Replace with your title

Yao-Liang Yu
School of Computer Science
University of Waterloo
Waterloo, ON, N2L 3G1
yaoliang.yu@uwaterloo.ca
report due: April 15.

Abstract

Put here a brief summary of the project: what is it about and what are the main results. Consider put a link to your code for reproducibility (if applicable). Be concise and to the point.

1 Introduction

In this section you are going to present a brief background and motivation of your project. Why is it interesting/significant? Consider summarizing the entire paper in one overarching figure, such as Figure 1.

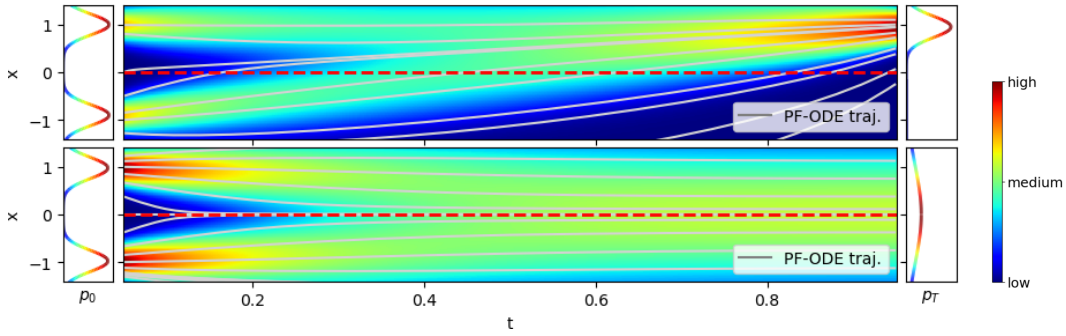

Figure 1: The evolution of p_t driven by diffusion processes where the data distribution p_0 is invariant under flipping with respect to the origin. We also plot the PF-ODE trajectories to visualize the transition direction of $p_t(x)$. The upper plot has $f(x,t) = \frac{1-x}{1-t}$ and $g(t) = 1$. The lower is VP-SDE with $\alpha_t = 1 - t$. For both processes, $T = 0.95$.

2 Related Works

Perform a reasonably thorough review of relevant literature. Has your problem, or one of similar nature, been considered before? By whom? What are the differences or limitations (if any)?

Submitted to CS886, 2024 Winter. Do not distribute.

Table 1: Model Comparison on 28x28x1 Rotated MNIST (Group C4). * indicates author-reported values.

Model	FID↓				Inv-FID↓	$\Delta\hat{x}_0 \downarrow$
	1%	5%	10%	100%	100%	100%
SPDiff	5.97	**3.05**	3.47	2.81	2.21	0.2997
SPDiff+WT	5.80	3.34	3.57	3.50	2.20	0.0004
SPDiff+OC	6.10	3.09	3.45	2.82	2.12	0.0002
SPDiff+Reg	**5.42**	3.69	**2.83**	2.75	2.09	0.1806
SPDiff+Reg+OC	5.64	3.67	2.86	**2.64**	**2.07**	0.0002
SP-GAN	149*	99*	88*	81*	–	–
SP-GAN (Reprod.)	16.59	11.28	9.02	10.95	19.92	–

3 Main Results

In the following, describe the background of your project, formulate your problem precisely (mathematically), and present the main findings (often backed up by experiments, proofs, figures and tables). If need be, consider having a separate background section, experiment section or discussion section.

Please always give proper citations to prior work or results. Be precise and concise. Pay some attention to the organization and layout of the entire paper: the smoother it reads and the more visually appealing and neat it is, the better (sounds superficial but remember: we are selling our work to very busy and impatient peers). Add variety (table, curves, bar graph, scatter plot, violin plot, pseudocode, etc.) and report statistical deviation (over at least 3∼5 runs).

I expect the report to be less than ($\leq$) **8 pages** (references excluded).

Algorithm 1: Stochastic variance reduced proximal gradient

Input: $\mathbf{w}_0 \in \operatorname{dom} f$

for $k = 0, 1, 2, \ldots$ **do**

  $\mathbf{g}_k \leftarrow \frac{1}{n}\sum_{i=1}^{n} \nabla \ell_i(\mathbf{w}_k)$ `// compute full gradient at epoch` k

  $\mathbf{w}_{k,0} \leftarrow \mathbf{w}_k$

  for $t = 0, \ldots, m-1$ **do**

    randomly draw $i_t = i$ with probability p_i

    $\mathbf{g}_{k,t} \leftarrow \mathbf{g}_k - \frac{1}{np_{i_t}}\nabla \ell_{i_t}(\mathbf{w}_k) + \frac{1}{np_{i_t}}\nabla \ell_{i_t}(\mathbf{w}_{k,t})$ `// amortized gradient`

    $\mathbf{w}_{k,t+1} \leftarrow \mathrm{P}_r^{\eta_k}(\mathbf{w}_{k,t} - \eta_k \mathbf{g}_{k,t})$ `// stochastic proximal gradient`

  $\mathbf{w}_{k+1} \leftarrow \frac{1}{m}\sum_{t=1}^{m} \mathbf{w}_{k,t}$ `// in practice, can also do` $\mathbf{w}_{k+1} \leftarrow \mathbf{w}_{k,m}$

4 Conclusion

What have we learned? What limitations or directions do you think are worth exploring in the future?

Acknowledgement

Thank people who have helped or influenced you in this project. Figure 1 and Table 1 are from Lu et al. (2024).

References

Karras, T., M. Aittala, T. Aila, and S. Laine (2022). "Elucidating the Design Space of Diffusion-Based Generative Models". In: *Advances in Neural Information Processing Systems 35 (NeurIPS)*.

Lu, H., S. Szabados, and Y. Yu (2024). "Structure Preserving Diffusion Models".

Villani, C. (2003). "Topics in Optimal Transportation". American Mathematical Society.

Vincent, P. (2011). "A Connection Between Score Matching and Denoising Autoencoders". *Neural Computation*, vol. 23, no. 7, pp. 1661–1674.

Below are some suggested structures for the report. You do not have to follow any of them. Do what you think is best to summarize your project.

Option A (Literature survey)

- Introduction
  - What is the problem?
  - Why is it an important problem?
- Survey
  - Summarize the range of techniques by highlighting their strengths and weaknesses (i.e., the 6-10 papers that you read)
  - Tip: this summary should not be a laundry list of techniques with an independent paragraph for each technique
  - Suggestion: organize your summary based on desirable properties of the techniques
- Analysis
  - What is the state of the art?
  - Any open problem?
- Conlusion
  - What have you learned?
  - What future research do you recommend?

Option B (Empirical evaluation)

- Introduction
  - What is the problem?
  - Why is it an important problem?
- Techniques to tackle the problem
  - Brief review of previous work concerning this problem (i.e., the 3-6 papers that you read)
  - Brief description of the techniques chosen and why
- Empirical evaluation
  - Describe the datasets you tested on; justify their relevance
  - Compare empirically the techniques for complexity, performance, ease of use, etc.
- Conclusion
  - What is the best technique, in terms of what?
  - Is any technique good enough to declare the problem solved?
  - What future research do you recommend?

Option C (Algorithm design)

- Introduction
  - What is the problem?
  - Why can't any of the existing techniques effectively tackle this problem?
  - What is the intuition behind the technique that you have developed?
- Techniques to tackle the problem
  - Brief review of previous work concerning this problem (i.e., the 3-6 papers that you read)
  - Describe the technique that you developed
  - Brief description of the existing techniques that you will compare to
- Evaluation
  - Describe the datasets you tested on; justify their relevance

  - Analyze and compare (empirically or theoretically) your new approach to existing approaches
- Conclusion
  - Can your new technique effectively tackle the problem?
  - What future research do you recommend?

Option D (Theoretical analysis)

- Introduction
  - What is the problem or technique?
  - What properties did you analyze/prove about this problem or technique?
- Analysis
  - Brief survey of previous work concerning this problem (i.e., the 3-6 papers that you read)
  - Describe the analysis performed
- Conclusion:
  - What have you discovered about the technique analyzed?
  - What future research do you recommend?