Exercise 2. *Deadline: 19 October 2009.*

the Java programming language

POLYNOMIALS

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Exercise

A *polynomial* is a mathematical expression involving a sum of powers in one or more variables multiplied by coefficients. A polynomial in one variable (a univariate polynomial) with constant coefficients is given by:

$$P(x) = a_n x^n + a_{n-1}x^{n-1} + \ldots + a_2 x^2 + a_1 x + a_0 = \sum_{i=0}^{n} a_i x^i$$

The individual summands with the coefficients included are called monomials. The highest power in a univariate polynomial is called its order, or sometimes its degree (if n is the degree of a polynomial $P(x)$ then $a_n \neq 0$ for $n > 0$).

Define a class `Polynomial`, which will represent a univariate polynomial. You should define the addition, subtraction and multiplication in this class.

```
public class Polynomial
{
    public final int deg; // degree
    private double[] c; // an array [0...n] with the coefficients

    // constructors
    public Polynomial () {/*...*/} // P(x) = 0 : c.length=0
    public Polynomial (int d) {/*...*/} // P(x) = x^d : c[deg]=1, c[deg-1]=...=c[0]=0
    public Polynomial (double a) {/*...*/} // P(x) = a : c[0]=a
    // P(x) = c[0] + c[1]*x + ... + c[deg]*x^deg : c[0]=a[0], ..., c[deg]=a[a.length-1]
    public Polynomial (int deg, double[] a) throws NullPointerException {/*...*/}

    // read the coefficient c[i]
    public double get (int i) throws IndexOutOfBoundException {/*...*/}
    // set the coefficient c[i]=a
    public void set (int i, double a) throws IndexOutOfBoundException, ArithmeticException {/*...*/}
    // evaluation of a polynomial P(x) - Horner scheme
    public double eval (double x) {/*...*/}

    public static Polynomial add (Polynomial first, Polynomial second) {/*...*/} // addition
    public static Polynomial sub (Polynomial first, Polynomial second) {/*...*/} // subtraction
    public static Polynomial mult (Polynomial first, Polynomial second) {/*...*/} // multiplication
    public static Polynomial mult (Polynomial poly, double c) {/*...*/} // multiply by a constant
    public static Polynomial mult (double c, Polynomial poly) {/*...*/} // multiply by a constant

    public String toString () {/*...*/}
};
```

Evaluation of a polynomial consists of assigning a number to each variable and carrying out the indicated multiplications and additions. Define evaluation method `eval(double)` more efficiently using the Horner scheme:

$$((\ldots(c_{deg}x + c_{deg-1})x + \ldots + c_2)x + c_1)x + c_0$$

Finally write a program, which will test your `Polynomial` class: read two polynomials P and Q from the standard input, calculates $P+Q$, $P-Q$, $P*Q$, $P*2$, and $3*Q$, and write the results to the standard output.