CSC 7003 : Basics of Software Engineering

J Paul Gibson, A207

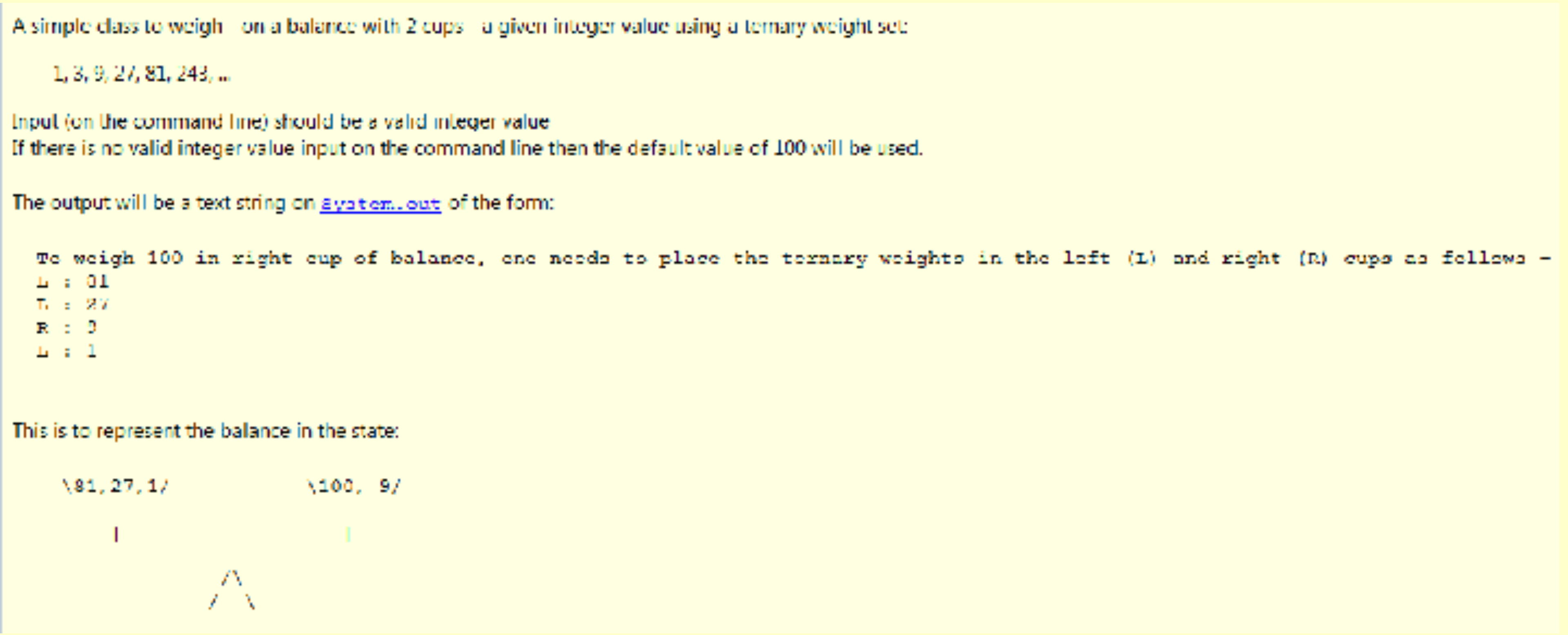
paul.gibson@telecom-sudparis.eu

http://www-public.telecom-sudparis.eu/~gibson/Teaching/CSC7003/

The Balance Problem : Sample Solution

/~gibson/Teaching/CSC7003/L2-TheBalanceProblem-SampleSolution.pdf

The Ternary Weight System



A simple class to weigh - on a balance with 2 cups - a given integer value using a ternary weight set:

1, 3, 9, 27, 81, 243, ...

Input (on the command line) should be a valid integer value
If there is no valid integer value input on the command line then the default value of 100 will be used.

The output will be a text string on system.out of the form:

```
 To weigh 100 in right cup of balance, one needs to place the ternary weights in the left (L) and right (R) cups as follows -
 L : 81
 L : 27
 R : 9
 L : 1
```

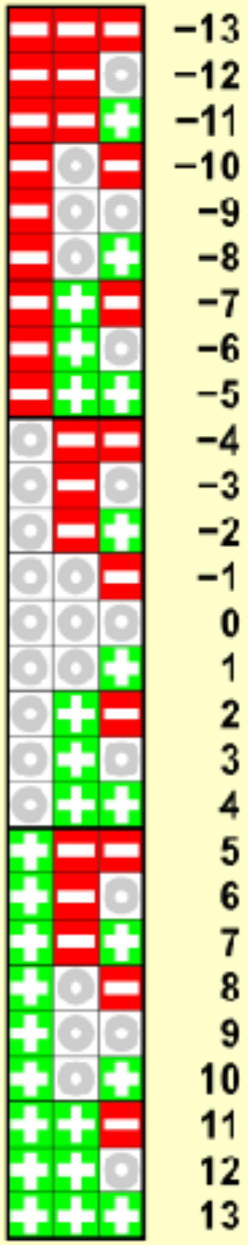
This is to represent the balance in the state:

```
   \81,27,1/           \100, 9/

       |                   |

              /\
             /  \
```

TO DO: Develop this application (in whatever language you wish) and demonstrate your best software engineering techniques/skills.

The Balanced Ternary System

Donald Knuth:
"Perhaps the prettiest number system of all is balanced ternary."



Some <u>**problem analysis**</u> (secondary sources):

1. http://en.wikipedia.org/wiki/Balanced_ternary
2. http://homepage.cs.uiowa.edu/~jones/ternary/arith.shtml
3. http://rosettacode.org/wiki/Balanced_ternary
4. http://ternary.3neko.ru/history_of_ternary.html

Solution C/C++

Rapid prototyping

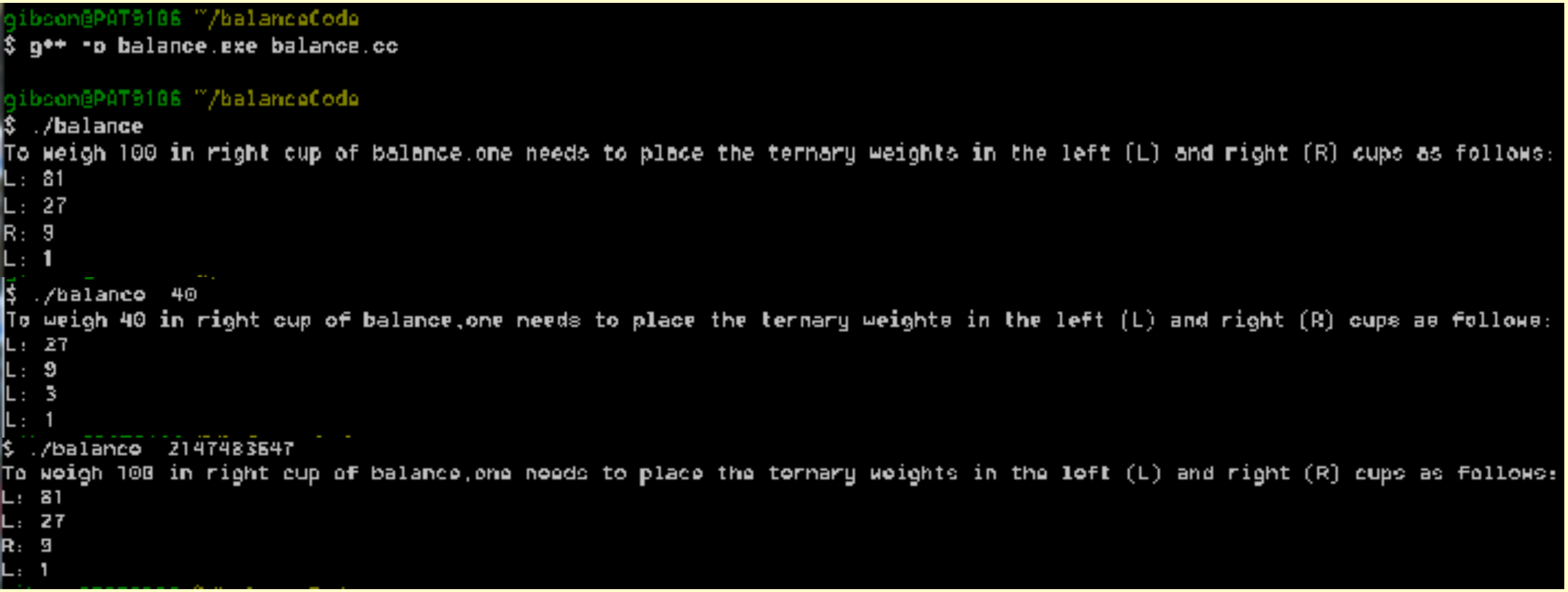
```
#include <iostream>
#include <stdlib.h>
#include <LIMITS.H>
using namespace std;

char flip(char side){
if (side == 'L') return 'R'; else return 'L';}

void split(int target, char side){
if (target ==0) return;
int power3 =1;
while (power3<target) power3=power3*3;
if (target == power3) {cout <<side<<": "<<target;return;}
if (target <= power3/2)
      {cout<<side<<": "<<power3/3<<endl; split(target-power3/3, side);}
else  {cout<<side<<": "<<power3<<endl; split(power3-target, flip(side));}
}

int main(int argc, char* argv[]){
int target;
if (argc <2) target = 100; else target = atoi(argv[1]);
if (target <1 || target > INT_MAX /2 )  target = 100;

cout <<"To weigh " << target <<" in right cup of balance,";
cout <<"one needs to place the ternary weights in the left (L) and right (R) cups as follows:\n";
split(target, 'L');
}
```

This shows my programming skills but not necessarily my software engineering skills

Solution C/C++

Is this solution acceptable?

- How (easy) to compile/make?
- How (easy) to execute?
- How (easy) to test?
- How (easy) to understand?
- How (easy) to maintain/improve?
- How (easy) to re-use?



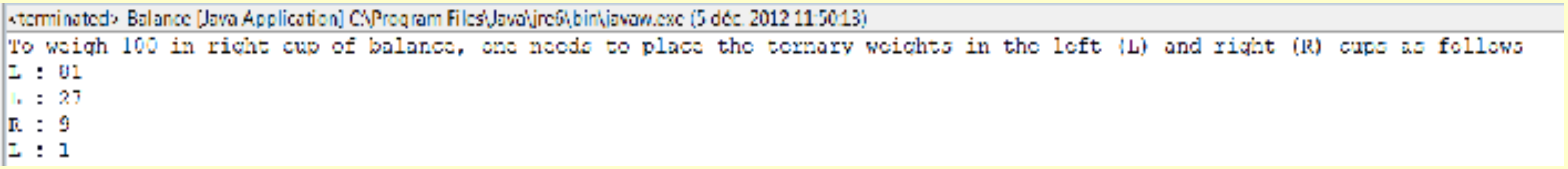
```
gibson@PAT9186 ~/balanceCode
$ g++ -o balance.exe balance.cc

gibson@PAT9186 ~/balanceCode
$ ./balance
To weigh 100 in right cup of balance.one needs to place the ternary weights in the left (L) and right (R) cups as follows:
L: 81
L: 27
R: 9
L: 1
$ ./balance  40
To weigh 40 in right cup of balance.one needs to place the ternary weights in the left (L) and right (R) cups as follows:
L: 27
L: 9
L: 3
L: 1
$ ./balance  2147483647
To weigh 100 in right cup of balance.one needs to place the ternary weights in the left (L) and right (R) cups as follows:
L: 81
L: 27
R: 9
L: 1
```

The *same* solution (in Java)

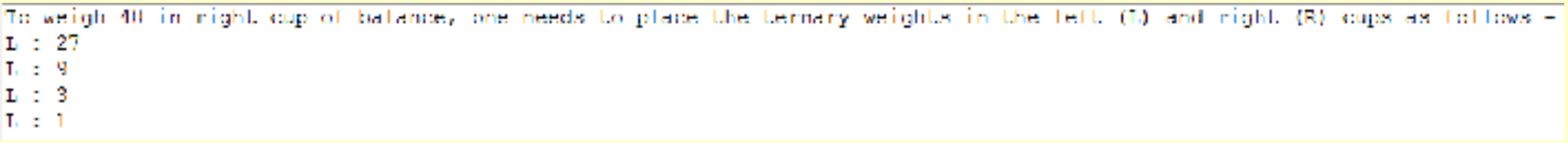
```
public class Balance
{

static char flip (char side){

if (side == 'L') return 'R';
                 else return 'L';
}

static void split (int target, char side){

if (target ==0) return;

int power3 =1;
while (power3 < target){power3=power3*3;}

if (target  == power3){System.out.println(side+" : "+ target);
return;}
if (target <= power3/2){System.out.println(side+" : "+ power3/3);
                        split(target-power3/3, side); return;}
else {System.out.println(side+" : "+ power3);
        split(power3-target, flip(side)); return;}

}
```

The *same* solution (in Java)

```
public static void main (String [] args){

int target = 100; // default test value

if (args.length > 0)
try{target = Integer.parseInt(args[0]);}
    catch (NumberFormatException exc){target = 100;}

if (target > Integer.MAX_VALUE/2) target = 100;

System.out.print("To weigh "+target+" in right cup of balance, one needs to place the
ternary weights in the ");
System.out.println("left (L) and right (R) cups as follows - ");
split(target, 'L');

}
}
```



```
<terminated> Balance [Java Application] C:\Program Files\Java\jre6\bin\javaw.exe (5 déc. 2012 11:50:13)
To weigh 100 in right cup of balance, one needs to place the ternary weights in the left (L) and right (R) cups as follows
L : 81
L : 27
R : 9
L : 1
```



```
To weigh 40 in right cup of balance, one needs to place the ternary weights in the left (L) and right (R) cups as follows -
L : 27
L : 9
L : 3
L : 1
```

The *same* solution (in Java)

Is this solution acceptable?

- How (easy) to compile/make?
- How (easy) to execute?
- How (easy) to test?
- How (easy) to understand?
- How (easy) to maintain?
- How (easy) to re-use?

Did changing language make any difference to these issues?

A software engineering *solution*

Functional correctness is important but there are other issues:

•How to compile/make? … should be as simple as possible (with as few dependencies/requirements as possible)

•How to execute? … should be as simple as possible

•How to test? … should be automated and ‘of high quality’

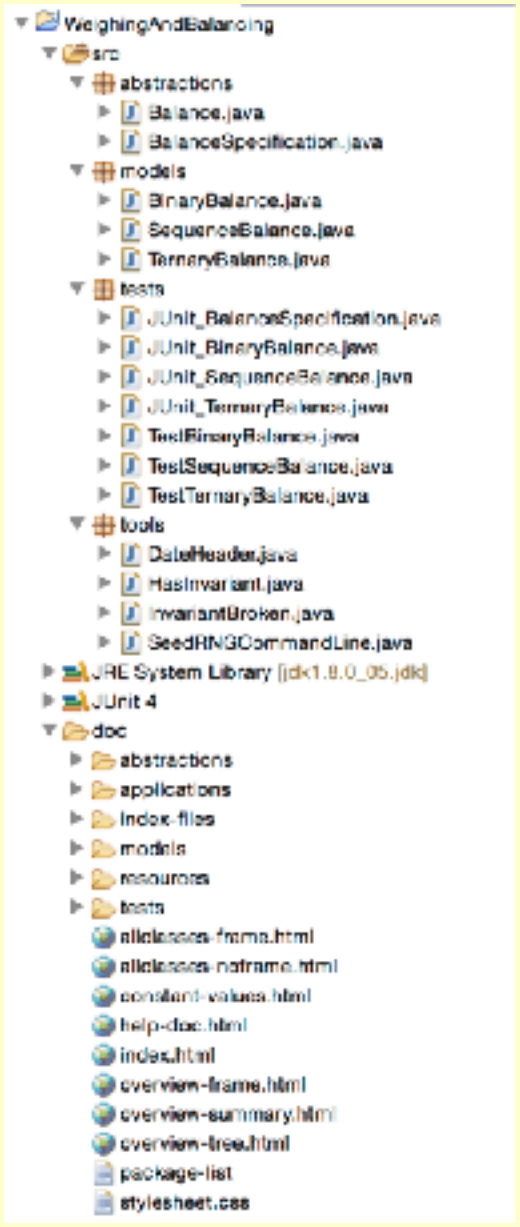
•How to understand? … should be documented and ‘of high quality’

•How to maintain? … should be documented and well-structured/designed

•How to re-use? … should be correct and documented

Did changing language make any difference to these issues?

A better solution: WeighingAndBalancing.zip


```
WeighingAndBalancing
  src
    abstractions
      Balance.java
      BalanceSpecification.java
    models
      BinaryBalance.java
      SequenceBalance.java
      TernaryBalance.java
    tests
      JUnit_BalanceSpecification.java
      JUnit_BinaryBalance.java
      JUnit_SequenceBalance.java
      JUnit_TernaryBalance.java
      TestBinaryBalance.java
      TestSequenceBalance.java
      TestTernaryBalance.java
    tools
      DateHeader.java
      HasInvariant.java
      InvariantBroken.java
      SeedRNGCommandLine.java
  JRE System Library [jdk1.8.0_05.jdk]
  JUnit 4
  doc
    abstractions
    applications
    index-files
    models
    resources
    tests
    allclasses-frame.html
    allclasses-noframe.html
    constant-values.html
    help-doc.html
    index.html
    overview-frame.html
    overview-summary.html
    overview-tree.html
    package-list
    stylesheet.css
```

QUESTIONS:

What design decisions did I make?

Is all this extra work worth the effort?

What could be improved?

I followed a process, and I used tools to help support the process

Analysis – Specification – Design – Implementation- Testing – Re-use/Maintenance

IDE (Eclipse + plugins) –
editor, compiler, debugger, profiler, version control

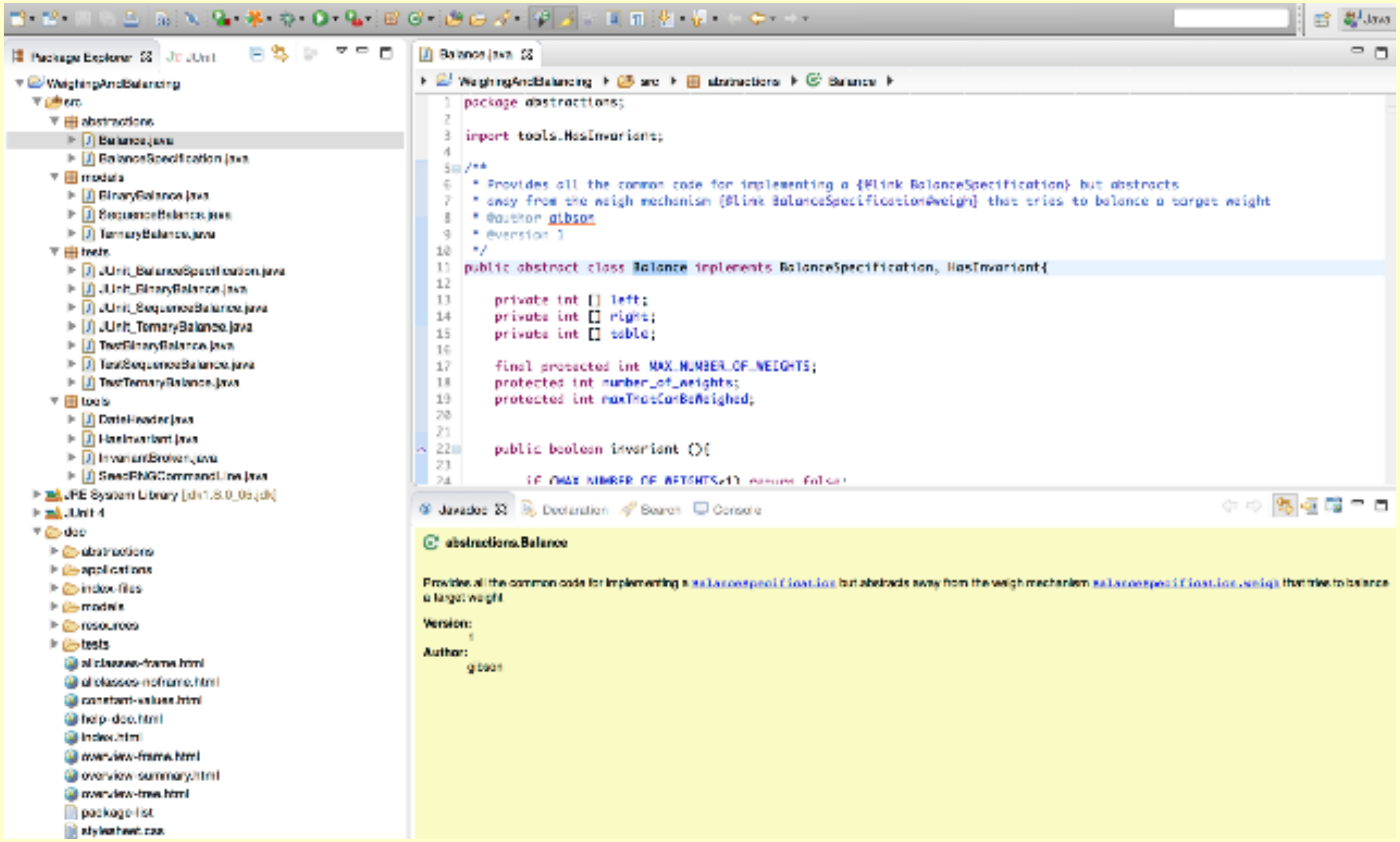
Documentation – Javadocs

Testing – JUnit

Design – OO (UML)

Implementation - Java

Typical Working Screenshot of a Software Engineer



Package Explorer | JUnit

```
▼ WeighingAndBalancing
  ▼ src
    ▼ abstractions
      ▶ Balance.java
      ▶ BalanceSpecification.java
    ▼ models
      ▶ BinaryBalance.java
      ▶ SequenceBalance.java
      ▶ TernaryBalance.java
    ▼ tests
      ▶ JUnit_BalanceSpecification.java
      ▶ JUnit_BinaryBalance.java
      ▶ JUnit_SequenceBalance.java
      ▶ JUnit_TernaryBalance.java
      ▶ TestBinaryBalance.java
      ▶ TestSequenceBalance.java
      ▶ TestTernaryBalance.java
    ▼ tools
      ▶ DateHeader.java
      ▶ HasInvariant.java
      ▶ InvariantBroken.java
      ▶ SeedRNGCommandLine.java
  ▶ JRE System Library [jdk1.8.0_05.jdk]
  ▶ JUnit 4
  ▼ doc
    ▶ abstractions
    ▶ applications
    ▶ index-files
    ▶ models
    ▶ resources
    ▶ tests
      allclasses-frame.html
      allclasses-noframe.html
      constant-values.html
      help-doc.html
      index.html
      overview-frame.html
      overview-summary.html
      overview-tree.html
      package-list
      stylesheet.css
```

Balance.java

WeighingAndBalancing ▶ src ▶ abstractions ▶ Balance ▶

```java
package abstractions;

import tools.HasInvariant;

/**
 * Provides all the common code for implementing a {@link BalanceSpecification} but abstracts
 * away from the weigh mechanism {@link BalanceSpecification#weigh} that tries to balance a target weight
 * @author gibson
 * @version 1
 */
public abstract class Balance implements BalanceSpecification, HasInvariant{

    private int [] left;
    private int [] right;
    private int [] table;

    final protected int MAX_NUMBER_OF_WEIGHTS;
    protected int number_of_weights;
    protected int maxThatCanBeWeighed;


    public boolean invariant (){

        if (MAX_NUMBER_OF_WEIGHTS<1) return false;
```

Javadoc | Declaration | Search | Console

abstractions.Balance

Provides all the common code for implementing a BalanceSpecification but abstracts away from the weigh mechanism BalanceSpecification.weigh that tries to balance a target weight

Version:
1

Author:
gibson

Let’s Experiment Together With The ‘Solution’ (for a few minutes)