World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(Research Article)

Check for updates

Inverse Method for Order n Matrix

Kasimu Juma Ahmed [1,*], Bashir Saidu Musa [2], Mustapha Muhammad Lamido [3], Shehu Adamu [4], Muhammad Bello Mustapha [5] and Ado Bappayo [6]

[1] *Department of Mathematics and Statistics, Federal Polytechnic Bali, Taraba, Nigeria.*
[2] *Department of Mathematical Sciences, Gombe State University, Nigeria.*
[3] *Department of Mathematics and Statistics, Federal Polytechnic Bauchii, Nigeria.*
[4] *Department of Computer Science, Federal Polytechnic Bali, Taraba, Nigeria.*
[5] *Department of Science Laboratory Technology, Federal Polytechnic Bali, Taraba, Nigeria.*
[6] *Department of Mathematics and Statistics, Federal Polytechnic Bauchii, Nigeria.*

World Journal of Advanced Research and Reviews, 2025, 26(02), 4148–4157

Publication history: Received on 12 April 2025; revised on 27 May 2025; accepted on 30 May 2025

Article DOI: https://doi.org/10.30574/wjarr.2025.26.2.1978

Abstract

The power of matrix algebra was seen not only in applied mathematics, applied sciences, engineering but also in economics, sociology, modern psychology and industrial management (i.e., system of linear equation, cryptography, optics, signal processing, image processing, graph theory, Machine Learning, Data Science etc.). In practice the matrix inverse methods is suitable only for non-singular small system because the higher the size of the system the more difficult finding the inverse of the system even with the help of software/application. With experience we were able to find the inverse of order 4, 5, … , n matrix with ease and also verified the method by computing $AA^{-1} = I$.

Keywords: Matrix; Determinant; Inverse Method; Cryptography; Data Science

1. Introduction

Matrix (Plural matrices) is a Square or rectangular array of an elements (which are usually numbers) in rows and columns.

The general form of matrix with m rows and n column is:

$$A = \begin{bmatrix} a_{11} & a_{21} & \cdots & a_{1n} \\ a_{12} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix}$$

Which is written in compact form as $A_{mn} = [a_{ij}]_{mn}$

1.1. Statement of the Problem

In practice the matrix inverse methods is suitable only for non-singular small system (2 by 2 and 3 by 3 matrix). Hence, the need for order 4, 5, 6, … , n matrix.

* Corresponding author: Kasimu Juma Ahmed.

1.2. Aim and Objectives of the Study

This research paper aim to solve inverse of 4 by 4, 5 by 5, … , n b y n non-singular matrix.

1.2.1. The specific objectives are to

- find the determinant of n by n matrix
- test for non-singularity of the matrix if singular stop else
- find $Adjoint\ (A) = [\boldsymbol{A_{ij}}]^T$
- Compute $A^{-1} = \frac{1}{\det(A)} \times Adjoint(A)$.
- Verified by computing $AA^{-1} = I$.

1.3. Scope and Limitation

The study is restricted in finding inverse of order 4, 5, … , n non-singular matrix.

1.4. Significance of the Study

The field of matrix is fortunate to be blessed with lots of contribution but scholars used to restrict themselves on 3 by 3 matrix when it comes to matrix inverse method. As an optimizers we dimmed it fit to teach our student how to obtain inverse of order n because we do believe that unravelling the full strength of any method will certainly help our young one to think more deeply and be able to develop more sophisticated devices, applications etc. in time to come [1].

1.5. Operational Definition of Basic Terms

1.5.1. Transpose is an operator that flips a matrix over its diagonal

1.5.2. Sign factor is a + (plus) or – (minus) sign that is attached to each entry element of a matrix (i.e., if $(-1)^{i+j} = even\ then\ the\ sign\ factor\ for\ that\ element\ a_{ij}$ *is + else it must be – (odd))*

1.5.3 Minor $(\boldsymbol{M_{ij}})$ is a determinant of some smaller square matrix generated from the original matrix (say A) by removing one or more of its rows and columns.

1.5.4 Cofactor $(\boldsymbol{A_{ij}})$ it is calculated by multiplying the sign factor by the Minor

1.5.5 Adjoint matrix is the transpose of the cofactor matrix

1.5.6 Determinant is a scalar value computed for a given square matrix

2. History

Matrix concept has ancient roots, with some early ideas found in Chinese mathematics. Over the years, matrices have seen an extended use in research, social science, commerce and are being used in cryptography, computer graphics, economics, chemistry, optics geology, animation, communication, wireless, signal processing, robotics, image processing, machine learning, data science and finance. Matrices also have in particular a wide range of applications in science and have been applied to solve real-world problems. Matrices are used to represent real-world data, message encryption and decryption, cryptography, coding theory, creating 3-D image and 2-D motion, to compress electronic data and to store fingerprint data, robotics and automation, CT scans and MRI scans, in economics to calculate gross domestic products, wireless application protocol, profit prediction, UV spectroscopy, automobiles, etc. The matrices are used in physics while applying Kirchhoff's Laws of Voltage and Current to solve problems, to explore electrical circuits, quantum mechanics and optics, to create graphs, calculate statistics, and conduct scientific research in a variety of domains. Matrices have a long history of use in solving linear equations, dating back to 300BC. [2, 3, 4, 5, 9, 10, 14].

2.1. Overview: Inverse Method

The square matrix A is called an invertible matrix if there exist a square matrix A^{-1} such that $AA^{-1} = I$ (where I is a unit matrix, provided that the two matrices are of the same order). Then A^{-1} is called an invertible matrix of A, denoted by A^{-1}.

It should be noted that, if $A^{-1}$is a square matrix and det. (A) ≠ 0 then A is an invertible matrix, and we always have the property $AA^{-1} = A^{-1}A = I$ and $A^{-1} = \frac{1}{det\,(A)} \times Adj.(A)$ [6, 7, 8, 11, 13, 12, 15].

The divisibility of determinants within square matrices serves as a captivating area of study, offering profound insights into the underlying structures and properties of these mathematical constructs. By exploring the divisibility of determinants, researchers delve into the intricate interplay between the elements within matrices, unraveling patterns and relationships that underpin their mathematical behavior. This pursuit extends beyond mere theoretical conjecture, finding practical relevance in various fields where matrices are indispensable tools for problem-solving and analysis. Understanding the divisibility of determinants empowers professionals to optimize their use of matrices in diverse applications, enhancing their efficacy in tasks ranging from data analysis to algorithm design. Some significant advancements have been made regarding the divisibility among determinants of power matrices. Moreover, the study of the divisibility of determinants within square matrices represents a testament to the enduring relevance and versatility of mathematical concepts across different domains of knowledge. As scholars probe deeper into this phenomenon, they uncover connections that transcend disciplinary boundaries, shedding light on the underlying principles governing complex systems and phenomena.

An invertible matrix must be non-singular, meaning its determinant must be non-vanishing else the system is either linearly dependent or inconsistent. In Cryptography Matrix A is a key matrix which we used to encrypt our message and decrypt our messages by finding A^{-1}. Hence, one of the importance of learning how to find inverse of large systems. In optimization we often pay attention to details (i.e., see how we can come out with a result that is more accurate and more convergent than the existing/common knowledge) [1, 3, 7, 15].

3. Results

3.1. Linear Equation with two variables

Write the system of equation

$$2x + 3y = 4$$

$$5x + 4y = 17$$

In matrix form, find A^{-1}. Hence, solve the simultaneous linear equation

Solution

$$AX = B \quad (1)$$

$$\begin{bmatrix} 2 & 3 \\ 5 & 4 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 4 \\ 17 \end{bmatrix}$$

Table 1 Cofactor of order 2 matrix

$(\boldsymbol{a_{ij}})$th	$\boldsymbol{a_{ij}}$	$(\boldsymbol{-1})^{\boldsymbol{i+j}}$	$\boldsymbol{M_{ij}}$	$\boldsymbol{A_{ij}}$
a_{11}	2	+	4	4
a_{12}	3	-	5	-5
a_{21}	5	-	3	-3
a_{22}	4	+	2	2

$$|A| = det.\,(A) = \sum_{j=1}^{2} a_{1j}\,A_{1j} = a_{11}A_{11} + a_{12}A_{12} \quad (2)$$

$$= 2(4) + 3(-5)$$

$$= -7 \rightarrow \text{non-singular, hence matrix A is invertible}$$

$$A^{-1} = \frac{1}{|A|} \times Adj.(A) \quad (3)$$

$$\text{Adj. (A)} = (A_{ij})^T \quad (4)$$

$$\text{Adj. (A)} = \begin{bmatrix} 4 & -3 \\ -5 & 2 \end{bmatrix}$$

$$A^{-1} = \frac{1}{-7}\begin{bmatrix} 4 & -3 \\ -5 & 2 \end{bmatrix}$$

$$X = A^{-1}B \quad (5)$$

$\begin{bmatrix} x \\ y \end{bmatrix} = \frac{1}{-7}\begin{bmatrix} 4 & -3 \\ -5 & 2 \end{bmatrix}\begin{bmatrix} 4 \\ 17 \end{bmatrix} = \begin{bmatrix} 5 \\ -2 \end{bmatrix}$. Therefore, (x, y) = (5, -2)

3.2. System of Linear Equation with three variables

Write the system of equation in matrix form, find A^{-1}, Hence, solve the simultaneous linear equation

$$x - y + 3z = 5$$

$$4x + 2y - z = 0$$

$$x + 3y + z = 5$$

<u>Solution</u>

AX = B

$$\begin{bmatrix} 1 & -1 & 3 \\ 4 & 2 & -1 \\ 1 & 3 & 1 \end{bmatrix}\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 5 \\ 0 \\ 5 \end{bmatrix}$$

Table 2 Cofactor of order 3 matrix

$(a_{ij})th$	a_{ij}	$(-1)^{i+j}$	M_{ij}	A_{ij}
a_{11}	1	+	5	5
a_{12}	-1	-	5	--5
a_{13}	3	+	10	10
a_{21}	4	-	-10	10
a_{22}	2	+	-2	-2
a_{23}	-1	-	4	-4
a_{31}	1	+	-5	-5
a_{32}	3	-	-13	13
a_{33}	1	+	6	6

$$|A| = \det.(A) = \sum_{j=1}^{3} a_{1j}\, A_{1j} = a_{11}A_{11} + a_{12}A_{12} + a_{13}A_{13} \quad (6)$$

$$= 1(5) + (-1)(-5) + 3(10)$$

= 40 → non-singular, hence matrix A is invertible

$$A^{-1} = \frac{1}{|A|} \times Adj.(A) \quad (7)$$

$$\text{Adj. (A)} = (A_{ij})^T \quad (8)$$

$$\text{Adj. (A)} = \begin{bmatrix} 5 & -5 & 10 \\ 10 & -2 & -4 \\ -5 & 13 & 6 \end{bmatrix}^T = \begin{bmatrix} 5 & 10 & -5 \\ -5 & -2 & 13 \\ 10 & -4 & 6 \end{bmatrix}$$

$$A^{-1} = \frac{1}{40}\begin{bmatrix} 5 & 10 & -5 \\ -5 & -2 & 13 \\ 10 & -4 & 6 \end{bmatrix}$$

$$X = A^{-1}B \quad (9)$$

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \frac{1}{40}\begin{bmatrix} 5 & 10 & -5 \\ -5 & -2 & 13 \\ 10 & -4 & 6 \end{bmatrix}\begin{bmatrix} 5 \\ 0 \\ 5 \end{bmatrix} = \frac{1}{40}\begin{bmatrix} 0 \\ 40 \\ 80 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ 2 \end{bmatrix}.$$

Therefore, (x, y, z) = (0, 1, 2)

3.3. System of Linear Equation with four variables

Write the system

$$w + x + y - z = 2$$

$$4w + 4x + y + z = 0$$

$$w - x - y + 2z = 0$$

$$2w + x + 2y - 2z = 2$$

In matrix form, find A^{-1}. Hence, solve the simultaneous linear equation

Solution

AX = B

Table 3 Cofactor of order 4 matrix

$(a_{ij})th$	a_{ij}	$(-1)^{i+j}$	M_{ij}	A_{ij}
a_{11}	1	+	-9	-9
a_{12}	1	-	2	--2
a_{13}	1	+	27	27
a_{14}	-1	-	-17	17
a_{21}	4	-	-1	1
a_{22}	4	+	0	0
a_{23}	1	-	3	-3
a_{24}	1	+	-2	-2
a_{31}	1	-	-2	-2

a_{32}	-1	-	0	0
a_{33}	-1	+	5	5
a_{34}	2	-	-3	3
a_{41}	2	-	-3	3
a_{42}	2	+	1	1
a_{43}	2	-	10	-10
a_{44}	-2	+	-6	-6

$$|A| = \det.(A) = \sum_{j=1}^{4} a_{1j} A_{1j} = a_{11}A_{11} + a_{12}A_{12} + a_{13}A_{13} + a_{14}A_{14} \quad (10)$$

$$= 1(-9) + 1(-2) + 1(27) + (-1)17$$

= -1 → non-singular, hence matrix A is invertible

$$A^{-1} = \frac{1}{|A|} \times Adj.(A) \quad (11)$$

$$\text{Adj.}(A) = (A_{ij})^T \quad (12)$$

$$\text{Adj.}(A) = \begin{bmatrix} -9 & -2 & 27 & 17 \\ 1 & 0 & -3 & -2 \\ -2 & 0 & 5 & 3 \\ 2 & 1 & 2 & -6 \end{bmatrix}^T = \begin{bmatrix} -9 & 1 & -2 & 3 \\ -2 & 0 & 0 & 1 \\ 27 & -3 & 5 & -10 \\ 17 & -2 & 3 & -6 \end{bmatrix}$$

$$A^{-1} = \frac{1}{-1} \begin{bmatrix} -9 & 1 & -2 & 3 \\ -2 & 0 & 0 & 1 \\ 27 & -3 & 5 & -10 \\ 17 & -2 & 3 & -6 \end{bmatrix}$$

$$X = A^{-1}B \quad (13)$$

$$\begin{bmatrix} w \\ x \\ y \\ z \end{bmatrix} = \frac{1}{-1} \begin{bmatrix} -9 & 1 & -2 & 3 \\ -2 & 0 & 0 & 1 \\ 27 & -3 & 5 & -10 \\ 17 & -2 & 3 & -6 \end{bmatrix} \begin{bmatrix} 2 \\ 0 \\ 0 \\ 2 \end{bmatrix} = \begin{bmatrix} 12 \\ 2 \\ -34 \\ -22 \end{bmatrix}.$$

Therefore, (w, x, y, z) = (12, 2,-34, -22)

3.4. System of Linear Equation with five variables

Write the system of equation

$$2v + 3w + x + y + 4z = 34$$

$$5v + 2w - 4x + 2y + z = 9$$

$$3v + w + 2x + 3y - 5z = -19$$

$$v + 2w + 3x + 4y + 7z = 53$$

$$4v - 3w + 2x - 5y + 2z = 37$$

In matrix form, find A^{-1}. Hence, solve the simultaneous linear equation

Solution

$$AX = B$$

$$\begin{bmatrix} 2 & 3 & 1 & 1 & 4 \\ 5 & 2 & -1 & 2 & 1 \\ 3 & 1 & 2 & 3 & -5 \\ 1 & 2 & 3 & 4 & 7 \\ 4 & -3 & 2 & -5 & 2 \end{bmatrix} \begin{bmatrix} v \\ w \\ x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 34 \\ 9 \\ -19 \\ 53 \\ 37 \end{bmatrix}$$

Table 4 Cofactor of order 5 matrix

$(a_{ij})th$	a_{ij}	$(-1)^{i+j}$	M_{ij}	A_{ij}
a_{11}	2	+	150	150
a_{12}	3	-	1650	--1650
a_{13}	1	+	-516	-516
a_{14}	1	-	-954	954
a_{15}	4	+	126	126
a_{21}	5	-	546	-546
a_{22}	2	+	444	444
a_{23}	-1	-	-840	840
a_{24}	2	+	-432	-432
a_{25}	1	-	162	-162
a_{31}	3	+	-94	-94
a_{32}	1	-	202	-202
a_{33}	2	+	-616	-616
a_{34}	3	-	54	-54
a_{35}	-5	+	366	366
a_{41}	1	-	4	-4
a_{42}	2	+	662	662
a_{43}	3	-	184	-184
a_{44}	4	+	-594	-594
a_{45}	7	-	300	-300
a_{51}	4	+	-248	-248
a_{52}	-3	-	-256	256
a_{53}	2	+	-284	-284
a_{54}	-5	-	-252	252
a_{55}	2	+	-60	-60

$$|A| = \text{det. }(A) = \sum_{j=1}^{5} a_{1j}\, A_{1j} = a_{11}A_{11} + a_{12}A_{12} + a_{13}A_{13} + a_{14}A_{14} + a_{15}A_{15} \text{ ………… } (15)$$

$$= 2(150) + 3\ (-1650) + 1\ (-516) + 1\ (1954) + 4\ (126)$$

$$= -3708 \rightarrow \text{non-singular, hence matrix A is invertible}$$

$$A^{-1} = \frac{1}{|A|} \times Adj.(A) \quad (16)$$

$$\text{Adj. (A)} = (A_{ij})^T \qquad (17)$$

$$\text{Adj. (A)} = \begin{bmatrix} 150 & -1650 & -516 & 954 & 126 \\ -546 & 444 & 840 & -432 & -162 \\ -94 & -202 & -616 & -54 & 360 \\ -4 & 662 & -184 & -594 & -300 \\ -248 & 256 & -284 & 252 & -60 \end{bmatrix}^T$$

$$X = A^{-1}B \qquad (18)$$

$$\begin{bmatrix} v \\ w \\ x \\ y \\ z \end{bmatrix} = \frac{1}{-3708} \begin{bmatrix} 150 & -1650 & -516 & 954 & 126 \\ -546 & 444 & 840 & -432 & -162 \\ -94 & -202 & -616 & -54 & 360 \\ -4 & 662 & -184 & -594 & -300 \\ -248 & 256 & -284 & 252 & -60 \end{bmatrix}^T \begin{bmatrix} 34 \\ 9 \\ -19 \\ 53 \\ 37 \end{bmatrix} = \begin{bmatrix} 2 \\ 1 \\ 5 \\ -2 \\ 6 \end{bmatrix}$$

Therefore, (v, w, x, y, z) = (2, 1, 5, -2 6)

4. Discussion

Table 1, 2, 3 & 4 shows the a_{IJ} entry elements of the given matrix, sign factor $(-1)^{i+j}$, minor (M_{ij}) and the respective cofactor (A_{ij}). Equation 1 shows the standard form of writing simultaneous linear equation in matrix form. Equation 2, 6, 10 and 15 present the formula for computing determinant of order 2, 3, 4 and 5 matrix respectively. Equation 3, 7, 11 and 16 present the formula for computing A^{-1} of order 2, 3, 4 and 5 matrix respectively

Equation 4, 8, 12 and 17 present the formula for computing adjoint of order 2, 3, 4 and 5 matrix respectively. Equation 5, 9, 13 and 18 present the formula for computing unknowns of order 2, 3, 4 and 5 matrix respectively. It was proved that inverse method can be applied to non-singular matrix of higher order (i.e., 4, 5, ... , n).

5. Conclusion

Inverse method for solving order n non-singular matrix has been developed. Future research can consider implementing inverse method for solving order n matrix as software package and its deployment to different fields of knowledge.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Ahmed, K. J. (2023). Batch-stochastic sub-gradient method for solving non-smooth convex loss function problems. 3rd International Conference on AI, Machine learning in Communications and Networks (AIMLNET 2023) October 21-22, 2023, Sydney, Australia. DOI: 10.5121/csit.2023.131806.

[2] Antony, R. & Alemayehu, H. (2015). A Note on Special Matrices. Italian Journal of Pure and Applied Mathematics, 35, 587–604.

[3] Brijesh. S. G. (2024). Application of matrices in engineering. International Journal of Science and Research (IJSR) Volume 13 Issue 3, March 2024. DOI: https://dx.doi.org/10.21275/SR24306151438. Paper ID: SR24306151438.

[4] Carl, H., Meyer, S. & Matyas, M. (1982). Cryptography: a new dimension in computer data security; a guide for the design and implementation of secure systems. A Wiley-Interscience Publication. IBM Corporation, Kingston, New York.

[5] Chen, L., & Hong, S. (2020). Divisibility among determinants of power matrices associated with integer-valued arithmetic functions. AIMS Mathematics, 5(3), 1946-1959. https://doi.org/10.3934/math.2020130

[6] Chi, Y., Lu, Y. M., & Chen, Y. (2019). Nonconvex optimization meets low-rank matrix factorization: An overview. IEEE Transactions on Signal Processing, 67(20), 5239-5269.

[7] Dao Le K.O., Le Dinh, H., Do Phuong, T., & Shin-Hung P. (2022). Review of matrix theory with applications in economics and finance. Published: September 2, 2022.

[8] Dymova, L., Sevastjanov, P., and Pilarek, M. (2013), A method for solving systems of linear interval equations applied to the leontief input–output model of economics. Expert Systems with Applications, 40(1), 222-230.

[9] Edelman, A. & Strang, G. (2004). Pascal matrices. Department of mathematics, Massachusetts Institute of Technology. The American Mathematical Monthly, 111, 189-197

[10] Harneet, K.M., Rashmi, V., Salvi, J. & Sonia, A. (2022). Special types of matrices and their applications. SAMIKHIYA A Multidisciplinary Research Journal ISSN: 2583-827X (Online), Vol. 1, Issue 01, Oct.-2022, pp.77-93 Available at: https://journal.mscw.ac.in/Research_Journal/mscw_Journal.aspx

[11] Hau, N. H., Tinh, T. T., Tuong, H. A., and Wong, W. K. (2020). Review of matrix theory with applications in education and decision sciences. Advances in Decision Sciences, 24(1), 1-41

[12] Lee, P. Y. (2005). Secret codes with matrices. Mathematics Teacher, 78 (9), 676 - 680.

[13] Radhakrishna, R. C., and Bhaskara, R. M. (1998), Matrix algebra and its applications to statistics and econometrics, World Scientific.

[14] Rezaifar, O., & Rezaee, H. (2007). A new approach for finding the determinant of matrices. Applied Mathematics and Computation, 188(2), 1445-1454. https://doi.org/10.1016/j.amc.2006.11.010

[15] Sujan, P., Kubilay, D., Kholil, I. M., & Ana, V. (2024). Matrices: Peculiar Determinant. Optimum Science Journal. Property Norfolk State University, Norfolk, Virginia, USA Journal homepage: https://optimumscience.org

Author’s short biography

	**Ado Bappayo:** Currently pursuing M.sc. Mathematics programme at Nasarawa State University Keffi, Nigeria. My recent publication was in “International Journal of Modelling and Applied Science Research. Manuscript ID: CJMA SR:2024-0055. Paper title: Prediction of Clustering Analysis Tool for Highway Traffic Network.
	**Muhammad Bello Mustapha:** Currently pursuing a master’s degree in Applied Ecology from the prestigious Abubakar Tafawa Balewa University, Bauchi, Nigeria. Some of my popularly known publications via Martaba FM Online (English) include the following; Nosocomial infections: Prevention and Universal precautions, Psychoactive effects of non-medical use of cannabis, Leagalization of cannabis (Marijuana) use on medical grounds, how to practice Biosafety Techniques, Intervention of Microorganisms to sustainable agriculture etc.
	**Shehu Adamu:** Currently pursuing Ph.D in Gazi University, Ankara, Turkiye by winning the prestigious scholarship of Turkiye Burslari. Main research mostly focusses in machine learning with application to educational data and agriculture and also have specialization in the role of IT in social development and less privilege environment.

	**Mustapha Muhammad Lamido:** M.Sc. Computational Mathematics holder whose areas of research include matrix analysis and statistical modelling, with a focus on developing computational methods for large scale linear systems and multi-variate statistical techniques. I am actively involved in teaching and mentoring students through research and has contributed to academic development through scholarly publications.
	**Bashir Saidu Musa:** Member of research group named “Mathematics for Innovative Research GSU (GSU-MIR)”, and my area of interest includes Computational optimization and mathematical modelling. M.Sc. Mathematics (Computational Optimization) holder and I have contributed a lot through lecturing and scholarly publications.
	**Kasimu Juma Ahmed:** Computational Optimizer and member Nigerian Society of Physical Sciences (NSPS), International Society for Data Science and Analytics (ISDSA), Professional Statisticians Society of Nigeria (PSSN) and also member Institute of Mathematical Statistics (IMS). Research areas include data science, machine learning etc. I like to always work in growing organization where creativity is encouraged and critical thinking takes centre stage.