Level 0x04

Intro to C

Topics

- White Hats
- C Stuff
  - Compiling
  - Printf
  - Operators (shifts, xor)

Upcoming Events

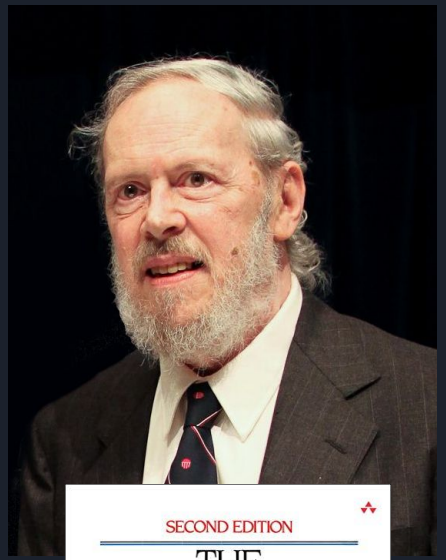
- Maker Faire Orlando - “Greatest Show & Tell on Earth”
  - Saturday Nov 5th - Sunday Nov 6th, 2022
  - https://www.makerfaireorlando.com/
  - Orange County Fair Grounds
  - $25 Adults, $20 Students, $5 off if pre-purchased

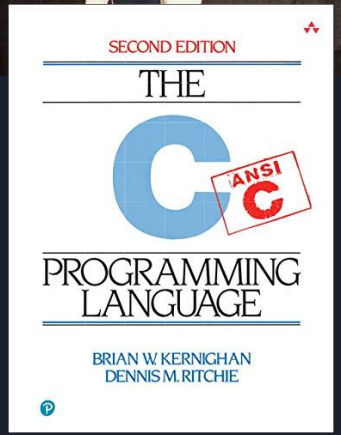
George Hotz
aka GeoHot aka tomcr00se

- Famous research
  - First iOS sim unlock, later made iOS jailbreak
  - Escaped hypervisor container on PS3 OtherOS (Linux)
- Security researcher for Google Project Zero
- Legendary CTF Player
  - Competing as himself tomcr00se, won:
    - CSAW13 (13,000 teams competed)
    - Secuinside 2014
  - Won DEFCON CTF with PPP in 2013, 2014, and 2016
- Works on self-driving cars now

Background of C

- History
  - Developed in 1972 by Dennis Ritchie at Bell Labs
  - Standardized in 1989 (ANSI C)
- Purpose
  - General purpose programming language
  - Compiles down to machine instructions
- Applications:
  - Operating systems
  - Bare-metal / Embedded
  - Performance
  - Not typically used for Web
- Influenced 70+ other languages:
  - C++, Objective-C, Java, PHP, C#, Go, Rust





Hello World

- Comments
  - /* orig C multi-line */
  - // C++ style single line
- Single main function
  - You can access command line args
  - Return code to the calling script
    - 0 = success
- printf = print formatted
- Indentation doesn't matter

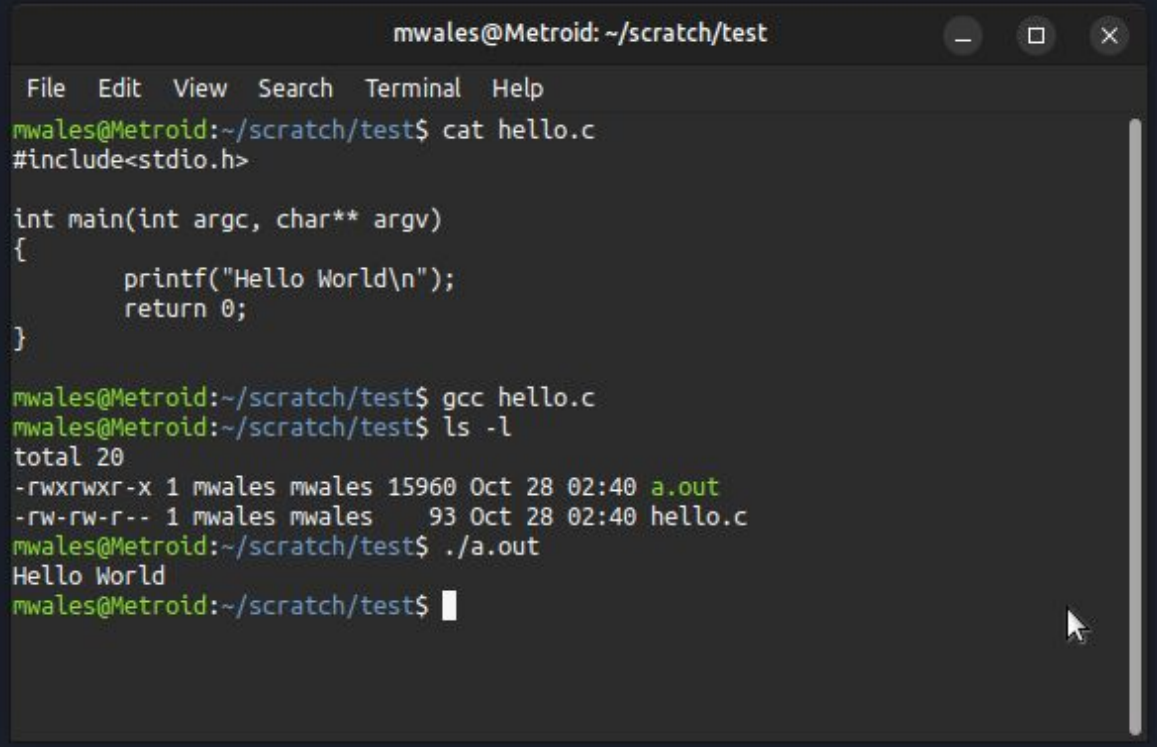
```c
#include <stdio.h>

/*
  Multi-line comments!

  argc is number of args to program
  argv is list of the args
*/

int main(int argc, char** argv)
{
   // Every C program has a main function
   printf("Hello World\n");
   return 0;
}
```

Compiling C applications



Variables / Integer Types

- Character type + Integer Type
  - char
- Integer types
  - short
  - int
  - long
  - long long
- Floating point type
  - float
  - double
  - long double
- Size Type
  - size_t
- Integer types can also be unsigned

```
// old standard declaration
char smallNum, otherNum;
smallNum = 10;
otherNum = 42;

// typical declaration + assign
int numPoints = 10000;
unsigned long altitude = 5000;

// OK to reassign later
smallNum = 0xb7;  // hex

// doubles are more precise
float pi = 3.14159;
double r = 45.0;

double area = pi * r * r;
```

#include<stdint.h> (C99)

stdint.h type	Num Bytes	Minimum	Maximum
int8_t	1	-128	127
uint8_t	1	0	255
int16_t	2	-32,768	32,767
uint16_t	2	0	65,535
int32_t	4	-2,147,483,648	2,147,483,647
uint32_t	4	0	4,294,967,295
int64_t	8		
uint64_t	8		

Output

- Some terminology
  - A character (or char).
    - Single letter or number.
    - Single quote. ‘A’
  - A string.
    - Series of characters or numbers.
    - Double quotes. “Abcde”
    - Ends with a null character (0x00)
- A few different ways to output from standard C library stdio.h
  - `printf(“text and a number %d. ”, 42);  // By far the most common`
  - `puts(“just a single string”);  // Built-in newline`
  - `putchar(‘a’);`

Printf formatting

- Escape sequences
  - `\n` is a newline
  - `\t` is a tab
- Conversions / extra args
  - `%d` or `%i` for signed integer, `%u` for unsigned integer
  - `%x` or `%X` for hexadecimal numbers
  - `%c` for single characters
  - `%s` for strings
  - `%f` for floating point
- Flags, width, and precision
  - `printf("Name: %10s  Weight%3.1f\n", name, weight);`
  - `printf("32 bit num in hex is 0x%08x\n", 0xbeef);`
- Not just C uses it...
  - Python: `"format str %s = %d" % ("age", 12)`
  - Java: `System.out.println(format, args)`

Arithmetic

- Basic operations: add (+), subtract (-), multiply (*), divide (/)
- Modulus operations: % (division remainder of)
- Increment (++) and Decrement (--)
  - Prefix form: int xVal = ++i; // i is incremented, xVal is then set to value of i
  - Postfix form: int xVal = i++; // xVal is set to the value of i, then i is incremented
- Assignment and operations can be combined
  - Operations followed by =
  - varX *= 2; // equivalent to varX = varX * 2
- Bitwise Operators
  - Operates on bits of value (see previous slides)
  - And (&), Or (|), Xor (^)
  - Shift operation
    - Left shift (<<) and right shift (>>)
    - 0b0001110 << 2 is equivalent to 0b0111000

Links

- GeoHot - By Steve Jennings/Getty Images - CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=80789049
- Many graphics from Wikipedia / wikimedia.org (Creative Commons License)
  - https://en.wikipedia.org/wiki/Dennis_Ritchie#/media/File:Dennis_Ritchie_2011.jpg
- Amazon.com - K&R The C Programming Language
  - https://www.amazon.com/Programming-Language-2nd-Brian-Kernighan/dp/0131103628
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