

Towards Diffeomorphism-Equivariant Neural Networks via Canonicalization (DiffeoNN)

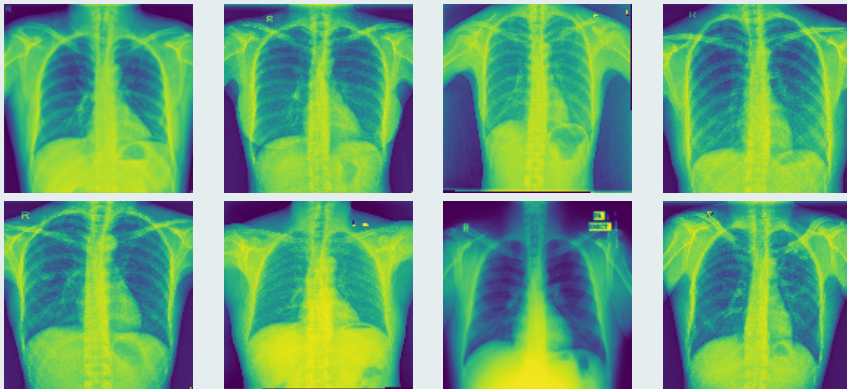


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¹Institute of Mathematics and Image Computing, University of Luebeck and ²Department of Applied Mathematics and Theoretical Physics, University of Cambridge

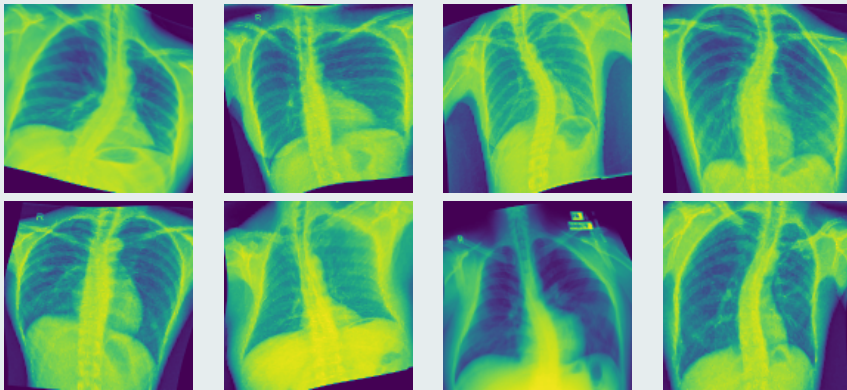
<https://github.com/mic-uzl/DiffeoNN>

Standard CNNs are typically trained on well-aligned data...

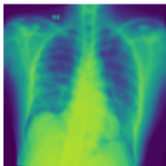


data: [Karmakar, 2024]

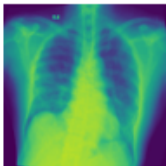
But, data naturally varies...



Input



Input

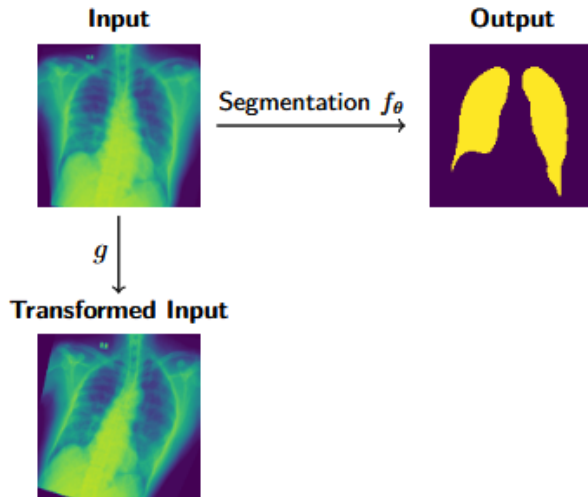


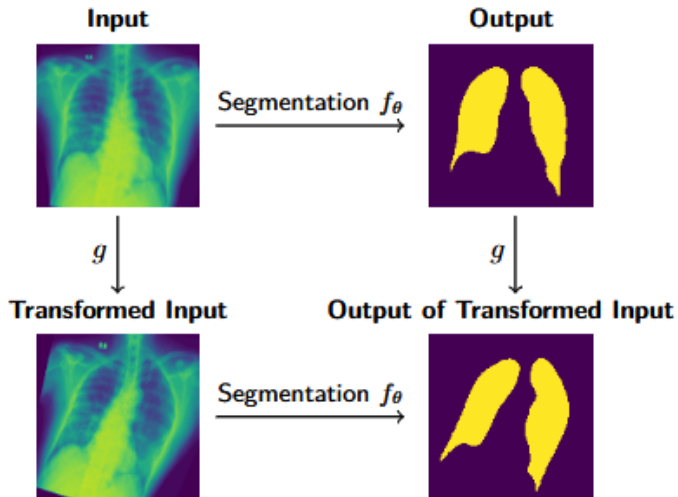
Segmentation f_θ



Output

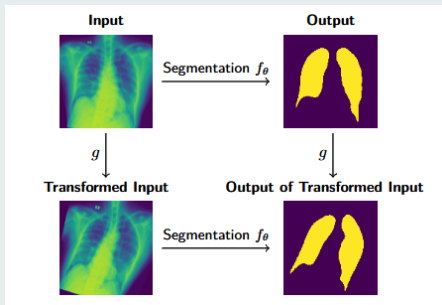






Equivariance

G-Equivariant

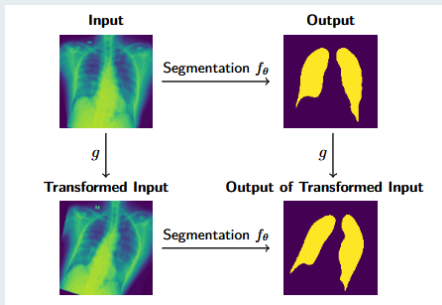


$$\tilde{f}_\theta(g \cdot x) = g \cdot \tilde{f}_\theta(x)$$

data: [RSUA, 2023]

Equivariance

G-Equivariant



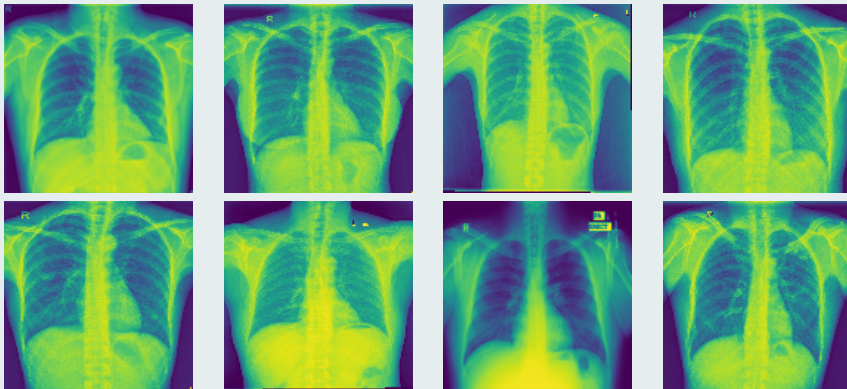
$$\tilde{f}_\theta(g \cdot x) = g \cdot \tilde{f}_\theta(x)$$

Approaches

- Data augmentation [Shorten & Khoshgoftaar, 2019]
- Group-equivariant layers [Cohen & Welling, 2016]
- Averaging-based methods: group averaging [Murphy et al., 2019], frame averaging [Puny et al., 2022]
- **Canonicalization** [Kaba et al., 2023] [Shumaylov et al., 2024]

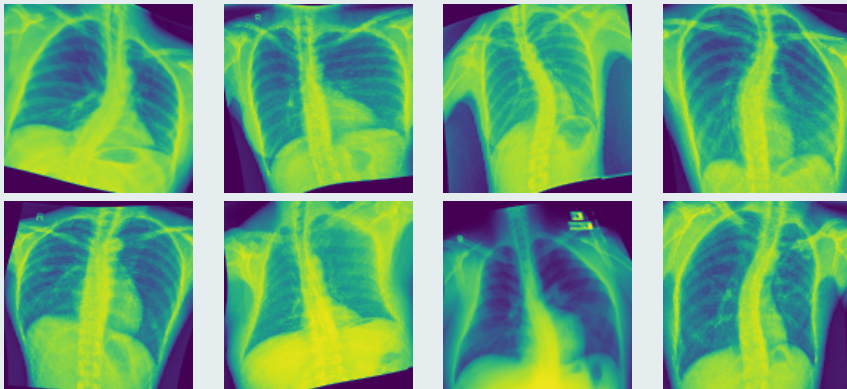
data: [RSUA, 2023]

Training Data X_E

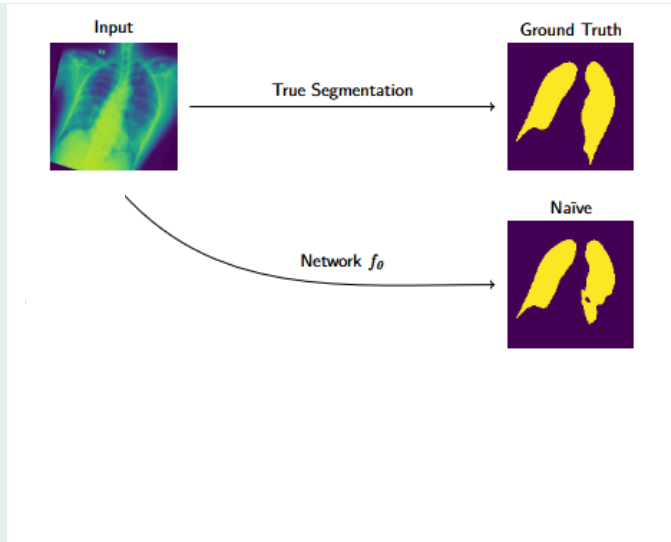


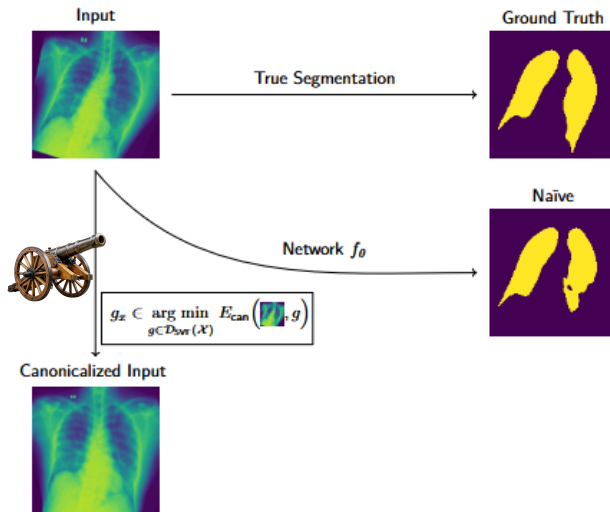
data: [Karmakar, 2024]

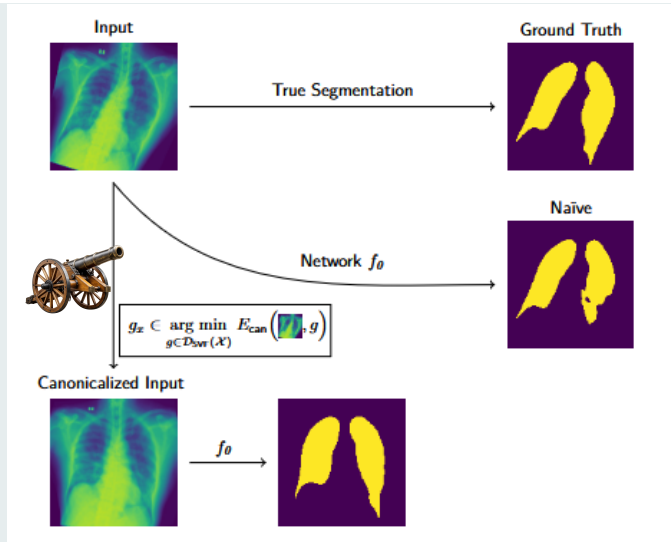
Input Images (Diffeomorphic Transformations of X_E)

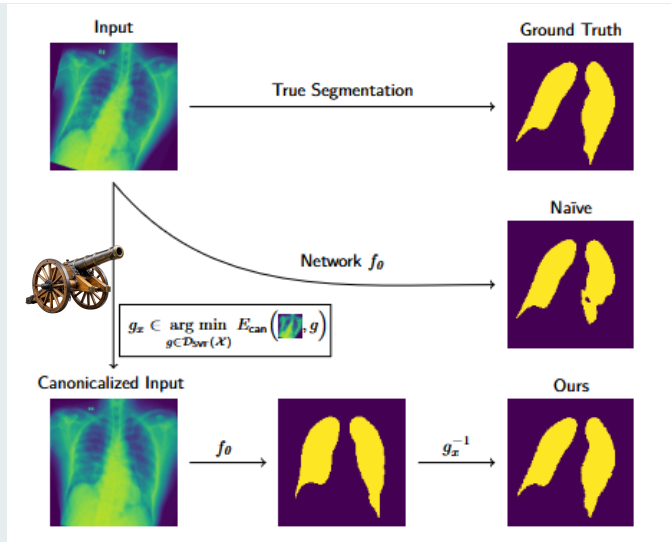






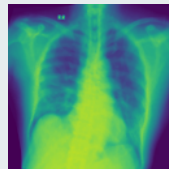
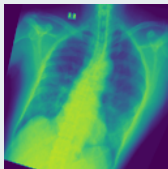






Diffeomorphism-Equivariant Neural Networks (DiffeoNN)

- turn any network
diffeomorphism-equivariant
- no data augmentation or
retraining necessary (only training
on original training dataset X_E)



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