Adversarial examples in deep learning

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Basic notions

Adversarial example

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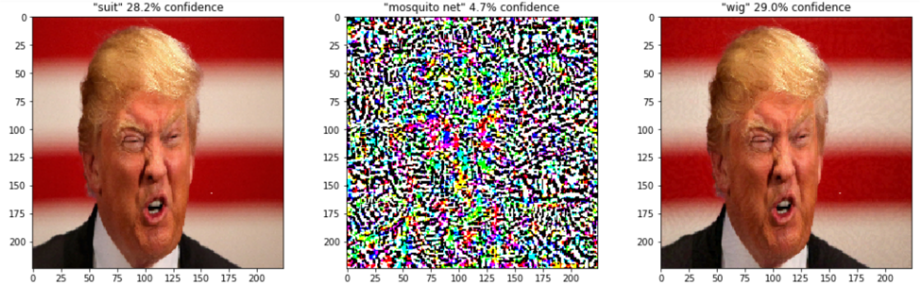
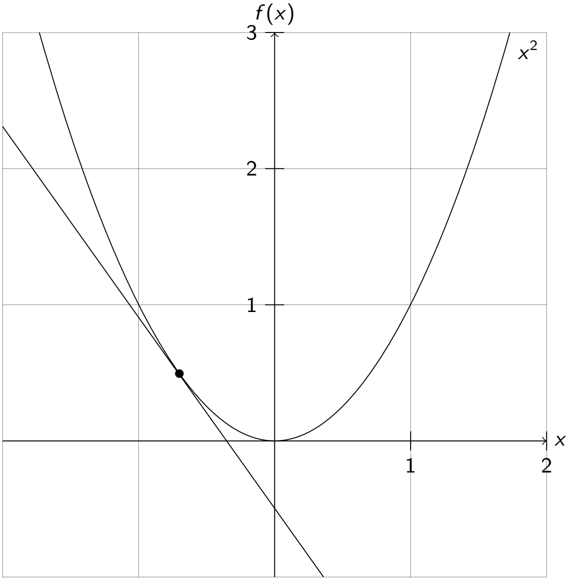
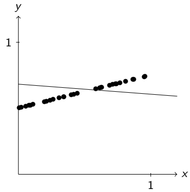


Gradient descent

Basic concept



Gradient descent
Model optimization

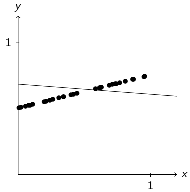


We have a set of points that we want to approximate with a line.

$$y = ax + b$$

Gradient descent

Model optimization



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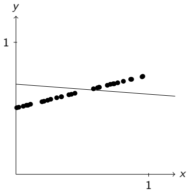
First we choose a loss that measures how good our predictions are.

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

Gradient descent

Model optimization



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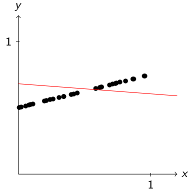
We compute how the loss is affected by small changes of a and b:

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

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

Gradient descent

Being evil

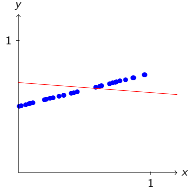


In our previous example, we have modified the model in order to minimize the loss.

$$y = ax + b$$

Gradient descent

Being evil



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Now suppose we are an attacker who wants to maximise the loss of a model, its parameters being fixed. The only thing we can modify is the inputs.

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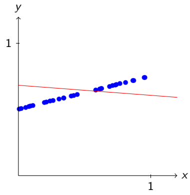

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Now suppose we are an attacker who wants to maximise the loss of a model, its parameters being fixed. The only thing we can modify is the inputs.

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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.

Fast Gradient Sign Method

Move along the derivate away from the correct value as a way to maximise the error.

FGSM variants

- Targeted FGSM
- Iterative FGSM
- RAND + FGSM

Black box attack

This is nice but happens if you cannot access the gradients

Adversarial examples in the physical world

This is nice but in the physical world, we are not feeding the network with our own data, it is acquired by the network's system (using camera for example).

Defense