Computer Vision Systems Programming VO

Object Category Recognition

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Topics

Scene classification using the bag of words model

Fast face detection using boosted Haar features

Convolutional neural networks for large-scale problems

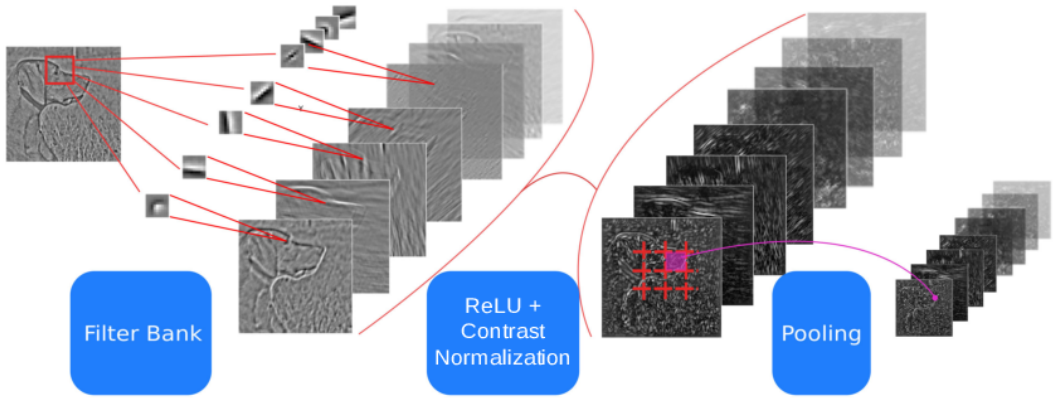


Image adaoted from Kavukcuoglu 2011

Scene Classification

We want to distinguish between c scene categories

- So $w \in \{0, \ldots, c-1\}$ (classification problem)

Street Scenes

Sea Scenes

Image adapted from Prince 2012

Scene Classification
Bag of Visual Words

We represent an image as a collection of visual words

- Images can be compared based on visual word distribution

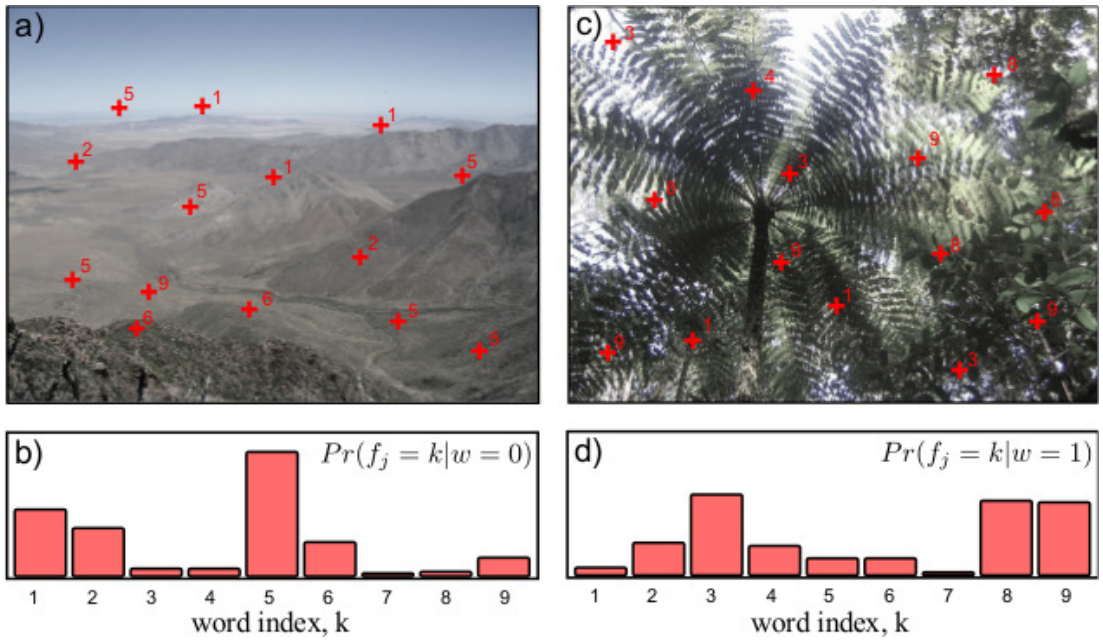


Image from Prince 2012

Scene Classification
Bag of Visual Words

Visual words are learned from an image collection

- Compute (SIFT) keypoints and descriptors for all images
- Cluster descriptors into k clusters using k-means
- k cluster means represent visual words

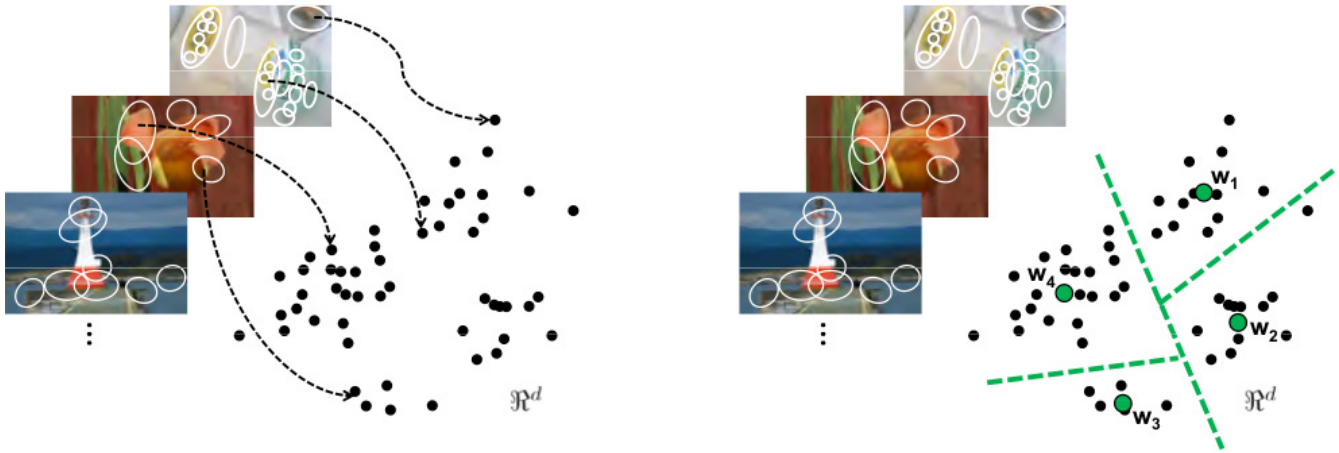


Image from Grauman and Leibe 2011

Scene Classification
Bag of Visual Words

Visual word distribution $\mathbf{x} \in \mathbb{N}^k$ of image obtained by

- Computing keypoints and descriptors
- Assigning each feature to closest visual word
- Summing up the assignment counts for each visual word

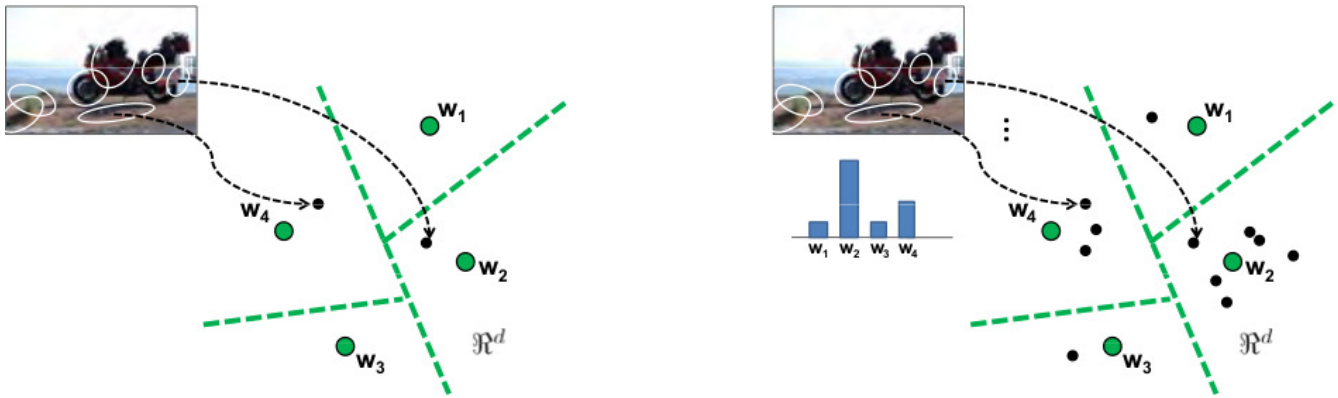


Image from Grauman and Leibe 2011

This image representation is called bag of (visual) words

Now that we have $\mathbf{x}$ we can select and learn a suitable model

- SVMs are often used in the literature
- For a probabilistic alternative see Prince 2012

Scene Classification
Bag of Visual Words – Remarks

Many improvements to this model exist

- Better clustering schemes
- Fuzzy assignment to visual words
- Spatial information (constellation model)

Popular and can work well, but no longer state of the art

Face Detection

Image from olympus-europa.com

Face Detection

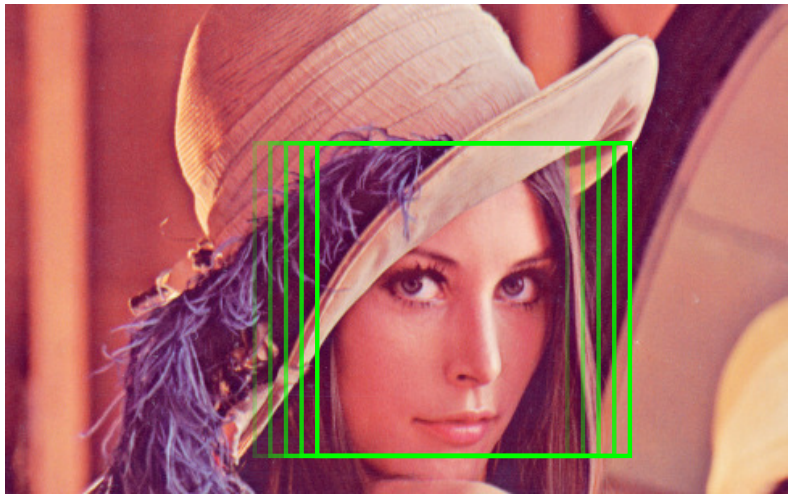
Many applications

- Smart cameras (autofocus on faces)
- Security (preprocessing step to face recognition)
- Augmented reality

Face Detection

We don't know where the faces are so we

- Slide a fixed-size window over the image
- Compute $\Pr(w|\mathbf{x})$ for each window ($w = 1$ if face, 0 if not)



Face Detection

Many windows, so computing $\mathbf{x}$ and $\Pr(w|\mathbf{x})$ must be fast

We focus on the popular method from Viola and Jones 2001

Bibliography I

Grauman, Kristen and Bastian Leibe (2011). *Visual object recognition*. Morgan & Claypool.

Kavukcuoglu, Koray (2011). *Learning feature hierarchies for object recognition*. PhD thesis.

Prince, S.J.D. (2012). *Computer Vision: Models Learning and Inference*. Cambridge University Press.

Viola, Paul and Michael Jones (2001). *Rapid object detection using a boosted cascade of simple features*.