Part II: Functional Models and Finite State Machines

Introduction to Finite State Machines

Finite state machines (or FSMs) can be constructed prior to or independent of source code.

- Can serve as a specification of allowed behavior.

A finite state machine is a set of states and a set of transitions.

- A directed graph.
- Node represents a program state.
- Edge represents an operation that transforms one program state to another. Usually are labeled with a program operation, condition, or event.
- Since infinitely many states, an FSM must be an abstraction.

The reason why finite models are useful for testing

Using finite models, we can draw a state transition tables. These transition tables can help us check the completeness of the program. These completeness can help us do the followings conditions.

1. Help analyze the original state of program.
2. Help analyze the complete process of program.
3. Help test potential bugs.
4. Testing might pass all the branches
5. After analyzing the branches, we can test in more detailed and more targeted way.
6. When encountered with bug, we can target at which branch has the bugs.

Choose a feature or component that lends itself well to being described by a non-trivial functional model

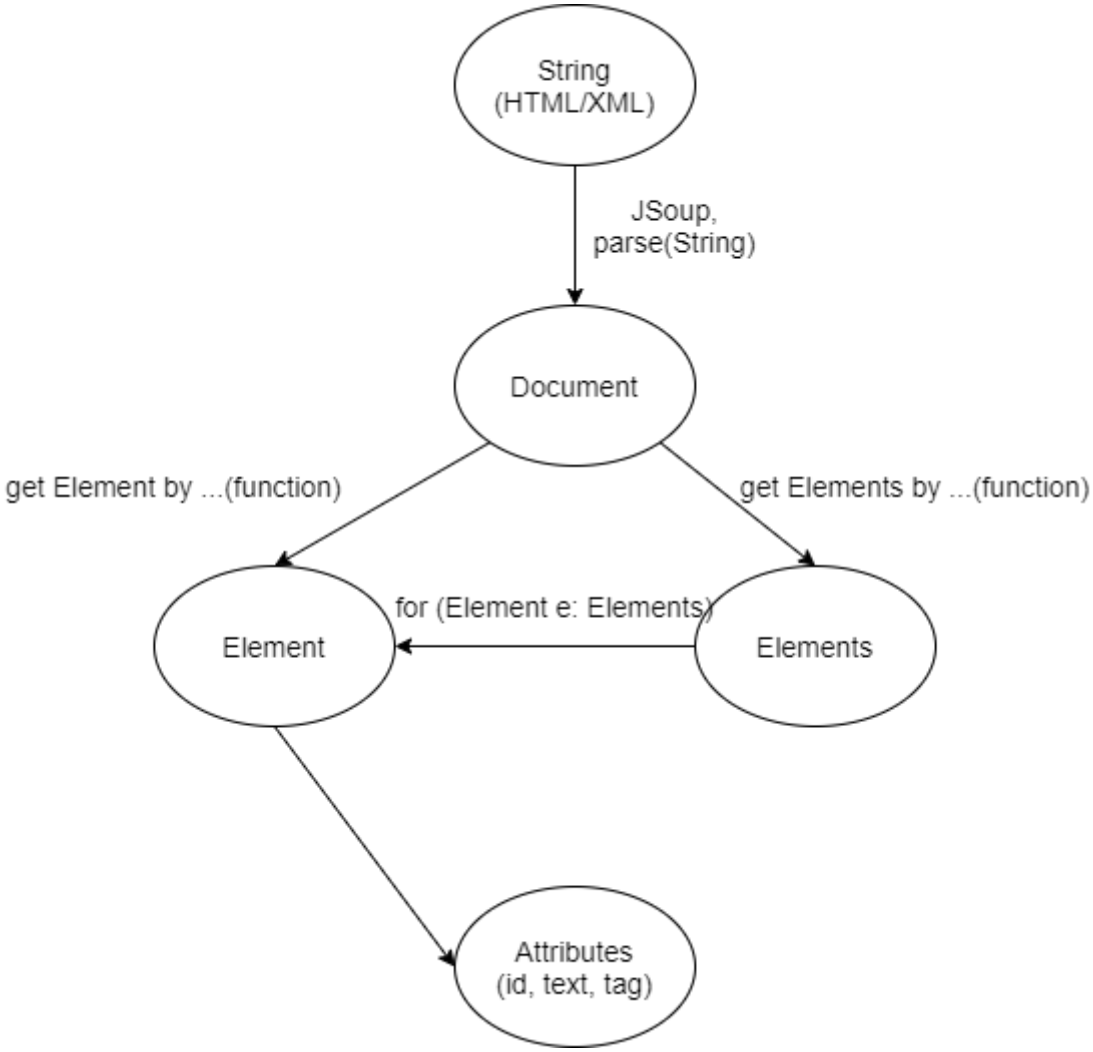
In our project `JSoup`, it is a Java library for working with real-world HTML/XML. In functional model, we extracted two features from `JSoup`.

- scrape and parse HTML from a URL, file, or string
- manipulate the HTML/XML elements, attributes, and text.

Create, draw, and describe that functional model, how it works

In `JSoup` progress, you can see the process through the picture below.

1. Firstly, `parse` HTML or XML Strings to `Document`.
2. Then get `Element` or `Elements` by `JSoup` functions.
3. Using `for (Element e : Elements)`, `Elements` can transfer to `Element`.
4. Using `Element`, we can see the `Attributes`.



How to use functional models in `JSoup`

Write test cases that "cover" the functional model in JUnit. Push it to your Github fork. Also document these in the document.

The test cases are stored in the directory -
`/src/test/java/org.jsoup/swe261/FiniteStateMachinesTest.java`

The files within are written here.

```
public class FiniteStateMachinesTest {

    @Test
    public void String2Document() {
        String html = "<html><head><title>First!</title></head>
<body><p>First post! <img src=\"foo.png\" /></p><p>Second post!
<img src=\"foo2.png\" /></p></body></html>";
        Document doc = Jsoup.parse(html);
        String expStr = "<body>\n" +
                " <p>First post! <img src=\"foo.png\"></p>\n" +
                " <p>Second post! <img src=\"foo2.png\"></p>\n" +
                "</body>";
        System.out.println(doc.body());
        assertEquals(expStr, doc.body().toString());
    }

    @Test
    public void Document2Element() {
        String html = "<html><head><title>First!</title></head>
<body><p>First post! <img src=\"foo.png\" /></p><p>Second post!
<img src=\"foo2.png\" /></p></body></html>";
        Document doc = Jsoup.parse(html);
        Element ele = doc.body();
        String expStr = "<p>First post! <img src=\"foo.png\"></p>";
        //System.out.println(ele.children());
        assertEquals(expStr,ele.child(0).toString());
        expStr = "<p>Second post! <img src=\"foo2.png\"></p>";
        assertEquals(expStr,ele.child(1).toString());
    }

    @Test
    public void Element2Elements() {
        String html = "<html><head><title>First!</title></head>
<body><p>First post! <img src=\"foo.png\" /></p><p>Second post!
<img src=\"foo2.png\" /></p></body></html>";
        Document doc = Jsoup.parse(html);
        Element ele = doc.body();
        Elements eles = ele.children();
        int exp = 2;
        assertEquals(exp, eles.size());
    }

    @Test
```

```
    public void Document2Elements() {
        String html = "<html><head><title>First!</title></head>
<body><p>First post! <img src=\"foo.png\" /></p><p>Second post!
<img src=\"foo2.png\" /></p></body></html>";
        Document doc = Jsoup.parse(html);
        Elements eles = doc.getElementsByTag("p");
        int exp = 2;
        assertEquals(exp, eles.size());
    }

    @Test
    public void Elements2Element() {
        String html = "<html><head><title>First!</title></head>
<body><p>First post! <img src=\"foo.png\" /></p><p>Second post!
<img src=\"foo2.png\" /></p></body></html>";
        Document doc = Jsoup.parse(html);
        Elements eles = doc.getElementsByTag("p");
        String expStr = "<p>First post! <img src=\"foo.png\"></p>";
        assertEquals(expStr,eles.get(0).toString());
        expStr = "<p>Second post! <img src=\"foo2.png\"></p>";
        assertEquals(expStr,eles.get(1).toString());
    }

    @Test
    public void Element2Attr() {
        String html = "<html><head><title>First!</title></head>
<body><p class=\"foo > bar\">First post! <img src=\"foo.png\" />
</p></body></html>";
        Document doc = Jsoup.parse(html);

        // need a better way to verify these:
        Element p = doc.body().child(0);
        assertEquals("p", p.tagName());
        assertEquals("foo > bar", p.attr("class"));
    }


}
```

To explain these code,

1. `String2Document` is the first process. This one `parse` HTML or XML Strings to `Document`

```
    @Test
    public void String2Document() {
        String html = "<html><head><title>First!</title></head>
<body><p>First post! <img src=\"foo.png\" /></p><p>Second post!
<img src=\"foo2.png\" /></p></body></html>";
        Document doc = Jsoup.parse(html);
        String expStr = "<body>\n" +
                " <p>First post! <img src=\"foo.png\"></p>\n" +
                " <p>Second post! <img src=\"foo2.png\"></p>\n" +
                "</body>";
        System.out.println(doc.body());
        assertEquals(expStr, doc.body().toString());
    }
```

Reversely, `Document` can transfer to HTML/XML

```
@Test
    public void Document2Element() {
        String html = "<html><head><title>First!</title></head>
<body><p>First post! <img src=\"foo.png\" /></p><p>Second post!
<img src=\"foo2.png\" /></p></body></html>";
        Document doc = Jsoup.parse(html);
        Element ele = doc.body();
        String expStr = "<p>First post! <img src=\"foo.png\"></p>";
        //System.out.println(ele.children());
        assertEquals(expStr,ele.child(0).toString());
        expStr = "<p>Second post! <img src=\"foo2.png\"></p>";
        assertEquals(expStr,ele.child(1).toString());
    }
```

2. Using `for (Element e : Elements)`, `Elements` can transfer to `Element`.

```
@Test
    public void Element2Elements() {
        String html = "<html><head><title>First!</title></head>
<body><p>First post! <img src=\"foo.png\" /></p><p>Second post!
<img src=\"foo2.png\" /></p></body></html>";
        Document doc = Jsoup.parse(html);
        Element ele = doc.body();
        Elements eles = ele.children();
        int exp = 2;
        assertEquals(exp, eles.size());
    }
```

Reversely, `Elements` can transfer to `Element`.

```
@Test
    public void Elements2Element() {
        String html = "<html><head><title>First!</title></head>
<body><p>First post! <img src=\"foo.png\" /></p><p>Second post!
<img src=\"foo2.png\" /></p></body></html>";
        Document doc = Jsoup.parse(html);
        Elements eles = doc.getElementsByTag("p");
        String expStr = "<p>First post! <img src=\"foo.png\"></p>";
        assertEquals(expStr,eles.get(0).toString());
        expStr = "<p>Second post! <img src=\"foo2.png\"></p>";
        assertEquals(expStr,eles.get(1).toString());
    }
```

3. Using `Element`, we can see the `Attributes`.

```
@Test
    public void Element2Attr() {
        String html = "<html><head><title>First!</title></head>
<body><p class=\"foo > bar\">First post! <img src=\"foo.png\" />
</p></body></html>";
        Document doc = Jsoup.parse(html);

        // need a better way to verify these:
        Element p = doc.body().child(0);
        assertEquals("p", p.tagName());
        assertEquals("foo > bar", p.attr("class"));
    }
```