**BrowserMonkey**

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**Low Level Design Document**

v 0.5

**Software House One**

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# Notes

Since the last deliverable, we have moved svn servers to ones hosted at google code. To request admin rights on this project, please email any of the team leaders.

We made this move because of a few problems in the old system which make updating and committing a time consuming process. The old svn directory has been frozen and the new one has all the changes we’ve made to the project from the point we moved over.

<http://code.google.com/p/browsermonkey/>

We have also been forced to make a change in project leader since our previous one was no longer able to stay with us for personal reasons. We lost a member of the QA team on similar grounds as well.

Object diagrams need to be completed

Reflection process needs a bit of re-wording

Follow link sequence diagram need to be rescued from netbeans and inserted

Class Diagram needs some explaining.

# C:\Users\Paul Calcraft\Documents\University\Computer Science\Year 2\Software Engineering\Subversion\Design Team\scratch\Low Level\Images\New\Class Diagram.pngArchitectural Design

Figure : Browser Monkey Class diagram

# Tokeniser & Parser

The tokeniser and the parser are responsible for turning a html document into a set of document nodes which can later be rendered to our surface.

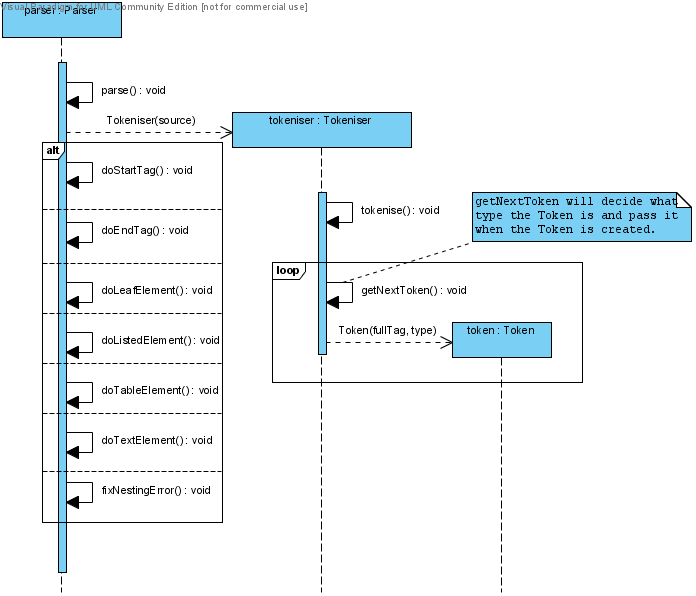


Figure : Parser and Tokeniser Sequence Diagram

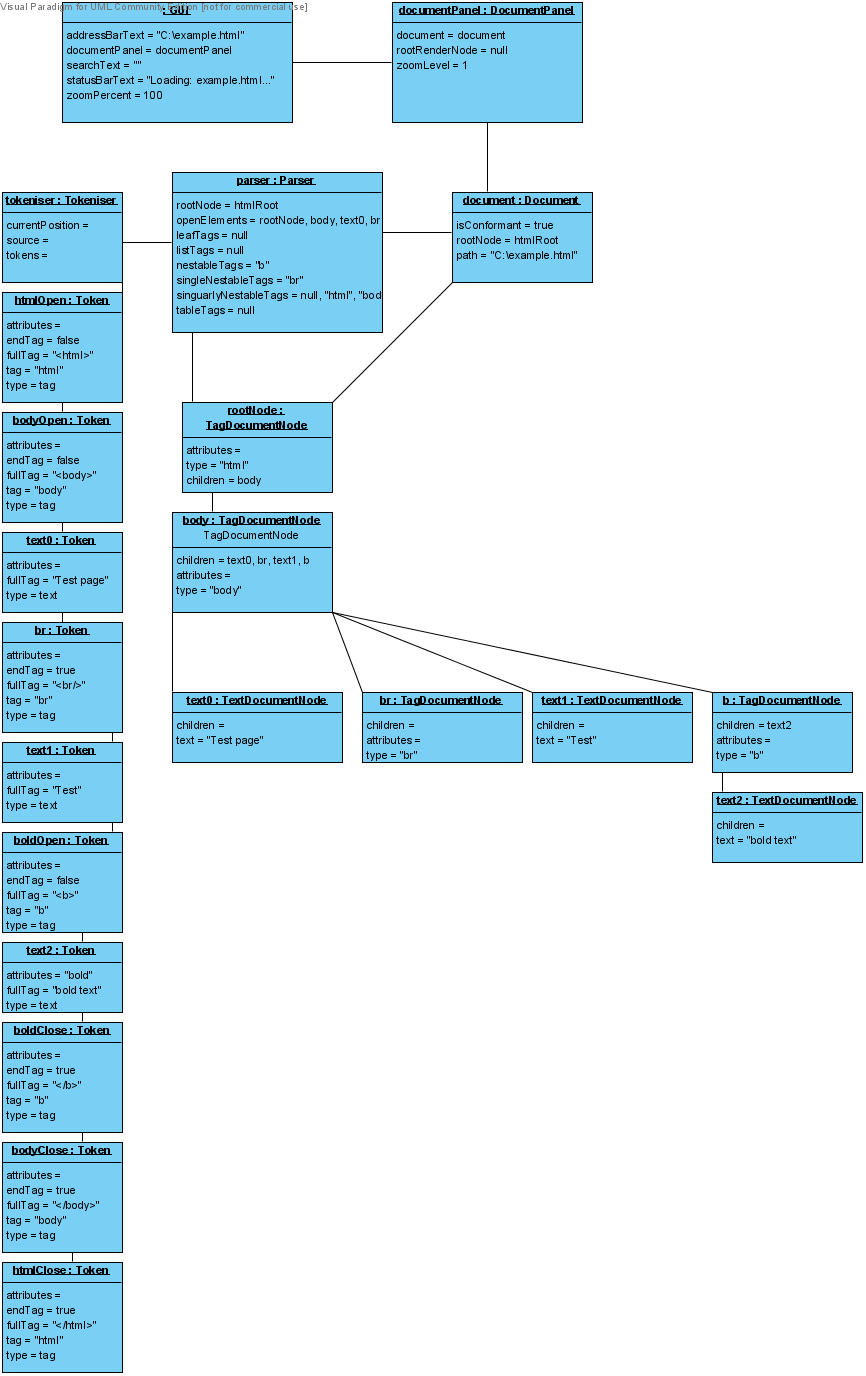


Figure : Parser end state object diagram

## C:\Users\Daniel\Documents\Computer Science\Year 2\Software engeneering\browsermonkey\Design Team\scratch\Low Level\Images\New\Parsing and Tokeniser Start.png

Figure : Parser start state object diagram

## Tokeniser & Tokens

The tokeniser splits up the raw text of the html document into token object. A token object represents an atomic segment of the html. Consider the string “<b>bold</b>”: this would produce three tokens –“<b>”, “bold” and “</b>”.

### Prototype

A prototype tokeniser has been developed, using a scripting language called Ruby, to act as a proof of concept and as near- pseudocode like documentation.

**class** MonkeyTokenizer

#attr\_reader is ruby short hand for a getter method

# so in java we'd write getPage() and getToken

attr\_reader **:**page**,** **:**tokens

#in java this would be the public MonkeyTokenizer(String page){...}

def initialize**(**page**)**

#puts page

@current\_pos **=** 0

@page **=** page**.**to\_s

@tokens **=** Array**.new** #array of MonkeyTokens

tokenize

end

def get\_next\_token

**if** **?<** **==** @page**[**@current\_pos**]** #is **this** a tag

**if** @page**[(**@current\_pos **+** 1**),** 3**]** **==** "!--" #is **this** a comment

#calculate length of token and move token

tag\_token\_end **=** @page**.**index**(**'-->'**,** @current\_pos **+** 1**)**

raise "malformed html" **if** tag\_token\_end **==** nil

@current\_pos **+=** tag**.**length

**else**

#calculate length of token and move pointer - then add to token list

tag\_token\_end **=** @page**.**index**(**'>'**,** @current\_pos **+** 1**)**

raise "malformed html" **if** tag\_token\_end **==** nil

tag **=** @page**[**@current\_pos**...**tag\_token\_end **+** 1**]**

@tokens **<<** MonkeyToken**.new(**tag**,** **:**tag**)**

@current\_pos **+=** tag**.**length

end

**else**

#calculate length of text and move pointer - then add to token list

text\_token\_end **=** @page**.**index**(**'<'**,** @current\_pos**)**

text **=** @page**[**@current\_pos**...**text\_token\_end**]** **if** text\_token\_end **!=** nil

text **=** @page**[**@current\_pos**...**@page**.**length**]** **if** text\_token\_end **==** nil

@tokens **<<** MonkeyToken**.new(**text**,** **:**text**)**

@current\_pos **=** @page**.**length **if** text **==** ""

@current\_pos **+=** text**.**length

end

end

def tokenize

**while** @current\_pos **<** @page**.**length

get\_next\_token

end

end

end

**class** MonkeyToken

attr\_reader **:**full\_tag**,** **:**tag**,** **:**attributes**,** **:**type

def initialize**(**full\_tag**,** type**)**

#@variables are class variables

#<b>

@full\_tag **=** full\_tag

#:text or :tag

@type **=** type

#:foo => "bar"

@attributes **=** Hash**.new**

@end\_tag **=** **false**

# grab the tag name of the tag, if it's text then just keep the whole thing

@tag **=** full\_tag **if** type **==** **:**text

**if** type **==** **:**tag

#regex to get the a in <a href="b">

@tag **=** full\_tag**.**scan**(**/[\w:-]+/**)[**0**]**

**if** @tag**.**nil**?**

raise "Error, tag is nil: #{@full\_tag}"

end

classify\_tag

end

end

def has\_attributes**?**

**return** **!**@attributes**.**empty**?**

end

def is\_end\_tag**?**

**return** @end\_tag

end

def is\_start\_tag**?**

**return** **!**@end\_tag

end

def classify\_tag

#

# <a foo="test" bar="test" >

# produces three results: 1)a 2.1)foo 2.2)test 3.1)bar 3.2)test

#

# This function creates a hash of the attributes of a tag and determines if this tag is an end tag

#

# 'scan' breaks up a string based on a regex, with each group being a new element in an array. Sounds like hassle in java.

atts **=** @full\_tag**.**scan**(**/<[\w:-]+\s+(.\*)>/**)**

attr\_arr **=** atts**[**0**].**to\_s**.**scan**(**/\s\*([\w:-]+)(?:\s\*=\s\*("[^"]\*"|'[^']\*'|([^"'>][^\s>]\*)))?/m**)**

#this is a bit like a for each loop

attr\_arr**.**each **do** **|**n**|**

@attributes**[**n**[**0**].**downcase**]** **=** n**[**1**]**

end

#determine if the tag is an end tag by looking for a / before the tag name ( </b> )

end\_tag **=** @full\_tag**.**index**(**'/'**,** 0**)**

**if** end\_tag **!=** nil

tag\_pos **=** @full\_tag**.**index**(**@tag**,** 0**)**

@end\_tag **=** **true** **if** end\_tag **<** tag\_pos

end

end

end

The tokeniser works by keeping a counter of it’s position in the string to be evaluated then stepping though. If it sees a ‘<’ then it checks forward to the next “>” and assumes that to be a tag type token (unless it’s a comment). It then produces a new token object. A token object is able to be passes a string like “<foo att=’bar’>” and correctly identify that:

1. It’s a start tag
2. It’s a foo tag
3. It has an attribute “att” with the value “bar”

Each token object is kept by the tokeniser in a list. Although not demonstrated in this prototype, the tokeniser must also perform basic syntactic error correction – that is to say that the tokeniser must be able to correct “bad” html where tags are not closed or invalid symbols are present.

## Parser

The parser takes a stream of tokens from the tokeniser and applies a set of rules on those tokens. It then produces a list of DocumentNodes of various types. The parser checks that:

1. Each element is an element type we can render
2. Each element is correctly nested in appropriate elements
3. Each element has valid attributes
4. Each element correctly terminates

It maintains a series of lists which detail elements and how they are to be treated. In the implementation, these lists will be created from a properties file when the parser is created.

The parser is able to correct basic html error, like the incorrect nesting of tags and the improper use of tags. It is however fairly limited and does not always produce the correct output when given extremely poor html.

### Prototype

**class** MonkeyParser

attr\_reader **:**original\_page**,** **:**document\_node

def initialize**(**page**)**

@original\_page **=** page

@tokenizer **=** MonkeyTokenizer**.new** page

@tokens **=** @tokenizer**.**tokens

#define all the tags and their general attributes. In the actual implementation

#this will be populated by a properties file.

#these tags are to demo, and are by no means an exausive list.

@single\_nestable\_tags **=** **[**'html'**,**'head'**,**'body'**]** #tags that can only be used once

@table\_tags **=** **[**'table'**,**'tr'**,**'td'**]** #table tags need a special **case**

@nestable\_tags **=** **[**'b'**,**'i'**,**'strong'**,**'em'**]** #normal**,** nestable**,** tags

@singuarly\_nestable\_tags **=** **[**'p'**]** #these tags cannot be nested inside themselfs

@leaf\_tags **=[**'br'**,**'img'**]** #can have no children

@listed\_tags **=[**'li'**,**'ol'**,**'ul'**]** #list elements also need a special **case**

@open\_elements **=** Array**.new**

end

def parse

@tokens**.**each\_with\_index **do** **|**token**,**i**|**

#add html if needed

**if** i **==** 0 **&&** token**.**tag **!=** "html"

@document\_node **=** MonkeyDocumentNode**.new(**"html"**,** **:**tag**)**

@open\_elements **<<** @document\_node

end

**if** i **==** 0 **&&** token**.**tag **==** "html"

@document\_node **=** MonkeyDocumentNode**.new(**"html"**,** **:**tag**)**

@open\_elements **<<** @document\_node

end

**if** token**.**type **==** **:**tag

**if** token**.**is\_start\_tag**?**

#if it's a table tag or if a row has been opened but not a cell - add the approprate elements

**if** @table\_tags**.**member**?** token**.**tag

do\_table\_element token

elsif @open\_elements**.**length **>=** 1

**if** @open\_elements**.**last**.**tag **==** "tr" **||** @open\_elements**.**last**.**tag **==** "table"

do\_table\_element MonkeyToken**.new** '<td>'**,** **:**tag

end

end

#perform listed tag functions

**if** @listed\_tags**.**member**?** token**.**tag

do\_listed\_element token

end

#pre elements should not have any children, just text

**if** @open\_elements**.**length **>=** 1 **&&** @open\_elements**.**last**.**tag **==** "pre"

@open\_elements**.**last**.**text **=** @open\_elements**.**last**.**text **+** token**.**full\_tag

end

#For singuarly nestetable tags, check if the last tag is the same. If it is

#fix the nesting, if not - carry on.

**if** @singuarly\_nestable\_tags**.**member**?** token**.**tag

**if** @open\_elements**.**length **>** 1 **&&** @open\_elements**.**last**.**tag **==** token**.**tag

do\_end\_token token

end

do\_start\_token token

end

#basic nestable tag

**if** @nestable\_tags**.**member**?** token**.**tag

do\_start\_token token

end

#add the leaf tag

**if** @leaf\_tags**.**member**?** token**.**tag

do\_leaf\_element token

end

**else**

#close and remove the token

do\_end\_token token

end

**else**

#add a text element - but not without checking the state of the tables.

**if** @open\_elements**.**length **>=** 1

**if** @open\_elements**.**last**.**tag **==** "tr" **||** @open\_elements**.**last**.**tag **==** "table"

do\_table\_element MonkeyToken**.new** '<td>'**,** **:**tag

end

end

do\_text\_element token

end

end

end

#Does a standard list. If the user chooses to not close li tags then it assumes that the next li

#signifies the start of the tag. Also, if no list type is given, it defaults to ul

def do\_listed\_element token

**if** token**.**tag **==** 'li'

**if** @open\_elements**.**length **>=** 1

**if** @open\_elements**[-**1**].**tag **==** "ol" **||** @open\_elements**[-**1**].**tag **==** "ul"

do\_start\_token token

elsif @open\_elements**[-**1**].**tag **==** "li"

do\_end\_token @open\_elements**[-**1**]**

do\_start\_token token

**else**

do\_listed\_element MonkeyToken**.new** '<ul>'**,** **:**tag

do\_start\_token token

end

**else**

do\_table\_token MonkeyToken**.new** '<ul>'**,** **:**tag

do\_start\_token token

end

elsif token**.**tag **==** 'ol' **||** token**.**tag **==** 'ul'

do\_start\_token token

end

end

#ensures that tables are properly nested.

def do\_table\_element token

**if** token**.**tag **==** 'td'

**if** @open\_elements**.**length **>=** 1

**if** @open\_elements**[-**1**].**tag **==** "tr"

do\_start\_token token

**else**

do\_table\_element MonkeyToken**.new** '<tr>'**,** **:**tag

do\_start\_token token

end

**else**

do\_table\_token MonkeyToken**.new** '<tr>'**,** **:**tag

do\_start\_token token

end

elsif token**.**tag **==** 'tr'

**if** @open\_elements**.**length **>=** 1

**if** @open\_elements**[-**1**].**tag **==** "table"

do\_start\_token token

**else**

do\_table\_element MonkeyToken**.new** '<table>'**,** **:**tag

do\_start\_token token

end

**else**

do\_table\_element MonkeyToken**.new** '<table>'**,** **:**tag

do\_start\_token token

end

elsif token**.**tag **==** "table"

do\_start\_token token

end

end

def do\_leaf\_element token

@open\_elements**.**last **<<** MonkeyDocumentNode**.new(**token**.**tag**,** token**.**type**,** token**.**attributes**)**

end

def do\_text\_element token

do\_leaf\_element token

end

def fix\_nesting\_error token

@open\_elements**.**reverse\_each **do** **|**element**|**

**if** element**.**tag **==** token**.**tag

@open\_elements**.delete** element

**break**

end

end

end

def do\_end\_token token

**if** token**.**tag **==** @open\_elements**.**last**.**tag

@open\_elements**.**pop

**else**

fix\_nesting\_error token

end

end

#adds a new standard token onto the last open element and appends a new element onto

#that list

def do\_start\_token token

new\_node **=** MonkeyDocumentNode**.new(**token**.**tag**,** token**.**type**,** token**.**attributes**)**

@open\_elements**.**last **<<** new\_node

@open\_elements **<<** new\_node

@document\_node **<<** @open\_elements**.**first **if** @open\_elements**.**size **==** 1

end

end

**class** MonkeyDocumentNode

#A MonkeyDocumentNode is a node in a tree. It has children and a parent.

#In the implementation, two types of node will exist - tag and text.

#both a getter and a setter

attr\_accessor **:**type**,** **:**tag**,** **:**attributes**,** **:**children

def initialize**(**value**,** type**,** attributes **=** Hash**.new)**

@tag **=** value

@type **=** type

@children **=** Array**.new**

@attributes **=** attributes

end

#aliases for the tag method.

def text

**return** @tag

end

def text**=(**text**)**

@tag **=** text

end

#This allow to add documentnode to the children of a parent node documentnode1 << documentnode2

def **<<(**value**)**

@children **<<** value

**return** value

end

#each provides the standard ruby way of itterating over a collection

#We're traversing the tree recurivly and each time we find an element we yield back to the calling block.

def each

yield value

@children**.**each **do** **|**child\_node**|**

child\_node**.**each **{** **|**e**|** yield e **}**

end

end

#prints as if it was still html

def friendly\_print

**if** @type **==** **:**tag

**return** "<"**+**@tag**+**"/>" **if** @children**.**empty**?**

string **=** "<"**+**@tag**+**">"

@children**.**each **do** **|**n**|**

string **<<** n**.**friendly\_print

end

string **<<** "</"**+**@tag**+**">"

**else**

**return** @tag

end

end

end

## Prototype Testing

In order to informally test the workings of the tokeniser and the parser, a small test suite has been written. The code for this is listed here:

def run\_test page**,** name

puts ""

puts "-------------------------------------------"

puts "Test name: "**+**name

puts "testing with string: "**+**page

puts "testing tokeniser:"

tokenizer **=** MonkeyTokenizer**.new(**page**)**

tokenizer**.**tokens**.**each **do** **|**n**|**

**if** n**.**type **==** **:**tag

string **=** "start\_tag: " **if** n**.**is\_start\_tag**?**

string **=** "end\_tag: " **if** n**.**is\_end\_tag**?**

string **<<** n**.**tag

**if** n**.**has\_attributes**?**

string **<<** " with attributes:"

n**.**attributes**.**each\_pair **{|**key**,** value**|** string **<<** " #{key}=#{value}"**}**

end

puts string

end

puts "text:" **+** n**.**tag **if** n**.**type **==** **:**text

end

puts "testing parser:"

parser **=** MonkeyParser**.new(**page**)**

parser**.**parse

puts parser**.**document\_node**.**friendly\_print

puts "-------------------------------------------"

end

The test will focus on the edge cases of the parser – correcting mistakes in the html.

The tests are defined as so:

run\_test "<b>hello<i>world</i></b>"**,** "Simple"

run\_test "<b>hello<i>world</b></i>"**,** "Incorrect Nesting"

run\_test "<tr>hello</tr>"**,** "Missing table cell"

run\_test "<html><table><td>hello</table></td></html>"**,** "Badly Formed Table"

run\_test "<table><tr>hello<table>world</table></tr></table>"**,**"badly formed and nested tables"

run\_test "<li>hello<li>world"**,** "li shortcut"

run\_test "hello world"**,** "just text"

run\_test "<p>hello<p>world</p></p>"**,** "p nesting"

run\_test "<ol><b>hello</b><li>world</li></ol>"**,** "element inside list"

run\_test "<br>hello</br>"**,** "nest attempt on br"

And the output of this script is as follows:

-------------------------------------------

Test name: Simple

testing with string: <b>hello<i>world</i></b>

testing tokeniser:

start\_tag: b

text:hello

start\_tag: i

text:world

end\_tag: i

end\_tag: b

testing parser:

<html><b>hello<i>world</i></b></html>

-------------------------------------------

-------------------------------------------

Test name: Incorrect Nesting

testing with string: <b>hello<i>world</b></i>

testing tokeniser:

start\_tag: b

text:hello

start\_tag: i

text:world

end\_tag: b

end\_tag: i

testing parser:

<html><b>hello<i>world</i></b></html>

-------------------------------------------

-------------------------------------------

Test name: Missing table cell

testing with string: <tr>hello</tr>

testing tokeniser:

start\_tag: tr

text:hello

end\_tag: tr

testing parser:

<html><table><tr><td>hello</td></tr></table></html>

-------------------------------------------

-------------------------------------------

Test name: Badly Formed Table

testing with string: <html><table><td>hello</table></td></html>

testing tokeniser:

start\_tag: html

start\_tag: table

start\_tag: td

text:hello

end\_tag: table

end\_tag: td

end\_tag: html

testing parser:

<html><table><tr><td>hello</td></tr></table></html>

-------------------------------------------

-------------------------------------------

Test name: badly formed and nested tables

testing with string: <table><tr>hello<table>world</table></tr></table>

testing tokeniser:

start\_tag: table

start\_tag: tr

text:hello

start\_tag: table

text:world

end\_tag: table

end\_tag: tr

end\_tag: table

testing parser:

<html><table><tr><td>hello<table><tr><td>world</td></tr></table></td></tr></table></html>

-------------------------------------------

-------------------------------------------

Test name: li shortcut

testing with string: <li>hello<li>world

testing tokeniser:

start\_tag: li

text:hello

start\_tag: li

text:world

testing parser:

<html><ul><li>hello</li><li>world</li></ul></html>

-------------------------------------------

-------------------------------------------

Test name: just text

testing with string: hello world

testing tokeniser:

text:hello world

testing parser:

<html>hello world</html>

-------------------------------------------

-------------------------------------------

Test name: p nesting

testing with string: <p>hello<p>world</p></p>

testing tokeniser:

start\_tag: p

text:hello

start\_tag: p

text:world

end\_tag: p

end\_tag: p

testing parser:

<html><p>hello</p><p>world</p></html>

-------------------------------------------

-------------------------------------------

Test name: element inside list

testing with string: <ol><b>hello</b><li>world</li></ol>

testing tokeniser:

start\_tag: ol

start\_tag: b

text:hello

end\_tag: b

start\_tag: li

text:world

end\_tag: li

end\_tag: ol

testing parser:

<html><ol><b>hello</b><li>world</li></ol></html>

-------------------------------------------

-------------------------------------------

Test name: nest attempt on br

testing with string: <br>hello</br>

testing tokeniser:

start\_tag: br

text:hello

end\_tag: br

testing parser:

<html><br/>hello</html>

-------------------------------------------

All of these tests test bad data, and as such there is not standard way to know if it the corrections are correct. However, we believe that the parser prototype is able to make a good attempt at invalid code while being compliant on standard code.

# Renderer

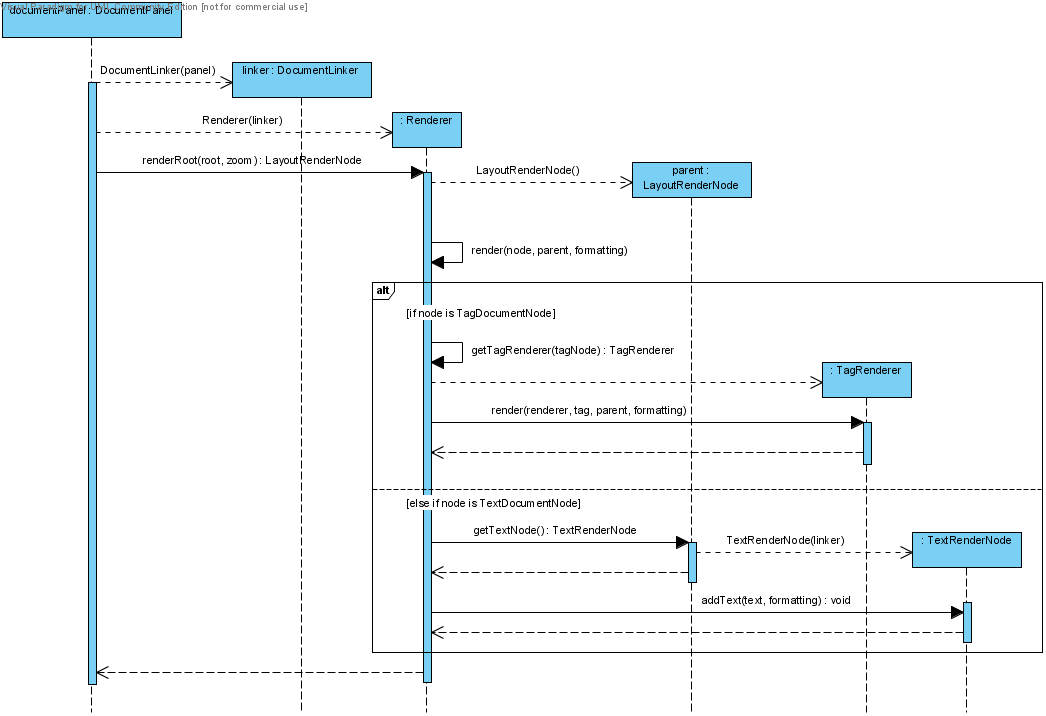


Figure : Rendering the DocumentNode tree in the DocumentPanel

The renderer takes the DocumentNode tree as outputted by the parser, and creates a RenderNode tree.

To demonstrate this process, the following example HTML file has been constructed:

<html>

<body>

Test page<br/>

Test <b>bold text</b>

</body>

</html>

Before the renderer process begins, the state is as follows:

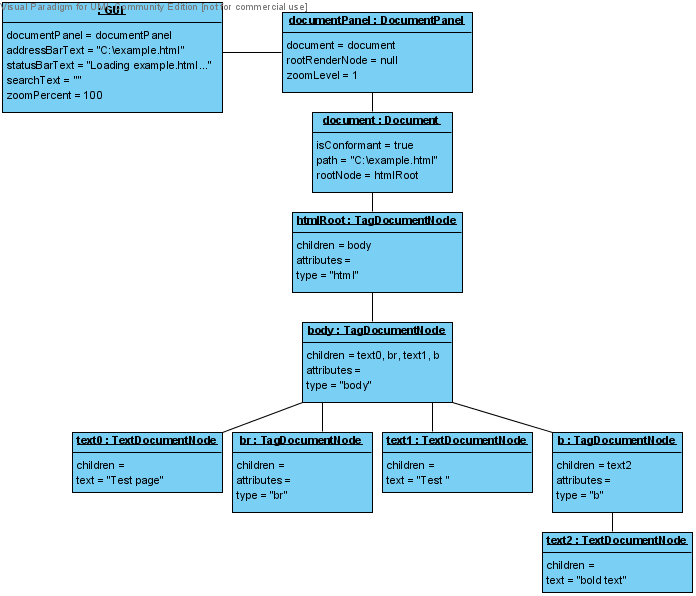


Figure : Renderer Initial Object Diagram

The DocumentPanel contains no rootRenderNode, so at this point no components are visible, and the render tree hasn’t been created. The parser has provided the Document with a DocumentNode tree, the root of which is the html tag, a TagDocumentNode object called htmlRoot.

After the process, the following is the state of the system:

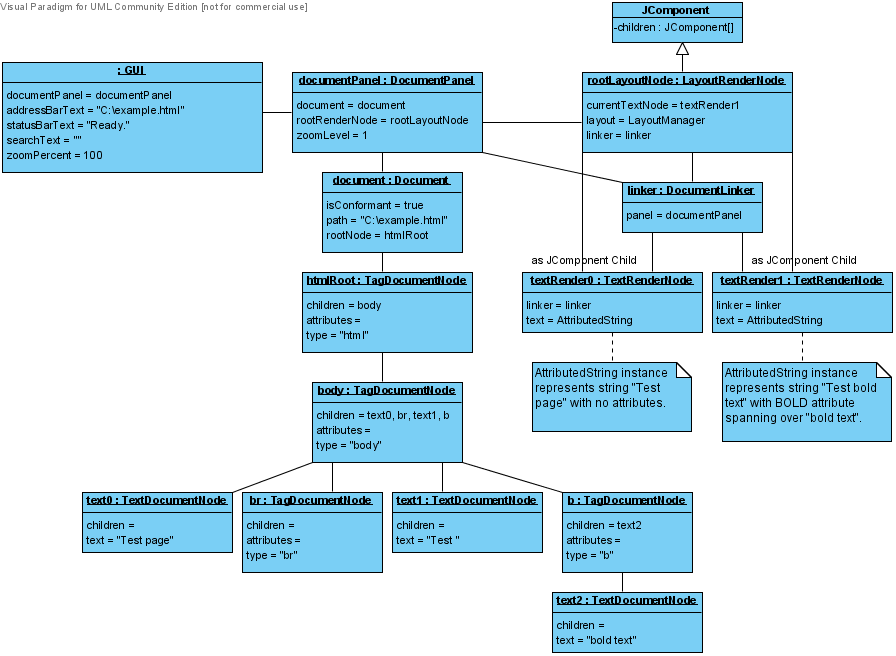


Figure : Renderer Completed Object Diagram

The DocumentPanel now has a root RenderNode which is a LayoutRenderNode containing the two text nodes that comprise the document. The first text node (representing the first line) has the text “Test page” and the second contains “Test bold text” with the BOLD attribute assigned to the range of characters “bold text”.

# Logging

Java provides a built in logging tool which is able to write well formatted and time stamped logs to a file of our choosing. A thin static wrapper called BrowserMonkeyLogger will be produced that will allow the programmer – from anywhere that the utilities classes have been imported – to write to the log at a given level of severity: ranging from info to fatal error.

# Search

Searching is one of the areas where there is some change from the high level design. Due to the built in java API we’re using in the DocumentPanel, which enables highlighting on the view level, there is no longer a need to split up render nodes as we previously thought.

The below sequence diagram illustrates the steps that are required.

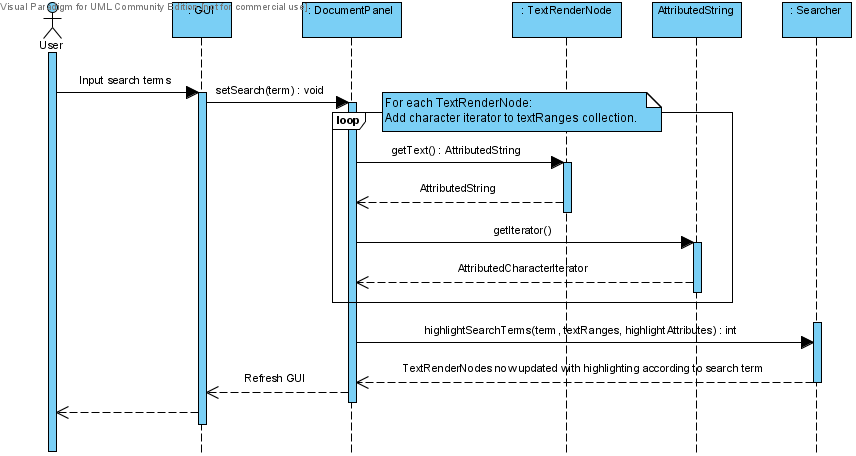


Figure : Search Sequence Diagram

The process of searching loops through all the TextRenderNodes in the Document and adds their AttributedCharacterIterators to an array, textRanges. This array gets passed into the highlightSearchTerms static method, which tries to find instances of the search term (which it can find even if straddling multiple character iterators) and then uses the attributed iterator to add highlighting to the appropriate parts of the strings.

The Object Diagram representing the state of the system before a search can be seen by referring to the Renderer Completed Object Diagram above. It represents the state of all the components as a page is being viewed. The user would then opt to search via the GUI, and the following would be the resulting Object Diagram. This assumes the user has searched for “Test bold”:

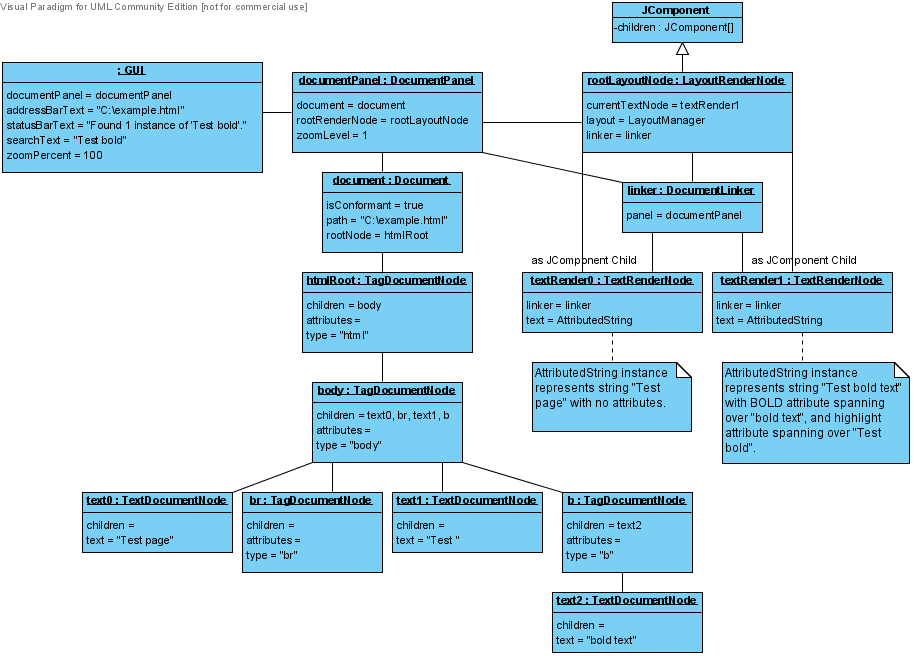


Figure : Search Completed Object Diagram

The second text render node, textRender1, has had its AttributedString updated to add a highlighted range over the characters “Test bold”, and the GUI has updated to reflect the search – the status bar and search text specifically.

# Zoom

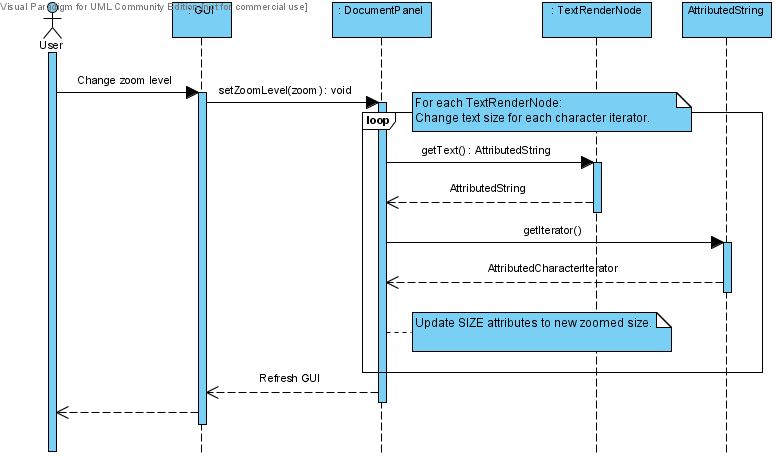


Figure : Zoom Sequence Diagram

Similar to searching, the zoom loops through all TextRenderNodes and scales up the size attributes of the text according to the new zoom level.

The initial Object Diagram for this feature is also the Renderer Completed Object Diagram.

After zooming to a level of 125%, the Object Diagram is the following:

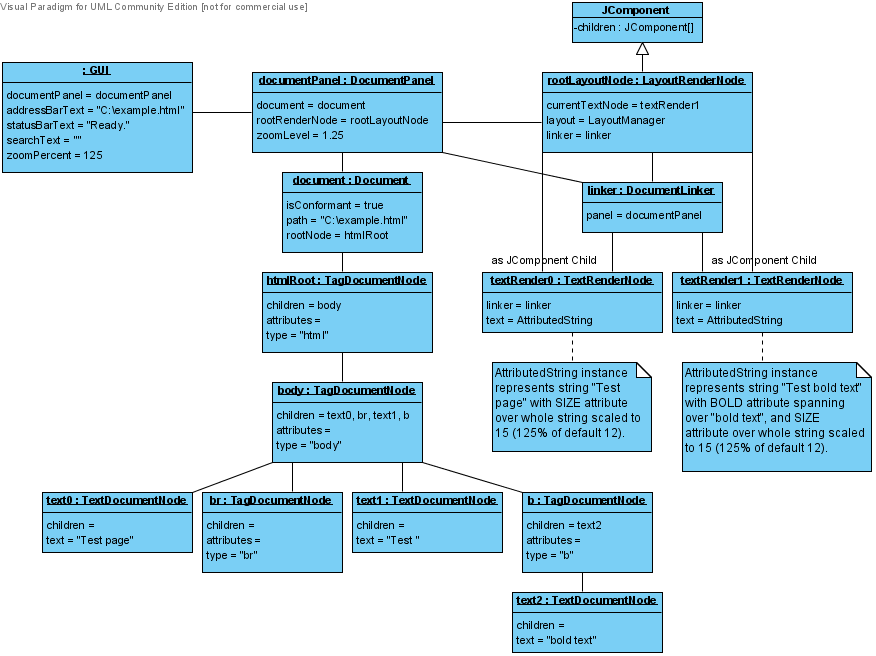
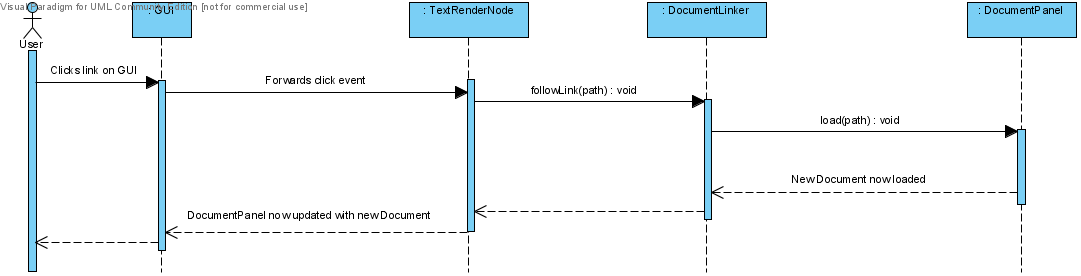


Figure : Zoom Completed Object Diagram

The AttributedStrings in the TextRenderNodes have been updated to reflect the new zoom level. The GUI holds this new zoom value as a percentage, and the DocumentPanel holds it as a floating point scale factor. The way our renderer works uses Swing resizable components, so resizing the text will cause the “preferred size” of that component to increase, and with that any components containing that (e.g. a table cell) will enlarge accordingly. In this way, it allows us to centre the zooming functionality on the text and allow the rest of the page to react correctly without having to write lots of explicit zooming code.

# Follow Link



Follow Link Sequence Diagram

The details of the loading process can be referred to above in the Load Document Sequence Diagram. (The parser/tokeniser sequence diagram should be renamed Load Document and include the user action that intiates it, but then have the renderer process referred to after the DocumentNode tree is created.

The following is a cut down Object Diagram of a document called linkerDocument.html which contains a link to a document named destination.html. For brevity, the detailed document and render trees have been omitted, they would be very similar to those featured in the Renderer Completed Object Diagram.

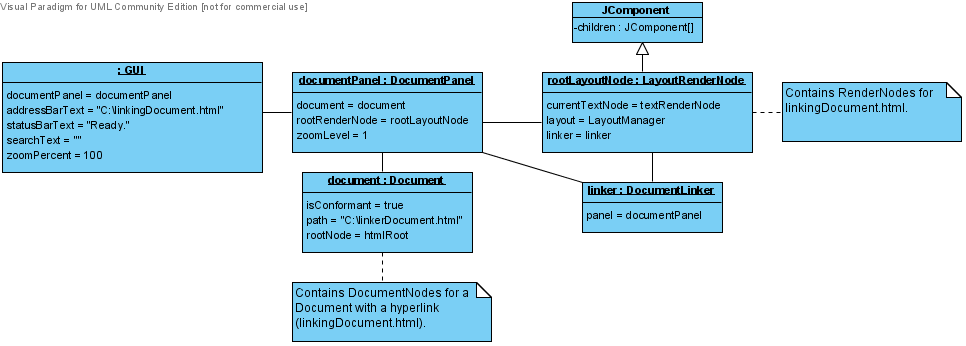


Figure : Follow Link Initial Object Diagram

After a link is clicked, the state of the system would be the following:

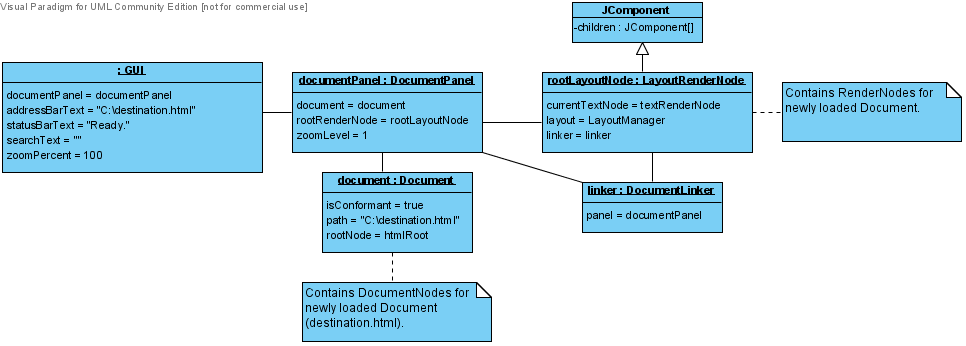


Figure : Follow Link Completed Object Diagram

The new document is now loaded as shown by the GUI with the updated address bar and Document with new path. The Load Document Sequence Diagram shows how the DocumentNodes are created for the new document, and the Renderer Sequence Diagram shows how the RenderNodes are then created.

# Tag Interpretation Using Reflection

The BrowserMonkey program needs to interpret a large number of tags and do this process in a modular way to allow for future usage of the tag handling system. Most importantly this must be done very efficiently. It would be possible create an HTML tag handler by using an enormous if-else statement but this would be hard to debug and horrible to reuse or update (for example to new HTML standards). This is why we have decided to use reflection.

## In Theory

The program can use an external file (such as a config file) that is easily editable to lookup required information for use while the program is running. An alternative way of doing this is having the information in the file loaded into the program when is it initially run. This allows for the addition of useful modular features to a program.

Reflection is the process by which a computer program can observe and modify its own structure and behaviour.

Reflection allows the programmer to use multiple different classes and methods in a generic way, perfect for something like html rendering where you have many different processes used to draw the code. Reflection is also very handy for creating a modular piece of software such as a tag interpreter.

Essentially when you instantiate a class using a reflection method you don’t need to know what the class is or what methods it has, the reflection implementation will have methods that will allow you to grab any methods that class has and invoke the one you need.

## In Java

Now I will give a brief introduction of how these techniques could be implemented in Java. Java has a properties class that can be used to implement this kind of idea. There’s a specific convention to use to create a properties file which can be read by included methods. This will then generate a kind of hash table that can be accessed easily.

### External Files

To access the external file to be read into the properties object:

Code:

Properties properties = new Properties();

properties.load(“<root>:\properties.txt”);

You can then access the properties in this file using a Hash table-like key function:

Code:

String thisPropertyIsSetTo = properties.get(thisProperty);

This Code will find the property key ‘thisProperty’ and set the String thisPropertyIsSetTo to the value stored in the properties file as the value for ‘thisProperty’.

### Reflection

Java has a built in class for handling reflection: java.lang.reflect

Here is some code for a simple example of reflection. Code:

import java.lang.reflect.\*;

public class DumpMethods {

public static void main(String args[])

{

try {

Class c = Class.forName(args[0]);

Method m[] = c.getDeclaredMethods();

for (int i = 0; i < m.length; i++)

System.out.println(m[i].toString());

}

catch (Throwable e) {

System.err.println(e);

}

}

}

This code reads the command line arguments and compares the first argument to all available classes in java if it finds a matching class it will output a toString of each method that class contains. If there is no matching class it will throw an error.

## In BrowserMonkey Browser

To apply the above techniques in the BrowserMonkey Browser we will use a Class for each HTML tag that extends an abstract class called TagRenderer that has a render method which for each different class tag will have code used for rendering the item related to the current tag.

There will be an external file that will be loaded into a Map within the Renderer class during its constructor code. We will then use the map to relate the tag the renderer is looking at to the name of the equivalent mini Tag Class. Next the renderer will use reflection to get the necessary rendering method and pass it the current attributes and variables so that it can build the required component based on the tag.

### Pseudo Code

A simple pseudo code representation of how the above ideas would work within the program:

Each mini Tag Class will have the required render method for the tag they relate to. This will be so because it will implement the TagRenderer abstract class. The render method is called repeatedly and relies on information from the former rendering methods that have been run above it in the document node tree.

The signature for the render method is as follows: render(Renderer renderer, TagDocumentNode tag, LayoutRenderNode parent, Map formatting).

The render method will decide what needs to be done with the tag based on the current formatting provided in the formatting variable.

In the Renderer:

During Constructor:

Map rendererMap = new Map();

properties.load(<root>:\properties.txt)

tags = properties.propertyNames()

for each tag in tags

String tagClass = properties.get(tag)

TagRenderer thisTagRenderer = new Class.forName(tagClass)

rendererMap.add(tag,thisTagRenderer)

The above code builds the renderMap from the properties file when the renderer is first initialised. This allows the renderer to find the TagRenderers later during the rendering process:

During Rendering Process:

Recursively going over each documentNode:

if documentNode is not plain text

currentTagRenderer = rendererMap.get(Tag)

currentTagRenderer.render(documentNode as TagDocumentNode)

Rendering is a recursive process, document nodes will continue render their children.