Deep Learning and Temporal Data Processing

0 - Gradient Descent

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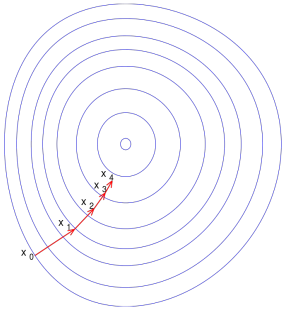
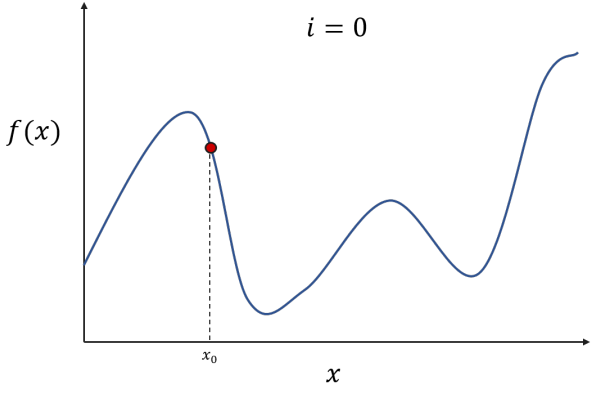
Agenda

Gradient Descent

Gradient descent is an iterative optimization algorithm for finding the minimum of a function. How? Take step proportional to the negative of the gradient of the function at the current point.



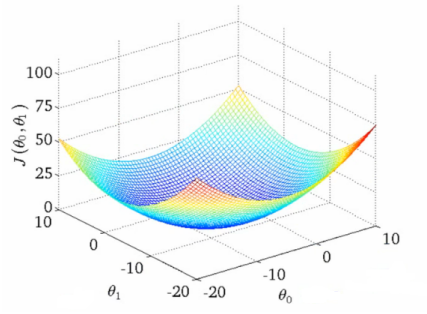
Gradient Descent for 1-d function $f(x)$.



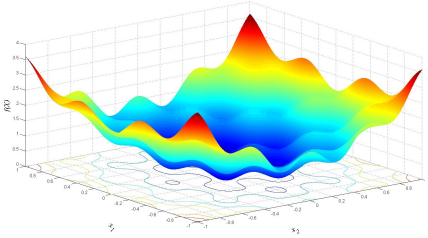
$$\frac{df}{dx} < 0$$

$$x_{new} = x_{old} - \alpha \frac{df}{dx}$$

Turns out that if the function is **convex** gradient descent will converge to the **global minimum**. For **non-convex** functions, it may converge to **local minima**.



Convex Function



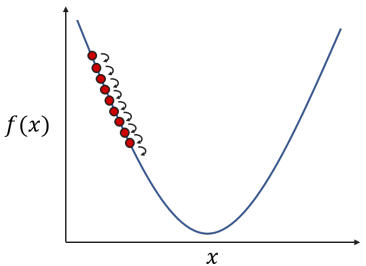
Non-Convex Function

Gradient descent is often used in machine learning to **minimize a cost function**, often also called *objective* or *loss* function.

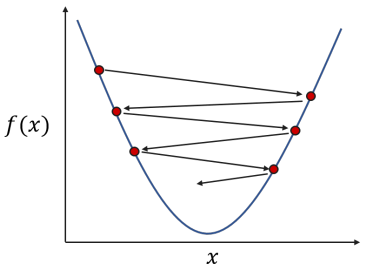
The cost function depends on the model's parameters and is a proxy to evaluate model's performance. Generally speaking, minimizing the cost equals to maximizing the effectiveness of the model.

In practice, SGD

Choosing the the right **learning rate** α is essential to correctly proceed towards the minimum. A step *too small* could lead to an extremely *slow* convergence. If the step is *too big* the optimizer could *overshoot* the minimum or even *diverge*.



Learning Rate too small



Learning Rate too big

A number of different optimizer [2, 1, 3] are commonly used , but these are out of the scope of this short introduction.

Credits

These slides heavily borrow from a number of awesome sources. I'm really grateful to all the people who take the time to share their knowledge on this subject with others.

In particular:

- Stanford CS231n Convolutional Neural Networks for Visual Recognition
  http://cs231n.stanford.edu/
- Deep Learning Book (GoodFellow, Bengio, Courville)
  http://www.deeplearningbook.org/
- Convolution arithmetic animations
  https://github.com/vdumoulin/conv_arithmetic

- Andrej Karphathy personal blog
  http://karpathy.github.io/
- WildML blog on AI, DL and NLP
  http://www.wildml.com/
- Michael Nielsen Deep Learning online book
  http://neuralnetworksanddeeplearning.com/

References

References i

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arXiv preprint arXiv:1412.6980, 2014.

[3] M. D. Zeiler.
Adadelta: an adaptive learning rate method.
arXiv preprint arXiv:1212.5701, 2012.