CSCI 1730
C Crash Course

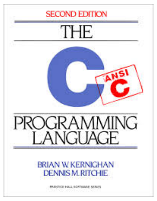
August 26 2014

Outline

- Overview comparison of C and Java
- “Hello World” (we’ll do this again!)
- Preprocessor
- Command line arguments
- Arrays and structures
- Pointers and dynamic memory

What we will cover

- A crash course in the basics of C
- K&R C book is a good reference



Like Java, like C

- Operators same as Java:
  - Arithmetic
    - `i = i+1; i++; i--; i *= 2;`
    - `+, -, *, /, %,`
  - Relational and Logical
    - `<, >, <=, >=, ==, !=`
    - `&&, ||, &, |, !`
- Syntax same as in Java:
  - `if ( ) { } else { }`
  - `while ( ) { }`
  - `do { } while ( );`
  - `for(i=1; i <= 100; i++) { }`
  - `switch ( ) {case 1: … }`
  - `continue; break;`

Simple Data Types

datatype	size	values
char	1	-128 to 127
short	2	-32,768 to 32,767
int	4	-2,147,483,648 to 2,147,483,647
long	4	-2,147,483,648 to 2,147,483,647
float	4	3.4E+/-38 (7 digits)
double	8	1.7E+/-308 (15 digits long)

Java programmer gotchas (1)

```
{
  int i;
  for( i = 0; i < 10; i++ )
    …
```

NOT

```
{
    …
  for( int i = 0; i < 10; i++ )
```

… Some c compilers allow it! (c99, we are at c11 now) -Wall to see.

Java programmer gotchas (2)

- Uninitialized variables
  - catch with –Wall compiler option

```
#include <stdio.h>

int main(int argc, char* argv[])
{
  int i;
  factorial(i);
  return 0;
}
```

Java programmer gotchas (3)

- Error handling
  - No exceptions
  - Must look at return values (manually)

Review “Hello World”

```
#include <stdio.h>
int main(int argc, char* argv[])
{
  /* print a greeting */
  printf(”Hello World!\n");
  return 0;
}
```

```
$ ./helloworld
Hello World!
$
```

Breaking down the code

- **#include <stdio.h>**
  - Include the contents of the file stdio.h
    - Case sensitive – lower case only
    - Defines proto types of functions that are folded
      - Into executable.
  - No semicolon at the end of line
- **int main(…)**
  - The OS calls this function when the program starts running.
- **printf(format_string, arg1, …)**
  - Prints out a string, specified by the format string and the arguments.

Printf: format_string

- Composed of ordinary characters (not %)
  - Copied unchanged into the output (% is just a place holder).
- Conversion specifications (start with %)
  - Fetches one or more arguments
  - For example

• char	%c
• char*	%s
• int	%d
• float	%f

- For more details: **man 3 printf (do in now)!**

C Preprocessor

```
#define SEVENTEEN_THIRTY\
  "The Class That Gives UGA Its Zip\n"

int main(int argc, char* argv[])
{
  printf( SEVENTEEN_THIRTY );
  return 0;
}
```

Stop after the preprocessor (gcc –E)

```
int main(int argc, char* argv)
{
  printf("The Class That Gives UGA its Zip\n”);
  return 0;
}
```

https://gcc.gnu.org/onlinedocs/gcc-4.4.5/gcc/Option-Summary.html#Option-Summary

See 1730.c

Conditional Compilation

```
#define CS1730

int main(int argc, char* argv)
{
  #ifdef CS1730
  printf("The Class That Gives UGA Its Zip\n");
  #else
  printf("Some unimportant class\n");
  #endif
  return 0;
}
```

// file: if1730.c

After the preprocessor (gcc –E)

```
int main(int argc, char* argv)
{
  printf("The Class That Gives UGA its Zip\n");
  return 0;
}
```

Command Line Arguments (1)

- ***`int main(int argc, char* argv[])`***
- **`argc`**
  - Number of arguments (including program name)
- **`argv`**
  - Array of char*s (that is, an array of ‘c’ strings)
  - `argv[0]`: = program name
  - `argv[1]`: = first argument
  - …
  - `argv[argc-1]`: last argument

Command Line Arguments (2)

```
#include <stdio.h>

int main(int argc, char* argv[])
{
  int i;
  printf("%d arguments\n", argc);
  for(i = 0; i < argc; i++)
    printf("  %d: %s\n", i, argv[i]);
  return 0;
}
```

Command Line Arguments (3)

```
$ ./cmdline The Class That Gives UGA Its Zip
8 arguments
  0: ./cmdline
  1: The
  2: Class
  3: That
  4: Gives
  5: UGA
  6: Its
  7: Zip
$
```

Arrays

- **char foo[80];**
  - An array of 80 characters
  - **sizeof(foo)**
    = 80 × **sizeof(char)**
    = 80 × 1 = 80 bytes
- **int bar[40];**
  - An array of 40 integers
  - **sizeof(bar)**
    = 40 × **sizeof(int)**
    = 40 × 4 = 160 bytes

Structures

- Aggregate data

```
#include <stdio.h>

struct name
{
  char*     name;
  int       age;
}; /* <== DO NOT FORGET the semicolon */

int main( int argc, char* argv[] )
{
  struct name svensson;
  svensson.name = ”Gunnar Svensson";
  svensson.age = 25;

  printf("%s is %d years old\n", svensson.name, svensson.age);
  return 0;
}

// file: aggregatedata.c
```

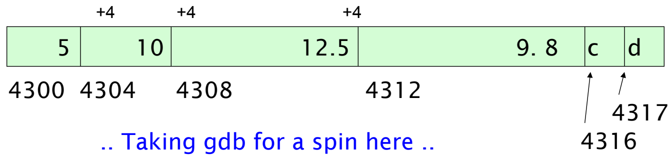
Pointers

Pointers

- Pointers are variables that hold an address in memory.
- That address contains another variable.

Memory layout and addresses

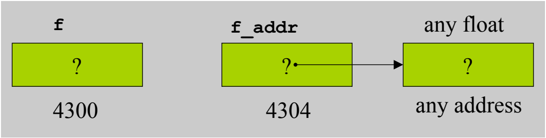
```
int x = 5, y = 10;        // 4 bytes each
float f = 12.5, g = 9.8;  // 4 bytes each
char c = ‘c’, d = ‘d’;     // 1 byte each
```



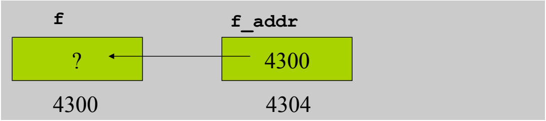
.. Taking gdb for a spin here ..
print &x

Using Pointers (1)

```
float f;        /* data variable */
float *f_addr;  /* pointer variable */
```

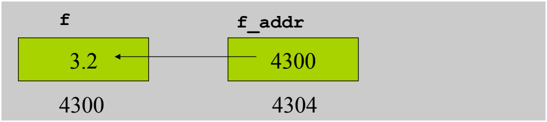


```
f_addr = &f;    /* & = address operator */
```

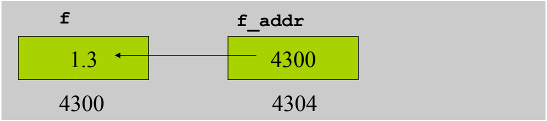


Pointers made easy (2)

```
*f_addr = 3.2;     /* indirection operator ‘content’ */
```



```
float g = *f_addr;/* indirection: g is now 3.2 */
f = 1.3;          /* but g is still 3.2 */
```



Function Parameters

- Function arguments are passed “by value”
- What is “pass by value”?
  - The called function is given a copy of the arguments (not a reference)
- What does this imply?
  - The called function can’ t alter a variable in the caller function, but its private copy (a private copy)
- Three examples

Example 1: swap_1

```
void swap_1(int a, int b)
{
  int temp;
  temp = a;
  a = b;
  b = temp;
}
```

Q: Let x=3, y=4,
after swap_1(x,y);
x =? y=?

~~A1: x=4; y=3;~~

A2: x=3; y=4;

Example 2: swap_2

```
void swap_2(int *a, int *b)
{
  int temp;
  temp = *a;
  *a = *b;
  *b = temp;
}
```

Q: Let x=3, y=4,
after
swap_2(&x,&y);
x =? y=?

~~A1: x=3; y=4;~~

A2: x=4; y=3;

Example 3: scanf

```
#include <stdio.h>

int main()
{
  int  x;
  scanf(“%d\n”, &x);
  printf(“%d\n”, x);
}
```

Q: Why using pointers in scanf?

A: We need to assign the value to x.

Dynamic Memory

- Java manages memory for you, C does not
  - C requires the programmer to *explicitly* allocate and deallocate memory
  - Unknown amounts of memory can be allocated dynamically during run-time with **`malloc()`** and deallocated using **`free()`**

Not like Java

- No **new**
- No garbage collection
- You ask for *n* bytes
  - Not a high-level request such as "I' d like an instance of class **String**"

malloc

- Allocates memory in the heap
  - Lives between function invocations
- Example
  - Allocate an integer

```
• int* iptr =
      (int*) malloc(sizeof(int));
```

  - Allocate a structure

```
• struct name* nameptr = (struct name*)
      malloc(sizeof(struct name));
```

free

- Deallocates memory in heap.
- Pass in a pointer that was returned by **malloc**.
- Example

```
– int* iptr =
    (int*) malloc(sizeof(int));
  free(iptr);
```

- Caveat: don' t free the same memory block twice!