Unit 3:
URLs and URIs

By

Khushbu Kumari Sarraf

EMBA,BE

URL

- A URL (Uniform Resource Locator) is a unique identifier used to locate a resource on the Internet. It is also referred to as a web address. URLs consist of multiple parts -- including a protocol and domain name -- that tell a web browser how and where to retrieve a resource.
- In theory, each valid URL points to a unique resource. Such resources can be an HTML page, a CSS document, an image, etc. In practice, there are some exceptions, the most common being a URL pointing to a resource that no longer exists or that has moved.

URL

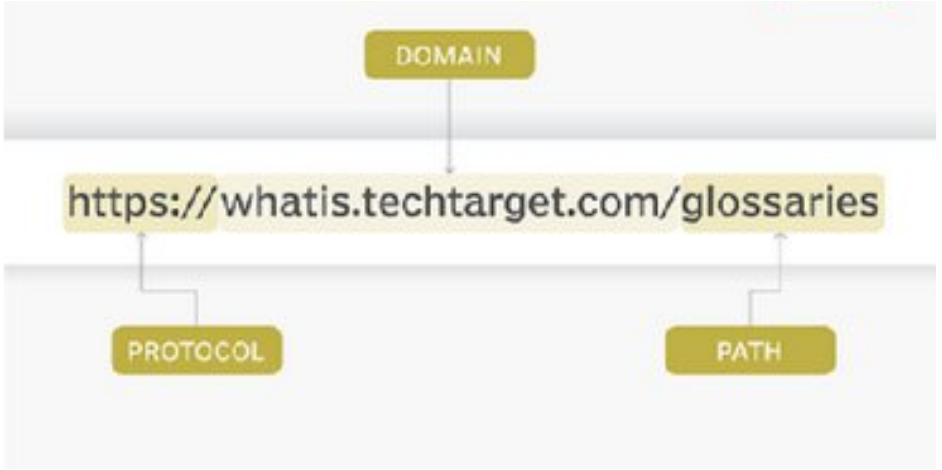
- The URL contains the name of the protocol needed to access a resource, as well as a resource name. The first part of a URL identifies what protocol to use as the primary access medium. The second part identifies the IP address or domain name -- and possibly subdomain -- where the resource is located.
- URL protocols include HTTP (Hypertext Transfer Protocol) and HTTPS (HTTP Secure) for web resources, mail to for email addresses, FTP for files on a File Transfer Protocol (FTP) server, and telnet for a session to access remote computers. Most URL protocols are followed by a colon and two forward slashes; "mail to" is followed only by a colon.
    - Optionally, after the domain, a URL can also specify:
    - a path to a specific page or file within a domain;
    - a network port to use to make the connection;
    - a specific reference point within a file, such as a named anchor in an HTML file; and
    - a query or search parameters used -- commonly found in URLs for search results.

URL

- **Importance of a URL design**
  - URLs can only be sent over the Internet using the ASCII character-set. Because URLs often contain non-ASCII characters, the URL must be converted into a valid ASCII format. URL encoding replaces unsafe ASCII characters with a "%" followed by two hexadecimal digits. URLs cannot contain spaces.
- **URL examples**
  - When designing URLs, there are different theories about how to make the syntax most usable for readers and archivists. For example, in the URL's path, dates, authors, and topics can be included in a section referred to as the "slug." Consider, for example, the URL for this definition:
  - ***https://www.techtarget.com/searchnetworking/definition/URL***

URL

- **Basic Structure of URL**



- Look past the protocol (identified as HTTPS) and the permalink (www.techtarget.com) and we see the file path includes two paths (searchnetworking and definition) and the title of the definition (URL).
- Additionally, some URL designers choose to put the date of the post, typically, as (YYYY/MM/DD).

Parts of URL

- Using the URL **https://whatis.techtarget.com/search/query?q=URL** as an example, components of a URL can include:
- **The protocol or scheme.** Used to access a resource on the internet. Protocols include http, https, ftps, mailto and file. The resource is reached through the domain name system (DNS) name. In this example, the protocol is https.
- **Host name or domain name.** The unique reference the represents a webpage. For this example, whatis.techtarget.com.
- **Port name.** Usually not visible in URLs, but necessary. Always following a colon, port 80 is the default port for web servers, but there are other options. For example, :port80.
- **Path.** A path refers to a file or location on the web server. For this example, search/query.
- **Query.** Found in the URL of dynamic pages. The query consists of a question mark, followed by parameters. For this example, ?.
- **Parameters.** Pieces of information in a query string of a URL. Multiple parameters can be separated by ampersands (&). For this example, q=URL.
- **Fragment.** This is an internal page reference, which refers to a section within the webpage. It appears at the end of a URL and begins with a hashtag (#). Although not in the example above, an example could be #history in the URL https://en.wikipedia.org/wiki/Internet#History.

Relative URL

- A relative URL points to a file or directory in relation to the present file or directory. It does not include the entire pathname of the page to link but the pathname to use is relative to the current page. A relative URL is a shorthand form of absolute URL. With this shorten version of the URL, various parts of the web site address such as the protocol, domain name, and directory is inferred by the browser based on the URL of the current document or through the location specified in the tag.
- It is used to point to a file that is located in the same folder and on the server as the originating file and not use them to link to pages on other domain names. An originating file is the file that contains the link. A destination file is the file to which a link is made.
- It is similar to saying, “I live in Okhla Estate, three meters from here,” which is relative to wherever “here” is but absolute way to say will be “I live 4, Okhla Estate, Delhi-110054”. Relative URLs are mostly used to link from one web page in web site to another.
- But web browser still requests the full absolute URL, not the shortened relative URL, thus browser manipulates the relative URLs into full absolute URLs.

Relative URL

- A relative URL is a URL that only includes the path. The path is everything that comes after the domain, including the directory and slug.
- Because relative URLs don’t include the entire URL structure, it is assumed that when linking a relative URL, it uses the same protocol, subdomain and domain as the page it’s on.
- Here’s an example of a relative URL:

  /about/team/

URI (Uniform Resource Identifier):

- Similar to URL, URI (Uniform Resource Identifier) is also a string of characters that identifies a resource on the web either by using location, name or both. It allows uniform identification of the resources. A URI is additionally grouped as a locator, a name or both which suggests it can describe a URL, URN or both. The term identifier within the URI refers to the prominence of the resources, despite the technique used.

Key differences between URI and URL

URI	URL
URI is an acronym for Uniform Resource Identifier.	URL is an acronym for Uniform Resource Locator.
URI contains two subsets, URN, which tell the name, and URL, which tells the location.	URL is the subset of URI, which tells the only location of the resource.
All URIs cannot be URLs, as they can tell either name or location.	All URLs are URIs, as every URL can only contain the location.
A URI aims to identify a resource and differentiate it from other resources by using the name of the resource or location of the resource.	A URL aims to find the location or address of a resource on the web.
An example of a URI can be ISBN 0-486-35557-4.	An example of an URL is https://www.javatpoint.com.
It is commonly used in XML and tag library files such as JSTL and XSTL to identify the resources and binaries.	It is mainly used to search the webpages on the internet.
The URI scheme can be protocol, designation, specification, or anything.	The scheme of URL is usually a protocol such as HTTP, HTTPS, FTP, etc.

URL class in Java

- The URL class is the gateway to any of the resource available on the internet. A Class URL represents a Uniform Resource Locator, which is a pointer to a “resource” on the World Wide Web. A resource can point to a simple file or directory, or it can refer to a more complicated object, such as a query to a database or to a search engine.
- A URL is represented by an instance of the java.net.URL class. A URL object manages all the component information within a URL string and provides methods for retrieving the object it identifies

Features of URLConnection class

1. URLConnection is an abstract class. The two subclasses HttpURLConnection and JarURLConnection makes the connetion between the client Java program and URL resource on the internet.
2. With the help of URLConnection class, a user can read and write to and from any resource referenced by an URL object.
3. Once a connection is established and the Java program has an URLConnection object, we can use it to read or write or get further information like content length, etc.

Constructors of Java URL class

URL(String spec)	Creates an instance of a URL from the String representation.
URL(String protocol, String host, int port, String file)	Creates an instance of a URL from the given protocol, host, port number, and file.
URL(String protocol, String host, String file)	Creates an instance of a URL from the given protocol name, host name, and file name.
URL(URL context, String spec)	Creates an instance of a URL by parsing the given spec within a specified context.
URL(URL context, String spec, URLStreamHandler handler)	Creates an instance of a URL by parsing the given spec with the specified handler within a given context.

Commonly used methods of Java URL class

Method	Description
public String getProtocol()	it returns the protocol of the URL.
public String getHost()	it returns the host name of the URL.
public String getPort()	it returns the Port Number of the URL.
public String getFile()	it returns the file name of the URL.
public String getAuthority()	it returns the authority of the URL.
public String toString()	it returns the string representation of the URL.
public String getQuery()	it returns the query string of the URL.
public String getDefaultPort()	it returns the default port of the URL.
public URLConnection openConnection()	it returns the instance of URLConnection i.e. associated with this URL.
public boolean equals(Object obj)	it compares the URL with the given object.
public Object getContent()	it returns the content of the URL.
public String getRef()	it returns the anchor or reference of the URL.
public URI toURI()	it returns a URI of the URL.

Example of Java URL class

```
//URLDemo.java
import java.net.*;
public class URLDemo{
public static void main(String[] args){
try{
URL url=new URL("http://www.javatpoint.com/java-tutorial");

System.out.println("Protocol: "+url.getProtocol());
System.out.println("Host Name: "+url.getHost());
System.out.println("Port Number: "+url.getPort());
System.out.println("File Name: "+url.getFile());

}catch(Exception e){System.out.println(e);}
}
}
```

Output:

```
Protocol: http
Host Name: www.javatpoint.com
Port Number: -1
File Name: /java-tutorial
```

Example of Java URL class

```
//URLDemo.java
import java.net.*;
public class URLDemo{
public static void main(String[] args){
try{
URL url=new URL("https://www.google.com/search?q=javatpoint&oq=javatpoint&sourceid=chrome&ie=UTF-8");

System.out.println("Protocol: "+url.getProtocol());
System.out.println("Host Name: "+url.getHost());
System.out.println("Port Number: "+url.getPort());
System.out.println("Default Port Number: "+url.getDefaultPort());
System.out.println("Query String: "+url.getQuery());
System.out.println("Path: "+url.getPath());
System.out.println("File: "+url.getFile());

}catch(Exception e){System.out.println(e);}
}
}
```

Output:

```
Protocol: https
Host Name: www.google.com
Port Number: -1
Default Port Number: 443
Query String: q=javatpoint&oq=javatpoint&sourceid=chrome&ie=UTF-8
Path: /search
File: /search?q=javatpoint&oq=javatpoint&sourceid=chrome&ie=UTF-8
```

Constructing a URL from its component parts

You can also build a URL by specifying the protocol, the hostname, and the file:

```
public URL(String protocol, String hostname, String file)
```

```
throws MalformedURLException
```

This constructor sets the port to -1 so the default port for the protocol will be used. The file argument should begin with a slash and include a path, a filename, and optionally a fragment identifier. Forgetting the initial slash is a common mistake, and one that is not easy to spot. Like all URL constructors, it can throw a MalformedURLException. For example:

```
try {
URL u = new URL("http", "www.eff.org", "/blueribbon.html#intro");
} catch (MalformedURLException ex)
 {
throw new RuntimeException("shouldn't happen; all VMs recognize http");
}
```

Constructing a URL from its component parts

This creates a URL object that points to *http://www.eff.org/blueribbon.html#intro*, using the default port for the HTTP protocol (port 80). The file specification includes a reference to a named anchor. The code catches the exception that would be thrown if the virtual machine did not support the HTTP protocol. However, this shouldn't happen in practice.

For the rare occasions when the default port isn't correct, the next constructor lets you specify the port explicitly as an int. The other arguments are the same. For example,this code fragment creates a URL object that points to *http://fourier.dur.ac.uk:8000/~dma3mjh/jsci/*, specifying port 8000 explicitly:

```
try {
URL u = new URL("http", "fourier.dur.ac.uk", 8000, "/~dma3mjh/jsci/");
} catch (MalformedURLException ex) {
throw new RuntimeException("shouldn't happen; all VMs recognize http"); }
```

Constructing relative URLs

This constructor builds an absolute URL from a relative URL and a base URL:

```
public URL(URL base, String relative) throws MalformedURLException
```

For instance, you may be parsing an HTML document at *http://www.ibiblio.org/javafaq/ index.html* and encounter a link to a file called *mailinglists.html* with no further qualifying information. In this case, you use the URL to the document that contains the link to provide the missing information. The constructor computes the new URL as *http:// www.ibiblio.org/javafaq/mailinglists.html*. For example:

```
try {
URL u1 = new URL("http://www.ibiblio.org/javafaq/index.html");
URL u2 = new URL (u1, "mailinglists.html");
} catch (MalformedURLException ex) {
System.err.println(ex);
}
```

The filename is removed from the path of u1 and the new filename *mailinglists.html* is appended to make u2. This constructor is particularly useful when you want to loop through a list of files that are all in the same directory. You can create a URL for the first file and then use this initial URL to create URL objects for the other files by substituting their filenames.

Retrieving Data from a URL

Naked URLs aren't very exciting. What's interesting is the data contained in the documents they point to. The URL class has several methods that retrieve data from a URL:

```
public InputStream openStream() throws IOException

public URLConnection openConnection() throws IOException

public URLConnection openConnection(Proxy proxy) throws IOException

public Object getContent() throws IOException

public Object getContent(Class[] classes) throws IOException
```

The most basic and most commonly used of these methods is openStream(), which returns an InputStream from which you can read the data. If you need more control over the download process, call openConnection() instead, which gives you a URLConnection which you can configure, and then get an InputStream from it. Finally, you can ask the URL for its content with getContent() which may give you a more complete object such as String or an Image. Then again, it may just give you an InputStream anyway.

public final InputStream openStream() throws IOException

The openStream() method connects to the resource referenced by the URL, performs any necessary handshaking between the client and the server, and returns an Input Stream from which data can be read. The data you get from this InputStream is the raw (i.e., uninterpreted) content the URL references: ASCII if you're reading an ASCII text file, raw HTML if you're reading an HTML file, binary image data if you're reading an image file, and so forth. It does not include any of the HTTP headers or any other protocol-related information. You can read from

```
try {
  URL u = new URL("http://www.lolcats.com");
  InputStream in = u.openStream();
  int c;
  while ((c = in.read()) != -1) System.out.write(c);
  in.close();
} catch (IOException ex) {
  System.err.println(ex);
}
```

public final InputStream openStream() throws IOException

The preceding code fragment catches an IOException, which also catches the MalformedURLException that the URL constructor can throw, since MalformedURLException subclasses IOException. As with most network streams, reliably closing the stream takes a bit of effort. In Java 6 and earlier, we use the dispose pattern: declare the stream variable outside the try block, set it to null, and then close it in the finally block if it's not null. For example:

```
InputStream in = null
try {
  URL u = new URL("http://www.lolcats.com");
  in = u.openStream();
  int c;
  while ((c = in.read()) != -1) System.out.write(c);
} catch (IOException ex) {
  System.err.println(ex);
} finally {
  try {
    if (in != null) {
      in.close();
    }
  } catch (IOException ex) {
    // ignore
  }
}
```

Splitting a URL into Pieces

URLs are composed of five pieces:

- The scheme, also known as the protocol
- The authority
- The path
- The fragment identifier, also known as the section or ref
- The query string

- For example, in the URL *http://www.ibiblio.org/javafaq/books/jnp/index.html? isbn=1565922069#toc*, the scheme is *http*, the authority is *www.ibiblio.org*, the path is */javafaq/books/jnp/index.html*, the fragment identifier is *toc*, and the query string is *isbn=1565922069*. However, not all URLs have all these pieces. For instance, the URL *http://www.faqs.org/rfcs/rfc3986.html* has a scheme, an authority, and a path, but no fragment identifier or query string. The authority may further be divided into the user info, the host, and the port. For
- example, in the URL *http://admin@www.blackstar.com:8080/*, the authority is *admin@www.blackstar.com*:8080. This has the user info *admin*, the host *www.blackstar.com*, and the port *8080*.
- Read-only access to these parts of a URL is provided by nine public methods: getFile(), getHost(), getPort(), getProtocol(), getRef(), getQuery(), getPath(),getUserInfo(), and getAuthority().

Splitting a URL into Pieces

public String getProtocol()

The getProtocol() method returns a String containing the scheme of the URL (e.g., “http”, “https”, or “file”). For example, this code fragment prints *https*:

```
URL u = new URL("https://xkcd.com/727/");

System.out.println(u.getProtocol());
```

public String getHost()

The getHost() method returns a String containing the hostname of the URL. For example, this code fragment prints *xkcd.com*:

```
URL u = new URL("https://xkcd.com/727/");

System.out.println(u.getHost());
```

Splitting a URL into Pieces

public int getPort()

The getPort() method returns the port number specified in the URL as an int. If no port was specified in the URL, getPort() returns -1 to signify that the URL does not specify the port explicitly, and will use the default port for the protocol. For example, if the URL is *http://www.userfriendly.org/*, getPort() returns -1; if the URL is *http://www.userfriendly.org:80/*, getPort() returns 80. The following code prints -1 for the port number because it isn't specified in the URL:

```
URL u = new URL("http://www.ncsa.illinois.edu/AboutUs/");

System.out.println("The port part of " + u + " is " + u.getPort());
```

public int getDefaultPort()

The getDefaultPort() method returns the default port used for this URL's protocol when none is specified in the URL. If no default port is defined for the protocol, then getDefaultPort() returns -1. For example, if the URL is *http://www.userfriendly.org/*,getDefaultPort() returns 80; if the URL is *ftp://ftp.userfriendly.org:8000/*, getDefaultPort() returns 21.

Splitting a URL into Pieces

public String getFile()

The getFile() method returns a String that contains the path portion of a URL; remember that Java does not break a URL into separate path and file parts. Everything from the first slash (/) after the hostname until the character preceding the # sign that begins a fragment identifier is considered to be part of the file. For example:

```
URL page = this.getDocumentBase();

System.out.println("This page's path is " + page.getFile());
```

If the URL does not have a file part, Java sets the file to the empty string.

public String getPath()

The getPath() method is a near synonym for getFile(); that is, it returns a String containing the path and file portion of a URL. However, unlike getFile(), it does not include the query string in the String it returns, just the path.

Splitting a URL into Pieces

public String getRef()

The getRef() method returns the fragment identifier part of the URL. If the URL doesn’t have a fragment identifier, the method returns null. In the following code, getRef() returns the string xtocid1902914:

```
URL u = new URL(
"http://www.ibiblio.org/javafaq/javafaq.html#xtocid1902914");
System.out.println("The fragment ID of " + u + " is " + u.getRef());
```

public String getQuery()

The getQuery() method returns the query string of the URL. If the URL doesn’t have a query string, the method returns null. In the following code, getQuery() returns the

string category=Piano:

```
URL u = new URL(
"http://www.ibiblio.org/nywc/compositions.phtml?category=Piano");
System.out.println("The query string of " + u + " is " + u.getQuery());
```

The URI Class

A URI is a generalization of a URL that includes not only Uniform Resource Locators but also Uniform Resource Names (URNs). Most URIs used in practice are URLs, but most specifications and standards such as XML are defined in terms of URIs. In Java, URIs are represented by the java.net.URI class. This class differs from the java.net.URL class in three important ways:

- The URI class is purely about identification of resources and parsing of URIs. It provides no methods to retrieve a representation of the resource identified by its URI.
- The URI class is more conformant to the relevant specifications than the URL class.
- A URI object can represent a relative URI. The URL class absolutizes all URIs before storing them.

The URI Class

A URL object is a representation of an application layer protocol for network retrieval, whereas a URI object is purely for string parsing and manipulation. The URI class has no network retrieval capabilities. The URL class has some string parsing methods, such as getFile() and getRef(), but many of these are broken and don’t always behave exactly as the relevant specifications say they should. Normally, you should use the URL class when you want to download the content at a URL and the URI class when you want to use the URL for identification rather than retrieval, for instance, to represent an XML namespace. When you need to do both, you may convert from a URI to a URL with the toURL() method, and from a URL to a URI using the toURI() method.

Constructing a URI

- URIs are built from strings. You can either pass the entire URI to the constructor in an single string, or the individual pieces:

```
public URI(String uri) throws URISyntaxException
public URI(String scheme, String schemeSpecificPart, String fragment)
    throws URISyntaxException
public URI(String scheme, String host, String path, String fragment)
    throws URISyntaxException
public URI(String scheme, String authority, String path, String query,
    String fragment) throws URISyntaxException
public URI(String scheme, String userInfo, String host, int port,
    String path, String query, String fragment) throws URISyntaxException
```

Constructing a URI

- Unlike the URL class, the URI class does not depend on an underlying protocol handler. As long as the URI is syntactically correct, Java does not need to understand its protocol in order to create a representative URI object. Thus, unlike the URL class, the URI class can be used for new and experimental URI schemes.
- The first constructor creates a new URI object from any convenient string. For example:

```
URI voice = new URI("tel:+1-800-9988-9938");
URI web   = new URI("http://www.xml.com/pub/a/2003/09/17/stax.html#id=_hbc");
URI book  = new URI("urn:isbn:1-565-92870-9");
```

The Parts of the URI

- A URI reference has up to three parts: a scheme, a scheme-specific part, and a fragment identifier. The general format is:
- *scheme*:*scheme-specific-part*:*fragment*
- If the scheme is omitted, the URI reference is relative. If the fragment identifier is omitted, the URI reference is a pure URI. The URI class has getter methods that return these three parts of each URI object. The getRawFoo() methods return the encoded forms of the parts of the URI, while the equivalent getFoo() methods first decode any percent escaped characters and then return the decoded part:

The Parts of the URI

- A URI reference has up to three parts: a scheme, a scheme-specific part, and a fragment identifier. The general format is:

  scheme:scheme-specific-part:fragment

- If the scheme is omitted, the URI reference is relative. If the fragment identifier is omitted, the URI reference is a pure URI. The URI class has getter methods that return these three parts of each URI object. The getRawFoo() methods return the encoded forms of the parts of the URI, while the equivalent getFoo() methods first decode any percent escaped characters and then return the decoded part:

```
public String getScheme()
public String getSchemeSpecificPart()
public String getRawSchemeSpecificPart()
public String getFragment()
public String getRawFragment()
```

The Parts of the URI

- These methods all return null if the particular URI object does not have the relevantcomponent: for example, a relative URI without a scheme or an http URI without a fragment identifier. A URI that has a scheme is an *absolute* URI. A URI without a scheme is *relative*. The isAbsolute() method returns true if the URI is absolute, false if it's relative:

  public boolean isAbsolute()

- The details of the scheme-specific part vary depending on the type of the scheme. For example, in a *tel* URL, the scheme-specific part has the syntax of a telephone number. However, in many useful URIs, including the very common *file* and *http* URLs, the scheme-specific part has a particular hierarchical format divided into an authority, a path, and a query string. The authority is further divided into user info, host, and port. The isOpaque() method returns false if the URI is hierarchical, true if it's not hierarchical that is, if it's opaque:

The Parts of the URI

public boolean isOpaque()

- If the URI is opaque, all you can get is the scheme, scheme-specific part, and fragment identifier. However, if the URI is hierarchical, there are getter methods for all the different parts of a hierarchical URI:

```
public String getAuthority()
public String getFragment()
public String getHost()
public String getPath()
public String getPort()
public String getQuery()
public String getUserInfo()
```

The Parts of the URI

- These methods all return the decoded parts; in other words, percent escapes, such as %3C, are changed into the characters they represent, such as <. If you want the raw, encoded parts of the URI, there are five parallel getRaw_Foo_() methods:

```
public String getRawAuthority()
public String getRawFragment()
public String getRawPath()
public String getRawQuery()
public String getRawUserInfo()
```

Resolving Relative URIs

- The URI class has three methods for converting back and forth between relative and absolute URIs:

```
public URI resolve(URI uri)
public URI resolve(String uri)
public URI relativize(URI uri)
```

- The resolve() methods compare the uri argument to this URI and use it to construct a new URI object that wraps an absolute URI. For example, consider these three lines of code:

```
URI absolute = new URI("http://www.example.com/");
URI relative = new URI("images/logo.png");
URI resolved = absolute.resolve(relative);
```

Resolving Relative URIs

- After they've executed, resolved contains the absolute URI *http://www.example.com/ images/logo.png*. If the invoking URI does not contain an absolute URI itself, the resolve() method resolves as much of the URI as it can and returns a new relative URI object as a result. For example, take these three statements:

```
URI top = new URI("javafaq/books/");
URI resolved = top.resolve("jnp3/examples/07/index.html");
```

- After they've executed, resolved now contains the relative URI javafaq/books/jnp3/ examples/07/index.html with no scheme or authority. It's also possible to reverse this procedure; that is, to go from an absolute URI to a relative one. The relativize() method creates a new URI object from the uri argument that is relative to the invoking URI. The argument is not changed. For example:

```
URI absolute = new URI("http://www.example.com/images/logo.png");
URI top = new URI("http://www.example.com/");
URI relative = top.relativize(absolute);
```

The URI object `relative` now contains the relative URI *images/logo.png*.

Equality and Comparison

- URIs are tested for equality pretty much as you'd expect. It's not quite direct string comparison. Equal URIs must both either be hierarchical or opaque. The scheme and authority parts are compared without considering case. That is, *http* and *HTTP* are the same scheme, and *www.example.com* is the same authority as *www.EXAMPLE.com*. The rest of the URI is case sensitive, except for hexadecimal digits used to escape illegal characters. Escapes are *not* decoded before comparing. *http://www.example.com/A* and *http://www.example.com/%41* are unequal URIs.
- The hashCode() method is consistent with equals. Equal URIs do have the same hash code and unequal URIs are fairly unlikely to share the same hash code.

Equality and Comparison

- URI implements Comparable, and thus URIs can be ordered. The ordering is based on string comparison of the individual parts, in this sequence:
    1. If the schemes are different, the schemes are compared, without considering case.
    2. Otherwise, if the schemes are the same, a hierarchical URI is considered to be less than an opaque URI with the same scheme.
    3. If both URIs are opaque URIs, they're ordered according to their scheme-specific parts.
    4. If both the scheme and the opaque scheme-specific parts are equal, the URIs are compared by their fragments.
    5. If both URIs are hierarchical, they're ordered according to their authority components, which are themselves ordered according to user info, host, and port, in that order. Hosts are case insensitive.
    6. If the schemes and the authorities are equal, the path is used to distinguish them.
    7. If the paths are also equal, the query strings are compared. If the query strings are equal, the fragments are compared.
- URIs are not comparable to any type except themselves. Comparing a URI to anything except another URI causes a ClassCastException

String Representations

- Two methods convert URI objects to strings, toString() and toASCIIString():

  public String toString()

  public String toASCIIString()

- The toString() method returns an *unencoded* string form of the URI (i.e., characters like e and \ are not percent escaped). Therefore, the result of calling this method is not guaranteed to be a syntactically correct URI, though it is in fact a syntactically correctIRI. This form is sometimes useful for display to human beings, but usually not for retrieval. The toASCIIString() method returns an *encoded* string form of the URI. Characters like e and \ are always percent escaped whether or not they were originally escaped. This is the string form of the URI you should use most of the time. Even if the form returned by toString() is more legible for humans, they may still copy and paste it into areas that are not expecting an illegal URI. toASCIIString() always returns a syntacticallycorrect URI.

x-www-form-urlencoded

- One of the challenges faced by the designers of the Web was dealing with the differences between operating systems. These differences can cause problems with URLs: for example, some operating systems allow spaces in filenames; some don’t. Most operating systems won’t complain about a # sign in a filename; but in a URL, a # sign indicates that the filename has ended, and a fragment identifier follows. Other special characters, non alphanumeric characters, and so on, all of which may have a special meaning inside a URL or on another operating system, present similar problems. Furthermore, Unicode was not yet ubiquitous when the Web was invented, so not all systems could handle characters such as e and 本.To solve these problems, characters used in URLs must come from a fixed subset of ASCII, specifically:
  - The capital letters A–Z
  - The lowercase letters a–z
  - The digits 0–9
  - The punctuation characters - _ . ! ~ * ' (and ,)

x-www-form-urlencoded

- The characters : / & ? @ # ; $ + = and % may also be used, but only for their specified purposes. If these characters occur as part of a path or query string, they and all other characters should be encoded. The encoding is very simple. Any characters that are not ASCII numerals, letters, or the punctuation marks specified earlier are converted into bytes and each byte is written as a percent sign followed by two hexadecimal digits. Spaces are a special case because they’re so common. Besides being encoded as %20, they can be encoded as a plus sign (+). The plus sign itself is encoded as %2B. The / # = & and ? characters should be encoded when they are used as part of a name, and not as a separator between parts ofthe URL. The URL class does not encode or decode automatically. You can construct URL objects that use illegal ASCII and non-ASCII characters and/or percent escapes. Such characters and escapes are not automatically encoded or decoded when output by methods such as getPath() and toExternalForm(). You are responsible for making sure all such characters are properly encoded in the strings used to construct a URL object. Luckily, Java provides URLEncoder and URLDecoder classes to cipher strings in this format.

URLEncoder

- To URL encode a string, pass the string and the character set name to the URLEncoder.encode() method. For example: String encoded = URLEncoder.encode("This*string*has*asterisks", "UTF-8"); URLEncoder.encode() returns a copy of the input string with a few changes. Any non alphanumeric characters are converted into % sequences (except the space, underscore, hyphen, period, and asterisk characters). It also encodes all non-ASCII characters. The space is converted into a plus sign. This method is a little overaggressive; it also converts tildes, single quotes, exclamation points, and parentheses to percent escapes, even though they don’t absolutely have to be. However, this change isn’t forbidden by theURL specification, so web browsers deal reasonably with these excessively encoded URLs.Although this method allows you to specify the character set, the only such character set you should ever pick is UTF-8. UTF-8 is compatible with the IRI specification, the URI class, modern web browsers, and more additional software than any other encoding you could choose.

a program that uses URLEncoder.encode() to print various encoded strings.

```
import java.io.*;
import java.net.*;

public class EncoderTest {

  public static void main(String[] args) {

    try {
      System.out.println(URLEncoder.encode("This string has spaces",
                                           "UTF-8"));
      System.out.println(URLEncoder.encode("This*string*has*asterisks",
                                           "UTF-8"));
      System.out.println(URLEncoder.encode("This%string%has%percent%signs",
                                           "UTF-8"));
      System.out.println(URLEncoder.encode("This+string+has+pluses",
                                           "UTF-8"));
      System.out.println(URLEncoder.encode("This/string/has/slashes",
                                           "UTF-8"));
      System.out.println(URLEncoder.encode("This\"string\"has\"quote\"marks",
                                           "UTF-8"));
      System.out.println(URLEncoder.encode("This:string:has:colons",
                                           "UTF-8"));
      System.out.println(URLEncoder.encode("This~string~has~tildes",
                                           "UTF-8"));
      System.out.println(URLEncoder.encode("This(string)has(parentheses)",
                                           "UTF-8"));
      System.out.println(URLEncoder.encode("This.string.has.periods",
                                           "UTF-8"));
      System.out.println(URLEncoder.encode("This=string=has=equals=signs",
                                           "UTF-8"));
      System.out.println(URLEncoder.encode("This&string&has&ampersands",
                                           "UTF-8"));
      System.out.println(URLEncoder.encode("Thisésthringéhasé
                                           non-ASCII characters", "UTF-8"));
    } catch (UnsupportedEncodingException ex) {
      throw new RuntimeException("Broken VM does not support UTF-8");
    }
  }
}
```

URL Decoder

- The corresponding URLDecoder class has a static decode() method that decodes strings encoded in x-www-form-url-encoded format. That is, it converts all plus signs to spaces and all percent escapes to their corresponding character:

public static String decode(String s, String encoding) **throws** Unsupported Encoding Exception

- If you have any doubt about which encoding to use, pick UTF-8. It's more likely to be correct than anything else. An IllegalArgumentException should be thrown if the string contains a percent sign that isn't followed by two hexadecimal digits or decodes into an illegal sequence. Since URLDecoder does not touch non-escaped characters, you can pass an entire URL to it rather than splitting it into pieces first. For example:

Proxies

Many systems access the Web and sometimes other non-HTTP parts of the Internetthrough *proxy servers*. A proxy server receives a request for a remote server from a local client. The proxy server makes the request to the remote server and forwards the result back to the local client. Sometimes this is done for security reasons, such as to prevent remote hosts from learning private details about the local network configuration. Other times it's done to prevent users from accessing forbidden sites by filtering outgoing requests and limiting which sites can be viewed. For instance, an elementary school might want to block access to *http://www.playboy.com*. And still other times it's done purely for performance, to allow multiple users to retrieve the same popular documents from a local cache rather than making repeated downloads from the remote server. Java programs based on the URL class can work through most common proxy servers and protocols. Indeed, this is one reason you might want to choose to use the URL class rather than rolling your own HTTP or other client on top of raw sockets.

The ProxyClass

- The Proxy class allows more fine-grained control of proxy servers from within a Java program. Specifically, it allows you to choose different proxy servers for different remote Hosts. The proxies themselves are represented by instances of the java.net.Proxy class. There are still only three kinds of proxies, HTTP, SOCKS, and direct connections (no proxy at all), represented by three constants in the Proxy.Type enum:
  - Proxy.Type.DIRECT
  - Proxy.Type.HTTP
  - Proxy.Type.SOCKS

- Besides its type, the other important piece of information about a proxy is its address and port, given as a SocketAddress object. For example, this code fragment creates a Proxy object representing an HTTP proxy server on port 80 of *proxy.example.com*:

```
SocketAddress address = new InetSocketAddress("proxy.example.com", 80);
Proxy proxy = new Proxy(Proxy.Type.HTTP, address);
```

- Although there are only three kinds of proxy objects, there can be many proxies of the same type for different proxy servers on different hosts.

The ProxySelector Class

- Each running virtual machine has a single java.net.ProxySelector object it uses to locate the proxy server for different connections. The default ProxySelector merely inspects the various system properties and the URL's protocol to decide how to connect to different hosts. However, you can install your own subclass of ProxySelector in place of the default selector and use it to choose different proxies based on protocol, host, path, time of day, or other criteria. The key to this class is the abstract select() method:
  - **public abstract** List<Proxy> select(URI uri)
- Java passes this method a URI object (not a URL object) representing the host to which a connection is needed. For a connection made with the URL class, this object typically has the form *http://www.example.com/* or *ftp://ftp.example.com/pub/files/*, for example. For a pure TCP connection made with the Socket class, this URI will have the form *socket://host:port*:, for instance, *socket://www.example.com:80*. The ProxySelector object then chooses the right proxies for this type of object and returns them in a List<Proxy>.
- The second abstract method in this class you must implement is connectFailed():
  - **public void** connectFailed(URI uri, SocketAddress address, IOException ex)

The ProxySelector Class

- This is a callback method used to warn a program that the proxy server isn't actually making the connection. Example below demonstrates with a ProxySelector that attempts to use the proxy server at *proxy.example.com* for all HTTP connections unless the proxy server has previously failed to resolve a connection to a particular URL. In that case, it suggests a direct

```
import java.io.*;
import java.net.*;
import java.util.*;

public class LocalProxySelector extends ProxySelector {

  private List<URI> failed = new ArrayList<URI>();

  public List<Proxy> select(URI uri) {

    List<Proxy> result = new ArrayList<Proxy>();
    if (failed.contains(uri)
        || !"http".equalsIgnoreCase(uri.getScheme())) {
      result.add(Proxy.NO_PROXY);
    } else {
      SocketAddress proxyAddress
          = new InetSocketAddress( "proxy.example.com", 8000);
      Proxy proxy = new Proxy(Proxy.Type.HTTP, proxyAddress);
      result.add(proxy);
    }

    return result;
  }

  public void connectFailed(URI uri, SocketAddress address, IOException ex) {
    failed.add(uri);
  }
}
```

The ProxySelector Class

- Selector, pass the new selector to the static ProxySelector.setDefault() method,
- like so:
  - ProxySelector selector = **new** LocalProxySelector():
  - ProxySelector.setDefault(selector);
- From this point forward, all connections opened by that virtual machine will ask the ProxySelector for the right proxy to use. You normally shouldn’t use this in code running in a shared environment. For instance, you wouldn’t change the ProxySelector in a servlet because that would change the ProxySelector for all servlets running in the same container.

Communicating with Server-Side Programs Through GET

- The URL class makes it easy for Java applets and applications to communicate with serverside programs such as CGIs, servlets, PHP pages, and others that use the GET method. (All you need to know is what combination of names and values the program expects to receive. Then you can construct a URL with a query string that provides the requisite names and values. There are a number of ways to determine the exact syntax for a query string that talks to a particular program. If you've written the server-side program yourself, you already know the name-value pairs it expects. If you've installed a third-party program on your own server, the documentation for that program should tell you what it expects. If you're talking to a documented external network API such as the eBay Shopping API, then the service usually provides fairly detailed documentation to tell you exactly what data to send for which purposes.
- Many programs are designed to process form input. If this is the case, it's straightforward to figure out what input the program expects. The method the form uses should be the value of the METHOD attribute of the FORM element. This value should be either GET, in which case you use the process described here, or POST, in which case you use the process described later. The part of the URL that precedes the query string is given by the value of the ACTION attribute of the FORM element. Note that this may be a relative URL, in which case you'll need to determine the corresponding absolute URL. Finally, the names in the name-value pairs are simply the values of the NAME attributes of the INPUT elements. The values of the pairs are whatever the user types into the form.

Communicating with Server-Side Programs Through GET

- For example, consider this HTML form for the local search engine on my Cafe con Leche site. You can see that it uses the GET method. The program that processes the form is accessed via the URL *http://www.google.com/search*. It has four separate name-value pairs, three of which have default values:

```
<form name="search" action="http://www.google.com/search" method="get">
  <input name="q" />
  <input type="hidden" value="cafeconleche.org" name="domains" />
  <input type="hidden" name="sitesearch" value="cafeconleche.org" />
  <input type="hidden" name="sitesearch2" value="cafeconleche.org" />
   <br />
   <input type="image" height="22" width="55"
      src="images/search_blue.gif" alt="search" border="0"
      name="search-image" />
</form>
```

- The type of the INPUT field doesn’t matter. For instance, it doesn’t matter if it’s a set of checkboxes, a pop-up list, or a text field. Only the name of each INPUT field and the value you give it is significant. The submit input tells the web browser when to send the data but does not give the server any extra information. Sometimes you find hidden INPUT fields that must have particular required default values. This form has three hidden INPUT fields. There are many different form tags in HTML that produce pop-up

Communicating with Server-Side Programs Through GET

- menus, radio buttons, and more. However, although these input widgets appear different to the user, the format of data they send to the server is the same. Each form element provides a name and an encoded string value. In some cases, the program you're talking to may not be able to handle arbitrary text strings for values of particular inputs. However, since the form is meant to be read and filled in by human beings, it should provide sufficient clues to figure out what input is expected; for instance, that a particular field is supposed to be a two-letter state abbreviation or a phone number. Sometimes the inputs may not have such obvious names. There may not even be a form, just links to follow. In this case, you have to do some experimenting, first copying some existing values and then tweaking them to see what values are and aren't accepted. You don't need to do this in a Java program. You can simply edit the URL in the address or location bar of your web browser window.

Accessing Password-Protected Sites

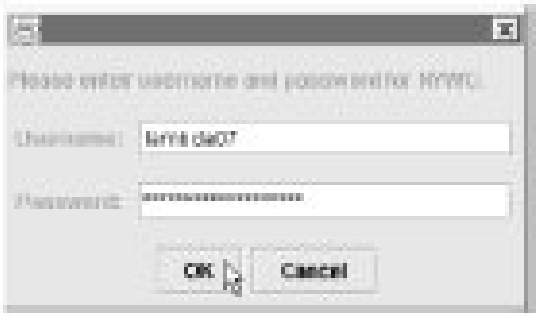
- Many popular sites require a username and password for access. Some sites, such as the W3C member pages, implement this through HTTP authentication. Others, such as the *New York Times* website, implement it through cookies and HTML forms. Java's URLclass can access sites that use HTTP authentication, although you'll of course need to tell it which username and password to use. Supporting sites that use nonstandard, cookie-based authentication is more challenging, not least because this varies a lot from one site to another. Implementing cookie authentication is hard short of implementing a complete web browser with full HTML forms and cookie support; . Accessing sites protected by standard HTTP authentication is much easier.

The Authenticator Class

- The java.net package includes an Authenticator class you can use to provide a username and password for sites that protect themselves using HTTP authentication:

  public abstract class Authenticator extends Object

- Since Authenticator is an abstract class, you must subclass it. Different subclasses may retrieve the information in different ways. For example, a character mode program might just ask the user to type the username and password on System.in. A GUI program would likely put up a dialog box like the one shown in Figure . An automated robot might read the username out of an encrypted file.



An authentication dialog

The Authenticator Class

- To make the URL class use the subclass, install it as the default authenticator by passing it to the static Authenticator.setDefault() method:
  - **public static void** setDefault(Authenticator a)
- For example, if you've written an Authenticator subclass named DialogAuthenticator, you'd install it like this:

```
Authenticator.setDefault(new DialogAuthenticator());
```

- You only need to do this once. From this point forward, when the URL class needs a username and password, it will ask the DialogAuthenticator using the static Authenticator.requestPasswordAuthentication() method:
  - **public static** PasswordAuthentication requestPasswordAuthentication(
  - InetAddress address, **int** port, String protocol, String prompt, String scheme) **throws** SecurityException

The Authenticator Class

- The address argument is the host for which authentication is required. The port argument is the port on that host, and the protocol argument is the application layer protocol by which the site is being accessed. The HTTP server provides the prompt. It's typically the name of the realm for which authentication is required. (Some large web servers such as *www.ibiblio.org* have multiple realms, each of which requires different usernames and passwords.) The scheme is the authentication scheme being used. (Here the word *scheme* is not being used as a synonym for *protocol*. Rather, it is an HTTP authentication scheme, typically basic.) Untrusted applets are not allowed to ask the user for a name and password. Trusted applets can do so, but only if they possess the requestPasswordAuthentication Net Permission. Otherwise, Authenticator.requestPasswordAuthentication() throwsa SecurityException. The Authenticator subclass must override the getPasswordAuthentication() method. Inside this method, you collect the username and password from the user or some other source and return it as an instance of the java.net.PasswordAuthentication class:
  - **protected** PasswordAuthentication getPasswordAuthentication()

The Authenticator Class

- If you don’t want to authenticate this request, return null, and Java will tell the server it doesn’t know how to authenticate the connection. If you submit an incorrect username or password, Java will call getPasswordAuthentication() again to give you another chance to provide the right data. You normally have five tries to get the username and password correct; after that, openStream() throws a ProtocolException. Usernames and passwords are cached within the same virtual machine session. Once you set the correct password for a realm, you shouldn’t be asked for it again unless you’ve explicitly deleted the password by zeroing out the char array that contains it. You can get more details about the request by invoking any of these methods inherited from the Authenticator superclass:

The Authenticator Class

```
protected final InetAddress getRequestingSite()
protected final int         getRequestingPort()
protected final String      getRequestingProtocol()
protected final String      getRequestingPrompt()
protected final String      getRequestingScheme()
protected final String      getRequestingHost()
protected final String      getRequestingURL()
protected Authenticator.RequestorType getRequestorType()
```

- These methods either return the information as given in the last call to requestPass wordAuthentication() or return null if that information is not available. (If the port isn't available, getRequestingPort() returns -1.) The getRequestingURL() method returns the complete URL for which authentication has been requested—an important detail if a site uses different names and passwords for different files. The getRequestorType() method returns one of the two named constants (i.e., Authenticator.RequestorType.PROXY or Authenticator.Requestor Type.SERVER) to indicate whether the server or the proxy server is requesting the authentication

The Authenticator Class

```
protected final InetAddress getRequestingSite()
protected final int         getRequestingPort()
protected final String      getRequestingProtocol()
protected final String      getRequestingPrompt()
protected final String      getRequestingScheme()
protected final String      getRequestingHost()
protected final String      getRequestingURL()
protected Authenticator.RequestorType getRequestorType()
```

- These methods either return the information as given in the last call to requestPass wordAuthentication() or return null if that information is not available. (If the port isn't available, getRequestingPort() returns -1.) The getRequestingURL() method returns the complete URL for which authentication has been requested—an important detail if a site uses different names and passwords for different files. The getRequestorType() method returns one of the two named constants (i.e., Authenticator.RequestorType.PROXY or Authenticator.Requestor Type.SERVER) to indicate whether the server or the proxy server is requesting the authentication

The PasswordAuthentication Class

- PasswordAuthentication is a very simple final class that supports two read-only properties: username and password. The username is a String. The password is a char array so that the password can be erased when it's no longer needed. A String would have to wait to be garbage collected before it could be erased, and even then it might still exist somewhere in memory on the local system, possibly even on disk if the block of memory that contained it had been swapped out to virtual memory at one point. Both username and password are set in the constructor:

```
public PasswordAuthentication(String userName, char[] password)
```

Each is accessed via a getter method:

```
public String getUserName()
public char[] getPassword()
```

The JPasswordField Class

- One useful tool for asking users for their passwords in a more or less secure fashion is the JPasswordField component from Swing:
  - **public class JPasswordField extends** JTextField
- This lightweight component behaves almost exactly like a text field. However, anything the user types into it is echoed as an asterisk. This way, the password is safe from anyone looking over the user's shoulder at what's being typed on the screen. JPasswordField also stores the passwords as a char array so that when you're done with the password you can overwrite it with zeros. It provides the getPassword() method to return this:
  - **public char**[] getPassword()