



TRAINING MATERIAL- VERSION 1

Deliverable D8.7.1

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Lead partner:	UCL
Contributing partners:	TU Delft, Fraunhofer
Authors:	J. Boehm, K. Liu, C. Alis, M. Krämer, B. Sirmacek, F. Michel
Quality Controllers:	Anna Cristofol
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Consisting of

SINTEF	STIFTELSEN SINTEF, Department of Applied Mathematics, Oslo, Norway
Fraunhofer	Fraunhofer Institute for Computer Graphics Research, Darmstadt, Germany
CNR-IMATI-GE	Institute for Applied Mathematics and Information Technologies of the National Research Council (CNR-IMATI), Genova, Italy
MOSS	M.O.S.S. Computer Grafik Systeme GmbH (MOSS), Munich, Germany
HRW	HR Wallingford Ltd (HRW), Wallingford, UK
FOMI	Hungarian National Mapping and Cadastral Agency (FOMI), Institute of Geodesy, Cartography and Remote Sensing, Budapest, Hungary
UCL	University College London (UCL), Research centre for Photogrammetry, 3D Imaging and Metrology, London, UK
TU Delft	Delft University of Technology (TU Delft), Department of Earth and Climate Sciences & Man-Machine Interaction Group, Delft, The Netherlands
IGN	Institut National de l'Information Géographique et Forestière (IGN), Paris, France
UBO	Université de Bretagne Occidentale (UBO), European Institute for Marine Studies, Brest, France
Ifremer	L'Institut Français de Recherche pour l'Exploitation de la Mer (Ifremer), Brest, France
Liguria	Regione Liguria, Genova, Italy

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Document History

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0.1	29.07.2015		Initial Scoping
0.2	04.09.2015		Contribution for tables from partners
0.3	25.09.2015		Cleaned layout of slides
0.4	15.10.2015		Version for QC
0.5	28.10.2015		Integrate Comments from QC
1.0	29.10.2015		Final deliverable

¹ Integers correspond to submitted versions

1 EXECUTIVE SUMMARY

This is the first deliverable of Task 8.7 ‘Training Materials’. The task provides material to train a wider community on aspects of the IQmulus system. In this first year the task provides 8 training modules. Each module is 15 to 20 minutes long. It consists of training slides along with supplementary material. The modules are designed to be useful for both taught training sessions and self-study. The training modules are categorized into three main audiences: end users, expert users and external developers. They cover three main topics: Services, Workflows, Data Exchange and Visualization.

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3 INTRODUCTION

This is the first deliverable of Task 8.7 ‘Training Materials’. The task provides material to train a wider community on aspects of the IQmulus system. The members of the task have investigated different possible training techniques including online learning platforms (moodle, EduX, etc.), API documentation tools (e.g. readme.io), video and classical slides based training. We have found slides supported by further media and training content to be the most versatile medium for effectively delivering training. Slides can both be used in a classroom setting, used online and be used for self-study. Currently we host the training material on the IQmulus Eroom server. Participants of the IQmulus Projects and associated partners have access to the training material through this portal. Selected material could be offered through the IQmulus web page as PDF documents.

We have identified three potential audiences, which require training

- End-users
- Expert users
- External Developers

End users require training mostly on the web GUI and visualization components of the system. They need to learn how to upload single dataset, how to execute pre-set workflows and how to visualize results. Expert users need to learn more advance techniques including mass data upload and modifying or scripting new workflows. External developers may wish to extend the IQmulus system by providing new services and integrate them with existing services.

From these different responsibilities we can identify some main system areas that the training material can be categorized into

- Services
- Workflows
- Data Exchange
- Visualization

For the first version of the deliverable we have attempted to cover all three user groups and all four system areas. The following section gives an overview of the existing training modules and introduces to the classification system. For future versions of the deliverable we plan to update the existing modules where components of the GUI have changed. We plan to add further modules on workflows, e.g. provide a training mode for each prioritizes workflow, such as LS1 and US2. We also plan to add modules on visualization for other data types and modules particularly on the thin client.

4 OVERVIEW OF TRAINING MODULES

The training material is structured into modules. Each module contains material for a training session of 15 to 20 minutes. Several modules can be combined for an extensive training session. Modules can be combined either by topic (e.g. services, data exchange ...) or by audience (user, expert user or external developer).

The format of the training modules is in presentation slides with supplementary material in the form of scripts, data sets or service containers. The presentation slides can be used both for classroom training or self-training via downloadable PDFs. The training material is shared within the consortium via the Eroom system provided by SINTEFF.

	Services	Workflow	Data Exchange	Visualization
End-Users		U3: Execution of existing workflow through web GUI	U2: Upload of geospatial dataset with metadata	U1: Visualization of Point cloud Data
Expert-Users	E1: DSL Syntax	E2: Use of DSL editor	E3: Data transfer via HDFS and WebHDFS	
External-Developers	D1: Checking out and executing a service from the repository D2: Execution of single service from command line			

4.1 END-USERS

Currently there are three training modules available for End-Users. The modules are mainly concerned with introducing the web-based GUI of the system. Training modules for End-Users are marked by the letter 'U' and a consecutive numbering.

4.1.1 Module U1: Visualization of Point cloud Data (Fraunhofer)

This module shows the use of the visualization client also known as the 'IQmulus Fat Client' (IFC). The IFC is visualization tool that is an executable running on the user's machine. In this module users are shown how the client can be used to visualize point clouds that were generated by the Urban Showcase Workflow 2 (US2). US2 aims to classify and extract trees from mobile mapping point clouds.

Topic	Details	
Visualize trees extracted by Urban Showcase Workflow 2.	Eroom Link	https://project.sintef.no/eRoom/math/IQmulus/0_3f1ac
	Length	20 minutes (12 slides)
	Supplement Material	Executable for visualization tool, Data files

4.1.2 Module U2: Upload of geospatial metadata for dataset (UCL / MOSS)

Before a dataset can be selected in the IQmulus GUI its metadata has to be uploaded. This tutorial shows how metadata can be uploaded in batch-mode, i.e. for multiple datasets at once.

Topic	Details	
Batch upload of metadata for multiple datasets.	Eroom Link	https://project.sintef.no/eRoom/math/IQmulus/0_3f1af
	Length	20 minutes (13 slides)
	Supplement Material	CSV metadata example and template

4.1.3 Module U3: Execution of existing workflow through web GUI (TU Delft / MOSS)

Non-expert users will mainly want to execute existing workflows from the system's web interface. This tutorial shows the steps necessary to achieve this.

Topic	Details	
Show the execution of a workflow through the web interface.	Eroom Link	https://project.sintef.no/eRoom/math/IQmulus/0_3f1b2
	Length	15 minutes (7 slides)
	Supplement Material	none

4.2 EXPERT USERS

Currently there are three training modules for Expert Users. The training material is on generating new workflows and managing cloud storage. Training modules for Expert Users are marked by the letter 'E' and a consecutive numbering.

4.2.1 Module E1: DSL Syntax (Fraunhofer)

This training module introduces to the syntax of the Domain Specific Language (DSL). It explains the selection of datasets from the storage and the use of the 'apply' statement to execute a service. The tutorial also shows the available control flow statements.

Topic	Details	
Explain the IQmulus DSL syntax for workflows.	Eroom Link	https://project.sintef.no/eRoom/math/IQmulus/0_3f1b5
	Length	10 minutes (6 slides)
	Supplement Material	none

4.2.2 Module E2: Use of DSL editor (Fraunhofer)

This training module introduces to the use of the IQmulus workflow editor through the web interface. It introduces the editor area, sidebar and toolbar of the workflow editor. Expert users can use this tutorial to learn how to edit an existing workflow or how to create a new workflow.

Topic	Details	
Show the use of the IQmulus workflow editor through the web interface.	Eroom Link	https://project.sintef.no/eRoom/math/IQmulus/0_3f1b8
	Length	10 minutes (7 slides)
	Supplement Material	none

4.2.3 Module E3: Data transfer via HDFS and WebHDFS (UCL)

All data in IQmulus is held in the cloud. New data sets have to be uploaded first. The system uses a distributed file system over several nodes, the Hadoop Distributed File System (HDFS). There are two ways to access HDFS, either directly or via a web interface (WebHDFS). This tutorial explains both methods of access for uploading new data sets.

Topic	Details	
Explain the differences and functionalities available for the WebHDFS and direct HDFS upload.	Eroom Link	https://project.sintef.no/eRoom/math/IQmulus/0_3f954
	Length	30 minutes (26 slides)
	Supplement Material	1 LAS file, Download links to tools.

4.3 EXTERNAL DEVELOPERS

Currently there are two training modules for External Developers. The training material is on extending the framework and interacting with individual services. Training modules for External Developers are marked by the letter 'D' and a consecutive numbering.

4.3.1 Module D1: Checking out and executing a service from the repository (UCL)

To access an individual service via command line it has to be checked out of the service repository. IQmulus uses Artifactory for this purpose. Services are delivered in containers to ensure that they can be executed in a wide variety of environments. IQmulus uses Docker for container shipment. This tutorial shows external developers how they can check out a container from the repository and run it on a node of the cloud.

Topic	Details	
Introduction to Artifactory, Docker and use of SSH for interactive session on cloud node.	Eroom Link	https://project.sintef.no/eRoom/math/IQmulus/0_3f1bb
	Length	20 minutes (16 slides)
	Supplement Material	Download links to tools

4.3.2 Module D2: Execution of single service from command line (TU Delft)

To run a service individually outside the IQmulus web interface it has to be started from the command line. This tutorial uses service #11 “Spatial Extent” as an example to show the procedure. The procedure is in principle identical for other services.

Topic	Details	
Use service for bounding box computation as an example to explain how to execute a service on the command line.	Eroom Link	https://project.sintef.no/eRoom/math/IQmulus/0_3f1be
	Length	15 minutes (9 slides)
	Supplement Material	Docker container, XYZ file

5 APPENDIX

5.1 MODULE U1



VISUALIZATION OF POINT CLOUD DATA (SHOW EXTRACTED TREES)

IQmulus Training Module U1



VISUALIZATION OF EXTRACTED TREES

- Prerequisites: IQmulus FatClient (IFC)
 - The IQmulus FatClient can be downloaded from the Artifactory:
 - <http://146.140.214.134/artifactory/webapp/search/artifact/?2&q=IFC>
 - Always use the latest version available to have all features available
 - Current version at time of slide creation is V2.0





VISUALIZATION OF EXTRACTED TREES

- Start the IQmulus FatClient (IFC)
 - Double-click IFC.bat in the installation folder
 - The default view of the IFC as shown below will appear

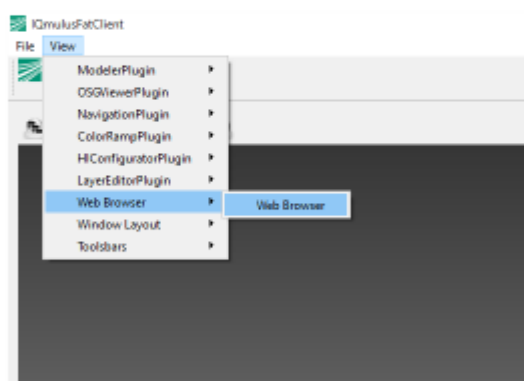


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VISUALIZATION OF EXTRACTED TREES

- Load IQmulus Visualization File (.iqv) from the Data Access Service
 - Open the internal web browser from the view menu



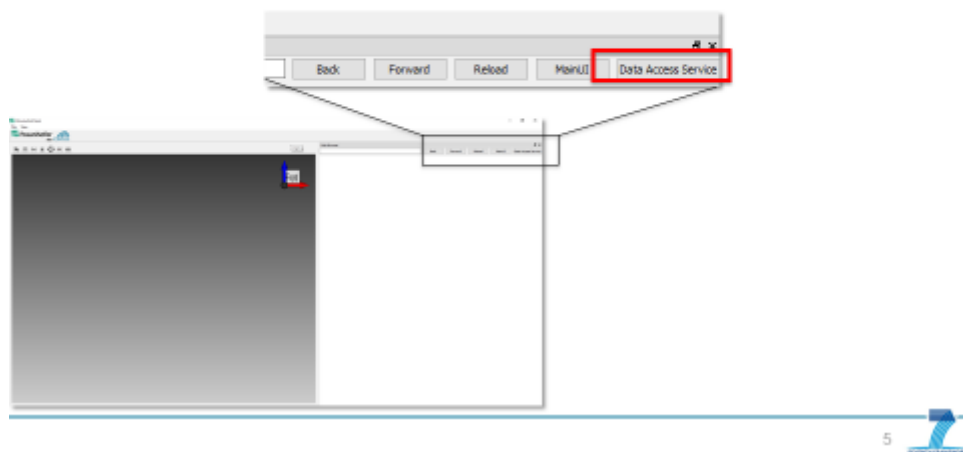
4





VISUALIZATION OF EXTRACTED TREES

- Load IQmulus Visualization File (.iqv) from the Data Access Service
- Connect to the data access service by selecting the corresponding button in the web browser

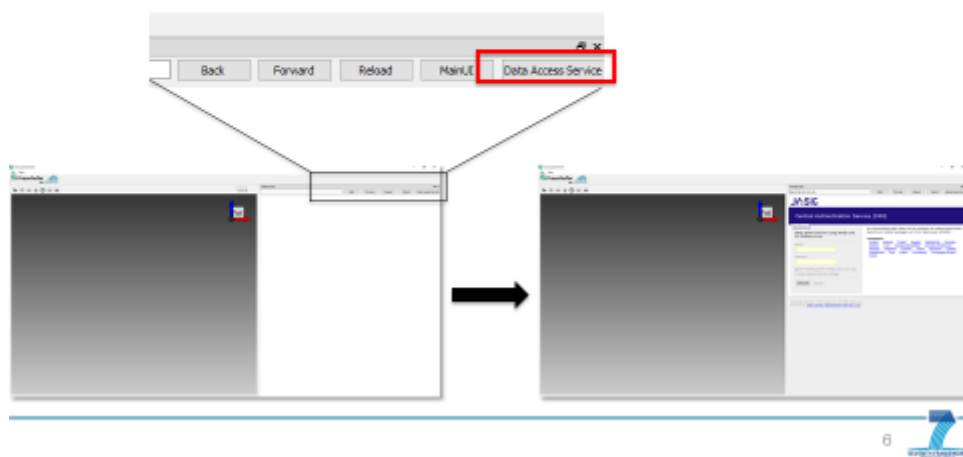


5



VISUALIZATION OF EXTRACTED TREES

- Load IQmulus Visualization File (.iqv) from the Data Access Service
- Connect to the data access service by selecting the corresponding button in the web browser

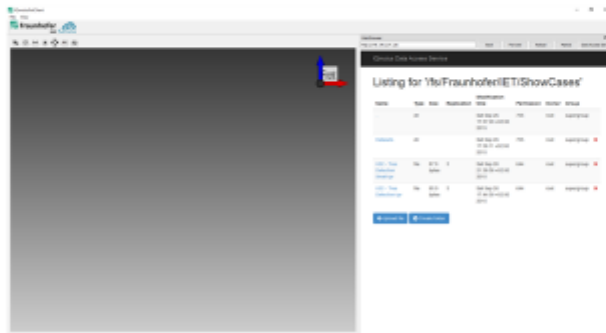


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VISUALIZATION OF EXTRACTED TREES

- Load IQmulus Visualization File (.iqv) from the Data Access Service
- Login and navigate in the browser to the iqv-file you want to visualize
- Example are located at /fs/Fraunhofer/IET/ShowCases



Note: IQV File

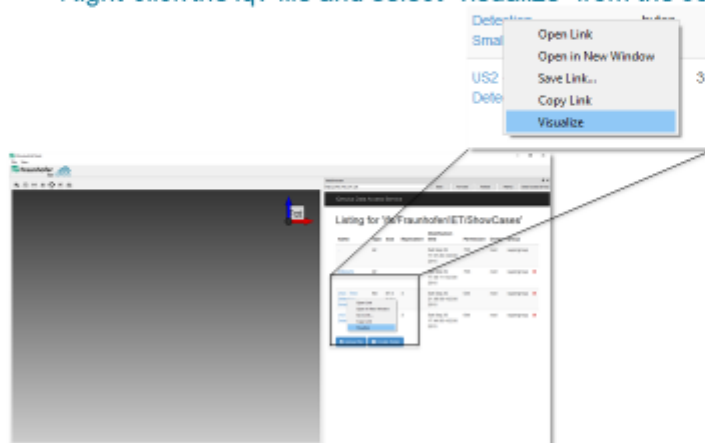
The .iqv file is generated by the workflow and contains links and settings which should not be manipulated by the enduser.

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VISUALIZATION OF EXTRACTED TREES

- Load IQmulus Visualization File (.iqv) from the Data Access Service
- Right-click the iqv-file and select "visualize" from the context menu



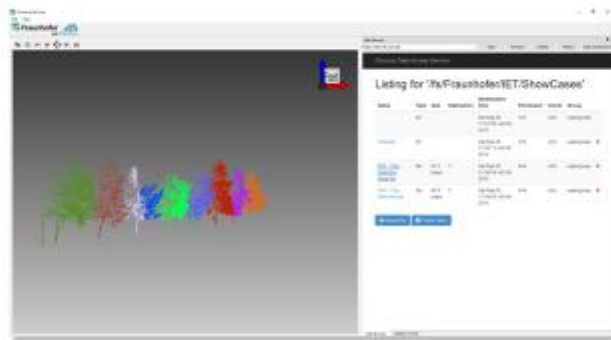
8





VISUALIZATION OF EXTRACTED TREES

- The data will be downloaded and visualized
- Scene navigation
 - Left mouse button: rotate
 - Middle mouse button: pan
 - Right mouse button: zoom

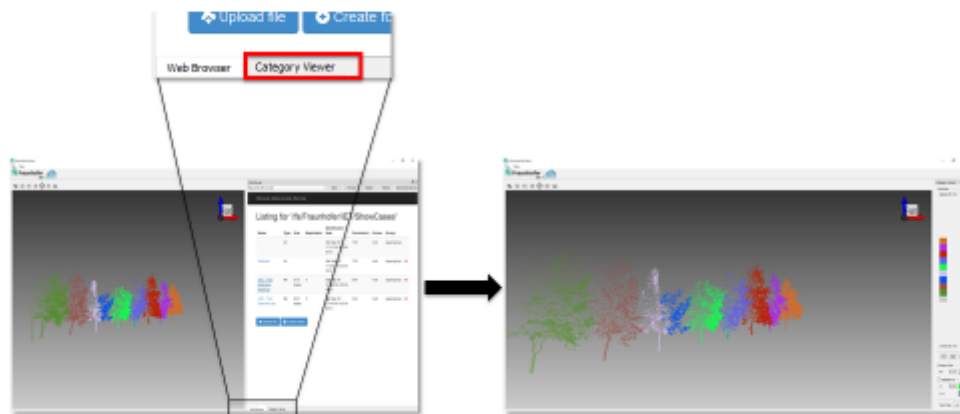


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VISUALIZATION OF EXTRACTED TREES

- Show the scenario specific user interface
- Select the Category Viewer tab below the web browser

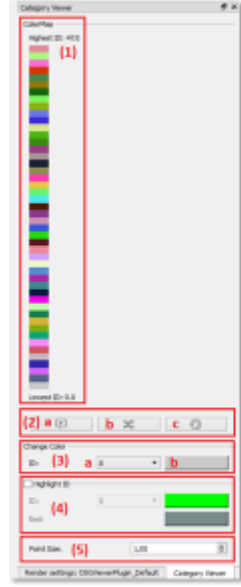


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VISUALIZATION OF EXTRACTED TREES



Scenario specific user interface details

1. The generated or loaded color map which is mapped onto the point cloud.
2. Buttons to change the color map. You can either:
 - a) Load your own image
 - b) Shuffle the colors in the color map
 - c) Generate a completely new color map
3. Field to change the color of a selected ID
4. Field to highlight a selected ID
5. Field to change the size of the points in the point cloud

2a. Loading an Image
 You press button (2a). A File dialog will open where you can choose an image to be loaded. The image must have at least a height (in pixel) of the number of IDs in the loaded point cloud.

2b. 2c. Manipulating the loaded color map
 You can manipulate the color map by pressing the buttons 2b or 2c.
 If you press **button 2b** the colors in the color map will be rearranged.
 If you press **button 2c** the color map will be completely regenerated with new randomly selected colors.
 Keep in mind that the color with the ID 0 won't be changed or shuffled. It can only be manipulated manually via the "Change Color" field.

3. Change the Color of a selected ID
 You can change the color of a specific ID via the fields at (3).
 To change the color of a specific ID you first select the ID in the selection box (3a). Afterwards you can click on the colored button (3b) to open a color picker and select the wanted color. After pressing "Ok" the color will be applied to the color map and the point cloud.

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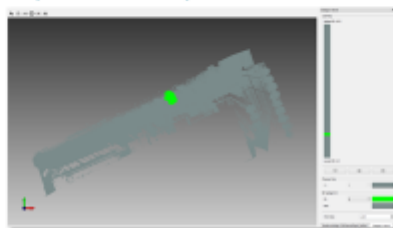
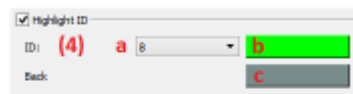




VISUALIZATION OF EXTRACTED TREES

- Example: Highlight a specific tree (ID)

- You can enter a highlighting mode by activating the checkbox "(4) Highlight ID".
- Here you can select the ID which you want to highlight (4a).
- Furthermore you can customize the highlight color (4b) and the background color (4c) by pressing the colored buttons and choosing a color via the color picker. An example is shown below.



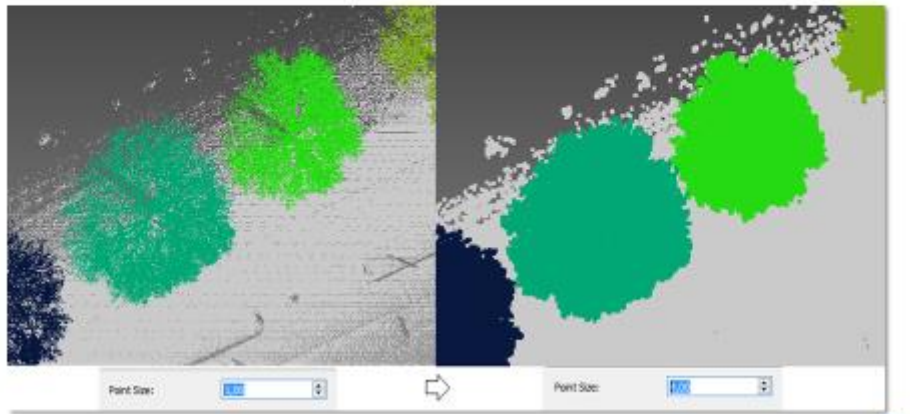
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VISUALIZATION OF EXTRACTED TREES

- Example: Changing point size
 - You can change the size of the points in the point cloud by entering a value in the combo box at (5) (see above).



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5.2 MODULE U2



UPLOAD OF GEOSPATIAL METADATA FOR DATASET

IQmulus Training Module U2



BACKGROUND

- Before data can be processed using an IQmulus workflow, the metadata for the data needs to be established.
- The metadata allows the DSL to select the dataset.
- The metadata for a geospatial dataset describes e.g. the type of the data, the date it was created, its spatial extent, etc.
- The metadata is linked to the dataset via the URI (Uniform Resource Identifier).
- The URI for a dataset in IQmulus is its webHDFS address.





MOTIVATION

- IQmulus deals with big datasets, typically large collections of files.
- Thus recommend to use the 'Batch-Upload' option.
- It is simpler than uploading each dataset one-by-one.
- With 'Batch-Upload' you define the metadata in an Comma Separated Values File (.CSV).
- Each row of the file corresponds to one dataset (file).

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PREPARING METADATA

- Metadata describes the actual data (like a library register describes books)
- Metadata is managed in GeoNetwork according to ISO 19115 / 19139
- You have to describe uploaded data accordingly in order to be able to search it in the IQmulus GUI
- ISO metadata comes with a minimum set of about 15 mandatory parameters
- Especially important for the IQmulus GUI are name, hdfs-location, bounding-box, organization and description

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PREPARING METADATA

- To make capturing the metadata easier we prepared an excel-sheet ([download link from eRoom](#))
- Please note that there are three sheets (1) to punch in the data (2) example data (3) description of metadata fields
- For small numbers of datasets you can just use the excel-sheet to punch in the metadata and afterwards export the sheet as .csv file (no empty lines, ";" as separator)
- Make sure to get the syntax right (e.g. date and bounding box) otherwise you will get an import error
- For larger numbers of metadata sets you can create a script to generate the .csv file directly
- Most of the metadata fields in a series actually are repeating - varying should mainly be hdfs-location and bounding-box

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UPLOADING METADATA

Just upload the .csv file from the upload form: csv-upload.
The script will then:

- Check the content of the .csv file for correctness
- Generate ISO 19139 XML files from the .csv files
- Batch import them to GeoNetwork
- Publish them

In case of errors or success you will get the Log-File for the run to be able to estimate what actually happened.

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UPDATING / DELETING METADATA

There are three ways to update metadata:

- In case you just want to edit a single metadataset just edit it in GeoNetwork
- In case you still got the .csv file and generated an ID you can update the files via batch import
- An easy way also is to just search for the metadataset in GeoNetwork then delete it (select all) and reimport the updated csv file

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METADATA CSV

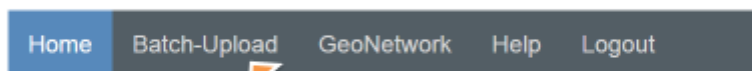
	A	B	C	D	E	F	G	H
1	fileIdentifier	parentID	hierarchy	dataSetURI	beginDate	topic category	keywords	th K
2			dataset	http://146.140.214.126/qs_moss_vk_n/test.txt	2009	bathymetry	point cloud	q
3			dataset	http://146.140.214.126/qs_moss_vk_n/test.txt	2013	bathymetry	point cloud	q
4			dataset	http://146.140.214.126/qs_moss_vk_n/test.txt	2009	bathymetry	point cloud	q
5			dataset	http://146.140.214.126/qs_moss_vk_n/test.txt	2013	bathymetry	point cloud	q
6			dataset	http://146.140.214.126/qs_moss_vk_n/test.txt	2009	bathymetry	point cloud	q
7			dataset	http://146.140.214.126/qs_moss_vk_n/test.txt	2013	bathymetry	point cloud	q
8								

8





IQmulus Metadata Manager

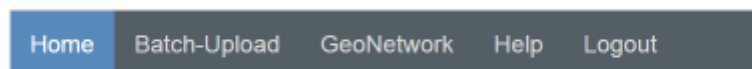


Welcome to IQmulus Metadata Manager!

You can:

[Edit single Metadata file with GeoNetwork >>>Tutorial \(eRoom\)](#)[Batch upload Metadata from Excel-Template >>>Tutorial](#)[Visit us at www.iqmulus.eu](#)

IQmulus Metadata Manager

[Download template for metadata \(eRoom\)](#)

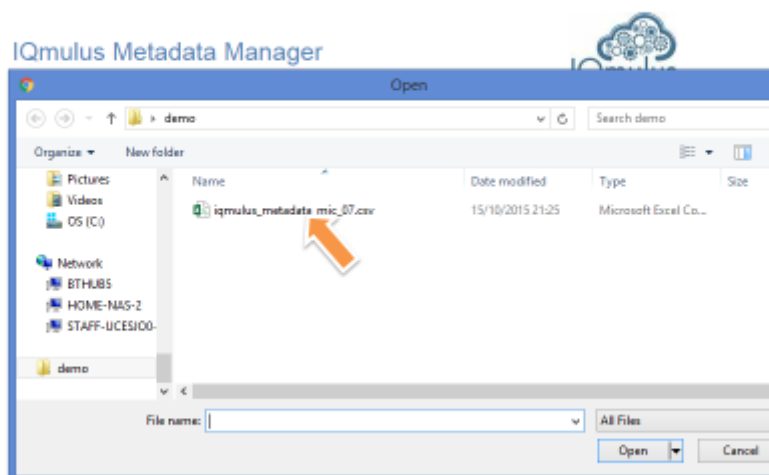
Select .csv file for metadata upload

Select a new .csv file to upload: max. 42 megabytes

 No file chosen[Help/Tutorials](#)[Visit us at www.iqmulus.eu](#)



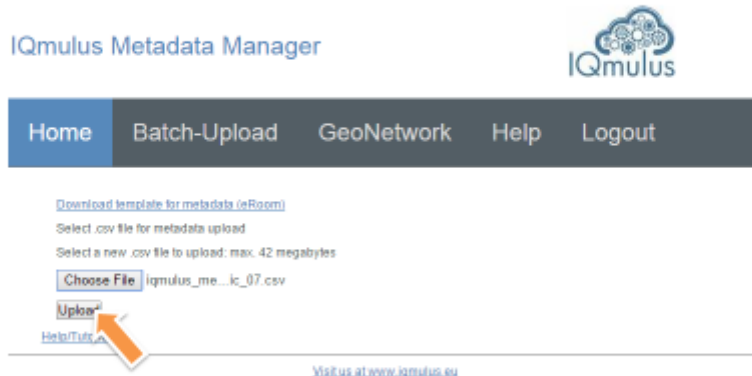
WEB INTERFACE: CHOOSE FILE



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WEB INTERFACE: UPLOAD



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5.3 MODULE U3



EXECUTION OF EXISTING WORKFLOW THROUGH WEB GUI

IQmulus Training Module U3

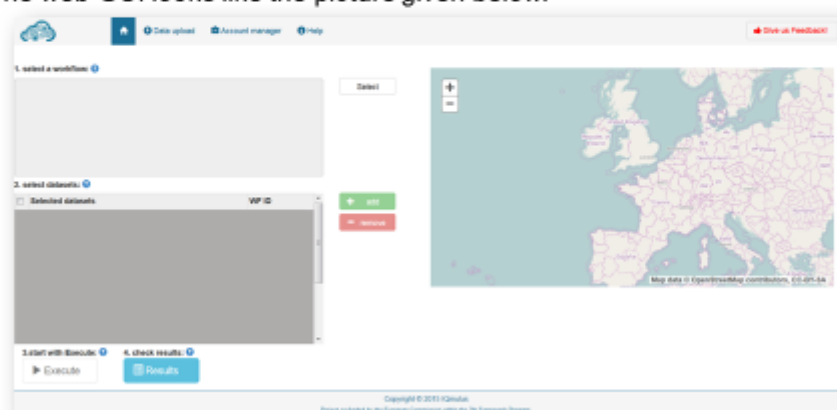


EXECUTING A WORKFLOW THROUGH WEB GUI

The workflows can be called from the IQmulus web GUI which can be accessed from the following link;

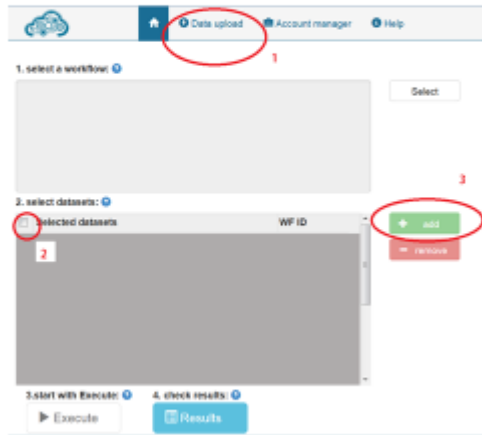
http://146.140.214.133/CswRequest/GUI/main_folder/

The web GUI looks like the picture given below.



EXECUTING A WORKFLOW THROUGH WEB GUI

The data to be used can be uploaded by clicking on the link given as Step1. Then the user must select the point clouds to be processed by selecting the option in Step2 and pressing to the ADD button in Step3.



The details of the interface data upload procedure can be found in the user manual which is provided in the following link;

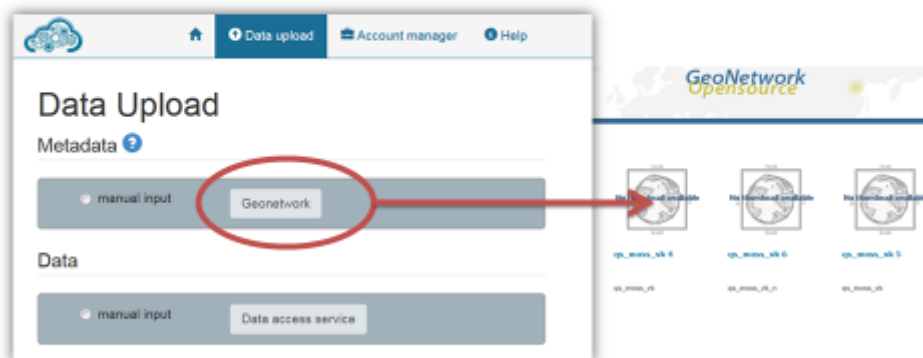
http://146.140.214.133/CswRequest/GUI/main_folder/UserManual.pdf

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EXECUTING A WORKFLOW THROUGH WEB GUI

When the data upload option is selected, there are two options provided to the user. The user can select a data set which is provided for free public usage through **GeoNetwork**.

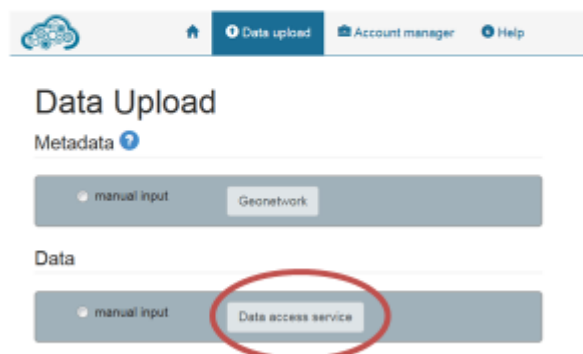


4



EXECUTING A WORKFLOW THROUGH WEB GUI

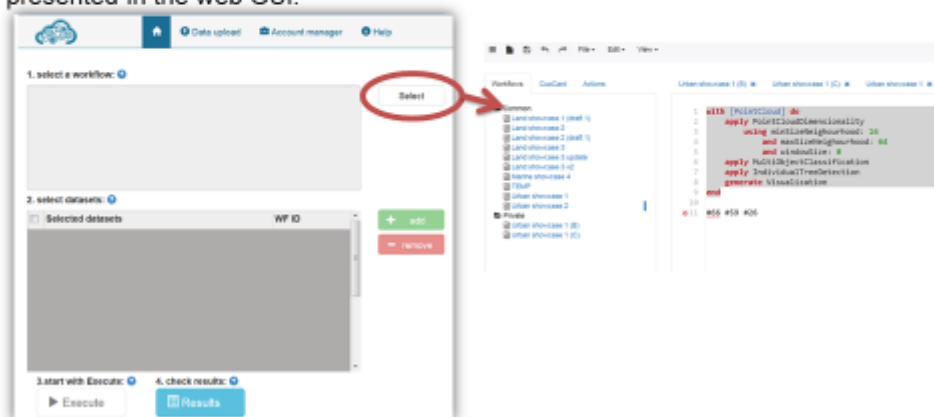
As a second option, the user can upload a data set to the **HDFS** of the project directly. However this second option requires the user to be registered to the **HDFS** file usage system with a user password which must be provided by the IQmulus project developers.



5

EXECUTING A WORKFLOW THROUGH WEB GUI

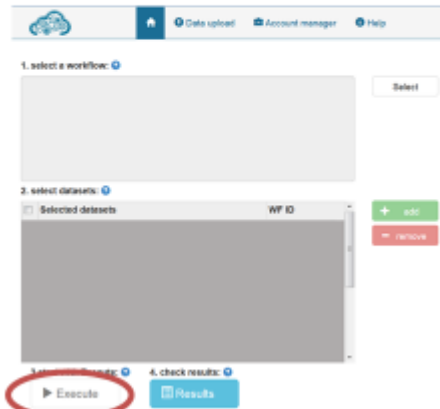
After selecting the point cloud to be processed, the workflow can be selected by clicking on the **Select** button shown below. The user will be directed to a new page which is shown at the right side of the figure. Here, the user can select one of the existing workflows. When it is necessary, the user can also apply changes on the workflow by changing the domain specific language which is also presented in the web GUI.



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EXECUTING A WORKFLOW THROUGH WEB GUI

Finally the selected workflow can be called for the selected data sets by clicking on the **Execute** button. The user can save the results and the workflows in order to use them later.



5.4 MODULE E1



DSL SYNTAX

IQmulus Training Module E1



DOMAIN-SPECIFIC LANGUAGE (DSL)

```
1 with latest Buildings do
2   apply BuildingChangeDetection
3 end
4
```

With-do-end

Use a *with-do-end* block to select a specific dataset from the IQmulus storage cloud (HDFS).

```
1 with [Buildings] do
2   apply BuildingChangeDetection
3 end
4
```

Placeholders

Use square brackets [] to specify a *placeholder* for a dataset you can later select in the IQmulus main user interface.

```
1 apply BuildingChangeDetection
2   with [Buildings]
3
```

Placeholders as parameters

You may use placeholders wherever a dataset expression is allowed (e.g. as a parameter of an *apply* command).





DOMAIN-SPECIFIC LANGUAGE (DSL)

```
1 apply BuildingChangeDetection
2 with [Buildings]
3
```

Apply command

Use the **apply** command to apply a processing service to a dataset

```
1 apply BuildingChangeDetection
2 with [Buildings]
3 and [DTM] and [DSM]
4 using tolerance: 10
5 and method: "Compare"
6
```

Parameters

You can specify parameters for the processing service with the *using* keyword. Multiple parameters are separated by the *and* keyword. Datasets must be specified using the *with* keyword.

```
1 with latest Buildings do
2   apply BuildingChangeDetection
3 end
4
```

Context

Place an *apply* command in a *with-do-end* block. The specified service will be applied to the dataset you selected in the *with-do-end* block.



DOMAIN-SPECIFIC LANGUAGE (DSL)

```
1 apply Service1
2 apply Service2
3 # this is the same as
4 apply Service1 as b
5 apply Service2 with b
6
```

Consecutive apply statements

Consecutive *apply* commands will pick up the result of the previous command as input if you don't specify an input otherwise.

```
1 apply BuildingChangeDetection
2 with [Buildings]
3 and [DTM] and [DSM]
4 using tolerance: 10
5 and method: "Compare"
6 as result
7
```

Assign result to name

You can assign the result of an *apply* command to a name using the *as* keyword.

```
7
8 b = result
9 define result as c
10
```

Assignments

Assign names to other names using the *equals sign* =. Alternatively you can use the *define* and *as* keywords.





DOMAIN-SPECIFIC LANGUAGE (DSL)

- The IQmulus Domain-Specific Language knows only constants (i.e. names with immutable values).
- A name's value cannot change during the script's execution.
- This allows us to create an optimized execution plan for running the script in the Cloud.



DOMAIN-SPECIFIC LANGUAGE (DSL)

```
1 apply BuildingChangeDetection
2 store
3
```

Store

Use the store command to save the result of a processing service (or of a whole workflow) to the IQmulus storage cloud

```
apply VectorLayerPartitioning
using boundaries: [boundaries]
as result

for each result.metadata do
# service 49
  apply ConstrainedTriangulation
  using boundaries: [boundaries]
  store
end
```

For-each-end

Some services create multiple results (oftentimes a folder with many files). You can apply one or more services to each of these results by specifying a *for-each-end* block.

If you are familiar with other programming languages you might know for loops. The for each expression is not a traditional for loop because the statements in the for-each-end block may be executed in parallel and in arbitrary order in the Cloud.



5.5 MODULE E2

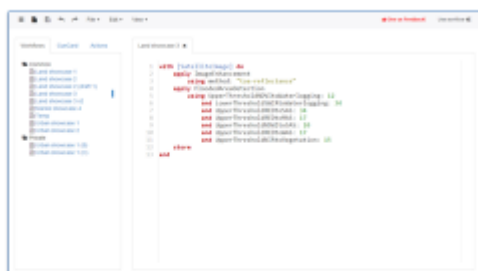


USE OF DSL EDITOR

IQmulus Training Module E2



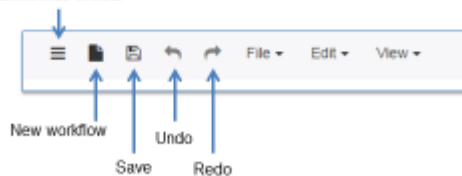
IQMULUS WORKFLOW EDITOR



The IQmulus Workflow Editor consists of three parts


- The editor area on the right
- The sidebar area on the left
- The toolbar on the top

Show/hide toolbar

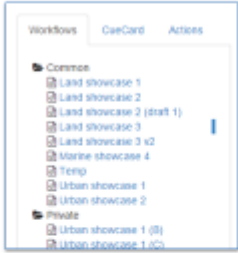


The toolbar contains buttons to quickly access the editor's most used features

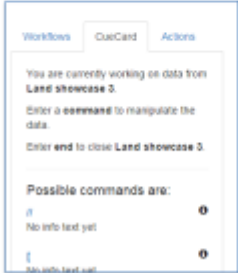




IQMULUS WORKFLOW EDITOR




The *Workflows* tab in the sidebar contains a list of all workflows currently stored in the database. There are common workflows that are shared amongst all users and private ones that can only be seen by the user currently logged in. Click on the name of a workflow to open it in the editor area on the right hand side.

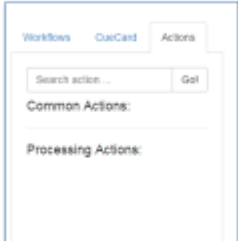


The *CueCard* tab assists users in creating workflows. It is context-sensitive and shows possible commands that users can enter while they type in the editor area.






IQMULUS WORKFLOW EDITOR

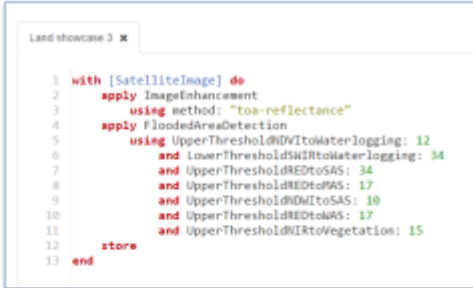


The *Actions* tab lists all commands that can be used in a workflow script. You can use the *Search action* input field to quickly search the catalog for a specific command.





IQMULUS WORKFLOW EDITOR

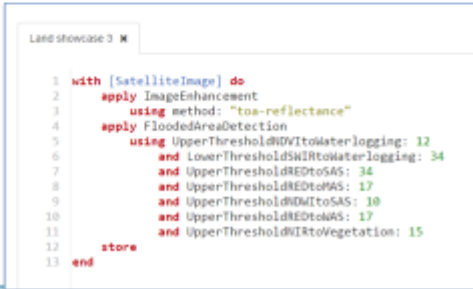


```

1 with [SatelliteImage] do
2   apply ImageEnhancement
3   using method: "toa-reflectance"
4   apply FloodedAreaDetection
5   using UpperThresholdNDVItoWaterlogging: 12
6     and LowerThresholdSWIRtoWaterlogging: 34
7     and UpperThresholdREDtoSAS: 34
8     and UpperThresholdREDtoSAS: 17
9     and UpperThresholdNDVItoSAS: 10
10    and UpperThresholdREDtoSAS: 17
11    and UpperThresholdNDVItoVegetation: 15
12   store
13 end

```

The **editor area** on the right hand side contains the workflow script that is currently open and being edited.




```

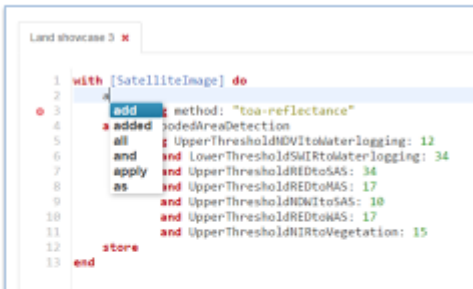
1 with [SatelliteImage] do
2   apply ImageEnhancement
3   using method: "toa-reflectance"
4   apply FloodedAreaDetection
5   using UpperThresholdNDVItoWaterlogging: 12
6     and LowerThresholdSWIRtoWaterlogging: 34
7     and UpperThresholdREDtoSAS: 34
8     and UpperThresholdREDtoSAS: 17
9     and UpperThresholdNDVItoSAS: 10
10    and UpperThresholdREDtoSAS: 17
11    and UpperThresholdNDVItoVegetation: 15
12   store
13 end

```

Syntax highlighting
The editor highlights keywords and other parts of the workflow script in different colors so they can be easily identified.



IQMULUS WORKFLOW EDITOR

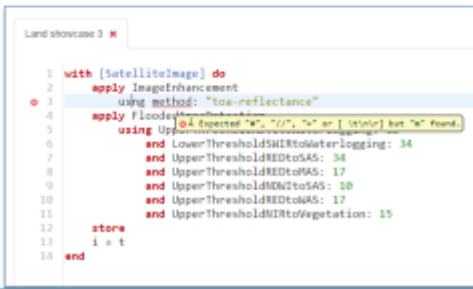


```

1 with [SatelliteImage] do
2   apply ImageEnhancement
3   using method: "toa-reflectance"
4   apply FloodedAreaDetection
5   using UpperThresholdNDVItoWaterlogging: 12
6     and LowerThresholdSWIRtoWaterlogging: 34
7     and UpperThresholdREDtoSAS: 34
8     and UpperThresholdREDtoSAS: 17
9     and UpperThresholdNDVItoSAS: 10
10    and UpperThresholdREDtoSAS: 17
11    and UpperThresholdNDVItoVegetation: 15
12   store
13 end

```

Auto completion
You can press **Ctrl+Space** at any time while you type. The editor will display a list of possible completions for the term you just entered.




```

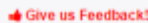
1 with [SatelliteImage] do
2   apply ImageEnhancement
3   using method: "toa-reflectance"
4   apply FloodedAreaDetection
5   using UpperThresholdNDVItoWaterlogging: 12
6     and LowerThresholdSWIRtoWaterlogging: 34
7     and UpperThresholdREDtoSAS: 34
8     and UpperThresholdREDtoSAS: 17
9     and UpperThresholdNDVItoSAS: 10
10    and UpperThresholdREDtoSAS: 17
11    and UpperThresholdNDVItoVegetation: 15
12   store
13   i = t
14 end

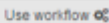
```

Error highlighting
The workflow editor checks your input while you type. Red wavy underlines indicate syntactical and semantical errors. If you point your mouse cursor over one of the errors a tooltip will appear with a detailed description.

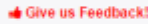


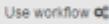
IQMULUS WORKFLOW EDITOR







When you're done editing the workflow press the *Use Workflow* button in the upper right corner to select the workflow and transfer it back to the IQmulus main user interface.






Press the Give us Feedback button if you have remarks and ideas regarding the workflow editor or if you found a bug. You will be redirected to the IQmulus redmine system where you can file an issue.





If you haven't selected a workflow there will be a *Back* button in the upper right corner. Press it to go back to the IQmulus main user interface.



5.6 MODULE E3



DATA TRANSFER VIA HDFS AND WEBHDFS

IQmulus Training Module E3



HDFS AND WEBHDFS

All files and data sets are stored in the cluster
on a robust distributed file system known as **HDFS**

WebHDFS is the web interface to HDFS





METHODS FOR UPLOADING DATA

	WebHDFS	Direct upload into HDFS
Graphical user interface	✓	✗
Multiple file upload	✓	✓
Recursive directory upload	✗	✓
No third party software required on Windows	✓	✗
No third party software required on Mac/Linux	✓	✓

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Uploading data using WebHDFS

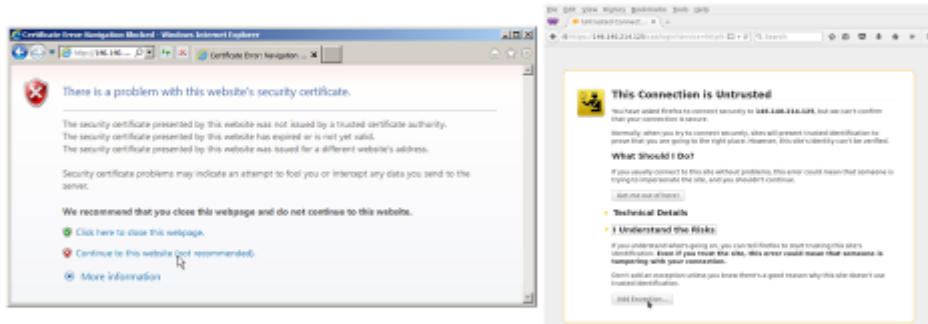
DATA TRANSFER VIA HDFS AND WEBHDFS

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LOGGING IN TO WEBHDFS

- Open web browser and visit <http://146.140.214.126/fs>
- Ignore security warning when prompted



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LOGGING IN TO WEBHDFS

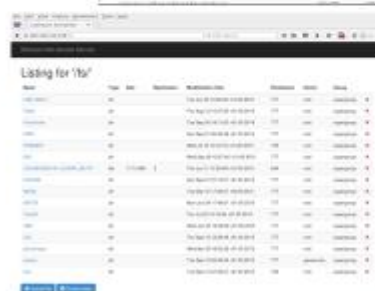
After logging in...



... click the link to [/fs/](#)...




... to see a listing of
the root directory



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NAVIGATING WEBHDFS

IQmulus Data Access Service

Listing for '/fs/'

Click to delete file or directory

Name	Type	Size	Replication	Modification time	Permission	Owner	Group	
CNR_IMAT1	dir			Tue Jun 30 13:52:30 +01:00 2015	777	root	supergroup	
FCMI	dir			Thu Aug 13 19:37:06 +01:00 2015	777	root	supergroup	
FourWater	dir			Tue Sep 30 18:11:53 +01:00 2014	777	root	supergroup	
HFW	dir			Sun Sep 21 08:48:08 +01:00 2014	777	root	supergroup	
IFEMORY	dir			Wed Jul 15 13:12:18 +01:00 2015	755	root	supergroup	
IGN	dir			Wed Sep 09 18:57:45 +01:00 2015	777	root	supergroup	
IQM66060211113LQW05_85.TF	file	117.4 MB	3	Thu Jun 11 12:35:49 +01:00 2015	644	root	supergroup	
LDLPA	dir			Sun Sep 21 07:19:07 +01:00 2014	777	root	supergroup	
MOSS	dir			Tue Mar 10 17:58:37 +00:00 2015	777	root	supergroup	
SATSEF	dir			Mon Jun 29 17:49:51 +01:00 2015	777	root	supergroup	
TuData	dir			Thu Jul 02 19:19:48 +01:00 2015	777	root	supergroup	
UBO	dir			Wed Jun 03 12:38:05 +01:00 2015	777	root	supergroup	
UCL	dir			Thu Sep 10 12:58:49 +01:00 2015	777	root	supergroup	
plmmanager	dir			Wed Apr 29 16:02:26 +01:00 2015	777	root	supergroup	
system	dir			Tue Sep 15 02:08:44 +01:00 2015	777	gessemio	supergroup	
tmp	dir			Tue Sep 15 07:28:21 +01:00 2015	755	root	supergroup	

Upload file Create folder

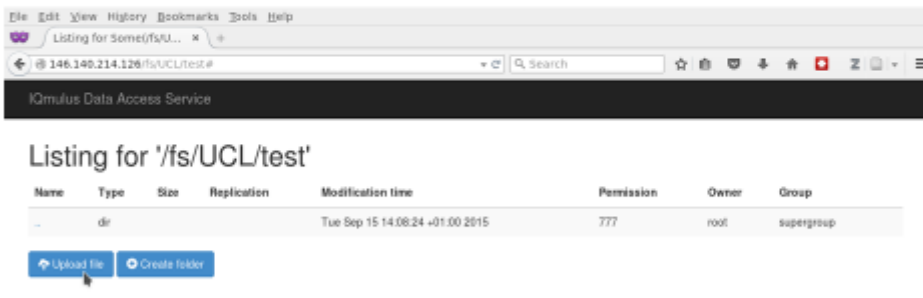
Click directory name to explore
Click filename to download
Upload a file/files
Create folder in the current directory

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UPLOADING FILES ON WEBHDFS

- Navigate to desired directory
- Create directories as needed
- Press *Upload file*



Listing for '/fs/UCL/test/'

Name	Type	Size	Replication	Modification time	Permission	Owner	Group
..	dir			Tue Sep 15 14:08:24 +01:00 2015	777	root	supergroup

Upload file Create folder

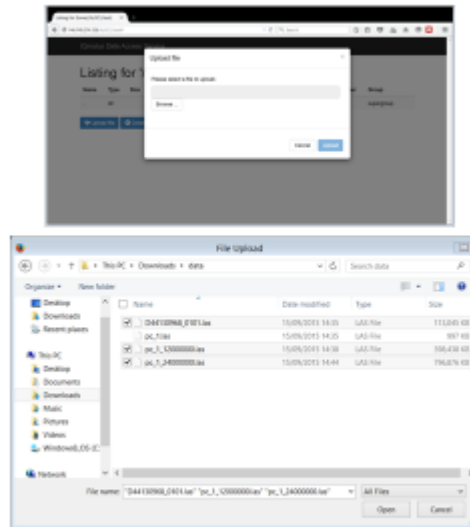
8





UPLOADING FILES ON WEBHDFS

- Click *Browse...*
- Navigate to the desired directory containing the files to be uploaded
- Select the files. Multiple files can be uploaded by pressing CTRL while clicking, or by dragging a box.
- Click *Open* to close the window then click *Upload*.



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Directly uploading data into HDFS

DATA TRANSFER VIA HDFS AND WEBHDFS

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DIRECTLY UPLOADING DATA INTO HDFS

- Method 1: Upload to intermediate server then copy to HDFS
- Con: Max file size limited by intermediate server disk space



- Method 2: Change permissions on HDFS then upload directly
- Con: More steps involved



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REQUIRED SOFTWARE ON WINDOWS

- SFTP client
Install *FileZilla* from filezilla-project.org
- SSH client
Install *PuTTY* from
<http://www.chiark.greenend.org.uk/~sgtatham/putty/> or search for *putty*
- May also be installed on Mac and Linux

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Directly uploading data into HDFS

Method 1: Upload into intermediate server then copy to HDFS

DATA TRANSFER VIA HDFS AND WEBHDFS

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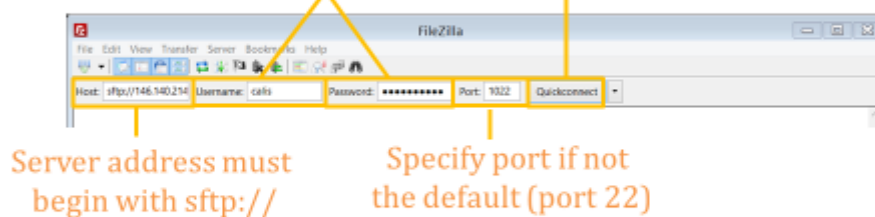


UPLOAD INTO INTERMEDIATE SERVER THEN COPY

Connect to the intermediate server using FileZilla

Same credentials
used for SSH access

Click to
connect



Server address must
begin with sftp://

Specify port if not
the default (port 22)

Accept to trust host when prompted



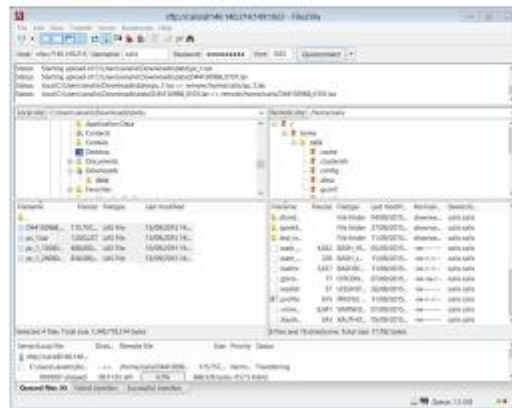
14





UPLOAD INTO INTERMEDIATE SERVER THEN COPY

- Navigate to source and destination directories
- Select source files and directories then drag to right pane
- Wait for upload to finish



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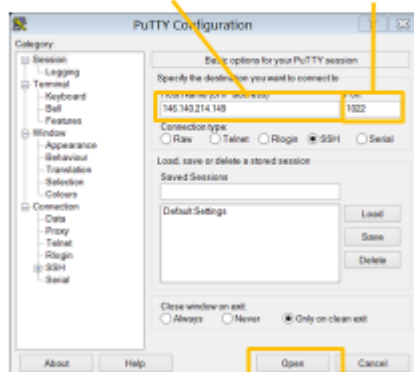


UPLOAD INTO INTERMEDIATE SERVER THEN COPY

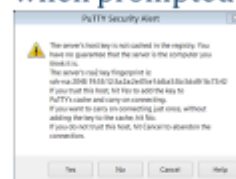
Connect to the intermediate server using PuTTY

Accept to trust host when prompted

Specify port if not the default (port 22)



Click to connect



Enter SSH credentials



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UPLOAD INTO INTERMEDIATE SERVER THEN COPY

After logging in, move uploaded files to desired directory:

- The HDFS root directory is mounted at */mnt/hdfs*
- Create target directory as required

Example: the command to create the directory *data/test* under the *UCL* directory is

```
sudo mkdir -p /mnt/hdfs/UCL/data/test
```

- Move uploaded files to target directory

Example: to move the uploaded **.las* from the current directory to the created directory above, the command is

```
sudo mv *.las /mnt/hdfs/UCL/data/test
```

- Log out of the server by issuing the command *exit*

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Directly uploading data into HDFS

Method 2: Change permissions on HDFS then upload directly

DATA TRANSFER VIA HDFS AND WEBHDFS

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ISSUES WITH INTERMEDIATE SERVER AND HDFS

- Issue: Max upload size is limited by disk space on server
Solution: upload directly to HDFS
- Issue: No write permission for non-root users on HDFS
Solution: temporarily change permission before uploading

Name	Type	Size	Modification	Modification Date	Permissions	Status	Storage
./	dir		Tue Jan 30 15:02:00 +01:00 2018		757	not	unresponsive
./bin	dir		Thu Jan 10 09:57:00 +01:00 2018		757	not	unresponsive
./browser	dir		Tue Jan 30 15:01:00 +01:00 2018		757	not	unresponsive
./dev	dir		Sun Jan 27 09:49:00 +01:00 2018		757	not	unresponsive
./examples	dir		Wed Jan 17 15:17:00 +01:00 2018		756	not	unresponsive
./GA	dir		Wed Jan 30 10:47:00 +01:00 2018		757	not	unresponsive
./GCM_BACKEND/GOOGLE_MAPS	dir	117.4 KB			844	not	unresponsive
./GCM_BACKEND/GOOGLE_MAPS/GOOGLE_MAPS	dir		Tue Jan 30 17:37:00 +01:00 2018		757	not	unresponsive
./GCM_BACKEND/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS	dir		Tue Jan 30 17:38:00 +01:00 2018		757	not	unresponsive
./GCM_BACKEND/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS	dir		Mon Jan 29 17:45:00 +01:00 2018		757	not	unresponsive
./GCM_BACKEND/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS	dir		Tue Jan 30 15:01:00 +01:00 2018		757	not	unresponsive
./GCM_BACKEND/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS	dir		Wed Jan 30 15:38:00 +01:00 2018		757	not	unresponsive
./GCM_BACKEND/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS	dir		Thu Jan 10 09:48:00 +01:00 2018		757	not	unresponsive
./GCM_BACKEND/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS	dir		Wed Jan 30 16:02:00 +01:00 2018		757	not	unresponsive
./GCM_BACKEND/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS	dir		Tue Jan 30 09:04:00 +01:00 2018		757	responsive	unresponsive
./GCM_BACKEND/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS/GOOGLE_MAPS	dir		Tue Jan 30 09:05:00 +01:00 2018		756	not	unresponsive

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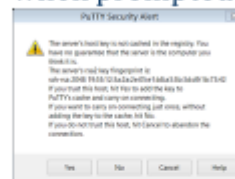
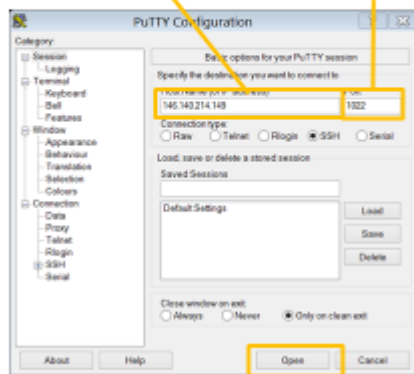


CHANGE PERMISSIONS THEN UPLOAD DIRECTLY

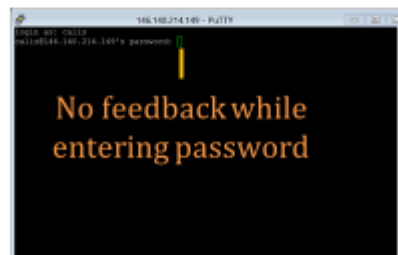
Connect to the intermediate server using PuTTY

Accept to trust host
when prompted

Server address	Specify port if not the default (port 22)
----------------	---



Enter SSH credentials



Click to connect

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CHANGE PERMISSIONS THEN UPLOAD DIRECTLY

After logging in, change permissions of target directory:

- The HDFS root directory is mounted at `/mnt/hdfs`
- Create target directory as required

Example: the command to create the directory `data/test` under the `UCL` directory is

```
sudo mkdir -p /mnt/hdfs/UCL/data/test
```

- Add write permission for others on target directory

Example: to add write permission to the created directory above, the command is

```
sudo chmod o+w /mnt/hdfs/UCL/data/test
```

- Do not log out or close the SSH session

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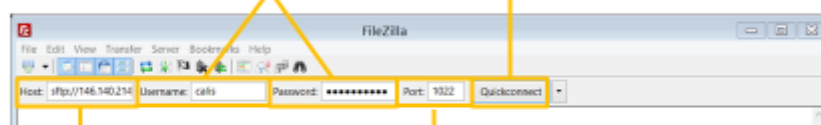


CHANGE PERMISSIONS THEN UPLOAD DIRECTLY

Connect to the intermediate server using FileZilla

Same credentials
used for SSH access

Click to
connect



Server address must
begin with `sftp://`

Specify port if not
the default (port 22)

Accept to trust host when prompted



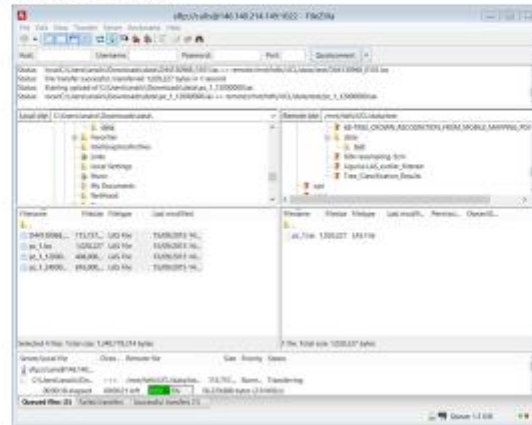
22





CHANGE PERMISSIONS THEN UPLOAD DIRECTLY

- Navigate to source and destination (HDFS) directories
- Select source files and directories then drag to right pane
- Wait for upload to finish



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CHANGE PERMISSIONS THEN UPLOAD DIRECTLY

- Go back to the SSH console
- Remove write permission for others on target directory
Example: to remove the write permission to the previously created directory, the command is

```
sudo chmod o-w /mnt/hdfs/UCL/data/test
```
- Log out of the server by issuing the command *exit*

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Uploading data from Mac and Linux

DATA TRANSFER VIA HDFS AND WEBHDFS

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UPLOADING DATA FROM MAC AND LINUX

- FileZilla and PuTTY can be installed on Mac and Linux
- Same steps as in Windows after installing these clients
- Use *scp* as alternative to FileZilla
Example: to upload *.las files from current directory to home directory on server 123.456.789.101 on port 1022, the command is

```
scp *.las -P 1022 username@123.456.789.101:~
```
- Use *ssh* as alternative to PuTTY
Example: to connect to server 123.456.789.101 on port 1022, the command is

```
ssh username@123.456.789.101 -p 1022
```

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5.7 MODULE D1



CHECKING OUT AND EXECUTING A SERVICE FROM THE REPOSITORY

IQmulus Training Module D1



TOOLS

- SSH (Secure Shell)
 - an encrypted network protocol for launching shell sessions on remote machines securely
- The Artifactory repository
 - the repository manager for IQmulus
- Docker
 - creates and runs containers for automating the deployment of applications





SSH

- SSH clients for different platforms
 - Windows: PuTTY
 - has a friendly GUI
 - can be download from <http://www.putty.org/>
 - Linux: OpenSSH
 - has official packages for many linux distributions
 - Mac OS X: OpenSSH
 - available within the operation system



SSH BASICS

- OpenSSH 101:
 - `ssh [options] [username@]hostname [command]`
- common options
 - `-p`: port to connect to on the remote host
 - `-i`: selects a file from which the identity for public key authentication is read
 - `-x`: disables X11 forwarding
 - `-X`: enables X11 forwarding
 - `-f`: requests ssh to go to background just before command execution



ARTIFACTORY

- It manages binaries through throughout the software release cycle
 - Build integration: deploy build artifacts into Artifactory from Jenkins
 - Docker: use Artifactory to manage in-house Docker images
 - Repository replication: actively synchronize the repository with remote Artifactory repositories using pull or push replication.

5



OVERVIEW OF ARTIFACTORY

- Login into Artifactory with credentials

Home Artifacts Deploy Admin

Welcome to Artifactory

Please Sign In to Artifactory

★ Username

★ Password

☐ Remember Me

Log In Cancel

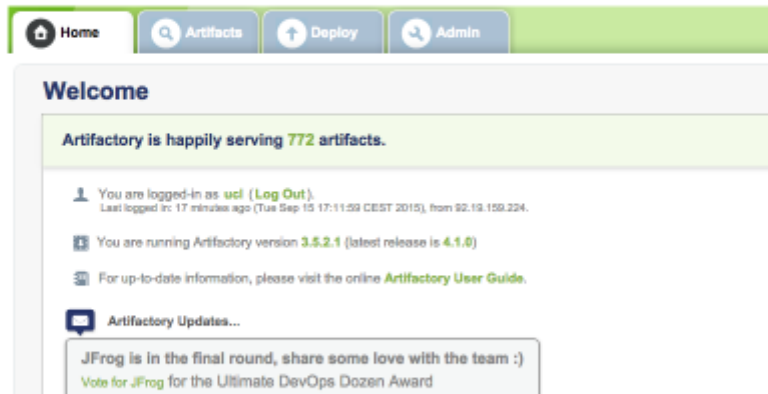
6





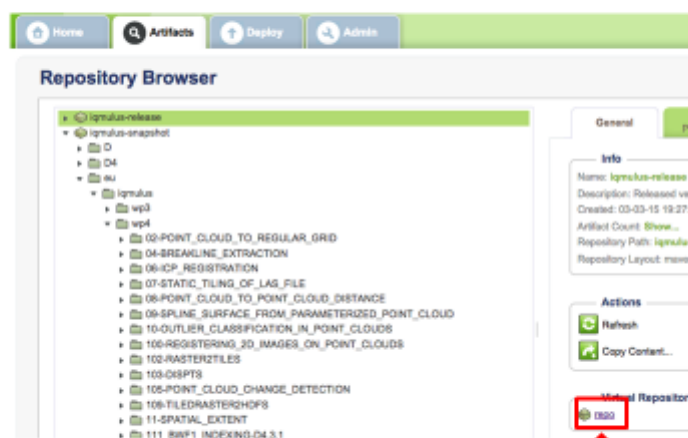
OVERVIEW OF ARTIFACTORY

- The dashboard in home page



OVERVIEW OF ARTIFACTORY

- Released services in Artifactory



Click "repo" to check service links for downloading



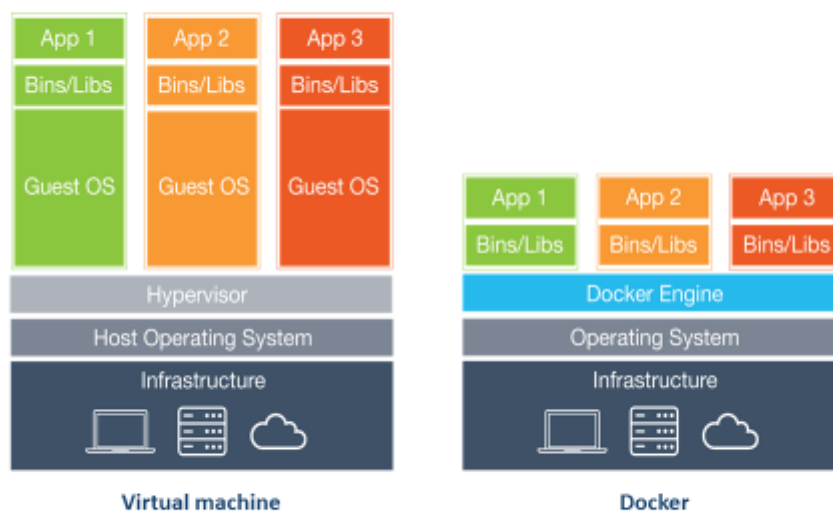
DOCKER

- Lightweight
 - containers running on a single machine share the same operating system kernel so they start instantly and make more efficient use of RAM
- Open
 - run on all major Linux distributions and Microsoft operating systems
- Secure
 - containers isolate applications from each other

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VIRTUAL MACHINE V.S. DOCKER



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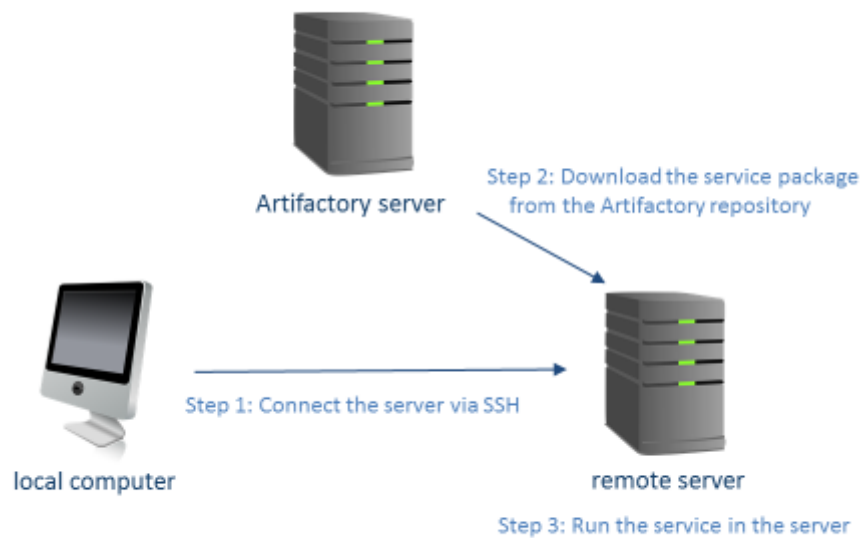
DOCKER BASICS

- Build an image using the Dockfile
 - `docker build -t IMAGE:[TAG] .`
- Run processes in containers
 - `docker run -v host-dir:container-dir -w work-dir -ti IMAGE:[TAG] [COMMAND]`
 - `-v`: create a bind mount
 - `-w`: working directory inside the container
 - `-t`: allocate a pseudo-tty
 - `-i`: keep STDIN open even if not attached

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OUTLINE



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STEP 1: CONNECT THE SERVER VIA SSH

- Type SSH command in the terminal to connect the server

```

1. bash
Last login: Tue Sep 15 15:46:26 on ttys000
Kuns-MacBook-Air-2:~ kun$ ssh -p 1022 kliu@146.140.214.149

```

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STEP 2: DOWNLOAD SERVICE PACKAGE

- Use curl or wget to download the service package from the Artifactory
 - the download link is obtained from the Artifactory Web pages
 - the username and the password for the Artifactory are required

```

1. kliu@iqmulus-wp4-uc110: ~ (ssh)
kliu@iqmulus-wp4-uc110:~$ curl -u ucl: -o 1.zip http://146.140.214.134/artifactory/repos/eu/iqmulus/wp4/10-OUTLIER_CLASSIFICATION_IN_POINT_CLOUDS/D4.3.1-1.4/10-OUTLIER_CLASSIFICATION_IN_POINT_CLOUDS-D4.3.1-1.4.zip
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100 61490  100 61490    0     0  322k      0  --:--:-- --:--:-- --:--:--  321k
kliu@iqmulus-wp4-uc110:~$

```

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STEP 3: RUN THE SERVICE

- Change the current directory to the root of the uncompressed service package
- Build the Docker image for the service by running the provided script `install.sh`

```
1. klu@iqmulus-wp4-uc10: ~/D4.3.1-1.4 (ssh)
klu@iqmulus-wp4-uc10:~/D4.3.1-1.4$ sudo ./test/bin/install.sh
[sudo] password for klu:
Sending build context to Docker daemon 194 kB
```

- Test the service using the provided script `test.sh`

```
1. klu@iqmulus-wp4-uc10: ~/D4.3.1-1.4 (ssh)
klu@iqmulus-wp4-uc10:~/D4.3.1-1.4$ sudo ./test/bin/test.sh
<*)>>>><[2015-09-15 17:07:54]-[1442336874]-[info]-[service]-[service10]-[Outlier
Filtering]-[outlierClassificationInPointClouds]-[***** Service 10 starts **
*****]-[[:0] }
```

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STEP 3: RUN THE SERVICE

- Run the service using the provided script `run.sh` with arguments for the service

```
1. klu@iqmulus-wp4-uc10: ~/D4.3.1-1.4 (ssh)
klu@iqmulus-wp4-uc10:~/D4.3.1-1.4$ sudo ./test/bin/run.sh -input_file_name dat
a/D44130968_0101.las -output_file_name data/D44130968_0101_inlier.ply -outlier_f
iltering_K 15 -outlier_filtering_stddev 3.0
<*)>>>><[2015-09-15 17:14:01]-[1442337241]-[info]-[service]-[service10]-[Outlier
Filtering]-[outlierClassificationInPointClouds]-[***** Service 10 starts **
*****]-[[:0] }
```

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5.8 MODULE D2



EXECUTION OF SINGLE SERVICE FROM COMMAND LINE

IQmulus Training Module D2



SERVICE 11: SPATIAL EXTENT

General Information and Relevance:

Spatial extent service is developed for general usage within any workflow in order to be able to extract spatial information about the input or the output data when it is needed.

Functionality of the Service:





SERVICE 11: SPATIAL EXTENT

Big Data Aspects:

The recent version of the software can deal with point clouds which consists of a couple of million points however it is always computer RAM which might limit the input data size requirement. If the input point cloud is larger than TB sizes, then the process can be done by downsampling or tiling the input cloud.

Development History and Current Status of The Service:

In the 2nd year of the project, Windows version of the service was released on GitHub.

In the 3rd year of the project, Linux (Ubuntu 14.04) version of the service is released on Artifactory. *Logging* messages are implemented in the software. *Docker* and *test.sh* files are shared in the latest Artifactory folder.

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SERVICE 11: SPATIAL EXTENT

Files and Usage 1/2:

1. This service needs only PCL library to be installed. This library can be installed manually from the Linux Terminal Window using the following command lines;

```
RUN apt-get update
RUN apt-get install -y software-properties-common
RUN add-apt-repository -y ppa:v-launchpad-jochen-sprickerhof-de/pcl
RUN apt-get update
RUN apt-get install -y libpcl-all
```

Another option to have the PCL library installed on the working computer is using the provided Dockerfile and creating an image as it is described below;

```
sudo apt-get install docker
sudo docker build -t my_image
sudo docker run --name my_instance -i -t my_image
```

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SERVICE 11: SPATIAL EXTENT

Files and Usage 2/2:

2. The software can be called by typing following command in the terminal;

```
$ ./BoundingBox mycloud.xyz
```

(The input file must be an ASCII file of a point cloud with xyz, txt, ascii, etc. file extensions. The software processes only the first three columns of the input point cloud. Therefore if there are more than three columns they will be ignored, however it will not be a problem for the software.)

3. You can call the demo by typing;

```
$ ./BoundingBox AHN-subset.xyz
```

4. The spatial extent will be written into a PLY file in the same working folder. Check the *BoundingBox.ply* file. You can visualize the result in *MeshLab* program which is free to download from <http://meshlab.sourceforge.net/>

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SERVICE 11: SPATIAL EXTENT

Details of The Output File:

The output header contains the following information. This header indicates that the output is a 3D box with the x y z coordinates and order of edges which are represented in the rest of the file.

```
ply
format ascii 1.0
comment this file is a boundingbox
element vertex 8
property float x
property float y
property float z
property uchar red
property uchar green
property uchar blue
element edge 12
property int vertex1
property int vertex2
property uchar red
property uchar green
property uchar blue
end_header
```

The x, y, z coordinates are the real geographical coordinates of the points, therefore it is possible to use the service to find the location of the input point clouds in *Google Earth* or other world maps easily.

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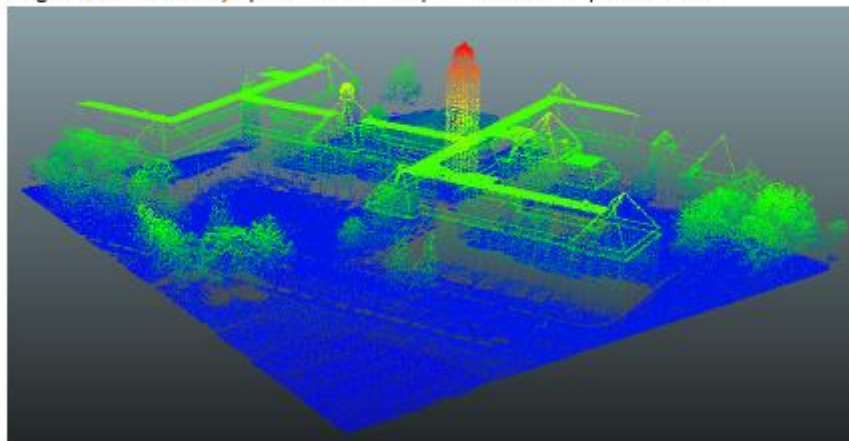




SERVICE 11: SPATIAL EXTENT

Examples:

An example point cloud is provided in the Artifactory folder of the software. The original **AHN-subset.xyz** point cloud file is presented in the picture below.



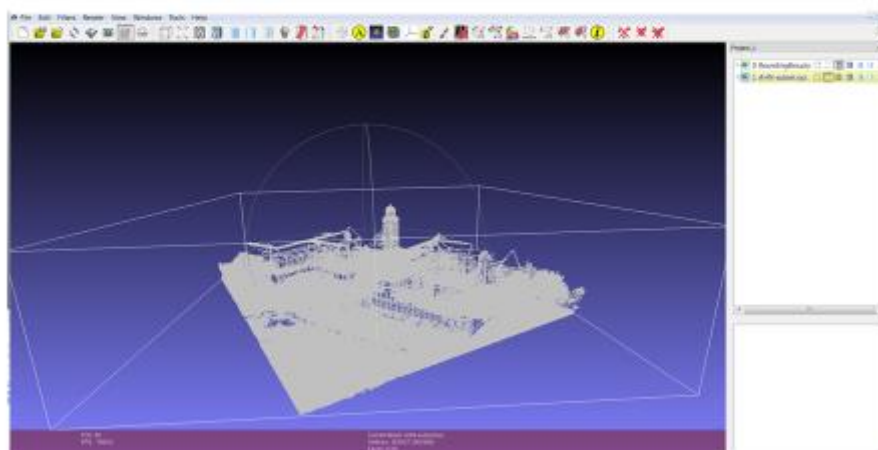
7



SERVICE 11: SPATIAL EXTENT

Examples:

The result **BoundingBox.ply** file can be displayed in MeshLab program.



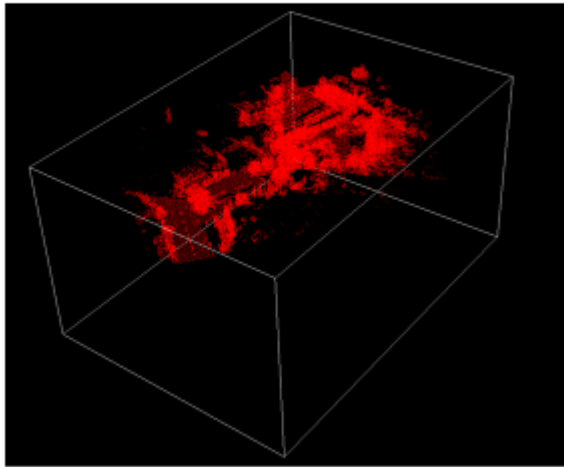
8





SERVICE 11: SPATIAL EXTENT

Possible Errors:



Outlier points might cause obtaining a larger bounding box than the extent that user wishes to extract.