A photograph of a double rainbow over a park. The sky is filled with dark, heavy clouds, and a bright sun is visible in the upper right corner. Two distinct rainbows are visible, one above the other, spanning across the sky. The foreground is filled with lush green trees and foliage. In the bottom left corner, there is a sign for '3460 MITCHELL LANE' and a 'STOP' sign is visible in the bottom right corner.

# The Joy of Deep Learning

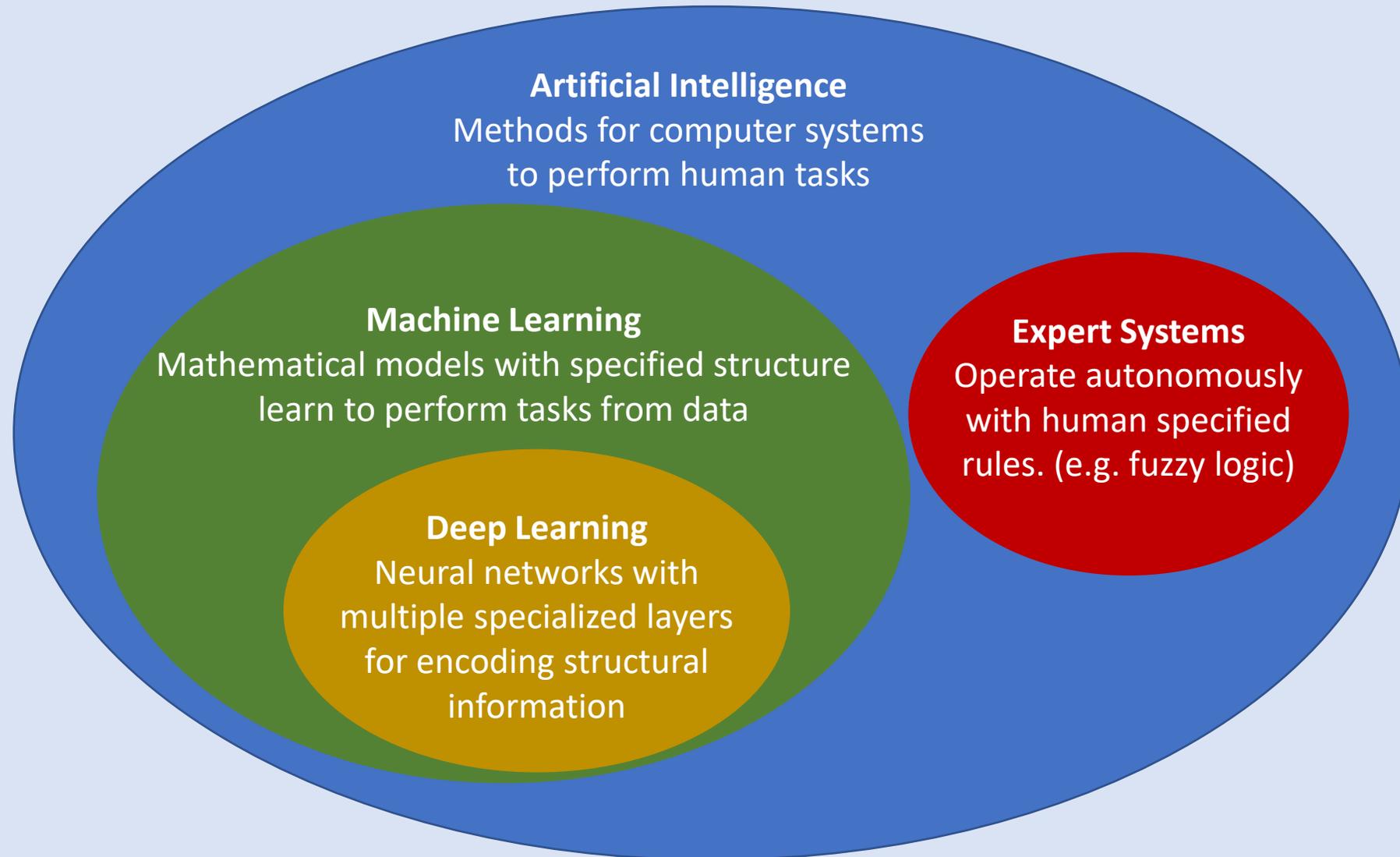
David John Gagne

NCAR

Unidata Users Workshop

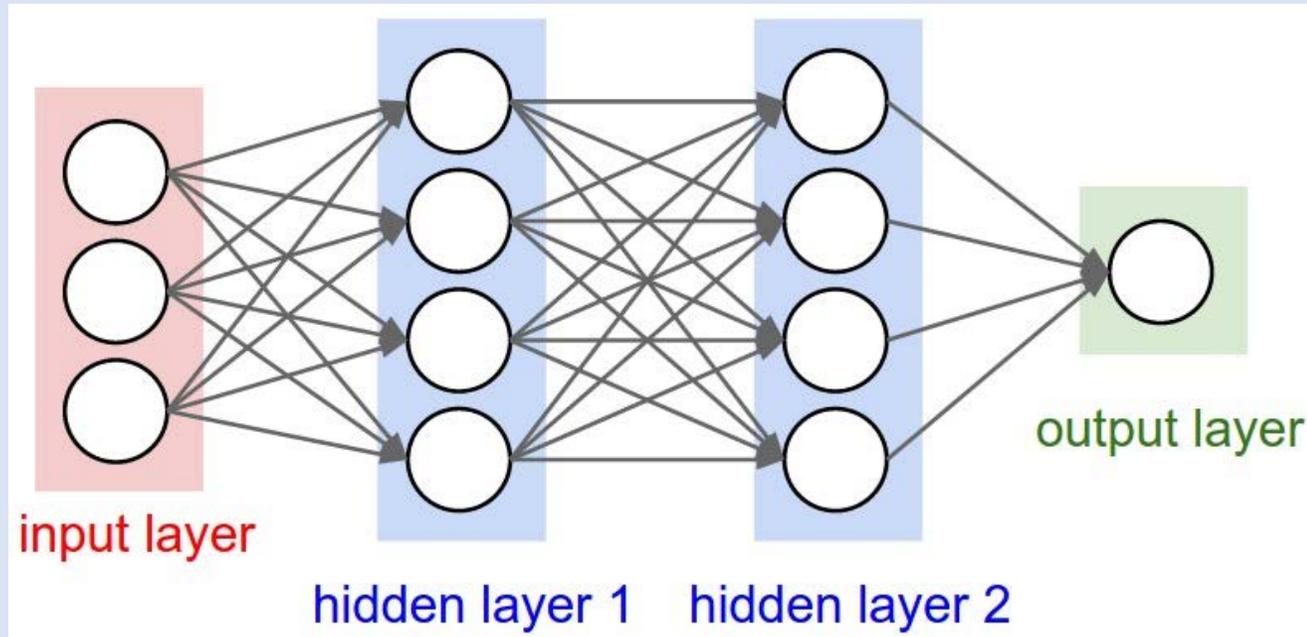
June 26, 2018

# What Is Deep Learning?

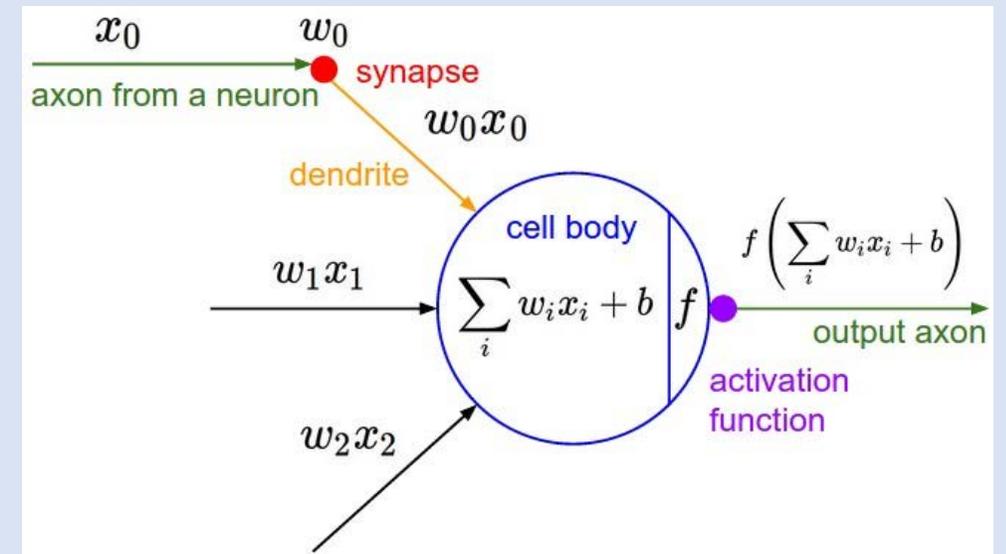


# Neural Network Basics

## Artificial Neural Network Structure



## Perceptron (artificial neuron)



## Training Procedure

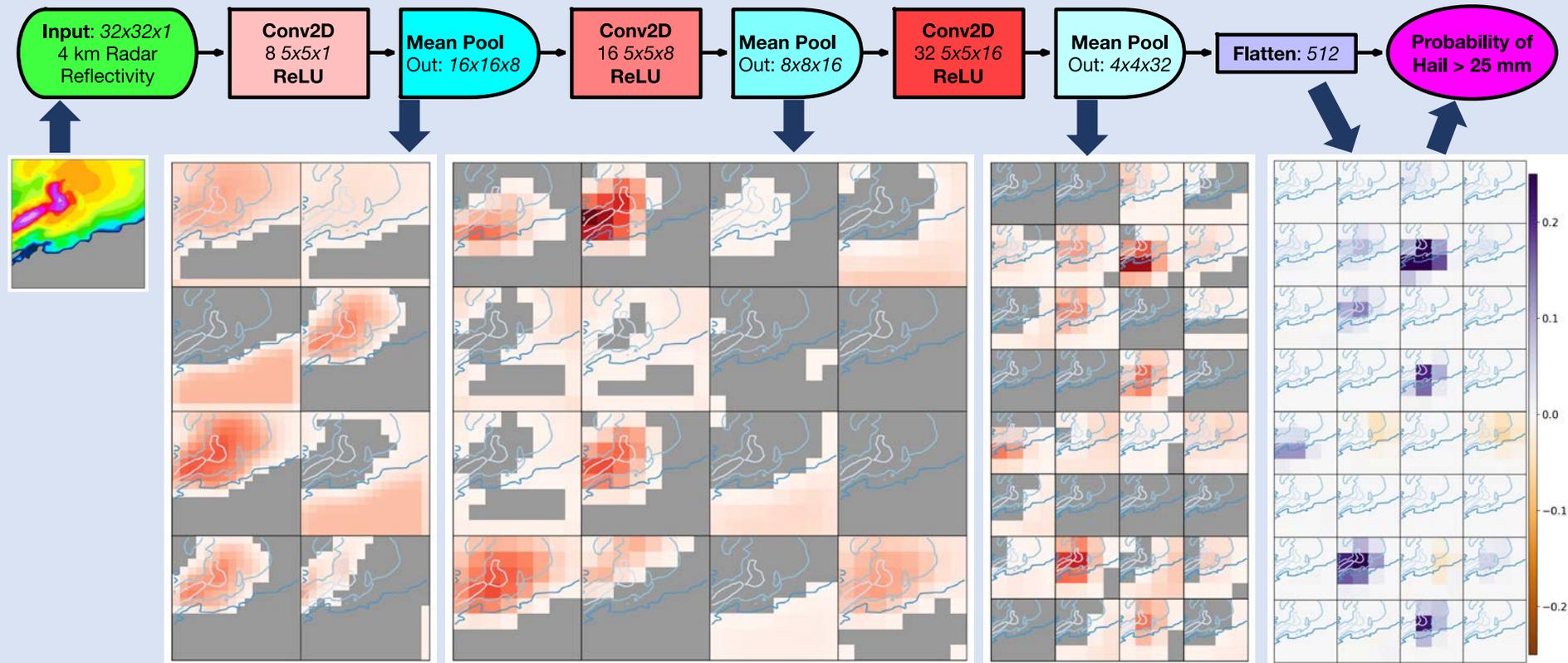
1. Send batch of training examples through network
2. Calculate prediction error
3. Calculate error gradients back through layers and update weights
4. Repeat over all training examples until errors are satisfactory

## Definitions

- Batch: subset of training examples used to update weights
- Epoch: One pass through all examples in training set

# Convolutional Neural Network

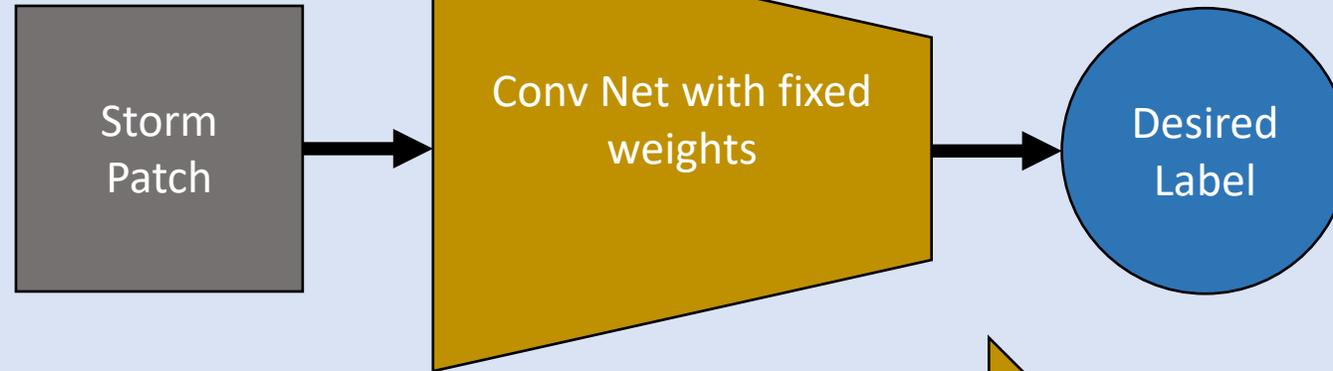
Deep neural network that encodes spatial information with learned convolutional filters



Convolution filter weights  
tuned through iterative  
optimization

# Feature Visualization by Optimization

1. Start with all 0s storm patch



2. Send input forward through net to get error
3. Pass error back through net to get change in input
4. Update input by subtracting error derivative

Forward pass to infer probability

Backpropagate error to update input image

Repeat steps 2-4 until prediction matches desired output

# How do I get started?

- Software
  - Anaconda Python Distribution
  - Tensorflow and Keras (available in Python and R)
  - PyTorch
- Books
  - Deep Learning by Ian Goodfellow et al.
  - Deep Learning with Python by Francois Chollet
- Tutorials
  - Swirlnet: <https://github.com/djgagne/swirlnet>
    - Predict mesocyclones with deep learning
  - Stanford CS231n: <http://cs231n.github.io/>
    - Great notes and visuals explaining convolutional neural networks

