Extended Abstract
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European Stroke 2020: Stroke detection and subtype classification using Convolutional Neural Networks (CNNs)

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Introduction: The objective of this study is to identify stroke in head computed tomography (CT) scans and to classify it into an ischemic or hemorrhagic stroke using convolutional neural networks (CNN).

Methods: Brain CT images were obtained from 791 patients (Ischemic stroke = 341, Hemorrhagic stroke = 119, and Normal = 331). The patients were separated into three sets: training (n=641), validation (for parameter optimization, n=100), and test (n=50). Axial sections containing the lesions were manually selected. Skull stripping was performed to isolate brain regions5 for model training. We employed CNN, a deep learning method that classifies images without a priori feature definition, to classify the CT images. Implementation was accomplished using DLTK4 and TensorFlow using an Adam optimizer, a learning rate of 0.0001, and a batch size of 24. The model was trained over 10,000 steps. One CNN was used to classify images featuring stroke from normal images while a second CNN was used to classify between ischemic and hemorrhagic strokes.

Results: Our CNN for stroke detection successfully identified images with stroke, with a sensitivity of 0.933 and a specificity of 0.8 (F1 score = 0.901, accuracy = 0.88, area under the receiver operator characteristic curve = 0.819) at its optimal decision point. The CNN for differentiating ischemic and hemorrhagic strokes achieved a sensitivity of 0.9 and a specificity of 0.4 (F1 score = 0.818, accuracy = 0.733, area under the receiver operator characteristic curve = 0.667).

Conclusion: CNNs identified stroke in head CT images and classified it as ischemic or hemorrhagic with good performance. Implementation of CNNs for stroke classification may facilitate the analysis and classification of brain lesions, thereby reducing the time required for diagnosis and decreasing morbidities. We plan to improve our CNN for patients presenting within the first minutes and hours of an ischemic stroke due to middle cerebral artery occlusion. Further steps will include ASPECTS score calculation using these CT scans to support transfer or therapy decisions in early management. For patients presenting with hemorrhagic stroke, the intracranial hematoma volume will be calculated to decide further management.

Learning Objectives: We established a CNN algorithm to identify and classify strokes. This approach may reduce the time required to consider the next steps in personalised stroke management.

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