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Optimization Algorithms

Mini-batch gradient descent

Batch vs. mini-batch gradient descent

Vectorization allows you to efficiently compute on m examples.

Mini-batch gradient descent

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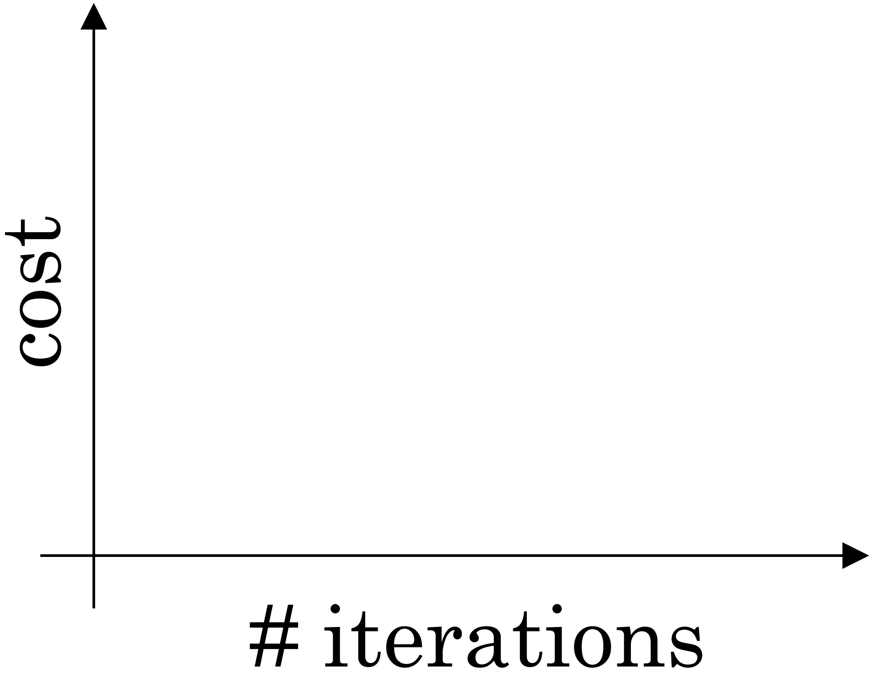
Optimization Algorithms

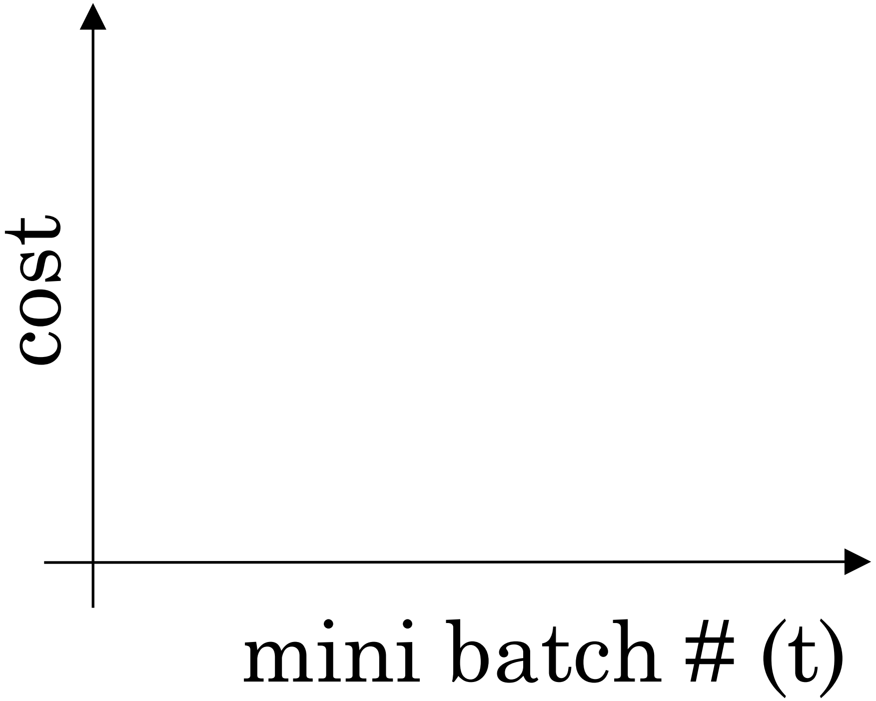
Understanding mini-batch gradient descent

Training with mini batch gradient descent

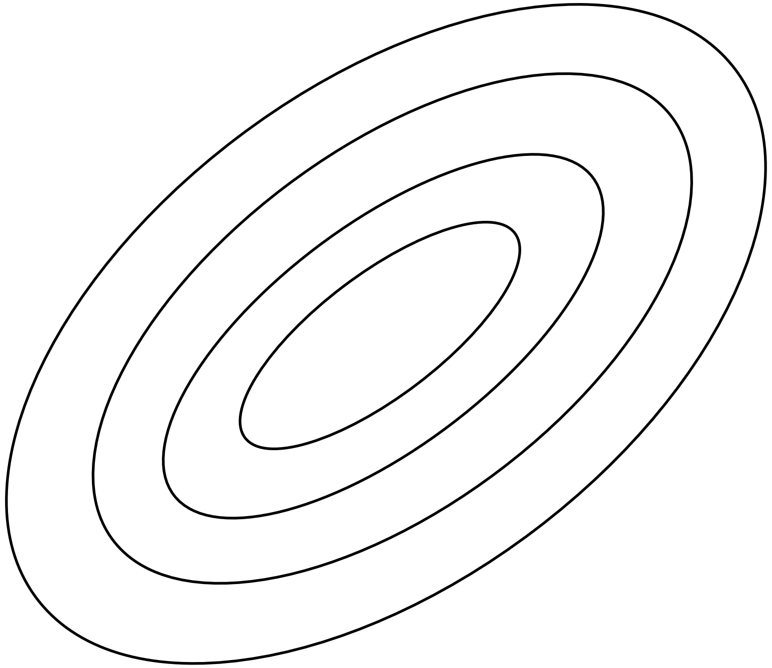
Batch gradient descent



Mini-batch gradient descent



Choosing your mini-batch size



Choosing your mini-batch size

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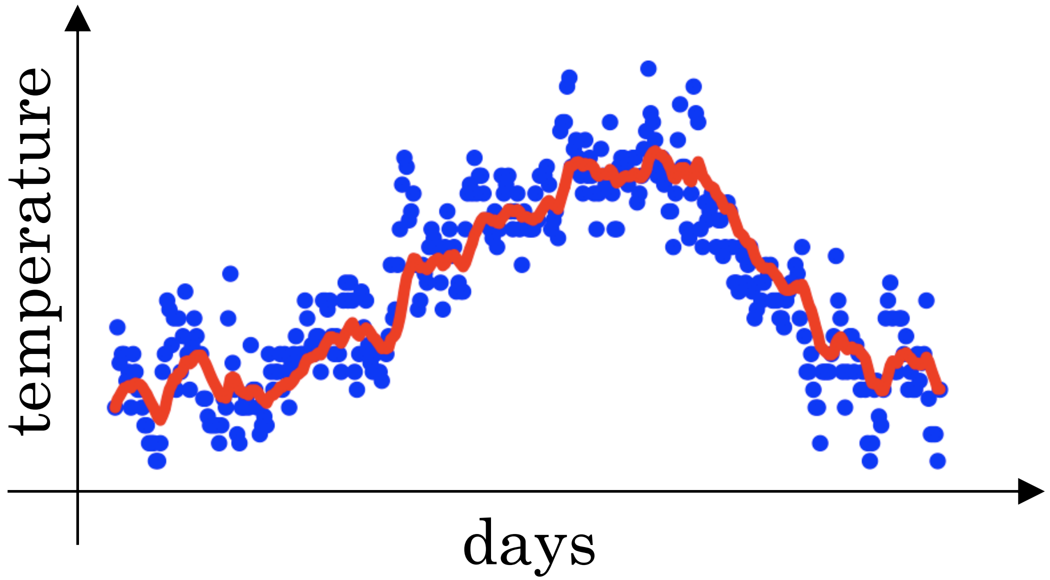
Optimization Algorithms

Exponentially weighted averages

Temperature in London

$\theta_1 = 40°\text{F}$
$\theta_2 = 49°\text{F}$
$\theta_3 = 45°\text{F}$
$\vdots$
$\theta_{180} = 60°\text{F}$
$\theta_{181} = 56°\text{F}$
$\vdots$



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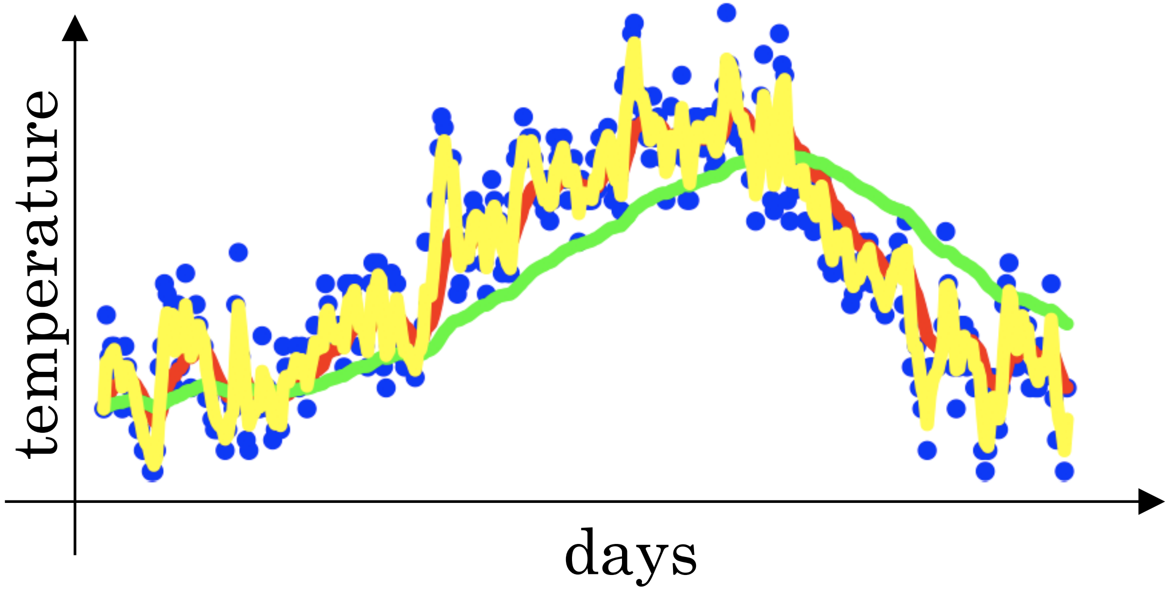
Exponentially weighted averages



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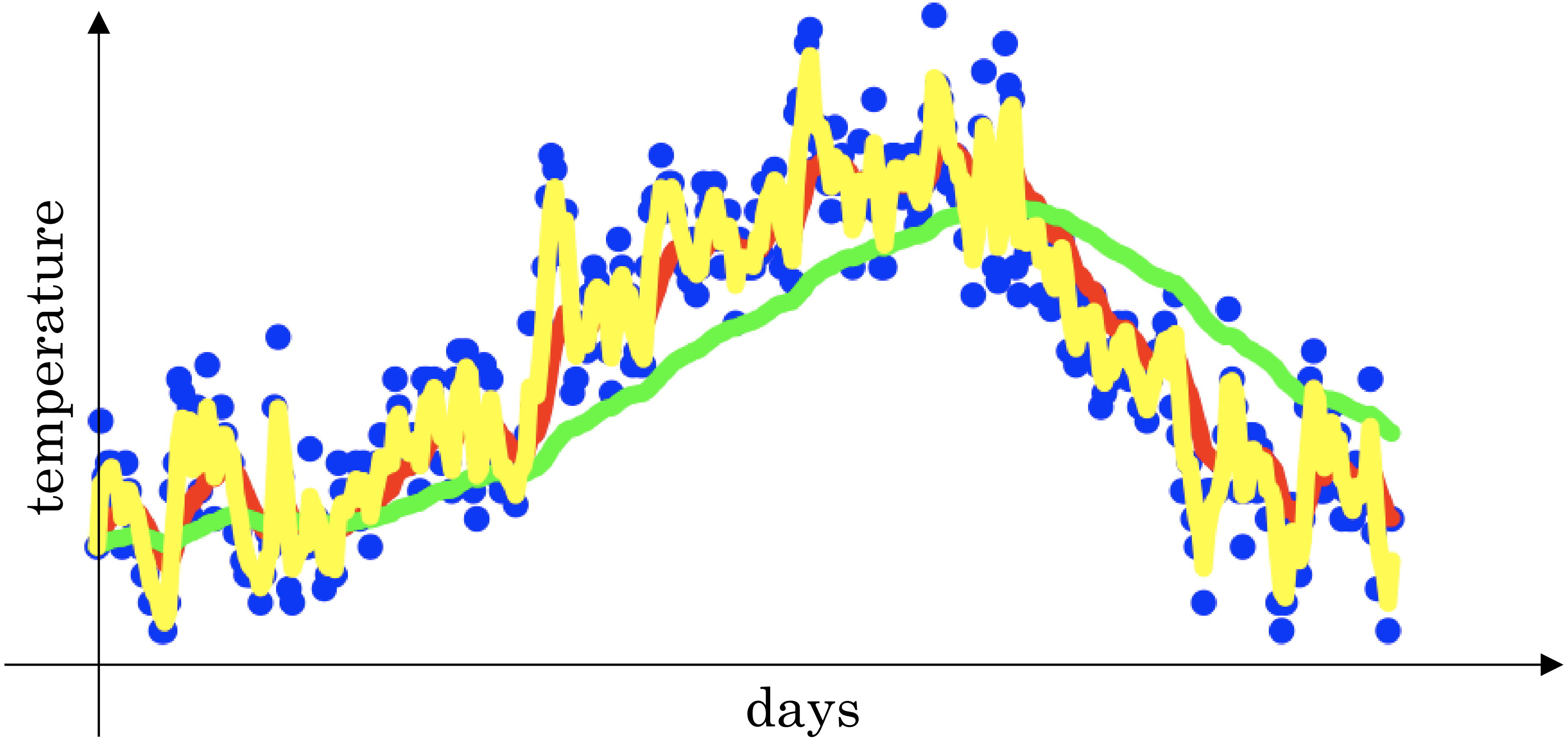
Optimization Algorithms

Understanding exponentially weighted averages

Exponentially weighted averages

$$v_t = \beta v_{t-1} + (1-\beta)\theta_t$$



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Exponentially weighted averages

$$v_t = \beta v_{t-1} + (1-\beta)\theta_t$$

$$v_{100} = 0.9 v_{99} + 0.1 \theta_{100}$$

$$v_{99} = 0.9 v_{98} + 0.1 \theta_{99}$$

$$v_{98} = 0.9 v_{97} + 0.1 \theta_{98}$$

…

Implementing exponentially weighted averages

$$v_0 = 0$$

$$v_1 = \beta v_0 + (1-\beta)\,\theta_1$$

$$v_2 = \beta v_1 + (1-\beta)\,\theta_2$$

$$v_3 = \beta v_2 + (1-\beta)\,\theta_3$$

$$\ldots$$

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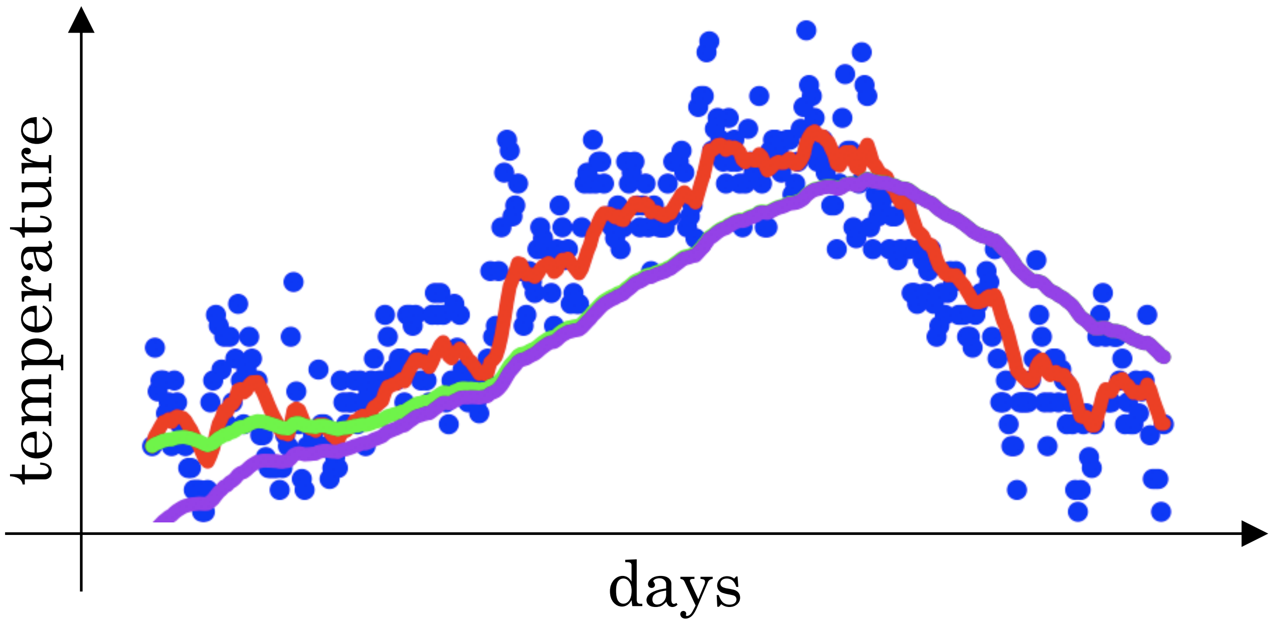
Optimization Algorithms

Bias correction in exponentially weighted average

Bias correction



$$v_t = \beta v_{t-1} + (1 - \beta)\theta_t$$

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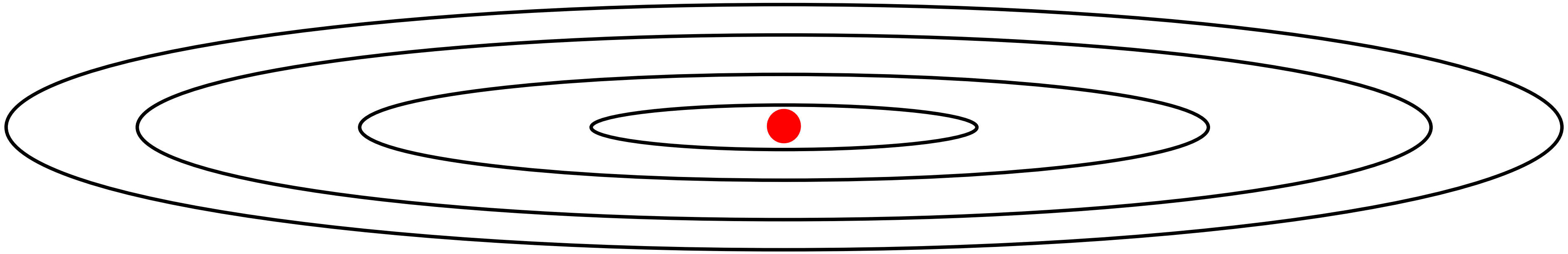
Optimization Algorithms

Gradient descent with momentum

Gradient descent example



Implementation details

On iteration t:

Compute dW, db on the current mini-batch

$$v_{dW} = \beta v_{dW} + (1-\beta)dW$$

$$v_{db} = \beta v_{db} + (1-\beta)db$$

$$W = W - \alpha v_{dW}, \;\; b = b - \alpha v_{db}$$

Hyperparameters: α, β $\qquad\qquad$ $\beta = 0.9$

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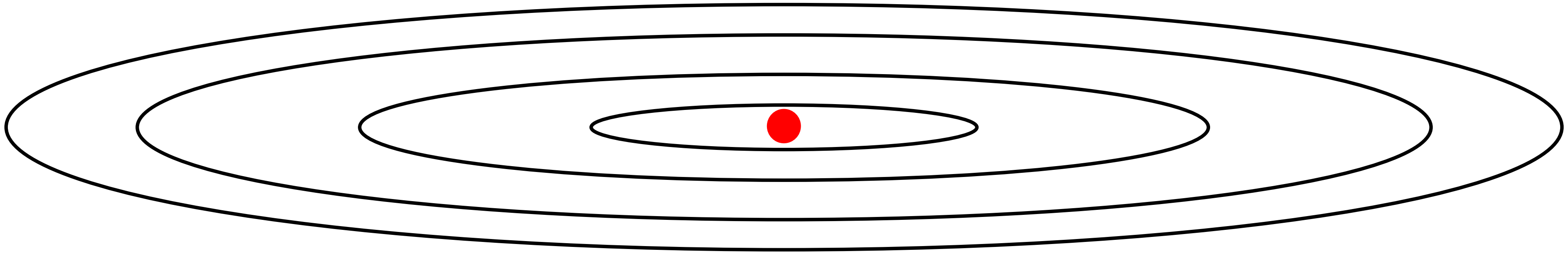
Optimization Algorithms

RMSprop

RMSprop



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Optimization Algorithms

Adam optimization algorithm

Adam optimization algorithm

```
yhat = np.array([.9, 0.2, 0.1, .4, .9])
```

Hyperparameters choice:

Adam Coates

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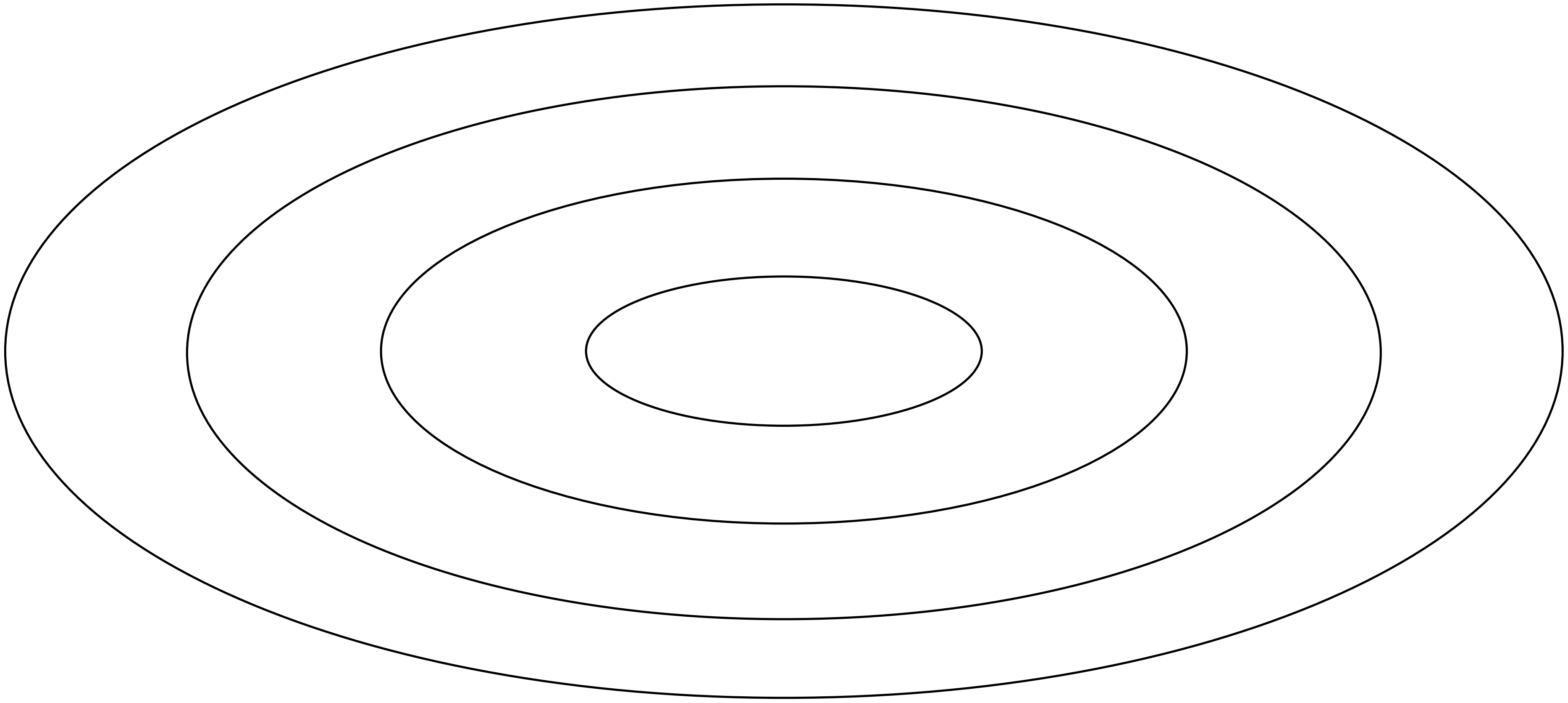
Optimization Algorithms

Learning rate decay

Learning rate decay



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Learning rate decay

Other learning rate decay methods

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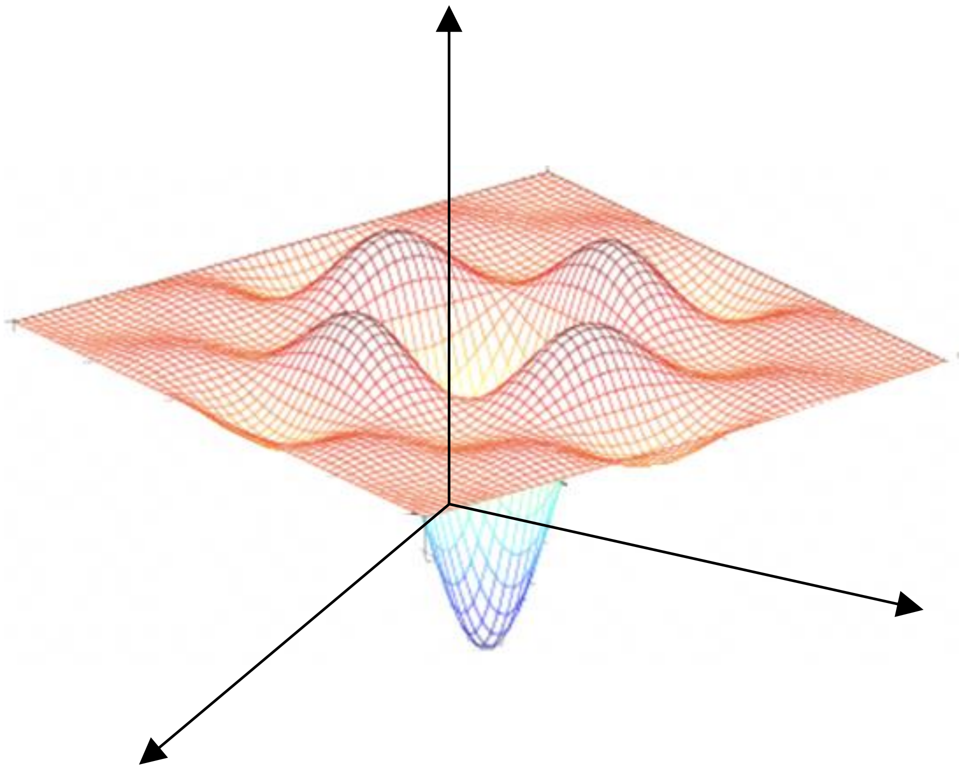
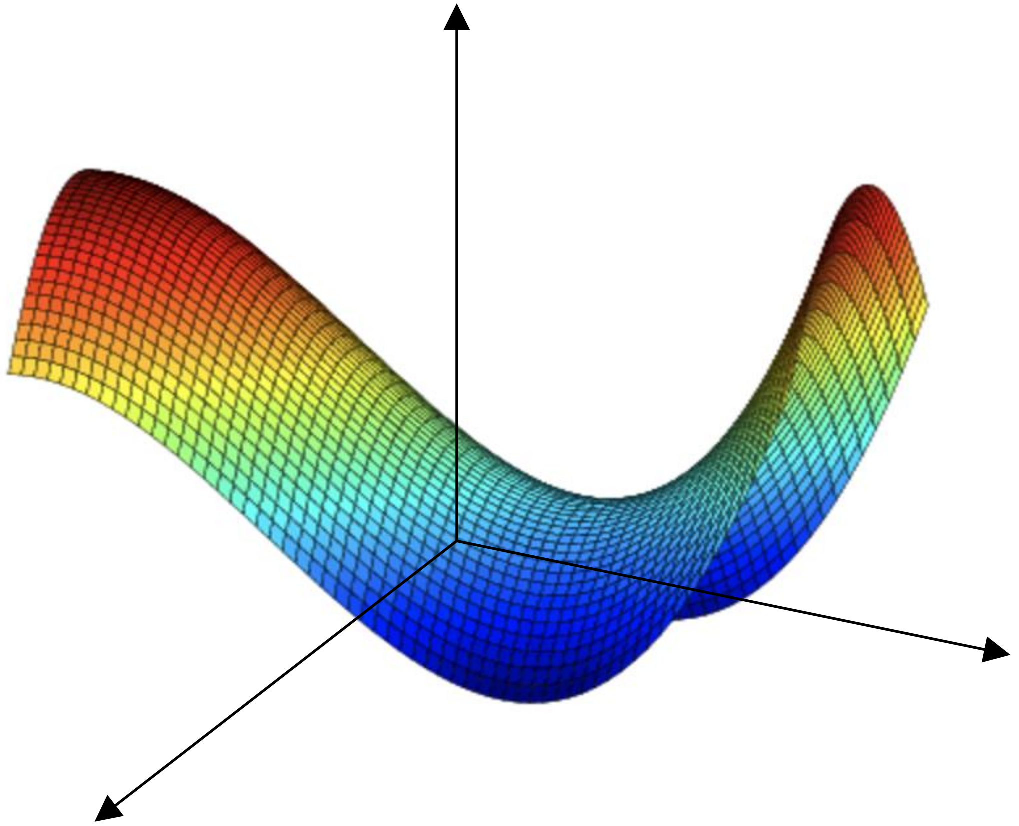
Optimization Algorithms

The problem of local optima

Local optima in neural networks





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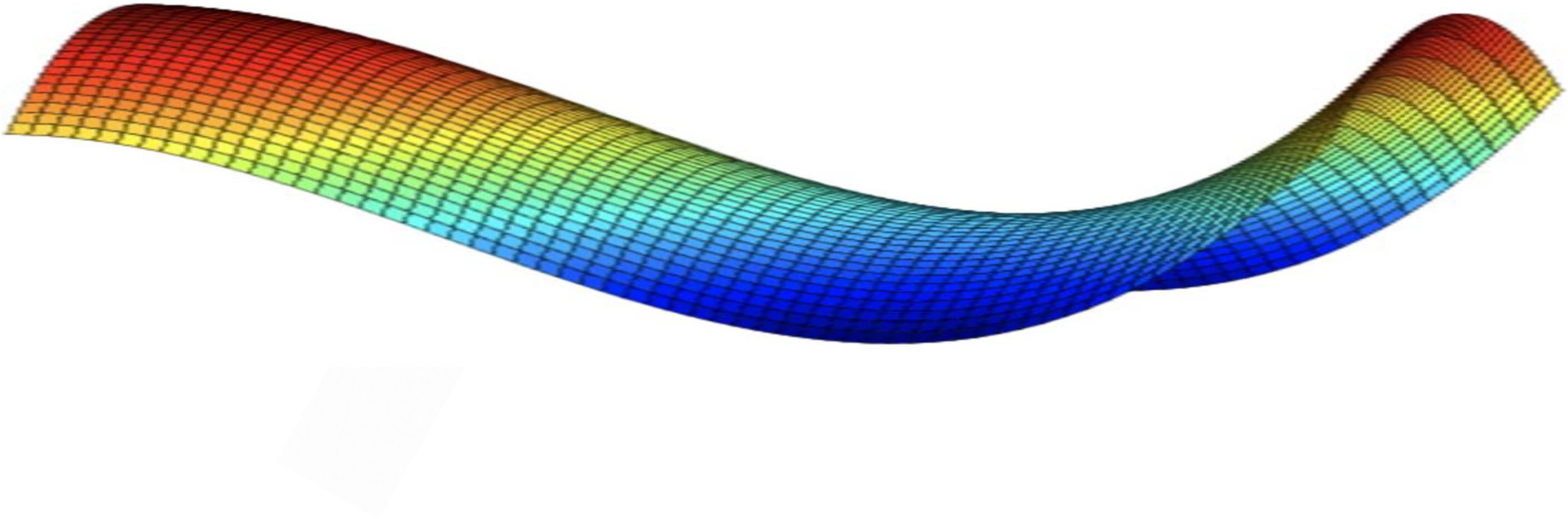
Problem of plateaus



- Unlikely to get stuck in a bad local optima
- Plateaus can make learning slow