ACQ Excel Add-in

BASED ON EXCEL-DNA

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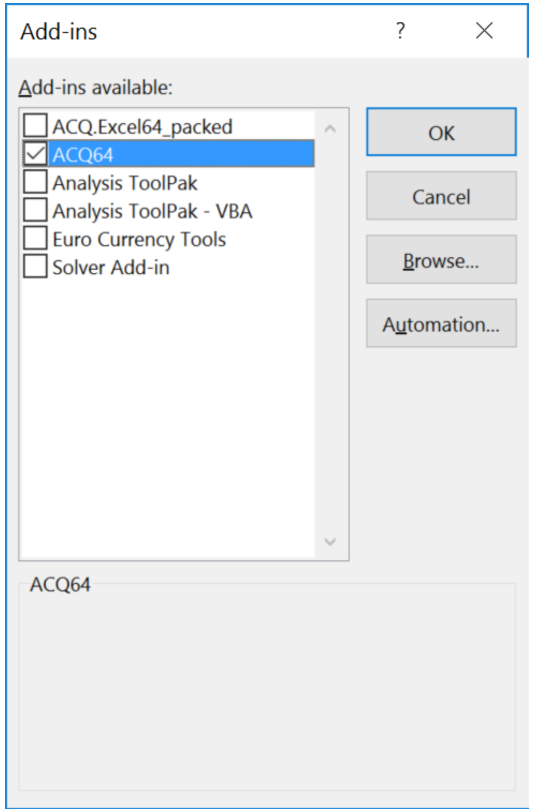
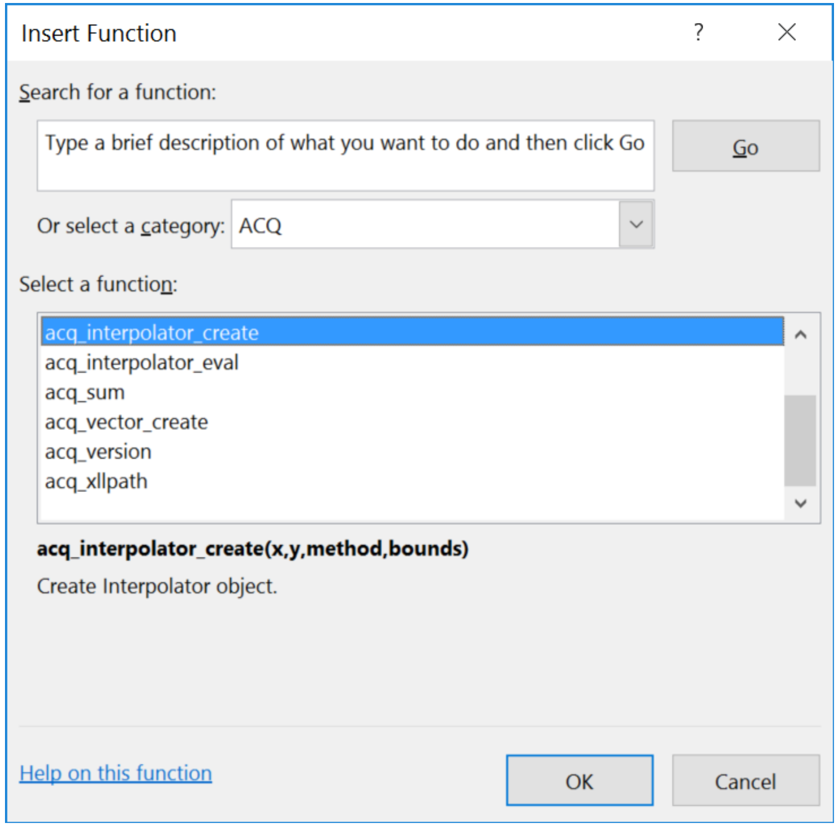
Installation



1. Start Excel. Click the File tab, click Options, and then click the Add-Ins category
2. In the Manage box, click Excel Add-ins, and then click Go. The Add-Ins dialog box appears
3. Browse to the location of the ACQ32.xll/ACQ64.xll files, and pick the xll file based on Excel bitness.
4. Make sure your Excel security settings allow you to run Add-ins

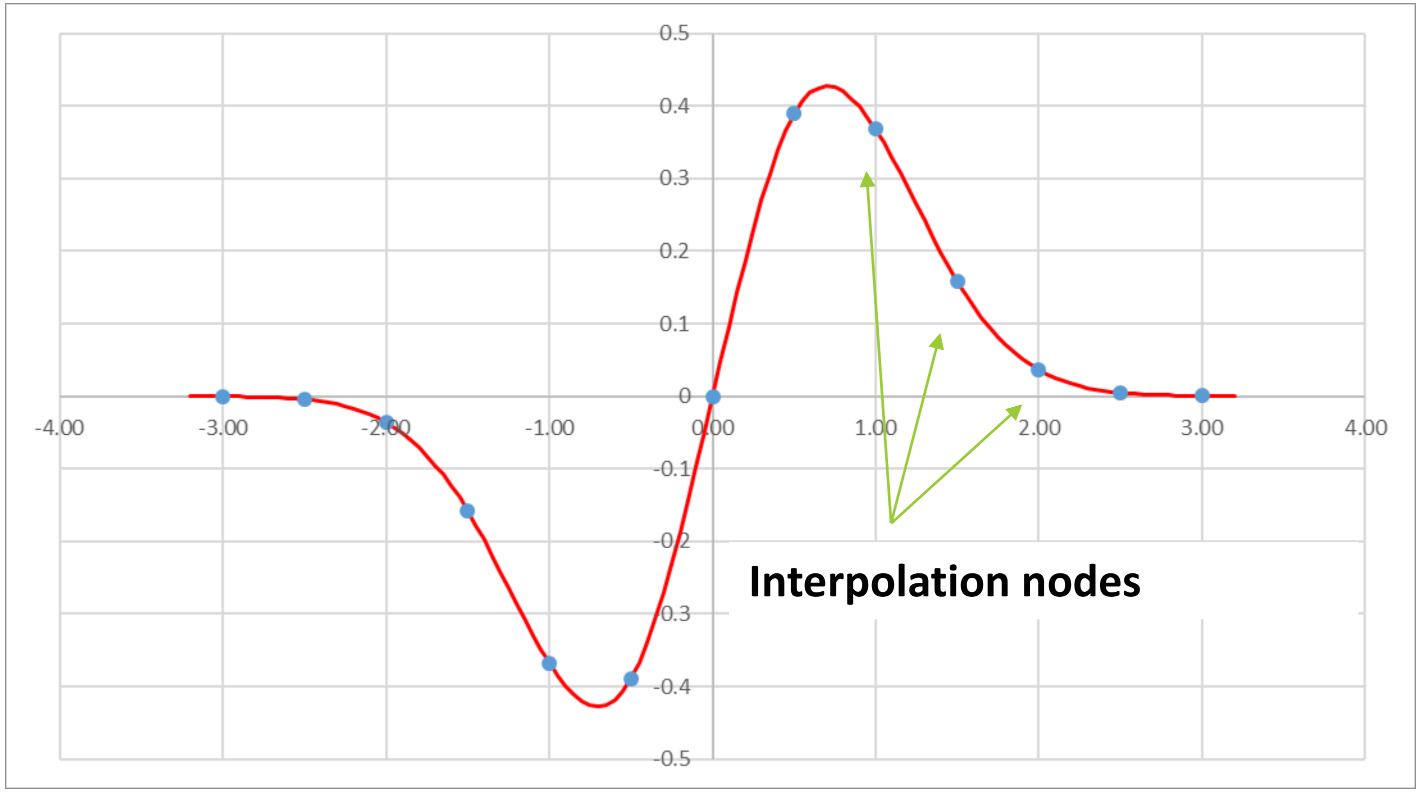
ACQ Functions



1. ACQ functions have prefix "acq_" and located in ACQ category.
2. Ctrl+Shift+H shows log window with error messages

Function	Description
acq_interpolator_create	Create Interpolator
acq_interpolator_eval	Compute interpolated value
acq_interpolation	Compute interpolated value: interpolator object is created on each call.
acq_xllpath	Returns path to the acq.xll
acq_version	ACQ version
acq_exceldna_version	Excel-DNA version

Interpolation



1. Given the location **x** and value of the function **y** at interpolation nodes, the function values between the nodes are estimated.
2. There are many interpolation methods. The choice of the method depends on underlying function.

Interpolation Procedure

=acq_interpolator_create(x,y,"Akima",TRUE)

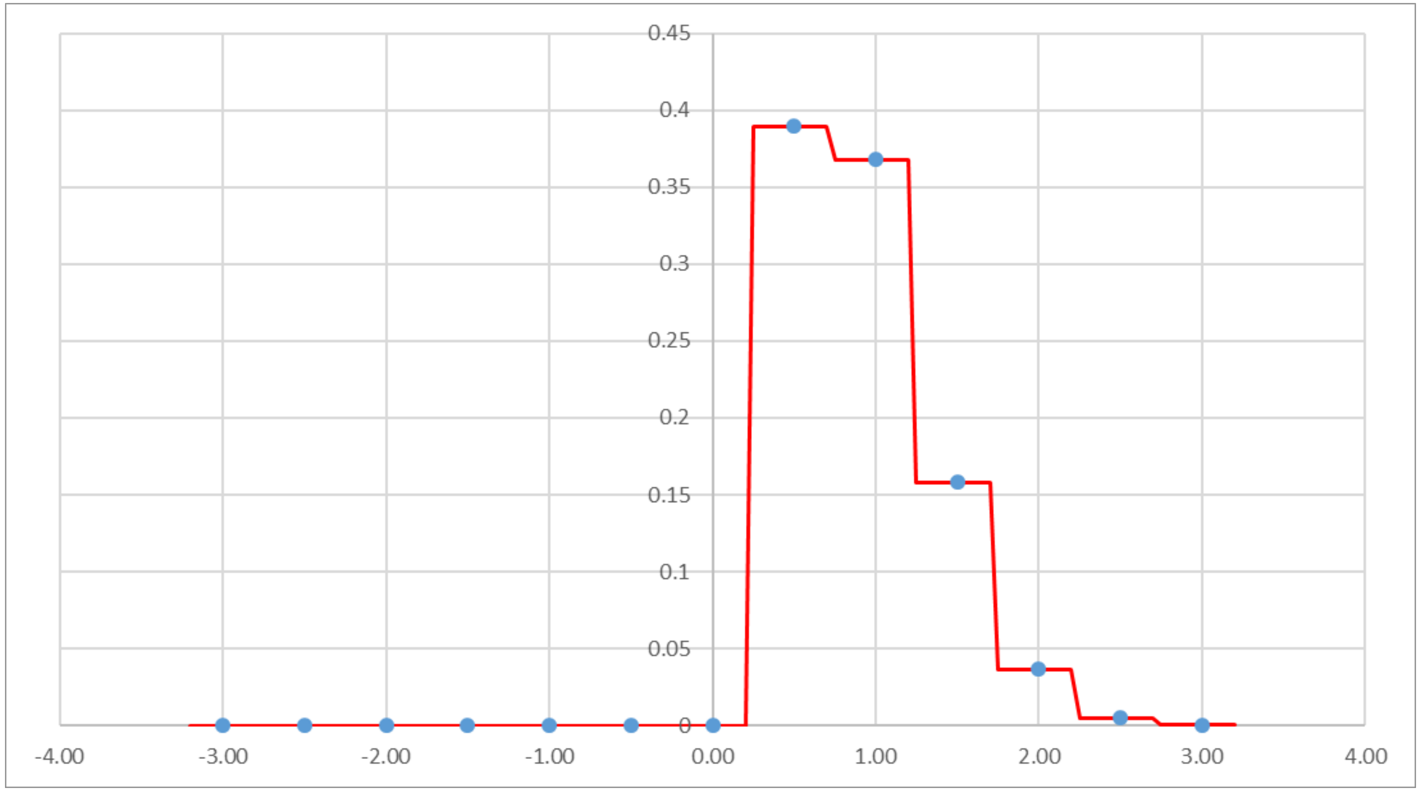
1. **x** – interpolation nodes (have to be arranged from small to large, no repeated values are allowed)
2. **y** – function values at interpolation nodes. (at least two nodes should be specified)
3. Interpolation method (string). Argument is optional, default is linear. Not case sensitive.
4. Bounds: TRUE or FALSE. Optional, default is true.

x	y
-3.0	0
-2.5	0
-2.0	0
-1.5	0
-1.0	0
-0.5	0
0.0	0
0.5	0.3894
1.0	0.367879
1.5	0.158099
2.0	0.036631
2.5	0.004826
3.0	0.00037

Method	Akima
Bounds	TRUE
Interpolator	#Interpolator:11

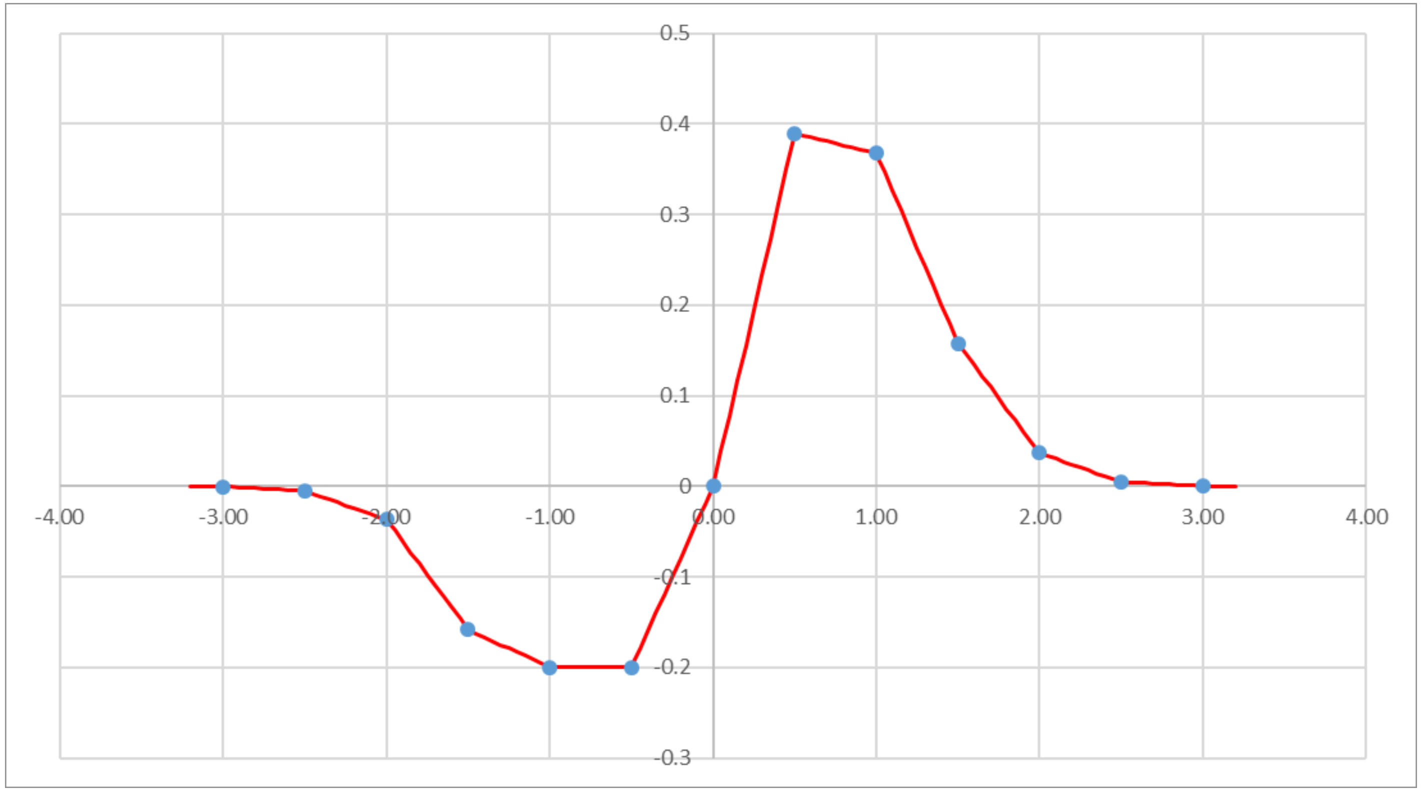
1. The function creates an interpolator object that can be used to evaluate interpolation at given point.
2. The handle will be automatically updated when any input argument change (if Automatic Calculation is enabled).

Nearest Interpolation



- Method: **Nearest**
- Nearest interpolation returns a value of the function at the node which is closest to the specified point.
- It is appropriate when interpolating function that can only take discrete values.

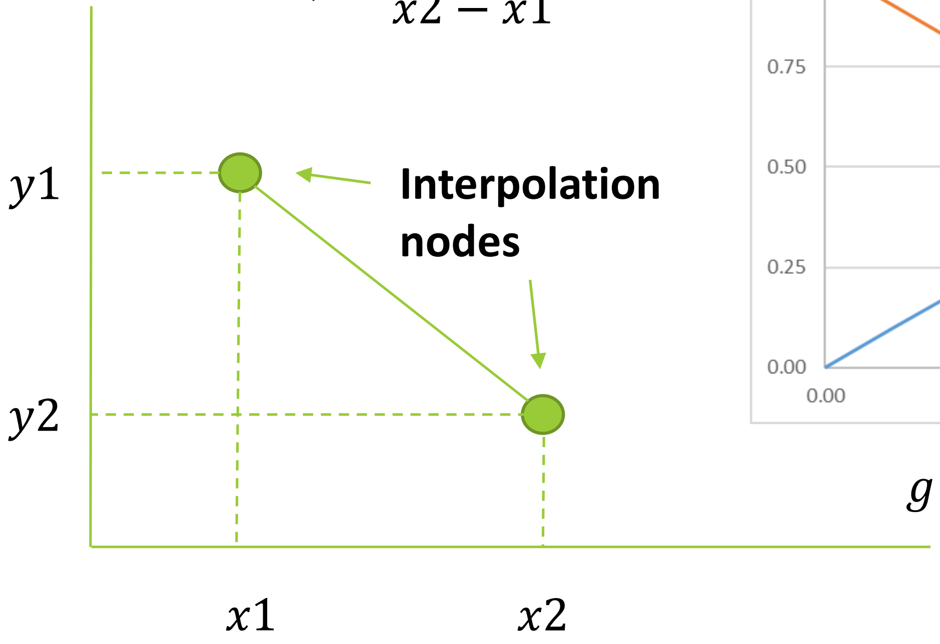
Linear Spline Interpolation

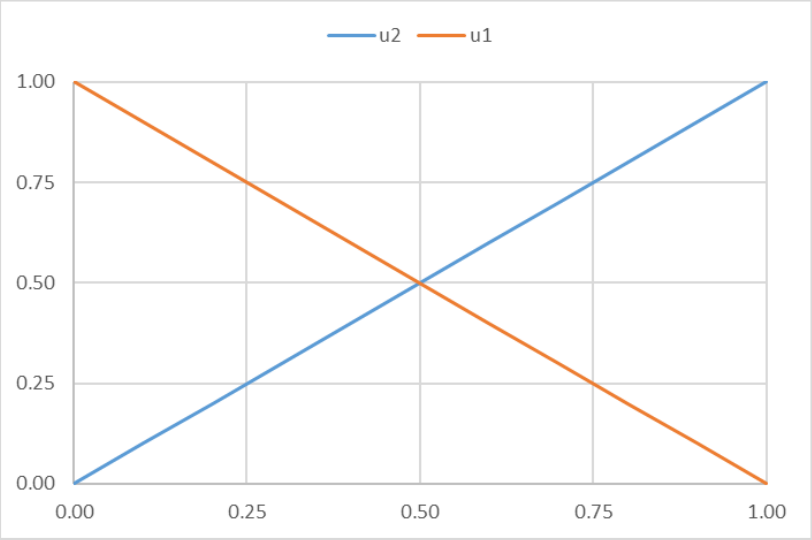


- Method: **Linear**
- Linear interpolation constructs a straight line between interpolation nodes.
- The line is a shortest distance between two points.
- The derivative of interpolation function is constant between nodes, and has discontinuity at the node points.
- Second derivative is zero on each interval.

Linear Basis Functions

$$\xi = \frac{x - x1}{x2 - x1}$$

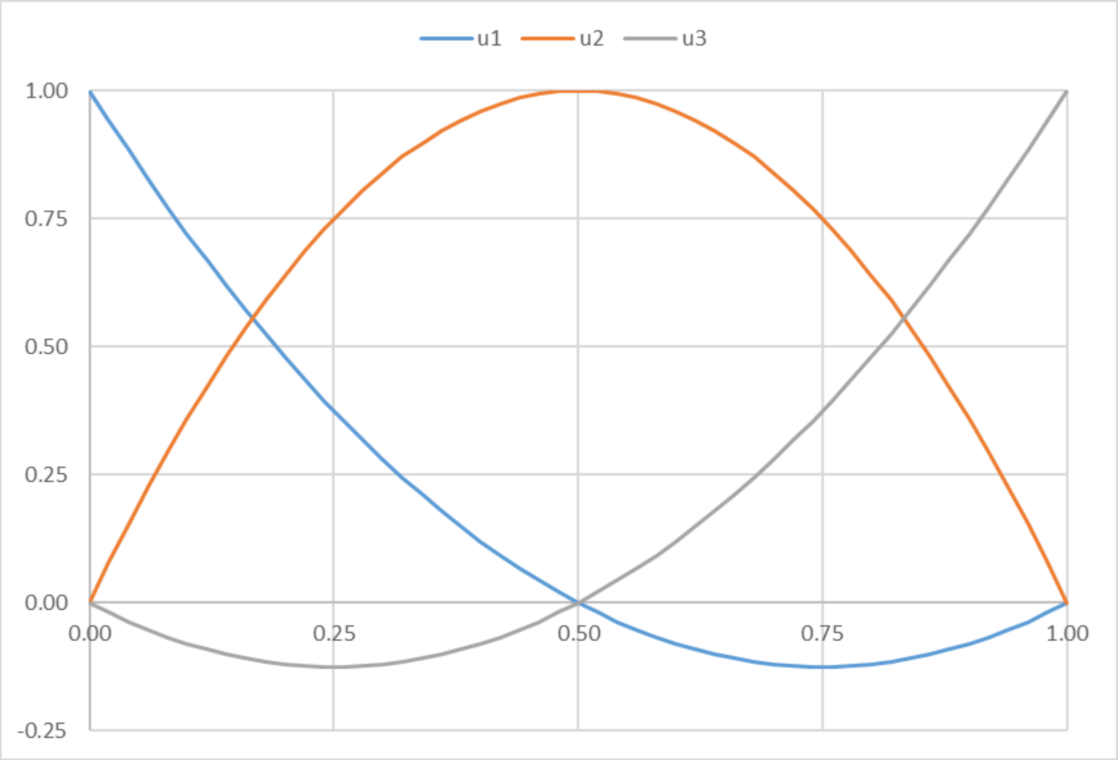




$$g(\xi) = y1 \cdot u1(\xi) + y2 \cdot u1(\xi)$$

- Interpolation on each interval is constructed as linear combination of basis functions
- Basis functions are defined on interval from 0 to 1, so each interpolation interval is normalized
- There are two linear basis function u1 and u2 (i.e. first order basis).
- Linear spline can be constructed using only function values at the nodes: y1 and y2.

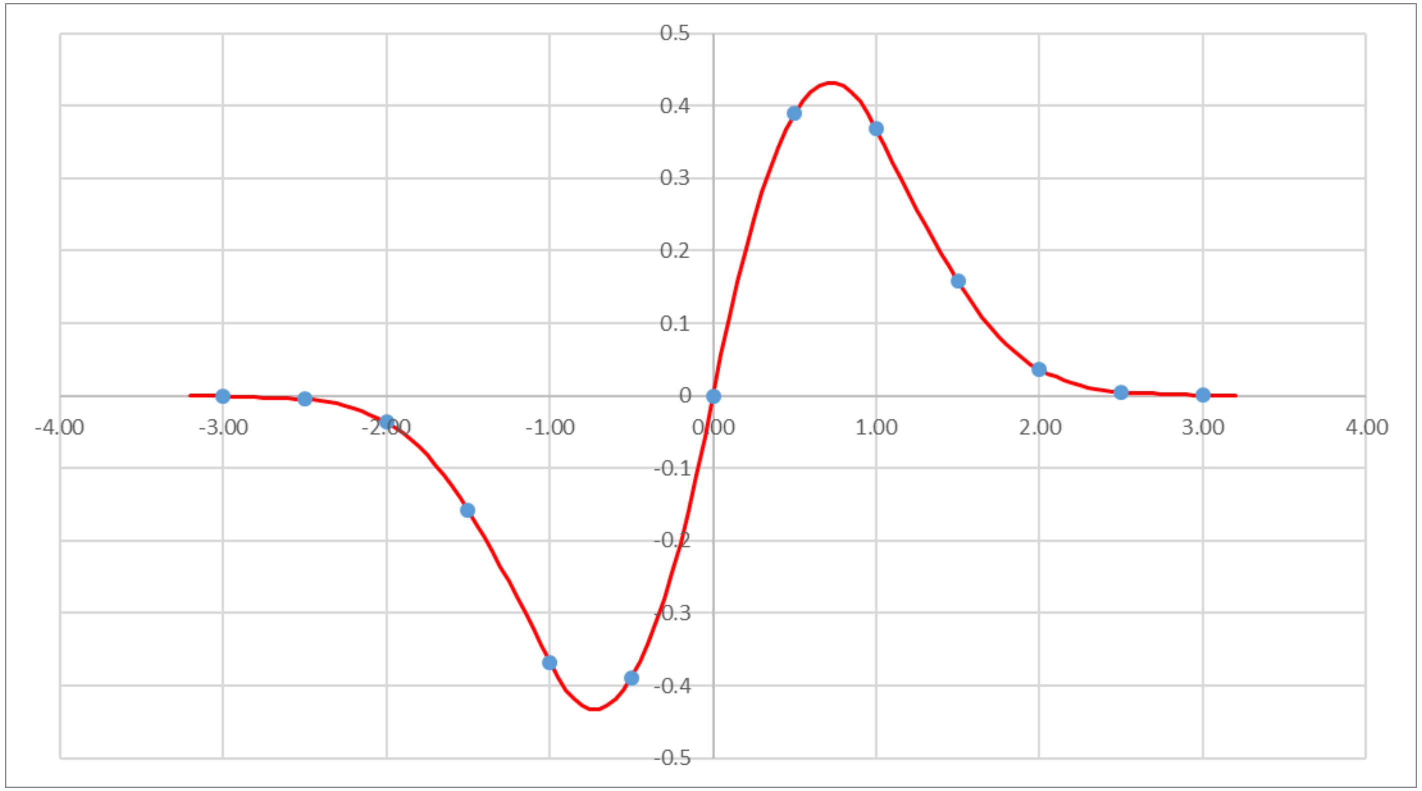
Quadratic Basis Functions



$$u1(\xi) = 1 - 3\xi + 2\xi^2$$
$$u2(\xi) = 4\xi - 4\xi^2$$
$$u3(\xi) = 2\xi^2 - \xi$$

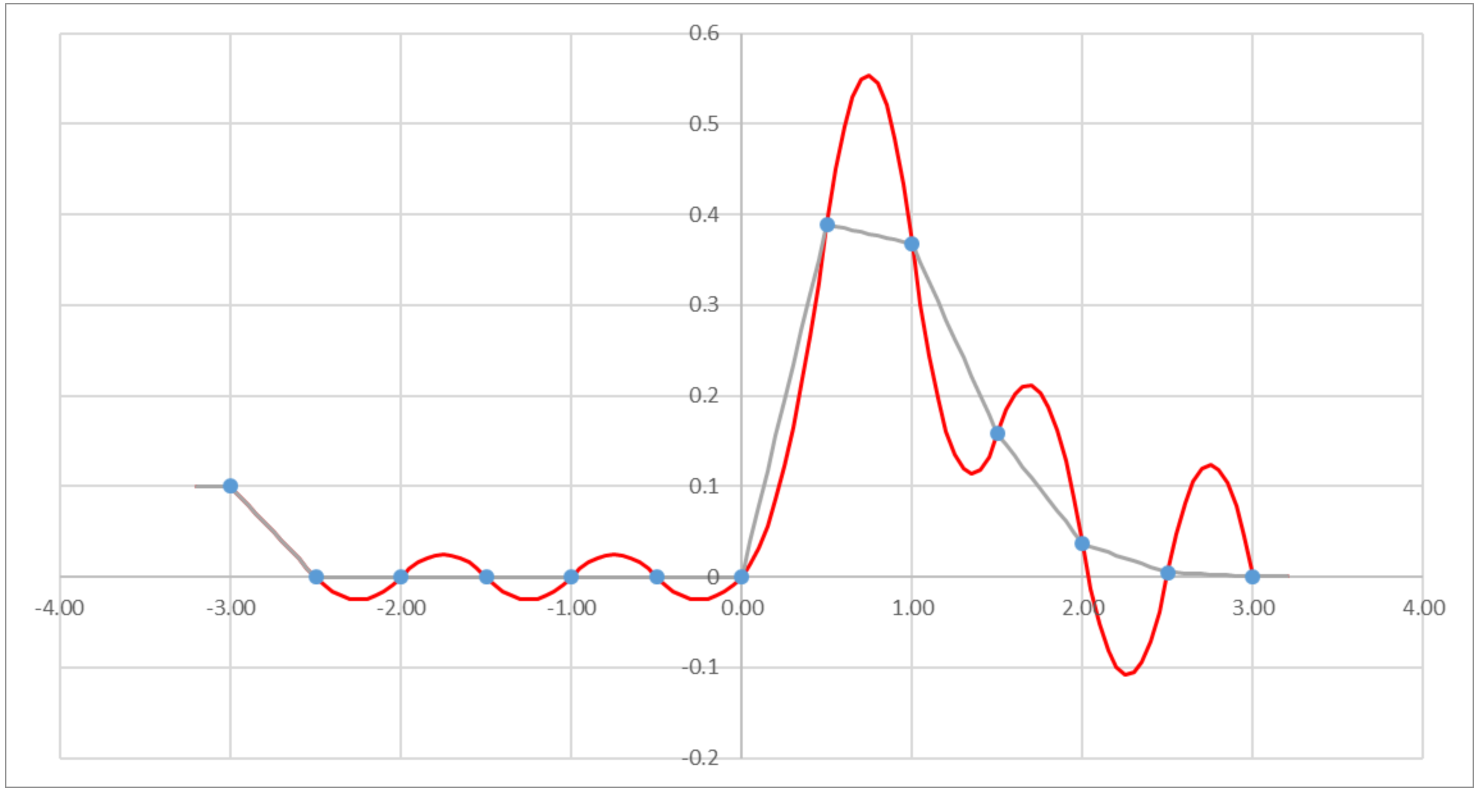
- U1 – controls the value of the function at $\xi = 0$
- U3 – controls the value of the function at $\xi = 1$
- U2- controls the value of the function at the midpoint (which we don't know).
- Coefficient for U2 is selected by matching derivative at the end of the interval (i.e. derivative at the end of the first interval is assumed to be the same as derivative at the start of the next interval). The derivative at the start of the first interval is assumed to be the same as implied by linear interpolation (i.e. first interval will be linearly interpolated).

Quadratic Spline Interpolation



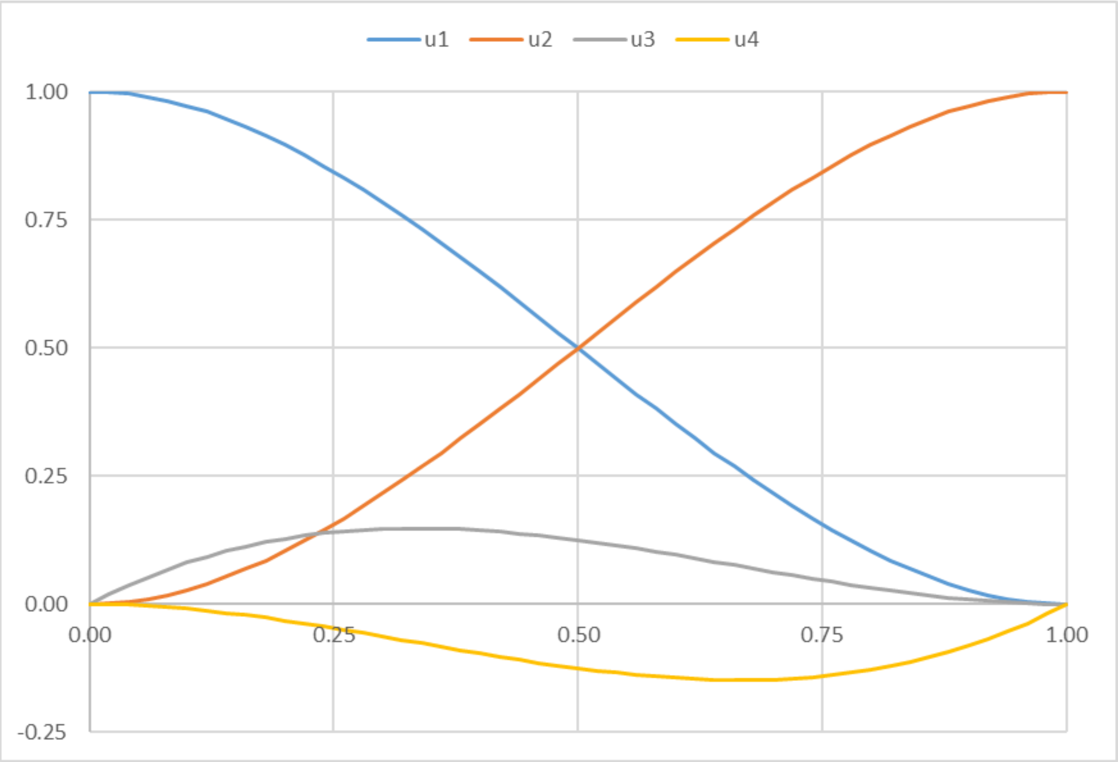
- Method: **Quadratic**
- Quadratic spline interpolation uses second order basis functions on each interval.
- First derivative is piecewise linear
- Second derivative is constant on each interval.
- Suitable for very smooth function

Quadratic Spline Interpolation



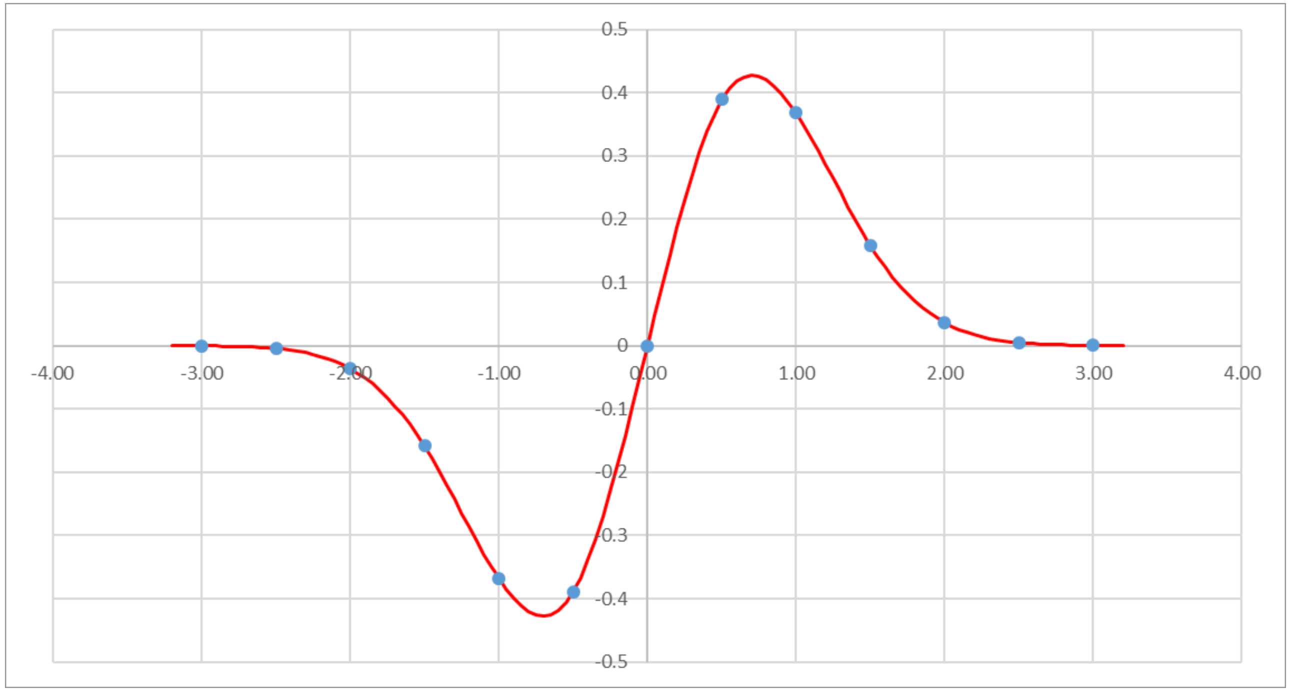
- Stability issues become pronounced for functions with fast changing derivatives (i.e. large second derivatives).

Cubic Basis Functions (Hermite)



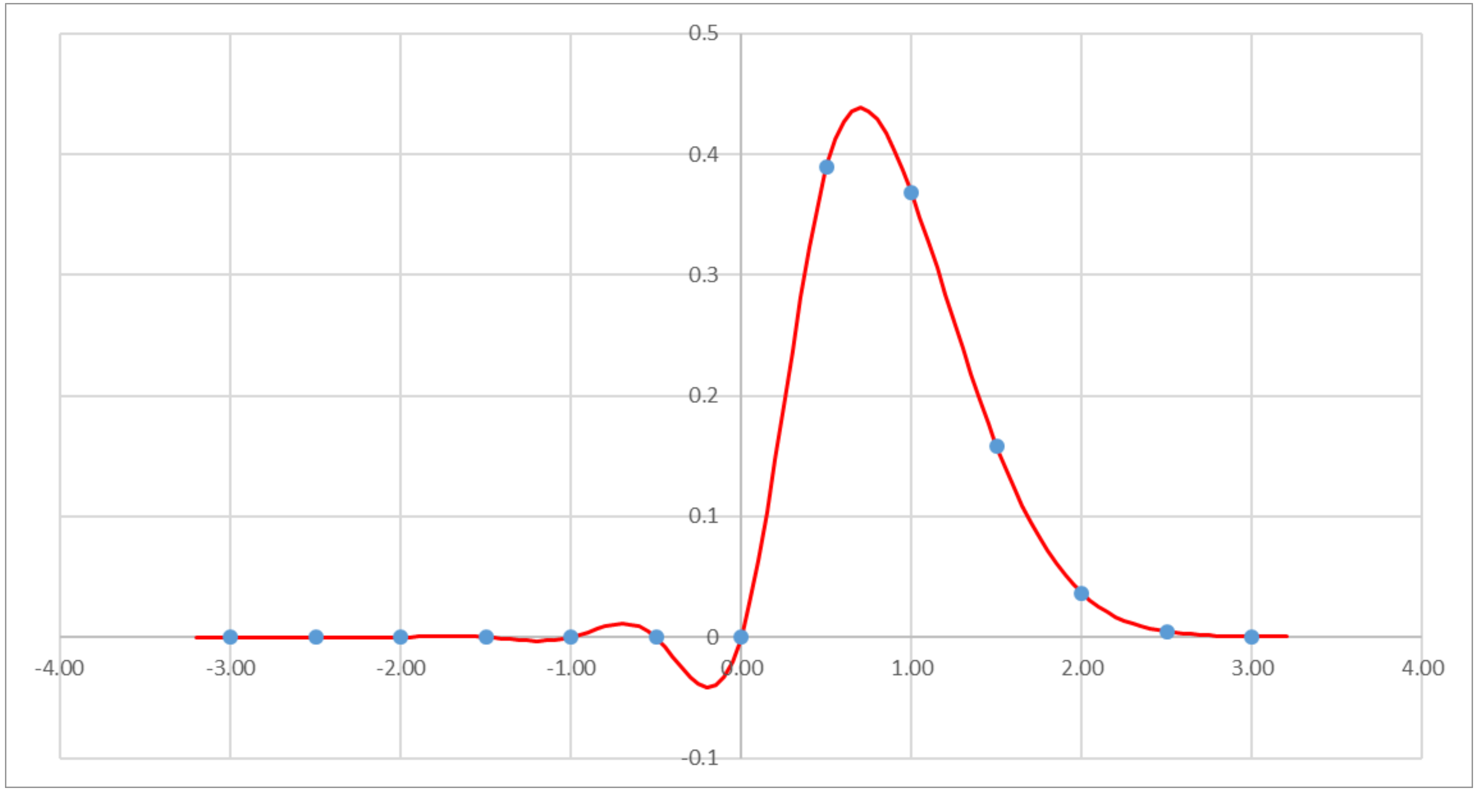
- Many different interpolation methods use cubic basis (aka Hermite basis). It is popular because it decouples function values from derivatives at the nodes.
- Akima, Steffen, Hermit, Cubic spline, and many other interpolation methods use Hermite basis functions.
- Coefficients for U1 and U2 are given by function values at the node.
- U3 and U4 control the derivatives at the nodes without affecting values of the function.
- There are a lot of different algorithms for choosing coefficients for U3 and U4.

Cubic Spline Interpolation



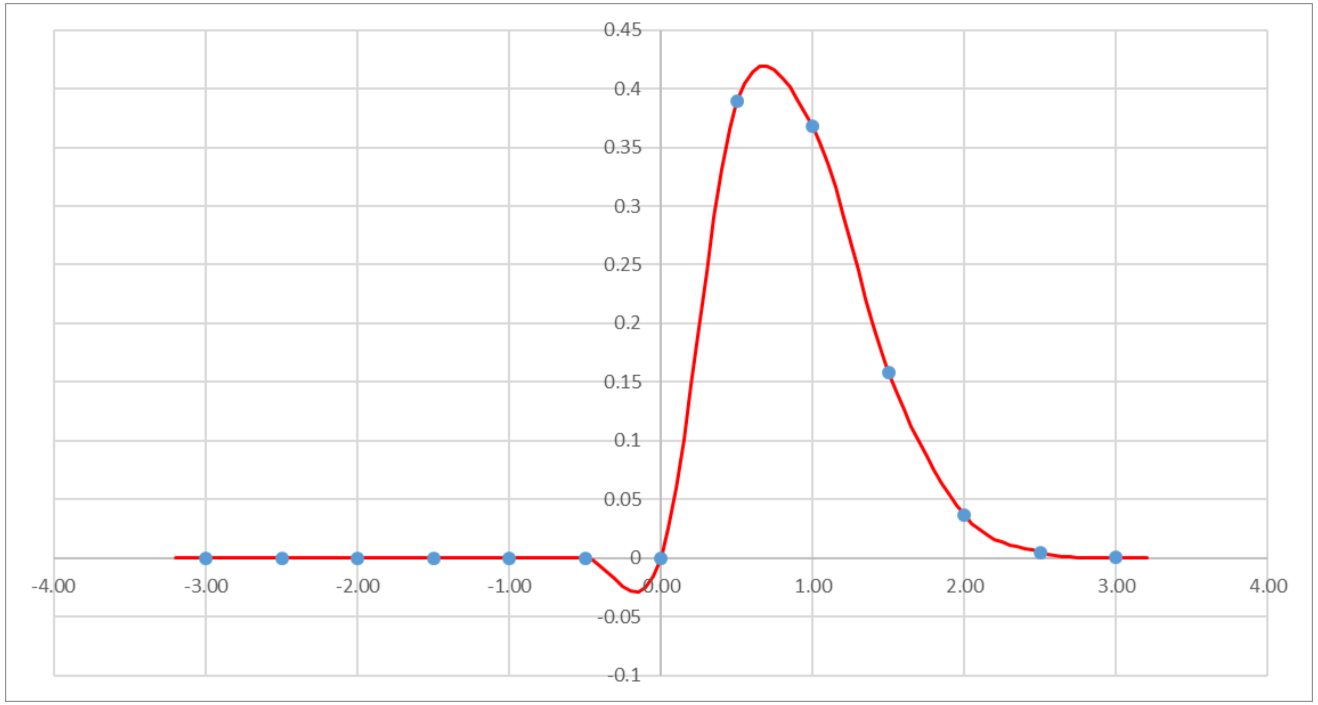
- Method: **Cubic**
- Cubic spline or Natural Cubic spline each interval is constructed such that first and second derivatives are continuous at the nodes.
- This is done by considering all interpolation points and solving tridiagonal system of equations.
- Therefore interpolation is not local, changes to function values at one node affect all interpolated points.
- Produces very smooth but sometimes wiggly interpolation curve.

Cubic Spline Interpolation



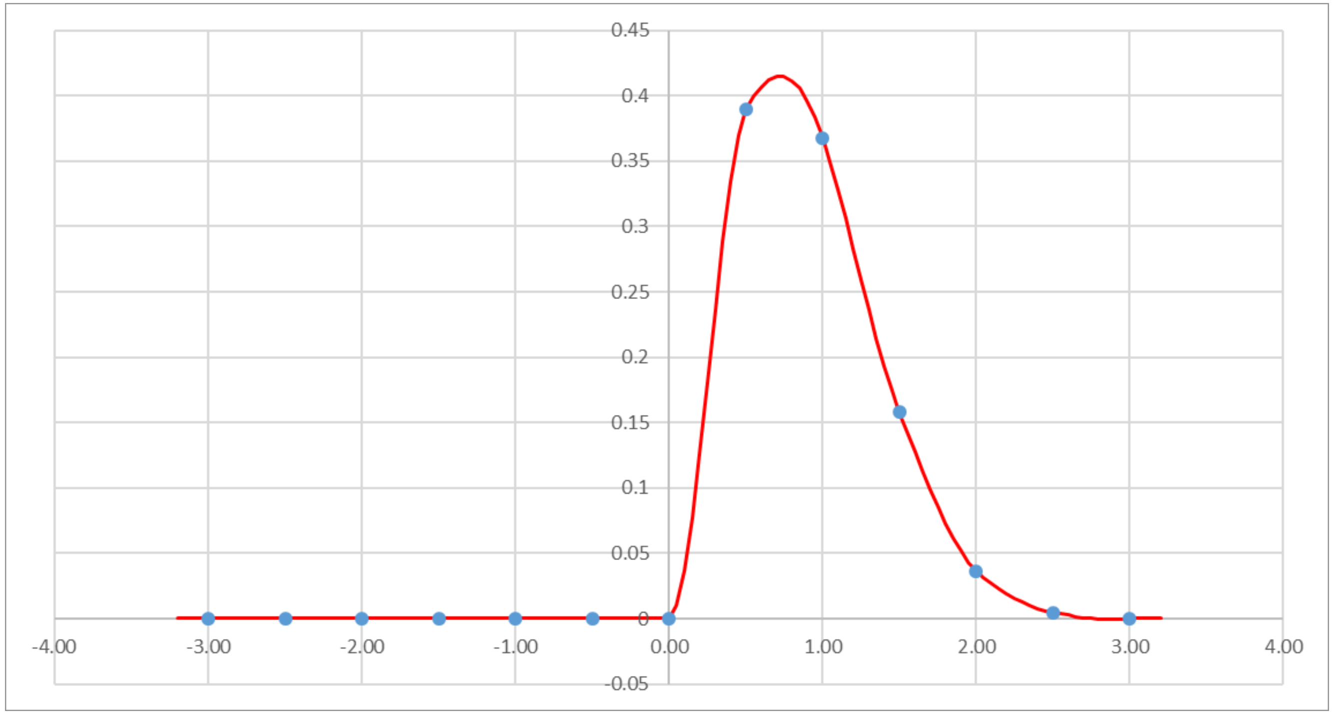
- Method: **Cubic**
- Functions with sharp bends tend to produce wiggles

Hermite Spline Interpolation



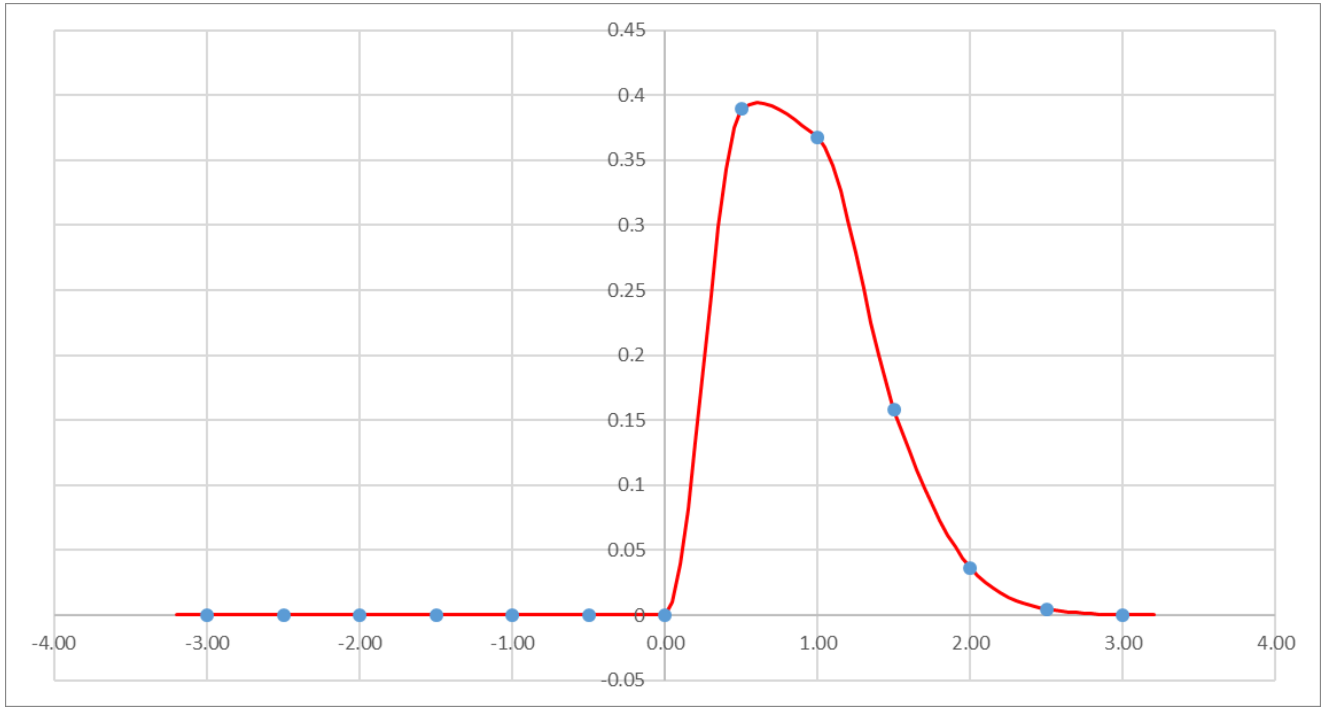
- Method: **Hermite**
- Cubic spline interpolation with derivatives at the nodes determined by finite differences (i.e. fitting Lagrange polynomial at each node and differentiating it).
- Second derivative is not continuous at the nodes.
- Interpolation is local (compared with natural cubic spline at x<0).

Akima Spline Interpolation



- Method: **Akima**
- Interpolation based on cubic spline but uses extra heuristic conditions to limit derivatives.
- It is popular method, but it can be unstable under certain conditions (i.e. small changes in node values lead to very large changes in interpolated values).
- Notice that wiggle at x=-0.5 is completely eliminated (compared to Hermite and Cubic).

Steffen Spline Interpolation



- Method: **Steffen**
- Interpolation based on cubic spline but limit the derivatives to enforce monotonicity.
- It is stable but tend to produce interpolation function with large second derivatives.