



UNIVERSITÀ DEGLI STUDI  
DI MILANO

Corso di  
**Visione Artificiale**

Laurea Magistrale in Informatica (F94)

Docente:  
*Raffaella Lanzarotti*

*Dipartimento di Informatica  
Università degli Studi di Milano*

# Informazioni generali

❖ **Sito web del corso** <https://github.com/lanzarotti/Visione-Artificiale-2025-26>

❖ **Orario delle Lezioni:**

➤ *martedì e giovedì 10:00 ÷ 12:30, Lab. LM 5 piano*

❖ **Materiale didattico**

- Testi (disponibili online)
  - ◆ D.A. Forsyth, J. Ponce, Computer Vision – A Modern Approach – 2e, Pearson
  - ◆ C.M. Bishop, H. Bishop - Deep Learning - Foundations and Concepts - Springer
- *Slide / materiale: sul sito del corso*

# Informazioni generali

## ❖ Modalità delle lezioni

- *Frontale*
- *Demo in python*

## ❖ Modalità d'esame

- *Prova teorica scritta* (*consistente di domande aperte riguardanti tutti gli argomenti trattati a lezione*)

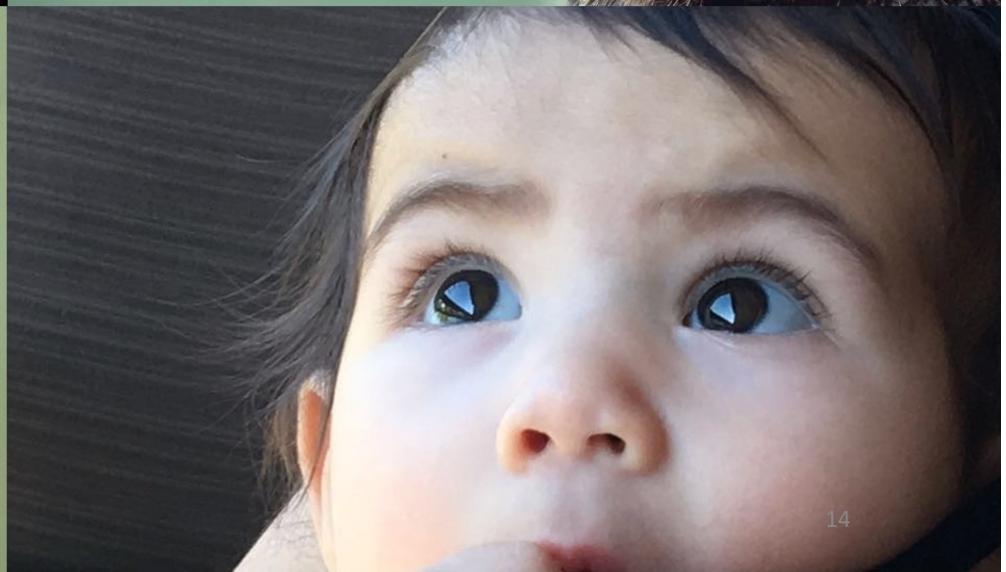
**OPPURE**

- *Progetto* (*consistente nell'implementazione in Python, la stesura di una relazione e la presentazione della soluzione proposta e dei risultati ottenuti. A fine corso verranno date le possibili tracce da seguire per realizzare il progetto*)

# INTRODUCTION TO COMPUTER VISION

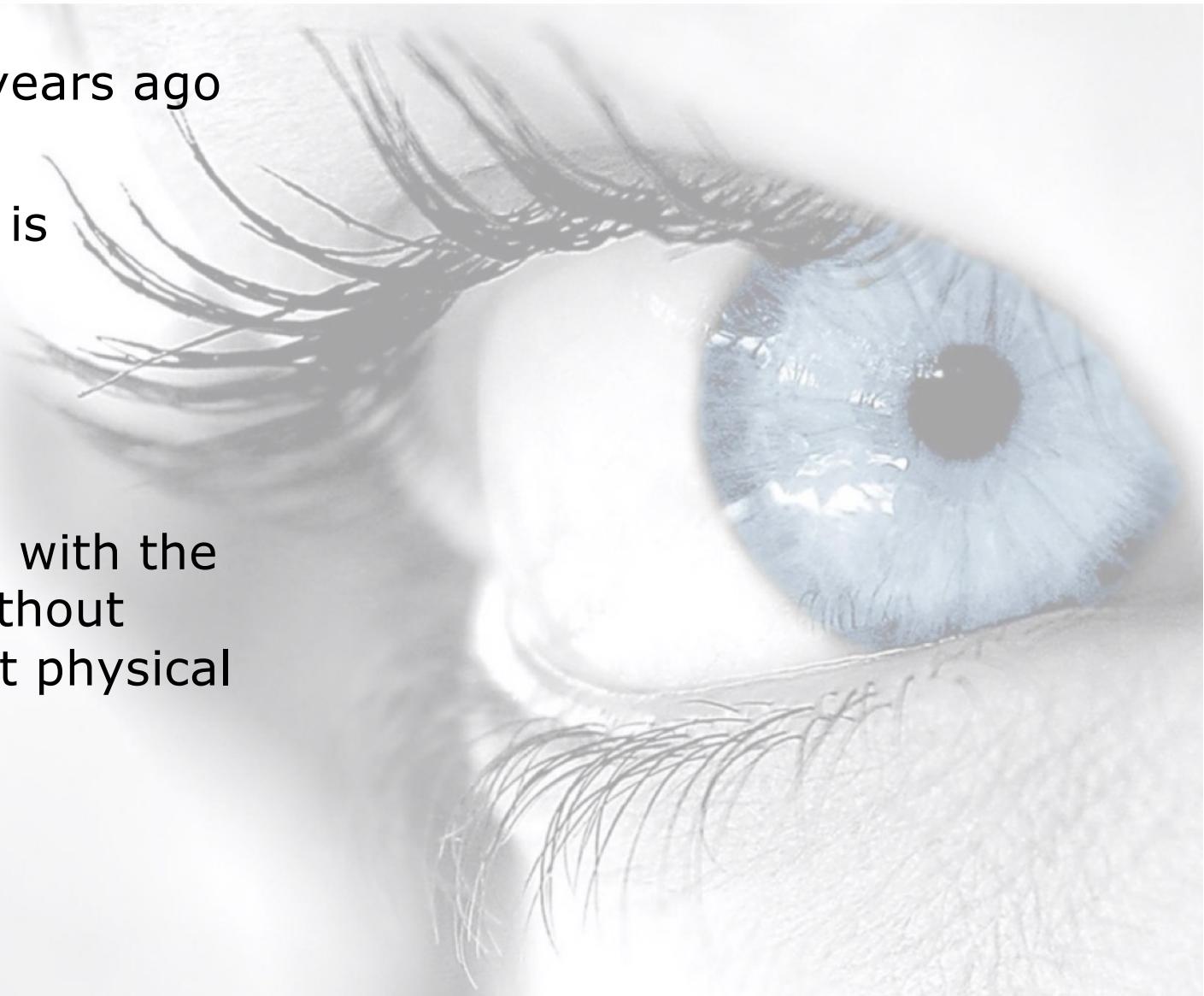
Credits: Luigi Cinque

## What is Vision?



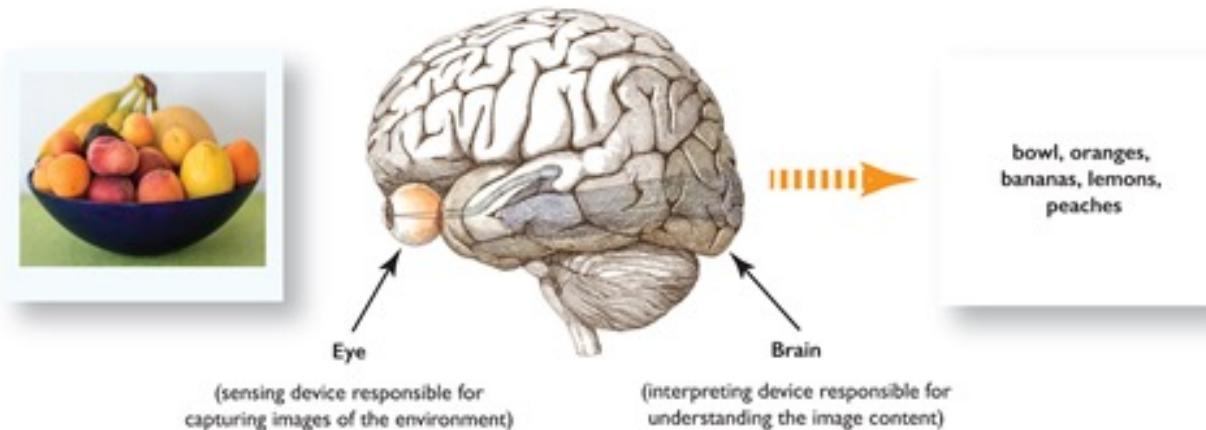
## What is Human Vision?

- Origin: 540 mln years ago
- 60% of the brain is involved in visual processing
- Allows to interact with the physical world without making any direct physical contact

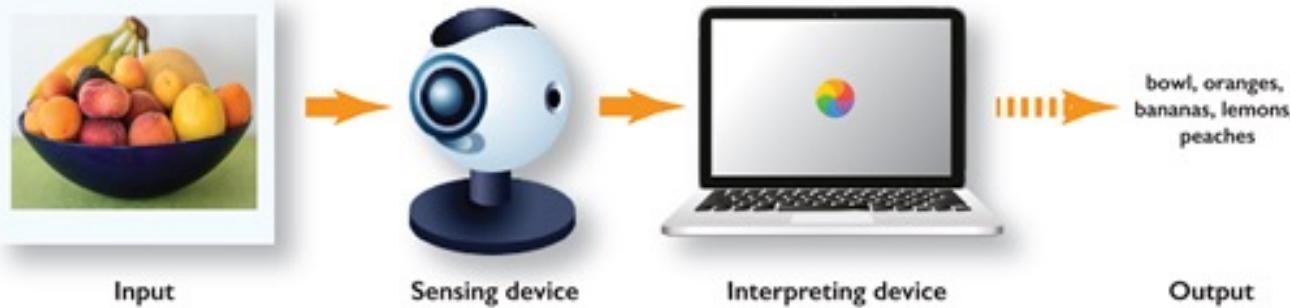


# What is Computer Vision?

**Human Vision System**



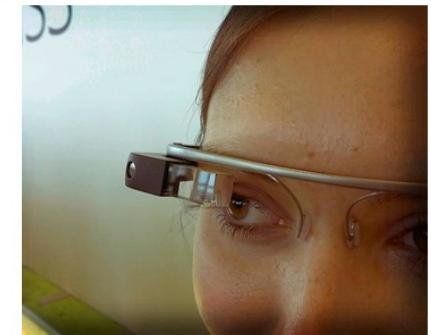
**Computer Vision System**



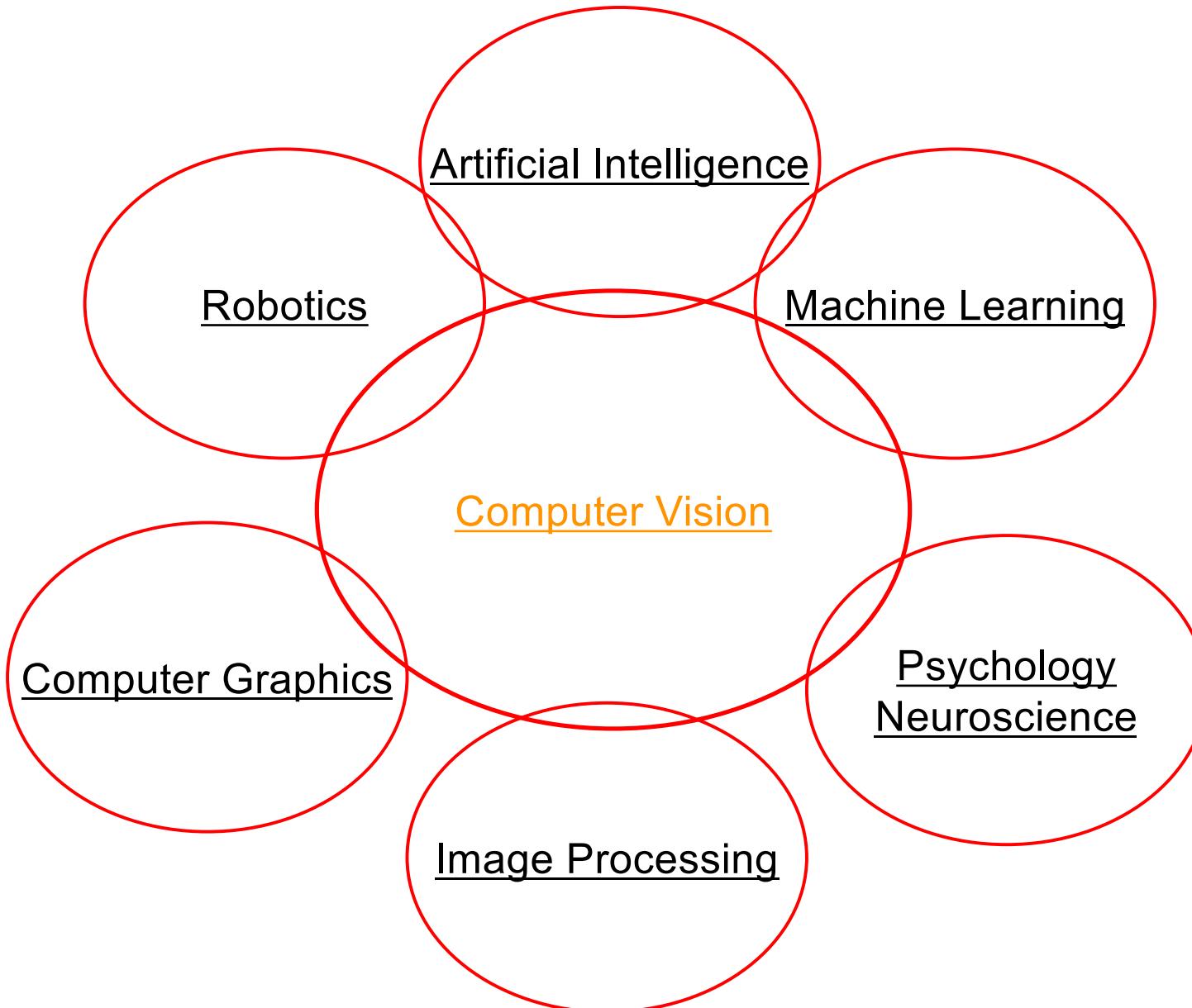
<https://freecontent.manning.com/mental-model-graphic-grokking-deep-learning-for-computer-vision/>

# Why study computer vision?

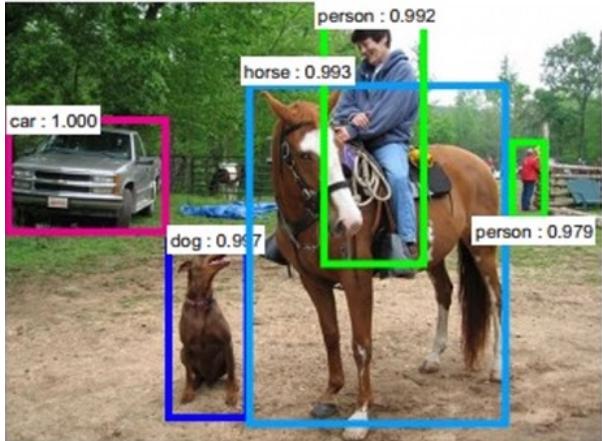
- ❖ Computer vision is everywhere!



## Connections to other disciplines



# Applications of computer vision



Object detection

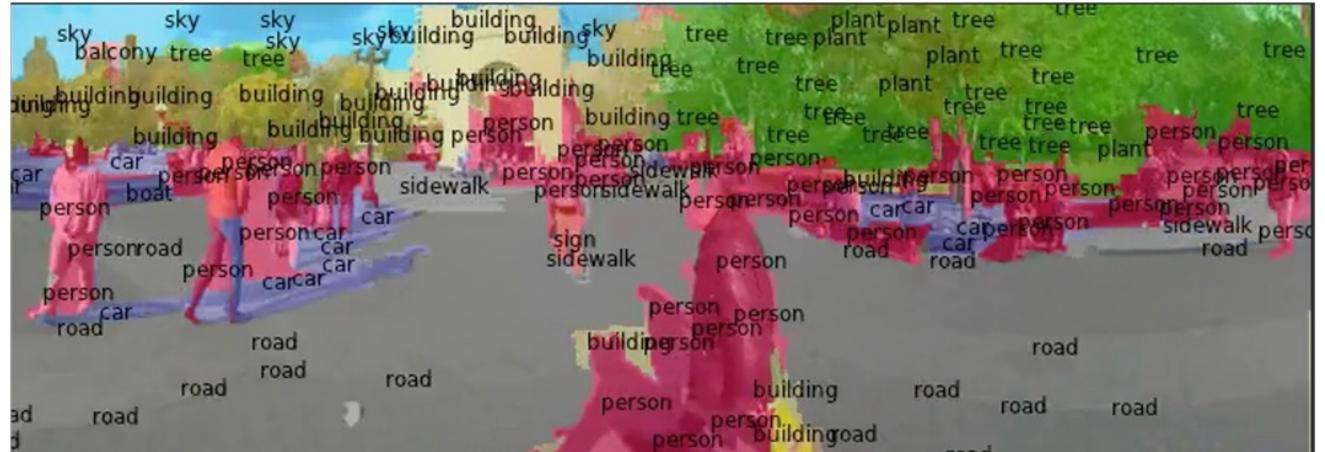


Image Segmentation



Human Skeleton



*A white teddy bear  
sitting in the grass*

Image Captioning



A sofa imitating a banana

Text-to-Image

# The goal of computer vision

- ❖ To perceive the “world behind the picture”

153	156	148	152	149	147	139	146	142	150	146	144	137	125	120	119	136	146	151	164	172	175	183	188	196	200	205	208	214	214	219	217
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## The goal of computer vision

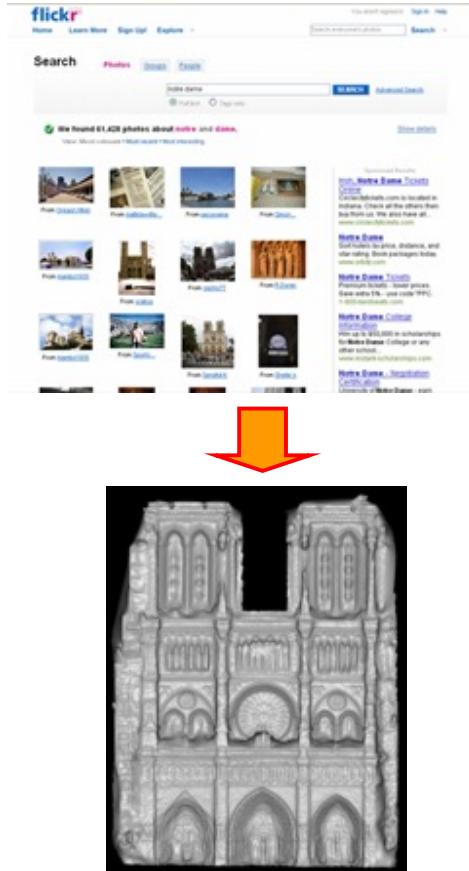
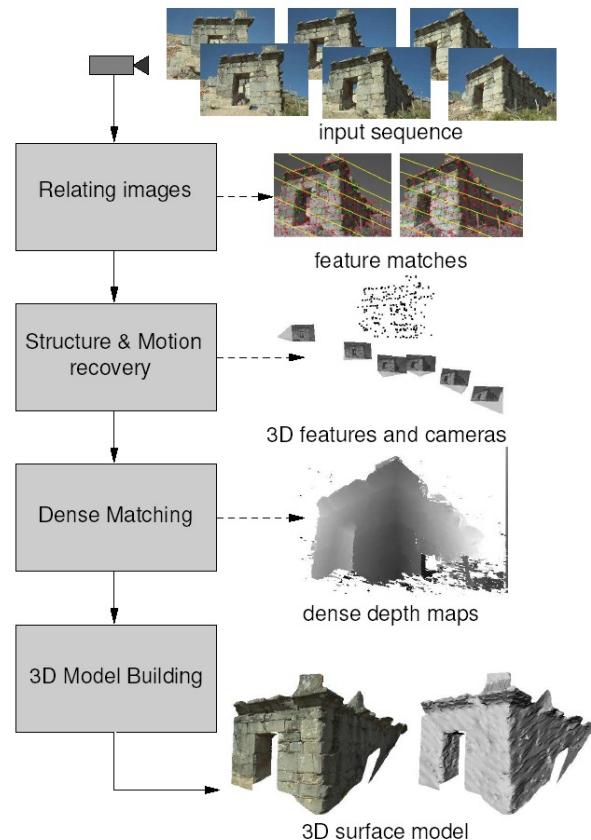
- ❖ To perceive the “world behind the picture”



## The goal of computer vision

- ❖ To perceive the “world behind the picture”
- ❖ What exactly does this mean?
  - *Vision as a source of metric 3D information*
  - *Vision as a source of semantic information*

# Vision as measurement device



- Amazing success story!

# Vision as a source of semantic information



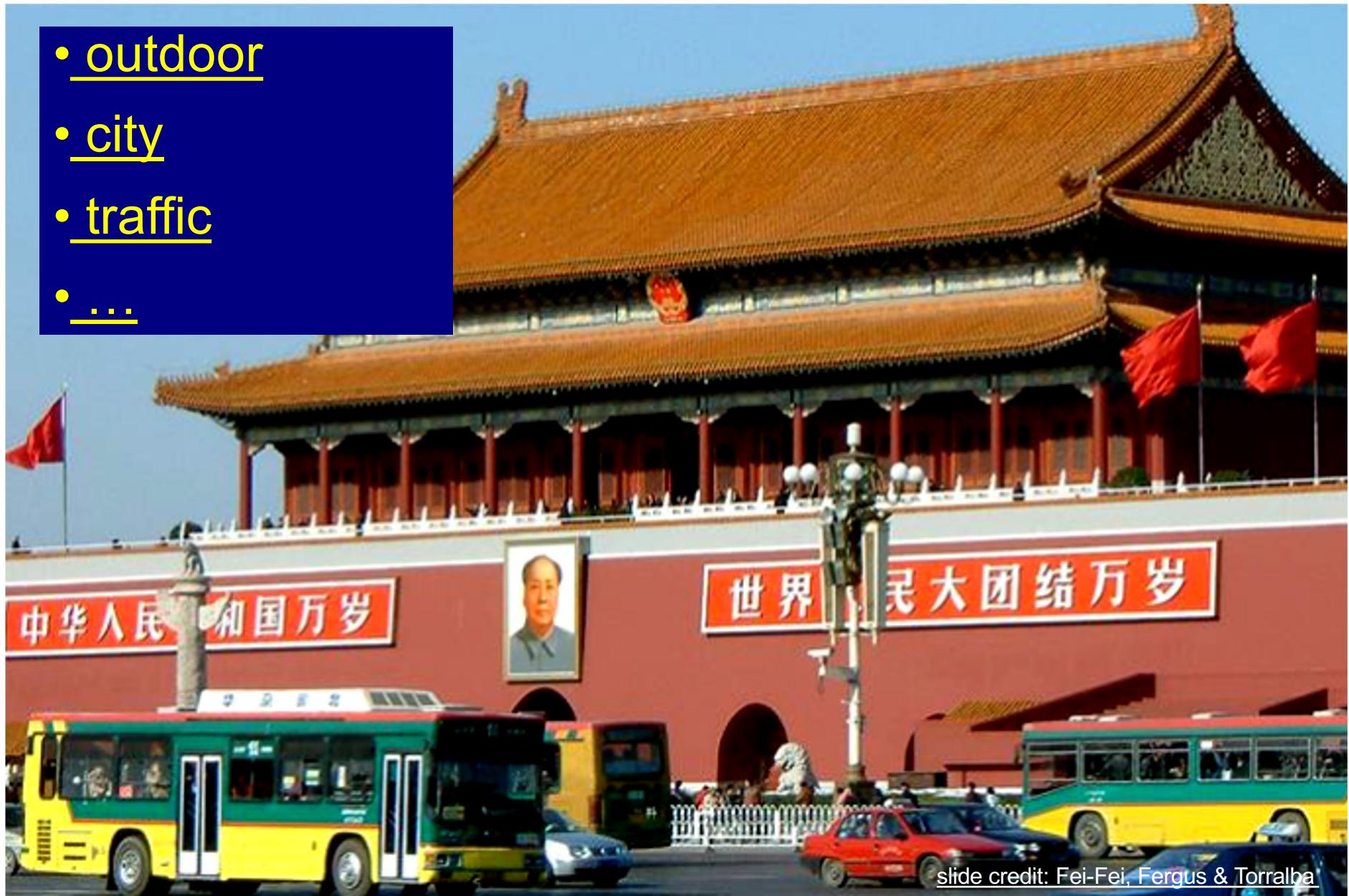
slide credit: Fei-Fei, Fergus & Torralba

# Object categorization



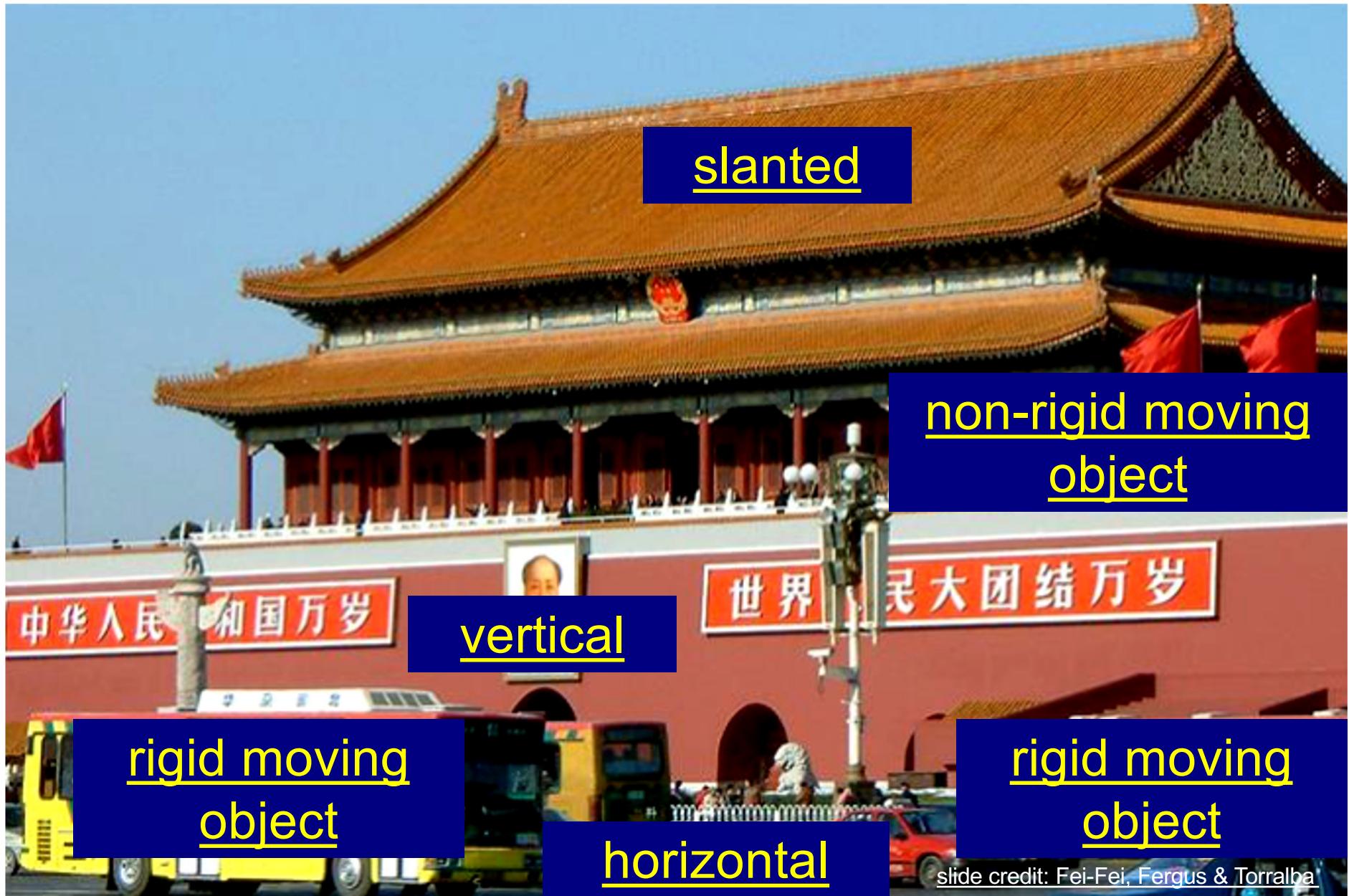
# Scene and context categorization

- outdoor
- city
- traffic
- ...

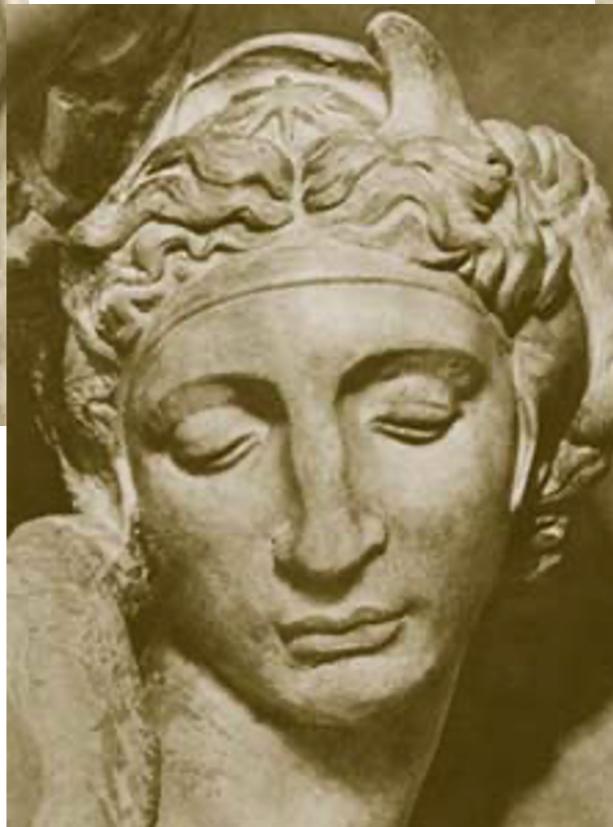


slide credit: Fei-Fei, Fergus & Torralba

# Qualitative spatial information



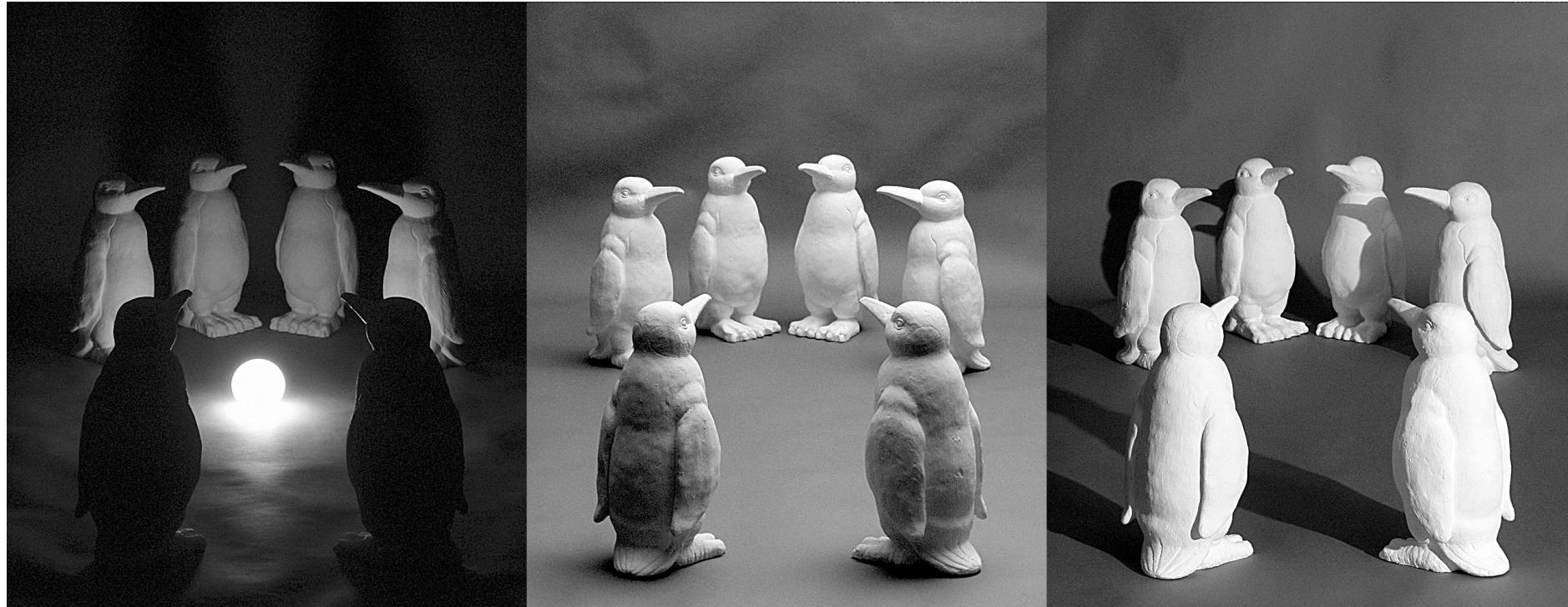
# Challenges: viewpoint variation



Michelangelo 1475-1564

slide credit: Fei-Fei, Fergus & Torralba

# Challenges: illumination



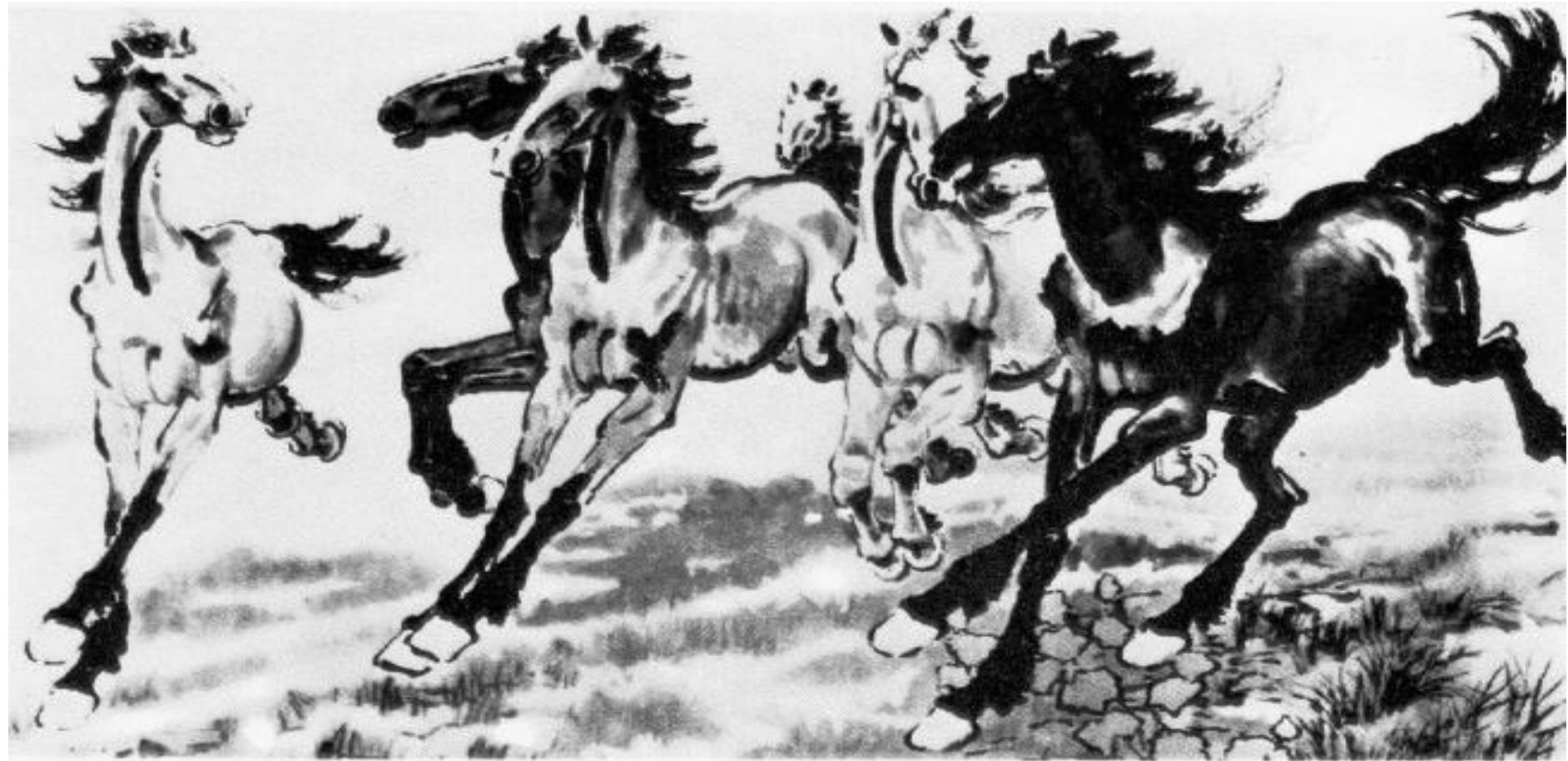
[image credit: J. Koenderink](#)

## Challenges: scale



slide credit: Fei-Fei, Fergus & Torralba

# Challenges: deformation



Xu, Beihong 1943

slide credit: Fei-Fei, Fergus & Torralba

# Challenges: occlusion



# Challenges: background clutter

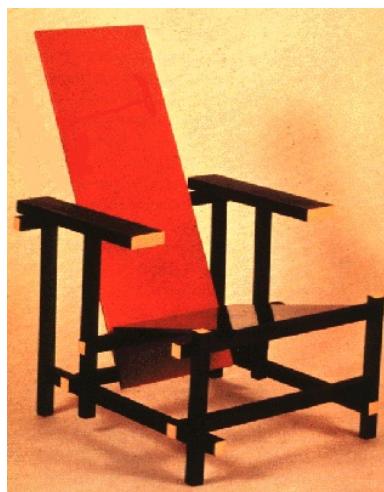


Emperor shrimp and commensal crab on a sea cucumber in Fiji  
Photograph by Tim Laman

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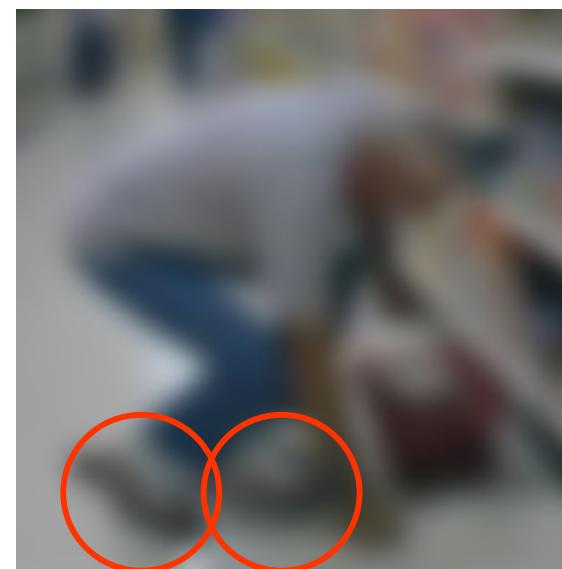
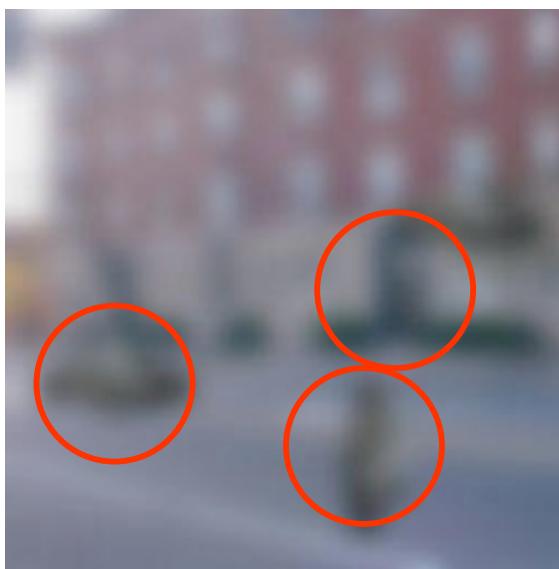
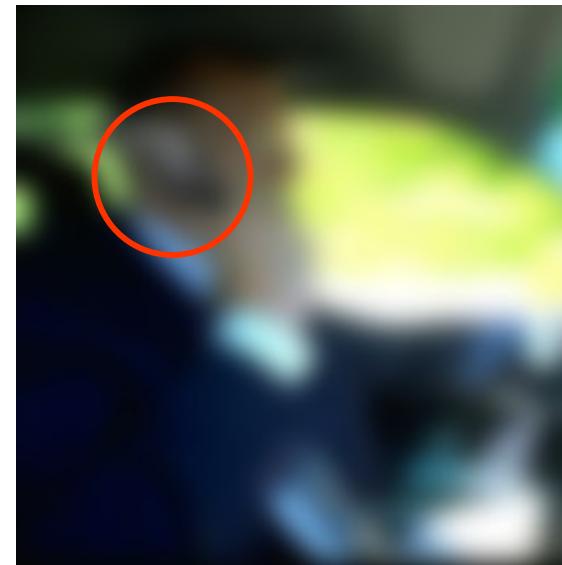
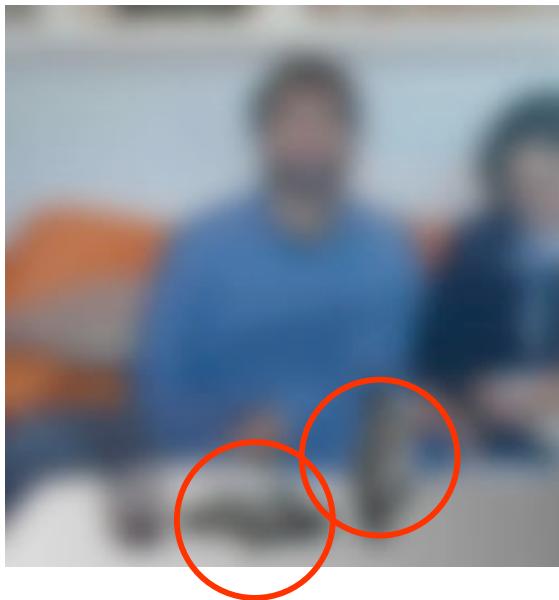
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## Challenges: object intra-class variation



slide credit: Fei-Fei, Fergus & Torralba

## Challenges: local ambiguity



slide credit: Fei-Fei, Fergus & Torralba

# Course Program (tentative)

## First part:

### Image formation and Early vision

- Image formation
  - Geometric Camera Models
  - Color spaces
- Image Processing
  - Punctual and spatial processing
  - Feature Extraction
- Reconstruction
  - Camera calibration
  - Stereo Vision
  - Structure from Motion and RGB-d Cameras
  - Optical flow and Tracking

## Second part:

### Machine learning for CV

- Linear Neural Network
- Multi Layer Perceptron
- 
- Convolutional Neural Networks
- Recurrent Neural Networks
- Transformers
- Variational Auto-Encoders
- Generative Adversarial Networks
- Graph Neural Networks
- Self-supervised Learning
- Vision Language Models