



COMP110: Principles of Computing
4: Logic and memory



Worksheet 4

Due **next Friday!**

Scholarly literature



Scholarly work

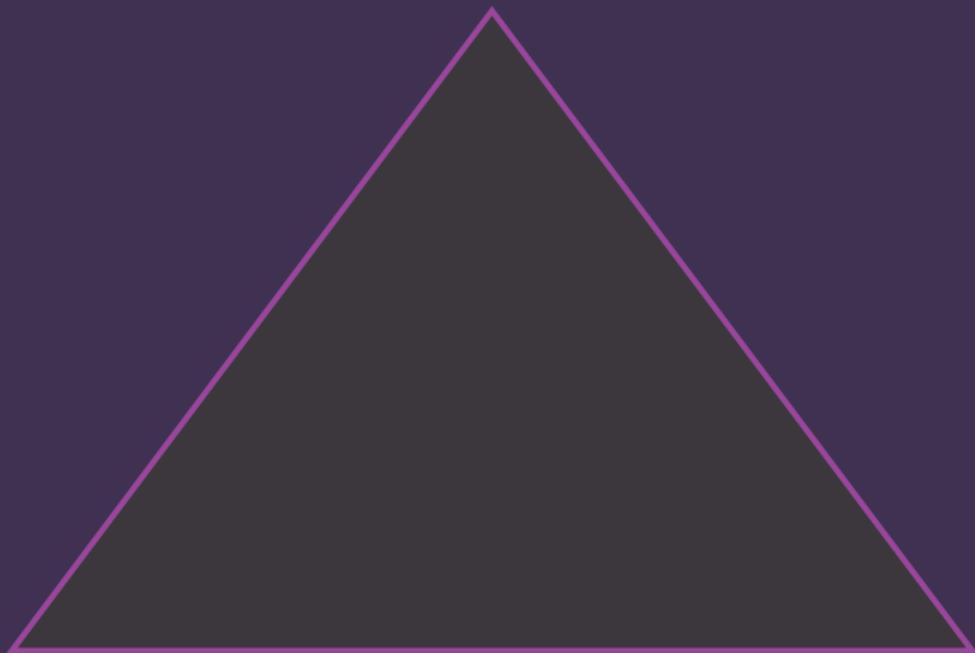
Scholarly work

- ▶ What is a “scholarly” work?

Scholarly work

- ▶ What is a “scholarly” work?
- ▶ How do we know if something is scholarly?

Pyramid of sources



Pyramid of sources

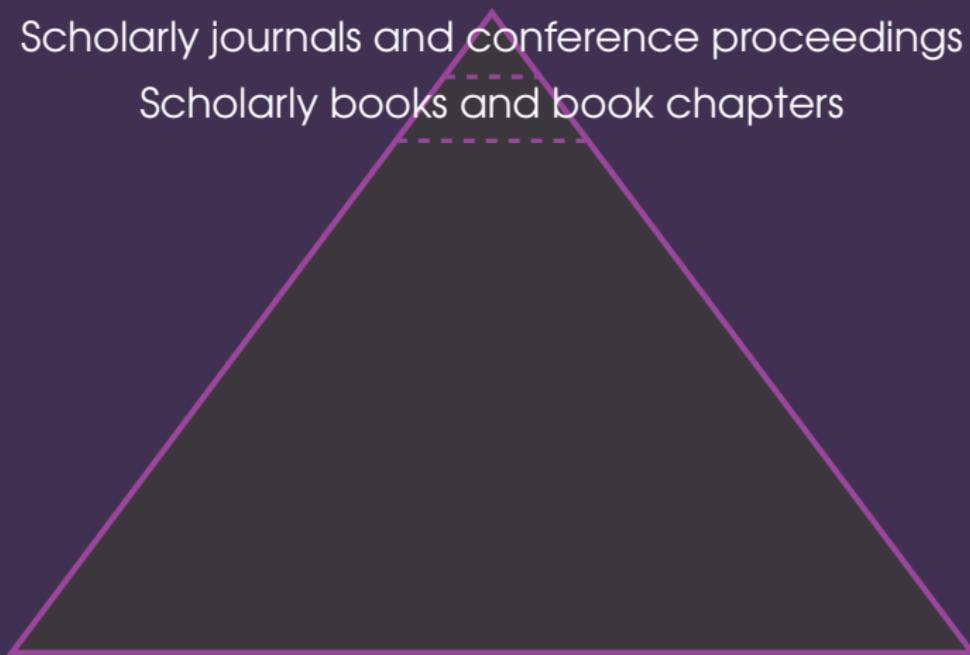
Scholarly journals and conference proceedings



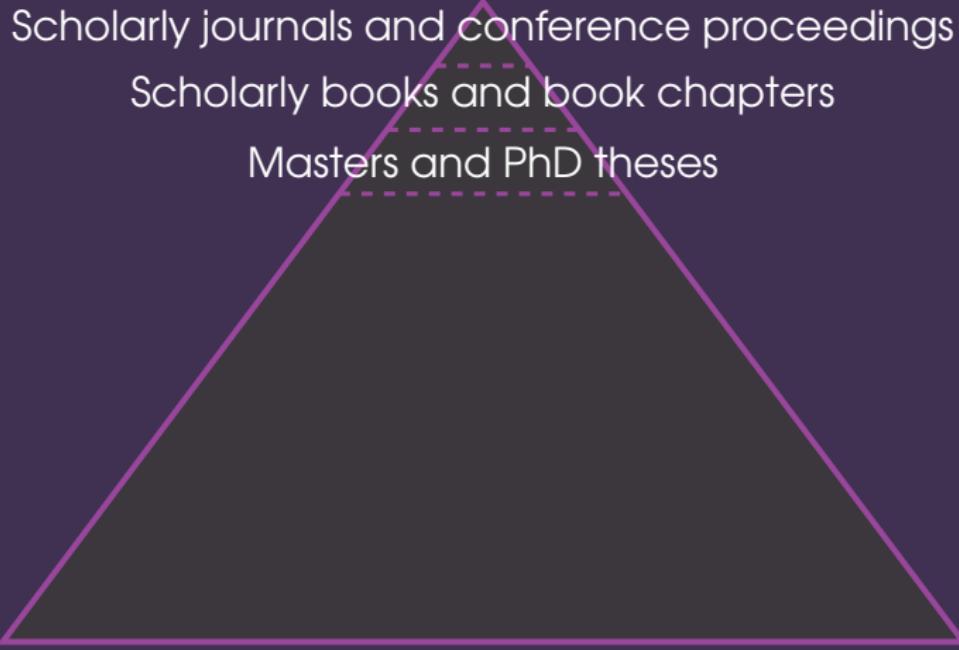
Pyramid of sources

Scholarly journals and conference proceedings

Scholarly books and book chapters



Pyramid of sources



A large, dark grey triangle is centered on the slide. Inside the triangle, there are three horizontal dashed lines of increasing height from bottom to top, creating three distinct levels. The top level contains the text "Scholarly journals and conference proceedings". The middle level contains "Scholarly books and book chapters". The bottom level contains "Masters and PhD theses".

Scholarly journals and conference proceedings

Scholarly books and book chapters

Masters and PhD theses

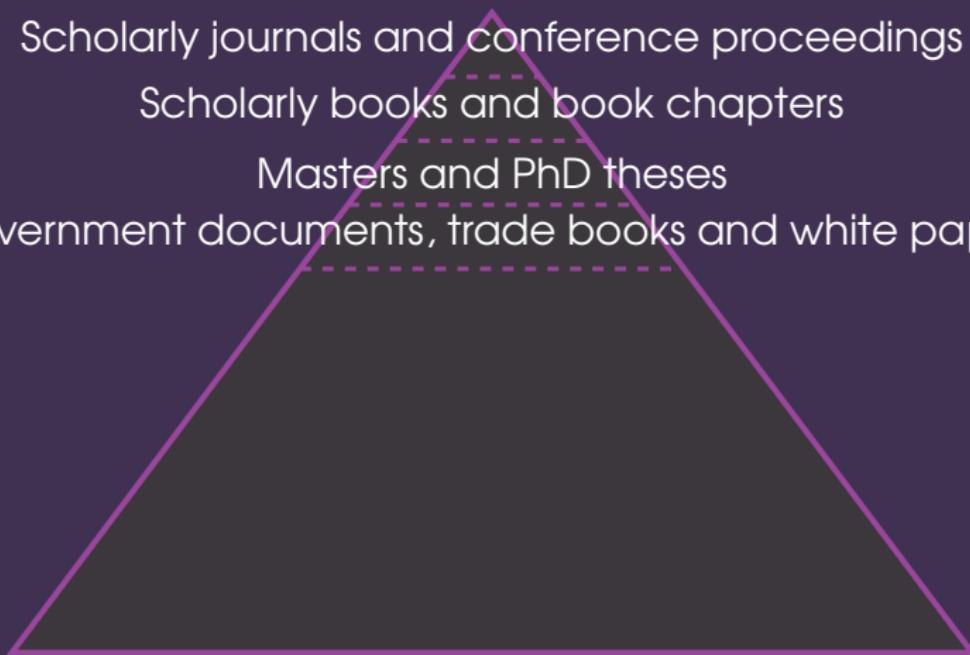
Pyramid of sources

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Government documents, trade books and white papers



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Specialised magazines

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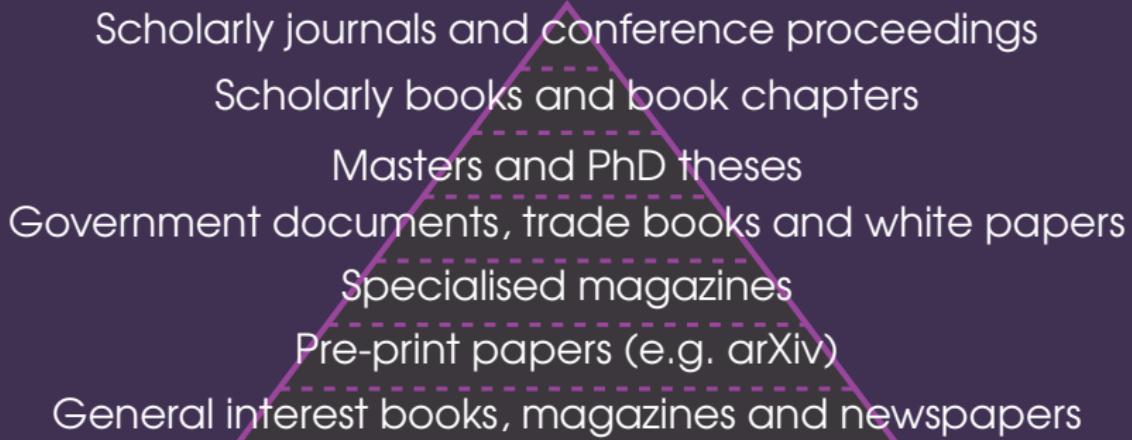
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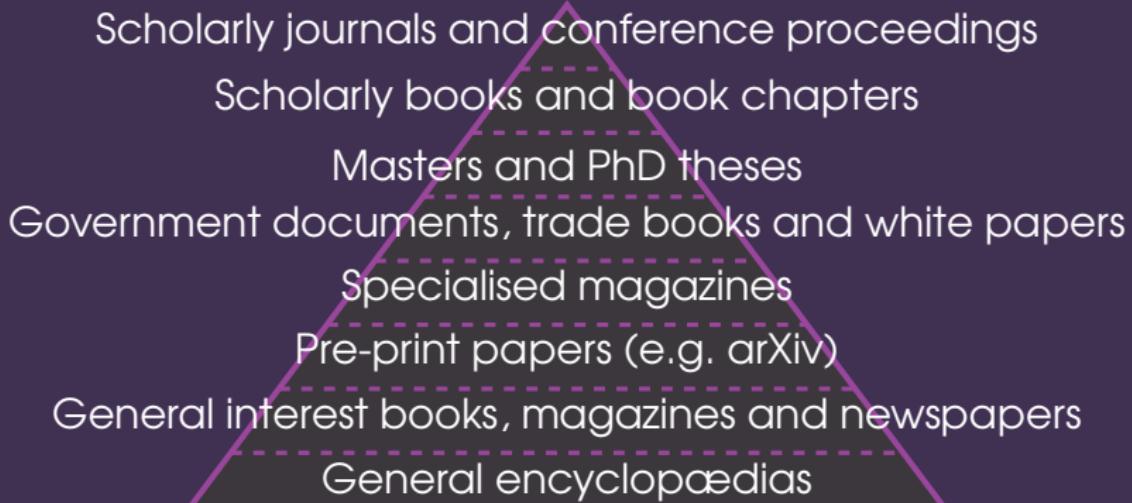
Specialised magazines

Pre-print papers (e.g. arXiv)

Pyramid of sources



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Appropriateness of sources

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- ▶ **Venue:** Is the publisher reputable and free of undue editorial influences?

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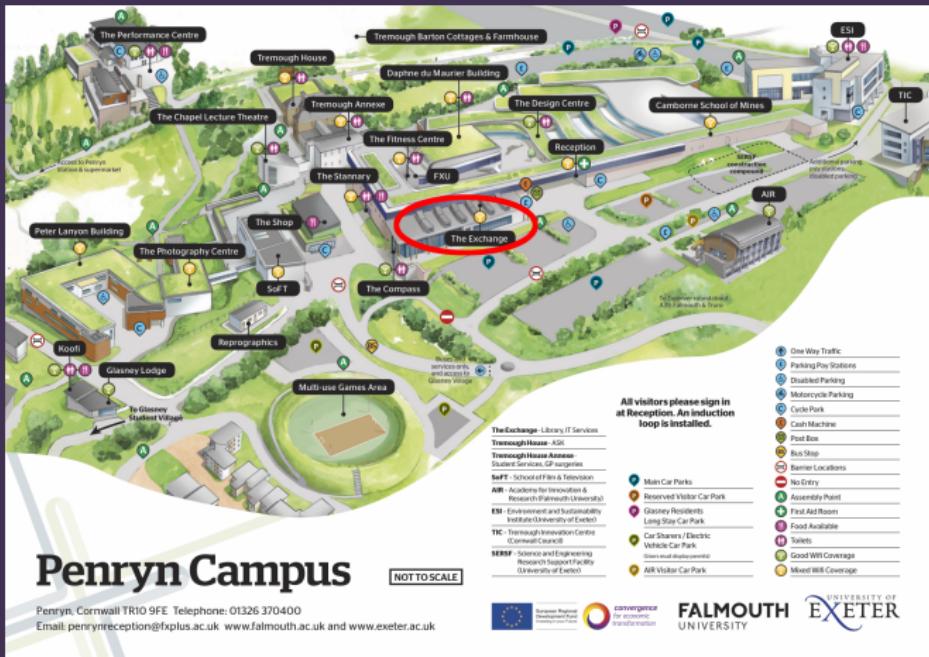
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The **way** in which sources are **used** is therefore important

Library resources



The library



Library catalogue

<http://library.fxplus.ac.uk/>

Web proxy

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ACM Digital Library

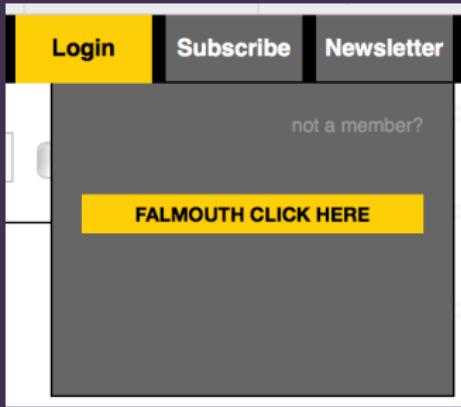
<http://dl.acm.org.ezproxy.falmouth.ac.uk/>

IEEE Xplore

<http://ieeexplore.ieee.org.ezproxy.falmouth.ac.uk/>

GDC Vault

<http://www.gdcvault.com.ezproxy.falmouth.ac.uk/>



There are only a limited number of login slots available —
remember to log out when you have finished!

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- ▶ Sites like **sci-hub** have sprung up, providing illegal downloads of papers

Referencing



IEEE referencing style

[https://ieeearchercenter.ieee.org/wp-content/
uploads/IEEE-Reference-Guide.pdf](https://ieeearchercenter.ieee.org/wp-content/uploads/IEEE-Reference-Guide.pdf)

BibTeX entry types

https://en.wikibooks.org/wiki/LaTeX/Bibliography_Management#BibTeX

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Logic gates



Boolean logic

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- Works with two values: TRUE and FALSE

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- ▶ Foundation of the **digital computer**: represented in circuits as **on** and **off**

Boolean logic

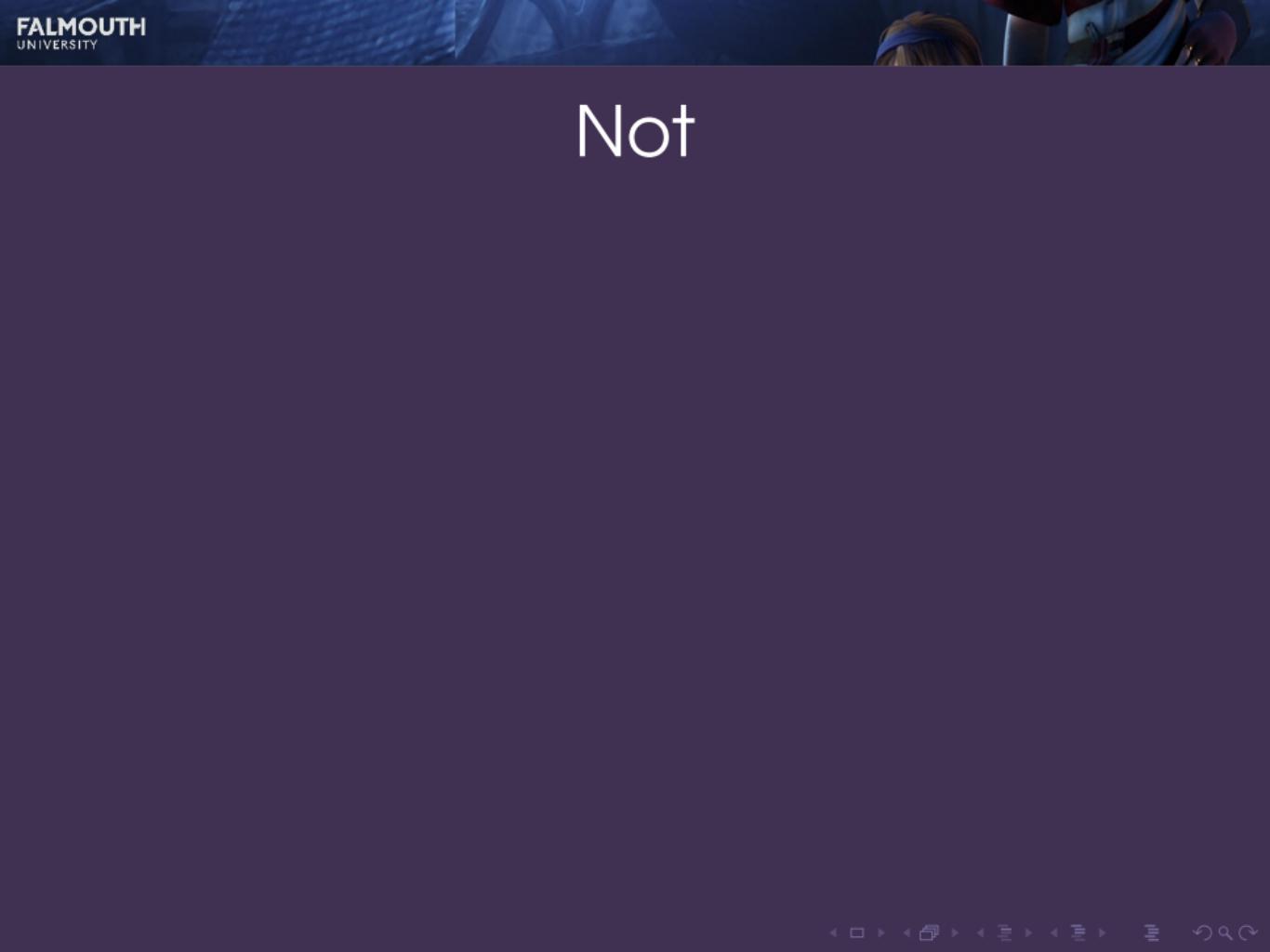
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- ▶ One boolean value = one **bit** of information
- ▶ Programmers use boolean logic for conditions in **if** and **while** statements



Not

Not

NOT A is TRUE
if and only if
 A is FALSE

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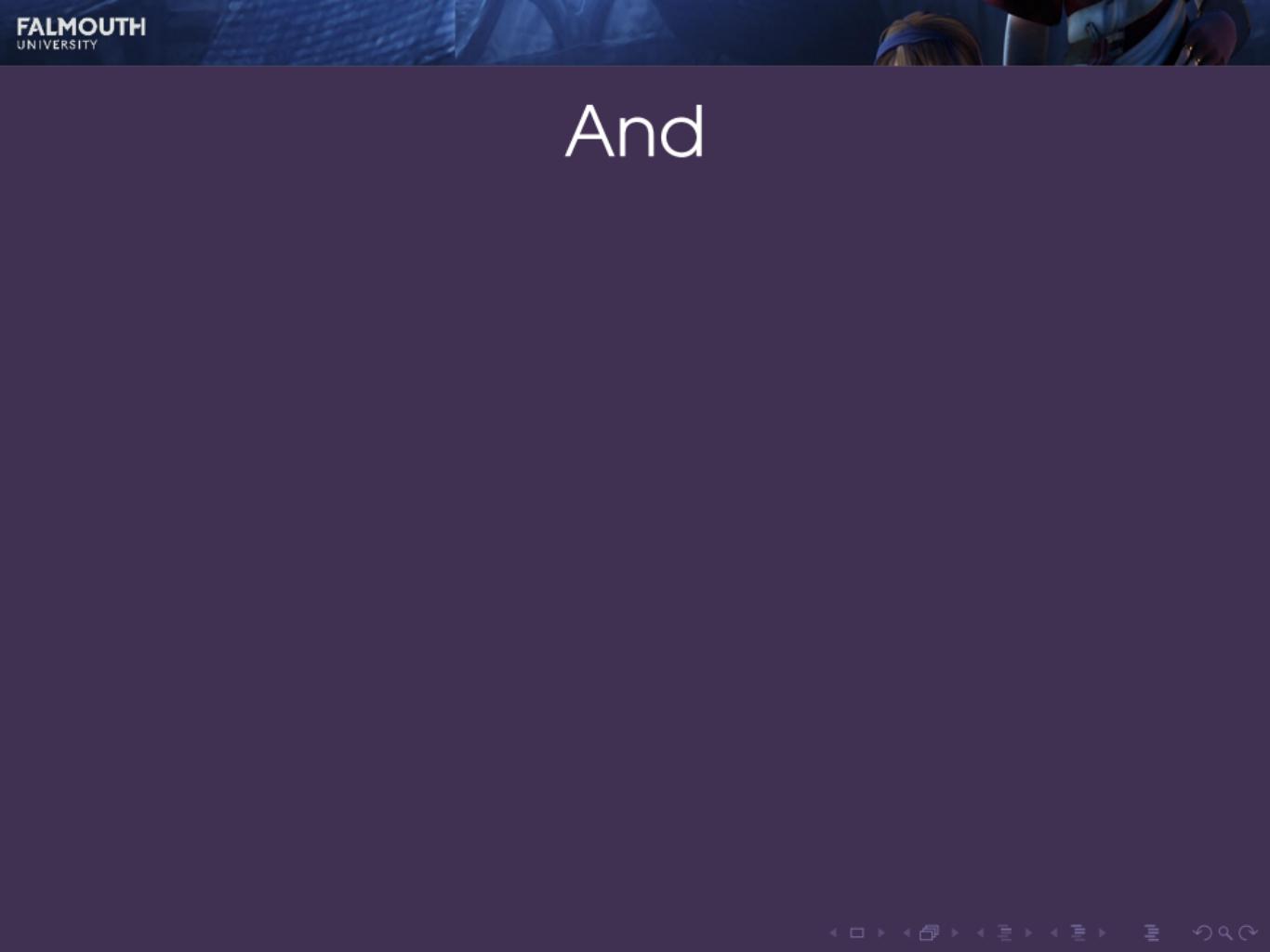
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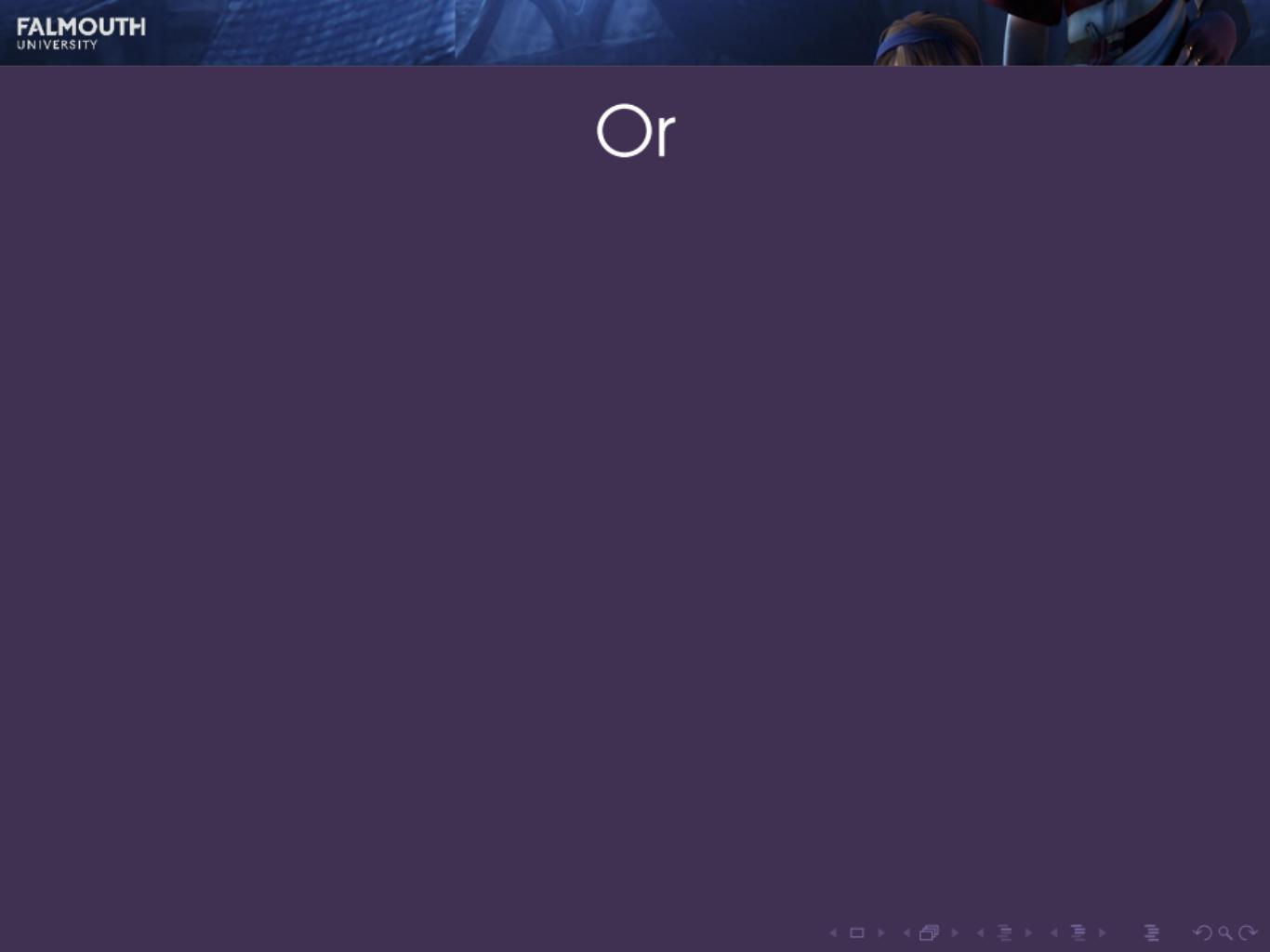
A	B	A AND B
FALSE	FALSE	FALSE
FALSE	TRUE	FALSE
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And

$A \text{ AND } B$ is TRUE
if and only if
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A	B	$A \text{ AND } B$
FALSE	FALSE	FALSE
FALSE	TRUE	FALSE
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Socrative FALCOMPED

What is the value of

$A \text{ AND } (B \text{ OR } C)$

when

$A = \text{TRUE}$

$B = \text{FALSE}$

$C = \text{TRUE}$

?

Socrative FALCOMPED

What is the value of

$$(\text{NOT } A) \text{ AND } (B \text{ OR } C)$$

when

$$A = \text{TRUE}$$

$$B = \text{FALSE}$$

$$C = \text{TRUE}$$

?

Socrative FALCOMPED

For what values of A, B, C, D is

$A \text{ AND NOT } B \text{ AND NOT } (C \text{ OR } D) = \text{TRUE}$

?

Socrative FALCOMPED

What is the value of

A OR NOT A

?

Socrative FALCOMPED

What is the value of

A AND NOT A

?

Socrative FALCOMPED

What is the value of

$A \text{ OR } A$

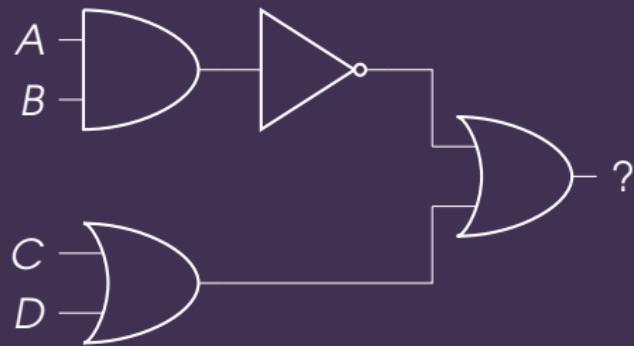
?

Socrative FALCOMPED

What is the value of
 $A \text{ AND } A$
?

Socrative FALCOMPED

What expression is equivalent to this circuit?



Writing logical operations

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Operation	Python	C family	Mathematics
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Other operators can be expressed by combining these

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Proof: Worksheet 4, questions 3a and 3b

Truth tables



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- ▶ For n variables there are 2^n possible combinations
- ▶ Essentially, all the n -bit binary numbers
- ▶ A **truth table** enumerates all the possible values of a boolean expression
- ▶ Can be used to prove that two expressions are equivalent

Truth table example

$(A \text{ OR NOT } B) \text{ AND } C$

A	B	C	NOT B	$A \text{ OR NOT } B$	$(A \text{ OR NOT } B) \text{ AND } C$

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A	B	C	NOT B	A OR NOT B	$(A \text{ OR NOT } B) \text{ AND } C$
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Other logic gates



Exclusive Or

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if and only if
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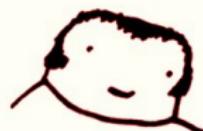


Socrative FALCOMPED

How can $A \text{ XOR } B$ be written using the operations AND , OR , NOT ?

BOOLEAN HAIR LOGIC

A



B



AND



OR



XOR

Negative gates

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NAND , NOR , XNOR
are the **negations** of
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$$A \text{ NAND } B = \text{NOT } (A \text{ AND } B)$$

$$A \text{ NOR } B = \text{NOT } (A \text{ OR } B)$$

$$A \text{ XNOR } B = \text{NOT } (A \text{ XOR } B)$$

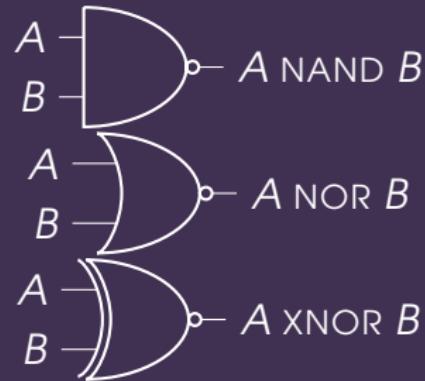
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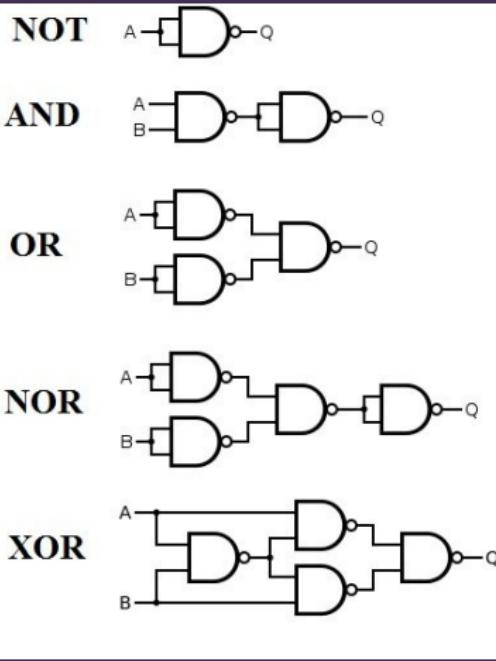
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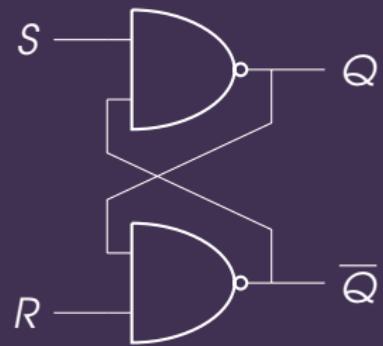
$$A \text{ XNOR } B = \text{NOT}(A \text{ XOR } B)$$



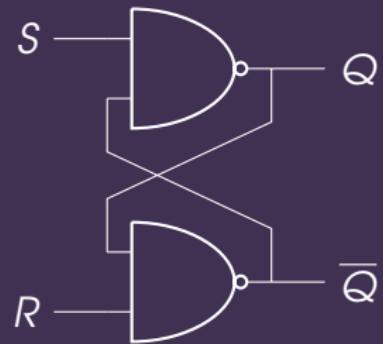
Any logic gate can be constructed from NAND gates



What does this circuit do?

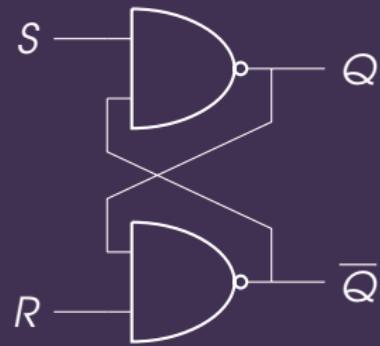


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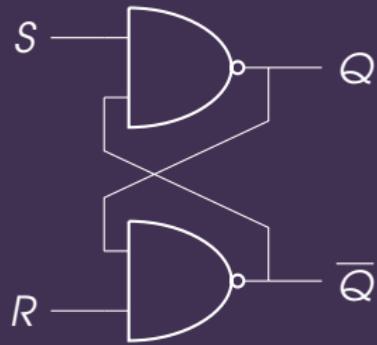
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- ▶ Put a few billion of these together (along with some control circuitry) and you’ve got **memory!**

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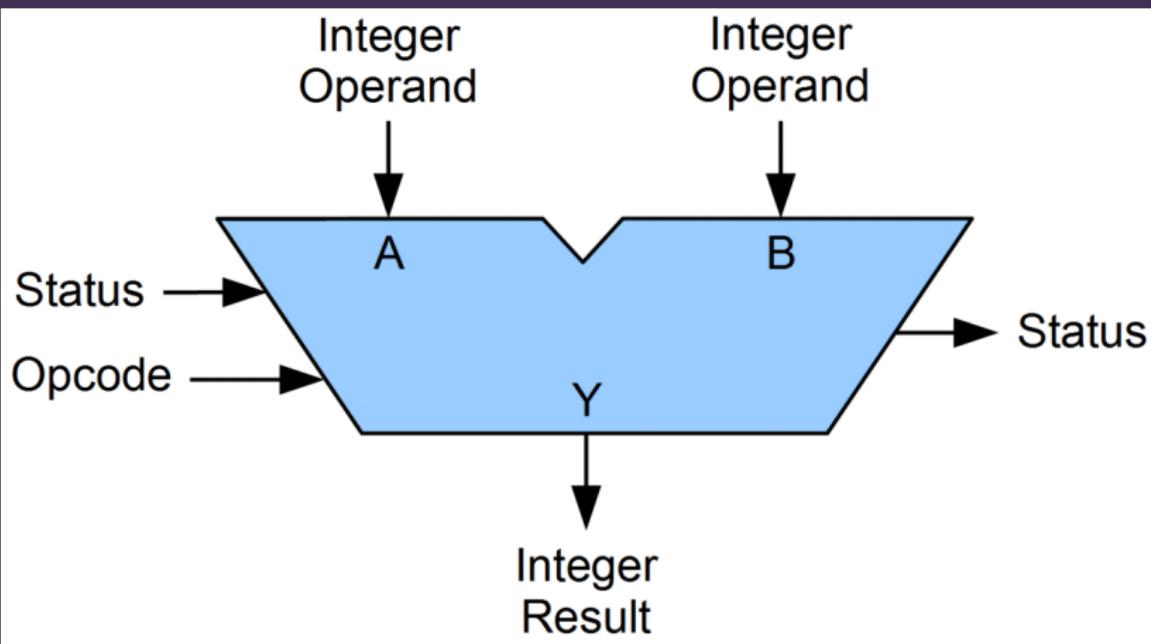
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- ▶ The same is true of NOR gates

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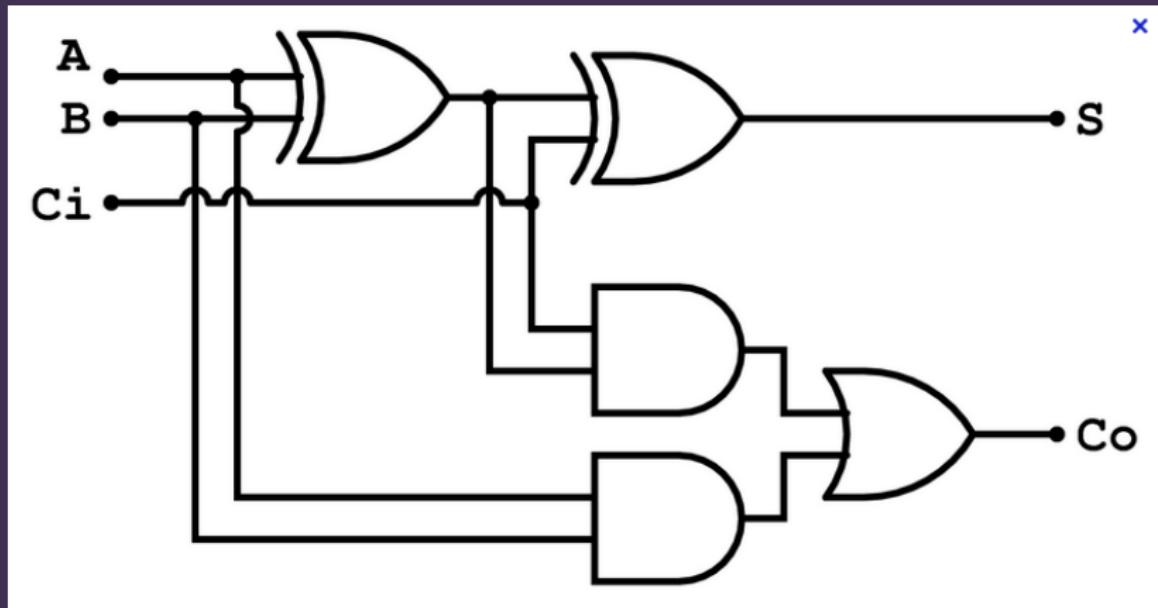
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- ▶ Bitwise AND, OR, NOT, ...
- ▶ Bit shifts

Adding 3 bits

A	B	C	$A + B + C$
0	0	0	00
0	0	1	01
0	1	0	01
0	1	1	10
1	0	0	01
1	0	1	10
1	1	0	10
1	1	1	11

1-bit adder



How does the 1-bit adder work?

Exercise:

- ▶ Write down the boolean expressions for S and Co
- ▶ Draw a truth table for these
- ▶ Compare the truth table to the addition table on a previous slide

n -bit adder

