SECANT METHOD – DOCUMENTATION

This program finds real roots of polynomial equations using the Secant Method.
It supports multiple test cases, file input, and outputs results to both the console and a text file.

PURPOSE

To determine all real roots of a polynomial by applying the Secant Method across a calculated search interval.
The program reads polynomial coefficients from an input file and applies numerical root-finding to each test case.

METHOD OVERVIEW

The Secant Method is an iterative numerical technique used to approximate roots of equations of the form:

f(x)=0

It uses two initial guesses and applies:

$$X_{n+1} = \frac{x0f(x1) - x1f(x0)}{f(x1) - f(x0)}$$

Iteration continues until:

$$|x_{n+1} - x_n| < \epsilon \text{ and } |f(x_n + 1)| < \epsilon$$

where ε is the error tolerance.

POLYNOMIAL EVALUATION

The polynomial is defined as:

$$f(x) = a_0 + a_1x + a_2x2 + \cdots + a_nx_n$$

Coefficients are supplied from highest degree to constant term but internally reversed for computation.

ROOT BOUND (Cauchy's Bound)

To ensure all real roots are detected, the program computes:

$$|x| \leq 1 + \max\left(\left|\frac{ai}{an}\right|\right)$$

This value defines the search interval: [−B,B]

where B is the computed bound.

STEP-WISE ROOT SEARCH

The interval is scanned using small sub-intervals:

- Step size: 0.45
- Error tolerance: 0.001

Each sub-interval $[x, x + 0.45]$ becomes an initial guess pair for the Secant method.

Duplicate roots (closely spaced values) are automatically ignored.

INPUT FORMAT (input.txt)

```
T
n
a_n a_(n−1) … a_1 a_0
n
a_n a_(n−1) … a_1 a_0
…
```

Where:

- **T** = number of test cases
- **n** = degree of the polynomial
- Next line has n+1 coefficients from highest degree to constant term

EXAMPLE INPUT

```
3
```

2
1 -5 6
3
1 -6 11 -6
4
1 0 -7 0 6

This represents 3 polynomials:

1. $x^2-5x+6x$
2. $x^3-6x^2+11x-6$
3. x^4-7x^2+6

OUTPUT DESCRIPTION

For each test case, the program outputs:

1. The polynomial in readable form
2. The computed root bound
3. Each detected real root
4. The interval used in Secant Method
5. Number of iterations required
6. A separator line between test cases

Output is written:

- To console
- To output.txt

OUTPUT EXAMPLE

Polynomial: 1x^2 - 5x + 6
Root bound: 6
range: [1.800000, 1.350000] Root: 2.000371 Iterations: 4
range: [2.700000, 2.250000] Root: 3.000117 Iterations: 4

FEATURES

- Supports multiple test cases
- Uses Cauchy's Bound to guarantee root coverage

- Detects and avoids duplicate roots
- Outputs to both console and file (output.txt)
- Nicely formatted polynomial printing
- Error tolerance = 0.001
- Step size = 0.45
- Clean and organized code structure