MAGAZINE EXCLUSIVE

GETTING MORE FROM LARGE-SCALE 3D RADIOLOGY IMAGE DATA

EU-funded researchers with the VISCERAL project are organising benchmarks to process large-scale 3D radiology image data with the ultimate aim of generating new medical knowledge.

It is estimated that medical imaging data occupies 30 % of all data storage worldwide. However, because this data is unstructured in the form of images which are all different, it is very difficult to use it to gain new knowledge about disease prevalence and disease development. The EU-funded VISCERAL (Visual Concept Extraction Challenge in Radiology) project is organising benchmarks for algorithms that can automatically turn the unstructured image data into semi-structured data. The ultimate aim is for new medical knowledge to be generated from the data for the benefit of patients and the research community at large.

"Ultimately, VISCERAL's work will provide an unprecedented dataset on which to develop and test algorithms for the analysis of medical images."

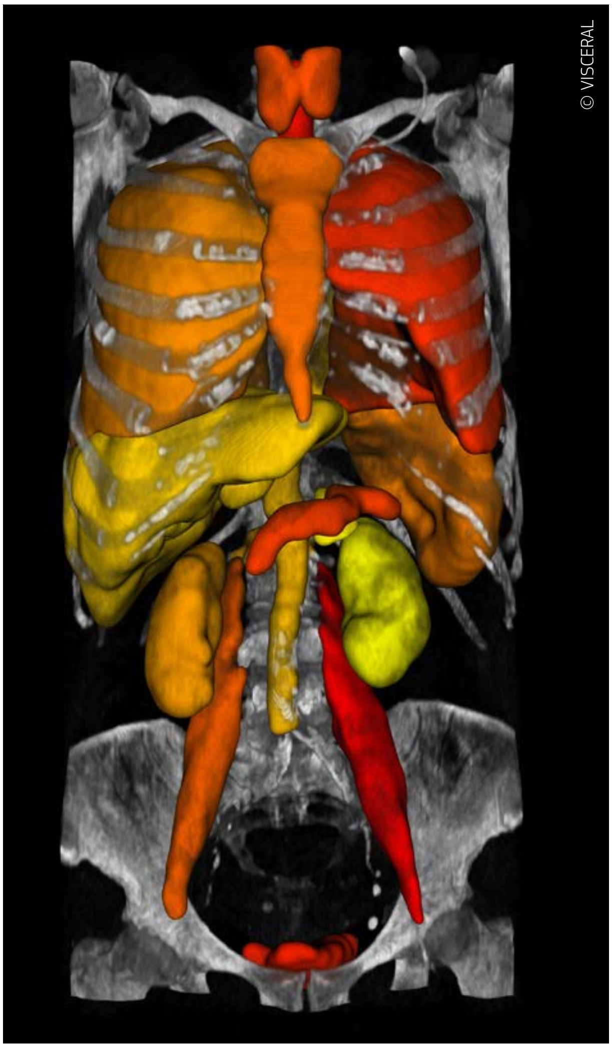
The VISCERAL project, which has been running for two years and comes to an end in April 2015, has made impressive headway towards its objectives. The team created an evaluation infrastructure and software which has already been used in two completed and three ongoing anatomy benchmarks. These benchmarks facilitate the development of algorithms that can automatically turn the unstructured image data stored in radiology information systems in hospitals into semi-structured data.

Project coordinator Allan Hanbury from the Vienna University of Technology explains how the completed benchmarks worked: 'They involved the automated localisation and segmentation of organs in CT (Computed Tomography) and MRI (Magnetic Resonance Imaging) images of humans. We provided images and ground truth on the organs, and challenged participants in the benchmarks to create algorithms to do this automatically. We then tested the algorithms submitted by participants on images that they had never seen.' The benchmarks provided information on which submitted algorithm performs best for which organ or structure.

'Training' algorithms to automatically recognise organs or pathologies in radiology images requires large amounts of training data to learn from. The VISCERAL team has adopted two approaches for getting this training data: a gold corpus and a silver corpus. Mr Hanbury elaborates: 'The gold corpus is created by qualified radiologists manually annotating the radiology images, which means that the annotations are very accurate, but we cannot get many annotations as a radiologist's time is expensive. The silver corpus is less accurate but there is no limit on how many annotations can be created. The silver corpus is created by fusing the submissions by participants in the benchmarks. The results of the fusion are better than each of the individual submissions, and can hence be used to train new algorithms.'

The benchmarks currently underway (focused on anatomy segmentation, lesion detection and the retrieval of radiology images and reports) were actually an unforeseen addition to the project work plan, made possible by sponsorship for the cloud infrastructure used by the team. VISCERAL's innovative cloud-based evaluation approach is another key aspect of the project. It allows for the data to be centrally stored on a cloud on which the benchmark participants have programmed their approaches to the benchmarks in Virtual Machines. Mr Hanbury adds, 'In effect, we are bringing the algorithms to the data, rather than the traditional approach of bringing the data to the algorithms. This makes sense, as the programs implementing the algorithms are significantly smaller than the data on which they operate.'

The VISCERAL team has certainly enjoyed significant success over the past two years, but naturally this complex task has also presented it with challenges. The sheer size of the images and the volume of data have been an issue, as Mr Hanbury explains: 'The data handling has been the greatest challenge. We are working with a large number of huge 3D images, so transferring the data between various systems and ensuring



that the quality of images is good enough for what we want to do with them have been challenging. Furthermore, ensuring that the manual annotations are of high quality has required some effort, as radiologists do not always fully agree with each other on the positions of the boundaries of the organs.'

Although VISCERAL is heading into the last few months of the project, the team is far from slowing down the pace of work. In fact, team members are currently running three benchmarks with submission deadlines in March 2015. They will gather to discuss the results of these benchmarks at two workshops next year. In parallel to this, the team is carrying out further analysis of the results of the first two anatomy benchmarks to extract the largest amount of knowledge from having run them.

Additionally, they are finalising the images, gold corpus and silver corpus for scientific use, as Mr Hanbury explains: 'Making the images, gold corpus and silver corpus available for scientific use beyond the end of the project will allow computer scientists to continue to improve the automated radiology image analysis algorithms. We have now satisfied an ethics committee that this will be done in a responsible way, so the data generated in the VISCERAL project will continue to be available for scientific use after the end of the project. In terms of lasting scientific impact, this is a very significant point.'

Ultimately, VISCERAL's work will provide an unprecedented dataset on which to develop and test algorithms for the analysis of medical images. The conversion of unstructured medical image data to semi-structured data will allow new medical knowledge to be generated from this data which will be significant for the medical community and patients.

Considering VISCERAL's significant achievements, it's hardly surprising that the team is keen to build on the project's momentum, as Mr Hanbury concludes: 'We are working on potential follow-up projects. One particularly pressing challenge to getting this approach to evaluation more widely accepted is to provide more flexible Virtual Machines on the cloud; and we are currently having discussions on doing this.'

VISCERAL
★ Coordinated by Vienna University of Technology in Austria.
★ Funded under FP7-ICT.
★ http://cordis.europa.eu/project/rcn/106174_en.html
★ Project website:
http://www.visceral.eu/

NOVEL CARRIERS FOR EFFICIENT DRUG DELIVERY

Therapeutics based on genetics promise solutions for devastating illnesses that cannot be treated by conventional approaches. The development of gene carriers is necessary for specific, efficient and safe treatment.

The recent discovery of gene silencing by 'RNA interference' (siRNA) led to the development of a new class of oligonucleotide-based therapeutics.

"TACIT is likely to have a broad impact on the development of personalised therapeutics."

These genetic elements specifically inactivate genes and are being investigated for treatment of cancer, diabetes, viral infections and inflammation.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This novel drug development has been hampered by a problem known as systemic delivery. siRNA oligonucleotides suffer from a poor pharmacological profile *in vivo*. Attempts to use conventional liposomes for delivery have resulted in non-specific immune stimulation, toxicity issues and limited distribution.

The EU-financed TACIT (Targeted amphoteric carriers in immunotherapy) project was put together by two academic and two commercial partners to address the urgent need for an effective delivery system. The aim was to develop novel, clinically-relevant carriers for delivery to the immune system and test them in inflammatory disease models.

The TACIT researchers designed and synthesised new lipids with rational variations of the head group and lipid anchor chemistry. Amphoteric liposome carriers for systemic delivery of oligonucleotides were developed using the new lipids and a methodology that predicts the stability and efficacy of liposomes.

The liposomes were tested for siRNA delivery *in vitro*, and effective formulations were identified. New liposomal carriers were further tested *in vivo* for their tropism (attraction) to specific immune cell populations, such as macrophages and dendritic cells, their potency for target knock-down and their safety. For topical administration of siRNA straight to the lung, the scientists developed several formulations.

In addition, TACIT evaluated novel peptide carriers for the *in vivo* delivery of siRNA molecules. These vehicles efficiently delivered cargo siRNA to macrophages in cell culture and *in vivo* in the model of allergic asthma in mice. Researchers used their expertise to target a central signalling pathway in macrophage activation (Akt kinase) in culture and *in vivo* in a model of aspiration-induced lung injury in mice.

Overall, new lipid-based and non-lipid carriers were developed and can be effective for systemic or topical delivery of siRNA to immune cells and inflamed tissues. TACIT is likely to have a broad impact on the development of personalised therapeutics.

TACIT
★ Coordinated by the Biomedical Research Foundation, Academy of Athens in Greece.
★ Funded under FP7-PEOPLE.
★ http://cordis.europa.eu/result/rcn/88923_en.html