LINEAR REGRESSION USING GRADIENT DESCENT

Multiple features

GRADIENT DECENT

$$\vec{w} = (w_1 \quad w_2 \quad \cdots \quad w_{16})$$
$$\vec{d} = (d_1 \quad d_2 \quad \cdots \quad d_{16})$$

```
w = np.array([0.5, 1.3, … 3.4])
d = np.array([0.3, 0.2, … 0.4])
```

compute $w_j = w_j - 0.1d_j$ for $j = 1 \ldots 16$

Without vectorization

$$w_1 = w_1 - 0.1d_1$$
$$w_2 = w_2 - 0.1d_2$$
$$\vdots$$
$$w_{16} = w_{16} - 0.1d_{16}$$

```
for j in range(0,16):
    w[j] = w[j] - 0.1 * d[j]
```

With vectorization

$$\vec{w} = \vec{w} - 0.1\vec{d}$$

```
w = w - 0.1 * d
```

GRADIENT DESCENT WITH MULTIPLE FEATURES

Parameters $w_1, w_2, \cdots, w_n$

b

Model $f_{\vec{w},b}(\vec{x}) = w_1 x_1 + \cdots + w_n x_n + b$

Cost function $J(w_1, w_2, \cdots, w_n, b)$

Vectorized Representation

$\vec{w} = [w_1, w_2, \cdots, w_n]$

b

$f_{\vec{w},b}(\vec{x}) = \vec{w} \cdot \vec{x} + b$

$J(\vec{w}, b)$

GRADIENT DESCENT WITH MULTIPLE FEATURES

Gradient Descent

repeat {

$$w_j = w_j - \alpha \frac{\partial}{\partial w_j} J(w_1, w_2, \cdots, w_n, b)$$

$$b = b - \alpha \frac{\partial}{\partial b} J(w_1, w_2, \cdots, w_n, b)$$

}

repeat {

$$w_j = w_j - \alpha \frac{\partial}{\partial w_j} J(\vec{w}, b)$$

$$b = b - \alpha \frac{\partial}{\partial b} J(\vec{w}, b)$$

GRADIENT DESCENT WITH MULTIPLE FEATURES

Single value (x)

repeat

$$w = w - \frac{\alpha}{m} \sum_{i=1}^{m} \left[f_{w,b}(x^{(i)}) - y^{(i)} \right] x^{(i)}$$

$$b = b - \frac{\alpha}{m} \sum_{i=1}^{m} \left(f_{w,b}(x^{(i)}) - y^{(i)} \right)$$

w_j (for $j = 1, \ldots n$) and b simultaneous update

Multiple value ($\vec{x}$)

repeat

$$w_1 = w_1 - \frac{\alpha}{m} \sum_{i=1}^{m} \left[f_{\vec{w},b}(\vec{x}^{(i)}) - y^{(i)} \right] x_1^{(i)}$$

$$\vdots$$

$$w_n = w_n - \frac{\alpha}{m} \sum_{i=1}^{m} \left[f_{\vec{w},b}(\vec{x}^{(i)}) - y^{(i)} \right] x_n^{(i)}$$

$$b = b - \frac{\alpha}{m} \sum_{i=1}^{m} \left[f_{\vec{w},b}(\vec{x}^{(i)}) - y^{(i)} \right]$$

PRACTICAL

Age	BMI	BloodPressure	Cholesterol	HealthScore
58	27.91	97.28	276.63	213.55
71	27.09	123.27	289.5	239.14
48	34.36	111.79	160.56	139.43
34	32.43	162.28	181.34	163.7
62	30.83	132.33	250.67	201.26
27	27.4	178.51	203.8	178.43
40	28.18	125.89	188.12	160.5
58	34.43	163.48	194.29	179.41
77	28.52	161.85	198.38	198.96
38	23.05	103.56	277.3	210.24