Exercise walk-through

Artificial intelligence ▪ 6.3

eXercise

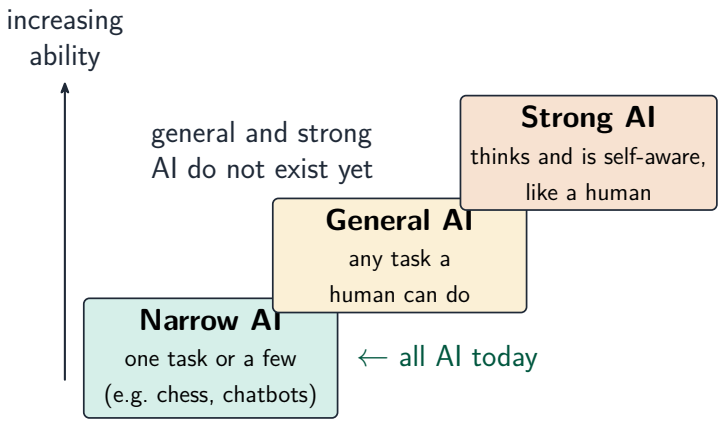
You must be able to

- define AI and give its characteristics
- give examples of AI (expert systems, NLP, self-driving cars)
- distinguish narrow, general and strong AI

Method — Levels of AI

- **AI:** the simulation of human intelligence by computers.
- **characteristics:** collect data + rules; reason; draw conclusions; learn; adapt.

Method — Levels of AI



Narrow, general and strong AI as rising steps

Method — Logic gates, expressions and truth tables

Six gates, with their symbols in words and their rule:

Gate	Output is 1 when	Expression
NOT	the input is 0	$\overline{A}$
AND	**both** inputs are 1	$A \cdot B$
OR	**at least one** input is 1	$A + B$
NAND	**not** both are 1	$\overline{A \cdot B}$
NOR	**neither** input is 1	$\overline{A + B}$
XOR	the inputs are **different**	$A \oplus B$

Method — Logic gates, expressions and truth tables

Building a truth table. With n inputs there are 2^n rows. Write the input columns in binary counting order, then add one working column per gate, in the order the signals flow, before the final output column. Working columns earn marks even if the last column is wrong.

Worked example. Complete a truth table for $X = (A \cdot B) + \overline{C}$.

A	**B**	**C**	$A \cdot B$	$\overline{C}$	**X**
0	0	0	0	1	1
0	0	1	0	0	0
0	1	0	0	1	1
0	1	1	0	0	0
1	0	0	0	1	1
1	0	1	0	0	0
1	1	0	1	1	1
1	1	1	1	0	1

Method — Logic gates, expressions and truth tables

Turning a problem into a circuit. Read the sentence for the joining words. "The alarm sounds when the door is open **and** the system is armed" is AND. "...when the door **or** the window is open" is OR. "...when the system is **not** armed" is NOT. Write the expression first, then draw one gate per operator, feeding the outputs forward.

Practice 2.1 ▪ 1 mark

Define artificial intelligence.

Solution 2.1

Worked steps

the simulation of human intelligence by computer systems B1.

Practice 2.2 ▪ 1 mark

Give one example of an AI application.

Solution 2.2

Worked steps

any of: expert system; natural language processing; self-driving car B1.

Practice 2.3 ▪ 2 marks

Give the logic expression for each: the output is 1 only when both inputs are 1; the output is 1 when the inputs are different.

Solution 2.3

Method: Logic gates, expressions and truth tables

Worked steps

$A \cdot B$ for AND B1; $A \oplus B$ for XOR B1.

Practice 2.4 ▪ 2 marks

State how many rows a truth table needs for four inputs, and explain why.

Solution 2.4

Method: Logic gates, expressions and truth tables

Worked steps

16 rows B1; each input has two possible values, so there are $2^4 = 16$ combinations B1.

Practice 2.5 ▪ 1 mark

Identify the gate whose output is 1 unless both inputs are 1.

Solution 2.5

Method: Logic gates, expressions and truth tables

Worked steps

NAND B1.

Exam-style 3.1 ▪ 1 mark

A chess-playing program that can do only that one task is an example of:

A narrow AI

B general AI

C strong AI

D an automated system

Solution 3.1

A narrow AI ✓

B general AI

C strong AI

D an automated system

Worked steps

A. A single-task program is narrow AI.

Exam-style 3.2 ▪ 2 marks

AI systems have several characteristics.
(a) State two characteristics of an AI system.
(b) State the difference between narrow AI and general AI.

Solution 3.2

Method: Levels of AI

Worked steps

(a) any two of: collect data and rules; reason; draw conclusions; learn; adapt B1 B1.

(b) narrow AI can do only one (or a few) tasks M1; general AI could do any task a human can do A1.

Exam-style 3.3 ▪ 3 marks

A greenhouse system sounds an alarm. The alarm sounds when the temperature is too high **and** the window is closed, **or** when the water level is low.
Let $T = 1$ mean the temperature is too high, $W = 1$ mean the window is open, and $L = 1$ mean the water level is low.
(a) Write the logic expression for the alarm output X.
(b) Complete the truth table for your expression.

T	**W**	**L**	$\overline{W}$	$T \cdot \overline{W}$	**X**
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

Exam-style 3.3 ▪ 3 marks

(c) Explain, using a row of your table, what happens when the temperature is too high and the window is open.
(d) Identify the single gate that could replace $\overline{T \cdot \overline{W}}$, and state its rule.
(e) A second system sounds only when the two sensors disagree. Name the gate needed and give its expression.

Solution 3.3

Method: Logic gates, expressions and truth tables

Worked steps

(a) $X = (T \cdot \overline{W}) + L$ B1 B1 B1 *for T AND NOT W, for the OR with L, for a fully correct expression.*
(b) $\overline{W}$ column: 1, 1, 0, 0, 1, 1, 0, 0 B1. $T \cdot \overline{W}$ column: 0, 0, 0, 0, 1, 1, 0, 0 B1. X column: 0, 1, 0, 1, 1, 1, 0, 1 B2 *one mark for at least six correct.*
(c) The row $T = 1$, $W = 1$, $L = 0$ gives $X = 0$ B1; the alarm does not sound, because an open window already lets the heat escape, so no action is needed B1.
(d) A NAND gate B1; its output is 1 unless both of its inputs are 1 B1.
(e) XOR B1; $X = T \oplus W$ B1.