# *Algorithm and Flowchart*

# Programming Methodology

## Problem solving

- Problem statement and analysis
- Develop a high-level algorithm
- Detail out a low-level algorithm

## Coding

- Choose a programming language
- Code the program using the selected algorithm
- Test the program and correct the errors

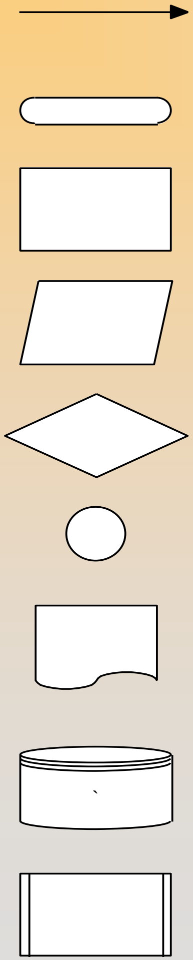
# Algorithm

Definition – Solution to a computer programming problem.

Algorithm can be written in 2 different ways

- ☺ Pseudo-code – English-like steps that describes the solution
- ☺ Flowcharts – Picture with specific blocks detailing out the logical flow of the solution

# Flowchart Building Blocks



CONTROL FLOW

TERMINAL POINT - Start / End

PROCESS - Initializing, Calculation ...

INPUT / OUTPUT - Keyboard, Display ...

DECISION

CONNECTOR - used for big diagram across pages

PRINTOUT

STORAGE - Read or Write from CDs, Disks, Tapes

SUB-ROUTINE

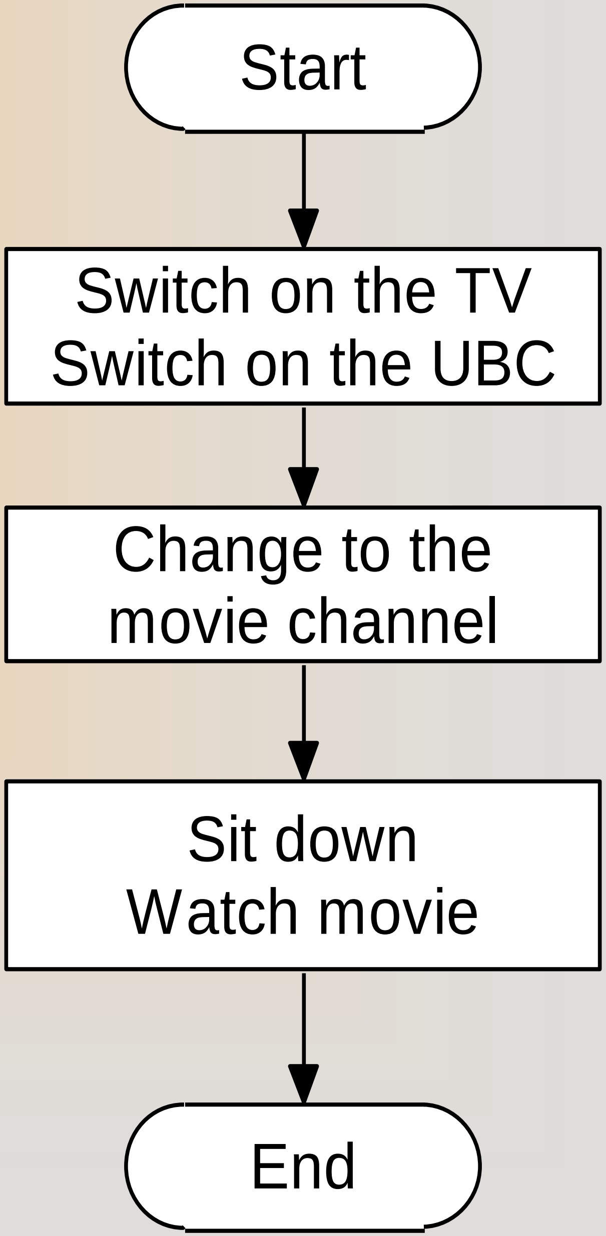
# Example 1

## Problem Statement

Watch a movie at home

## Algorithm

1. Switch on the TV and UBC sets
2. Change to the required movie channel
3. Sit down and watch the movie



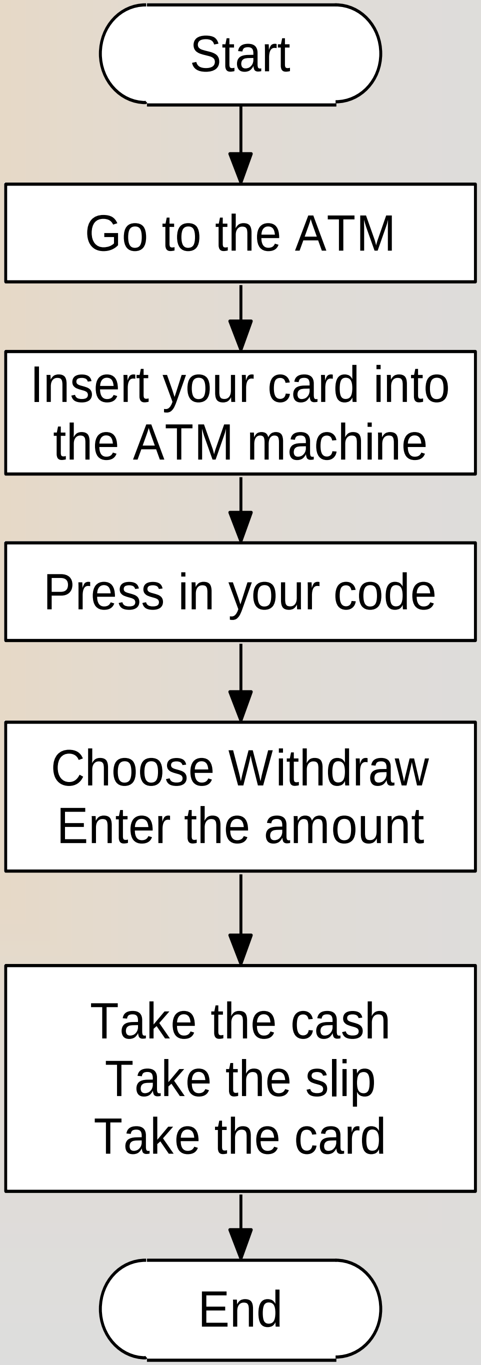
# Example 2

## Problem Statement

Withdraw cash from ATM

## Algorithm

1. Go to the ATM
2. Insert your card into the machine
3. Press in your code
4. Choose “Withdraw” and enter Amount required
5. Take the cash, slip and card.



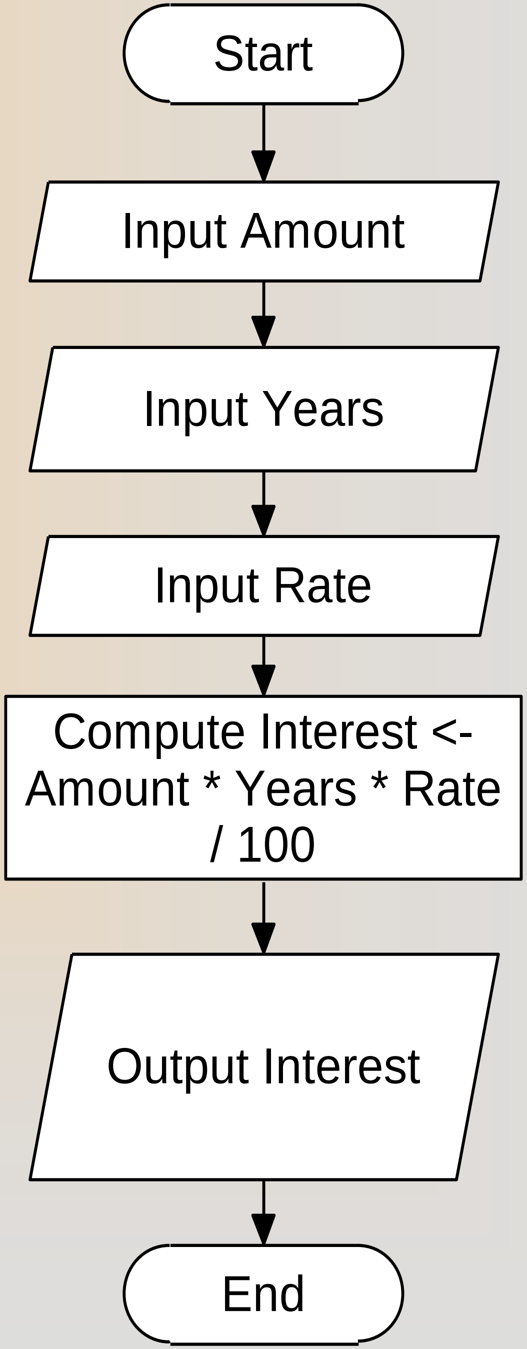
# Example 3

## Problem Statement

Calculate the interest of a bank deposit. You are to read the amount, years and interest rate from the keyboard and print the interest amount.

## Algorithm

1. Read Amount
2. Read Years
3. Read Rate
4. Set Interest as Amount * Rate * Years / 100
5. Print Interest



# Example 3 – Input/Output Samples

| Inputs | Outputs |
|---|---|
| Amount = 5000<br>Years = 2<br>Rate = 2 | Interest = 200 |
| Amount = 1000<br>Years = 1.5<br>Rate = 2.5 | Interest = 37.50 |

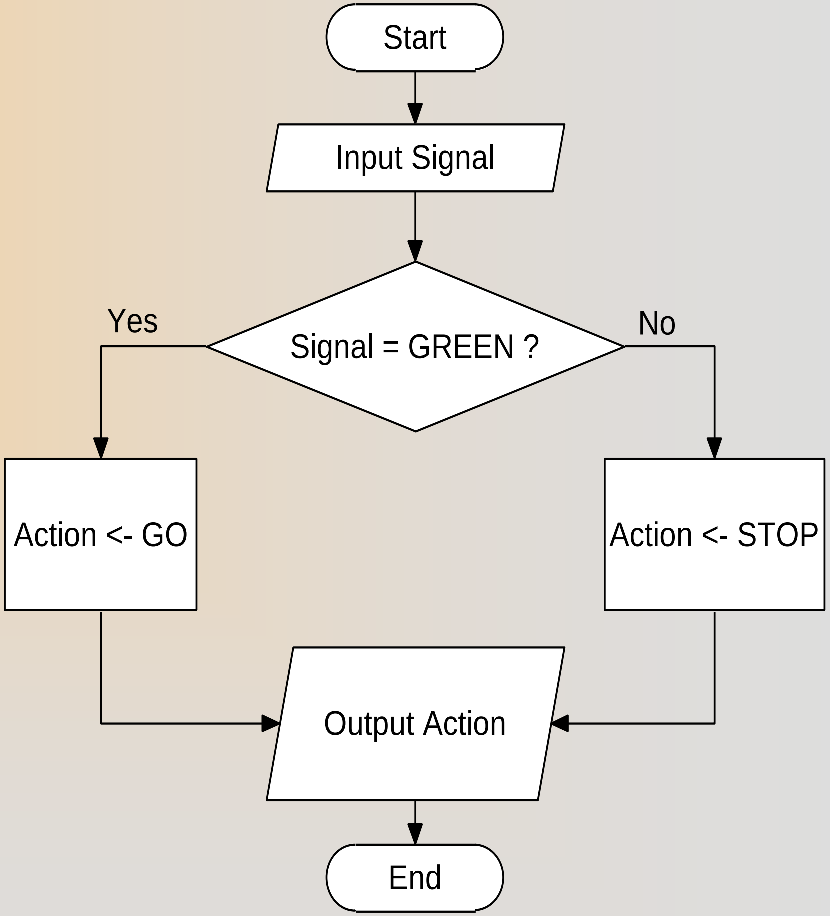
# Example 4

## Problem Statement

Print what to do when driving to a traffic signal

## Algorithm

```
1.  Read traffic signal
2.  If signal is GREEN then
        Set Action as GO
    Else
        Set Action as STOP
3.  Print Action
```



# *Example 4 – Input/Output Samples*

| **Inputs** | **Outputs** |
|---|---|
| Signal = GREEN | Action = GO |
| Signal = RED | Action = STOP |
| Signal = YELLOW | Action = STOP |
| Check what happens if<br>Signal = BLUE | Action = |

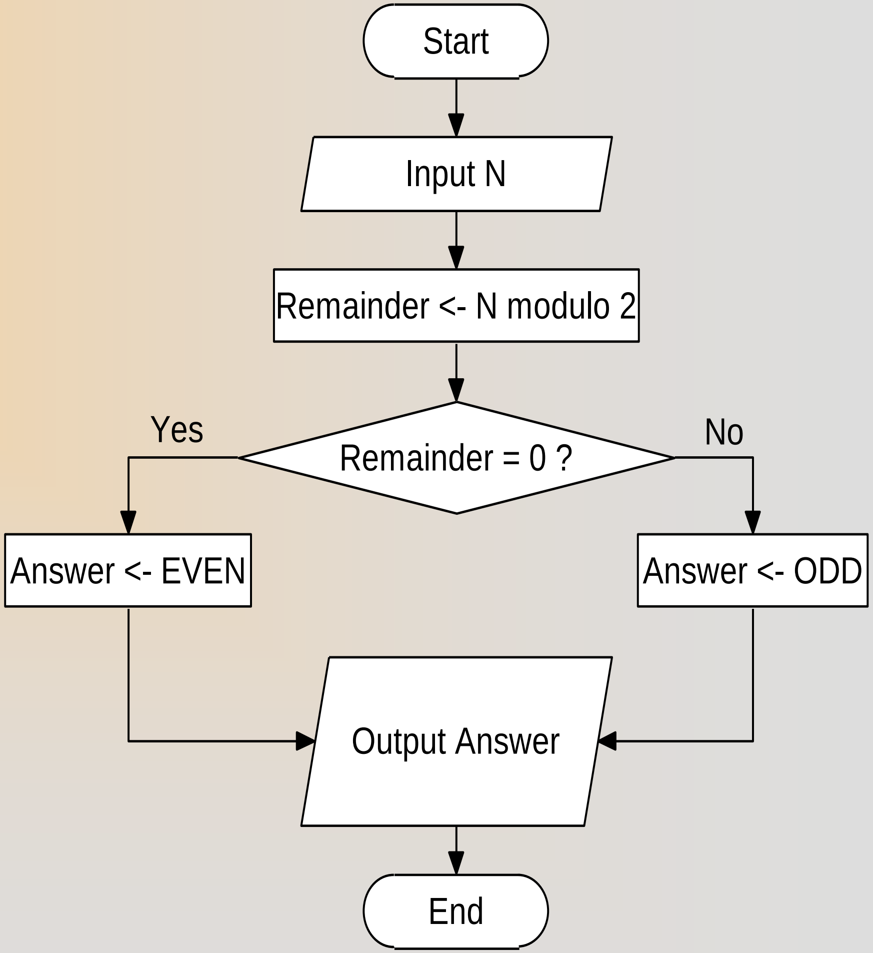
# Example 5

## Problem Statement

Read a number from the keyboard. Check and output if a given number N is ODD or EVEN

## Algorithm

```
1.  Read N
2.  Set Remainder as N modulo 2
3.  If Remainder is equal to 0 then
        Set Answer as EVEN
    Else
        Set Answer as ODD
4.  Print Answer
```



# Example 5 – Input/Output Samples

| **Inputs** | **Outputs** |
|---|---|
| N = 5 | Answer = ODD |
| N = 8 | Answer = EVEN |
| N = 0 | Answer = EVEN |
| N = -1 | Answer = ODD |

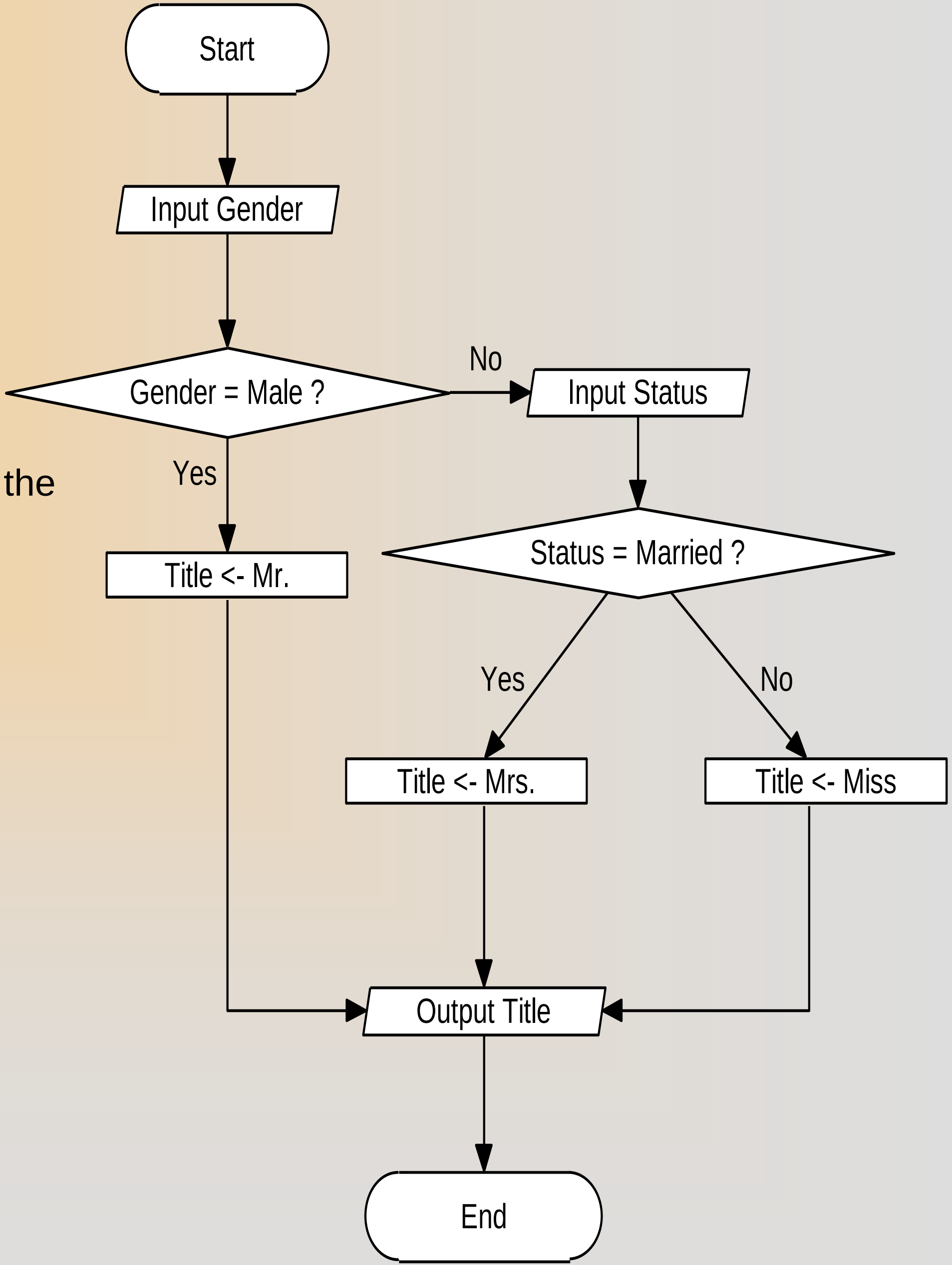
# Example 6

## Problem Statement

Print Title for a person (Either Mr. or Miss. or Mrs.). You are to read the gender (and status if needed).

## Algorithm

```
1.  Read Gender
2.  If Gender is MALE then
        Title is Mr.
    Else
        Read Status
        If Status is MARRIED then
            Title is Mrs.
        Else
            Title is Miss.
3.  Print Title
```



# Example 6 – Input/Output Samples

| **Inputs** | **Outputs** |
|---|---|
| Gender = Male | Title = Mr. |
| Gender = Female<br>Status = Married | Title = Mrs. |
| Gender = Female<br>Status = Single | Title = Miss. |
| Check what happens if<br>Gender = Boy<br>Status = Intelligent | Title = |

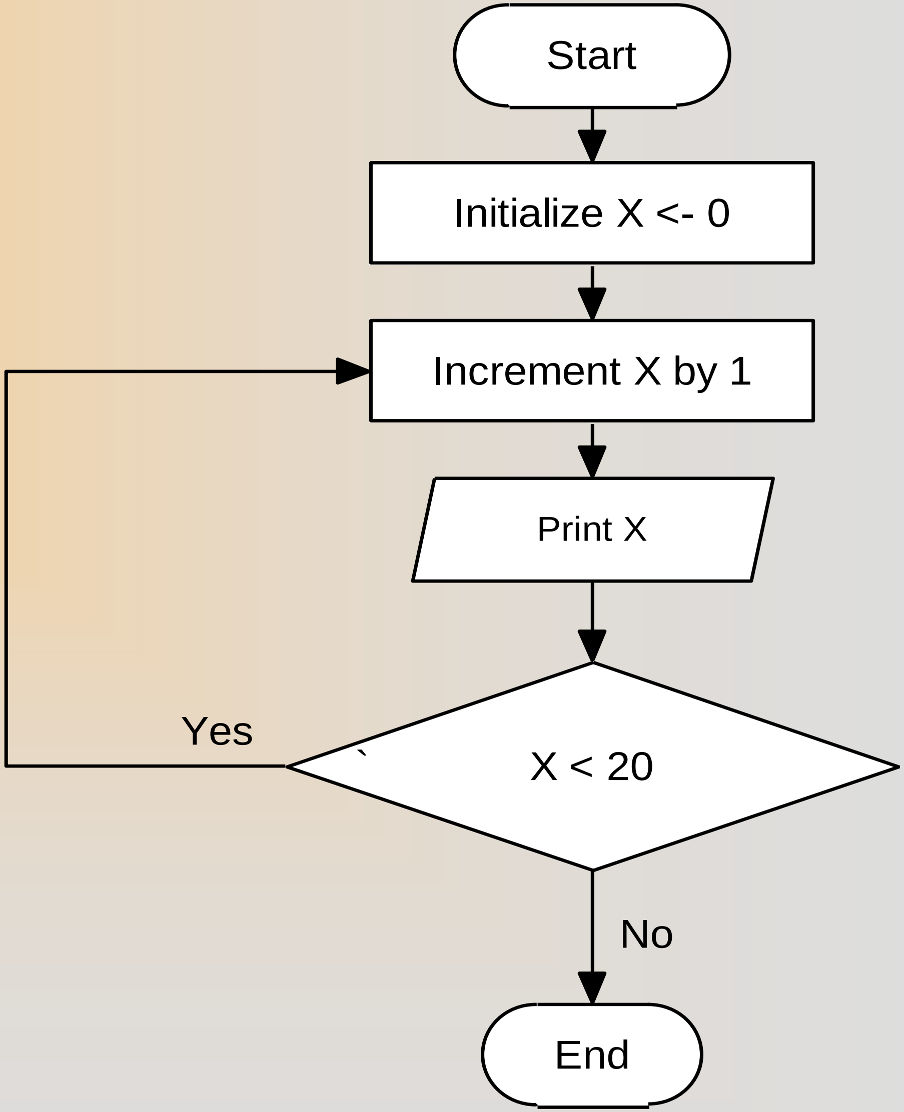
# Example 7

## Problem Statement

Print 1 to 20

## Algorithm

1. Initialize X as 0
2. Increment X by 1
3. Print X
4. If X is less than 20 then go back to Step 2



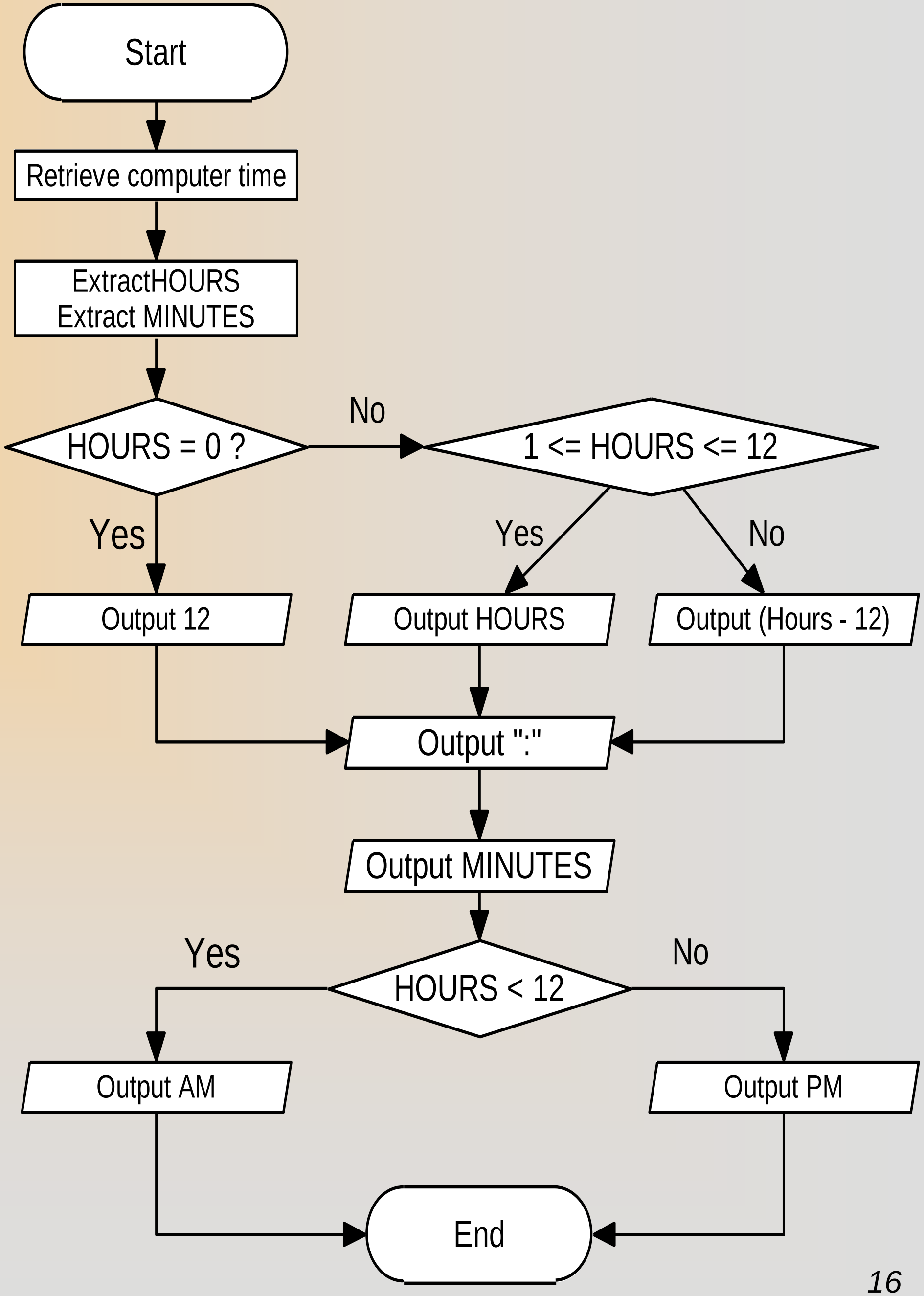
# Example 8

## Problem Statement

Given computer time is stored in 24 hours format, you are to print the time in AM/PM format

## Algorithm

```
1.  Retrieve computer time
2.  Extract Hours and Minutes
3.  If Hours is equal to 0 then
        Print 12
    Else
        If Hours is between 1 and 12
        then
            Print Hours
        Else
            Print Hours – 12
4.  Print ‘:’
5.  Print Minutes
6.  If Hours is less than 12 then
        Print AM
    Else
        Print PM
```



# Example 8 – Input/Output Samples

| **Inputs** | **Outputs** |
|---|---|
| Computer time = 8:30 | Printed time – 8:30 AM |
| Computer time = 20:30 | Printed time – 8:30 PM |
| Computer time = 0:15 | Printed time – 12:15 AM |
| Computer time = 12:15 | Printed time – 12:15 PM |

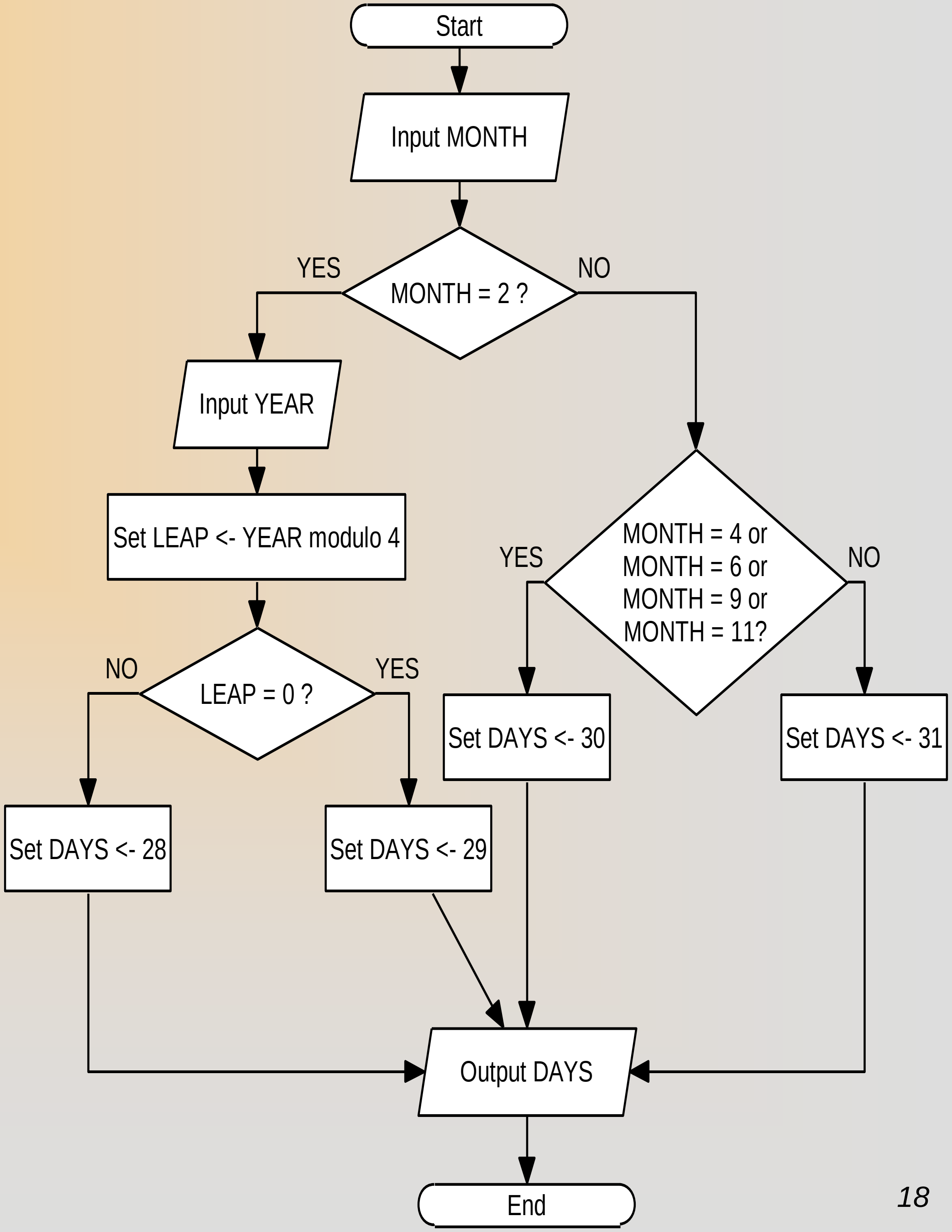
# Example 9

## Problem Statement

Read the Month (and Year, if needed) and print the number of days in that month

## Algorithm

```
1.  Read MONTH
2.  If MONTH is equal to 2 then
        Read YEAR
        If YEAR is a leap year then
            Set DAYS as 29
        Else
            Set DAYS as 28
    Else
        If MONTH is either 4 or 6 or 9 or 11
        then
            Set DAYS as 30
        Else
            Set DAYS as 31
3.  Print DAYS
```



# *Example 9 – Input/Output Samples*

| **Inputs** | **Outputs** |
|---|---|
| Month = 2<br>Year = 2004 | Days = 29 |
| Month = 2<br>Year = 2005 | Days = 28 |
| Month = 10 | Days = 31 |
| Month = 4 | Days = 30 |
| Check what happens if<br>Month = -1 | Days = |

# Example 10

## Problem Statement

Prepare sandwiches

## High-level Algorithm

1. Go to the nearest supermarket
2. Pick the groceries you need
3. Pay at the cashier
4. Bring the groceries home
5. Prepare the sandwiches

## Low-level Algorithm

1.1 Take the car keys and wallet from the counter
1.2 Drive the car to the supermarket
1.3 Park the car
1.4 Take the lift to the supermarket floor
2.1 Take an empty cart and walk around the floor
2.2 Put the needed groceries into the cart
2.3 Take the cart to the cashier
3.1 Give the credit card to the cashier
3.2 Sign on the credit card slip
4.1Take the cart with the plastic bags to the car
4.2 Put the plastic bags to the car
4.3 Drive the car home
4.4 Remove the plastic bags from the car
5.1 Cut the bread into half
5.2 Prepare the bacon and salad
5.3 Put the ingredients between 2 slices of bread

# Example 11

## Problem Statement

Make an urgent call to your friend from the airport

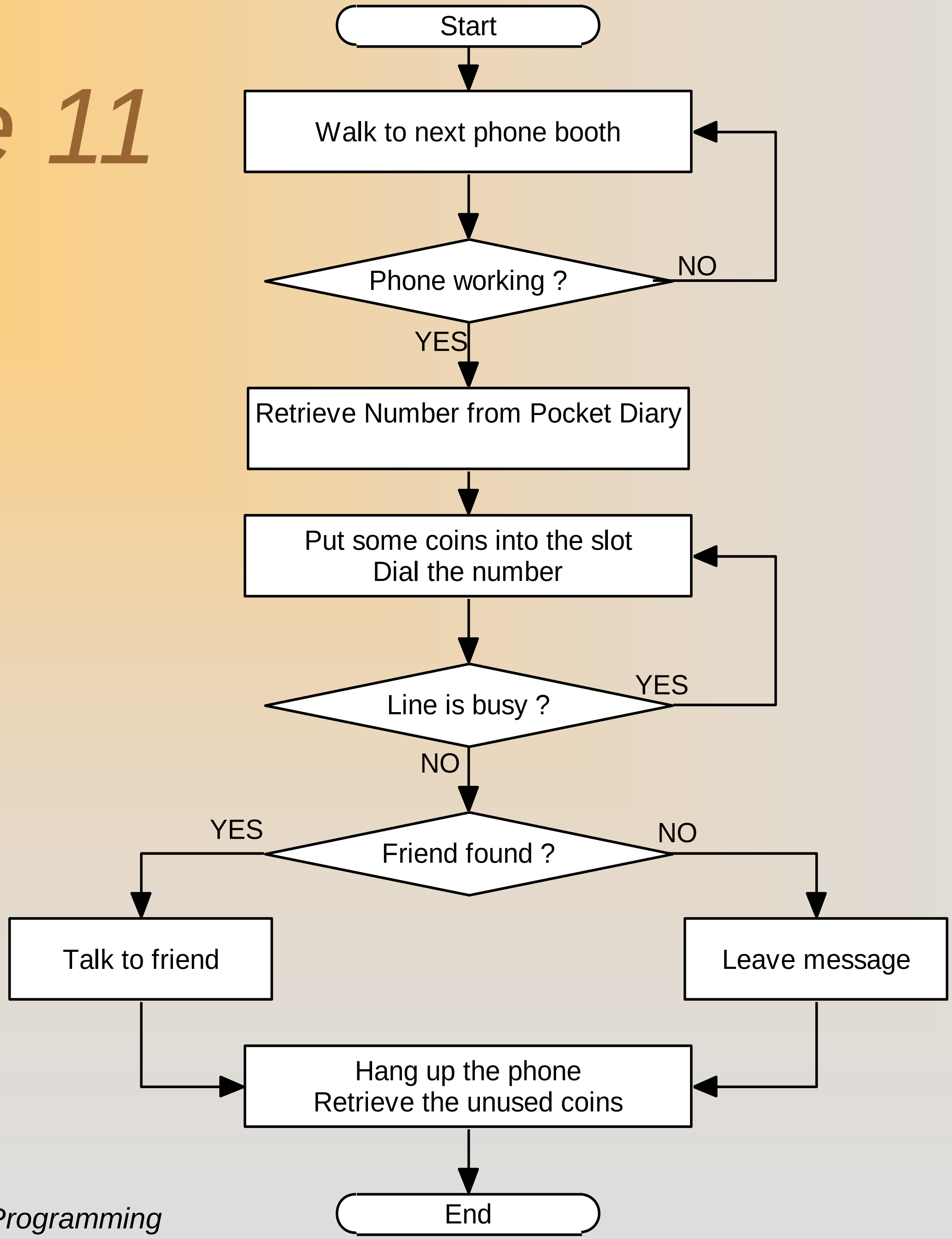
## High-level Algorithm

1. Go to a public booth
2. Dial your friend's number
3. Give the message to your friend

## Low-level Algorithm

```
1.1 Walk to the next phone booth
1.2 If phone booth is not working, then repeat
    from step 1.1
2.1 Retrieve the number from pocket diary
2.2 Put some coins into the slot.
2.3 Dial the number
2.4 If the line is busy, hang up, then take
    back the coins and repeat from step 2.2
3.1 If your friend can come to the phone, then
    talk to your friend.
3.2 If your friend cannot come to the phone,
    then leave a message for your friend.
3.2 Hang up the phone.
3.4 Retrieve any coins not used.
```

# Example 11


Start
Walk to next phone booth
Phone working ?
NO
YES
Retrieve Number from Pocket Diary
Put some coins into the slot
Dial the number
Line is busy ?
YES
NO
Friend found ?
YES
NO
Talk to friend
Leave message
Hang up the phone
Retrieve the unused coins
End

# Example 12

## Problem Statement

Automatically return change for a purchase of N baht when given a 20 baht note.  Check that N is between 1 and 20.

## High-level Algorithm

1. Read and Validate N
2. Calculate Change
3. Decide how many 10 baht coins, 5 baht coins and 1 baht coins to return

What happens if customer can pay by any kinds of banknotes: 1000, 500, 100, 20, and 10. and any kinds of coins: 10, 5, 2, and 1. That means N is not be fixed.

## Low-level Algorithm

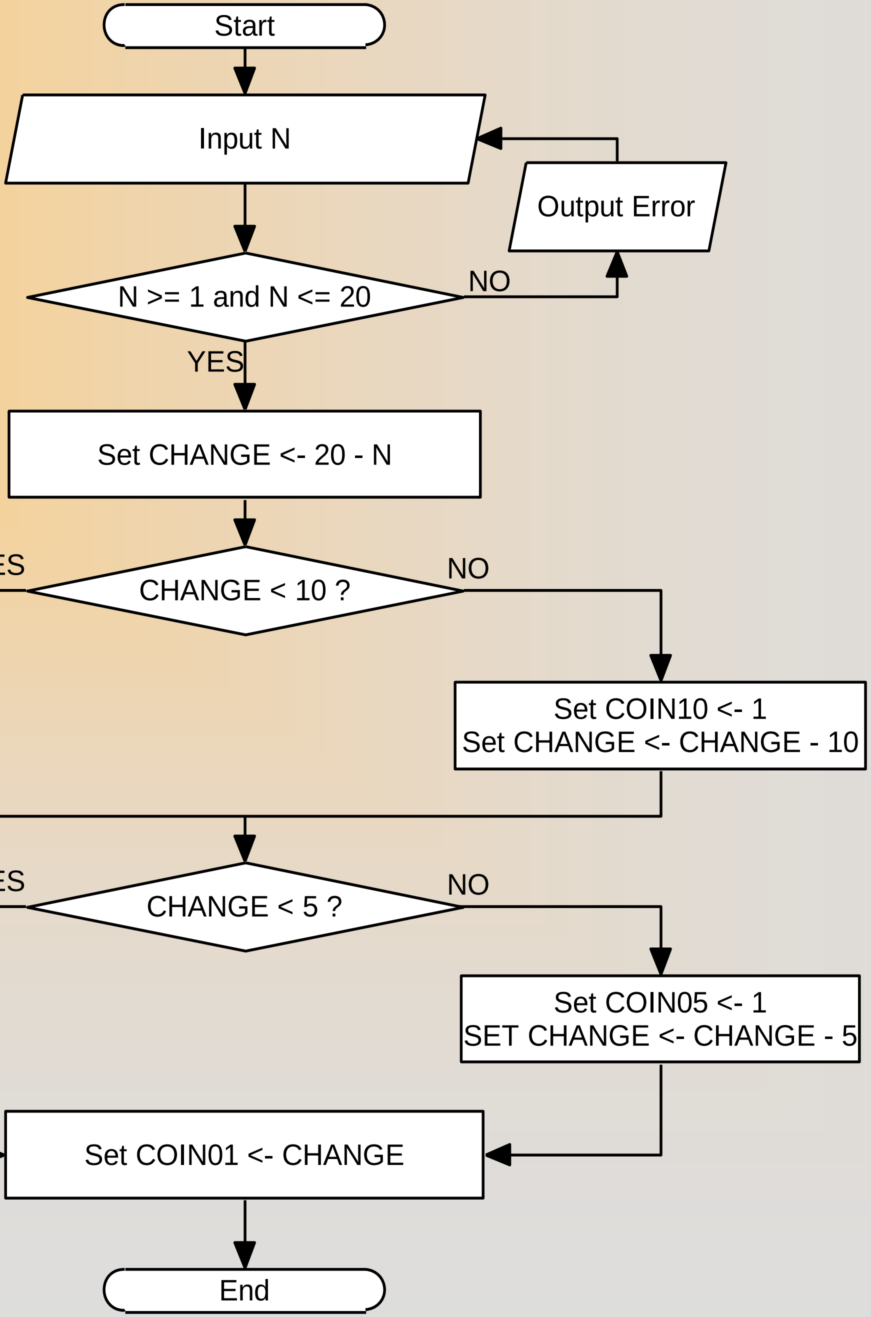
```
1.1   Read N
1.2   If NOT (1 <= N <= 20) then
          Print Error Message
          Go back to Step 1.1
2.1   Initialize CHANGE as 20
2.2   Deduct N from CHANGE
3.1   If CHANGE is less than 10 then
          Number of 10 baht coin is 0.
      Else
          Number of 10 baht coin is 1.
          Deduct 10 from CHANGE
3.2   If CHANGE is less than 5 then
          Number of 5 baht coin is 0.
      Else
          Number of 5 baht coin is 1.
          Deduct 5 from CHANGE
3.3   Number of 1 baht coin is CHANGE
```

# Example 12

Check what happens if N = 20

Check what happens if N = 0

Check what happens if N = 21



# *Example 12 – Input/Output Samples*

| **Inputs** | **Outputs** |
|---|---|
| N = 17 | Number of 10 B coin – 0<br>Number of 5 B coin – 0<br>Number of 1 B coin – 3 |
| N = 6 | Number of 10 B coin – 1<br>Number of 5 B coin – 0<br>Number of 1 B coin – 4 |
| N = 13 | Number of 10 B coin – 0<br>Number of 5 B coin – 1<br>Number of 1 B coin – 2 |
| Check what happens if N = 20<br>Check what happens if N = 0<br>Check what happens if N = 21 | |

# Example 13

## Problem Statement

Find the average of a given list of numbers

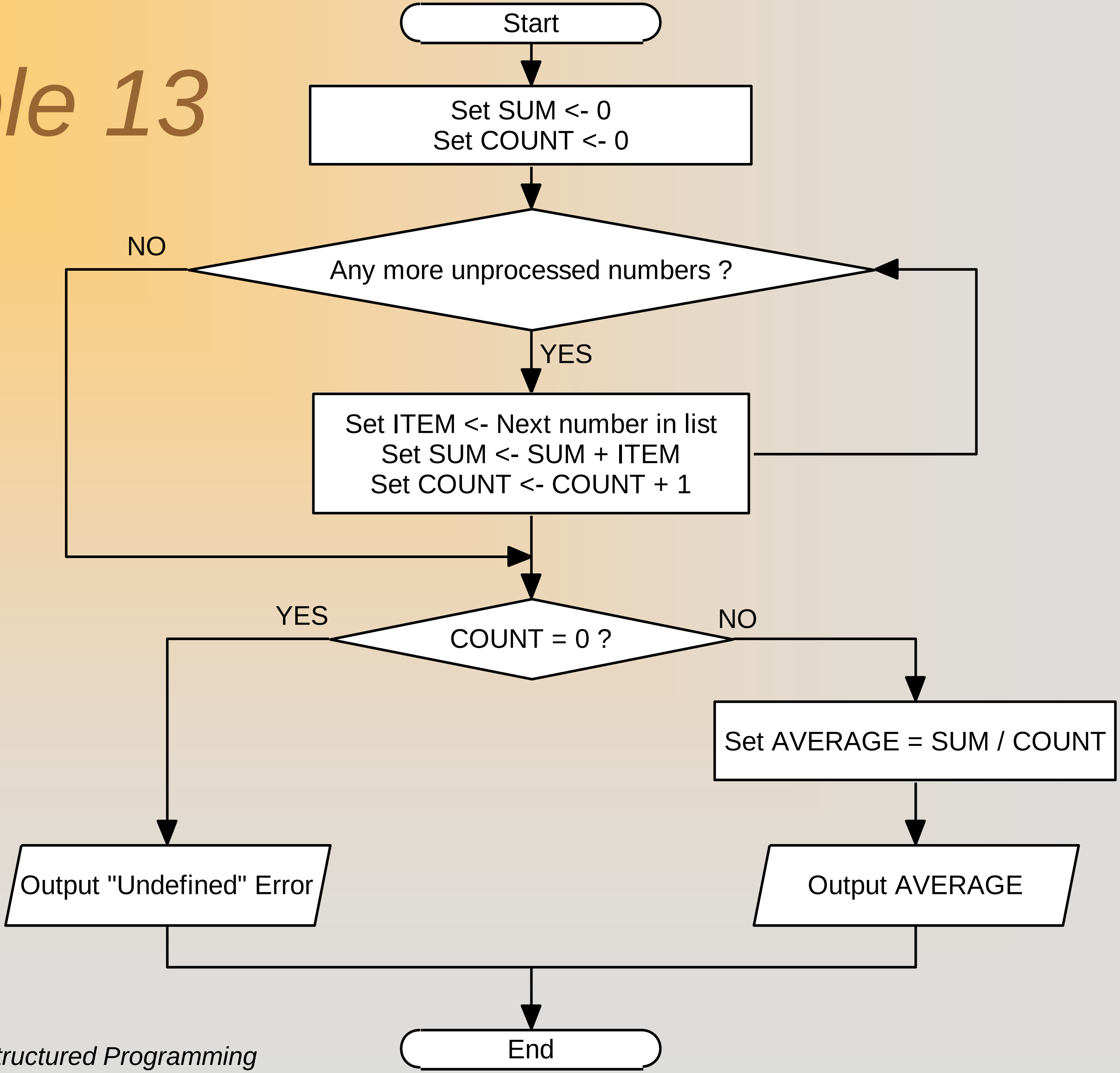
## High-level Algorithm

1. Find the SUM of the given numbers
2. Find the COUNT of the given numbers
3. AVERAGE is SUM ÷ COUNT

## Low-level Algorithm

```
1. Initialize SUM as 0 and COUNT as 0
2. If there are no more numbers remaining to be processed, then go to step 7.
3. Set ITEM as next number in the list
4. Add ITEM to SUM
5. Increment COUNT by 1
6. Go back to step 2
7. If COUNT is equal to 0, then
       AVERAGE is “undefined”
   Else
       AVERAGE is SUM ÷ COUNT
```

# Example 13


Start
Set SUM <- 0
Set COUNT <- 0
Any more unprocessed numbers ?
NO
YES
Set ITEM <- Next number in list
Set SUM <- SUM + ITEM
Set COUNT <- COUNT + 1
COUNT = 0 ?
YES
NO
Set AVERAGE = SUM / COUNT
Output "Undefined" Error
Output AVERAGE
End

# *Example 13 – Input/Output Samples*

| **Inputs** | **Outputs** |
|---|---|
| List = 20, 2, 5, -3 | Average = 6 |
| List = 2, 5, -3, -8, -1 | Average = -1 |
| List = 2, 7, 5, 3, 6 | Average = 4.60 |
| List = 4 | Average = 4 |
| List = | Average = “undefined” |

# Example 14

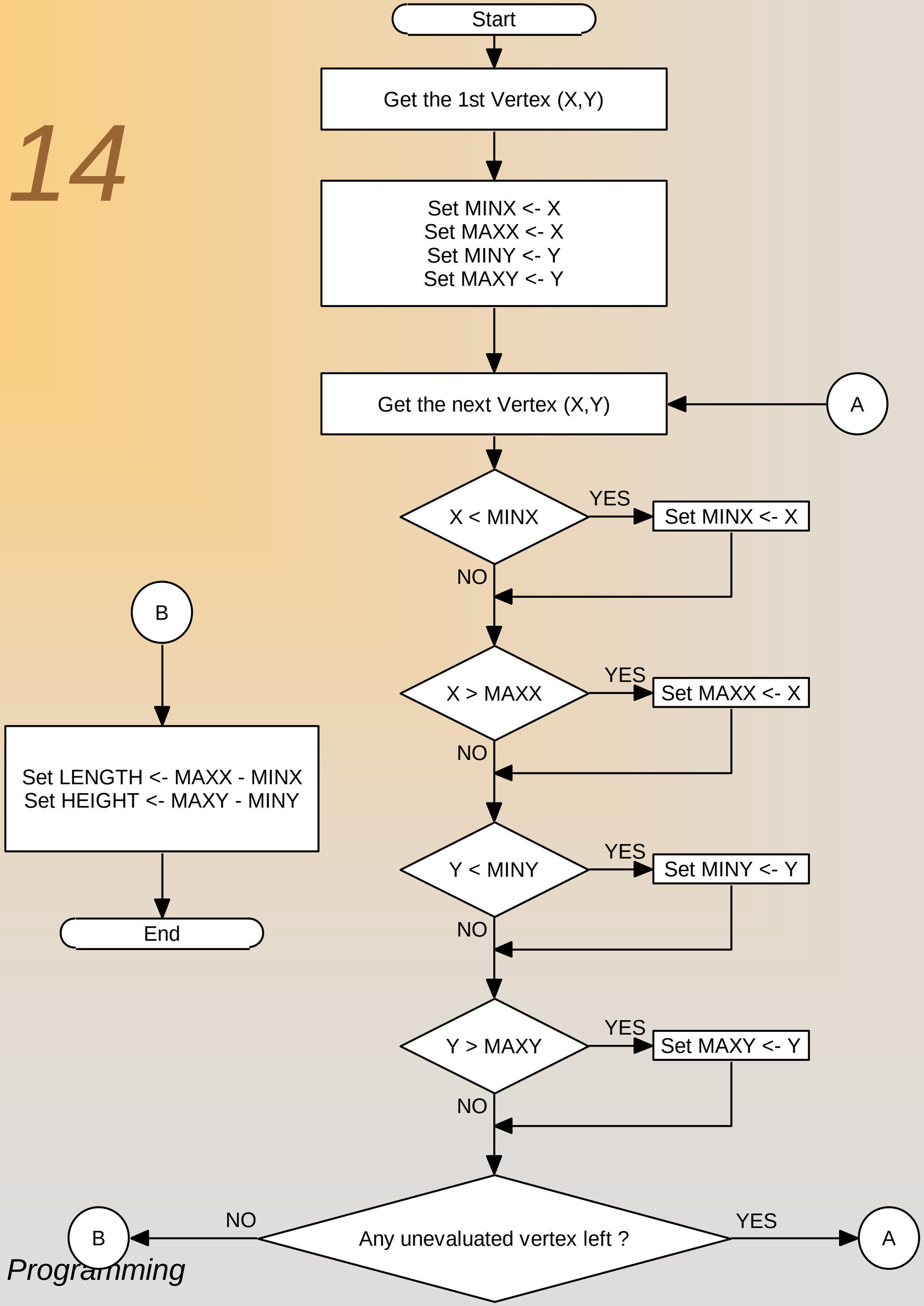
**Problem Statement**

Given a 2-D polygon with N sides (and N vertices). Find the smallest rectangular box required to cover the polygon completely

**Algorithm**

1. Initialize MINX, MINY, MAXX, MAXY using the 1st Vertex
2. Retrieve the next unevaluated vertex (X, Y)
3. If X < MINX, then set MINX as X
4. If X > MAXX, then set MAXX as X
5. If Y < MINY, then set MINY as Y
6. If Y > MAXY, then set MAXY as Y
7. If all vertices have not been evaluated then go back to step 2
8. Set LENGTH as MAXX – MINX
9. Set HEIGHT as MAXY – MINY

# Example 14



Start

Get the 1st Vertex (X,Y)

Set MINX <- X
Set MAXX <- X
Set MINY <- Y
Set MAXY <- Y

Get the next Vertex (X,Y)

A

X < MINX

YES

Set MINX <- X

NO

X > MAXX

YES

Set MAXX <- X

NO

Y < MINY

YES

Set MINY <- Y

NO

Y > MAXY

YES

Set MAXY <- Y

NO

Any unevaluated vertex left ?

YES

A

NO

B

B

Set LENGTH <- MAXX - MINX
Set HEIGHT <- MAXY - MINY

End

# *Example 14 – Input/Output Samples*

| **Inputs** | **Outputs** |
|---|---|
| 4 sides (2,2) (5,3) (3,5) (6,2) | Length = 4<br>Height = 3 |
| 3 sides (1,2) (5,3) (8, -2) | Length = 7<br>Height = 5 |
| 5 sides (2,5) (7,1) (3,2) (-3, -5) (4,1) | Length = 10<br>Height = 10 |