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DATA PRECISION AND DISPERSION ANALYSIS OF INTERACTING SIMULATED DATA WITH RANDOM NOISE FLUCTUATION

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ABSTRACT

In this study, a nonlinear model from a polluted environment is proposed and analyzed to study the predicting data precision and dispersion error between interacting simulated data with random noise fluctuation using the MATLAB ODE45 Numerical method. The study defined D_1, D_3 and D_4 representing 1-norm, 2-norm, 3-norm and infinity norm. The study adopted the Runge-Kutta(R-K) method from order method in the simulation experiment. The steady state solution was obtained for the equilibrium points the positivity and existence of the solution were also obtained for the dynamical system. The results showed that on the basis of p-vector norm, calculated with respect to the difference between the controlled and uncontrolled data corresponding to D_1, D_2, D_3 and D_4 which satisfied

Introduction

In nature, most physical and ecological problems bring about an investigation into the competition processes between the interacting components of the system, noise pollution is negatively damaging the environment of this city and producing physical and psychological difficulties, and so become a worrying health threat. In this densely populated metropolis some critical places are being employed in multifaceted reasons that increase the potentiality for noise pollution. The Environmental Conservation Act of 1995

the monotonically decreasing sequence. Further the statistical dispersion analysis of the numerically simulated data involving p-vector norm shows an error on the value of the Range, Mean, Standard deviation and Variance. It has been proven that difference in the data values of controlled and uncontrolled data of the model from a polluted the environment has predicted monotonic decreases in data variability and precision due to the system of perturbation.

Keywords: Random noise, controlled and uncontrolled data, modelling, numerical analysis, p vector norm, Data Precision, Dispersion

(ECA'95) and the Environmental Conservation Rules of 1997 (ECR'97), (Rule 12, Schedule-4) categorize areas to indicate sound standards, and according to these legal instruments, a "Mixed Area" is primarily a residential area that is also used for commercial and industrial purposes.

Noise pollution is an unpleasant sound level that impairs quality of life in industrial roadside regions with heavy traffic. Traffic jams and heavy traffic are extremely aggravating and obstructive not only because of time lost and increased engine exhaust air pollution effects, but also because of sound pollution. Intelligent, adaptable traffic control is a popular area of smart city research. Noise levels are taken into account while developing solutions to improve the quality of life for residents living along roadways. There are several passive construction design methods to mitigate traffic noise, such creating protective walls, modifying the road surface, or planting appropriate vegetation between the road and residences. (Nemes et al., 2018). Muhirwa and Ndanguza (2017) studied the effect of random noise, quasi random noise and systematic random noise on unknown continuous stirred tank reactor (cstr). They introduced Continuous stirred tank reactors (CSTRs) which play a big role in chemical engineering and in industries nowadays. The results look at the impact of different kind of uncertainties (errors) to the model fitting and the parameter estimation of the CSTR's, for both cases of exothermic and endothermic reactors by taking into consideration of high and low variances of noise into concentration and temperature of the model. Results showed that, the increase of noise in measurements affects activation energy. Obtained, the endothermic CSTR is more sensitive than the exothermic CSTR for any kind of noise according to much deviation observed in its estimated activation energy values.

Zafar (2013) examined the determinants of stock market overall performance in Pakistan, using time series statistics set between 1988 and 2008. The study utilised overseas direct investment as percentage of GDP, actual activity rate, domestic credit score supplied by the banking sector and value traded as share of GDP. The result shows that direct foreign investment and value alternate positively have an effect on the overall performance of the stock market. Yu et al., (2009) in their work used Numerical methods to show that the equilibrium of the model with random perturbation is stochastic and asymptotically stable. Also, the stability condition is obtained by the construction of the Lyapunov function.

Zhong and Deng (2013) **used a** numerical method, Stability and steady state solutions methods to establish that the new classical deterministic Lotka–Volterra models are obtained by a probabilistic method; they also showed in particular that large population sizes of predator and prey coexist only for a very short time, and most of the time one of the populations is exponentially small.

Tornatore et al. (2005) in their research work, applied many mathematical tools which include the SIR model, delay SIR model, the Lyapunov function, Stochastic processes Numerical simulation and Stochastic stability to prove that numerical simulation of the stochastic SIR model shows that the introduction of noise modifies the threshhold of the system for an epidemic to occur and the threshold stochastic value is found. Yuan et al. (2012) in their paper, used mathematical tools like numerical simulations, the Lyapunov function and graph theory to prove that the endemic equilibriums of the two models are both stochastic and asymptotically stable. Also, the stability condition is obtained by the construction of the Lyapunov function and graph theory.

Wen-Long et al. (2012) showed that this system was stable in time average under certain conditions. They also showed that there was a stationary distribution of this system, if extra conditions are satisfied and they gave the extinction condition of this system using numerical and simulation methods.

Ryszard et al (2007) used mathematical tools like the Prey–predator model, Diffusion process, Markov semigroups, Asymptotic stability, Mathematical Biosciences and Numerical methods to investigate the influence of various stochastic perturbations on the prey–predator systems. The prey–predator model was described by stochastic versions of a deterministic Lotka–Volterra system. The authors studied long-time behaviour of both trajectories and distributions of the solutions and indicated the differences between the deterministic and stochastic models.

Due to poor reporting by investigators and the limited scientific experience of experimentalist, the issue of the error between interacting data is inevitable. It is a challenging problem that requires sound mathematical reasoning in order to provide the needed insight for its realistic solution. The environmental perturbation otherwise called environmental noise has been recognized as one of the inherent factors that affect the dynamics of interacting species and time (Liu, 2008; Kurushina and Druzhinina, 2015; Abanum and Eli, 2024; Eli and Abanum,2020; Abanum et al, 2020; Abanum et al, 2024; Abanum et al, 2024; Abanum et al, 2024; May et al., 2008;).

1. The question is: what is the rationale for conducting the error analysis between interacting data? The answer to this important scientific concern hinges on two fundamental hypotheses of scientific logic in research which we hereby clearly state as follows; Mathematical formulation is not an exact description of a real-life phenomenon
2. Model parameter values are only estimate from a best fit model parameter with an expected local minimum error.

It is against this background that we have attempted to apply the method of numerical analysis to quantify the magnitude between controlled and uncontrolled data from a mathematical model of a polluted environment that is undergoing some sort of environmental perturbation

Materials and Methods

The present methodology for this Paperwork which includes presentation of the model equations, coding of the interacting function into the applicable Matlab program and definition of other related components of the method of analysis implemented in this research work.

Following Dubey (1991), we have considered the following system of Nonlinear First Order Ordinary Differential Equations

$$\frac{dN}{dt} = r(B)N - \frac{r_0 N^2}{K(B,T)} \quad (1)$$

$$\frac{dB}{dt} = r_B(U,\ N) - \frac{rB_0 B^2}{K_B(T)} \quad (2)$$

$$\frac{dT}{dt} = Q(t) - \delta_0 T - \alpha BT + \theta_1 \delta_1 U + \pi v BU \quad (3)$$

$$\frac{dU}{dt} = \beta B - \theta_0 \delta_0 T - \delta_1 U + \alpha BT + vBU \quad (4)$$

$$N(0) \geq 0, \quad B(0) \geq 0, \quad T(0) \geq 0, \quad U(0) \geq 0 \quad (5)$$

Here, $N(t)$ is the density of the biological species at time t; $B(t)$ is the density of the resource biomass at time t; $T(t)$ is the concentration of the pollutant present in the environment at time t, and $U(t)$ is the concentration of the pollutant taken up by the population, $Q(t)$ is the rate of introduction of pollutant to the environment, δ_0 is the rate coefficient of the pollutant from the environment, δ_1 is the natural depletion rate coefficient of $U(t)$ due to ingestion. α is the depletion rate coefficient of the pollutant present in the environment due to its uptake by the resource biomass. β is the net intake of pollutant by the resource biomass, $r(B)$ is the specific growth rate of the biomass species. $K(B,T)$ is the maximum density of the species population, $r_B(U,N)$ is the specific growth rate of the resource biomass, $K_B(T)$ is the maximum density of the resource

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biomass, $r(u)$ is the specific growth rate of the population which increases as u increases, $r_0 = r(0)$ is the initial value of r_0 when $t = 0$ i.e. t is time.

Following Dubey (1991), we now redefine the following functions

$$r(B) = r_0 + r_1 B \quad (6)$$

$$k(B,T) = k_0 + k_1 B - k_2 T \quad (7)$$

$$r_B(U,N) = r_{B_0} - r_{B_1} U - r_{B_2} N \quad (8)$$

$$k_B(T) = k_{B_0} - k_{B_1} T \quad (9)$$

Determination of Steady State Solution

We first investigate the steady state solution of the given system (1) – (4).

At steady state,

$$\frac{dN}{dt} = \frac{dB}{dt} = \frac{dT}{dt} = \frac{dU}{dt} = 0$$

From (1)

$$(r_0 + r_1 B)N - \frac{r_0 N^2}{k_0 + k_1 B - k_2 T} = 0$$

yielding

$$N = \frac{1}{r_0}[(r_0 + r_1 B)(k_0 + k_1 B - k_2 T)] \quad (10)$$

From (2)

$$\left(r_{B_0} - r_1 U - r_2 N\right)B - \frac{r_{B_0} B^2}{k_{B_0} - k_{B_1} T} = 0$$

yielding

$$B = \frac{1}{r_{B_0}}\left[\left(r_{B_0} - r_1 U - r_2 N\right)\left(k_{B_0} - k_{B_1} T\right)\right] \quad (11)$$

From (3)

$$Q(t) - \delta_0 T - \alpha BT + \theta_1 \delta_1 U + \pi v BU = 0$$

yielding

$$T = \frac{Q + \theta_1 \delta_1 U + \pi v BU}{\delta_0 - \alpha B} \quad (12)$$

From (4)

$$\beta B + \theta_0 \delta_0 T - \delta_1 U + \alpha BT - vBU = 0$$

$$\beta B + \theta_0 \delta_0 T + \alpha BT = \delta_1 U + vBU$$

$$U = \frac{\beta B + \theta_0 \delta_0 T + \alpha BT}{\delta_1 + vB} \quad (13)$$

To find the steady-state solutions or equilibrium points.

1. When $N = 0$

$$B = B^* = \frac{1}{r_{B_0}}\left(r_{B_0} + r_1 U\right)\left(k_{B_0} - k_{B_1} T\right)$$

$$T = T^* = \frac{Q + \theta_1 \delta_1 U + \pi v BU}{\delta_0 + \alpha B}$$

$$U = U^* = \frac{\beta B + \theta_0 \delta_0 T + \alpha BT}{\delta_1 + vB} \quad (14)$$

Therefore, $(0,\ B^*,\ T^*,\ U^*)$ is a steady state solution.

2. When $N = N_m = \frac{1}{r_{B_0}}(r_0 - r_1 B)(k_0 + k_1 B - k_2 T)$

$$B^{**} = \frac{1}{r_{B_0}}\left(r_{B_0} - r_1 U - r_{B_2} N_m\right)\left(k_{B_0} - k_{B_1} T\right) = B \quad (15)$$

$$T^{**} = T^* = \frac{Q + \theta_1 \delta_1 U + \pi v BU}{\delta_0 + \alpha B} \quad (16)$$

$$U^{**} = U^* \quad (17)$$

$(N_m,\ B^{**},\ T^{**},\ U^{**})$ is the second steady state solution.

3. When $N = B = 0$

$$\bar{T} = \frac{Q + \theta_1 \delta_1 U}{\delta_0} = \frac{Q + \theta_1 \delta_1 \left(\frac{\theta_1 \delta_0 T}{\delta_1}\right)}{\delta_0}$$

$$= \frac{Q + \theta_1(\theta_0 \delta_0 T)}{\delta_0} \quad (18)$$

$$\bar{U} = \frac{\theta_0 \delta_0 T}{\delta_1} = \frac{\theta_0 \delta_0}{\delta_1}\left(\frac{Q + \theta_1 \delta_1 U}{\delta_0}\right)$$

$$= \frac{\theta_0}{\delta_1}(Q + \theta_1 \delta_1 U) \quad (19)$$

Therefore $(0,\ 0,\ \bar{T},\ \bar{U})$ is a steady state solution.

4. When $\bar{\bar{B}} = B_m$

$$\bar{\bar{N}} = \frac{1}{r_0}\left(r_0 + r_1 \bar{\bar{B}}_m\right)(k_0 + k_1 B_m + k_2 T)$$

$$\bar{\bar{T}} = \frac{Q + \theta_1 \delta_1 U + \pi v B_m v}{\delta_0 + \alpha B_m} \quad (20)$$

$$\bar{\bar{U}} = \frac{\beta B_m + \theta_0 \delta_0 T + \alpha B_m T}{\delta_1 + v B_m} \quad (21)$$

Therefore, $\left(\bar{\bar{B}},\ \bar{\bar{N}},\ \bar{\bar{T}},\ \bar{\bar{U}}\right)$ is another equilibrium point or steady state solution.
We further evaluate the partial derivatives at each steady state to set up a 4×4 Jacobian matrix consisting of twenty elements.

$$\frac{dN}{dt} = F_1 = (r_0 + r_1 B)N - \frac{r_0 N^2}{k_0 + k_1 B - k_2 T}$$

$$J_{11} = \frac{dF_1}{dN} = (r_0 + r_1 B)N - \frac{2 r_0 N}{k_0 + k_1 B - k_2 T},\ J_{12} = \frac{dF_1}{dB} = r_1 N - \frac{k_1 r_0 N^2}{[(k_0 + k_1 T) + k_1 B]^2}$$

$$J_{13} = \frac{dF_1}{dT} = \frac{k_2 r_0 N^2}{(k_0 + k_1 - k_2 T)^2}, \qquad J_{14} = \frac{dF_1}{dU} = 0$$

$$\frac{dB}{dt} = \left(r_{B_0} - r_1 U - r_{B_2} N\right)B - \frac{r_{B_0} B^2}{k_{B_0} + k_{B_1} T} = F_2$$

$$J_{21} = \frac{dF_2}{dN} = -B r_{B_2}, \qquad J_{22} = \frac{dF_2}{dB} = r_{B_0} - r_1 U - r_{B_2} N - \frac{2 r_{B_0} B}{k_{B_0} - k_{B_1} T}$$

$$J_{23} = \frac{dF_2}{dT} = \frac{k_{B_1} r_{B_0} B^2}{\left[k_{B_0} + k_B T\right]^2}, \qquad J_{24} = \frac{dF_2}{dU} = -r_1 B$$

$$\frac{dT}{dt} = Q - \delta_0 T - \alpha BT + \theta_1\delta_1 U + \pi vBU = F_3$$

$$J_{31} = \frac{dF_3}{dN} = 0, \qquad J_{32} = \frac{dF_3}{dB} = -\alpha T + \pi vU$$

$$J_{33} = \frac{dF_3}{dT} = -\delta_0 - \alpha B, \qquad J_{34} = \frac{dF_3}{dU} = \theta_1\delta_1 + \pi vB$$

$$\frac{dU}{dt} = \beta B + \theta_0\delta_0 T - \delta_1 U + \alpha BT - vBU = F_4$$

$$J_{41} = \frac{dF_4}{dN} = 0, \qquad J_{42} = \frac{dF_4}{dB} = \beta + \alpha T - vU$$

$$J_{43} = \frac{dF_4}{dT} = \theta_0\delta_0 + \alpha B, \qquad J_{44} = \frac{dF_4}{dU} = -\delta_1 - vB$$

$$J = \begin{pmatrix} J_{11} & J_{12} & J_{13} & J_{14} \\ J_{21} & J_{22} & J_{23} & J_{24} \\ J_{31} & J_{32} & J_{33} & J_{34} \\ J_{41} & J_{42} & J_{43} & J_{44} \end{pmatrix}$$

Considering the steady-state solution $(0,\ 0,\ \bar{T},\ \bar{U})$ and simplifying the Jacobian elements at the steady-state solution.

$$J_{11} = r_0, \qquad J_{12} = 0, \qquad J_{13} = 0, \qquad J_{14} = 0$$

$$J_{21} = 0, J_{22} = r_{B_0} - r_1\bar{U}, \qquad J_{23} = 0, \qquad J_{24} = 0$$

$$J_{31} = 0, J_{32} = -\alpha\bar{T} + \pi v\bar{U}, \qquad J_{33} = -\delta_0, \qquad J_{34} = \theta_1\delta_1$$

$$J_{41} = 0, J_{42} = \beta 0 + \alpha\bar{T} - v\bar{U}, \qquad J_{43} = \theta_0\delta_0, \qquad J_{44} = -\delta_1$$

Therefore, the Jacobian matrix at $(0,\ 0,\ \bar{T},\ \bar{U})$

$$J = \begin{pmatrix} r_0 & 0 & 0 & 0 \\ 0 & r_{B_0} - r_1\bar{U} & 0 & 0 \\ 0 & -\alpha\bar{T} + \pi v\bar{U} & -\delta_0 & \theta_1\delta_1 \\ 0 & \beta + \alpha\bar{T} - v\bar{U} & \theta_0\delta_0 & -\delta_1 \end{pmatrix}$$

$$\lambda_1 = r_0, \quad \lambda_2 = r_{B_0} - r_1\bar{U}, \quad \lambda_3 = -\delta_0, \quad \lambda_4 = -\delta_1$$

λ_1 is positive. Therefore, the system of equation is unstable for a system to be stable, all the four eigenvalues must be negative. But the main focus of this work here again is investigating the bounded monotone sequence relative to eigenvalues. Rand(1) is 0.2 random noise intensity

Model with Random Noise Inclusion

A random noise is introduced into the four systems to perturb the environment resulting to

$$\frac{dN}{dt} = r(B)N - \frac{r_0 N^2}{K(B,T)} + \left(rni * rand(1)\right)$$

$$\frac{dB}{dt} = r_B(U,\ N) - \frac{rB_0 B^2}{K_B(T)} + \left(rni * rand(1)\right)$$

$$\frac{dT}{dt} = Q(t) - \delta_0 T - \alpha BT + \theta_1\delta_1 U + \pi vBU + \left(rni * rand(1)\right)$$

$$\frac{dN}{dt} = \beta B - \theta_0\delta_0 T - \delta_1 U + \alpha BT + vBU + \left(rni * rand(1)\right)$$

Rand(1) is 0.2 random noise intensity

It is observed that when the random noise (rni ∗rand(1)) is zero equation 22 – 25 will reduce to equation (1) – (4).

Numerical Simulation

For clarity and focus, this paperwork seeks to explore the deterministic implementation of ODE 45 numerical method which is computationally more efficient than ODE 23, ODE 155, in other to quantify the effect of p-vector norm error on the difference between two parallel data without minimum threshold.

For the purpose of this study, we have considered the following parameter values provided by Dubey and Hussain (2006)

$$r_0 = 2, \quad r_{B_0} = 1.51, \ k_0 = 60.0, \ Q_0 = 2.0, \ \delta_0 = 0.21$$

$$\alpha = 0.01, \ Q_1 = 0.03, \ \delta_1 = 3.50, \ \pi = 0.03, \ v = 0.039$$

$$\beta = 0.01, \ \theta_0 = 0.3, \quad r_1 = 0.09, \ k_1 = 0.02, \ k_2 = 0.03, \ k_{B_1} = 0.03$$

The core method of analysis utilized in this work is called a numerical simulation. It is imperative to implement this method because the posed system of nonlinear first order ordinary differential equation does not have a closed form solution. Therefore, the available option in tackling this challenging environmental problem would require the technical application of a numerical simulation based on a Matlab programming language (ODE45) known as Runge-Kutta numerical scheme.

Results and Discussions

The result from numerically simulated data is utilized in Predicting data precision and dispersion error between controlled and uncontrolled data with random noise fluctuation using the MATLAB ODE45 Numerical scheme are displayed and discussed in detail.

Table 1: Statistical dispersion analysis of interacting simulated data with random error for 1-norm using ODE 45 Numerical Scheme

D_1 T	Range	$\bar{x}$	δ^2	δ
1	1.7755	1.5304	0.2730	0.5223
2	6.7604	2.9116	3.998	1.9994
3	3.5586	1.5050	1.0970	1.0475
4	5.2989	2.2957	2.4180	1.5550
5	5.3106	2.3737	2.3680	1.5387
6	3.6115	2.3070	1.1570	1.0756

D_1 T	Range	$\bar{x}$	δ^2	δ
7	5.4306	2.7905	2.5930	1.6101
8	3.0096	1.5914	0.8090	0.8996
9	5.3865	2.5638	2.5590	1.5998
10	5.2122	2.7884	2.3410	1.5299
11	4.5222	2.7535	1.8060	1.3439
12	4.7572	2.7155	2.0130	1.4190
13	4.3612	2.3667	1.6580	1.2876
14	4.2023	1.6503	1.5320	1.2379
15	3.1659	1.3993	0.8680	0.9316
16	4.0739	3.0930	1.4650	1.2103
17	3.7926	2.3853	1.2100	1.0999
18	5.1403	2.1638	2.2420	1.4974
19	2.3173	1.0536	0.4530	0.6731
20	3.0928	1.9089	0.8470	0.9205

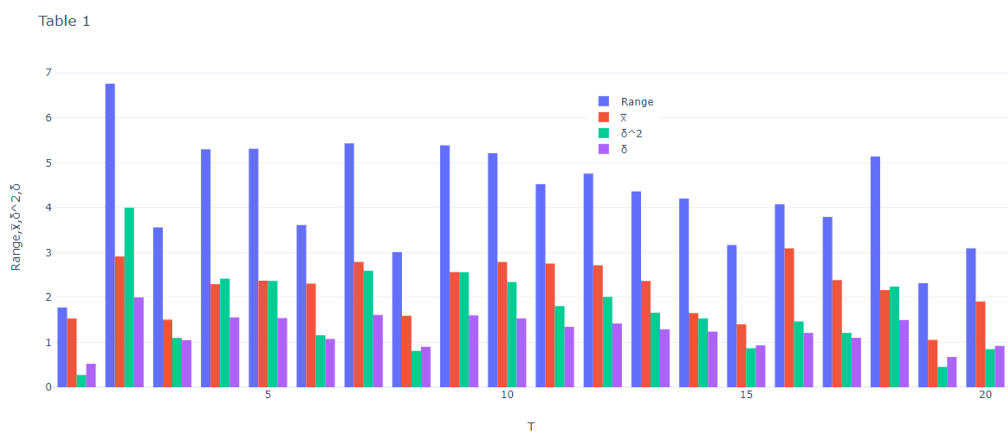

Fig 1: Graphical dispersion analysis of interacting simulated data with random error for 1-norm using ODE 45 Numerical Scheme

The dispersion analysis of numerical simulation data tuples involving p vector norm error was examined for 20 experimental data set. Hence fluctuation in the values of the Range Mean Standard deviation and Variance was observed. The repeated simulation has the minimum data values and also the maximum data values. The Range showed the minimum value on Table 1 (1.7755) and the maximum value Table 2 (6.7604), Mean Table 19 (1.0556) and Table 16 (3.0930), Standard deviation Table 1 (0.2756) and Table 2 (3.998) and Variance showed minimum data values Table 1 (0.5223) and the maximum data values (T) Table 4 (1.5550) In summary, the difference between the controlled and the uncontrolled data obeying the condition of a monotonical decrease the variability of data and precision is due system Perturbation was observed for modelling exercise.

Table 2: Statistical dispersion analysis of interacting simulated with random error for 2-norm using ODE 45 Numerical Scheme

D_2 T	Range	$\bar{x}$	δ^2	δ
1	56.9263	22.0210	269.1370	16.4054
2	53.5195	20.7945	239.6230	15.4798
3	71.2514	21.3245	321.1800	17.9215
4	56.4167	22.4329	267.5780	16.3578
5	55.7121	21.6004	259.1680	16.0987
6	54.1031	21.0281	244.1950	15.6267
7	58.5671	22.5448	283.3320	16.8325
8	55.4732	21.4035	255.5460	15.9858
9	56.5310	21.5823	265.0350	16.2799
10	56.9462	21.8020	266.3650	16.3207
11	58.4940	22.8564	286.0550	16.9132
12	58.0083	22.3945	278.8650	16.6993
13	56.0638	21.4914	260.3610	16.1357
14	55.4200	22.0163	259.2350	16.1008
15	54.9009	21.2746	252.1460	15.8791
16	56.4888	21.7023	262.4940	16.2017
17	57.0474	21.7560	268.2400	16.3780
18	57.9083	22.3185	277.0350	16.6444
19	58.6148	22.7456	283.7210	16.8440
20	56.9919	22.4366	271.1430	16.4664

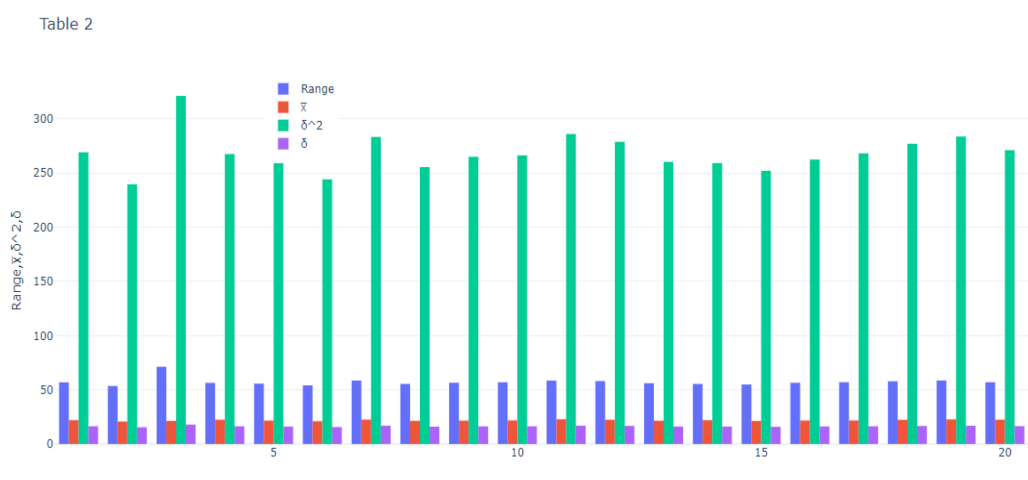

Fig 2: Graphical dispersion analysis of interacting simulated with random error for 2-norm using ODE 45 Numerical Scheme

In statistical dispersion analysis numerical simulated data involving p vector norm error was examined for 20 experimental data sets. The fluctuation in the values of Range, Mean, Standard derivation and Variance was observed. The simulation has showed the minimum data values and also the maximum data values. The Range showed minimum data values in Table 2 (53.5195) and the maximum data values Table 3 (71.2514), Mean Table 2 (20.7945) and Table 11(22.8564), Standard deviation Table 2 (239.6230) and Table 3 (321.1800), Variance showed the minimum values in Table 2 (15.4798) and the maximum data values Table 3 (17.9215).In summary, the difference between the controlled and the uncontrolled data obeying the condition of a monotonical decrease the variability of data and precision is due system Perturbation was observed

Table 3: Statistical dispersion analysis of interacting simulated with random error for 3-norm using ODE 45 Numerical Scheme

D_3 T	Range	$\bar{x}$	δ^2	δ
1	0.0080	0.0037	0.0000	0.0035
2	0.0050	0.0016	0.0000	0.0015
3	0.0050	0.0016	0.0000	0.0014
4	0.0051	0.0016	0.0000	0.0015
5	0.0045	0.0015	0.0000	0.0013
6	0.0049	0.0016	0.0000	0.0014
7	0.0051	0.0016	0.0000	0.0015
8	0.0049	0.0016	0.0000	0.0014
9	0.0044	0.0015	0.0000	0.0013
10	0.0047	0.0015	0.0000	0.0014
11	0.0053	0.0019	0.0000	0.0016
12	0.0043	0.0015	0.0000	0.0012
13	0.0051	0.0020	0.0000	0.0015
14	0.0050	0.0023	0.0000	0.0015
15	0.0049	0.0019	0.0000	0.0015
16	0.0044	0.0015	0.0000	0.0013
17	0.0042	0.0015	0.0000	0.0012
18	0.0047	0.0015	0.0000	0.0014
19	0.0052	0.0023	0.0000	0.0016
20	0.0045	0.0015	0.0000	0.0013

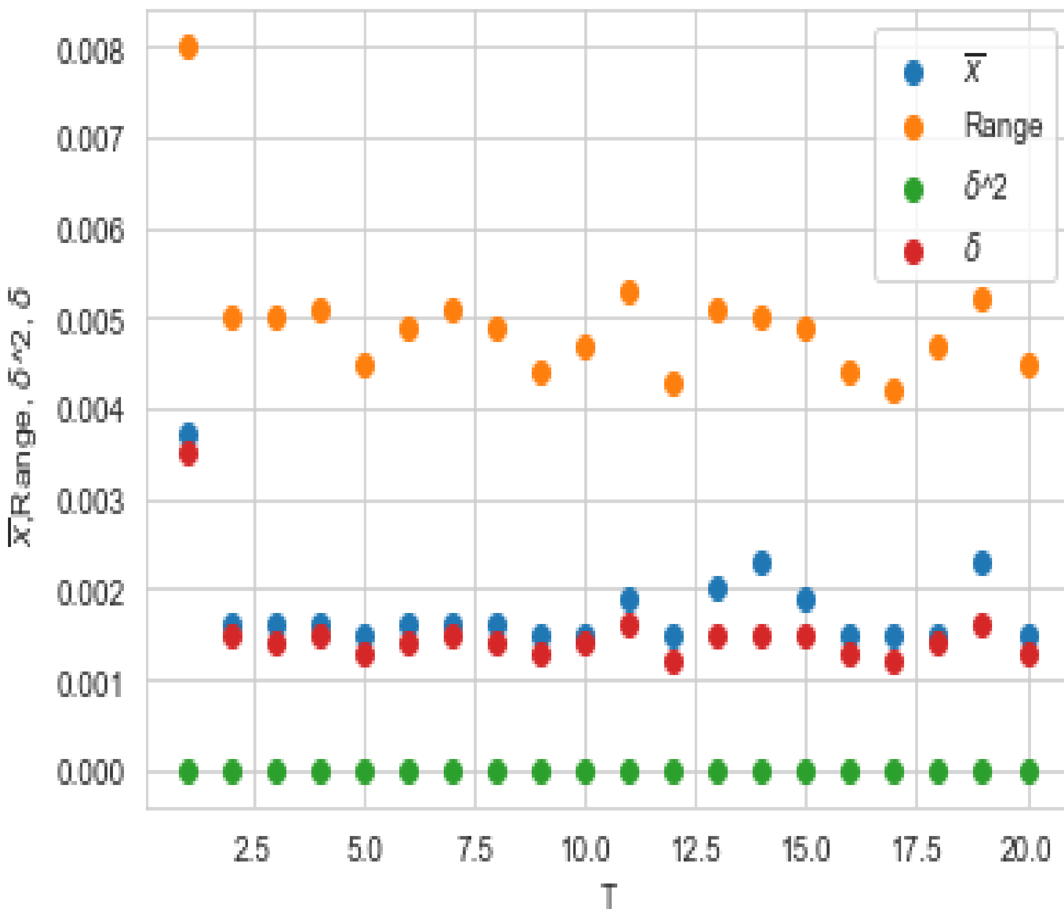

Fig 3: Graphical dispersion analysis of interacting simulated with random error for 3-norm using ODE 45 Numerical Scheme

Table 3 in statistical dispersion analysis of numerical simulation data tuples involving p vector norm error was examined for 20 experimental data set. Hence fluctuation in the values of the Range Mean Standard deviation and Variance was observed. The repeated simulation has the minimum data values and also the maximum data values. The Range showed the minimum value on Table 17 (0.0042) and the maximum value Table 1 (0.0080), Mean Table 5 (0.0015) and Table 1 (0.0037), Standard deviation Table 1 (0.000) and Table 2 (0.000) and Variance showed minimum data values Table 12 (0.0012) and the maximum data values Table 4 (0.0035) In summary, the difference between the controlled and the uncontrolled data obeying the condition of a monotonical decrease the variability of data and precision is due system Perturbation was observed for modelling exercise.

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Table 4: Statistical dispersion analysis of interacting simulated with random error for infinity norm for 20 experimental scenarios

D_4T	Range	$\overline{x}$	δ^2	δ
1	0.0531	0.0196	0.0000	0.0153
2	0.1104	0.0286	0.001	0.0340
3	0.0540	0.0120	0.0000	0.0141
4	0.0536	0.0200	0.0000	0.0155
5	0.0522	0.0192	0.0000	0.0151
6	0.0514	0.0188	0.0000	0.0148
7	0.0544	0.0201	0.0000	0.0157
8	0.0527	0.0191	0.0000	0.0152
9	0.0517	0.0199	0.0000	0.0151
10	0.0532	0.0194	0.0000	0.0152
11	0.0550	0.0202	0.0000	0.0159
12	0.0540	0.0199	0.0000	0.0155
13	0.0541	0.0194	0.0000	0.0156
14	0.0541	0.0198	0.0000	0.0157
15	0.0522	0.0191	0.0000	0.0151
16	0.0525	0.0193	0.0000	0.0151
17	0.0531	0.0193	0.0000	0.0153
18	0.0546	0.0110	0.0000	0.0157
19	0.0561	0.0203	0.0000	0.0161
20	0.0536	0.0110	0.0000	0.0155

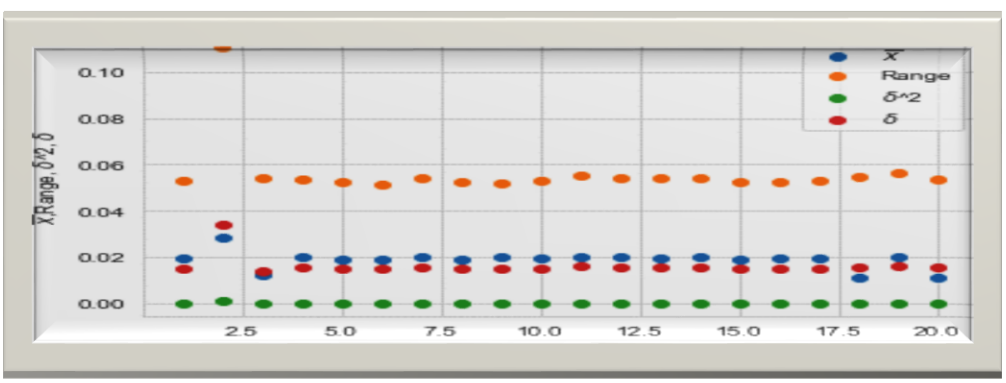

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Fig 4: Graphical dispersion analysis of interacting simulated with random error for infinity norm for 20 experimental scenarios

Table 4 in statistical dispersion analysis of numerical simulation data tuples involving p vector norm error was examined for 20 experimental data set. Hence fluctuation in the values of the Range Mean Standard deviation and Variance was observed. The repeated simulation has the minimum data values and the maximum data values. The Range showed the minimum value on Table 2 (0.0514) and the maximum value Table 19 (0.1104), Mean Table 18 (0.0110) and Table 2 (0.0286), Standard deviation Table 1 (0.000) and Table 2 (0.001) and Variance showed minimum data values Table 1 (0.0141) and the maximum data values Table 2 (0.00340) In summary, the difference between the controlled and the uncontrolled data obeying the condition of a monotonical decrease the variability of data and precision is due system Perturbation was observed for modelling exercise.

Conclusion

In this study a numerical approach was applied to quantify the p vector norm error inherent in the controlled and uncontrolled data set given a 0.2 random noise intensity level of r_0. It is significant that at this level of analysis in mathematical modelling and numerical simulation, the study adopted the investigation of Statistical dispersion analysis of interacting simulated with random error for infinity norm for 20 experimental scenarios of parallel data tuples from a model of interacting biological species to enable this work to select the best-fit data. For model development validation and prediction, the adopted principle here of error analysis is advisable. The dispersion analysis of numerical simulation data tuples involving p vector norm error was examined for 20 experimental data set. Hence fluctuation in the values of the Range, Mean, Standard deviation and Variance was observed. The repeated simulation has the minimum data values and the maximum data values. Results showed that.

1. On the statistical dispersion analysis of a numerically simulated data involving the p vector norm has shown random fluctuations in the value of the range, the mean standard deviation, and the variance.
2. The difference in the data values of the controlled and the uncontrolled data tuples has predicted a monotonically decreasing sequence in data variability and precision due to system perturbation.

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