

```
/*  
 * C- Programming Notes  
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 */
```

Init:

Features:

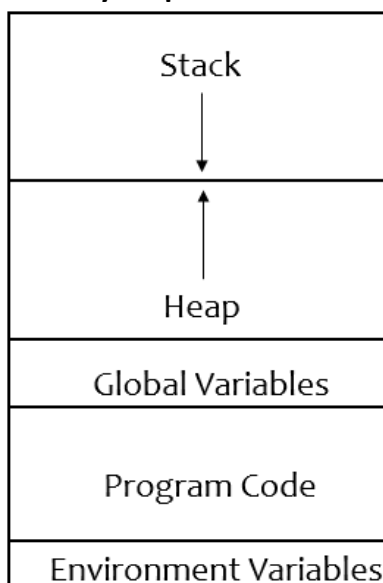
- Dennis Ritchie, 1972, Bell Labs to write Unix OS
- General Purpose, modular and portable
- Low-level memory access
- C-Standards: C89/90 (1989/90), C99 (1999), C11 (2011), C18(2018)

Structure of C Program:

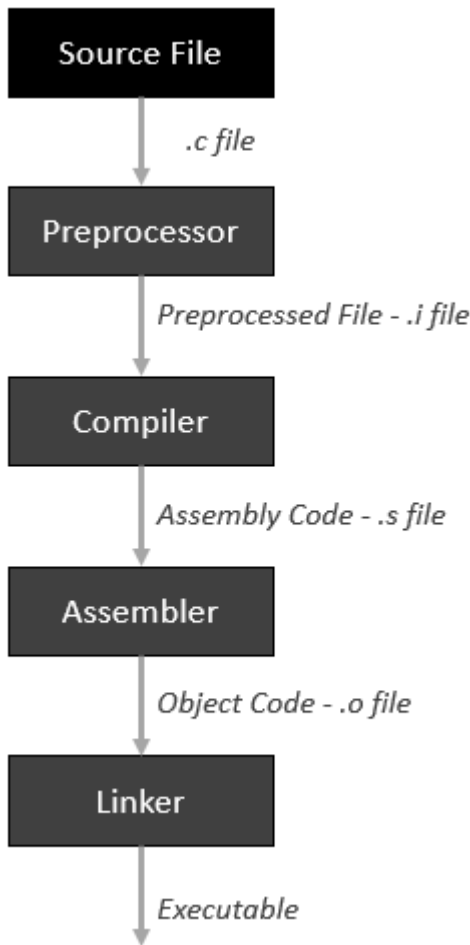
| | |
|----------------------|---------------------------------------|
| Header | <code>#include <stdio.h></code> |
| main() | <code>int main() {</code> |
| Variable Declaration | <code>int a = 10;</code> |
| Body | <code>printf("%d", a);</code> |
| Return | <code>return 0; }</code> |

- Header Files inclusion: Contains C function declarations and macro definitions to be shared between source files.
- Main Method: Execution starts from this function
- Variable Declaration: Variables that are to be used in the function. No variables can be used without being declared
- Body: Refers to operations that are performed in the functions.
- Return: Depending on return type of the function, the return refers to the returning values from a function

Memory Map:



Compilation: Process of converting the source code of C lang into machine code.



1. Source File: Create a c program using an editor and save the file as filename.c
2. Pre-processor: This phase includes the following and produces filename.i
 - a. Removal of comments
 - b. Expansion of Macros
 - c. Expansion of Included files
 - d. Conditional Compilation
3. Compiling: Compiles filename.i and produces filename.s which includes assembly-level instructions.
4. Assembler: Takes filename.s as input and produces filename.o – object code. Existing code is converted into machine language.
5. Linking: All function calls linked, adds extra code to mark delimiters of each block.

`$gcc -Wall -save-temps filename.c -o filename //` To save all intermediate files during compilation

Comments and Line Splicing:

Single Line: //

Multi Line: /* */

```
#include <stdio.h>
int main()
{
    // Line Splicing\
    printf("Hello GFG\n");
    printf("welcome\n");
    /* Below lines will be printed*/ \
}
```

```

printf("Hello\t");
printf("World");
return (0);
}
/* Output
welcome
Hello World
*/

```

Prefer using Multi Line Comments every where

Tokens:

- Keywords
- Identifiers
- Constants/Literals: Variables with fixed values. *const a=19;*
- Strings: Array of chars with a null char at end. *char string[] = "ravikumar";*
- Special Symbols: `[](){}.,:;*=#.~`
- Operators:

| | |
|------------|---|
| Assignment | =, +=, -=, *=, /=, %=, &=, =, ^=, >>=, <<= |
| Arithmetic | +, -, *, /, %, ++, -- |
| Relational | ==, !=, >, <, >=, <= |
| Logical | &&, , ! |
| Bitwise | &, , ^ |
| Ternary | Condition? True : False; |
| Pointer | &, * |
| Misc | sizeof(), . (obj.val), &(ptr), *(access) |

Keywords: Predefined and reserved words that special meanings to compiler

| | | | |
|-----------------|-----------------|----------------------|---------------|
| <i>auto</i> | <i>break</i> | <i>case</i> | <i>char</i> |
| <i>double</i> | <i>else</i> | <u><i>enum</i></u> | <i>extern</i> |
| <i>int</i> | <i>long</i> | <i>register</i> | <i>return</i> |
| <i>struct</i> | <i>switch</i> | <i>typedef</i> | <i>Union</i> |
| <i>const</i> | <i>continue</i> | <i>default</i> | <i>do</i> |
| <i>float</i> | <i>for</i> | <i>goto</i> | <i>if</i> |
| <i>short</i> | <i>signed</i> | <u><i>sizeof</i></u> | <i>static</i> |
| <i>unsigned</i> | <i>void</i> | <i>volatile</i> | <i>while</i> |

Identifiers - Variables and Constants:

- Named location which has some memory allocated to it.
- Always start with letter/_, only alphanumeric, no whitespace, no keywords.

Types of variables:

- Local Variables: Declared inside a function or block of code
- Global Variables: When we have same name for local and global variable, local variable will be given preference over the global variable by the compiler. For accessing global variable in this case:

```
#include <stdio.h>

// Global variable x
int x = 50;

int main()
{
    // Local variable x
    int x = 10;
    {
        extern int x;
        printf("Global x: %d\n", x);
    }
    printf("Local x: %d\n", x);
    return 0;
}
/* Output:
    Global x: 50
    Local x: 10 */
```

- Automatic Variables: All local variables are local by default. Scope is local and their life time is till the end of the block
- Extern Variables: To share variables between multiple C files.

```
-----myfile.h-----
extern int x=10; //external variable (also global)
```

```
-----pgm1.c-----
#include "myfile.h"
#include <stdio.h>
void printValue(){
    printf("X: %d", x);
}
```

- Static Variables: Retains its value between multiple function calls.

```
#include <stdio.h>
void function(){
    int x = 20; //local variable
    static int y = 30; //static variable
    x = x + 10;
    y = y + 10;
    printf("\n%d,%d",x,y);
}
int main() {

    function();
```

```
function();
function();
return 0;
}
```

```
/* Output:
30,40
30,50
30,60 */
```

- Register Variables: Stored in CPU register instead of conventional storage (RAM).
register int var = 20;

Type Qualifiers:

| | |
|----------|--|
| const | Variables of type const cannot be changed by program. They can only be given an initial value. |
| volatile | Variable's value may be changed in ways not explicitly specified by the program. Global variable which is passed to the OS's clock routine is a good example. Most compilers do not expect such changes and look for assignment operators for changes. |
| restrict | Applied to pointer declarations. Object |

Storage Class Specifiers:

Scope Rules:

| Scope | Meaning |
|--------------------------|--|
| File Scope | Starts at beginning of the file and ends with end of the file |
| Block Scope | Starts at the opening of { and ends at } |
| Function prototype scope | Identifiers declared in a func prototype; visible within the prototype |
| Function Scope | Starts at the opening of { of a function and ends at } of a function |

Escape Sequences:

| | |
|-------------|--------------------|
| <i>\a</i> | Alarm or Beep |
| <i>\b</i> | Backspace |
| <i>\f</i> | Form Feed |
| <i>\n</i> | New Line |
| <i>\r</i> | Carriage Return |
| <i>\t</i> | Tab (Horizontal) |
| <i>\v</i> | Tab (Vertical) |
| <i>\\</i> | Backslash |
| <i>\'</i> | Single Quote |
| <i>\"</i> | Double Quote |
| <i>\?</i> | Question Mark |
| <i>\ooo</i> | Octal Number |
| <i>\xhh</i> | Hexadecimal number |
| <i>\0</i> | Null |

Macros and Preprocessors:

All lines that start with # are processed by preprocessor; the functionality is processed prior to other statements in the program.

- When we use *include* directive, the contents of included header file are copied to the current file. Angulars < and > indicate preprocessor to look in the standard folder where all header files are held. Double Quotes " and " indicate it to look into the current folder.
- When we use *define* for a constant, the preprocessor produces a C program where the defined constant is searched and matching tokens are replaced with the given expression.
- Macros can take full function like args and args are not checked for data type.

```
#define INC(x) x++;
```

- Macro args are not evaluated before macro expansion.

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

```
#define MULTIPLY(a, b) a* b
```

```
int main()
```

```
{
```

```
    // The macro is expanded as 2 + 3 * 3 + 5, not as 5*8
```

```
    printf("%d", MULTIPLY(2 + 3, 3 + 5));
```

```
    return 0;
```

```
}
```

```
// Output: 16
```

- Tokens passed to macros can be concatenated using ##

```
#define concat(a,b) a##b
```

- A token passed to macro can be converted to a string literal by using # before it

```
#define conv_str(a) #a
```

- The macros can be written in multiple lines:

```
#define PRINT(i, limit) \
    while (i < limit) { \
        printf("GeeksQuiz "); \
        i++; \
    }
```

- It's better to avoid macros with arguments and inline functions should be preferred as they have type checking.
- Preprocessors also support if-else directives: #if, #else, #endif, #ifdef, #ifndef, #undef
- Standard Macros: __FILE__, __FUNCTION__, __LINE__, __DATA__, __TIME__

void main() or main(): In C, void main() has no defined (legit) usage, and it can sometimes throw garbage results or an error. However, main() is used to denote the main function which takes no arguments and returns an integer data type. To summarize the above, it is never a good idea to use void main() or simply, main() as it doesn't confirm standards. It may be allowed by some compilers though.

int main() and int main(void): In C, if a function signature doesn't specify any argument, it means that the function can be called with any number of parameters or without any parameters.

Program Error Signals:

| | | |
|---------|---|---|
| SIGFPE | Arithmetic Error | Division by zero, Floating point error etc. |
| SIGILL | Illegal Instruction: Instruction with no privilege to get executed, got executed. | Stack overflow, Object file corrupted |
| SIGSEGV | Segmentation fault: Process trying to access a mem location not allocated to it. | De-referencing a wild pointer, Programs gets far from its mem space |

| | | |
|---------|---|---|
| SIGBUS | Bus error. Invalid memory is accessed (not existing mem accessed) | De-referencing memory location out of mem space |
| SIGABRT | Internal Error | General used in assert function |
| SIGSYS | System Call error | Invalid arg passed to a sys call |
| SIGTRAP | Exception Occurred, debugger to be informed | Variable changes its value. |

Data Types:

| Type | Bits | Range |
|------------------------|-------|-------------------------|
| char | 8 | -127 to 127 |
| unsigned char | 8 | 0 to 255 |
| signed char | 8 | -127 to 127 |
| int | 16/32 | -32767 to 32767 |
| unsigned int | 16/32 | 0 to 65535 |
| signed int | 16/32 | -32767 to 32767 |
| short int | 16 | -32767 to 32767 |
| unsigned short int | 16 | 0 to 65535 |
| signed short int | 16 | -32767 to 32767 |
| long int | 32 | $-2^{31}-1$ to 2^{31} |
| long long int | 64 | $-2^{63}-1$ to 2^{63} |
| signed long int | 32 | $-2^{31}-1$ to 2^{31} |
| unsigned long int | 32 | 0 to 2^{31} |
| unsigned long long int | 64 | $2^{64} - 1$ |
| float | 32 | 0 to 2^{31} |
| double | 64 | $2^{64} - 1$ |
| long double | 80 | $2^{80} - 1$ |

INT_MIN and INT_MAX in limits.h give the limits of an integer

Notes for next class:

Completed till part8 in Variable declaration in GFG and Type Qualifiers in ONote.