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COMPETITION ENTRY FORM

PARTICIPANT DETAILS	First name:	
	Last name:	
	SA ID No.	
TEAM NAME*		
POSTAL ADDRESS	Address line 1:	
	Address line 2:	
	City:	
	Postal code:	
	Province:	
PRIMARY CONTACT NUMBER		
ALTERNATIVE CONTACT NUMBER * *		
EMAIL ADDRESS		
SIGNATURE		

** If Participant is to participate as a member of the Team, the team name must be specified.*

*** Optional*

(the "Participant" or "you")

By signing this form, the Participant acknowledges that s/he has read the attached GeoSmart Competition Terms and Conditions, and that s/he understands and agrees to abide by such terms. Participants must be at least 18 years of age to enter. If the Participant is a member of a team, each team member must separately complete and sign a Competition Entry Form, specifying the Team of which the Participant is a member.

GeoSmart Competition Terms and Conditions

Introduction

GeoSmart Space is hosting a competition for the development of a system to automatically delineate waterbodies from high resolution RGB imagery. R10 000 will be offered to the best submission, along with an additional R10 000 contract for full implementation of the solution.

Background:

GeoSmart Space, in partnership with the Centre for Geographic Analysis (CGA) at Stellenbosch University, is producing a 2 metre spatial resolution digital surface model of South Africa (DEMSA2). In essence the DEMSA2 is a spatially referenced grid, with each cell recording the elevation (height above mean sea level) for a specific location.

Although the generation process is automated, a considerable amount of manual editing is required on the raw output of DEMSA2 tiles, as they contain anomalies. A significant amount of time is specifically devoted to the manual correction of anomalies that result from water bodies (dams, lakes and rivers). An example is shown in Figure 1 below:

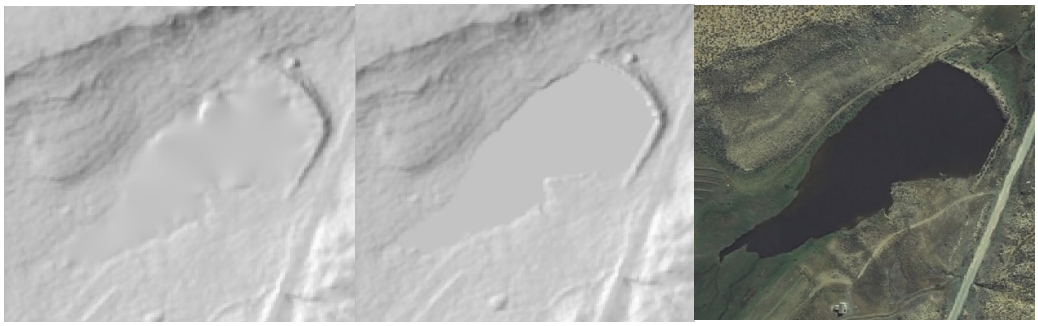

Figure 1 - Example of water body anomalies on the DEMSA2 product. Left is a raw DEMSA2 tile with a water anomaly, middle is the same tile after editing (removal of the anomaly), right is an RGB aerial image for reference.

The editing process involves the manual delineation of the water body (Figure 2 below), followed by the manual application of a correction function. The digitising of water bodies in this manner is a very time consuming process.

Figure 2 - A manually delineated water body

1. Aim:

The aim of the competition is to develop a computer vision system which GeoSmart can use to automatically detect and delineate water bodies from high resolution, geo-referenced RGB imagery.

2. Requirements:

a. The solution should be software code that adhere to the following technical requirements:

1. It should be able to detect and accurately delineate surface water.
2. The output should be a georeferenced polygon vector dataset in a common geospatial format. Examples of file formats include geoJSON, ESRI shapefile or GeoPackage. The output polygon vector dataset should be able to be dragged and dropped into QGIS for visualization.
3. Delineation should be as accurate as possible. The minimum accuracy requirement is an average MAEi (see Addendum) of 4 pixels (2 metres), measured against the validation set.
4. Detection should be as accurate as possible (i.e. not many omissions and not many commissions).
5. Both a training and validation set will be provided (the use of the validation set for training or model building will result in immediate disqualification).
6. The product has to be well-documented and should be easy to integrate into an automated workflow.
7. All software libraries used must be open source.
8. The use of Python is compulsory with Python 3 preferred. Only open source libraries may be utilized.

Submission:

b. Submissions should be sent to info@geosmart.space and should consist of a completed entry form, packaged source code, output polygons and relevant documentation as well as a report. The report should comprise of the following:

1. An introduction detailing the approach used to delineate waterbodies;
2. A methods section detailing how the software functions. It should also contain a workflow diagram and detail software libraries and data used;
3. An accuracy assessment section detailing the performance of the software. This section should comprise of the following:
    a. a description and workflow diagram detailing how accuracy assessment was conducted;
    b. a table summarising the performance of the software per image in the validation set. An example is given below. For a description of MAE_i and MAE_j, the participant is referred to the addendum.

Metric	MAE_i	MAE_j	Commission error	Omission error	Kappa index
Test case					

    c. a subsection where the participant can add any additional comments on the performance of their submission.
4. A concluding section where the participant can elaborate their thoughts on the performance of their software solution, and note any limitations as well as improvements that could be made.
5. A reference list, summarising all literature and software used to construct the software.

c. Ownership in the "Submissions" described under 3(a) above developed by the Participant(s) shall vest in GeoSmart, and the Participant(s) accordingly hereby cede, assign and transfer all of his/her rights, title and interest (including intellectual property rights) in and to the deliverables contained in such submissions to GeoSmart with effect from the date of delivery thereof to GeoSmart.

3. Resources:

A data package containing a set of 100 orthorectified and geocoded RGB aerial images each with a set of manually delineated waterbodies can be found here ("Data Package"). Around 400 manually delineated dams across South Africa are included in the set, which was manually curated. You are, however, free to obtain any other information deemed necessary, as long as it is open source and can be easily implemented into an automated workflow. Ownership of the Data Package (including all intellectual property rights therein) shall at all times remain vested in GeoSmart, and Participants are not permitted use the Data Package for any purpose other than to achieve the "Aim" described under 1.

4. Prize:

R10 000 is to be rewarded alongside a possible R10 000 contract for the implementation of the system. The winner will be selected by GeoSmart Space based on the performance of the software and operationalization potential. GeoSmart reserves the right not to choose a winner.

5. Competition dates:

Competition will open on 2020-03-11 and final submission should be submitted by 2020-03-27. No late submissions will be accepted. The winner will be announced by 2020-04-03.

Addendum - accuracy metrics:

MAEi and MAEj refer to two accuracy assessment metrics based on mean absolute error (MAE) distance. Two variants will be considered:

- MAEi measures the distance from each reference boundary (50x50cm) cell to the nearest extracted boundary cell, which provides an indication of how close in geographical space the extracted boundaries are to the actual boundary.

$$MAE_i = \frac{\sum EDi}{N}$$

- MAEj measures the distance from each extracted boundary cell to the nearest reference boundary cells and is an indicator of boundaries within a water body (caused by oversemgentation).

$$MAE_j = \frac{\sum EDj}{N}$$

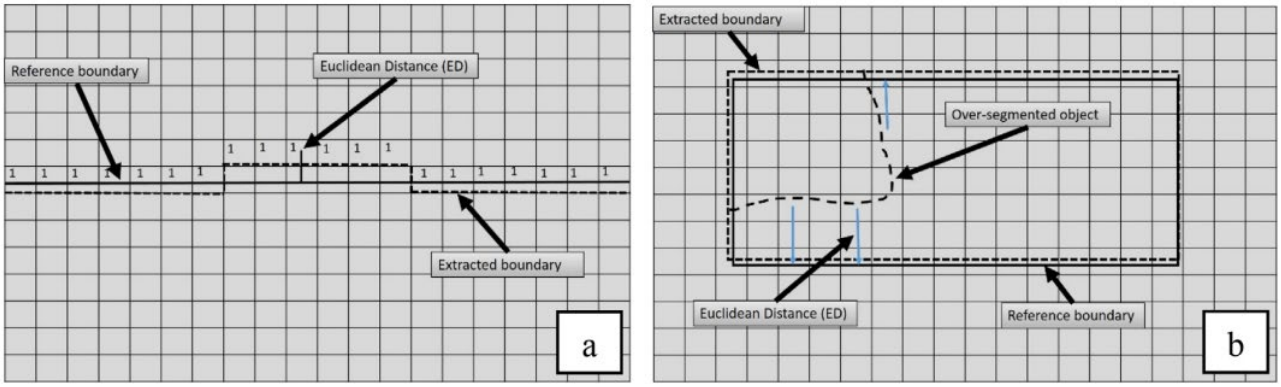

Fig. 3. Conceptual illustration of ED calculations, where (a) MAEi is depicting the accuracy along the boundary and (b) MAEj represents the level of over segmentation (Watkins & van Niekerk 2019).

Error of commission, omission and kappa index are all confusion matrix based error metrics. A confusion matrix (also known as an error matrix) is a table layout that visualises the performance of a classification algorithm.

		Reference class	
		Water	Not water
Predicted class	Water	a	b
	Not water	c	d

Commission error refers to the false negative percentage. Would be calculated as c / (a + c).
Omission error refers to false positive percentage. Would be calculated as b / (a + b).
Kappa index refers to Cohen's kappa, which is a measure of inter-raster reliability.

Addendum - recommended readings:

- Watkins & van Niekerk 2019 provides the basis for the accuracy assessment metrics that will be used.
- Land cover mapping from high resolution, RGB aerial imagery - https://www.hindawi.com/journals/js/2018/7195432/
- Waterbody mapping: a comparison of remotely sensed and GIS open data sources https://www.tandfonline.com/doi/full/10.1080/01431161.2018.1538584