

Scalable Gaussian Process Variational Autoencoders

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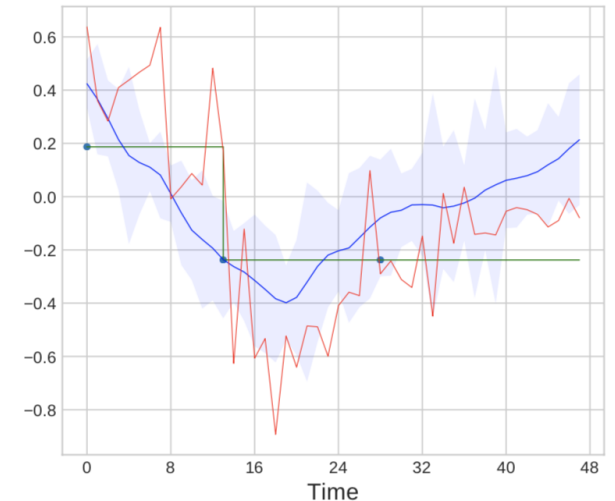


Gaussian Process Variational Autoencoders (GP-VAE)

😊 Bayesian properties of GPs + representational powers of VAEs

😊 GP-VAEs shown to perform well on various tasks:

- Conditional generation
- Time series imputation
- Learning interpretable embeddings



☹️ Need to get around cubic complexity of GP inference.

[Gaussian process prior variational autoencoders. F. P. Casale, A. Dalca, L. Saglietti, J. Listgarten, and N. Fusi. NeurIPS 2018]

[Gp-vae: Deep probabilistic time series imputation. V. Fortuin, D. Baranchuk, G. Rätsch, and S. Mandt. AISTATS 2020]

[The gaussian process prior vae for interpretable latent dynamics from pixels. M. Pearce. AABI 2020]

Scalable GP-VAEs

- Sparse GPs: variational learning of inducing points (Titsias 2009, Hensman et al. 2013)



Reduce GP complexity



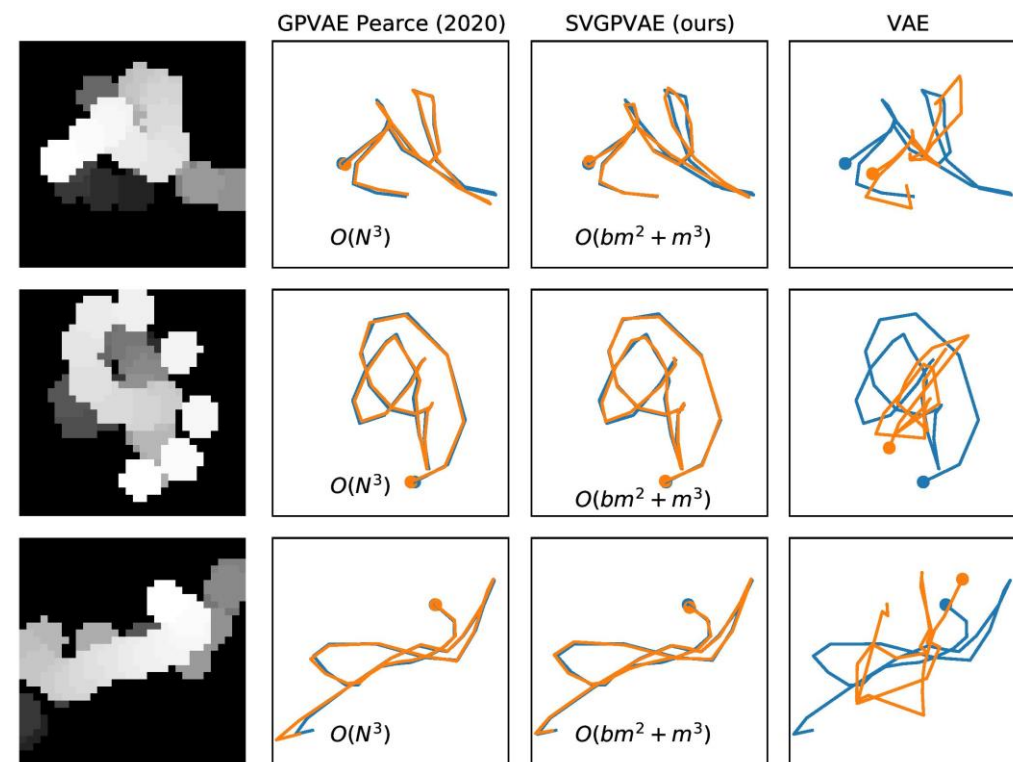
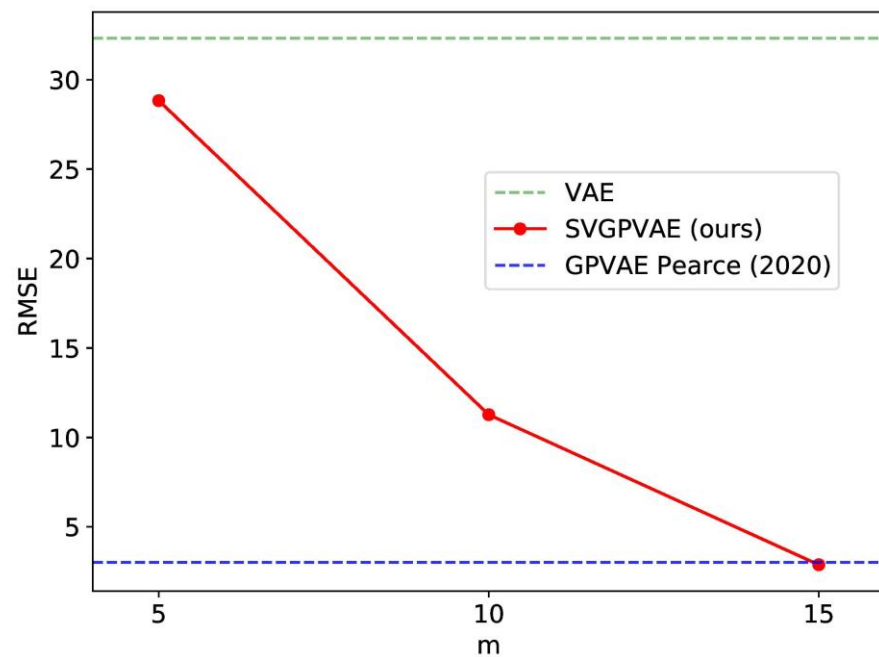
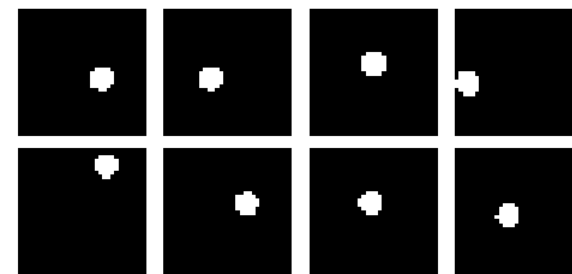
Can not be used off-the-shelf in GP-VAE inference

- Hybrid sparse GP: simultaneous support for amortization and mini-batching

[Variational learning of inducing variables in sparse gaussian processes. M. Titsias. AISTATS 2009]

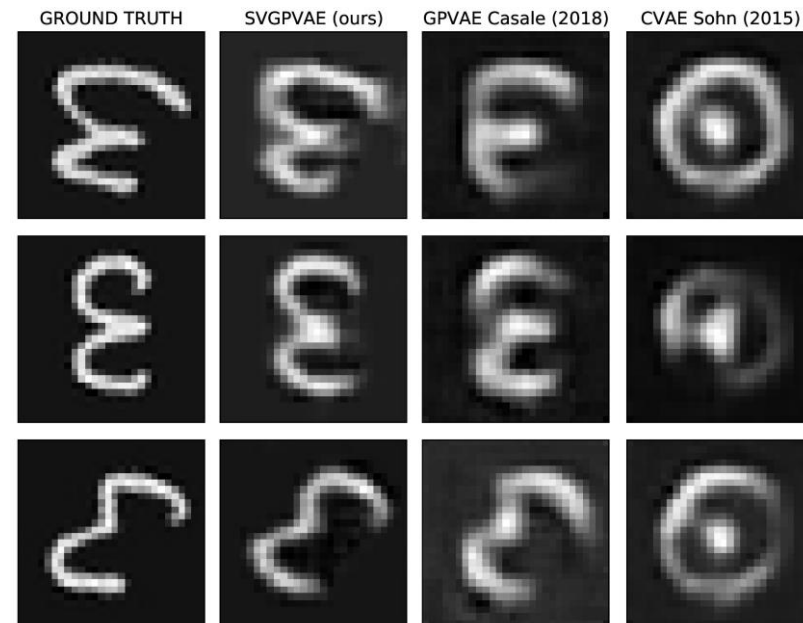
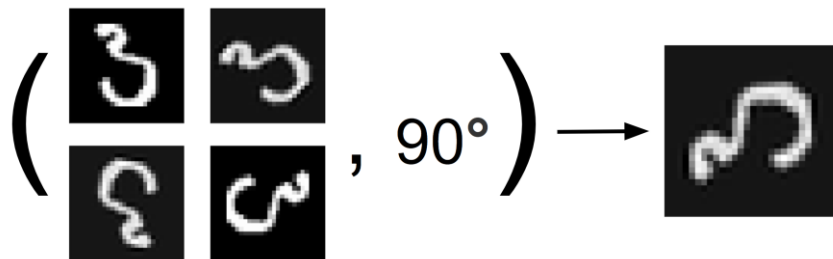
[Gaussian processes for big data. J. Hensman, N. Fusi, and N. D. Lawrence. UAI 2013]

Experiments: Moving Ball



Experiments: Rotated MNIST

- Conditional generation:



	MSE	GP complexity	Time/epoch [s]
CVAE (Sohn et al., 2015)	0.0796 ± 0.0023	-	0.39 ± 0.01
GPPVAE (Casale et al., 2018)	0.0370 ± 0.0012	$\mathcal{O}(NH^2)$	19.10 ± 0.66
SVGP-VAE (ours)	0.0251 ± 0.0005	$\mathcal{O}(bm^2 + m^3)$	1.90 ± 0.02
Deep SVIGP (Hensman et al., 2013)	0.0233 ± 0.0014	$\mathcal{O}(bm^2 + m^3)$	1.15 ± 0.04

Conclusions

- Bridge the gap between sparse GP and GP-VAE literature
- Scalable GP-VAE that is agnostic to the structure of the GP kernel
- Easy to train, all model components can be trained jointly end-to-end

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Thanks for your attention!

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