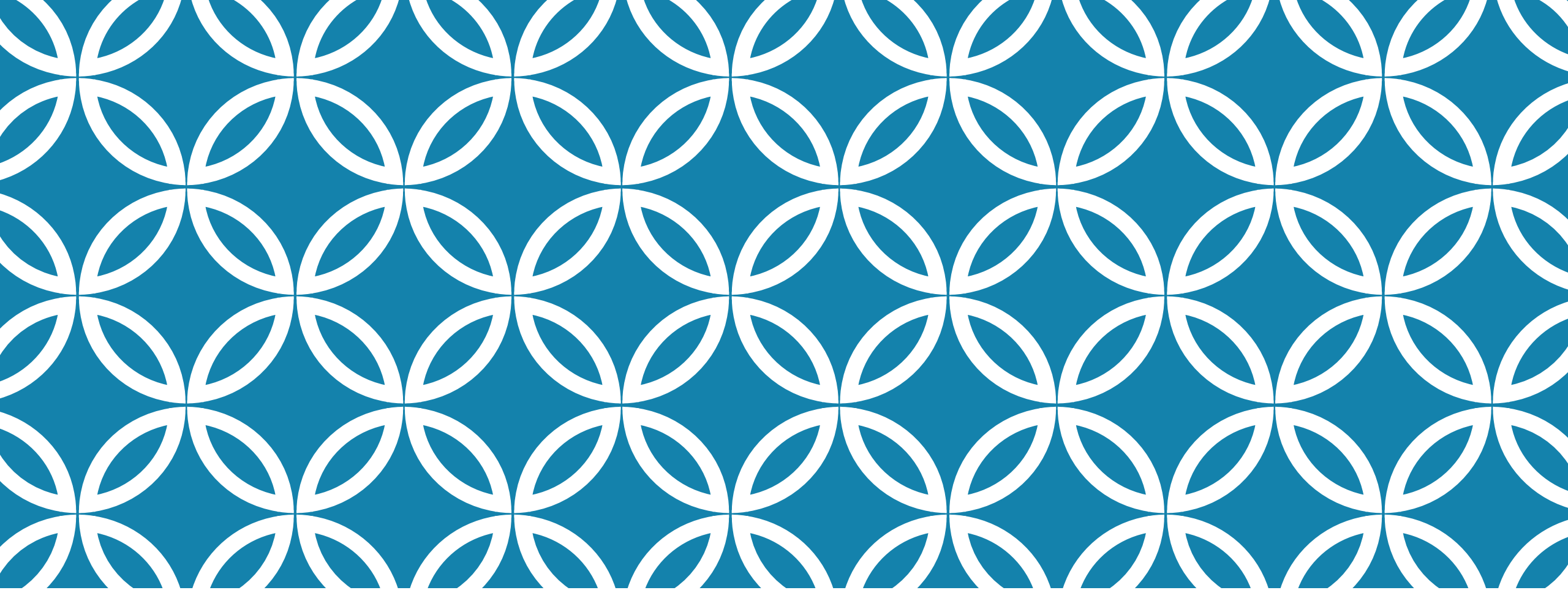


OBJECT DETECTION USING HAAR CASCADE

CS512 Computer Vision
Lin Zhuo
Cvn Prajwal

BACKGROUND

Objective: detection of self-defined object

Traditional object detection:

Background & Foreground segmentation

Geometric properties (size, shape, position, etc. of the object)

Drawbacks:

Uncontrollable and unexpected interferences from external environment

-Shifted light and shadows

-Interrupt of smoke, rain or the other layers

-…

Research paper: Fares Jalled et al., Object Detection Using Image Processing

HAAR-LIKE FEATURES

Similar to convolution kernels

$f_0(x) = A$

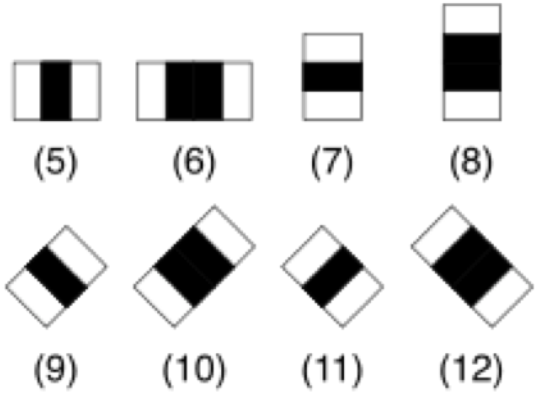
$f_3(x) = f_4(x) = B - A - C$

$f_1(x) = f_2(x) = B - A$

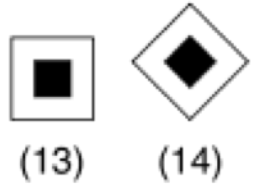
$f_5(x) = B + C - A - D$

Edge Features

Line Features



Center-surround Features



THE VOILA JONES FRAMEWORK

Problem: huge number of Haar cascade features in the window.

Integral Image

$$ii(x,y) = \Sigma_{x'<=x;y'<=y} i(x',y')$$

$$\Sigma_{(x,y)\in ABCD} i(x,y) = ii(D) - ii(B) - ii(C) + ii(A)$$

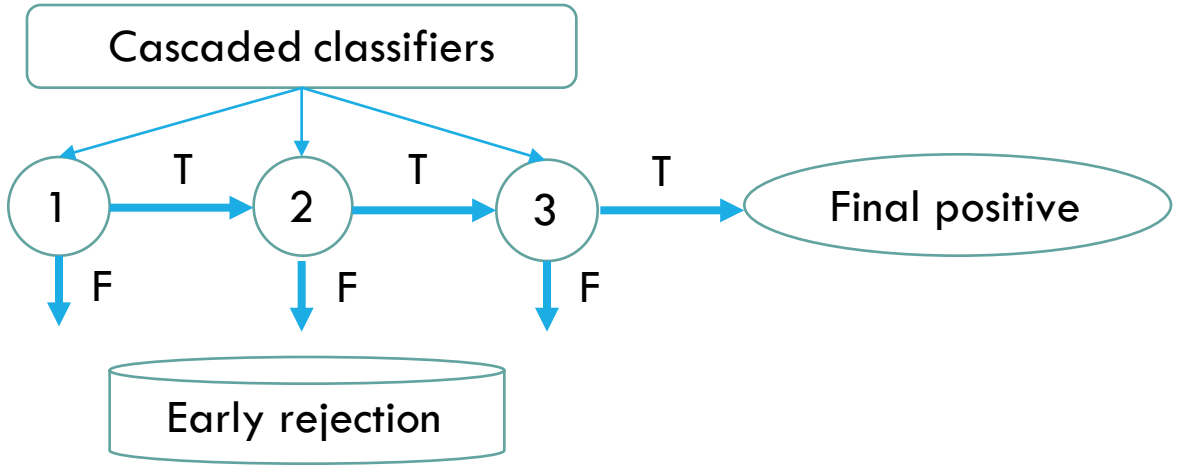
Compute the Haar feature in O(1) time.

Adaboost

$$F(x) = \alpha_1 f_1(x) + \alpha_2 f_2(x) + \ldots + \alpha_n f_n(x)$$

Combines the weak classifiers.

Cascading



SAMPLES

2414 negative samples (100 x 100)


1.jpg


4.jpg


5.jpg


6.jpg


7.jpg


10.jpg


12.jpg


13.jpg


16.jpg


17.jpg


22.jpg


23.jpg


24.jpg


27.jpg


29.jpg


33.jpg


34.jpg


36.jpg


37.jpg


38.jpg

1 “real” positive sample (50 x 50)


hand.jpg


phone.jpg


watch.jpg


Scale, rotation, translation

2414 artificial positive samples

TRAINING

10-15 stages of strong cascade classifiers have been trained.

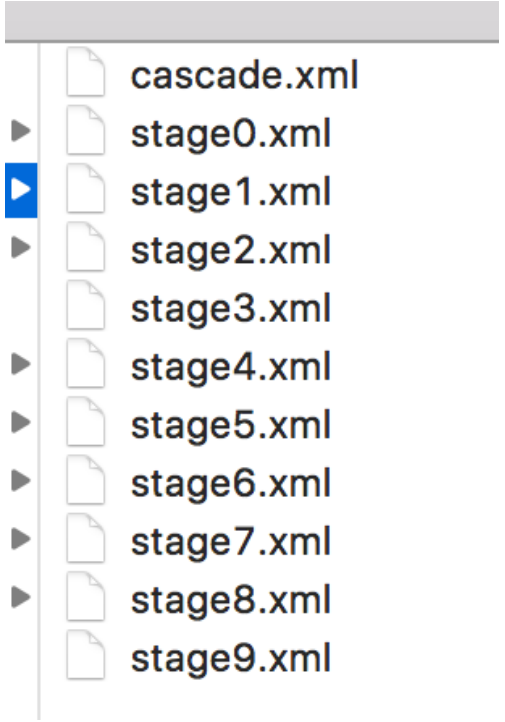
```
Precalculation time: 7
+----+---------+---------+
|  N |    HR   |    FA   |
+----+---------+---------+
|   1|        1|        1|
+----+---------+---------+
|   2|        1|        1|
+----+---------+---------+
|   3|        1|        1|
+----+---------+---------+
|   4|        1| 0.998889|
+----+---------+---------+
... ... ...
+----+---------+---------+
|  96| 0.995556| 0.697778|
+----+---------+---------+
|  97| 0.995556|     0.67|
+----+---------+---------+
|  98| 0.995556| 0.633333|
+----+---------+---------+
|  99| 0.995556| 0.652222|
+----+---------+---------+
| 100| 0.995556|     0.63|
+----+---------+---------+
```

Hit ratio

Each stage must validate all objects

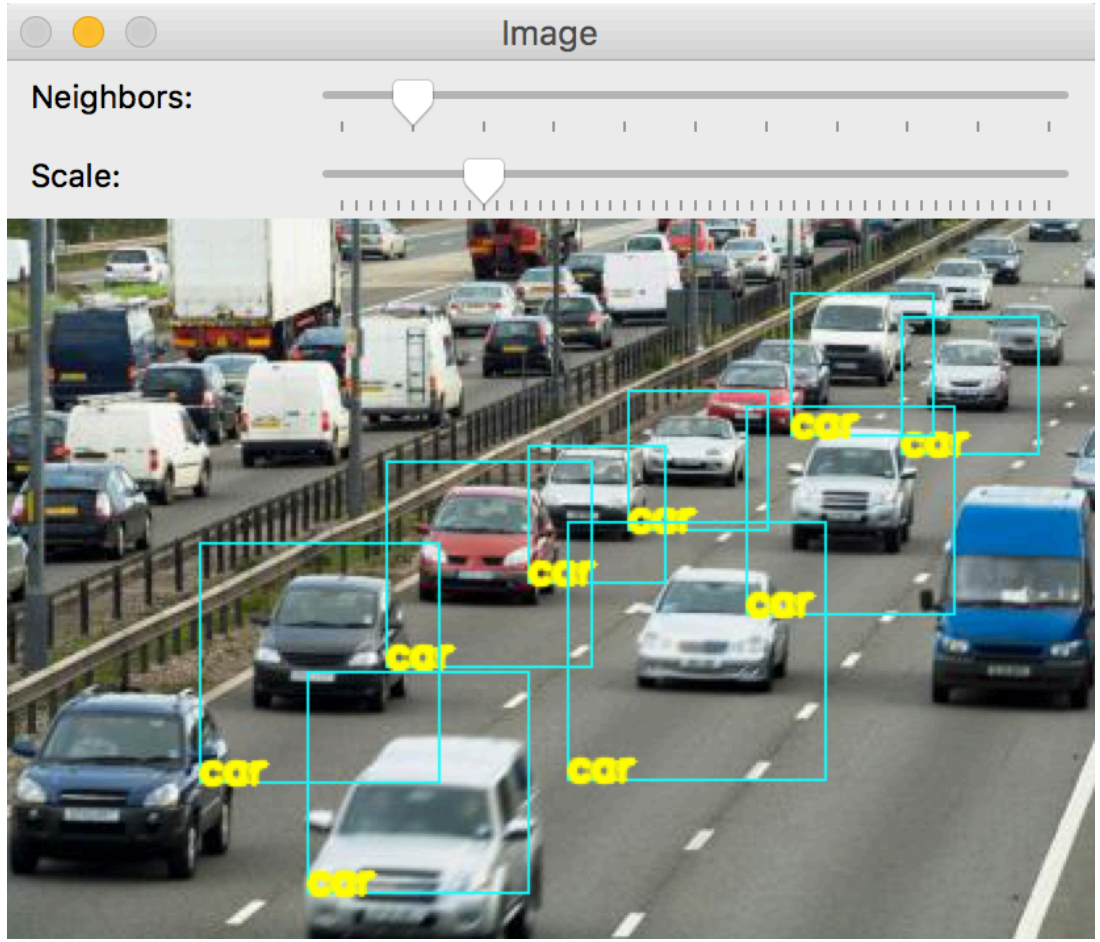
False alarm ratio

Also produces many false positives

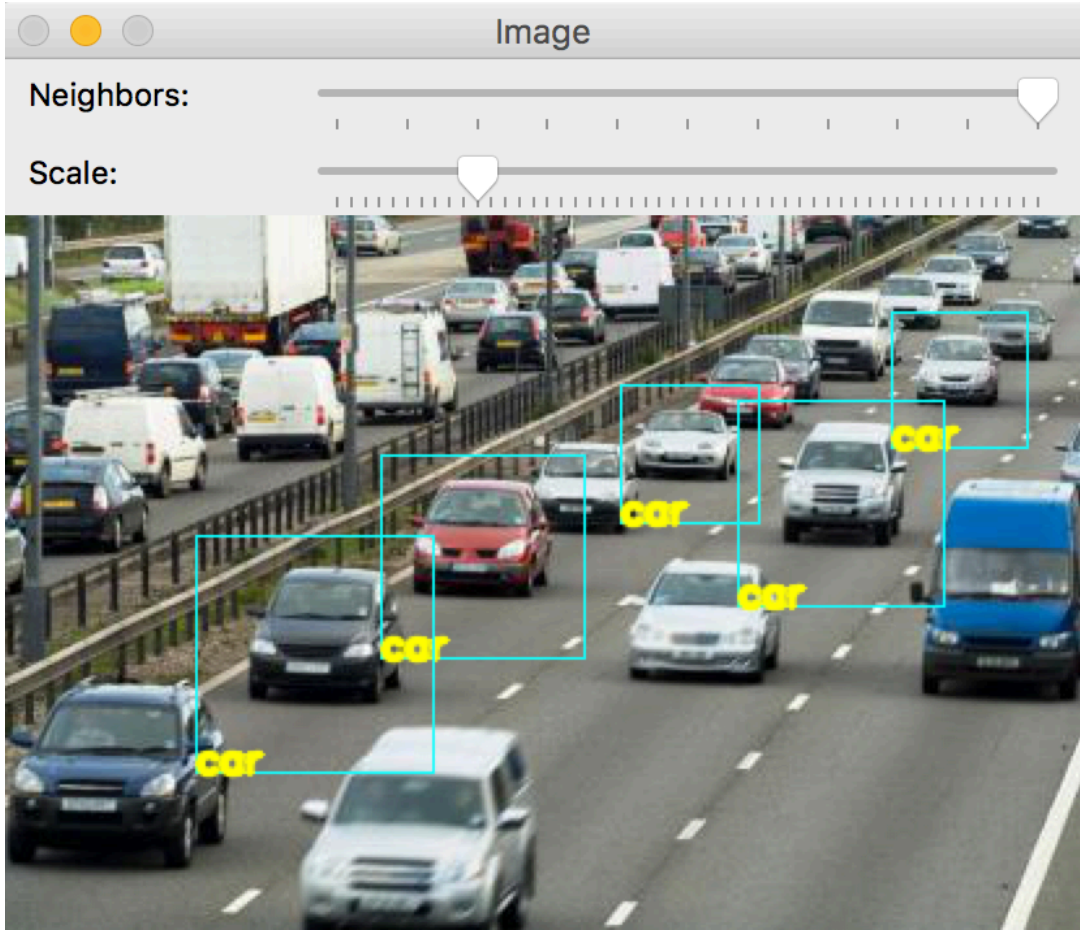


Haar cascade classifiers

PROGRAM

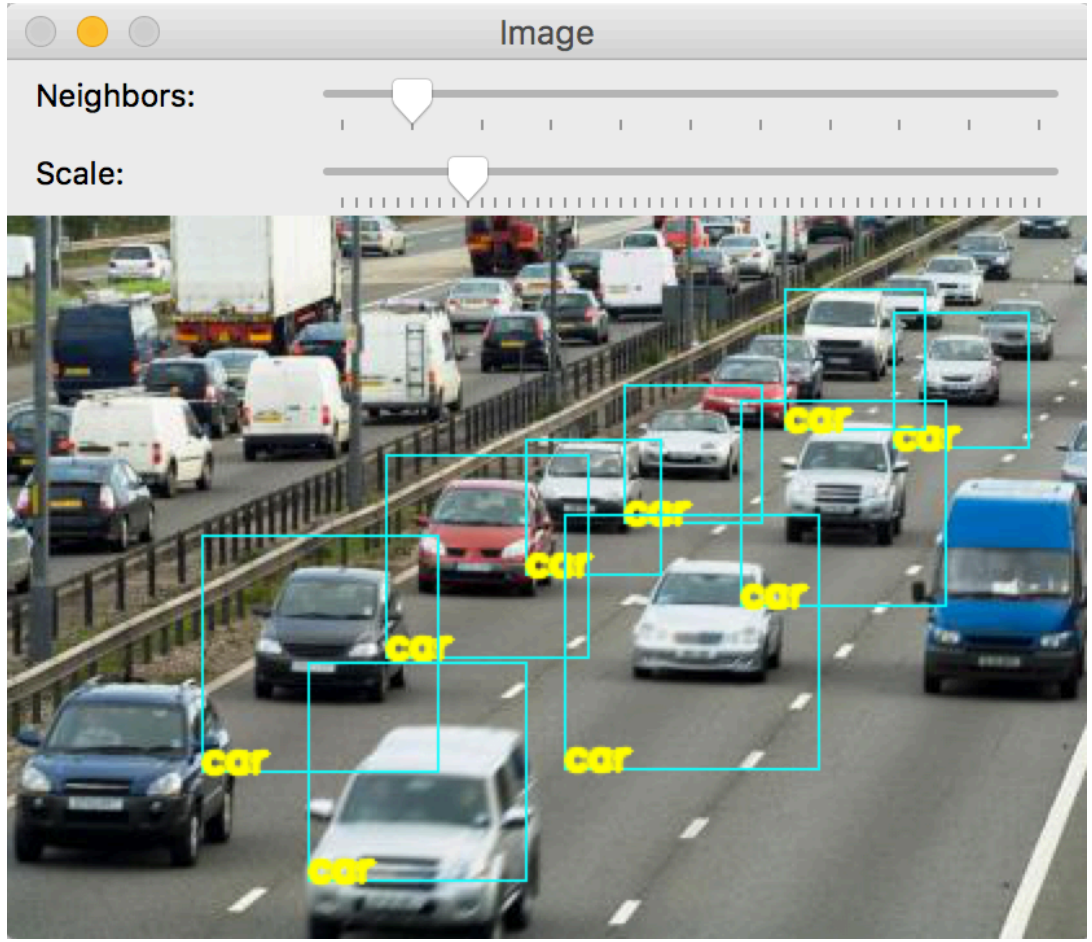


minNeighbors = 1, scale = 1.1

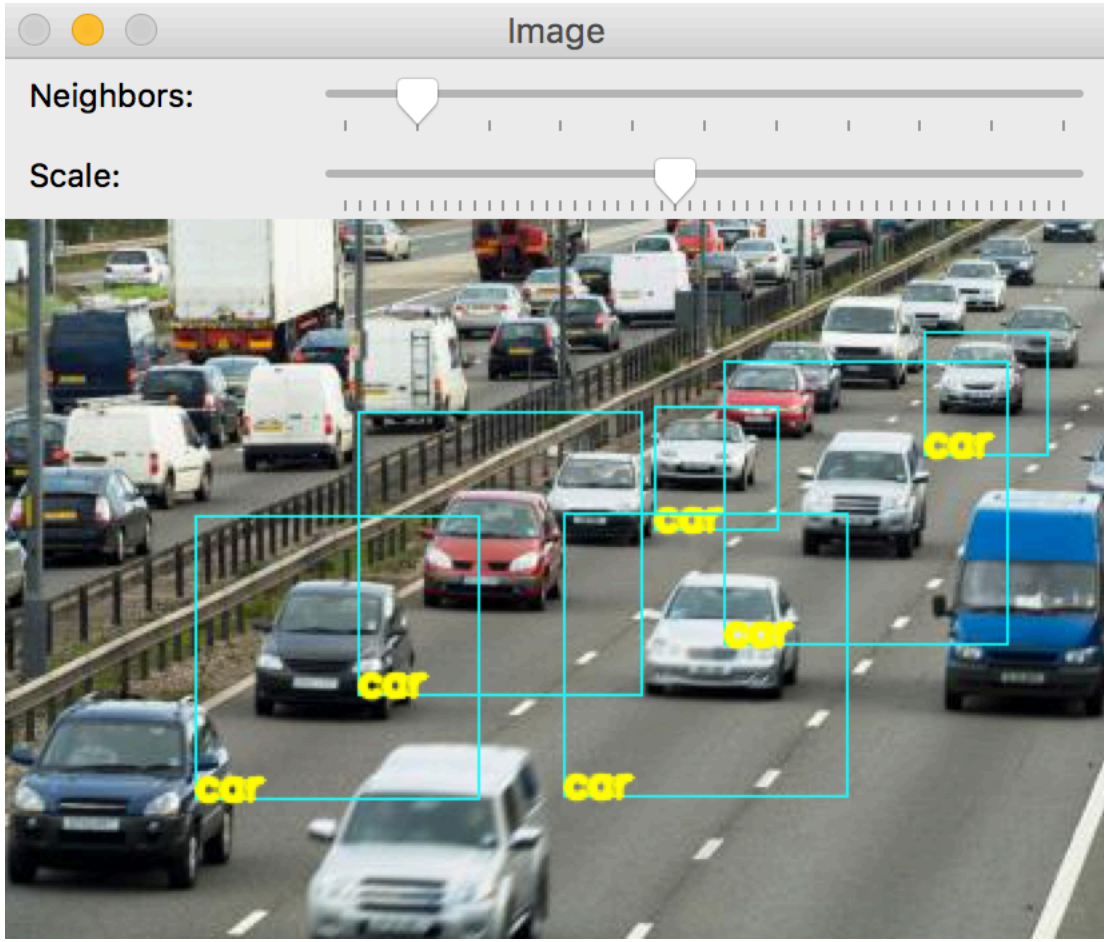


minNeighbors = 1, scale = 3.0

PROGRAM

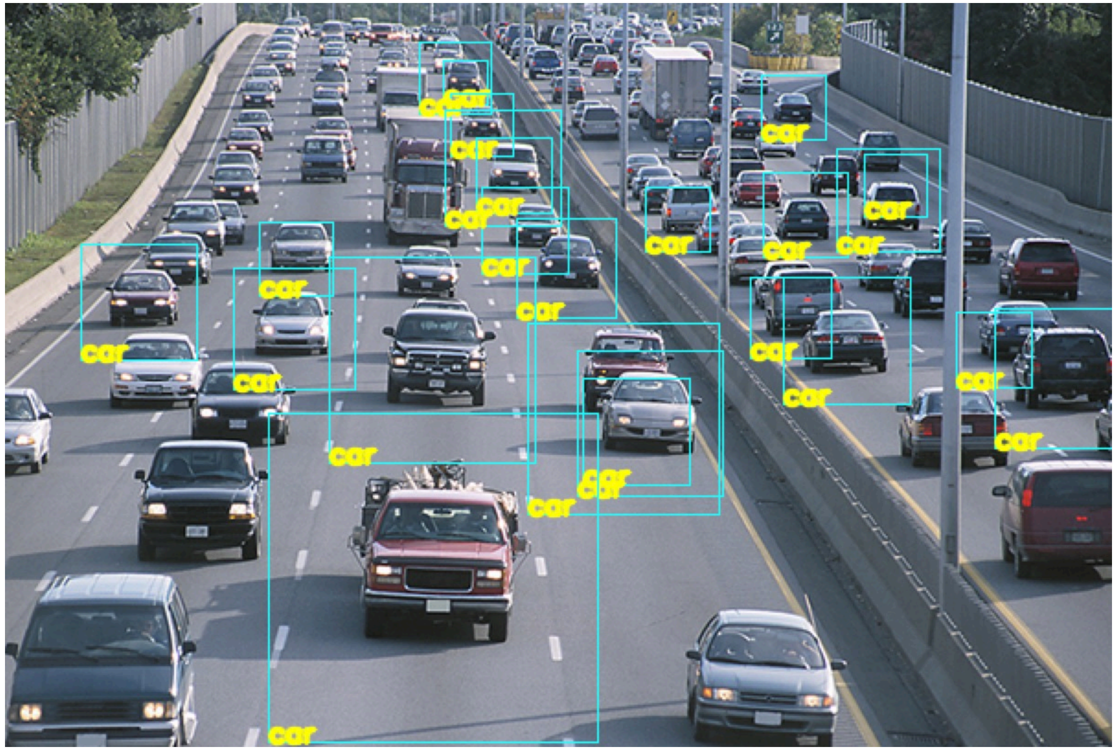


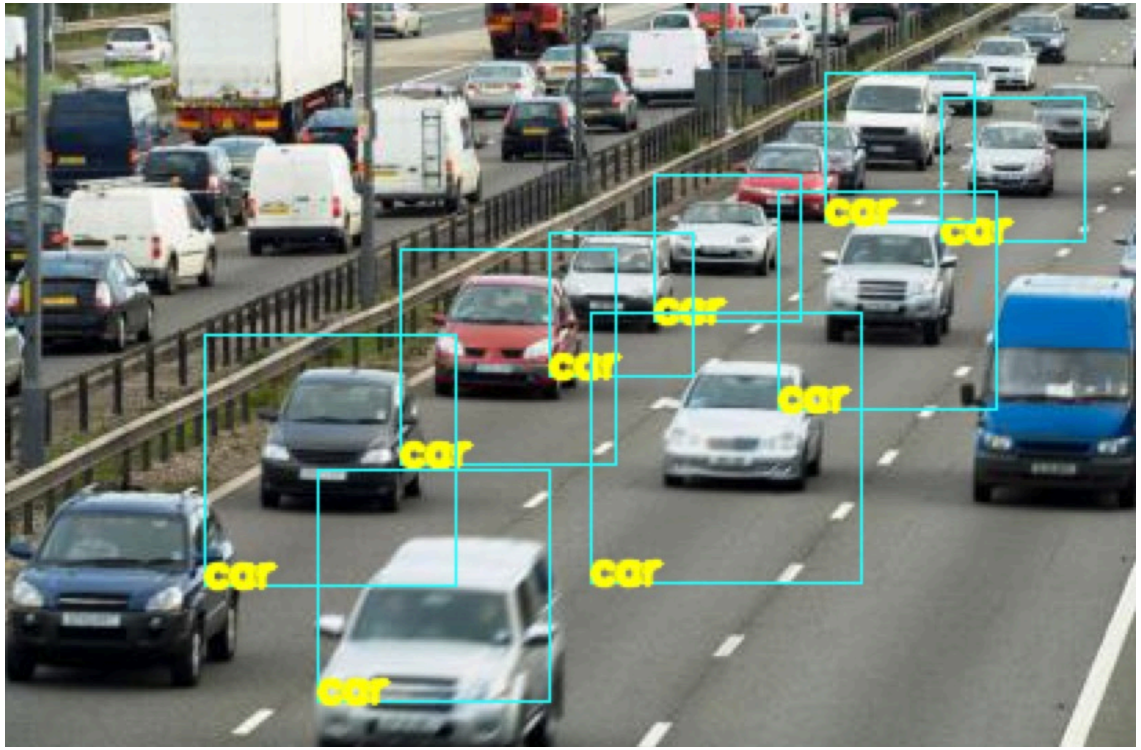
minNeighbors = 1, scale = 1.1



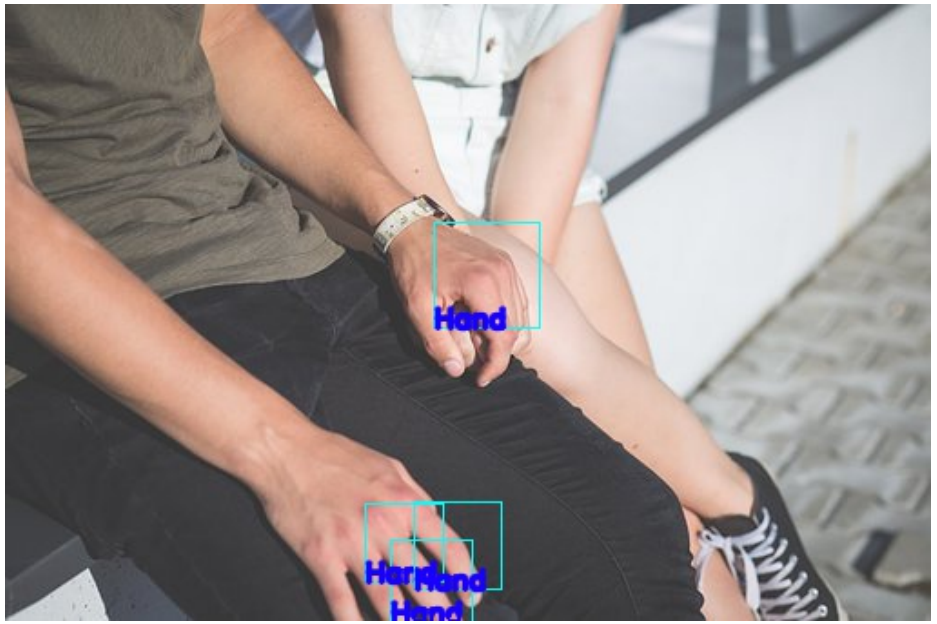
minNeighbors = 10, scale = 1.1

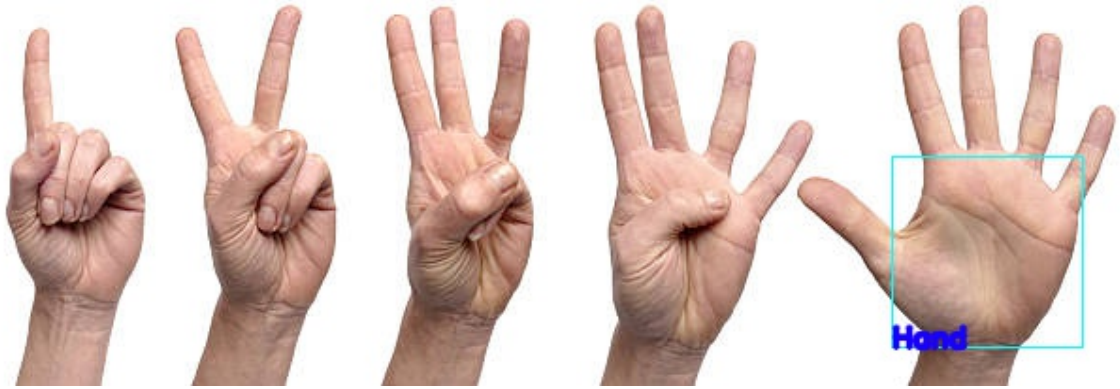
RESULTS





RESULTS





CONCLUSION

Pros

- Can generalize to any kind of object
- Efficient (eliminate false region quickly)

Cons

- High false positive rate (when the parameters not well tuned)
- Lowering bias while increasing variance

REFERENCE

[1] Fares Jalled et al., Object Detection Using Image Processing

[2]https://docs.opencv.org/2.4.13.2/modules/objdetect/doc/cascade_classification.html

[3] ir.library.louisville.edu/cgi/viewcontent.cgi?article = 2731&context = etd

Thank you.