CS 188: Artificial Intelligence

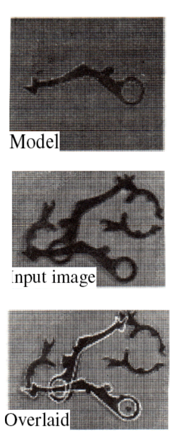
Lecture 24: Computer Vision

Pieter Abbeel – UC Berkeley

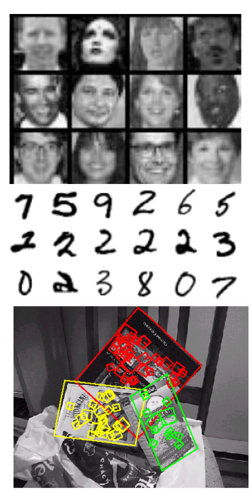
Slides adapted from Trevor Darrell (and his sources)

Rough evolution of focus in recognition research

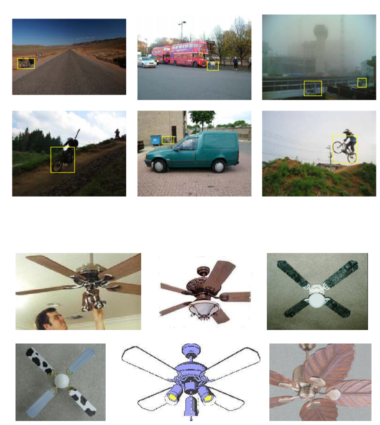
Visual Object Recognition Tutorial



1980s



1990s to early 2000s



2000-2010…

Inputs/outputs/assumptions

- What is the **goal**?
  - Say yes/no as to whether an object present in image

  And/or:
  - Determine pose of an object, e.g. for robot to grasp
  - Categorize all objects
  - Forced choice from pool of categories
  - Bounding box on object
  - Full segmentation
  - Build a model of an object category

Scanning windows…

Visual Object Recognition Tutorial

Detection via classification: Main idea

Basic component: a binary classifier

Car/non-car Classifier

No, not a car.

Yes, car.

K. Grauman, B. Leibe

Visual Object Recognition Tutorial

Detection via classification: Main idea

If object may be in a cluttered scene, slide a window around looking for it.

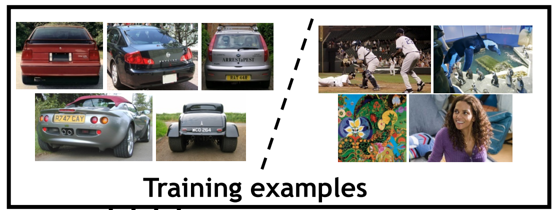
Car/non-car Classifier

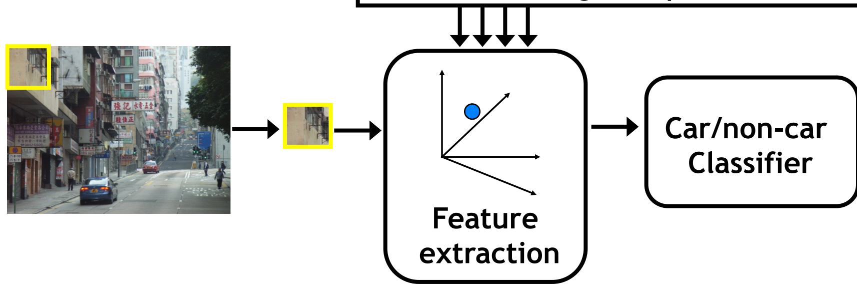
K. Grauman, B. Leibe

Detection via classification: Main idea

Fleshing out this pipeline a bit more, we need to:

1. Obtain training data
2. Define features
3. Define classifier

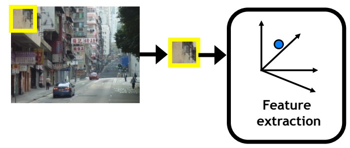


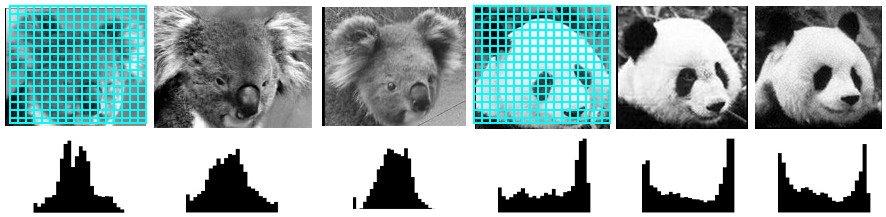


Detection via classification: Main idea

- Consider all subwindows in an image
  - Sample at multiple scales and positions (and orientations)
- Make a decision per window:
  - "Does this contain object category X or not?"

Feature extraction: global appearance



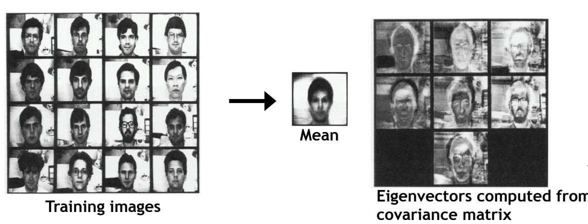


Simple holistic descriptions of image content

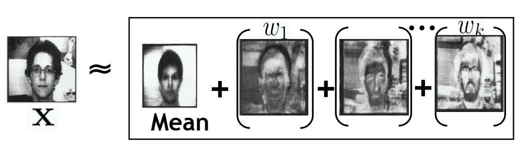
- grayscale / color histogram
- vector of pixel intensities

Eigenfaces: global appearance description

An early appearance-based approach to face recognition



Generate low-dimensional representation of appearance with a linear subspace.



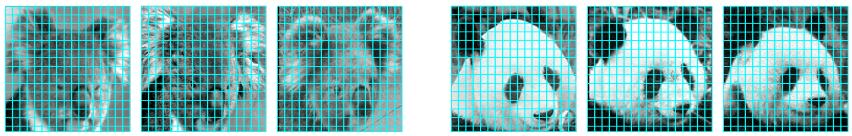
Project new images to “face space”.

Recognition via nearest neighbors in face space

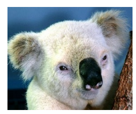
Turk & Pentland, 1991

Feature extraction: global appearance

- Pixel-based representations sensitive to small shifts



- Color or grayscale-based appearance description can be sensitive to illumination and intra-class appearance variation



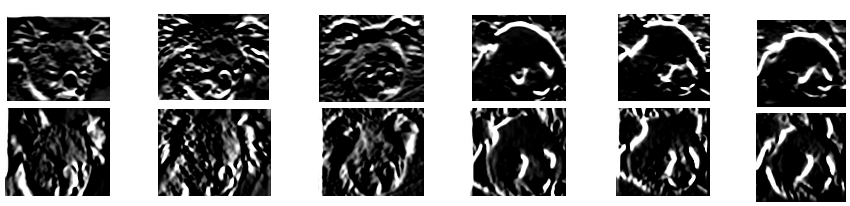
Cartoon example:
an albino koala

Visual Object Recognition Tutorial

K. Grauman, B. Leibe

Gradient-based representations

- Consider edges, contours, and (oriented) intensity gradients



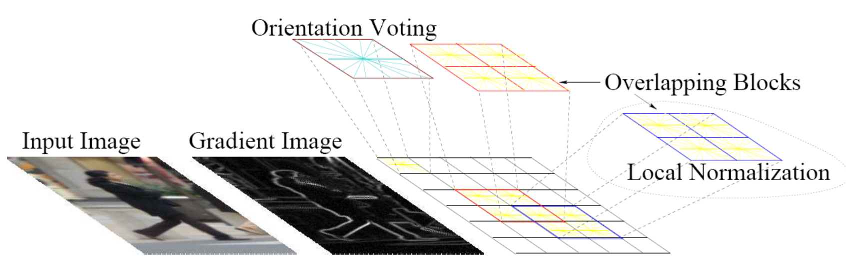
Visual Object Recognition Tutorial

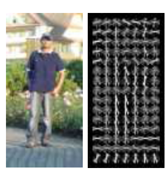
K. Grauman, B. Leibe

HOG

(one of the most widely used features)

Gradient-based representations: Histograms of oriented gradients (HoG)





Map each grid cell in the input window to a histogram counting the gradients per orientation.

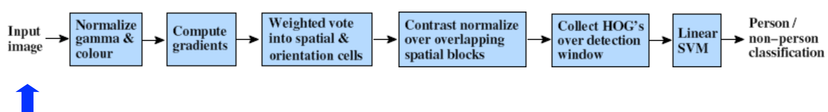
Code available: http://pascal.inrialpes.fr/soft/olt/

Dalal & Triggs, CVPR 2005

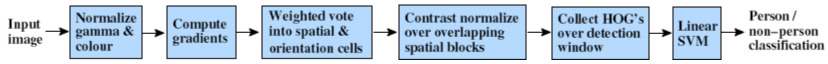
K. Grauman, B. Leibe

Visual Object Recognition Tutorial

Slide credit: Dalal, Triggs, P. Barnum



Slide credit: Dalal, Triggs, P. Barnum



-1	0	1

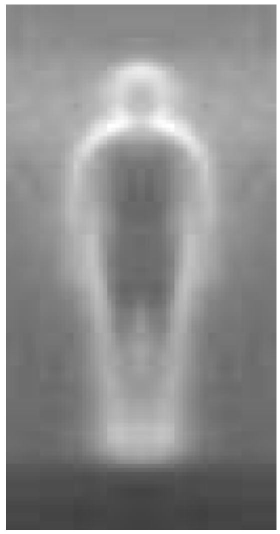
centered

-1	1

uncentered

1	-8	0	8	-1

cubic-corrected



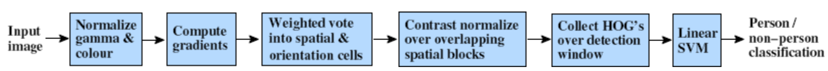
0	1
-1	0

diagonal

-1	0	1
-2	0	2
-1	0	1

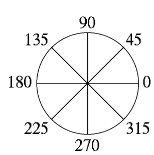
Sobel

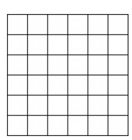
Slide credit: Dalal, Triggs, P. Barnum



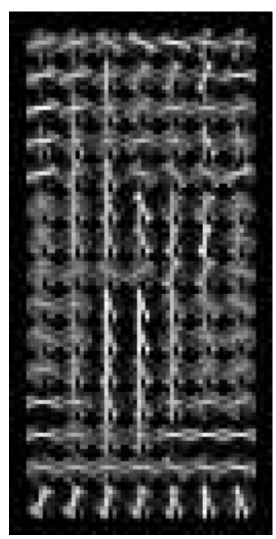
- Histogram of gradient orientations

  -Orientation -Position

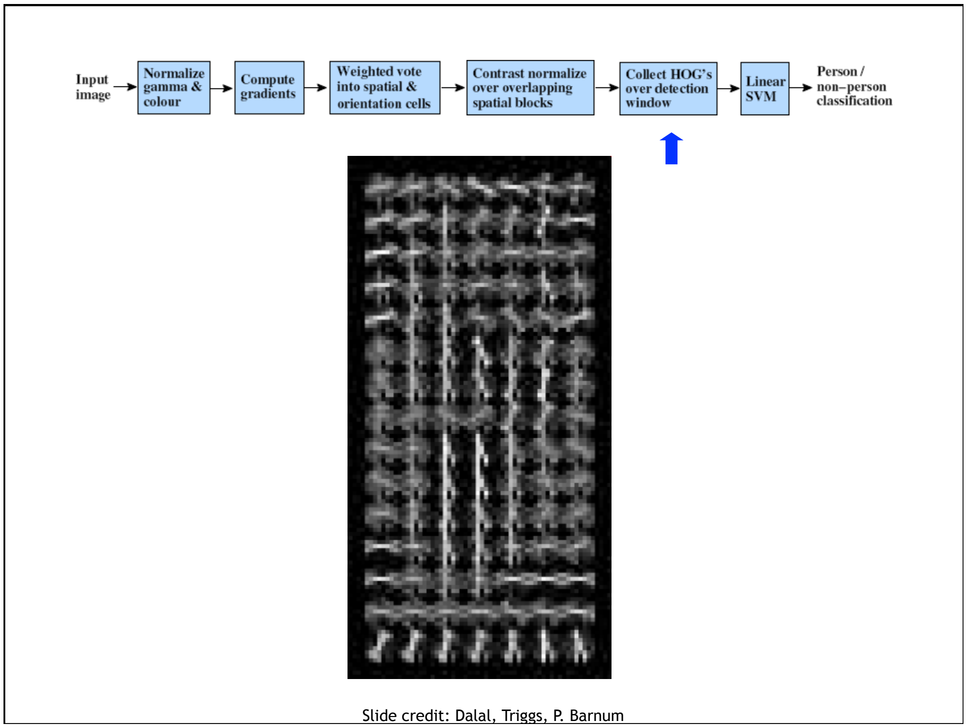


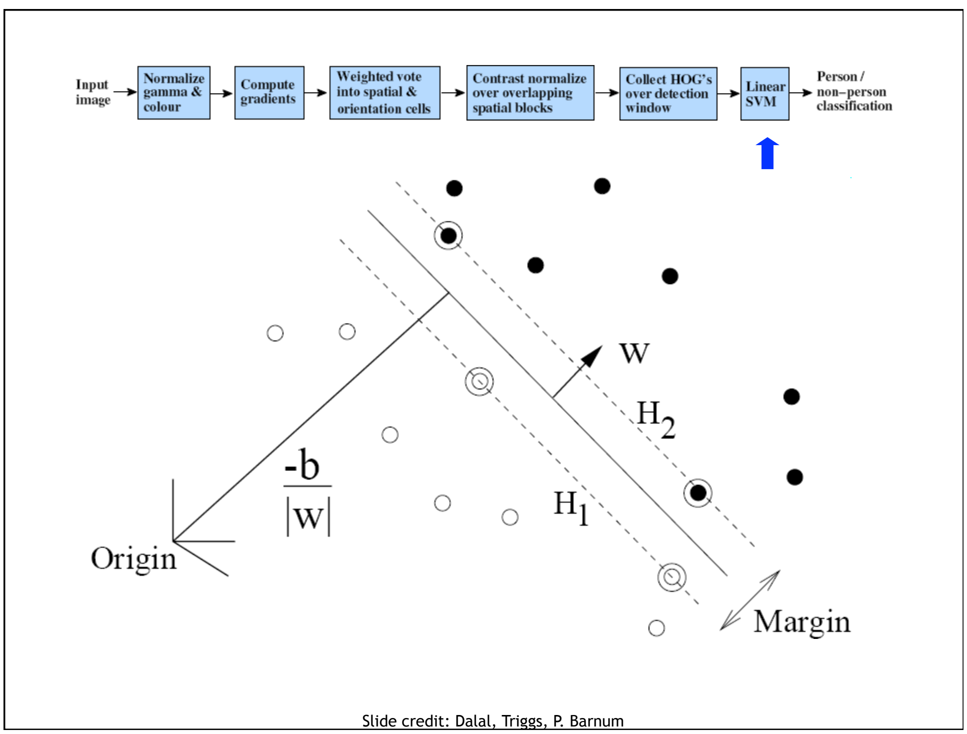


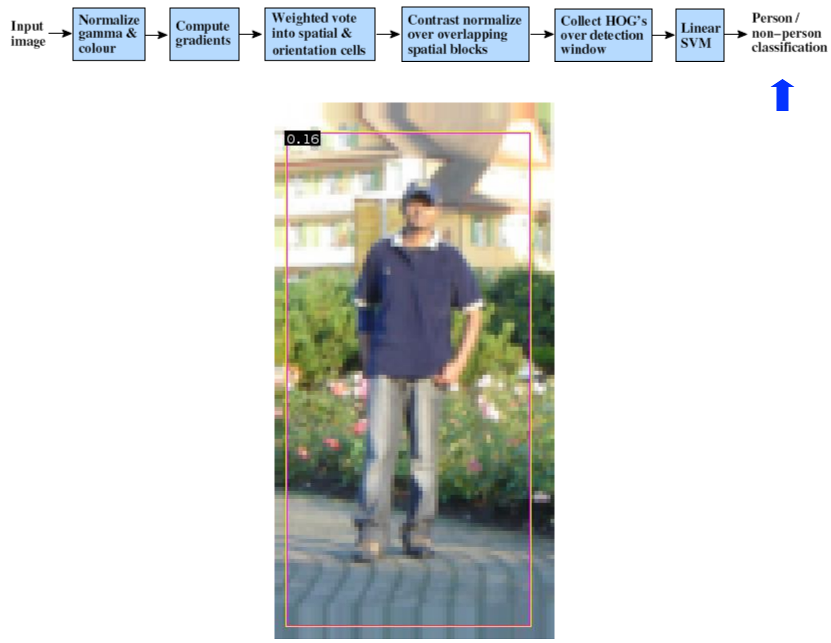
  – Weighted by magnitude



Slide credit: Dalal, Triggs, P. Barnum


Input image
Normalize gamma & colour
Compute gradients
Weighted vote into spatial & orientation cells
Contrast normalize over overlapping spatial blocks
Collect HOG's over detection window
Linear SVM
Person / non−person classification
Slide credit: Dalal, Triggs, P. Barnum


Input image
Normalize gamma & colour
Compute gradients
Weighted vote into spatial & orientation cells
Contrast normalize over overlapping spatial blocks
Collect HOG's over detection window
Linear SVM
Person / non−person classification
W
H2
H1
-b
|W|
Origin
Margin
Slide credit: Dalal, Triggs, P. Barnum



Slide credit: Dalal, Triggs, P. Barnum

Slide credit: Dalal, Triggs, P. Barnum