETE') and False Negative (remaining words).

The next task after handling these risks was to integrate the prototypes into the main application. The remaining programming tasks were then refactoring the first approach and testing the application. The final software architecture is described in the abbreviation under D. The test concept is described under lkasjfasldöf.

The final programming task was then adapting the application so that it is possible to evaluate a single test instead of getting the results for a summary of tests. The reason doing this is described in the section 2.2.3. The most information about a single test such as Precision, Recall and the extracted text by the algorithms was already available. The more challenging part was the output of the evaluation based on bocks. The problem is that both algorithm have no way of getting the classification of the single blocks. Which means that the two algorithms needed to be modified.

2.1.3 Modification Justext

After getting used to the programming language python, the task was easier then expected. The algorithm is working with blocks during the whole process and prints the blocks classified as content. All I needed to do is to print the classification values at the beginning of each block and evaluate the outcome with the Java application. This is an example of the printed string after my modification.

```
<p class="bad" cfclass="bad" heading="0" word\_count="3" link\_density="1"
stopword\_count="1" stopword\_density="0"\> Kites with Antennas>
```

This string could then be parsed by the Java application into block objects and all the classification data like link density and stop word count could be set for each block.

2.1.4 Modification Boilerpipe

Adapting the boilerpipe algorithm on the other hand was not as easy as expected. Boilerpipe does merge the single blocks during the algorithm and the classification information for some blocks are lost due to this approach. My solution was then to edit the algorithm that each block is backed before it is merged with others and all the available classification information as well. The problem with this approach is that some blocks are

[4] https://code.google.com/p/google-diff-match-patch/

classified different at a later point of time and the backed data is not correct anymore. To solve this problem, bigger changes of the algorithm would be needed. However, this solution is good enough to evaluate the results accordingly.

2.2 Results

2.2.1 Statistical data

TODO: conclusion of the output data and some graphs -.-

2.2.2 Analysis

With the test framework it was finally possible to produce the classification data for the algorithms using an HTML file and a content file as input data. Doing this with a few test files, it is not possible to produce a concrete quality criterion for a algorithm. A bigger test data was needed. The gold standard test data was used for this purpose. This test data was used for a text extraction competition called CLEANEVAL [5]. This test data was not only used in the competition but as well in other papers which broach the issue of text extraction. The paper 'More Effective Boilerplate Removal—the GoldMiner Algorithm' used the same test data to compare the Goldminer algorithm to Justext and Boilerpipe. The results from this paper were used to determine if my approach is heading into the right direction or if the outcome is completely wrong. The results from the paper testing the different algorithms with the gold standard are

Algorithm	**Precision**	**Recall**
Justext	95.29 %	91.99 %
Boilerpipe	95.15 %	74.38 %

The results from my test framework are

Algorithm	**Precision**	**Recall**
Justext	95.86 %	87.27 %
Boilerpipe	91.14 %	70.60 %

The results are not exaclty the same but they are close. The difference could be explained by several points. First, there is no guaranty that the results from the paper are correct. Second most of the common approaches comparing these text extraction algorithms were done in comparing the correct classified HTML blocks and not the single words like I did

[5] The test data and more information about CLEANEVAL can be found under http://cleaneval.sigwac.org.uk/

it in this project. This can change the results significantly. Following example should clarify this statement.

Suppose we have a HTML document with ten blocks which have a certain amount of words and are classified by an algorithm as defined in following table.

Block No.	**Word count**	**Classification**
1	10	True Positive
2	100	True Positive
3	50	True positive
4	30	True Positive
5	1	False Positive
6	1000	False Positive
7	20	False Positive
8	300	False Positive
9	200	False Negative
10	50	False Negative

The calculated values for Precision and Recall would be as follow.

	Calculation based on blocks	**Calculation based on words**
Precision	50 %	12.57 %
Recall	66.67 %	25.68 %

We can see that the difference between the two approach is very big because a block which is classified wrong and contains a lot of words is not weighted as high if the values are calculated based on blocks instead of words. From my point of view comparing algorithms based on words is the better approach to compare the performance of text extraction algorithms since the results are more accurate. Furthermore, each algorithm can define the size of a block by itself and it is not defined that a HTML document extracted by two algorithms produce the same blocks. Comparing a different amount of blocks does not produce very accurate results as well.

2.2.3 Detailed Analysis

It is now possible to compare multiple algorithms with each other and get a general idea if the algorithms are working well or not. However it is not possible to evaluate the strengths and weaknesses of a single algorithm more close. But this is needed to implement a new algorithm or improve the existing ones. As decided on the MS4 meeting I am not implementing a new algorithm but extending the functions of the existing application so it is easier to find this strengths or weaknesses. The ways to do this is described in this section.

As described in the introduction, the algorithms split the HTML file into single blocks and classify these blocks based on several classification data. To find out, why a certain test went very bad with one and very good with the other algorithm, it would be helpful to get the information about the block classification. After modifying the implementation of the algorithms (2.1.3) it is possible to get this data for both Justext and Boilerpipe. This is an example from the results of one block for both Justext and Boilerpipe.

Boilerpipe

```
[link_density: 1.0; classification: BOILEPLATE; word_count: 3; stop_Word_Count:
NOT_DEFINED; text_Density: 3.0; context_Free_classification: NOT_DEFINED; ]
Kites with Antennas
```

Justext

```
[link_density: 1.0; classification: BOILEPLATE; word_count: 3; stop_Word_Count: 1;
text_Density: NOT_DEFINED; context_Free_classification: CFC_BAD; ]
Kites with Antennas
```

This are the classification values which can be extracted from the algorithms without modifying the algorithms too much and it already can help evaluating how the algorithms work and why a specific block is classified as content by one algorithm and classified as boilerplate by the other one. Some classification values are only used by one algorithms. Because of this some values in the example are shown as NOT_DEFINED.

Chapter 3

Results

3.1 Main Section 1

Chapter 4

Lesson learned

4.1 Main Section 1

Chapter 5

Further work

5.1 Main Section 1

Appendix A

Planning

A.1 Version

Version	Date	Change	Author
0.1	15.09.2014	Setup document	JR
1.0	28.09.2014	Draft planning	JR
1.1	18.09.2014	Adding overview	JR
1.2	6.10.2014	Stories for MS2	JR

A.2 Planning concept

So as to plan the project, a combination of the two well known planning frameworks scrum and RUP are used.
For a first rough planning, the assignment is split into working packages and assigned to milestones. Delivery objects are defined for each milestone.
This plan is then assigned to the given time table of about 12 weeks. The project effort is defined as 180 hours. This results in about 15 hours work load per week.

A more detailed planning is done for the incoming milestone / sprint. The predefined working packages are split into smaller packages. For the first draft, only the first milestone is split into smaller packages. The later milestones are going to be defined in more detail as soon as all needed information is available.

The effort needed for the documentation is not listed separately. All the tasks already contain additional time for updating the documentation.

The milestones dates are not finally defined, which means that the meeting dates can vary by up to some days. sadfjsalödkfjsadlk

A.3 Milestones overview

Name	**Shortcut**	**Weeks**	**Estimated hours**	**Hours total**	**Closing date**
Milestone one	m1	2.5	39	39	01.10.2014
Milestone two	m2	3	45	84	22.10.2014
Milestone three	m3	2	30	114	05.11.2014
Milestone four	m4	2	30	144	19.11.2014
Milestone five	m5	2.5	38	182	08.12.2014

A.4 Delivery objects

Milestone	**Delivery date**	**Delivery objects**
Milestone one	01.10.2014	• System specification • Sketch software architecture • Short presentation CI environment • Draft risk evaluation
Milestone two	22.10.2014	• Elaborated software architecture • Tested code of test framework (tbd: which components) • Interface definition for justext/boilerplate components • HTML test data
Milestone three	05.11.2014	• Working test environment with both justext and boilerplate components integrated
Milestone four	19.11.2014	• Evaluation environment for output data of test framework • First approach to new algorithm
Milestone five	08.12.2014	• Implementation of new algorithm • Final documentation • Final presentation

A.5 Milestone one - m1

- Closing date date: 1.10.2014
- Available time: ca. 39h

Story	**Shortcut**	**Estimated time**
Planning	s1	4h
Research HTML / Algorithms	s2	8h
System specification	s3	12h
Risk evaluation	s4	3h
Draft software architecture	s5	8h
Configuration CI environment	s6	4h
Total		39h

A.5.1 Stories m1

Title	Planning
Id	s0
Estimated time	4h
Description	As a project owner, you need to have a time schedule so that you can see when you will achieve which results. The PAWI project is split into several working packages which are then split into single stories. The working packages are assignment to milestones and for each milestone, delivery objects are defined. This can be a document, a piece of test or production code or some other kind of work.

Title	Research HTML / Algorithms
Id	s1
Estimated time	8h
Description	My knowledge of HTML and content extraction algorithms is still limited. In order to find out what challenges I will face and which aspects I will have to take into consideration for performing the first tasks, a short research on these topics is needed.

Title	System specification
Id	s2
Estimated time	12h
Description	The PAWI project is defined through a short project description. This description does not cover all necessary information to both plan and perform this project. The key features, interfaces and delivered objects have to be defined more closely. The system specification should cover all these requirements.

Title	Draft software architecture
Id	s3
Estimated time	8h
Description	A first rough software architecture should be made as soon as possible, so that any misunderstandings between tutors and student can be uncovered. Moreover, it is much easier to plan the further steps when the software is split into several parts.

Title	Risk evaluation
Id	s4
Estimated time	8h
Description	Potential risks should be uncovered with the knowledge that was gathered by defining the specification and the software architecture. What is more, further actions can be defined to minimize the above mentioned risks.

Title	Configuration CI environment
Id	s5
Estimated time	4h
Description	To deliver high quality software a continuous integration environment is required. Following tools should be evaluated and configured for further use: • Version control (git) • Project build automation tool (gradle) • continuous integration service (Travis CI)

A.6 Milestone two - m2

- Closing date date: 22.10.2014
- Available time: ca. 45h

Story	**Shortcut**	**Estimated time**
Implementation test framework	s6	20h
Prototype Integration of justext/boilerpipe	s7	17h
Collection of test data	s8	8h
Total		45h

A.6.1 Stories m2

Title	Implementation Config Reader
Id	s6
Estimated time	4h
Description	The configuration for the test framework is located in a text file in the resources folder of the project. The data is formated in a key value structure. This text file is read at the startup of the program and saved in a Config object.

Title	Implementation File Reader
Id	s7
Estimated time	6h
Description	The html and content files are located in two folders (content/html) in the resources folder of the project.. For each file pair with the same name, a test object is generated and the content of the file is read and put into the test objects.

Title	Implementation File Writer
Id	s8
Estimated time	4h
Description	The results of a test is written in an output text file into the resources folder of the project.

Title	Implementation Test Manager
Id	s9
Estimated time	6h
Description	The Test Manager contains the business logic of the program and coordinates the reading, testing and writing.

Title	Prototype Integration of boilerpipe
Id	s10
Estimated time	4h
Description	Implementation of a small prototype which uses the existing implementation of boilerpipe. A final interface for boilerpipe is defined for further use.

Title	Prototype Integration of justext
Id	s11
Estimated time	12h
Description	Implementation of a small prototype which uses the existing implementation of justext. A final interface for justext is defined for further use.

Title	Collection of test data
Id	s12
Estimated time	8h
Description	To evaluate the functionality of the text extraction algorithms, a certain amount of test data is needed. This test data contains HTML files of several web pages. The HTML code is categorized into content and boilerplate.

A.7 Milestone three - m3

- Closing date date: 5.11.2014
- Available time: ca. 30

Story	**Shortcut**	**Estimated time**
Implementation test framework	s9	20h
Final integration of justext / boilerplate	s10	10h
Total		30h

A.7.1 Stories m3

Title	Implementation test framework
Id	s9
Estimated time	20h
Description	Final implementation of the test framework. This story will be divided into smaller stories as soon as the software architecture and the system specification is reviewed.

Title	Prototype Integration of justext/boilerpipe
Id	s10
Estimated time	4h
Description	Complete integration of the justext and boilerplate algorithms into the test framework. This story will be divided into smaller stories as soon as the software architecture and the system specification is reviewed.

A.8 Milestone four - m4

- Closing date date: 19.11.2014
- Available time: ca. 30h

Story	**Shortcut**	**Estimated time**
Evaluation environment for results	s11	20h
Research on new algorithm	s12	10h
Total		30h

A.8.1 Stories m4

Title	Evaluation environment of results
Id	s11
Estimated time	20h
Description	The test framework will produce a lot of output data, which has to be reviewed using an evaluation environment. This should process this data and present the results in a descriptive way. This story will be divided into smaller stories as soon as the software architecture and the system specification is reviewed.

Title	Research on new algorithm
Id	s12
Estimated time	20h
Description	A first research on the new algorithm should be performed. After this research it should be possible to decide if this solution is possible and if an implementation with the remaining time resources is realistic. This story will be divided into smaller stories as soon as the software architecture and the system specification is reviewed.

A.9 Milestone five - m5

- Closing date date: 8.12.2014

- Available time: ca. 38h

Story	**Shortcut**	**Estimated time**
Implementation of new algorithm	s13	19h
Complete documentation	s14	15h
Prepare final presentation	s15	4h
Total		38h

A.9.1 Stories m5

Title	Implementation of new algorithm
Id	s13
Estimated time	19h
Description	Implementation of the new algorithm and analysis of the test results with the existing evaluation environment.

Title	Complete documentation
Id	s14
Estimated time	15h
Description	Complete and review all chapters of the documentation.

Title	Prepare final presentation
Id	s15
Estimated time	4h
Description	Prepare the final presentation and the final printed / digital version of the thesis.

A.10 Time tracking

Appendix B

Risk Analysis

B.1 Version

Version	Date	Change	Author
0.1	20.09.2014	Setup document	JR
0.2	28.09.2014	Add risks, evaluation, consequences	JR
1.0	05.10.2014	Grammar, layout	JR

B.2 Introduction

B.2.1 Purpose

This document evaluates and calculates all possible risks and defines actions that can minimize these risks as well as possible.

B.3 Risk evaluation

B.3.1 Unclear requirements

The start of a project is normally no easy task because its requirements are vaguely known. If they are not well defined as soon as possible, the requirements will stay vague throughout the whole project, which can lead to a disaster.

B.3.2 New technologies

The new technologies which are present in this project are the following:

- Gradle
- Travis CI
- Python

Each of them brings its own risk.

B.3.3 Integration Boilerpipe

The Boilerplate algorithm needs to be integrated into the text extraction framework. Every interface of an external component is a possible risk factor.

B.3.4 Integration Justext

The Justext algorithm needs to be integrated into the text extraction framework. Every interface of an external component is a possible risk factor.

B.3.5 Implementation RSS algorithm

The development and implementation of a new algorithm is predestined to generate risks.

B.4 Assessment of risks

Risk	**Impact**	**Probability of occurrence**	**Risk factor**
Unclear requirements	2	4	8
New technologies	3	3	9
Integration Boilerpipe	5	1	5
Integration Justext	5	5	20
Implementation RSS algorithm	1	5	5

B.5 Consequences

B.5.1 Unclear requirements

As I am working with the client everyday, it is very easy to prevent misunderstandings by communicating with the client as soon as any difficulty appears. Nonetheless, misunderstandings can occur between student and expert. In order to prevent this, it is necessary to have a document defining the requirements as soon and as exact as possible. This will be done in the form of the system requirement specification in the first mile stone. Possible ambiguities can be clarified at the first milestone meeting.

B.5.2 New technologies

It is important to do prototyping with new technologies in the first phase of the project to eliminate these risks as soon as possible.

Gralde and Travic CI are needed in the first milestone to launch the programming environment. If there is any problem it will occur in a very early stage of the project and a possible solution can be found.

B.5.3 Integration Boilerpipe

This risk is rated much lower than the Justext interface because its implementation is in Java and it provides a Java API. Nevertheless, a prototype should be done as soon as possible to prevent any unwelcome surprises with the interface.

B.5.4 Integration Justext

This aspect is classified as the highest risk of all. This is because the implementation happens in Python and it is not clarified yet how it will be integrated into the text extraction framework. An analysis of a possible solution with prototypes needs to be done as soon as possible.

Possible solution are:

- jython (`http://www.jython.org`)
- Implementation in Java
- Java Processor Interface

B.5.5 Implementation RSS algorithm

This risk has a very high probability of occurrence because it is very likely that a development and an implementation of a new algorithm will cause problems. There is no real solution to that risk. However, because this requirement is noncompulsory, the impact on the outcome of the project is very low. Furthermore, Patrik Lengacher, the tutor of this project, is very experienced in this subject area and will be able to assist if any problems occur.

Appendix C

Software Requirement Specification

C.1 Version

Version	Date	Change	Author
0.1	20.09.2014	Setup document	JR
0.2	28.09.2014	Add features	JR
0.3	30.09.2014	Change features, grammar, layout	JR
0.4	02.10.2014	Add overview of application/evaluation	JR
0.5	04.10.2014	Corrections evaluation	JR
1.0	05.10.2014	Grammar, layout	JR
1.1	20.11.2014	Fix FN definition	JR

C.2 Introduction

C

C.2.1 Purpose

The software requirement specification is providing all needed information to develop the context extraction framework and define all delivery objects. All interfaces to external components, input and output data, deployment considerations and quality attribute are well defined within this document.

C.2.2 Scope

The context extraction framework will perform automated text extraction on a set of HTML test data with two to three different text extraction algorithms. After measuring the performance of each algorithm, an output file with the measured results is generated.

C.3 General description

C.3.1 Operating Environment

The operation environment for the text extraction framework is defined in this section.

C.3.1.1 Local environment

Ubuntu	12.04
JDK	1.7.X
Gradle	1.11
Eclipse Keppler	2.X
git	1.9.X
python	2.7.X

C.3.1.2 Continuous Integration Environment

Ubuntu	12.04
Open JDK	1.6.X
Open JDK	1.7.X
Oracle JDK	1.7.X
Oracle JDK	1.8.X
Gradle	2.0
Travis CI	

C.3.2 Design and Implementation Constraints

C.3.2.1 User interface

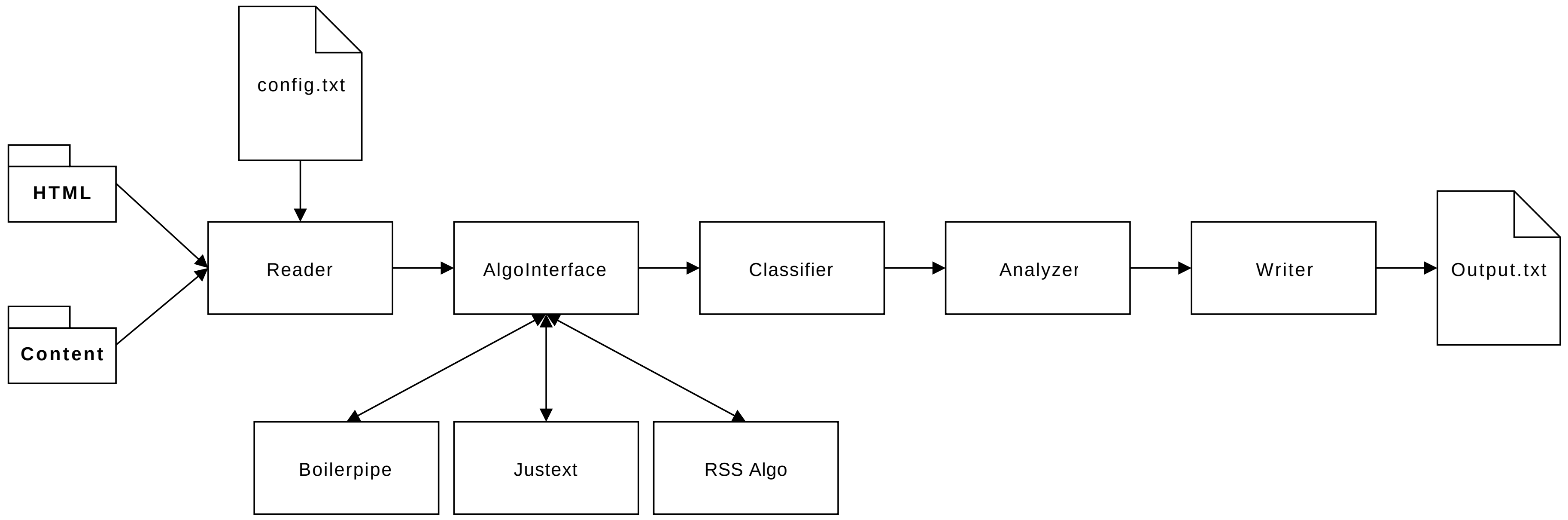
As parts of the text extraction framework may be implemented in a server environment at a later point in time and a user interface is not desired from the client, there will be no graphical user interface. The application is built, deployed and started by gradle. While the application is running, no interaction is needed.

C.4 System Features

This section specifies all system features. Each feature is specified more closely with multiple user stories. However, all the important information, such as external dependencies and output files, are defined in this chapter. The related user stories for each feature are located in the planning section.

C.4.1 Basic functionality

The following diagram and text describes the basic functionality of the application.



There are two folders defined by the configuration file (config.txt). The HTML folder contains HTML files of web pages. The content folder contains text files with the relevant content of the related HTML files. As soon as a test is started, the HTML file and the text file are read and the HTML file is extracted and classified with all the available algorithms. The result of the classification is then compared to the relevant content and performance data is generated. This performance data is then analyzed with statistical methods.

C.4.2 Overview

ID	Name	Chapter	Relevance
f1	Read configuration	C.4.2.1	needed
f2	Create test	C.4.2.2	needed
f3	Integration Justext algorithm	C.4.2.3	needed
f4	Integration Boilerpipe algorithm	C.4.2.4	needed
f5	Evaluation and Implementation RSS feed algorithm	C.4.2.5	nice to have
f6	Evaluation of classification text	C.4.2.6	needed
f7	Evaluation of classification blocks	C.4.2.7	nice to have
f8	Analyze data	C.4.3	needed

C.4.2.1 Read configuration

Name	Read configuration
Feature id	f1
Description	The text extraction framework is configurable with an external text file. The configuration file will contain following items: • Path to folder with HTML files • Path to folder with text files • Path to folder with output files • Configuration for algorithms • etc. The configuration file location is defined as a relative path to the source directory and structured in a key value list: `key:value;` `key:value;` `key:value;`
Relevance	needed
Related stories	tbd

C.4.2.2 Create test

Name	Create test
Feature id	f2
Description	A test contains two input files which are an HTML file and a text file. They are located in the directories defined by the configuration. As soon as the test framework finds an HTML and a text file with the same name, the files are read and the test is started.
Relevance	needed
Related stories	tbd

C.4.2.3 Integration Justext algorithm

Name	Integration Justext algorithm
Feature id	f3
Description	Justext is implemented in python. That is the reason why a service is needed to call the python script and get the extracted text or the extracted blocks.
Relevance	needed
Related stories	tbd

C.4.2.4 Integration Boilerpipe algorithm

Name	Integration Boilerpipe algorithm
Feature id	f4
Description	Boilerplate is implemented in Java. An interfae is needed in order to call the Boilerplate component and get the extracted text or the extracted blocks.
Relevance	needed
Related stories	tbd

C.4.2.5 Evaluation and Implementation RSS feed algorithm

Name	Evaluation and implementation RSS feed algorithm
Feature id	f5
Description	The basic idea of the RSS feed algorithm is to match the content of an HTML document with the related RSS feed and in doing so, define the relevant content. This needs to be evaluated, implemented and integrated into the text extraction framework.
Relevance	nice to have
Related stories	tbd

C.4.2.6 Evaluation of classification text

Name	Evaluation of classification
Feature id	f6
Description	All the text extraction algorithms return an extracted document as text. This document needs to be checked for accuracy, which is achieved by comparing the result of the algorithms with the actual content. • Check each classified block from the algorithms if its content can be found in the actual content • Categorize text as boilerplate or content • Insert results in an output text file Both the evaluation and classification are defined in more detail in section C.4.4.
Relevance	needed
Related stories	tbd

C.4.2.7 Evaluation of classification blocks

Name	Evaluation of classification blocks
Feature id	f6
Description	A more detailed evaluation of the algorithms could be done if not only the text but also each block of an HTML file is classified. So as to achieve the more detailed evaluation, the implementation of Justext and Boilerpiple has to be adapted so that they return classified blocks instead of the extracted text. These blocks are afterwards compared with the actual content and classified. • Check each classified block from the algorithms if its content can be found in the content file • Categorize all blocks as boilerplate or content • Insert the results in an output text file (structure output file: tbd) Both the evaluation and classification are defined in more detail in section C.4.4.
Relevance	nice to have
Related stories	tbd

C.4.3 Analyze data

Name	Analyze data
Feature id	f7
Description	From the results of the comparison further values can be evaluated for a better understanding of the results. These values are described in more detail in section C.4.5.
Relevance	needed
Related stories	tbd

C.4.4 Evaluation of classification

The general meaning of the expressions true positive, true negative, false positive and false negative related to the text extraction topic is shown in following table.

When the results are compared based on words, the expressions are interpreted as follows.

	Classified as content	**Classified as boilerplate**
Actual content	True positive (TP)	False negative(FN)
Actual boilerplate	False positive (FP)	True negative (TN)

	Classified as content	**Classified as boilerplate**
Actual content	Word classified as content by algorithm and is content	Word classified as boilerplate by algorithm but is content
Actual boilerplate	Word classified as content by algorithm but is boilerplate	Word classified as boilerplate by algorithm and is Boilerplate

When the results are compared based on HTML blocks, the expressions are interpreted as follows.

	Classified as content	**Classified as boilerplate**
Actual content	Block is classified as content by algorithm and is content	Block is classified as boilerplate by algorithm but is content
Actual boilerplate	Block is classified as content by algorithm but is boilerplate	Block is classified as boilerplate by algorithm and is boilerplate

In conclusion, TP + FN is the correct outcome of the algorithm i.e. content classified as content and boilerplate as boilerplate. On the other hand, TN + FP is the wrong outcome of the algorithm i.e. content classified as boilerplate and boilerplate as content.

C.4.5 Analytical values

In this paragraph we use the notion of objects instead of word/block. The results of the comparison deliver basic characteristics which can be used to calculate statistical values which help you analyze the test outcome.

Sensitivity / Recall /True positive rate / TPR / Hitrate

Recall is the probability that a relevant document is retrieved in a search which in our case is

$$Recall = \frac{TP}{TP + FN} \tag{C.1}$$

correct classified content objects divided by the sum of all actual objects.

Precision / True negative rate / TNR

Precision is the probability that a retrieved document is relevant which in our case is

$$Presicion = \frac{TP}{TP + FP} \tag{C.2}$$

correct classified content objects divided by the sum of all objects classified as content.

F-measure / F1-score / F-score

F-measure is the harmonic mean of precision and recall which in our case is

$$Fmeasure = 2 * \frac{presicion * recall}{presicion + recall} \tag{C.3}$$

a measure of the test's accuracy.

Fallout / False positive rate / FPR

Fallout is the proportion of non-relevant objects that are retrieved out of all non-relevant objects available which in our case is

$$Fallout = \frac{FP}{FP + TN} \tag{C.4}$$

C.5 External Interface Requirements

C.5.1 Boilerpipe

The boilerpipe algorithm is implemented in Java and the documentation is found under `https://code.google.com/p/boilerpipe/`.

C.5.2 justext

The justext algorithem is implemented in python and the documentation is found under `https://code.google.com/p/justext/`. It is not yet defined how it will be integrated into the text extraction framework. See risk analysis for further information.

Appendix D

Software Architecture

D.1 Version

Version	Date	Change	Author
0.1	8.10.2014	Setup document	JR
0.2	12.10.2014	Class diagrams	JR
0.3	16.10.2014	Text	JR
0.4	20.10.2014	Activity diagram	JR
1.0	21.10.2014	Grammar, Diagram fixes	JR
1.1	22.10.2014	Adding description of all business logic classes, approach and extended introduction	JR
1.2	23.10.2014	Grammar	JR,LR

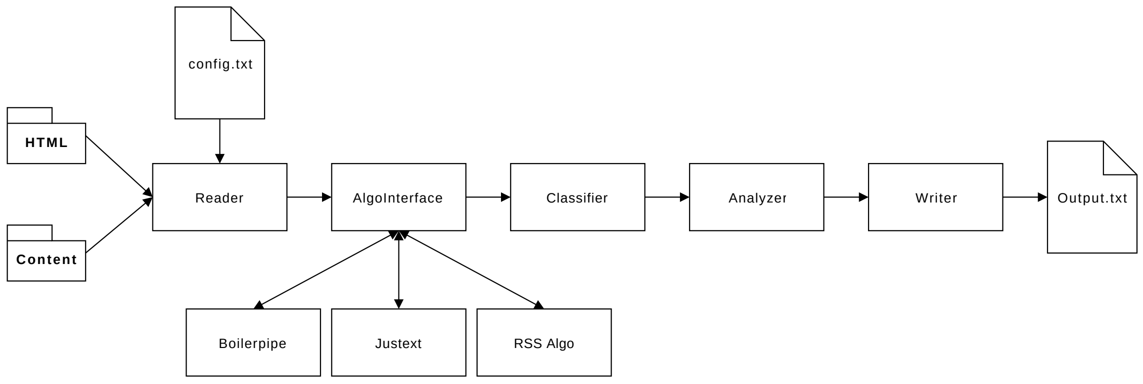
D.2 Introduction

This document describes the software architecture of the context extraction test framework. The context extraction test framework will perform automated text extraction on a set of HTML test data with two to three different text extraction algorithms. After measuring the performance of each algorithm, an output file with the measured results is generated.

D.3 Logical view

D.3.1 Approach

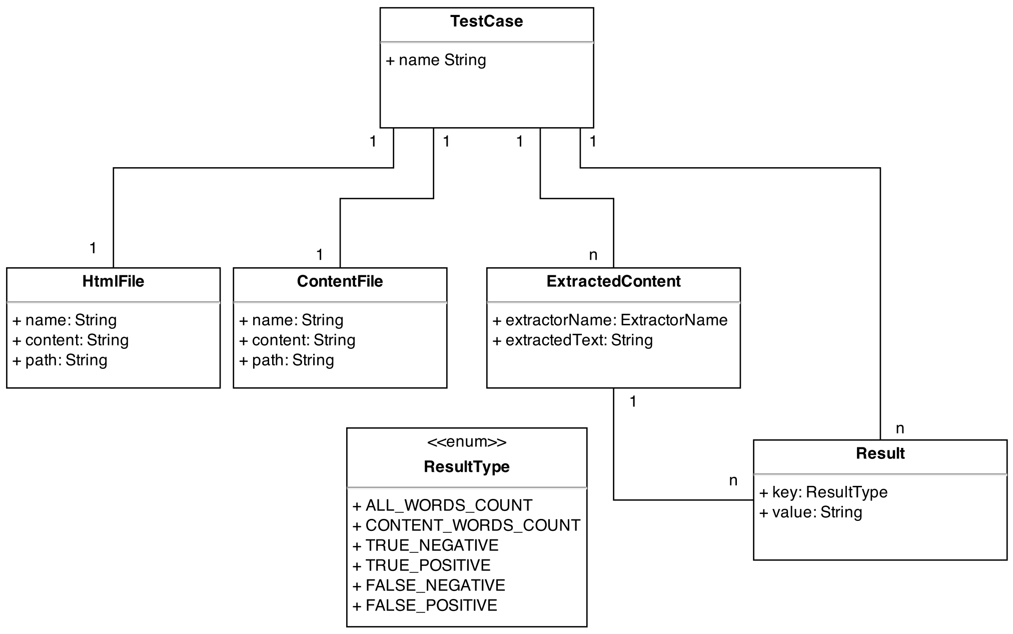
This section describes the approach for elaborating the software architecture. The following figure from the software requirement specification is the basis for elaborating the software architecture.



First all possible entities in the domain are identified and a data model is elaborated. The data model is described in D.4. Then the business logic is researched based on the figure above. With this knowledge, the five packages main, reader, classifier, analyzer and writer are defined. The functions for each package is then evaluated and split into single classes. During the implementation of the first approach, some classes are adapted due to unforeseen circumstances. The outcome is described in D.5.

D.4 Data model

The following diagram shows the data model of the application.



D.4.1 TestCase

A TestCase object is generated for each HTML/content file pair in the input folders. A TestCase has a a name which is unique and which matches the name of the content and HTML file.

D.4.2 HtmlFile

Each TestCase has an HtmlFile object. It contains the content of the actual HTML file as String and the file path.

D.4.3 ContentFile

Each TestCase has a ContentFile object. It contains the content of the actual text file as String and the file path.

D.4.4 ExctractedContent

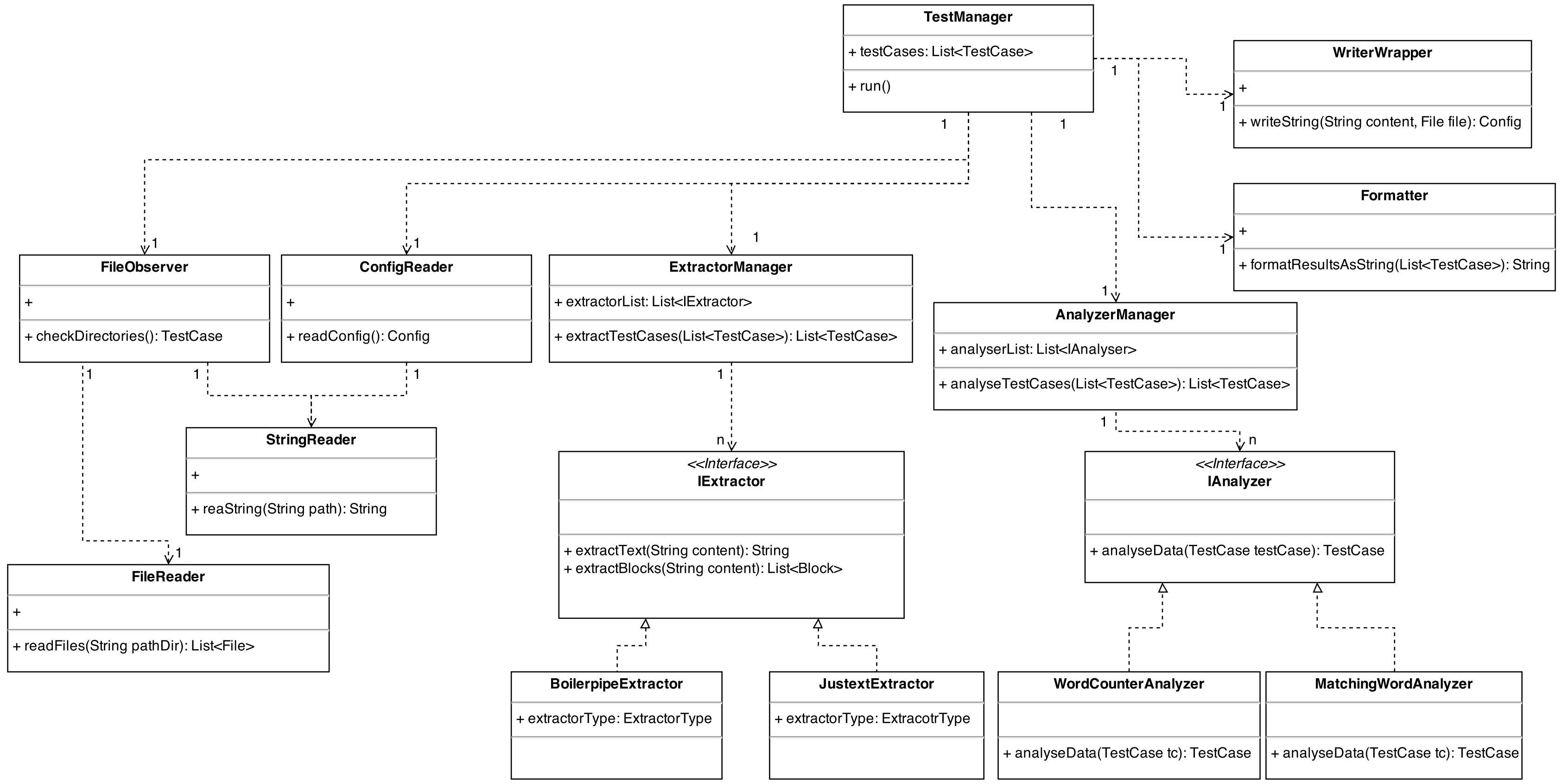
Each TestCase can have multiple ExctractedContent objects. Each of them represents a result of a content extraction from an extractor such as Justext or Boilerpipe.

D.4.5 Result

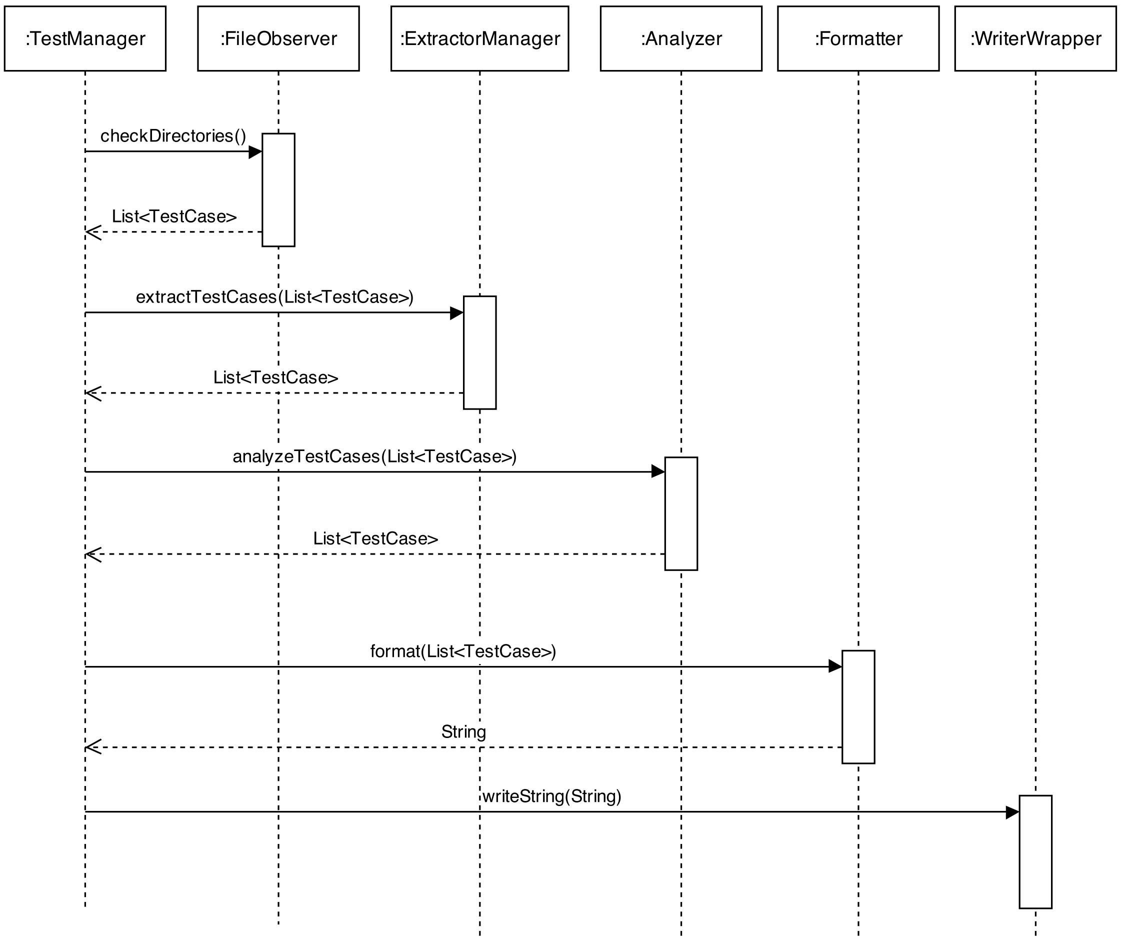
A TestCase or an ExctractedContent object can have Result objects. The results are key value pairs which represent analytical data. An example for a Result related to a TestCase would be the word count of the content file, which is generally valid. An example for a Result related to an ExctractedContent would be the word count of true negative words, which is only valid for one specific ExctractedContent.

D.5 Business Logic

The following diagram shows the business logic of the application. The diagram does not show all of the classes but the most important ones.



TestManager
+ testCases: List<TestCase>
+ run()
WriterWrapper
+
+ writeString(String content, File file): Config
Formatter
+
+ formatResultsAsString(List<TestCase>): String
FileObserver
+
+ checkDirectories(): TestCase
ConfigReader
+
+ readConfig(): Config
ExtractorManager
+ extractorList: List<IExtractor>
+ extractTestCases(List<TestCase>): List<TestCase>
AnalyzerManager
+ analyserList: List<IAnalyser>
+ analyseTestCases(List<TestCase>): List<TestCase>
StringReader
+
+ reaString(String path): String
<<Interface>>
IExtractor
+ extractText(String content): String
+ extractBlocks(String content): List<Block>
<<Interface>>
IAnalyzer
+ analyseData(TestCase testCase): TestCase
FileReader
+
+ readFiles(String pathDir): List<File>
BoilerpipeExtractor
+ extractorType: ExtractorType
JustextExtractor
+ extractorType: ExtracotrType
WordCounterAnalyzer
+ analyseData(TestCase tc): TestCase
MatchingWordAnalyzer
+ analyseData(TestCase tc): TestCase
1
n



The data model is passed through the business logic and is enriched with data during the test procedure. First the input directories are checked for files by the FileObserver and TestCases are generated for each file pair with the same name. Then all the TestCases are then handed over to the ExtractorManager. The ExtractorManager extracts each TestCase with all available implementations of IExtractor and puts the Results into ExtractionResults. After that, all the TestCases are handed over to the Analyzer which runs each implementation of IAnalyzer. Each IAnalyzer produces at least one Result and puts it into the TestCase. To simplify the diagram, only two Analyzers are drawn. After generating some Results, the Formatter serializes the Result Objects into a String as a CSV table and the WriterWrapper persists the CSV data into an output file.

D.5.1 Description of single classes

Class	**Package**	**Description**
TestManager	testManager	The TestManager class manages the whole business logic that manages TestCase objects through the whole test process from reading the file content to writing the test results into an output file.
FileObserver	reader	The FileObserver class checks the HTML and content directory for files of the same name and creates TestCases from each found pair. The folders are checked with the FileReader class and the content of the files are read with the StringReader class.
StringReader	reader	The StringReader class reads a text file and returns the content as String. The class is made for easier mocking of the BufferedReader so that testing of other classes which are dependent on external files becomes much easier.
FileReader	reader	The FileReader class returns a File objects for each found file in a directory given by a parameter.
ExtractorManager	classifier	The ExtractorManager manages all available Extractors. Each extractor which is used for the actual test must be initialized in this class and added to the ExtractorList. Each TestCase is then extracted by every IExtractor in the ExtractorList.
IExtractor	classifier	The IExtractor is the interface to the different extractor. The interface is very lightweight. The parameter is the text that should be extracted and the return value is the extracted text.
BoilerpipeExtractor	classifier	The BoilerpipeExtractor implements the IExtractor and is the interface to the Boilerpipe package. It handles all dependencies on the Boilerpipe package and returns the extracted content as a string.

JustextExtractor	classifier	The BoilerpipeExtractor implements the IExtractor and is the interface to the Justext python program. The Java ProcessBuilder is used to create operating processes. One can then perform operating system commands and run the python script. The python script creates a text file with the extracted content which is read by the JustextExtractor class and returned as String.
AnalyzerManager	analyzer	The AnalyzerManager manages all available analyzers. Each analyzer which is used for the actual test must be initialized in this class and added to the AnalyzerList. Each TestCase is then analyzed by every IAnalyzer in the AnalyzerList.
IAnalyzer	analyzer	The IAnalyzer interface is a simple interface to the different analyzers. Each analyzer can generate one or more Result objects.
WordCounterAnalyzer	analyzer	The WordCounterAnalyzer is a simple analyzer which counts all words of the content file, the HTML file and each extracted content.
MatchingWordAnalyzer	analyzer	The MatchingWordAnalyzer compares the content file with each extracted content and calculates the values for true positive, true negative, false positive and false negative.
Formatter	writer	The Formatter class formats a string from all TestCase objects as a CSV file structure. This means that a table with the Result keys as table header for each column is created. For each TestCase a row with the Result value field as values is added to the table. The outcome is a CSV file which can easily be imported into another program such as Excel so that one can work with the data.

WriterWrapper	writer	The writer wrapper writes a string into a text file. It is used to wrap the BufferedWriter so that mocking and testing of dependent classes is easier.
ConfigReader	reader	The ConfigReader class reads the config.txt file and puts the key value pairs into a HashMap.

D.6 Development view

This chapter describes the used frameworks and tools which are used during the development process.

D.6.1 git

Git is a distributed version control system. Unlike other version control systems like Subversion, git is not using a central server but each user has his own copy with the complete history on the local system. It is much easier to work with additional branches or tags. Because of these advantages and because Layzapp is working with it as well, git was chosen to use for this project for the code sources and as well for the documentation. The resources are open source and are available under following links.

- code: `https://github.com/heya87/pawiTwo`
- documentation: `https://github.com/heya87/pawi_doc`

D.6.2 Gradle

Gradle is a project automation tool which uses a Groovy-based domain-specific language (DSL) instead of the more traditional XML form of declaring the project configuration. All the dependencies of the project are handled with Gradle and it is very easy to deploy on a new system. The user only needs to download the git repository and can build the project with the Gradle wrapper without installing any new software. All dependencies are then downloaded automatically and the user can start working without caring about missing packages. The build process is defined in the build.gradle file which is located in the source directory of the project.

D.6.3 Travic CI

Travic CI is an open source build server. It is easy to use in combination with git. One only needs to add a config file in the source directory of the project and define the git repository. Afterwards the project is build for every change. If the build does not pass, a mail is sent to the user. The actual status of the build can be found under following link https://travis-ci.org/heya87/pawiTwo.

D.6.4 Justext

An implementation of the Justext algorithm is available in Python. The ressources are available under following link https://code.google.com/p/justext/. There is no implementation in Java so for the first approach the python application is called from Java with a ProcessBuilder. The command to extract an HTML file with justext is very simple:

```
justext -s English /path/page.html > cleaned-page.txt
```

This command extracts the HTMl file page.html into a text file called cleaned-page.txt. The Java ProcessBuilder performs system commands as they are used in a console and can handle the outcome if needed. For the project there is no return values needed. The needed content is the generated text file which is then read and processed for further use.

D.6.5 Boilerpipe

An implementation of the Boilerpipe Algorithm is available in Java. The resources are available under following link https://code.google.com/p/boilerpipe/. This algorithm can be used out of the box with calls against the Java API.

D.7 Process view

D.8 Physical view

Appendix E

MS1 meeting report

E.1 Introduction

This document is a short report about the MS1 meeting. The meeting took place on the 1.10.2014.

E.2 Version

Version	Date	Change	Author
1.0	1.10.2014	Setup document / text	JR
1.1	22.10.2014	forgot Manu!! / grammar / rework	JR

E.3 Attendees

- Joel Rolli
- Michael Kaufmann
- Patrick Huber
- Patrik Lengacher
- Manuel Schneider

E.4 Delivery objects

- System specification

- Sketch software architecture
- Short presentation CI environment
- Draft risk evaluation

E.5 Decisions

The risk evaluation and the CI environment are approved. The evaluation of the text extraction was discussed again and it was decided that the evaluation is still done with Words instead of HTML blocks. Doing the evaluation with HTML blocks can still be done but is not part of the PAWI project and would be bonus content. Furthermore it was decided that no handmade test data is needed and the data from cleanEval and Gold standard are used for this project. The draft of the software architecture is ok but needs to be digitalized. The software architecture needs to be extended with additional data about the analysis of the extracted data. Which means all the formula for TN, FP, TP, FN etc. needs to be defined.

E.6 Rework

Following rework needs to be done until the 5.10.2014

- Extended software specification
- Digital version of software architecture sketch

Update: The listed delivery objects were delivered and approved on the 5.10.2014.

Appendix F

MS2 meeting report

F.1 Introduction

This document is a short report about the MS1 meeting. The meeting took place on the 24.10.2014.

F.2 Version

Version	Date	Change	Author
0.1	20.10.2014	Setup document	JR
1.0	27.10.2014	add meeting report	JR

F.3 Attendees

- Joel Rolli
- Michael Kaufmann

F.4 Delivery objects

- Elaborated software architecture
- Tested code of test framework (reader / writer)
- Interface definition for justext/boilerplate components
- HTML test data

F.5 Decisions

All delivery objects are approved. We discussed the text comparison and came to a conclusion that I am going to search for diff tool libraries to do the comparison of text files. Mr. Kaufmann sent me some proposal later on.

F.6 Rework

There is no rework to do. The proposed diff tool libraries are

- https://code.google.com/p/google-diff-match-patch/
- https://commons.apache.org/proper/commons-lang/javadocs/api-2.6/org/apache/commons/lang

The next milestone, which is the implementation of the whole test framework and integration of justext and boilerpipe, is already achieved as well. We decided that MS3 is obsolete and we are going to meet again if there are any ambiguity and if there is not, for MS4.