Window Level is a Strong Denoising Surrogate

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Overview

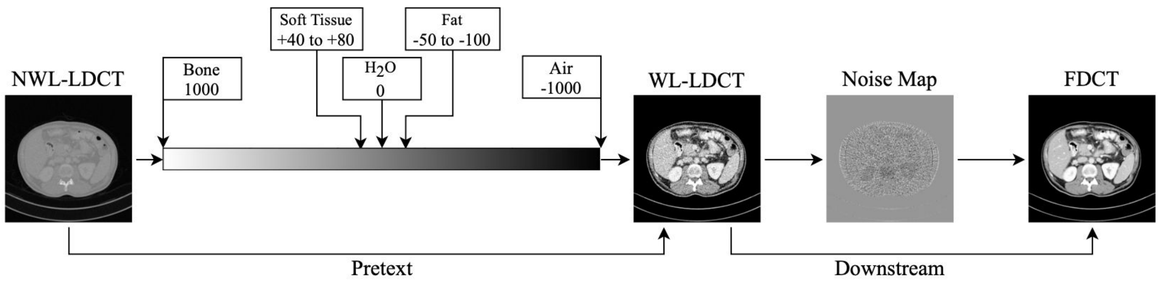
Problem

- Tradeoff between noise and radiation dose for CT warrants deep learning approaches
- Self-supervised learning and VAEs can improve denoising performance

SSWL-IDN (Self-Supervised Window Leveling Image DeNoising)

- Novel, task-relevant SSL surrogate of window-level prediction for denoising
- Code: https://github.com/ayaanzhaque/SSWL-IDN

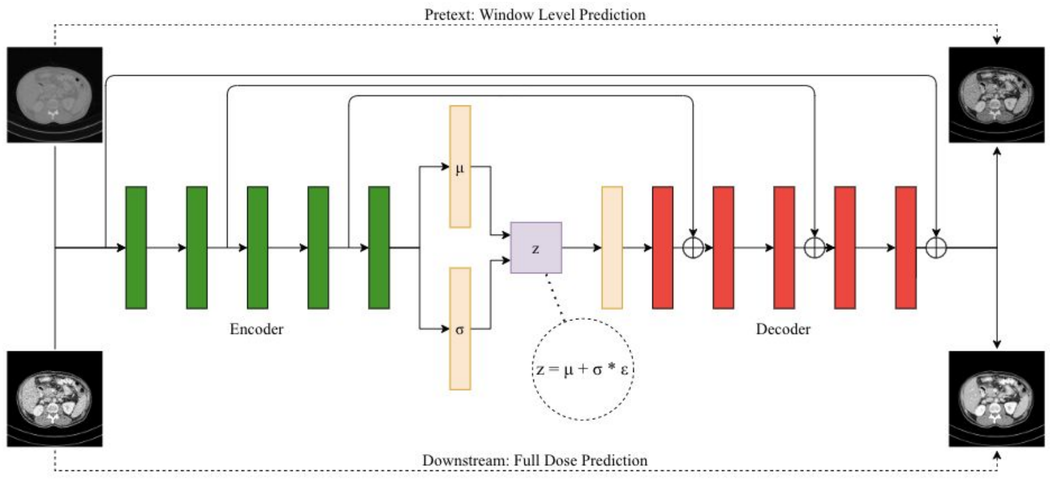
SSWL-IDN



Relationship between window-leveling and CT denoising

Denoising:

- We map non-window-leveled images to window-leveled images as a surrogate task
- Similarity in transformations results in a task-relevant surrogate



Schematic of our SSWL-IDN model

Training:

- Residual VAE: RED-CNN [1] + VAEs, improves generalization, reduces overfitting
- Hybrid loss function between MSE and Perceptual Loss

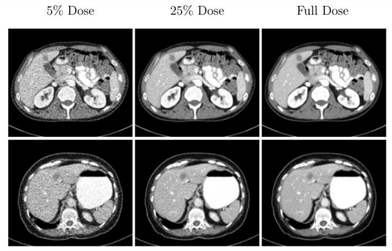
Dataset

Details

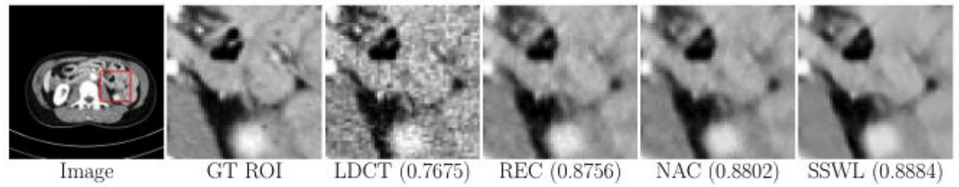
- Mayo CT dataset, abdomen and chest

Dose

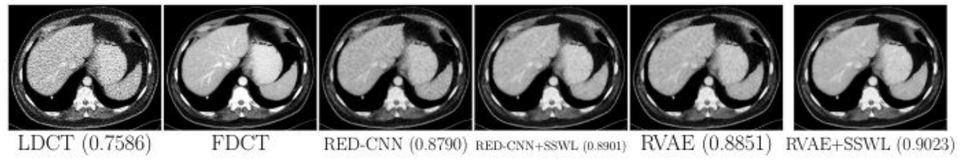
- Trained and evaluated at 5% ultra low dose for thorough denoising evaluation



Qualitative Results

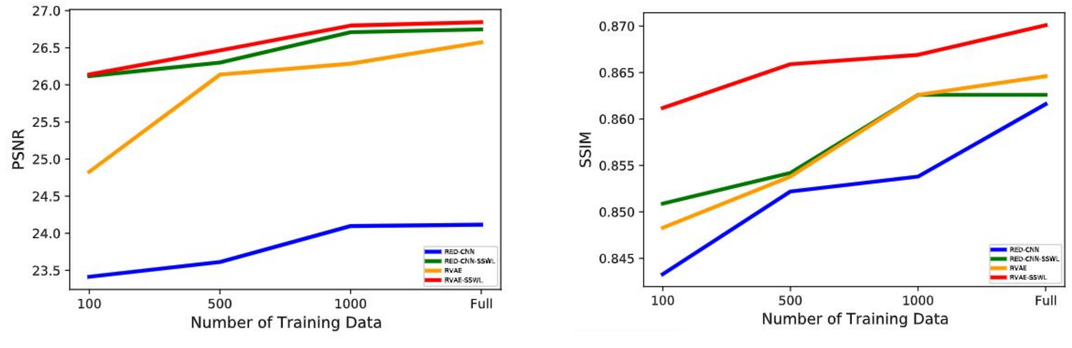


SSWL outperforms baseline and SOTA methods for denoising ROIs



RED-CNN and RVAE produce more accurate FDCT predictions than counterparts

Quantitative Results



SSWL and RVAE outperform baseline and SOTA counterparts

Conclusion and References

- SSWL outperforms many SOTA methods, proving a task-relevant surrogate is important
- Future work includes joint surrogate and downstream training and 3D applications

[1] Chen, Hu, et al. "Low-dose CT with a residual encoder-decoder convolutional neural network." IEEE transactions on medical imaging 36.12 (2017): 2524-2535.
[2] Krull, Alexander, Tim-Oliver Buchholz, and Florian Jug. "Noise2void-learning denoising from single noisy images." Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition. 2019.
[3] Xu, Jun, et al. "Noisy-as-clean: learning self-supervised denoising from corrupted image." IEEE Transactions on Image Processing 29 (2020): 9316-9329.