fittype

Fit type for curve and surface fitting

Syntax

```
aFittype = fittype(libraryModelName)
```
example

```
aFittype = fittype(expression)
```
example

```
aFittype = fittype(expression,Name,Value)
```
example

```
aFittype = fittype(linearModelTerms)
```
example

```
aFittype = fittype(linearModelTerms,Name,Value)
```
example

```
aFittype = fittype(anonymousFunction)
```
example

```
aFittype = fittype(anonymousFunction,Name,Value)
```
example

Description

`aFittype = fittype(libraryModelName)` creates the `fittype` object `aFittype` for the model specified by `libraryModelName`. example

`aFittype = fittype(expression)` creates a fit type for the model specified by the MATLAB® expression. example

`aFittype = fittype(expression,Name,Value)` constructs the fit type with additional options specified by one or more `Name,Value` pair arguments. example

`aFittype = fittype(linearModelTerms)` creates a fit type for a custom linear model with terms specified by the cell array of string expressions in `linearModelTerms`. example

`aFittype = fittype(linearModelTerms,Name,Value)` constructs the fit type with additional options specified by one or more `Name,Value` pair arguments. example

`aFittype = fittype(anonymousFunction)` creates a fit type for the model specified by `anonymousFunction`. example

`aFittype = fittype(anonymousFunction,Name,Value)` constructs the fit type with additional options specified by one or more `Name,Value` pair arguments. example

Examples

collapse all

Create Fit Types for Library Models

Construct fit types by specifying library model names.

Open This Example

Construct a `fittype` object for the cubic polynomial library model.

```
f = fittype('poly3')
```

```
f = 

     Linear model Poly3:
     f(p1,p2,p3,p4,x) = p1*x^3 + p2*x^2 + p3*x + p4
```

Construct a fit type for the library model `rat33` (a rational model of the third degree for both the numerator and denominator).

```
f = fittype('rat33')
```

```
f = 

     General model Rat33:
     f(p1,p2,p3,p4,q1,q2,q3,x) = (p1*x^3 + p2*x^2 + p3*x + p4) /
               (x^3 + q1*x^2 + q2*x + q3)
```

For a list of library model names, see `libraryModelName`.

Create Custom Linear Model

Open This Example

To use a linear fitting algorithm, specify a cell array of terms.

Identify the linear model terms you need to input to `fittype`: `a*x + b*sin(x) + c`. The model is linear in `a`, `b` and `c`. It has three terms `x`, `sin(x)` and `1` (because `c=c*1`). To specify this model you use this cell array of terms: `LinearModelTerms = {'x','sin(x)','1'}`.

Use the cell array of linear model terms as the input to `fittype`.

```
ft = fittype({'x','sin(x)','1'})
```

```
ft = 

     Linear model:
     ft(a,b,c,x) = a*x + b*sin(x) + c
```

Create a linear model fit type for `a*cos(x) + b`.

```
ft2 = fittype({'cos(x)','1'})
```

```
ft2 = 

     Linear model:
     ft2(a,b,x) = a*cos(x) + b
```

Create the fit type again and specify coefficient names.

```
ft3 = fittype({'cos(x)','1'},'coefficients',{'a1','a2'})
```

```
ft3 = 

     Linear model:
     ft3(a1,a2,x) = a1*cos(x) + a2
```

Create Custom Nonlinear Models and Specify Problem Parameters and Independent Variables

Open This Example

Construct fit types for custom nonlinear models, designating problem-dependent parameters and independent variables.

Construct a fit type for a custom nonlinear model, designating `n` as a problem-dependent parameter and `u` as the independent variable.

```
g = fittype('a*u+b*exp(n*u)',...
            'problem','n',...
            'independent','u')
```

```
g = 

     General model:
     g(a,b,n,u) = a*u+b*exp(n*u)
```

Construct a fit type for a custom nonlinear model, designating `time` as the independent variable.

```
g = fittype('a*time^2+b*time+c','independent','time','dependent','height')
```

```
g = 

     General model:
     g(a,b,c,time) = a*time^2+b*time+c
```

Construct a fit type for a logarithmic fit to some data, use the fit type to create a fit, and plot the fit.

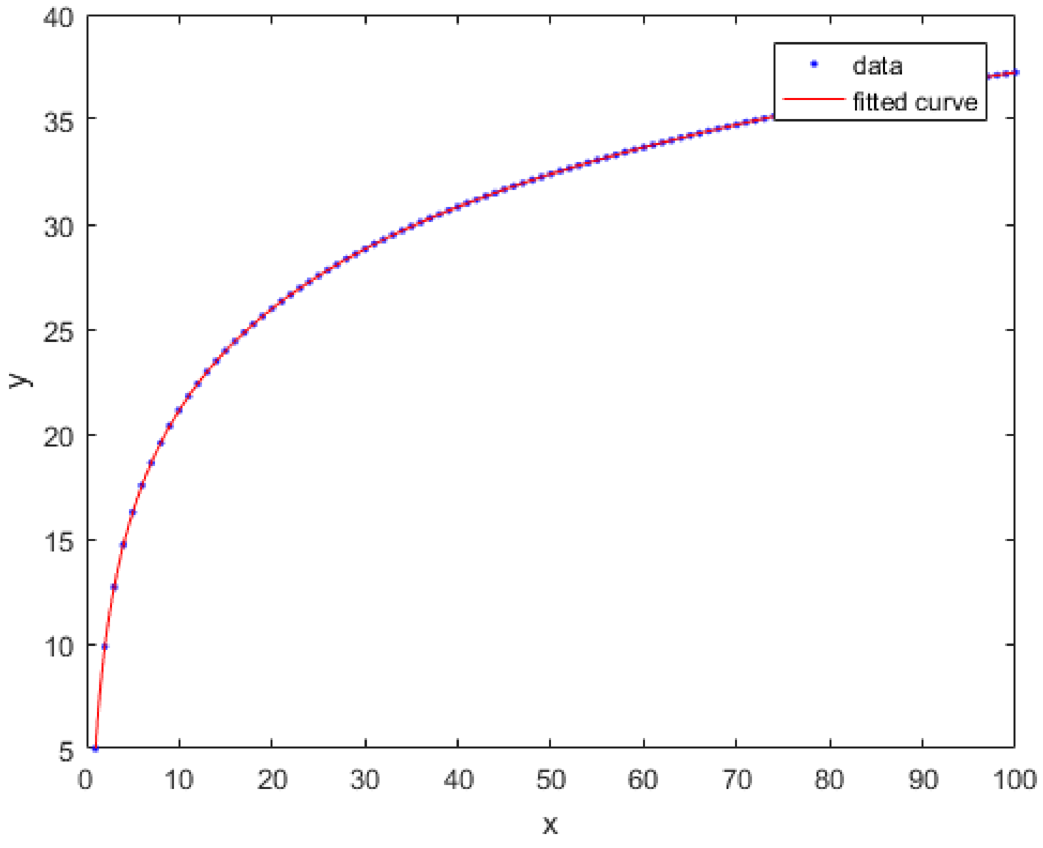
```
x = linspace(1,100);
y = 5 + 7*log(x);
myfittype = fittype('a + b*log(x)',...
    'dependent',{'y'},'independent',{'x'},...
    'coefficients',{'a','b'})
myfit = fit(x',y',myfittype)
plot(myfit,x,y)
```

```
myfittype = 

     General model:
     myfittype(a,b,x) = a + b*log(x)
Warning: Start point not provided, choosing random start point.

myfit = 

     General model:
     myfit(x) = a + b*log(x)
     Coefficients (with 95% confidence bounds):
       a =           5  (5, 5)
       b =           7  (7, 7)
```



You can specify any MATLAB command and therefore any `.m` file.

Fit a Curve Defined by a File

Define a function in a file and use it to create a fit type and fit a curve.

Define a function in a MATLAB file.

```
function y = piecewiseLine(x,a,b,c,d,k)
% PIECEWISELINE   A line made of two pieces
% that is not continuous.

y = zeros(size(x));

% This example includes a for-loop and if statement
% purely for example purposes.
for i = 1:length(x)
    if x(i) < k,
        y(i) = a + b.* x(i);
    else
        y(i) = c + d.* x(i);
    end
end
end
```

Save the file.

Define some data, create a fit type specifying the function `piecewiseLine`, create a fit using the fit type `ft`, and plot the results.

```
x = [0.81;0.91;0.13;0.91;0.63;0.098;0.28;0.55;...
    0.96;0.96;0.16;0.97;0.96];
y = [0.17;0.12;0.16;0.0035;0.37;0.082;0.34;0.56;...
    0.15;-0.046;0.17;-0.091;-0.071];
ft = fittype( 'piecewiseLine( x, a, b, c, d, k )' )
f = fit( x, y, ft, 'StartPoint', [1, 0, 1, 0, 0.5] )
plot( f, x, y )
```

Create Custom Linear Model

To use a linear fitting algorithm, specify a cell array of terms.

Open This Example

Identify the linear model terms you need to input to `fittype`: `a*x + b*sin(x) + c`. The model is linear in `a`, `b` and `c`. It has three terms `x`, `sin(x)` and `1` (because `c=c*1`). To specify this model you use this cell array of terms: `LinearModelTerms = {'x','sin(x)','1'}`.

Use the cell array of linear model terms as the input to `fittype`.

```
ft = fittype({'x','sin(x)','1'})
```

```
ft = 

     Linear model:
     ft(a,b,c,x) = a*x + b*sin(x) + c
```

Create a linear model fit type for `a*cos(x) + b`.

```
ft2 = fittype({'cos(x)','1'})
```

```
ft2 =

     Linear model:
     ft2(a,b,x) = a*cos(x) + b
```

Create the fit type again and specify coefficient names.

```
ft3 = fittype({'cos(x)','1'},'coefficients',{'a1','a2'})
```

```
ft3 =

     Linear model:
     ft3(a1,a2,x) = a1*cos(x) + a2
```

Create Fit Types Using Anonymous Functions

Create a fit type using an anonymous function.

```
g = fittype( @(a, b, c, x) a*x.^2+b*x+c )
```

Create a fit type using an anonymous function and specify independent and dependent parameters.

```
g = fittype( @(a, b, c, d, x, y) a*x.^2+b*x+c*exp(...
 -(y-d).^2 ), 'independent', {'x', 'y'},...
     'dependent', 'z' );
```

Create a fit type for a surface using an anonymous function and specify independent and dependent parameters, and problem parameters that you will specify later when you call `fit`.

```
g = fittype( @(a,b,c,d,x,y) a*x.^2+b*x+c*exp( -(y-d).^2 ), ...
        'problem', {'c','d'}, 'independent', {'x', 'y'}, ...
        'dependent', 'z' );
```

Use an Anonymous Function to Pass in Workspace Data to the Fit

Use an anonymous function to pass workspace data into the `fittype` and `fit` functions.

Create and plot an S-shaped curve. In later steps, you stretch and move this curve to fit to some data.

```
% Breakpoints.
xs = (0:0.1:1).';
% Height of curve at breakpoints.
ys = [0; 0; 0.04; 0.1; 0.2; 0.5; 0.8; 0.9; 0.96; 1; 1];
% Plot S-shaped curve.
xi = linspace( 0, 1, 241 );
plot( xi, interp1( xs, ys, xi, 'pchip' ), 'LineWidth', 2 )
hold on
plot( xs, ys, 'o', 'MarkerFaceColor', 'r' )
hold off
title S-curve
```

Create a fit type using an anonymous function, taking the values from the workspace for the curve breakpoints (`xs`) and the height of the curve at the breakpoints (`ys`). Coefficients are `b` (base) and `h` (height).

```
ft = fittype( @(b, h, x) interp1( xs, b+h*ys, x, 'pchip' ) )
```

Plot the `fittype` specifying example coefficients of base `b=1.1` and height `h=-0.8`.

```
plot( xi, ft( 1.1, -0.8, xi ), 'LineWidth', 2 )
title 'Fittype with b=1.1 and h=-0.8'
```

Load and fit some data, using the fit type `ft` created using workspace values.

```
% Load some data
xdata = [0.012;0.054;0.13;0.16;0.31;0.34;0.47;0.53;0.53;...
   0.57;0.78;0.79;0.93];
ydata = [0.78;0.87;1;1.1;0.96;0.88;0.56;0.5;0.5;0.5;0.63;...
   0.62;0.39];
% Fit the curve to the data
f = fit( xdata, ydata, ft, 'Start', [0, 1] )
% Plot fit
plot( f, xdata, ydata )
title 'Fitted S-curve'
```

Use Anonymous Functions to Work with Problem Parameters and Workspace Variables

This example shows the differences between using anonymous functions with problem parameters and workspace variable values.

Load data, create a fit type for a curve using an anonymous function with problem parameters, and call `fit` specifying the problem parameters.

```
% Load some data.
xdata = [0.098;0.13;0.16;0.28;0.55;0.63;0.81;0.91;0.91;...
    0.96;0.96;0.96;0.97];
ydata = [0.52;0.53;0.53;0.48;0.33;0.36;0.39;0.28;0.28;...
    0.21;0.21;0.21;0.2];

% Create a fittype that has a problem parameter.
g = fittype( @(a,b,c,x) a*x.^2+b*x+c, 'problem', 'c' )

% Examine coefficients. Observe c is not a coefficient.
coeffnames( g )

% Examine arguments. Observe that c is an argument.
argnames( g )

% Call fit and specify the value of c.
f1 = fit( xdata, ydata, g, 'problem', 0, 'StartPoint', [1, 2] )

% Note: Specify start points in the calls to fit to
% avoid warning messages about random start points
% and to ensure repeatability of results.

% Call fit again and specify a different value of c,
% to get a new fit.
f2 = fit( xdata, ydata, g, 'problem', 1, 'start', [1, 2] )

% Plot results. Oberve the specified c constants
% do not make a good fit.
plot( f1, xdata, ydata )
hold on
plot( f2, 'b' )
hold off
```

Modify the previous example to create the same fits using workspace values for variables, instead of using problem parameters. Using the same data, create a fit type for a curve using an anonymous function with a workspace value for variable c:

```
% Remove c from the argument list.
try
    g = fittype( @(a,b,x) a*x.^2+b*x+c )
catch e
    disp( e.message )
end
% Observe error because now c is undefined.
% Define c and create fittype:
c = 0;
g1 = fittype( @(a,b,x) a*x.^2+b*x+c )

% Call fit (now no need to specify problem parameter).
f1 = fit( xdata, ydata, g1, 'StartPoint', [1, 2] )
% Note that this f1 is the same as the f1 above.
% To change the value of c, recreate the fittype.
c = 1;
g2 = fittype( @(a,b,x) a*x.^2+b*x+c ) % uses c = 1
f2 = fit( xdata, ydata, g2, 'StartPoint', [1, 2] )
% Note that this f2 is the same as the f2 above.
% Plot results
plot( f1, xdata, ydata )
hold on
plot( f2, 'b' )
hold off
```

Related Examples

- Custom Linear Fitting

Input Arguments

collapse all

`libraryModelName` — Library model to fit
string

Library model to fit, specified as a string. This table shows some common examples.

Library Model Name	Description
`'poly1'`	Linear polynomial curve
`'poly11'`	Linear polynomial surface
`'poly2'`	Quadratic polynomial curve
`'linearinterp'`	Piecewise linear interpolation
`'cubicinterp'`	Piecewise cubic interpolation
`'smoothingspline'`	Smoothing spline (curve)
`'lowess'`	Local linear regression (surface)

For a list of library model names, see Model Names and Equations.

Example: `'poly2'`

Data Types: `char`

`expression` — Model to fit
string

Model to fit, specified as a string. You can specify any MATLAB command and therefore any `.m` file. See Fit a Curve Defined by a File.

Data Types: `char`

`linearModelTerms` — Model to fit
cell array of strings

Model to fit, specified as a cell array of strings. Specify the model terms by the expressions in the strings. Do not include coefficients in the expressions for the terms. See Linear Model Terms.

Data Types: `cell`

`anonymousFunction` — Model to fit
anonymous function

Model to fit, specified as an anonymous function. For details, see Input Order for Anonymous Functions.

Data Types: `char`

Name-Value Pair Arguments

Specify optional comma-separated pairs of `Name,Value` arguments. `Name` is the argument name and `Value` is the corresponding value. `Name` must appear inside single quotes (`' '`). You can specify several name and value pair arguments in any order as `Name1,Value1,...,NameN,ValueN`.

Example: `'coefficients',{'a1','a2'}`

`'coefficients'` — Coefficient names
string | cell array of strings

Coefficient names, specified as the comma-separated pair consisting of `'coefficients'` and a string, or a cell array of strings for multiple names. You can use multicharacter symbol names. You cannot use these names: `i`, `j`, `pi`, `inf`, `nan`, `eps`.

Data Types: `char` | `cell`

`'dependent'` — Dependent (response) variable name
y (default) | string

Dependent (response) variable name, specified as the comma-separated pair consisting of `'dependent'` and a string. If you do not specify the dependent variable, the function assumes `y` is the dependent variable.

Data Types: `char`

`'independent'` — Independent (response) variable names
x (default) | string | cell array of strings

Independent (response) variable names, specified as the comma-separated pair consisting of `'independent'` and a string or cell array of strings. If you do not specify the independent variable, the function assumes `x` is the independent variable.

Data Types: `char`

`'options'` — Fit options
`fitoptions`

Fit options, specified as the comma-separated pair consisting of `'options'` and the name of a `fitoptions` object.

`'problem'` — Problem-dependent (fixed) parameter names
cell array

Problem-dependent (fixed) parameter names, specified as the comma-separated pair consisting of `'problem'` and a string, or cell array or strings with one element per problem dependent constant.

Data Types: `char` | `cell`

Output Arguments

collapse all

`aFittype` — Model to fit
`fittype` object

Model to fit, returned as a `fittype`. A `fittype` encapsulates information describing a model. To create a fit, you need data, a `fittype`, and (optionally) `fitoptions` and an exclusion rule. You can use a `fittype` as an input to the `fit` function.

More About

collapse all

Dependent and Independent Variables

How do I decide which variables are dependent and independent?

To determine dependent and independent variables and coefficients, consider this equation:

$$y = f(x) = a + (b * x) + (c * x^2).$$

- *y* is the dependent variable.
- *x* is the independent variable.
- *a*, *b*, and *c* are the coefficients.

The `'independent'` variable is what you control. The `'dependent'` variable is what you measure, i.e., it depends on the independent variable. The `'coefficients'` are the parameters that the fitting algorithm estimates.

For example, if you have census data, then the year is the independent variable because it does not depend on anything. Population is the dependent variable, because its value depends on the year in which the census is taken. If a parameter like growth rate is part of the model, so the fitting algorithm estimates it, then the parameter is one of the `'coefficients'`.

The `fittype` function determines input arguments by searching the fit type expression input for variable names. `fittype` assumes `x` is the independent variable, `y` is the dependent variable, and all other variables are coefficients of the model. `x` is used if no variable exists.

Input Order for Anonymous Functions

If the fit type expression input is an anonymous function, then the order of inputs must be correct. The input order enables the `fittype` function to determine which inputs are coefficients to estimate, problem-dependent parameters, and independent variables.

The order of the input arguments to the anonymous function must be:

```
fcn = @(coefficients,problemparameters,x,y) expression
```

You need at least one coefficient. The problem parameters and y are optional. The last arguments, x and y, represent the independent variables: just x for curves, but x and y for surfaces. If you don't want to use x and/or y to name the independent variables, then specify different names using the `'independent'` argument name-value pair. However, whatever name or names you choose, these arguments must be the last arguments to the anonymous function.

Anonymous functions make it easier to pass other data into the `fittype` and `fit` functions.

1. Create a fit type using an anonymous function and a variable value (c) from the workspace.

   ```
   c = 1;
    g = fittype( @(a, b, x) a*x.^2+b*x+c )
   ```

2. The `fittype` function can use the variable values in your workspace when you create the fit type. To pass in new data from the workspace, recreate the fit type, e.g.,

   ```
   c=5 % Change value of c.
   g = fittype( @(a, b, x) a*x.^2+b*x+c )
   ```

3. Here, the value of c is fixed when you create the fit type. To specify the value of c at the time you call `fit`, you can use problem parameters. For example, make a fit with `c = 2` and then a new fit with `c = 3`.

   ```
   g = fittype( @(a,b,x) a*x.^2+b*x+c, 'problem', 'c' )
   f1 = fit( xdata, ydata, g, 'problem', 2 )
   f2 = fit( xdata, ydata, g, 'problem', 3 )
   ```

Linear Model Terms

How do I define linear model terms?

To use a linear fitting algorithm, specify `linearModelTerms` as a cell array of terms.

```
afittype = fittype({expr1,...,exprn})
```

Specify the model terms by the expressions in the strings `expr2,...,exprn`. Do not include coefficients in the expressions for the terms. If there is a constant term, use `'1'` as the corresponding expression in the cell array.

To specify a linear model of the following form:

```
 coeff1 * term1 + coeff2 * term2 + coeff3 * term3 + ...
```

where no coefficient appears within any of `term1`, `term2`, etc., use a cell array where each term, without coefficients, is specified in a cell of `expr`, as follows:

```
LinearModelTerms = {'term1', 'term2', 'term3', ... }
```

For example, the model

```
a*x + b*sin(x) + c
```

is linear in a, b, and c. It has three terms `x`, `sin(x)` and 1 (because c=c*1) and therefore `expr` is:

```
LinearModelTerms = {'x','sin(x)','1'}
```

In the Curve Fitting app, see the `Linear Fitting` model type.

Algorithms

If the fit type expression input is a string or anonymous function, then the toolbox uses a nonlinear fitting algorithm to fit the model to data.

If the fit type expression input is a cell array of terms, then the toolbox uses a linear fitting algorithm to fit the model to data.

- Parametric Fitting

See Also

Apps

Curve Fitting

Functions

`fit` | `fitoptions`

Introduced before R2006a