DEPARTMENT OF PHYSICS & ASTRONOMY
PHAS3459 EXAM 1
17th November 2010, 10:00 to 13:00

Please read the exam guidelines, rules, instructions and marking criteria at
http://moodle.ucl.ac.uk/mod/wiki/view.php?id=13963&page=Mid-term+exam
(linked from the Exams and coursework page).

This exam is worth 25% of your final mark for the course and is made up of
two parts:
  • 15 multiple-choice questions, worth 7.5% of your final mark;
  • a programming exercise, worth 17.5% of your final mark.

You should endeavour to spend no more than 30 minutes on the
multiple-choice section.

Both your answers to the multiple-choice questions (in a file called mc.txt) and the
Java source code of your solution to the programming exercise should be
uploaded using Moodle under the section headed "Exam 1".

PROGRAMMING EXERCISE

Note : no knowledge of particle physics is required to answer this question.

You will write Java classes and methods to read data from two URLs, analyse the data and present the results.

Five different neutrino oscillation experiments have produced a list of all of the neutrino events that were detected before 2010. The file containing this list of events is available at:

> `http://www.hep.ucl.ac.uk/undergrad/3459/exam-data/NeutrinoEvents.txt`

Each line in the file contains data for a single neutrino event, in the following order:
- the name of the experiment,
- the type of neutrino interaction (`nue`, `numu`, `nutau` or `NC`),
- the energy of the neutrino in GeV.

The experiments are aiming to detect neutrino oscillations by either measuring an excess or a deficit of events, relative to the prediction in the absence of oscillations. The file containing the list of predictions is at:

> `http://www.hep.ucl.ac.uk/undergrad/3459/exam-data/NeutrinoExperiments.txt`

This file contains information in the following order:
- the name of the experiment,
- the type of neutrino interaction (`nue`, `numu`, `nutau` or `NC`),
- the predicted number of events of this interaction type (note this is not necessarily an integer).

Note that each experiment is only able to detect a subset of the neutrino interaction types, the file only contains lines for those interaction types for which the individual experiments are sensitive.

You should write a program using appropriate classes and methods to read the data from the two URLs and store them in suitable collection objects. You should
- print out the number of events each experiment measures, N_M, for each of the interaction types to which the experiment is sensitive;
- calculate the "significance" of each measured excess or deficit using $(N_M - N_P)/\sqrt{N_P}$ where N_P is the predicted number of events.
- for each neutrino interaction type print a summary of the experimental evidence for neutrino appearance, which requires $(N_M - N_P)/\sqrt{N_P} > 3$, or disappearance, which requires $(N_M - N_P)/\sqrt{N_P} < -3$.

MULTIPLE CHOICE

You should endeavour to spend no more than 30 minutes on the multiple-choice section.

DO NOT WASTE TIME CODING THE QUESTIONS TO GET THE ANSWERS

You should enter your answers to the multiple-choice questions into a text file called mc.txt created using a text editor such as WordPad. Please use plain text, not e.g. RTF or Word format.

The file should have the following format:

01 a

02 b

03 c

...

14 b

15 a

There is exactly one correct answer to each question.

Q1   How many lines will be printed to the screen if the following code is compiled and run?

```
int x=0;
do {
    System.out.println("Hello");
    x++;
} while (x<0);
```

(a) 0
(b) 1
(c) 2
(d) 3

Q2   What will be printed to the screen if the following code is compiled and run?

```
for (int j=4; j>0; j--) {
    System.out.print(j);
}
```

(a) 1234
(b) 4321
(c) 43210
(d) 3210

Q3   What will be printed to the screen if the following code is compiled and run?

```
int a[] = {1, 2, 3, 4, 5};
System.out.println(a[4]);
```

(a) 1234
(b) 4
(c) 5
(d) java.lang.ArrayIndexOutOfBoundsException

Q4   What will be printed to the screen if the following code is compiled and run?

```
HashMap<String,String> m = new HashMap<String,String>();
m.put("key", "value");
m.put("key", "new value");
System.out.println(m.get("key"));
```

(a) key
(b) value
(c) new value
(d) value new value

Q5   What will be printed to the screen if the following code is compiled and run?

```java
public class MyClass {
    private String name;
    public MyClass(String name) {this.name = name;}
    public void setName(String newName) {
        name = newName;
    }
    public void printName() {System.out.println(name);}
    public static void main(String[] args) {
        MyClass a = new MyClass("Alpha");
        MyClass b = a;
        b.setName("Bravo");
        a.printName();
    }
}
```

(a) a
(b) b
(c) Alpha
(d) Bravo

Q6   Which of the following lines will successfully create an ArrayList object and add a String element?

(a) `ArrayList k = new ArrayList("a");`
(b) `ArrayList<String> k = new ArrayList<String>();`
   `k.add("a");`
(c) `ArrayList k = {"a"};`
(d) `ArrayList<String> k = new String[]; k.add("a");`

Q7   What does `static` mean in the following code extract?

```java
public class Calculator {
    private static String name = "Charlie";
    // ...
}
```

(a) There is only one variable called name in the class Calculator shared across all instances of the class.
(b) There is one variable called `name` in each instance of the class `Calculator`.
(c) The value of `name` cannot be changed once it has been set.
(d) The value of `name` can only be read within the class `Calculator`.

Q8   What must be changed to make this code compile correctly?

```
public class ExceptionTest {
    public static void main(String[] args) {
        method();
    }
    private static void method() {
        throw new Exception();
    }
}
```

(a) Put a `try` block around the call to method and catch the exception.
(b) Add a `throws` clause to the declaration of method.
(c) Both (a) and (b).
(d) Change `private` to `public` in the declaration of method.

Q9   What does `private` mean in the declaration of a method?

(a) The method can only be called from within the object it belongs to.
(b) The method can only be called from within the class it belongs to.
(c) The method can only be called from within the package it belongs to.
(d) The method can only be called from within the application it belongs to.

Q10   Which test would check whether the contents of two strings called `a` and `b` are equal?

```
(a)     if (a=b) // ...
(b)     if (a==b) // ...
(c)     if (equal(a,b)) // ...
(d)     if (a.equals(b)) // ...
```

Q11   What will happen when the following code fragment is compiled and run?

```
double x = Double.parseDouble("10.1");
System.out.println(x);
```

(a) x will be printed to the screen.
(b) 10.1 will be printed to the screen.
(c) A `NumberFormatException` will be thrown.
(d) The code will fail to compile.

Q12 What will be printed to the screen if the following code is compiled and run?

```
String sum = "0";
Scanner s = new Scanner("1 2 3");
while (s.hasNext()) {
    sum += s.next();
}
System.out.println(sum);
```

(a)   123
(b)   0123
(c)   6
(d)   0+1+2+3

Q13 Which of the following would NOT be a valid line of code (i.e. would result in a compilation error) when incorporated into an existing class?

(a)   `public void a(double x) {}`
(b)   `private static double b(int i) {return 2.0;}`
(c)   `public int c() {return 5;}`
(d)   `public void d(int j) {return j*j;}`

Q14 Which three classes would you use in order to read text from a web page?

(a) `URL, BufferedReader, InputStreamReader`
(b) `File, FileReader, BufferedReader`
(c) `URL, FileReader, BufferedReader`
(d) `URL, URLReader, BufferedReader`

Q15 What will be printed to the screen if the following code is compiled and run?

```
System.out.println("Finished " + "1" + "2");
```

(a) `Finished +1+2`
(b) `Finished 3`
(c) `Finished 12`
(d) `Finished Finished Finished`

END OF PAPER