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Introduction to Flowcharting

This slide is based upon Appendix C from *Starting Out with C++: From Control Structures to Objects* (5th Edition), Tony Gaddis 2007, Published by Addison-Wesley

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Contents

- Flowchart
- Basic flowchart symbols
- Stepping through the flowchart
- Three flowchart structures
- Examples
- Exercises

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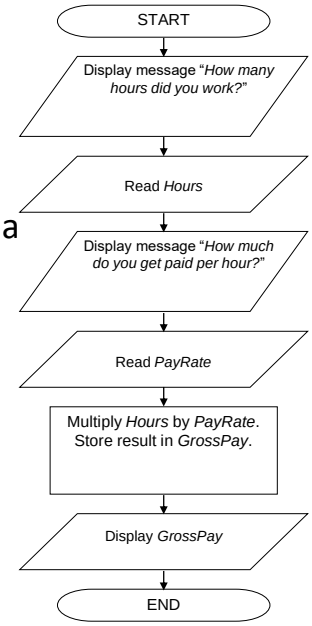
What is a Flowchart?

- A flowchart is a diagram that depicts the "flow of control" of a program.



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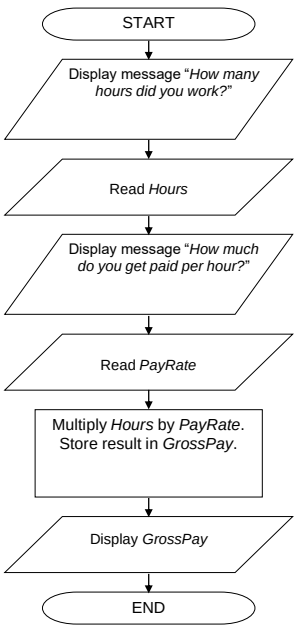
What is a Flowchart?

- A flowchart
  - shows logic of an algorithm
  - emphasizes individual steps and their interconnections

  e.g. control flow from one action to the next



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Basic Flowchart Symbols

- Three types of symbols in this flowchart:
  - rounded rectangle
  - parallelogram
  - rectangle
- Each symbol represents a different type of operation.

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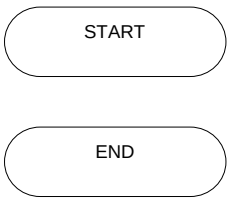
Basic Flowchart Symbols

- Terminals
  - represented by rounded rectangles
  - indicate a starting or ending point



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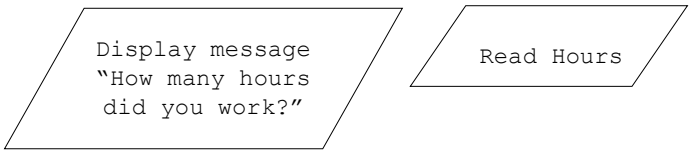
Basic Flowchart Symbols

- Input/Output Operations
  - represented by parallelograms
  - indicate an input or output operation



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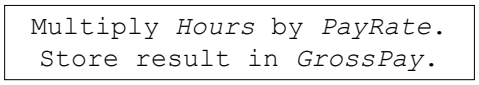
Basic Flowchart Symbols

- Processes
  - represented by rectangles
  - indicates a process such as a mathematical computation or variable assignment



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Three Flowchart Structures

Sequence

Selection

Iteration

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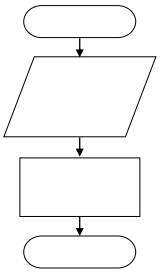
Sequence Structure

- A series of actions are performed in sequence
- The pay-calculating example was a sequence flowchart.



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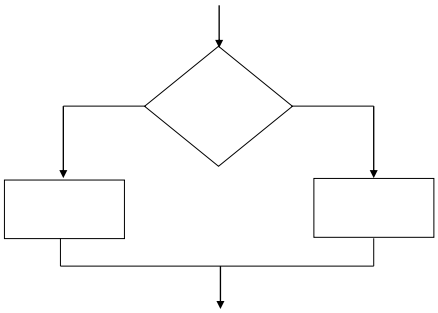
Selection Structure

- One of two possible actions is taken, depending on a condition.



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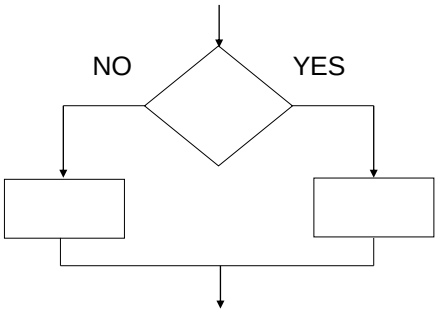
Selection Structure

- A new symbol, the **diamond**, indicates a **yes/no question**.
  - If the answer to the question is yes, the flow follows one path.
  - If the answer is no, the flow follows another path



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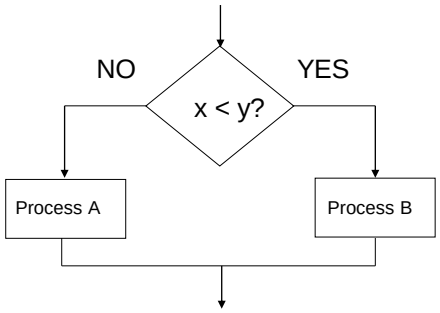
Selection Structure

- In the flowchart segment below, the question "**is x < y?**" is asked.
  - If the answer is no, then process A is performed.
  - If the answer is yes, then process B is performed.



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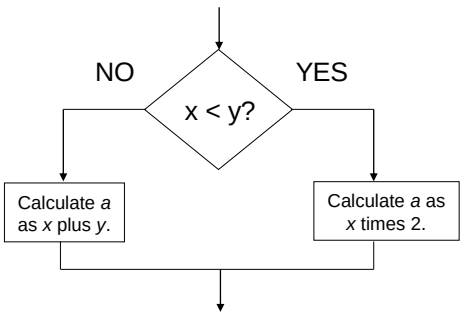
Selection Structure

- The flowchart segment below shows a decision structure is expressed in C++ as an if/else statement.



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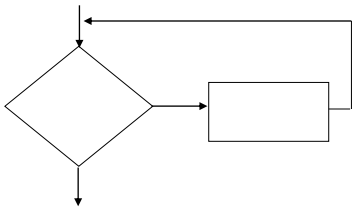
Iteration Structure

- An **iteration** structure represents part of the program that **repeats**. This type of structure is commonly known as a **loop**.



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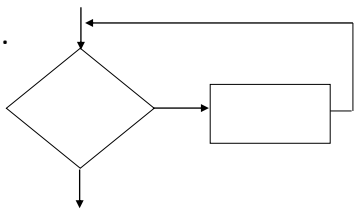
Iteration Structure

- Notice the use of the diamond symbol.
- A loop tests a condition,
  - and if the condition exists, it performs an action.
  - Then it tests the condition again. If the condition still exists, the action is repeated.
  - This continues until the condition no longer exists.



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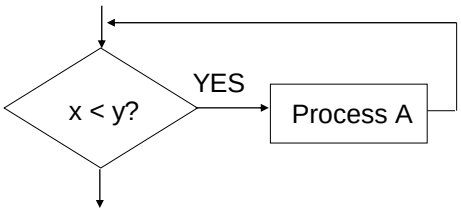
Iteration Structure

- In the flowchart segment, the question "**is x < y?**" is asked.
  - If the answer is *yes*, then **Process A** is performed.
  - The question "*is x < y?*" is asked again. Process A is repeated as long as *x* is less than *y*.
  - When *x* is no longer less than *y*, the iteration stops and the structure is exited.



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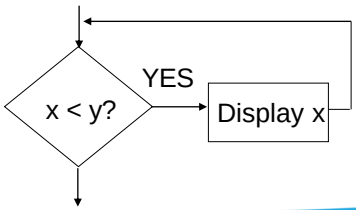
Controlling an Iteration Structure

- The action performed by an iteration structure MUST eventually cause the loop to terminate.
- Otherwise, an **infinite loop** is created.
- In this flowchart segment, *x* is never changed. Once the loop starts, it will never end.



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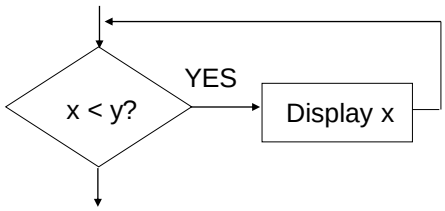
Controlling an Iteration Structure

- *x* is never changed. Once the loop starts, it will never end.
- **How can this flowchart be modified so it is no longer an infinite loop?**



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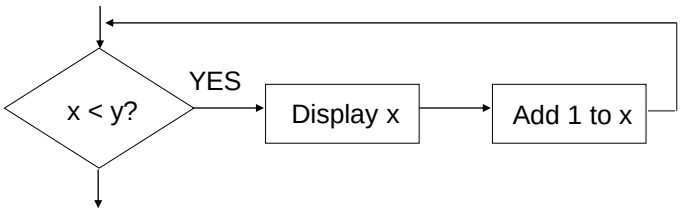
Controlling an Iteration Structure

- By adding an action within the iteration that changes the value of *x*.



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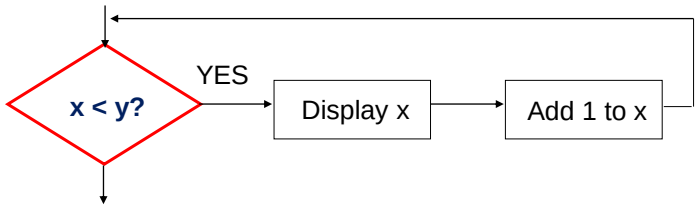
A Pre-Test Iteration Structure

- This type of structure is known as a **pre-test iteration structure**. The condition is tested **BEFORE** any actions are performed.



- if the condition does not exist, the loop will never begin.

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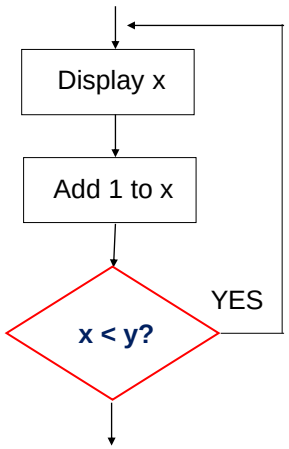
A Post-Test Iteration Structure

- This flowchart segment shows a **post-test iteration** structure.
- The condition is tested **AFTER** the actions are performed.
- A post-test iteration structure always performs its actions **at least once**.



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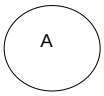
Connectors

- Sometimes a flowchart will not fit on one page.
- A **connector** (represented by a small circle) allows you to connect two flowchart segments.



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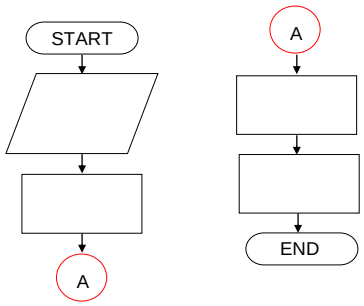
Connectors

- The “A” connector indicates that the second flowchart segment begins where the first segment ends.



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Modules

- A program module, such as a subprogram (or function in C++), is represented by a special symbol.

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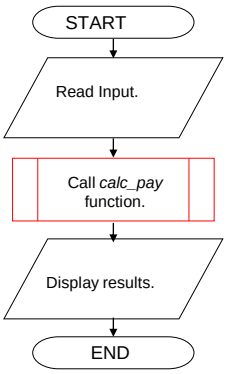
Modules

- The position of the module symbol indicates the point the module is executed.
- A separate flowchart can be constructed for the module.



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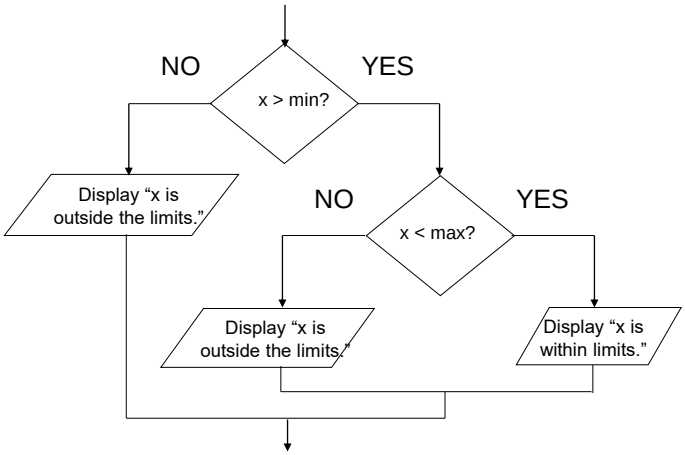
Combining Structures

- This flowchart segment shows two selection structures combined.



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Examples

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Example 01

```
Step 1:    Input M1,M2,M3,M4
Step 2:    GRADE ← (M1+M2+M3+M4)/4
Step 3:    if (GRADE <50) then
                Print "FAIL"
           else
                Print "PASS"
           endif
```


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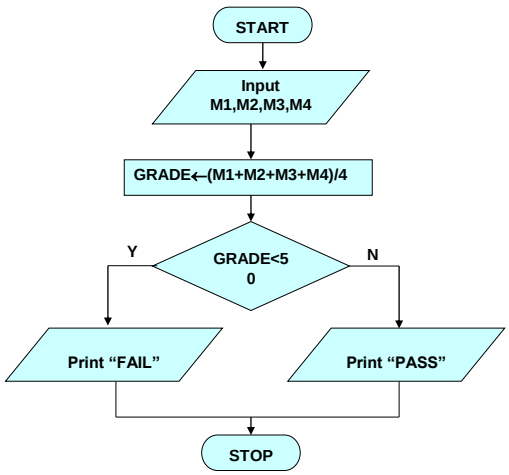
Example 01

```
Step 1:    Input M1,M2,M3,M4
Step 2:    GRADE ← (M1+M2+M3+M4)/4
Step 3:    if (GRADE <50) then
                Print "FAIL"
           else
                Print "PASS"
           endif
```



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Example 02

- Write an algorithm and draw a flowchart to convert the length in feet to centimeter.

- Pseudocode:

```
Input the length in feet (Lft)
Calculate the length in cm
(Lcm) by multiplying Lft with
30
Print length in cm (Lcm)
```


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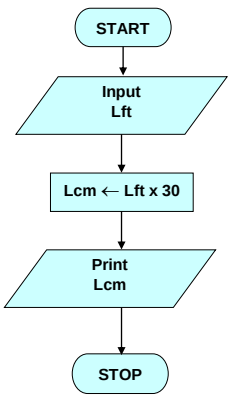
Example 02

- Write an algorithm and draw a flowchart to convert the length in feet to centimeter.



- Pseudocode:

```
Input the length in feet (Lft)
Calculate the length in cm
(Lcm) by multiplying Lft with
30
Print length in cm (Lcm)
```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Example 03

- Write an algorithm and draw a flowchart that will read the two sides of a rectangle and calculate its area.

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Example 03

- Write an algorithm and draw a flowchart that will calculate the roots of a quadratic equation.

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Example 03

- Write an algorithm and draw a flowchart that will calculate the roots of a quadratic equation.

- Hint:

d = sqrt(b^2 - 4ac),
if d < 0, there is no root.
else if d == 0, x1 = x2 = -b/2a
else the roots are: ***x1*** = ($-b$ + d)/2a and ***x2*** = ($-b$ - d)/2a

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Example 04

- Write an algorithm that reads two values, determines the largest value and prints the largest value with an identifying message.

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Example 05

- Write an algorithm that reads **three** numbers and prints the value of the largest number.

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Exercises

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Exercises

- Check whether an input year is a *leap* year.
  - Ref: https://en.wikipedia.org/wiki/Leap_year#Algorithm

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Exercises

- Electricity cost calculator:
  - Ref: https://www.evn.com.vn/c3/evn-va-khach-hang/Bieu-gia-ban-le-dien-9-79.aspx
  - Ref: https://www.evn.com.vn/c3/calc/Cong-cu-tinh-hoa-don-tien-dien-9-172.aspx

d) Sinh hoạt

TT	Nhóm đối tượng khách hàng	Giá bán điện (đồng/kWh)
1	Giá bán lẻ điện sinh hoạt	
	Bậc 1: Cho kWh từ 0 - 50	1.678
	Bậc 2: Cho kWh từ 51 - 100	1.734
	Bậc 3: Cho kWh từ 101 - 200	2.014
	Bậc 4: Cho kWh từ 201 - 300	2.536
	Bậc 5: Cho kWh từ 301 - 400	2.834
	Bậc 6: Cho kWh từ 401 trở lên	2.927

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Questions and Answers