Machine Learning for Computer Vision

EE462 (EEE&EIE),EE9SO25,EE9CS728

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Lecturers

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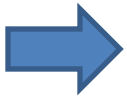
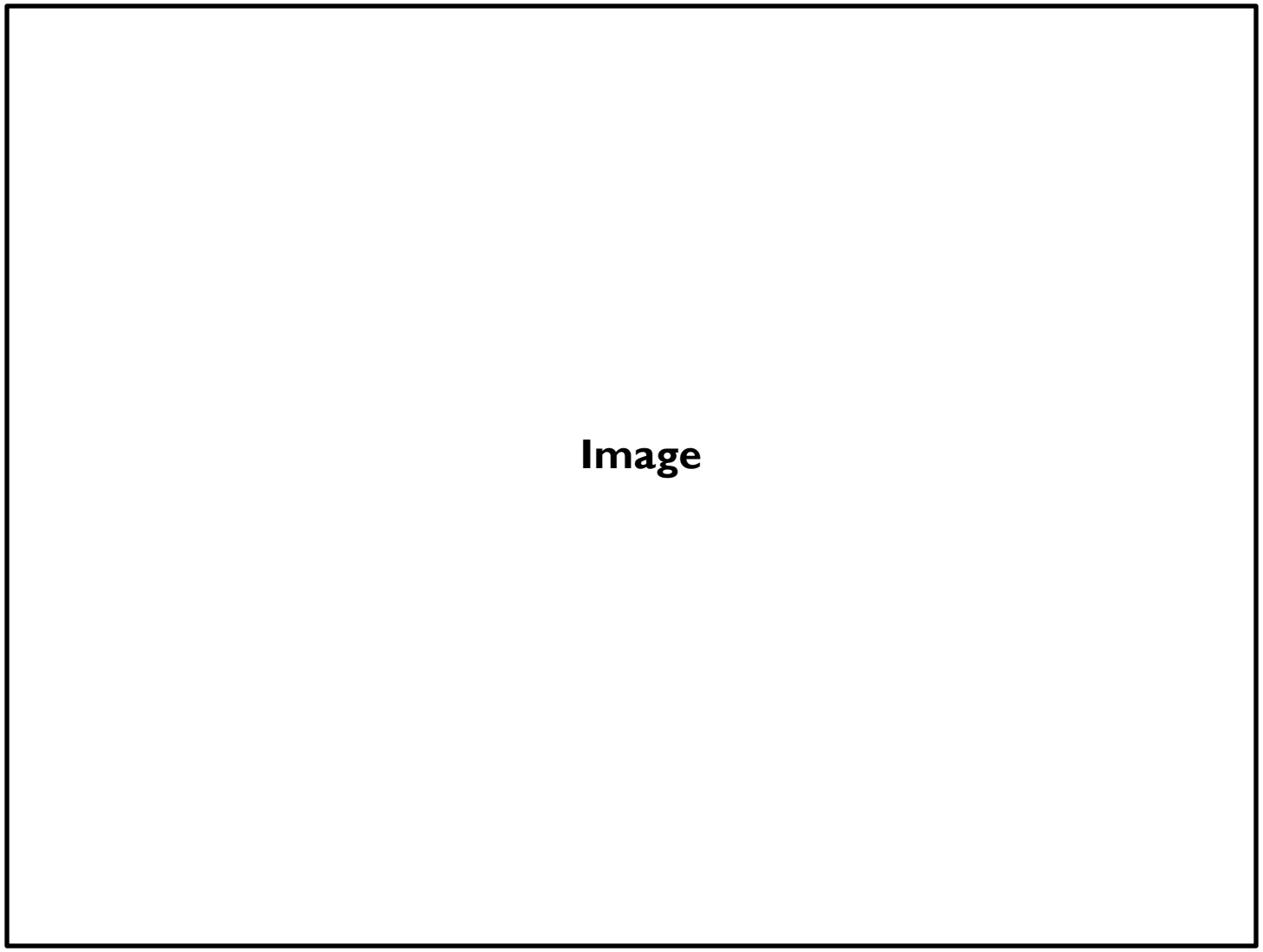
Why understanding images is hard

Very many sources of variability



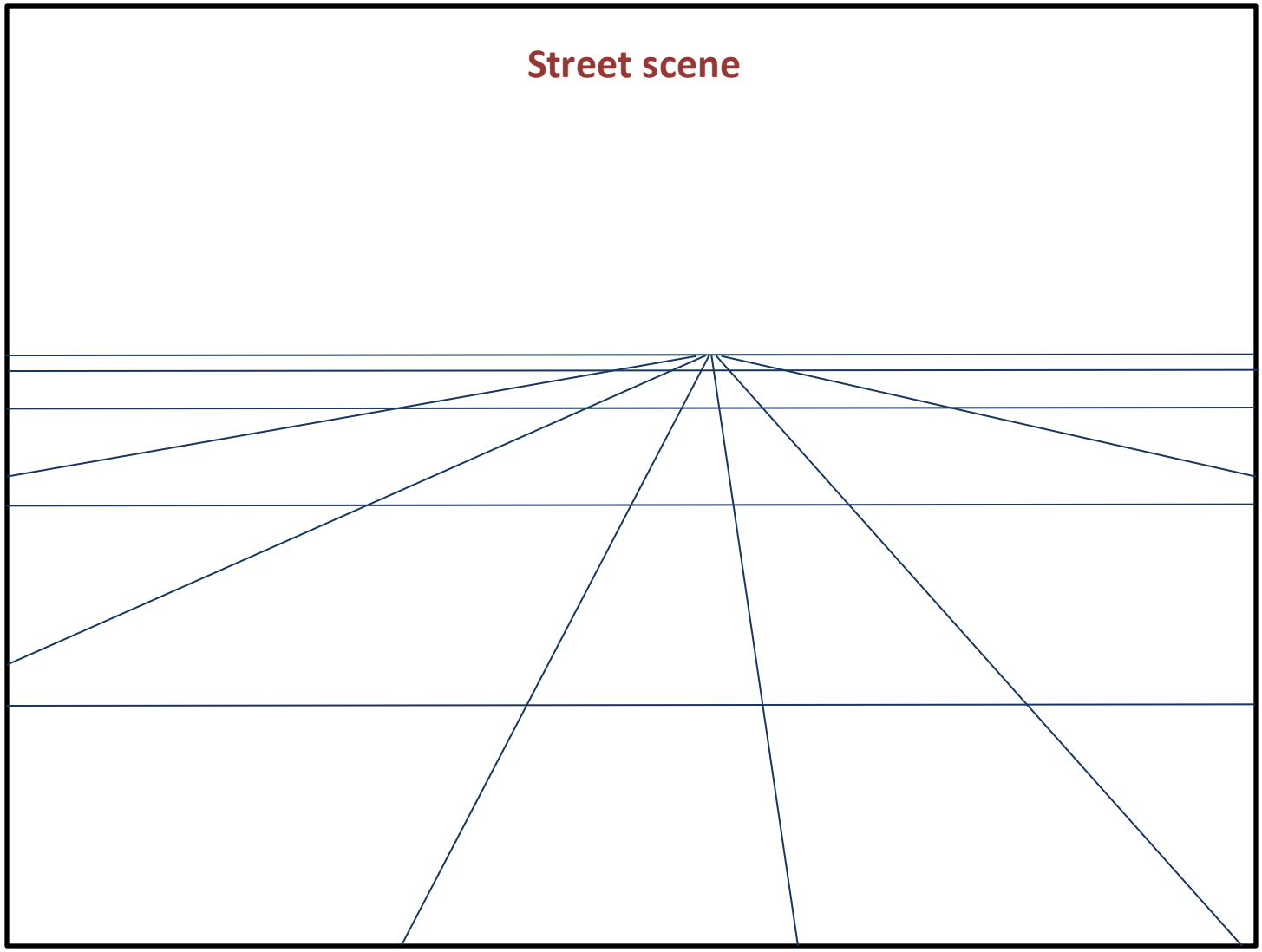


From J. Winn, MSR

Sources of image variability

Scene type

Scene geometry



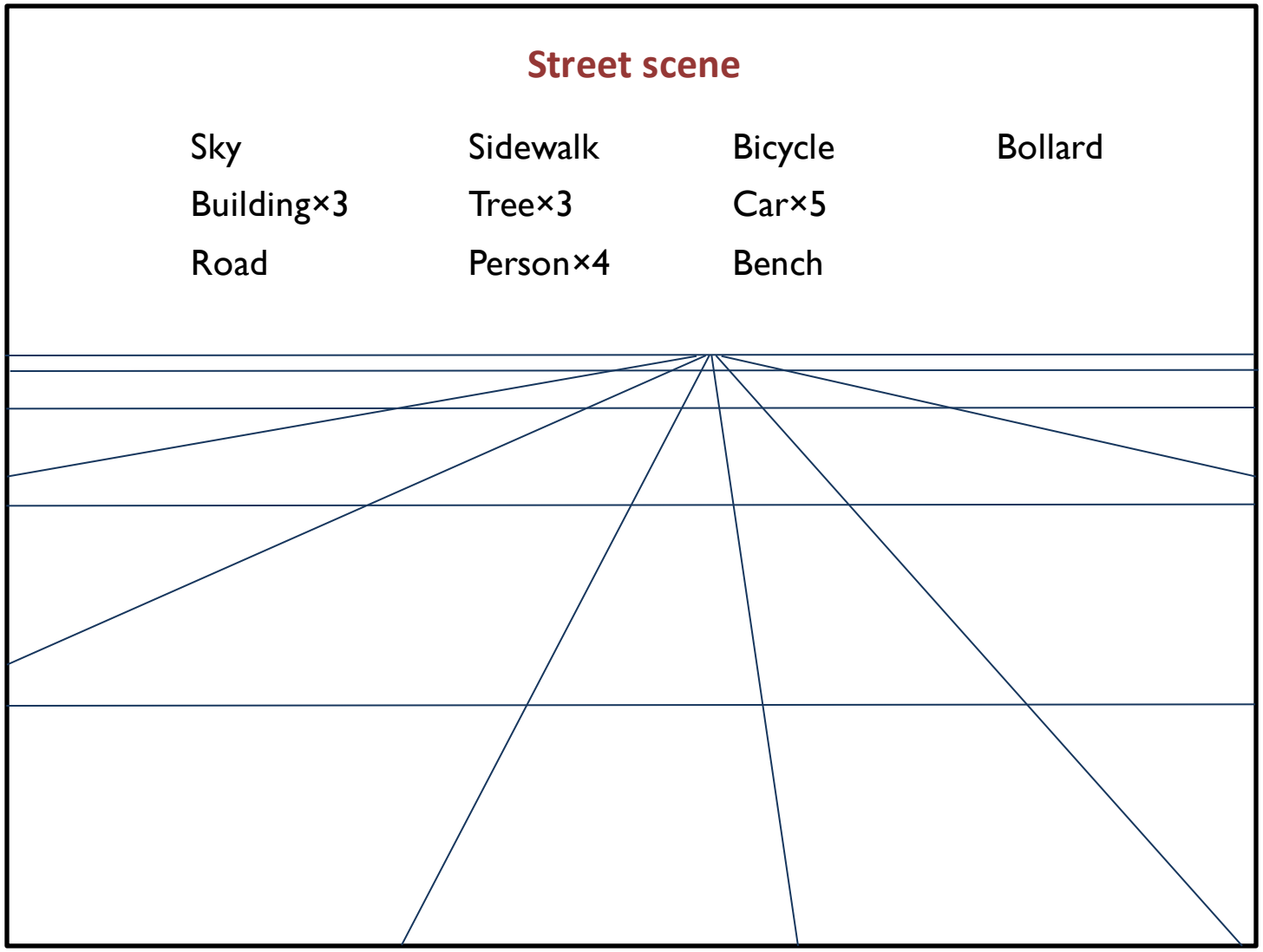
From J. Winn, MSR

Sources of image variability

Scene type

Scene geometry

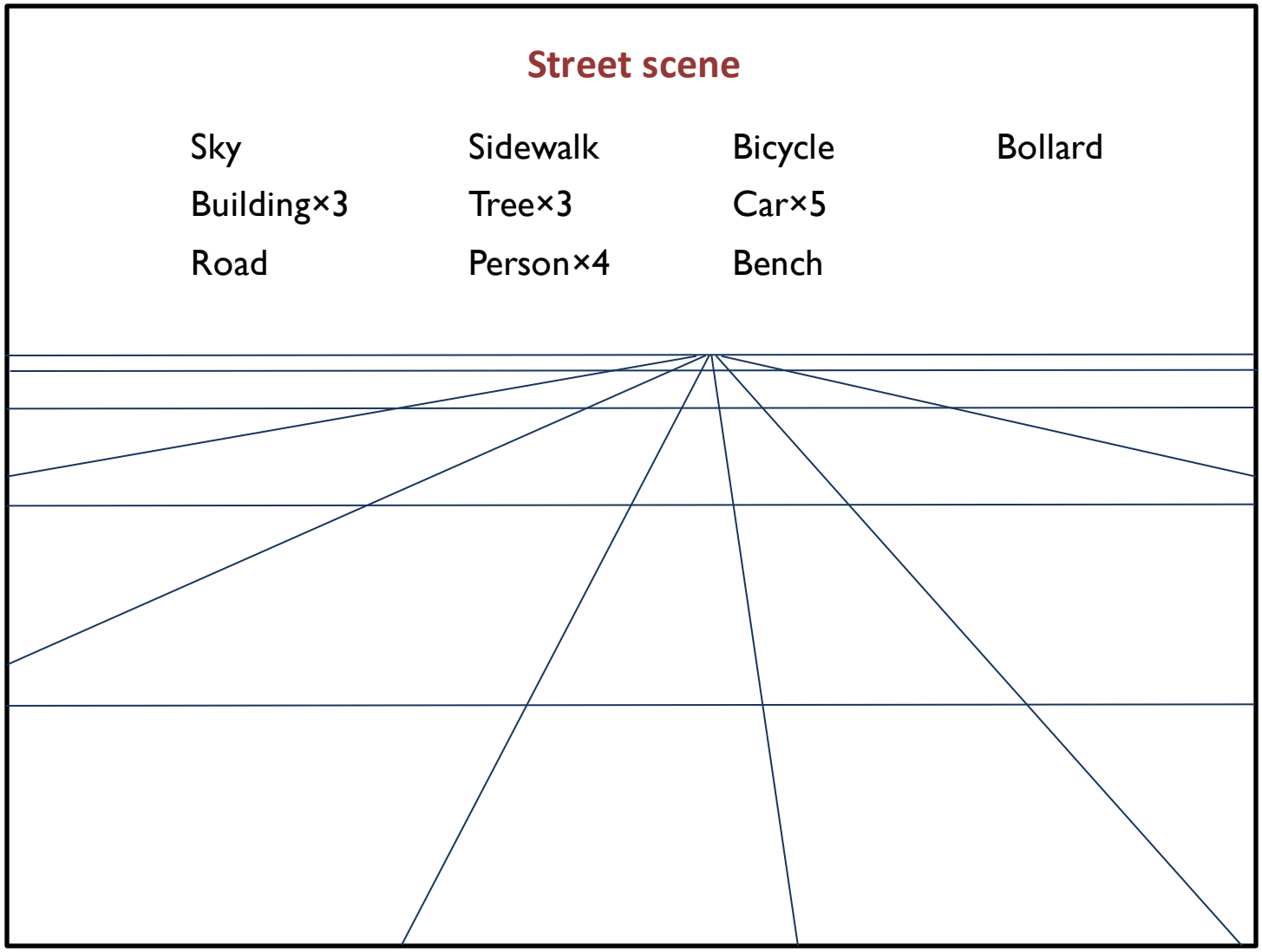
Object classes



From J. Winn, MSR

Sources of image variability

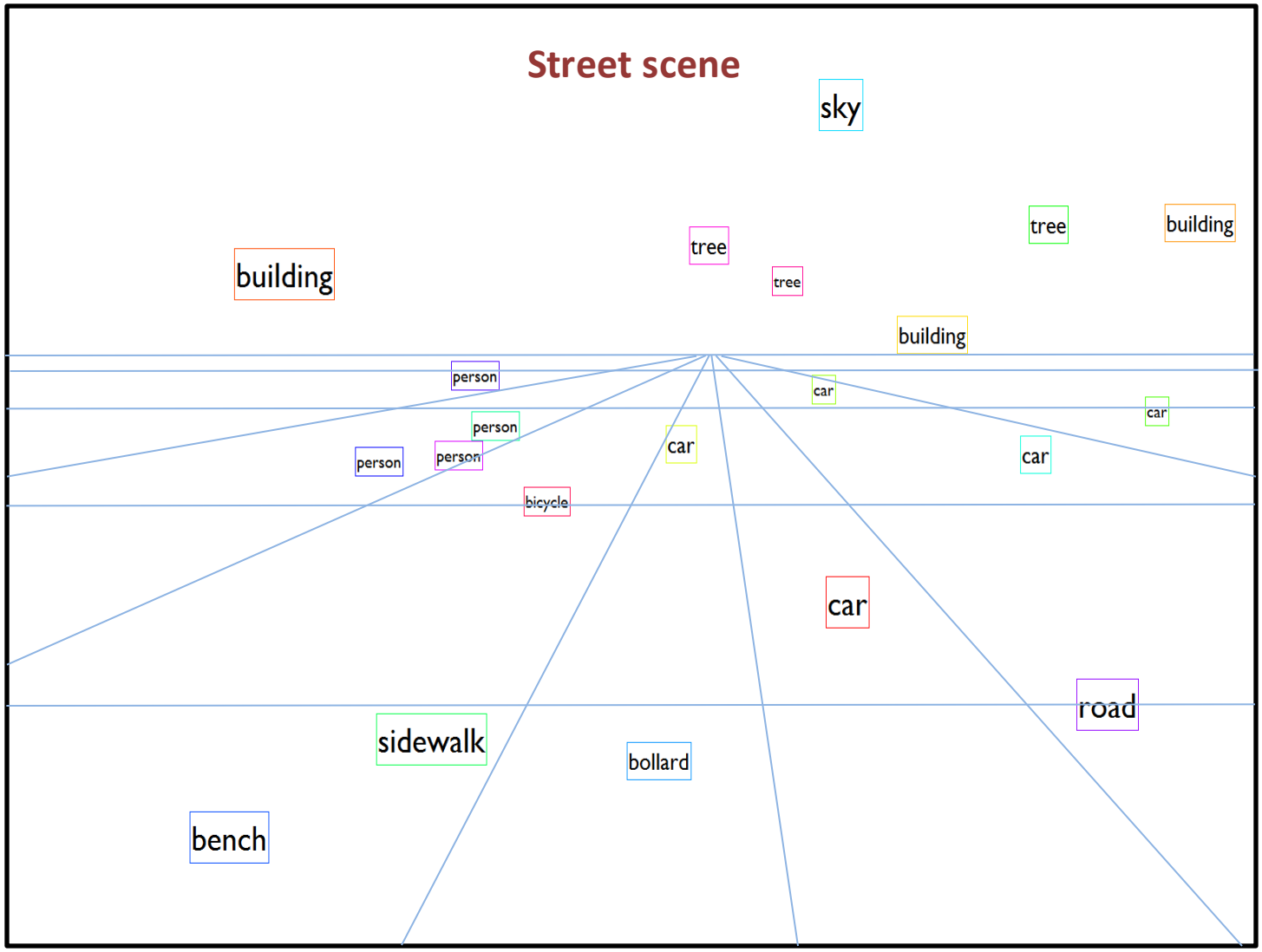
Scene type
Scene geometry
Object classes
Object position
Object orientation



From J. Winn, MSR

Sources of image variability

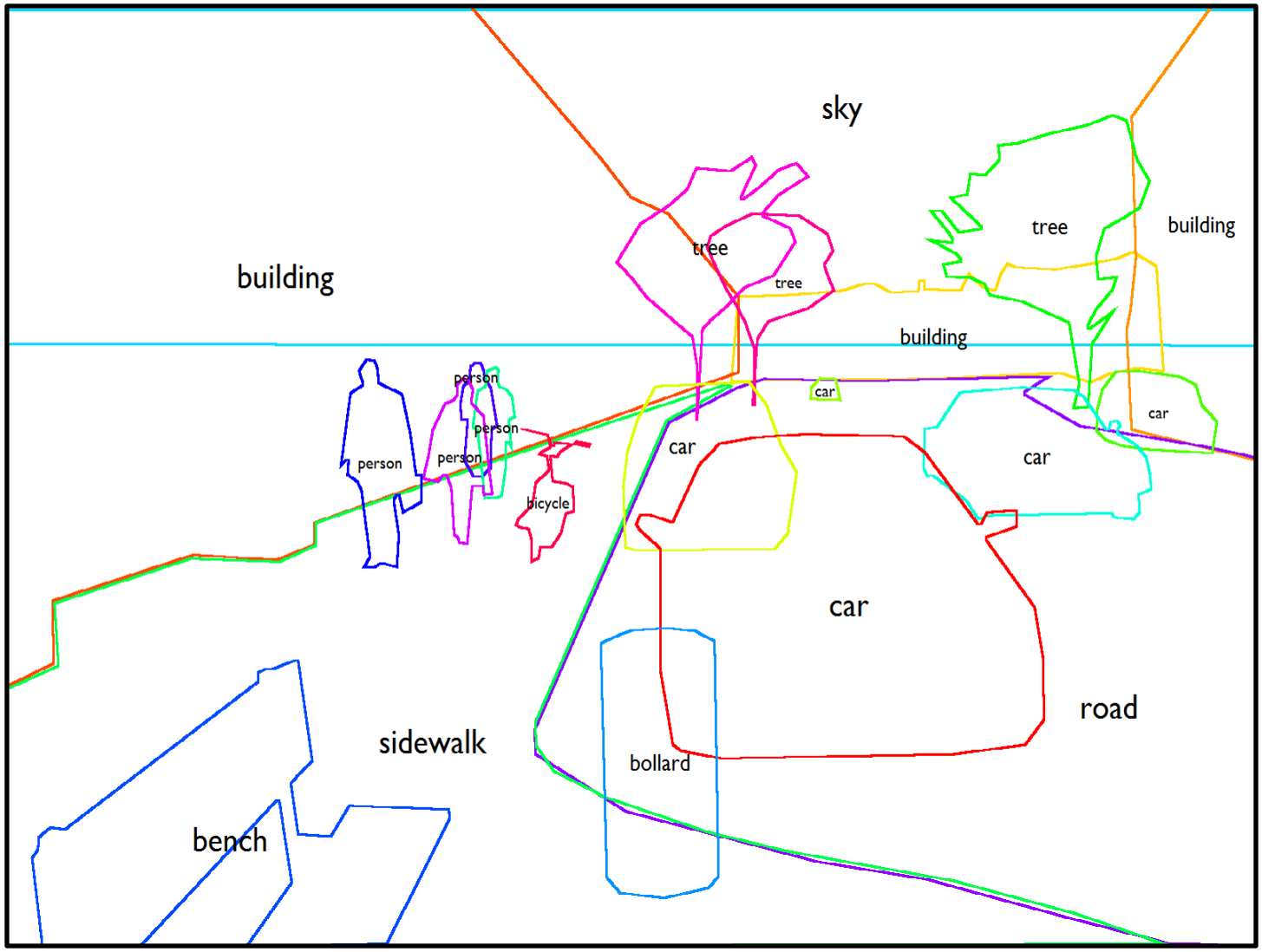
Scene type
Scene geometry
Object classes
Object position
Object orientation
Object shape



From J. Winn, MSR

Sources of image variability

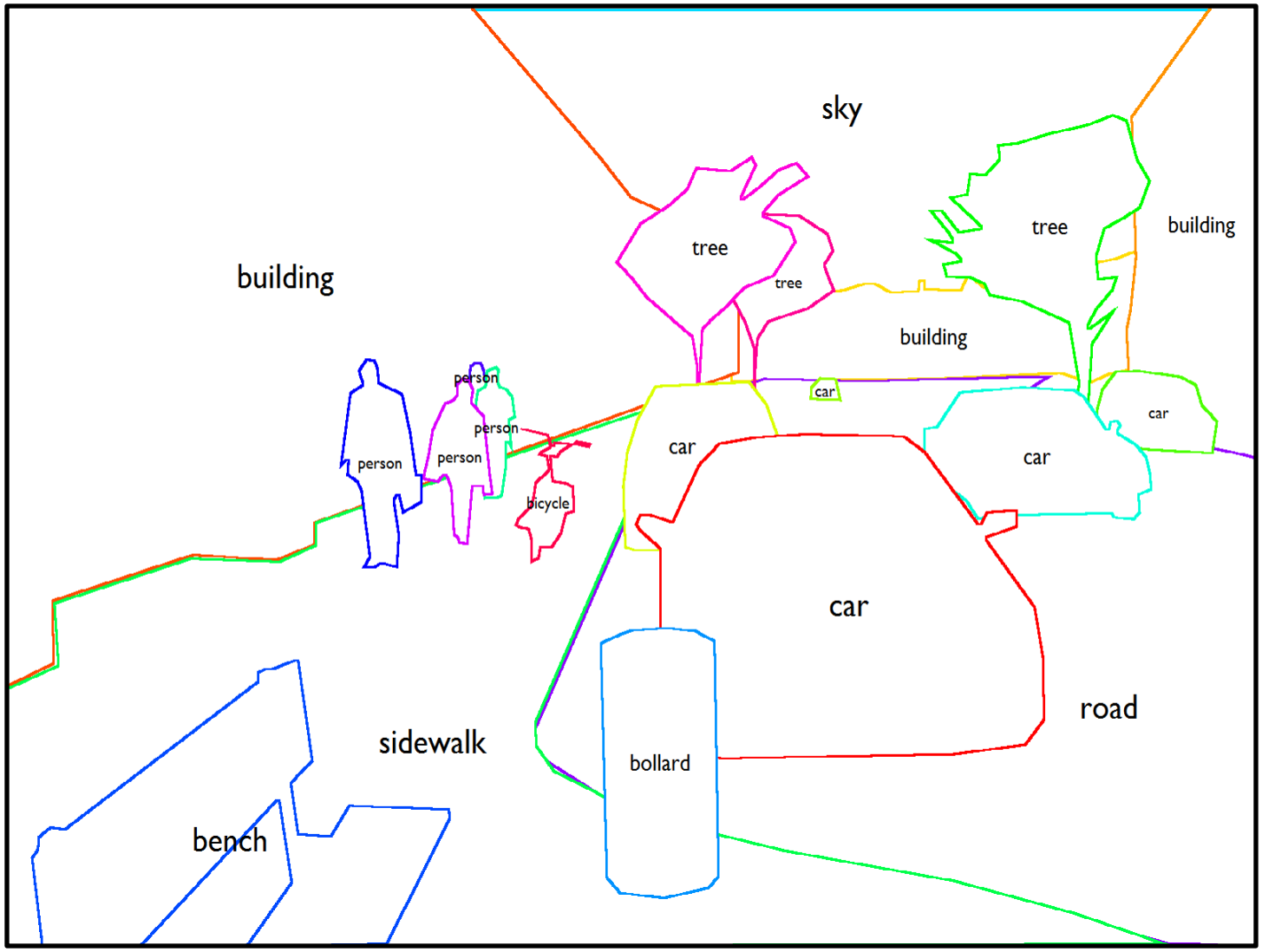
Scene type
Scene geometry
Object classes
Object position
Object orientation
Object shape
Depth/occlusions



From J. Winn, MSR

Sources of image variability

Scene type
Scene geometry
Object classes
Object position
Object orientation
Object shape
Depth/occlusions
Object appearance



From J. Winn, MSR

Sources of image variability

Scene type

Scene geometry

Object classes

Object position

Object orientation

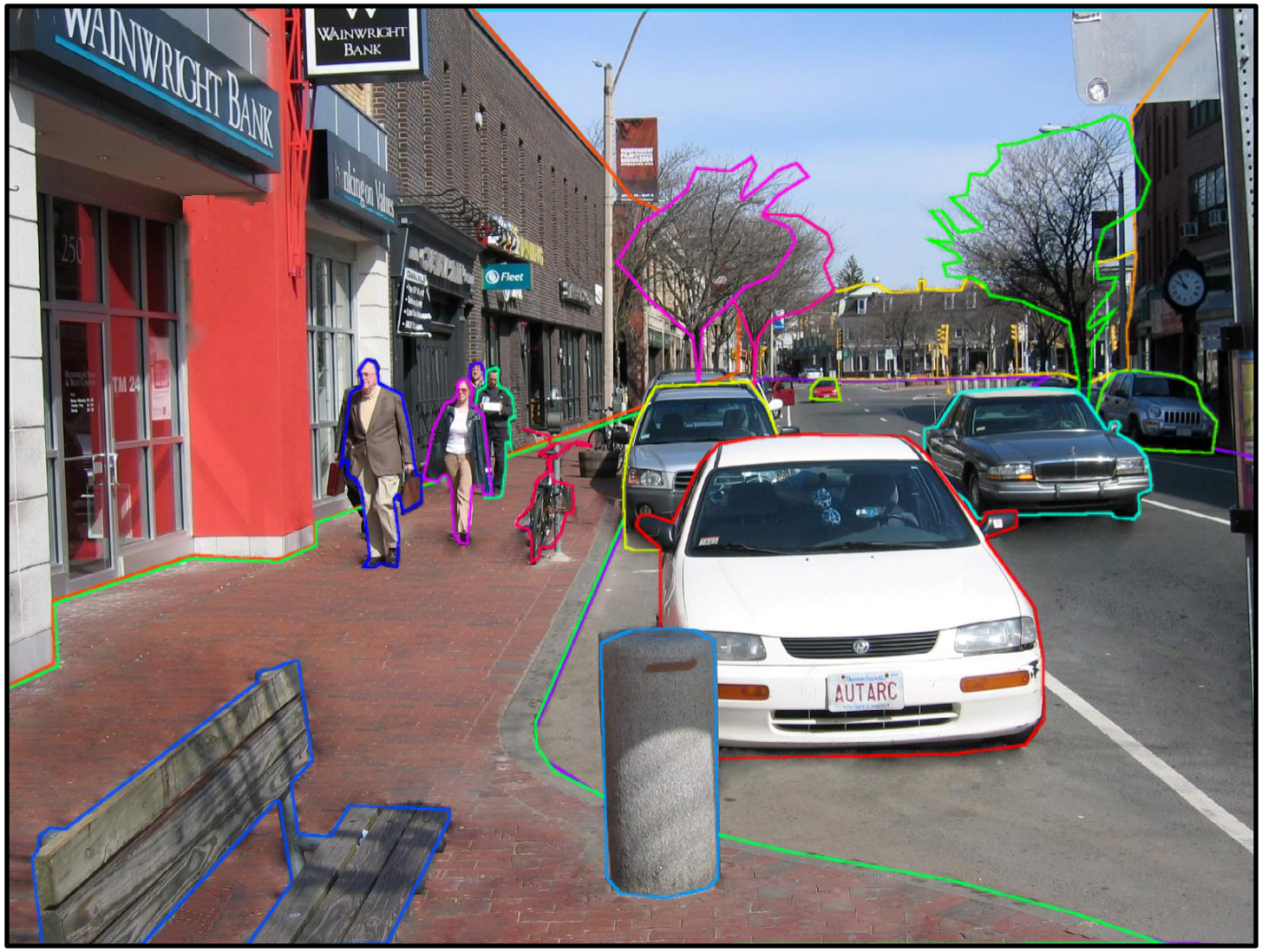
Object shape

Depth/occlusions

Object appearance

Illumination

Shadows



From J. Winn, MSR

Sources of image variability

Scene type

Scene geometry

Object classes

Object position

Object orientation

Object shape

Depth/occlusions

Object appearance

Illumination

Shadows

From J. Winn, MSR

Sources of image variability

Scene type
Scene geometry
Object classes
Object position
Object orientation
Object shape
Depth/occlusions
Object appearance
Illumination
Shadows
Motion blur
Camera effects

From J. Winn, MSR

Course Aims

- The course studies concepts, theories and state-of-the-art algorithms for visual learning and recognition.

- The lectures introduce selected topics of visual recognition by machine learning techniques, including: object categorisation, image segmentation, pose estimation, object detection.

- Formulations and theories of machine learning techniques are presented, including: Bag of Words, K-means, Randomised Forests, Boosting.

Face Recognition vs Object Categorisation

- Both are as multi-class (cf. binary) classification problem.
- The classes are different object categories in object categorisation, while the classes are different person identities in face recognition.

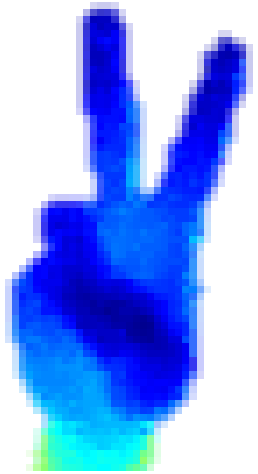
Face dataset

Object category dataset

Pose Estimation

- Given an input image, the system yields an output vector of joint angles/locations.
- The joint angles/locations take continuous values, this is formulated as a regression problem.

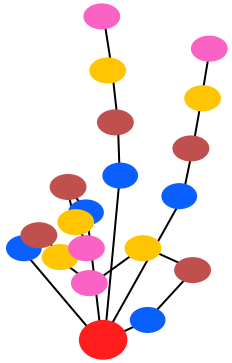
Input Depth Image



Z

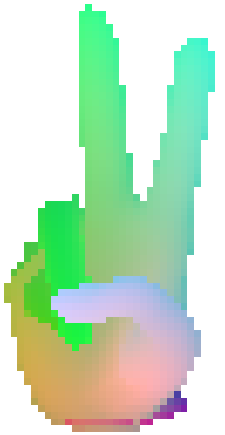
Extract joint angles
$\theta \in \mathbb{R}^d$
for current frame

Skeleton



θ

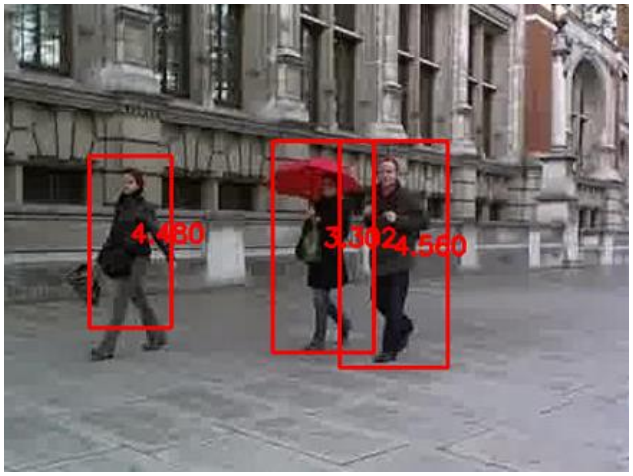
Rendered Depth Image

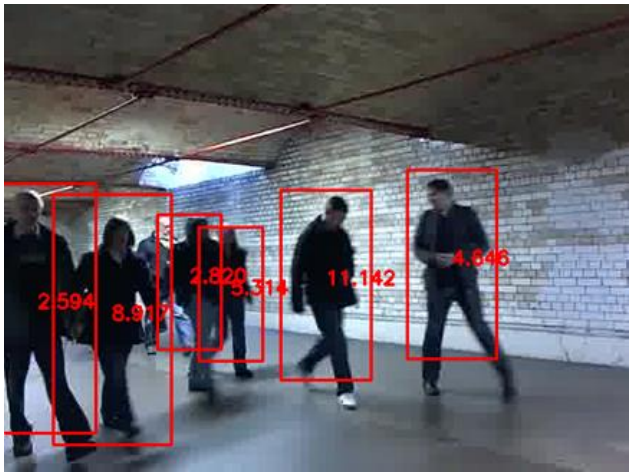


R_θ

Object Detection

– The task is to determine the locations and sizes of objects present in an image, given a known object class: e.g. pedestrian, or face.





Backgrounds

The module is coursework-based and the coursework requires Matlab programming.

The lectures require background on:

- Optimisation (EE429)
- Matrix and vector derivatives

*Further reading: Appendix A Mathematical Foundations, R.Duda, P.Hart, D.Stork, Pattern Classifcation (Second Edition), JOHN WILEY & SONS, Inc. 2001.
http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.320.4607&rep=rep1&type=pdf
http://cns-classes.bu.edu/cn550/Readings/duda-etal-00.pdf

This module is benefited from

- (EEE courses) 468 Pattern Recognition, Introduction to Machine Learning
- (Computing courses) 316 Computer Vision, 395 Machine Learning, 333 Robotics, 495 Advanced Statistical Machine Learning and Pattern Recognition

Lecture Schedules

20 lectures (in spring term)

- Every Tuesday, 4-6pm (2 hours)
- Room 509A EEE

100% coursework

- Computer programming based (Matlab, other tools)
- 2 courseworks (by the end of lectures)
- (refer to PR or MLCV in the previous years)

Course homepage:

- https://intranet.ee.ic.ac.uk/electricalengineering/eecourses_t4/course_content.asp?c=EE4-62&s=T4
- https://bb.imperial.ac.uk

Lecture schedules

Week 1.

- Course Introduction
- Object Categorisation, Bag of Words, K-means Clustering for Image Quantisation

Week 2.

- Randomised Decision Forests (for classification)

Week 3.

- Regression Forests, Pose Estimation

Week 4.

- Object Detection, Boosting

Week 5.

- Hands-on Session: Boosting for Face Detection