scipy-interpolation

March 23, 2024

[ ]:
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'''Interpolation is a mathematical method for constructing a function from a␣
↪discrete set of
data points. The interpolation function, or interpolant, should exactly␣
↪coincide with the
given data points, and it can also be evaluated for other intermediate input␣
↪values within
the sampled range.'''
'''Extrapolation is a concept that is related to interpolation. It refers to␣
↪evaluating
the estimated function outside of the sampled range, while interpolation only␣
↪refers
to evaluating the function within the range that is spanned by the given data␣
↪points.
Extrapolation can often be riskier than interpolation, because it involves␣
↪estimating a
function in a region where it has not been sampled.'''
'''To perform plynomial interpolation in Python, we use the polynomial module␣
↪from
NumPy and the interpolate module from SciPy for spline and multivariate␣
↪interpolation.'''
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[92]:
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from numpy import polynomial as P
p1 = P.Polynomial([1, 2, 3]) #Polynomial is a function in polynomial module to␣
↪create a polynomial
print(p1)
```

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1.0 + 2.0 x + 3.0 x**2
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[93]:
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#Finding roots of a Polynomial:
print(p1.roots())
```

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[-0.33333333-0.47140452j -0.33333333+0.47140452j]
```

[94]:
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#Approximating Polynomial from roots:
p2 = P.Polynomial.fromroots([-0.33333333-0.47140452j, -0.33333333+0.47140452j])
print(p2)
```

```
(0.3333333303653193+0j) + (0.66666666+0j) x + (1+0j) x**2
```

[95]:
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#Evaluating Polynomial at specific value of x:
print(p2(1),'\n',p2(array([1,2,3])))
```

```
(1.9999999903653194+0j)
 [ 1.99999999+0.j  5.66666665+0.j 11.33333331+0.j]
```

[96]:
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'''In addition to the Polynomial class for polynomials in the standard power␣
↪basis,
the polynomial module also has classes for representing polynomials in␣
↪Chebyshev,
Legendre, Laguerre, and Hermite bases, with the names Chebyshev, Legendre,
Laguerre, Hermite (Physicists'), and HermiteE (Probabilists'), respectively.'''
c1 = P.Chebyshev([1, 2, 3])
l1=P.Legendre([1, 2, 3])
print(c1.roots())
l1
```

```
[-0.76759188  0.43425855]
```

[96]:

$x \mapsto 1.0\,P_0(x) + 2.0\,P_1(x) + 3.0\,P_2(x)$

[99]:
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#Polynomial Interpolation:
# Define the data points (x, y)
x = array([1, 2, 3, 4])
y = array([1, 3, 5, 4])
'''To interpolate a polynomial through these points, we need to use a␣
↪polynomial of
third degree (number of data points minus one).'''
deg=len(x)-1
A = P.polynomial.polyvander(x, deg) # The Vandermonde matrix is used in␣
↪polynomial interpolation to find the coefficients of the interpolating␣
↪polynomial(lEARN FROM NM).
c = linalg.solve(A, y)
polynomial = P.Polynomial(c)
print('polynomial(2.5)=',polynomial(2.5))
polynomial
```

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polynomial(2.5)= 4.187499999999998
```

[99]:

$x \mapsto 2.0 - 3.5\,x + 3.0\,x^2 - 0.5\,x^3$

[116]:
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#Visualization of Model Consistency:
from matplotlib.pyplot import *
fig,ax=subplots(1,1,figsize=(12,6))
ax.scatter(x,y,color='red',label='Plot(x,y)')
ax.plot(x,polynomial(x),'g',label='Plot(x,Polynomial(x))')
ax.set_xlabel('x')
ax.set_ylabel('y')
ax.legend()
```

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ax.grid()
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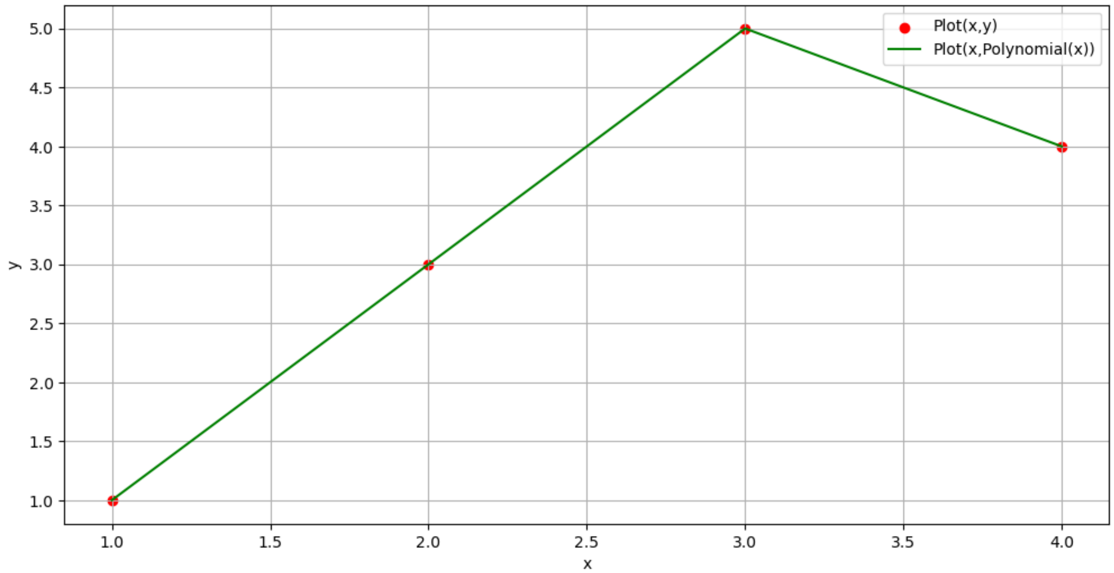

[122]:
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#Spline Interpolation:
'''In spline interpolation, instead of fitting a single polynomial over the␣
↪entire range of data,
the data range is divided into smaller intervals, and different polynomials are␣
↪fitted to each interval.
These polynomials are typically low-degree, such as linear (degree 1),␣
↪quadratic (degree 2), or cubic (degree 3) polynomials.
Hence, we cannot print resutling polynomials.'''
from scipy import interpolate as I
# Define the data points (x, y)
x = array([1, 2, 3, 4, 5])
y = array([4, 2, 1, 3, 6])
# Perform linear interpolation using interp1d
linear_interp = I.interp1d(x, y) #equvivalent to interp1d(x,y,kind=1)
x_=linspace(1,5,100)
fig,ax=subplots(1,1,figsize=(12,6))
ax.scatter(x,y,color='red',label='Plot(x,y)')
ax.plot(x_,linear_interp(x_), 'g',label='Plot(x_,linear_interp(x_))')
ax.set_xlabel('x')
ax.set_ylabel('y')
ax.legend()
ax.grid()
```

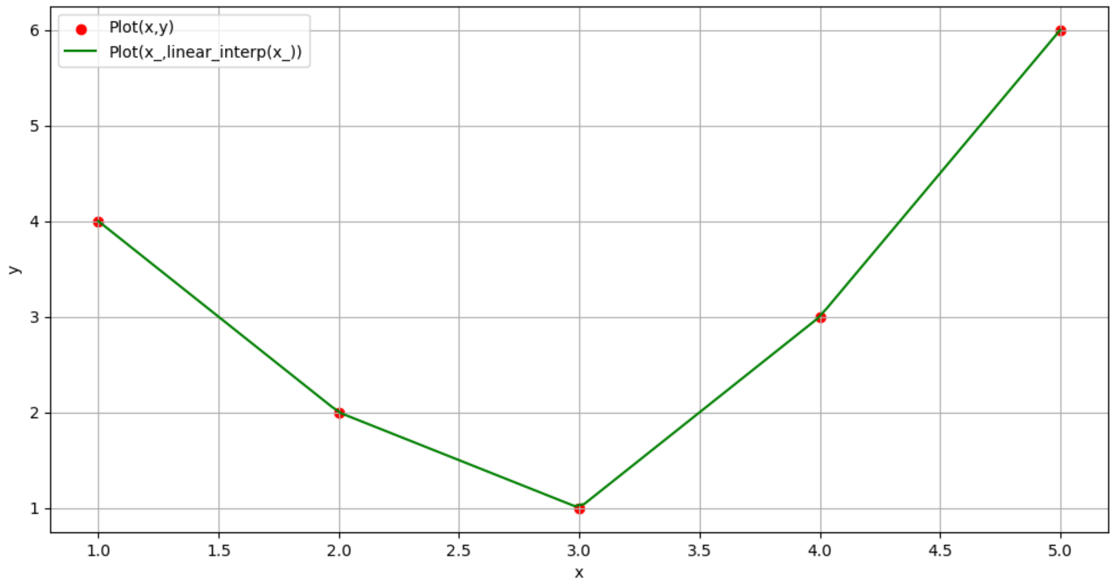

[125]:
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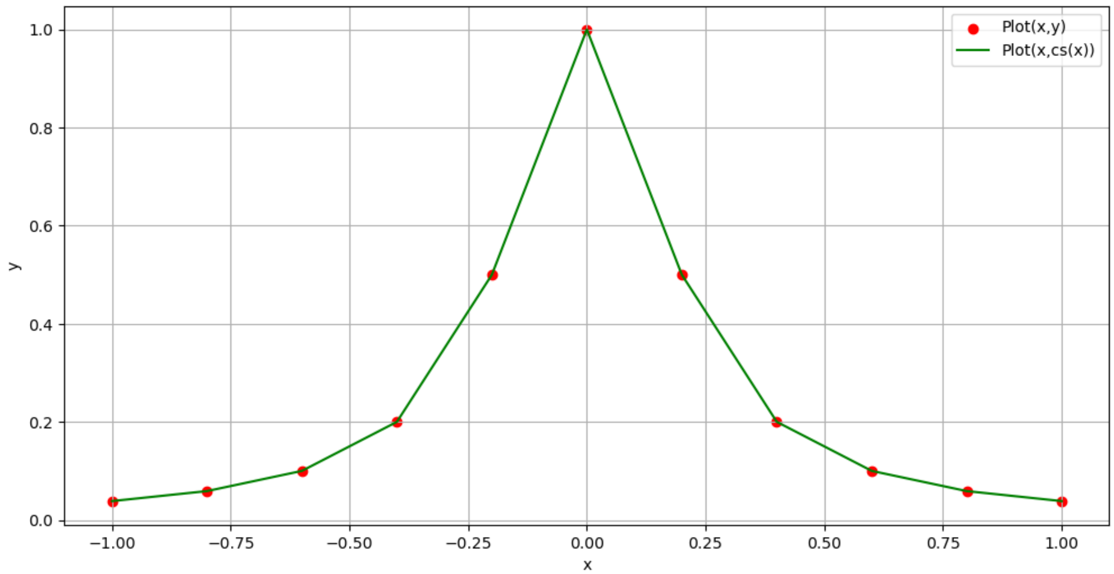
#CubicSpline:
x = linspace(-1, 1, 11)
def runge(x):
    return 1/(1 + 25 * x**2)
y = runge(x)
cs = interpolate.interp1d(x, y, kind=3)
fig,ax=subplots(1,1,figsize=(12,6))
ax.scatter(x,y,color='red',label='Plot(x,y)')
ax.plot(x,cs(x),'g',label='Plot(x,cs(x))')
ax.set_xlabel('x')
ax.set_ylabel('y')
ax.legend()
ax.grid()
```



[149]:
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#Multivariate Interpolation:
'''Out of Scope of this course. You can learn in Higher Mathematics'''
```