Selected Topics in Computer Vision

EE462,EE9SO25,EE9CS728

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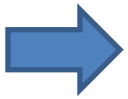
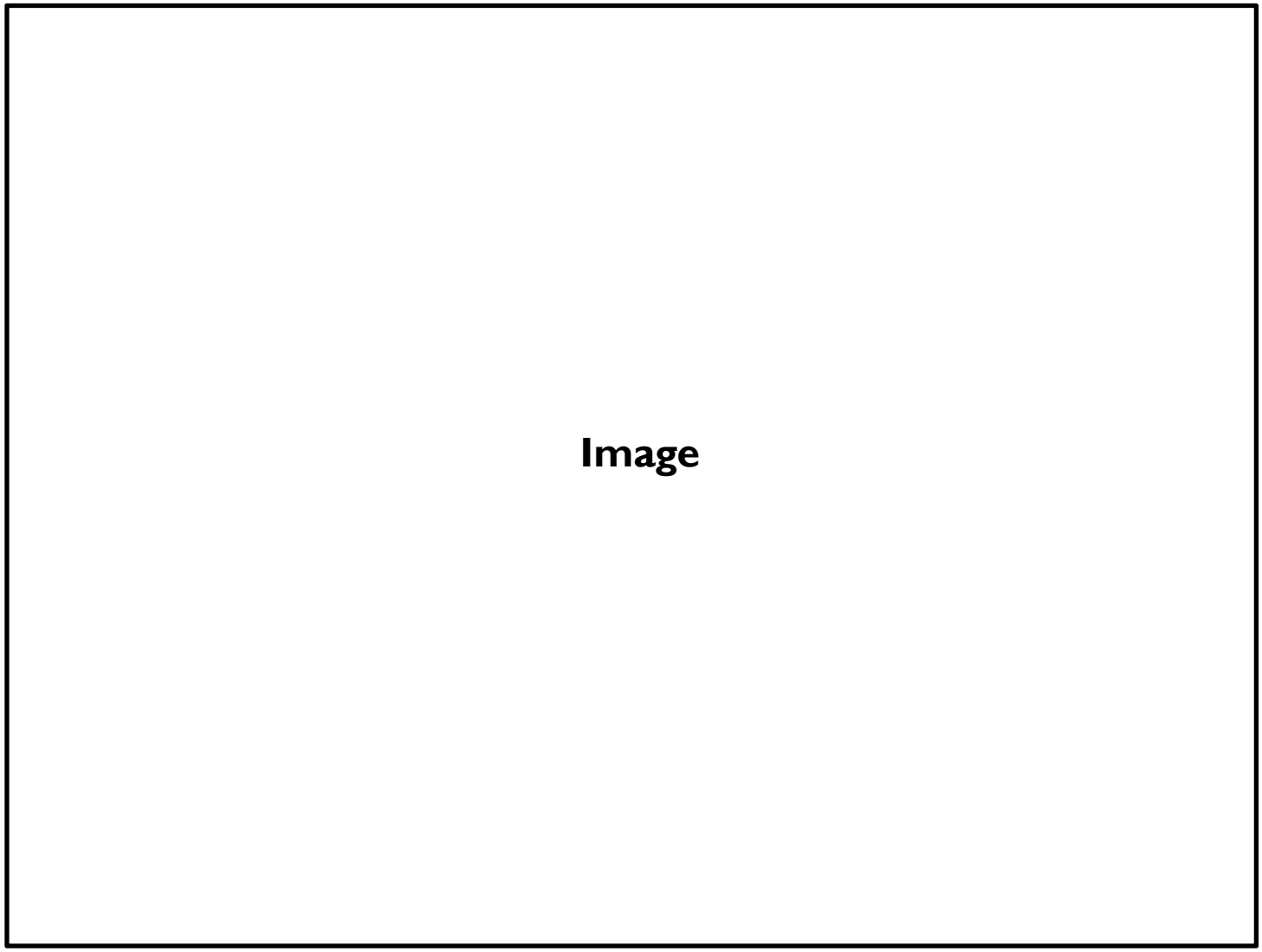
Why understanding images is hard

Very many sources of variability



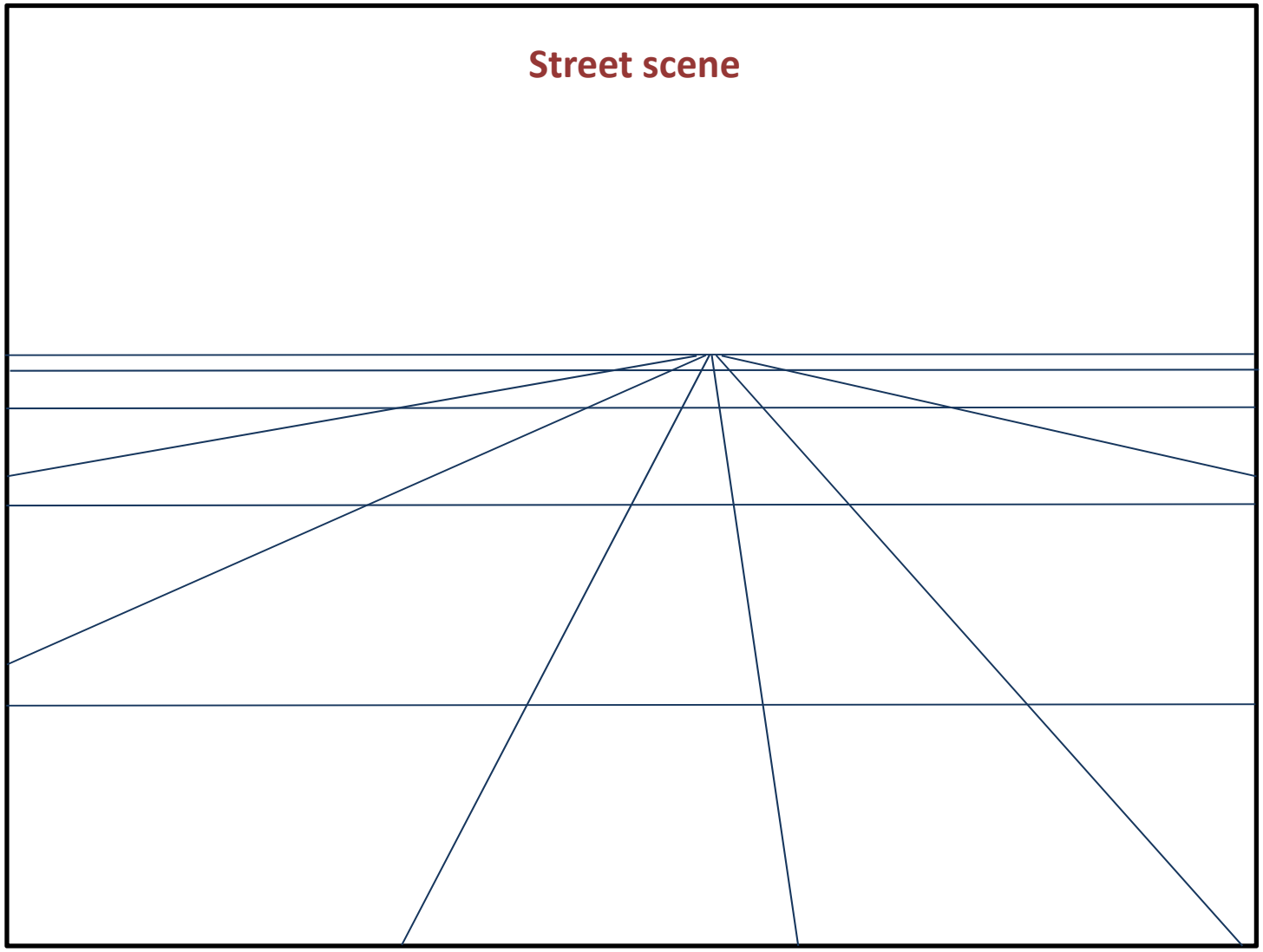


From J. Winn, MSR

Sources of image variability

Scene type

Scene geometry



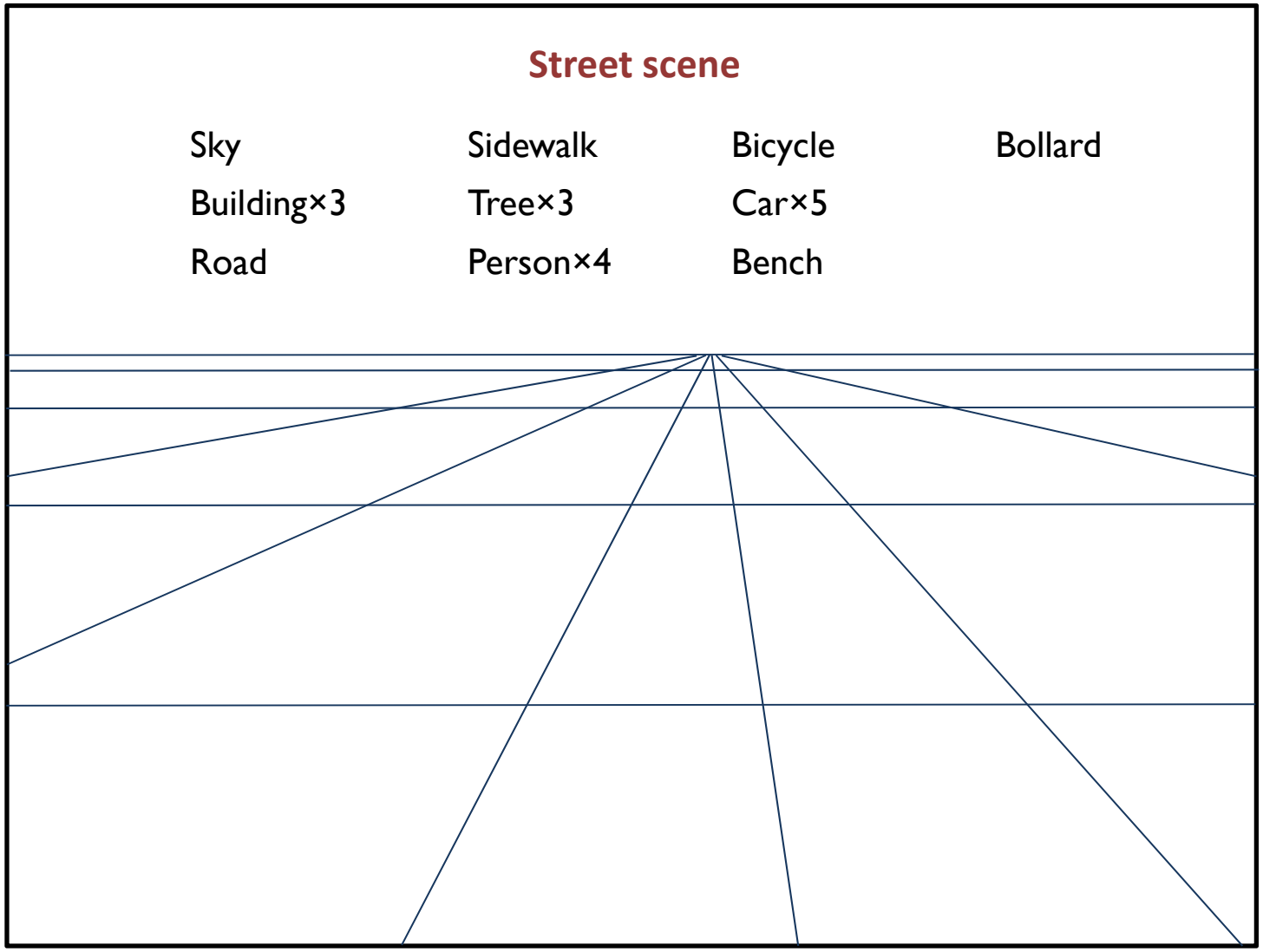
From J. Winn, MSR

Sources of image variability

Scene type

Scene geometry

Object classes



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Sources of image variability

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Object position

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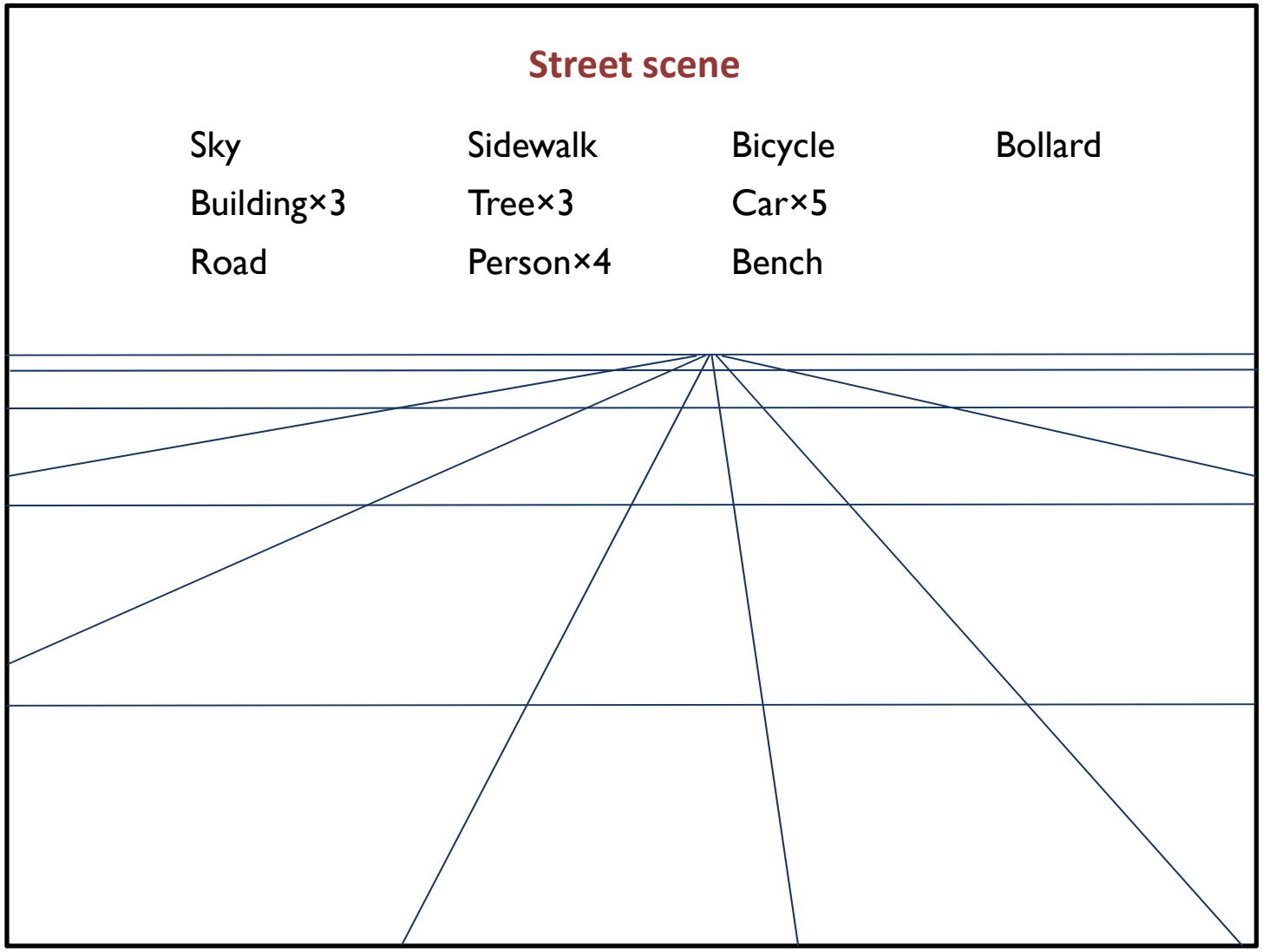

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Sources of image variability

Scene type

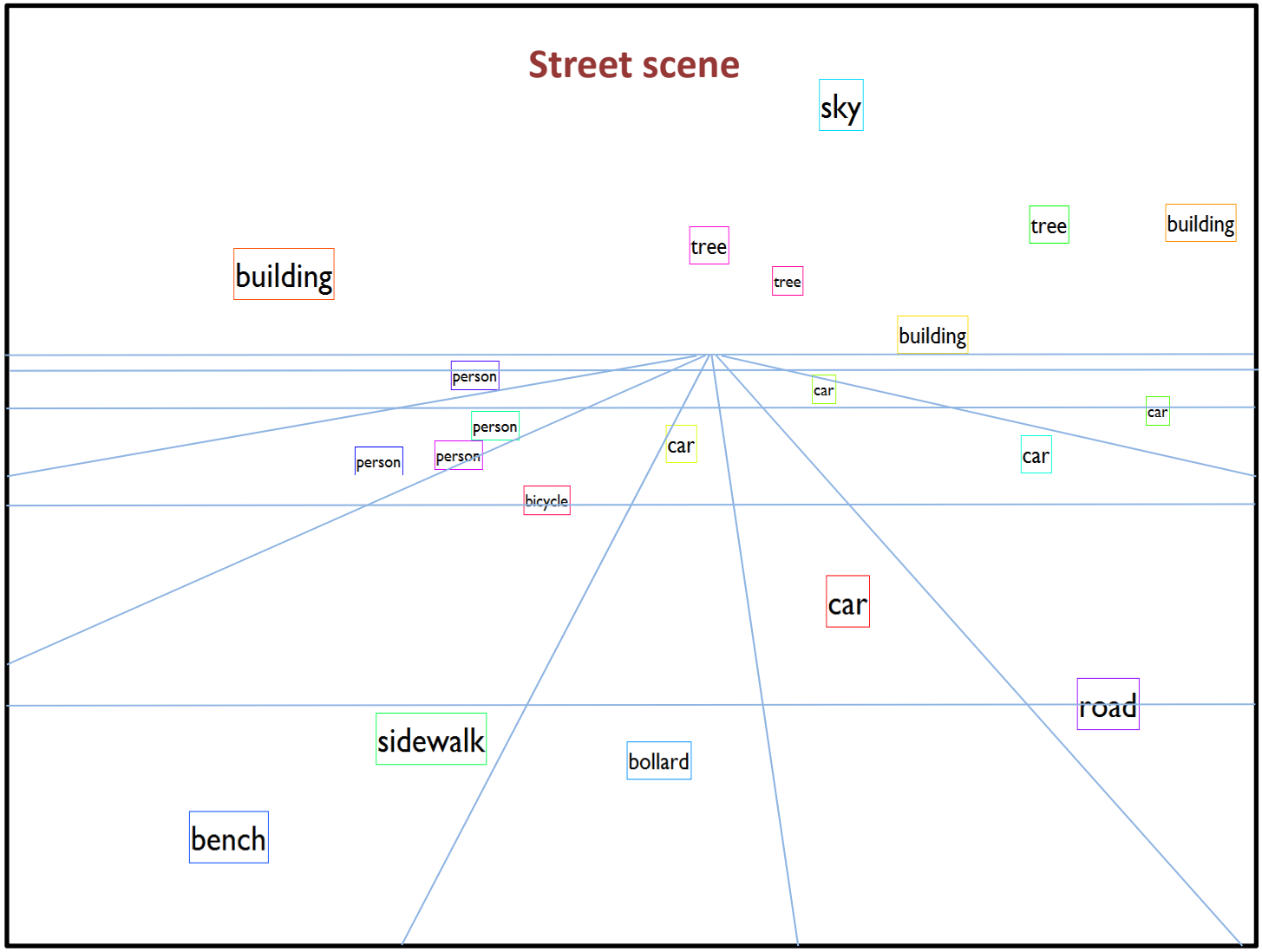
Scene geometry

Object classes

Object position

Object orientation

Object shape



From J. Winn, MSR

Sources of image variability

Scene type

Scene geometry

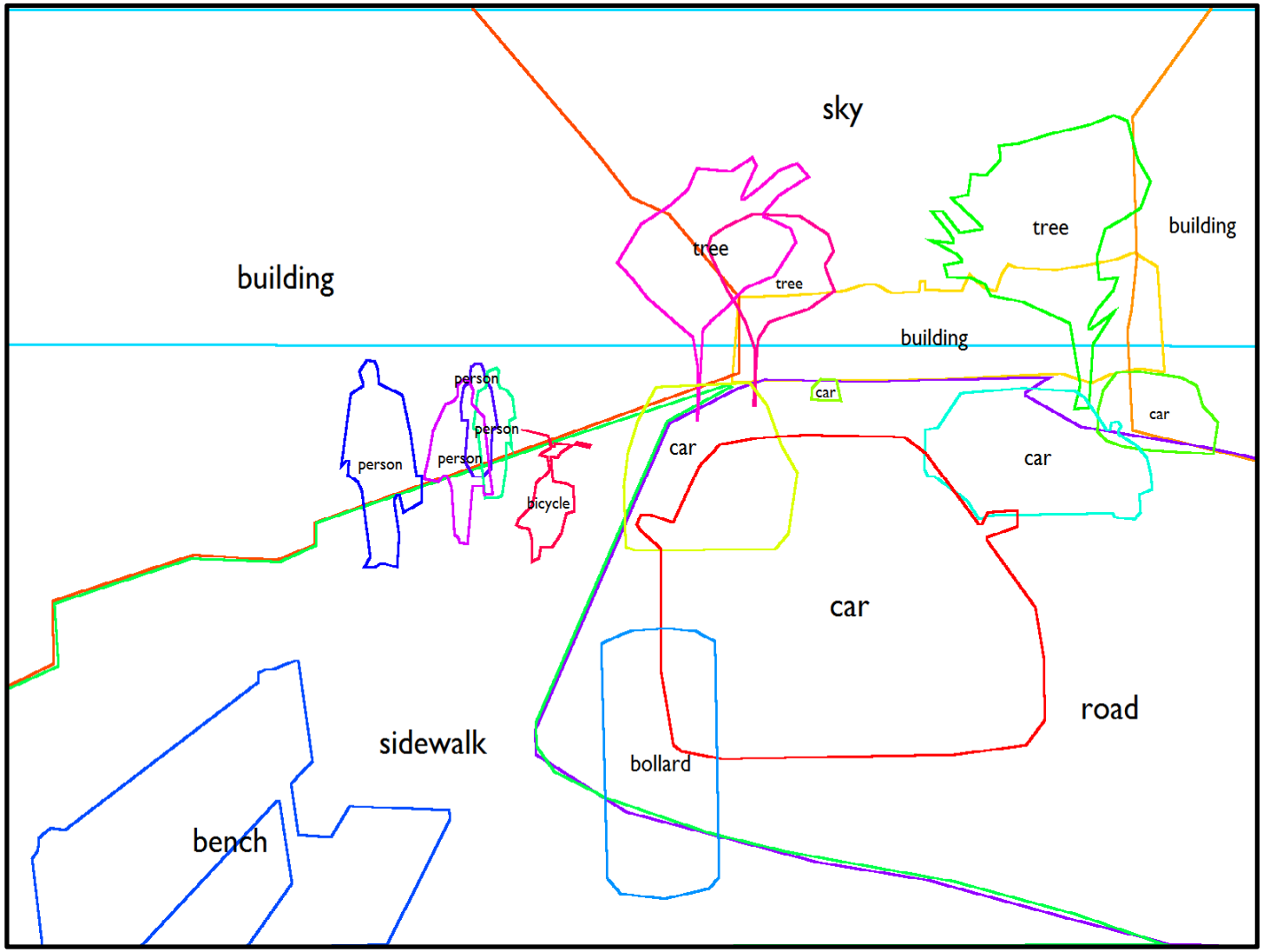
Object classes

Object position

Object orientation

Object shape

Depth/occlusions



From J. Winn, MSR

Sources of image variability

Scene type

Scene geometry

Object classes

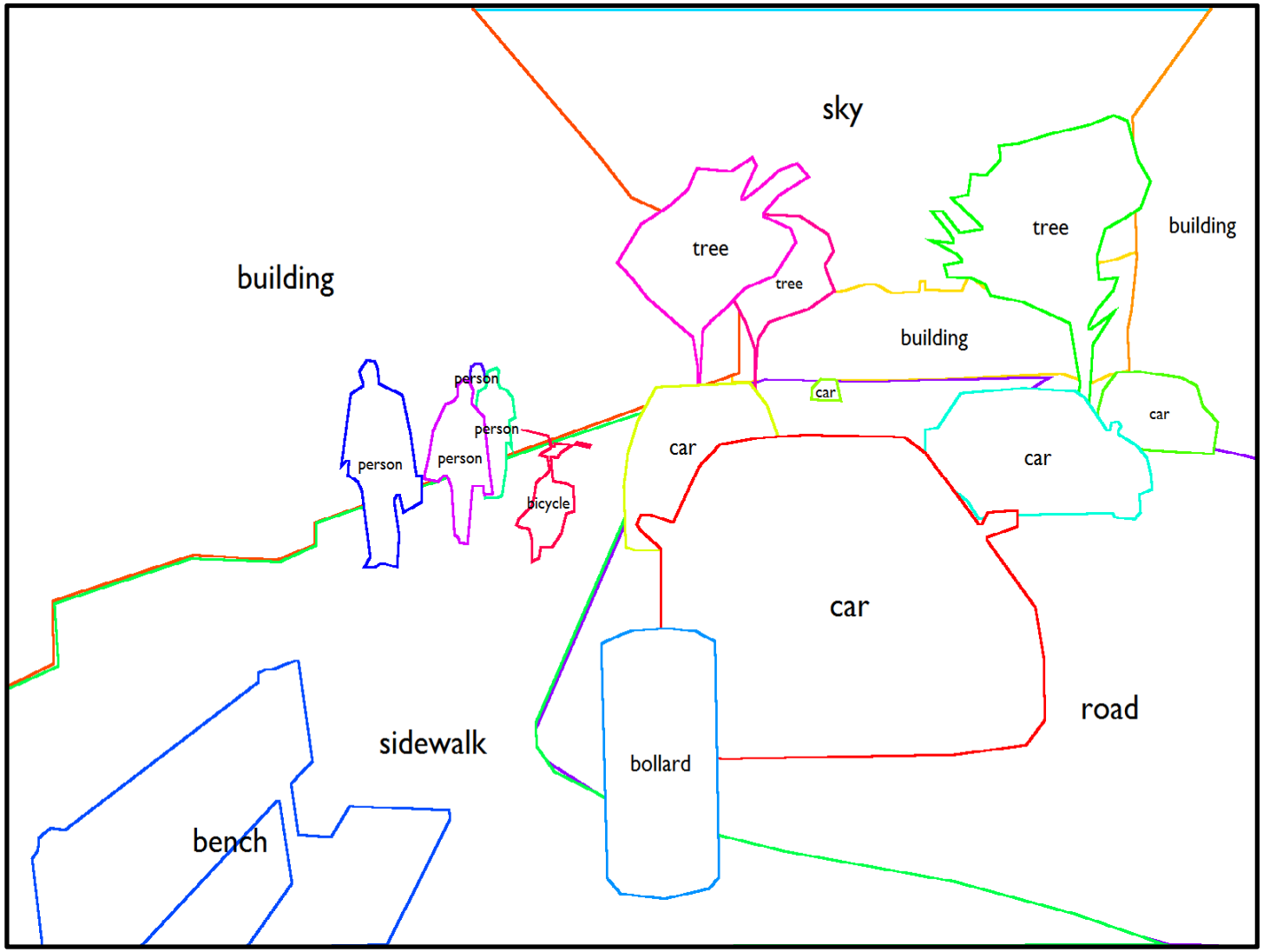
Object position

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

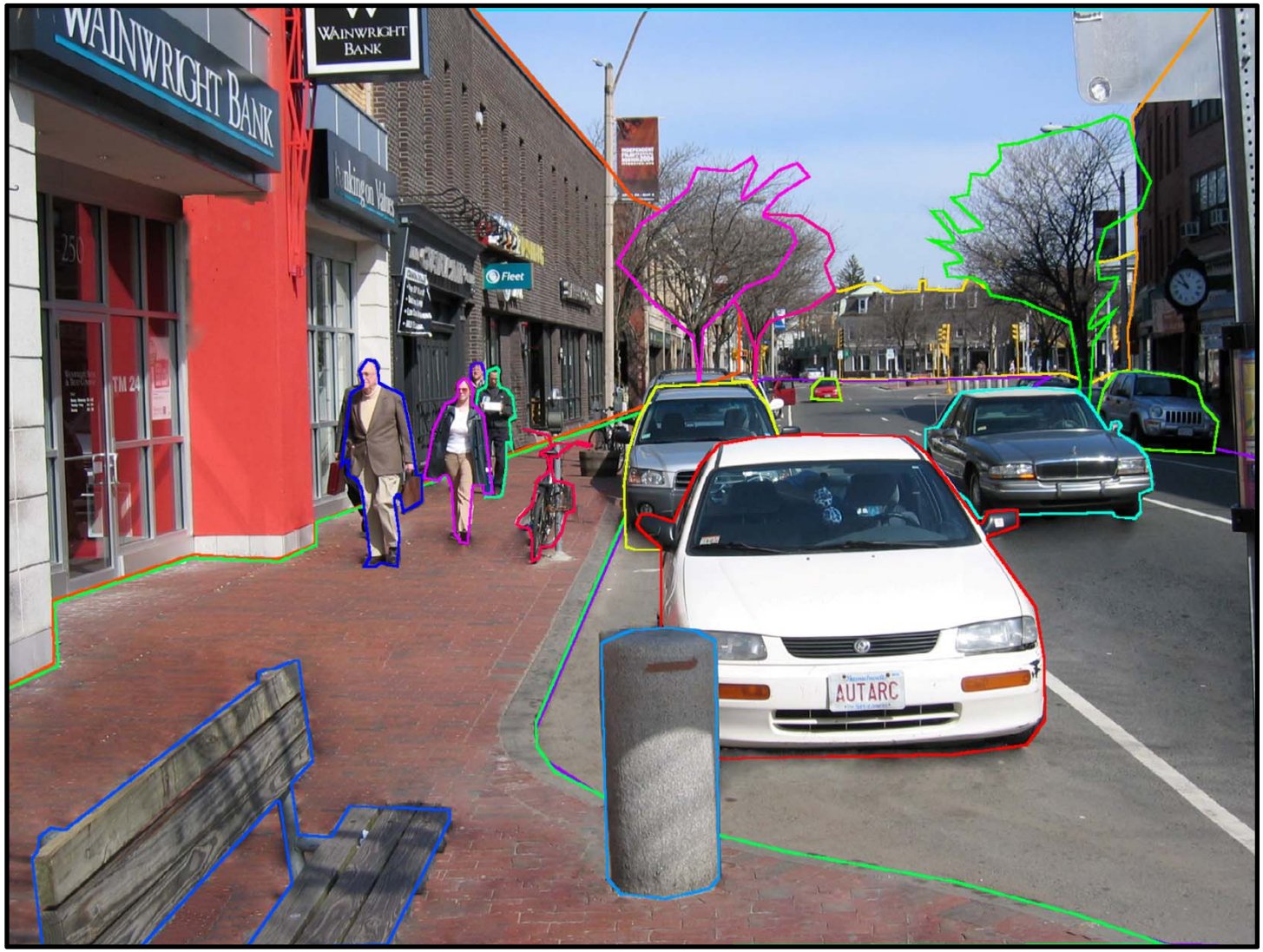
Object shape

Depth/occlusions

Object appearance

Illumination

Shadows



From J. Winn, MSR

Sources of image variability

Scene type

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From J. Winn, MSR

Sources of image variability

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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.

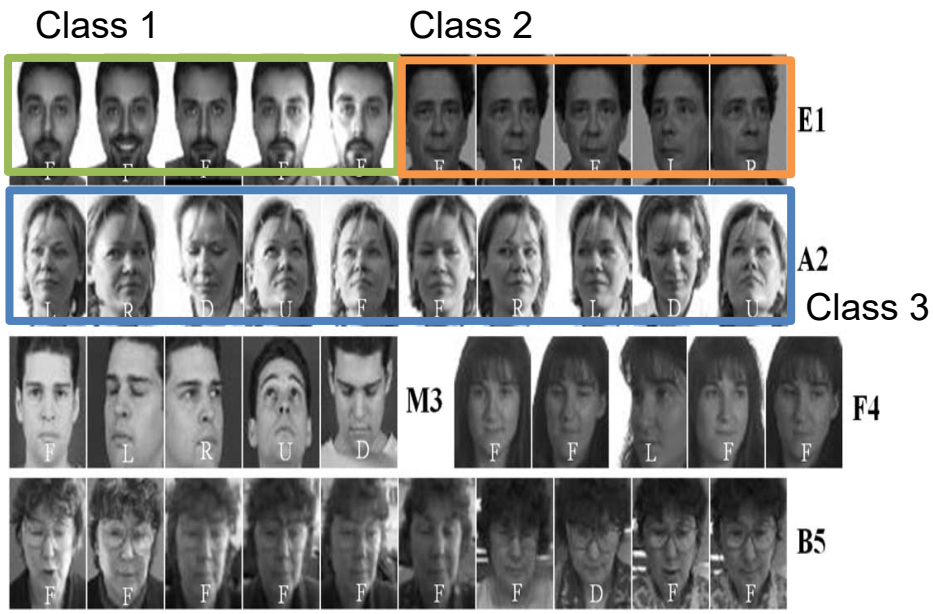
- The lectures introduce selected topics of visual recognition by machine learning techniques, including: object categorisation, image generation, activity recognition, image segmentation, pose estimation, object detection.

- Formulations and theories of machine learning techniques are presented, including: Bag of Words, Randomised Forests, Convolutional Neural Networks, Generative Adversarial Networks, Recurrent Neural Networks, LSTM, Boosting, K-means.

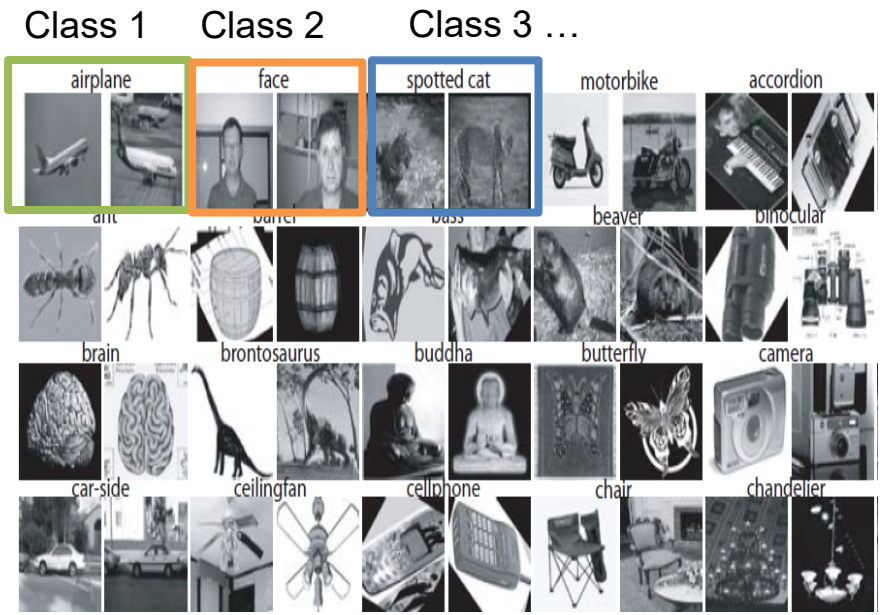
Face Recognition vs Object Categorisation

- Both are multi-class (cf. binary) classification problems.
- The classes are different object categories in object categorisation, while the classes are different person identities in face recognition.
- They need different representations suited for the problems.

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

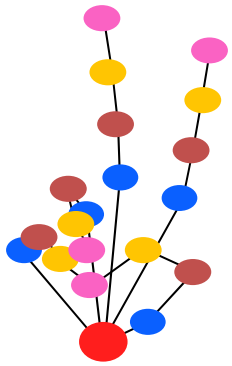
Z

Extract joint angles

$\theta \in \mathbb{R}^d$

for current frame

Skeleton



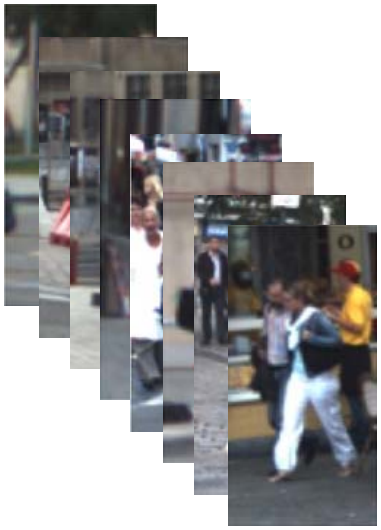
θ

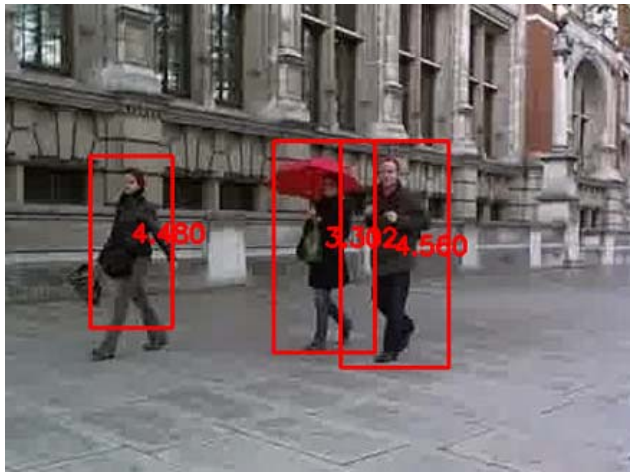
Rendered Depth Image

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.





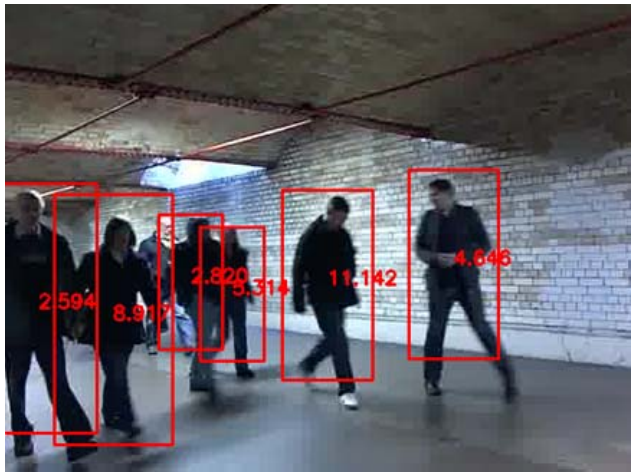
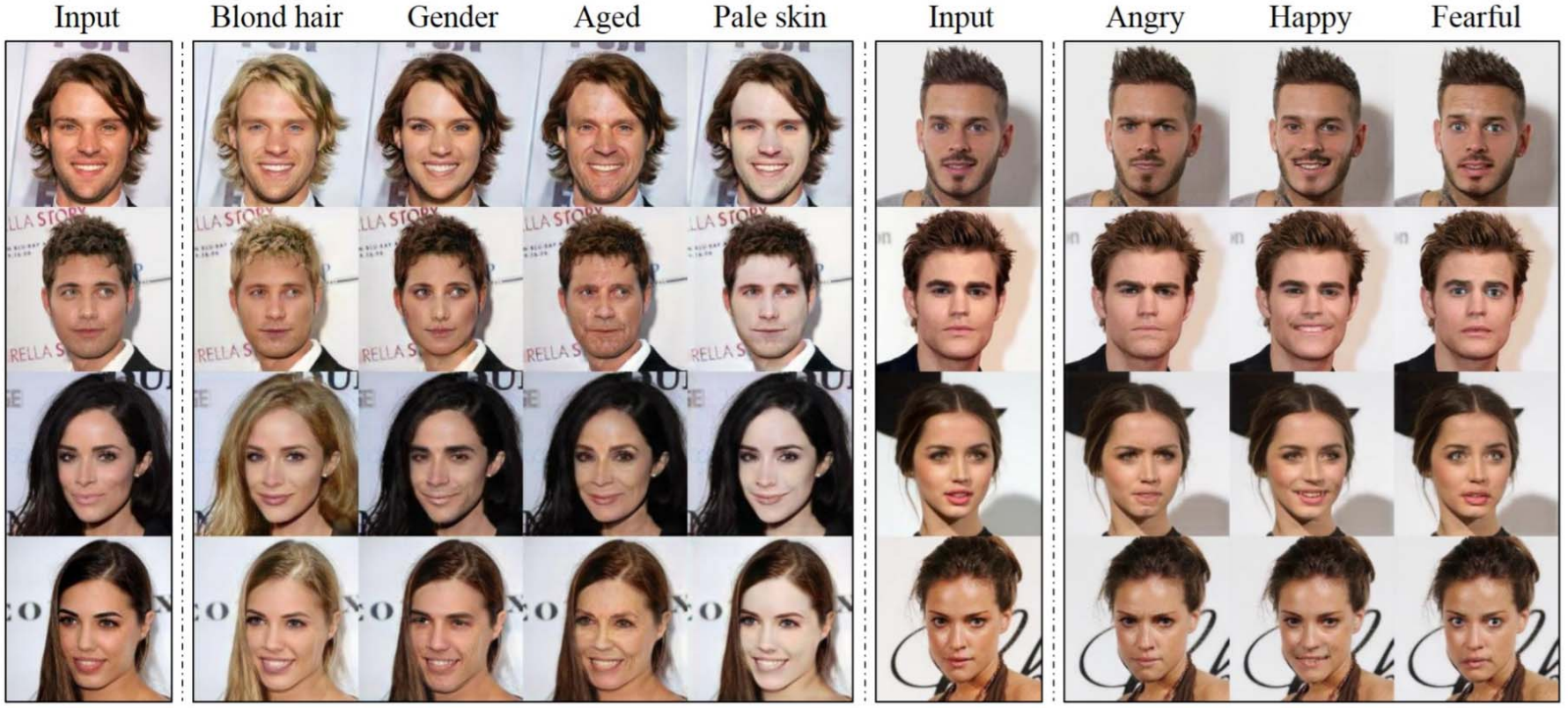


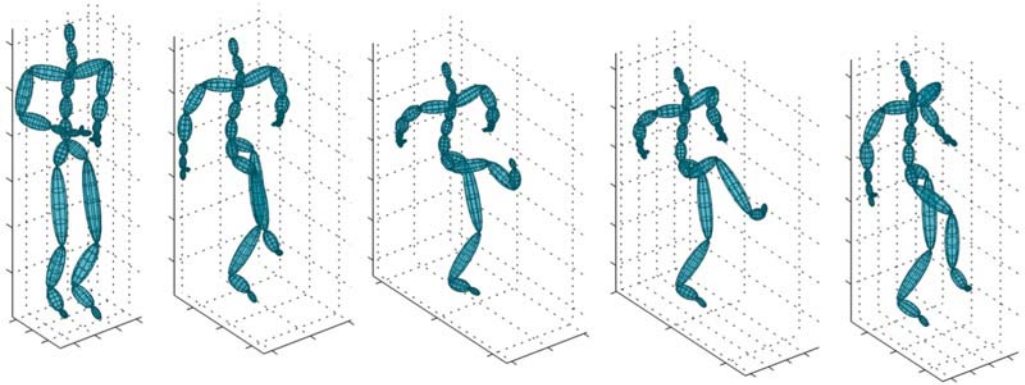
Image Generation

– E.g. Multi-domain image-to-image translation results are shown below. The first and sixth columns show input images while the remaining columns are images generated by a generator network, and facial expression labels.



Activity Recognition

- It aims to recognize the actions and goals of one or more agents from a series of observations.
- It is a multi-class classification problem.
- The observations could be series of motion capture data, depth images, or RGB images.



motion capture data

series of depth images

Backgrounds

The module is coursework-based and the coursework requires Python (Tensorflow)/Matlab programming.

- We offer two hands-on sessions (i.e. computer labs).

EE468 Pattern Recognition is a pre-requisite.

- The GAN, RNN lectures of this module go on top of the deep learning lecture of EE468 Pattern Recognition.
- The RF lecture reiterates ensemble learning.

This module is also benefited from

- Optimisation (EE429)
- Matrix and vector derivatives

*Appendix A Mathematical Foundations, R.Duda, P.Hart, D.Stork, Pattern Classifcation (Second Edition), JOHN WILEY & SONS, Inc. 2001.

- (EEE Y3 modules) Machine Learning, Deep Learning
- (Computing modules) 316 Computer Vision, 395 Machine Learning, 333 Robotics, 495 Advanced Statistical Machine Learning and Pattern Recognition

Lecture Schedules

17 lectures + 2 computer labs + 1 short interview (in the spring term)

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

Evaluations

- 15%: 1 oral examination (by a short interview)
- 35%: CW1 on Decision Forests
- 50%: CW2 on Generative Adversarial Network
- *Both courseworks are computer programming based (using Python, Matlab, and/or other tools)
  - similar to those of Pattern Recognition module in this year

Course homepage:

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

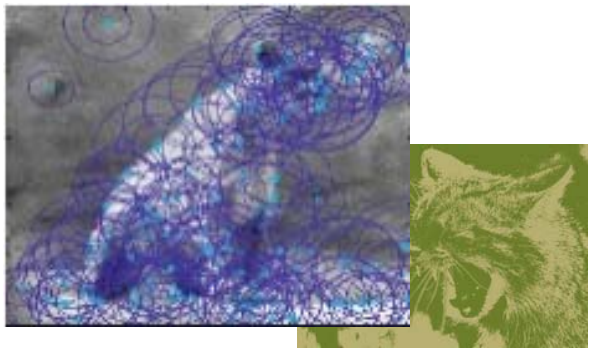
Lecture schedules

Module title: Selected Topics in Computer Vision

Prerequisite: Pattern Recognition

Week 2.

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



Week 3.

- Randomised Decision Forests (for classification)

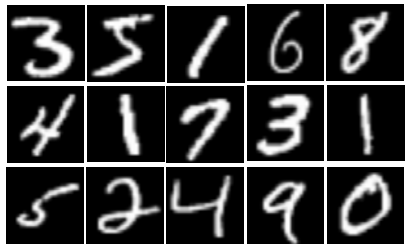
Week 3.

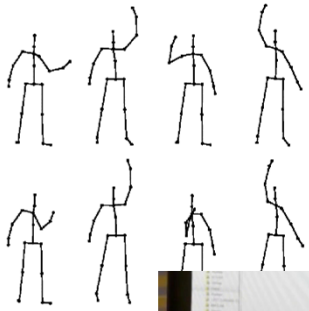
- Hands-on Session: Randomised Decision Forests (or Boosting for Face Detection)

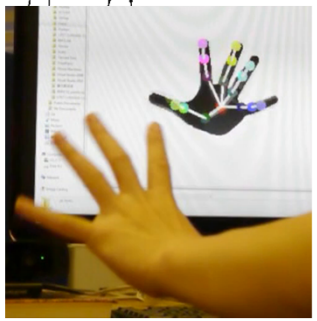
<u>CW1 and CW2 out (on RFs and GANs)</u>

Week 4.

- Intro to CNNs
- Generative Adversarial Network







Week 5.

- Activity Recognition, Recurrent Neural Network, LSTM

Week 6.

- Hands-on Session: Phython for TensorFlow

CW1 deadline

Week 7.

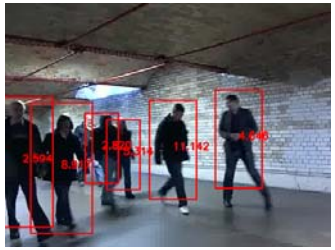
- Short interviews

Week 8.

- Classification Forest (continued), Regression Forests, Pose Estimation

Week 9.

- Recurrent Neural Network, LSTM (continued)
- Object Detection, Boosting



Week 10.

- Object Detection, Boosting (continued)
- Summary (tree-structured machine learning)

CW2 deadline