INTRO TO QUANTUM COMPUTING

Lab

#1

BOOLEAN LOGIC AND ALGORITHMS

PROGRAM FOR TODAY

- TA introduction
- Announcements
- Ground rules for lab sessions
- Pre-lab student feedback
- Lab content
- Post-lab student feedback

INTRODUCTION

INSERT TA PICTURE

Insert TA info

ANNOUNCEMENTS

- **Attendance**: We will **not** take attendance in Lab this week. In future weeks, we will use Canvas to take attendance. Students have two unexcused absences each semester.
- **Homework:** A reminder that you won't submit this week's homework until **next week** when Canvas is available. Students should still do the assignment! You will have another assignment next week, and they'll both be due on Canvas on Saturday, October 31 at 11:59pm ET.
- **Discord:** Look on Discord in the #course-announcements channel for all important course information.

GROUND RULES

- We want to ensure that every student participating in this lab feels welcome and included

- We ask that you:
  - **Do not** spam the chat or Q&A with repeated questions or messages
  - **Do not** put answers to problems in the chat or Q&A, **unless your TA asks you to**
  - **Keep your questions relevant** to the topics being discussed. We have Piazza for other content-related questions, and Discord for questions on logistics
  - Only raise your hand if the TAs ask students to

GROUND RULES

- As instructors and TAs, we want to hear from diverse voices
  - **Step up, step back**

- We will not be able to address all content-questions in lecture or lab
  - Look at answers to similar questions on Piazza or Discord
  - Post your question in the relevant folder **in Piazza** (e.g. week 1)
  - We will continue to explore new content each week, and will likely answer your question in future weeks! Hold on 😊

PRE-LAB STUDENT FEEDBACK

- On a scale of 1 to 5, how would you rate your understanding of this week's content?
  - 1 –Did not understand anything
  - 2 – Understood some parts
  - 3 – Understood most of the content
  - 4 – Understood all of the content
  - 5 – The content was easy for me/I already knew all of the content
- This week – Zoom poll
- From next week – Canvas quiz; **will be used for lab attendance**

LEARNING OBJECTIVES FOR LAB 1

- Getting comfortable with binary numbers
  - Binary to decimal conversions
  - Decimal to binary conversions
  - Binary addition
- Using logic gates to design circuits
  - Review of logic gates
  - Design of 1-bit adder*
- Thinking about algorithms and their complexity*
  - Linear search algorithm*

*Optional content

BINARY NUMBERS

Decimal numbers	Binary numbers
147	10001111

BINARY TO DECIMAL CONVERSION

DECIMAL TO BINARY CONVERSION

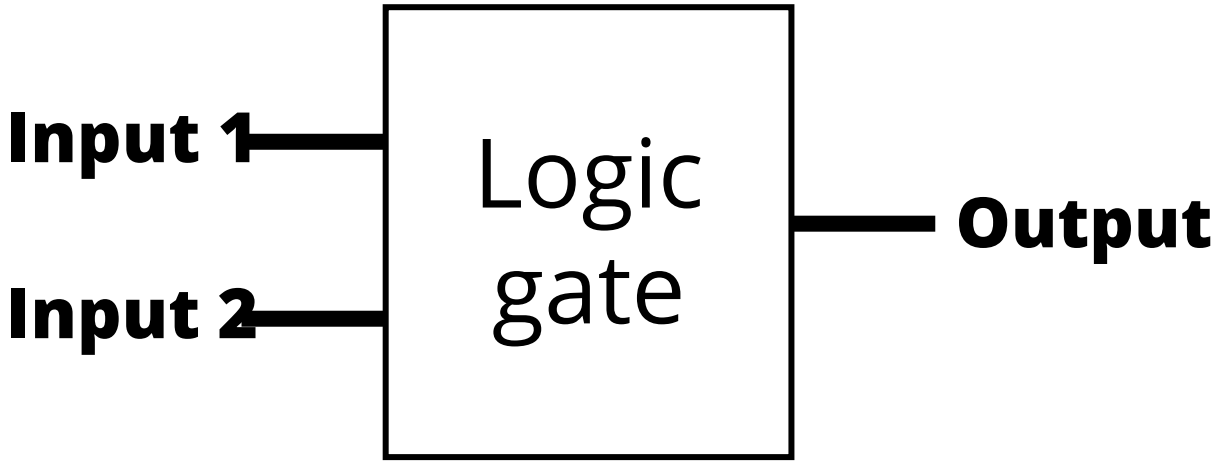
BINARY ADDITION

QUESTIONS

Questions about content so far?

LOGIC GATES

Building blocks of computers

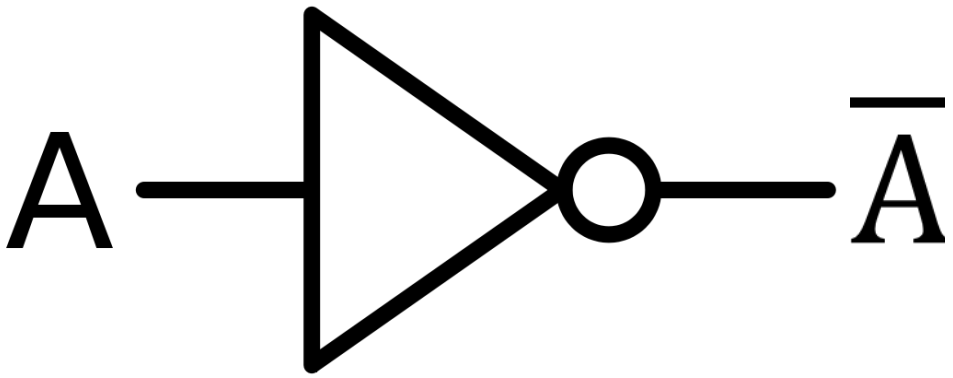


Truth table

Input 1	Input 2	Output
0	0	1
0	1	0
1	0	0
1	1	1

NOT GATE

$$\overline{A}$$



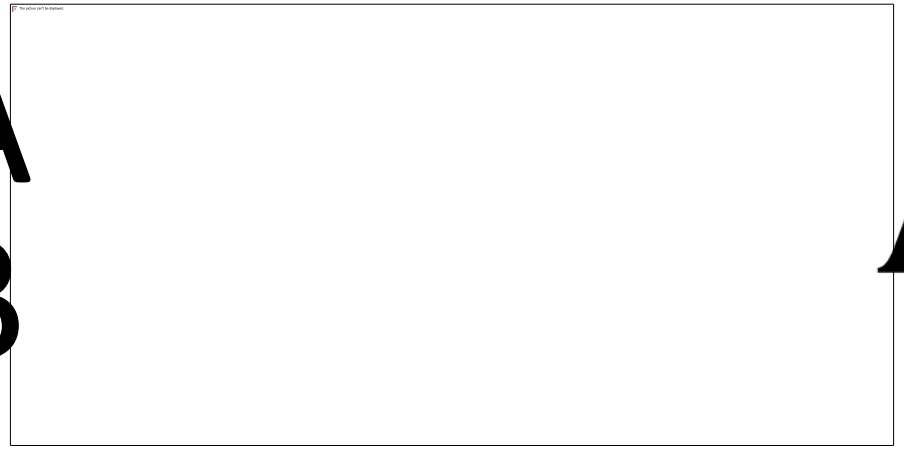
Truth table

A	
0	1
1	0

AND GATE

$$A \cdot B$$

A
B



$$A \cdot B$$

Truth table

A	B	
0	0	0
0	1	0
1	0	0
1	1	1

NAND GATE

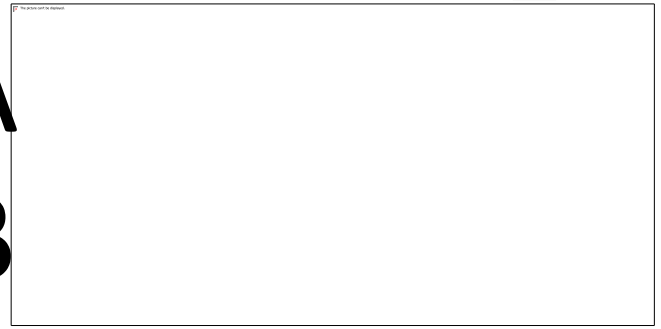
$$\overline{A \cdot}$$

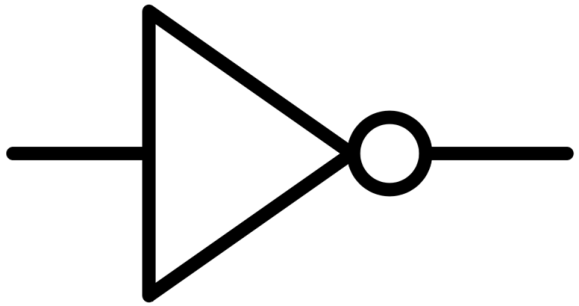
$$\overline{A \cdot B}$$

=

A

B





Truth table

A	B	
0	0	1
0	1	1
1	0	1
1	1	0

OR GATE

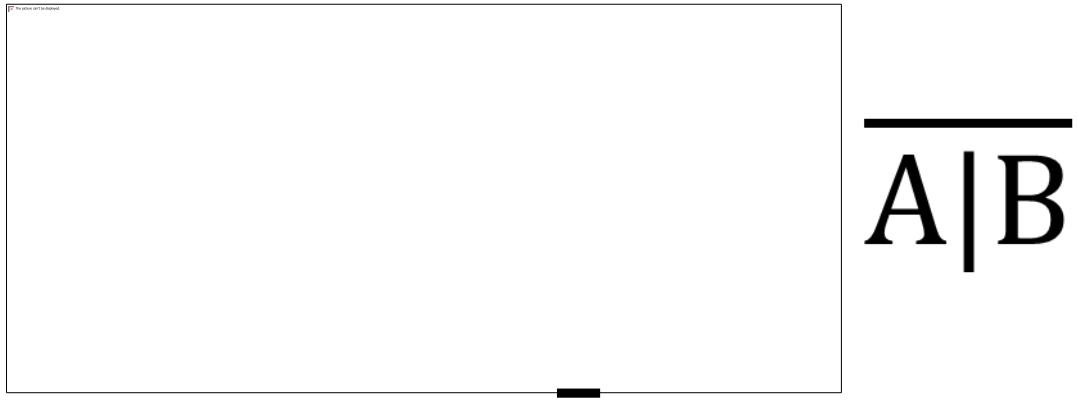
$$A|B$$

$$A|B$$

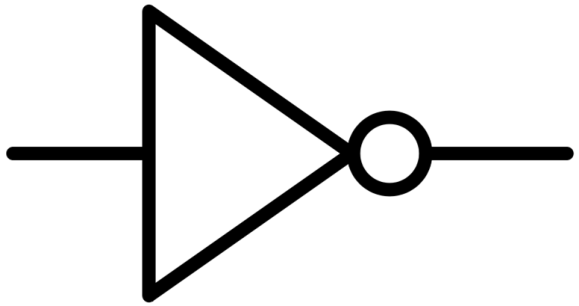
Truth table

A	B	
0	0	0
0	1	1
1	0	1
1	1	1

NOR GATE



$$\overline{A|B}$$

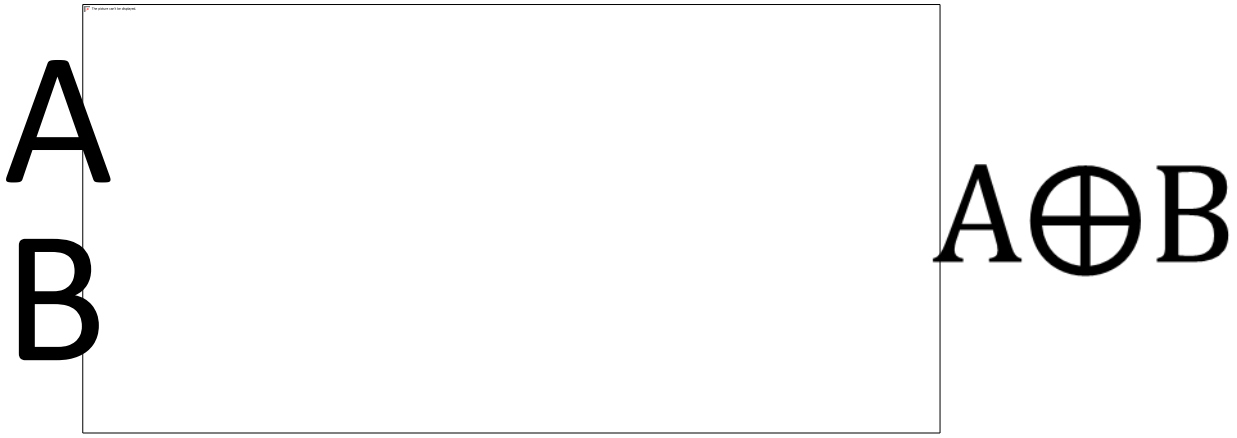


Truth table

A	B	
0	0	1
0	1	0
1	0	0
1	1	0

XOR GATE

$A \oplus B$



Truth table

A	B	
0	0	0
0	1	1
1	0	1
1	1	0

QUESTIONS

Questions about content so far?

POST-LAB STUDENT FEEDBACK

- **After this lab**, on a scale of 1 to 5, how would you rate your understanding of this week's content?
  - 1 –Did not understand anything
  - 2 – Understood some parts
  - 3 – Understood most of the content
  - 4 – Understood all of the content
  - 5 – The content was easy for me/I already knew all of the content

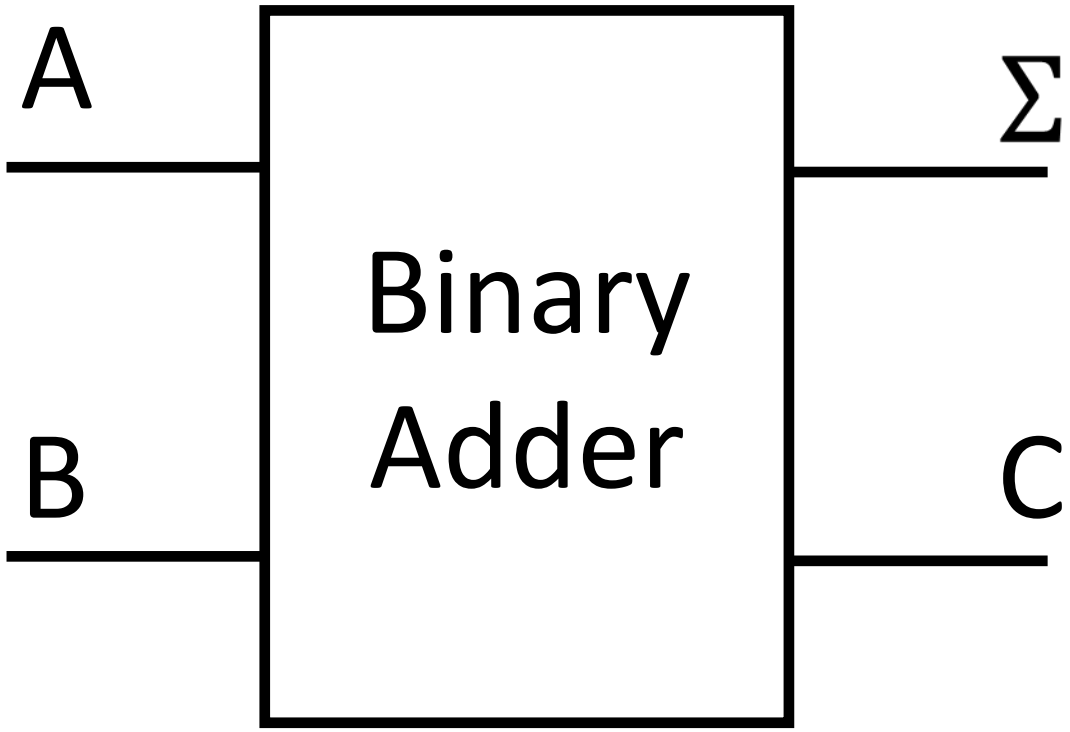
- This week – Zoom poll

- From next week – Canvas quiz

OPTIONAL CONTENT

EXPLORATORY PROBLEM

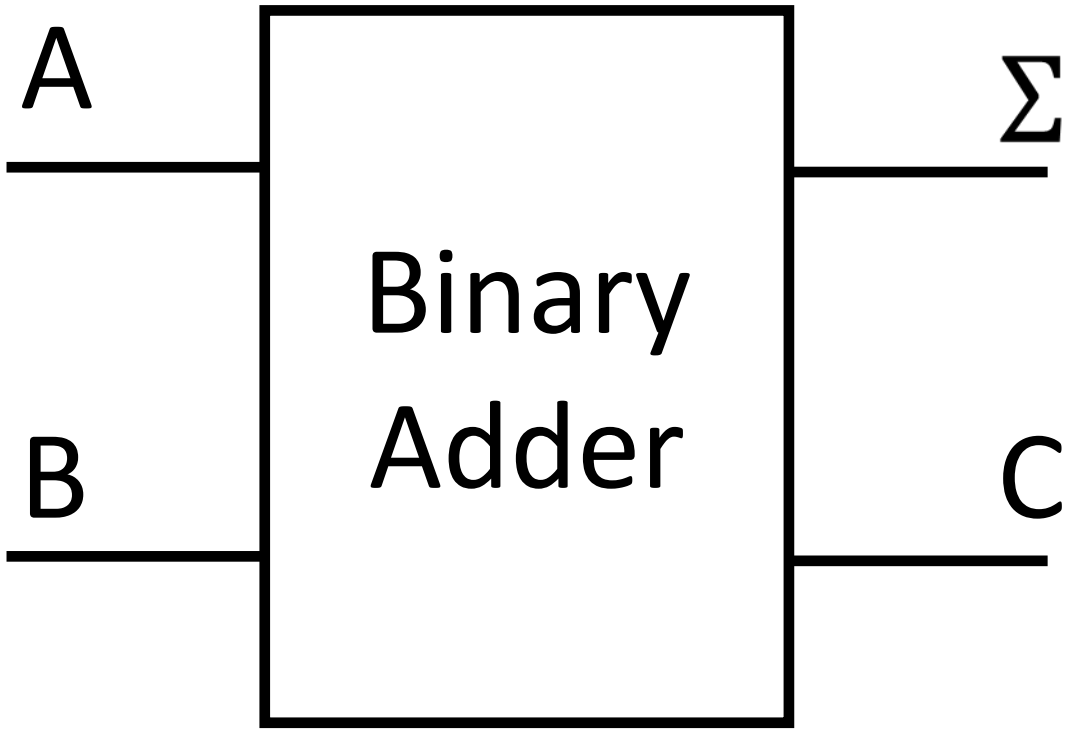
Design a logic circuit to compute the sum of two 1-bit bits. Have one bit (S) to output the 1-bit result and a carry-out bit (C) for the carry of the sum.



A	B		Carry C
0	0		
0	1		
1	0		
1	1		

EXPLORATORY PROBLEM

Design a logic circuit to compute the sum of two 1-bit bits. Have one bit (S) to output the 1-bit result and a carry-out bit (C) for the carry of the sum.



A	B		Carry C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

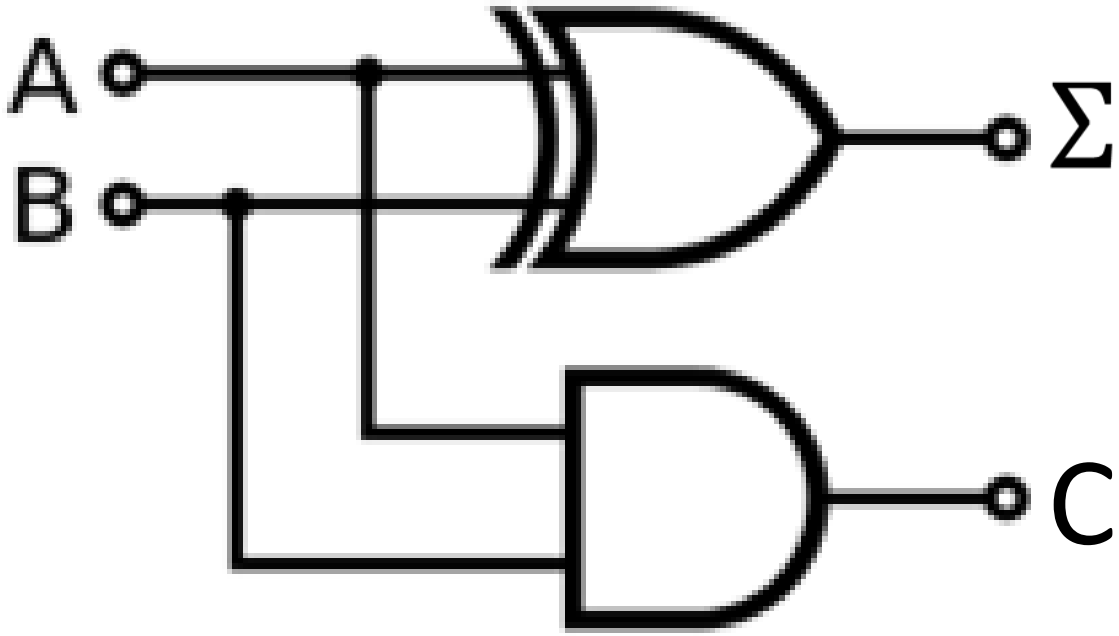
EXPLORATORY PROBLEM

Design a logic circuit to compute the sum of two 1-bit bits. Have one bit (S) to output the 1-bit result and a carry-out bit (C) for the carry of the sum.

EXPLORATORY PROBLEM

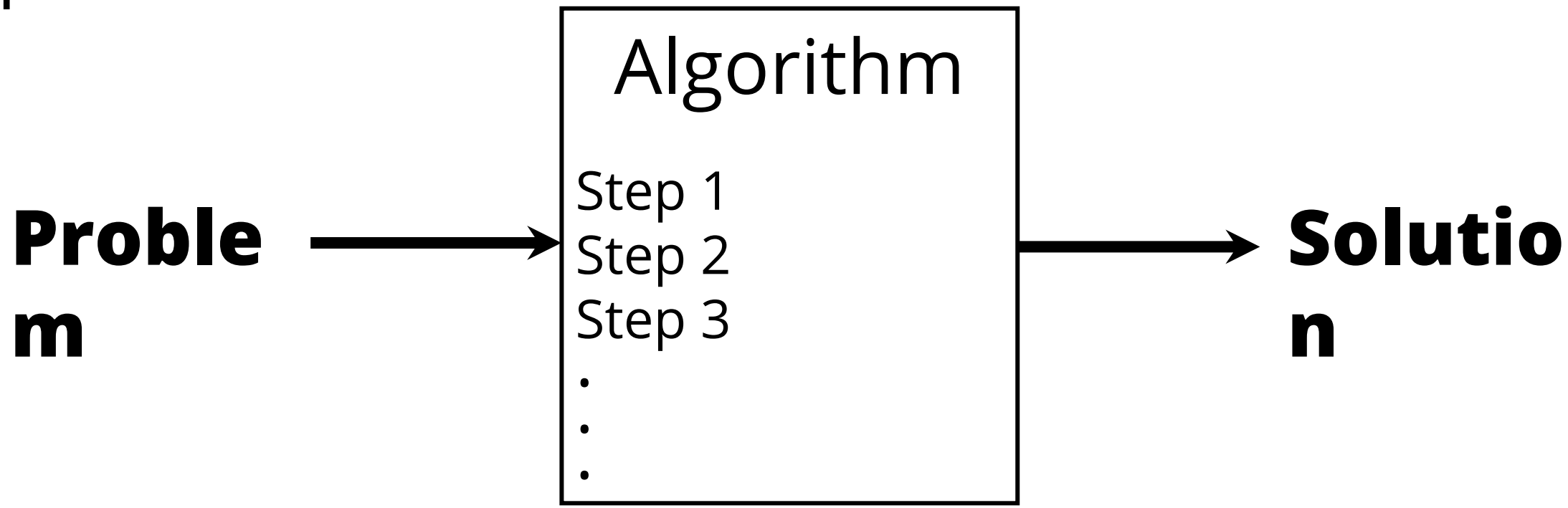
Design a logic circuit to compute the sum of two 1-bit bits. Have one bit (S) to output the 1-bit result and a carry-out bit (C) for the carry of the sum.

Solution:



ALGORITHMS

An algorithm is a set of steps to solve a problem



ALGORITHMS AND BIG-O NOTATION

Problem: Find the student whose age is 19 years from the following list:

Student name	Age
Sarah	17
Rahul	16
Elina	20
Aziza	23
Aman	18
Phil	14
Corbin	15
⋮	
Brian	19
Fran	20
⋮	

ALGORITHMS AND BIG-O NOTATION

Problem: Find the student whose age is 19 years from the following list:

Linear search algorithm:

- Check age of each student sequentially (one after the other) until the student whose age is 19 years is found.
- If list has N students, will perform ~N comparisons
- The complexity of this algorithm is O(N)

ANNOUCEMENTS LINK

Link