

Gradient Descent For Multiple Variables

Gradient Descent for Multiple Variables

The gradient descent equation itself is generally the same form; we just have to repeat it for our 'n' features:

```
repeat until convergence: {
   $\theta_0 := \theta_0 - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)}) \cdot x_0^{(i)}$ 
   $\theta_1 := \theta_1 - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)}) \cdot x_1^{(i)}$ 
   $\theta_2 := \theta_2 - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)}) \cdot x_2^{(i)}$ 
  ...
}
```

In other words:

```
repeat until convergence: {
   $\theta_j := \theta_j - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)}) \cdot x_j^{(i)}$     for j := 0...n
}
```

The following image compares gradient descent with one variable to gradient descent with multiple variables:

Gradient Descent

Previously (n=1):

Repeat {

$\theta_0 := \theta_0 - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)})$

$\frac{\partial}{\partial \theta_0} J(\theta)$

$\theta_1 := \theta_1 - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)}) x_1^{(i)}$

(simultaneously update θ_0, θ_1)

}

New algorithm (n ≥ 1):

Repeat {

$\theta_j := \theta_j - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)}) x_j^{(i)}$

(simultaneously update θ_j for $j = 0, \dots, n$)

}

$\theta_0 := \theta_0 - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)}) x_0^{(i)}$

$\theta_1 := \theta_1 - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)}) x_1^{(i)}$

$\theta_2 := \theta_2 - \alpha \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x^{(i)}) - y^{(i)}) x_2^{(i)}$

Handwritten notes in red:

- For the first algorithm, the term $\frac{\partial}{\partial \theta_0} J(\theta)$ is boxed, and a red arrow points from the first equation to it.
- For the second algorithm, the term $\frac{\partial}{\partial \theta_j} J(\theta)$ is written above the first equation, with a red arrow pointing to it.
- Red circles highlight $x_0^{(i)}$ and $x_1^{(i)}$ in the equations of the second algorithm.
- Red arrows indicate the flow of the algorithms.