Stackfit

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This program, written for the GNU Octave language, fits the two-stream model described by Rees et al. (Rees et al. 2020) to measurements of the reflectance of stacks of leaves. It should work as-is in MATLAB.

Inputs:

matrix *s* (*n* rows x 2 columns) containing the number of leaves in a stack (column 1) and the corresponding measured reflectance (column 2).

scalar r_g, the reflectance of the background to the leaf stack. This is typically zero if the measurements have been taken using a *Fieldspec* leaf probe or similar arrangement, i.e. with a matte black backing support under the leaf stack.

Output:

matrix *u* (3 × 3): Columns are respectively reflectance, transmittance absorptance. Row 1 contains the best-fitting values of the parameters, row 2 the minimum values, and row 3 the maximum values. The fitting criterion is the sum of squared errors, with the range of acceptable values being defined as the region for which this sum does not exceed twice the minimum value.

Calling: `u = stackfit(s, rg)`

Note: the parameter nstep is hard-coded into the routine. It controls the precision (=1/nstep) with which the reflectance, transmittance and absorptance of leaves are specified. The routine will fit values to 5 datapoints in around 4 s for nstep=200, and 46 s for nstep = 500.

Other functions called by the program:

stacksse(s, rg, rho, tau)

Inputs: *s*, r_g (defined above), ρ (1 × 1) (value of leaf reflectance), τ (1 × 1) (value of leaf transmittance).

Output: *ss* (1 × 1), the sum of squared errors when fitting the two-stream model defined by the parameters r_g, ρ and τ to the stack measurements in *s*.

twostreamiter(rg, rho, tau, n)

Inputs: r_g (defined above), ρ (1 × 1) (defined above), τ (1 × 1) (defined above), *nmax* (maximum number of leaves in the stack data).

Output: *rr* (nmax × 1): Calculated reflectance of leaf stacks with 1, 2, …, *nmax* leaves on a background with reflectance r_g, where each leaf has reflectance ρ and transmittance τ.

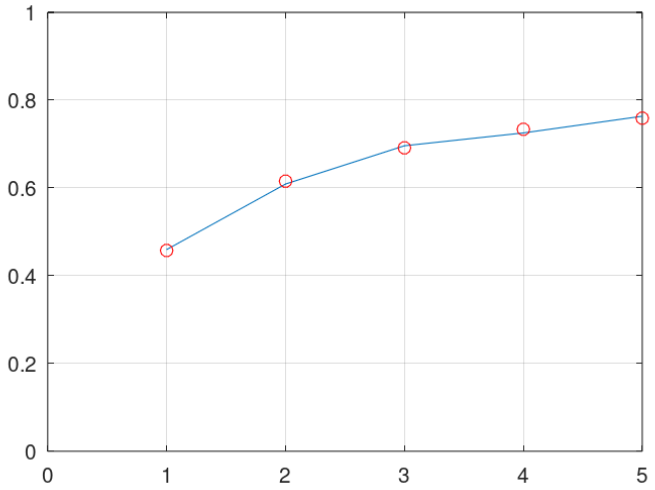
twostream(ρ, τ, *r*)

Inputs: ρ (1 × 1) (defined above), τ (1 × 1) (defined above), *r* (1 × 1) reflectance of a stack of *m* leaves.

Output: *r2*: Reflectance of a stack of *m*+1 leaves.

Example of use

```
>> a=load('stackdata.txt')
a =

   5.0000   0.7634
   4.0000   0.7253
   3.0000   0.6961
   2.0000   0.6089
   1.0000   0.4595

>> u=stackfit(a,0)
u =

   0.457500   0.522500   0.020000
   0.447500   0.510000   0.015000
   0.465000   0.537500   0.025000

>> plot(a(:,1),a(:,2))
>> hold on
>> rfit=twostreamiter(0,u(1,1),u(1,2),5)
rfit =

   0.4575
   0.6155
   0.6914
   0.7336
   0.7589

>> plot(rfit,'ro')
>> hold off
>> axis([0 5 0 1])
```



Reference

Rees, W. G., E. I. Golubeva, O. V. Tutubalina, M. V. Zimin, and A. A. Derkacheva. 2020. ‘Relation between Leaf Area Index and NDVI for Subarctic Deciduous Vegetation’. *INTERNATIONAL JOURNAL OF REMOTE SENSING* 41 (22): 8573–89. https://doi.org/10.1080/01431161.2020.1782505.