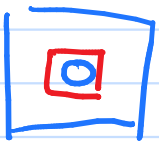
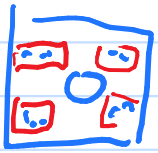
- **Deep Learning:**
  - Abt of inputs → Varying outputs

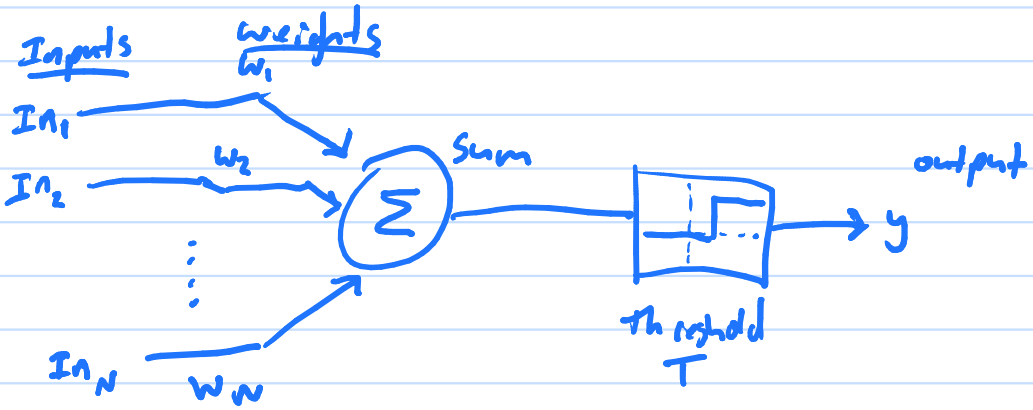
- classification

- object detection



- dense segmentation

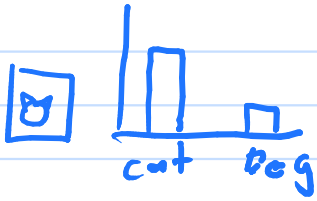




- **Convolutional Neural Networks (CNN)**
  - Differential function
  - Used for Handwritten

- **ImageNet Classification problem : 4 Visual Recognition**

e.g. • weighting between different animals



Neural Networks - general

- Deep Learning → more like differentiable programming
- Supervised machine learning.
  - monitors x & y data.
- objective function $J(\theta; x, y)$

- Fully connected NNs (what's wrong?)
  - very high dimensional complexities
  - too much data (takes a long time to compute)

- Solutions
  - Pixels aren't independent - 2D Assembly

- Invariance & equivariance
  - Can adapt our Data to be alot smaller.
    - (less computional time)

- Convolutional Neural Network?
  - uses convolution to operate on spatial data.

Example CNN:

input → Convolution, Pooling x2 or more → Classification

Combined featurizing

- output types

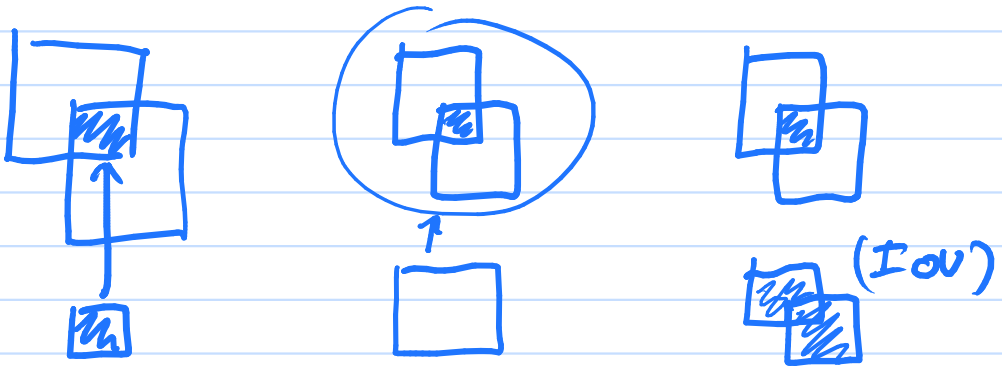
use: - Classification } estimating outputs
- regression

- **Dense Segmentation**
  - per pixel classification
  - Irregular shaped objects
  - Scene understanting

- identifies the specific tree

- **Segmentation - measurement**
  - Intersection over union (IOU)

Perciption & Recall vs IoU



- **Loss function.**
  - can use soft (IOU)

- **segmentation - architecture = different**
  - Top -> Bottom up

- **Object Detection**
  - Localisation + Classification
  - Challenge - variable number of outputs

- **measuring OD**
  - Average Precision, area under precision vs. recall graph.