Bayesian Neural Networks

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A Brief History

1979 — The patent a 'Method of providing digital signatures' is filed by Ralph C. Merkle [**merkle-patent**].

1999 — The original patent expires.

2009 — Bitcoin uses Merkle Trees for 'block header commitment.' [**friedenb**

2023 — Twenty students taking a cryptography class .

Applications

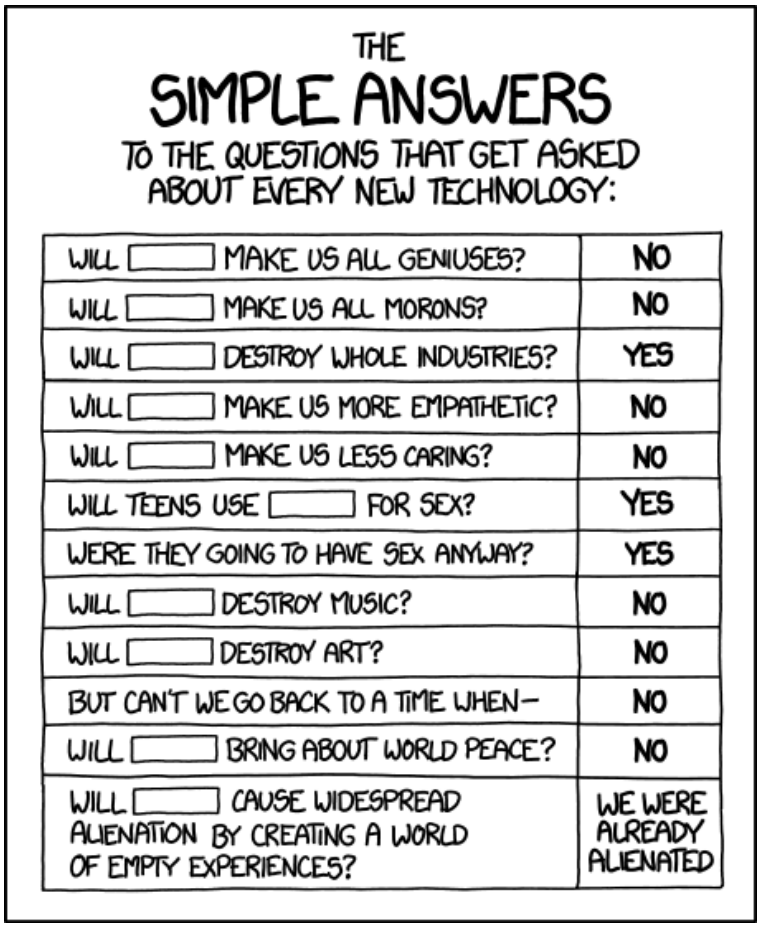

Figure: XKCD: "*Simple Answers*" [5]

What are....

Neural Networks (NN)

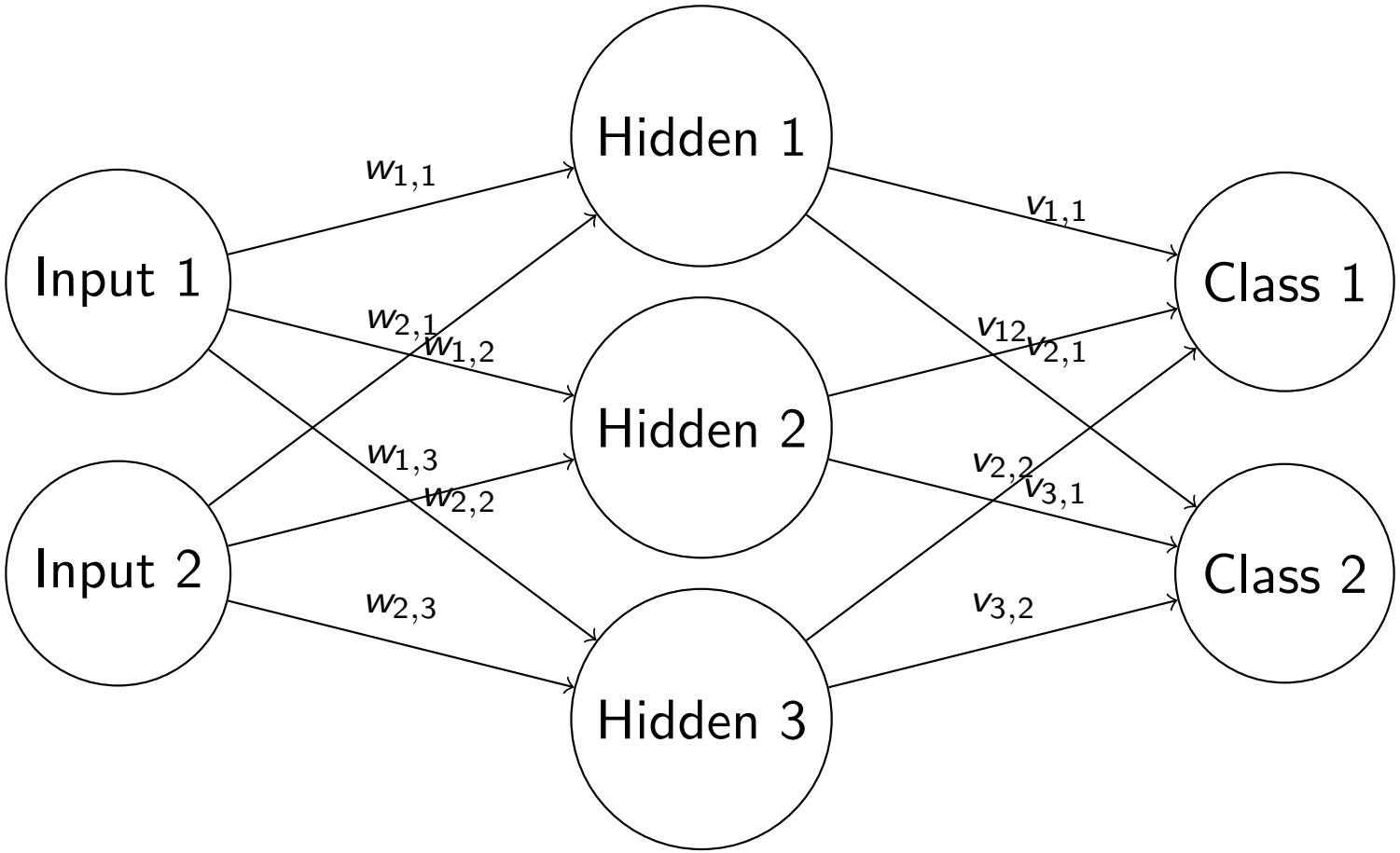

Figure: Example neural network

Issues with Neural Networks

Figure: XKCD: "*Machine Learning*" [7]

- Stir data and pray
-

Convolutional Neural Networks (CNN)

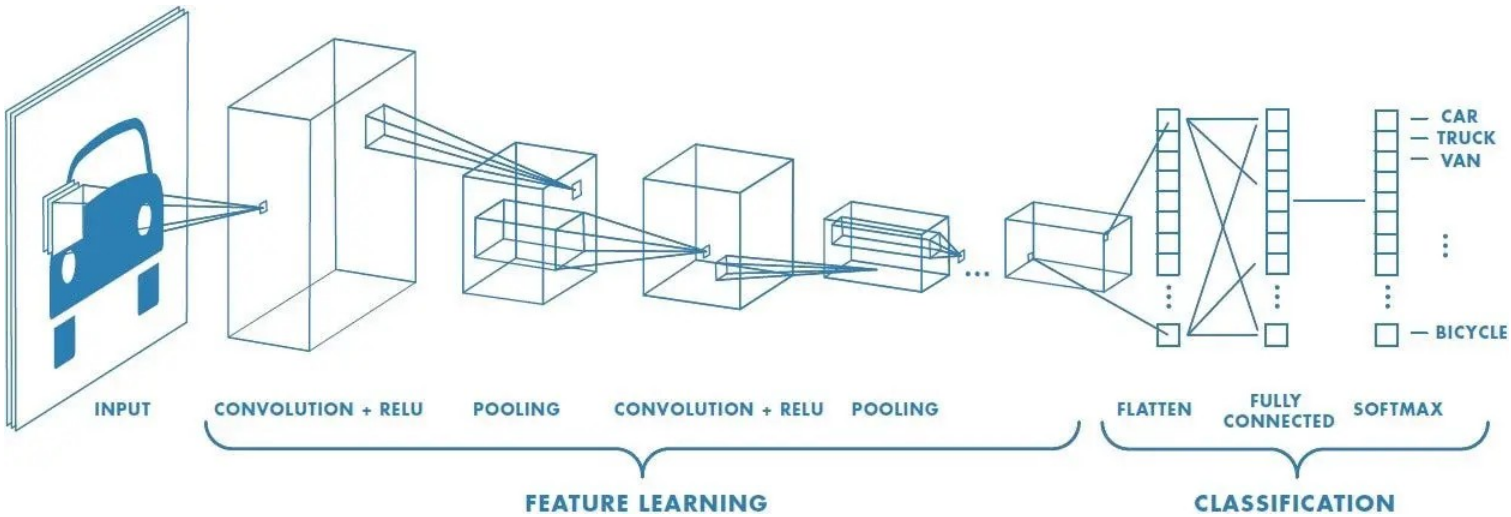

Figure: CNN pipeline [9]

Why we use CNNs

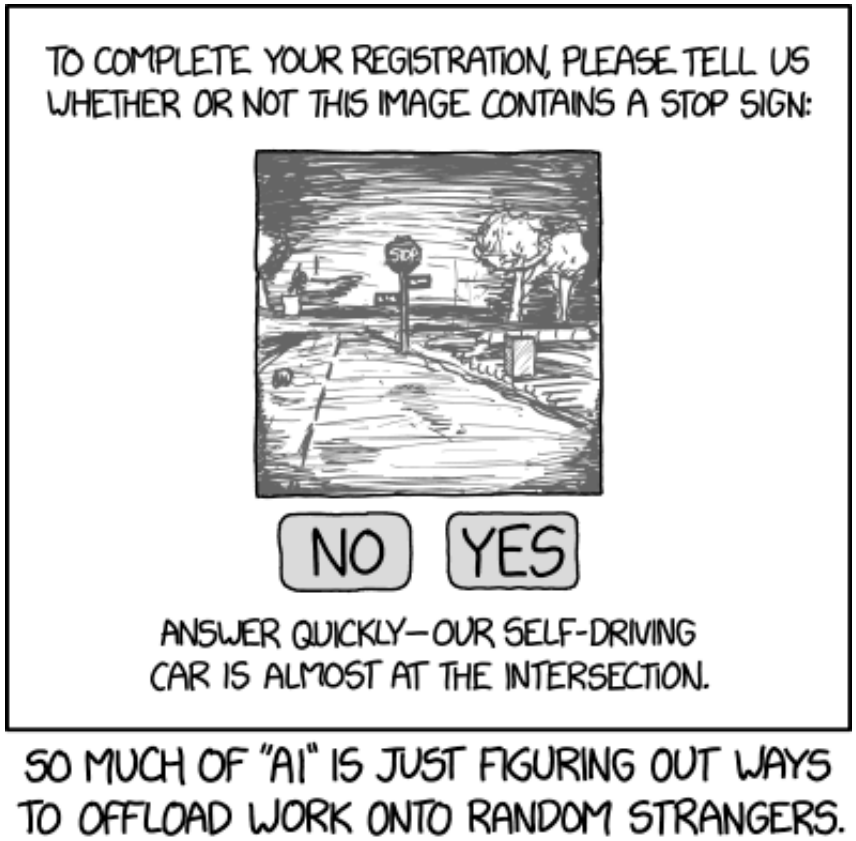

Figure: XKCD: "*Self Driving*" [8]

- They are more efficient for image based tasks
- Channels...

Bayesian Neural Network

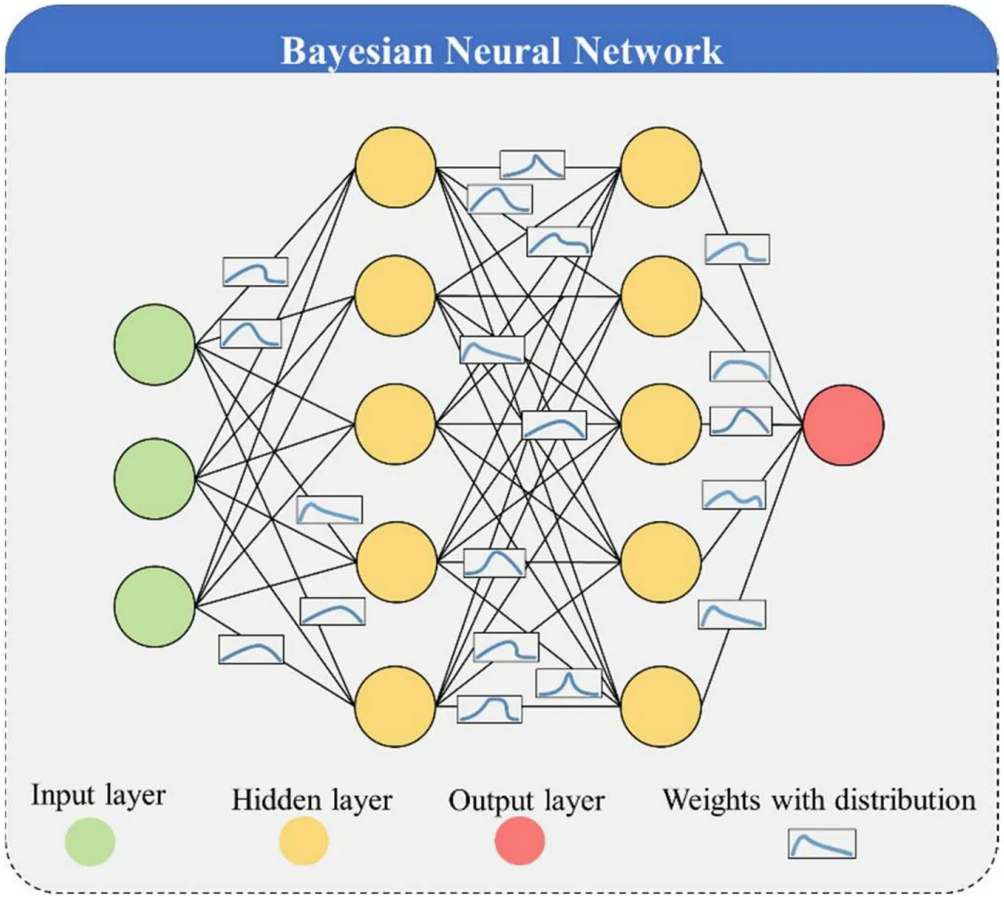

Figure: Example BNN [1]

BNN Neuron

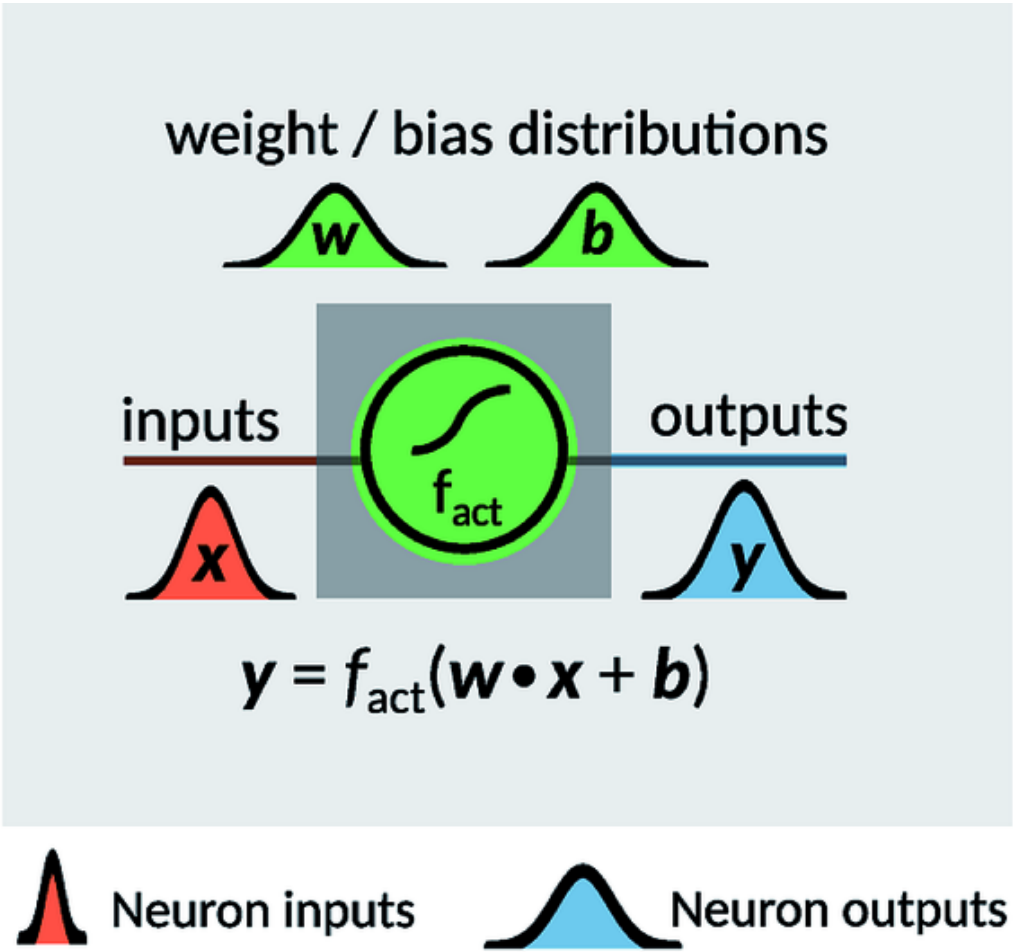

Figure: Example BNN Neuron [2]

Why we use BNN

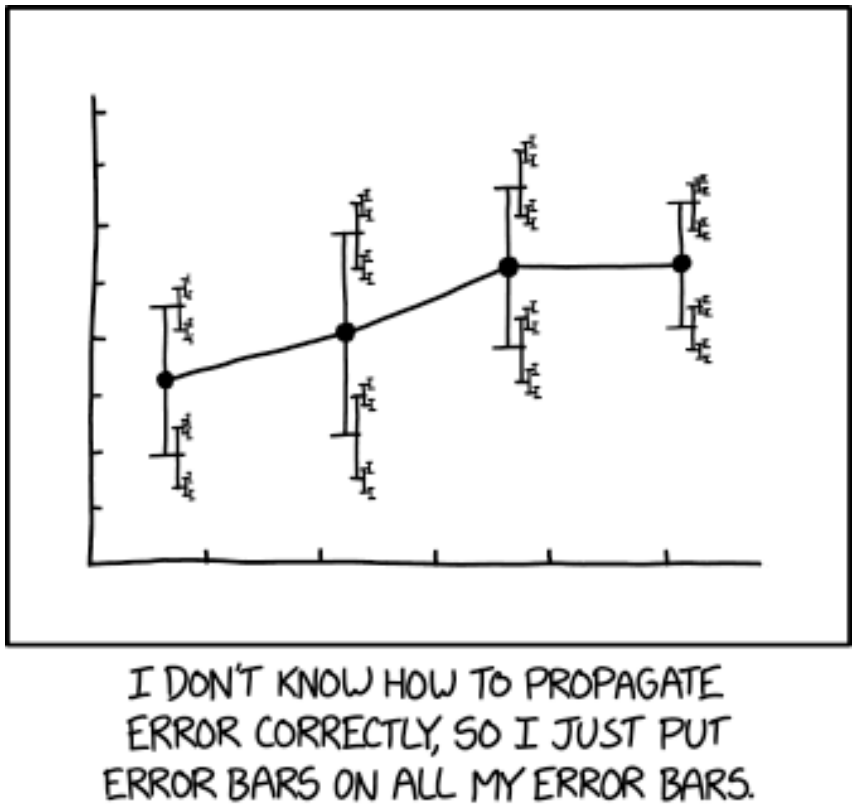

Figure: XKCD: "*Error Bars*" [8]

- We can put uncertainty on our weights
- ....

Difference between BNNs and BCNNs

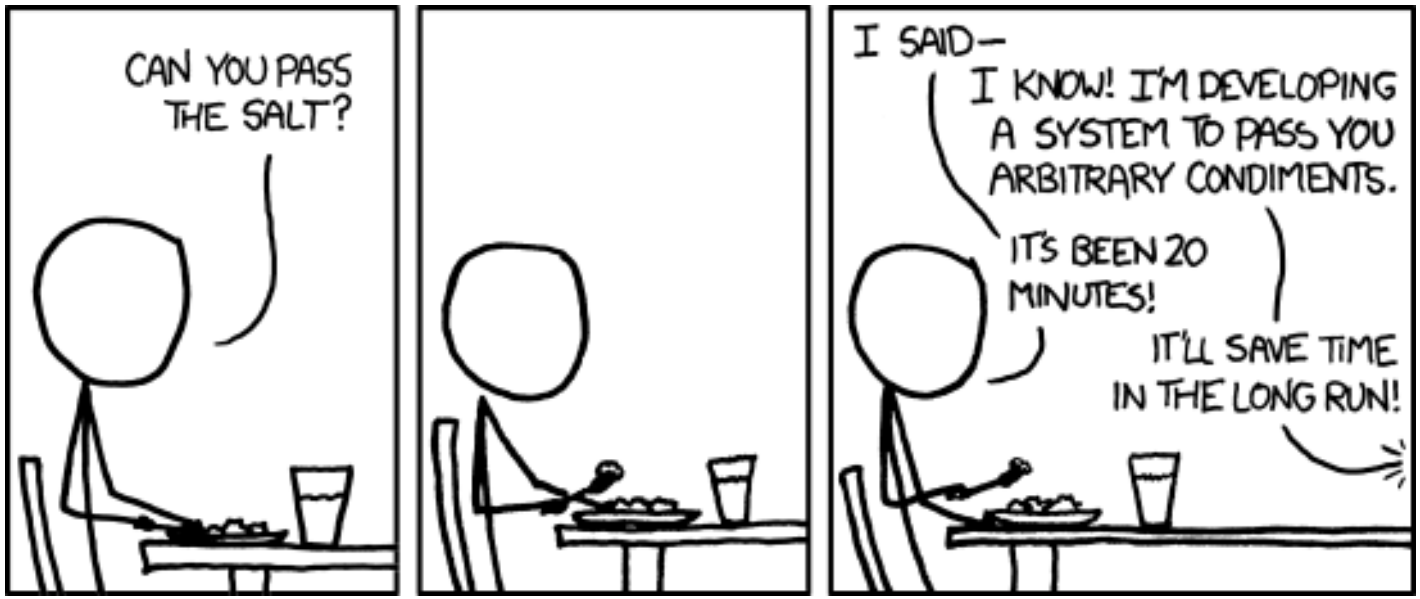

Figure: XKCD: "*The General Problem*" [4]

The relationship between BNNs and BCNNs is the same as NNs and CNNs.

CIFAR-10

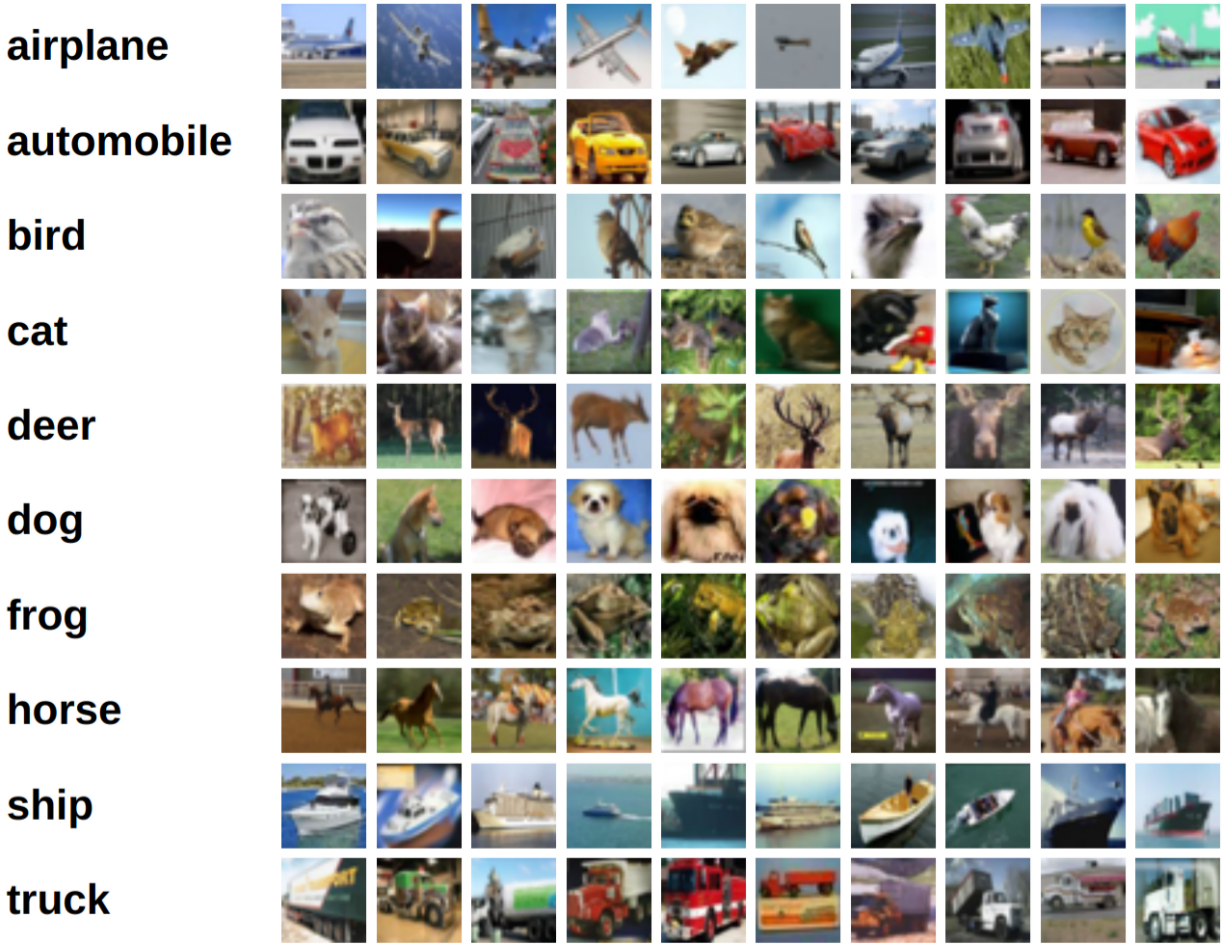

Figure: Example CIFAR-10 images [3]

Hyperparameters

Hyperparameter	**CNN**	**BCNN**
Epochs	500	500
Learning Rate	....	May be higher (0.01 - 0.1) due to simpler structure
Regularization	L1/L2 weight decay or Dropout common to prevent overfitting	Can benefit from Dropout, but weight decay might be less crucial
Optimizer	Adamw	Adamw

Results

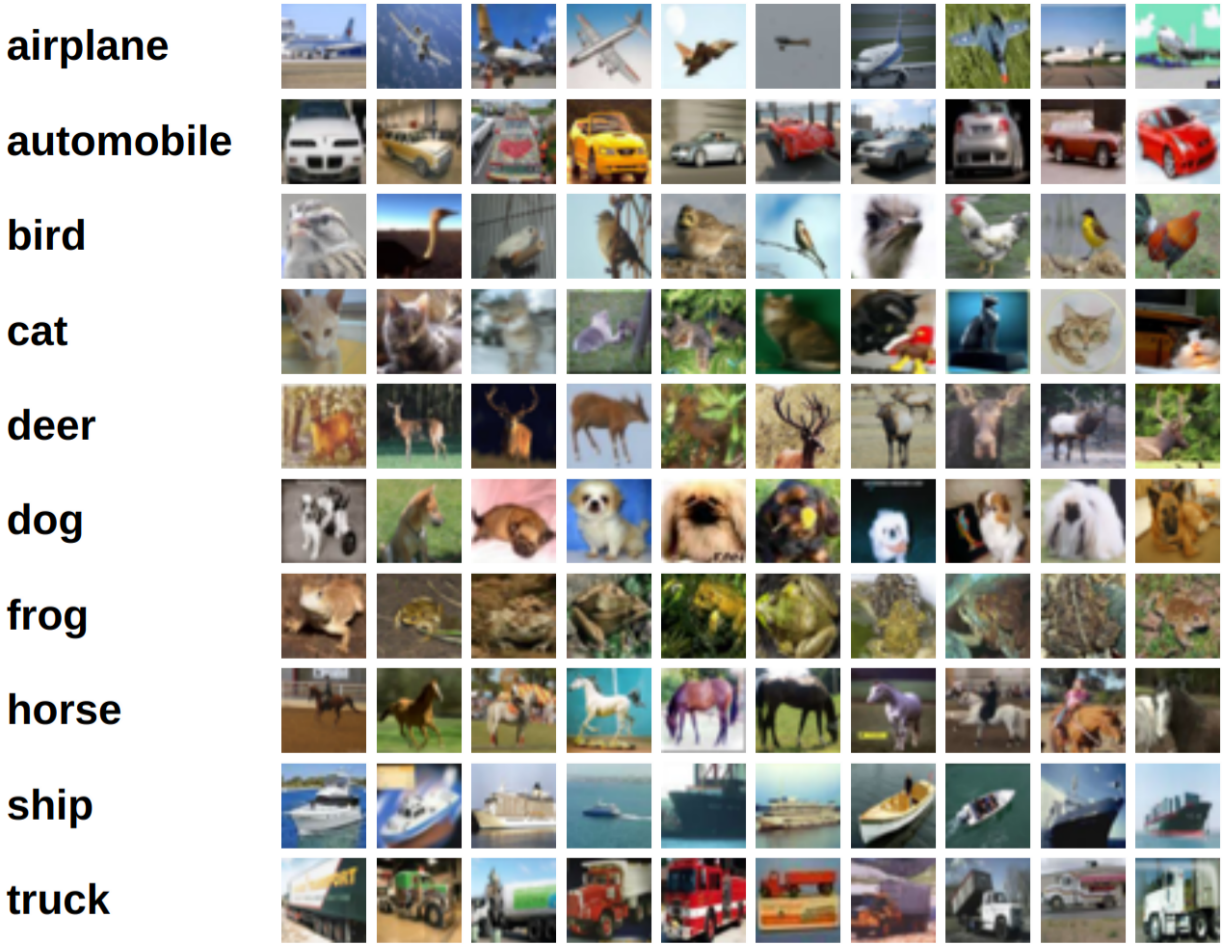

Figure: Example CIFAR-10 images [3]

Confusion Matrix

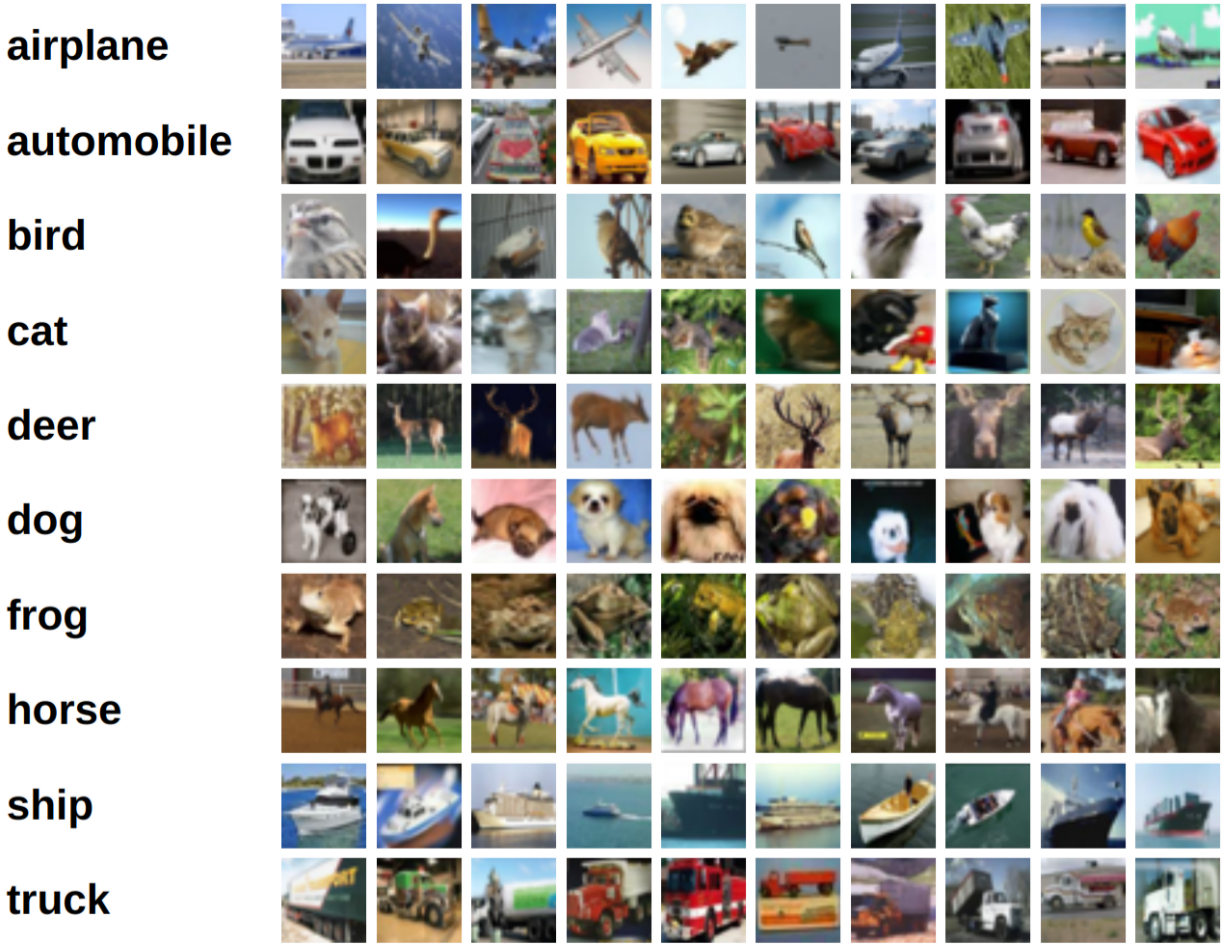

Figure: Example CIFAR-10 images [3]

Live Demo

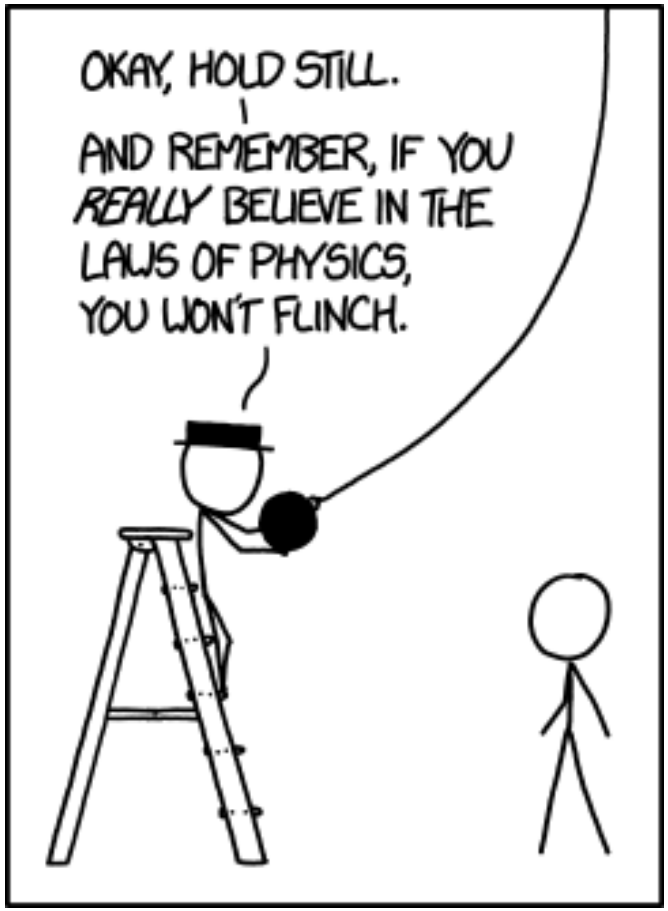

Figure: XKCD: "*Laws of Physics*" [6]

Questions

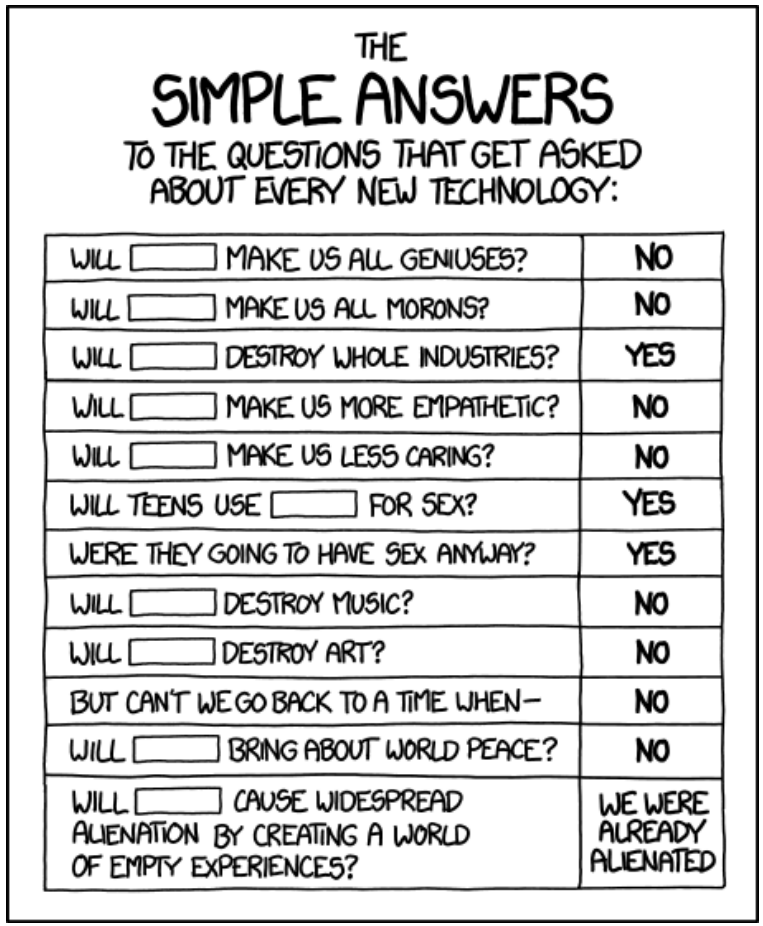

Figure: XKCD: "*Simple Answers*" [5]

References I

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