

### EDA095

## Uniform Resource Locators (URLs) and HTML Pages

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Covers: Chapter 7, pages 184-222, and Chapter 8, pages 248-266, *Java Network Programming*, 3<sup>rd</sup> ed., Elliott Rusty Harold



## Uniform Resource Locators (URL)

A URL is the name of a “resource” on the Internet and an access mode. It goes beyond data that can be exchanged using HTTP. It can extend to FTP, telnet, mail protocols, and many more. In its simplest form, a URL is a string that consists of three parts: `protocol://hostname/path/object`

- The protocol can be `http`, `ftp`, `telnet`, `rmi`, etc.
- The hostname is an Internet address such as `www.cs.lth.se` or `130.235.16.34`
- The path/object corresponds for instance to `/home/pierre/file.html`

URLs are defined by RFC 2396 and RFC 2732.  
(<http://www.rfc-editor.org/rfc/rfc2396.txt>,  
<http://www.rfc-editor.org/rfc/rfc2732.txt>)



## URL (Continued)

Everybody knows what the web is. No need to present it. When it started, it was a combination of three main features:

- A document format in plain text: HTML derived from the older and clumsy SGML
- A communication protocol to transfer data: HTTP
- A way to name and address objects on the network: URLs

We will review ways to handle URLs and HTML directly from Java.

Protocols have a default port.  
The URL can specify a new one:  
`http://www.cs.lth.se:80/EDA095/index.html`  
A URL can be absolute or relative to a base URL  
The link `labs.html` in a document whose URL is  
`http://www.cs.lth.se:80/EDA095/index.html`  
has the URL  
`http://www.cs.lth.se:80/EDA095/labs.html`



## The URL Class

The URL class defines a way to build and parse URL strings

Constructors:

- `URL(String spec)`
- `URL(String protocol, String host, String file)`
- `URL(URL context, String spec)`

The last one creates a URL by parsing the given spec within a specified context.

`http://download.oracle.com/javase/6/docs/api/java/net/URL.html#URL(java.lang.String)`

The constructor throws a `MalformedURLException` if it fails to create the URL



## A First Program Using the URL Class

Creating URLs

The constructor does not check the syntax. See MyDoc3

```
import java.net.*;
public class MyURL {
    public static void main(String[] args) {
        try {
            URL myDoc1 = new URL("http://www.cs.lth.se/index.html");
            URL myDoc2 = new URL("http", "www.cs.lth.se", "/index.html");
            URL myDoc3 = new URL("http", "www.cs.lth.se", "index.html");
            URL myDoc4 = new URL(new URL("http://www.cs.lth.se/EDA095/"),
                                "labs.shtml");
            URL myDoc5 = new URL(new URL("http://www.cs.lth.se/EDA095/"),
                                "labs.shtml");
        } catch (Exception e) { }
    }
} //MyURL.java
```



## Client and Server Communications Using HTTP

The communication between a server and a client in its simplest form starts with a TCP connection from the client to port 80.

Then we have the exchange:

- The client sends a request
- The server sends a response.

Both request and response messages feature a header that consists of parameter-value pairs

In addition:

- The request consists of a command word (HTTP method) to identify the request, parameters, and possibly other data.
- The response consists of a response code and objects to be displayed or rendered by the client



## HTTP Request

The request behind the URL `http://cs.lth.se/pierre_nugues` consists of:

- 1 HTTP method, URL, version  
`GET /pierre_nugues HTTP/1.1`
- 2 Sequence of parameter names (46 types) followed by ':' and values – pairs Name: Value  
`Accept: text/plain`  
...  
`Host: cs.lth.se`  
`User-Agent: Mozilla/4.0`
- 3 Empty line: `\r\n`
- 4 Possibly a message body (data) whose size is given by the Content-Length attribute

RFC 2616 (<http://www.ietf.org/rfc/rfc2616.txt>)



## HTTP Response

Servers send a response: header followed by data

- ❶ Protocol, status code, textual phrase  
HTTP/1.0 200 OK
- ❷ Sequence of parameter names followed by ':' and values  
Date: Wed, 28 Mar 2007 12:12:54 GMT  
Server: Apache/2.0.52 (sparc-sun-solaris2.8)  
...  
Connection: close
- ❸ Empty line: \r\n
- ❹ Data  
<html>  
...  
</html>



## Getting Data from a Server

In its simplest form, the client does not send data

It just requests the content of the URL file

For HTTP, the corresponding methods are GET or POST.

The method is sent automatically by the URL class and is hidden to the programmer.

We will review the steps to get data from simple to more complex

The URL class uses GET by default, hides the header details, and receives data



## Getting Data from a Server

The URL class has methods to open a connection from a URL:

- `InputStream openStream()` //Opens a connection and returns an `InputStream` for reading from that connection.
- `URLConnection openConnection()` //Returns a `URLConnection` object.

The opening methods will connect to the resource using the specified protocol

Once open, the stream can be read and contain data sent by the server

The protocol machinery (http, ftp, etc.) is invisible to the programmer

We will first consider examples with `openStream()`

The combination of the URL constructor and `openStream()` uses the GET method



## Getting Data Using `openStream()`

```
//ViewHTML.java
try {
    URL myDoc = new URL("http://cs.lth.se/");
    InputStream is = myDoc.openStream();
    BufferedReader bReader =
        new BufferedReader(new InputStreamReader(is));
    String line;
    while ((line = bReader.readLine()) != null) {
        System.out.println(line);
    }
} catch (Exception e) {
    e.printStackTrace();
}
```



## Relative URLs

Using the 3rd constructor, we can create URLs relatively to a context (MyURL2.java)

```
URL myDoc1 = new URL("http://www.cs.lth.se/home/index.html");
URL myDoc2 = new URL(myDoc1, "pierre.html");
URL myDoc3 = new URL(myDoc1, "/pierre.html");
URL myDoc4 = new URL(myDoc1, "http://www.lu.se/pierre.html");
URL myDoc5 = new URL(myDoc1, "mailto:pierre@cs.lth.se");
```



## URL Exceptions

The description in the URL class exceptions

*Throws: MalformedURLException – If the string specifies an unknown protocol.*

is not consistent with that of MalformedURLException:

*Thrown to indicate that a malformed URL has occurred. Either no legal protocol could be found in a specification string or the string could not be parsed.*

The URL constructor only checks the protocol.



## Exceptions

```
//MyURL3.java
package url;
import java.net.*;
public class MyURL {
    public static void main(String[] args) {
        try {
            URL myDoc1 = new URL("http://www.cs.lth.se/index.html");
            URL myDoc2 = new URL("http", "www.cs.lth.se", "index.html");
            URL myDoc3 =
                new URL(new URL("http://www.cs.lth.se/EDA095/"),
                    "labs.shtml");
            URL myDoc4 = new URL("http:///www.cs;lth.se\\~/index.html");
        } catch (Exception e) {
            e.printStackTrace();
        }
    }
}
```



## Exceptions II

```
try {
    URL myDoc5 = new URL("http:///www.cs;lth.se\\~/index.html ");
} catch (Exception e) {
    e.printStackTrace();
}
try {
    URL myDoc6 = new URL("http", "www.cs.lth,se", "index.html");
} catch (Exception e) {
    e.printStackTrace();
}
}
```



## Methods of the URL Class

Some useful methods are:

- `String getProtocol()` //Gets the protocol name.
- `String getHost()` //Gets the host name.
- `int getPort()` //Gets the port number.
- `String getPath()` //Gets the path part and the file name.
- `String getFile()` //Gets the path, the file name, and the query if it exists. In fact nearly the same as `getPath()`, see documentation



## Using URL Methods

```
//myURL4.java
URL myDoc1 = new URL("http://www.cs.lth.se/index.html");
URL myDoc2 = new URL("http", "www.cs.lth.se", "/index.html");
URL myDoc3 = new URL("http:///www.cs;lth.se\\~/index.html");
System.out.println("Protocols: " + myDoc2.getProtocol() + " " +
    myDoc3.getProtocol());
System.out.println("Files: " + myDoc2.getFile() + " " +
    myDoc3.getFile());
System.out.println("Ports: " + myDoc2.getPort() + " " +
    myDoc3.getPort());
System.out.println("Hosts: " + myDoc2.getHost() + " " +
    myDoc3.getHost());
```



## Testing Available Protocols

Using the URL class, can we find protocols supported by a machine

Idea: Create a set of URL objects and call `getProtocol()`

Try: `http`, `https`, `ftp`, `tftp`, `mailto`, `telnet`, `file`, `gopher`, `ladp`, `jar`, `nfs`, `jdbc`, `rmi`, etc.

and catch the errors...

This is the idea of `ProtocolTester.java`, Elliotte Rusty Harold, *Java Network Programming*, page 186.

The code available here:

<http://www.cafeaulait.org/books/jnp3/examples/index.html>



## Uniform Resource Identifiers (URI)

URIs are name conventions close to URLs (RFC 2396)

`[scheme:]scheme-specific-part[#fragment]`

However, URIs do not provide a method to access a network resource.

URIs can be absolute (with a scheme) or relative (without a scheme)

URIs can also be:

- Opaque: The scheme-specific part does not begin with a `/`. They are not parsed as: `mailto:java-net@java.sun.com`, `news:comp.lang.java`, `urn:isbn:096139210x`
- Hierarchical: They are absolute and begin with a `/` or they are relative and have no scheme as: `http://java.sun.com/j2se/1.3/` or `docs/guide/collections/designfaq.html#28`



## Parsing a URI

A hierarchical URI is parsed according to the syntax

```
[scheme:] [//authority] [path] [?query] [#fragment]
```

If the authority is a server, its syntax is:

```
[user-info@]host[:port]
```

The user info can consist of a user name and a password,  
anonymous:pierre@cs.lth.se on an anonymous ftp server



## URI Methods

The Java implementation of the URI class is more conformant than the URL one.

The URI class has methods to build a URI from its components.

Constructors:

- URI(String str)
- URI(String scheme, String ssp, String fragment)
- URI(String scheme, String userInfo, String host, int port, String path, String query, String fragment)

It has Booleans to determine whether it is:

- opaque or hierarchical, isOpaque()
- relative or absolute, isAbsolute()



## URI Methods

The URI class has methods to parse a string (a hierarchical URI):

```
[scheme:] [//authority] [path] [?query] [#fragment]
```

- String getScheme()
- String getAuthority()
- String getPath()
- String getQuery()
- String getFragment()
- URI parseServerAuthority(), parses the authority,  
(String getUserInfo(), String getHost(), int getPort())

URISplitter.java from Elliott Rusty Harold, Java Network Programming  
page 218.

```
java url.URISplitter http://www.cs.lth.se:80/pierre/index.htm
```



## Sending Data from the HTTP Client

Clients can send data to HTTP servers using a list of parameter-value pairs:

- book=Java Network Programming
- author=Harold

This is used when you fill in HTML forms, for instance  
GET and POST are the two methods to carry this out

We review GET now



## Sending Parameters with GET

GET sends the list of parameter-value pairs in the URL in the query part:

```
[scheme:] [//authority] [path] [?query] [#fragment]
```

The parameter list must comply with a specific format and encoding for the accents:

```
Arg1=Value1&Arg2=Value2
```

as in

```
book=Java+Network+Programming&author=Harold
```

The preferred encoding is UTF8

The `URLEncoder` class carries this out with the method:

```
static String encode(String s, String enc)
```



## HTML Forms

Web clients send data to servers using HTML forms

Forms define the possible parameters that will be filled by the user with values

Input components are defined by `<input>` elements with a type attribute. Possible types are hidden, text (default), radio, scroll down menus, submit buttons, reset, etc.

Data in the form of pairs (parameter name, value) are sent using GET and POST methods.

GET uses the URL string to send the parameters

POST sends a MIME message



## Example of Search Box

The course home page: <http://www.eit.lth.se/>, contains an input box:

```
<input name="search" type="hidden" value="1" />
<input name="L" type="hidden" value="0" />
<input name="q" type="text" value="" class="field" />&nbsp;
<input name="start" type="hidden" value="1" />
<input name="no_cache" type="hidden" value="1" />
<input name="x" type="submit" value="Sök" class="button" />
<input type="hidden" name="category" value="" />
</form>
```



## Queries

The query Nugues to the course home page is a sequence of pairs (name, value)

```
http://www.eit.lth.se/index.php?search=1&L=0&q=Nugues&
start=1&no_cache=1&x=S%F6k&category=
```

URISplitter extracts the query:

```
search=1&L=0&q=Nugues&start=1&no_cache=1&x=S%F6k&category=
```

We can create a GET request using the URL constructor and send it to LTH using `openStream()`

POST would send

Content-Type: application/x-www-form-urlencoded

Content-Length: 42

Connection: close

```
s=1&so=1&i=sv&category=cs&q=nugues&x=S%F6k
```





## Encoding Characters in URLs

Some characters are encoded like *Sök* in our example

From the Java specifications:

- The alphanumeric characters a through z, A through Z and 0 through 9 remain the same.
- The special characters ., -, \*, and \_ remain the same.
- The space character ' ' is converted into a plus sign +.
- All other characters are unsafe and are first converted into one or more bytes using some encoding scheme. Then each byte is represented by the 3-character string %xy, where xy is the two-digit hexadecimal representation of the byte. The recommended encoding scheme to use is UTF-8.

You have to encode the string explicitly with UTF-8

We will review UTF-8 and other types of encoding in a next lecture



## Encoding Strings

To demonstrate `URLEncoder`, we will use the program `EncodeTest.java` from Elliotte Rusty Harold, *Java Network Programming*, page 210.

We call:

```
URLEncoder.encode("Sök", "UTF-8");  
URLEncoder.encode("Sök", "ISO-8859-1");  
URLEncoder.encode("This string has spaces", "UTF-8");
```

In the textbook, there is a mistake with the encoding option of `javac`. It assumes that the editor saves the program in UTF-8.

Thus is not always the case. Many editors use the machine's encoding, MacRoman on a Mac, Latin 1 on Linux...

Use:

```
pierre% javac -encoding UTF8 url/EncodeTest.java
```

only if your program has been saved with UTF 8.



## URL Decoders

`URLDecoder` decodes a string encoded using UTF-8 in the machine's encoding

It has one method:

```
static String decode(String s, String enc)
```

You have to decode the string explicitly with UTF-8

```
System.out.println(URLDecoder.decode("S%C3%B6k", "UTF-8"));  
System.out.println(URLDecoder.decode("S%F6k", "ISO-8859-1"));  
System.out.println(URLDecoder.decode("S%C3%B6k", "ISO-8859-1");  
System.out.println(URLDecoder.decode("S%F6k", "UTF-8"));
```

(`DecodeTest.java`)



## HTML

HTML is the page description language used by the web.

Derives from SGML

Very messy:

- Sloppy syntax
- Many versions, many flavors

There are tons of sites where to learn it

We will review basic Java tools to analyze HTML pages to display and parse HTML





## Displaying HTML Tags

Most Swing components understand HTML tags as JLabel:

```
public class SimpleGUI {
    public static void main(String[] args) {
        JFrame frame = new JFrame();
        JLabel label = new JLabel("<html>
            <p>Hello! This is a multiline label with <b>bold</b>
            and <i>italic</i> text<hr></p></html>");
        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        frame.getContentPane().add(label);
        frame.setSize(300, 300);
        frame.setVisible(true);
    }
} // SimpleGUI.java
```



## Displaying HTML Pages: JEditorPane

```
public static void main(String[] args) {
    JFrame f = new JFrame("LTH");
    f.setDefaultCloseOperation(WindowConstants.DISPOSE_ON_CLOSE);
    JEditorPane jep = new JEditorPane();
    jep.setEditable(false);
    try {
        jep.setPage("http://cs.lth.se");
    } catch (IOException ex) {
        jep.setContentType("text/html");
        jep.setText("<html>Could not load http://? </html>");
    }
    JScrollPane scrollPane = new JScrollPane(jep);
    f.setContentPane(scrollPane);
    f.setSize(512, 342);
    f.setVisible(true);
} //LTHHomePage.java
```



## Parsing HTML Pages

Java has a class to implement a primitive HTML parser:  
HTMLToolkit.Parser in the javax.swing.html.text package  
It is an inner class of HTMLToolkit  
Parser is an abstract class that is instantiated using an obscure and complex sequence of operations. See textbook, page 248.  
The code is idiosyncratic: hardwired and impossible to explain  
We get the parser using the getParser() method that needs to be made public



## Making getParser() Public

*Java Network Programming*, chapter 8, page 250

```
import javax.swing.text.html.*;

public class ParserGetter extends HTMLToolkit {
    // purely to make this method public
    public HTMLToolkit.Parser getParser(){
        return super.getParser();
    }
}
```

We can then parse a page using the HTMLToolkit.Parser method:

```
parse(Reader r, HTMLToolkit.ParserCallback cb,
      boolean ignoreCharset)
```

cb uses the parsing results and reacts to HTML tags, text, or comments



## Parsing HTML

You create an event-driven HTML analyzer using the class `HTMLToolkit.ParserCallback` where you overload the undocumented methods you need:

```
void handleText(char[] data, int pos) //TagStripper.java
void handleStartTag(HTML.Tag t, MutableAttributeSet a,
    int pos)
void handleEndTag(HTML.Tag t, int pos)
void handleSimpleTag(HTML.Tag t, MutableAttributeSet a,
    int pos)
void handleComment(char[] data, int pos)
void handleEndOfLineString(String eol)
void handleError(String errorMsg, int pos)
```



## Printing the Text of a Web Page

`TagStripper.java` by Elliott Rusty Harold, *Java Network Programming*, page 251.

```
public class TagStripper extends HTMLToolkit.ParserCallback
{
    private Writer out;
    public TagStripper(Writer out) {
        this.out = out;
    }
    public void handleText(char[] text, int position) {
        try {
            out.write(text);
            out.flush();
        } catch (IOException ex) {
            System.err.println(ex);
        }
    }
}
```



## Printing the Text of a Web Page

```
public static void main(String[] args) {
    ParserGetter kit = new ParserGetter();
    HTMLToolkit.Parser parser = kit.getParser();
    HTMLToolkit.ParserCallback callback =
        new TagStripper(new OutputStreamWriter(System.out));
    try {
        URL url = new URL("http://cs.lth.se/EDA095/");
        InputStream in =
            new BufferedInputStream(url.openStream());
        InputStreamReader r = new InputStreamReader(in);
        parser.parse(r, callback, true);
    } catch (IOException ex) {
        ex.printStackTrace();
        System.err.println(ex);
    }
}
```



## Parsing Tags

HTML tags:

```
static HTML.Tag.A
static HTML.Tag.ADDRESS
static HTML.Tag.APPLET
static HTML.Tag.AREA
static HTML.Tag.B
static HTML.Tag.H1
```

etc.

Formatting instructions:

```
boolean breaksFlow()
boolean isBlock()
boolean isPreformatted()
```



## Outlining the Titles of a Web Page

The HTML source:

```
<h1>Text header 1</h1>
<h2>Text header 21</h2>
<h3>Text header 3</h3>
<h2>Text header 21</h2>
```

will be displayed as:

```
Text header 1
  Text header 21
    Text header 3
  Text header 21
```



## Outlining the Titles of a Web Page

```
public class OutlinerSimple extends HTMLEditorKit.
    ParserCallback {
    private Writer out;
    private boolean inHeader = false;
    private int level = 0;
    public void handleStartTag(HTML.Tag tag,
        MutableAttributeSet attributes, int position) {
        if (tag == HTML.Tag.H1 || tag == HTML.Tag.H2 ||
            tag == HTML.Tag.H3 || tag == HTML.Tag.H4) {
            inHeader = true;
            if (tag == HTML.Tag.H1) level = 1;
            if (tag == HTML.Tag.H2) level = 2;
            if (tag == HTML.Tag.H3) level = 3;
            if (tag == HTML.Tag.H4) level = 4;
        }
    }
}
```



## Outlining the Titles of a Web Page

```
public void handleEndTag(HTML.Tag tag, int position) {
    if (tag == HTML.Tag.H1 || tag == HTML.Tag.H2 ||
        tag == HTML.Tag.H3 || tag == HTML.Tag.H4) {
        inHeader = false;
        level = 0;
    }
}

public void handleText(char[] text, int position) {
    if (inHeader == true) {
        if (level == 2) System.out.print("\t");
        if (level == 3) System.out.print("\t\t");
        if (level == 4) System.out.print("\t\t\t");
        System.out.println(text);
    }
}
```



## Outlining the Titles of a Web Page

```
public static void main(String[] args) {
    ParserGetter kit = new ParserGetter();
    HTMLEditorKit.Parser parser = kit.getParser();
    HTMLEditorKit.ParserCallback callback =
        new OutlinerSimple();
    try {
        URL url = new URL("http://cs.lth.se/EDA095/");
        InputStream in =
            new BufferedInputStream(url.openStream());
        InputStreamReader r = new InputStreamReader(in);
        parser.parse(r, callback, true);
    } catch (IOException ex) {
        ex.printStackTrace();
        System.err.println(ex);
    }
}

} // OutlinerSimple.java
```



## Printing the Links of a Web Page

HTML links have the form:

```
<a href="blackhole.html">click me!</a>
```

where

- A is called the tag or element in XML
- HREF is an attribute: `HTML.Attribute.HREF`

HTML frames have the form: `<frame src="myframe.html"/>`

HTML images have the form: ``

To build absolute URLs from relative URLs, we extract the BASE tag from the current web page and its HREF attribute, if it exists, as in

```
<base href="http://cs.lth.se/" />
```

otherwise we use the address of the page.



## Printing the Links of a Web Page

We extract them using the code:

```
public void handleStartTag(HTML.Tag tag,
    MutableAttributeSet a, int position) {
    if(tag == HTML.Tag.A) {
        String href = (String)
            a.getAttribute(HTML.Attribute.HREF);
        System.out.println("Link: " + href);
    }
    if(tag == HTML.Tag.FRAME) {
        String href = (String) a.getAttribute(HTML.Attribute.SRC);
        System.out.println("Frame: " + href);
    }
}
```



## Printing the Links of a Web Page

```
public void handleSimpleTag(HTML.Tag t,
    MutableAttributeSet a, int pos) {
    if (tag == HTML.Tag.BASE) {
        String href =
            (String) attributes.getAttribute(HTML.Attribute.HREF);
        baseUrl = href;
        System.out.println("Base URL: " + href);
    }
    if(t == HTML.Tag.IMG) {
        String href = (String) a.getAttribute(HTML.Attribute.SRC);
        System.out.println("Image: " + href);
    }
} // LinkGetter.java
```



## Absolute Links

Some links are absolute, while others are relative.

We can use this piece of code to create absolute links in `handleStartTag()`:

```
try {
    if (!new URI(href).isAbsolute()) {
        System.out.println(
            "\tAbsolute link: " + new URL(new URL(baseUrl), href));
    }
} catch (Exception e) { }

or just

new URL(new URL(baseUrl), href)
```

