Tutorial 9

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1.   Significant points

We have built a detector to monitor suspicious alien activity. The detector, which is pointed at space, counts the number of detected subspace transmissions during a certain period of time and writes this data to a file called `detReadout.dat`. Each row of the file has three numbers. The format is *<time> <counts> <flag>*. Table 1 explains the meaning of each field.

Table 1: The meaning of each field in `detReadout.dat`. The data in this file could be represented by a set of points in a graph with time on the x-axis and counts on the y-axis.

<time>	The time in hours at which the detector was read out
<counts>	The number of counts detected since the last readout
<flag>	This flag is 1 if the data is OK, 0 otherwise

The data is probably all background noise, but we want to be sure. Write a C++ program that checks if, at any point, a significant number of subspace transmissions were detected. A point is considered significant if it is at least five standard deviations away from the mean. In case you forgot, the standard deviation of a data sample is given by

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (y_i - \mu)^2} = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (y_i^2) - \mu^2} \tag{1}$$

where N is the number of data points, y_i is the number of counts in the i:th point and μ is the average number of counts in the sample.

Remember to check the data quality flag. If a point is not OK, it should not be included in the calculation.

What values did you obtain for μ and σ?

Answer: The mean is $\mu = 24.96$, the standard deviation is $\sigma = 10.48$ and there is alien activity at 149h (130 counts), 486.4h (219 counts) and 653.8h (84 counts).

1.1 Hints

If you get stuck, you can modify this skeleton code:

```cpp
#include <iostream>
#include <fstream>
#include <vector>
#include <cmath>

using namespace std;

int main() {
    // read the data file
  ifstream inFile("detReadout.dat");
  if(!inFile) {
    cout << "Can't open dataSetFile detReadout.dat" << endl;
    return 1;
  }

  double time = 0.;
  int count = 0;
  bool isOk = false;

  vector<double> times; //Vectors to store the times and counts
  vector<int> counts;

  while(inFile >> time) { //Read each line and store it if it's OK
    inFile >> count;
    inFile >> isOk;
    if(isOk) {
      times.push_back(time);
      counts.push_back(count);
    }
  }
  inFile.close();

  // TODO calculate mean and standard deviation

  double mean = 0;
  double standardDeviation = 0;

  cout << "Mean: " << mean << endl;
  cout << "Standard deviation: " << standardDeviation << endl;

  // TODO loop over counts and calculate deviation from mean. If deviation is
    bigger than 5*standardDeviation - print it.

  return 0;
}
```