

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.' [**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" [5]

Neural Networks (NN)

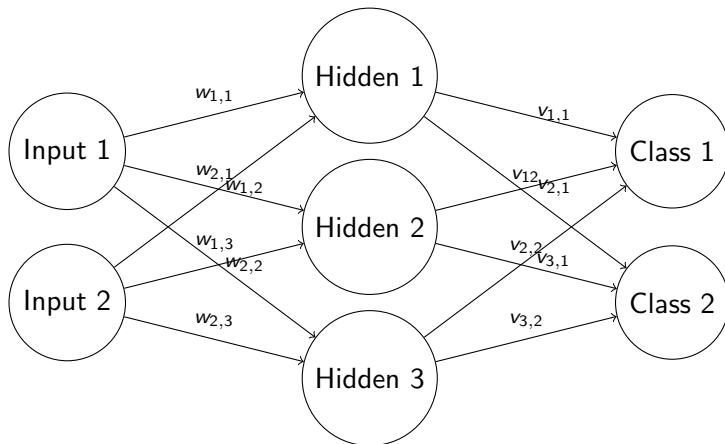


Figure: Example neural network



Issues with Neural Networks



- Stir data and pray
-

Figure: XKCD: "Machine Learning" [7]



Convolutional Neural Networks (CNN)

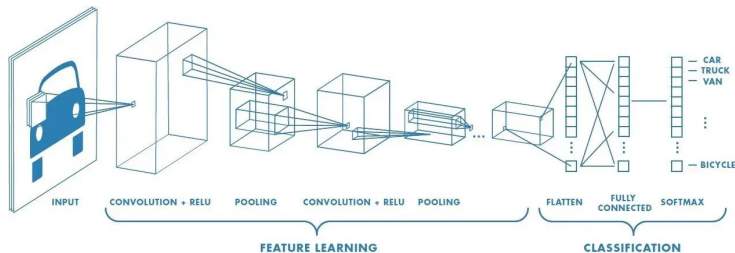


Figure: CNN pipeline [9]



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" [8]



Bayesian Neural Network

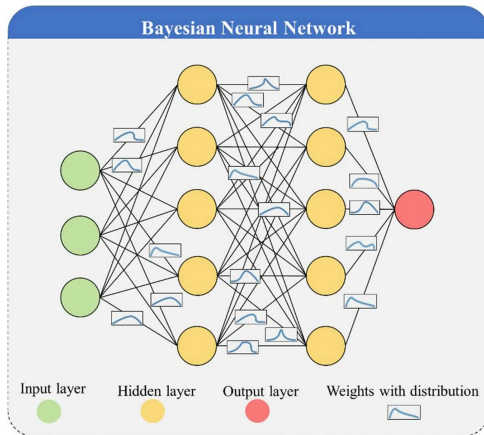


Figure: Example BNN [1]



BNN Neuron

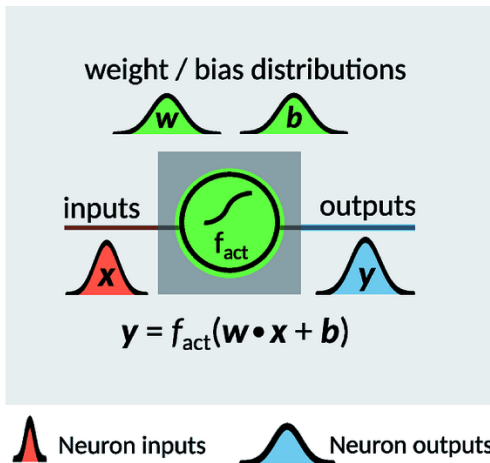
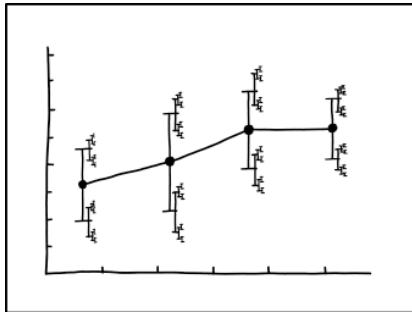


Figure: Example BNN Neuron [2]



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" [8]



Difference between BNNs and BCNNs

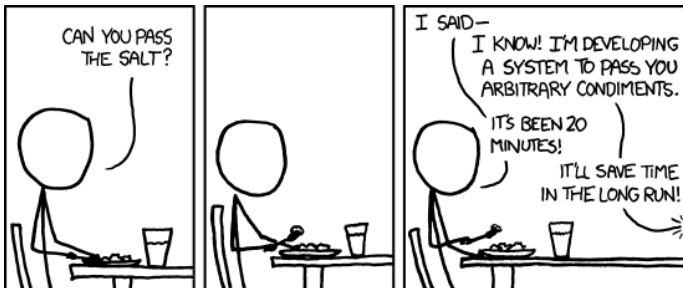


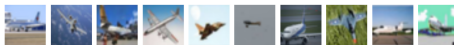
Figure: XKCD: "The General Problem" [4]

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



CIFAR-10

airplane



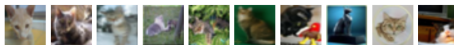
automobile



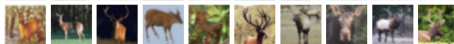
bird



cat



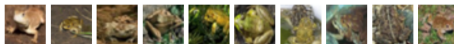
deer



dog



frog



horse



ship



truck



Figure: Example CIFAR-10 images [3]



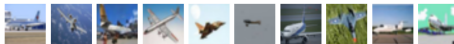
Hyperparameters

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

airplane



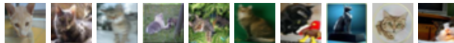
automobile



bird



cat



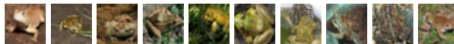
deer



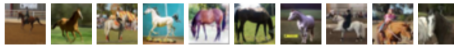
dog



frog



horse



ship



truck



Figure: Example CIFAR-10 images [3]



Confusion Matrix

airplane



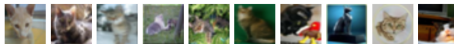
automobile



bird



cat



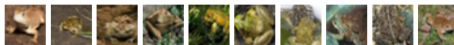
deer



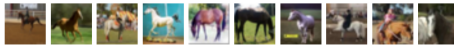
dog



frog



horse



ship



truck



Figure: Example CIFAR-10 images [3]



Live Demo

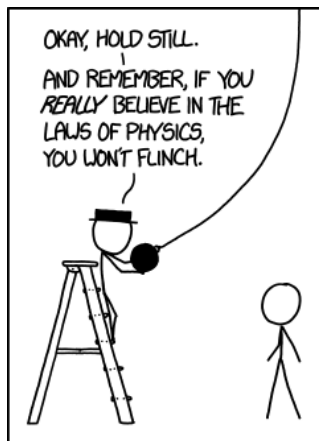


Figure: XKCD: "Laws of Physics" [6]



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