

Vehicle Detection for Cities

Machine Learning for Cities

By

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PROJECT GOAL

- › Can we track the vehicle flows in real-time using traffic camera feeds?



Source: NYC DOT

- › Possible Uses:
 - › Detecting and Tracking Congestions in real-time
 - › Efficient Traffic Planning and Management



APPROACH

- › **Shallow Learning Techniques:**

- 1) Using HOG Features and applying an SVM Classifier
- 2) Using HAAR Features and applying a Cascade Classifier (In this presentation)

- › **Deep Learning Techniques:**

- › Convolutional Neural Networks
- › R-CNN



HAAR – CASCADE CLASSIFIER

HAAR-like Features

Type 1



Type 2



Type 3



Type 4



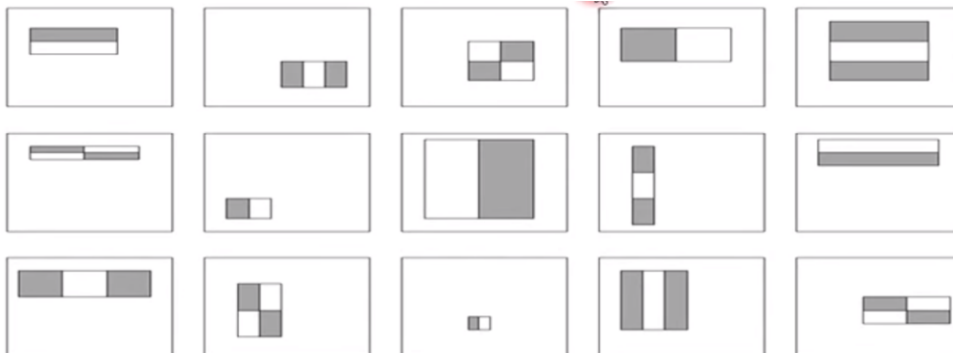
Type 5



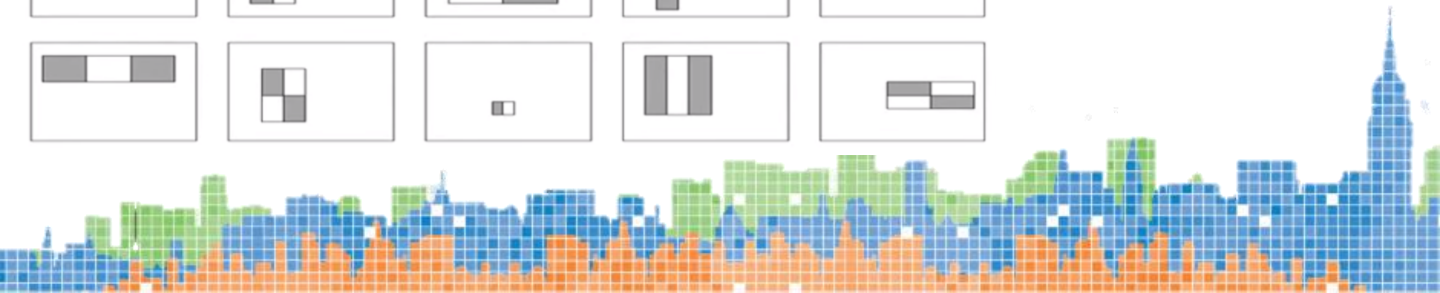
Haar Features used in Viola Jones



Applying on a given image



**16,000 + features in a
24x24 pixel window**



HAAR – CASCADE CLASSIFIER

Adaboost Classifier



- Only few set of features useful among 16,000 plus features.
- That's why, We have Adaboost.
- weighted combination of all features, each features is called a weak Classifier

$$F(x) = \alpha_1 f_1(x) + \alpha_2 f_2(x) + \alpha_3 f_3(x) + \dots$$

Strong classifier

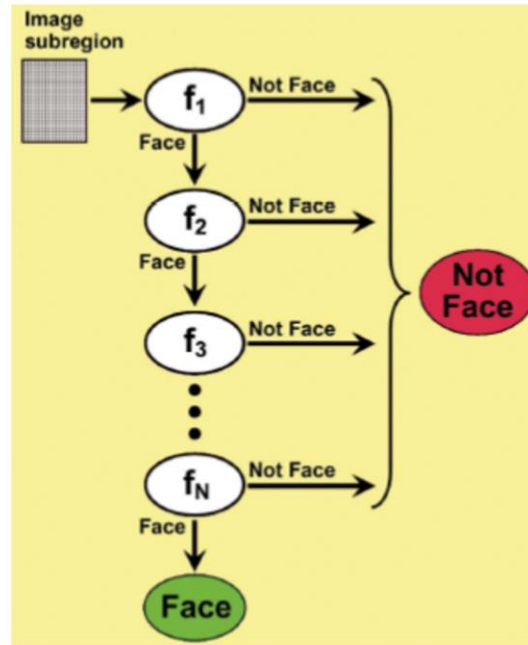
Weak classifier

Disadvantage: High Computation Cost



HAAR – CASCADE CLASSIFIER

Cascading



Source: <http://bit.ly/2nH5gwC>

HAAR – CASCADE CLASSIFIER

Training Function

```
opencv_traincascade -data data -vec positives.vec  
-bg bg.txt -numPos 1200 -numNeg 600 -numStages 10  
-w 20 -h 20
```

boostType: GAB => Gentle AdaBoost

featureType: HAAR

mode: BASIC => Upright rectangle Haar-like features

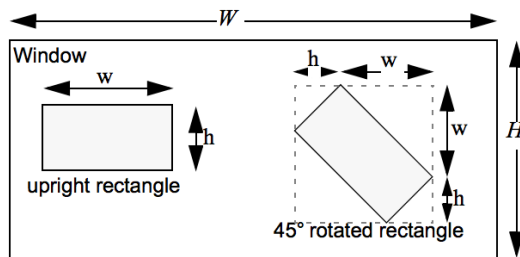


Image Source: Rainer Lienhart, Alexander Kuranov, Vadim Pisarevsky, *Empirical Analysis of Detection Cascades of Boosted Classifiers for Rapid Object Detection* Intel Corporation.

HAAR – CASCADE CLASSIFIER

Results

```
===== TRAINING 1-stage =====
<BEGIN
POS count : consumed   1380 : 1384
NEG count : acceptanceRatio   900 : 0.347222
Precalculation time: 6
+-----+
| N | HR | FA |
+-----+
| 1 | 1 | 1 |
+-----+
| 2 | 1 | 1 |
+-----+
| 3 | 1 | 1 |
+-----+
| 4 | 0.998551 | 0.593333 |
+-----+
| 5 | 0.995652 | 0.258889 |
+-----+
END>
Training until now has taken 0 days 0 hours 0 minutes 56 seconds.

===== TRAINING 2-stage =====
<BEGIN
POS count : consumed   1380 : 1390
NEG count : acceptanceRatio   900 : 0.0803715
Precalculation time: 5
+-----+
| N | HR | FA |
+-----+
| 1 | 1 | 1 |
+-----+
| 2 | 1 | 1 |
+-----+
| 3 | 0.995652 | 0.788889 |
+-----+
| 4 | 0.995652 | 0.788889 |
+-----+
| 5 | 0.998551 | 0.634444 |
+-----+
| 6 | 0.995652 | 0.603333 |
+-----+
| 7 | 0.995652 | 0.41 |
+-----+
END>
Training until now has taken 0 days 0 hours 1 minutes 31 seconds.
```

- N = Current feature for this cascade.
- HR = Hit Rate based on the Stage Threshold (hit rate/numPos)
- FA = False Alarm based on the Stage Threshold (false alarm rate / numNeg)

Stage Threshold = Value set to achieve accuracy of at least 50% in identification of positive vehicle images.

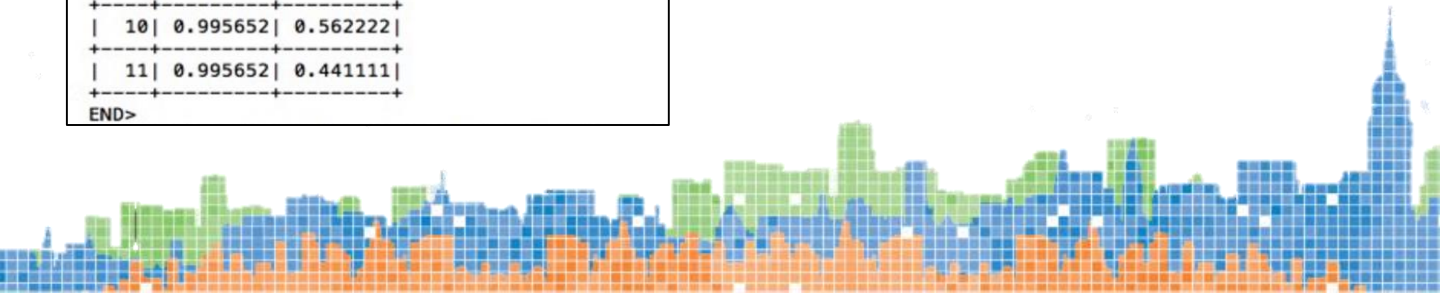
HAAR – CASCADE CLASSIFIER

Results

```
===== TRAINING 6-stage =====  
<BEGIN  
POS count : consumed    1380 : 1414  
NEG count : acceptanceRatio    900 : 0.00320153  
Precalculation time: 6  
+-----+  
| N |      HR |      FA |  
+-----+  
| 1 |      1 |      1 |  
+-----+  
| 2 |      1 |      1 |  
+-----+  
| 3 | 0.998551 | 0.797778 |  
+-----+  
| 4 | 0.998551 | 0.797778 |  
+-----+  
| 5 | 0.996377 | 0.718889 |  
+-----+  
| 6 | 0.996377 | 0.627778 |  
+-----+  
| 7 | 0.995652 | 0.582222 |  
+-----+  
| 8 | 0.995652 | 0.627778 |  
+-----+  
| 9 | 0.995652 |    0.55 |  
+-----+  
| 10 | 0.995652 | 0.562222 |  
+-----+  
| 11 | 0.995652 | 0.441111 |  
+-----+  
END>
```

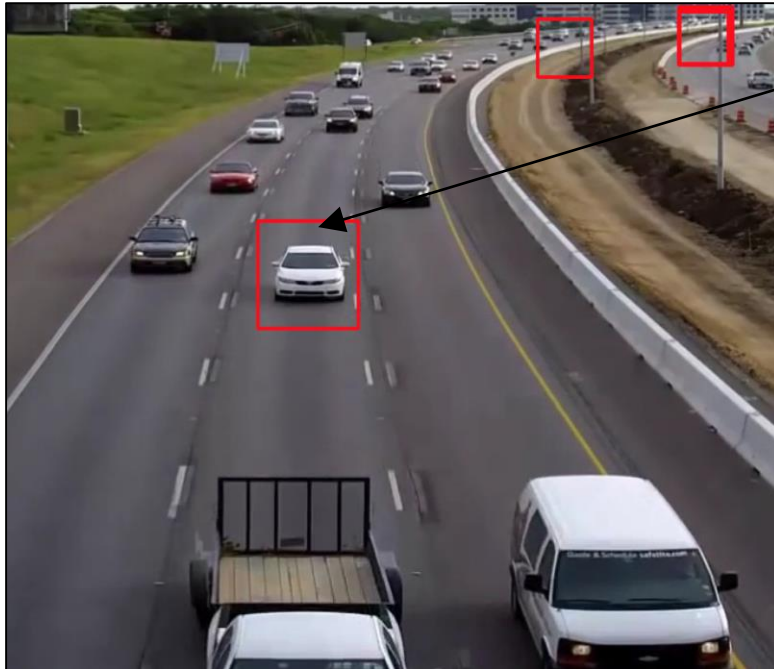
Training the Classifier - Stage 6

- Acceptance Ratio improves for each subsequent training stage.
- Acceptance Ratio value for -
Stage 1 = 0.35
Stage 2 = 0.08
and Stage 6 = 0.0032



HAAR – CASCADE CLASSIFIER

Results

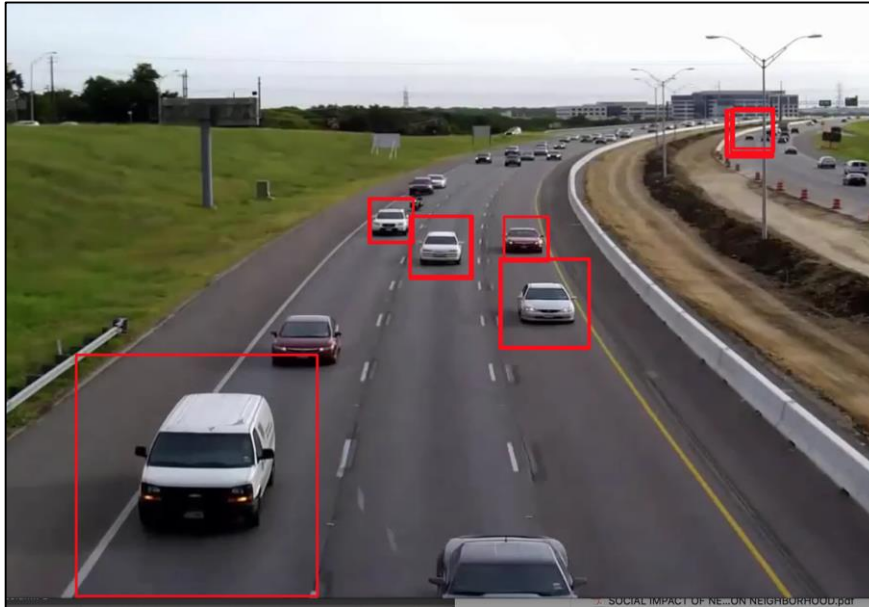


Vehicle used
to train the
classifier



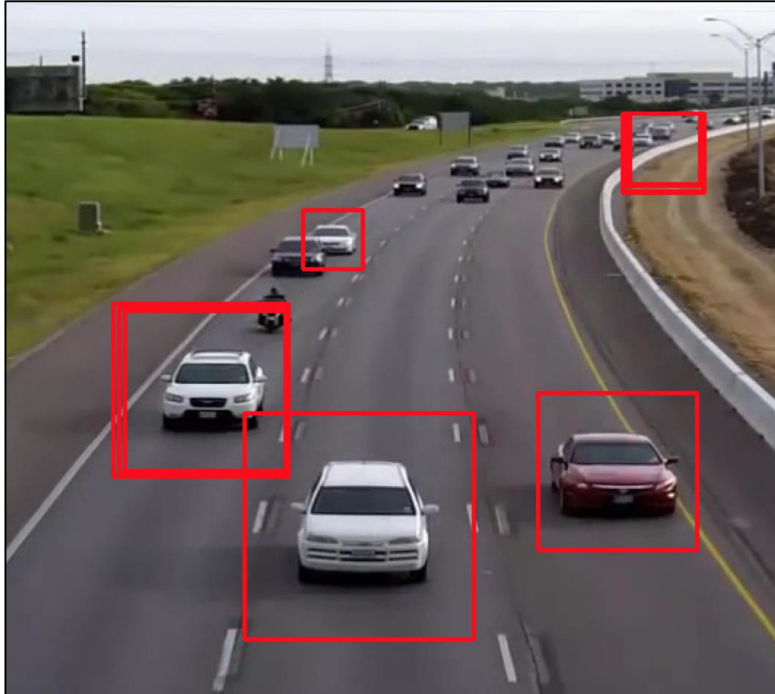
HAAR – CASCADE CLASSIFIER

Results



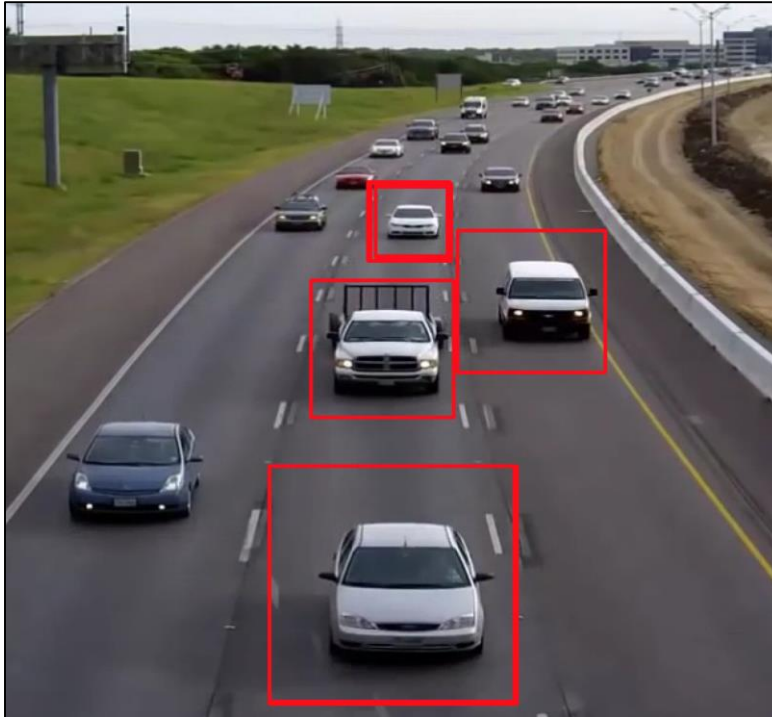
HAAR – CASCADE CLASSIFIER

Results



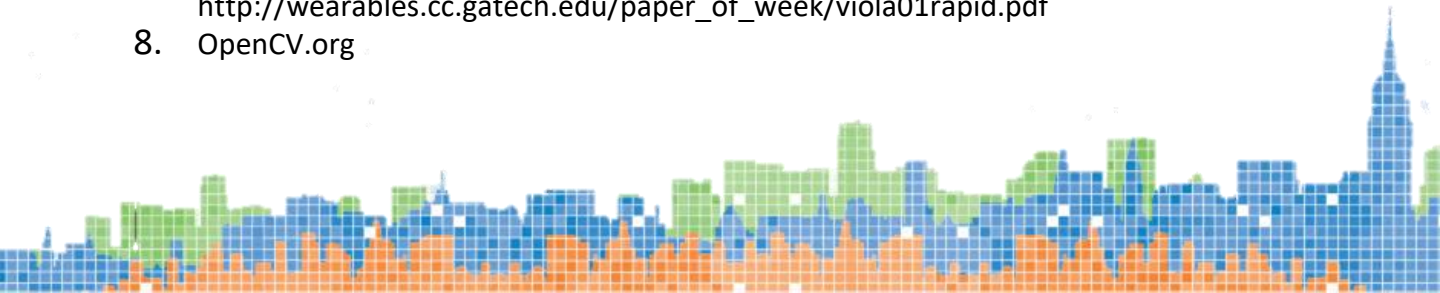
HAAR – CASCADE CLASSIFIER

Results



REFERENCES/ACK

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2. Rainer Lienhart, Alexander Kuranov, Vadim Pisarevsky Microprocessor Research Lab, 2003, Intel Labs Intel Corporation, Empirical Analysis of Detection Cascades of Boosted Classifiers for Rapid Object Detection: <http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.139.4825>
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5. Haiming Gang, NYU Industrial Engineering Graduate Student, Mechatronics Major
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7. Paul Viola, Microsoft Research, Michael J. Jones, Mitsubishi Electric Research Laboratory, 2001, Rapid Object Detection using a Boosted Cascade of Simple Features: http://wearables.cc.gatech.edu/paper_of_week/viola01rapid.pdf
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THANK YOU

