**Project ideas for CS772 (2024-2025-II semester)**

Most of the project ideas listed below are based on recently published research papers in the area of probabilistic ML (and many of them also involve deep learning models, so working on them would require some familiarity about deep learning which I hope you have from courses like CS771 or other deep learning courses you may have taken here at IITK or from other online sources).

If you decide to work on a research based project, a “seed” paper on a topic will need to be chosen by each group (some seed paper suggestions are provided below for various topics). The group will be expected to gain a thorough understanding of the seed paper(s) (methodology, experimental analysis, strengths and weaknesses, etc) and also research other related work (both before and after the publication of this paper - Google Scholar can be helpful for this), and propose a new method to solve the problem that the paper is about in a better way (e.g., computationally more efficient or more accurate). That being said, we understand that in (less than) a semester’s time, and because this may probably be your very first exposure to such topics (and because the project may require you to learn some more advanced concepts that might not be covered in the course), achieving all the goals may not be possible. So it’s still okay if you can’t come up with a great improvement to the idea(s) proposed in the paper you chose for the project, but that your group has demonstrated a solid understanding of the paper, and has made sincere efforts towards the stated goals.

Please form your groups and pick the project to work on by Feb 15, and submit a 2 page document with information about group members (it should have 4-5 members) and some basic details about the project you are going to work on (the specific paper(s) you have chosen as seed paper(s), and some plan about what you will be trying to accomplish in this project). The proposal should be submitted on this URL (only one member from a group should submit): <https://www.dropbox.com/request/iVvDiwhqTUfvItya3UGg>

Some seed papers are listed below:

[Streamlining Bayesian Deep Learning](https://openreview.net/pdf?id=pW387D5OUN) (2025): Can we compute PPD without relying on Monte-Carlo averaging when our likelihood model is complex (e.g., based on a deep neural network)?

[Decoding based regression](https://arxiv.org/pdf/2501.19383v1) (2025): Can we use LLMs to learn p(y|x) where x and y are numerical quantities instead of text?

[LLM Processes: Numerical Predictive Distributions Conditioned on Natural Language](https://arxiv.org/pdf/2405.12856) (2024): Can we condition p(y|x) of the problem description's text by taking an LLM based approach?

[In-Context Learning for Full Bayesian Inference](https://openreview.net/pdf?id=a79bwlyUNp) (2025): Can we compute posterior distribution using LLM ideas such as in-context learning (ICL)

[AutoElicit: Using Large Language Models for Expert Prior Elicitation in Predictive Modelling](https://arxiv.org/pdf/2411.17284) (2024): Can we extract the "right" prior distribution using an LLM?

[Kernel Language Entropy: Fine-grained Uncertainty Quantification for LLMs from Semantic Similarities](https://arxiv.org/pdf/2405.20003) (2025): How to estimate the uncertainty in the LLM generated output

[Dream the Impossible: Outlier Imagination with Diffusion Models](https://proceedings.neurips.cc/paper_files/paper/2023/file/bf5311df07f3efce97471921e6d2f159-Paper-Conference.pdf) (2023): Outlier detection methods need access to some outlier examples during training. We often do not have such examples. Can we learn to generate them?

[Shaving Weights with Occam’s Razor: Bayesian Sparsification for Neural Networks using the Marginal Likelihood](https://arxiv.org/pdf/2402.15978) (2024): How can we train a deep neural network so that lots of weights are zero (i.e., sparse weights)? This leads to computational speed-ups and memory savings at inference time in deep neural nets

[Post-hoc Probabilistic Vision-Language Models](https://arxiv.org/pdf/2412.06014) (2024): Efficient post-hoc uncertainty estimation approach for large-scale vision-language models (VLMs)

[Riemannian Laplace approximations for Bayesian neural networks](https://proceedings.neurips.cc/paper_files/paper/2023/file/631f99d8e860054410c239fc90d18270-Paper-Conference.pdf) (2023)

[Effective Bayesian Heteroscedastic Regression with Deep Neural Networks](https://openreview.net/pdf?id=A6EquH0enk) (2023).

[Function-Space Regularization in Neural Networks: A Probabilistic Perspective](https://proceedings.mlr.press/v202/rudner23a/rudner23a.pdf) (2023)

[Should We Learn Most Likely Functions or Parameters?](https://arxiv.org/pdf/2311.15990.pdf) (2023)

[Do Bayesian Neural Networks Need To Be Fully Stochastic?](https://proceedings.mlr.press/v206/sharma23a/sharma23a.pdf) (2023)

[Improving Neural Additive Models with Bayesian Principles](https://arxiv.org/pdf/2305.16905.pdf) (2023)

[Prioritized Training on Points that are learnable, Worth Learning, and Not Yet Learnt](https://proceedings.mlr.press/v162/mindermann22a/mindermann22a.pdf) (2022).

[Make Me a BNN: A Simple Strategy for Estimating Bayesian Uncertainty from Pre-trained Models](https://openaccess.thecvf.com/content/CVPR2024/papers/Franchi_Make_Me_a_BNN_A_Simple_Strategy_for_Estimating_Bayesian_CVPR_2024_paper.pdf) (2024)

[Efficient Detection of LLM-generated Texts with a Bayesian Surrogate Model](https://aclanthology.org/2024.findings-acl.366.pdf) (2024)

[Probabilistic weather forecasting with machine learning](https://www.nature.com/articles/s41586-024-08252-9) (2024)