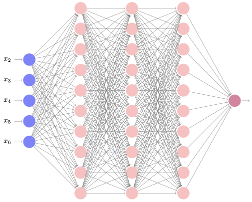

Perceptrons and Multilayer Perceptrons

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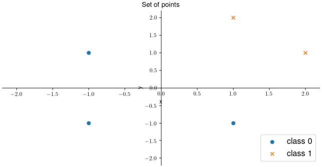
Learning the perceptron

A toy example

- 5 points $\boldsymbol{x}_i = (x_i^1, x_i^2)$
- 2 classes (0,1)
- Linear perceptron $\boldsymbol{w}^T x + b > 0?$
- Error e = real class - predicted class
- Init: $(w_0, w_1, b) = (-0.1, 0.1, 0)$
- Parameters update:
  1. $\boldsymbol{w}_{k+1} = \boldsymbol{w}_k + e\boldsymbol{x}$
  2. $\boldsymbol{b}_{k+1} = \boldsymbol{b}_k + e$



x^1	x^2	c
1	2	1
2	1	1
-1	1	0
-1	-1	0
1	-1	0

Learning the perceptron

w_0	w_1	b	x^1	x^2	C	$z = \boldsymbol{w}^T x + b$	$H(z)$	e

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w_0	w_1	b	x^1	x^2	c	$z = \boldsymbol{w}^T x + b$	$H(z)$	e
-0.1	0.1	0	1	2	1	0.1	1	0

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w_0	w_1	b	x^1	x^2	c	$z = \boldsymbol{w}^T x + b$	$H(z)$	e
-0.1	0.1	0	1	2	1	0.1	1	0
-0.1	0.1	0	2	1	1	-0.1	0	1

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w_0	w_1	b	x^1	x^2	c	$z = \boldsymbol{w}^T x + b$	$H(z)$	e
-0.1	0.1	0	1	2	1	0.1	1	0
-0.1	0.1	0	2	1	1	-0.1	0	1
1.9	1.1	1	-1	1	0	0.2	1	-1

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1.9	1.1	1	-1	1	0	0.2	1	-1
2.9	0.1	0	-1	-1	0	-3	0	0

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-0.1	0.1	0	1	2	1	0.1	1	0
-0.1	0.1	0	2	1	1	-0.1	0	1
1.9	1.1	1	-1	1	0	0.2	1	-1
2.9	0.1	0	-1	-1	0	-3	0	0
2.9	0.1	0	1	-1	0	2.8	1	-1

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Learning the perceptron

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2.9	0.1	0	1	-1	0	2.8	1	-1
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1.9	1.1	1	-1	1	0	0.2	1	-1
2.9	0.1	0	-1	-1	0	-3	0	0
2.9	0.1	0	1	-1	0	2.8	1	-1
1.9	1.1	-1	1	2	1	3.1	1	0
1.9	1.1	-1	2	1	1	3.9	1	0

Learning the perceptron

w_0	w_1	b	x^1	x^2	c	$z = \boldsymbol{w}^T x + b$	$H(z)$	e
-0.1	0.1	0	1	2	1	0.1	1	0
-0.1	0.1	0	2	1	1	-0.1	0	1
1.9	1.1	1	-1	1	0	0.2	1	-1
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1.9	1.1	-1	1	2	1	3.1	1	0
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-0.1	0.1	0	1	2	1	0.1	1	0
-0.1	0.1	0	2	1	1	-0.1	0	1
1.9	1.1	1	-1	1	0	0.2	1	-1
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-0.1	0.1	0	2	1	1	-0.1	0	1
1.9	1.1	1	-1	1	0	0.2	1	-1
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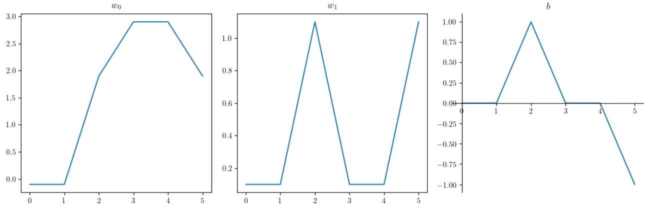
2.9	0.1	0	1	-1	0	2.8	1	-1
1.9	1.1	-1	1	2	1	3.1	1	0
1.9	1.1	-1	2	1	1	3.9	1	0
1.9	1.1	-1	-1	1	0	-0.8	0	0
1.9	1.1	-1	-1	-1	0	-3	0	0
1.9	1.1	-1	1	-1	0	-0.8	0	0

Learning the perceptron



And the decision boundary is $1.9x^1 + 1.1x^2 - 1 = 0$