C Programming

- Getting started
- Variables
- Basic C operators
- Conditionals
- Loops
- Functions

Getting started

https://www.onlinegdb.com/online_c_compiler

Hello world example

```
#include <stdio.h>
main() {
    printf(“hello, world\n”);
}
```

- Prints “`hello, world`” to the screen
- Type this in with a text editor and save it as `hello.c`

Breaking down `hello.c`

```
#include <stdio.h>
```

- Tells the compiler to use the library functions described in `stdio.h`
- `printf()` function is inside `stdio`

Breaking down `hello.c`

`main()`

- Beginning of the main function
- All code execution starts at `main()`

`{}`

- Curly brackets group lines of code
- All functions start and end with curly brackets

Breaking down `hello.c`

```
printf(…);
```

- Prints to the screen
- The argument is in parenthesis
- The argument is what is printed
- Note the semicolon at the end

Breaking down `hello.c`

`”hello, world\n”`

- This is the argument to `printf()` which appears on the screen
- It is a string because it is in quotes (“”)
- `\n` is a special character that indicates newline

Variables

Variables

- Names that represents values in the program
- Similar to algebraic variables
- All variables have a type which must be declared

```
int x;
float y;
```

- Type determines how arithmetic is performed, how much memory is required

Types and type qualifiers

- Several built-in types, different sizes

Type	Size	
`char`	1 byte	Fixed size
`int`	16 bit minimum	Typically, word size
`float`	64 bits, typical	Floating point
`double`	64, 128 bits, typical	Double precision

- Type qualifiers exist:
  - `short, long`
- `char` is 8 bits on all platforms

Variable names

- A sequence of visible characters
- Must start with a non-numerical character
  - `int testval2` (O)
  - `int 2testval` (X)
- No C language keywords
  - `if, else, while` (X)

Constants

- Can use #define compiler directive
  - `#define ANSWER 42`
- Any instance of the string is substituted at compile time
- Character constants
  - Written as a single character in single quotes
  - `#define TERMINATOR 'x'`
  - Integer equal to the ASCII value of the character
  - Some characters are not easy to represent (i.e., bell)

Global variables

```
int global_i;
void foo() {
    extern int global_i;
}
```

- A variable is global if it is defined outside of any function
- A global variable must be declared as an `extern` in any function using it
  - `extern` not needed if global declaration is before the function
- Variables can be global across files

Globals can be dangerous

```
void foo() {
    extern int global_i;
    …
    global_i = a+b-c;
    …
}
```

```
void bar () {
    extern int global_i;
    …
    x = global_i*… ;
    …
}
```

- Global variables can propagate bugs
  - Bug in `foo` can cause `bar` to crash
- Debugging can become harder
- Reduce modularity of the code

Basic C operators

Arithmetic/Relational operators

- `+` (addition), `-` (subtraction), `*` (multiplication), `/` (division)
- `%` is the modulo operator, division remainder
  - `9 % 2 = 1`
  - `9 % 3 = 0`
- `++` (increment), `--` (decrement)
- `==`, `<`, `>`, `<=`, `>=`, `!=`
  - `if (x<5) …`

Logical operators

- `&&` (and), `||` (or), `!` (not)
- Treat arguments as 1-bit binary values
  - `0 is FALSE`
  - `!0 is TRUE`
- `if ( (A==1) && !B )`
  - The above is `TRUE` if `A` is `TRUE` and `B` is `FALSE`

Conditionals

Conditional statements

```
if (expression)
      statement1
else
      statement2
```

```
if (expr1)
      state1
else if (expr2)
      state2
else
      state3
```

- `else` is optional
- *expression* is evaluated
  - Execute *statement1* if `TRUE`, *statement2* if `FALSE`
- *expr2* evaluated if *expr1* is `FALSE`

Conditional example

```
int main() {
     int x=1;
     if (x==1)
          printf(“Correct”);
     else
          printf(“Incorrect”);
}
```

Switch

```
switch (expression) {
      case condition1 :      statement1
      case condition2 :      statement2
      default: statement3
}
```

- *expression* is evaluated, compared to *conditions*
- *statements* corresponding to the first matching *conditions* are executed
- *`default` is optional*

Break in a switch

```
switch (x) {
     case 0:
          y=1;
     case 1:
          y=2;
          break;
     case 2:
          y=3;
}
```

- Without a `break` statement, the case will not end
  - If `x==0` then both `y=1;` and `y=2;` are executed

Loops

For loops

```
for (expr1; expr2; expr3) {
    statement
}
```

- Initialization and increment are built into the `for` loop

While and do-while loops

```
expr1;
while (expr2) {
    statement
    expr3;
}
```

```
expr1;
do {
    statement
    expr3;
} while (expr2);
```

- Condition checked at the top of a `while` loop
- Condition checked at the bottom of `do-while` loop

While example

```
int main() {
     int i=0;
     while (i<3) {
          printf(“%i”, i);
          i = i + 1;
     }
}
```

- Three passes through the loop; `i=0,1,2`
- Exits loop when `i=3`

All built into the for statement

```
int main() {
    int i;
    for (i=0; i<3; i++) {
        printf("%i", i);
    }
}
```

- Initialization: `i=0`
- Termination: `i<3`
- Step: `i++`

Break and continue

```
while (x>5) {
     y++;
     if (y<3) break;
     x++;
}
```

```
while (x>5) {
     y++;
if (y<3) continue;
     x++;
}
```

- `break` jumps to the end of a loop
- `continue` jumps to the next iteration of a loop

Functions

Functions

```
void foo(int a, int b) {          // function definition
     int x, temp;
     temp = a + b;
     x = temp;
     printf("%i",x);
}
int main() {
     foo(2,3);                    // function call
}
```

- Functions can replace groups of instructions
- Data can be passed to functions as arguments

Function return value

```
int foo(int a, int b) {      // function definition
     int x;
     x = a + b;
     return x;
}
int main() {
     printf("%i", foo(2,3));// function call
}
```

- Functions can return a value to the caller
- The type of the return value must be declared

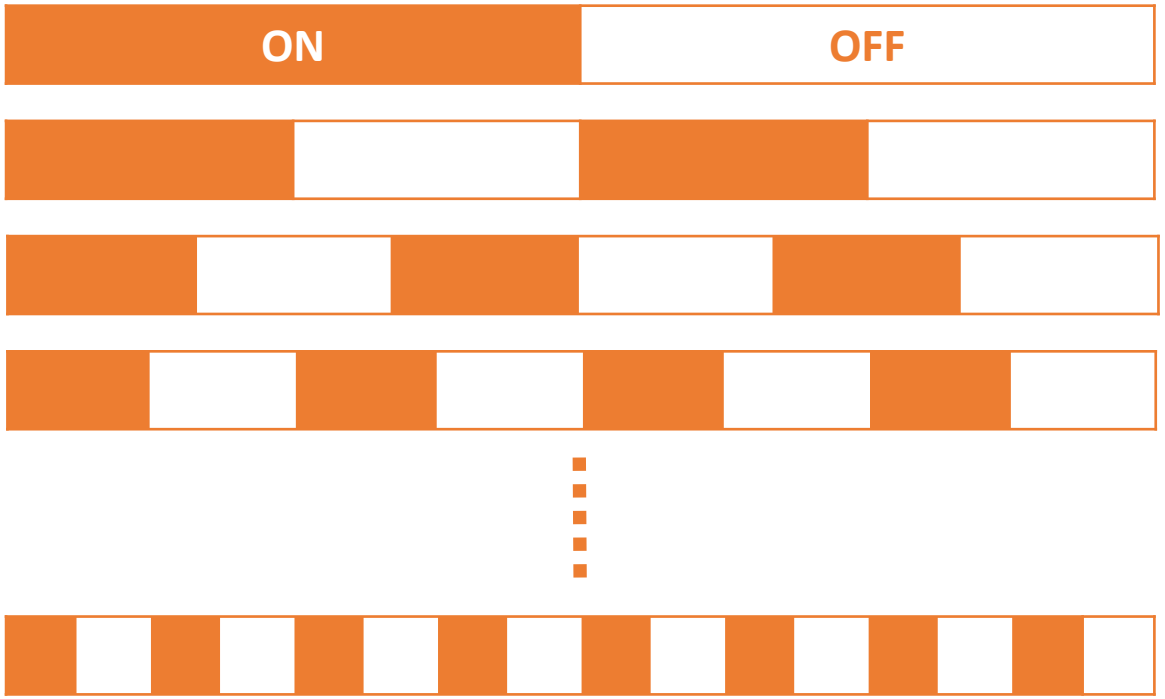
Lab

Blink example extended

- Come back to the Blink example.
- Write a function `void blink_n_times(int n, int ms)`
  - which turns the on-board LED
    on for `ms` milliseconds and
    off for `ms` milliseconds
    `n` times

Blink example extended

- Use `for` loops and `blink_n_times()` function from `loop()` to have your Arduino repeat the following



For the first 1 second

Next second

Next second

Next second

Next second