COMP-112 Software Development Lab I
Assignment 3 : Calculating π

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HAND-IN DATE: Final Exam Day.

You must hand in:

1. A **report** of your project;
2. The C++ source code of your program.

Any assignment which doesn't include these two items will not be accepted! *A penalty of 10% per day reduction will be applied in case of late submission.*

Problem Description

π is an irrational number, i.e. it cannot be written as a fraction. It's approximate value of π is 3.141592653589793. Below are five different series which can be used to approximate π:

(1) Using the series: $\pi = 4(1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - ...)$

(2) Using the series: $\pi = \sqrt{6(1 + \frac{1}{4} + \frac{1}{9} + \frac{1}{16} + \frac{1}{25} + ...)}$

(3) Using random numbers: if you consider the ratio between the area of the square and the circle of radius 1, both centred in $(0, 0)$, it is approximatively $\pi/4$. Thus an estimate of the value of π can be made from the ratio of the count of points inside the circle to the total number of points in the square.

In order to do that, pick 2 random numbers between -1 and 1. This will give you the coordinate in the plane of a point (x, y). Then check if that point is inside the circle of radius 1 and centre at (0,0) i.e. if $x^2 + y^2 < 1$. Repeat this process as many times as desired.

Since `rand()` generates an integer between 0 and RAND_MAX-1 then `rand() / float(RAND_MAX)` generates a fraction in the range $(0, 1)$. If x is a random number in the range $(0, 1)$ then $1 - 2x$ is a random fraction in the range $(-1, +1)$.

The purpose of the project is to be able to compare these different approximations. For this project, you **will have to write functions** to do each part of the program. Your program will consist of:

- A function for each of the three approximations to calculate the value of π:
  - `double firstApproximation (int n)` returns the approximate value of π using the first series on n terms.
  - `double secondApproximation (int n)` returns the approximate value of π using the second series on n terms.
  - `double thirdApproximation (int n)` returns the approximate value of π using the third random approximation on n random points in the plane.
- A `void` function to display the following menu and return the choice:

```
1.  Approximate Pi using one function.
2.  Compare the different approximations
3.  Exit
```

  - If the user chooses 1, in a function ask the number of iterations and which series he/she wants to use.

```
Which approximation do you want?
1
On how many iterations?
10
```

    It will display the approximated value of π for the series.
  - If the user chooses 2, in a function, ask the number of iterations

```
How many iterations?
10
```

    It will display the result for each series, as well as the best one (i.e. the series that is the closest to the real value of π).
  - If the user chooses 3, the program will exit.