Machine Learning for Visual Computing Oral Exam备考

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模拟考试1

Topic 1: Optimization and Neural Networks Fundamentals
Main Question: "Could you explain what gradient descent is and how it works in machine learning?"
Follow-up 1: "What's the difference between batch gradient descent and stochastic gradient descent?"
Follow-up 2: "How do we handle the vanishing gradient problem in deep networks?"

Topic 2: Convolutional Neural Networks
Main Question: "Can you explain what convolution is in CNNs and how it differs from traditional matrix multiplication?"
Follow-up 1: "What are the main components of a CNN architecture? Please explain each one's role."
Follow-up 2: "How does backpropagation work in CNNs, particularly through convolution and pooling layers?"

Topic 3: Style Transfer and Feature Visualization
Main Question: "Can you explain what neural style transfer is and how it works?"
Follow-up 1: "What is the Gram matrix and why is it crucial for style transfer?"
Follow-up 2: "What are the different loss functions used in style transfer and their purposes?"

模拟考试2

Topic 1: RNN and Sequence Learning
Main Question: "Can you explain the different types of sequence modeling tasks and give examples in visual computing?"
Follow-up 1: "What are the main challenges with RNNs, and how does LSTM address them?"
Follow-up 2: "How does adding attention to RNN improve its performance? Can you explain the RNN+Attention architecture?"

Topic 2: Feature Understanding and Visualization
Main Question: "What is CAM (Class Activation Mapping) and Grad-CAM, and how do they help us understand CNNs?"
Follow-up 1: "What is Feature Inversion and how does it help us understand CNN representations?"
Follow-up 2: "Can you explain Gradient Ascent in the context of feature visualization?"

Topic 3: Generative Models
Main Question: "Could you compare VAEs and GANs? What are their respective strengths and weaknesses?"
Follow-up 1: "How does the reparameterization trick work in VAEs, and why is it necessary?"
Follow-up 2: "What is Neural Implicit Representation, and why is it important for generative models?"

模拟考试3

Topic 1: Loss Functions and Optimization
Main Question: "What is the role of loss functions in machine learning for visual computing? Can you explain some common loss functions and their applications?"
Follow-up 1: "How do we choose between different loss functions for different visual computing tasks?"
Follow-up 2: "Could you explain the LPIPS loss and why it's particularly useful for image generation tasks?"

Topic 2: Attention and Transformers
Main Question: "Could you explain how the attention mechanism works and why it's important in visual computing?"
Follow-up 1: "How does self-attention differ from cross-attention, and when would you use each?"
Follow-up 2: "Walk me through the architecture of a Transformer and explain its advantages for visual tasks."

Topic 3: Diffusion Models
Main Question: "Could you explain what a diffusion process is and how it works in generative models?"
Follow-up 1: "How does the training process work in diffusion models?"
Follow-up 2: "What are the key components of Latent Diffusion Models (LDM) and how do they differ from regular diffusion models?"

模拟考试4

Topic 1: Neural Networks Basics and Position Encoding
Main Question: "What is positional encoding and why is it important in neural networks? Can you explain its applications in different architectures?"
Follow-up 1: "How does positional encoding help in tasks like NeRF and Transformers?"
Follow-up 2: "Can you explain the mathematical formulation of positional encoding and why sinusoidal functions are used?"

Topic 2: Image Analysis and Feature Detection
Main Question: "What are the different ways we can extract and represent features from images? Please discuss both traditional and deep learning approaches."
Follow-up 1: "How do CNNs learn hierarchical features through different layers, and how can we visualize these features?"
Follow-up 2: "Could you explain how we handle multi-scale feature extraction and why it's important?"

Topic 3: Style and Texture
Main Question: "Can you explain what texture synthesis is, and how it relates to style transfer?"
Follow-up 1: "How does the Gram matrix capture style information, and what are its limitations?"
Follow-up 2: "What is feedforward style transfer, and how does it differ from optimization-based approaches?"

模拟考试5

Topic 1: Architectures and Optimization
Main Question: "Can you explain the evolution of CNN architectures from AlexNet to ResNet to DenseNet? What are the key innovations in each?"
Follow-up 1: "Why are skip connections important in deep networks, and how do they help with

training?"
Follow-up 2: "How do we handle issues like vanishing gradients and exploding gradients in deep architectures?"

Topic 2: Autoencoding and Compression
Main Question: "What are autoencoders, and how do they differ from PCA? Please explain their applications in visual computing."
Follow-up 1: "How do VAEs extend traditional autoencoders, and what makes them suitable for generation tasks?"
Follow-up 2: "What is the relationship between the latent space dimension and model performance in autoencoders?"

Topic 3: Advanced Visual Computing Applications
Main Question: "How do we handle different input sizes in CNNs, and what are the implications for the architecture?"
Follow-up 1: "Can you explain how CNN filters evolve through different layers of the network and what patterns they typically learn to detect?"
Follow-up 2: "What role do fully connected layers play in CNNs, and why are they typically placed at the end of the network?"

模拟考试6

Topic 1: Visual Data Representation and Processing
Main Question: "Can you explain the different ways we represent images and video data in visual computing? What are the advantages and disadvantages of each approach?"
Follow-up 1: "How do we handle multi-scale processing in visual computing, and why is it important?"
Follow-up 2: "What are image pyramids, and how are they used in various visual computing tasks?"

Topic 2: Sequential Learning and Generation
Main Question: "Can you explain the basic architecture and working principle of RNN? How does it handle sequential data?"
Follow-up 1: "What is the chain rule and how does it apply in backpropagation through time (BPTT)?"
Follow-up 2: "How do we handle long-term dependencies in sequential models, and what solutions have been proposed?"

Topic 3: Advanced Generation and Control
Main Question: "Could you explain what GAN mode collapse is and how we can address it?"
Follow-up 1: "What are the different types of conditional generation in GANs, and how do they work?"
Follow-up 2: "How does classifier guidance work in diffusion models, and how does it differ from classifier-free guidance?"

模拟考试7

Topic 1: Neural Network Training and Regularization
Main Question: "What are the different approaches to prevent overfitting in neural networks? Can you explain how they work and when to use each?"
Follow-up 1: "How do dropout and batch normalization work together in modern architectures?"
Follow-up 2: "What is the relationship between model capacity, dataset size, and regularization strength?"

Topic 2: Feature Understanding and Loss Functions
Main Question: "What are perceptual losses and how do they differ from traditional pixel-space losses?"
Follow-up 1: "How do we choose appropriate layers for perceptual losses in different applications?"
Follow-up 2: "Can you explain the mathematical foundations of content loss versus style loss in neural style transfer?"

Topic 3: Modern Image Generation
Main Question: "How does sampling work in diffusion models, and what are the key parameters we need to control?"
Follow-up 1: "What are the trade-offs between speed and quality in different sampling strategies?"
Follow-up 2: "How do we handle conditioning in diffusion models, and what are the different approaches available?"

模拟考试8

Topic 1: Fundamental Optimization Techniques
Main Question: "Could you explain the difference between first-order and second-order optimization methods? What role does momentum play in modern optimization?"
Follow-up 1: "How does adaptive learning rate optimization (like Adam) work, and when should we use it?"
Follow-up 2: "What are the trade-offs between different optimization strategies in visual computing tasks?"

Topic 2: Advanced CNN Understanding
Main Question: "How do we use Grad-CAM and other visualization techniques to understand what CNNs have learned?"
Follow-up 1: "What are adversarial examples, and what do they tell us about CNN behavior?"
Follow-up 2: "How can we measure and improve the interpretability of CNNs in visual computing tasks?"

Topic 3: Modern Architectures and Applications
Main Question: "What are the key differences between transformer-based and CNN-based approaches in visual computing?"
Follow-up 1: "How do we handle the quadratic complexity of self-attention in vision transformers?"
Follow-up 2: "What are the advantages and limitations of using transformers for visual tasks compared to traditional CNNs?"

模拟考试9

Topic 1: Data Processing and Feature Engineering
Main Question: "What is the role of feature representation in visual computing? How do different types of features (hand-crafted vs learned) compare?"
Follow-up 1: "How do we handle different types of invariance (translation, rotation, scale) in visual feature extraction?"
Follow-up 2: "Can you explain the relationship between receptive field size and feature hierarchy in deep networks?"

Topic 2: Generative Model Training
Main Question: "What is the Evidence Lower Bound (ELBO) in VAEs and why is it important for training?"
Follow-up 1: "How do we balance the reconstruction and KL terms in the VAE objective?"

Follow-up 2: "What are the different approaches to conditional generation in VAEs versus GANs?"

Topic 3: Advanced Applications and Architectures
Main Question: "How does neural implicit representation work for representing visual data? What are its advantages over discrete representations?"
Follow-up 1: "What role does positional encoding play in neural implicit representations like NeRF?"
Follow-up 2: "How do we handle different types of conditioning in modern generative models (text, image, class labels)?"

模拟考试10

Topic 1: Model Understanding and Learning
Main Question: "What are the different approaches to understanding what deep networks learn? How do visualization techniques help us understand model behavior?"
Follow-up 1: "How do we analyze the trade-off between model capacity and generalization in deep networks?"
Follow-up 2: "What role does feature space analysis play in understanding network representations?"

Topic 2: Loss Functions and Training Dynamics
Main Question: "How do different loss functions affect the learning dynamics in visual computing tasks?"
Follow-up 1: "What are the considerations when combining multiple loss terms (e.g., in style transfer or image generation)?"
Follow-up 2: "How do adversarial and perceptual losses differ from traditional reconstruction losses, and when should we use each?"

Topic 3: Modern Visual Analysis
Main Question: "How do we handle image retrieval tasks in modern visual computing? What are the different approaches and their trade-offs?"
Follow-up 1: "What role do learned embeddings play in visual search and retrieval?"
Follow-up 2: "How do CNN-based denoising approaches differ from traditional methods, and what are their respective advantages?"

模拟考试11（高频率可能考点）

Topic 1: Backpropagation and Chain Rule
Main Question: "Could you explain the chain rule and its role in backpropagation? Please provide a concrete example."
Follow-up 1: "How does backpropagation work differently in CNNs versus standard neural networks?"
Follow-up 2: "Can you walk through the gradient computation process in a simple neural network, explaining each step?"

Topic 2: Position Encoding and Applications
Main Question: "What is position encoding and why is it important in modern deep learning architectures?"
Follow-up 1: "How is position encoding used differently in Transformers versus NeRF?"
Follow-up 2: "Can you explain the mathematical intuition behind sinusoidal position encoding?"

Topic 3: Loss Functions and Style Transfer
Main Question: "Can you explain the different loss functions used in style transfer? How do they work together?"
Follow-up 1: "What's the relationship between Gram matrices and style representation?"
Follow-up 2: "How do perceptual losses differ from traditional pixel-space losses?"

模拟考试12（高频率可能考点）

Topic 1: CNN Feature Visualization and Understanding
Main Question: "Can you explain what CAM and Grad-CAM are, and how they help us understand CNNs? What are their differences?"
Follow-up 1: "How do we visualize features at different layers of a CNN, and what patterns do we typically observe?"
Follow-up 2: "What does feature inversion tell us about CNN representations at different layers?"

Topic 2: Diffusion Models and Sampling
Main Question: "Could you explain what a diffusion process is and how sampling works in diffusion models?"
Follow-up 1: "What are the key differences between standard diffusion models and latent diffusion models?"
Follow-up 2: "How does classifier-free guidance work in diffusion models, and why is it important?"

Topic 3: LSTM and Attention Mechanism
Main Question: "What are the main challenges with RNNs, and how does LSTM address them? Please explain the LSTM architecture."
Follow-up 1: "How does the attention mechanism improve sequence modeling?"
Follow-up 2: "Can you explain self-attention versus cross-attention in visual computing tasks?"

模拟考试13（高频率可能考点）

Topic 1: VAE vs GAN Comparison
Main Question: "Could you compare VAEs and GANs in terms of their architecture, training process, and applications in visual computing?"
Follow-up 1: "How does the reparameterization trick work in VAEs, and why is it necessary?"
Follow-up 2: "What are the different types of mode collapse in GANs, and how do we address them?"

Topic 2: Modern Optimization Techniques
Main Question: "Can you explain the differences between batch gradient descent, stochastic gradient descent, and mini-batch gradient descent?"
Follow-up 1: "How do adaptive learning rate methods like Adam improve upon standard SGD?"
Follow-up 2: "What strategies do we use to address issues like vanishing gradients in deep networks?"

Topic 3: Image Representation and Processing
Main Question: "What are the different ways we can represent and process images in visual computing? How do traditional and deep learning approaches compare?"
Follow-up 1: "How do CNNs learn hierarchical features from images, and how can we visualize these features?"
Follow-up 2: "Can you explain how multi-scale processing works in visual computing and why it's important?"

这三套最可能考到的模拟题（共9个topic）特别强调了：

1. 深度学习的核心机制（反向传播、特征可视化）
2. 现代架构的关键创新（位置编码、注意力机制）
3. 生成模型的最新发展（扩散模型、VAE/GAN）
4. 基础理论（优化、损失函数）
5. 视觉计算的实际应用