Arch Bronconeumol. 2021;57(2):77–78

Sociedad Española de Neumología y Cirugía Torácica SEPAR

ARCHIVOS DE Bronconeumología

www.archbronconeumol.org

Editorial

Artificial intelligence in respiratory diseases☆

Inteligencia artificial en las enfermedades respiratorias

The use of artificial intelligence (AI) in various fields of medicine has grown significantly in recent years[1]. This has been mainly due to the progress of high performance computing and the development of deep learning (DL), a subset of AI algorithms that use neural networks to learn how to solve specific tasks from expert-labeled databases.

One field of medicine that is undergoing a paradigm shift due to the application of AI is medical imaging, since the analysis of the different imaging acquisition modalities using traditional image processing algorithms (shadowing, filtering, and the use of geometric atlas, among others) has so far failed to efficiently solve complex problems, such as high-accuracy detection of lung fissures in a computed tomography (CT) study. This scenario has changed significantly in recent years, thanks to convolutional neural networks (CNN), which are a particular type of DL algorithm that learn convolutional filters from databases of labeled images. These filters are capable of extracting a large number of imaging characteristics, the sequential combination of which allows the interpretation of complex patterns, such as those present in medical images.

CNN are highly versatile, and have now opened many lines of research in tasks such as reducing image acquisition times, improving the quality of various imaging modalities, reducing the amount of contrast medium administered to the patient in certain tests, case screening, disease detection, and segmentation of regions of interest. Research in some of these fields has reached such an advanced level of development that fully AI-based products are now on the market, and these have shown benefits in clinical practice via the applicable validation processes needed for authorization as medical devices.

Classification consists of assigning CNN inputs the probability of belonging to a class, that is, an estimate of the extent to which the images contain patterns that are common to a class. In medical imaging, the automatic classification of chest X-rays with CNN has attracted special attention from both the scientific community and the industrial sector. Furthermore, large public databases with hundreds of thousands of tagged images have been released to drive the development of new algorithms in this area. One of the main catalysts of this interest is the lack of resources in radiology departments for reporting the large amount of chest X-rays that are acquired in routine clinical practice[2]. For this reason, chest X-ray classification algorithms have been developed to pre-screen images of healthy subjects so that radiologists can focus their efforts on reporting potentially pathological cases. The impact of such algorithms on clinical practice has already been measured in different studies, which have concluded that these tools can reduce the reporting time of critical studies from 11.2 to 2.7 days[3], and that the accuracy of expert radiologists in classifying normal and pathological radiographs measured by the area under the curve increases from 0.93 to 0.96[4].

Segmentation consists of delineating an anatomical region, a process that can be automated with CNN because they can assign a probability to each voxel of an image of belonging or not belonging to the region of interest. Lung segmentation is a fundamental step in the quantification of respiratory diseases by imaging studies, because it prevents the analysis algorithms from being influenced by extra-pulmonary regions. The automation of this process by CNN has achieved unprecedented results in both chest X-rays and CT scans, with a coefficient of overlap between manual segmentation by radiologists and segmentation estimated by CNN of 0.975[5] and 0.968[6], respectively, 1 being the perfect overlap value. One of the image analysis techniques that has been improved by CNN lung segmentation on CT is the automatic quantification of emphysema. This is because this technique is based on the count of voxels in the lung CT that are below a certain Hounsfield Units threshold, so the accurate estimation of the voxels belonging to the lung is essential for a correct calculation of emphysema volume.

However, not all CNN medical imaging applications are intended to improve processes in healthcare systems. Indeed, they can also be used for cyber attacks aimed at preventing successful diagnosis. For example, a Generative Adversarial Networking (GAN)-based method was developed to artificially alter CT images by adding or removing pulmonary nodules. The use of this method in routine clinical practice was simulated, and the radiological diagnosis was successfully altered by injecting false nodules into the images of 99.2% of cases, and by deleting real nodules in 95.8%[7].

In conclusion, AI techniques, and more specifically DL techniques, have enabled the development of new tools that improve healthcare processes, and have led to a paradigm shift in the evaluation of respiratory diseases by medical imaging by automating processes that currently slow down hospital workflow and by improving physician diagnostic yield. However, these new technologies also raise a number of ethical issues, such as who should be responsible for misdiagnosis when AI technologies are used for supporting decisions. Moreover, it is also possible to use these algorithms in cyber attacks to maliciously alter the correct diagnosis of

☆ Please cite this article as: López-González R, Sánchez-García J, García-Castro F. Inteligencia artificial en las enfermedades respiratorias. Arch Bronconeumol. 2021;57:77–78.

1579-2129/

patients. These scenarios will have to be taken into consideration by multidisciplinary committees so that safe and effective AI systems are implemented in hospitals in order to provide a more efficient and accurate healthcare system that improves people's health.

References

1. Pasapane F, Codari M, Sardanelli F. Artificial intelligence in medical imaging: threat or opportunity? Radiologists again at the forefront of innovation in medicine. Eur Radiol Exp. 2018;2:35, http://dx.doi.org/10.1186/s41747-018-0061-6.
2. Unreported X-rays, computed tomography (CT) and magnetic resonance imaging (MRI) scans: Results of a snapshot survey of English National Health Service (NHS) trusts. The Royal College of Radiologists [consulted 28 Nov 2019] Available from: https://www.rcr.ac.uk/sites/default/files/unreported_studies_feb2015.pdf.
3. Annarumma M, Withey S, Bakewell R, Pesce E, Goh V, Montana G. Automated triaging of adult chest radiographs with deep artificial neural networks. Radiology. 2019;291:196–202, http://dx.doi.org/10.1148/radiol.2018180921.
4. Hwang EJ, Park S, Jin KN, Kim JI, Choi SY, Lee JH, et al. Development and validation of a deep learning-based detection algorithm for major thoracic diseases on chest radiographs. JAMA Netw Open. 2019;2:e191095, http://dx.doi.org/10.1001/jamanetworkopen.2019.1095.
5. Youbao T, Yuxing T, Jing X, Summers R. XLSor: A Robust and Accurate Lung Segmentor on Chest X-Rays Using Criss-Cross Attention and Customized Radiorealistic Abnormalities Generation. ArXiv:1904.09229.
6. Xu M, Qi S, Yue Y, Teng Y, Xu L, Yao Y, et al. Segmentation of lung parenchyma in CT images using CNN trained with the clustering algorithm generated dataset. Biomed Eng Online. 2019;18:2, http://dx.doi.org/10.1186/s12938-018-0619-9.
7. Mirsky Y, Mahler T, Shelef I, Elovici Y. CT-GAN: Malicious Tampering of 3D Medical Imagery using Deep Learning. ArXiv:1901.03597.

Rafael López-González,* José Sánchez-García, Fabio García-Castro
R&D Department, QUIBIM, Valencia, Spain

* Corresponding author.
E-mail address: rafaellopez@quibim.com (R. López-González).

29 November 2019