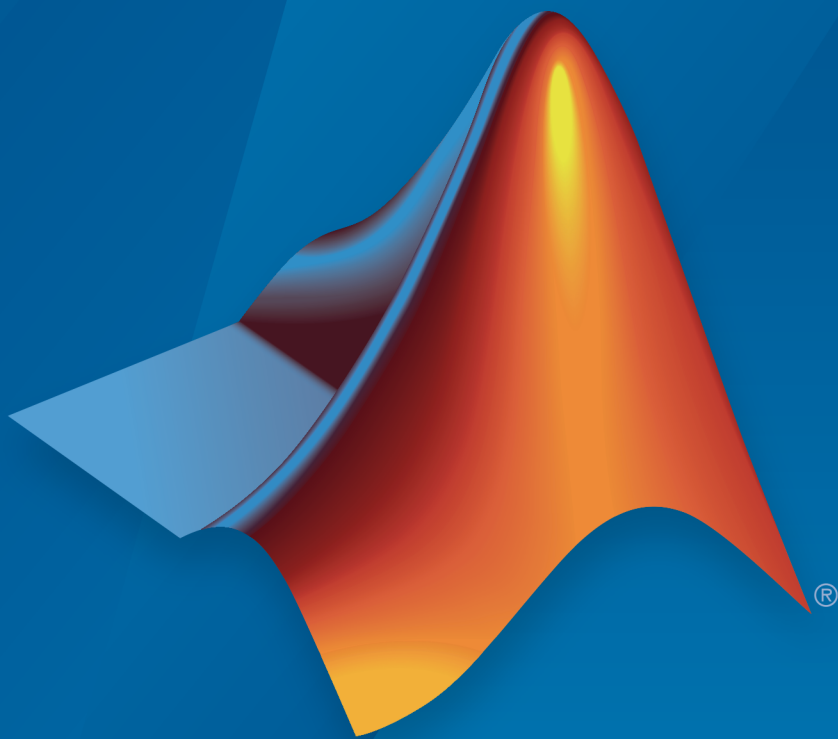


Wavelet Toolbox™ Release Notes



MATLAB®

How to Contact MathWorks



Latest news: www.mathworks.com
Sales and services: www.mathworks.com/sales_and_services
User community: www.mathworks.com/matlabcentral
Technical support: www.mathworks.com/support/contact_us



Phone: 508-647-7000



The MathWorks, Inc.
3 Apple Hill Drive
Natick, MA 01760-2098

Wavelet Toolbox™ Release Notes

© COPYRIGHT 1997–2016 by The MathWorks, Inc.

The software described in this document is furnished under a license agreement. The software may be used or copied only under the terms of the license agreement. No part of this manual may be photocopied or reproduced in any form without prior written consent from The MathWorks, Inc.

FEDERAL ACQUISITION: This provision applies to all acquisitions of the Program and Documentation by, for, or through the federal government of the United States. By accepting delivery of the Program or Documentation, the government hereby agrees that this software or documentation qualifies as commercial computer software or commercial computer software documentation as such terms are used or defined in FAR 12.212, DFARS Part 227.72, and DFARS 252.227-7014. Accordingly, the terms and conditions of this Agreement and only those rights specified in this Agreement, shall pertain to and govern the use, modification, reproduction, release, performance, display, and disclosure of the Program and Documentation by the federal government (or other entity acquiring for or through the federal government) and shall supersede any conflicting contractual terms or conditions. If this License fails to meet the government's needs or is inconsistent in any respect with federal procurement law, the government agrees to return the Program and Documentation, unused, to The MathWorks, Inc.

Trademarks

MATLAB and Simulink are registered trademarks of The MathWorks, Inc. See www.mathworks.com/trademarks for a list of additional trademarks. Other product or brand names may be trademarks or registered trademarks of their respective holders.

Patents

MathWorks products are protected by one or more U.S. patents. Please see www.mathworks.com/patents for more information.

Code Generation: Generate C code for DWT, wavelet packets, and denoising using MATLAB Coder	1-2
Continuous Wavelet Transform: Analyze signals with improved automatic selection of wavelet and scales	1-2
Morse Wavelets: Family of analytic wavelets for continuous wavelet analysis	1-3
Wavelet Leaders and Wavelet Transform Modulus Maxima: Characterize fractal data and singularities	1-3
Haar Lifting Transforms: Perform multiresolution analysis of images and multichannel signals	1-3
Compression data files default to uint64 data	1-4
Wavelet Design and Analysis App renamed to Wavelet Analyzer	1-4
wavedemo function removed	1-4
Functionality being removed or changed	1-5

Maximal Overlap Discrete Wavelet Packet Transform: Perform nondecimated wavelet packet analysis on arbitrary-length signals	2-2
Wavelet Synchrosqueezing: Sharpen time-frequency estimates and extract signal modes	2-2
Wavelet Coherence: Compare time-varying frequency content between signals	2-2
Fejer-Korovkin filter with 18 coefficients	2-3
Maximum derivative output of gauswavf and cgauwavf ...	2-3
Functionality being removed or changed	2-3

Maximal Overlap Discrete Wavelet Transform: Perform nondecimated analysis on arbitrary-length signals and obtain multiscale variance and correlation estimates ...	3-2
Frequency-Localized Wavelets: Perform more frequency-localized discrete and continuous wavelet analysis	3-2
Time-Frequency Analysis: Convert scale to frequency to interpret the continuous wavelet transform as a time-frequency transform	3-2
Application examples: Analyze financial data and physiologic signals using wavelets	3-3

R2015a

Functionality being removed or changed	4-2
---	------------

R2014b

Bug Fixes

R2014a

Dual-Tree Wavelet Transforms	6-2
---	------------

R2013b

Two-Dimensional Continuous Wavelet Transform (2-D CWT)	7-2
Dual-Tree Transforms and Double-Density Transforms	7-2

R2013a

Bug Fixes

R2012b

Bug Fixes

R2012a

Matching Pursuit 10-2

R2011b

**Fourier Transform Based Continuous Wavelet Transform
GUI** 11-2

**Inverse Continuous Wavelet Transform Using Linear
Scales** 11-2

**MATLAB Code Generation Support for Denoising and
Compression GUIs** 11-2

**Signal Reconstruction from Continuous Wavelet Transform
Coefficients Demo** 11-2

**Changes in Fourier Transform Based Continuous Wavelet
Transform Defaults for Derivative of Gaussian (DOG) and
Paul Wavelets** 11-2

R2011a

Inverse Continuous Wavelet Transform 12-2

FFT-based Continuous Wavelet Transform	12-2
Pattern-adapted Wavelets for Signal Detection Demo	12-2

R2010b

Cone of Influence for Continuous Wavelet Transform	13-2
Wavelet Cross Spectrum and Coherence	13-2
Wavelet Packet Spectrum	13-2
Natural and Frequency Ordering of Wavelet Packet Terminal Nodes	13-2
Image and Signal Approximation Quality Metrics	13-2

R2010a

3-D Discrete Wavelet Transform	14-2
Nondecimated Wavelet Transform	14-2
New Denoising Function	14-2

R2009b

Bug Fixes

R2009a

New Demos	16-2
------------------------	-------------

R2008b

True Image Compression Support	17-2
New Demo	17-2

R2008a

True Color Images Support	18-2
New Extension Modes for Continuous Wavelets	18-2
New Norms Calculation	18-2
Wavelet Families Display	18-2
Single Data Type Support	18-2
New Demos	18-2

R2007b

Importing and Exporting between GUIs and Workspace ..	19-2
Scalograms for Continuous Wavelet Transforms	19-2

R2007a

1D Multisignal Analysis, Compression, and Denoising Added	20-2
1D Multisignal Wavelet and Clustering Added	20-2
Wavelet 1D Multisignal Analysis GUI Added	20-2

R2006b

Multivariate De-noising Added	21-2
Multiscale Principal Component Analysis Added	21-2
New Demos	21-2

R2006a

No New Features or Changes

R14SP3

No New Features or Changes

No New Features or Changes

R2016b

Version: 4.17

New Features

Bug Fixes

Compatibility Considerations

Code Generation: Generate C code for DWT, wavelet packets, and denoising using MATLAB Coder

You can now generate code for workflows that support:

- 1-D and 2-D critically sampled discrete wavelet transforms (DWT)
- 1-D maximal overlap discrete wavelet transforms (MODWT)
- Wavelet packet transforms (MODWPT)
- 1-D and 2-D wavelet denoising

You must have MATLAB[®] Coder[™] to generate code. The following functions support code generation:

- `dwt`, `idwt`
- `dwt2`, `idwt2`
- `modwt`, `imodwt`, `modwtmra`
- `modwpt`, `imodwpt`, `modwptdetails`
- `appcoef`, `appcoef2`
- `detcoef`, `detcoef2`
- `wavedec`, `wavedec2`
- `waverec`, `waverec2`
- `wden`, `wdencomp`, `ddencomp`
- `qmf`
- `dyadup`
- `wextend`
- `thselect`
- `wthresh`, `wthcoef`, `wthcoef2`

Continuous Wavelet Transform: Analyze signals with improved automatic selection of wavelet and scales

This release provides an updated version of the continuous wavelet transform, `cwt`, and a new inverse transform, `icwt`, for reconstructing the original signal. These functions

are easier to use because they have simple interfaces and include default values for the wavelet and scales and frequency and period ranges are easy to specify. When you use the updated `cwt`, which use analytic wavelets and L1 normalization, `icwt` produce a more accurate reconstruction.

Compatibility Considerations

The old version of `cwt` continues to work, however, updating existing code to use the new version of `cwt` is recommended. Both the old and updated versions use the same function name. The inputs to the function determine automatically which version is used.

`icwt` is recommended instead of `icwtft` and `icwtlin`.

Morse Wavelets: Family of analytic wavelets for continuous wavelet analysis

The Morse family of analytic wavelets are ideal for continuous wavelet analysis. These exactly analytic wavelets are characterized by two parameters. You can vary these parameters to change the shape and duration of the wavelet as needed to analyze your signal or image.

Wavelet Leaders and Wavelet Transform Modulus Maxima: Characterize fractal data and singularities

The `wtmm` function returns an estimate of the global Holder exponent, which characterizes multifractal behavior. You can use `wtmm` to characterize cusp-like singularities. The `dwtleader` function distinguishes monofractal from multifractal behavior. You can use `WTMM` and wavelet leaders to analyze turbulence, electrophysical signals, and financial time series. Both functions accept 1-D data.

Haar Lifting Transforms: Perform multiresolution analysis of images and multichannel signals

Four Haar lifting transform functions have been added to the toolbox: `haart` and `ihaart` for 1-D signals, and `haart2` and `ihaart2` for 2-D signals. The Haar wavelet, though not continuous, is the simplest possible wavelet and is a special case of the Daubechies wavelet, `db1`. These new Haar lifting transforms are computationally efficient.

Compression data files default to uint64 data

By default, `wcompress` now writes `.wtc` files using `uint64` precision data. A new 'legacy' flag has been added to write `.wtc` files using the earlier `uint32` precision data format. You do not need to include the 'legacy' flag for reading a `.wtc` file because `wcompress` automatically detects and correctly reads the data format.

Compatibility Considerations

To share a data file with someone using a previous release, use the 'legacy' flag to create a `.wtc` file of `uint32` data. For example, `wcompress('c',x,'comp_data.wtc','legacy')`.

Wavelet Design and Analysis App renamed to Wavelet Analyzer

The Wavelet Design and Analysis app has been renamed to Wavelet Analyzer. To open the Wavelet Analyzer from the command line, use `waveletAnalyzer` instead of `wavemenu`.

Compatibility Considerations

Change all calls to `wavemenu`, which opens the app, to the new `waveletAnalyzer` command. The app functionality remains unchanged.

wavedemo function removed

The `wavedemo` function has been removed. Use “Wavelet Toolbox Examples” instead.

Compatibility Considerations

Change all calls and links to `wavedemo` to point to “Wavelet Toolbox Examples”.

Functionality being removed or changed

Functionality	What Happens When You Use This Functionality?	Use This Instead	Compatibility Considerations
Old cwt	Old functionality is detected based on the input syntax and the old cwt still runs.	Updated cwt	Update all instances of cwt to use the updated cwt syntax.
wcompress	An error occurs if you read .wtc files saved using uint32 data.	Add a 'legacy' flag to use uint32 data instead of default uint64 data	Add a 'legacy' flag to instances of wcompress commands that read .wtc files containing uint32 data.
wavemenu	Still opens Wavelet app	waveletAnalyzer	Update instances of wavemenu to use the new waveletAnalyzer function.
wavedemo	An error occurs .	“Wavelet Toolbox Examples”	Update instances of wavedemo to point to the Examples page.

R2016a

Version: 4.16

New Features

Bug Fixes

Compatibility Considerations

Maximal Overlap Discrete Wavelet Packet Transform: Perform nondecimated wavelet packet analysis on arbitrary-length signals

This release adds support for the maximal overlap discrete wavelet packet transform (MODWPT) for 1-D signals. You can decompose signals using `modwpt` and invert the transform using `imodwpt`. Also, you can obtain MODWPT details using `modwptdetails`. For an example of using wavelet packets, see [Wavelet Packets: Decomposing the Details](#).

Wavelet Synchrosqueezing: Sharpen time-frequency estimates and extract signal modes

This release adds support for the wavelet synchrosqueezed transform and mode extraction for 1-D signals. Wavelet synchrosqueezing is a time-frequency reassignment technique that enables you to reconstruct the signal from the reassigned transform. This technique enables you to extract and visualize oscillatory modes in the signal. To obtain the synchrosqueezed transform of a signal, use `wsst`. To invert the transform, use `iwsst`. You can determine or extract time-frequency ridges in the synchrosqueezed transform with `wsstridge`. For an example of synchrosqueezing, see [Time-Frequency Reassignment and Mode Extraction with Synchrosqueezing](#).

Wavelet Coherence: Compare time-varying frequency content between signals

This release adds the `wcoherence` function, which computes the magnitude-squared wavelet coherence of two input signals. The `wcoherence` function also computes the wavelet cross spectrum. Wavelet coherence is useful for detecting common time-localized oscillations in nonstationary, bivariate signals. `wcoherence` also provides visualizations that show the magnitude-squared coherence, cross-spectrum phase, and the cone of influence. The phase plot is helpful in determining the lead-lag relationships between the signals. The cone of influence demonstrates where edge effects become significant. For an example of using `wcoherence`, see [Compare Time-Frequency Content in Signals with Wavelet Coherence](#).

Compatibility Considerations

`wcoher` is not recommended. Update code that uses `wcoher` to use `wcoherence` instead.

Fejer-Korovkin filter with 18 coefficients

This release adds support for Fejer-Korovkin (`fejerkorovkin`) scaling and wavelet filters with 18 coefficients. The valid short name is `'fk18'`.

Maximum derivative output of `gauswavf` and `cgauwavf`

As of R2016a, the highest order derivative supported for the Gaussian (`gauswavf`) and complex Gaussian wavelet (`cgauwavf`) is 8.

Compatibility Considerations

Specifying a derivative order greater than 8 produces an error. In code that uses `gauswavf` or `cgauwavf`, update these functions to use a derivative value from 1 to 8. The requirement to have Symbolic Math Toolbox™ has been removed.

Functionality being removed or changed

Functionality	What Happens When You Use This Functionality?	Use This Instead	Compatibility Considerations
<code>wcoher</code>	Still runs	<code>wcoherence</code>	Replace all instances of <code>wcoher</code> with <code>wcoherence</code> .
<code>gauswavf</code> and <code>cgauwavf</code>	Errors when the order of the derivative is greater than 8		Update instances of <code>gauswavf</code> and <code>cgauwavf</code> to use a maximum derivative value of 8.

R2015b

Version: 4.15

New Features

Bug Fixes

Maximal Overlap Discrete Wavelet Transform: Perform nondecimated analysis on arbitrary-length signals and obtain multiscale variance and correlation estimates

This release adds support for the maximal overlap discrete wavelet transform (MODWT) for 1-D signals. You can decompose signals using `modwt` and invert the transform using `imodwt`. Additionally, you can obtain a MODWT-based multiresolution analysis using `modwtmra`. You can also obtain wavelet variance, correlation, and cross-correlation sequence estimates with confidence intervals using `modwtvar`, `modwtcorr`, and `modwtxcorr`.

Frequency-Localized Wavelets: Perform more frequency-localized discrete and continuous wavelet analysis

This release adds new frequency-localized wavelets for continuous and discrete wavelet analysis. The bump wavelet is a frequency-localized wavelet with an adjustable center frequency and bandwidth.

You can use the bump wavelet with `cwtft`. For discrete decimated and nondecimated wavelet or wavelet packet analysis, use the new Fejer-Korovkin family of frequency-localized orthogonal wavelets. To obtain information on the Fejer-Korovkin wavelets, enter `waveinfo('fk')` at the MATLAB command prompt. To obtain the Fejer-Korovkin filters, use `wfilters` or `fejerkorovkin`. You can specify the Fejer-Korovkin filters in all discrete wavelet and wavelet packet command line and interactive applications using the short name, 'fk' with a valid filter number. For example, `wavedec(data,N,'fk8')` or `modwt(data,'fk8')`.

Time-Frequency Analysis: Convert scale to frequency to interpret the continuous wavelet transform as a time-frequency transform

This release adds scale-to-frequency conversion for `cwtft` and `cwt`. `cwtft` returns the scale-to-frequency conversions as a field in the structure array output. `cwt` accepts an optional sampling interval input, which enables you to output scale-to-frequency conversions. This release also adds a featured example, Time-Frequency Analysis with the Continuous Wavelet Transform.

Application examples: Analyze financial data and physiologic signals using wavelets

This release introduces new examples for analyzing financial data and physiologic signals using wavelets. The financial example, *Wavelet Analysis of Financial Data*, shows how you can use wavelets to analyze multiscale volatility in financial time series data and explore multiscale correlation in bivariate time series data. The physiologic signal analysis example, *Wavelet Analysis of Physiologic Signals*, showcases QRS detection in the electrocardiogram using wavelets, wavelet coherence, and time-frequency analysis.

R2015a

Version: 4.14.1

Bug Fixes

Compatibility Considerations

Functionality being removed or changed

Functionality	What Happens When You Use This Functionality?	Use This Instead	Compatibility Considerations
ndwt, indwt, ndwt2, indwt2	Errors	swt, iswt, swt2, iswt2	Replace all instances of ndwt, indwt, ndwt2, and indwt2 with the corresponding function for the stationary wavelet transform.

R2014b

Version: 4.14

Bug Fixes

R2014a

Version: 4.13

New Features

Bug Fixes

Dual-Tree Wavelet Transforms

This release introduces a new example, Dual-Tree Wavelet Transforms, which demonstrates the advantages of the dual-tree discrete wavelet transform (DWT) over the critically sampled DWT. The example illustrates the approximate shift invariance and directional selectivity of the complex dual-tree wavelet transform. These properties enable the dual-tree wavelet transform to outperform the critically sampled DWT in a number of applications.

R2013b

Version: 4.12

New Features

Bug Fixes

Two-Dimensional Continuous Wavelet Transform (2-D CWT)

This release introduces the 2-D continuous wavelet transform (CWT) for images. The 2-D CWT provides information about images at specified scales, rotation angles, and positions in the plane. Applications of the 2-D CWT include:

- Fault detection in images
- Object recognition
- Fringe pattern profilometry

For information on how to implement the 2-D CWT at the MATLAB command line, see `cwtft2`.

To use `cwtft2` in the Wavelet Toolbox™ interactive tool, enter

```
>> wavemenu
```

Then, from the **Two-dimensional** tools section, select **Continuous Wavelet Transform 2-D**. See 2-D Continuous Wavelet Transform App for more information on the 2-D CWT app.

`cwtft2` supports both isotropic and anisotropic 2-D wavelets. Use isotropic wavelets to perform pointwise analysis in images or when oriented features are not relevant. Use anisotropic wavelets when your goal is to detect oriented features.

`cwtft2` implements the 2-D CWT using the 2-D discrete Fourier transform. Use `cwtftinfo2` to obtain the 2-D Fourier transforms of the supported analyzing wavelets.

Dual-Tree Transforms and Double-Density Transforms

This release introduces two types of 1-D and 2-D oversampled (frame) wavelet perfect reconstruction filter banks. For 1-D wavelet analysis, use `dddtree` to obtain the following wavelet transforms:

- Complex dual-tree
- Double-density
- Complex dual-tree double-density

For 2-D wavelet analysis, use `dddtree2` to obtain the following wavelet transforms:

- Double-density

-
- Real oriented dual-tree
 - Complex oriented dual-tree
 - Real oriented double-density dual-tree
 - Complex oriented double-density dual-tree

The dual-tree and double-density transforms mitigate a number of shortcomings of the critically sampled discrete wavelet transform. The double-density and dual-tree transforms achieve directional selectivity and approximate shift invariance with significantly less computational cost than the undecimated discrete wavelet transform.

R2013a

Version: 4.11

Bug Fixes

R2012b

Version: 4.10

Bug Fixes

R2012a

Version: 4.9

New Features

Matching Pursuit

In R2012a you can decompose a 1-D signal in a dictionary of time/frequency or time/scale atoms with matching pursuit.

Representing a signal in a union of time-frequency/time-scale bases can provide sparser signal representations than attainable with any single basis. Matching pursuit uses iterative greedy algorithms to reduce the computational complexity of searching through a redundant dictionary.

Wavelet Toolbox software supports basic matching pursuit, orthogonal matching pursuit, and weak orthogonal matching pursuit at the command line with `wmpdictionary` and `wmpalg`. You can also perform matching pursuit with the interactive `wavemenu` tool.

You can build dictionaries using several internally supported options or provide your own custom dictionaries. See [Matching Pursuit](#) for background information and examples.

R2011b

Version: 4.8

New Features

Bug Fixes

Compatibility Considerations

Fourier Transform Based Continuous Wavelet Transform GUI

In R2011b, you can compute the Fourier transform based continuous wavelet transform (CWT) and inverse CWT using the Wavelet Toolbox graphical user interface `wavemenu`. To access these graphical tools, enter `wavemenu` at the command line, and select **Continuous Wavelet 1-D (using FFT)**.

Inverse Continuous Wavelet Transform Using Linear Scales

In R2011b, you can compute the inverse continuous wavelet transform (CWT) for a wider class of analyzing wavelets using `icwtlin`. `icwtlin` returns the inverse for CWT coefficients obtained at linearly spaced scales. `icwtlin` supports the output of `cwtft` and the output of `cwt` for a select number of wavelets. See `icwtlin` for detailed information.

MATLAB Code Generation Support for Denoising and Compression GUIs

In R2011b, you can generate MATLAB code for 1-D and 2-D discrete wavelet transforms (DWT), stationary wavelet transforms (SWT), and wavelet packet transforms. You can denoise or compress a signal or image in the GUI and export the MATLAB code to implement that operation at the command line. This approach allows you to set denoising thresholds or compression ratios aided by visualization tools and save the commands to reproduce those operations at the command line. See `Generating MATLAB Code from Wavelet Toolbox GUI` for examples.

Signal Reconstruction from Continuous Wavelet Transform Coefficients Demo

R2011b includes a new demo illustrating signal reconstruction using the continuous wavelet transform (CWT). The demo emphasizes the use of the CWT to analyze a signal and reconstruct a time- and scale-based approximation with select coefficients using the inverse CWT. See `Signal Reconstruction from Continuous Wavelet Transform Coefficients` for details.

Changes in Fourier Transform Based Continuous Wavelet Transform Defaults for Derivative of Gaussian (DOG) and Paul Wavelets

In R2011b, the default values for the smallest scale, scale increment, and number of scales have changed in `cwtft` for the derivative of Gaussian (DOG) and Paul wavelets.

The change in the defaults also affects the Mexican hat wavelet, which is a special case of the DOG wavelet. In R2011b, the default value of the smallest scale for the Paul and DOG wavelets is $2 \cdot dt$, where dt is the sampling period. The default scale increment, ds , is 0.4875. The default number of scales is $\text{fix}(\log_2(\text{length}(\text{sig}))/ds)+1$ for the Paul wavelet and $\max([\text{fix}(\log_2(\text{length}(\text{sig}))/ds), 1])$ for the DOG wavelets, where sig is the input signal.

Compatibility Considerations

`cwtft` was introduced in R2011a. In that release, the default smallest scales for the DOG and Paul wavelets are $dt/8$ and dt respectively, where dt is the sampling interval. The default scale increment is 0.5. The default number of scales is $\text{fix}(1.5 \cdot \log_2(\text{length}(\text{sig}))/ds)+1$ for the Paul wavelet. For DOG wavelets, the default number of scales is $\text{fix}(1.25 \cdot \log_2(\text{length}(\text{sig}))/ds)+1$, where sig is the input signal. You can obtain results in R2011b using `cwtft` with the DOG and Paul wavelets identical to results in R2011a with the default values. To do so, specify the smallest scale, scale increment, and number of scales in a structure or cell array. See `cwtft` for details.

R2011a

Version: 4.7

New Features

Bug Fixes

Inverse Continuous Wavelet Transform

In R2011a, you can compute the inverse continuous wavelet transform (CWT) using an FFT-based algorithm. The inverse CWT allows you to synthesize approximations to your 1D signal based on selected scales. The inverse CWT is only supported for coefficients obtained using the FFT-based CWT. See `icwtft` and `cwtft` for details.

FFT-based Continuous Wavelet Transform

In R2011a, you can compute the continuous wavelet transform (CWT) using an FFT-based algorithm with `cwtft`. The CWT computed using an FFT algorithm supports the computation of the inverse CWT. See `cwtft` and `icwtft` for details. Only select wavelets are valid for use with `cwtft`. See `cwtftinfo` for a list of supported wavelets.

Pattern-adapted Wavelets for Signal Detection Demo

In R2011a there is a new demo using pattern adapted wavelets for signal detection. You can view this demo here [Pattern adapted wavelets for signal detection](#). The Wavelet Toolbox software enables you to design admissible wavelets based on the pattern you wish to detect. Designing a valid wavelet based on your desired pattern allows you to exploit the optimality of matched filtering in the framework of the CWT. The demo illustrates this process on simulated data and human EEG recordings.

R2010b

Version: 4.6

New Features

Bug Fixes

Cone of Influence for Continuous Wavelet Transform

In R2010b, you can compute the cone of influence (COI) for the continuous wavelet transform (CWT) of a signal. At each scale, the COI determines the set of CWT coefficients influenced by the value of the signal at a specified position. The COI provides an important visual aid in interpreting the CWT. By overlaying the cone of influence on the CWT image, you can determine which CWT coefficients each value of the signal affects at every scale. See `conofinf` for details.

Wavelet Cross Spectrum and Coherence

In R2010b, you can estimate the wavelet cross spectrum and wavelet coherence of two time series. The wavelet cross spectrum and coherence provide wavelet-based alternatives for the Fourier-based cross spectrum and coherence. These wavelet estimators are suitable for nonstationary signals. Using a complex-valued analyzing wavelet, you can also examine intervals in the time-scale plane where the two time series exhibit common phase behavior. See `wcoher` and the new demo `Wavelet Coherence` for details.

Wavelet Packet Spectrum

In R2010b, you can compute the wavelet packet spectrum with `wpspectrum`. The wavelet packet spectrum provides a time-frequency analysis of a time series. The wavelet packet spectrum is useful as wavelet-based counterpart of the short-time Fourier transform.

Natural and Frequency Ordering of Wavelet Packet Terminal Nodes

In R2010b, you can order the wavelet packet transform terminal nodes by natural (Payley) or frequency (sequency) order. See `otnodes` for details.

Image and Signal Approximation Quality Metrics

In R2010b, you can measure the quality of your signal or image approximation using a number of widely-used quality metrics. These metrics include: the peak signal-to-noise ratio (PSNR), the mean square error (MSE), the maximum absolute error, and the energy ratio of the approximation to the original. See `measerr` for details.

R2010a

Version: 4.5

New Features

Bug Fixes

3-D Discrete Wavelet Transform

This release adds new functions and a GUI to support the 3-D discrete wavelet transform. This new functionality lets you decompose, analyze, and display a 3-D object using a different wavelet for each dimension. The new functions are: `dwt3`, `idwt3`, `wavedec3`, and `waverec3`. A demo (`wavelet3ddemo`) is also included.

Nondecimated Wavelet Transform

New nondecimated wavelet transform functions support signals of arbitrary size and different extension modes. Previous functionality had two limitations: signal length had to equal a power of 2 and the only allowable extension mode was periodized. The new functions are: `ndwt`, `indwt`, `ndwt2`, and `indwt2`. A demo (`ndwtdemo`) is also included.

New Denoising Function

The new `cmdddenoise` function uses interval-dependent denoising to compute the denoised signal and coefficients. This allows you to apply different denoising thresholds to different portions of the signal, which is typically nonuniform. You can also export thresholds from the GUI and use them in the `cmdddenoise` function. The toolbox includes a denoising demo (`cmdddenoise`).

R2009b

Version: 4.4.1

Bug Fixes

R2009a

Version: 4.4

New Features

Bug Fixes

New Demos

The toolbox now includes three new demos:

Adding a New Wavelet

Wavelet Interval-dependant Denoising

Wavelet Scalograms

R2008b

Version: 4.3

New Features

Bug Fixes

True Image Compression Support

The new `wcompress` functions lets you compress 2D image data. You can also interactively compress images using the new Two-Dimensional Images Compression GUI.

New Demo

The toolbox now includes a new codepad demo on image compression.

R2008a

Version: 4.2

New Features

Bug Fixes

True Color Images Support

The toolbox can now process true color images. All major toolbox GUIs and all of the 2D-oriented command line functions have been also updated and support true color images.

New Extension Modes for Continuous Wavelets

The new `cwtext` function lets you calculate 1D continuous wavelet parameters using extension parameters.

New Norms Calculation

The Multisignal 1D GUI and other related GUIs now include 1-norm, 2-norm, and inf-norm calculations.

Wavelet Families Display

A new function, `waveletfamilies`, displays all the available wavelet families and their properties.

Single Data Type Support

The `swt2` and `iswt2` functions now support single data types.

New Demos

The toolbox now includes the following new codepad demos:

- Multiscale Principal Component Analysis
- Multivariate Denoising

R2007b

Version: 4.1

New Features

Bug Fixes

Importing and Exporting between GUIs and Workspace

You can now import data from the workspace to all toolbox GUIs and export data from all toolbox GUIs to the workspace. Use **Import from Workspace** and **Export to Workspace**, respectively, on the GUI's **File** menu.

Scalograms for Continuous Wavelet Transforms

The ability to compute scalograms of the wavelet coefficients in continuous wavelet analysis has been added as an option to the `cwt` function. You can also pass the structure produced by `cwt` directly to the new `wscalogram` function. Scalograms show the percentage of energy in each wavelet coefficient.

Constructing Clusters from Hierarchical Cluster Trees

You can now construct clusters from hierarchical cluster trees in multisignal analysis using the new `mdwtcluster` function.

R2007a

Version: 4.0

New Features

Bug Fixes

1D Multisignal Analysis, Compression, and Denoising Added

The following command-line functions for 1D multisignal analysis, compression, and denoising have been added to the toolbox:

mawcmp	Multisignal 1D compression using wavelets.
mawcmpscr	Multisignal 1D wavelet compression scores.
mawcmptp	Multisignal 1D compression thresholds and perf.
mawden	Multisignal 1D denoising using wavelets.
mawthresh	Performs Multisignal 1D thresholding.

1D Multisignal Wavelet and Clustering Added

The following command-line functions for 1D multisignal wavelets and clustering have been added to the toolbox:

chgwdeccfs	Change Multisignal 1D decomposition coeffs
mdwtdec	Multisignal 1D wavelet decomposition
mdwtrec	Multisignal 1D wavelet reconstruction.
wdecenergy	Multisignal 1D decomposition energy repartition

Note Clustering analyses require that Statistics Toolbox™ is installed.

Wavelet 1D Multisignal Analysis GUI Added

A graphical user interface for 1-D multisignal analysis has been added. To start this GUI, select **Multisignal Analysis 1D** from the wavemenu dialog.

R2006b

Version: 3.1

New Features

Bug Fixes

Multivariate De-noising Added

A new command-line function (`wmulden`) and a new GUI (**Multivariate Denoising** from the `wavemenu` initial window) for de-noising a matrix of signals have been added. Both the function and GUI take into account the signals themselves and the correlations between the signals. A two-step process is used. First, a change of basis is performed to deal with noise spatial correlation de-noising in the new basis. Then, a principal component analysis is performed to take advantage of the deterministic relationships between the signals, leading to an additional de-noising effect.

Multiscale Principal Component Analysis Added

A new command-line function (`wmspca`) and a new GUI (**Multiscale Princ. Comp. Analysis** from the `wavemenu` initial window) for simplifying a matrix of signals have been added. Both the function and GUI take into account the signals themselves and the correlations between the signals. The multiscale principal component analysis mixes wavelet decompositions and principal component analysis.

New Demos

The following new demos are added:

- Continuous and Discrete Wavelet Analysis
- Detecting Discontinuities and Breakdown Points
- De-Noising Signals and Images
- Data Compression using 2D Wavelet Analysis
- Image Fusion
- Detecting Self-Similarity
- Wavelet Packets: Decomposing the Details

R2006a

Version: 3.0.4

No New Features or Changes

R14SP3

Version: 3.0.3

No New Features or Changes

R14SP2

Version: 3.0.2

No New Features or Changes

