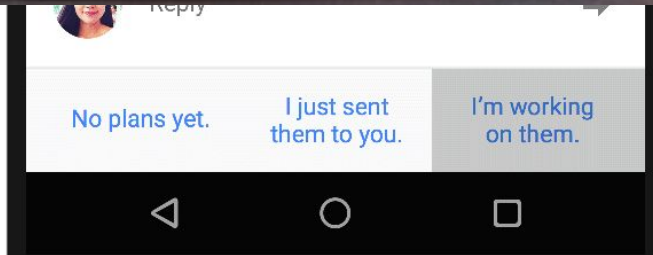


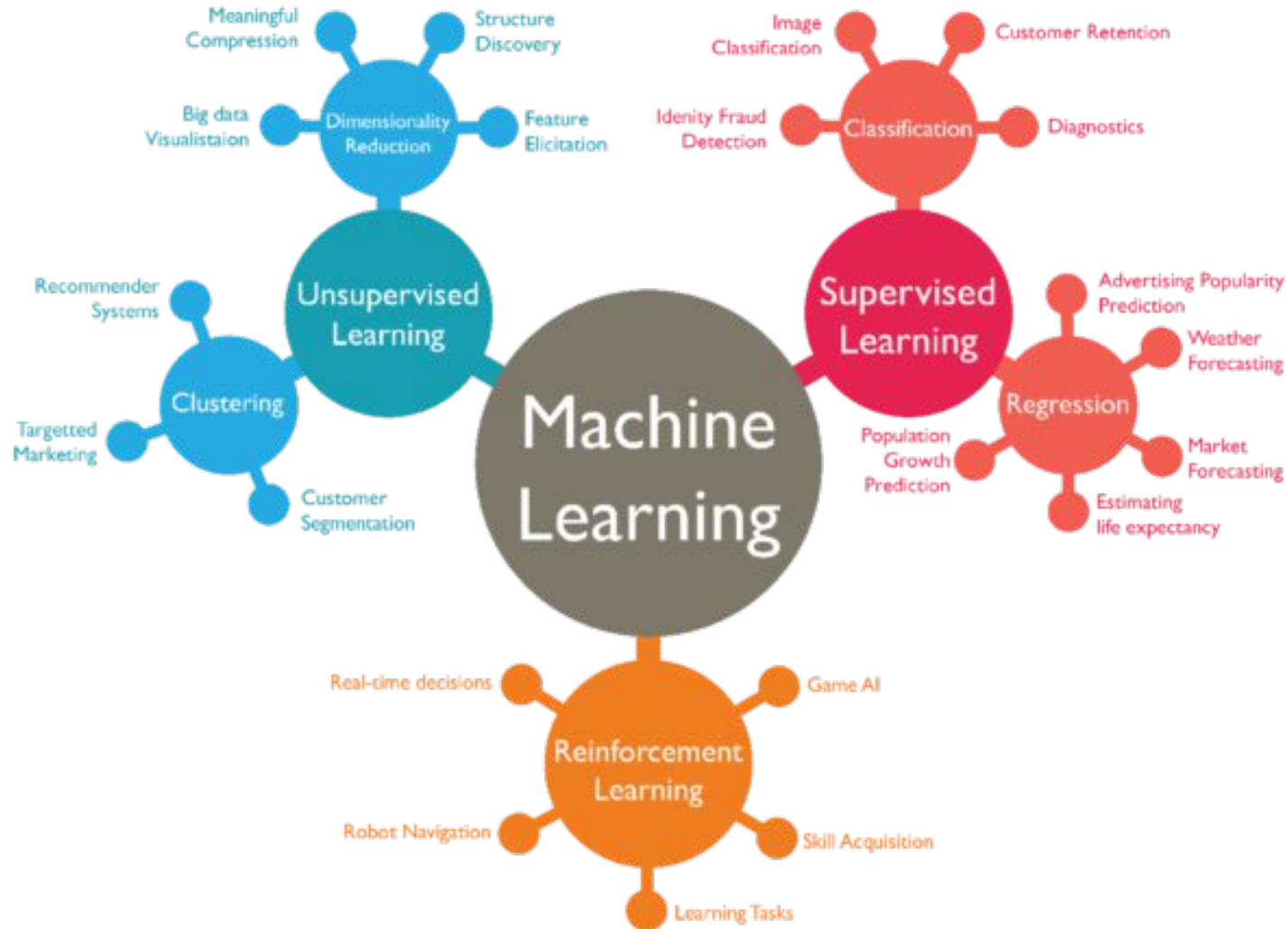
# ML for Surveillance Video Analytics

Vishal Kaushal  
Video Analytics Lab @CSE, IITB  
[www.vishalkaushal.in](http://www.vishalkaushal.in)



# Gmail PRIORITY INBOX





# ARTIFICIAL INTELLIGENCE

Early artificial intelligence stirs excitement.



# MACHINE LEARNING

Machine learning begins to flourish.



# DEEP LEARNING

Deep learning breakthroughs drive AI boom.



1950's

1960's

1970's

1980's

1990's

2000's

2010's

Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.





*What is this?*

```
function predict(image)  
  -- ????  
  return class_label  
end
```

# Data Driven Paradigm

## Traditional Programming



## Machine Learning





**Illumination**



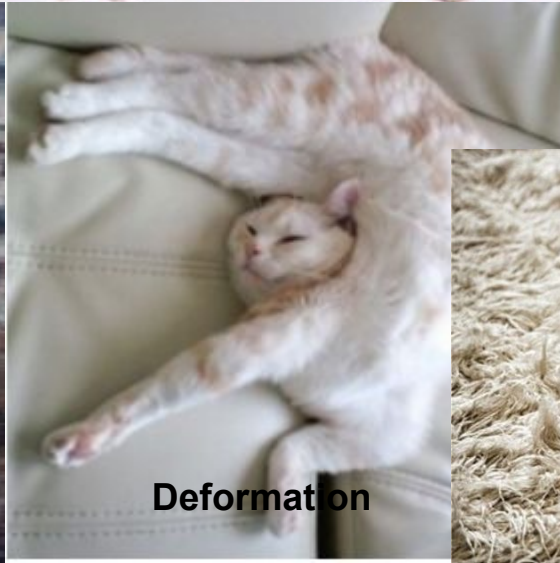
**Intra Class Variation**



**Occlusion**



**Occlusion**



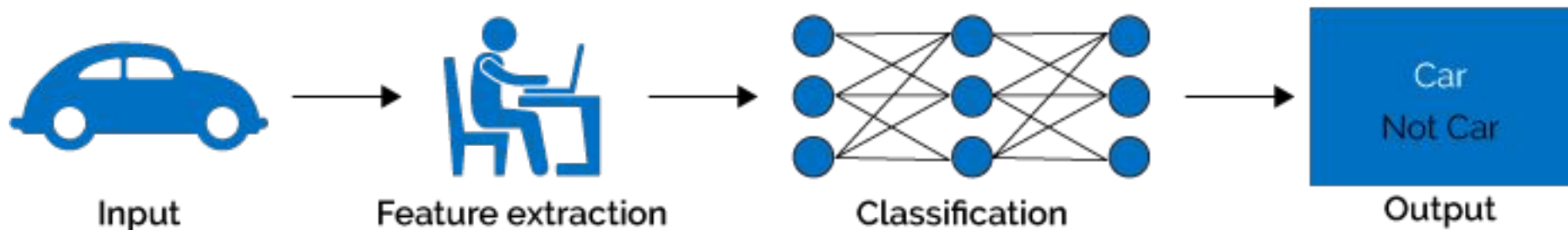
**Deformation**



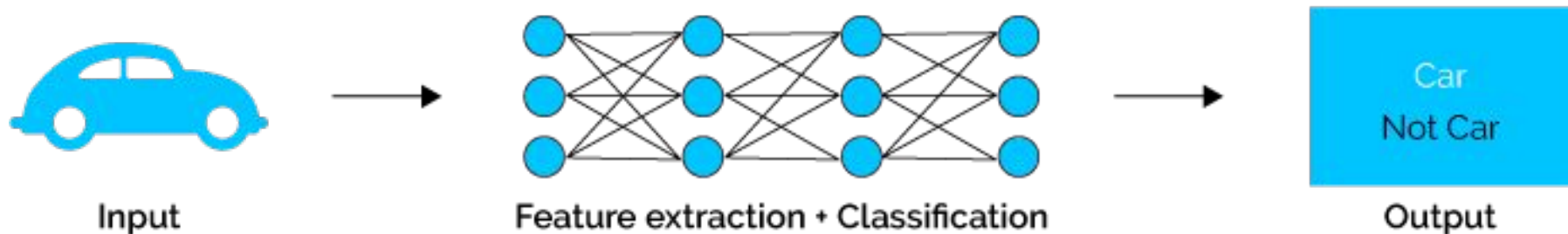
**Background Clutter**

# The New New Oil

## Machine Learning



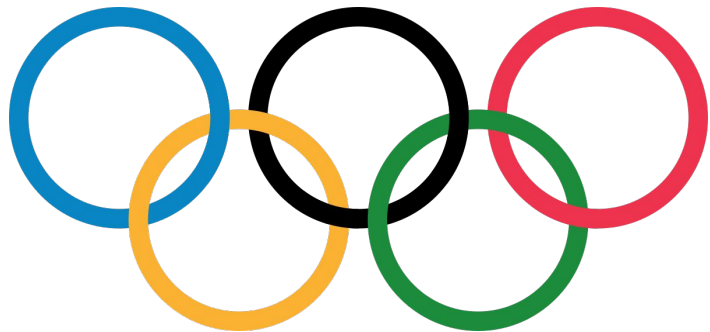
## Deep Learning





## 2012: The Turning Point

- ImageNet Classification Task
- Previous Best: ~25% (CVPR 2011)
- AlexNet: ~15% (NIPS 2012)

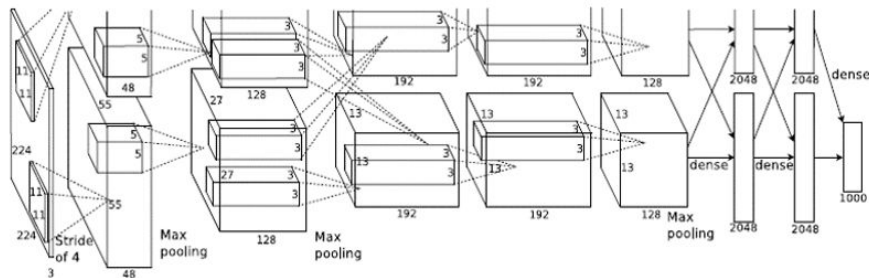


## Classification

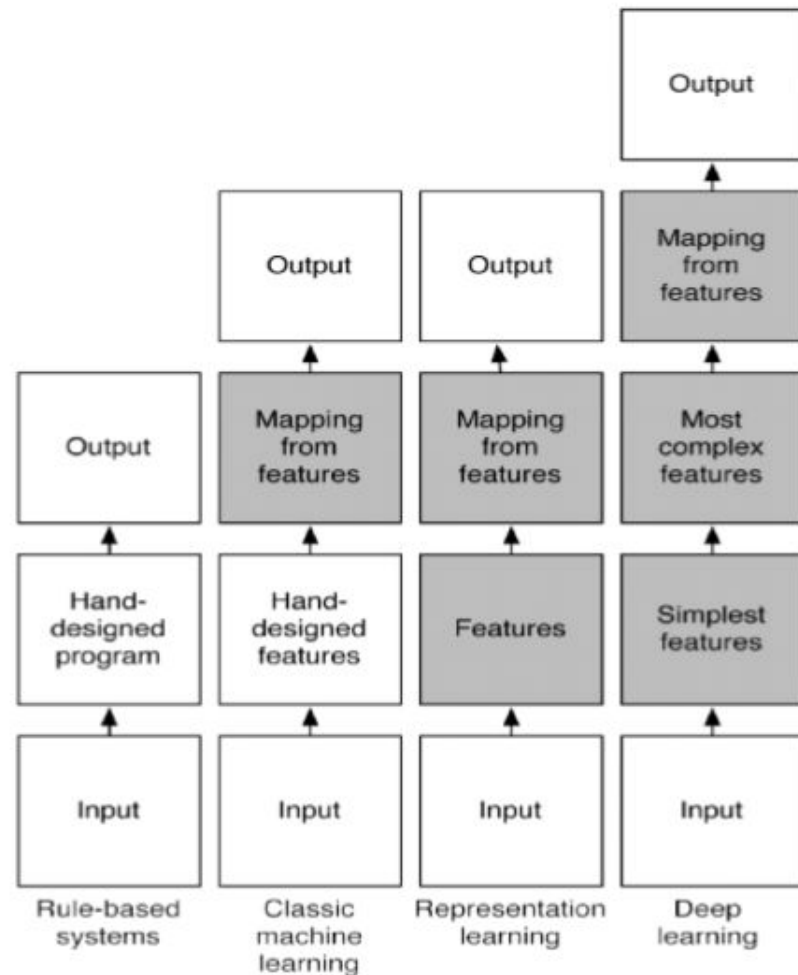


CAT

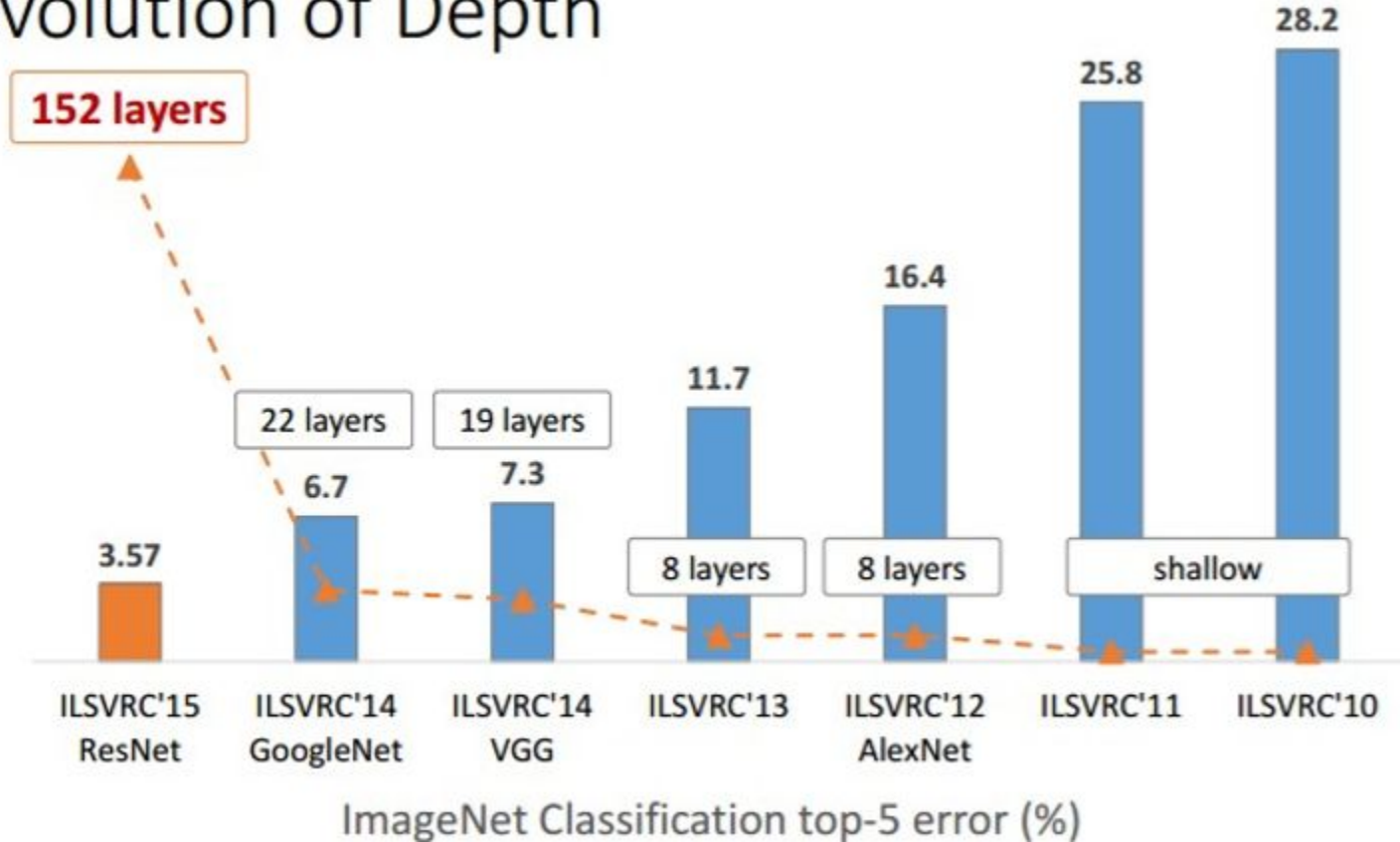
# What Is Deep Learning?



- Captures compositionality: world is compositional
- Exploiting compositionality gives better representational power and semantics



# Revolution of Depth



Courtesy: Kaiming He's Presentation [Deep Residual Learning for Image Recognition]

# Only Going to get Bigger and Better (Hopefully)



deepart.io



Google Deep Dream



Deep Fakes

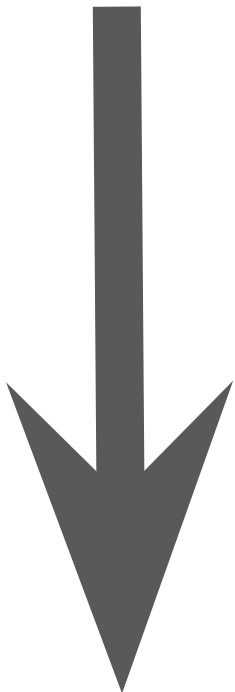
Creating video from AN image

<http://news.mit.edu/2016/creating-videos-of-the-future-1129>



# Increasing Complexity

Nouns,  
Images



Verbs,  
Context,  
Videos

- Image Classification / Object Recognition
  - What is this object / image?
- Object Localization
  - Where is this object?
- Object Detection
  - Classification + Localization of every instance of the object
- Semantic segmentation
- Face, Pose, Human Attributes
- Image captioning
- Action Recognition
- Visual Question Answering
- Suspicious Activity, Anomaly ....

# Motivation: Videos are everywhere!



THE VALUE OF A  
1-MINUTE VIDEO  
IS WORTH  
1.8 MILLION WORDS



*Dr. James McQuivey*



# Visual Data Explosion: Two Sided Coin



“Capture first, filter later” mentality

# Problem With Manual Surveillance



Limited attention  
span of humans



# Problem With Manual Surveillance



“A wealth of information  
creates a poverty of  
attention”

Herb Simon

Father of Artificial Intelligence

# Solutions

## Search in Videos

You know what you are looking for, but do not have the patience to sit through long videos!

## Summarize Videos

You do not know what you are looking for, but want to watch a 6 hours video in 6 minutes!

## Analyze Videos

For count of objects, people, motion information, compliance related analysis ...

# Video Analytics for Security & Surveillance

## Real-time Alerts

Email / Mobile / Audio  
/ Visual

“Alert me when a human enters a restricted area”

## Smart Search

for Entities / Color /  
Gender

“Show me all people wearing yellow shirt”

## Summarization

Watch hours in  
minutes!

“Show me a digest of whatever happened today”

## Analytics

Count of entities /  
Motion Analysis

“Show me the period of maximum motion”

**First-Aid Redefined**

# Video Analytics for Compliance / Monitoring

## Education

- Number of students in the class
- Is everybody wearing uniform?
- Has the class started on time?

## Healthcare

- Are the nurses visiting the patients?
- Is there somebody always at the help desk?
- Is there a congestion somewhere?

## Businesses

- How is the footfall?
- What kind of people come to our mall?  
Males? Females? Young? Old?
- Flow of motion in the mall?





# Surveillance Video Analytics for Security

# Smart Encoder Appliance

Live Feed

Past Feed

Statistics

Configuration

Smart Encoder

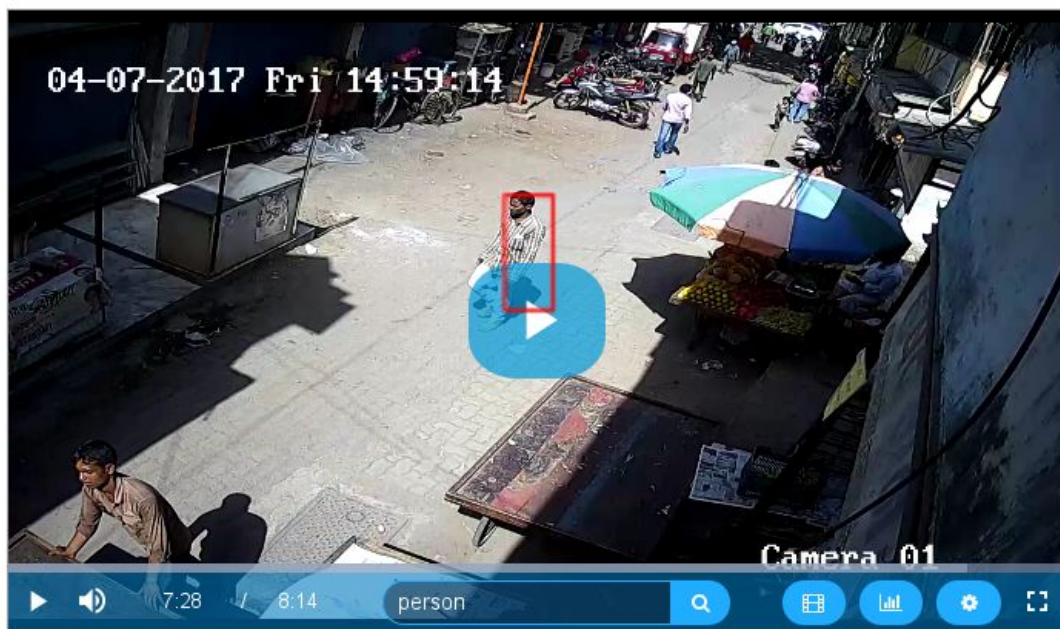
New View 2 ▾



18:03 | 10th Sept 2017



# Self Service Portal



Bg Sub Analytics

Background Subtraction Algo [MLBGS/MOG]

## All Uploads



Name: vid.mp4 2017-08-

23T16:18:35.000Z



Name: vid.mp4 2017-08-

23T15:50:09.000Z



Name: video\_7.mp4 2017-

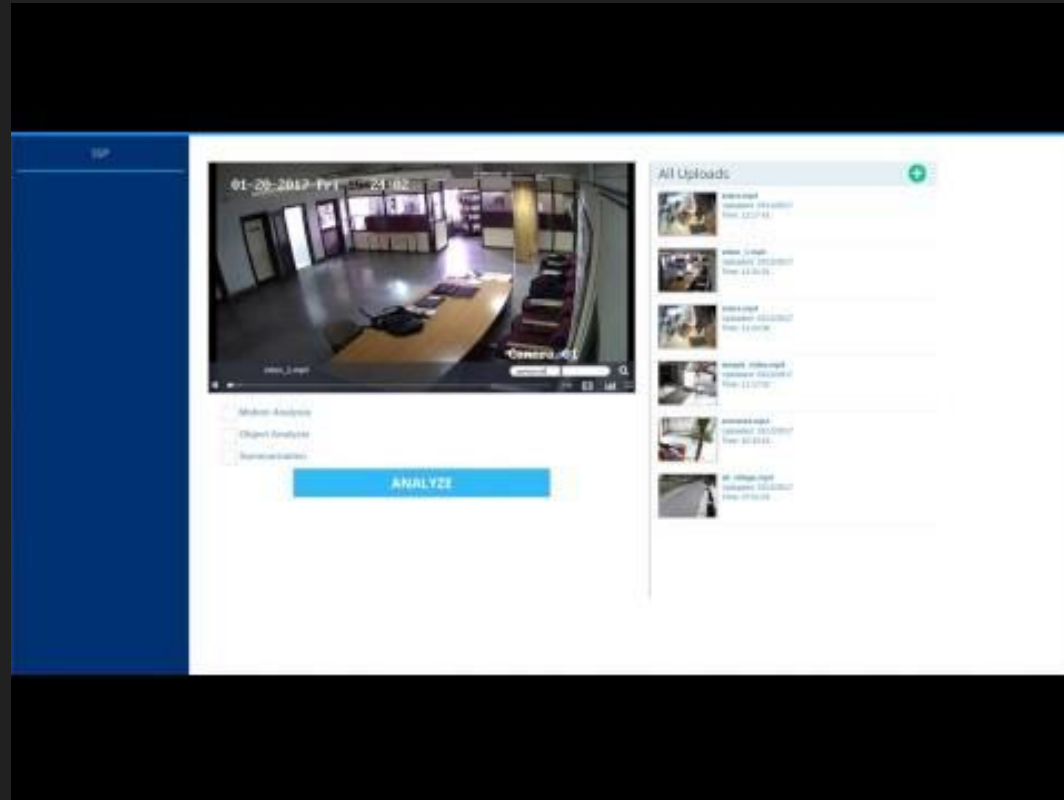
08-23T14:27:08.000Z



Name: Demo-2017-03-

24\_15.43.57.mp4 2017-08-22T06:03:30.000Z

# Smart Search Example: “person wearing blue”



The screenshot displays a software interface for video analysis. On the left, a blue sidebar contains a 'TOP' button. The main area features a video player showing a meeting room with a timestamp of '01-29-2017-Fri 11:24:02'. Below the video are three tabs: 'Motion Analysis', 'Object Analysis', and 'Sound Analysis'. A prominent blue 'ANALYZE' button is centered below these tabs. On the right, an 'All Uploads' section lists several video files with their respective thumbnails and timestamps.

Thumbnail	Filename	Timestamp
	video1.mp4	01-29-2017-Fri 11:27:14
	video1.mp4	01-29-2017-Fri 11:28:25
	video1.mp4	01-29-2017-Fri 11:28:36
	video1.mp4	01-29-2017-Fri 11:27:17
	video1.mp4	01-29-2017-Fri 11:27:17
	video1.mp4	01-29-2017-Fri 11:27:17

# Video Summarization

- Hours into minutes
- Enables quick analysis of stored footages
- Smarter than vanilla motion detection
- Give me a summary of yesterday's footages
- Current research: learn what is important for a domain

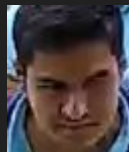




# Statistics Dashboard



# Suspect Identification




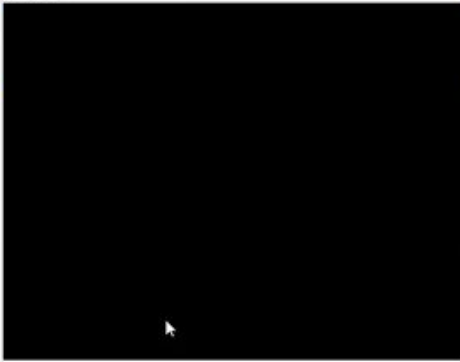




# Real-Time Alerts

Columns: 3  
Rows: 2  
Height: 356  
Width: 431

Add Layout  
Add All  
Remove All  
Clear Grid  
Hide Headers  
Show Headers  
Add Cam  
Rem Cam

Disable Human Detection when Cpu Usage rises above:  
 25  
 50  
 75

Please Configure pushbullet to receive pushbullet alerts.  
Configure Pushbullet

	A	B	C
1	<p>PlatWashing</p> 	<p>MainGate1</p> 	<p>MainGate2</p> <p>05-31-2016 Tue 12:35:14 Temple Courtyard</p> 
2	<p>OurWorkStation</p> <p>31-05-2016 Tue 12:42:26</p> 	<p>Shalgramroom</p> 	<p>CarpenterAndCooksTerrace</p> 

Surveillance Video  
Analytics for  
Compliance & Quality  
Monitoring



*Compliance and Quality Monitoring System*

admin

.....

LOGIN

# Overall Dashboard

The screenshot displays the 'Overall Dashboard' for DDU-GKY (Deen Dayal Upadhyaya Gramin Kaushalya Yojana) in a web browser. The browser's address bar shows the URL `localhost:4000/#/dashboard-overview`. The dashboard features a dark purple sidebar on the left with the DDU-GKY logo and the text 'Empowering India • Powering the World'. Below the logo, the sidebar lists 'Training Centers' with 'Maharashtra' selected and 'APOLLO' highlighted. The main content area shows a map of India with training centers marked by color-coded dots. A legend on the right indicates the status of the centers: Active (pink), Passive (green), and Inactive Center (yellow). The user is logged in as 'admin'.

Center Name	Status
APOLLO	Active
Maharashtra	Passive
Other Centers	Inactive Center



# SDC Dashboard

The screenshot displays the SDC Dashboard in a Google Chrome browser. The browser's address bar shows the URL `localhost:4000/#/dashboard`. The dashboard features a dark purple sidebar on the left with the DDU-GKY logo and navigation options for 'Training Centers', 'Maharashtra', and 'APOLLO'. The main content area is titled 'APOLLO Non Compliances' and includes a search filter for the date range '2018-04-02' to '2018-04-03'. Below the filter, five compliance metrics are shown in white boxes:

Metric	Percentage
Punctuality	80%
Attendance	90%
Instructor	75%
Dress Code	60%
Inactive	70%

# Punctuality Non Compliances

Application - Google Chrome

localhost:4000/#/punctuality

admin (admin)

APOLLO Non Compliances ([View report of all activities instead](#))

From: 2018-03-01 To: 2018-04-03 Search

Punctuality Non Compliances [Download Report](#)

Classroom	Activity	Date	Start Time	End Time	Actual Start Time	Actual End Time	% Conducted	Original Video	Summary Video
PA	PA-lab	03/04/2018	05:00 PM	06:30 PM	05:00 PM	06:30 PM	100%	<a href="#">view</a>	<a href="#">view</a>
GDA	GDA-Theory	03/04/2018	10:00 AM	12:00 PM	11:15 AM	12:00 PM	38%	<a href="#">view</a>	<a href="#">view</a>

# Apparel Recognition



- Detect unauthorized people
- Verify compliance
- ...

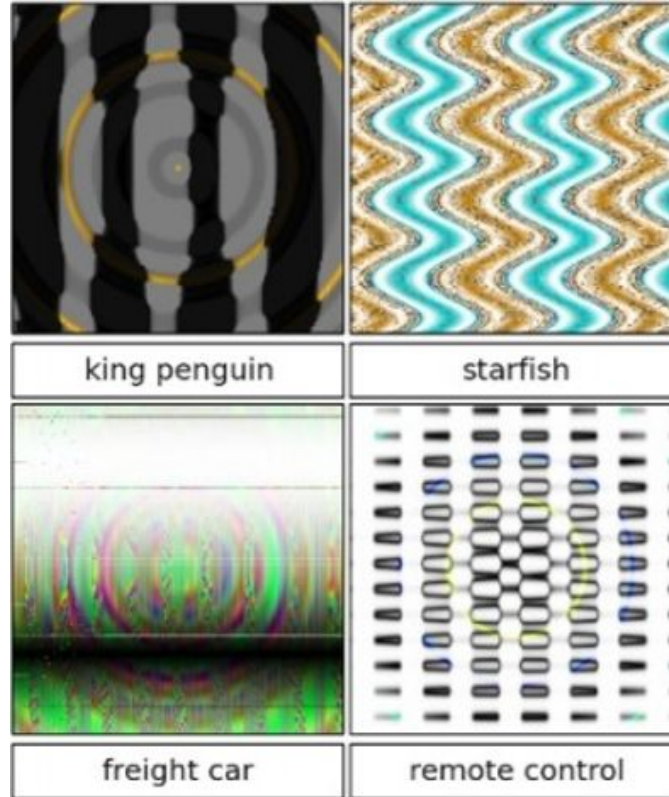
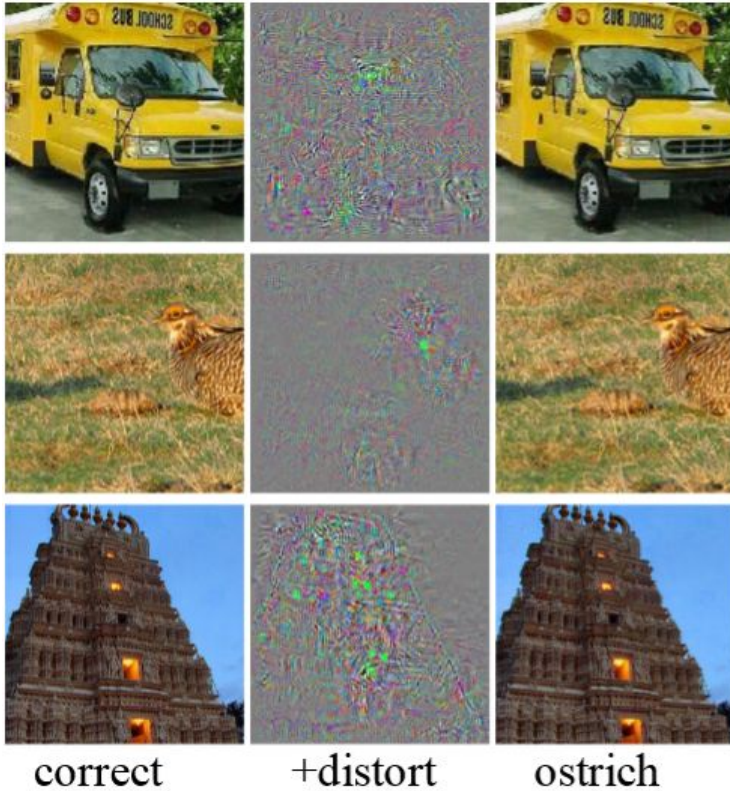
Miles to go before we sleep ...



*“Two pizzas  
sitting on top of  
a stove top  
oven”*

*“Two pizzas  
being heated  
on top of a  
stove top oven”*

# AI/ML/DL is NOT God / Magic / Black Art



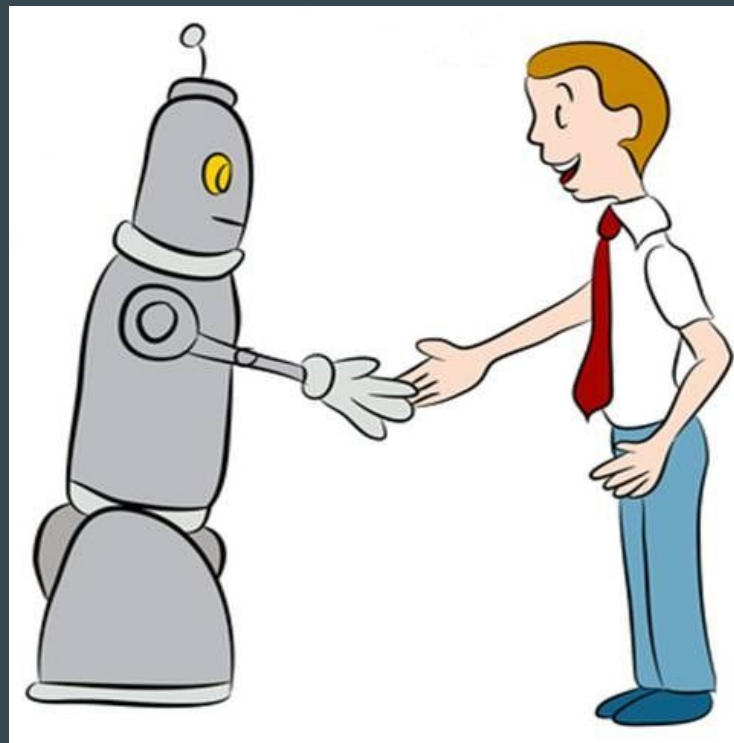
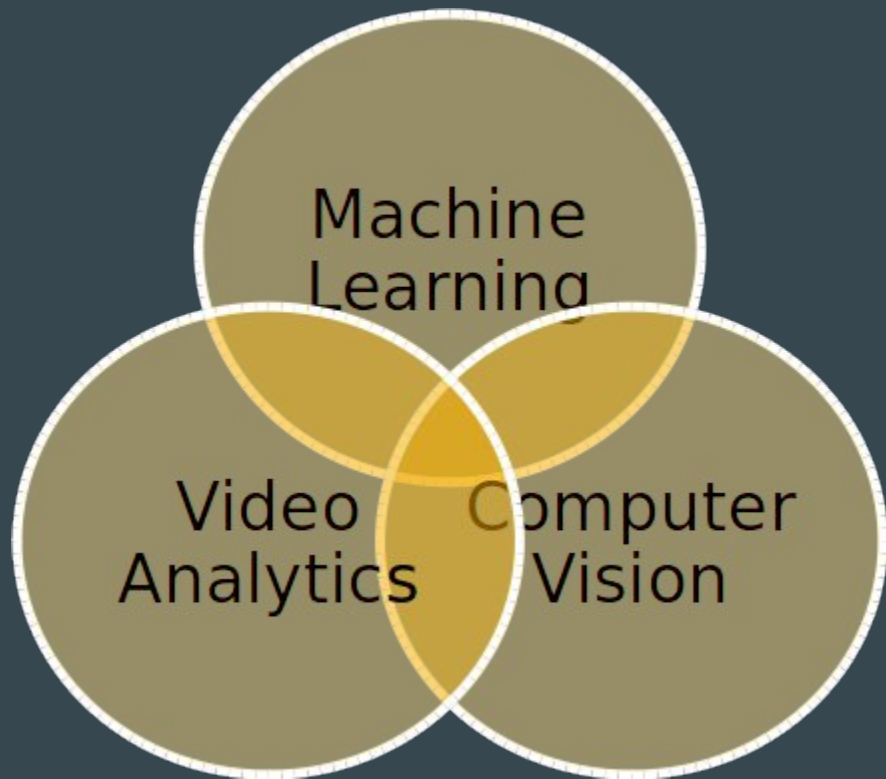
>99.6%  
confidences

[Intriguing properties of neural networks, Szegedy et al., 2013]

[Deep Neural Networks are Easily Fooled: High Confidence Predictions for Unrecognizable Images Nguyen, Yosinski, Clune, 2014]



# Our Vision: From Human to Machine Assisted Human





# Team / Credits

- Prof. Ganesh Ramakrishnan (Faculty, CSE, IITB)
- Dr. Rishabh Iyer (Alumnus)
- Vishal Kaushal (PhD Student, jointly supervised by both)
- AISIGHT Video Analytics Pvt. Ltd. (Collaborator)
- Some other students and interns

And of course, National Center of Excellence in Technology for Internal Security (NCETIS)

# Thank You

Vishal Kaushal  
Video Analytics Lab, CSE, IITB  
[www.vishalkaushal.in](http://www.vishalkaushal.in)