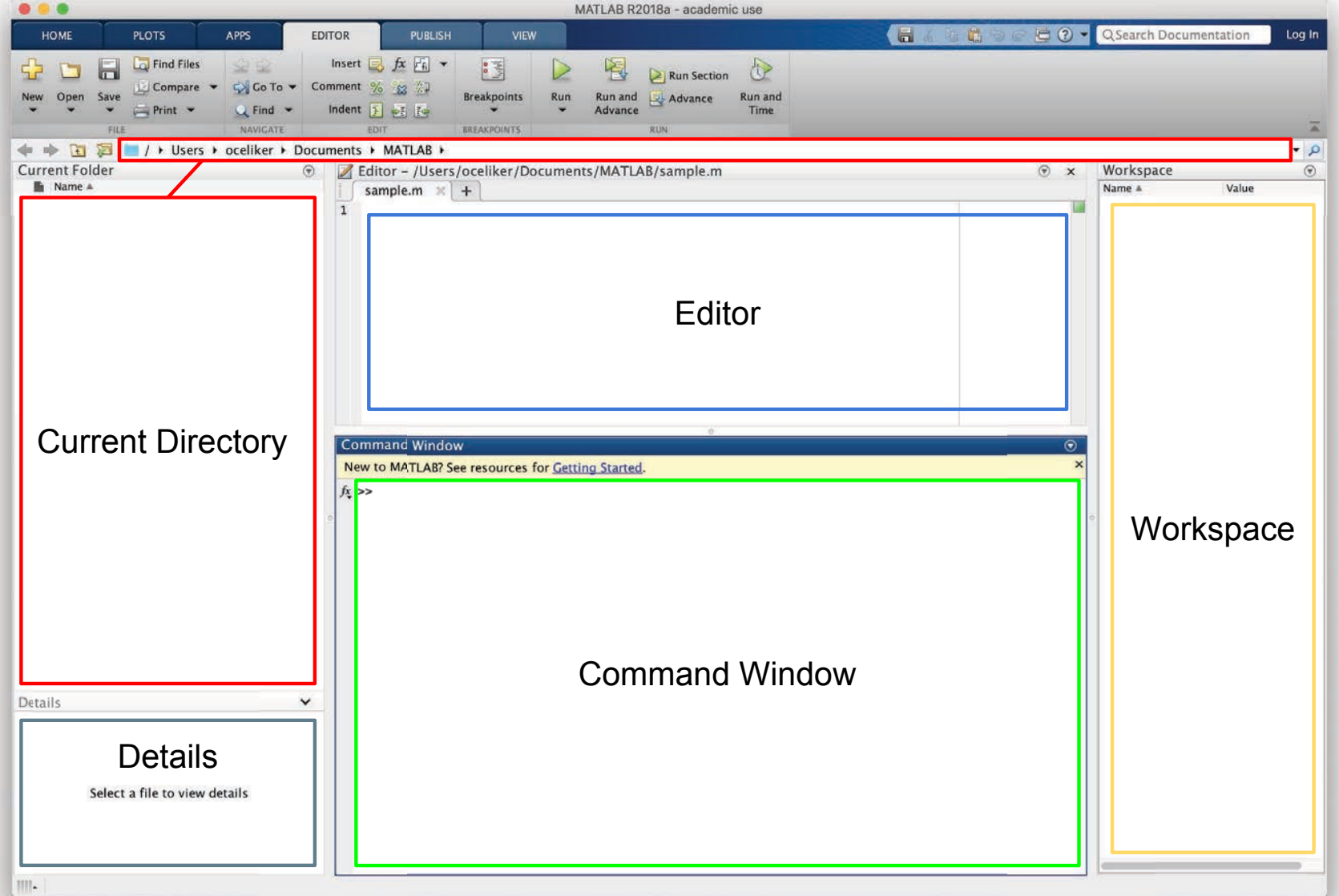
6.057
Introduction to MATLAB

Orhan Celiker, IAP 2019

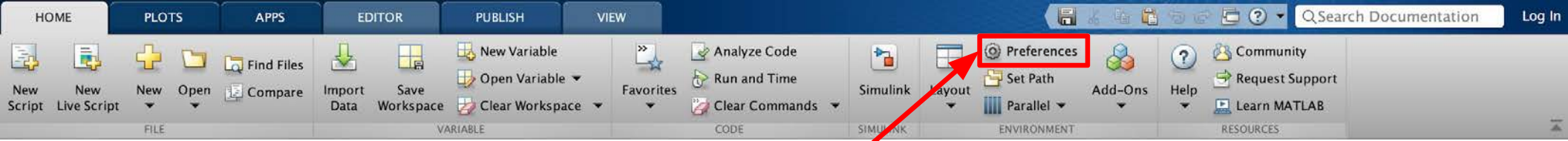
Revised by Min Ding, Feb 1 2021

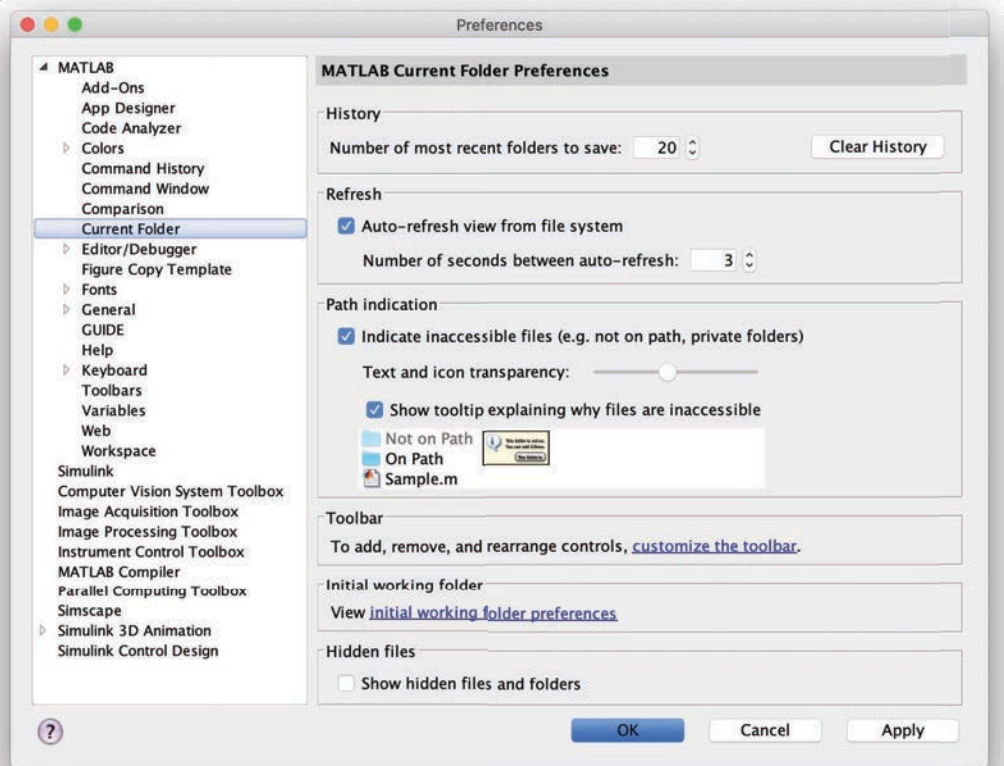


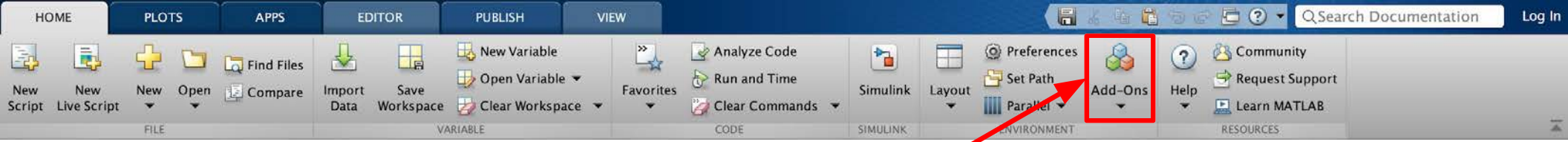
Customization

- In the top ribbon, navigate to:
  Home -> Environment -> Preferences

- Allows you to customize your MATLAB experience (colors, fonts, etc.)





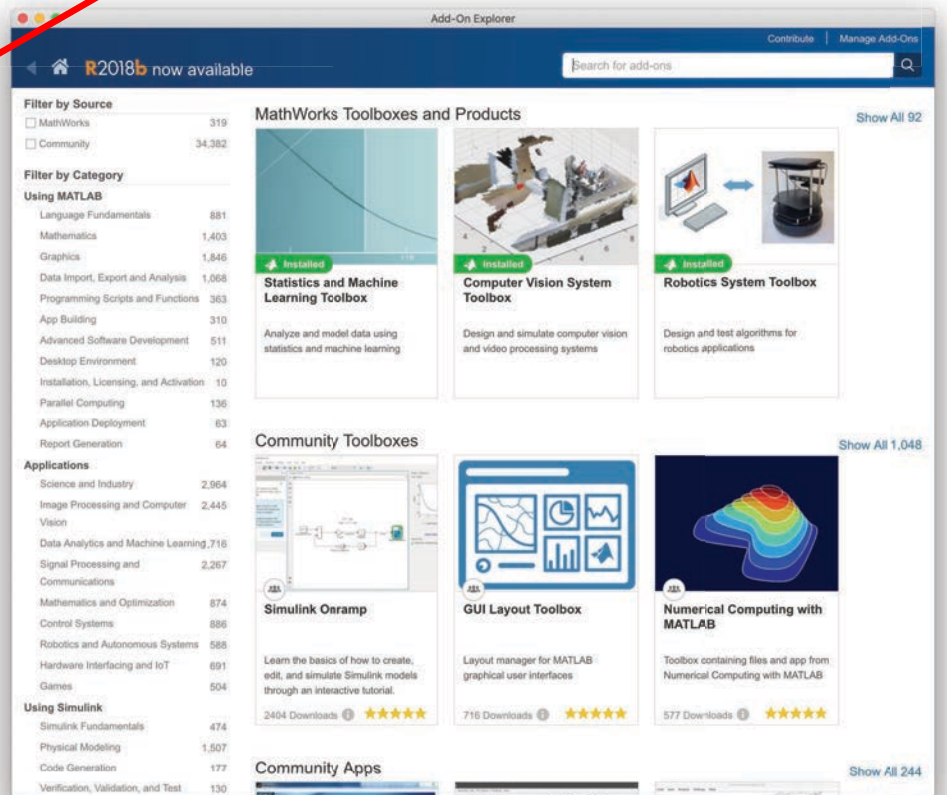


Installing Toolboxes

- In the top ribbon, navigate to:
  Home -> Environment -> Add-Ons

- Allows you to install toolboxes included with your license

- Recommended toolboxes:
  - Curve Fitting Toolbox
  - Computer Vision System Toolbox
  - Image Processing Toolbox
  - Optimization Toolbox
  - Signal Processing Toolbox
  - and anything related to your field!



File Exchange - MATLAB Centra

https://www.mathworks.com/matlabcentral/fileexchange/?s_tid=gn_mlc_fx

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Applications

Most Recent

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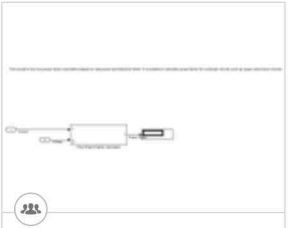


True power factor calculation block

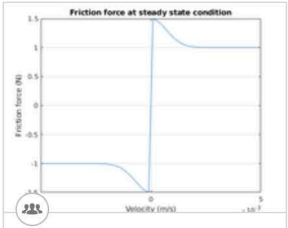
It is suitable to calculate power factor for nonlinear circuits such as power electronics circuit

1 Download

scGEAToolbox

a Matlab toolbox for single-cell RNA-seq data analyses

9 Downloads



LuGre friction model in MATLAB

A full reconstruction of the paper: A new model for control systems with friction

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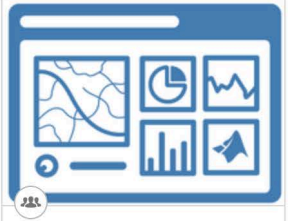
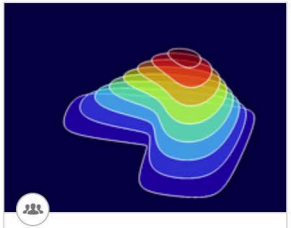
Community Toolboxes

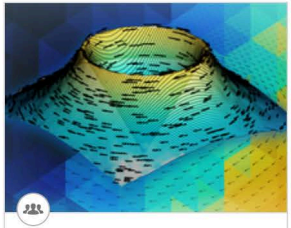
Show All 1,356



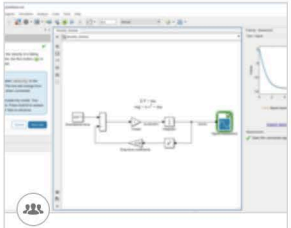
GUI Layout Toolbox



Numerical Computing with MATLAB



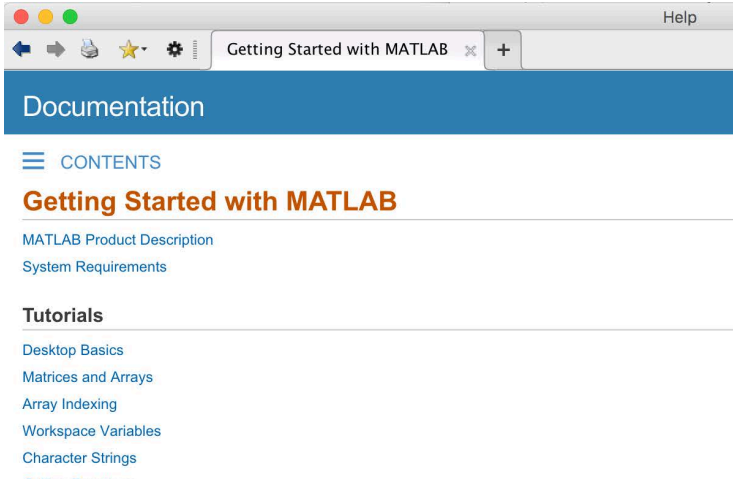
PIVlab - particle image velocimetry (PIV) tool with GUI



Simulink Onramp

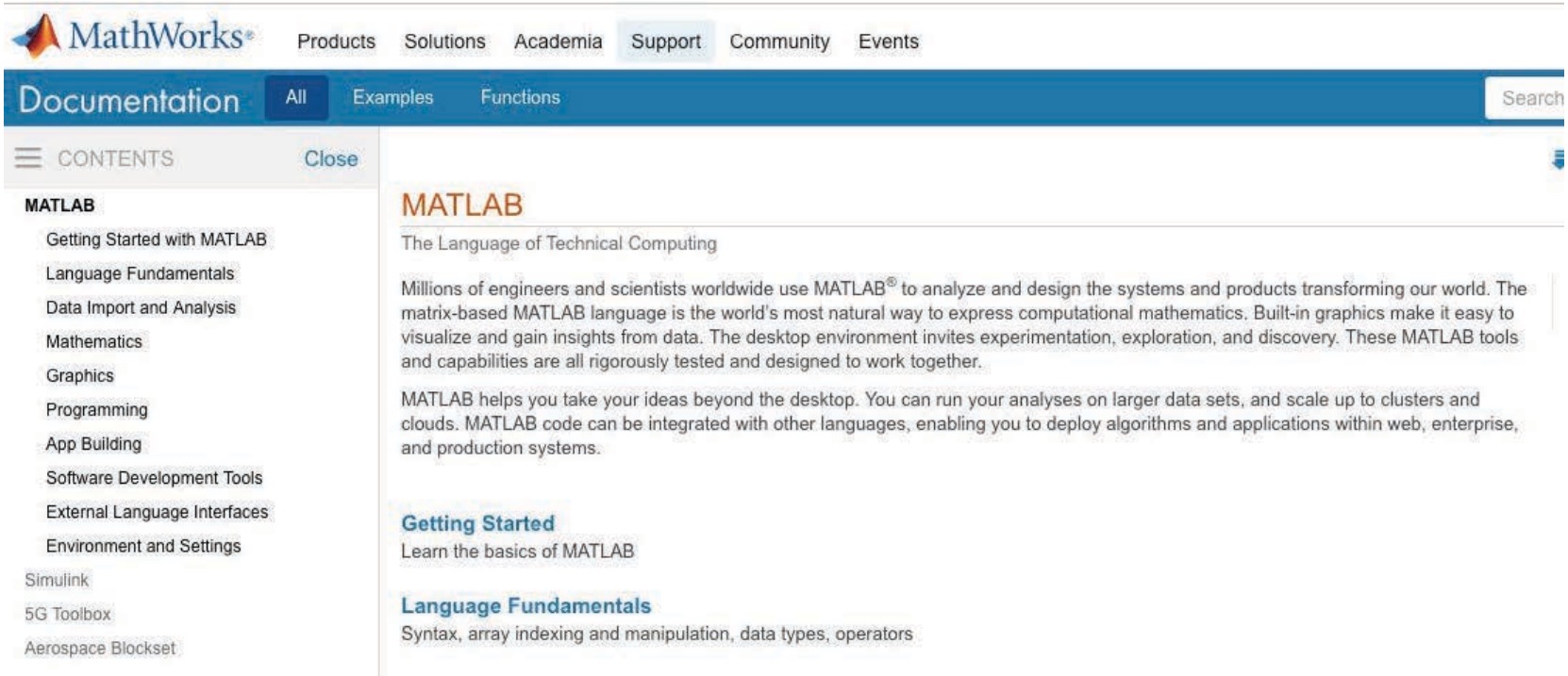
Help/Docs

- `help`
  - The most important command for learning MATLAB on your own!
- To get info on how to use a function:
  - `help sin`
    - Help lists related functions at the bottom and links to the documentation
- To get a nicer version of help with examples and easy-to-read description:
  - `doc sin`
- To search for a function by specifying keywords:
  - `docsearch sin trigonometric`



Official Documentation

- http://www.mathworks.com/help/matlab/



Outline

Example 1. Variables, Index, and Numerical Operations
Example 2. Optimization & User-defined Functions
Example 3. Image Processing
4. Statistics and ML Toolbox

2. Optimization Toolbox

Optimization Toolbox

Solve linear, quadratic, integer, and nonlinear optimization problems

Optimization Toolbox™ provides functions for finding parameters that minimize or maximize objectives while satisfying constraints. The toolbox includes solvers for linear programming, mixed-integer linear programming, quadratic programming, nonlinear optimization, and nonlinear least squares. You can use these solvers to find optimal solutions to continuous and discrete problems, perform tradeoff analyses, and incorporate optimization methods into algorithms and applications.

Examples
Functions
Release Notes
PDF Documentation

Getting Started
Learn the basics of Optimization Toolbox

Optimization Problem Setup
Choose solver, define objective function and constraints, compute in parallel

Nonlinear Optimization
Solve constrained or unconstrained nonlinear problems with one or more objectives, in serial or parallel

Linear Programming and Mixed-Integer Linear Programming
Solve linear programming problems with continuous and integer variables

Quadratic Programming
Solve problems with quadratic objectives and linear constraints

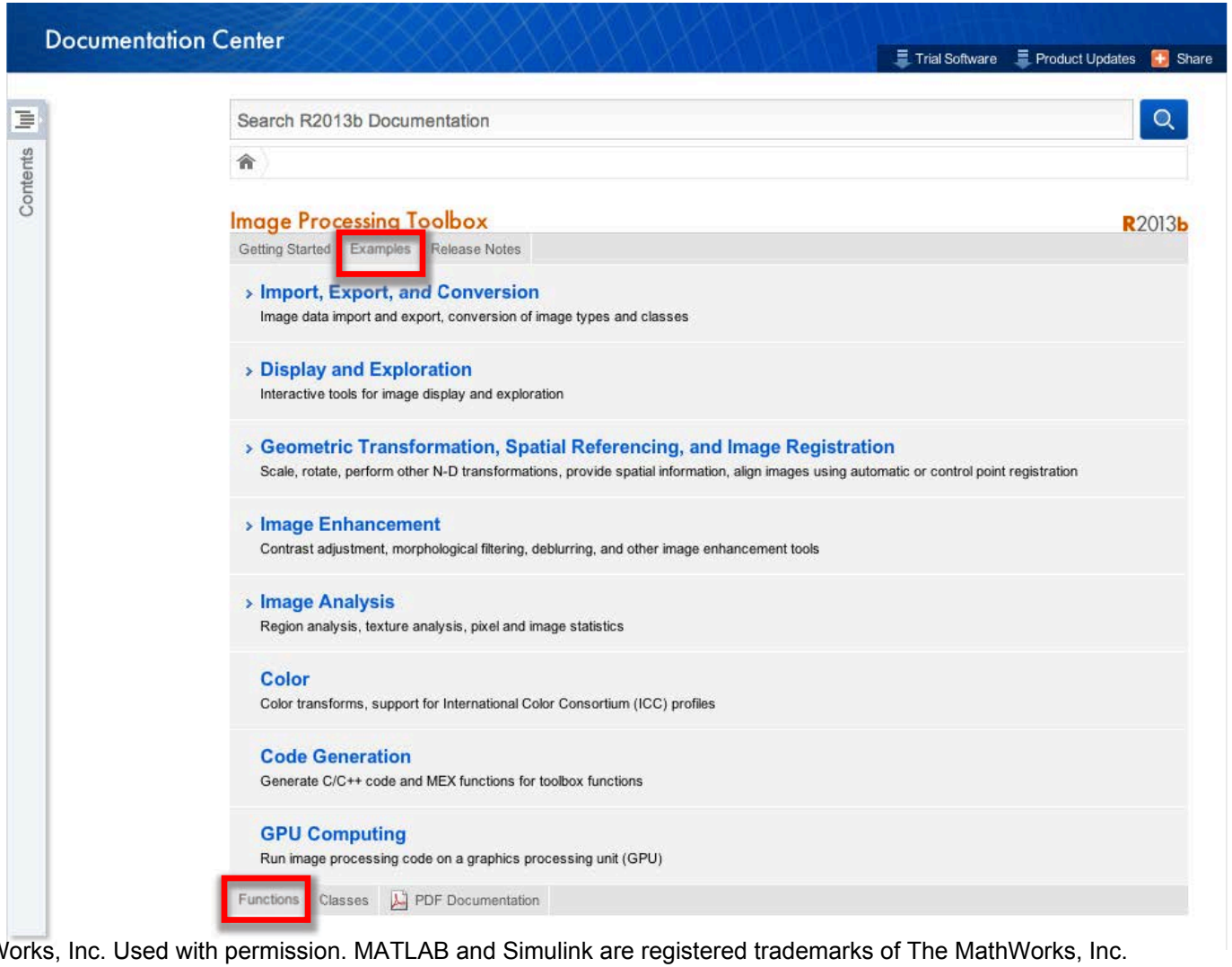
Least Squares
Solve least-squares (curve-fitting) problems

Systems of Nonlinear Equations
Find roots of sets of nonlinear equations

Optimization Results
Understand solver outputs and improve results

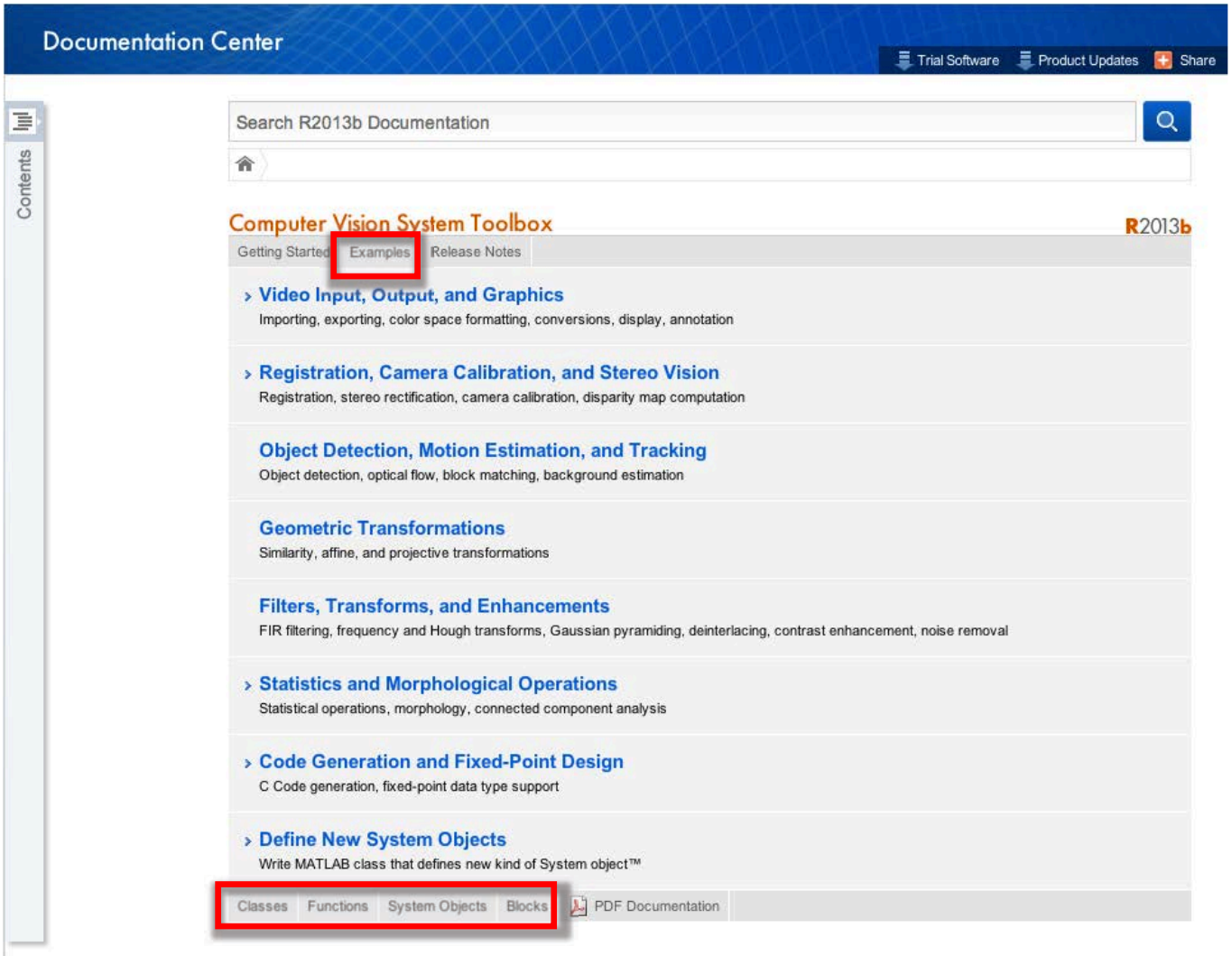
3. Image Processing Toolbox

- http://www.mathworks.com/help/images/index.html



… and also Computer Vision

- http://www.mathworks.com/help/vision/index.html



… and also Computer Vision

- http://www.mathworks.com/help/vision/functionlist.html

Feature Detection, Extraction, and Matching

detectFASTFeatures	Find corners using FAST algorithm
detectHarrisFeatures	Find corners using Harris–Stephens algorithm
detectMinEigenFeatures	Find corners using minimum eigenvalue algorithm
detectMSERFeatures	Detect MSER features
detectSURFFeatures	Detect SURF features
extractFeatures	Extract interest point descriptors
extractHOGFeatures	Extract Histograms of Oriented Gradients (HOG) features
matchFeatures	Find matching features
showMatchedFeatures	Display corresponding feature points
binaryFeatures	Object for storing binary feature vectors
cornerPoints	Object for storing corner points
SURFPoints	Object for storing SURF interest points
MSERRegions	Object for storing MSER regions
vision.BoundaryTracer	Trace object boundary
vision.CornerDetector	Detect corner features
vision.EdgeDetector	Find object edge

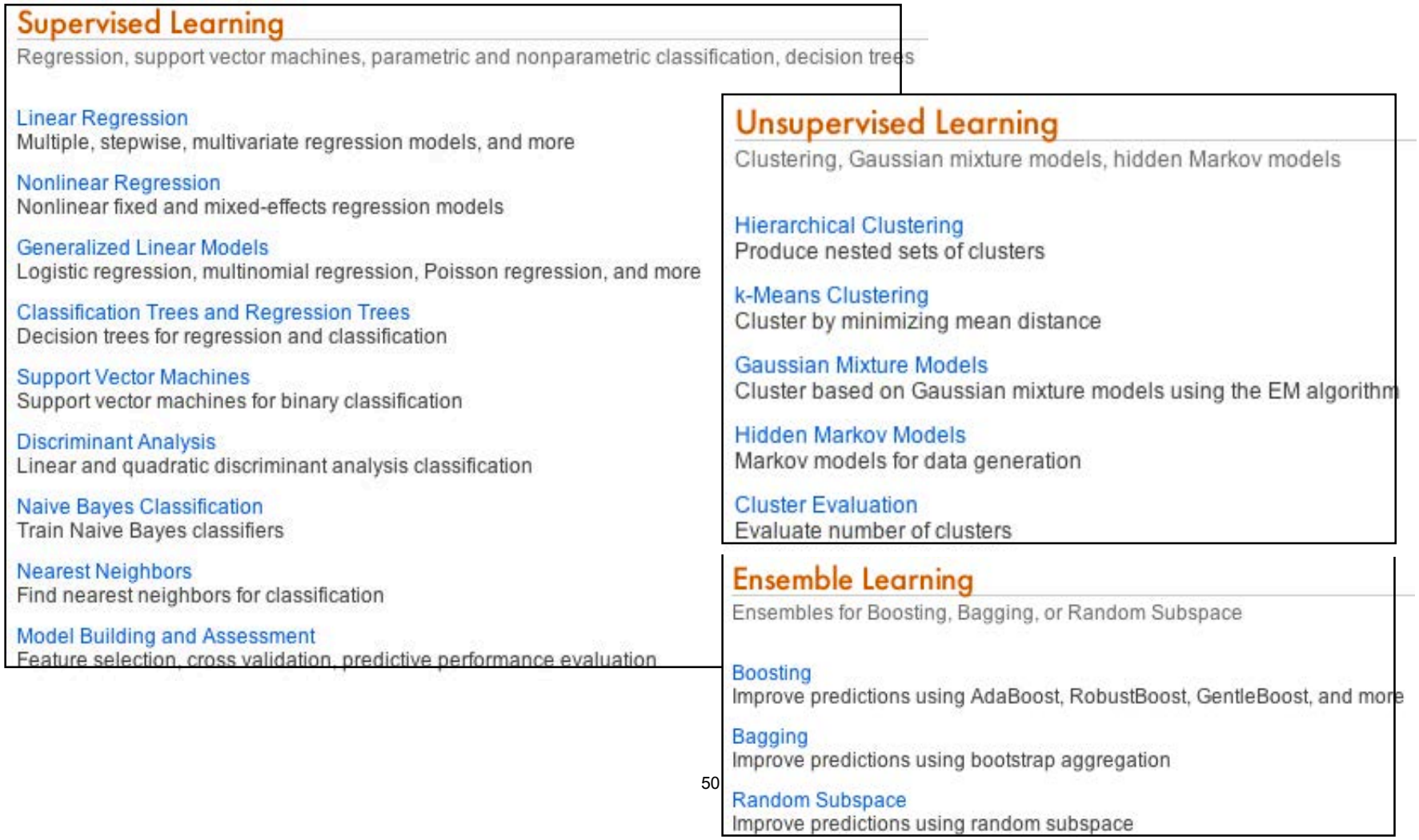
Object Detection, Motion Estimation, and Tracking

configureKalmanFilter	Create Kalman filter for object tracking
disparity	Disparity map between stereo images
trainCascadeObjectDetector	Train cascade object detector model
detectFASTFeatures	Find corners using FAST algorithm
detectHarrisFeatures	Find corners using Harris–Stephens algorithm
detectMinEigenFeatures	Find corners using minimum eigenvalue algorithm
detectMSERFeatures	Detect MSER features
detectSURFFeatures	Detect SURF features
extractFeatures	Extract interest point descriptors
extractHOGFeatures	Extract Histograms of Oriented Gradients (HOG) features
insertObjectAnnotation	Annotate truecolor or grayscale image or video stream
assignDetectionsToTracks	Assign detections to tracks for multiobject tracking
matchFeatures	Find matching features
cornerPoints	Object for storing corner points
SURFPoints	Object for storing SURF interest points
MSERRegions	Object for storing MSER regions
vision.KalmanFilter	Kalman filter for object tracking
vision.BlockMatcher	Estimate motion between images or video frames
vision.CascadeObjectDetector	Detect objects using the Viola-Jones algorithm
vision.ForegroundDetector	Detects foreground using Gaussian mixture models
vision.HistogramBasedTracker	Histogram-based object tracking
vision.OpticalFlow	Estimate object velocities
vision.PeopleDetector	Detect upright people using HOG features
vision.PointTracker	Track points in video using Kanade-Lucas-Tomasi (KLT) algorithm
vision.TemplateMatcher	Locate template in image

Also consider OpenCV+MATLAB
http://www.mathworks.com/discovery/matlab-opencv.html

4. Machine Learning (Stats Toolbox)

- http://www.mathworks.com/help/stats/index.html



Supervised Learning

Regression, support vector machines, parametric and nonparametric classification, decision trees

Linear Regression
Multiple, stepwise, multivariate regression models, and more

Nonlinear Regression
Nonlinear fixed and mixed-effects regression models

Generalized Linear Models
Logistic regression, multinomial regression, Poisson regression, and more

Classification Trees and Regression Trees
Decision trees for regression and classification

Support Vector Machines
Support vector machines for binary classification

Discriminant Analysis
Linear and quadratic discriminant analysis classification

Naive Bayes Classification
Train Naive Bayes classifiers

Nearest Neighbors
Find nearest neighbors for classification

Model Building and Assessment
Feature selection, cross validation, predictive performance evaluation

Unsupervised Learning

Clustering, Gaussian mixture models, hidden Markov models

Hierarchical Clustering
Produce nested sets of clusters

k-Means Clustering
Cluster by minimizing mean distance

Gaussian Mixture Models
Cluster based on Gaussian mixture models using the EM algorithm

Hidden Markov Models
Markov models for data generation

Cluster Evaluation
Evaluate number of clusters

Ensemble Learning

Ensembles for Boosting, Bagging, or Random Subspace

Boosting
Improve predictions using AdaBoost, RobustBoost, GentleBoost, and more

Bagging
Improve predictions using bootstrap aggregation

Random Subspace
Improve predictions using random subspace