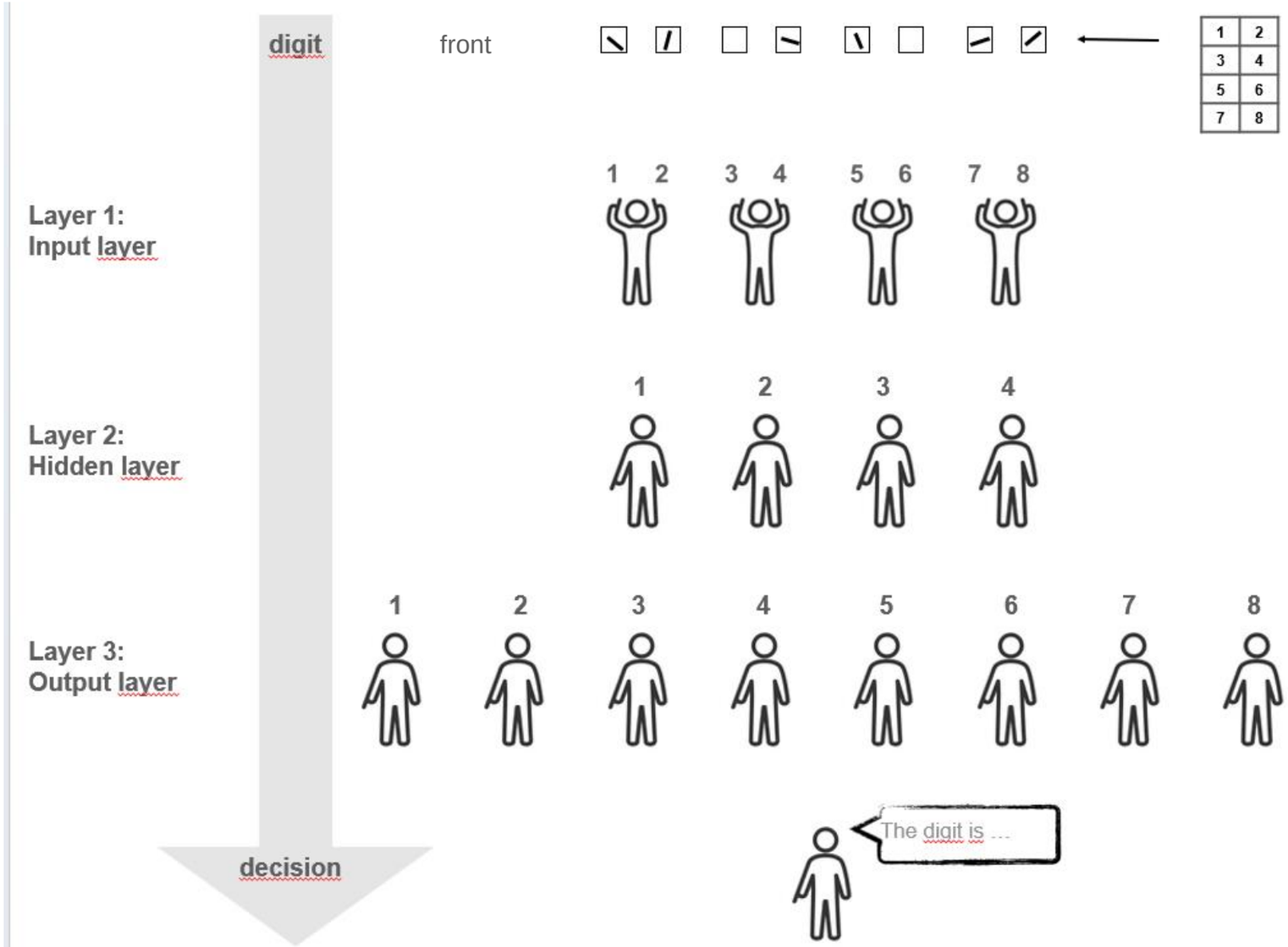
A neural network of people

The material can be used to simulate a neural network as an **enactive model**. This neural network of people consists of three layers and is suitable for recognising digits.

The implementation used here is a highly simplified reduction of the “Stilwell Brain” simulated by Michael Stevens and Chris Eliasmith with over 200 people for their YouTube video (Mind Field S3 E3, https://www.youtube.com/watch?v=rA5qnZUXcqo).

The model requires **17 persons** + 1 experimenter. The neural network used here has already been trained and is able to identify the digits **1 to 8** on a 2x4 pixel grid.

The 17 people are lined up as shown in the illustration. The direction of view is such that all the people are looking forwards in the direction of the digit to be distributed; the decision-maker can therefore see the backs of all the people. The experimenter draws a number on a large sheet of paper according to the instructions (see template at the end of this file), then cuts it into 8 “pixels” and distributes them in the correct order to the four people who form the eight neurons of the input layer with their arms. Those who have a stroke on their sheet “fire” by raising the respective arm. The four person-neurons in the hidden layer (like the eight person-neurons in the output layer) get a piece of paper specifying the conditions under which they should also “fire”, symbolised by raising the piece of paper. At the end of the information flow through the neural network for the pixelated digits 1 to 8, the corresponding person in the output layer will "fire" alone, allowing the decision-maker to announce which digit was involved.

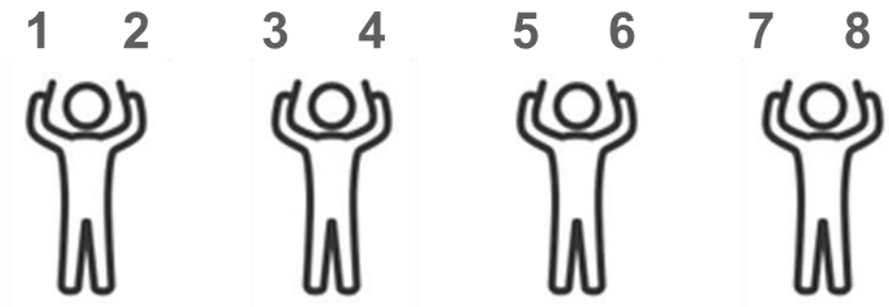


Author: D. Janssen

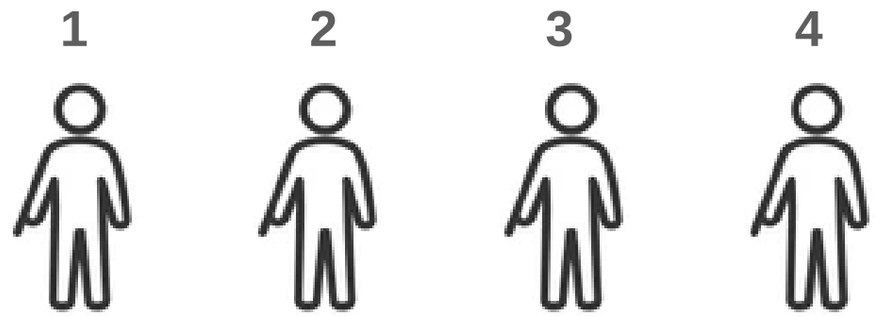
digit

1	2
3	4
5	6
7	8

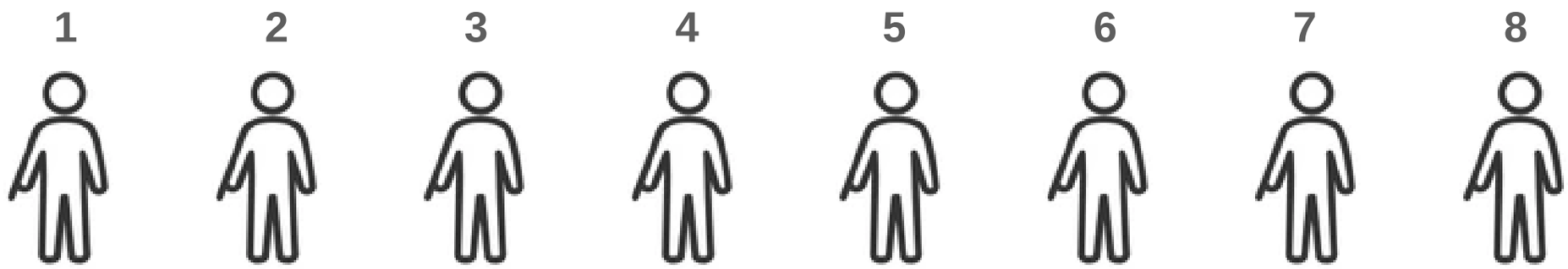
Layer 1:
Input layer



Layer 2:
Hidden layer



Layer 3:
Output layer



decision

You are seeing **eight** neurons of the input layer in front of you,

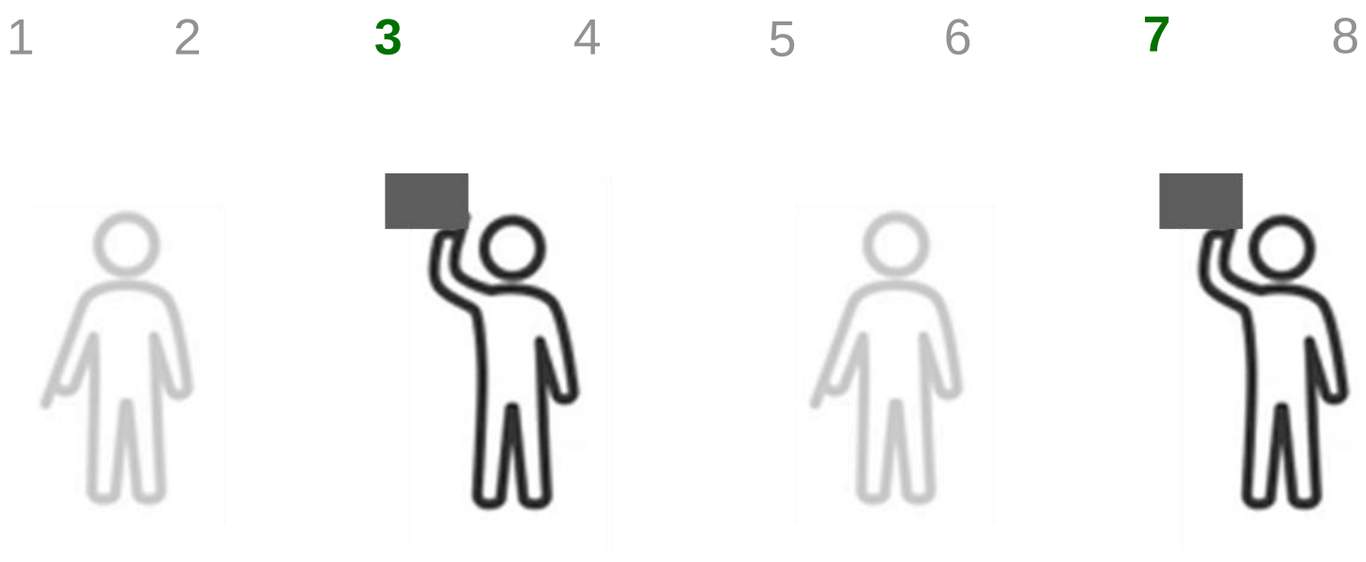
represented by the **eight** arms of the four people in front.

For you, only neurons **3** and **7** are relevant because you are only connected to them.

(You can therefore ignore all other neurons, it doesn‘t matter what they do.)

If the following pattern emerges (i.e. neuron **3** and neuron **7** fire),

then you also fire (hold your piece of paper up with both arms)!



You are: layer 2, neuron 1

You are seeing **eight** neurons of the input layer in front of you,

represented by the **eight** arms of the four people in front.

For you, only neurons **2** and **7** are relevant because you are only connected to them.

(You can therefore ignore all other neurons, it doesn‘t matter what they do.)

If the following pattern emerges (i.e. neuron **2** and neuron **7** fire),

then you also fire (hold your piece of paper up with both arms)!

1 **2** 3 4 5 6 **7** 8

You are: layer 2, neuron 2

You are seeing **eight** neurons of the input layer in front of you,

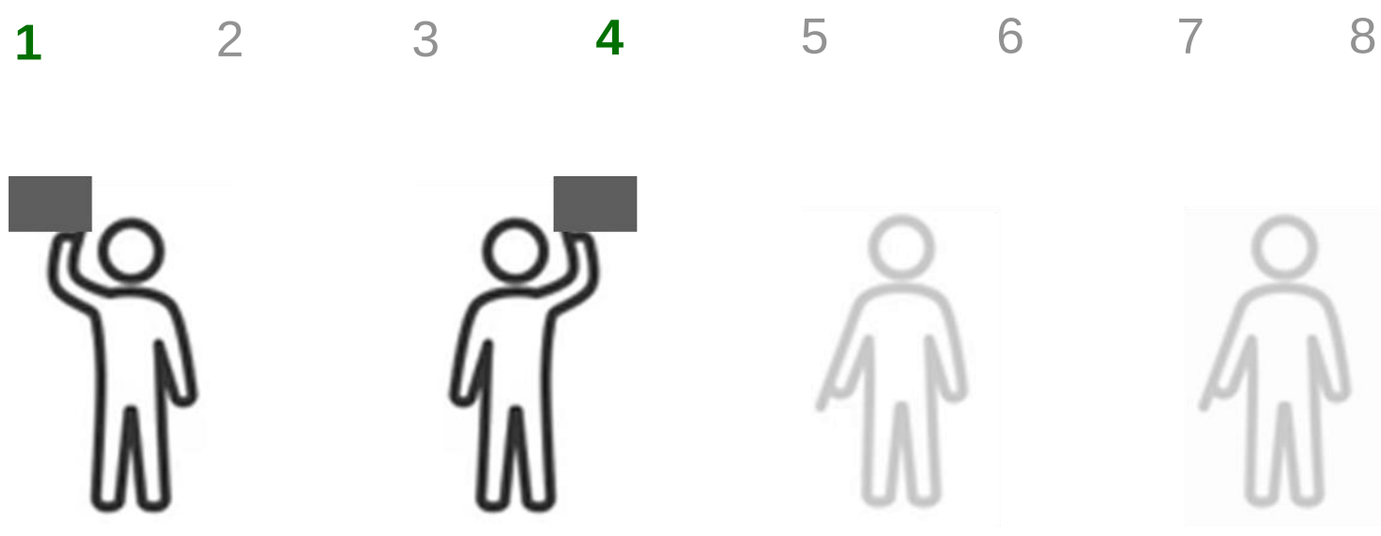
represented by the **eight** arms of the four people in front.

For you, only neurons **1** and **4** are relevant because you are only connected to them.

(You can therefore ignore all other neurons, it doesn‘t matter what they do.)

If the following pattern emerges (i.e. neuron **1** and neuron **4** fire),

then you also fire (hold your piece of paper up with both arms)!



You are: layer 2, neuron 3

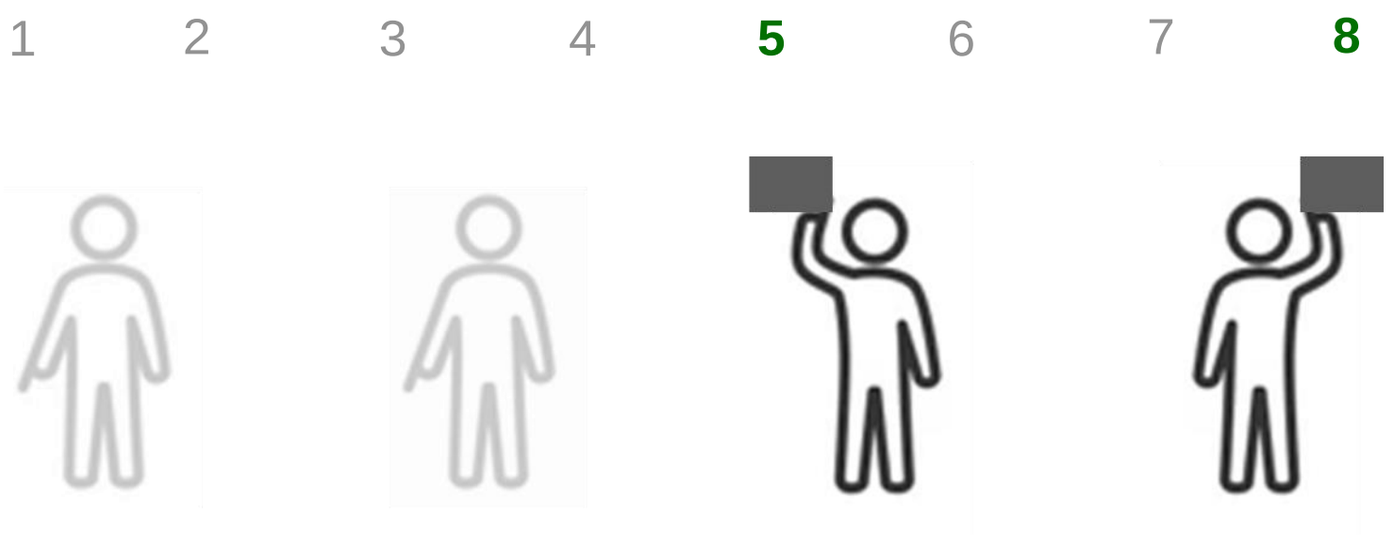
You are seeing **eight** neurons of the input layer in front of you.

For you, only neurons **5** and **8** are relevant because you are only connected to them.

(You can therefore ignore all other neurons, it doesn‘t matter what they do.)

If the following pattern emerges (i.e. neuron **5** and neuron **8** fire),

then you also fire (hold your piece of paper up with both arms)!



You are: layer 2, neuron 4

You are seeing **four** neurons of the hidden layer in front of you.

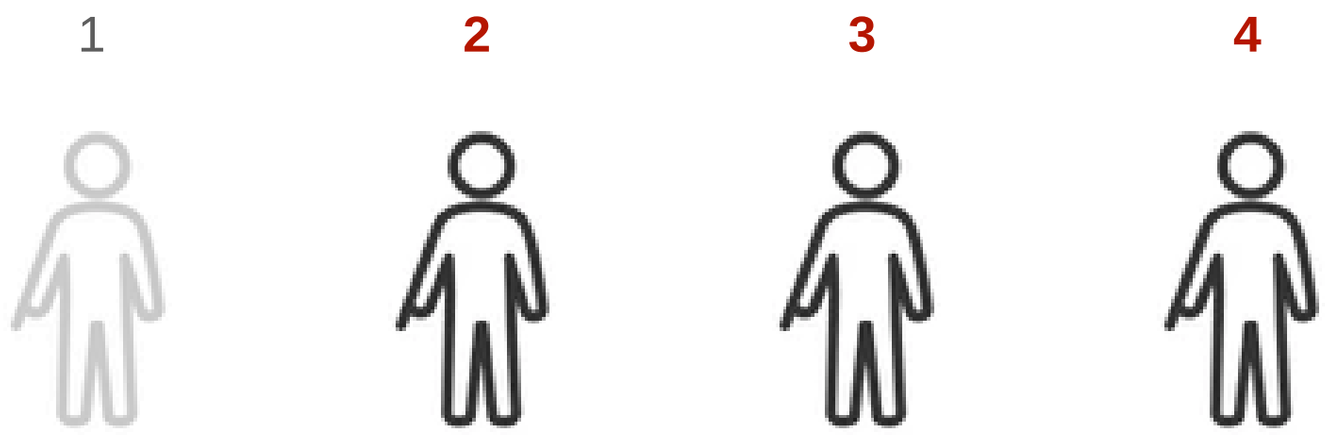
For you, only neuron **2** and **3** and **4** are relevant because you are only connected to them.

(You can therefore ignore the other neuron,it doesn‘t matter what it does.)

If the following pattern emerges

(i.e. neuron **2** and neuron **3** **a**nd neuron **4** do not fire),

then you fire (hold your piece of paper up with both arms)!



You are: layer 3, neuron 1

You are seeing **four** neurons of the hidden layer in front of you.

For you, only neuron **1** and **3** and **4** are relevant because you are only connected to them.

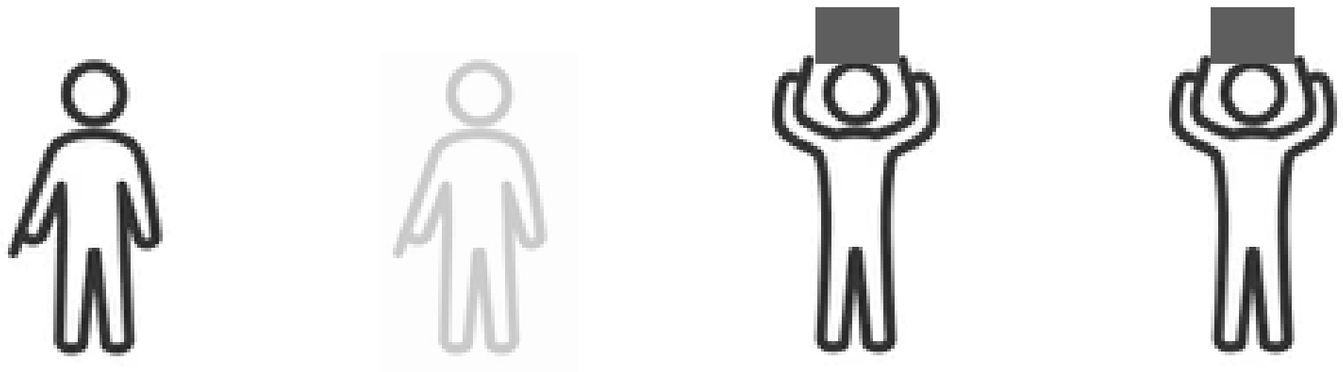
(You can therefore ignore the other neuron, it doesn‘t matter what it does.)

If the following pattern emerges

(i.e. neuron **1** does not fire and neuron **3** and neuron **4** both fire),

then you fire (hold your piece of paper up with both arms)!

1 2 **3** **4**



You are: layer 3, neuron 2

You are seeing **four** neurons of the hidden layer in front of you.

For you, only neuron **1** and **2** and **4** are relevant because you are only connected to them.

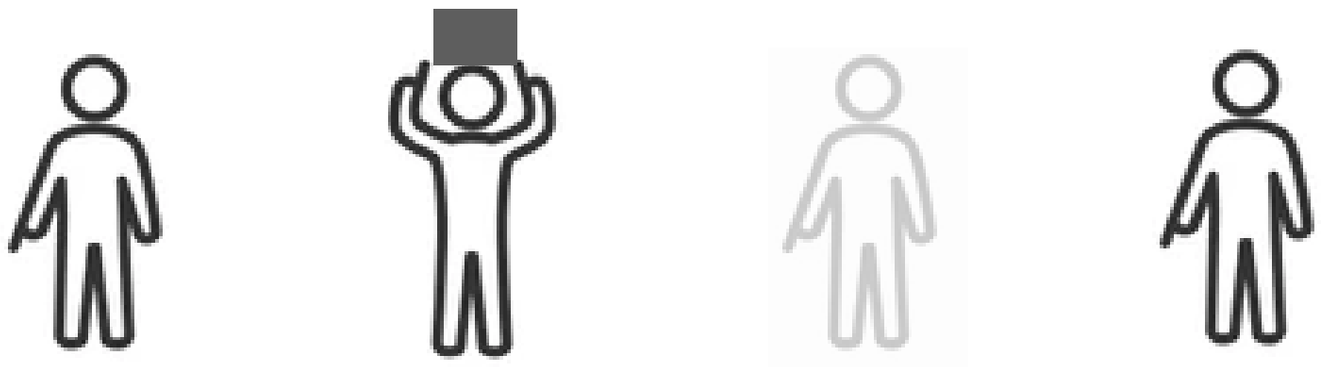
(You can therefore ignore the other neuron, it doesn‘t matter what it does.)

If the following pattern emerges

(i.e. neuron **1** does not fire and neuron **2** fires and neuron **4** does not fire),

then you fire (hold your piece of paper up with both arms)!

1 **2** 3 **4**



You are: layer 3, neuron 3

You are seeing **four** neurons of the hidden layer in front of you.

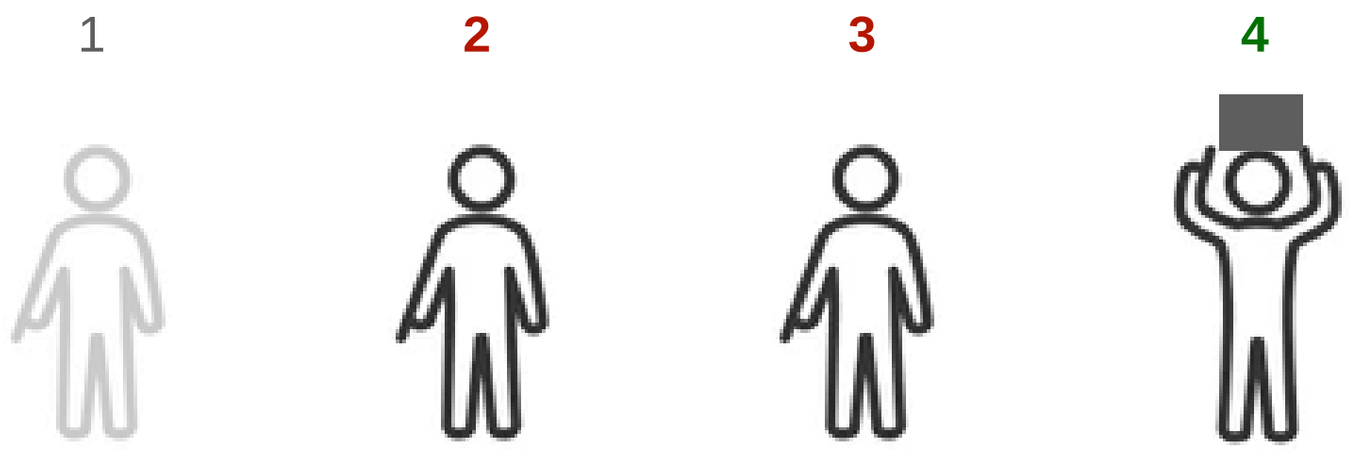
For you, only neuron **2** and **3** and **4** are relevant because you are only connected to them.

(You can therefore ignore the other neuron, it doesn‘t matter what it does.)

If the following pattern emerges

(i.e. neuron **2** and neuron **3** do not fire and neuron **4** fires),

then you fire (hold your piece of paper up with both arms)!



You are: layer 3, neuron 4

You are seeing **four** neurons of the hidden layer in front of you.

For you, only neuron **1** and **2** and **4** are relevant because you are only connected to them.

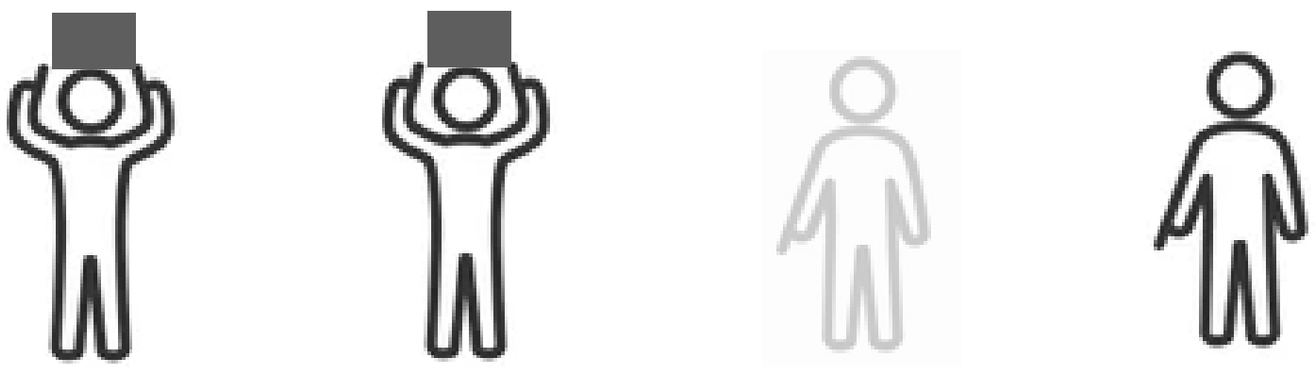
(You can therefore ignore the other neuron, it doesn‘t matter what it does.)

If the following pattern emerges

(i.e. neuron **1** and neuron **2** fire and neuron **4** does not fire),

then you fire (hold your piece of paper up with both arms)!

1 **2** 3 **4**



You are: layer 3, neuron 5

You are seeing **four** neurons of the hidden layer in front of you.

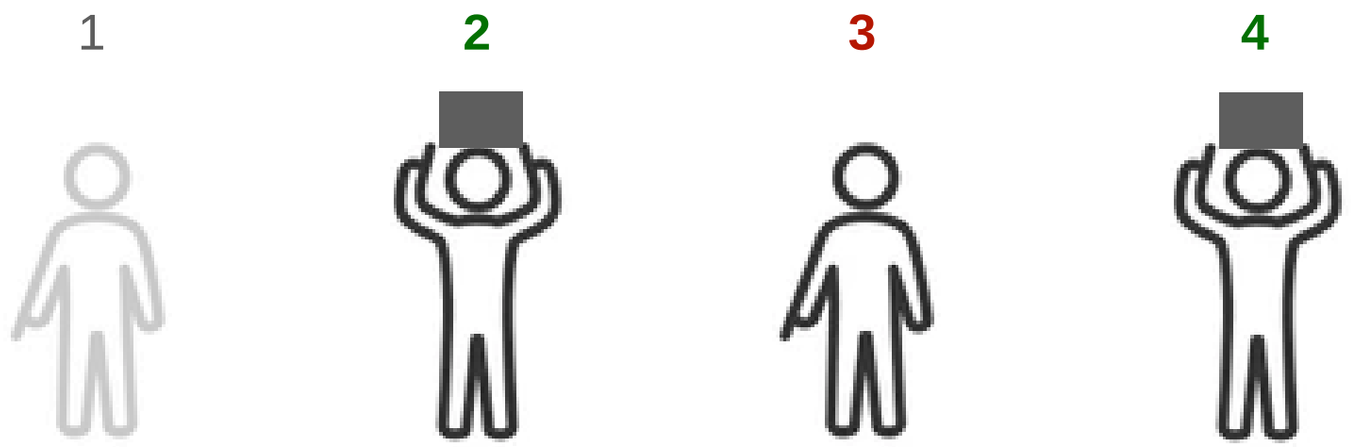
For you, only neuron **2** and **3** and **4** are relevant because you are only connected to them.

(You can therefore ignore the other neuron, it doesn‘t matter what it does.)

If the following pattern emerges

(i.e. neuron **2** fires and neuron **3** does not fire and neuron **4** fires),

then you fire (hold your piece of paper up with both arms)!



You are: layer 3, neuron 6

You are seeing **four** neurons of the hidden layer in front of you.

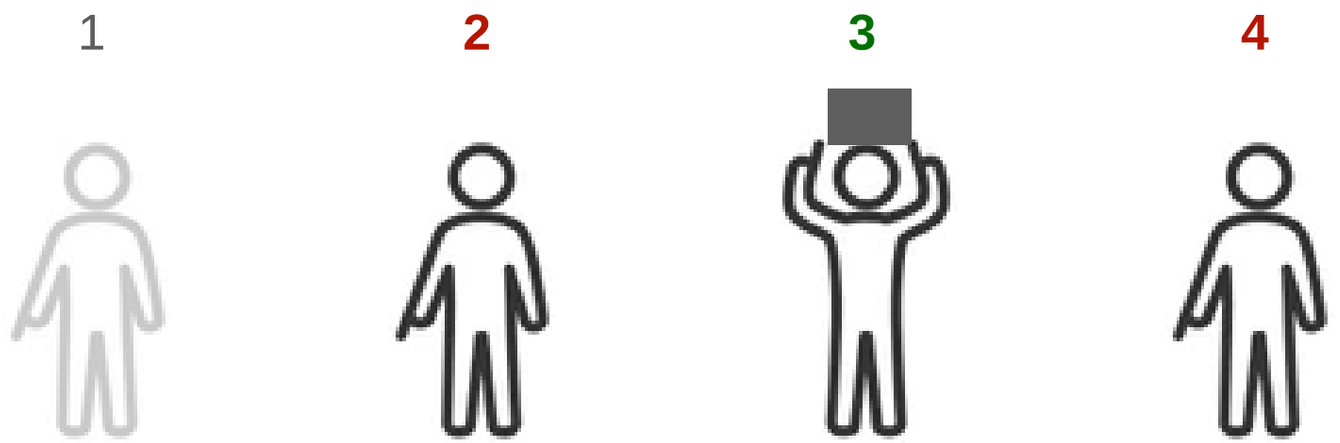
For you, only neuron **2** and **3** and **4** are relevant because you are only connected to them.

(You can therefore ignore the other neuron, it doesn‘t matter what it does.)

If the following pattern emerges

(i.e. neuron **2** does not fire and neuron **3** fires and neuron **4** does not fire),

then you fire (hold your piece of paper up with both arms)!



You are: layer 3, neuron 7

You are seeing **four** neurons of the hidden layer in front of you.

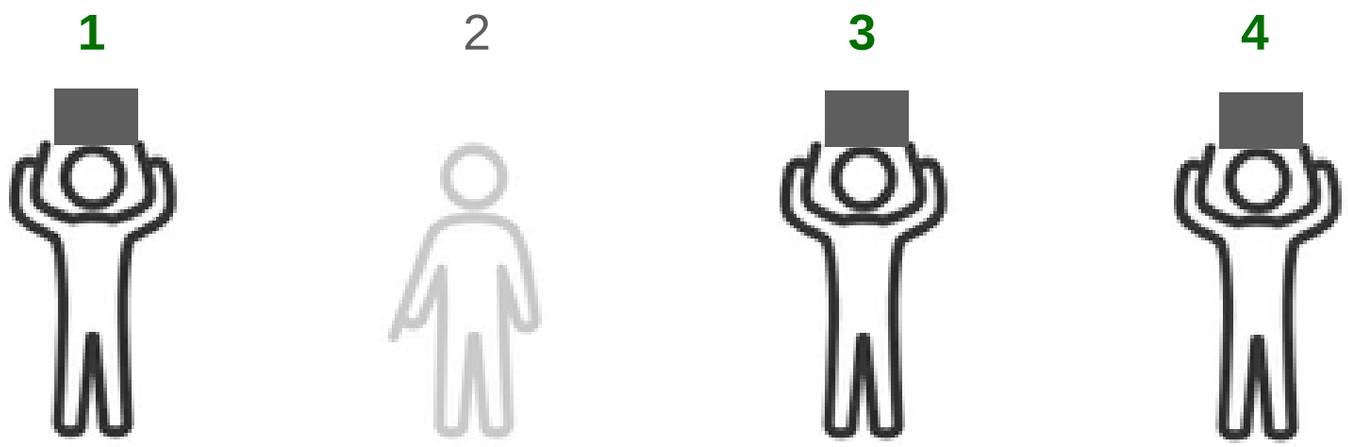
For you, only neuron **1** and **3** and **4** are relevant because you are only connected to them.

(You can therefore ignore the other neuron, it doesn‘t matter what it does.)

If the following pattern emerges

(i.e. neuron **1** and neuron **3** and neuron **4** fire),

then you fire (hold your piece of paper up with both arms)!



You are: layer 3, neuron 8

You are seeing **eight** neurons of the output layer in front of you.

They represent the digit that is to be identified based on the pattern.

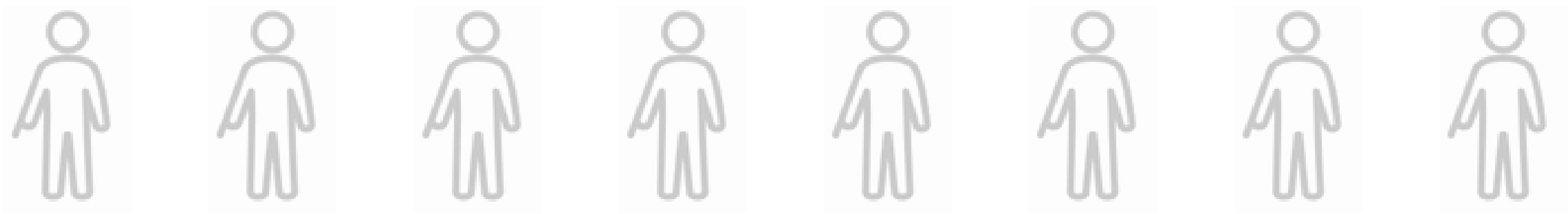
You decide:

Depending on which neuron **fires** (i.e. holds up its piece of paper),

you name the digit shown here above it!

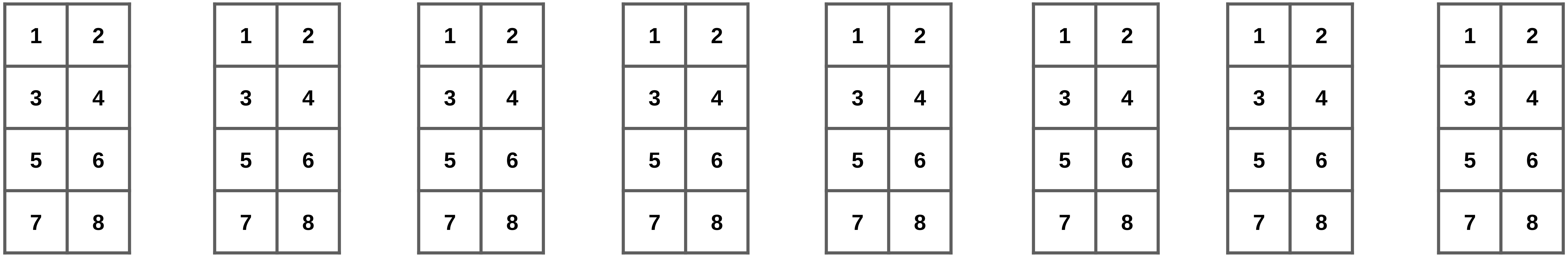
(If several neurons fire, you decide which number you think is more likely!)

1 2 3 4 5 6 7 8

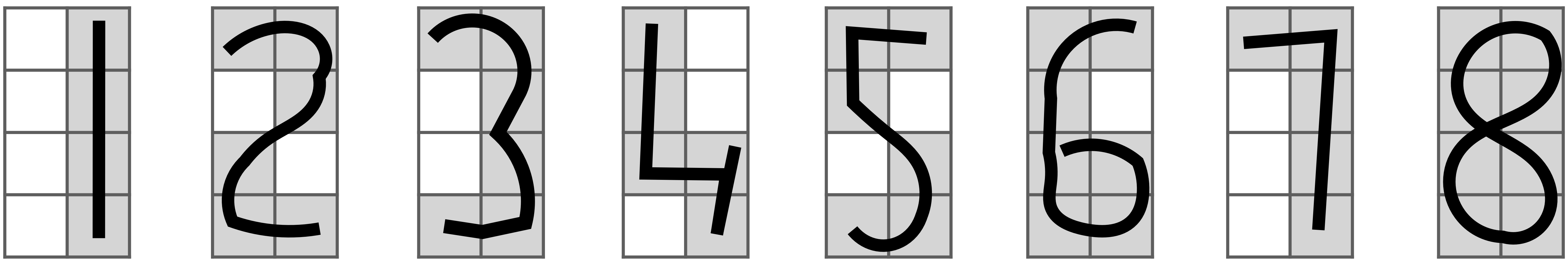


You are: the decision

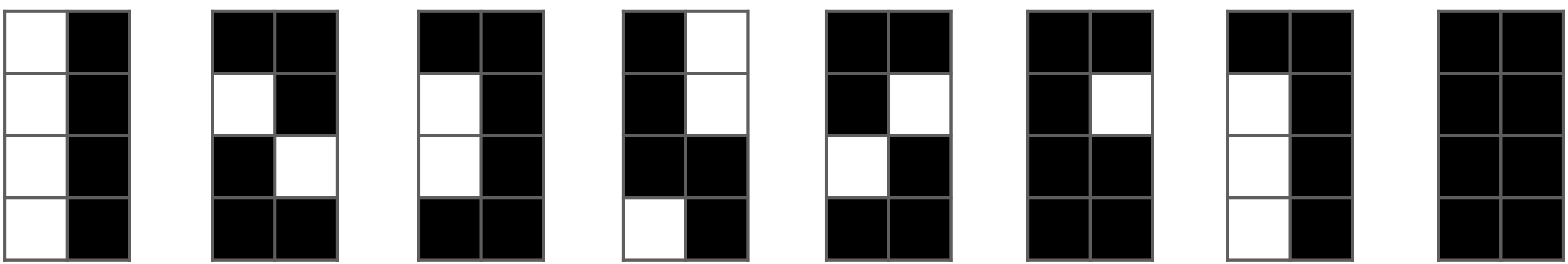
Sheet of paper marked with digits 1 to 8 for the input neurons 1 to 8



Labelled sheet of paper – please ensure that (only) the fields marked in grey are written on



Underlying representation of the digits 1 to 8 in a 4x2 grid



Print out the template, label it as nicely and accurately as possible with a digit, cut it up and distribute to the correct input neurons with the correct numbers.

Top left

1	2
3	4
5	6
7	8

Background

The underlying neural network looks as follows:

- There are 8 inputs, which can be 0 or 1.
- The weights of the connections between the first and the middle layer are all 1.0.
- There are 4 hidden neurons, which can also output 0 or 1 and whose threshold value is 1.5 in each case.
- The weights between the middle layer and the output layer are either -1.0 (blue) or 1.0 (red).
- The 8 neurons of the output layer can also output 0 or 1 and have the following threshold values (from bottom to top): -0.5, 1.5, 0.5, 0.5, 1.5, 1.5, 0.5, 2.5
- The illustration shows the processing of digit 2. [S=layer]