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EDITORIAL

Medical imaging informatics, more than 'just' deep learning

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Introduction

The past years, medical imaging informatics research has increasingly been dominated by Artificial Intelligence (AI) as the primary topic and then especially deep learning (DL). DL applications for detection, segmentation, diagnosis and prediction are an ever-growing part of the abstracts received in international conferences and the main topic of many courses and meetings. However, the field of medical imaging informatics as defined in the ESR Training Curriculum includes a multitude of different topics (https://www.myesr.org/education/training-curricula). Because of this, also this year, we still see a variety of abstracts covering the most recent developments in different medical imaging informatics topics. This year, this resulted in 27 orally presented abstracts from all over the world in roughly 12 different topics. This number is excluding all abstracts that were submitted to the section of AI and DL. Two main Imaging Informatics topics are the increased use of radiomics & texture analysis and the more extensive application of Business Analytics and data mining.

Radiomics and texture analysis

One of the major research trends, evident from the number of abstracts (~50%) directly on or related to this topic, is radiomics. The gaining popularity, especially among the research community, is due to its symbiosis between high-throughput data and clinical decision making.

Radiomics can be defined as a data mining approach aiming to extract high-dimensional data in the form of a multitude of features from clinical images for building machine learning (ML) or statistical models. Radiomics can be applied to various imaging modalities (MR, DXA, US, and CT examples are presented) to answer relevant clinical questions in various anatomy and pathology including Head & Neck Masses, Pancreatic fistulas, hip osteoporosis, lymph nodes and lung disease. The successful application of radiomics depends on the different stages in image analysis such as image acquisition, feature extraction and model validation [1–5] (fig. 1). Each stage needs to be carefully evaluated to achieve reliable construction of a model that can be transferred into clinical practice for the purposes of prognosis [4], disease prediction [3], and evaluation of disease response to treatment [5].

As part of the radiomics approach, ML techniques can be employed to learn from given examples and detect hard-to-discern patterns from large and complex data sets [2, 3]. This approach leads to the selection of quantitative features that may not be straight forward for a human observer. Although, the performance of radiomics models are fluctuating due to high-dimensionality features, some studies report performance that exceeds that of radiologists [3]. One of the additional advantages of radiomics is that the outcome is shown to be less susceptible for changes in the acquisition protocol [6].

In recent studies, common limitations pertaining radiomics are related to reproducibility and generalizability. These two aspects are often challenged by the relatively small amount of data available [1, 4, 5], the limitation to data from only one single medical centre, and the lack of independent external validation that is needed to to assess generalizability [2, 3] and clinical applicability [1].

Business analytics and data mining

The widespread adoption of IT systems in the past years also resulted in growing databases containing a diversity of data on the business side of radiology. These allow us to perform data

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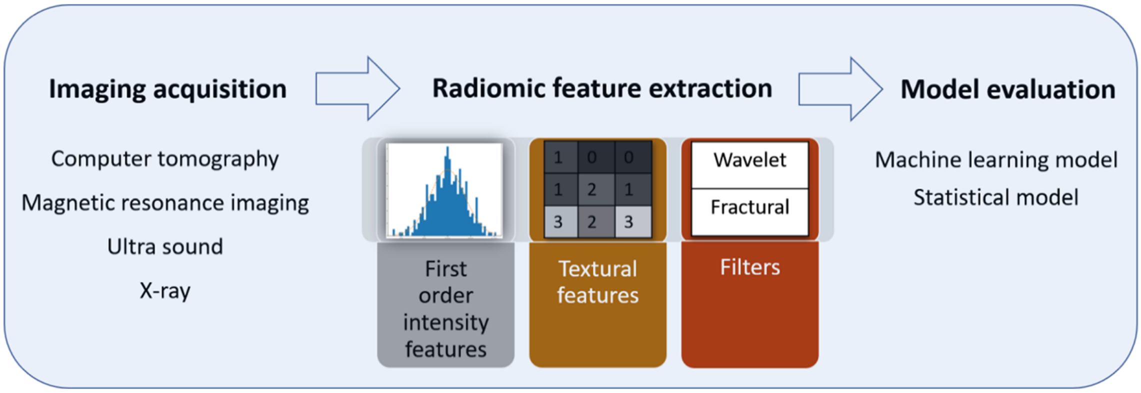

Fig. 1 Illustration of radiomics workflow for various application involving image acquisition, radiomic feature extraction and model evaluation for diagnosis and prediction

mining and analytics to get more insight into issues related to the radiological business processes. In many cases, the ability to perform analytics relies on the use of structured data captured in digital information systems.

Analytics can be performed on the IT systems running within the healthcare system itself. For example, to use the information captured in the Picture Archiving and Communication System (PACS), Radiology Information System (RIS) and/or Electronic Medical Record (EMR). Using structured information from these sources, questions can be answered on a departmental level such as "should we perform all radiological tests that are requested? [7]" and "What are the trends in diagnostic imaging [8]". It could also provide insight in the way radiologists work, for example by exploring the satisfaction of radiologists concerning peer review [9] or by evaluating the radiology workload [10, 11]. These kinds of analyses will provide insight in the current quality of radiological work and allow to track improvements after implementation of new interventions. A good example of this is the work by Vosshenrich et al [12], where they showed that there are shift dependent trends in the completeness of preliminary reports dictated by radiology residents.

When performing analytics, they can also be used to benchmark against other institutions to look at aspects like image quality or operational metrics. Szatmari et al. [13], for example, collected data from 112 MR systems in 11 countries to implement proactive operational improvements in the local hospital increasing the number of patients and machine utilization.

Imaging IT also has a role in regional quality improvement by implementing teleradiology [14], and IT innovation is an essential component of radiology oriented global health initiative programs [15].

Besides the technical implementation, the human-machine-interaction aspects of IT developments are also of vital importance. To evaluate this impact of IT systems, registration of user information is a valuable asset. For example, analysis of this type of data can provide information about PACS user acceptance [16], the impact of innovative teaching systems [17], and the professional use of social media [18]. These insights could contribute to future developments, as they explore areas for improvement. Awareness of the preferences of referring physicians helps to contribute to valuable innovation, for example, in the development of structured reporting tailored to specific clinical conditions [19].

Conclusion

The impact of developments in imaging informatics on the day-to-day work of the radiology department is significant. With the development of Imaging Informatics and the implementation of an increasing number of (automated) software tools, the way radiologists are trained is also changing. Currently, most radiologists lack knowledge and skills in the area of imaging informatics although there is a clear will to learn about these topics [20]. Studies have shown that most radiologists and residents agree that academic training in imaging informatics should be implemented although it is also recognized that time constraints during radiology training hampers the inclusion of imaging informatics [20].

The fast developments in Imaging Informatics combined with the increasing (technical) complexity has resulted in the promotion of multidisciplinary collaboration to drive innovation in radiology [21]. Medical and technical professionals should work together to ensure optimal development and utilization of Imaging Informatics tools in radiology.

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Methodology
• No specification required, as it is an editorial.

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