Getting started with neural networks

R/keras Part 2

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Slides: http://bit.ly/UZH_DL

Content

Review: objects of ANN

Deep learning frameworks

Tensors

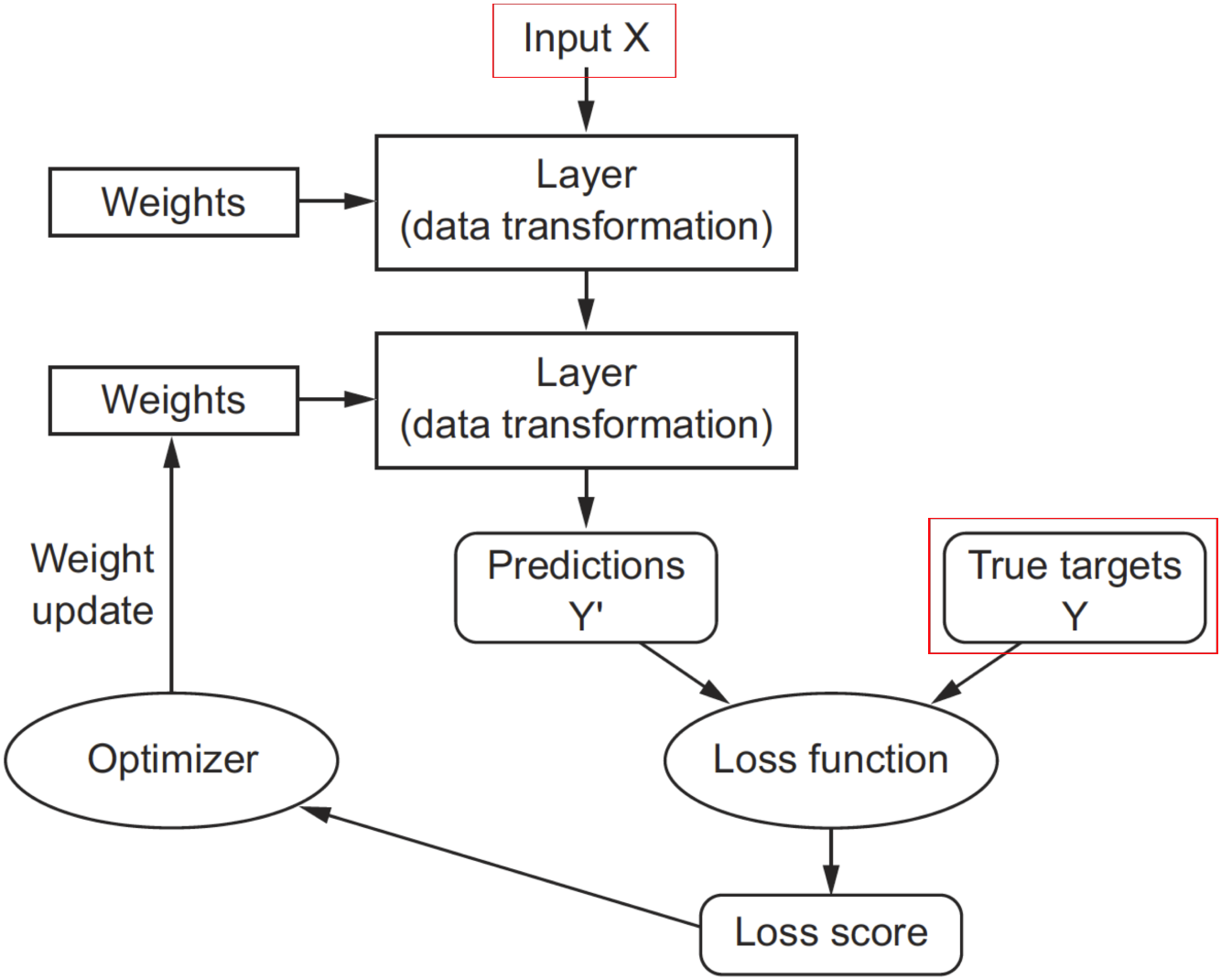
Classification

Normalization

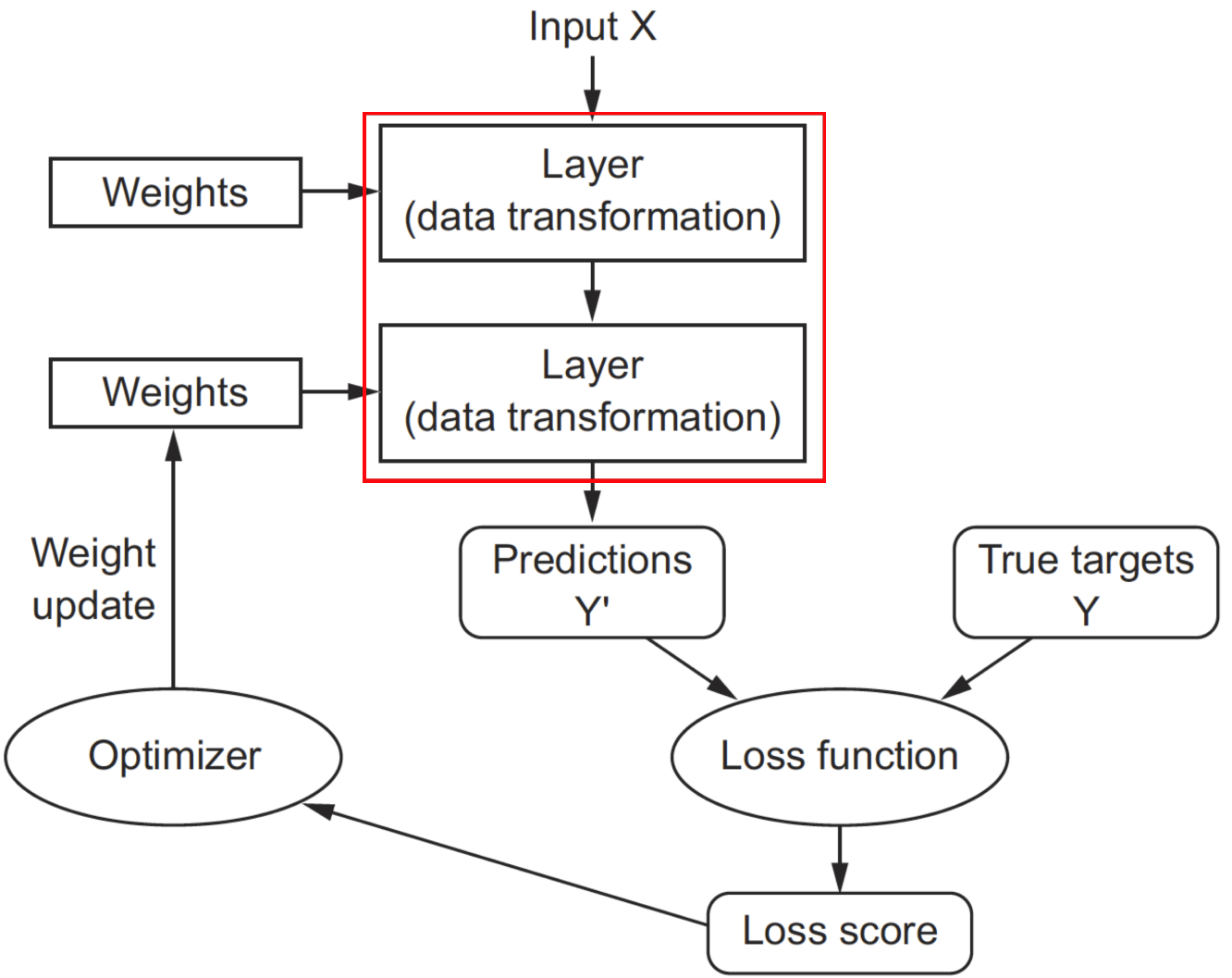
Train, validation and test sets

Cross validation

Relationship between objects of ANN



Relationship between objects of ANN



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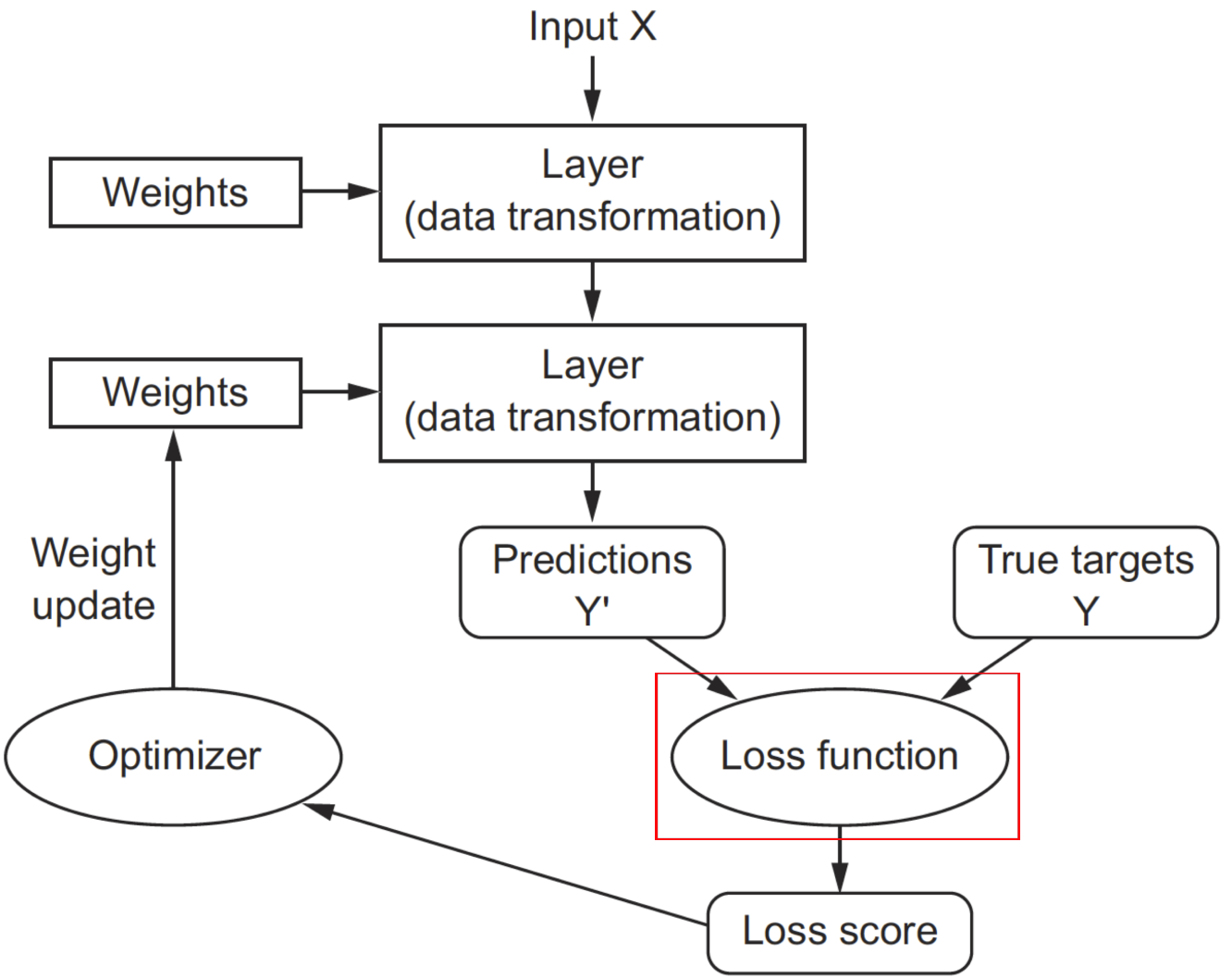

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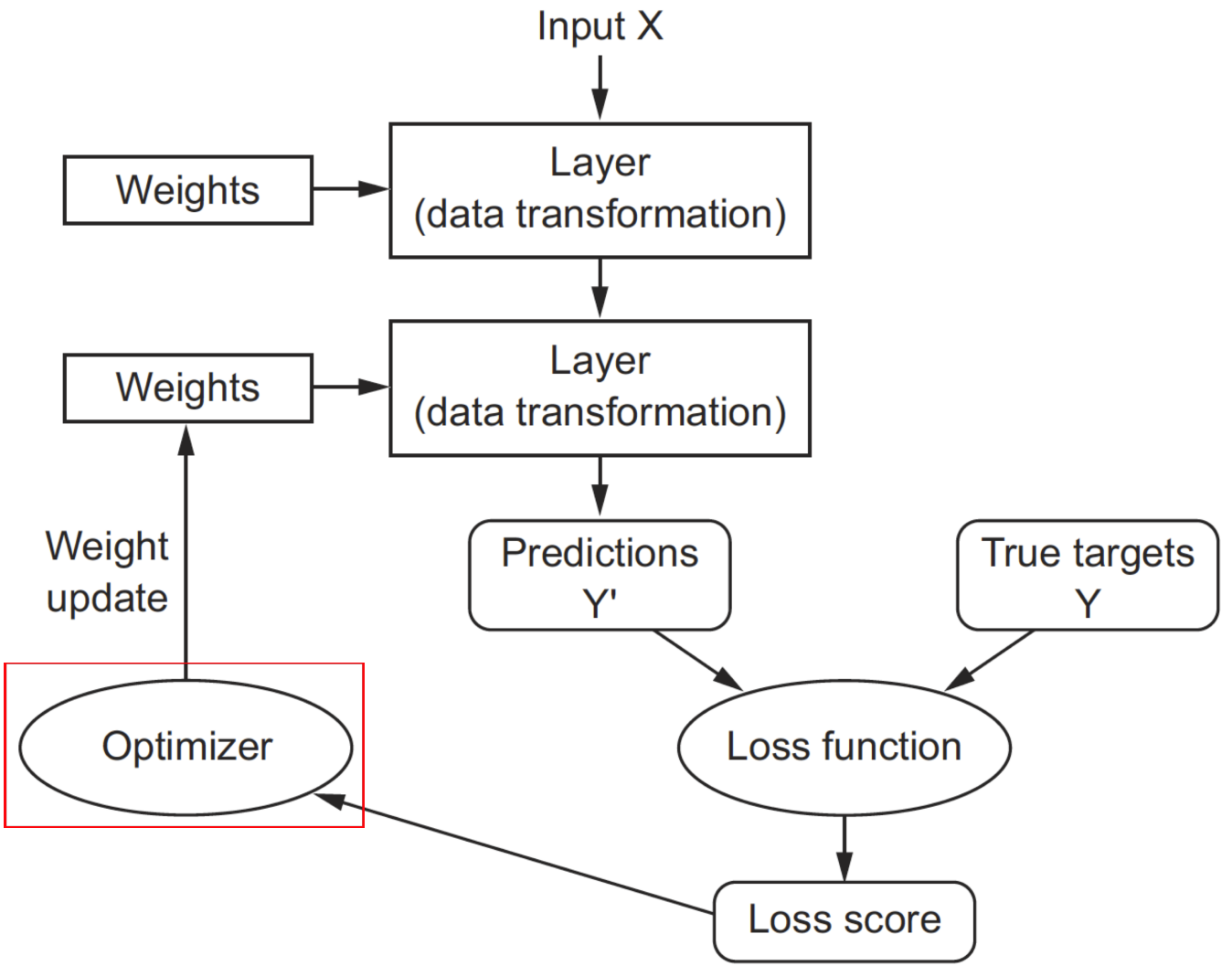
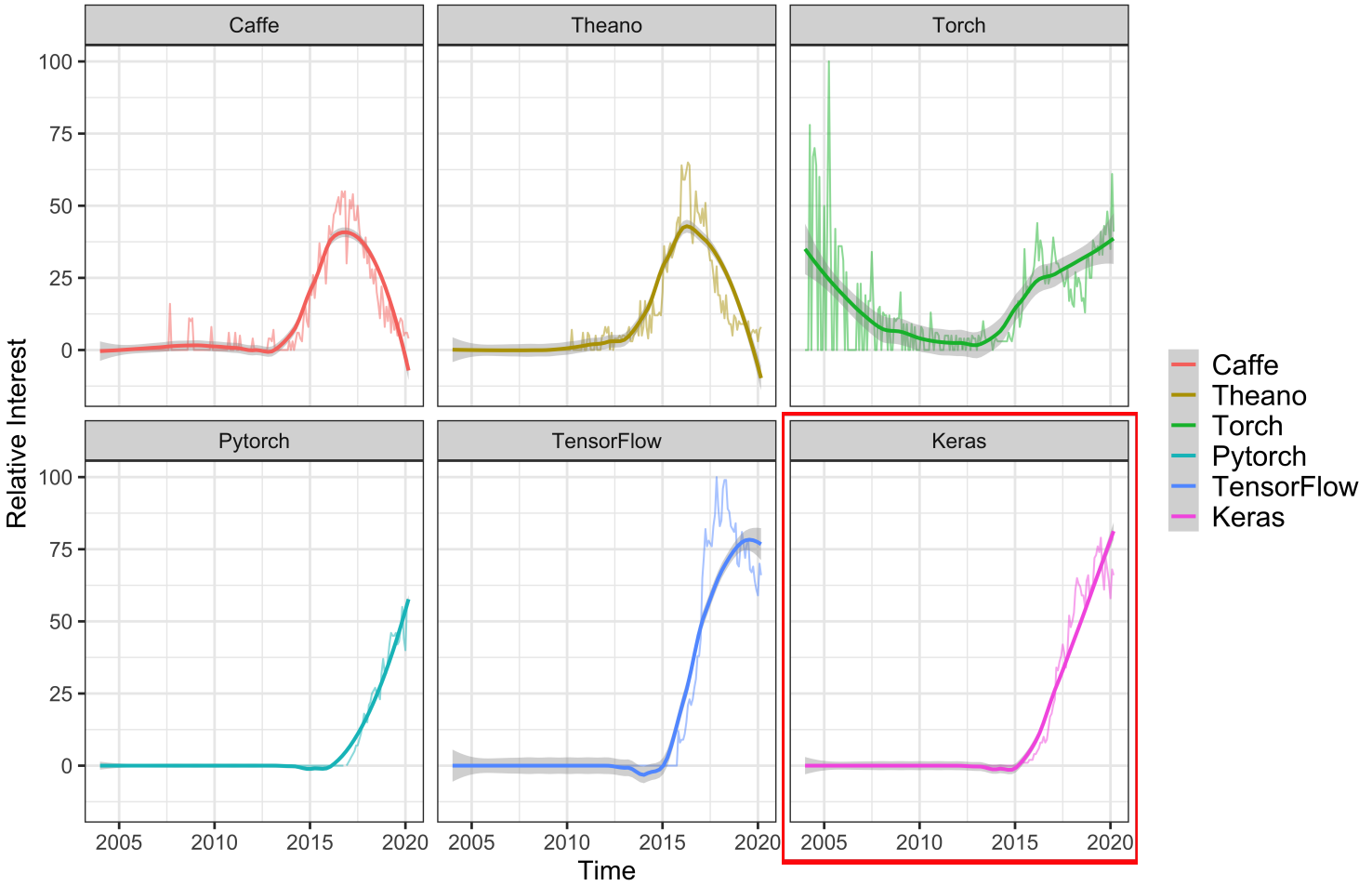


Deep learning frameworks



Introduction to Keras (κέρας)

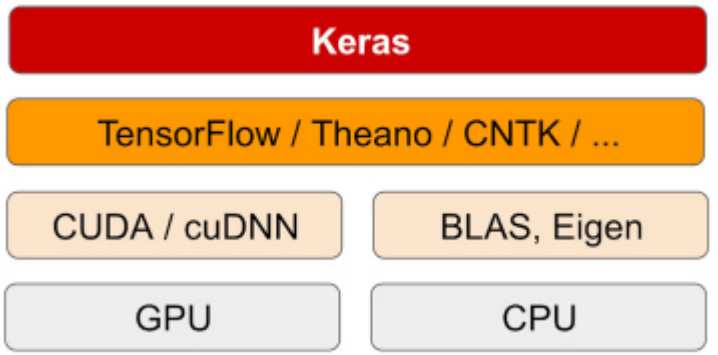
Keras is a **deep-learning framework** that provides a convenient way to define and train almost any kind of deep-learning model.

Features of Keras

1. Allows the same code to run seamlessly on CPU or GPU
2. User-friendly API
3. Built-in support for convolutional networks, recurrent networks, and any combination of both
4. It supports arbitrary network architectures: multi-input or multi-output models, layer sharing, model sharing, and so on.
5. Keras makes it easy to turn models into products
6. Keras development is backed by key companies in the deep learning:

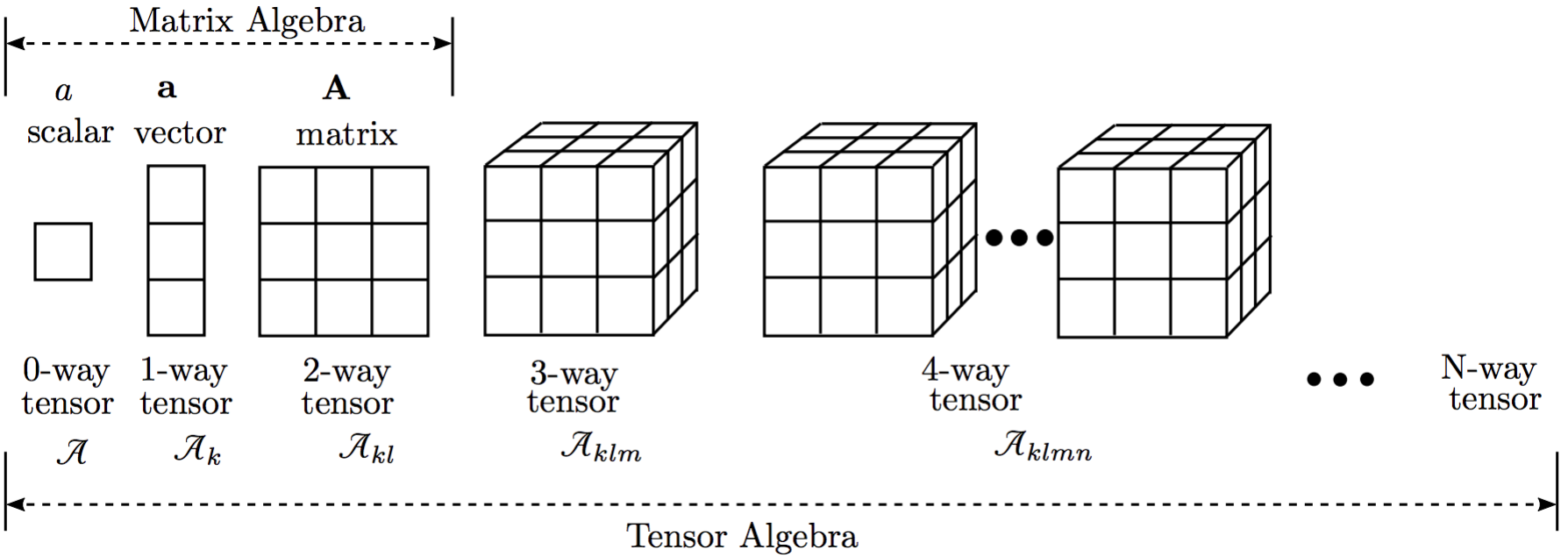
Google Microsoft NVIDIA aws

The deep-learning software and hardware stack



Keras supports multiple backend engines and does not lock you into one ecosystem.

Tensors



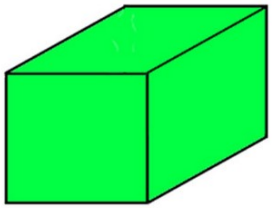
Tensors as generalizations of scalars, vectors and matrices

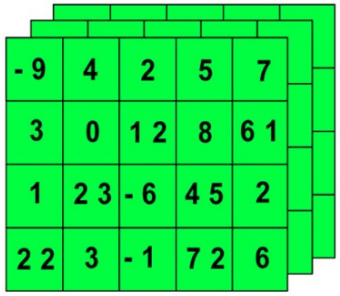
1D TENSOR/
VECTOR

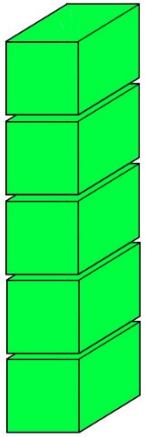
2D TENSOR /
MATRIX

- 9	4	2	5	7
3	0	1 2	8	6 1
1	2 3	- 6	4 5	2
2 2	3	- 1	7 2	6

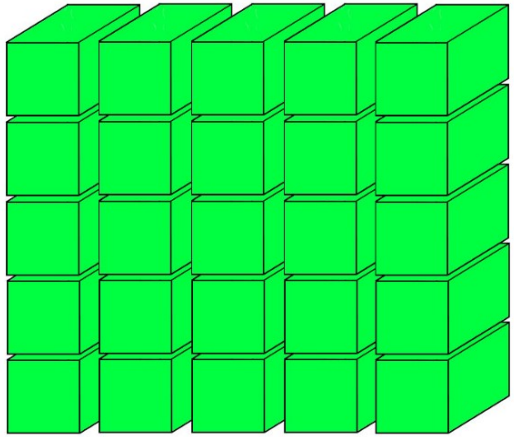
3D TENSOR/
CUBE







4D TENSOR
VECTOR OF CUBES



5D TENSOR
MATRIX OF CUBES

Source

Binary classification

1 (cat) vs 0 (non cat)

Binary classification

1 (cat) vs 0 (non cat)

Binary classification

1 (cat) vs 0 (non cat)

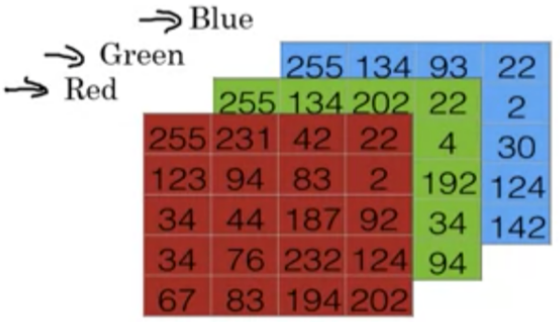
Binary classification

$\rightarrow$ 1 (cat) vs 0 (non cat)

y

Binary classification

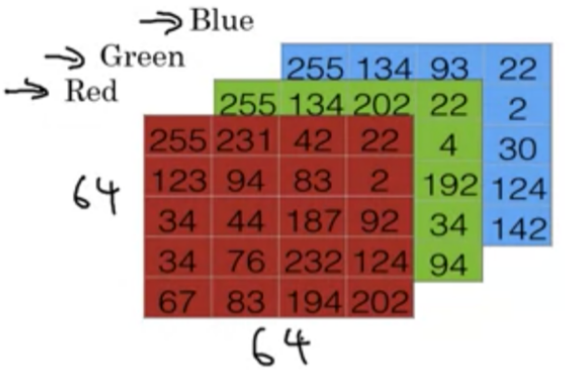
1 (cat) vs 0 (non cat)



Binary classification

$\rightarrow$ 1 (cat) vs 0 (non cat)

y



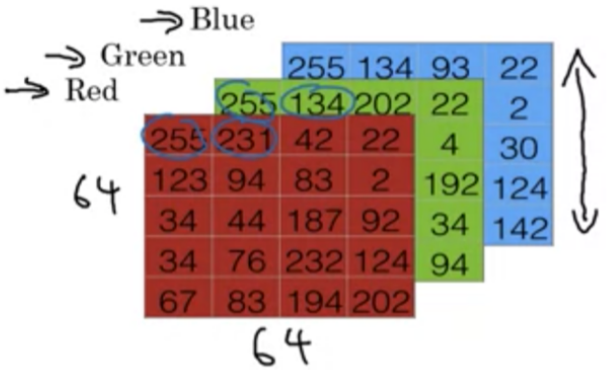
Binary classification

64

64

1 (cat) vs 0 (non cat)

y

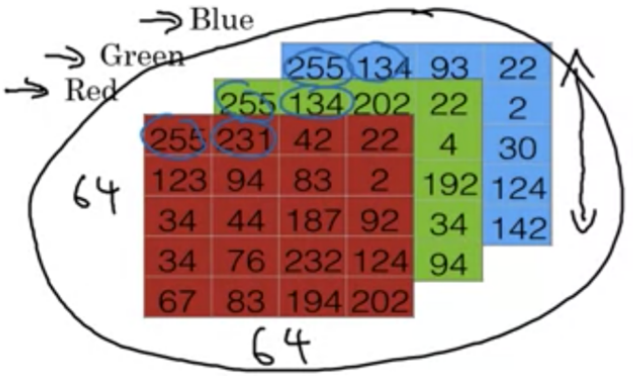


$$X = \begin{bmatrix} 255 \\ 231 \\ \vdots \\ \vdots \\ 255 \\ 134 \\ \vdots \\ \vdots \end{bmatrix}$$

Binary classification

64

64



$x = \begin{bmatrix} 255 \\ 231 \\ \vdots \\ 255 \\ 134 \\ \vdots \end{bmatrix}$

$64 \times 64 \times 3 = 12288$

1 (cat) vs 0 (non cat)

y

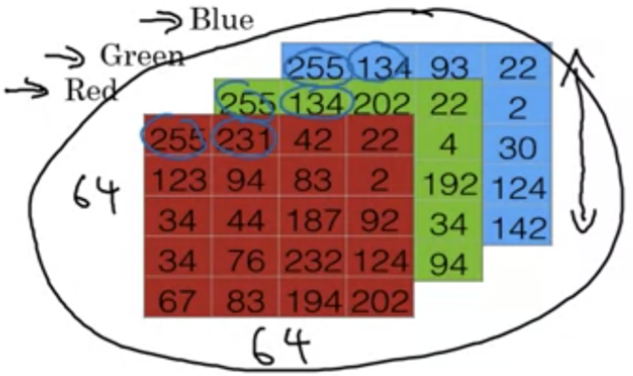
Binary classification

64

64

1 (cat) vs 0 (non cat)

y



$$x = \begin{bmatrix} 255 \\ 231 \\ \vdots \\ 255 \\ 134 \\ \vdots \end{bmatrix}$$

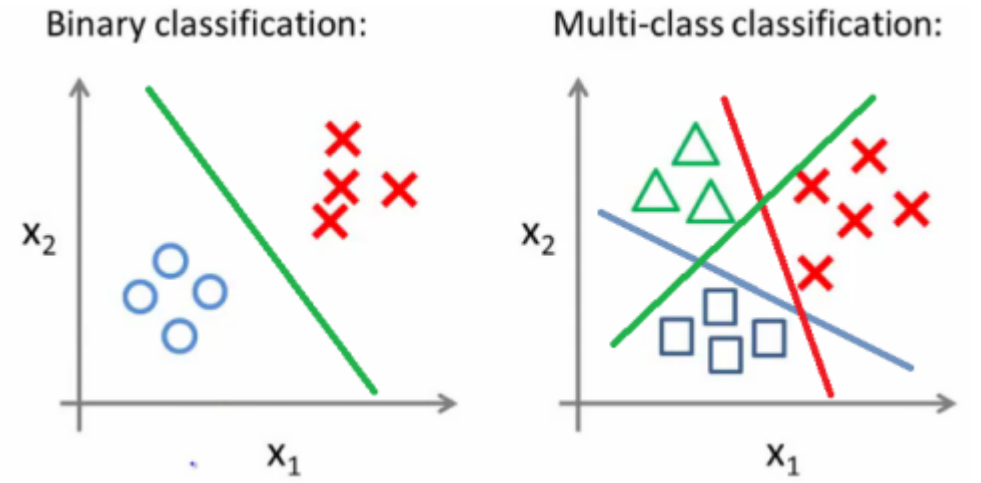
$64 \times 64 \times 3 = 12288$

$n = n_x = 12288$

$x \longrightarrow y$

Multiclass classification

Multiclass problems involve classifying something into one of N classes (e.g. “red”, “white” or “blue”, etc).



Source

Recommendations

Binary classification

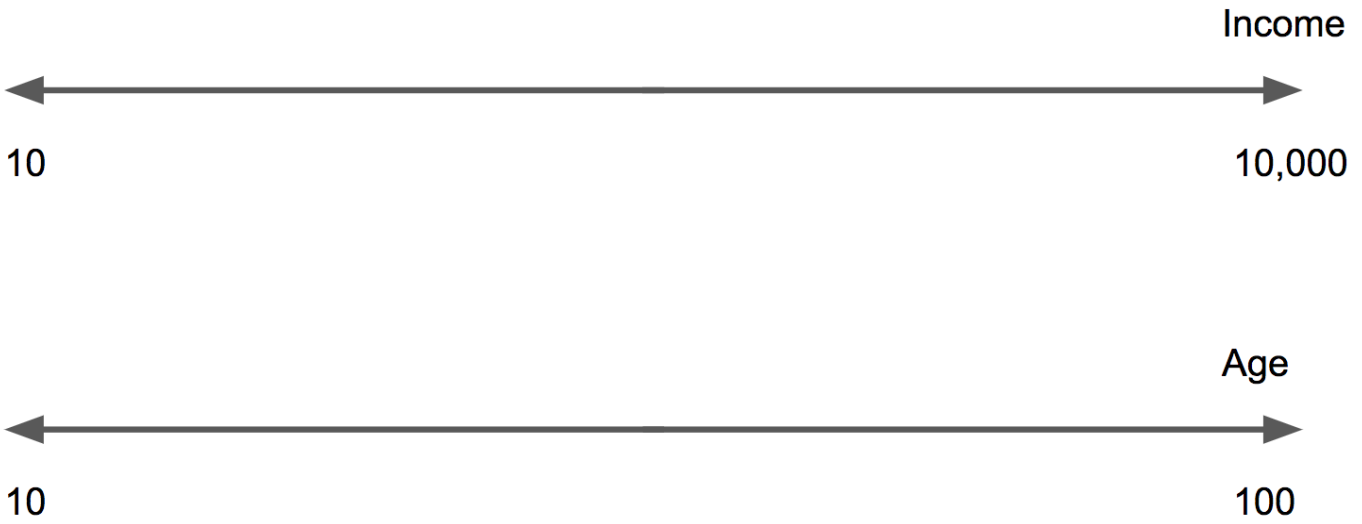
- Activation function: sigmoid
- Output: between 0 and 1
- Loss function: binary_crossentrop
- Optimizer: rmsprop

Multiclass classification

- Activation function: softmax
- Output: probability distribution over the N output classes
- Loss function: Categorical crossentropy
- Optimizer: rmsprop

Normalization methods in Deep Learning

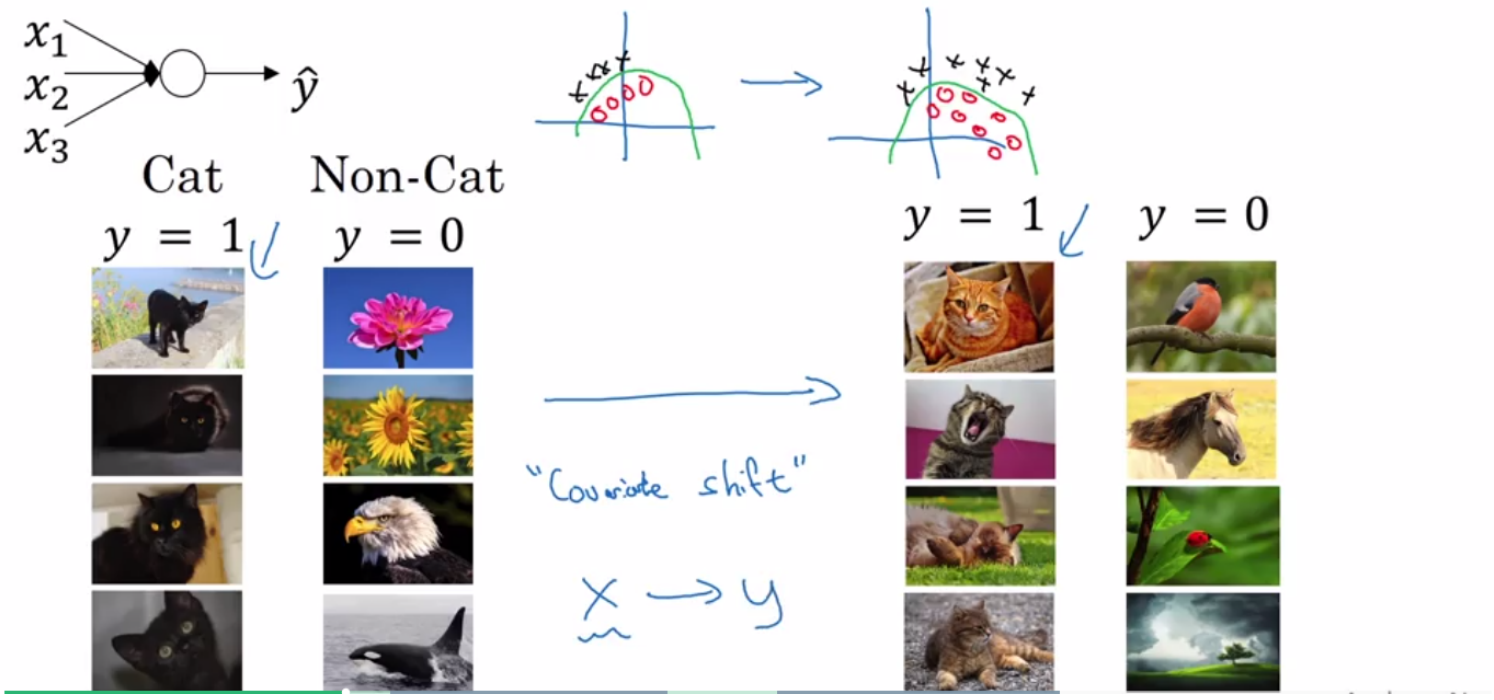
Problem 1: Data Distribution



we can observe that the range of income is larger than the range of age. If we do not do some preprocessing methods on these data, the effect of income feature may influence more than the one of age.

Source

Problem 2: Internal Covariate Shift



For a cat classifier, we may face a problem with the diverse data distribution of different batches. Even though there is a function which can split the data point, it is hard for the model to distinguish the data correctly in one mini-batch. We call this phenomenon “Internal Covariate Shift”.

Source

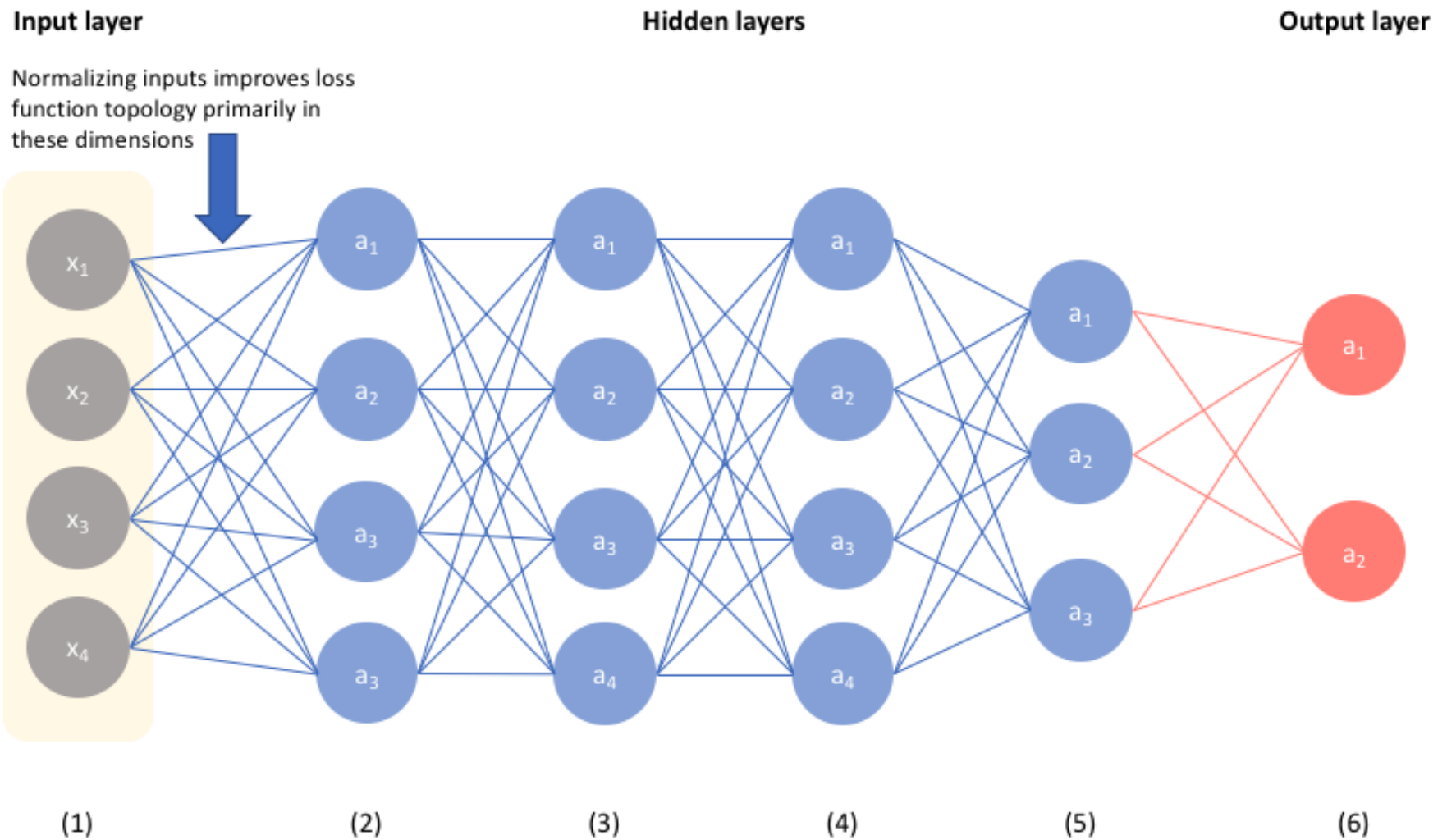
Problem 3: Vanishing/ Exploding Gradients

$$\frac{\partial \mathbf{h}^{(T)}}{\partial \mathbf{h}^{(1)}} = \frac{\partial \mathbf{h}^{(T)}}{\partial \mathbf{h}^{(T-1)}} \cdots \frac{\partial \mathbf{h}^{(2)}}{\partial \mathbf{h}^{(1)}}.$$

For a very deep neural network, we will multiply several gradients. If any of them is too small or too large, the neural network will face a vanishing/exploding gradients problem. Normalization can stable each value to reduce the vanishing/exploding gradient problem.

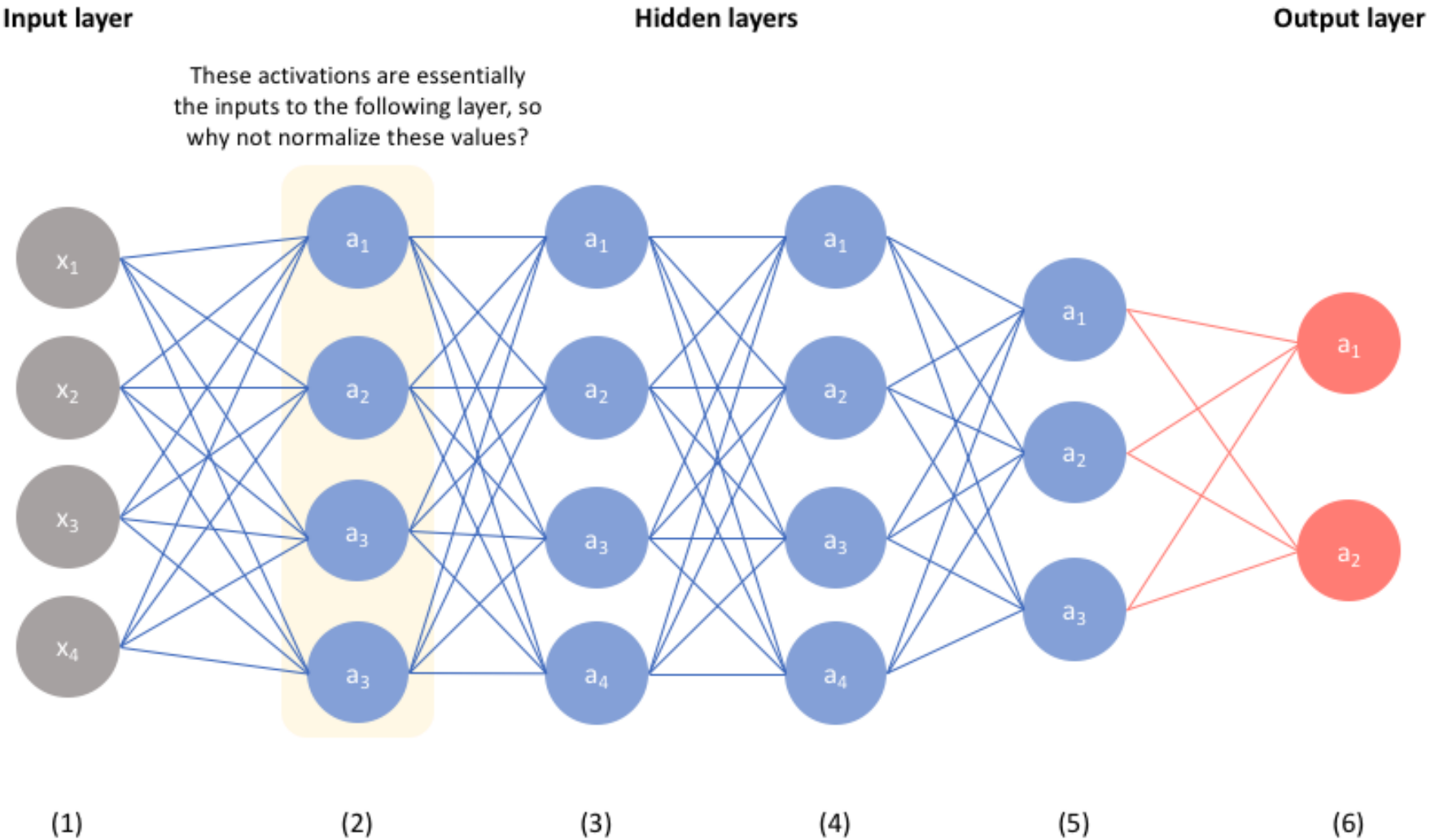
Source

Batch Normalization



arxiv.org/abs/1502.03167

Batch Normalization



arxiv.org/abs/1502.03167

When not to Batch Normalize?

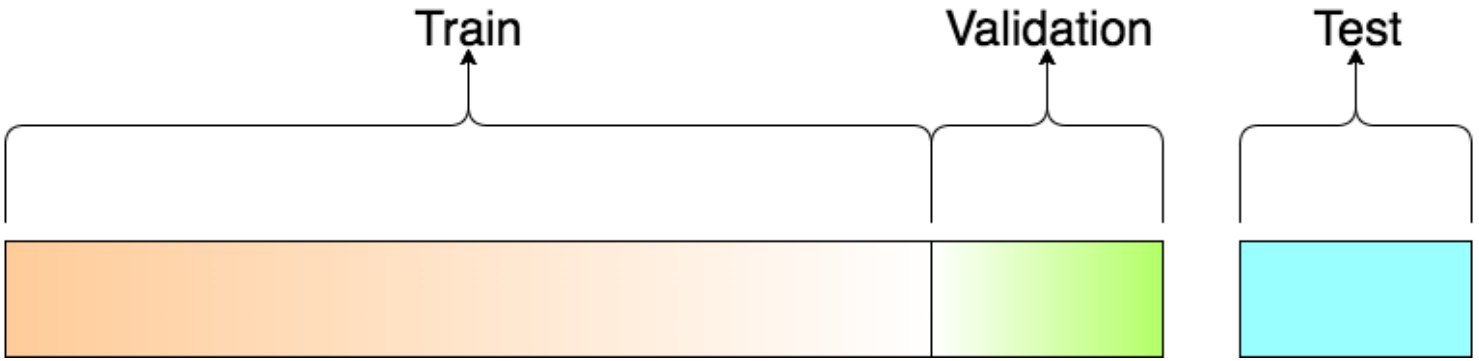
1. Small batch size
2. Recurrent connections in an RNN

What are the Alternatives?

1. Weight Normalization
2. Layer Normalization
3. Instance Normalization
4. Group Normalization
5. Batch Renormalization
6. Batch-Instance Normalization
7. Switchable Normalization
8. Spectral Normalization
9. ScaleNorm

Source

Train, validation and test sets



Training Dataset: The sample of data used to fit the model.

Validation Dataset: The sample of data used to provide an unbiased evaluation of a model fit on the training dataset while tuning model hyperparameters. The evaluation becomes more biased as skill on the validation dataset is incorporated into the model configuration.

Test Dataset: The sample of data used to provide an unbiased evaluation of a final model fit on the training dataset.

Source

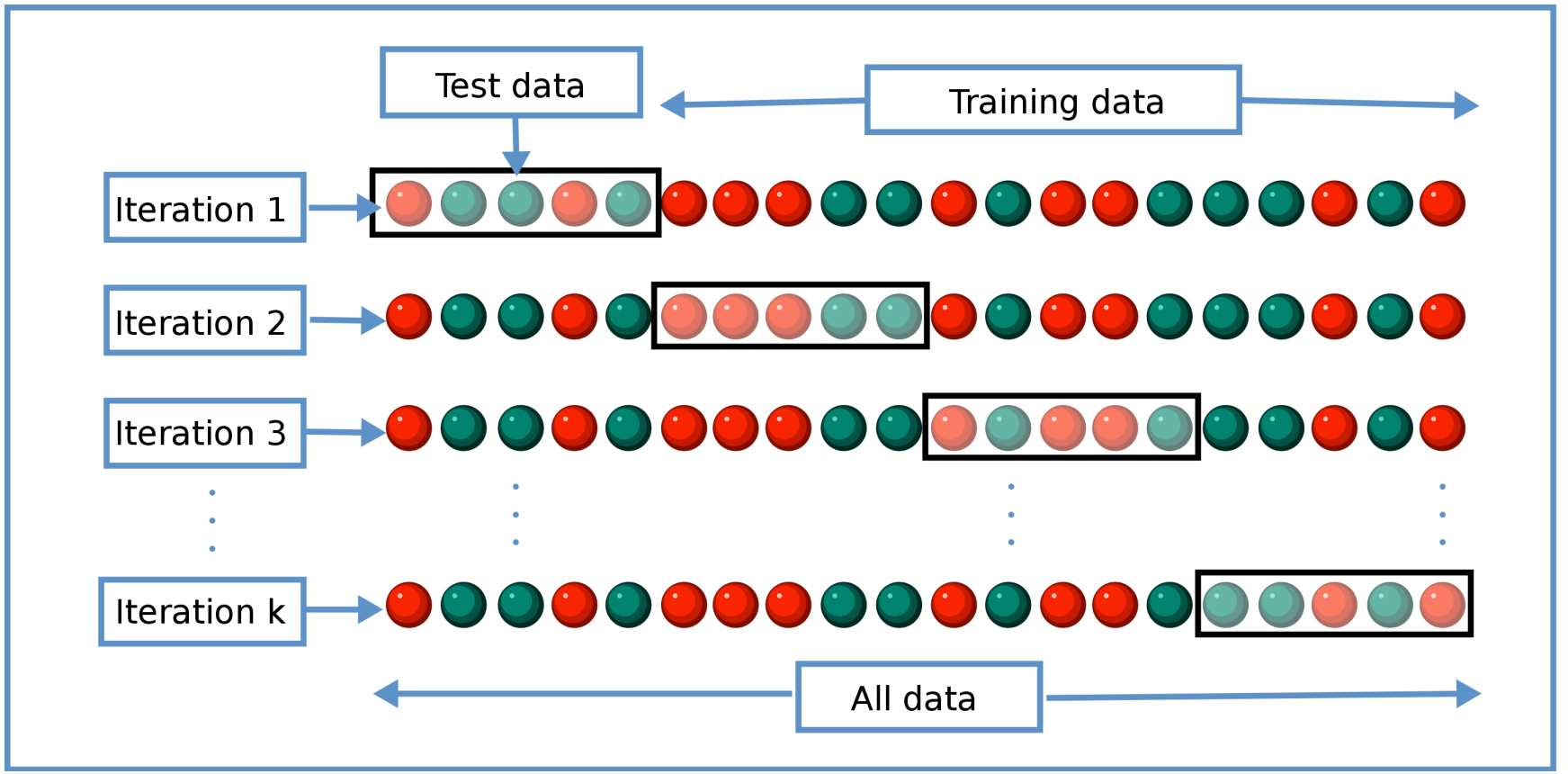
Dataset split ratio

Depends on 2 things:

1. The total number of samples in data
2. The actual model you are training

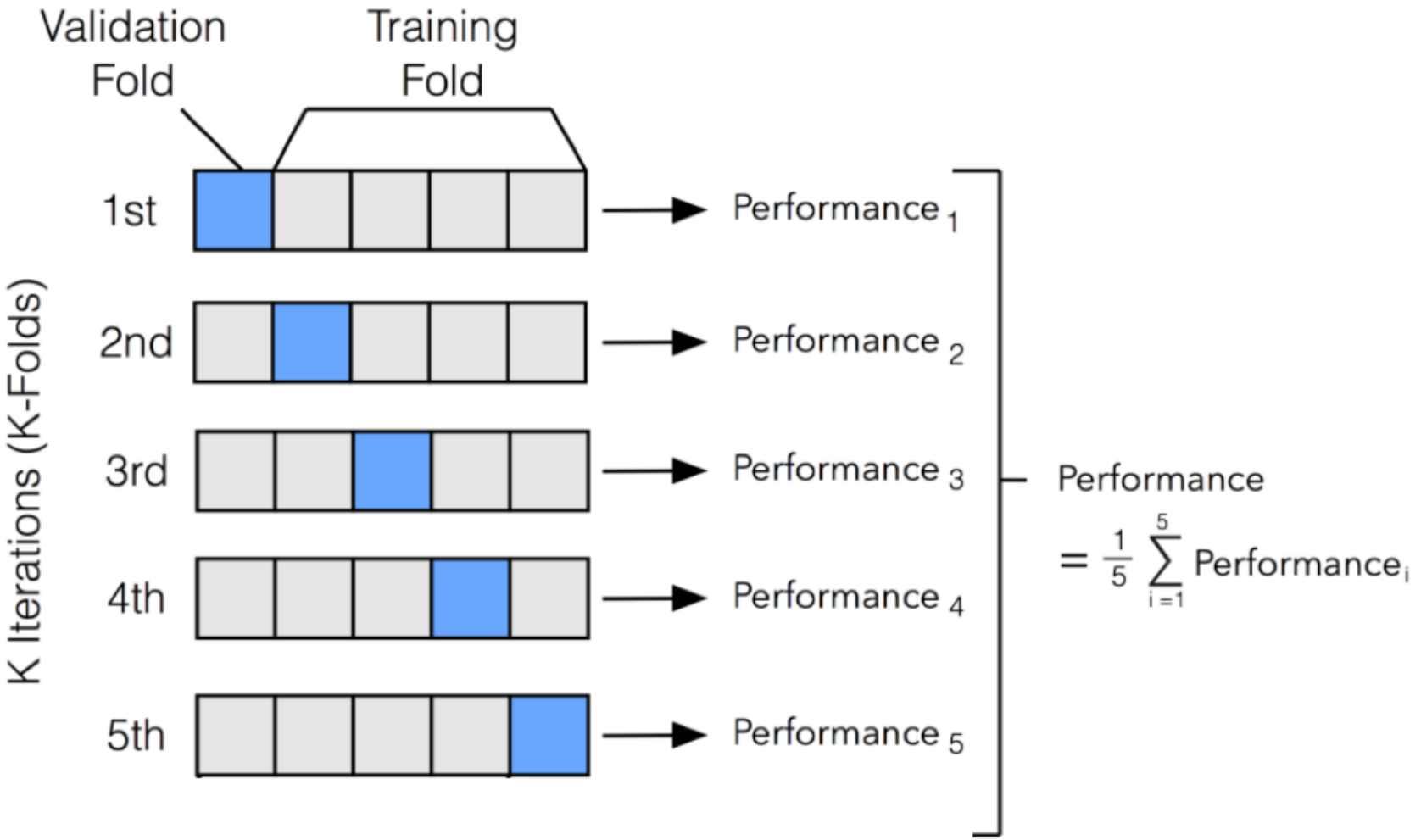
- Models with very few hyperparameters will be easy to validate and tune, so you can probably reduce the size of your validation set
- If the model has many hyperparameters, you would want to have a large validation set as well (although you should also consider cross validation).
- If the model have no hyperparameters or ones that cannot be easily tuned, probably don't need a validation set too!

Cross validation



Wikipedia

K-fold cross-validation



Source

Thank you!