Efficient visual image search in clinical radiology

By Georg Langs

Imagine the following: you're looking at a high resolution CT and see a pattern you are uncertain about. You click on the image and within a few seconds get all cases in your department, or region, containing similar patterns, together with the corresponding report; that's all before you even enter a search keyword. The patterns that match your query are highlighted, and you can quickly browse through them and the attached reports. Wouldn't that be helpful?

Search and information retrieval is an active area of research. Since the advent of internet search engines we know that they are a driving-force in knowledge acquisition, and have become central to our daily work. We understand that retrieval is only useful if it is able to deliver reliable information efficiently, and if it answers a specific need for information. Recent findings have highlighted the potential of fast, efficient and accurate information retrieval to contribute substantially to improving radiological reporting.

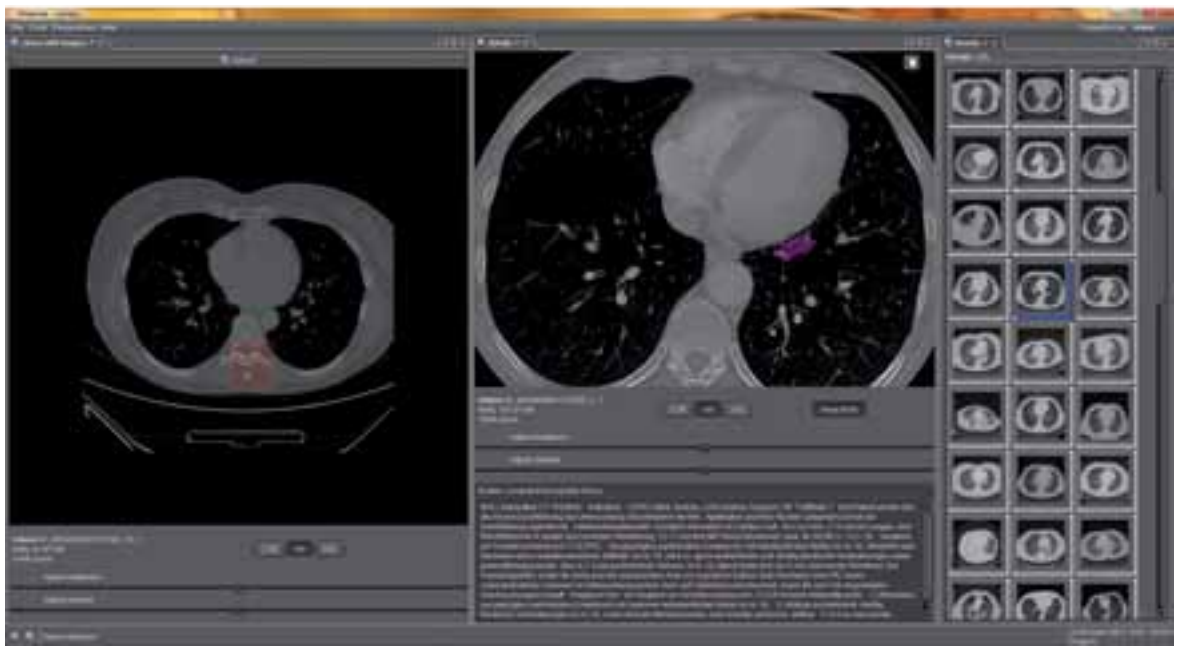
Since 2010, the European Union has been funding the integrated project KHRESMOI. It is a joint effort to develop a multilingual and multimodal search system for biomedical information. The central user group which the project focuses on is radiologists and their information needs during daily routine, research, or teaching. Queries in such a search system can be based on a few keywords, an image, or both. The system presents results together with relevant information that facilitates quick browsing, and provides transparency regarding the source and its quality. Sources range from literature databases and secondary sources to image databases (PACS) within hospitals.

Visual queries: searching the PACS for patterns in image data

A particularly relevant area of radiological research is content-based image retrieval (CBIR). The aim is to use image data itself – for instance a region of interest in a CT volume marked by the user – to query large image databases for similar patterns, and to provide the user with quick access to the corresponding data, such as images, reports, or even outcomes.

The key to successful content-based image retrieval is the extraction of visual features that capture relevant characteristics of the imaged structure, together with fast matching and ranking algorithms that robustly identify similarities across millions of samples. CBIR, in the context of radiology, raises additional challenges to those in other domains. The visual information relevant to matching pathological features is often subtle compared to differences across organs. The variability of anatomical appearance, even in a healthy population, renders the learning of models challenging.

Nevertheless, search results from realistic samples of several terabytes of medical imaging data have proved promising. The automatic identification of anatomical structures and the location of images work accurately. Initial results on the retrieval of anomalies suggest that methodology developed at the interface of machine learning, computer vision and medical imaging can provide clinically relevant search results. Current research is focusing on further improving the accuracy of the search.



An early version of the search system, showing the query case, and results together with the corresponding radiology report data.

Scaling methods to make use of large data

A central insight is that transitioning from hundreds of data examples to millions changes many established paradigms. On the one hand, it makes efficient algorithms for matching and representation essential. On the other hand, the enormous amount of variability represented in the data allows for far more comprehensive models to be learned, while at the same time attracting attention to unsupervised modelling approaches. The methodological challenges touch on interesting mathematical problems ranging from basics such as graph theory, or algebra, to machine learning and pattern recognition.

While methodological research continues, there is agreement regarding the goal. The knowledge that can be gained from millions of radiological imaging data, which have only been examined once so far, is tremendous. Make it more accessible, and gaining structure from this data are key to helping clinicians, researchers and teachers take full advantage of it.

KHRESMOI (www.khresmoi.eu) is an integrated project (IP) funded by the European Union aiming to develop information retrieval systems for patients, medical professionals, and in particular radiologists. The CIR Lab (www.cir.meduniwien.ac.at) at the Medical University of Vienna leads the work package on large scale biomedical image search. Video demo: http://tinyurl.com/ck6vm53.

Georg Langs works at the CIR Lab at the Medical University of Vienna, Austria.

Georgians become regional leaders in radiology

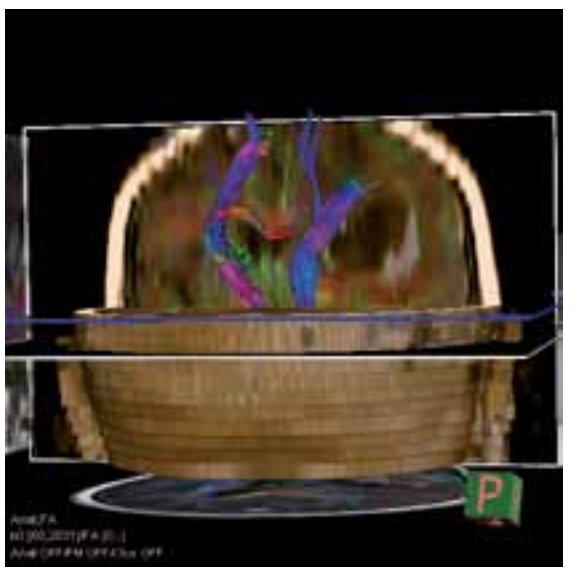
By Fridon Todua

The Georgian Association of Radiology (GAR), since its foundation in 1995, has played a very important role in the development of radiology in Georgia, and it continues to contribute to the development of radiology. Due to its work, various specialties in radiology and therapy such as CT, MRI, US diagnostics, nuclear medicine and radiotherapy have been brought together as one discipline; medical radiology. The association organises international congresses, symposia and seminars. There are also training courses dedicated to various fields of radiology for young specialists.

Scientific research takes priority in the activities of the Georgian Association of Radiology. Many members of GAR have scientific degrees and young radiologists have been awarded grants. Many young members of the association have participated in the ECR and the RSNA's Annual Meeting, as well as in conferences and workshops throughout Europe. In Georgia a radiologist must master all areas of radiology. We have a three-year residency programme with one year for subspecialisation and doctoral study. In the first term of residency they study roentgenoanatomy. After residency, young specialists perfect their skills in the subspecialty of their choice. We consider the postgraduate period of teaching to be our great achievement: after receiving their degree, young doctors who pass their exams receive licenses which are in accordance with European standards. During this period, alongside radiology training, they attend lectures and take courses on different subjects: e.g. surgery, neurology, etc. As a result we have achieved our main goal; doctors and radiologists who are clinically-oriented.

One of the main goals of our association is the development of medical radiology through the unification of the medical, scientific and technical resources of our country.

The Research Institute of Clinical Medicine at the University Clinic is the main scientific base of the association. It is equipped with four MR scanners with which investigations are carried out using functional MRI imaging, tractography and MRI spectroscopy. These methods are used for the presurgical diagnosis of patients. There are 64-, 128- and 640-slice CT scanners as well. The 640-slice CT enables radiologists to make a precise diagnosis of cardiovascular and brain pathologies. It is also possible to investigate brain perfusion and perform CT coronarography. Today in Georgia, the Research Institute of Clinical Medicine is the only institution that has a department of nuclear medicine equipped with two E. Cam systems. These conditions attract young specialists from all over the southern Caucasus to master radiology.



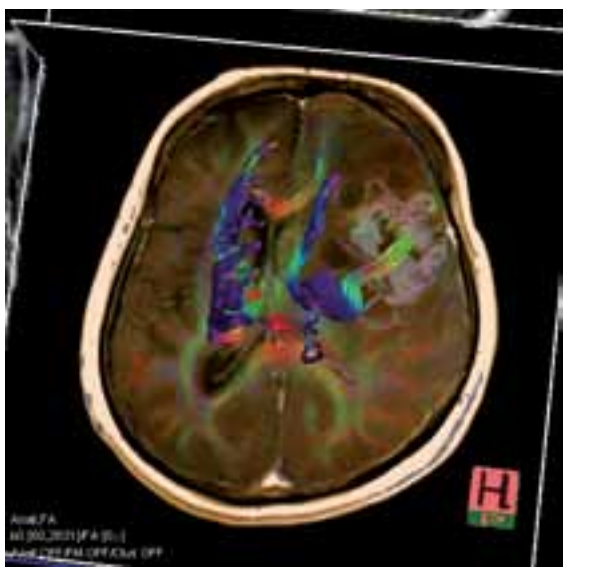


Figure 1 and 2 display deviation and disruption of white matter tracts by the infiltrative intraaxial glial tumour.

In recent years, with achievements in advanced methods in medical radiology, the Institute of Clinical Medicine, as a leading institution in this field in Georgia, is applying new methods of investigation, research and therapy in our country. The new high-field MR and 640-slice CT scanners have given us the ability to investigate not only structural, but also functional changes during different diseases. FMRI, arterial spin labelling, diffusion tensor imaging, magnetic resonance spectroscopy, and perfusion CT; these advanced methods give us unique opportunities for research. At the same time the obtained results can be implemented in clinical routine. In Georgia, surgery and neurosurgery, in particular, have benefited a great deal from these techniques – surgery can be planned with more precision and postsurgical outcome is better in these cases; indeed it is very efficient for the general surgery as a whole.

Considering the modern technical equipment and high professional standards of radiologists in Georgia, it has developed a reputation as regional leader in the Caucasus. Specialists are referring patients from many parts of the southern Caucasus to Georgian centres.

Professor Fridon Todua from Tbilisi, Georgia, is the President of the Georgian Association of Radiology.