「モデリングとシミュレーション特論」課題 2 （解答例)

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1 乱数と MonteCarlo 法

課題 1 In the example estimating π by a simulation, we generate random numbers in a square with unit length and estimate the value of π using relative frequency of the numbers fallen in the arc within the square. This corresponds to estimate the value of the following integral:

$$\int_0^1 \left(1 - x^2\right)^{1/2} \mathrm{d}x \tag{1.1}$$

As an application of the method above, estimate the following integral using random numbers. Show the code and result here. And validate the result.

$$\int_0^\pi \sin(x)\mathrm{d}x \tag{1.2}$$

解答例 Source Code 1 shows the code to integrate Eq. (1.2) numerically. The method `simpleIntegral` has five arguments. The first `func` denotes the function to be integrated, the second `from` and the third `to` the range of integration, the fourth `max` the maximum of the function `func`, and the last `n` the number of the random points.

Source Code 1 SimpleIntegral.java

```
1 package simpleIntegral;
2
3 import java.util.function.DoubleFunction;
4
5 /**
6  *
```

```
 * @author tadaki
 */
public class SimpleIntegral {

    public static double simpleIntegral(DoubleFunction<Double> func,
            double from, double to, double max, int n) {
        int count = 0;
        for (int i = 0; i < n; i++) {
            double x = (to - from) * Math.random();
            double y = max * Math.random();
            if (y < func.apply(x)) {
                count++;
            }
        }
        return (to - from) * max * count / n;
    }

    /**
     * @param args the command line arguments
     */
    public static void main(String[] args) {
        double s = simpleIntegral(x -> Math.sin(x), 0, Math.PI, 1, 1000000);
        System.out.println(s);
    }

}
```

We obtain the result as 1.997. We can integrate Eq. (1.2) analytically.

$$\int_0^{\pi} \sin(x)\mathrm{d}x = -\left[\cos(x)\right]_0^{\pi} = -\cos(\pi) + \cos(1) = 2$$

As a result, Source Code 1 generates the correct answer.