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Report on Dissemination, Sustainability and Exploitation

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Executive Summary

The document reports on the Dissemination, Sustainability and Exploitation in the VISCERAL project.

Dissemination

The VISCERAL website (http://visceral.eu) is the central source of information on VISCERAL. It has been visited over the full project duration by 7754 people in 15 090 sessions. PDF documents on the VISCERAL Website have been downloaded 12 627 times in the last 12 months of the project, with the most downloaded deliverable being *D1.1 - Prototype of 3D annotation software interface*, downloaded 1486 times in this time period.

VISCERAL is producing results of interest in two areas:

- Medical imaging: the benchmarks and their results are of interest to research groups working in the medical imaging area;

- Evaluation infrastructure: the cloud-based evaluation infrastructure is of interest to research groups working, amongst others, in the areas of Big Data analysis, eScience and Information Retrieval.

The VISCERAL project has so far led to the publication of 12 scientific papers, which have in total 41 citations according to Google Scholar. An open access book on VISCERAL outcomes has been approved by Springer, the contract signed and the open access fee paid. The book is planned to be complete by the end of 2015. The VISCERAL project has organised 5 workshops, summarised in the following table:

Workshop	Date	Attendees
Anatomy2 Interim Challenge Workshop	1 May 2014	50
MICCAI Workshop on Medical Computer Vision: Algorithms for Big Data (Anatomy2 Benchmark special session)	18 September 2014	80
Evaluation as a Service Expert Workshop	5-6 March 2015	12
Multimedia Retrieval in the Medical Domain (MRMD) workshop	29 March 2015	14
Anatomy3 Benchmark Challenge Workshop	16 April 2015	10
	Total	**166**

Exploitation

Twelve exploitable assets have been identified in VISCERAL, and all exploitable assets planned have been made available by the end of the project. These are summarised here:

- Software Assets – all four software assets developed in VISCERAL are available on GitHub. These are the metric calculation software, registration system, ticketing system for managing gold corpus creation, and silver corpus fusion software.

- Infrastructure Assets – a virtual machine image containing the VISCERAL registration system is available, and continued running of the VISCERAL benchmarks on the Microsoft Azure Cloud has been secured for a year after project end.

- Documentation Assets – public Deliverables are available on the website, including methods, protocols, results, and tutorials. Through the Springer open access book, these deliverables will be transferred to a more sustainable form, ensuring lasting impact of VISCERAL results.

- Data Assets – the radiology data and the annotations can continue to be used beyond the end of the VISCERAL project.

Sustainability

The website will continue to be available for at least five years after the end of the project, ensuring that project deliverables remain available in the foreseeable future. The most important results and experience from VISCERAL will be available as a Springer open access book in early 2016, which will ensure their longevity.

All medical image corpora generated in VISCERAL are currently stored on the HES-SO and MUW servers, and on the Microsoft Azure Cloud. Further initiatives described below will also ensure long-term sustainability of the data.

The VISCERAL consortium has now secured sponsorship from Microsoft to continue running the VISCERAL Infrastructure in the Azure Cloud until latest 1st May 2016 (or a usage cap of US$20 000 has been reached). This will be used to continue running the Anatomy3 Benchmark. The consortium will investigate further opportunities for sustainability of VISCERAL in the longer term.

Table of Contents

1 Introduction

The document reports on the Dissemination, Sustainability and Exploitation in the VISCERAL project, as well as measures of its impact.

It begins with Dissemination in Section 2. In order to give a full overview of all dissemination in the project, the deliverable presents dissemination activities throughout the project runtime. It is clearly indicated in the dissemination report which activities correspond to the first 18 months and which to the last 12 months of the VISCERAL project. Sections on the dissemination activities in the first 18 months of the project are partly taken over from D6.3.3. For completeness, this deliverable also includes short descriptions of the workshops that were organised as part of WP5.

The document continues with a report on the exploitable assets and their status in Section 3. Sustainability plans and their current status are presented in Section 4, while Section 5 presents a short analysis of the VISCERAL impact.

2 Dissemination

Four main groups have been identified to be targeted for VISCERAL dissemination. For completeness, these are described here:

- **Scientific community**, including researchers and students in computer science, primarily in the areas of medical image processing and medical informatics; as well as research infrastructures;

- **Business community**, primarily SMEs and large companies developing PACS systems, or medical imaging hardware;

- **Medical community**, primarily radiologists;

- **General public**.

The dissemination activities targeting these groups are covered in Sections 2.1 to 2.4. The VISCERAL website (http://visceral.eu) serves as a central platform for dissemination of information to all groups. It also serves as an up-to-date source of information for the research groups participating in the benchmarks. An open mailing list for VISCERAL information has also been set up, and can be subscribed to via the VISCERAL website. A VISCERAL LinkedIn group and Twitter account has been set up, and serve as sources of information primarily for the participants in the benchmarks.

2.1 Dissemination to the Scientific Community

VISCERAL is producing results of interest in two areas:

- Medical imaging: the benchmarks and their results are of interest to research groups working in the medical imaging area;

- Evaluation infrastructure: the cloud-based evaluation infrastructure is of interest to research groups working, amongst others, in the areas of Big Data analysis, eScience and Information Retrieval.

These two target groups are treated separately in this section.

2.1.1 Medical Imaging

2.1.1.1 Month 19 to Month 30

Over 80 people attended the MICCAI Workshop on Medical Computer Vision: Algorithms for Big Data (bigMCV - https://sites.google.com/site/miccaimcv2014/) on the 18th of September 2014, where the results of the VISCERAL Anatomy2 Benchmark were presented in a special session. After an overview presentation of the Anatomy2 Benchmark by the organisers, five participants presented their segmentation approaches. The proceedings are published as Springer LNCS 8848. A photo of the workshop is shown below:

Fourteen people attended the Multimedia Retrieval in the Medical Domain (MRMD) workshop, held on the 29th of March in conjunction with the European Conference on Information Retrieval (ECIR) in Vienna, Austria (http://www.visceral.eu/workshops/mrmd-2015/). The programme consisted of two invited speakers (Camille Kurtz of the University Paris Descartes and Eldad Elnekave of Zebra Medical Vision). Papers on multimodal medical information retrieval that passed a review process were also presented, as were papers presenting the results of participants of the VISCERAL Retrieval Benchmark. The proceedings of the workshop will be published in the next months as Springer LNCS 9059. The photo below shows the workshop in progress:

Participants of the Anatomy3 Benchmark gathered at a challenge workshop held at 2015 IEEE International Symposium on Biomedical Imaging (ISBI) on the 16th of April 2015 in New York, USA (http://www.visceral.eu/workshops/anatomy-grand-challenge-workshop). Ten people took part in the workshop. The proceedings of the workshop, including an overview paper, will be published in the CEUR online proceedings in the next months. The photo below shows the workshop attendees:

The following publications focussing on medical imaging have appeared :

- H. Müller, B. Menze, G. Langs, A. Montillo, M. Kelm, S. Zhang, W. Cai and D. Metaxas, *Overview of the 2014 Workshop on Medical Computer Vision: Algorithms for Big Data (MCV 2014)*, volume LNCS 8848 of Springer, 2015

- H. Müller, O. A. Jiménez del Toro, A. Hanbury, G. Langs, A. Foncubierta–Rodríguez, *Workshop Multimodal Retrieval in the Medical Domain (MRMD)*, Springer LNCS 9022, pp 834-837, 2015

- O. A. Jiménez del Toro and H. Müller, *Hierarchical multi-atlas based segmentation for anatomical structures: Evaluation in the VISCERAL anatomy benchmarks*, Medical Computer Vision. Large Data in Medical Imaging, Boston, USA, Springer, September 2014

- O. A. Jiménez del Toro, O. Goksel, B. Menze, H. Müller, G. Langs, M. Weber, I. Eggel, K. Gruenberg, M. Holzer, A. Jakab, G. Kontokotsios, M. Krenn, T. Salas Fernandez, R. Schaer, A. A. Taha, M. Winterstein and A. Hanbury, *VISCERAL - VISual Concept Extraction Challenge in RAdioLogy: ISBI 2014 Challenge Organization*, Proceedings of the VISCERAL Challenge at ISBI, Vol. 1194, page 6-15. 2014

- E. Schwartz, A. Jakab, G. Langs. A locally linear method for enforcing temporal smoothness in serial image registration. in Proc. MICCAI STIA'14, 2014

The following presentations focussing on medical imaging have been held:

- May 31, 2014, Invited speaker at PRIP 2014, Minsk Belarus (Henning Müller, HES-SO)
- June 2, 2014, invited speaker at ICSCAI, Zakopane, Poland (Henning Müller)
- September 18, 2014: VISCERAL presentation of status and next benchmarks during MICCAI bigMCV, Cambridge, USA (Georg Langs)
- September 18, 2014: Presentation of atlas learning methodology (WP3) in the MICCAI Spatio-Temporal Image Analysis Workshop, Cambridge, USA (Ernst Schwartz)
- September 18, 2014: Presentation of labelling methodology (WP3) in MICCAI bigMCV, Cambridge, USA (Georg Langs, Thomas Schlegl)
- December 12, 2014, workshop organization and introduction: Machine Learning and Interpretation in NeuroImaging Workshop at NIPS 2014, Montreal, Canada (Georg Langs)
- January 14, 2015, invited speaker at Vienna Data Science Meeting, Vienna, Austria (Georg Langs)

2.1.1.2 Month 1 to Month 18

An interim VISCERAL Anatomy2 workshop, framed as the VISCERAL Organ Segmentation and Landmark Detection Challenge, was held at 2014 IEEE International Symposium on Biomedical Imaging on May 1st, 2014 in Beijing, China. In summary, the goal of our ISBI challenge session was three-fold: i) the submitting groups presenting their techniques, ii) reporting the results of the evaluation, iii) publicizing our benchmark series widely. With over 50 participants, the challenge session was a success; and we have received very positive feedback from participants both at the session and afterwards via email. The submitted written contributions have been published as online CEUR proceedings (http://ceur-ws.org/Vol-1194/). The following photo shows session attendees:

The following presentations focussing on medical imaging have been held:

- 1 May 2014, IEEE International Symposium on Biomedical Imaging, presentation on multi-structure segmentation and the VISCERAL dataset, Beijing, China (Oscar Jimenez)

- 27 June 2013, VRVis Research Centre, invited talk on Search in Medical Texts and Images, Vienna, Austria (Allan Hanbury)

- 7 June 2013, presentation of eHealth projects of the HES-SO, among them VISCERAL, eHealth day, Sierre, Switzerland (Henning Müller)

- 11 May 2013, 3D object retrieval workshop in Girona Spain, invited talk on Medical 3D data retrieval (Henning Müller)

The following publications with a focus on medical imaging have appeared:

- R. Donner, BH. Menze, H. Bischof, G. Langs. Global Localization of 3D Anatomical Structures by Pre- filtered Hough Forests and Discrete Optimization. in Medical Image Analysis 17(8): 1304-1314, 2013

- E. Dittrich, T. Riklin-Raviv, G. Kasprian, R. Donner, P. C. Brugger, D. Prayer, and G. Langs, A spatio- temporal latent atlas for semi-supervised learning of fetal brain segmentations and morphological age estimation., Medical Image Analysis, vol. 18, no. 1, pp. 921, Jan. 2014.

- F. Ganglberger, F. Schulze, L. Tirian, A. Novikov, B. Dickson, K. Bhler, and G. Langs, Structure-Based Neuron Retrieval Across Drosophila Brains., Neuroinformatics, pp. 112, Jan. 2014.

2.1.2 Evaluation Infrastructure

2.1.2.1 Month 19 to Month 30

Twelve experts in Evaluation Infrastructure were invited to an Evaluation-as-a-Service workshop held in Sierre, Switzerland on the 5th to 6th of March 2015. This included representatives of the following initiatives that make use of the Algorithm-to-Data evaluation paradigm:

- VISCERAL – EU
- TREC Microblog Task – USA
- PAN@CLEF (and the TIRA system) – EU
- BioASQ – EU
- CLEF NewsREEL – EU
- CLEF Living Labs – EU
- CodaLab – USA
- C-BIBOP – USA
- NTCIR – Japan

Two days of intensive discussion led to a summary paper submitted to the SIGIR Forum (see below), and plans for a more detailed white paper. The workshop attendees started the Evaluation-as-a-Service Initiative (http://eaas.cc), which will continue to develop and promote the EaaS approach in multiple areas. The workshop participants are shown in the following photo:

The following publications focussing on the evaluation infrastructure have appeared in project months 19–30:

- A. A. Taha and A. Hanbury, *An Efficient Algorithm for Calculating the Exact Hausdorff Distance*, IEEE Transactions on Pattern Analysis and Machine Intelligence, 2015

- A. A. Taha, A. Hanbury and O. A. Jiménez del Toro, *A Formal Method For Selecting Evaluation Metrics for Image Segmentation*, IEEE International Conference on Image Processing (ICIP), 2014

The following paper has been submitted :

- F. Hopfgartner, A. Hanbury, H. Müller, N. Kando, S. Mercer, J. Kalpathy-Cramer, M. Potthast, T. Gollub, A. Krithara, J. Lin, K. Balog, I. Eggel, *Report on the Evaluation-as-a-Service (EaaS) Expert Workshop*, Submitted to the June 2015 edition of SIGIR Forum

2.1.2.2 Month 1 to Month 18

The following publications focussing on the evaluation infrastructure have appeared:

- A. Hanbury, H. Müller, G. Langs and B. H. Menze, *Cloud–based Evaluation Framework for Big Data*, The Future Internet - Future Internet Assembly 2013: Validated Results and New Horizons, Springer LNCS 7858, pages 104–114, 2013.

- A. Hanbury, H. Müller, G. Langs, M. Weber, B. H. Menze and T. Salas Fernandez, *Bringing the Algorithms to the Data: Cloud-based Benchmarking for Medical Image Analysis*, In Proc. of the CLEF Conference, 2012, Springer LNCS 7488, pages 24–29, Rome, Italy.

- G. Langs, H. Müller, B. H. Menze and A. Hanbury, *VISCERAL: towards large data in medical imaging - challenges and directions*. Proc. MICCAI 2012 Workshop on Medical Content-based Retrieval for Clinical Decision Support (MCBR-CDS), 2012, Springer LNCS 7723, pages 92–98, Nice, France.

The following presentations have been held:

- 8 April 2014, Big Data Innovators Gathering (BIG) 2014, talk on A Cloud-based Framework for Evaluation on Big Data, Seoul, Korea (Allan Hanbury)

- 6 June 2013, COST Multilingual and Multifaceted Interactive information Access (MUMIA) meeting, presentation of the VISCERAL evaluation architecture, Tallinn, Estonia (Allan Hanbury)

- 14 May 2013, Latin American eScience Workshop, A Cloud-based Evaluation Infrastructure for Medical Image Analysis and Search, Sao Paulo, Brazil (Allan Hanbury)

- 10 April 2013, European Data Forum, Algorithm any good? A Cloud-based Infrastructure for Evaluation on Big Data, Dublin, Ireland (Allan Hanbury)

- 24 March 2013, Workshop on Integrating IR/MT technologies for Professional Search (with the European Conference on Information Retrieval 2013), Toward a Cloud-Based Integration of IR Tools, Moscow, Russia (Allan Hanbury)

2.1.3 Overall Project Results

It is planned to have an edited book on the VISCERAL benchmarks. We have approached Springer for this, and have already signed an Open Access agreement with Springer and paid the Open Access fee to publish an edited book on VISCERAL. The book will include methodology papers by the organisers covering the evaluation approaches and infrastructure, and papers by the participants describing their approaches used in the benchmarks. The plan is for the book to appear by the end of 2015.

2.1.4 Cooperation with Projects

VISCERAL has started a cooperation with the BioASQ project (http://www.bioasq.org/), and has signed a Memorandum of Understanding with this project. Allan Hanbury is on the Advisory Board of BioASQ. A representative of BioASQ was invited to and attended the Evaluation-as-a-Service workshop in March 2015 (see Section 2.1.2.1).

Allan Hanbury and Henning Müller are in the Advisory Board of the C-BIBOP project, funded by the National Cancer Institute (NCI) in the US (http://grantome.com/grant/NIH/U24-CA180927-01A1). C-BIBOP is developing an infrastructure for running medical image segmentation challenges, and will take advantage of knowledge and software from VISCERAL for this. A representative of C-BIBOP was invited to and attended the Evaluation-as-a-Service workshop in March 2015 (see Section 2.1.2.1).

As both VISCERAL and the PROMISE NoE are working with evaluation infrastructures, a cooperation took place. The VISCERAL ideas have already been presented at the CLEF conference in 2012, and a poster on VISCERAL was presented at the PROMISE Winter School in February 2013.

Through having three common partners, exchange of knowledge with the Khresmoi project was guaranteed. Technology developed in Khresmoi was evaluated in the VISCERAL benchmarks. A joint talk between the Khresmoi and VISCERAL projects was given at the Medical Content-based Retrieval for Clinical Decision Support (MCBR-CDS 2012) workshop at the MICCAI 2012.

As vice-chair of the Working Group 2 on *Processing Infrastructures for IR and MT* of the COST Action on *Multilingual and Multifaceted Information Access* (MUMIA - http://www.mumia-network.eu/), Allan Hanbury ensured that infrastructure knowledge and experience from VISCERAL was transferred to the MUMIA partners.

2.2 Dissemination to the Business Community

Allan Hanbury presented a talk entitled "Roadmap into the Future: Data Science als Motor von Innovation" (Roadmap into the Future: Data Science as Motor of Innovation) at the LSZ Big Data Management Conference on the 3rd of March 2015. This talk focussed on the use of competitions to encourage open innovation, and contained lessions learned from the VISCERAL project.

Extensive cooperation has taken place with the company Zebra Medical Vision (http://www.zebra-med.com), a startup company working with radiology images on the cloud. Eldad Elnekave, Chief Medical Officer of Zebra Medical Vision, was an invited presenter at the workshop on Multimodal Retrieval in the Medical Domain (MRMD, see Section 2.1.1.1), where he gave a talk presenting a more commercial perspective of exploiting medical imaging data.

Allan Hanbury and Henning Müller had a telco with people from Sage Bionetworks (http://sagebase.org/) on the 11th of February 2015. Sage Bionetworks is the company behind the Dream Challenges (http://dreamchallenges.org/), challenges about systems biology and translational medicine. The experiences with using a Virtual Machine-based approach to running challenges was discussed.

The VISCERAL project has collaborated with Microsoft Research Connections. Microsoft Research Connections is sponsoring the VISCERAL project by providing cloud services on their Azure cloud to the consortium and participants. The VISCERAL framework was presented in an invited talk at the Microsoft Faculty Summit (Latin American eScience Workshop) in São Paulo in May 2013. Discussions on cooperating with Microsoft Research Connections in their project on the creation of an open source medical imaging evaluation framework have taken place, and the VISCERAL metrics calculation software (EvaluateSegmentation) has been integrated into this framework on GitHub. Microsoft will continue to provide Azure cloud services for VISCERAL Benchmarks for a limited amount of time (see Section 4).

2.3 Dissemination to the Medical Community

2.3.1 Month 19 to Month 30

The following publications aimed at the medical community have appeared:

- K. Gruenberg, M. Weber, O. A. Jiménez del Toro, O. Goksel, B. Menze, H. Müller, G. Langs, I. Eggel, M. Holzer, G. Kontokotsios, M. Krenn, R. Schaer, A. A. Taha, M. Winterstein and A. Hanbury, *VISCERAL-VISual Concept Extraction challenge in Radiology: Segmentation challenge: overview, insights and preliminary results*, European Congress of Radiology (ECR) 2015, Vienna, Austria, 2015

- M Winterstein, K Grünberg, A Hanbury, O Jimenez del Toro, O Göksel, B Menze, H Müller, G Langs, I Eggel, M Holzer, G Kontokotsios, M Krenn, R Schär, A Taha, M Weber, *VISCERAL-VISual Concept Extraction challenge in RadioLogy: Organsegmentierung: Übersicht, Einblicke und erste Ergebnisse*, Fortschr Röntgenstr 2015; 187 - WISS101_5, DOI: 10.1055/s-0035-1550783

The following presentations aimed at the medical community were given:

- 19 January 2015: Wiener Ophthalmologoische Gesellschaft, Big Data and Machine Learning in Medical Imaging, Vienna, Austria (Georg Langs)

- 18 March 2015, Presentation at the legal medicine of Graz Medical University, Graz, Austria (Henning Müller)

- 30 March 2015: European Congress of Psychiatry, Machine Learning for Structure Detection, Vienna, Austria (Georg Langs)

- 3 June 2015, Medical innovation in Switzerland, Healthtech Village, Geneva, Switzerland (Henning Müller)

- 18 June 2015, DICOM Tage, Mainz, Germany (Henning Müller)

2.3.2 Month 1 to Month 18

The following publications have appeared:

- H. Müller, *Semantik und Bilddaten: wie Terminologien in der Radiologie helfen könnten*, Deutscher Roentgenkongress, Hamburg, Germany, 2013.

The following presentations have been held:

- 30 May 2013, presentation on semantics in radiology, including VISCERAL, Deutscher Röntgenkongress, Hamburg, Germany (Henning Müller)

2.4 Dissemination to the General Public

An article about VISCERAL appeared in the research*eu results magazine N° 38 / December 2014 / January 2015 - http://www.visceral.eu/assets/assets/VISCERAL-ZZAC14010ENN-002.pdf.

Methods developed in VISCERAL were mentioned in an Austrian TV Documentary 'Die Kathedrale des Wissens' focusing on interdisciplinary research at the University of Vienna and the Medical University of Vienna (Servus TV, March 2015)

3 Exploitation

At the beginning of the VISCERAL project, a list of exploitable assets arising from the project was created, and received minor adaptations over the project runtime. The final version of the list is shown in Section 3.1, while details on each of the assets is given in Section 3.2.

3.1 Exploitable Assets

The table of exploitable assets from Deliverable D6.4 is reproduced below with minor modifications. The "Status" column gives a summary of the current status of the exploitation or sustainability of the asset.

For consistency with the DoW, the assets are grouped into "Technical," "Resources," and "Services" groups in the table, but they can also be clustered into four groups based on their nature as follows:

- Software Assets (Assets 1–4)

- Infrastructure Assets (Assets 5 and 12)

- Documentation Assets (Assets 6, 10 and 11)

- Data Assets (Assets 7, 8 and 9)

These groups are indicated by the colours in the leftmost column of the table. Each of the assets in the table is described in more detail in Section 3.2, which is organised based on the four groups above.

The "Project Partners" column shows those project partners that are involved in the exploitation of the assets. These partners have been adapted in the table below compared to the DoW, as their roles in the creation of the assets is now clear.

The three target groups for exploitation identified in the DoW are still relevant, and are shown in the "Targets" column:

(i) **Companies** developing EHR and PACS software,

(ii) **Medical informatics research groups**, primarily in the area of medical image processing,

(iii) **Big data research groups**, wishing to organize evaluation campaigns using huge amount of data.

#	Assets	Status	Project Partners	Targets
		Technical		
1	Open source software for the evaluation infrastructure developed in WP1 (D1.3, D1.4)	Available on GitHub	HESSO, TUW	Big data research groups, Companies
2	Software for calculating evaluation metrics comparing two segmentations developed in WP4	Available on Github as part of CodaLab	TUW	Medical informatics research groups, Companies

#	Assets	Status	Project Partners	Targets
3	Gold corpus active annotation framework and ticketing system (D1.1, D3.1)	This software is available as open source on GitHub	MUW	Medical informatics research groups, Companies
4	Silver corpus merging framework (D3.3)	This software is available as open source on GitHub	MUW, ETHZ	Medical informatics research groups, Big data research groups
5	Evaluation architecture in the cloud, including continuous evaluation capability (D1.3, D1.4)	A Virtual Machine image with the evaluation architecture installed is available on GitHub	HESSO, TUW	Big data research groups, Companies
6	Results of the benchmarks, including the evaluation protocol and evaluation measures, as well as objective evaluation results of algorithms applied to standard data (D5.3, D5.4)	Two Benchmark workshop proceedings have already been published. Two are in preparation. An Open Access edited book contract has been signed with Springer	TUW, HESSO, MUW, ETHZ, UKL-HD	Medical informatics research groups, Big data research groups, Companies
	Resources			
7	Huge database of 3D radiology images with anonymised radiology reports (D2.3.1, D2.3.2)	The data can be used beyond the end of the VISCERAL project for benchmark purposes. The data will be stored at MUW and HES-SO, and on the Azure cloud	MUW, UKL-HD, GENCAT	Medical informatics research groups, Companies
8	Silver corpus (D3.4, D3.5)	The data can be used beyond the end of the VISCERAL project for benchmark purposes. The data will be stored at MUW and HES-SO, and on the Azure cloud	MUW, ETHZ	Medical informatics research Groups, Companies
9	Gold corpus (with manual annotation) (D3.2.1, D3.2.2, D3.5)	The data can be used beyond the end of the VISCERAL project for benchmark purposes. The data will be stored at MUW and HES-SO, and on the Azure cloud	UKL-HD, MUW	Medical informatics research groups, Companies
10	Evaluation methodologies for segmentation and retrieval (D4.1–D4.5)	The evaluation methodologies will be published in the VISCERAL Open Access Springer book, for which a contract has been signed	TUW, HESSO, MUW, ETHZ	Big data research groups, Companies

#	Assets	Status	Project Partners	Targets
11	Tutorial material (D5.5)	The tutorial material will be published in the VISCERAL Open Access Springer book, for which a contract has been signed	TUW, HESSO, MUW, ETHZ, UKL-HD	Medical informatics research groups, Big data research groups, Companies
	Services			
12	Evaluation service for large scale visual annotation and retrieval (D1.3, D1.4)	The Anatomy evaluation service will continue to be hosted on Microsoft Azure for around a year after project end	HESSO, TUW	Big data research groups, Medical informatics research groups

3.2 Status of the Exploitation of each Asset

3.2.1 Software Assets (Assets 1–4)

Assets 1–4 are the components of the evaluation infrastructure developed in VISCERAL, and have been released as open source software.

3.2.1.1 Asset 1: Open source software for the evaluation infrastructure

This asset includes the registration and administration system for the benchmarks, as well as the automated evaluation capability. The software is described in VISCERAL Deliverable D1.4. The code is available for download from GitHub: https://github.com/Visceral-Project/registration-system.

The aim in writing this code was to demonstrate the concept of cloud-based evaluation through having a working registration and administration system for the benchmarks. Due to this being the first version of the registration system that interacts so closely with the Azure cloud, the code is rather poorly documented and contains many workarounds and quick solutions. The code is therefore not well suited for easy installation, nevertheless we make it available so that the work in the VISCERAL project remains available for further development beyond the project.

3.2.1.2 Asset 2: Software for calculating evaluation metrics comparing two segmentations

EvaluateSegmentation, the software for efficiently calculating twenty evaluation metrics comparing two segmentations, as well as landmark detection metrics, is available on Github as part of the CodaLab project: https://github.com/codalab/EvaluateSegmentation. It is documented extensively in Section 5 of VISCERAL Deliverable D5.5.

3.2.1.3 Asset 3: Gold corpus active annotation framework and ticketing system

The gold corpus active annotation framework and ticketing system is available as open source software on GitHub: https://github.com/Visceral-Project/annotationTicketingFramework. The package includes installation guidelines, documentation on input and output parameters for each Matlab function, Matlab tutorial scripts, and workflow overview descriptions.

3.2.1.4 Asset 4: Silver corpus merging framework

The silver corpus merging framework is available as open source software on GitHub: https://github.com/Visceral-Project/silverCorpusFramework. The package includes installation guidelines, documentation on input and output parameters for each Matlab function, Matlab tutorial scripts, and workflow overview descriptions.

3.2.2 Infrastructure Assets (Assets 5 and 12)

Assets 1, 5 and 12 are closely related, and are based on the same two deliverables. They differ in terms of how they are made available: Asset 1 (described in Section 3.2.1.1) is the source code of the VISCERAL evaluation infrastructure, and needs to be compiled and installed before being used. Asset 5 corresponds to the VISCERAL evaluation infrastructure available in a way that is immediately ready to use in the cloud: a virtual machine for the cloud. Asset 12 corresponds to the provision of the evaluation infrastructure in the form of a service, in that it is already installed on a cloud infrastructure – End users get logins to make use of the running evaluation infrastructure.

3.2.2.1 Asset 5: Evaluation architecture in the cloud

On the GitHub website (https://github.com/Visceral-Project/registration-system) there is available for download a Virtual Machine (VirtualBox) which is equipped with everything necessary to continue further the development of the registration system, which can simplify further use of the code. This can be used with any cloud system that supports VirtualBox.

3.2.2.2 Asset 12: Evaluation service for large scale visual annotation and retrieval

Asset 12 provides a running evaluation service that can be used to make available challenges, competitions, benchmarks, etc. and used to participate in these activities. The evaluation service created in the VISCERAL project is optimised for medical segmentation and retrieval benchmarks. The cloud-based evaluation concept as well as the software are however extensible to be more generally applicable to evaluation in Data Science and Big Data, which will make the evaluation service more widely applicable.

The VISCERAL consortium has now secured sponsorship from Microsoft to continue running the VISCERAL Infrastructure in the Azure Cloud until latest 1/5/2016 (or a usage cap of US$20 000 has been reached). This will be used to continue running the Anatomy3 Benchmark.

During this time, the consortium will investigate further opportunities to keep this service available. Section 4 on Sustainability provides more information on this.

3.2.3 Documentation Assets (Assets 6, 10 and 11)

Assets 6, 10 and 11 are the outputs from the project in the form of documents and publications, covering all aspects of the benchmarks (Asset 6), the evaluation methodology on the cloud (Asset 10), and tutorial material (Asset 11). All of these documents will be downloadable in pdf form from the VISCERAL website.

3.2.3.1 Asset 6: Results of the benchmarks

An Open Access edited book covering details of the VISCERAL benchmarks will be published by Springer (the contract with Springer has already been signed and the open access fee has been paid). The consortium is currently in the process of preparing this book. The results are also available for download from the VISCERAL website (D4.3, D4.4, D5.3, D5.4).

3.2.3.2 Asset 10: Evaluation methodologies for segmentation and retrieval

Extensive details on the evaluation methodologies will be included in the VISCERAL Open Access Springer Book. Section 2.1.2 lists the publications that have appeared on the evaluation infrastructure and methodologies.

3.2.3.3 Asset 11: Tutorial material

Tutorial material is available from the VISCERAL website in Deliverable D5.5, and will also be included in the VISCERAL Open Access Springer Book.

3.2.4 Data Assets (Assets 7, 8 and 9)

Assets 7, 8 and 9 are the datasets produced by the VISCERAL project. Asset 7 is the "raw" data used for the Benchmarks; Asset 8 is the silver corpus that is created by fusing benchmark entries from multiple participants; while Asset 9 is the gold corpus consisting of the manual annotations done by the radiologists. These assets will require long-term storage solutions, with Asset 7 requiring a storage solution with controlled access, as researchers will need to obtain permission to use this dataset due to the sensitive nature of the data.

3.2.4.1 Asset 7: Huge database of 3D radiology images with anonymised radiology reports

Asset 7 consists of sensitive data (radiology images of humans and associated anonymised radiology reports), hence it will be necessary to develop a mechanism by which this data can be further used for scientific research. The first step has already been taken during the process of obtaining ethical approval: initially the ethical committee required that the data be deleted after its use in the benchmark, but further negotiations led to removal of this requirement. Also, for the data from UKL-HD, permission to publish the anonymised images in scientific publications has been obtained. An ethics amendment has been obtained that allows the data to be used for research purposes as part of Benchmarks until the end of April 2018.

In order to continue making this data available, the Anatomy3 Benchmark will continue running beyond the project. Retrieval2 and Detection2 Benchmarks will also be launched.

3.2.4.2 Asset 8: Silver corpus

The Silver Corpus will remain available for use beyond the end of the project. It is planned to include these volumes as training data in a future edition of the Anatomy benchmark.

3.2.4.3 Asset 9: Gold corpus

The Gold Corpus will continue to be available as part of the Anatomy3, Retrieval2 and Detection2 Benchmarks.

4 Sustainability

This section presents the VISCERAL sustainability initiatives.

4.1 Website and Book

The website will continue to be available for at least five years after the end of the project, ensuring that project deliverables remain available in the foreseeable future. The most important results and

experience from VISCERAL will be available as a Springer open access book in early 2016, which will ensure their longevity.

4.2 Data

All medical image corpora generated in VISCERAL are currently stored on the HES-SO and MUW servers, and on the Microsoft Azure Cloud. Further initiatives described below will also ensure long-term sustainability of the data. Even though some cloud providers do host scientific data free of charge, the requirement is that the data is freely accessible – due to the sensitive nature of the VISCERAL radiology images, this option is not possible, so other options are being investigated.

4.3 Microsoft Azure

The VISCERAL consortium has now secured sponsorship from Microsoft to continue running the VISCERAL Infrastructure in the Azure Cloud until latest 1ˢᵗ May 2016 (or a usage cap of US$20 000 has been reached). This will be used to continue running the Anatomy3 Benchmark.

4.4 Further Initiatives

The consortium will investigate further opportunities for sustainability of VISCERAL in the longer term. Unfortunately, the submitted proposal for the creation of a European medical imaging research infrastructure will not be funded, so this avenue for extending and scaling up the VISCERAL approach is currently closed, although further possibilities for such infrastructure projects will be investigated. An alternative is represented by collaboration with the NIH-funded C-BIBOP project (see Section 2.1.4).

5 Impact Analysis

This section provides a quantitative analysis of the VISCERAL impact by measuring the following indicators:

Total number of VISCERAL publications	12
Total number of citations of VISCERAL articles on Google Scholar	41
VISCERAL web page visits (sessions) throughout the project	15 090
Total number of downloads of PDFs from the VISCERAL website in Months 18-30	12 627
Total number of attendees at VISCERAL workshops	166
Total number of registrations for all VISCERAL Benchmarks	263
Total number of VMs assigned for all VISCERAL Benchmarks	102
Total number of submitted VMs for all VISCERAL Benchmarks	26
Total number of FTP downloads of the data	20

For some of these indicators, a more detailed breakdown is provided below.

5.1 Publications and Citations

On the 7th of May 2015, the citation counts of the following VISCERAL publications were take from Google Scholar:

| Publication	Citations
H. Müller, B. Menze, G. Langs, A. Montillo, M. Kelm, S. Zhang, W. Cai and D. Metaxas, Overview of the 2014 Workshop on Medical Computer Vision: Algorithms for Big Data (MCV 2014), volume LNCS 8848 of Springer, 2015	0
H. Müller, O. A. Jiménez del Toro, A. Hanbury, G. Langs, A. Foncubierta–Rodríguez, Workshop Multimodal Retrieval in the Medical Domain (MRMD), Springer LNCS 9022, pp 834-837, 2015	0
O. A. Jiménez del Toro and H. Müller, Hierarchical multi-atlas based segmentation for anatomical structures: Evaluation in the VISCERAL anatomy benchmarks, Medical Computer Vision. Large Data in Medical Imaging, Boston, USA, Springer, September 2014	0
O. A. Jiménez del Toro, O. Goksel, B. Menze, H. Müller, G. Langs, M. Weber, I. Eggel, K. Gruenberg, M. Holzer, A. Jakab, G. Kontokotsios, M. Krenn, T. Salas Fernandez, R. Schaer, A. A. Taha, M. Winterstein and A. Hanbury, VISCERAL - VISual Concept Extraction Challenge in RAdioLogy: ISBI 2014 Challenge Organization, Proceedings of the VISCERAL Challenge at ISBI, Vol. 1194, page 6-15. 2014	3
A. A. Taha and A. Hanbury, An Efficient Algorithm for Calculating the Exact Hausdorff Distance, IEEE Transactions on Pattern Analysis and Machine Intelligence, 2015	0
A. A. Taha, A. Hanbury and O. A. Jiménez del Toro, A Formal Method For Selecting Evaluation Metrics for Image Segmentation, IEEE International Conference on Image Processing (ICIP), 2014	0
A. Hanbury, H. Müller, G. Langs and B. H. Menze, Cloud–based Evaluation Framework for Big Data, The Future Internet - Future Internet Assembly 2013: Validated Results and New Horizons, Springer LNCS 7858, pages 104–114, 2013.	4
A. Hanbury, H. Müller, G. Langs, M. Weber, B. H. Menze and T. Salas Fernandez, Bringing the Algorithms to the Data: Cloud-based Benchmarking for Medical Image Analysis, In Proc. of the CLEF Conference, 2012, Springer LNCS 7488, pages 24–29, Rome, Italy.	11
G. Langs, H. Müller, B. H. Menze and A. Hanbury, VISCERAL: towards large data in medical imaging - challenges and directions. Proc. MICCAI 2012 Workshop on Medical Content-based Retrieval for Clinical Decision Support (MCBR-CDS), 2012, Springer LNCS 7723, pages 92–98, Nice, France.	23
K. Gruenberg, M. Weber, O. A. Jiménez del Toro, O. Goksel, B. Menze, H. Müller, G. Langs, I. Eggel, M. Holzer, G. Kontokotsios, M. Krenn, R. Schaer, A. A. Taha, M. Winterstein and A. Hanbury, VISCERAL-VISual Concept Extraction challenge in Radiology: Segmentation challenge: overview, insights and preliminary results, European Congress of Radiology (ECR) 2015, Vienna, Austria, 2015	0

Publication	Citations
M Winterstein, K Grünberg, A Hanbury, O Jimenez del Toro, O Göksel, B Menze, H Müller, G Langs, I Eggel, M Holzer, G Kontokotsios, M Krenn, R Schär, A Taha, M Weber, VISCERAL-VISual Concept Extraction challenge in RAdioLogy: Organsegmentierung: Übersicht, Einblicke und erste Ergebnisse, Fortschr Röntgenstr 2015; 187 - WISS101_5, DOI: 10.1055/s-0035-1550783	0
H. Müller, Semantik und Bilddaten: wie Terminologien in der Radiologie helfen könnten, Deutscher Roentgenkongress, Hamburg, Germany, 2013.	0
Total	**41**

5.2 Webpage

Over the full period of the VISCERAL project (1st November 2012 to 30th April 2015), the following statistics were obtained from Google Analytics for the webpage www.visceral.eu:

- Sessions: 15 090

- Users: 7 754

- Pageviews: 45 338

The following diagram shows the development in terms of number of sessions per month for the full duration of the project. For the last 6 months of the VISCERAL project, around 1000 sessions were recorded each month.
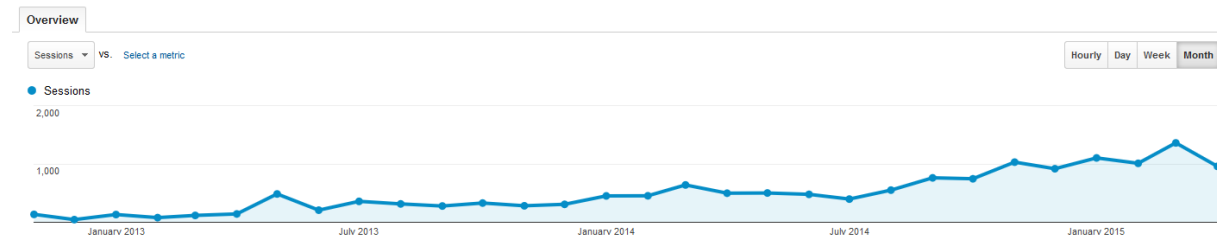
The accesses from countries for this time period are below:

	Country	Sessions	% Sessions
1.	China	1,819	12.05%
2.	United States	1,615	10.70%
3.	Germany	1,449	9.60%
4.	Switzerland	1,342	8.89%
5.	South Korea	947	6.28%
6.	Austria	904	5.99%
7.	United Kingdom	743	4.92%
8.	France	718	4.76%
9.	Brazil	581	3.85%
10.	Australia	458	3.04%

We also collected the number of PDF downloads from the visceral.eu website in months 18-30. The total number of PDFs downloaded in this period is 12 627. The top 10 PDF downloads in this period are shown in the following table:

Document	Downloads
D1.1 - Prototype of 3D annotation software interface	1486
D4.1 - Definition of the evaluation protocol and goals for Competition 1	820
Anatomy2 Factsheet	593
D3.1 - Prototype of gold corpus active annotation framework	578
Detection Benchmark Specification	528
D2.3.1 - Data set for first competition	527
D2.2.1 - Data format definition focusing on Competition 1	507
Anatomy2 ISBI Segmentation results	475
Anatomy2 final results	472
Anatomy2 ISBI landmark results	453

The number of downloads for these documents per month is shown in the following plot:
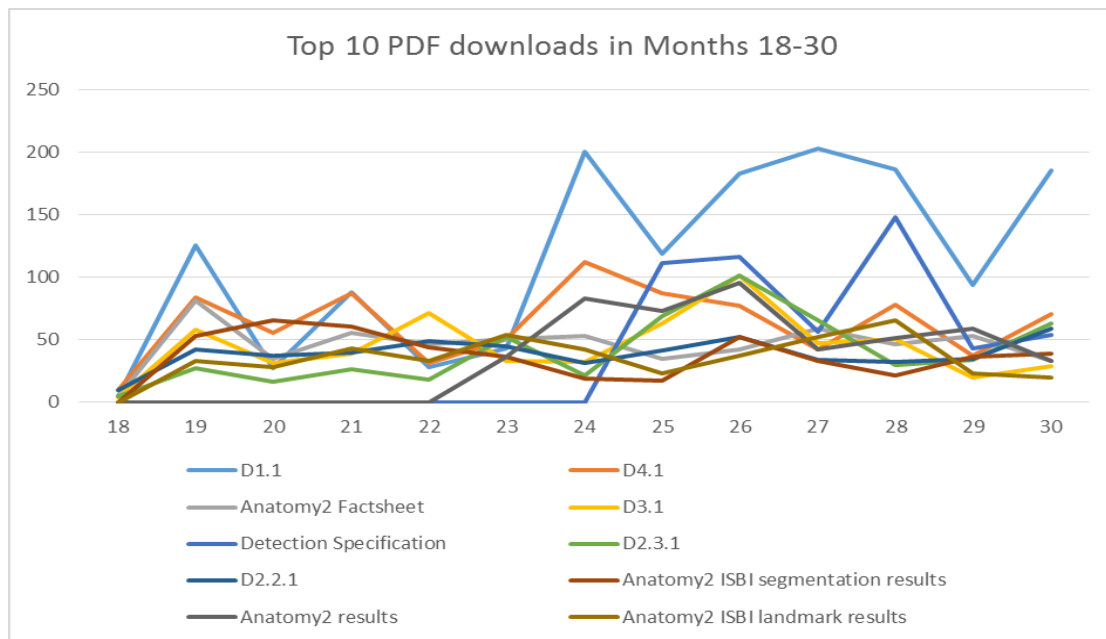
5.3 Benchmark Participation

The following table shows, for each of the Benchmarks organised during the VISCERAL project, the number of registrations for each of the Benchmarks, the number of VMs assigned (i.e. to participants that signed a participation agreement), and the number of submitted VMs.

	Registrations	VMs assigned	Submissions
Anatomy1	37	17	7
Anatomy2	56	19	8
Anatomy3	84	29	7
Retrieval	28	14	4
Detection	58	23	0
Total	**263**	**102**	**26**

5.4 Workshop Attendees

The following table shows the VISCERAL workshops organised and the number of attendees for each workshop:

Workshop	Date	Attendees
Anatomy2 Interim Challenge Workshop	1 May 2014	50
MICCAI Workshop on Medical Computer Vision: Algorithms for Big Data (Anatomy2 Benchmark special session)	18 September 2014	80
Evaluation as a Service Expert Workshop	5-6 March 2015	12
Multimedia Retrieval in the Medical Domain (MRMD) workshop	29 March 2015	14
Anatomy3 Benchmark Challenge Workshop	16 April 2015	10
	Total	**166**

6 Conclusion

This document describes the dissemination activities over the full duration of the VISCERAL project, with a focus on the last 12 months of the project. However, dissemination activities about VISCERAL activities and results will continue beyond the project. The two main avenues of dissemination beyond the project are: the Springer Open Access VISCERAL book and the Evaluation-as-a-Service Community.

In terms of exploitation of project results, the VISCERAL project has delivered all exploitable assets planned at the beginning of the project. Sustainability of the VISCERAL evaluation infrastructure is a more complex topic. The consortium currently has secured further sponsorship to keep running the infrastructure on the Microsoft Azure Cloud for a year after project end (or until a cap on the costs of the cloud usage has been reached). Further initiatives for sustainability beyond this time period are currently under investigation.

Finally, the impact of the VISCERAL project is presented in terms of publications, website accesses, benchmark registration and participation, and workshop attendance. Some of the Deliverables released by the VISCERAL project have already achieved a good number of downloads.