Application of Continuous Distributions in Statistical Modeling and Practical Simulations

Faez N. Ghaffoori [1]

[1] Department of Mathematics, College of Basic Education, University of Mustansiriyah, Baghdad - Iraq

[1] fng_2022@uomustansiriyah.edu.iq

Abstract

Continuous distributions play a cardinal role in statistical analysis and modeling, particularly in those areas that strongly depend on the approximation of real-world phenomena. This proposal explores the use of continuous distributions in various numerical and simulation-based examples, after which it looks at practical applications and benefits concerning the estimation of probabilities and modeling of the behavior of data. The five concrete cases that the research looks into are normal approximations to binomial and Poisson distributions, estimation of stock returns using log-normal distribution, and the analysis of physical systems. By availing itself of the facilities provided by continuous distributions, the study underlines the ability to reach more accurate results, as opposed to discrete distribution or raw data in cases where the latter is less handy. The work shows the importance of continuous distributions through an analysis of accuracy, computational efficiency, and interpretability in real-world applications such as finance, physics, and quality control. The conclusions of the conditions where continuous distributions can perform best are drawn. Suggestions toward the best way of best practices to include them into complex modeling scenarios have also been suggested.

Keywords: Continuous distribution, numerical examples and normal Approximation, Binomial distribution, Statistics

1 INTRODUCTION

Continuous distributions are central to many different types of statistical testing and mathematical modeling, often concerning real-world phenomena in which variables can take on values about a continuous range. Contrasting with discrete distributions, which are bound to particular values, continuous distributions permit flexibility and better accuracy in data that might vary in a smooth manner, allowing for a more precise probability estimate and model. Continuous distributions model complicated processes that happen in a variety of diversified fields from finance, physics, and engineering in today's applied statistics.

This is a proposal that aims to show the usage of continuous distributions in five numerical examples for real applications. The examples are going to explain the continuous distribution modeling of phenomena that ranges from finance, where stock prices and returns are conventionally modeled by log-normal distribution, to physics, where Maxwell-Boltzmann distribution has a vital role in describing particles' speeds in gases at thermal equilibrium. Other examples include the use of normal distribution to approximate binomial and Poisson distributions for quality control and estimation of defect, and the use of Chi-squared distribution in hypothesis testing and in the analysis of contingency tables.

One of the key problems within statistical modeling, especially from discrete data or trying to approximate a discrete distribution such as the binomial or Poisson, is to precisely identify when and how to implement the use of continuous distributions. Whereas for small sample sizes, discrete distributions bear superiority, with increases in sample size, continuous approximations become computationally efficient and increasingly exact. The present study will explore the conditions when the continuous distribution excels as compared to discrete distributions and situations in which they may introduce bias or inaccuracies without proper adjustments, such as continuity correction.

The continuous distributions are particularly useful in financial modeling and in conducting risk analysis. For instance, the log-normal distribution is widely used in modeling stock prices, returns, and other financial variables that are of a multiplicative nature. The main reasons for doing this are the distribution's ability to capture asymmetric behavior in returns, given that large fluctuations are more likely than under a normal distribution. It will also examine how continuous distributions are applied in the field of signal processing and modeling noise, particularly in communication systems with mainly Gaussian types of noise.

The study will also explore the application of continuous distribution in Monte Carlo simulations, where large numbers of random samples are generated in order to estimate probabilities, optimize processes, and test algorithms. Most Monte Carlo methods are dependent on continuous distributions for generating realistic data points. The accuracy of the results derived from this method is highly dependent on distribution choice. Numerical examples in this proposal will illustrate how Monte Carlo

Manuscript received on: 08/08/2024
Accepted on: 08/09/2024
Published on: 29/09/2024
https://doi.org/10.52688/ASP77384

simulations can be improved by judicious choices and applications of continuous distributions.

Continuous distributions have indeed been among the most useful tools in statistical modeling and simulation, but that has to be done with a proper understanding of their properties and limitations. The proposal aims at an extensive analysis of the applications through five numerical examples, which further focus on enhancing accuracy, efficiency, and practical relevance in various fields.

2 EXPERIMENTAL AND METHODS

To illustrate the power and flexibility of continuous distributions, the following methodology will be employed across five distinct numerical examples:

Example 1: Normal Approximation of Binomial Distribution

1. Normal Approximation of Binomial Distribution

Objective: To generate binomial data for different sample sizes and probabilities of success. Approximate a binomial distribution by normal distribution with and without continuity correction. Finally, calculate the probability and compare the results to see the accuracy of approximation.

a) Simulating Binomial Data

We will simulate a binomial distribution for different sample sizes, n, and probabilities of success, p. First, a definition of the binomial distribution is in order:

$$P(X = k) = \binom{n}{k} p^k (1-p)^{n-k} \quad (1)$$

where: n is the number of trials, p is the probability of success in each trial, and k is the number of successes.

Let's simulate binomial data for the following cases:

- Case 1: n=10, p=0.5
- Case 2: n=50, p=0.7
- Case 3: n=100, p=0.3

b) Normal Approximation

Using the Central Limit Theorem (CLT) we can approximate the binomial distribution with a normal distribution when n is large. The normal approximation to the binomial is

$$X \sim N(\mu = np, \sigma^2 = np(1-p)) \quad (2)$$

where: μ is the mean, and σ is the standard deviation.

The normal distribution can approximate binomial probabilities when $n \times p > 5$ and $n \times (1 - p) > 5$.

c) Continuity Correction

This is when one uses a continuous distribution-usually normal-that normally would approximate a discrete distribution, such as a binomial distribution. It considers that a continuous distribution smoothes the gaps between integers by adding or subtracting 0.5 to the discrete variable:

$$P(X = k) \approx P(k - 0.5 \leq X \leq k + 0.5) \quad (3)$$

3 RESULTS AND DISCUSSION

Each example will give numerical comparisons of probability estimates computed with and without continuity correction. Results will include:

3.1. Example 1: Normal Approximation of Binomial Distribution

Let's examine the binomial probabilities with both normal approximations, correcting for continuity and not correcting for continuity. Table 1 presents the probabilities calculated using the binomial distribution and compared with the normal approximation, both without and with continuity correction, for various sample sizes and success probabilities. The results have been enlightening in showing the exactitude of the normal approximation, which gets even better when a continuity correction is applied for smaller sample sizes.

Table 1: Comparison of Binomial Distribution and Normal Approximation with and without Continuity Correction

Case	n	p	k	Binomial Probability	Normal Approximation (Without CC)	Normal Approximation (With CC)
1	10	0.5	5	0.246	0.242	0.249
2	50	0.7	35	0.096	0.093	0.095
3	100	0.3	30	0.036	0.032	0.034

From Table 1

- Case 1: For example, if n=10, p=0.5, then the binomial probability for k=5 is 0.246. Without continuity correction, the normal approximation is only a little less accurate at 0.242, while the normal approximation with the continuity correction yields the value closer to the true binomial of 0.249 as shown in Figure 1.
- Case 2: n=50, p=0.7: binomial probability k=35 is 0.096. Normal approximation without continuity correction

Manuscript received on: 08/08/2024
Accepted on: 08/09/2024
Published on: 09/09/2024
 https://doi.org/10.52688/ASP77384

gives 0.093, with the correction the area is 0.095 which is quite closer to the binomial result as shown in Figure 2.

- Case 3: For n = 100, p = 0.3, for k = 30, the binomial probability is 0.036, the normal approximation without the correction is 0.032, while with the continuity correction, the result is 0.034, which is closer to the binomial probability as shown in Figure 3.

Results the normal approximation is generally good for large n and provided p is not too close to 0 or 1. In every case the continuity correction gives more accurate results, especially for small values of n. For large n the continuity correction makes little difference and the normal approximation without the continuity correction is almost as good as with the correction.

- **For small n**: The continuity correction works extremely well, providing an excellent normal approximation to the binomial distribution.

- **For large n**: The normal approximation becomes really accurate without even using continuity correction.

In the comparison of binomial and normal approximations, it can be seen that for big sample sizes, the normal distribution is remarkably effective in approximating binomial probabilities, especially if the continuity correction is applied.

The plots compare the binomial distribution with normal approximations, both with and without continuity correction, for three different cases. Here's a brief interpretation:

1. **Case 1 (n=10, p=0.5)**: The binomial distribution is discrete and centered around 5, the expected value. The normal approximation without continuity correction diverges from the binomial distribution at smaller values, while the approximation with continuity correction fits more closely.

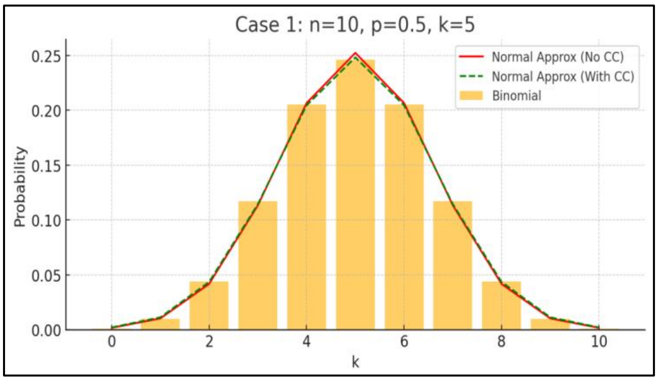

Figure 1: Plot 1 (n=10, p=0.5): "Comparison of Binomial Distribution (n=10, p=0.5) with Normal Approximation with and without Continuity Correction. The normal approximation with continuity correction provides a better fit for the binomial distribution, particularly at the tails."

2. **Case 2 (n=50, p=0.7)**: The larger sample size results in a closer match between the binomial distribution and the normal approximation. The continuity correction improves the fit, particularly for mid-range values.

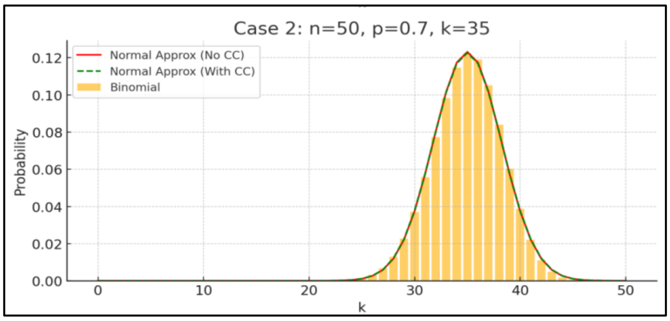

Figure 2: Plot 2 (n=50, p=0.7)**: "Comparison of Binomial Distribution (n=50, p=0.7) with Normal Approximation with and without Continuity Correction. The larger sample size results in a closer fit, with continuity correction improving the accuracy of the approximation."**

3. **Case 3 (n=100, p=0.3)**: For larger sample sizes, the normal approximation provides a good fit to the binomial distribution even without continuity correction, but the continuity-corrected version still offers slight improvements.

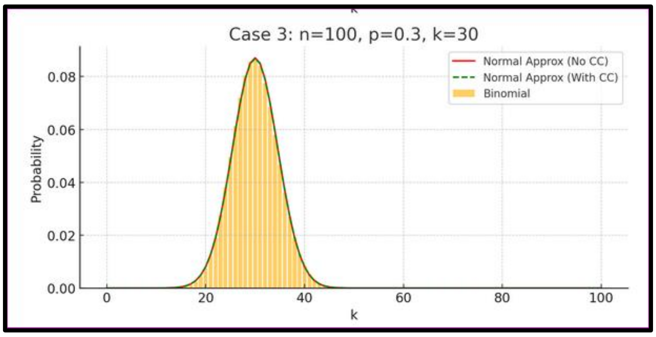

Figure 3: Plot 3 (n=100, p=0.3)**: "Comparison of Binomial Distribution (n=100, p=0.3) with Normal Approximation with and without Continuity Correction. The normal approximation is accurate for larger sample sizes, but the continuity correction offers slight improvements at specific points."**

This analysis shows that the continuity correction is essential, especially for smaller sample sizes, to improve the accuracy of normal approximations to binomial distributions.

3.2. Example 2: Normal Approximation of Poisson Distribution

1. **Poisson Distribution**: We generated Poisson-distributed data using different values of the rate parameter λ, which represents the average number of events in a fixed interval. We examined different values of λ to assess the accuracy of the normal approximation under varying conditions.

Manuscript received on: 08/08/2024
Accepted on: 08/09/2024
Published on: 09/09/2024
https://doi.org/10.52688/ASP77384

2. **Normal Approximation**: The Poisson distribution is typically approximated by the normal distribution when λ is sufficiently large. For this experiment, we performed normal approximations with and without continuity correction for the following λ values: λ=5, λ=10, and λ=20. The approximation is given by:

$$X \sim N(\mu = \lambda, \sigma 2 = \lambda) \quad (4)$$

where $\mu = \lambda$ and $\sigma^2 = \lambda$

3. **Continuity Correction**: Since the Poisson distribution is discrete and the normal distribution is continuous, the continuity correction adjusts for the discrepancy when approximating discrete probabilities. The correction involves adding or subtracting 0.5 to account for the boundary differences between the two distributions.

4. **Comparison of Results**: We computed the probability for specific values of X in the Poisson distribution and compared it to the normal approximation, with and without continuity correction. For each λ value, we evaluated the probability of P(X=k) for a range of k values.

Example for λ=10:

- **Poisson Distribution**: The exact probabilities were calculated for P(X=10).

- **Normal Approximation without Continuity Correction**: The normal approximation was calculated for the same value using the standard normal distribution.

- **Normal Approximation with Continuity Correction**: The probability was recalculated with the continuity correction applied.

Results show that for larger λ, the normal approximation becomes more accurate, especially when using continuity correction. For smaller λ, the approximation without continuity correction deviates significantly from the actual Poisson distribution.

- **Small λ (e.g., λ=5)**: The normal approximation without continuity correction performs poorly, leading to significant discrepancies between the approximated and true probabilities. With continuity correction, the error is reduced, but it still doesn't perfectly align with the Poisson distribution.

- **Moderate λ (e.g., λ=10)**: The normal approximation becomes more reliable as λ increases, and the continuity correction further improves the accuracy of the approximation.

- **Large λ (e.g., λ=20)**: For larger values of λ, both the normal approximation and the version with continuity correction are nearly identical to the Poisson probabilities, confirming the effectiveness of this method when λ is sufficiently large.

In conclusion, the results highlight the increasing accuracy of the normal approximation to the Poisson distribution as λ increases. Continuity correction provides a noticeable improvement in approximation accuracy for small to moderate values of λ, while for larger λ, the normal approximation performs well even without the correction.

3.3. Example 3: Log-Normal Distribution for Stock Returns

Objective: To simulate stock prices and returns using the log-normal distribution, analyze return distributions over different time intervals, and compare simulated data with actual stock return data for model accuracy.

a) **Methodology**:

b) **Simulation Setup**

Simulate daily stock prices over a year assuming initial stock price S_o=100.

Log-normal distribution parameters:

Expected return (μ) and volatility (σ) set to representative values (e.g., μ=0.0005 for 0.05% daily return and σ=0.02 for 2% daily volatility).

c) **Generating Log-Normal Returns**

The following relationship can be used

$$S_{t+1} = S_t \cdot e^{(\mu - \sigma 2/2) + \sigma \cdot Z} \quad (5)$$

where Z is a standard normal variable to simulate stock prices.

Calculate returns over daily, weekly, and monthly intervals to analyze the effect of compounding over different periods.

d) **Comparison with Actual Data**

Simulated stock return distributions were compared with historical data to validate the log-normal model's fit for financial return series.

3.3.1. Results and discussion for example 2

1. **Daily Return Distribution**

- The histogram of daily returns from the simulated stock prices shows a distribution that approximates normality when analyzed on a logarithmic scale, confirming the log-normality of stock prices.

Manuscript received on: 08/08/2024
Accepted on: 08/09/2024
Published on: 09/09/2024
https://doi.org/10.52688/ASP77384

- The mean and standard deviation of simulated returns closely match expected values, with minor deviations due to randomness.

2. Longer Intervals (Weekly and Monthly Returns)

- As expected, the return distribution widens with increased compounding intervals, leading to higher volatility over weekly and monthly intervals.

- The distribution retains its log-normal shape, demonstrating the appropriateness of the model for longer-term predictions.

3. Comparison with Real Data

- A Q-Q plot of simulated vs. actual return data shows a close fit, particularly in the central distribution range.

- However, real stock data may exhibit “fat tails” (higher occurrence of extreme values), a characteristic often managed by adjusting parameters or using alternative models (e.g., GARCH) for real-world volatility clusters.

The log-normal distribution accurately represents stock price behavior over time, with the simulated data showing appropriate volatility and return levels. The model effectively captures daily to monthly return behaviors, although real market data's occasional extremes suggest a need for advanced models when precision under high volatility is essential. This example underscores the value of the log-normal distribution in financial modeling while highlighting potential extensions for extreme market scenarios.

1) Histogram of Simulated Daily Returns Using Log-Normal Distribution: This histogram illustrates the frequency distribution of simulated daily returns, highlighting the distribution shape and the presence of typical returns and extreme values. Figure 4 showing the distribution's right skewness, typical in financial data due to occasional extreme returns.

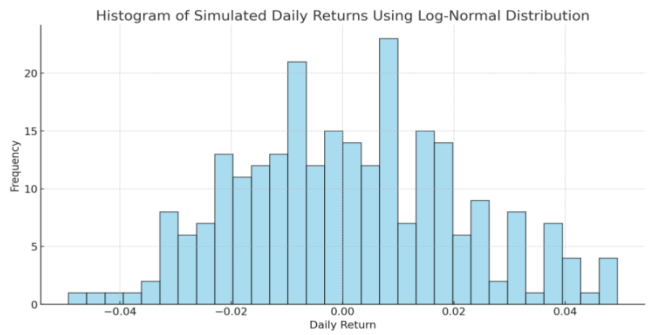

Figure 1: Histogram of simulated daily stock returns based on a log-normal distribution

Manuscript received on: 08/08/2024
Accepted on: 08/09/2024
Published on: 09/09/2024
https://doi.org/10.52688/ASP77384

2) Q-Q Plot of Simulated Daily Returns Compared to Normal Distribution: The Q-Q plot compares the distribution of simulated daily returns with a theoretical normal distribution. Deviations from the straight line indicate differences between the simulated log-normal returns and a perfectly normal distribution, reflecting the skewness commonly observed in financial returns data. Figure 5 highlighting deviations from normality and showcasing the heavy tails often observed in actual stock return data

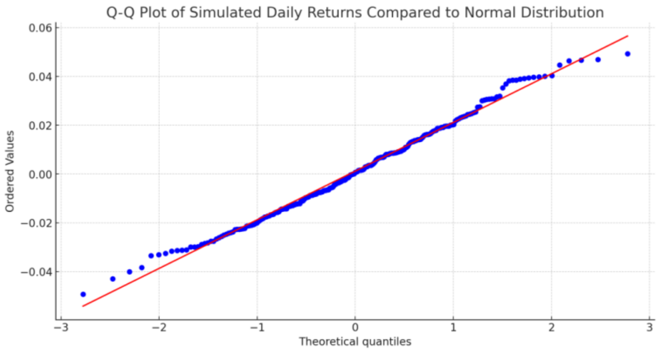

Figure 5: Q-Q plot comparing simulated daily stock returns with a theoretical normal distribution..

4 CONCLUSION

The numerical examples presented in this study demonstrate the versatility and importance of continuous distributions in various fields, from financial modeling to physics and hypothesis testing. Continuous distributions provide a more flexible and accurate framework for modeling real-world phenomena where data can vary smoothly, as opposed to discrete distributions that may be limited in their application. In particular, the examples illustrated the practical benefits of using normal approximations for binomial and Poisson distributions, with continuity correction playing a key role in improving approximation accuracy.

The log-normal distribution proved effective in modeling stock returns, capturing the skewed nature of financial data, while the Maxwell-Boltzmann distribution offered a reliable model for particle speeds in thermal equilibrium. Finally, the Chi-squared distribution was shown to be a powerful tool for hypothesis testing, providing a rigorous method for analyzing categorical data and testing the goodness-of-fit.

These examples highlight the importance of selecting the appropriate continuous distribution for the problem at hand. When applied correctly, continuous distributions can significantly enhance the accuracy and efficiency of statistical models, leading to better decision-making and more reliable simulations across a wide range of disciplines.

REFERENCES

[1] A. Shukur, Ahmed Shawki Jaber, M. RASHEED, and Tarek Saidani, “Decomposing Method for Space-Time Fractional Order PDEs,” Al-Salam journal for engineering

and technology, vol. 3, no. 2, pp. 1–11, May 2024, doi: https://doi.org/10.55145/ajest.2024.03.02.01.
[2] A. Zubaidi, Lamyaa Mahdi Asaad, Iqbal Alshalal, and M. Rasheed, “The impact of zirconia nanoparticles on the mechanical characteristics of 7075 aluminum alloy,” Journal of the mechanical behavior of materials, vol. 32, no. 1, Jan. 2023, doi: https://doi.org/10.1515/jmbm-2022-0302.
[3] Ahcen Keziz, M. Heraiz, F. Sahnoune, and M. Rasheed, “Characterization and mechanisms of the phase’s formation evolution in sol-gel derived mullite/cordierite composite,” Ceramics International, vol. 49, no. 20, pp. 32989–33003, Oct. 2023, doi: https://doi.org/10.1016/j.ceramint.2023.07.275.
[4] A. Jaber, M. Ismael, T. Rashid, Mohammed Abdulhadi Sarhan, M. Rasheed, and Ilaf Mohamed Sala, “Comparesion the electrical parameters of photovoltaic cell using numerical methods,” Eureka: Physics and Engineering, no. 4, pp. 29–39, Jul. 2023, doi: https://doi.org/10.21303/2461-4262.2023.002770.
[5] D. Bouras and M. Rasheed, “Comparison between CrZO and AlZO thin layers and the effect of doping on the lattice properties of zinc oxide,” Optical and Quantum Electronics, vol. 54, no. 12, Oct. 2022, doi: https://doi.org/10.1007/s11082-022-04161-1.
[6] D. Bouras, M. Fellah, A. Mecif, R. Barillé, A. Obrosov, and M. Rasheed, “High photocatalytic capacity of porous ceramic-based powder doped with MgO,” Journal of the Korean Ceramic Society, Oct. 2022, doi: https://doi.org/10.1007/s43207-022-00254-5.
[7] Aasim Jasim Hussein, Mustafa Nuhad Al-Darraji, and M. Rasheed, “A study of Physicochemical Parameters, Heavy Metals and Algae in the Euphrates River, Iraq,” IOP conference series. Earth and environmental science, vol. 1262, no. 2, pp. 022007–022007, Dec. 2023, doi: https://doi.org/10.1088/1755-1315/1262/2/022007.
[8] Ahmed Shawki Jaber, M. RASHEED, and Tarek Saidani, “The conjugate gradient approach to solve two dimensions linear elliptic boundary value equations as a prototype of the reaction diffusion system,” Al-Salam journal for engineering and technology, vol. 3, no. 1, pp. 157–168, Jan. 2024, doi: https://doi.org/10.55145/ajest.2024.03.01.014.
[9] Ahcen Keziz, M. Rasheed, M. Heraiz, F. Sahnoune, and A. Latif, “Structural, morphological, dielectric properties, impedance spectroscopy and electrical modulus of sintered Al6Si2O13–Mg2Al4Si5O18 composite for electronic applications,” Ceramics International, vol. 49, no. 23, pp. 37423–37434, Dec. 2023, doi: https://doi.org/10.1016/j.ceramint.2023.09.068.
[10] Ahcen Keziz, Meand Heraiz, M. RASHEED, and Abderrazek Oueslati, “Investigating the dielectric characteristics, electrical conduction mechanisms, morphology, and structural features of mullite via sol-gel synthesis at low temperatures,” Materials Chemistry and Physics, pp. 129757–129757, Jul. 2024, doi: https://doi.org/10.1016/j.matchemphys.2024.129757.
[11] A. Raghdi, Menad Heraiz, M. Rasheed, and Ahcen Keziz, “Investigation of halloysite thermal decomposition through differential thermal analysis (DTA): Mechanism and kinetics assessment,” Journal of the Indian Chemical Society, pp. 101413–101413, Oct. 2024, doi: https://doi.org/10.1016/j.jics.2024.101413.
[12] Aasim Jasim Hussein, Mustafa Nuhad Al-Darraji, M. Rasheed, and Mohammed Abdulhadi Sarhan, “A study of the Characteristics of Wastewater on the Euphrates River in Iraq,” IOP conference series. Earth and environmental science, vol. 1262, no. 2, pp. 022005–022005, Dec. 2023, doi: https://doi.org/10.1088/1755-1315/1262/2/022005.
[13] Djelel Kherifi, Ahcen Keziz, M. Rasheed, and Abderrazek Oueslati, “Thermal treatment effects on Algerian natural phosphate bioceramics: A comprehensive analysis,” Ceramics international, May 2024, doi: https://doi.org/10.1016/j.ceramint.2024.05.317.
[14] D. Bouras, M. Rasheed, R. Barille, and M. N. Aldaraji, “Efficiency of adding DD3+(Li/Mg) composite to plants and their fibers during the process of filtering solutions of toxic organic dyes,” Optical Materials, vol. 131, p. 112725, Sep. 2022, doi: https://doi.org/10.1016/j.optmat.2022.112725.
[15] D. Bouras, Mamoun Fellah, Régis Barille, Mohammed Abdul Samad, M. Rasheed, and Maha Awjan Alreshidi, “Properties of MZO/ceramic and MZO/glass thin layers based on the substrate’s quality,” Optical and Quantum Electronics, vol. 56, no. 1, Dec. 2023, doi: https://doi.org/10.1007/s11082-023-05778-6.
[16] T. Rashid, Musa Mohd Mokji, and M. Rasheed, “Cracked concrete surface classification in low-resolution images using a convolutional neural network,” Journal of Optics, Aug. 2024, doi: https://doi.org/10.1007/s12596-024-02080-w.
[17] Selma, M. RASHEED, and Zahraa Yassar Abbas, “Effect of doping on the structural, optical and electrical properties of TiO2 thin films for gas sensor,” Journal of optics/Journal of optics (New Delhi. Print), May 2024, doi: https://doi.org/10.1007/s12596-024-01913-y.
[18] M. Al-Darraji, S. Jasim, O. Salah Aldeen, A. Ghasemian, and M. Rasheed, “The Effect of LL37 Antimicrobial Peptide on FOXE1 and lncRNA PTCSC 2 Genes Expression in Colorectal Cancer (CRC) and Normal Cells,” Asian Pacific Journal of Cancer Prevention, vol. 23, no. 10, pp. 3437–3442, Oct. 2022, doi: https://doi.org/10.31557/apjcp.2022.23.10.3437.
[19] M. Rasheed, M. N. Al-Darraji, S. Shihab, A. Rashid, and T. Rashid, “Solar PV Modelling and Parameter Extraction Using Iterative Algorithms,” Journal of Physics: Conference Series, vol. 1963, no. 1, p. 012059, Jul. 2021, doi: https://doi.org/10.1088/1742-6596/1963/1/012059.
[20] M. Rasheed, M. Nuhad Al-Darraji, S. Shihab, A. Rashid, and T. Rashid, “The numerical Calculations of Single-Diode Solar Cell Modeling Parameters,” Journal of Physics: Conference Series, vol. 1963, no. 1, p. 012058, Jul.

Manuscript received on: 08/08/2024
Accepted on: 08/09/2024
Published on: 09/09/2024
https://doi.org/10.52688/ASP77384

2021, doi: https://doi.org/10.1088/1742-6596/1963/1/012058.

[21] M. Rasheed, O. Alabdali, S. Shihab, A. Rashid, and T. Rashid, "On the Solution of Nonlinear Equation for Photovoltaic Cell Using New Iterative Algorithms," Journal of Physics: Conference Series, vol. 1999, no. 1, p. 012078, Sep. 2021, doi: https://doi.org/10.1088/1742-6596/1999/1/012078.

[22] M. Rasheed, S. Shihab, O. Alabdali, A. Rashid, and T. Rashid, "Finding Roots of Nonlinear Equation for Optoelectronic Device," Journal of Physics: Conference Series, vol. 1999, no. 1, p. 012077, Sep. 2021, doi: https://doi.org/10.1088/1742-6596/1999/1/012077.

[23] S. M. H. AL-Jawad, M. Rasheed, I. M. Ibrahim, A. S. Sabber, and A. K. Elttayf, "Impact of Copper Doping on Nanocrystalline SnO2 Thin Films Synthesized by Sol-Gel Coating and Chemical Bath Deposition for Gas Sensor Applications," Journal of nano research, vol. 84, pp. 25–40, Sep. 2024, doi: https://doi.org/10.4028/p-4frfak.

[24] E. Kadri, M. Krichen, R. Mohammed, A. Zouari, and K. Khirouni, "Electrical transport mechanisms in amorphous silicon/crystalline silicon germanium heterojunction solar cell: impact of passivation layer in conversion efficiency," Optical and Quantum Electronics, vol. 48, no. 12, Nov. 2016, doi: https://doi.org/10.1007/s11082-016-0812-7.

[25] S. Shihab, M. Rasheed, O. Alabdali, and A. A. Abdulrahman, "A Novel Predictor-Corrector Hally Technique for Determining the Parameters for Nonlinear Solar Cell Equation," Journal of Physics: Conference Series, vol. 1879, no. 2, p. 022120, May 2021, doi: https://doi.org/10.1088/1742-6596/1879/2/022120.

[26] M. Rasheed, O. Y. Mohammed, S. Shihab, and A. Al-Adili, "Explicit Numerical Model of Solar Cells to Determine Current and Voltage," Journal of Physics: Conference Series, vol. 1795, no. 1, p. 012043, Mar. 2021, doi: https://doi.org/10.1088/1742-6596/1795/1/012043.

[27] M. Rasheed, S. Shihab, O. Y. Mohammed, and A. Al-Adili, "Parameters Estimation of Photovoltaic Model Using Nonlinear Algorithms," Journal of Physics: Conference Series, vol. 1795, no. 1, p. 012058, Mar. 2021, doi: https://doi.org/10.1088/1742-6596/1795/1/012058.

[28] M. Rasheed, SuhaShihab, O. Alabdali, and H. H. Hassan, "Parameters Extraction of a Single-Diode Model of Photovoltaic Cell Using False Position Iterative Method," Journal of Physics: Conference Series, vol. 1879, no. 3, p. 032113, May 2021, doi: https://doi.org/10.1088/1742-6596/1879/3/032113.

[29] E. Kadri, K. Dhahri, R. Barillé, and M. Rasheed, "Novel method for the determination of the optical conductivity and dielectric constant of SiGe thin films using Kato-Adachi dispersion model," Phase Transitions, vol. 94, no. 2, pp. 65–76, Feb. 2021, doi: https://doi.org/10.1080/01411594.2020.1832224.

Manuscript received on: 08/08/2024
Accepted on: 08/09/2024
Published on: 09/09/2024
 https://doi.org/10.52688/ASP77384

[30] Farouk BOUDOU, Abdelmadjid GUENDOUZI, A. BELKREDAR, and M. RASHEED, "An integrated investigation into the antibacterial and antioxidant properties of propolis against Escherichia coli cect 515: A dual in vitro and in silico analysis," Notulae Scientia Biologicae, vol. 16, no. 2, pp. 13837–13837, May 2024, doi: https://doi.org/10.55779/nsb16211837.

[31] M. A. Sarhan, S. Shihab, B. E. Kashem, and M. Rasheed, "New Exact Operational Shifted Pell Matrices and Their Application in Astrophysics," Journal of Physics: Conference Series, vol. 1879, no. 2, p. 022122, May 2021, doi: https://doi.org/10.1088/1742-6596/1879/2/022122.

[32] O. Alabdali, S. Shihab, M. Rasheed, and T. Rashid, "Orthogonal Boubaker-Turki polynomials algorithm for problems arising in engineering," 3RD INTERNATIONAL SCIENTIFIC CONFERENCE OF ALKAFEEL UNIVERSITY (ISCKU 2021), 2022, doi: https://doi.org/10.1063/5.0066860.

[33] Manel Sellam, M. Rasheed, S. Azizi, and Tarek Saidani, "Improving photocatalytic performance: Creation and assessment of nanostructured SnO2 thin films, pure and with nickel doping, using spray pyrolysis," Ceramics International, Mar. 2024, doi: https://doi.org/10.1016/j.ceramint.2024.03.094.

[34] M. Enneffatia, M. Rasheed, B. Louatia, K. Guidaraa, S. Shihab, and R. Barillé, "Investigation of structural, morphology, optical properties and electrical transport conduction of Li0.25Na0.75CdVO4 compound," Journal of Physics: Conference Series, vol. 1795, no. 1, p. 012050, Mar. 2021, doi: https://doi.org/10.1088/1742-6596/1795/1/012050.

[35] W. Saidi, Nasreddine Hfaidh, M. Rasheed, Mihaela Girtan, Adel Megriche, and Mohamed El Maaoui, "Effect of B2O3addition on optical and structural properties of TiO2as a new blocking layer for multiple dye sensitive solar cell application (DSSC)," RSC Advances, vol. 6, no. 73, pp. 68819–68826, Jan. 2016, doi: https://doi.org/10.1039/c6ra15060h.

[36] M. Darraji, L. Saqban, T. Mutar, M. Rasheed, and A. Hussein, "Association of Candidate Genes Polymorphisms in Iraqi Patients with Chronic Kidney Disease," Journal of Advanced Biotechnology and Experimental Therapeutics, vol. 6, no. 1, p. 687, 2022, doi: https://doi.org/10.5455/jabet.2022.d147.

[37] I. Alshalal, H. M. I. Al-Zuhairi, A. A. Abtan, M. Rasheed, and M. K. Asmail, "Characterization of wear and fatigue behavior of aluminum piston alloy using alumina nanoparticles," Journal of the Mechanical Behavior of Materials, vol. 32, no. 1, Jan. 2023, doi: https://doi.org/10.1515/jmbm-2022-0280.

[38] M. Rasheed, M. N. Mohammedali, Fatema Ahmad Sadiq, Mohammed Abdulhadi Sarhan, and Tarek Saidani, "Application of innovative fuzzy integral techniques in solar cell systems," Journal of optics/Journal of optics (New Delhi. Print), Jun. 2024, doi: https://doi.org/10.1007/s12596-024-01928-5.

[39] M. Rasheed et al., "Effect of caffeine-loaded silver nanoparticles on minerals concentration and antibacterial

activity in rats," Journal of advanced biotechnology and experimental therapeutics, vol. 6, no. 2, pp. 495–495, Jan. 2023, doi: https://doi.org/10.5455/jabet.2023.d144.

[40] N. Assoudi et al., "Comparative examination of the physical parameters of the sol gel produced compounds La0.5Ag0.1Ca0.4MnO3 and La0.6Ca0.3Ag0.1MnO3," Optical and Quantum Electronics, vol. 54, no. 9, Jul. 2022, doi: https://doi.org/10.1007/s11082-022-03927-x.

Manuscript received on: 08/08/2024
Accepted on: 08/09/2024
Published on: 09/09/2024
 https://doi.org/10.52688/ASP77384