Report

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Paper Title:
Federated deep learning for detecting COVID-19 lung abnormalities in CT: a privacy-preserving multinational validation study

Paper Link:
https://www.nature.com/articles/s41746-021-00431-6

1 Summary

1.1 Motivation/purpose/aims/hypothesis: The study aimed to develop an AI model using federated learning for COVID-19 CT abnormality detection.The hypothesis was that federated learning could enhance the model's generalizability across multiple centers without sharing patient data which is crucial during a pandemic.

1.2 Contribution: This research demonstrates the feasibility of federated learning in a multicenter environment for COVID-19 image analysis. It highlights the effectiveness of decentralized training for developing AI tools while protecting patient privacy. The study's primary contribution is in showing the successful implementation of the AI model for detecting COVID-19 while preserving privacy across varied datasets.

1.3 Methodology: The authors gathered datasets comprising CT images representing individuals with confirmed COVID-19 infections from three local hospitals in Hong Kong. To ensure consistent intensity ranges across all volumes, the Hounsfield units (HU) were clipped. Instance-level normalization was performed on the dataset, individually normalizing each volume based on its statistics rather than using global dataset statistics.During the federated implementation, each hospital served as a local node, training individual models. A central server facilitated the periodic exchange of network parameters. The FedAvg algorithm was employed to aggregate local models and update the central model. Transfer learning from publicly available DeepLesion CT Scan dataset was utilized to address data insufficiency, fine-tuning a deep convolutional network with COVID-19 training images. Post-processing involved non-maximum suppression for extracting high-confidence bounding boxes. An open-source lung segmentation AI model was then used to eliminate false positives outside the lung region.

1.4 Conclusion: The research validates the efficiency of an AI model based on convolutional neural networks (CNN), which was trained through a federated learning approach that safeguards privacy. This model demonstrates broad applicability across various regional and international cohorts, highlighting the potential of AI to offer scalable tools for estimating lesion burden.

2 Limitations

2.1 First Limitation/Critique: The first limitation of the study is the relatively small count of patients from all contributing center. Although this multicenter approach was valuable, it resulted in an imbalance between centers in terms of the number of patients contributing to the study. This imbalance could impact the model's performance, especially in the context of COVID-19, where the number of cases at each center varied.

2.2 Second Limitation/Critique: The AI model showed reduced effectiveness on the German cohort, potentially due to demographic differences in the patient populations across different regions and differences in lesion annotation procedures. This challenge points out the need for standardized procedures in multicenter studies to ensure compatibility between datasets. Furthermore, it highlights the complexities of applying AI models to datasets with significant concept shifts.

3 Synthesis

Despite certain limitations regarding sample sizes and cross-center variations, the study holds promise for facilitating real-time clinical support and continuous patient monitoring using AI-based tools. The emphasis on federated learning as a solution for healthcare applications and the challenges posed by multi-center studies underscore the potential and future pathways of AI in healthcare.

Report

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2	Qi Dou, Tiffany Y. So, Meirui Jiang, Quande Liu et al. "Federated deep learning for detecting COVID-19 lung abnormalities in CT: a privacy-preserving multinational validation study", npj Digital Medicine, 2021 Publication	1%

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