Pedestrian Detection and Localization

Members:

Đặng Trương Khánh Linh 0612743

Bùi Huỳnh Lam Bửu 0612733

Advisor:

A.Professor Lê Hoài Bắc

UNIVERSITY OF SCIENCE

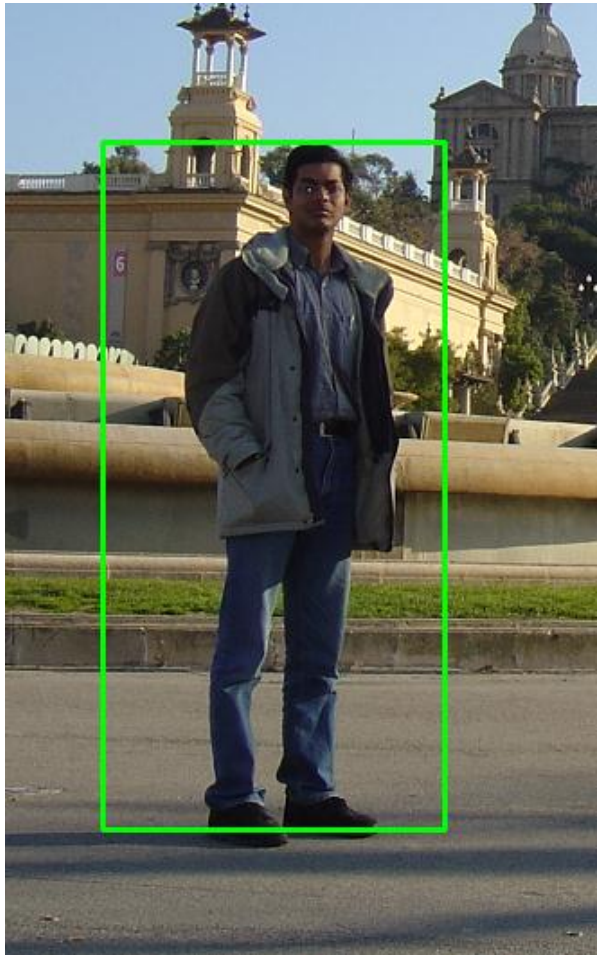
ADVANCED PROGRAM IN COMPUTER SCIENCE

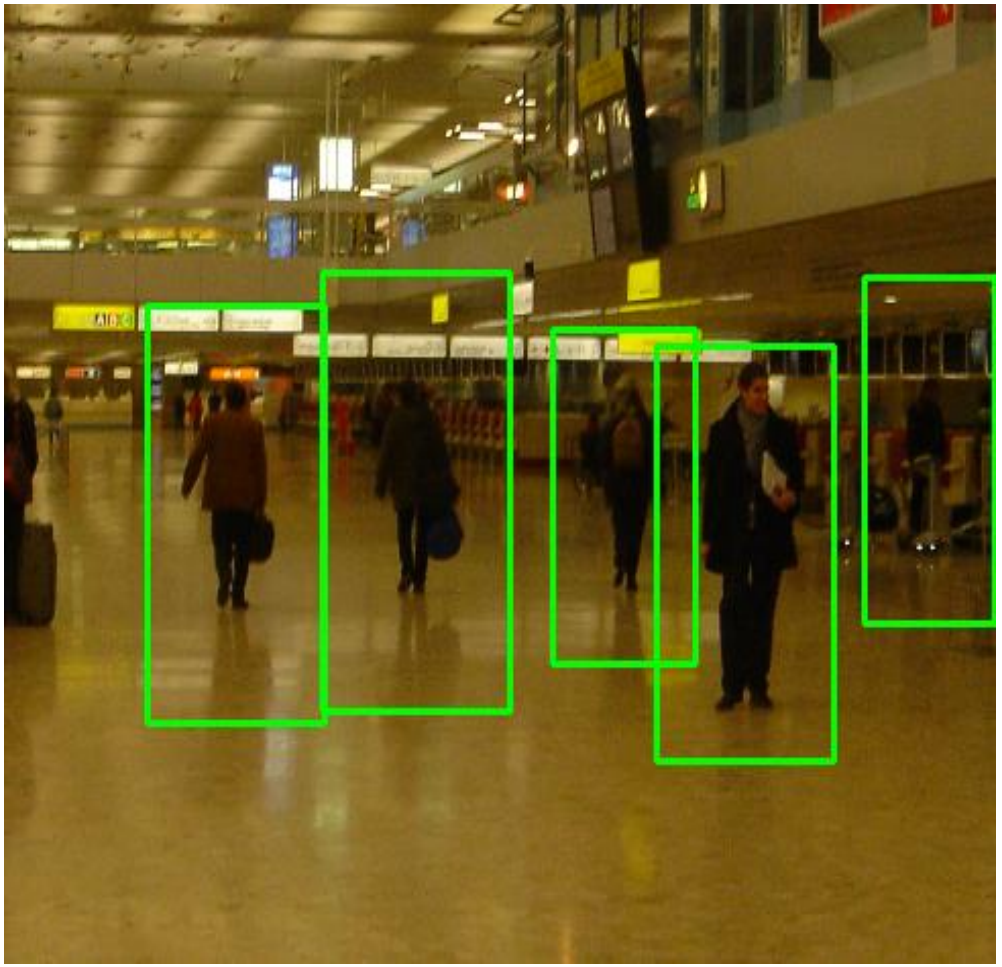
Year 2011

Problem statement

- Build up a system which automatically detects and localizes pedestrians in static image.
- Constraints:
  - Pedestrians stand up and fully visible people.
  - Size of pedestrian is not less than 64x128 pixels.

Some examples





Applications

- Using in smart car system, or smart camera in general.
- Build a software to categorize personal album images to proper catalogue.

Challenges

- Huge variation in intra-class.
- Variable appearance and clothing.
- Complex background.
- Non-constraints illumination.
- Occlusions, different scales.

Outline

- Existing approaches.
- Motivation.
- Overview of methodology.
  - Learning phase
  - Detection
- Some contributions:
  - Spatial selective approach
  - Multi-level based approach
- Non-maxima Suppression
- Conclusions
- Future work
- Reference

Existing approaches

- Haar wavelets + SVM: Papageorgiou & Poggio, 2000; Mohan et al 2000
- Rectangular differential features + adaBoost: Viola & Jones, 2001
- Model based methods: Felzenszwalb & Huttenlocher, 2000; Loffe & Forsyth, 1999
- Lowe, 1999 (SIFT).
- LBP, HOG, …

Motivation of choosing HOG

- The blob structure based methods are false to object detection problem.
- Use the advantage of rigid shape of object.
- Low complexity and fast running time.
- Has a good performance.

Contributions

- Re-implement HOG description.
- Spatial Selective Method.
- Multi-level Method.

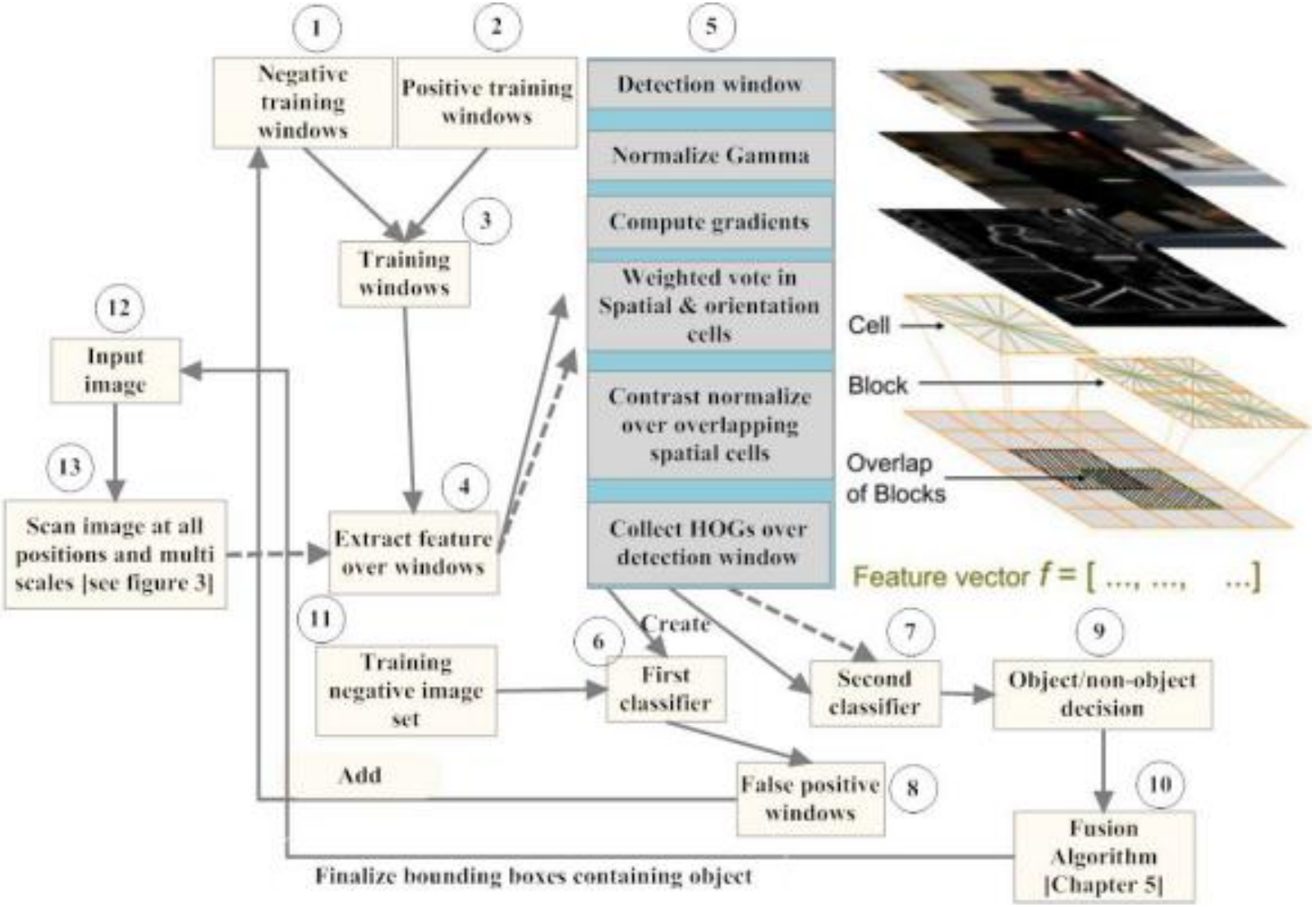
Dataset

INRIA pedestrian dataset

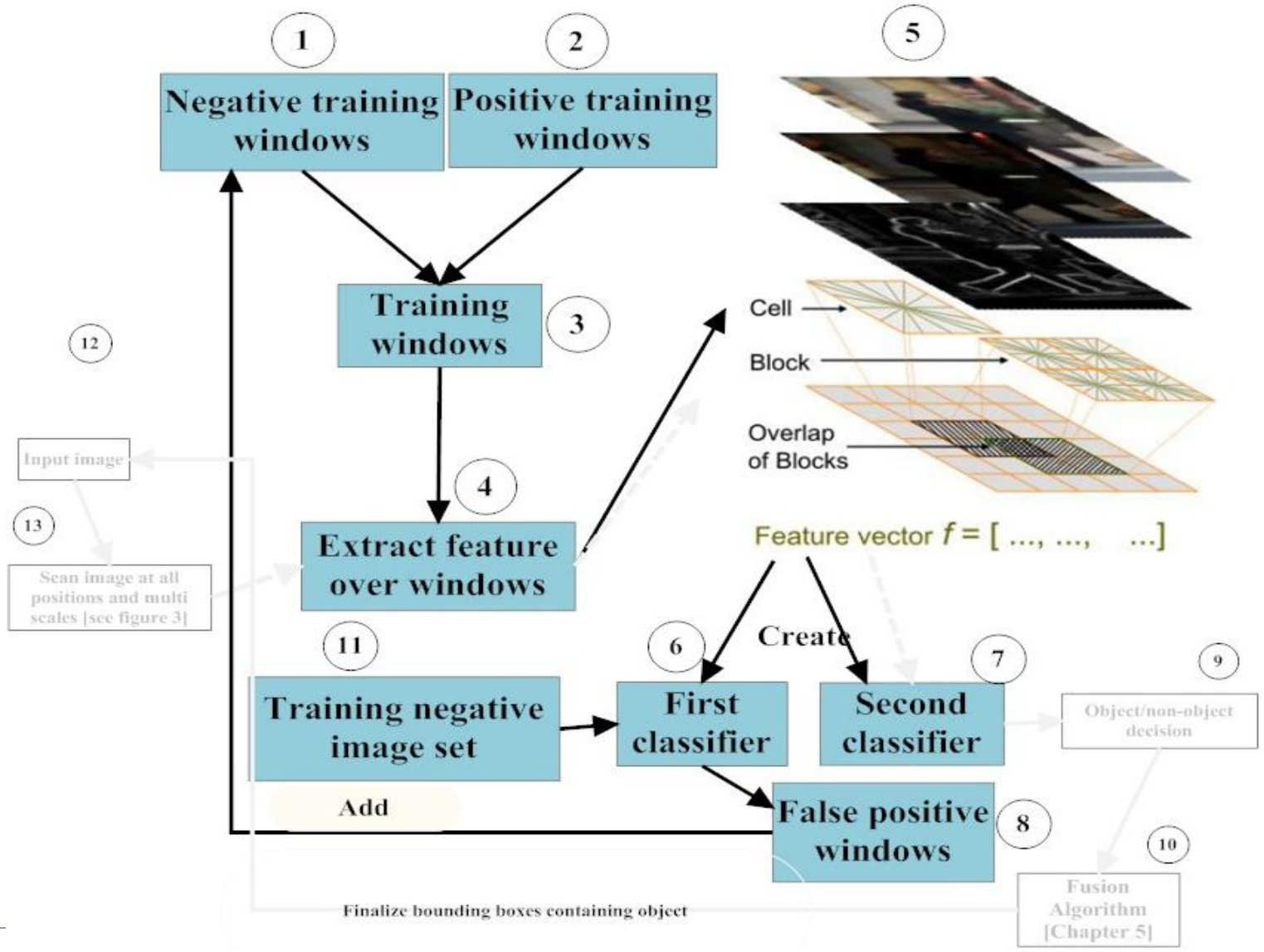
Train:
1208 positive windows
1218 negative images

Test:
566 positive windows
453 negative images

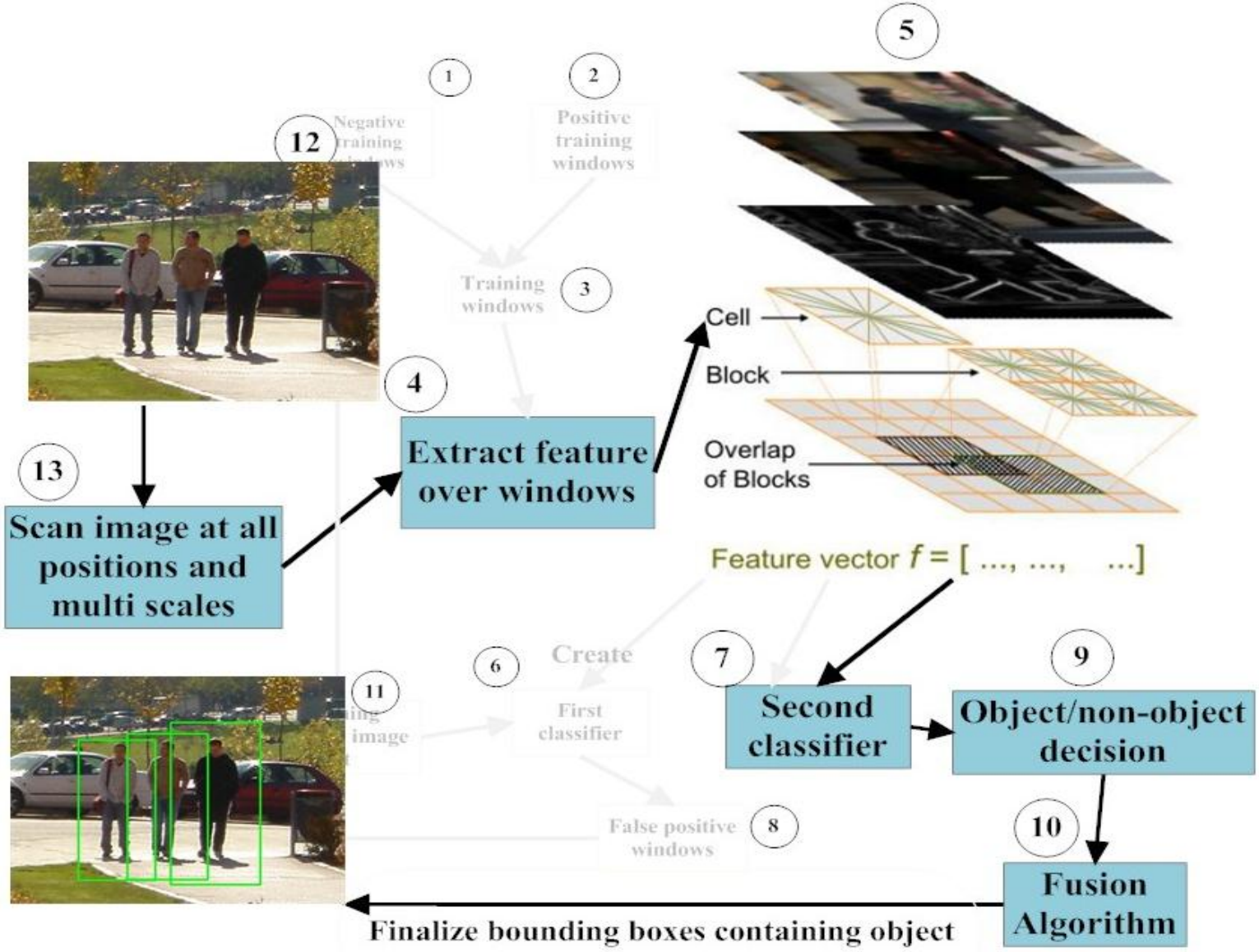
Overview of methodology



Learning Phase

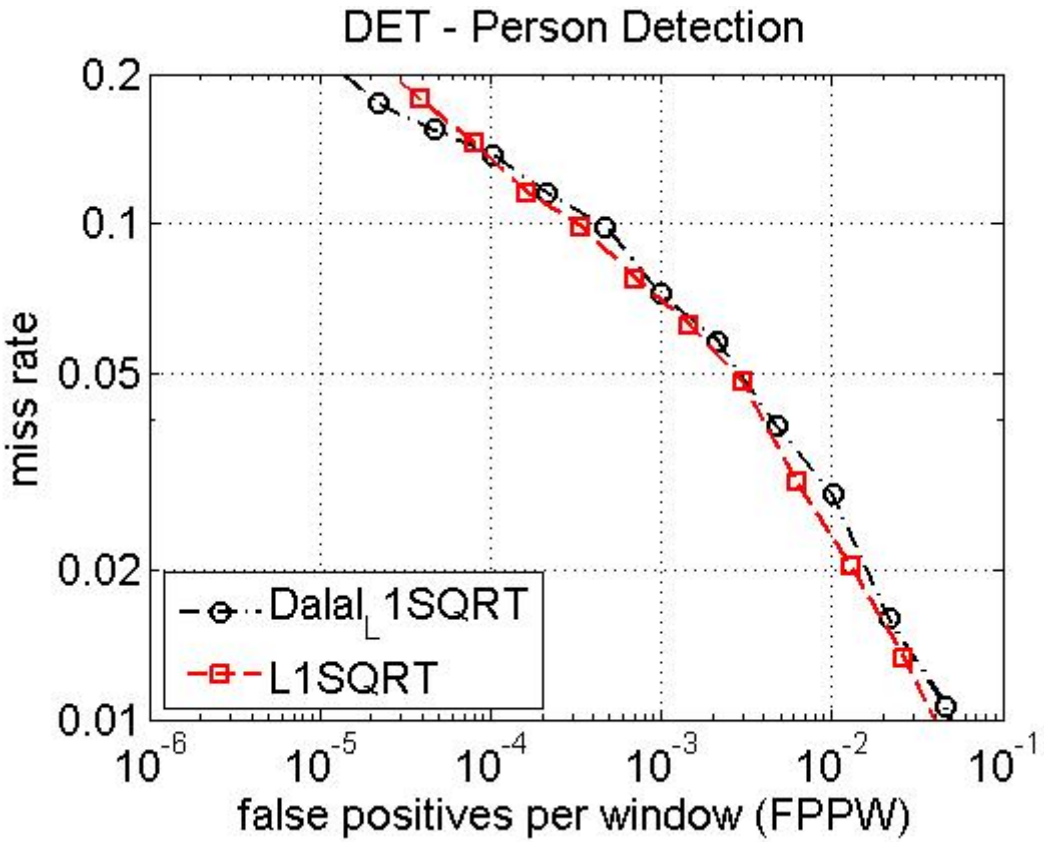


Detection Phase

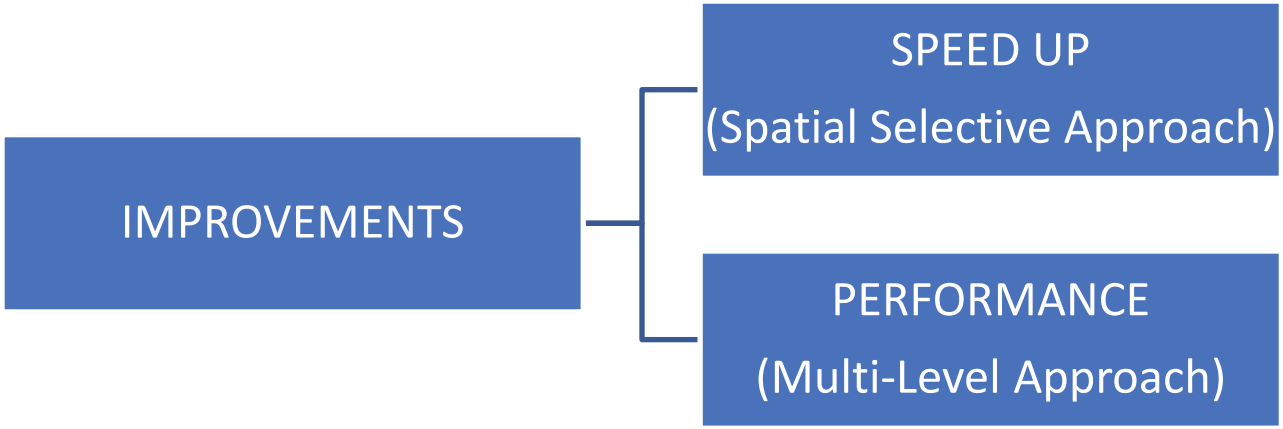


Scan image at all positions and scales

Result of experiment

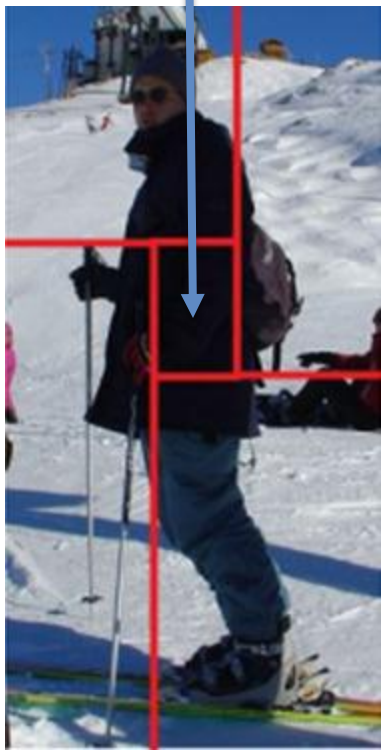


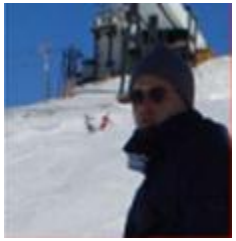
Some Contributions



Spatial Selective Approach

Less informative region





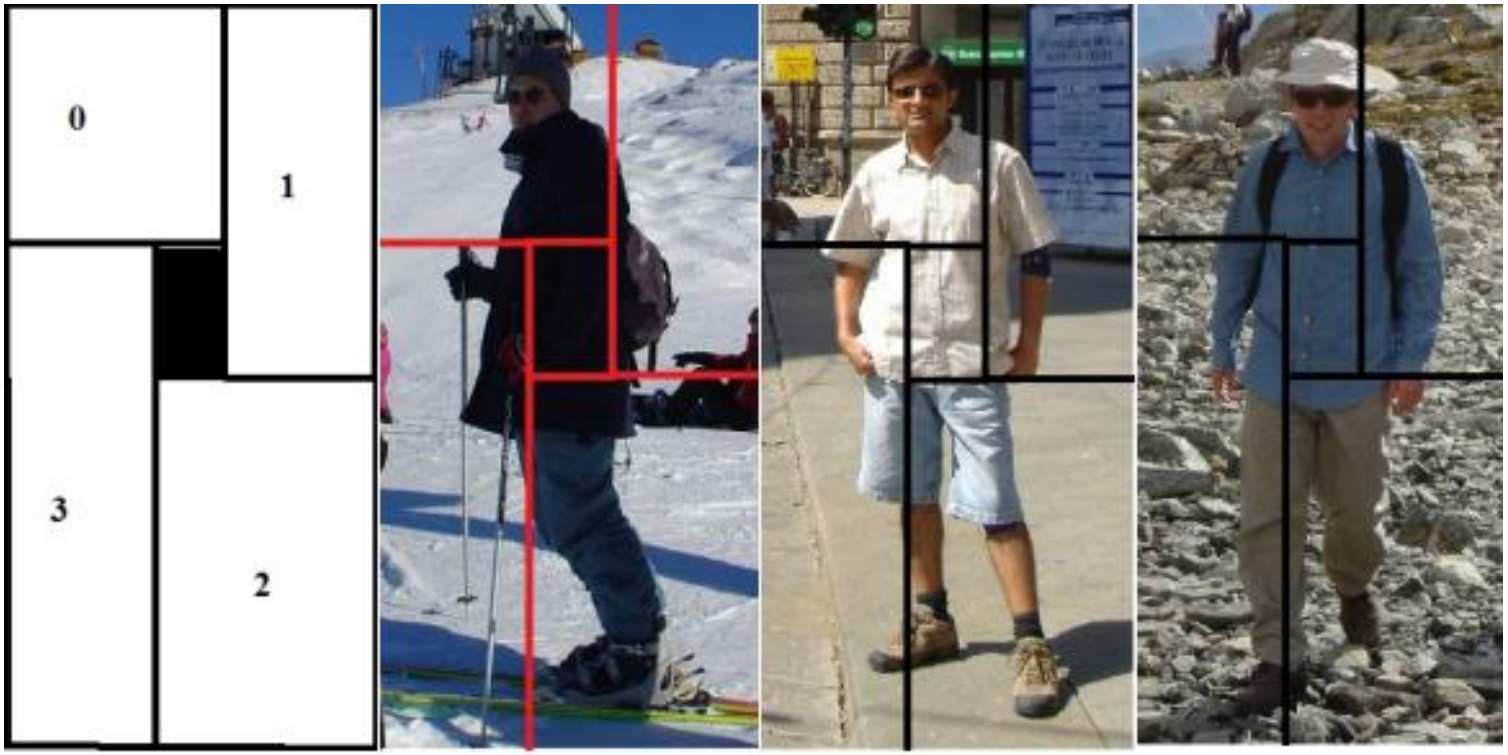
H O G

[A1,..,Z1] [A2,..,Z2] [A3,..,Z3] [A4,..,Z4]

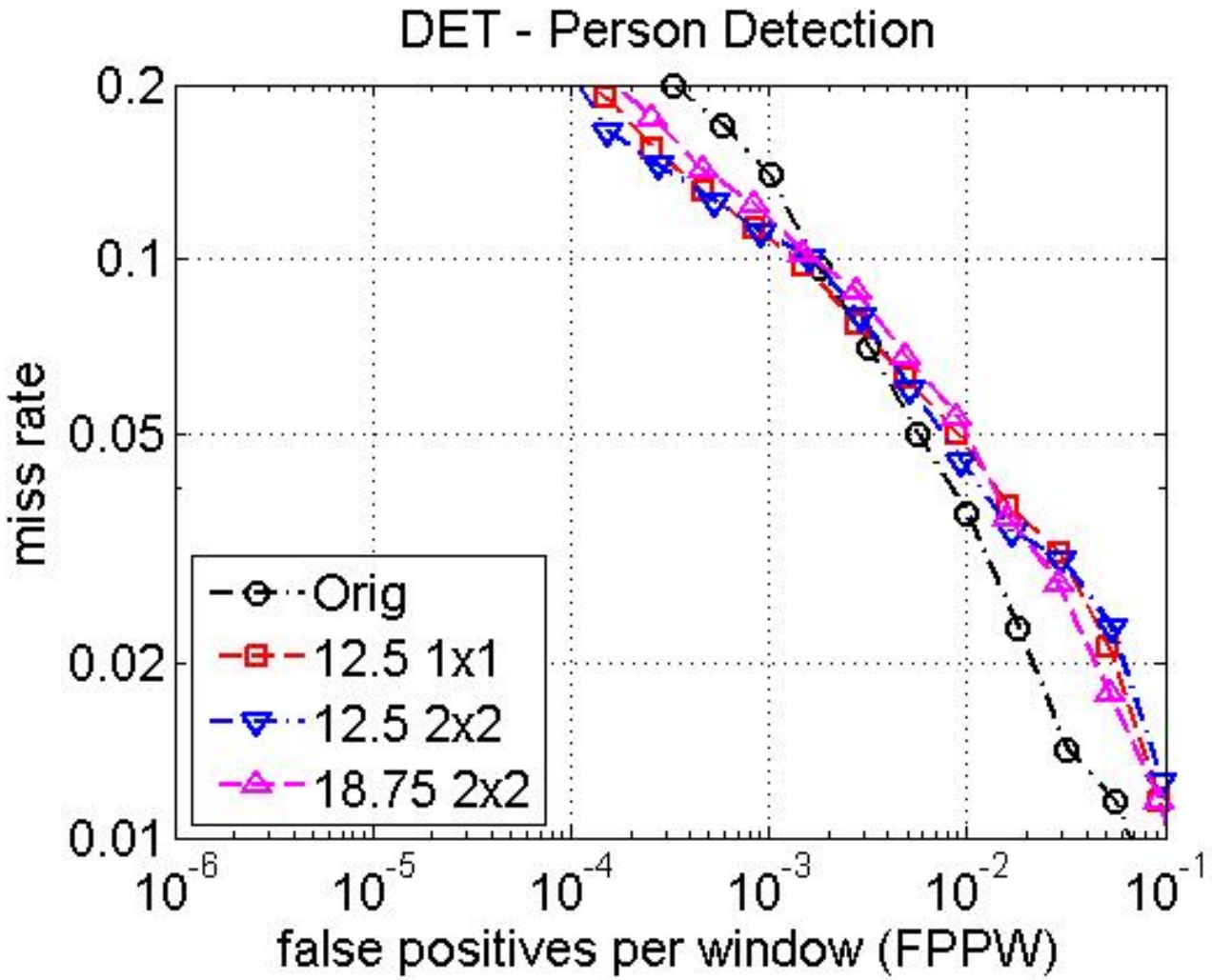
[A1,..,Z1, A2,..,Z2, A3,..,Z3, A4,..,Z4]

Spatial Selective Approach

- Examples:



Result


DET - Person Detection
0.2
0.1
0.05
0.02
0.01
miss rate
Orig
12.5 1x1
12.5 2x2
18.75 2x2
10^-6
10^-5
10^-4
10^-3
10^-2
10^-1
false positives per window (FPPW)

Vector Length v.s Speed

A:B → Deleted cell(s): Overlap cell(s)

Multi-level Approach

- Purpose: enhance the performance by getting more information about shape and contour of object.

Multi-level Approach

H
O
G

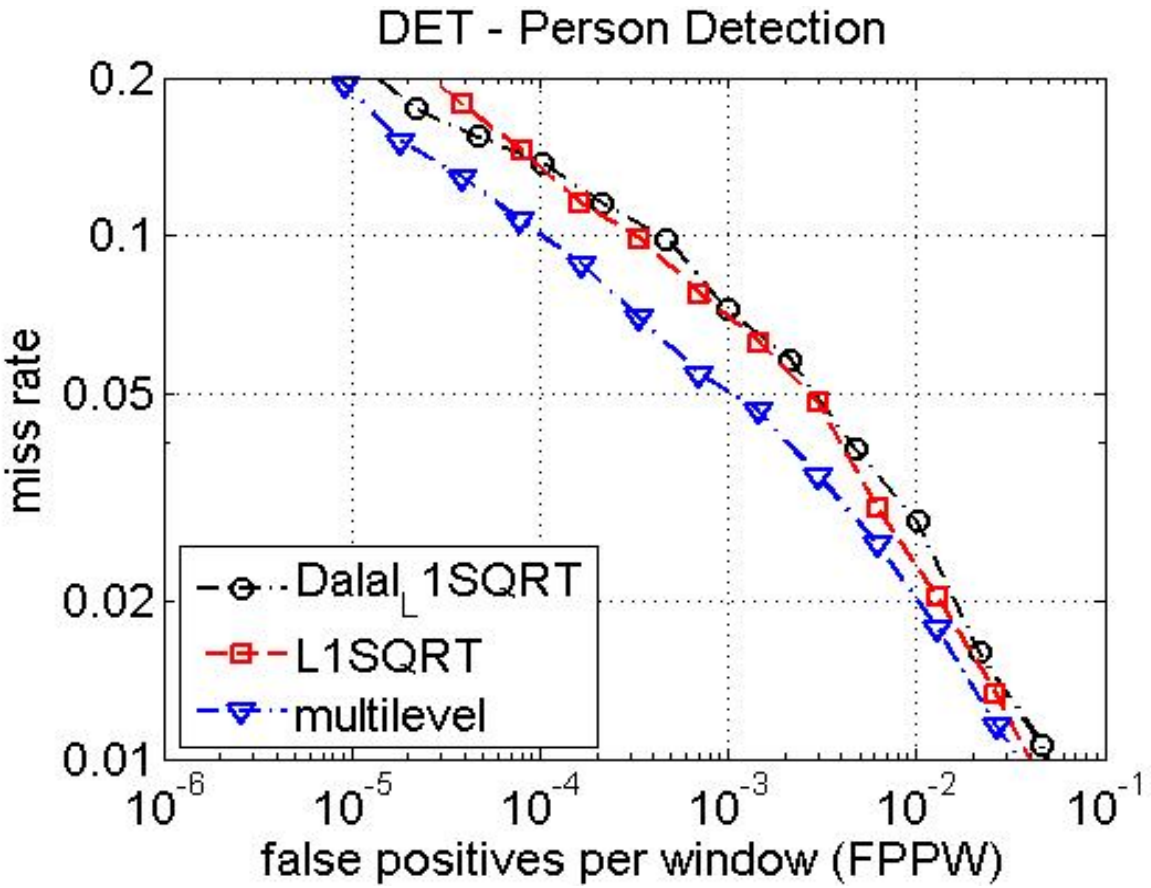
[A1,..,Z1]

[A2,..,Z2]

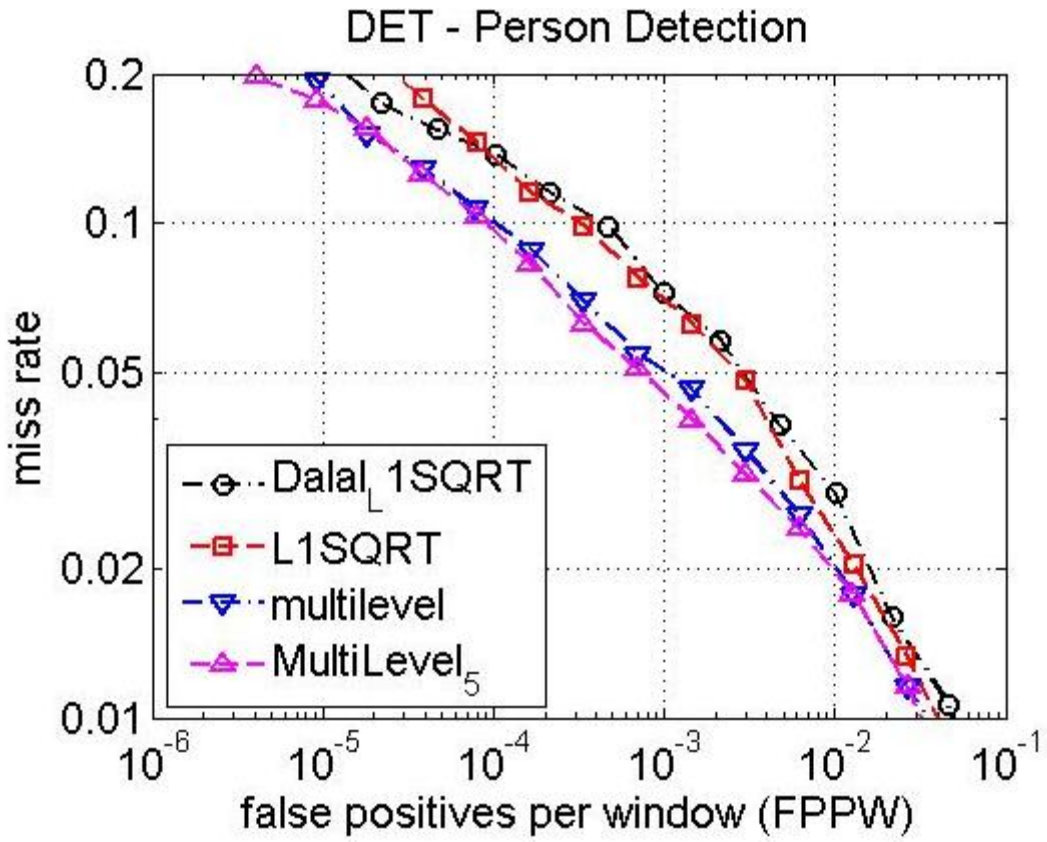
[A3,..,Z3]

[A1,..,Z1, A2,..,Z2, A3,..,Z3, A4,..,Z4]

Result


DET - Person Detection
miss rate
0.2
0.1
0.05
0.02
0.01
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
false positives per window (FPPW)
Dalal_L 1SQRT
L1SQRT
multilevel

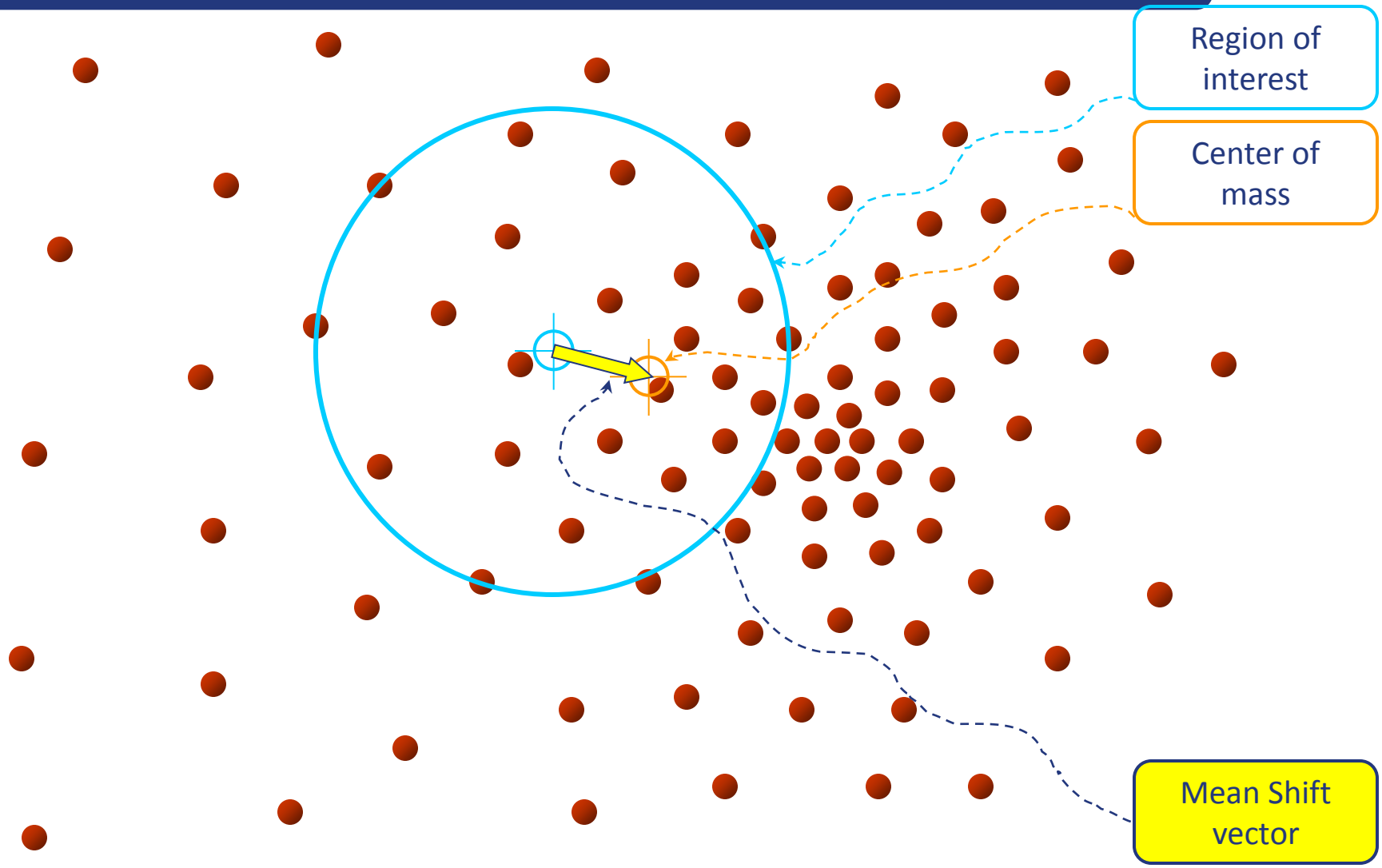
Result(cont…)


DET - Person Detection
miss rate
0.2
0.1
0.05
0.02
0.01
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
false positives per window (FPPW)
Dalal_L 1SQRT
L1SQRT
multilevel
MultiLevel_5

Mean Shift as Non-maxima Suppression

Mean shift

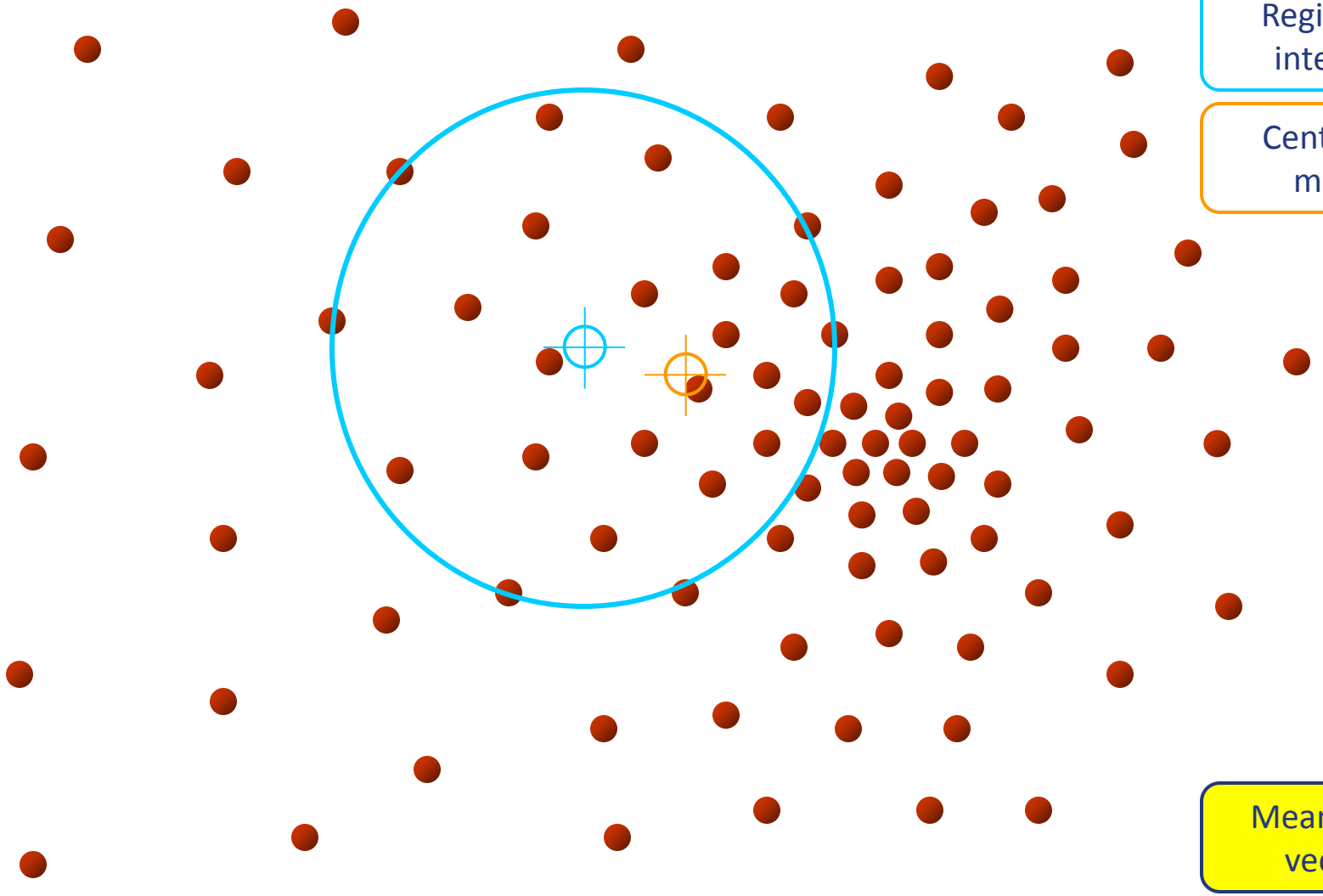
LOGO



Slide by Y. Ukrainitz & B. Sarel

Mean shift

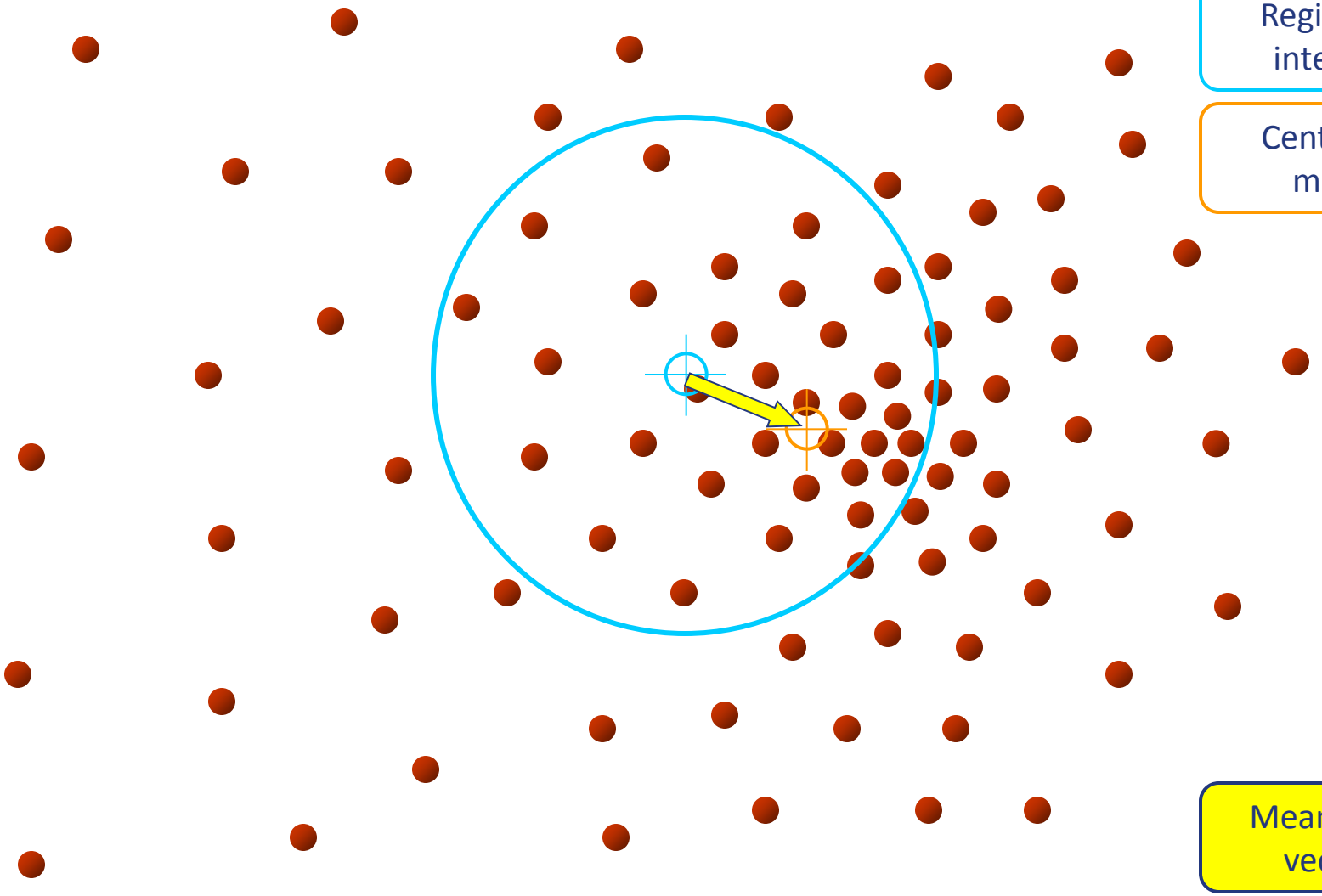
LOGO



Slide by Y. Ukrainitz & B. Sarel

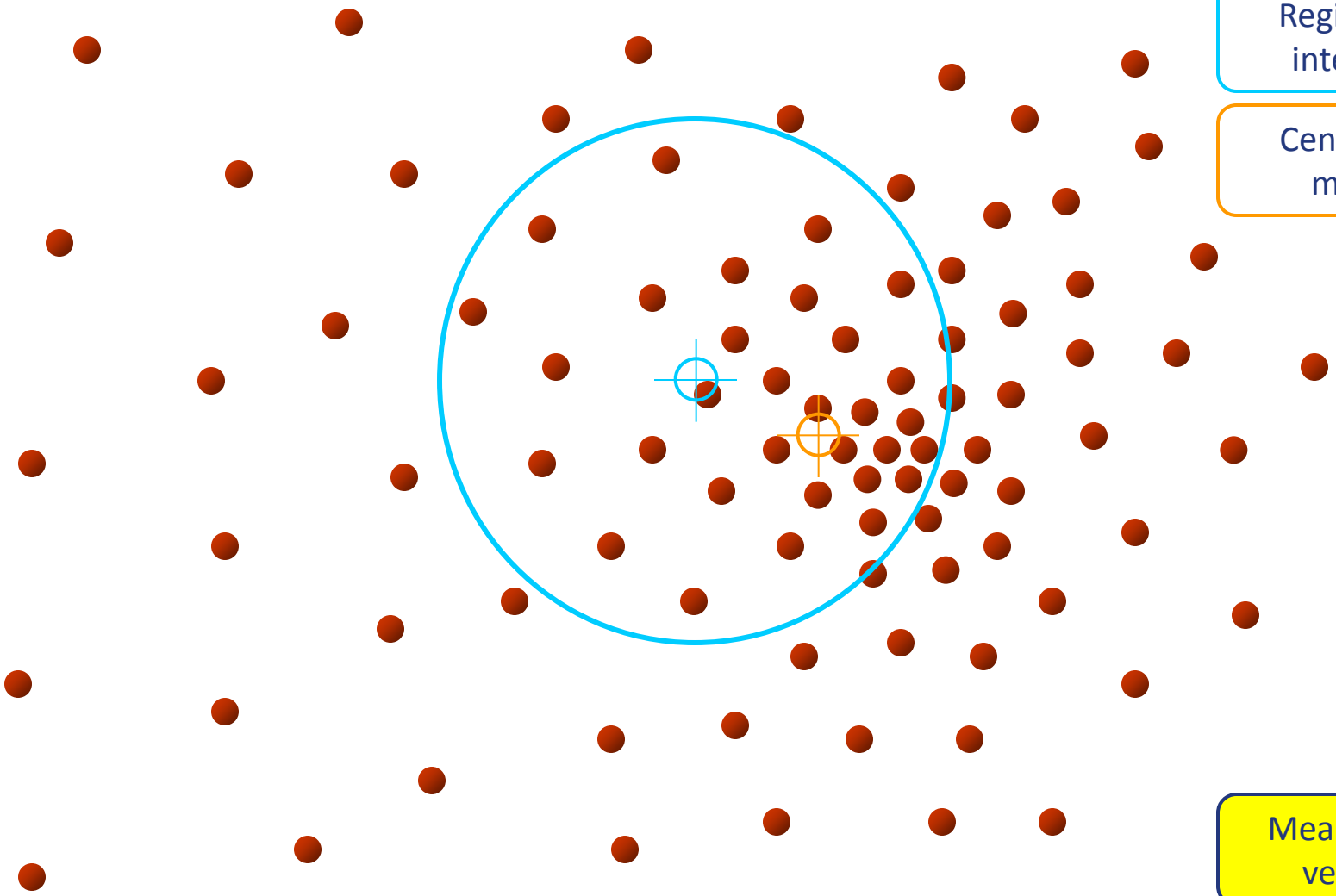
Mean shift

LOGO



Slide by Y. Ukrainitz & B. Sarel

Mean shift



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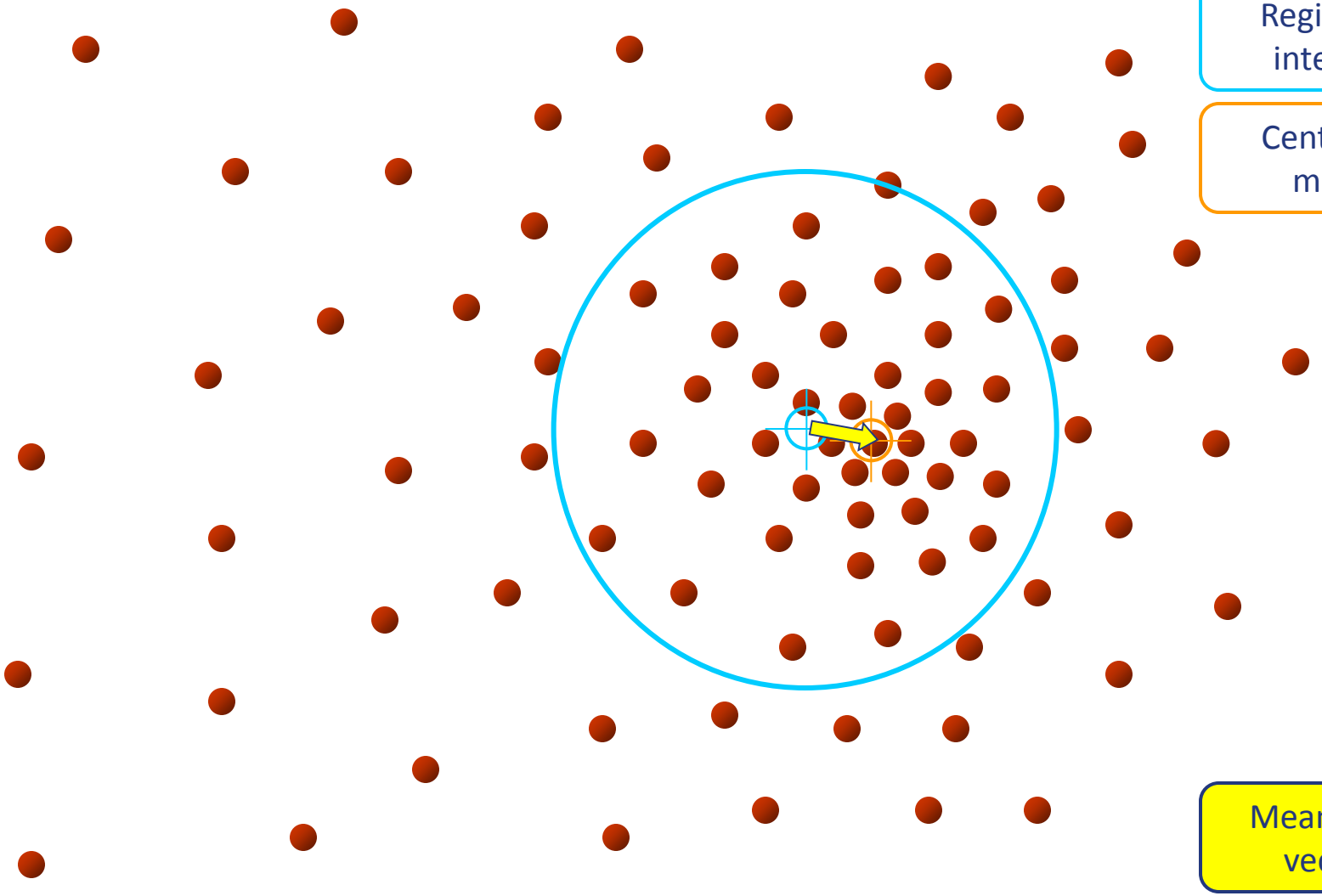
Mean shift

LOGO



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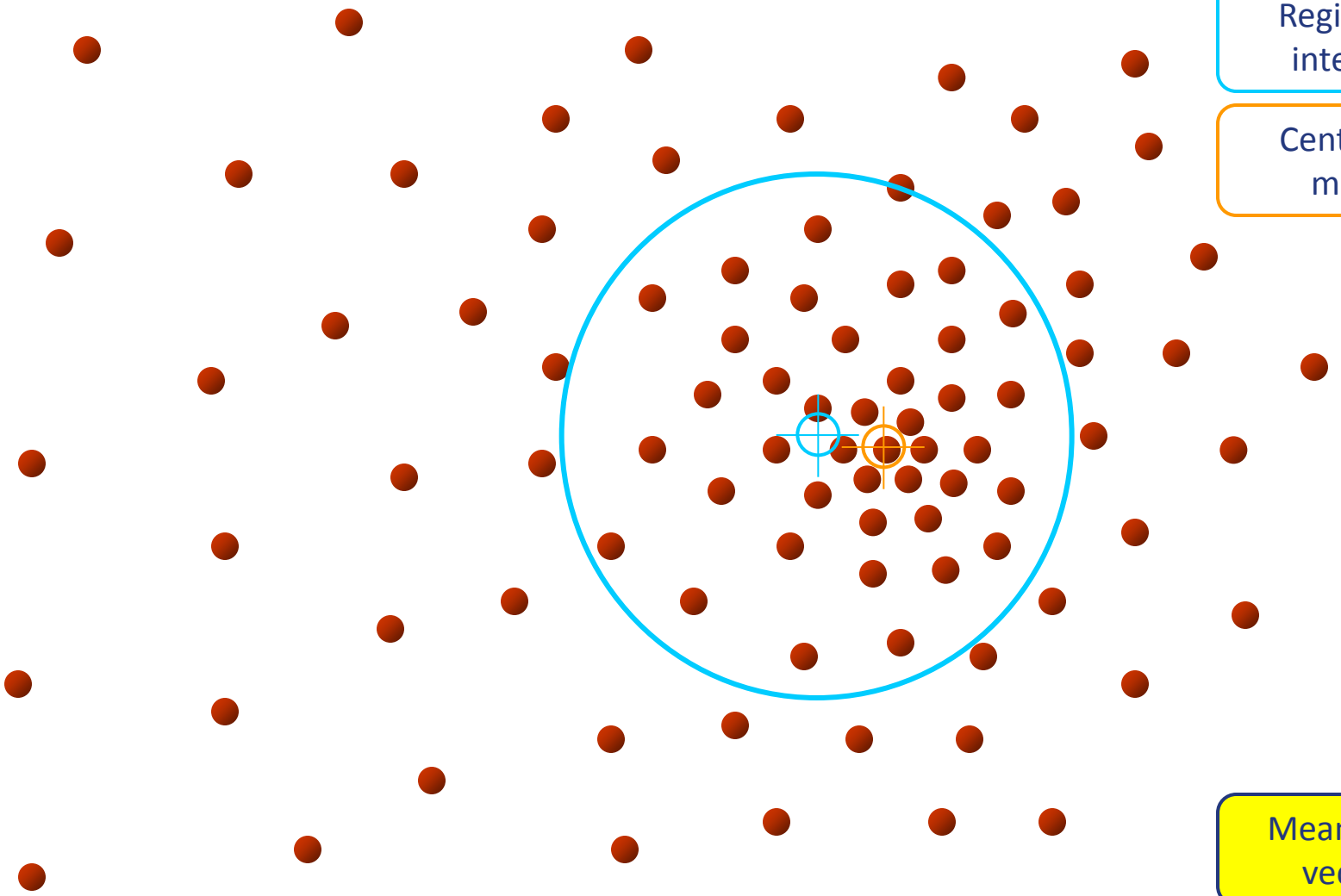
Mean shift

LOGO



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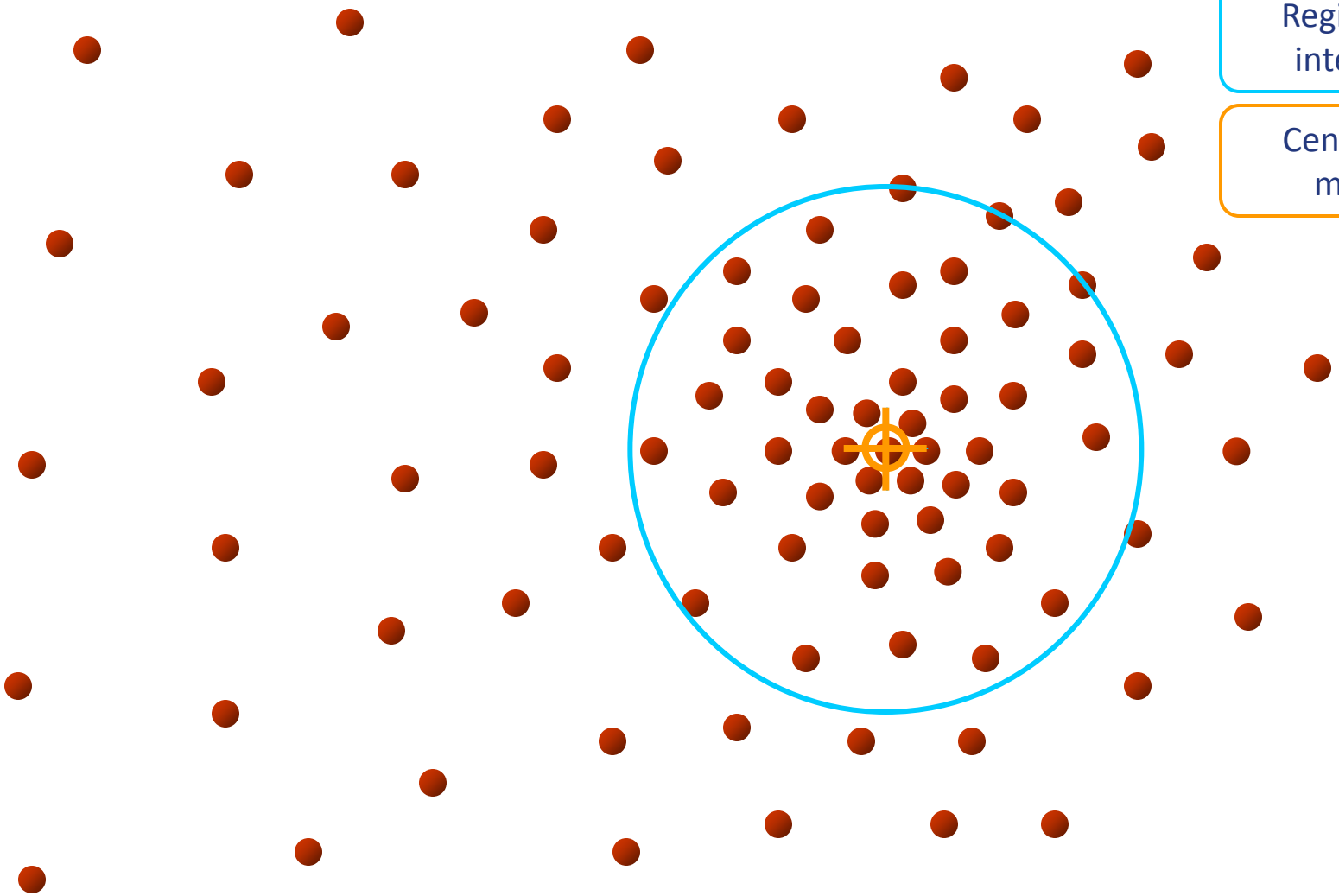
Mean shift

LOGO



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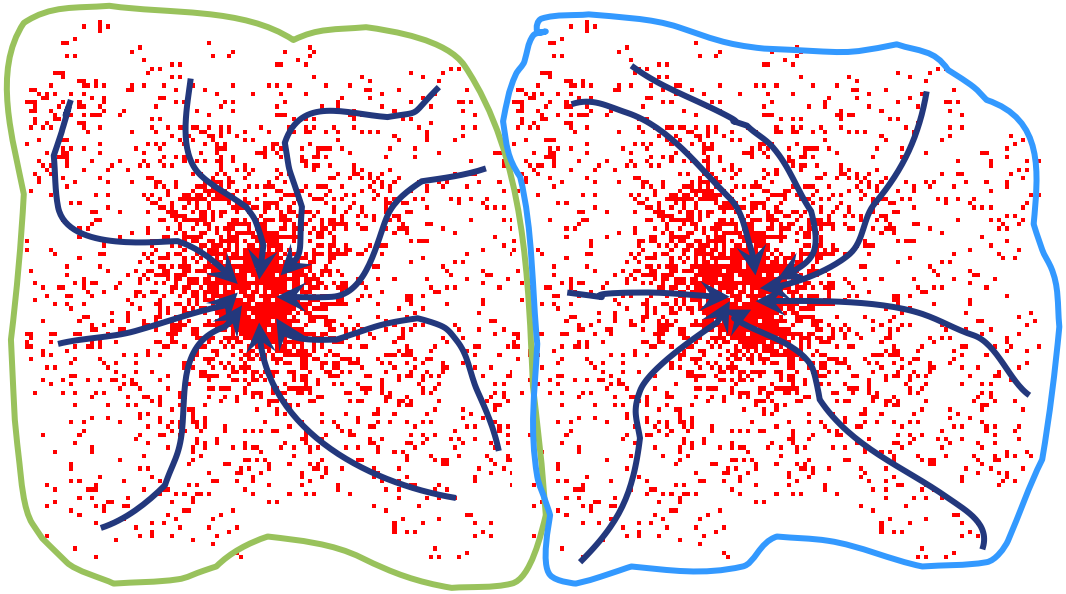
Mean shift clustering

- Cluster: all data points in the attraction basin of a mode
- Attraction basin: the region for which all trajectories lead to the same mode



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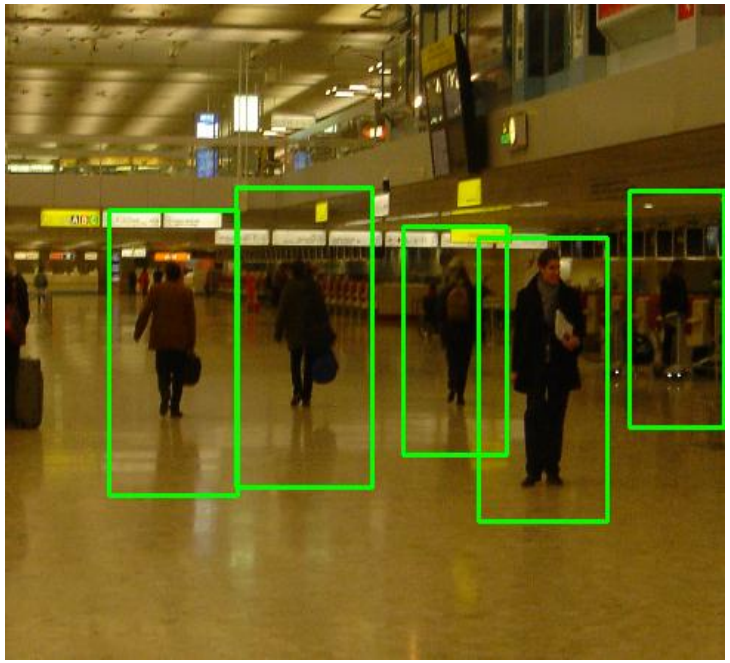
Non-maximum suppression

- Using non-maximum suppression such as mean shift to find the modes.



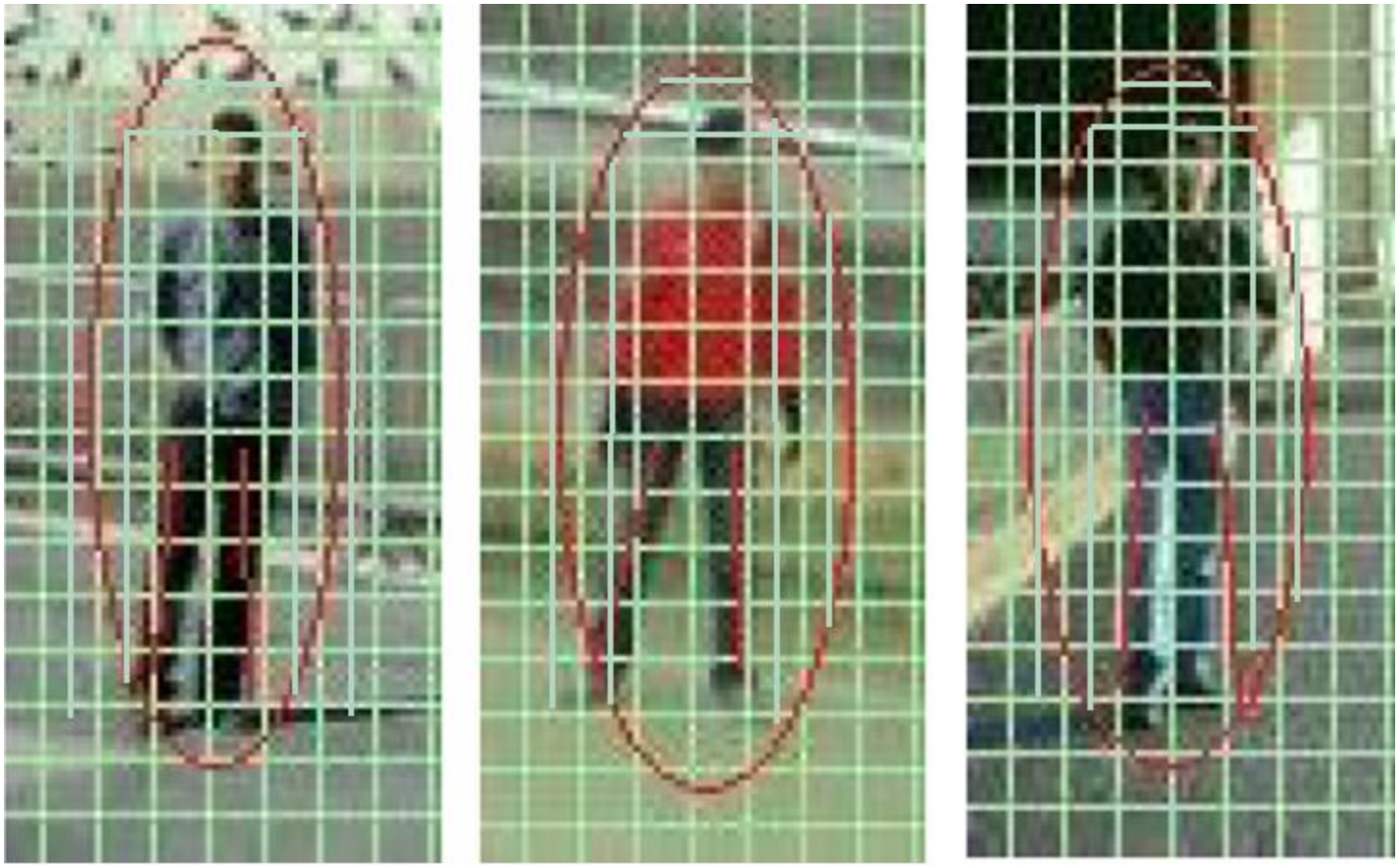
Conclusions

- Successfully re-implement HOG descriptor.
- Propose the Spatial Selective Approach which take advantages of less informative center region of image window.
- Multi-level has more information about shape and contour of object.

Future work

- Non-uniform grid of points.
- Combination of Spatial Selective and Multi-level approach.

Non-uniform grid of points



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