Built local interpolation cubic spline function

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Abstract: To analyze the spline function with a higher order of approximation based on the given data, to solve the problem in the object on the basis of experimental data by the working group in order to eliminate the problem that occurred in an object. Based on the experimental data obtained to solve the given problem, a mathematical model focused on this object is built, and based on the built model, the solution to the problem in the object is determined and analyzed.

Keywords: spline functions, local splines, second-degree polynomials, cubic splines

First level interpolation spline function based on built local interpolation cubic spline function approaching analysis to do

Below $f(x)$ function values are given. Construct a locally interpolating cubic spline function.

The general form of the Lagrangian interpolation polynomial $(x_0, f_0),\ (x_1, f_1)$ passing through the points is as follows:

$$L_1(x) = \frac{x - x_1}{x_0 - x_1} f(x_0) + \frac{x - x_0}{x_1 - x_0} f(x_1).$$

The Lagrange interpolation polynomial passing through the specified points has the following form: $(0;4),\ (1;1)$

$$\mathrm{L}_1(x) = -3x + 4$$

$(x_1, f_1),\ (x_2, f_2)$ passing through the points is as follows:

$$L_2(x) = \frac{x - x_2}{x_1 - x_2} f(x_1) + \frac{x - x_1}{x_2 - x_1} f(x_2).$$

passing through the given points $(1;1),\ (2;-1)$ has the following form:

$\mathrm{L}_2(x) = -2x + 3$

Let’s assume that the 2nd-order derivative of the third-order local interpolation spline function we want to construct is a linear interpolation spline function constructed based on the Lagrange interpolation polynomial passing through two points .

$S''_{3,1}(x) = -3x + 4$ (1)

$S''_{3,2}(x) = -2x + 3$ (2)

(1) - by integrating the equality twice, third-order local interpolation spline functions were constructed based on certain calculations:

(2)

$$\int S''_{3_1}(x)dx = \int (-3x + 4)\, dx = -\frac{3}{2}x^2 + s_1 + 4x + s_2$$

$$S'_{3_1}(x) = -\frac{3}{2}x^2 + s_1 + 4x + s_2$$

$$\int S'_{3_1}(x)dx = \int (-\frac{3}{2}x^2 + s_1 + 4x + s_2)\, dx =$$

$$= -\frac{1}{2}x^3 + 2x^2 + s_1x + c_1^* + s_2x + c_2^*$$

$$S_{3_1}(x) = -\frac{1}{2}x^3 + 2x^2 + s_1x + c_1^* + s_2x + c_2^* \quad (3)$$

a third-order local interpolation spline function in the form (3) . Here

$$A_1\frac{x_1 - x}{h_1} = c_1x + c_1^*\ B_1\frac{x - x_0}{h_1} = c_2x + c_2^*. h_1 = x_1 - x_0$$

$$S_{3_1}(x) = -\frac{1}{2}x^3 + 2x^2 + A_1(1 - x) + B_1x \quad (4)$$

Here $A_1$and $B_1$are the integration constants, which are determined from the $S(x_{i-1}) = f_{i-1}$and $S(x_i) = f_i$interpolation terms.

$S_{3_1}(x_0) = f_0$ from$A_1 = 4$ comes from.

$S_{3_1}(x_1) = f_1$from$B_1 = -\frac{1}{2}$ comes from.

A_1 and putting B_1them into (4), we get the following.

$$S_{3_1}(x) = -\frac{1}{2}x^3 + 2x^2 - \frac{9}{2}x + 4\ x \in [0; 1]$$

(3) - by integrating the equality twice, third-order local interpolation spline functions were constructed based on certain calculations:

(4)

$$\int S''_{3_2}(x)dx = \int (-2x + 3)\, dx = -x^2 + s_1 + 3x + s_2$$

$$S'_{3_2}(x) = -x^2 + s_1 + 3x + s_2$$

$$\int S'_{3_2}(x)dx = \int (-x^2 + s_1 + 3x + s_2)\, dx =$$

$$= -\frac{1}{3}x^3 + \frac{3}{2}x^2 + s_1x + c_1^* + s_2x + c_2^*$$

$$S_{3_2}(x) = -\frac{1}{3}x^3 + \frac{3}{2}x^2 + s_1x + c_1^* + s_2x + c_2^* \quad (5)$$

a third-order local interpolation spline function in the form (5). Here

$$A_2 \frac{x_2-x}{h_2} = c_1x + c_1^* \; B_2 \frac{x-x_1}{h_2} = c_2x + c_2^*.h_2 = x_2 - x_1$$

$$S_{3_2}(x) = -\frac{1}{3}x^3 + \frac{3}{2}x^2 + A_2(2-x) + B_2(x-1 \qquad (6)$$

Here $A_2$and $B_2$are the integration constants, which are determined from the $S(x_i\ ) = f_i$and $S(x_{i+1}\ ) = f_{i+1}$interpolation terms.

$S_{3_2}(x_1) = f_1$ from$A_2 = -\frac{1}{6}$ comes from.

$S_{3_2}(x_2) = f_2$from$B_2 = -\frac{13}{3}$ comes from.

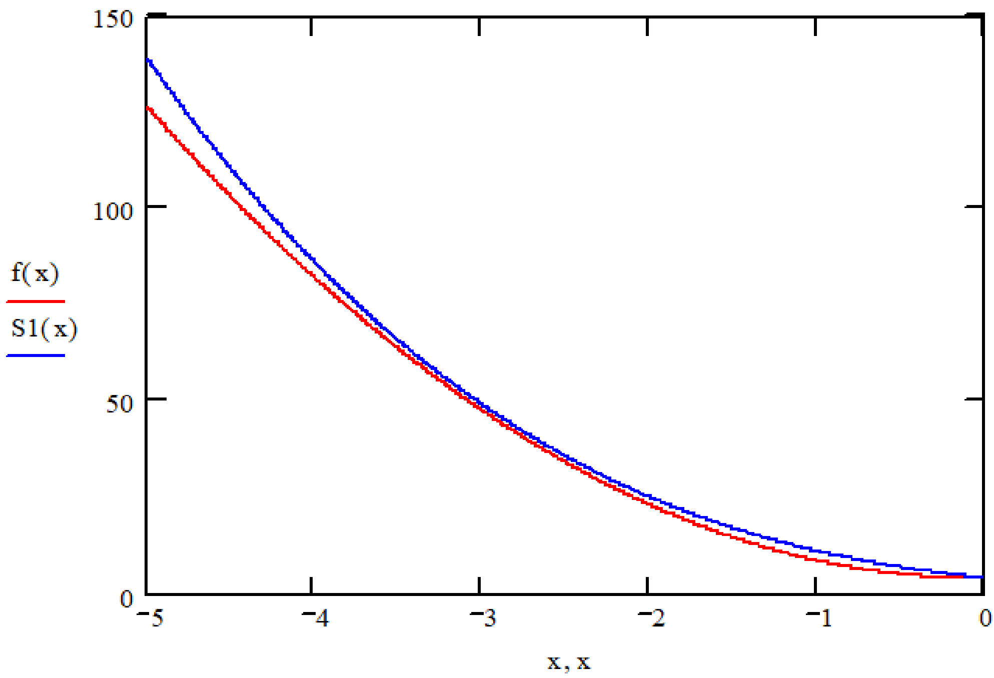
A_2 and putting B_2them into (6), we get:

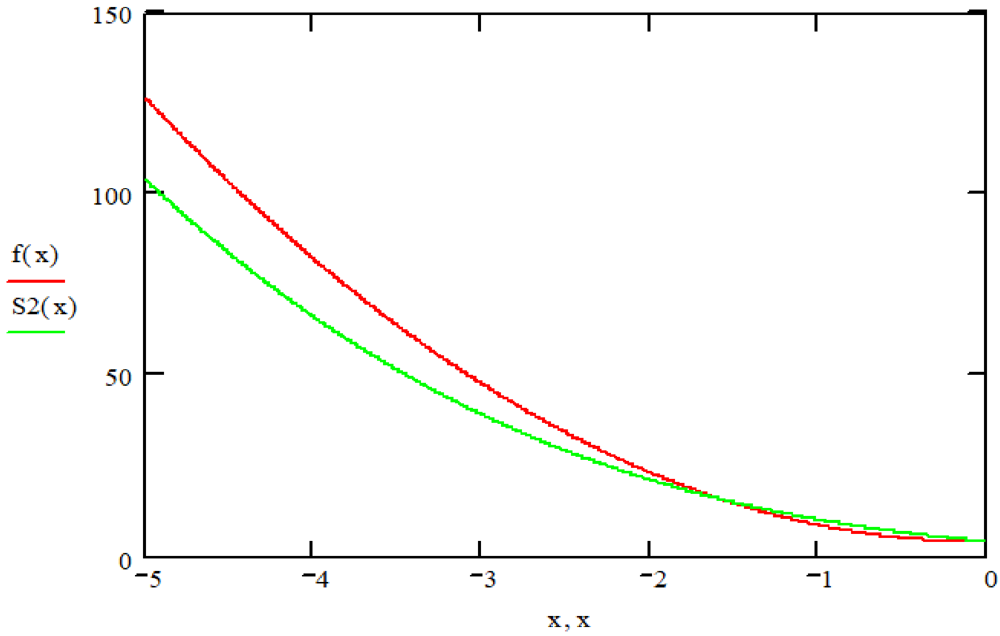
$$S_{3_2}(x) = -\frac{1}{3}x^3 + \frac{3}{2}x^2 - \frac{25}{6}x + 4 \; x \in [1;2]$$

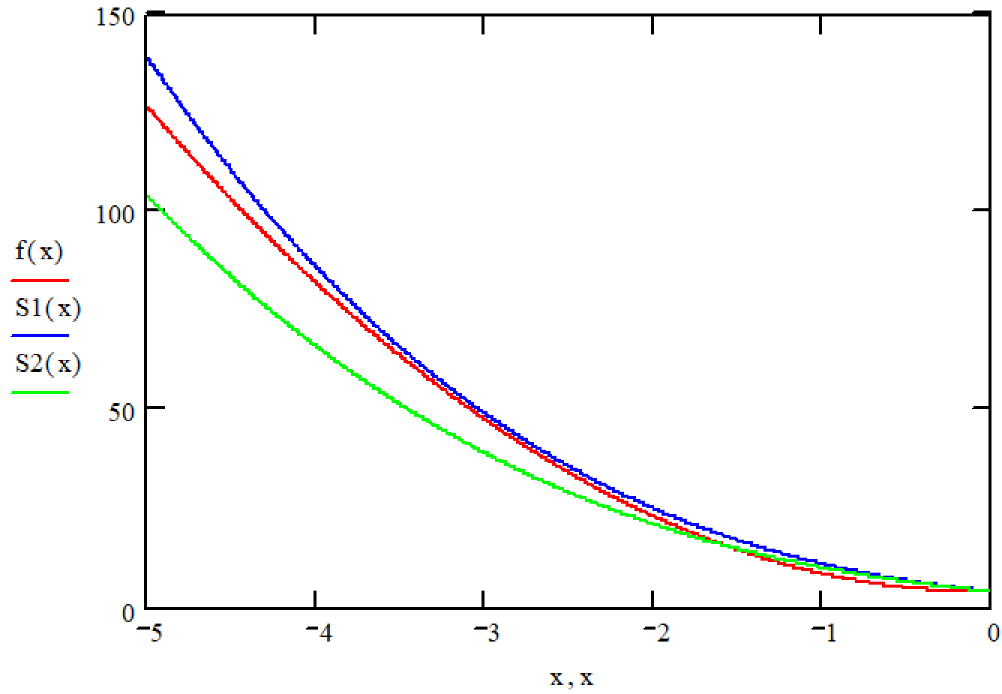
For the derived third-order local interpolation spline function We check that the interpolation conditions are met:

$$S_{3_1}(x_0) = f(x_0) \; S_{3_1}(0) = 4$$
$$S_{3_1}(x_1) = f(x_1) \; S_{3_1}(1) = 1$$
$$S_{3_2}(x_1) = f(x_1) \; S_{3_2}(1) = 1$$
$$S_{3_1}(x_1) = S_{3_2}(x_1) \; S_{3_2}(x_2) = f(x_2)$$
$$S_{3_1}(2) = -1 \; S_{3_2}(x_2) = f(x_2)$$
$$S_{3_2}(2) = -1 \; S_{3_1}(x_2) = S_{3_2}(x_2)$$

the MathCad program, the continuity of local interpolated cubic spline functions at connection node points was checked, and the locations of local interpolated cubic spline functions constructed on a graphical basis were analyzed.







Conclusion

A local interpolation cubic spline function was built based on the first-order interpolation spline function, the construction of a local interpolation cubic spline was shown in general, and a local interpolation cubic spline function was built based on the given specific data. Local interpolation cubic spline function graphs based on MathCad software were analyzed with the function graphs being recovered.

References

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