Problems with Gradient Descent

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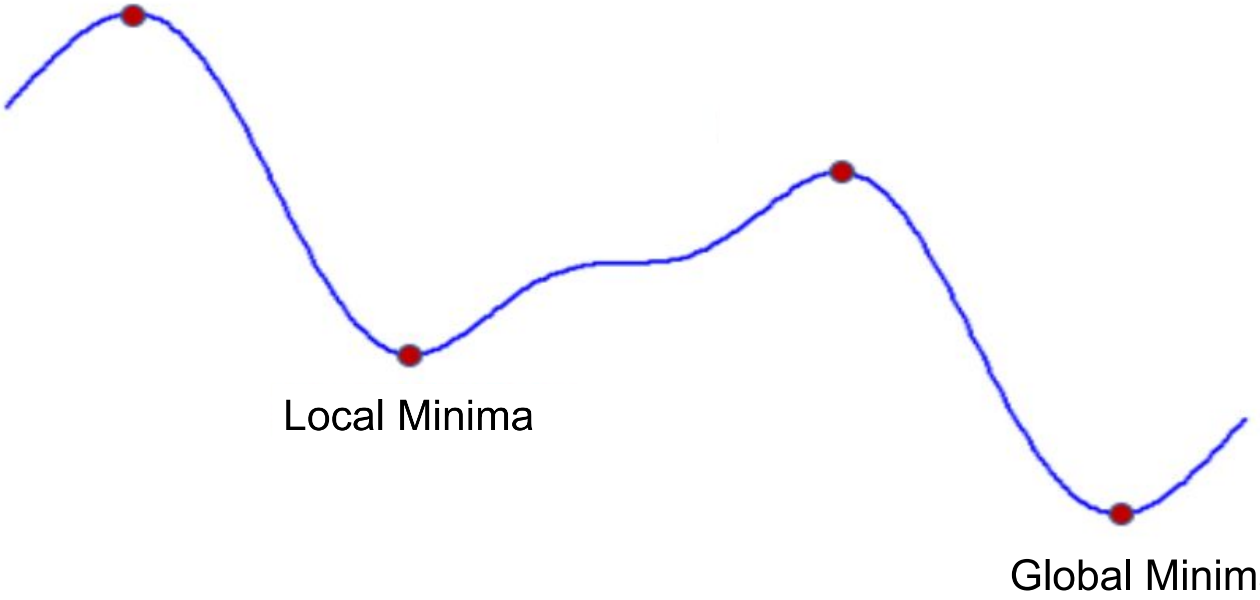
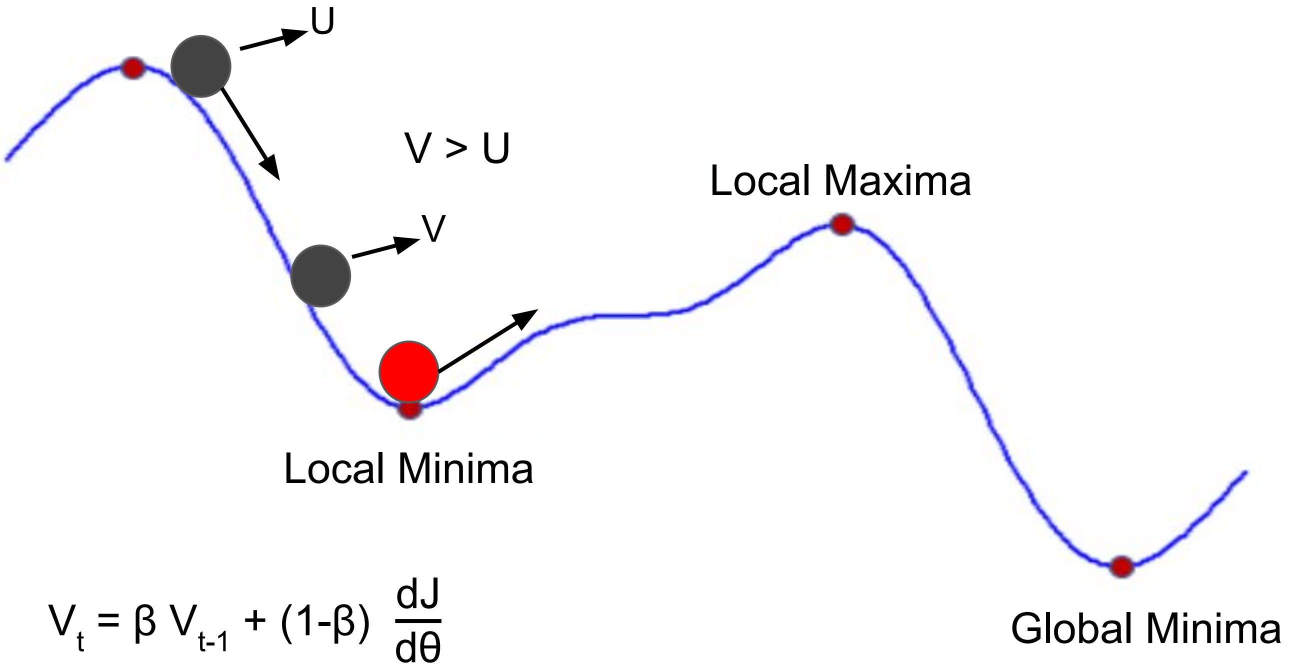
1. Getting stuck at local minima



Analytics Vidhya
Learn everything about analytics

SGD with Momentum



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

$$\theta_i = \theta_{i-1} - \alpha * V_t$$

Problems with Gradient Descent

1. Getting stuck at local minima

2. Same Learning rate throughout the training process

Problem: Same learning rate for all parameters

$$\frac{dJ}{d\theta}$$

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$$\eta = \sum_{i=1}^{t-1} \frac{dJ}{d\theta}$$

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$$\theta_i = \theta_{i-1} - \frac{\alpha}{\sqrt{\eta}} \frac{dJ}{d\theta}$$

Problem: Same learning rate for all parameters

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Always Increase

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Problem: Same learning rate for all parameters

$$\boxed{\eta = \sum_{i=1}^{t-1} \left[\frac{dJ}{d\theta}\right]^2}$$

Always Increase

$$\theta_i = \theta_{i-1} - \boxed{\frac{\alpha}{\sqrt{\eta}}} \frac{dJ}{d\theta}$$

Always Decrease

Problem: Same learning rate for all parameters

$$\eta = \sum_{i=1}^{t-1} \left[\frac{dJ}{d\theta}\right]^2$$

$$\theta_i = \theta_{i-1} - \boxed{\frac{\alpha}{\sqrt{\eta}} \frac{dJ}{d\theta}} \rightarrow \text{Tends to Zero}$$

Problem: Same learning rate for all parameters

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$$\theta_i = \theta_{i-1} - \boxed{\frac{\alpha}{\sqrt{\eta}} \frac{dJ}{d\theta}} \rightarrow \text{Tends to Zero}$$

$$\theta_i \simeq \theta_{i-1}$$

Problem: Same learning rate for all parameters

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

RMSProp

$$\mu_t = \beta \, \mu_{t-1} + (1-\beta) \left[\frac{dJ}{d\theta}\right]^2$$

Update equation: RMSProp

$$\mu_t = \beta\, \mu_{t-1} + (1-\beta) \left[\frac{dJ}{d\theta}\right]^2$$

$$\theta_i = \theta_i - \frac{\alpha}{\sqrt{\mu_t + \varepsilon}} \frac{dJ}{d\theta}$$

Update equation: RMSProp

High

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Low

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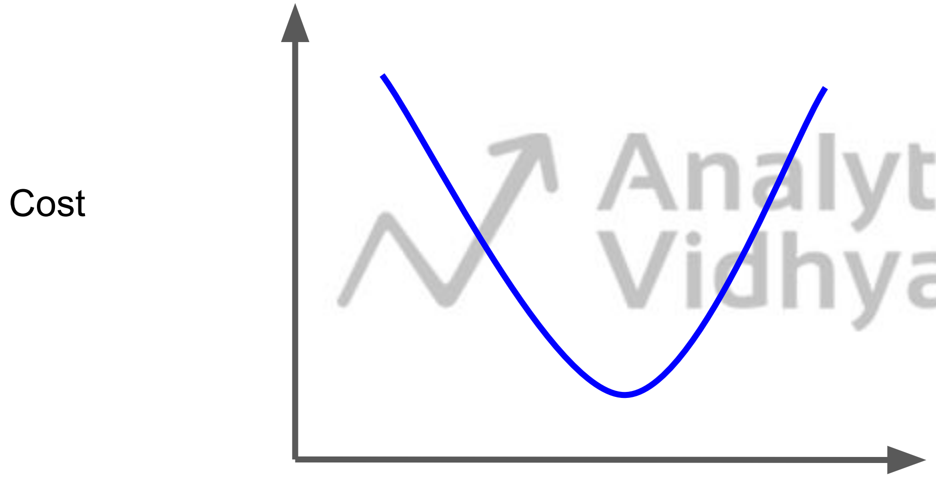
Understanding RMSProp



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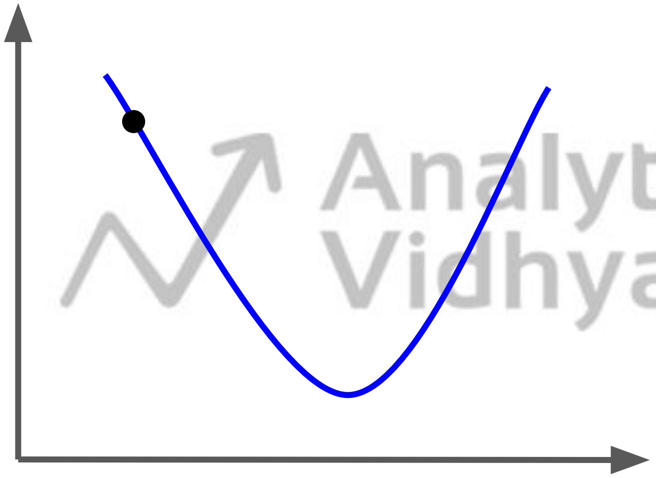
Understanding RMSProp

Cost



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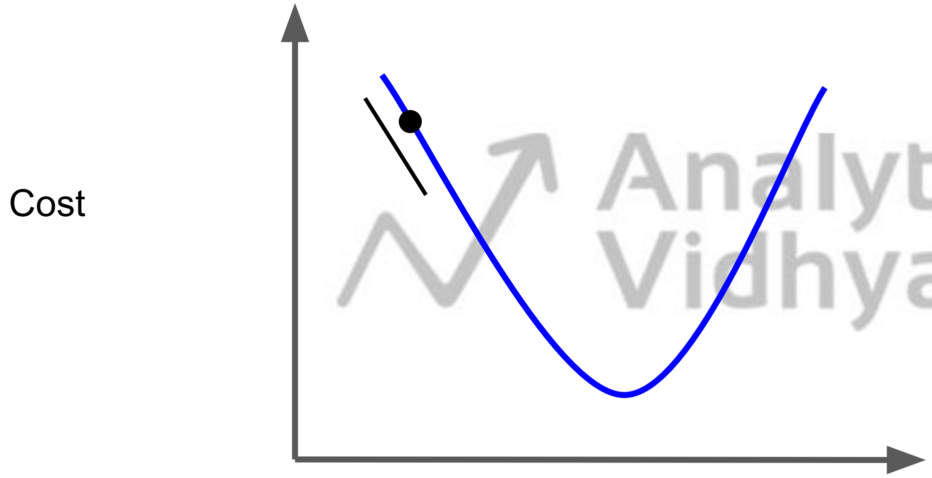
Understanding RMSProp



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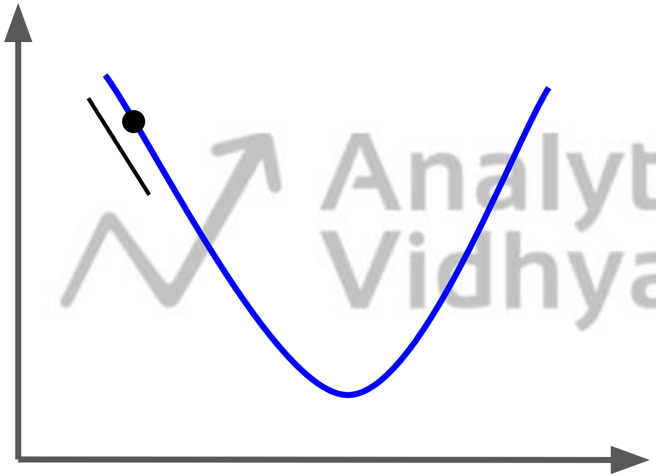
Understanding RMSProp

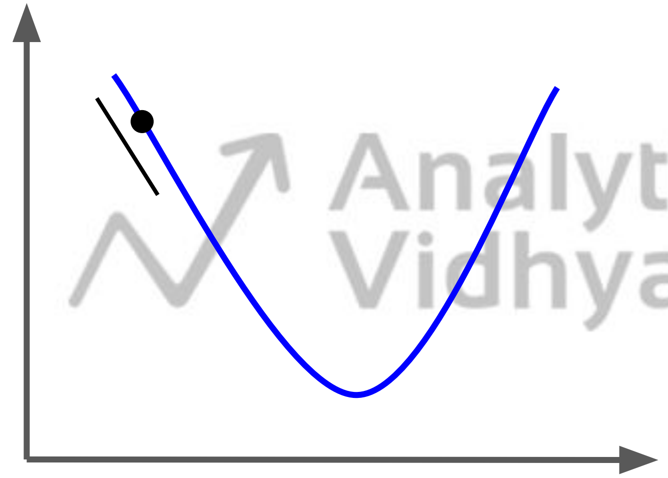


$$\mu_t = \beta\, \mu_{t-1} + (1-\beta) \overbrace{\boxed{\left[\frac{dJ}{d\theta}\right]^2}}^{\text{High}}$$

$$\theta_i = \theta_i - \frac{\alpha}{\sqrt{\mu_t + \varepsilon}} \frac{dJ}{d\theta}$$

Understanding RMSProp

Cost



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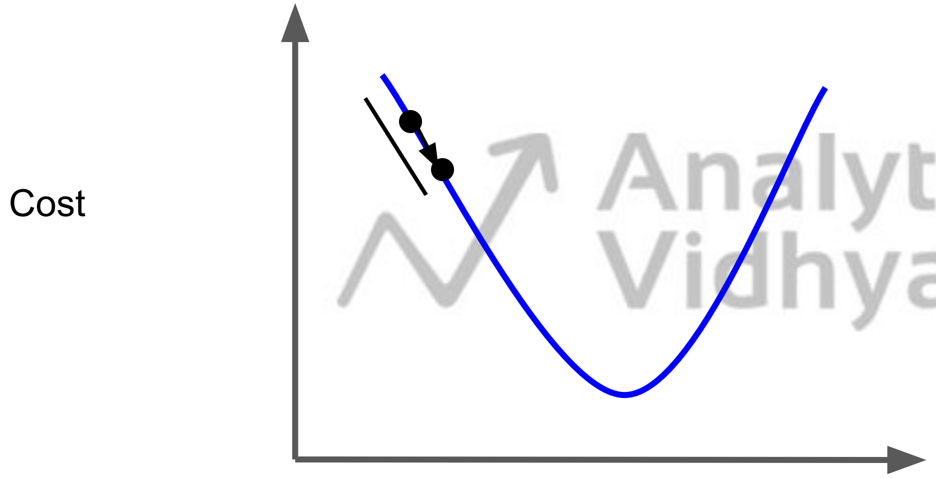
Low

Understanding RMSProp



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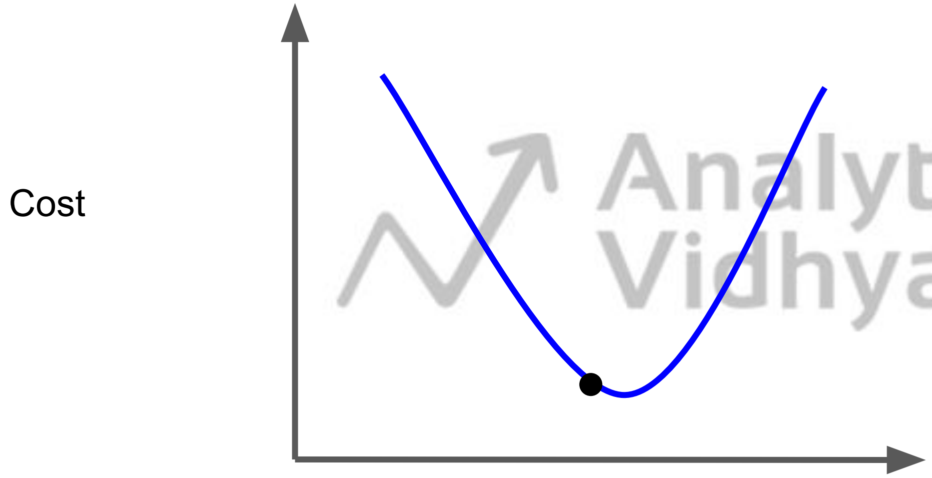

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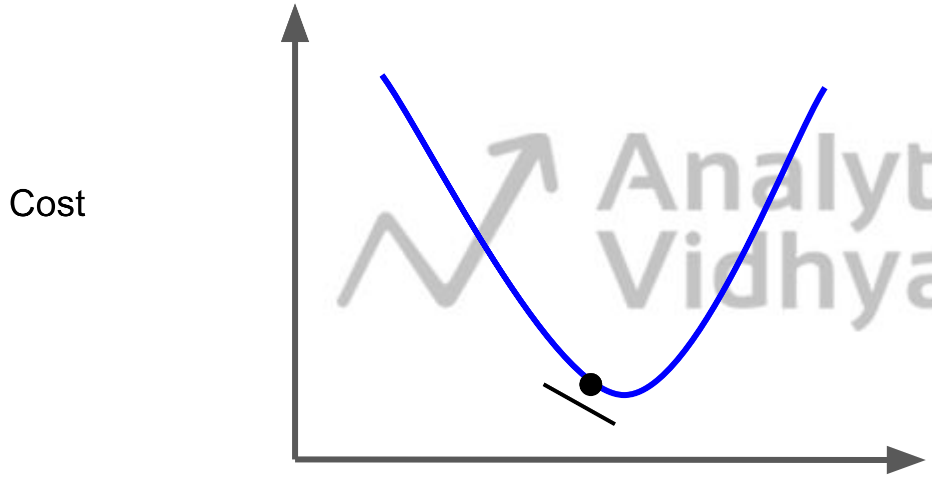
Understanding RMSProp



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Understanding RMSProp

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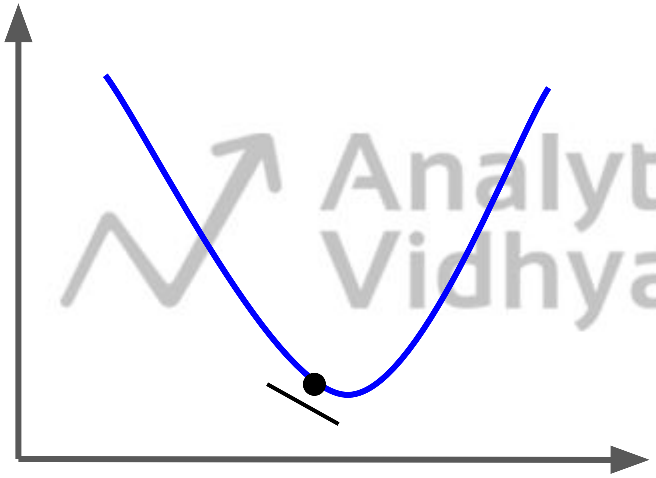

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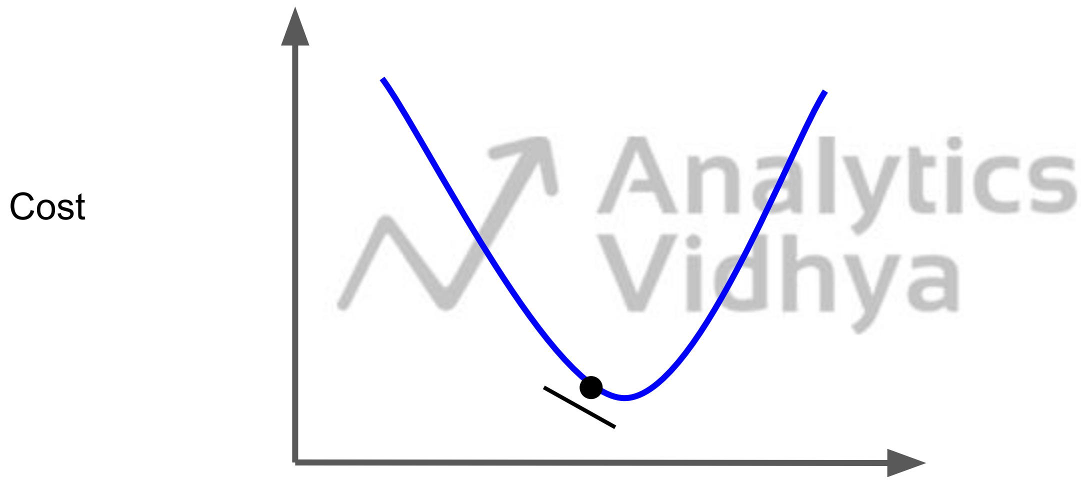
Understanding RMSProp



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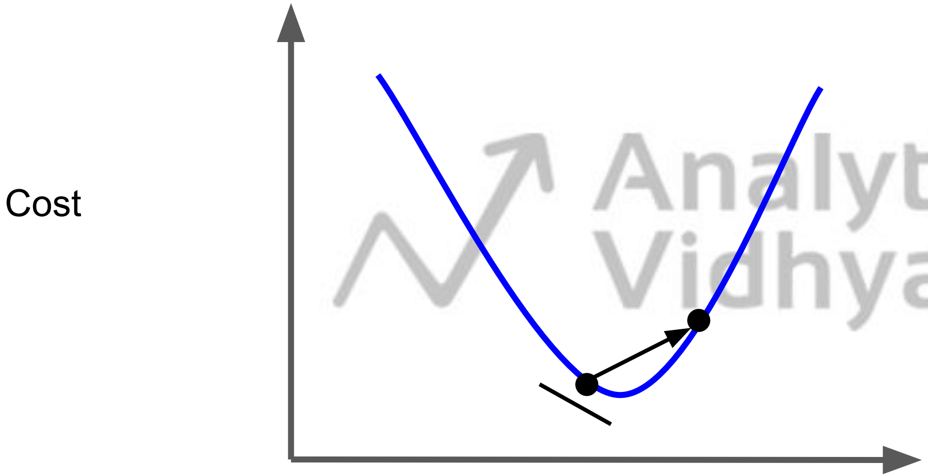

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Thank You