Center of Excellence CETEMPS Telesensing of Environment and Model Prediction of Severe events

Dipartimento di Ingegneria dell'Informazione Elettronica e Telecomunicazioni

SAPIENZA Università di Roma

imaa Consiglio Nazionale delle Ricerche Istituto di Metodologie per l'Analisi Ambientale

HOMEWORK PLAN AND OBJECTIVES

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NOTE on EODA HOMEWORK DATA AND SLIDES

Data and slides, useful for EODA homeworks, can be found on
https://www.dropbox.com/sh/a8xzl57wxtjvqt0/AABg9-8xYDI70L7Qd4gKTZ7Ta?dl=0
Data for **HW03 and HW04a** are available on http://www.learn-eo.org.

NOTE on EODA EXAM PROCEDURE

For those students **ATTENDING** lectures:

- participate to laboratory exercises and seminars
- do the foreseen 3 homeworks (see above) + 1 laboratory on EO data analysis during the course

For those students **NOT ATTENDING** lectures:

- answer to 1 oral question on the course topics during the exam (flexible date to be agreed with the professor; in case of permanence abroad or difficulties to meet personally, a Skype-based examination can be organized)
- do the foreseen 4 homeworks (see above) on EO data analysis case study to be discussed during the exam

NOTE on EODA HOMEWORK GROUPS AND REPORTS

Homeworks shall satisfy the following rules:

- Groups with no more than 2 students;
- Each homework should be illustrated by a short report discussing each step with a printscreen/plot of results

HW01. HOMEWORK ON MODIS/AQUA DATA - VEGETATION

Objective: explore MODIS satellite data and apply **SNAP classification tools and vegetation indexes**
Material: SNAP official manual, Short-guide-to-SNAP and course slides on EODA-Lab01
References: Myneni et al., TGRS, 1995; Vina et al., RSE, 2011.

1. Download and install SNAP (if needed, you can use a Virtual Machine to exploit the resources available within ESA Cloud ToolBox facility at http://eogrid.esrin.esa.int/cloudtoolbox after registering)
2. Download a first MODIS image at 1-km resolution over Italy or other geographical area of interest during a summer season from https://ladsweb.modaps.eosdis.nasa.gov/search (select MYD021KM*.*). As an example, you can download MODIS/AQUA sample imagery provided on the course website.
3. Perform data quality check
4. Perform and display data analysis by spectrum, histogram and profile tools
5. Perform and display channel data correlation of the whole image
6. Perform and display channel data correlation of selected ROI (Region of Interest)
7. Perform and display principal component analysis
8. Perform, display and interpret unsupervised classification with at least 3 classes (sea, land, cloud)
9. Perform, display and interpret supervised classification with at least 4 classes (sea, land, cloud)
10. Implement at least 3 formulas of 2-band and 3-band vegetation index (VI) using SNAP processing tools
11. Apply at least 3 VI formulas to land pixels and interpret their output results and differences
12. Perform an unsupervised classification by using an arbitrary VI index instead of MODIS channel
13. Download a second MODIS image at 1-km resolution over the same geographical area of interest during a winter season. Apply the same selected VI index and qualitatively compare the differences.
14. To perform a quantitative change detection (difference) of the vegetation coverage class by reprojecting the 2 winter and summer MODIS images over the same grid in a selected region of interest (ROI).

Output: short report (max about 20 pages, single interline, font 11), documenting step by step (1-11) the results by image outputs and/or screen snapshots.
Deadline: April 17 (or before the examination date)

HW02. HOMEWORK ON MSI/SENTINEL2 DATA – OCEAN COLOR

Objective: explore MSI/Sentinel2 data for estimating **chlorophyll-a and suspended sediments along coastlines**

Material: SNAP official manual, Sentinel-2_ ToolboxTutorial_Basics.pdf and course slides on EODA-Lab03
References: Gitelson et al., RSE, 2008; Sravanthi et al., IJERS, 2013.

1. Download and install SNAP (if needed, you can use a Virtual Machine to exploit the resources available within ESA Cloud ToolBox facility at http://eogrid.esrin.esa.int/cloudtoolbox after registering)
2. Download a MSI/S2 image over a target area coastline (e.g., Central Italy near Rome, Argentario or Pescara) during the summer period from https://scihub.copernicus.eu (as an example you can download MSI/S2 imagery provided by the professor). You can also choose any target area coastline (e.g., Tiber river estuary in Italy, Po river delta in Italy, your home country coastline …).
3. Perform data quality check
4. Apply atmospheric correction to image data if needed and compare the results with and without this correction
5. Select a ROI (Region of Interest) around the target area coastline
6. Perform and display channel data correlation of selected ROI
7. Implement at least 3 regressive algorithms to estimate chlorophyll-a (Chl-a) using SNAP processing tool
8. Apply the Chl-a retrieval algorithms around the target area coastline and compare their results
9. Implement at least 2 regressive algorithms to estimate total suspended sediments (TSS) using SNAP
10. Apply the TSS retrieval algorithms around the target area coastline and compare their results
11. Download all MSI/S2 images over the target area coastline within a period of at least 2 summer weeks from https://scihub.copernicus.eu. You can also choose any summer time interval on a target area in order to have at least 4 images.
12. Apply the chosen Chl-a and TSS retrieval algorithm to MSI image time series around the target area coastline and show/discuss the time evolution of the retrieved parameters.
13. Download all MSI/S2 Chl-a and TSS products around the target area coastline within the selected period from Copernicus Marine Service at http://marine.copernicus.eu
14. Compare Chl-a and TSS retrievals with official Copernicus S2 products within the selected period

Output: short report (max about 20 pages, single interline, font 11), documenting step by step (1-14) the results by image outputs and/or screen snapshots.

Deadline: April 30 (or before the examination date)

HW03. HOMEWORK ON SEVIRI/METEOSAT DATA – ASH CLOUDS

Objective: explore SEVIRI and MODIS data for **discriminating ash clouds**

Material: SNAP official manual and course slides on EODA-Lab02
References: Wen and Rose, JGR, 1994; Corradini et al., RS, 2016.

1. Download and install SNAP (if needed, you can use a Virtual Machine to exploit the resources available within ESA Cloud ToolBox facility at http://eogrid.esrin.esa.int/cloudtoolbox after registering)
2. Follow LearnEO-Lesson13 (http://www.learn-eo.org/lessons/l13), step by step as in the following, by using SNAP instead of Bilko tool
3. Download the SEVIRI/METEOSAT and MODIS/AQUA imagery on the case study of the 2010 Icelandic eruption of 2010, following LearnEO-Lesson13 instructions or download data provided by the professor.
4. Perform data quality check
5. Perform and display "visible" RGB (RedGreenBlue) composite with MODIS data
6. Perform and display "virtual" RGB composite using SEVIRI data channels
7. Perform and display ash-cloud transects on SEVIRI RGB composite data
8. Perform and display Brightness Temperature Difference (BTD) using SEVIRI data
9. Implement Volcanic Ash Detection Algorithm (VASD) using SNAP processing tools
10. Apply VASD (algorithm 1 and 2) and interpret their output results and differences
11. Develop and implement a TIR optical thickness retrieval algorithm by applying the no-scattering radiative transfer theory for a thermal homogeneous ash cloud layer noting that $T_B \leq T_0$ (you can use SNAP, Python/Matlab or R-language environment to implement the algorithm depending on its complexity)
12. Apply the TIR retrieval algorithm at 10.8 μm and at 12.0 μm to ash-cloud mask using SEVIRI data and interpret the output results (you can use SNAP, Python/Matlab or R-language environment to implement the algorithm depending on its complexity). Note that thermodynamical data (useful to compute the Planck law) can be retrieved from http://weather.uwyo.edu/upperair/sounding.html.

Output: short report (max about 20 pages, single interline, font 11), documenting step by step (1-12) the results by image outputs and/or screen snapshots.
Deadline: May 15 (or before the examination date)

HW04a. HOMEWORK ON SAR DATA (if you did not follow the ESA Lab)

Objective: explore ASAR/ENVISAT and Landsat7 data for monitoring urban growth
Material: SNAP official manual and course slides on EODA-Lab04
https://earth.esa.int/pub/ESA_DOC/ENVISAT/ASAR/asar.ProductHandbook.2_2.pdf
References: Moreira et al, GRSM, 2013; Ferretti et al., ESA, 2007

1. Download and install SNAP (if needed, you can use a Virtual Machine to exploit the resources available within ESA Cloud ToolBox facility at http://eogrid.esrin.esa.int/cloudtoolbox after registering)
2. Follow LearnEO-Lesson08 (http://www.learn-eo.org/lessons/l8/), step by step as in the following, by using SNAP instead of Bilko tool
3. Download ASAR and Landsat7 imagery, following LearnEO-Lesson13 instructions or download data provided by the professor.
4. Perform data quality check
5. Open the SAR data and review the Metadata information
6. Compute the SAR backscattering image
7. Co-register SAR data using ground control point (GCP) available set
8. Apply speckle filtering to SAR imagery
9. Analyze principal scattering mechanisms in an urban context
10. Feature extraction for change detection in time domain:
    a. evaluate the changes in 2004 by color composite
    b. analyze the backscattering changes in time
11. Feature extraction for change detection in space domain: textural analysis
12. Change detection on a pixel base
13. Visual comparison with optical images: compare the SAR change detection results with optical data

Output: short report (max about 20 pages, single interline, font 11), documenting step by step (1-13) the results by image outputs and/or screen snapshots.
Deadline: May 31 (or before the examination date)

HW04b. LABORATORY ON SENTINEL DATA (if you are following the ESA Lab)

Objective: explore Sentinel-1/2/3 data for monitoring Earth targets
Material: SNAP official manual and course slides provided by ESA RSS group
https://sentinel.esa.int/web/sentinel/toolboxes/sentinel-1/tutorials
http://step.esa.int/main/doc/tutorials/sentinel-2-toolbox-tutorials/
http://step.esa.int/main/doc/tutorials/sentinel-3-toolbox-tutorials/
References: Moreira et al, GRSM, 2013; Ferretti et al., ESA, 2007; Marchetti et al., GRSNL, 2012
Lecturers: G. Rivolta, J.M. Delgado, G. Sabatino, R. Cuccu
Location: RSS at ESA-ESRIN, Via Galilei, Frascati (Roma) – "Tor Vergata" train stop from Termini station

1. Download and install SNAP (if needed, you can use a Virtual Machine to exploit the resources available within ESA Cloud ToolBox facility at http://eogrid.esrin.esa.int/cloudtoolbox after registering)
2. RSS service presentation
3. SAR and InSAR basics and applications
4. Practicals on Sentinel-1 SAR data: InSAR basics and applications
5. SNAP environment. Examples:
    a. Change detection
    b. Flood detection with SAR
    c. Ship Detection
6. Practicals on Sentinel-2 data: practicals in basics and applications
7. Practicals on Sentinel-3 data: practicals in basics and applications
8. Practicals on Sentinel-1 SAR data: practicals in InSAR basics and applications
    a. Applications to Earthquake analysis
    b. Applications to Coherence Change detection
9. Optionals. ESA distributed processing platform for Research Support

   a. Architecture
   b. Infrastructure and integrated applications)
10. Optionals. Practicals on basic processing platform set-up: Ad-hoc exercises

Output: short report (max about 20 pages, single interline, font 11), documenting the work carried out step by step (3-8).

Deadline: May 31 (or before the examination date)