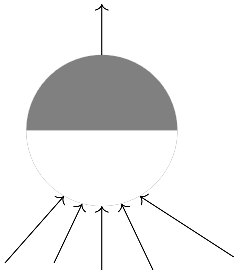
Module 2.2: McCulloch Pitts Neuron



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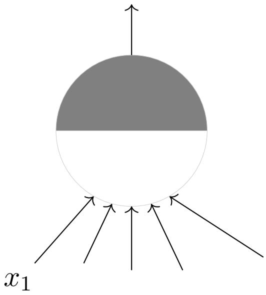

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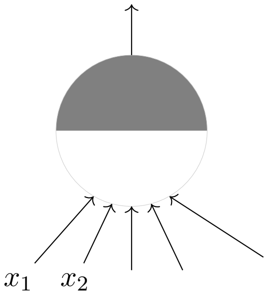

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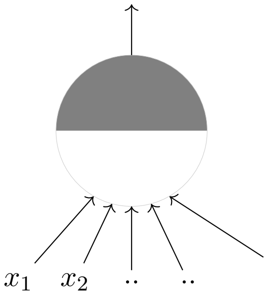

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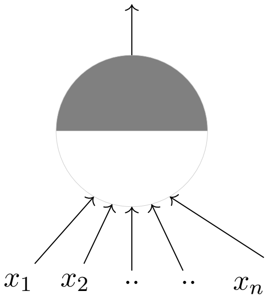

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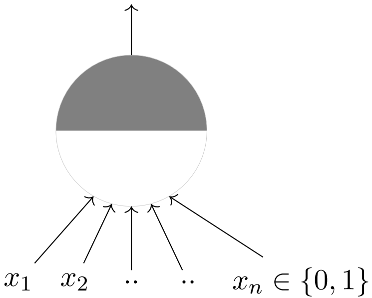

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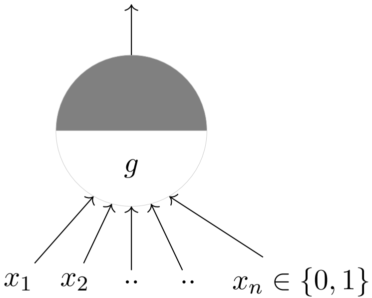

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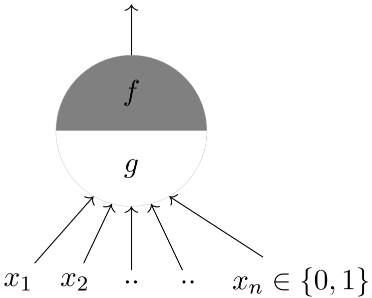

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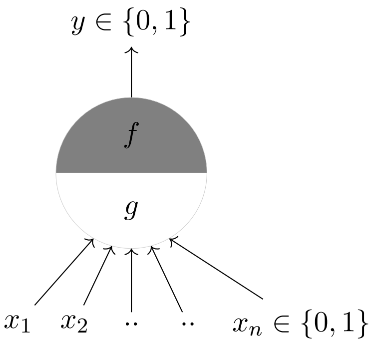

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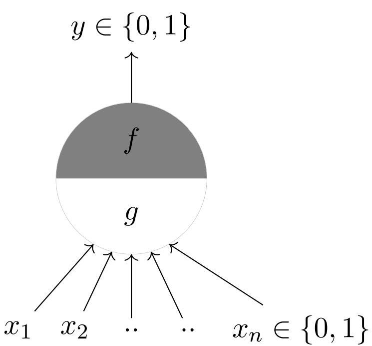

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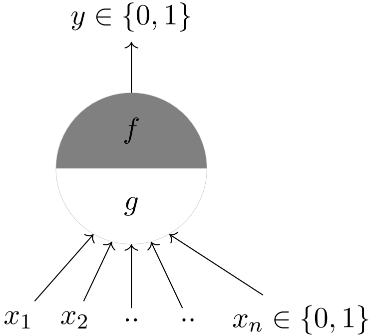

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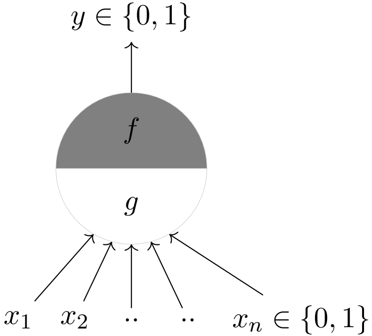

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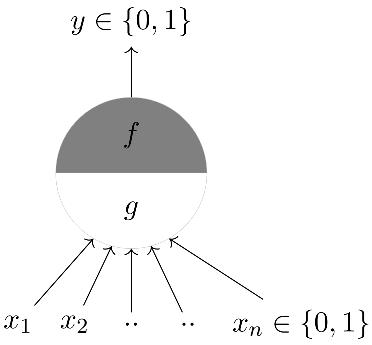

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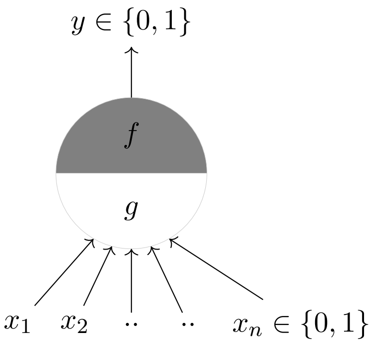
$$y = f(g(\mathbf{x})) = 1 \quad if \quad g(\mathbf{x}) \geq \theta$$



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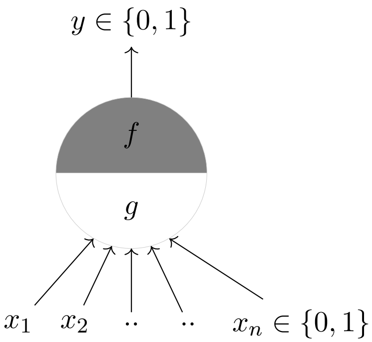

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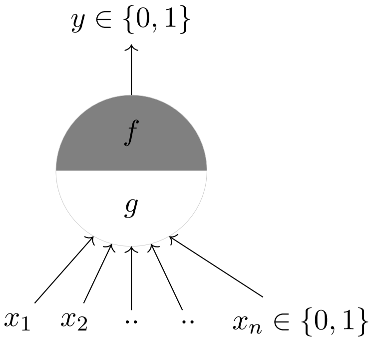

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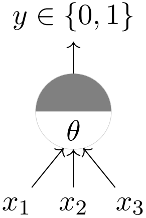
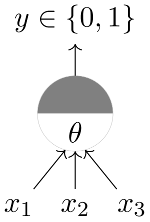
- θ is called the thresholding parameter
- This is called Thresholding Logic

Let us implement some boolean functions using this McCulloch Pitts (MP) neuron ...



A McCulloch Pitts unit



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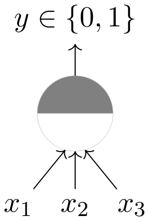
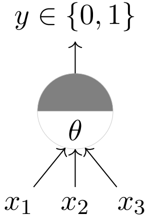


AND function



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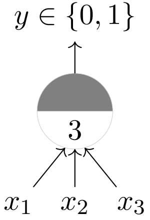

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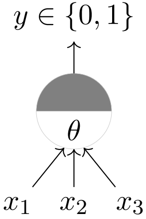

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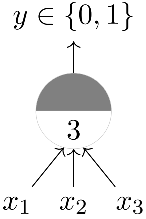

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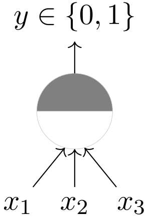

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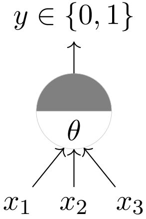

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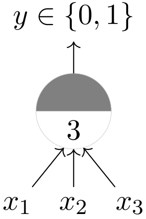

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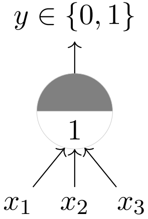

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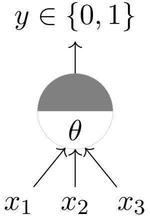

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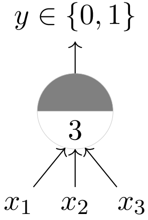

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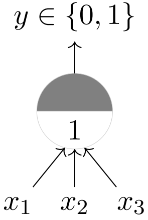

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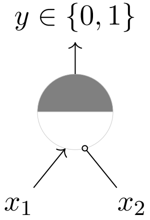

x_1 AND $!x_2$*

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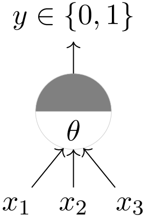

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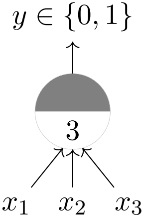

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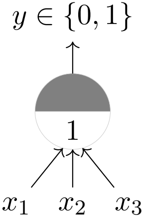

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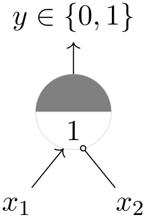

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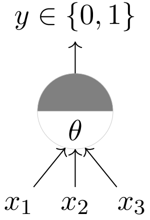

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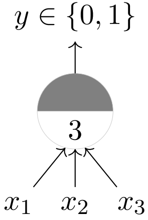

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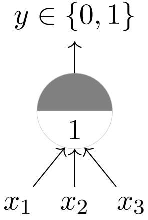

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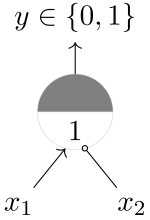

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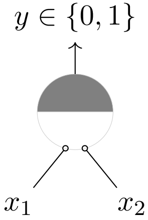

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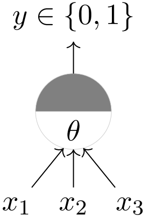

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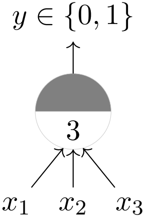

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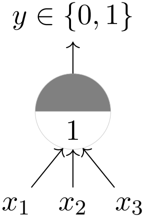

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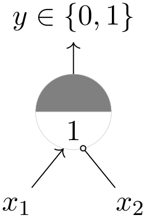

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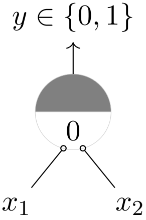

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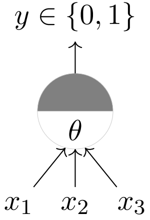

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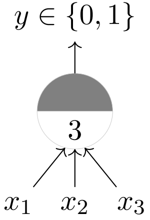

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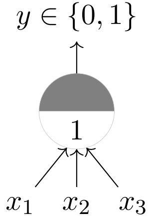

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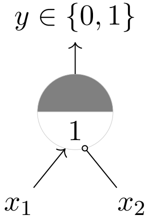

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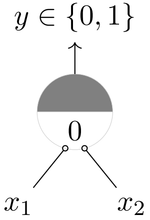

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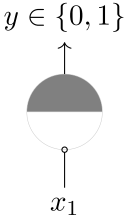

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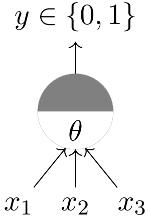
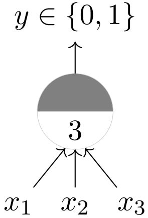


A McCulloch Pitts unit



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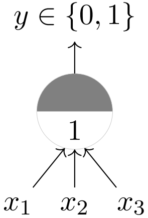

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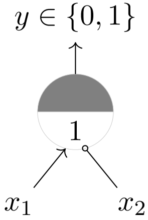

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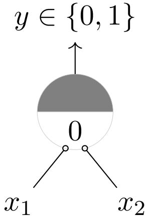

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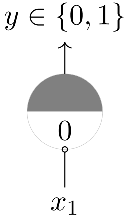

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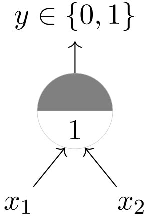
- Before answering this question let us first see the geometric interpretation of a MP unit ...



OR function

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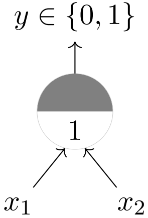

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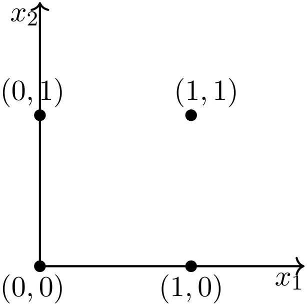

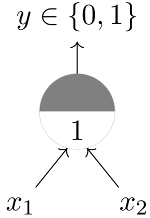

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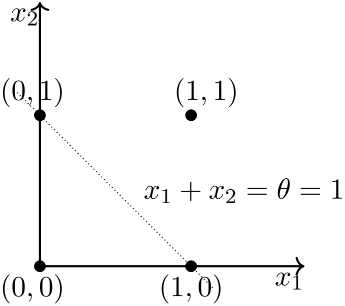

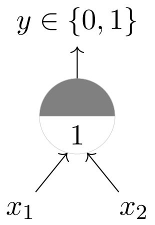

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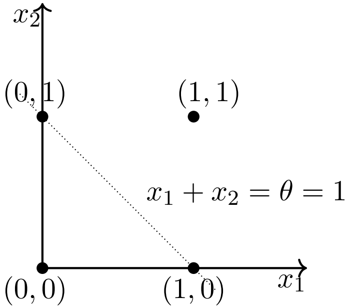
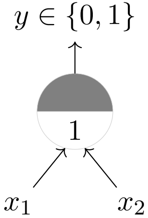


- A single MP neuron splits the input points (4 points for 2 binary inputs) into two halves



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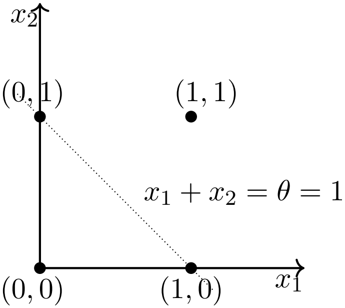
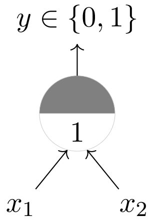


- A single MP neuron splits the input points (4 points for 2 binary inputs) into two halves
- Points lying on or above the line $\sum_{i=1}^{n} x_i - \theta = 0$ and points lying below this line



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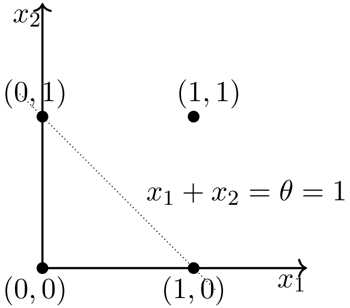

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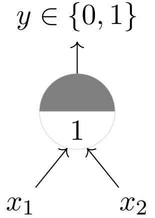

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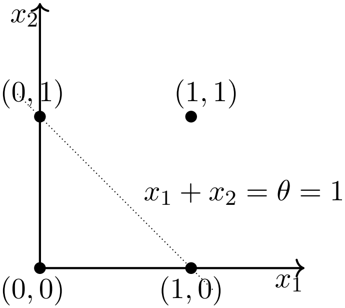

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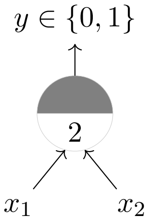
- Let us convince ourselves about this with a few more examples (if it is not already clear from the math)



AND function
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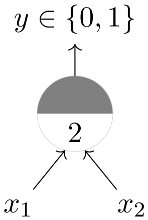

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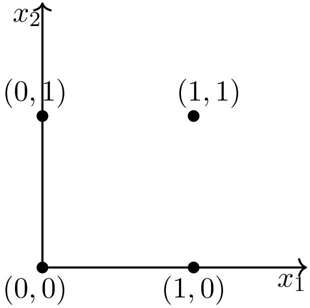

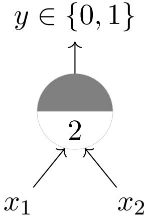

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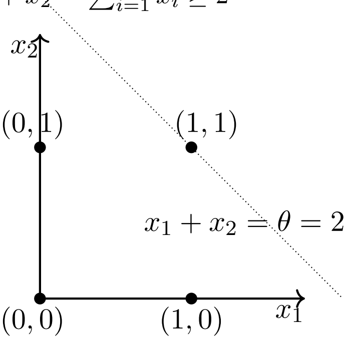

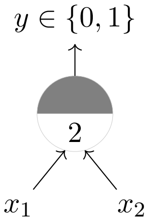

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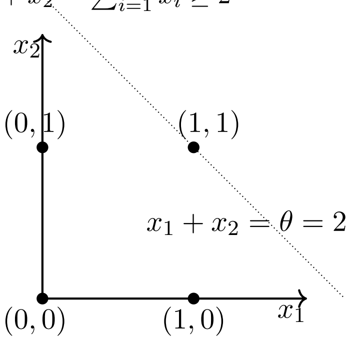
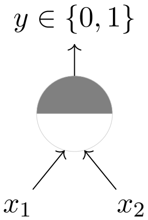
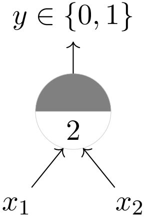




Tautology (always ON)



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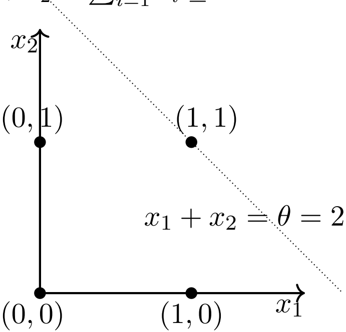

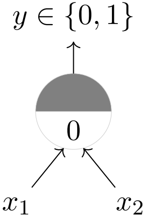

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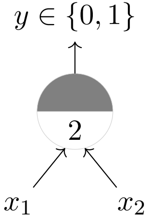

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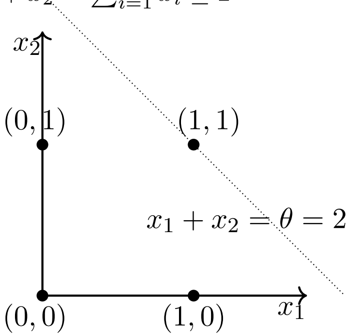

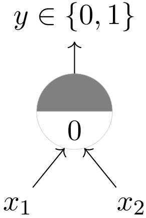

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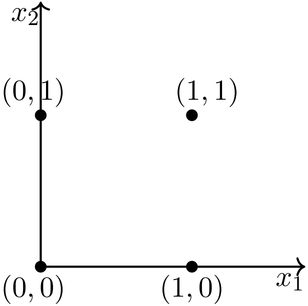

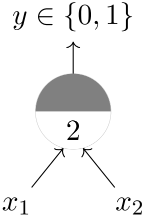

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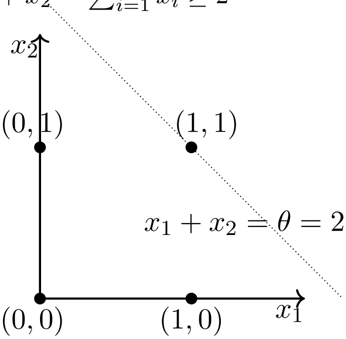

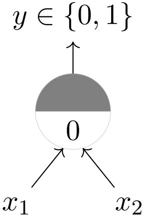

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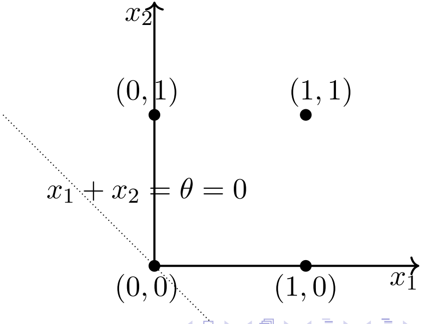
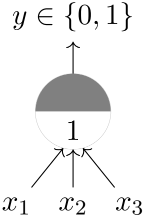
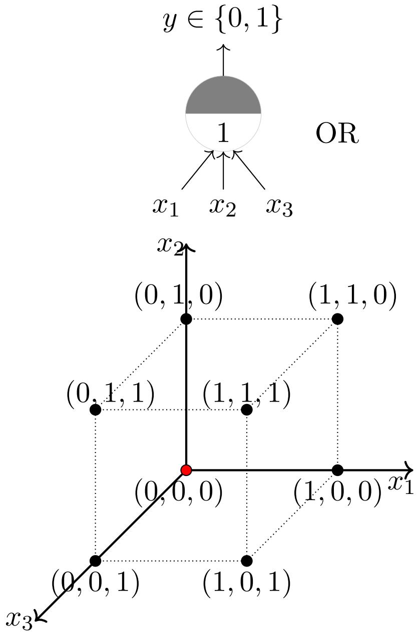




OR

- What if we have more than 2 inputs?



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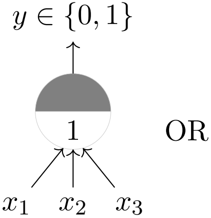

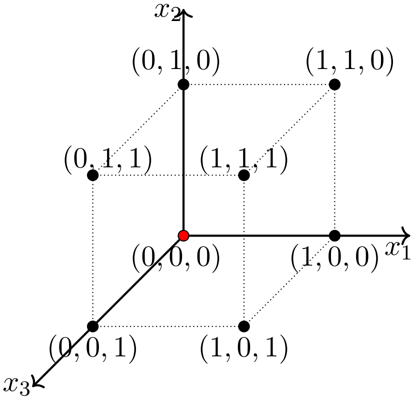

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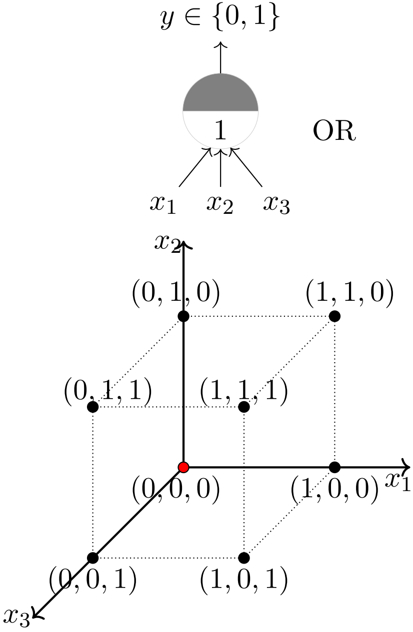

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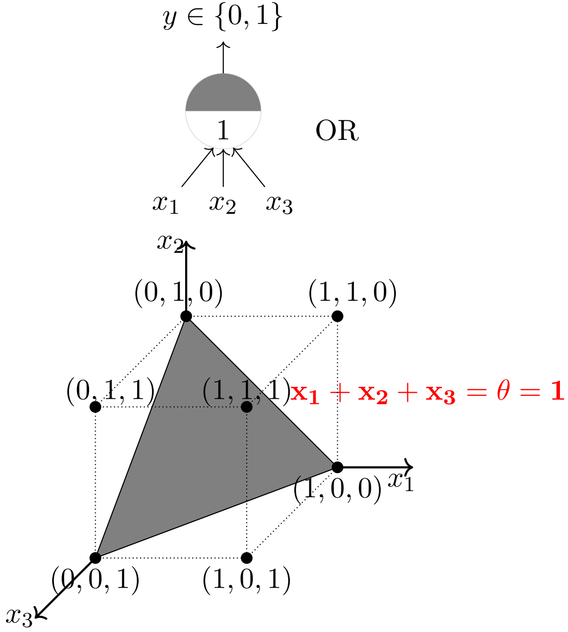
- For the OR function, we want a plane such that the point (0,0,0) lies on one side and the remaining 7 points lie on the other side of the plane



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- A single McCulloch Pitts Neuron can be used to represent boolean functions which are linearly separable

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- A single McCulloch Pitts Neuron can be used to represent boolean functions which are linearly separable
- Linear separability (for boolean functions) : There exists a line (plane) such that all inputs which produce a 1 lie on one side of the line (plane) and all inputs which produce a 0 lie on other side of the line (plane)