

**Exploiting *spatial consistency* is important, and
BLURS BEHAVE LIKE ENSEMBLES**

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SCAN AND
SEE A GITHUB

What Is a Spatial Ensemble?

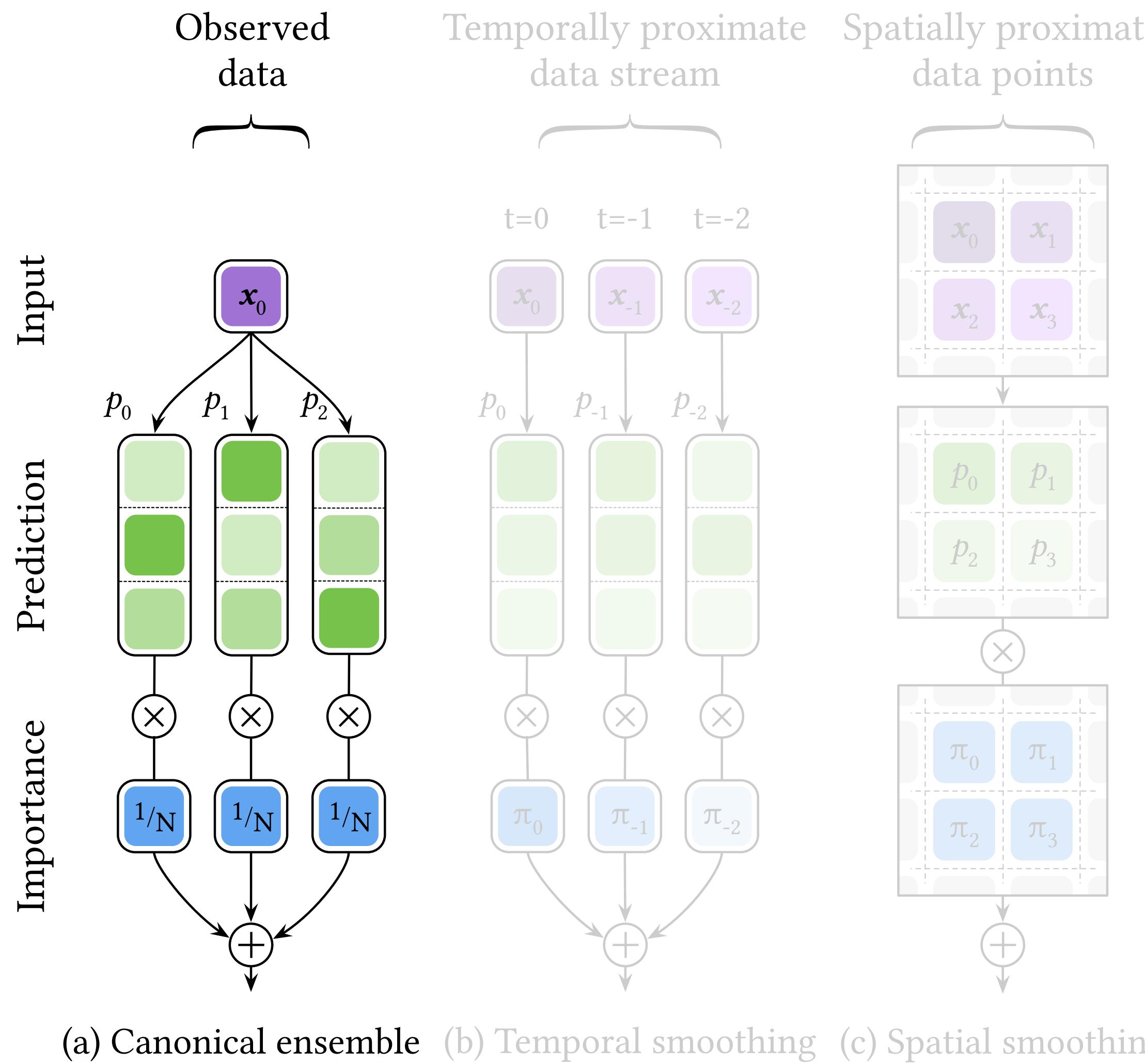


Figure 1. **Comparison of three different neural network ensembles:** canonical ensemble average, temporal smoothing (Park et al., AAAI 2021), and spatial smoothing (ours).

By exploiting spatial consistency of images, this *spatial ensemble* averages neighboring feature maps to aggregate predictions for proximate data points.

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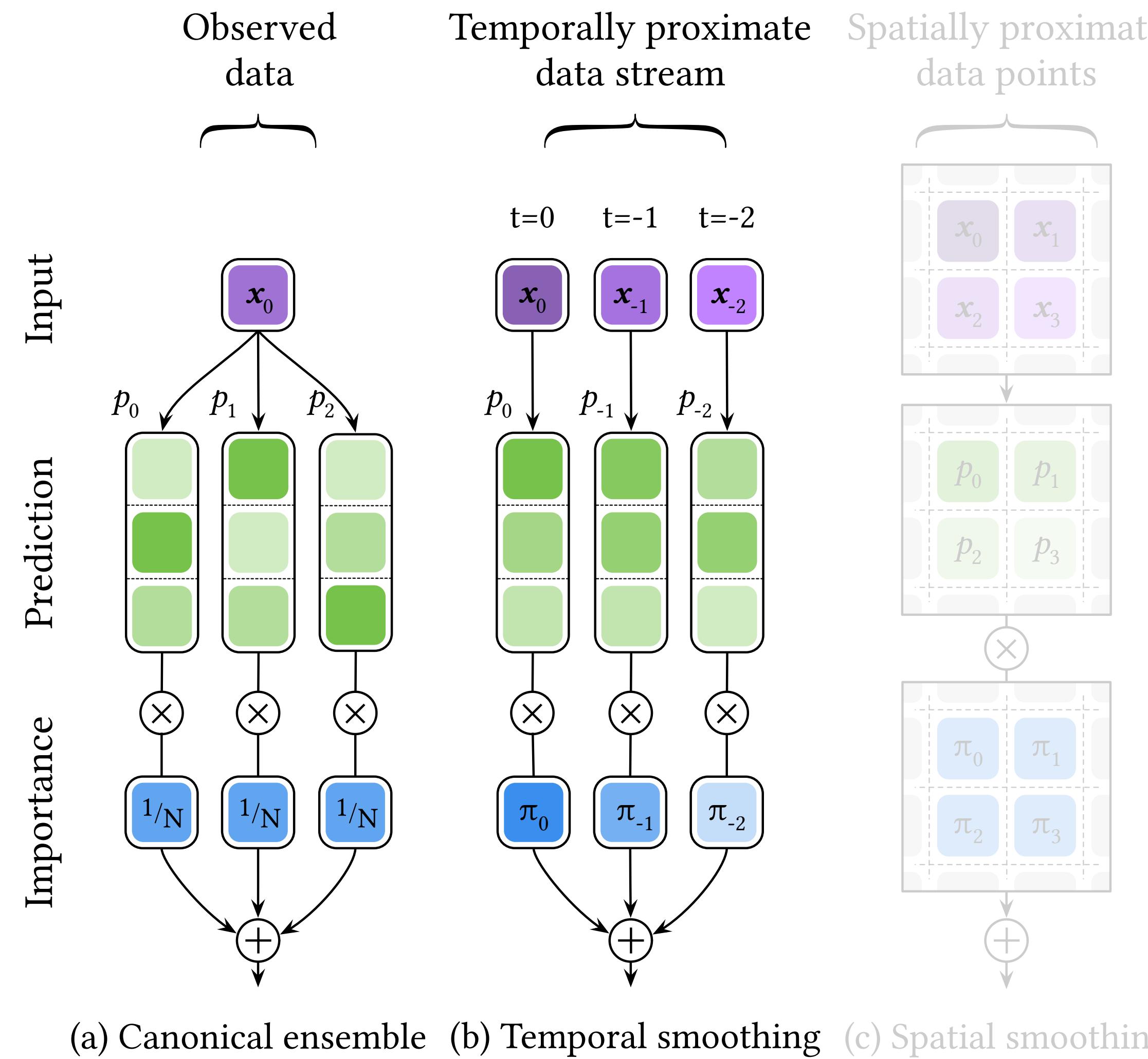


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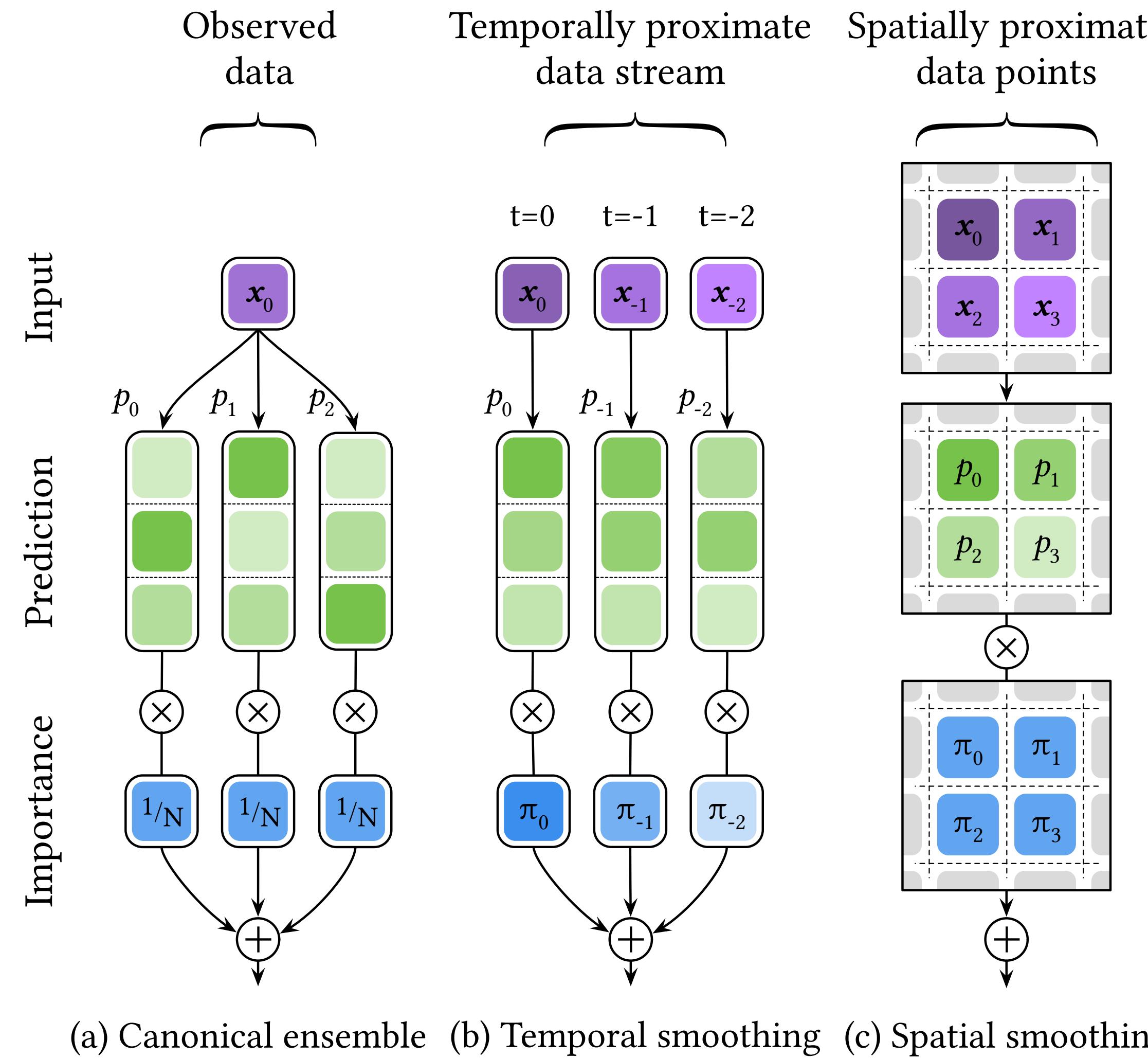


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How Can We Apply Spatial Smoothing to Our Models?

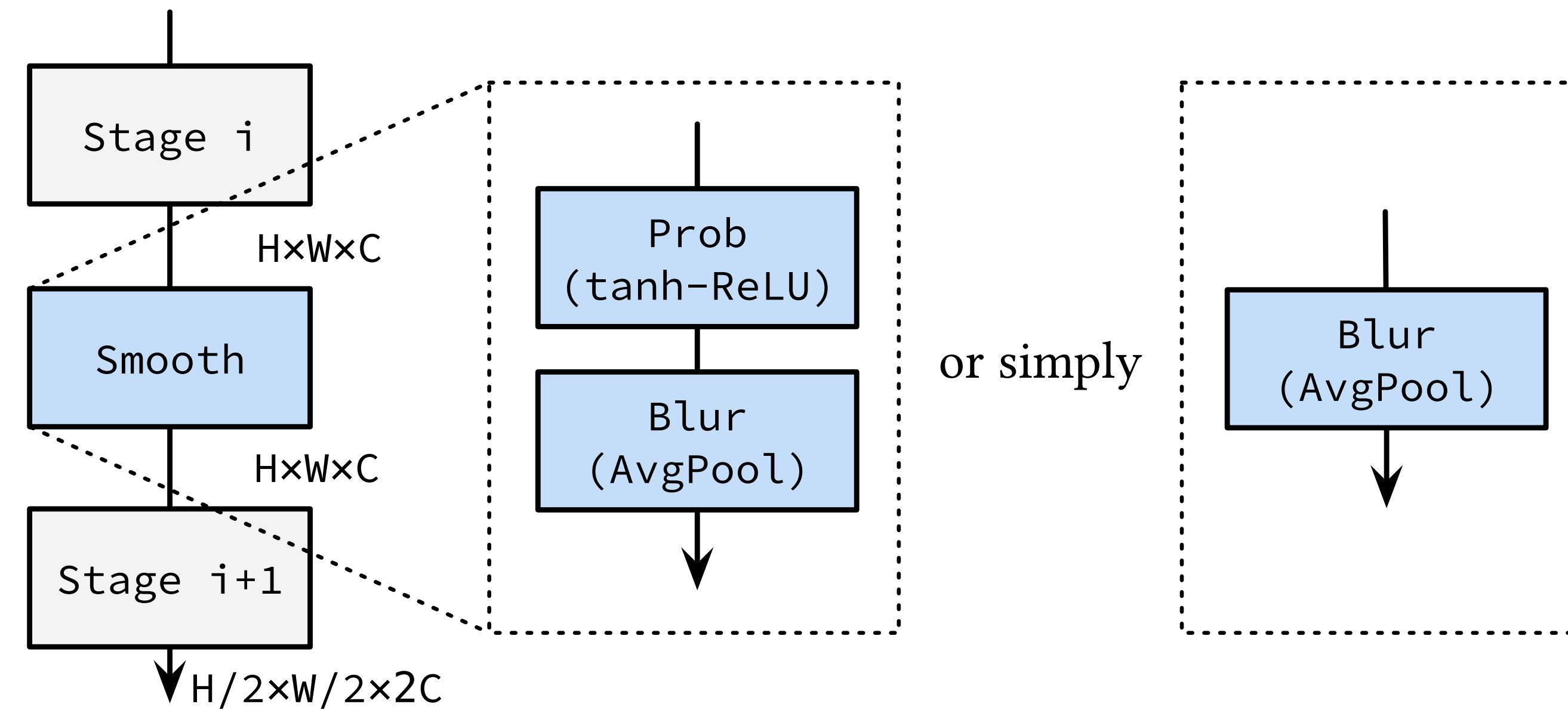


Figure 4. **Spatial smoothing is easy to implement.** Simply add average pooling (AvgPool) before the subsampling layers (*right*), or add tanh-ReLU-AvgPool (*left*) for better results.

Spatial Smoothing Significantly Improves MC Dropout

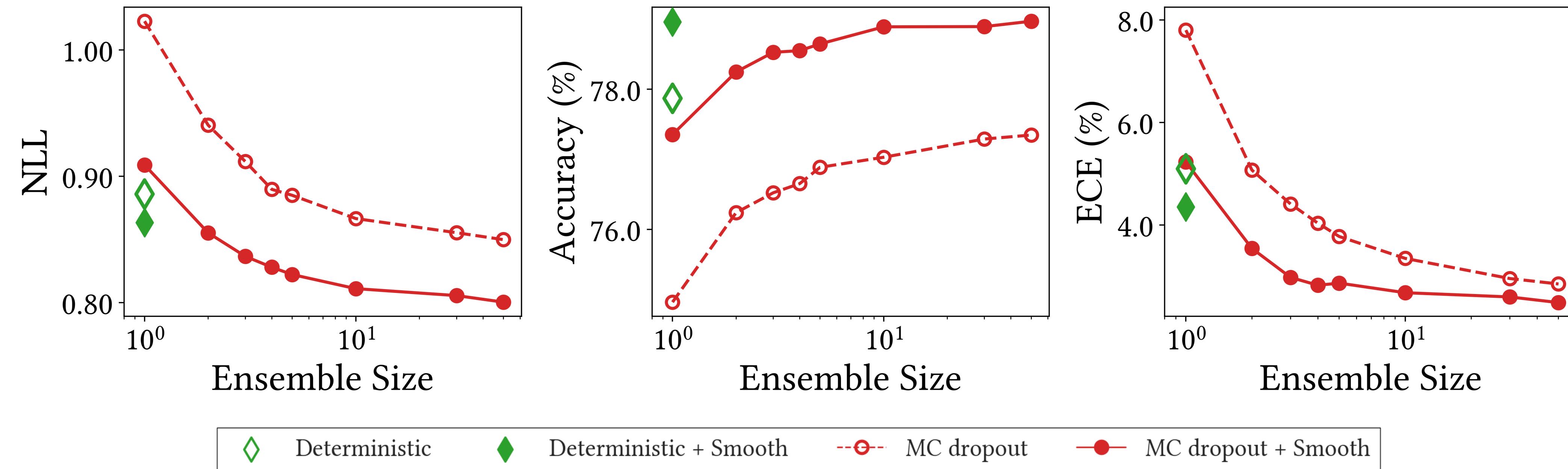


Figure 2 & 3. **Spatial smoothing improves both accuracy and uncertainty of MC dropout across a whole range of ensemble sizes.** In particular, “MC dropout + spatial smoothing” is 25× faster than canonical MC dropout with similar predictive performance.

How Does Spatial Smoothing Improve Neural Nets?

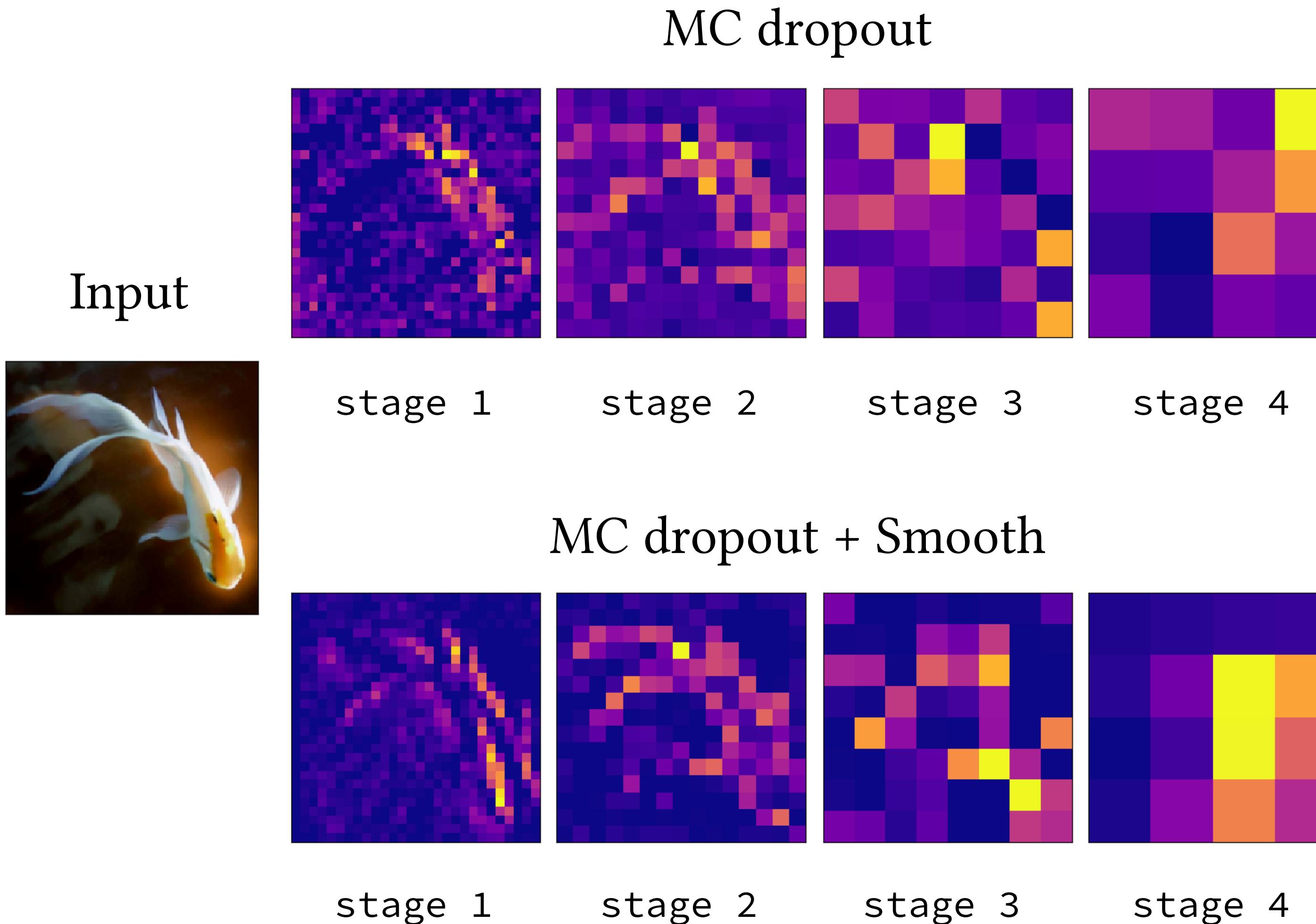


Figure 5. Spatial smoothing stabilizes feature maps and reduces feature map variance.
Since the randomness of feature maps (high-frequency noise) hinders NN optimization, spatial smoothing stabilizes NN optimization and improves the predictive performance.

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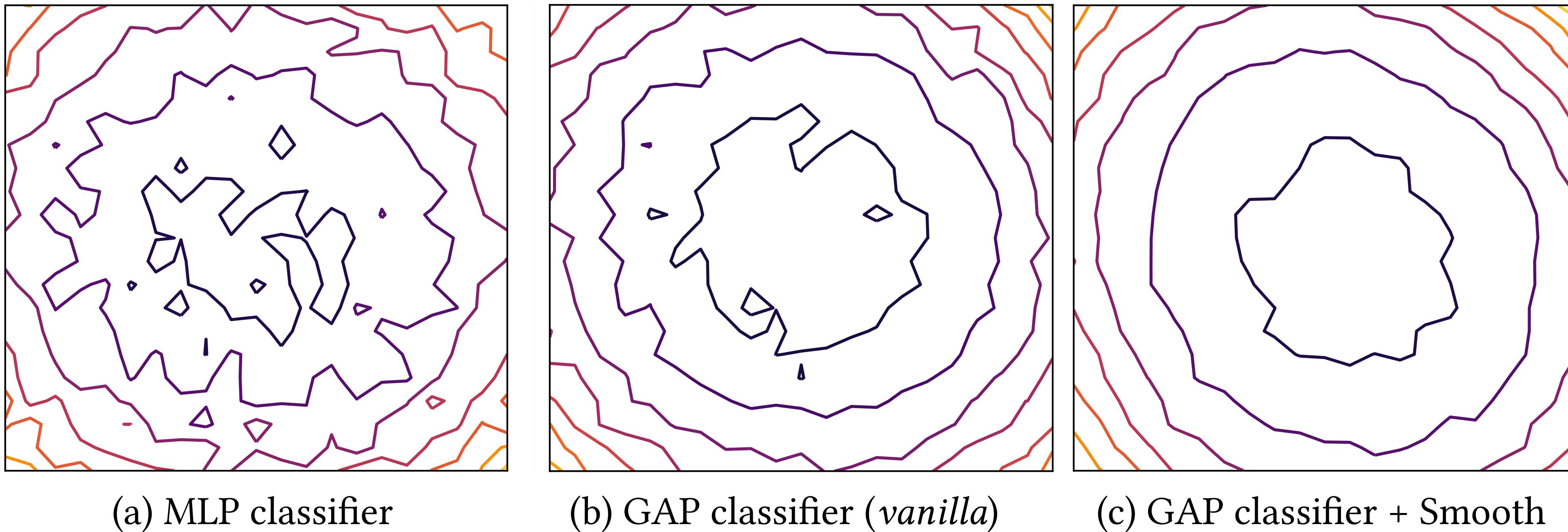


Figure 7 & 8. **Both spatial smoothing and GAP** (an extreme case of spatial smoothing) **stabilize and smoothen the loss landscapes**. MLP classifier hinders NN optimization, i.e., it does not overfit the training dataset.