Problems with Gradient Descent

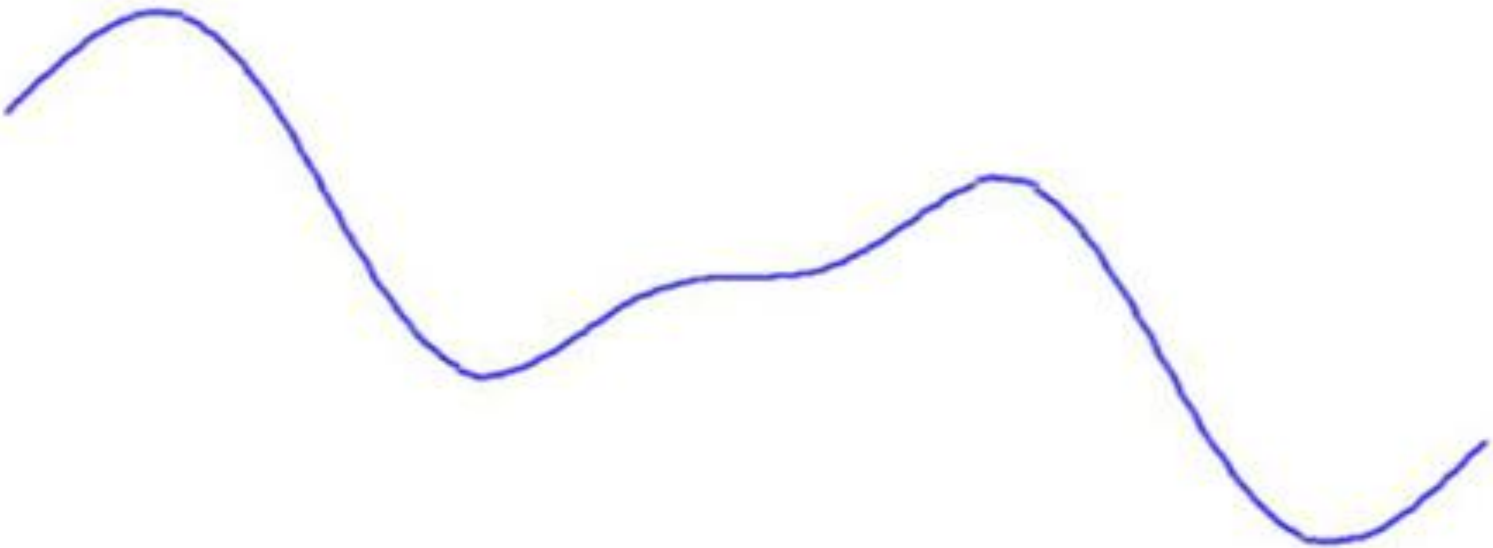
Problems with Gradient Descent

1. Getting stuck at local minima

Analytics
Vidhya

Problems with Gradient Descent

1. Getting stuck at local minima



Analytics Vidhya
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Problems with Gradient Descent

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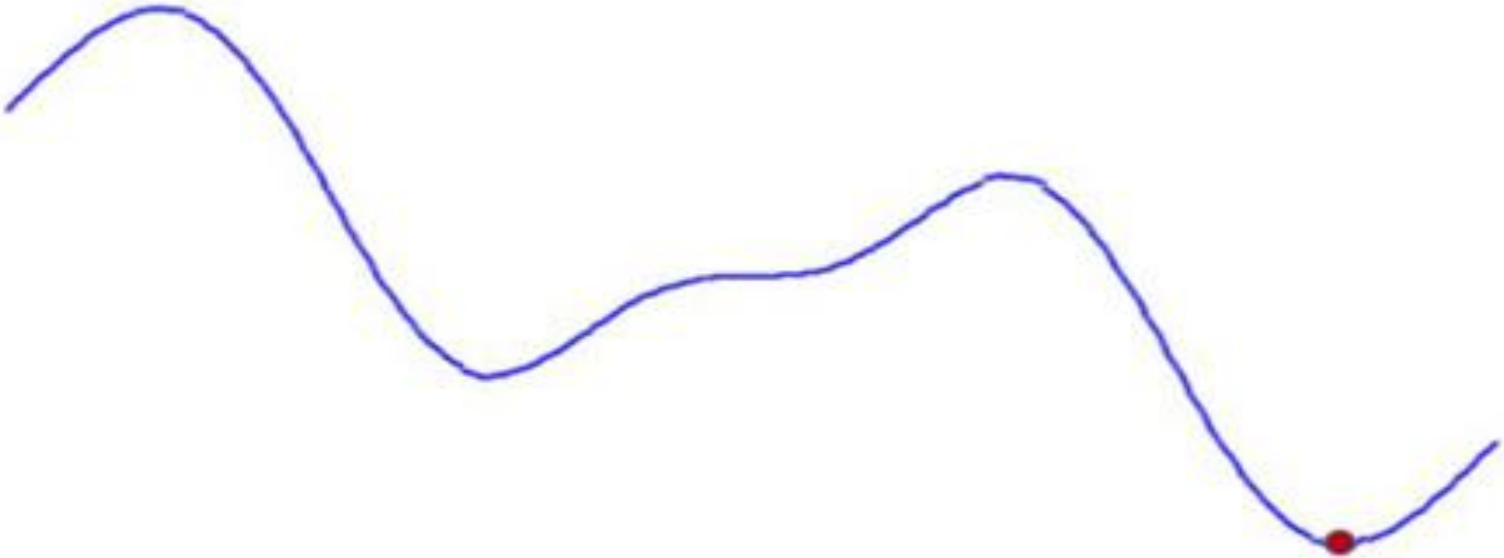

Problems with Gradient Descent

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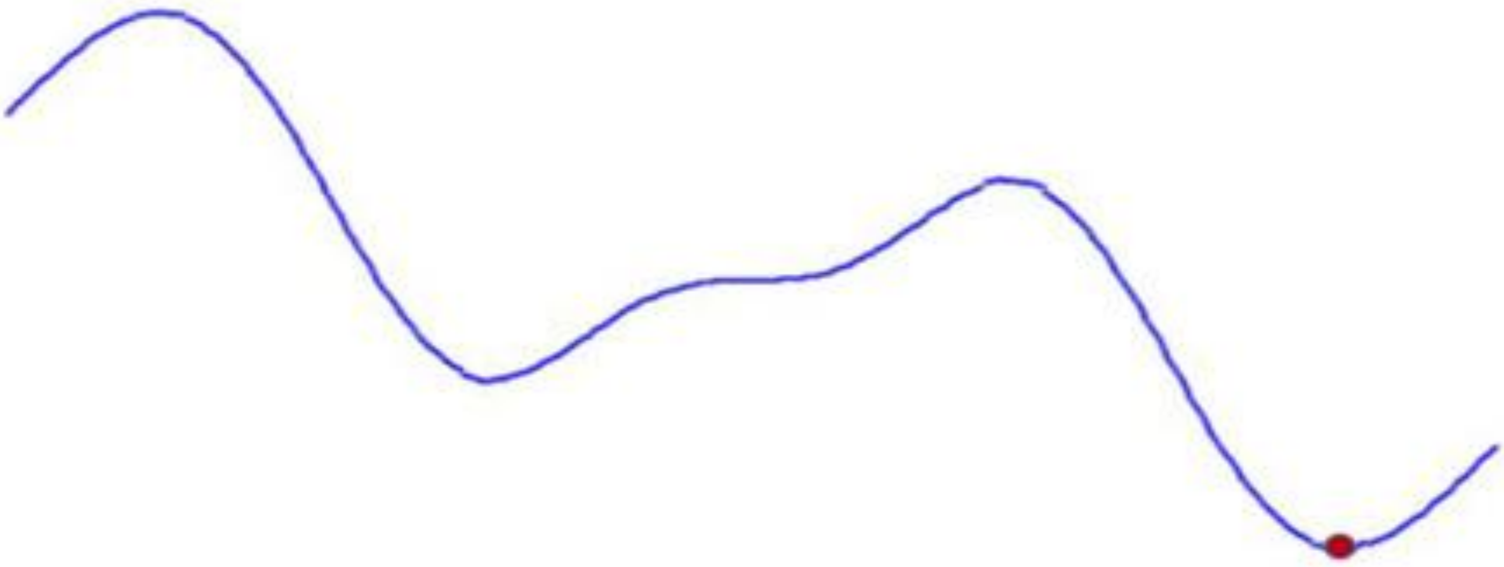

Global Minima

Problems with Gradient Descent

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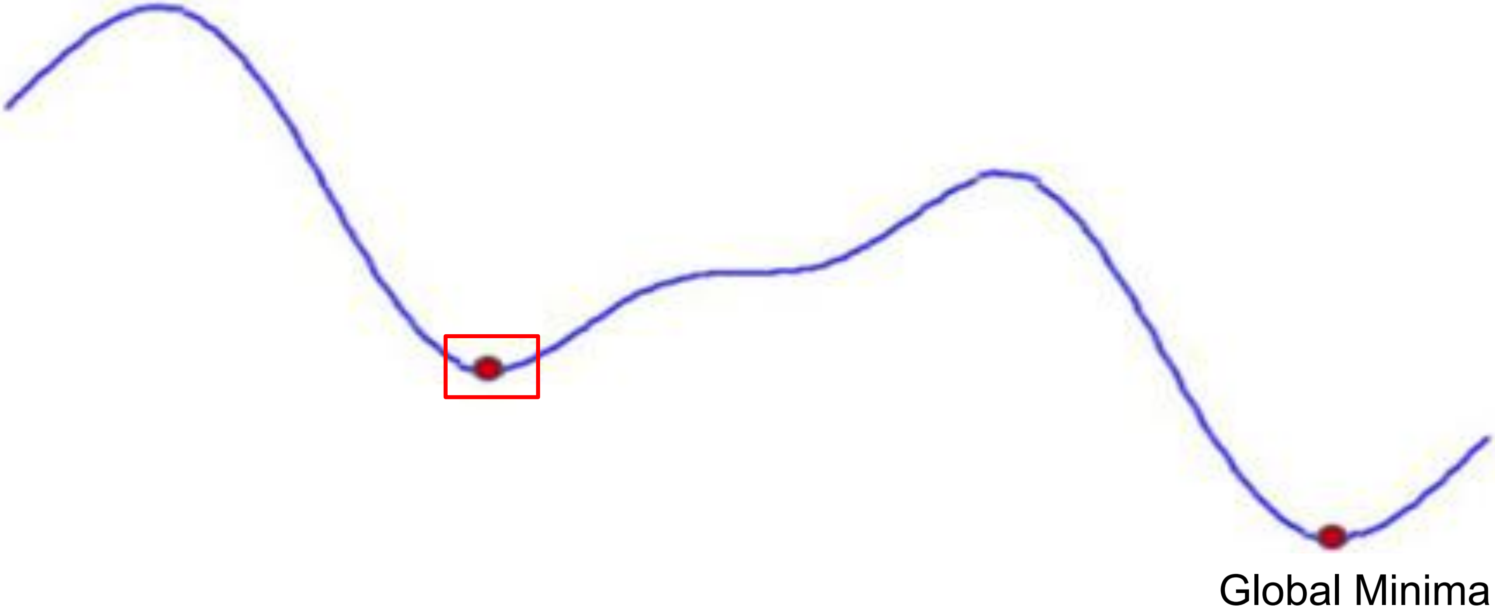
Global Minima

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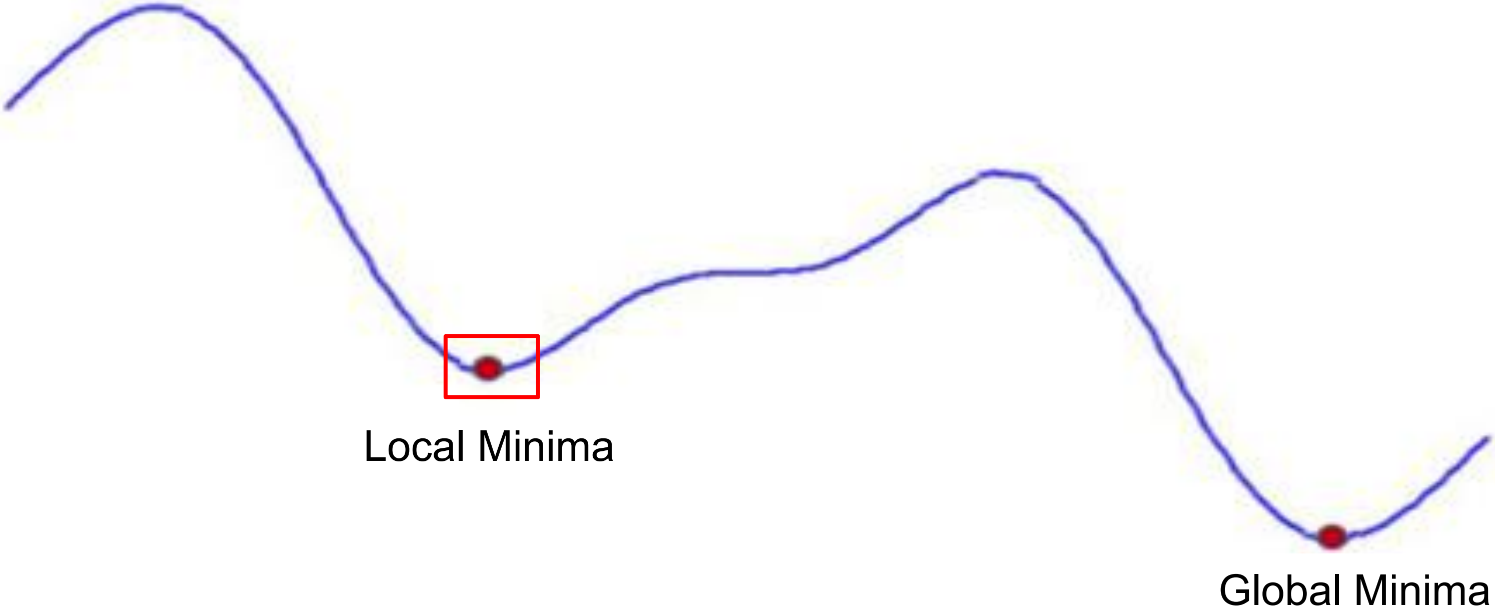
Local Minima
Global Minima

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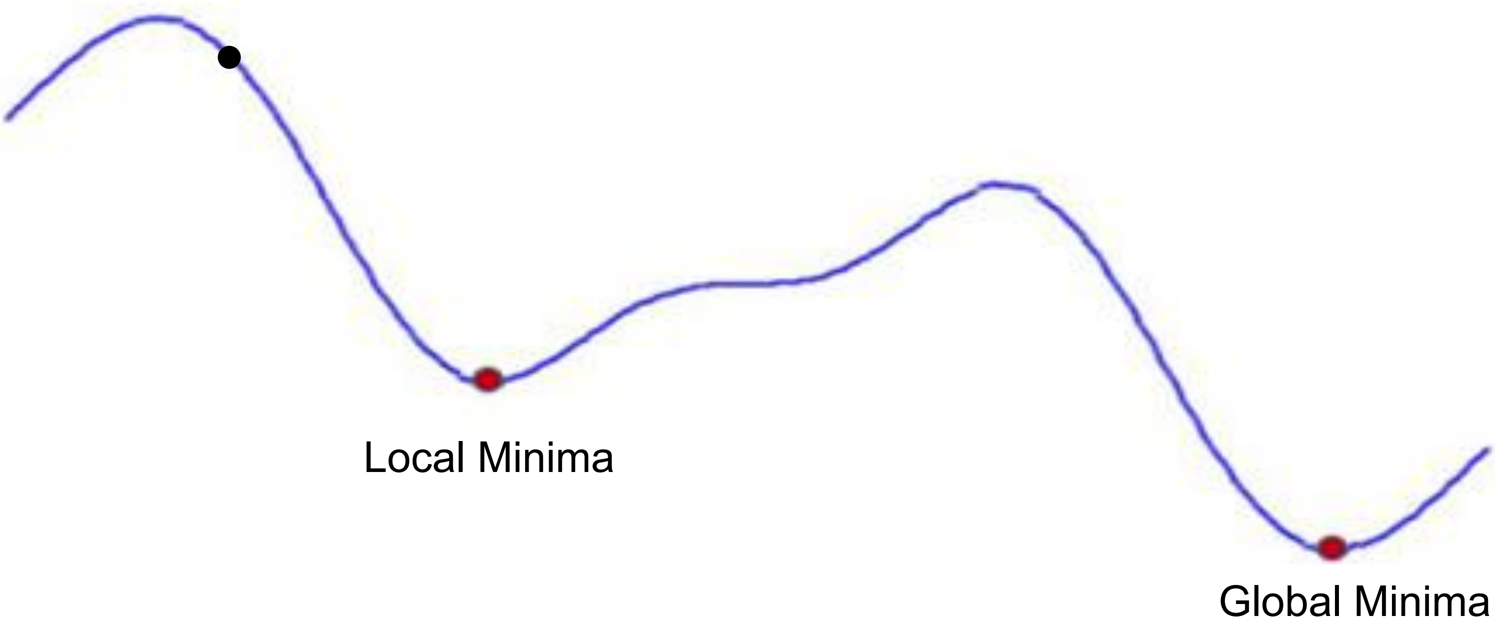
Local Minima
Global Minima

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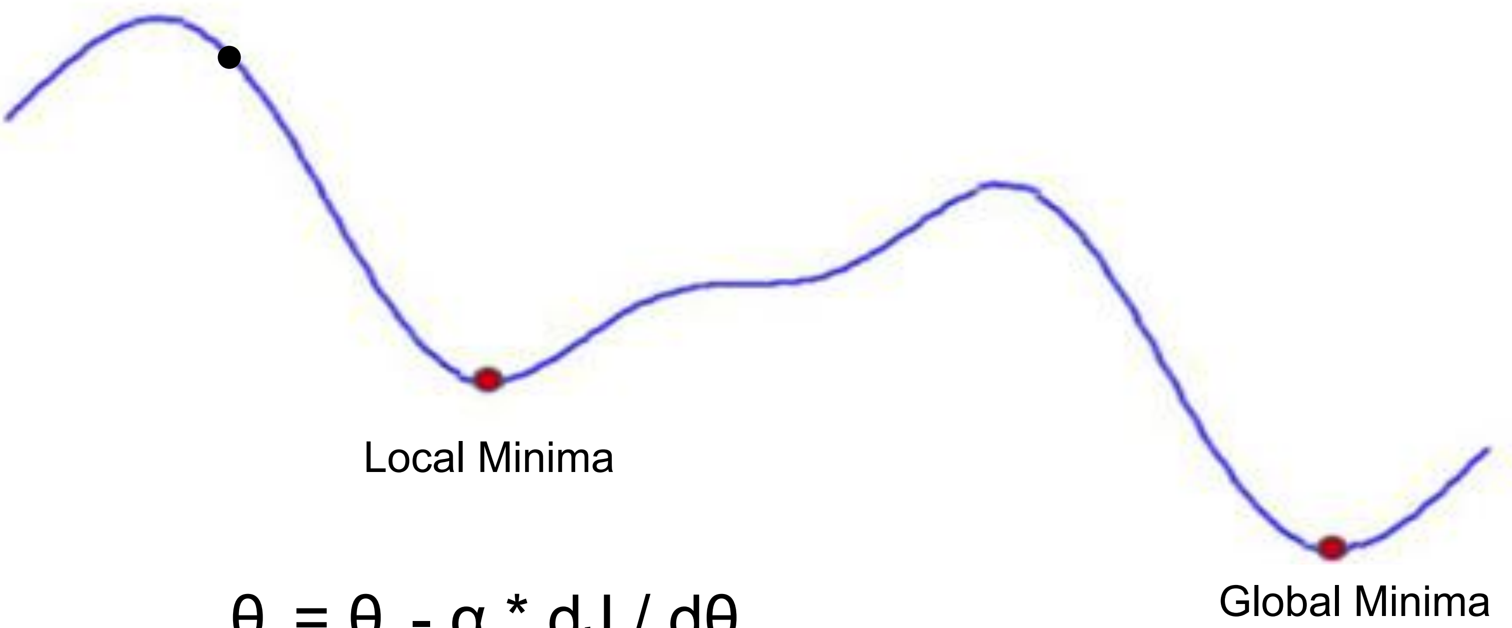
Local Minima
Global Minima

$$\theta_i = \theta_i - \alpha * dJ / d\theta_i$$

Problems with Gradient Descent

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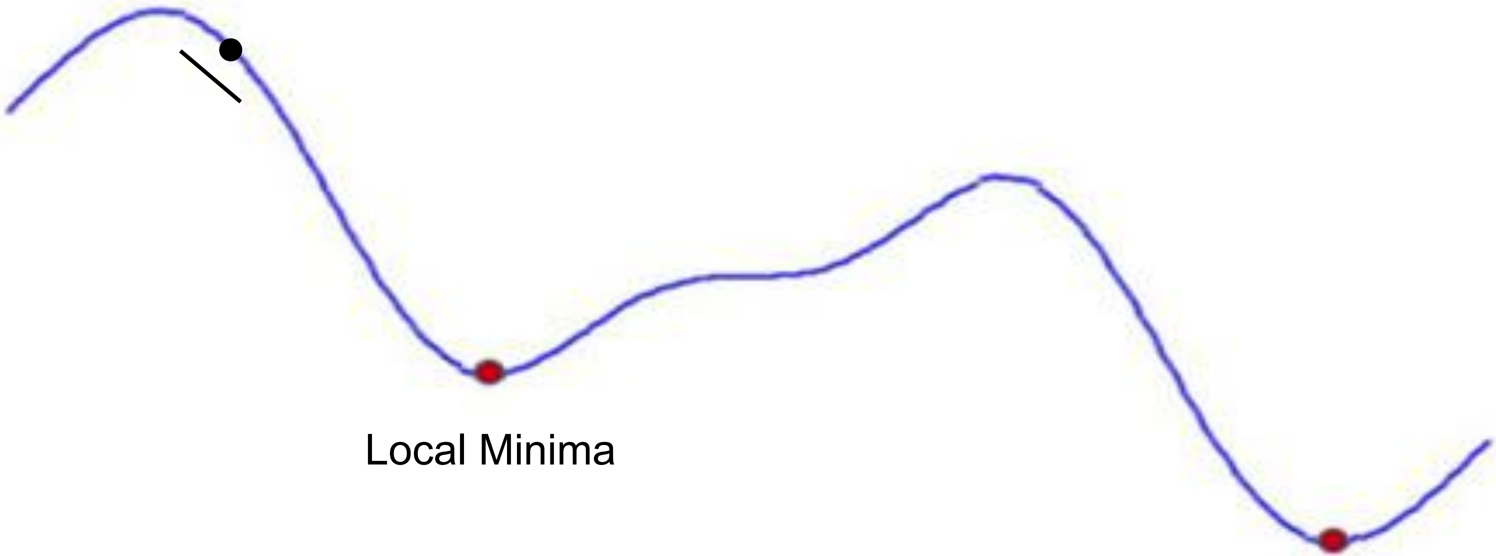

Local Minima

Global Minima

$$\theta_i = \theta_i - \alpha * dJ / d\theta_i$$

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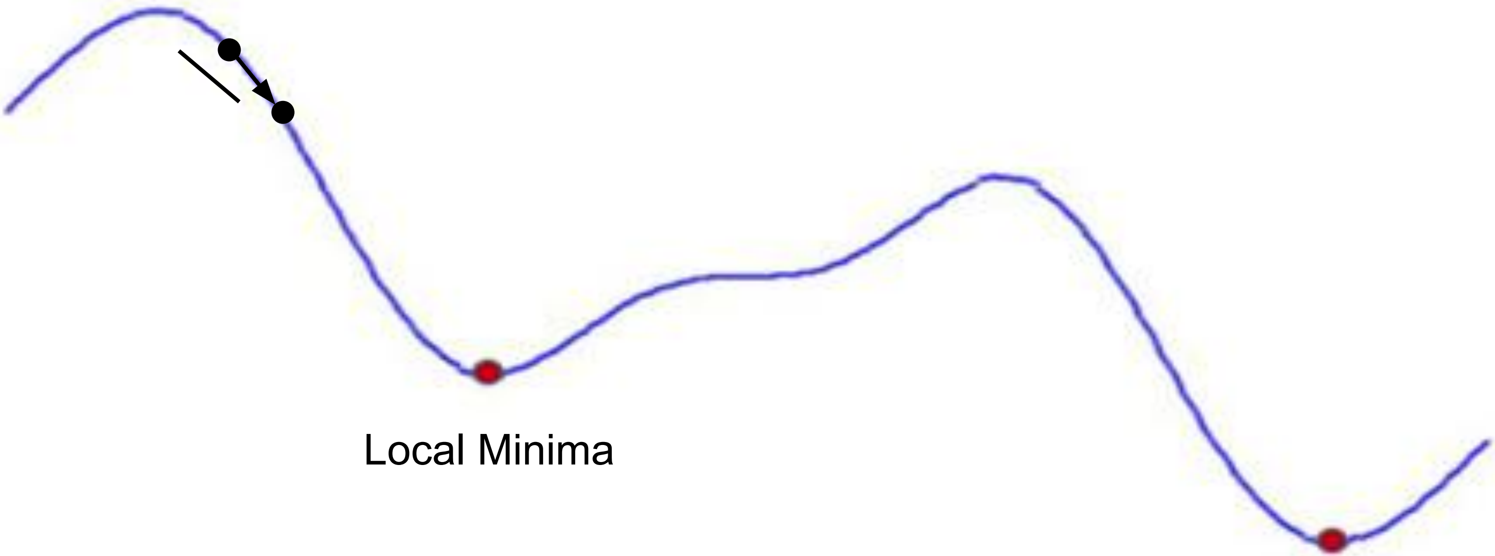

Local Minima

Global Minima

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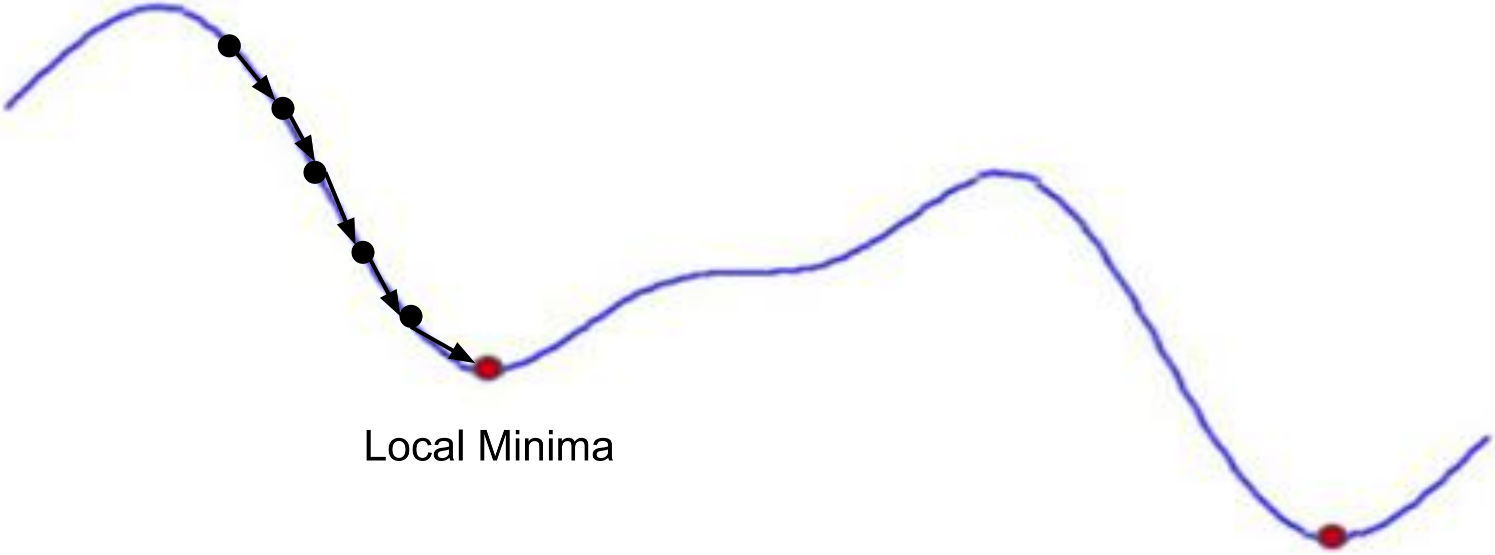

Local Minima
Global Minima

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Problems with Gradient Descent

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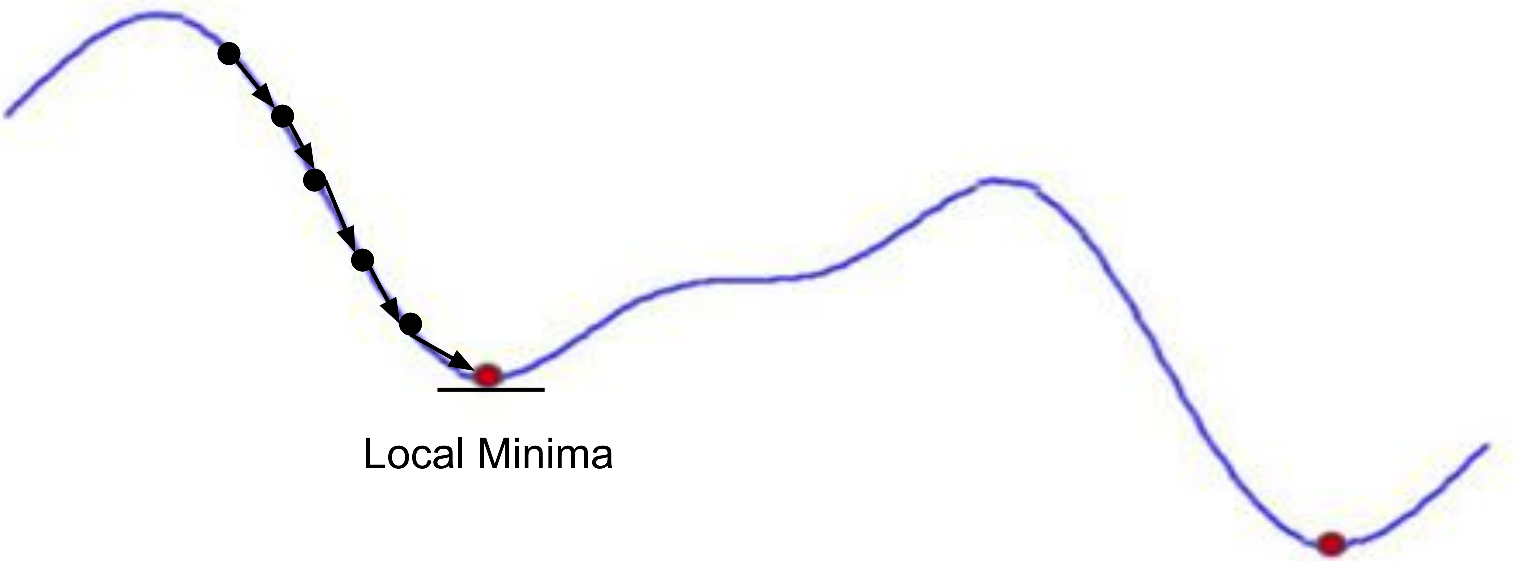
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Global Minima

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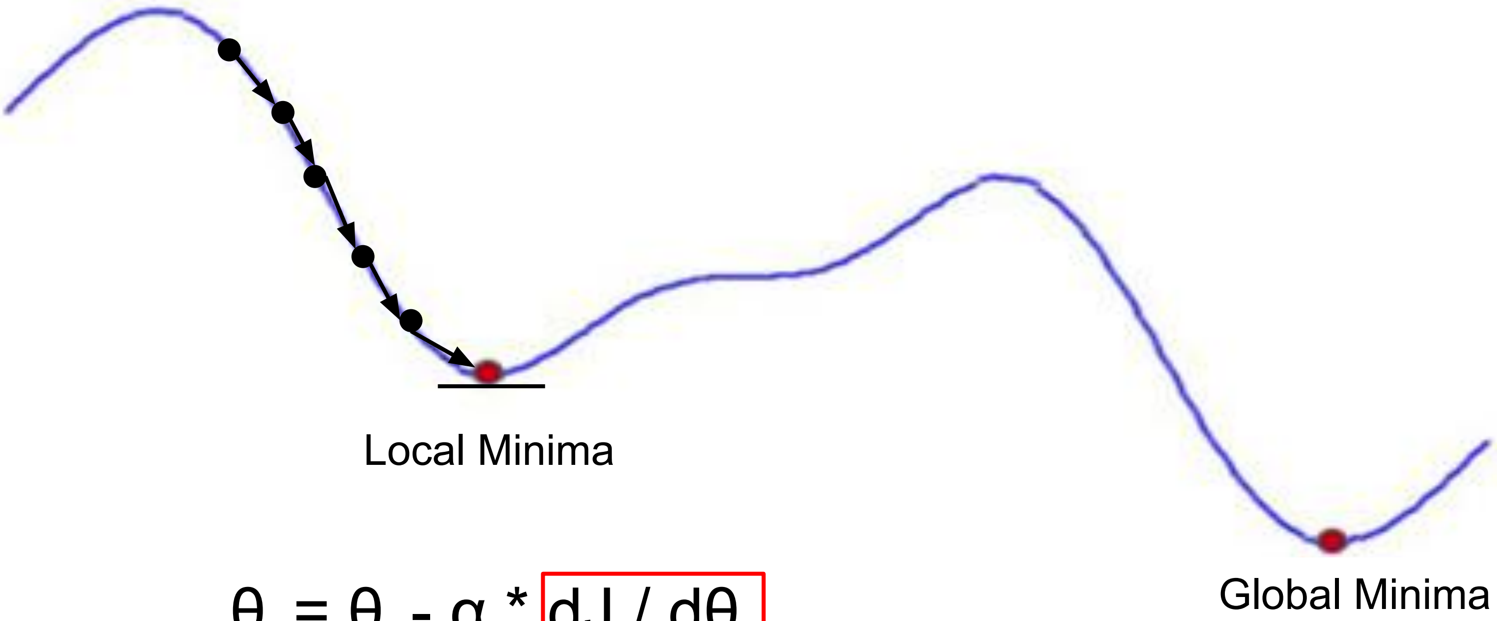
Local Minima
Global Minima

$$\theta_i = \theta_i - \alpha * \boxed{dJ / d\theta_i}$$

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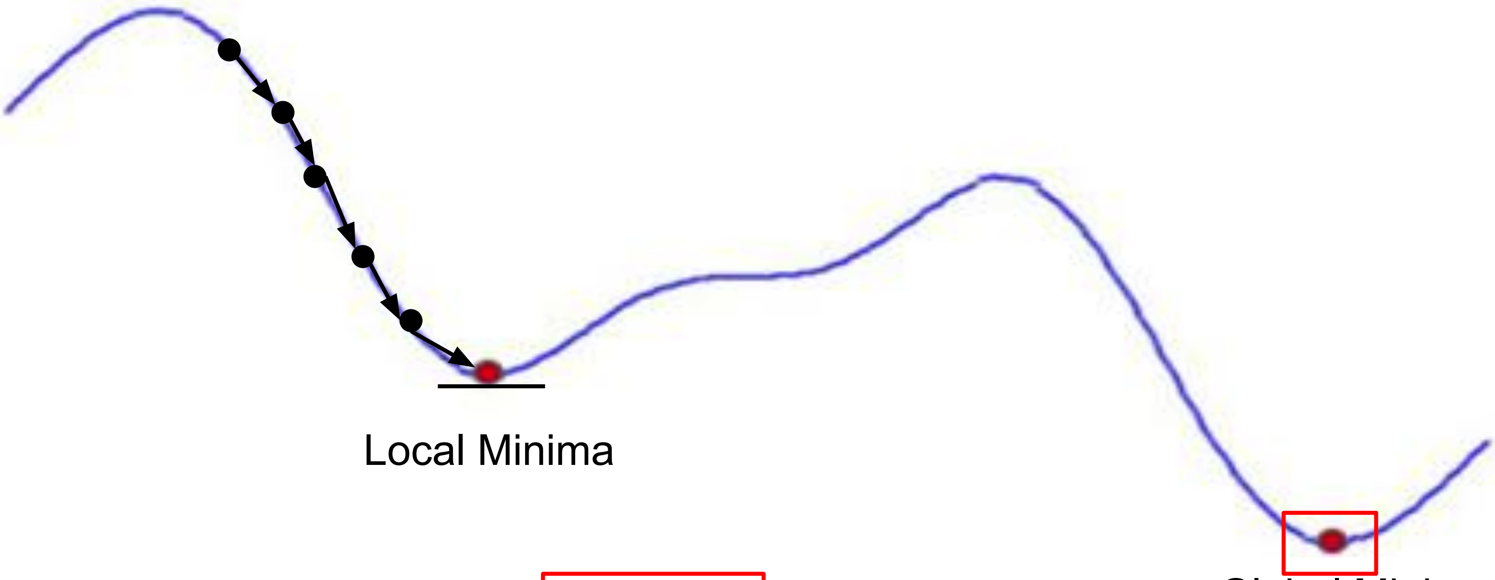
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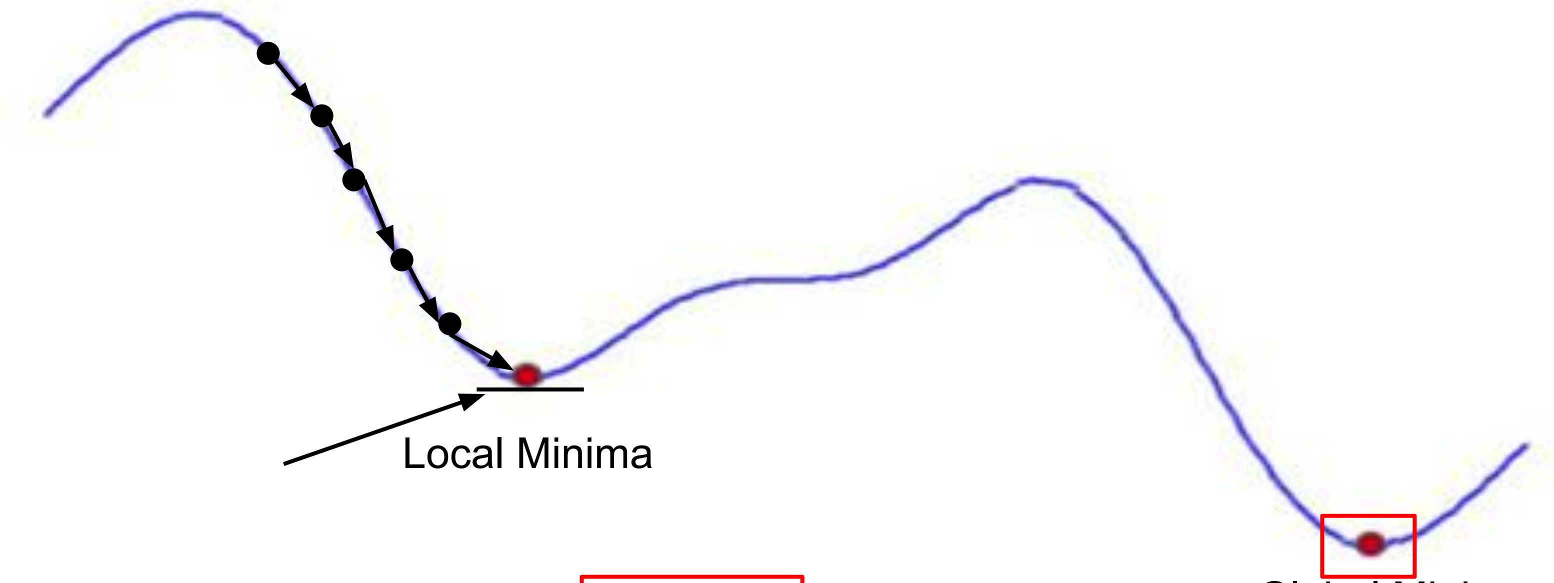
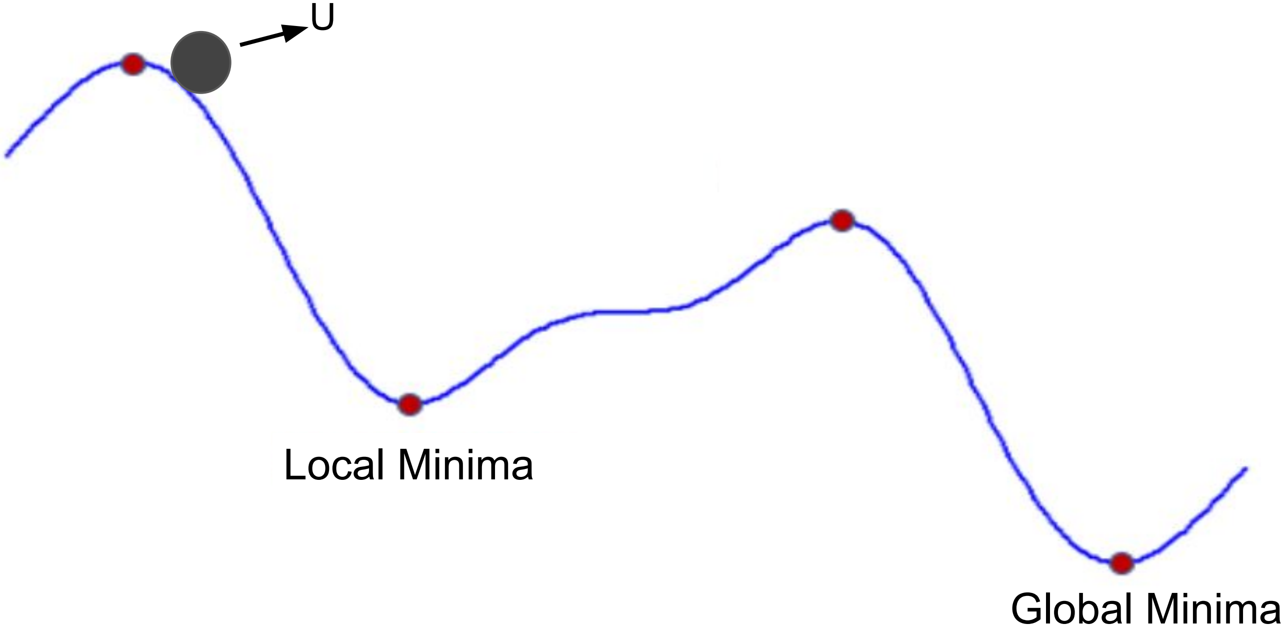
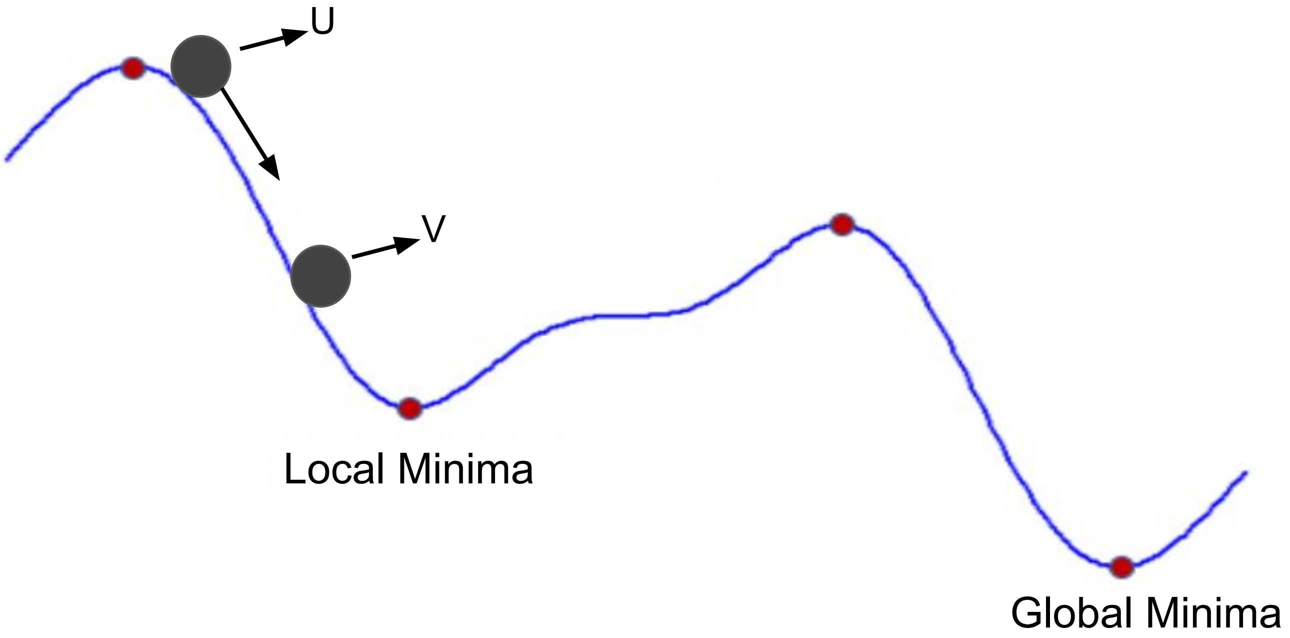

Local Minima
Global Minima

$$\theta_i = \theta_i - \alpha * \boxed{dJ / d\theta_i}$$

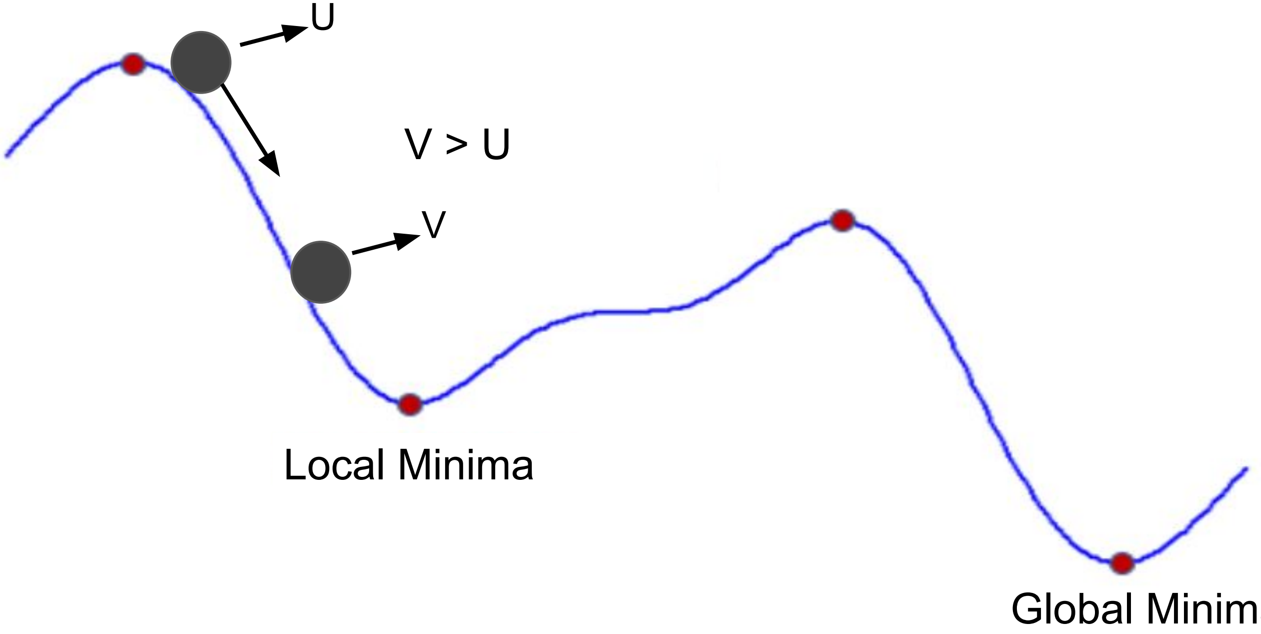
Solution: Getting stuck at local minima


U
Local Minima
Global Minima

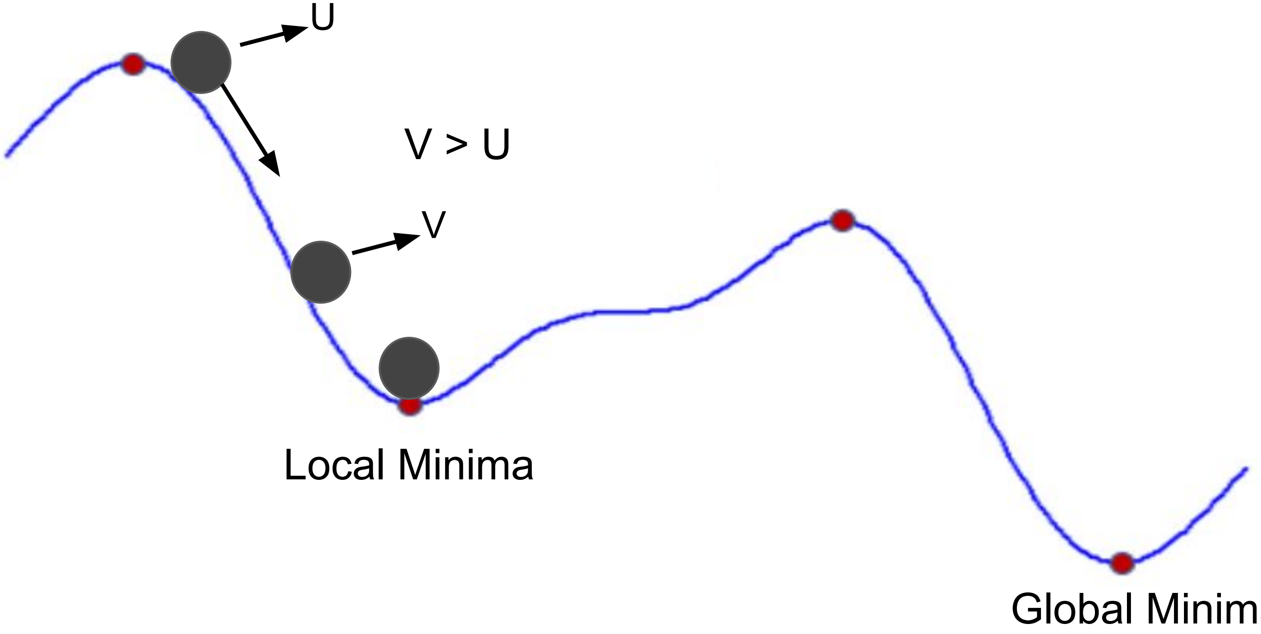
Solution: Getting stuck at local minima


U
V
Local Minima
Global Minima

Solution: Getting stuck at local minima


U
V > U
V
Local Minima
Global Minima

Solution: Getting stuck at local minima


U
V > U
V
Local Minima
Global Minima

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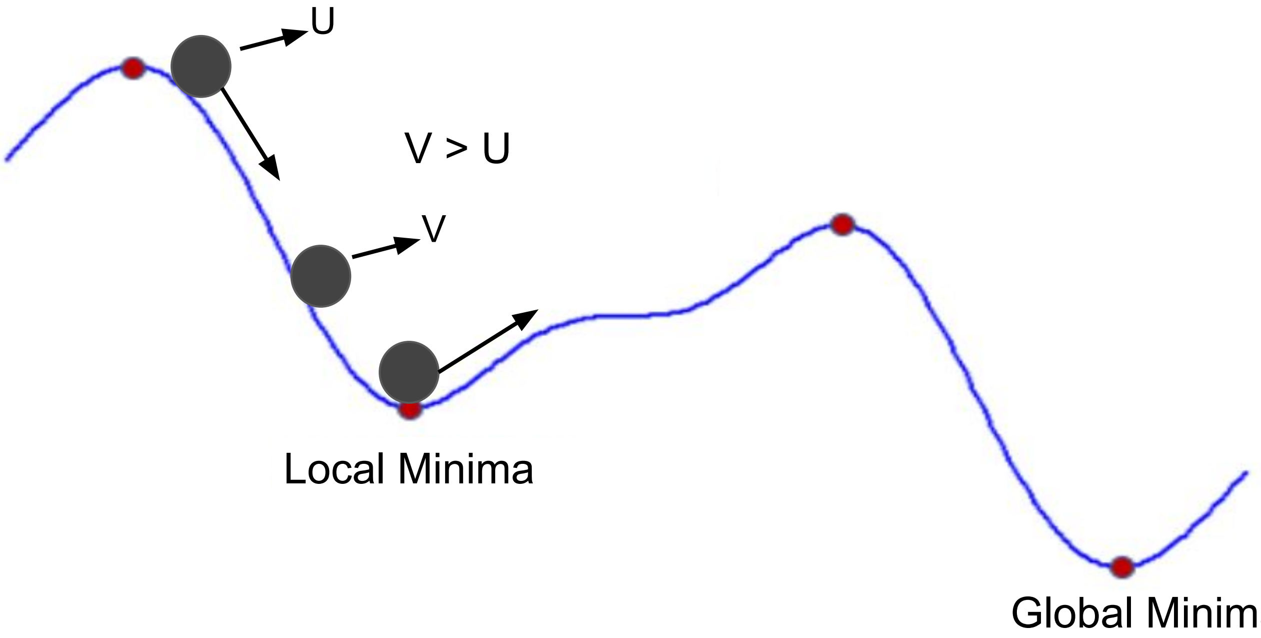
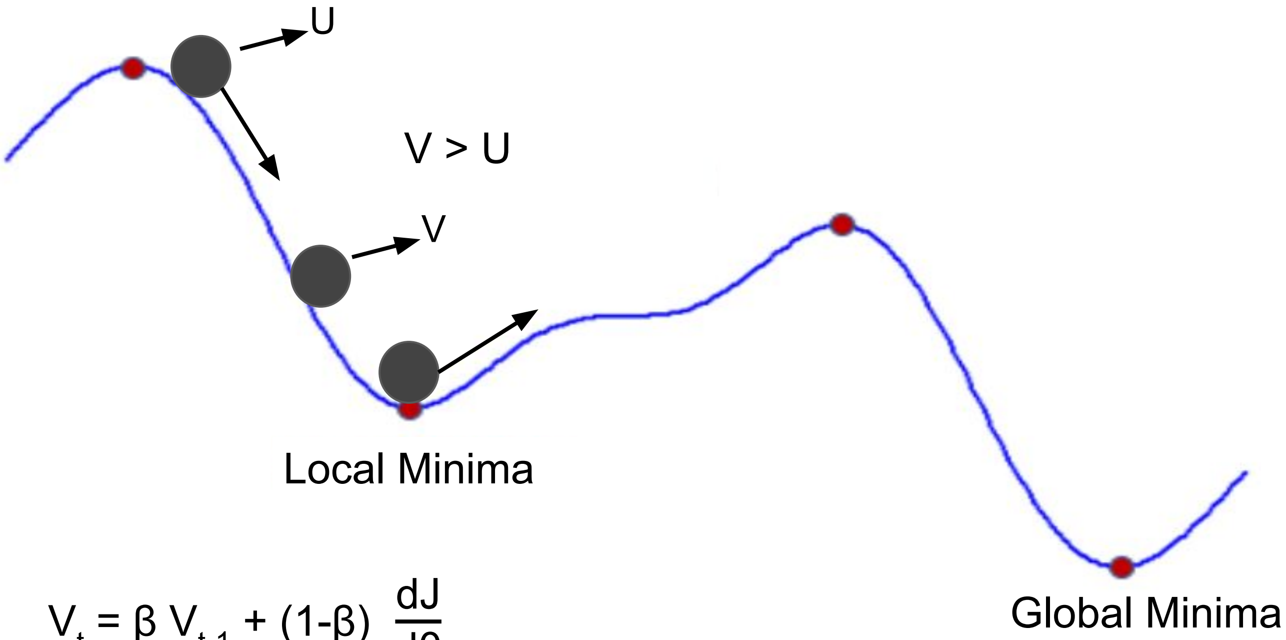
Solution: Getting stuck at local minima

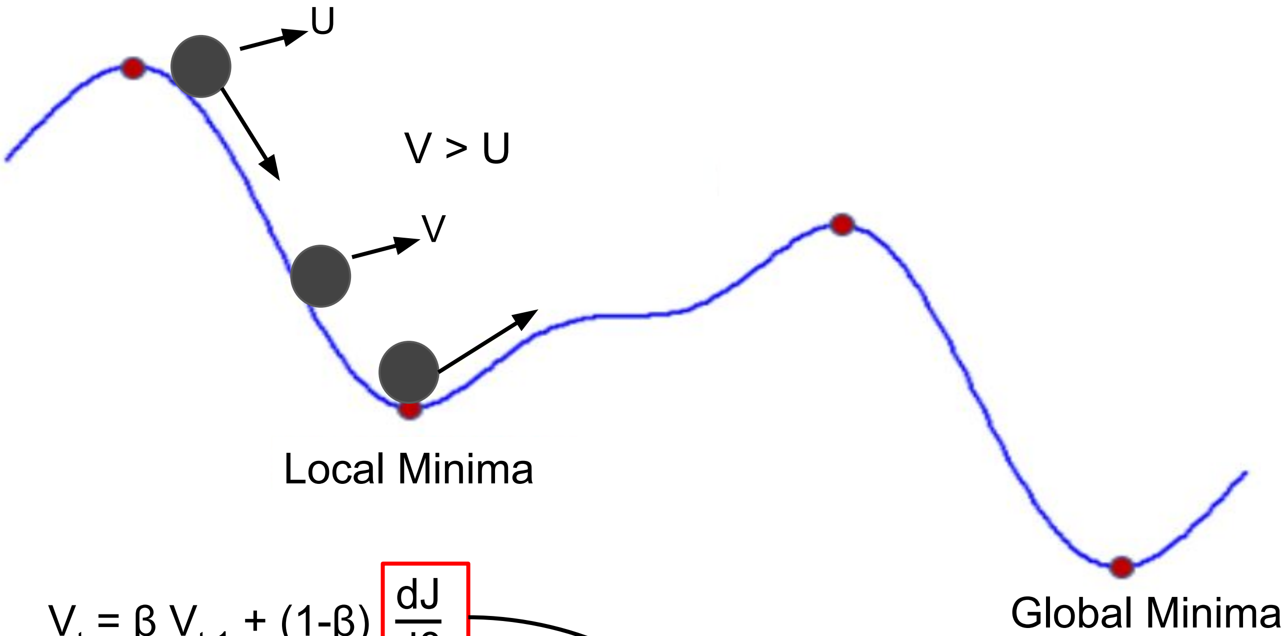

U
V > U
V
Local Minima
Global Minima

Weighted Gradient


U
V > U
V
Local Minima
Global Minima

$$V_t = \beta\, V_{t-1} + (1-\beta)\, \frac{dJ}{d\theta}$$

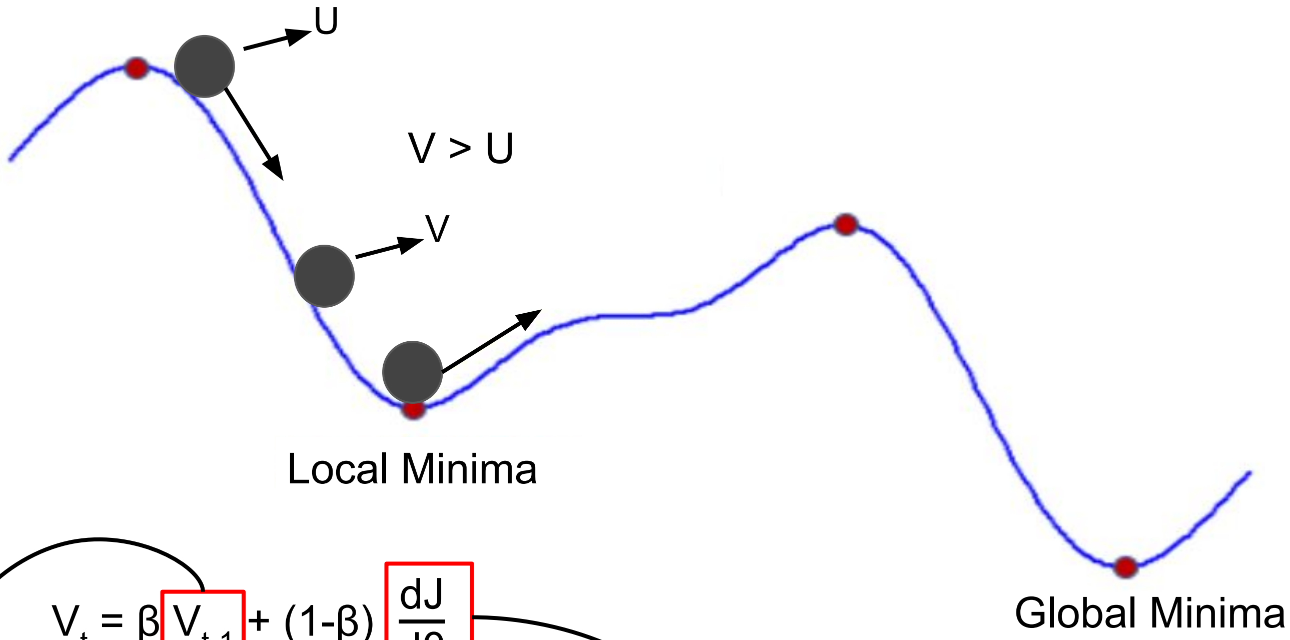
Weighted Gradient


U
V > U
V
Local Minima
Global Minima

$$V_t = \beta V_{t-1} + (1-\beta) \boxed{\frac{dJ}{d\theta}}$$

Current Gradient

Weighted Gradient

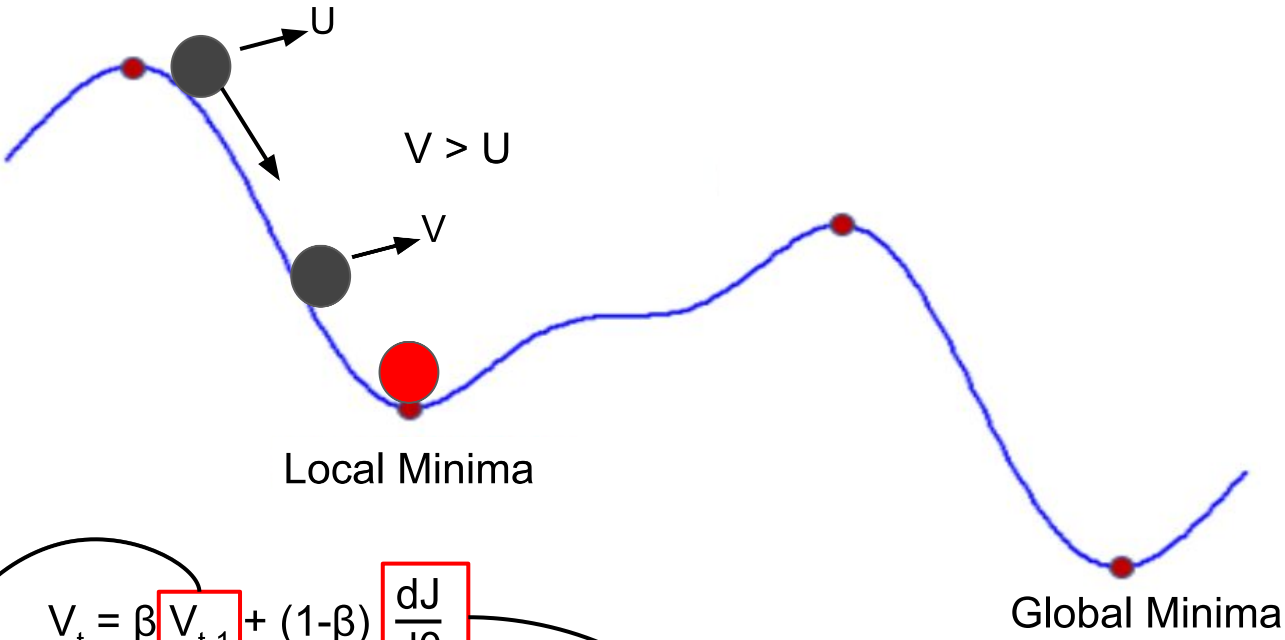

U
V > U
V
Local Minima
Global Minima

$$V_t = \beta \boxed{V_{t-1}} + (1-\beta) \boxed{\frac{dJ}{d\theta}}$$

Previously Accumulated Gradient

Current Gradient

Weighted Gradient

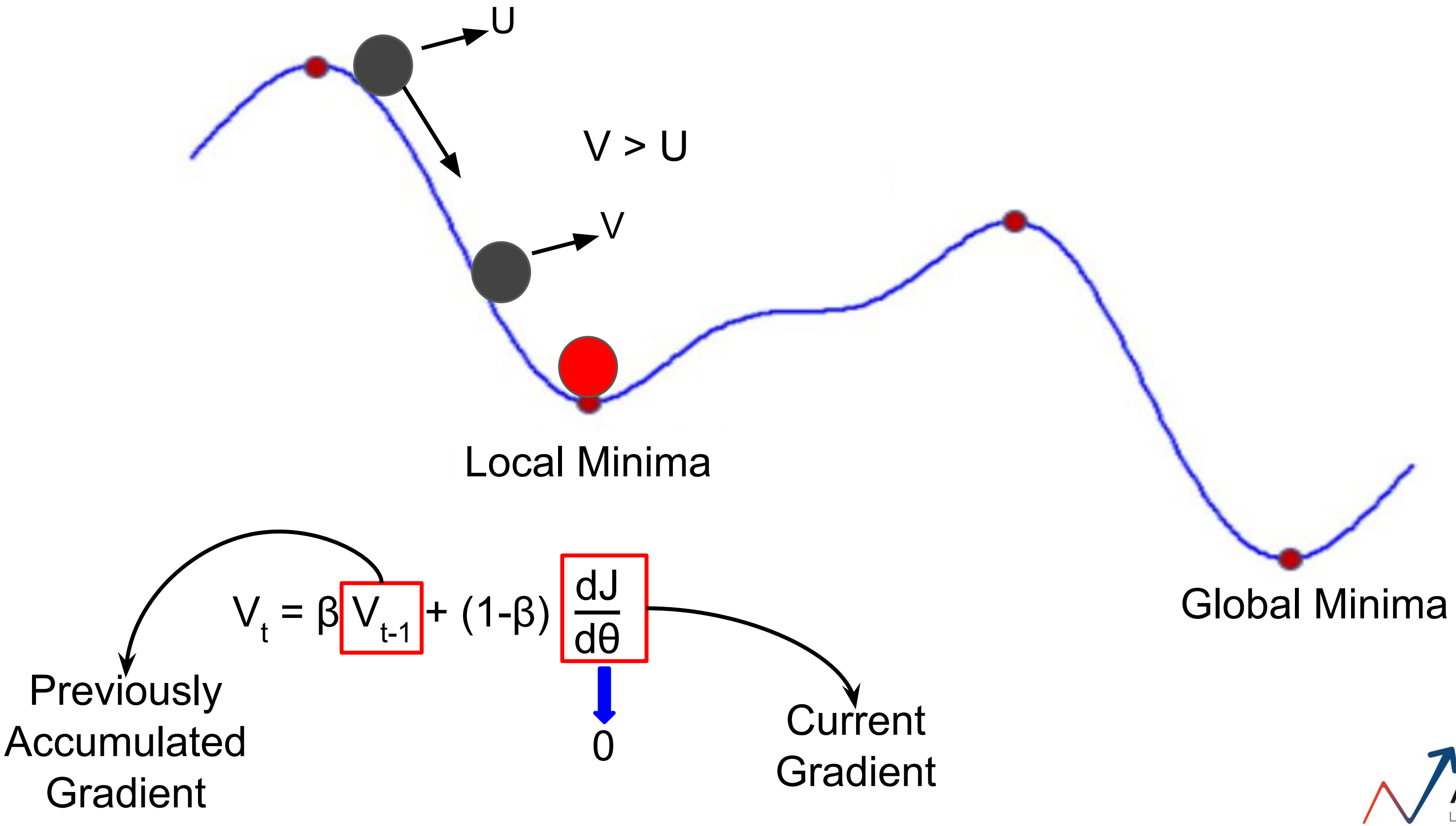

U
V > U
V
Local Minima
Global Minima

$$V_t = \beta \boxed{V_{t-1}} + (1-\beta) \boxed{\frac{dJ}{d\theta}}$$

Previously
Accumulated
Gradient

Current
Gradient

Weighted Gradient



U

V > U

V

Local Minima

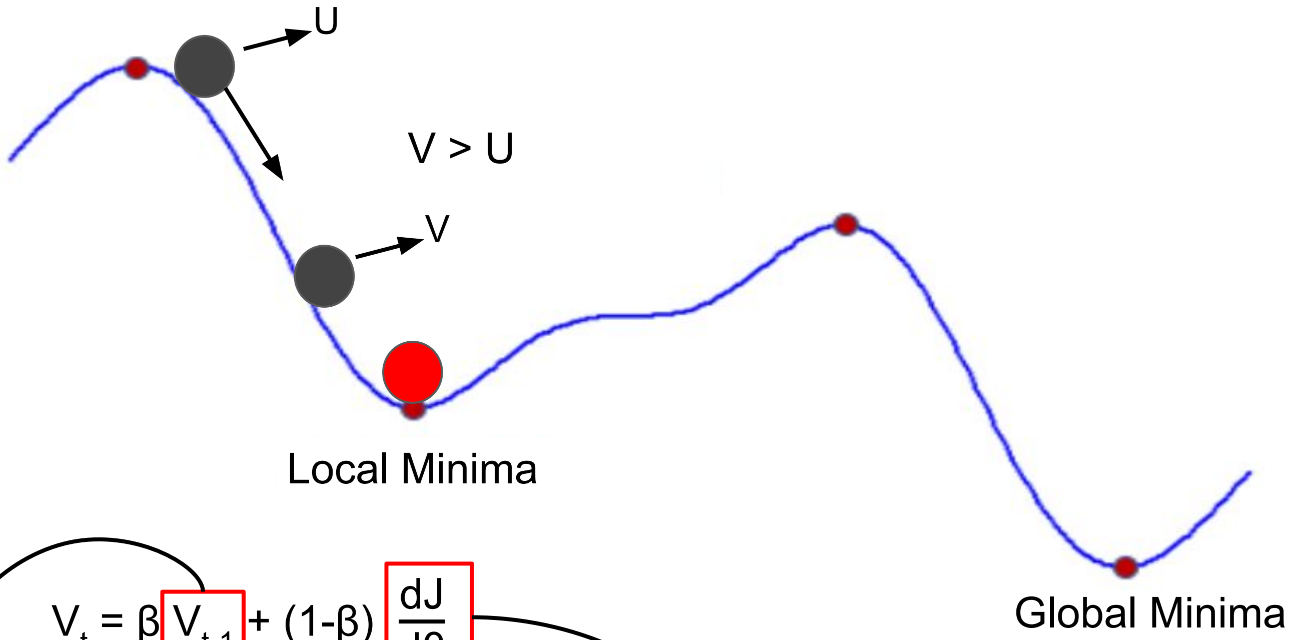
Global Minima

$$V_t = \beta \boxed{V_{t-1}} + (1-\beta) \underset{0}{\underset{\downarrow}{\boxed{\frac{dJ}{d\theta}}}}$$

Previously Accumulated Gradient

Current Gradient

Weighted Gradient


U
V > U
V
Local Minima
Global Minima

$$V_t = \beta \boxed{V_{t-1}} + (1-\beta) \boxed{\frac{dJ}{d\theta}}$$

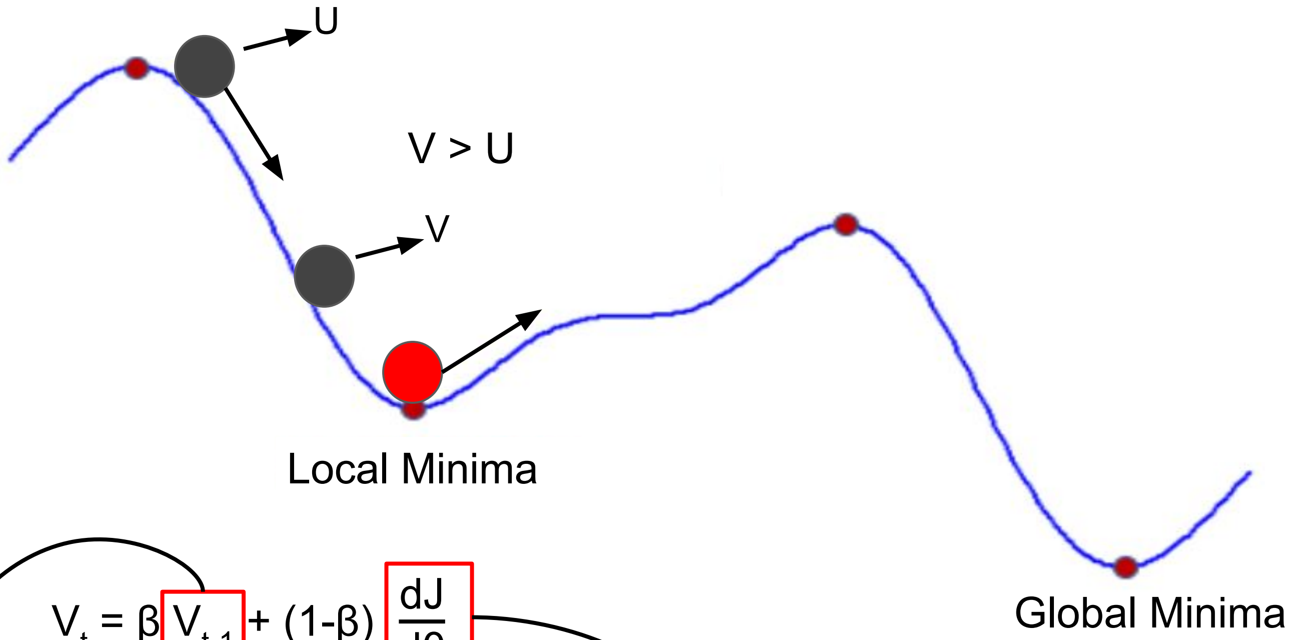
Previously Accumulated Gradient

Some value

0

Current Gradient

Weighted Gradient


U
V > U
V
Local Minima
Global Minima

$$V_t = \beta \boxed{V_{t-1}} + (1-\beta) \boxed{\frac{dJ}{d\theta}}$$

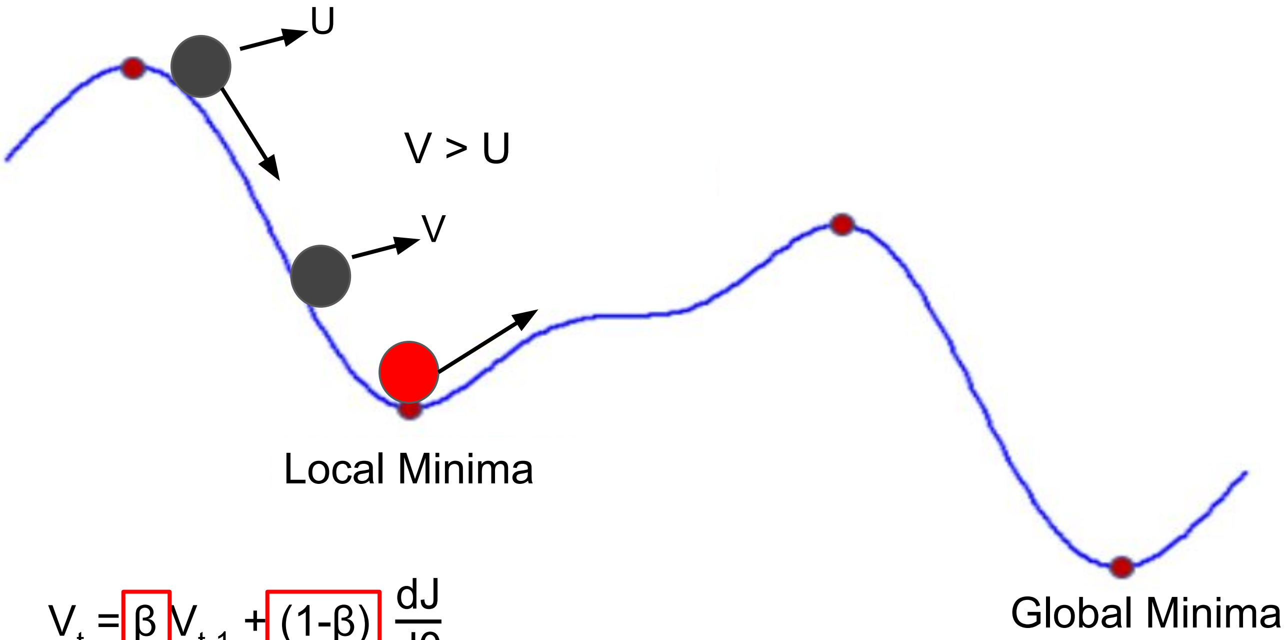
Previously Accumulated Gradient

Some value

0

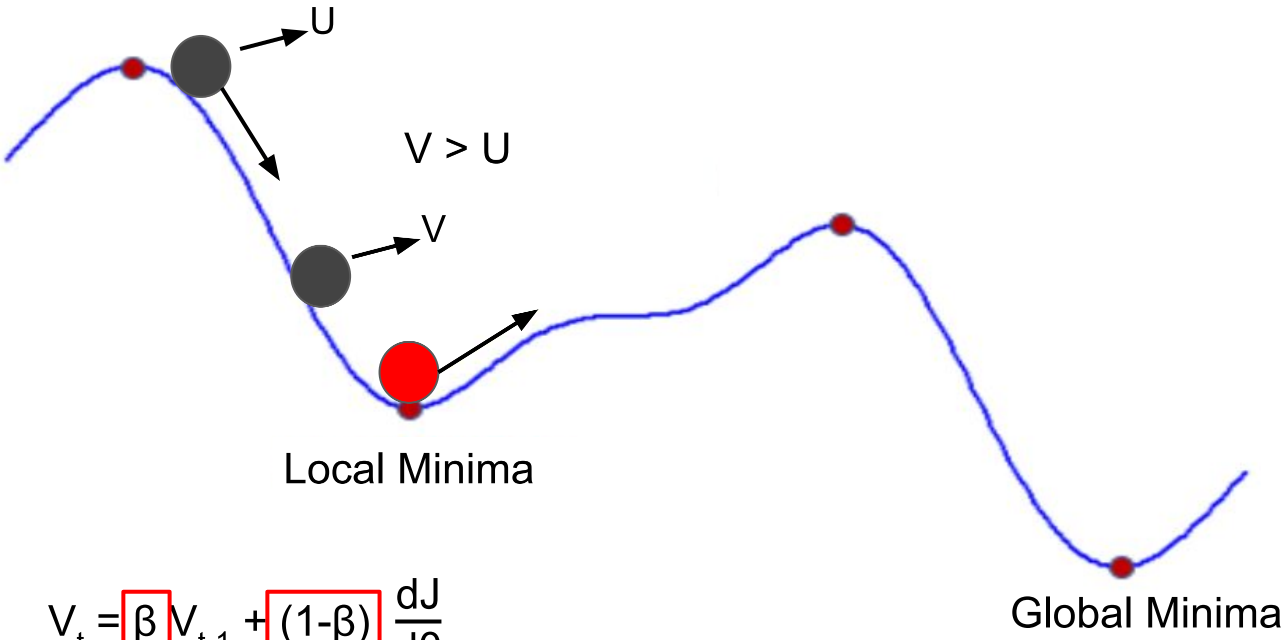
Current Gradient

Weighted Gradient


U
V > U
V
Local Minima
Global Minima

$$V_t = \boxed{\beta} V_{t-1} + \boxed{(1-\beta)} \frac{dJ}{d\theta}$$

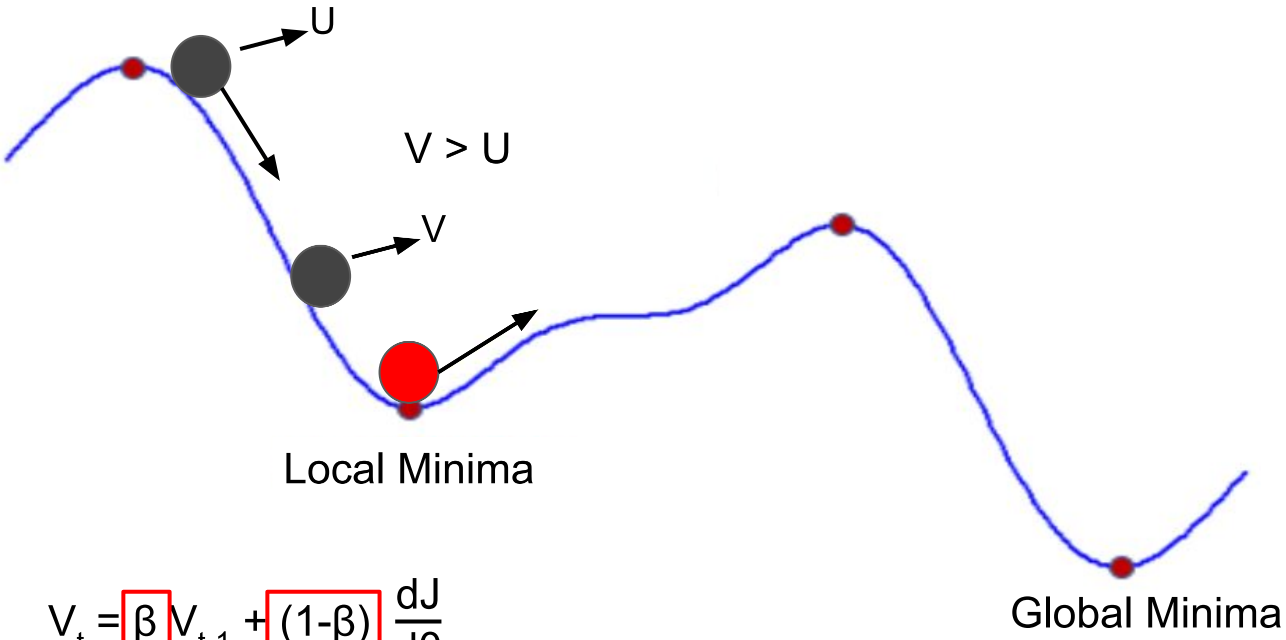
Weighted Gradient


U
V > U
V
Local Minima
Global Minima

$$V_t = \boxed{\beta} V_{t-1} + \boxed{(1-\beta)} \frac{dJ}{d\theta}$$

$\beta = 0.9$

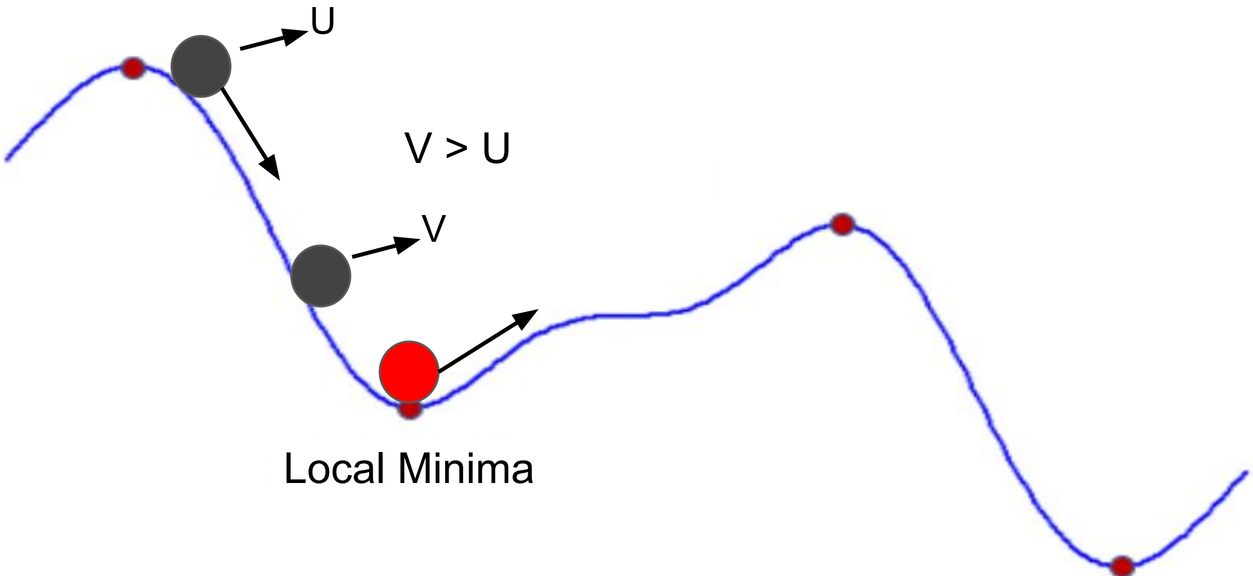
Weighted Gradient


U
V > U
V
Local Minima
Global Minima

$$V_t = \boxed{\beta} V_{t-1} + \boxed{(1-\beta)} \frac{dJ}{d\theta}$$

$\beta = 0.9$ → 10% weight to current gradient

Weighted Gradient


U
V > U
V
Local Minima
Global Minima

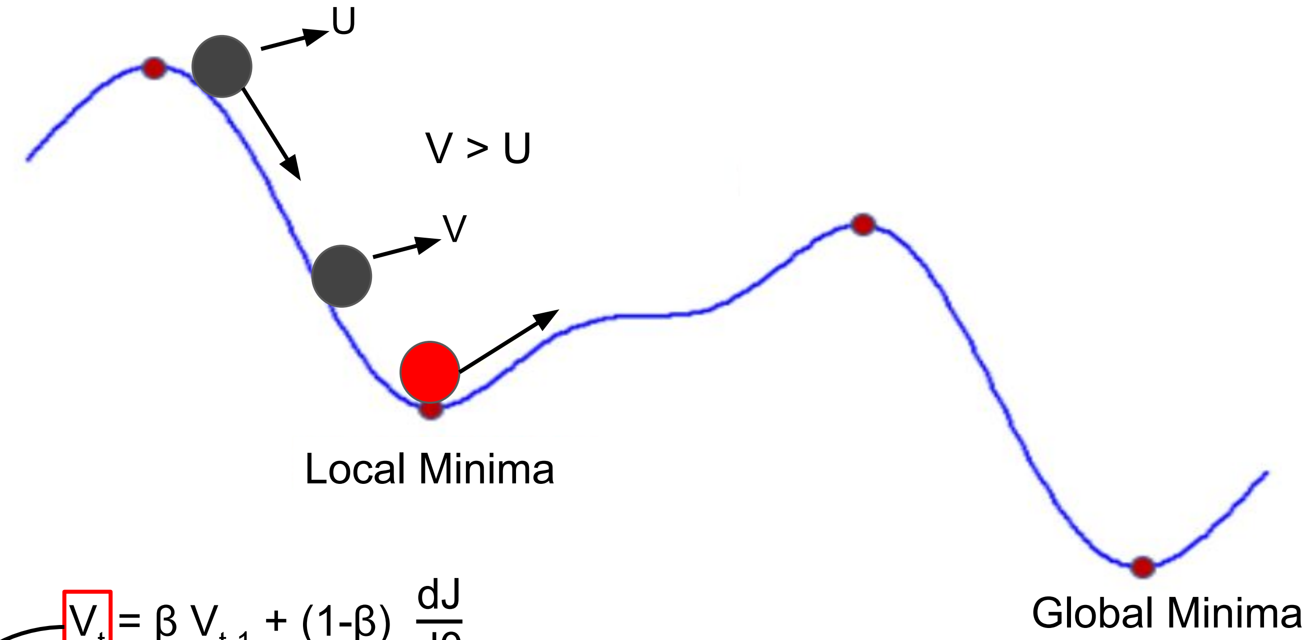
$$V_t = \boxed{\beta} V_{t-1} + \boxed{(1-\beta)} \frac{dJ}{d\theta}$$

$\beta = 0.9$

10% weight to current gradient

90% weight to previous gradient

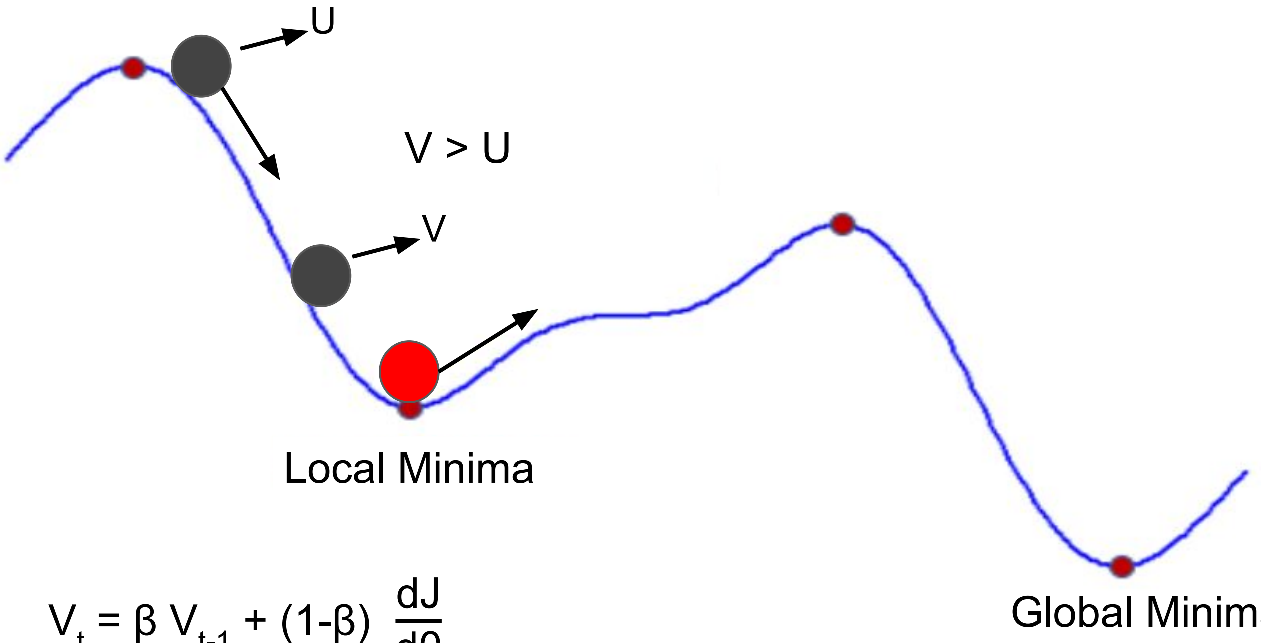
Weighted Gradient


U
V > U
V
Local Minima
Global Minima

$$\boxed{V_t} = \beta V_{t-1} + (1-\beta)\frac{dJ}{d\theta}$$

New Gradient

Stochastic Gradient Descent with Momentum


U
V > U
V
Local Minima
Global Minima

$$V_t = \beta\, V_{t-1} + (1-\beta)\, \frac{dJ}{d\theta}$$

$$\theta_i = \theta_i - \alpha * V_t$$

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Thank You