Assisted teaching and self-learning Virtual tool in Land use and Cover Maps

José Antonio VALERO MEDINA and José Luis HERRERA ESCORCIA, Colombia

Key words: Self-learning, land use map, collective knowledge

SUMMARY

This paper presents a web computational framework for the evaluation of teaching-learning processes and collective construction of knowledge in the preparation of land use and land cover maps. The proposed computational framework facilitates management from the initial assignment of work to the final delivery of the work carried out, promoting self-learning, and using Open-Source software. The automated evaluation contemplates, on the one hand, geometric consistency based on the precision and coverage of the segment boundaries, and on the other hand, semantic consistency based on the coincidence of the assigned semantic labels. The computational framework allows a flexible configuration of the scenarios required in the student-tutor and knowledge collective construction approaches contemplated. The experiments carried out made it possible to demonstrate the capacity of the proposed computational environment as a sustainable alternative for the improvement of teaching-learning processes in Earth Sciences in training in the generation of use maps and quality coverage.

RESUMEN

Este artículo presenta un marco computacional web para la evaluación de los procesos de enseñanza-aprendizaje y construcción colectiva de conocimiento en la elaboración de mapas de uso y cobertura de la tierra. El marco computacional propuesto facilita la gestión desde la asignación inicial de trabajo hasta la entrega final del trabajo realizado propiciando el auto aprendizaje y utilizando software Open-Source. La evaluación automatizada contempla por un lado la consistencia geométrica basada en la precisión y cobertura de los límites de los segmentos, y por otro lado la consistencia semántica basada en la coincidencia de las etiquetas semánticas asignadas. El marco computacional permite una configuración flexible de los escenarios requeridos en los enfoques estudiante-tutor y construcción colectiva de conocimiento contemplados. Los experimentos realizados permitieron evidenciar la capacidad del entorno computacional propuesto como alternativa sostenible para el mejoramiento de los procesos de enseñanza-aprendizaje en Ciencias de la Tierra en la capacitación en generación de mapas de uso y cobertura de calidad.

Assisted teaching and self-learning Virtual tool in Land use and Cover Maps

José VALERO and José HERRERA, Colombia

1. INTRODUCTION

Commonly, countries and organizations generate land use and land cover maps as a tool to evaluate what is happening on the Earth's surface. This allows scarce economic resources to be focused on actions that continue or redirect the plans and programs in execution. Therefore, professionals capable of producing good quality use and coverage maps are required.

In the training of professionals for the preparation of land use and land cover maps, it is necessary, in addition to theoretical concepts, to also acquire sufficient practical skill to determine both the geometric and semantic assignment to designate each minimum mapping unit according to the study type and the detail level. Therefore, in the teaching-learning processes the tutor requires tools that allow personalized monitoring, which provide environments for evaluating the expertise level that the student has acquired. To make this quality assessment, usually, the tutor carries out a visual exploration based on her/his experience. However, this can require a significant effort by having to assess a considerable number of students, and even introduce a detriment to the teacher's subjective judgment as she/he accumulates more and more students whose work has been evaluated. To get a less subjective quality assessment of each student work, a visual comparison is also usually made with a previously prepared version of the teacher (ground truth). This can clearly reduce the gradual degradation of the teacher's judgment, but reviewing the work of each of his students can still be time-consuming.

This paper presents an assisted teaching and self-learning Virtual tool for Land use and Cover Maps which carries out a quality assessment of maps prepared by students. Based on its results this tool allows a tutor to carry out an assisted qualification of the work done by each student, as well as reduce the time that she/he needs to dedicate to that work. Specifically, the proposed tool manages to: (i) increase the tutor's qualification objectivity, (ii) allow students to improve their work before the tutor's final grade, (iii) making a fairer request when a tutor performs the final grade, (iv) build collective knowledge about use and coverage for a geographic area.

The proposed tool is built on a web computing environment which is configured to provide the teaching-learning/collective construction of knowledge facilities that are required. The web server is supported by a spatial data repository in which both use and coverage maps and digital earth observation images used as reference are maintained. The server provides the services required to download and upload the produced use and coverage maps, as well as the service of consistency/quality assessment. For access control, the authentication server-based access control scheme is used with an available corporate authentication service such as Google or Microsoft Azure. The produced tool has been used with students of Cadastral and Geodesy Engineering in the Remote sensing and image interpretation subject.

In the following, in section 2, a background is introduced. In section 3, the data set used is presented. Next, in section 4, the implemented web computing environment is presented in more detail. Then, in section 5, the implemented web computing environment is presented in more detail. Finally, in section 6, some conclusions and future work are presented.

2. BACKGROUND

For two years, the F.J.C. District University has decided to update its undergraduate study plans, to standardize and allow the mobility of both its students and those of other national and international institutions.

This is how the Engineering Faculty decided to adopt a smaller number of credits for all undergraduate courses, including those in sustainable development, in accordance with international standards and policies. This generated processes of analysis and improvement of curricular competencies at the macro, medium and detailed levels.

In this context, the teaching-learning methods used by the University have also been reviewed, allowing certain flexibility for the proposal of improvements in both in-person and virtual and semi-virtual teaching-learning process.

In Cadastral and Geodesy Engineering, sustainable development is managed, not only conceptually but also methodologically and operationally. It is considered that one of the ways to monitor the earth's surface for the management of sustainable development in the country is with the use of remote sensing images. Therefore, it is necessary that the different competencies for the use of remote sensing images in sustainable development be generated and evaluated in the teaching-learning processes (Wilhelm et al., 2019).

This type of initiative is framed in the competency selection model in the mission statement in higher education institutions (Meijers et al, 2005), as the Distrital University has defined it explicitly, generating new proposals in the complex world of engineering sciences. That is why this tool is designed to evaluate the conscious execution of a student of the subject Radar Systems in the competence of spatial information management from radar, specifically to generate an evaluation of the management of the pictorial-morphological with an ontology specific land use and coverage, which has already been implemented so far, but which remains to be used and adjusted for assisted face-to-face teaching, as is the situation in Cadastral Engineering and Geodesy, but thinking that in the future the subject can be offered in a totally virtual, self-directed and constructivist learning context.

Next, in section 2.1 a synthesis of the general theoretical context of the evaluation of the quality of image segmentations produced by computational algorithms is made. Then section 2.2 develops the background of the work carried out within the context of the International Federation of Surveyors (FIG for its acronym in French) and the District University.

2.1. Quality assessment framework of the of image segmentations produced.

The evaluation framework proposed in (Martin et al., 2001; Arbelaez et al., 2011) provides an empirical basis to validate the quality of segmentation produced by segmentation algorithms. This methodology can be applied to any segment boundary data set. Based on those works, the task of the assessment framework proposed here is to determine how well the boundary map produced by one segmentation is comparing it with the boundaries of another, calculating two quantities, precision and recall, and thus producing a measure of relative "precision-recall".

In (Martin et al., 2001) the performance measurement of a segmentation is summed up in a single number. The summary statistic used is a measure of the distance from the origin to the precision-recall. This is the F measure, the mean harmonic of the precision and recall when a segmentation set is compared with other. In the update presented in (Arbelaez et al., 2011), two additional region-based metrics are included: the best F measure in the dataset for a fixed scale (ODS) and the aggregate F measure in the dataset for the best scale in each image (OIS).

2.2. Environment Learning Object for Self-learning

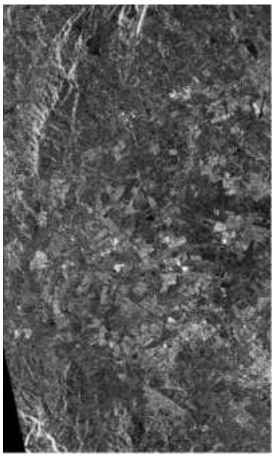
In January 2010, the FIG (FIG, 2010) defined as a policy the use of E-learning for the training and professional updating of surveyors, which implies significant and inclusive paradigm changes in educational institutions in programs and courses related to land administration. This implies at the societal level thinking about the improvement of public and private institutions and at the individual level about improving the dimensions of evaluation and the development capabilities (Groenendijk et al., 2010).

This paper focuses on a proposal to improve the development capacity in the terms of the FIG document "a Virtual Library", initially intended in the context of Cadastral and Geodesy Engineering professionals in Colombia, but later as support to contrast the segmentations of optical and radar images, carried out by segmentation algorithms to improve performance, and maintain the quality of this type of information.

In 2020, the Distrital F.J.C. University made an agreement with Procalculo Prosis SAS company for the analysis of images of recent radar sensors (Capella 2020) for the production and update of maps of Rural Physical Homogeneous Zones, including the land use and cover map, and the achievement of stereo-images for the generation of Digital Elevation Models for image geocoded and generation of slope maps. Developing this research, the possibility became evident that the evaluation environment for the Image Bank for segmentation could also be used as support in the evaluation of students of the radar systems subject. Therefore, its use as a Virtual Learning Environment and as a cooperative and/or collaborative work environment began.

3. DATA

In the reference segmentation survey, it was used two satellite images. In the student-tutor approach, a Radarsat 2 satellite image of 2015 (Sabana of Bogota, Cundinamarca) municipality was used with. The image (shown in Fig. 1 along with its metadata) was assigned to four students (as part of the Radar systems subject). The second level of the field classification established by the Agustín Coddazi Geographic Institute (IGAC by its Spanish acronym) was established as the semantic detail level.



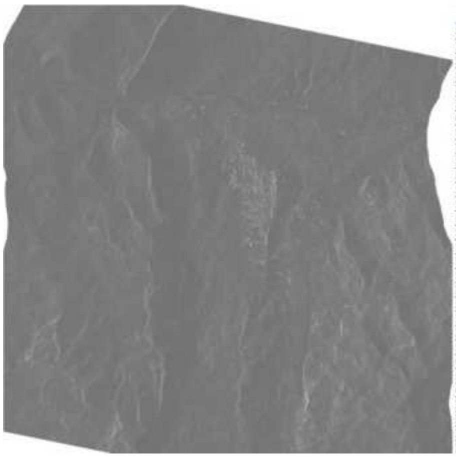
Metadata item	Value
SAR Frequency Band	C
Instruments	Radarsat-2
Datetime	2015-06-09T23
Start Datetime	2015-06-09T23:13:03.694031
End Datetime	2015-06-09T23:13:04. 510512
Platform	Radarsat-2
Constellation	Radarsat-2
SAR Instrument	Mode Ultrafine
SAR Center Frequency	5.404 GHz
SAR Polarizations	HH
SAT	Orbit State:Ascending
SAR Product Type	SGF
SAR Pixel Spacing Range	1.56 m
SAR Pixel Spacing Azimuth	1.56 m
SAR Looks Range	1
SAR Looks Azimuth	1
SAR Looks Equivalent Number	1
SAR Resolution Range	1.6 m
Resolution Ground Range	4.6 m
SAR Resolution Azimuth	2.8 m
Incidence Angle Near	3.47143631e+01
Incidence Angle Far	3.75857887e+01
Squint Angle	-1.106013208202324e-04°
Orbital Plane	97°
SAR Observation Direction	Right
Product Id	PDS_04838400
Product Category	custom
Billable Area	400000000
Date Processing	2015-12-03T01:16:07.000000
Date Updated	2015-12-03T01:16:07.000000

Fig. 1. Radarsat 2 satellite image used in the reference segmentation survey with student-tutor approach.

In the knowledge collective building approach, a radar satellite image of Cáqueza (Cundinamarca) municipality was used (Capella, 2022). The image (shown in Fig. 2 along with its metadata) was segmented by students in two iterations. During the second iteration, it was assigned to four students. The third level of the field classification established by the Agustín Coddazi Geographic Institute (IGAC by its Spanish acronym) was established as the semantic detail level.

4. METHOD

It has been possible to develop a stable and reliable computational environment, which allows the teacher to have a quantitative tool to evaluate competence in the management of spatial information from radar. On the other hand, the student can consciously produce a map of land cover and use, using pictorial-morphological principles used in the radar image to obtain semantic units according to a national market ontology. The results are compared with the results of the teacher or a group of experts to know how close or far a student is from reality on the ground. This allows the student to reflect and analyze these results with the teacher and use this feedback for subsequent practices.



Metadata item	Value
SAR Frequency Band	X
Instruments	capella-radar-3
Datetime	2021-06-12T14:48:43.343984
Start Datetime	2021-06-12T14:48:30.979216
End Datetime	2021-06-12T14:48:55.708753
Platform	capella-3
Constellation	capella
SAR Instrument	Mode spotlight
SAR Center Frequency	9.65 GHz
SAR Polarizations	HH
SAT	Orbit State:descending
SAR Product Type	GEO
SAR Pixel Spacing Range	0.42 m
SAR Pixel Spacing Azimuth	0.42 m
SAR Looks Range	1
SAR Looks Azimuth	9
SAR Looks Equivalent Number	9
SAR Resolution Range	0.5 m
Resolution Ground Range	0.74 m
SAR Resolution Azimuth	0.64 m
Incidence Angle	41.9°
Look Angle	38.1°
Squint Angle	-0.1°
Orbital Plane	97°
SAR Observation Direction	left
Collect Id	6cf32242-3935-4803-a587-d8dae7295005
Product Category	custom
Billable Area	25567987.965252765
Date Created	2021-06-12T17:34:36.939Z
Date Updated	2021-06-13T01:35:18.911Z

Fig. 2. Capella Radar satellite image used in the reference segmentation survey with collective knowledge building approach.

In the future, it is expected that this tool will allow the student to autonomously improve their results, either by making the map again or using the teacher's feedback in the following practices proposed in the virtual course.

The assessment framework proposed in (Martin et al., 2001), which employs two sets of segmentations: the reference one and the one being evaluated, is used in the tool proposed here to provide several configurable server-side operating approaches for evaluating the quality/consistency of the produced use and cover segmentations: (i) a single tutor, (ii) a set of tutors and (iii) knowledge collective construction group. Therefore, the presentation of quality/consistency assessment outcomes will change depending on the configured approach. The first two approaches assess the quality with respect to a reference segmentation set. The last assesses the internal consistency of a given set of segmentations based on the relative consistency of each pair of segmentations in the set, it allows a collective construction of knowledge to take place since every member can know the level of consistency of the segmentations set. If that consistency is low, the knowledge is not very similar, while if the consistency is high, the collective knowledge converges towards the elaboration of a solid common concept. With the purpose of allowing the two previous approaches, the architecture of the system gives the possibility of working asynchronously. Furthermore, to promote the collective construction of knowledge, each segmenter can have in their background the segmentations that other members propose. The system architecture and assessment approach adopted are described in the following subsections.

The architecture used is made up of three main components (see Fig. 3): (i) a web portal (WGS_NIDE_Portal) based on WMS/WFS/WCS server a quality/consistency assessment environment (QAsssessment) and a provider (BissServer) of download, upload an assessment services in a user authentication environment (Oauth2Authenticator); (ii) a segmentation survey environment (SegmentationSurvey) based on a Qgis Desktop client; and (iii) a semantic segmentation database based on a PostGis database (PostGisDB). A description of each of the main components is given below. The use of free software allows to ensure that more community members can make use of the proposed computational framework.

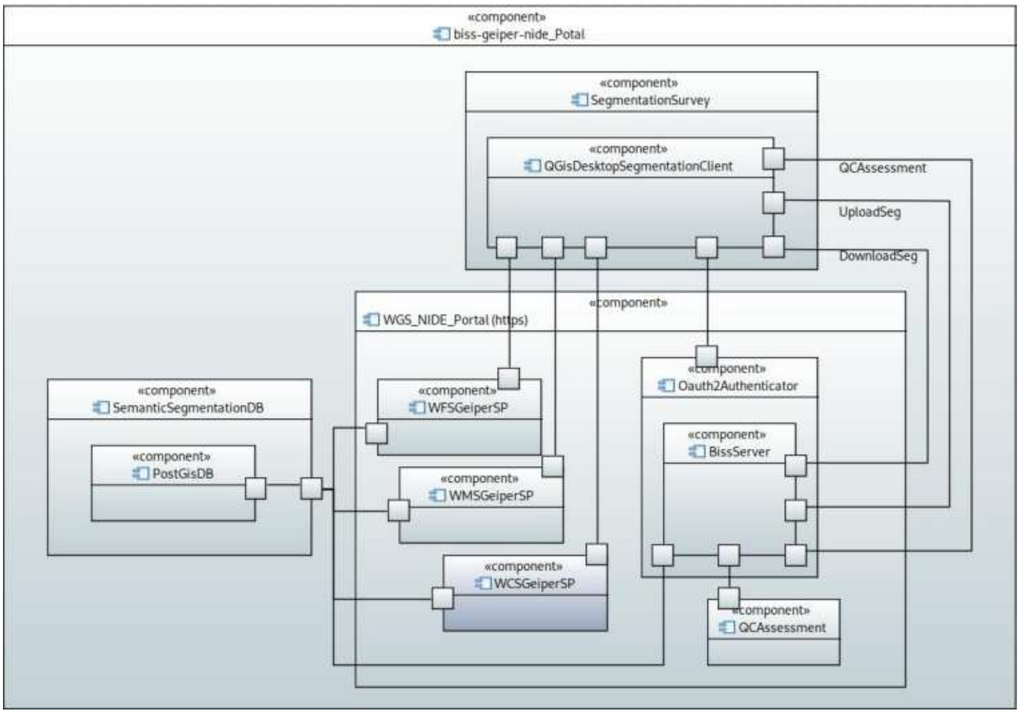


Fig. 3. System architecture for assisted teaching and self-learning in Land use and Cover Maps.

4.1. QGis Desktop-based client

When a user is enabled, the task of segmenting the assigned image can be done from any client capable of accessing WMS/WFS/WCS servers in accordance with the standards specified by the OpenGIS Consortium. The client software that is chosen must also implement authentication based on OAuth 2. As part of the implemented computational framework (see Fig. 3), the environment provided by QGis Desktop has been used and extended by three plugins for downloading, uploading and assessing use and coverage maps.

The proposed architecture implementation uses authentication based on server using accounts provided to each member. So, a user should provide all OAuth2 connection (a configuration file can be used). Each user must get the assigned segmentation file to the local environment using the download plugin (DownloadSeg). The upload plugin (UploadSeg) must be used when a user requires to make a partial or final segmentation delivery. If the quality/consistency assessment service is enabled on the service provider BissServer, a user can use it to request segmentation evaluations using the assessment plugin (QCAssessment).

4.2. Web Geographic Server for NIDE Portal (WSG_NIDE_Portal)

With the purpose of guaranteeing the confidentiality of the connections, the implementation of the computational framework proposed here was configured over the https protocol using a pair of public and private keys provided by the Distrital Francisco José de Caldas University. The site was also protected using the server-based OAuth2 authentication control scheme (Oauth2Autenticator) using Google/Microsoft Azure as the authentication server based on institutional accounts.

The segmentation layers are provided by the service provider BissServer using the connection information provided by the user and authentication server to offer three services: downloading (DownloadSeg), uploading (UploadSeg) and assessing (QCAssessment). DownloadSeg service will access the semantic segmentation database to get the assigned segmentation and to return it to the user environment. UploadSeg service will place the segmentation received from a user in the segmentation database. The QCAssessment service will fetch the requested segmentations from the segmentation database to perform the requested geometric and semantic tests generating the graphs that are finally returned to the QCAssessment plugin to be shown to the user. WGS_NIDE_Portal provides a WMS (WMSGeiperSP) resource with the earth surface digital image that a suer should use as background. A WCS (WCSGeiperSP) resource also can be provided to download the background image if a suer so prefers. If the configuration established is for the knowledge collective construction, access to the segmentations of the other users to whom the same digital image was assigned will also be available through the WMSGeiperSP. The segmentation layers also can be provided by a non-editing WFS server (WFSGeiperSP.

Once a segmentation (tutor-student scheme) or a set of segmentations (collective knowledge construction scheme) is available in the spatial database (SemanticSegmentationDB), the consistency assessment environment (QAssessment) is used to produce the respective quality measures. The environment proposed in (Arbelaez et al., 2011), was implemented to perform the consistency tests. Matlab is used to perform each quality assessment task using the API produced by (Arbelaez et al., 2011), depending on the configuration parameters of the BissServer server.

Each quality/consistency assessment is performed in raster format and includes both a measure of geometric performance in the form of a graph in precision/recall space; as well as a measure of semantic performance based on the coincidence analysis of the label assigned to each segment in a segmentation. The QCAssessment service rasterizes each segmentation so that the number of rows and columns preserves the shape proportion of the reference digital image, and the total number of pixels matches a given number. The larger this number, the better the geometric resolution, but the longer the evaluation process will take. QCAssessment component calculates each measure by comparing each segment pixel with the reference pixel within a tolerance of 5 times the reciprocal of the diagonal size of the raster.

4.3. Semantic Segmentation Database (SemanticSegmentationDB)

All the segmentations made by the students are kept in a repository (PostGisDB) based on the Postgresql open-source database management system using its PostGis option for geographic data. Each user has a schema in which all the segmentations that he/she has performed are grouped. Each segmentation is included in a group together with the other segmentations of other students if the collective knowledge approach is applied. When the tutor-student focus is the employee one, each tutor has a scheme in which all the reference segmentations that she/he has available are included. A tutor scheme also can include the digital image which must be used as a geographic reference.

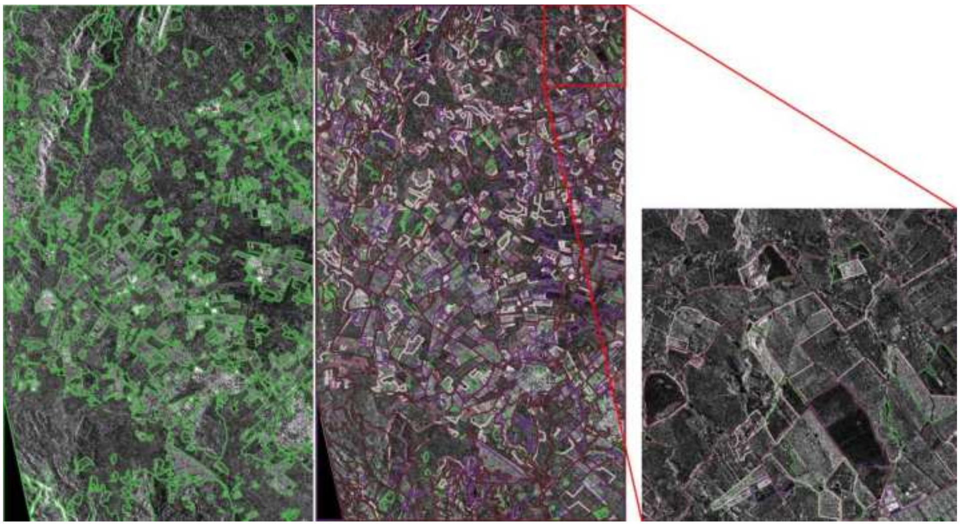
5. OUTCOMES

This section presents the possible scenarios with the results obtained in each case using the data entered in section 3. For performance purposes, each quality/consistency assessment outcome was performed rasterizing each segmentation so that the total number were 262144 pixels. For the results presented in section 5.2, the total number of pixels used was 65536. The results of the geometric quality/consistency evaluations are presented in this section based on the metrics developed in (Martin et al., 2001) and (Arbelaez et al., 2011). According to (Martin et al., 2001), the geometric (Boundary) evaluation is summarized in a single number, the F-measure. The F-measure is the harmonic mean of the precision and recall defined at each point of a set of points located in the precision-recall space as a measure of the distance from the origin to a location in "precision/recall" space. The semantic (Region) assessment is stablished from the way in which a segmentation covers the ground truth by matching its semantic label (GT covering). Two metrics are used for both F-measure and GT covering (Arbelaez et al., 2011): i) the scale (threshold or) at which the best measure was obtained for the entire evaluated data set, called Optimal Dataset Scale (ODS); and ii) the scale (threshold or segmentation version) at which the best measure was obtained for each image in the evaluated data set, the best of them is called optimal scale per image (OIS). The best measures are presented as text in the lower part of each figure.

In the following subsections each geometric performance measure appears as a dot (red for a student or member and cyan for a tutor) labeled with the user's id and (in parentheses), the coordinates of its evaluation in the Precision-Recall space.

5.1. Student-tutor approach

In the Student-tutor approach, the quality measure is basically used to provide feedback to a tutor or student regarding the performance with respect to the expected ideal (the reference segmentation taken as a basis by the tutor). Fig. 4 shows the student-tutor approach with a tutor and a group of four students. Fig. 4 a) shows the reference segmentation (to which the students had to arrive). Fig. 4 b) shows the four that the students carried out (that of the tutor in the background). All lines that are not green are precision errors (lower precision). Fig. 4 c) shows the reference segmentation in the background on a zoom of base digital image, the green lines that were not covered by the other four segmentations are constituted in recall errors (lower recall).



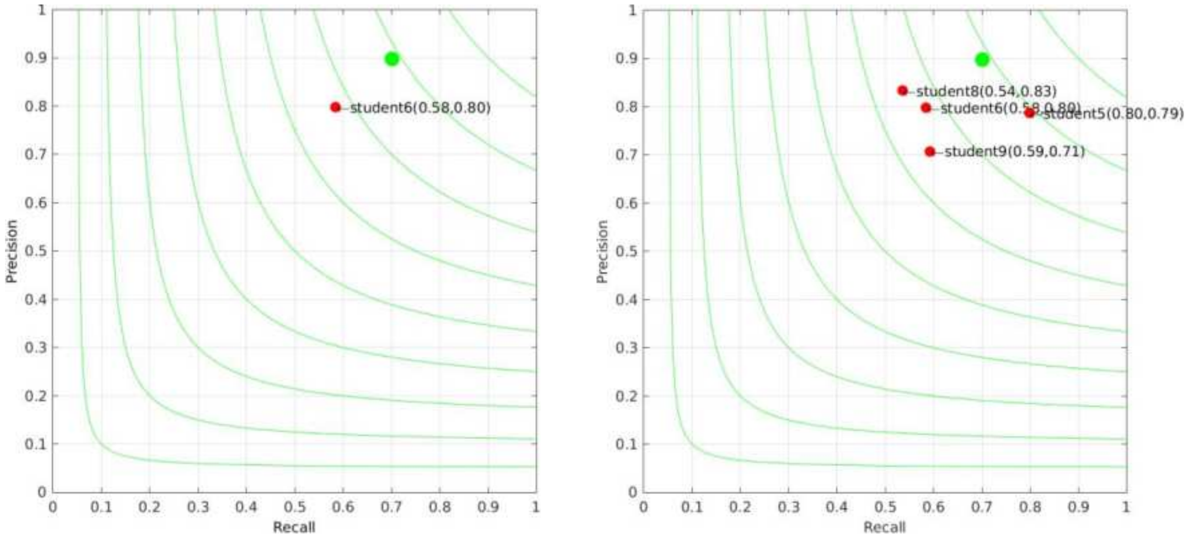
a) b) c)

Fig. 4. a) Digital image used with tutor's reference. b) Four produced segmentations by students with that of the tutor in the background. c) Zoom in on red window.

5.1.1. Student-tutor approach with only one tutor

In the student-tutor approach with a single tutor, the tutor can request the quality assessment results for all students, or for a particular student by specifying the desired student id. In the case of the student, she/he may only request her/his own quality assessment outcomes. Fig. 5a shows the performance of a student (student6) with respect to the tutor reference segmentation. Since only one segmentation was evaluated, ODS and OIS for both the boundary and region evaluations coincide. The threshold (th) of 1 corresponds to the only segmentation evaluated. Although the geometric performance seems acceptable, the GT covering measure (0.22) shows poor semantic performance. This outcome allows the student to be more aware of his current performance and be able to undertake self-correctives that allow her/him to have a better performance later. This result also allows a tutor to make a more objective evaluation of the work done by a student.

Fig. 5b shows the performance assessment outcomes for all students with respect to the tutor reference segmentation. The general performance measures were calculated for each student, but for reasons of space only the results are shown for student student5 (text in the lower part of the figure). Since only one segmentation was evaluated, ODS and OIS, for both the boundary and the region evaluations, coincide. The threshold (th) of 1 corresponds to a single segmentation evaluated for each student. Although the geometric performances seem acceptable, the GT covering measure (0.25) shows poor semantic performance. This result also allows the tutor to have a visual appreciation of the distribution of the learning process of the group of students.



student6

Boundary
ODS: F(0.58, 0.80) = 0.67 [th = 1.00]
OIS: F(0.58, 0.80) = 0.67

Region (GT covering)
ODS = 0.22 [th = 1.00]
OIS = 0.22

a)

student5

Boundary
ODS: F(0.80, 0.79) = 0.79 [th = 1.00]
OIS: F(0.80, 0.79) = 0.79

Region (GT covering)
ODS = 0.25 [th = 1.00]
OIS = 0.25

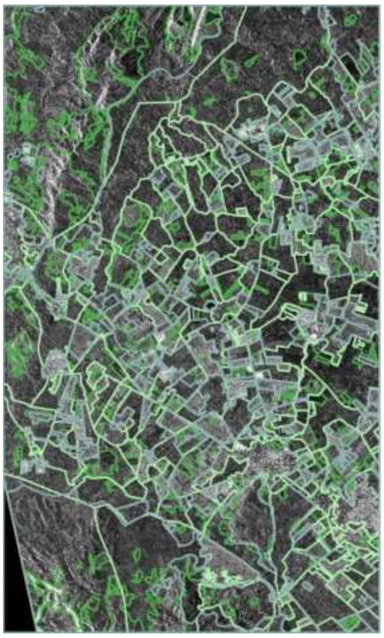
b)

Fig. 5. Student-tutor approach consistency measurement outcomes based on the precision and recall: a) for only a student (grupo6), b) for all students.

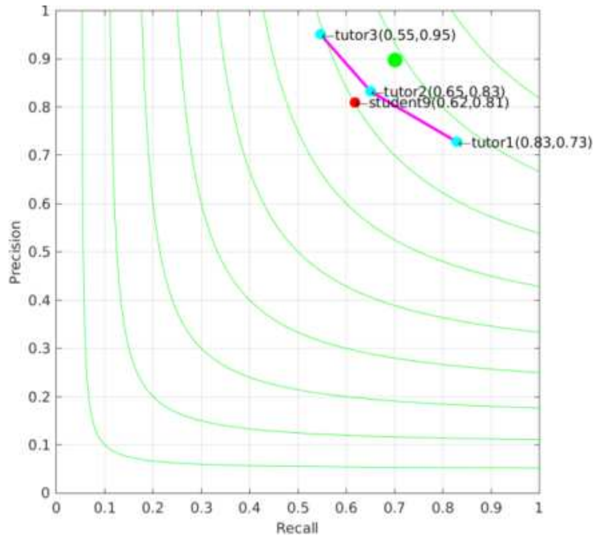
5.1.2. Student-tutor approach with several tutors

In the student-tutor approach, it is possible to employ several reference segmentations from different tutors. Fig. 6a shows two additional use and coverage maps (semantic segmentations) to the one presented in Figure 4. a).

When a tutor in the group requests the evaluation of a student, the result also shows the performance (relative consistency) of the tutor group (see Fig. 6b), so that the tutor can take it into account when grading the student. Fig. 6b shows the performance assessment outcomes for a student with respect to three reference segmentations of the tutor group. Since only one segmentation was evaluated, ODS and OIS coincide. The th value 1 corresponds to the only segmentation evaluated. The presence of several versions of reference semantic segmentations between which there are semantic discrepancies makes it even more difficult to obtain good semantic performance, which explains such a low GT coverage performance measure (0.14339). This result allows the tutor to have a visual appreciation of the distribution of the collective knowledge construction process established by the group of tutors and to make a fairer grade for each student. When a student requests their performance evaluation, it will be presented an outcome like that shown in Fig. 5a without the tutors' reference segmentations.



a)



student9

	Boundary	**Region** (GT covering)
ODS:	F(0.62, 0.81) = 0.70 [th = 1.00]	ODS = 0.14 [th = 1.00]
OIS:	F(0.62, 0.81) = 0.70	OIS = 0.14

b)

Fig. 6. Student-tutor approach with three tutors: a) tutor's references, b) consistency assessment outcomes for a student (student9). Tutor relative consistency measurements are connected (magenta line) in the evaluation order.

5.2. knowledge collective construction approach

In the collective construction of knowledge approach, instead of student or tutor users, there are group member users, although some of them may be leaders. Each member cooperates in the construction of collective knowledge, so the measure of its consistency is evaluated relatively with respect to each of the remaining members. Therefore, the consistency measure is used to provide feedback to each member of the group about the individual's performance relative to that of the others so that it is evident how significant a contribution is. If a consistency measure is far from that of the group, it is possible to have an idea of the extent to which it could be improved to improve the knowledge of the group. The collective knowledge construction approach was used in an experiment with two iterations to evidence the progressive improvement in the knowledge produced.

In the first iteration, the area was divided into 9 windows (see Fig. 7) assigned to 11 volunteer members (see **table 1**). 23 manual semantic segmentations were finally available. Each segmentation was evaluated against the other versions of the same window and that result was considered as an independent evaluation each time. Fig. 8a shows the overall relative performance assessment outcomes but it was not possible to apply a general evaluation with several images, given that each image (window) had a different number of members (see 'seg versions' column in **table 1**). Therefore, the evaluation was made independently for each segmentation and a single overall measure was obtained. Since each segmentation was independently evaluated, ODS and OIS coincide. The threshold (th) of 1corresponds to the only segmentation independently evaluated each time. The presence of several versions of reference semantic segmentations explains the GT coverage obtained (0.47).

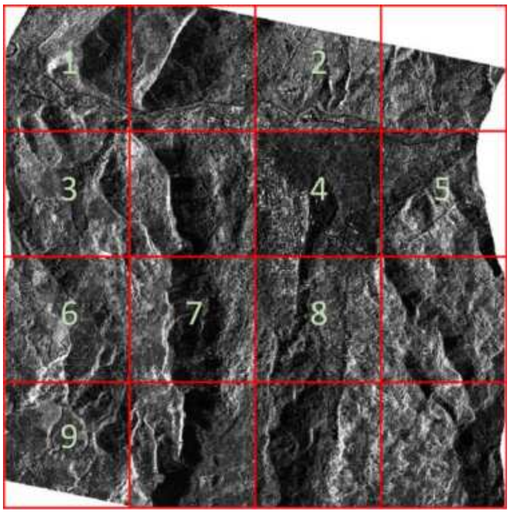
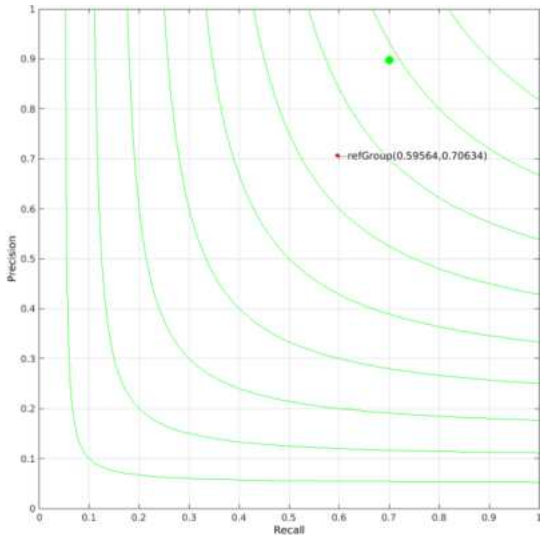


Fig. 7. Digital image used in first iteration of collective building approach.

Table 1. Manual segmentations produced during first iteration. For aech member (column) a 'X' is put when a manual segmentation was produced for a window (row).

		Member											Seg versions
		1	2	3	4	5	6	7	8	9	10	11	
Window	1	X	X	X									3
	2	X	X		X								3
	3		X	X		X	X						4
	4	X						X					2
	5					X		X	X				3
	6									X	X		2
	7						X		X				2
	8							X			X		2
	9						X					X	2
Number of manual segmentations													**23**

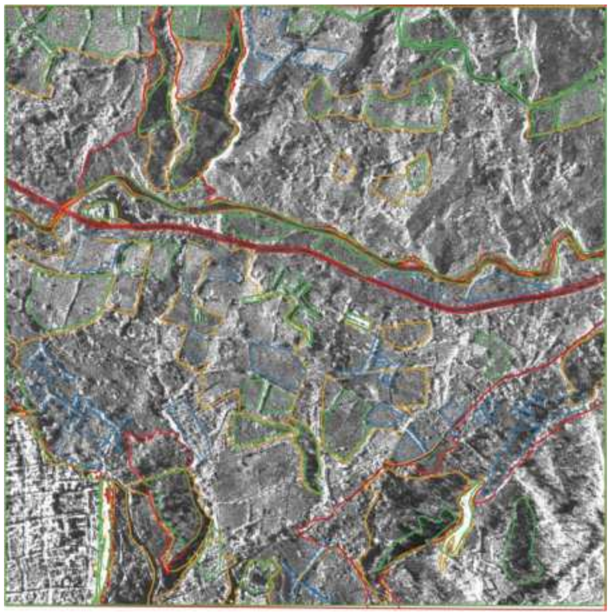
For the second iteration, it was worked only with a window and four volunteer members. Fig. 8b shows the image used along with the four segmentations.



group

Boundary	**Region** (GT covering)
ODS: F(0.60, 0.71) = 0.65 [th = 1.00]	ODS = 0.47 [th = 1.00]
OIS: F(0.60, 0.71) = 0.65	OIS = 0.47

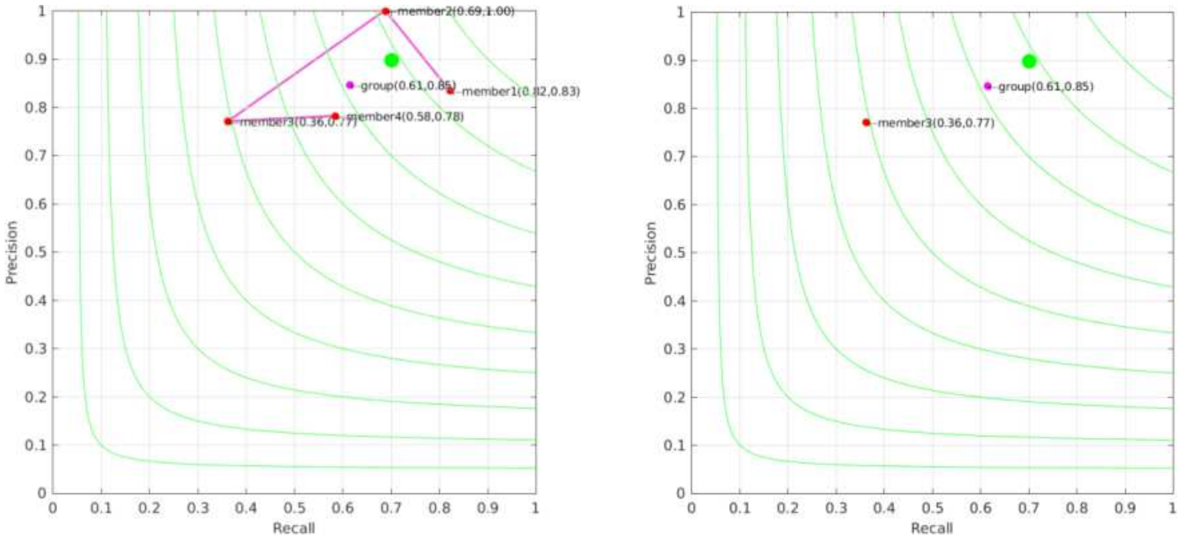
a)



b)

Fig. 8. a) Consistency Measurement outcomes for first iteration. a) Digital image used in second iteration.

Each segmentation was evaluated relative to the others and that result was involved in a collective evaluation. Fig. 9a shows the performance assessment outcomes for the group of segmentations (linking them with a magenta line in the evaluation order) along with the overall relative consistency (magenta dot). The work was evaluated applying an overall evaluation with 4 segmentations. Since the segmentations were evaluated collectively, the computational framework interpolated the best F ODS measure between the first and second evaluated segmentations (member1 and meber2), which explains their coordinates (0.79, 0.88) and the th value (1.25) obtained. For the semantic evaluation both ODS and OIS GT covering measures coincide. The presence of several versions of semantic segmentations explains the GT coverage measure obtained (0.58). To the extent that this measure is located closer to the upper right corner of the precision vs. recall space, more reliable is the semantic knowledge achieved by the group in the set of segmentations produced. As seen in Fig. 8b and Fig. 9a, the group improved the overall measure of precision/recall for the second iteration. Fig. 9b shows the performance assessment outcomes for a member group segmentation (member3) along with the overall relative consistency (magenta dot). This outcome allows a member to be more aware of her/his current performance and be able to undertake self-correctives that allow her/him to have a better performance later.



group

Boundary
ODS: F(0.79, 0.88) = 0.83 [th = 1.25]
OIS: F(0.82, 0.83) = 0.83

Region (GT covering)
ODS = 0.58 [th = 1.00]
OIS = 0.58

a)

member3

Boundary
ODS: F(0.36, 0.77) = 0.49 [th = 1.25]
OIS: F(0.36, 0.77) = 0.49

Region (GT covering)
ODS = 0.27 [th = 1.00]
OIS = 0.27

b)

Fig. 9. Consistency Measurement outcomes based on the precision/recall, using the knowledge collective construction approach: a) for the group, b) for the member3.

6. CONCLUSIONS AND FUTURE WORK

The experiments showed that, although it is possible to obtain acceptable performance in geometric evaluation, similar semantic performance is more difficult to achieve. The above means that, in the field of creating use and coverage maps, the radiometric differences of the reference image make it easier to establish geometric knowledge than semantic.

In the case of semantic knowledge, the challenge seems to be more difficult and seems to require very good expertise from the person who makes the respective labeling of the segments. This coincides with the fact that in the student-tutor with several tutors, it is necessary to achieve good performance measures, especially in the semantic aspect that presents the greatest challenge, so that the student can have more accurate feedback on the improvements. that must be carried out for the evaluated work. Beyond the results, it becomes a much less subjective tool than the academic evaluation approach usually followed by a teacher.

The work presented has made it possible to carry out a series of pilot surveys of manual segmentations. These experiments have made it possible to establish that the differences between the segmentations of the same image can make it appear that in the case of images of the earth's surface, it can become very difficult to achieve a high internal consistency. However, the progression in the improvement of the consistency of the two iterations carried out seems to show that if the iterative process continues, a member will gradually gain the level of expertise necessary to consider that the collective work of knowledge construction is significant.

ACKNOWLEDGMENT

Thanks to Procalculo Prosis SAS, cappella images distributor in Colombia, with whom it was possible to obtain the images used.

Thanks to the students linked to the GEIPER research hotbed for their volunteer work in preparing the use and coverage maps.

REFERENCES

Arbelaez, P., Maire, M., Fowlkes, C. & Malik, J. (2011), 'Contour detection and hierarchical image segmentation', IEEE Trans. Pattern Anal. Mach. Intell. 33(5), 898–916. http://dx.doi.org/10.1109/TPAMI.2010.161.

Capella, 2020, https://www.capellaspace.com/

FIG, FIG Report. (2010), Enhancing Surveying Education through e-Learning, FIG Publication No 46, ISBN 978-87-90907-76-1, January 2010.

Groenendijk L., van der Molen P., Lemmen C. (2010) FIG Congress 2010, Facing the Challenges – Building the Capacity, E-learning: The future for Land Administration Studies?, Sydney, Australia, 11-16 April 2010.

Martin, D. et al. (2001). "A Database of Human Segmented Natural Images and its Application to Evaluating Segmentation Algorithms and Measuring Ecological Statistics." In: Proc. 8th Int'l Conf. Computer Vision. Vol. 2, pp. 416–423.

Meijers, A.W.M.; Borghuis, V.A.J.; Mutsaers, E.J.P.J.; van Overveld, C.W.A.M.; Perrenet, J.C. Academic Criteria for Bachelor and Master Curricula, 2nd ed.; Technische Universiteit Eindhoven, Delft University of Technology, University of Twente: Eindhoven, the Netherlands, 2005.

Valero J., Herrera J., Quijano K. (2022). WMS-Based Web Environment for Ground Truth Semantic Segmentation Creation of Earth Surface Digital Images. In: Proc. Workshop on Engineering Applications - WEA 2022.

Tang Pang-Ning, Steinbach M., Kumar V. (2004). Intro-duction to Data Mining, (First Edition). Boston, MA, USA: Addison-Wesley Longman Publishing Co., Inc.

Wilhelm S., Förster R. Zimmermann A. (2019) Implementing Competence Orientation: Towards Constructively Aligned Education for Sustainable Development in University-Level Teaching-And-Learning, Sustainability MDPI. https://doi.org/10.3390/su1107189

BIOGRAPHICAL NOTES

J. A. Valero is NIDE research group member and professor of the Faculty of Engineering of the Francisco José de Caldas District University. He is the main researcher of the institutionalized research titled "Banco de imágenes para la aplicación de pruebas comparativas de desempeño (Benchmarking) de algoritmos de segmentación de imágenes". ORCID id https://orcid.org/0000-0003-1228-0241

J. L. Herrera is NIDE research group member and professor of the Faculty of Engineering of the Francisco José de Caldas District University. He the GEIPER research hotbed CO.

CONTACTS

Mr. José Antonio Valero Medina
Distrital F.J.C. University.
Calle 13 # 31 -75
Bogotá D.C.,
COLOMBIA
Tel. + 57 + 3208511412
Email: jvalero@udistrital.edu.co
Web site: udistrital.edu.co

Mr. José Luis Herrera Escorcia
Distrital F.J.C. University.
Calle 13 # 31 -75
Bogotá D.C.,
COLOMBIA
Tel. + 57 + 310 5530557
Email: jherrera@udistrital.edu.co
Web site: udistrital.edu.co