



# Installation notes

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In recent years MATLAB undertook several important changes, which made difficult for us to keep FSDA aligned to the MATLAB system. For example, from R2012b a Toolstrip replaced menus and toolbars in the MATLAB Desktop, a gallery of apps was introduced in the desktop and the documentation system was redesigned, for the first time after years of stability; with R2014a third party software documentation was moved to a separate section without filtering and searching possibilities; with R2014b there was a major update of the MATLAB graphics system that forced us to revisit most of the FSDA plotting functions; with R2015a the third party documentation was changed again, and was partly reintegrated in the MATLAB documentation system. This is why you may find these installation notes rather intricate: we apologise if this is going to happen and we invite you to signal problems or bugs that you think are in contradiction with, or should be reported in, these notes. With your help, it will be easier for us to make these installation notes ... superfluous.

1. FSDA works from the release R2009b of MATLAB and uses the Statistics toolbox.
2. FSDA can be installed:
  - a. Automatically with our setup program for Windows platforms. The automatic installation updates your MATLAB search path and installs the FSDA documentation pages in:

`(docroot folder)\FSDA`, If your release of MATLAB is  $\leq$ 2012a

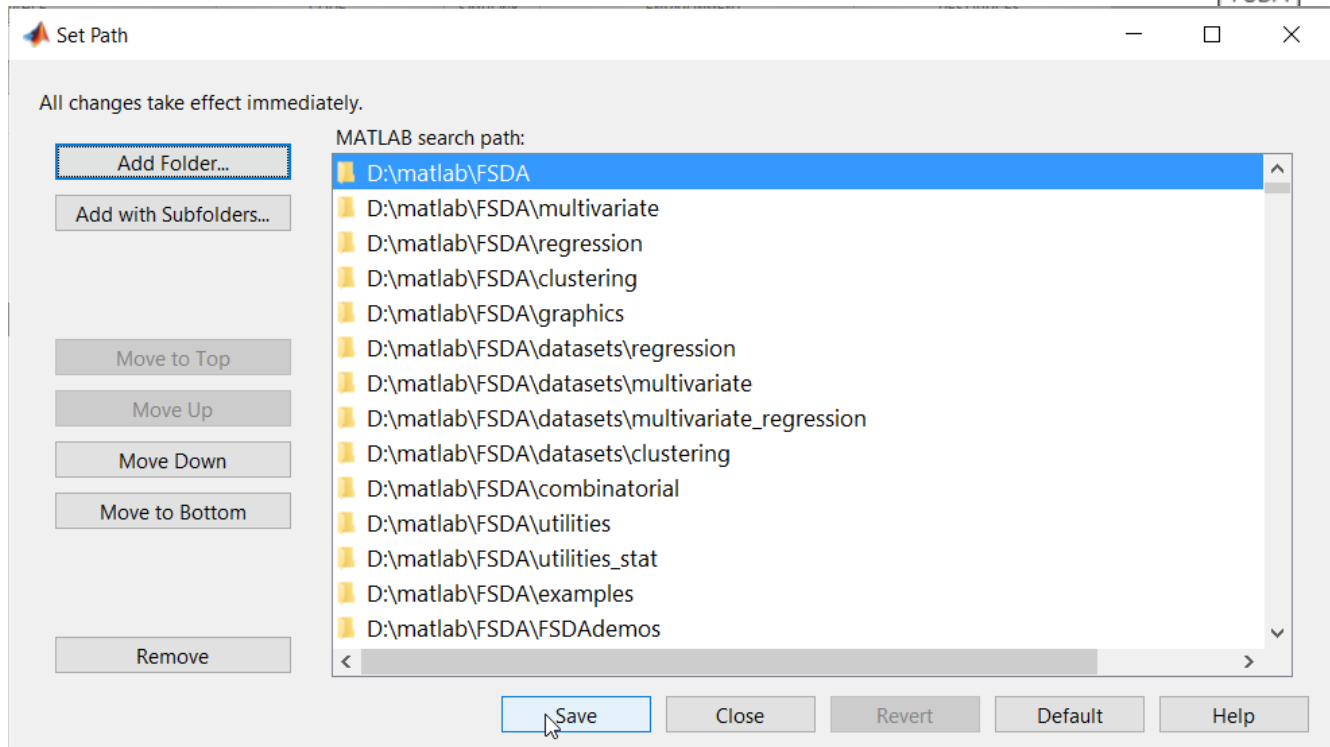
`(FSDA root folder)\helpfiles\FSDA`, if your release of MATLAB is  $>$ 2012a.

To find out where your `docroot` folder is located it is enough o type `docroot` in the command prompt.

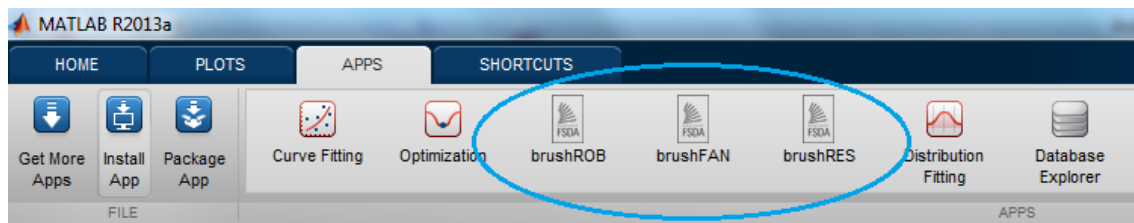
- b. Manually by unpacking the compressed tar file `FSDA.tar.gz` under a folder of your choice (say `programs`). The search path update can be done by running the MATLAB scripts `addFSDA2path.m` that is located in the `FSDA root folder`. If your release is  $>$ 2012a the files present inside `(FSDA root folder)\helpfiles\FSDA` must be moved to `(docroot folder)\FSDA`.
3. If there are multiple releases of MATLAB installed in your computer, our setup program will ask you to **choose to which release the FSDA Toolbox has to be associated and where** (under which folder) it has to be installed. The search path update and documentation setup are modified accordingly. However, if other MATLAB releases are present and the user intends to run FSDA also on them, the two steps should be completed manually by using the already mentioned `addFSDA2path.m` (see 2b) as follows (now assuming a MS Windows platform installation under `D:\programs\FSDA`):

```
>> addFSDA2path('D:\programs\FSDA')
```

4. If FSDA has been installed properly (in what follows without loss of generality we assume, for example, that FSDA has been installed in folder `D:\matlab\FSDA`), after the installation the **“Set Path” window of MATLAB should include the following FSDA search paths** (the last three being introduced with FSDA V3.0 (i.e. starting with MATLAB R2015a).



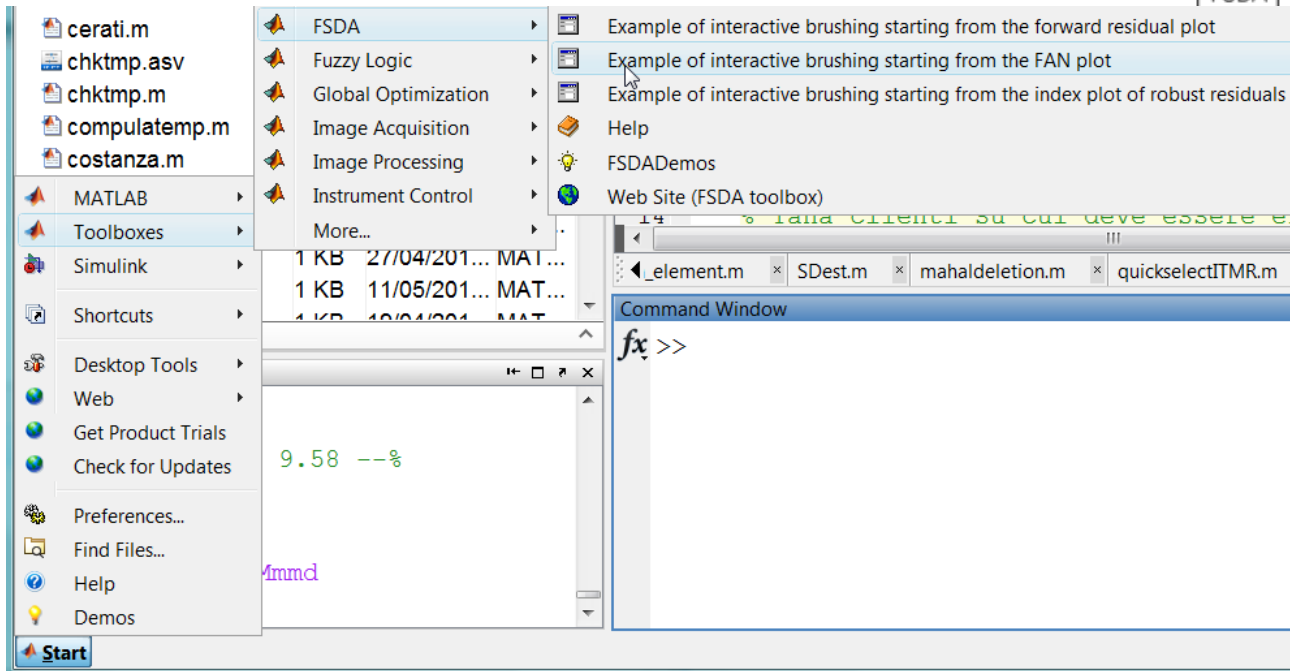
5. If FSDA is installed in MATLAB R2012b or subsequent releases, three APPS (brushRES, brushFAN and brushROB) are automatically installed:



Remark: if the three APPS have not been automatically installed, you can easily install them manually by double clicking on the files brushFAN.mlappinstall, brushRES.mlappinstall and brushROB.mlappinstall contained in the root folder of FSDA.

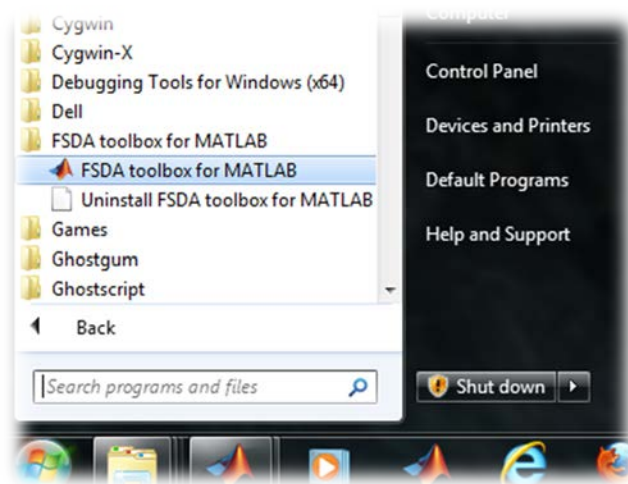
Current Folder		Workspace		
Name	Type	Date...	Size	
InstallationNotes.pdf	Adobe Acrobat Document	30/04...	869 ...	
brushFAN.mlappinstall	MATLAB App Installer	30/04...	44 KB	
brushRES.mlappinstall	MATLAB App Installer	30/04...	34 KB	
brushROB.mlappinstall	MATLAB App Installer	30/04...	11 KB	

If FSDA is installed in MATLAB 2012a or earlier the three APPS appear inside MATLAB Start button | Toolboxes | FSDA.



These APPS are graphical user interfaces conceived to demonstrate some functionalities of FSDA.

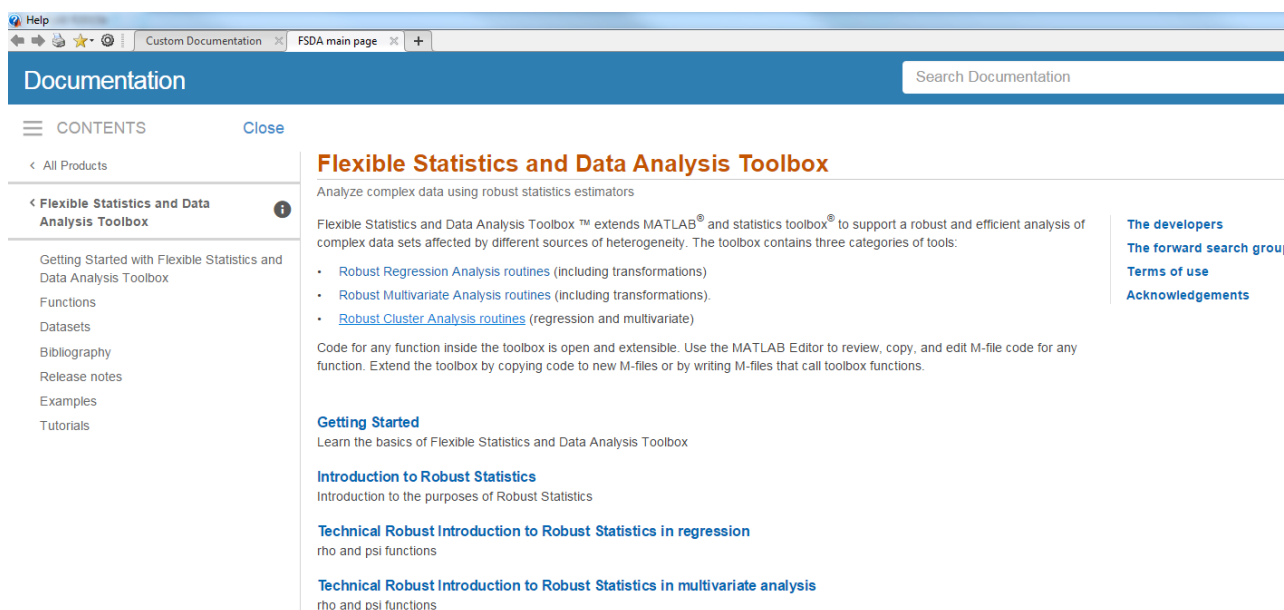
6. Our setup program, if successfully executed, adds to the “Program Files” Windows Menu the entry “FSDA toolbox for MATLAB”, including a **FSDA uninstall program** that should be used by the user to remove an obsolete FSDA release, before an update:



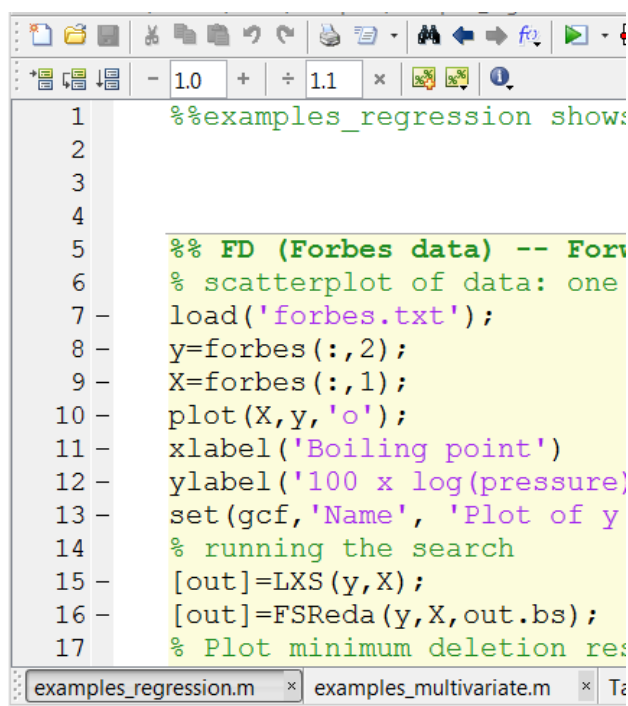
7. Nonetheless, to avoid problems that may occur if FSDA is installed with our setup program more than once, the setup program tries to locate and remove (with the agreement of the user) previous FSDA installations.
8. If everything went well with an automatic or manual installation, when you open MATLAB, the MATLAB “Help” pages should include FSDA with all its submenus.



a. The MATLAB “Help” pages should include FSDA, as shown below:

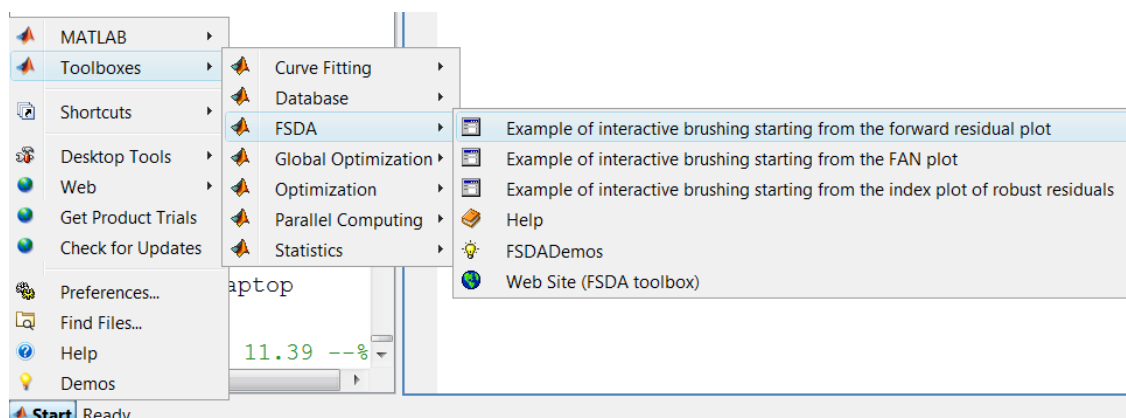


b. With the setup installer, two example files named “examples\_regression.m” and “examples\_multivariate.m” should be opened automatically. These files contain a series analysis of several well-known datasets in the literature of robust statistics and have the purpose to let the user familiarize with the toolbox (these two files are contained in (main folder of FSDA) \examples).

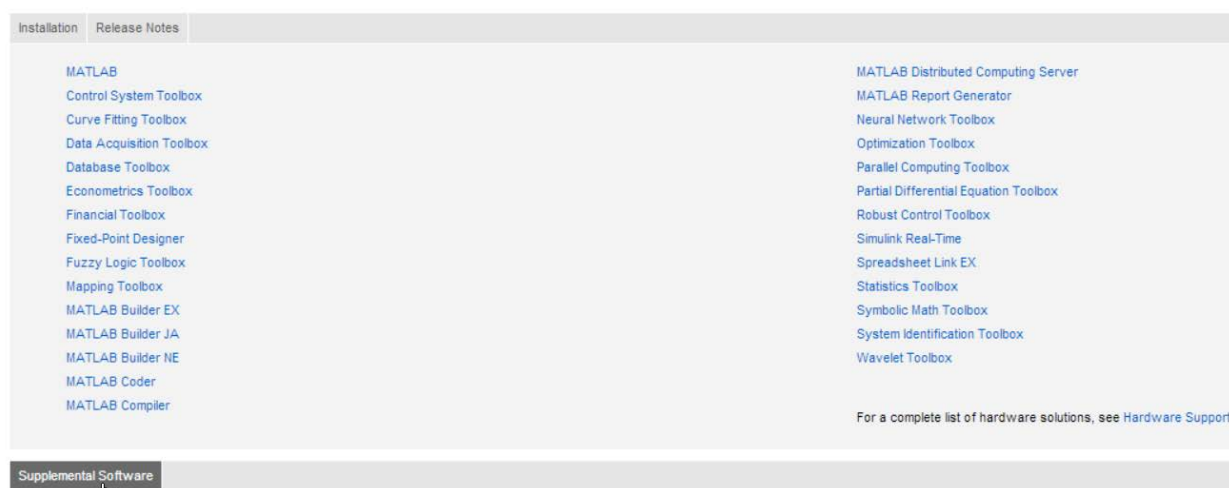




- c. **FSDA should appear among the installed “Toolboxes” in the MATLAB “Start Menu” (only for MATLAB releases before R2012b)**



- d. **For MATLAB R2012b to R2014b installations, the html help files can be found in the Supplemental Software tab which appears at the bottom of the Doc Center home page (see screenshot below).**





For MATLAB 2015a-2016b installations, the html help files can be found in the **Supplemental Software** link, (see screenshot below)

### Screenshot for MATLAB 2016b

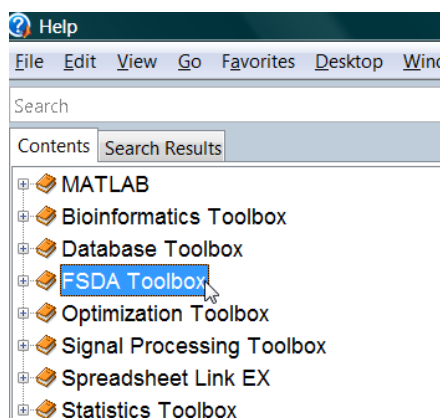
The screenshot shows the MATLAB 2016b Documentation page. The top navigation bar is blue with the word "Documentation" on the left and a search box on the right. Below the navigation bar is a sidebar with a "CONTENTS" button and a "Close" button. The sidebar lists "All Products" with links to Installation, Release Notes, and Other Releases. The main content area is divided into two columns. The left column lists various toolboxes and toolboxes, including MATLAB, Simulink, Aerospace Toolbox, Bioinformatics Toolbox, Communications System Toolbox, Computer Vision System Toolbox, Control System Toolbox, Curve Fitting Toolbox, Data Acquisition Toolbox, Database Toolbox, DSP System Toolbox, Econometrics Toolbox, Embedded Coder, Financial Instruments Toolbox, Financial Toolbox, Fixed-Point Designer, Fuzzy Logic Toolbox, HDL Coder, Image Acquisition Toolbox, Image Processing Toolbox, Instrument Control Toolbox, Mapping Toolbox, and MATLAB Coder. The right column lists more toolboxes, including MATLAB Distributed Computing Server, Model Predictive Control Toolbox, Neural Network Toolbox, OPC Toolbox, Optimization Toolbox, Parallel Computing Toolbox, Partial Differential Equation Toolbox, Robotics System Toolbox, Robust Control Toolbox, Signal Processing Toolbox, SimBiology, Simscape, Simscape Electronics, Simscape Fluids, Simscape Multibody, Simscape Power Systems, Simulink Coder, Simulink Control Design, Simulink Design Optimization, Stateflow, Statistics and Machine Learning Toolbox, Symbolic Math Toolbox, System Identification Toolbox, and Wavelet Toolbox. At the bottom of the right column, there is a link to "Supplemental Software" and a link to "FSDA Toolbox".

### Screenshot for MATLAB 2017a

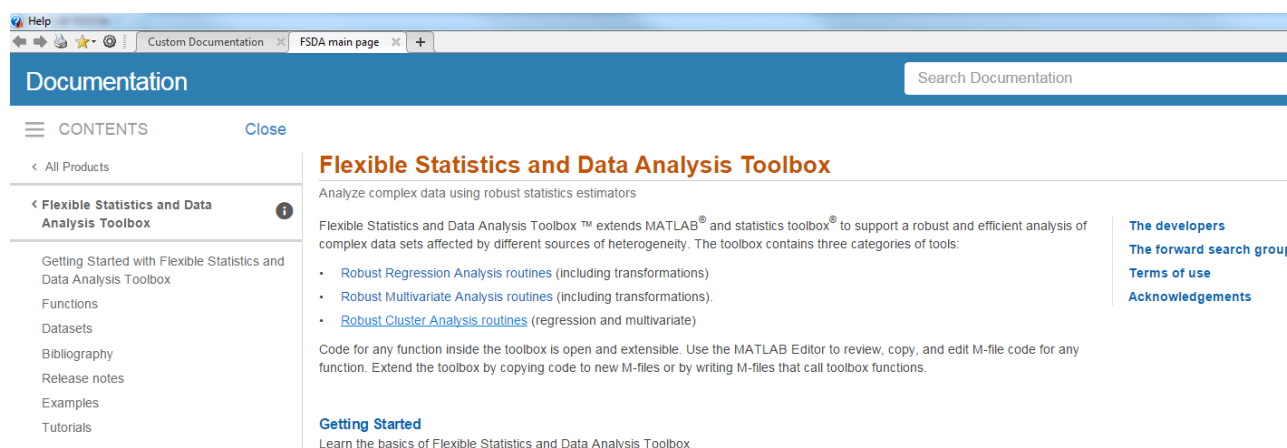
The screenshot shows the MATLAB 2017a Documentation page. The top navigation bar is blue with the word "Documentation" on the left and a search box on the right. Below the navigation bar is a sidebar with a "CONTENTS" button and a "Close" button. The sidebar lists "My Products" with links to MATLAB, Simulink, Aerospace Toolbox, Bioinformatics Toolbox, Communications System Toolbox, Computer Vision System Toolbox, Control System Toolbox, Curve Fitting Toolbox, Data Acquisition Toolbox, Database Toolbox, DSP System Toolbox, Econometrics Toolbox, Embedded Coder, Financial Instruments Toolbox, Financial Toolbox, and Fixed-Point Designer. The main content area is divided into three columns. The left column is titled "My Products" and lists "MATLAB Family" with links to MATLAB, Parallel Computing, MATLAB Distributed Computing Server, Parallel Computing Toolbox, Math, Statistics, and Optimization, Curve Fitting Toolbox, Global Optimization Toolbox, and Neural Network Toolbox. The middle column is titled "Simulink Family" and lists Simulink, Event-Based Modeling, Stateflow, Physical Modeling, Simscape, Simscape Electronics, Simscape Fluids, Simscape Multibody, and Simscape Power Systems. The right column is titled "Hardware Support" and lists "MATLAB Support Package for Raspberry Pi Hardware" and "For a complete list of hardware solutions, see Hardware Support." Below the "Hardware Support" section is a link to "Supplemental Software" and a link to "FSDA Toolbox".



e. For MATLAB installations earlier than 2012b, the documentation is located in the same place as all the other official Mathworks toolboxes (see bottom panel of screenshot below):



Independently from MATLAB version you use, once you click on the link FSDA Toolbox you should reach our main documentation page (see screenshot below)



Remark: you can reach our main documentation page also simply typing `docsearchFS` in the command prompt

```
>> docsearchFS
```

From our main documentation page you can go to the Examples page (see screenshot below),



< All Products

< Flexible Statistics and Data Analysis Toolbox

Getting Started with Flexible Statistics and Data Analysis Toolbox

Functions

Datasets

Bibliography

Release notes

Examples

Tutorials

## Flexible Statistics and Data Analysis Toolbox

Analyze complex data using robust statistics estimators

Flexible Statistics and Data Analysis Toolbox™ extends MATLAB® and statistics toolbox® to affected by different sources of heterogeneity. The toolbox contains three categories of tools:

- [Robust Regression Analysis routines](#) (including transformations)
- [Robust Multivariate Analysis routines](#) (including transformations).
- [Robust Cluster Analysis routines](#) (regression and multivariate)

Code for any function inside the toolbox is open and extensible. Use the MATLAB Editor to re toolbox by copying code to new M-files or by writing M-files that call toolbox functions.

### Getting Started

Learn the basics of Flexible Statistics and Data Analysis Toolbox

where you can find GUIs, example codes (see screenshot below).

CONTENTS Close

< All Products

< Flexible Statistics and Data Analysis Toolbox

**Flexible Statistics and Data Analysis Toolbox Examples**

ON THIS PAGE

Robust Regression

Robust Multivariate Analysis

Robust Transformations

Classification



Dynamic scatter plot matrix



Plotting



### Flexible Statistics and Data Analysis Toolbox Examples

#### Robust Regression



More Examples



 Displays a GUI where it is possible to brush steps from the monitoring residuals plot  App

 Displays a GUI where it is possible to brush units from the index plot of residuals  App



 Examples of Robust Regression Using Robust Estimators  Script

#### Robust Multivariate Analysis

 Displays a GUI where it is possible to brush steps from the monitoring distances plot  App

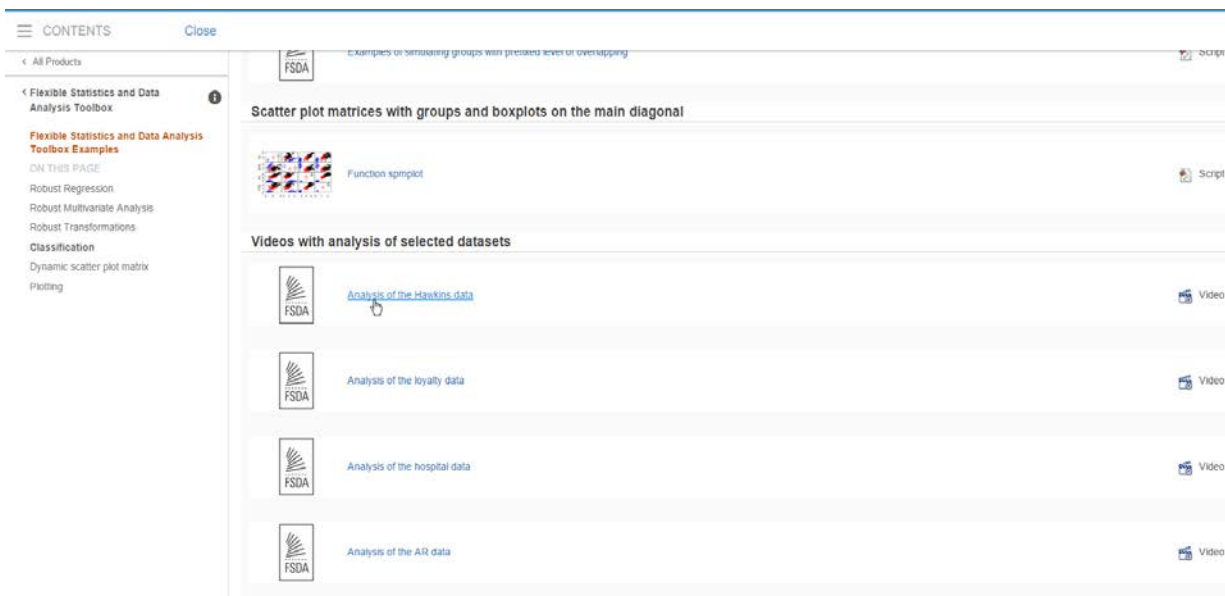
 Examples of multivariate analysis using Robust Estimators  Script

#### Robust transformations Analysis

 Displays a GUI where it is possible to brush steps from the fan plot  App

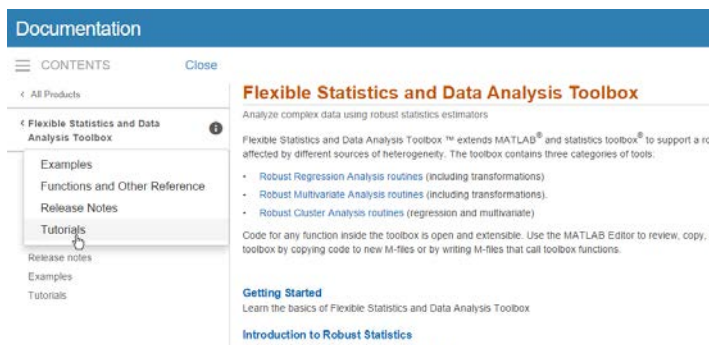


and links to videos containing the analysis of selected examples (see screenshot below)

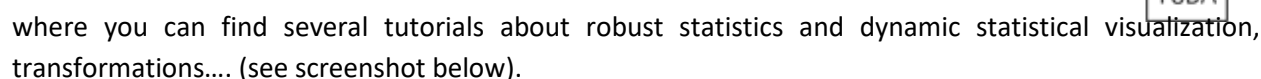


The screenshot shows the FSDA documentation interface. On the left, a sidebar contains a 'CONTENTS' menu with a 'Close' button. Below the menu, there are links to 'All Products' and 'Flexible Statistics and Data Analysis Toolbox'. The 'Flexible Statistics and Data Analysis Toolbox' section is expanded, showing a list of topics: 'Flexible Statistics and Data Analysis Toolbox Examples', 'ON THIS PAGE', 'Robust Regression', 'Robust Multivariate Analysis', 'Robust Transformations', 'Classification', 'Dynamic scatter plot matrix', and 'Plotting'. The main content area displays a section titled 'Scatter plot matrices with groups and boxplots on the main diagonal' with a 'Function script' link. Below this, there is a section titled 'Videos with analysis of selected datasets' which lists four videos: 'Analysis of the Hawkins data', 'Analysis of the loyalty data', 'Analysis of the hospital data', and 'Analysis of the AR data'. Each video entry includes an FSDA logo, a title, and a 'Video' icon.

From any point of our documentation system you can go to the “Tutorials” page (see screenshot below)



The screenshot shows the FSDA documentation interface with the 'Tutorials' page selected. The sidebar on the left has a 'CONTENTS' menu with a 'Close' button. Below the menu, there are links to 'All Products' and 'Flexible Statistics and Data Analysis Toolbox'. The 'Flexible Statistics and Data Analysis Toolbox' section is expanded, showing a list of topics: 'Examples', 'Functions and Other Reference', 'Release Notes', 'Tutorials', 'Release notes', 'Examples', and 'Tutorials'. The 'Tutorials' link is highlighted. The main content area displays the title 'Flexible Statistics and Data Analysis Toolbox' and a description: 'Analyze complex data using robust statistics estimators'. Below this, there is a list of topics: 'Getting Started', 'Introduction to Robust Statistics', and 'Introduction to Robust Statistics'. The 'Getting Started' link is highlighted.



CONTENTS

## < Flexible Statistics and Data Analysis Toolbox

## Functions and Other Reference

## Tutorials

## Examples

## Tutorials

## Introduction to robust statistics

- Technical introduction to robust statistics in regression
- Technical introduction to robust statistics in multivariate analysis
- Introduction to the forward search philosophy of data analysis

- Introduction to dynamic visualization
- Dynamic visualization in the context of the forward search
- Dynamic visualization in the index plot of residuals
- Dynamic visualization in the monitoring residuals plot
- Dynamic visualization in the minimum deletion residuals plot
- Dynamic visualization in the fan plot
- Dynamic visualization in the yXplot
- Dynamic visualization in the candlestickplot

- Introduction to robust estimators in linear regression
- Robust linear regression using LMS and LTS estimators
- Robust linear regression using S and MM estimators
- Robust forward linear regression with exploratory purposes
- Robust forward linear regression with automatic outlier detection procedure

- Introduction to robust transformations in linear regression
- Score test for transformation
- Forward score test

- Introduction to variable selection
- Variable selection using forward added-t-test
- Robust model selection using  $C_p$



On the other hand, if from the left menu one clicks on “Functions and Other References” (see screenshot above), it is possible to go the categorical list of functions present in the toolbox (see screenshot below)

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< All Products

< Flexible Statistics and Data Analysis Toolbox

**Flexible Statistics and Data Analysis Toolbox**

ON THIS PAGE

Robust regression analysis and transformations

Robust multivariate analysis and transformations

Robust clustering

Dynamic visualization

Guis

Utilities

## Flexible Statistics and Data Analysis Toolbox Functions

Alphabetical ListBy Category

### Robust regression analysis and transformations

#### Robust regression

<a href="#">addt</a>	Produces the t test for an additional expl. variable
<a href="#">FSR</a>	Gives an automatic outlier detection procedure in linear regression
<a href="#">FSRBbsb</a>	Returns the units belonging to the subset in each step of the Bayesian forward search
<a href="#">FSRbbsb</a>	Returns the units belonging to the subset in each step of the forward search
<a href="#">FSRbda</a>	Enables to monitor several quantiles in each step of the forward search
<a href="#">FSRbvmldr</a>	Computes the theoretical envelopes of Minimum Deletion Residual outside subset during the s
<a href="#">FSRinvmldr</a>	Converts values of minimum deletion residual into confidence levels
<a href="#">FSRmdr</a>	Computes minimum deletion residual and other basic linear regression quantities in each step
<a href="#">FSRr</a>	Forward search in linear regression reweighted
<a href="#">LXS</a>	Computes the Least Median of Squares (LMS) or Least Trimmed Squares (LTS) estimators
<a href="#">MMreg</a>	Computes MM estimator of regression coefficients
<a href="#">MMregcore</a>	Computes MM regression estimators for a selected fixed scale
<a href="#">RobCov</a>	Computes covariance matrix of robust regression coefficients

Of course clicking on the button 

Alphabetical List

 it is possible to browse in alphabetical order the documentation of the 185 functions present inside the FSDA toolbox (see screenshot below).

< Flexible Statistics and Data Analysis Toolbox

**Flexible Statistics and Data Analysis Toolbox**

ON THIS PAGE

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K

L

M

N

O

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R

**S**

T

U

V

X

Y

Z

## T

<a href="#">tabulateFS</a>	Create frequency table of unique values of x, excluding possible 0 counts
<a href="#">Taureg</a>	Computes Tau estimators in linear regression
<a href="#">TBbdp</a>	Finds the constant c associated to the supplied breakdown point for Tukey's biweight
<a href="#">TBc</a>	Computes breakdown point and efficiency associated with constant c for Tukey's biweight
<a href="#">TBcEff</a>	Finds the constant c which is associated to the requested efficiency for Tukey biweight estimat
<a href="#">TBpsi</a>	Computes psi function (derivative of rho function) for Tukey's biweight
<a href="#">TBpsidr</a>	Computes derivative of psi function (second derivative of rho function) for Tukey's biweight
<a href="#">TBpsix</a>	Computes psi function (derivative of rho function) times x for Tukey's biweight
<a href="#">TBrho</a>	Computes (rho) function for Tukey biweight
<a href="#">TBwei</a>	Computes weight function psi(u)/u for Tukey biweight
<a href="#">tclust</a>	Computes trimmed clustering with restrictions on the eigenvalues
<a href="#">tclustIC</a>	Computes tclust for different number of groups k and restriction factors c
<a href="#">tclustICplot</a>	Plots information criterion as a function of c and k
<a href="#">tclustICsol</a>	Extracts a set of best relevant solutions
<a href="#">tclustreg</a>	Performs robust linear grouping analysis
<a href="#">tkmeans</a>	Computes trimmed k-means
<a href="#">triu2vec</a>	Extracts in a vector the linear indexes or the elements on and above the k-th diagonal of a squ

## U

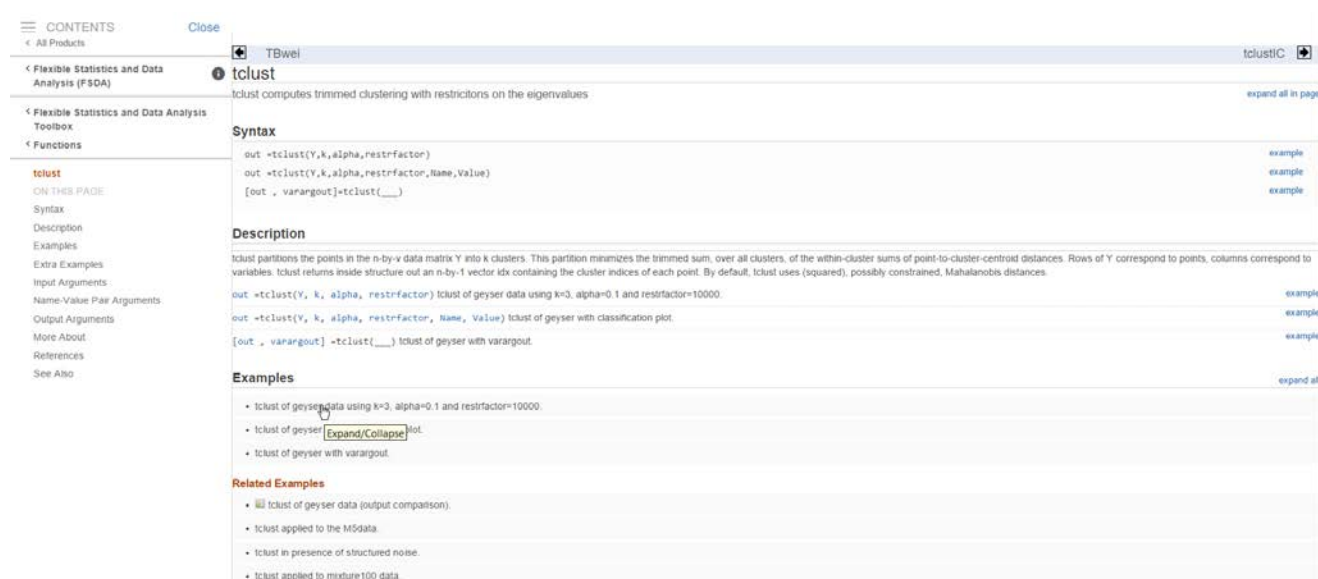
<a href="#">unibiv</a>	Has the purpose of detecting univariate and bivariate outliers
<a href="#">upperfracpos</a>	Positions two figures on the upper part of the screen

## V


## W

<a href="#">winsor</a>	Returns a winsorized copy of input
------------------------	------------------------------------


By clicking on one of these links (for example on `tcclust`, see screenshot above) it is possible to reach the HTML documentation of the function in a perfect new MATLAB documentation style (see screenshot below)




These HTML documentation pages have been created automatically by our routines publishFS. Every HTML documentation contains a series of **Examples** and **Related Examples**.

The icon  at the beginning of the line, indicates that the associated example has been executed and its output has been captured inside the HTML file. For example, if you click on the first of the Related Examples (see screenshot below)

## Related Examples

-  `tcclust` of geyser data (output comparison).  
[Expand/Collapse](#)
- `tcclust` applied to the M5data.

It is possible to see both the code (note that the code is displayed inside HTML using typical Matlab colouring) and the output which was generated (see the two screenshots below)

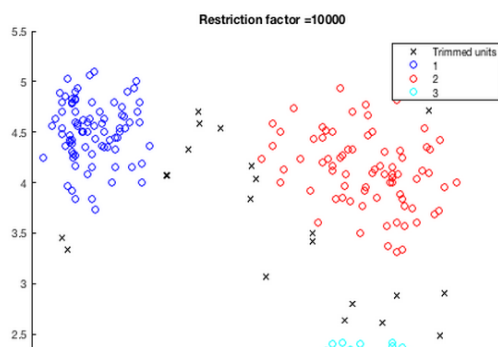
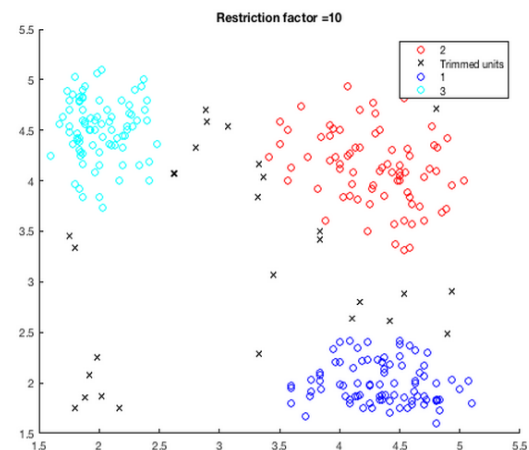
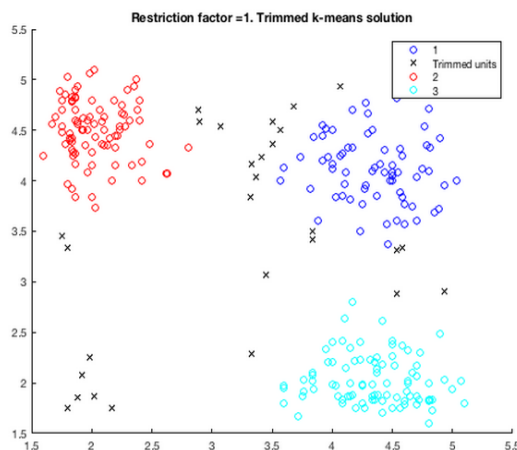
-  tclust of geyser data (output comparison).

[Expand/Collapse](#)

We compare the output using three different values of restriction factor.

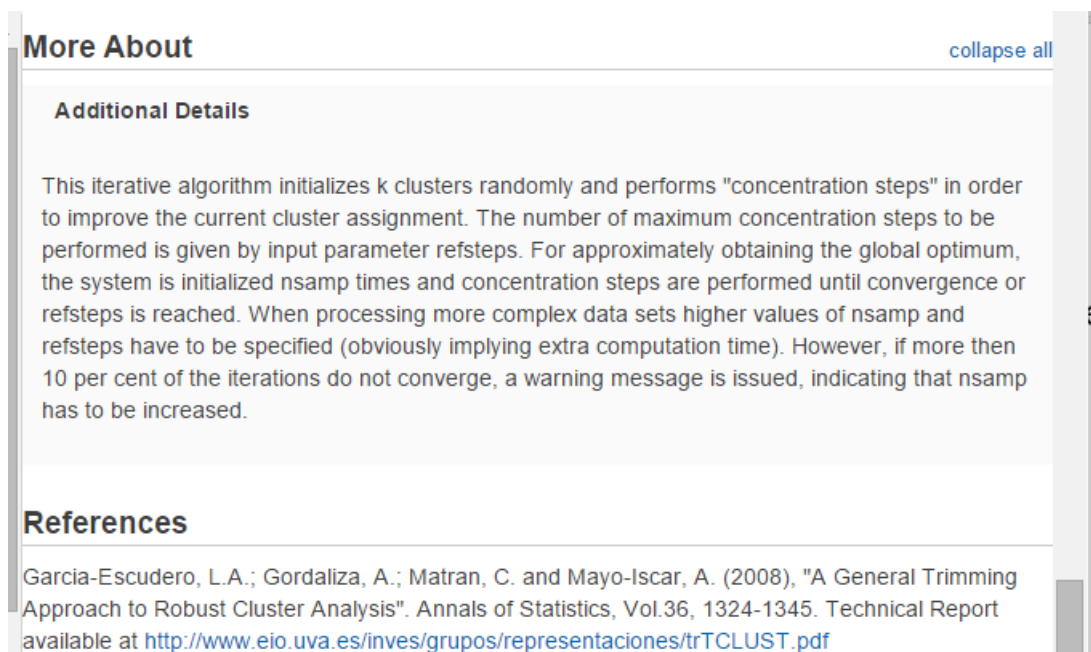
```
close all
Y=load('geyser2.txt');
restrfactor=10000;
% nsamp = number of subsamples which will be extracted
nsamp=500;
out=tclust(Y,3,0.1,restrfactor,'nsamp',nsamp,'plots',1);
title(['Restriction factor = ' num2str(restrfactor)])
restrfactor=10;
out=tclust(Y,3,0.1,restrfactor,'nsamp',nsamp,'refsteps',10,'plots',1);
title(['Restriction factor = ' num2str(restrfactor)])
% trimmed k-means solution restrfactor=1
restrfactor=1;
out=tclust(Y,3,0.1,restrfactor,'nsamp',nsamp,'refsteps',10,'plots',1);
title(['Restriction factor = ' num2str(restrfactor) ' . Trimmed k-means solution'])
cascade
```

Total estimated time to complete tclust: 4.16 seconds



In the `More About` section of our HTML files (see screenshot below), it is possible find the theoretical background which accompanies a particular function.

For example, the screenshot below shows what you get in the case of function `tclust`.



**More About** collapse all

**Additional Details**

This iterative algorithm initializes  $k$  clusters randomly and performs "concentration steps" in order to improve the current cluster assignment. The number of maximum concentration steps to be performed is given by input parameter `refsteps`. For approximately obtaining the global optimum, the system is initialized `nsamp` times and concentration steps are performed until convergence or `refsteps` is reached. When processing more complex data sets higher values of `nsamp` and `refsteps` have to be specified (obviously implying extra computation time). However, if more than 10 per cent of the iterations do not converge, a warning message is issued, indicating that `nsamp` has to be increased.

**References**

Garcia-Escudero, L.A.; Gordaliza, A.; Matran, C. and Mayo-Isacar, A. (2008), "A General Trimming Approach to Robust Cluster Analysis". *Annals of Statistics*, Vol.36, 1324-1345. Technical Report available at <http://www.eio.uva.es/inves/grupos/representaciones/trTCLUST.pdf>

Remark: there is a one to one correspondence between the documentation contained inside the `.m` file and the corresponding `.html` file.

The documentation inside the `.m` file can be easily accessed from the command prompt typing `help` and the name of the function.



For example, the screenshot below shows what you get if you type in the prompt “help MixSim”

```

>> help MixSim
MixSim generates k clusters in v dimensions with given overlap

Link to the help function

Required input arguments:

    k: number of groups (components). Scalar.
        Desired number of groups.
        Data Types - int16|int32|int64|single|double
    v: number of dimensions (variables). Scalar.
        Desired number of variables.
        Data Types - int16|int32|int64|single|double

Optional input arguments:

    BarOmega : Requested average overlap. Scalar. Value of desired average
        overlap. The default value is ''
        Example - 'BarOmega',0.05
        Data Types - double
    MaxOmega : Requested maximum overlap. Scalar. Value of desired maximum

```

Sometimes inside the .m file (especially in the section “More About”) we have added a number of formulae in latex language (see screenshot below)

More About:

**MixSim**(k,v) generates k groups in v dimensions. It is possible to control the average and maximum or standard deviation of overlapping.

Given two generic clusters  $i$  and  $j$  with  $i \neq j = 1, \dots, k$ , indexed by  $\phi(x; \mu_i, \Sigma_i)$  and  $\phi(x; \mu_j, \Sigma_j)$  with probabilities of occurrence  $\pi_i$  and  $\pi_j$ , the misclassification probability with respect to cluster  $i$  (that is conditionally on  $x$  belonging to cluster  $i$ , which is called  $w_{j|i}$ ) is defined as  $\Pr[\pi_i \phi(x; \mu_i, \Sigma_i) < \pi_j \phi(x; \mu_j, \Sigma_j)]$ . The matrix containing the misclassification probabilities  $w_{j|i}$  is called OmegaMap

The probability of overlapping between groups  $i$  and  $j$  is given by:

$$w_{j|i} + w_{i|j} \quad \quad \quad i, j = 1, 2, \dots, k$$

The diagonal elements of OmegaMap are equal to 1.

The average overlap (which in the code is called below BarOmega) is



Clearly all these latex formulae will show up correctly (thanks to MathJax technology) in the corresponding HTML help page. For example, in the case of `MixSim` function, in the command window, by clicking on the link “Link to the help function”,

`MixSim` generates  $k$  clusters in  $v$  dimensions with given overlap

[Link to the help function](#)

one is redirected to the corresponding HTML documentation page. Here, in the “More About” section it is possible to see the code in proper mathematical style.

< Flexible Statistics and Data Analysis Toolbox

< Functions

**MixSim**

ON THIS PAGE

Syntax

Description

Examples

Extra Examples

Input Arguments

**Name-Value Pair Arguments**

BarOmega

MaxOmega

StdOmega

sph

hom

ecc

restrfactor

PiLow

Structure

**More About**

Additional Details

MixSim(k,v) generates  $k$  groups in  $v$  dimensions. It is possible to control the average and maximum or standard deviation of overlapping.

Given two generic clusters  $i$  and  $j$  with  $i \neq j = 1, \dots, k$ , indexed by  $\phi(x; \mu_i, \Sigma_i)$  and  $\phi(x; \mu_j, \Sigma_j)$  with probabilities of occurrence  $\pi_i$  and  $\pi_j$ , the misc cluster  $i$ , which is called  $w_{j|i}$  is defined as  $Pr[\pi_i \phi(x; \mu_i, \Sigma_i) < \pi_j \phi(x; \mu_j, \Sigma_j)]$ .

The matrix containing the misclassification probabilities  $w_{j|i}$  is called OmegaMap. The probability of overlapping between groups  $i$  and  $j$  is given by:

$$w_{j|i} + w_{i|j} \quad i, j = 1, 2, \dots, k$$

The diagonal elements of OmegaMap are equal to 1.

The average overlap (which in the code is called below BarOmega) is defined as the sum of the off diagonal elements of OmegaMap (matrix of misclassification called MaxOmega) is defined as  $\max(w_{j|i} + w_{i|j}), i \neq j = 1, 2, \dots, k$ .

The probability of misclassification  $w_{j|i}$  is nothing but the cdf of a linear combination of non central  $\chi^2$  distributions with 1 degree of freedom + a linear combination of non central  $\chi^2$  and  $N(0, 1)$  depend on the eigenvalues and eigenvectors of matrix  $\Sigma_{j|i} = \Sigma_i^{0.5} \Sigma_j^{-1} \Sigma_i^{0.5}$ .

Point  $c$  depends on the same eigenvalues and eigenvectors of matrix  $\Sigma_{j|i}$ , the mixing proportions  $\pi_i$  and  $\pi_j$  and the determinants  $|\Sigma_i|$  and  $|\Sigma_j|$ .

This probability is computed using routine `ncx2mixtcdf`

Finally, it is worthwhile to remark that it is possible to go directly to the HTML documentation page simply typing `docsearchFS` and the name of the requested function. For example, in the case of `tclust` to reach file `tclust.html` it is possible to type:

```
fx >> docsearchFS tclust
```

Generally, the output of our functions is a structure, which contains several fields, documented in detail inside the initial part of the .m function. For example, in the case of tclust inside tclust.m it is possible to navigate to section Output ( see screenshot below):

```
% Output:
%
%      out:  structure which contains the following fields
%
%      out.muopt= k-by-v matrix containing cluster centroid locations.
%               Robust estimate of final centroids of the groups.
%      out.sigmapopt= v-by-v-by-k array containing estimated constrained
%                   covariance for the k groups.
%      out.idx  = n-by-1 vector containing assignment of each unit to
%               each of the k groups. Cluster names are integer
%               numbers from 1 to k. 0 indicates trimmed
%               observations.
%      out.siz  = matrix of size k-by-3
%               1st col = sequence from 0 to k
%               2nd col = number of observations in each cluster
%               3rd col = percentage of observations in each cluster
%               Remark: 0 denotes unassigned units
%      out.post = n-by-k matrix containing posterior probabilities
%               I out.post(i,j) contains posterior probability of unit
%               i from component (cluster) j. For the trimmed units
%               posterior probabilities are 0
%      out.MIXMIX = BIC which uses parameters estimated using the
```

In the corresponding HTML file our parser publishFS.m puts all the fields of input and output structure inside a HTML table (see screenshot below):

Output Arguments	
out — description Structure	<a href="#">Expand/Collapse</a>
Structure which contains the following fields	
Value	Description
muopt	k-by-v matrix containing cluster centroid locations. Robust estimate of final centroids of the groups.
sigmapopt	v-by-v-by-k array containing estimated constrained covariance for the k groups.
idx	n-by-1 vector containing assignment of each unit to each of the k groups. Cluster names are integer numbers from k. 0 indicates trimmed observations.
siz	matrix of size k-by-3 1st col = sequence from 0 to k 2nd col = number of observations in each cluster 3rd col = percentage of observations in each cluster Remark: 0 denotes unassigned units
post	n-by-k matrix containing posterior probabilities out.post(i,j) contains posterior probability of unit i from component (cluster) j. For the trimmed units posterior probabilities are 0
MIXMIX	BIC which uses parameters estimated using the mixture loglikelihood and the maximized mixture likelihood as good of fit measure. Remark: this output is present just if input option mixt is >0
MIXCLA	BIC which uses the classification likelihood based on parameters estimated using the mixture likelihood (in some cases this quantity is called ICL) Remark: this output is present just if input option mixt is >0
CLACLA	BIC which uses the classification likelihood based on parameters estimated using the classification likelihood Remark: this output is present just if input option mixt is =0
notconver	scalar. Number of subsets without convergence
bs	k-by-1 vector containing the units forming initial subset associated with muopt.
obj	scalar. Value of the objective function which is minimized (value of the best returned solution). If input option mixt >1 the likelihood which is maximized is a mixture likelihood as follows $\prod_{i=1}^n \sum_{j=1}^k \pi_j \phi(y_i; \theta_j).$



Every subfolder of FSDA contains file contents.m (automatically created by our routine makecontentsfileFS.m) which contains a series of detailed information about all the .m files of the folder, which have the corresponding HTML documentation. For example, the screenshot referred to the left part of file contents.m inside subfolder “utilities” is given below.

Name	Description
cabcc	Closes all open figures except the one in foreground (the current)
cascade	Is a third party function used in FSDA demos and examples
clickableMultiLegend	Hides/shows symbols inside all gplotmatrix subplots (or similar)
findDir	Finds recursively all directories in root
findFile	Finds recursively all files in root
isFunction	Checks if a function exists
makecontentsfileFS	Extends Matlab function makecontentsfile
PoolClose	Closes the pool of MATLAB instances opened with PoolPrepare to
PoolPrepare	Prepares a pool of MATLAB instances for executing code in parallel
position	Controls the position of the open figures
publishFS	I Enables to create automatic HELP FILES from structured .m functions
publishFunctionAlpha	Enables to create web page which contains the alphabetical list
publishFunctionCate	Enables to create web page which contains the alphabetical list
quickselectFS	Finds the k-th order statistic
triu2vec	Extracts in a vector the linear indexes or the elements on and above the diagonal
upperfracpos	Positions two figures on the upper part of the screen
zscoreFS	Computes (robust) standardized z scores



Similarly, inside the main root of FSDA file `contents.m` lists in alphabetical order all files present in all subfolders of FSDA, which have the corresponding HTML page (see screenshot below):

---

% FSDA	
%	
% File names, description, category and date last modified	
%	
% Name	- Description
% -----	
% add2spm	- Adds objects (personalized clickable multi-
% addt	- Produces the t test for an additional exp
% basicPower	- Computes the basic power transformation
% bc	- Returns the Binomial coefficient
% boxplotb	- Computes a bivariate boxplot
% brushFAN	- Displays a GUI which enables brushing in t
% brushRES	- Displays a GUI which enables brushing in :
% brushROB	- Displays a GUI which enables brushing in :
% cabc	- Closes all open figures except the one in
% cascade	- Is a third party function used in FSDA der
% cdsplot	- Produces the candlestick plot for robust r
% clickableMultiLegend	- Hides/shows symbols inside all gplotmatri
% combsFS	- Is an iterative algorithm equivalent to tl
% covplot	- Plots the trajectories of the elements of
% ellipse	- Generates an ellipse given mu (location ve
% fanplot	- Plots the fan plot for transformation in :
% findDir	- Finds recursively all directories in root
% findFile	- Finds recursively all files in root

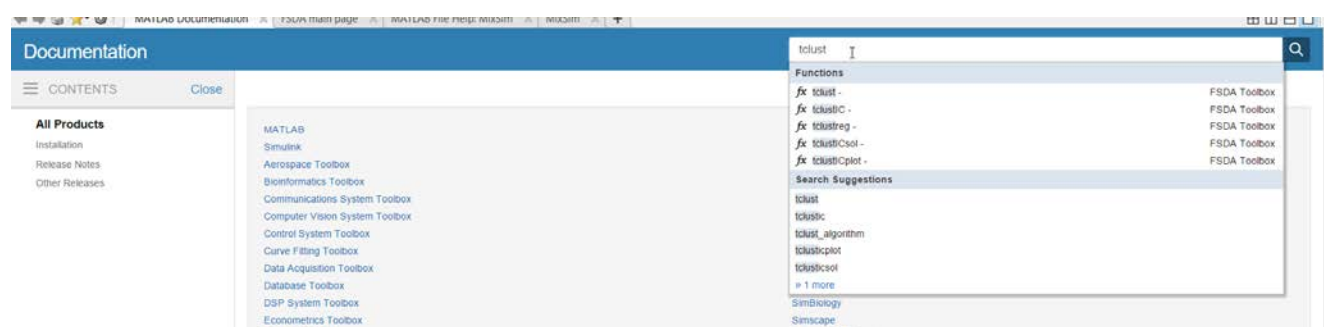
---

## FSDA html documentation files and MATLAB search engine

Particular attention has been devoted by the FSDA team to have all our HTML files indexed by the old and new search engine of MATLAB. Below we describe what you should get depending on the MATLAB version you have.

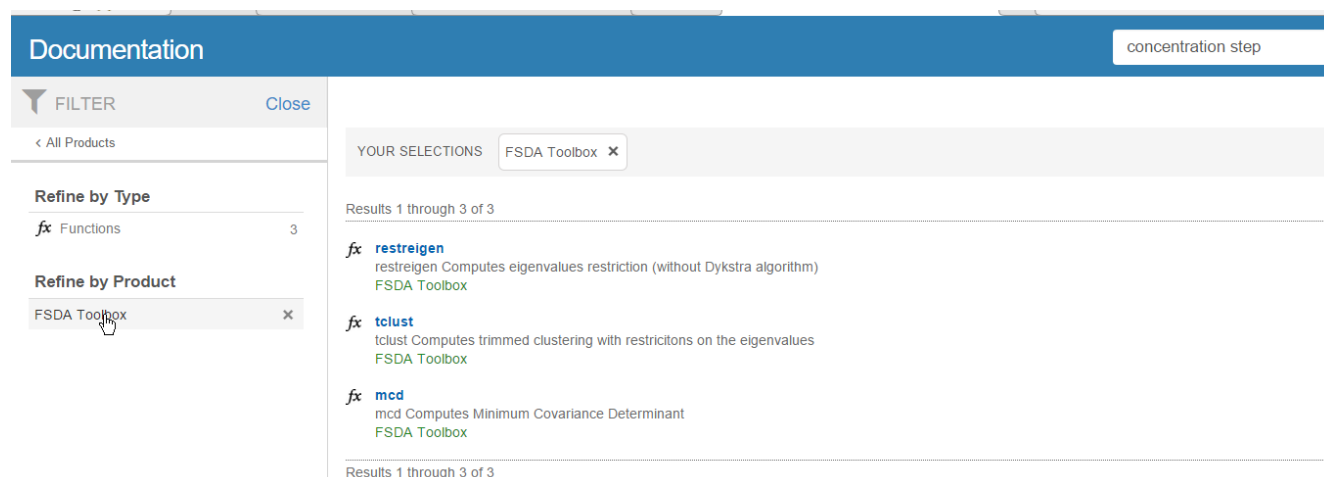
### MATLAB 2015a-2017a

If your version of MATLAB is in the range 2015a-2017a, typing inside the engine a word you get also the results from the FSDA toolbox. For example, typing `tclust` you should automatically have the search suggestion from the drop down menu which automatically appears (see screenshot below)



and you should be brought directly to the `tclust` documentation page.

If, for example, you type “concentration step” and you do Refine by Product and select the FSDA toolbox these are the three instances you should get.



If you put your mouse on the word `restreigen` you can see from the status bar that the function is located inside (main FSDA folder)/helpfiles/pointersHTML, (screenshot of status bar is given below):

`FSDA/helpfiles/pointersHTML/restreigen.html?searchHighlight=concentration step product:3ptoolbox::fsda_toolbox`



Once you click on `restreigen` you can go to page `restreigen.html` (see screenshot below) which is located inside `docrootFS/FSDA` (see screenshot below)

Help

tclust x FSDA main page x MATLAB File Help: MixSim x MixSim x restreigen x restreigen x +

## Documentation

CONTENTS Close

< All Products

< Flexible Statistics and Data Analysis (FSDA)

< Flexible Statistics and Data Analysis Toolbox

< Functions

**restreigen**

ON THIS PAGE

Syntax

Description

Examples

Input Arguments

Output Arguments

References

See Also

### restreigen

restreigen computes eigenvalues restriction (without Dykstra algorithm)

#### Syntax

```
out=restreigen(eigenvalues, niini, restr)
out=restreigen(eigenvalues, niini, restr, tol)
out=restreigen(eigenvalues, niini, restr, tol, userepmat)
```

#### Description

restreigen restricts the eigenvalues according to the constraint specified in scalar `restr`. This function is called in every conce overlapping

`out =restreigen(eigenvalues, niini, restr)` Example using all default options.

`out =restreigen(eigenvalues, niini, restr, tol)` Second example of eigenvalue restriction.

`out =restreigen(eigenvalues, niini, restr, tol, userepmat)` Trimmed k-means using geyser data.

#### Examples

- Example using all default options.
- Second example of eigenvalue restriction.
- Trimmed k-means using geyser data.

#### Input Arguments

`eigenvalues` — Eigenvalues

From the toolstrip on top you will notice that two instances of `restreigen` have been opened.



The first on the left is the page which has been indexed by MATLAB search engine which is located inside `(main FSDA folder)/helpfiles/pointersHTML` (see screenshot below):

☰ CONTENTS
Close

< All Products

Flexible Statistics Data Analysis Toolbox  
(OLD HTML main page which used xml files) (Supplemental Software)

Examples

Syllabus page indexed by builddocsearchdb for function: restrigen

## restrigen

### restrigen Computes eigenvalues restriction (without Dykstra algorithm)

#### Description

restrigen restricts the eigenvalues according to the constraint specified in scalar restr. This function is called in every concentration step of function tclust and ce MixSim to generate groups with a prespecified level of overlapping

#### More About

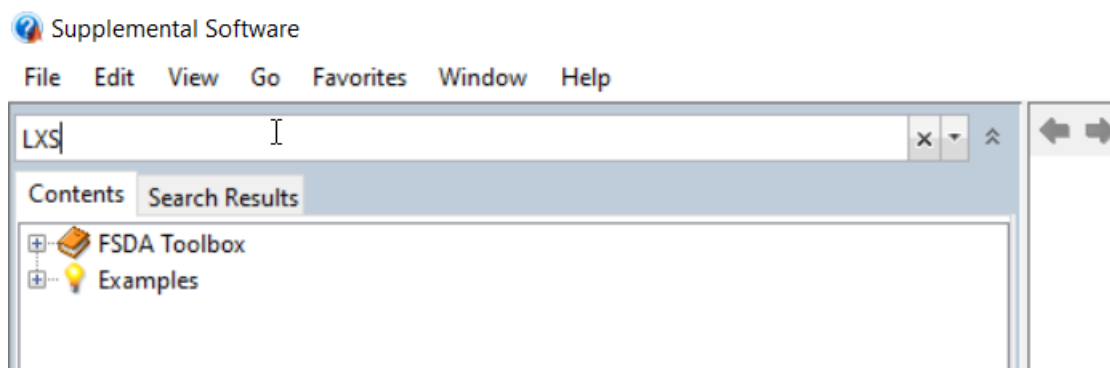
#### References

Fritz H. Garcia-Escudero, L.A. and Mayo-Isar, A. (2012), A fast algorithm for robust constrained clustering. Available at <http://www.eio.uva.es/infor/personas/>

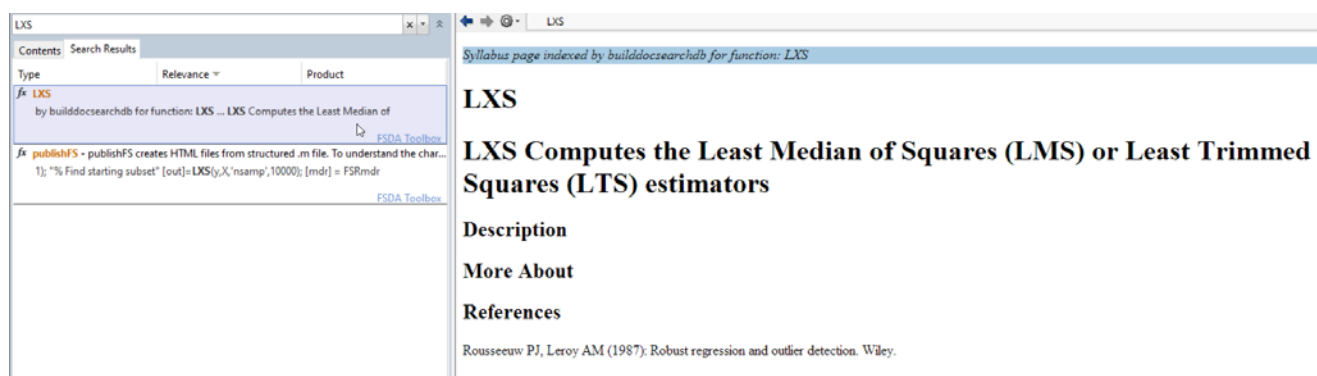
All these syllabus pages have been automatically created by our routine `createFSDAhelp.m`. It was necessary to have the intermediate pages because MATLAB forces these pages to be opened on the iframe on the right. All these syllabus pages contain a redirect to our final HTML pages, which are contained inside `docroot/FSDA`. Files inside `docroot/FSDA` are not forced to be opened on the iframe on the right.

## MATLAB 2012b-2014b

If your version of MATLAB is between 2012b-2014b it is necessary to use the old MATLAB search engine inside supplemental software (see screenshot below)

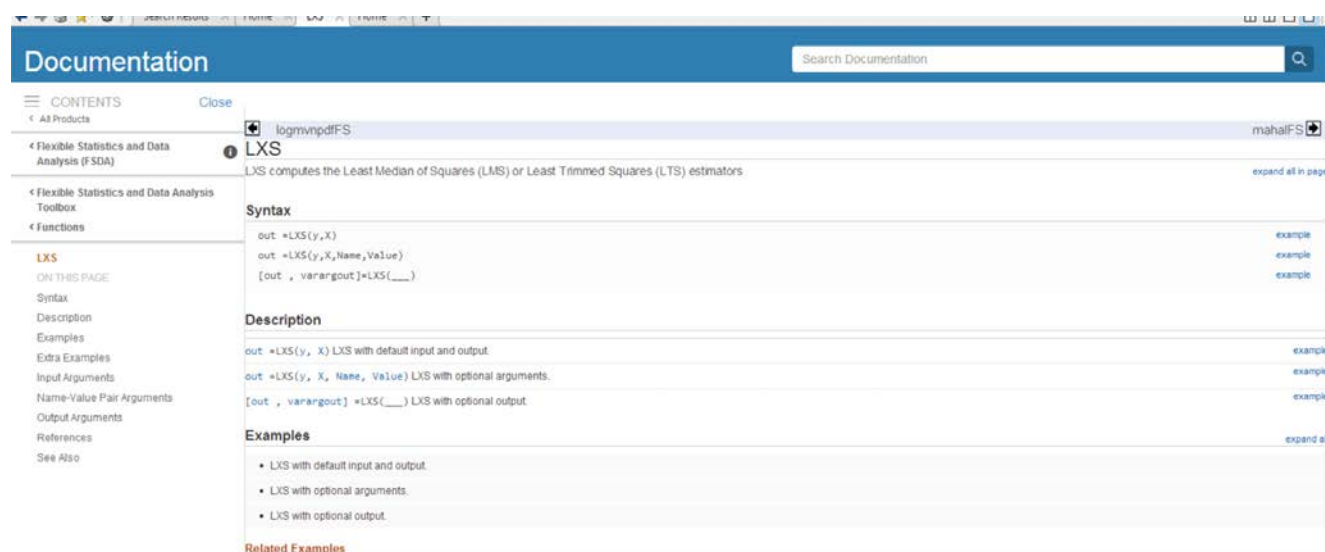


also, in this case, passing through the syllabus page contained in (`FSDA root`)\helpfiles\pointersHTML





It is possible to automatically reach our page LXS.html contained inside docroot/FSDA



The screenshot shows the MATLAB Documentation page for the `LXS` function. The page is titled "Documentation" and includes a search bar. The left sidebar shows the "CONTENTS" menu with options like "Flexible Statistics and Data Analysis (FSDA)", "Flexible Statistics and Data Analysis Toolbox", and "Functions". The main content area displays the function name `LXS`, its description, syntax, and examples. The syntax section shows the function signature `out = LXS(y,X)` and `out = LXS(y,X,Name,Value)`. The description section explains that `LXS` computes the Least Median of Squares (LMS) or Least Trimmed Squares (LTS) estimators. The examples section lists three examples: `LXS` with default input and output, `LXS` with optional arguments, and `LXS` with optional output.

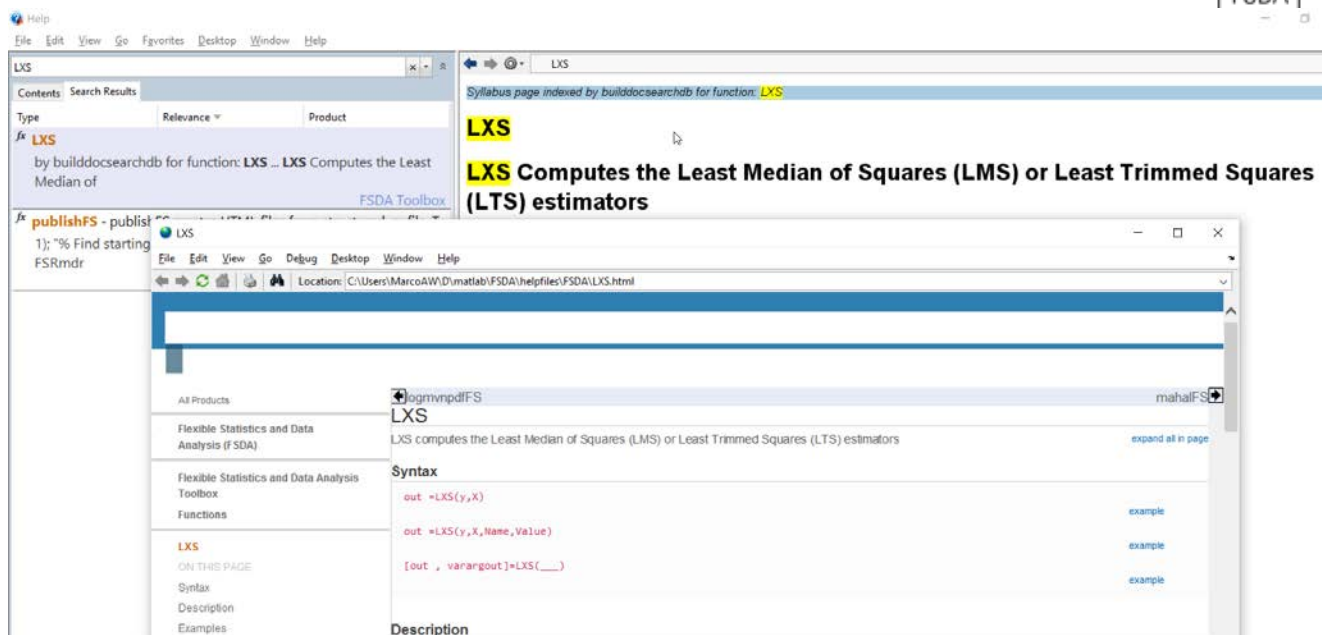
## MATLAB <=2012b

In MATLAB older or equal than 2012a, there was no distinction between MATLAB toolboxes and third parties toolboxes (as concerns the documentation), therefore it is possible to search directly from the unique official MATLAB engine. For example searching for LXS



The screenshot shows the MATLAB search results for the `LXS` function. The left sidebar shows the "Contents" menu with options like "MATLAB", "FSDA Toolbox", and "Other Demos". The main content area displays the search results for `LXS`, including the function name, description, and examples. The search results are displayed in a table format with columns for "Functions" and "Handle Graphics". The "Functions" column lists `LXS` and `LXS` with optional arguments. The "Handle Graphics" column lists `LXS` and `LXS` with optional output. The "What's New" section includes a link to "MATLAB Release Notes".

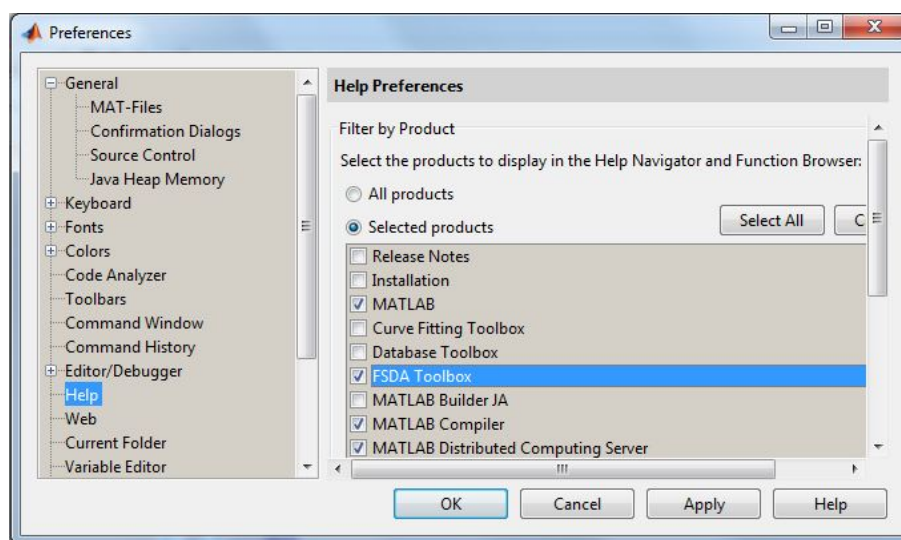
the output of the search is again the syllabus page which automatically redirects to the true HTML page (both are shown in the screenshot below):



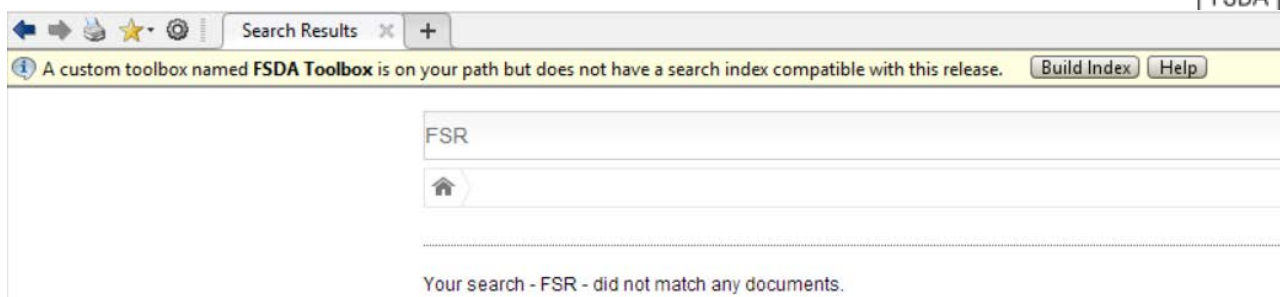
Remark 1: note that the old MATLAB browser enables us to see correctly just 95% of the javascripts which characterize the new MATLAB help style.

Remark 2: given that in MATLAB versions earlier than 2012b the new engine lucene did not exist, all the “true HTML files” during the installation are not move to folder docroot/FSDA but are left inside (main root of FSDA)/helpfiles/FSDA.

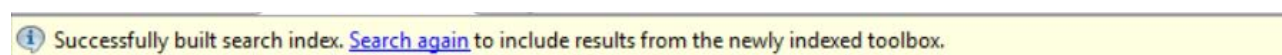
Remark 3: If you are using a release lower than R2012b and you think that the MATLAB Help Browser is not producing proper search results for FSDA functions, check first that in the MATLAB Help Preferences FSDA is selected, as shown in Figure below:



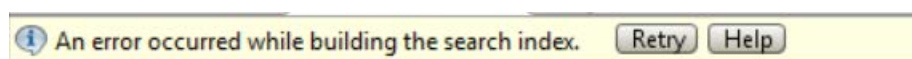
Remark 4: **From MATLAB R2015a**, when you search for a given third party function for the first time, the search results window will display a yellow message warning that a toolbox in the path does not have the proper documentation index file. The window and message produced when attempting to search for documentation about `FSR` function, are shown here:



Only after clicking on the **Build Index** button you should start getting the desired documentation. You will be informed of the successful update of the search database with this message:



If, instead of this message and instead of receiving back the desired results, **you receive an error message** such as this one



again it is likely that you have installed FSDA in a location without proper permissions and, thus, the index building operation (i.e. the `builddocsearchdb` command) could not update the search database. The only solution in this case is to obtain the writing permissions or to change location for FSDA. What you should get if the search is successful, is something like the following:



Therefore, if by some obscure reason you cannot find our HTML files using old or new (lucene) engine, it might be necessary to run again `builddocsearchdb`. For example assuming that FSDA main folder is `D:\MATLAB\FSDA` then it is necessary to run

```
>> builddocsearchdb('D:\MATLAB\FSDA\helpfiles\pointersHTML')
```

IF YOU THINK THAT SOMETHING NOT DESCRIBED IN THESE NOTES WENT WRONG

PLEASE DO NOT HESITATE TO SEND AN E-MAIL TO

[FSDA@unipr.it](mailto:FSDA@unipr.it)