Out of Distribution detection in 2D semantic segmentation

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Contents

- Deep Uncertainty Quantification (DUQ) - Classification
- Adaptation idea to semantic segmentation
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DUQ - Classification [1]

- Radial Basis Function (RBF) in final layer with score as uncertainty
  $K = exp[-\frac{\frac{1}{n}.||W_c.f(x)-e_c||_2^2}{2.\sigma^2}]$
- Update centroids (e_c) with the exponential moving average
- Two sided gradient penalty to avoid *feature collapse*
  $\lambda[||\delta \sum_c K_c||_2^2 - 1]^2$

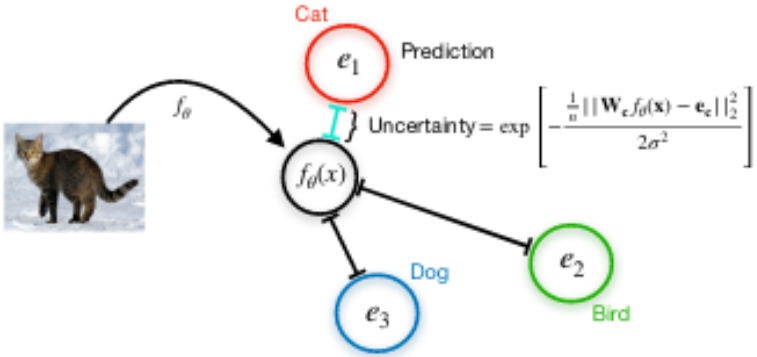

Figure: DUQ architecture for classification [1]

$$n_{c,t} = \gamma * n_{c,t-1} + (1-\gamma) * n_{c,t}$$
$$\mathbf{m}_{c,t} = \gamma * \mathbf{m}_{c,t-1} + (1-\gamma) \sum_i \mathbf{W}_c f_\theta(\mathbf{x}_{c,t,i})$$
$$\mathbf{e}_{c,t} = \frac{\mathbf{m}_{c,t}}{n_{c,t}}$$

Figure: Update equations for the centroids [1]

DUQ Adaptation - Semantic Segmentation

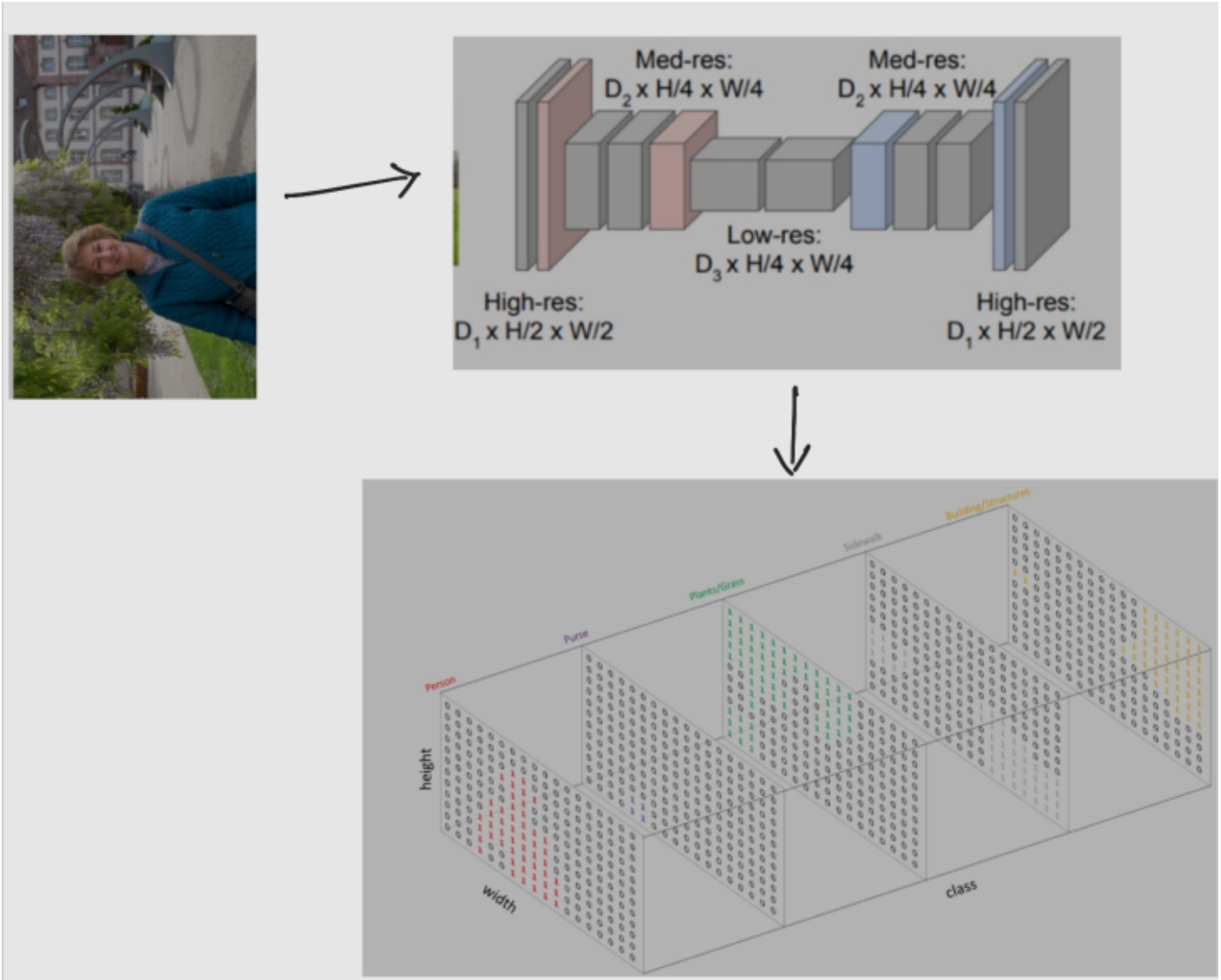

Figure: Semantic segmentation [2]

DUQ Adaptation - Semantic Segmentation

- Classification RBF - $K = exp[-\frac{\frac{1}{n}.||W_c.f(x)-e_c||_2^2}{2.\sigma^2}]$

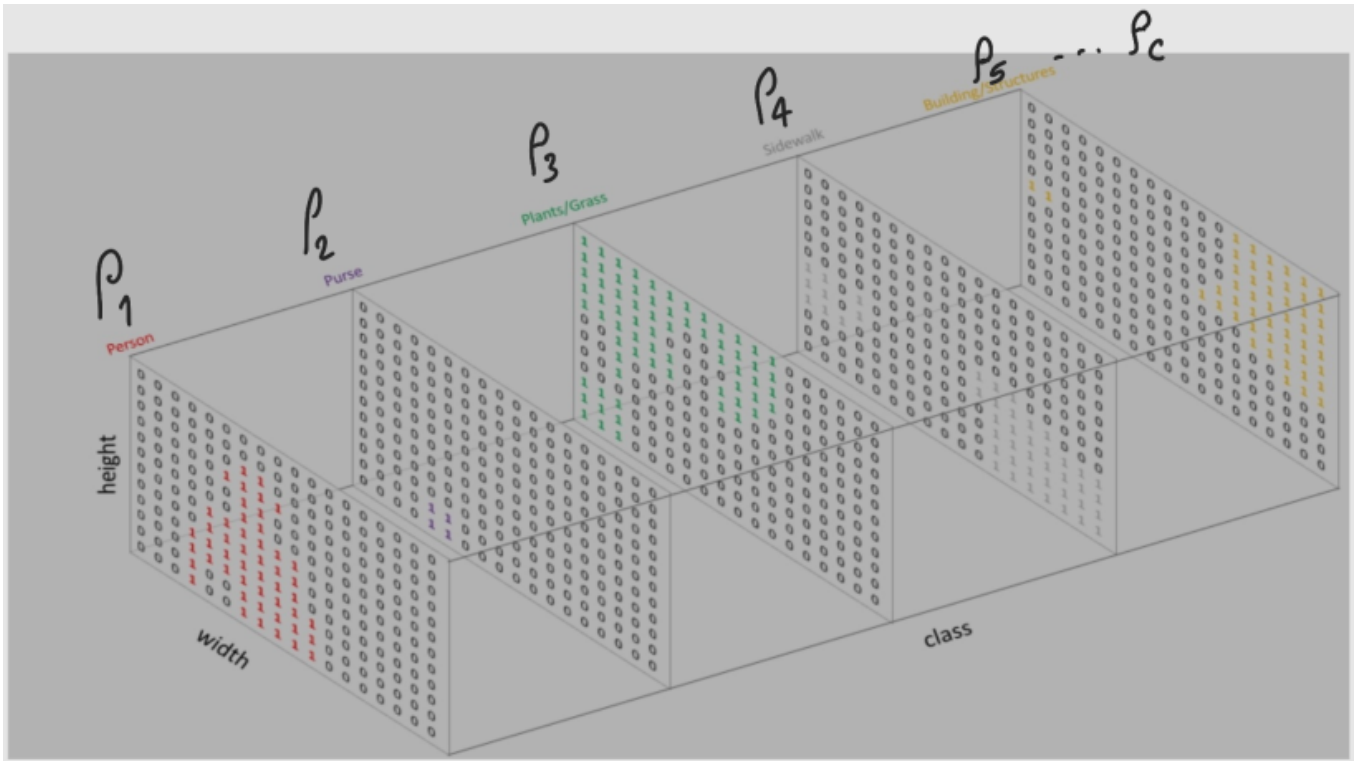

Figure: DUQ for semantic segmentation idea

- Same exponential moving average for centroids can be used

Other OOD methods for semantic segmentation

- MetaSeg - Train a NN over the segmentation metrics for segmantation IoU [3].
- Pixel level OOD for semantic segmentation [4].
- GAN discriminator based OOD detection [5].
- More generative models as in [6], [7].

References

- J. van Amersfoort, L. Smith, Y. W. Teh, and Y. Gal, "Uncertainty estimation using a single deep deterministic neural network,"
- J. Jordan, "An overview of semantic image segmentation."
- P. Oberdiek, M. Rottmann, and G. A. Fink, "Detection and retrieval of out-of-distribution objects in semantic segmentation," in *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops*, June 2020.
- M. Angus, K. Czarnecki, and R. Salay, "Efficacy of pixel-level ood detection for semantic segmentation,"
- P. Bevandic, I. Kreso, M. Orsic, and S. Segvic, "Discriminative out-of-distribution detection for semantic segmentation,"
- E. Nalisnick, A. Matsukawa, Y. W. Teh, D. Gorur, and B. Lakshminarayanan, "Do deep generative models know what they don't know?," *arXiv preprint arXiv:1810.09136*, 2018.
- D. Li, J. Yang, K. Kreis, A. Torralba, and S. Fidler, "Semantic segmentation with generative models: Semi-supervised learning and strong out-of-domain generalization," in *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, pp. 8300–8311, June 2021.