

Bayesian Neural Networks

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March 31, 2024

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

THE
SIMPLE ANSWERS
TO THE QUESTIONS THAT GET ASKED
ABOUT EVERY NEW TECHNOLOGY:

WILL <input type="checkbox"/> MAKE US ALL GENIUSES?	NO
WILL <input type="checkbox"/> MAKE US ALL MORONS?	NO
WILL <input type="checkbox"/> DESTROY WHOLE INDUSTRIES?	YES
WILL <input type="checkbox"/> MAKE US MORE EMPATHETIC?	NO
WILL <input type="checkbox"/> MAKE US LESS CARING?	NO
WILL TEENS USE <input type="checkbox"/> FOR SEX?	YES
WERE THEY GOING TO HAVE SEX ANYWAY?	YES
WILL <input type="checkbox"/> DESTROY MUSIC?	NO
WILL <input type="checkbox"/> DESTROY ART?	NO
BUT CAN'T WE GO BACK TO A TIME WHEN--	NO
WILL <input type="checkbox"/> BRING ABOUT WORLD PEACE?	NO
WILL <input type="checkbox"/> CAUSE WIDESPREAD ALIENATION BY CREATING A WORLD OF EMPTY EXPERIENCES?	WE WERE ALREADY ALIENATED

What are....

Figure: XKCD: "Simple Answers"

[xkcd-simple-answers]



Neural Networks (NN)

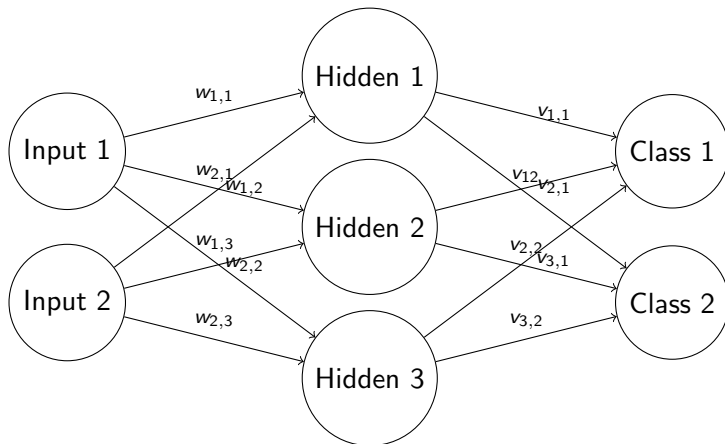


Figure: Example neural network



Issues with Neural Networks



- Stir data and pray
-

Figure: XKCD: "Machine Learning"
[xkcd-ml]



Convolutional Neural Networks (CNN)

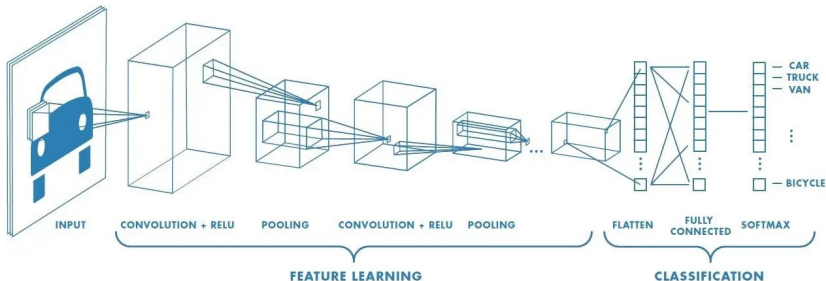
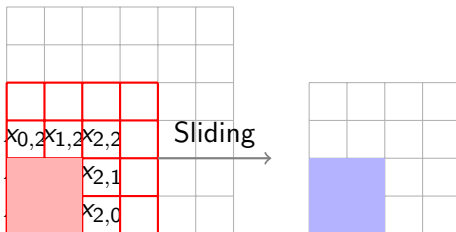


Figure: CNN pipeline [eli5CNN]



Convolutional Neural Networks (CNN)



Convolutional Kernel Input Matrix

Output Feature Map



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"
[xkcd-self-driving]



Bayesian Neural Network

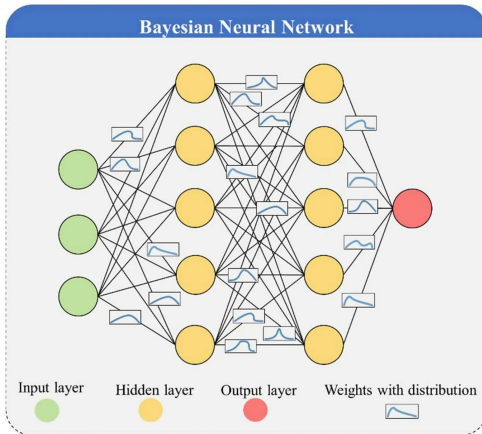


Figure: Example BNN [FleszarBNN]



BNN Neuron

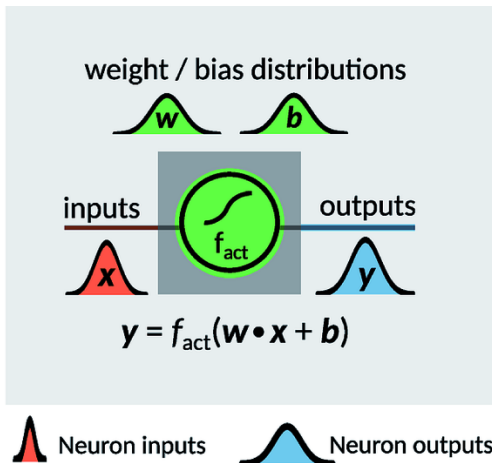
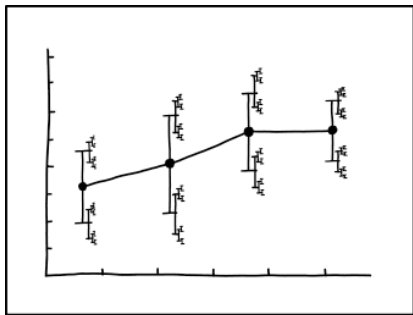


Figure: Example BNN Neuron [hase2019machine]



Why we use BNN



I DON'T KNOW HOW TO PROPAGATE
ERROR CORRECTLY, SO I JUST PUT
ERROR BARS ON ALL MY ERROR BARS.

- We can put uncertainty on our weights
-

Figure: XKCD: "Error Bars"
[xkcd-self-driving]



Difference between BNNs and BCNNs

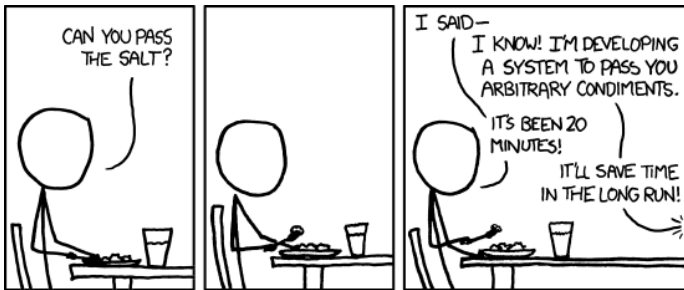


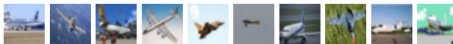
Figure: XKCD: "The General Problem" [xkcd-general-problem]

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



CIFAR-10

airplane



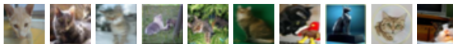
automobile



bird



cat



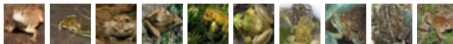
deer



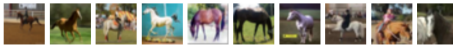
dog



frog



horse



ship



truck



Figure: Example CIFAR-10 images [cifar10]



Hyperparameters

Hyperparameter	CNN	BCNN
Epochs	50	50
Learning Rate	0.0004	0.0004
Regularization Rate	0.0001	0.0001
Optimizer	Adamw	Adamw



Results

Hyperparameter	CNN	BCNN
Train Accuracy	81.609%	70.664%
Validation Accuracy	64.499%	61.399%
Optimizer	Adamw	Adamw



Confusion Matrix (CNN)



Confusion Matrix (BCNN)



Live Demo

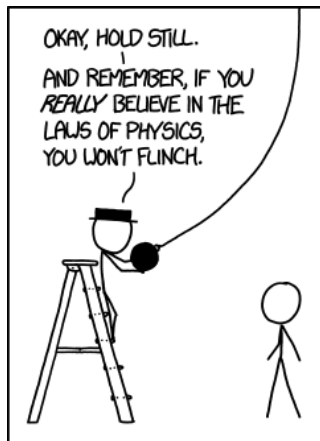


Figure: XKCD: "Laws of Physics" [xkcd-laws-of-physics]



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Figure: XKCD: "Simple Answers" [xkcd-simple-answers]



References I

