ĐẠI HỌC ĐÀ NẴNG
TRƯỜNG ĐẠI HỌC CÔNG NGHỆ THÔNG TIN VÀ TRUYỀN THÔNG VIỆT - HÀN
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Chapter 1:

Introduction to Computers and Programming

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1.8

Number systems

Number systems

- A number system is defined as the representation of numbers by using digits or other symbols in a consistent manner.
- It is also called the system of numeration.

Types of Number Systems

- There are different types of number systems.
- Four main types are:
  - Binary number system (Base - 2)
  - Octal number system (Base - 8)
  - Decimal number system (Base - 10)
  - Hexadecimal number system (Base - 16)

Binary Number System

- The numbers in this system have a base of 2.
- The binary number system uses only two digits: 0 and 1.
- Digits 0 and 1 are called bits and 8 bits together make a byte. The data in computers is stored in terms of bits and bytes.
- For example: 10001_2 111101_2

Octal Number System

- The numbers in this system have a base of 8.
- The octal number system uses eight digits: 0,1, 2, 3, 4, 5, 6, 7.
- For example:

35_8
141_8

Decimal Number System

- The numbers in this system have a base of 10.
- The octal number system uses ten digits: 0,1, 2, 3, 4, 5, 6, 7, 8, 9.
- The decimal number system is the system that we generally use to represent numbers in real life
- For example: 723_{10} 32_{10} 4257_{10}

Hexadecimal Number System

- The numbers in this system have a base of 16.
- The hexadecimal number system uses sixteen digits/alphabets:

  0,1, 2, 3, 4, 5, 6, 7, 8, 9

  A, B, C, D, E, F (the numbers 10-15)
- For example: $7B3_{16}$ $6F_{16}$ $4B2A_{16}$

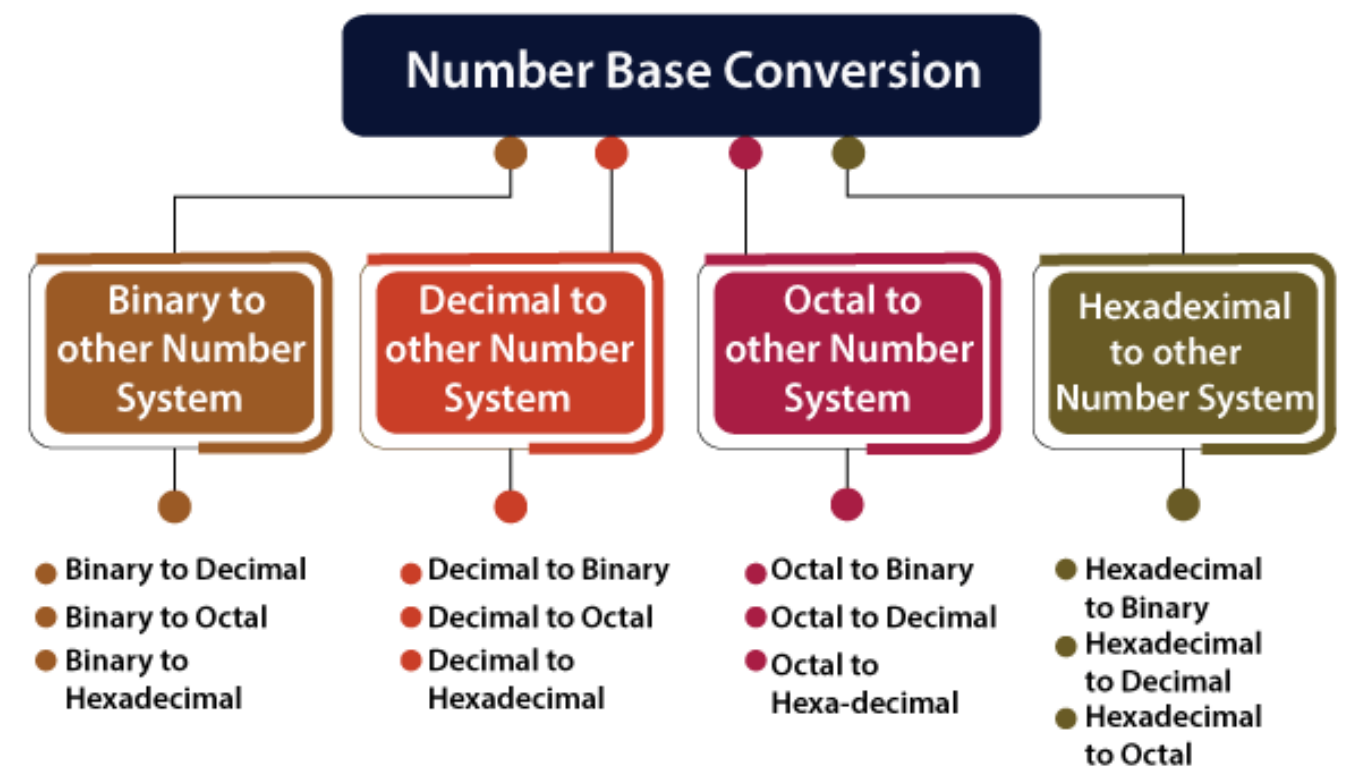
Number systems

Number Systems		
System	Base	Digits
Binary	2	0 1
Octal	8	0 1 2 3 4 5 6 7
Decimal	10	0 1 2 3 4 5 6 7 8 9
Hexadecimal	16	0 1 2 3 4 5 6 7 8 9 A B C D E F

Decimal Base-10	Binary Base-2	Octal Base-8	Hexa Decimal Base-16
0	0	0	0
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	5	5
6	110	6	6
7	111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F
16	10000	20	10

Conversion Rules of Number Systems

- A number can be converted from one number system to another number system.

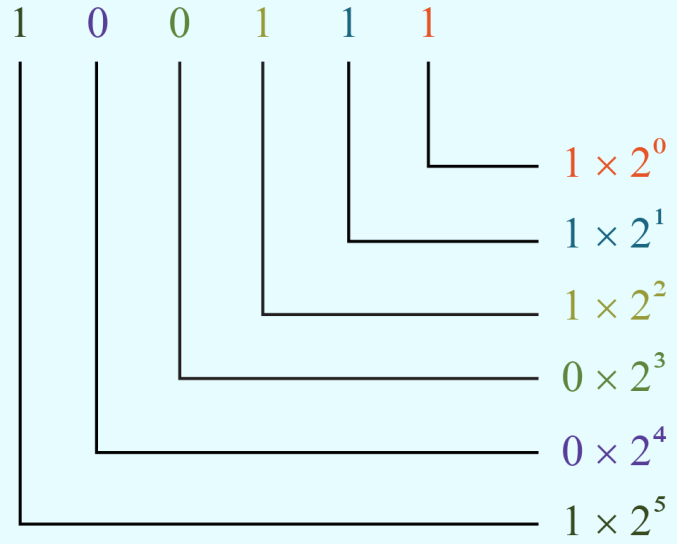


Conversion of Number Systems to Decimal Number System

- Example: Convert 100111_2 into the decimal system.
- Step 1: Identify the base of the given number.
- Here, the base of 100111_2 is 2.

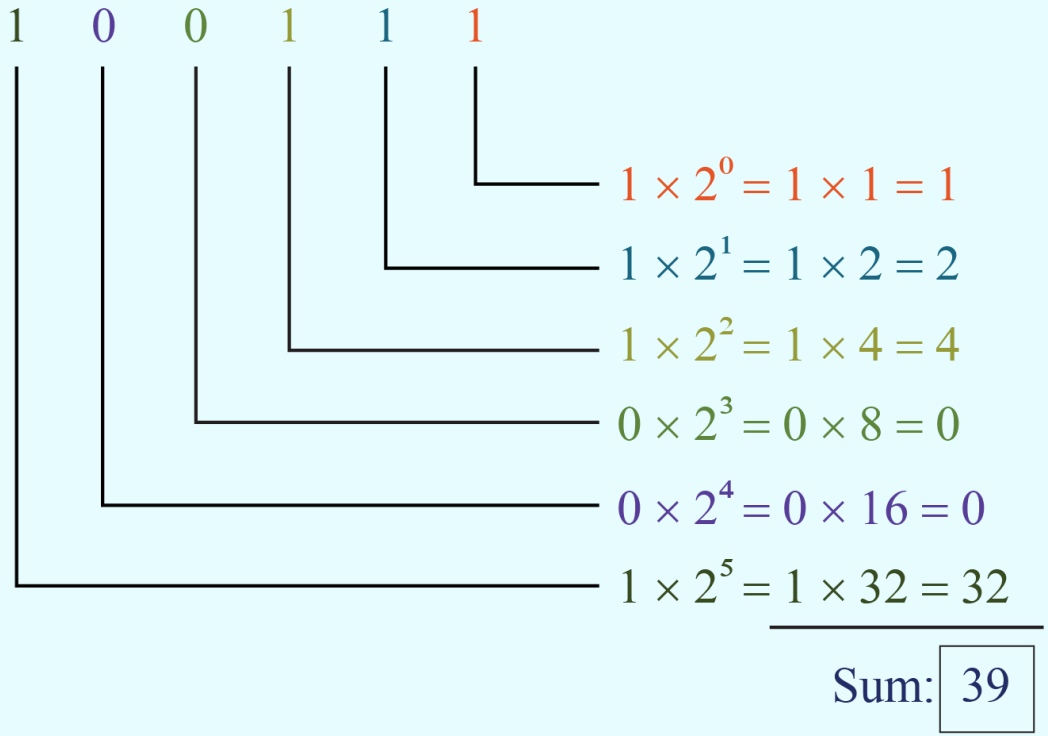
Conversion of Number Systems to Decimal Number System

- Step 2:
  - Multiply each digit of the given number, starting from the rightmost digit, with the exponents of the base.
  - The exponents should start with 0 and increase by 1 every time as we move from right to left.



Conversion of Number Systems to Decimal Number System

- Step 3: We just simplify each of the above products and add them.



$$100111_2 = 39_{10}$$

Conversion of Number Systems to Decimal Number System

- We can use the following steps to make this process simplified.

$100111_2=(1\times2^5)+(0\times2^4)+(0\times2^3)+(1\times2^2)+(1\times2^1)+(1\times2^0)$

$=(1\times32)+(0\times16)+(0\times8)+(1\times4)+(1\times2)+(1\times1)$

$=32+0+0+4+2+1$

$=39_{10}$

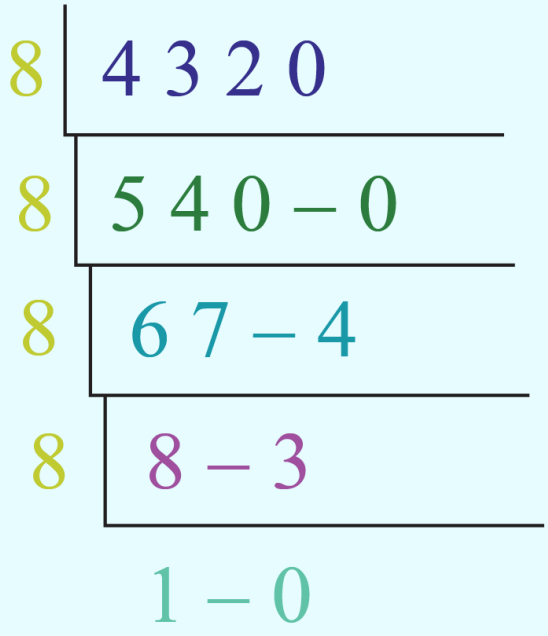
Conversion of Decimal Number System to Other Number Systems

- Example: Convert 4320_{10} into the octal system

- Step 1: Identify the base of the required number.
- The base of the required number is 8

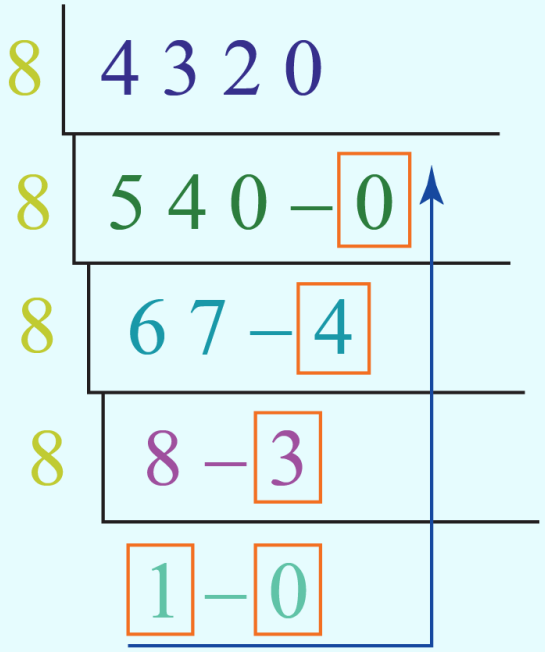
Conversion of Decimal Number System to Other Number Systems

- Step 2:
  - Divide the given number by the base of the required number and note down the quotient and the remainder in the quotient-remainder form.
  - Repeat this process (dividing the quotient again by the base) until we get the quotient to be less than the base.



Conversion of Decimal Number Systems to Other Number Systems

- Step 3: The required number in the octal number system is obtained just by reading all the remainders and the last quotient from bottom to top.



$4320_{10}=10340_{8}$

Conversion of Decimal Number Systems to Other Number Systems

- Example: $2020.65625_{10} \rightarrow (\ ?\ )_{16}$

For Real Part: The real part is 2020_{10}
We convert the real part from base 10 to base 16 using division method same as above.
So, $2020_{10} = 7E4_{16}$

For Fractional Part: The fractional part is 0.65625_{10}
We convert the fractional part from base 10 to base 16 using multiplication method.

	Real part	Fractional Part
0.65625 x 16	10 = A	0.5
0.5 x 16	8	0.0

From here, $0.65625_{10} = 0.A8_{16}$

Combining the result of real and fractional parts:
$2020.65625_{10} = 7E4.A8_{16}$

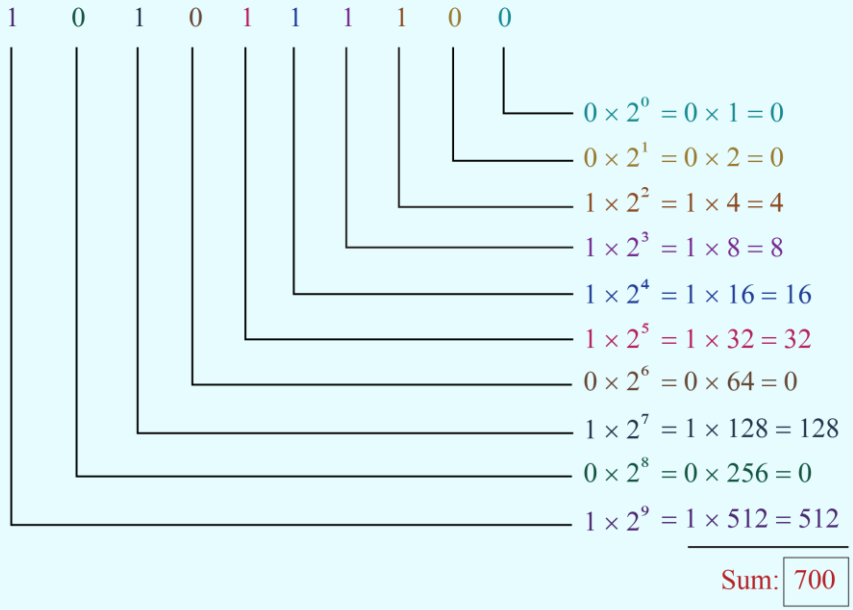
Conversion from One Number System to Another Number System

- To convert a number from one of the binary/octal/hexadecimal systems to one of the other systems:
  - Step 1: We first convert it into the decimal system.
  - Step 2: We convert it to the required systems.

Conversion from One Number System to Another Number System

- Example: Convert 1010111100_2 to the hexadecimal system.

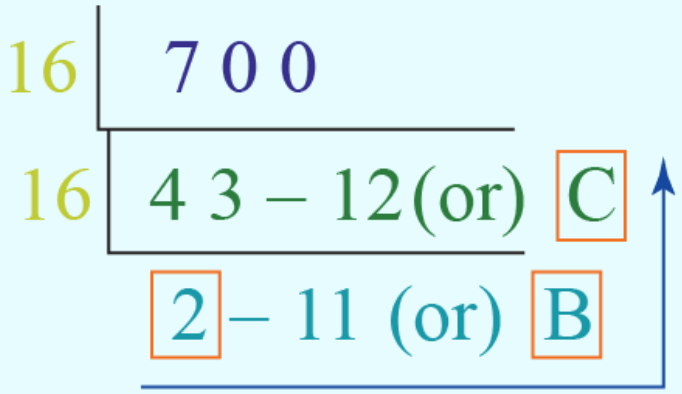
- Step 1: Convert this number to the decimal number system as explained in the above process.



$1010111100_2 = 700_{10}$

Conversion from One Number System to Another Number System

- Step 2: Convert the above number (which is in the decimal system), into the required number system.



$700_{10} = 2BC_{16}$

$1010111100_2 = 700_{10}$

$700_{10} = 2BC_{16}$

$\Rightarrow 1010111100_2 = 2BC_{16}$

1.9

Algorithm

What is Algorithm?

- An algorithm is a procedure or formula for solving a problem, based on conducting a sequence of specified actions.
- For an algorithm to be useful, it must satisfy five properties:
  - The inputs must be specified.
  - The outputs must be specified.
  - Definiteness.
  - Effectiveness.
  - Finiteness.

What is Algorithm?

- How can we create an algorithm to show the steps in getting ready for school?
  - Get out of bed.
  - Take a shower and clean teeth.
  - Get dressed.
  - Turn on the kettle.
  - Put bread in the toaster and turn it on.
  - Wait for the kettle to boil and make tea.
  - Wait for bread to toast, butter it and add Jam.
  - Drink tea and eat toast.
  - Gather school books and put in bag.
  - Put on shoes and coat.
  - Leave the house.

What is Algorithm?

- Build a program:
  - Problem definition
  - Requirement analysis
  - Build the algorithms
  - Coding
  - Testing and debugging
  - Maintenance
  - Documentation

Algorithm development process

- Algorithm development process consists of five major steps:
  - Step 1: Obtain a description of the problem.
  - Step 2: Analyze the problem.
  - Step 3: Develop a high-level algorithm.
  - Step 4: Refine the algorithm by adding more detail.
  - Step 5: Review the algorithm.

Presentation of Algorithm

- There are two main ways that algorithms can be represented:
  - Pseudocode
    - Pseudocode is a plain language description of the steps in an algorithm.
    - It uses programming-style constructs, but is not written in an actual programming language.
  - Flowchart
    - Flowcharts can be used to represent algorithms visually.
    - They use diagrams which use particular symbols to show the flow of data, processing and input/output that takes place within a program or task.

Pseudocode

- Example 1: Add two numbers entered by the user

Step 1: Start
Step 2: Declare variables num1, num2 and sum.
Step 3: Read values num1 and num2.
Step 4: Add num1 and num2 and assign the result to sum.
sum←num1+num2
Step 5: Display sum
Step 6: Stop

Pseudocode

- Example 2: Find the largest number among three numbers

```
Step 1: Start
Step 2: Declare variables a,b and c.
Step 3: Read variables a,b and c.
Step 4:
if ((a >= b) && (a >= c))
      Display a is the largest number.
if ((b >= a) && (b >= c))
      Display b is the largest number.
if ((c >= a) && (c >= b))
      Display c is the largest number.
Step 5: Stop
```

```
Step 1: Start
Step 2: Declare variables a,b and c.
Step 3: Read variables a,b and c.
Step 4:
if (a >= b)
        if (a >= c)
            Display a is the largest number.
        else
            Display c is the largest number
else
        if (b >= c)
            Display b is the largest number.
        else
            Display c is the largest number.
Step 5: Stop
```

Pseudocode

- Example 3: Check whether a number is prime or not

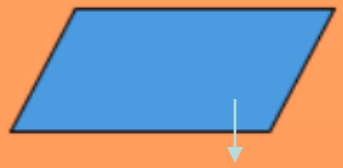
Step 1: Start
Step 2: Declare variables n, i, flag.
Step 3: Initialize variables
flag ← 1
i ← 2
Step 4: Read n from the user.
Step 5: If n == 2
flag ← 0
Go to step 7
else
Go to step 6
Step 6: Repeat the steps until i=(n/2)
6.1 If remainder of n÷i equals 0
flag ← 0
Go to step 7
6.2 i ← i+1
Step 7: If flag = 0
Display n is not prime
else
Display n is prime
Step 8: Stop

Pseudocode

- Example 4: Find the Fibonacci series till the term less than 1000

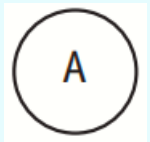
Step 1: Start
Step 2: Declare variables first_term, second_term, temp.
Step 3: Initialize variables first_term ← 0, second_term ← 1
Step 4: Display first_term and second_term
Step 5: Repeat the steps while second_term ≤ 1000
    5.1: temp ← second_term
    5.2: second_term ← second_term + first_term
    5.3: first_term ← temp
    5.4: Display second_term
Step 6: Stop

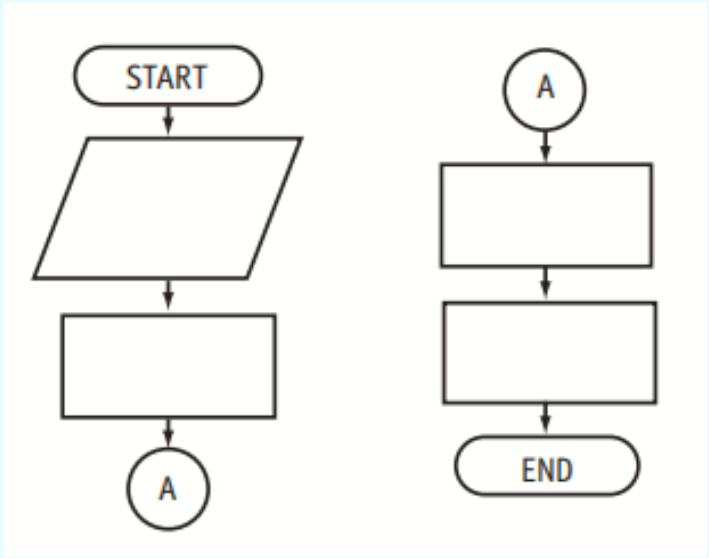
Flowchart

This represents the start or end point of the flowchart.	
You use this to represent data input or data output.	
You use this where a decision has to be made. It is also called selection and will contain a question.	
You use this to represent a process that must be carried out by the algorithm.	

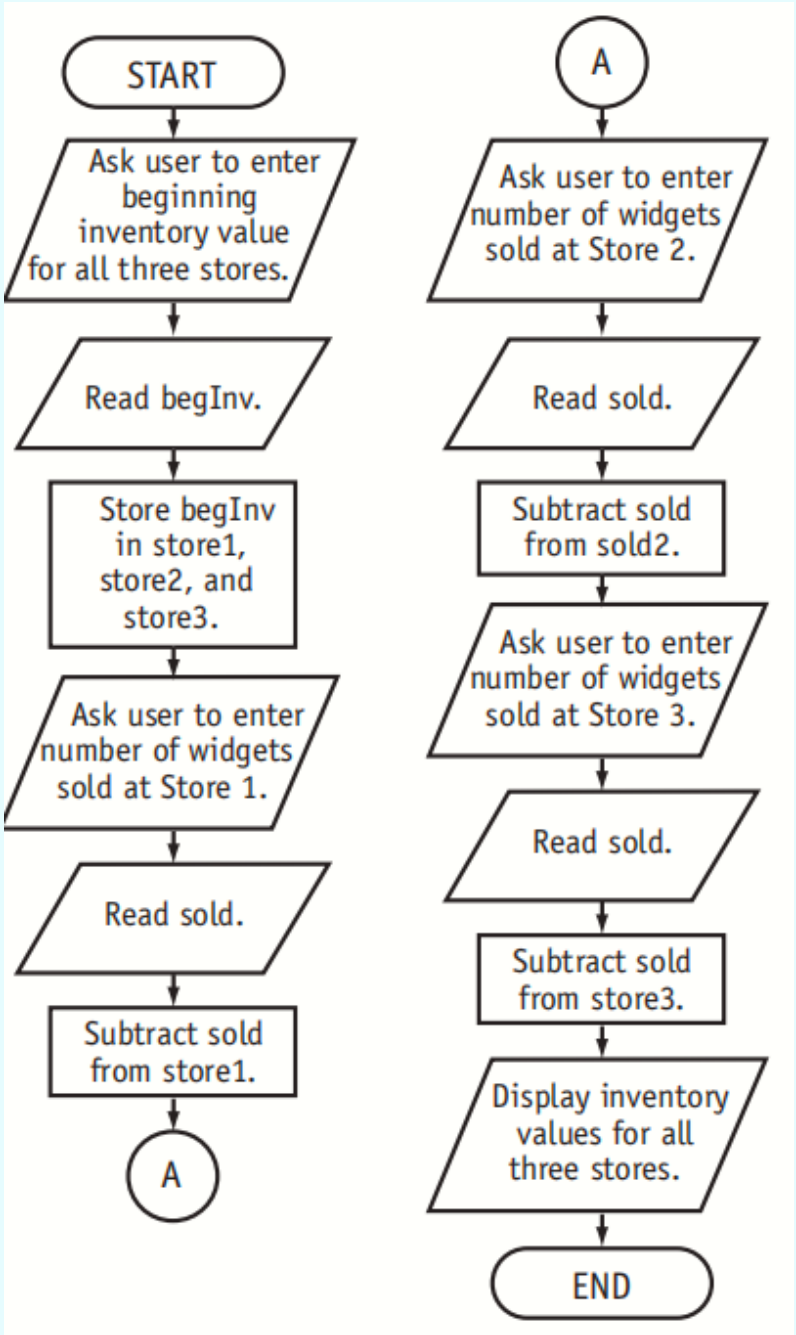
Flowchart

- Connectors





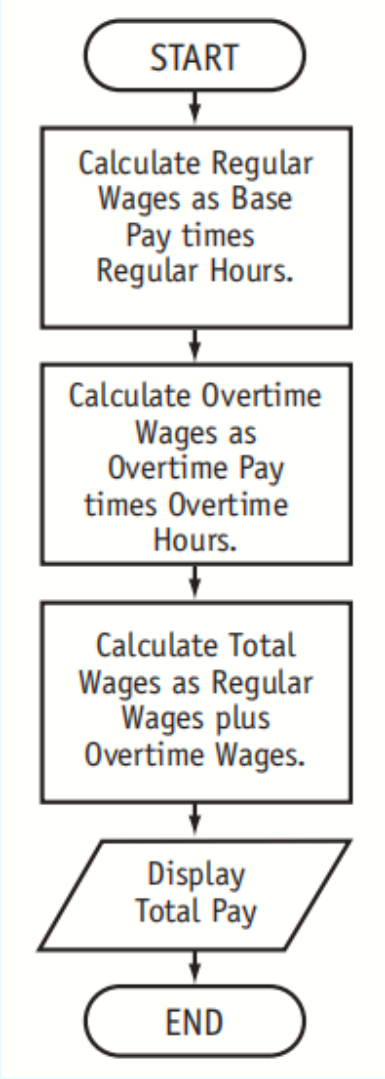
Example 5



Flowchart

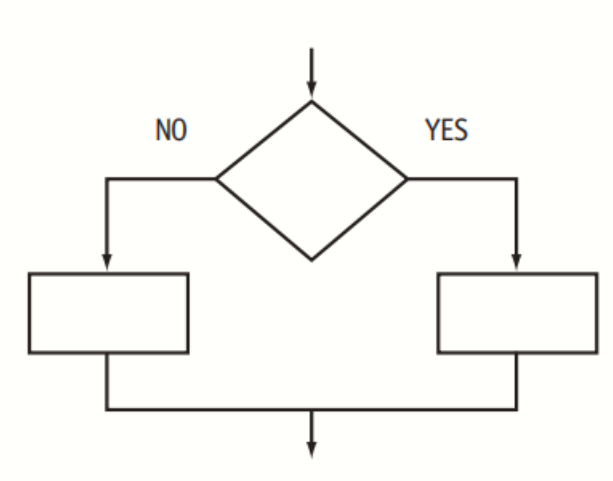
- The Sequence structure

Example 6

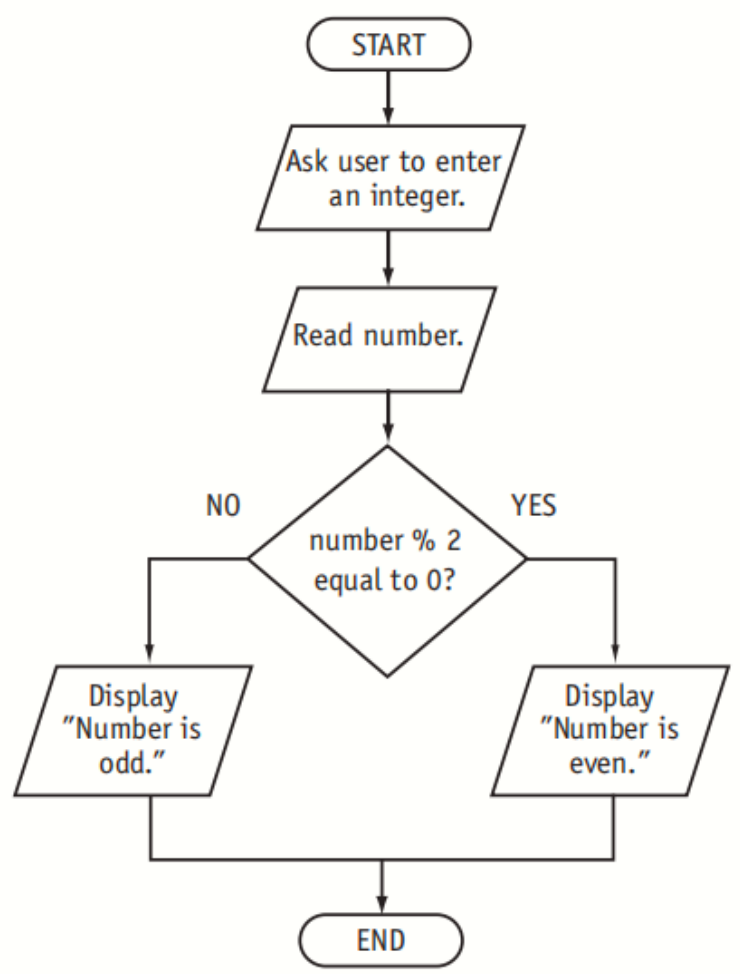


Flowchart

- The Decision Structure

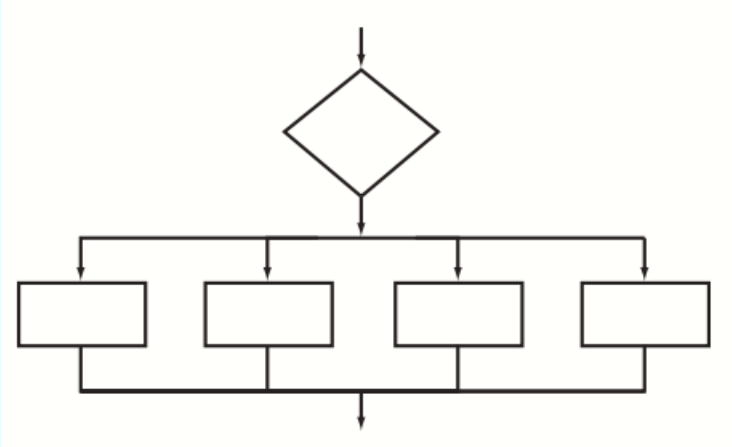


Example 7

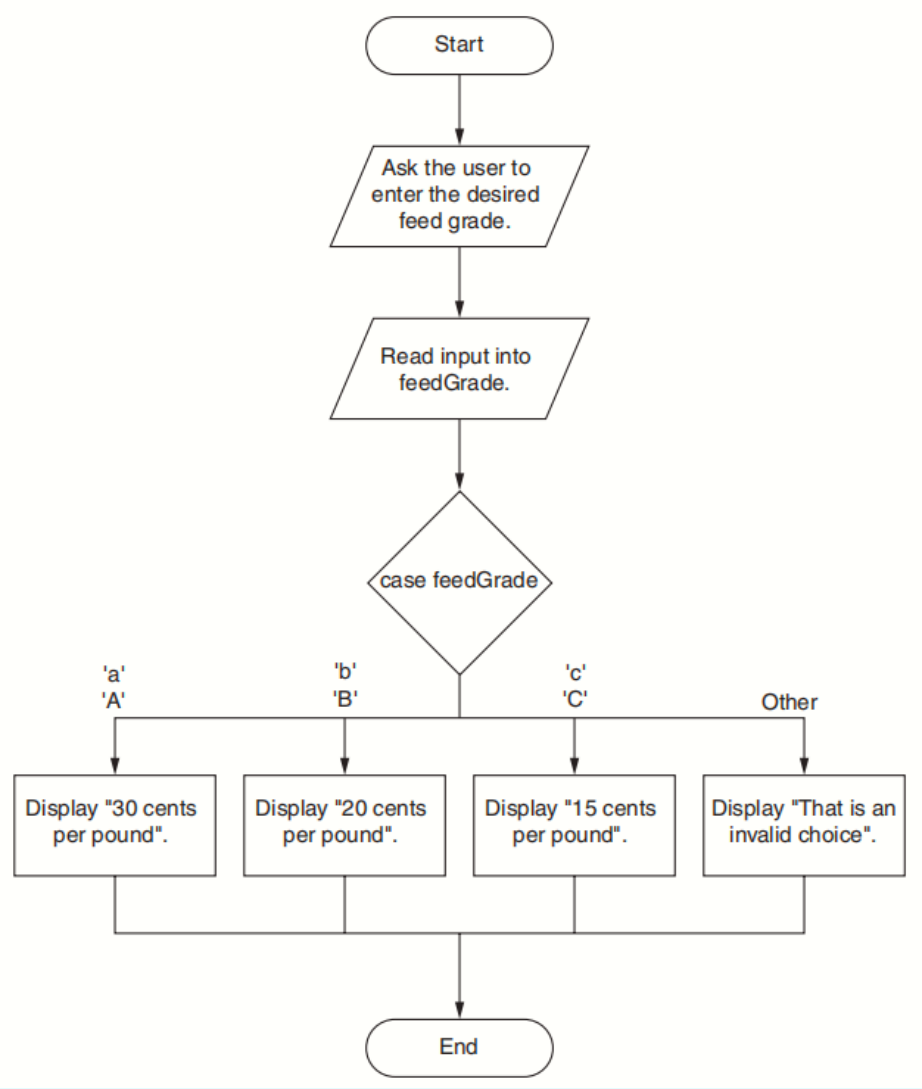


Flowchart

- The Case Structure

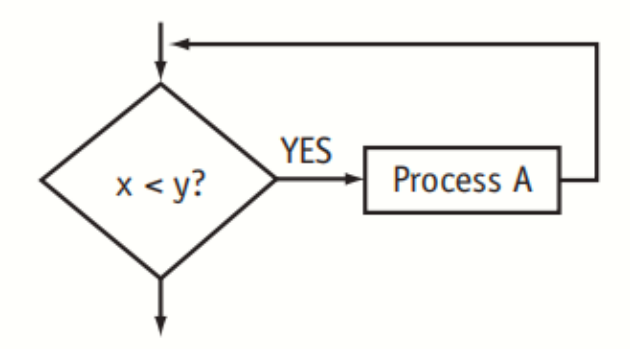


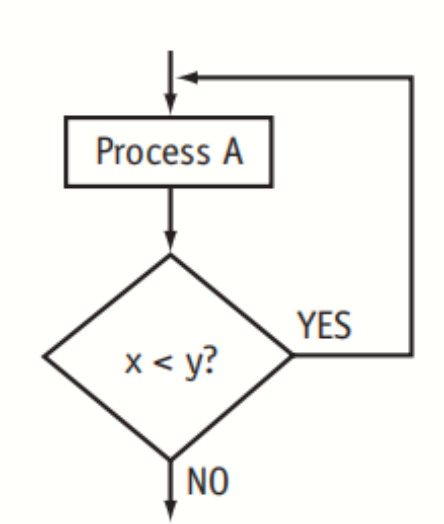
Example 8



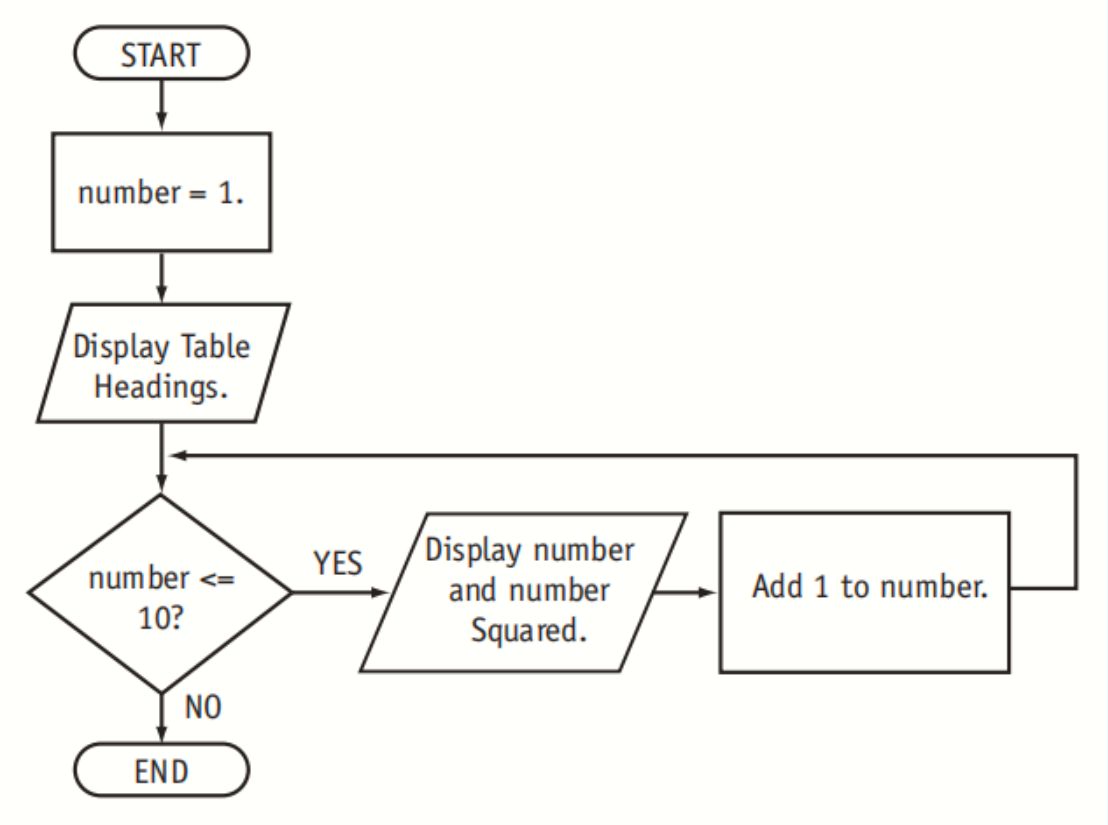
Flowchart

- Repetition Structures





Example 9



Example 10

Flowchart

- Modules