

EVALUATING AI-ASSISTED DEVELOPMENT OF MATHEMATICAL ALGORITHMS FOR TIDAL ANALYSIS: A CASE STUDY OF BONNY PORT, NIGERIA

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ABSTRACT

Artificial intelligence (AI) is a branch of computer science that deals with the research and development of simulating and extending human intelligence theory, methods, and applications in technical science. This study evaluates the contribution of AI tools to the development of mathematical algorithms and programming code for tidal analysis at the Bonny Port, Nigeria. The Twenty (20) best AI coding tools were employed for the retrieval of mathematical algorithms for long period tidal analysis, computations of orbital elements (s, h, P, N and P¹), astronomical argument (E), nodal correction (u) and nodal factor (f), formation of the Normal (N) matrix from the design (A) Matrix, inversion of the N matrix by Least Squares Method (LSM) and monthly tidal analysis for the year 2018. Results obtained from each of the 20 best AI tools were evaluated compared with each other using a Likert scale of 1-5 point rating scale method based on their significance. Also, the results from each of the 20 best AI coding tools were compared with the results produced by the Author's code using the same Likert scale of 1-5 point rating scale method. Each of the 20 AI tools contributed its results that enhance this study, although to various degrees. The Author's codes presented complete results of monthly tidal analysis in which tidal constants (H, g) for the 28 primary constituents of tide are presented and the monthly Mean Sea Level (MSL). This study shows that AI tools have brought advancements to the development of programming codes, but with some critical issues, such as the nature of some AI models and algorithms used, the interpretation of the codes, and accuracy. This study also shows that AI is augmenting human capabilities and reducing their workload. Therefore, it can be concluded that AI coding tools are enhancing the development of mathematical algorithms and programming codes, and also improving data processing and analysis for tidal analysis for the Bonny port, Nigeria. However, AI is not a replacement for human skills.

Keywords: Artificial Intelligence (AI), Algorithms, Programming Codes, Tidal Analysis, Least Squares Method (LSM), Tidal Constants, Mean Sea Level (MSL).

INTRODUCTION

Artificial intelligence (AI) is an interdisciplinary (Wang, 2023; Yuan & Liu, 2024) branch of computer science that deals with the research and development of simulation and extension of human intelligence theory, method, and application of technical science (Lei, 2022; Khade & Sambhe, 2025) using intelligent machines that resemble human intelligence, including machine learning, computer vision (Khade & Sambhe, 2025), robots, language recognition, image recognition, natural language processing, and expert systems (Yuan & Liu, 2024). AI can be described as the

simulation of the human mind to make computers think, make decisions (Yuan & Liu, 2024); and act like humans by performing tasks like learning and problem-solving based on the data it processes (Zhang & Lu, 2021; Wang, 2023; Mathews & Nagappan, 2024). Furthermore, AI exhibited by machines or software (Saini et al., 2025), and it's enhancing human life in several areas of endeavours (Patit et al., 2023). There is continuous improvement of AI theoretical technology and the expansion of its scope of applications (Yuan & Liu, 2024).

AI is an embodiment of mathematics, linear algebra, probability theory (Li et al., 2025), statistics, calculus, and various mathematical theories (Gajbhiye et al., 2024; Opesemowo et al., 2024; Ximenes, 2025). Mathematics is an essential cornerstone in the understanding and applications of AI (Opesemowo et al., 2024). Mathematics, as a basic science, makes AI a standardized science (Vortia, 2025); provides the theoretical foundation and methodology for AI algorithms (Li et al., 2025) and models (Holman et al., 2025). Therefore, Mathematics is the indispensable foundation for the development of AI and models (Yuan & Liu, 2024; Holman et al., 2025; Ximenes, 2025). Mathematics is an essential part of AI development and promotion of innovations (Yuan & Liu, 2024; Vortia, 2025).

Mathematics has assumed an important and irreplaceable role in the development of AI and plays a key role in all stages of its development (Asy'ari & Sharov, 2024). Mathematical methods in the application of AI scenarios continue to improve and develop in order to promote scientific intelligence (Asy'ari & Sharov, 2024). AI is the flower blossomed by the theory of mathematical science (Barrientos et al., 2024). In intelligent algorithms, the role of mathematics and to the entire formalized logical dimension is highlighted (Odeh et al., 2024; Wu, 2025). Therefore, mathematics is the essential connotation of AI, while AI is the external appearance of mathematical theory (Barrientos et al., 2024).

An algorithm is a simple set of instructions constructed to accomplish a task (UK Artificial Intelligence Council, 2018; EU Ethics, 2019; Zongben, 2021). An algorithm is a series of steps taken to solve a particular problem or achieve a definite result (Huang & Wang, 2018). The specific steps required to solve a problem are the algorithms needed to write a program, which is the finite number of steps required for a computer to complete a task (Li et al., 2025). The algorithm is the cornerstone of AI, the source of the vigour of machine learning, and the degree of intelligence of the machine, depending on the algorithm (Yuan & Liu, 2024). Therefore, the algorithm is an element that acts as a bridge between mathematics and AI (Lei, 2022; Tang, 2025).

Algorithms demonstrate the innovative ability and potential of AI technology in different fields and applications (Li et al., 2025). Algorithms determine the intelligence (Holman et al., 2025), humanization, and generalization ability of models (Asy'ari & Sharov, 2024); and also affect the speed of innovation and the scope of applications (Tang, 2025). Algorithms are the core element of AI competition and the driving force for progress (Yuan & Liu, 2024; Mo & Wang, 2025). Algorithms are considered programs for solving a given type of mathematical problem (EU Ethics, 2019). AI algorithms are implemented using programming codes (Xiaojun, 2021; Mathews & Nagappan, 2024).

Hence, Mathematics and algorithms play an important and irreplaceable role in the process of the AI journey (Yuan & Liu, 2024; Lin & Zhou, 2025). The principle of the AI field integrates mathematics, algorithm theory, and practice (Borah, 2024). The practical use of mathematical theories and algorithms that are constantly improved and optimized is indispensable to AI (Yuan & Liu, 2024).

Programming codes provide the means to create AI systems, train them, and make them operational (Saini et al., 2025). AI is a coding process that transforms input data into a desired output based on a specified computation (Lei, 2022). Also, AI introduces new programming paradigms and tools focused on enabling machines to learn and solve problems autonomously (Lee & Davis, 2025). The flexibility of AI allows it to solve complex problems that standard programming struggles with (Adetiba et al., 2021; Dwianto et al., 2025). AI takes input that describes the purpose of the code, and makes contextual recommendations for code that developers can work with and refine (Kosmyrna et al., 2025; Qian, 2025). AI-powered analysis tools improved the speed and accuracy of testing and identifying bugs in code (Wang et al., 2024; Rahe & Maalej, 2025); generate structure or boilerplate code to get started faster (Li et al., 2025); great for handling repetitive tasks (Lin & Chen, 2024; Kohen-Vacs et al., 2025). The customized AI-generated code suits the specific needs of the project (Zhou & Peng, 2025). In addition, AI is heavily dependent on programming languages and techniques to function (Khade & Sambhe, 2025).

However, despite these advancements, challenges remain in the AI-assisted software development (Tang, 2025). Critical concerns and issues such as model bias and interpretability, accuracy, code security, data quality, context, ethics, and explainability need to be addressed to ensure the reliability and ethical usage of AI-generated code (Saini et al., 2025). In addition, the "black box" nature of some AI algorithms raises concerns about trust, transparency, and accountability, especially in safety-critical or regulated environments (Svyatkovskiy et al., 2019). Furthermore, as AI is a powerful tool, it's not a replacement for human skills but to empower them by augmenting their capabilities, reducing their workload, and enabling them to focus on the creative and strategic aspects of software engineering (Song et al., 2024; Takerngsaksiri et al., 2024; Xu, 2024; Dwianto et al., 2025; Saini et al., 2025).

Figure 1 shows the relationship among mathematics, algorithms, programming codes, and AI.

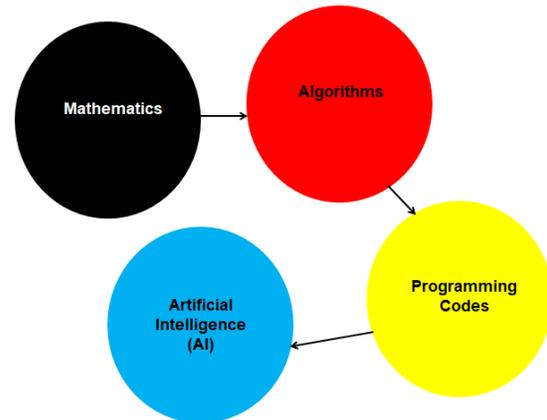


Figure 1: Relationship among Mathematics, Algorithms, Programming Codes, and Artificial Intelligence

The crucial gap before this research is that limited research has been published to date in exploring AI tools for the development of the mathematical algorithms, programming codes, and data processing for marine studies (Morakinyo, 2024a, b; Morakinyo, 2025) with specific to the analysis of tide for the only primary port (Bonny port) located in the Rivers State, Niger Delta region, Nigeria. Also, no previous research has applied the methodology discussed in this study. The basis for this research is the concept that combining the author's mathematical algorithms and programming codes with AI algorithms and programming codes would result in significantly better data computation, processing, and analysis that give better results.

Therefore, the three (3) basic research questions for this study are: (1) What are the minimum twenty (20) best AI coding tools that can be used in this study? (2) What are the contributions of the 20 best AI on the development of mathematical algorithms, programming codes, data processing, and analysis with a focus on tidal analysis? (3) Do the 20 best AI tools provide the expected results for the observations? The overall aim of this study is to evaluate the impact of AI coding tools on the development of mathematical algorithms, programming codes, data processing, and analysis for tidal analysis for the Bonny port, Nigeria, and to compare the results obtained from the AI coding tools with the results obtained from the Author's programming codes. The following objectives are set for this study: (1) Selection of the 20 best AI coding tools that can be used for the long period tidal analysis; (2) Comparison of mathematical algorithms and programming codes obtained from each of the 20 best AI tools and that of the Author; (3) Assessing the level of the contribution of each of the 20 best AI coding tools to the development of mathematical algorithms, and programming codes used for this study; (4) Monthly tidal analysis using Least Square Adjustment Method (LSM); and (5) Comparison of the results obtained from the 20 best AI tools and that of the Author.

MATERIALS AND METHODS

Study Site

Bonny Port is located at Bonny town, the coastal town in Rivers State, Nigeria, and it is the only primary tidal station for Nigeria (Morakinyo, 2024 a, b). The Bonny tidal station is the only internationally published primary port for Nigeria to date (Morakinyo, 2024 b). The Bonny tidal station is located at the

geographical coordinate of Latitude 4° 27' N and Longitude 7° 10' E. Figures 2A, 2B, and 2C show the location of Bonny town in Rivers State, the location of Bonny port, and the exact location of the tidal recording station, respectively.

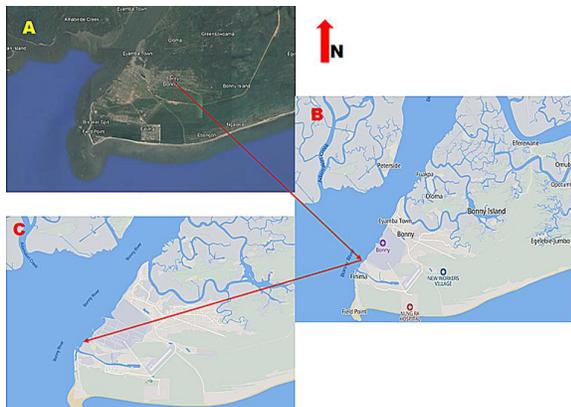


Figure 2: A) Bonny Town in Rivers State: B) Location of Bonny Port: C) Location of Tidal Station.

Study Data

The year 2018 data from January to December were used for this study. The data were recorded every minute of each day on a monthly basis. Table 1 presents the sample of one hour of corrected water level (CWL) reading for 01/01/2018. Table 2 shows the lowest and highest water level readings recorded for the year 2018.

Table 1: Sample of One Hour of Corrected Water Level Readings (CWLR) for Bonny Port on 01/01/2018.

S/N	CWLR	Observed time (A.M)	S/N	CWLR	Observed time (A.M)
1	1.90	7.01	31	1.88	7.31
2	1.89	7.02	32	1.87	7.32
3	1.90	7.03	33	1.86	7.33
4	1.88	7.04	34	1.87	7.34
5	1.89	7.05	35	1.87	7.35
6	1.88	7.06	36	1.88	7.36
7	1.87	7.07	37	1.86	7.37
8	1.88	7.08	38	1.87	7.38
9	1.86	7.09	39	1.85	7.39
10	1.85	7.10	40	1.85	7.40
11	1.87	7.11	41	1.85	7.41
12	1.87	7.12	42	1.89	7.42
13	1.89	7.13	43	1.90	7.43
14	1.88	7.14	44	1.90	7.44
15	1.85	7.15	45	1.89	7.45
16	1.84	7.16	46	1.88	7.46
17	1.86	7.17	47	1.85	7.47
18	1.87	7.18	48	1.84	7.48
19	1.86	7.19	49	1.83	7.49
20	1.86	7.20	50	1.84	7.50
21	1.88	7.21	51	1.84	7.51
22	1.85	7.22	52	1.85	7.52
23	1.84	7.23	53	1.88	7.53
24	1.84	7.24	54	1.87	7.54
25	1.83	7.25	55	1.88	7.55
26	1.84	7.26	56	1.86	7.56
27	1.83	7.27	57	1.86	7.57
28	1.85	7.28	58	1.87	7.58
29	1.86	7.29	59	1.88	7.59
30	1.86	7.30	60	1.88	8.00

Table 2: Lowest and Highest Water Level Readings (m) for 2018 Data

Month	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Lowest	0.45	0.37	0.40	0.39	0.58	0.37	0.61	0.63	0.96	0.93	0.92	0.78
Highest	2.54	2.66	2.61	2.67	2.53	2.51	2.45	2.61	3.17	3.12	3.14	2.97

Selection of the Twenty (20) Best AI Coding Tools

In this section, the 20 best AI coding tools used for this study were carefully selected (Table 3). The following criteria are used for the selection of these 20 best AI tools: (1) Their main features, and (2) Their best application areas, which include the development of mathematical algorithms, programming codes, and data analysis.

Comparison of Mathematical Algorithms and Programming Codes for each of the 20 Best AI tools and the Author's Own Mathematical Equation

The Author employed the general basic equation for tide (Eqn. 1) for the study. Also, each of the AI tools was used for the retrieval of this general basic equation for the presentation title. All 20 of the best AI tools provided this basic equation as shown in equation 1 (Abubakar et al., 2021; Morakinyo, 2024 a, b; Rusdin et al., 2024).

$$h_t = h_0 + \sum_{i=1}^m f_i H_i \cos(E_i + u_i + n_i t - g_i) \quad (1)$$

(Morakinyo, 2024b; Morakinyo, 2024a; Meriman, 1985)

Where,

h_0 = The height of Mean Sea Level above the chart datum;

f = The Nodal factor;

H = The Amplitude constant;

E_i = The phase of the theoretical tide raising force at Greenwich. It increases at a rate n°/hr ;

u_i = The Nodal correction to phase lag;

n_i = The speed of constituents in $^\circ/\text{hr}$;

t_i = the time of observations;

g = The Phase lag constant at the place of observation;

h_t = The height of tide above chart datum;

m = The number of constituents.

From equation 1, the required parameters for tidal analysis are h_t , E_i , n_i , f_i , u_i , and t_i

Mathematical Algorithms

All the selected 20 best AI coding tools (Table 5) were employed to retrieve and study the mathematical algorithms for tide and its analysis.

Computation of Orbital Elements (s, h, P, N, and P¹), Astronomical Argument (E), Nodal Correction (u), and Nodal Factor (f)

In this section, each of the 20 best AI coding tools (Saharawat, 2025; Salminen, 2025)(Table 5) was used for the retrieval of codes for the computation of orbital elements(s, h, P, N, and P¹), astronomical argument (E), nodal correction (u), and nodal factor (f). Each of the tools produced different results (Table 6).

Formation of the Normal Matrix (N) from the Design Matrix (A) and Inversion of the N

Matrix by Least Squares Method (LSM)

Each of the 20 best AI tools was applied to the retrieval of codes for the formation of Normal

(N) matrix from the design matrix (A), and for the inversion of the N matrix using Least Squares

Method.

Monthly Analysis of Tide

The selected 20 best AI tools were applied to each for the retrieval of codes for the monthly analysis of the tide. Each tool produced different results.

Mathematical Algorithms, Computation of Orbital Elements, Astronomical Argument (E), Nodal Correction (u), Nodal Factor (f), Formation of the N Matrix from the A Matrix, and Inversion of the N matrix by the Least Squares Method (LSM) Using the Author's Algorithms and Programming Codes

The mathematical algorithms and programming codes developed by the Author were also used for this study. This is to enable the comparison of the results produced by each of the 20 best AI tools and the Author's own. The algorithms were developed to follow sequential processes for the analysis of the tide. The orbital elements (s, h, P, N and P¹) (Merriman, 1985) were first computed, followed by the determination of astronomical argument (E), nodal correction (u), nodal factor (f), formation of the normal matrix (N) from the design matrix (A), and the inversion of the N matrix using the LSM.

From equation 1, the astronomical arguments (E) and the Nodal corrections (u and f) for each harmonic constituent are computed as functions of the five orbital elements s, h, P, N, and P¹ (Merriman, 1985).

Where,

s = Mean longitude of the moon, increasing by 0.0549017° per mean solar hour;

h = Mean longitude of the sun, increasing by 0.041068° per mean solar hour;

P = Mean longitude of lunar perigee, increasing by 0.0004642° per mean solar hour;

N = Mean longitude of the moon's ascending node, increasing by 0.002206° ;

P^1 = Mean longitude of the solar perigee, increasing by 0.000002° per mean solar hour.

The orbital elements are calculated from the following equations:

$$s = 277.02^\circ + 129.3848^\circ (Y - 1900) + 13.1764^\circ (D + i) \quad (2)$$

$$h = 280.19^\circ - 0.2387^\circ (Y - 1900) + 0.9857^\circ (D + i) \quad (3)$$

$$P = 334.39^\circ + 40.6625^\circ (Y - 1900) + 0.1114^\circ (D + i) \quad (4)$$

$$N = 259.16^\circ - 19.3282^\circ (Y - 1900) - 0.0530^\circ (D + i) \quad (5)$$

$$P^1 = 282.8^\circ \text{ assumed for the century 1900 to 2000} \quad (6)$$

Where,

Y = Year of observations;

D = Number of days elapsed since January first in the year;

I = The integral part of $0.25 (Y - 1901)$, which is the number of leap years between 1900 and the year Y , excluding Y as the leap day in this year is counted in D (Merriman, 1985).

The basic formula for the computation of equilibrium argument is given by Doodson (Merriman, 1985) as;

$$E = A(h-s)+s(B-5)+h(C-5)+P(D-5)+N(E-5)+P^1(F-5)+90(G - 5) \quad (7)$$

Where,

s, h, P, N, and P¹ are orbital elements
 A, B, C, D, E, F, and G are the Doodson (XDO) numbers, which can be extracted from Table 3.

and they are dependent on the longitude of the ascending node of the moon.

E varies with time because it makes use of orbital elements that vary with time in its computations. Also, u and f are factors varying with a period of 18.6 years, being the nodal cycle of the Moon. u and f are worked out for each complete cycle of about 19 years,

The final formulae for the computation of the astronomic arguments E, u, and f are discussed in Merriman (1985). Table 3 presents the list of 28 primary constituents of tides (Merriman, 1985).

Table 3: List of Twenty-Eight Primary Constituents of Tides (Merriman, 1985).

S/N	Name	XDO	Speed (°/hr)	Nodal Correction (u)	Nodal Factor (f)
1	Zo	0555555	0.00000	N. A	N. A
2	Mm	0654555	0.54437	Zero	Table 4
3	MSf	0735555	1.01590	- M ₂	M ₂
4	Q ₁	1356554	13.39866	O ₁	O ₁
5	O ₁	1455554	13.94304	Table 4	Table 4
6	M ₁	1555556	14.49205	Table 4	Table 4
7	K ₁	1655556	15.04107	Table 4	Table 4
8	J ₁	1754556	15.58544	Table 4	Table 4
9	MU ₂	2375555	27.96821	M ₂	M ₂
10	N ₂	2456555	28.43973	M ₂	M ₂
11	M ₂	2555555	28.98410	Table 4	Table 4
12	L ₂	2654557	29.52848	Table 4	Table 4
13	S ₂	2735555	30.00000	Zero	One
14	MQ ₃	3356554	42.38277	M ₂ + O ₁	M ₂ x O ₁
15	MO ₃	3455554	42.92714	M ₂ + O ₁	M ₂ x O ₁
16	M ₃	3555557	43.47616	Table 3	(√M ₂) ³
17	MK ₃	3655556	44.02517	M ₂ + K ₁	M ₂ x K ₁
18	2MQ ₃	3754556	44.56955	2(M ₂) - O ₁	(M ₂) ² x O ₁
19	3MS ₄	4375555	56.95231	3 (M ₂)	(M ₂) ³
20	MN ₄	4456555	57.42383	2 (M ₂)	(M ₂) ²
21	M ₄	4555555	57.96821	2 (M ₂)	(M ₂) ²
22	SN ₄	4636555	58.43973	M ₂	M ₂
23	MS ₄	4735555	58.98411	M ₂	M ₂
24	4MS ₆	6375555	85.93642	4 (M ₂)	(M ₂) ⁴
25	2MN ₆	6456555	86.40794	3(M ₂)	(M ₂) ³
26	M ₆	6555555	86.95231	3(M ₂)	(M ₂) ³
27	4MN ₆	6654555	87.49669	3(M ₂)	(M ₂) ⁵
28	2MS ₆	6735555	87.96821	2(M ₂)	(M ₂) ²

Table 4 gives details of the expressions for the computation of u and f that are not supplied in Table 3.

Table 4: Computation of nodal corrections u and f (Merriman, 1985).

Constituents	(u) Coefficient for			(f) Coefficient for			
	Sin (N)	Sin (2N)	Sin (3N)	Constant	Cos (N)	Cos (2N)	Cos (3N)
Mf	-23.7	+ 2.70	-0.40	1.043	+0.414	-	-
O ₁	+10.80	- 1.34	+0.19	1.0089	+0.1871	-0.0417	+0.0014
K ₁	-8.86	+ 0.68	-0.07	1.0060	+0.1150	-0.0080	+0.0006
J ₁	-12.94	+ 1.34	-0.19	1.0129	+0.1676	-0.0170	+0.0016
M ₂	-2.14	-	-	1.004	-0.373	+0.0002	-
K ₂	-17.74	+ 0.68	- 0.04	1.0246	+0.2863	+0.0083	-0.0015
M ₃	-3.21	-	-	See Table 3			

The observation equation technique of LSM (Abubakar et al., 2019; Morakinyo, 2024 a, b; Rusdin et al., 2024) is adopted for the monthly tidal analysis, and the inversion of the N matrix by LSM was carried out. The tidal analysis with monthly tidal datasets resulted in the computation of tidal constants (Phase lag (g) and amplitude (H)) for the 28 primary tidal constituents (Table 5); and the monthly Mean Sea Level (MSL) (Madah, 2020; Morakinyo, 2024 a, b). The actual analysis of the monthly tide was carried out accurately using MATLAB programming codes designed by the Author that were based on the Least Squares Adjustment approach. The program was designed to first compute E, u, and f; and to perform the following operations:

1. The formation and generation of the design matrix (A);
2. The formation of the Normal equations (N) from A;
3. Inversion of the Normal matrix by the Least Squares principle;
4. The computations of tidal constants for all twenty-eight (28) primary constituents; and
5. The computation of MSL for every monthly analysis.

The design matrix (A) generated is a 720×55 matrix, i.e., 720 rows and 55 columns. The normal matrix (N) obtained from the matrix A is a 55×55 matrix, the matrix (U) is a 55×1 ; and the matrix of the unknown or parameter (X) is a 55×1 matrix. The

The results obtained from each of the 20 best AI tools are compared to one another in order to assess the performance of each of the tools. Also, each of the result from the AI tools are compared to the results produced by using the author's programming codes in order to evaluate the extent to which the AI has impacted tidal analysis research.

Figure 3 shows the stages of methodology adopted for data processing for this study.

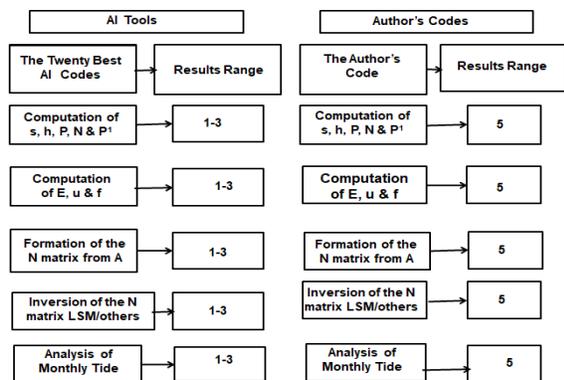


Figure 3: Methodological Flowchart for the Study

stepwise application of the Author's programming codes is:

1. Long or short period (L/S). The choice must be (L), indicating a long period.
2. Enter the number of days, e.g., for January 2018, the number of days is 31, while for February, 2018, the number of days is 28.
3. Enter station code, e.g., for Bonny = 1. Since readings are from Bonny Port, the station code chosen is 1 (one).
4. Enter recording interval in hours (hr), No. of days. For example, for 01/01/2018-31/01/2018, the recording interval is 1 hr while the number of days is 31. Therefore, we have 1, 31.
5. Enter start date and end date. Referring to the above example in step 4, the start date is 1 while the end date is 31, i.e., 1, 31.
6. Enter the correction to gauge zero as given in the field book.

The correction (-0.1) to the zero gauge was applied to the observed data before the creation of the data file.

Comparison of the Twenty Best AI Tools and the Author's Results.

RESULTS AND DISCUSSION

The Twenty (20) Best AI Coding Tools

Table 5 shows the 20 best AI coding tools applied for this study. Table 5 contains four (4) columns, with column 1 for the serial number, column 2 for the name of the specific AI tool, column 3 describing the best area of application of each AI tool used for this study, and column 4 describing the main features of each of the AI tools used.

Table 5: The Twenty (20) Best AI Coding Tools (Saharawat, 2025; Salminen, 2025)

S/N	Tool	Best for	Main Features
1.	GitHub Copilot	VS Code users	Autocompletes code, supports multiple languages, and integrates with VS Code/GitHub
2.	Tabnine	Privacy and control	Local deployment, language-specific models, privacy-first
3.	Cursor AI	All-in-one IDE	AI-powered IDE, chat feature, context-aware refactoring
4.	Windsurf	Learning and teaching	Code generation with explanations, learns from context
5.	Visual Copilot	Design-to-code	Converts Figma designs to React, exports to multiple frameworks
6.	Qodo	Code review automation	Automated PR reviews, highlights bugs/security issues
7.	OpenAI Codex	Custom workflows	Powers tools like Copilot, accessible via API, are highly accurate
8.	AskCodi	All-in-one assistant	Generates code, tests, SQL queries, and documentation
9.	Replit	Cloud coding and learning	Cloud IDE, instant code execution, deploys with one click
10.	Blackbox AI	Coding partner	Autocomplete, search, works across VS Code/JetBrains/Chrome DevTools
11.	ChatGPT (GPT-4o)	Python programming	Conversational AI excels at Python, debugging and explanations
12.	Claude	Python code generation	Advanced Python generation, better at clean, maintainable code
13.	Microsoft Copilot	Microsoft ecosystem users	Integrated with Microsoft 365, automates coding and documentation tasks
14.	DeepSeek Coder	Accurate code generation	Supports multiple languages, emphasizes high accuracy and low error rates
15.	Devin AI	Automating full engineering tasks	Automates code writing, testing, and reviews, collaboration support
16.	CodeGeeX	Open-source AI	Customizable, open-source AI for code generation, supports multiple languages
17.	Amazon Developer Q	AWS developers	AI agent, integrates with AWS services, automates code reviews, enhances security
18.	StarCoder	Customizable LLM	Open-source LLM, customizable for research or commercial use
19.	TabbyML	Open-source AI autocomplete	Local deployment, privacy-focused, supports multiple languages
20.	Sourcegraph	Large codebases, open-source projects	AI-powered code search, deep GitHub/GitLab integration, smart code navigation, multi-language support

Comparison of Results among the Twenty Best AI Coding Tools

In this section, the results produced by each of the 20 best AI codes using the following five (5) parameters: (1) Computation of s, h, P, N and P¹; (2) Computation of E, u and f; (3) Formation of the N matrix from A matrix; (4) Inversion of the N matrix by LSM; and (5) Analysis of monthly tide were evaluated, compared to each other

and analyzed one by one using Likert scale of 1-5 point rating scale method based on their significance. The degree of importance is rated as 5 = Excellent (E); 4 = Very Good (VG); 3 = Good (G); 2 = Fair (F); and 1 = Poor (P). This is to know the strength of each tool in solving each of the parameters, and to evaluate which AI tools provide the top results. Table 6 shows the results obtained.

Table 6: Comparison of Results from Each of the Twenty Best AI Coding Tools

S/N	Tool	Computation of s, h, P, N & P ¹	Computation of E, u & f	Formation of the N matrix from the A matrix	Inversion of the N matrix by LSM	Analysis of Monthly Tide
1.	GitHub Copilot	2	2	3	2	2
2.	Tabnine	1	1	2	2	1
3.	Cursor AI	1	1	2	2	1
4.	Windsurf	2	2	2	2	2
5.	Visual Copilot	2	2	3	2	1
6.	Qodo	1	1	2	1	1
7.	OpenAI Codex	2	3	2	3	3
8.	AskCodi	1	2	1	1	1
9.	Replit	1	1	1	1	1
10.	Blackbox AI	1	1	2	1	2
11.	ChatGPT (GPT-4o)	2	2	3	2	2
12.	Claude	1	1	1	1	1
13.	Microsoft Copilot	2	2	2	1	1

14.	DeepSeek Coder	3	3	3	3	3
15.	Devin AI	2	1	2	1	2
16.	CodeGeeX	1	2	1	1	1
17.	Amazon Q Developer	1	1	1	1	1
18.	StarCoder	1	1	2	1	1
19.	TabbyML	1	1	2	1	1
20.	Sourcegraph	2	2	2	2	1

Results of Orbital Elements for 2018 From the Author's Codes

The computed results of orbital elements s, h, P, N, and P¹ obtained from equations 2-6 using the Author's codes are presented in Table 7.

Table 7: Results of Orbital Elements for 2018

Date	s	h	P	N	P ¹
16/01/2018	150.61	295.23	003.66	162.93	282.80
16/02/2018	199.08	325.80	007.11	161.29	282.80
16/03/2018	208.02	353.40	010.48	159.80	282.80
16/04/2018	256.49	023.95	013.69	158.16	282.80
16/05/2018	291.78	053.52	017.03	156.57	282.80
16/06/2018	340.25	084.08	020.48	154.93	282.80
16/07/2018	015.54	113.65	023.82	153.34	282.80
16/08/2018	064.01	144.21	027.28	151.69	282.80
16/09/2018	112.48	174.76	030.73	150.05	282.80
16/10/2018	147.77	204.34	034.72	148.46	282.80
16/11/2018	196.24	234.89	037.53	146.82	282.80
16/12/2018	231.53	264.46	040.87	145.23	282.80

Comparison of Results among the Twenty Best AI Coding Tools and the Author's Codes

The Author's codes processed the datasets systematically and the expected results for the parameters i.e., computation of orbital elements (h, P, N and P¹); equilibrium arguments (E, u and f); formation of the N matrix from A matrix; inversion of the N matrix by LSM; and analysis of monthly tide used for the assessment were obtained. Hence, the Author's codes performed excellently for all the criteria used.

The results produced by the 20 best AI codes (Table 6) are compared with the results from the Author's codes using the same 5 parameters and a Likert scale of 1-5 point rating scale method. Table 8 shows the results obtained.

Table 8: Comparison of Results from Each of the Twenty Best AI Coding Tools

S/N	Tool	Computation of s, h, P, N & P ¹	Computation of E, u & f	Formation of the N matrix from A matrix	Inversion of the N matrix by LSM	Analysis of Monthly Tide
1.	GitHub Copilot	2	2	3	2	2
2.	Tabnine	1	1	2	2	1
3.	Cursor AI	1	1	2	2	1
4.	Windsurf	2	2	2	2	2
5.	Visual Copilot	2	2	3	2	1
6.	Qodo	1	1	2	1	1
7.	OpenAI Codex	2	3	2	3	3
8.	AskCodi	1	2	1	1	1
9.	Replit	1	1	1	1	1
10.	Blackbox AI	1	1	2	1	2
11.	ChatGPT (GPT-4o)	2	2	3	2	2
12.	Claude	1	1	1	1	1
13.	Microsoft Copilot	2	2	2	1	1
14.	DeepSeek Coder	3	3	3	3	3
15.	Devin AI	2	1	2	1	2
16.	CodeGeeX	1	2	1	1	1
17.	Amazon Q	1	1	1	1	1

	Developer					
18.	StarCoder	1	1	2	1	1
19.	TabbyML	1	1	2	1	1
20.	Sourcegraph	2	2	2	2	1
Author's Codes	MATLAB	5	5	5	5	5

Results of Monthly Tidal Analysis: Computation of Amplitude (H), Phase lag (g), and Mean Sea Level (MSL)

The results obtained from monthly tidal analysis for January to December 2018 data analyzed using the Author's code, are shown in Tables 9-20. The three different results obtained are amplitude

(H), Phase lag (g), and MSL. Both H and g are referred to as tidal constants. The monthly analysis is computed for the H and g of the 28 primary constituents of tide, and the monthly MSL as shown in Tables 9-20.

Table 9: H and g for 28 Primary Constituents of Tide for January 2018

	1	2	3	4	5	6	7	8	9	10
Const.	Z ₀	M _m	MSF	Q ₁	O ₁	M ₁	K ₁	J ₁	MU ₂	N ₂
Amp. (H)	0.00	0.01	0.03	0.00	0.03	0.00	0.14	0.00	0.01	0.11
Phase (g)	0.00	55.56	70.36	193.58	343.50	316.19	18.30	252.85	286.07	114.31
	11	12	13	14	15	16	17	18	19	20
Const.	M ₂	L ₂	S ₂	MQ ₃	MO ₃	M ₃	MK ₃	2MQ ₃	3MS ₄	MN ₄
Amp. (H)	0.66	0.01	0.22	0.00	0.02	0.01	0.03	0.02	0.01	0.02
Phase (g)	146.24	342.16	189.24	225.84	170.52	295.04	335.71	79.70	148.21	119.07
	21	22	23	24	25	26	27	28		
Const.	M ₄	SN ₄	MS ₄	4MS ₆	2MN ₆	M ₆	4MN ₆	2MS ₆	MSL	
Amp. (H)	0.04	0.01	0.02	0.01	0.01	0.02	0.00	0.01	1.459	
Phase (g)	135.73	215.64	230.24	250.77	31.87	75.04	324.40	146.25		

Table 10: H and g for 28 Primary Constituents of Tide for February 2018

	1	2	3	4	5	6	7	8	9	10
Const.	Z ₀	M _m	MSF	Q ₁	O ₁	M ₁	K ₁	J ₁	MU ₂	N ₂
Amp. (H)	0.00	0.04	0.01	0.01	0.03	0.01	0.11	0.01	0.01	0.07
Phase (g)	0.00	254.86	305.17	306.50	350.15	214.43	17.28	151.93	281.09	227.82
	11	12	13	14	15	16	17	18	19	20
Const.	M ₂	L ₂	S ₂	MQ ₃	MO ₃	M ₃	MK ₃	2MQ ₃	3MS ₄	MN ₄
Amp. (H)	0.69	0.01	0.23	0.05	0.04	0.03	0.07	0.03	0.04	0.03
Phase (g)	147.00	294.22	186.17	236.76	117.57	242.81	6.58	230.73	309.91	293.70
	21	22	23	24	25	26	27	28		
Const.	M ₄	SN ₄	MS ₄	4MS ₆	2MN ₆	M ₆	4MN ₆	2MS ₆	MSL	
Amp. (H)	0.09	0.03	0.02	0.03	0.04	0.04	0.03	0.00	1.503	
Phase (g)	188.57	210.60	97.43	236.03	237.93	108.99	355.87	348.34		

Table 11: H and g for 28 Primary Constituents of Tide for March 2018

	1	2	3	4	5	6	7	8	9	10
Const.	Z ₀	M _m	MSF	Q ₁	O ₁	M ₁	K ₁	J ₁	MU ₂	N ₂
Amp. (H)	0.00	0.04	0.04	0.00	0.02	0.00	0.11	0.00	0.01	0.10
Phase (g)	0.00	124.45	329.60	295.31	341.74	215.55	21.99	251.49	68.05	144.60
	11	12	13	14	15	16	17	18	19	20
Const.	M ₂	L ₂	S ₂	MQ ₃	MO ₃	M ₃	MK ₃	2MQ ₃	3MS ₄	MN ₄
Amp. (H)	0.70	0.01	0.26	0.01	0.01	0.01	0.03	0.00	0.01	0.01
Phase (g)	147.89	269.54	188.24	59.66	100.56	236.75	4.39	60.78	92.06	96.56
	21	22	23	24	25	26	27	28		
Const.	M ₄	SN ₄	MS ₄	4MS ₆	2MN ₆	M ₆	4MN ₆	2MS ₆	MSL	
Amp. (H)	0.05	0.01	0.03	0.01	0.01	0.00	0.00	0.00	1.451	
Phase (g)	107.68	199.75	147.15	175.67	311.17	251.59	217.33	352.85		

Table 12: H and g for 28 Primary Constituents of Tide for April 2018

	1	2	3	4	5	6	7	8	9	10
Const.	Z ₀	M _m	MSF	Q ₁	O ₁	M ₁	K ₁	J ₁	MU ₂	N ₂
Amp. (H)	0.00	0.01	0.04	0.01	0.05	0.00	0.07	0.00	0.01	0.12
Phase (g)	0.00	165.45	236.72	120.48	350.79	250.82	21.76	325.79	305.55	171.24
	11	12	13	14	15	16	17	18	19	20
Const.	M ₂	L ₂	S ₂	MQ ₃	MO ₃	M ₃	MK ₃	2MQ ₃	3MS ₄	MN ₄
Amp. (H)	0.69	0.01	0.26	0.01	0.02	0.01	0.02	0.01	0.01	0.03
Phase (g)	148.17	131.21	185.74	54.84	316.47	11.04	326.13	25.53	304.50	68.80
	21	22	23	24	25	26	27	28		
Const.	M ₄	SN ₄	MS ₄	4MS ₆	2MN ₆	M ₆	4MN ₆	2MS ₆	MSL	
Amp. (H)	0.05	0.01	0.03	0.00	0.00	0.01	0.00	0.00	1.453	
Phase (g)	103.98	243.76	126.36	343.94	219.66	18.90	96.11	251.27		

Table 13: H and g for 28 Primary Constituents of Tide for May 2018

	1	2	3	4	5	6	7	8	9	10
Const.	Z ₀	M _m	MSF	Q ₁	O ₁	M ₁	K ₁	J ₁	MU ₂	N ₂
Amp. (H)	0.00	0.01	0.05	0.01	0.03	0.00	0.14	0.00	0.01	0.09
Phase (g)	0.00	136.16	339.63	62.71	351.46	87.80	20.30	175.59	336.64	149.39
	11	12	13	14	15	16	17	18	19	20
Const.	M ₂	L ₂	S ₂	MQ ₃	MO ₃	M ₃	MK ₃	2MQ ₃	3MS ₄	MN ₄
Amp. (H)	0.70	0.01	0.24	0.01	0.03	0.01	0.02	0.01	0.02	0.02
Phase (g)	147.50	47.82	190.98	182.47	204.55	244.46	0.35	125.63	151.73	142.62
	21	22	23	24	25	26	27	28		
Const.	M ₄	SN ₄	MS ₄	4MS ₆	2MN ₆	M ₆	4MN ₆	2MS ₆	MSL	
Amp. (H)	0.04	0.00	0.03	0.01	0.00	0.01	0.01	0.01	1.465	
Phase (g)										

Table 14: H and g for 28 Primary Constituents of Tide for June 2018

	1	2	3	4	5	6	7	8	9	10
Const.	Z ₀	M _m	MSF	Q ₁	O ₁	M ₁	K ₁	J ₁	MU ₂	N ₂
Amp. (H)	0.00	0.11	0.12	0.01	0.03	0.01	0.06	0.00	0.00	0.16
Phase (g)	0.00	156.57	344.64	12.21	347.33	47.99	10.42	297.35	181.79	125.10
	11	12	13	14	15	16	17	18	19	20
Const.	M ₂	L ₂	S ₂	MQ ₃	MO ₃	M ₃	MK ₃	2MQ ₃	3MS ₄	MN ₄
Amp. (H)	0.63	0.00	0.21	0.01	0.02	0.01	0.01	0.01	0.10	0.02
Phase (g)	147.05	269.91	184.86	49.12	91.49	108.80	282.92	123.30	6.67	346.50
	21	22	23	24	25	26	27	28		
Const.	M ₄	SN ₄	MS ₄	4MS ₆	2MN ₆	M ₆	4MN ₆	2MS ₆	MSL	
Amp. (H)	0.02	0.01	0.01	0.00	0.01	0.01	0.01	0.01	1.417	
Phase (g)	71.00	352.86	79.19	349.711	7.01	312.49	107.99	8.95		

Table 15: H and g for 28 Primary Constituents of Tide for July 2018

	1	2	3	4	5	6	7	8	9	10
Const.	Z ₀	M _m	MSF	Q ₁	O ₁	M ₁	K ₁	J ₁	MU ₂	N ₂
Amp. (H)	0.00	0.03	0.02	0.01	0.02	0.00	0.08	0.00	0.01	0.09
Phase (g)	0.00	351.02	322.19	33.08	322.99	180.66	17.35	136.41	183.09	159.25
	11	12	13	14	15	16	17	18	19	20
Const.	M ₂	L ₂	S ₂	MQ ₃	MO ₃	M ₃	MK ₃	2MQ ₃	3MS ₄	MN ₄
Amp. (H)	0.67	0.01	0.26	0.02	0.02	0.01	0.01	0.01	0.01	0.01
Phase (g)	146.07	178.95	189.28	88.74	124.44	5.29	160.02	252.39	87.29	64.35
	21	22	23	24	25	26	27	28		
Const.	M ₄	SN ₄	MS ₄	4MS ₆	2MN ₆	M ₆	4MN ₆	2MS ₆	MSL	
Amp. (H)	0.03	0.00	0.03	0.00	0.01	0.01	0.01	0.01	1.490	
Phase (g)	103.72	169.36	117.59	241.35	108.43	35.04	270.34	65.94		

Table 16: H and g for 28 Primary Constituents of Tide for August 2018

	1	2	3	4	5	6	7	8	9	10
Const.	Z ₀	M _m	MSF	Q ₁	O ₁	M ₁	K ₁	J ₁	MU ₂	N ₂
Amp. (H)	0.00	0.03	0.03	0.01	0.01	0.01	0.02	0.00	0.01	0.11
Phase (g)	0.00	48.17	96.17	8.09	350.80	294.65	19.28	122.62	222.03	158.74
	11	12	13	14	15	16	17	18	19	20
Const.	M ₂	L ₂	S ₂	MQ ₃	MO ₃	M ₃	MK ₃	2MQ ₃	3MS ₄	MN ₄
Amp. (H)	0.68	0.02	0.35	0.02	0.01	0.00	0.02	0.02	0.00	0.01
Phase (g)	147.18	14.65	187.08	304.54	340.80	202.02	300.20	208.56	180.31	70.65
	21	22	23	24	25	26	27	28		
Const.	M ₄	SN ₄	MS ₄	4MS ₆	2MN ₆	M ₆	4MN ₆	2MS ₆	MSL	
Amp. (H)	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	1.529	
Phase (g)										

Table 17: H and g for 28 Primary Constituents of Tide for September 2018

	1	2	3	4	5	6	7	8	9	10
Const.	Z ₀	M _m	MSF	Q ₁	O ₁	M ₁	K ₁	J ₁	MU ₂	N ₂
Amp. (H)	0.00	0.01	0.06	0.01	0.03	0.01	0.13	0.00	0.01	0.09
Phase (g)	0.00	170.65	322.39	48.20	350.30	104.86	19.85	131.17	328.08	147.82
	11	12	13	14	15	16	17	18	19	20
Const.	M ₂	L ₂	S ₂	MQ ₃	MO ₃	M ₃	MK ₃	2MQ ₃	3MS ₄	MN ₄
Amp. (H)	0.67	0.01	0.24	0.01	0.03	0.01	0.02	0.02	0.02	0.01
Phase (g)	149.21	30.14	191.52	174.07	234.11	87.06	359.96	135.83	212.03	164.40
	21	22	23	24	25	26	27	28		
Const.	M ₄	SN ₄	MS ₄	4MS ₆	2MN ₆	M ₆	4MN ₆	2MS ₆	MSL	
Amp. (H)	0.03	0.00	0.03	0.01	0.00	0.00	0.00	0.01	1.548	
Phase (g)	139.70	76.01	187.92	173.38	33.88	99.02	209.74	68.48		

Table 18: H and g for 28 Primary Constituents of Tide for October 2018

	1	2	3	4	5	6	7	8	9	10
Const.	Z ₀	M _m	MSF	Q ₁	O ₁	M ₁	K ₁	J ₁	MU ₂	N ₂
Amp. (H)	0.00	0.03	0.02	0.01	0.01	0.00	0.09	0.00	0.01	0.10
Phase (g)	0.00	354.40	320.18	27.18	300.40	159.21	11.24	173.80	179.40	159.72
	11	12	13	14	15	16	17	18	19	20
Const.	M ₂	L ₂	S ₂	MQ ₃	MO ₃	M ₃	MK ₃	2MQ ₃	3MS ₄	MN ₄
Amp. (H)	0.64	0.01	0.23	0.01	0.02	0.00	0.01	0.01	0.01	0.01
Phase (g)	147.23	165.71	183.13	96.79	156.09	224.98	164.37	246.32	134.87	104.78
	21	22	23	24	25	26	27	28		
Const.	M ₄	SN ₄	MS ₄	4MS ₆	2MN ₆	M ₆	4MN ₆	2MS ₆	MSL	
Amp. (H)	0.03	0.00	0.02	0.00	0.00	0.01	0.01	0.01	1.479	
Phase (g)										

Table 19: H and g for 28 Primary Constituents of Tide for November 2018

	1	2	3	4	5	6	7	8	9	10
Const.	Z ₀	M _m	MSF	Q ₁	O ₁	M ₁	K ₁	J ₁	MU ₂	N ₂
Amp. (H)	0.00	0.04	0.04	0.01	0.02	0.01	0.02	0.00	0.01	0.11
Phase (g)	0.00	72.30	76.46	26.07	318.05	291.62	20.28	111.63	207.51	159.28
	11	12	13	14	15	16	17	18	19	20
Const.	M ₂	L ₂	S ₂	MQ ₃	MO ₃	M ₃	MK ₃	2MQ ₃	3MS ₄	MN ₄
Amp. (H)	0.67	0.02	0.23	0.02	0.01	0.01	0.01	0.02	0.01	0.01
Phase (g)	144.40	10.69	190.40	330.69	40.89	85.51	334.90	220.13	249.94	97.36
	21	22	23	24	25	26	27	28		
Const.	M ₄	SN ₄	MS ₄	4MS ₆	2MN ₆	M ₆	4MN ₆	2MS ₆	MSL	
Amp. (H)	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.01	1.501	
Phase (g)	114.91	278.49	147.34	122.10	347.08	353.15	159.30	24.11		

Table 20: H and g for 28 Primary Constituents of Tide for December 2018

	1	2	3	4	5	6	7	8	9	10
Const.	Z ₀	M _m	MSF	Q ₁	O ₁	M ₁	K ₁	J ₁	MU ₂	N ₂
Amp. (H)	0.00	0.04	0.02	0.01	0.03	0.01	0.02	0.00	0.01	0.17
Phase (g)	0.00	77.98	342.93	202.42	353.97	265.53	26.81	162.84	230.84	192.32
	11	12	13	14	15	16	17	18	19	20
Const.	M ₂	L ₂	S ₂	MQ ₃	MO ₃	M ₃	MK ₃	2MQ ₃	3MS ₄	MN ₄
Amp. (H)	0.68	0.02	0.31	0.02	0.03	0.02	0.01	0.01	0.00	0.01
Phase (g)	147.08	80.12	184.92	302.72	321.74	40.15	313.60	46.89	92.41	110.65
	21	22	23	24	25	26	27	28		
Const.	M ₄	SN ₄	MS ₄	4MS ₆	2MN ₆	M ₆	4MN ₆	2MS ₆	MSL	
Amp. (H)	0.03	0.00	0.01	0.00	0.00	0.01	0.01	0.01	1.486	
Phase (g)	120.33	140.41	120.85	85.91	254.37	82.71	153.18	31.90		

The mathematical algorithms for tide and its analysis produced by the 20 best AI tools used are not all the same. The following eight (8) AI tools, GitHub Copilot, Windsurf, Visual Copilot, OpenAI Codex, ChatGPT (GPT-4o), DeepSeek Coder, Devin AI, and Sourcegraph were on top (Table 6)(Saharawat, 2025; Salminen, 2025). The remaining Twelve (12), which are Tabnine, Cursor AI, Qodo, AskCodi, Replit, Blackbox AI, Claude, Microsoft Copilot, CodeGeeX, Amazon Q Developer, StarCoder, TabbyML, presented similar results (Table 6)(Saharawat, 2025; Salminen, 2025).

Furthermore, for the computation of the four parameters: orbital elements (s, h, P, N and P¹), astronomical argument (E), nodal correction (u) and nodal factor (f), each of the 20 best AI tools used for this research were applied one after the other to assess the codes produced by each of them for the computation of the above mentioned parameters. GitHub Copilot, Visual Copilot, ChatGPT (GPT-4o), DeepSeek Coder, and Sourcegraph presented almost the same results that were rated as the top useful ones for this study based on the Likert scale method (Table 6) (Saharawat, 2025; Salminen, 2025).

In addition, for the formation of the N matrix from the A matrix and inversion of the N matrix, each of the 20 best AI tools used for this study was tested one after the other for the assessment of the codes produced by each of them on the subject. The results obtained for the formation of the N matrix from the A matrix show that GitHub Copilot, Visual Copilot, ChatGPT(GPT-4o), and DeepSeek Coder is on top based on the Likert scale method (Table 6). However, for the inversion of the N matrix using LSM (Mikhail, 1981), the following AI tools presented the top results OpenAI Codex, ChatGPT (GPT-4o), DeepSeek Coder, and Sourcegraph (Table 6).

For the analysis of the monthly tide, the following 7 AI tools presented the top results based on the Likert scale method. They are OpenAI Codex, DeepSeek Coder gave the top results, followed by GitHub Copilot, Windsurf, Blackbox AI, ChatGPT (GPT-4o), and Devin AI tools with similar results (Table 6) (Saharawat, 2025; Salminen, 2025).

The comparison of the results recorded from each of the 20 best AI tools used for this study and the Author's codes (Table 8) was carefully studied and evaluated. The Author's codes solved the algorithms stage by stage and produced the complete results for the monthly tidal analysis (H, g, and MSL) (Tables 9-20). This is

supported by Abubakar et al. (2019), Madah (2020), and Rusdin et al. (2024), that analysis of monthly tidal datasets produced tidal constants (H, g) for the 28 primary constituents and also the monthly MSL. Tables 9-20 show the values of H and g obtained from January to December 2018 for all 28 primary constituents, and their variations. The MSL from January to December 2018 is also presented after the H and g for the 28th constituent (2MS₆) in Tables 9-20.

In summary, AI tools have brought advancements to the development of programming codes (Tang, 2025) by assisting the users. However, the critical issues, such as the nature of some AI models and algorithms used, the interpretation and explainability of the codes, accuracy, context, etc., have not been resolved, and this is supported by Svyatkovskiy et al. (2019) and Saini et al. (2025). Furthermore, this study also shows that AI is a powerful tool for empowering humans by augmenting their capabilities, reducing their workload, and enabling them to focus on the creative and strategic aspects of software engineering (Song et al., 2024; Takerngsaksiri et al., 2024; Xu, 2024; Saini et al., 2025; Dwiantoro et al., 2025). However, it's not a replacement for human skills.

Conclusion

This study assessed the contributions of AI coding tools on the development of mathematical algorithms, programming codes, data processing, and analysis for tidal analysis for the Bonny port, Nigeria. The results obtained from the 20 best AI coding tools used for the retrieval and evaluation of tidal algorithms vary. Also, for the computation of orbital elements (s, h, P, N, and P¹), astronomical argument (E), nodal correction (u), and nodal factor (f), the 20 AI coding tools presented limited and various results. Furthermore, the AI results obtained for the formation of the N matrix from the A matrix, the inversion of the N matrix using LSM, and the analysis of monthly tide varies and also limited.

The top 20 best AI tools results for each parameter were compared to each other, and also with the results produced by the Author's code. The Author's codes presented complete results of monthly tidal analysis, in which tidal constants (H, g) for the 28 primary constituents of tide are presented and the monthly MSL. This study show that AI tools have brought advancements to the development of programming codes but with some critical issues such as nature of some AI models and algorithms used, interpretation and explainability of the codes, accuracy, context etc. followed. Furthermore, this study also show that AI is a powerful tool for empowering human by augmenting their capabilities, and enabling

them to focus on the creative and strategic aspects of software engineering. However, it's not a replacement for human skills. Therefore, it can be concluded that AI coding tools are enhancing the development of mathematical algorithms, programming codes, and also improving data processing and analysis for tidal analysis for the Bonny port, Nigeria.

Further study on this research includes the use of more AI coding tools, e.g., 50, for better analysis, and application of another method of adjustment, such as the Gauss-Jordan method instead of LSM. It is therefore recommended that the Nigerian policy makers should initiate a comprehensive policy on the ethics, use, and adoption of AI for use in the academic institutions and in all spheres of life in Nigeria.

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