计算机视觉
——目标识别

目的

- 了解什么是目标识别？
- 熟悉两种目标识别方法

目标识别（分类）

- 任务：通用目标识别

目标识别（分类）

- 任务：通用目标识别

horse

person

目标识别（分类）

- 基于特征点的目标识别

- 局部特征 + BOW

Bag-of-words目标识别框架

Object → **Bag of 'words'**

(Li Fei-Fei, ICCV 2005)

Bag-of-words目标识别框架

Of all the sensory impressions proceeding to the brain, the visual experiences are the dominant ones. Our perception of the world around us is bas… messages tha… eyes. For a long … inal image wa… visual ce… x was a m… the ima… the disc… know th… perceptio… more com… following t… h to the various… ex, Hubel and Wies… demonstrate that th… *image falling on the retina undergo… ep-wise analysis in a system of nerve ce… ed in columns. In this system each cell ha… specific function and is responsible for … specific detail in the pattern of the retina… image.*

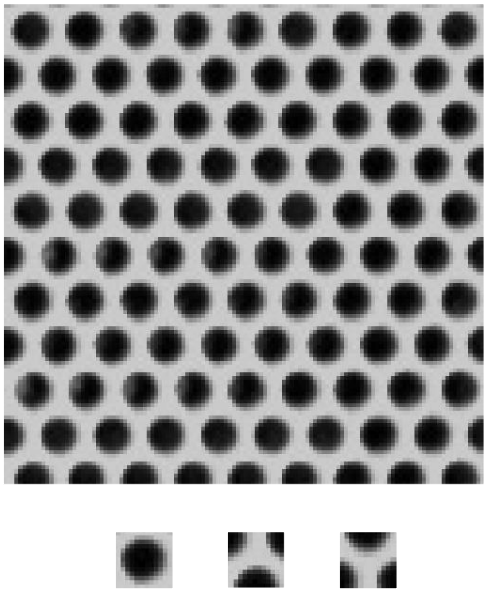
sensory, brain, visual, perception, retinal, cerebral cortex, eye, cell, optical nerve, image Hubel, Wiesel

China is forecasting a trade surplus of $90bn (£51bn) to $100bn this year, a threefold increase on 2004's $32bn. The Commerce Ministry said the … be created by a predicted 30… $750bn, compared … $660bn. … annoy t… China's … delibe… agrees … yuan i… govern… also nee… demand s… country. Ch… yuan against … and permitted it to tra… nd, but the US wants the yuan to be a… to trade freely. However, Beijing has … clear that it will take its time and trea… carefully before allowing the yuan to … further in value.

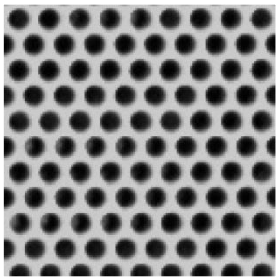
China, trade, surplus, commerce, exports, imports, US, yuan, bank, domestic, foreign, increase, trade, value

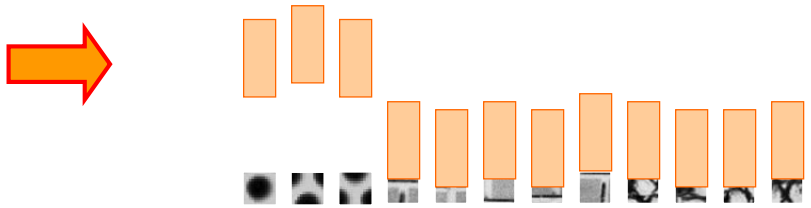
Bag-of-words目标识别框架

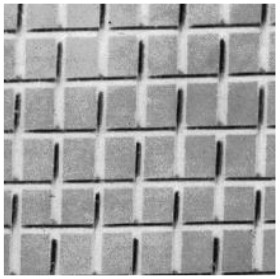
- 纹理是由一些重复的基元（texton）组成的
- 对于有明显统计特征的纹理来讲，我们只需要确认其基元，而不需要确定空间排列

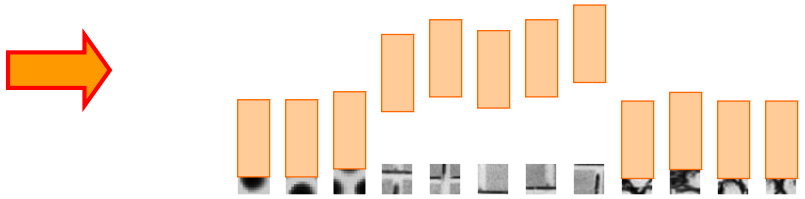


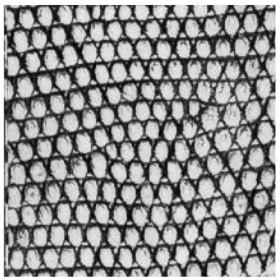
Bag-of-words目标识别框架

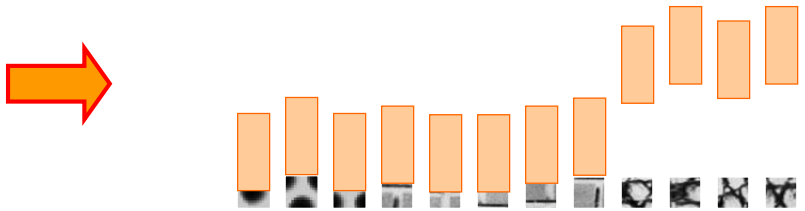






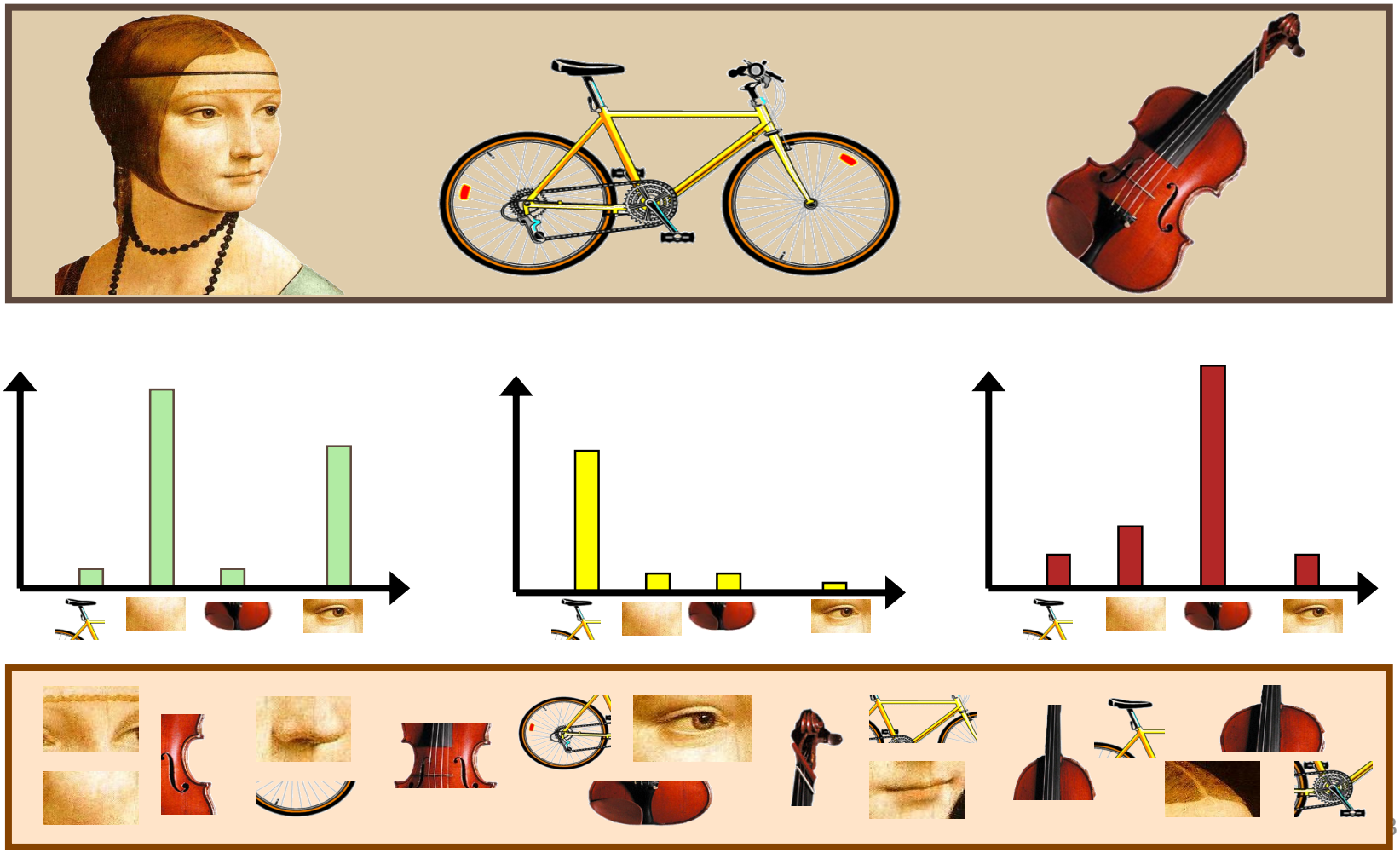


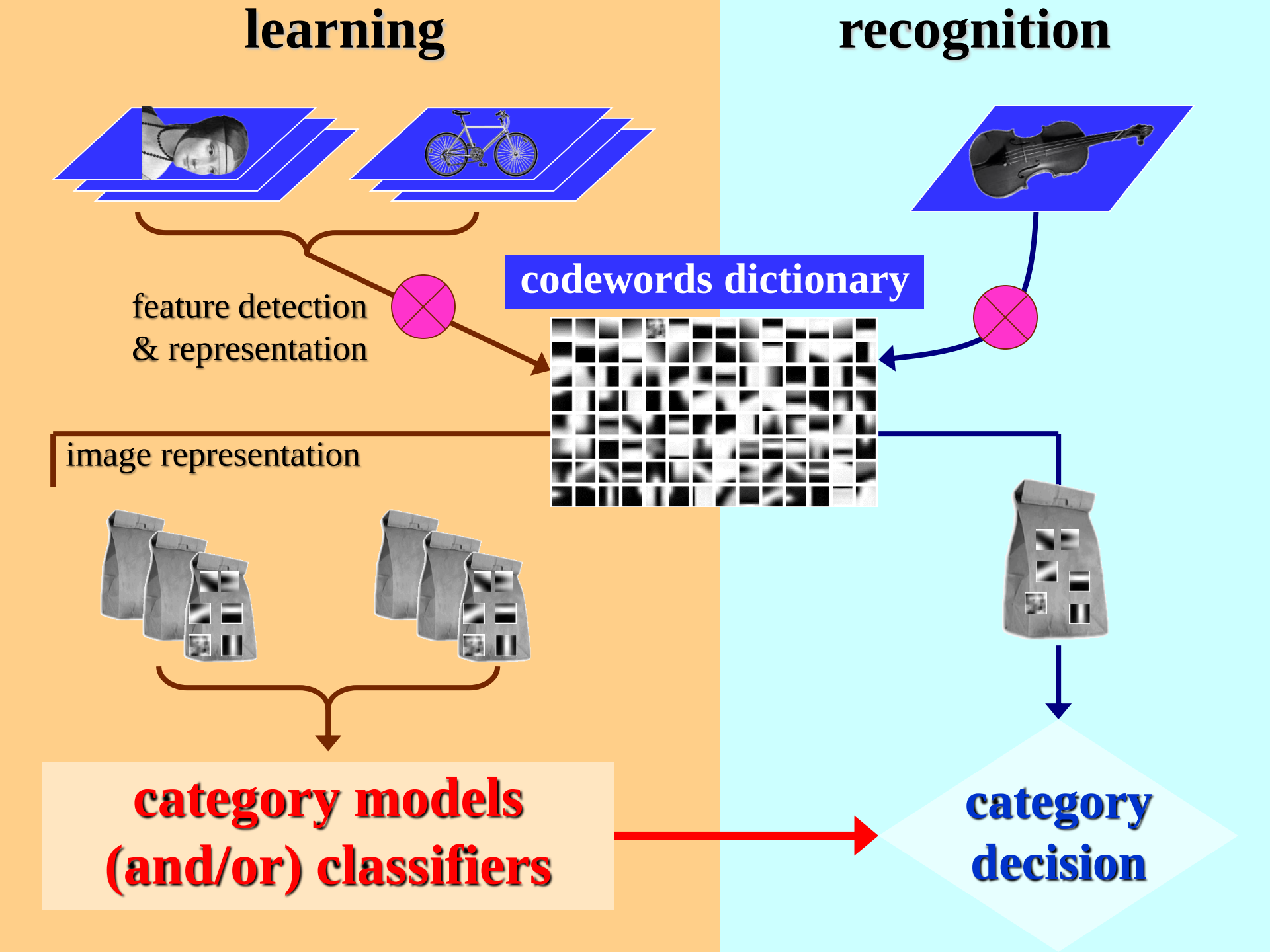




Bag-of-words目标识别框架

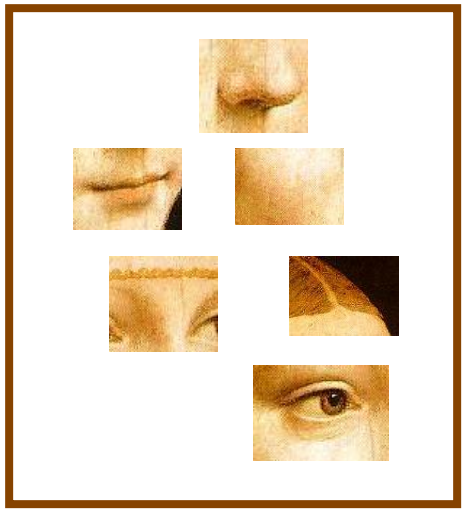
- Bag-of-words框架




learning
recognition
feature detection
& representation
codewords dictionary
image representation
category models
(and/or) classifiers
category
decision

基于Bags of features的目标识别

1. 特征提取



基于Bags of features的目标识别

1. 特征提取
2. 学习视觉字典

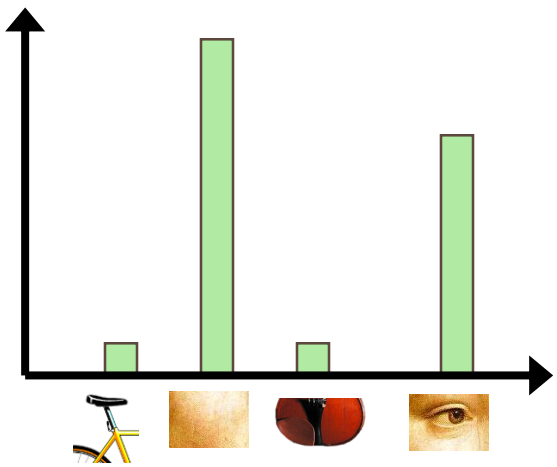
基于Bags of features的目标识别

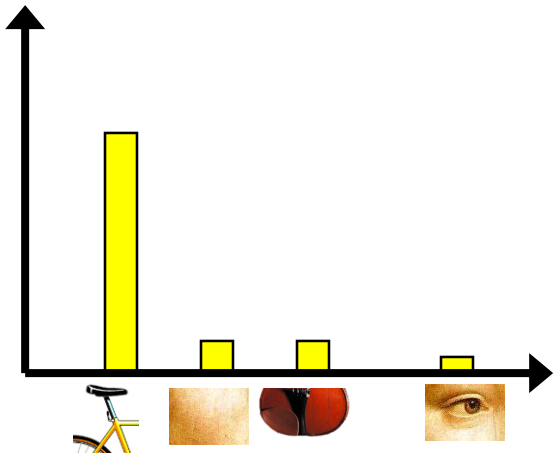
1. 特征提取
2. 学习视觉字典
3. 利用视觉字典对特征进行量化

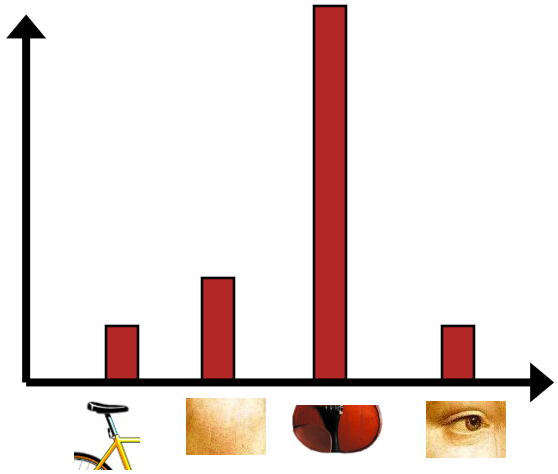
基于Bags of features的目标识别

1. 特征提取
2. 学习视觉字典
3. 利用视觉字典对特征进行量化
4. 将图像表达为视觉字典出现的频率

图像表达





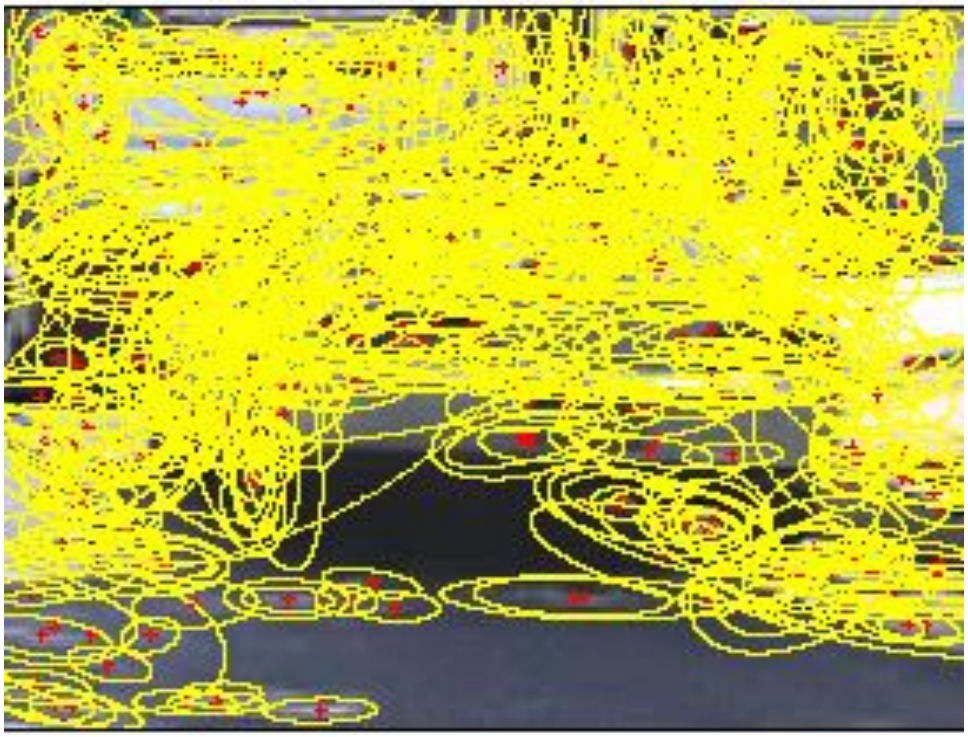


特征提取

1. 规则的网格区域

特征提取

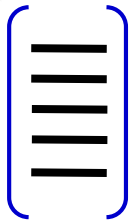
1. 规则的网格区域
2. 感兴趣点



特征提取

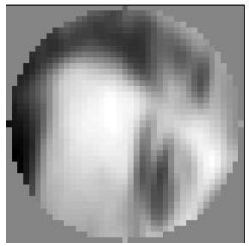
1. 规则的网格区域
2. 感兴趣点
3. 其他方法（随机采样、基于分割的区域）

特征提取

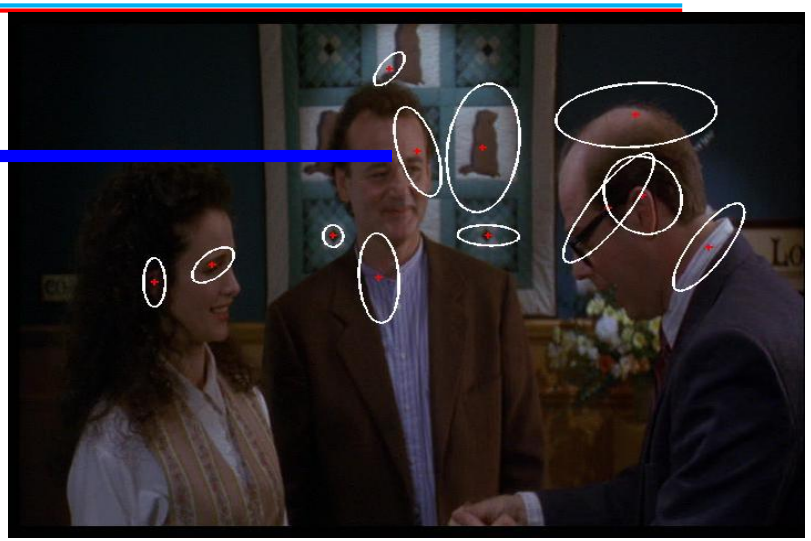


计算

SIFT描述子



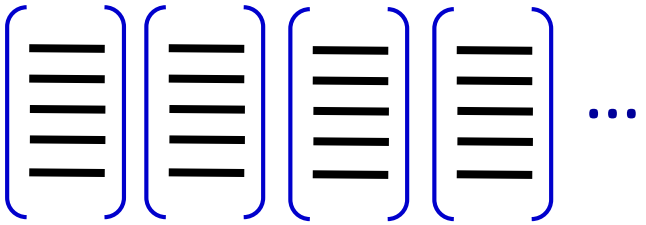
区域归一化

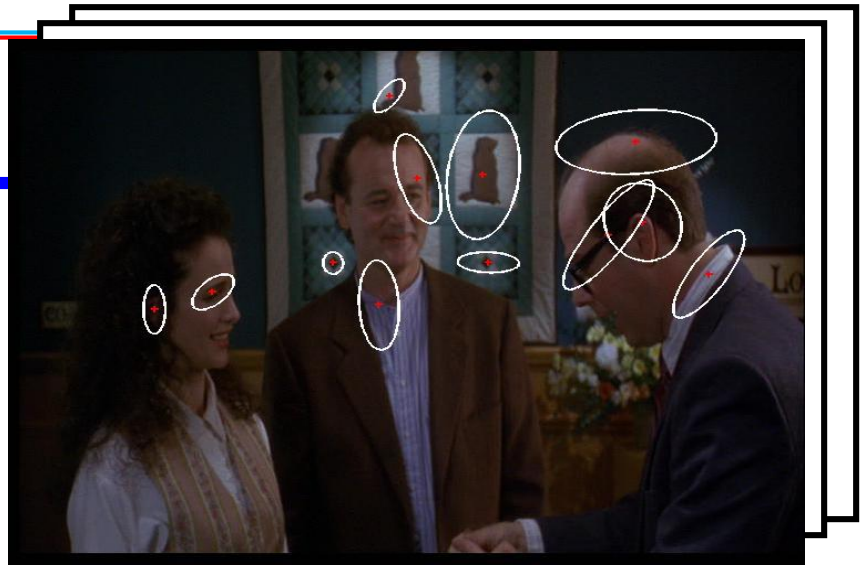


感兴趣点检测

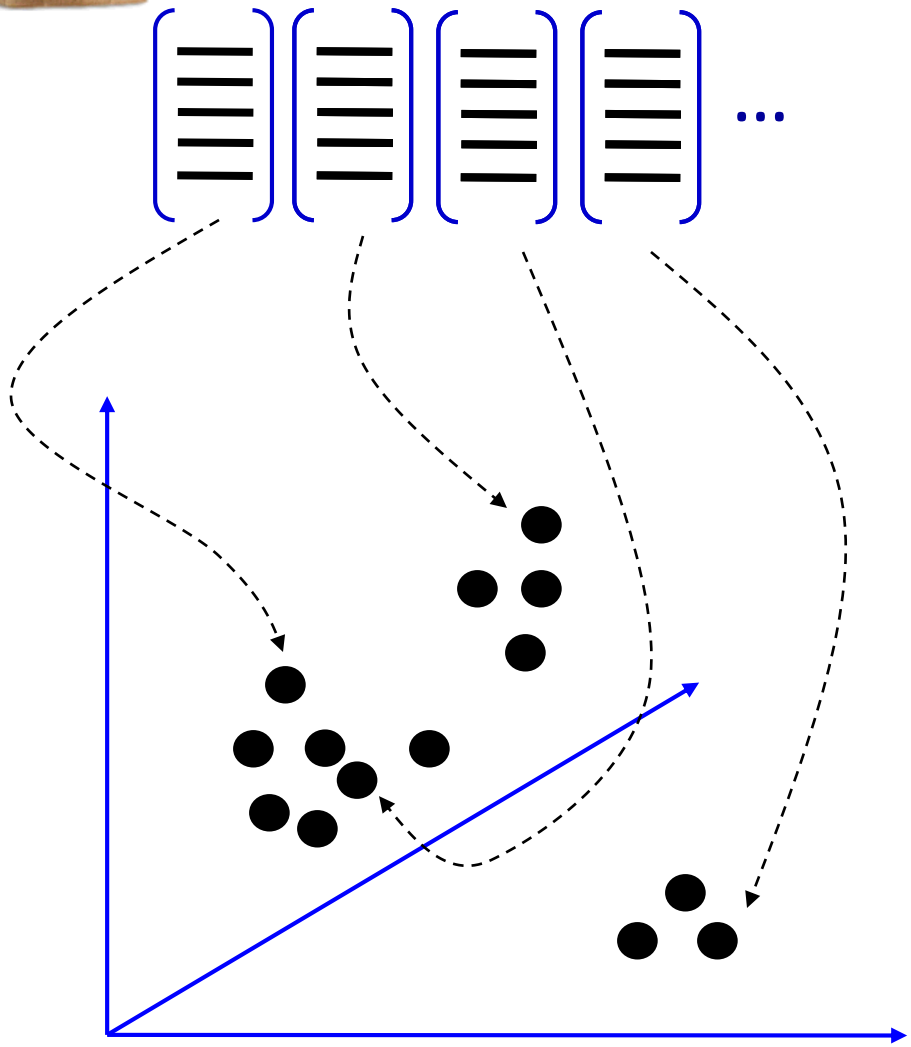
Slide credit: Josef Sivic

特征提取

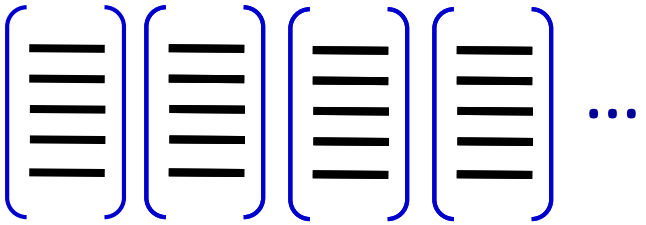


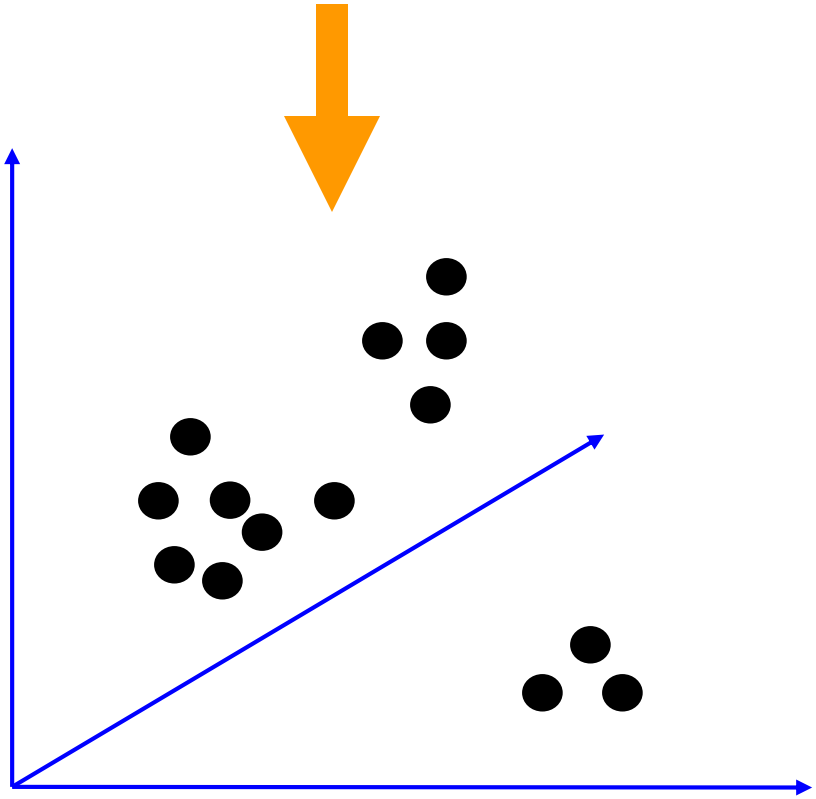


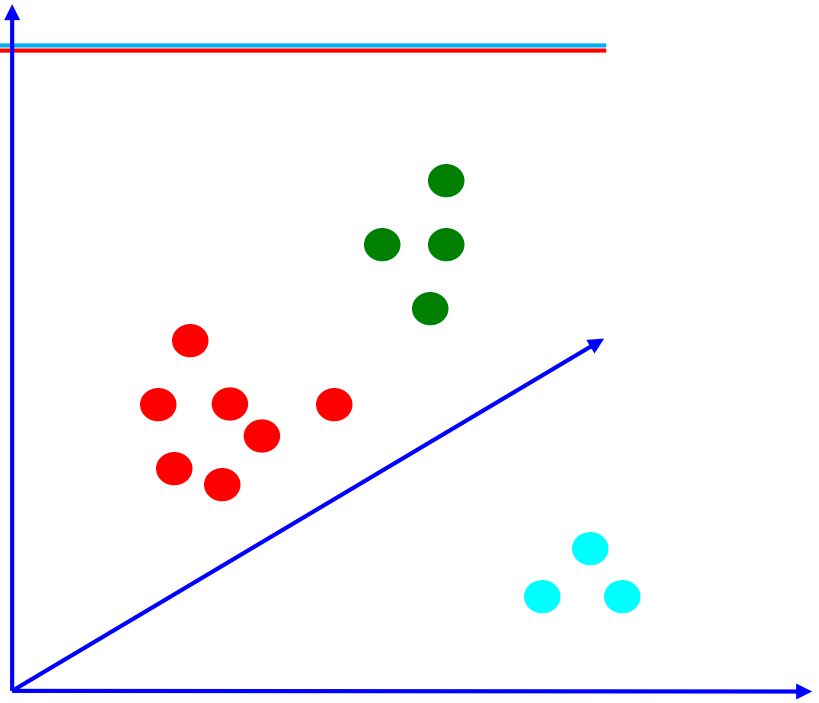
学习视觉字典



学习视觉字典



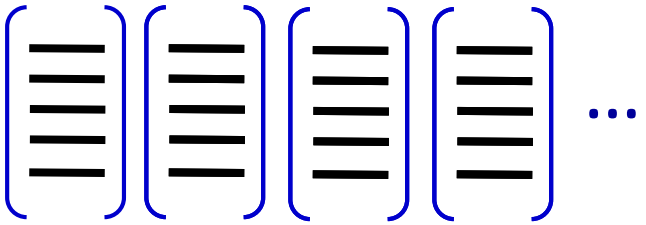


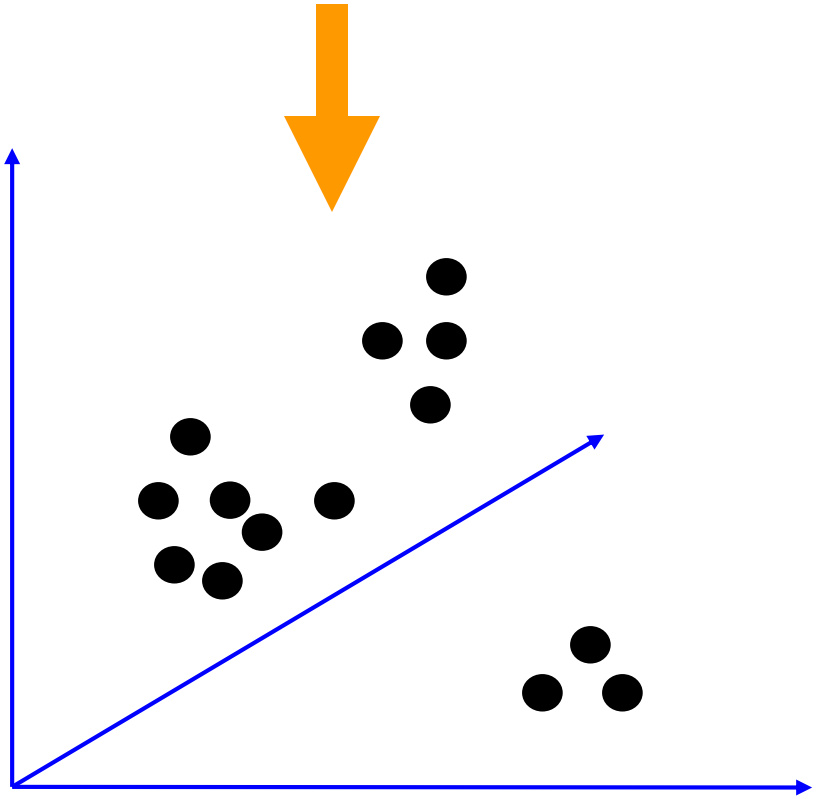


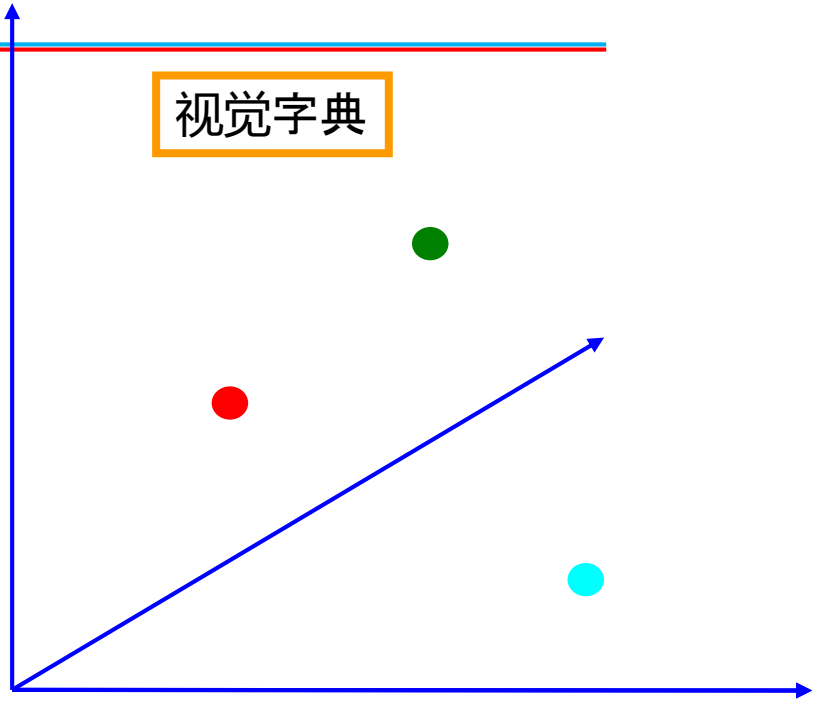
聚类

Slide credit: Josef Sivic

学习视觉字典



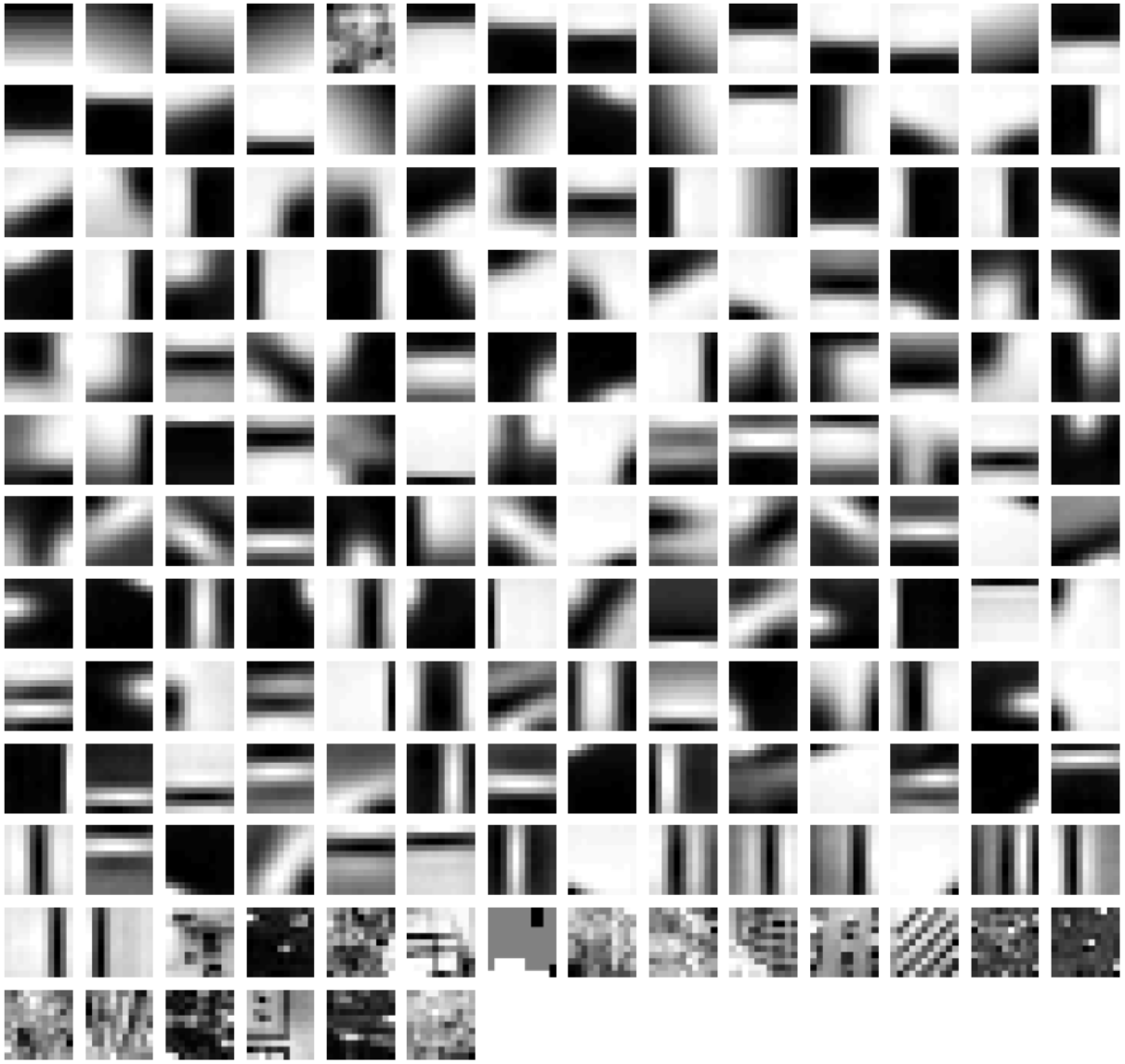




聚类

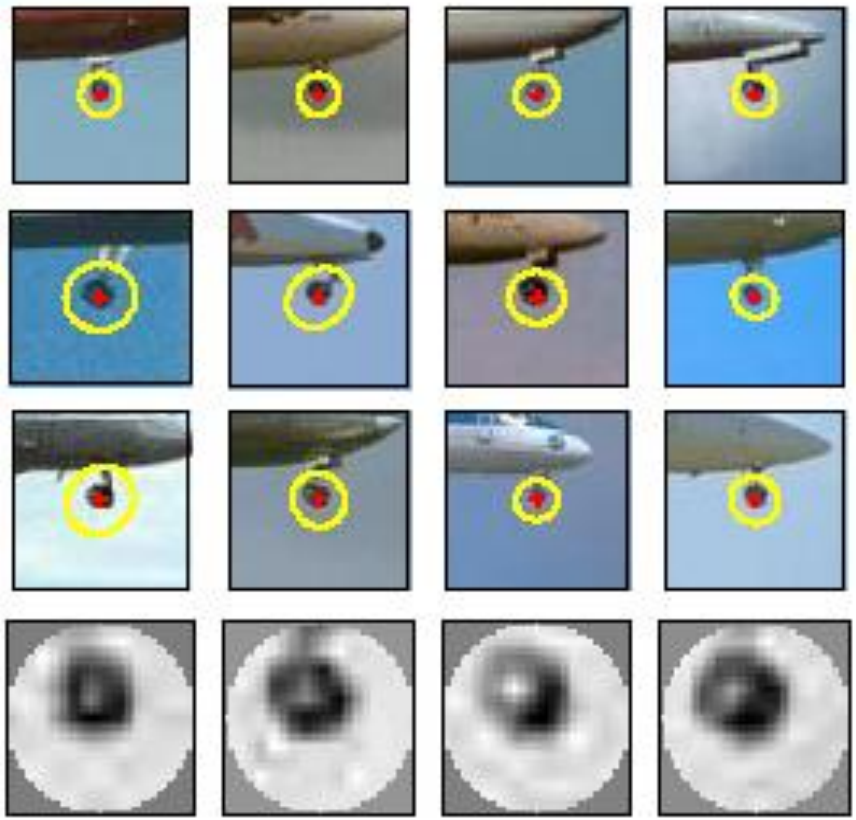
Slide credit: Josef Sivic

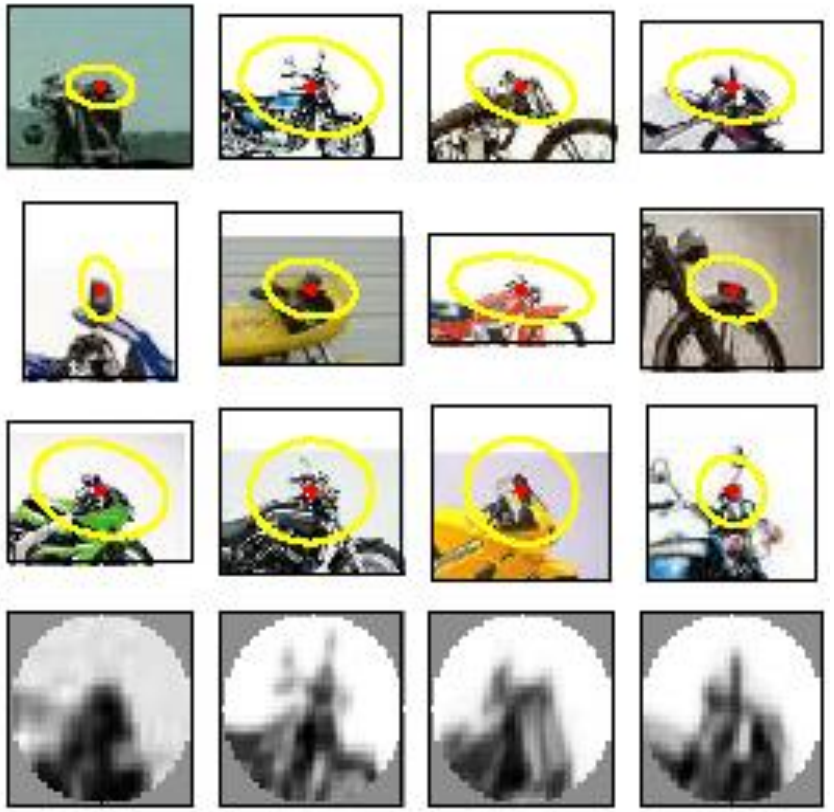
视觉字典举例



Fei-Fei et al. 2005

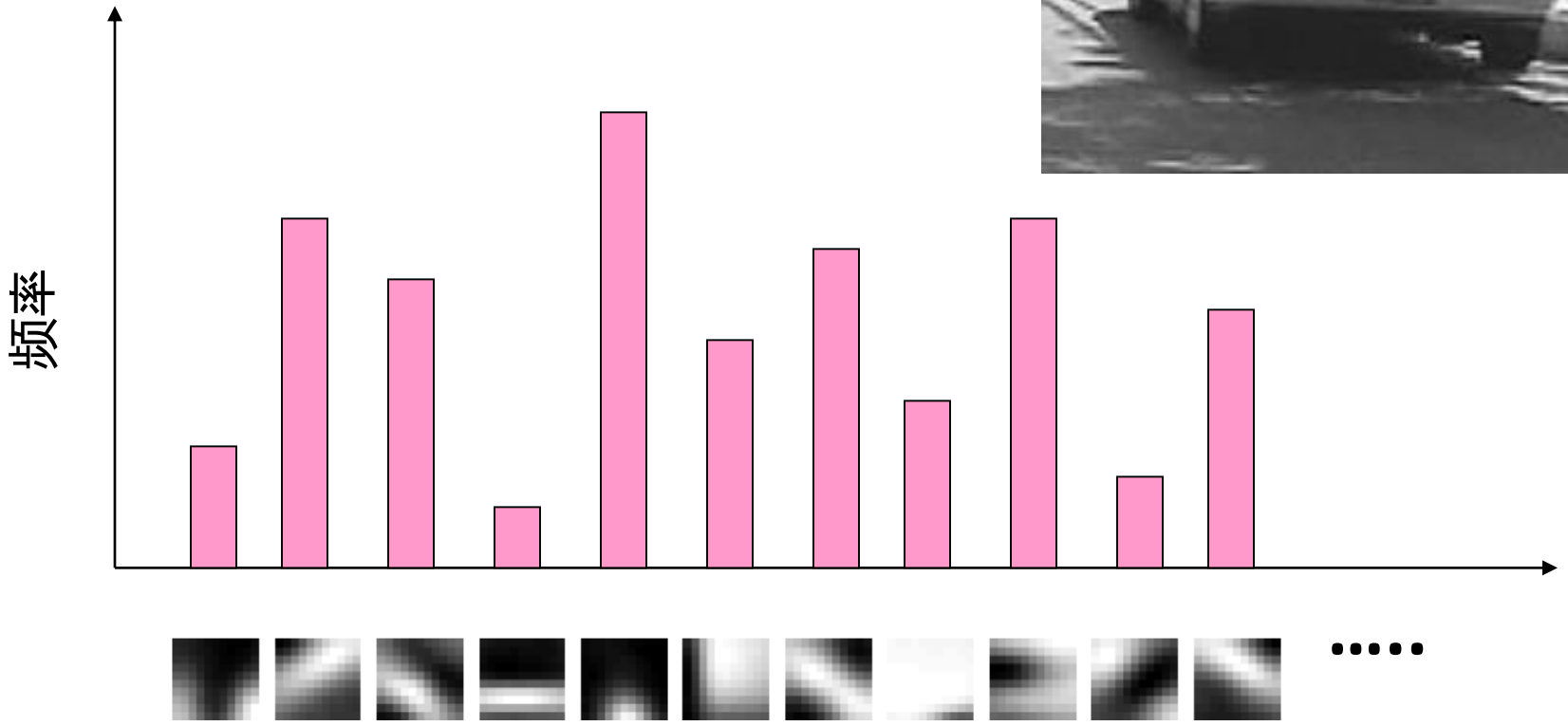
字典对应的图像区域





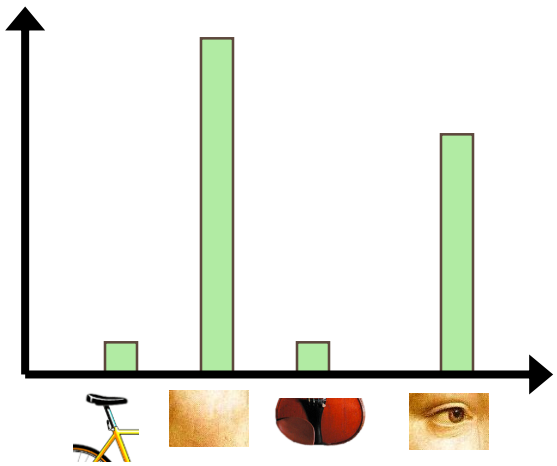
Sivic et al. 2005

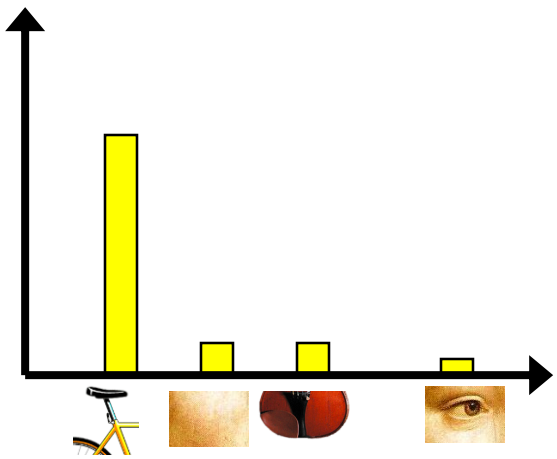
图像表达

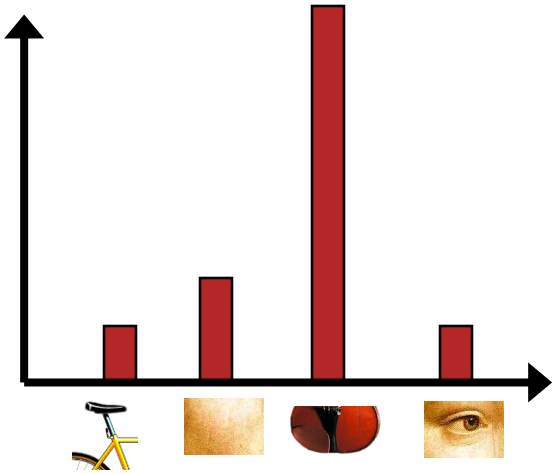


图像表达

- 得到不同类型目标的bag-of-features的表达后，我们如何对它们进行区分？

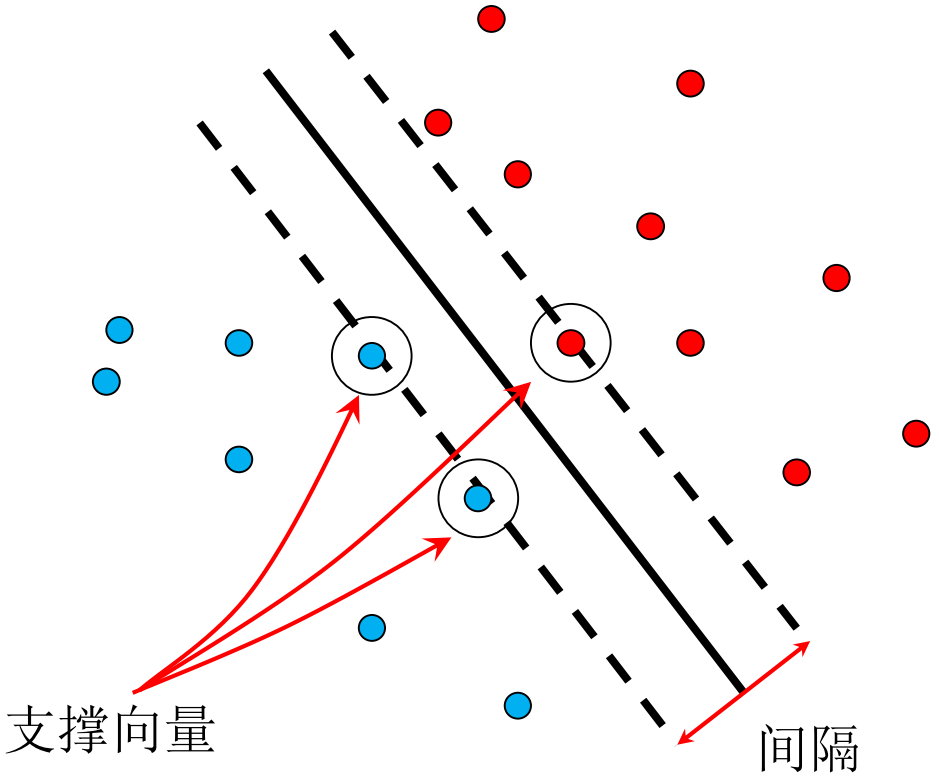






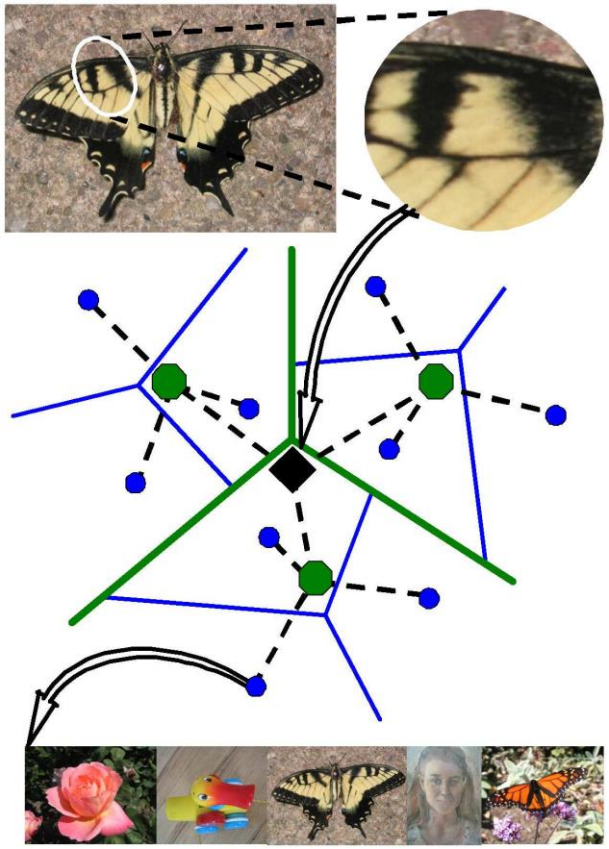
目标分类

- 产生式与判别式
  - 最近邻分类器
  - K近邻分类器
  - SVM分类器



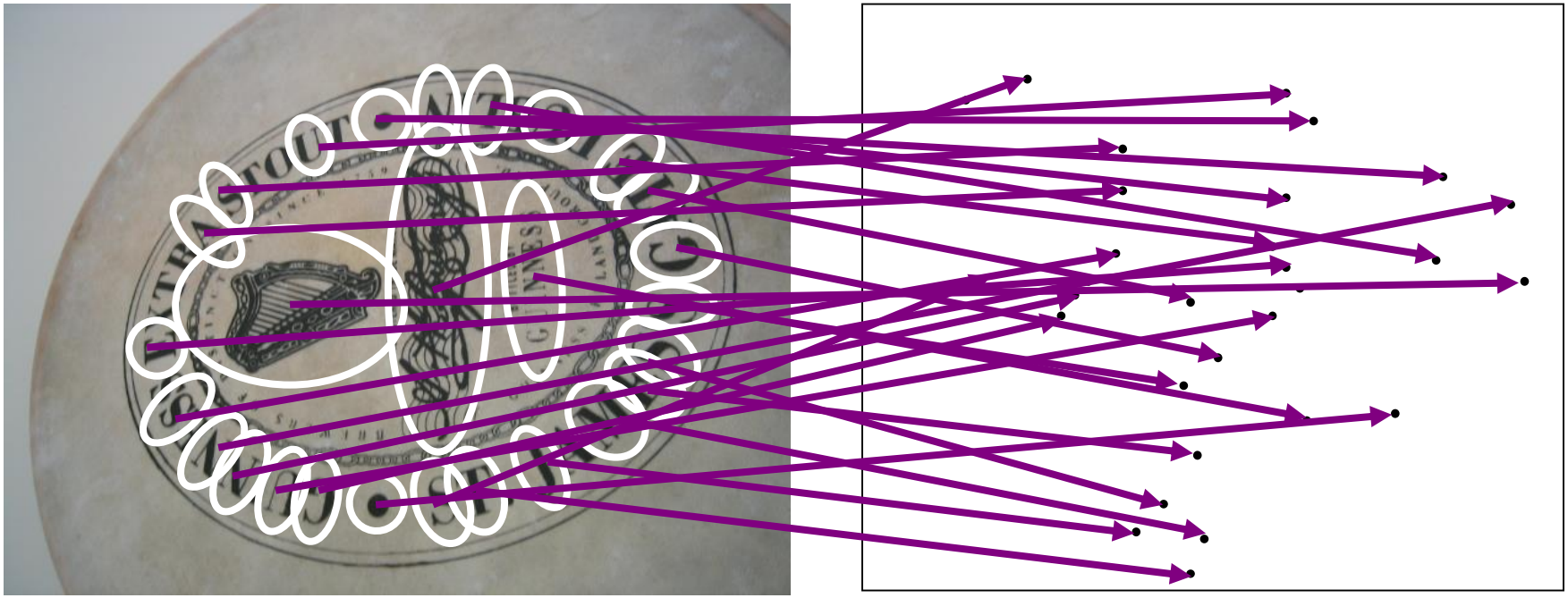
问题

- 如何选择字典大小
- 产生式还是判别式
- 计算效率
  - 字典树
    (Scalable Recognition with a Vocabulary Tree
    Nister & Stewenius, 2006)

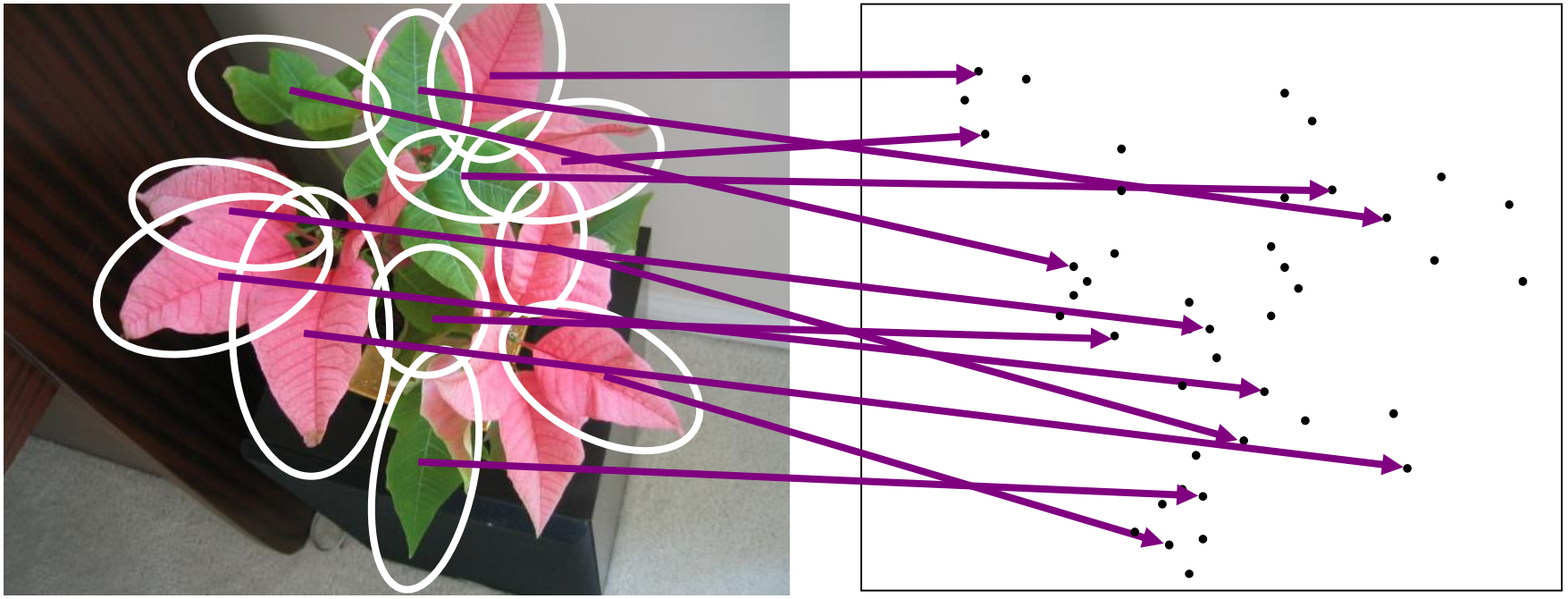


示例：基于字典树的识别

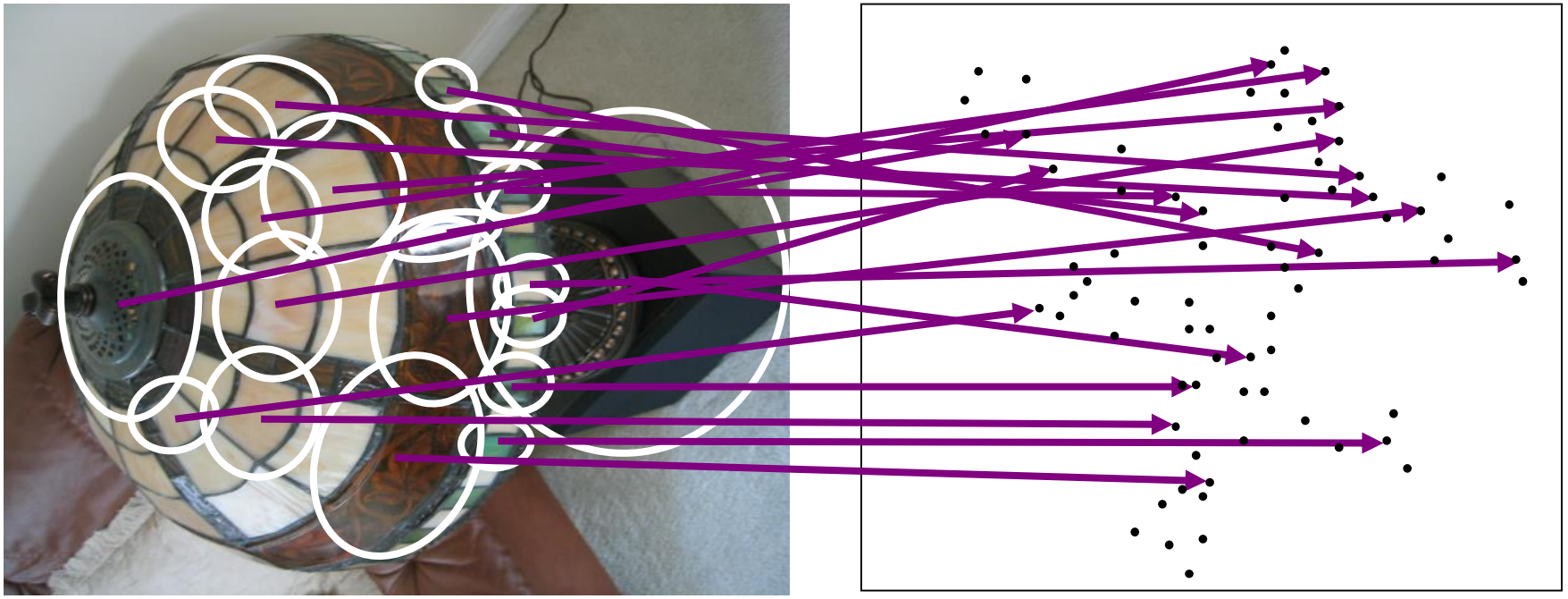
- 提取图像的局部特征



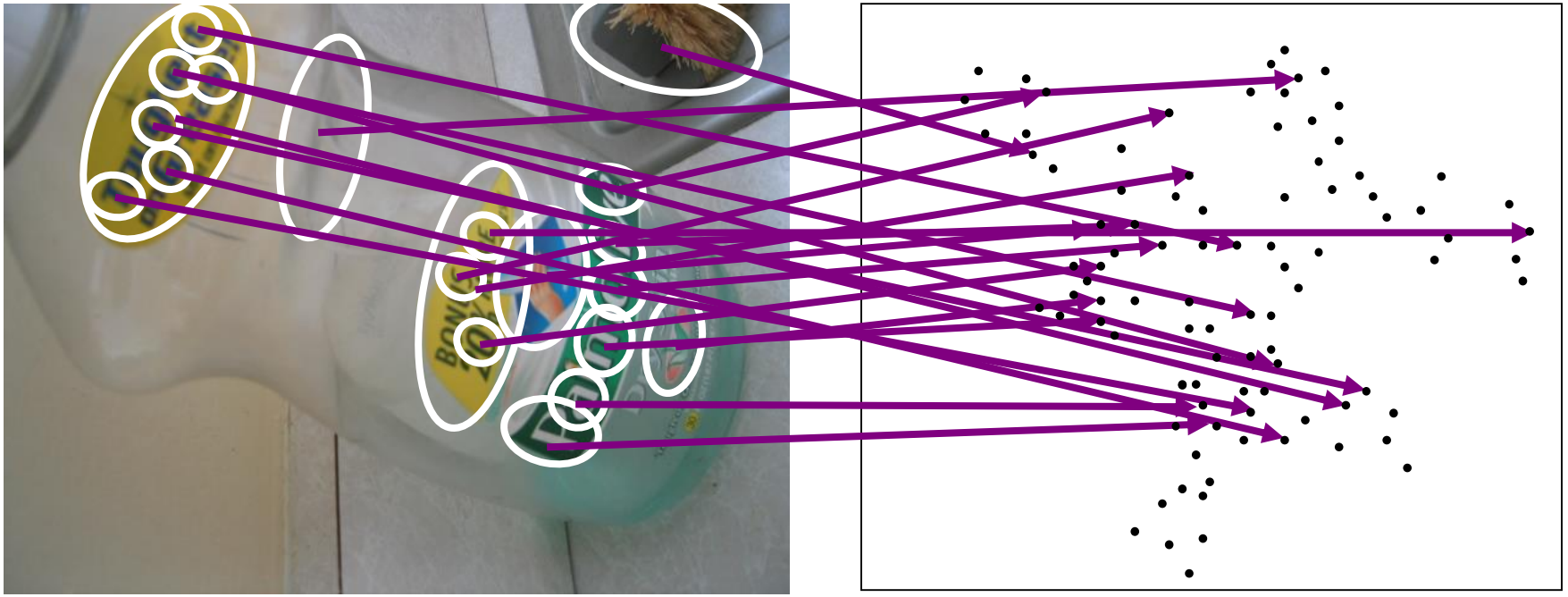
示例：基于字典树的识别

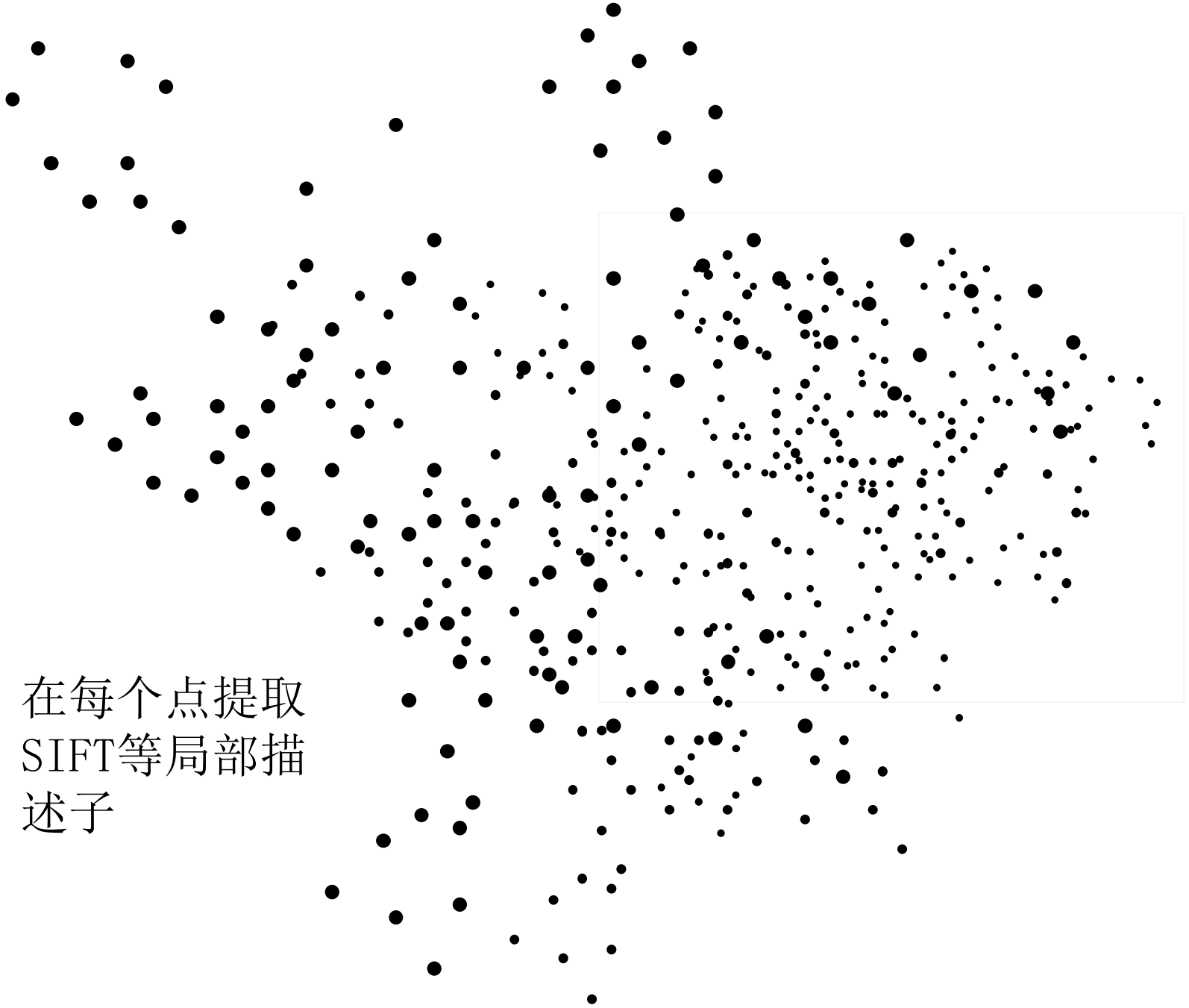


示例：基于字典树的识别

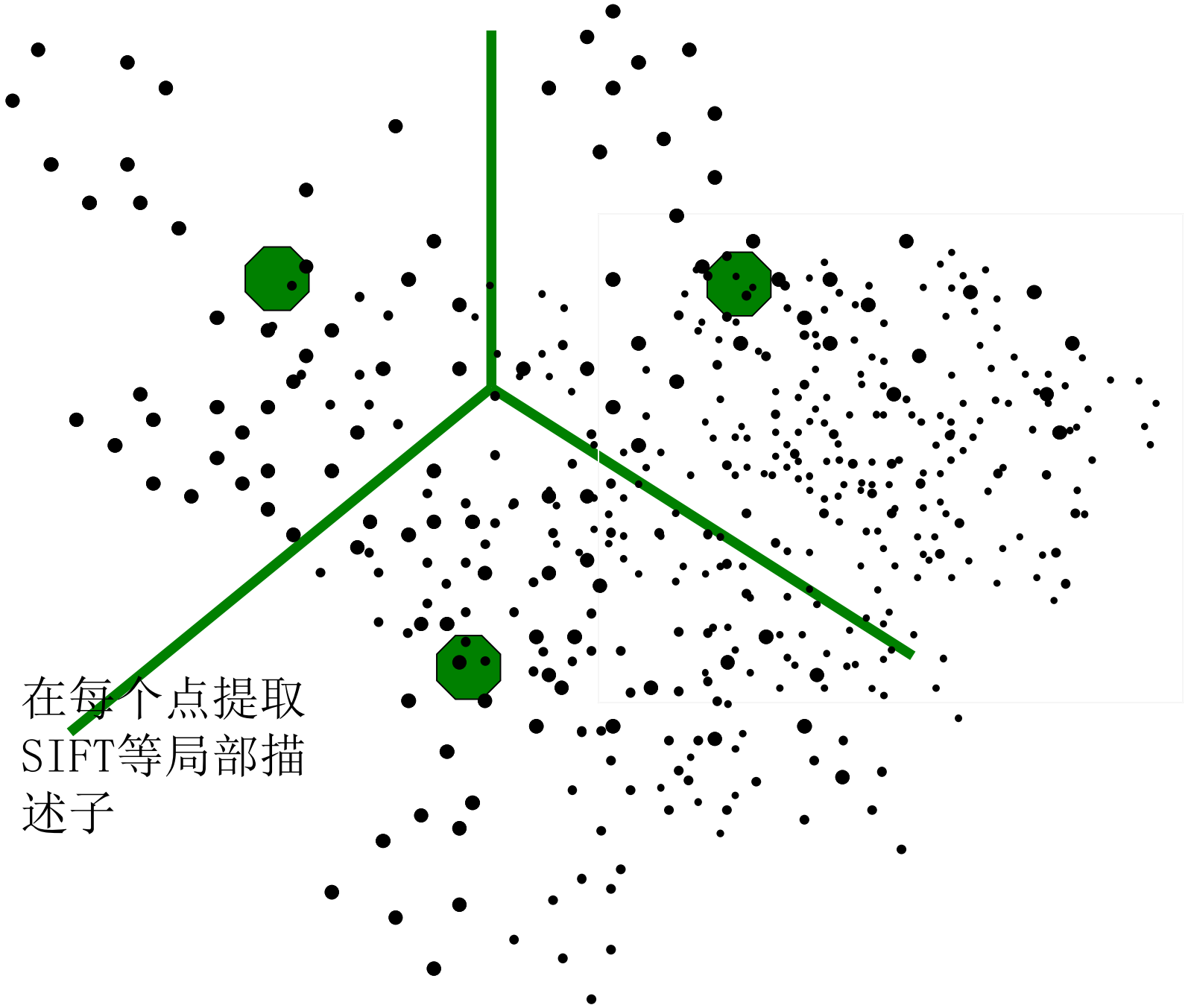


示例：基于字典树的识别



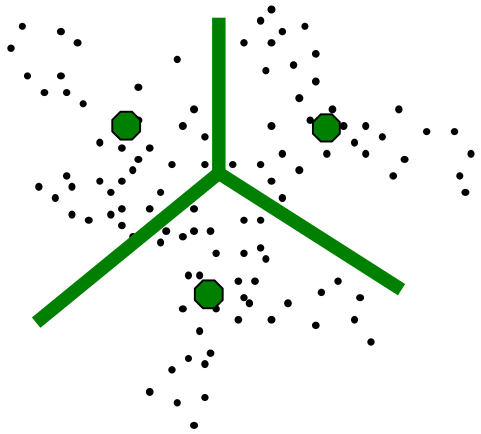


在每个点提取SIFT等局部描述子


在每个点提取
SIFT等局部描
述子

示例：基于字典树的识别

- 视觉单词
- 每一组属于一个语义



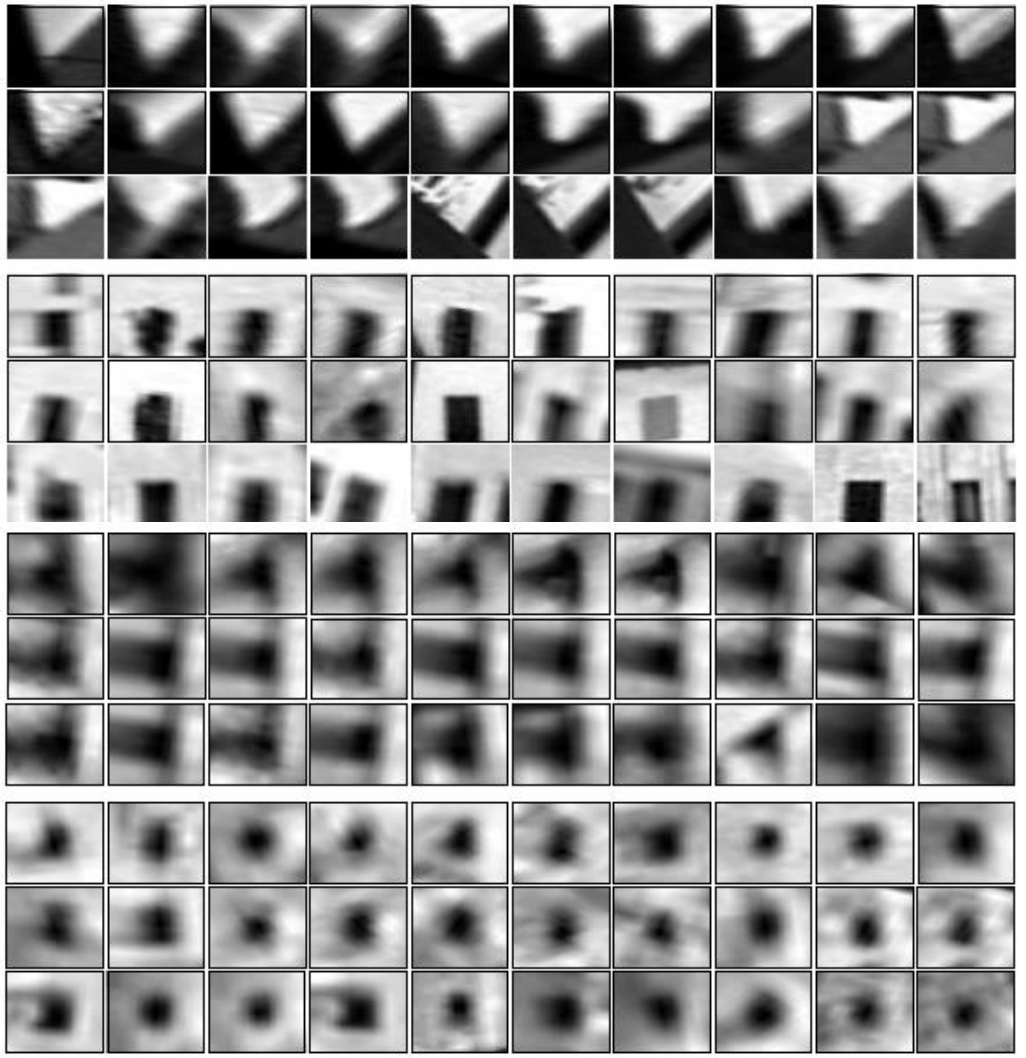
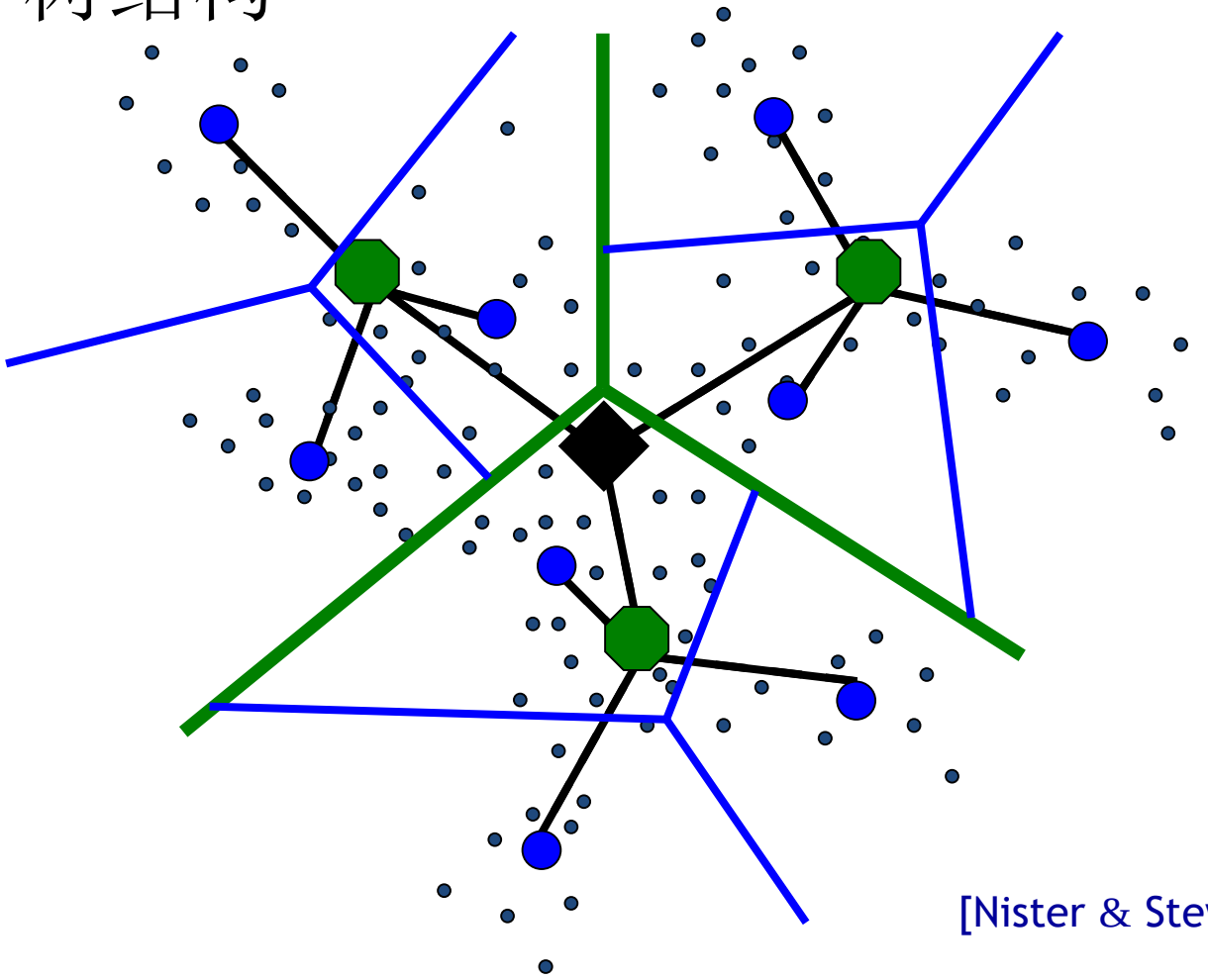


Figure from Sivic & Zisserman, ICCV 2003

示例：基于字典树的识别

- 树结构

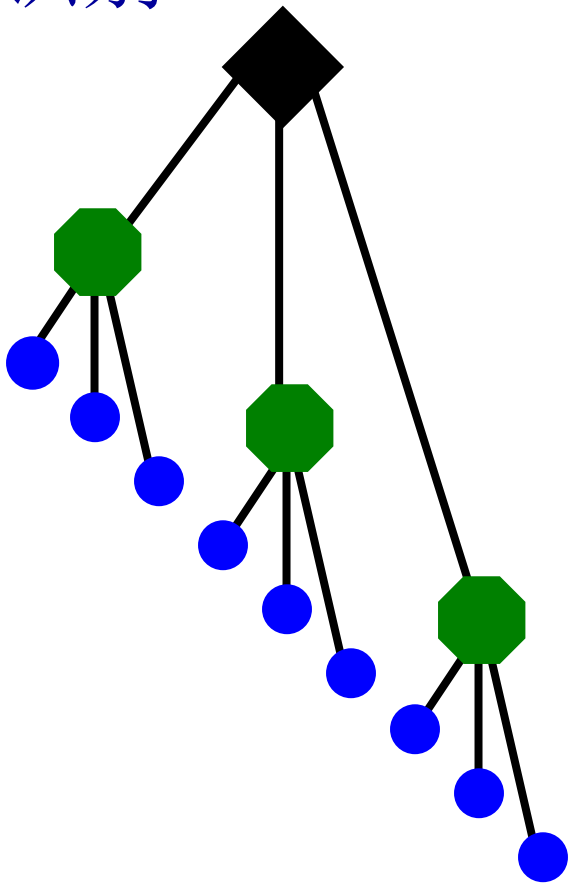


[Nister & Stewenius, CVPR'06]

Slide credit: David Nister

示例：基于字典树的识别

- 字典树
- 训练：完成树结构



[Nister & Stewenius, CVPR'06]

Slide credit: David Nister

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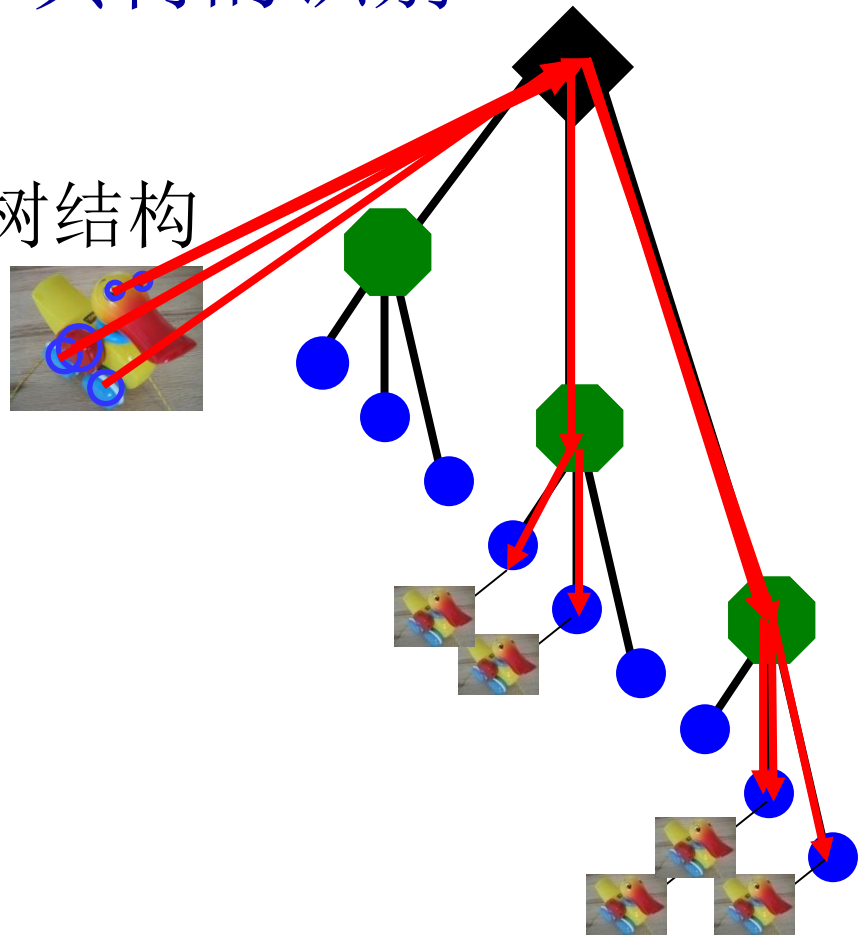
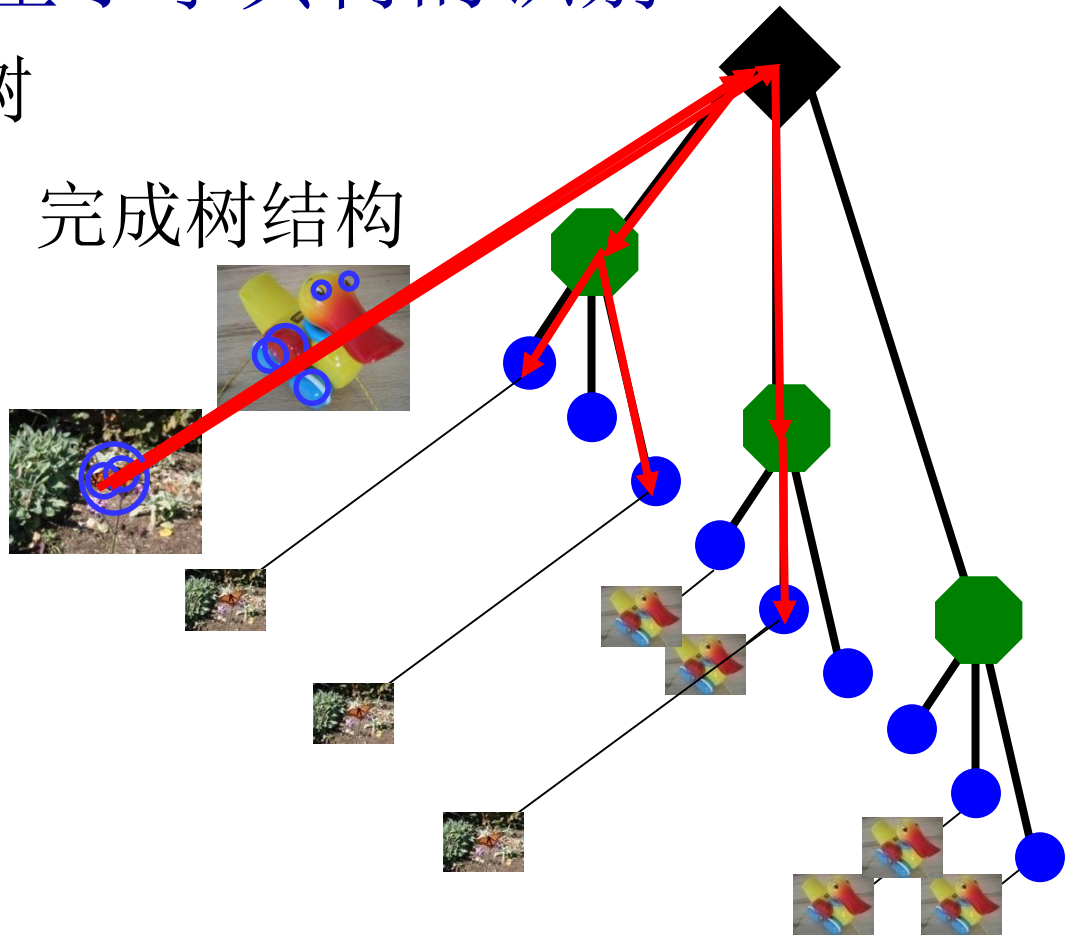


[Nister & Stewenius, CVPR'06]

Slide credit: David Nister

示例：基于字典树的识别

- 字典树
- 训练：完成树结构



[Nister & Stewenius, CVPR'06]

Slide credit: David Nister

示例：基于字典树的识别

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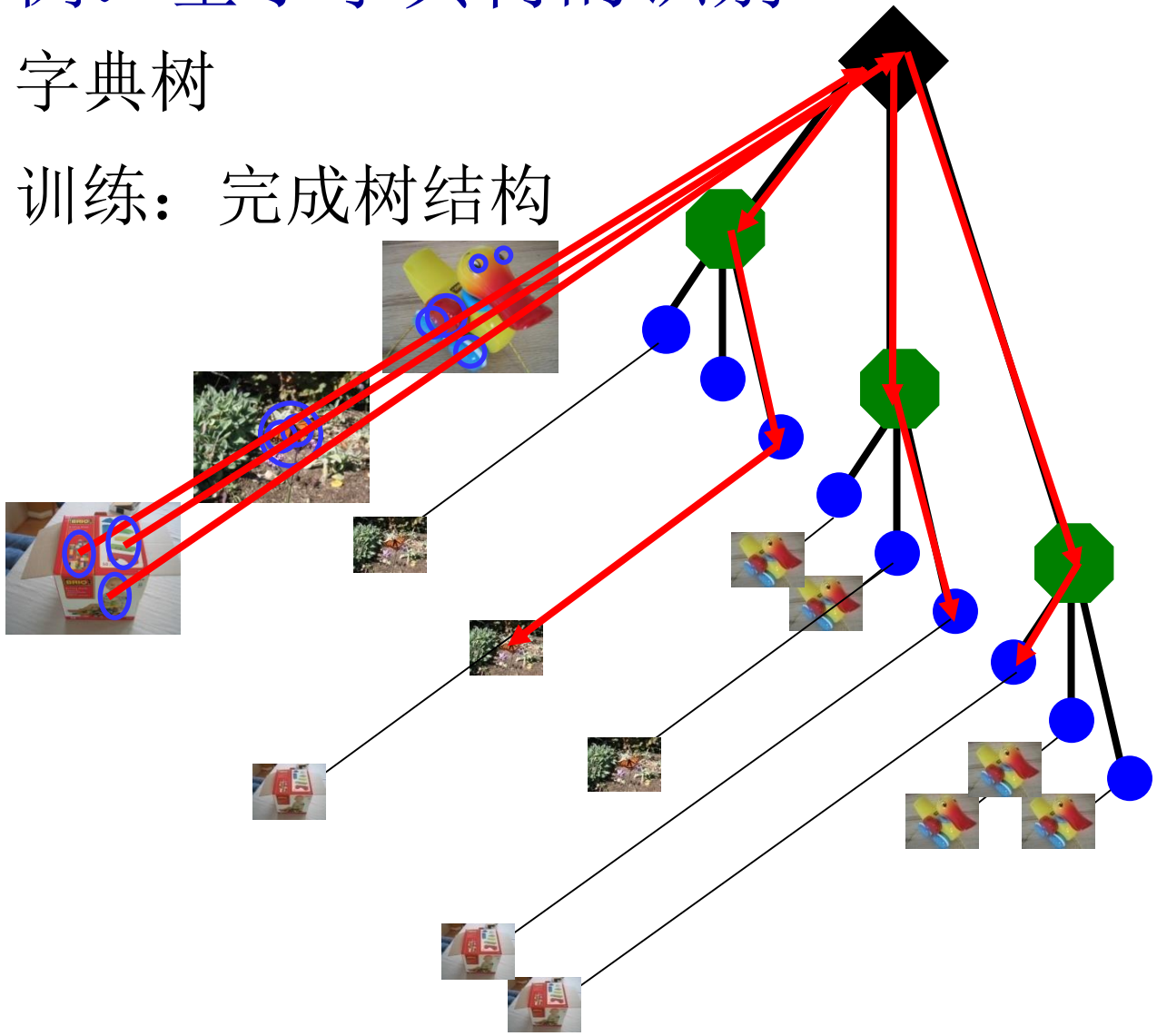

[Nister & Stewenius, CVPR'06]

Slide credit: David Nister

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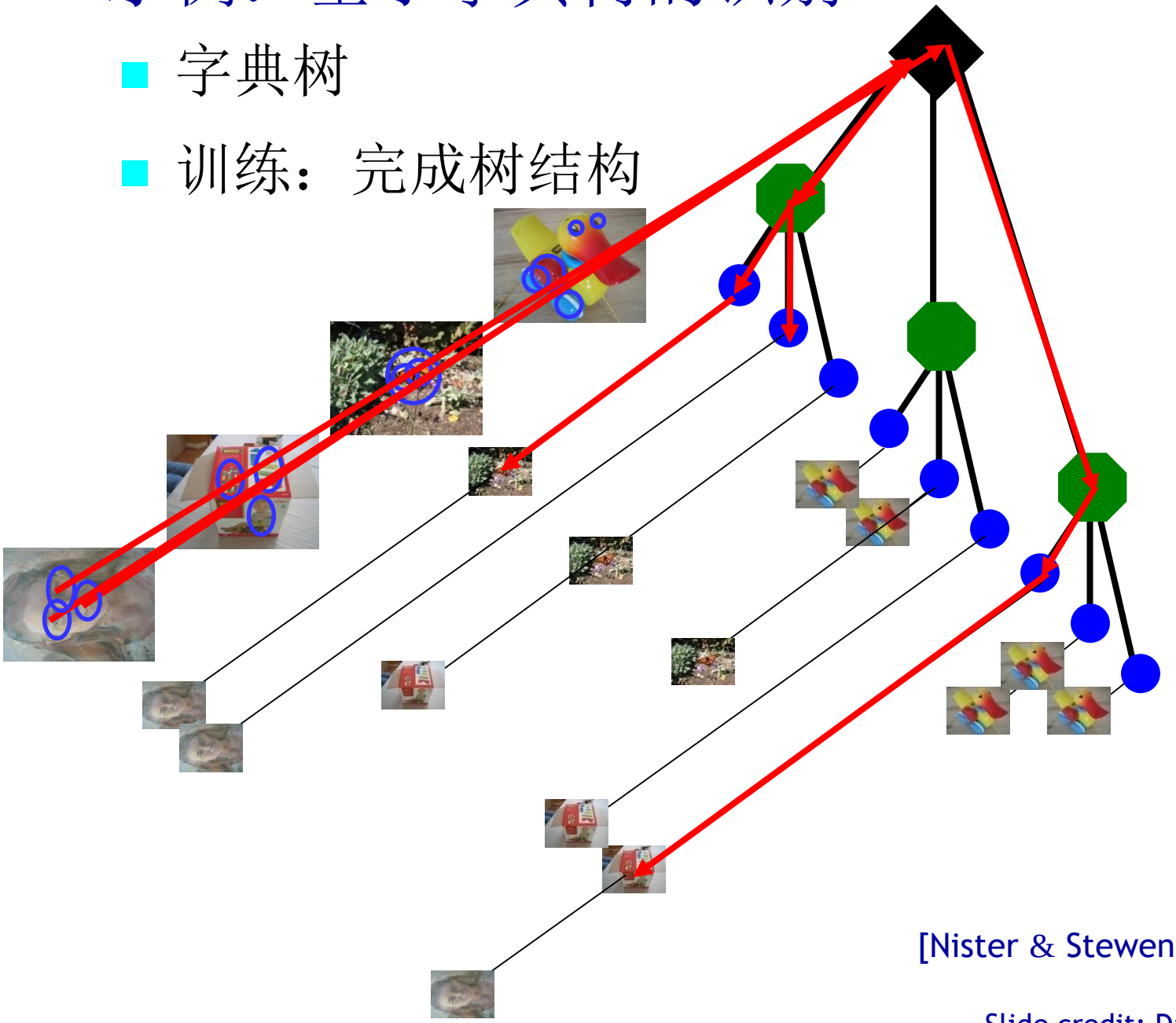
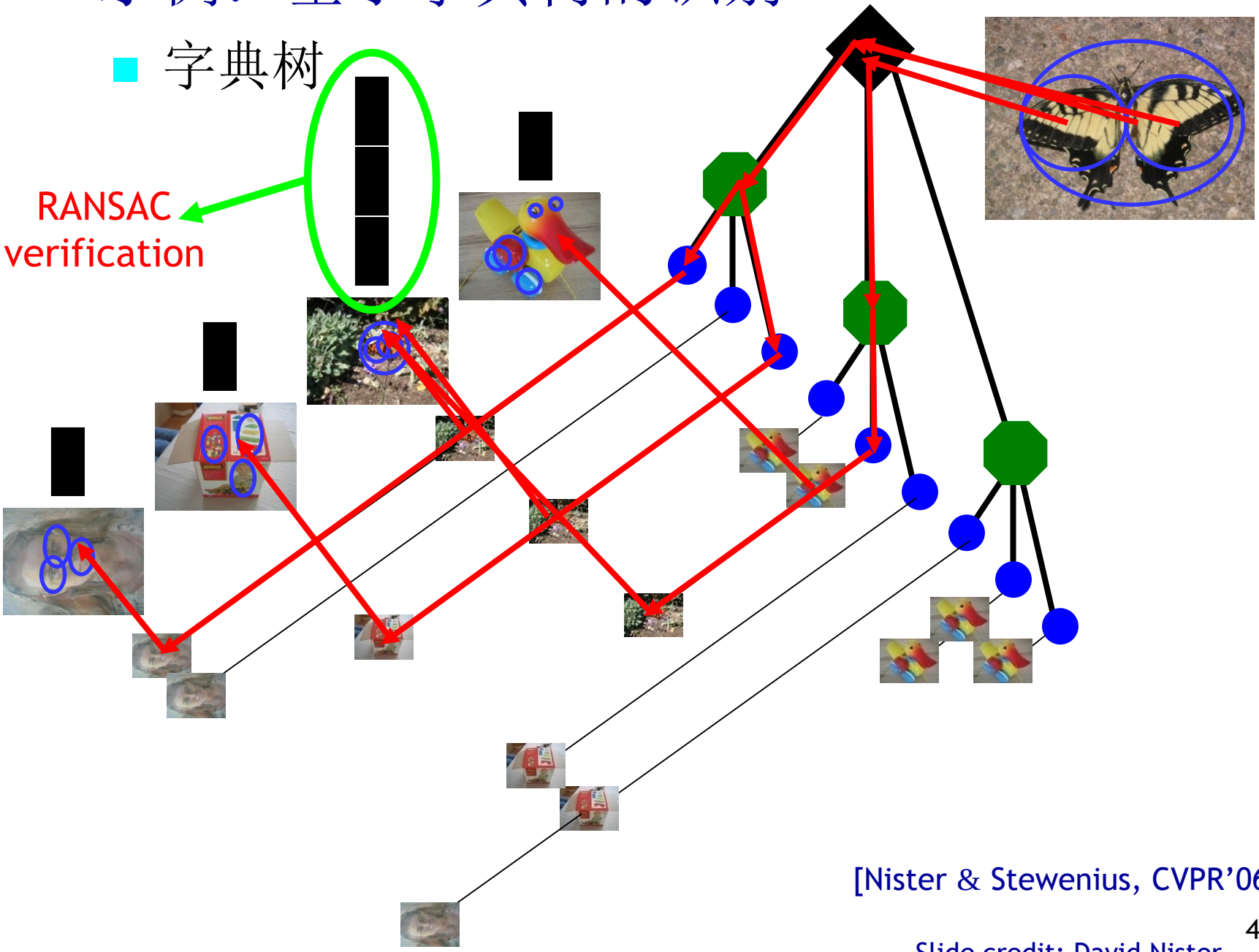


[Nister & Stewenius, CVPR'06]

Slide credit: David Nister

示例：基于字典树的识别

- 字典树



[Nister & Stewenius, CVPR'06]

Slide credit: David Nister

示例：基于字典树的识别

- 节点权重设置问题

$$w_i = \ln \frac{N}{N_i},$$

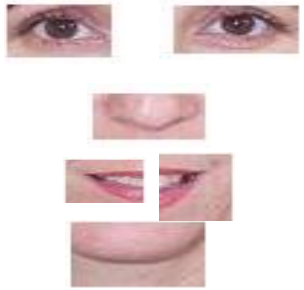
- 距离度量问题

$$\begin{aligned}
\| \mathbf{q}-\mathbf{d} \|_p^p &= \sum_i |q_i - d_i|^p \\
&= \sum_{i|d_i=0} |q_i|^p + \sum_{i|q_i=0} |d_i|^p + \sum_{i|q_i\neq 0, d_i\neq 0} |q_i - d_i|^p \\
&= \|\mathbf{q}\|_p^p + \|\mathbf{d}\|_p^p + \sum_{i|q_i\neq 0, d_i\neq 0} (|q_i - d_i|^p - |q_i|^p - |d_i|^p) \\
&= 2 + \sum_{i|q_i\neq 0, d_i\neq 0} (|q_i - d_i|^p - |q_i|^p - |d_i|^p),
\end{aligned}$$

$$\| \mathbf{q} - \mathbf{d} \|_2^2 = 2 - 2 \sum_{i|q_i\neq 0, d_i\neq 0} q_i d_i,$$

基于特征点的目标检测方法示例

- Bag-of-words框架
- 缺点？



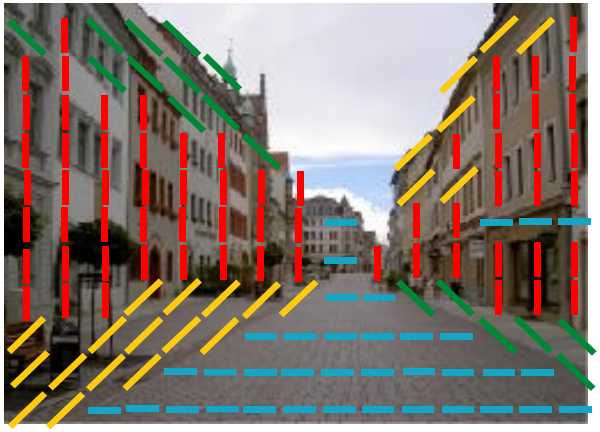
基于特征点的目标检测方法示例

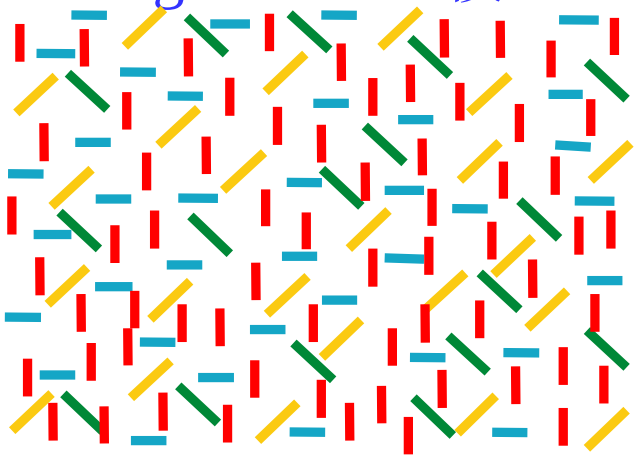
- Bag-of-words框架
- 缺点？

- 如何引入空间信息
- 特征点之间的空间关系
  - 星群模型
  - 空间金字塔模型

基于特征点的目标检测方法示例

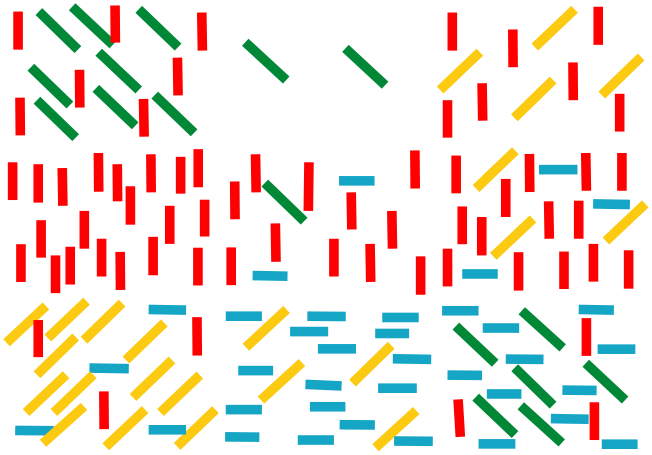
Bag of words 模型





65 17 23 36

加入空间信息

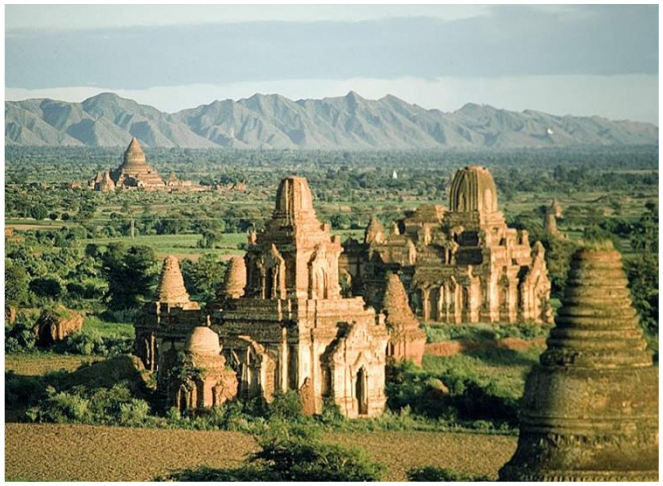


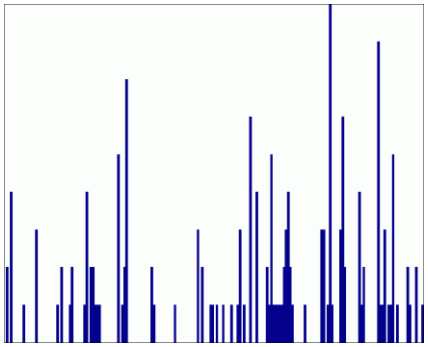
7 8 0 0 0 2 0 0 7 0 4 0

20 0 0 0 11 1 0 2 14 0 3 3

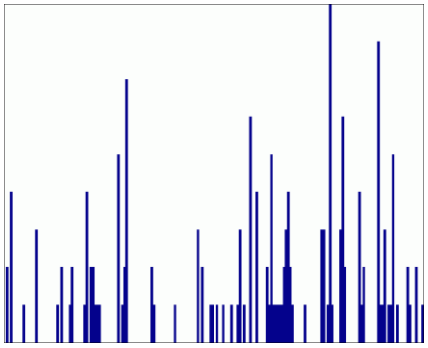
3 0 12 4 0 0 4 16 3 6 0 11

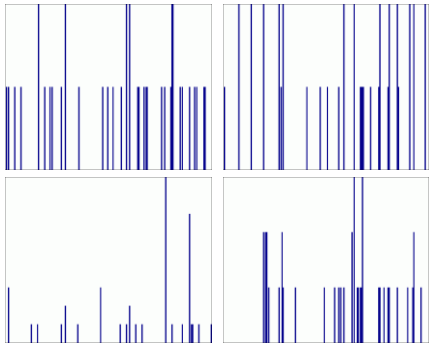
空间金字塔表达



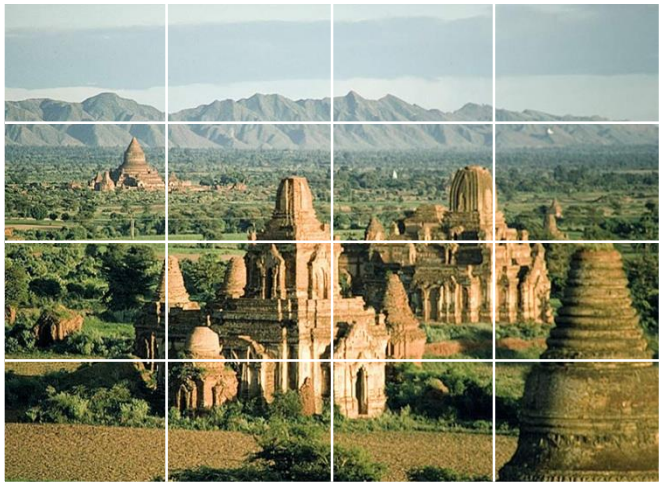


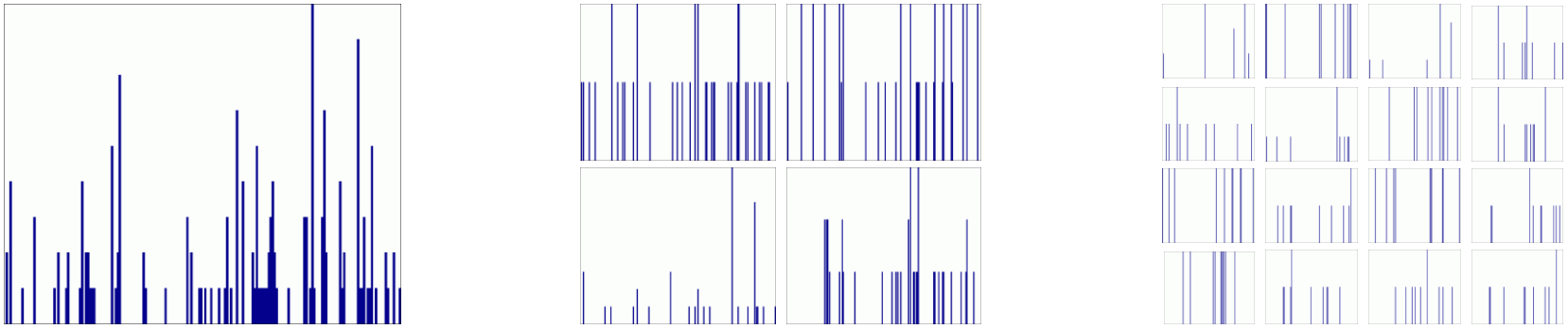
空间金字塔表达





空间金字塔表达





The end !