#### Deep Learning: Modern Artificial Vision

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#### Contents

A	kno	wledgements	iii
Pr	efac	e	v
Ι	Fo	undations of Modern Computer Vision	1
1	Wh	at is Computer Vision?	3
	1.1	Baisic Concepts	3
	1.2	The Role of Deep Learning in Computer Vision	3
2	Cor	nvolutional Neural Networks (CNNs)	5
	2.1	The Basics of Convolution	5
	2.2	Pooling Layers	5
	2.3	Wide Convolutions and Point-wise Convolutions	5
	2.4	Activation Functions	5
3	Opt	imization in Deep Learning	7
	$3.1^{-}$	Gradient Descent and Backpropagation	7
	3.2	Optimizers	7
	3.3	Challenges in Optimization	7
4	Bui	lding Blocks of Modern CNNs	9
	4.1	Batch Normalization	9
	4.2	UpSampling and Transposed Convolutions	9
	4.3	Gradient Flow Through Layers	9
II	$\mathbf{C}$	Fore Architectures and Building Blocks	11
-1		ore members and building blocks	11
<b>5</b>	Bac	kbone Networks	13
	5.1	CNN-based Backbones	13

Mi	Provect	o de	LaTeX

	$\angle$	L
		Į
_	_	-

		5.1.1 ResNet	13
		5.1.2 ResNeXt	13
		5.1.3 EfficientNet	13
		5.1.4 MobileNet	13
	5.2	Introduction to Transformers in Vision	13
		5.2.1 Vision Transformer	13
	5.3	Advanced Transformer Backbones	13
		5.3.1 Swin Transformer	13
6	Nec	k Networks	15
	6.1	FPNs	
	6.2	PANs	
	6.3	BiFPN	
7	Haa	nd Networks	17
1	7.1	TOOD	
	1.1	100D	11
8	Atte	ention Mechanisms	19
	8.1	Attention with CNNs	19
		8.1.1 Deformable Convolutions	19
	8.2	Attention with ViTs	19
Π	т (	Core Teels in Computer Vision	21
11	1 (	Core Tasks in Computer Vision	<b>4</b> 1
9	Ima	ge Classification	23
10	Obj	ect Detection	25
	10.1	Key Models	25
		10.1.1 YOLO	
		10.1.2 R-CNN	25
		10.1.3 Faster R-CNN	25
		10.1.4 DETR	25
		10.1.5 RT-DETR	25
		10.1.6 RetinaNet	25
	10.2	The State of the Art Models	25
		10.2.1 YOLOv12	25
		10.2.2 CO-DETR	25
11	Sem	nantic Segmentation	27
		Key Models	27
		11.1.1 U-Net	

Mi ]	Proyecto de LaTeX	5
-		27 27 27
=	12.1 Key Models	29 29 29 29 29
${f IV}$	Generative Models and Advanced Applications 3	31
-	13.1 Generative Adversarial Networks	<b>33</b> 33 33
-	14.1 Neural Style Transfer	<b>35</b> 35 35
		<b>37</b> 37
- - -	16.1 Text-to-Image Diffusion Models	<b>39</b> 39 39
V	Production Deployment 4	41
-	17.1 Model Compression	43 44 44 44 44 44 44
	17.2.2 ONNX Runtime	44 44 44

	17.2.4	TensorFlow Lite	4
17.3	Model	Deployment	4
	17.3.1	TensorFlow Serving	4
	17.3.2	TorchServe	4
	17.3.3	NVIDIA Triton Inference Server 4	4
	17.3.4	MLflow	4
	17.3.5	Kubeflow	4
17.4	Model	Monitoring	4
	17.4.1	Prometheus	4
	17.4.2	Grafana	4
	17.4.3	Seldon	4
	17.4.4	Evidently	4
17.5	Model	Versioning	4
	17.5.1	DVC	4
	17.5.2	MLflow	4
	17.5.3	Weights & Biases	4
VI I	Explai	inability and Interpretability 45	5
18 Exp	lainab	ility in Computer Vision 4	7
18.1	Introd	uction to Explainability 4	8
		What is Explainability? 4	8
	18.1.2	Why is Explainability Important? 4	8
		Types of Explainability 4	8
		Challenges in Explainability 4	8
18.2	Metho	ds for Explainability	8
		Saliency Maps	8
	18.2.2	Grad-CAM	8
		Integrated Gradients 4	
	18.2.4	LIME	8
		SHAP	
18.3	_	retable Models	
	18.3.1	Decision Trees	
	18.3.2	Rule-Based Models	
		Linear Models	8
	18.3.4		
18.4		Prototype-Based Models 4	
	Evalua	Prototype-Based Models	8
	Evalua 18.4.1	Prototype-Based Models	8:8
	Evalua 18.4.1 18.4.2	Prototype-Based Models	8.8

Mi Proyecto de La	±e∠	/
-------------------	-----	---

18.5	Applic	ations of Explainability	48
	18.5.1	Medical Imaging	48
	18.5.2	Autonomous Vehicles	48
	18.5.3	Security and Privacy	48
	18.5.4	Fairness and Bias	48

i

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#### Preface

This is the preface of the document...  $\,$ 

I Foundations of Modern Computer Vision

#### What is Computer Vision?

#### 1.1 Baisic Concepts

Computer vision is a field of artificial intelligence that focuses on enabling machines to interpret and understand visual information from the world, similar to how humans do. It involves the development of algorithms and models that can analyze images and videos, extract meaningful features, and make decisions based on visual data. Computer vision has applications in various domains, including autonomous vehicles, medical imaging, surveillance, robotics, and augmented reality.

# 1.2 The Role of Deep Learning in Computer Vision

# Convolutional Neural Networks (CNNs)

- 2.1 The Basics of Convolution
- 2.2 Pooling Layers
- 2.3 Wide Convolutions and Point-wise Convolutions
- 2.4 Activation Functions

## Optimization in Deep Learning

- 3.1 Gradient Descent and Backpropagation
- 3.2 Optimizers
- 3.3 Challenges in Optimization

# Building Blocks of Modern CNNs

- 4.1 Batch Normalization
- 4.2 UpSampling and Transposed Convolutions
- 4.3 Gradient Flow Through Layers

#### **Backbone Networks**

- 5.1 CNN-based Backbones
- 5.1.1 ResNet
- 5.1.2 ResNeXt
- 5.1.3 EfficientNet
- 5.1.4 MobileNet
- 5.2 Introduction to Transformers in Vision
- 5.2.1 Vision Transformer
- 5.3 Advanced Transformer Backbones
- 5.3.1 Swin Transformer

#### **Neck Networks**

- 6.1 FPNs
- 6.2 PANs
- 6.3 BiFPN

## **Head Networks**

#### 7.1 TOOD

#### **Attention Mechanisms**

- 8.1 Attention with CNNs
- 8.1.1 Deformable Convolutions
- 8.2 Attention with ViTs

III Core Tasks in Computer Vision

# Chapter 9 Image Classification

#### **Object Detection**

- 10.1 Key Models
- 10.1.1 YOLO
- 10.1.2 R-CNN
- 10.1.3 Faster R-CNN
- 10.1.4 DETR
- 10.1.5 RT-DETR
- 10.1.6 RetinaNet
- 10.2 The State of the Art Models
- 10.2.1 YOLOv12
- 10.2.2 CO-DETR

#### Semantic Segmentation

- 11.1 Key Models
- 11.1.1 U-Net
- 11.1.2 U2-Net
- 11.1.3 SegFormer
- 11.2 The State of the Art Models

## **Density Map Estimation**

- 12.1 Key Models
- 12.1.1 CSRNet
- 12.1.2 Cascaded CSRNet
- 12.2 The State of the Art Models

# IV Generative Models and Advanced Applications

## Generative Adversarial Networks (GANs)

- 13.1 Generative Adversarial Networks
- 13.2 CycleGAN
- 13.3 Pix2Pix

### Style Transfer

- 14.1 Neural Style Transfer
- 14.2 Fast Neural Style Transfer

# Chapter 15 Diffusion Models

15.1 Stable Diffusion

#### Text-to-Image and Layout-to-Image Diffusion Models

- 16.1 Text-to-Image Diffusion Models
- 16.2 Layout-to-Image Diffusion Models

V Production Deployment

#### **Model Optimization**

1 - 1	7 / I I	$\boldsymbol{\alpha}$	•
17.1	Model	Com	pression
	1110401	O 111	

- 17.1.1 Quantization
- 17.1.2 Pruning
- 17.1.3 Knowledge Distillation
- 17.1.4 Neural Architecture Search
- 17.2 Model Acceleration
- 17.2.1 TensorRT
- 17.2.2 ONNX Runtime
- 17.2.3 OpenVINO
- 17.2.4 TensorFlow Lite
- 17.3 Model Deployment
- 17.3.1 TensorFlow Serving
- 17.3.2 TorchServe
- 17.3.3 NVIDIA Triton Inference Server
- 17.3.4 MLflow
- 17.3.5 Kubeflow
- 17.4 Model Monitoring
- 17.4.1 Prometheus
- 17.4.2 Grafana

VI Explainability and Interpretability

# Explainability in Computer Vision

101	T . 1		T 1 . 1 . 1 . 1 . 1 . 1 . 1 . 1
18.1	Introduction	to	Explainability

- 18.1.1 What is Explainability?
- 18.1.2 Why is Explainability Important?
- 18.1.3 Types of Explainability
- 18.1.4 Challenges in Explainability
- 18.2 Methods for Explainability
- 18.2.1 Saliency Maps
- 18.2.2 Grad-CAM
- 18.2.3 Integrated Gradients
- 18.2.4 LIME
- 18.2.5 SHAP
- 18.3 Interpretable Models
- 18.3.1 Decision Trees
- 18.3.2 Rule-Based Models
- 18.3.3 Linear Models
- 18.3.4 Prototype-Based Models
- 18.4 Evaluating Explainability
- 18.4.1 Quantitative Evaluation