Publishing linked and FAIR-compliant radiomics data in radiation oncology via ontologies and Semantic Web techniques

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Keywords: Ontologies, Radiation Oncology, Radiomics, Imaging.

1 Introduction

Medical images potentially embed much more information ('features') than can be exploited via visual inspection. Radiomics, the automated extraction of informative quantitative imaging features from patients' scans, could provide additional knowledge besides clinical prognostic factors for decision support systems in radiation oncology[1]. However, several limitations exist: no consensus on radiomics features' standardization, strong feature dependencies on how images are acquired and on settings (e.g. digital image pre-processing) defined for computations, poor quality of reporting and lack of transparency[2]. The IBSI (Image Biomarker Standardization Initiative) is a worldwide effort aiming at the standardization of radiomics computations[3]. One of the pillars of the IBSI workbook is that simply recording and comparing raw features values is not enough. Storing metadata associated with features computation, as well as the possibility to overcome differences in nomenclature between different computational packages to guarantee their interoperability and reproducibility in multi-center studies is needed. Also, radiomics data and metadata should be connected to corresponding clinical data (linked data) as input for AI algorithms. In this study, we present a proof-of-concept study using our newly developed radiomics ontology, combined with Semantic Web technologies, as instrument for enabling interoperability of radiomics data following FAIR principles: a) Findable→ associated radiomics studies data and metadata have unique identifiers as per the Radiomics Ontology (RO); Accessible→ metadata and data for a radiomics experiment are permanently stored in repository (e.g. SPARQL endpoint); Interoperable→ via universal concepts defined in the RO full experiment results and methods can be retrieved; Reusable→ data and metadata can be re-used to re-produce the study.

2 Material and Methods

We developed a the radiomics ontology (RO)[4]: 458 classes and 76 predicates covering the whole spectrum of the workflow of radiomics computation, fully compliant to the IBSI guidelines. To test the RO, two institutions used two different open source radiomics packages in a blind fashion to extract radiomics from a publicly available dataset of CT scans of lung cancer patient. Each institution converted features and associated metadata of their experiments to RDF triples and uploaded to a SPARQL endpoint.

3 Results

Each of the users could independently query all the features generated from the other institution, without having any prior knowledge of the original labels used to store features and associated computational details. Using SPARQL queries, we could for example extract properties of the software used for computations from the other institution. Finally, radiomics features were linked to corresponding clinical data. To help the users with familiarize with this experiment, the full proof of concept is available at https://github.com/albytrav/RadiomicsOntologyIBSI.

4. Conclusion

Ontologies and Sematic Web technologies allows the integration of radiomics with multi-source clinical data for biomarker discoveries. The Radiomics Ontology could speed up harmonization, standardization transparency of radiomics studies.

References

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