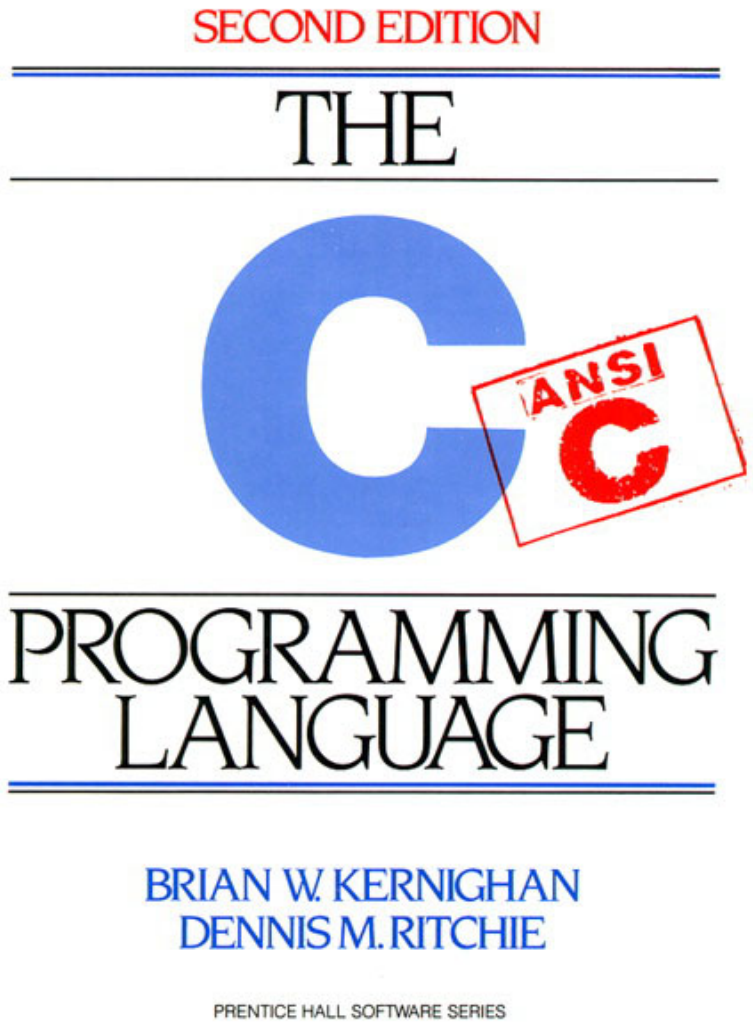
Topic 3: C Basics

CSE 30: Computer Organization and Systems Programming
Summer Session II 2011

Dr. Ali Irturk
Dept. of Computer Science and Engineering
University of California, San Diego

C Basics


SECOND EDITION

THE

C

ANSI C

PROGRAMMING LANGUAGE

BRIAN W. KERNIGHAN
DENNIS M. RITCHIE

PRENTICE HALL SOFTWARE SERIES

Has there been an update to ANSI C?

- Yes! It's called the "C99" or "C9x" std
  - You need "`gcc -std=c99`" to compile
- References

  `http://en.wikipedia.org/wiki/C99`

  `http://home.tiscalinet.ch/t_wolf/tw/c/c9x_changes.html`
- Highlights
  - Declarations anywhere, like Java (#15)
  - Java-like `//` comments (to end of line) (#10)
  - Variable-length non-global arrays (#33)
  - `<inttypes.h>`: explicit integer types (#38)
  - `<stdbool.h>` for boolean logic def's (#35)
  - `restrict` keyword for optimizations (#30)

C vs. Java™ Overview (1/2)

Java

- Object-oriented (OOP)
- "Methods"
- Class libraries of data structures
- Automatic memory management

C

- No built-in object abstraction. Data separate from methods.
- "Functions"
- C libraries are lower-level
- Manual memory management
- Pointers

C vs. Java™ Overview (2/2)

Java

- High memory overhead from class libraries
- Relatively Slow
- Arrays initialize to zero
- Syntax:

```
/* comment */
// comment
System.out.print
```

C

- Low memory overhead
- Relatively Fast
- Arrays initialize to garbage
- Syntax:

```
/* comment */
printf
```

C Syntax: General

- Header files (`.h`) contain function declarations - the function interface
- The `.c` files contain the actual code.

File.h

```
void func1(int, char *);
int func2(char *, char *);
```

File.c

```
void func1(int a, char *b)
{
    if(a > 0)
    { *b = 'a' ; }
}

int func2(char *a, char *b)
{
   …
```

- Comment your code:
  - only `/* */` works, & they can't be nested
  - `//` doesn't work in C

C Syntax: `main`

- To get the main function to accept arguments, use this:

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

- What does this mean?
  - `argc` will contain the number of strings on the command line (the executable counts as one, plus one for each argument).
    - Example: `unix% sort myFile`
  - `argv` is a pointer to an array containing the arguments as strings (more on pointers later).

C Syntax: Variable Declarations

- All variable declarations must go before they are used (at the beginning of the block).
- A variable may be initialized in its declaration.
- Examples of declarations:
  - correct: `{`

```
            int a = 0, b = 10;
                         . . .
```

  - incorrect: `for (int i = 0; i < 10; i++)`

(but OK for C99)

Common C Error

- There is a difference between assignment and equality

  `a = b` is assignment

  `a == b` is an equality test

- This is one of the most common errors for beginning C programmers!
  - One solution (when comparing with constant) is to put the variable on the right!
    If you happen to use = it won't compile.

    ```
    if (3 == a) { ...
    ```

C Syntax: True or False?

- What evaluates to FALSE in C?
  - 0 (integer)
  - NULL (pointer: more on this later)
  - no such thing as a Boolean
- What evaluates to TRUE in C?
  - everything else…

C syntax : control flow

- Within a method / function
  - `if-else`
  - `switch`
  - `while and for`
  - `do-while`

If-else control structure

```
…
if(a == 0)
{ i++; }
else if(a == 1)
{ i--; }
else if(a == 2)
{ i = 2; }
else
{ i = 3; }
```

How do we convert this into an equivalent case control structure?

For control structure

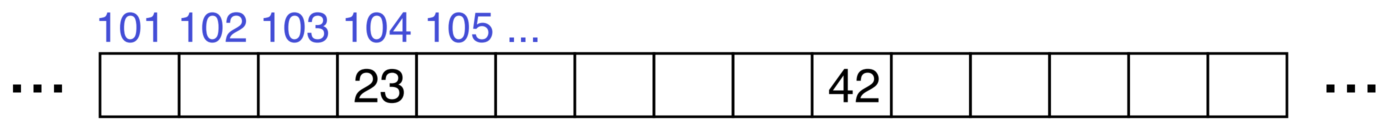
```
for(i = 0; i < 20; i++)
{  a[i] = b[i]; }
```

How do we convert this into an equivalent while control structure?

Address vs. Value

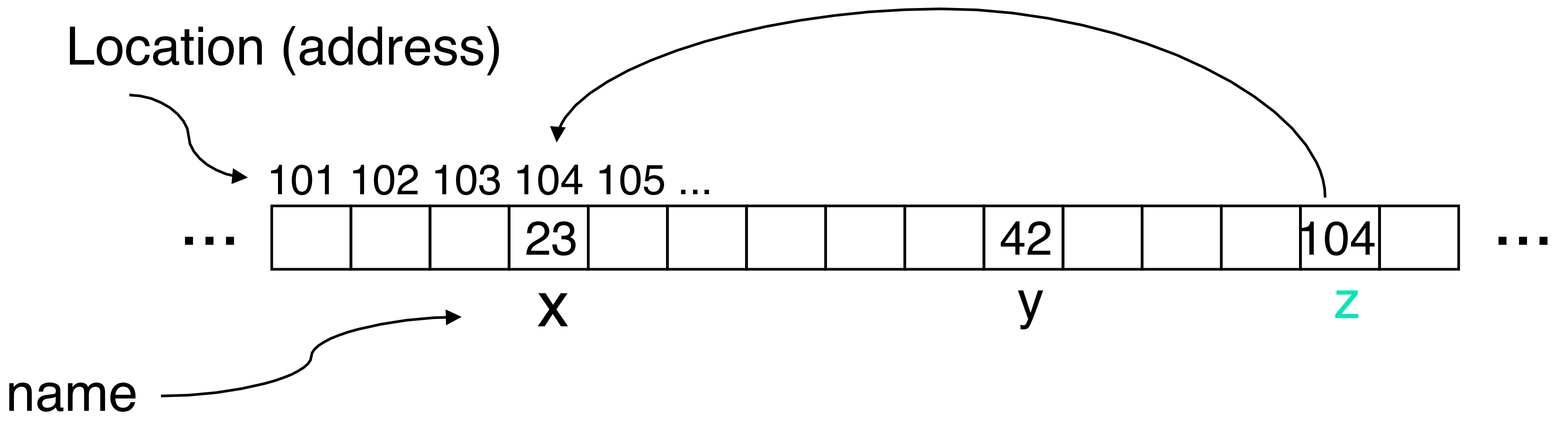
- Consider memory to be a single huge array:
  - Each cell of the array has an address associated with it.
  - Each cell also stores some value.

- Don't confuse the address referring to a memory location with the value stored in that location.



Pointers

- An address refers to a particular memory location. In other words, it points to a memory location.
- Pointer: A variable that contains the address of a variable.



UCSD

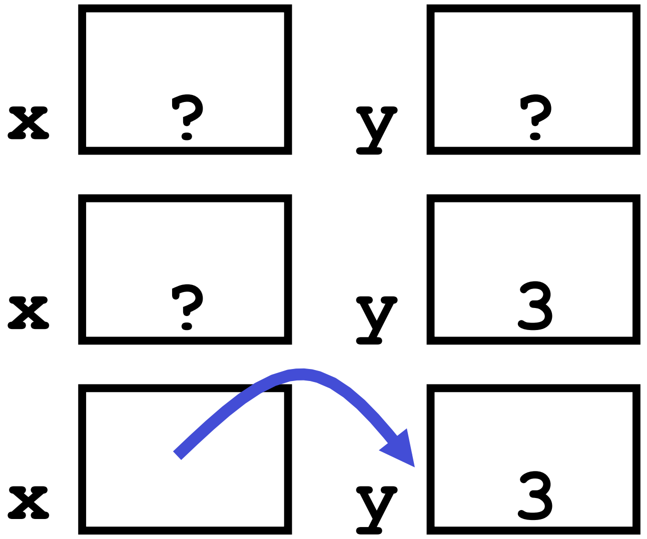
Pointers

- How create a pointer:
  - & operator: get address of a variable

```
int *x, y;

    y = 3;

    x = &y;
```



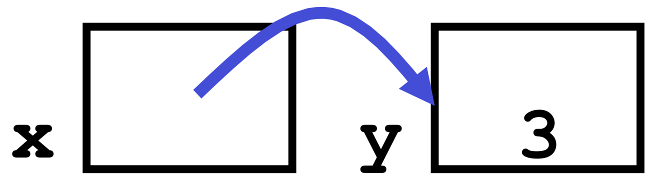
- How get a value pointed to?
  - * "dereference operator" : get value pointed to

```
    printf("x points to %d\n",*x);
```

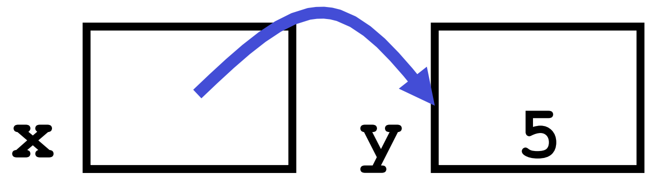
UCSD

Pointers

- How change variable pointed to?
  - Use dereference * operator to left of =



`*x = 5;`



Pointers and Parameter Passing

- C passes a parameter "by value"
  - procedure/function gets a copy of the parameter, so changing the copy cannot change the original

```
void addOne (int x) {
    x = x + 1;
}
int y = 3;
addOne(y);
  printf("The value of y is %d", y);
```

  - What will be displayed?

Pointers and Parameter Passing

- How to get a function to change a value?

```
void addOne (int *x) {
  *x = *x + 1;
}
int y = 3;


addOne(&y);
```

  - What will be displayed?

Pointers

- Normally a pointer can only point to one type (`int`, `char`, a `struct`, etc.).
  - `void *` is a type that can point to anything (generic pointer)
  - Use sparingly to help avoid program bugs!

More C Pointer Dangers

- Declaring a pointer just allocates space to hold the pointer – it does not allocate something to be pointed to!
- Local variables in C are not initialized, they may contain anything.
- What does the following code do?

```
void f()
{
    int* x;
    *x = 5;
}
```

Pointers & Allocation

- After declaring a pointer:

```
int *ptr;
```

`ptr` doesn’t actually point to anything yet. We can either:

  - make it point to something that already exists, or
  - allocate room in memory for something new that it will point to… (next lecture)

Pointers & Allocation

❖Pointing to something that already exists:

```
int *ptr, var1, var2;
     var1 = 5;
ptr  = &var1;
     var2 = *ptr;
```

❖`var1` and `var2` have room implicitly allocated for them.

Peer Instruction Question

```
void main(); {
  int *p, x=5, y; // init
  y = *(p = &x) + 10;
  int z;
  flip-sign(p);
  printf("x=%d,y=%d,p=%d\n",x,y,p);
}
flip-sign(int *n){*n = -(*n)}
```

```
#Errors
      0
      1
      2
      3
      4
      5
      6
      7
```

How many syntax/logic errors in this C99 code?

Peer Instruction Answer

```
void main(); {
  int *p, x=5, y; // init
  y = *(p = &x) + 10;
  int z;
  flip-sign(p);
  printf("x=%d,y=%d,p=%d\n",x,y,*p);
}
flip-sign(int *n){*n = -(*n);}
```

#Errors
0
1
2
3
4
5
6
7

How many syntax/logic errors? I get 5.
(signed printing of pointer is logical error)

Conclusion

- All declarations go at the beginning of each function except if you use C99.
- Only 0 and NULL evaluate to FALSE.
- All data is in memory. Each memory location has an address to use to refer to it and a value stored in it.
- A pointer is a C version of the address.
  - `*` "follows" a pointer to its value
  - `&` gets the address of a value