Introduction

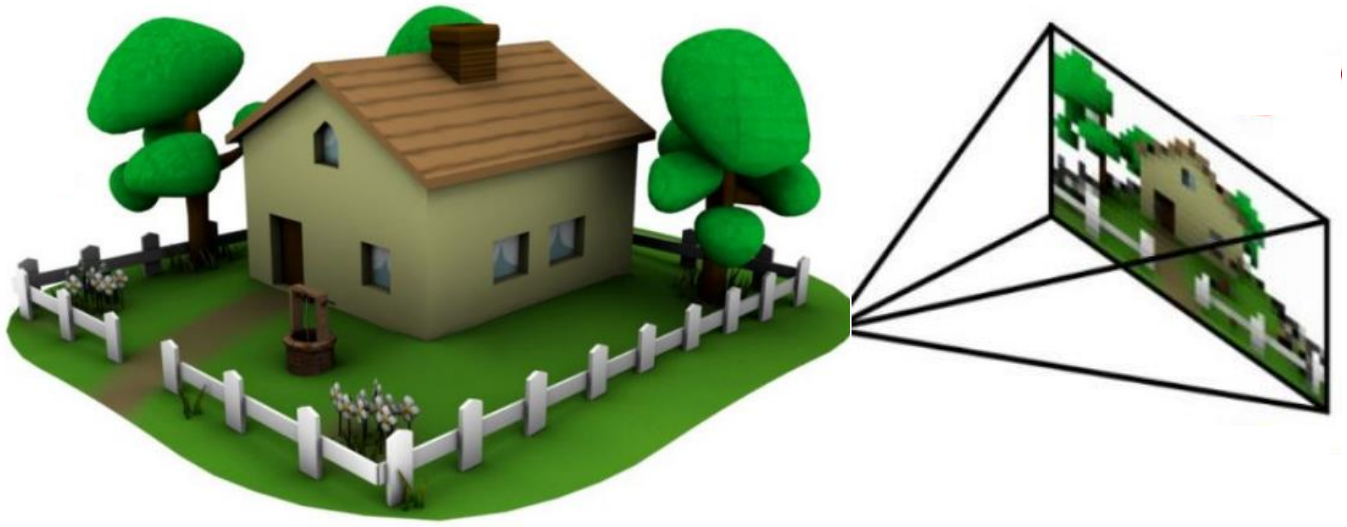
Computer Vision

Goal of Computer Vision

extract semantic information from digital image data

to be used for decision making support or automated systems

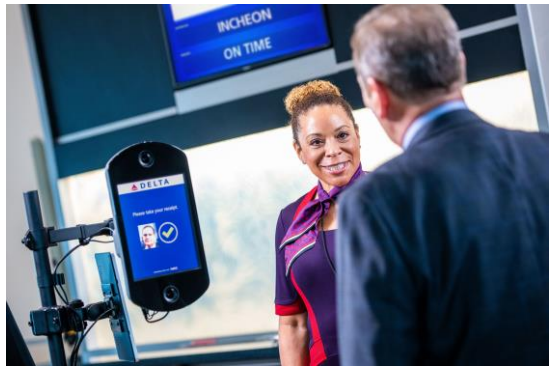
challenging problem:
images are only 2D projections
of the 3D world



nowadays heavily powered by artificial intelligence (AI), especially machine learning (ML)

Applications of Computer Vision

facial recognition



automated inspection

autonomous driving

medical imaging

optical character recognition

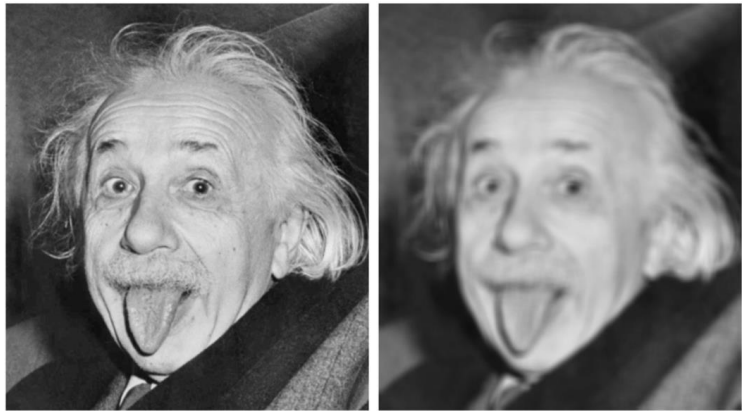
augmented reality

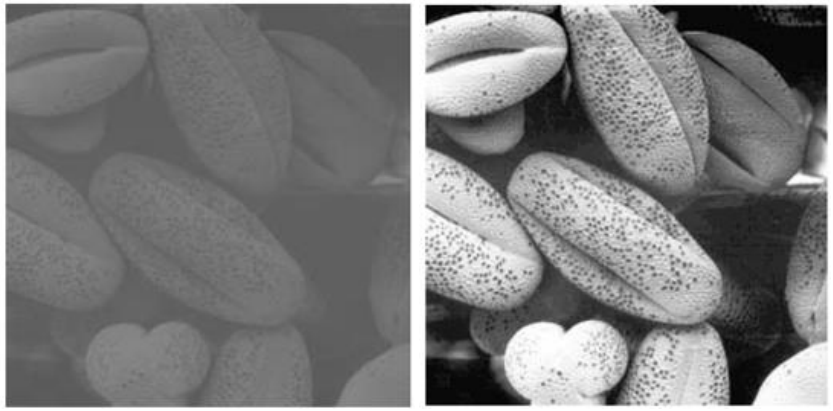
and many more ...

Image Processing

transformations from image to image

(such as scaling, smoothing, sharpening, or contrast stretching)

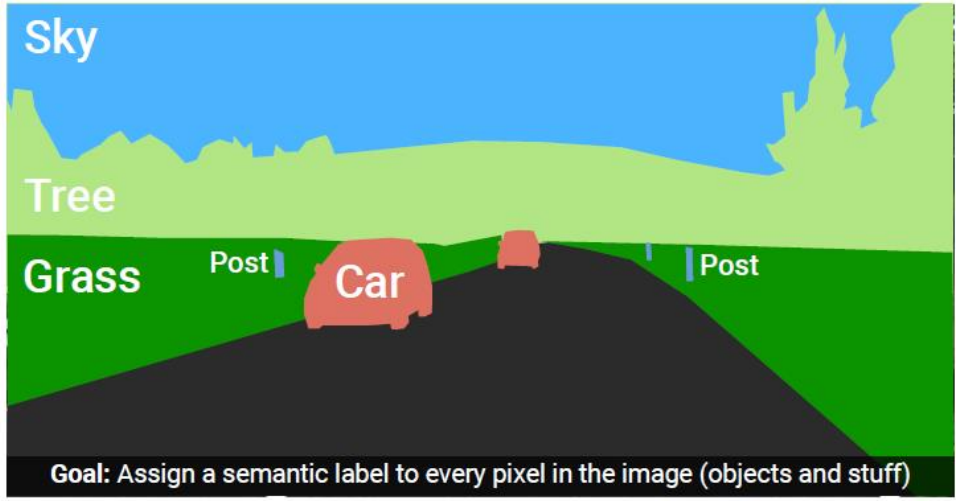




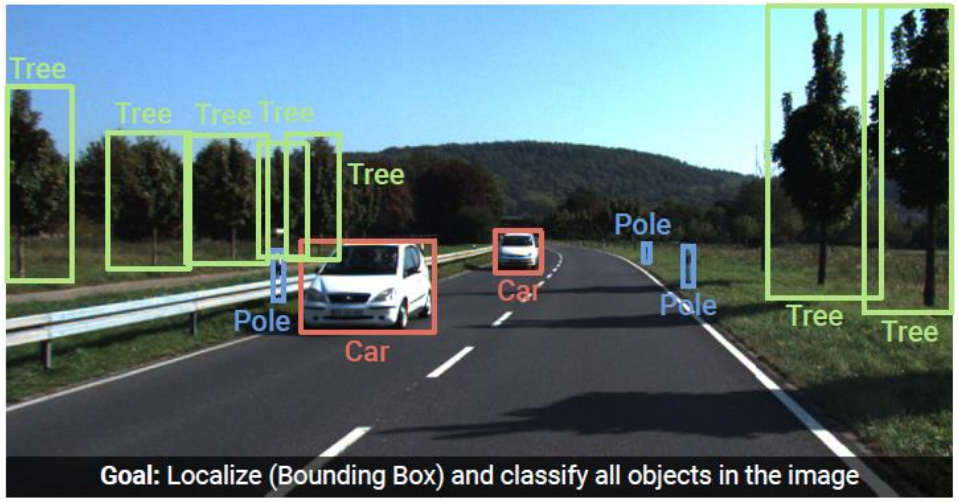
to facilitate either machine perception or just human interpretation

Image Understanding (Recognition)

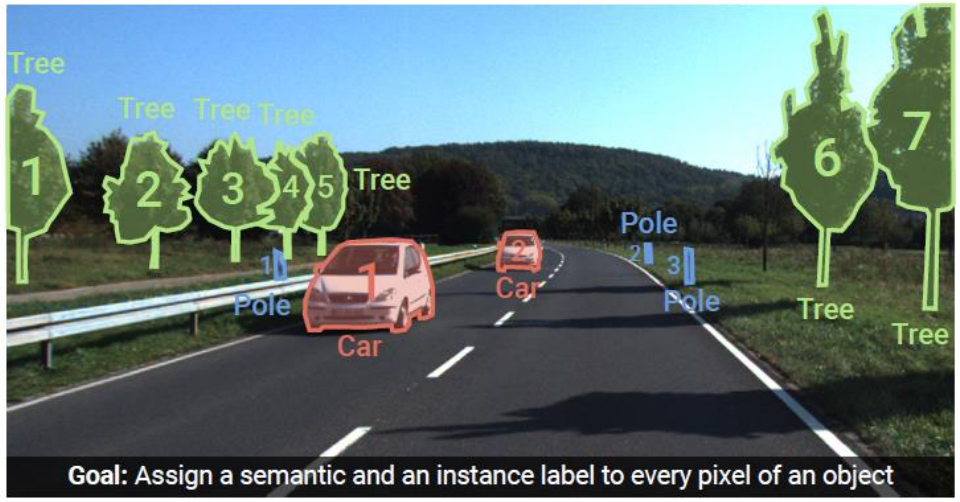
Image Classification



Semantic Segmentation



Object Detection



Instance Segmentation

Course Schedule

Part 1: Old-School Computer Vision

1. Digital Image Processing
   image formation, compression, intensity transformations, spatial filtering, Fourier transform, aliasing, image pyramids
2. Edges and Features
   Canny & Marr-Hildreth edge detectors, Hough transform, feature detection (Harris corner detector) and description (SIFT), feature matching, eigenfaces
3. Projective Geometry
   geometric transformations, image alignment, stereo vision, camera calibration

Part 2: Machine Learning

4. Image Classification: From Classic ML to Deep Learning
   supervised learning, linear regression, bias-variance tradeoff, neural networks, convolutional neural networks, transfer learning, transformers (language models, ViT, DINO, CLIP)
5. Segmentation and Detection
   semantic segmentation, object detection (R-CNN, YOLO), object tracking, instance segmentation, promptable segmentation
6. Image Synthesis
   generative models, GAN, VAE, diffusion

Main Areas of AI/ML

empowered by one key component: learning from data (ML)

tabular data

	Id	MSSubClass	MSZoning	LotFrontage	LotArea	Street	Alley	LotShape	LandContour	Utilities	...	PoolArea	PoolQC	Fence	MiscFeature	MiscVal	MoSold	YrSold	SaleType	SaleCondition	SalePrice
0	1	60	RL	65.0	8450	Pave	NaN	Reg	Lvl	AllPub	...	0	NaN	NaN	NaN	0	2	2008	WD	Normal	208500
1	2	20	RL	80.0	9600	Pave	NaN	Reg	Lvl	AllPub	...	0	NaN	NaN	NaN	0	5	2007	WD	Normal	181500
2	3	60	RL	68.0	11250	Pave	NaN	IR1	Lvl	AllPub	...	0	NaN	NaN	NaN	0	9	2008	WD	Normal	223500
3	4	70	RL	60.0	9550	Pave	NaN	IR1	Lvl	AllPub	...	0	NaN	NaN	NaN	0	2	2006	WD	Abnorml	140000
4	5	60	RL	84.0	14260	Pave	NaN	IR1	Lvl	AllPub	...	0	NaN	NaN	NaN	0	12	2008	WD	Normal	250000
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1455	1456	60	RL	62.0	7917	Pave	NaN	Reg	Lvl	AllPub	...	0	NaN	NaN	NaN	0	8	2007	WD	Normal	175000
1456	1457	20	RL	85.0	13175	Pave	NaN	Reg	Lvl	AllPub	...	0	NaN	MnPrv	NaN	0	2	2010	WD	Normal	210000
1457	1458	70	RL	66.0	9042	Pave	NaN	Reg	Lvl	AllPub	...	0	NaN	GdPrv	Shed	2500	5	2010	WD	Normal	266500
1458	1459	20	RL	68.0	9717	Pave	NaN	Reg	Lvl	AllPub	...	0	NaN	NaN	NaN	0	4	2010	WD	Normal	142125
1459	1460	20	RL	75.0	9937	Pave	NaN	Reg	Lvl	AllPub	...	0	NaN	NaN	NaN	0	6	2008	WD	Normal	147500

[1460 rows x 81 columns]

language models

The Lord of the Rings

Article Talk

From Wikipedia, the free encyclopedia

(Redirected from Lord of the rings)

This article is about the book. For other uses, see The Lord of the Rings (disambiguation). "War of the Ring" redirects here. For other uses, see War of the Ring (disambiguation).

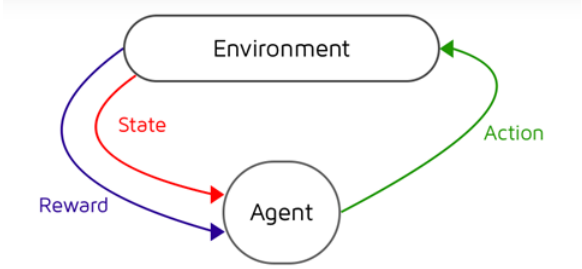
The Lord of the Rings is an epic[1] high fantasy novel[2] by the English author and scholar J. R. R. Tolkien. Set in Middle-earth, the story began as a sequel to Tolkien's 1937 children's book *The Hobbit*, but eventually developed into a much larger work. Written in stages between 1937 and 1949, *The Lord of the Rings* is one of the best-selling books ever written, with over 150 million copies sold.[2]

The title refers to the story's main antagonist,[3] Sauron, the Dark Lord who in an earlier age created the One Ring to rule the other Rings of Power given to Men, Dwarves, and Elves, in his campaign to conquer all of Middle-earth. From homely beginnings in the Shire, a hobbit land reminiscent of the English countryside, the story ranges across Middle-earth, following the quest to destroy the One Ring, seen mainly through the eyes of the hobbits Frodo, Sam, Merry, and Pippin. Aiding Frodo are the Wizard Gandalf, the Men Aragorn and Boromir, the Elf Legolas, and the Dwarf Gimli, who unite in order to rally the Free Peoples of Middle-earth against Sauron's armies and give Frodo a chance to destroy the One Ring in the fire of Mount Doom.

Although often mistakenly called a trilogy, the work was intended by Tolkien to be one volume in a two-volume set along with *The Silmarillion*.[3][T 3] For economic reasons, *The Lord of the Rings* was first published over the course of a year from 29 July 1954 to 20 October 1955 in three volumes rather than one[3][4] under the titles *The Fellowship of the Ring*, *The Two Towers*, and *The Return of the King*; *The Silmarillion* appeared only after the author's death. The work is divided internally into six books, two per volume, with several appendices of background material.[5] These three volumes were later published as a boxed set, and even finally as a single volume, following the author's original intent.

computer vision

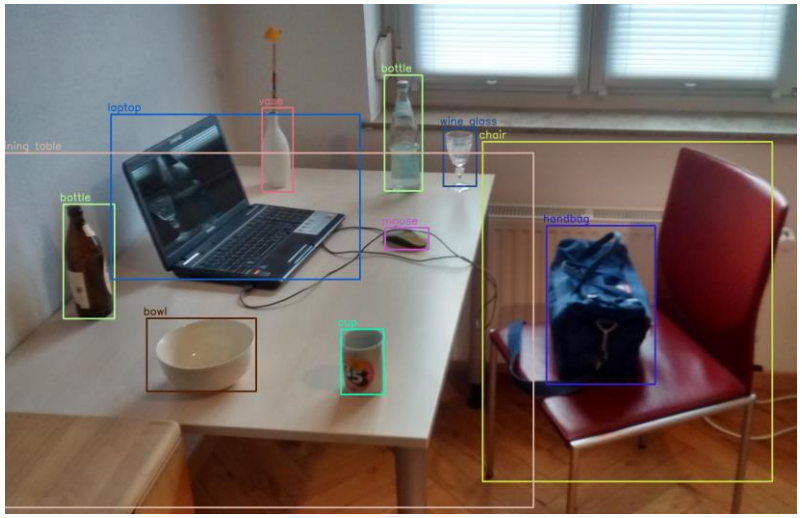
control



When to Use ML (Learning from Data)

automation

too complex for rules



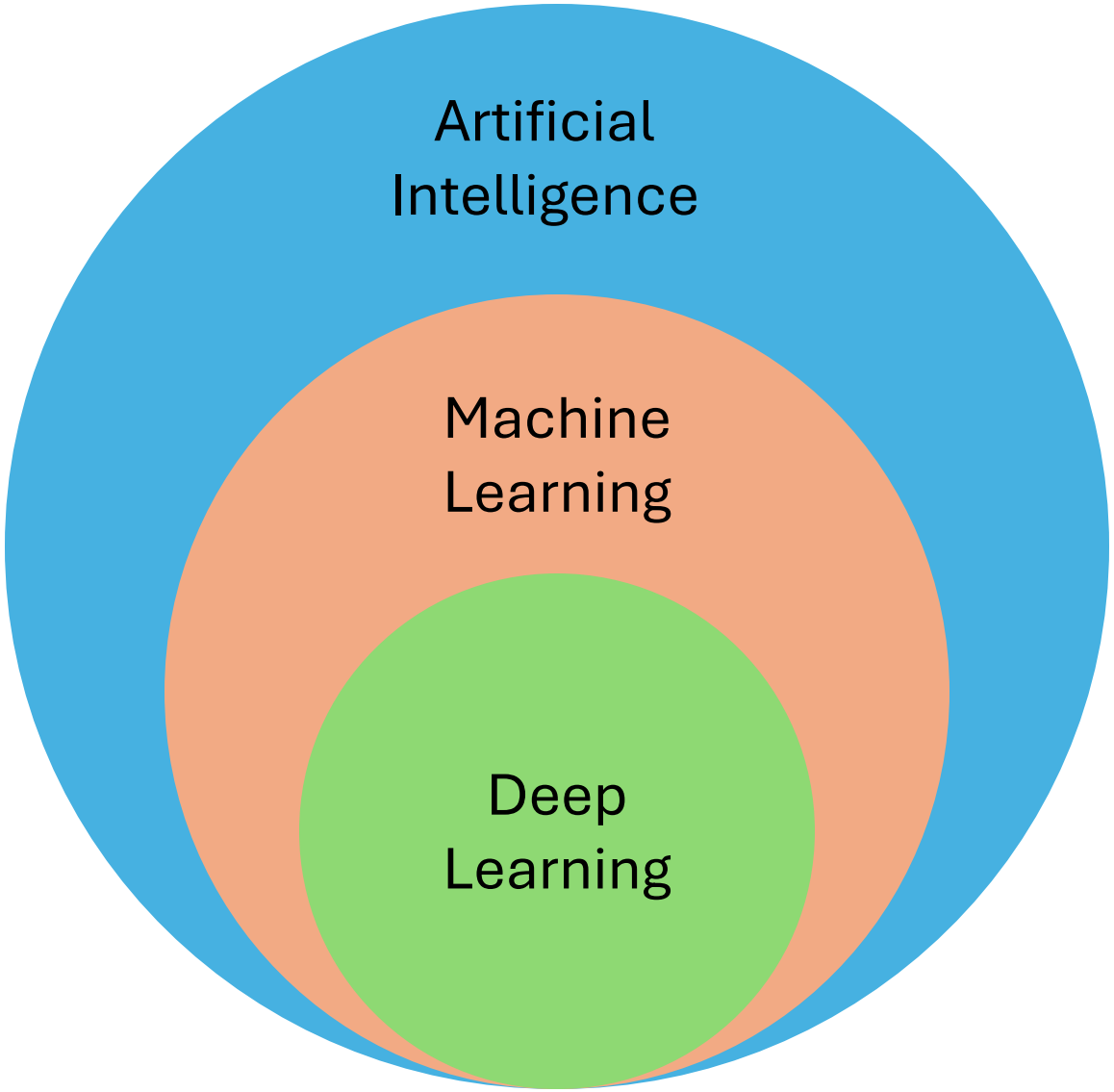
object recognition, chat bot, …

uncertainty

too complex for humans

AlphaFold

protein structure predictions, demand forecasting, …



blend of diverse components from different domains (statistics, optimization, computer science, …)

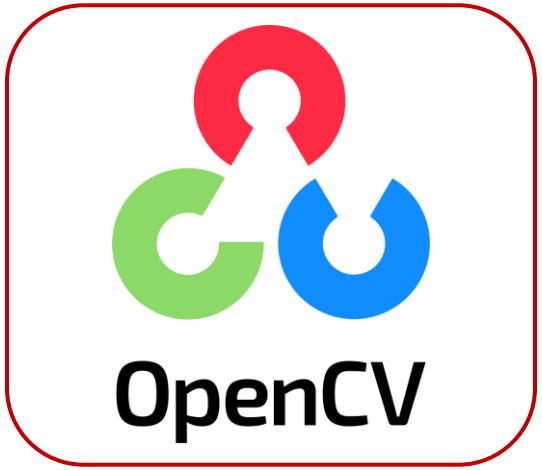
Deep Learning: special kind of ML methods using *deep* neural networks (e.g., CNNs, transformers)

Used Programming Language: Python

- good compromise between rapid prototyping and production
- vast ecosystem
- very popular for data processing and ML: scientific Python stack

Used Python Libraries

computer vision:



deep learning:

Programming Environments

both plain Python files or Jupyter notebooks are fine

locally, best use

- a virtual environment to flexibly install packages (e.g., venv)
- an IDE of your choice (VS Code or PyCharm)

but cloud-based environments also fine (e.g., Google Colab)

Literature

- Computer Vision: Algorithms and Applications
- Digital Image Processing, Gonzales & Woods

- Deep Learning
- The Little Book of Deep Learning
- Understanding Deep Learning