ANOMALY DETECTION IN VIDEO FEEDS

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INTRODUCTION

❖ Anomaly

- Unusual motion patterns of unusual objects in unusual locations

- **Objective:** Identify such **outliers** in video feeds using Machine Learning techniques

MOTIVATION

- Requirement to **process high volumes of data automatically**

USE CASES

1. Security
2. Health
3. Old-age home monitoring
4. Child Monitoring

CHALLENGES INVOLVED

1. **High Computational Complexity** : Have to deal with video feeds which may be several 100 GBs in size

2. **Online Detection of Anomalies :** May be required to detect anomalies in the videos in real time especially for surveillance tasks

3. **Anomaly is Context-Dependent** : Similar events and actions can be considered anomalous in some scenarios and regular in others

4. **Annotating extremely rare events** : Anomalies occur rarely making manually spotting and annotating them a tedious and diffucult task

DATASET

❖ UCSD Anomaly Detection Dataset [1]

- Stationary camera mounted at an elevation, overlooking pedestrian walkways

❖ Reasons for Anomaly

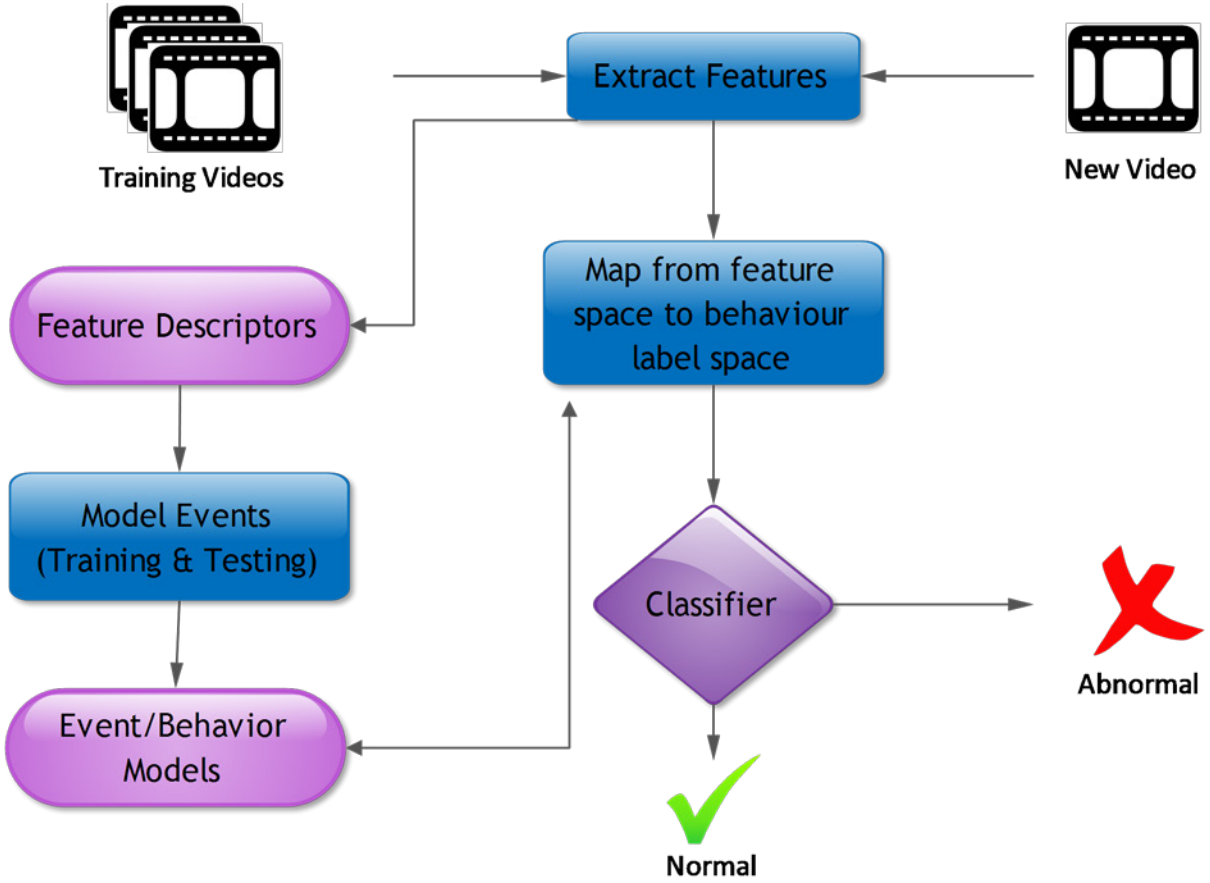
- Circulation of non-pedestrian entities in walkways
- Anomalous pedestrian motion patterns

❖ Dataset Composition

- **2 subsets** - Ped1 and Ped2
- **Ped1:** Contains **34 training** and **36 testing** videos
- **Ped2:** Contains **16 training** and **12 testing** videos
- 10 clips from Ped1 and 12 from Ped2 are provided with manually generated pixel level binary masks

[1] http://www.svcl.ucsd.edu/projects/anomaly/dataset.htm

GENERAL APPROACH



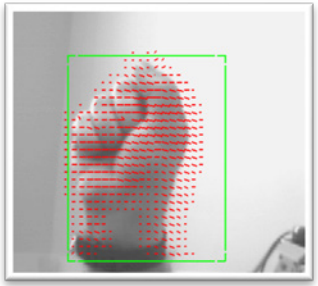
APPROACH 1: Using Optical Flow

- Feature Extraction

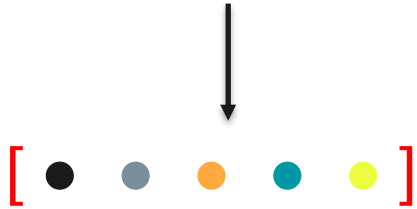
Video

Convert to Pixels and Frames

Background Subtraction



Optical Flow



Feature Vector

APPROACH 1: Using Optical Flow

- Classification using Decision Tree

APPROACH	PED1			PED2		
	F1-Score	ROC	EER	F1-Score	ROC	EER
Optical Flow (Threshold = 10)	0.57	71.55%	36.23%	0.25	57.88%	45.71%
Optical Flow (Threshold = 50)	0.64	78.15%	30.03%	0.29	59.76%	44.58%

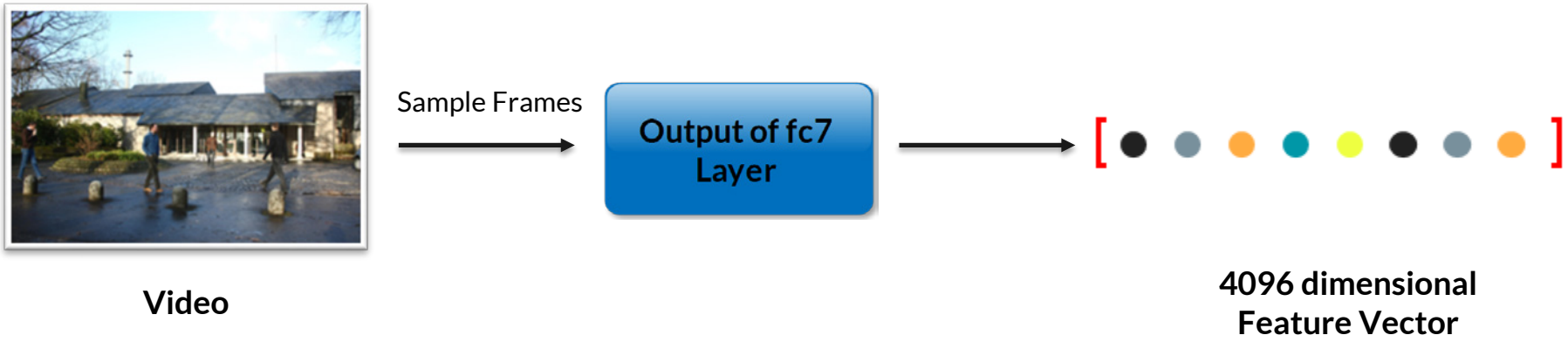
APPROACH 2: Feature Extraction using AlexNet

❖ **AlexNet**

- Object Classification using deep neural networks

❖ **BVLC Reference Caffenet**

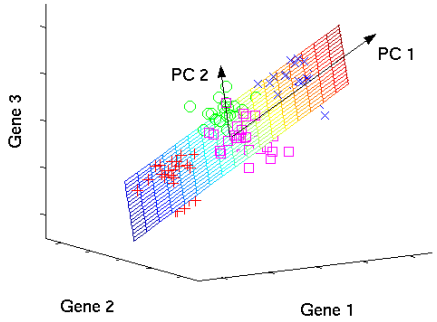
- Pre-trained AlexNet on the 1.2M image ILSVRC-2012 dataset



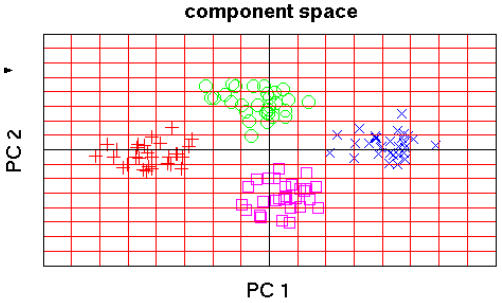
APPROACH 2: Feature Extraction using AlexNet

APPROACH	PED1		
	F1-Score	ROC	EER
AlexNet	0.39	58.05%	45.08%
Optical Flow (Threshold = 50)	0.64	78.15%	30.03%

APPROACH 3: Time Series Analysis



PCA



Time Series Analysis over each dimension

[ ]

1 2 3 4 ..... No. of frames

4096 dimensional feature space for each frame

Dimensionality Reduction (300)

No. of dimensions Anomalous in each frame

ANOMALY

>= threshold

No. of dimensions with anomaly ?

< threshold

Normal

- **Seasonal Hybrid ESD (S-H-ESD):**
- Employing time series decomposition and using median along with ESD

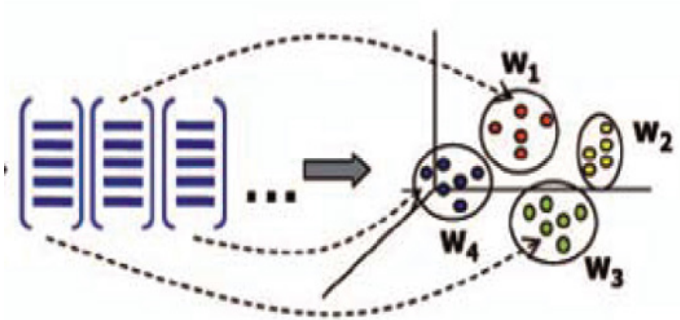
F1-Score: 0.64

APPROACH 4: Utilizing Topic Models

Set of Video Frames

Represented as

Bag of Words



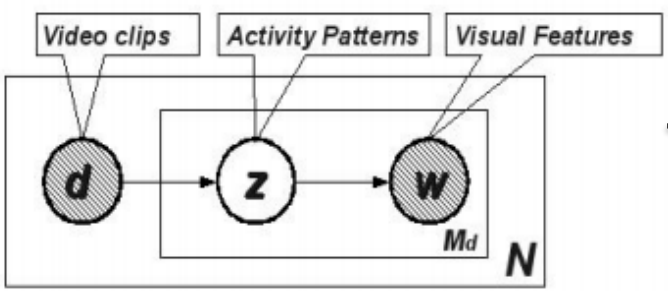
Cluster using K-Means

Extract

Cluster Centers

Cluster Centers as Words

APPROACH 4: Utilizing Topic Models

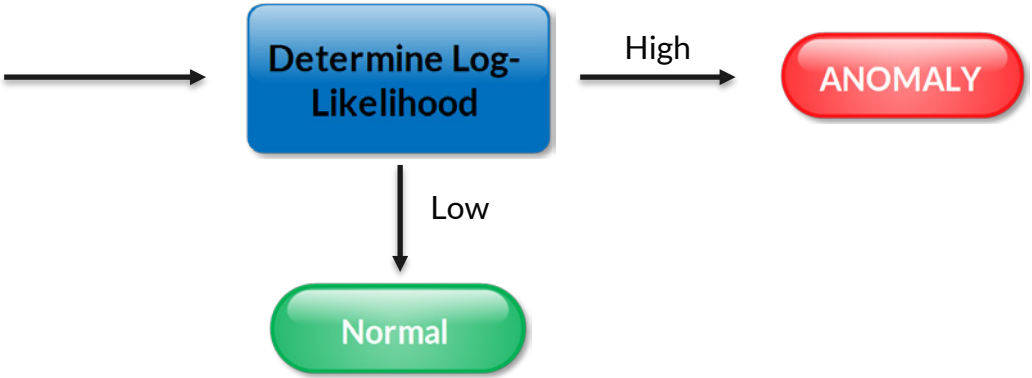


pLSA over set of frames

$$L_d^{nl}(P(z|d)) = \sum_w \frac{\mathrm{n}(d,w)}{\mathrm{n}_d} \log \sum_z P(z|d)P(w|z)$$
$$= \sum_w P_o(w|d) \log P_c(w|d)$$

Find Normalized log-likelihood

Test Frame



Evaluation

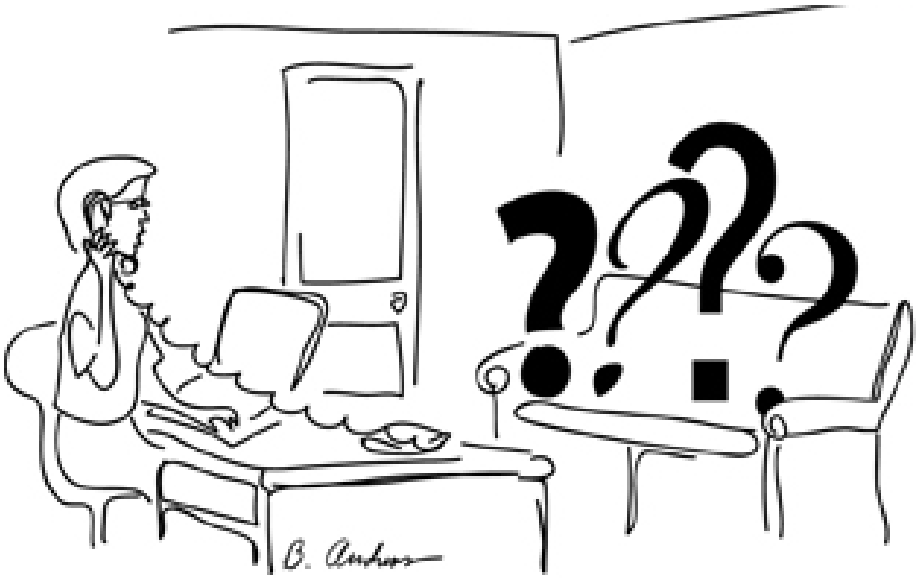
APPROACH	PED1			PED2		
	F1-Score	ROC	EER			
AlexNet	0.39	58.05%	45.08%			
Optical Flow (Threshold = 50)	0.64	78.15%	30.03%	0.29	59.76%	44.58%

Algorithm	Ped1(frame)		Ped1(pixel)		Ped2	
	EER	AUC	EER	AUC	EER	AUC
MPPCA	40%	59.0%	81%	20.5%	30%	69.3%
Social force	31%	67.5%	79%	19.7%	42%	55.6%
Social force+MPPCA	32%	66.8%	71%	21.3%	36%	61.3%
Sparse reconstruction	19%	–	54%	45.3%	–	–
Mixture dynamic texture	25%	81.8%	58%	44.1%	25%	82.9%
Local Statistical Aggregates	16%	92.7%	–	–	–	–
Detection at 150 FPS	15%	91.8%	43%	63.8%	–	–

Conclusion

- Explored 4 abstractive summarization approaches:
  - **Extractive Summarization** followed by **Seq2Seq Model**
  - Utilizing **Paragraph Embeddings**
- **LSTMs have potential** to work for long documents but **require more computational power**

THANK YOU !



"Ms. Jones, there are a number of big questions here to see you. They say they won't leave until they have some answers."