PHYS 488
Exercises Week 3 (14/02 and 15/02/2017)

Please complete the following exercises and submit a report as PDF document (e.g. exported from MS Word) to VITAL as soon as the work is finished. The deadline is the end of Friday, 17/02/2017. Please attend the practical sessions on Tuesday and Wednesday morning in CTL6-PCTC-Orange.

Histogram Class

Last week you worked on a program GenerateHistogram. Today you will perform several improvements to this program, most notably the functionality to make histograms will be moved to a separate, reusable class **Histogram**. As a starting point, you will find two files on VITAL:

- Histogram.java – contains a core functionality for making and filling histograms
- MakeHistograms.java – program to produce random numbers and fill a histograms

Please provide the program code including all the changes you will make only once in your report.

Task 1 **[2 marks]**

Copy the content of these two files into BlueJ and ensure that you can run the program and understand the functionality. What does the constructor do?

Add more methods and variables to the **Histogram class** as outlined in the list below**.** Remember to perform changes step-by-step, testing if the program still compiles after each change. You may also want to briefly test each new functionality before moving on to the next point.

- Add a class member variable that counts how often the histogram has been filled, called "**nfilled**". (It should be set to zero when a histogram is created and incremented any time the "**fill()**" function is called)
- We have no access to the class member variables **underflow, overflow, nfilled.** Add three class methods, that return the value of these variables. They will look similar to the "**getSize()**" function.
- Add a class method that returns the statistical error per bin (in absolute). This should look similar to the "**getContent()**" method.
- Add a class method that returns the sum of all histogram bins, called e.g. "**getIntegral()**".
- Add a class method "**print()**", that reports the contents of all bins, and uses the above functions to report the number of times the histogram has been filled, the sum of all bins, overflows and underflows.

Change the **MakeHistogram** program to use the new "**print()**" method to report the histogram information after filling the histogram.

Explain in your report, why we need dedicated methods to obtain the values of underflow, overflow and nfilled.

Provide an example output of your program.

Task 2 **[1.5 marks]**

Add the method **writeToDisk** from last weeks exercises as a further method to the **Histogram** class. Revise the parameter list and remove parameters that are no longer needed. Explain briefly in your report, why less parameters are needed.

As in the exercise last week, redefine the histogram to cover the range 0.4 to 0.9 and make a graph with Excel that has correctly labelled axes and errors on the y-values.

Please turn over

Task 3 **[1.5 marks]**

Use the method **nearGauss** of the program **MakeHistograms** to fill a second histogram in the main method of MakeHistograms. As parameters for **nearGauss** choose *mean=0 and sigma=0.5*. Print the histogram bin contents and find a suitable combination of number of bins and histogram range to record the distribution (overflows and underflows should be minimal (<1%) and the bulk of the distribution should be represented by a sufficient number of bins).

Write the histogram to disk and make a graph in Excel.

Explain in your report, why the method **nearGauss** gives you a (nearly) Gaussian distribution (look up "central limit theorem") .

Task 4 **[1 mark]**

Use your code make a third histogram that you fill with the numbers D calculated from random numbers r uniformly distributed in the range 0 < r <1 as:

$$D=-C\cdot\ln(r) \qquad \text{with} \quad C=15$$

Work out an appropriate range and binning for this histogram and make a graph of the histogram in Excel.