Deep Learning for Plankton Image Retrieval

Project Summary

- Worked for the Scripps Institute of Oceanography

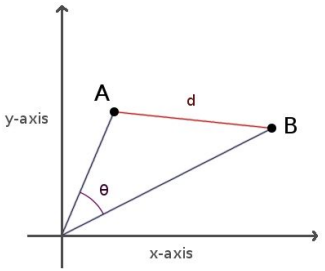
- Implement a system to aid in the labeling of plankton images.
- Design an image retrieval system using Machine Learning techniques

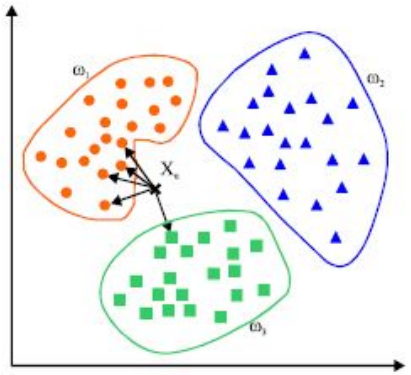
Topics

- Machine Learning Basics
- Search Methods
- System Overview
- Final Results

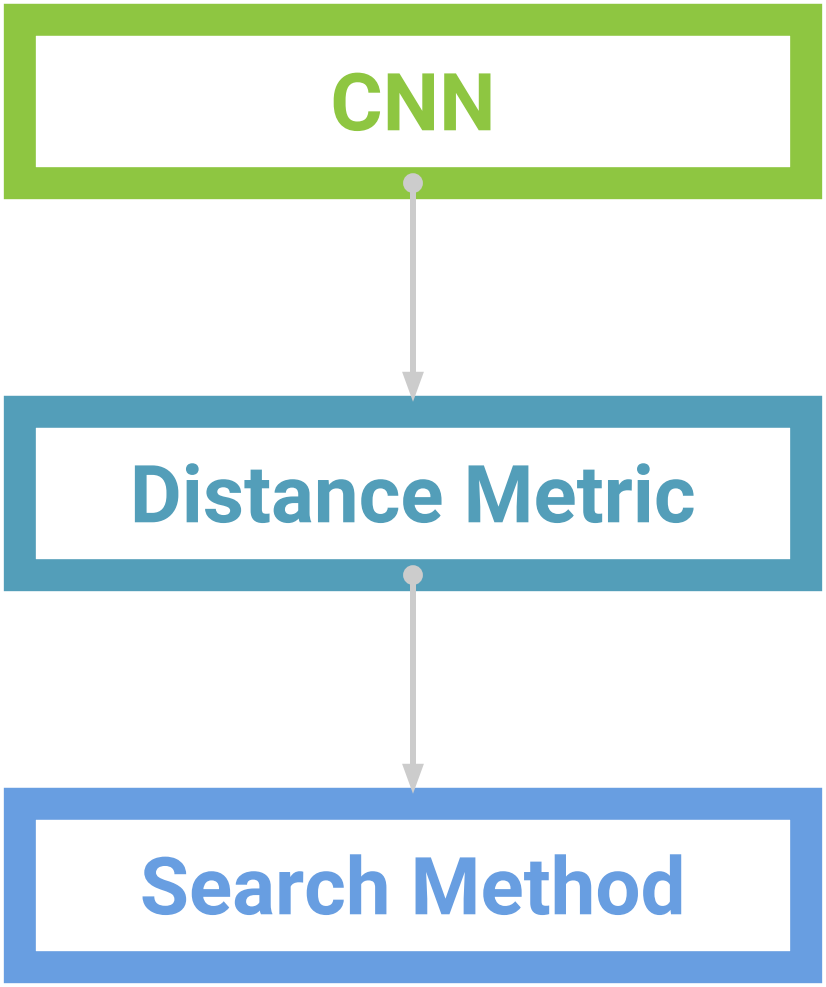
Machine Learning Basics

- Feature vector extraction with CNN
- Distance metrics
  - Euclidean
  - Cosine
  - Hamming
- Search Methods
  - ANN's
  - Hashing
  - Hyperplanes





Process Outline



CNN's

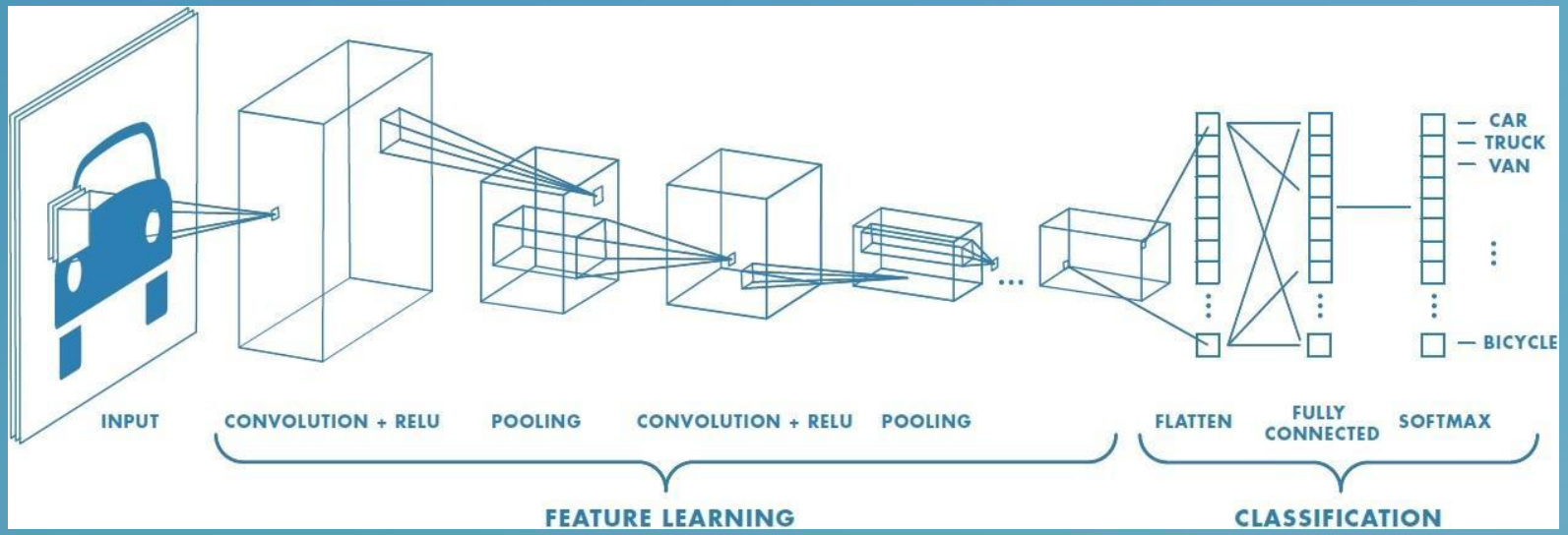
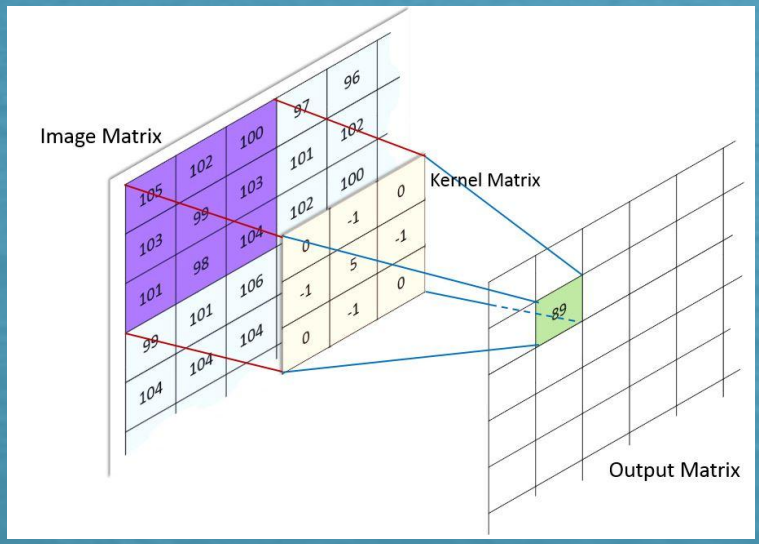
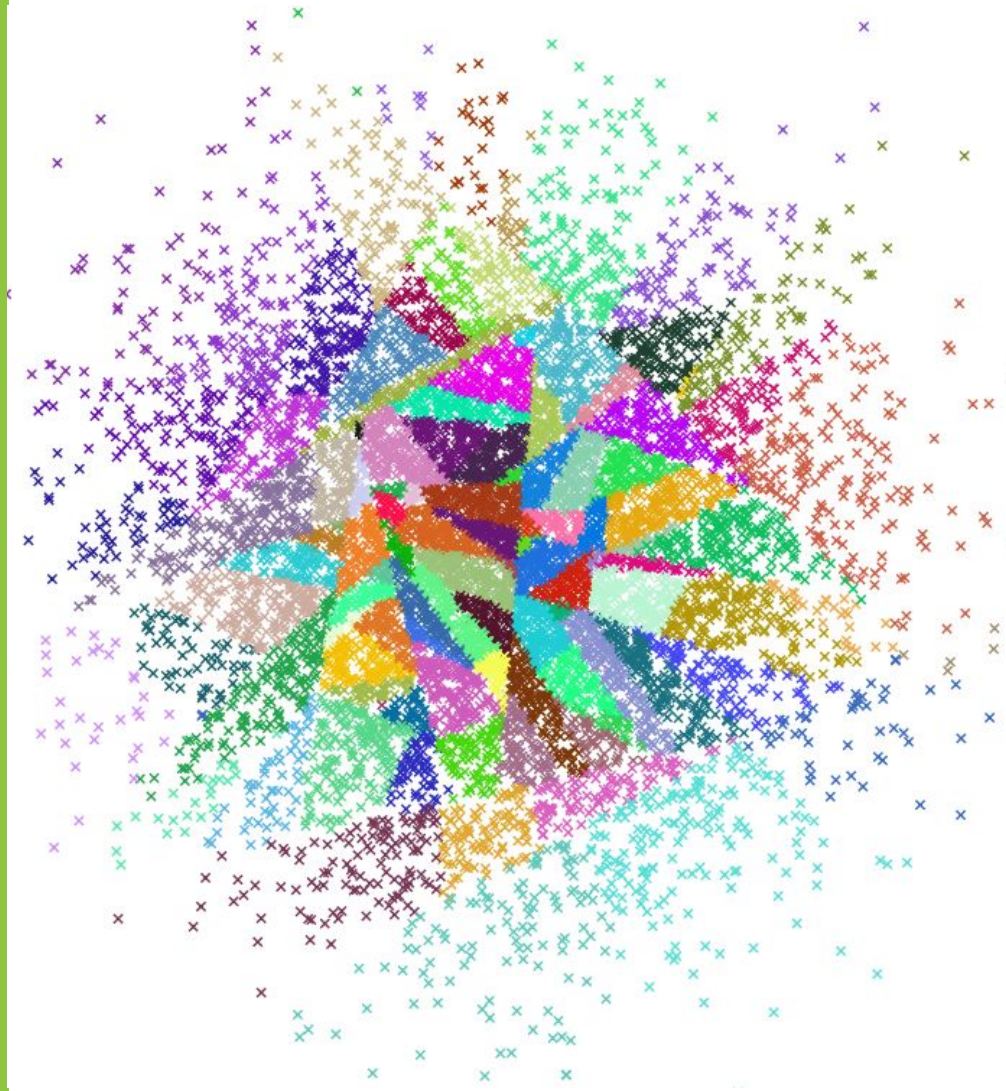


Image is passed through a series of convolutional layers:

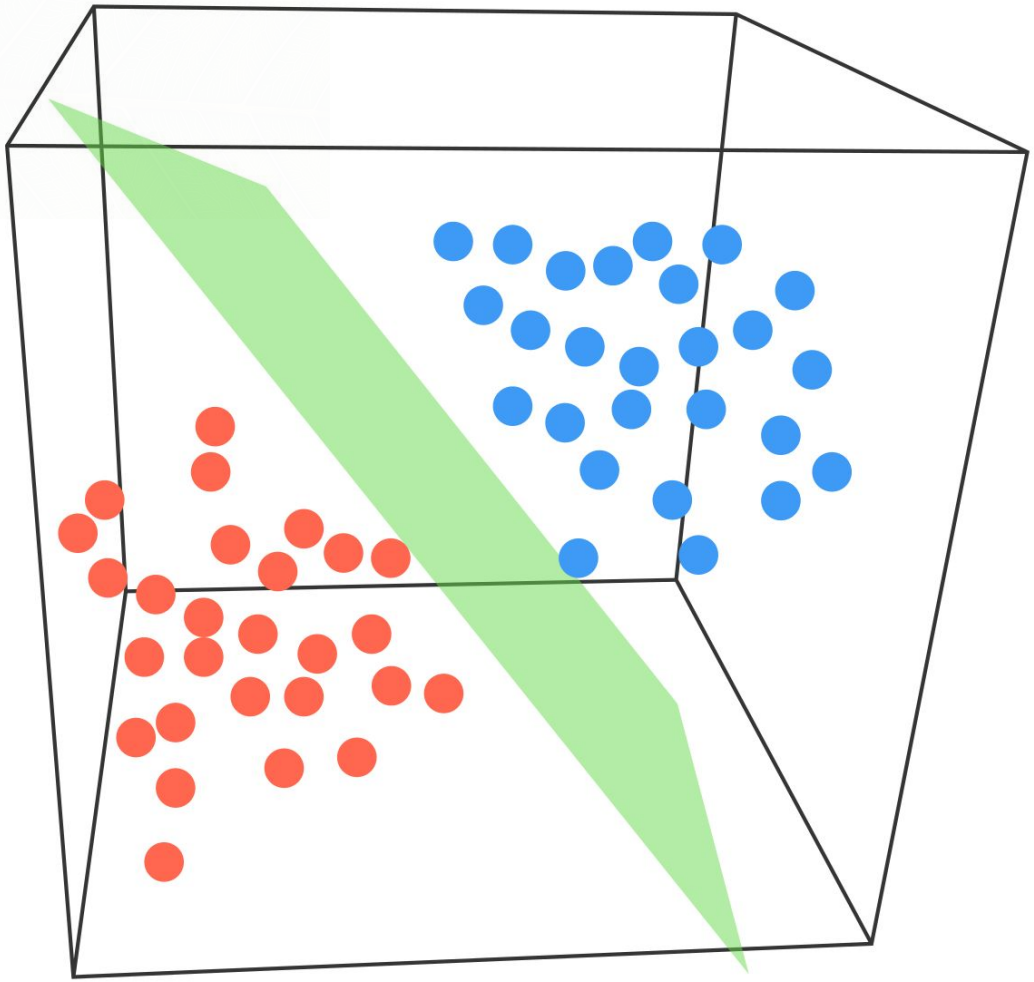
- Successive layers detect higher-level features
- Final result (without classification layer) is extracted feature vector





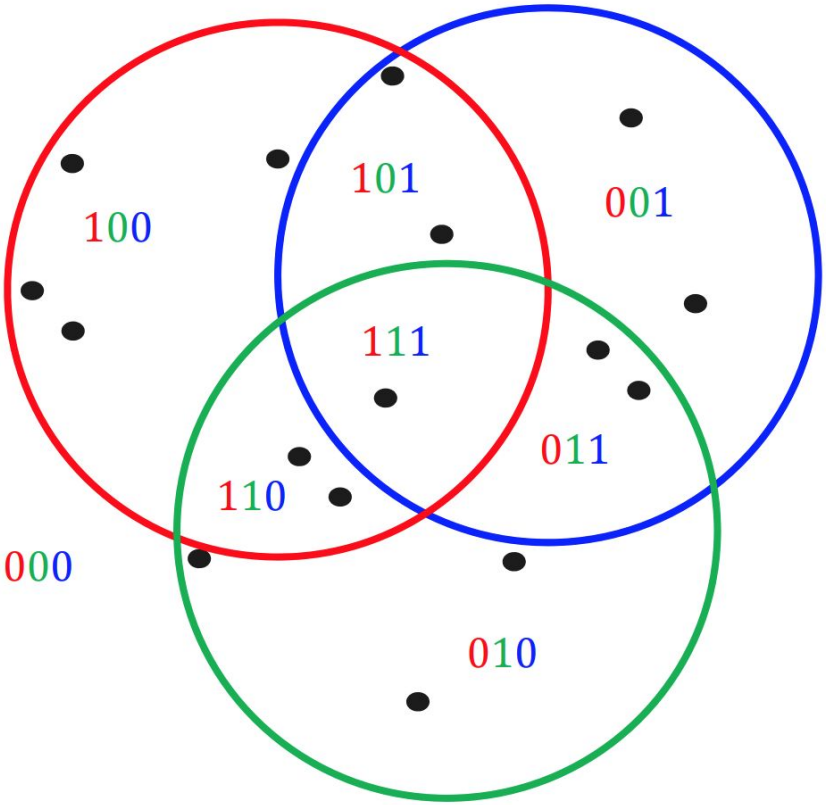
ANN's

1. Map feature vectors in N-dimension space.
2. Compares distances to search vector.
3. Select closest vectors approximately.



Hyperplanes

1. Plot feature vectors in N-dimension space.
2. Partition data space based off of natural groupings of feature vectors.
3. Plot search vector.
4. All vectors in search vector's partition are considered "similar".



Hashing

1. Calculate the hash code of each feature vector.
2. Partition data space similar to hyperplanes.
3. Calculate hash code of search vector and plot.
4. Vectors with shortest hamming distance to search vector are “similar”.

0101010011110

1 Billion Images In total

- Took 1 scientist 1 month to label 30,000 images
- Our system makes the process about 5-10 times faster.

200,000

Unlabeled Images

40,000

Labeled Images

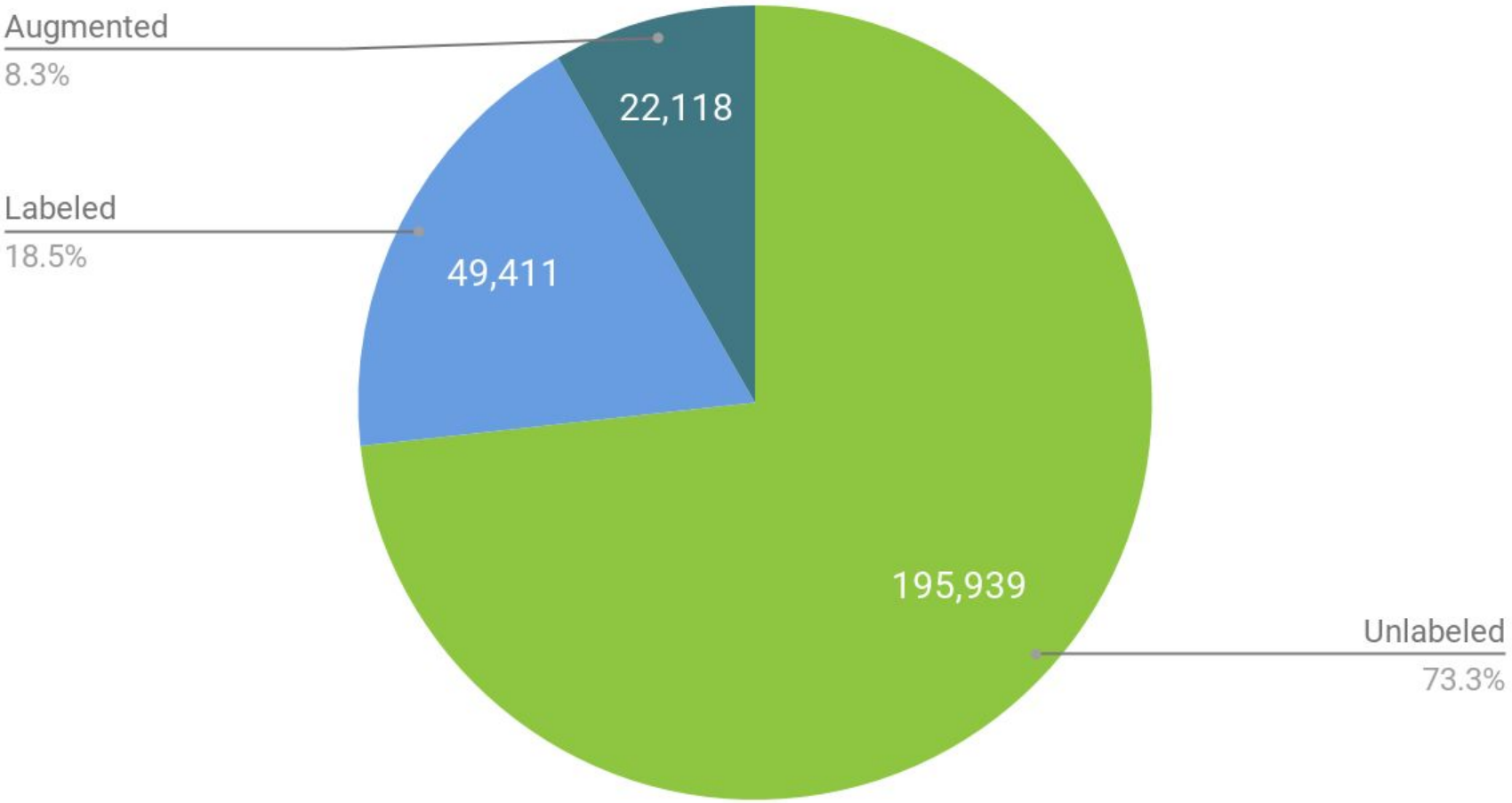
6 Images/Sec

Taken By Underwater Camera

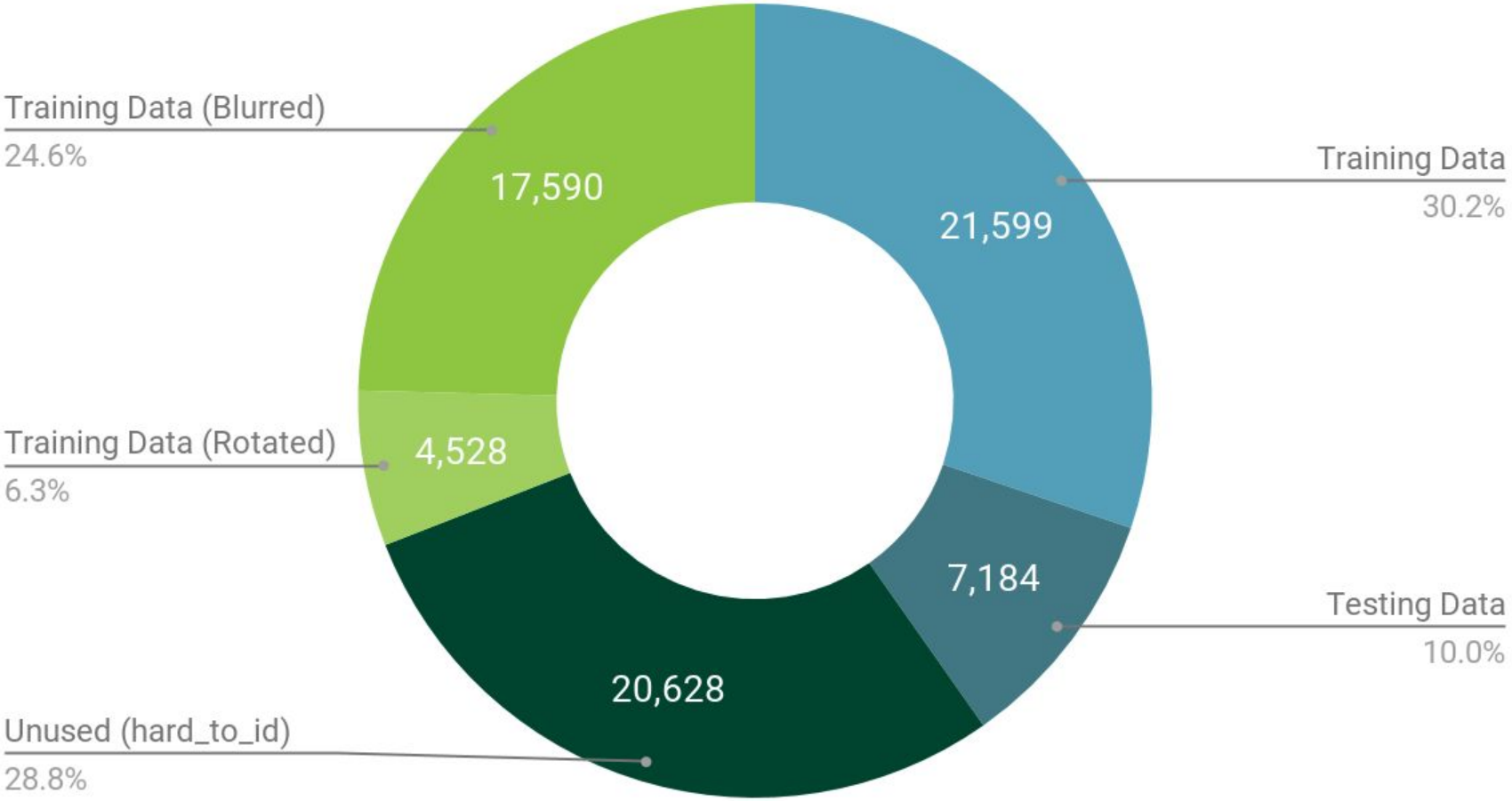
8 Images/Sec

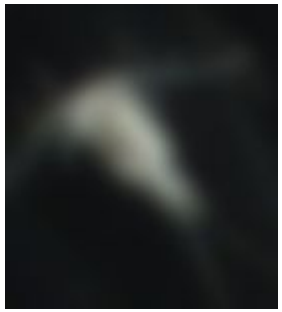
Labeled by user

Dataset Composition



Labeled Data Composition

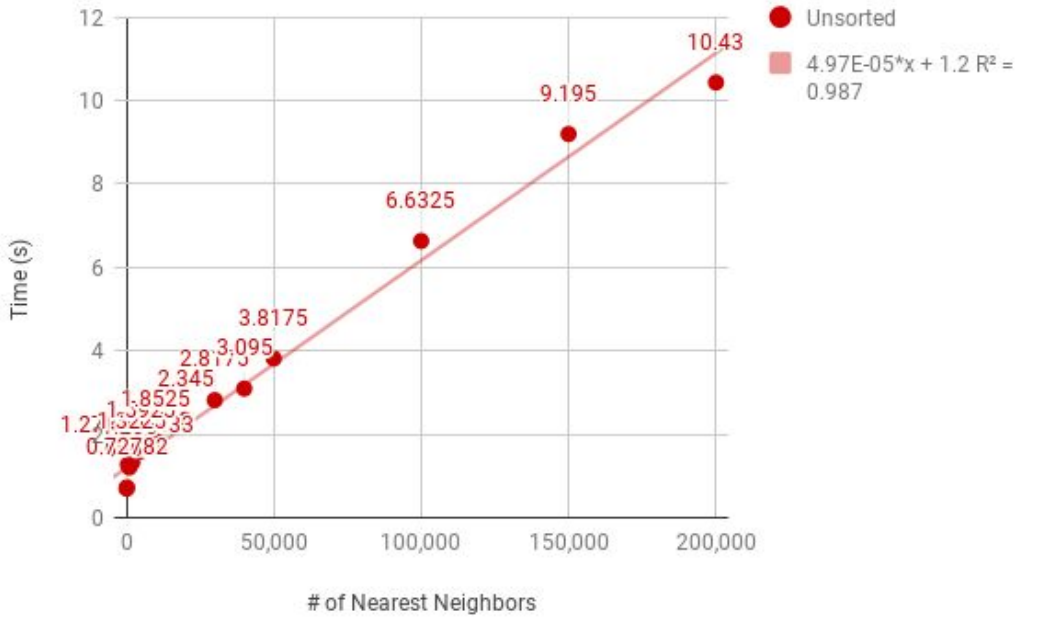


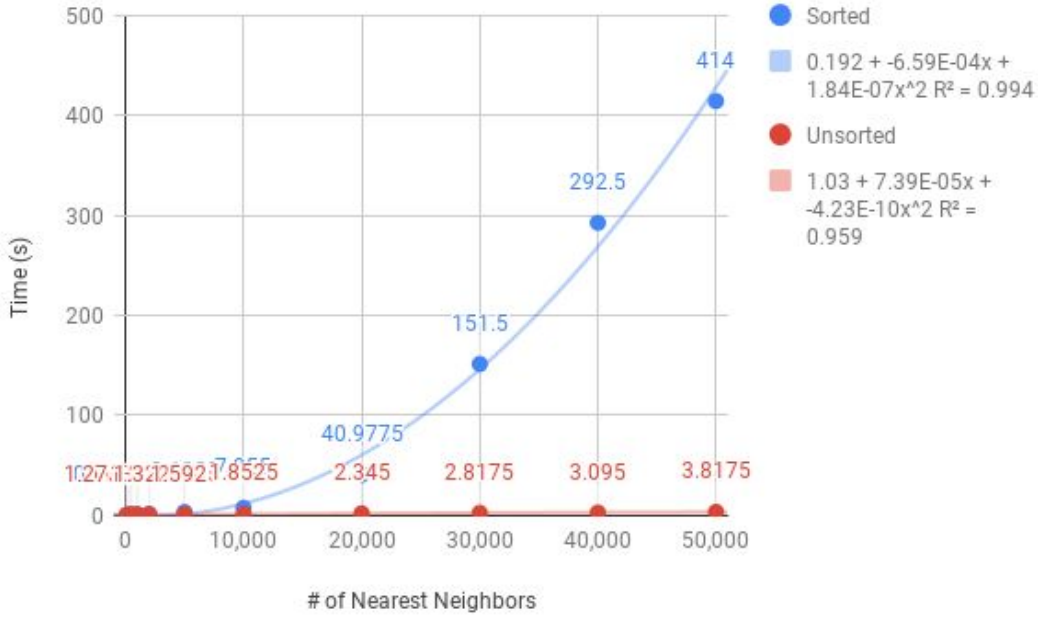


Data Augmentation

- Improves accuracy of neural network
- Generate rotated and flipped variations of original training data
- Generate blurred images from original training data

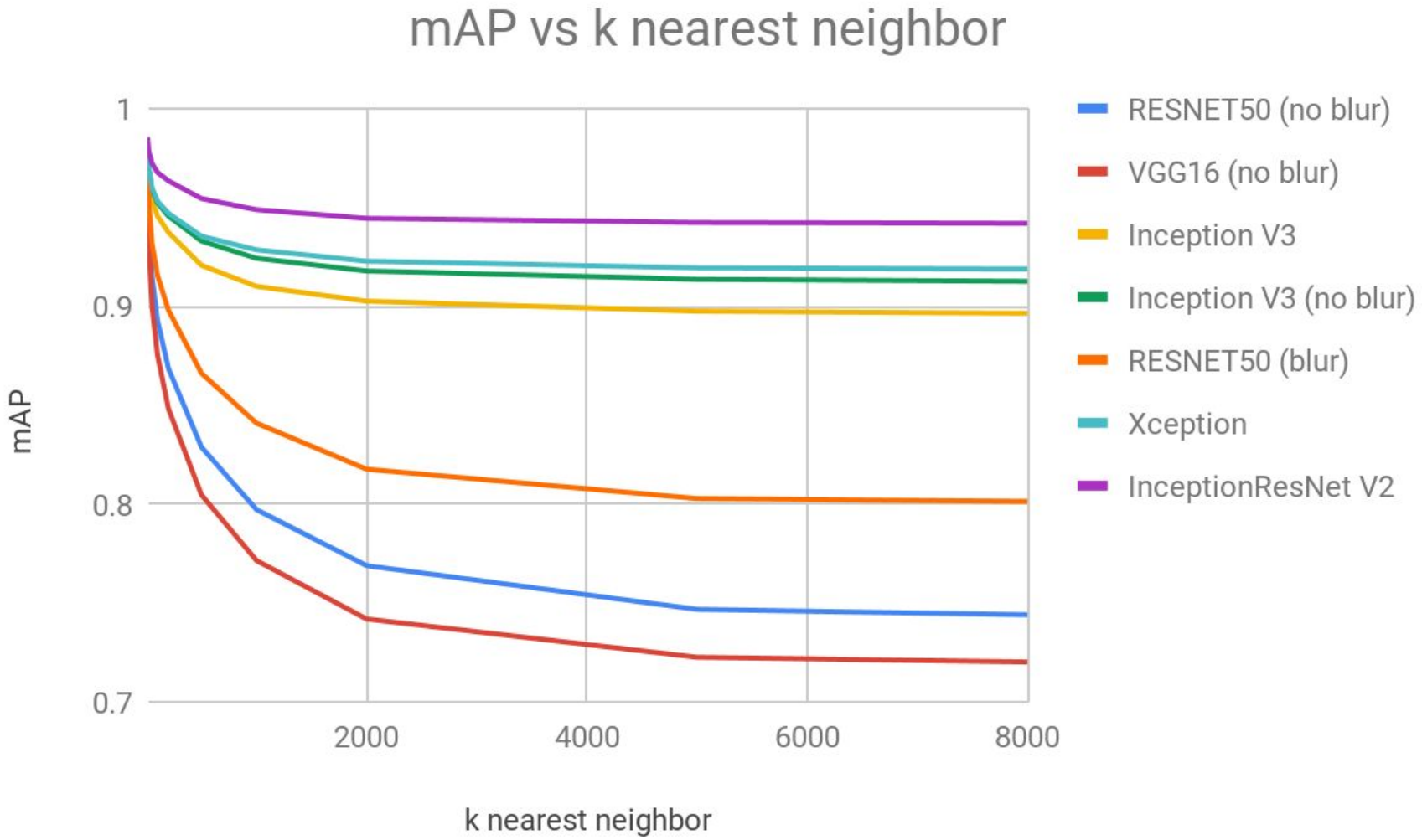
Retrieval Times



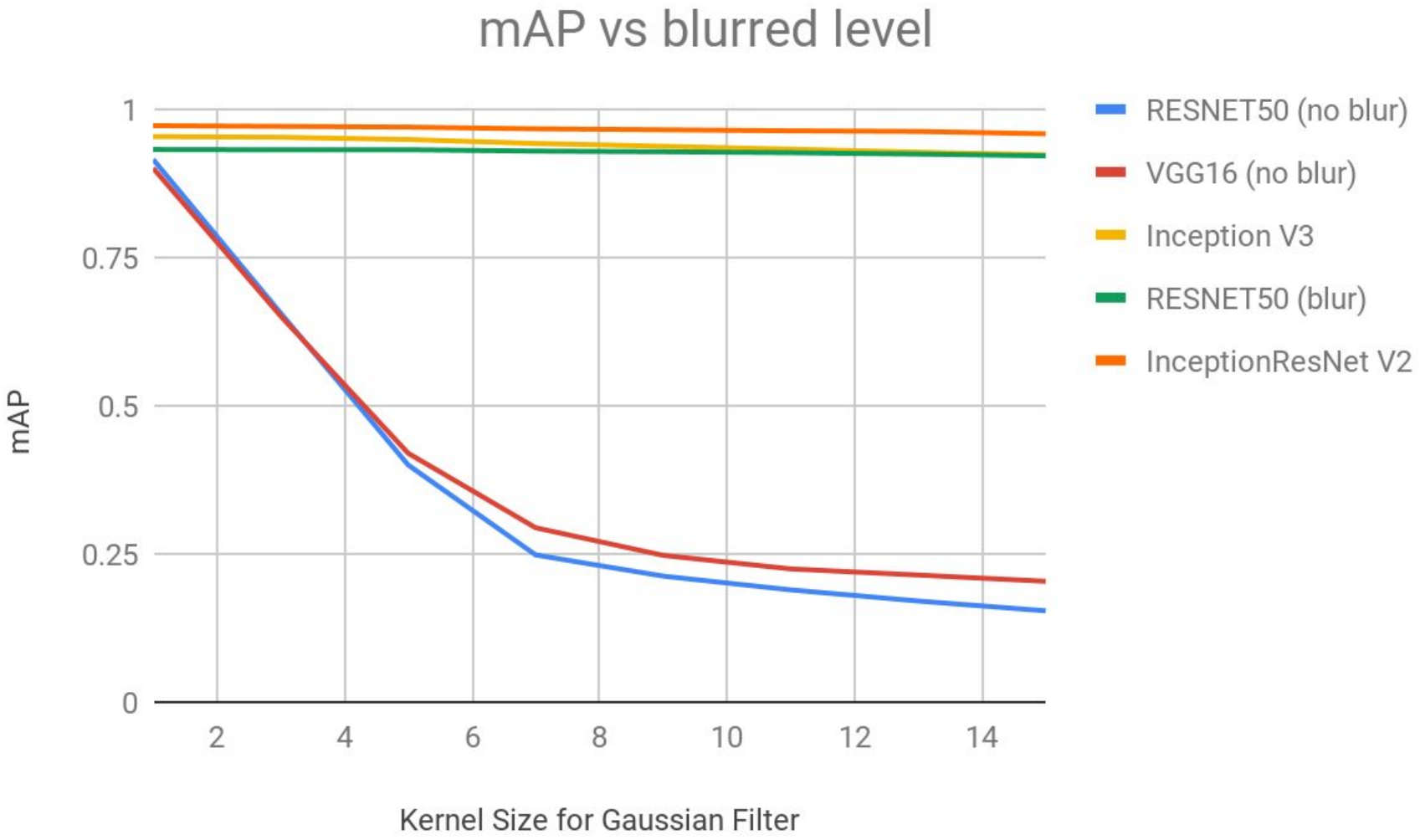


1. Unsorted times are extremely fast
2. While the output of the ANN function is sorted, the database(SQL) parse leaves the list unsorted
3. Data must be resorted

Performance Metric



Performance vs Abnormalities



Full System Overview

Retrieval System

InceptionResnetV2 CNN for feature extraction combined with ANN search for similar images.

Database Backend

Django database interface programming

Frontend Interface

JQuery javascript functions to handle input commands and output displays.

Multiple Servers

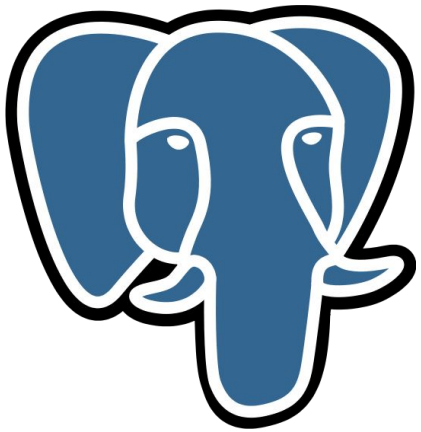
SVCL server at UCSD for training the CNN and building the ANN tree.

SPC server for running the website and searching through ANN tree to find nearest matches.

Backend

Django

Web server with PostgreSQL database, retrieves requested images based on queries



Limitations

The ANN retrieval system has about a 4sec delay around the 10k image mark.

The Database however has about a 40 sec delay around the 10k image mark.

System Demo

Thanks!

Any questions?