ILLINOIS
CSL | Coordinated Science Lab
COLLEGE OF ENGINEERING

Subho S. Banerjee, James Cyriac, Saurabh Jha, Zbigniew T. Kalbarczyk and Ravishankar K. Iyer
Computer Science, Electrical and Computer Engineering

Towards a Bayesian Approach for Assessing the Fault Tolerance of Deep Neural Networks

Fault Injection Tools in Neural Networks

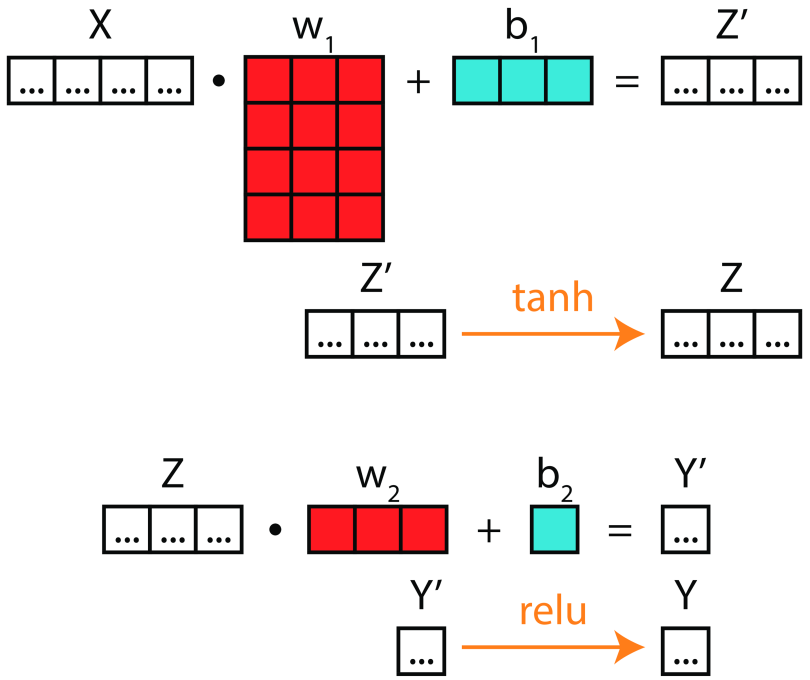
- Fault injection is one of the primary methods for assessing reliability validation/assessment

- Fault injection in NNs is difficult
  - Large space of fault locations and program states that must be injected/investigated
  - Need for significant system support to build system-specific injectors
  - Inability to provide statistical guarantees

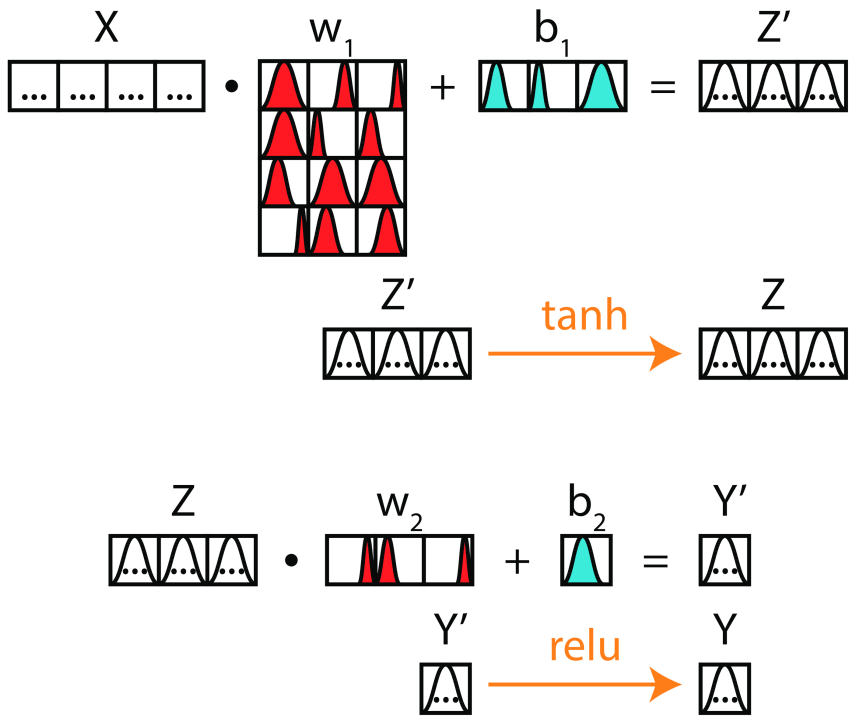
- **Question:** Can we address these challenges by taking cognizance of latest developments in the machine learning space dealing with deep learning?

Bayesian Deep Learning & Fault Modelling

Deep Learning is **compositions of functions on matrices**.



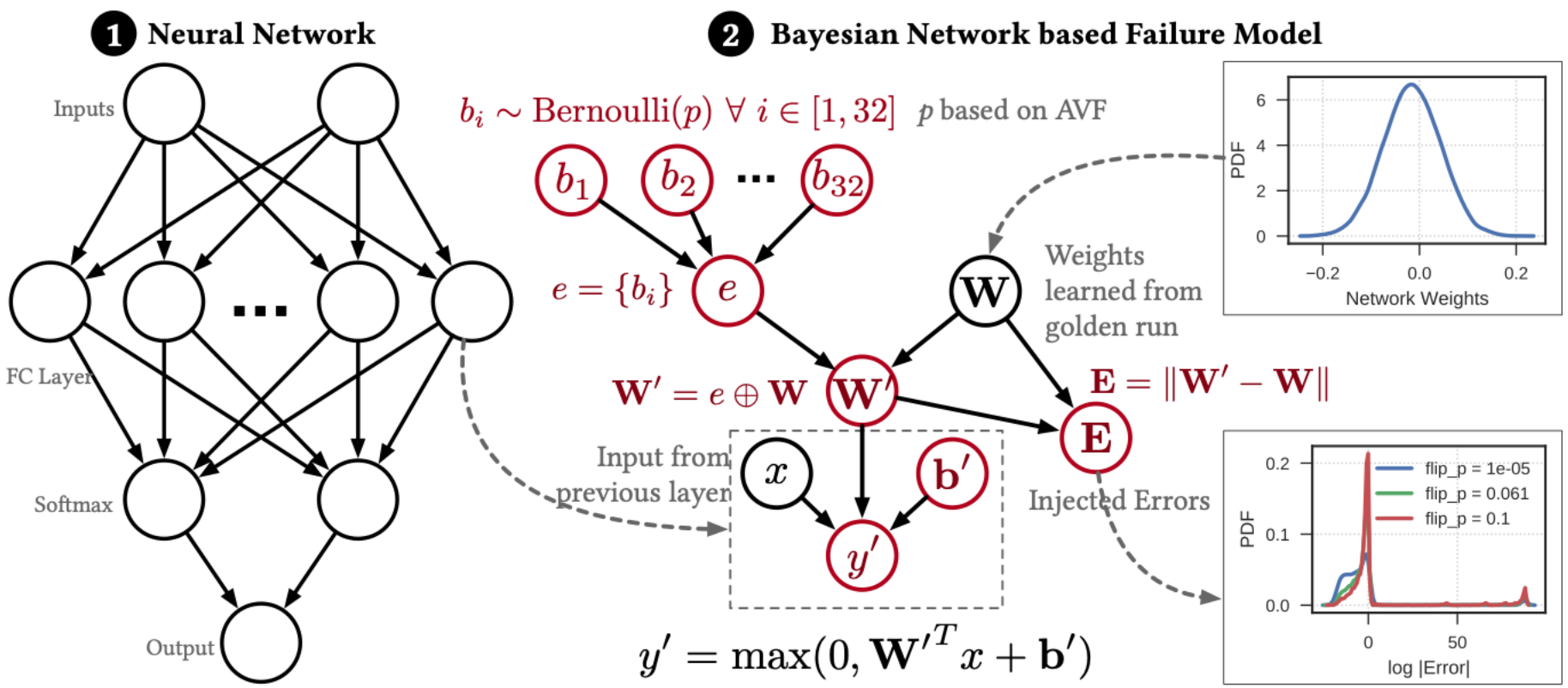
Bayesian deep learning is **composition of functions on probability distribution of matrices**.

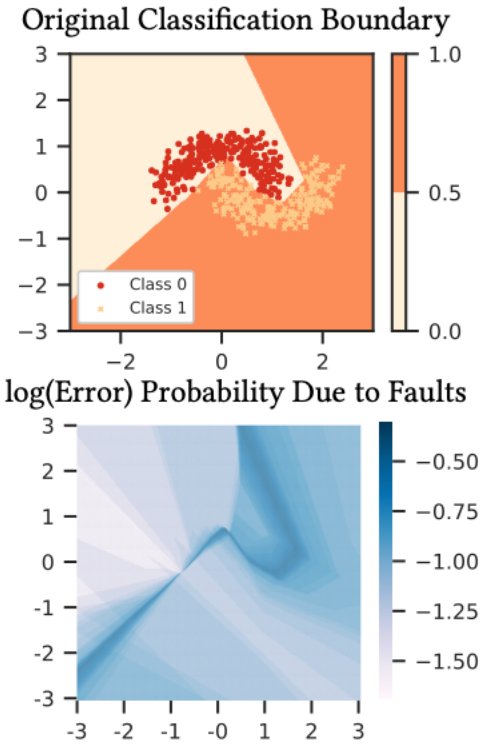


Goal: Encode the fault model as a set of probability distributions over the parameters

Source: https://chenjj.github.io/bayesian-deep-learning-demystified/

BDLFI: Bayesian Deep Learning Fault Injector





Looking Forward

- What advantage does this method give us?

- **Case 1:** Algorithmic Acceleration: *Fault injection == Monte Carlo*
  - Gradient-based Monte Carlo methods (NUTS sampler)
  - Importance sampling

- **Case 2:** Automate Reliable DL: *AutoML/Neural Architecture Search*
  - Design space: Duplication, TMR…
  - Approximations: Voltage scaling, DRAM refresh rate