THE IEEE GRSS STANDARDIZED REMOTE SENSING DATA WEBSITE: A STEP TOWARDS "SCIENCE 2.0" IN REMOTE SENSING

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ABSTRACT

The issue of homogeneity in performance assessment of proposed algorithms for information extraction is generally perceived also in the Earth Observation (EO) domain. Different authors propose different datasets to test their developed algorithms and to the reader it is frequently difficult to assess which is better for his/her specific application, given the wide variability in test sets that makes pure comparison of e.g. accuracy values less meaningful than one would desire. With our work, we gave a modest contribution to ease the problem by making it possible to automatically distribute a limited set of possible "standard" open datasets, together with some ground truth info, and automatically assess processing results provided by the users.

1. CONTEXT AND RATIONALE

The Geoscience and Remote Sensing Society (GRSS) [1] of the IEEE [2] has a mandate to foster research and advance science in Remote Sensing.

The fields of interest of the Society are the theory, concepts, and techniques of science and engineering as they apply to the remote sensing of the Earth, oceans, atmosphere, and space, as well as the processing, interpretation and dissemination of such information.

The Image Analysis and Data Fusion Technical Committee (IADFTC) [3] of the GRSS serves as a global, multi-disciplinary network for geospatial data fusion, with the aim of connecting people and resources, educating students and professionals, and promoting the best practices in data fusion applications.

Under the auspices of the GRSS Image Analysis and Data Fusion Technical Committee, an initiative called the Standardized Algorithm and Data Evaluation Working Group (SADE WG) has identified a set of community data sets and algorithm evaluation standards for use by the Earth remote sensing community.

Encouraging young scientists and researchers to invest in Remote Sensing and pursuing a scientific career in the field has always been a priority for the GRS Society in general, and the IADFTC in particular. This is accomplished at various levels, including organizing a yearly Data Fusion Contest promoting progress on fusion and analysis methodologies for multisource remote sensing data; also, facilitating the dissemination and testing of new methods and algorithms for Remotely Sensed data processing, envisaging different applications.

In this context, an important initiative of the GRSS was to envisage the "Standardized Algorithm and Data Evaluation" (SADE) web site, intended to distribute a set of community data sets and algorithm evaluation standards for use by the Earth observation community to support research, development, and testing of algorithms for remote sensing data products. The SADE website is conceived for remote sensing scientists, students, and professionals, who wish to evaluate the performances of their image analysis methods on freely available data against undisclosed test samples. This is meant as an effort in favour of further steps towards "Science 2.0" in the Remote Sensing arena.

A call for proposals for a web portal with the above-mentioned features was issued by IEEE GRSS in 2014. Our response to the call turned out to be the starting point for the current GRSS Data and Algorithm Standardized website (DASE) [4], as it was renamed after a discussion on the final denomination of the real product. The web site is undergoing further development, which will make it even more user-friendly and flexible, and will hopefully encourage further curiosity and interest in the remote sensing research community at large.

2. THE SITE

The call envisioned the site to grow and encompass many remote sensing modalities and applications. Yet the initial effort focused on distribution of high resolution hyperspectral imagery (HSI) data sets and three common HSI applications: target detection, classification, and endmember determination. As of today, classification and target detection are implemented, while endmember determination is still in a planning phase.

The design of the website has been done using the 'Bootstrap' framework relying on *html*, *css*, *js*

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languages where appropriate. The web site and its relations with the database are managed through Apache, php and MySQL. The accuracy assessment algorithms were developed using an open source language (Python 2), and various open-source libraries (Numpy, Scipy, GDAL, Scikit-Learn).
As shown in *Figure 1*, the web site is composed of a user interface behind which a database managing system handles user requests and provides data consequently.

Figure 1. Block description of the web site

New users need to register before interacting with the web site, but the registration procedure is very simple. From the user standpoint, the system works as illustrated in Figure 2.

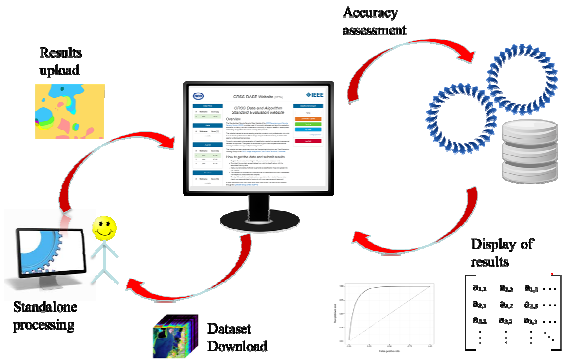

Figure 2. Operations of the web site

A registered user downloads a dataset together with a *training set*. Then, he/she classifies the dataset on his/her own computer using the algorithm under development, and uploads the resulting classification map to the website. Here, the result is compared with a hidden *test set* to produce accuracy figures that are then recorded and presented to the user, together with the rank achieved with respect to other users. The test set remains hidden to make it difficult to bias the assessment by forging "perfect" yet fake results in order to escalate the ranks.
Each uploaded result produces a recorded item, which is shown to the user in his/her workspace as in Figure 3

Overall Accuracy [%]	Average Accuracy [%]	Kappa	User's Accuracy	Producer's Accuracy	Confusion Matrix
54.74	52.99	0.46	User's accuracy	Producer's accuracy	Confusion Matrix

Figure 3. Report selection

By clicking on the buttons, the user may obtain more specific reports like the one reported in Figure 4.

Uploaded Map	Ground Truth								
	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9
Class 1	726	15	103	0	15	63	0	261	5
Class 2	12	1704	0	1	0	489	0	5	77
Class 3	156	21	218	1	0	15	0	132	1
Class 4	0	0	2	793	0	0	15	17	16
Class 5	46	0	0	0	352	3	10	97	0
Class 6	12	1317	0	0	1	5	0	158	390
Class 7	0	0	0	0	0	0	184	0	0
Class 8	146	169	27	14	573	1	41	1311	90
Class 9	0	158	0	0	0	0	0	0	791

Legend:
- **Class 1** = Self-Blocking Bricks
- **Class 2** = Meadows
- **Class 3** = Gravel
- **Class 4** = Shadow
- **Class 5** = Bitumen
- **Class 6** = Rare Soil
- **Class 7** = (painted) metal sheets
- **Class 8** = Asphalt
- **Class 9** = Trees

Figure 4. Full report of confusion matrix

In the case of target detection, a map with pixel values between *0* and *1* is instead expected as a feedback from the user. Each pixel value represents the likelihood of each pixel to belong to the "target" class as assigned by the user's algorithm. In this case, the assessment is made by sweeping across threshold values from *0* to *1*, assigning the class "target" to each pixel above the current threshold, and assessing false positive and false negative rates at each threshold value. This is the so-called parametric "ROC curve" (Receiver Operating Characteristic) method [5], the graphical result looks like Figure 5, and can be produced in either log or linear axes.

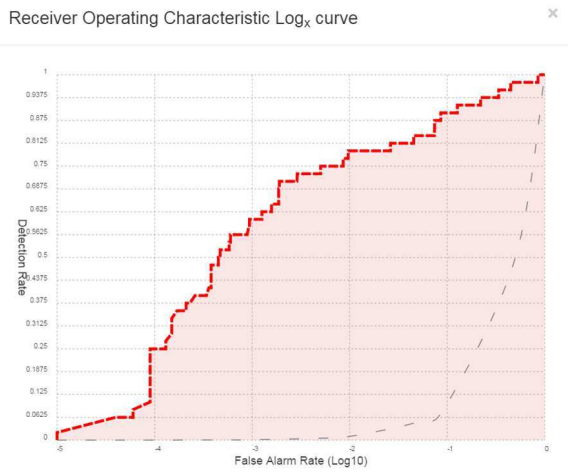

Figure 5. ROC curve output for performance assessment of target detection algorithms.

The administrators operate on a separate administrator panel, which enables them to maintain the web site in its daily operation, including removing junk uploads, blocking malicious users, making new datasets and/or new training sets available, etc. An administrator may also start a "challenge", i.e. make a new dataset available –including metadata- for a pre-defined interval of time, and let the user process it and upload their results. At the end of the "challenge" the accuracy rank will determine the winner.

3. DATASETS

Currently, 5 different datasets are freely distributed from the DASE web site:

- Indian Pines: Hyperspectral AVIRIS data
- Pavia: Hyperspectral ROSIS data
- Flevoland: JPL AirSAR data
- San Francisco: JPL AirSAR data
- Avon-12: Hyperspectral SpecTIR data

The first four sets are intended for classification, while the last one for target detection; additional datasets devoted to spectral un-mixing will be made available in the future. A user can register, download the data and simply use it for his/her research purposes, or get back to the web site with results to be assessed and ranked.
Visual examples of the Pavia and Avon-12 datasets are visible in Figure 6 and Figure 7.

Figure 6. True-colour visualization of the Pavia dataset, intended for classifier performance assessment. It consists of a fraction of a ROSIS dataset acquired in year 2001 over the town of Pavia, Italy, and comes with fairly detailed ground reference data.

Figure 7. True-colour visualization of the Avon-12 data set, intended for assessing performance of target detection algorithms.

4. CONCLUSIONS

The SADE WG of the IEEE GRSS IADF TC has identified a set of community data sets and algorithm evaluation standards for use by the Earth remote sensing community. The GRSS funded an initiative to make such standardization a reality through the development of an ad-hoc portal for distribution of the data sets and automatic assessment of results obtained by participating scientists.
The development of the "DASE portal" is in progress, with a Beta version already online distributing open datasets and accepting results to assess performances of land cover classifiers and target detectors [4].
The DASE portal is continuing its development and will publish new features soon. Users are encouraged to test the web site and report their feedback to the authors. To the reader's convenience, a QR pointing to the current URL of the beta web site is reported in *Figure 8*. The final version of the web site will be migrated to the IEEE GRSS server.

Figure 8. QR pointing to the current (May 2016) DASE beta web site.

5. REFERENCES

[1] The IEEE Geoscience and Remote Sensing Society (GRSS) web site [Online]. Available: http://www.grss-ieee.org/

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[5] Andrew P. Bradley, The use of the area under the ROC curve in the evaluation of machine learning algorithms, Pattern Recognition, v.30 n.7, p.1145-1159, July, 1997. DOI: 10.1016/S0031-3203(96)00142-2]