Computational Methods in Physics (PHY 365)

FA23

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Lab 6

Lagrange form

Write a MATLAB program to interpolate the following data

x	1	−4	0
f (x)	3	13	−23

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- Given data

```
data_x = [1, -4, 0];
data_y = [3, 13, -23];
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  data_y = [3, 13, −23];

- The basis polynomials

  syms x

Lagrange form

```
for i = 1 : length(data_x)
    x_i = data_x(i);
    my_prod = 1;
    for j = 1 : length(data_x)
        x_j = data_x(j);
        if j ~= i
            my_prod = my_prod * (x - x_j) / (x_i - x_j);
        end
    end
    basis_poly(i) = my_prod;
end
```

Lagrange form

- Lagrange polynomial

```
lagrange_poly = 0;
for k = 1 : length(data_x)
    lagrange_poly = lagrange_poly + basis_poly(k) *
data_y(k);
end
lagrange_poly_simp = simplify(lagrange_poly);
disp ( ['The required Lagrange polynomial is ',
char(lagrange_poly_simp) ] )
```

Lagrange form

- Plotting

```
fplot(basis_poly , [min(data_x) , max(data_x) ] ,
'linewidth' , 2)

figure

fplot(lagrange_poly, [min(data_x) , max(data_x) ] , 'b -
-' )

hold on

plot(data_x , data_y ,'r*')

hold off
```

Lagrange form

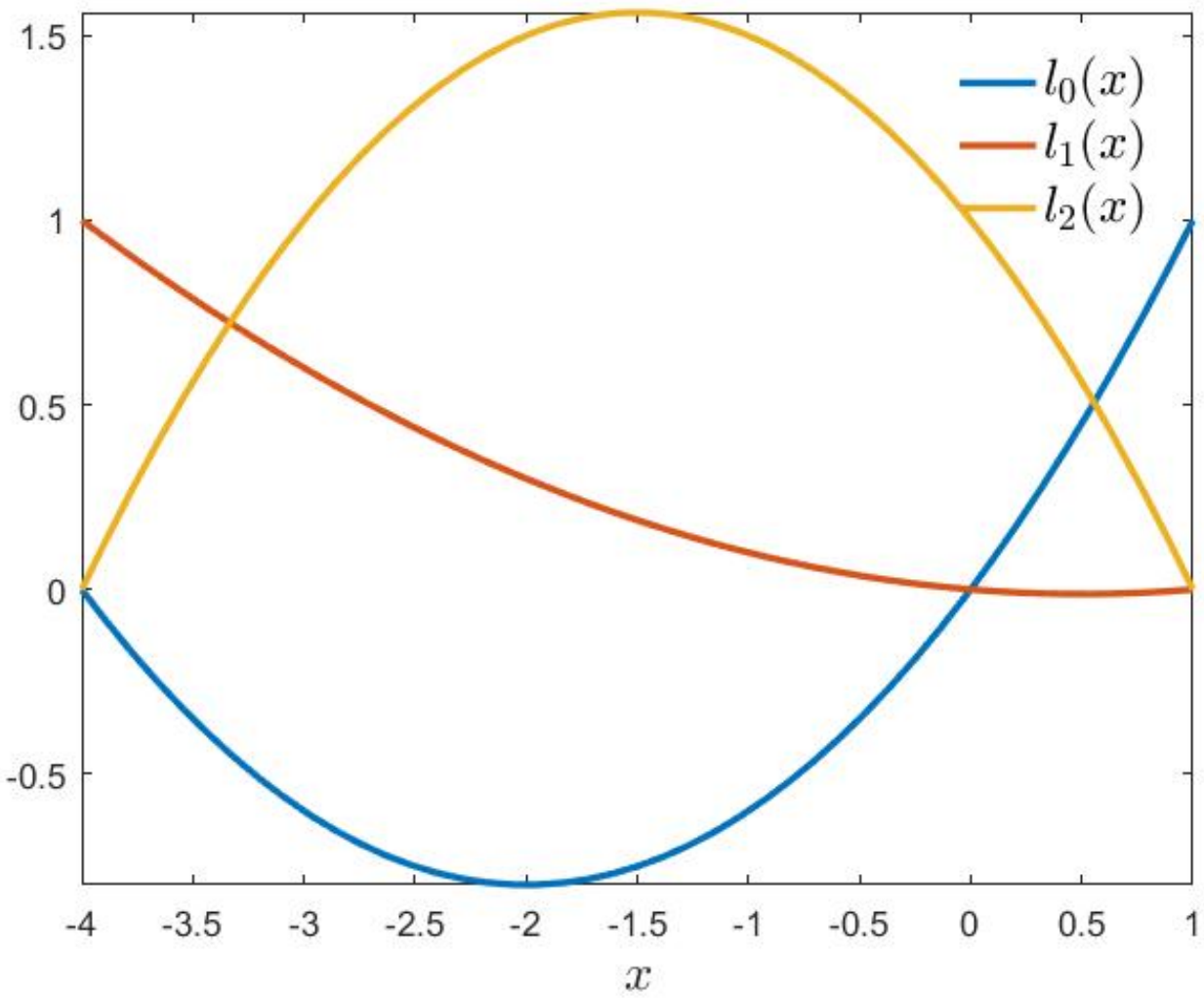

Figure: The basis polynomials

Lagrange form

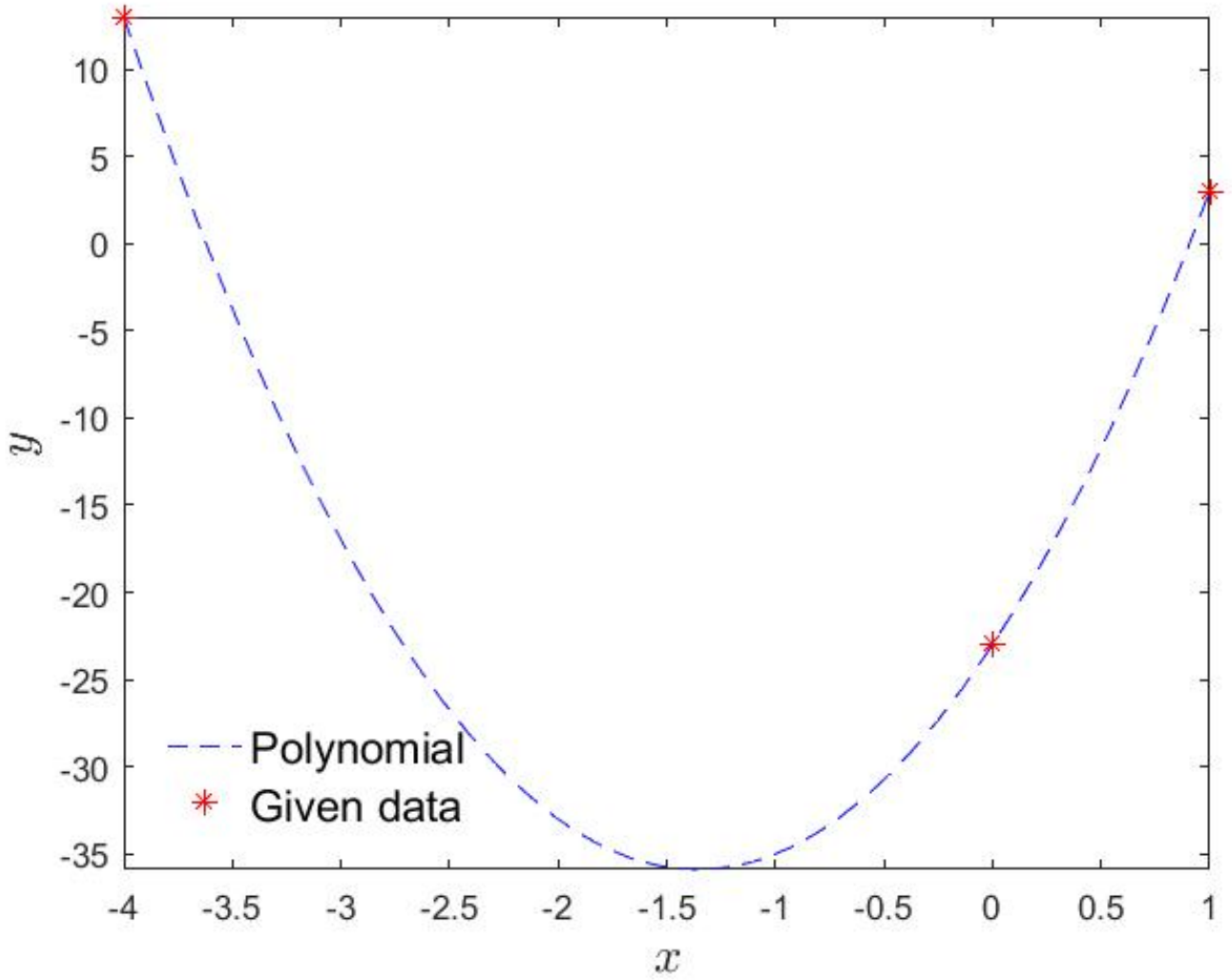

Figure: Lagrange polynomial

MATLAB's interp1 function

- vq = interp1(x , v , xq) returns interpolated values of a 1-D function at specific query points using linear interpolation.
  - Vector x contains the sample points.
  - Vector v contains the corresponding values, v(x).
  - Vector xq contains the coordinates of the query points.

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- vq = interp1(x , v , xq , method) specifies an alternative interpolation method.
- vq = interp1(x , v , xq , method , extrapolation) specifies a strategy for extrapolation of data.
  - Set extrapolation to 'extrap' when you want to use the method algorithm for extrapolation.
  - Alternatively, a scalar value can be specified, in which case, interp1 returns that value for all points outside the domain of x.

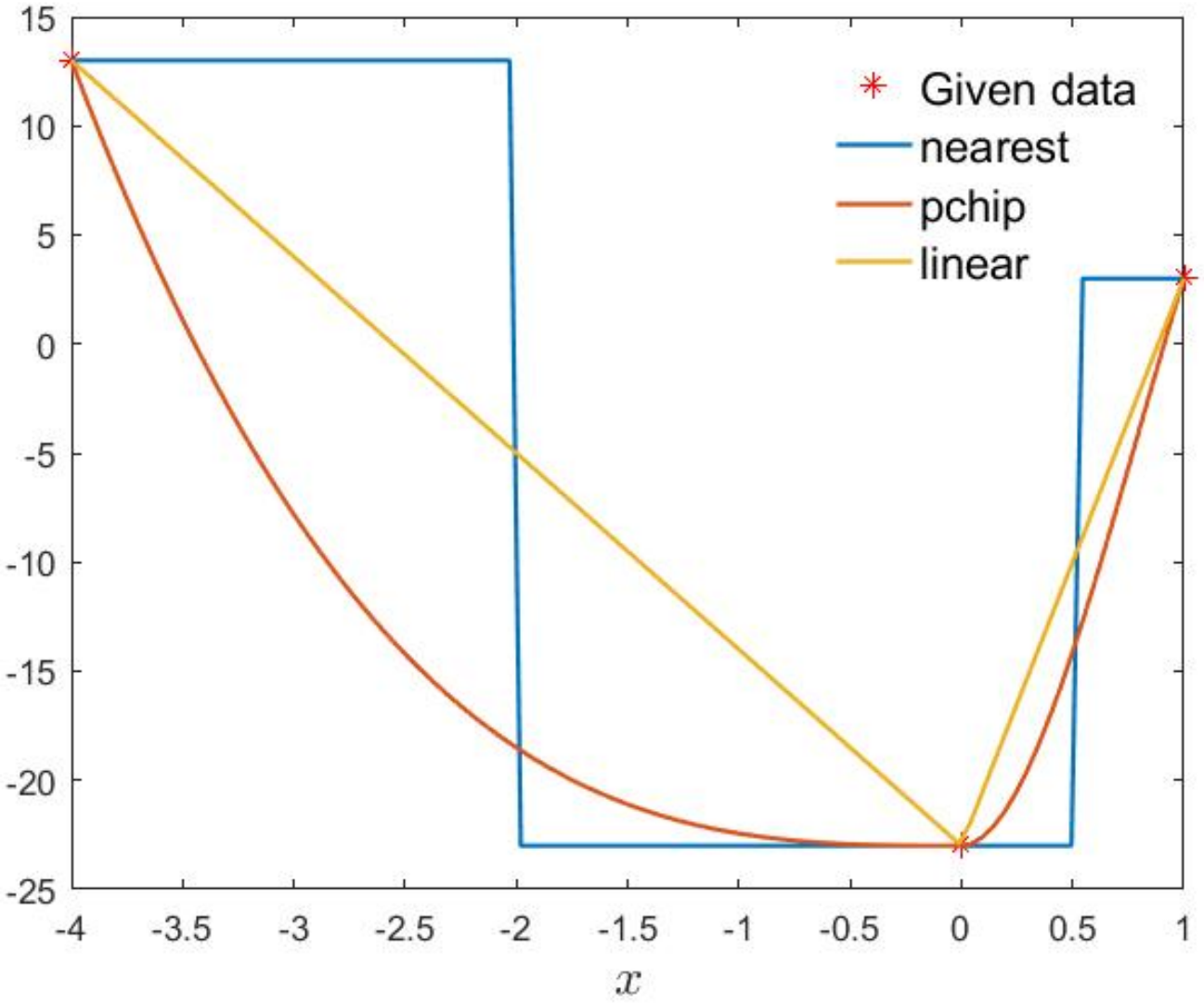
MATLAB's interp1 function

Method	Description
linear	Linear interpolation. The interpolated value at a query point is based on linear interpolation of the values at neighboring grid points in each respective dimension. This is the default interpolation method.
nearest	Nearest neighbor interpolation. The interpolated value at a query point is the value at the nearest sample grid point.
next	Next neighbor interpolation. The interpolated value at a query point is the value at the next sample grid point.
previous	Previous neighbor interpolation. The interpolated value at a query point is the value at the previous sample grid point.

MATLAB's interp1 function

Method	Description
pchip	Shape-preserving piecewise cubic interpolation. The interpolated value at a query point is based on a shape-preserving piecewise cubic interpolation of the values at neighboring grid points.
cubic	Same as 'pchip'. The behavior of interp1(...,'cubic') will change in a future release. In a future release, this method will perform cubic convolution.
spline	Spline interpolation using not-a-knot end conditions. The interpolated value at a query point is based on a cubic interpolation of the values at neighboring grid points in each respective dimension.

MATLAB's interp1 function



MATLAB's interp2 function

- Vq = interp2(X , Y , V , Xq , Yq) returns interpolated values of a function of two variables at specific query points using linear interpolation.
  - The results always pass through the original sampling of the function.
  - X and Y contain the coordinates of the sample points.
  - V contains the corresponding function values at each sample point.
  - Xq and Yq contain the coordinates of the query points.

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- Vq = interp2(___ , method) specifies an alternative interpolation method.
  - 'nearest'.
  - 'cubic'.
  - 'spline'.

MATLAB's interp2 function

Write a MATLAB program to interpolate the surface $\sin\left(\sqrt{x^2+y^2}\right)/\sqrt{x^2+y^2}$ $(-2 \leq x, y \leq 2)$.

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- Given data

```
[X , Y] = meshgrid(-2 : 2);
R = sqrt(X .^2 + Y .^2);
V = sin(R) ./ R;
```

MATLAB's interp2 function

Write a MATLAB program to interpolate the surface $\sin\left(\sqrt{x^2+y^2}\right)/\sqrt{x^2+y^2}$ $(-2 \le x, y \le 2)$.

- Given data

```
[X , Y] = meshgrid(-2 : 2);
R = sqrt(X .^2 + Y .^2);
V = sin(R) ./ R;
```

- The query points

```
[Xq , Yq] = meshgrid(-2 : 0.2 : 2);
```

MATLAB's interp2 function

Write a MATLAB program to interpolate the surface $\sin\left(\sqrt{x^2+y^2}\right)/\sqrt{x^2+y^2}$ $(-2 \le x, y \le 2)$.

- Given data

```
[X , Y] = meshgrid(-2 : 2);
R = sqrt(X .^2 + Y .^2);
V = sin(R) ./ R;
```

- The query points

```
[Xq , Yq] = meshgrid(-2 : 0.2 : 2);
```

- The interp2 function

```
interp2_poly_1 = interp2(X , Y , V, Xq , Yq);
```

MATLAB's interp2 function

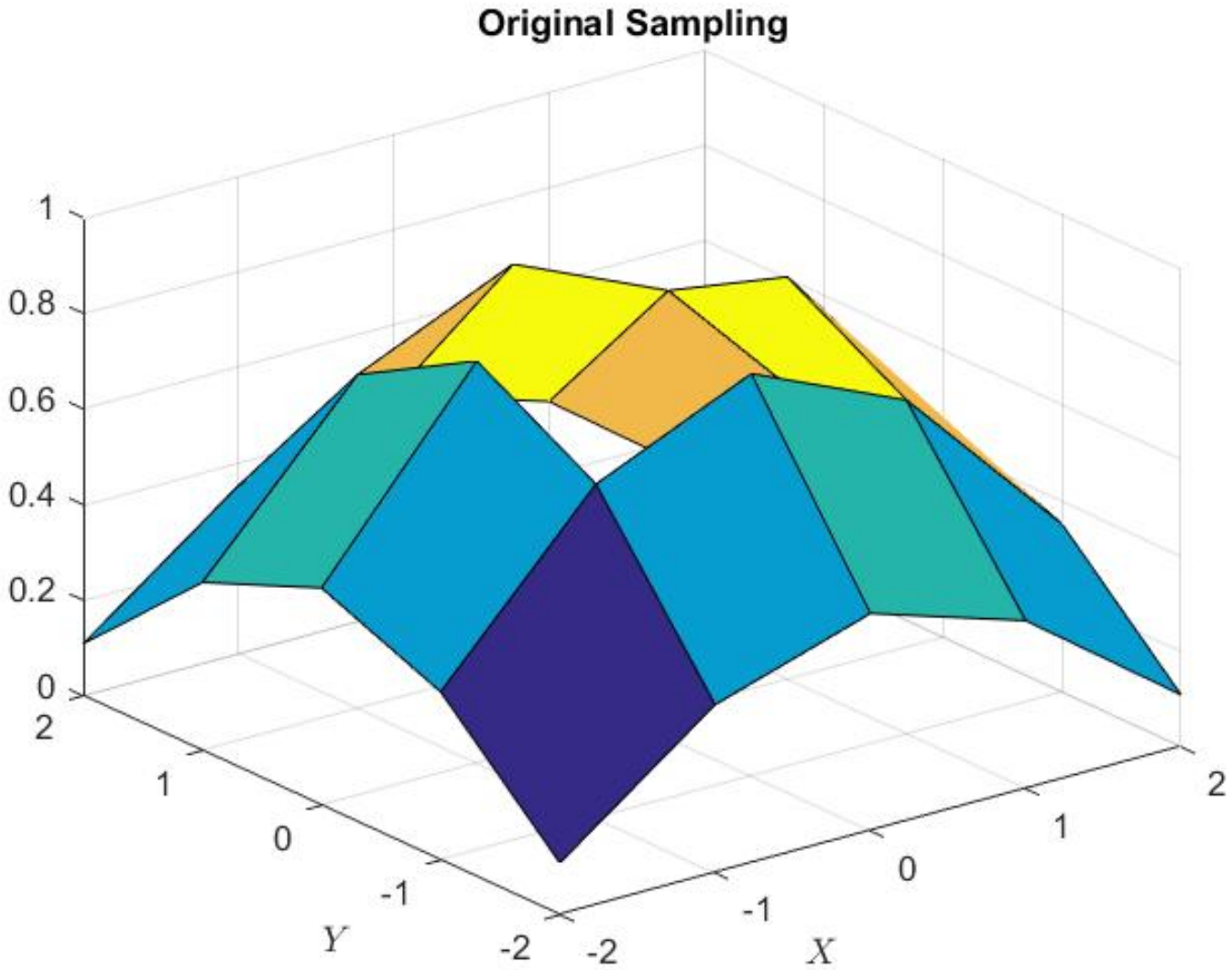
- Plotting

  surf(X , Y , V)

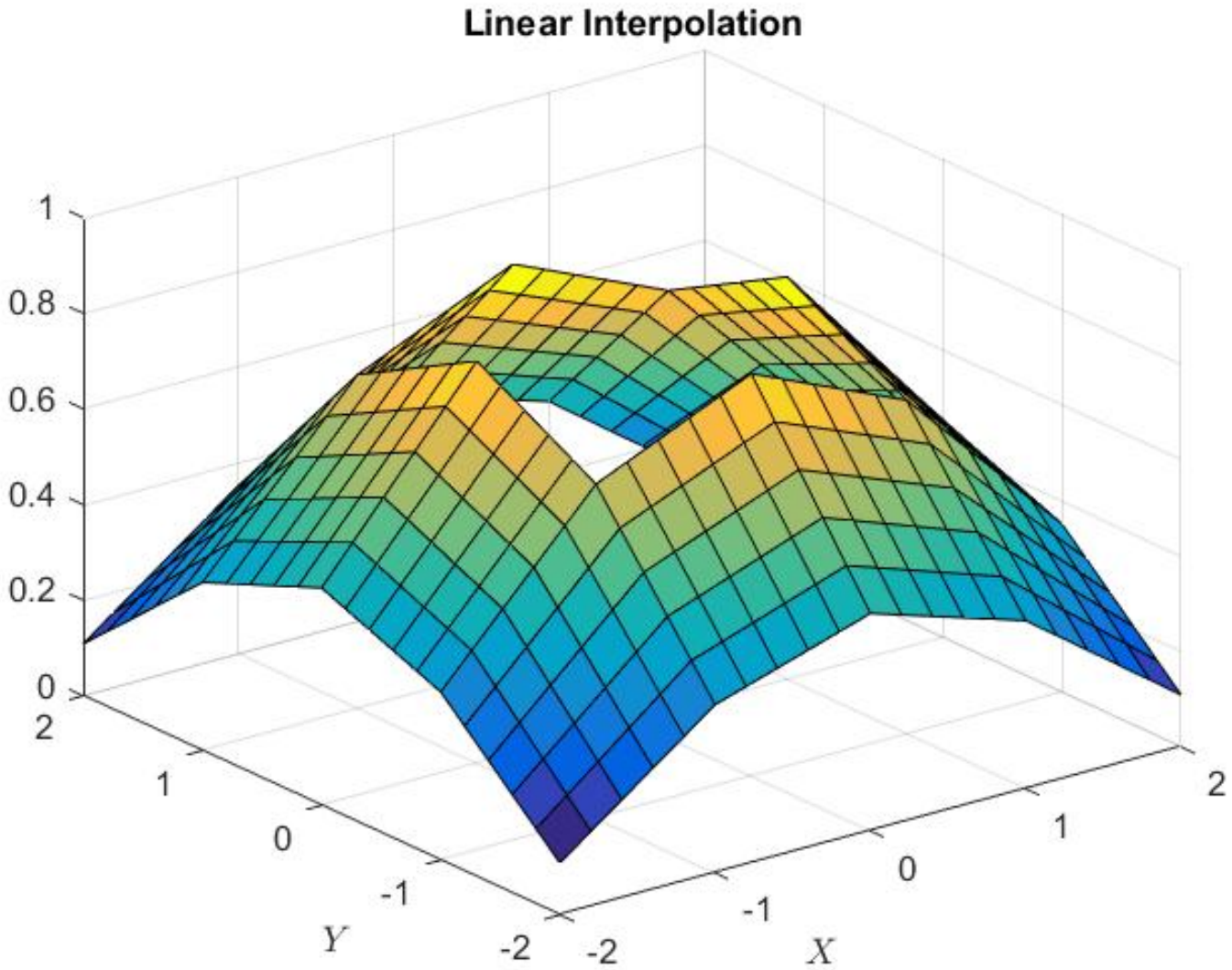
  figure

  surf(Xq , Yq , interp2_poly_1)

MATLAB's interp2 function



MATLAB's interp2 function



MATLAB's interp3 function

- Vq = interp3(X , Y , Z , V , Xq , Yq , Zq) returns interpolated values of a function of three variables at specific query points using linear interpolation.
  - The results always pass through the original sampling of the function.
  - X, Y, and Z contain the coordinates of the sample points.
  - V contains the corresponding function values at each sample point.
  - Xq, Yq, and Zq contain the coordinates of the query points.

MATLAB's interp3 function

- Vq = interp3(X , Y , Z , V , Xq , Yq , Zq) returns interpolated values of a function of three variables at specific query points using linear interpolation.
  - The results always pass through the original sampling of the function.
  - X, Y, and Z contain the coordinates of the sample points.
  - V contains the corresponding function values at each sample point.
  - Xq, Yq, and Zq contain the coordinates of the query points.
- Vq = interp3(___ , method) specifies an alternative interpolation method.
  - 'nearest'.
  - 'cubic'.
  - 'spline'.

MATLAB's spline function

- s = spline(x , y , xq) returns a vector of interpolated values s corresponding to the query points in xq.
  - The values of s are determined by cubic spline interpolation of x and y.

MATLAB's spline function

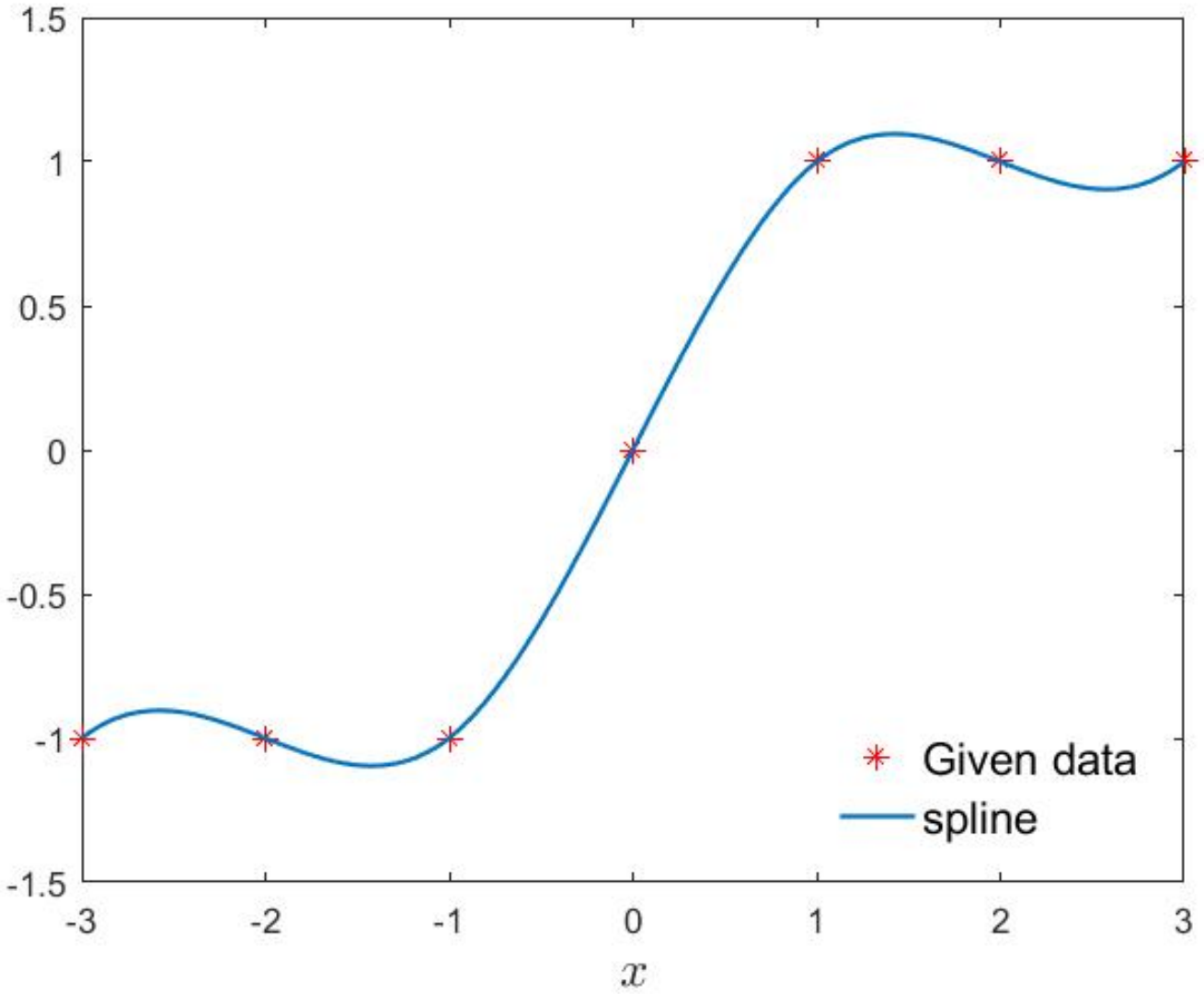
- s = spline(x , y , xq) returns a vector of interpolated values s corresponding to the query points in xq.
  - The values of s are determined by cubic spline interpolation of x and y.
- pp = spline(x , y) returns a piecewise polynomial structure for use by ppval and the spline utility unmkpp.

MATLAB's spline function

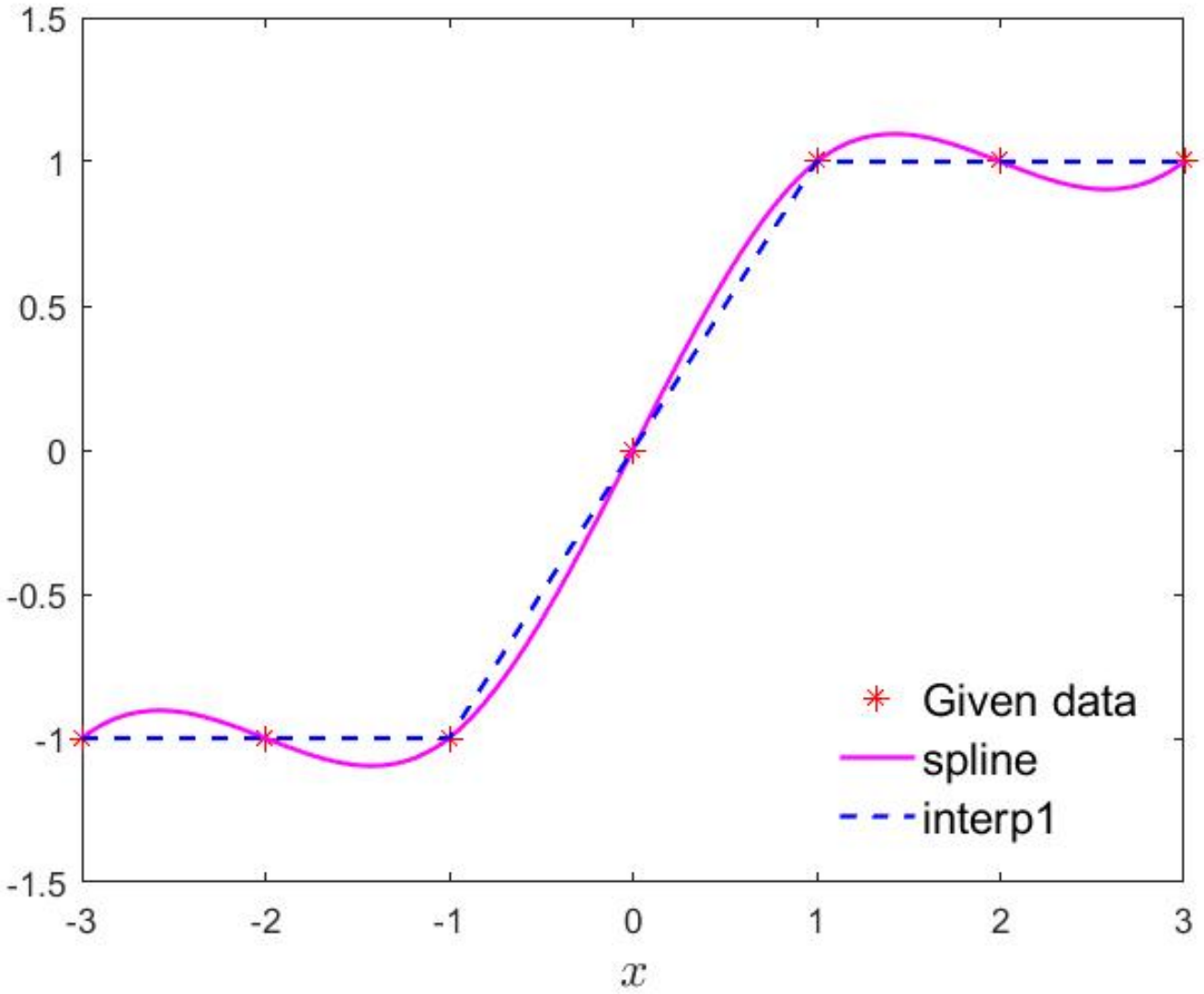
Use the spline function to interpolate the following data

x	−3	−2	−1	0	1	2	3
y	−1	−1	−1	0	1	1	1

MATLAB's spline function



MATLAB's spline function



References

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