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RV COLLEGE OF ENGINEERING®

(An Autonomous Institution Affiliated to VTU)

VIISemester B. E. Regular Examinations Mar/Apr-2025

Artificial Intelligence and Machine Learning

GENERATIVE ARTIFICIAL INTELLIGENCE (ELECTIVE)

Time: 03 Hours ***Maximum Marks: 100***

Instructions to candidates:

1. Answer all questions from Part A. Part A questions should be answered in first three pages of the answer book only.
2. Answer FIVE full questions from Part B. In Part B question number 2is compulsory. Answer any one full question from 3 and 4, 5 and 6, 7 and 8, 9 and 10.

PART-A

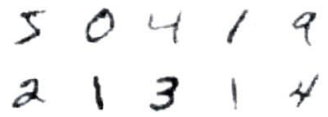
			M	BT	CO
1	1.1	How can binary classification be applied to develop an artist discriminator for identifying Van Gogh's paintings?	2	2	1
	1.2	What is the role of embedding layer in Large Language Models?	2	1	1
	1.3	Write purpose of introducing Random Noise in GAN.	2	1	1
	1.4	Why does the discriminator training process involve both fake and real images?	2	1	1
	1.5	Explain latent space in Auto Encoders.	2	2	1
	1.6	Define Positional Encoding.	2	2	1
	1.7	Compare DownBlocks and UpBlocks.	2	3	3
	1.8	What is an Energy-Based Model(EBM)?	2	1	3
	1.9	Define algorithmic bias and data bias in the context of generative AI.	2	2	4
	1.10	What is statistical parity, and how is it used to measure fairness in AI models?	2	2	5

PART-B

2	a	Analyze the strengths and weaknesses of generative and discriminative models in the context of real-world applications. Provide specific examples where each type of model would be more suitable and justify your reasoning.	8	3	2
	b	Explain the architecture of a Large Language Model (LLM) and discuss its functionalities.	8	2	1
3	a	Explain the architecture of an Autoencoder and its main components. How does the encoder network transform high-dimensional input data, such as an image, into a lower-dimensional embedding vector?	8	3	2
	b	Consider A Health Care application where a Variational Autoencoder(VAE) is used to generate synthetic data for simulating patient health records. In a healthcare system. Evaluate the use of a VAE in this simulation pipeline. Discuss the following aspects in your answer: i) The role and importance of the latent space in this application. ii) The impact of the parameterization trick on the training process.	8	3	3

OR

4	a	Critically evaluate the concept of morphing between faces using VAEs. What are the key steps, and what factors influence the smoothness of the transformation?	8	3	3
	b	Explain how latent space arithmetic works in VAEs and explain its practical applications using an example.	8	3	3
5	a	You are training a GAN to generate realistic images of human faces. However, during the training process, you encounter several challenges: • The generator collapses to producing a limited set of similar outputs (mode collapse). • The discriminator quickly becomes too strong, making it difficult for the generator to improve. • Training becomes unstable, and the loss functions for both the generator and discriminator oscillate or fail to converge. i) Identify any 2 challenges encountered during GAN training in this scenario. ii) Suggest one potential solutions or adjustments to address each of these challenges.	8	3	3
	b	Along with suitable diagram discuss Discriminator and Generator training process in detail.	8	3	3
		OR			
6	a	A gaming company is developing a new video game and needs to create realistic textures and 3D assets for characters, landscapes, and objects. The team is using a diffusion model to generate these assets. They have already experimented with traditional procedural generation techniques but found that the assets lack the realism and detail required for the game's visual quality. The company is particularly interested in using diffusion models for texture generation and scene synthesis, as they believe this could reduce manual effort and improve creative design iterations. The process they plan to follow includes: • Forward Diffusion Process:They add Gaussian noise to high-quality texture from an existing game database, systematically transforming them into random noise. • Reverse Diffusion Process:A neural network is trained to reverse the noise addition process, gradually generating realistic textures and 3D models from noisy data. • They aim to generate textures in high resolution while maintaining the variability and creative control that is needed for a large-scale game development project. i) InWhat ways do diffusion models provide an advantage over GANs in the context of game asset creation, specifically in terms of stability and output diversity? ii) Identify one potential real-world limitation of using diffusion models in the context of large-scale game development and suggest a solution to address it.	8	4	3
	b	Neural Style Transfer (NST) optimizes an image to combine the content of one image with the artistic style of another. However, balancing content preservation and style application is a challenge.			

		i) Explain the role of Content Loss, Style Loss, and Total Variance Loss in NST. ii) During training, the generated image sometimes exhibits excessive distortions or fails to capture the style properly. Analyze how modifying the loss weights or using alternative optimization techniques can improve NST results.	8	4	3
7	a	Given an Energy- Based Model(EBM) trained on the MNIST dataset consisting of gray scale images of hand-written digits,  i) Explain how Langevin Dynamics is used for sampling new digit images. ii) Illustrate the process with mathematical equations and discuss the impact of step size noise on sample quality.	8	3	3
	b	Explain Langevin dynamics in the context of energy-based models. How does it help in sampling from complex energy functions?	8	2	1
		OR			
8	a	How do diffusion schedules affect the performance and efficiency of denoising diffusion models? Explain the impact of different schedules on the generated data.	8	3	1
	b	A game development studio wants to use Denoising Diffusion Models(DDMs) to generate realistic textures for virtual environments. The team has access to a large dataset of natural texture but needs to understand how the forward diffusion process aids in the training and generation of new textures. i) Explain how the forward diffusion process in DDMs helps the model learn the data distribution of natural textures. Discuss its importance in the training phase. ii) During testing, the generated textures exhibit visible artifacts. Suggest how modifying the reverse diffusion process or loss function could mitigate these issues.	8	3	3
9		Generative AI models can inherit biases from various sources, including data, algorithms, and societal structures. a) Critically analyze the impact of algorithmic, data, and societal biases on generative AI outputs. b) Provide real-world examples where these biases have led to ethical concerns. c) Propose an approach to systematically evaluate and reduce bias in a generative AI system.	16	4	5
		OR			

10	Fairness in AI measured using different metrics such as Statistical parity, equal opportunity, and disparate impact. a) Compare these fairness metrics in terms of their applicability and limitations in generative AI models. b) Evaluate the effectiveness of pre-processing, in-processing, and post-processing mitigationstrategies in addressing bias. c) suggest an optimal bias mitigation strategy for agenerative AI model used in hiring decisions and justify your choice.	16	4	5