Programming, control structures

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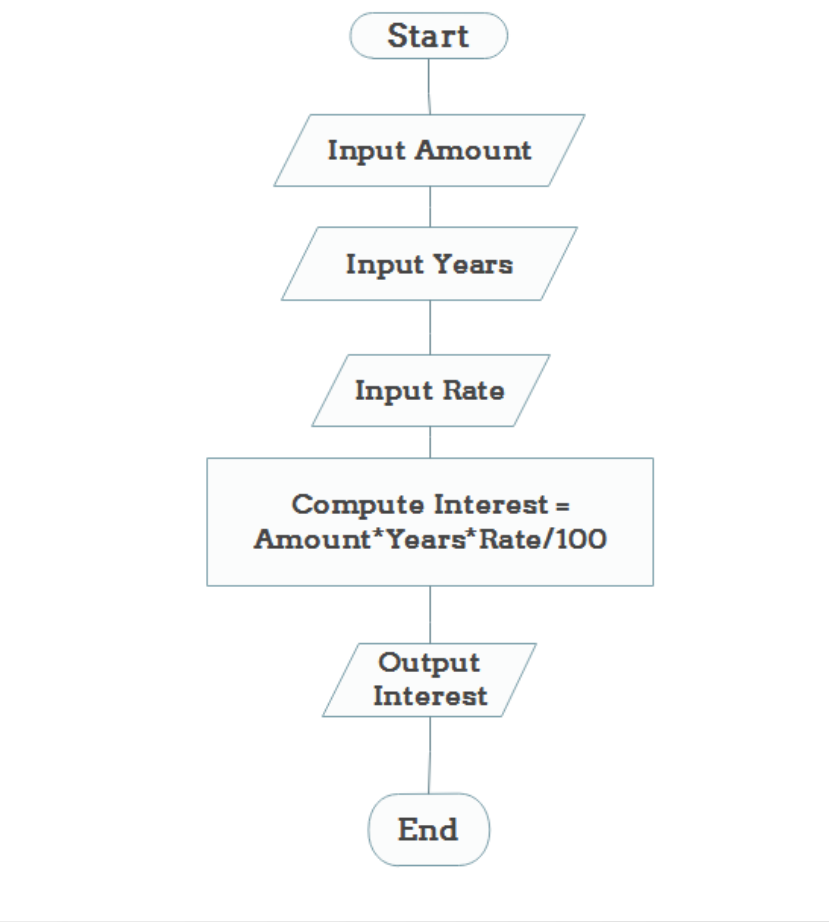
FLOWCHART AND PSEUDOCODE

FLOWCHART AND PSEUDOCODE

- We will only go through some basic example: Calculate the Interest of a Bank Deposit

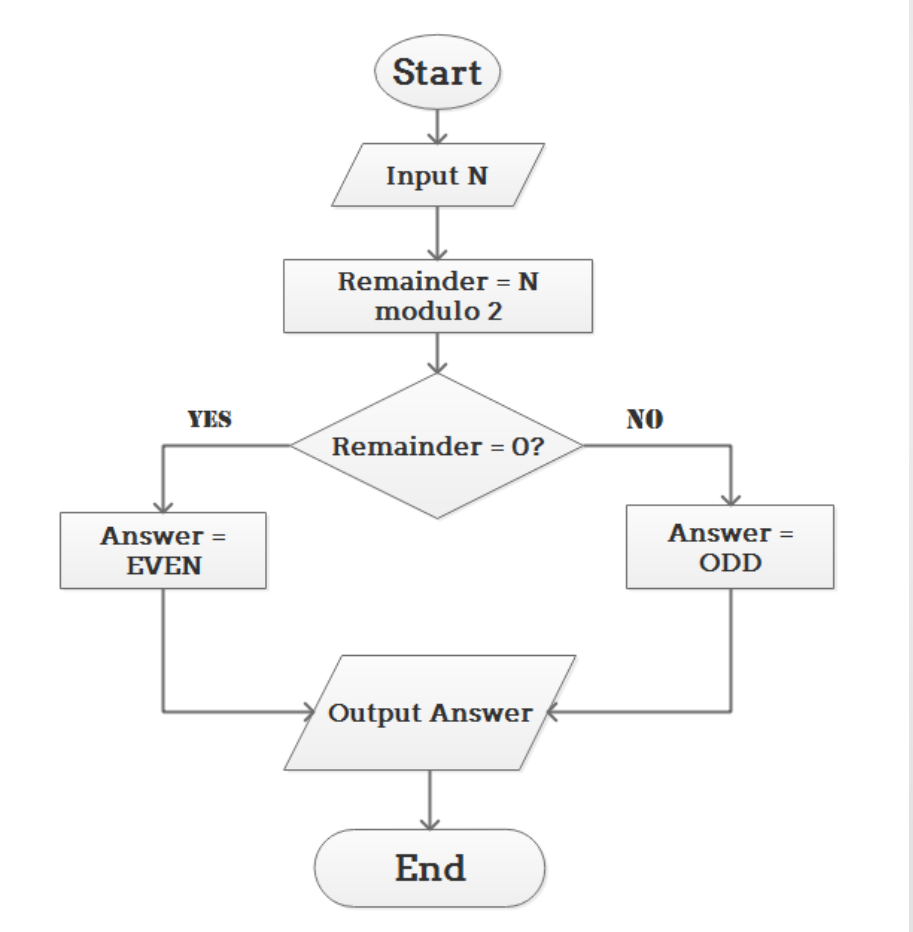
Step 1: Read amount,
Step 2: Read years,
Step 3: Read rate,
Step 4: Calculate the interest with formula
"Interest=Amount*Years*Rate/100
Step 5: Print interest,



FLOWCHART AND PSEUDOCODE

- Determine and Output Whether Number N is Even or Odd

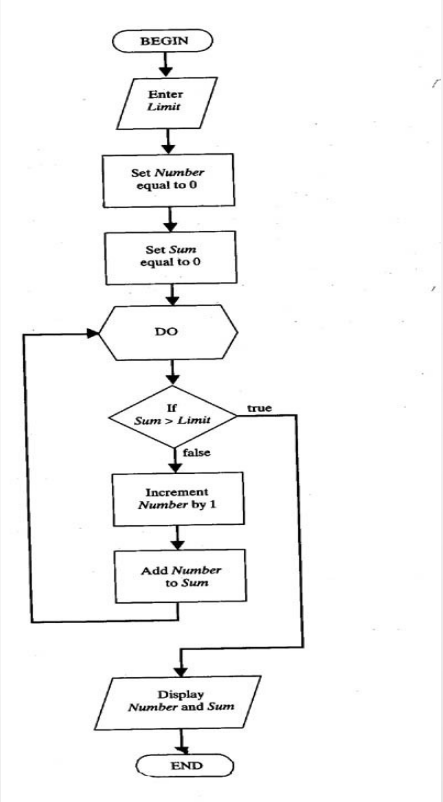
Step 1: Read number N,
Step 2: Set remainder as N modulo 2,
Step 3: If remainder is equal to 0 then number N is even, else number N is odd,
Step 4: Print output.



FLOWCHART AND PSEUDOCODE

- For a given value, Limit, what is the smallest positive integer **Number** for which the sum Sum = 1 + 2 + ... + Number **is greater than Limit. What is the value for this Sum?**

1. Enter Limit
2. Set Number = 0.
3. Set Sum = 0.
4. Repeat the following:
   a. If Sum > Limit, terminate the repitition, otherwise.
   b. Increment Number by one.
   c. Add Number to Sum and set equal to Sum.
5. Print Number and Sum.



CONTROL STRUCTURES

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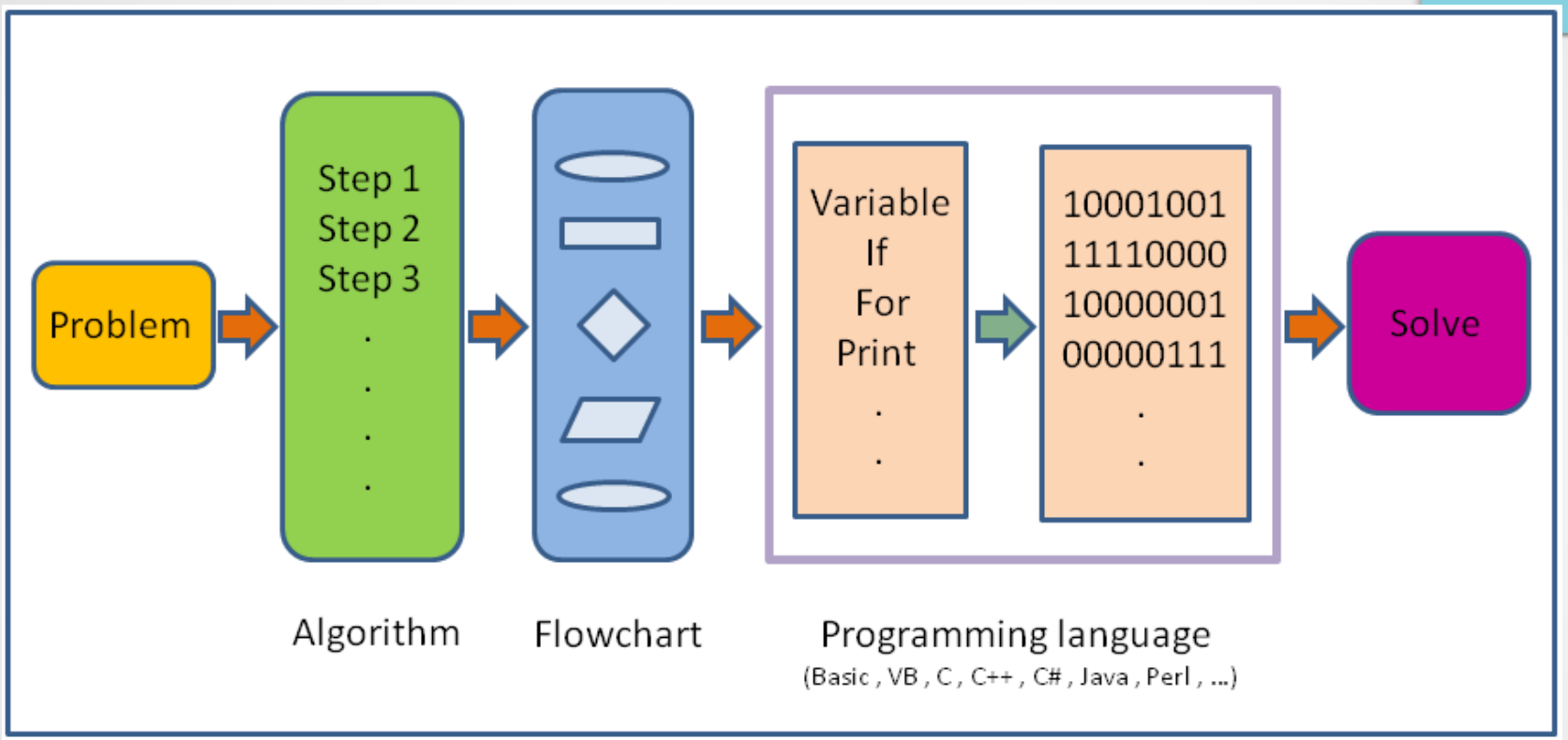


There are three fundamental structures that are used for the algorithmic resolution of problems: **selection, iterations and sequence** (sequence of instructions) (the GOTO present in machine languages since the 70s has been progressively discouraged / eliminated)

Examples: https://bitbucket.org/lstorchi/teaching
https://github.com/lstorchi/teaching

SEQUENCES

Sequences

- **Sequence control structure** refers to the line-by-line execution by which statements are executed sequentially, in the same order in which they appear in the program. They might, for example, carry out a series of read or write operations, arithmetic operations, or assignments to variables.

Step 1: Read amount,
Step 2: Read years,
Step 3: Read rate,
Step 4: Calculate the interest with formula
"Interest=Amount*Years*Rate/100
Step 5: Print interest,

SELECTION

Selections

- The general structure of a selection instruction is as follows:

if (condition 1)

statements 1

else if (condition 2)

statements 2

...

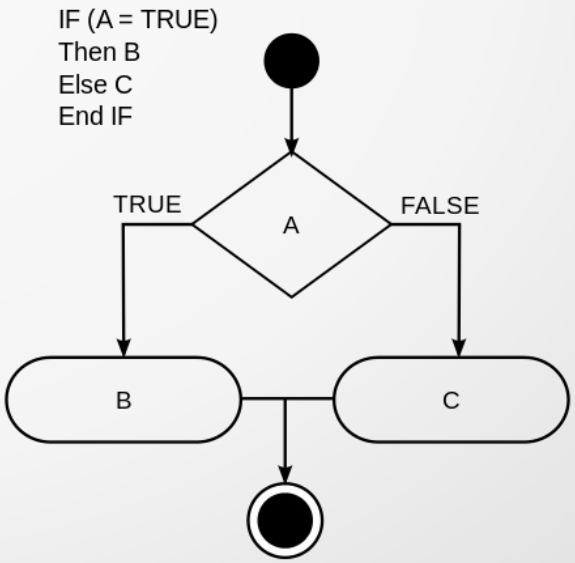
else

statements N

endif

There can be so many else if

They do not necessarily have to show all three elements, if, else if and else, I can also have just a single if



Selections

- **Nesting**, I can nest the selection instructions of course:

```
if (condition 1)
  statement 1
  if (condituion 2)
    statements 2
  end if
else
  statements 3
end if
```

Operators

- In all programming languages, I can use relationship operators to compare numbers and variables, for example:

Description	Java, C, C++	Fortran
Greater than	>	.GT.
Greater than or equal	>=	.GE.
Less than	<	.LT.
Less than or equal	<=	.LE.
Equal	==	.EQ.
Not Equal	!=	.NE.

```
Int a;

a = 4 // operatori di  assegnazione

If  (a == 5)
{
   cout << “Hello” << std::endl;
}
else if (a > 5)
{
    cout <<  a << “ > 5 “ << std::endl;
}
```

Logical Operators

- I take for granted the logical operators AND, OR and NOT

Logical Operators		
Operator	Description	Example
&&	AND	x=6 y=3 x<10 && y>1 Return True
||	OR	x=6 y=3 x==5 || y==5 Return False
!	NOT	x=6 y=3 !(x==y) Return True

Examples the following expression

5 < a < 7

In programming languages it is broken into two elementary expressions linked by the operator AND:

(a > 5) AND (a < 7)

Bitwise operations

- Do not confuse the previous with the bitwise operations
- These are the operations that are used to manipulate bitwise data, not to be confused with qunto seen in the previous slide
  - & (AND)
  - | (OR)
  - ^ (XOR I.e. 1 XOR 1 is zero)
  - ~ (ones' complement i.e. 0 to 1 and 1 to 0)
  - >> (right shift 11100101 >> 1 is 01110010)
  - << (left shift)

Bitwise operations

- A simple test just to clarify

```
└─ $ python3
Python 3.6.9 (default, A
[GCC 8.4.0] on linux
Type "help", "copyright"
>>> a = 60
>>> b = 13
>>> print(a&b)
12
>>> exit()
```

```
a = 60
b = 13

print(a&b)
```

```
12
```

```
a = 0011 1100

b = 0000 1101

---------------

a&b = 0000 1100
```

Case structure

- Basically a series of if-then-else with some constraint. In practice, the choice between the blocks of instruction is guided by the value of a certain variable:

```
switch variable:
   case val1:
      statements 1
   case val2:
      statements 2
   …
   default:
     default statements
```

```
If (variable == val1)
{
    Statements 1
}
else if (variables == val2)
{
   Statements 2
}
…
else
{
  Default statements
}
```

Example

```
int i;
i = 4;
switch (i)
{
  case 1:
    printf("vale uno \n");
    break;
  case 2:
    printf("vale due \n");
    break;
  default:
    printf("non uno non due\n");
    break;
}
```

LOOPS

Loops

- There are three different types: **while..do** , **do..while** e **for**
- **Not all languages necessarily have all three of these structures**
- **These structures allow to repeat a block of instructions until a condition occurs**
- Also in this case it is possible to **nest** more loops one inside the other

While..do e Do..while

- The block of instructions can also never be executed, since **the condition is checked at the beginning**, as long as the condition is true, the block of instructions is executed

  WHILE (condition)

  statements

  END DO

- do..while instead **executes the block of instructions until the condition is false**

  DO

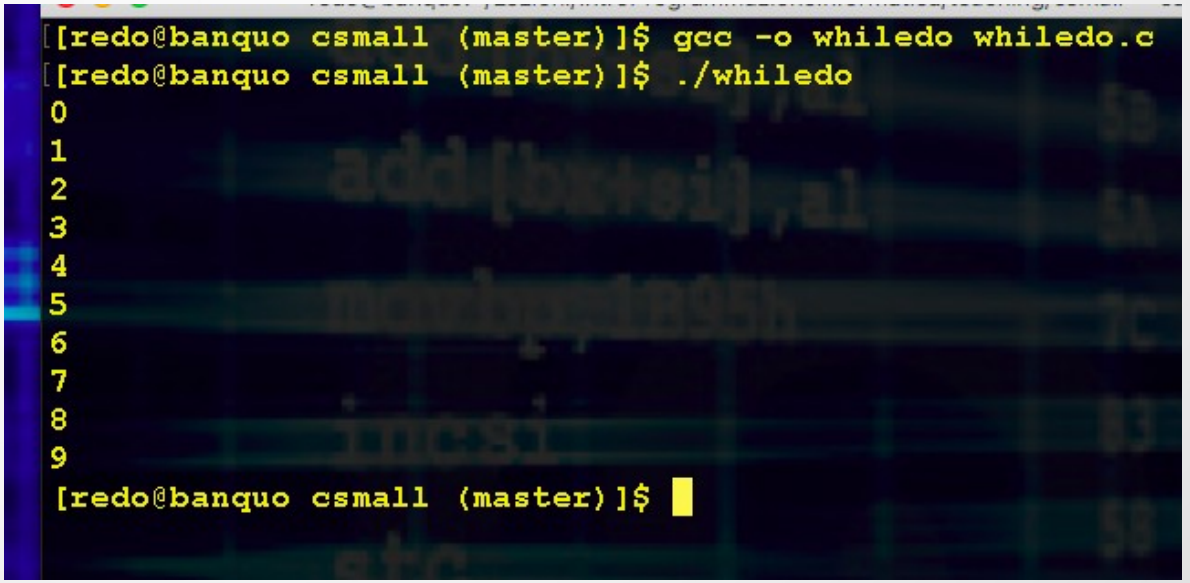
  statements

  WHILE (condition)

Example

- A simple C example:

```
int i = 0, N = 10;
while (i != N)
{
    printf("%d \n", i);
    i++;
}
```



Example

```
Type "help", "copyright"
>>> while True:
...     print("here")
...
```

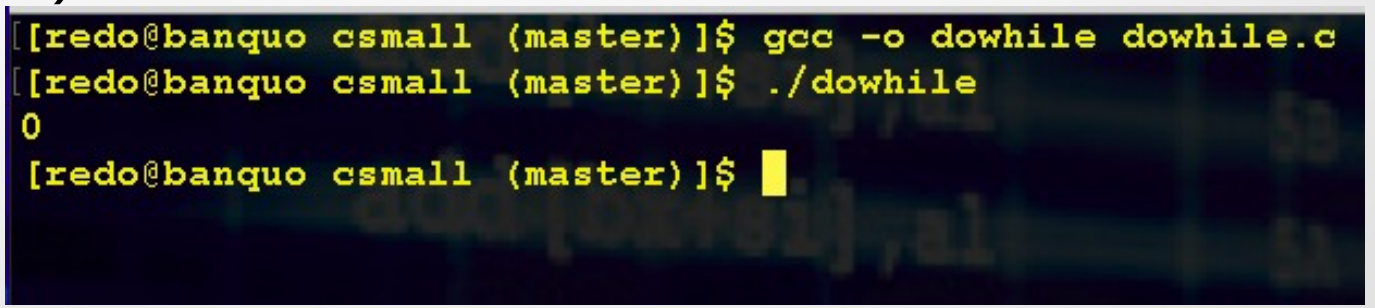
```
while True:
    print("here")
```

```
here
here
here
here
here
here
here
here
here
here
here
```

Example

```
Int i = 0, N = 10;


do
{
    printf (“%d \n”, i);
    i++; // i = i + 1
} while (i >= N);
```



For loop

- It executes a block of instructions a number of times known from the beginning. Many programming languages force the programmer to use a counter.
- Generally there is a counter which is an integer variable whose value is "changed" step by step
- The end condition is generally determined by comparing the counter variable with a value

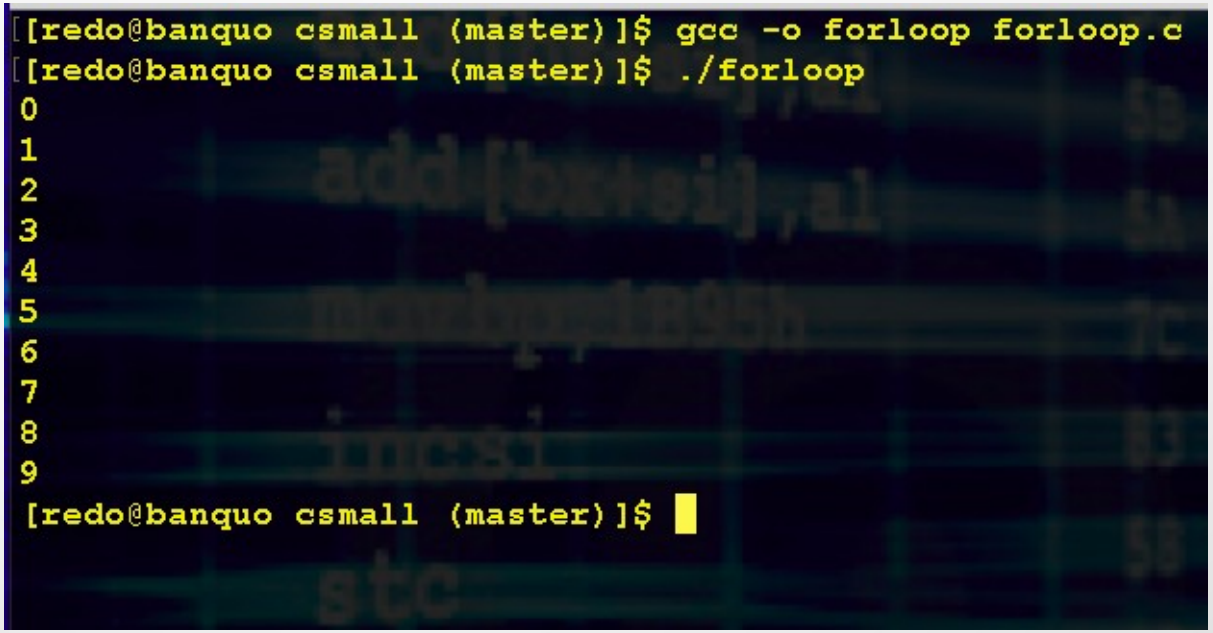
for (counter = startingvalue A endvalue STEP = stepvalue)

statements

end for

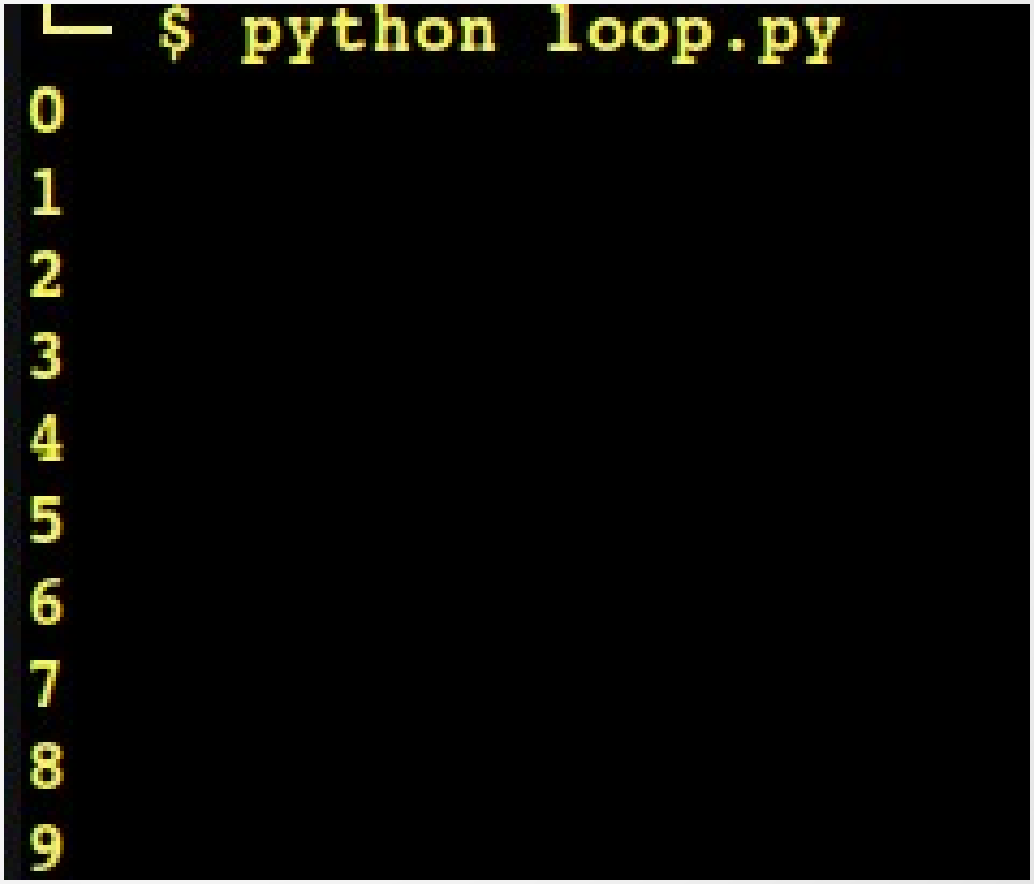
Example

```
int i;
for (i=0; i<10; ++i)
{
   printf (“%d \n”, i);
}
```



Example

```
for i in range(10):
    print(i)
```

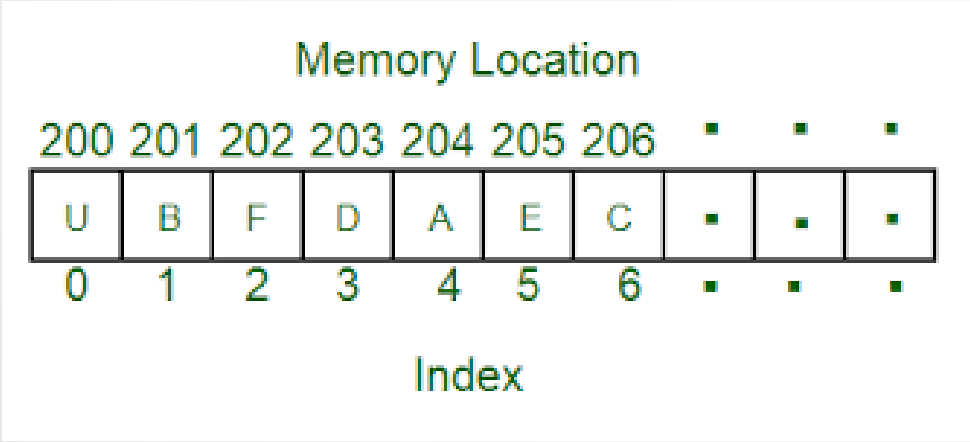


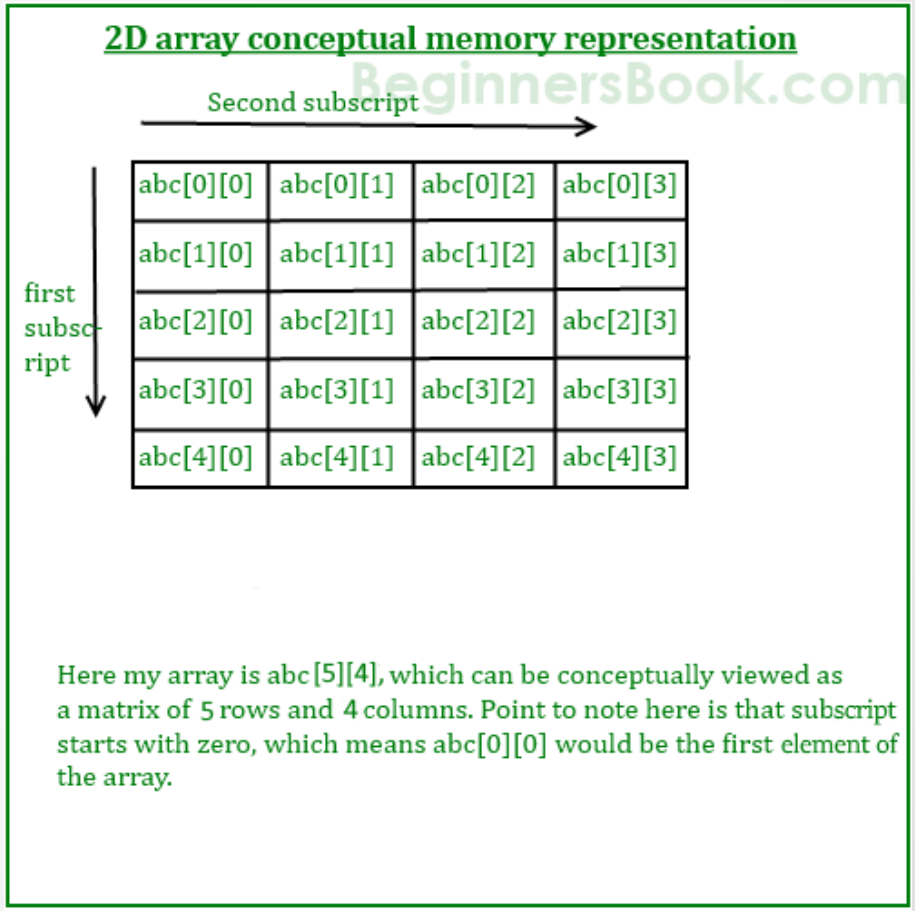
ARRAY

Array

- How can I easily handle information that is structured by nature? For example a complex number, or a vector or a matrix?
- Typical structured variables are arrays
  - For example, a vector of floating-point numbers in C can be declared as: float v [10];
  - We can then access the i-th element of the vector: v [i-1] = 3.5;
- Likewise I can define an array (two-dimensional array) as: float m [10] [10];

Array

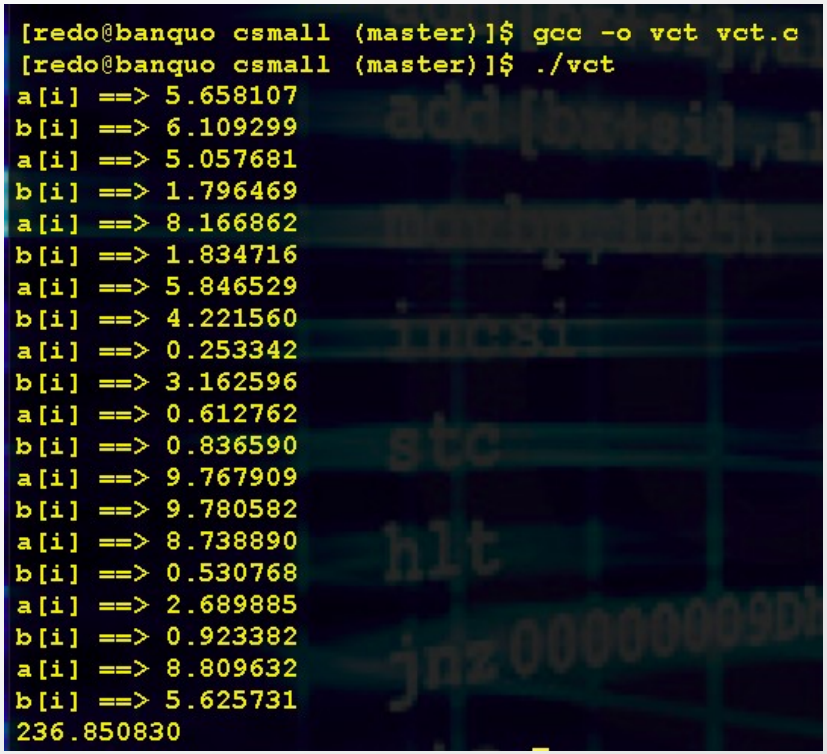

Memory Location
200 201 202 203 204 205 206
U B F D A E C
0 1 2 3 4 5 6
Index


2D array conceptual memory representation
BeginnersBook.com
Second subscript
first subscript
abc[0][0] abc[0][1] abc[0][2] abc[0][3]
abc[1][0] abc[1][1] abc[1][2] abc[1][3]
abc[2][0] abc[2][1] abc[2][2] abc[2][3]
abc[3][0] abc[3][1] abc[3][2] abc[3][3]
abc[4][0] abc[4][1] abc[4][2] abc[4][3]
Here my array is abc[5][4], which can be conceptually viewed as a matrix of 5 rows and 4 columns. Point to note here is that subscript starts with zero, which means abc[0][0] would be the first element of the array.

Example

- Example loops to perform a scalar multiplication between vectors

```
float a[N], b[N];
for (i=0; i<N; ++i)
{
  a[i] = (float)rand()/(float)(RAND_MAX/N);
  b[i] = (float)rand()/(float)(RAND_MAX/N);
}
s = 0.0;
for (i=0; i<N; ++i)
{
    s = s + a[i]*b[i];
}
```



Example

```
import random

N = 20

a = []
b = []

for i in range(N):
    a.append(random.randrange(1, 30))
    b.append(random.randrange(1, 30))

for i in range(N):
    print("%3d %3d"%(a[i], b[i]))

s = 0.0
for i in range(10):
    s = s + float(a[i]*b[i])

print("")
print("S = %.5e"%s)
```