Vision Intelligence III: Visual Object Computations

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Vision Intelligence: Visual Features

Visual Features

- **Pixel colour**: Binary, pseudo, real colour, etc.
- **Histogram**: Color histogram, vector histogram, etc.
- **Texture**: Gabor texture, Tamura texture, GLCM, etc.
- **Edge**: Canny(5×5), Sobel (3×3), Robert (2×2), etc.
- **Gradient**: Horizontal, vertical, both, etc.
- **Local features**: SIFT, HOG, etc.
- ......

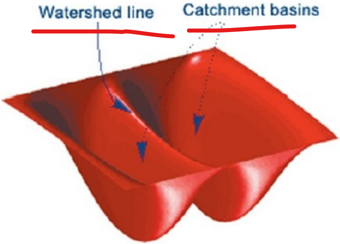
Vision Intelligence: Object Segmentation

Object Segmentation

- Thresholding
- Clustering methods
- Histogram-based methods
- Edge detection
- Region growing methods
- Watershed segmentation
- ......

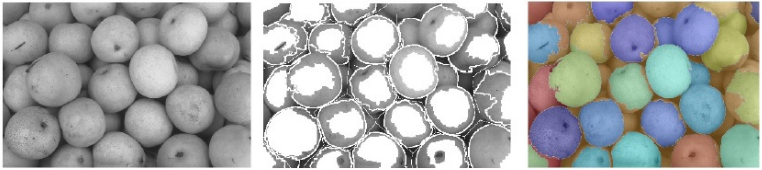
MATLAB: Examples

MALAB: Watershed Segmentation



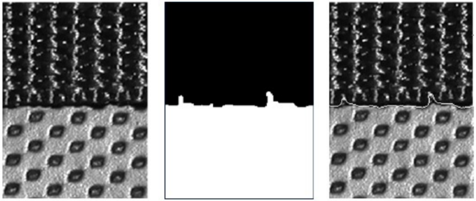
MATLAB: Examples

MATLAB: Watershed Segmentation



- Use gradient magnitude as segmentation function;
- Mark foreground objects;
- Compute background markers.

MATLAB: Texture Image Segmentation



- Create a rough mask for the texture;
- Use the rough mask to segment the top texture;
- Display segmentation result.

OpenCV: Examples

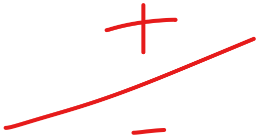
OpenCV: Image Segmentation

Questions?

Vision Intelligence III: Visual Object Detection

Object Detection

- Given positive and negative samples (well selected)
- Supervised learning provides a natural framework for studying object recognition.
- Train a function that can map novel images to one of labels (e.g., face or non-face).

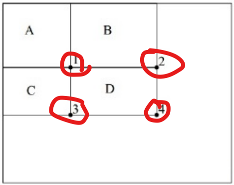


AX+BY+C=0

OpenCV: Face Detection - Training Set

OpenCV: Viola & Jones Face Detection

- Haar Feature Selection
- Creating Integral Image
- AdaBoost Training algorithm
- Cascaded Classifiers

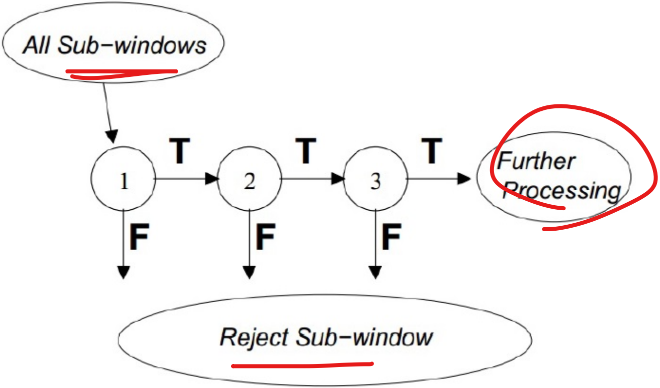


(a)

(b)

Paul Viola and Michael Jones (2001) Rapid Object Detection using a Boosted Cascade of Simple Features. CVPR 2001.

OpenCV: Viola & Jones Face Detection (Cascade Classifier)



Paul Viola and Michael Jones (2001) Rapid Object Detection using a Boosted Cascade of Simple Features. CVPR 2001.

OpenCV: Viola & Jones Face Detection (Advantage)

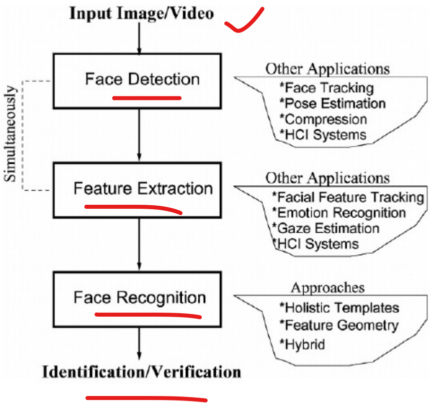
- Extremely fast feature computation
- Efficient feature selection
- Scale and location invariant detector
- Detect other types of objects (e.g., cars, hands, etc.).

OpenCV: Viola & Jones Face Detection (Disadvantage)

- Detector is most effective only on frontal images of a face.
- It can hardly cope with 45° face rotation both around vertical and horizontal axes.
- Sensitive to lighting conditions

Questions?

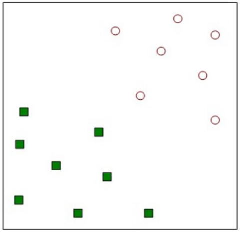
OpenCV: Face Detection and Recognition System

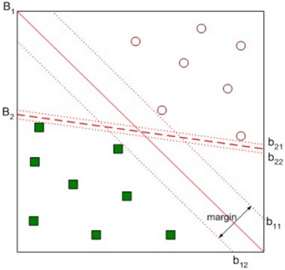


W. Zhao, et al. Face recognition: a literature survey, ACM Computing Surveys, Vol. 35, No. 4, 2003, pp. 399–458.

Support Vector Machine

- *Problem*: Given a vector dataset, find a linear hyperplane (decision boundary) that will separate the data.
- *Solution*: Find a hyperplane maximizes the margin (B_1 is better than B_2),
- *SVM Readings*: `http://www.csie.ntu.edu.tw/~cjlin/libsvm/`





WEKA: Computational Tool

WEKA
The University of Waikato

Machine Learning Group at the University of Waikato

Project | **Software** | Book | Courses | Publications | People | Related

Weka 3: Data Mining Software in Java

Weka is a collection of machine learning algorithms for data mining tasks. The algorithms can either be applied directly to a dataset or called from your own Java code. Weka contains tools for data pre-processing, classification, regression, clustering, association rules, and visualization. It is also well-suited for developing new machine learning schemes.

Found only on the islands of New Zealand, the Weka is a flightless bird with an inquisitive nature. The name is pronounced like **this**, and the bird sounds like **this**.

Weka is open source software issued under the **GNU General Public License**.

We have put together several free online courses that teach machine learning and data mining using Weka. Check out the **website for the courses** for details on when and how to enrol. The videos for the courses are available **on Youtube.**

Yes, it is possible to apply Weka to **big data**!

Getting started

- **Requirements**
- **Download**
- **Documentation**
- **FAQ**
- **Getting Help**

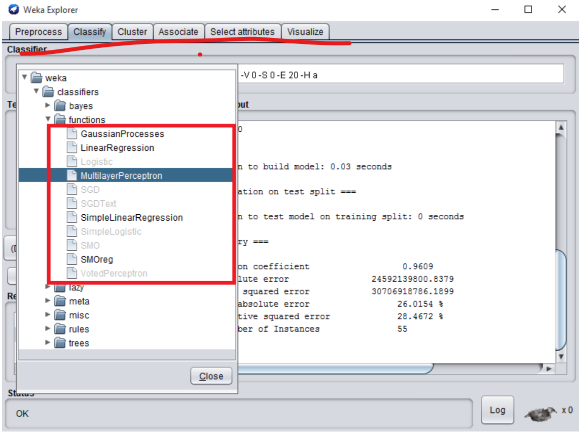
Further information

- **Citing Weka**
- **Datasets**
- **Related Projects**
- **Miscellaneous Code**
- **Other Literature**

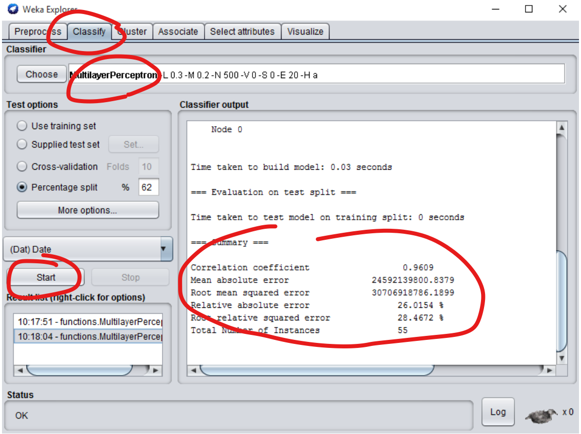
Developers

- **Development**
- **History**
- **Subversion**
- **Contributors**
- **Commercial licenses**

WEKA: Computational Tool



WEKA: Computational Tool



WEKA: Computational Tool

```
% 5. Number of Instances: 150 (50 in each of three classes)
% 6. Number of Attributes: 4 numeric, predictive attributes and the class
% 7. Attribute Information:
%    1. sepal length in cm
%    2. sepal width in cm
%    3. petal length in cm
%    4. petal width in cm
%    5. class:
%       -- Iris Setosa
%       -- Iris Versicolour
%       -- Iris Virginica
% 8. Missing Attribute Values: None
% Summary Statistics:
%              Min  Max   Mean    SD   Class Correlation
%    sepal length: 4.3  7.9   5.84  0.83    0.7826
%     sepal width: 2.0  4.4   3.05  0.43   -0.4194
%    petal length: 1.0  6.9   3.76  1.76    0.9490  (high!)
%     petal width: 0.1  2.5   1.20  0.76    0.9565  (high!)
% 9. Class Distribution: 33.3% for each of 3 classes.

@RELATION iris
@ATTRIBUTE sepallength  REAL
@ATTRIBUTE sepalwidth   REAL
@ATTRIBUTE petallength  REAL
@ATTRIBUTE petalwidth   REAL
@ATTRIBUTE class     {Iris-setosa,Iris-versicolor,Iris-virginica}
@DATA
5.1,3.5,1.4,0.2,Iris-setosa
4.9,3.0,1.4,0.2,Iris-setosa
```

Evaluations of Empirical Algorithms

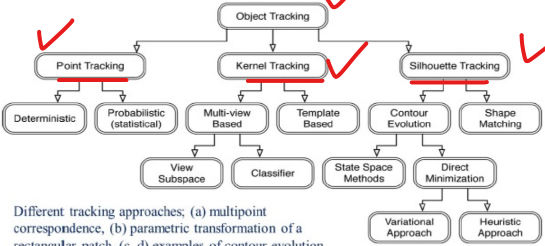
- Training set
- Test set
- Ground truth
- Precision: $p = \frac{TP}{TP+FP}$
- Recall: $r = \frac{TP}{TP+FN}$
- F-measure: $F = \frac{2 \cdot p \cdot r}{p+r}$
- G-measure: $G = \sqrt{p \cdot r}$

Note: F-measure is the harmonic mean (average) of recall and precision, G-measure is the geometric mean (average).

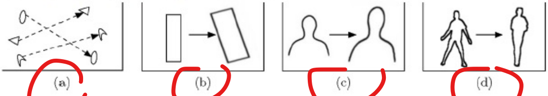
Precision?

Questions?

Object Tracking (Demo)



Different tracking approaches; (a) multipoint correspondence, (b) parametric transformation of a rectangular patch, (c, d) examples of contour evolution.



A. Yilmaz, Object Tracking: A Survey. ACM Computing Surveys, Vol. 38, No. 4, Article 13, 2006.

Object Tracking

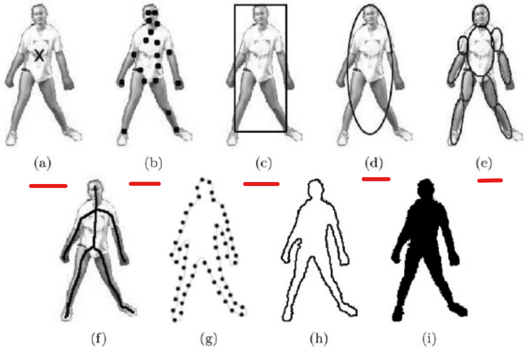


Fig. 1. Object representations. (a) Centroid, (b) multiple points, (c) rectangular patch, (d) elliptical patch, (e) part-based multiple patches, (f) object skeleton, (g) complete object contour, (h) control points on object contour, (i) object silhouette.

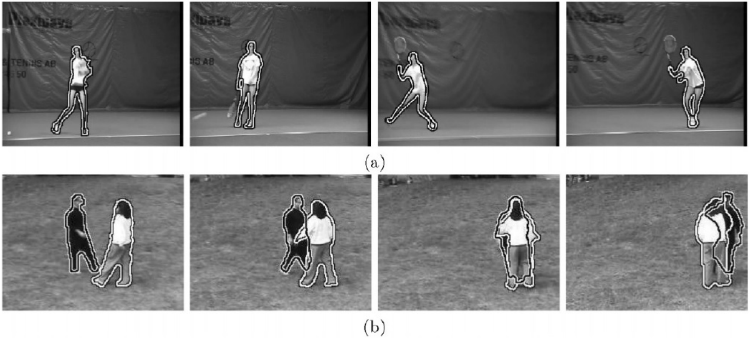
A. Yilmaz, Object Tracking: A Survey. ACM Computing Surveys, Vol. 38, No. 4, Article 13, 2006.

Car Tracking Using Level Set

Car tracking using the level sets method

A. Yilmaz, et al. (2006) Object Tracking: A Survey. ACM Computing Surveys, Vol. 38, No. 4, Article 13.

Contour Track



Contour tracking results. (a) tracking of a tennis player, (b) tracking in presence of occlusion

A. Yilmaz, et al. (2006) Object Tracking: A Survey. ACM Computing Surveys, Vol. 38, No. 4, Article 13.

Questions?

Learning Objectives

- Explain how AI theories could be used in visual analytics.
- Evaluate the complexities involved in the automatic extraction of knowledge encoded in free texts and images.