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CUBIC SPLINE INTERPOLATION ANALYSIS USING MAPLE PACKAGE

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Abstract. We talk about using the Maple package for abstract cubic interpolation analysis. We review the capabilities of the package and provide an in-depth analysis of cubic spline interpolation. Our analysis shows the effectiveness of this method in solving complex problems in different fields. In this analysis, we will examine the basics of cubic spline interpolation, including how it works, its advantages and disadvantages, and how to implement it using the Maple software package. We will also discuss some real-world applications of cubic spline interpolation, such as data smoothing and curve fitting. Through this analysis, we hope to provide a comprehensive understanding of cubic spline interpolation and its importance in various contexts. Using Maple, cubic splines can be easily calculated, plotted, and even manipulated to suit specific needs. In addition, Maple allows the creation of interactive graphs, which can be used to explore the properties of cubic lines and gain a deeper understanding of their behavior.

Keywords: Cubic spline interpolation, maple package, Polyinterp.

Introduction

Cubic spline is a powerful method for approximating functions. It is a mathematical technique that allows us to construct a smooth curve that passes through a set of given data points. This is useful in many applications, such as computer graphics, engineering, and finance. In cubic spline interpolation, we divide the data set into segments and fit a cubic polynomial to each segment. The polynomials are then joined together in a way that ensures that the resulting curve is continuous and has a continuous first and second derivative. Maple is a software program that provides built-in functions and tools for cubic spline interpolation. It makes the process even easier and allows for the creation of interactive plots. In this conversation, we will explore the conclusion of using cubic spline interpolation in Maple. It is useful and beneficial to express relationships in data using functions. This allows us to estimate dependent variables at values of independent variables that are not given in the data. This work is done in MAPL using the interpolation method [1, 2]. The Maple software offers the most recent numerical analysis applications in a quicker and more effective manner, which has helped to solve significant scientific and technical problems [3]. Maple is a powerful math solver and versatile math learning tool that provides 2D and 3D diagrams and even step-by-step solutions with detailed answers. Whether you're doing simple calculations or working on advanced math problems, Maple Calculator can do it all. It should be noted that a residual term is not calculated by the Cubic Spline command, so we cannot use it with the polynomial interpolation command Remainder Term or InterpolantRemainderTerm, and the remaining term is interpolated from a structure command. Because this method works numerically. That is, the inputs that are not numerical are first evaluated with floating point numbers before continuing the calculations so that they can be analyzed computationally [8]. Less spline means more distance between nodes [4]. Traditional termination conditions for cubic spline interpolation include the values of the first or second derivatives of the interpolation functions at the boundary interpolation nodes. The node-free boundary condition proposed by de Boor (1985) is a kind of cubic spline interpolation boundary condition for practical application without the requirement of derivatives at the end nodes. However, a significant disadvantage of such end conditions is that there is a sharp decrease in interpolation accuracy at boundary distances [5]. Interpolating cubic splines are popular for fitting data because they use low-order polynomials. Cubic contours are widely used to fit a smooth continuous function through discrete data. They play an important role in fields such as computer graphics and image processing, where smooth interpolation is essential in modeling, animation, and image scaling. For example, in computer graphics, interpolation cubic

lines are often used to define the smooth movement of objects and cameras that pass through user-specified positions in a key frame animation system. In image processing, splines are useful in implementing high-quality image magnification [6]. Another good feature of the Maple package is that the Maple software has many features, including converting outputs to MATLAB codes and LaTeX commands [7]. In the Maple package, it returns the linear system of equations used to solve the cubic spline interpolants. It should also be said that the Linear System command retrieves the matrix and vector in the linear system of equations that were solved when calculating the cubic spline interpolants. A POLYINTERP structure is created using the Cubic Spline command. It should be noted that the Linear System command only accepts interpolation structures created using the cubic Spline command, since the cubic spline interpolation method is the only method that has an associated linear system [https://www.maplesoft.com/images2015/Maplesoft_logo2x.png].

Materials and methods

We perform cubic spline interpolation on a set of data using the Maple package. The points given by the Cubic Spline command are cubically interpolated so that all the derived data is stored in a POLYINTERP structure. so that we can transfer them to various interpolation commands under the [Numerical Analysis] student package. There we can extract and manipulate information well. In Maple, the Spline command can be used to perform cubic spline interpolation with natural boundary conditions. Natural boundary conditions assume that the second derivative of the spline function is zero at the endpoints of the interval [3,4]. This means that the spline curve will be linear outside of the interval defined by the data points, resulting in a smoother curve compared to other boundary conditions. To use natural boundary conditions in Maple, first input the data points as a set of ordered pairs. Then, use the Spline command with the option `method="natural"`. The resulting curve will be a piecewise-defined polynomial function that passes through the data points and has continuous first and second derivatives. The plot command can be used to visualize the resulting curve. Maple's Spline command can be used for cubic spline interpolation with clamped boundary conditions. Clamped boundary conditions are used when the first derivatives at the endpoints are known. This means that the curve will have a fixed slope at the endpoints, which can be useful in some applications. To use clamped boundary conditions in Maple, you can specify the first derivatives at the endpoints using the `left` and `right` options in the Spline command. Cubic spline interpolation with clamped boundary conditions can be useful in a variety of applications, such as in engineering and physics, where the slope of a curve at the endpoints may be known or constrained. One of these applications is in the field of optics, where it is used to determine the refractive index of a material as a function of wavelength [2]. In addition, cubic spline interpolation is also used in numerical simulation of physical phenomena, such as solving partial differential equations [1]. Another application of cubic spline interpolation is in the field of experimental physics, where it is used to interpolate experimental data to obtain a smooth curve that can be used for predictions or to fit a theoretical model [2]. In general, cubic spline interpolation is a powerful tool for physicists to analyze and interpret data and make predictions about physical systems.

Cubic Spline Interpolation

A cubic spline is a mathematical function used to interpolate between points of data. It is a piecewise-defined function composed of cubic polynomials. Cubic splines are commonly used in engineering and scientific applications where the smoothness of a curve is important. They are particularly useful for approximating complex shapes or curves that cannot be easily represented by a simple mathematical function. In this analysis, we will explore the fundamentals of cubic spline interpolation, including how it works, its advantages and disadvantages, and how to implement it using the Maple software package. We will also discuss some real-world applications of cubic spline interpolation, such as data smoothing and curve fitting. Through this analysis, we hope to provide a comprehensive understanding of cubic spline interpolation and its significance

in various fields. In Maple, you can use the spline command to perform cubic spline interpolation. The spline command takes in two vectors, x and y , where x contains the x -coordinate data points and y contains the corresponding y -coordinate data points [8].

Here's an example of how to use the spline command in Maple:

```
x := [0, 1, 2, 3, 4];
y := [1, 3, 2, 4, 1];
s := spline(x, y);
```

In this example, x and y represent the data points we want to interpolate. The spline command returns the function s representing the cubic spline interpolation of the data. We can use the plot command to visualize the spline. This will plot the cubic spline interpolation of the x and y data points. In general, the spline command in Maple makes it easy to perform cubic spline interpolation and gain insight into the behavior of a function [2,3].

Examples

```
> with(Student[NumericalAnalysis]) :
> xy := [[0, 4.0], [0.5, 0], [1.0, -2.0], [1.5, 0], [2.0, 1.0], [2.5, 0], [3.0, -0.5]]
      xy := [[0, 4.0], [0.5, 0], [1.0, -2.0], [1.5, 0], [2.0, 1.0], [2.5, 0], [3.0, -0.5]]
> p1 := CubicSpline(xy, independentvar = x) :
> expand(Interpolant(p1))
```

```
4. - 8.48076923076923 x + 1.92307692307692 x3
-5.13461538461539 x + 3.44230769230769 - 6.69230769230769 x2 + 6.38461538461538
21.2884615384615 - 58.6730769230769 x + 46.8461538461538 x2 - 11.4615384615385 x
15.0576923076923 x - 15.5769230769231 - 2.30769230769231 x2 - 0.538461538461538
-64.8076923076923 + 88.9038461538461 x - 39.2307692307692 x2 + 5.61538461538461
-52.4423076923077 x + 52.9807692307692 + 17.3076923076923 x2 - 1.92307692307692
```

```
> Draw(p1)
```

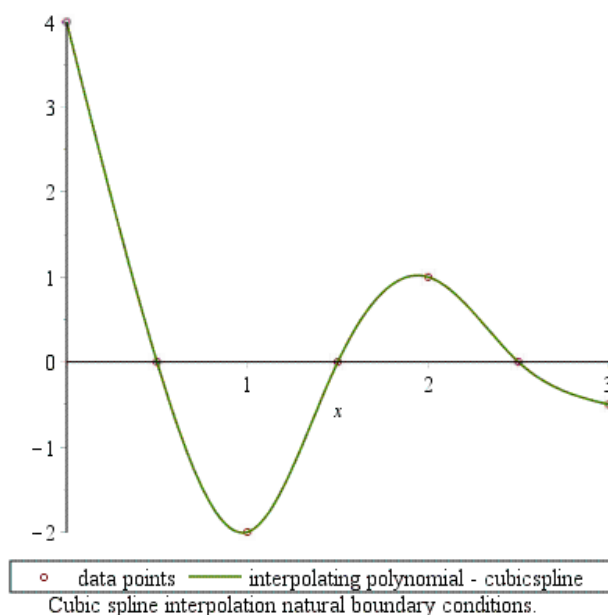


Figure 1 - Cubic spline interpolation natural boundary conditions.

```
> p2 := CubicSpline(xy, independentvar = x, boundaryconditions = clamped(0, 6)) :
> Draw(p2)
```

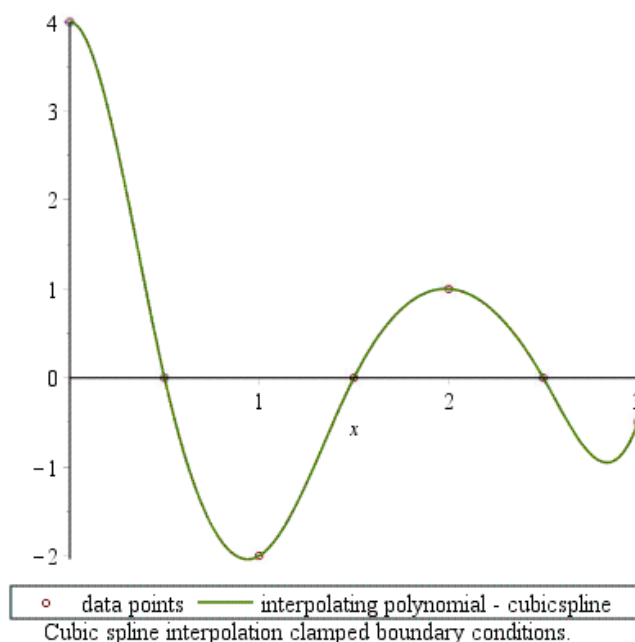


Figure 2- Cubic spline interpolation clamped boundary conditions.

To conclude a cubic spline in Maple, you can use the spline command. This command requires the input data points and generates a piecewise cubic polynomial that passes through each of these points. The resulting spline function can be used to interpolate values between the input data points.

Conclusion

Cubic spline interpolation is a powerful method for approximating functions that are not easily modeled using traditional methods. With Maple, the process of computing cubic splines is made even easier due to its built-in functions and tools. By using Maple, one can easily compute cubic splines, plot them, and even manipulate them to fit specific needs. Additionally, Maple allows for the creation of interactive plots, which can be used to explore the properties of cubic splines and gain a deeper understanding of their behavior. Overall, Maple is an excellent tool for anyone looking to utilize cubic splines in their work. Maple is a great software program that provides built-in functions and tools for cubic spline interpolation, making the process even easier. With Maple, you can create interactive plots and explore the behavior of the function in question. In conclusion, using cubic spline interpolation in Maple can be a great way to approximate functions and gain insights into their behavior. With its user-friendly interface and powerful tools, Maple makes it easy to work with cubic spline interpolation and explore the data in question. Whether you're a researcher, student, or professional, Maple can help you make sense of your data and gain a deeper understanding of your subject matter. Overall, cubic spline interpolation is a powerful tool for physicists to analyze and interpret data in a meaningful way.

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MAPLE ПАКЕТІН ПАЙДАЛАНЫП ТЕКШЕ СПЛАЙНДАРЫНЫҢ ИНТЕРПОЛЯЦИЯСЫН ТАЛДАУ

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Аңдатпа. Біз текше интерполяцияны дерексіз талдау үшін Maple бумасын пайдалану туралы айтып отырмыз. Біз пакеттің мүмкіндіктерін қарастырамыз және текше сплайндармен интерполяцияға терең талдау жасаймыз. Біздің талдауымыз әр түрлі салалардағы күрделі мәселелерді шешуде осы әдістің тиімділігін көрсетеді. Бұл талдауда біз текше сплайн интерполяциясының негіздерін, оның қалай жұмыс істейтінін, оның артықшылықтары мен кемшіліктерін және оны Maple бағдарламалық жасақтамасымен қалай жүзеге асыруға болатындығын қарастырамыз. Біз сондай-ақ деректерді тегістеу және қисық сызықты сәйкестендіру сияқты текше сплайн интерполяциясының кейбір нақты қолданбаларын талқылаймыз. Осы талдау арқылы біз текше сплайн интерполяциясы және оның әртүрлі контексттердегі маңыздылығы туралы жан-жақты түсінік аламыз деп үміттенеміз. Maple көмегімен текше сплайнды нақты қажеттіліктерге сәйкес оңай есептеуге, сызуға және тіпті басқаруға болады. Сонымен қатар, Maple текше сызықтарының қасиеттерін зерттеу және олардың мінез-құлқын тереңірек түсіну үшін пайдалануға болатын интерактивті графиктерді жасауға мүмкіндік береді.

Кілттік сөздер: Текше сплайн интерполяциясы, maple пакеті, Polyinterp.

АНАЛИЗ ИНТЕРПОЛЯЦИИ КУБИЧЕСКИХ СПЛАЙНОВ С ИСПОЛЬЗОВАНИЕМ ПАКЕТА MAPLE

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Аннотация. Мы говорим об использовании пакета Maple для абстрактного анализа кубической интерполяции. Мы рассматриваем возможности пакета и проводим углубленный анализ интерполяции кубическими сплайнами. Наш анализ показывает эффективность этого метода при решении сложных задач в различных областях. В этом анализе мы рассмотрим основы кубической сплайновой интерполяции, включая то, как она работает, ее преимущества и недостатки, а также как ее реализовать с помощью программного пакета Maple. Мы также обсудим некоторые реальные приложения кубической сплайновой интерполяции, такие как сглаживание данных и подгонка кривой. С помощью этого анализа мы надеемся получить всестороннее представление о кубической сплайновой интерполяции и ее важности

в различных контекстах. Используя Maple, кубические сплайны можно легко вычислять, строить графики и даже манипулировать ими в соответствии с конкретными потребностями. Кроме того, Maple позволяет создавать интерактивные графики, которые можно использовать для изучения свойств кубических линий и получения более глубокого понимания их поведения.

Ключевые слова: Кубическая сплайновая интерполяция, пакет maple, Polyinterp.

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