Open Foris Geospatial Toolkit

USER MANUAL

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Version 1.25.4 October 2013

Contents

1 Introduction

1.1 About this manual

The user manual is developed to help getting into spatial analysis using the Open Foris Geopsatial Toolkit. It gives basic explanations of how OFGT functions. It is not attempted to explain the theoretical background on how to do geo-spatial analysis using remote sensing or GIS, but rather will guide you through **hands-on examples** for each tool, next to some general areas, such as the installation. Further, the manual will link to relevant man pages and other documentation.

In addition, the user manual is written in a way that it can be understood by people who are experienced Windows or Mac users, but have not used Linux or OFGT much before. Sources and documentation for OFGT can be obtained here: http://km.fao.org/OFwiki/index.php/Open_Foris_Geospatial_Toolkit

1.2 What is OFGT?

OFGT - Open Foris Geospatial Toolkit is a a collection of prototype command-line utilities for processing of geographical data. The tools can be divided into stand-alone programs and scripts and they have been tested mainly in Ubuntu Linux environment although can be used with other linux distros, Mac OS, and MS Windows (Cywgin) as well. Most of the stand-alone programs use GDAL libraries and many of the scripts rely heavily on GDAL command-line utilities.

The OFGT project started under the Open Foris Initiative to develop, share and support software tools and methods for multi-purpose forest assessment, monitoring and reporting. The Initiative develops and supports innovative, easy-to-use tools needed to produce reliable, timely information on the state of forest resources and their uses. The command-line tools aim to simplify the complex process of transforming raw satellite imagery for automatic image processing to produce valuable information. These tools contain radiometric harmonisation, image segmentation and image arithmetic, as well as image statistics, feature extraction and other image processing analysis.

Overview of OFGT versions currently available

- *OFGT 1.25.4* - continuously updated
- *OFGT 1.0* -

1.3 The great potential of OFGT

The toolkit comes to its own when dealing with large data sets:

- First of all the **processing itself takes a fraction** of time than with conventional software.
- And second, **automatised data processing makes applications repeatable**, which is of high advantage for many projects.
- All tools and methods developed under the Initiative are open-source.

1.4 First time users

First time users, the terminal is your friend: The Open Foris Geospatial Toolkit tutorial is aiming to provide straight forward guidelines and examples to help first time users to familiarise themselves with the Open Foris Geospatial Toolkit. This includes the installation of Ubuntu, various geospatial tools and, in particular, the installation and application of the Open Foris Geospatial Toolkit. You do not need to be an expert, we just would like you to be curious to try things out. Do not be afraid of using the command-line! We know that the terminal window is for many users a barrier of being afraid ruining everything and having to start from scratch. These days the terminal is not exclusively for advanced computer enthusiasts. Give it a try and just start playing around following the tutorials and instructions you can find in the wiki.

2 License

Open Foris Geospatial Toolkit is released under GNU GPLv3 license.

3 Installation of Open Foris Geospatial Toolkit

The Open Foris Geospatial Toolkit comes with an installer which is frequently updated. It is named **OpenForisToolkit.run**. To run the installer please use the Terminal.

3.1 Linux: debian-based distributions (Ubuntu, Debian, etc.)

The installer has been tested with various Ubuntu Linux versions and it should work with other Debian based distros as well.

1. First make sure that you have installed all the necessary gdal and gsl libraries and tools. If you do not have them download and install them by using following commands:

```
sudo apt-get install gcc
sudo apt-get install g++
sudo apt-get install gdal-bin
sudo apt-get install libgdal1-dev
sudo apt-get install libgsl0-dev
sudo apt-get install libgsl0ldbl
sudo apt-get install python-gdal
sudo apt-get install python-gdal
sudo apt-get install perl
sudo apt-get install python-scipy
sudo apt-get install python-tk
```

2. Then download the OpenForisToolkit.run installer

```
wget http://foris.fao.org/static/geospatialtoolkit/releases/
   OpenForisToolkit.run
```

```
sudo chmod u+x OpenForisToolkit.run
```

```
sudo ./OpenForisToolkit.run
```

3. To accept the license terms type 1 and hit enter.

3.2 Linux: rpm-based systems (PCLinuxOS, RedHat, SuSE, etc.)

Open Foris Toolkit is tested on and we recommend PCLinuxOS. Always ensure that your system is fully updated: Open Synaptic, click *Reload* to get a current file list, click *Mark All Upgrades*, click *Apply*.

1. If you do not have gdal and gsl libraries and tools installed, install them via Synaptic:
   - Open Synaptic, click *Reload*, click *Search*, then search for the following packages and and mark them for installation: libgdal-devel, gdal, gdal-python, prom, gsl-devel, gsl-progs
   - Click *Apply* to install them
2. Download the OpenForisToolkit.run installer

   ```
   wget http://foris.fao.org/static/geospatialtoolkit/releases/OpenForisToolkit.run
   ```

   Make the installer executable open a Terminal and enter the command:

   ```
   chmod u+x OpenForisToolkit.run
   ```

   Install OpenForisToolkit, enter the command:

   ```
   su -c './OpenForisToolkit.run'
   ```

3.3 Mac OS-X: Lion

1. Download wget, make it executable, and copy it into the system: open a Terminal and enter the command:

   ```
   chmod a+x wget; sudo cp wget /usr/bin/
   ```

2. Download and install the latest version of the gsl-framework and gdal-complete from kyngchaos:
3. Download the OpenForisToolkit.run installer

   ```
   wget http://foris.fao.org/static/geospatialtoolkit/releases/
      OpenForisToolkit.run
   ```

4. Making the installer executable open a Terminal and enter the command:

   ```
   chmod u+x OpenForisToolkit.run
   ```

5. Amend the $PATH environment for the installation, enter the command:

   ```
   Export PATH=/Library/Frameworks/GSL.framework/Programs:$PATH
   ```

6. Install OpenForisToolkit, enter the command:

   ```
   sudo ./OpenForisToolkit.run
   ```

3.4 Windows Cygwin installation

WARNING

ADMINISTRATIVE PRIVILEGES ARE REQUIRED IN ORDER TO PERFORM THE INSTALLATIONS AND EVENTUALLY ALSO TO USE THE APPLICATION. USERS WITH STANDARD PRIVILEGES MAY WANT TO CREATE A VIRTUAL MACHINE WITH VIRTUAL BOX AND UBUNTU 12.04 WHERE ADMINISTRATIVE RIGHTS WILL BE REQUESTED ONLY FOR THE INSTALLATION.

The Cygwin project provides a Linux terminal in Windows.

1. Download either setup-x86.exe or setup-x86_64.exe
2. Run it as admin (right-click on setup.exe and Run as [admin credentials])
3. Click Next
4. Choose Install from Internet
5. You may leave the destination folder as C:\cygwin (for All Users)
6. Choose any local package directory (it will be used for future storage of installers)
7. Select Direct Connection (unless your connection requirements are different)
8. Choose a download site, basing on site country domain or known availability, or add your own preferite
9. If it is a first time installation of CygWin, acknowledge the warning with OK or click on 'Skip' to activate them (if you already have CygWin installed, you could skip the installation or check how the installation may affect the existing version)
10. During the installation, ensure to flag the following options under the Bin column (use the Search field for a faster retrieval of the needed components: type the package name in the field, expand the correct group, search for the package and click on "Skip" to see it changed to the version number)
    (a) under Devel
        i. gcc-g++

ii. make

(b) under Net

i. wget

(c) under Libs

i. gsl
ii. gsl-apps
iii. gsl-devel
iv. gsl-doc

11. Click Next
12. Flag "Select required packages" and click Next to resolve the related dependencies
13. Click Next
14. The installation may take some time
15. Choose whether or not to create a Desktop and a Start Menu icon
16. Click Finish

To compile the Open Foris Geospatial Toolkit you need to compile GDAL manually.

1. Download the installer from the gdal official repository (e.g. gdal-1.10.1.tar.gz)
2. Save it in your CygWin home folder (e.g. C:\cygwin\home or C:\cygwin64\home) or in another destination of your choice
3. Run CygWin (**NOTE: FOR INSTALLATION, RUN CYGWIN AS ADMIN; Right click on Start >(All) Programs >CygWin >CygWin Terminal and Run as [admin credentials]**)
4. Install GDAL using the following commands (the last two can take some time to complete)

```
cd [folder containing gdal-1.10.1.tar.gz] (e.g. cd C:/cygwin/
   home, mind the simple slash)
tar -xvzf gdal-1.10.1.tar.gz
cd gdal-1.10.1
./configure
make
make install
```

Now you can install OpenForis. Still in CygWin, run the following commands:

```
wget http://foris.fao.org/static/geospatialtoolkit/releases/
    OpenForisToolkit.run
chmod u+x OpenForisToolkit.run
./OpenForisToolkit.run
```

4 Get Info

After the first installation, you can check the **current version info** with the command:

```
sudo oft-info.bash
```

5 Update the tools

Update to the latest version use follwoing command:

```
sudo oft-update.bash
```

6 Uninstallation

You can also **uninstall** all the tools. To do that, enter the command:

```
sudo oft-uninstall.bash
```

7 OFGT- Tools documented

GENERAL TOOLS

7.1 CsvToPolygon.py

NAME
CsvToPolygon.py - converts CSV file from GExml2csv.bash into a shapefile

OFGT VERSION
1.25.4

SYNOPSIS *CsvToPolygon.py*
CsvToPolygon.py <input.csv><output.shp>

DESCRIPTION
CsvToPolygon.py is written in Python and creates shapefile polygons from a text file.
- The program is modified form the one by Chris Garrard:
`http://www.gis.usu.edu/~chrisg/python/2009/lectures/ospy_hw2a.py`
-The input is a text file of the following format: Polygon id, land cover class, land cover subclass, tree cover class, resolution of the image in GE (Google Earth), year and month of image in GE. After the ":" mark there are corner coordinates in WGS84 system. - This input data can be output from another script, GExml2csv.bash and originally derives from a training data collection tool created for GE.

EXAMPLE

For this exercise following tools are used: CsvToPolygon.py
Open your working directory using

```
cd /home/...
```

An example of the beginning of input data is following:

106,OWL,OWL_Open,2,Coarse,2002/1:-5.47450324983224 32.54081338469396,-5.47450324983224
32.5417154317423,-5.47540856036825 32.5417154317423,-5.47540856036825 32.54081338469396

107,Grassland,Grassland_Bushed,1,Coarse,2002/1:-5.47456561893842 32.63108751846197,-5.47456561893842 32.63198971163985,-5.47547080384603 32.63198971163985,-5.47547080384603 32.63108751846197

108,Bushland,Bushland_Thicket,2,Medium,2002/10:-5.47461439045748 32.72136258245697,-5.47461439045748 32.72226491949511,-5.47551944746972 32.72226491949511,-5.47551944746972 32.72136258245697

This is how you run the command:

```
python CsvToPolygon.py inputdata.csv output.shp
```

7.2 genericCsvToPolygon.py

NAME

GenericCsvToPolygon.py - Program for creating polygons from text files

OFGT VERSION

1.25.4

SYNOPSIS *genericCsvToPolygon.py*

genericCsvToPolygon.py <input.csv><output.shp>

DESCRIPTION

GenericCsvToPolygon.py Program for creating polygons from text files.

- The input file is a text file of the following format: *Polygon_id:corner coordinates in WGS84 system*
- Coordinate pairs are separated from others with a space and x,y with a comma, see under **EXAMPLE**:

NOTES

The program is modified form the one by Chris Garrard:
`http://www.gis.usu.edu/~chrisg/python/2009/lectures/ospy_hw2a.py`

SEE ALSO

This input data is output from another script, genericGEkml2csv.bash and originally comes from Google Earth (self-digitized polygon kml's).

EXAMPLE

The input file is a text file of the following format: Polygon_id:corner coordinates in WGS84 system

```
Bushland1:38.99408253760913,-11.04146530113384,0
    38.99380823486723,-11.04205402821617,0
    38.99380826389991,-11.04206992654894,0
    38.99382544867113,-11.04261044223288,0
    38.9938254776416,-11.04262634062336,0
    38.99415014990515,-11.04300732377466,0
    38.9941664064954,-11.04303909164155,0
    38.99466885692982,-11.04319717791531,0
    38.99473365203311,-11.04319706202726,0
    38.99479844656671,-11.0431969461398,0
    38.99515464117336,-11.04310091874687,0
    38.99518697983437,-11.04306906417552,0
```

```
bushland2:39.00340243948988,-11.04234996851613,0
    39.00296537982829,-11.04267663255115,0
    39.00290506714792,-11.04270636631092,0
    39.00271044958266,-11.04355103802362,0
    39.00271058813281,-11.04362510127527,0
    39.00308922316352,-11.04433543402553,0
    39.0031345553759,-11.04436497858972,0
    39.00316485086498,-11.04442417551431,0
    39.00373863444808,-11.04457127447502,0
    39.00378391140981,-11.04457119324793,0
```

Then run the actual command:

```
genericCsvToPolygon.py input.csv output.shp
```

The output shp is in geographic WGS84, but does not carry that information. You can transform it e.g. into UTM 36S WGS84 with the following command:

```
ogr2ogr -s_srs EPSG:4326 -t_srs EPSG:32736 proj_output.shp
    output.shp
```

Where EPSG:4326 stands for WGS84 (source system) and EPSG:32736 for UTM 36S WGS84 (target system). You can select any target system and find the EPSG code, see http://spatialreference.org/ref/epsg/

EXAMPLE

For this exercise following tools are used: genericCsvToPolygon.py, genericGEkml2csv.bash, ogr2ogr

This script performs conversion from a set of generic .kml format polygons created in Google Earth (GE) into one combined textfile. This textfile can then be converted into a shapefile using script genericCsvToPolygon.py

- How to create polygons in Google Earth and save them as .kml files
- Then open your working directory using

```
cd /home/...
```

The procedure is:
1. Put the kml's into one folder
2. Launch genericGEkml2csv.bash in that kml-folder. This creates a csv file "output.csv"

```
genericGEkml2csv.bash
```

3. Launch genericCsvToPolygon.py in the same folder, with parameters as follows:

```
genericCsvToPolygon.py output.csv output.shp
```

The shapefile name can be as you wish (e.g. settlements168063.shp). The shapefile is in geographic WGS84, but does not carry that information. You can transform it e.g. into UTM 36S WGS84 with the following command - Input: output.shp; Output: proj_output.shp:

```
ogr2ogr -s_srs EPSG:4326 -t_srs EPSG:32736 proj_output.shp
    output.shp
```

Where EPSG:4326 stands for WGS84 (source system) and EPSG:32736 for UTM 36S WGS84 (target system). You can select any target system and find the EPSG code, see http://spatialreference.org/ref/epsg/

7.3 genericGEkml2csv.bash

NAME

genericGEkml2csv.bash - converts separate kml files from Google Earth into one CSV file.

OFGT VERSION

1.25.4

SYNOPSIS *genericGEkml2csv.bash*

DESCRIPTION

genericGEkml2csv.bash converts separate kml files from Google Earth (GE) into one CSV file.
This script performs conversion from a set of generic .kml format polygons created in GE into one combined textfile.

NOTES

All kml files need to be in one folder from where the script needs to be launched

SEE ALSO

The output textfile of genericGEkml2csv.bash can then be converted into a shapefile using script genericCsvToPolygon.py.

EXAMPLE

1. Put all kml files into one folder
2. Launch *genericGEkml2csv.bash* in that kml-folder. This creates a csv file "output.csv"

```
genericGEkml2csv.bash  //no need to define input output
```

3. Look into your working directory and see if *output.csv* was created. Take a closer look at its first lines:

```
head output.csv
```

3. Conversion of *output.csv* into a shapefile: Launch *genericCsvToPolygon.py* in the same folder, with parameters as follows:

```
genericCsvToPolygon.py output.csv output.shp
```

The shp name can be as you wish (e.g. settlements168063.shp).
4. The shapefile is in geographic WGS84, but does not carry that information. You can transform it e.g. into UTM 36S WGS84 with the following command (Input: *output.shp*; Output: *proj_output.shp*).

```
ogr2ogr -s_srs EPSG:4326 -t_srs EPSG:32736 proj_output.shp
    output.shp
```

Where EPSG:4326 stands for WGS84 (source system) and EPSG:32736 for UTM 36S WGS84 (target system). You can select any target system and find the EPSG code, see http://spatialreference.org/ref/epsg/

7.4 GExml2csv.bash

NAME

GExml2csv.bash - converts xml files from Google Earth training data collection tool into one CSV file.

OFGT VERSION

1.25.4

SYNOPSIS *GExml2csv.bash*

DESCRIPTION

GExml2csv.bash converts single files originating from Google Earth (GE) training data collection tool into a combined CSV file.

NOTES

The script is to be launched in a directory containing the target xml's

EXAMPLE

For this exercise following tools are used: GExml2csv.bash
Open your working directory where you stored you xml files using

```
cd /home/...
```

hen simply run following command:

```
GExml2csv.bash
```

7.5 oft-addattr.py

NAME
oft-addattr.py - adds one integer attribute in a shape file.

OFGT VERSION
1.25.4

SYNOPSIS *oft-addattr.py*
oft-addattr.py <shapefile><JoinAttrName><NewAttrName><textfile>

DESCRIPTION
oft-addattr.py adds one integer attribute in a shape file:
oft-addattr.py reads a space separated text file and uses the first and second columns to construct a lookup table which is used to add a new attribute in an existing shapefile. Each time the value in the first column is found in the JoinAttributeName field of the shapefile, the value in the second column is added in the field NewAttrName. In case the corresponding value is not present in the textfile, the NewAttrName value for that record becomes -9999.

NOTES
The values need to be in **integer!**

EXAMPLE
-For this exercise following tools are used: **oft-addattr.py**
- You might have created it already in exercise in the OFGT wikipedia 'How to create and export polygons from Google Earth (GE)'.
- Open your working directory using

```
cd /home/...
```

- The first lines of the attribute table of **landuse.shp** look like this:

```
1 red
2 green
```

```
3 orange
5 pink
6 red
7 blue
8 orange
9 green
10 orange
```

- In this exercise we create a space separated text file as a lookup table. You can create it in any text editor, such as gedit or kate and save the file as **lookup.txt** in your working directory.
Note: The first column contains the ID linking the lookup table to your shapefile and the second column contains the values you want to add to the new column of your shapefile.

```
1 11
2 22
3 33
4 44
5 55
6 66
8 88
9 99
10 1000
```

- Now run the script in the command line.
Each time the value in the first column of **lookup.txt** is found in the JoinAttributeName of the **landuse.shp**, field in our case called **id**. The value in the second column is added in the field NewAttrName, here called **newcol**. Note: The values need to be in integer! How to change the data type in QGIS see further down.

```
oft-addattr.py  landuse.shp id newcol lookup.txt
```

- Load *landuse.shp* in QGIS and look at your attribute table. You should now find the new column called *newcol* with it values.
- Take a look at the ID 7. The newcol value in *landuse.shp* is -9999. This is due to the fact that there was no value 7 in the first column of the lookup table. In that case the corresponding value is not present in the lookuptable, therefore the newcol value for that record becomes -9999.

	id	colour	newcol
0	1	red	11
1	2	green	22
2	3	blue	33
3	4	orange	44
4	5	pink	55
5	6	red	66
6	7	blue	-9999
7	8	orange	88
8	9	green	99
9	10	orange	1000

Figure 1: Attribute table of landuse.shp containing the new column called newcol with values.

HOW TO CHANGE THE DATA TYPE OF THE VALUES IN THE ATTRIBUTE TABLE IN QGIS

Add plugin Table Manager:

1. Click on the top bar'Plugins' ->click 'Fetch Python Plugins'.
2. Type in the filter 'Manager' ->then you should find 'Table Manager - Manages the attribute table structure'.
3. Install it. Close and re-open QGIS.
4. On top bar click 'Plugin' ->click 'Manage Plugins' ->tick box for 'Table Manager'.
5. On top bar click 'Plugin' ->you should now see 'Table' somewhere under 'Manage Plugins', click it and the option 'Table Manager' can be chosen.
6. From there you can edit your attribute table, add a new colum and choose the data type.

7.6 oft-addpct.py

NAME
oft-addpct.py - adds pseudo color table to an image.

OFGT VERSION
1.25.4

SYNOPSIS *oft-addpct.py*
oft-addpct.py <inputfile><outputfile>

DESCRIPTION
oft-addpct.py adds a pseudo color table to an image keeps the original values of the image, but ensures that classes are shown in pre-defined colors, no matter which application is used to open the image.

After defining the first line, the command will ask for the text file containing the color table:
Give LUT file name: <colortable>
Where:
- <inputfile>is an image file
- <outputfile>is an image file (if it is the same as <inputfile>, <inputfile>will be overwritten)
- <colortable>is a text file with 4 or 5 columns containing the color table in the following format:

  - 1st column: class value
  - 2nd - 4th column: RGB values
  - optional: 5th column for alpha, if not set, it is assumed to be 255
  - Important: The <colortable>must NOT contain any empty lines!

- see Wikipedia for more information on RGBA color space.

The <colortable>could look like this:

```
1 103 51 1 255
2 254 0 0 255
3 0 0 254 255
4 0 255 0 255
```

EXAMPLE

- For this exercise following tools are used: **oft-addpct.py**
- Create the colortable for the file images/forestc.tif. If you do not know which classes are present in images/forestc.tif, you could use oft-stat with images/forestc.tif both as input and mask file. The first column of the mask file shows all present classes (besides 0). Create a text file called *txt/coltable.txt*, with the first column indicating all possible classes. It could look like this:

```
1 0 0 0 0
44 122 122 0 255
33 103 51 1 255
55 4 253 255 255
22 122 0 122 255
11 255 0 0 255
4 122 122 122 255
3 255 255 0 255
2 200 200 200 255
6 0 255 0 255
```

Important: Make sure that the text file does not contain any empty lines.

- Run oft-addpct.py:

```
oft-addpct.py images/forestc.tif results/forestcolor.tif
```

- The command will ask you about the colortable file:

```
Give LUT file name
```

Enter the path to your color table file and hit enter:

```
txt/coltable.txt
```

- You can visualize the result in QGIS:

```
qgis results/forestcolor.tif
```

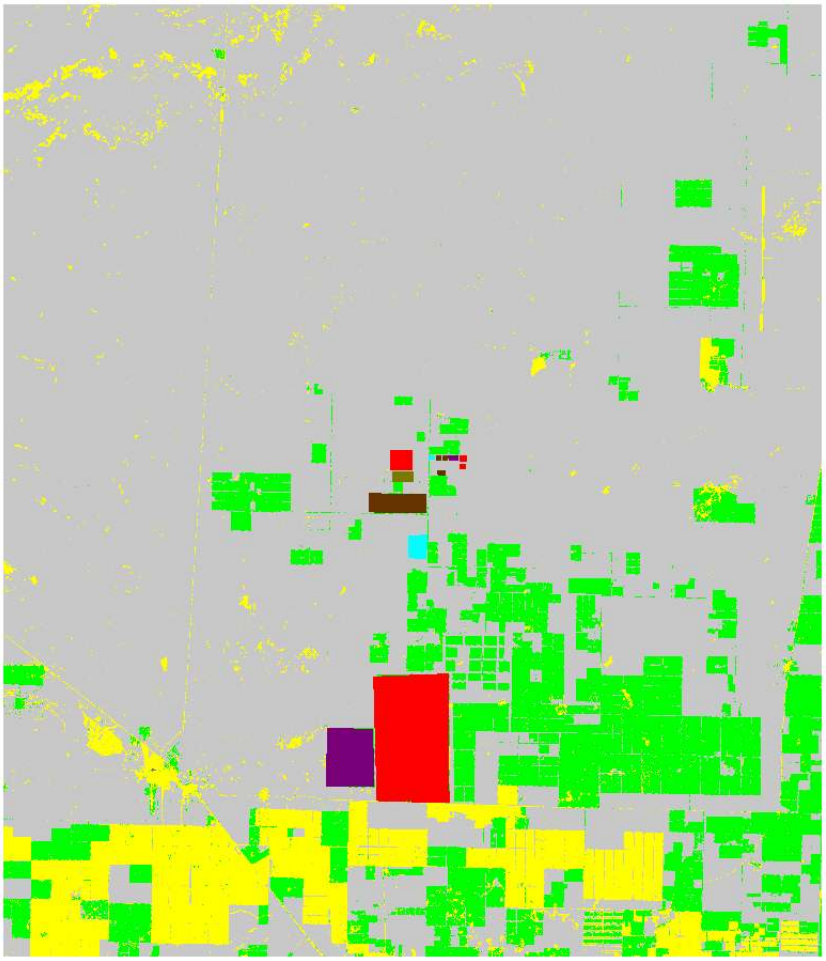


Figure 2: Example of using oft-addpct.py to define the colour table.

7.7 oft-admin-mask.bash

NAME

oft-admin-mask.bash - this script prepares a mask of administrative areas within a satellite image.

OFGT VERSION

1.25.4

SYNOPSIS *oft-admin-mask.bash*

oft-admin-mask.bas <mask for Landsat image><administrative area image>[ID of wanted administrative area]

DESCRIPTION

- If no ID is given the script just clips and re-projects (if needed) the admin image to match the Landsat image mask
- If an ID is given, the admin area with this ID is added to the base mask and other areas are set to 0
- The input administrative image does not need to be of the same size and projection (script utilises oft-clip.pl for clipping and re-projecting)

EXERCISE

- For this exercise following tools are used: **oft-admin-mask.bash**, **oft-shptif.bash**
- Open your working directory using

```
cd /home/...
```

- In a first step we need to prepare an image with administrative areas using oft-shptif.bash. For exercise purpose we simply use *landuse.shp* as an input for hypothetical admin areas. Output: *landuse_raster.tif*

```
oft-shptif.bash landuse.shp landsat_t1.tif landuse_raster.tif
    landuse
```

- Let's run oft-admin-mask.bash now using *landuse_raster.tif*. **Note:** the output is automatically called *landsat_t1_adm.tif*.

```
oft-admin-mask.bash landsat_t1.tif landuse_raster.tif
```

- Verify in QGIS using a contrast enhancement if the pixel values of *landsat_t1_adm.tif* are correctly processed.

7.8 oft-bb

NAME

oft-bb - is a a bounding box calculator t.

OFGT VERSION

1.25.4

SYNOPSIS *oft-bb*

oft-bb [-um maskfile] <inputfile><value>

DESCRIPTION

oft-bb studies every pixel of the input file and reports minimum and maximum pixels coordinates of pixels having the given value. The minimum coordinates are 1,1. - <inputfile>is an image file
- <value>is the value you want to query
- -um use mask file. It will consider only pixels which have mask value >0

EXERCISE

- For this exercise following tools are used: **oft-bb**, **gdal_translate**
- Open your working directory using

```
cd /home/...
```

- Find the bounding box of the Forest tree cover file *forestc.tif* with value "33"

```
oft-bb images/forestc.tif 33
```

- It should provide the following result :

```
Band 1 BB (xmin,ymin,xmax,ymax) is 1408 1740 1713 1964
```

- You can visualize the result by subsetting the image to these extents using *gdal_translate*

```
gdal_translate -srcwin 1408 1740 305 224 images/forestc.tif
    results/bb_33.tif
```

The parameters for the size of the box are calculated as xmax-xmin and ymax-ymin
Visualize the results

```
qgis images/forestc.tif results/bb_33.tif
```

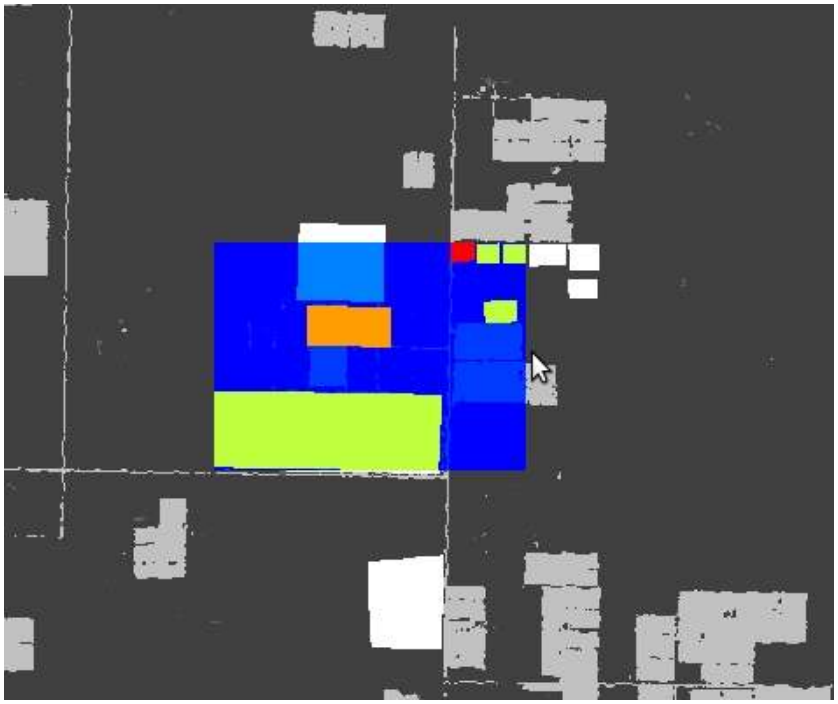


Figure 3: Example of using oft-bb output bb_ 33.tif.

7.9 oft-classvalues-compare.bash - To be tested

NAME

oft-classvalues-compare.bash - creates comparison plots of classes based on result of previous script oft-classvalues-plot.bash.

OFGT VERSION

1.25.4

SYNOPSIS *oft-classvalues-compare.bash*

oft-classvalues-compare.bash <class1><class2>
oft-classvalues-compare.bash <class1><class2>[class3] [class4] [class5]

DESCRIPTION

oft-classvalues-compare.bash This script is meant to be used after script oft-classvalues-plot.bash. It plots 2-5 classes in the same figure and the distinction of classwise point clouds can be evaluated.
- It is launched in the folder containing classwise plots and text files produced by the above mentioned script.

OPTION

Additional classes that can be plotted in the same figure:

Parameters:
- *[class3]*
- *[class4]*
- *[class5]*

SEE ALSO

Look at oft-classvalues-plot.bash, which computes input data for this tool

EXAMPLE

- For this exercise following tools are used: oft-classvalues-plot.bash
- Input data deriving from exercise oft-classvalues-plot.bash
- Change your working directory to the one of the previous exercise *oft-classvalues-plot.bash*:

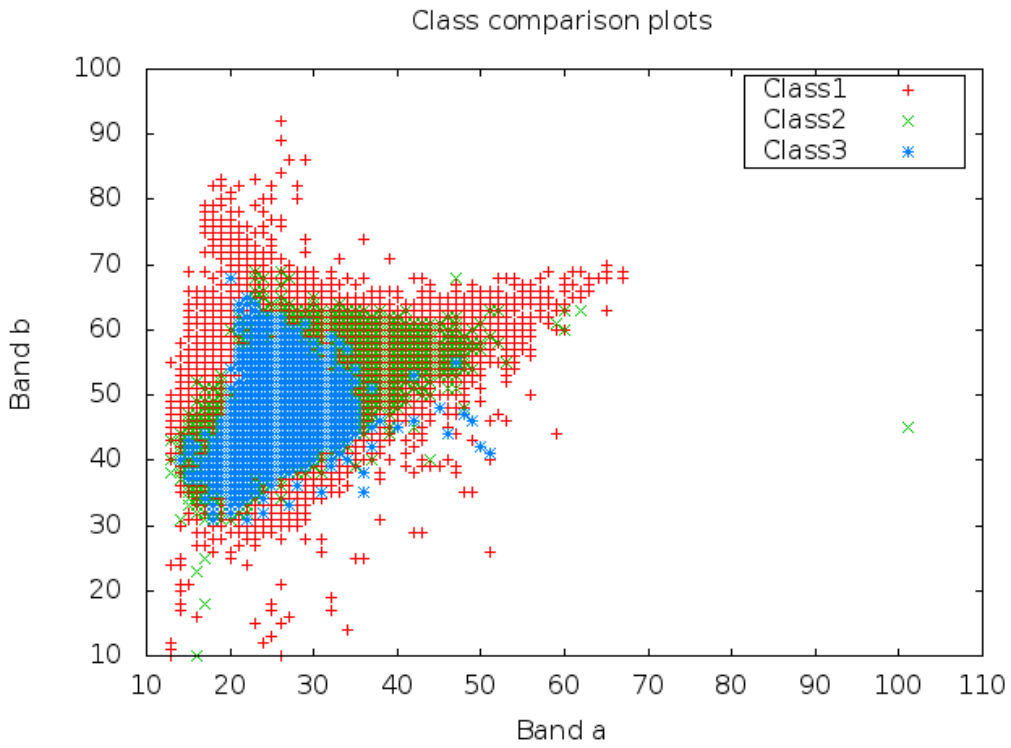
```
cd /home/...
```

- Use oft-classvalues-compare to create a comparison plot of band2 and band3.
Output to be found in folder *plots_LT52_CUB00.tif_bands_3_4* created after running *oft-classvalues-plot.bash*.
Output: *Comparison1_3.png*

```
oft-classvalues-compare.bash 1 3
```

- Now compare band1, band2 and band3; Output: *Comparison1_2_3.png*

```
oft-classvalues-compare.bash 1 2 3
```



7.10 oft-classvalues-plot.bash - To be tested

NAME

oft-classvalues-plot.bash - creates scatterplots of pixels within training classes (given in a shapefile).

OFGT VERSION

1.25.4

SYNOPSIS *oft-classvalues-plot.bash*

oft-classvalues-plot.bash <input image><shapefile_basename> <shapefile_class_fieldname><image band for x-axis><image band for y-axis>

DESCRIPTION

oft-classvalues-plot.bash This script creates scatterplots of image grey values in different classes of training data. Also figures of class means and standard deviations are provided.

- Training areas need to be in shapefiles.
- The figures of class means and std's for both required bands are created in the launching folder (.png format).
- It also puts the class means and standard deviations into text files.
- Pixel-by-pixel values are stored in a separate text file.
- The pixel plots are created in a folder named *plots_imagename_band1_band2*. They are for all classes, .png image files. And same as text files.

NOTES

Make sure that you have installed GNUPLOT.

SEE ALSO

A further script oft-classvalues-compare.bash can then be used to compare up to 5 classes in one view.

EXAMPLE

- For this exercise following tools are used: *oft-classvalues-plot.bash* - Input data: download for this exercise the Landsat imagery *landsat_t1.tif* and the shapefile: *landuse.shp*
- Open your working directory using

```
cd /home/...
```

- First of all make sure that you have installed textbfGNUPLOT. Further information on Gnuplot and Ubuntu. If you don't have Gnuplot type in your terminal:

```
sudo apt-get install gnuplot //press 'enter'
```

- Run *oft-classvalues-plot.bash* with input: satellite image || shapefile || Attribute column for ID in this case *name* || band3 || band4; Input image: *landsat_t1.tif*, input shapefile: *landuse.shp*; Note: the output is automatically processed.

```
oft-classvalues-plot.bash landsat_t1.tif landuse name 3 4
```

Output:

1. *pixelvalueslandsat_t1.tif_bands_3_4.txt*:

```
head pixelvalueslandsat_t1.tif_bands_3_4.txt
```

Column 1-6: Pixel_ID, X , Y , class (from attribute name), pixelvalue_bandnr3, pixelvalue_bandnr4

```
1.00 771870.00 -2402010.00 6.00 22.00 47.00
2.00 771900.00 -2402010.00 6.00 22.00 53.00
3.00 771930.00 -2402010.00 6.00 23.00 55.00
4.00 771960.00 -2402010.00 6.00 22.00 55.00
5.00 771990.00 -2402010.00 6.00 21.00 53.00
```

2. *classvalues_landsat_t1.tif_band_3.txt*:

```
head classvalues_landsat_t1.tif_band_3.txt
```

Column 1-3: classvalue, bandnr3 , std

```
7 27.224344 2.480986
13 28.945946 1.679205
8 28.140811 2.322499
9 29.036641 2.258223
12 27.879464 1.288049
11 27.423695 1.199933
```

3. classvalues_landsat_t1.tif_band_4.txt

```
head classvalues_landsat_t1.tif_band_3.txt
```

Column 1-3: classvalue, bandnr4 , std

```
7 48.176611 2.622561
13 45.385749 1.525189
8 49.842482 2.397968
9 52.786260 3.513642
12 49.943452 2.232350
11 48.779116 1.172885
```

4. Folder plots_landsat_t1.tif_bands_3_4 contains the classes to be used for *oft-classvalues-compare.bash*.

7.11 oft-combine-masks.bash

NAME

oft-combine-masks.bash - combines several masks (raster and shapefiles) to one mask file

OFGT VERSION

1.25.4

SYNOPSIS *oft-combine-masks.bash*

oft-combine-masks.bash <input1><input2>.... <nodata>
oft-combine-masks.bash <input1><input2>.... <nodata>[EPSG code]

DESCRIPTION

oft-combine-masks.bash is a UNIX bash script that allows the user to use both mask images and mask shapefiles as input and the script combines them into one mask file.
- The first inputfile is the base and it must be an image not shapefile
- The following input files will be written on only if there is nodata (user-defined value)
- The extent is defined by the first input image
- If the projection is not given by the user, all files are assumed to be in same projection
- Concerning the shapefiles, the last field is assumed to be the one containing the mask values
- At least 2 files and nodata value are needed

OPTION

The projection can be defined by the user.

Parameters:
[EPSG code]

EXAMPLE

- For this exercise following tools are used: *oft-combine-masks.bash*, *oft-calc*, *gdal_rasterize* - Open your working directory using

```
cd /home/...
```

STEP 1: CREATE MASKS

- To run *oft-combine-masks.bash* we need to create some mask files. To do so, we burn the attribute values of the column *mask* from the shapefile *landuse.shp* into the raster *forestc.tif*:

```
gdal_rasterize -b 1 -a mask -l landuse landuse.shp forestc.tif
forest.tif
```

- Verify in QGIS if your pixel values of *forestc.tif* match the polygon values of *landuse.shp*.
- Note: if the raster output is black, click on it's *Properties* ->*Style* ->*Colour Map* and chose *Pseudo Colour*

Attribute table - polyN20 :: 0 / 13 feature(s) selected

	id	colour	newcol	name	mask
0	1	red	11	1	11
1	2	green	22	2	22
2	3	blue	33	3	55
3	4	orange	44	4	33
4	5	pink	55	5	44
5	6	red	66	6	11
6	7	blue	-9999	7	55
7	8	orange	88	8	33
8	9	green	99	9	22
9	10	orange	1000	10	33
10	11	red	1111	11	11
11	12	red	1222	12	11
12	13	orange	1333	13	33

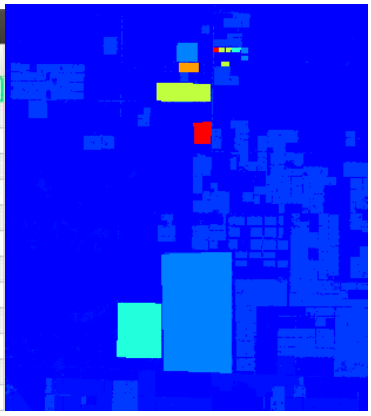


Figure 4: Left: Attribute table of *landuse.shp*. Right: Zoom of output raster *forestc.tif* in QGIS using the colourmap *Pseudocolour*.

- *Forestc.tif* is the base raster to create some masks files by extracting those pixels that contain values which were previously in the shapefile and then burned into the raster:

```
oft-calc forestc.tif mask1.tif
1
#1 55 = 0 1 ?   //If the pixel values is 55 in forestc.tif, then
    give it in mask1.tif the value 1, otherwise 0
```

```
oft-calc forestc.tif mask2.tif
1
#1 11 = 0 2 ?   //If the pixel values is 11 in forestc.tif, then
    give it in mask2.tif the value 2, otherwise 0
```

```
oft-calc forestc.tif mask3.tif
1
#1 33 = 0 3 ?   //If the pixel values is 33 in forestc.tif, then
    give it in mask3.tif the value 3, otherwise 0
```

```
oft-calc forestc.tif mask4.tif
1
#1 44 = 0 4 ?   //If the pixel values is 44 in forestc.tif, then
    give it in mask4.tif the value 4, otherwise 0
```

```
oft-calc forestc.tif mask5.tif
1
#1 22 = 0 5 ?   //If the pixel values is 22 in forestc.tif, then
    give it in mask5.tif the value 5, otherwise 0
```

- Again, check in QGIS if the masks contain the extracted value for the same location of the corresponding polygon in *landuse.shp*.
- In the final step we run the command *oft-combine-masks.bash*. Note that output file is automatically processed called *combined-mask.img*

```
oft-combine-masks.bash mask1.tif mask2.tif mask3.tif mask4.tif
   mask5.tif 0
```

STEP 2: COMBINE MASKS USING RASTER AND SHAPEFILE

- Run oft-combine-masks.bash: Input: mask1.tif, mask2.tif, mask3.tif, mask4.tif, mask5.tif and the additional shapefile clouds.shp In the shapefile the values of the **last column** are picked up for processing; output is automatically processed: combined-masks.img
textbfNOTE: copy your combined-mask.img output from the first exercise as it will be overwritten running *oft-combine-masks.bash* again.

```
combine_masks.bash mask1.tif mask2.tif mask3.tif mask4.tif mask5
    .tif clouds.shp 0 //the 0 defines nodata values to be 0
```

- Verify in QGIS if *combined-masks.img* contains all mask values, and if the additional polygon of *clouds.shp* has the values 99 (look into attribute table of *clouds.shp* under the last column).

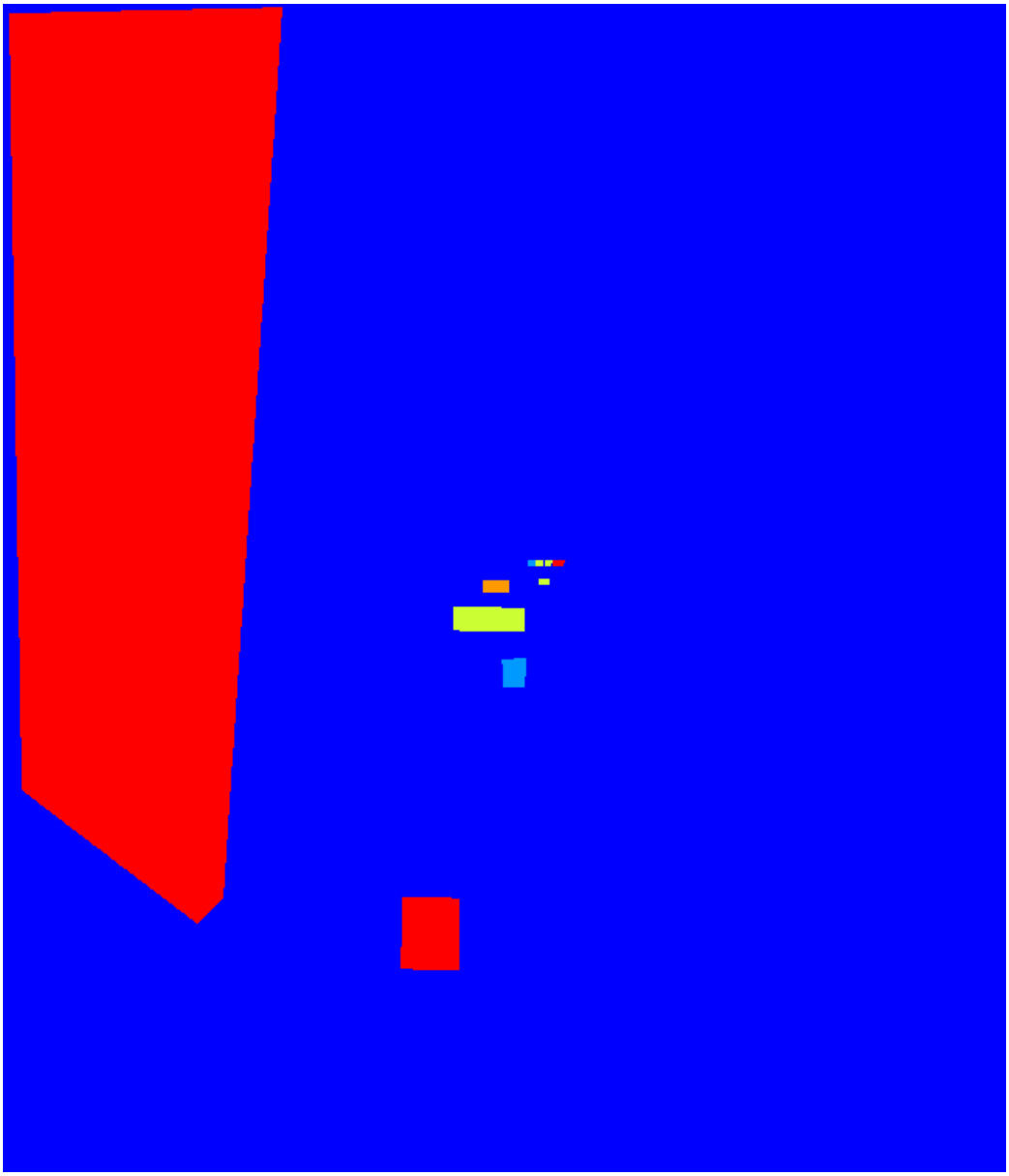


Figure 5: Combined masks including the larger polygon from *clouds.shp*.

7.12 oft-compare-overlap.bash - To be tested

NAME

oft-compare-overlap.bash - This script compares overlapping areas of 2 images and produces between-band correlations.

OFGT VERSION

1.25.4

SYNOPSIS *oft-compare-overlap.bash*

oft-compare-overlap.bash <image1.img><image2.img><mask1.img><mask2.img><grid_spacing>[EPSG:img1]

- Give the spacing in metres (1000 = 1 km)
- Give the last parameter in format EPSG:32637 (replace number with your own, this is for UTM 37 N)

DESCRIPTION

- Meant for evaluation of the brdf correction of 2 images, but other imagery can be compared as well
- The second image is projected to the same projection as the first, if the projections differ
- In that case, user gives the projection of first image ad EPGS code. And both images need to have a projection defined (although it differs)
- Similar number of bands must exist
- Masks must be given for both images to exclude cloud/shadow areas
- They must be of same size and in same projection as their corresponding images
- Only areas where **mask has value 2** are used in comparison (you may give a mask full of 2 if needed)
- User gives the spacing of the sampling points as well

EXAMPLE

- For this exercise following tools are used: *oft-compare-overlap.bash*, *oft-calc*, *gdal_translate*, *oft-trim-mask.bash*

- Open your working directory using

```
cd /home/...
```

- Convert*landsat_t1.tif* into 6 bands as both need to have same nr of bands. Output: *landsat_t1_6bands.tif*

```
gdal_translate landsat_t1.tif landsat_t1_6bands.tif -b 1 -b 2 -
    b 3 -b 4 -b 5 -b 6
```

- Create mask for *landsat_t1_6bands.tif*;
automatic output:*landsat_t1_6bands_mask.tif*

```
oft-trim-mask.bash landsat_t1_6bands.tif
```

- **NOTE:** the mask value to be used is **2**, so conversion of mask from value 1 to 2: input: *landsat_t1_6bands_mask.tif*; output: *mask1.tif*

```
oft-calc landsat_t1_6bands_mask.tif mask1.tif
1
#1 1 = 0 2 ?
```

- Create mask for *landsat_t2*; automatic output: *landsat_t2_mask.tif*

```
oft-trim-mask.bash landsat_t2.tif
```

- Convert mask value to 2: *landsat_t2_mask.tif*; output: *mask2.tif*

```
oft-calc landsat_t2_mask.tif mask2.tif
1
#1 1 = 0 2 ?
```

- Run *oft-compare-overlap.bash*

```
oft-compare-overlap.bash landsat_t1_6bands.tif landsat_t2.tif
    mask1.tif mask2.tif  1000
```

- Output: *img12mask12_sed.txt* printed on screen:

```
head img12mask12_sed.txt
```

```
329.00 732285.00 -2447885.00 100.00 3166.00 2.00 2.00 100.00
    3166.00 2.00 2.00 100.00 3166.00 53.00 25.00 27.00 48.00
    71.00 131.00 53.00 25.00 27.00 48.00 71.00 131.00 100.00
    3166.00 66.00 60.00 66.00 88.00 98.00 69.00 66.00 60.00 66.00
     88.00 98.00 69.00
```

```
330.00 732285.00 -2446885.00 100.00 3133.00 2.00 2.00 100.00
    3133.00 2.00 2.00 100.00 3133.00 54.00 25.00 27.00 48.00
    71.00 128.00 54.00 25.00 27.00 48.00 71.00 128.00 100.00
    3133.00 61.00 53.00 51.00 100.00 77.00 49.00 61.00 53.00
    51.00 100.00 77.00 49.00
331.00 732285.00 -2445885.00 100.00 3100.00 2.00 2.00 100.00
    3100.00 2.00 2.00 100.00 3100.00 56.00 25.00 29.00 53.00
    73.00 128.00 56.00 25.00 29.00 53.00 73.00 128.00 100.00
    3100.00 67.00 61.00 66.00 95.00 89.00 65.00 67.00 61.00
    66.00 95.00 89.00 65.00
332.00 732285.00 -2444885.00 100.00 3066.00 2.00 2.00 100.00
    3066.00 2.00 2.00 100.00 3066.00 46.00 19.00 17.00 40.00
    41.00 124.00 46.00 19.00 17.00 40.00 41.00 124.00 100.00
    3066.00 55.00 44.00 36.00 80.00 53.00 25.00 55.00 44.00
    36.00 80.00 53.00 25.00
333.00 732285.00 -2443885.00 100.00 3033.00 2.00 2.00 100.00
    3033.00 2.00 2.00 100.00 3033.00 46.00 20.00 18.00 39.00
    45.00 124.00 46.00 20.00 18.00 39.00 45.00 124.00 100.00
    3033.00 56.00 43.00 35.00 81.00 56.00 26.00 56.00 43.00
    35.00 81.00 56.00 26.00
334.00 732285.00 -2442885.00 100.00 3000.00 2.00 2.00 100.00
    3000.00 2.00 2.00 100.00 3000.00 48.00 20.00 18.00 36.00
    42.00 125.00 48.00 20.00 18.00 36.00 42.00 125.00 100.00
    3000.00 55.00 43.00 35.00 77.00 54.00 27.00 55.00 43.00
    35.00 77.00 54.00 27.00
```

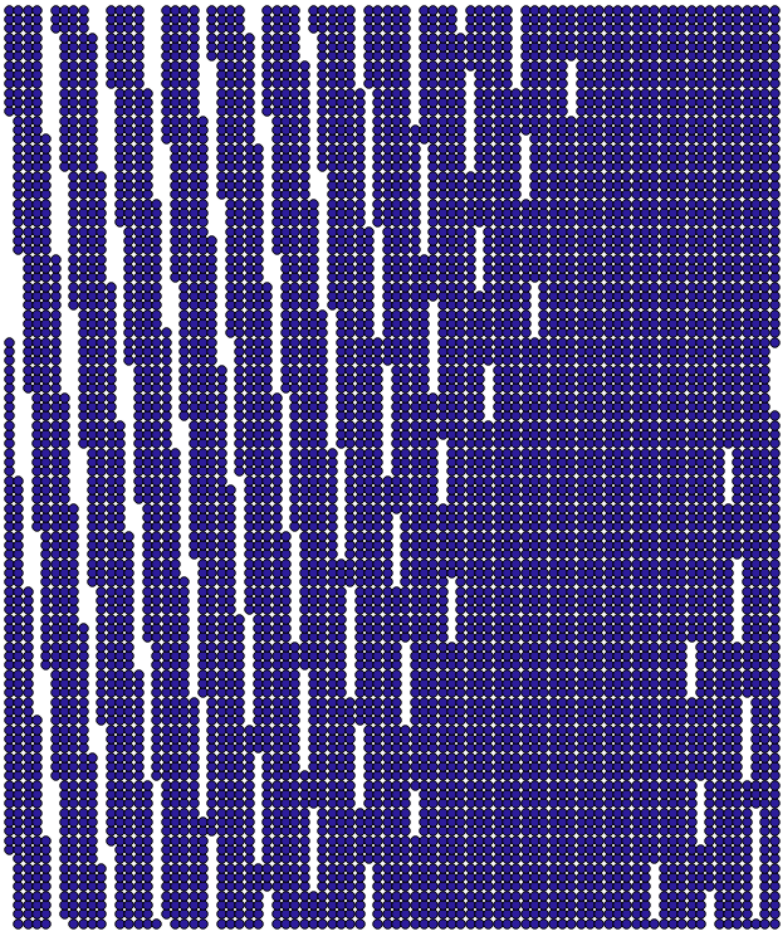


Figure 6: Output of oft-compare-overlap.bash visualized in QGIS.

7.13 oft-crop.bash

NAME

oft-crop.bash - crops a raster image to the extent of a certain pixel value.

OFGT VERSION

1.25.4

SYNOPSIS *oft-crop.bash*

oft-crop.bash <input-img><output-img>[value / -all] [nodata-value]

OPTION

- [value / -all]: [value] = is the value of the inputfile it should be cropped to -all = if image should be cropped to every unique pixel value; output will be named accordingly
- [nodata-value]: for this value no cropping will be done; if not provided, it is assumed to be 0 (only applicable for option -all)

DESCRIPTION

- Oft-crop.bash crops a raster image to the extent of a certain pixel value. This can be useful when, for example, one wants to produce a separate raster image for every district of a country.
- Input image is a raster image with unique pixel values for each region of interest.
- In the output image, the value for the region of interest is kept. All other pixels are set to 0.
- The user can choose to either:
  - do the cropping for one single pixel value
  - do the cropping for all occurring pixel values besides the nodata-value. The nodata-value can be specified with the [nodata]-option. If not specified, it is assumed to be 0. In this case,

output files will carry the value they have been cropped to in their name.

EXAMPLE

- For this exercise following tools are used: *oft-crop.bash*, *gdal_rasterize*
- Open your working directory using

```
cd /home/...
```

- You will need for this exercise the file *landuse.shp*, digitized manually with QGIS
- Create a raster file that has the landuse class attribute of the landuse.shp file

```
gdal_rasterize -a newcol -l landuse -tr 30 30 shapefiles/landuse
    .shp results/landuse.tif
```

- Extract one particular class (in that case the zone that has the label 2000)

```
oft-crop.bash results/landuse.tif results/lu_class.tif 2000
```

7.14 oft-cuttile.pl

NAME

oft-cuttile.pl - Cuts image tiles on the basis of a given list of locations

OFGT VERSION

1.25.4

SYNOPSIS *oft-cuttile.pl*

oft-cuttile.pl <coord_list><CRS_file><input_dir><output_basename>

OPTIONS

- <coord_ist>is a text file containing the coordinates of the center of the tiles. It must arranged as **id x y**
- <CRS_file>is a text file containing the projection definitions of the dataset in **PROJ4** format.
- <input_dir>is the directory containing the image. Image must be in geotiff format, extension must be .**TIF** with capitals.
- <output_basename>is the base name of the tiles that will be generated

DESCRIPTION

oft-cuttile.pl Cuts image tiles on the basis of a given list of locations.

1. converts the point locations into the projection of the image,
2. cuts a set of 20 km x 20 km tiles around the locations
3. converts the tiles to the coordinate system of the points (20 km x 20 km)

EXAMPLE

- For this exercise following tools are used: *oft-cuttile.pl*, *gdal_translate*, *cs2cs*
- Open your working directory using

```
cd /home/...
```

1. First, we need to convert the imagery into .TIF format. You can use the gdal_translate function to convert your input imagery from any gdal supported format to TIF using the option [-of GTiff] input.your_format output.TIF

```
gdal_translate -of GTiff images/landsat_t1.tif results/
    landsat_t1.TIF
```

2. In the next step we take a closer look at our additional input data *coordinates.txt* and *proj.txt*

- *coordinates.txt* is a space separated text file: col1: ID, col2: X, col3: Y coordinates

```
gedit results/coordinates.txt
```

Then copy paste the following list and save your file.

```
1 767360 -2415219
2 755310 -2378377
3 781072 -2379346
4 789936 -2440150
```

- *proj.txt* must contain one line with the projection definition of the tiles coordinates and one line with the projection definition of the imagery. Here it is UTM zone 20, for both, with the following proj4 format:

```
+init=epsg:32620 +proj=utm +zone=20 +datum=WGS84 +units=m +
    no_defs +ellps=WGS84
```

Create the file

```
gedit results/proj.txt
```

Paste the projection definition **twice**, as two separate lines. Save proj.txt

```
+init=epsg:32620 +proj=utm +zone=20 +datum=WGS84 +units=m +
    no_defs +ellps=WGS84
+init=epsg:32620 +proj=utm +zone=20 +datum=WGS84 +units=m +
    no_defs +ellps=WGS84
```

NB: If you do not have it, you can get the PROJ4 format of an image by using the function cs2cs

```
cs2cs -v +init=epsg:32620
```

- If you don't know the EPSG code of your image use gdalinfo for your imagery:

```
gdalinfo landsat_t1.TIF
```

5. Now we run the actual script to create the tiles in the terminal. Output: Tiles

```
cd results
oft-cuttile.pl coordinates.txt proj.txt . Tiles
```

Figure 7: The four tiles overlayed on base image, displayed with differing band composition to base imagery.

7.15 oft-filter

NAME
oft-filter - moving window filters

OFGT VERSION
1.25.4

SYNOPSIS *oft-filter*
oft-filter [-ot Byte/Int16/UInt16/UInt32/Int32/Float32/Float64/CInt16/CInt32 /CFloat32/CFloat64] [-h] [-x xdim] [-y xdim] [-c const] [-n nodata] [-f filter][-v] <-i inputfile><-i inputfile>

OPTIONS
- [-x dim] Window size in x-direction (default=3)
- [-y dim] Window size in y-direction (default=3)
- [-c const] Constant used to multiply the resulting value
- [-n value] Input NoData value, ignored in calculation (Def. from infile)
- [-v] Verbose
- [-f filter] Type of statistics to be computed (default=1):

0: mean
1: standard deviation
2: variance
3: skewness
4: rank
5: coefficient of variation: 100*std/mean

DESCRIPTION
oft-filter The program computes local statistics on values of a raster within the zones of a moving window.

1. converts the point locations into the projection of the image,

2. cuts a set of 20 km x 20 km tiles around the locations
3. converts the tiles to the coordinate system of the points (20 km x 20 km)

EXAMPLE

- For this exercise following tools are used: *oft-filter*
- Open your working directory using

```
cd /home/...
```

- In the first exercise we want to create the **standard deviation** for the moving window using the default window size and default statistics (without defining -f). The output image is called std.tif:

```
oft-filter -i landsat_t1.tif -o std.tif
```

- Now we go through an example calculating the *coefficient of variation (100*std/mean)* using the option -f 5. Output: coe_var.tif

```
oft-filter -i landsat_t1.tif -o coe_var.tif -f 5.
```

Calculation of the *mean* using the option *-f 0*. Output: mean.tif

```
oft-filter -i landsat_t1.tif -o mean.tif -f 0
```

Load your computed rasters in QGIS and verify your output statistics using Identify Results.

Figure 8: Example of the computed mean.tif

7.16 oft-gengrid.bash

NAME

oft-gengrid.bash - generates a systematic grid over a raster image.

OFGT VERSION

1.25.4

SYNOPSIS *oft-gengrid.bash*

oft-gengrid.bash <input_img><DX><DY><-output>

DESCRIPTION

oft-gengrid.bash generates a grid of points over an image (text file), with user-defined spacing in x and y directions. Output is a text file with the coordinates of the points. - Generates a text file with 3 entries for each point: ID Xcoord Ycoord - <input_img>is a georeferenced input image

- <DX>is the distance between the points in X direction
- <DY>is the distance between the points in Y direction

- Prints the average, RMSE and bias on screen.
- Saves original value, estimate and difference in an output file. If id or x and y are given, they are printed out as well.
- If the *id* is indicated in the command line, the id's of 10 nearest neighbours are printed into the output file.

EXAMPLE

- For this exercise following tools are used: *oft-gengrid.bash*
- Open your working directory using

```
cd /home/.../OFGT-data
```

- Run the command line for generating the grid of 1000 x 1000 m distance between the points in X and Y directions on the input

image *landsat_t1.tif* with an output text file consisting of three columns for <ID><X><Y>:

```
oft-gengrid.bash images/landsat_t1.tif 1000 1000 results/
    grid_points.txt
```

- Look at the first ten lines of your result:

```
head  results/grid_points.txt
```

```
1 730785 -2456134
2 730785 -2455134
3 730785 -2454134
4 730785 -2453134
5 730785 -2452134
6 730785 -2451134
7 730785 -2450134
8 730785 -2449134
9 730785 -2448134
10 730785 -2447134
```

- Load the data in QGIS using 'Add Delimited Text Layer' and see if it overlays on your Landsat image.

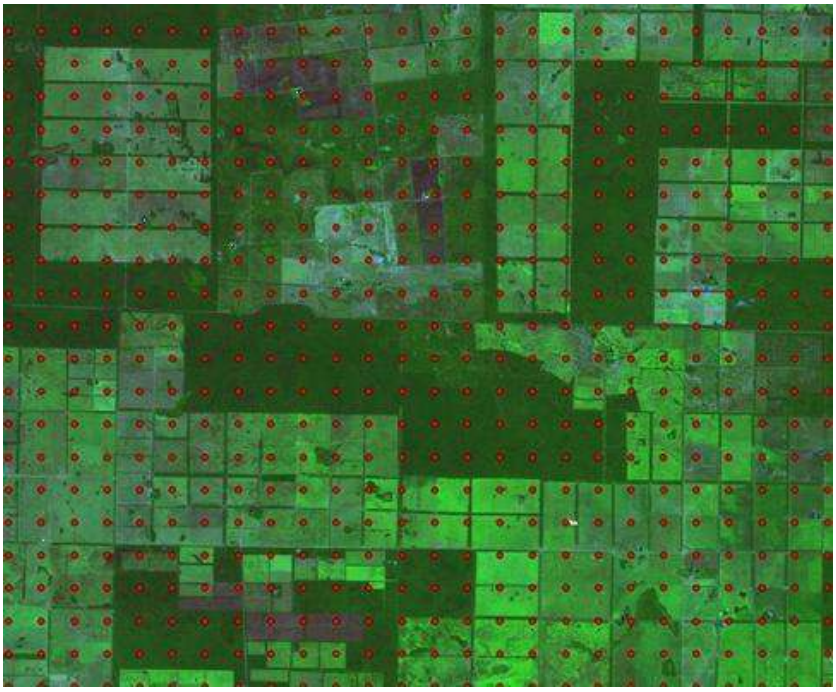


Figure 9: Zoom of the result overlayed on the original Landsat image in QGIS.

7.17 oft-getcorners.bash

NAME

oft-getcorners.bash - gets the coordinates of corners of a raster image or OGR vector layer .

OFGT VERSION

1.25.4

SYNOPSIS *oft-getcorners.bash*

oft-getcorners.bash <inputfile>[-ul_lr /-min_max]

OPTION

Where: <inputfile>is a GDAL raster layer or OGR vector layer
-ul_lr = ulx uly lrx lry (default)
-min_max = xmin ymin xmax ymax (ulx lry lrx uly)

DESCRIPTION

oft-getcorners.bash outputs the corner coordinates for a GDAL raster layer or OGR vector layer.
The user can choose the order of the output:
- ulx: upper left x-coordinate
- uly: upper left y-coordinate
- lrx: lower right x-coordinate
- lry: lower right y-coordinate

EXAMPLE

- For this exercise following tools are used: *oft-getcorners.bash*
- Open your working directory using

```
cd /home/.../OFGT-data
```

1. Run the oft-getcorners.bash:

```
oft-getcorners.bash images/landsat_t1.tif
```

2. You should get the following output:

```
Not an OGR vector layer
Using GDAL raster layer
Output in order ulx uly lrx lry
729285.000 -2352885.000 819285.000 -2457885.000
```

7.18 oft-polygonize.bash

NAME

oft-polygonize.bash - a wrapper for *gdal_polygonize*.

OFGT VERSION

1.25.4

SYNOPSIS *oft-polygonize.bash*

oft-polygonize.bash <input.img><output.shp>

EXAMPLE

- For this exercise following tools are used: *oft-polygonize.bash*
- Open your working directory using

```
cd /home/.../OFGT-data
```

1. Let's run *oft-polygonize.bash* using the input image *landsat_t1.tif* to create the output *oft-polygonize.shp*

```
oft-polygonize.bash landsat_t1.tif oft-polygonize.shp
```

2. Take a look at your shapefile in QGIS on go on propertiesof the .shp ->*Labels* ->tick *Display Labels*, set *Field Containing Label* to *DN* ->Press OK. The *DN* of each polygon in *oft-polygonize.shp* should be the same as the pixel value of *landsat_t1.tif* for the same location.

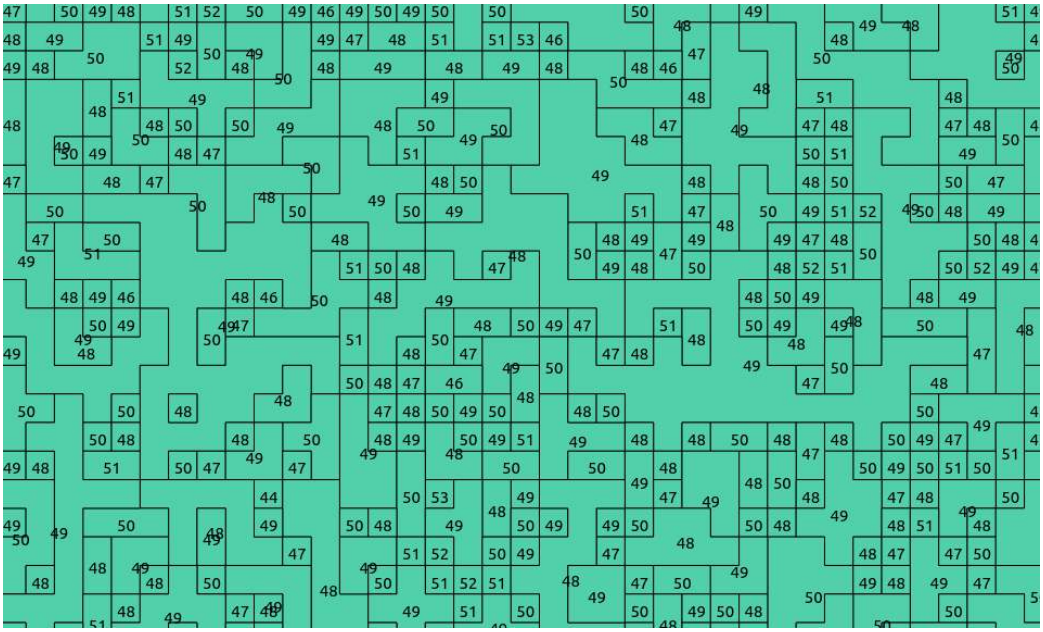


Figure 10: Zoomed view of *oft-polygonize.shp*.

7.19 oft-sample-within-polys.bash

NAME

oft-sample-within-polys.bash - samples pixels within polygons and generates training data for k-nn.

OFGT VERSION

1.25.4

SYNOPSIS

oft-sample-within-polys.bash
oft-sample-within-polys.bash <image><shapefile_basename>
<shapefile_class_fieldname>
<size_of_sample>
oft-sample-within-polys.bash <image><shapefile_basename>
<shapefile_class_fieldname><size_of_sample>[-sample_only]

DESCRIPTION

oft-sample-within-polys.bash samples pixel values from an image within areas determined by training data polygons (shapefile).

Output is named sample_*shapefile_basename*.txt

Specifications:
- Sample size (nbr of pixels) is given by the user
- The sample is distributed within classes in relation to class frequencies
- Output is a text file to be used e.g. in k-nn
- A histogram is also printed out, sample size per class is shown in last column
- The image and the shapefile need to be in the same projection

OPTIONS

- [-sample_only]
- It is possible to pick a new sample by running the script with option -sample_only (do not delete greyvals_*shapefile_basename*.txt if you are going to re-run)
- At this point the image and the shapefile need to be in the same projection

OTHERS

Also look at oft-knn

EXAMPLE

- For this exercise following tools are used: *oft-oft-sample-within-polys.bash*
- You might have created it already in exercise *Google Earth training data into shapefile*, which can be found in the Wiki
- Open your working directory using

```
cd /home/...
```

- Now run the script in the command line within input-raster *landsat_t1.tif* and input-shapefile *landuse.shp*; 'name' refers to the shapefile ID. If you look at the attribute table of *landuse.shp* you see, that you could also use the column *id*. Here we chose *name* to make it more transparent. 100 is the sample size chosen for this exercise.

Note: In the commmand line the extension **.shp** of the shapefile is **not** included!

```
oft-sample-within-polys.bash landsat_t1.tif landuse name 100
```

- **Output** are three text files:
  - greyvalues - greyvals_landuse.txt
  - histogram - histogramlanduse.txt
  - sample output - sample_landuse.txt

Here you can see an excerpt of sample_landuse.txt
Order is: pixel_id x y class band1 band2 band3 band4 band5 band6 band7:

```
10557.00 772650.00 -2404770.00 5.00 53.00 26.00 28.00 54.00
   81.00 131.00 39.00
94788.00 773490.00 -2431680.00 1.00 51.00 24.00 25.00 45.00
   65.00 127.00 33.00
201536.00 774750.00 -2439390.00 1.00 54.00 25.00 27.00 50.00
   71.00 130.00 35.00
88531.00 771450.00 -2431110.00 1.00 47.00 21.00 18.00 37.00
   48.00 126.00 21.00
123374.00 774150.00 -2433990.00 1.00 54.00 24.00 30.00 35.00
   75.00 132.00 42.00
```

7.20 oft-shptif.bash

NAME

oft-shptif.bash - Rasterizes a shapefile to the resolution of a reference image.

OFGT VERSION

1.25.4

SYNOPSIS *oft-shptif.bash*

oft-shptif.bash <shapefile><raster_reference><raster_output>[fieldname]
input files:
- shapefile that is supposed to be rasterized
- reference raster image - the shapefile will be rasterized to the same extent and resolution of this image

OPTION

- [fieldname]: the fieldname of the attribute of the shapefile that is supposed to be rasterized
- If no fieldname is specified, every polygon will be assigned an arbitrary, but unique ID.

EXAMPLE

- For this exercise following tools are used: *oft-shptif.bash*
- Open your working directory using

```
cd /home/.../OFGT-data
```

1. We are going to rasterize the shapefile *landuse.shp* with *landsat_t1.tif* as a reference image. We are interested in the landuse specified in the shapefile, so we choose *landuse* as field name.
2. Run oft-shptif.bash:

```
oft-shptif.bash shapefile/landuse.shp images/landsat_t1.tif
    results/raster_landuse.tif landuse
```

3. Open the output *results/raster_landuse.tif* in QGIS, or use it for further calculations. For all areas without landuse information in the shapefile, value 0 will be recorded in the output image.

7.21 oft-sigshp.bash

NAME

oft-sigshp.bash - creates a signature file of an image based on training area polygons.

OFGT VERSION

1.25.4

SYNOPSIS

- *oft-sigshp.bash*
- *oft-sigshp.bash* <image><shapefile_basename><shapefile_id_fieldname> <shapefile_coverclass_fieldname><output_sigfile>
- *oft-sigshp.bash* <image><shapefile_basename><shapefile_id_fieldname> <shapefile_coverclass_fieldname><output_sigfile><image_projection_EPSG> <shp_projection_EPSG>

DESCRIPTION

oft-sigshp.bash creates a signature file of an image, e.g. Landsat, based on training area polygons in shapefile format. This file can be used in knn-classification with stand alone program *oft-nn*.

NOTE: do **not** put **.shp** into the second parameter (basename)!

- The training areas and the image must be in the same projection OR you may give the projections in the command line as EPSG codes.
- If the projections are not defined (for both or one of the inputs), or the program does not recognize it, the script will warn. This is not dangerous if the files really are similarly aligned.
- The ID's must fit into a 16-bit Unsigned image (65500).
- The class values may be either numerical or verbal (e.g. "bushland")

Minimum parameters needed:

```
1 = imagefile
2 = shapefile
```

```
3 = field name storing ids in shape
4 = field name storing numeric class values in shape
5 = ouput signaturefilename
```

OPTIONS

Parameters:

```
6 = projection of image file
7 = projection of shapefile
```

OTHERS

This script can also be used after oft-nn.

EXAMPLE

- For this exercise following tools are used: *oft-sigshp.bash* - Open your working directory using

```
cd /home/...
```

The script *oft-sigshp.bash* is able to create a signature file for both data types, numerical and factorial, depending on the stored data in your shapefile. In the next steps we will lead you through an example exercises for each data type:

	id	colour	newcol
0	1	red	11
1	2	green	22
2	3	blue	33
3	4	orange	44
4	5	pink	55
5	6	red	66
6	7	blue	-9999
7	8	orange	88
8	9	green	99
9	10	orange	1000

Figure 11: Attribute table of polyN20.shp.

1. oft-sigshp.bash creating signature file with numerical values

- First, we run in the command line *oft-sigshp.bash* with the input raster*landsat_t1.tif* and your input shapefile *landuse.shp*. **id** stands for the shapefile_id_fieldname; **newcol** refers to the shapefile cover-class fieldname. If you look at the attribute table of your*landuse.shp* you will see that under *newcol* numerical data is stored. Output: *sig_newcol.txt*.

Note: the extension *.shp* of your shapefile is **not** included in the command line - only the basename!

- Run in terminal:

```
oft-sigshp.bash landsat_t1.tif landuse id newcol sig_newcol.txt
   EPSG:32620 EPSG:32620
```

- Lets take a look at the first lines of our output *sig_newcol.txt*:

```
head sig_newcol.txt
```

```
1 11 52.097317 23.696463 24.919711 45.321753 65.427785
   129.033459 32.060358
2 22 54.157159 25.348832 28.176561 48.805278 72.468158
   129.166550 34.397944
4 44 53.864419 25.231642 27.932243 51.411361 71.957973
   129.559346 33.277298
5 55 54.367835 25.734659 28.453136 53.725893 74.190155
   130.886716 36.174309
6 66 50.987633 23.044892 23.452312 52.655091 65.861426
   128.754701 29.121125
7 -9999 52.926014 24.353222 27.224344 48.176611 77.276850
   132.054893 38.276850
8 88 54.133652 25.214797 28.140811 49.842482 74.985680
   131.004773 37.408115
9 99 54.772519 25.961832 29.036641 52.786260 78.035115
   130.658015 39.607634
10 1000 51.588723 23.134328 24.255390 45.487562 68.208955
   130.310116 33.121061
11 1111 53.236948 24.644578 27.423695 48.779116 68.943775
   131.594378 33.905622
```

- The first column refers to the ID, col2 refers to the numerical data that stored under *newcol* in the shapefile, Col3 - col9 contain pixel values of band1 - band7 of the Landsat imagery.

2. oft-sigshp.bash creating signature file with factorial values

- second, we run the script using the id column called **colour**, which stores factorial values. Output: *sig_colour.txt*. Output signature file: *sig_colour.txt*.
- Run in terminal:

```
oft-sigshp.bash landsat_t1.tif landuse id colour sig_colour.txt
   EPSG:32620 EPSG:32620
```

Again let's take a closer look at the first lines of the output file *sig_colour.txt*:

```
head sig_colour.txt
```

```
1 red 52.097317 23.696463 24.919711 45.321753 65.427785
   129.033459 32.060358
2 green 54.157159 25.348832 28.176561 48.805278 72.468158
   129.166550 34.397944
4 orange 53.864419 25.231642 27.932243 51.411361 71.957973
   129.559346 33.277298
5 pink 54.367835 25.734659 28.453136 53.725893 74.190155
   130.886716 36.174309
6 red 50.987633 23.044892 23.452312 52.655091 65.861426
   128.754701 29.121125
7 blue 52.926014 24.353222 27.224344 48.176611 77.276850
   132.054893 38.276850
8 orange 54.133652 25.214797 28.140811 49.842482 74.985680
   131.004773 37.408115
9 green 54.772519 25.961832 29.036641 52.786260 78.035115
   130.658015 39.607634
10 orange 51.588723 23.134328 24.255390 45.487562 68.208955
   130.310116 33.121061
11 red 53.236948 24.644578 27.423695 48.779116 68.943775
   131.594378 33.905622
```

- In comparison to the output of *sig_newcol.txt* we can now see that col2 of s*ig_colour.txt* contains the factorial data.

7.22 PointsToSquares.py

NAME

PointsToSquares.py - converts XY-locations into 100 x 100 m squares in a kml-file.

OFGT VERSION

1.25.4

SYNOPSIS

PointsToSquares.py
PointsToSquares.py <infile><outfile><UTM zone number><ID><X-field><Y-field>

DESCRIPTION

PointsToSquares.py Conversion of user-defined plot centre points in a text file into squares of 100 x 100 m in kml format. These squares are training data collection locations, meant to be used with a specific tool made for Google Earth.
Input textfile projection needs to be UTM South WGS84 zones. Output kml is in latlon WGS84.

EXAMPLE

- For this exercise following tools are used: *PointsToSquares.py*, *gdalinfo*

  - Either use your own .txt file consisting of three columns: <ID><X-field><Y-field>or
  - Generate it by using *oft-gengrid.bash*

- Open your working directory using

```
cd /home/...
```

3. In this exercise we use the .txt file derived from *oft-gengrid.bash* called *training.txt*. This is how the first 10 rows look like:

```
head training.txt
```

4. **NOTE**, that the projection is UTM **South WGS84** zones. In our case it is UTM Zone 20S.
5. How to find out? Before running *oft-gengrid.bash*, check the projection of the input image (*landsat_t1.tif*), which is the base to calculate *training.txt* using

```
gdalinfo landsat_t1.tif //part of output: PROJCS["WGS 84 / UTM
    zone 20S"
```

5. After generating *training.txt* run the command line for calculating your points to 100 x 100x meter squares, creating an kml outputfile called *Points2Squares_training.kml* :

```
PointsToSquares.py training.txt Points2Squares_training.kml 20 1
    2 3 //20 refers to our UTM Zone, nr 1-3 refer to the columns
    in our input file training.txt
```

6. Load your result *Points2Squares_training.kml* e.g. in GoogleEarth
7. Check if the individual square is 100 x 100 meter!

IMAGE MANIPULATION

7.23 multifillerThermal.bash

NAME

multifillerThermal.bash - is a script which utilizes several Landsat scenes to build a multi-temporal image composite using the warmest pixel -method.

OFGT VERSION

1.25.4

SYNOPSIS

multifillerThermal.bash
multifillerThermal.bash <anchor><filler1><filler2>... <filler_n>

DESCRIPTION

The aim is to have one good image so called *anchor* with as few problematic areas as possible and then another which is from same season (as close a date as possible) and has clouds in different locations so called *filler*.

EXAMPLE

- For this exercise following tools are used: *multifillerThermal.bash*
- Open your working directory using

```
cd /home/...
```

- Then run

```
multifillerThermal.bash anchor.tif filler.tif
```

7.24 oft-calc

NAME

oft-calc - is a raster image calculator.

OFGT VERSION

1.25.4

SYNOPSIS *oft-calc*

oft-calc <input><output>
oft-calc <input><output>[-um maskfile] [-inv] [-of format] [-Z/M/Q/C/L/X/M]
oft-calc <input><output>[-ot Byte/Int16/UInt16/UInt32/Int32/Float32/Float64/CInt16/CInt32/CFloat32/CFloat64]

DESCRIPTION

oft-calc based on an input raster file, oft-calc creates an output raster file as result of a simple calculation between the original bands. The bands used for the calculation must be all stacked in the input raster file.

After defining the first line, following parameters will be asked:

1. *Number of output bands*
2. *Input postfix equations*

Band 1: The equation for output band 1 has to be specified. The input bands are referred to with #. The implemented operators between input bands include:

```
+ addition
- subtraction
/ division
* multiplication
= equals to
< less than
> larger than
! not equal to
? if clause
M maximum of two values
m minimum of two values
```

```
B bit level operator
e natural logarithm
c pixel column coordinate
r pixel row coordinate
^ power
e natural logarithm
x base-e exponential function
```

OPTION

Parameters:

-inv the notation of the equations has changed in version 2.0. In case you want to use the old notations, please use the -inv option.

-of format. Any GDAL output format can be specified. If not specified, output format will be tif.

-ot output data type. If not specified, output data type will be the same as input data type. *-[-ot Byte/Int16/UInt16/UInt32/Int32/Float32/Float64]* - output data type

-[Z/M/Q/C/L/X/M] - try to speed up the processing by reading n lines at the time.

Z=2000 M=1000 Q=500 L=50 X=10

-um mask. If a raster file is provided as a mask, only pixels with value different than 0 in the mask will be used for the calculation.

NOTE

The notation of the equations has changed in version 2.0. In case you want to use the old notations, please use the -inv option.

EXAMPLE

For this exercise following tools are used: oft-calc

1. EXAMPLES: OPERATORS

1. **Addition**
   Simple band addition: band1 + band2

```
oft-calc in_image out_image //hit return after defining this
    line
```

```
2 //this number defines the number of bands your out_image
    will have; hit return again
#1 #2 + //type your clause and hit return. Now out_image
    should be in process!
```

2. **Division**
   band1 / band2

```
oft-calc in_image out_image
2
#1 #2 /
```

3. **Equals to**
   if pixel value of band1 equals 0 then set it to 0, otherwise to 1

```
oft-calc in_image out_image
1 // if(?) band1 = 0 (#1 0 =) then 0 otherwise 1 (1 0)
#1 0 = 1 0 ?
```

4. **Boolean**
   You can also use boolean larger than operator to determine if #1 >#2

```
oft-calc in_image out_image
2
#1 #2 >
```

5. **The usage of the IF clause**
   if band1 ¿ 50, output=1 else output=0. This also creates also a simple mask containing 1 for pixels of interest and 0 for background

```
oft-calc in_image out_image
1
#1 50 > 0 1 ?   //if(''?'') band1 > 50 (''#1 50 >'') then 1
    otherwise 0 (''0 1'') if band1 + band2 = 2, output=1
    else output=0
```

```
oft-calc in_image out_image
1
#1 #2 + 2 = 0 1 ?  //if(''?'') band1 + band2  (''#1 #2 +'')
    = 2 (''2 ='') then 1 otherwise 0 (''0 1'') if band1 > 50
     or band2 > 50, output=1 else output=0
```

```
oft-calc in_image out_image
1
#1 50 > #2 50 > 0 1 ? 1 ?  //if band1 > 50 (''#1 50 >'')
   then 1 (''1 ?'') otherwise if band2 > 50 (''#2 50 >'')
   then 1 otherwise 0 (''0 1 ?'')
```

2. EXAMPLES ON APPLICATIONS

1. **NDVI**
   Calculate the NDVI for your Landsat image (band3 = Red band, band4 = NIR Band)

```
oft-calc -ot Float32  in_image out_image
1
#4 #3 - #4 #3 + / //(b4-b3) / (b4+b3)
```

   Note that the band4 in the input layerstack image should be the NIR band and the band 3, the Red band. Note also that the output data type should be specified as Float32 in order to have output values from -1 to 1
   oft-ndvi.bash also creates a NDVI image using (NIR-VIS) / (NIR + VIS) .

2. **NBR - Normalised Burn Ratio**
   NBR highlights areas that have burned using Landsat TM.
   Calculate the NBR for your Landsat image:

```
oft-calc in_image out_image
1
#4 #7 - #4 #7 + /      //(b4-b7) / (b4+b7)
```

3. **dNBR**
   In addition, the differnence NBR (dNBR) technique is a form of Change Detection which is used to index the severity of a fire
   Calculate the differenced (or delta) dNBR for NBR_prefire - NBR_postfire:
   Note: as you can't have two separate input files, one for

NBR_prefire and a second for NBR_postfire, you need to combine the two output_bands into one file before applying the equation (band 1 (#1) containing information on NBR_prefire and band 2 (#2) containing info on NBR_postfire):

```
oft-calc in_image out_image
1
#1 #2 -    //band 1 (#1) contains info on NBR_prefire and
    band 2 (#2) contains NBR_postfire
```

4. **Average of bands**
   Compute an average of bands 1,2 and 3 of an image:

```
oft-calc in_image out_image
1
#1 #2 + #3 + 3 / // band1 + band 2 (#1 #2 +) + band3 (#3 +)
    divided by 3 (3 /)
```

5. **Build a mask from LEDAPS QA layer**
   Bit level operators: does the first bit of band 2 equals to 1?

```
1 #2 B
```

to build a mask from LEDAPS QA layer:

```
1 #1 B 0 2 #1 B 4 #1 B + 8 #1 B + 9 #1 B + 12 #1 B + < 2 1 ?
    1 ?
```

which becomes

```
1 #1 B  : if bit one of band 1 equals to 1
0       : constant
2 #1 B  : if bit 2 of band 1 equals to 1
4 #1 B  : if bit 4 of band 1 equals to 1
+       : sum up the previous two terms
8 #1 B  : if bit 8 of band 1 equals to 1
+       : sum up previous two terms
9 #1 B  : if bit 9 of band 1 equals to 1
+       : sum up previous two terms
12 #1 B : if bit 12 of band 1 equals to 1
+       : sum up previous two terms
<       : if previous term is smaller than
```

```
2       : output 2 (if clause false)
1       : output 1 (if clause true)
?       : if
1       : output 1 (if clause true)
?       : if
```

Now, what happens in practice, is the following:

```
1) Check bit 1 and record 0 if its is false and 1 if it is
   true
2) Check bits 2,4,8,9 and 12 and return their sum
3) if output of 2) is larger than zero (second line above)
   return 1 else return 2
4) if output of 1) is 1 return 1 else return output of 3)
```

6. **Creating a mask file**

   Create a simple mask containing 1 for pixels of interest and 0 for background:

   The equation in words: if your pixel value equals 0 then set it to 0, otherwise to 1

```
oft-calc in_image out_image
1  //note that here we want to define our mask called
   out_image to consist of 1 band
#1 0 = 1 0 ?
```

7. **Including a mask file**

```
oft-calc -um in_mask in_image out_image   //here the option
   -um defining the mask file is added to the command
2
#1 #2 +
```

7.25 oft-chdet.bash

NAME

oft-chdet.bash - automated change detection.

OFGT VERSION

1.25.4

SYNOPSIS *oft-chdet.bash*

oft-chdet.bash <input1><input2><output><nodata_value>[threshold]

- <input1>- Input raster 1 (with extension).
- <input2>- Input raster 2 (with extension).
- <output>- A raster consisting of binary values (0 or 1) indicating pixels of likely change between the two dates. Values of 1 indicate change. Values of 0 indicate no-change.
- <nodata_value>- Value indicating no-data within the image.
- [threshold] - Default 0.99. Specifies the threshold value of the cumulative frequency distribution (of the resulting Chi-square layer...see Reference below) above which pixels are identified as changed. Higher threshold values indicate more stringent limits for detecting changes and, thus, produce less changed area than lower thresholds. Threshold values must be specified as a proportion using 0.XX notation.

DESCRIPTION

This tool performs automated change detection between 2 input images. The script uses the Iteratively Re-weighted Multivariate Alteration Detection (MAD) algorithm (Canty and Nielsen, 2008). Input imagery must have the same format, extent, resolution, number of bands and type of data.

REFERENCE

M. J. Canty and A. A. Nielsen (2008), Automatic radiometric normalization of multitemporal satellite imagery with the iteratively re-weighted MAD transformation RSE 112(3), 1025-1036.

EXAMPLE

To automatically find changes between a landsat image from year 2000 and 2005 using a threshold of 0.85:

```
oft-chdet.bash landsat00.tif landsat05.tif change00_05.tif 0
    0.85
```

EXERCISE

- For this exercise following tools are used: **oft-chdet.bash**
- Identify changed areas between year 2000 and 2012 using Landsat imagery using *landsat_t1.tif* and *landsat_t2.tif*

1. Open your working directory using

```
cd /home/...
```

2. Unpack the data
3. Now we run *oft-chdet.bash* to do the automated change detection using the input Landsat data

```
oft-chdet.bash landsat_t1.tif landsat_t2.tif change_0012.tif 0
    0.85
```

Output includes the following:
A file beginning with *imad-[name of outfile].tif.* This file contains the raw results of the IMAD process, one for each input band and the chi-squared layer (see Reference).
The specified output file:
This file contains 1's and 0's; 1's indicate areas of change and 0's indicate areas of no change.

7.26 oft-clip.pl

NAME

oft-clip.pl - subsets an input image using the extent, pixels size and projection of a reference image.

OFGT VERSION

1.25.4

SYNOPSIS *oft-clip.pl*

oft-clip.pl <reference><input><output>

DESCRIPTION

oft-clip.pl The straight forward tool oft-clip.pl subsets an input image using the extension, pixel size and projection of the reference image.

EXERCISE

-For this exercise following tools are used: *oft-clip.pl*

1. Use for this exercise the MODIS imagery *vcf-2010.tif* and the Landsat imagery clip *landsat_t1.tif*

2. Open your working directory using

```
cd /home/.../OFGT-Data
```

3. Reproject, clip and resample the MODIS image (resolution 230 m, lat/long) to the projection, extent and pixel size of the Landsat tile (resolution 30m, UTM 35)

```
oft-clip.pl images/landsat.tif images/vcf-2010.tif results/vcf-
    clip.tif
```

4. Visualize the results in QGIS

```
qgis images/landsat_t1.tif results/vcf-clip.tif
```

7.27 oft-combine-images.bash

NAME

oft-combine-images.bash - combines 2 images into one.

OFGT VERSION

1.25.4

SYNOPSIS *oft-combine-images.bash*

oft-combine-images.bash <-a first image><-b second image><-m first image mask><-s second mask>

-a First image = Better image, whose area is used whenever possible

-b Second image = Image to be used elsewhere

-m First image mask = 0/1 mask indicating bad areas on first image with 0

-s Second mask = 0/1 mask indicating bad areas on second image with 0

DESCRIPTION

- Can be used to merge same-day Landsat images (adjacent) or two gapfill results (stack)
- Takes as input the images and their masks
- Masks for same-day can be prepared with oft-trim-mask.bash and for gapfill with *oft-prepare-images-for-gapfill.bash*
- All ok areas are taken from image 1, and image 2 is used elsewhere
- Also produces a mask that indicates ok areas of the resulting combined image with 1
- All material needs to be in same projection
- Works with 6 or 7 band images

EXERCISE

- For this exercise following tools are used: *oft-combine-images.bash*, *gdal_translate*, *trim*

- Open your working directory using

```
cd /home/.../OFGT-Data
```

- In a first step we need to adjust the nr of bands of landsat_t1.tif (7 bands) to the nr of bands of our second image (6 bands):

```
gdal_translate landsat_t1.tif landsat_t1_6bands.tif -b 1 -b 2 -b
    3 -b 4 -b 5 -b 6
```

- Then we need to prepare our mask files for each landsat image using *oft-trim*

```
oft-trim-mask.bash landsat_t2.tif
oft-trim-mask.bash landsat_t1.tif
```

Now we can run oft-combine-images.bash. The output is automatically processed, in this case it is called *stack_landsat_t1_6bands_landsat_t2.tif*

```
oft-combine-images.bash -a landsat_t1_6bands.tif -b landsat_t2
    .tif -m landsat_t1_mask.tif -s landsat_t2_mask.tif
```

7.28 oft-gapfill

NAME

oft-gapfill - regression based gap and cloud filler.

OFGT VERSION

1.25.4

SYNOPSIS *oft-gapfill*

oft-gapfill <-um maskfile><input><output>
oft-gapfill <-um maskfile><input><output>[-la nbrLargeAreaWindows] [-nolocal] [-smooth] [-pm] [-da] [-sd sampling density] [-ws WindowSize]

DESCRIPTION

oft-gapfill fills the gaps in an input image using locally built regression models. The models can be built
1. separately for every gap pixel using a local model built using its adjacent pixels or
2. for a given number of Large Area subsets or
3. using both of these methods

- In the case 2), the option -la followed by the number of requested Large Area (LA) subsets in X direction should be given. The total number of LA subsets is the square of the given parameter. If the user wants to use only Large Area models, the option -nolocal should be used.
- Maskfile, inputfile and outputfile are all required inputs. They may be in any of the formats understood by GDAL.
- The input image is a stack of the Anchor image and the Filler image. The output values for Anchor are computed using Filler and the model. The input image bands should be organized as follows:

- band 1 to nbr_bands/2 = Anchor image
- bands nbr_bands/2 + 1 to nbr_bands = Filler image

- The mask file shows the locations of the gaps, areas which are suitable for collecting training data, and areas which should not be processed. The mask values are as follows:

```
1 = fill these pixels (unusable data in anchor, good data in
    filler)
2 = collect training data for regression model (good data in
    both images)
3 = do nothing, i.e., use the original values (2 cases: good in
    anchor, bad in filler OR non-good in both images)
0 = do nothing (image margins)
```

OPTIONS

1. -la (nbrLargeAreaWindows) = number of LA windows in X direction. The total number of LA windows will be the square of this parameter.
2. -da (do4allpixels) = use to built model to predict output value for every pixel of the anchor using the built models and the values of the Filler.
3. -sd (sampling density) = sampling density used to build the LargeArea model. Value two, for example, would force the algorithm to collect every other valid pixel within the scene to be used in building the model.
4. -ws (WindowSize) = size of the neighbourhood from which the data for local model construction is collected

NOTE

The input image can be produced from 2 image stacks (for instance, 2 Erdas imagine composites consisting of 7 bands). The script *stack2images.bash* produces the composite. It can also be produced from HDF-images that are stored in folders. The script *stack2images_hdf.bash* is for that purpose.

The model may be very sensitive to outliers. Therefore it is important that the mask value 2 is present only in location where both Anchor and Filler have valid data.

IMPORTANT: The stack and the mask must have been reprojected to the same geographical window and they do must have the same number of rows and cols

EXAMPLE

```
oft-gapfill -la 2 -nolocal -sd 5 -ws 13 -um mymask.img
    my14bandimage.img filled.img
```

The program performs 2 passes over the image:
- Pass1: collect the data to build the model
- Pass2: fill the gaps with Large Area models.

EXERCISE

- For this exercise following tools are used: *oft-gapfill*, gdal_translate, oft-stack, oft-calc
- Open your working directory using

```
cd /home/...
```

- As *oft-gapfill* only allows even number of bands, first, we need to adjust the number of bands of *landsat_t1.tif* (7 bands) *landsat_t2.tif* (6 bands):

```
gdal_translate landsat_t1.tif landsat_t1_6bands.tif -b 1 -b 2 -b
    3 -b 4 -b 5 -b 6
```

- *oft-gapfill* takes as input an image stack of the **anchor** (*landsat_t2.tif*) and the **filler** (*landsat_t1.tif*):

```
oft-stack -o stack.tif landsat_t2.tif landsat_t1_6bands.tif
```

- Gapfilling with mask of the scan-line using a simple mask created with *oft-calc* in two steps:

    Rules:

- if band 1 or band 6 are 0 put 1 (fill)
- if band 7 or band 12 are 0 put 3 (do nothing)
- else put 2 (collect training data for regression models)

Step 1:

```
oft-calc stack.tif tmp.tif
Step 2:
#1 0 = #6 0 = + 0 > 2 1 ?
#7 0 = #12 0 = + 0 > 2 3 ?
```

Step 2:

```
oft-calc stack.tif tmp.tif
Step 2:
#1 0 = #6 0 = + 0 > 2 1 ?
#7 0 = #12 0 = + 0 > 2 3 ?
```

Now, use *oft-gapfill* to fill the areas indicated as "1" in the mask:

```
oft-gapfill -la 1 -nolocal -pm -sd 2 -um simple_mask.tif stack.
    tif filled_la1_sd2_simplemask.tif
```

Output automatically processed: *filled_la1_sd2_simplemask.tif*

Figure 12: Original Landsat image.

Figure 13: Landsat imager after gap fill

7.29 oft-ndvi.bash

NAME
oft-ndvi.bash - computes ndvi images.

OFGT VERSION
1.25.4

SYNOPSIS *oft-ndvi.bash*
oft-ndvi.bash <input><output><R_band><NIR_band>
<input><output><R_band><NIR_band>[mask]

DESCRIPTION
oft-ndvi.bash creates an NDVI image using (NIR-VIS) / (NIR + VIS).
- Input data is an image stack. User gives the location of Red and NIR band (in regular Landsat TM/ETM 3 and 4)
- Number of bands is not restricted

OPTIONS
- [mask] - include a mask_image into this process by using this option

EXAMPLE
- For this exercise following tools are used: *oft-ndvi.bash*
- Open your working directory using

```
cd /home/...
```

- Run the command line for calculating the *NDVI* for your satellite image where *landsat_t1.tif* is your input image and *NDVI_landsat_t1.tif* will be your *NDVI* output image. The numbers <3>and <4>refer to the band numbers for the *VIS* and *NIR* bands.

```
oft-ndvi.bash landsat_t1.tif ../results/NDVI_landsat_t1.tif 3 4
```

- Load*NDVI_landsat_t1.tif* in QGIS
- Check that all pixels of your NDVI image have the expected values between -1 and 1.
- Here is an example of how the result looks like:

Figure 14: Zoomed view of the original Landsat image.

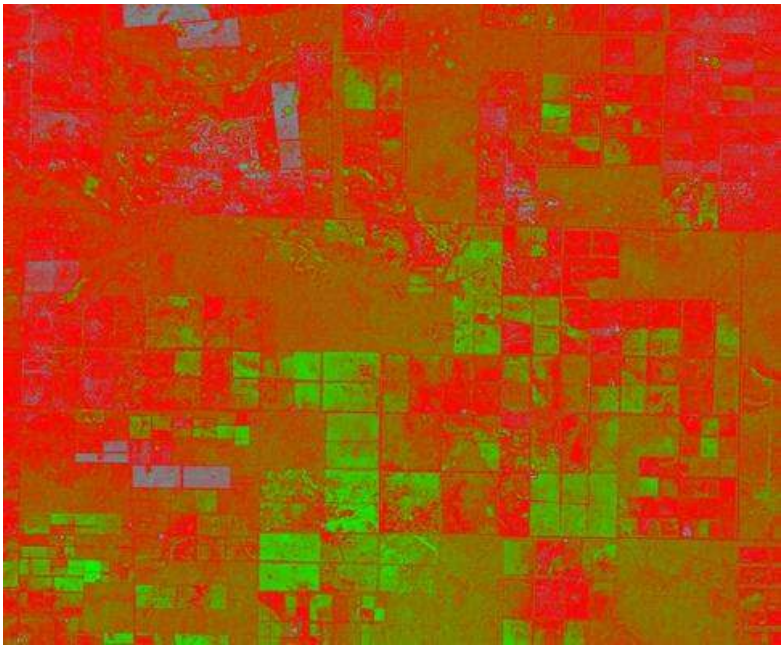


Figure 15: Zoomed view of the NDVI-result using the 'freak out' colour map in QGIS.

7.30 oft-prepare-images-for-gapfill.bash

NAME

oft-prepare-images-for-gapfill.bash - prepares images and masks for oft-gapfill

OFGT VERSION

1.25.4

SYNOPSIS *oft-prepare-images-for-gapfill.bash*

oft-prepare-images-for-gapfill.bash <-a anchor><-f filler><-m anchor mask><-s second mask (filler)>
oft-prepare-images-for-gapfill.bash <-a anchor><-f filler><-m anchor mask><-s second mask (filler)>[-n ndvi threshold]

-a Anchor = Better image, whose gaps are to be filled
-f Filler = Filler image
-m Anchor mask = 0/1 mask indicating bad areas on anchor image with 0
-s Second mask = 0/1 mask indicating bad areas on filler image with 0

OPTIONS

-n ndvi threshold = If images differ a lot, NDVI can be used to select only vegetated areas for mask
Values like 0.4 or 0.5 are useful at some location on the world, check your particular situation yourself!

DESCRIPTION

oft-prepare-images-for-gapfill.bash
- Takes the anchor and filler images as input
- Also their 0/1 masks indicating clouds and gaps are needed
- NDVI can be used to threshold areas with low vegetation off from

the models
- At this point, bands 3 and 4 are used for NDVI computation
- Otherwise, nbr of bands is not fixed, but must be equal in the input images
- All material needs to be in same projection

EXAMPLE

- For this exercise following tools are used: *oft-prepare-images-for-gapfill.bash*
- Open your working directory using

```
cd /home/...
```

- As *landsat_t1.tif* and *landsat_t2.tif* differ in their number of bands we need to exclude band 7 from *landsat_t1.tif* by carrying out following procedure:

```
gdal_translate landsat_t1.tif landsat_t1_6bands.tif -b 1 -b 2 -b
    3 -b 4 -b 5 -b 6
```

Let's run *oft-prepare-images-for-gapfill.bash* using following input:

```
oft-prepare-images-for-gapfill.bash -a landsat_t1_6bands.tif -f
   landsat_t2.tif -m landsat_t1_mask.tif -s landsat_t2_mask.tif
```

Two output images mask are automatically processed: *gapmask_landsat_t1_6bands_lanc* and *goodarea_mask_landsat_t1_6bands_landsat_t2.tif*

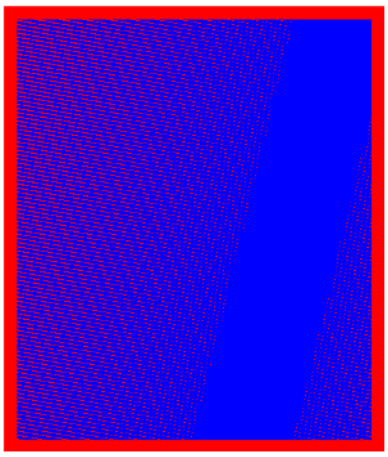


Figure 16: gapmask_landsat_t1_6bands_landsat_t2.tif

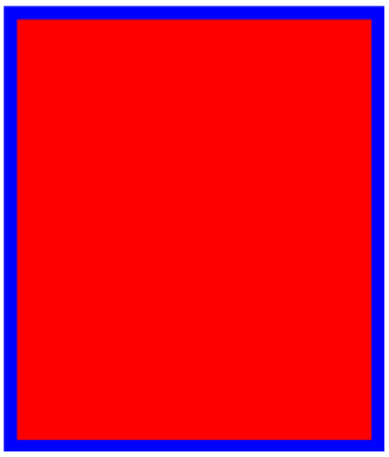


Figure 17: goodarea_mask_landsat_t1_6bands_landsat_t2.tif

7.31 oft-reclass

NAME
oft-reclass - is a reclassification program.

OFGT VERSION
1.25.4

SYNOPSIS
oft-reclass
oft-reclass <inpufile>
oft-reclass [OPTIONS] <inpufile>

DESCRIPTION
oft-reclass changes pixel values to alterenative values given in a text file .

The *maxval* parameter is used to allocate memory for the reclassification table. If it is not given in the command line, it will be asked interactively.

The reclassification text file should consist of records with input value (column 1) and one or more space separated output values. Thus, the structure could be:

```
1 255 255 255
2 0 0 0
3 125 100 16
4 0 0 112
```

The program asks, how many output values the user wants to produce for each input band. With the given example reclassification file, the user could produce a 3 band RGB image from a single band input file.

OPTIONS

```
-um <maskfile>
```

```
-oi  <output_image>
-maxval <maximum pixel value in infile>
```

EXAMPLE

- For this exercise following tools are used: *oft-reclass*
- For this exercise we use a single band image *images/forestc.tif* and a segmented image *images/segments.tif* which you can also create yourself using *oft-seg*.
- Open your working directory using

```
cd /home/...
```

1. oft-reclass

- First you need to create a text file called *input_reclass.txt* that should look like this:

```
1 255 255 255
2 0 100 0
3 125 100 16
4 0 0 112
5 0 225 0
6 225 0 0
99 200 0 200
```

- Now we run oft-reclass with Input: *image/forestc.tif* and *text/input_reclass.txt*; Output: *results/reclassforestc.img*:

```
oft-reclass -oi results/reclassforestc.img  txt/input_reclass.
   txt images/forestc.tif
```

- Then tool will ask you then for further information:

```
Input reclass file name?: txt/input_reclass.txt
Nbr of out bands per input channel?:3
Col of input value?: 1
Col of output value 1: 2
Col of output value 2: 3
Col of output value 3: 4
NODATA value?: 0
```

- Open QGIS and load your the original imagery *image/forestc.tif* (Colour map: Pseudocolour) and the result *results/reclassforestc.img*. Click with the *Identify Features* Tool over the the different classes and see how they have changed after the reclassification:

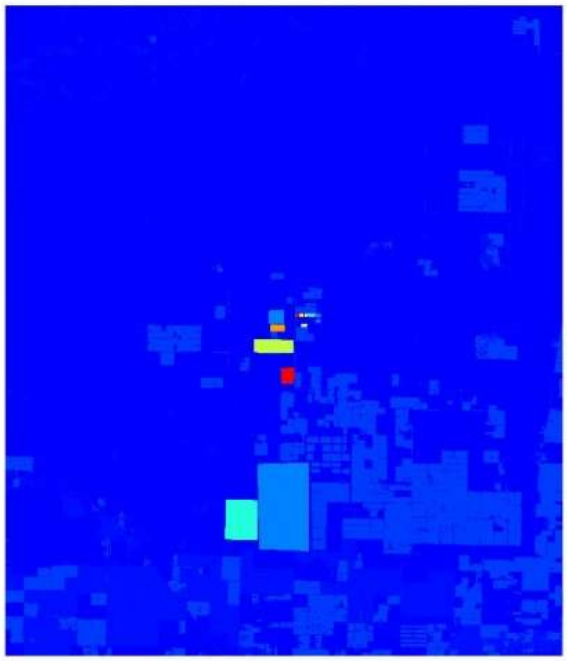


Figure 18: Original input image forestc.tif.

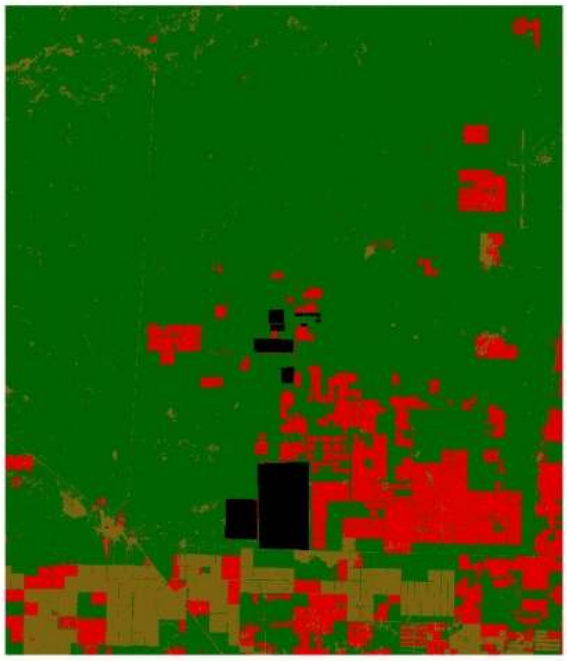


Figure 19: Reclassified output raster reclassforestc.img.

2. Second example for oft-reclass

- Lets run oft-reclass again with a different input image: Input: landsat_t1_min50.tif, input_reclass.txt, input_reclass.txt; Output: reclass_min50.img:

```
oft-reclass -oi reclass_min50.img  input_reclass.
   txtlandsat_t1_min50.tif
```

Again the tool will ask you for further information:

```
Input reclass file name?: input_reclass.txt
Nbr of out bands per input channel?:3
Col of input value?: 1
Col of output value 1: 2
Col of output value 2: 3
Col of output value 3: 4
NODATA value?: 0
```

- Open QGIS and load your result image reclass_min50.img and zoom into the top left corner. You can see that the original classes 1-6 and 99 of landsat_t1_min50.tif were reclassified the way we defined it in the lookup table input_reclass.txt.

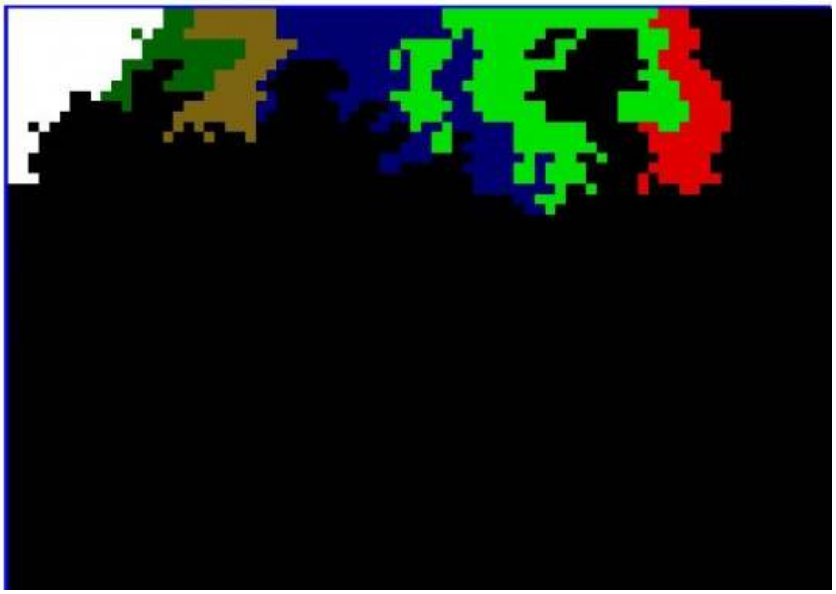


Figure 20: Zoom into the top left corner of our final result reclass_min50.img.

7.32 oft-shrink

NAME
oft-shrink - to be combined with *oft-trim*.

7.33 oft-stack

NAME
oft-stack - Create a muti-band image stack.

OFGT VERSION
1.25.4

SYNOPSIS
oft-stack
oft-stack <-o outputfile><inputfiles>
oft-stack [-ot Byte/Int16/UInt16/UInt32/Int32/Float32/Float64/CInt16/CInt32/CFloat32/CFloat64] [-um <maskfile>] <-o outputfile><inputfiles>

```
-o outputfile - The name of the output file to be created (
    include extension).
inputfiles - A set of input files (include extension), each
    separated by a space.
```

DESCRIPTION
oft-stack builds image stack from input files in the order of appearance.
- The output format of the first input file is used.
- The images need to have exactly the same size (rows x cols)

OPTIONS

```
-ot - Optional. The output image type. By default, the first
    input image type is used.
```

```
-um - Optional. A mask file used to restrict the extent of the
    processing.
```

- *oft-stack* builds an image stack from input files in the order of appearance. By default, the output format and type of the first input file is used.
- N.B.: The images need to have exactly the same size (rows x cols)

EXAMPLE

To create a 6-band stack of Landsat data from individual input rasters in .TIF format.

```
oft-stack -o landsat7band.tif landsatb1.tif landsatb2.tif
    landsatb3.tif landsatb4.tif landsatb5.tif landsatb7.tif
```

the above can be written using wildcards...

```
oft-stack -o landsat7band.tif landsat*.tif
```

EXERCISE

For this exercise following tools are used: *oft-stack*

1. Open your working directory using

```
cd /home/...
```

2. Now we run oft-stack using two input images *landsat_t1.tif* and *landsat_t2.tif* to create the output stack image called *stack.tif*:

```
oft-stack -o stack.tif landsat_t1.tif landsat_t2.tif
```

3. Take a closer look at your output in QGIS and you will see that *stack.tif* has 13 bands (*landsat_t1.tif* contains 7 bands and *landsat_t2.tif* 6 bands). Or print the raster information on your screen by typing in your terminal

```
gdalinfo stack.tif
```

7.34 oft-trim

NAME
oft-trim - erosion filter producing binary output.

OFGT VERSION
1.25.4

SYNOPSIS
oft-trim
oft-trim -um <maskfile><inputfile><outfile>
oft-trim [-ws WindowSize] [-origval] -um <maskfile><inputfile><outfile>

DESCRIPTION
oft-trim analyses the content of the spatial neighbourhood of each pixel. If all the pixels within the window are less or equal to zero, output is zero. Else, output is one.

OPTIONS
Parameter:
-um = maskfile
-ws = window size
-origval = original value

EXERCISE
For this exercise following tools are used: *oft-trim*
1. Open your working directory using

```
cd /home/...
```

2. Lets run *oft-trim* with the input file *landsat_t1.tif* with the option *-ws* set to 3 to create the output file *trim.tif*:

```
oft-trim -ws 3 landsat_t1.tif trim.tif
```

3. Verify in QGIS that all the values of your output image are all trimmed to 1.

7.35 oft-trim-maks.bash

NAME

oft-trim-maks.bash - This script makes a 0/1 mask of a 6 or 7 band (Landsat) image .

OFGT VERSION

1.25.4

SYNOPSIS

oft-trim-maks.bash
oft-trim-maks.bash <image>

DESCRIPTION

oft-trim-maks.bash
- detects the margins and Landsat 7 missing scanlines, and trims the edges
- accepts 6 or 7 band image
- all values ¡= 0 are considered nodata
- **Note:** the output of *oft-trim-maks.bash* can be furhter used for *oft-combine-images.bash*

EXERCISE

For this exercise following tools are used: *oft-trim-mask.bash*
1. Open your working directory using

```
cd /home/...
```

2. Lets run *oft-trim-mask.bash* using *landsat_t2.tif*. Automatically processed output: *landsat_t2_mask.tif*:

```
oft-trim-mask.bash landsat_t2.tif
```

3. Verify in QGIS your our result if the mask pixel values are 1 or 0.

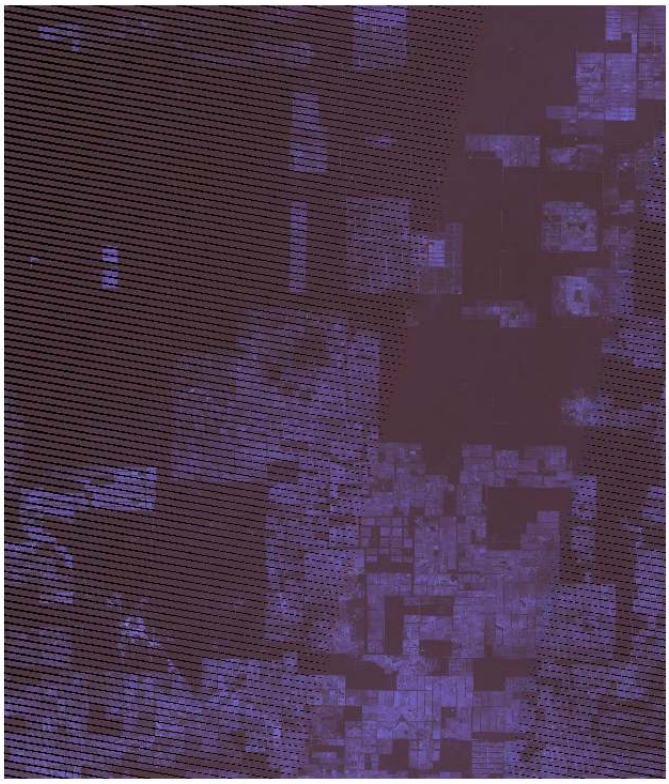


Figure 21: Original image landsat_t2.tif with visible gaps in QGIS

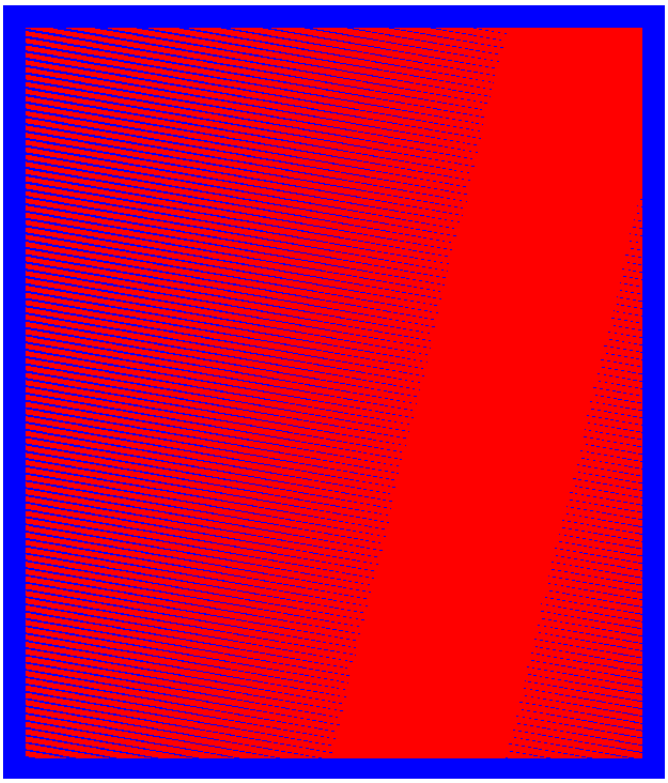


Figure 22: Output landsat_t2_mask.tif using the Pseudo-colour colour map in QGIS

STATISTICS

7.36 oft-ascstat.awk

NAME

oft-ascstat.awk - computes basic statistics for a space separated text file.

OFGT VERSION

1.25.4

SYNOPSIS *oft-ascstat.awk*

oft-ascstat.awk <input_file
textgreater

DESCRIPTION

oft-ascstat.awk computes basic statistics for a given input file or stdin.
Please not that the data must be provided as space separated!

EXAMPLE

1.For this exercise following tools are used: *oft-ascstat.awk*
2. Open your working directory using

```
cd /home/...
```

3. The script *oft-ascstat.awk* computes basic statistics for our **space separate** input file *sample_landuse.txt*:

```
head sample_landuse.txt
```

```
10557.00 772650.00 -2404770.00 5.00 53.00 26.00 28.00 54.00
   81.00 131.00 39.00
94788.00 773490.00 -2431680.00 1.00 51.00 24.00 25.00 45.00
   65.00 127.00 33.00
```

```
201536.00 774750.00 -2439390.00 1.00 54.00 25.00 27.00 50.00
    71.00 130.00 35.00
88531.00 771450.00 -2431110.00 1.00 47.00 21.00 18.00 37.00
    48.00 126.00 21.00
123374.00 774150.00 -2433990.00 1.00 54.00 24.00 30.00 35.00
    75.00 132.00 42.00
97345.00 776220.00 -2431950.00 1.00 52.00 23.00 24.00 42.00
    60.00 131.00 30.00
199041.00 773190.00 -2439120.00 1.00 51.00 23.00 23.00 52.00
    58.00 130.00 28.00
144276.00 775860.00 -2435400.00 1.00 49.00 22.00 21.00 45.00
    59.00 125.00 30.00
180961.00 772680.00 -2437890.00 1.00 49.00 21.00 21.00 36.00
    61.00 126.00 28.00
185386.00 772410.00 -2438190.00 1.00 49.00 21.00 18.00 43.00
    51.00 126.00 22.00
```

Explanation of the columns: pixel_id x y class band1 band2 band3 band4 band5 band6 band7

4. Lets run *oft-ascstat.awk*

```
oft-ascstat.awk sample_landuse.txt
```

Result is printed on screen:

Col	Min	Max	Avg	Std
1	4923	220664.0	116318.43	6345.83
2	736440	787020.0	771921.0	798.10
3	-2448000	-2403090	-2431097.6	1035.67
4	1.0	25.0	2.844444	0.519269
5	44.00	69.0	53.455556	0.491606
6	19.0	37.0	24.82	0.383203
7	16.0	48.0	27.02	0.691350
8	34.0	62.0	46.74	0.711611
9	42.0	103.0	69.455	1.450889
10	124.0	136.0	129.43	0.252272

Explanation of the columns same as before: pixel_id x y class band1 band2 band3 band4 band5 band6 band7
And of course the interesting lines are line 4-11.

7.37 oft-avg

NAME

oft-avg - computes zone/segment averages and standard deviations.

OFGT VERSION

1.25.4

SYNOPSIS *oft-avg*

oft-avg -i <input>-o <output>-um <maskfile>
oft-avg -i <input>-o <output>-um <maskfile>[-std]
oft-avg -i <input>-o <output>[-ot Byte/Int16/UInt16/UInt32/Int32 /Float32/Float64] [-h help]

DESCRIPTION

- oft-avg computes zone/segment averages and standard deviations.
- It produces two output files: an output image and a text file.
- You need to give at least the input image file (-i option), the output image (-o) and the maskfile (-um).
- In the output image, each pixel gets assigned the average/standard deviation for the zone/segment it belonged to.
- The output format in the text file is: ID number_pixels avgband1 ...avgbandN.

OPTION

Parameters:
[-std] - The program computes and prints out also the std's (as extra bands in the output image and extra columns in the text file)
[-ot Byte/Int16/UInt16/UInt32/Int32/Float32/Float64] - output data type
[-h help]

NOTE

For the benefit of users that are running scripts using the older version based on order of datafiles instead of options *-i*, *-o* and *-um*, the program can still be used that way

EXAMPLE

For this exercise following tools are used: *oft-avg*

1. Open your working directory using

```
cd /home/...
```

2. Now we run oft-avg with input: *images/landsat_t1.tif*, output: *results/oftavg.tif*, mask: *images/segments.tif*

The output text file will be named as the output image plus ".txt" (in this case *oftavg.tif.txt*).

```
oft-avg -i images/landsat_t1.tif -o results/oftavg.tif -um
    images/segments.tif
```

3. Print the first 10 lines of the output text file in terminal:

```
head results/oftavg.tif.txt
```

```
1 135 49.051852 20.081481 18.370370 36.785185 46.674074
    126.059259 20.192593
 2 54 49.351852 20.370370 18.407407 37.500000 46.555556
    125.925926 19.870370
 3 76 48.578947 19.828947 17.710526 36.657895 43.881579
    125.907895 18.881579
 4 194 49.005155 20.077320 18.268041 37.530928 46.000000
    125.670103 19.721649
 5 221 49.090498 20.176471 18.574661 37.542986 47.565611
    125.728507 20.339367
 6 82 48.878049 20.304878 18.695122 37.243902 48.097561
    125.597561 20.780488
 7 53 48.886792 20.056604 18.339623 37.207547 45.698113
    125.698113 19.396226
 8 120 48.991667 20.216667 18.583333 36.908333 47.200000
    126.041667 20.283333
 9 154 48.980519 19.993506 18.389610 32.474026 45.000000
    125.987013 20.337662
10 150 49.540000 20.220000 18.853333 32.260000 47.233333
    125.973333 21.433333
```

Explanation of values for each column:
- Col1: ID (value for zone/segment)
- Col2: Number of pixels
- Col3 - col9: Average value of band1, band2, ... band7

4. Open the output file *results/oftavg.tif* in QGIS. Use *Identify Features* that can be chosen form the top bar and click on the image. The window *Identify Results* should pop up and with the average value for each band for that zone/segment:
Band1 49
Band2 21
Band3 20
Band4 41
Band5 50
Band6 126
Band7 22

5. If you also choose to output standard deviations, the format of the output files will be as follows:
- text file:

  - Col1: ID (value for zone/segment)
  - Col2: Number of pixels
  - Col3 - col9: Average value of band1, band2, ... band7
  - Col10 - col16: Standard deviation of band1, band2, ... band7

- raster image file:

  - band1 - band7: average for band1, band2, ... band7
  - band8 - band14: standard deviation for band1, band2, ... band7

7.38 oft-countpix.pl

NAME

oft-countpix.pl - counts number of pixel with, below or above a specific value.

OFGT VERSION

1.25.4

SYNOPSIS *oft-countpix.pl*

oft-countpix.pl <input><value>[-b/-v/-a [band]]

<input>is a raster image
<value>is an real number. If not precised, oft-countpix.pl gives the total number of pixels. If value is below the min or above the max of the image, a warning is given

OPTION

-v = count all pixels with value value (default)
-b = count all pixels below value
-a = count all pixels above value
[band] = number of the band. Default is Band 1

DESCRIPTION

oft-countpix.pl counts the number of pixels within an image with (default), below or above (options) a specific value .

EXAMPLE

For this exercise following tools are used: *oft-avg*
Open your working directory using

```
cd /home/...
```

Usage of **oft-countpix.pl** using the input image forestc.tif with pixel value of 33

```
ft-countpix.pl images/forestc.tif 33
oft-countpix.pl images/forestc.tif 33 -a
```

Usage of **oft-countpix.pl** using the input image landsat_t1.tif with value 50, counting all pixels below, in band 4

```
oft-countpix.pl images/landsat_t1.tif 50 -b 4
```

7.39 oft-crossvalidate

NAME

oft-crossvalidate - computes RMSE and bias estimates for k-nn via leave-one-out cross-validation.

OFGT VERSION

1.25.4

SYNOPSIS *oft-crossvalidate*

oft-crossvalidate <-i datafile><-k val><-v col><-bands val>
oft-crossvalidate <-i datafile><-k val><-v col><-bands val>[-dw {1/2/3}] [-x col] [-y col] [-id col] [-norm] [-mindist val] [-maxdist val] [-dem col thres] [-lu col]

DESCRIPTION

oft-crossvalidate is a Program for carrying out a leave-one-out cross-validation using nearest neighbour estimation.
- You need to give at least the datafile, number of neighbours (k), the column for your variable and nbr of bands.
- Bands must be located after all other variables.
- Program is terminated if the spatial neighbourhood restriction leaves too few (less than k) potential neighbours
- A possible order of data is: id, variable, x-coordinate, y-coordinate, feature1...featureN.
- Values must be separated with a space or tab.

- Prints the average, RMSE and bias on screen.
- Saves original value, estimate and difference in an output file. If id or x and y are given, they are printed out as well.
- If the *id* is indicated in the command line, the id's of 10 nearest neighbours are printed into the output file.

OPTION

Parameters:
- *[-dw]* - weight the nearest neighbour data with 1=equal (default), 2=inverse distance, 3=squared inv. distance weights.
- *[-x]* - column for x-coordinate
- *[-y]* - column for y-coordinate
- *[-id]* - column for id
- *[-norm]* - normalize the image features (default is no normalization
- *[-mindist]* - use a minimum spatial distance (e.g. 1000). Observations closer than that, based on the x and y-coordinates are not allowed as neighbours (default is no restriction)
- *[-maxdist]* - use a maximum spatial distance (e.g. 50000). Observations outside that radius are not allowed as neighbours (default is no restriction)
- *[-dem]* - column and threshold value (e.g. 1000) for restriction of neighbours in vertical direction (default is no restriction)
- *[-lu]* - column used for stratification of the data. If given, separate RMSEs are computed for each class indicated in the column (default is no stratification)

EXAMPLE

1. Input data: download for this exercise *sample_landuse.txt*. You might have created it already in exercise *oft-sample-within-polys.bash*.

2. Open your working directory using

```
cd /home/...
```

3. The script *oft-crossvalidate* prints the average, RMSE and bias on screen using the input data file *sample_landuse.txt*. Lets take a closer look at the input file (space or tab separate):

```
head sample_landuse.txt
```

```
10557.00 772650.00 -2404770.00 5.00 53.00 26.00 28.00 54.00
    81.00 131.00 39.00
94788.00 773490.00 -2431680.00 1.00 51.00 24.00 25.00 45.00
    65.00 127.00 33.00
201536.00 774750.00 -2439390.00 1.00 54.00 25.00 27.00 50.00
    71.00 130.00 35.00
88531.00 771450.00 -2431110.00 1.00 47.00 21.00 18.00 37.00
    48.00 126.00 21.00
123374.00 774150.00 -2433990.00 1.00 54.00 24.00 30.00 35.00
    75.00 132.00 42.00
97345.00 776220.00 -2431950.00 1.00 52.00 23.00 24.00 42.00
    60.00 131.00 30.00
199041.00 773190.00 -2439120.00 1.00 51.00 23.00 23.00 52.00
    58.00 130.00 28.00
144276.00 775860.00 -2435400.00 1.00 49.00 22.00 21.00 45.00
    59.00 125.00 30.00
180961.00 772680.00 -2437890.00 1.00 49.00 21.00 21.00 36.00
    61.00 126.00 28.00
185386.00 772410.00 -2438190.00 1.00 49.00 21.00 18.00 43.00
    51.00 126.00 22.00
```

Explanation of the columns: pixel_id x y class band1 band2 band3 band4 band5 band6 band7

4. Lets run *oft-crossvalidate* defining our inputfile with -i in front, number of neighbours -k 10, -v defines the column of the variable we want use - only to exemplify the tool we use column 1 containing the IDs as our input data has no additional column with values, -bands defines the number of bands, -x defines to look up the x coordinates in column 2 and -y defines to look up the y coordinates in column 3:

```
oft-crossvalidate -i  sample_landuse.txt -k 10 -v 1 -bands 7 -x
    2 -y 3
```

Result is printed on screen:

```
k=10
normalize=0
RMSE=   62255.181
Bias=    1367.027
Avg =  116318.433
```

Further, and output file sample_landuse.txt_out is created:

```
head sample_landuse_out
```

772650.000	−2404770.000	10557.00	103566.30	−93009.30
773490.000	−2431680.000	94788.00	128938.00	−34150.00
774750.000	−2439390.000	201536.00	110055.80	91480.20
771450.000	−2431110.000	88531.00	127395.30	−38864.30
774150.000	−2433990.000	123374.00	102471.90	20902.10
776220.000	−2431950.000	97345.00	123907.80	−26562.80
773190.000	−2439120.000	199041.00	105271.30	93769.70
775860.000	−2435400.000	144276.00	130783.50	13492.50
772680.000	−2437890.000	180961.00	127426.40	53534.60
772410.000	−2438190.000	185386.00	126411.20	58974.80

Explanation of the columns: x, y, pixel_id, estimate, difference (col3 - col4).

7.40 oft-extr

NAME
oft-extr - extracts pixel values from an image into a text file.

OFGT VERSION
1.25.4

SYNOPSIS *oft-extr*
oft-extr [-nomd] [-mm] [-avg] [-var] [-ws n] [-o outfile] <pointfile><img-file>-um <maskfile>

DESCRIPTION
- oft-extr computes zone/segment averages and standard deviations.
- It produces two output files: an output image and a text file.
- You need to give at least the input image file *(-i option)*, the output image *(-o)* and the maskfile *(-um)*.
- In the output image, each pixel gets assigned the average/standard deviation for the zone/segment it belonged to.
- The output format in the text file is: ID number_pixels avgband1 ...avgbandN.

OPTION
-nomd = do not print metadata
-mm = extract min and max values
-avg = extract average values
-var = extract variances
-ws n = size (n) of extraction window (odd)
-o outfile = output file name
Please note that the default behaviour is to extract window's center pixel values.

EXAMPLE

For this exercise following tools are used: *oft-extr*

1. Open your working directory using

```
cd /home/...
```

1. Let's run oft-extr using the input image landsat_t1.tif with the point text file training.txt. Output: extr.txt with no extra option:

```
oft-extr -o extr.txt txt/training.txt images/landsat_t1.tif
```

You will be asked

```
X-coord. column in input file?: 2
Y-coord. column in input file?: 3
```

Now we take a closer look at our result:

```
head extr.txt
```

```
1.00  730785.00 -2456134.00      50.00    3441.00      52.00
        24.00      24.00      51.00      65.00     128.00
   29.00
      2.00  730785.00 -2455134.00      50.00    3408.00
         59.00      27.00      34.00      47.00      82.00
         132.00      46.00
      3.00  730785.00 -2454134.00      50.00    3374.00
         57.00      28.00      33.00      50.00      82.00
         131.00      44.00
      4.00  730785.00 -2453134.00      50.00    3341.00
         55.00      26.00      29.00      52.00      72.00
         129.00      34.00
      5.00  730785.00 -2452134.00      50.00    3308.00
         60.00      28.00      35.00      54.00      87.00
         129.00      45.00
      6.00  730785.00 -2451134.00      50.00    3274.00
         47.00      19.00      18.00      37.00      47.00
         124.00      20.00
      7.00  730785.00 -2450134.00      50.00    3241.00
         46.00      19.00      17.00      38.00      44.00
         123.00      18.00
      8.00  730785.00 -2449134.00      50.00    3208.00
         59.00      28.00      33.00      60.00      84.00
         129.00      43.00
```

```
      9.00   730785.00  -2448134.00       50.00     3174.00
         66.00       34.00       42.00       57.00       98.00
         130.00       56.00
     10.00   730785.00  -2447134.00       50.00     3141.00
        52.00       23.00       21.00       53.00       61.00
        127.00       27.00
```

Explanation of values for each column:
- Col1: pixel ID
- Col2: x-coordinates
- Col3: y-coordinates
- Col4: pixel col coordinate
- Col5: pixel row coordinate
- Col6 - Col7: center pixel value for bands 1-7

2. Exercise using option -mm and -ws:

```
oft-extr -ws 3 -mm -o extr_mm.txt training.txt landsat_t1.tif
```

```
head extr_mm.txt
```

```
1.00  730785.00  -2456134.00       50.00     3441.00       52.00
         24.00       24.00       51.00       65.00      128.00
    29.00       50.00       23.00       24.00       46.00       64.00
        128.00       28.00       52.00       24.00       25.00
    53.00       70.00      129.00       32.00
2.00  730785.00  -2455134.00       50.00     3408.00       59.00
         27.00       34.00       47.00       82.00      132.00
    46.00       56.00       27.00       33.00       46.00       80.00
        131.00       44.00       59.00       31.00       39.00
    49.00       90.00      132.00       53.00
3.00  730785.00  -2454134.00       50.00     3374.00       57.00
         28.00       33.00       50.00       82.00      131.00
    44.00       54.00       27.00       29.00       48.00       77.00
        130.00       41.00       58.00       29.00       36.00
    52.00       82.00      131.00       44.00
4.00  730785.00  -2453134.00       50.00     3341.00       55.00
         26.00       29.00       52.00       72.00      129.00
    34.00       52.00       24.00       27.00       48.00       68.00
        128.00       31.00       58.00       27.00       32.00
    54.00       80.00      129.00       41.00
5.00  730785.00  -2452134.00       50.00     3308.00       60.00
         28.00       35.00       54.00       87.00      129.00
```

```
   45.00       56.00       27.00       31.00       51.00       76.00
       129.00       36.00       60.00       30.00       37.00
   60.00       90.00      129.00       48.00
6.00   730785.00  -2451134.00       50.00     3274.00       47.00
        19.00       18.00       37.00       47.00      124.00
   20.00       45.00       19.00       17.00       37.00       45.00
       124.00       18.00       49.00       20.00       19.00
   38.00       48.00      125.00       21.00
7.00   730785.00  -2450134.00       50.00     3241.00       46.00
        19.00       17.00       38.00       44.00      123.00
   18.00       46.00       19.00       17.00       37.00       40.00
       123.00       17.00       49.00       20.00       18.00
   39.00       46.00      124.00       21.00
```

Explanation of values for each column:
- Col1: pixel ID
- Col2: x-coordinates
- Col3: y-coordinates
- Col4: pixel x coordinated
- Col5: pixel y coordinates
- Col6 - Col12: min values for bands 1-7
- Col13 - Col19: max values for bands 1-7
- Col20 - Col26: center pixel values for bands 1-7

3. Exercise using option -csv and -ws:

```
oft-extr -ws 3 -csv -o extr_3.txt training.txt landsat_t1.tif
head extr_3.txt
```

```
1.000000,730785.000000,-2456134.000000,50.000000,3441.000000,...
2.000000,730785.000000,-2455134.000000,50.000000,3408.000000,...
3.000000,730785.000000,-2454134.000000,50.000000,3374.000000,...
4.000000,730785.000000,-2453134.000000,50.000000,3341.000000,...
5.000000,730785.000000,-2452134.000000,50.000000,3308.000000,...
6.000000,730785.000000,-2451134.000000,50.000000,3274.000000,.
```

7.41 oft-his

NAME

oft-his - computes image histogram by segments.

OFGT VERSION

1.25.4

SYNOPSIS *oft-his*

oft-his -i <infile>-o <outfile>
oft-his -i <infile>-o <outfile>[-um maskfile] [-hr/-compact][-maxval val]

OPTIONS

```
-i = specify input image file
-o = specify output text file
-um = specify mask file
-hr = use human readable output format
-compact = use compact output format
-maxval = give maximum input value
-h = print out more help
```

DESCRIPTION

- *oft-his* extracts histograms for the different bands of an input image to an output text file.
- You need to give at least the input image file *-i option* and the output file *-o*
- Typically, you also give a mask file *-um*. Each mask value gets own histogram, except 0 which is treated as *nodat*a
- If no mask file is given, a common histogram is computed for whole image
- Maximum input value needs to be given to allocate enough memory for the histogram table. If the *maxval* parameter is not given in the command line, it will be asked. For example, for a 8 Bit Landsat image, the maximum value parameter would be 255. - The output format is: mask value, frequency of mask value and number of band.

The rest of the columns values are frequencies for each image pixel value.

NOTES

For the benefit of users running scripts using the older version based on order of datafiles instead of options *-i, -o and -um*, the program can still be used that way.

Example with typical parameter setting:

```
oft-his -i input.img -o histogram.txt -um mask.img -hr -maxval
   255
```

The output file will contain nbr_bands lines for every input mask value. The output format is: mask value, frequency of mask value and number of band; the rest of the columns values are frequencies for each image pixel values. For example, in the following output:

```
1 657846 1 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
    0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 5 205 2166 10162
   29145 70813 136848 145398 117541 82955 40937 14060 4255 1618
   707 345 208 140 103 83 48 42 15 17 13 6 3 2 0 3 1 0 0 0 0 0 0
    0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
   0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
    0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
   0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
    0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
   0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

1. 1 = Mask value
2. 657846 = Frequency of mask value 1
3. 1 = Number of band
4. 0 = frequency of value 0 in input image
5. 0 = frequency of value 1 in input image
6. 0 = frequency of value 2 in input image

7. 0 = frequency of value 3 in input image
8. .
9. .
10. .

- An alternative output format is provided by the *-compact* option
1 657846 1 12 1 46 1 47 5 48 205 49 2166 50 10162 51 29145 52 70813 53 136848 54 145398 55 117541 56 82955 57 40937 58 14060 59 4255 60 1618 61 707 62 345 63 208 64 140 65 103 66 83 67 48 68 42 69 15 70 17 71 13 72 6 73 3 74 2 76 3 77 1
- where first three values are

1. 1 = Mask value
2. 657846 = Frequency of mask value 1
3. 1 = Number of band

- After that, the output consists of value-frequency pairs. That is, entry
12 1 means that 1 pixel of value 12 was found within the region determined by mask value 1. Accordingly, we can see that also single pixels with values 46 was found and that the number of pixels with value 47 was five.
- In practical applications, the output needs to be converted into more readable format and usable information. For example, one could be interested in the median Landsat DN value within the mask. When using -hr option to produce the output the median could be computed using awk and the following equation:

```
awk '{obs_point = ($2 - $4)/2} { if (NR == 1) { for(i=5; i<NF;
    i++) {sum=sum+$i; if(sum >= obs_point) { print i-4; exit }}}}
    ' his1.txt
```

Note: that here we exclude background value (0) from the computation.

EXERCISE

- For this exercise following tools are used: *oft-his*
- Open your working directory using

```
cd /home/...
```

1. oft-his

Lets run a oft-his with Input: *landsat_t1.tif*, Ouptut: *histogram.txt*, when asked set the maximum input value to 255:

```
oft-his -i landsat_t1.tif -o histogram.txt
```

```
head histogram.txt
```

Extraction of histogram.txt - output is all in one line:

```
1 10500000 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0
    1 1 2 1 1 4 2 3 5 2 5 8 7 5 176 1576 12371 114959 758774
   1773981 2035039 1918290 1222961 558651 332962 287434 320286
   311067 217529 180595 138396 93221 57114 38722 32169 25924
   18311 12510 9783 7020 5022 3874 3116 2294 1647 1193 848 632
   408 284 185 163 134 72 73 41 16 11 8 10 4 5 7 10 4 6 2 2 0 2
   1 2 3 0 1 2 2 2 1 0 1 0 1 1 1 1 0 1 1 3 1 1 0 1 2 1 0 0 0 2 0
    1 2 1 0 1 0
```

2. oft-his with option -hr for readability (one line per band

2.1 Lets run a oft-his with Input: *landsat_t1.tif*, Ouptut: *histogram_hr.txt*, again, the maximum input value to 255

```
oft-his -i landsat_t1.tif -o histogram-hr.txt -hr
```

```
head histogram-hr.txt
```

Extraction of histogram_hr.txt- output is 7 lines (for each band one), which makes it more readable

```
1 10500000 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0
    0 1 1 2 1 1 4 2 3 5 2 5 8 7 5 176 1576 12371 114959 758774
   1773981 2035039 1918290 1222961 558651 332962 287434 320286
   311067 217529 180595 138396 93221 57114 38722 32169 25924
   18311 12510 9783 7020 5022 3874 3116 2294 1647 1193 848 632
   408 284 185 163 134 72 73 41 16 11 8 10 4 5 7 10 4 6 2 2 0 2
```

```
    1 2 3 0 1 2 2 2 1 0 1 0 1 1 1 1 0 1 1 3 1 1 0 1 2 1 0 0 0 2 0
     1 2 1 0 1 0 0 0 0 0 1 1 0 0 0 0 1 0 0 1 0 0 0 0 1 0 0 0 1 0
    0 0 0 0 0 0 0 2 0 0 1 1 0 0 0 0 1 0 1 0 0 0 1 0 0 0 0 0 0 1 0
     0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0
    0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0
     0 0 0 0 0 2

1 10500000 2 0 1 1 0 3 2 0 2 3 2 3 0 3 3 2 26 646 8742 191086
    2508329 4562947 718031 338584 429870 487321 333295 255746
    231077 161926 99078 52656 37538 26630 15925 11265 8864 6682
    4744 3055 2146 1396 847 494 320 232 190 105 60 29 16 12 6 6 2
     3 3 0 5 3 1 3 0 2 0 1 0 1 0 0 1 2 1 0 0 0 0 0 0 0 1 1 0 1 0
    0 0 0 0 1 0 0 0 0
```

Explanation:
- 1 = Image value - 10500000 = Frequency of image value 1 - 0 = Number of band - 0 = frequency of value 1 in input image - 0 = frequency of value 2 in input image - 0 = frequency of value 3 in input image - ... - 1 = frequency of value 20 in input image //1 pixel with value 20 - ... - 4 = frequency of value 32 in input image //4 pixels with value 32

2.2 Calculation of median Landsat DN value using AWK

For this we are using the output *histogramm_hr.txt* from 2.1 as the input:

```
awk '{obs_point = ($2 - $4)/2} {if (NR == 1) {for(i=5; i<NF; i++) {sum=sum+$i; if (sum >= obs_point) {print i-4; exit}}}}' histogram_hr.txt
```

The output is printed in the terminal: in our case the median DN values is 48.

3. oft-his with option -compact

Lets run a oft-his with Input: *landsat_t1.tif*, Ouptut: *histogram_compact.txt*, again, the maximum input value to 255

```
oft-his -i landsat_t1.tif -o histogram_compact.txt -compact
```

```
head histogram_compact.txt
```

Extraction of *histogram_compact.txt* - output is 7 lines (for each band one), which makes it more readable

```
1 10500000 1 20 1 27 1 28 1 29 2 30 1 31 1 32 4 33 2 34 3 35 5
   36 2 37 5 38 8 39 7 40 5 41 176 42 1576 43 12371 44 114959 45
    758774 46 1773981 47 2035039 48 1918290 49 1222961 50 558651
    51 332962 52 287434 53 320286 54 311067 55 217529 56 180595
   57 138396 58 93221 59 57114 60 38722 61 32169 62 25924 63
   18311 64 12510 65 9783 66 7020 67 5022 68 3874 69 3116 70
   2294 71 1647 72 1193 73 848 74 632 75 408 76 284 77 185 78
   163 79 134 80 72 81 73 82 41 83 16 84 11 85 8 86 10 87 4 88 5
    89 7 90 10 91 4 92 6 93 2 94 2 96 2 97 1 98 2 99 3 101 1 102
    2 103 2 104 2 105 1 107 1 109 1 110 1 111 1 112 1 114 1 115
   1 116 3 117 1 118 1 120 1 121 2 122 1 126 2 128 1 129 2 130 1
    132 1 138 1 139 1 144 1 147 1 152 1 156 1 165 2 168 1 169 1
   174 1 176 1 180 1 187 1 196 1 206 1 208 1 220 1 246 1 255 2

1 10500000 2 1 1 2 1 4 3 5 2 7 2 8 3 9 2 10 3 12 3 13 3 14 2 15
   26 16 646 17 8742 18 191086 19 2508329 20 4562947 21 718031
   22 338584 23 429870 24 487321 25 333295 26 255746 27 231077
   28 161926 29 99078 30 52656 31
```

Explanation:

1. 1 = image value
2. 10500000 = Frequency of image value 1
3. 1 = Number of band

After that, the output consists of value-frequency pairs. More detailed: the pair *20 1* means that 1 pixel of value 20 was found within the region determined by image value 1. Also a single pixel with value 27 was found and the number of pixels with value 28 was again 1.

7.42 oft-mm

NAME
oft-mm - computes minimum and maximum values for each band of the input file .

OFGT VERSION
1.25.4

SYNOPSIS *oft-mm*
oft-mm [-um maskfile] <input>

DESCRIPTION
For the input image, the command provides inline minimum and maximum values per band.

OPTION
[um maskfile] - zero values in the maskfile will be excluded in the calculation (maskfile extent must match inputfile extent)

EXAMPLE
```
oft-mm input.tif
```

EXERCISE
For this exercise following tools are used: *oft-mm*, *grep*
1. Open your working directory using

```
cd /home/...
```

2. Now we run *oft-mm* with input: *images/landsat_t1.tif*

```
oft-mm images/landsat-t1.tif
```

3. The output will be printed in the terminal:

```
argc 2
Driver: GTiff/GeoTIFF
Size is 3000, 3500
Corner Coordinates:
```

```
Upper Left (729285.000,-2352885.000)
Lower Left (729285.000,-2457885.000)
Upper Right (819285.000,-2352885.000)
Lower Right (819285.000,-2457885.000)
Center (774285.000,-2405385.000)
Done
Band 1 min = 20.000000
Band 1 max = 255.000000
Band 2 min = 1.000000
Band 2 max = 255.000000
Band 3 min = 1.000000
Band 3 max = 208.000000
Band 4 min = 8.000000
Band 4 max = 255.000000
Band 5 min = 5.000000
Band 5 max = 255.000000
Band 6 min = 112.000000
Band 6 max = 195.000000
Band 7 min = 1.000000
Band 7 max = 255.000000
DoneClose
```

4. If you are only interested in the min and max values for a certain band, you can use the grep command. Example for band 1:

```
oft-mm images/landsat_t1.tif |grep "Band 1"
```

```
Band 1 min = 20.000000
Band 1 max = 255.000000
```

7.43 oft-segstat

NAME

oft-segstat - output segments shape and spectral statistics in a text file.

OFGT VERSION

1.25.4

SYNOPSIS

oft-segstat
oft-segstat <maskfile><input><output>
oft-segstat [-std] [-shape] <maskfile><input><output>

DESCRIPTION

oft-segstat Extracts segment level shape (size, bounding box, # edge pixels) and spectral (averages and standard deviations) to a text file.
- Mask file is an image consisting of pixels with integer values. Pixels having value 0 are not processed. For all other mask values the statistics are reported separately.
The output: The basic usage outputs the following space separated columns:

```
1 Segment ID
2 Size
3 - (3+n) Segment averages pixel values for all n input image
    bands
```

OPTIONS

-std = adds standard deviations for all input bands in the end of each record. -shape = changes the output format to follwoing:

```
1 Segment ID
2 Size
3 # of neighbours
4 xmin
```

```
5 xmax
6 ymin
7 ymax
8 # edge pixels
9 - (9 + n) Segment averages pixel values for all n input image
    bands
```

OTHERS

This script can also be used after oft-seg.

EXERCISE

For this exercise following tools are used: **oft-segstat** For this exercise we use the Landsat imagery *landsat_t1.tif*, *landuse.shp*. Further you need to run oft-seg in a first step to calculated the segmentation file *landsat_t1.tif*.

2. Open your working directory using

```
cd /home/...
```

1. oft-segstat

- Now we run oft-segstat with Input: *landsat_t1.tif*, *landsat_t1_min50.tif* ; Output: *segstats.txt*:

```
oft-segstat landsat_t1_min50.tif landsat_t1.tif segstats.txt
```

The tool will ask you now to define the NoData value which we will set to 0:

```
Please give NODATA value: 0    //in this step you only need to
    type the number 0
```

- Lets take a look at the first 10 lines of our result segstats.txt:

```
head segstats.txt
```

```
49 60  49.183333 20.366667 18.883333 36.800000 47.866667
    126.500000 20.700000
89 56  47.714286 20.053571 18.428571 37.125000 49.035714
    125.571429 20.660714
26 132  49.310606 20.295455 18.651515 35.840909 46.863636
    126.833333 20.257576
```

```
220 54  51.203704 22.629630 23.666667 38.592593 58.777778
    131.370370 28.685185
231 132  56.416667 27.325758 34.606061 43.409091 82.636364
    134.871212 45.454545
236 55  46.200000 19.272727 16.290909 41.963636 39.927273
    124.654545 15.000000
7 53  48.886792 20.056604 18.339623 37.207547 45.698113
    125.698113 19.396226
52 105  49.580952 20.866667 19.666667 38.161905 53.990476
    126.361905 22.847619
114 51  46.960784 19.470588 16.235294 41.294118 37.725490
    124.764706 15.039216
138 55  45.690909 19.272727 16.054545 40.672727 40.036364
    123.563636 14.909091
```

Explanation of the values of each column:
- Col1: Segment ID
- Col2: Size
- Col3 - Coln: Segment average pixel values of band3 - bandn

2. oft-segstat including -std

- Lets run **oft-segstat** including the option of adding the standard deviation: Input: *landsat_t1.tif*, *landsat_t1_min50.tif* ; Output: *segstats_std.txt*:

```
oft-segstat -std landsat_t1_min50.tif  landsat_t1.tif
    segstats_std.txt
```

- Again, lets take a look at the first 10 lines of our result *segstats_std.txt*:

```
head segstats_std.txt
```

```
49 60  49.183333 20.366667 18.883333 36.800000 47.866667
    126.500000 20.700000 0.000000 0.000000 0.000000 0.000000
    0.000000 0.000000 0.000000
89 56  47.714286 20.053571 18.428571 37.125000 49.035714
    125.571429 20.660714 0.000000 0.000000 0.000000 0.000000
    0.000000 0.000000 0.000000
26 132  49.310606 20.295455 18.651515 35.840909 46.863636
    126.833333 20.257576 0.000000 0.000000 0.000000 0.000000
    0.000000 0.000000 0.000000
220 54  51.203704 22.629630 23.666667 38.592593 58.777778
    131.370370 28.685185 0.000000 0.000000 0.000000 0.000000
    0.000000 0.000000 0.000000
```

```
231 132  56.416667 27.325758 34.606061 43.409091 82.636364
    134.871212 45.454545 0.000000 0.000000 0.000000 0.000000
    0.000000 0.000000 0.000000
236 55  46.200000 19.272727 16.290909 41.963636 39.927273
    124.654545 15.000000 0.000000 0.000000 0.000000 0.000000
    0.000000 0.000000 0.000000
7 53  48.886792 20.056604 18.339623 37.207547 45.698113
    125.698113 19.396226 0.000000 0.000000 0.000000 0.000000
    0.000000 0.000000 0.000000
52 105  49.580952 20.866667 19.666667 38.161905 53.990476
    126.361905 22.847619 0.000000 0.000000 0.000000 0.000000
    0.000000 0.000000 0.000000
114 51  46.960784 19.470588 16.235294 41.294118 37.725490
    124.764706 15.039216 0.000000 0.000000 0.000000 0.000000
    0.000000 0.000000 0.000000
138 55  45.690909 19.272727 16.054545 40.672727 40.036364
    123.563636 14.909091 0.000000 0.000000 0.000000 0.000000
    0.000000 0.000000 0.000000
```

Explanation of the values of each column:
- Col1: Segment ID
- Col2: Size
- Col3 - Col9: Segment average pixel values of band3 - band9
- Col10 - Col16: standard deviation value for each band

3. oft-segstat including option -shape

- For this exercise we want to create in a first step a mask file that is needed to define which pixels of the satellite image will be included in the calculation. In this case we exclude all pixels that were 0. Input: *landsat_t1.tif*, Output: *landsat_t1_mask.tif* :

```
oft-calc  landsat_t1.tif LT52_CUB00_mask.tif //create mask same
    dimension same location
1
#1 0 = 1 0 ?
```

- Now we run the segmentation statistic not with the segmentation file we created before using **oft-seg**, but using a shapefile instead: Input: *landuse.shp*, *landsat_t1_mask.tif*, *landsat_t1.tif* Output: *segstats_shp.txt*

```
oft-segstat -shape landuse  landsat_t1_mask.tif landsat_t1.tif
    segstats_shp.txt
```

- Again, lets take a look at our result *segstats_shp.txt*:

```
head segstats_shp.txt
```

```
1 10500000 0  0 2999 0 3499 6000 48.742120 21.032891 19.848100
   41.126436 50.192329 126.019212 21.810292
```

Explanation of the values of each column:

```
Col1: Segment ID
Col2: Size
Col3: # of neighbours
Col4: xmin
Col5: xmax
Col6: ymin
Col7: ymax
Col8: # edge pixels
Col9: Segment average pixel values of band1
Col10: Segment average pixel value of band2
Coln: Segment average pixels valued of bandn
```

7.44 oft-stat

NAME

oft-stat - computes segment statistics in a text file.

OFGT VERSION

1.25.4

SYNOPSIS

oft-stat
oft-stat -i <infile>-o <outfile>
oft-stat -i <infile>-o <outfile>[-um maskfile] [-mm] [-noavg] [-nostd] [-h help]

DESCRIPTION

oft-stat extracts segment level image statistics into a text file.
- Computes image statistics at segment level and outputs a text file.
- The output format in the text file is: ID #pixels avgband1 ...avgbandN stdband1 ...stdbandN
- You need to give at least the input image file (-i option) and the output file (-o)
- Normally, you give also a maskfile (-um ¡maskfile¿) which is an image consisting of pixels with integer values:
  - Pixels having value 0 are not processed.
  - For all other mask values the statistics are reported separately.
  - When the -um option is not used, statistics are a summary of all pixels in the image

OPTIONS

-noavg = program does not compute the averages
-nostd = program does not compute the std's
-mm = program computes and prints out also minimum and maximum

-h = prints out help

NOTE

For benefit of users running scripts using the older version based on order of datafiles instead of options -i, -o and -um, the program can still be used that way.

EXAMPLE

```
oft-stat -i images/input.tif -o results/stats.txt -um images/
    segments.tif
```

EXERCISE

- For this exercise following tools are used: **oft-stat**
- Open your working directory using

```
cd /home/...
```

1. Now we run *oft-stat* with input: images/*landsat-t1.tif*, output: results/*stats.txt*:

```
oft-stat -i images/landsat_t1.tif -o results/stats.txt
```

2. Print the output in terminal:

```
less results/stats.txt
```

```
1 10500000 48.742120 21.032891 19.848100 41.126436 50.192329
    126.019212 21.810292 3.532883 2.776924 5.170575 6.554972
    13.140675 2.275625 8.220984
```

Explanation of values for each column:
- Col1: ID
- Col2: Number of pixels
- Col3: Average value of band1
- Col4 - col9: Average value of band2 - band7
- Col10 - col16: Standard deviation of band1 - band7

3. Now we run oft-stat with input: images/*landsat-_1.tif*, output: results/*stats_mm.txt*, and the option *-mm* to produce also minimum and maximum values:

```
oft-stat -i images/landsat_t1.tif -o results/stats_mm.txt -mm
```

4. Print the output in terminal:

```
less results/stats.txt
```

```
1 10500000 20.000000 1.000000 1.000000 8.000000 5.000000
   112.000000 1.000000 255.000000 255.000000 208.000000
   255.000000 255.000000 195.000000 255.000000 48.742120
   21.032891 19.848100 41.126436 50.192329 126.019212 21.810292
   3.532883 2.776924 5.170575 6.554972 13.140675 2.275625
   8.220984
```

Explanation of values for each column:
- Col1: ID (in this case one as no mask file has been given)
- Col2: Number of pixels
- Col3: Minimum value of band1
- Col4 - col9: Minimum value of band2 - band7
- Col10 - col16: Maximum value of band1 - band7
- Col17 - col23: Average value of band1 - band7
- Col24 - col30: Standard deviation of band1 - band7

5. Now we run *oft-stat* with input: images/*landsat_t1.tif*, output: results/*stats_mask.txt*; optional mask: images/*segments.tif*:

```
oft-stat -i images/landsat-t1.tif -o results/stats_mask.txt -um
   images/segments.tif
```

6. Print the first 10 lines of the output in terminal:

```
head results/stats_mask.txt
```

```
49 60 49.183333 20.366667 18.883333 36.800000 47.866667
   126.500000 20.700000 0.929583 0.551321 0.640224 1.054450
   1.890804 0.504219 1.046382
 89 56 47.714286 20.053571 18.428571 37.125000 49.035714
    125.571429 20.660714 1.073893 0.553325 0.598700 1.280092
    1.747354 0.499350 0.977507
 26 132 49.310606 20.295455 18.651515 35.840909 46.863636
    126.833333 20.257576 0.989507 0.490188 0.552370 0.799136
    1.763812 0.481199 1.088603
 220 54 51.203704 22.629630 23.666667 38.592593 58.777778
    131.370370 28.685185 2.870669 2.139444 4.374023 2.375333
    9.681078 0.957518 6.804061
```

```
231 132 56.416667 27.325758 34.606061 43.409091 82.636364
    134.871212 45.454545 1.644058 1.207459 2.153490 1.689458
    4.386434 2.786021 3.416090
236 55 46.200000 19.272727 16.290909 41.963636 39.927273
    124.654545 15.000000 1.145038 0.449467 0.533081 0.961550
    0.939948 0.479899 0.769800
7 53 48.886792 20.056604 18.339623 37.207547 45.698113
    125.698113 19.396226 1.049915 0.534037 0.586495 0.947841
    1.169893 0.463470 0.967543
52 105 49.580952 20.866667 19.666667 38.161905 53.990476
    126.361905 22.847619 0.988209 0.555855 0.780368 0.951960
    2.100802 0.482856 1.089998
114 51 46.960784 19.470588 16.235294 41.294118 37.725490
    124.764706 15.039216 0.937247 0.542326 0.789639 0.807319
    1.201306 0.428403 0.847603
138 55 45.690909 19.272727 16.054545 40.672727 40.036364
    123.563636 14.909091 1.051854 0.449467 0.890655 1.155575
    1.439697 0.739460 0.866511
```

The output is basically the same as in step 4. However, now average and standard deviation are not given for the whole image, but for each zone/segment value of the mask file (exception: value 0 that is not processed).
Explanation of values for each column:

- Col1: ID (in this case one as no mask file has been given)
- Col2: Number of pixels
- Col3: Average value of band1
- Col4 - col9: Average value of band2 - band7
- Col10 - col16: Standard deviation of band1 - band7

7. Depending on the purpose, you can now try the different options:

-mm if you want to compute minimum and maximum values as well

-noavg if you do not want to output the average

-nostd if you do not want to compute the standard deviation.

The output will always be in the following order:
ID, number of pixels, [minimum if -mm is chosen], [maximum if -mm is chosen], average, standard deviation.
If the input image has several bands, the parameters are given for all bands.

CLASSIFICATION

7.45 oft-cluster.bash

NAME
oft-cluster.bash - clusters raster images.

OFGT VERSION
1.25.4

SYNOPSIS *oft-cluster.bash*
oft-cluster.bash <input.img><output.img><nbr_clusters><sampling_density%>
oft-cluster.bash <input.img><output.img><nbr_clusters>...
...<sampling_density%>[mask]

DESCRIPTION
oft-cluster.bash clusters input image into a given number of clusters. The clustering process is as follows:
1) generate a systematic sample using the given sample density and covering the area of input.img. For more details, please have a look at oft-gengrid.bash
2) extract spectral (or other) information for every point of the grid using oft-extr
3) cluster the grid points into given number of clusters using k-means algorithm oft-kmeans
4) classify each image pixel in one of the generated clusters using NN classification with Euclidean distance in the feature space

The mask values are:
0 = do not classify

1 = classify

OPTION

Parameters:
[mask] - use maskfile and process only areas having mask value >0

NOTES

If you're using LEDAPS input, you can generate the mask using *trim_ledaps.bash*

EXAMPLE

```
cluster.bash LT51650672009351JSA00_stack.img 50classes10percent.
   img 50 10 mask_LT51650672009351JSA00.img
```

This example will create an output image (50classes10percent.img) were every pixel has been assigned a class from 0 to 50 except the pixels of value 0 in the mask image.

EXERCISE

- For this exercise following tools are used: *oft-cluster.bash*, *oft-clump*, *gdal_polygonize* to compute clusters and convert them into polygons.
- Open your working directory using

```
cd /home/...
```

1. oft-cluster.bash

Let's run oft-cluster with Input: *landsat_t1.tif* ; Output: *cluster50.tif* for 50 classes and 10 percent
Note: it takes some time computing, so be patient.

```
oft-cluster.bash andsat_t1.tif cluster50.tif 50 10
```

Load the result in QGIS and see that all the pixel values are between 1 and 50 corresponding to the 50 classes we defined in the command line.

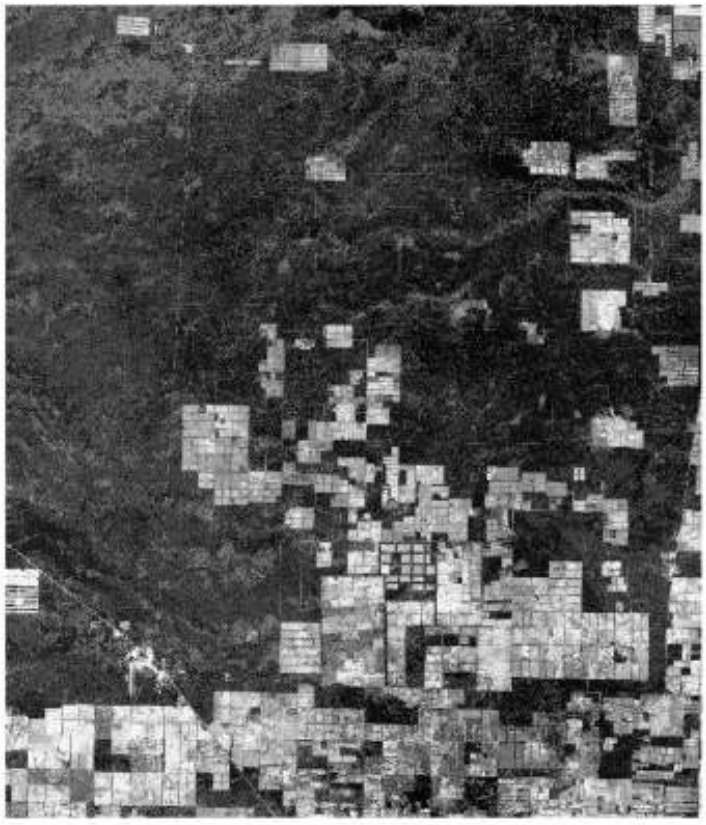


Figure 23: Cluster50.tif

2. oft-clump.bash

Now we will run **oft-clump**. This tool is meant for separating uniform regions in a class image. Get detailed information under oft-clump:
Input: *cluster50.tif*
Output: *clump_clus50.tif*

```
oft-clump cluster50.tif clump_clus50.tif
```

3. oft-cluster.bash

In the last step we want to create polygons using the Input: *clump_clus50.tif*
Output: *clump_clus50.shp*

```
gdal_polygonize.py clump_clus50.tif -f "ESRI Shapefile"
    clump_clus50.shp
```

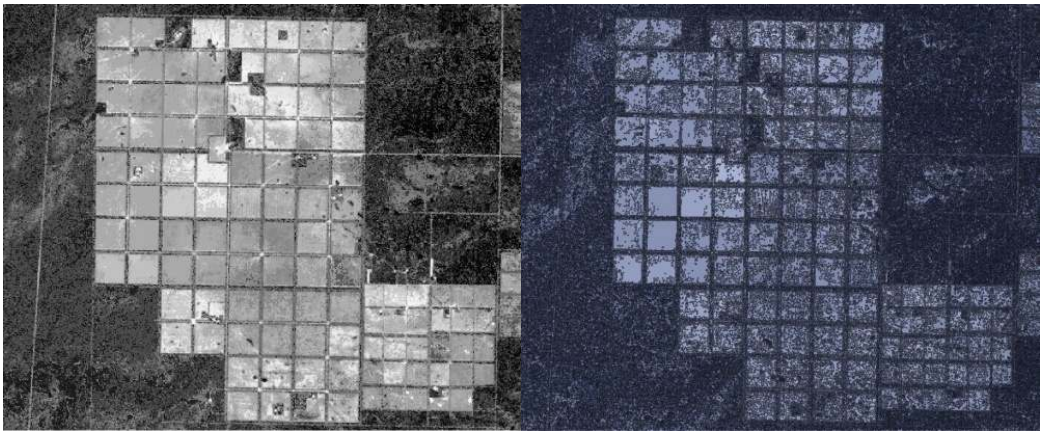


Figure 24: Left: Zoom into the cluster image Cluster50.tif. Right: Corresponding zoom into the shapefile clump_clus50.shp.

7.46 oft-kmeans

NAME

oft-kmeans - for kmeans clustering

OFGT VERSION

1.25.4

SYNOPSIS *oft-kmeans*

oft-kmeans -i <infile>-o <outfile>
oft-kmeans -i <infile>-o <outfile>[OPTIONS]

DESCRIPTION

oft-kmeans carries out unsupervised classification with k-means algorithm.

- By default, the program asks user to input two parameters:
  1. input text file
  2. number of classes

The input text file is a collection of signatures from the input file.

- It contains at minimum the greyvalues of each band
- It can be done with *oft-gengrid.bash* and *oft-extr*
- The program uses it to establish the cluster centres and proceeds by assigning each pixel the Class ID of the closest cluster centre. **The proximity of the cluster centres is computed using Euclidean distance in the spectral feature space.

- If the -auto option is used, the program divides the data automatically and the number of clusters is not requested.
- If the -aw option is used, the programs asks user to provide weight for each of the input bands.

OPTIONS

- [-ot] - { Byte/Int16/UInt16/UInt32/Int32/Float32/Float64}
- [-um] - specify mask band

- [-auto] - automated division of data
- [-aw] - ask weights for input bands
- [-h] - print out more help

NOTES

For the benefit of users running scripts using the older version based on order of files instead of option *-i*, the program can still be used that way.

EXAMPLE

- For this exercise following tools are used: *oft-kmeans*, *oft-gengrid.bash*, *oft-extr*
- Open your working directory using

```
cd /home/...
```

- The exercise is divided into two step: first we prepare the input signature text file which is need for textitoft-kmeans, then we will run the classification tool itself:

1. Creation of input signature text file

- We want to generate a grid of points over our image *landsat_t1.tif* using *oft-gengrid.bash* with user-defined spacing in x and y directions, in this case 5000 x 5000 m distance between the points in X and Y directions. The output file *gengrid.txt* contains information on the created grid: ID x y

```
oft-gengrid.bash landsat_t1.tif 5000 5000 gengrid.txt
```

```
head gengrid.txt
```

```
1 730785 -2456134
2 730785 -2451134
3 730785 -2446134
4 730785 -2441134
5 730785 -2436134
6 730785 -2431134
7 730785 -2426134
8 730785 -2421134
```

```
9 730785 -2416134
10 730785 -2411134
```

- To extract the values from our input image *landsat_t1.tif* f for those pixels that lay on our grid we created in the previous step we run *oft-extr*. Output: *my_extr.txt*

```
oft-extr -o my_extr.txt gengrid.txt  landsat_t1.tif
```

```
head my_extr.txt
```

```
1.00 730785.00 -2456134.00  50.00 3441.00 52.00 24.00 24.00
   51.00 65.00 128.00 29.00
2.00 730785.00 -2451134.00  50.00 3274.00 47.00 19.00 18.00
   37.00 47.00 124.00 20.00
3.00 730785.00 -2446134.00  50.00 3108.00 52.00 23.00 22.00
   53.00 57.00 127.00 26.00
4.00 730785.00 -2441134.00  50.00 2941.00 49.00 20.00 17.00
   34.00 43.00 124.00 19.00
5.00 730785.00 -2436134.00  50.00 2774.00 47.00 20.00 18.00
   34.00 44.00 125.00 19.00
6.00 730785.00 -2431134.00  50.00 2608.00 51.00 21.00 20.00
   36.00 51.00 128.00 23.00
7.00 730785.00 -2426134.00  50.00 2441.00 62.00 29.00 38.00
   53.00 85.00 136.00 45.00
8.00 730785.00 -2421134.00  50.00 2274.00 48.00 21.00 18.00
   34.00 45.00 126.00 19.00
9.00 730785.00 -2416134.00  50.00 2108.00 49.00 20.00 19.00
   35.00 47.00 125.00 20.00
10.00 730785.00 -2411134.00 50.00 1941.00 49.00 20.00 18.00
   35.00 45.00 125.00 18.00
```

2. Unsupervised classification - oft-kmeans

- Now we run **oft-kmeans** with Input:*landsat_t1.tif* and Output: *my_kmeans.tif*

```
oft-kmeans -o my_kmeans.tif -i landsat_t1.tif
```

The program will ask you for:

```
Input signature file name?: my_extr.txt
Number of clusters?: 25                    //For this example we
   choose 25 clusters
```

- Load your result my_kmeans.tif in QGIS:

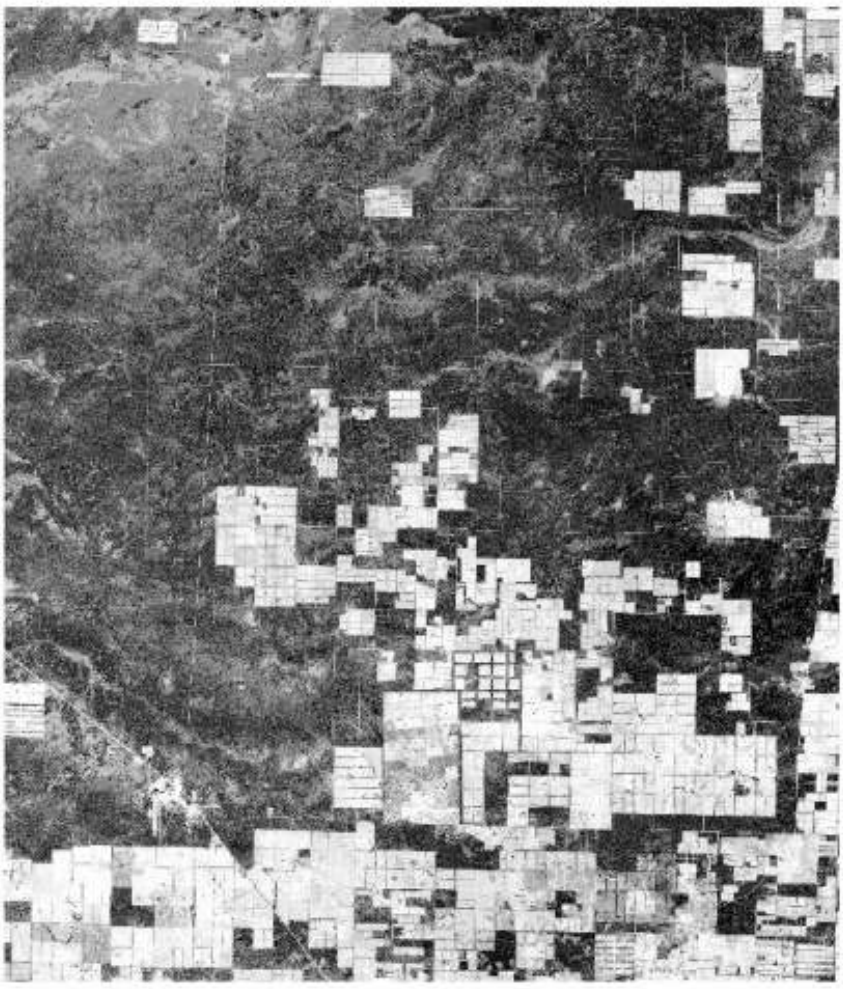


Figure 25: shows the classified image my_kmeans.tif with pixel values between 1 and 25.

7.47 oft-nn - To be tested

NAME

oft-nn - is a nearest neighbour classifier.

OFGT VERSION

1.25.4

SYNOPSIS

oft-nn

oft-nn <-i input image><-o output image/-or output text file>

oft-nn<-i input image><-o output image/-or output text file>[OPTIONS]

OPTIONS

```
-h = help
-ot {Byte/Int16/UInt16/UInt32/Int32/Float32/Float64/CInt16/
    CInt32/CFloat32/CFloat64} = define output type
-um <maskfile> = only areas having mask value larger than 0 are
    processed
-dem <demfile> = use given dem and vertical distance rules
    prompted by the program
-hrules = use horizontal distance rules (prompted by the program
    ) to restrict the search in horizontal direction
-segme = use segments in the mask file. If this option is used,
    the processing is done at the segment level.
-speed = approximate k-nn, asks for speed parameter.
    Experimental.
-or <output_txtfile> = save weights for training data records
    for later calculations of large area statistics
-aw = ask weights for the input bands
-dw {1/2/3} = weight the nearest neighbor data with 1=equal, 2=
    inverse distance, 3=inverse distance squared (default)
    weights
-norm = normalize the image features and the training data
    features to mean 0 and std 1 (default is no normalization).
-lu <image> = use given land use image for stratification of the
     reference data.
NOT IMPLEMENTED YET -adm <image> = use given administrative
    borders to collect weights for field plots by
administrative unit (e.g. county). This enables you to compute
    statistics for each adm. unit separately.
```

DESCRIPTION

oft-nn carries out nearest neighbour estimation or classification of an image.

- oft-nn classifies or estimates an output value for every image analysis unit using given training data set and *k nearest neighbour algorithm*. Nearest neighbours are determined based on Euclidean distances in the feature space.
- In a classification, the output is the class having the largest sum of weights. In estimation, the output value is computed as straight or weighted average of the k nearest neighbours.
- You need to give at least the input image file (-i option) and the output image (-o option) OR the output text file (-or option)
- **NOTE:** the program will ask for the datafile, number and location of target variables, nbr of neighbours (k) and data type (continuous or class). Other parameters are asked when needed, if you use extra options specified under **OPTIONS**.

- Last columns of the training data set are used as the feature space. In other words, if the input image has four bands, last four columns of the training data set should correspond to the values for training observations.
- In cases of *-dem* or *-lu* you need to have a corresponding column in your field data text file (prompted by the program).
- In case of *dem* is used, we use absolute difference: if you want to reject observations >500 m above or below the target pixel, give 500
- In case of *-norm*, the normalization parameters are computed from the field data.

  NOTE: you may also normalize your features (image and training data) BEFORE using *oft-nn*, Just be sure that the values come from the same distribution.
- In case of *-or* the output text file contains the target variable and collected weight for each training data observation.

- If the *-lu* option is given, only observations from the same land use category/class will be used for estimation.

EXERCISE

- For this exercise following tools are used: *oft-nn*, *oft-sigshp.bash*

1. You will need for this exercise the following data: textitlandsat_t1.tif and textitlanduse.shp which was digitized manually in QGIS
2. Create the signature file using *oft-sigshp.bash*

```
cd /home/.../OFGT-Data
oft-sigshp.bash images/landsat_t1.tif shapefiles/landuse id
    newcol txt/sig_landuse.txt
```

3. Take a look at the input signature file *sig_landuse.txt*:

```
more txt/sig_landuse.txt
```

```
14 4 54.872263 26.561314 28.113869 58.320438 75.259854
    129.021898 33.874453
15 4 58.635842 29.131097 35.067535 50.379166 86.387111
    131.054293 47.649746
16 4 58.217101 29.102204 34.695057 54.351035 82.787575
    130.169673 43.795925
17 1 54.840000 25.463590 29.768205 43.720000 80.614359
    132.413333 42.431795
18 2 54.172608 25.085366 28.419325 48.404315 74.633208
    131.336773 37.128518
19 3 55.198990 26.094949 30.674747 49.970707 76.598990
    131.734343 36.209091
20 2 57.269874 26.903766 31.171548 42.291841 78.776151
    133.120293 41.883891
21 5 55.277745 26.597769 29.771580 56.949501 76.772754
    128.934234 36.727540
22 4 54.130526 24.966316 29.842105 42.627368 85.372632
    134.662105 45.390526
23 4 54.960094 26.014085 28.808685 54.773474 75.338028
    129.531690 34.167840
24 1 57.802077 27.928833 34.113622 48.773060 83.804520
    132.198839 43.640501
25 3 58.298009 28.367690 33.835545 48.340315 82.241186
    132.243467 45.336790
```

Explanation of columns:

```
col 1:    ID of the polygon
col 2:    landuse class of the polygon
```

```
col 3-9: pixel values of band1-band7 of the Landsat imagery
```

4. Now run **oft-nn** with

```
oft-nn -i images/landsat_t1.tif -o results/my_knn.tif
```

Following variables will be asked:

```
Input signature file name?:sig_landuse.txt
Number of k?:5
 Nbr of output variables?:1
 Cols of 1 output vars in sig file?
 Output var 1: 2  //Here we define col2 where the information on
     landuse-classes is stored in sig_landuse.txt
 Class/Other = (0/1)?: 1
```

5. Load your result *my_knn.tif* in QGIS:
You can see the polygons labelled corresponding to their landuse-class on top of our result *my_knn.tif*, of which the pixel values vary between 1-5 (eg 1.78283) as there are 5 landuse-classes (1,2,3,4,5).

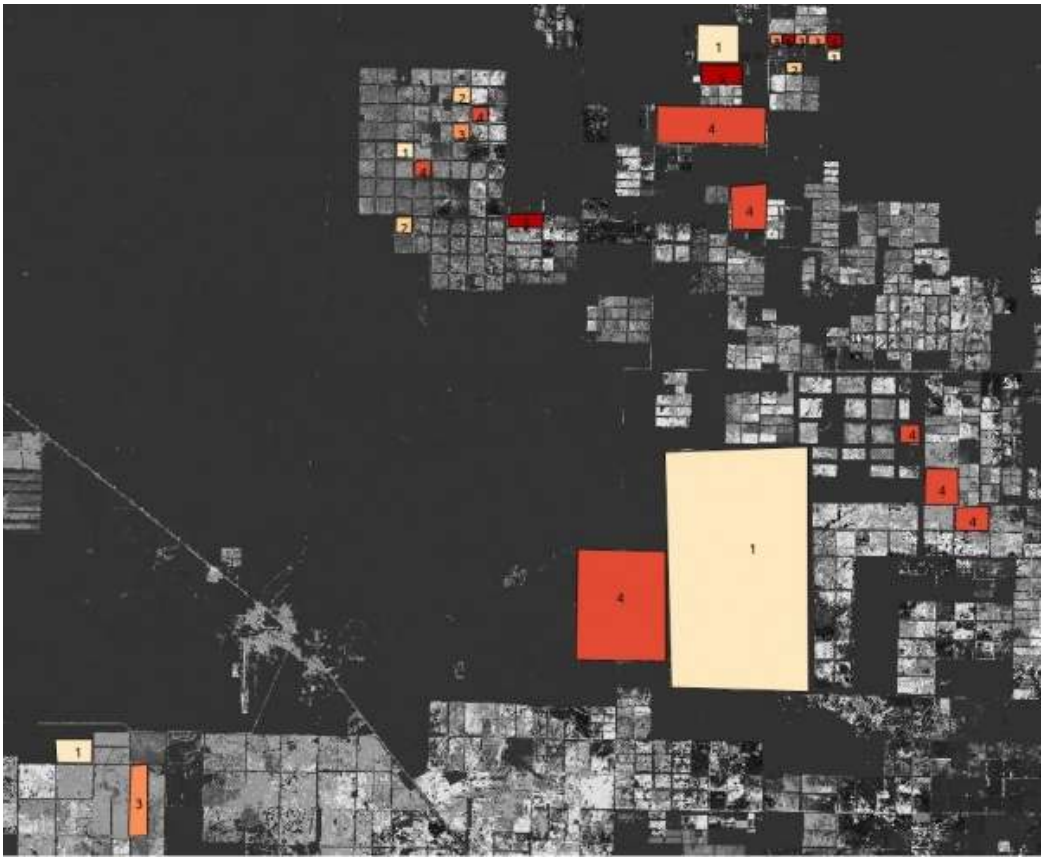


Figure 26: Result my_knn.tif overlayed with landuse.shp.

7.48 oft-nn-training-data.bash

NAME

oft-nn-training-data.bash - Script for preparing a training data text file for oft-nn analysis

OFGT VERSION

1.25.4

SYNOPSIS *oft-nn-training-data.bash*

oft-nn-training-data.bash <-i image.tif><-f field_data.txt><-x col><-y col>
oft-nn-training-data.bash <-i image.tif><-f field_data.txt><-x col><-y col>[-m mask.tif] [-d dem] [-l lu]

-i = give the landsat image where grey values are to be picked for the field plot locations
-f = give the field data text file
-x = give the column where x-coordinate resides in the text file
-y = give the column where y-coordinate resides in the text file

OPTIONS

-m = give a mask with values 0 and 1, where 0 tells that "this location is not to be picked if a field plot falls here"
-d = give a digital elevation model file from which the elevations at field plot locations are to be added to the training data
-lu = give a land-use, land cover etc image file from which this information is to be added to the training data

DESCRIPTION

- Picks field data in a text file based on the extent of given image
- Image may contain 6 or 7 bands
- Extracts image values based on field data locations

- If a mask is given, pixels with mask value 0 are dropped
- At this point the materials must to be in the same projection
- The text file is preserved as such. Image grey values are added to the end of each row. If *lu* and/or *dem* are given, they appear between the original field data and grey values (*lu* before dem in case of both)

NOTES

Checking of the result is obligatory!!!!

EXAMPLE

- For this exercise following tools are used: *oft-nn-training-data.bash*
- Open your working directory using

```
cd /home/...
```

- The script *oft-nn-training-data.bash* extracts image values based on field data locations using input image *landsat_t1.tif* and for the field data we are using *training.txt*.

```
oft-nn-training-data.bash -i landsat_t1.tif -f  training.txt -x
   2 -y 3
```

Let's take a closer look at our output *values_for_nn*

```
head values_for_nn
```

```
1 730785 -2456134 1.00 730785.00 -2456134.00 52.00 24.00 24.00
   51.00 65.00 128.00 29.00
2 730785 -2455134 2.00 730785.00 -2455134.00 59.00 27.00 34.00
   47.00 82.00 132.00 46.00
3 730785 -2454134 3.00 730785.00 -2454134.00 57.00 28.00 33.00
   50.00 82.00 131.00 44.00
4 730785 -2453134 4.00 730785.00 -2453134.00 55.00 26.00 29.00
   52.00 72.00 129.00 34.00
5 730785 -2452134 5.00 730785.00 -2452134.00 60.00 28.00 35.00
   54.00 87.00 129.00 45.00
6 730785 -2451134 6.00 730785.00 -2451134.00 47.00 19.00 18.00
   37.00 47.00 124.00 20.00
7 730785 -2450134 7.00 730785.00 -2450134.00 46.00 19.00 17.00
   38.00 44.00 123.00 18.00
8 730785 -2449134 8.00 730785.00 -2449134.00 59.00 28.00 33.00
   60.00 84.00 129.00 43.00
9 730785 -2448134 9.00 730785.00 -2448134.00 66.00 34.00 42.00
   57.00 98.00 130.00 56.00
```

```
10 730785 -2447134 10.00 730785.00 -2447134.00 52.00 23.00 21.00
    53.00 61.00 127.00 27.00
```

- Explanation of values for each column:

  - Col1: pixel ID
  - Col2: x-coordinates
  - Col3: y-coordinates
  - Col4: pixel ID
  - Col5: x-coordinates
  - Col6: y-coordinates
  - Col7 - Col13: center pixel value for bands 1-7

7.49 oft-normalize.bash

NAME

oft-normalize.bash - Script for preparing a training data text file for oft-nn analysis

OFGT VERSION

1.25.4

SYNOPSIS *oft-normalize.bash*

oft-normalize.bash <-i image>
oft-normalize.bash <-i image>[-t training data] [-f 1/2] [-m mask]

OPTIONS

-i image = give the Landsat image with 6 or 7 bands to be normalized
-t training data = give a text file containing ground truth and image bands (in last columns)
-f 1/2 = normalization will be based on the distribution present in the image (1) or the training data file (2)
-m mask = give a mask file showing areas to be processed with 1 and others with 0

DESCRIPTION

- Image grey values in both files are converted to mean 0 and std 1 based on the selected source of distribution (image or training data file)
- Procedure for converting each grey value on each band in the image and/or training data file is (value - average)/std
- It is possible to

  - Normalize just the image based on it's grey value distribution on each band
  - Normalize also the training data text file using the same distribution or

- Normalize both files using the grey value distribution obtained from the training data file

EXAMPLE

- For this exercise following tools are used: *oft-normalize.bash*
- Open your working directory using

```
cd /home/...
```

- Let's run a simple exercise using *landsat_t1.tif* as the only input:

```
oft-normalize.bash -i landsat_t1.tif
```

Output: l*andsat_t1_norm.tif* and *stat_landsat_t1.txt*

- Now we run it including the training data option *values_for_nn*:

```
oft-normalize.bash -i landsat_t1.tif -f values_for_nn
```

7.50 oft-prepare-image-for-nn.bash

NAME

oft-prepare-image-for-nn.bash - for preparing a Landsat image for nn-analysis with oft-nn

OFGT VERSION

1.25.4

SYNOPSIS *oft-prepare-image-for-nn.bash*

oft-prepare-image-for-nn.bash <-i image>
oft-prepare-image-for-nn.bash <-i image>[-b baseimage] [-p projection] [-s shapefile] [-a attribute]

DESCRIPTION

Re-projects and shifts an image if needed
Prepares a 0/1 mask of nodata in image, all values ¡= 0 are considered nodata
- Image = Landsat image with 6 or 7 bands to be prepared for oft-nn
- Baseimage = Image already in correct grid, meaning pixel size and pixel locations - Target projection in EPSG, e.g. EPSG:32736 - Shapefile = additional mask areas to be added to the base mask, e.g. clouds - If target projection is given, also shapefile is re-projected - Attribute = name of attribute field to be used in shapefile. Field must contain 0 in regions to be masked off

EXAMPLE

- For this exercise following tools are used: *oft-prepare-image-for-nn.bash*
2. Open your working directory using

```
cd /home/...
```

2. For this exercise we will use *landsat_t1.tif* as image file and *landsat_t2.tif* as the base image file, *landuse.shp* is the input shape-

file of which we define landuse as the attribute to be used:

```
oft-prepare-image-for-nn.bash -i landsat_t1.tif -b landsat_t2.
    tif -s landuse.shp -a landuse
```

3. The output image is automatically processed: *landsat_t1_mask.tif*

4. Check in QGIS the values of your output-mask

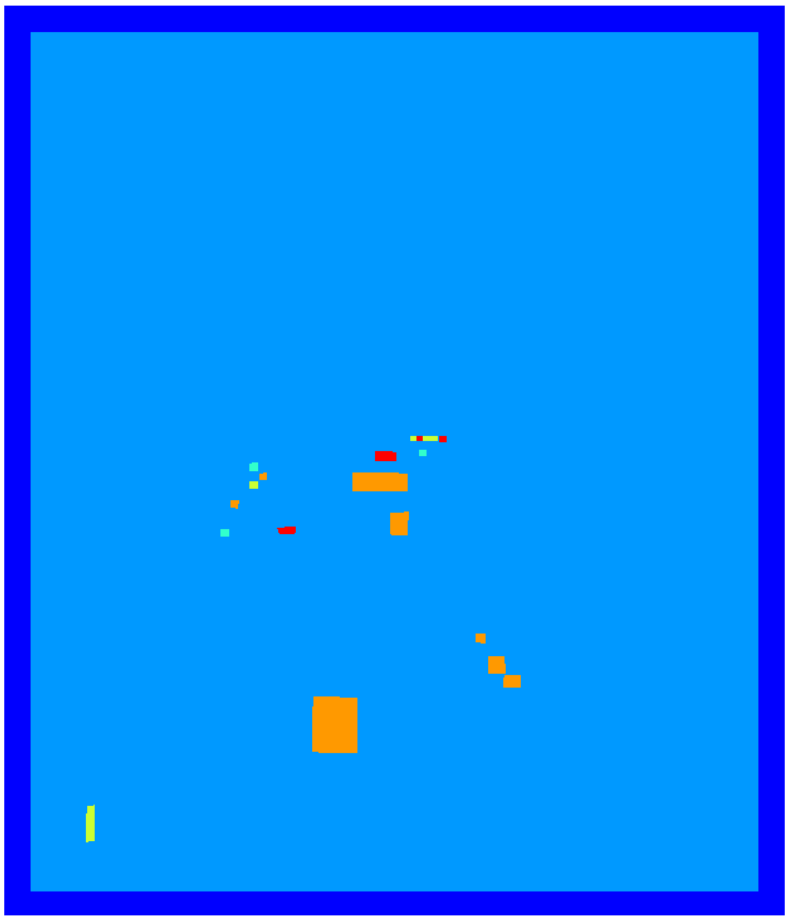


Figure 27: Output of *oft-prepare-image-for-nn.bash* is *landsat_t1_mask.tif*

7.51 oft-unique-mask-for-nn.bash

NAME

oft-unique-mask-for-nn.bash - creates a unique mask for oft-nn analysis.

OFGT VERSION

1.25.4

SYNOPSIS *oft-unique-mask-for-nn.bash*

oft-unique-mask-for-nn.bash <-m mask of base image><-s mask of new image>

DESCRIPTION

Unique means here, that same pixel is not classified from several images.
It is needed in 2 cases:
1. take an adjacent image into account or
2. use the new image to fill a cloud etc. on nn-classified base image

- As input you need a mask of the main image and a preliminary mask of the new image
- A preliminary mask for the new image can be run with oft-trim-mask.bash
- If you need to add clouds or water, do that before or after this unique mask script
- The new image must be in the same projection and gridding (pixel locations)
- In all masks, 0=do not use, 1=use
- To take several images into account, re-run
- Script produces also an accumulated mask, showing common ok areas

EXAMPLE

- For this exercise following tools are used: *oft-unique-mask-for-nn.bash*

2. Open your working directory using

```
cd /home/...
```

2. For this exercise we will use *mask.tif* as mask of the base image and *landsat_t2_mask.tif* as the mask of the new image:

```
oft-unique-mask-for-nn.bash -m mask.tif -s landsat_t2_mask.tif
```

3. Two output images are automatically processed:
landsat_t2_mask_unique_mask.tif and
landsat_t2_mask_accumulated_mask.tif

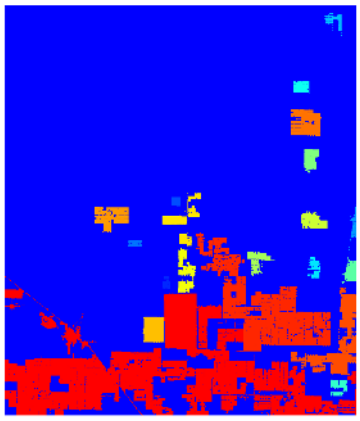


Figure 28: Mask of base image: *mask.tif*

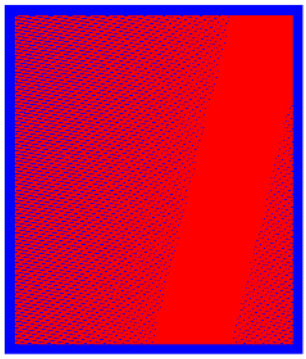


Figure 29: Mask of new image: *landsat_t2_mask.tif*

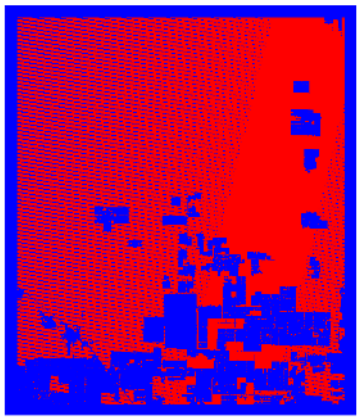


Figure 30: Output: *landsat_t2_mask_unique_mask.tif*

SEGMENTATION

7.52 oft-clump

NAME
oft-clump - connected component labeling.

OFGT VERSION
1.25.4

SYNOPSIS *oft-clump*
oft-clump <-i input><-o output>
oft-clump <-i input ><-o output>[-b band] [-um maskile] [-h help]

DESCRIPTION
oft-clump Add spatial coherency to existing classes by combining adjacent similar classified areas.
- Oft-clump is meant for separating uniform regions in a class imag
- You may obtain such a class image by using e.g. *oft-cluster.bash*, *oft-kmeans* or *oft-nn*.
- The program looks for similar and adjacent class values in the input image and gives each area an own id.

OPTION
Parameters:
- *[-b band]* - use determined band of the image
- *[- um maskfile]* - use maskfile and process only areas having mask value >0
- *[-h help]* - opens the help manual in the terminal

NOTES

- For the benefit of users running the script using the older version, where the datafiles are based on the file order instead of options -i and -o, the program can still be used that way.
- After clumping: pixels with identical class values, but are not spatially connected, will have different id

EXAMPLE

- For this exercise following tools are used: *oft-clump*
- Open your working directory using

```
cd /home/...
```

- To run the oft-clump we use the Input: *landsat_t1.tif*, Output: *clump.tif*:

```
oft-clump landsat_t1.tif clump.tif
```

7.53 oft-seg

NAME

oft-seg - Image segmentation tool.

OFGT VERSION

1.25.4

SYNOPSIS

oft-seg
oft-seg <input><output>
oft-seg <input><output>[OPTIONS]

OPTIONS

```
-aw = ask weights
-automin = use automatically computed minimum distance threshold
-4n = Describes the pixel connectivity. Default is -8n.
-automax = use automatically computed maximum distance threshold
-um maskfile = use mask/initial segment file
```

If -4n is indicated, the neighbourhood is reduced to consider only top, bottom, left and right pixels.

Additional Options upon Execution

```
-Min. segment size?: Minimum segment size in pixels.
-Min. spec. dist. btw segs?: Not asked if -automin is specified
    above.
-Max. spec. dist. btw segs?: Not asked if -automax is specified
    above.
-Use size weighting?: 0 indicates no size weighting, 1 indicates
     use size weighting.
```

DESCRIPTION

oft-seg region merging segmentation.

- *oft-seg* uses a simple iterative region merging algorithm to merge each segment with its spectrally nearest adjacent seg-

ment. The spectral distance *(D)* between the segments is computed using all input bands and *Euclidean distance*.

- The algorithm is controlled by three parameters: minimum segment size in pixels *(MinSize)*, and minimum required *(MinDist)* and maximum allowed *(MaxDist)* spectral distances in the feature space. The conditional merging is done in two phases. First, all segments which are 1) smaller than *MinSize* and 2) have a neighbouring segment to which the spectral distance is $<$*MaxDist* are merged. This step is iterated until no such segments exist. After that, all segments which have an adjacent segment with $D <$*MinDist* are merged with their spectrally nearest neighbour.

- In addition, the user can choose to weight the distance computation with the size (pixels) of the neighbouring segment.

- The tool can also compute the *MinDist* and *MaxDist* thresholds automatically. To do that, use *-automin*and/or *-automax* options. Otherwise the tool will ask for user input.

- If you do not want to use *MinDist* or *MaxDist* parameters or size weighting, reply 0 when the parameter is asked.

- If the given *MinSize* is 0, an image with unique labels for every pixel is produced.

- If a mask is given, initial segments are read from the mask.

- To do a hierarchical segmentation, the user should run the first iteration without a mask. In the subsequent iterations the resulting output of the previous segmentation step should be fed to the process using *-um* option.

- In case the input image is large and computing resources are low, an alternative method can be used. The initial segmentation

can be produced using oft-cluster.bash oft-clump and the final removal of undesired small segments with *oft-seg*.

NOTE

A further tool *oft-segstat* can then be used to extract segment level shape (size, bounding box, # edge pixels) and spectral statistics (averages and standard deviations) to a text file.

EXAMPLE

- For this exercise following tools are used: *oft-seg*, *gdal_polygonize.py*

1. Open your working directory using

```
cd /home/...
```

2. Now we run *oft-seg* to do the hierarchical segmentation with Input: *landsat_t1.tif* ; Output: *landsat_t1_min50.tif*

```
oft-seg landsat_t1.tif landsat_t1.tif_min50.tif
```

The tool will ask you now further details which we will define in this exercise as followed:

```
Please give NODATA value: 0
Min. segment size?: 50
Min. spec. dist. btw segs?: 0
Max. spec. dist. btw segs?: 0
Use size weighting?: 0
```

3. In the next step we create a shapefile where pixels of the same value, with other words of the same segment, combined into one polygon. Input: *landsat_t1_min50.tif*, Output: *landsat_t1_min50.shp*

```
gdal_polygonize.py landsat_t1_min50.tif -f "ESRI Shapefile"
   landsat_t1_min50.shp
```

4. Open your file *landsat_t1_min50.tif* in QGIS and overlay it with *landsat_t1_min50.shp*

- Right click of the shapefile ->Properties ->Label ->tick display

label and under Field containing label chose DN
- Right click of the shapefile ->Properties ->Style ->Transparency eg 50%
- Now zoom in and will see something similar to the image displayed, depending on the area you are zooming in, where each polygon refers to one segment and the displayed number is the corresponding ID.
Note: some segments have the same ID, but they still belong to the same segment as they are connect through neighbouring corner pixels.

5. The segmentation image *landsat_t1_min50.tif* can be used in a further step for *oft-segstat*.

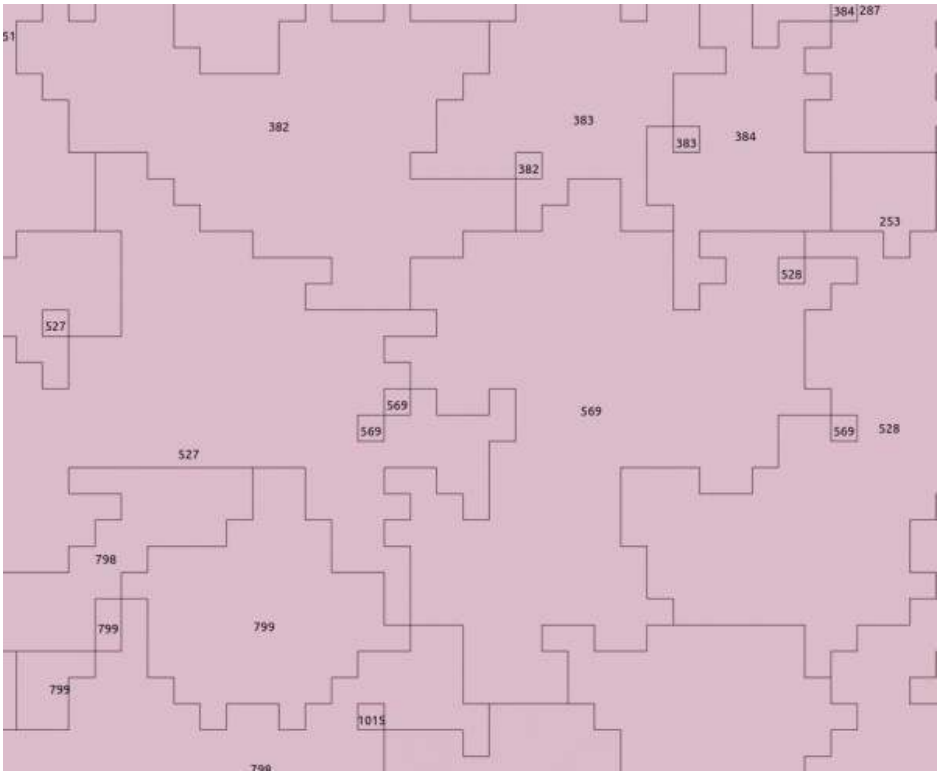


Figure 32: The segmentation image *landsat_t1_min50.tif*

PROJECTION

7.54 oft-getproj.bash

NAME

oft-getproj.bash - fetches projection definition files for UTM zones.

OFGT VERSION

1.25.4

SYNOPSIS *oft-getproj.bash*

DESCRIPTION

oft-getproj.bash fetches projection definition files for UTM zones:
- Downloads OGC WKT projection definition files for user-defined UTM S or N zones (in WGS84) from http://spatialreference.org/ref/epsg/
- Creates directory *~/ogcwkt* if does not exist, otherwise uses the existing
- Copies the downloaded files there and can be viewed with a text editor

EXAMPLE

- For this exercise following tools are used: *oft-getproj.bash*

1. Run the *oft-getproj.bash* for the UTM zone 20N

```
oft-getproj.bash 20N
```

2. Fetching the projection definition for several zones:

```
oft-getproj.bash 21N 22N 25N 31S
```

3. Change your working directory to:

```
cd ~/ogcwkt
```

4. Here you can find the downloaded projection definition file for the UTM zone 20N (*WGS84_UTM_20N.ogcwkt*). Open it with any text editor program, such as gedit:

```
PROJCS["WGS 84 / UTM zone 20N",GEOGCS["WGS 84",DATUM["WGS_1984",
    SPHEROID["WGS 84",6378137,298.257223563,AUTHORITY["EPSG","
    7030"]],
 AUTHORITY["EPSG","6326"]],
 PRIMEM["Greenwich",0,
 AUTHORITY["EPSG","8901"]],
 UNIT["degree",0.01745329251994328,
 AUTHORITY["EPSG","9122"]],
 AUTHORITY["EPSG","4326"]],
 UNIT["metre",1,AUTHORITY["EPSG","9001"]],
 PROJECTION["Transverse_Mercator"],
 PARAMETER["latitude_of_origin",0],
 PARAMETER["central_meridian",-63],
 PARAMETER["scale_factor",0.9996],
 PARAMETER["false_easting",500000],
 PARAMETER["false_northing",0],
 AUTHORITY["EPSG","32620"],
 AXIS["Easting",EAST],
 AXIS["Northing",NORTH]]
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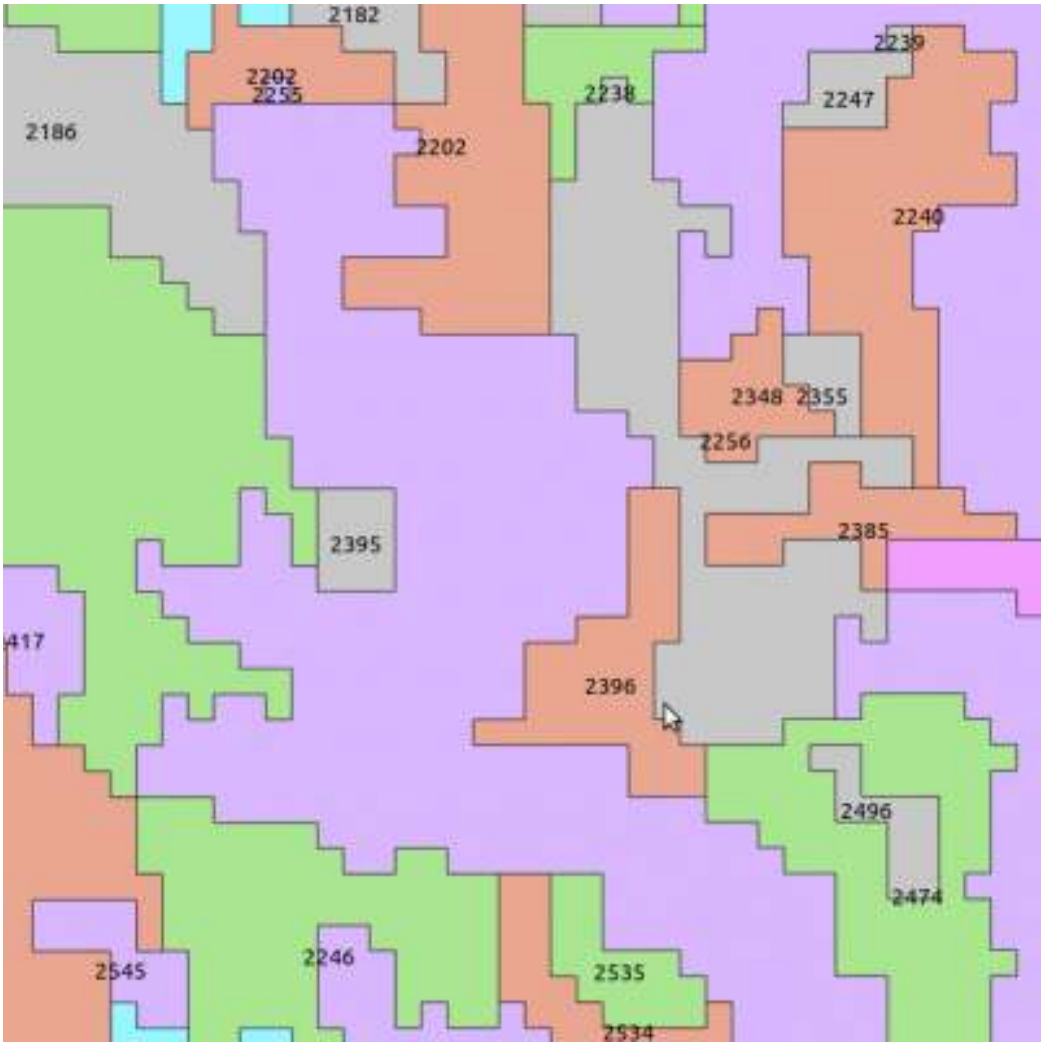
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2545
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2535
2534

Figure 31