# Recognition via "Constellations" and "Bags of Features"

CS 510

Lecture #17

April 12th, 2013

# Programming Assignment #3

- Any questions?
- How is it going?
- What will you be asked to do with the features you collect?

# Object recognition!

**Airplanes**


**Motorcyles**

**Spotted Cats**

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# Approach #1: Constellations of Features

- Learn spatial relationships among key parts of an object class.
- Parts are detected via special-purpose part detectors or by interest points.
- Detection is done by trying to fit the constellation model to the detected parts.

# Constellation[1]

- Step 1: Sample Images
  - Fergus et al. use “Scale Saliency”
  - Other sampling methods common

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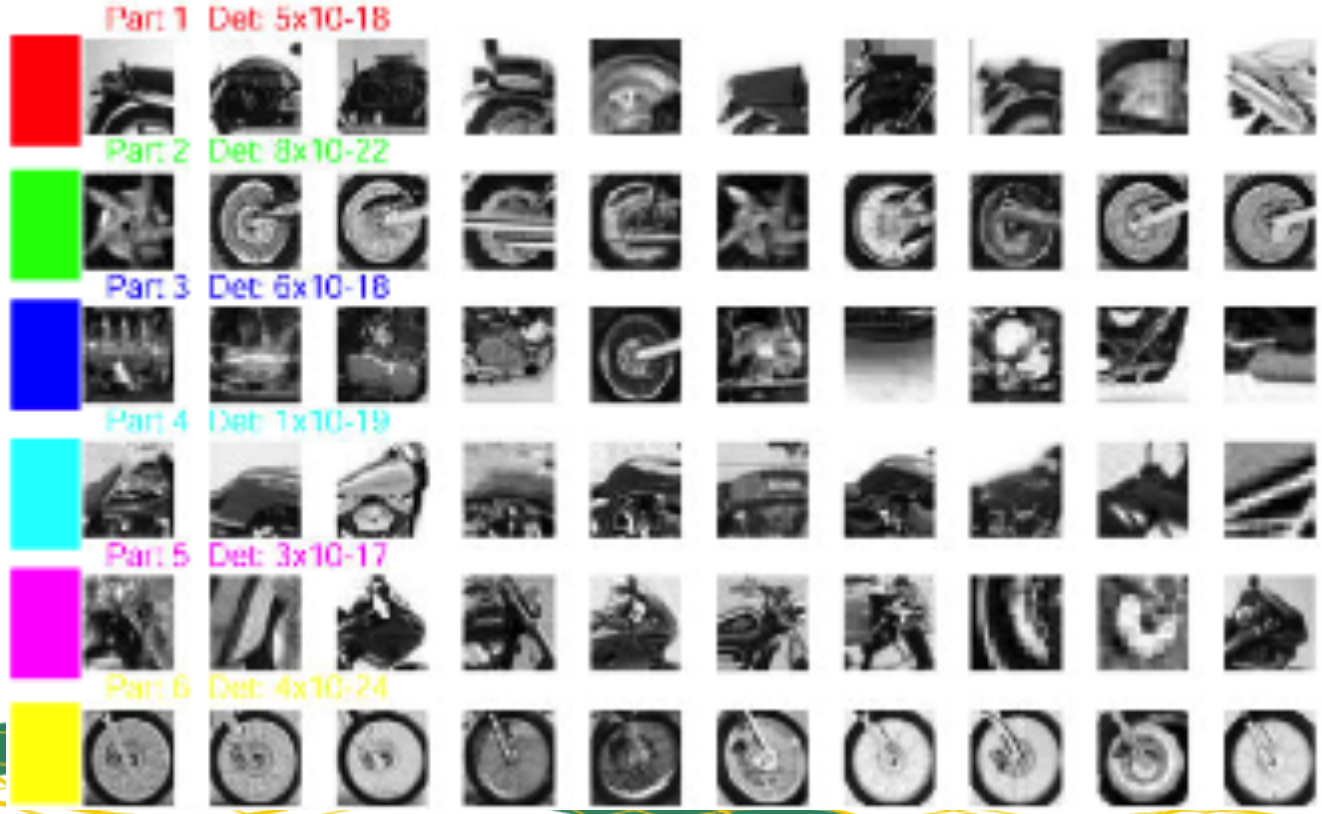
[1] Images from Fergus et al. 2003

# Constellation[1]

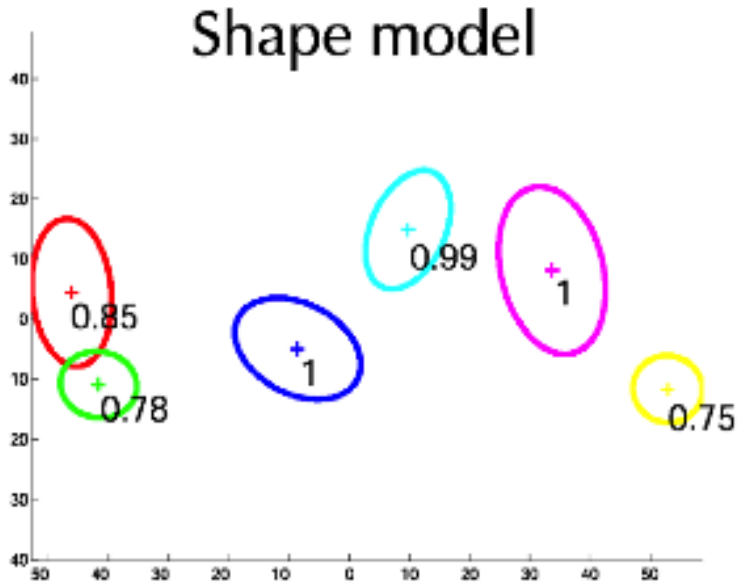
- Step 2: Learn Typical Parts
  - Feature Representation vs. Raw Pixels

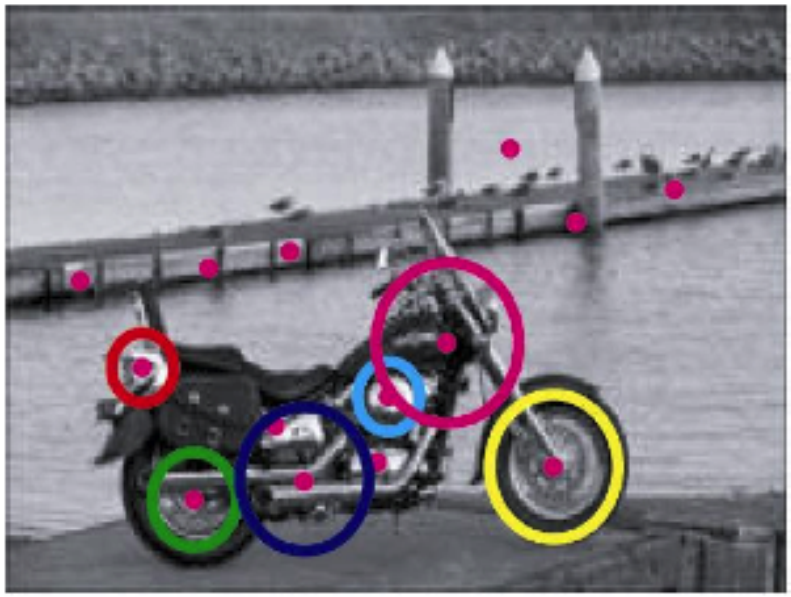



[1] Images from Fergus et al. 2003

# Constellation[1]

- Step 3: Learn Part Layout



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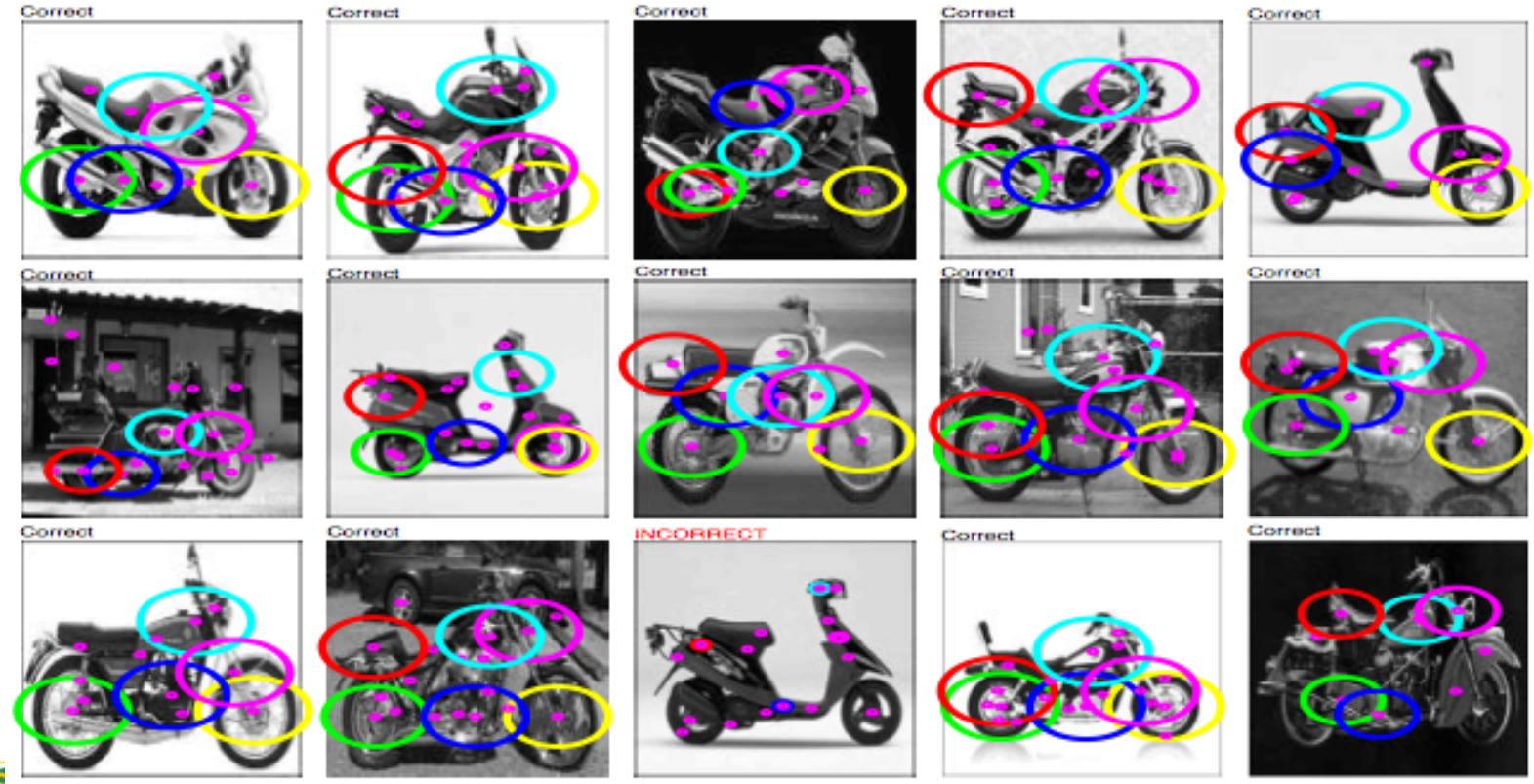
[1] Images from Fergus et al. 2003

# Constellation[1]

- Step 4: Classify Novel Images
  - Maximum Likely Part-Model




[1] Images from Fergus et al. 2003

# Constellations & GHT

- Note the similarity of constellations and the Generalized Hough Transform (GHT)
  - Instead of edges, parts
  - Parts relative to reference point
    - Modeled as a Gaussian around a mean position
  - Collect probabilistic votes for object position
- Parts may be learned by
  - Training a correlation filter
  - Training a classifier (e.g. SVM)
  - Building special-purpose detectors from standard features

# Constellation – Pros & Cons

- Pros
  - Robust To…
    - Partial Occlusion
    - Intra-class Variability (some)
    - Scale
  - Weakly Supervised Learning
- Cons
  - Not robust to large deformations or pose changes
  - Sensitive to Part Detection (Sampling)

# Where are we?

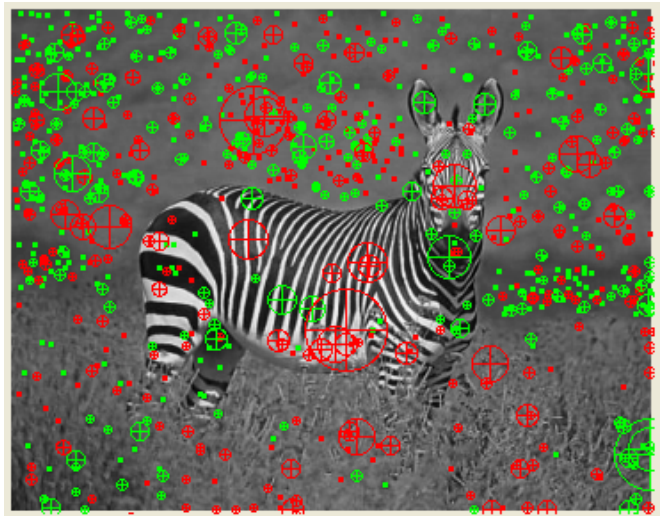
- Introducing general recognition frameworks
  - Constellations
  - Bag of Words (next)
- Pending issues
  - Underlying features
  - Feature representations
  - Classifiers
- We will go back and look more at these, once we have a framework for reference…

# Bag of Features

- Approach is to represent an image as an order-less set of features (hence “bag”).
- Image is sampled at 1000’s of locations to derive a histogram of occurring features.
- Histogram matching/discrimination done for classification.

# Bag of Features

- Step 1: Sample Image (Densely)
  - Dense Interest Points
  - Regular Grid of Points
  - Random Points

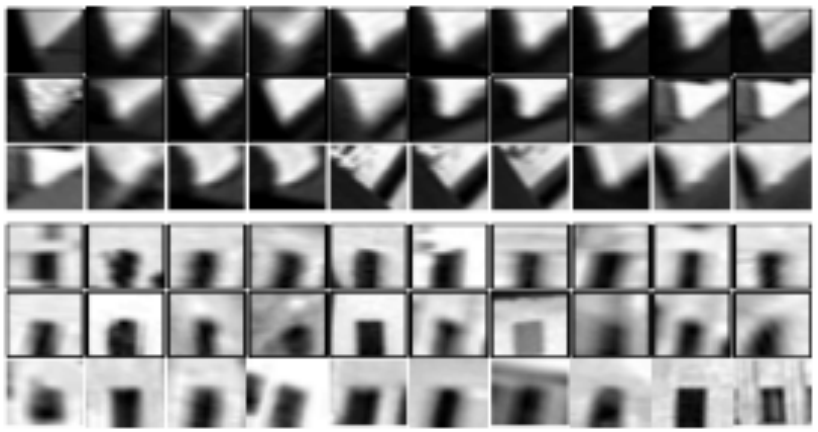


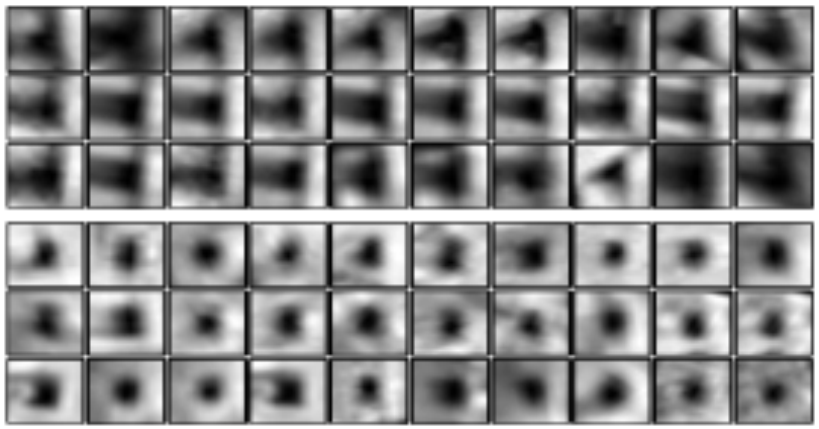
Difference of Gaussians Keypoints

Random Sampling

# Bag of Features

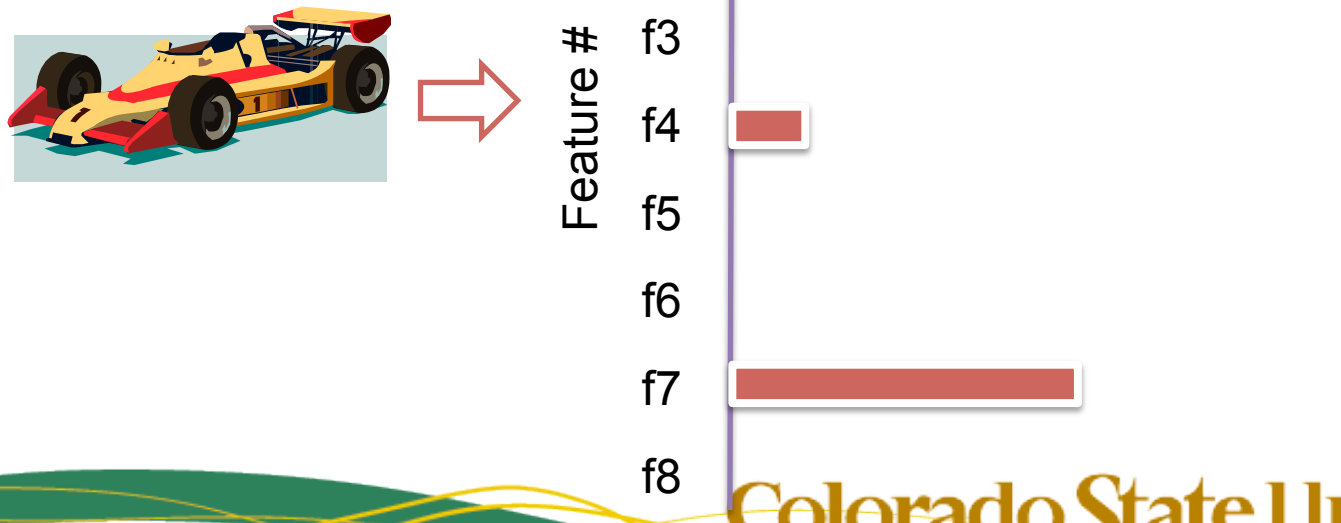
- Step 2: Cluster Features
  - Similar Features Grouped Together
  - "Visual Codebook"





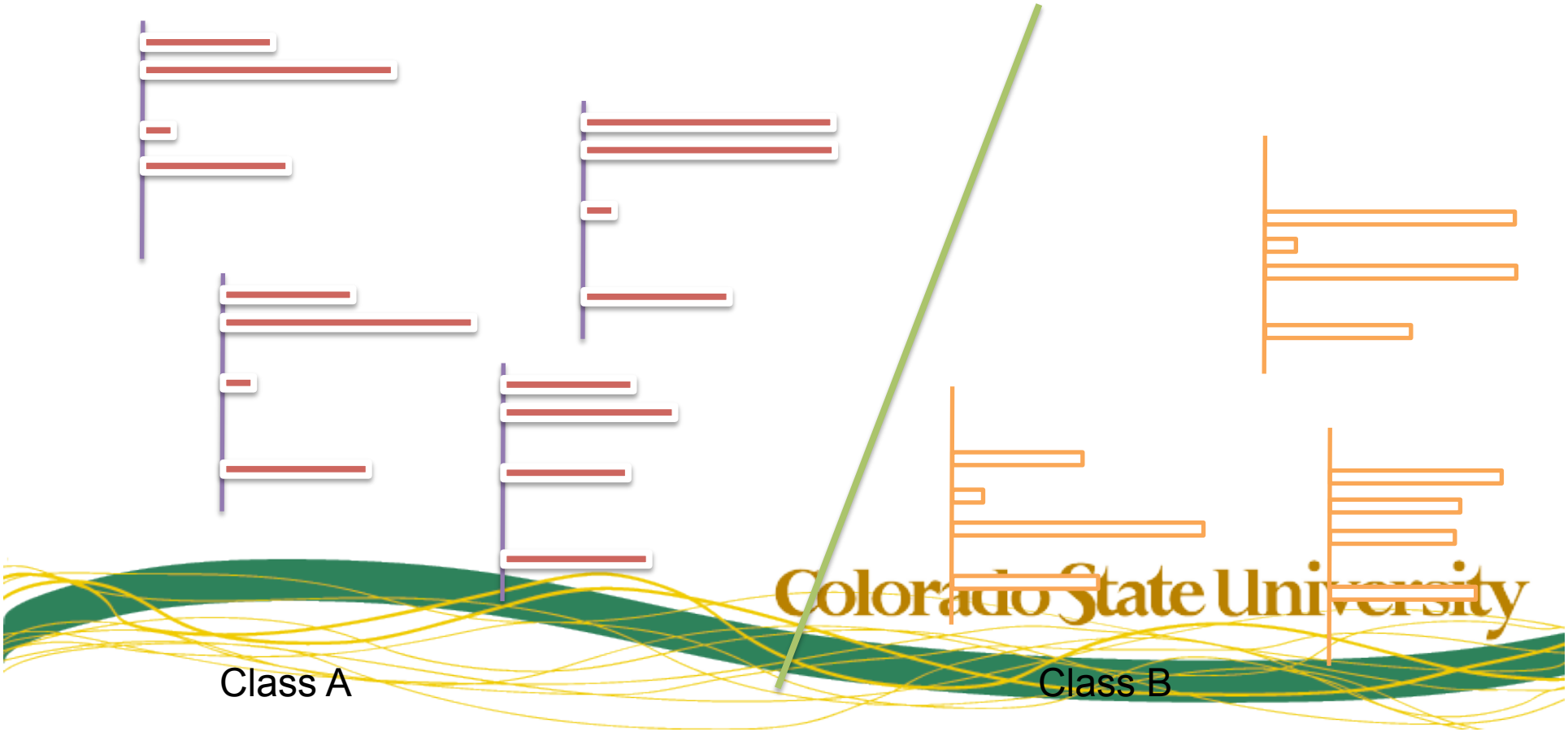
# Bag of Features

- Step 3: Represent Image as Histogram of Features (Order-less Collection)



# Bag of Features

- Step 4: Classify Feature Vector
  - Support Vector Machine (SVM) Typical



# Bag of Features: Pros & Cons

- Pros
  - Computationally Simple
  - Weakly Supervised
  - (Surprisingly) State-of-the-Art Performance
  - Perhaps more robust than Constellations
- Cons
  - Order-less Collection – lacks spatial info
  - Not well-suited for segmentation/localization
  - Not well-suited for object identification

# Web-Demo: Bag of Features

- Bag of Features methods can be applied to image retrieval.
- Demo of “Video Google” project: Oxford Visual Geometry Group - Video Google Demo
- URL: http://www.robots.ox.ac.uk/~vgg/research/vgoogle/index.html