Jožef Stefan Institute
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Artificial Intelligence
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Tackling class imbalance in radiomics

the COVID-19 use case

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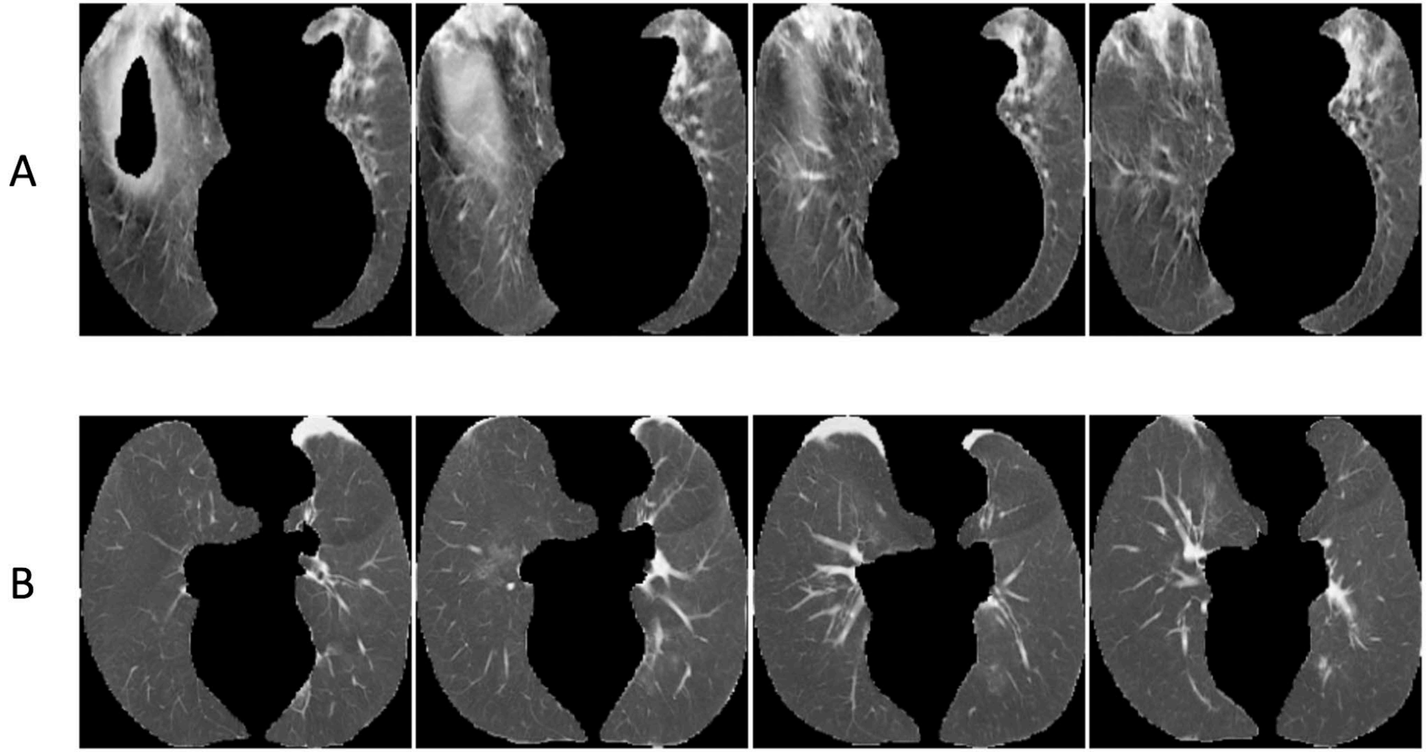
Radiomics for COVID-19 detection

Radiomics for COVID-19 detection

- **COVID-19 impact on respiratory system**
  - Visible on medical images:
    - ground-glass opacities and consolidations
    - peripheral and basal sites

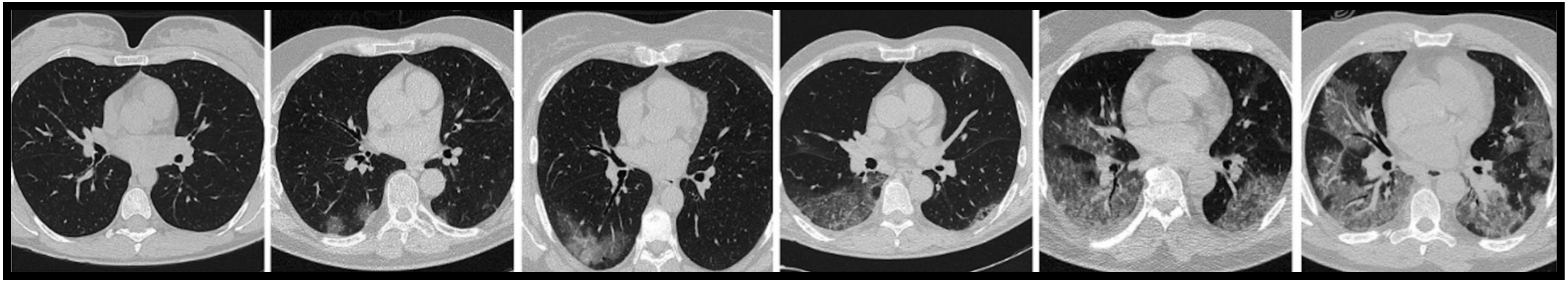


Radiomics for COVID-19 detection

- **Challenges**
  - dataset sizes
  - data sources: different image sources and protocols
  - different labelling
  - privacy concerns

Radiomics for COVID-19 detection

- **Use case**
  - 7100 images from CT scan segmentations
    - 289 healthy persons and 66 COVID-19 patients
  - score of pulmonary involvement with clinical staging of disease
    - <5%: non-COVID-19
    - ≥10%: COVID-19



0-5%

5-75+%%

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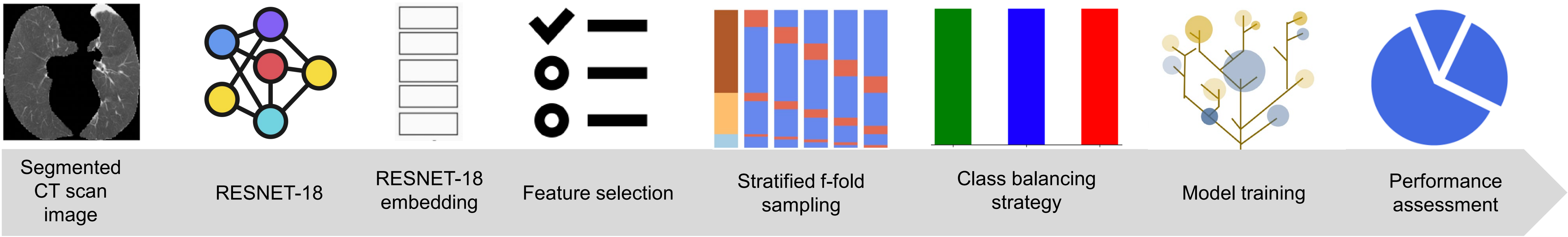
- **Methodology**



Algorithms: SVM, kNN, RF, CART, Gaussian Näive Bayes, Multi-layer Perceptron (MLP), GBM, and Isolation Forest (IF)

Imbalance mitigation strategies: NONE (no augmentation), RANDOM (näive random sampler), SMOTE, ADASYN, CTGAN

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- **Results and Analysis**

Class Imbalance Mitigation Strategies	CART	IF	kNN	MLP	Naive Bayes	RF	SVM	GBM
NONE	0,6429	0,6802	0,8504	0,7879	0,6653	**0,8601**	0,8066	*0,8555*
RANDOM	0,6402	0,5215	0,7846	*0,7993*↑	0,6464	0,6691	0,6888	**0,8150**
SMOTE	0,6147	0,5607	0,6813	*0,7663*	0,6590	0,6660	0,6817	**0,7826**
ADASYN	0,6020	0,5863	0,6660	*0,7655*	0,6282	0,6435	0,6652	**0,7787**
CTGAN	0,7401↑	0,5340	0,8118	*0,8419*↑	0,6395	0,7090	0,6896	**0,8871**↑

Average AUC ROC values obtained across the ten cross-validation folds.
Best results are **bolded**, second-best results are *highlighted in italics*.
Colour codes denote pairs of results without statistical significance at a p-value of 0.05.
Up arrow ↑ indicates whether the imbalance strategy outperformed NONE

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- **Conclusions**
  - New approach for class imbalance: CGAN on embeddings
    - Best results among strategies, further research required
  - Best model: gradient boosted machines

- **Future work**
  - Enhance CTGAN approach
    - why sometimes we get poor results?
  - Explainable Artificial Intelligence on embeddings
    - translate feature relevance to image

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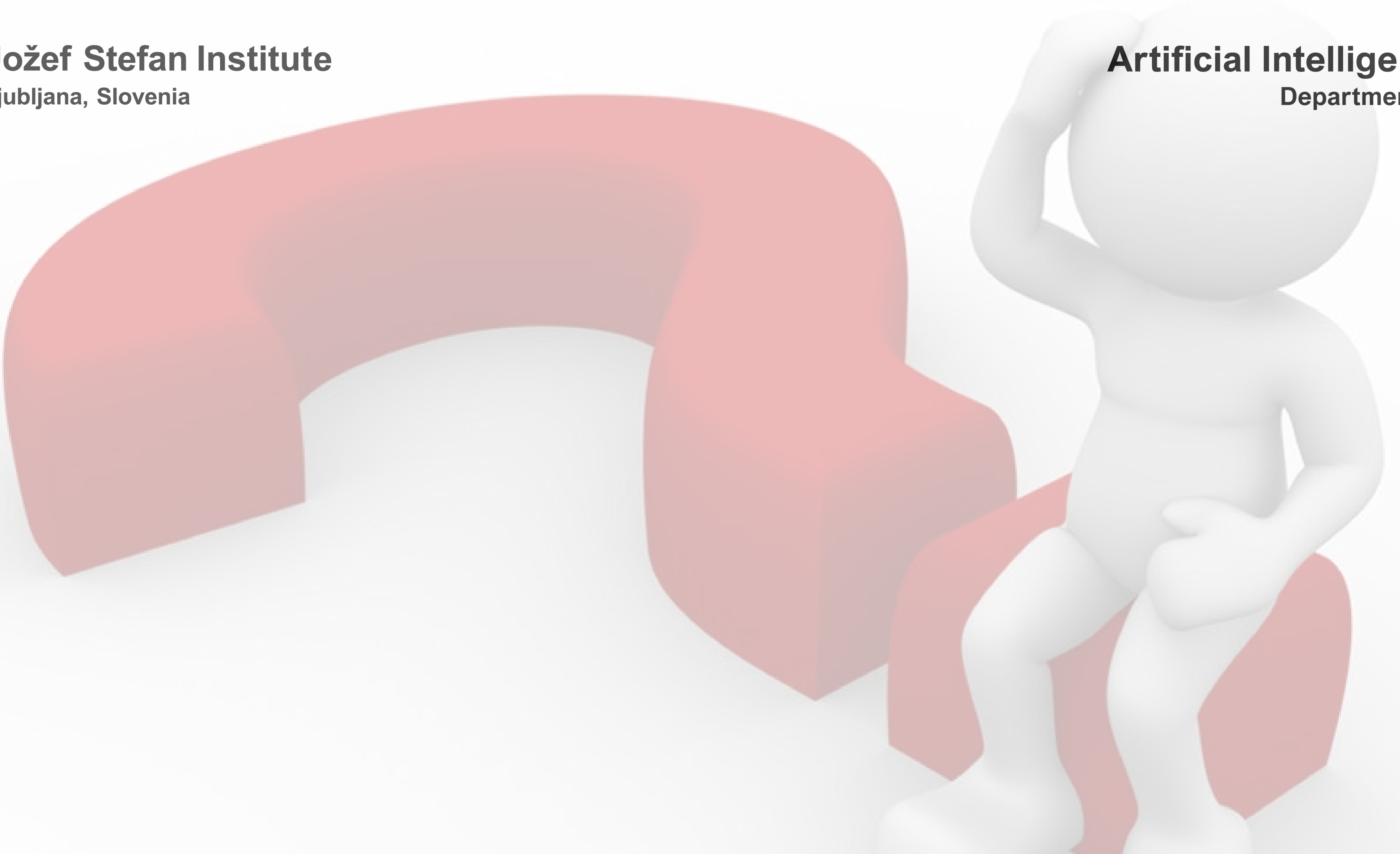

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