

reconstruction_and_feature_enhancement_plus

This program reconstructs a data cube using the results obtained with the PCA Tomography. This reconstruction of the data cube can be done in two different ways, which will be better explained below. The data cube generated by this program will have a header containing the parameters “CRVAL3”, “CRPIX3” and “CDELTA3” (related to the wavelength calibration). To use this program, first of all, it’s necessary to provide the following parameters (which must be added to the section “input parameters” in the program’s script):

infolder: directory containing ALL files that will be used during the execution of the program.

finalcube: name of the data cube (full path) reconstructed by the program.

logfile: name of the logfile (full path) to be created.

minspecpx and maxspecpx: values of the lowest and highest spectral pixel used in the execution of the PCA. If the user has made a re-binning in the data cube before the execution of the PCA, then, the parameters minspecpx and maxspecpx must correspond to the values of the already binned data cube.

minspatpx_x and maxspatpx_x: values of the lowest and highest spatial pixel of the horizontal axis of the data cube’s images used in the execution of the PCA.

minspatpx_y and maxspatpx_y: values of the lowest and highest spatial pixel of the vertical axis of the data cube’s images used in the execution of the PCA.

lambdazero: value of the wavelength corresponding to the lowest spectral pixel (minspecpx) considered in the execution of the PCA Tomography.

deltalambda: wavelength interval between two consecutive spectral pixels. If the initial data cube has been re-binned, then, the value of these parameters must be equal to original value of the wavelength interval between two consecutive spectral pixels multiplied by the value of the parameter “reduce factor”, provided for the execution of the program “pca_tomography_plus”.

After providing these parameters, the program shall be initiated. The following question will, then, appear to the user:

"Do you wish to perform a simple reconstruction of the datacube or a feature suppression and enhancement process (reconstruction/feature)?" (1)

The possible answers to this question are “reconstruction” or “feature” (the answers “r” or “f” will also be accepted by the program). The simple reconstruction of the data cube is the process in which all eigenvectors until a certain higher limit (r) are used to reconstruct the data cube. If this is the user’s choice, then, the following message will appear:

"Do you wish to execute the process using the constructed eigenspectra and tomograms or using the tables containing the parameters of the eigenspectra and tomograms (eigenspectra/tables)?" (2)

The possible answers to this question are “eigenspectra” or “tables” (the answers “e” or “t” will also be accepted by the program). This option is available because some users keep the tables corresponding to the parameters SCORE and PC of the program “pca_tomography_plus”, but others opt for delete them, keeping only the constructed eigenspectra and tomograms. With the option presented by the question (2), the user will be able to use this program in any of these circumstances. If the answer to the question (2) is “eigenspectra”, then the following messages will appear sequentially to the user:

"Enter the prefix of the eigenspectra files: " (3)

"Enter the prefix of the tomograms files: " (4)

"Enter the number of the highest order eigenvector to be used in the reconstruction process: " (5)

The user must provide, then, all the necessary parameters. The prefixes provided in (3) and (4) must be the same to those corresponding to the parameters “eigenspectra_prefix” and “tomograms_prefix” provided in the program “pca_tomography_plus”, unless the user has renamed, after the execution of “pca_tomography_plus”, the constructed eigenspectra and tomograms. If that is the case, the proper prefixes must be provided. It is worth to remember that the program will only accept eigenspectra in txt format and tomograms in fits format.

If the answer to the question (2) is “tables”, the following messages will appear sequentially:

"Enter the file's name of the table containing the parameters of the tomograms obtained with the PCA tomography: " (6)

"Enter the file's name of the table containing the parameters of the eigenvectors obtained with the PCA tomography: " (7)

"Enter the number of the highest order eigenvector to be used in the reconstruction process: " (8)

The user shall provide all the necessary parameters. After that, the user will be able to opt for adding back or not the average spectrum of the original data cube. The following question will appear:

"Do you wish to add the average spectrum to the reconstructed datacube (yes/no)?" (9)

The program will accept not only the answers “yes” or “no”, but also the answers “y” or “n”. If the answer chosen by the user is “yes”, the following message will appear:

"Enter the name of the file containing the average spectrum of the original datacube used in the PCA tomography: " (10)

The requested file in (10) was provided by the program “pca_tomography_plus”.

If the answer to the question (1) is “feature”, then, the process of the “feature suppression and enhancement” will be applied. In this process, the data cube is reconstructed using a specific combination of eigenvectors, in order to emphasize or suppress some characteristic or structure of the data cube. In this case, the question (2) will appear to the user. If the user’s answer to it is “eigenspectra”, the messages (3) and (4) will appear sequentially and the proper prefixes shall be provided. After that, the following question will appear:

"Do you wish to perform the feature suppression and enhancement process using method 1 or method 2 (1/2)?" (11)

The possible answers to this question are “1” or “2”. If method 1 is chosen, the reconstruction will be made by multiplying the columns of the matrix corresponding to the file given by the parameter PC (matrix containing the eigenvectors obtained with the PCA Tomography disposed in columns) by the respective “feature factors”, which will be provided by the user. If method 2 is chosen, not only the multiplication by the “feature factors” (which can assume the values -1, 0 or 1) will be made, but also the columns of the matrix corresponding to the file given by the parameter SCORE (matrix containing the tomograms obtained with the PCA Tomography disposed in columns) will be multiplied by the respective “Nk factors”, given by

$$Nk = \frac{1}{((eigenvalue_k) \cdot (n - 1))^{0.5}} \quad (I)$$

where eigenvalue_k = eigenvalue corresponding to the eigenvector k
n = number of spatial pixels of the data cube to be reconstructed

With the above procedure, each tomogram becomes normalized in such a way that the quadratic sum of the values of its spatial pixels is equal to 1. In the application of methods 1 and 2, the average spectrum of the original data cube is not added to the reconstructed data cube. If the user chooses method 1, then, the following messages will appear sequentially:

"Enter the number of the eigenvectors to be considered in the feature suppression and enhancement process: " (12)

"Enter the name of the file containing the eigenvectors to be considered in the process: " (13)

"Enter the name of the file containing the feature factors to be attributed to all the eigenvectors in the process: " (14)

The files requested by (13) and (14) must be located in the directory identified by the parameter "infolder". The file requested by (13) must be configured in the following way:

N1
N2
N3
.
.
.
Nn

where N1, N2, N3,..., Nn are the numbers of the eigenvectors to be considered in the f feature suppression and enhancement process

The file requested by (14) must be configured in the following way:

gama_k1
gama_k2
gama_k3
.
.
.
gama_kn

where gama_k1, gama_k2, gama_k3,... and gama_kn are the "feature factors" to be attributed to each ne of the eigenvectors mentioned in the previous file

It's important to mention that the order of the "feature factors" mentioned in this file must correspond exactly to the order of the eigenvectors mentioned in the file requested by (13).

If, after question (11), the user chooses method 2, the messages (12), (13) and (14) will appear sequentially and the requested parameters must be provided as explained above. After that, the following message will appear:

"Enter the name of the file containing the eigenvalues of the eigenvectors to be considered in the feature suppression and enhancement process: " (15)

The file requested by (15) must be located in the directory identified by the parameter "infolder". This file must be configured in the following way:

eigenvalueN1
eigenvalueN2
eigenvalueN3
.
.
.
eigenvalueNn

where eigenvalueN1, eigenvalueN2, eigenvalueN3,... and eigenvalueNn are the eigenvalues, obtained with the PCA Tomography, associated to each one of the eigenvectors mentioned in the file requested by (13)

Again, the order of the eigenvalues mentioned in this file must correspond exactly to the order of the eigenvectors mentioned in the file requested by (13).

IMPORTANT NOTE: A feature factor equal to 0 will be automatically attributed to all eigenvectors that aren't mentioned in the file requested by (13), i.e., these eigenvectors will not be taken into account in the reconstruction of the data cube.

If the user's answer to the question (1) is "feature" and, following that, the answer to the question (2) is "tables", then, the messages (6) and (7) will appear sequentially and the requested files must be provided as explained above. After that, the question (11) will appear to the user. If the answer is 1 (i.e., if the user chooses to execute the "feature suppression and enhancement process" using method 1), the messages (12), (13) and (14) will appear sequentially and the requested parameters must be provided. On the other hand, if the answer to the question (11) is 2 (i.e., if the user chooses to execute the "feature enhancement process" using method 2), the messages (12), (13), (14) and (15) will appear sequentially and the requested parameters must be provided, as explained above.