

Bayesian Neural Networks

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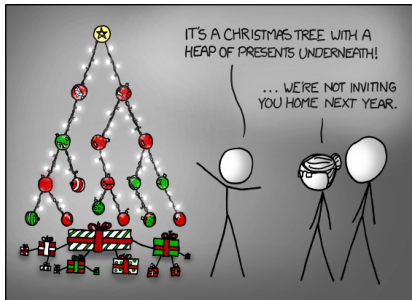
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A Brief History

- 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.' [**frieden**]
- 2023 — Twenty students taking a cryptography class .



Applications



Merkle trees are secured data structures whose operations can be used to prove/verify membership of a node in $\mathcal{O}(\log(n))$ hashes.

Figure: XKCD: "Tree" [xkcd-tree]



Neural Networks (NN)

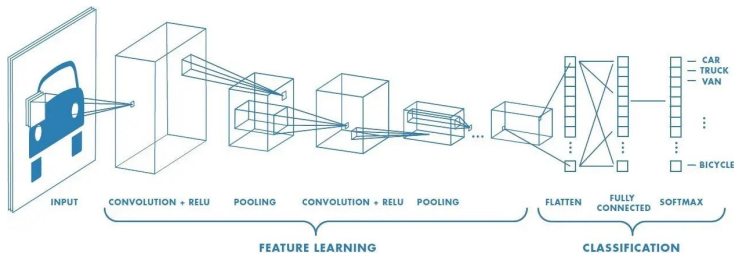


Figure: NEED NN PHOTO [5]



Issues with Neural Networks



- Stir data and pray
-

Figure: XKCD: "Machine Learning" [3]



Convolutional Neural Networks (CNN)

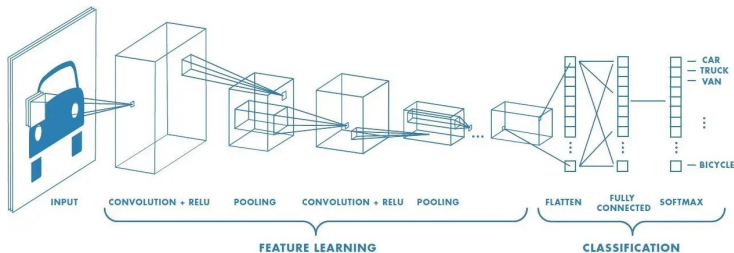


Figure: CNN pipeline [5]



Why we use CNNs



SO MUCH OF "AI" IS JUST FIGURING OUT WAYS TO OFFLOAD WORK ONTO RANDOM STRANGERS.

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

Figure: XKCD: "Self Driving" [4]



Difference between BNNs and CNNs

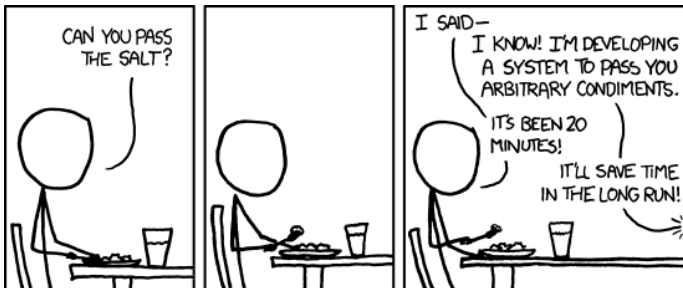


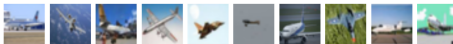
Figure: XKCD: "The General Problem" [2]

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



CIFAR-10

airplane



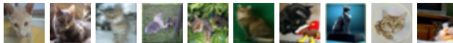
automobile



bird



cat



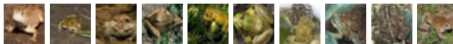
deer



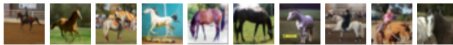
dog



frog



horse



ship



truck



Figure: Example CIFAR-10 images [1]



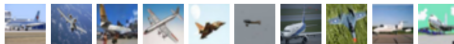
Hyperparameters

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

airplane



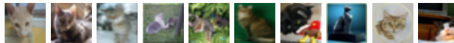
automobile



bird



cat



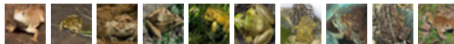
deer



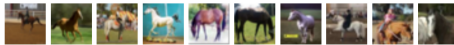
dog



frog



horse



ship



truck



Figure: Example CIFAR-10 images [1]



Confusion Matrix

airplane

automobile

bird

cat

deer

dog

frog

horse

ship

truck

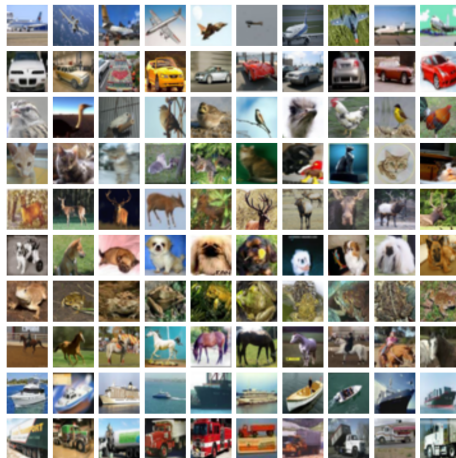


Figure: Example CIFAR-10 images [1]



References I

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