Introduction to the C programming language

Sorting Algorithms

Giuseppe Lipari
http://retis.sssup.it/~lipari

Scuola Superiore Sant'Anna – Pisa

February 16, 2010

Outline

Outline

Finding the root of an equation

- **Problem:** Given a function $f(x)$, find the roots of the equation $f(x) = 0$
- We have to write a C program that finds the root of a polynomial
  - How to represent a polynomial function?

$$f(x) = a_n x^n + a_{n-1} x^{n-1} + \ldots + a_0$$

- Iterative methods
  - Find the root starting from points close to it
  - **Secant method:** start from x_0 and x_1
  - **Newton-Raphson method:** start from one point, and from the derivative

Representation

- A polynomial can be represented by an array containing the coefficients
- The program should
  - Read the polynomial from the keyboard or from a file
  - Read the starting point of the iterations
    - How to read an array from the keyboard?
    - How to read an array from a file?
  - Compute the root
  - Ask if the user wants to find another root, else exit

Reading from command line

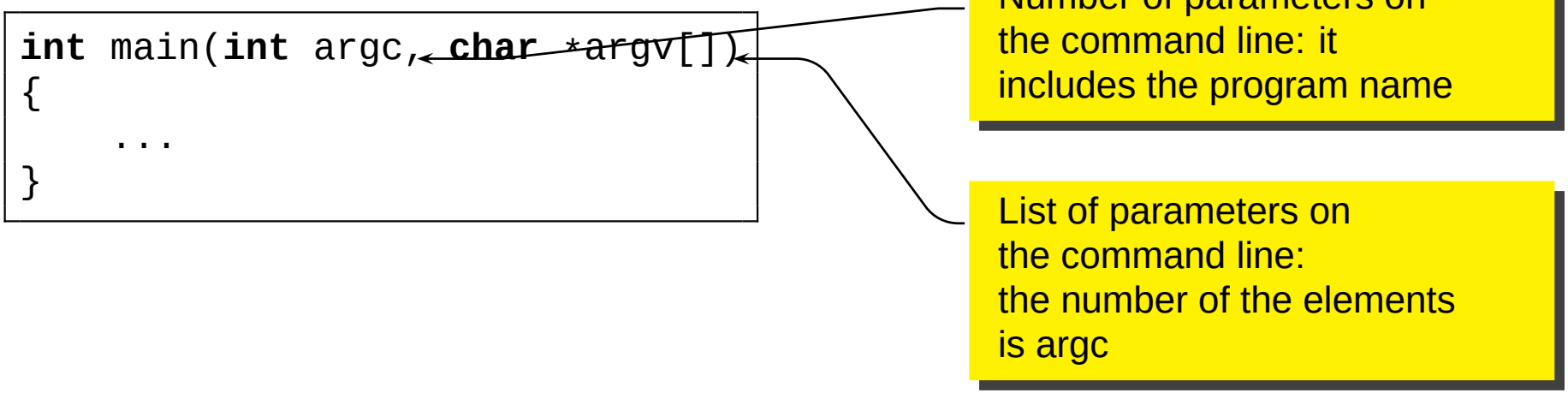
- It is possible to pass parameters to a C program via a command line
- This can be done by using a special version of the main function

```
int main(int argc, char *argv[])
{
    ...
}
```

Number of parameters on the command line: it includes the program name

Reading from command line

- It is possible to pass parameters to a C program via a command line
- This can be done by using a special version of the main function



Example

- Lists all parameters

roots/argcexample.cpp

```
bool isnumber(char str[]) //
{
    int i = 0;
    int len = strlen(str);

    while (i < len) {
        if (isdigit(str[i])) return true;
        else if (isspace(str[i])) i++;
        else if (str[i] == '-' ||
                 str[i] == '+' ||
                 str[i] == '.') i++;
        else return false;
    }
}

int main(int argc, char *argv[])
{
    int i;
    // Prints number of arguments
    cout << "Number of arguments: " << argc << endl;

    //Prints all arguments
    for (i=0; i<argc; i++) {
        cout << "argv[" << i << "] = " << argv[i];
        cout << " --> is a number? "
             << (isnumber(argv[i]) ? "Yes" : "No")
             << endl;
    }
}
```

Example

- Lists all parameters

roots/argcexample.cpp

```
bool isnumber(char str[]) //
{
    int i = 0;
    int len = strlen(str);

    while (i < len) {
        if (isdigit(str[i])) return true;
        else if (isspace(str[i])) i++;
        else if (str[i] == '-' ||
                 str[i] == '+' ||
                 str[i] == '.') i++;
        else return false;
    }
}

int main(int argc, char *argv[])
{
    int i;
    // Prints number of arguments
    cout << "Number of arguments: " << argc << endl;

    //Prints all arguments
    for (i=0; i<argc; i++) {
        cout << "argv[" << i << "] = " << argv[i];
        cout << " --> is a number? "
             << (isnumber(argv[i]) ? "Yes" : "No")
             << endl;
    }
}
```

Function that returns true if the string contains a number

Example

- Lists all parameters

roots/argcexample.cpp

```
bool isnumber(char str[]) //
{
    int i = 0;
    int len = strlen(str);

    while (i < len) {
        if (isdigit(str[i])) return true;
        else if (isspace(str[i])) i++;
        else if (str[i] == '-' ||
                 str[i] == '+' ||
                 str[i] == '.') i++;
        else return false;
    }
}

int main(int argc, char *argv[])
{
    int i;
    // Prints number of arguments
    cout << "Number of arguments: " << argc << endl;

    //Prints all arguments
    for (i=0; i<argc; i++) {
        cout << "argv[" << i << "] = " << argv[i];
        cout << " --> is a number? "
             << (isnumber(argv[i]) ? "Yes" : "No")
             << endl;
    }
}
```

Function that returns true if the string contains a number

Prints all arguments
For each one, tests if it is a number.

Outline

Find the maximum sum

- This problem has been takes from `http://projecteuler.net/index.php?section=proble`
- By starting at the top of the triangle below and moving to adjacent numbers on the row below, the maximum total from top to bottom is 23.

```
3
7 4
2 4 6
8 5 9 3
```

- Find the maximum sum of a larger triangle.

Outline

Fibonacci Numbers

- Fibonacci numbers can be defined as follows:
  - $F_0 = 0, F_1 = 1$
  - $F_n = F_{n-1} + F_{n-2}$
- The first numbers in the sequence are:

$$0,\ 1,\ 1,\ 2,\ 3,\ 5,\ 8,\ 13,\ 21,\ 34,\ 55,\ 89,\ 144,\ \ldots.$$

- Well know since ancient times

Fibonacci numbers

- Write two algorithms to generate the n-th Fibonacci number
  - An iterative algorithm
  - A recursive algorithm

The tower of Hanoi

- The tower of hanoi is a simple game
- The goal is to move all disks from the left stick to the right stick
- Rule: it is not possible to put a large disk on top of a small disk