[SY16] GU Symposium

SY16-01

Radiomics and Machine Learning in Gynecology Oncology MRI

Gigin Lin

Medical Imaging and Intervention, Chang Gung Memorial Hospital, Taoyuan, Taiwan

This talk reviews the critical concepts of **Radiomics**and **Machine Learning**, describes emerging applications in **Gynecology Oncology**, and outlines the limitations and future directions in this field. The aim is to help the audience to integrate machine learning into clinical workflow. Radiomic analysis exploits sophisticated image analysis tools and the rapid development and validation of medical imaging data that uses image-based signatures for precision diagnosis and treatment, providing a powerful tool in modern medicine. Ideally, high-throughput mining of quantitative image features from standard-of-care medical imaging that enables data to be extracted and applied within clinical-decision support systems to improve diagnostic and prognostic accuracy. Machine learning refers to computer algorithms that improve with the exposure of more data, and deep learning is the subtype that attracts particular interest in radiology. Deep learning has the benefit of not requiring feature identification and calculation as a first step; instead, features are identified as part of the learning process. For computer vision tasks such as radiology, convolutional neural networks have proven to be effective. The weightings of connections between nodes or neurons are iteratively adjusted based on the inputs and target outputs by back-propagating a corrective error signal through the network. Recently, early clinical applications of machine learning based on MRI have been proposed and studied ingynecology oncology. Radiologists who become familiar with the principles and potential applications of machine learning would have the opportunity to leverage radiomics and machine learning to become a centre of diagnostic information to improve patient outcomes.

Keywords : Cervical Cancer; Endometrial cancer; Radiomics; Machine learning; Gynecology oncology; MRI

[SY16] GU Symposium

SY16-02

Radiomics and Machine Learning in Prostate MRI

Sung Kyoung Moon

Department of Radiology, Kyung Hee University Hospital, Seoul, Korea

Multiparametric MRI (mpMRI) for prostate cancer is widely used and robust modality to stratify the risk of the prostate cancer. The Prostate Imaging Reporting and Data System (PI-RADS) version 2 is the reproducible method for the assessment of prostatic lesions on the mpMRI. The MR-guided or MR-US (ultrasound) fusion guided biopsy can be performed base on the PI-RADS assessment. It has improved the diagnostic performance on the diagnosis of prostate cancer and treatment planning. However, the interpretation of the prostate lesion on mpMRI requires the considerable clinical experience and usually takes long period of learning and training the qualified experts. The many previous studies and some multicenter studies reported the various interobserver agreement. This is a hurdle to overcome as radiologists.

AI (Artificial intelligence) is on the rise as the solution of aforementioned problems. Deep learning is the class of machine learning which is also the subfield of artificial intelligence. Deep learning is a type of learning in which the algorithm learns a composition of features that reflect a hierarchy of structures in the data. It is widely used in computer vision, speech recognition, natural language processing, playing games, etc. Deep learning extracts the features directly from data and has very complex process architectures. So called “black boxes” problems are inscrutable even though some strategies used for better understanding. However, some deep learning methods have shown the outstanding performances in the computer vision field. Convolutional Neural Network (CNN) is a well-known deep learning method, which is most effective in imaging, and has been used in medical imaging.

Radiomics - which generates high-dimensionality datasets from radiology images - provides insights to support precision medicine. Novel approaches have improved sharing of images and image-derived findings with patients and clinicians. Current research efforts go beyond pixel data to integrate imaging with other biomedical data, standardize imaging workflows, and improve the quality and utility of image-derived information in clinical practice.

This session reviews key advances in imaging informatics research in prostate MRI.

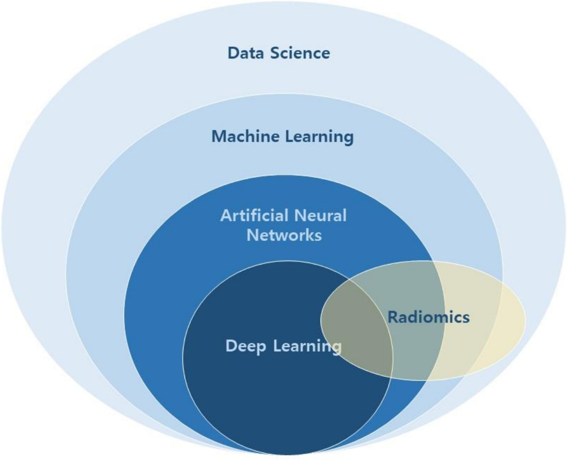

Figure 1. Diagram of the relationship between data science and radiomics

Keywords : Prostate, MRI, Radiomics, Machine learning, Deep learning

[SY16] GU Symposium

SY16-03

Radiomics and Machine Learning in Renal Oncologic Imaging

Sung Il Hwang[1], Hak Jong Lee[1], Seok Min Han[2], Helen Hong[3]

[1]Radiology, Seoul National University Bundang Hospital, Seongnam, Korea, [2]Computer Science, Korea National University of Transportation, Uiwang, Korea, [3]Software Convergence, Seoul Women's University, Seoul, Korea

The wide use of cross-sectional imaging leads to increased detection of renal tumors. As the tumor size smaller, the prevalence of benign tumor is known to be higher. Therefore, the differentiation of small renal cell carcinoma from benign small renal mass is critical to achieve proper management. Moreover, nephron saving surgery is now regarded as the standard surgery for renal mass, understanding renal anatomy and vasculature is also important for the presurgical planning.

There are a few suggested applications of AI and radiomics for small renal mass. Clinically, the differentiation between small renal cell carcinoma and rare variant of angiomyolipoma named as angiomyolipoma with minimal fat is very important and difficult. Macroscopic fat is the key imaging findings of typical angiomyolipoma, however, angiomyolipoma with minimal fat does not have gross fat. Precontrast CT scan, histogram analysis of CT, chemical shift imaging from MRI are used for the differentiation.

Image feature analysis using hand-crafted features (HCF) were used for the differential diagnosis of two diseases. Clear cell RCC generally has greater inhomogeneity in terms of the texture, and it has a more rounded appearance in terms of the shape as compared to AML with minimal fat. However, there is also a limitation in that the adaptability of these pre-defined features to a novel problem is occasionally degraded, which limits the learning performance. Recently, a deep feature classification (DFC) framework has been applied to this differentiation, where it trains classic ML methods using deep features (DF) extracted from neural network models without a feature learning process. DFC can improve the performance over conventional ML methods by using DFs that are proved to be superior to HCFs for natural images. As a result, the proposed method achieved the accuracy of 76.6±1.4% for the proposed HCF+DF with AlexNet and TIPs, which improved the accuracy by 6.6%p and 8.3%p compared to HCF-only and DF-only, respectively.

Subclassification of renal cell carcinoma is also important. Because, the biologic behavior is different and target therapy is dependent on cell types. We have reported subclssification of renal cell carcinoma by deep learning. Images with different phases were coded as red, green and blue. After registration of each CT scans, the images with different colors were superimposed one another to create one RGB image per each level of CT scan. GoogLenet v3 was used for deep learning tool after augmentation of images. Sensitivity, specificity, and area under the receiver operating characteristics curve (AUC) were measured and compared with an expert uroradiologist. The AUC of test set by deep learning for differentiating chromophobe RCC from other subtype was 0.923 (sensitivity, 90.59%; specificity, 89.84%). The diagnostic performance of the radiologist was AUC of 0.754 (sensitivity, 83.3%; specificity, 65.2%). The AUC of test set by deep learning for differentiating papillary RCC from other subtype was 0.782 (sensitivity, 62.8%; specificity, 83.8 %), while AUC by the radiologist was AUC of 0.884 (sensitivity, 70.0 %; specificity, 84.0%). The deep learning algorithm can differentiate RCC as the expert radiologist.

Keywords : Kidney, Radiomics, Deep learning, Machine learning