



RowanUniversity

HENRY M. ROWAN

COLLEGE OF ENGINEERING

Robust Deep Learning Systems Integrated with Confidence Evaluation

DIMAH DERA

PH.D. STUDENT

ROWAN UNIVERSITY

Outlines

1. Introduction to Deep Neural Networks
2. Limitations of Deep Neural Networks
3. Bayesian Neural Network
4. Uncertainty Propagation
5. Experimental Results

Introduction to Deep Neural Networks

Image Classification

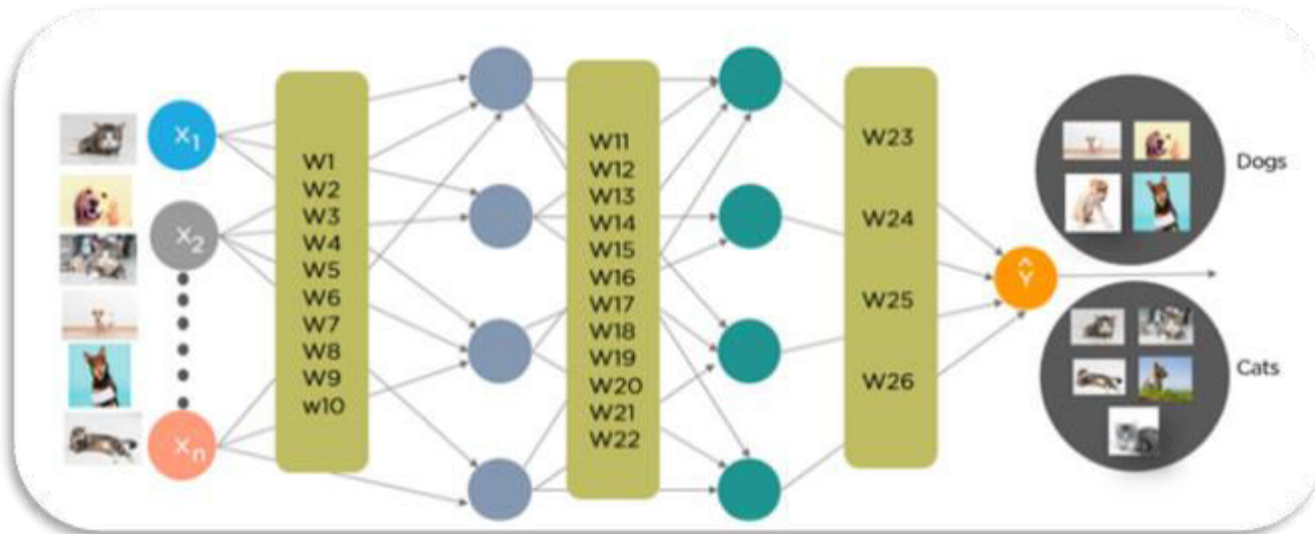


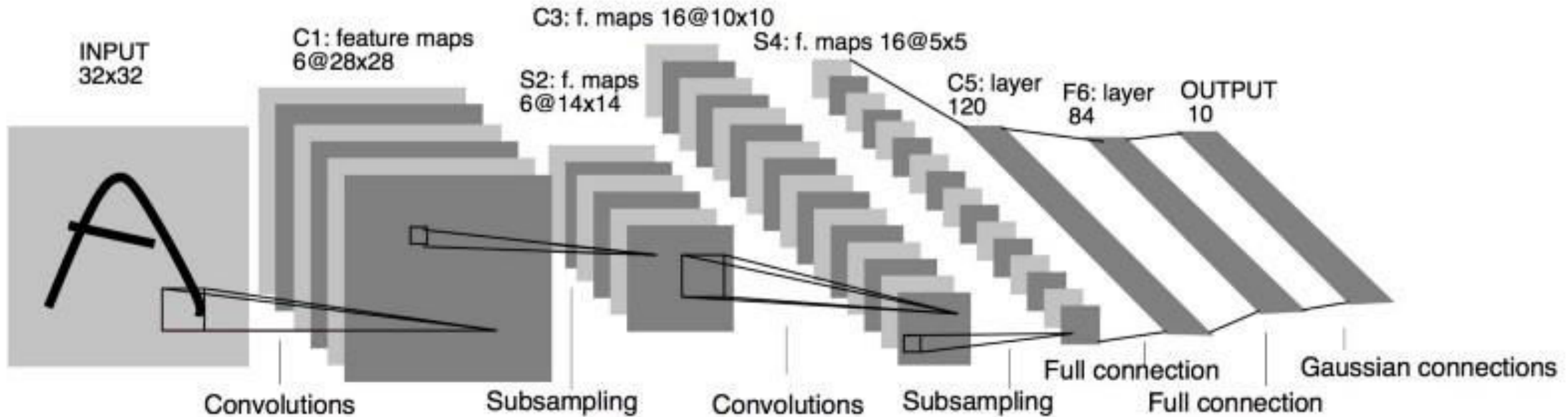
Image Segmentation



Automatic Machine Translation

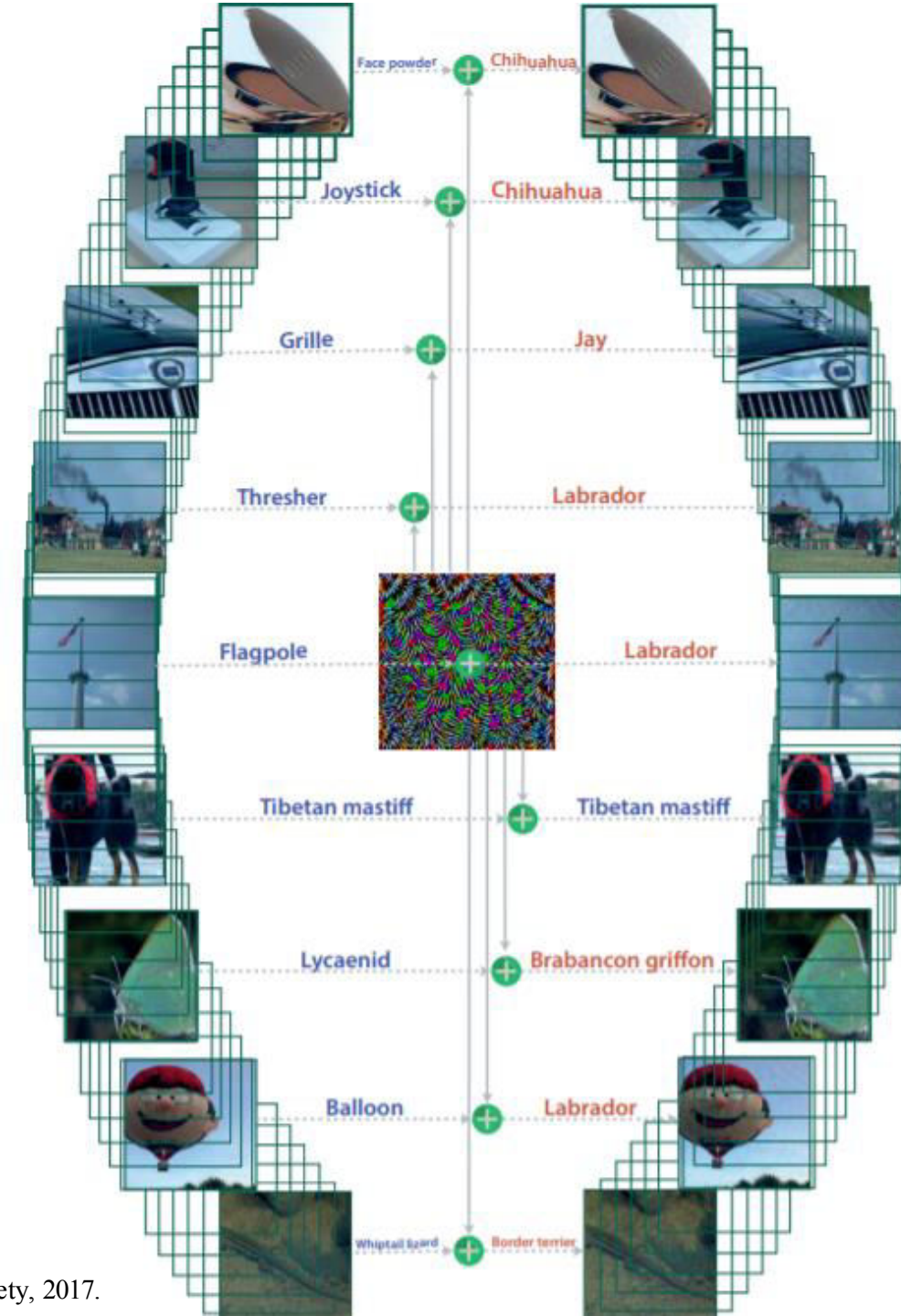


Convolutional Neural Network



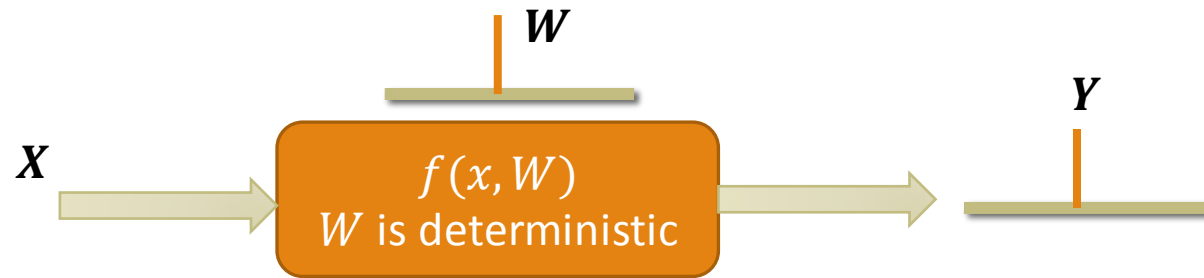
Limitations of Deep Neural Networks

- *Overfitting* especially when training data is insufficient.
- *Overconfident predictions* by assigning a high SoftMax value, towards the wrong class for things the network hasn't seen before.
- Inability to a reliable measure *uncertainty* measure of their prediction.



Bayesian Neural Networks

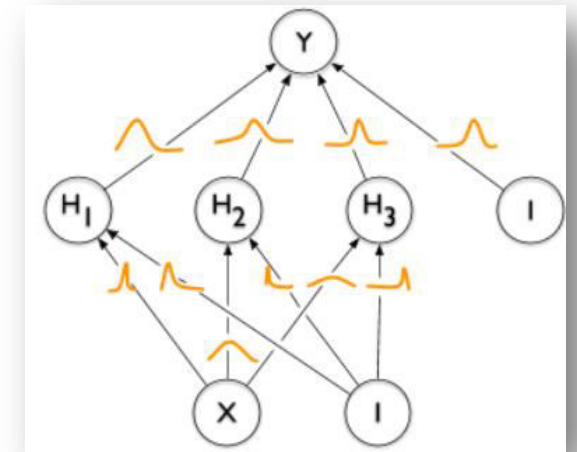
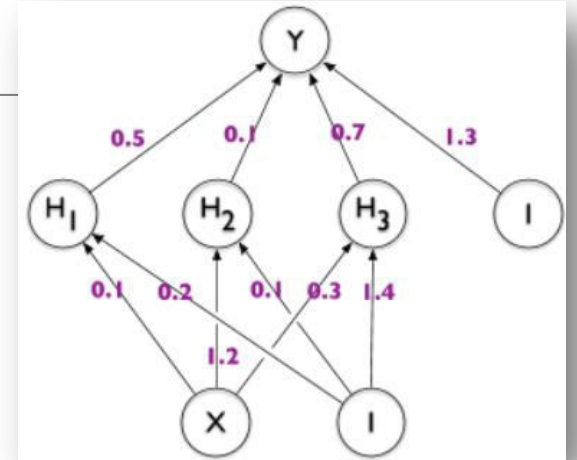
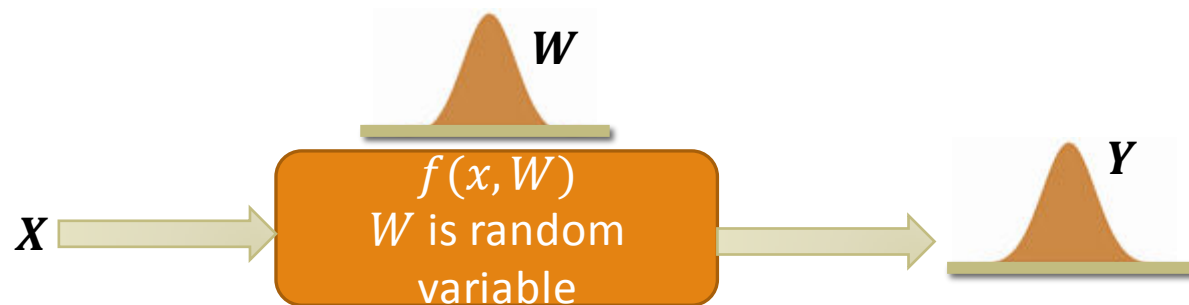
Neural Network: find a model $f(x, W)$ that best explains our data.



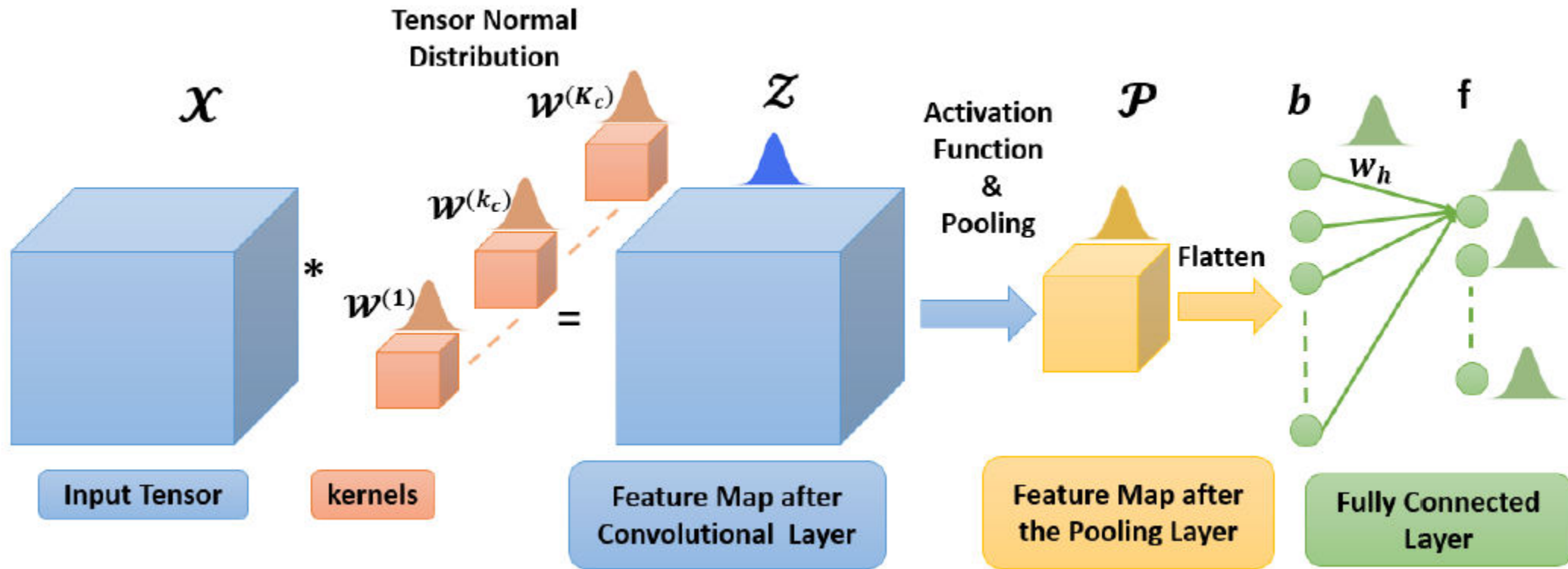
Bayesian Neural Network: assume the weights are random variables.

Distributions over the weights and network output.

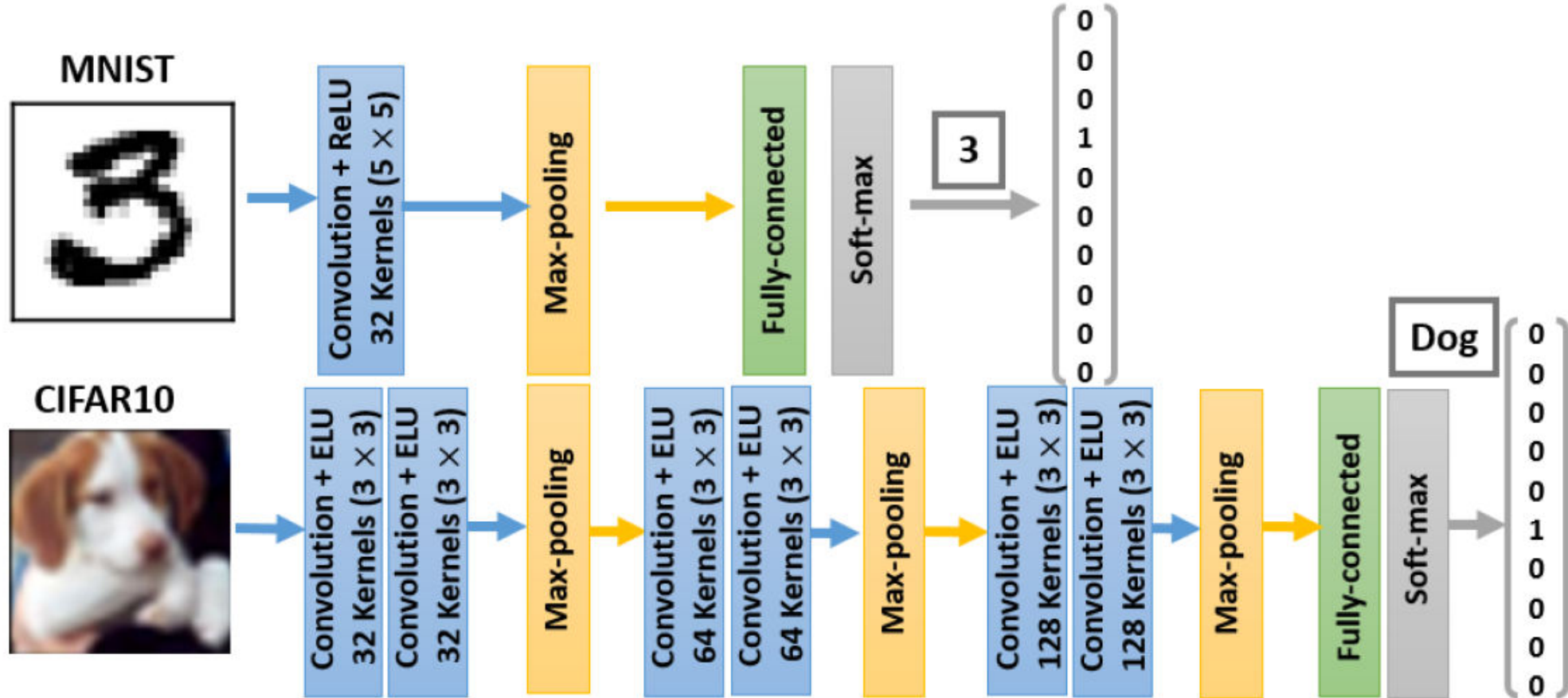
Modeling the uncertainty which is basically the $\text{Var}(Y)$.



Uncertainty Propagation

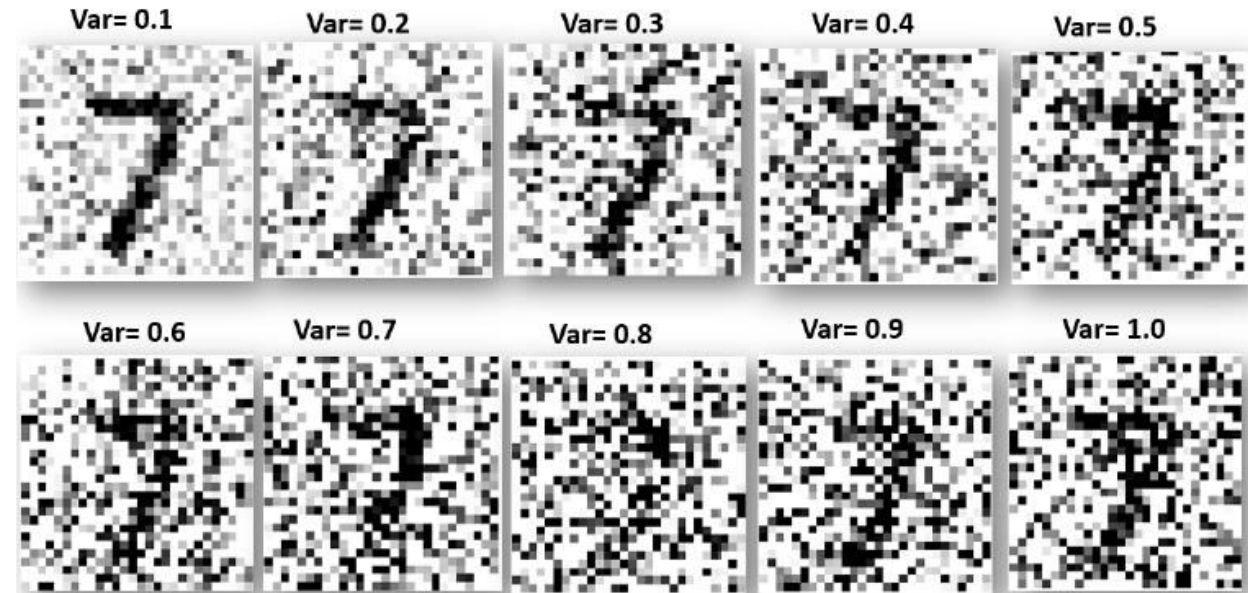
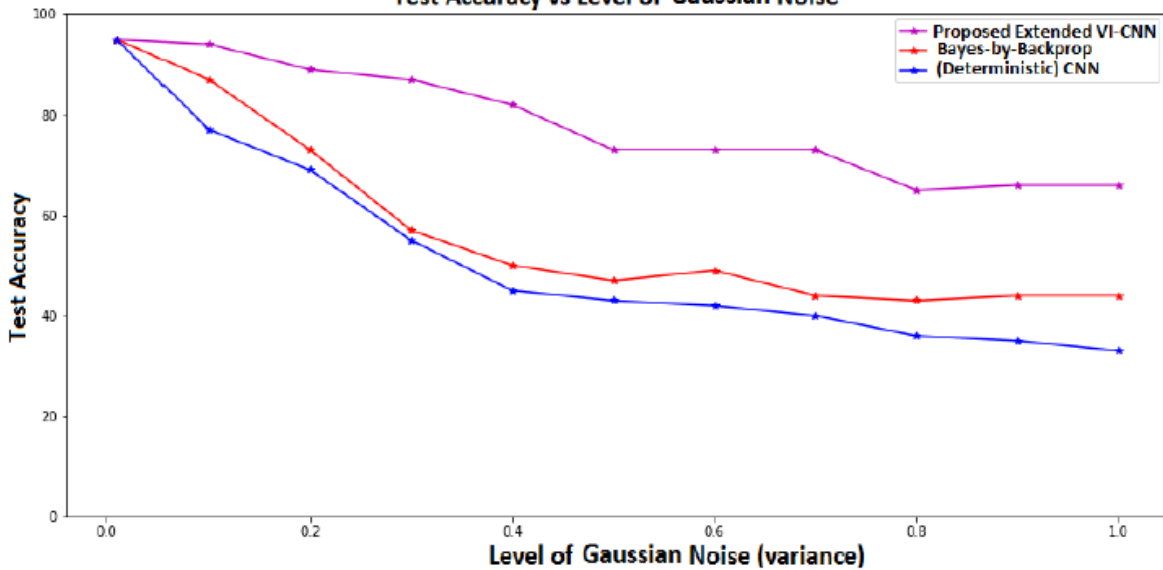


Experimental Results

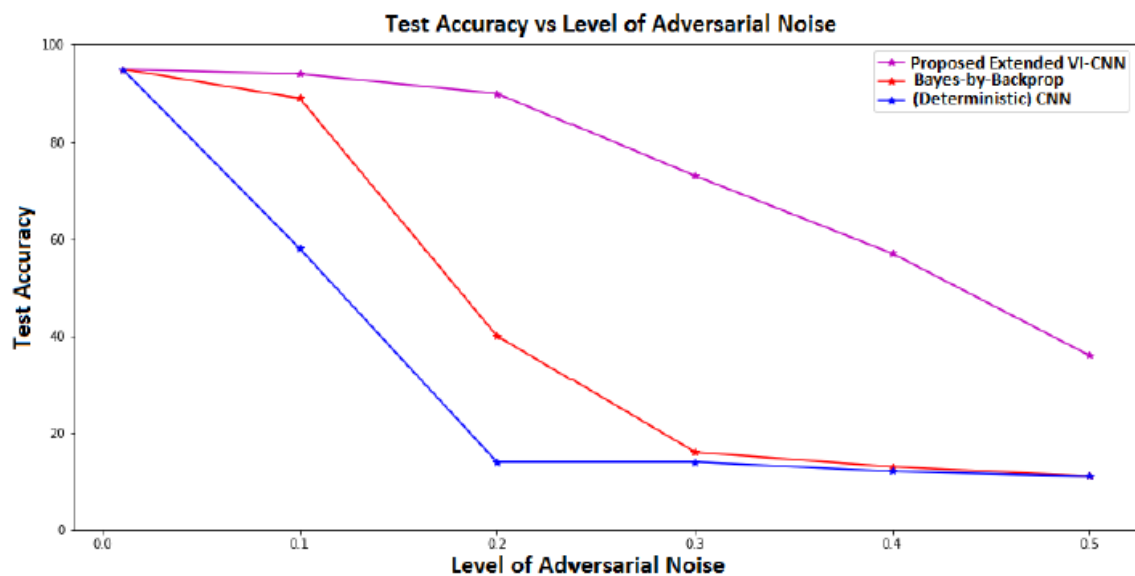


Experimental Results

Test Accuracy vs Level of Gaussian Noise



Experimental Results



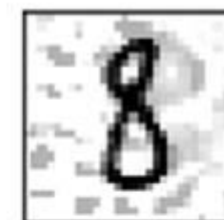
**(Deterministic)
CNN
Accuracy 10%**



True: 7, Pred: 3

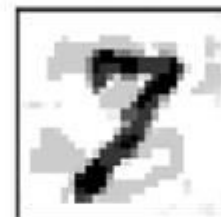


True: 2, Pred: 3

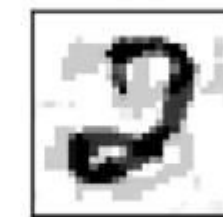


True: 8, Pred: 3

**Bayes By Backprop
Accuracy 40%**



True: 7, Pred: 3



True: 2, Pred: 3



True: 8, Pred: 3

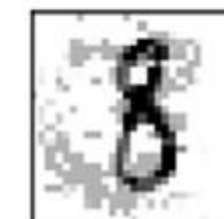
**Proposed
Extended VI CNN
Accuracy 88%**



True: 7, Pred: 7



True: 2, Pred: 2



True: 8, Pred: 8

Experimental Results

Dropout
Accuracy 52%



True: dog
Pred: cat



True: airplane
Pred: cat



True: horse
Pred: cat

Bayes-by-Backprop
Accuracy 68%



True: dog
Pred: dog



True: airplane
Pred: cat



True: horse
Pred: cat

Proposed
Extended VI-CNN
Accuracy 83%



True: dog
Pred: dog



True: airplane
Pred: airplane



True: horse
Pred: horse

Acknowledgement

This work is supported by,

- ❖ *National Science Foundation under Award Number DUE-1610911,*
- ❖ *National Science Foundation, NSF XSEDE,*
- ❖ *GCP* and
- ❖ *SIGHPC/ACM Fellowship.*

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect those of the National Science Foundation.



Questions