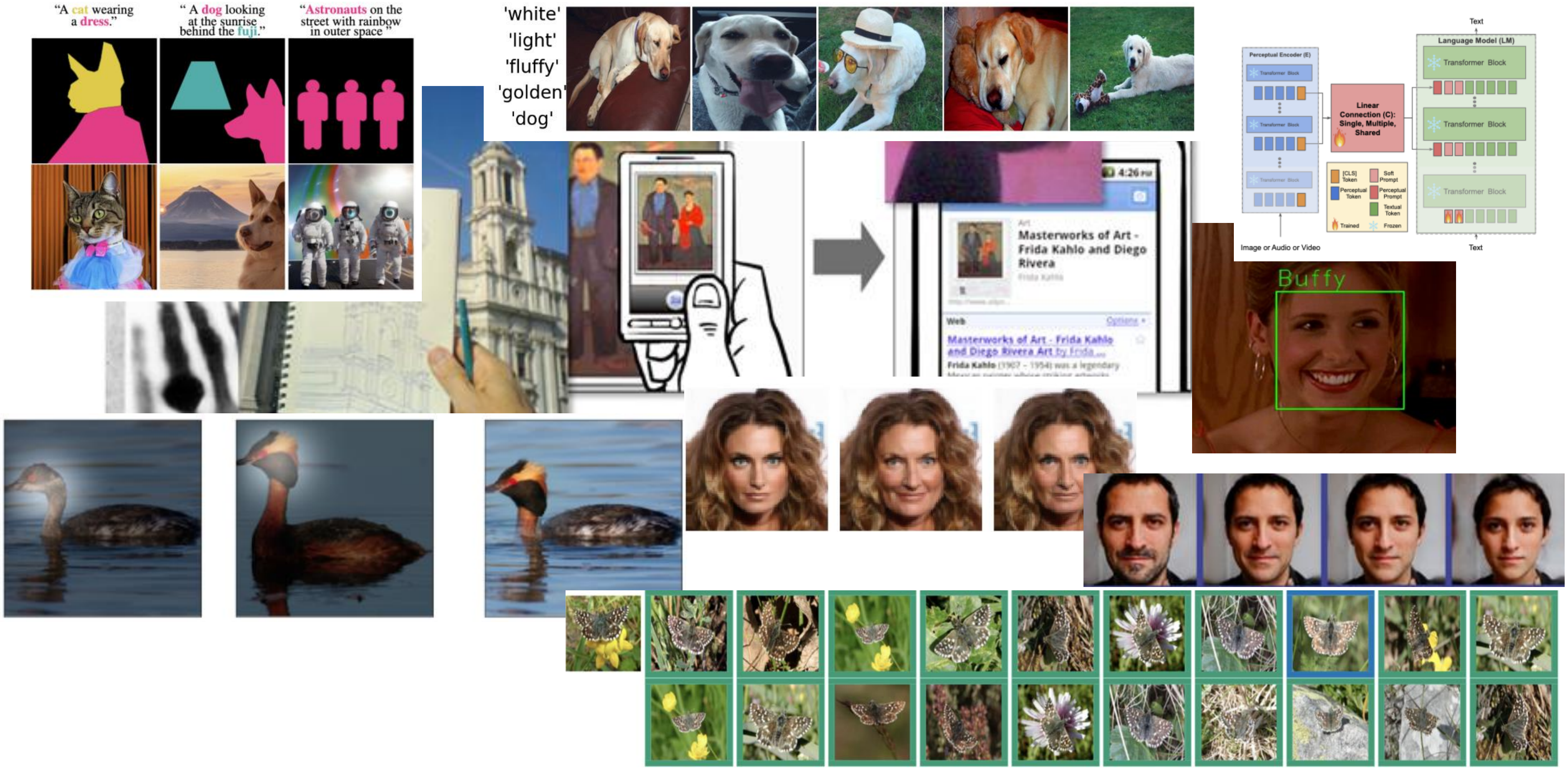
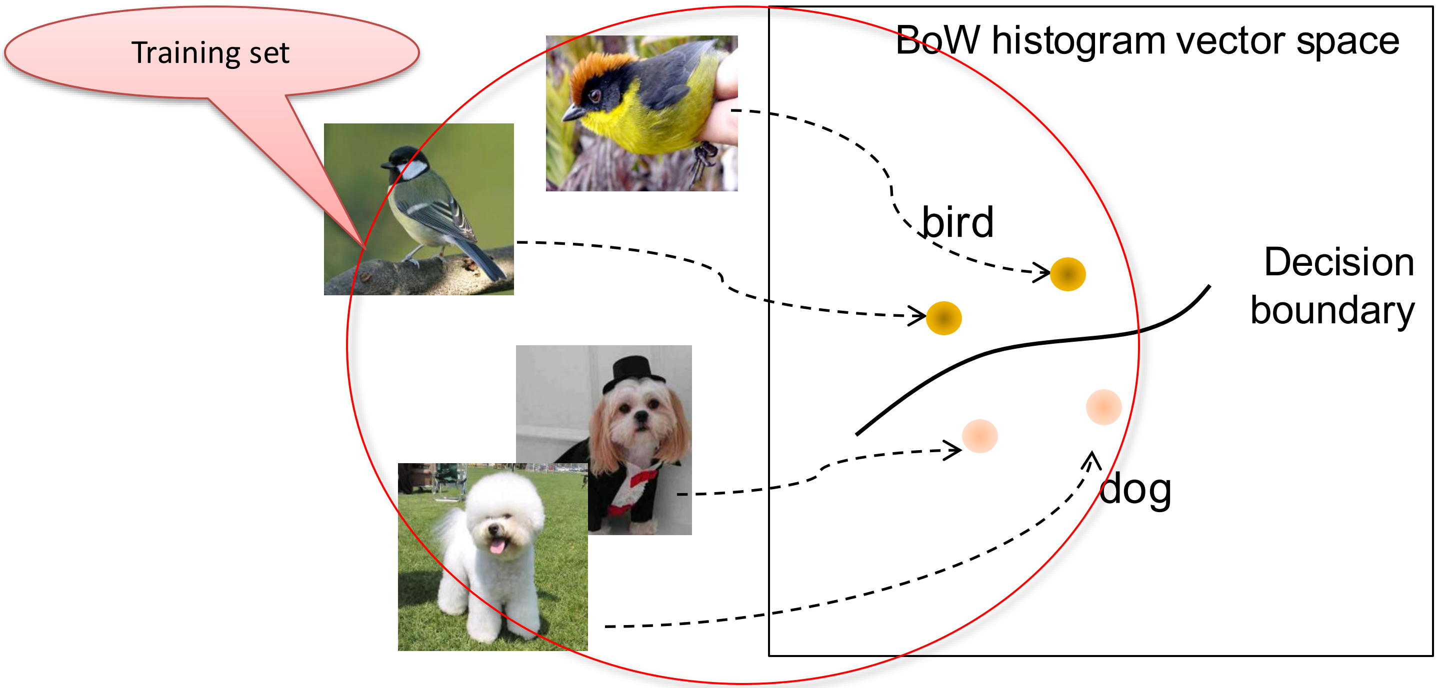


COURS RDFIA deep Image

https://cord.isir.upmc.fr/teaching-rdfia/

Matthieu Cord
Sorbonne University

Image classification based on BoW



Datasets for learning/testing

- How to define a category ?
  - Bicycle
  - Paintings with women
  - Portraits

  …

  Concepts, semantics, ontologies …

Image/video datasets for training/testing

CalTech 101

TRECVID

- Choice of the categories (objects, concepts)
    - Number of categories
    - Number of images per category
    - Hierarchical structure ?
- Mono-label/multi-labels
- Pre-processing
    - Color, resolution, centered …

Example: ImageNet dataset

- Large Scale Visual Recognition Challenge (ILSVRC)
  - 1,2 Million images, 1000 classes
- Paper:
  - ImageNet: A Large-Scale Hierarchical Image Database, Jia Deng, Wei Dong, Richard Socher, Li-Jia Li, Kai Li and Li Fei-Fei, CVPR 2009

Classes of ImageNet

- Based on WordNet
  - Each node is depicted by images
- A knowledge ontology
  - Taxonomy
  - Partonomy

- Website:

IMAGENET

14,197,122 images, 21,841 synsets indexed

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ImageNet is an image database organized according to the WordNet hierarchy (currently only the nouns), in which each node of the hierarchy is depicted by hundreds and thousands of images. Currently we have an average of over five hundred images per node. We hope ImageNet will become a useful resource for researchers, educators, students and all of you who share our passion for pictures.
Click here to learn more about ImageNet, Click here to join the ImageNet mailing list.

Constructing ImageNet

- 2-step process

Step 1 :
Collect candidate
images Via the Internet

→

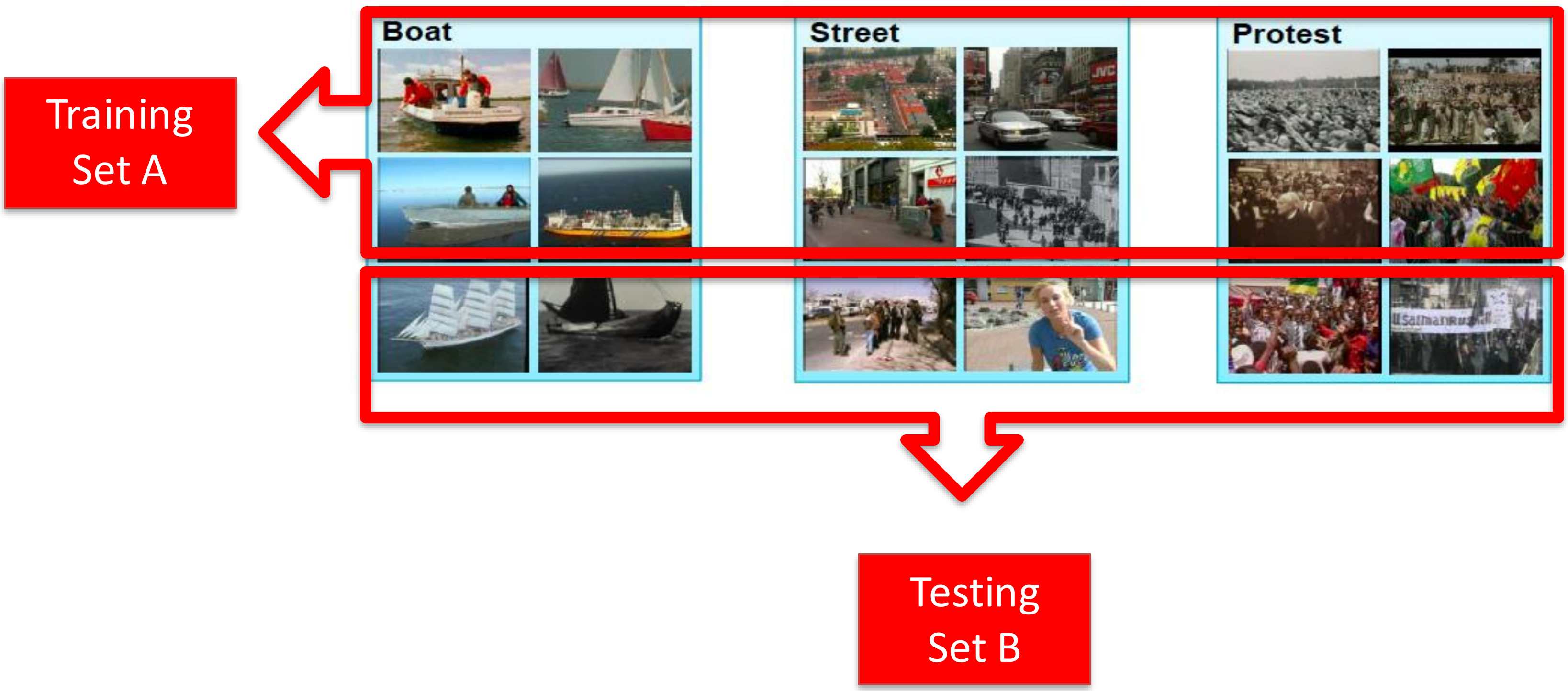
Step 2 :
Clean up candidate
Images by humans

- Still a lot of pbs, biases => ImageNetv2, …

Benchmarks and evaluation

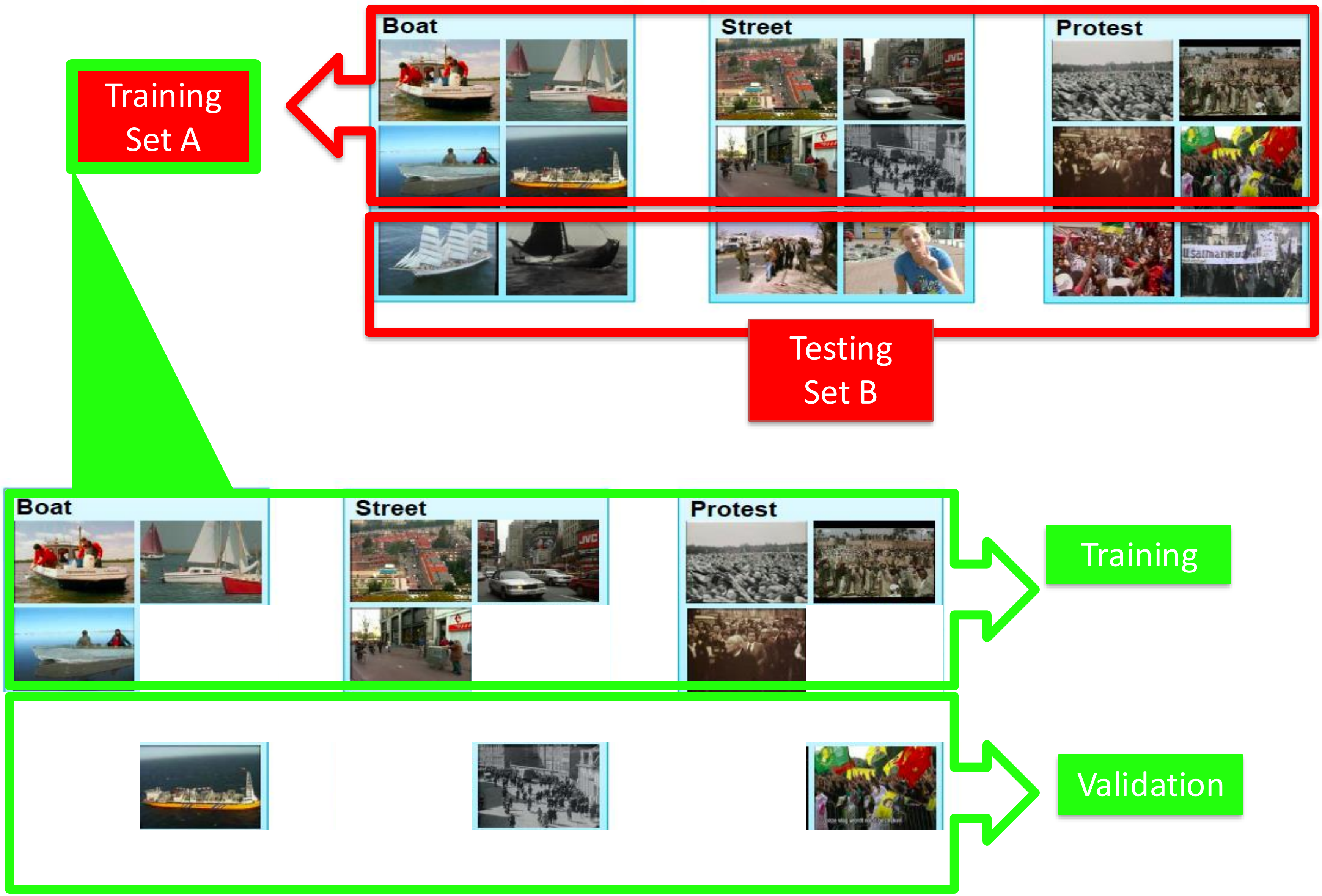
- Train / test / validation sets
  - Cross-validation (k-fold, leave-1-out)
  - Learning hyper parameters
- Evaluation
  - Test Error
  - Accuracy, MAP, confusion matrix, Per-class averaging
  - Significance of the comparison, statistical tests, …
- Dataset building, concepts and semantics
  - Data pre-processing, data augmentation

Image/video datasets for training/testing



- Training classifiers on A
- Testing on B: error evaluation
- A and B disjoints!

Training: Cross-validation

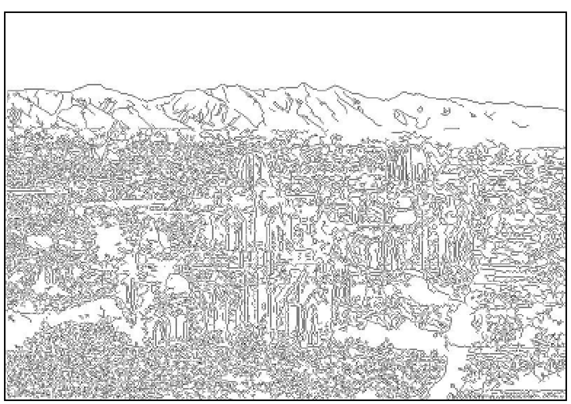


Complements

SPM algorithm and results

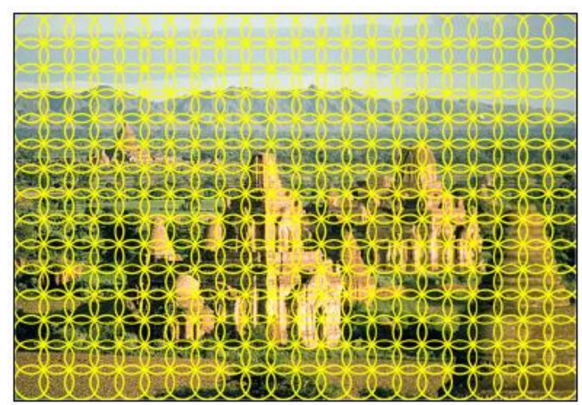
SPM Algorithm

1. Extract interest point descriptors (dense scan)
2. Construct visual word dictionary
3. Build spatial histograms
4. Train an SVM



Weak (edge orientations)

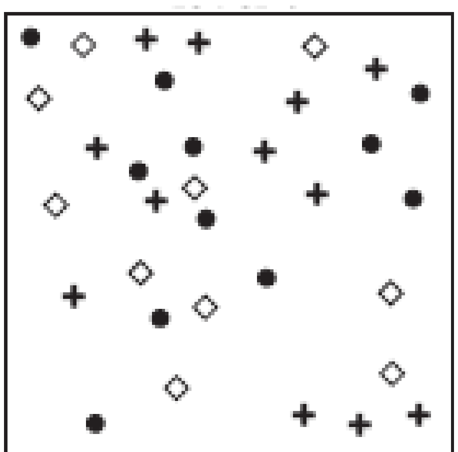
OR



Strong (SIFT)

Algorithm

1. Extract interest point descriptors (dense scan)
2. Construct visual word dictionary
3. Build spatial histograms
4. Train an SVM



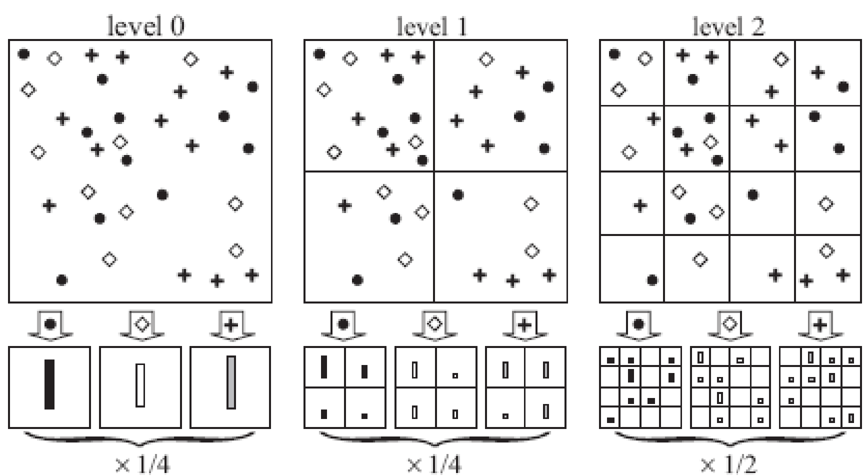
- Vector quantization

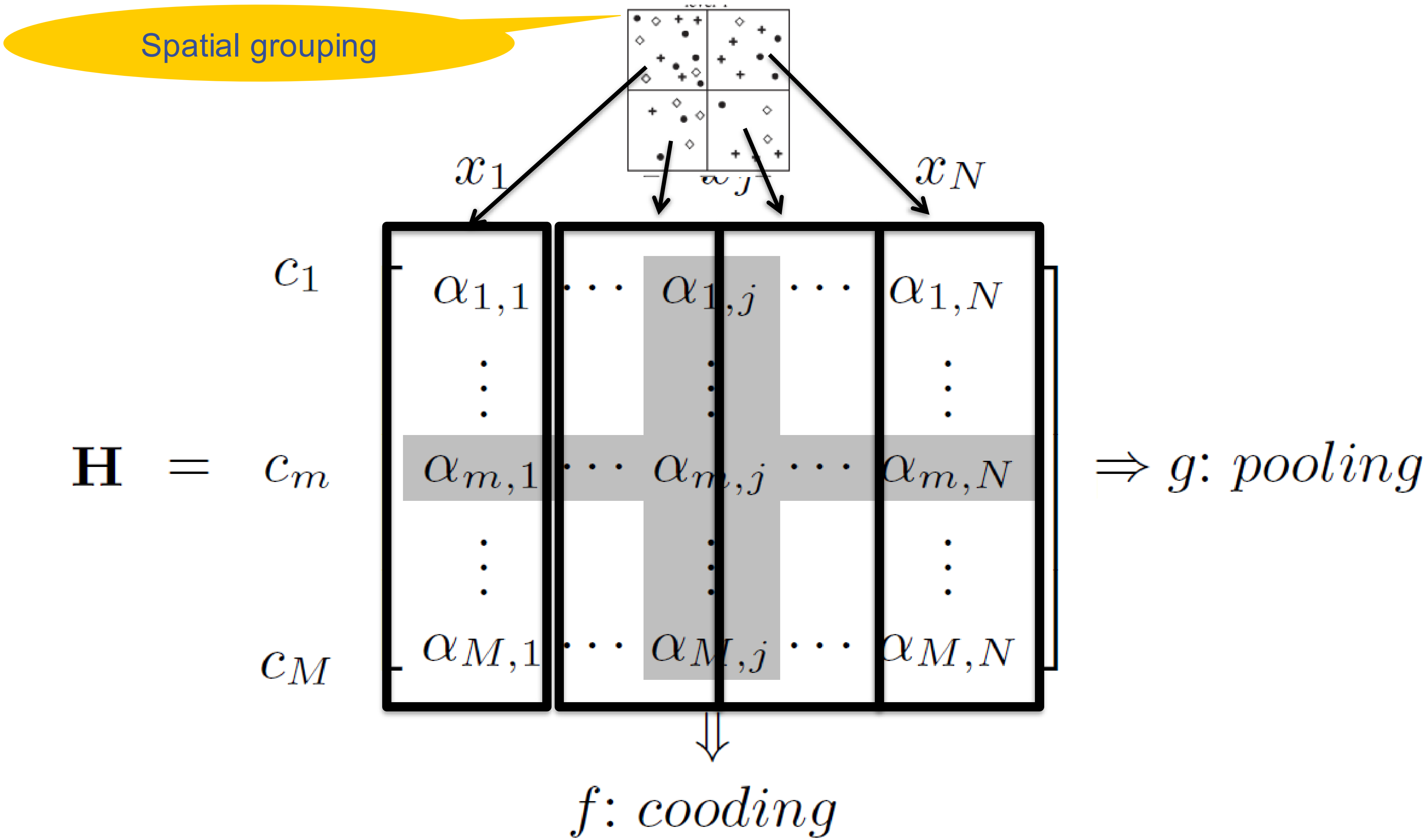
- Usually K-means clustering

- Vocabulary size (16 to 400)

Algorithm

1. Extract interest point descriptors (dense scan)
2. Construct visual word dictionary
3. Build spatial histograms
4. Train an SVM (with specific kernels)



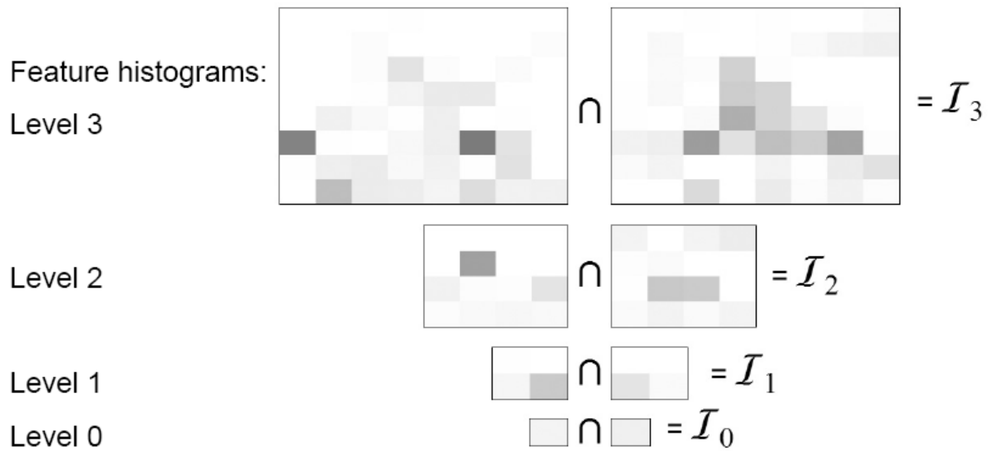


=> Break global invariance because of fixed pyramid

Algorithm

1. Extract interest point descriptors (dense scan)
2. Construct visual word dictionary
3. Build spatial histograms
4. Train an SVM

Similarity



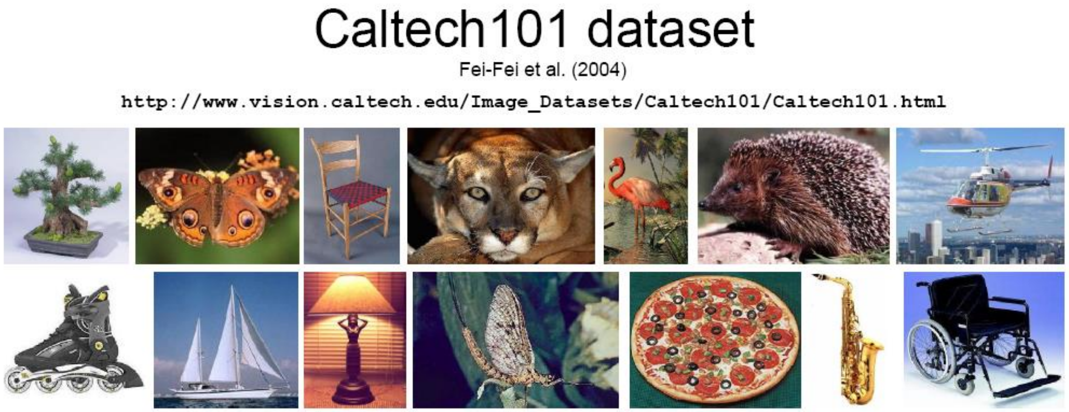
Total weight (value of *pyramid match kernel*): $\mathcal{I}_3 + \frac{1}{2}(\mathcal{I}_2 - \mathcal{I}_3) + \frac{1}{4}(\mathcal{I}_1 - \mathcal{I}_2) + \frac{1}{8}(\mathcal{I}_0 - \mathcal{I}_1)$

Algorithm

1. Extract interest point descriptors (dense scan)
2. Construct visual word dictionary
3. Build spatial histograms
4. **Train an SVM**

… Based on the kernel Similarity PMK

SPM Article: Results



- 3 Datasets
  - Nb images
  - Nb classes
- SVM multiclass !?!
- Eval protocol:
  - Train/test/val
    - 10 folds => average+standard deviation
    - Average per class
  - Nb of images per class in train (from 5 to 30)
- Parameter optimization
- Comparison to others

Multi-class SVM

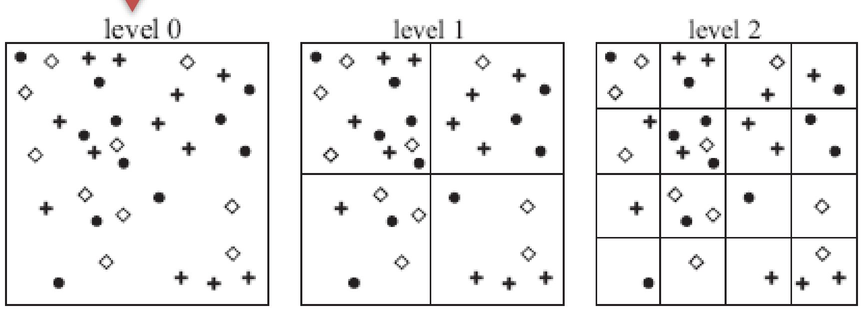
… By combining multiple two-class SVMs!

- One vs. All
  - Training: learn an SVM for each class vs. all others grouped in 1 class
  - Testing: apply each SVM to test example and assign to it the class of the SVM that returns the highest decision value
- One vs. One
  - Training: learn an SVM for each pair of classes
  - Testing: each learned SVM “votes” for a class to assign to the test example

SPM Article: Results on Caltech101

Multi-class classification results (30 training images per class)

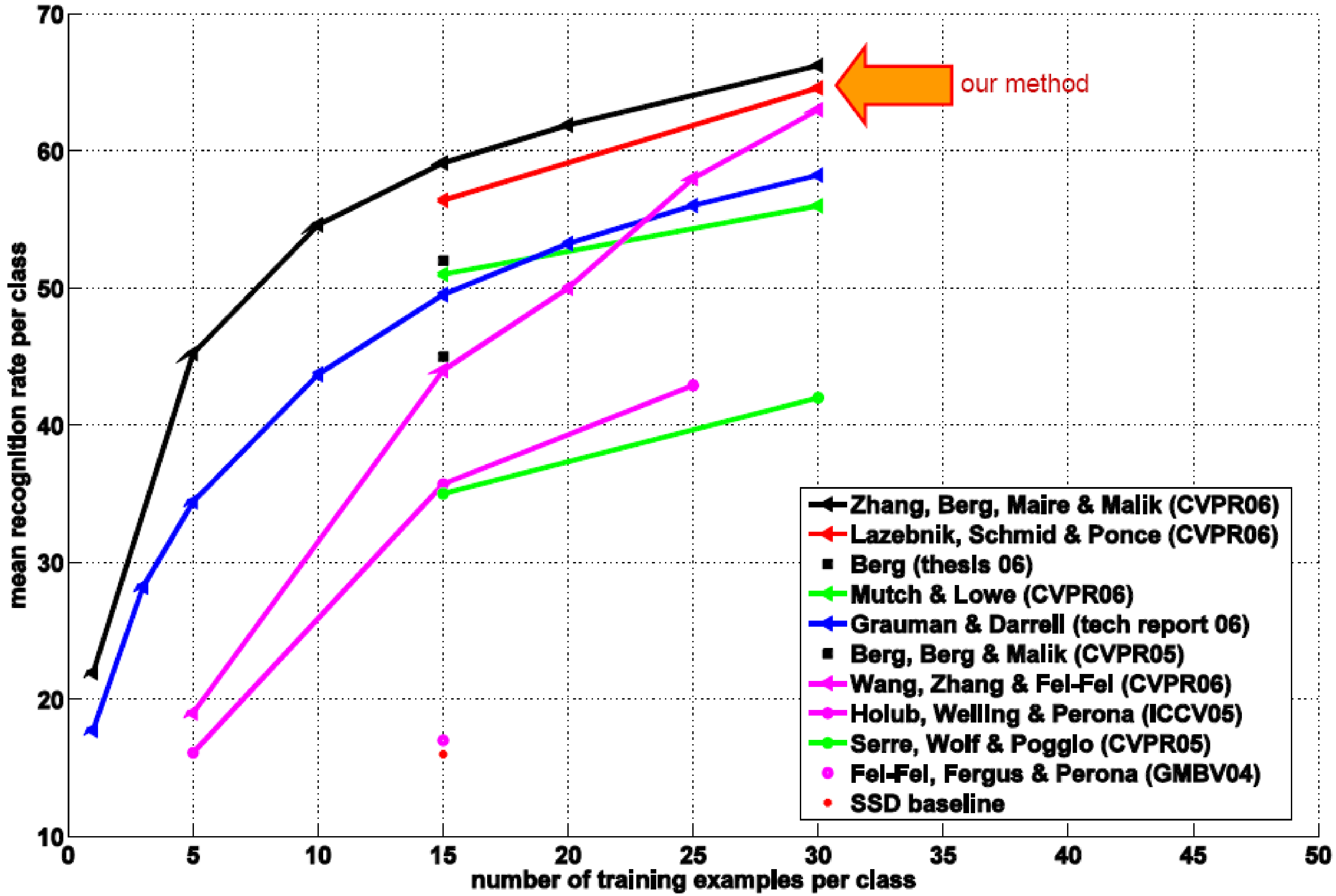
	Weak features (16)		Strong features (200)	
Level	Single-level	Pyramid	Single-level	Pyramid
0	15.5 $\pm$0.9		41.2 $\pm$1.2	
1	31.4 $\pm$1.2	32.8 $\pm$1.3	55.9 $\pm$0.9	57.0 $\pm$0.8
2	47.2 $\pm$1.1	49.3 $\pm$1.4	63.6 $\pm$0.9	**64.6** $\pm$0.8
3	52.2 $\pm$0.8	**54.0** $\pm$1.1	60.3 $\pm$0.9	64.6 $\pm$0.7



SPM Article

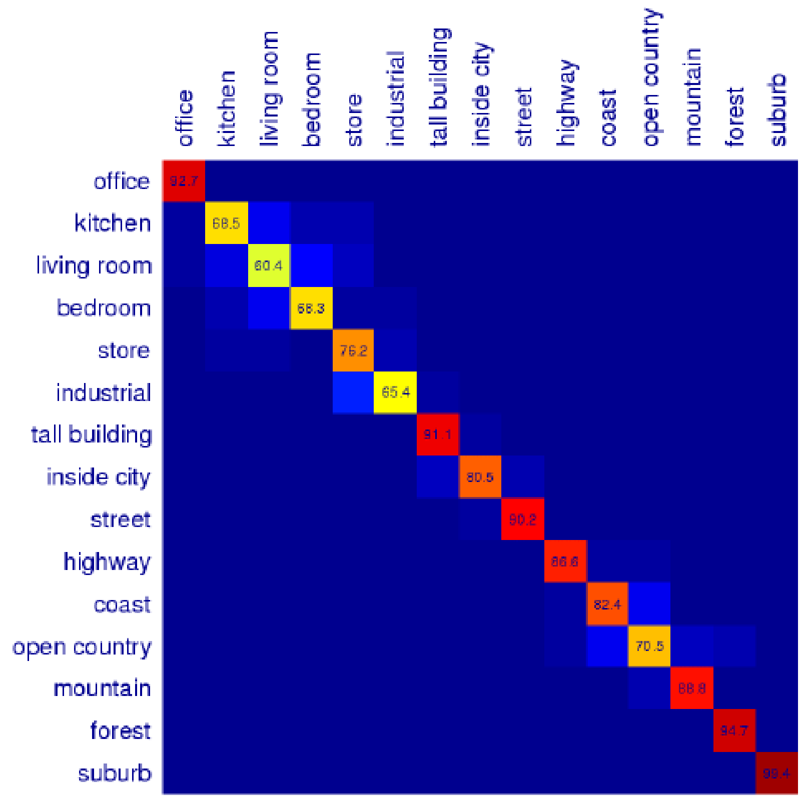
Caltech101 comparison

Zhang, Berg, Maire & Malik, 2006



SPM Article

Scene category confusions



Difficult indoor images

kitchen

living room

bedroom

SPM Article

Caltech101 challenges

Top five confusions

class 1 / class 2	class 1 mis-classified as class 2	class 2 mis-classified as class 1
ketch / schooner	21.6	14.8
lotus / water lily	15.3	20.0
crocodile / crocodile head	10.5	10.0
crayfish / lobster	11.3	9.1
flamingo / ibis	9.5	10.4

Easiest and hardest classes

minaret (97.6%)

windsor chair (94.6%)

joshua tree (87.9%)

okapi (87.8%)

cougar body (27.6%)

beaver (27.5%)

crocodile (25.0%)

ant (25.0%)

- Sources of difficulty: lack of texture, camouflage, "thin" objects, highly deformable shape

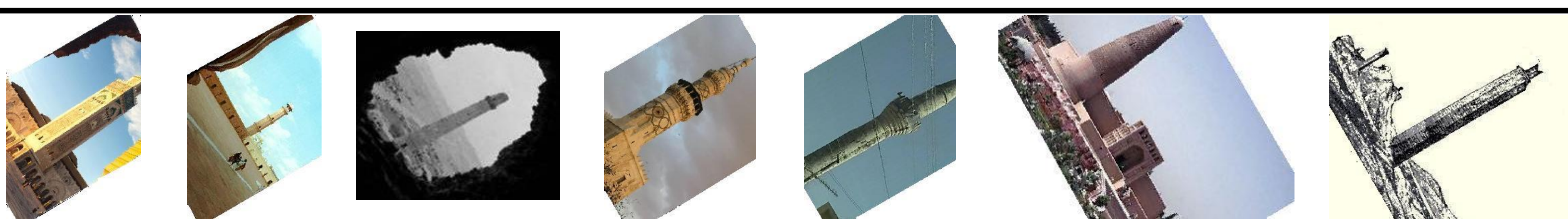
PMK/SIFT Best Categories (1-5)

100%

100%

99.7%

99.1%



98.2%

SPM Article

PMK/SIFT Best Categories (6-10)

97.7%

97.4%

95.7%

95.3%

95.2%

SPM Article

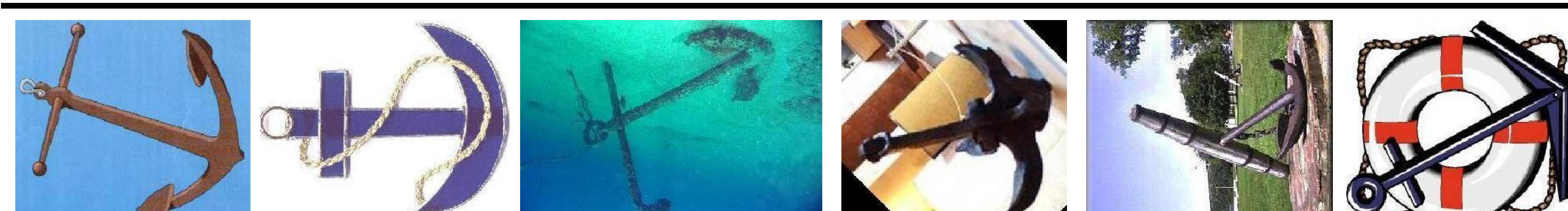
PMK/SIFT 5 Worst Categories

7.7%

11.2%

11.5%

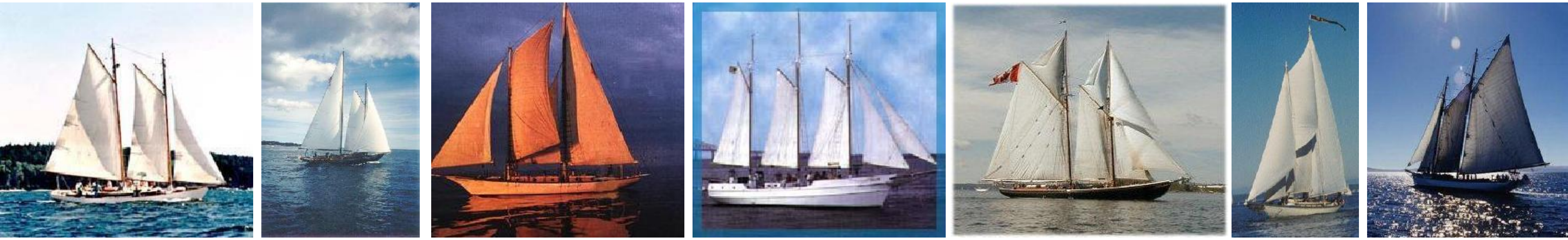
11.8%



12.3%

SPM Article

PMK/SIFT Most Confused Category Pairs



schooner

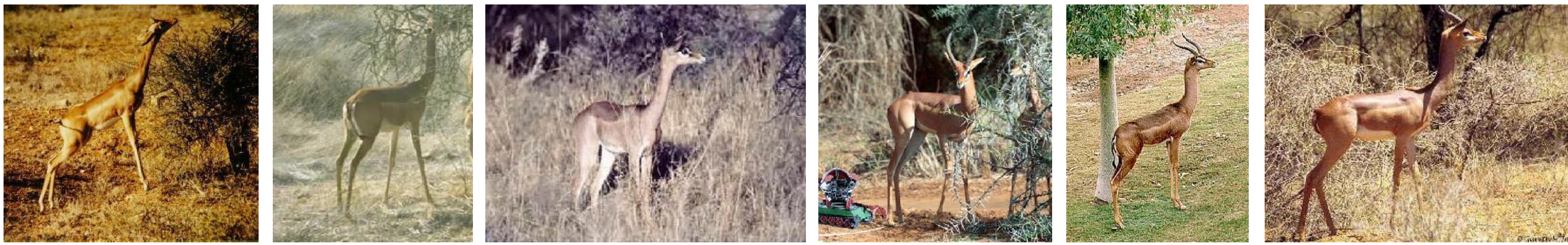
A fore-and-aft rigged sailing vessel having at least two masts, with a foremast that is usually smaller than the other masts.

ketch

A two-masted fore-and-aft-rigged sailing vessel with a mizzenmast stepped aft of a taller mainmast but forward of the rudder.

SPM Article

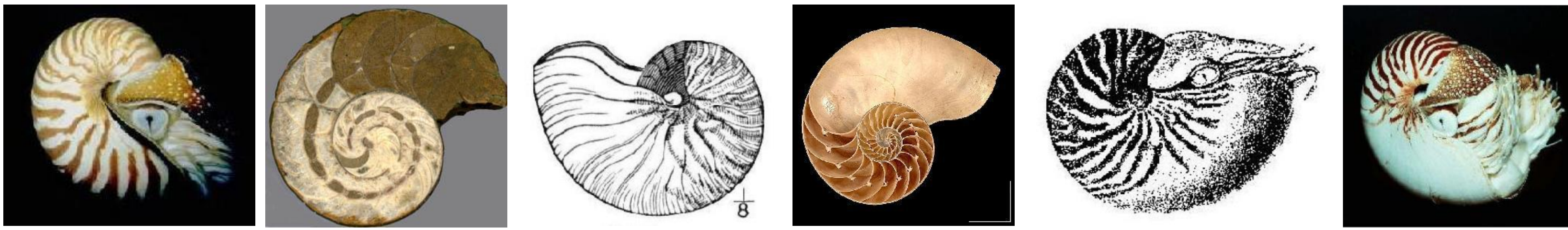
PMK/SIFT Most Confused Category Pairs



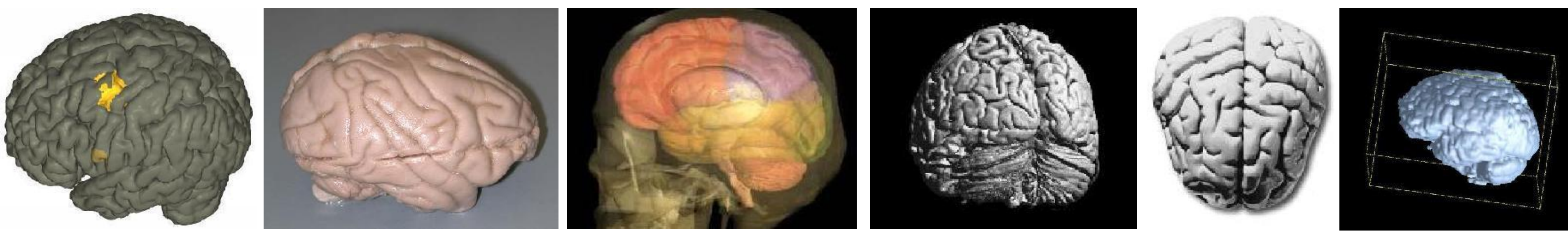
Gerenuk (**antilope girafe** ou **gérénuk)**

kangaroo

PMK/SIFT Most Confused Category Pairs



nautilus



brain