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(Research Article)

Modelling the first 100 digits of the number Pi (π) using the objective regressive regression methodology

Osés RR [1], Osés LC [2], del Valle LD [3] and Fimia DR [4,*]

[1] *Department of Forecasting, Provincial Meteorological Center of Villa Clara, Cuba.*
[2] *Department of Hygiene and Epidemiology. XX Anniversary Polyclinic, Santa Clara city, Villa Clara, Cuba.*
[3] *Department of Parasitology. Regional High Specialty Hospital (HARE), Dr. Juan Graham Casasús, México.*
[4] *Department of Hygiene and Epidemiology, Faculty of Health Technology and Nursing (FHTN), University of Medical Sciences of Villa Clara (UMS-VC), Cuba.*

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Abstract

Every year the existence of the number π is celebrated around the world, new applications are presented and festivities are held. The aim of this research is to model the first 100 digits of the number π using the ROR methodology. Through this research we will see a new definition of this number and we will try to encourage undergraduate students to be motivated to study mathematics, we will also see a modelling of the first 100 digits of π. As a result, the first 100 digits of the number π can be modelled and predicted explaining 88 % of variability, with an error of 2.74. By modelling the Objective Regressive Regression (ORR), a model with more variables that also explain a high level of variance is also obtained. The short-term model depends on the variables sawtooth and inverted sawtooth, which are characteristic of the ROR model, and also depends on the number of digits two steps back linearly.

Keywords: Hundred Digits; Cristosols; ROR Modelling; New Civilizations; Π-Number

1. Introduction

Every year the existence of the number π is celebrated around the world, new applications are presented and parties are held about it. In the following article we will see a new definition of this number and we will try to encourage undergraduate students to be motivated to study mathematics, we will also see a modelling of the first 100 digits of π.

Mathematicians all over the world are celebrating the world day of π, the constant number, whose current number is 3.14, on 14 March (3/14), in honor of its first three decimal places.

The world day was the brainchild of US physicist Larry Shaw in 1988, and was officially declared by the US Congress in 2009. Since then, it has spread to more places every year (Arbesú, 2017).

As we all know the classical definition of the number π is:

$\pi = L / 2r$, where L is the length of the circumference and r is its radius.

It could have been defined as L /d, where d is the diameter of the circumference, but we prefer the former, for its beauty and to show the appearance of the number 2.

* Corresponding author: Fimia DR.

Suppose that r = 0, if this happens, L would be zero and as we know 0/0 = 1, according to Osés et al. (2015a, b), therefore, we would have an approximation of $\pi \approx 1/2$, however, we can define more accurately this situation, so if r= 0, $\pi = L / 2 * 0$, defining 1/0 = i, $\pi = L\, i / 2$, so π would be equal to the length of the circumference multiplied by half of a Cristosol.

There could exist a civilization so advanced that it would use only the numbers Cristosols, and therefore this definition would fit like a glove, this civilization would have the capacity to move in time through the universes, it would have the capacity to travel unimaginable distances in a few nanoseconds and they would be considered as "Superstars", maybe someday our civilization will reach these developments, what do you think?

Imagine now that we use the definition with the diameter d, how would the new formula and its definition be using the Cristosols?

On the internet it can be seen that in the article: Pi Day; The history and importance of the world's best-known irrational number, from the Ministry of Science and Technology, Knowledge and Innovation of Chile, consulted on 18 March 2024, the article refers that: according to the NASA engineer Marc Rayman, 15 digits are used for the calculations of space missions and 40 would be enough to calculate the circumference of the visible Universe with high precision.

We recommend reading the book "Division by zero, of Cristosols to estimate universe longitude. Futurology and Regressive methodology finding information beyond a white noise" (Osés *et al*., 2015a), as well as the article on how to estimate the area and length of the universe using Cristosols, or numbers divided by zero (Osés *et al*., 2015b).

Another interesting problem with the number π is the possibility of estimating its numbers by means of a linear model, as it seems that this has not been possible so far.

The objective of the study was to model the first 100 digits of the number π using the ROR methodology.

2. Methodology

As there are so many blackouts in Cuba, we had to work as efficiently as possible, hence we will present our results in a concise and precise manner.

Google was asked to provide us with the first 100 digits of the number π, which we placed in an Excel column as if it were the variable Pi (π), and we proceeded to obtain the ROR model for this variable (Osés & Grau, 2011; Osés *et al*., 2018; Osés *et al*., 2021; Freire *et al*., 2023).

2.1. The Objective Regressive Regression methodology

In this methodology, the dichotomous variables DS, DI and NoC must be created first, where: NoC: Number of cases of the base (its coefficient in the model represents the trend of the series). DS = 1, if NoC is odd; DI = 0, if NoC is even, and vice versa. DS represents a saw tooth function and DI this same function, but in inverted form, so that the variable to be modeled is trapped between these parameters and a large amount of variance is explained.

Subsequently, the module corresponding to the Regression analysis of the statistical package SPSS version 19.0 (IBM Company) is executed, specifically the ENTER method where the predicted variable and the ERROR are obtained. Then, the autocorrelograms of the ERROR variable are obtained, paying attention to the maximum of the significant partial autocorrelations (PACF), and then the new variables are calculated, taking into account the significant Lag of the PACF. Finally, these variables are included in the new regression, regressed in a process of successive approximations until a white noise in the regression errors is obtained. In the case of atmospheric pressure, the lags of one year in advance were used.

3. Result

3.1. Main results obtained

The short-term model explains 87.2%, with an error of 2.8 (Table 1), where the Durbin Watson statistic is close to 2, although including new variables would be closer to 2, and the model would be more explanatory, which we will see later in the model with more variables.

Table 1 Short term model

Summary of the model[c,d]					
Model	**R**	**R square[b]**	**Adjusted R-square**	**Standard error of estimation**	**Durbin-Watson**
1	0.872a	0.761	0.753	2.801	1.796

a. Predictors: Lag2, DS, DI; b. For regression through the origin (the model without intercept), R-squared measures the proportion of the variability in the dependent variable about the origin explained by the regression. This CANNOT be compared to R-squared for models that include intercept; c. Dependent variable: Pi; d. Linear regression through the origin

Fisher's F is 100.7, significant at 100 % (Table 2).

Table 2 Fisher's F test results according to the ANOVA test

ANOVA[a, b]						
Model		**Sum of squares**	**gl**	**Quadratic mean**	**F**	**Sig.**
1	Regression	2370.759	3	790.253	100.738	0.000[c]
	Residue	745.241	95	7.845		
	Total	3116.000[d]	98			

a. Dependent variable: Pi; b. Linear regression through the origin; c. Predictors: Lag2, SD, DI
d. This total sum of squares is not corrected for the constant because the constant is zero for regression through the origin.

The short-term model depends on DS and DI, which are sawtooth and inverted sawtooth variables characteristic of the ROR model (Table 3), and also depends on the number of digits two steps back (Lag2).

Table 3 Short-term model results for DS and DI variables

Coefficients[a, b]						
Model		**Unstandardised coefficients**		**Standardised coefficients**	**t**	**Sig.**
		B	**Standard error**	**Beta**		
1	DS	5.185	0.566	0.650	9.154	0.000
	DI	6.887	0.670	0.864	10.279	0.000
	Lag2	-0.259	0.100	-0.255	-2.599	0.011

a. Dependent variable: Pi; b. Linear regression through the origin

Table 4 shows that the standard residual value has zero mean and 0.99 standard deviation.

Table 4 Residual value results according to predicted value

Waste statistics[a, b]					
	Minimum	**Max.**	**Half**	**Standard deviation**	**N**
Predicted value	2.85	6.89	4.82	1.002	98
Residue	-5.590	5.148	0.000	2.772	98
Standard predicted value	-1.960	2.065	0.000	1.000	98
Standard residue	-1.996	1.838	0.000	0.990	98

a. Dependent variable: Pi
b. Linear regression through the origin

Figure 1 shows that the residuals model does not differ from a normal distribution with zero mean and variance 0.99.

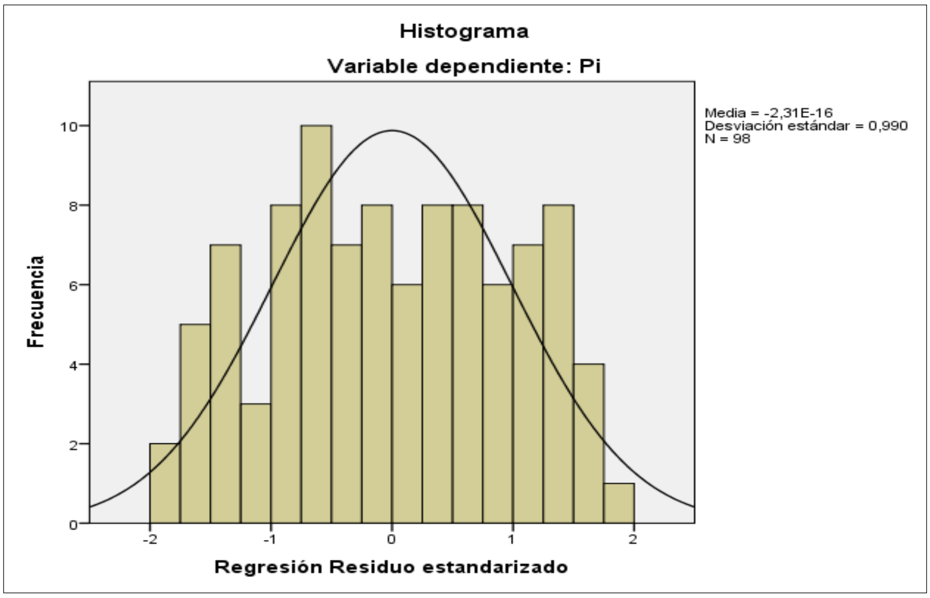

Figure 1 Histogram of Pi residuals

Figure 2 shows that the expected probability does not differ from the observed probability, it is a linear process.

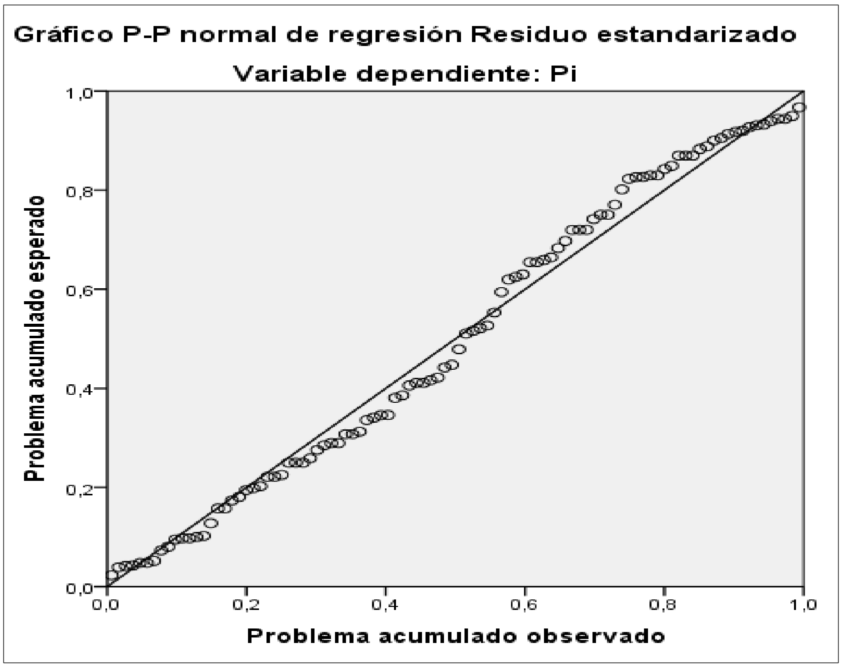

Figure 2 Expected cumulative probability vs Observed cumulative probability

However, we decided to include more variables in the model, leaving the following final model.

The model with more variables in question linearly explains 88.2% of the variance with an error of 2.74, and the Durbin Watson statistic is close to 2, so the residuals model can be white noise, and we can make predictions with the model.

The analysis of variance is significant at 100 % with an F of 38.9, somewhat less likely than the previous model.

The model in question depends on DS (Sawtooth), DI (Inverted Sawtooth), the number regressed in 2 steps (Lag2), in 15 steps (Lag15), thirteen steps back (Lag13) and Lag7, that is 7 steps back.

Table 5 Resumen del modelo según la variables DS, DI y los retardos

Coefficients[a,b]						
Model		**Unstandardised coefficients**		**Standardised coefficients**	**t**	**Sig.**
		B	**Standard error**	**Beta**		
1	DS	8.397	1.579	1.062	5.317	0.000
	DI	9.724	1.346	1.244	7.225	0.000
	Lag2	-0.344	0.105	-0.341	-3.265	0.002
	Lag15	-0.194	0.109	-0.199	-1.776	0.080
	Lag13	-0.126	0.109	-0.129	-1.157	0.251
	Lag5	-0.119	0.109	-0.121	-1.088	0.280
	Lag7	-0.129	0.110	-0.132	-1.172	0.245

a. Dependent variable: Pi
b. Linear regression through the origin

Finally, we plotted the actual and predicted values, as shown in figure 3.

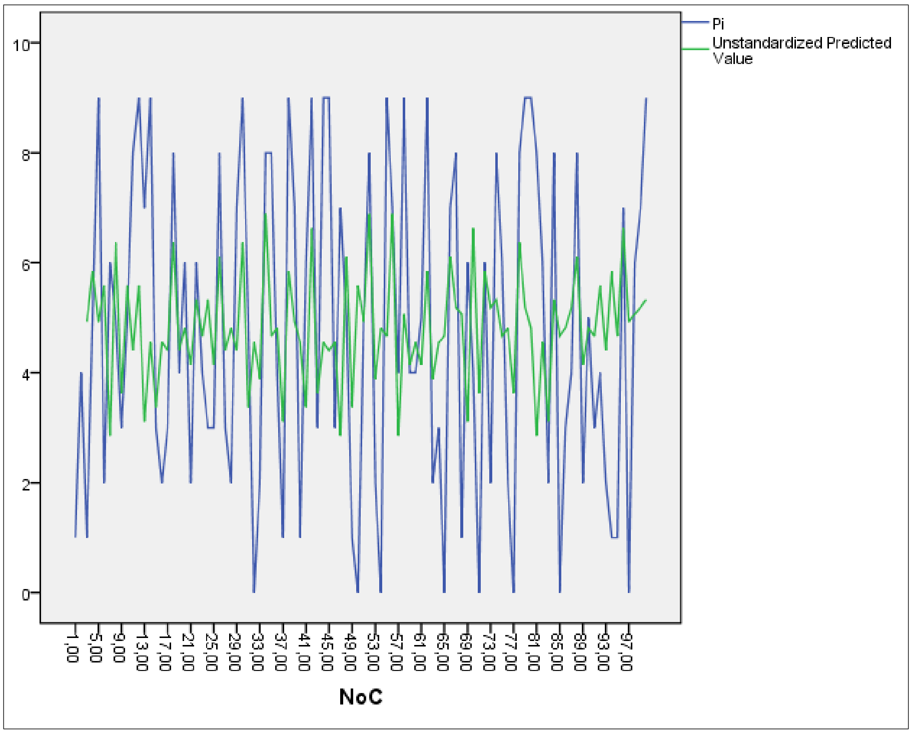

Figure 3 Plotting of the 100 digits and their value predicted by the short-term model

4. Conclusion

The first 100 digits of the number π can be modelled and predicted explaining 88 % of variability, with an error of 2.74 by ROR modelling, where the model obtained with more variables also explains a high level of variance. The short-term model depends on the variables DS and DI, characteristic of the ROR model, but it also depends on the number of digits two steps back.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors have declared that no competing interests exist.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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