

Chapter 4. Pointers

Programming Concepts in Scientific
Programming

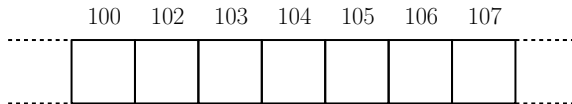
EPFL, Master class

October 13, 2017

Pointers and the Computer Memory

Addresses

```
int x = 1;  
int y = 2;  
std::cout << &x << "\n";
```



Debug this program (breakpoint on line 3)

```
(gdb) x/2wx &x
```

```
(gdb) x/2wx &y
```

```
(gdb) x/2wx &x
```

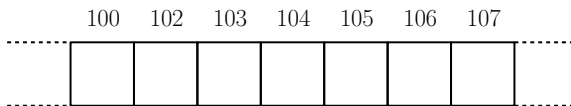
```
(gdb) x/2wx &y
```

Want to know more ? \Rightarrow (gdb) help x

Pointers and the Computer Memory

Addresses

```
int total_sum = 10;
```



Getting an address: &

```
std::cout << &total_sum << "\n";
```

Pointers and the Computer Memory

Pointer Variables

Using the *star* in types:

```
int *p_x;
```

Example of use

```
// x stores an int precision number
```

```
int x = 3;
```

```
// p_x stores the address of an int
```

```
int *p_x = &x;
```

Try it with CLion !

```
int x = 3;
```

```
int *p_x = &x;
```

```
std::cout << p_x << std::endl;
```

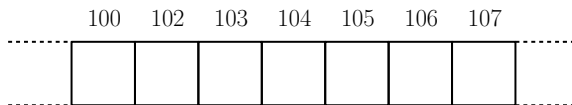
Debug this program (breakpoint)

Hit this command in gdb:

```
(gdb) x/3wx &x
```

Try it with CLion !

What is the memory structure ?



String of characters

Declare an array of characters:

```
char name[250] = "yopla";
```

However, I can write:

```
char *ptr = name;
```

because an array of characters is actually a pointer!

Aliasing/de-reference

```
int y = 3;  
int *p_x = &y;
```

```
// This changes the value of y  
*p_x = 1;
```


Pointers and the Computer Memory

Addresses

```
int x = 1;  
int y = 2;  
*(&y + 1) = 3;
```

What does this do ?

Main: argv structure

Considering this code:

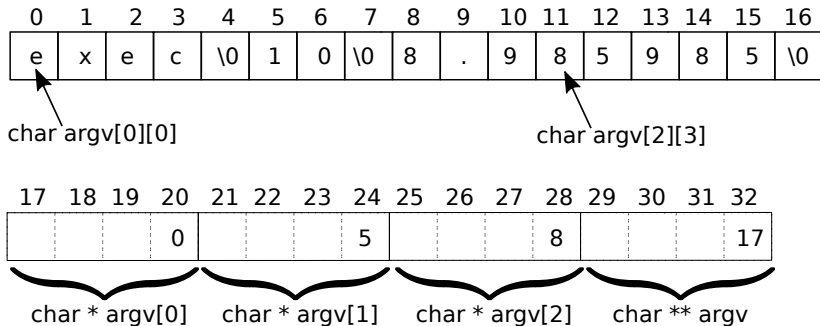
```
int main(int argc, char ** argv){  
    int p = atoi(argv[1]);  
    double z = atof(argv[2]);  
}
```

If I launch the executable like this:

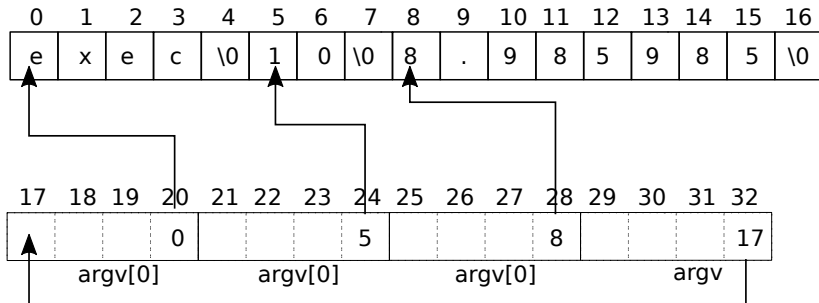
```
> ./exec 10 8.985985
```

What is the memory structure in that case ?

Main: argv structure



Main: argv structure



Warnings on the Use of Pointers

What is the problem with this code ?

```
int *p_x;
```

```
*p_x = 1;
```

Warnings on the Use of Pointers

```
// p_x stores the address of a int  
// not yet specified  
int *p_x;  
  
// trying to assign 1.0 in an unspecified  
// memory location  
*p_x = 1;
```

Dynamic Allocation of Memory

```
int *x = new int;
```

```
*x = 10;
```

```
delete x;
```

Dynamic Allocation of Memory

Vectors

```
double *x = new double[10];  
double *y = new double[10];  
  
for (int i = 0; i < 10; i++) {  
    x[i] = double(i);  
    y[i] = 2.0 * x[i];  
}
```

```
delete[] x;  
delete[] y;
```


Matrices

```
int rows = 5, cols = 3;  
double **A = new double *[rows];
```

```
for (int i = 0; i < rows; i++) {  
    A[i] = new double[cols];  
}
```

```
// you can access the values of the array with  
A[2][4] = 5;
```

```
// At the end: deallocate the memory  
for (int i = 0; i < rows; i++) {  
    delete[] A[i];  
}  
delete[] A;
```

ROW MAJOR format

```
double *p_a = new double[rows * cols];
```

```
double **A = new double *[rows];  
for (int i = 0; i < rows; i++) {  
    A[i] = &p_a[i * rows];  
    A[i] = p_a + i * rows;  
}
```

// you can access the values of the array with

```
A[2][4] = 5;
```

// or with

```
p_a[2 * rows + 4] = 5;
```

// At the end: de-allocate the memory

```
delete[] A;
```

```
delete[] p_a;
```

ROW MAJOR format

- ▶ ROW MAJOR: C, C++
- ▶ COLUMN MAJOR: Matlab and Fortran

Tips

- ▶ Pointer Aliasing: e.g. coding

- ▶ $C = A \cdot B$

- ▶ $A = A \cdot B$

- ▶ Dynamic Allocation: check non-null pointer:

```
int *p_x = new int;  
assert(p_x != NULL);
```

- ▶ Every new Has a delete