# Deep Video Analytics

Akshay Bhat, Cornell Tech, Cornell University.

A good overview of computer vision research by Tomasz Malisiewicz

http://www.computervisionblog.com/2015/01/from-feature-descriptors-to-deep.html

# A quick summary

Sift, Graph Cuts

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HOG, DPM

↓

Deep Learning

↓

??????

Internet

↓

Caltech 101, Matlab OpenCV

↓

VOC, Imagenet, Caffe, Theano

↓

??????

# Numerous high quality libraries & datasets

- **OpenCV**
- **ROS**
- **Caffe (model zoo!)**
- **Theano**
- **Torch**
- **Tensor Flow**
- **CNTK**
- **MXNET**
- **Pytorch**

- Caltech 101
- Imagenet
- COCO
- Too many to keep track!
  - Open Images
  - Soundnet
  - Mapnet
  - CMU Video patch dataset

# A deluge of datasets!

- VideoNet
- Yahoo Flickr Creative Commons 100M
- ViCom
- Visual Genome
- YouTube-BoundingBoxes
- Youtube 8M
- imSitu by AllenAI
- Charades by Allen AI
- Udacity car dataset
- KITTI
- Caltech, INRIA, ETH Pedestrians
- Stanford Drone Dataset

# State of the art pre trained models

- Imagenet classification
  - Inception
  - Resnet
  - VGG
- Detection models
  - R-CNN
  - YOLO
  - SSD
- Face detection / recognitions
  - Face-MTCNN
  - Facenet
- Semantic Segmentation models
  - Multipathnet
  - FCN
- Audio embedding models
  - Soundnet

# Question

What is natural progression after libraries, large datasets and pre trained models?

# Answer

A platform which seamlessly combines Data + Models + User Interface.

# What is hidden in plain sight?

# A Relational Model of Data for Large Shared Data Banks

By Edgar F. Codd

Can we develop an equivalent of relational model / databases for visual data?

Visual Data

=

{ Images, Videos, Annotations, Features}

Relational data : Postgres, MYSQL, SQLite

::

Text, HTML : Lucene/Solr, Elasticsearch

::

Videos & Images : _____

Relational data : Postgres, MYSQL, SQLite

::

Text, HTML : Lucene/Solr, Elasticsearch

::

Videos & Images : ***Deep Video Analytics***

Relational data : SQL

::

Text, HTML : inverted word index, Page Rank

::

Videos & Images : ***Approximate Nearest Neighbor***

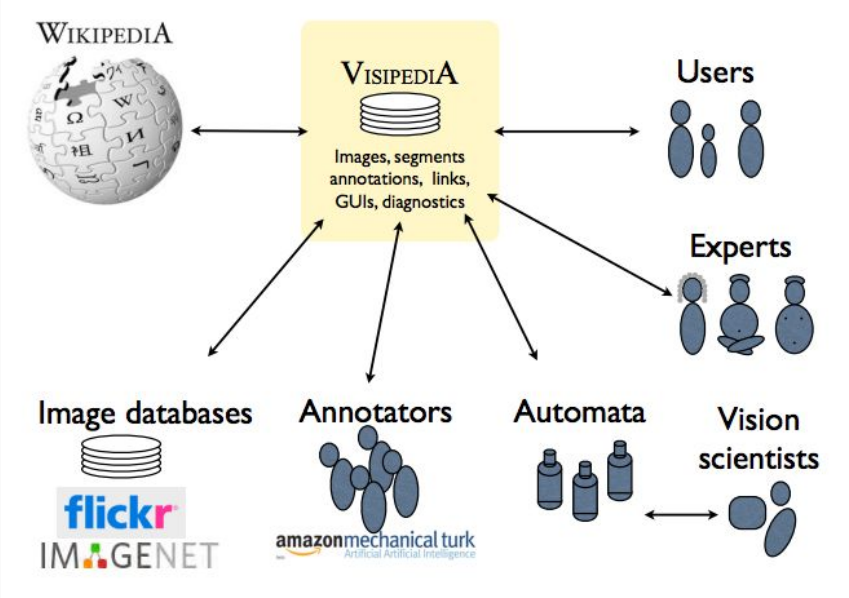
# Previous attempts: CloudCV

- Large Scale Distributed Computer Vision as a Cloud Service
- Intended for researchers, and non-researchers
- Support for OpenCV, Graphlab, Cafe
- Image Classification, VQA, stitching, etc
- **Does not retains state!**

# Previous attempts: NVidia DIGITS

- ”DIGITS (the Deep Learning GPU Training System) is a webapp for training deep learning models. ”
- Load/create datasets, train models, deploy models.
- Aimed at researchers
- Written in Python/Flask with Torch & Caffe supported
- **Retains uploaded images.**

# Previous attempts: Visipedia




*Taken from Vision of a Visipedia, Perona et. al.*

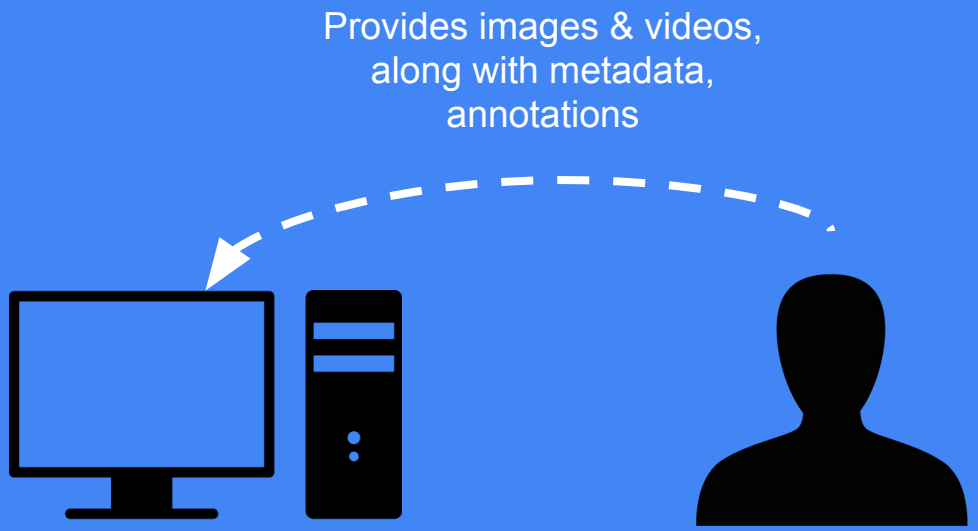
# Previous attempts: Visipedia

- Collaborative creation of visual data
- Pre-defined set of concepts E.g. Birds
- Different type of participants
  - Experts, Annotators, Citizen Scientists, Users, Computer scientists
- **Retains state!**

# Previous attempts: VMX.ai

- Unsuccessful Kickstarter project Circa Jan 2014
  - by Tomasz Malisiewicz Pre Tensor Flow, Pre Deep Learning
- Allow developers to create real time detectors
- Support for training model, works via browser canvas
- https://www.kickstarter.com/projects/visionai/vmx-project-computer-vision-for-everyone/description

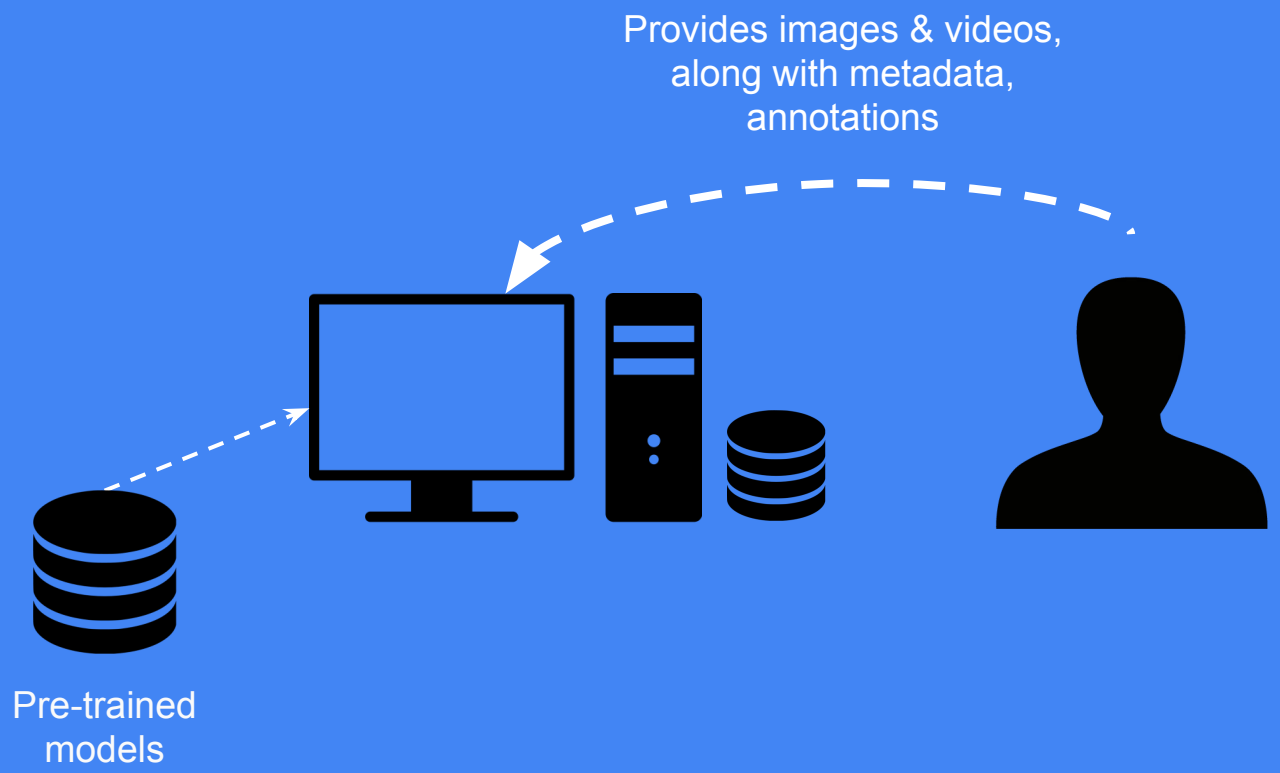
# Model of a Visual Intelligence Platform



# Model of a Visual Intelligence Platform

Provides images & videos,
along with metadata,
annotations

# Model of a Visual Intelligence Platform



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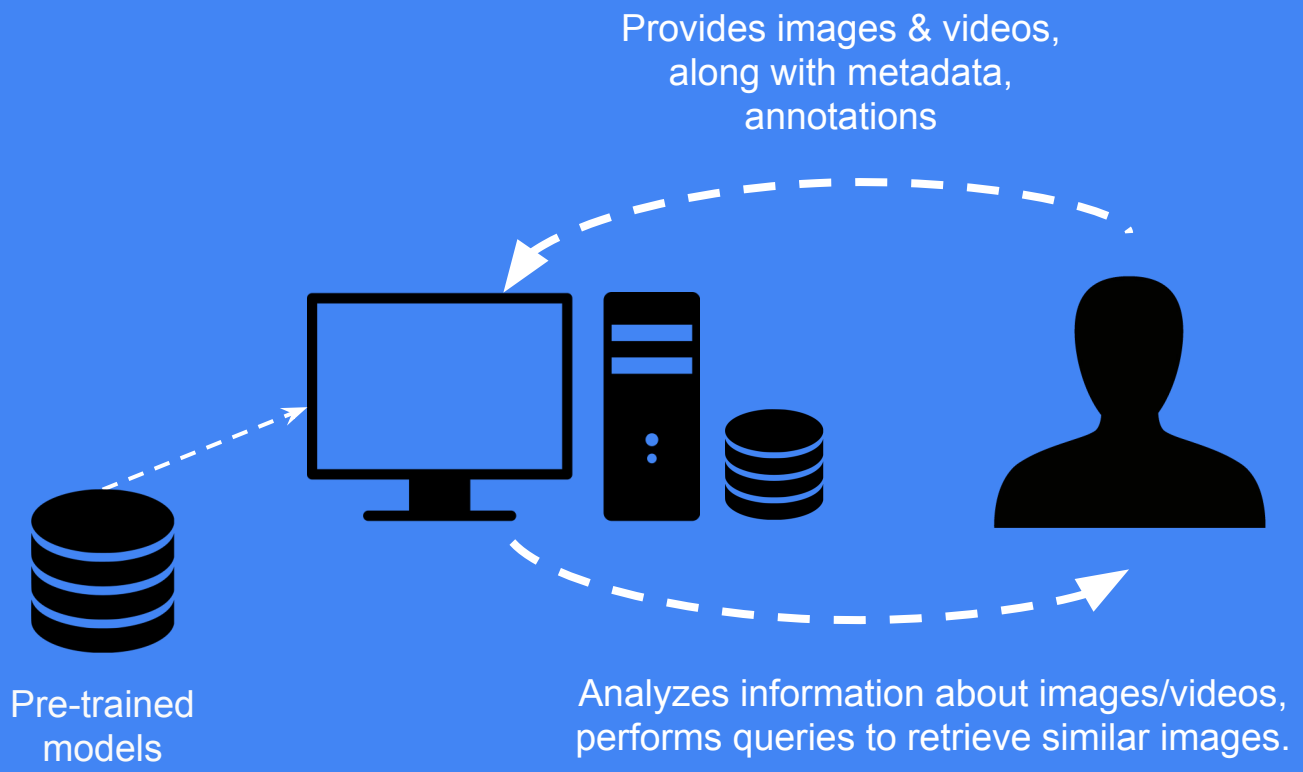

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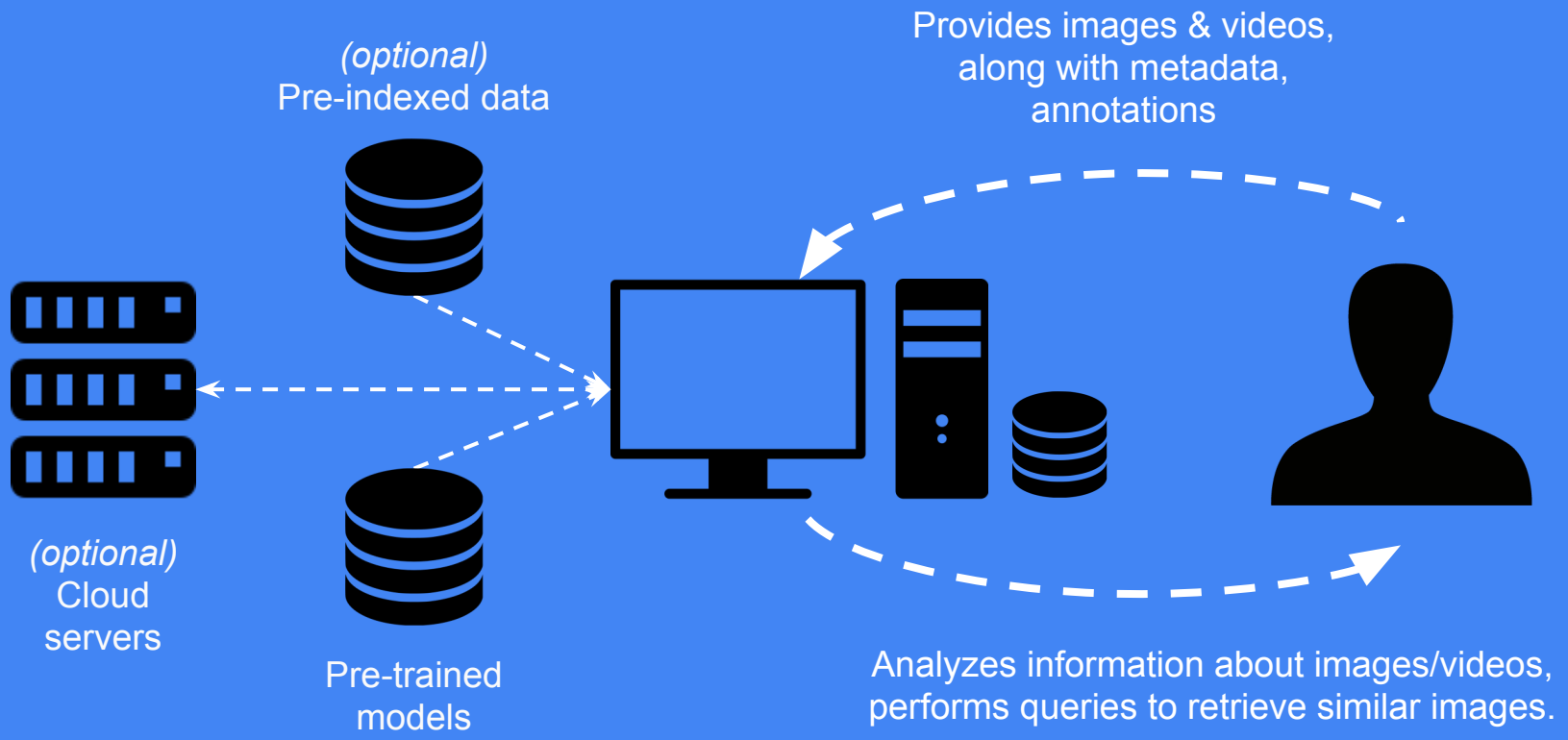

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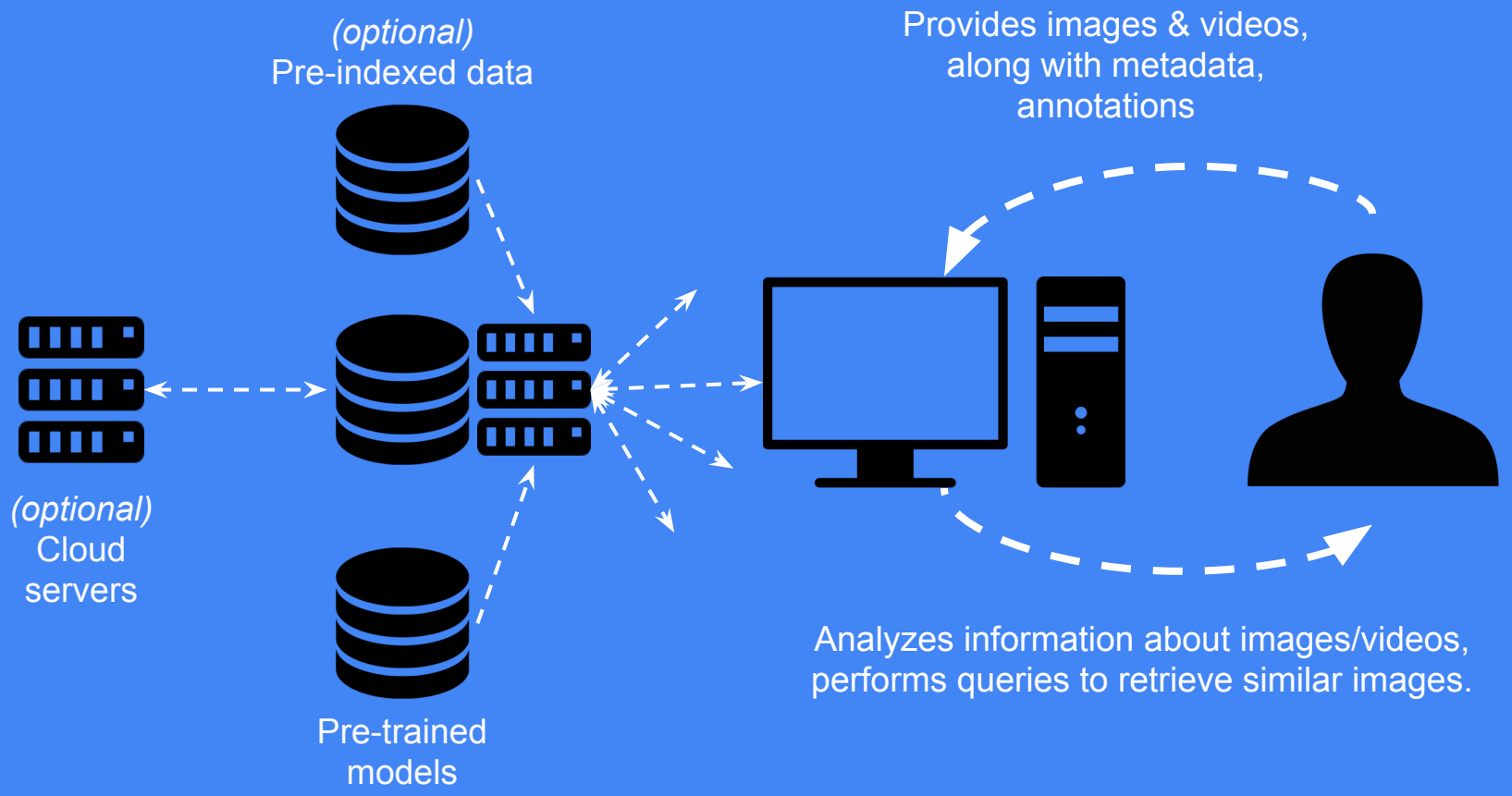


# Question

Why not just modify lucene to index images?

# Answer

Visual Search is significantly different compared to full text search. It requires a new user interface and ability to handle detections, segmentations, videos, etc.

# Deep Video Analytics

## Visual Search as a “Primary User Interface”

- Intended for **non-researchers**
- Make it easy for users to provide data (uploads, youtube-dl, etc.)
- Batteries-included approach with an indexing and detection pipeline
  - Tensor Flow Inception v3
  - Single Shot Detector trained on VOC & YOLO 9000
  - Face detection / alignment / recognition
  - More algorithms such Text detection, Audio features planned.
- Pre-indexed datasets from different domains can be quickly loaded
- Can be easily customized by developers & researchers.

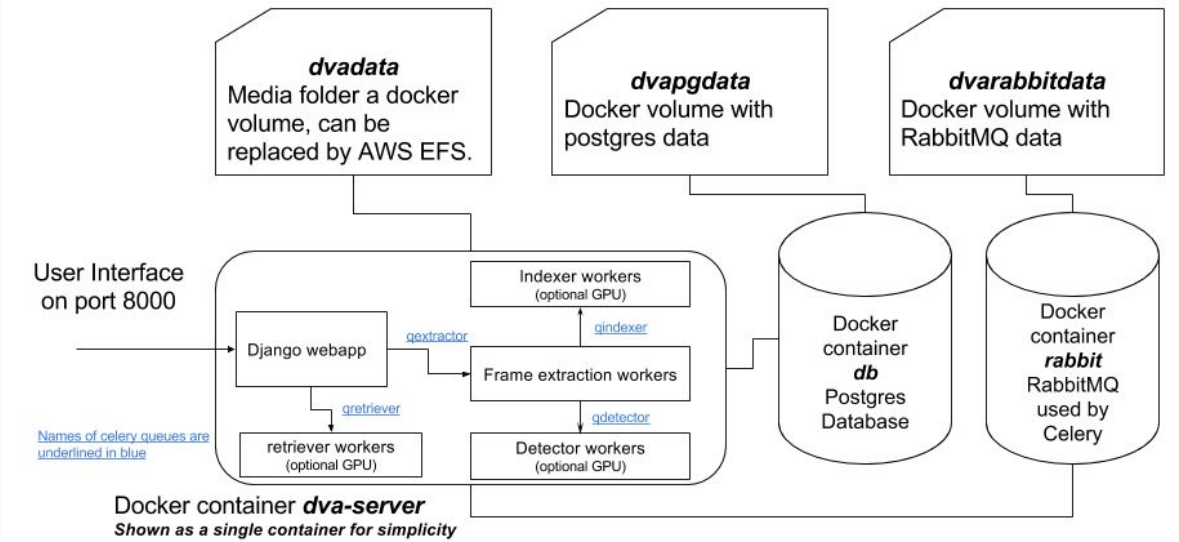
# Technical requirements

- Must be useful without having to write code or config
- Must work on machines with and without GPUs
- Must allow uploads and reindexing operations
- Easy to adapt by technical users
- Easy to dynamically scale out using cloud computing

# Emulating datacenter on a machine

## *Docker, Docker-compose, Nvidia-docker*

Docker enables same codebase across all configurations {a laptop, multi-GPU machine, datacenter} .



# Code organization:
## dvaapp & dvalib

**dvaapp:** a django app/project

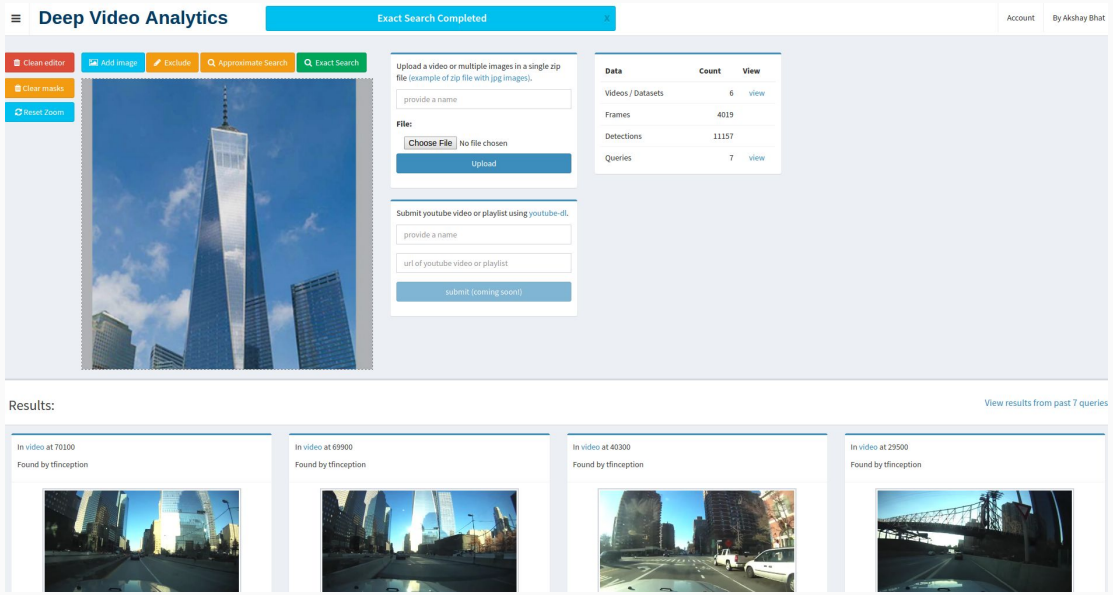
- Handles UI and data processing
- Data model
  - Video, Frame, Detection
  - Query, QueryResult
  - Event, etc.
- A set of celery tasks
  - Extract frames / process video
  - Perform indexing
  - Perform detection
- Uses dvalib to carry out tasks

**dvalib:** library for handling algorithms

- A database & celery agnostic library
- Interface with Tensor Flow & Pytorch for
  - extraction
  - detection
  - indexing
- Usable without having a running django instance, but designed to interface with it. E.g. assumptions regarding layout of directories containing videos, frames etc.

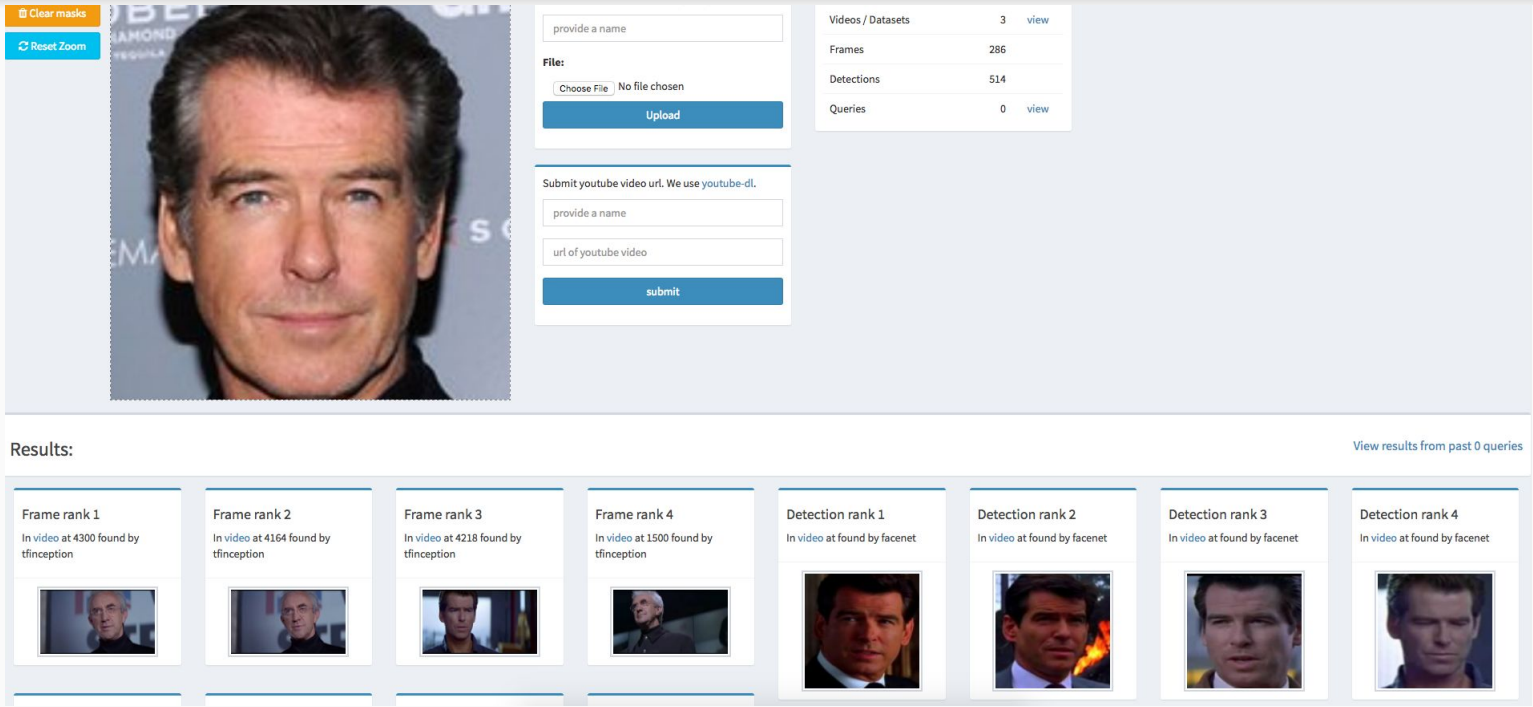
# User Interface:

## Visual Search as primary interface

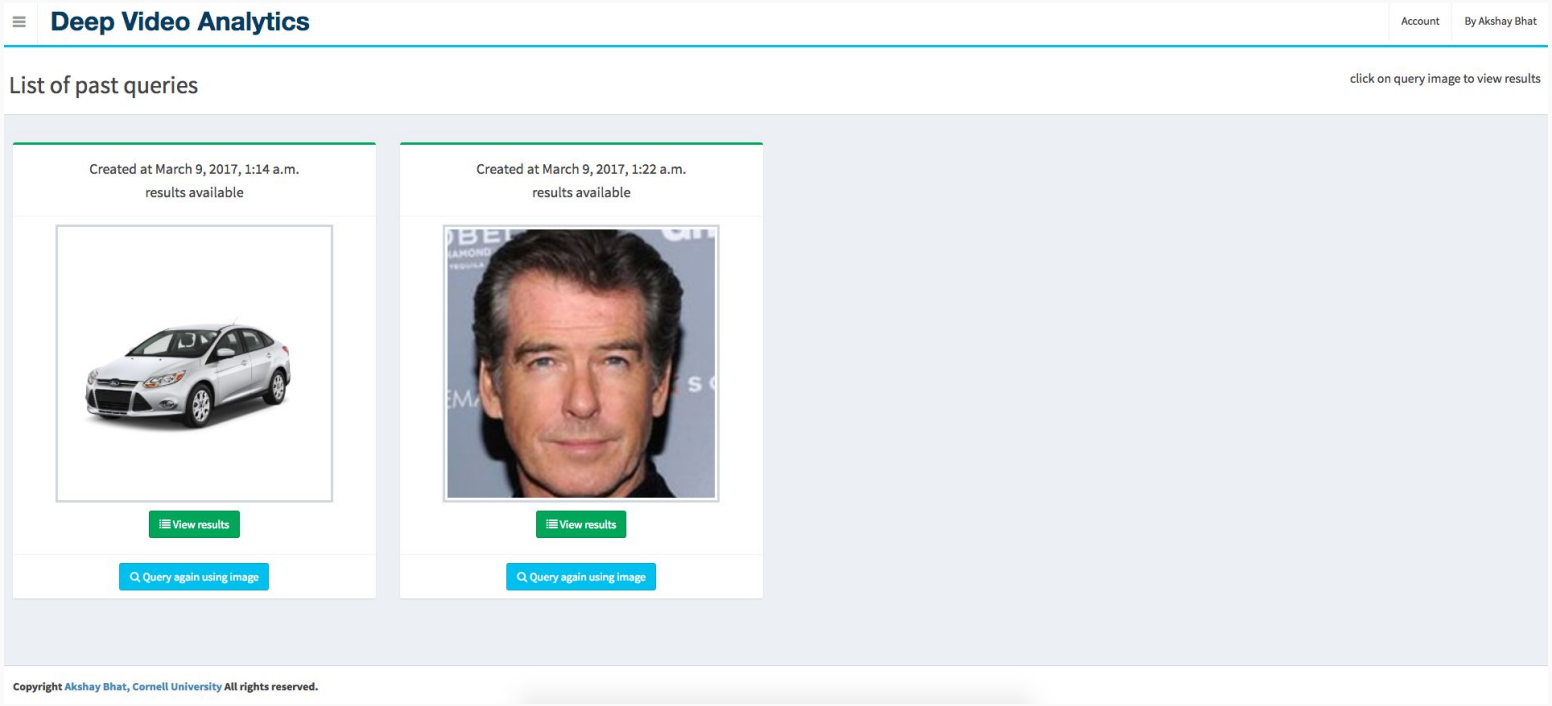


# User Interface:

## Search across frames + detections (faces, etc.)

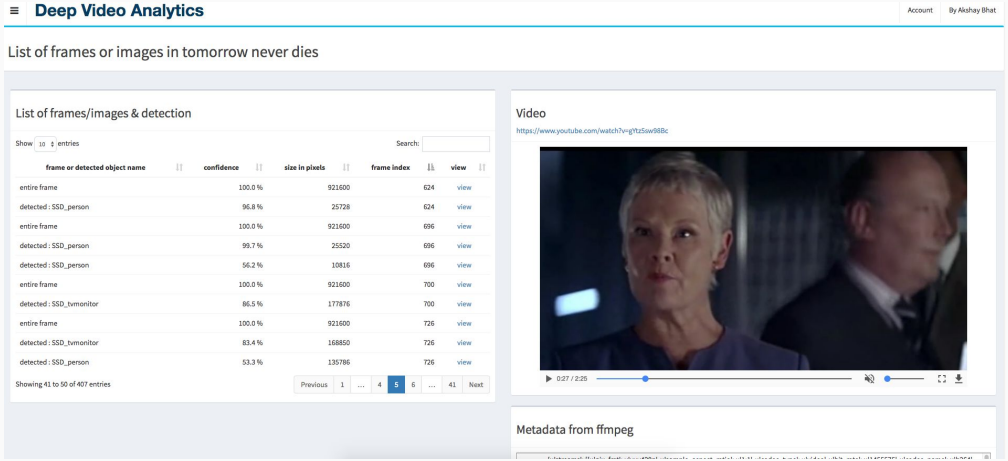


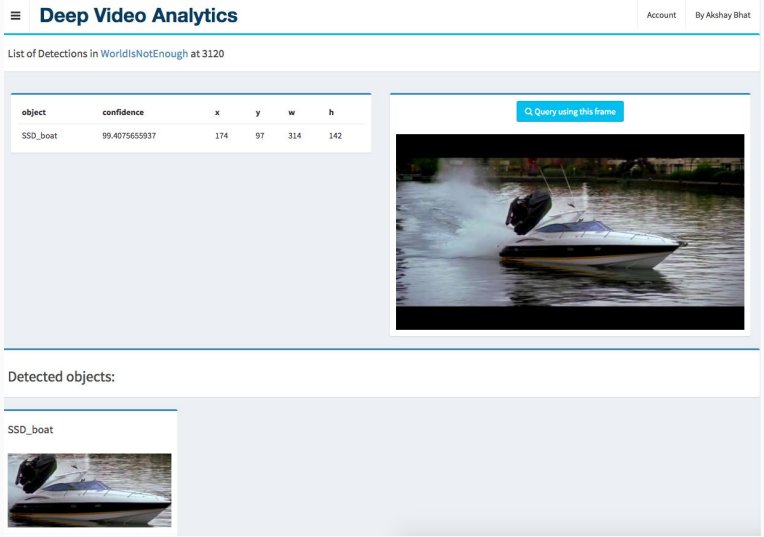
# User Interface:
## Browse previous queries



# User Interface:

## Browse videos, frames/images and detected objects



# User Interface:

## Get status of running and finished tasks & resubmit tasks.

≡ **Deep Video Analytics** Account By Akshay Bhat

System status and logs

| Data | Count | View |
|---|---|---|
| Videos / Datasets | 5 | view |
| Frames | 286 | |
| Detections | 514 | |
| Queries | 2 | view |

Events

Show 10 entries Search:

| Video | Operation | Started | Completed | timestamp | time taken in seconds | retry task |
|---|---|---|---|---|---|---|
| exampledataset | extract_frames_by_id | True | True | March 8, 2017, 11:31 a.m. | 3.2 | Retry |
| exampledataset | index_by_id | True | True | March 8, 2017, 11:33 a.m. | 3.0 | Retry |
| exampledataset | perform_detection_by_id | True | True | March 8, 2017, 11:47 a.m. | 188.1 | Retry |
| query_1 | query_by_id | True | True | March 9, 2017, 1:14 a.m. | 5.8 | Retry |
| query_1 | query_face_by_id | True | True | March 9, 2017, 1:14 a.m. | 197.1 | Retry |
| query_2 | query_face_by_id | True | True | March 9, 2017, 1:22 a.m. | 1.1 | Retry |
| query_2 | query_by_id | True | True | March 9, 2017, 1:22 a.m. | 2.0 | Retry |
| tomorrow never dies | extract_frames_by_id | True | True | March 8, 2017, 11:31 a.m. | 81.2 | Retry |
| tomorrow never dies | index_by_id | True | True | March 8, 2017, 11:33 a.m. | 72.5 | Retry |
| tomorrow never dies | perform_detection_by_id | True | True | March 8, 2017, 11:50 a.m. | 663.7 | Retry |

Showing 1 to 10 of 13 entries Previous 1 2 Next

Indexer log

Detector log

# Open questions:
## A work in progress

- How to rank results using auxiliary information?
- How to balance fast/static vs slow/dynamic indexes?
- How to incorporate external (pre & un) indexed data?
- How to incorporate text data extracted from images?
- Can the system continuously learn new categories?
- Can we create a real time plug-in?
- Can we create an android / iOS frontend app?

# Thanks!

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