Adversarial examples in deep learning

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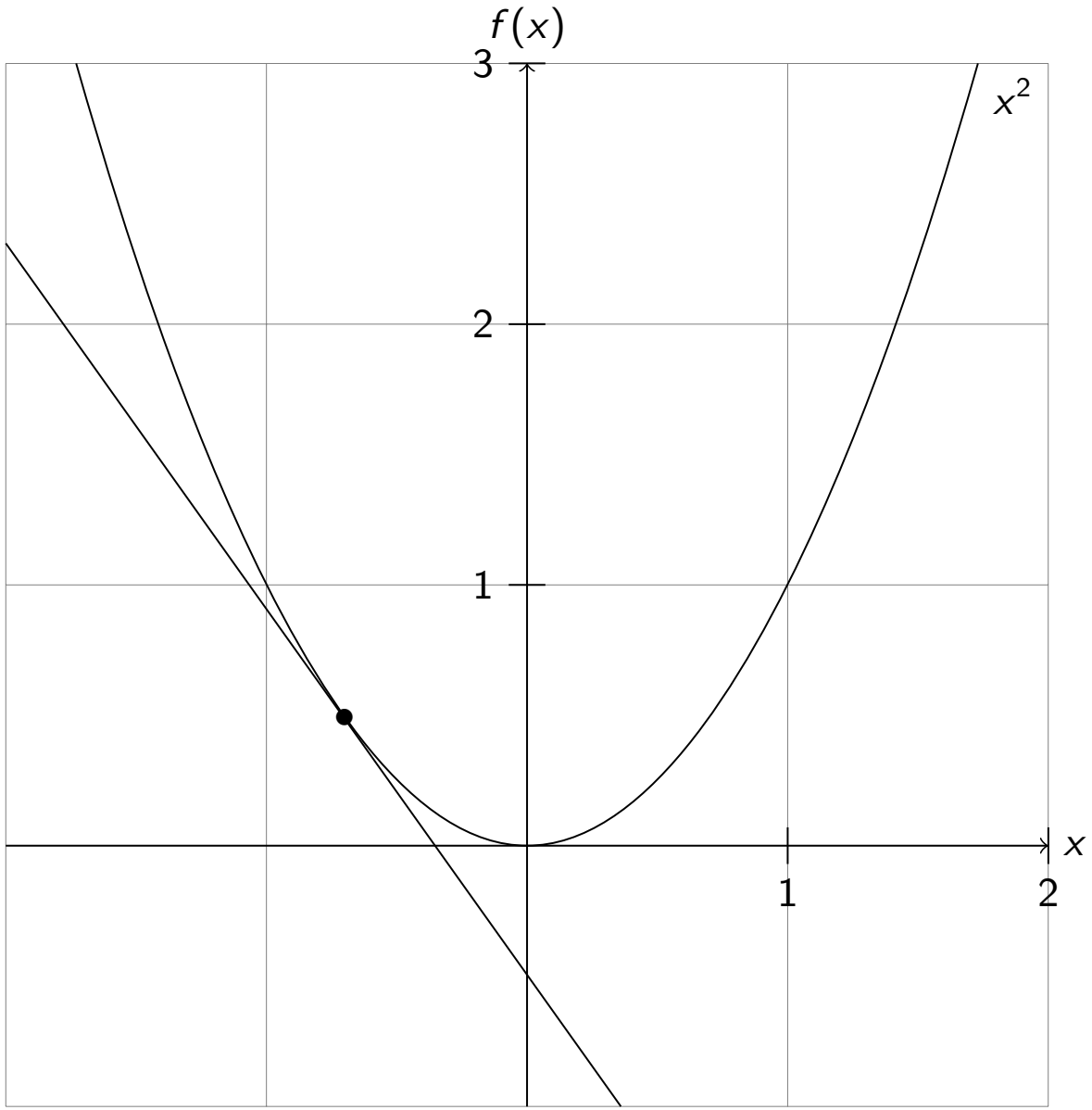
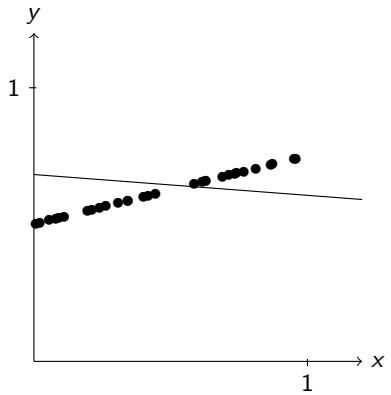
Basic notions

An adversarial example is a sample of input data which has been modified very slightly in a way that is intended to cause a machine learning classifier to misclassify it.

Gradient descent



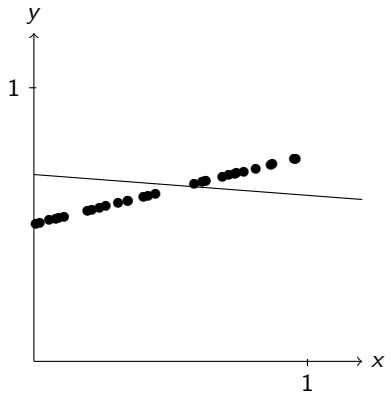
Gradient descent



We have a set of points that we want to approximate with a line.

$$y = ax + b$$

Gradient descent



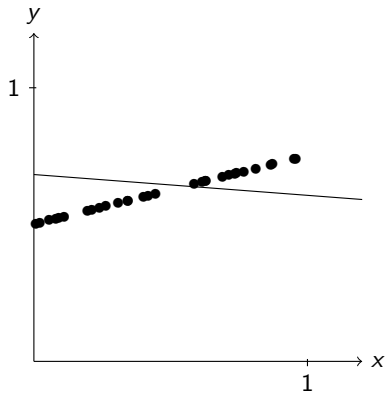
We have a set of points that we want to approximate with a line.

$$y = ax + b$$

First we choose a loss that measures how good our predictions are.

$$l(x, y, a, b) = (y - (ax + b))^2$$

Gradient descent



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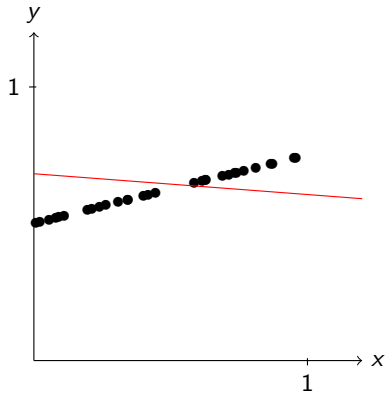
$$l(x, y, a, b) = (y - (ax + b))^2$$

We compute how the loss is affected by small changes of a and b:

$$\frac{\mathrm{d}l}{\mathrm{d}a} = 2x(ax + b - y) \qquad \frac{\mathrm{d}l}{\mathrm{d}b} = 2(ax + b - y)$$

And we update a and b iteratively until we reach a satisfying result (the average loss is low enough).

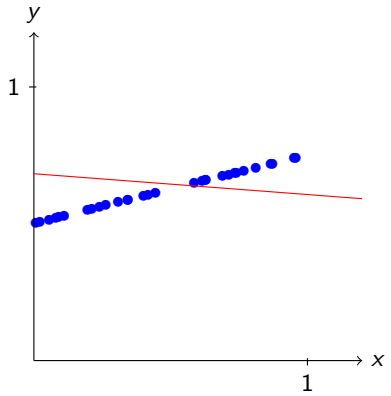
Gradient descent



In our previous example, we have modified the model in order to minimize the loss.

$$y = ax + b$$

Gradient descent



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Now suppose we are an evil attacker who wants to maximise the loss with the model being fixed. The only thing we can modify is the inputs.

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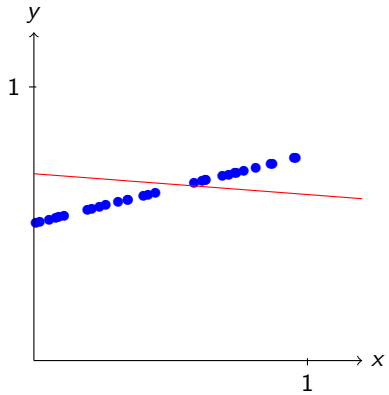
Gradient descent



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In order to do this, we compute how the loss is affected by small changes of the input:

$$\frac{\mathrm{d}l}{\mathrm{d}x} = 2a(ax + b - y)$$

We can now make *imperceptible* changes to the data points to make the loss grow.

Attack

Defense