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Approximate Computing with Emerging Devices

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Approximate Computation

WITH EMERGING DEVICES

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Overview of Project

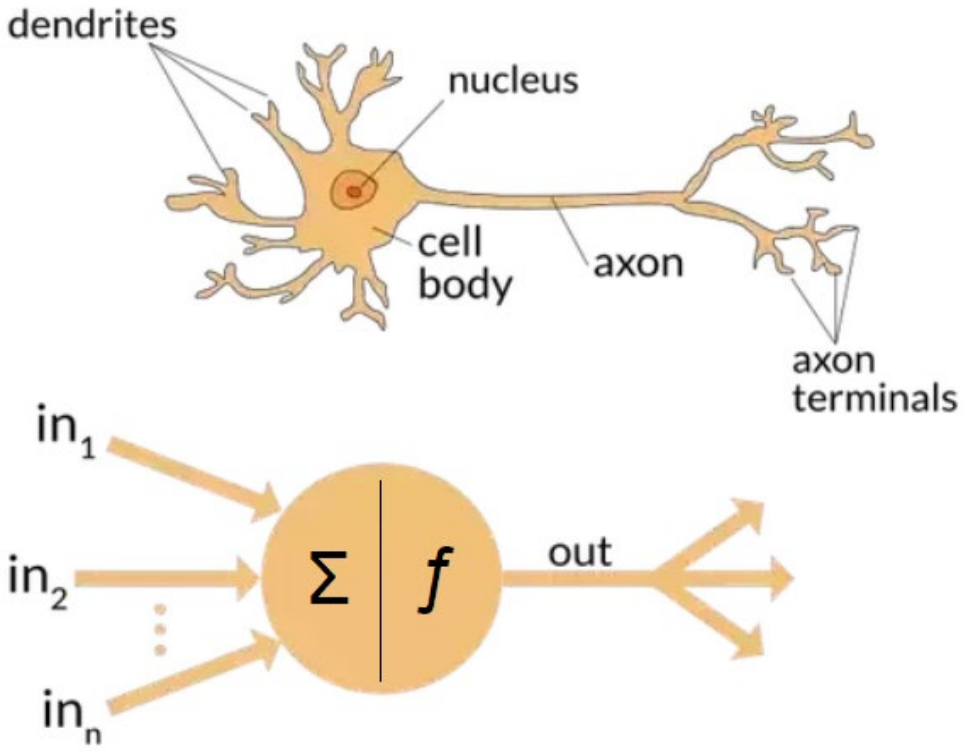
“Approximate computation is a new trend that explores and harnesses trade-offs between the precision and energy/power consumption of computing systems. The goal of this project is to design and implement approximate computing systems based on emerging devices, such as memristors. The student will first review the literature. In a second step, we will use reservoir computing systems as a platform for exploring approximate computing.”

What is a Neural Network?

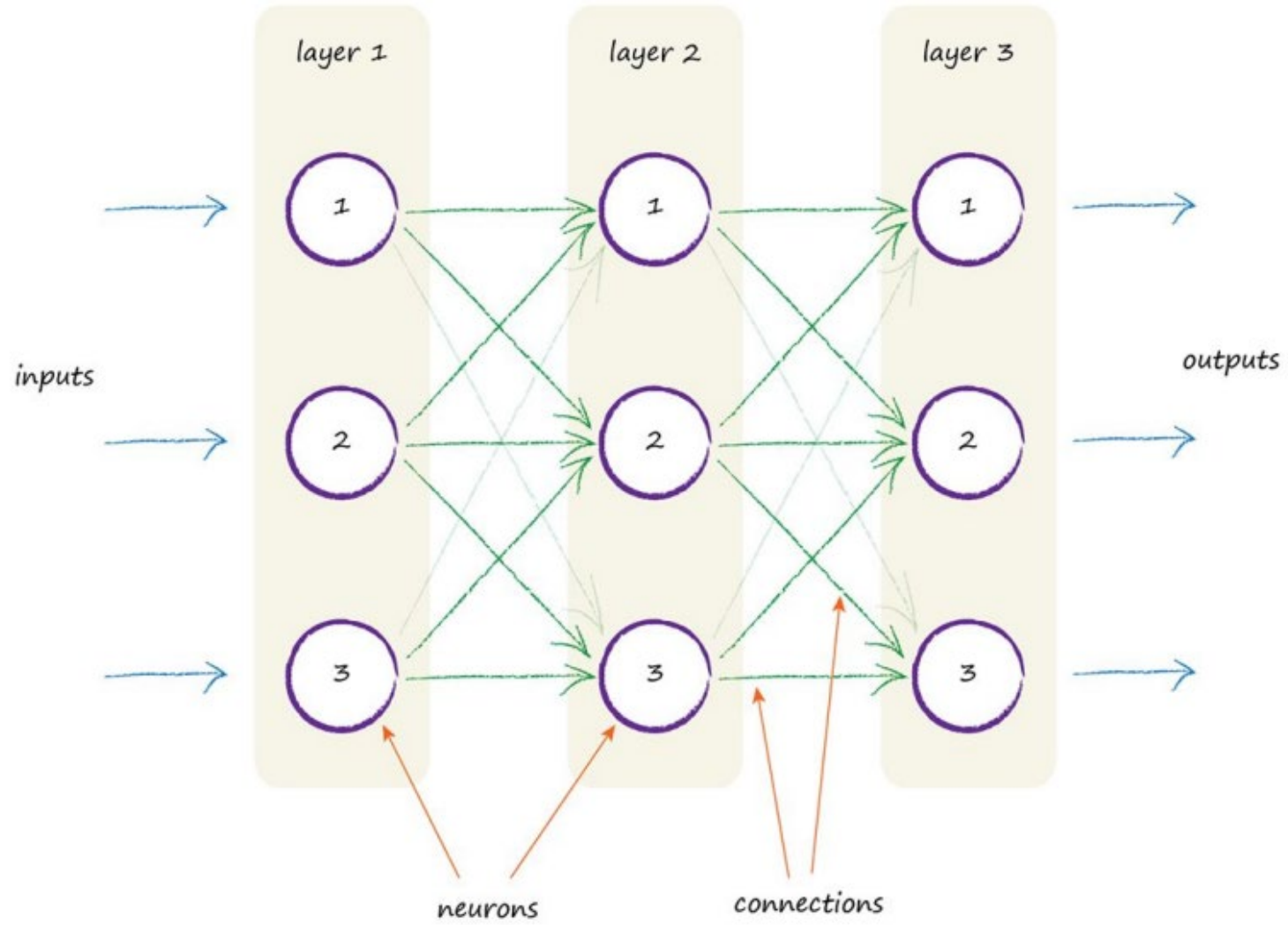
- Machine learning algorithm

- Attempts to model how the human brain works

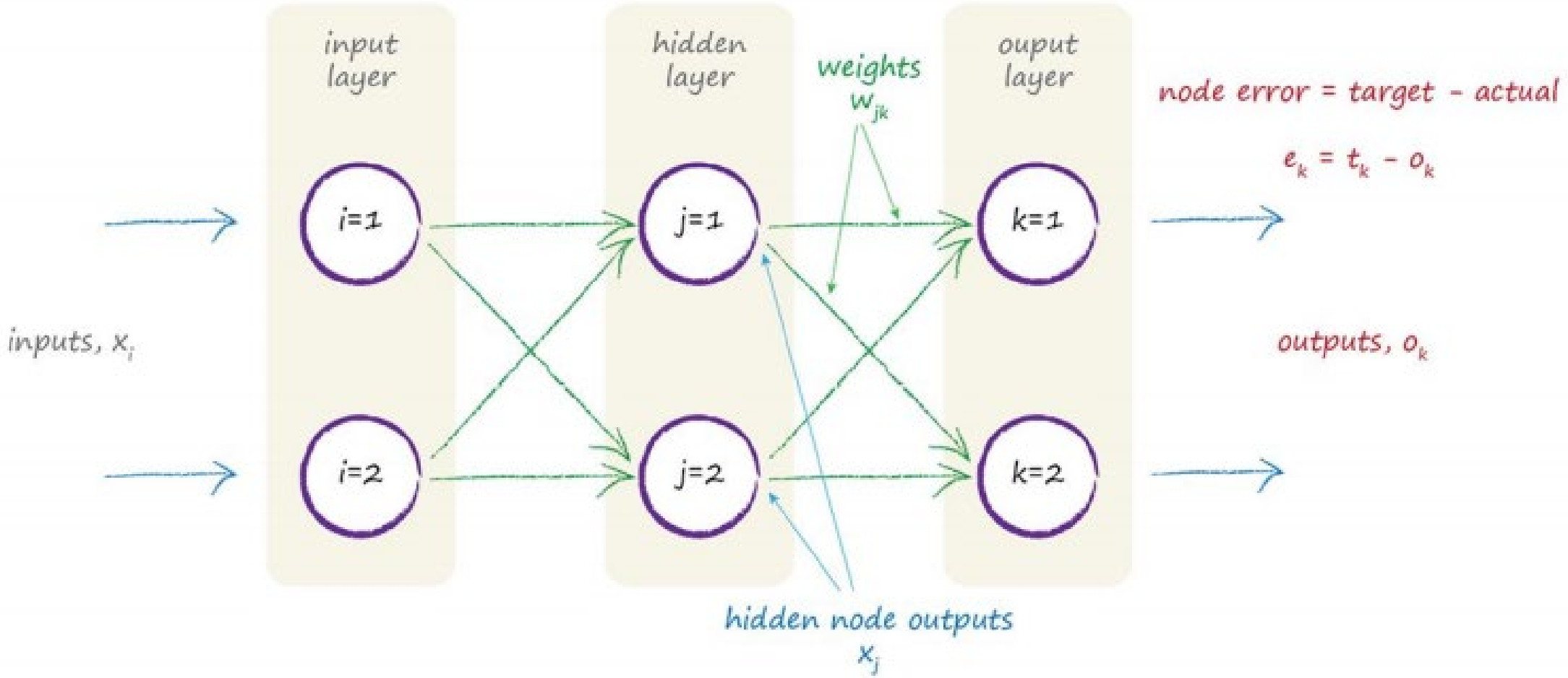
- Creates a relationship between an input and output



Source: towardsdatascience.com



Source: Make Your Own Neural Network



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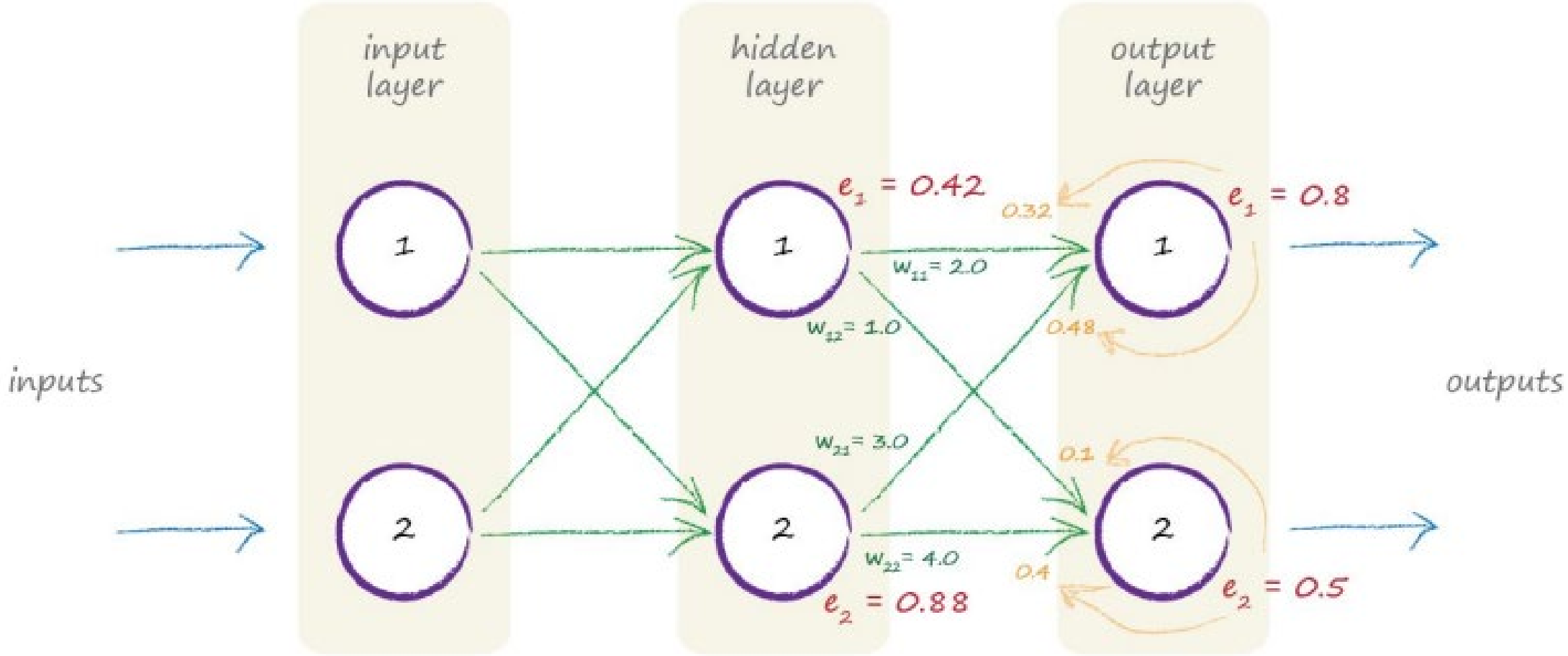


Source: Make Your Own Neural Network

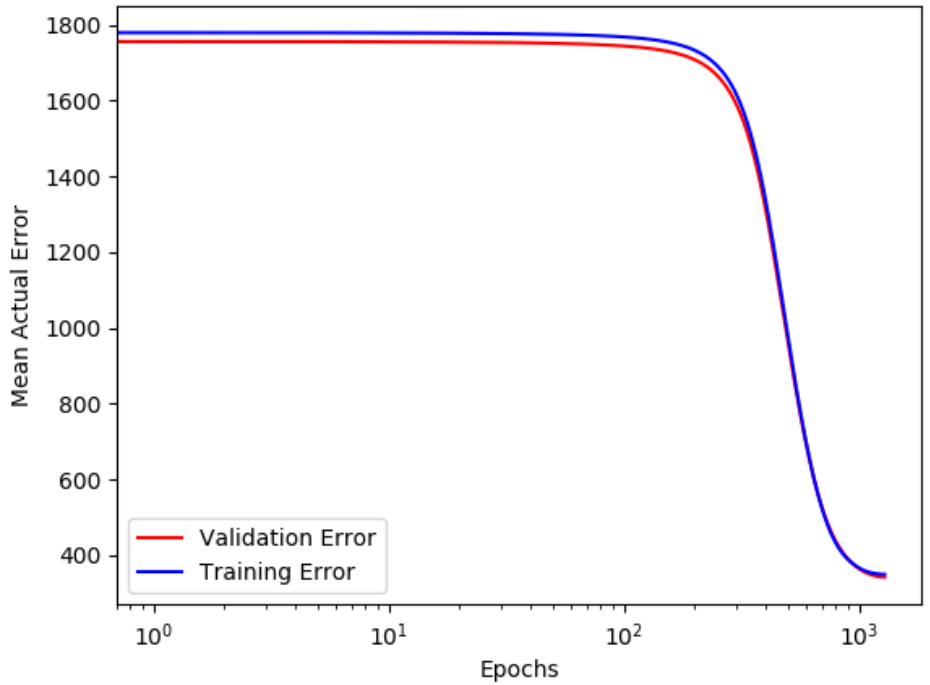
Multiplication Network

- Takes two numbers between 0 and 1000 as inputs

- Uses the product of the inputs as training for the output

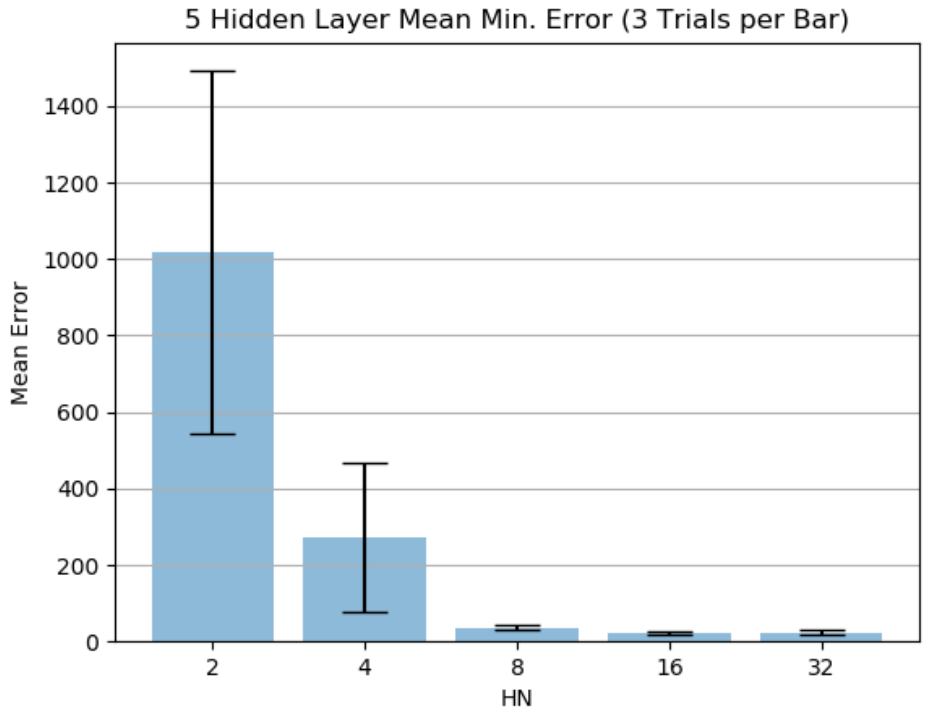
- 80% of data used for training, 20% for validation

- Validation data does not result in backpropagation

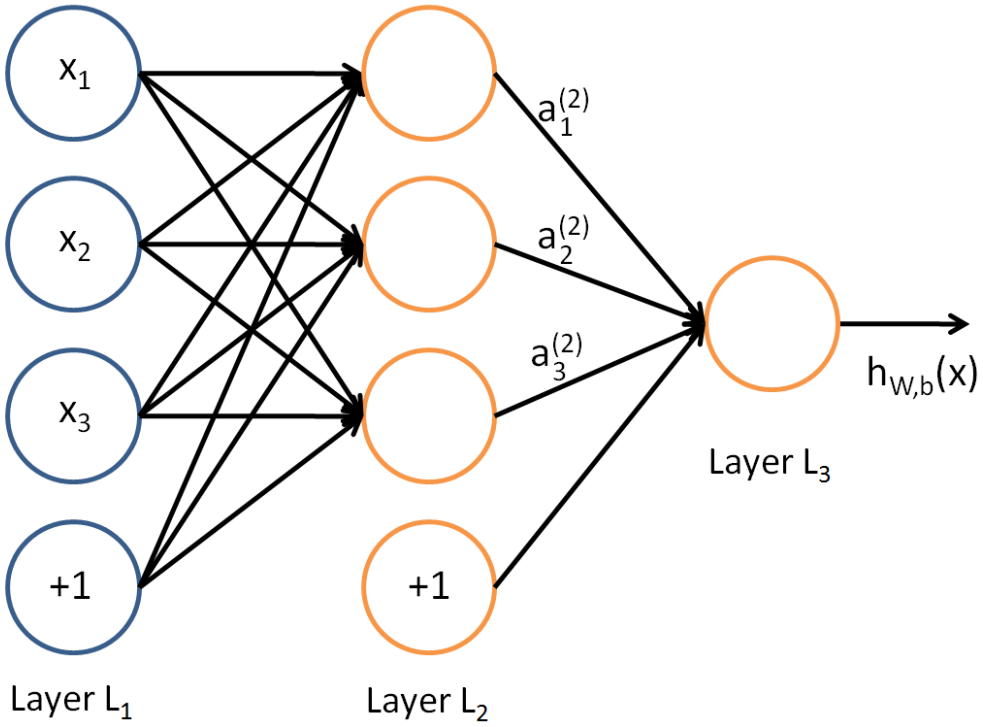


Optimizing the Network

- Adding hidden layers
- Adding hidden nodes to each layer
- Adjusting learning rate



Echo State Networks



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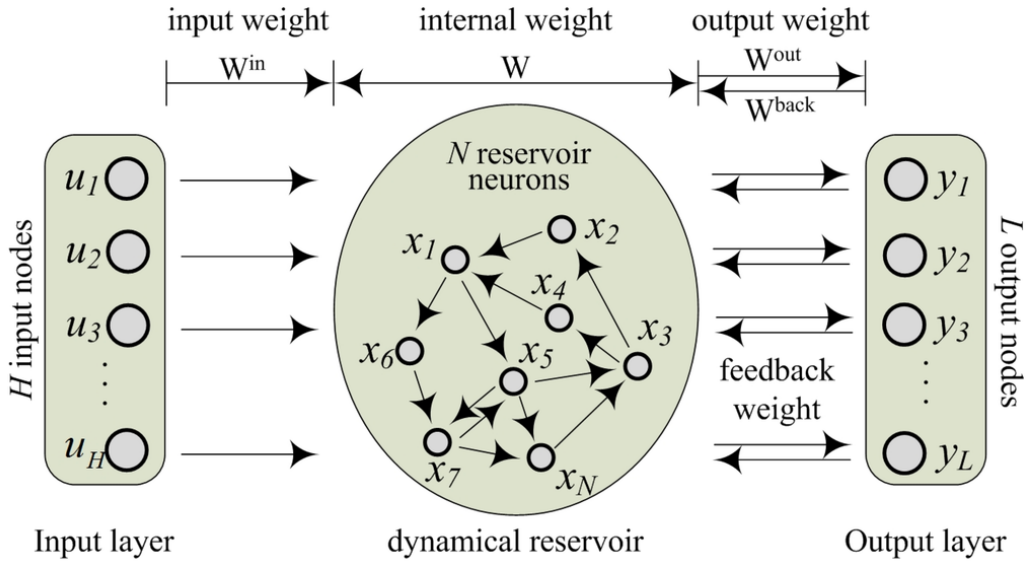
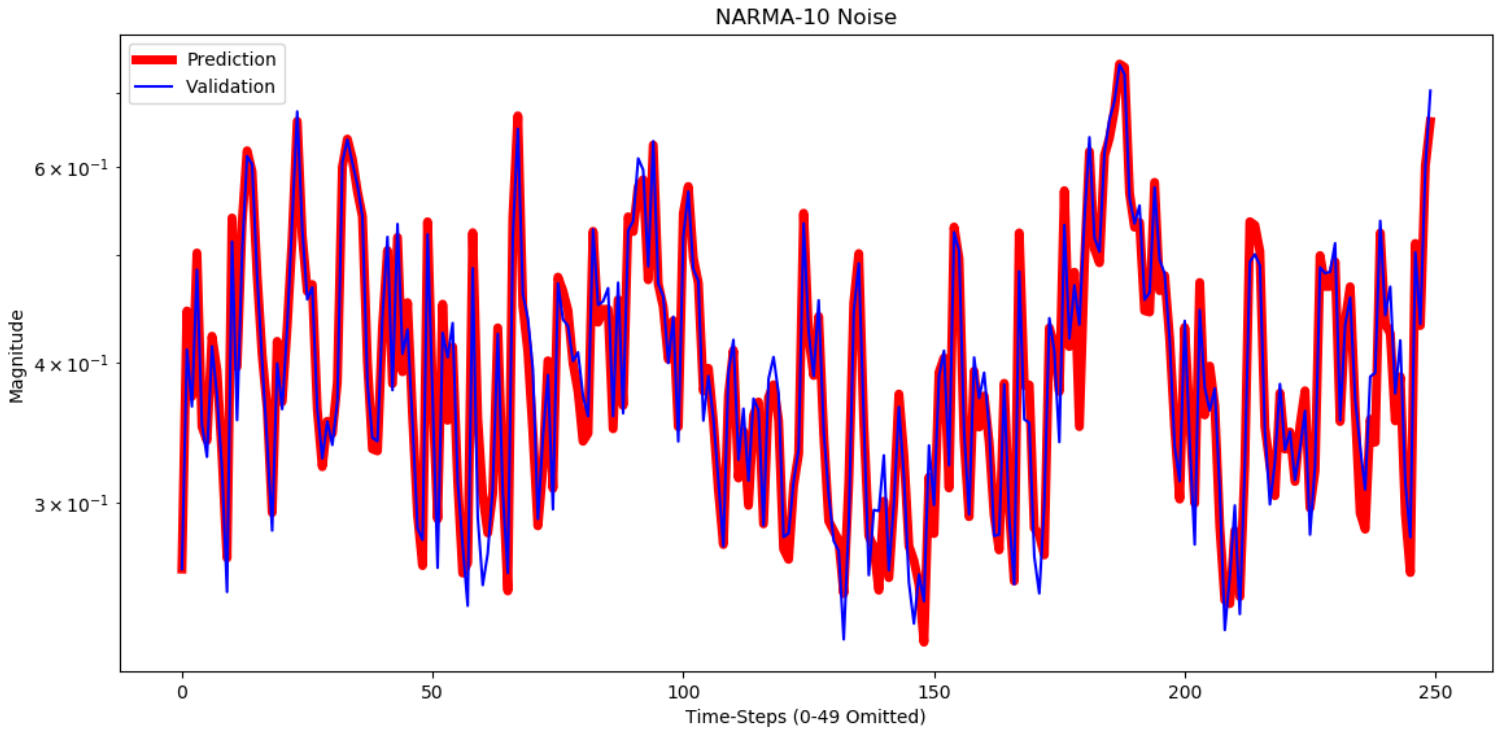


Source: Echo State Network with Bayesian Regularization for Forecasting Short-Term Power Production of Small Hydropower Plants

Echo State Networks



Echo State Networks

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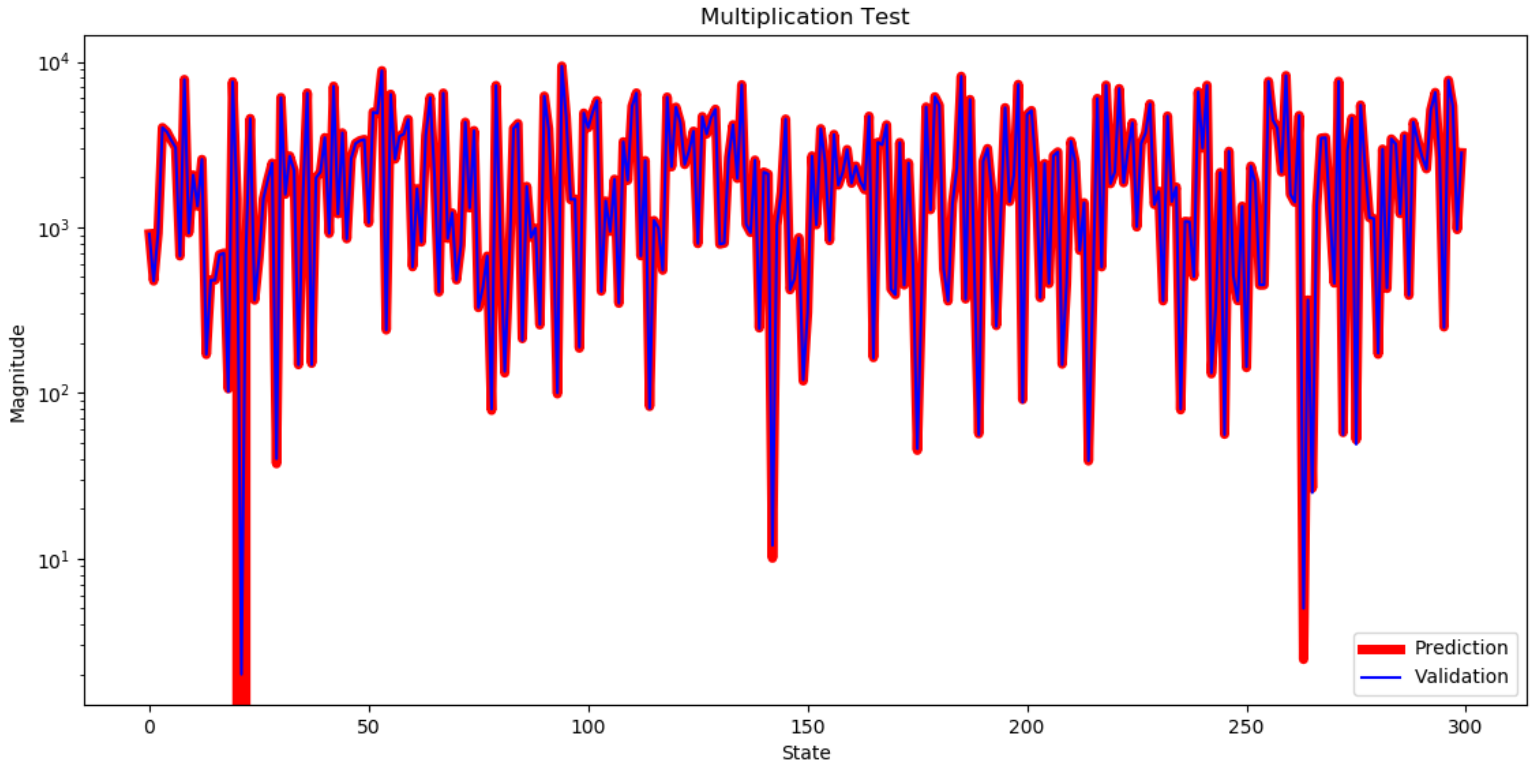


Optimizing the Reservoir

- Small-World Networks generate a regular lattice, and then rewire with probability p

- This shortens the mean path distance between any two nodes, while maintaining the clustering of regular lattices.

- Scale-Free Networks feature hubs which are highly connected to other nodes

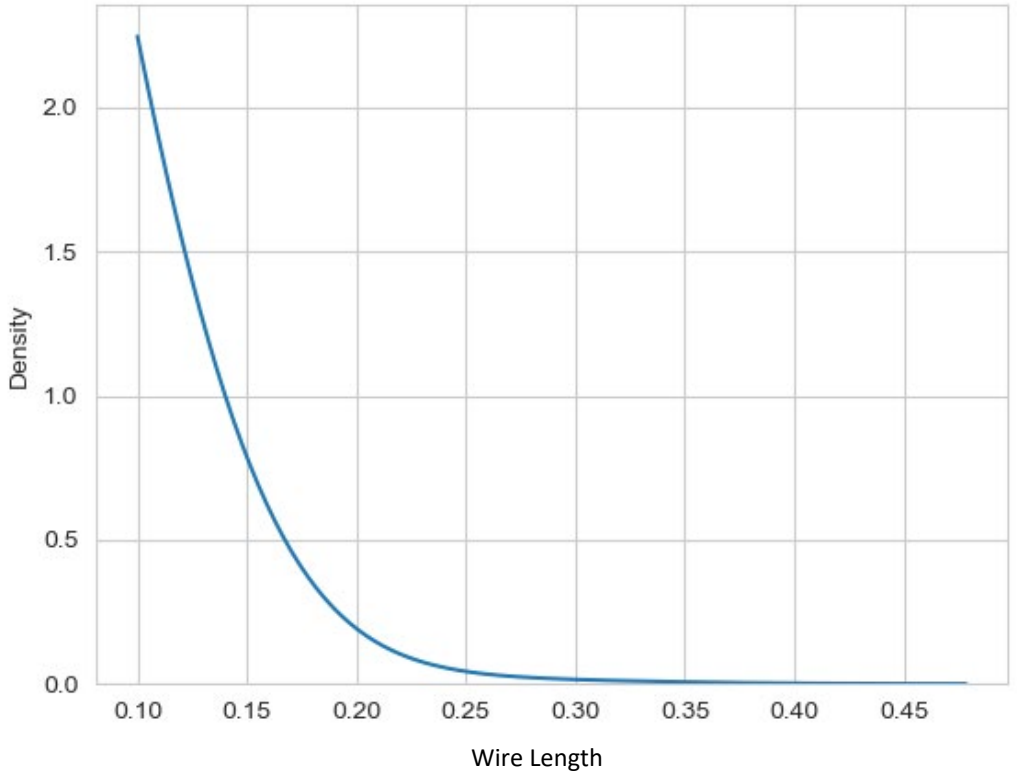
Petermann Network

- Similar to small-world networks

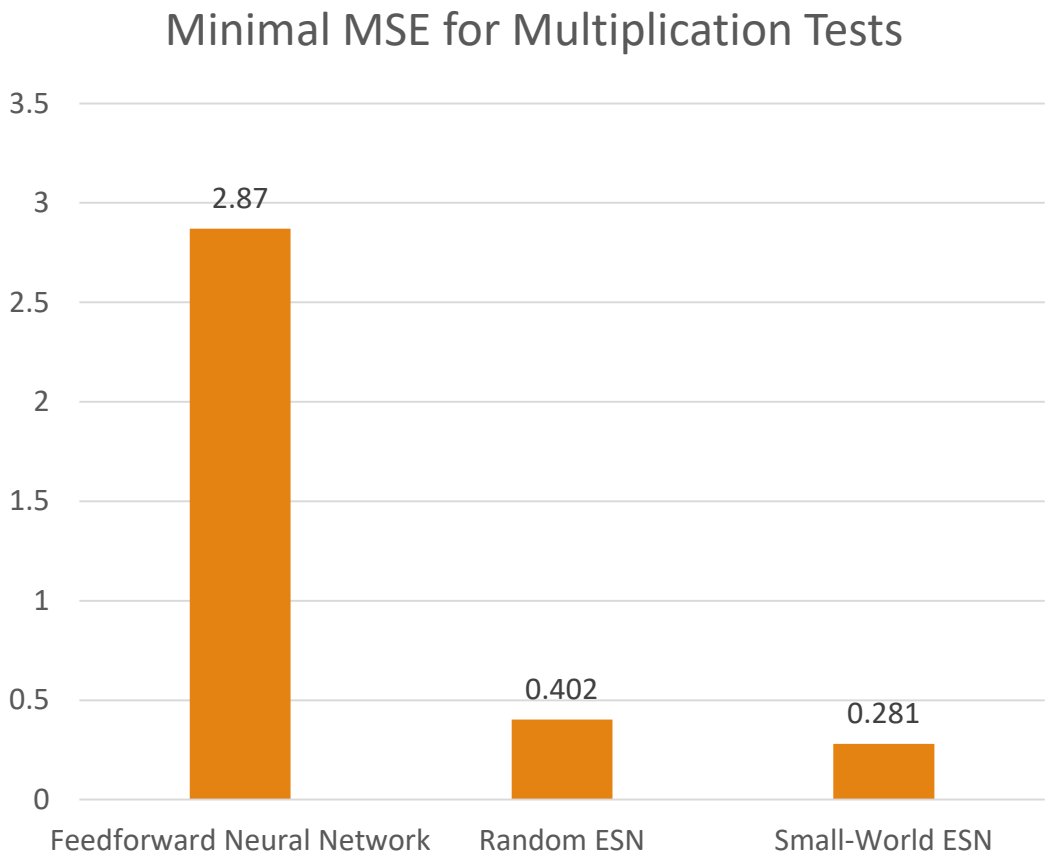
- Prioritizes short “wire lengths” between nodes, following inverse power-law

- Maintains interconnectedness of small-world networks

- Lowers the wiring cost of a network when physically realized



Preliminary Results



Next Steps

- Compare traditional neural network, random ESN, small-world ESN, scale-free ESN, and Petermann ESN

- Compare the robustness of different models to damage

Thanks for listening!

Questions?