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Analyzing the In-flow and Out-flow of water from the Annamayya Dam during the Years 2001 to 2021 and predicting the discharge using MAT LAB, Symmetric and Skew Processes.

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Abstract

In this study, a MATLAB framework for predicting the best low discharges in a multiple-storage system for mitigating flooding, data management, and visualization is presented**.** Water supplies goods and services that are utilized in homes,horticulture and businesses. Inundation is a crucial component of agricultural production in many underdeveloped countries. It is widely allow that most of the world's water is used by agriculture. In this work, we investigate the in-flow and out-flow of water in Annamayya Dam between 2001 and 2021 using Stochastic Differential Equations (SDE) and Symmetric and Skew Bessel Processes. The final results of the application indicate such an approach might reduce floods that occurred.

Keywords: Stochastic Differential Equation, in-flow and out-flow, MATLAB, Symmetric and Skew Bessel Processes.

1. Introduction:

An expert group has been assembled by the government to review the aforementioned work and recommend any necessary corrective actions. After inspecting the Annamayya Project, the expert group made certain recommendations for corrective action, including replacing gate number one that had collapsed and beginning work to strengthen the other four radial gates. Due to improper welding on each of the five gates, the expert committee recommended strict pinning to the flats and anchor girders. Corrective measures were duly performed to replace the collapsed gate No. 1, and work to correct the other four radial gates was finished in the year 5/2013.

Annamayya Project Main Canal & Distributaries:

The main canal is 23.600 kilometres long. There are 18 distributaries and 6 tank feeders that are fully functional throughout the canal. Additionally, the project's principal elements have all been finished.

3D Model studies:

The spillway of 5 gates is insufficient to discharge the maximum flood flow of 2.85 lakh Cusecs after Gate No. 1 collapsed, according to 3D model studies on the Annamayya Project Dam undertaken by APERL. The current five-gated spillway can only discharge 2,17,000 Cusecs under FRL conditions, hence it was suggested to seek out a different solution for the remaining discharge = 285,000 - 21700 = 68,000 Cusecs. The downstream protection projects were hampered by the floods and will need to be corrected; estimates are being prepared.

NOAA 2016(The National Oceanic and Atmospheric Administration) states that inland flooding is the meteorological event that causes the most damage to the United States each year. Inland flooding caused an average of $6.9 billion in damages annually between 1976 and 2006 (NOAA 2016).NASA's Earth Observatory (NASA 2017) claims that global warming is taking place. Will alter the main climatic patterns, floods, storms, and droughts will typically become high severe as precipitation patterns shift. The peak discharge and frequency of floods will also rise as a result of changes in land use brought on by rising urban growth trends (USGS 2003).

Recent years have seen an increase in interest in flood mitigation within the framework of a watershed, where the management goal is to protect the entire watershed. Networks of storage systems (such as detention ponds, marshes, and reservoirs) are frequently accessible within a watershed for the purpose of controlling flooding, but they are rarely managed in concert. The efficacy of storage systems for flood mitigation may be hampered by a lack of coordination in their control. Additionally, remote water release control in storage systems is uncommon and frequently restricted to reservoirs. To achieve specified objectives, such as lowering inundation levels at particular river segments, an ideal flood mitigation system would operate all of the watershed's storage facilities in a coordinated way in accordance with precipitation forecasts.

2. Literature Review:

Two types of one-dimensional SDE have strong solutions and are pathwise unique [1].Solid Markov One-dimensional solutions with continuous local martingalesSDE Part-I [18].Utilizing River water resources through dams and reservoirs is crucial for a number of purposes, including flood control, navigation, energy production, and water supply[19]. The flow of more than half of the world's major river systems is regulated or impacted by dammed reservoirs [20]. Therefore, managing water reservoirs in rivers is a serious issue, with a variety of potential solutions depending on the particular goals of the dammed reservoir. For several of these activities, such as assessing dam structural issues [3], water supply and resource availability [4,5], quality of water [6-7], and biodiversity conservation [8], The reservoir's dam water level must be predicted accurately.

Three issues that are of interest to us in this article are hydropower production optimization [10, 11], disaster prevention [9], and navigation management. The issue of predicting blocked water levels in reservoirs can be resolved by taking very many predicting factors (input data). Although hydro-meteorological data have been taken into account by several writers [12,13], there are other types of input data for prediction that are also available, including video cameras images [14], among others. Three issues that are of interest to us in this article are hydropower production optimization [10, 11], disaster prevention [9], and navigation management. The issue of predicting blocked water levels in reservoirs can be resolved by taking very many predicting factors (input data). Although hydro-meteorological data have been taken into account by several writers [12,13], there are other types of prediction data for input that are also available, including images from video cameras [14] or satellite-based data [16,17], among others. In relation to the computational techniques

3. Stochastic Differential Equations:

Water is one of the most important aspects of agriculture at many of its stages, with an impact on the final product. If plants do not receive enough water, even the best seeds and fertilizer products would fail to achieve their full potential [11].□□,F,P□□□represents the entire space of probabilities. Think about the SDE with one dimension [15].

$Z_{(t)} = z_0 + P_{(t)} + \int_{(0)}^{(t)} \alpha\text{-}1(2Z_{(s)})^{-1} ds$ [15]-----------9(i)

It is determined that solving (i) via an invertible space transformation is comparable to solving an SDE of the kind shown below.

$Xt = x0 + \int_0^t t(X_s) db_s + 1/2(L_+^x(t,0) - L_-^x(t,0))$[15]

In the equation above, is shown as a clear assessable function, and LX stands for the process's accurate local time. LX also denotes the solution's remaining local time. Stroock and Yor[10], Le Gall[8], Engelbert and Schmidt[5],[7] utilized the generalized Ito formula to convert the SDE known as generalized drift including local time of anonymous process to equations without drift. Zvonkin transformations are a process within the context of SDE space transformations. The space transformation equation is also used to handle equations with generalized drift, despite the fact that Bass and Chen[1] and Engelbert and Schmidt[5],[7] have given necessary and sufficient criteria for the existence and distinctness of SDE solutions. The reformed equation is written as follows with the assumptions Q(z)m, [-1,1]:The reformulated equations with certain conditions
L_m^z,□□□□□1,1□□are given as

$Z_t = z_0 + B_t + \int_0^t \propto -1(Z_s)^{-1} ds$
$L_m^z(t,0) - L_m^z(t,0-) = 2\rho L_m^z(t,0)$[15]

2. Skew Bessel and symmetric Bessel processes:

Scaled skew Bessel processes are defined, and their semi-group densities and Green's functions are calculated. Despite the fact that the related semi group densities are often not twice differentiable in the density and beginning point arguments, we demonstrate that these processes meet the time inversion property.

$\int_0^t h(Z_s) ds = \int_R h(x) L_m^z(t,x) f(x) dx, t \geq 0,$

Lets apply the conflict connection formula and the probability measure P to nearly certainly conclude that Z has no occupation time in zero.

$\int_0^t h(Z_s) d(Z)_S = \int_R L_+^z(t,x) h(x) dx, t \geq 0,$ almost surely with probability measure Pfor X.[15]

3. A different method of introducing the dimensional Bessel process:

Consideration of the equation is the recommended method to define a –dimensional Bessel in the context of SDE.

$$Y_t = y_0 + 2\int_0^1 \sqrt{|Y_s|} dB_s + \propto t$$

For an observing that the local time
f(Z)=|z|, Z$\in R$))and $L_+^{Z^1-Z^2}(t,0)$ of $Z^1 - Z^2$vanishes,
for $t \geq 0$ we presume almost surely with probability measure P

$$|z - z_t^2| = \int_0^l sgn(z_s^1 - z_s^2)\frac{\propto -1}{2}((z_s^1)^{-1})ds + L_+^{Z^1 - Z^2}(t, 0)$$

$$|z_t^1 - z_t^2| = \int_0^t \frac{1-\propto}{2}|z_s^1 z_s^2)^{-1}ds$$

$$|z_t^1 - z_t^2| \leq 0$$

Hence $z_t^1 = z_t^2, t \geq 0$, With the possibility of essentially probaby P

4. The Skew Bessel Process Speed Measure, Infinitesimal Generator and Scale Function:

Strong Markov processes exist for skew one-dimensional Bessel processes. Additionally, for (1,1) their state space is the entire real line and they are consistent, which we briefly justify below. In contrast, for =1(=-1) we may consider that half line is [0,+)([-,0)] as state space for consistency's sake, which means that Typically, we only work with beginning values that are not negative.. It is appropriate to provide the scale functions, speed measurements, and the skew -dimensional Bessel Processes in infinitesimal generators of strong Markov processes[9].

As previously said, in the meanwhile, and for each [-1,1] and random beginning value z∈R

$$\{z_t = z_0 + B_t + \int_0^t (\propto -1)(2Z_s)^{-1}\, ds,$$

$$\{L_m^z(t, 0) - L_m^z(t, 0-) = 2\rho L_m^z(t, 0)$$

5. Simulation Research:

Here, we examine the water Inflow and Outflow from Annamayya Dam between 2012 and 2021.We collected 20 sets of data from WRD, Annamayya Project , Kadapa for this study . Table 1 shows the annual in flow and out flow of water in cusecs.

Table 1: In-flow and Out-flow of Water in Cusecs at the Years 2001 to 2021

Year	Head in Inflow	Head in outflow	Discharge inflow	Discharge outflow
2001	102	72	1789	1060
2002	2884	2837	269545	262940
2003	149	315	3171	9728
2004	224	162	5846	3595
2005	0	0	0	0
2006	2303	2249	192304	185601
2007	0	0	0	0
2008	2186	2139	177892	172098

2009	1029	1052	57464	59338
2010	175	251	4031	6931
2011	1090	1051	62594	59305
2012	189	296	4512	8849
2013	193	141	4657	2900
2014	220	272	5689	7824
2015	0	11	0	64
2016	3582	3499	372972	360079
2017	3	368	9	12282
2018	1298	1227	81351	74814
2019	0	170	0	3854
2020	401	326	13957	10243
2021	4397	4446	507323	515815

Figure 1 depicts the graph that was created using the data from Table 1; following that, the graph was analyzed using SPSS to provide various distribution values.

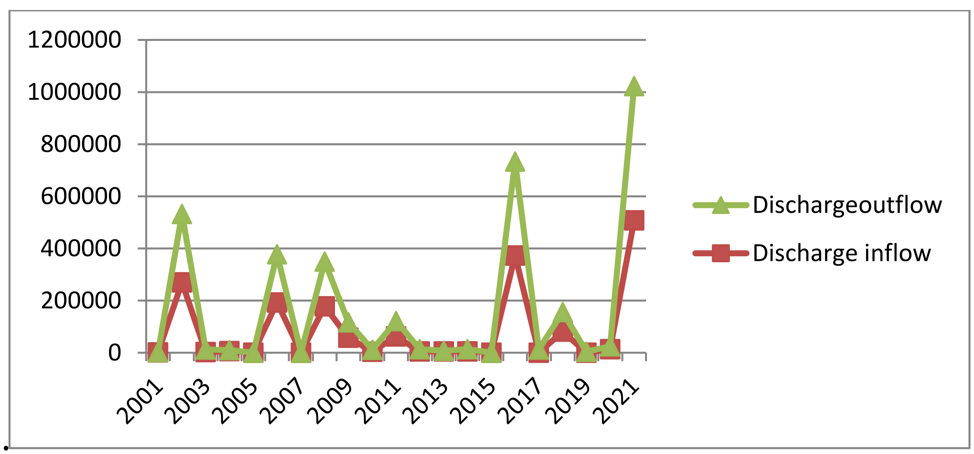

Figure1. Graph utilization of departmental data showing water input and outflow at Annamayya Dam from 2001 to 2021.

We next used MAT lab software to quantitatively fit out the skew and symmetric process as well as the distribution values for the 20 sets of data from Figure 1 together with the distribution values[10.]. We

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generate 20 points using mathematical calculations using skew and symmetric process. We next draw the graph for the theoretically determined points, which is shown in Figure 2.

Program for executed in MATLAB:

```
clearall
clc
x1=2000:2020;
x2=2001:2021;
y1=[1789 269545 3171 5846 0 192304 0 177892 57464 4031 62594 4512 4657
    5689 0 372972 9 81351 0 13957 507323];
y2=[1060 262940 9728 3595 0 185601 0 172098 59338 6931 59305 8849 2900
    7824 64 360079 12282 74814 3854 10243 515815 ];
plot(x1,y1);
holdon
plot(x2,y2);
```

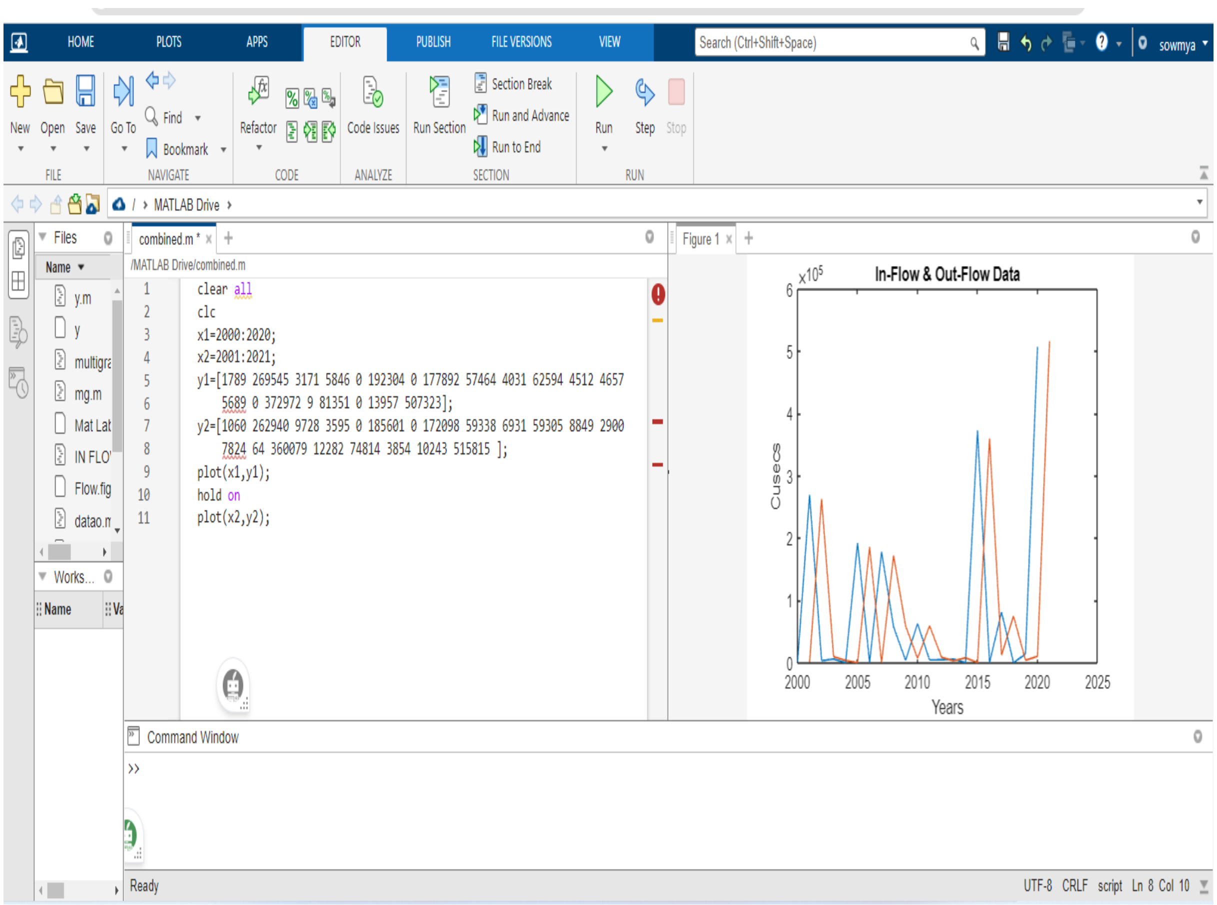

Figure 2: Screenshot for graph In-Flow & Out-Flow in MATLAB

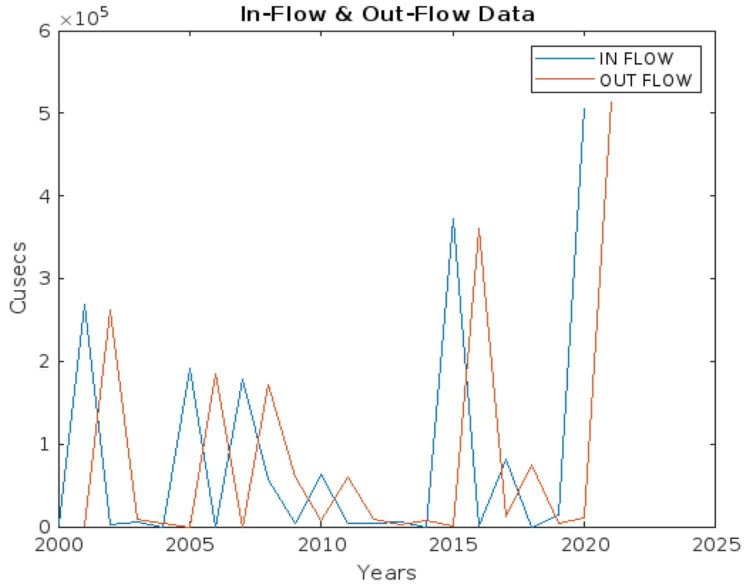

Figure 3:Graph In-Flow & Out-Flow in MATLAB

Here, we examine the water Inflow and Outflow from Annamayya Dam for 2022 and 2023.We collected 2 sets of data from WRD, Annamayya Project, Kadapa for this study. Table 2 shows the annual in flow and out flow of water in cusecs.

Table2: In-flow and Out-flow of Water in Cusecs for the Years 2022 and 2023

Year	Discharge inflow	Discharge outflow
2022	154240	63150
2023	86450	51815

Conclusion:

According to the Table 1: In-flow and Out-flow of Water in Cusecs at the Years 2001 to 2021 and Graph In-Flow & Out-Flow in MATLAB created using departmental data, the total in-flow is close to 507323 CUSECS[14.]. However, the Annamayya Dam does not release water for irrigation until the month of August because this is when the inflow reaches a sufficient level. Normally, cultivation should begin in the month of June, but due to the Annamayya Dam's insufficient inflow, this could not happen until the month of June. The case study's findings suggest that dynamic storage management can lessen the impact of floods. For instance, in the current example study, dynamic storage management can result in a 40%

reduction in the total cumulative area of shallow storage ponds needed to produce a given amount of flood mitigation. It is obvious that these findings are case-specific and cannot be applied [17.].

For the year of 2022 it is observed that there is a difference of 112 cusecs for inflow, 116 cusecs for outflow in between values given table 2 and the predicted values. And for the year of 2023 there has been variation of 38 cusecs for inflow and 85 cusecs for outflow is observed [18.]. In order to deal with the unknown future of climate change and to manage the operation of reservoirs efficiently and safely [15.], When employed as the foundational data for inflow prediction values of various multi-purpose dams, this work, which examined prediction values for inflow using hydrological data and deep learning models, is anticipated to help to stable dam operation management and disaster response.

Program for executed in MATLAB for predicted values:

```
clear all
clc
x1=2022:2031;
x2=2022:2031;
y1=[154218 86417 19105 9522 122 1001 415 18771 11257 1125778 ];
y2=[63008 50811 961073 2321 1740 1099 2007 117904 1211872 1250884 ];
plot(x1,y1);
hold on
plot(x2,y2);
```

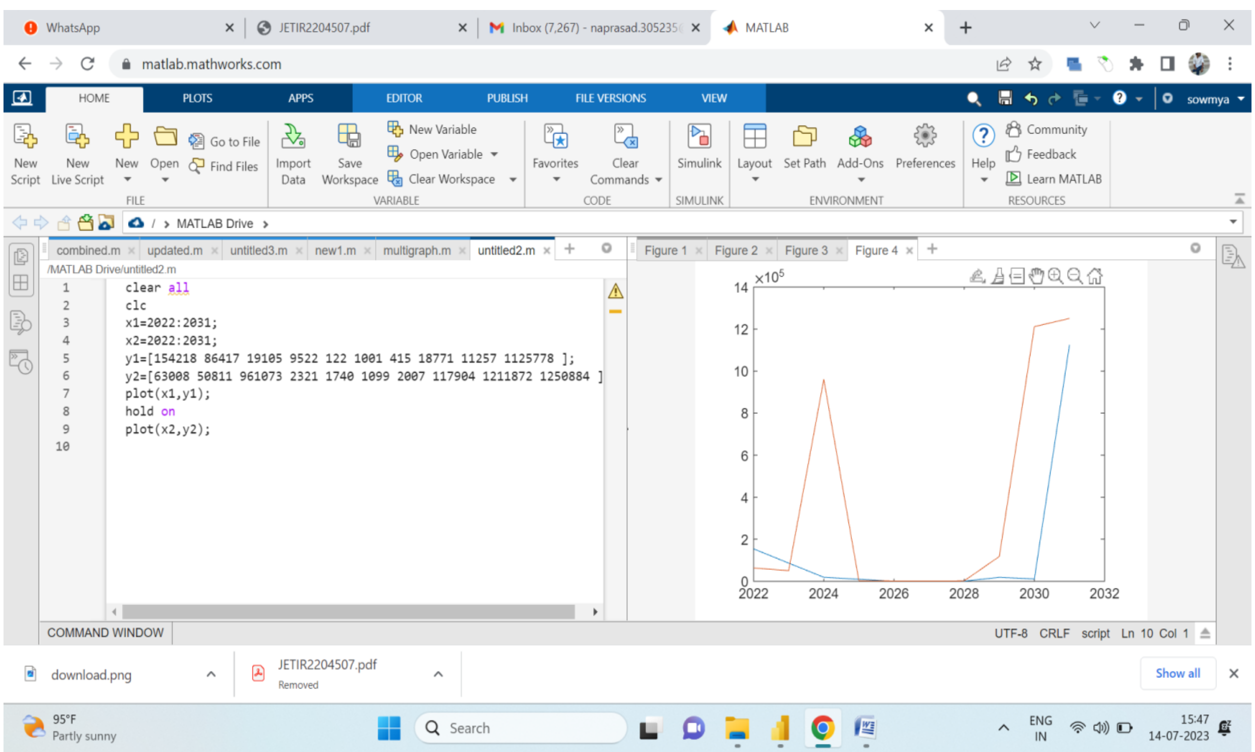

Figure 4: Screenshot for graph In-Flow & Out-Flow in MATLAB

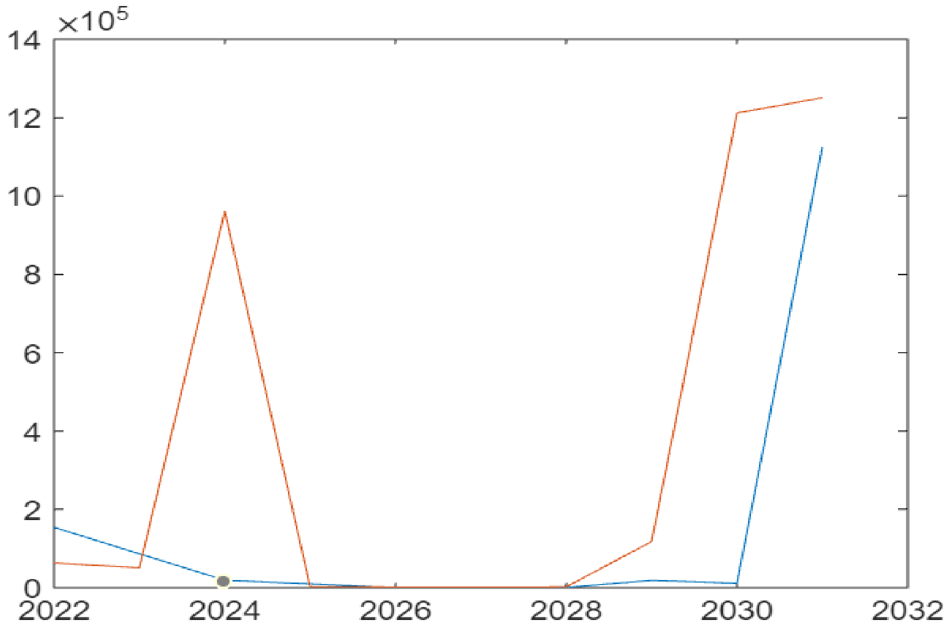

Figure 5: Graph In-Flow & Out-Flow in MATLAB for predicted values

Thus, for the purpose of studying the inflow and outflow of water, we employed the skew& symmetric Bessel processes, together with its theorem and significant conclusions. We came to the conclusion that the graphs shown using departmental data and the skew& symmetric Bessel processes are precisely identical.

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