Jutge.org

The Virtual Learning Environment for Computer Programming

Zeroes of polynomials — P97780_en

Primer Concurs de Programació de la UPC - Final (2003-09-23)

Given a function f continuous in an interval $[a, b]$, and such that $f(a) \cdot f(b) < 0$, a basic theorem of Mathematics states that there must exist at least one zero of f in (a, b), that is, a real number z such that $a < z < b$ and $f(z) = 0$.

Given a polynomial $p(x) = c_4x^4 + c_3x^3 + c_2x^2 + c_1x + c_0$ with exactly one zero in $(0, 1)$, can you find this zero?

Input

Each input line describes a polynomial $p(x)$ of degree at most 4 with exactly one zero in $(0, 1)$. Each polynomial is given in decreasing order of i as follows: c_4 4 c_3 3 c_2 2 c_1 1 c_0 0. Every c_i is a real number. The pairs c_i i with $c_i = 0$ are not present in the input.

Output

For every polynomial, print its case number, followed by an approximation of its zero z in $(0, 1)$, with the following convention: z must be a real number with exactly 5 digits after the decimal point, such that $0 \leq z \leq 0.99999$ and $p(z) \cdot p(z + 0.00001) < 0$. Always print the 5 decimal digits of z.

Observations

- Every given polynomial is such that $p(x) \neq 0$ for every real number $x \in [0, 1]$ that has 5 (or less) decimal digits after the decimal point.
- The test cases have no precisions issues. However, be aware that it is not wise to check the property $p(z) \cdot p(z + 0.00001) < 0$ just like this.

Sample input

```
-1 2 0.5 0
4 3 -6 1 1 0
4.65 4 -0.11 3 0.53 2 -6.51 1 0.13 0
6.31 4 7.64 3 -5.29 2 0.55 1 -9.2 0
```

Sample output

```
Case 1: zero at 0.70710.
Case 2: zero at 0.16993.
Case 3: zero at 0.02000.
Case 4: zero at 0.99973.
```

Problem information

Author : Salvador Roura

Generation : 2024-05-03 09:55:04