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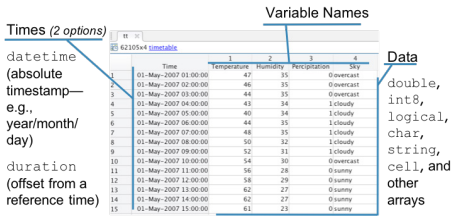
Preprocessing Time Series Data with MATLAB

This reference shows common use cases, but is by no means comprehensive.
The ≫ icon provides links to relevant sections of the MATLAB® documentation to learn more.

Timetable

MATLAB datatype designed to organize and work with time series data.

Components of a Timetable



Create Timetables ≫

```
tt = timetable(times, var1, var2,
     ... ,varN); ≫
```

(All variables must have the same number of rows.)

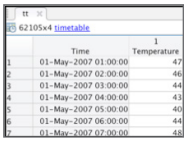
```
tt = table2timetable(t);
```

(The first datetime or duration variable in "t" becomes the row times.)

Timetable Manipulation

Access Data These return the same array:

```
tt.Temperature
tt{:,'Temperature'}
tt{:,1} ≫
```



Add a New Variable

```
tt.newVar = zeros(height(tt),1); ≫
```

Change Variable Names

```
tt.properties.VariableNames =
    newNames; ≫
```

(Names must be valid MATLAB identifiers)

Tip: Use `matlab.lang.makevalidname` *to create valid names from potentially invalid names.*

Resample Data Using Retime

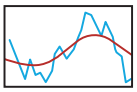
```
tt = retime(tt,newtimes,method); ≫
```

`method` is used to fill gaps after retiming, and has the same options as `synchronize` (see "Merge Timetables").

Data Cleaning

Smooth Data ≫

```
B = smoothdata(A,method);
```

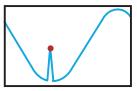


Smooth noisy data with methods:

```
'movmean','movmedian','gaussian',
'lowess','loess','rlowess',
'rloess','sgolay'
```

Detect Outliers ≫

```
TF = isoutlier(A,method);
```

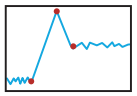


Identify outliers with methods:

```
'median','mean','quartiles',
'grubbs','gesd'
```

Detect Change Points ≫

```
TF = ischange(A,method);
```



Find abrupt changes with methods:

```
'mean','variance','linear'
```

Merge Timetables

Synchronize multiple timetables to a common time vector.

```
tt = synchronize(tt1,tt2,...,ttN); ≫
```

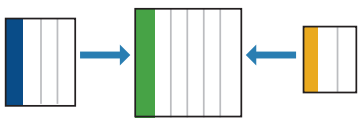
Synchronizing often results in missing data points (times at which a variable was not measured). **`synchronize`** supports several methods for adjusting data to fill in gaps: ≫

Fill: `'fillwithmissing','fillwithconstant'`

Interpolation: `'linear','spline','pchip'`

Nearest Neighbor: `'previous', 'next','nearest'`

Aggregation: `'mean','min','max',@func,...`



Missing Data

Find Missing Values

```
TF = ismissing(tt); ≫
```

Fill Missing Values

```
tt = fillmissing(tt,method); ≫
```

Replace missing values with values calculated from nearby points with methods:

```
'previous','next','nearest',
'linear','spline','pchip'
```

Remove Rows Containing Missing Values

```
tt = rmmissing(tt);
```

Time	1 Temperature	2 Humidity
01-May-2007 01:00:00	47	35
01-May-2007 02:00:00	46	NaN
01-May-2007 03:00:00	NaN	35
01-May-2007 04:00:00	NaN	34
01-May-2007 05:00:00	40	34
01-May-2007 06:00:00	44	35
01-May-2007 07:00:00	48	35

Big Data

Tall arrays extend MATLAB functions to work on data too big to load into memory.

Create a "tall" timetable:

```
% Create a datastore that points to
% the data
ds = datastore('*.csv');

% Create a tall table from the
% datastore
t = tall(ds); ≫

% Convert to a timetable
tt = table2timetable(t); ≫
```

M×5 tall timetable

Time	LATP	LONP	ALT	PTCH	ROLL
10-May-2001 16:24:12	39.055	-84.661	866	-0.37352	0.076902
10-May-2001 16:24:12	NaN	NaN	NaN	-0.37352	0.076902
10-May-2001 16:24:12	NaN	NaN	866	-0.37352	0.076902
10-May-2001 16:24:12	NaN	NaN	NaN	-0.37352	0.076902
10-May-2001 16:24:12	NaN	NaN	866	-0.37352	0.076902
10-May-2001 16:24:12	NaN	NaN	NaN	-0.37352	0.076902
10-May-2001 16:24:12	NaN	NaN	866	-0.37352	0.076902
10-May-2001 16:24:12	NaN	NaN	NaN	-0.37352	0.076902
:	:	:	:	:	:
:	:	:	:	:	: