Gliwice, 02-12-2024

Mathematical modelling and computer simulations in theory and practice

Documentation of laboratory task no 3

Title: SERIES APPROXIMATION

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Field of studies: Informatics (sem.V)

Project Objective:
We're going to present a few diffrent types of approxiamations for a given function: Fourier series, Taylor series and Pade approximation.

Description:
Program is giving approximation in relation to x and displaying both original function provided by user and approximating series on XY plot.

Inputs of the program are very simple – user is choosing a type of approximation by pressing a correct button. After that a few inputs fields are displayed where user can input data necessary for given type of approximation.

Figure 1: Buttons used for choosing correct approximation method

After that program is using Wolfram Mathematica methods to evaluete functions and display Plot.

User can provide range on X axis that is going to be displayed. Range on Y axis is approximately equal to 1.5 maximum value of the function.

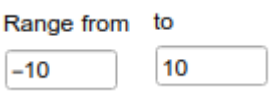

Figure 2: Range input.

User can also input function that is going to be approximated using Mathematica syntax.

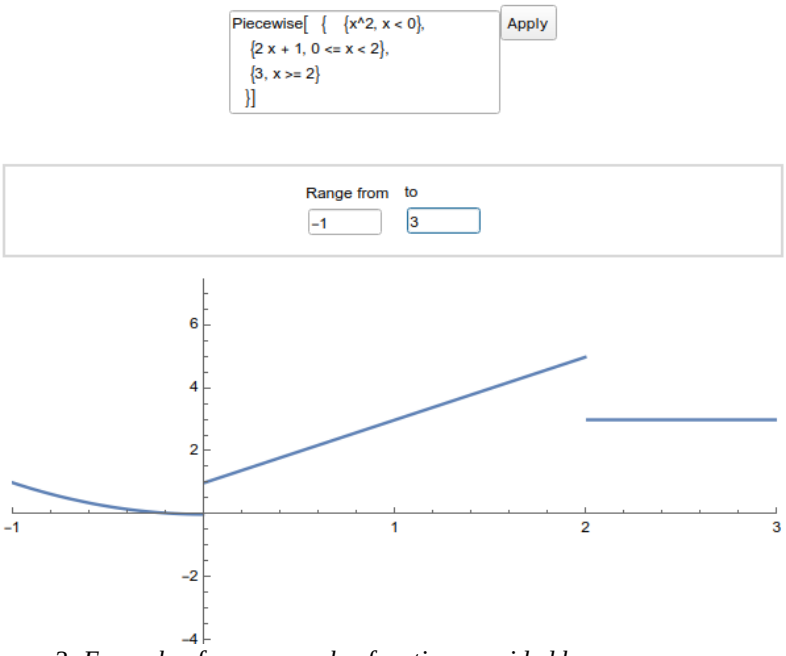

Figure 3: Example of more complex function provided by user.

Possible approximation methods are defined as follows [Parts of descriptions are quoted from Mathematica documentation]:

- „Fourier" gives Fourier series of n^{th} order:

The n^{th}-order Fourier series of $f(t)$ is by default defined to be $\sum_{k=-n}^{n} c_k\, e^{i\,k\,t}$ with $c_k = \frac{1}{2\pi} \int_{-\pi}^{\pi} f(t)\, e^{-i\,k\,t}\, dt$.

- „Taylor" gives a power series expansion around x_0 for default x_0=0 we will get Taylor series:

$$f(0) + f'(0)\, x + f''(0)\, x^2/2 + \ldots f^{(n)}(0)\, x^n/n!$$

- „Pade" produces a ratio of polynomial expressions of a given order.
- If „None" is choosen then only original funtion is dispalyed.

Inputs:

1. Approximation method (as press of a correct button)
2. Order 'n' for 'Fourier' option.
3. Order 'n' and 'x0' value for 'Taylor' option.
4. 'x0' value and order of numerator and denominator polonimals for „Pade" option.

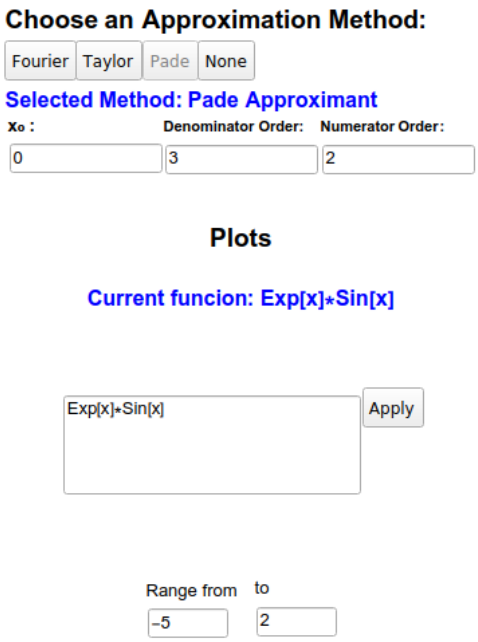

Figure 4: Input view.

Outputs:
As an otuput program is displaying plot with the representation according to inputs. Some examples are provided below.

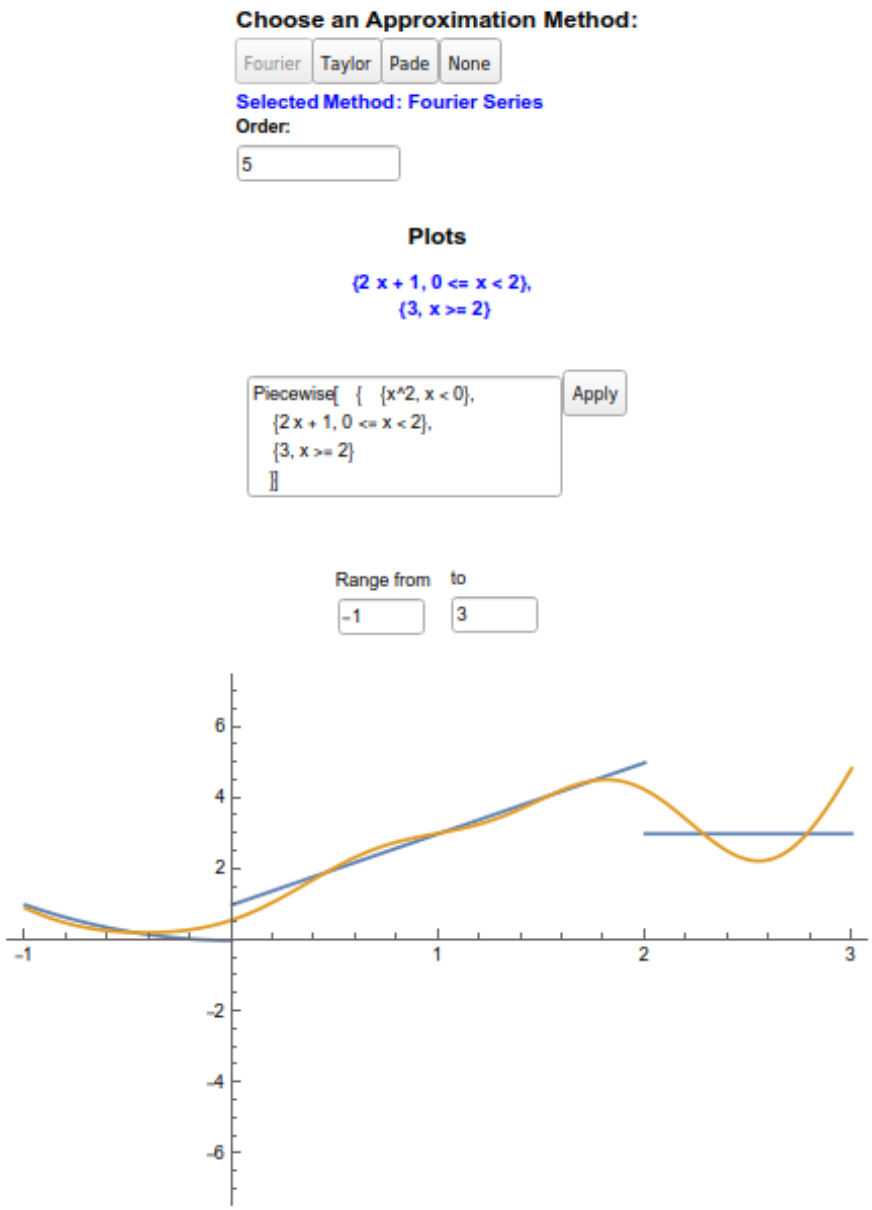

Figure 5: Example of Fourier series approximation.

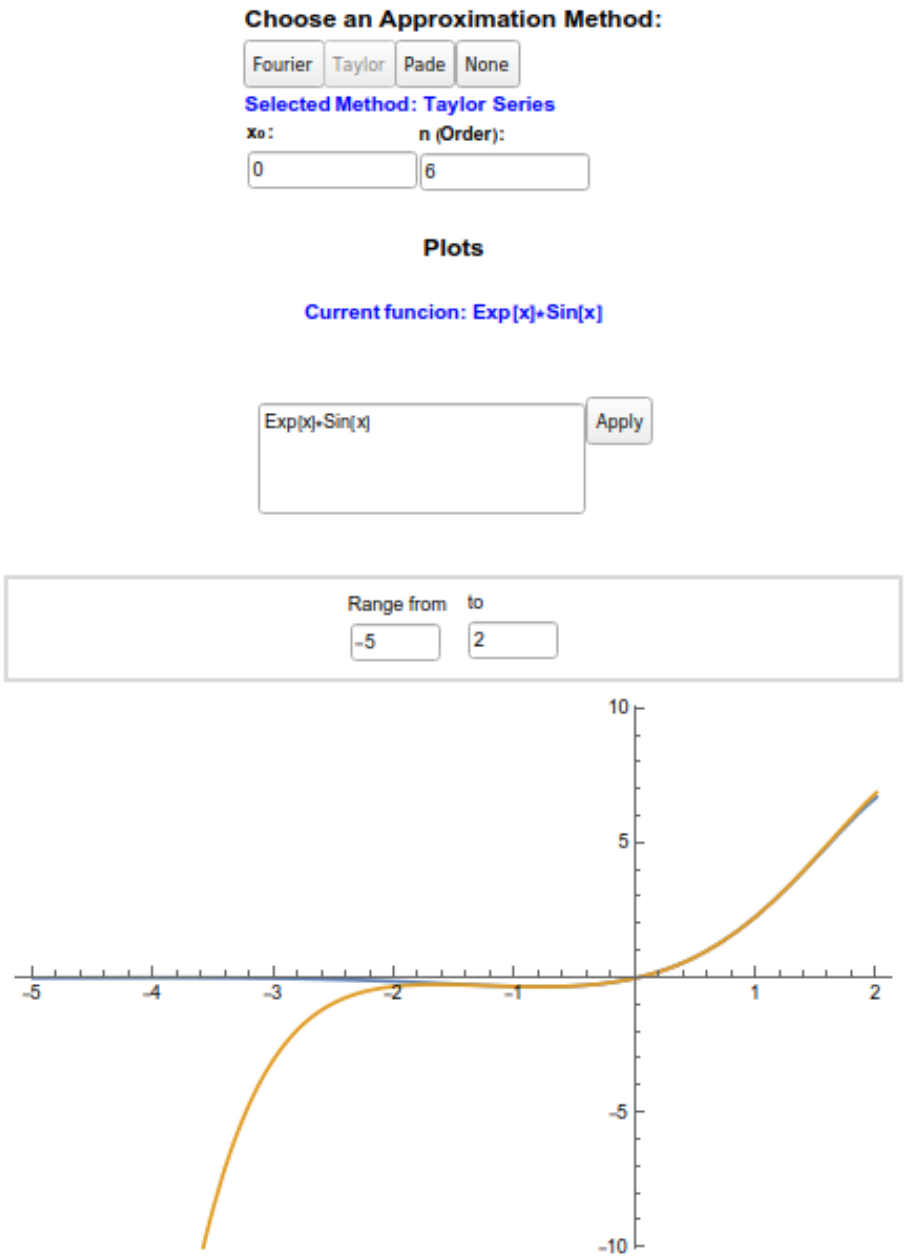

Figure 6: Example of Taylor series approximation.

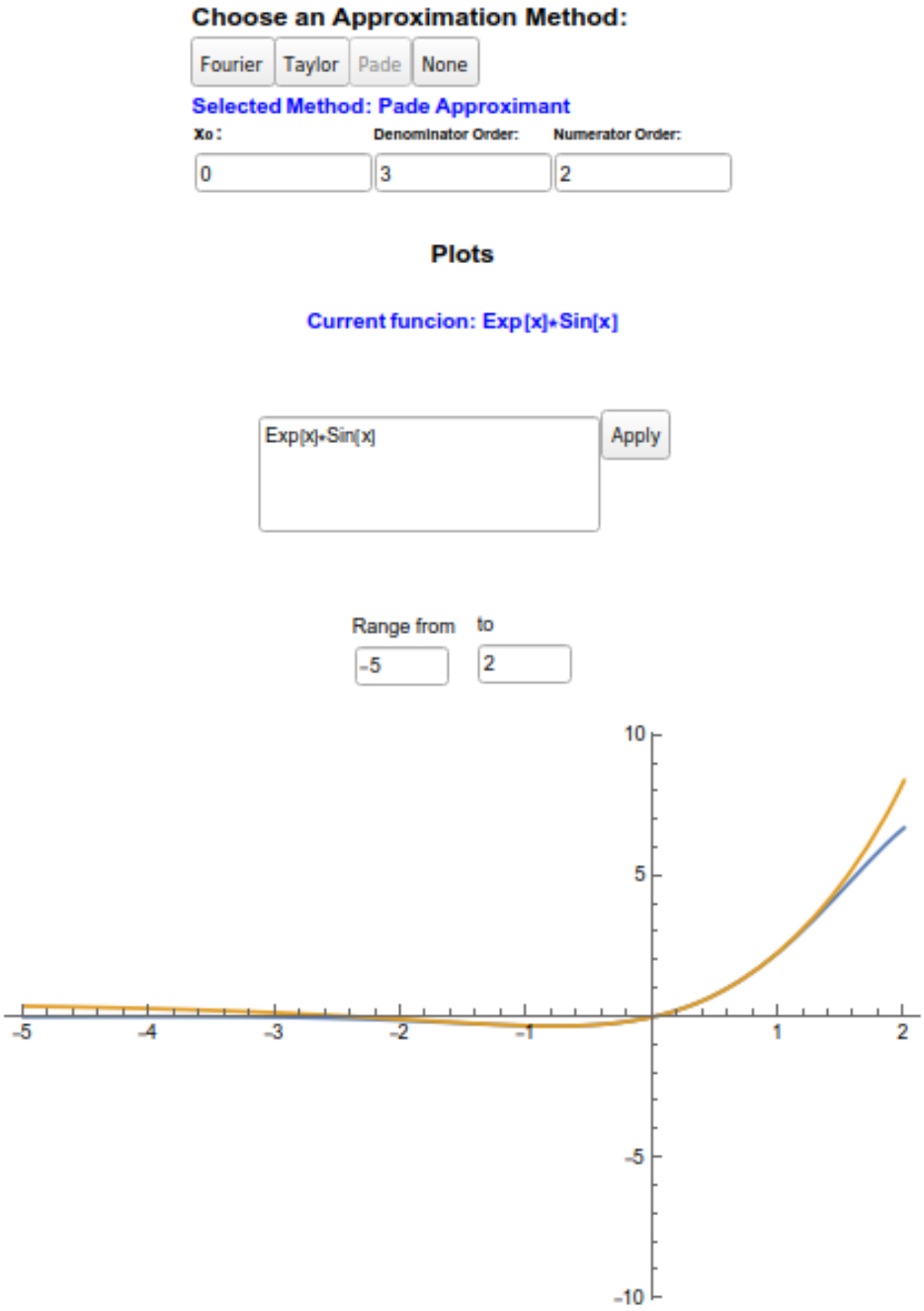

Figure 7: Example of Pade approximation.

Enclosures:

❑ File with the program (Jędrzejczyk_Radosław_proj_3)