

# Basic Logical Operations (Fascinating)



In this section you will learn some basic logical operations and how to evaluate expressions

Image from Star Trek © Paramount

James Tam

## Logic

- Refers to statements that are true or false:

$$2 + 3 = 5$$

$$2 + 3 = 4$$

The number 5

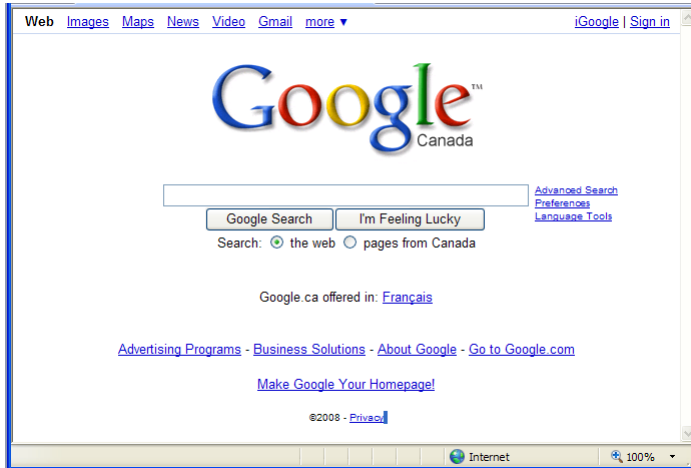
lol!

- Logic operations pertinent to this course
  - AND
  - OR
  - NOT

James Tam

## Logic Applied In Software

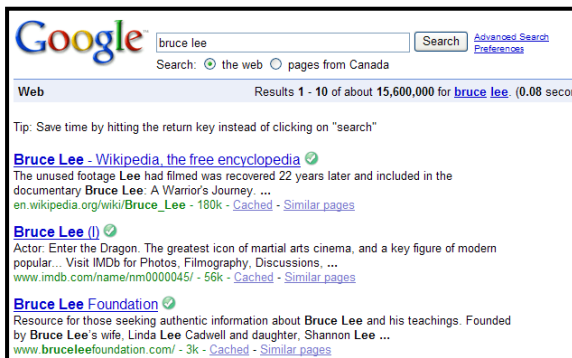
- The use of logic is common in some computer programs



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## Logical AND

- Search for all documents that contain the name 'Bruce' AND the name 'Lee'



Pages must have both words to show up as a search result

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## Logical AND

Truth table		
X	Y	X AND Y
False	False	False
False	True	False
True	False	False
True	True	True

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## Three Input AND

Truth table			
X	Y	Z	X AND Y AND Z
False	False	False	False
False	False	True	False
False	True	False	False
False	True	True	False
True	False	False	False
True	False	True	False
True	True	False	False
<b>True</b>	<b>True</b>	<b>True</b>	<b>True</b>

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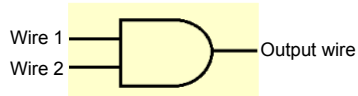
## Evaluating Logical AND Expressions

- True AND True AND True
- False AND True AND True
- True AND True AND True AND True
- True AND True AND True AND False
- False AND True AND False AND True AND True AND False AND False AND True AND True

James Tam

## Hardware Representation Of AND (“AND Gate”)

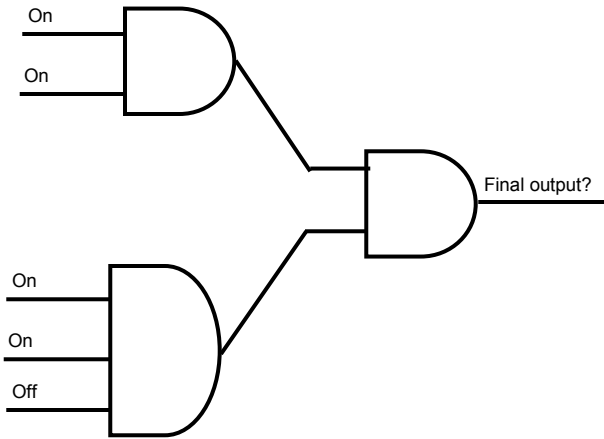
AND gate



Wire 1	Wire 2	Output
Off	Off	Off
Off	On	Off
On	Off	Off
On	On	On

James Tam

## Tracing Hardware Circuits: AND



James Tam

## Logical OR

- Search for all documents that contain the name 'Bruce' OR the name 'Lee'

The screenshot shows a Google search results page for the query "bruce OR lee". The search bar contains the text "bruce OR lee" and the search button is labeled "Search". The results show 10 results out of about 653,000,000 for "bruce OR lee" in 0.25 seconds. The results include several links, such as "Bruce Hardwood Flooring by Armstrong - Warmth, Beauty and...", "Lee Jeans Apparel for Men and Women", and "Bruce Springsteen News: bruce.springsteen.net". There are also video results for "Bruce Springsteen - Streets Of Philadelphia" and "Bruce Springsteen - Dancing In The Dark".

Pages can have either word and show up as a search result

James Tam

## Logical OR

Truth table		
X	Y	X OR Y
False	False	False
False	True	True
True	False	True
True	True	True

James Tam

## Three Input OR

Truth table			
X	Y	Z	X OR Y OR Z
<b>False</b>	<b>False</b>	<b>False</b>	<b>False</b>
False	False	True	True
False	True	False	True
False	True	True	True
True	False	False	True
True	False	True	True
True	True	False	True
True	True	True	True

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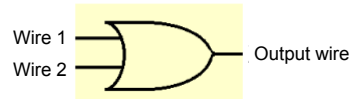
## Evaluating Logical OR Expressions

- True OR True OR True
- False OR True OR True
- False OR False OR False OR True
- False OR False OR False OR False
- False OR True OR False OR True or True OR False OR False OR True OR True

James Tam

## Hardware Representation Of OR (“OR Gate”)

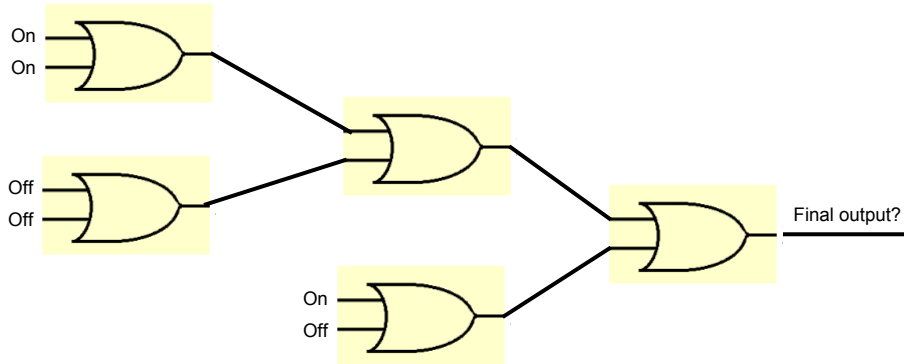
OR gate



Wire 1	Wire 2	Output
Off	Off	Off
Off	On	On
On	Off	On
On	On	On

James Tam

## Tracing Hardware Circuits: OR



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## Logical NOT

- Search for all documents that contain the name 'James Tam' NOT including those from the University of Calgary ("ucalgary")

The screenshot shows a Google search results page for the query "james tam" -ucalgary. The search bar contains the query and the search button. Below the search bar, there are several search results, including "The Scripps Research Institute - Faculty", "James Tam Nguyen | Facebook", "DBLP: Wa James Tam", "DBLP: James Tam", and "James Tam - LinkedIn". Each result includes a brief description and a link to the source.

James Tam



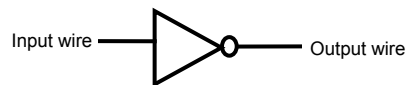
## Logical NOT

Truth table	
X	Not X
False	True
True	False

James Tam

## Hardware Representation Of NOT (“NOT Gate”)

NOT gate



Input wire	Output wire
Off	On
On	Off

James Tam

## **Evaluating More Complex Expressions**

- Expressions inside brackets get evaluated first
  - True AND (False OR True)
- Evaluate NOT before AND, OR
  - NOT True OR False
- Otherwise evaluate logical expressions left to right.
  - True OR False AND False OR True

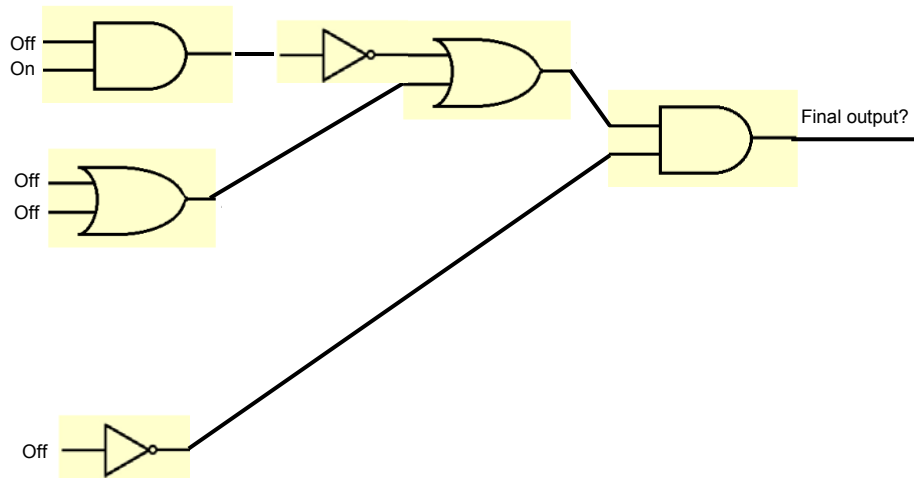
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## **Evaluating More Complex Expressions**

- True OR True AND True
- NOT (False OR True) OR True
- (False AND False) OR (False AND True)
- False OR (False OR True) AND False
- NOT NOT NOT NOT True
- NOT NOT NOT NOT False
- NOT NOT NOT False

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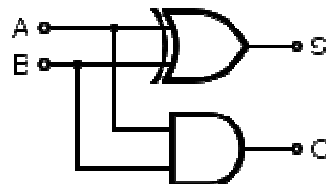
## Tracing A More Complex Combined Circuit



James Tam

## Reasons For Learning About Logic

- Software perspective:
  - Logic is used in database (e.g., web) searches
- Hardware perspective
  - The computer is built using logic circuits



James Tam

## **You Should Now Know**

- The different types of logical operations that a computer may perform:
  - AND
  - OR
  - NOT
- The role of logic when using software
- How logic gates form an important part in the hardware of computers
- How to trace the output or outcome of logical expressions and logic circuits