NPTEL ONLINE CERTIFICATION COURSES

Course Name: Deep Learning

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Department : E & ECE, IIT Kharagpur

Topic

Lecture 49: Normalization - IV

CONCEPTS COVERED

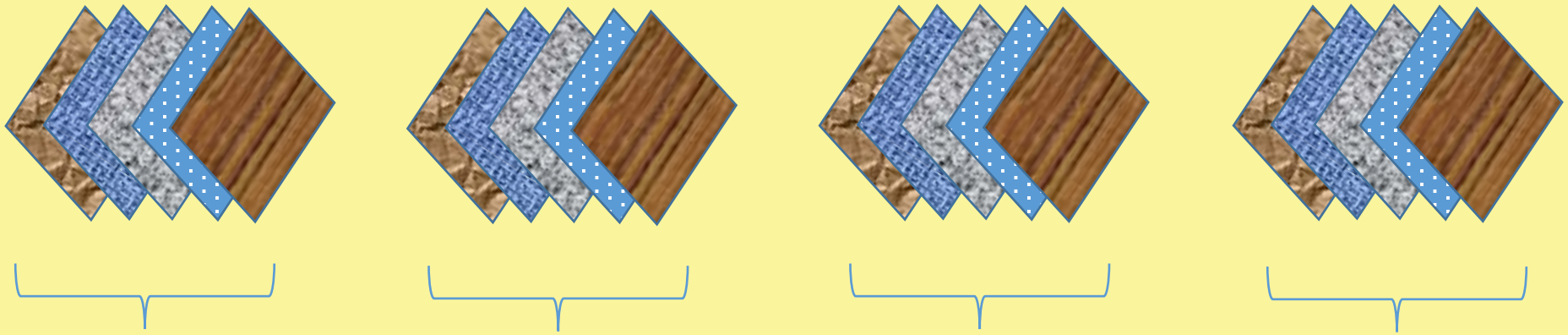
Concepts Covered:

- Deep Neural Network
  - Normalization
  - Batch Normalization
  - Layer Normalization
  - Instance Normalization
  - Group Normalization

Normalization

Layer Normalization

Layer Normalization



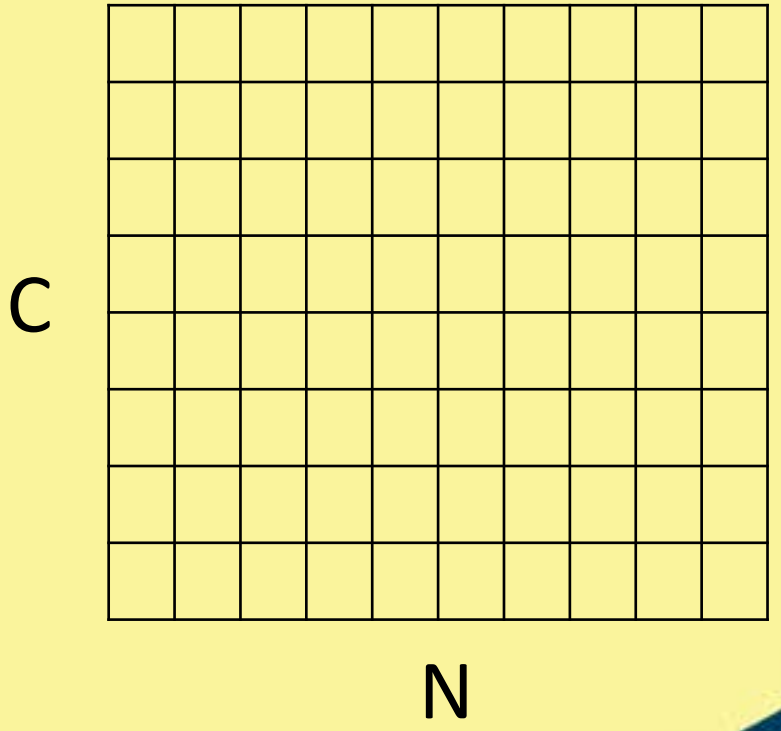
Layer Normalization

$$x \in \mathbb{R}^{N \times C \times W \times H}$$

$$\mu_N = \frac{1}{CWH} \sum_{i=1}^{C} \sum_{j=1}^{W} \sum_{k=1}^{H} x_{Nijk}$$

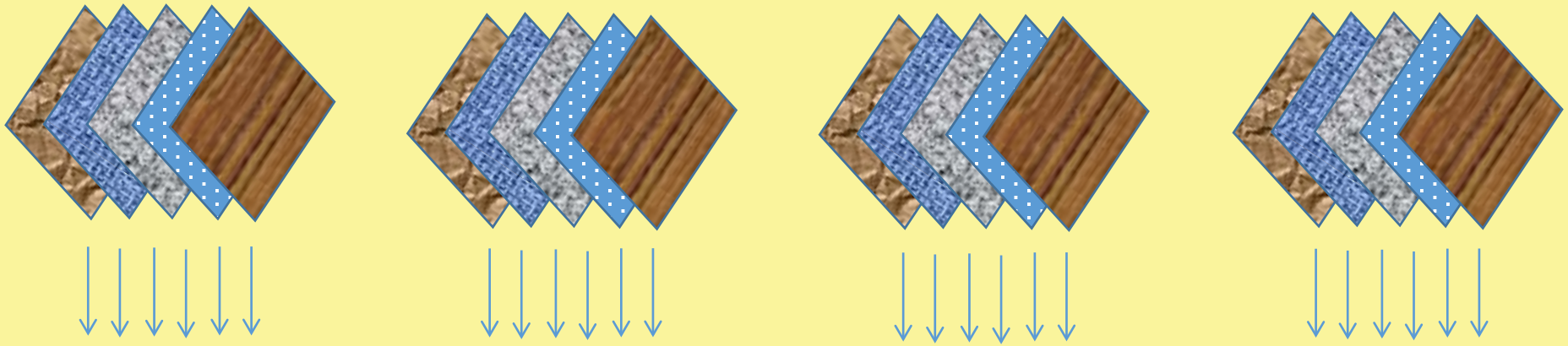
$$\sigma_N^2 = \frac{1}{CWH} \sum_{i=1}^{C} \sum_{j=1}^{W} \sum_{k=1}^{H} (x_{Nijk} - \mu_N)^2$$

$$\hat{x} = \frac{x - \mu_N}{\sqrt{\sigma_N^2 + \epsilon}}$$



Instance Normalization

Instance Normalization



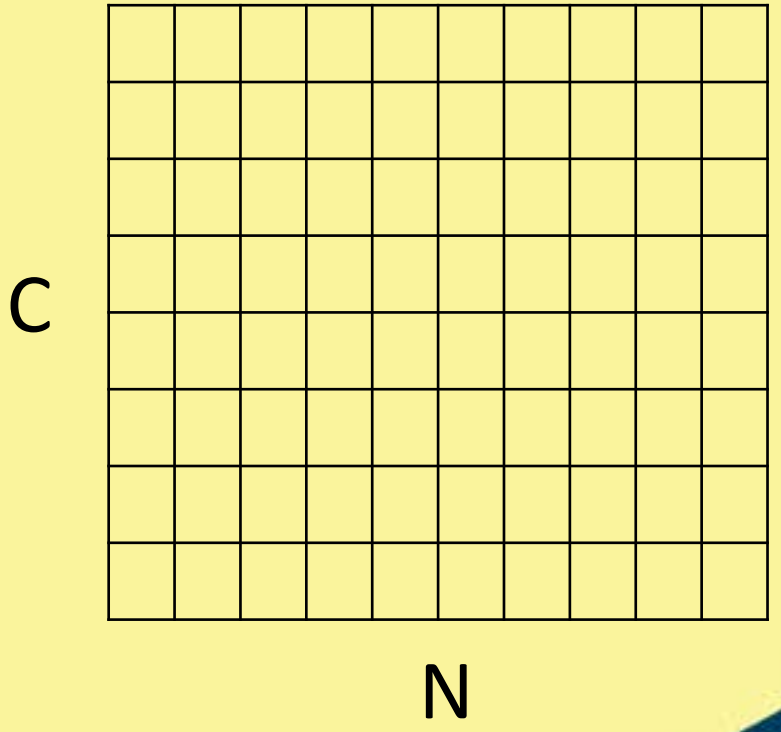
Instance Normalization

$$x \in \mathbb{R}^{N \times C \times W \times H}$$

$$\mu_{NC} = \frac{1}{WH} \sum_{j=1}^{W} \sum_{k=1}^{H} x_{Nijk}$$

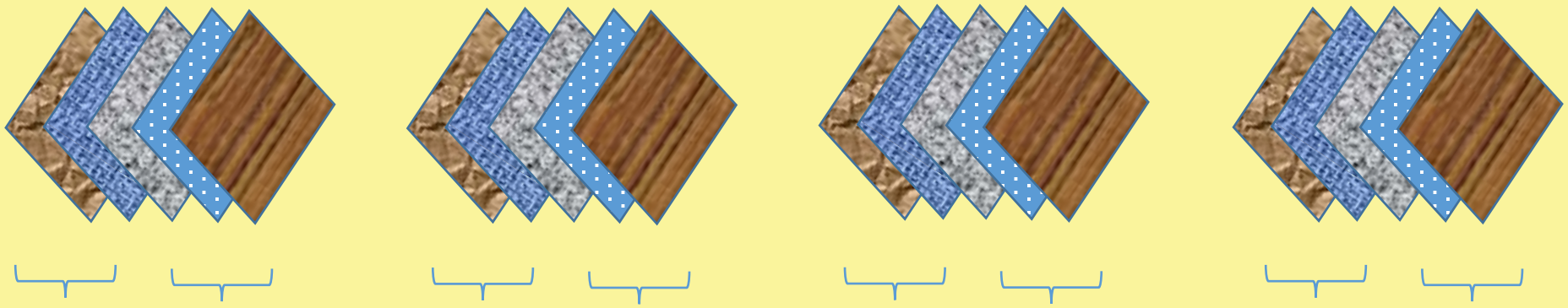
$$\sigma_{NC}^2 = \frac{1}{WH} \sum_{j=1}^{W} \sum_{k=1}^{H} (x_{Nijk} - \mu_N)^2$$

$$\hat{x} = \frac{x - \mu_{NC}}{\sqrt{\sigma_{NC}^2 + \epsilon}}$$



Group Normalization

Group Normalization

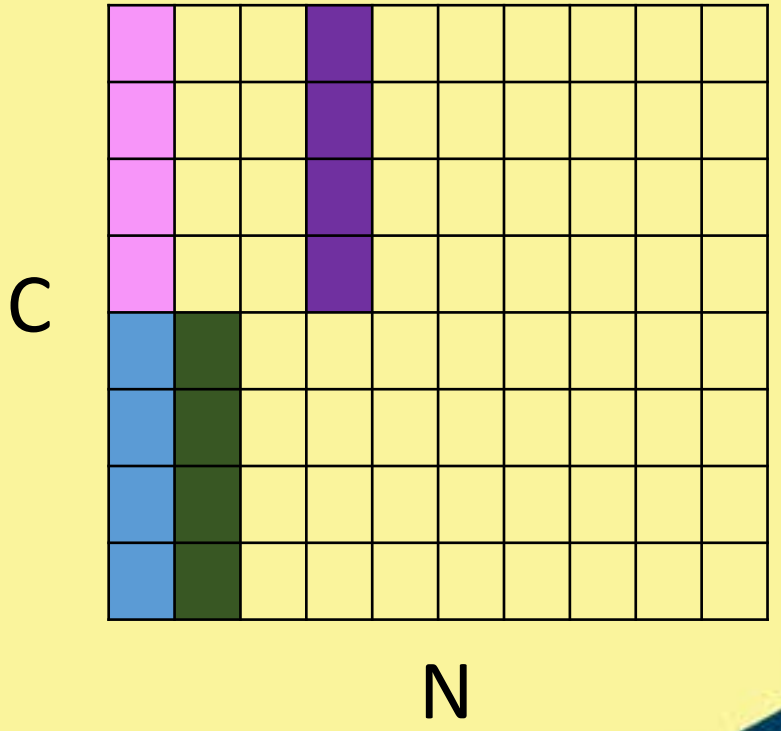


Group Normalization

$x \in \mathbb{R}^{N \times C \times W \times H} \rightarrow \mathbb{R}^{N \times G \times C' \times W \times H} \quad C = G.C'$

G=number of groups

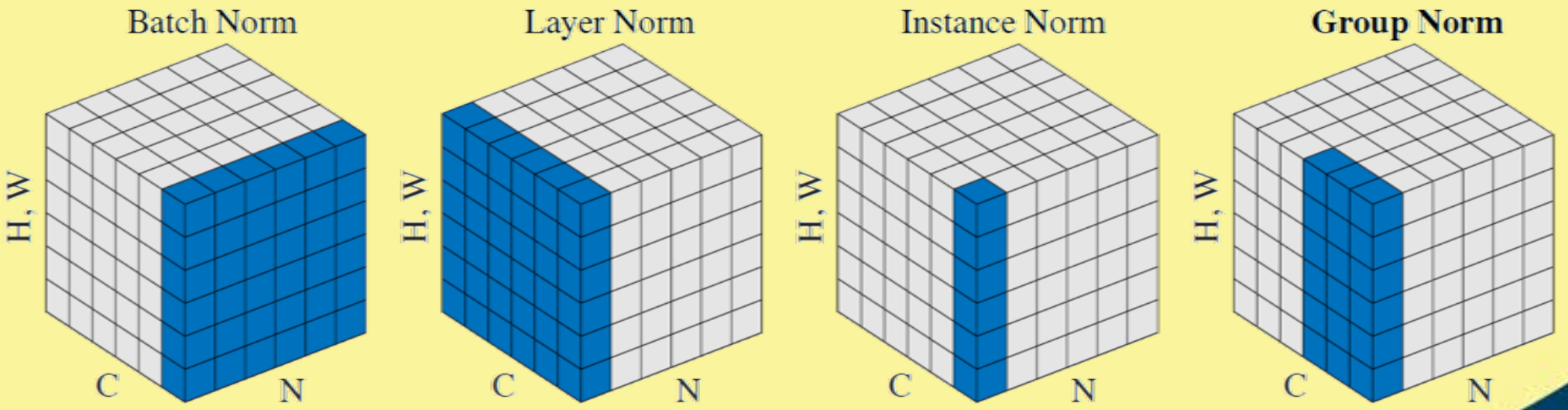
C'=number of channel per group



$$\mu_{NG} = \frac{1}{C'WH} \sum_{i=1}^{C'} \sum_{j=1}^{W} \sum_{k=1}^{H} x_{NGijk}$$

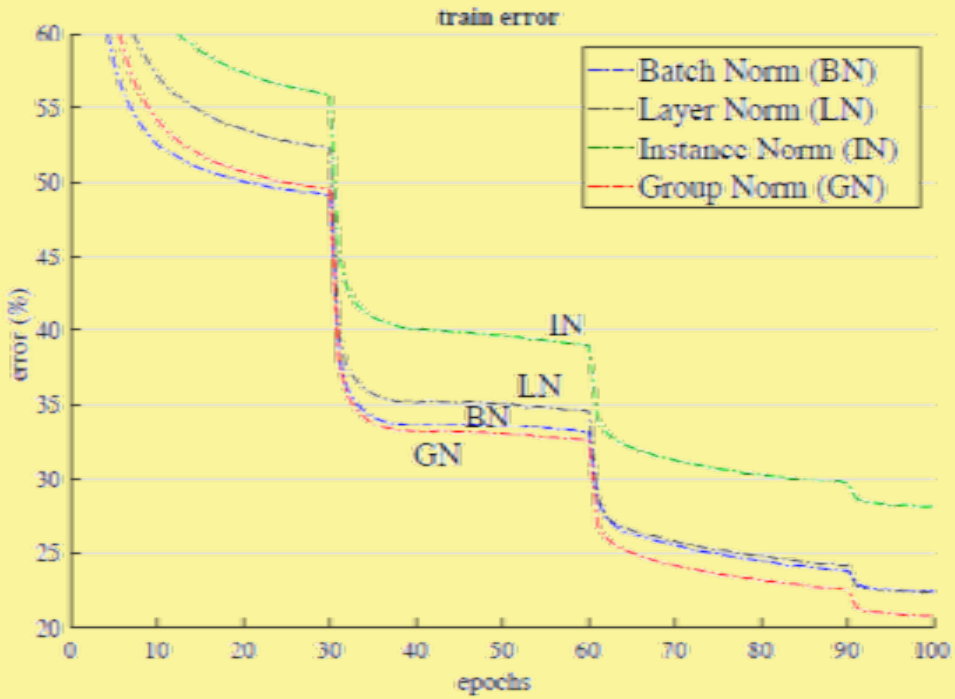
$$\sigma_{NG}^2 = \frac{1}{C'WH} \sum_{i=1}^{C'} \sum_{j=1}^{W} \sum_{k=1}^{H} (x_{NGijk} - \mu_{NG})^2$$

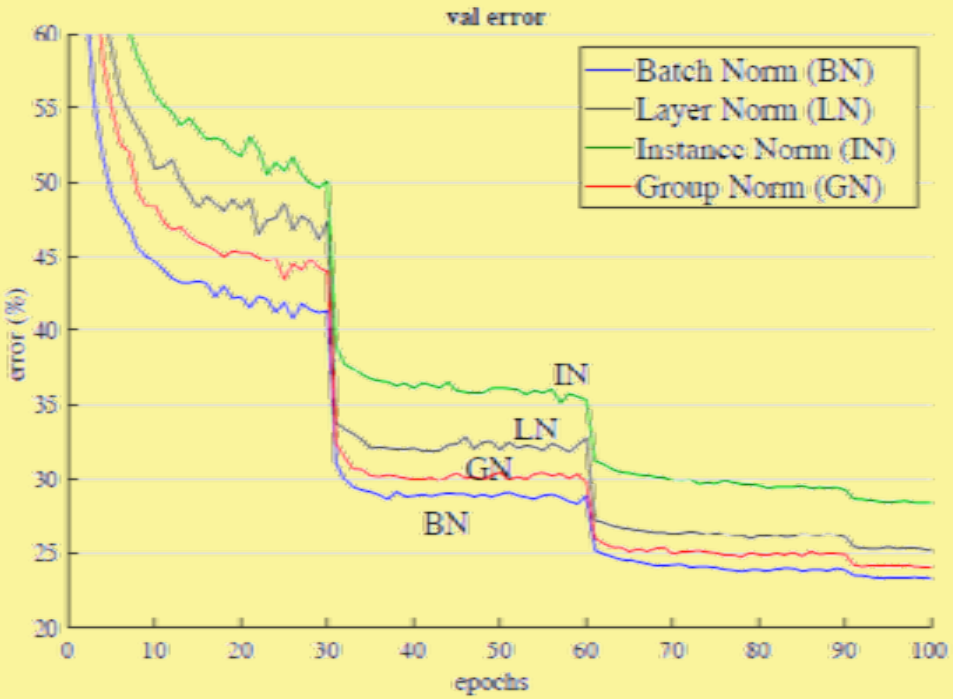
$$\hat{x} = \frac{x - \mu_{NG}}{\sqrt{\sigma_{NG}^2 + \epsilon}}$$



https://mlexplained.com/2018/11/30/an-overview-of-normalization-methods-in-deep-learning/

BN/LN/IN/GN Normalization

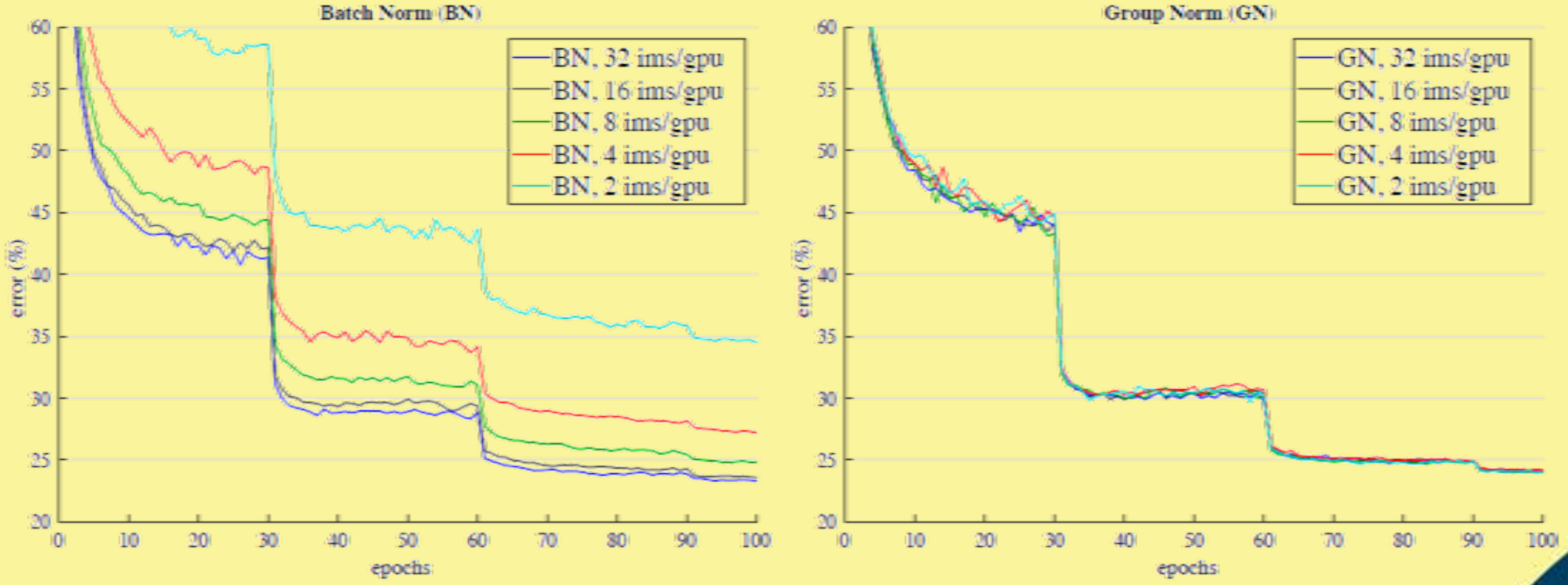




Model Name: Resnet-50, Dataset: Imagenet, Batch size: 32

Wu, Yuxin, and Kaiming He. "Group normalization." Proceedings of the European Conference on Computer Vision (ECCV). 2018.

Batch/Group Normalization



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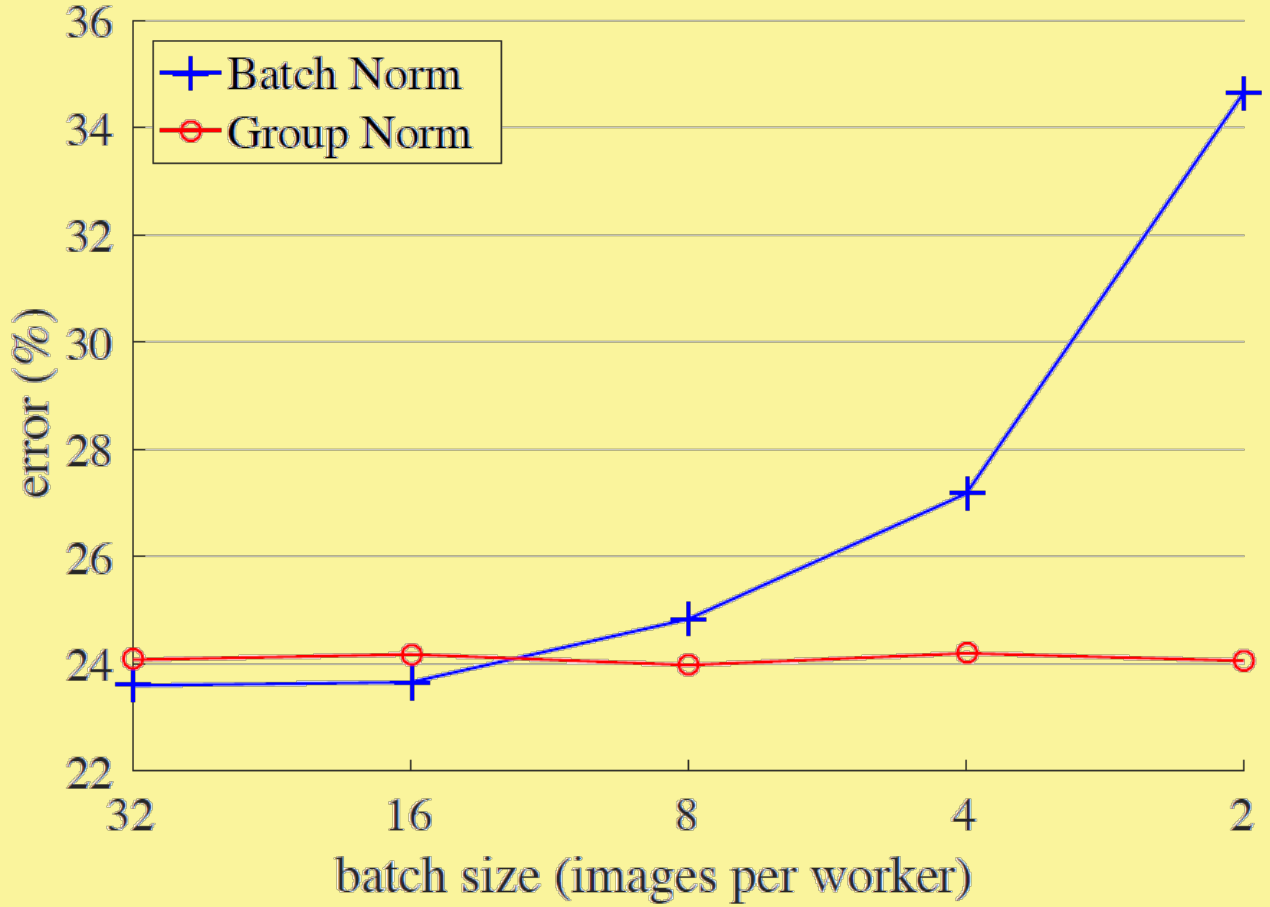

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Thank you