953103 Programming Logic Thinking

Repetition Structure

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Agenda

- Repetition Structure
- Problem Solving

Motivation

- Sequential structure = same process every time
- Selection structure = the program can choose between different alternatives.
- One advantage of computerized approach is to work tirelessly.
  - Can you implement it with the sequential structure and selection structure?

Example

"Create a program to read an integer and print out 'hello world' as much as the input"

Example

- If user inputs 3, the program should display

hello world
hello world
hello world

Example

- If user inputs 5, the program should display

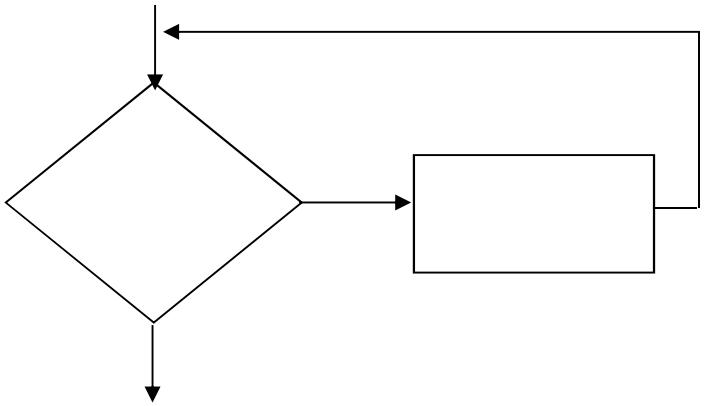
hello world
hello world
hello world
hello world
hello world

How can you implement the program using only the sequential structure and selection structure??

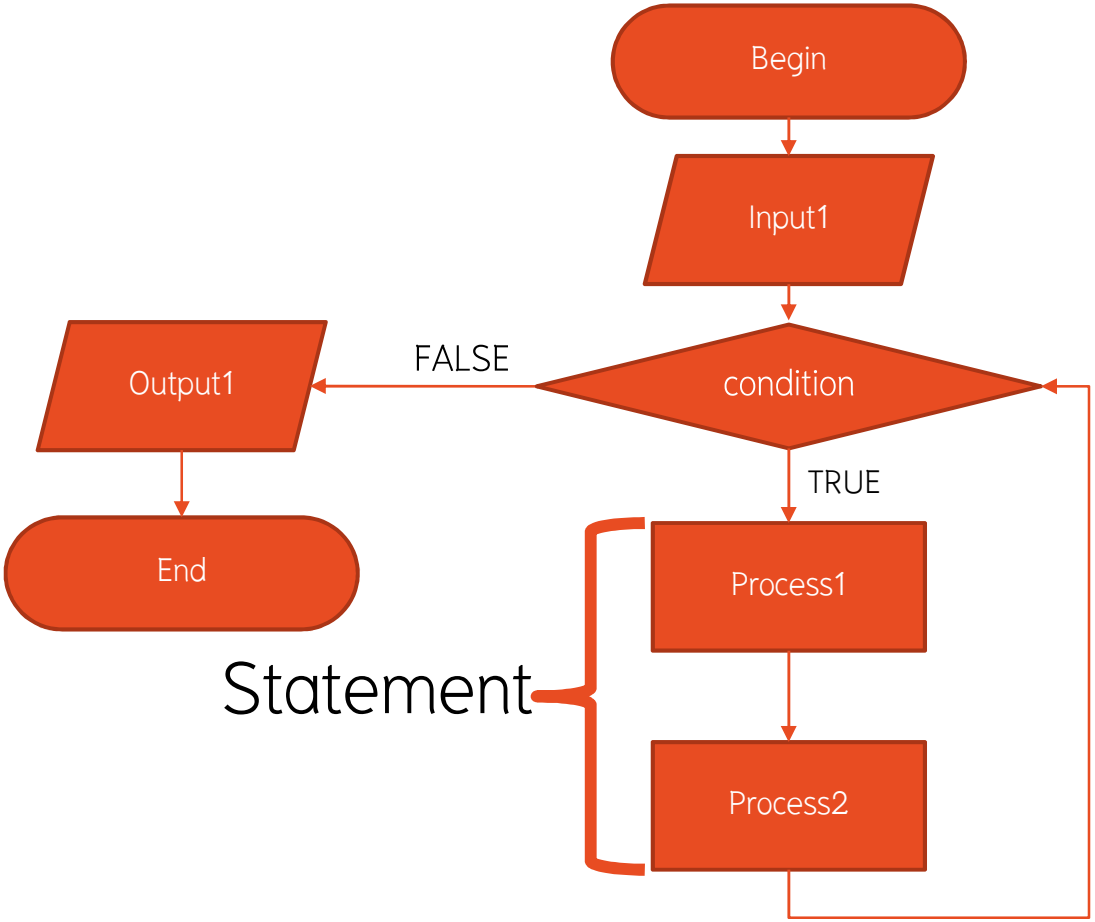
Repetition Structure

- A *repetition structure* represents part of the program that repeats.

- This type of structure is commonly known as a *loop*.



Flowchart: Example



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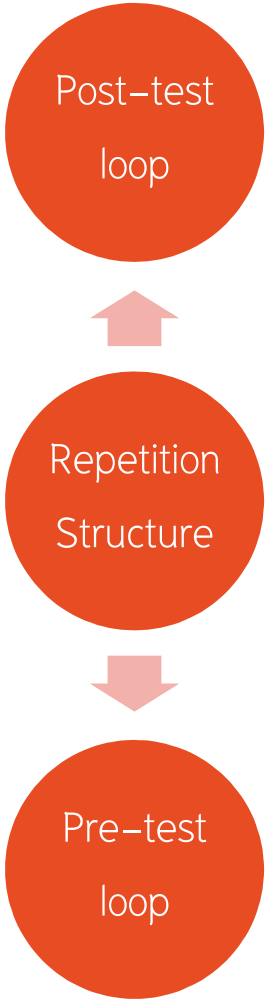
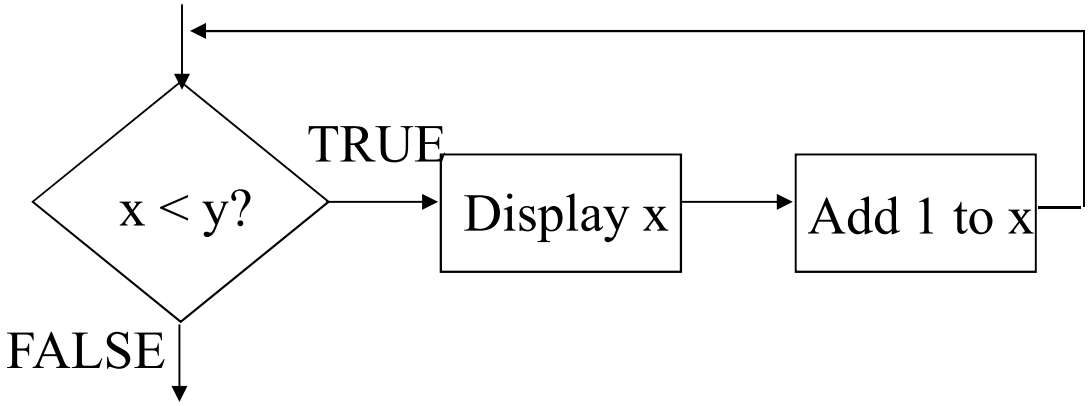

Post–test loop
Repetition Structure
Pre–test loop

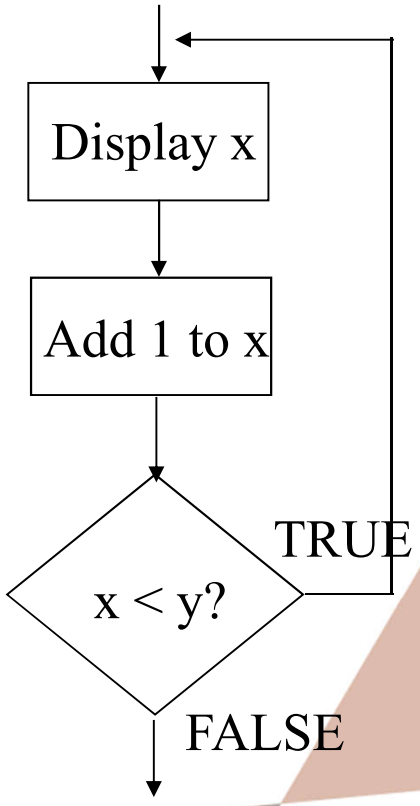
A Pre-Test Repetition Structure

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



A Post-Test Repetition Structure

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



Repetition Structure

- Pre-test structure: Check and Do

- Post-test structure: Do and Check

IPO and Repetition structure

- Don't forget the IPO

- What is the input?
  - Identify all of the values that you need
  - Get it from user or somewhere else
- What is the process?
  - Solution to the problem
  - The repetition structure is in this section
- What is the output?
  - Display the result
  - Make it readable

Analysis of Repetition Structure

- Analyze the problem

- If there is a requirement of the repetition structure.
  - Repeat a content for a fixed period of time
  - Repeat a content under conditions

- Identify the component of the repetition structure.
  - Initial condition
  - Stop condition
  - Update statement
  - Loop body

Repetition structure component

- Initial condition
  - Set the state of the repetition structure before the loop
  - Ex initialize the counter variable, initialize the cumulative variable
- Stop condition
  - Set the condition to terminate the loop
  - Ex number of round, terminal condition
- Update statement
  - Set how the repetition structure keeps track of repetition
  - AKA count the number of executed round
  - Ex add 1 to counter
- Loop body
  - Operations to repeat

Case Study

"Write a program to receive an integer number from user and display the factorial of the input number."

Case Study: Breaks the tasks

- What is the input?
  - An integer number.
- What is the process?
  - Calculate the factorial of the input
- What is the output?
  - Display the factorial of the input.

Case Study

- What is factorial ?????

$$\mathrm{n!} = n * (n-1) * \cdots * 1$$

$3! = 3 * 2 * 1 = 6$ User input 3

$5! = 5 * 4 * 3 * 2 * 1 = 120$ User input 5

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The factorial calculation

- The calculation of factorial varies based on the input from user.
  - Suggests that it is the repetition structure.

- The calculation of factorial

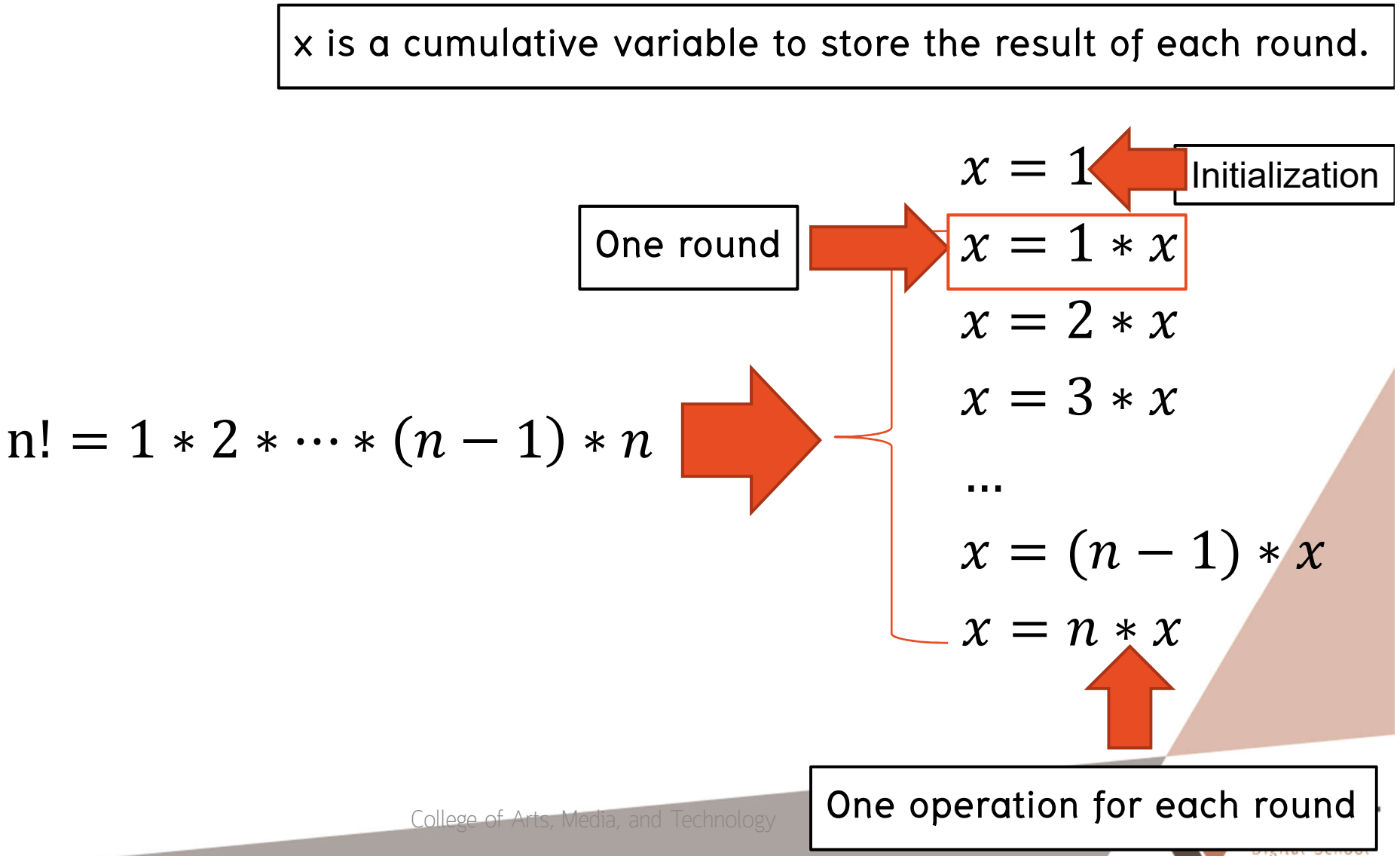
$$5 ! = 5 * 4 * 3 * 2 * 1$$
$$= 1 * 2 * 3 * 4 * 5$$

- Which operation is repeatedly performed?
  - Multiplication

Problem Analysis

- Identify the loop body
  - Which process is executed if the condition is true?
  - Decompose everything to a single calculation
  - Focus on the calculation of each round (Not all)
    - You may need a new variable to store the result of the operation.

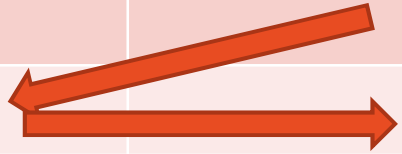
Example


x is a cumulative variable to store the result of each round.
$x = 1$
Initialization
One round
$x = 1 * x$
$x = 2 * x$
$x = 3 * x$
...
$x = (n-1) * x$
$x = n * x$
$n! = 1 * 2 * \cdots * (n-1) * n$
One operation for each round

The factorial calculation

- The process is to use the cumulative value (x) to store the result from the initial value.
  - Perform the operation and store the result in the cumulative variable

Round	Operation	Cumulative Variable (x)
Initialization		1
1	1*x	1
2	2*x	2
3	3*x	6
…		
n	n*x	n!



First Round

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The factorial calculation

- The process is to use the cumulative value (x) to store the result from the initial value.
  - Perform the operation and store the result in the cumulative variable

Round	Operation	Cumulative Variable (x)
		1
2	2*x	2
3	3*x	6
…		
n	n*x	n!

Second Round

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The factorial calculation

- The process is to use the cumulative value (x) to store the result from the initial value.
  - Perform the operation and store the result in the cumulative variable

Round	Operation	Cumulative Variable (x)
		2
3	3*x	6
…		
n	n*x	n!

Third Round

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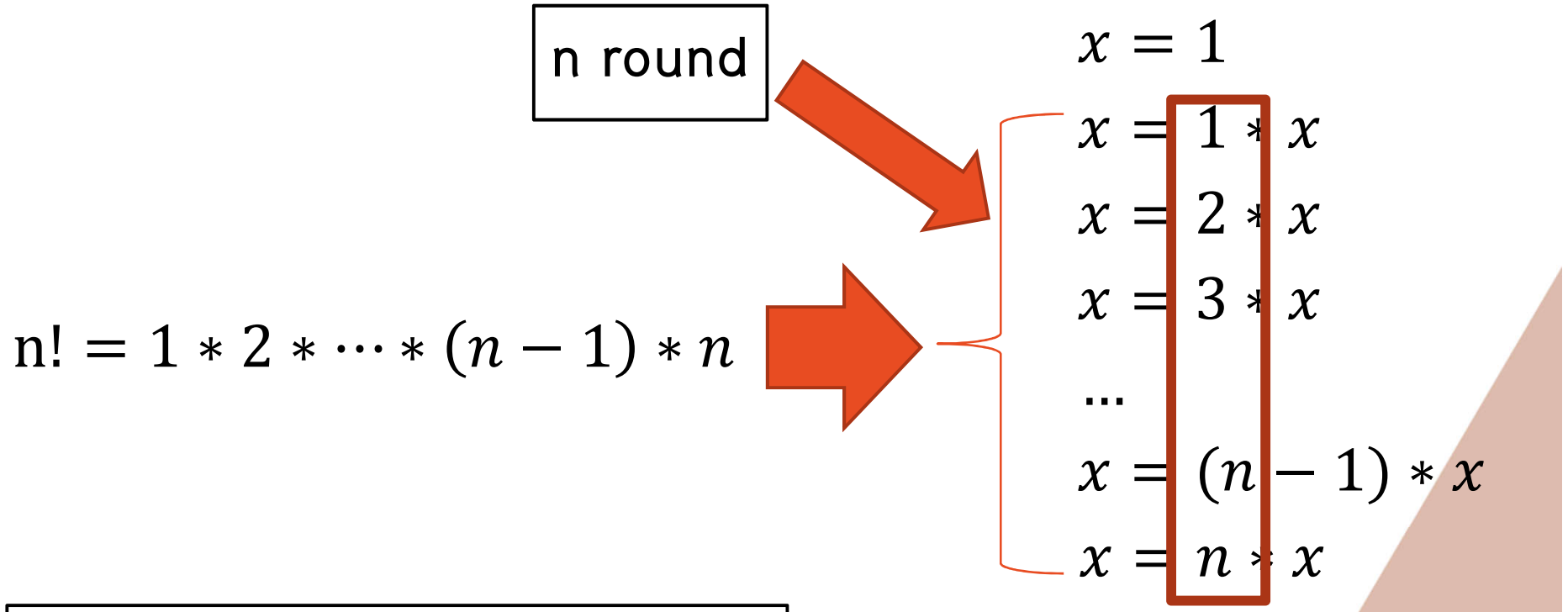
Why the cumulative variable is ‘1’?

Problem Analysis

- Identify the stop condition
  - When will the repetition structure stops?
  - Sometimes, it is number of round.
  - Sometimes, it is a specific condition.

Example



The loop will repeat for n times.

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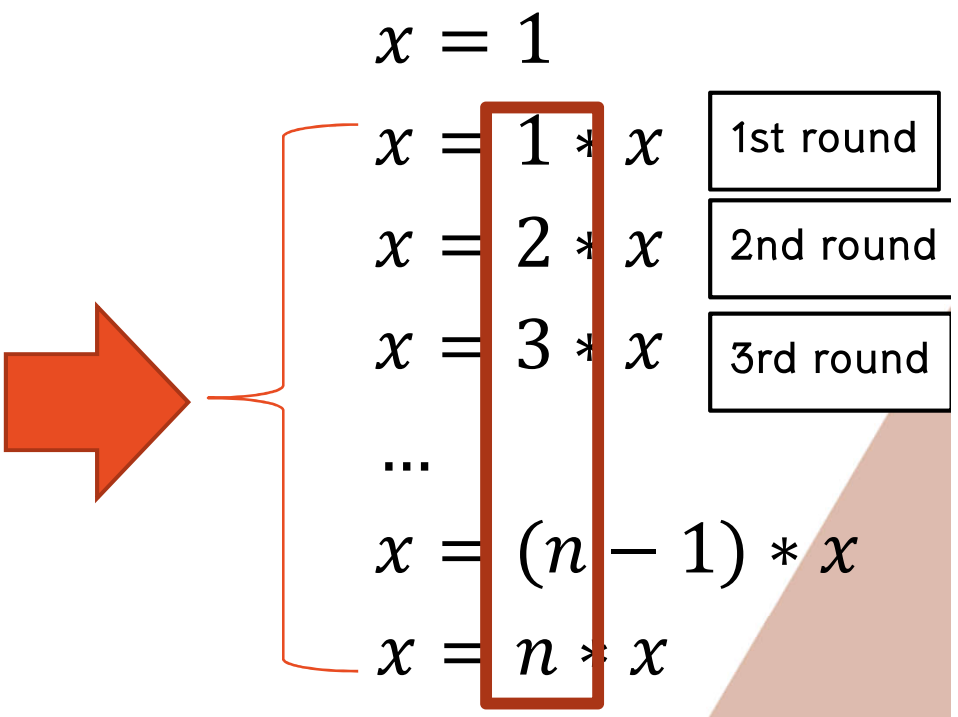
Problem Analysis

- Identify the update statements
  - Which process is executed if the condition is true?
  - Focus on the calculation of each round (Not all)
  - Decompose everything to be a single calculation
  - Identify the counter variable
    - A variable that keeps track of the repetition

Example

$$n! = 1 * 2 * \cdots * (n-1) * n$$



The cumulative variable is multiplied with the round.

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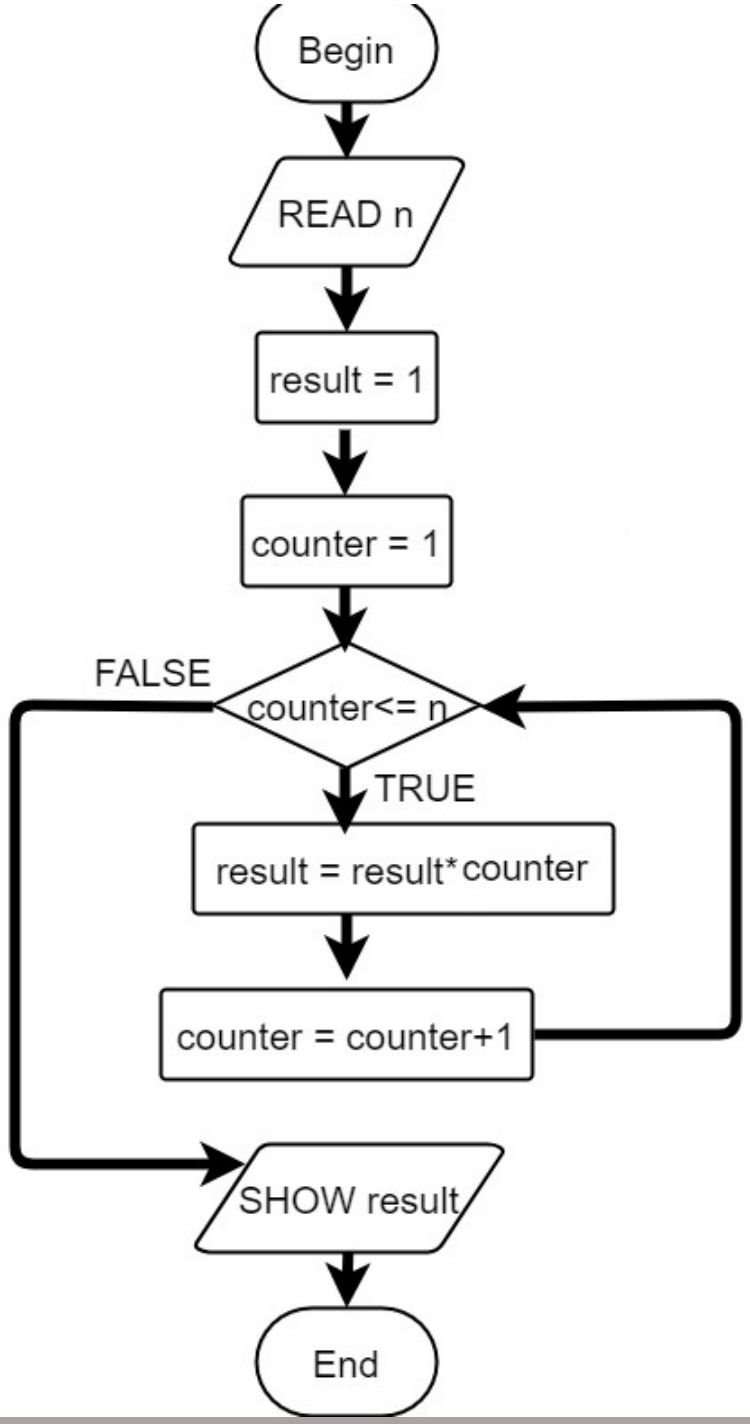
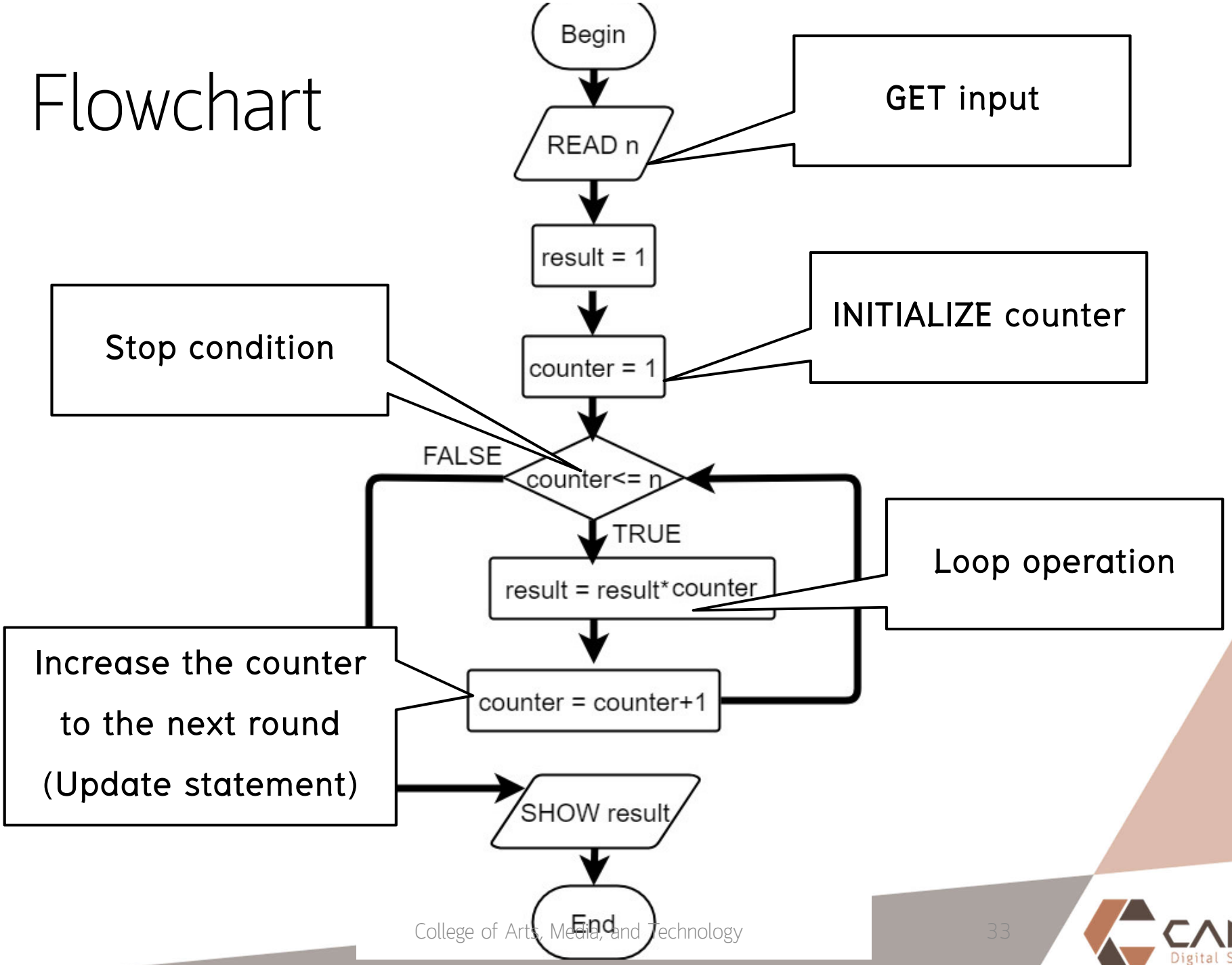
Flowchart

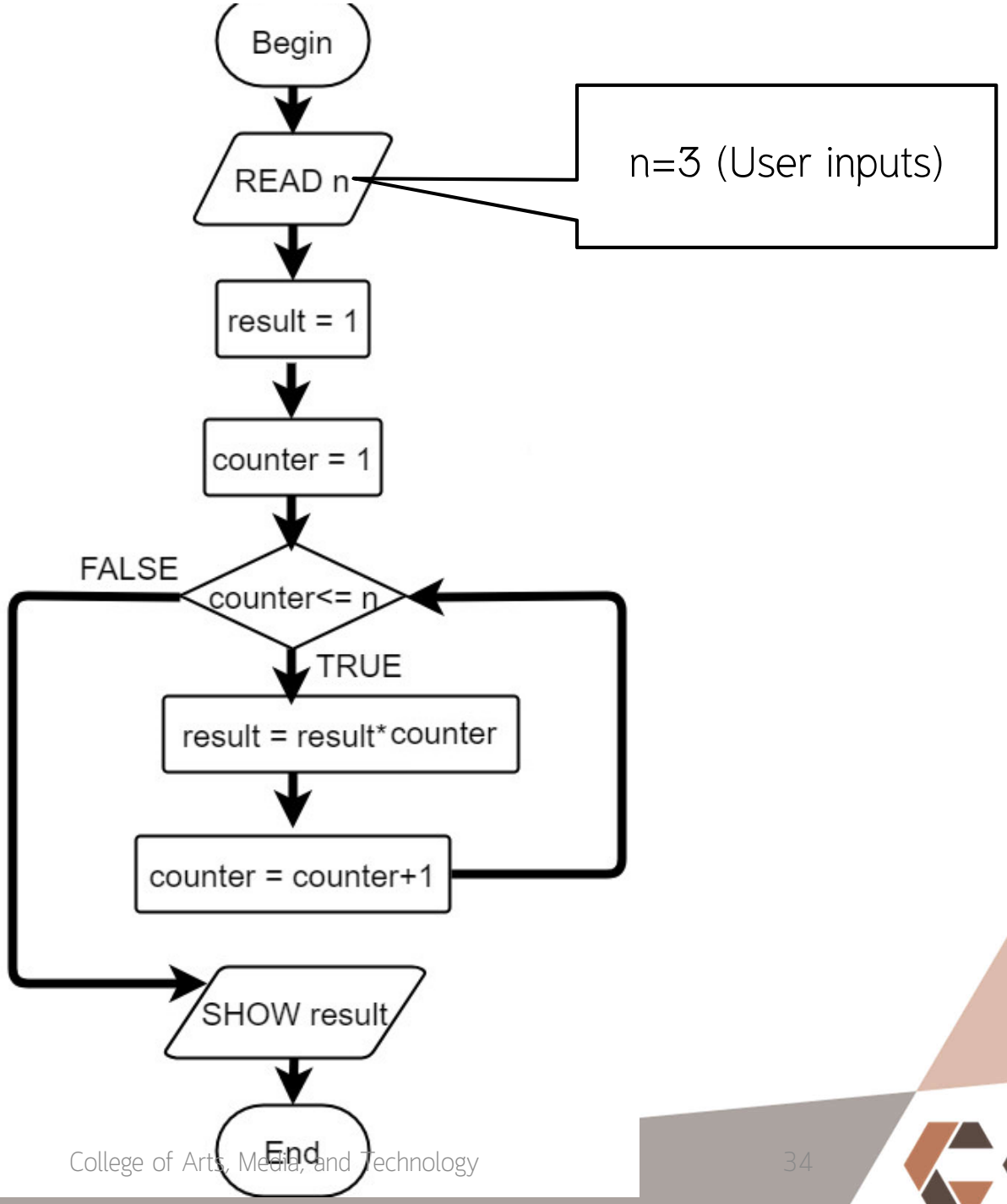


What if the user input 3 ?

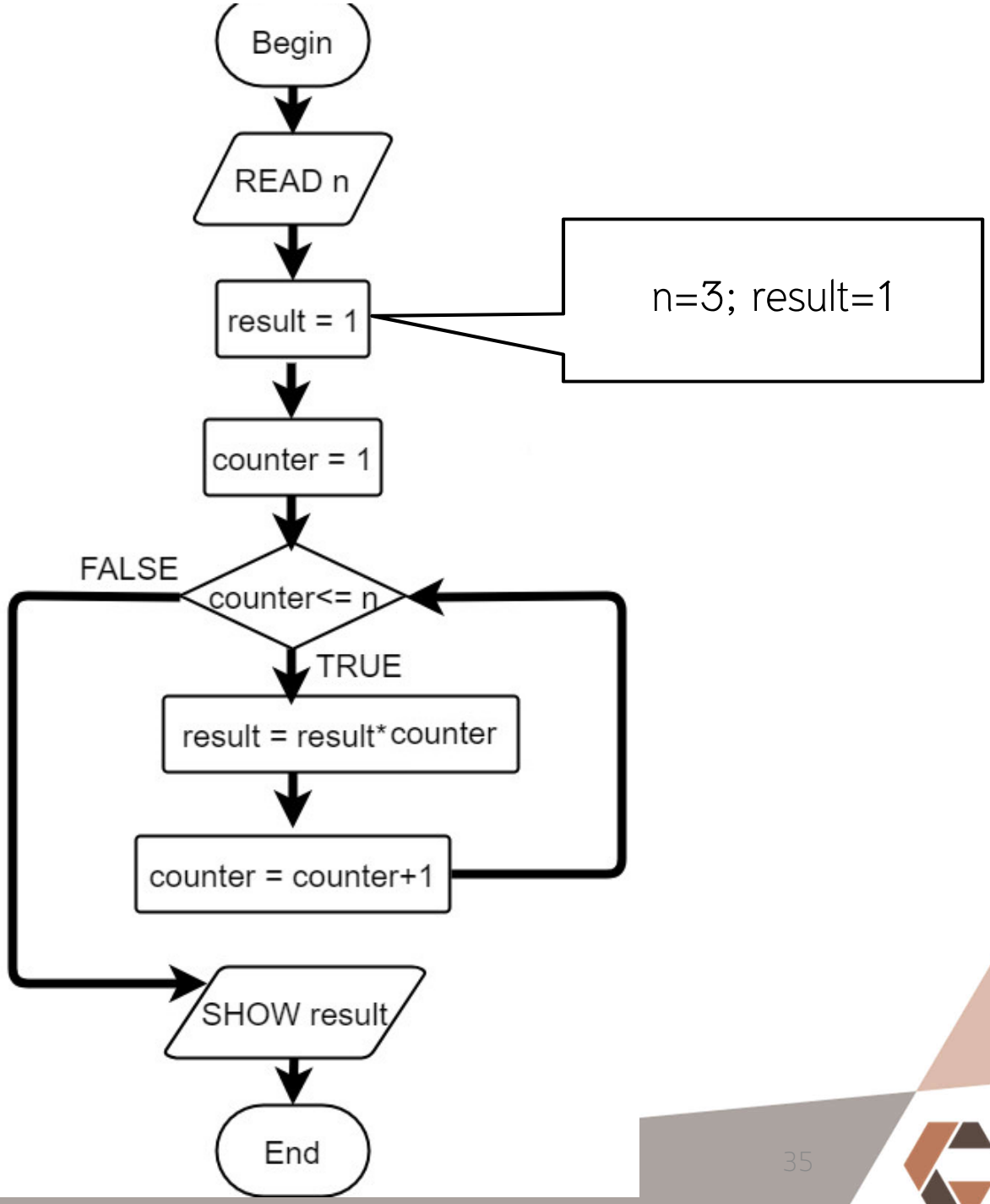
Flowchart


Begin
READ n
GET input
result = 1
counter = 1
INITIALIZE counter
Stop condition
FALSE
counter<= n
TRUE
result = result*counter
Loop operation
Increase the counter
to the next round
(Update statement)
counter = counter+1
SHOW result
End

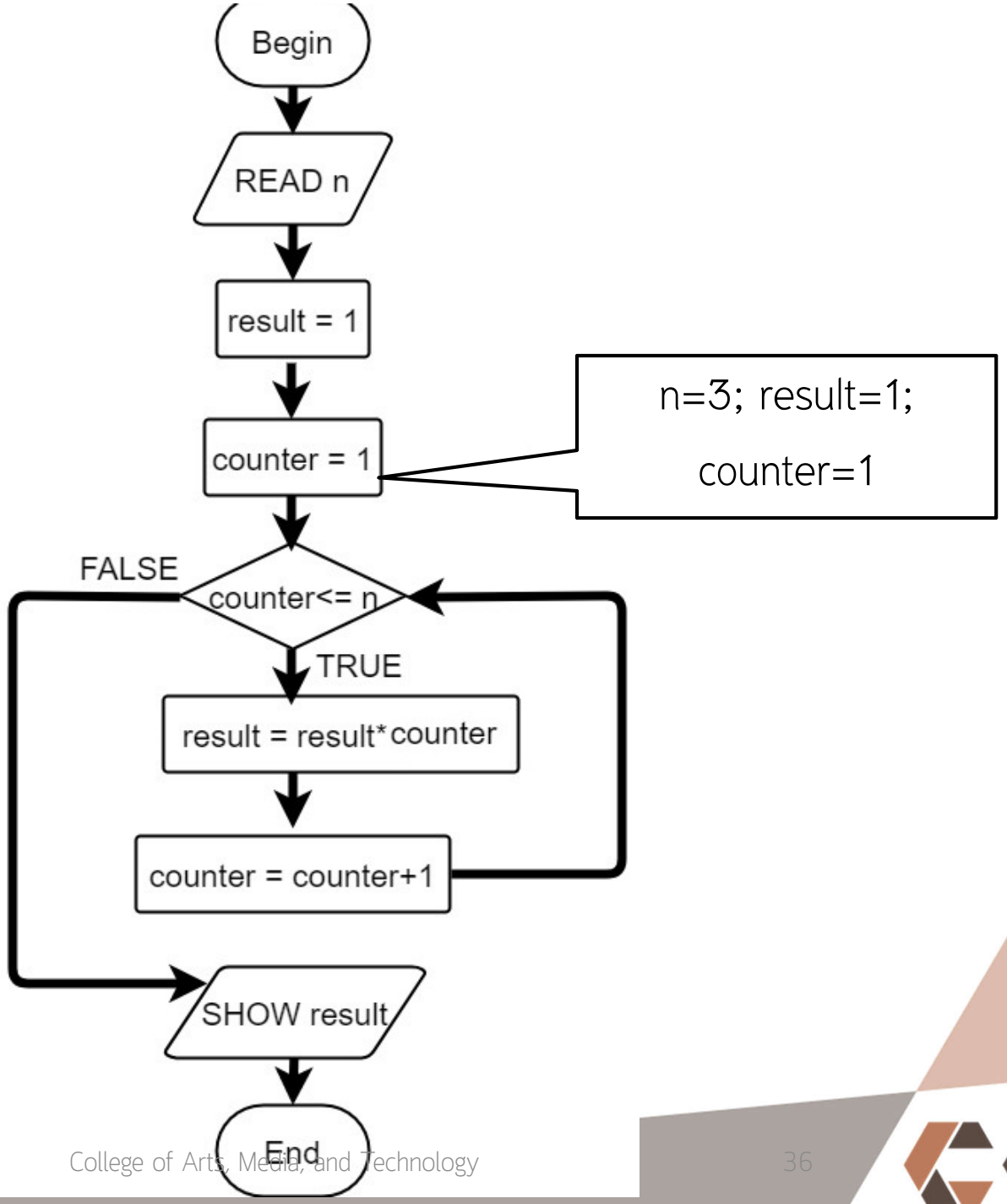
Flowchart


Begin
READ n
n=3 (User inputs)
result = 1
counter = 1
FALSE
counter<= n
TRUE
result = result*counter
counter = counter+1
SHOW result
End

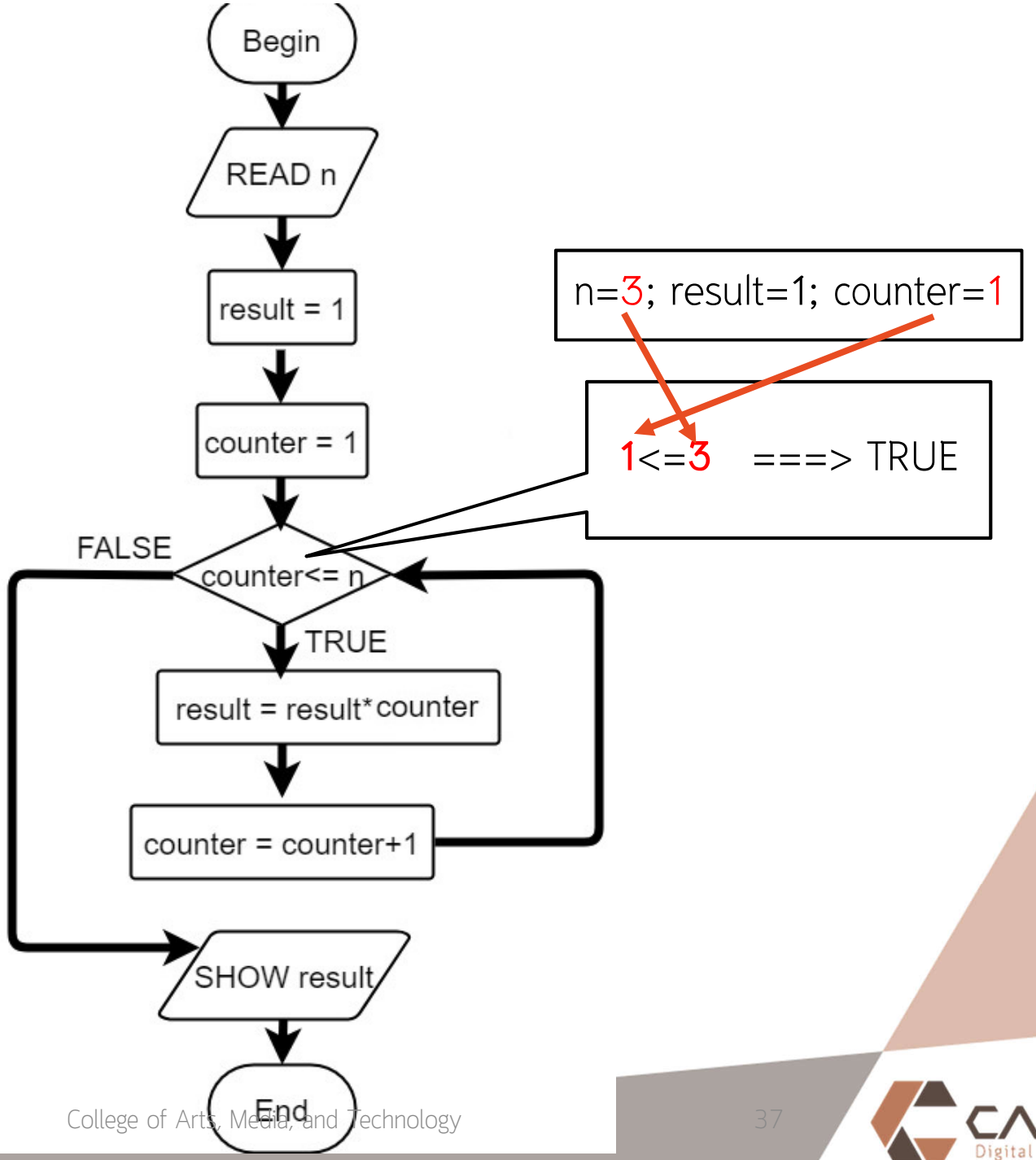
Flowchart



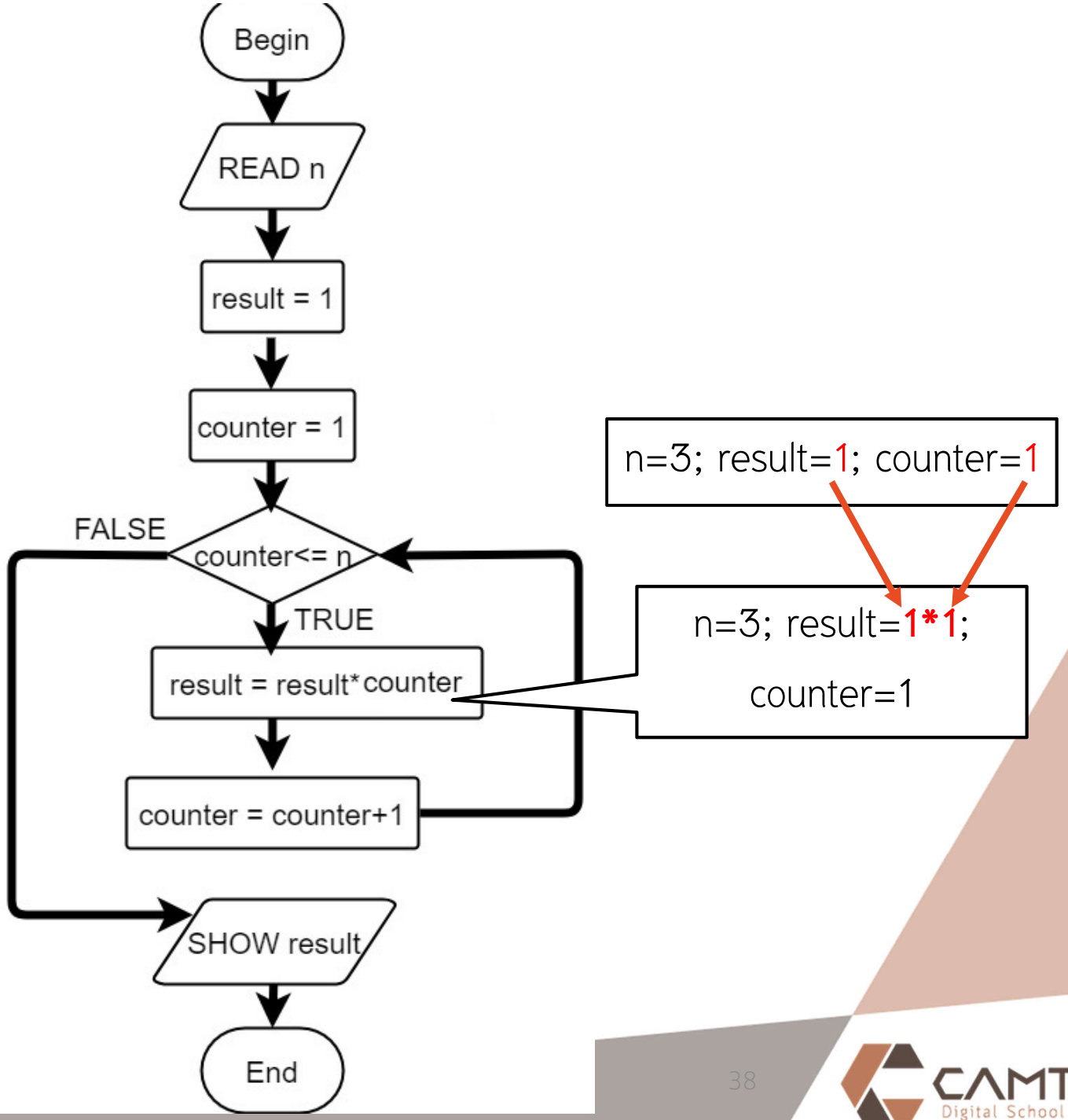
Flowchart


Begin
READ n
result = 1
counter = 1
n=3; result=1;
counter=1
FALSE
counter<= n
TRUE
result = result*counter
counter = counter+1
SHOW result
End

Flowchart


Begin
READ n
result = 1
counter = 1
counter<= n
FALSE
TRUE
result = result*counter
counter = counter+1
SHOW result
End
n=3; result=1; counter=1
1<=3 ===> TRUE

Flowchart



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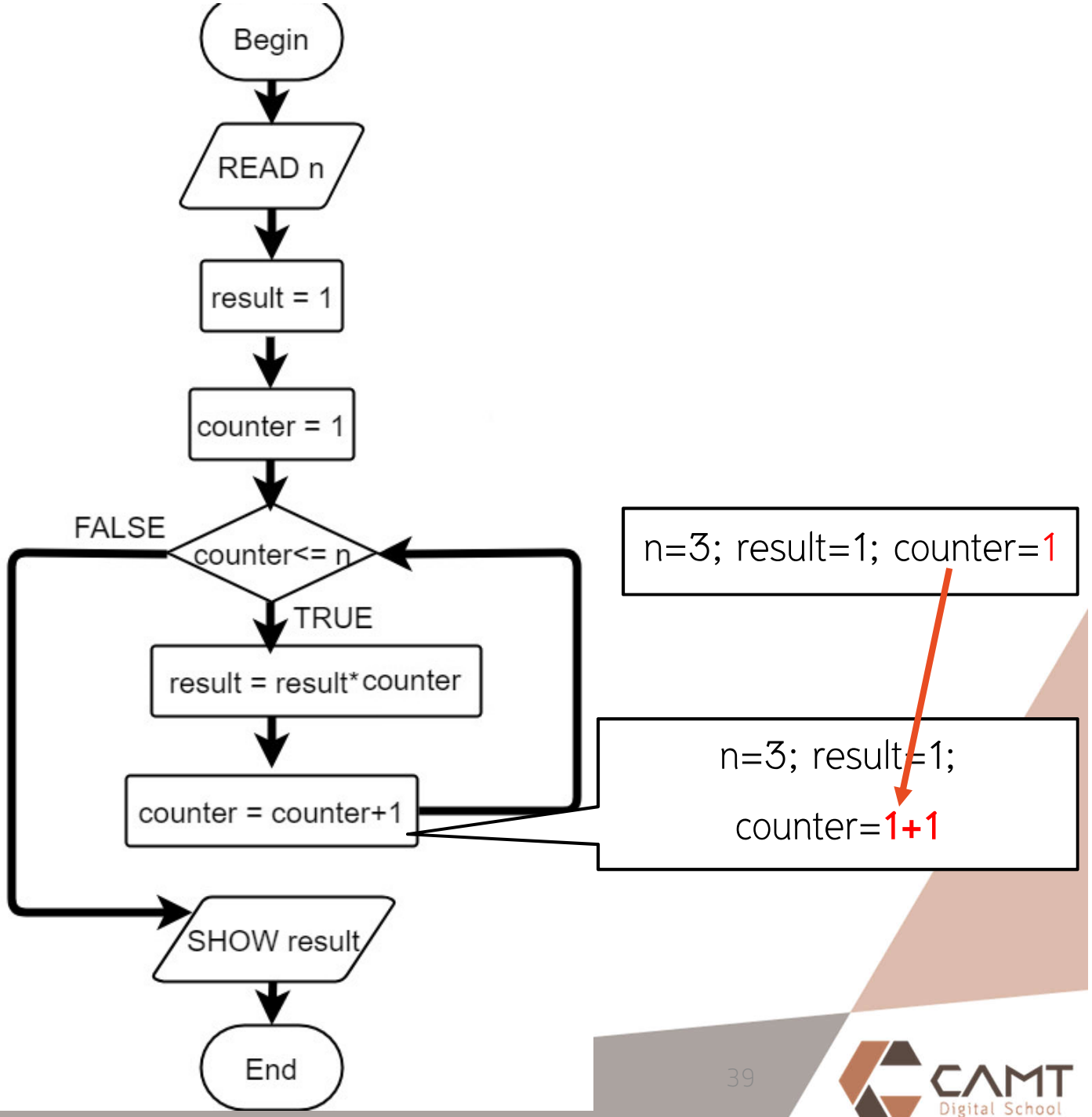
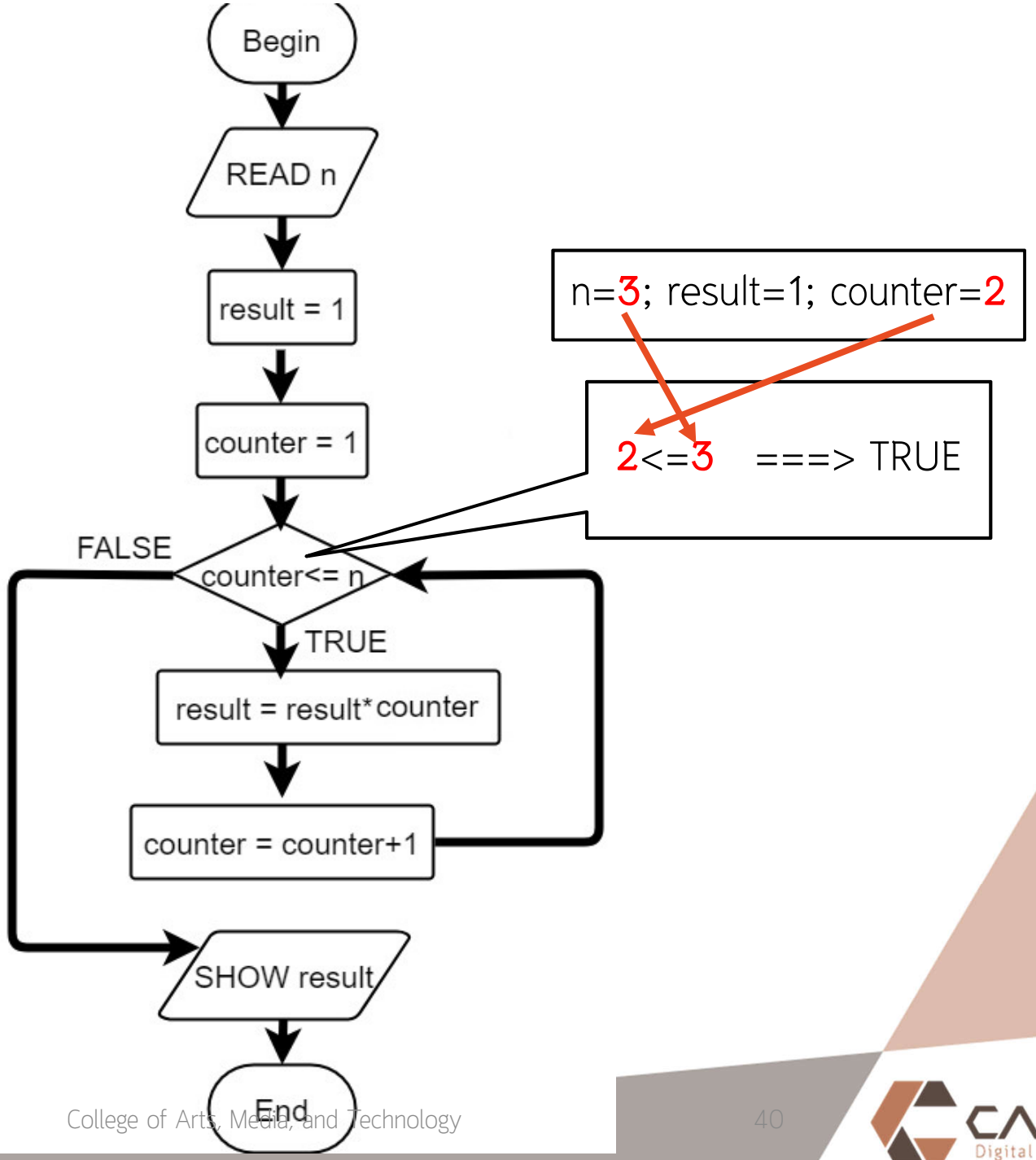
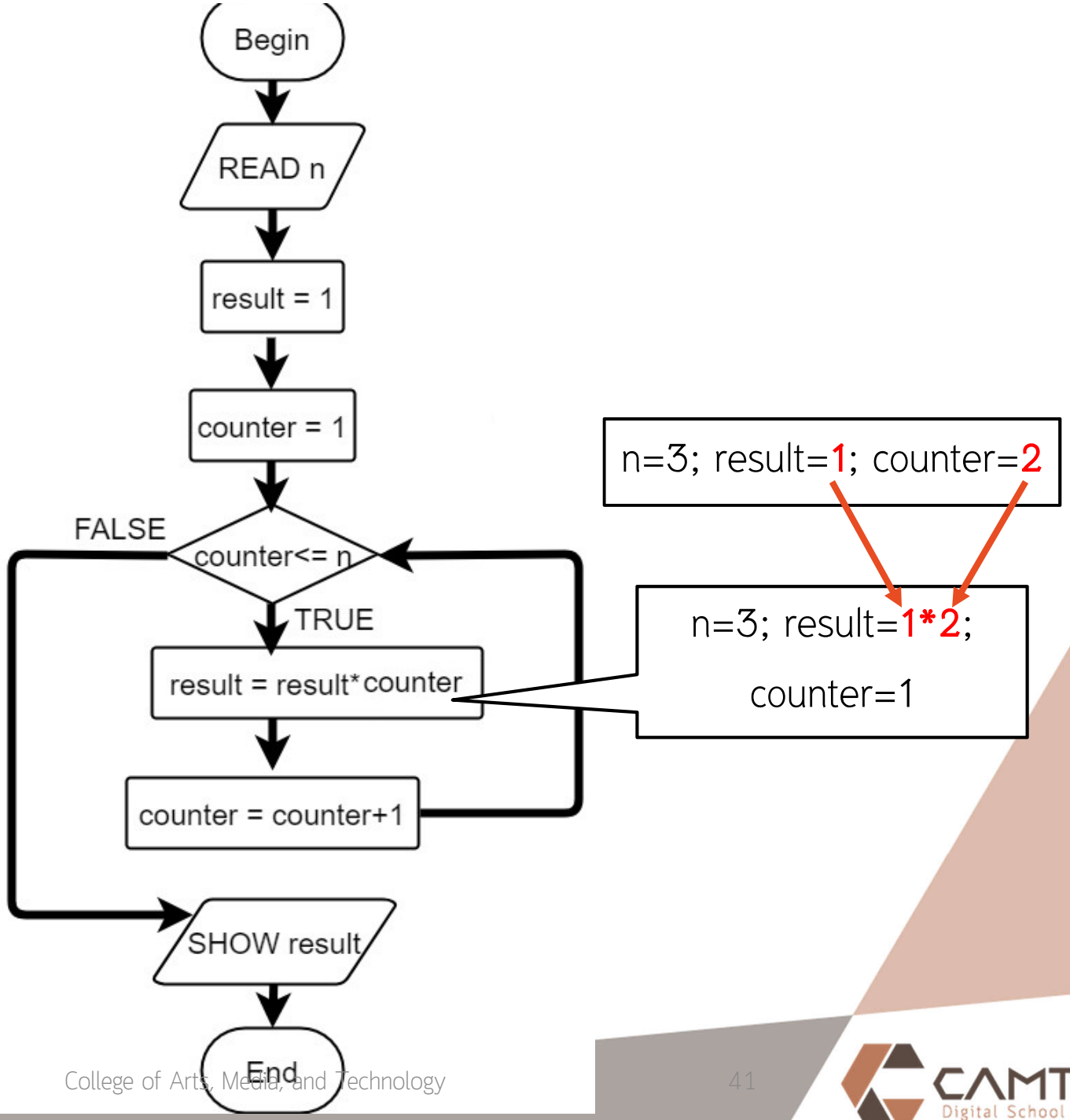
Flowchart



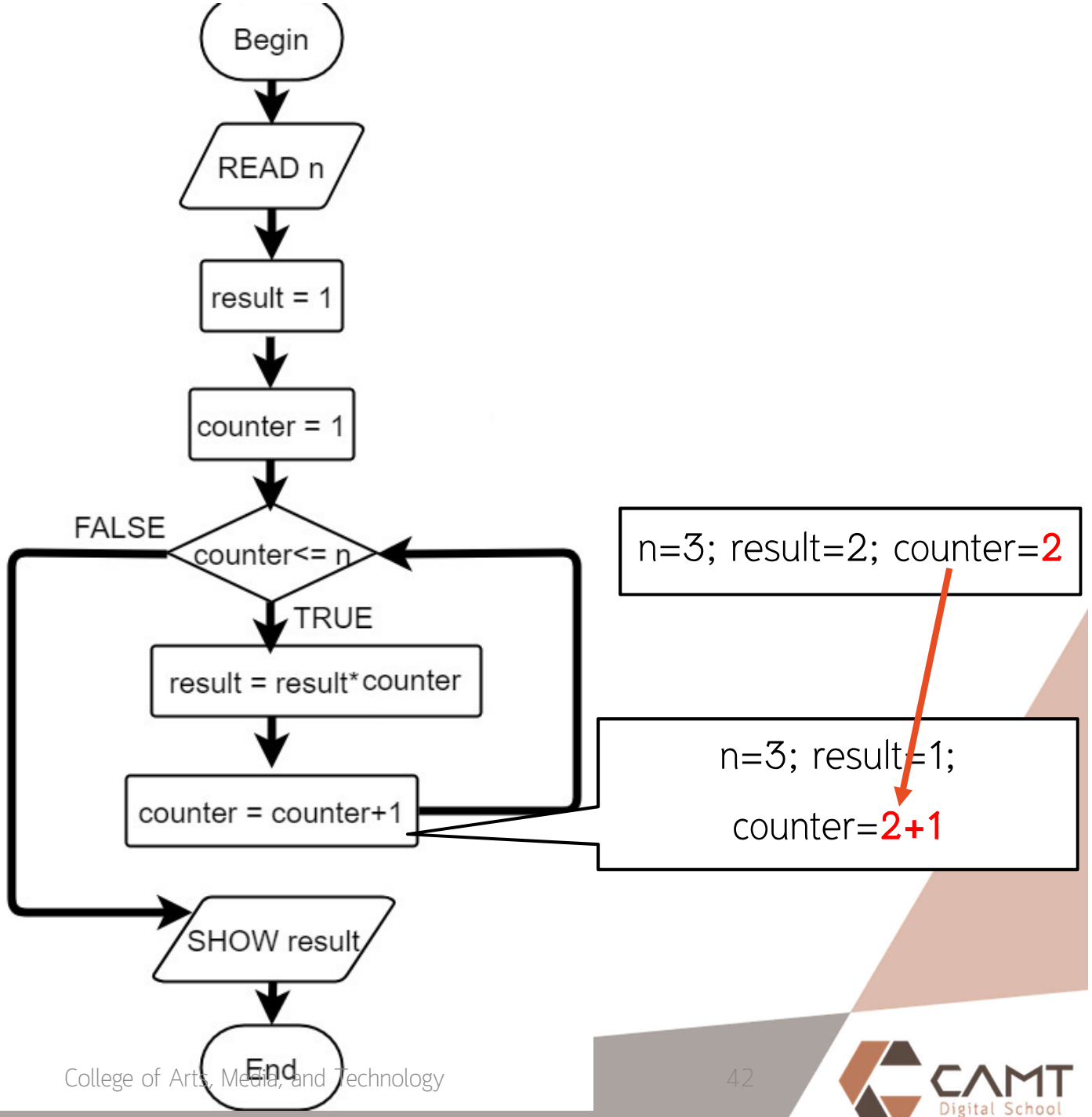
Flowchart


Begin
READ n
result = 1
counter = 1
counter<= n
FALSE
TRUE
result = result*counter
counter = counter+1
SHOW result
End
n=3; result=1; counter=2
2<=3 ===> TRUE

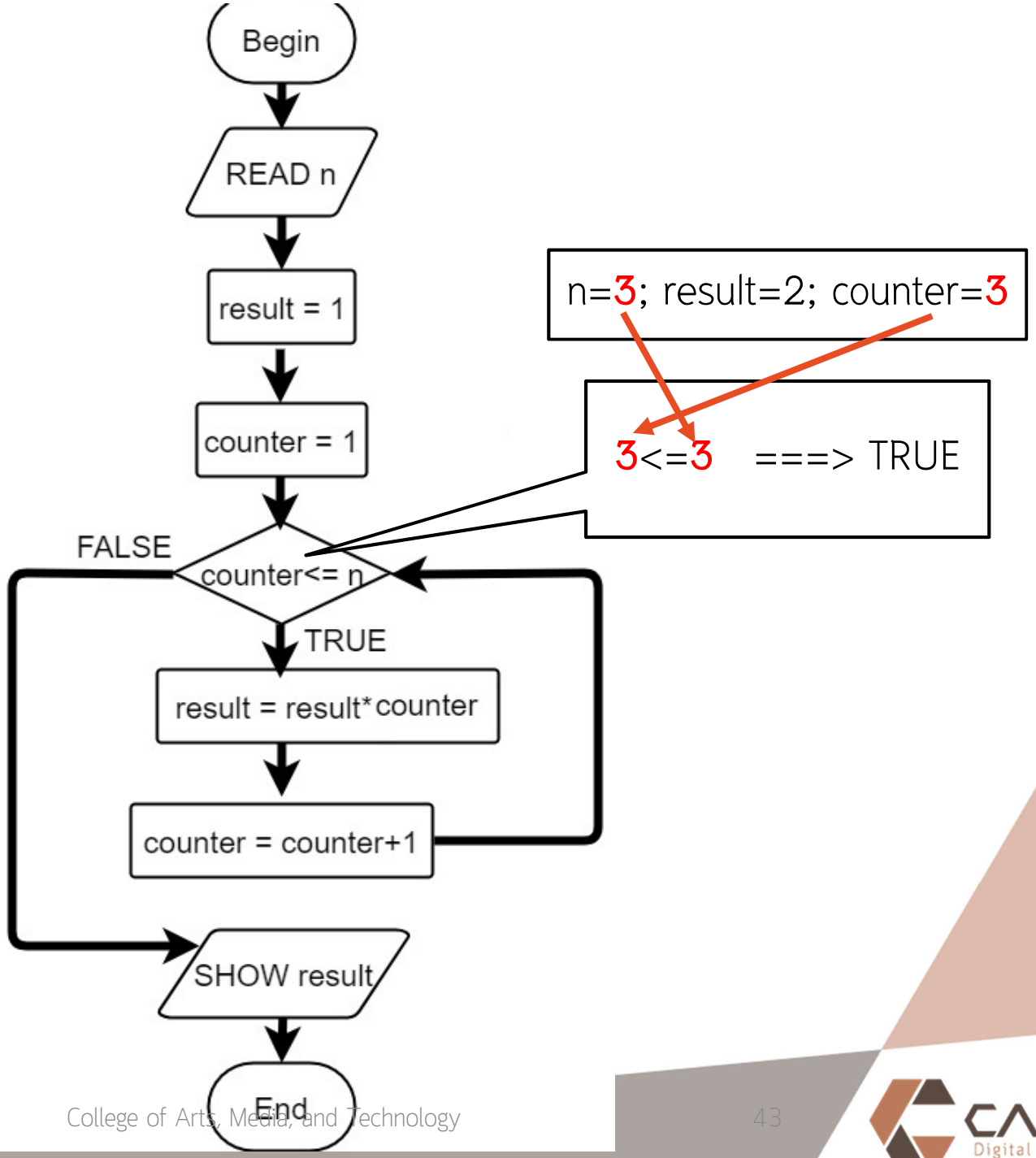
Flowchart


Begin
READ n
result = 1
counter = 1
FALSE
counter<= n
TRUE
result = result*counter
counter = counter+1
SHOW result
End
n=3; result=1; counter=2
n=3; result=1*2;
counter=1

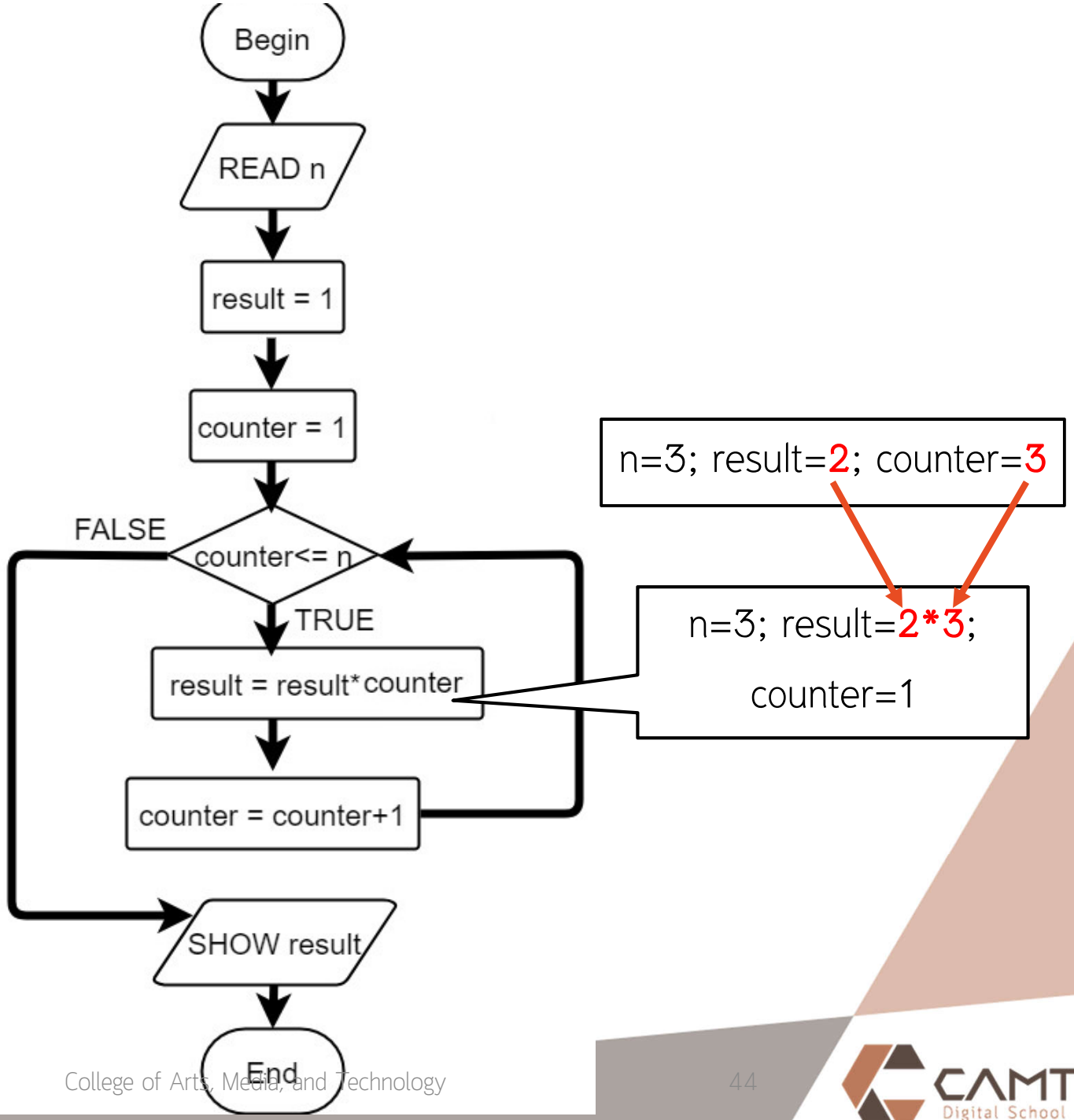
Flowchart


Begin
READ n
result = 1
counter = 1
FALSE
counter<= n
TRUE
result = result*counter
counter = counter+1
SHOW result
End
n=3; result=2; counter=2
n=3; result=1;
counter=2+1

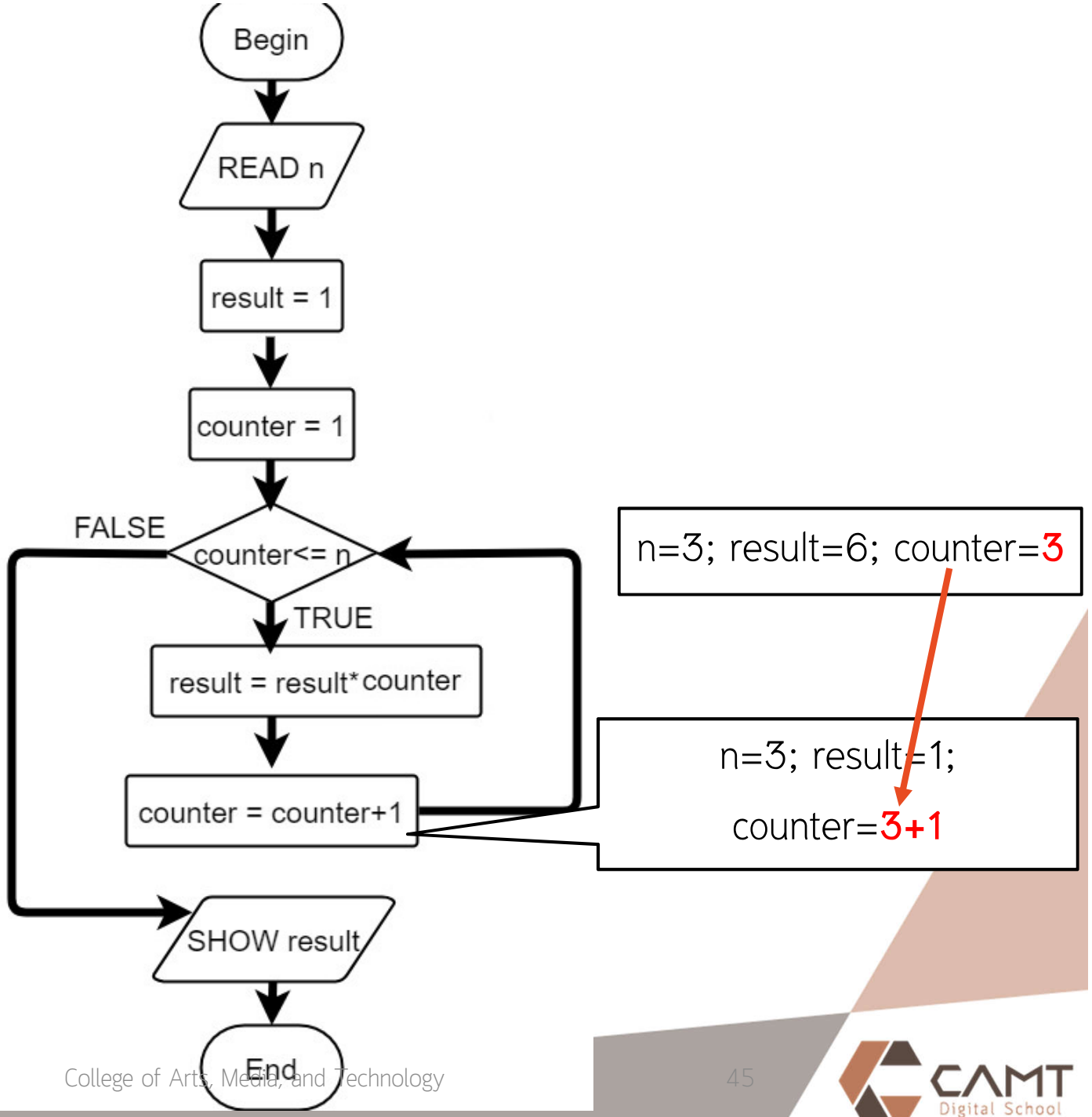
Flowchart


Begin
READ n
result = 1
counter = 1
counter<= n
FALSE
TRUE
result = result*counter
counter = counter+1
SHOW result
End
n=3; result=2; counter=3
3<=3 ===> TRUE

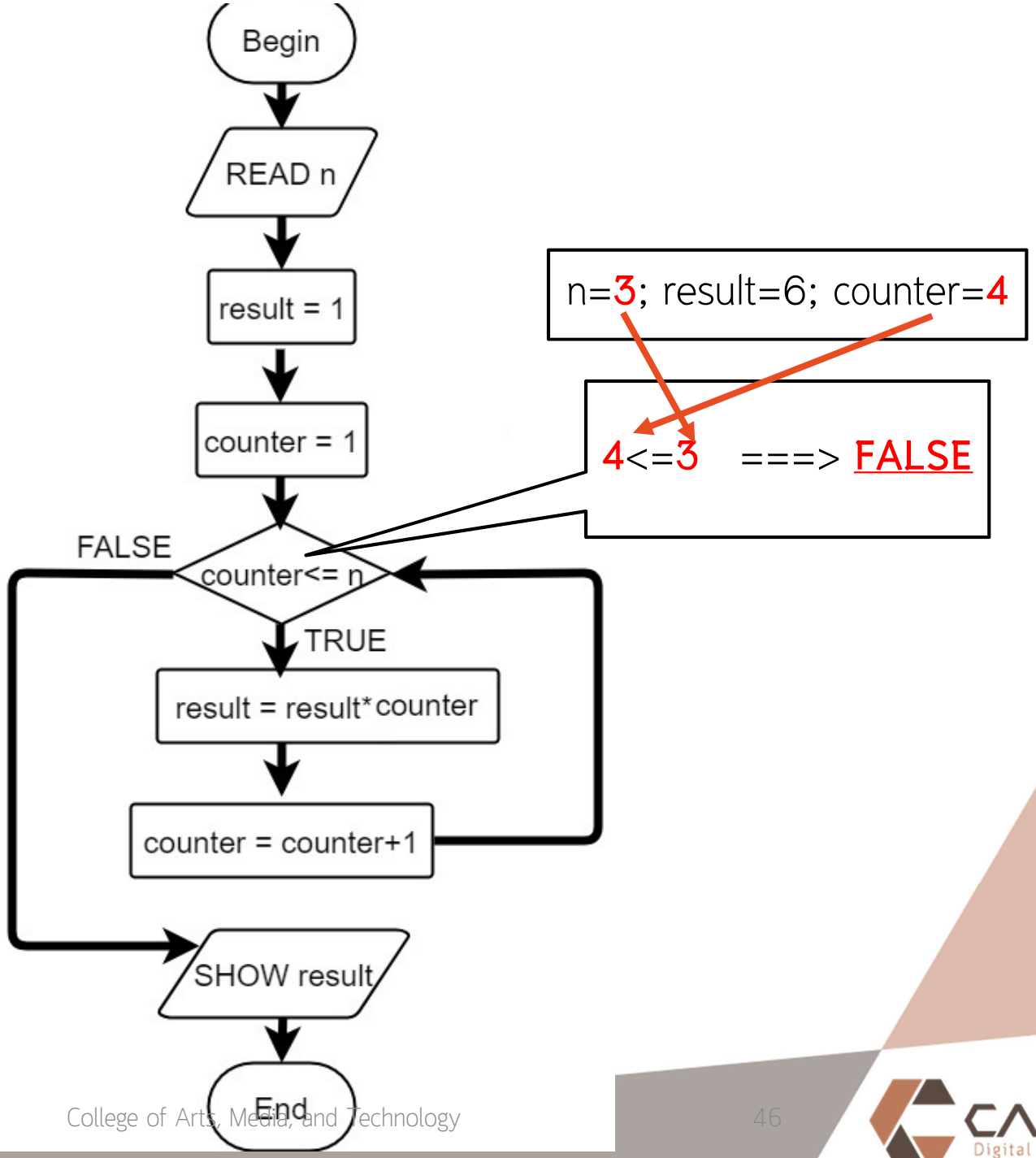
Flowchart


Begin
READ n
result = 1
counter = 1
FALSE
counter<= n
TRUE
result = result*counter
counter = counter+1
SHOW result
End
n=3; result=2; counter=3
n=3; result=2*3;
counter=1

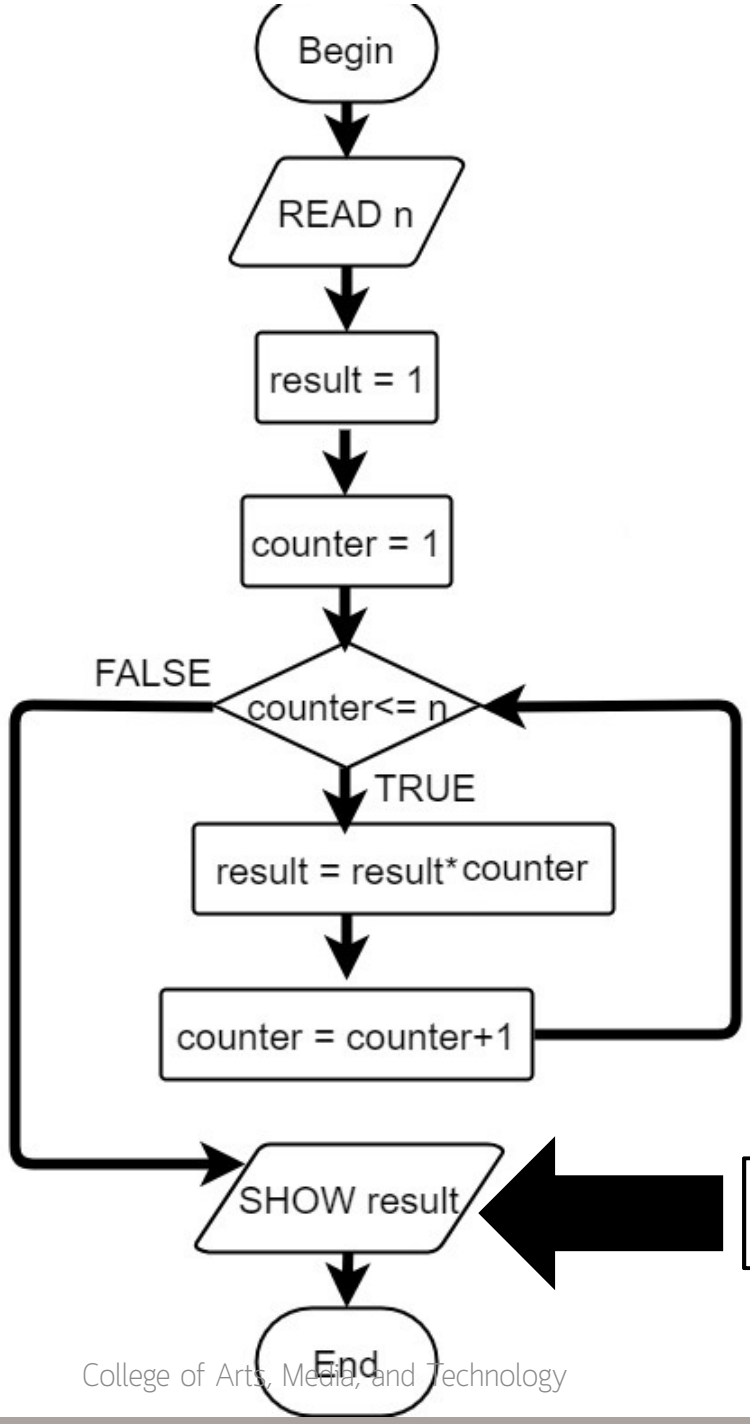
Flowchart


Begin
READ n
result = 1
counter = 1
FALSE
counter<= n
TRUE
result = result*counter
counter = counter+1
SHOW result
End
n=3; result=6; counter=3
n=3; result=1;
counter=3+1

Flowchart


Begin
READ n
result = 1
counter = 1
counter<= n
FALSE
TRUE
result = result*counter
counter = counter+1
SHOW result
End
n=3; result=6; counter=4
4<=3 ===> FALSE

Flowchart



n=3; result=6; counter=4

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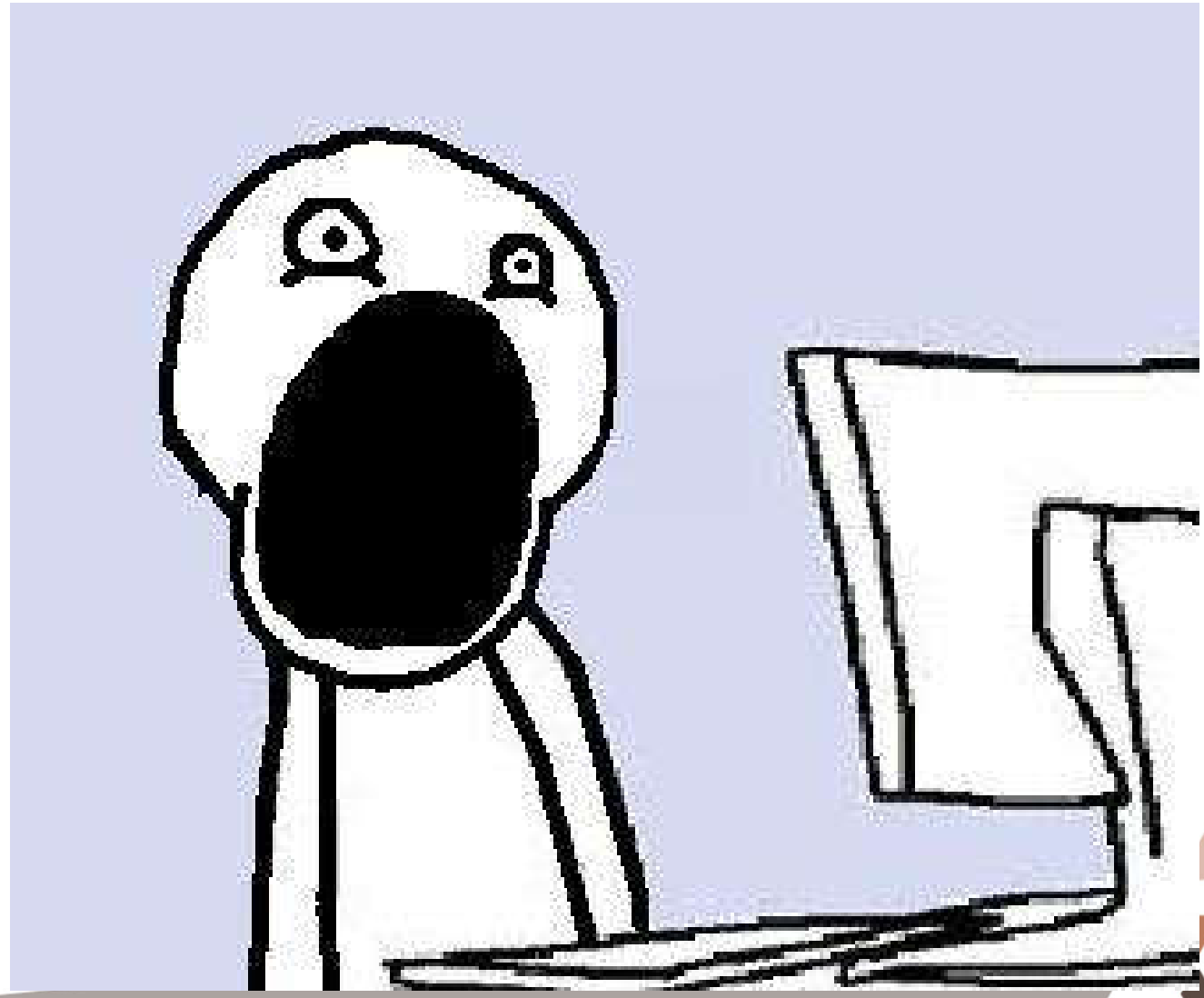
Q&A



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