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ON THE USE OF THE GRAPHING CALCULATOR IN SOME HIGH SCHOOL MATH TOPICS

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Abstract
This paper investigates Desmos Graphing Calculator's effectiveness as a teaching tool for high school math (academic lyceum). It showcases Desmos' applications for both senior and junior students. For seniors, it demonstrates how Desmos tackles continuous random distributions, solving for probabilities and moments (mean, median, etc.) of a given probability density function. For juniors, it exemplifies how Desmos aids in real-world data modeling with sine functions, fitting a curve to Tashkent's monthly temperature data. While initial syntax learning is required, Desmos' benefits outweigh the effort, promoting visualization, calculation speed, and ultimately, enhanced student understanding and engagement.

Keywords: Desmos Graphing Calculator, high school mathematics, continuous random distributions, sine functions, data modeling.

Introduction

Desmos Graphing Calculator can be an invaluable tool in teaching many topics of high school mathematics. This tool is available as an app for a phone from the Google Play Store, App Store as well as a web interface (desmos.com).

In this paper we consider the application of the tool in teaching some topics of mathematics at an academic lyceum to junior and senior students. There is a certain learning curve involved in studying the syntax of the app but it's worth it.

Year 2 (Seniors)

The topic is Continuous Random Distributions. Calculating the probabilities and some characteristics of a distribution requires integration. Although the integration was quite extensively covered by the syllabus, at times it's beneficial to use the technology to speed up the process. In the following example improper integration is used which is not studied in the Calculus I course.

Let X be a random variable with probability density function (pdf) given by

$$f(x) = 2e^{-2x}, x \geq 0.$$

1. Verify it's a valid probability density function (pdf) and find
2. Its mean
3. Median
4. Variance and standard deviation.

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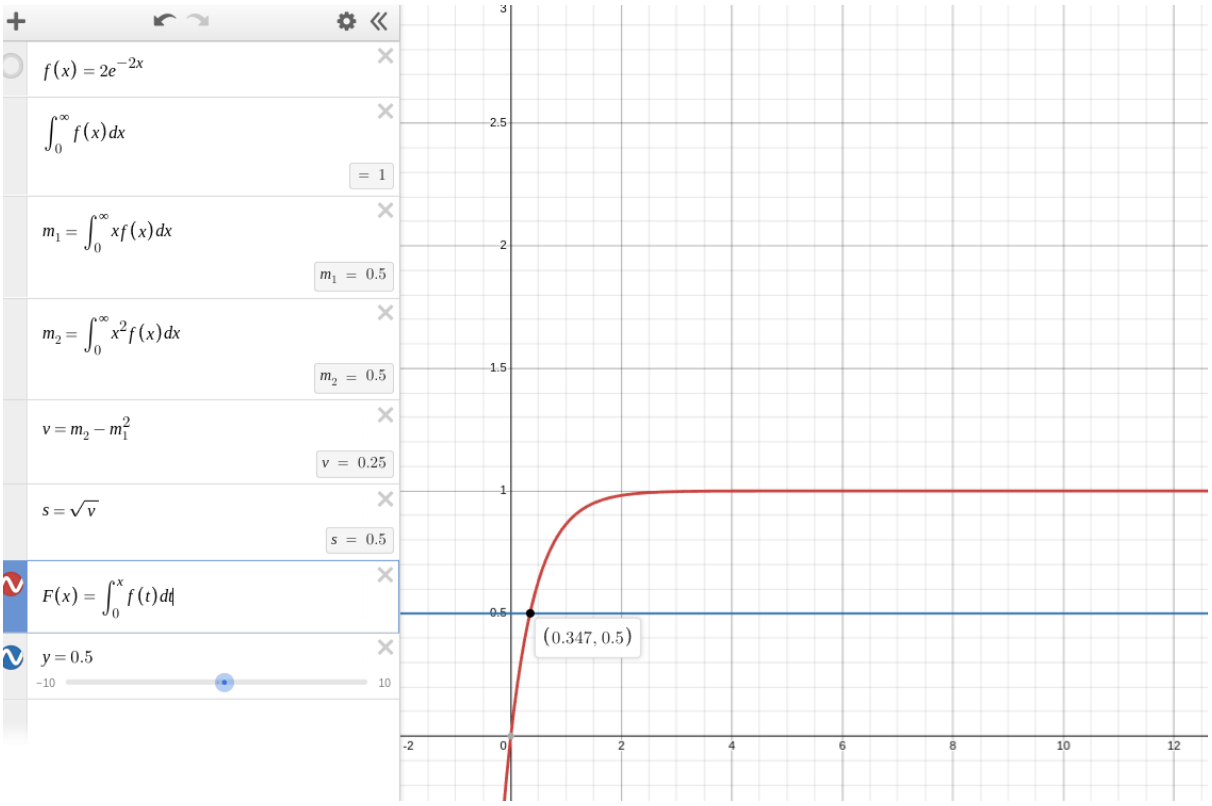
Using Desmos Calculator

- We define function $f(x)$.
- Then we calculate $\int_0^\infty f(x)dx$ to make sure its value is 1 (thus it's a valid pdf).
- We evaluate the first moment m_1 (the expectation, mean) as $\int_0^\infty xf(x)dx$.
- And the second moment $m_2 = \int_0^\infty x^2 f(x)dx$.
- The variance is found by the formula $Var(X) = E(X^2) - (E(X))^2 = m_2 - {m_1}^2$.
- The median of the distribution is found as the intersection of the graph of the Cumulative Distribution Function (cdf) $F(x) = \int_0^x f(t)dt$ and the horizontal line $y = 0.5$. Both graphs are shown below. The median value is 0.347 (or, $\frac{ln2}{2}$ exactly).
- The working example[1] is saved in desmos.com.



- The shaded area below the graph $y = f(x)$ which is equal to $\frac{1}{2}$ for $0 \le x \le$ 0.347(median) is shown below

[1] https://www.desmos.com/calculator/sfxqg53buw

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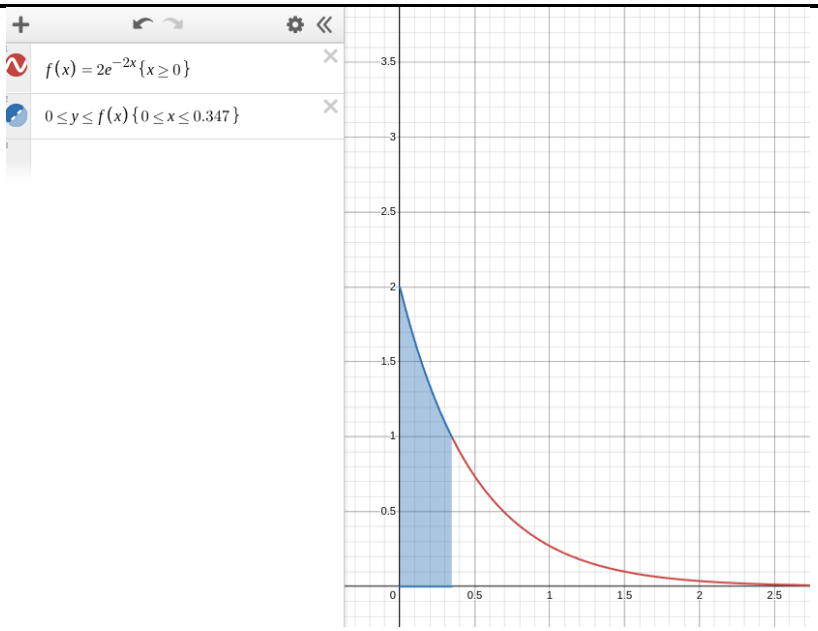

Year 1 (Juniors)

The topic is Modeling with Sine and Cosine Functions. The following data taken from this source[2] is to be modeled by the General Sine Function $T = a\ sin(b(t - c)) + d$, where t is time in months and T is the temperature in degrees Celsius. This data represents the mean monthly maximum temperature for Tashkent, Uzbekistan.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6.2	8.2	15.1	20.5	26.7	32.1	34.6	33.7	28.6	21	12.9	7.1

The task is done in Desmos Graphing Calculator.

- First, the data is entered as a table assuming Jan=1, Feb=2, etc.
- The amplitude a and the average d are calculated using the maximum and the minimum of the temperature over all 12 months.
- The coefficient b is found via the period of 12 months (assuming the pattern will continue next years) as $\frac{2\pi}{12}$.
- The most problematic is to find the appropriate value of coefficient c which signifies the horizontal shift of the sine curve. But the calculator allows us to use parameters in the equation. Each such parameter introduces a slider for changing the value of the parameter. So, by moving the slider for parameter c, we move the curve horizontally to match the scatter plot the best we can.
- The resulting equation for the data happens to be $T = 14.2\ sin(\frac{\pi}{6}(t - 4.1)) + 20.4$

[2] https://en.climate-data.org/asia/uzbekistan/tashkent/tashkent-485/#climate-table

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- The working example[3] is saved in desmos.com.
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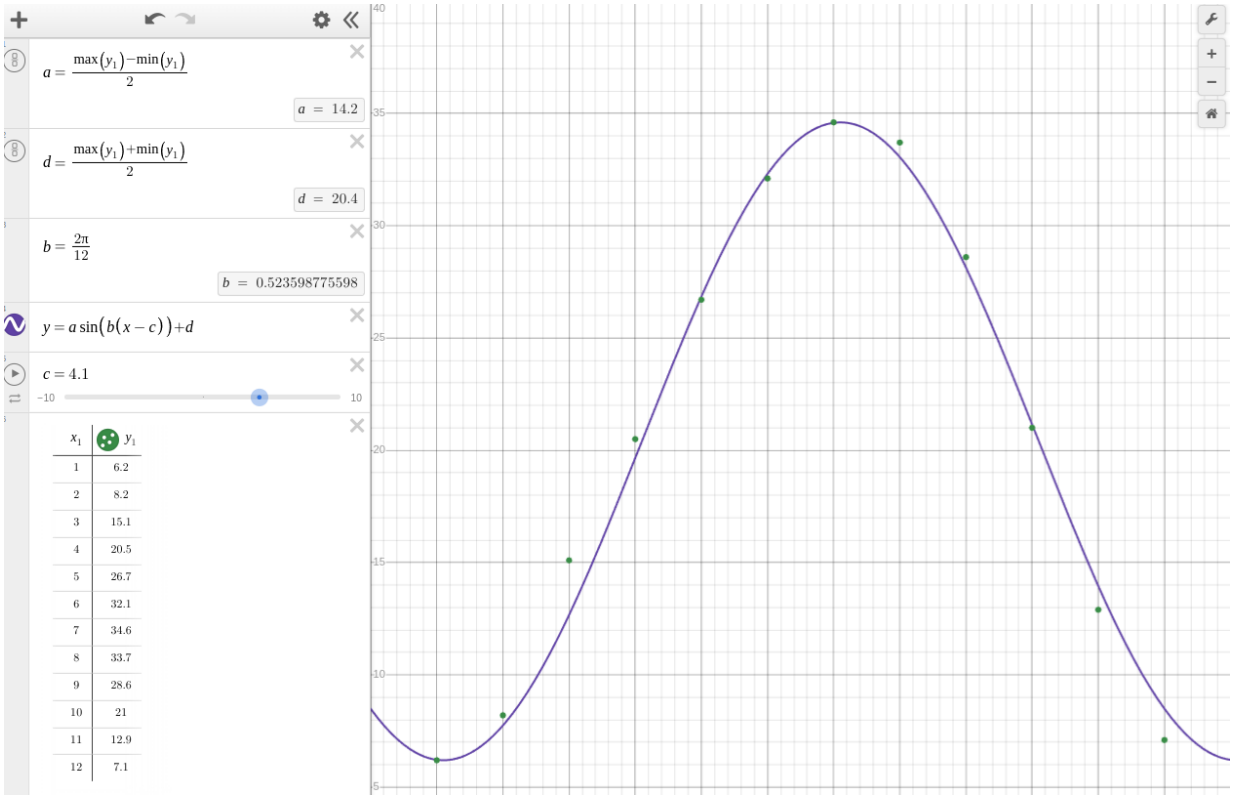

References:

1. https://www.desmos.com/calculator/sfxqg53buw;
2. https://en.climate-data.org/asia/uzbekistan/tashkent/tashkent-485/#climate-table;
3. https://www.desmos.com/calculator/gqvkhrokze.

[3] https://www.desmos.com/calculator/gqvkhrokze