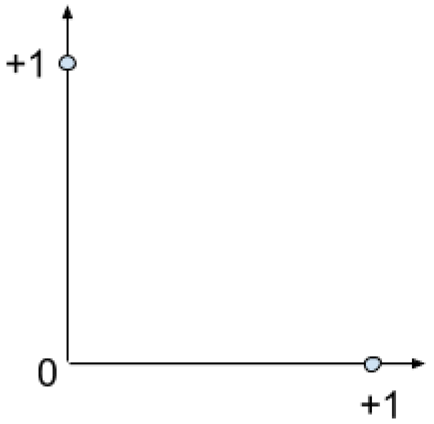
3.1.1



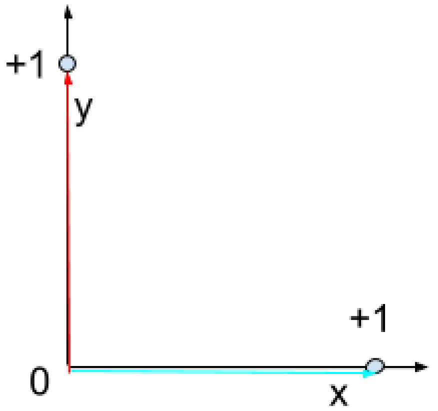
3.1.3

$x = (1, 0)$ -> $\|x\| = \sqrt{1^2 + 0^2} = 1$

3.1.4

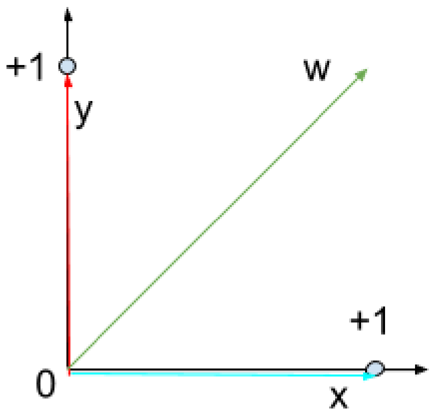
$x \cdot y = 1 * 0 + 0 * 1 = 0 + 0 = 0$

3.1.5

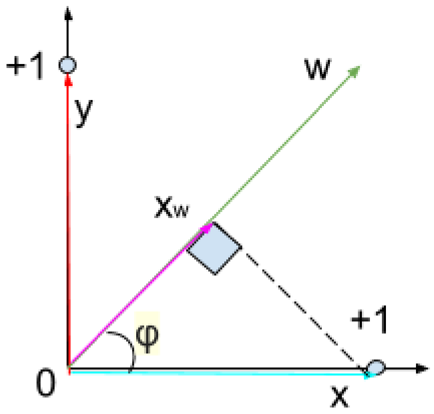


The two vectors x and y are perpendicular and the inner product of two perpendicular vectors is zero.

3.1.6



3.1.7



3.1.8

The cosine of angle f is defined as adjacent / hypotenuse and from the figure as we can see it is pretty obvious that cos(f) = $\frac{x_w}{||x||}$.

3.1.9

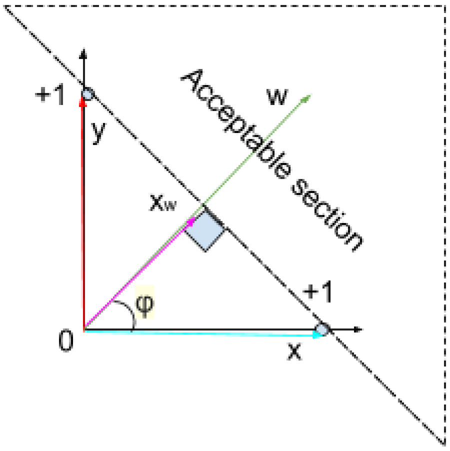
x · w = ||x|| ||w||cos(φ) (replacing the formula from the previus subquestion) =>

x · w = ||x|| ||w|| $\frac{x_w}{||x||}$ => x · w = ||w|| x_w

3.1.10

(a1*1+a2*1) -0,6 >0 => a1+a2 > 0,6

3.1.11



3.2.1

Action potential is the result of EPSP's that depolarized the membrane potential sufficiently overpassing the threshold so that a new action potential can be created. When an action potential reaches the axon terminal of a synapse, neurotransmitter is realised into the synaptic cleft. It reaches postsynaptic membrane and specifically receptor sites where molecules of neurotransmitter bind and create a PSP. Then it depends on the PSP type (EPSP, IPSP) if the membrane potential will change in a way so that a new action potential can be created.

3.2.2

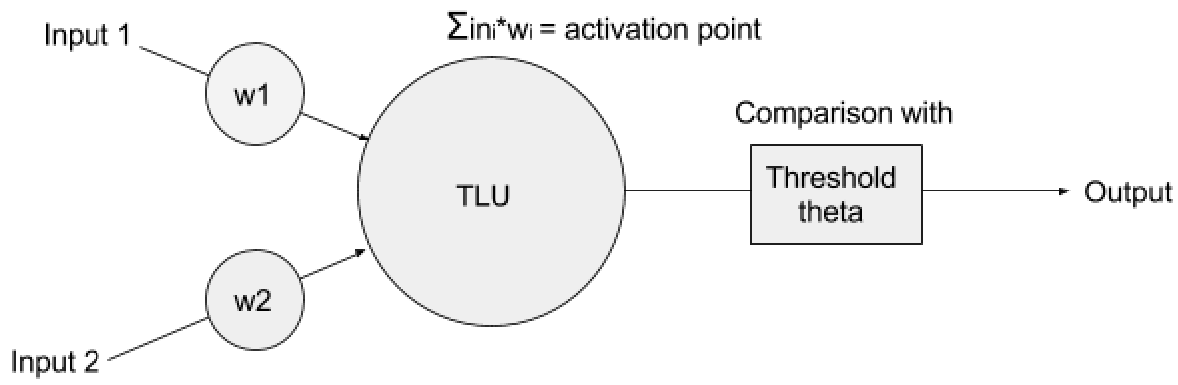
Hyperpolarization occurs when IPSP's are created and our membrane potential has a negative equilibrium value and as a result membrane potential gets even more negative.

3.2.3

PSP is the change in membrane potential that occurs from activity at a synapse.

In an artificial neuron it is represented as the summation of inputs multiplied with the weight vector (we must put the equation).
3.2.4
Both step function and action potential have to overpass the given threshold in order to continue farther.

3.3.1

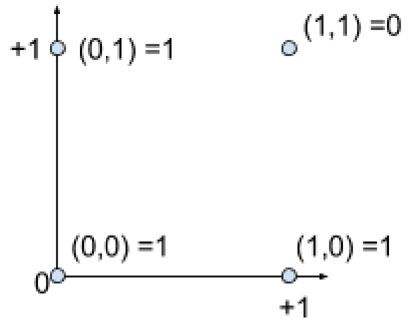


The 3 elements are :
1. the weighted vector
2. the activation point
3. the threshold

3.3.2
weighted vector = receptor sites
summation = PSP
threshold = membrane potential
3.3.3
Variables:
input
output
weight vector
activation point
threshold

Functions:
computation of activation point(input,weight vector)
compare activation point with threshold and output (activation point,threshold)
5.a
The error is not decreasing in each epoch because in some iterations with the weight changes the output is the desired one.
5.b
Because in the case of goal/output 1/0 and 0/1 even though the error should be the same we have 1 and -1 thats why we use the square.
5.c
Because the required iterations to reach 0 depend on the random starting values and the learn rate that we use.

5.d
With learning rate 0.6 we observe that more epochs are required to reach 0 error. Using higher learning rate is not always good. The learning rate that should be used depends on the training set.
5.e
The TLU is still capable of learning the AND-function after both changes however when we have 0.2 and 0.8 in some cases it needs more epochs to reach 0 error.
5.f
In sub-question 5.e we encountered with Resilience to noise our artificial neural network checks if the weighted summation of the inputs is above or below the threshold no matter the difference so small changes in the inputs or the weights don't lead to changes.
5.g
TLU can learn the NAND-function however both weights and threshold become negative because the NAND is exactly the opposite of AND so the weights and the threshold are from the other side.



6
We observe that the weights, threshold and errors change all the time because the TLU can’t solve nonlinear separable problems and XOR is one of them because of the positions that 1 and 0 have in the coordinate system we can’t a line that separates the outputs in two planes.