UNIVERSITY OF COPENHAGEN

FEATURE LEARNING BASED ON VISUAL SIMILARITY TRIPLETS IN MEDICAL IMAGE ANALYSIS

A case study of emphysema in chest CT scans

Silas N Ørting, Jens Petersen, Veronika Cheplygina, Laura H Thomsen, Mathilde M W Wille, Marleen de Bruijne

Contact Information:
Universitetsparken 1
2100 København
+45 51746394
silas@di.ku.dk

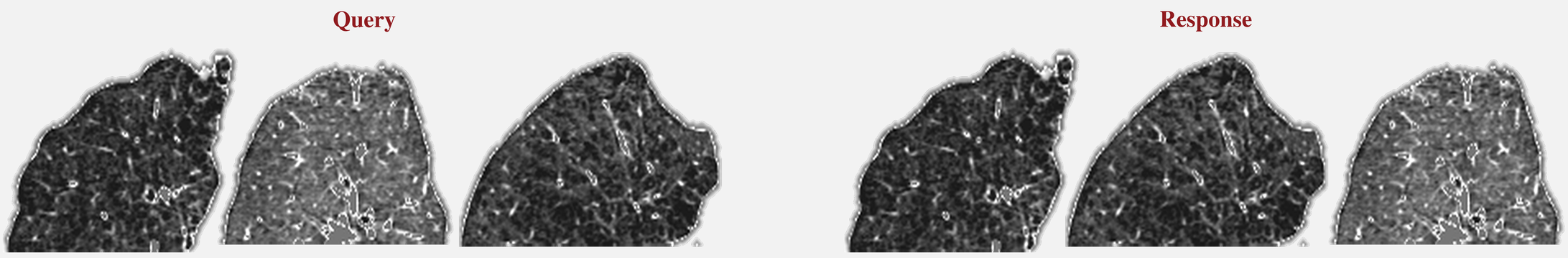
Objective

Can visual similarity triplets be used to learn an emphysema-sensitive embedding of CT scans?

Motivation

Assessing absolute emphysema extent is difficult and subject to substantial rater variability. Assessing relative similarity is potentially easier and more informative.

Visual similarity triplets



Reorder to satisfy $\delta(x_i, x_j) < \delta(x_i, x_k)$

Setup

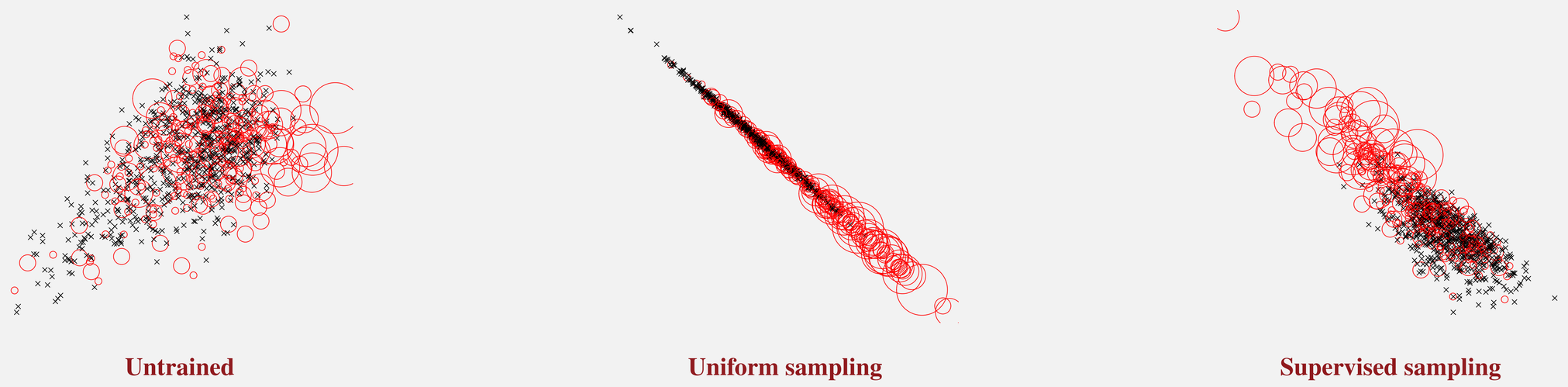
- Low-dose chest CT of 1947 from DLCST
- 974 subjects in training group and 973 subjects in test group.
- Visual similarity triplets simulated from expert assessed emphysema
- 2D embedding learnt with 3-5 layer CNNs

Bounded triplet violation loss

$$\Delta = \delta(x_i, x_j) - \delta(x_i, x_k)$$

$$\mathcal{L}_{l,u}(\Delta) = \begin{cases} 0 & \text{if } \Delta < l \\ 1 & \text{if } \Delta > u \\ \frac{\Delta - l}{u - l} & \text{otherwise} \end{cases}$$

Learned embeddings



Triplet satisfication performance

	Test triplet selection method				
Sampling scheme	All	0%	0-5%	0-25%	0-50%
Uniform	41.0	40.2	30.0	19.0	11.6
Supervised	39.3	39.0	26.4	14.6	9.4
Untrained	48.5	48.9	44.3	37.2	29.2

Conclusion

- CNNs can learn an emphysema sensitive embedding from visual similarity
- Uniform sampling yields almost as good performance as supervised sampling
- Next step is large-scale crowdsourcing of similarity triplets

Acknowledgments: Danish Council for Independent Research and the Netherlands Organization for Scientific Research