MedAGI

Generalizing Across Domains in Diabetic Retinopathy via Variational Autoencoders

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لـــلـــذكـــاء الاصـــطـــنـــاعـــي
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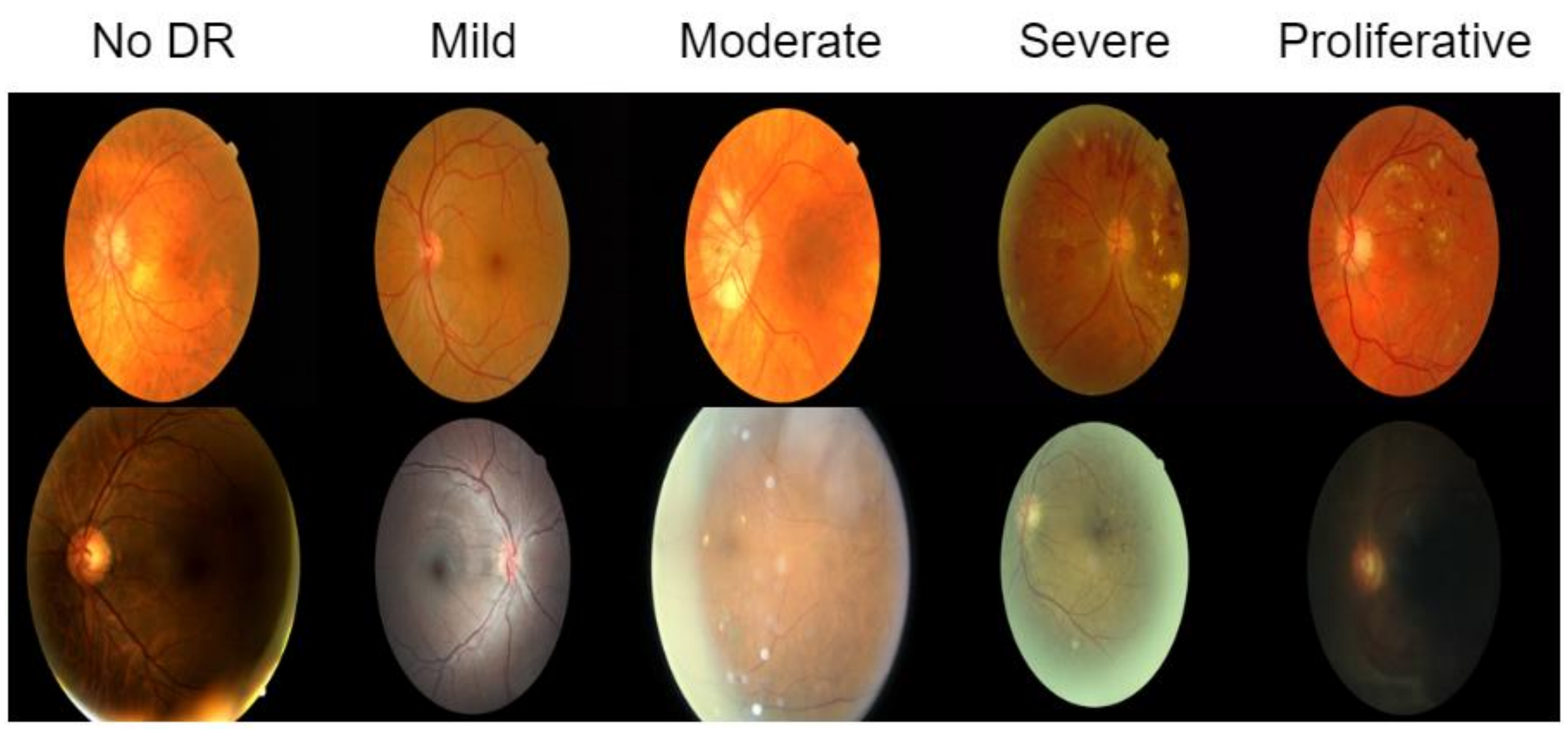
MOTIVATION

- Diabetes Mellitus is projected to reach approximately 700 million by 2045, thus Diabetic Retinopathy (DR) will remain a common place.
- Existing literature to tackle Domain Generalization (DG) for DR is limited.
- We exploit the disentangled latent representation of the fundus images which separates the domain specific and domain-invariant features.

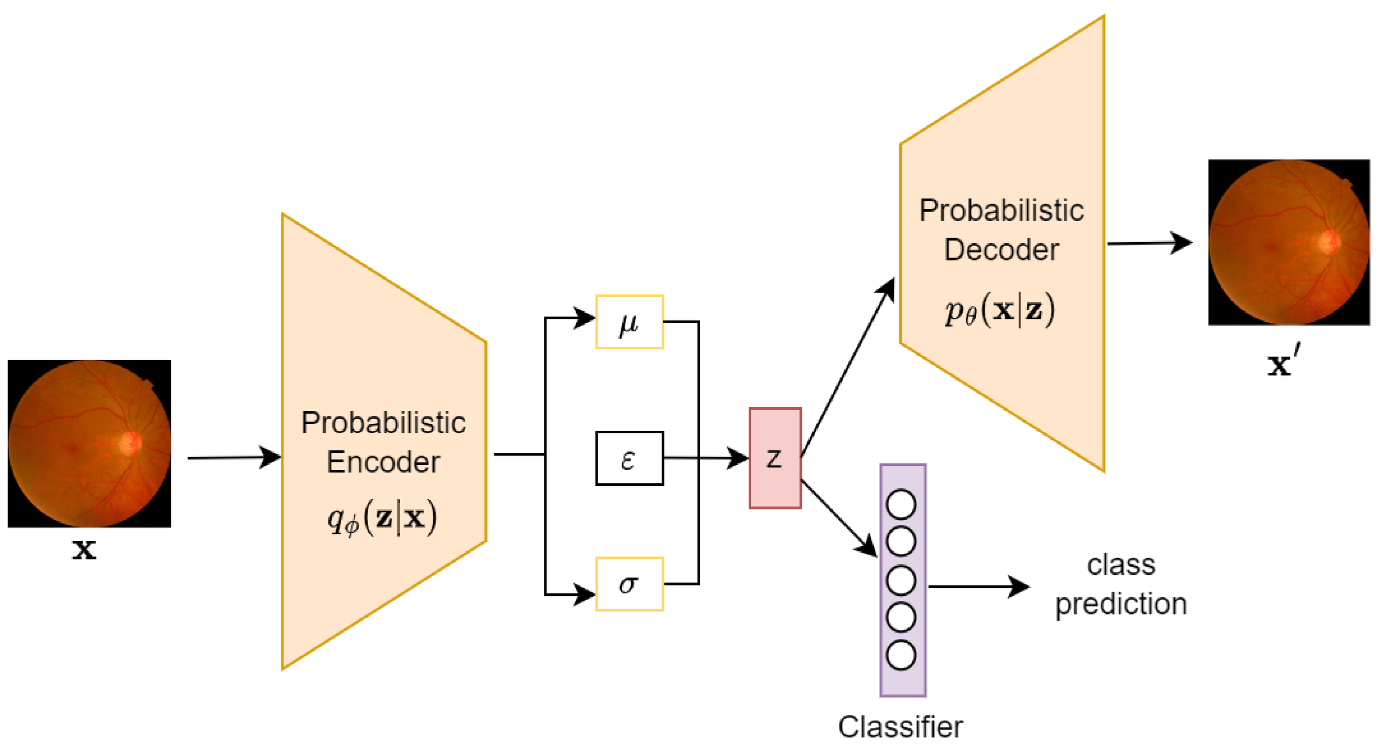


CONTRIBUTIONS

- We inspire researchers to explore a wider spectrum of techniques especially simple methods and we show that naive methods can outperform sophisticated DG methods.
- First to use Variational Autoencoders (VAE) for DG in DR.
- We rectify the existing work's limitation for future studies' fair comparisons with our method.

METHOD

- We hypothesize that an optimally disentangled latent space obtained via VAE contains domain-shared features which boosts DG to unseen target domains.



$$\mathcal{L} = -\mathbb{E}_{q_\phi(z|x)}\left[\log p_\theta(x|z)\right] + \beta D_{\mathrm{KL}}\left(q_\phi(z|x)||p(z)\right) - \alpha \sum_{i=1}^{n} \ell(f(x_i), y_i)$$

EXPERIMENTS AND RESULTS

Method	Aptos	EyePACS	Messidor	Messidor-2	Avg.
ERM	63.75 ± 5.5	70.22 ± 1.6	$\mathbf{66.11} \pm 0.8$	67.38 ± 1.0	66.86 ± 2.2
DRGen	57.06 ± 0.9	72.52 ± 1.3	61.25 ± 4.2	49.16 ± 16.3	60.00 ± 5.7
Fishr	62.89 ± 5.0	71.92 ± 1.3	65.69 ± 1.1	63.54 ± 3.8	66.01 ± 2.8
VAE-DG	$\mathbf{66.14} \pm 1.1$	$\mathbf{72.74} \pm 1.0$	65.90 ± 0.7	$\mathbf{67.67} \pm 2.0$	$\mathbf{68.11 \pm 1.2}$
Oracle Results					
VAE-DG	68.54 ± 2.5	74.30 ± 0.2	66.39 ± 1.3	70.27 ± 1.2	69.87 ± 1.3

ABLATION STUDIES

	APTOS	EyePACS	Messidor	Messidor-2	Avg.	Diff.
Extended Analysis						
VAE-DG ResNet-152	61.45±8.2	71.44±3.1	65.94±1.0	67.81±2.6	66.66±3.7	1.45(↓)
VAE-DG + SWAD	55.66±8.8	73.52±0.0	34.24±12.2	16.48±12.0	44.97±8.3	23.14(↓)
ERM + SWAD	54.93±0.6	71.35±0.5	64.76±0.7	58.48±3.1	62.38±1.2	4.5(↓)
Ablations Studies						
Latent-dim 64	62.15±3.1	73.80±0.4	66.42±2.1	68.98±3.0	67.84±2.2	0.27(↓)
Latent-dim 128	62.61±3.5	73.64±0.6	66.60±1.9	66.09±2.2	67.23±2.0	0.88(↓)
Fixed latent space	63.87±0.6	73.44±0.8	66.46±0.6	69.39±0.8	68.29±0.7	0.18(↑)
β, α = 10,000	64.38±1.8	73.17±0.5	65.42±0.4	69.27±4.0	68.06±1.7	0.05(↓)
β, α = 100,000	62.50±3.5	72.30±1.6	66.56±1.3	67.88±1.0	67.31±1.8	0.80(↓)
No Recon Loss	63.44±3.9	70.62±0.8	66.25±0.8	65.21±1.4	66.38±1.7	1.73(↓)
No KL Divergence	68.29±2.3	69.98±4.3	66.60±1.1	66.93±1.6	67.95±2.3	0.17(↓)

CONCLUSION

- We demonstrate that this simple approach provides effective results and outperforms contemporary state-of-the-art methods.
- Our study encourages the medical imaging community to consider simpler methods in order to realize robust models.

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