2026 Workshop on Deep Diffusion Models (National Taiwan University)

Aims:

This short workshop provides a practical introduction to the theory and application of deep diffusion models. Essential mathematical concepts are included and explained in a self-contained manner. We emphasize developing an intuitive understanding of both foundational and modern concepts, enabling participants to engage effectively with current literature in the field.

Prerequisite:

1. Basic probability theory and Bayesian methods
2. Basic understanding of Markov processes and diffusion (Langevin) dynamics
3. Deep learning: Feedforward networks, CNN, regression and classification, various regularization and optimization methods, validation methods, programming experience in R or python for DL applications

Meeting Place and Date:

Date: Mar 30 (Mon) - Apr 3 (Fri)
Morning sessions: 9:30am-noon
Afternoon sessions: 1:30pm-4:pm
Location: TBA

Meeting Plan (Tentative):

Mon (3/30)

Morning: Advanced concepts in Deep Learning: U-Net, attention mechanism, positional encoding, etc.
Afternoon: Continue on advanced concepts in deep learning

Tue (3/31)

Morning: Variational autoencoders and Deep Diffusion Probabilistic Models (DDPM)
Afternoon: Continue on DDPM, score matching and Langevin MCMC, small projects

Wed (4/1)

Morning: Continue on score matching and Langevin MCMC
Afternoon: Relations between different types of diffusion models, validation methods

Thu (4/2)

Morning: Classifier guidance and classifier-free guidelines
Afternoon: Continue on guidelines, latent diffusion models and diffusion transformers

Fri (4/3)

Morning: Continue on latent diffusion models and diffusion transformers, flow-based diffusion models (if time permits)
Afternoon: Discussion of project

References (Tentative)

Deep Learning
1. *Dive into Deep Learning* (2023)
2. *Goodfellow et al. (2016) Deep Learning*
   DDPM
3. *Sohl-Dickstein et al., (2015) Deep unsupervised learning using nonequilibrium thermodynamics (where the DDPM idea is from. No need to read)*
4. *Ho et al., (2020) Denoising Diffusion Probabilistic Models*
5. *Higham et al., (2023) Diffusion Models for Generative Artificial Intelligence: An Introduction for Applied Mathematicians*
6. *Nichol et al., (2021) Improved Denoising Diffusion Probabilistic Models*
   Score matching diffusion models
7. *Song et al., (2019) Generative modeling by estimating gradients of the data distribution*
8. *Song et al., (2020) Improved techniques for training score-based generative models*
9. *Song el al., (2023) Consistency Models*
   Score stochastic differential equations
10. *Song et al., (2021) Score-based generative modeling through stochastic differential equations*
    Guidance
11. *Dhariwal et al., (2021) Diffusion models beat GANs on image synthesis* (classifier guidance)
12. *Ho et al., (2022) Classifier-free diffusion guidance*
13. *Bansal et al., (2023) Universal guidance for diffusion models*
    Explanations and Interpretations
14. *Kong et al., (2024) Interpretable diffusion via information decomposition*
15. *Loaiza-Ganem et al., (2024) Deep generative models through the lens of the manifold hypothesis: A survey and new connections*
16. *Biroli et al., (2024) Dynamical regimes of diffusion models*
17. *Jeanneret et al., (2022) Diffusion models for counterfactual analysis*

18. *[Kamb et al., (2024) An analytic theory of creativity in convolutional diffusion models](#)*
19. *[Ross et al., (2025) A geometric framework for understanding memorization in generative models](#)*

Latent diffusion models and applications (used in Stable Diffusion, DALL E)

20. *[Rombach et al., (2022) High-resolution image synthesis with latent diffusion models](#)*

Diffusion transformers (DiT) (used in OpenAI's Sora)

21. *[Peebles et al., (2023) Scalable diffusion models with transformers](#)*

Diffusion models on graphs and geometric diffusion models

22. *[Liu et al., (2023) Generative diffusion models on graphs: Methods and applications](#)*
23. *[LoG conference online tutorial: (2024) Geometric generative models tutorial](#)*
24. *[Xu et al., (2022) GEODIFF: A geometric diffusion model for molecular conformation generation](#)*

Flow matching and applications

25. *[Machine learning group, Cambridge, An introduction to flow matching](#)*
26. *[Lipman et al., (2024) Flow matching guide and code](#)*
27. *[Jing et al., (2024) AlphaFold meets flow matching for generating protein ensembles](#)*