Understanding and Visualizing Generalization in UNets

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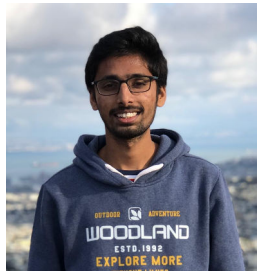
A.Rajagopal



V.C. Madala

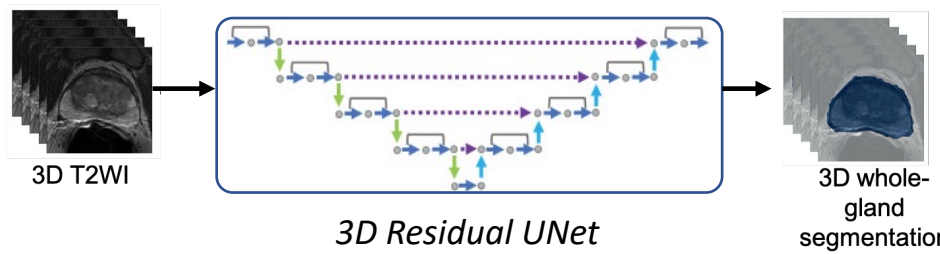

P. Larson

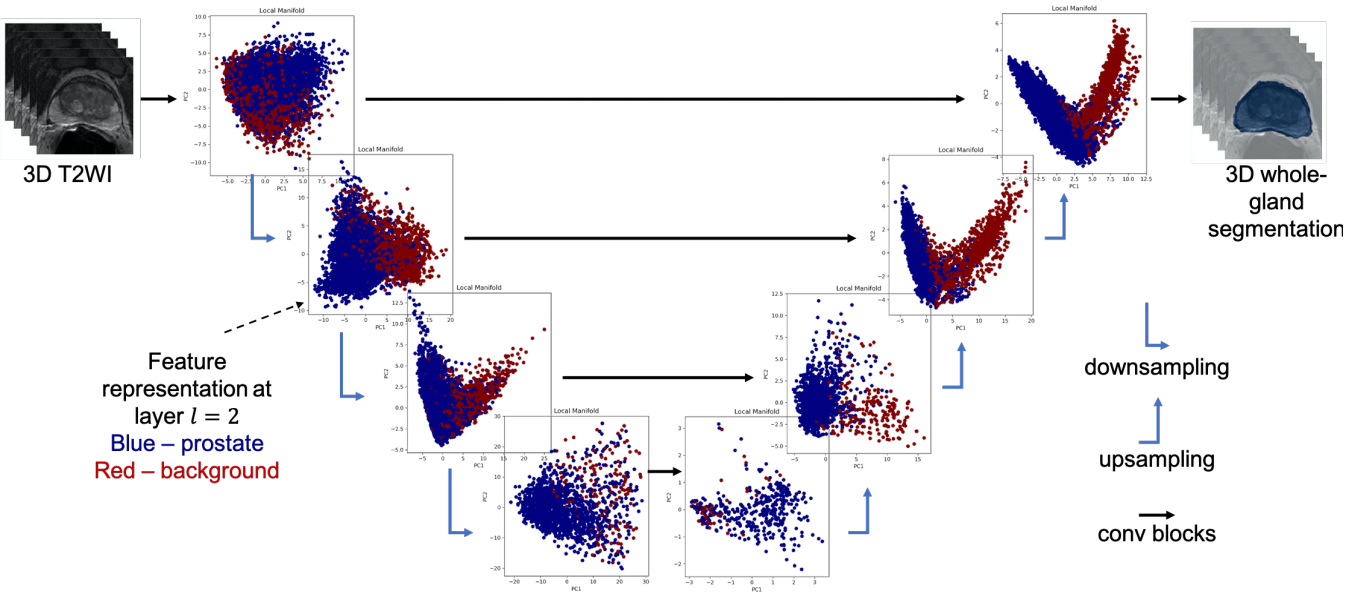

T.A. Hope

Experimentation Overview

>> **Goal**: predict generalization (test IoU) without using the groundtruth segmentations of the test data

- Dataset:
  - 973 mp-MRI exams (we only use T2w series)
  - Groundtruth whole-gland segmentations
  - Intersection-over-union (IoU) == accuracy
- Networks
  - 3D residual UNet
  - 4 different objective functions
  - 120 model training checkpoints
- Generalization Metrics:
  - Clustering
  - Roughness (local gradient)
  - Confidence (Gaussian mixture models)



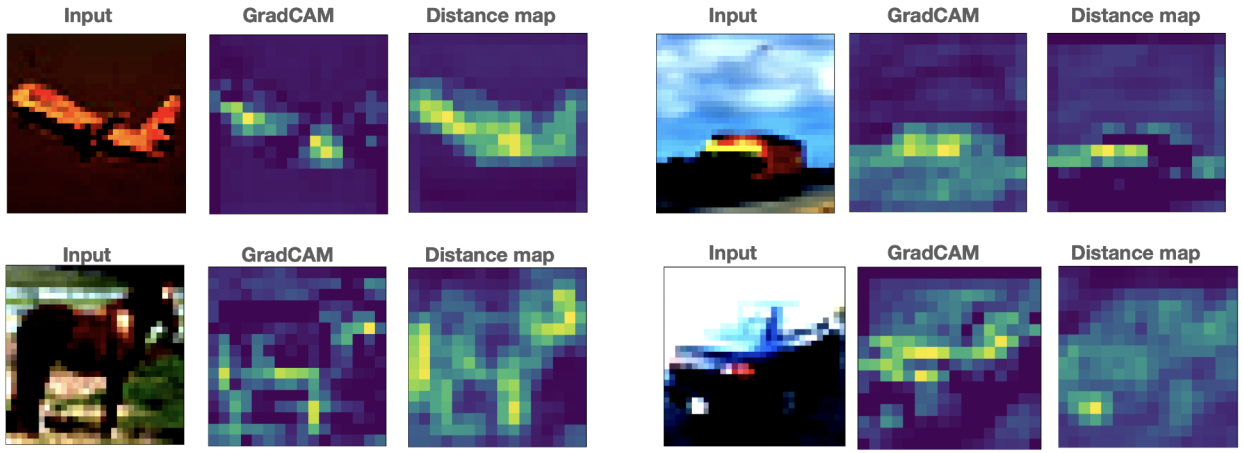


Confidence and Stability Metrics (without labels)

- *Distance / Confidence*
  - Distance to the training dataset
  - Cluster training data and measure max likelihood:

$$c_\ell \leftarrow \max\{p(x'_\ell|\Theta_{\ell,m_j,k_i})\ \forall\ m_j \in M,\ k_i \in k\ \}\forall \ell \in L$$

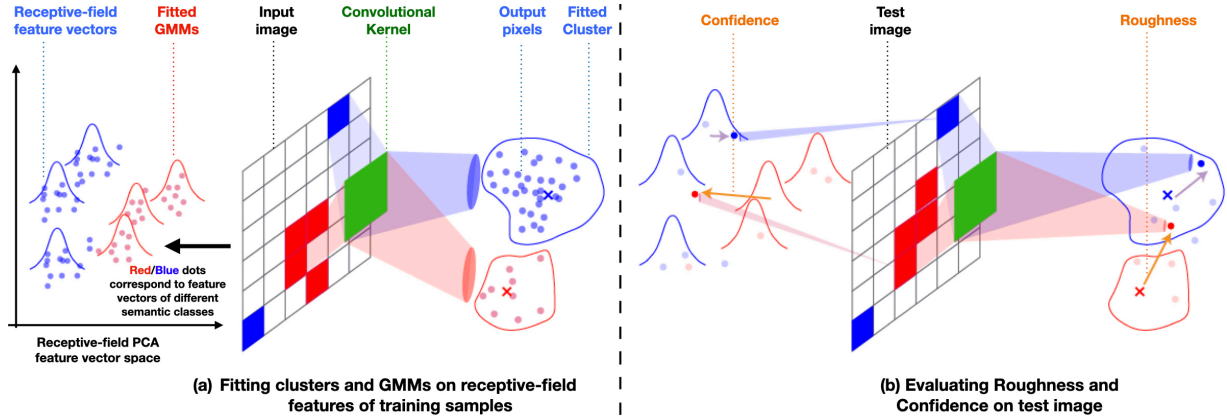
$$\texttt{confidence}(f, \mathcal{X}_{\text{tr}}, \mathcal{X}_{\text{val}}) = \frac{1}{L}\sum_{\ell=1}^{L} w_\ell c_\ell \forall \ell \in L$$



- *Roughness*
  - Magnitude of Jacobian around query point
  - Cheap surrogate to capture high gradients:

$$\texttt{roughness} = \texttt{davies\_bouldin}\big(f_\ell, \mathcal{X}_{\text{val}}(\ell-1), f_{\ell-1}(\mathcal{X}_{\text{val}}(\ell-1)), \mathcal{X}_{\text{val}}(\ell)\big)$$

$f_{\ell-1}(\mathcal{X}_{\text{val}}(\ell-1))$ is the cluster label assigned to input of layer ℓ.



Population-Level Pearson Correlation