



## Implementation of Interpolation on Linear and Quadratic Splines using SciLab

Melda Panjaitan<sup>1</sup>, Siti Nurhabibah Hutagalung<sup>2</sup>

<sup>1,2</sup>Teknik Informatika, Ilmu Komputer dan Teknologi Informasi, Universitas Budi Darma, Medan

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### ABSTRACT

In the study of spline Linear and quadratic interpolation and this method used the translation method of data formulation of rainfall and humidity data, simulation using excel and scilab programming. The data intervals are very clear and the spline graph outputs the comparison of data 1 with the next data. very helpful in explaining the lecture on numerical methods courses. through three consecutive control points, unusual formulations that have not been previously used for defining splines can be utilized as interpolation functions. In this section we provide some examples that demonstrate the effectiveness of our spline formulation. Note that since three points in space define a plane. Note that the compatibility of circular and elliptical interpolation functions, such that they form the same curve under certain conditions, makes it easy to combine them for defining our hybrid interpolation function, but a hybrid interpolation function can be defined using two (or more) incompatible interpolation functions as well. Instead of using a single threshold to switch between different

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#### Corresponding Author:

Melda Panjaitan,  
Teknik Informatika,  
Universitas Budi Darma  
Jalan Imam Bonjol No.41, Karawaci, Kecamatan Tangerang, Karawaci, Kota Tangerang, Banten  
15115, Indonesia.  
Email: [Meldapjt.78@gmail.com](mailto:Meldapjt.78@gmail.com)

### 1. INTRODUCTION

Interpolation studies in the Numerical Methods course at Budi Darma University discuss theory and simulation applications using Scilab programming. Talking about interpolation or let's call it lerp is the ability to predict a value between two other values listed in a table or line graph, (Yuksel, 2020). In some of the examples and cases in the discussion of data tables and line charts, we often encounter missing data and incorrect recording, and the data may jump due to certain intervals (Hartomo, 2006), Interpolation optimization can use a function called linear interpolation to determine the linearity of a line on a graph. To find data points that are close to a straight line, use a linear spline, (Rosidi, 2019). Quadratic splines can be used if there are values with the same function, a portion of the data points is continuous and the formation of the second derivative of the spline becomes zero between the first two data points, (Ati Maryati et al., 2021).

Researchers have studied interpolation methods that can be applied in the field of mathematics to two variable,(Heilat & Ismail, 2016), synthetic division to calculate the inverse of the Vandermonde matrix,(Seru, 2021), digital image processing in the computer world,(Dedi Thera, Sampe Hotlan Sitorus, 2020) the world of health disease prediction including HIV prediction,(Yulianto et al., 2016), the number of cases of Covid 19 modeling,(Munandar et al., 2022) , the engineering field of determining turbine efficiency PLTU, determination of rainfall using IDW and spline methods,(Kurniadi et al., 2018), Development of a therapeutic cubic spline interpolation method and its application to the target tracking problem, (Syafwan et al., 2022), Pilot Interpolation .Based Channel Estimation for LTE Systems, (Makkar et al., 2020), Quartic Lp-convergence of cubic Riemannian splines,(Hardering & Wirth, 2022), A Signal Reconstruction Method Based on Quadratic Spline Interpolation Applied in Power Quality Analysis for SCM-TTU, (Deng et al., 2020), Cubic Spline Interpolation in Real-Time Applications using Three Control Points, (Ogniewski, 2019)

From the lecture description, the problem faced by students is how to use program simulations to understand the use of the spline interpolation method (spline linear and spline quadratic) in solving cases that exist in our daily lives. Therefore the researcher took the title “Implementation of Interpolation on Linear and Quadratic Splines using SciLab “.

## 2. RESEARCH METHOD

To understand this research, the authors complete the understanding of linear and quadratic spline interpolation by including relevant variables. This study aims to find linear and quadratic spline data on motorized vehicle speeds and humidity intensity measurements using the Scilab programmer, (Akhil Prasad, Atul Manmohan, 2016).

## 3. RESULTS AND DISCUSSIONS

### 3.1 Research Stages

The data used in this study is the 2019 BMKG rainfall data, which originates from the Central Bureau of Statistics for North Sumatra Province.

<https://sumut.bps.go.id/indicator/151/341/1/curah-hujan-dan-banyaknya-hari-hujan-di-bmkg-wil-i.html>

**Table 1.** 2019 Rainfall data table

<b>Rainfall</b>	<b>Rainy day</b>	<b>2019</b>	<b>f(xi)</b>	<b>Spline Linear</b>
Januari	20	208	0,1889661	0,164101
Februari	14	205	0,186479567	-0,44729
Maret	12	131	0,123102197	0,479197
April	14	172	0,158711691	2,113313
Mei	21	425	0,354171814	-0,01028
Juni	21	374	0,317726194	-1,03632
Juli	16	200	0,182321557	-0,40987
Agustus	16	131	0,123102197	2,170719
September	21	388	0,327863862	0,806155
Oktober	26	456	0,37569295	-0,81932
Nopember	25	292	0,256191405	0,463016
Desember	21	319	0,276873874	-2,49186

The research method uses several stages including :

- a. Application of the theory of linear spline interpolation formulas,(Skjelbred & Kong, 2019):

$$f_1(x) = f(x_1) + \frac{f(x_2)-f(x_1)}{(x_2)-(x_1)} + (x - x_1) \quad ; \quad x_1 \leq x \leq x_2 \quad (1)$$

$$f_2(x) = f(x_2) + \frac{f(x_3)-f(x_2)}{(x_3)-(x_2)} + (x - x_2) \quad ; \quad x_2 \leq x \leq x_3 \quad (2)$$

$$f_{n-1}(x) = f(x_{n-1}) + \frac{f(x_n)-f(x_{n-1})}{(x_n)-(x_{n-1})} + (x - x_{n-1}) \quad ; \quad x_{n-1} \leq x \leq x_n \quad (3)$$

Enter the data in equation (1) in the Linear spline calculation

$$f_1(x) = 0,188961 + \frac{(0,186479567 - 0,1889661)}{1,2 - 1,1} + (x - 1,1)$$

$$f_1(x) = 0,186479567 + \frac{(0,23102197 - 0,186479567)}{1,3 - 1,2} + (x - 1,2)$$

Perform settlement on data 3 to 14, so that the solution is obtained in table 2. comparison of rainfall data on the input data of linear spline differences until it reaches the desired similarity value of the data interval.

b. Application of the theory of the quadratic Spline interpolation formula

$$S_i(x) = y_i \frac{x-x_{i+1}}{x_i-x_{i+1}} + y_{i+1} \frac{x-x_i}{x_i-x_{i+1}} = y_i \frac{y_{i+1}-y_i}{x_i-x_{i+1}} (x - x_i), \quad ; \quad x \in [x_i, x_{i+1}] \quad (4)$$

Spline Quadratic gives a quadratic equation  $(x_i, f(x_i)) = 1, 2, \dots, n$  which relates at least three pairs of adjacent data in a data set. The general form of the quadratic equation between the points  $(x_i, f(x_i))$  and  $(x_{i+1}, f(x_{i+1}))$ , (Ahmad, 2020).

The spline must be continuous inside the data points. This condition can expressed using the first derivative of the squared spline. The last condition can be formed independently as the second derivative of the spline between the first two data points becomes zero, (Thakur & Bragin, 2021).

**Table 2.** Moisture Intensity Measurement Data

i	1	2	3	4	5
x	0	5	7	8	10
y	0	2	-1	-2	20

Linear spline fit

$$S_1(x) = 0 \frac{x-5}{0-5} + 2 \frac{x-0}{5-0} = 2,5x \quad x \in [0,5]$$

$$S_2(x) = 2 \frac{x-7}{5-7} + 1 \frac{x-5}{8-7} = -1,5x + 9,5 \quad x \in [5,7]$$

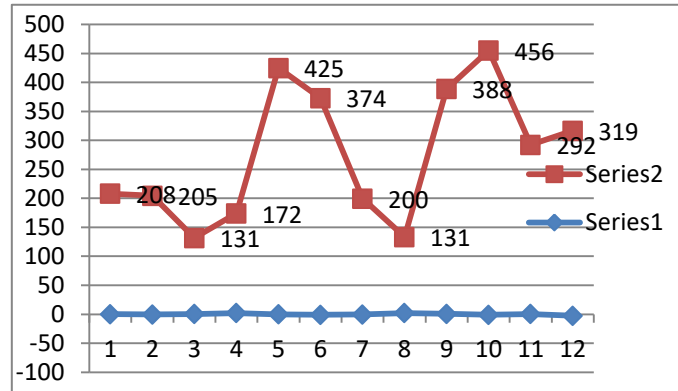
$$S_3(x) = -1 \frac{x-8}{7-8} + 2 \frac{x-7}{8-7} = -x + 6 \quad x \in [7,8]$$

$$S_4(x) = -2 \frac{x-10}{8-10} + 20 \frac{x-8}{10-8} = 11x + 90 \quad x \in [8,10]$$

In calculating data using a quadratic spline line, it requires at least 3 data pairs to input Humidity Measurement, The curve segment between these control points is contained within this area. Using our affine invariant representation, without loss of generality, in the following we assume that  $x_i$  is at the origin and  $x_{i+1}$  is along the x-axis at  $x = 1$ . Note that transforming a given curve to this frame does not require non-uniform scale.

c. Data simulation with Excel

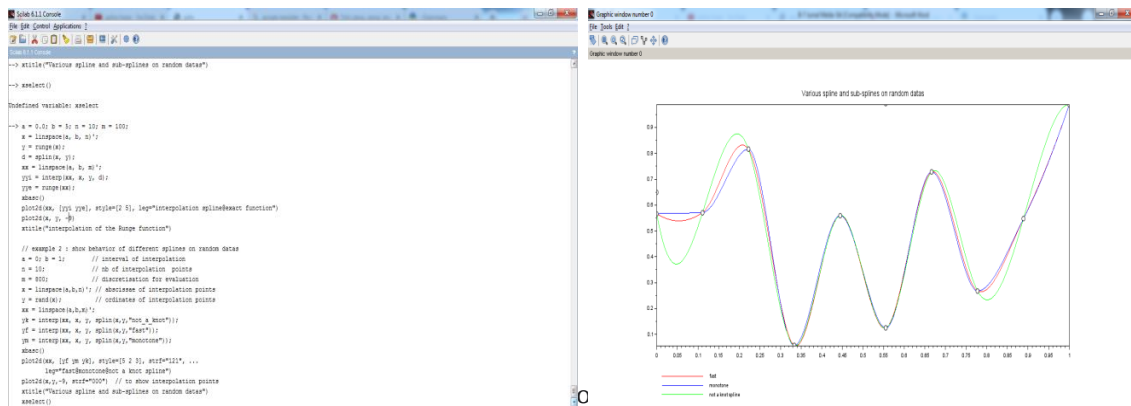
Based on the data in tables 3 and 4, linear and quadratic spline graphs can be made



This interpolation function produces perfect circular arcs whenever four consecutive control points are on the same circle. The resulting curves address a fundamental limitation of polynomial spline formulations.

d. Data simulation with SciLab

In scilab programming input, it is necessary to understand the linear spline input values and the intervals in the calculation results.



From the discussion of the implementation of interpolation on linear and quadratic splines both in the explanation of formulas, Excel and Scilab inputs really help students understand basic concepts and can be developed with other cases. Note that while we pick the  $t_i$  value that places  $p_i$  at the local maximum of curvature for the interpolation function, the final curve  $x_i$  that combines two interpolation functions can have its maximum local curvature at a slightly different position. Our experiments with this particular interpolation function revealed that the local curvature maxima appear very close to control points (Fig. 2). Constructing a global parameterization  $S$  with this interpolation function can be achieved by assigning global parameter values  $S_i$  to each control point.

4. CONCLUSION

In calculations using the translation of linear, quadratic spline interpolation formulations to scilab programming simulations it is very helpful for students in solving cases that exist in learning numerical methods at Budi Darma University. In the input of rainfall and humidity data, it can be seen that significant data intervals,

The role of an interpolation function is to define a curve that goes through three consecutive control points are clear both in theoretical calculations and in simulations.

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