Radiomics as a basis for transformation of radiologists skills and partnership

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Abstract. Artificial intelligence (AI) in the fourth industrial revolution is integrated into the life of modern society. Modern computer technology and software are opening the way for implementation of AI also in medicine. In fact, the position of AI in relation to medicine was unacceptable by the medical community a few years ago. Nevertheless, it is obvious today that the development of IT, including AI, has an impact on the quality of medical care, particularly of diagnosis. Integration of AI systems as an organisational innovation in the work of medical institutions is a significant challenge. It involves the revision of some aspects of the professional education and of issues of the interdisciplinary interaction. A scheme of effective cooperation of specialists of IT and radiologists is proposed in the paper. It aims at the permanent development of AI systems and their implementation in a daily medical practice and proposed by an example of the medical intellectual computer-aided diagnostic system Doctor Alzimov.

1. Introduction

Applications of artificial intelligence (AI) in medicine today are mainly related to automation of medical expert opinions, planning of programs to improve patient care, predicting a diseases course, choosing an optimal treatment. In particular, AI in radiation diagnosis becomes a powerful tool for 3D modeling, improving image quality in low-dose scanning, making decisions when interpreting data [1]. Many available diagnostic AI-based systems use data processing without taking into account the clinical and radiological classifications accepted in the medical community [2]. However, this data processing can be considered in the framework of radiomics which refers to the computerized extraction of data from radiologic images, and provides unique potential for making different medical tasks using machine learning algorithms, as an example making lung cancer screening more rapid and accurate [3]. Radiomics can be also viewed as a doctor’s view on the supervised learning approach used in medical intellectual computer-aided diagnostic (ICAD) systems, where a doctor plays the role of an expert for “training” a system. This view only partially touches on the data scientist point of view how an ICAD system should be constructed. This means that the development and implementation of ICAD systems is impossible without participation and effective interaction of experts with different professional backgrounds. In order to improve the developed ICAD systems, to update and structure datasets of diseases and to adopt them to the medical practice, to be incorporated into the AI world, doctor’s skills should be transformed to be as close as possible to data scientists.
With respect to the above, we propose a new scheme of the efficient cooperation of the data science experts with doctors (mainly radiologists) aimed at the development of ICAD systems and their incorporation into medical practice. This scheme can be viewed as a new radiologist’s transformation approach to diagnostics and to data processing in the framework of radiomics. We illustrate ideas of the radiologist involvement into the ICAD system development and updating by using a new ICAD system for lung cancer diagnostics called Doctor Azimov.

2. A radiologist’s role in the transformation approach to the development of ICAD systems

Traditionally, the processes implemented by a radiologist during the development of IADA are currently associated with the data collection phase [4, 5], that is, they are limited only to obtaining diagnostic data and contouring pathology images. In the developed system Dr. Azimov, the radiologist activity is expanded as follows:

1) Data acquisition. Images for further processing have to be homogeneous. In particular, a series of CT chest scans carried out with a slice thickness which is smaller than 2 mm with intravenous contrast enhancement (arterial phase) is used for implementation of machine learning algorithms in the Doctor Azimov system. The possible data heterogeneity may lead to significant classification errors.

2) Analysis and preliminary conclusion. This stage is the usual professional activity of the radiologist. After a preliminary conclusion about a disease, the patient data is stored on the hospital server until the disease is confirmed on the basis of the morphological, clinical, X-ray, or laboratory verification.

3) Control of pathology verification. The diagnosis confirmation is exactly the starting point for training the ICAD system because it allows us to minimize inaccuracies at the output of the system and to improve its characteristics.

4) Pathology contouring and annotating. For various modalities of radiation diagnostics, contouring can be implemented depending on a stated task. In particular, contouring in the Doctor Azimov project is carried out through a specially developed software MAIA (Medical Artificial Intelligence Assistant), which differs by contouring of lung objects on the basis of multiplanar reconstructions of a series of CT allowing us to contour a pathology in 2-10 times faster (depending on the nodule size) [6].

5) Feature definition (for future feature extraction by data scientist). Features that will be taken into account and taken as a basis for machine learning are selected in accordance with the up-to-date clinical and radiological classifications of diseases and criteria for their assessment adopted by the medical community. For example, the PIRADS criteria form a basis for estimating the prevalence of prostate cancer and also for implementing the machine learning algorithms [7, 8]. Features of a tissue shape, its internal structure and external environment (the structure of the surrounding lung tissue) are selected for implementing the ICAD system Doctor Azimov [6, 9].

6) Formation of data base. Datasets can be organized as a single dataset or divided into several subsets depending on types of containing pathologies. For example, the well-known dataset LIDC collected to train the lung lesions segmentation and classification algorithms is usually divided into subsets depending on the size of lesions detected by three radiologists. The dataset LIRA (Lung Image Resource Annotated) [9] is divided into subsets depending on the nodule malignancy patterns in the lung and in accordance with the morphological verification.

Thus, on the one hand, the expansion of the radiologist functional tasks brings the machine learning algorithms closer to the doctor’s logic, that is, it allows to develop a explainable ICAD system. This is an important condition of its usage in clinical practice. On the other hand, it allows us building an ICAD system based on clinical and radiological classifications. In addition, this approach allows the radiologist to contribute to the improvement and modification of the
system and, at the same time, to increase the level of its own competence because the disease verification control and the dataset acquisition improves the feedback between the preliminary and final diagnosis. The implementation of an expanded set of tasks is possible only when the radiologist receives basic knowledge in machine learning and AI.

3. Radiomics in ICAD Doctor AIzimov
The activities which are carried out by data scientist’s team are dedicated of data processing steps and data transferring control. Feature extraction should be corresponded to the tumor patterns chosen by the radiologist. Feature extraction by the tumor’s shape for ICAD system Doctor AIzimov is realized by chord method (NEOchord) [9]. For tumor structure analysis the feature vector is extend by histograms of radiodensities. It means that radiodensities in several points of each chord are measured. The central-peripheral gradient of radiodensity also taken into account [6]. The implementation of machine learning approaches which would be closer to “doctor’s logic” becomes possible with multidisciplinary information exchange.

The ICAD system in the practice of Oncological Oriented Center is implemented with cloud service, integrated with a supercomputer of Peter the Great Polytechnic University. CT-scans are transferred from the PACS to the AIzimov hospital server, anonymized automatically and pass to supercomputer for processing. After that data is sent back to the hospital server with previous results where the doctor can analyze them.

The task of the personal data protection can be implemented in two ways. Data anonimization can be carried out by the doctor with the assignment of a personal code that does not contain information about the patient. Also it would be done automatically with the appropriate software. In case of ICAD Doctor AIzimov, patient’s personal data are anonimised automatically in the way from hospital to supercomputer server [9].

4. Conclusion
Medical images which are obtained by radiodiagnostic methods are the basis of development of AI algorithms (radiomics). For the most effective feature extraction, it is necessary to use the objective confirmation of tumor patterns. This process is not possible without a radiologist who is oriented in changeable of tumor biologic behavior and it’s clinical particularity. The formation of datasets which would include morphologically confirmed pathologies is more effective with the doctor’s engagement. And vise versa doctor’s experience is not enough for realizing all possible radiomics instruments for developing ICAD systems. So, the partnership in the AI-team involves the expansion of skills and knowledge of both the radiologist and the data scientist.

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