UNIVERSITÀ DEGLI STUDI
DI MILANO

Corso di

Visione Artificiale

Laurea Magistrale in Informatica (F94)

Docente:

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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*

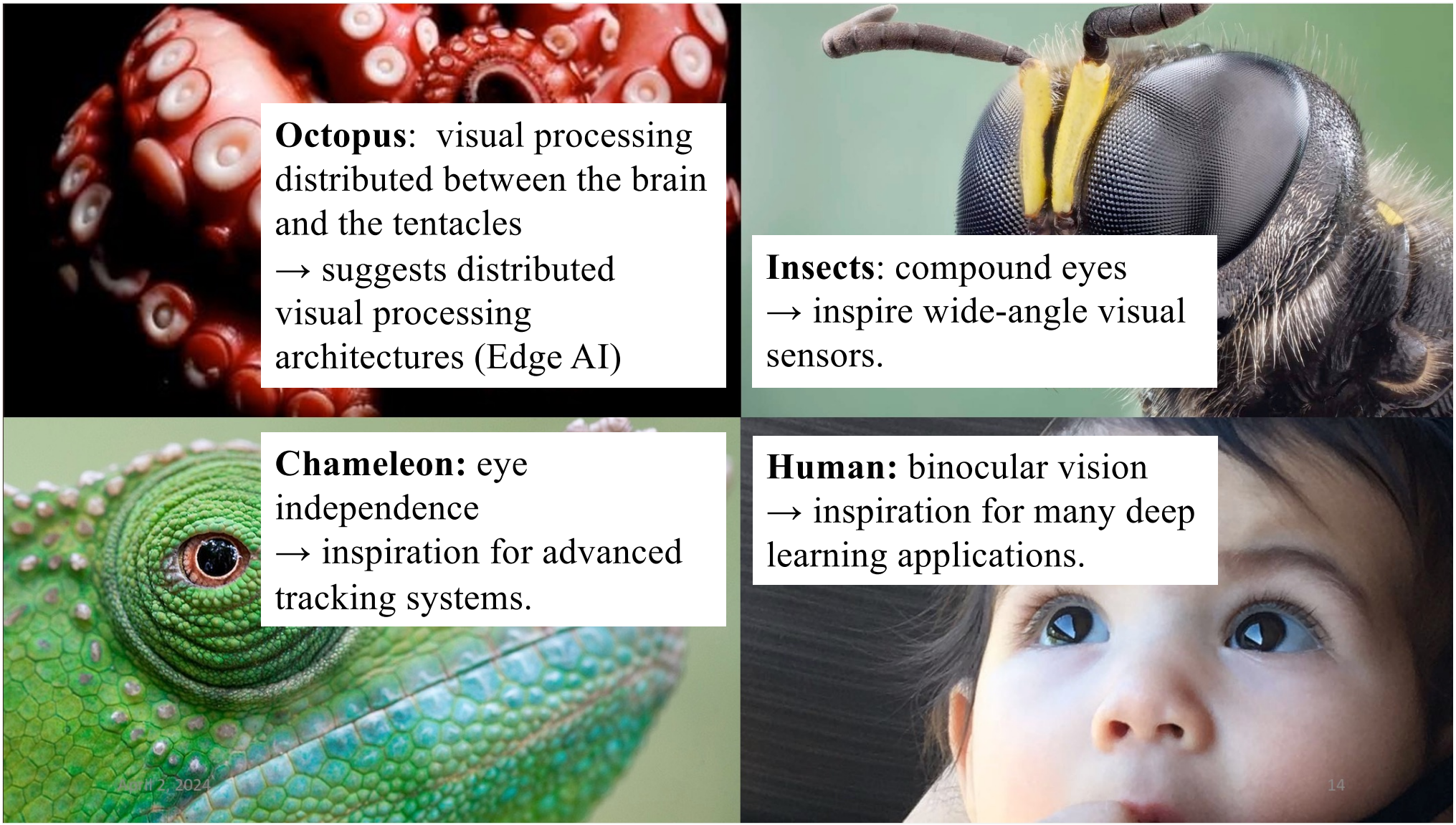
- **Modalità d'esame**
  - *Prova teorica scritta (consistente di domande aperte riguardanti tutti gli argomenti trattati a lezione)*

  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?



Octopus: visual processing distributed between the brain and the tentacles
→ suggests distributed visual processing architectures (Edge AI)

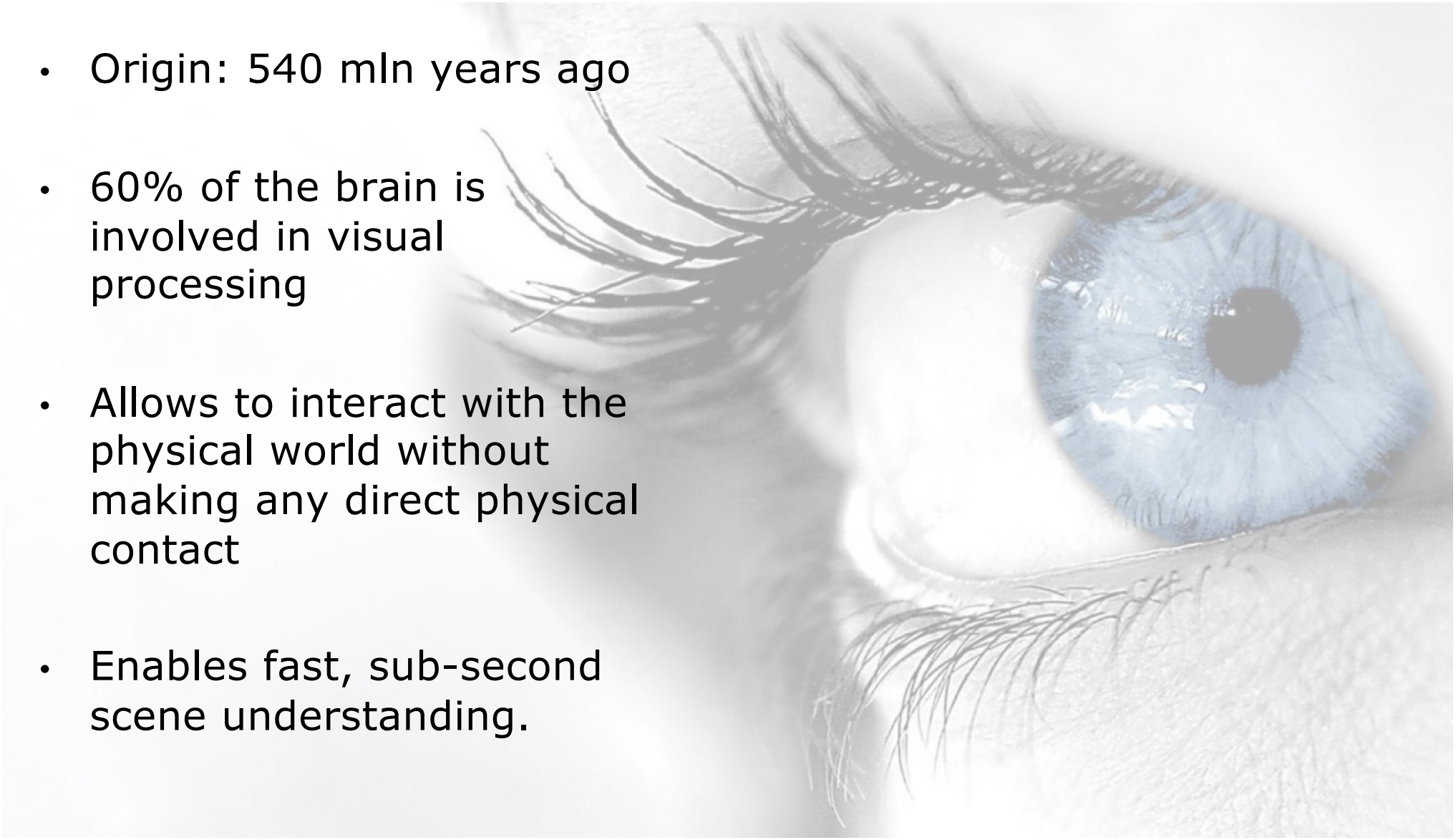
Insects: compound eyes
→ inspire wide-angle visual sensors.

Chameleon: eye independence
→ inspiration for advanced tracking systems.

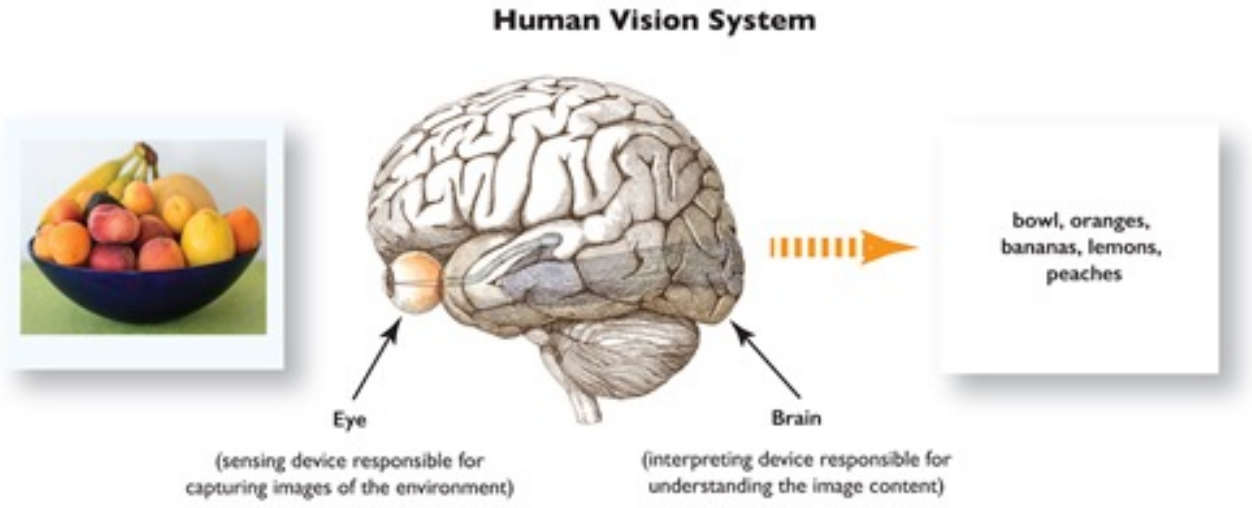
Human: binocular vision
→ inspiration for many deep learning applications.

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
- Enables fast, sub-second scene understanding.



What is Computer Vision?



COMPUTER VISION:

- Emulating the (human) visual system

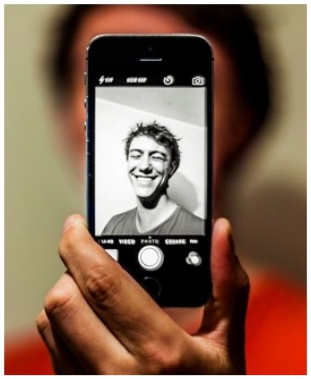
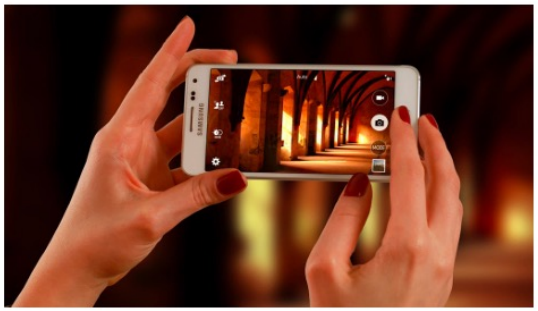
- Inputs extend beyond RGB (e.g., infrared, depth)

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

Why study computer vision?

- Computer vision is everywhere!

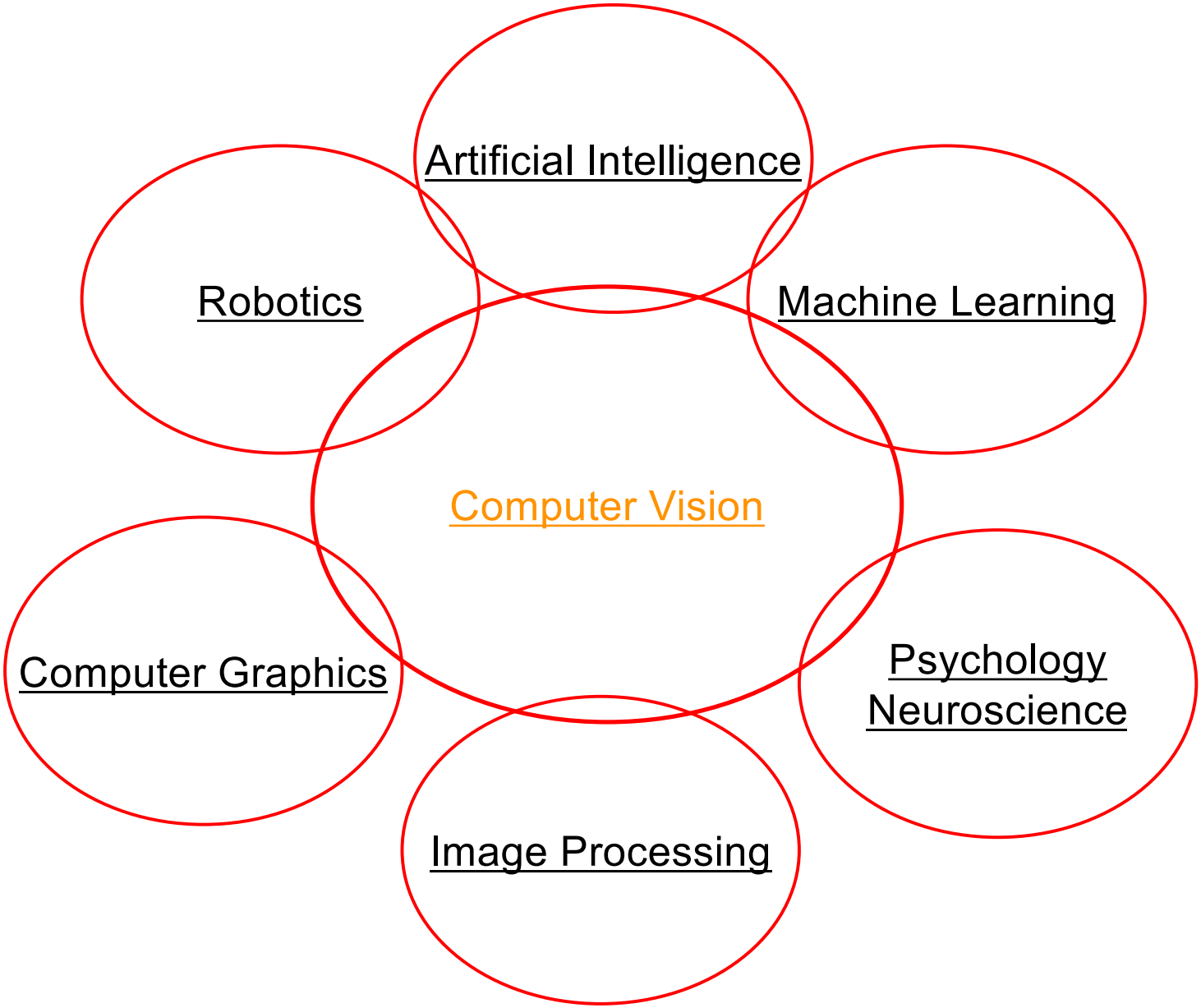


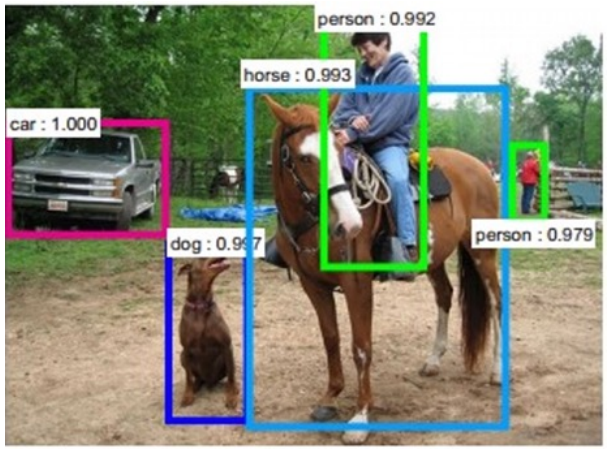





Connections to other disciplines



Applications of computer vision



Object detection

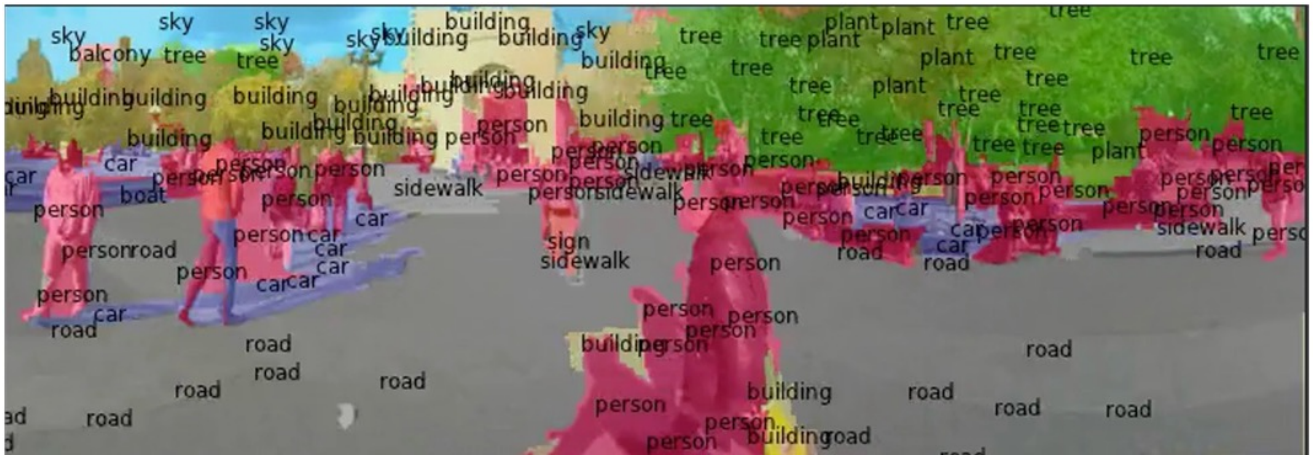


Image Segmentation

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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Computers see numbers.

The goal of computer vision

- To perceive the "world behind the picture"

Humans see objects and scenes; Computers see numbers.
Computer vision bridges this gap.

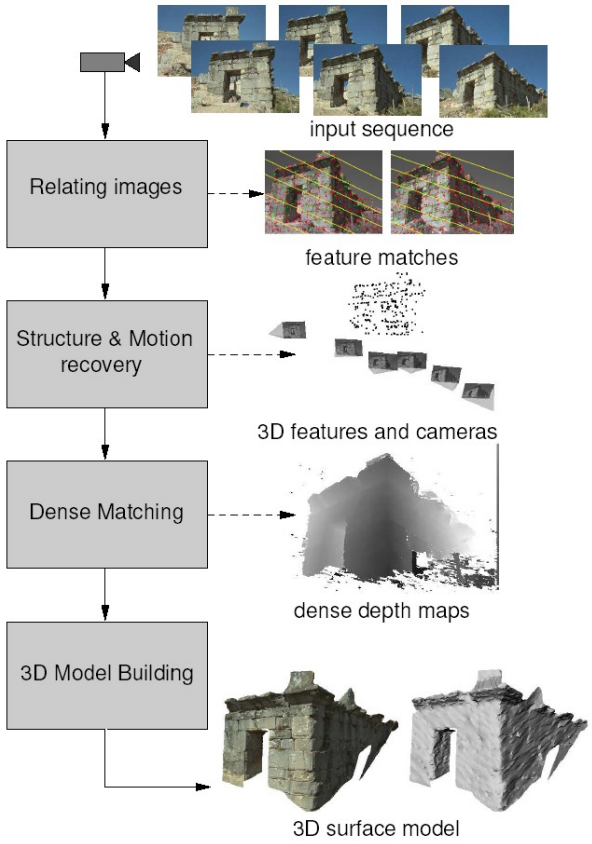
The goal of computer vision

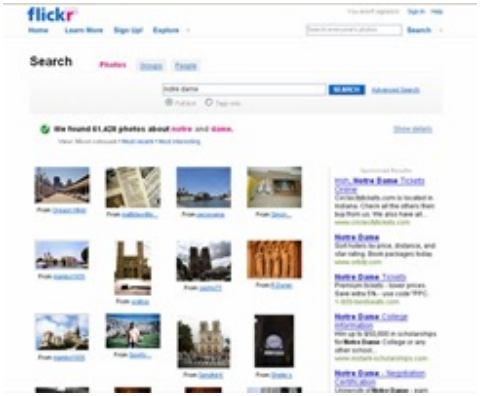
- To perceive the "world behind the picture"

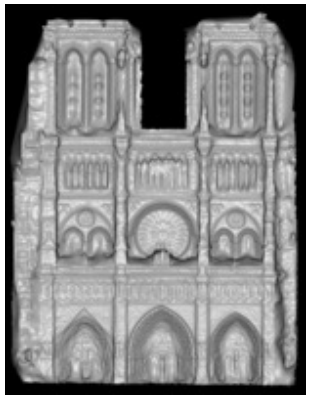
- What exactly does this mean?
  - *Vision as a source of metric 3D information*

  - *Vision as a source of semantic information*

Vision as measurement device







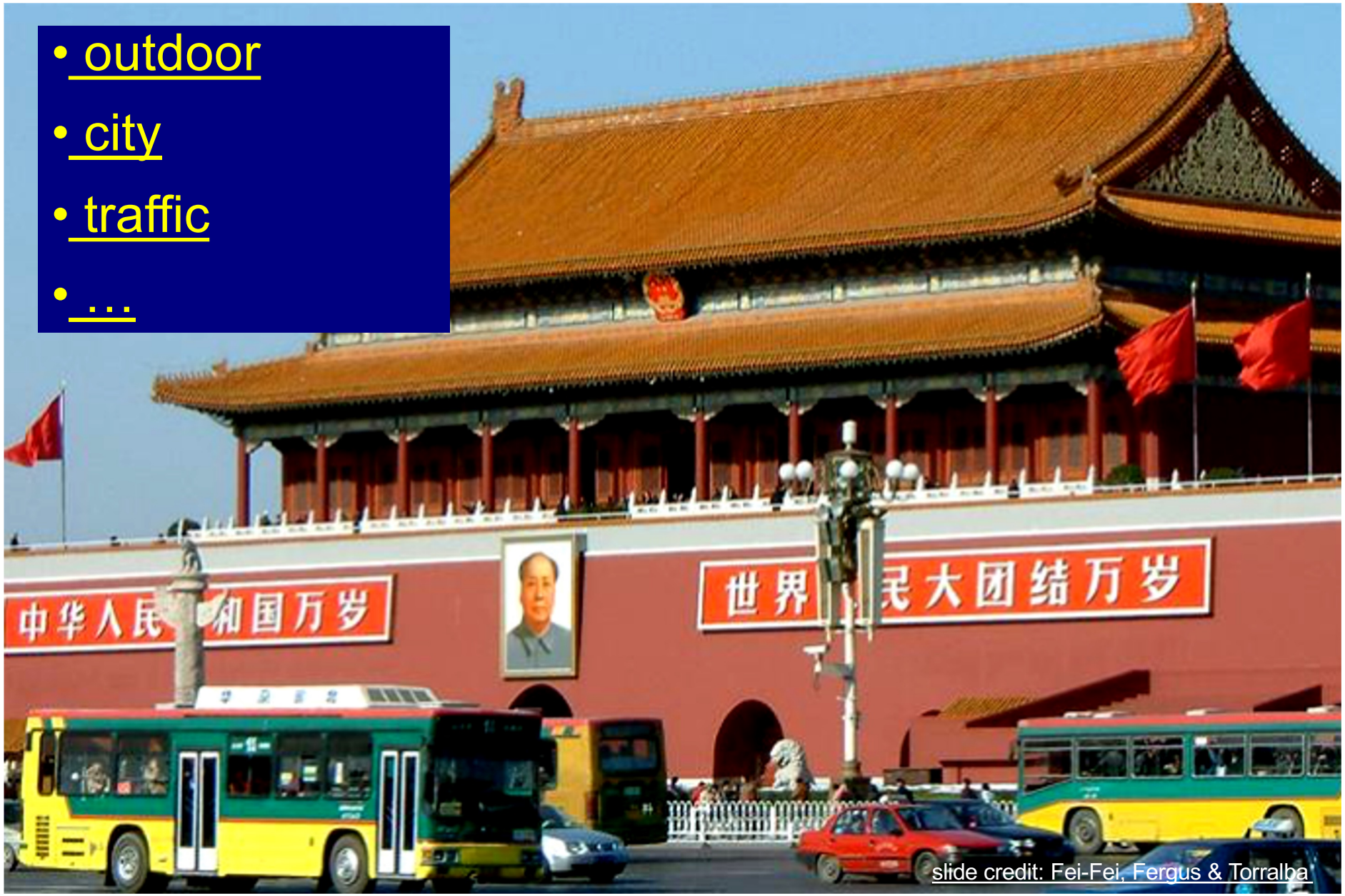
Amazing success story,
now even more incredible: SAM 3D:
https://www.aidemos.meta.com/segment-anything/editor/convert-image-to-3d

Vision as a source of semantic information

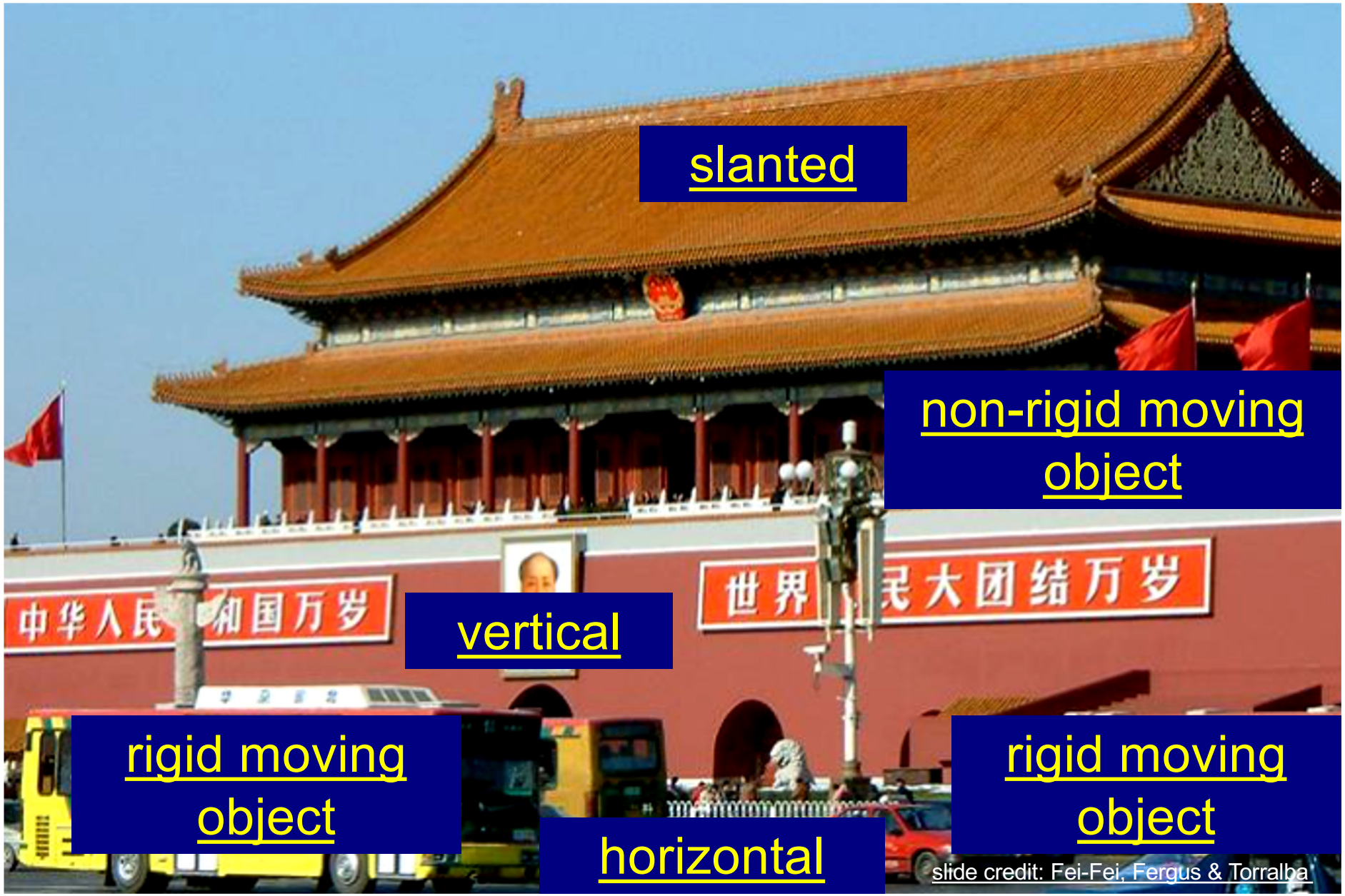
slide credit: Fei-Fei, Fergus & Torralba

Object categorization

Scene and context categorization



Qualitative spatial information



Challenges: viewpoint variation

Michelangelo 1475-1564

slide credit: Fei-Fei, Fergus & Torralba

Challenges: illumination

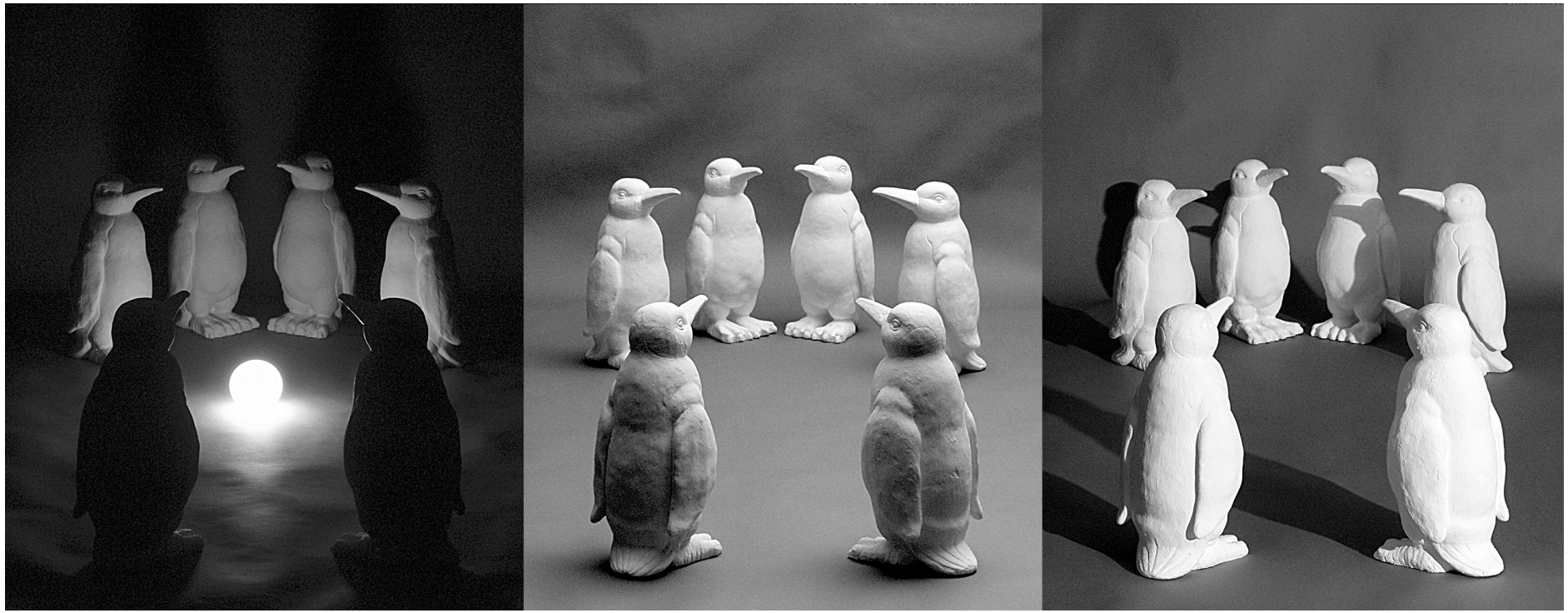
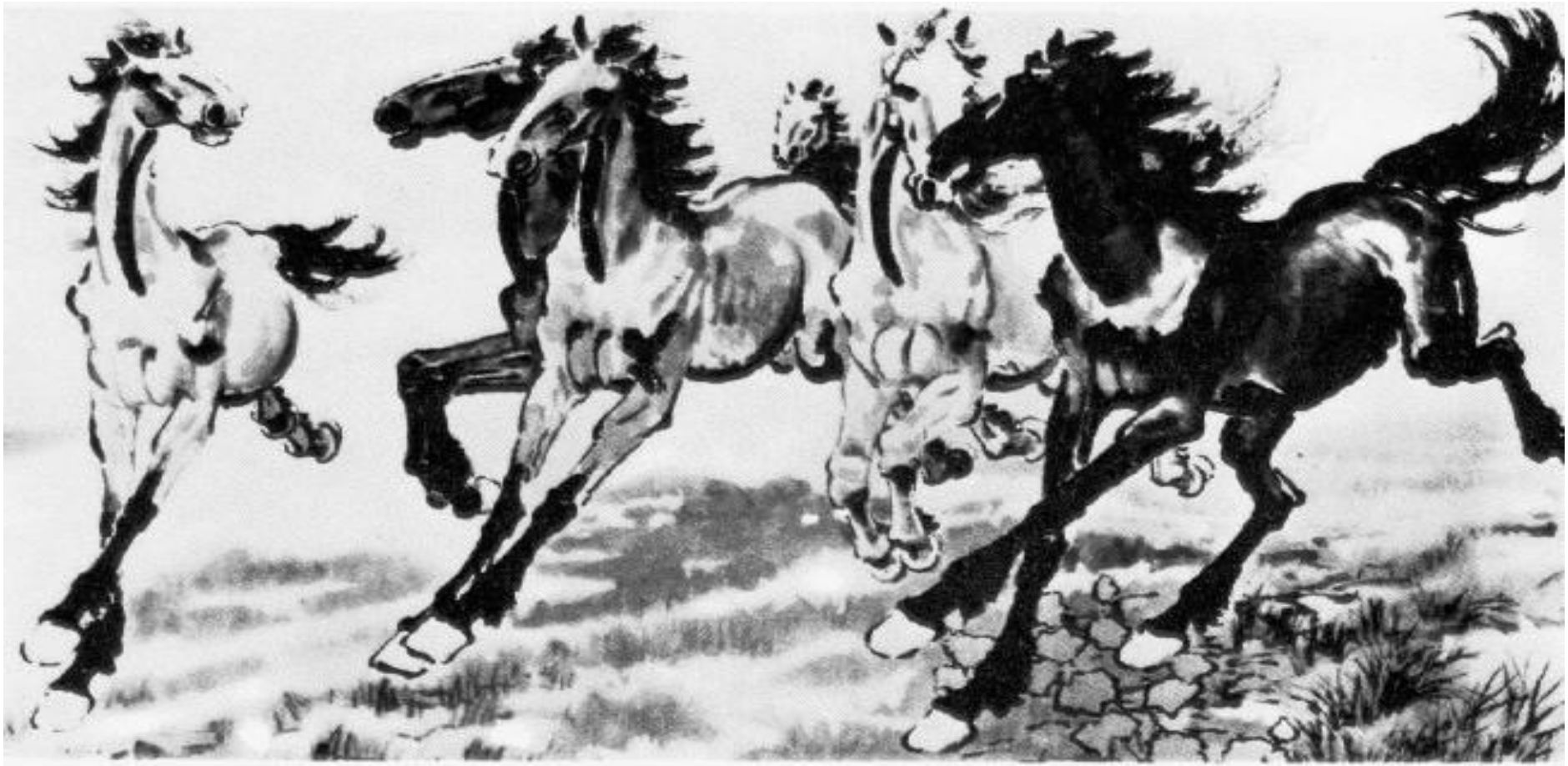


image credit: J. Koenderink

Challenges: scale

slide credit: Fei-Fei, Fergus & Torralba

Challenges: deformation



Xu, Beihong 1943

slide credit: Fei-Fei, Fergus & Torralba

Challenges: occlusion

Magritte, 1957

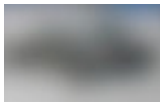
slide credit: Fei-Fei, Fergus & Torralba

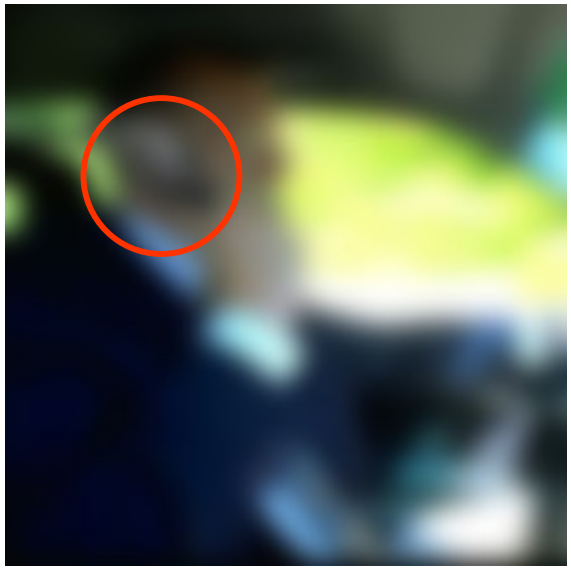
Challenges: background clutter

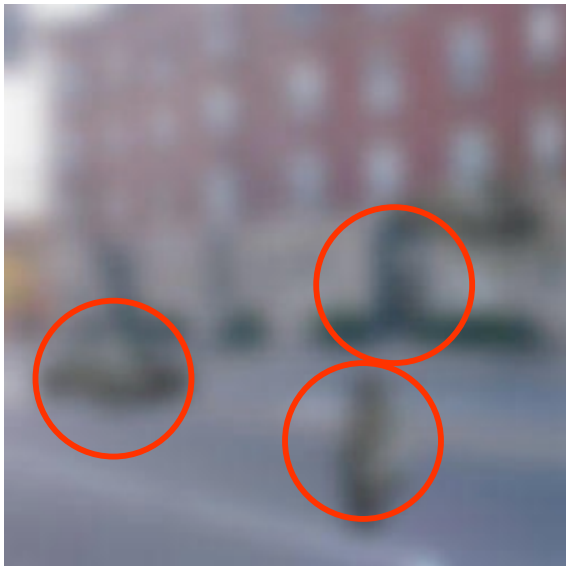
Challenges: object intra-class variation

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