A Divide-and-Conquer Approach Towards Understanding Deep Networks
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Motivation
- Aim to improve the interpretation of Artificial Neural Networks (ANN).
- Construct an explainable network pipeline with high performance according to the known operator theory [1, 2].
- Experiment design follows the divide-and-conquer approach using the U-Net [3] as a universal operator.

Quantitative Results
- Frangi-Net (FN) boosts from the original Frangi filter.
- The universal operator, i.e. the U-Net, improves the pipeline performance when used for preprocessing (UP).
- Using the Guided Filter Net (GF) for preprocessing maintains the performance enhancement.

Segmentation Network: Frangi-Net
- An trainable ANN counterpart of the Frangi vesselness filter [4].
- A Frangi-Net across 8 scales contains 6,525 parameters.

Qualitative Results
- UP performs as a edge-preserving denoising filter.
- Increasing the regularizer enforces the output of the preprocessing network to resemble the input.
- GF behaves as a band-pass filter rather than a denoising filter.
- The probability maps of pipelines with preprocessing networks are comparably good, and are superior to that without.

Universal Operator: U-Net
- Add BN Layers, replace DeConv with Upsampling and Conv Layers.
- U-Net with 3 levels and 16 initial filters contains 111,536 parameters.

Preprocessing Network: Guided Filter Net
- Use Context Aggregation Network to generate the guidance map $f$.
- The overall architecture contains 3,050 parameters.

Conclusion
- Using a universal operator as a tool to locate the bottleneck of a network pipeline is feasible. This confirms the known operator theory.
- The different UP outputs with varied regularizers give an example of the dilemma between ANN interpretability and performance.
- A network pipeline with well-interpretable component blocks as well as high performance is constructed.

References

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