

CS 4758: Bag of features

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- Orderless document representation: frequencies of words from a dictionary Salton & McGill (1983)

2007-01-23: State of the Union Address

George W. Bush (2001-)

abandon accountable affordable afghanistan africa aided ally anbar armed army **baghdad** bless **challenges** chamber chaos
choices civilians coalition commanders **commitment** confident confront congressman constitution corps debates deduction
deficit deliver **democratic** deploy dikembe diplomacy disruptions earmarks **economy** einstein **elections** eliminates
expand **extremists** failing faithful families **freedom** fuel **funding** god haven ideology immigration impose
insurgents iran **iraq** islam julie lebanon love madam marine math medicare moderation neighborhoods nuclear offensive
palestinian payroll province pursuing **qaeda** radical regimes resolve retreat rieman sacrifices science sectarian senate
september **shia** stays strength students succeed sunni **tax** territories **terrorists** threats uphold victory
violence violent **war** washington weapons wesley

US Presidential Speeches Tag Cloud

- Orderless document representation: frequencies of words from a dictionary Salton & McGill (1983)

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abandon

choices of

deficit of

expand

insurgen

palestini

septemb

violenc

1962-10-22: Soviet Missiles in Cuba

John F. Kennedy (1961-63)

abandon achieving adversaries aggression agricultural appropriate armaments **arms** assessments atlantic ballistic berlin
buildup burdens cargo college **commitment** communist constitution consumers cooperation crisis **cuba** dangers
 declined **defensive** deficit depended disarmament divisions domination doubled **economic** education
 elimination emergence endangered equals **europe** expand exports fact false family forum **freedom** fulfill gromyko
 halt hazards **hemisphere** hospitals ideals **independent** industries inflation labor latin limiting minister **missiles**
 modernization neglect **nuclear** oas obligation observer **offensive** peril pledged predicted purchasing quarantine quote
 recession rejection republics retaliatory safeguard sites solution **soviet** space spur stability standby **strength**
 surveillance **tax** territory treaty undertakings unemployment **war** warhead **weapons** welfare western widen withdraw

US Presidential Speeches Tag Cloud

Bag of words: <Explain on blackboard>

We will represent an email via a feature vector whose length is equal to the number of words in the dictionary. Specifically, if an email contains the i -th word of the dictionary, then we will set $x_i = 1$; otherwise, we let $x_i = 0$. For instance, the vector

$$x = \begin{bmatrix} 1 \\ 0 \\ 0 \\ \vdots \\ 1 \\ \vdots \\ 0 \end{bmatrix} \begin{array}{l} \text{a} \\ \text{aardvark} \\ \text{aardwolf} \\ \vdots \\ \text{buy} \\ \vdots \\ \text{zygmurgy} \end{array}$$

is used to represent an email that contains the words “a” and “buy,” but not “aardvark,” “aardwolf” or “zygmurgy.”² The set of words encoded into the

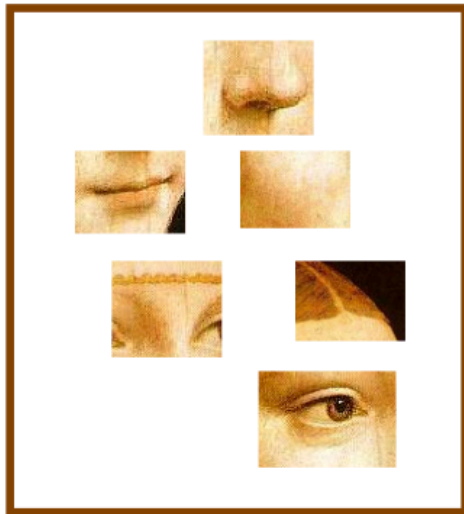
For 3D shapes / images.



Many slides adapted from Fei-Fei Li, Rob Fergus, and Antonio Torralba

Bag of features: outline

1. Extract features



Bag of features: outline

1. Extract features
2. Learn “visual vocabulary”

“Shape vocabulary for 3D point-clouds.”

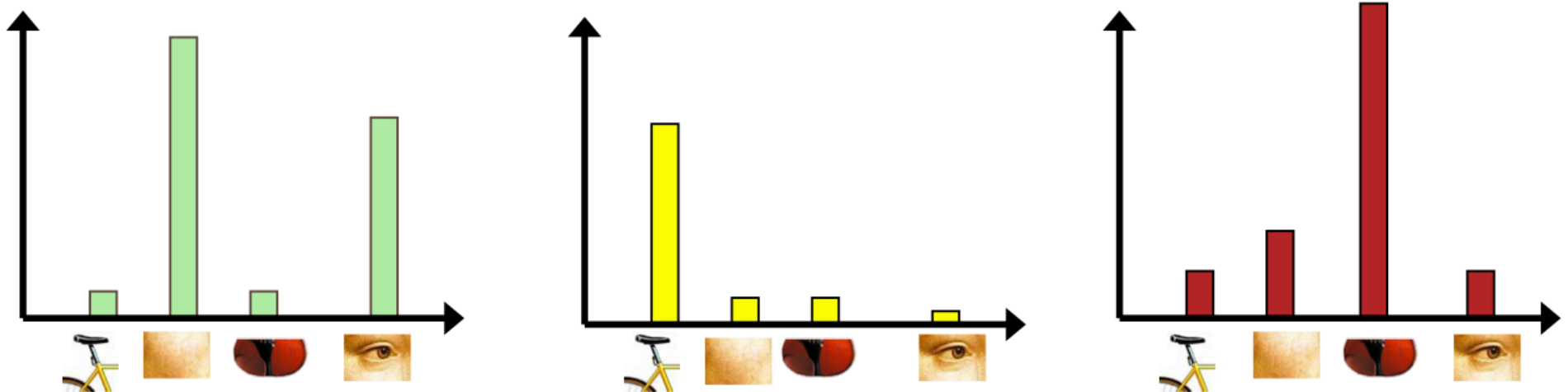


Bag of features: outline

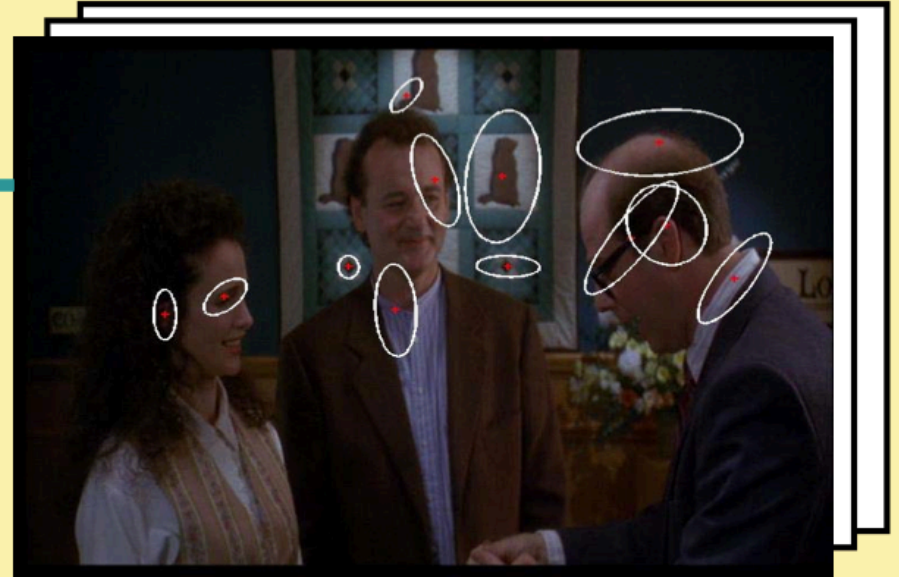
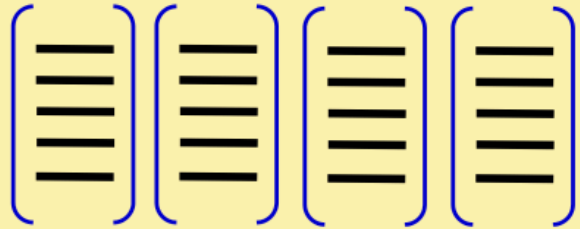
1. Extract features
2. Learn “visual vocabulary”
3. Quantize features using visual vocabulary

Bag of features: outline

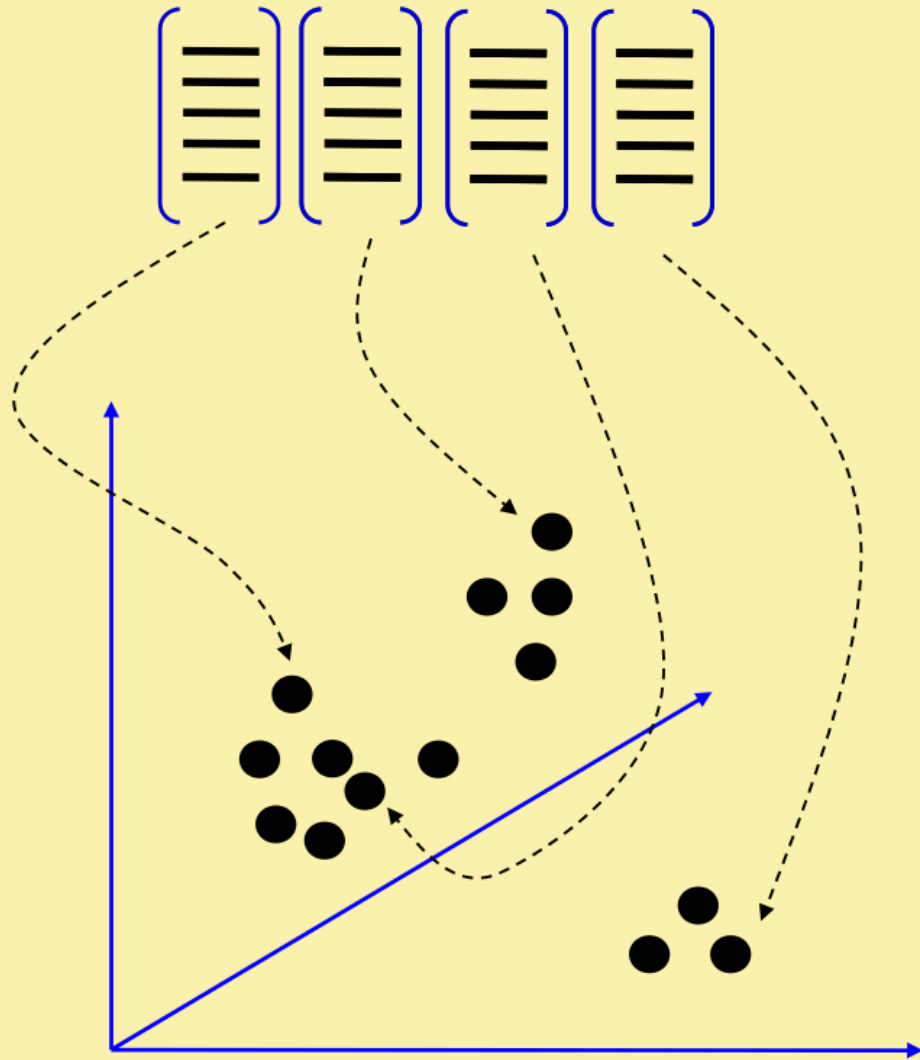
1. Extract features
2. Learn “visual vocabulary”
3. Quantize features using visual vocabulary
4. Represent images by frequencies of “visual words”



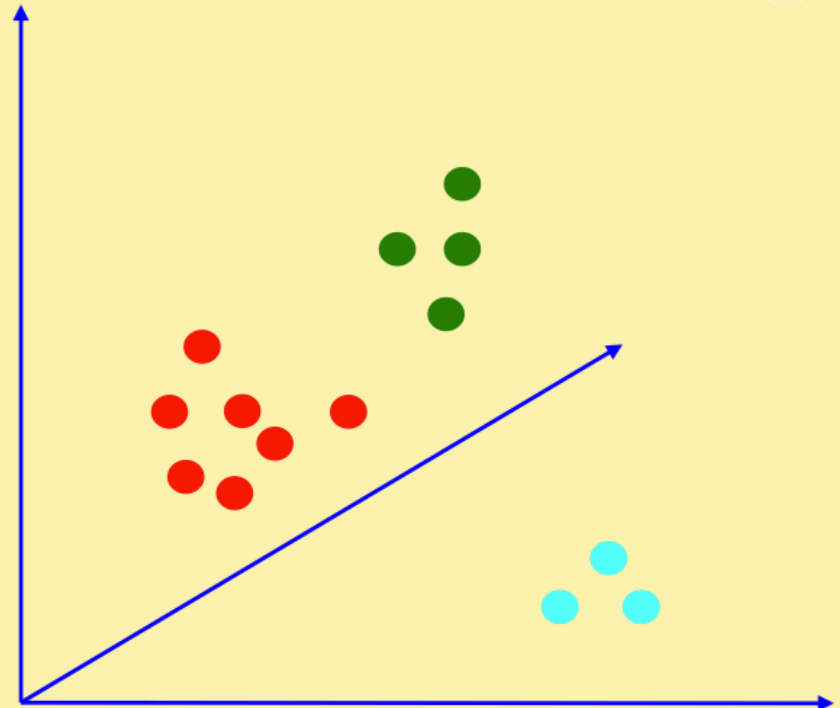
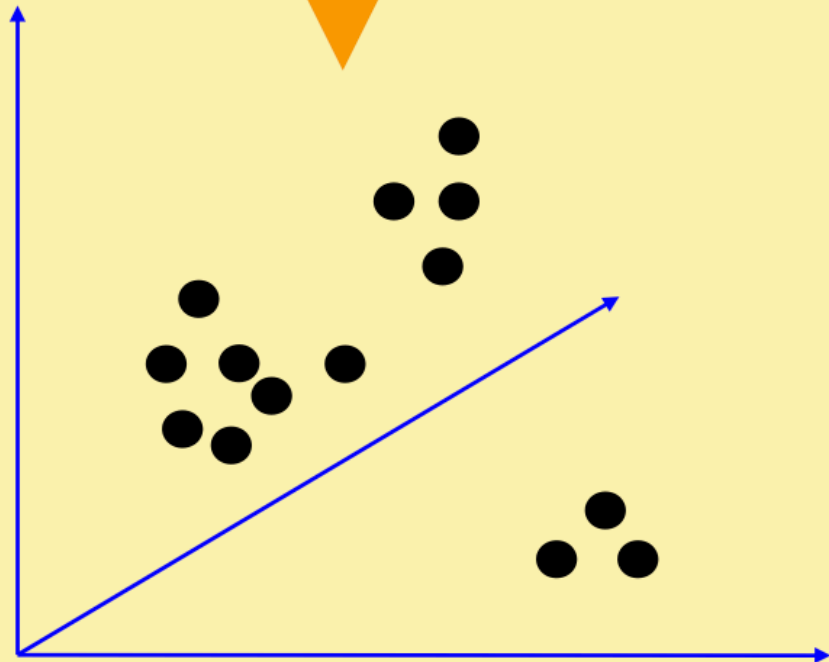
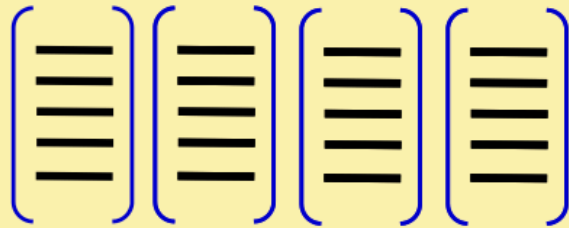
1. Feature extraction



2. Learning the visual vocabulary



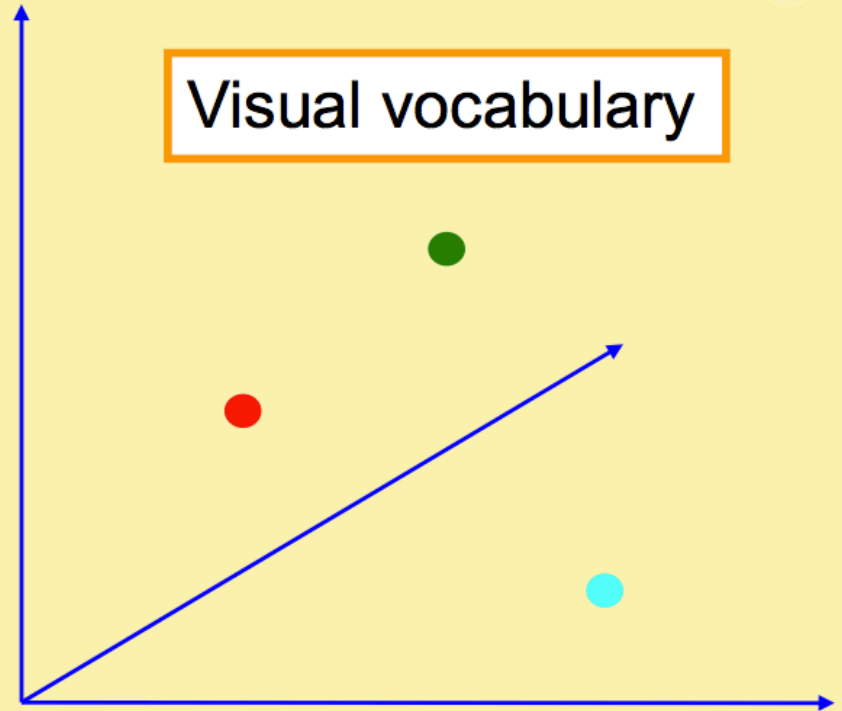
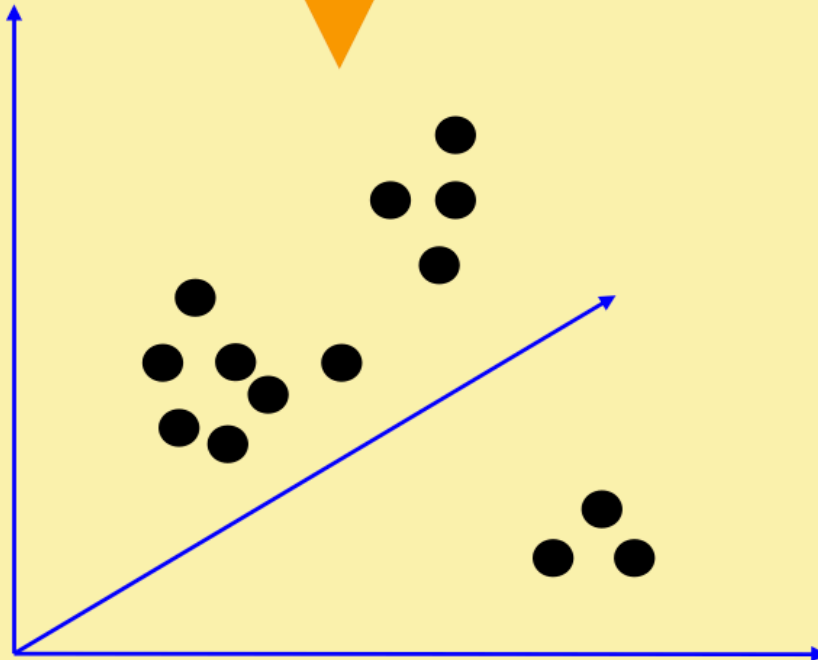
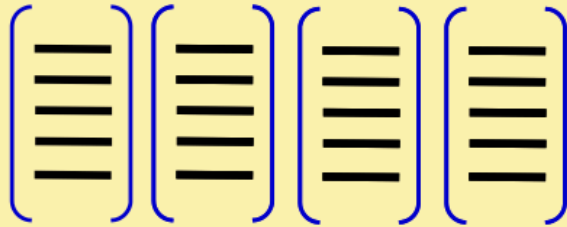
2. Learning the visual vocabulary



Clustering



2. Learning the visual vocabulary



Visual vocabulary

Clustering

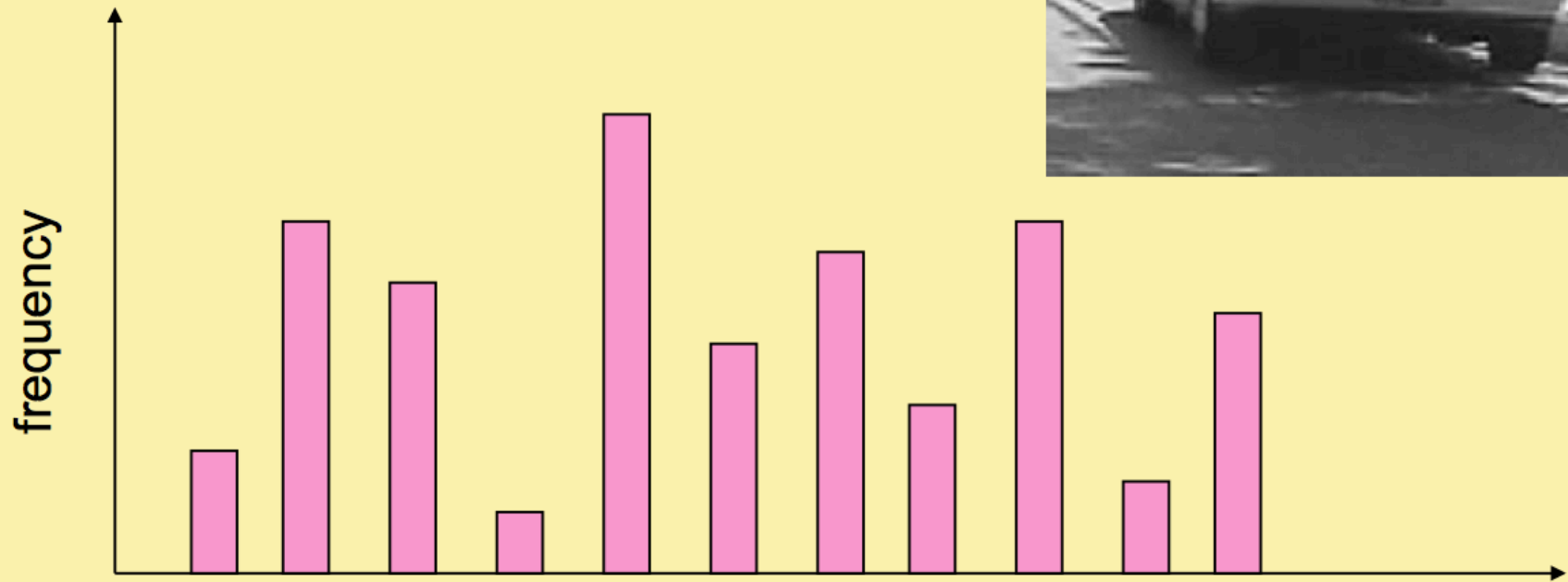
K-means clustering

- Want to minimize sum of squared Euclidean distances between points x_i and their nearest cluster centers m_k

$$D(X, M) = \sum_{\text{cluster } k} \sum_{\substack{\text{point } i \text{ in} \\ \text{cluster } k}} (x_i - m_k)^2$$

Algorithm:

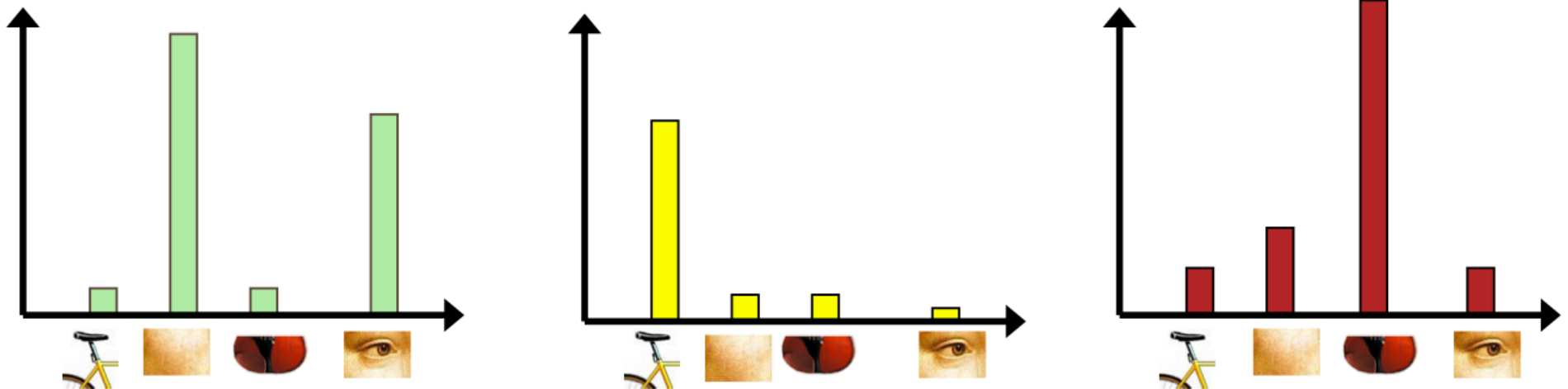
- Randomly initialize K cluster centers
- Iterate until convergence:
 - Assign each data point to the nearest center
 - Recompute each cluster center as the mean of all points assigned to it



codewords

Bag of features: outline

1. Extract features
2. Learn “visual vocabulary”
3. Quantize features using visual vocabulary
4. Represent images by frequencies of “visual words”



- Now you can run a classifier on the point-cloud/image represented as the vector of frequencies of visual words.