Introduction to C

```
Module Code: GEEN1064

Module Name: EEngineering Design and Implementation

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```
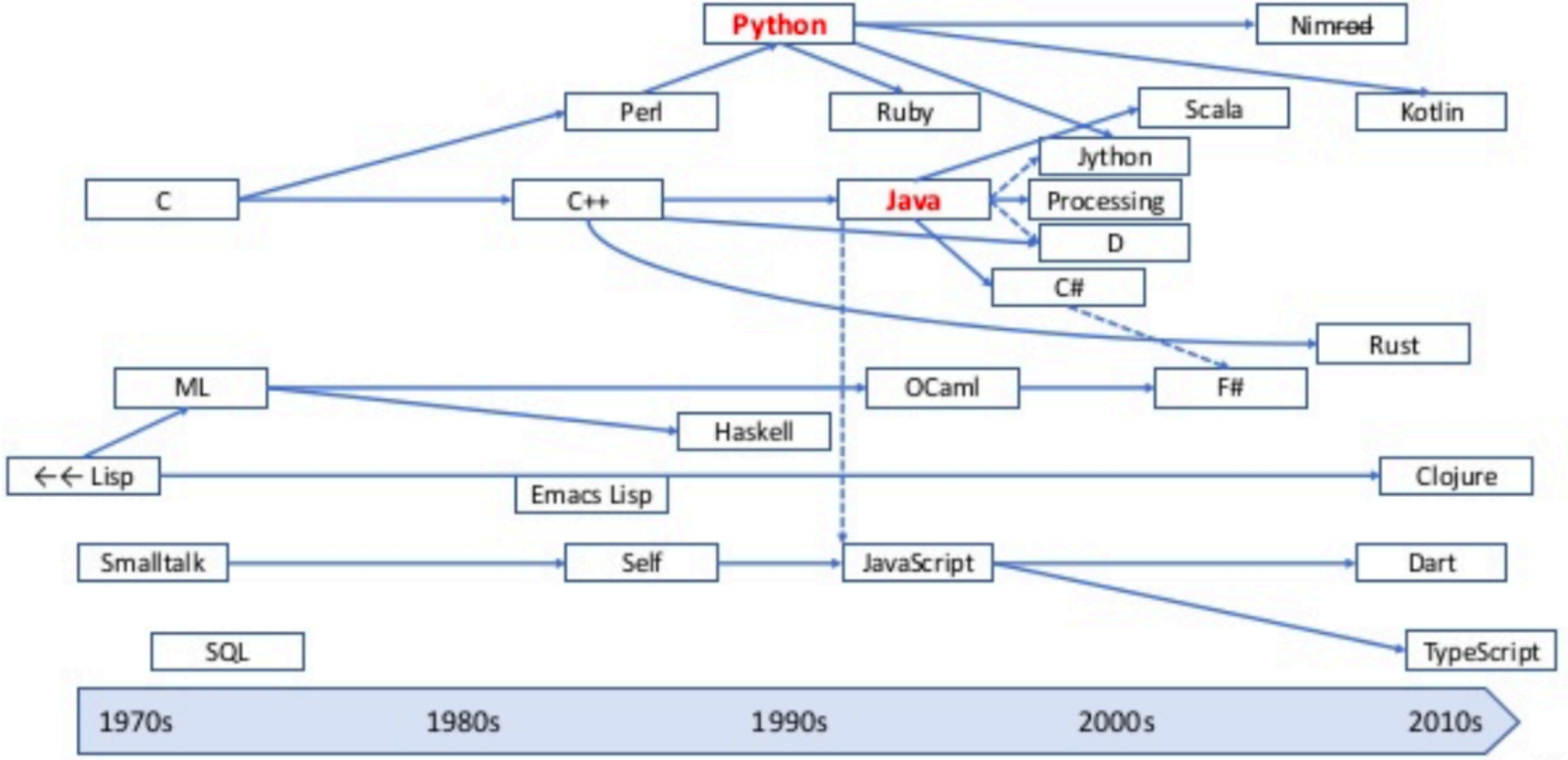

C is god's programming language



Why C?

> Developed by Denis Ritchie (Steve Jobs eat your heart out)

- general-purpose (oringially designed for UNIX)
- provides common ancestry
- structured programming language
- machine-independent
- low level


Memory Management
High Level Language
Faster
Structured Language
Pointers
Rich Library
Recursion
Extensible

First Program in C

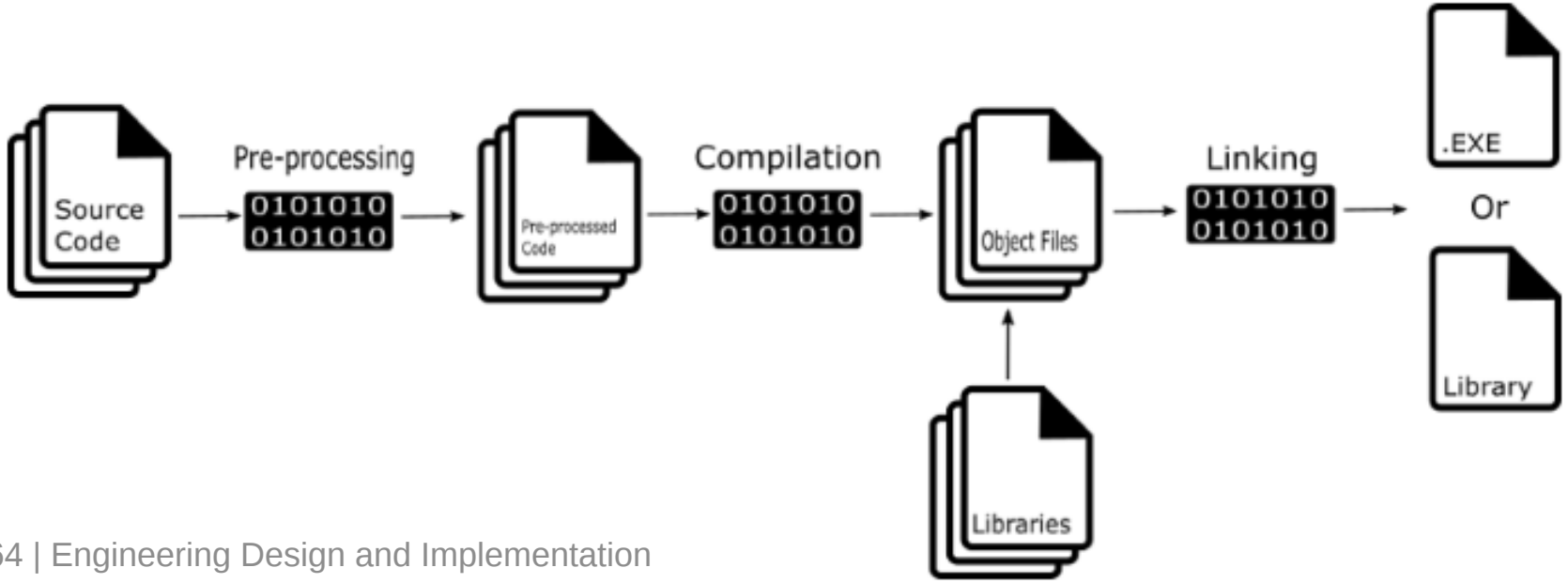
This is the first program we are going to create in C. It is a tribute to Denis Ritchie program written in C.

```c
// library or header file that contains  standard input/output operatioins

#include <stdio.h>

/*
  main() function every C program must have a main,
  it has a returnable 'int' this is for exit codes
*/
int main(void) // void means no input argument
{
    printf("Hello World!\n");
    printf("Goodbye World!\n");
    return 0; // return exit code 0, no error
}
```

Compile the code

We are going to use `gcc` compiler to compile our `c` code; first argument is the source file[s], and `-o` means output file. The file extension in linux can be left blank or called whatever you want.

```
$ gcc helloworld.c -o helloworld.[out,exe,...]
```



Execute the code

As we are using a terminal, we must prepend the newley created file with `./`. The `.` denotes the current directory. Since we want to run a file in our current directory and that directory is not in our `$PATH`, you need the `./` bit to tell the shell where the executable is.

Output:

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

Header Files

> Libraries

These files contain all scaffolding code that your `main()` will use as we do not want to overpopulate with excessive lines of code for readability.

Computers used to be too slow to compile a whole program in one single mega-blob where all the functions and types were visible.

To solve this, programs are split into c/h files which are each individually compiled into a machine code file (the ‘object’ file), and then linked together into an exe or dll.

Header Files Continued

usefulfunctions.h

```c
#ifndef USEFULFUNCTIONS_H_   /* Include guard */
#define USEFULFUNCTIONS_H_

int sqr(int x);  /* An example function declaration */

#endif // USEFULFUNCTIONS_H_
```

usefulfunctions.c

```c
#include "usefulfunctions.h"  /* Include the header (not strictly necessary here) */

int sqr(int x)    /* Function definition */
{
    return x * x;
}
```

Revist helloworld.c

We are modifiying the code to use our custom library:

```c
#include <stdio.h> /* searches system header file directories */
#include "usefulfunctions.h" /* notice "" searches current directory */

int main(void) /* void means no input argument */
{
    printf("Hello World\n!");  /* using standard ouput function to printf()*/
    printf("%d\n",sqr(255));
    printf("Goodbye World!\n");

    return 0; /* return exit code 0, no error */
}
```

Compile and run

We need to source all files needed to build our modified program.

Remember the header file points to the function in the `usefulfunctions.c` file.

```
$ gcc helloworld.c usefulfunctions.c -o helloworld.out
```

Output:

```
$ ./helloworld.out
Hello World!
65025
Goodbye World!
```

Standard Input and Output

- `stdio.h` is a large file that contains many function declarations, in fact there are 827 lines of code for this header file alone.
    - stdio.h source code

> You should feel a sense of accomplishment for the code you have written so far... just remember that someone wrote the code for your code to work .

Primitive Data Types

C has several data types and all variables **must** have a data type

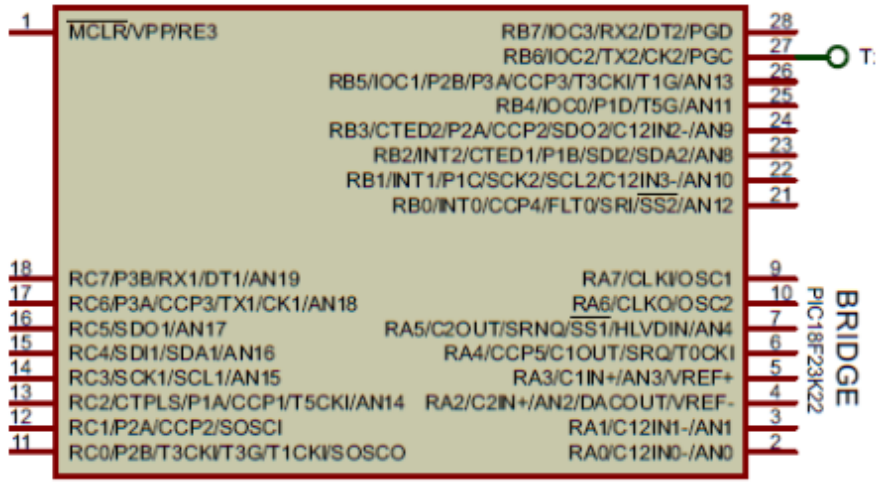
Data Type	Size (Bytes)	Range	Format Specifier
(unsigned)char	at least 1	-128 to 127 or 0 to 255	`%c`
(unsigned)short	at least 2	-32768 to 32767, 0 to 65535	`%h`
(unsigned)int	at least 2	$-2,147,483,648$ to $2,147,483,647$ 0 to 4294967295	`%u` , `%d`
long	least 4	$-9,223,372,036,854,775,808$ to $9,223,372,036,854,775,807$	`%l` , `%ll` , `%lld` , `%lli`
unsigned long	at least 4	0 to $18,446,744,073,709,551,615$	`%lu` , `%llu`
float	at least 2	$3.4e-038$ to $3.4e+038$	`%f`
(unsigned)double	at least 8	$1.7e-308$ to $1.7e+308$	`%lf`
long double	at least 10	$1.7e-4932$ to $1.7e+4932$	`%Lf`

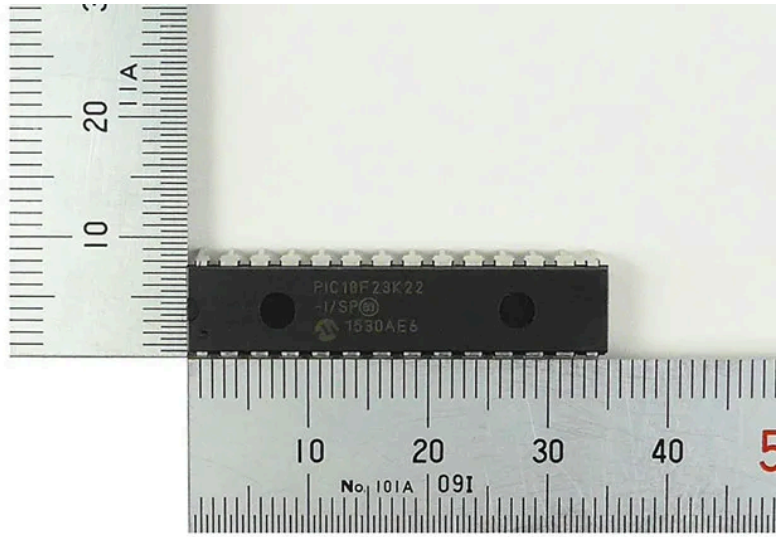
C Advanced Features

- Pointers and addressing, `int*`, `&var1` (more about this later)
- `struct`
  - Allows to combine data items of different kinds
  - `struct Books { char  title[50]; char author[50]; int book_id;} book`
- `enum`
  - It consists of constant integrals or integers that are given names by a user.
  - `enum enum_name{int_const1, int_const2, int_const3, …. int_constN};`
- `union`
  - allows to store different data types in the same memory location
  - `union Data { int i; float f; char str[20];} data;`

Embedded C

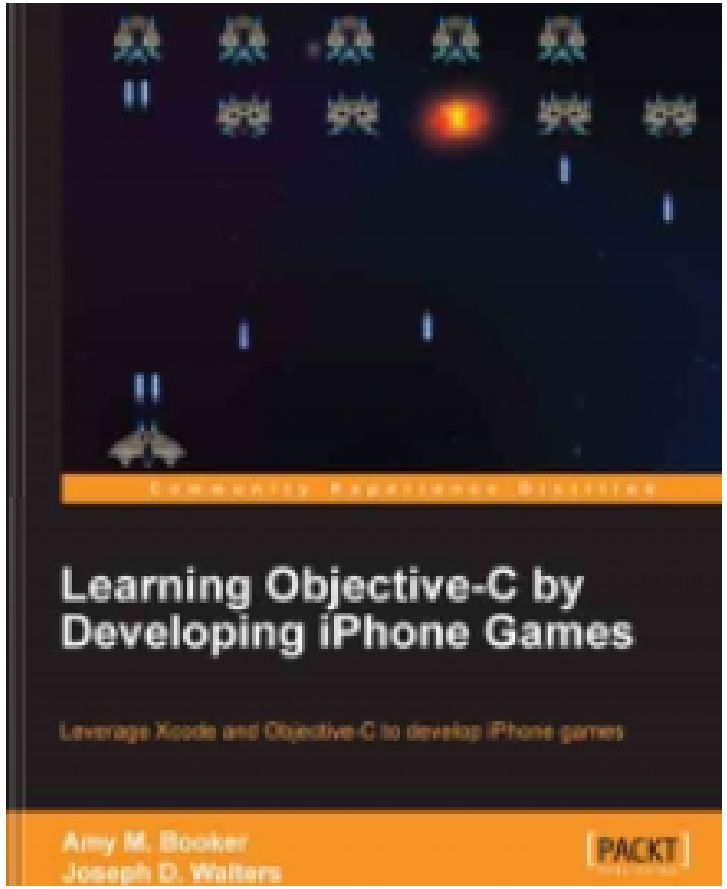
```
ANSEL  = 0;      // Configure AN pins as digital I/O
ANSELH = 0;
C1ON_bit = 0;    // Disable comparators
C2ON_bit = 0;
//          76543210
TRISC  = 0b10000000;   // PORTC is input
UART1_Init(9600); // Initialize UART PROTO

...

ANSELA  = 0;      // Configure AN pins as digital I/O
ANSELB  = 0;
ANSELC  = 0;
TRISB = 0;
```





Objective-C

```objc
#import "MyClass.h"

@implementation MyClass
- (id)initWithString:(NSString *)aName
{
    // code goes here
}

+ (MyClass *)myClassWithString:(NSString *)aName
{
    // code goes here
}
@end
```



Compilation

Throughout this lab we have been using `gcc` or `the GNU Compiler Collection'. The GNU is a recursive acronym: ‘GNU’s Not Unix!'

Supports:

- C,
- embedded-C ,
- Objective-C,
- C++,
- Fortran,
- Ada,
- Go,
- and D

Command Line Arguments

```c
#include <stdio.h>

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

   printf("Program name %s\n", argv[0]);

   if( argc == 2 ) {
      printf("The argument supplied is %s\n", argv[1]);
   }
   else if( argc > 2 ) {
      printf("Too many arguments supplied.\n");
   }
   else {
      printf("One argument expected.\n");
   }
   return 0;
}
```

Let's do this now...