

Deep Learning-based Patient Re-identification Is able to Exploit the Biometric Nature of Medical Chest X-ray Data

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Supplementary Material

Supplementary Table 1. Additional patient verification results: Comparison of different data handling techniques (FTS and RNP), training set sizes N_s and learning rates η . We present the AUC (together with the lower and upper bounds of the 95 % confidence intervals from 10,000 bootstrap runs), the accuracy, the specificity, the recall, the precision, and the F1-score.

Data handling	N_s	η	AUC + 95 % CI	Accuracy ($\frac{TP+TN}{P+N}$)	Specificity ($\frac{TN}{N}$)	Recall ($\frac{TP}{P}$)	Precision ($\frac{TP}{TP+FP}$)	F1-score	
FTS	100,000	10^{-4}	0.8509 $\begin{pmatrix} 0.8532 \\ 0.8485 \end{pmatrix}$	0.7461 $\begin{pmatrix} 74.605 \\ 100.000 \end{pmatrix}$	0.8414 $\begin{pmatrix} 42.071 \\ 50.000 \end{pmatrix}$	0.6507 $\begin{pmatrix} 32.534 \\ 50.000 \end{pmatrix}$	0.8040 $\begin{pmatrix} 32.534 \\ 40.463 \end{pmatrix}$	0.7193	
		10^{-5}	0.7429 $\begin{pmatrix} 0.7459 \\ 0.7399 \end{pmatrix}$	0.6322 $\begin{pmatrix} 63.223 \\ 100.000 \end{pmatrix}$	0.7924 $\begin{pmatrix} 39.619 \\ 50.000 \end{pmatrix}$	0.4721 $\begin{pmatrix} 23.604 \\ 50.000 \end{pmatrix}$	0.6945 $\begin{pmatrix} 23.604 \\ 33.985 \end{pmatrix}$	0.5621	
		10^{-6}	0.7257 $\begin{pmatrix} 0.7289 \\ 0.7225 \end{pmatrix}$	0.6702 $\begin{pmatrix} 67.020 \\ 100.000 \end{pmatrix}$	0.6719 $\begin{pmatrix} 33.594 \\ 50.000 \end{pmatrix}$	0.6685 $\begin{pmatrix} 33.426 \\ 50.000 \end{pmatrix}$	0.6708 $\begin{pmatrix} 33.426 \\ 49.832 \end{pmatrix}$	0.6696	
		10^{-7}	0.7440 $\begin{pmatrix} 0.7470 \\ 0.7409 \end{pmatrix}$	0.6741 $\begin{pmatrix} 67.410 \\ 100.000 \end{pmatrix}$	0.7002 $\begin{pmatrix} 35.008 \\ 50.000 \end{pmatrix}$	0.6480 $\begin{pmatrix} 32.402 \\ 50.000 \end{pmatrix}$	0.6837 $\begin{pmatrix} 32.402 \\ 47.394 \end{pmatrix}$	0.6654	
	200,000	10^{-4}	0.8886 $\begin{pmatrix} 0.8906 \\ 0.8866 \end{pmatrix}$	0.7920 $\begin{pmatrix} 79.203 \\ 100.000 \end{pmatrix}$	0.8547 $\begin{pmatrix} 42.736 \\ 50.000 \end{pmatrix}$	0.7293 $\begin{pmatrix} 36.467 \\ 50.000 \end{pmatrix}$	0.8339 $\begin{pmatrix} 36.467 \\ 43.731 \end{pmatrix}$	0.7761 $\begin{pmatrix} 24.713 \\ 31.844 \end{pmatrix}$	0.7781
		10^{-5}	0.8158 $\begin{pmatrix} 0.8185 \\ 0.8132 \end{pmatrix}$	0.6758 $\begin{pmatrix} 67.582 \\ 100.000 \end{pmatrix}$	0.8574 $\begin{pmatrix} 42.869 \\ 50.000 \end{pmatrix}$	0.4943 $\begin{pmatrix} 24.713 \\ 50.000 \end{pmatrix}$	0.7761 $\begin{pmatrix} 24.713 \\ 31.844 \end{pmatrix}$	0.6039	
		10^{-6}	0.7615 $\begin{pmatrix} 0.7645 \\ 0.7586 \end{pmatrix}$	0.6755 $\begin{pmatrix} 67.552 \\ 100.000 \end{pmatrix}$	0.7448 $\begin{pmatrix} 37.242 \\ 50.000 \end{pmatrix}$	0.6062 $\begin{pmatrix} 30.310 \\ 50.000 \end{pmatrix}$	0.7038 $\begin{pmatrix} 30.310 \\ 43.068 \end{pmatrix}$	0.6514	
		10^{-7}	0.7526 $\begin{pmatrix} 0.7556 \\ 0.7495 \end{pmatrix}$	0.6819 $\begin{pmatrix} 68.194 \\ 100.000 \end{pmatrix}$	0.6791 $\begin{pmatrix} 33.957 \\ 50.000 \end{pmatrix}$	0.6847 $\begin{pmatrix} 34.237 \\ 50.000 \end{pmatrix}$	0.6809 $\begin{pmatrix} 34.237 \\ 50.280 \end{pmatrix}$	0.6828	
	400,000	10^{-3}	0.9541 $\begin{pmatrix} 0.9552 \\ 0.9529 \end{pmatrix}$	0.8852 $\begin{pmatrix} 88.519 \\ 100.000 \end{pmatrix}$	0.8655 $\begin{pmatrix} 43.275 \\ 50.000 \end{pmatrix}$	0.9049 $\begin{pmatrix} 45.244 \\ 50.000 \end{pmatrix}$	0.8706 $\begin{pmatrix} 45.244 \\ 51.969 \end{pmatrix}$	0.8874	
		10^{-5}	0.8518 $\begin{pmatrix} 0.8542 \\ 0.8494 \end{pmatrix}$	0.7450 $\begin{pmatrix} 74.498 \\ 100.000 \end{pmatrix}$	0.8410 $\begin{pmatrix} 42.050 \\ 50.000 \end{pmatrix}$	0.6490 $\begin{pmatrix} 32.448 \\ 50.000 \end{pmatrix}$	0.8032 $\begin{pmatrix} 32.448 \\ 40.398 \end{pmatrix}$	0.7179	
		10^{-6}	0.7417 $\begin{pmatrix} 0.7449 \\ 0.7386 \end{pmatrix}$	0.6572 $\begin{pmatrix} 65.715 \\ 100.000 \end{pmatrix}$	0.7152 $\begin{pmatrix} 35.761 \\ 50.000 \end{pmatrix}$	0.5991 $\begin{pmatrix} 29.954 \\ 50.000 \end{pmatrix}$	0.6778 $\begin{pmatrix} 29.954 \\ 44.193 \end{pmatrix}$	0.6360	
		10^{-7}	0.7306 $\begin{pmatrix} 0.7337 \\ 0.7275 \end{pmatrix}$	0.6567 $\begin{pmatrix} 65.670 \\ 100.000 \end{pmatrix}$	0.6801 $\begin{pmatrix} 34.006 \\ 50.000 \end{pmatrix}$	0.6333 $\begin{pmatrix} 31.664 \\ 50.000 \end{pmatrix}$	0.6644 $\begin{pmatrix} 31.664 \\ 47.658 \end{pmatrix}$	0.6485	
RNP	800,000	10^{-3}	0.9826 $\begin{pmatrix} 0.9833 \\ 0.9820 \end{pmatrix}$	0.9324 $\begin{pmatrix} 93.238 \\ 100.000 \end{pmatrix}$	0.9393 $\begin{pmatrix} 46.966 \\ 50.000 \end{pmatrix}$	0.9254 $\begin{pmatrix} 46.272 \\ 50.000 \end{pmatrix}$	0.9385 $\begin{pmatrix} 46.272 \\ 49.306 \end{pmatrix}$	0.9319	
		10^{-4}	0.9940 $\begin{pmatrix} 0.9944 \\ 0.9937 \end{pmatrix}$	0.9555 $\begin{pmatrix} 95.545 \\ 100.000 \end{pmatrix}$	0.9822 $\begin{pmatrix} 49.111 \\ 50.000 \end{pmatrix}$	0.9287 $\begin{pmatrix} 46.434 \\ 50.000 \end{pmatrix}$	0.9812 $\begin{pmatrix} 46.434 \\ 47.323 \end{pmatrix}$	0.9542	
FTS	800,000	10^{-5}	0.9278 $\begin{pmatrix} 0.9294 \\ 0.9262 \end{pmatrix}$	0.8339 $\begin{pmatrix} 83.392 \\ 100.000 \end{pmatrix}$	0.8946 $\begin{pmatrix} 44.732 \\ 50.000 \end{pmatrix}$	0.7732 $\begin{pmatrix} 38.660 \\ 50.000 \end{pmatrix}$	0.8801 $\begin{pmatrix} 38.660 \\ 43.928 \end{pmatrix}$	0.8232	
		10^{-5}	0.9200 $\begin{pmatrix} 0.9217 \\ 0.9182 \end{pmatrix}$	0.8215 $\begin{pmatrix} 82.153 \\ 100.000 \end{pmatrix}$	0.8888 $\begin{pmatrix} 44.440 \\ 50.000 \end{pmatrix}$	0.7543 $\begin{pmatrix} 37.713 \\ 50.000 \end{pmatrix}$	0.8715 $\begin{pmatrix} 37.713 \\ 43.273 \end{pmatrix}$	0.8087	
		10^{-6}	0.8669 $\begin{pmatrix} 0.8692 \\ 0.8646 \end{pmatrix}$	0.7752 $\begin{pmatrix} 77.519 \\ 100.000 \end{pmatrix}$	0.8165 $\begin{pmatrix} 40.823 \\ 50.000 \end{pmatrix}$	0.7339 $\begin{pmatrix} 36.696 \\ 50.000 \end{pmatrix}$	0.7999 $\begin{pmatrix} 36.696 \\ 45.873 \end{pmatrix}$	0.7655	
		10^{-7}	0.8126 $\begin{pmatrix} 0.8152 \\ 0.8099 \end{pmatrix}$	0.7247 $\begin{pmatrix} 72.468 \\ 100.000 \end{pmatrix}$	0.7502 $\begin{pmatrix} 37.509 \\ 50.000 \end{pmatrix}$	0.6992 $\begin{pmatrix} 34.959 \\ 50.000 \end{pmatrix}$	0.7368 $\begin{pmatrix} 34.959 \\ 47.450 \end{pmatrix}$	0.7175	