

## Gradient Checking

Gradient checking will assure that our backpropagation works as intended. We can approximate the derivative of our cost function with:

$$\frac{\partial}{\partial \Theta} J(\Theta) \approx \frac{J(\Theta + \epsilon) - J(\Theta - \epsilon)}{2\epsilon}$$

With multiple theta matrices, we can approximate the derivative **with respect to  $\Theta_j$**  as follows:

$$\frac{\partial}{\partial \Theta_j} J(\Theta) \approx \frac{J(\Theta_1, \dots, \Theta_j + \epsilon, \dots, \Theta_n) - J(\Theta_1, \dots, \Theta_j - \epsilon, \dots, \Theta_n)}{2\epsilon}$$

A small value for  $\epsilon$  (epsilon) such as  $\epsilon = 10^{-4}$ , guarantees that the math works out properly. If the value is too small, we can end up with numerical problems.

Hence, we are only adding or subtracting epsilon to the  $\Theta_j$  matrix. In octave we can do it as follows:

```
1  epsilon = 1e-4;
2  for i = 1:n,
3      thetaPlus = theta;
4      thetaPlus(i) += epsilon;
5      thetaMinus = theta;
6      thetaMinus(i) -= epsilon;
7      gradApprox(i) = (J(thetaPlus) - J(thetaMinus))/(2*epsilon)
8  end;
9
```

We previously saw how to calculate the deltaVector. So once we compute our gradApprox vector, we can compare:  $\text{gradApprox} \approx \text{deltaVector}$ .

Once you have verified **once** that your backpropagation algorithm is correct, you don't need to compute gradApprox again. The code to compute gradApprox can be very slow.

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 **Completed**