Functional Web Application Testing with Selenium WebDriver

AGENDA

- Basics of functional testing
- Selenium WebDriver
- Page Object Pattern

BASICS OF FUNCTIONAL TESTING

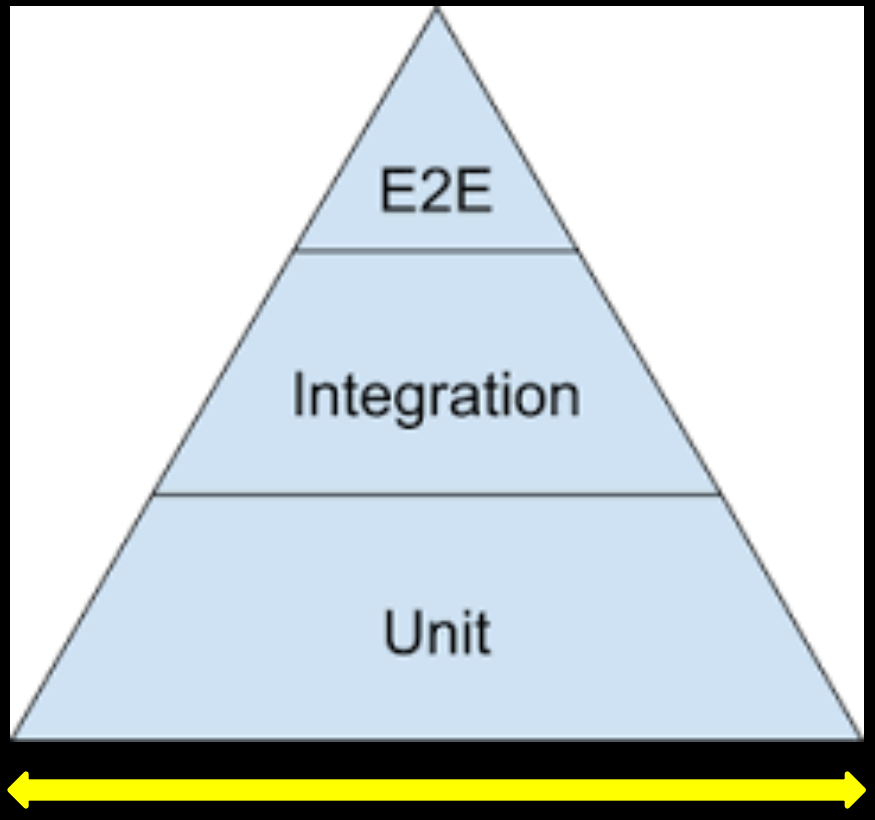
Functional Web Testing

Goal: Improving the correctness of Web apps

- **Should test all involved parts**
  - Everything can go wrong…
  - Pay attention to dynamism!
- **Client side**
  - HTML: Malformed HTML page?
  - JavaScript: Runtime Errors?
- **Server side**
  - PHP, Java…: Runtime Errors?
  - SQL: Malformed SQL query string?

Levels of software testing

Test pyramid rule



Testing the system as a whole (GUI)

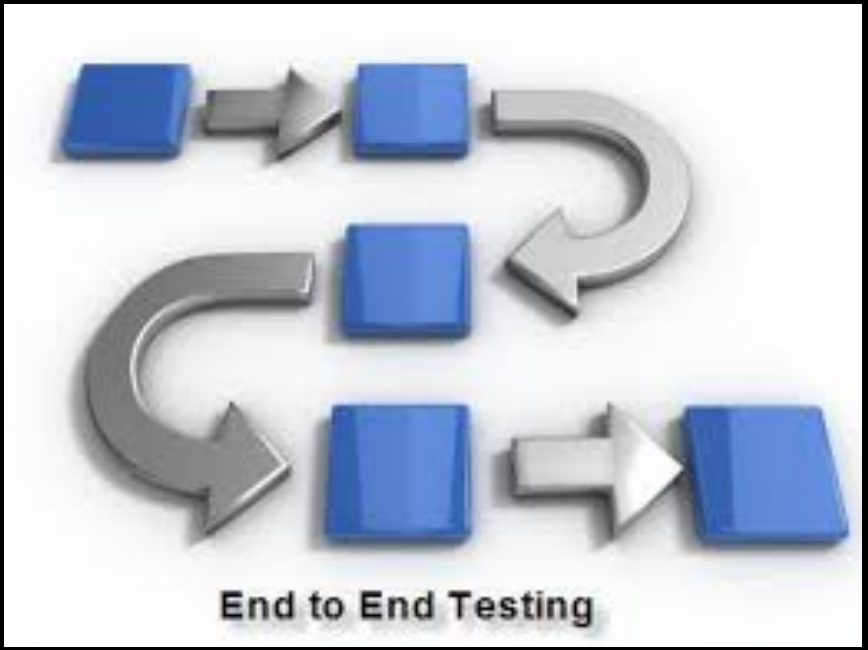
Individual units are combined and tested as a group

Testing of a single function/class

End-to-End (E2E) Testing

Testing the system as a whole, all interfaces and backend systems

Test entire flow in real conditions

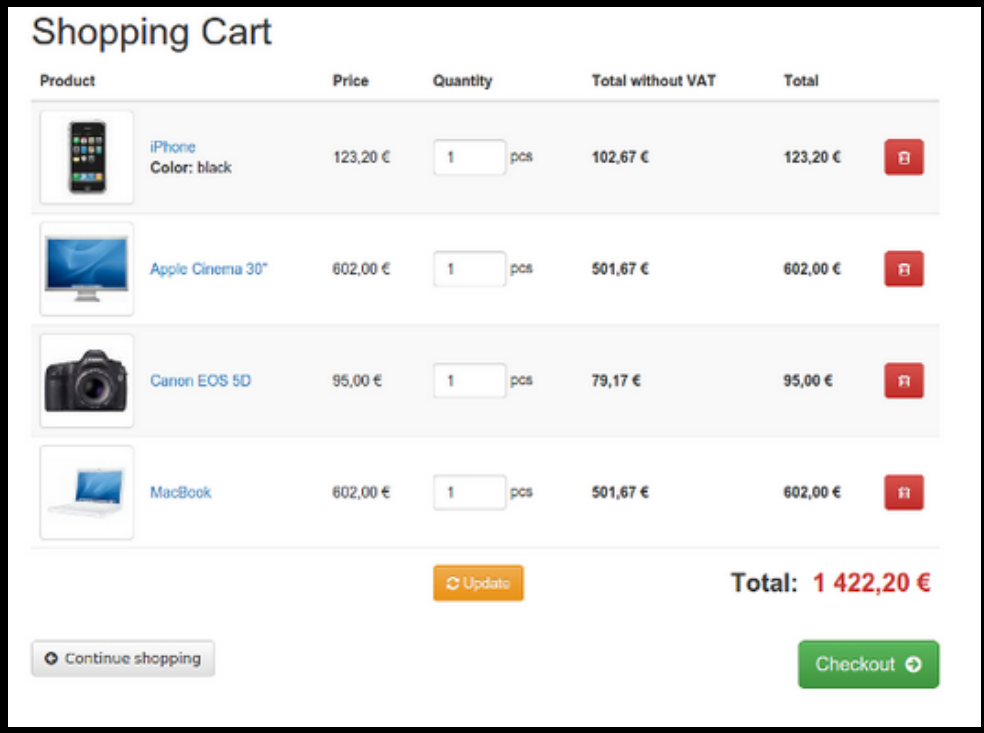


It is performed from start to finish under **real world scenarios** like communication of the application with hardware, network, database and other applications …

E2E Test Case

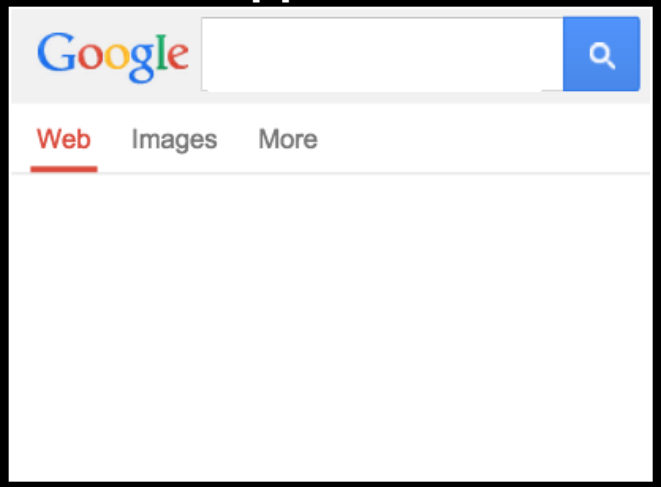
- **Triple**:
  - Sequence of **user events** from the initial page (state) to the target page (state)
  - Sequence of Inputs
    - E.g., to fill in a form
  - Expected result (oracle)

- Examples of **user events**:
  - Click a button
  - Select a CheckBox or Radio Button
  - Insert text in a text field
    - an input value is necessary



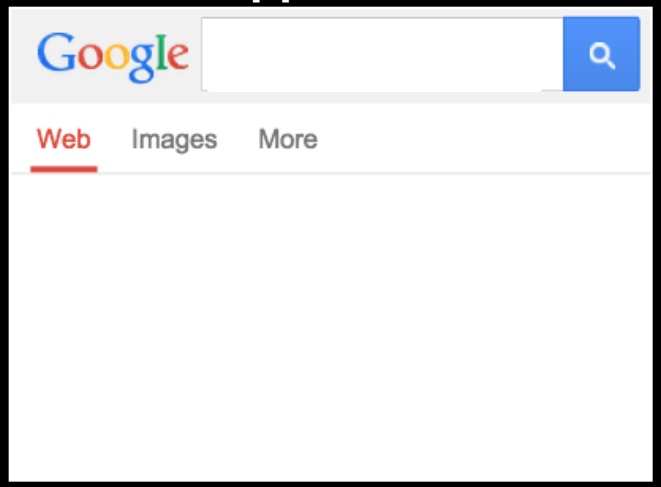
E2E Test case example

Web App under test



E2E Test case example

Web App under test

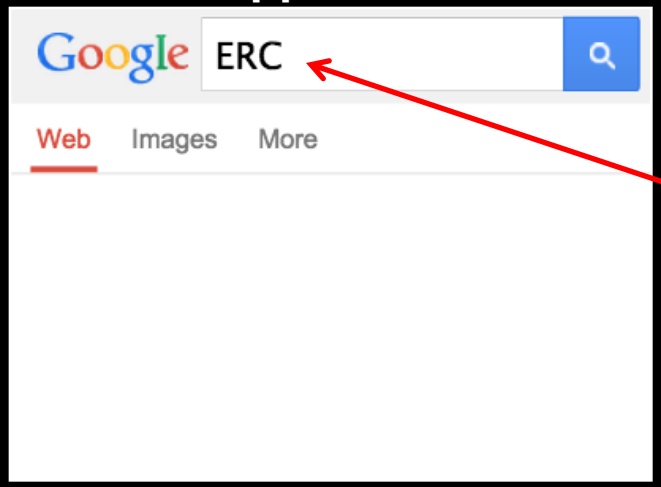


Test case (can be executed manually)

1. **Open** *www.google.com*
2. **Insert** "*ERC*" in input field
3. **Click** submit button
4. **Check** first result = "*ERC: European Research Council*"

E2E Test case example

Web App under test



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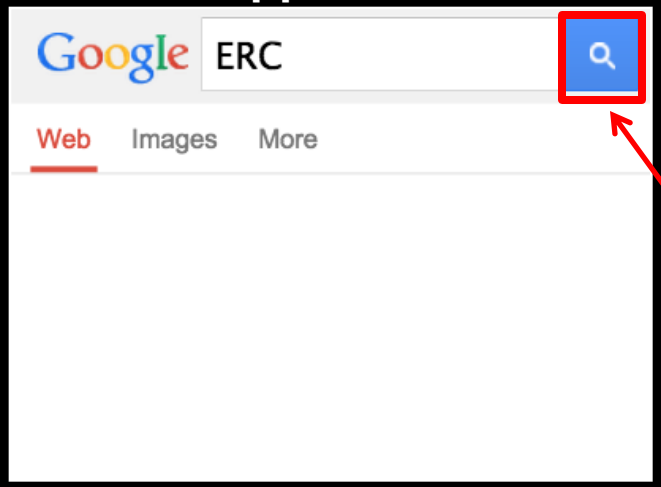
E2E Test case example

Web App under test



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E2E Test case example

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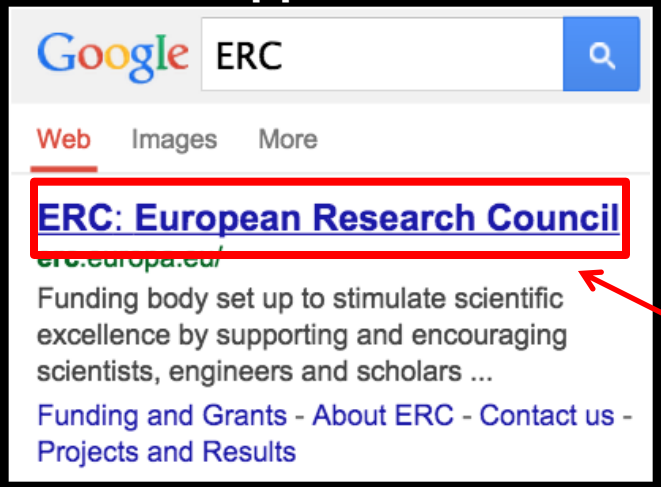
E2E Test case example

Web App under test

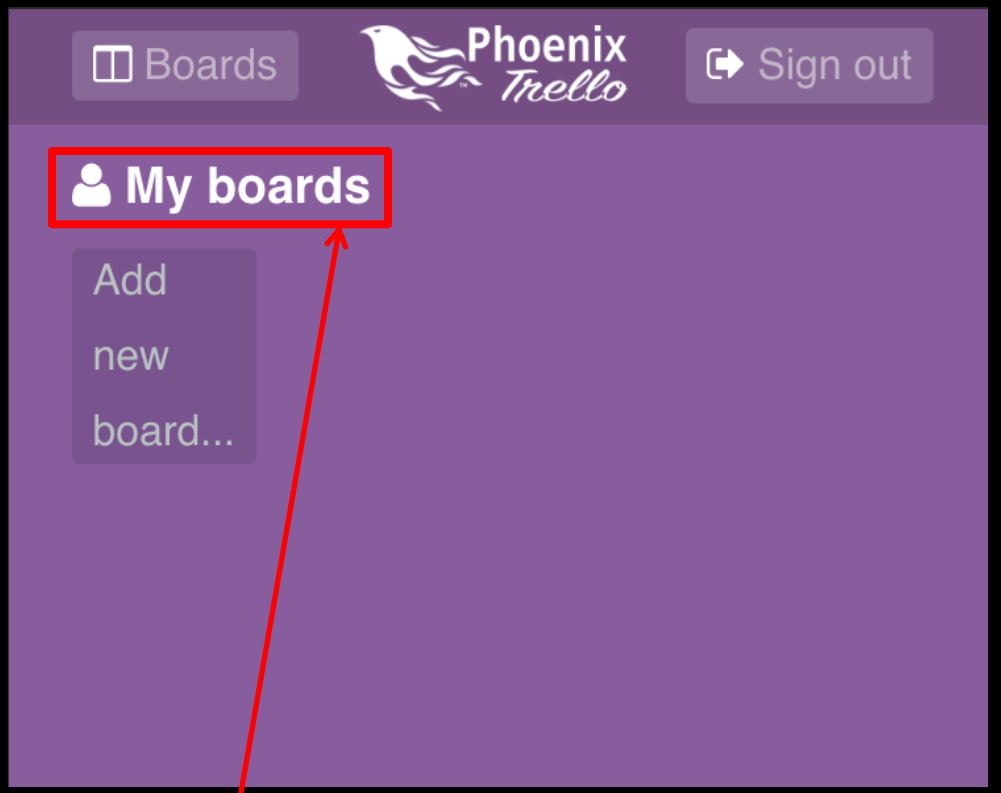


Test case (can be executed manually)

1. **Open** *www.google.com*
2. **Insert** "*ERC*" in input field
3. **Click** submit button
4. **Check** first result = "*ERC: European Research Council*"

If so the test case passes!

E2E Login Test Case: Happy case



check result

E2E Login Test Case: Corner case

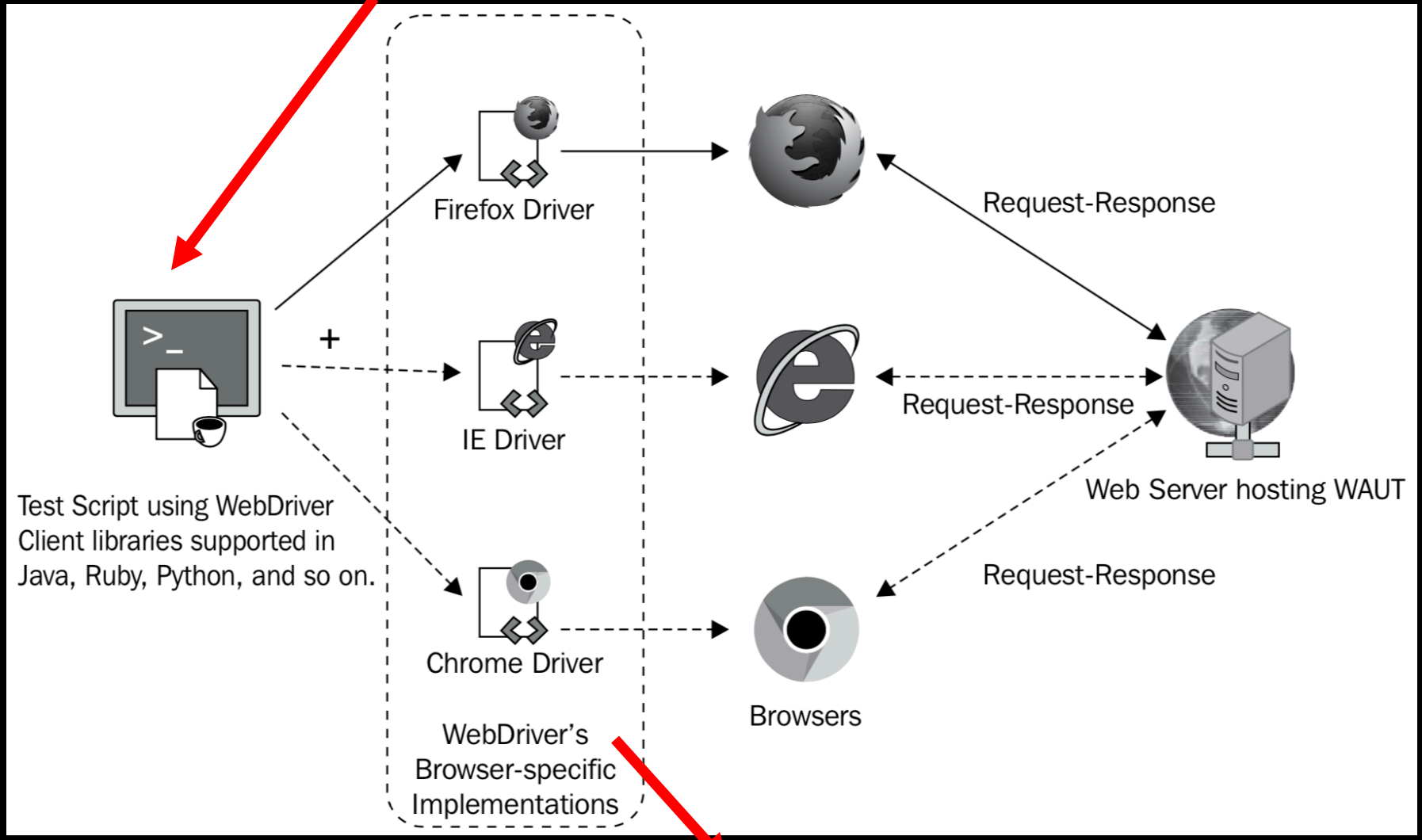
check result

SELENIUM WEBDRIVER

Selenium WebDriver

- Automates the browser
- Software designed to support modern dynamic web pages
- Exploits browser's native support for automation (WebDriver)
- Exposes these features through a uniformed programming interface (API)

Selenium WebDriver



Will work with the browser natively; execute command from outside the browser as the application user would.

How to use Selenium WebDriver

Write a Test script that …

(1) Goes to a page

(2) Locates an element

(3) Does something with that element (e.g., click)

...

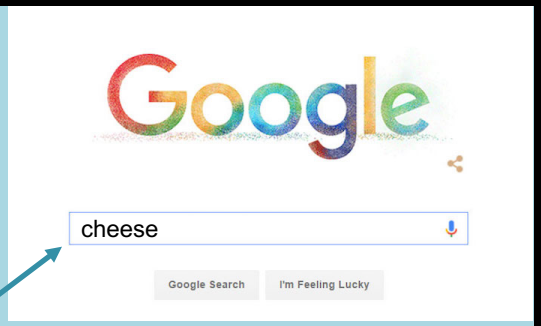
(i) Locates another element

(i+1) Does something with that element

(i+2) Asserts the result

A WebDriver Example

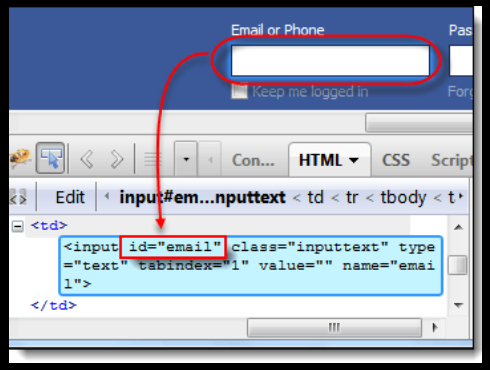
```
...
  libraries
...

public class GoogleTest {

public static void main(String[] args) {

        // Specify the path to Firefox driver executable
        System.setProperty("webdriver.gecko.driver", ”/path/to/geckodriver");
        // Create a new instance of the Firefox driver
        WebDriver driver = new FirefoxDriver();
        // And now use this to visit Google
        driver.get("http://www.google.it");
        // Find the text input element by its ID
        WebElement element = driver.findElement(By.id(“gs_htif0"));
        // Enter something to search for
        element.sendKeys("cheese");
        // Now submit the form. WebDriver will find the form for us from the element
        element.submit();
        // Check the title of the page
        assertEquals("cheese - Search with Google", driver.getTitle());
        //Close the browser
        driver.quit();

    }
}
```



How to locate an element

- **By id**
  - HTML: `<input id="email" ... />`
  - WebDriver:

```
driver.findElement( By.id("email") );
```



- **By name**
  - HTML: `<input name="cheese" type="text"/>`
  - WebDriver: `driver.findElement( By.name("cheese") );`

- **By Xpath**

  - HTML

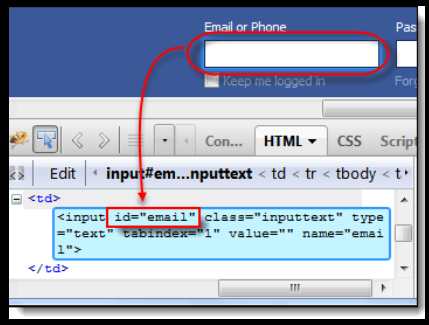
```
<html>
  <input type="text" name="example" />
  <input type="text" name="other" />
</html>
```

  - WebDriver: `driver.findElement( By.xpath("/html/input[1]") );`

- …

Different types of locators!

XPath locators:
an alternative



- **Ids** are the **best choice**, however…
  - Ids don't always exist
    - adding Ids everywhere is impractical or not viable
  - Their uniqueness is not enforced
  - In some cases, they are 'auto-generated' and so unreliable

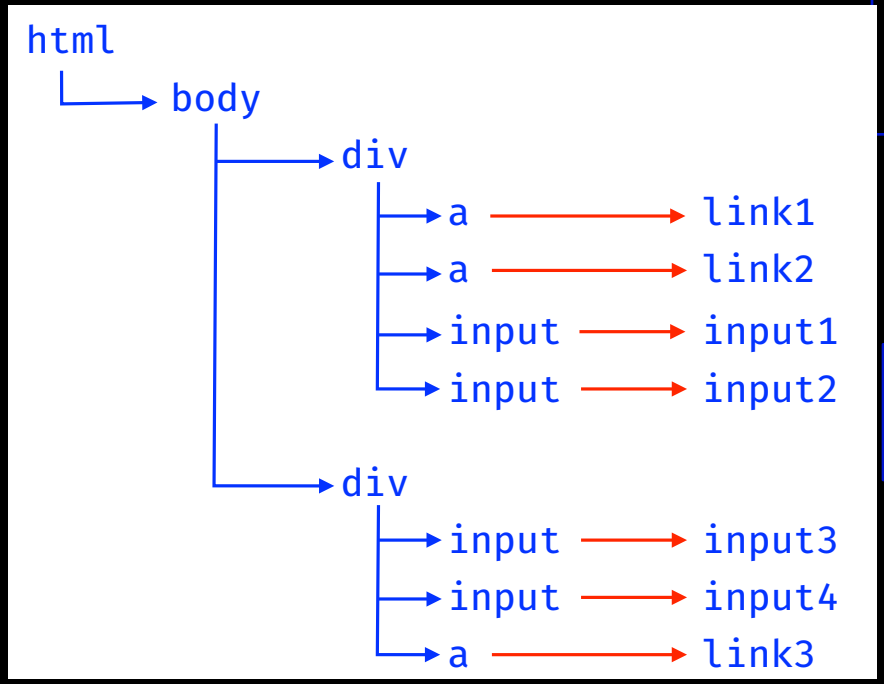
```
driver.findElement(By.id("id_fZI_1")).click();
```

- So **often it is not possible using IDs locators**
  - An alternative is using XPath expressions

Absolute vs. relative XPath

XPath (XML Path Language) is a query language for selecting nodes from an XML document

DOM tree representation



Absolute XPath. It begins with single slash "/" which means start the search from the **root** node

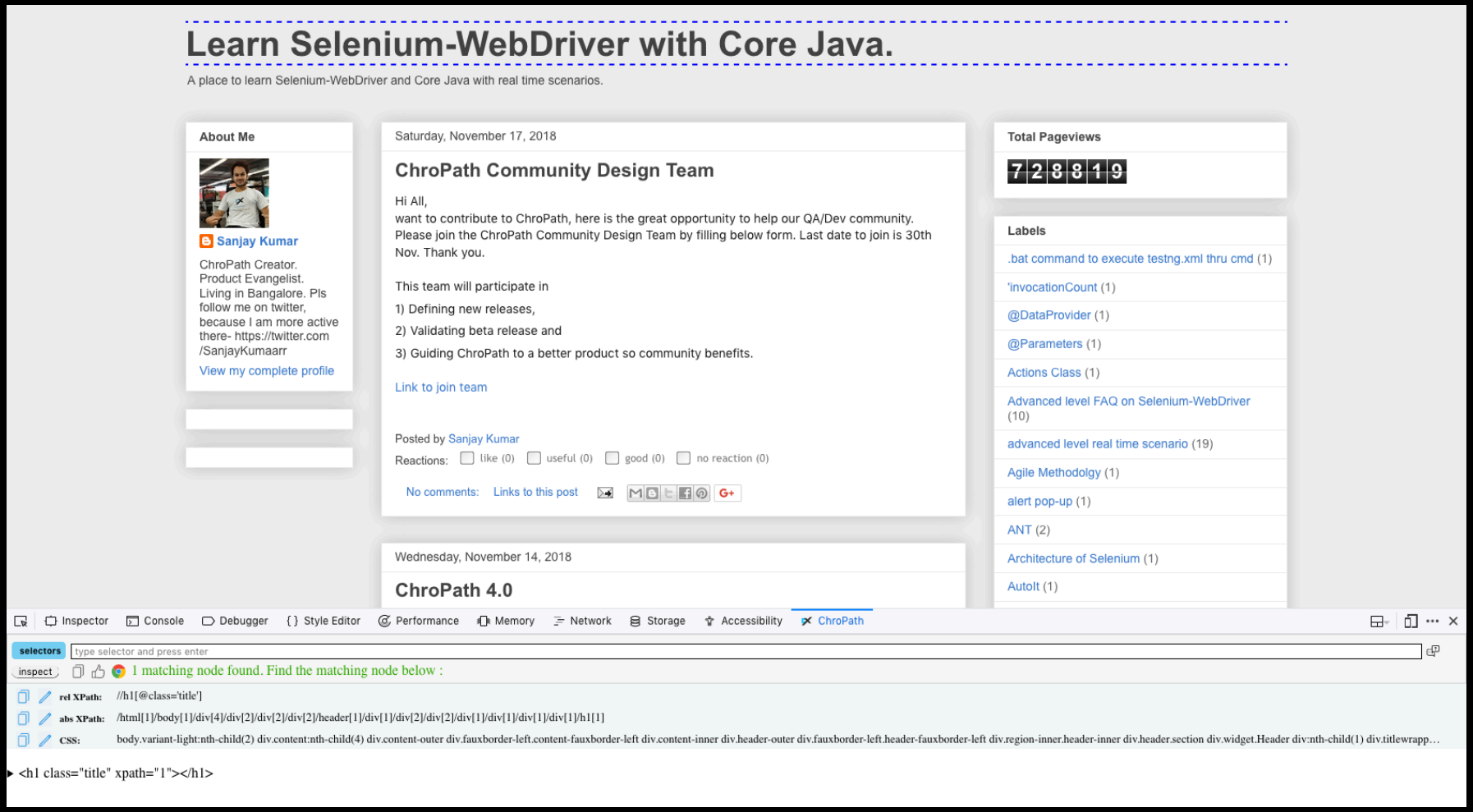
/html/body/div/input => input{1,2,3,4}
/html/body/div[1]/input[2] => input2

Relative XPath. It begins with double slash "//" which represents **search in the entire web page**

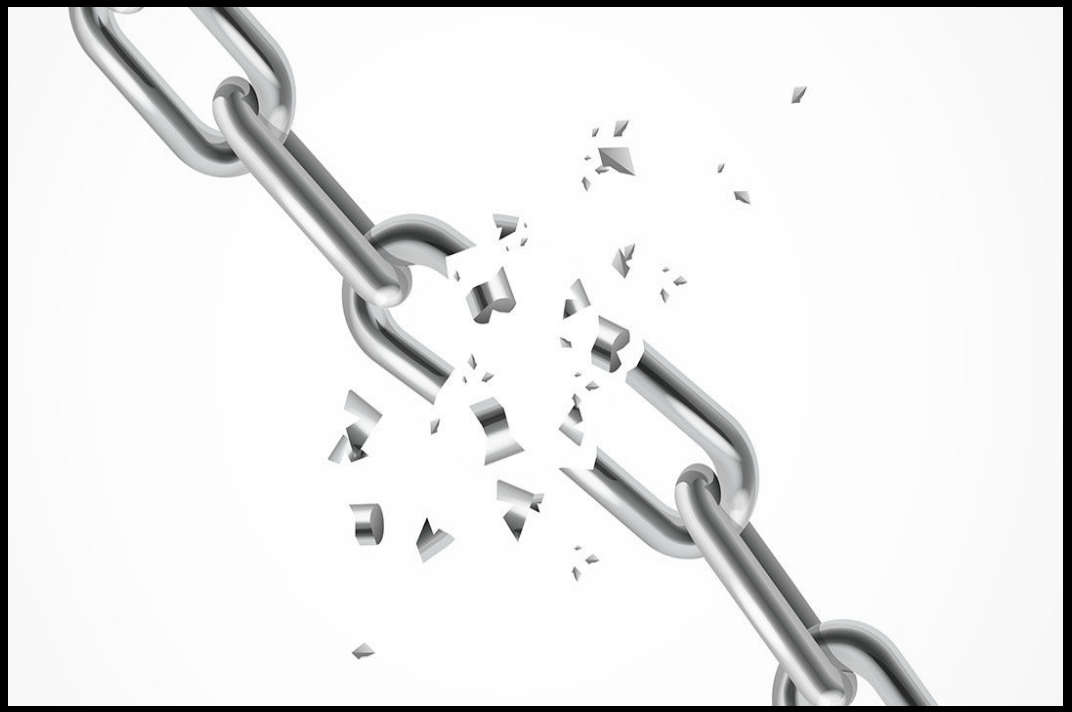
//input => input{1,2,3,4}
//div/input[1] => input{1,3}
//div[2]/input[2] => input4

Still relative: /body//a => link{1,2,3}
Search in the entire subtree under the body node

How to compute XPath



How to cope with dynamism



- One of top reason tests fail
- Due to Javascript DOM manipulation at runtime
- Workaround:
  - Static delays ←
  - Dynamic delays

PAGE OBJECT DESIGN PATTERN

Really Simple Web App

http://www.kimschiller.com/page-object-pattern-tutorial/

Test Script for Simple Web App

```
public class SimpleTestClass extends BaseTest {

private static WebDriver driver;

@Test
public void testMethod(){
   // Find the Web elements composing the form
   WebElement firstname = driver.findElement(By.id("//input[@id='firstname']"));
   WebElement lastname = driver.findElement(By.id("//input[@id='lastname']"));
   WebElement address = driver.findElement(By.id("//input[@id='address']"));
   WebElement zipcode = driver.findElement(By.id("//input[@id='zipcode']"));
   // Enter firstname and lastname
   firstname.sendKeys("foo");
   lastname.sendKeys("bar");
   // Enter address and zipcode
   address.sendKeys("street foobar, 10");
   zipcode.sendKeys("18017");
   // Now submit the form
   WebElement submitButton = driver.findElement(By.xpath("//input[@id='signup']"));
   submitButton.click();
   // Check the confirmation Header (novel page)
   assertEquals("Thank you!", driver.findElement(By.xpath("html[1]/body[1]/h1[1]")).getText());
 }
}
```

Test Script quality

- Test scripts are difficult to read
  - A lot of implementation details
- Often changes in the Web app breaks multiple tests
  - Fragile test scripts
- Duplication of locators and code across test scripts
  - **no reuse !**

IDEA

Adopting the Page Object Pattern!

Page Object Pattern

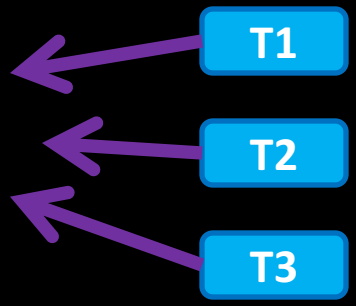
- A **level of abstraction** between the **test scripts** and the **web pages**
  - with the aim of **reducing** the **coupling** among them

- **Idea**: **creating** a **page class** for **each web page**
- Each **method encapsulates** a page's functionality
  - e.g., Login

Page Object Pattern: the idea …

Test scripts use login() offered by LoginPage


```
public class LoginPage {
...
  public HomePage login( ...) {
   ...
   ...
  }

  ... Other methods ...
}
```

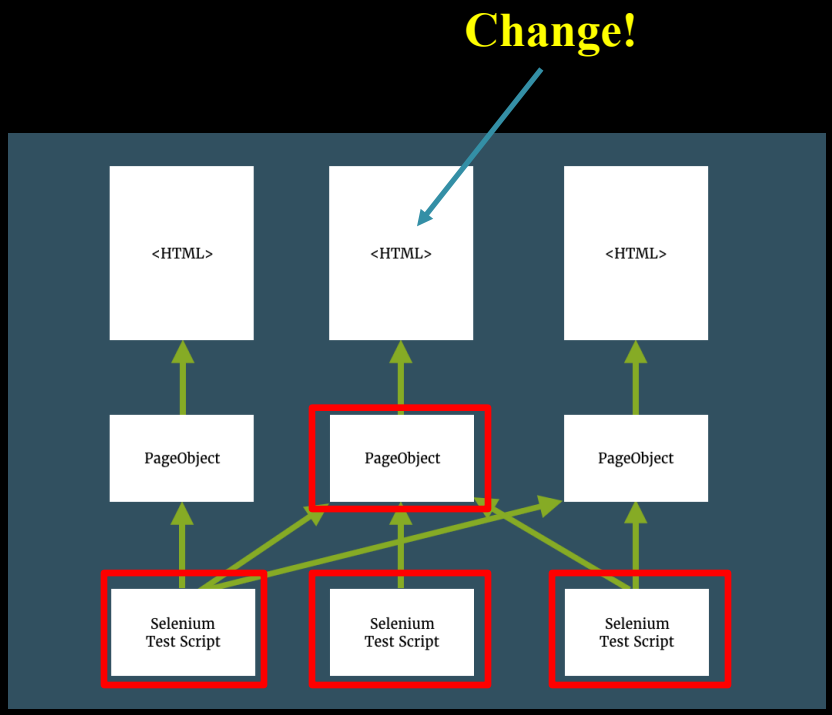


Implementation details are here!

Only Test Logic Here!

Advantages

- **Test scripts are simpler**
  - Implementation details are in the POs
  - Easier to read (app specific API)
- **Reuse**
  - The same method is called by several Test scripts
    - e.g., login()
- **Maintenance effort reduction**
  - A change in a Web page can affect only one PO
    - not a bunch of Test scripts!



Page Object Creation: SignUpPage

```
public class SignUpPage extends PageObject {

@FindBy(xpath="//input[@id='firstname']")
private WebElement firstName;

@FindBy(xpath="//input[@id='lastname']")
private WebElement lastName;

@FindBy(xpath="//input[@id='address']")
private WebElement address;

@FindBy(xpath="//input[@id='zipcode']")
private WebElement zipCode;

@FindBy(xpath="//input[@id='signup']")
private WebElement submitButton;

public SignUpPage(WebDriver driver) {
  super(driver);
}
```

@FindBy annotation!

PO methods

```
 public void enterName(String firstName, String lastName){
  this.firstName.clear();
  this.firstName.sendKeys(firstName);
  this.lastName.clear();
  this.lastName.sendKeys(lastName);
 }

 public void enterAddress(String address, String zipCode){
  this.address.clear();
  this.address.sendKeys(address);
  this.zipCode.clear();
  this.zipCode.sendKeys(zipCode);
 }

 public ReceiptPage submit(){
  this.submitButton.click();
  return new ReceiptPage(driver);
 }
}
```

Page Object Creation: ReceiptPage

```
public class ReceiptPage extends PageObject {

 @FindBy(xpath="/html[1]/body[1]/h1[1]")
 private WebElement header;

 public ReceiptPage(WebDriver driver) {
  super(driver);
 }

 public String confirmationHeader(){
  return header.getText();
 }
}
```

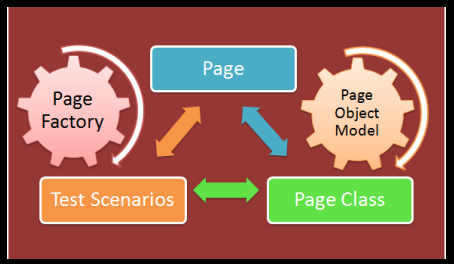
Getter method

Assertions are inserted in the Test Script

Page Object Creation: PageObject

- Now, this will actually not work, until we **initialize the Web Elements** that we have annotated

```
public class PageObject {

protected WebDriver driver;

 public PageObject(WebDriver driver){
  this.driver = driver;
  PageFactory.initElements(driver, this);
 }
}
```



The PageFactory (WebDriver framework) locates the element on the page using the annotated selector and instantiates the Web elements

(Refactored) Test script

Setup is included

PO methods are called

```
public class SignUpFormTest extends BaseTest {

@Test
public void signUp() {
 SignUpPage signUpPage = new SignUpPage(driver);

 signUpPage.enterName("foo", "bar");
 signUpPage.enterAddress("street foobar, 10", "18017");
 ReceiptPage receiptPage = signUpPage.submit();

 assertEquals("Thank you!", receiptPage.confirmationHeader());
 }
}
```

Test scripts are simpler!

Getter method is used for creating the assertion

Page Objects Best practices

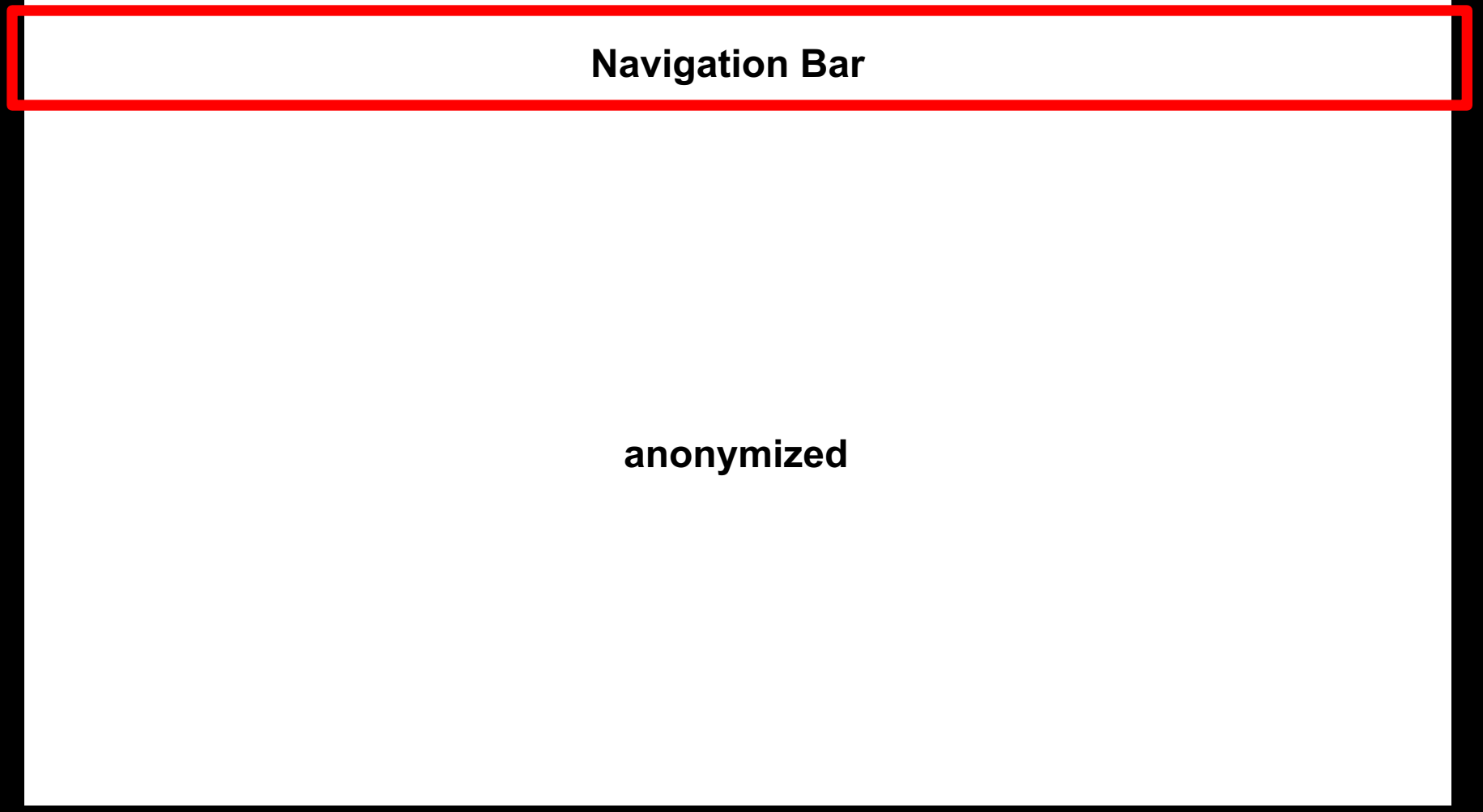
1. A page object should not have any assertion
   - but only **getter methods**

2. A page object should represent meaningful elements of a page and not necessarily a complete page

3. When you navigate you should return a page object for the next page

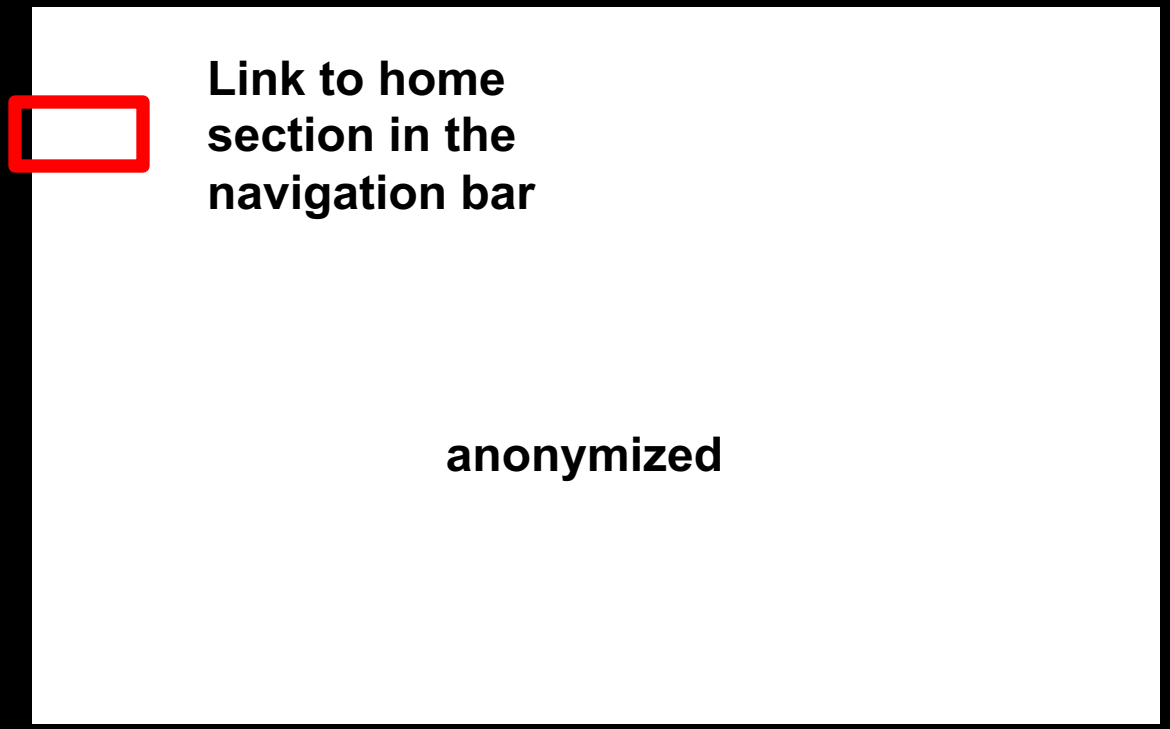
4. Factorize common components of a page
   - Ex. menu present in several pages = PO component
     the pages containing the Menu = PO containers

PO Containers and Components (1)



PO Containers and Components (2)

Home Page




```
public class HomePO extends PageObject {
  @FindBy(how=How.XPATH, xpath=" …")
  private WebElement home;
  @FindBy(how=How.XPATH, xpath ="…")
  private WebElement people;

  public HomePO goToHome() {
    home.click();
    return new HomePO(driver);
  }

  public PeopleContainerPO goToPeople() {
    people.click();
    return new PeoplePO(driver);
  }
}
```

PO Containers and Components (3)

People Page

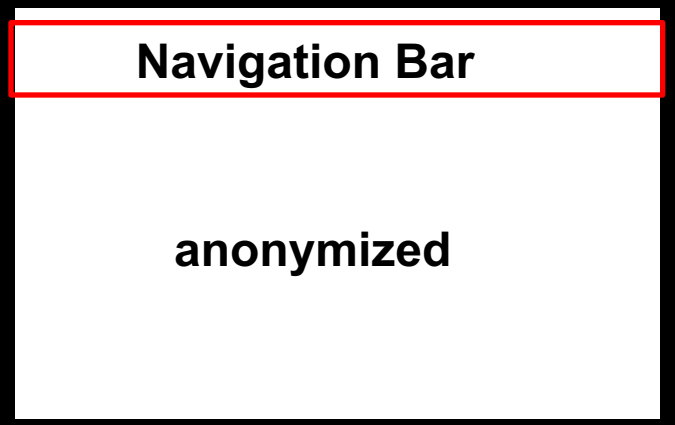
Link to people section in the navigation bar

anonymized

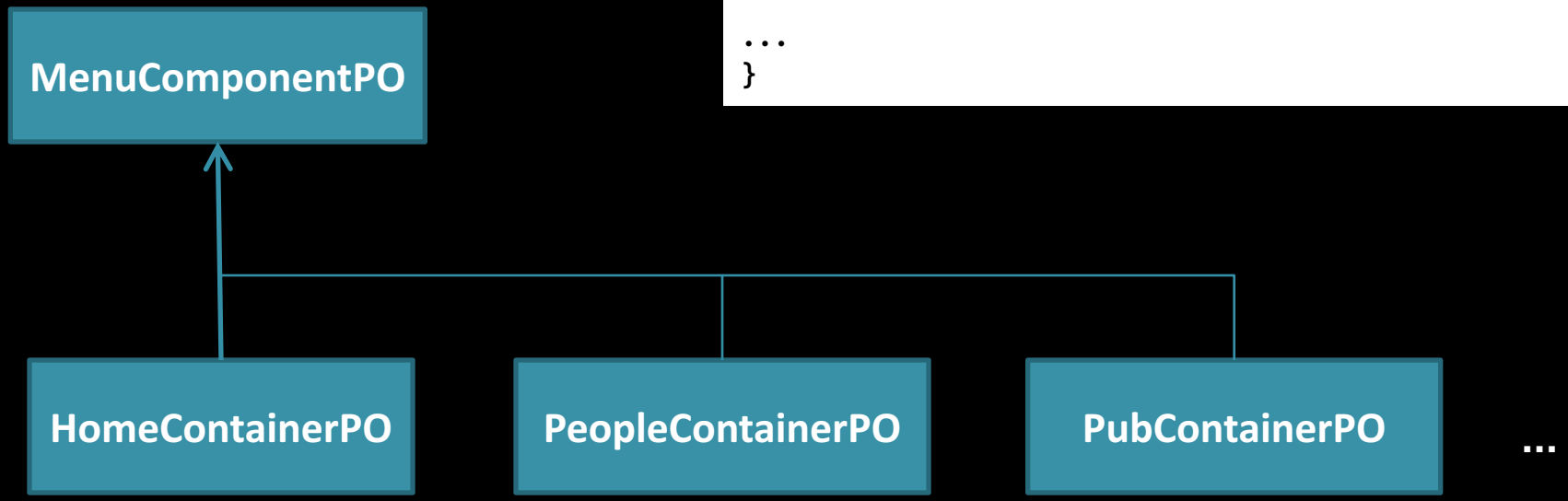
```
public class PeoplePO extends PageObject
{
  @FindBy(how=How.XPATH, xpath=" …")
  private WebElement home;
  @FindBy(how=How.XPATH, xpath ="…")
  private WebElement people;

  public HomePO goToHome() {
    home.click();
    return new HomePO(driver);
  }

  public PeopleContainerPO goToPeople() {
    people.click();
    return new PeoplePO(driver);
  }
}
```

Bad choice!! A lot of duplicated code …

PO Containers and Components (4)




```
public class MenuComponentPO extends PageObject {
  @FindBy(how=How.XPATH, xpath =" ... ")
  private WebElement home;
  @FindBy(how=How.XPATH, xpath =" ... ")
  private WebElement people;

public HomeContainerPO goToHome() {
  home.click();
  return new HomeContainerPO(driver);
}

public PeopleContainerPO goToPeople() {
  people.click();
  return new PeopleContainerPO(driver);
}

...
}
```



Useful References

- **Selenium WebDriver Documentation**
  - http://www.seleniumhq.org/docs/03_webdriver.jsp
- **Selenium WebDriver Tutorial**
  - http://toolsqa.com/selenium-tutorial/
  - http://toolsqa.com/selenium-webdriver/configure-eclipse-with-selenium-webdriver/
  - http://elementalselenium.com/tips/47-waiting
- **ChromeDriver**
  - https://sites.google.com/a/chromium.org/chromedriver/getting-started
- **XPath in Selenium: Complete Guide**
  - http://www.guru99.com/xpath-selenium.html
- **Getting started with Page Object Pattern**
  - https://www.pluralsight.com/guides/software-engineering-best-practices/getting-started-with-page-object-pattern-for-your-selenium-tests
- **Page Factory**
  - https://github.com/SeleniumHQ/selenium/wiki/PageFactory