Birla Institute of Technology & Science, Pilani
Hyderabad Campus

SecondSemester 2023-2024
Course Handout Part II

Date: 09.01.2024

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No.: CS F437
Course Title: Generative Artificial Intelligence
Instructor-in-Charge: Prof.N.L.Bhanu Murthy

1. Scope and Objectives

This course is an introductory course on Generative Artificial Intelligence. The course commences withoverview on Generative vs Discriminative models and Bayesian network vs neural networks. The main emphasis of the course is on popular generative modes like Autoregressive models; Variational autoencoders; Normalizing flow models; Generative adversarial networks; Energy-based models. The course also focusses on learning data distribution and discrete Latent Variable models. The necessary evaluation metrics for generative will also be discussed. The course also exposes students to some applications of generative models to NLP, Computer Vision etc.

This course aims to achieve the following goals:

- To introduce students to the algorithmic aspects of generative models and enable them to understand the basic underlying mathematical concepts and methods.
- To introduce students to research and development work in generative models and conditional generative models for vision, NLP, Image translation, machine translation, etc.
- To enable students to build generative AI applications with the necessary implementation skills.

2. Pre requisites:

BITS F464: Machine Learning or CS F429: Natural Language Processing

3. Text Books

T1. Probabilistic Machine Learning, Advanced Topics - Kevin P. Murphy, The MIT Press, 2023

Reference Books:

R1: Deep Generative Modeling, Jakub M.Tomczak, Springer, 2021
R2: Deep Learning by Ian Goodfellow, YoshuaBengio and Aaron Courville
R3: T1: Pattern Recognition and Machine Learning – Christopher M. Bishop, Springer – 2013

4. Course Plan

Lecture No	Learning Objectives	Topics to be covered	Chapter in the Text Book
1	To introduce the course	Introduction to Generative Artificial Intelligence	T1: 20.1, 20.2 andClass Notes
2 - 4	To understand the significance and goals of	Generative vs Discriminative; Bayesian Network vs. Neural	T1: 20.3, Class Notes

	generative modeling	Network; Goals of generative modelling	
5 – 10	To understand Variational autoencoders	Introduction to variational autoencoders (VAE), the model and objective, ELBO, components of VAE, reparameterization trick	T1: 21.1, 21,2, 21,3, Class Notes
11 – 16	To understand autoregressive models	Autoregressive Models, Neural Autoregressive Density estimation (NADE)	T1: 22, Class Notes
17 -18	To learn metrics to evaluate generative models	Evaluating generative models	T1: 20.4, Class Notes
19 - 24	To understand Generative Adversarial Networks	Likelihood-free learning, Discriminator, GAN, J-S Divergence, beyond JS and KL divergence	T1:26, Class Notes
25 – 29	To learn normalizing flow models	Normalizing flow models, Change in variables,Jacobian Determinant, Designing invertible transformations	T1: 23, Class Notes
30 - 34	To understand energy-based models and focus on their application as generative models	Parameterizing probability distributions, energy-based model, restricted Boltzmann machine, Deep Boltzmann Machines	T1:24, Class Notes
35 - 38	To learn diffusion generative models	Denoising diffusion probabilistic models, Encoder (forwards diffusion), Decoder (reverse diffusion), Model fitting	T1:25, Class Notes
39 - 40	To have an exposure to topics like learning data distribution and discrete Latent Variable models	Learning data distribution and discrete Latent Variable models	Class Notes

5. Evaluation Scheme

Component	Duration	Weightage	Date&Time	Nature of Component
Mid Semester Test	90 mins	**35%**	11/03 - 4.00 - 5.30PM	Closed
Assignments	-	**25%**	TBA	Open
Comprehensive	3 hours	**40%**	07/05 AN	Closed

Note: At least 40% of the evaluation components for Mid-semester grading.

6. CHAMBER CONSULTATION HOUR: Tuesday 5PM – 6PM

7. Make-up: Make-up will be granted only to genuine cases with prior permission only. No makeup for class participation and assignment.

8. NOTICES: All notices will be put up in CMS and students are strongly advised to log in to CMS and look for notices quite often.

9. Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Instructor-in-charge
CS F437