Estimating LAI Using Vegetation Indices

Quantitative remote sensing of biophysical parameters (part II)

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Preparation

In this exercise, we will use a software system for technical computations called Matlab. If you have not yet installed Matlab on your computer, please do so.

Data

You may copy the folder "measured" from the network in your computer. Needed files for this exercise are:

samples.mat
lai.mat
wl.mat

For further information, please see the articles which are provided on the network by Darvishzadeh et al. 2011, Darvishzadeh et al. 2009 and of course the Matlab help.

Outline

Developments in the field of hyperspectral remote sensing and imaging spectrometry have opened new ways for monitoring plant growth and estimating the properties of vegetation. They have promoted a new group of narrow-band vegetation indices. Utilizing hyperspectral data, VIs can generally be calculated for all possible two-band combinations. The aim of this exercise is to understand and highlight the importance of hyperspectral data in comparison to multispectral data. Therefore the performance of narrowband and a typical vegetation index namely *NDVI* in estimating the LAI of a Mediterranean grassland will be assessed using R^2 and RMSE obtained from Linear regression models.

Data Exploration

Start MATLAB software through the MATLAB-Icon. MATLAB contains five windows: usually command window in the center, workspace, and command history on the left side of the screen and on the right side of the screen folders, and the details of files are demonstrated.

☞Change your current directory to where you have copied the data by browsing it from the menu bar on top.

Calculation of best narrow bands NDVI for LAI Estimation

In order to find the best possible band combination for the estimation of LAI, we will calculate *all* possible two-band combinations in the hyperspectral data. The reflectance matrix (samples) contains 584 wavelengths. Therefore 584*584 combinations exist for the calculation of narrow bands NDVI. Each time a narrow band NDVI has calculated its relation with LAI data is computed and stored in a matrix.

☞Define two loops to consider all the wavelengths of the reflectance matrix (samples):

```
for i=1:584;

   for j=1:584;
```

☞Now use the NDVI formula that you used earlier and modify it by replacing i and j instead of the band numbers.

NDVIn= …

☞Calculate the coefficient of determination as you did earlier between the calculated narrow band NDVIn and LAI. Name it r2n.

Each time this coefficient is calculated it will be placed in a pool matrix called R2pool

☞In your script type:

```
R2pool(i,j)=r2n (1,2);
```

☞Close the two “*for”* loops by entering the “end” command two times end;

end;

In order to find the maximum R^2 value in the pooled matrix, it is easier if we convert it into a vector. The matrix of R2pool can be converted to vector "A "by writing :

☞In your script type:

```
A=R2pool(:);
```

The maximum of A is the maximum R^2 value between particular hyperspectral band combinations and LAI. To find the maximum:

☞In your script type:

```
mm=max(A);
```

Now we can find the optimal band combination:

☞In your script type:

```
[k l]=find(R2pool==mm)
```

☞Open the matrix of wavelengths by double-clicking it in the workspace window and write down the wavelengths that correspond to the "k "and "l". What are these bands? Are they similar to the bands used for building a typical NDVI?

Compare the R^2 obtained between LAI and standard NDVI (NDVIs) and R^2 obtained using the best narrowband NDVI (NDVIn). What are their differences? How do you explain these differences?

Plotting the relationships

In order to demonstrate the relationships between the LAI data and the calculated indices you can use the "plot" command

☞In your script type:

```
figure(1)
plot(lai,NDVIs,'k*')
xlabel('LAI (cm cm^-2)')
ylabel('Standard NDVI (680 nm, 833 nm)')
title([' R^2=',num2str(R2NDVIs)])
```

Choose another figure number and plot the other result just as you did for standard NDVI.

Describe the obtained results and interpret how we have benefited from using hyperspectral narrow bands for estimation of a biophysical variable such as LAI.

You can end the MATLAB through the menu File/Exit Matlab or type into the command window: quit

For feedback, please submit your results (the script+ figures+ answers to the questions) to the AC system.

Challenge

You can use the relationship between LAI and the best narrowband NDVI (NDVIn), as well as the relationship between LAI and the standard NDVI (NDVIs) to estimate the LAI values. For these you can use linear regression (first-degree polynomial suffices). Your task: Calculate the RMSE of measured and estimated LAI, using both relationships

Good luck