Black Sea Journal of Engineering and Science 3(1): 1-4 (2020)
doi: 10.34248/bsengineering.559140

Black Sea Journal of Engineering and Science
Open Access Journal
e-ISSN: 2619-8991

BSPublishers

Research Article
Volume 3 - Issue 1: 1-4 / January 2020

A TRIGONOMETRIC CURVE FITTING ON ANIMAL DATASET

Ayşe Betül ÖNEM[1]*, Ömer Faruk KARAOKUR[1], Aysel YENİPINAR[1], Şeyma KOÇ[1], Ercan EFE[2]

[1]Kahramanmaras Sutcu Imam University, Institute of Natural and Applied Sciences, Animal Science Section, 46040, Onikisubat, Kahramanmaras, Turkey

[2]Kahramanmaras Sutcu Imam University, Agricultural Faculty, Department of Animal Science, 46040, Onikisubat, Kahramanmaras, Turkey

***Received:** April 30, 2019; **Accepted:** October 15, 2019; **Published:** January 01, 2020*

Abstract

In the traditional growth curve or milk yield models used in animal husbandry; models such as Brody, Von Bertalanffy, Logistic, Gompertz and Richards are used based on classical regression analysis. In this study, an alternative growth curve or milk yield model was proposed with the help of sinusoidal functions based on trigonometric functions. In this model, a sinusoidal curve model fitting and parameter estimation have been made by using a numerical sample of milk yield data set. In addition, this study aims to explain the applicability of periodic features of sinusoidal functions in agriculture and animal data. It is thought that this solution which can be applied in different fields will be beneficial for researchers.

Keywords: Growth curves, Milk yield, Trigonometric functions, Sinusoidal

***Corresponding author:** Kahramanmaras Sutcu Imam University, Institute of Natural and Applied Sciences, Animal Science Section, 46040, Onikisubat, Kahramanmaras, Turkey
E mail: betul_onem@hotmail.com (A.B. ÖNEM)
Ayşe Betül ÖNEM https://orcid.org/0000-0002-4613-1204
Ömer Faruk KARAOKUR https://orcid.org/0000-0002-3436-8415
Aysel YENİPINAR https://orcid.org/0000-0001-2345-6789
Şeyma KOÇ https://orcid.org/0000-0001-5708-9905
Ercan EFE https://orcid.org/0000-0002-5131-323X
Cite as: Önem AB, Karaokur ÖF, Yenipınar A, Koç Ş, Efe E. 2020. A trigonometric curve fitting on animal dataset. BSJ Eng Sci, 3(1): 1-4.

1. Introduction

Conventional regression models are widely used in traditional growth curve models used in agriculture and animal husbandry. In this study, a different approach is achieved by using the periodicity feature of sinus and cosinus from trigonometric functions.

This method have also been used in many other fields such as medicine, engineering, physics, computer, climatology science; especially for oscillatory, up-and-down data such as inside and outside humidity, temperature, radiations of greenhouses, population changes of hunting-hunter animals, electric circuits, heart pulsation. Hamming (1973), Scheid (1989), Mathews

(1992), Akpinar and Kurum (2005) and Karagoz (2017) used this method for this type fluctuating data.

The main purpose of this study is to examine the utility of a trigonometric model that has not been used before in the field of livestock, for milk yield.

2. Material and Method

In this study, a hypothetical milk yield data set was prepared and given in Table 1.

Table 1. Sample data set for milk yield

t	0	1	2	3	4	5	6	7
y	14	17	16	15	13	12	10	8

Here, t denotes time (month) and y denotes individually average daily milk yield.

With the help of sinusoidal functions, the curve can be fitted to the sample data. Sinus and cosine functions share many desired properties of polynomials.

Moreover, they are easily calculated with fast converging series. Sequential derivatives and integrals are also sinuses and cosines. They also have orthogonality feature and periodicity that polynomials do not have. For these reasons, they are used in approximation theory of trigonometric functions.

A $f(x)$ function can be transform a Fourier series such as,

$$f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty}(a_n \cos nx + b_n \sin nx) \tag{1}$$

Here the coefficients a_n and b_n are given by;

$$a_n = \frac{1}{\pi}\int_0^{2\pi} f(x)\cos nx dx \text{ (n=0,1,2,...)}$$

$$b_n = \frac{1}{\pi}\int_0^{2\pi} f(x)\sin nx dx \text{ (n=0,1,2,...)} \tag{2}$$

The preconditions below must be satisfied for any function to be approximated by the Fourier (Chapra and Canale, 2006).

i. The function should has single value at each point where it's continuous in any desired interval.
ii. The function has finite number of discontinuities in the interval.
iii. The function has finite number of maximum and minimum in the interval.

If the function is not continuous and is given as n equally spaced discrete values, then the summation operator is used instead of the above integral operator. Especially, if the values of y vary periodically against increasing values of the x variable, the discrete Fourier series will be selected as a mathematical model. This model is written as following;

$$y_i = a_0 + \sum_{k=1}^{m}\left[a_k \cos\left(\frac{2\pi}{T}kx_i\right) + b_k \sin\left(\frac{2\pi}{T}kx_i\right)\right] + e_i \tag{3}$$

If the period cannot be determined by the points x, y then T is selected as below (Turker and Can, 1997).

$$T = \max(x_i) - \min(x_i) \tag{4}$$

$a_1, a_2, \ldots; b_1, b_2, \ldots$ coefficients are set to make sum of squares of error (SSE) minimum when,

$$\theta_i = \frac{2\pi}{T}x_i \qquad i=1,2,\ldots,n \tag{5}$$

transformation is done and equation can be written as;

$$s = \sum_{i=1}^{n}\left\{y_i - \left[a_0 + \sum_{k=1}^{m}(a_k \cos k\theta_i + b_k \sin k\theta_i)\right]\right\}^2 \tag{6}$$

The minimization of this expression is satisfied if and only if;

$$\frac{\partial s}{\partial a_k} = 0, \qquad k=0,1,\ldots,m \tag{7}$$

Then coefficients (parameters) are obtained as below;

$$a_0 = \frac{1}{n}\sum_{i=1}^{n} y_i$$

$$a_k = \frac{2}{n}\sum_{i=1}^{n} y_i \cos k\theta_i \tag{8}$$

$$b_k = \frac{2}{n}\sum_{i=1}^{n} y_i \sin k\theta_i$$

where k=0,1, . . ., m. Number of a_k and b_k parameters is $2m+1 \leq n$ when n is the number of observed points. In our numerical example, m value is 1 and parameters estimates were also given by Celik (2016) and Bayram (2013).

3. Results and Discussion

In this study, the prediction equation;

$$\hat{y}_i = a_0 + a_1 Cos\theta_i + b_1 Sin\theta_i \tag{9}$$

was regarded for the milk yield data set in Table 1. The period of the series is 8 and so;

$$\theta_i = \frac{2\pi}{8}t_i = \frac{\pi}{4}t_i \qquad i{:}0,1,\ldots,7 \qquad (10)$$

Some θ values were given in Table 2.

Table 2. Some θ values for t_i points

t	θ=(2*π/T)*t$_i$		Cos(θ$_i$)	Sin(θ$_i$)
0	0	1	0	1
1	π/4	0.707107	0.707107	0.707107
2	π/2	0	1	0
3	3*π/4	-0.70711	0.707107	-0.70711
4	π	-1	0	-1
5	5*π/4	-0.70711	-0.70711	-0.70711
6	3*π/2	0	-1	0
7	7*π/4	0.707107	-0.70711	0.707107

Parameters estimates are calculated as;

$$a_0 = \frac{1}{n}\sum_{i=1}^{n} y_i = \frac{1}{8}*105 = 13.125$$

$$a_1 = \frac{2}{n}\sum_{i=1}^{n} y_i \cos k\theta_i = \frac{2}{8}*(-0.41421) = -0{,}103355$$

$$b_1 = \frac{2}{n}\sum_{i=1}^{n} y_i \sin k\theta_i = \frac{2}{8}*14{,}48528 = 3.62132$$

Then, prediction equation is written as below;

$\hat{y}_i$ = 13.125 -0.10355 Cos θ_i + 3.62132 Sin θ_i

Figure 1 shows the actual data points and predicted points using the trigonometric prediction equation.

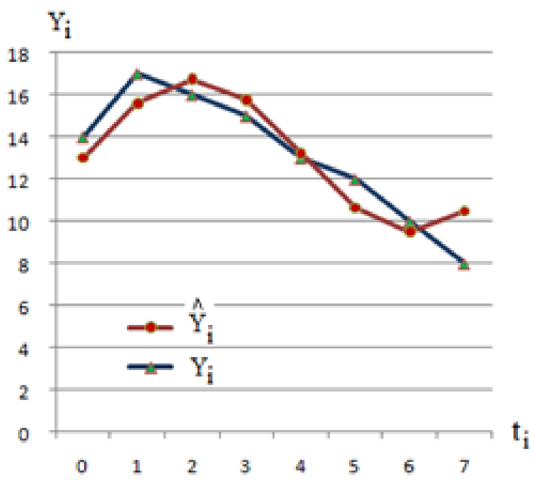

Figure 1. Observed and predicted milk yield curves.

As shown in Figure 1, both of the curves from observed and fitted values seems to be the same for our numerical example. At the right end of the prediction curve a little diverging from observed curve can be seen. However, especially in the first 7 months, relatively high fit has been seen and determination coefficient is obtained as R^2=0.81 (Table 3).

Table 3. Multiple Correlation and determination coefficients

R	R^2
0.90	0.81

Trigonometric models have been generally used for a periodically fluctuated data. We showed that researcher may be prefer this type model, if they have a little part of a periodic fluctuations. However, since these models are very specific for growth, milk yields, etc., researcher must be carefully.

4. Conclusion

In this study, it has been investigated whether the trigonometric model can be adapted to some livestock data such as growth and milk yield curves or not. A trigonometric model with three parameters (a_0, a_1, b_1) was fitted on a hypothetical milk yield example. It has been seen that trigonometric models can be fitted in some special cases that researcher has some part of a not regularly fluctuated data such as animal growth, milk yield etc. In this case the investigator should be careful.

However, trigonometric models can be fitted well to regularly fluctuated data such as population growth in wildlife prey-hunter relations, seasonal fish population changes, water temperature and salinity rather than single inflected data such as growth, milk yield.

Conflict of interest

The authors declare that there is no conflict of interest.

Acknowledgements

This research was presented as an oral presentation at the International Congress on Domestic Animal Breeding Genetics and Husbandry (ICABGEH-2018) held on 26-28 September 2018 in Antalya.

References

Akpinar S, Kurum H. 2005. Numerical analysis. Nobel Publishing House, Ankara, p.226-230.

Bayram M. 2013. Numerical Analysis. Surat University Publications, Istanbul, p.273-277.

Chapra SC, Canale RP. 2006. Numerical methods for engineers, 10/ed. McGraw-Hill, Singapore, p.507-562.

Celik Ş. 2016. Trigonometric curve fitting and an application. IJIRR, 3(5): 2422-2427.

Hamming RW. 1973. Numerical methods for scientists and engineers, 2/ed. McGraw-Hill, Newyork, p.503-602.

Karagoz İ. 2017. Numerical analysis and engineering applications. Dora Publishing, Bursa, p.269-280.

Mathews JH. 1992. Numerical methods for mathematics, science, and engineering, 2/ed. Prentice-Hall Englewood Cliffs, New Jersey, p.303-314.

Scheid F. 1989. Schaum's Outline series theory and problems of numerical analysis, 2/ed. McGraw-Hill, U.S.A., p.305-325.

Turker ES, Can E. 1997. Computer applied numerical analysis methods. Degisim Publications, Adapazari, p.234-240.