Cooperation of KeTCindyJS and Maxima

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Abstract

This paper presents some HTML teaching materials created through the integration of KeTCindyJS and Maxima. KeTCindyJS is suitable for mathematical visualization, but errors occur in the results because the operations are numerical calculations. Therefore, the HTML teaching materials were created by entrusting the computational processing to Maxima.

1 Introduction

In recent years, the digitization of education has progressed, and devices such as computers and tablets have been introduced into educational settings, where classes utilizing ICT and the Web are being implemented. Against this background, there is growing expectation for the provision of HTML teaching materials that can be shared online. There is KeTCindyJS developed by Setsuo Takato and others as a system for creating HTML teaching materials. This is a system that uses CindyJS, a plugin for the dynamic geometry software Cinderella2 (Cindy), along with the KeTCindy (a system based on Cindy that generates graphic code for inserting figures into TeX documents) library, to create diagrams and graphs and generate them as HTML files. To date, I have developed several HTML-based instructional materials solely using KeTCindyJS. In this time, an attempt was made to integrate Maxima so as to utilize the respective strengths of both systems in the creation of enhanced HTML teaching materials.

2 Example of teaching material

As an example, an HTML teaching material on Taylor expansion is presented here.

Although it is possible to represent Taylor expansions using only KeTCindyJS, CindyJS does not support symbolic differentiation (algebraically exact derivatives) and performs approximate differentiation using numerical differentiation, which leads to large errors in higher-order differentiation. On the other hand, Maxima's differential algorithm is essentially composed of rules and recursive algorithms based on the definition of differentiation, so higher-order differentiation is no problem. That is, accurate teaching materials can be developed by graphically representing the results computed by Maxima through KeTCindyJS and converting them into HTML files.

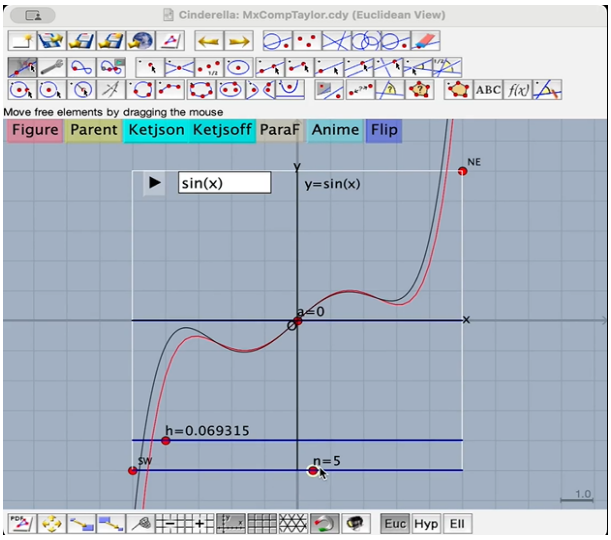

Figure 1: symbolic/numerical differentiation

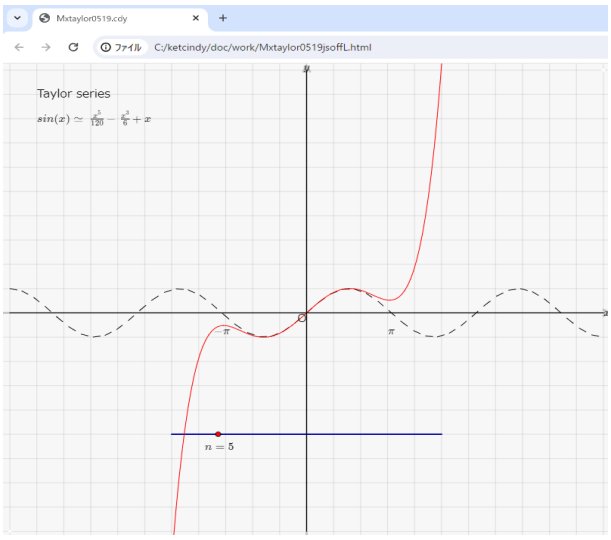

Figure 2: HTML teaching material

Figure 1 presents a comparison of the Taylor expansions of sin(x) obtained through symbolic and numerical differentiation. The red curve represents the result computed using Maxima, while the black curve corresponds to the result obtained via numerical differentiation. In the case of numerical differentiation, the approximation remains accurate up to the fourth-order term; however, from the fifth order onward, substantial errors become evident. Figure 2 shows the result computed using Maxima, exported as an HTML file using the functionality of KeTCindyJS. By adjusting the order of differentiation with a slider, one can interactively observe how the Taylor-expanded function gradually approaches the graph of sin(x).

3 Conclusion and Future Work

Through symbolic computation with Maxima and visualization with KeTCindyJS, it becomes possible to develop accurate and interactive teaching materials. Future challenges include the enhancement of HTML teaching materials, as well as integration with computer algebra systems other than Maxima.

References

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