Automated Quality Control of Chest X-Rays

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CMIH Academic Engagement Event
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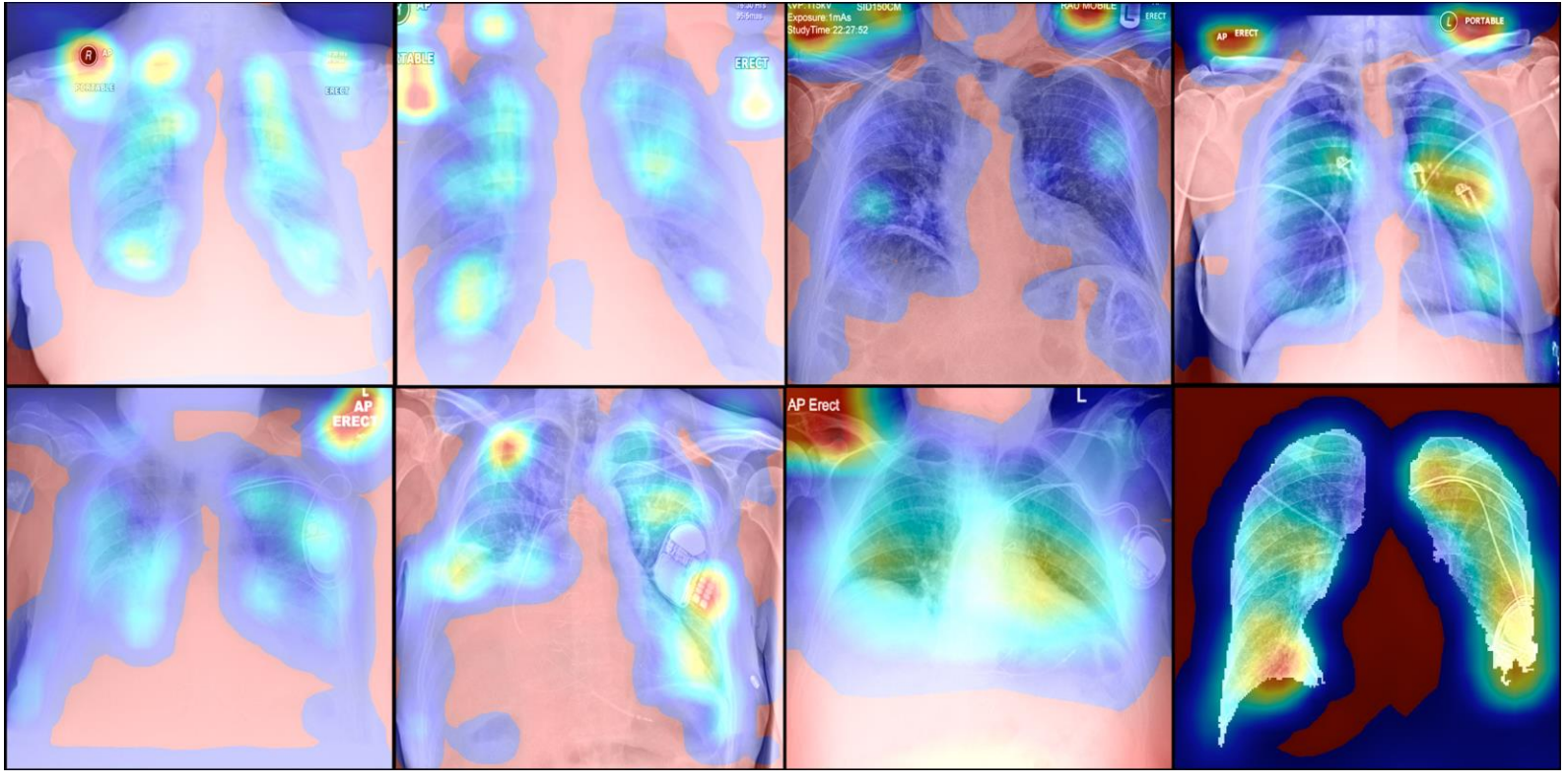
UNIVERSITY OF CAMBRIDGE

NHS
Cambridge University Hospitals
NHS Foundation Trust

The Problem

[1] Roberts, M., Driggs, D., et al.: Common pitfalls and recommendations for using machine learning to detect and prognosticate for COVID-19 using chest radiographs and CT scans. Nature Machine Intelligence 3(3), 199–217 (2021).
[2] DeGrave, A.J., Janizek, J.D., Lee, S.I.: AI for radiographic COVID-19 detection selects shortcuts over signal. Nature Machine Intelligence 2021 3:7 3(7), 610–619 (May 2021).

- Radiological artificial intelligence models have not been of clinical use during the COVID-19 pandemic due to methodological flaws and biases[1].
- Shortcut learning is a significant reason why CXR models fail to generalise[2].

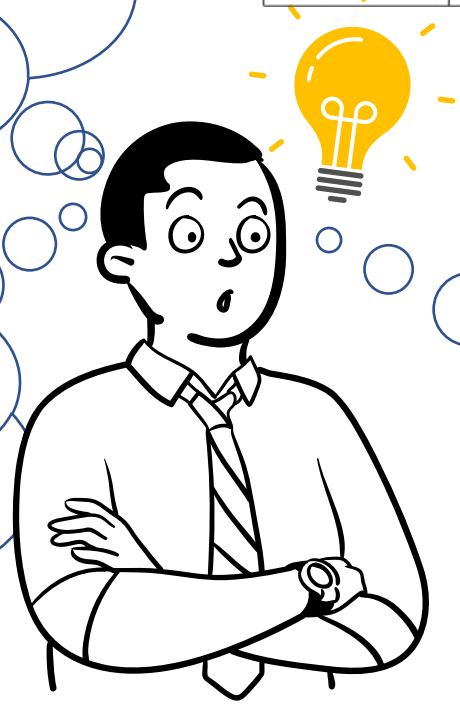


A Solution?

Dataset	CXRs	Patients	Centres	Partition
NCCID[3]	22,606	6,977	22 (UK)	Development
BIMCV[4]	25,447	9,072	11 (Spain)	Development
CUH[5]	13,952	5,299	1 (UK)	Validation
Brixia[6]	4,695	2,351	1 (Italy)	Validation
RICORD-1c[7]	1,257	361	4 (US/CA/BR/TR)	Validation
TOTAL	67,957	24,060	39 (7 countries)	-

Pipeline of tools to:

1. Standardise or reject chest X-rays (CXRs)
2. Provide labels for identifying confounders



- Improve model generalisation.
- Assist developers in identifying potential shortcuts.
- Promote ethical AI.
- Facilitate faster model development.

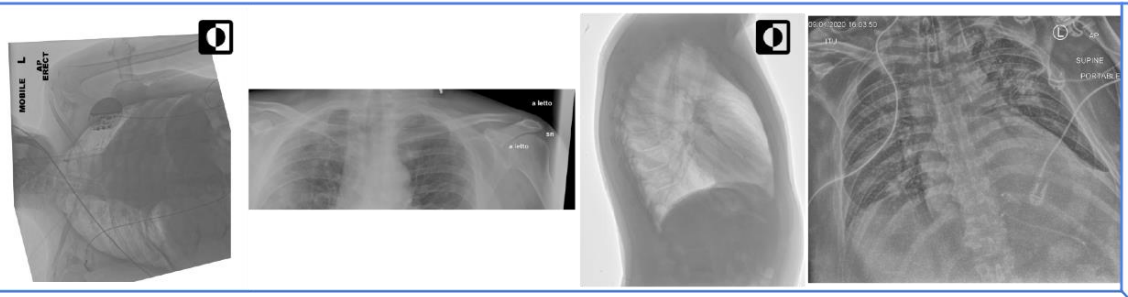
Statistical techniques

and/or

Convolutional neural networks (CNNs)

Auto-QC Pipeline

Input

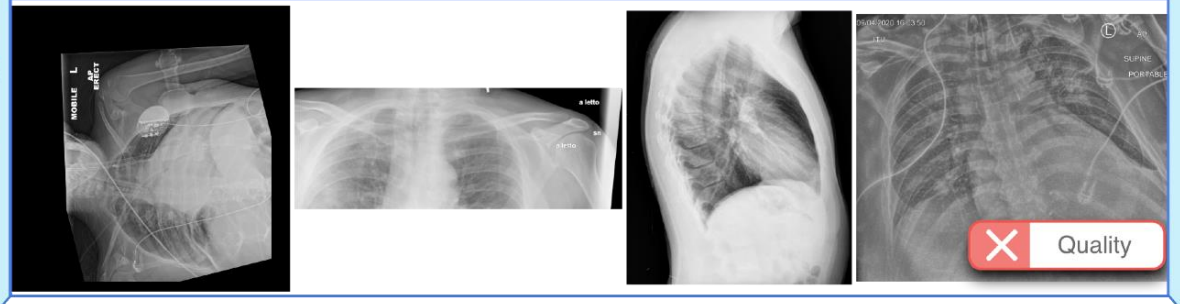


Stage 1

Initial Pixel Standardisation: LUTs / Rescaling / Windowing applied if available

Greyscale Inversion (◐): Image inverted according to DICOM header if available. AI model checks images, inverting if necessary. *[Sens./spec. for inversion = 94% / 98%]*

Image Quality: Scored using the range of pixel values in full CXR & the centre

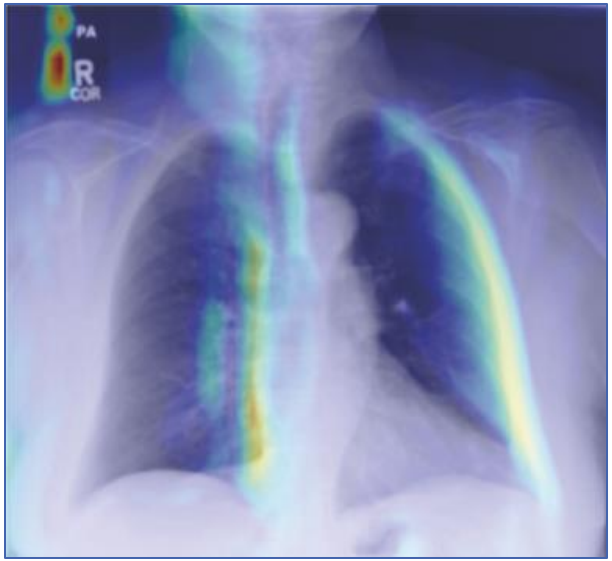


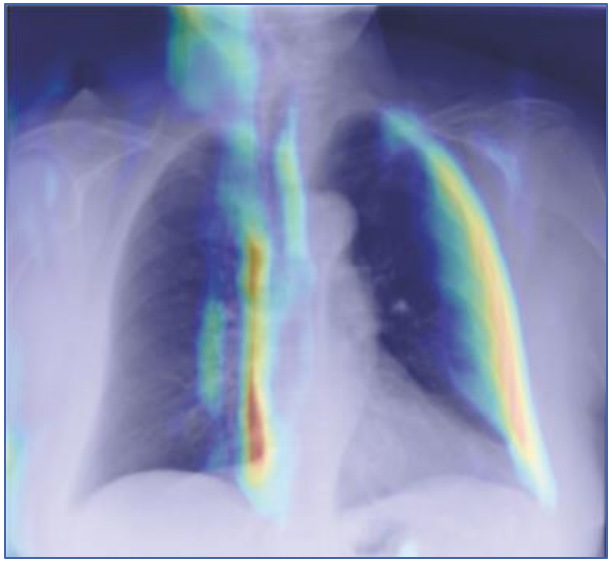
Annotations (▢): Mask created using thresholding & filters. Annotations removed by in-painting. Digital annotations fully removed & image not adversely affected in 97%

Cropping: Padding surrounding the CXR is removed

Aspect Ratio: Images with a width:height ratio <0.77 or >1.30 are flagged for

Example of a Downstream Experiment





- A classifier was trained to distinguish CXR frontal view:
  - Anteroposterior (AP) vs. Posteroanterior (PA)
- Saliency maps used to understand the features and biases

Any Questions?

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