

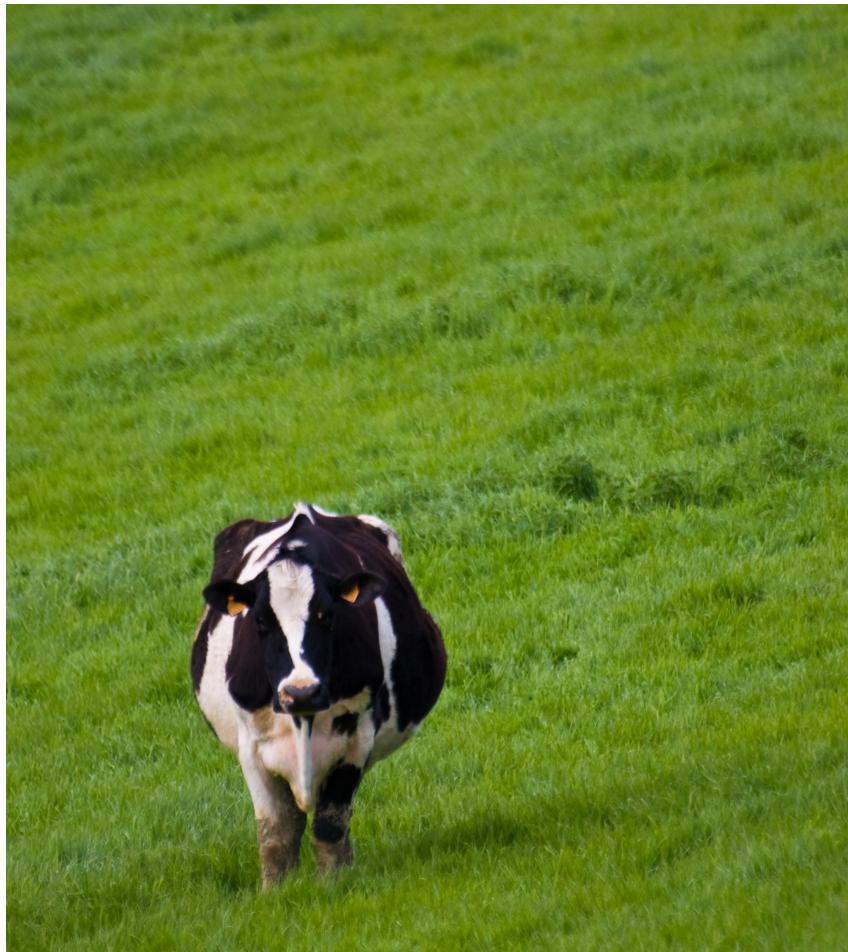
Face Detection

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Object Detection



- Input:
Image

Object Detection



- Input:
Image
- Output:
Bounding box
Label

Challenges



illumination



occlusion



orientation

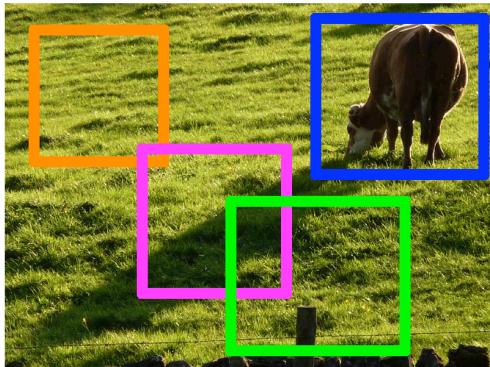


intra-class variance



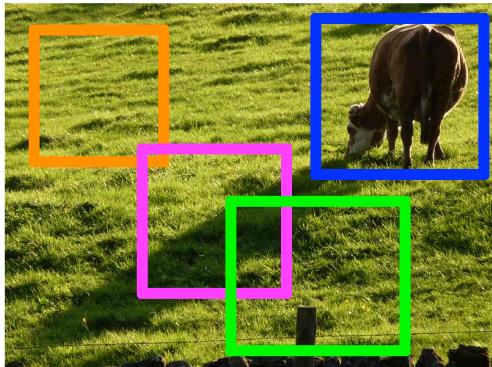
clutter

Sliding Window



- For every window

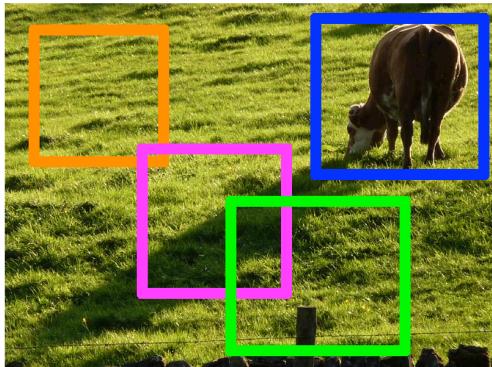
Sliding Window



d1 d2 d3 d4

- For every window
- Compute feature descriptor

Sliding Window



$d_1 \quad d_2 \quad d_3 \quad d_4$

0 0 0 1

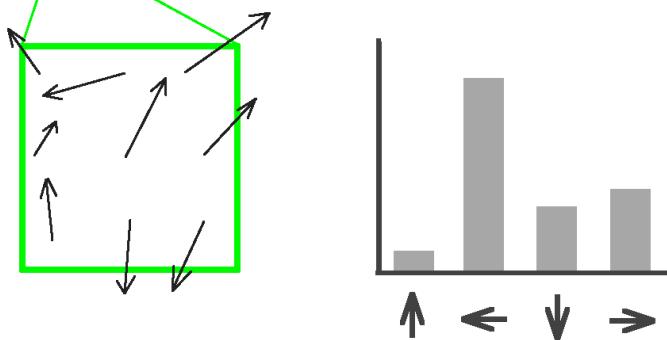
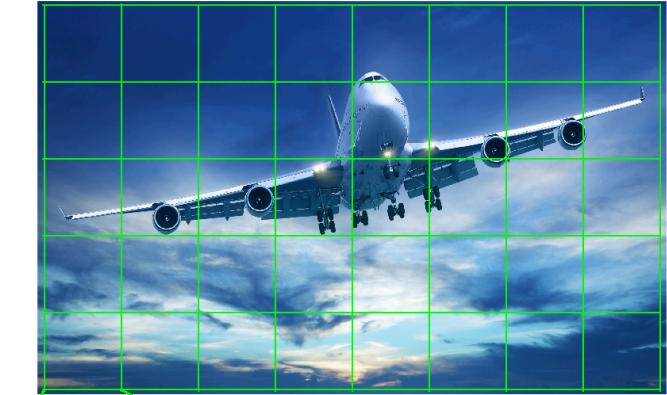
- For every window
- Compute feature descriptor
- Classify window
(presence of object)

Histograms of Oriented Gradients (Dalal and Triggs, 2005)



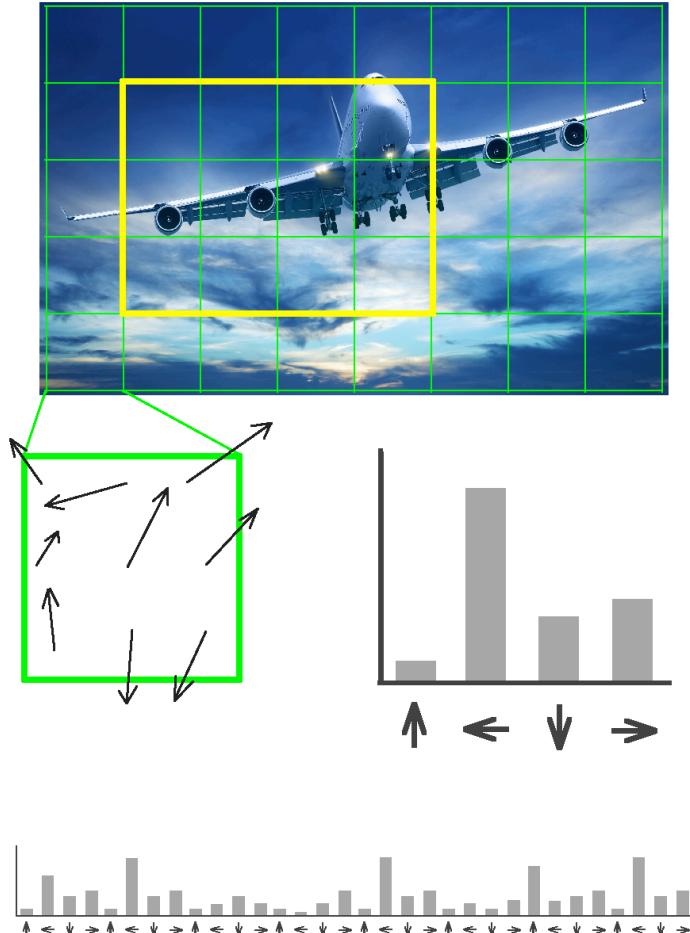
- Image

Histograms of Oriented Gradients



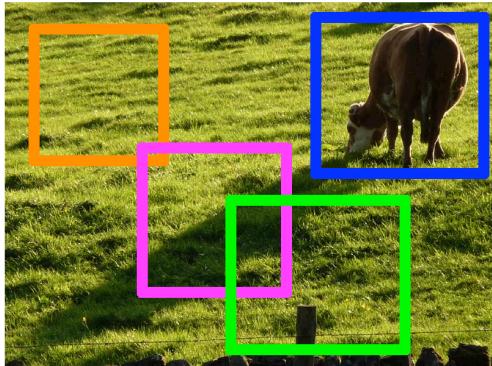
- Image
- Histogram of Oriented Gradients

Histograms of Oriented Gradients



- Image
- Histogram of Oriented Gradients
- Concatenate histograms of blocks

Inference



d1 d2 d3 d4

0 0 0 1

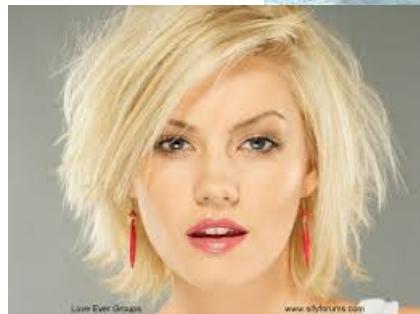
- For every window
 - Compute HOG descriptor
 - Linear classification:
$$d_i = (x_1; x_2; x_3; \dots)$$

$$f(d_i) = W^T d_i + B$$

Is $f(d_i) \geq \text{threshold}$?

Training

- Positive examples

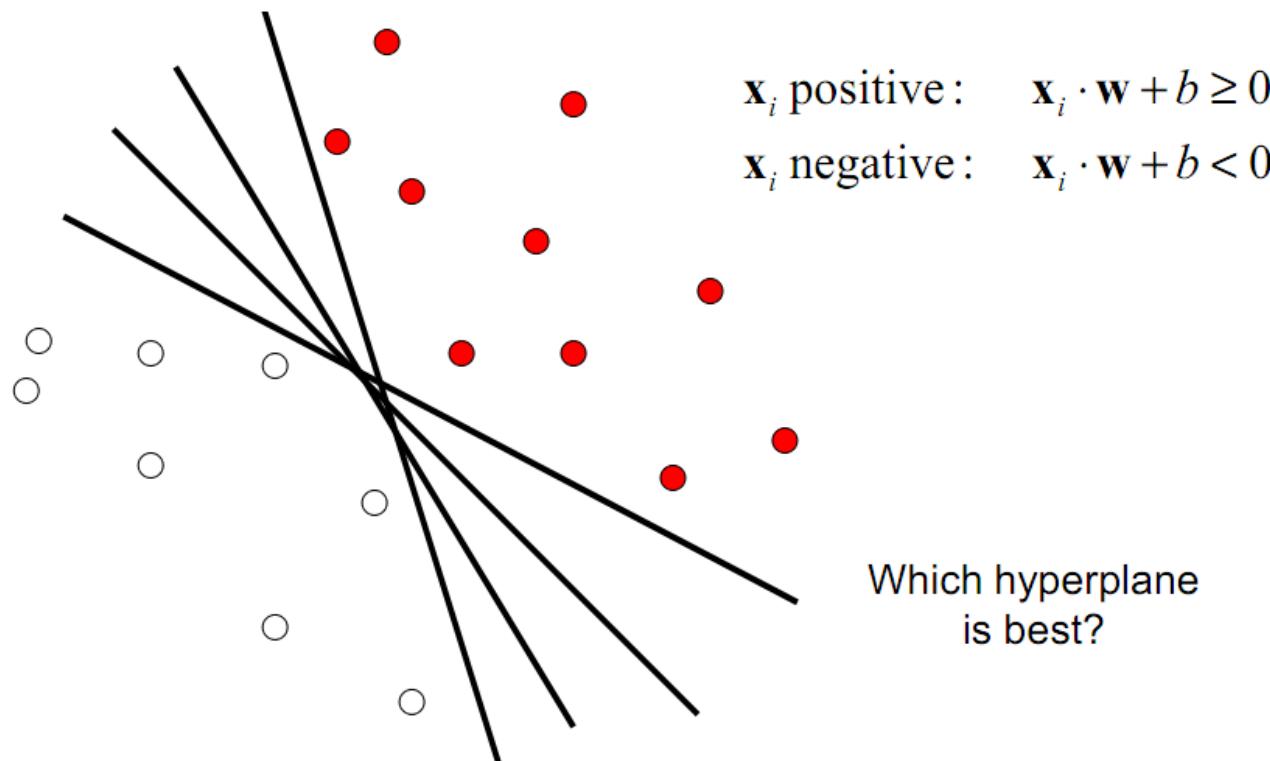


- Negative examples



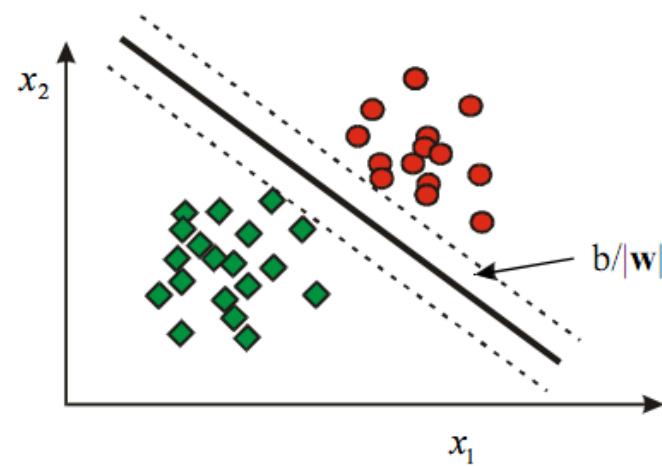
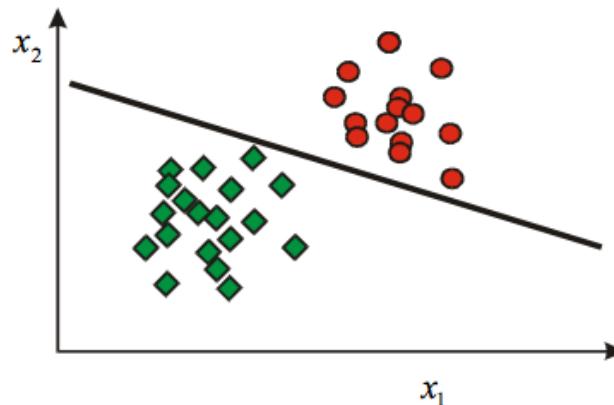
Linear Classifier

- Find a hyperplane that separates the negative and positive examples

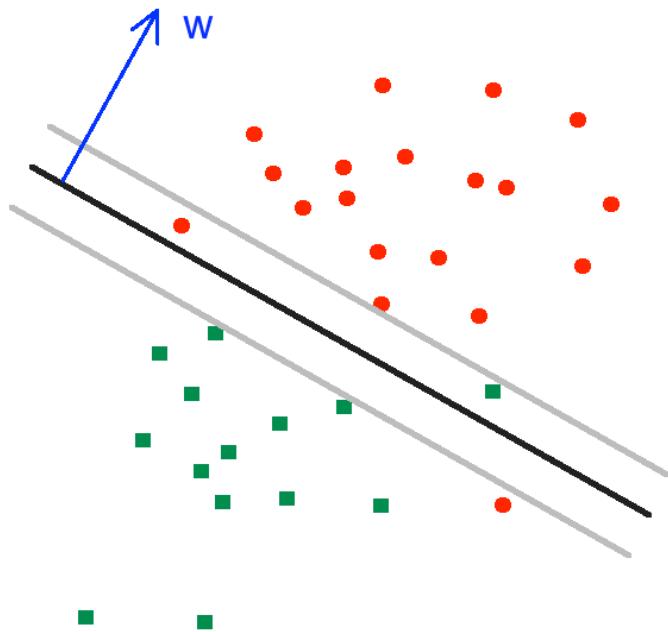


Maximum Margin Classifier, SVM

- Generalization is not good in this case:
- Better if a margin is introduced:

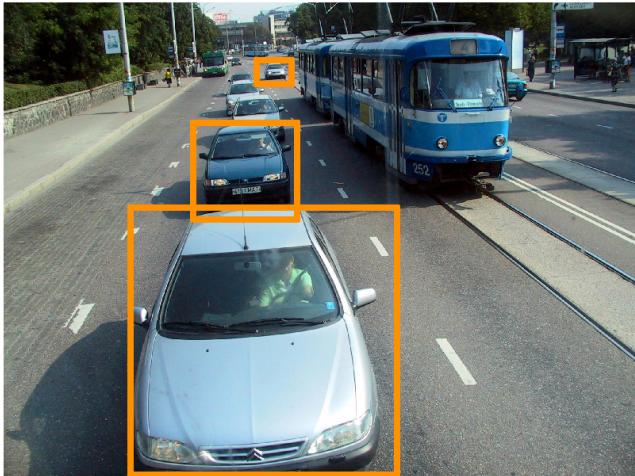


What if the problem is not separable?



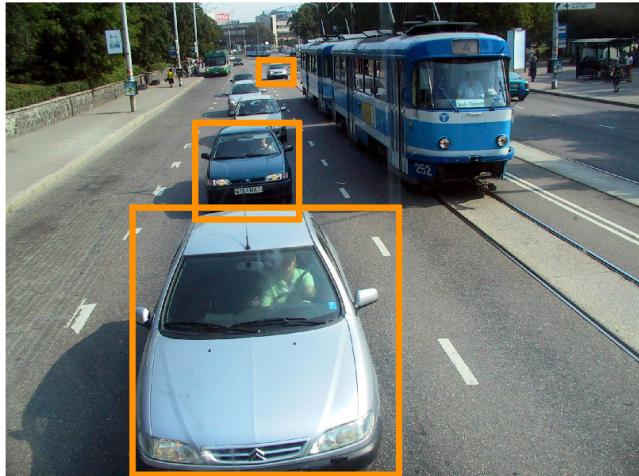
- Regularization: Allow some training samples to have some error

Multiple Scales

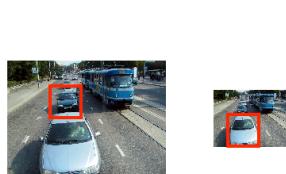


- How can we detect objects at different scales?

Multiple Scales



- How can we detect objects at different scales?



- We simply compute the HOG features on resized images