Logistic Regression
to Deep Learning

Limitations of Logistic Regression: Part I
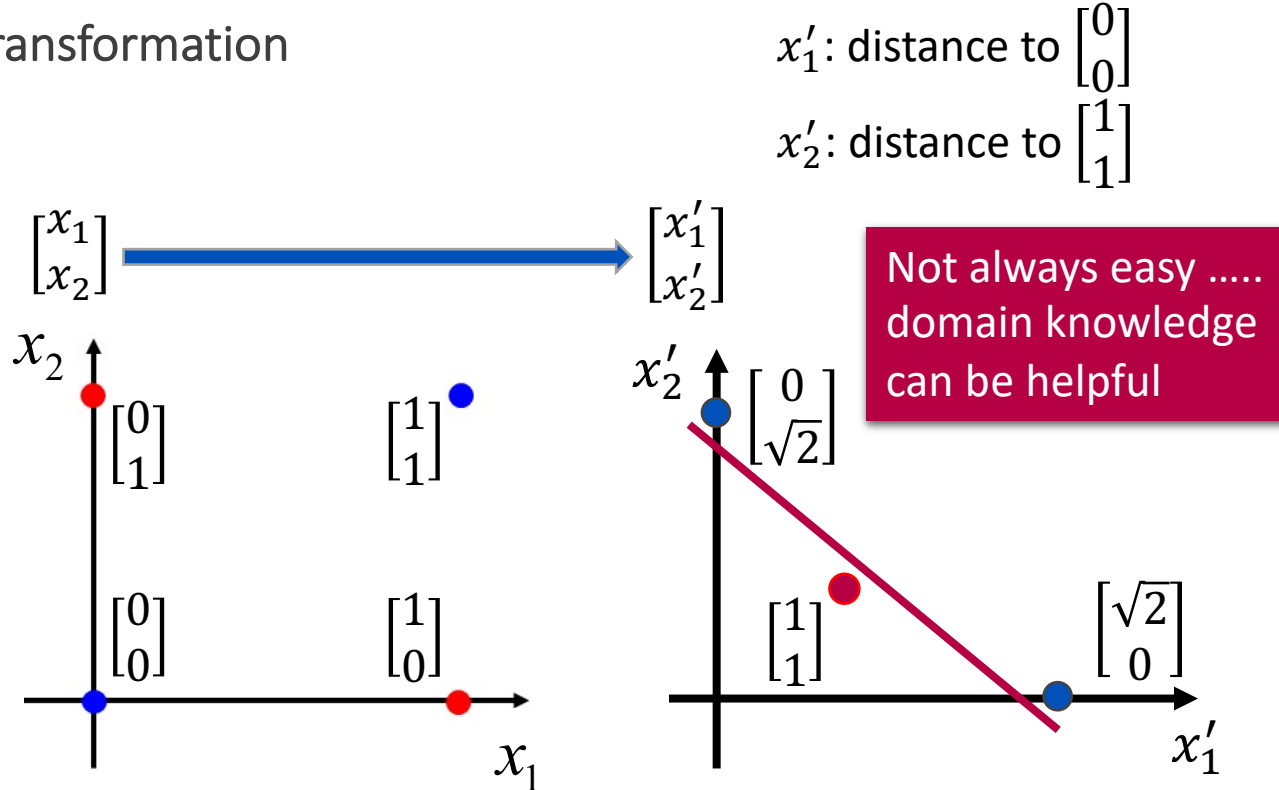
$$z = w_1 x_1 + w_2 x_2 + b$$

x_1 w_1

z

w_2

$+$

x_2

b

y

$$\begin{cases} Class\,1 & y \geq 0.5 \quad (z \geq 0) \\ Class\,2 & y < 0.5 \quad (z < 0) \end{cases}$$
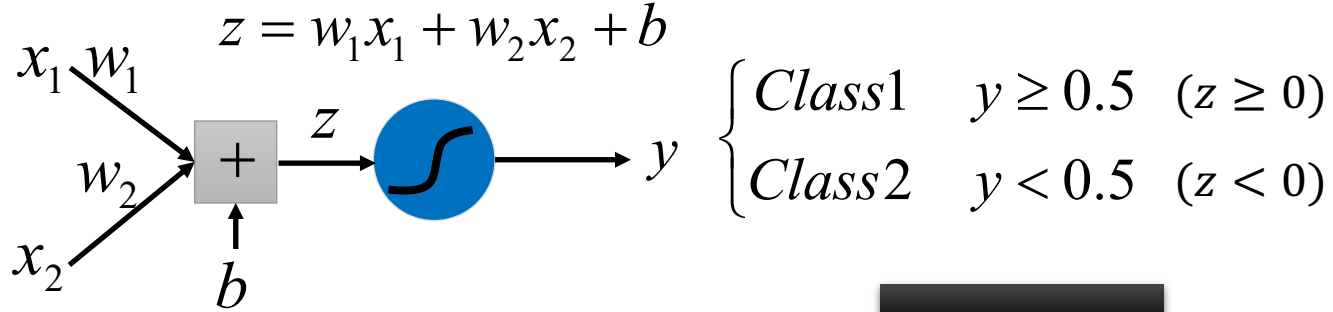
Input Feature		Label
x_1	x_2	
0	0	Class 2
0	1	Class 1
1	0	Class 1
1	1	Class 2

Can we?

x_2

z ≥ 0

z < 0

z < 0

z ≥ 0

x_1
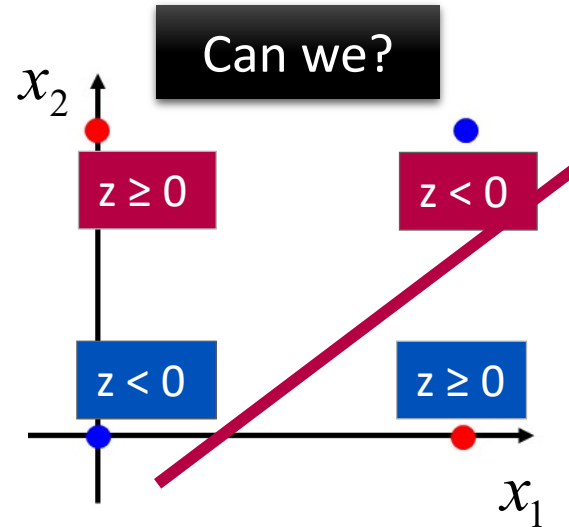
Limitations of Logistic Regression: Part II

Feature transformation

x_1': distance to $\begin{bmatrix} 0 \\ 0 \end{bmatrix}$

x_2': distance to $\begin{bmatrix} 1 \\ 1 \end{bmatrix}$

$$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \longrightarrow \begin{bmatrix} x_1' \\ x_2' \end{bmatrix}$$

Not always easy ….. domain knowledge can be helpful

x_2

$\begin{bmatrix} 0 \\ 1 \end{bmatrix}$ $\begin{bmatrix} 1 \\ 1 \end{bmatrix}$

$\begin{bmatrix} 0 \\ 0 \end{bmatrix}$ $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$

x_1

x_2' $\begin{bmatrix} 0 \\ \sqrt{2} \end{bmatrix}$

$\begin{bmatrix} 1 \\ 1 \end{bmatrix}$ $\begin{bmatrix} \sqrt{2} \\ 0 \end{bmatrix}$
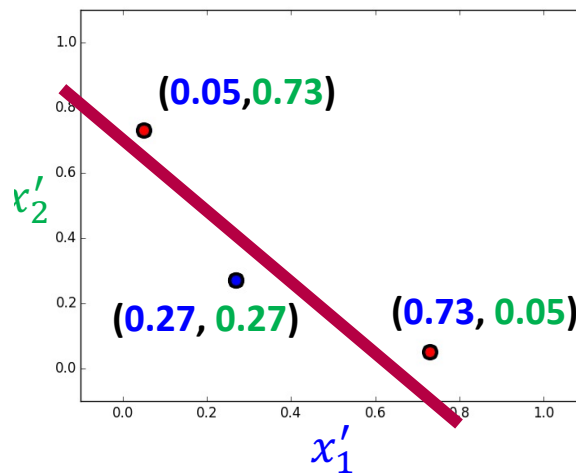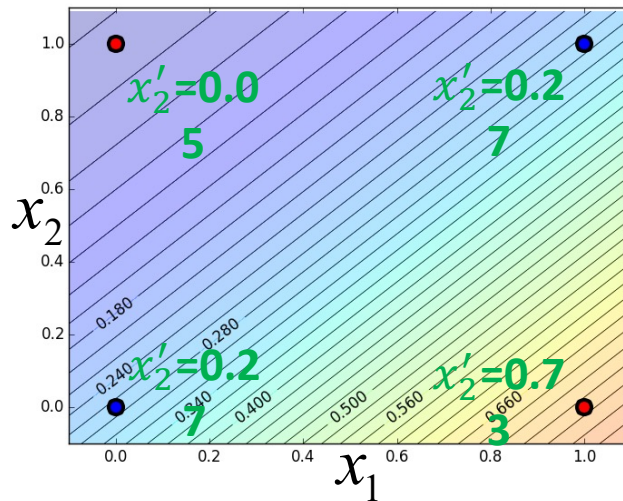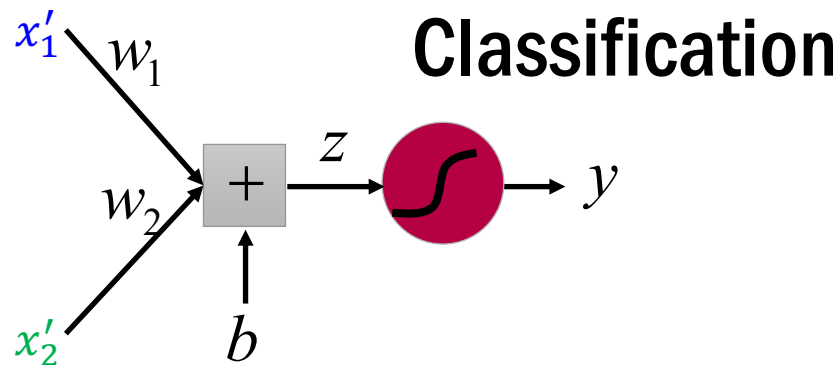
x_1'

Limitations of Logistic Regression: Part III
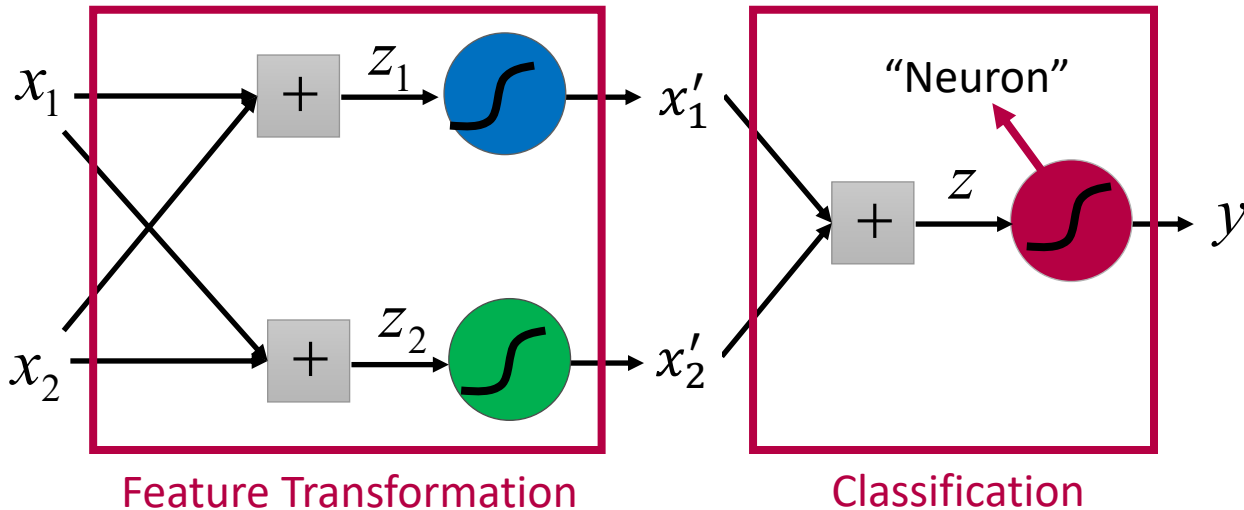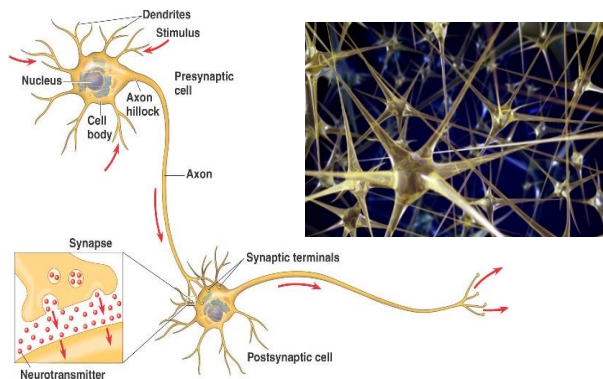
Cascading logistic regression models

(ignore the bias in this figure)
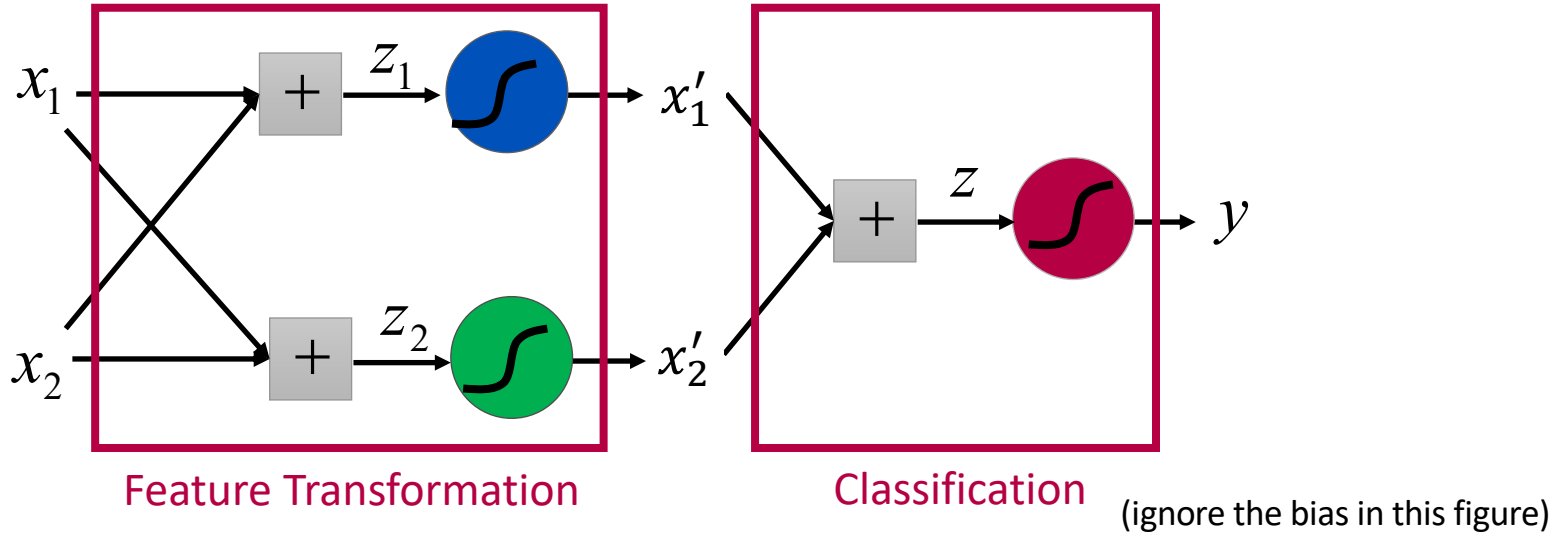
Feature Transformation

Classification
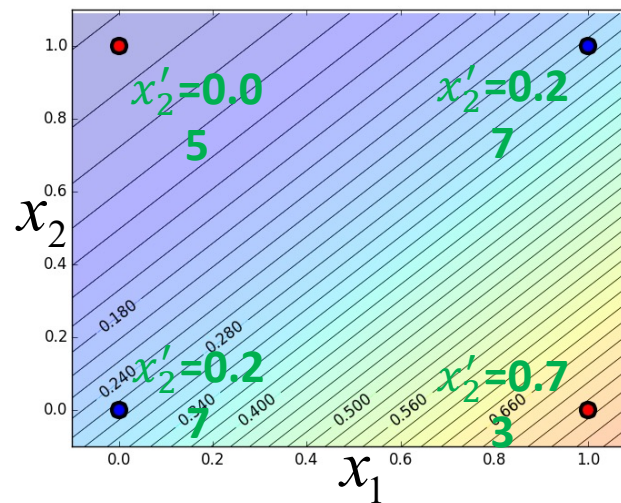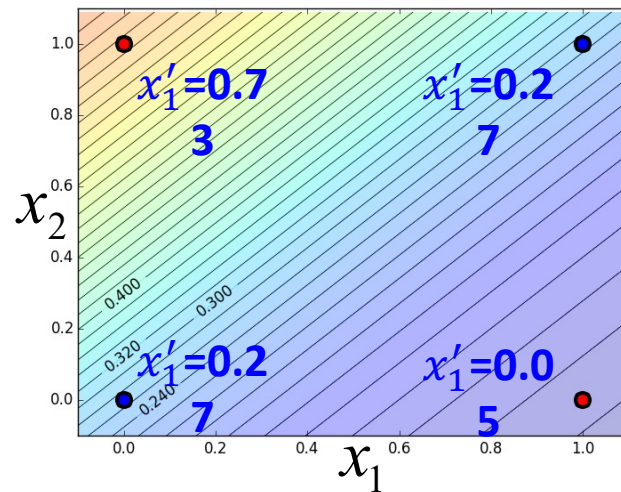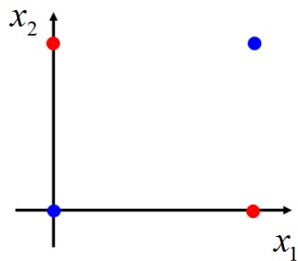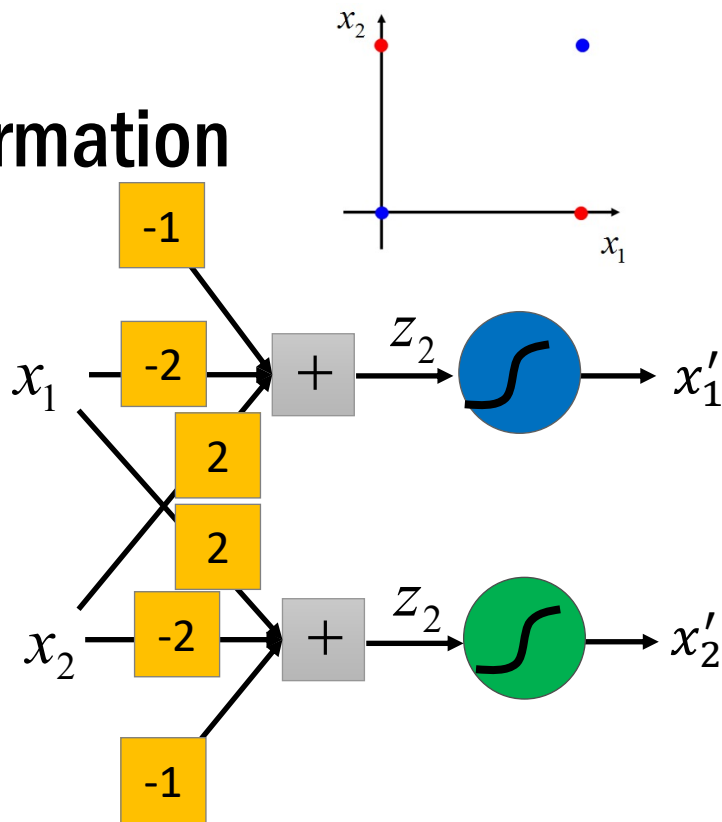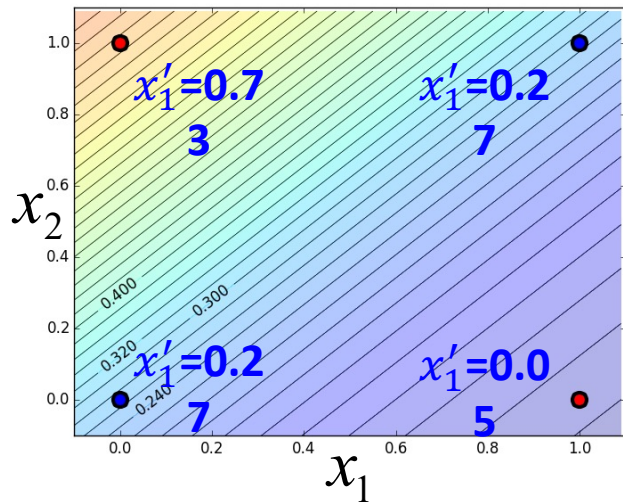
Deep Learning

All the parameters of the logistic regressions are jointly learned.

Neural Network