Deep Learning for Computer Vision

Lecture 1 - Overview

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Today’s agenda

- A brief history of computer vision
- In overview

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In overview

- Deep Learning Basics
- Perceiving and Understanding the Visual World
- Generative and Interactive Visual Intelligence
- Human-Centered Applications and Implications

Deep Learning Basics

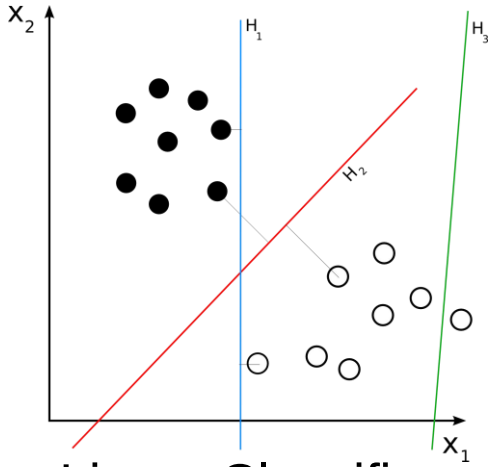
- Image Classification: A core task in Computer Vision

→ cat

Deep Learning Basics

- Image Classification: A core task in Computer Vision

cat

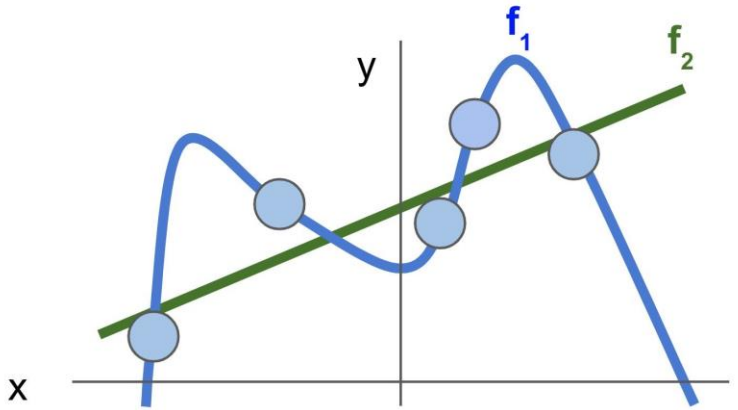


Linear Classifier

Deep Learning Basics

- Image Classification: A core task in Computer Vision

cat

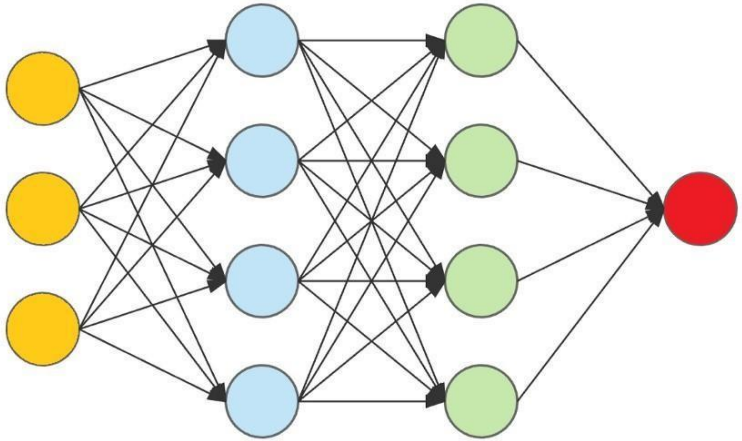


Regularization & Optimization

Deep Learning Basics

- Image Classification: A core task in Computer Vision

cat



Neural Networks

CS231n overview

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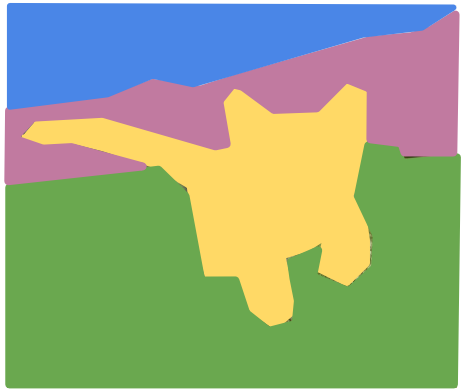
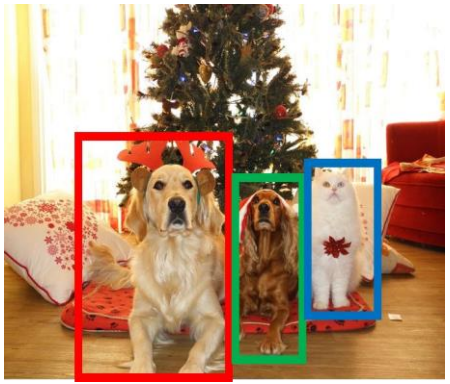
Perceiving and Understanding the Visual World

Tasks Beyond Image Classification

Classification	Semantic Segmentation	Object Detection	Instance Segmentation
			
CAT	**GRASS**, **CAT**, **TREE**, **SKY**	**DOG**, **DOG**, **CAT**	**DOG**, **DOG**, **CAT**
No spatial extent	No objects, just pixels	Multiple Object	

Tasks Beyond Image Classification

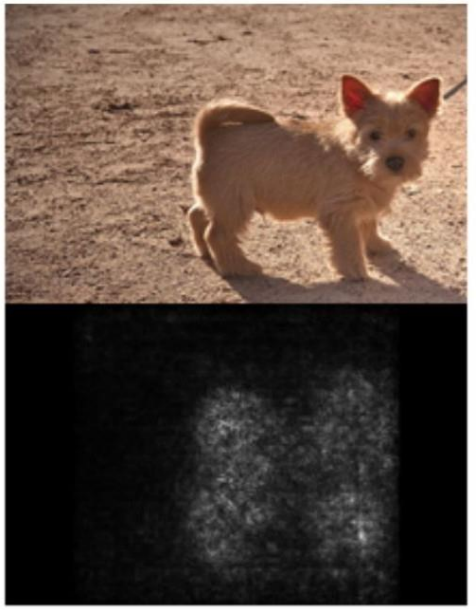
Video Classification

Running?
Jumping?

Multimodal Video Understanding

Introducción

Visualization & Understanding



Models Beyond Multi-Layer Perceptron

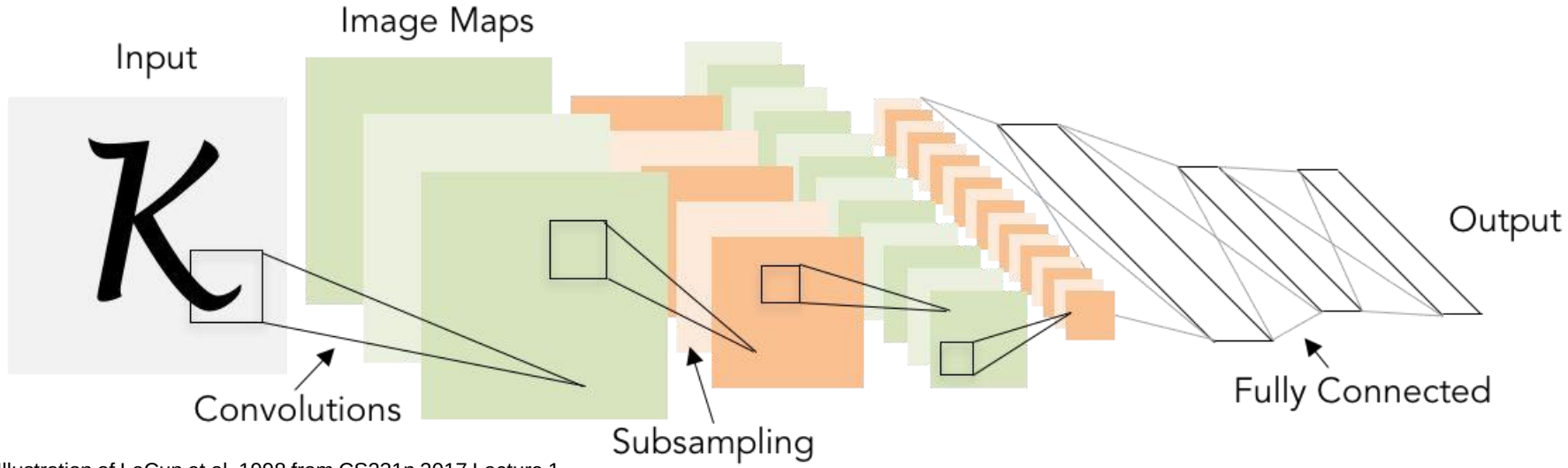
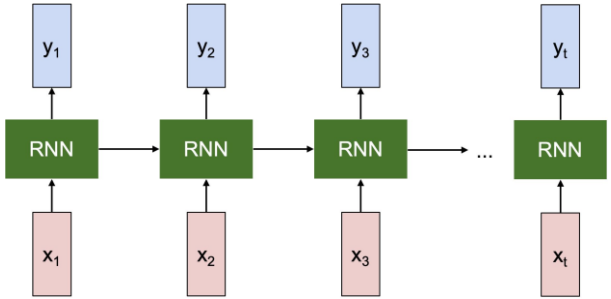
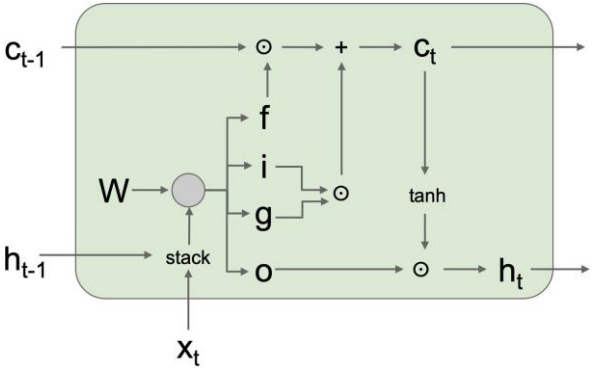


Illustration of LeCun et al. 1998 from CS231n 2017 Lecture 1

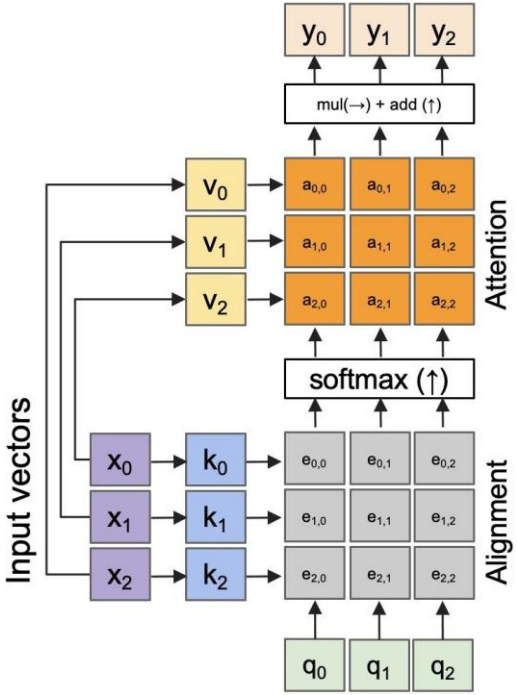
Convolutional neural network

Models Beyond Multi-Layer Perceptron





Recurrent neural network



Attention mechanism / Transformers

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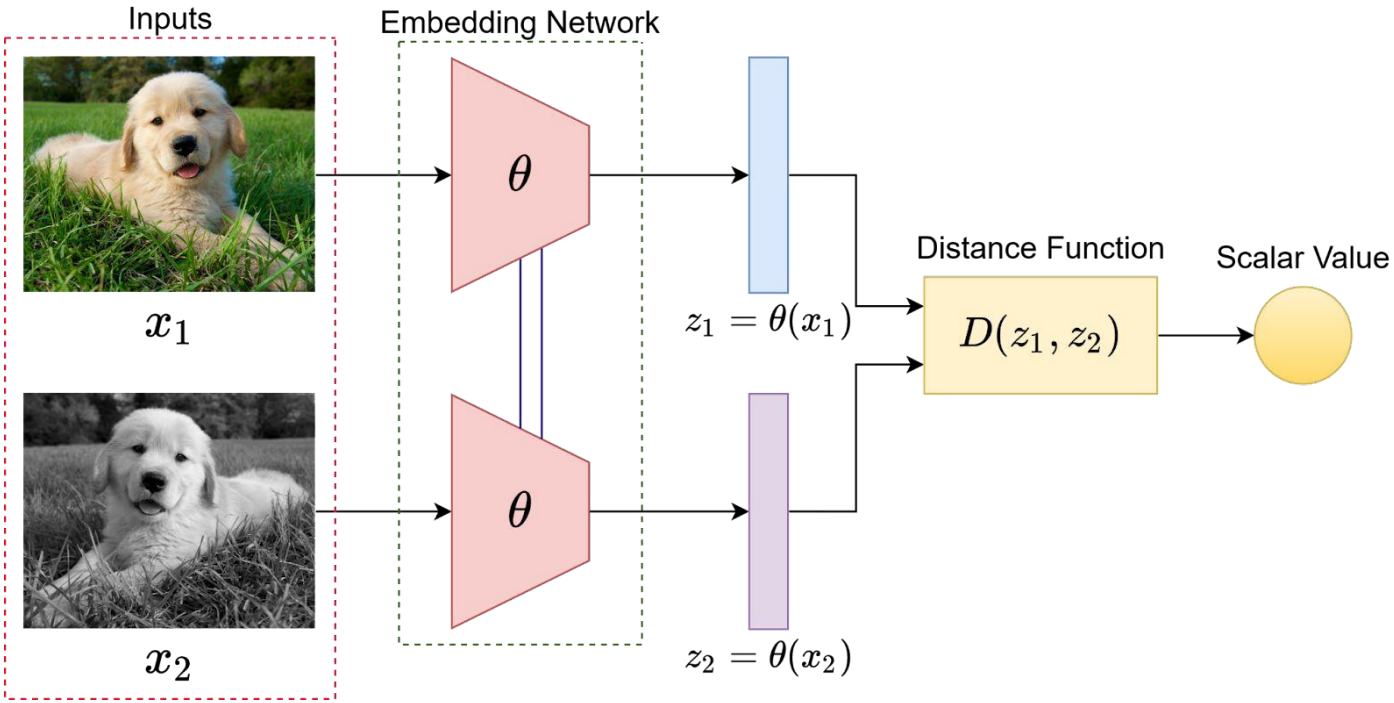
Beyond 2D Recognition

Beyond 2D Recognition: Self-supervised Learning

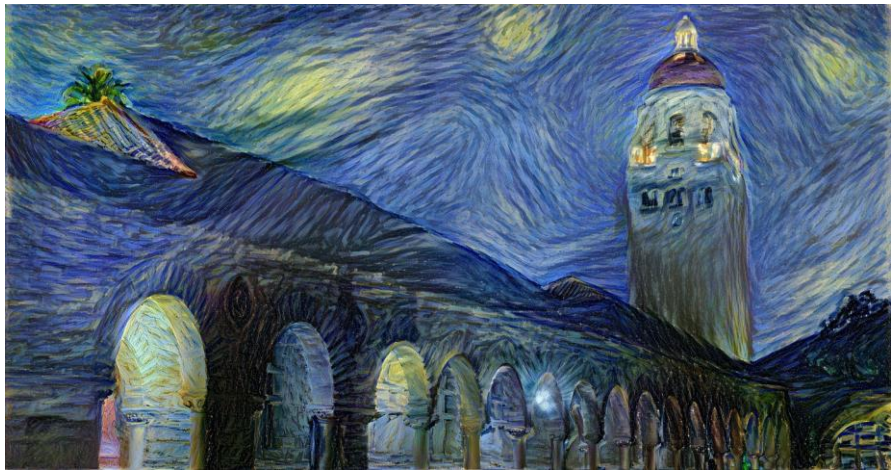


Beyond 2D Recognition: Generative Modeling

“Teddy bears working on new AI research underwater with 1990s technology”

DALL-E 2

Beyond 2D Recognition: Generative Modeling

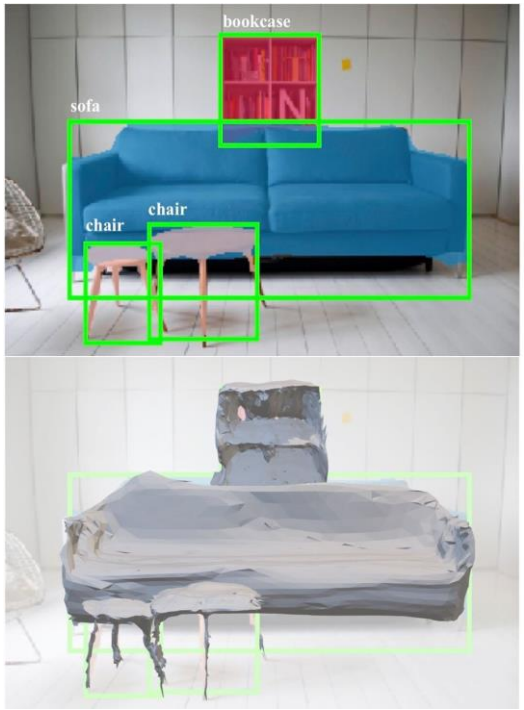


Style Transfer

Beyond 2D Recognition: 3D Vision

Choy et al., 3D-R2N2: Recurrent Reconstruction Neural Network (2016)

Zhou et al., 3D Shape Generation and Completion through Point-Voxel Diffusion (2021)



Gkioxari et al., "Mesh R-CNN", ICCV 2019

Beyond 2D Recognition: Embodied Intelligence

Li et al., BEHAVIOR-1K: A Benchmark for Embodied AI with 1,000 Everyday Activities and Realistic Simulation (2022)

Mandlekar and Xu et al., Learning to Generalize Across Long-Horizon Tasks from Human Demonstrations (2020)

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2018 Turing Award for deep learning

most prestigious technical award, is given for major contributions of lasting importance to computing.

Jeffrey Hinton

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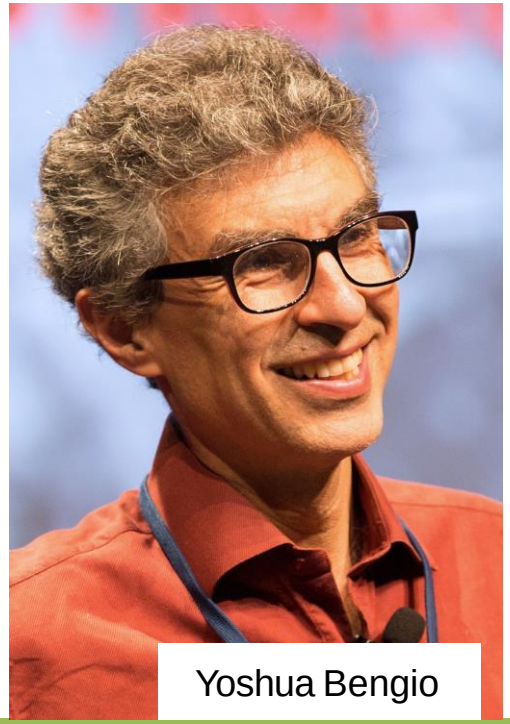

Yoshua Bengio

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Yann LeCun

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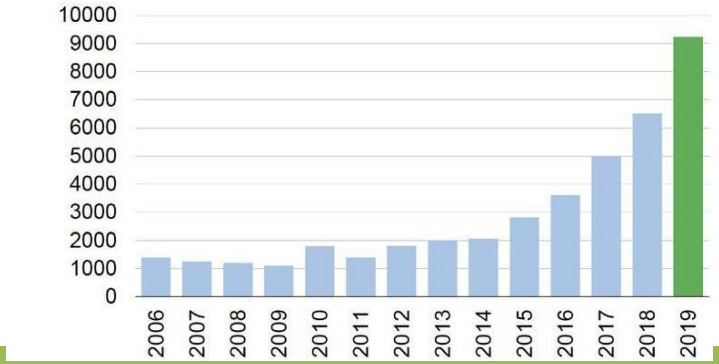
IEEE PAMI Longuet-Higgins Prize

Award recognizes ONE Computer Vision paper from **ten years ago** with **significant impact on computer vision** research.

At CVPR 2019, it was awarded to the 2009 original ImageNet paper

CVPR Attendance Trend



JUNE 18-22, 2023
CVPR
VANCOUVER, CANADA

>9k submissions, 2,360 accepted papers

Optional textbook resources

- *Deep Learning*
  - by Goodfellow, Bengio, and Courville
  - Here is a free version
- Mathematics of deep learning
  - Chapters 5, 6 7 are useful to understand vector calculus and continuous optimization
  - Free online version
- Dive into deep learning
  - An interactive deep learning book with code, math, and discussions, based on the NumPy interface.
  - Free online version

Learning objectives

Formalize computer vision applications into tasks

- Formalize inputs and outputs for vision-related problems
- Understand what data and computational requirements you need to train a model

Develop and train vision models

- Learn to code, debug, and train convolutional neural networks.
- Learn how to use software frameworks like PyTorch and TensorFlow

Gain an understanding of where the field is and where it is headed

- What new research has come out in the last 0-5 years?
- What are open research challenges?
- What ethical and societal considerations should we consider before deployment?

Why should you take this class?

Become a vision researcher (an incomplete list of conferences)

- Get involved with vision research at Stanford: apply using this form.
- CVPR 2022 conference
- ICCV 2021 conference

Become a vision engineer in industry (an incomplete list of industry teams)

- Perception team at Google AI, Vision at Google Cloud
- Vision at Meta AI
- Vision at Amazon AWS
- Nvidia, Tesla, Apple, Salesforce, ……

General interest

Deep Learning for Computer Vision

- Deep Learning Basics (Lecture 2 – 4)
- Perceiving and Understanding the Visual World (Lecture 5 – 12)
- Reconstructing and Interacting with the Visual World (Lecture 13 – 16)
- Human-Centered Artificial Intelligence (Lecture 17 – 18)

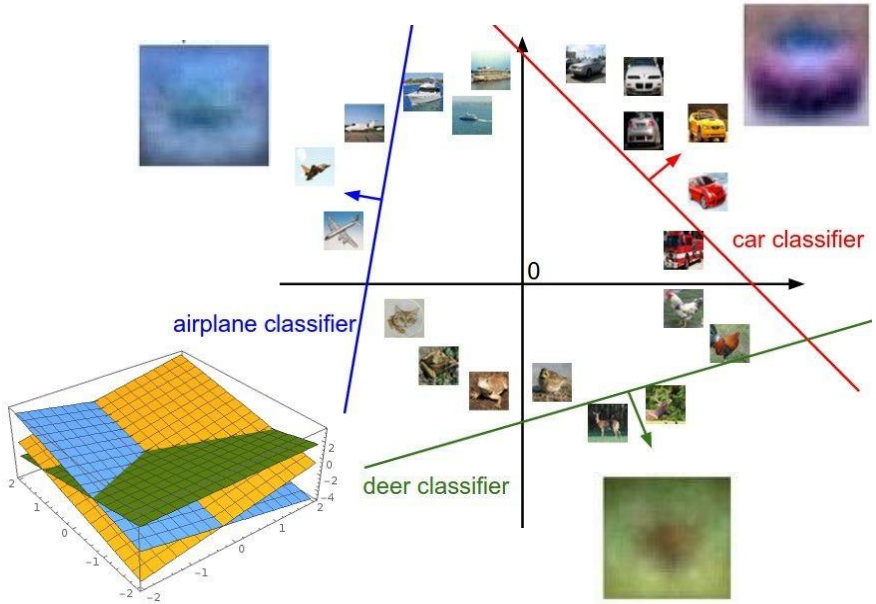
Syllabus

Deep Learning Basics	Convolutional Neural Networks	Computer Vision Applications
Data-driven learning	Convolutions	RNNs / Attention / Transformers
Linear classification & kNN	PyTorch / TensorFlow	Image captioning
Loss functions	Activation functions	Object detection and segmentation
Optimization	Batch normalization	Style transfer
Backpropagation	Transfer learning	Video understanding
Multi-layer perceptrons	Data augmentation	Generative models
Neural Networks	Momentum / RMSProp / Adam	Self-supervised learning
	Architecture design	3D vision
		Robot learning
		Human-centered AI
		Fairness & ethics

Next time: Image classification with Linear Classifiers

k- nearest neighbor

Linear classification



Introducción

Universidad Popular del Cesar