

Mathematica Special Assignment

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As part of this assignment we demonstrate some features of Mathematica we have used in attempting to create effective tutorials for 4 increasingly complex problems.

- I. As a warm-up exercise we use Mathematica to solve a standard divide-and-conquer recurrence relation. We plot the solution using a line graph and provision sliders to dynamically vary the constants involved. By doing so one can see the change in the plot on-the-go as the constants are changed as well as see which constants affects the solution the most and in what way.
- II. We created an interactive tutorial to demonstrate asymptotic growth of two functions, how they compare with each other and as a consequence how they are related to one another by means of the asymptotic notations big-O and small-o. These two functions can be entered interactively by the user. The appropriate asymptotic limits for the function ratios are calculated and the conclusion in terms of big-O and small-o notation is output. Also a line plot of the two functions is output to visually understand the behavior of the two functions.
- III. Next we have implemented a simple demonstration of merge-sort. In this demonstration the user can enter a list of number that are to be sorted. The output is a merge-sort tree showing how the merging of each sub-list happens at various levels of the tree, finally yielding the sorted list at the root of the tree.
- IV. In our fourth notebook we present a tutorial for the machine learning concept of k-degree polynomial regression models for predicting real-valued outputs. Here we have presented a comparison of regression models with $k=1,2,3,4$ and an additional model with $k=1$ and a linear threshold measure to attempt noise-cancellation. We have used a data set to predict the Miles-per-gallon(MPG) of a vehicle given 6 of its attributes such as cylinders, maximum speed, horsepower rating etc. The user can achieve better understanding through visual depiction of the various vectors involved and the change in the number of vectors as well as their form with increasing k-values. Also we show the change in accuracy of the models with increasing k-values.

Note: Please copy the provided data set (i.e. the ".data" file) to your D:/ drive in order for this notebook to work.

Through this assignment we have a hands-on experience of Mathematica as a tool to build interactive and effective tutorials. The visualization features certainly help a learner in visualizing concepts leading to better understanding. Our last demonstration, although very verbose and less interactive in nature, is evidence of the computational capabilities of Mathematica that enable creation of tutorials for concepts requiring heavy mathematical computation with substantially less amount of code.

Once the slightly steep learning curve of Mathematica notation and syntax is overcome it becomes a fun and quick way to teach and learn.