Algorithms and Flowcharts

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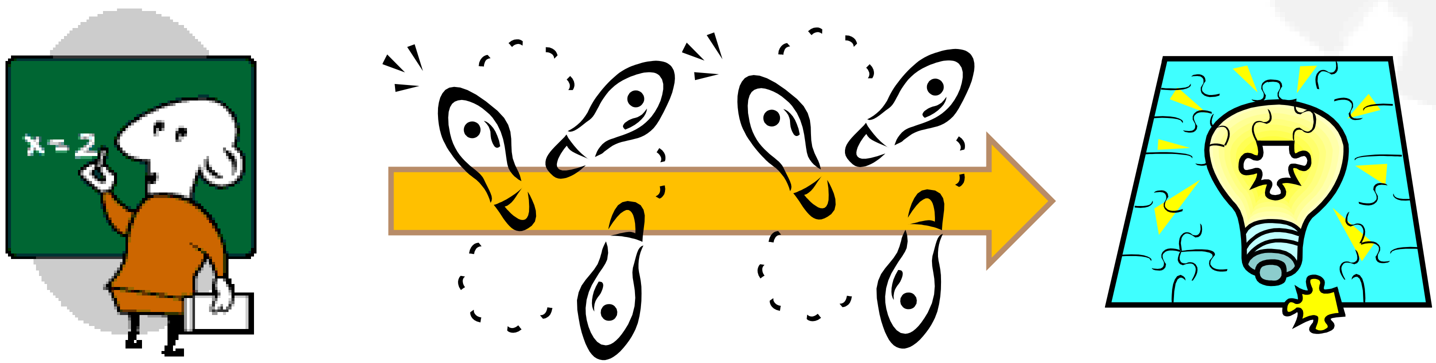
Agenda

- Algorithms
- Flowchart components
- Flowchart rules
- Lots of examples

Algorithm



Problem Algorithm Solution

- A set of <u>steps</u> to provide a solution to a specific problem
  - Steps on how to solve a problem

Characteristics of Algorithms

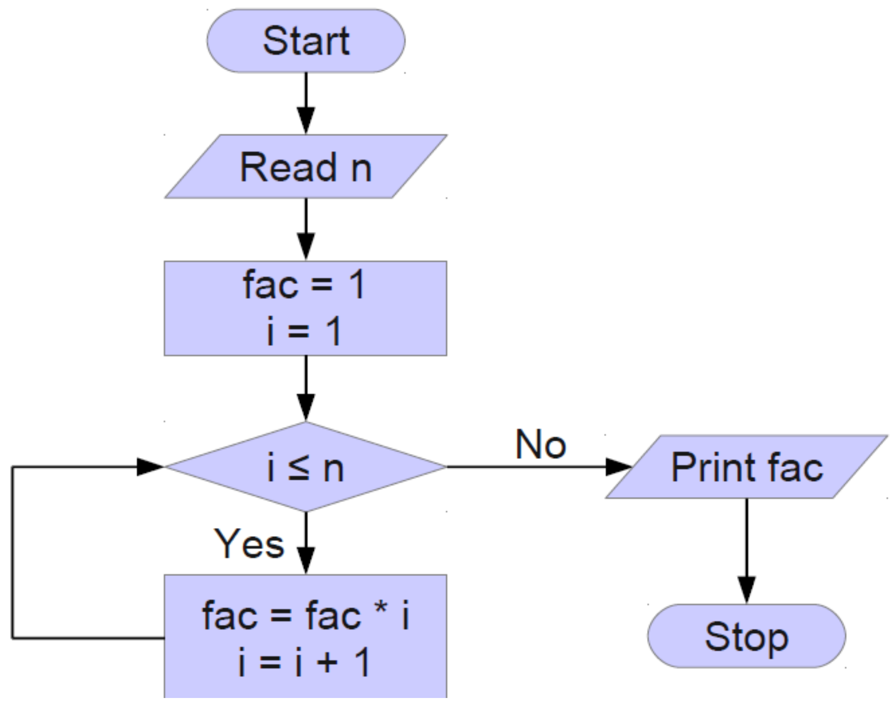
- Input: ≥ 0
  - Input(s) or no input
- Output: ≥ 1
  - At least an output
- Finite
  - With an ending point
- Each instruction is defined clearly
- Each instruction is basic and easy to perform

Algorithm Representation

Psudo-Code

Flowchart

```
read n;
set fac = 1;
set i = 1;
while (i ≤ n) {
    fac = fac * i;
    incr i;
}
print fac;
done;
```

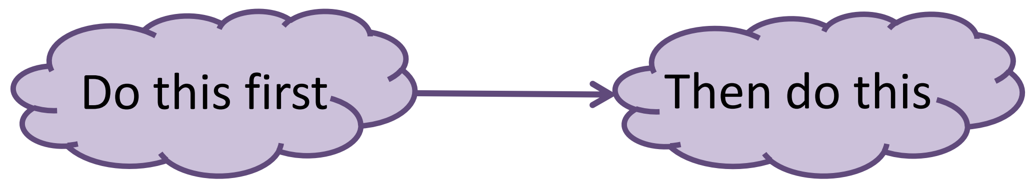


Text Representation

Graphical Representation

Flowchart Components (1)

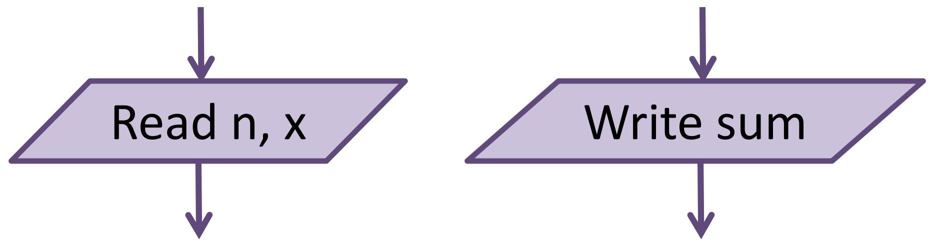
Arrow – indicate flow of steps in an algorithm



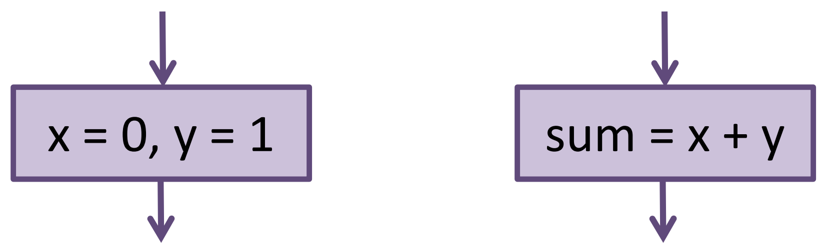
Terminator – denote a starting point (1st symbol) or an ending point (last symbol) of an algorithm

Flowchart Components (2)

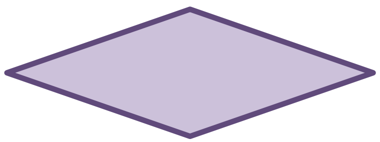
Input/Output – denote input/output function in an algorithm



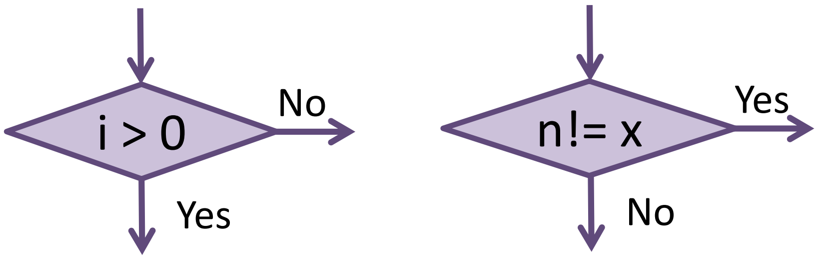
Process – processing of an algorithm, e.g. what you calculate, set/change values

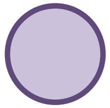


Flowchart Components (3)



Decision – denote a decision making operation in an algorithm (branching) , e.g. if .. then .. else



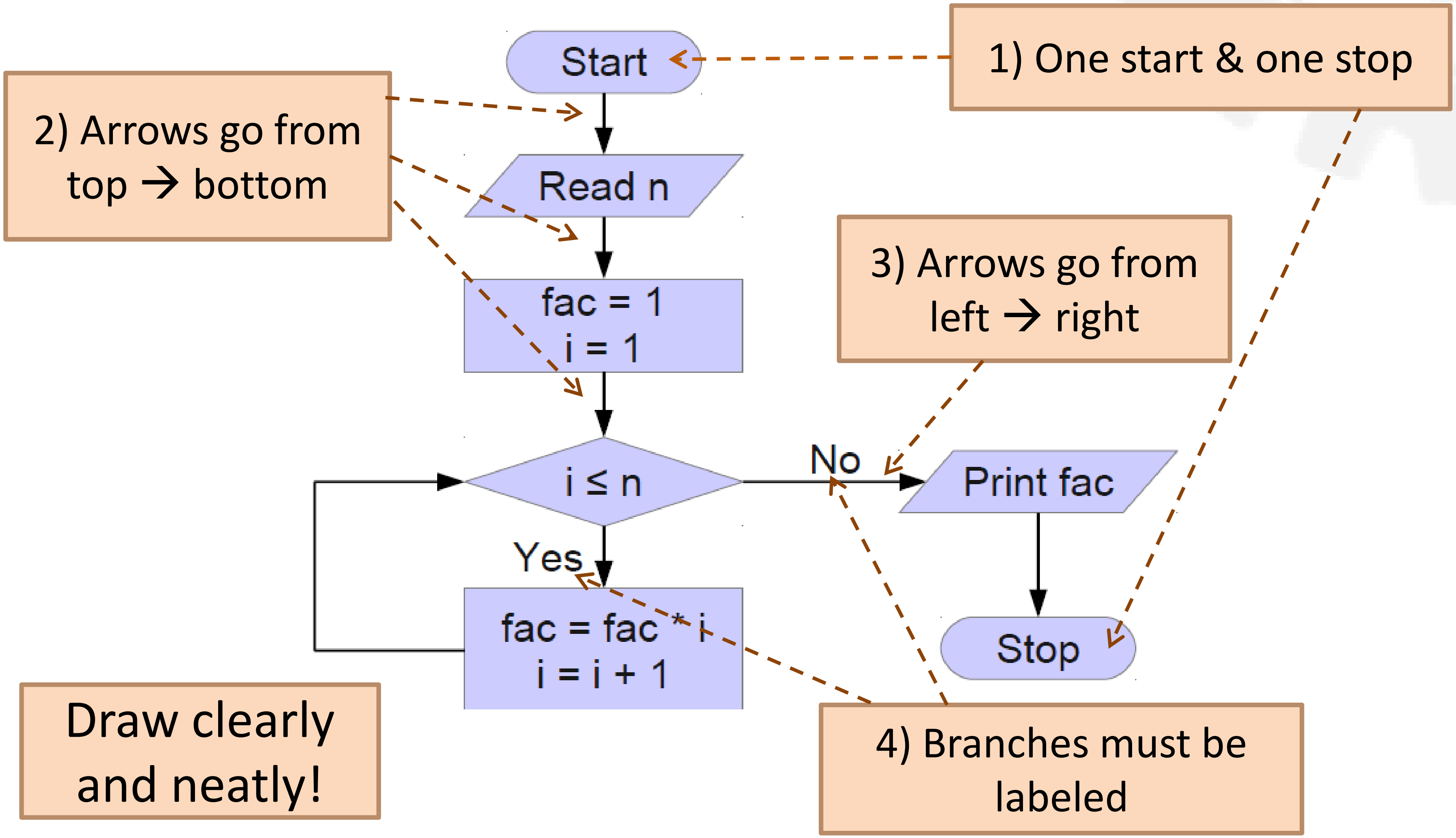


Connector – link between parts of a flowchart when the flowchart is unfit in a single page

On this page

On next page

Flowchart Rules



Pros and Cons

- ✓ Easy to understand the solution
- ✓ Good for documentation
- ✓ ** Guideline for coding **

- ✗ Not suitable for large program
  - – Flowchart will be too large and complicated

Example #1: F -> C

- Problem: convert Fahrenheit to Celsius
- What you know:

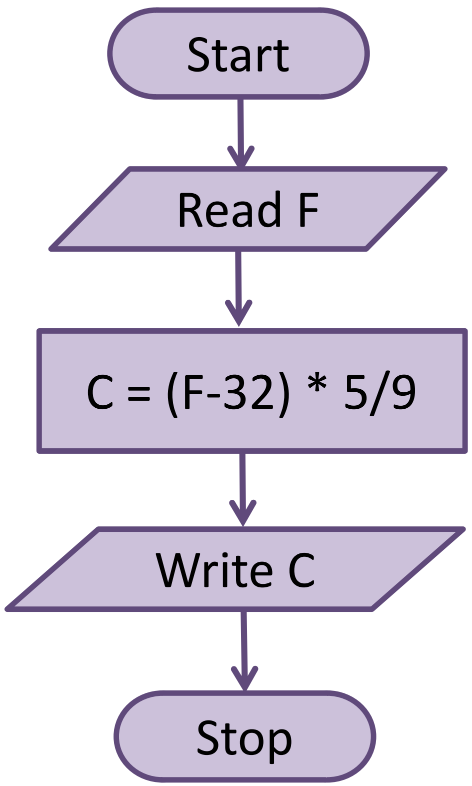
$$\boxed{C} = (\boxed{F} - 32) * 5/9$$

What you want to find out -> result -> what you <u>write out</u>

What the problem should give you -> what you <u>read in</u>

- Output: C, Input: F
- Process: C = (F-32) * 5/9

Example #1: F -> C Flowchart



Terminator: Begin the program

Input: Get the value of F

Process: Calculate C

Output: Print the value of C

Terminator: End the program

Example #2: Days -> Months+Days

- Problem: convert a number of days (d) into a number of months and days
  - Assume 1 month = 30 days
- What you know:

What you want to find out -> <u>output</u>

months(d) =

days(d) =

What you need to calculate -> <u>process</u>

What is given -> <u>input</u>

Example #2: Days -> Months+Days Flowchart

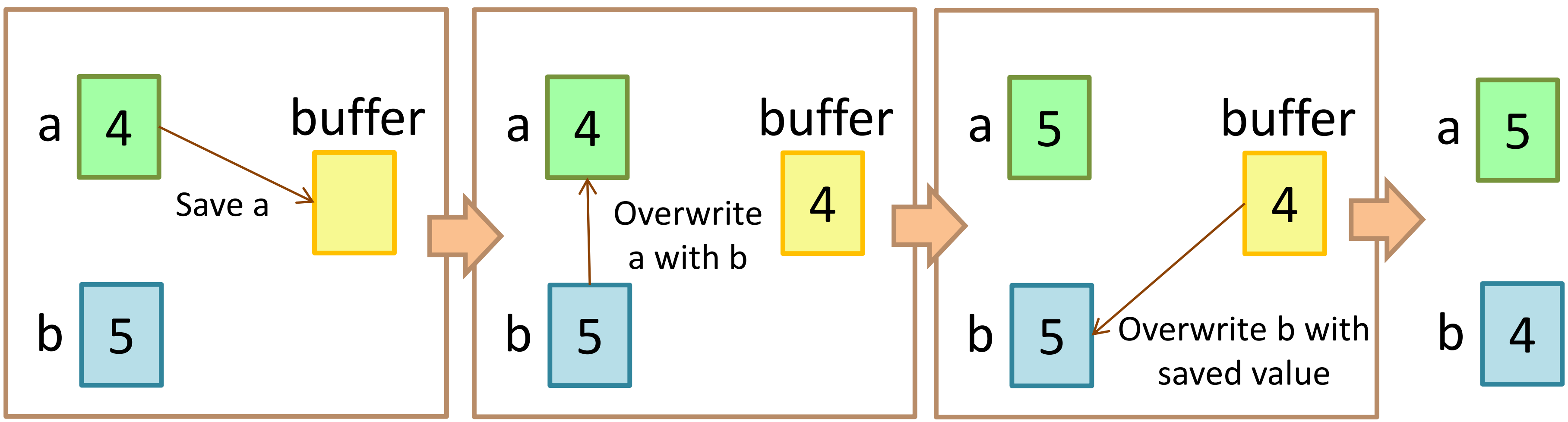
Input: Get the value of d

Process: Calculate months and days

Output: Print the value of months and days

Example #3: Swap

- Problem: swap 2 numbers
  - From: a = 4, b = 5
  - To: a = 5, b = 4
- What you know: we need a buffer!



Example #3: Swap Flowchart

What are inputs, outputs, and process?

Example #4: Final Grade

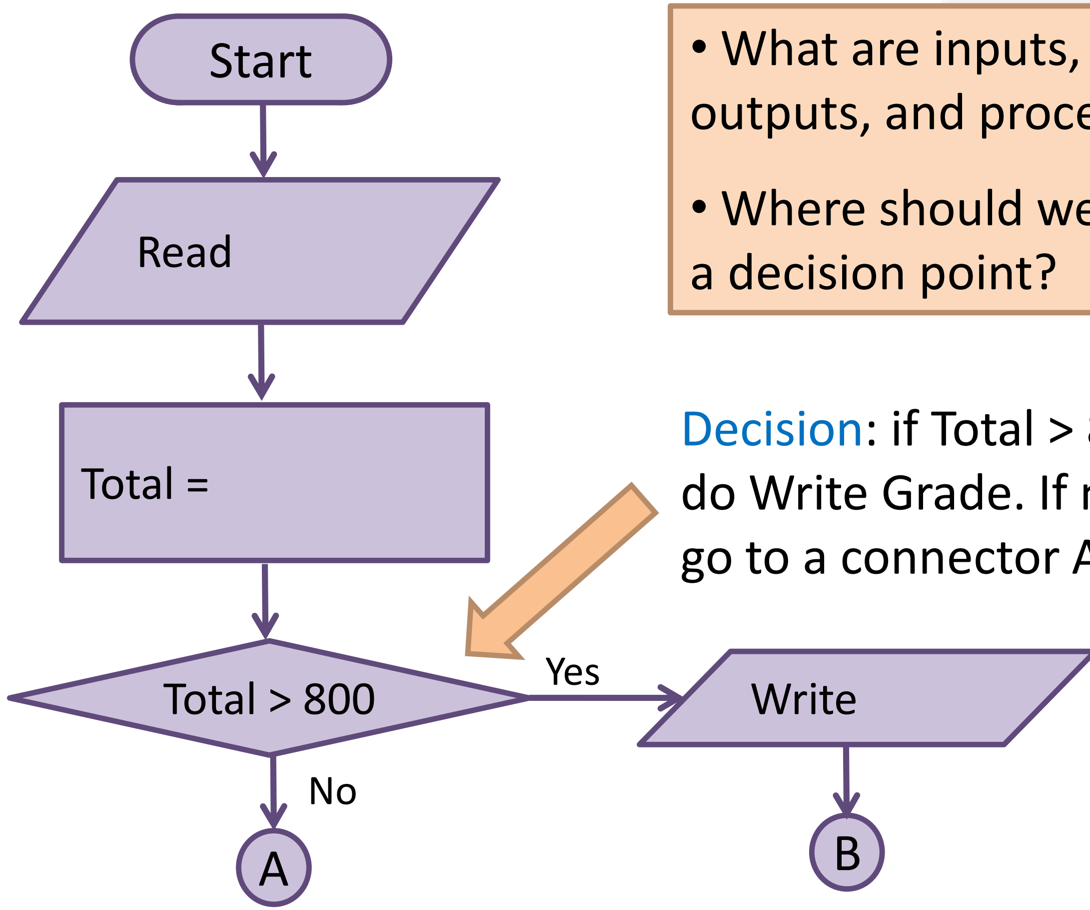
- Problem: sum scores of 4 subjects and assign a final grade based on a total score

	Total Marks	Grade
598? →	> 800	A
598? →	601 – 800	B
598? →	401 – 600	C
598? →	201 – 400	D

- How to assign a final grade given a total score?
  - Compare a total score within ranges -> Use Decision!

Example #4: Final Grade Flowchart

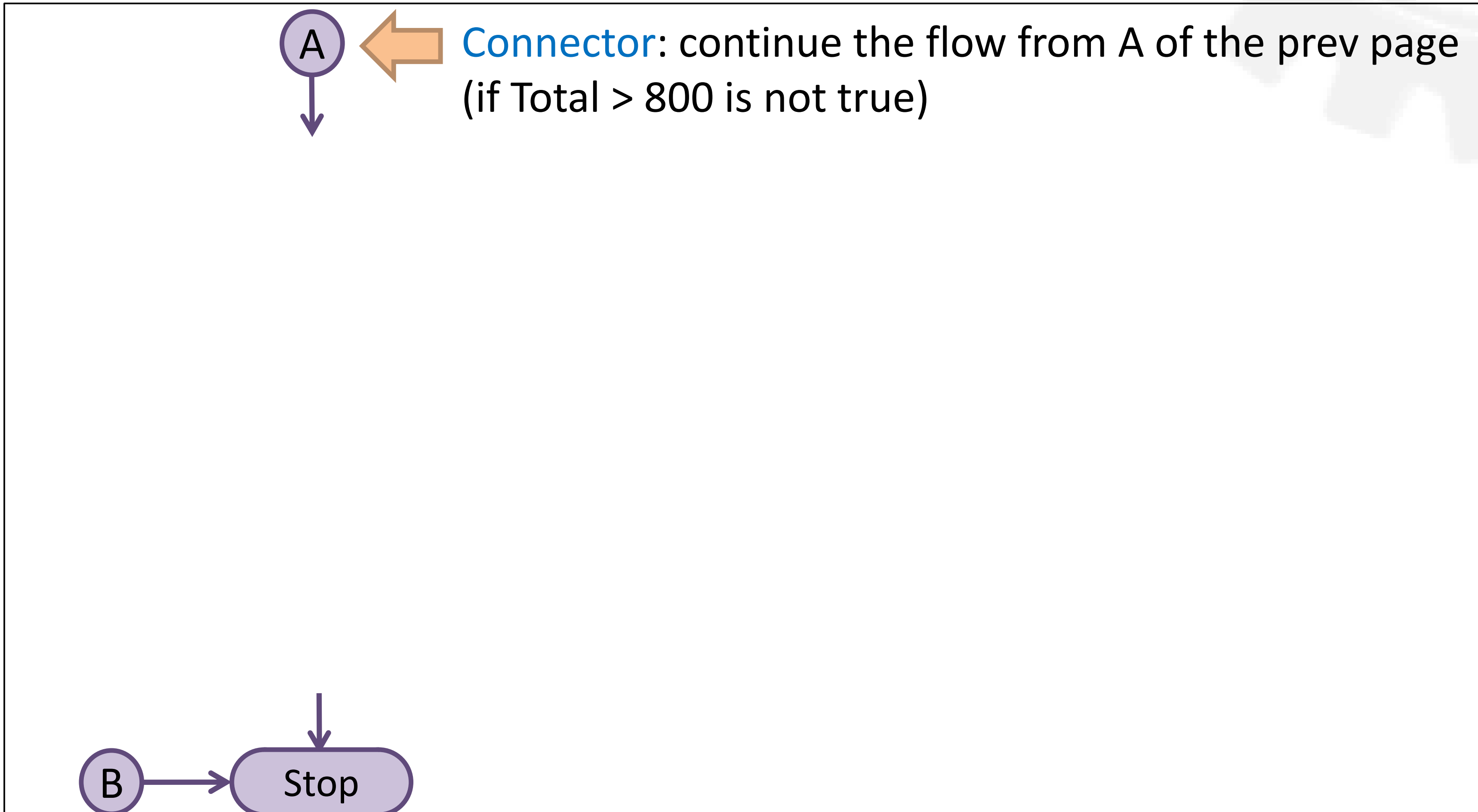
- What are inputs, outputs, and process?
- Where should we put a decision point?



Decision: if Total > 800, do Write Grade. If not, go to a connector A

- One page is not enough?
- Put connector(s) and go to the next page!

Example #4: Final Grade Flowchart



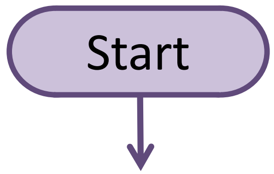
Example #5: Factorial

- Problem: find a factorial of a number (n)
- What you know: $\boxed{n! = 1 * 2 * \ldots * n}$

1^{st} round: 1	fac = 1 * $\boxed{1}$ = $\boxed{1}$
2^{nd} round: 1*2	fac = $\boxed{1}$ * $\boxed{2}$ = $\boxed{2}$
3^{rd} round: 1*2*3	fac = $\boxed{2}$ * $\boxed{3}$ = $\boxed{6}$
4^{th} round: 1*2*3*4	fac = $\boxed{6}$ * $\boxed{4}$ = $\boxed{24}$
5^{th} round: 1*2*3*4*5	fac = $\boxed{24}$ * $\boxed{5}$ = 120

Q: When to stop?
A: When this is n
(after the n^{th} round)

Example #5: Factorial Flowchart



- What are inputs, outputs, and process?
- Where should we put a decision point?

Example #5: Factorial (2)

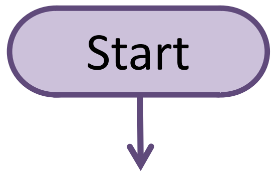
- Same problem, different method
  - Can have > 1 algorithm to solve the same problem
- Problem: find a factorial of a number (n)
- What you know:

Before:	$n! = 1 * 2 * \ldots * n$
But also:	$n! = n * (n-1) * (n-2) * \ldots * 1$

n = 5

$$5! = \overset{n}{5} * \underset{n-1}{4} * \overset{n-2}{3} * \underset{n-3}{2} * \overset{n-4 = 1}{1}$$

Example #5: Factorial (2) Flowchart



- What are inputs, outputs, and process?
- Where should we put a decision point?
- What is different from the prev flowchart?

Example #6: Sum

- Problem: Sum numbers from 1 to n
- What do you know?

Example #6: Sum Flowchart

- What are inputs, outputs, and process?
- Where should we put a decision point?

Example #7: Print Odd Numbers

- Problem: Print odd number from 1 to n
- What do you know?

Example #7: Print Odd Numbers Flowchart

- What are inputs, outputs, and process?
- Where should we put a decision point?

Example #8: Print Even Numbers

- Problem: Print even number from 1 to n
- What do you know?

Example #8: Print Even Numbers Flowchart

- What are inputs, outputs, and process?
- Where should we put a decision point?
- What is different from the prev flowchart (odd numbers)?

Take Home Message

- Flowchart represents an algorithm
  - How to solve a problem systematically
  - Very helpful with coding
- 1 Start and 1 Stop (terminators)
- What are inputs, processes, decisions, and outputs?
  - Also where to put them?
- A problem can have > 1 solution
- Draw clearly and neatly and label branches

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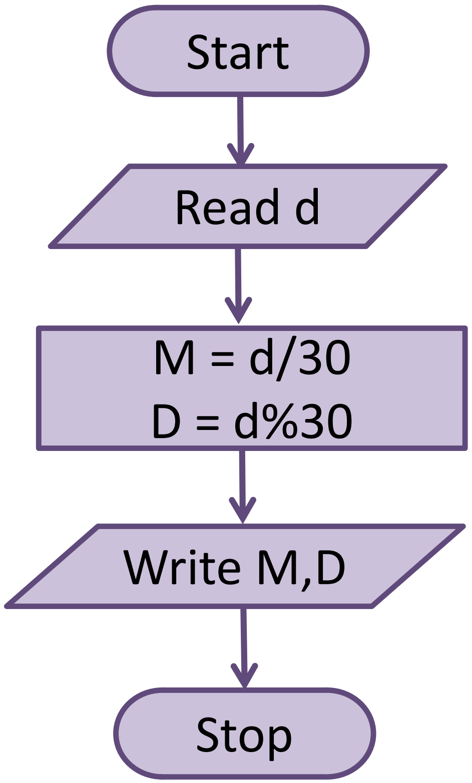
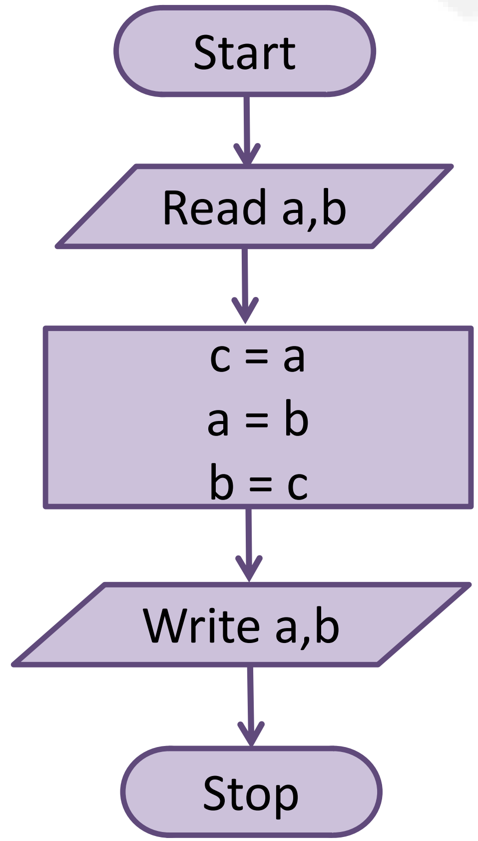
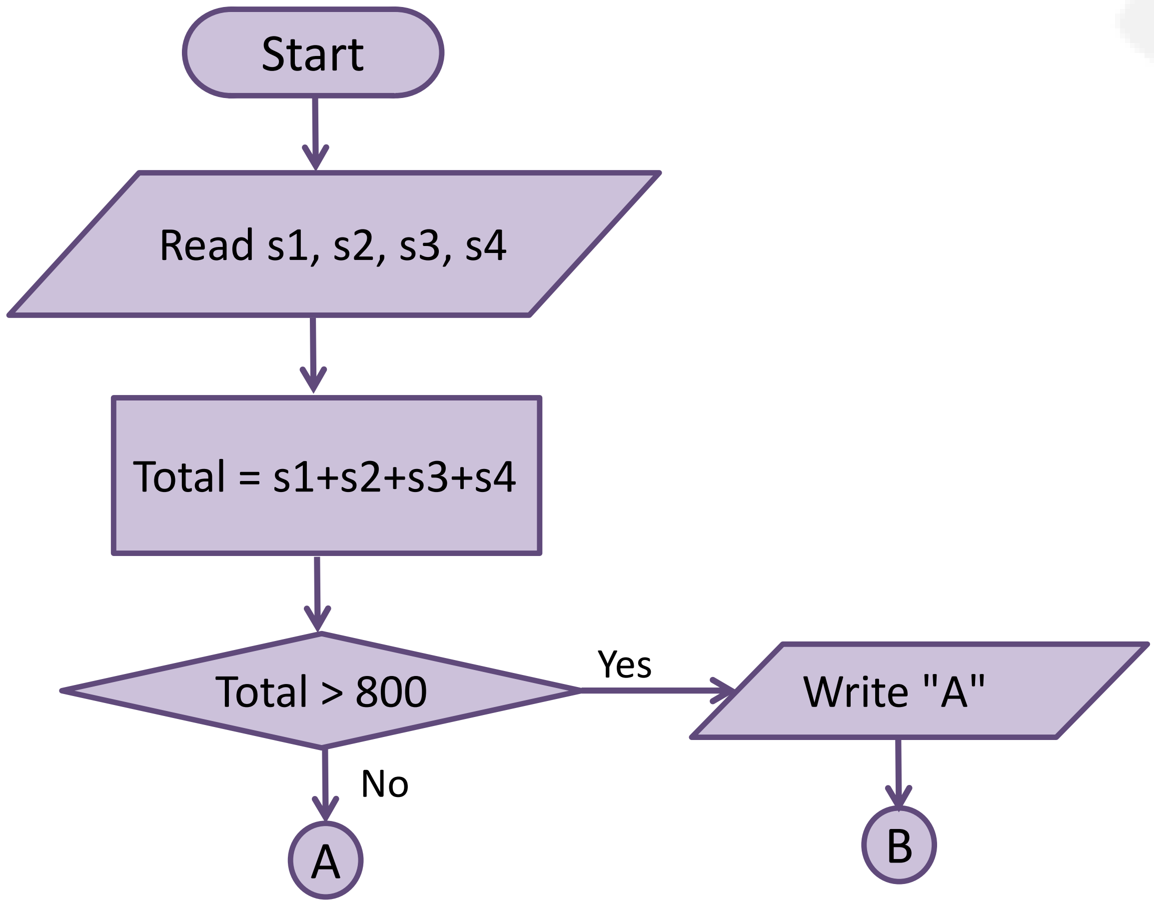
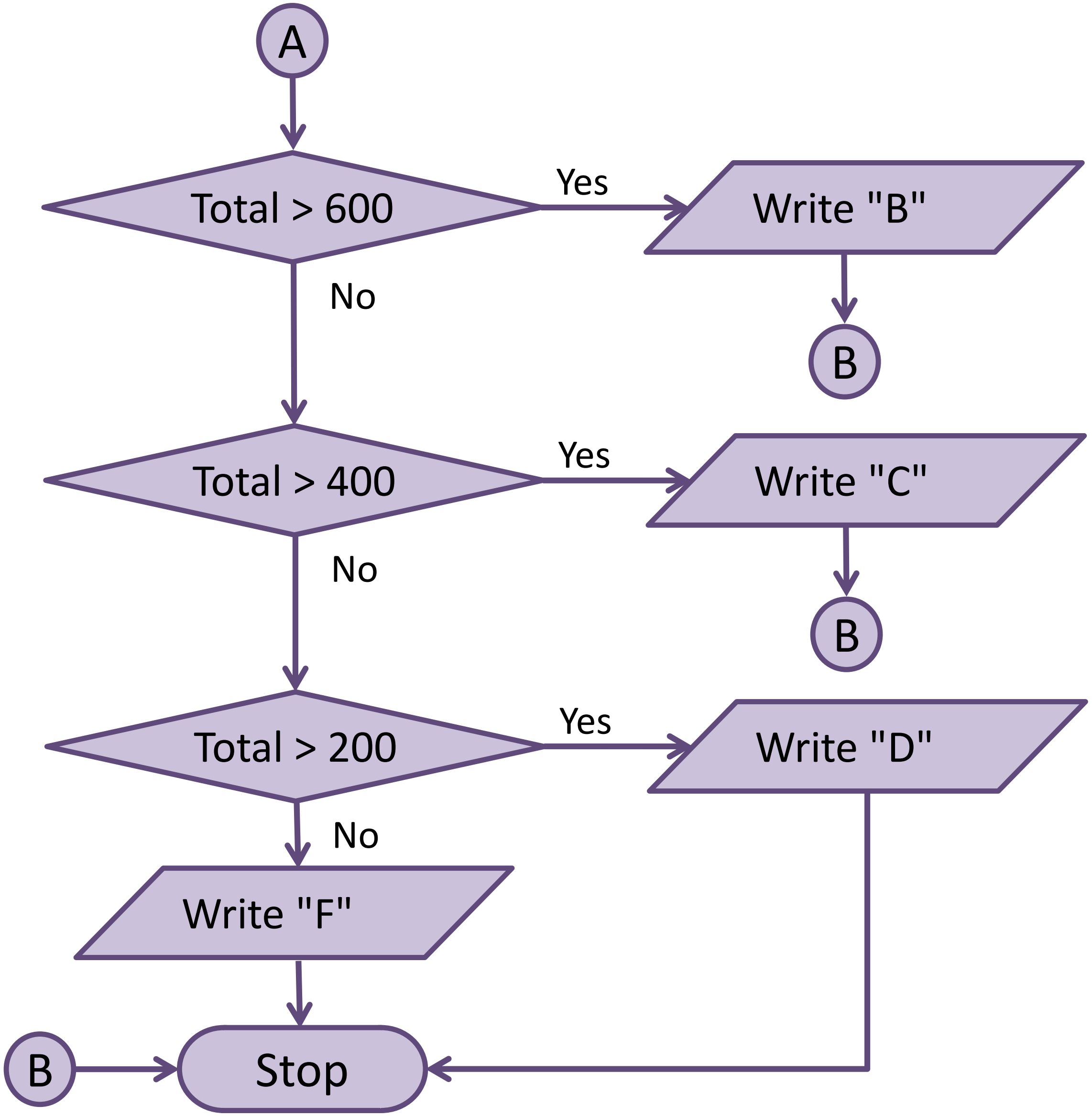
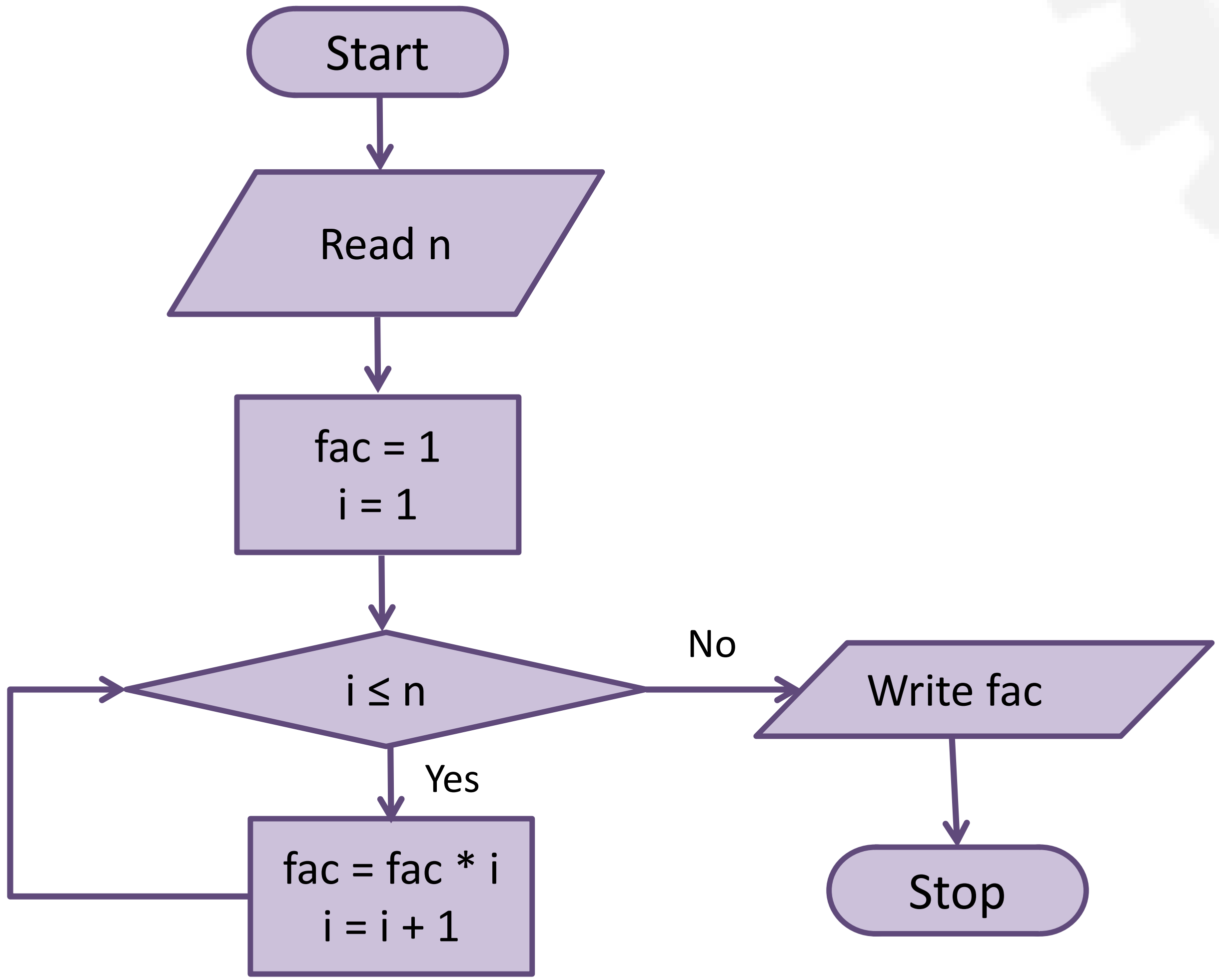
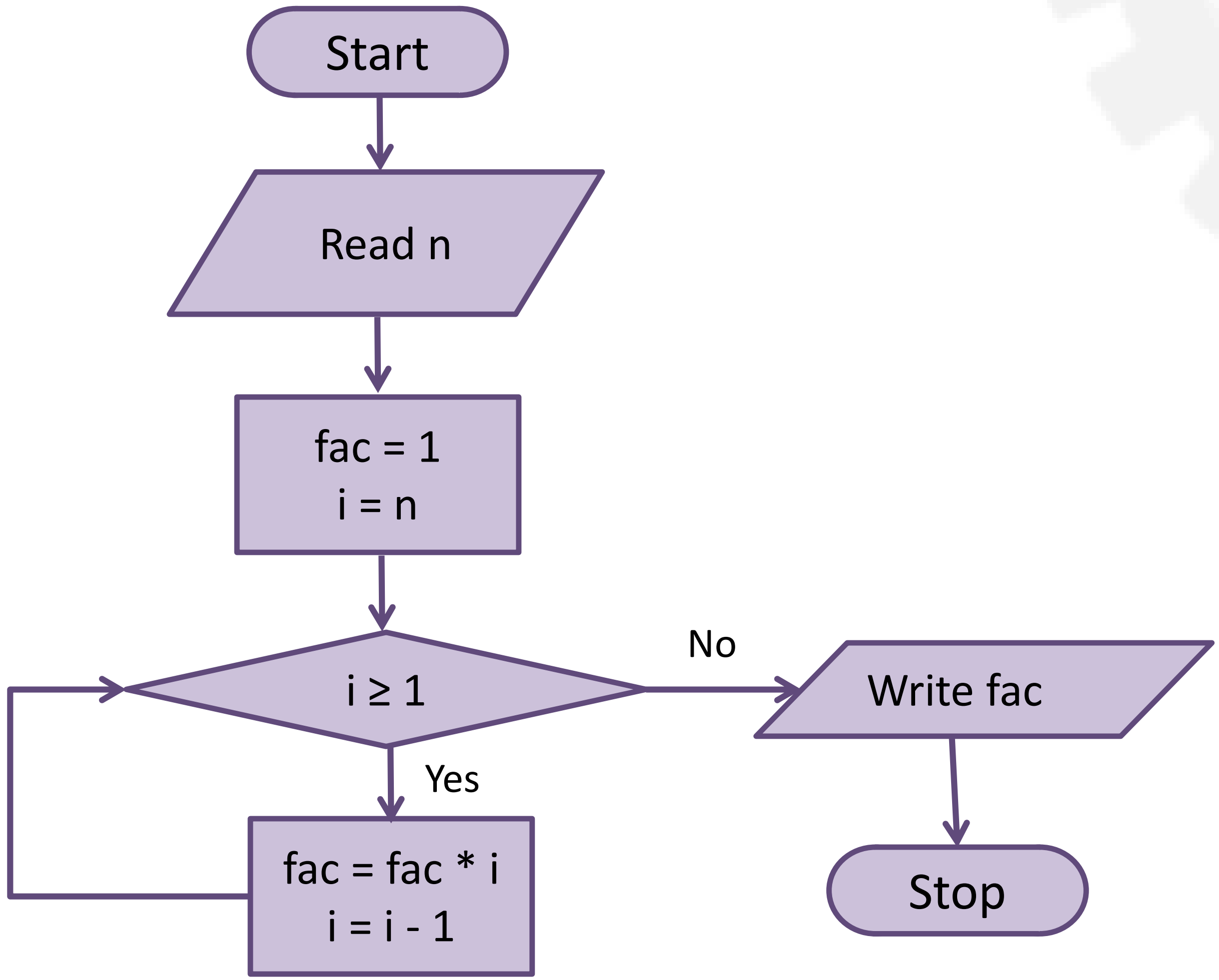

Start
Read d
M = d/30
D = d%30
Write M,D
Stop

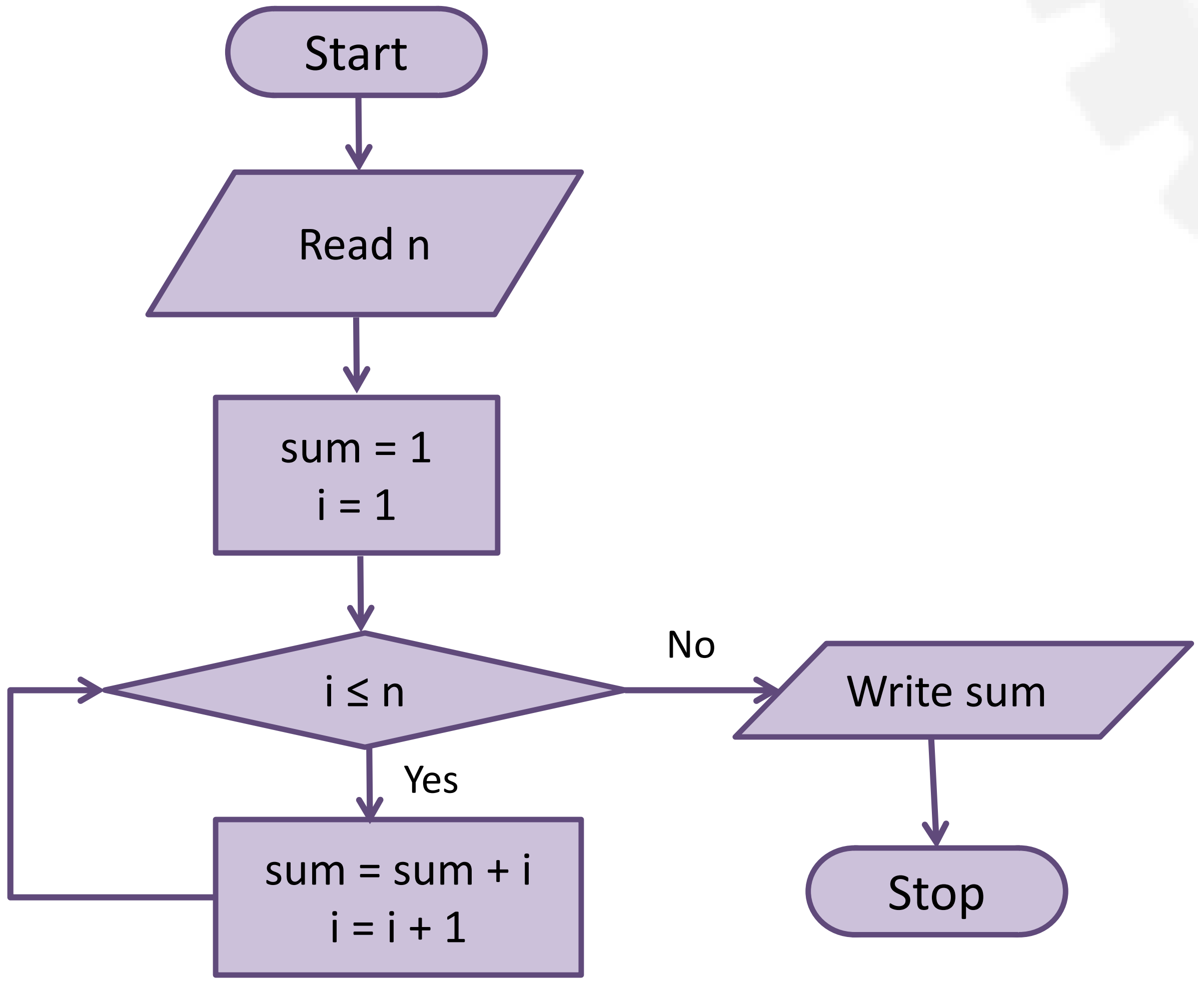

Start
Read a,b
c = a
a = b
b = c
Write a,b
Stop

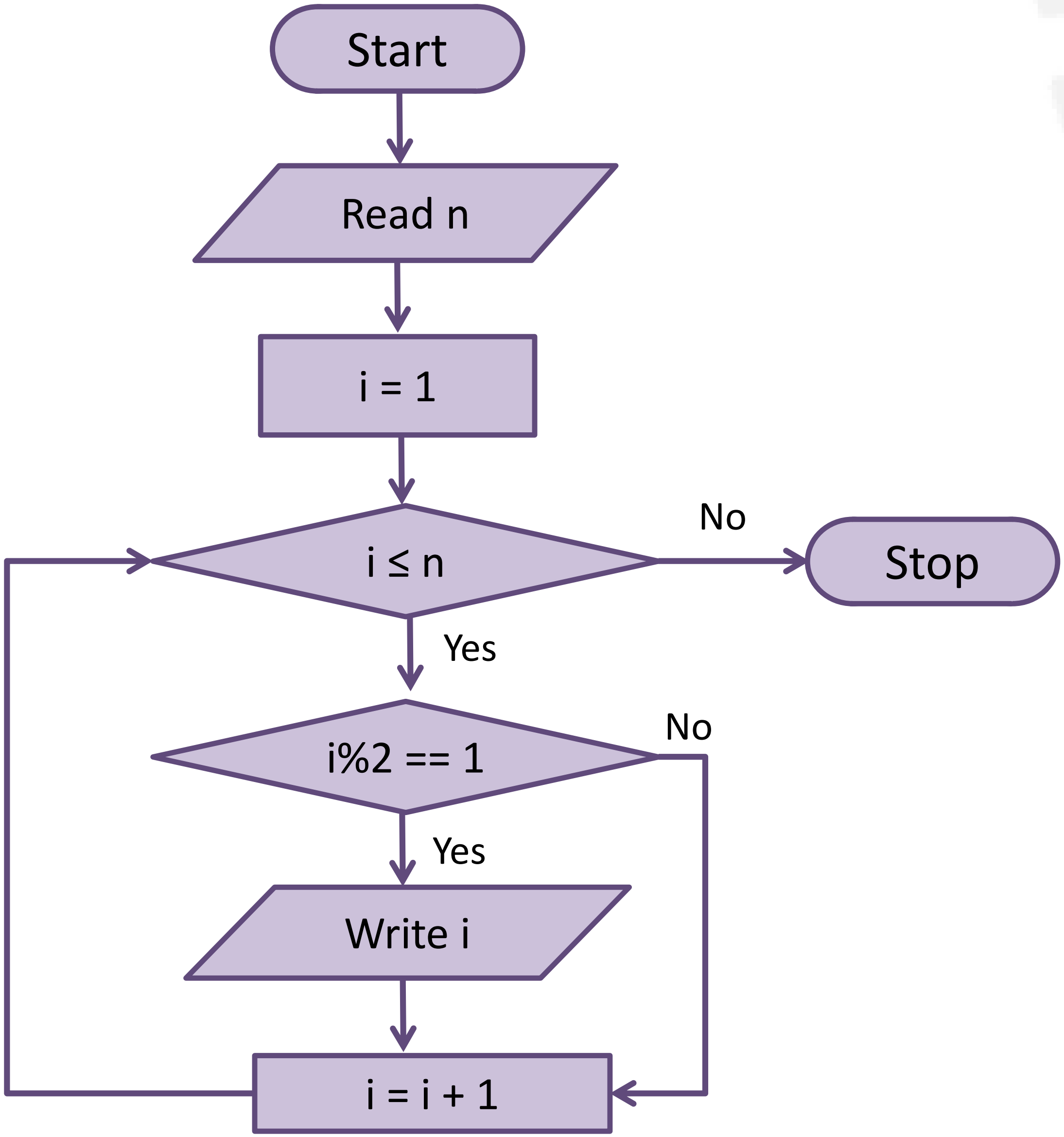

Start
Read s1, s2, s3, s4
Total = s1+s2+s3+s4
Total > 800
Yes
Write "A"
No
A
B


A
Total > 600
Yes
Write "B"
No
B
Total > 400
Yes
Write "C"
No
B
Total > 200
Yes
Write "D"
No
Write "F"
B
Stop

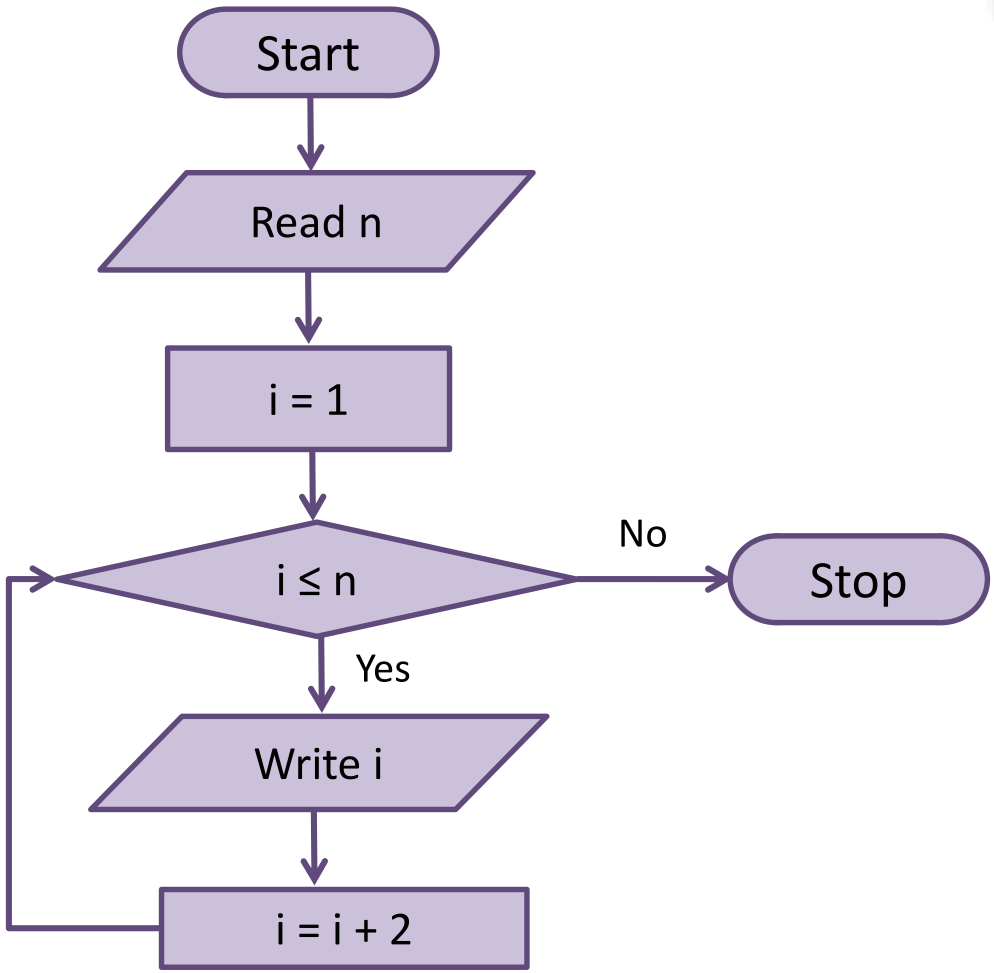

Start
Read n
fac = 1
i = 1
i ≤ n
No
Write fac
Yes
fac = fac * i
i = i + 1
Stop

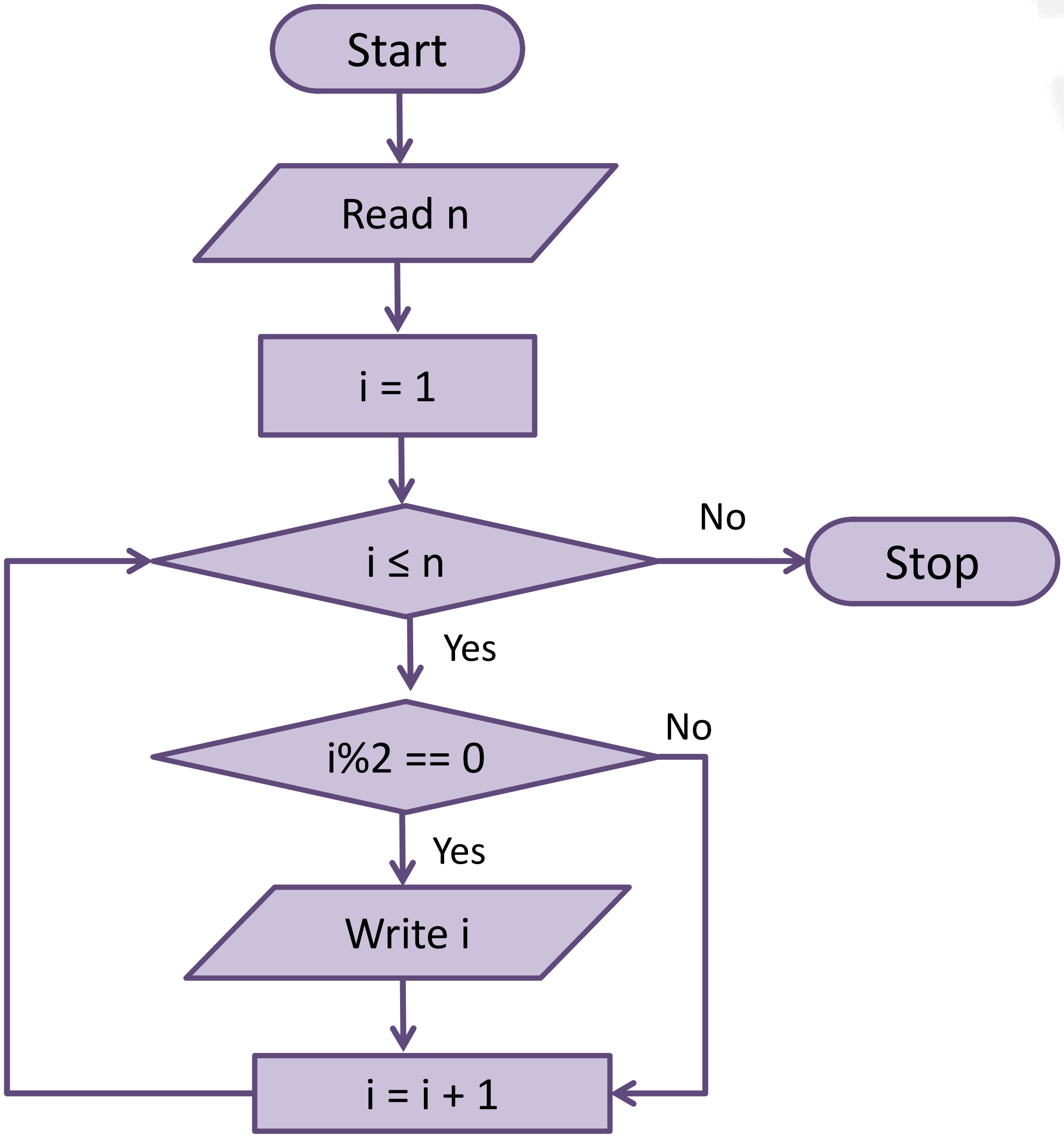

Start
Read n
fac = 1
i = n
i ≥ 1
No
Write fac
Yes
fac = fac * i
i = i - 1
Stop

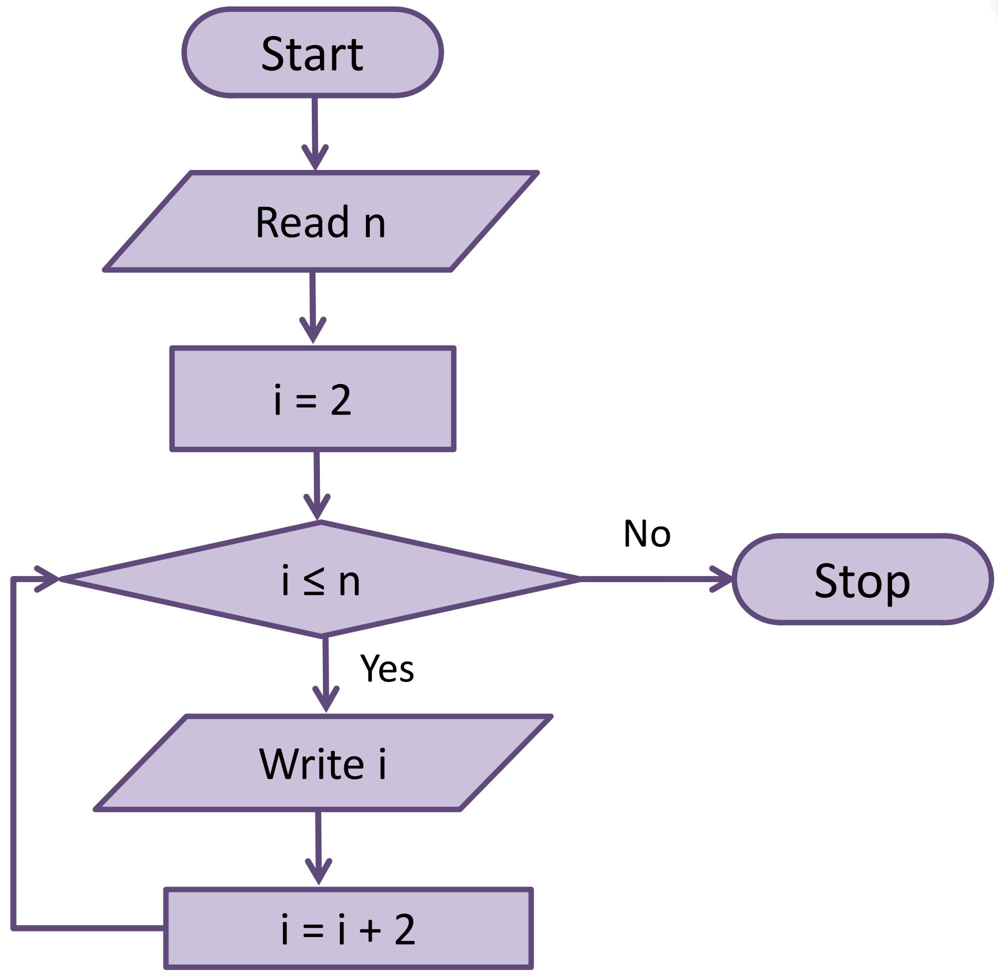

Start
Read n
sum = 1
i = 1
i ≤ n
No
Write sum
Yes
sum = sum + i
i = i + 1
Stop



Start
Read n
i = 1
i ≤ n
No
Stop
Yes
i%2 == 1
No
Yes
Write i
i = i + 1


Start
Read n
i = 1
i ≤ n
No
Stop
Yes
Write i
i = i + 2


Start
Read n
i = 1
i ≤ n
No
Stop
Yes
i%2 == 0
No
Yes
Write i
i = i + 1


Start
Read n
i = 2
i ≤ n
No
Stop
Yes
Write i
i = i + 2