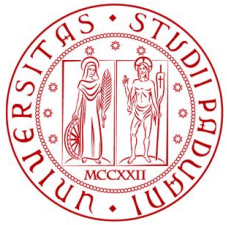
# CyberSecurity: Principle and Practice

*BSc Degree in Computer Science*
*2024-2025*

## Bonus Lesson: C Recap


Prof. Mauro Conti
Department of Mathematics
University of Padua
conti@math.unipd.it
http://www.math.unipd.it/~conti/

Teaching Assistants
Tommaso Bianchi
tommaso.bianchi@phd.unipd.it.
Riccardo Preatoni
riccardo.preatoni@phd.unipd.it


UNIVERSITÀ DEGLI STUDI DI PADOVA

SPRITZ SECURITY & PRIVACY RESEARCH GROUP

DIPARTIMENTO MATEMATICA

# Overview of C



- C is developed by Dennis Ritchie 1972
- C is a structured programming language
- C supports functions that enables easy maintainability of code, by breaking large file into smaller modules
- Comments in C provides easy readability
- C is a powerful language

# Program structure



A sample C Program

```
#include<stdio.h>

int main()
{
    --other statements
    // Comments after double slash
}
```

# Header files



- The files that are specified in the include section are called header files
- These are precompiled files that have some functions defined in them
- We can call those functions in our program by supplying parameters
- Header file is given an extension .h
- C Source file is given an extension .c

# Main function



- This is the entry point of a program
- When a file is executed, the start point is the main function
- From main function the flow goes as per the programmers choice.
- There may or may not be other functions written by user in a program
- Main function is compulsory for any c program

# Writing the first program



```
#include<stdio.h>
int main()
{
    printf("Hello");
    return 0;
}
```

This program prints Hello on the screen when we execute it

# Running a C Program



- Type a program
- Save it
- Compile the program: gcc main.c -o output
  This will generate an executable file
- Run the program (Actually the exe created out of compilation will run and not the .c file)
- In different compiler we have different option for compiling and running. We give only the concepts.

# Comments in C



- Single line comment
  - // (double slash)
  - Termination of comment is by pressing enter key
- Multi line comment

  /*….

  …….*/

  This can span over to multiple lines

# Data types in C



- Primitive data types
  - int, float, double, char
- Aggregate data types
  - Arrays come under this category
  - Arrays can contain collection of int or float or char or double data
- User defined data types
  - Structures and enum fall under this category.

# Variables



- Variables are data that will keep on changing
- Declaration

  <<Data type>> <<variable name>>;

  int a;

- Definition

  <<varname>>=<<value>>;

  a=10;

- Usage

  <<varname>>

  a=a+1;  //increments the value of a by 1

# Variable names - Rules



- Should not be a reserved word like int etc..
- Should start with a letter or an underscore(_)
- Can contain letters, numbers or underscore.
- No other special characters are allowed including space
- Variable names are case sensitive

  A and a are different.

# Input and Output



- Input
  - scanf(“%d”,&a);
  - Gets an integer value from the user and stores it under the name “a”. Stops at whitespace
  - gets(char *str) reads a line from stdin and stores it into the string pointed to by str
- Output
  - printf(“%d”,a);
  - Prints the value present in variable a on the screen
  - puts(const char *str) writes a string to stdout but not including the null character.

# Placeholder



%f,%g:  placeholders for a float or double value
 %d:  placeholder for a decimal value (for printing char, short, int values)
 %u:  placeholder for an unsigned decimal
 %c:  placeholder for a single character
 %s:  placeholder for a string value
 %p:  placeholder to print an address value

 To print out long type values need to use l prefix:
   %lu: print an unsigned long value
   %lld: print a long long  value

Placeholders for specifying the numeric representation
 %x:  print value in hexidecimal (base 16)

# For loops



The syntax of for loop is

```
for(initialisation;condition checking;increment)
{
   set of statements
}
```

Eg: Program to print Hello 10 times

```
for(I=0;I<10;I++)
{
   printf(“Hello”);
}
```

# While loop



The syntax for while loop

```
while(condition)
{
        statements;
}
```

Eg:

```
a=10;
while(a != 0)
{
        printf("%d",a);
        a--;
}
```

Output: 10987654321

# Do While loop



The syntax of do while loop

```
do
 {
    set of statements
 } while(condn);
```

Eg:

```
    i=10;
    do
    {
        printf("%d",i);  i--;
    }  while(i!=0)
```

Output: 10987654321

# Conditional statements



```
if (condition)
{
    stmt 1;    //Executes if Condition is true
}
else
{
     stmt 2;   //Executes if condition is false
}
```

# Conditional statement



```
switch(var)
{
case 1:        //if var=1 this case executes
               stmt;
               break;
case 2:        //if var=2 this case executes
               stmt;
               break;
default:       //if var is something else this will execute
               stmt;
}
```

# Operators



- Arithmetic (+,-,*,/,%)
- Relational (<,>,<=,>=,==,!=)
- Logical (&&,||,!)
- Bitwise (&,|)
- Assignment (=)
- Compound assignment(+=,*=,-=,/=, %=,&=,|=)
- Shift (right shift >>, left shift <<)

# Procedures



- Procedure is a function whose return type is void
- Functions will have return types int, char, double, float or even structs and arrays
- Return type is the data type of the value that is returned to the calling point after the called function execution completes

# Functions and Parameters



**Declaration section**

*<<Returntype>> funname(parameter list);*

**Definition section**

*<<Returntype>> funname(parameter list)*
*{*
*body of the function*
*}*

**Function Call**

*Funname(parameter);*

# Example function



```
#include<stdio.h>

void fun(int a);                    //declaration
int main()
{
    fun(10);                        //Call
}
void fun(int x)                     //definition
{
    printf("%d",x);
}
```

# Actual and Formal parameters



- Actual parameters are those that are used during a function call (value is known)

- Formal parameters are those that are used in function definition and function declaration (value is unknown)

# Arrays



- Arrays fall under aggregate data type
- Aggregate – More than 1
- Arrays are collection of data that belong to same data type
- Arrays are collection of homogeneous data
- Array elements can be accessed by its position in the array called as index

# Arrays



- Array index starts with zero
- The last index in an array is num – 1 where num is the no of elements in a array
- int a[5] is an array that stores 5 integers
  - a[0] is the first element where as a[4] is the fifth element
- We can also have arrays with more than one dimension
- float a[5][5] is a two dimensional array. It can store 5x5 = 25 floating point numbers
  - The bounds are a[0][0] to a[4][4]

# String functions



Strings are arrays of chars -- char c[] = "c string";

- strlen(str) – To find length of string str
- strrev(str) – Reverses the string str as rts
- strcat(str1,str2) – Appends str2 to str1 and returns str1
- strcpy(st1,st2) – copies the content of st2 to st1
- strcmp(s1,s2) – Compares the two string s1 and s2
- strcmpi(s1,s2) – Case insensitive comparison of strings

# Structures



- Structures are user defined data types
- It is a collection of heterogeneous data
- It can have integer, float, double or character data in it
- We can also have array of structures

```
struct <<structname>>
{
   members;
} element;
```

We can access element.members;

# Structures



```
struct Person
{
    int id;
    char name[5];

} P1;

P1.id = 1;
P1.name = “vasu”;
```

# Pointers



- Pointer is a special variable that stores address of another variable
- Addresses are integers. Hence pointer stores integer data
- Size of pointer = size of int
- Pointer that stores address of integer variable is called as integer pointer and is declared as int *ip;

# Pointers



- Pointers that store address of a double, char and float are called as double pointer, character pointer and float pointer respectively.
- char *cp
- float *fp
- double *dp;
- Assigning value to a pointer

```
int *ip = &a; //a is an int already declared
```

# Examples



```
int a;
a=10;       //a stores 10
int *ip;
ip = &a;    //ip stores address of a (say 1000)
```

ip : fetches 1000

*ip : fetches 10

* Is called as dereferencing operator

# Call by Value

Calling a function with parameters passed as values

```
int a=10;
fun(a);
```

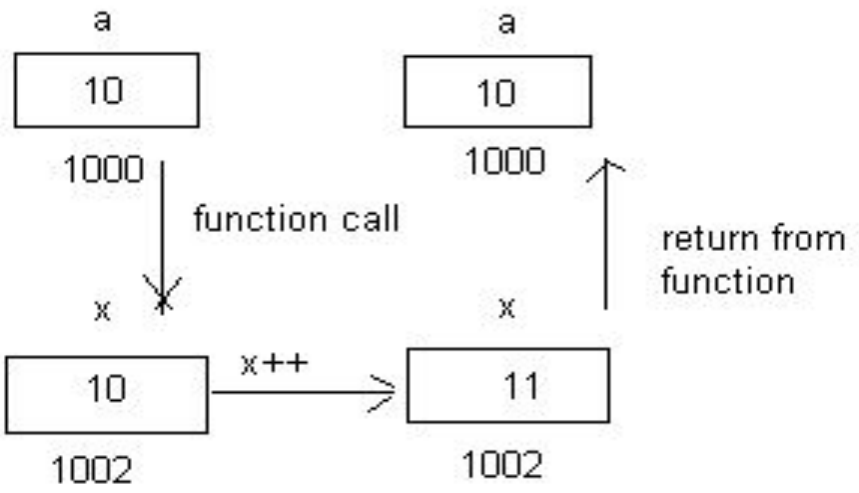
```
void fun(int a)
{
        defn;
}
```

Here fun(a) is a call by value.

Any modification done with in the function is local to it and will not be effected outside the function

# Example program – Call by value

```
#include<stdio.h>
void main()
{
    int a=10;
    printf("%d",a);          a=10
    fun(a);
    printf("%d",a);          a=10
}
void fun(int x)
{
    printf("%d",x)           x=10
    x++;
    printf("%d",x);          x=11
}
```



# Call by reference



Calling a function by passing pointers as parameters (address of variables is passed instead of variables)

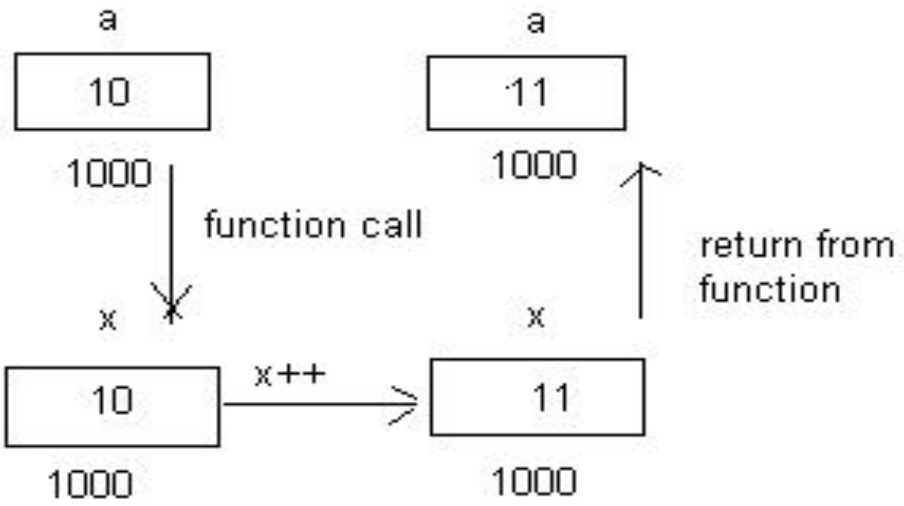
```
int a=1;
fun(&a);
```

```
void fun(int *x)
{
        defn;
}
```

Any modification done to variable a will effect outside the function also

# Example Program - Call by reference

```
#include<stdio.h>
void main()
{
    int a=10;
    printf("%d",a);          a=10
    fun(a);
    printf("%d",a);          a=11
}
void fun(int x)
{
    printf("%d",x)           x=10
    x++;
    printf("%d",x);          x=11
}
```



# Conclusion



- Call by value => copying value of variable in another variable. So any change made in the copy will not affect the original location.
- Call by reference => Creating link for the parameter to the original location. Since the address is the same, changes to the parameter will refer to original location and the value will be overwritten.

# Exercises



Get familiar with C at

https://www.w3resource.com/c-programming-exercises/

A couple of suggestions:

- Basic Declarations and expressions

  1,5,10,28
- Input Output

  7
- Conditional Statement

  3
- Array

  2,3

Try to compile the programs on your PC!

# Questions? Feedback? Suggestions?