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Basics of Neural Network Programming

Vectorizing Logistic Regression

Vectorizing Logistic Regression

$z^{(1)} = w^T x^{(1)} + b$

$a^{(1)} = \sigma(z^{(1)})$

$z^{(2)} = w^T x^{(2)} + b$

$a^{(2)} = \sigma(z^{(2)})$

$z^{(3)} = w^T x^{(3)} + b$

$a^{(3)} = \sigma(z^{(3)})$

$$X = \begin{bmatrix} | & | & & | \\ x^{(1)} & x^{(2)} & \cdots & x^{(m)} \\ | & | & & | \end{bmatrix} \qquad (n_x, m) \qquad \mathbb{R}^{n_x \times m}$$

$$[\;\text{———}\;]\; w^T \begin{bmatrix} | & | & & | \\ x^{(1)} & x^{(2)} & \cdots & x^{(m)} \\ | & | & & | \end{bmatrix}$$

$$Z = [z^{(1)}\ z^{(2)} \cdots z^{(m)}] = \underbrace{w^T X + \underbrace{[b\ b \cdots b]}_{1 \times m}} = [\boxed{w^T x^{(1)} + b}\ \ \underbrace{\boxed{w^T x^{(2)} + b}}_{1 \times m}\ \cdots\ w^T x^{(m)} + b]$$

"Broadcasting"

$\rightarrow$ Z = np.dot(w.T, X) + b $\quad (1,1) \quad \mathbb{R}$

$$A = [a^{(1)}\ a^{(2)} \cdots a^{(m)}] = \sigma(Z)$$

Andrew Ng

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Vectorizing Logistic Regression's Gradient Computation

Vectorizing Logistic Regression

$dz^{(1)} = a^{(1)} - y^{(1)}$ $\quad dz^{(2)} = a^{(2)} - y^{(2)}$ $\quad \ldots$

$\boxed{dZ = [dz^{(1)} \; dz^{(2)} \ldots dz^{(m)}]}$ $\leftarrow$

$1 \times m$

$A = [a^{(1)} \ldots a^{(m)}]. \quad Y = [y^{(1)} \ldots y^{(m)}]$

$\rightarrow dZ = A - Y = [a^{(1)} - y^{(1)} \quad a^{(2)} - y^{(2)} \quad \ldots]$

$\rightarrow dw = 0$

$dw \mathrel{+}= x^{(1)} dz^{(1)}$

$dw \mathrel{+}= x^{(2)} dz^{(2)}$

$\vdots$

$dw \mathrel{/}= m$

$\cancel{dw_1}$

$\cancel{dw_2}$

$db = 0$

$db \mathrel{+}= dz^{(1)}$

$db \mathrel{+}= dz^{(2)}$

$\vdots$

$db \mathrel{+}= dz^{(m)}$

$db \mathrel{/}= m.$

$db = \frac{1}{m} \sum_{i=1}^{m} dz^{(i)}$

$= \frac{1}{m} \, np.sum(dZ)$

$\boxed{dw = \frac{1}{m} X \, dZ^T}$

$= \frac{1}{m} \begin{bmatrix} | & & | \\ x^{(1)} & \ldots & x^{(m)} \\ | & & | \end{bmatrix} \begin{bmatrix} dz^{(1)} \\ \vdots \\ dz^{(m)} \end{bmatrix}$

$= \frac{1}{m} \left[x^{(1)} dz^{(1)} + \ldots + x^{(m)} dz^{(m)} \right]$

$n \times 1$

Implementing Logistic Regression

$J = 0, \; dw_1 = 0, \; dw_2 = 0, \; db = 0$

for i = 1 to m:

$$z^{(i)} = w^T x^{(i)} + b$$

$$a^{(i)} = \sigma(z^{(i)})$$

$$J \mathrel{+}= -\left[y^{(i)} \log a^{(i)} + (1 - y^{(i)}) \log(1 - a^{(i)})\right]$$

$$dz^{(i)} = a^{(i)} - y^{(i)}$$

$$\left.\begin{aligned} dw_1 &\mathrel{+}= x_1^{(i)} dz^{(i)} \\ dw_2 &\mathrel{+}= x_2^{(i)} dz^{(i)} \end{aligned}\right\} \quad dw \mathrel{+}= x^{(i)} * dz^{(i)}$$

$$db \mathrel{+}= dz^{(i)}$$

$J = J/m, \; dw_1 = dw_1/m, \; dw_2 = dw_2/m$

$db = db/m$

for iter in range(1000):

$$Z = w^T X + b$$

$$= \text{np.dot}(w.T, X) + b$$

$$A = \sigma(Z)$$

$$dZ = A - Y$$

$$dw = \frac{1}{m} X dZ^T$$

$$db = \frac{1}{m} \text{np.sum}(dZ)$$

$$w := w - \alpha\, dw$$

$$b := b - \alpha\, db$$