GAS Journal of Arts Humanities and Social Sciences (GASJAHSS)

OPEN ACCESS

Volume 2, Issue 11, 2024 Journal Homepage: https://gaspublishers.com/gasjahss/ ISSN: 3048-5002

Optimizing Judicial Decision-Making in Nigeria through Boolean Algebra Algorithms: A Prologomena to Systemic Transformation

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Received: 13.11.2024 | **Accepted:** 14.11.2024 | **Published:** 17.11.2024

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DOI: 10.5281/zenodo.14177068

Abstract **Original Research Article**

The application of Boolean algebra towards the development of an algorithm for enhancing decision-making in the Nigerian judiciary represents a transformative approach towards the optimization of legal processes and fostering justice. The Nigerian justice system has experienced a lot of difficulties ranging from; judicial backlogs, sentencing disparities, limited access to resources, biased judgments founded on emotions and corruption. This has not only undermined the integrity of the system, but has also made citizens loose trust in the system. Boolean algebra with its foundational principles offers clear and precise logical operations which serves as critical tools in the construction of algorithms that promotes objectivity, mitigating the influences of bias, emotion and corruption amongst judges. This work recommends that the integration of Boolean logic into an algorithmic framework for the Nigerian judiciary will facilitate a structured and transparent analysis of legal cases, ensuring decisions predicated on defined criteria rather than subjective interpretations. This work uses both the expository and analytical methods of philosophy. While the former is meant to provide detailed insights on the flaws of the Nigerian Judiciary, the later will be used to highlight and provide a breakdown of the potential and applicability of Boolean algebra to standardize judicial processes. By eliminating the ambiguities and contradictions embedded in natural language through enabling categorizations of evidence, legal propositions and arguments into binary outcomes under the Boolean framework as true or false, it will foster impartial and equitable law application, reflecting the blindfolded nature of *justilia* who administers justice devoid of bias.

Keywords: Judicial Decision-Making, Boolean algebra, Algorithms, Systemic Transformation, Nigeria

1. BACKGROUND TO THE STUDY

In the Nigerian judiciary, there have been profound issues in relation to inefficient legal decisions and rulings. When such rulings are weighed against the law's embrace, they reveal themselves not only unjust, but lacking grace. These rulings echoes inconsistency and challenge the mind, leaving reason adrift and fairness hard to find. In many instances, the judicial rulings and decisions are products of human emotions (emotions of the judge or judges) and other influences that could be termed as political biases and subjective judgments. The malady of this is that it saps the well of public faith in the judiciary by fraying the tapestry of trust. In the shadows of this doubt, Boolean algebra and its integration into building an algorithm can be a promising tool and strategy towards helping the judiciary make more efficient decisions, owing to its ability to yield access to relevant precedent and construct complex search queries that could bring about precise results through the utilization of its operators (AND, OR AND NOT). With this, the judicial system can benefit from a massive assistance in making decisions which are based on adequate case laws, research/review, risk assessment and proper predictive analytics which will all be possible within the Boolean logical framework.

As a consequence of this innovation, a judge will have swift access to cases in line with some specific legal principles with coverage of pertinent rulings in the past, while excluding irrelevant ones. This will help and guide in making precise and correct decisions in line with the legal principles. This clamor for precision aligns with Aristotle's emphasis on clarity and precision in logical reasoning as he highlights in his work *Prior Analytics*, the importance of syllogistic reasoning where valid conclusions are derived from established premises (25b15 – 26b30). Similarly, Kant advices that the systematic categorization of experiences, and forming judgments based on the logical understanding of these experiences are essential for understanding complex realities.

Ipso facto, this mirrors the objective and aim of Boolean algebra and logic in the development of such algorithm.

However, the thrust of this work is to offer insights on how to brace judges and the jury with insights, to facilitate informed decisions, militate potential biases and serve the broader objective of justice. The work also offers critical ethical issues to be considered which necessitates the need for applying human insight within the ambience of "context" and "interpretation". This aligns with the thoughts of Hans-Georg Gadamer who emphasizes the need for contextual understanding and contextual interpretation to drive meaning and truth in any given system. Accordingly, he posits that it is within a context that we can justify the truth content of any written source (Gadamer 178), be it legal or logical. Within this work, this perspective underscores the need to apply human oversights and contextual interpretation alongside the algorithmic outputs. This work will offer useful insights that could help in enhancing the Nigerian Judiciary, by providing a framework for software developers who in future will integrate this technological plan into the Nigerian Legal System. Thus, this work serves as a valuable evolution and enhancement within the realm of judicial policy-making.

2. STATEMENT OF THE PROBLEM

The Nigerian legal system faces pertinent challenges including; sentencing disparities, judicial biases, corruption and cases backlogs. This brings a shadow cast on justice and fairness in judicial decision making, fostering a tempest where fairness decays, justice delayed and equality unacknowledged. In most cases, decisions are influenced by human emotions and biases shaping how judges and juries interpret evidence, and such variability results in decisions that misalign with legal principles. What way can this miasma be eliminated to ensure public trust in the judicial system? Can the integration of Boolean algebra with its algorithm have potential of eliminating these challenges through data driven approaches? Can algorithm operate on an objective criteria and predefined parameters that can breed a consistent and transparent decision making process?

3. CURRENT CHALLENGES IN NIGERIAN JUDICIAL SYSTEM

The challenges facing Nigerian judiciary includes; judicial backlogs, sentencing disparities, access to resources, judicial emotions and corruption. Many courts are burdened with an overwhelming number of pending cases (awaiting trial), while many take longer years to reach decision and a conclusion. As stated by Jimoh *et al*, most of these delays are engendered by some lawyers who seek unmerited adjournment from court for flimsy reasons (74). This also resonates with the judges. The unfortunate reality is that most of the files of these cases are not traceable any longer. On 16th October 2024, the London-based world news channel *Arise News* reported that the Chief Justice of Nigeria rebuked the increasing number of pending cases in superior courts, holding the judges accountable for this faltering light, which unfolds as a consequence of their poor performance. She stated that in the first quarter of 2024, there were about two hundred and forty three thousand, five hundred and twenty-three (243, 523) pending cases in superior courts excluding the supreme courts. She also narrated that amongst these, one hundred and ninety-nine thousand, seven hundred and forty-seven (199,747) were civil cases, while forty-three thousand, five-hundred and six (43, 506) were criminal cases. Thus, it is indubitable that in Nigeria's prison walls, we can find countless souls lingering as justice hesitate. Some stand in these shadows for five long years, while others hold on for six or more, lost in tears without appearing in court. There are a few who have appeared in the court once, and it takes a very long time to reappear after adjournment. This betrays public trust in the system and denies a timely justice to individuals awaiting trial or resolution.

Another significant challenge is sentencing disparity. Most often, judges have the discretion of sentencing which is amongst the causes of the inconsistencies which may be rooted in personal beliefs or social background of the judge. In line with this, Agbo in his work entitled; *Sentencing Guidelines and Prison Congestion in Nigeria: Challenges and Prospects for Decongestion* asserts that the problem about sentencing disparity is Nigeria stems from a lack of comprehensive sentencing guidelines, and the absence has prompted the usage of imprisonment as a sanction by the court (33). Analogously, Anchovur in his studies entitled; *Judicial Discretion and Sentencing Disparities In Nigeria: The Case Of Benue State Judiciary* received a response from one his respondents (a staff of the Nigerian Ministry of Justice), who uttered that if judges are given limits to their exercise of powers, it will reduce the level of discretion exercised by most of them (7). In *addendum,* Anchovur also asserts that if the amount of discretion that is exercised by judges is being curtailed, the level of sentencing disparity will reduce (7). This also highlights how sentencing disparity rooted in judges' exercise of discretion constitute a limitation of justice.

Emotions and biases of judges constitute another problem owing from their societal norms and personal experiences that may inadvertently shape and affect their rulings. Peter-Hagene *et al* in their work *Emotion and Legal Judgment* assert that "…experienced emotions can directly or indirectly, within or outside awareness, motivate decision makers to blame, punish or forgive" (726). Such emotional states can be a foundation for bias, significantly impacting judicial rulings, leading to outcomes which do not reflect the

evidence presented. Most of the times, these biases could manifest in unequal treatment of litigants based on factors like gender, social class, and ethnicity.

Corruption is amongst the pervasive challenges that have ripped the integrity of the Nigerian Judiciary. Corruption of this sort manifests itself in various forms including bribery, favoritism and manipulation of legal outcomes. In 2012, Nigeria was ranked by the Transparency International Corruption Perception Index (CPI) as the 135 of 176 (of 176 being the most corrupt country). In the past year 2023, Nigeria was ranked 145 of 180 (of 180 being the most corrupt country). This reveals how Nigeria stands beneath the crushing tide of corruption's embrace. However, most Nigerians perceive the judiciary as one of the most corrupt institutions in the country. Sequel to this, Jimoh*et al* writes that since corruption has been crowned with ubiquitous honour at various stages of legal processes and proceedings, it is not surprising that the un-guilty usually become victims of corrupt judgments (67). Corruption within the present state of our justice system, hints the dawn of a troubling era where the shadows of misconduct looms larger on the horizon. Many people are discouraged from seeking justice because of the pervasive nature of the menace of corruption in the judiciary. It is sad that as the scale of justice teeter precariously, the specter of judicial malfeasance threatens to envelop us, casting a pall over every foundation of law and equity.

4. FRAMEWORKS FOR BOOLEAN ALGEBRA AND ALGORITHMIC PROCESSES IN NIGERIAN JUDICIARY

The following frameworks will aid the application of Boolean Logic in the algorithmic development that will help Nigerian Judiciary to attend to cases effectively and efficiently.

4.1 Data Base: There is need to have a database such as; the relational database which suits more with complex queries and structured data, and the document-oriented database which is flexible with the capacity of storing unstructured legal documents like case files with a good query system and indexing for effective retrieval.

4.2 Boolean Operations: The Boolean operations which are characteristically AND, OR and NOT can be applied to legal propositions and variables to derive conclusions. We will explain its usage in the examples as we progress into the next section.

4.3 Boolean Variable: Within the context of the law which this algorithm is geared to serve, legal propositions should operate and coded based on Boolean variables true (1) or false (0) with the usage of various operations (AND, OR and NOT). For example, if the driver hits a child (1) and runs (1) → it is murder. Here we can see that the combination of Boolean variable under these two conditions with both being true combined with the operator "and", gives a glimpse to the law of what murder is in the case of a driver who hits a child with a car. Another example is this, if the driver hits a child (1) and does not run (0) → it is not murder. Here we can see that the combination of Boolean variable under these two conditions with one being true and another being false combined by the operator "and" give a glimpse to the law of what murder is not. This is just an example to demonstrate how the Boolean variable true (1) and false (0) can be used to represent legal propositions, in line with the Boolean operator. With the usage of Boolean variable in coding legal propositions and the combination of the Boolean operations; AND, OR and NOT, we can draw insights and conclusions towards efficient decision making processes in the judiciary.

4.4 Rule-based System: There is a need for the implementation of a rule-based system in the algorithm. A rule based system is either an expert system or a database system comprising of a set of conditional rules (if → then) which can be used in real world for practical purposes (Liu *et al* 259). While applying its usage in the legal field, such a system will help in making decisions using a set of predefined rules or parameters which are also based on the legal framework and legal propositions to solve tasks. Within the context of Boolean algebra, the rule-based system will make use of logical operations to manipulate legal proposition. This will work in a way of translating the variables with the use of the Boolean operations into conditional statements to draw conclusion. Let us take a look at the Boolean operations:

AND (∧) → this returns true if both operands are true.

OR (∨) → returns true if at least one is true.

NOT (¬) → returns opposite of the operand, making true false and vice versa.

In this case, a statement like if the driver hits a child (1) and runs (1) then it is murder can be symbolized as (A ∧ B) → C. This clearly shows how Boolean operations can be turned into conditional statements. This can also come out in another form, (A ∧¬B) → D. This means that if A is true and B if false, then D. Within this context, it could mean that if the driver hits a child (1) and does not run (0) → it is not murder.

Let us now examine this in line with the standard form of conditional statements which is the *Modus Ponens* structure.

Symbolizing Legal Statements

Here, we will demonstrate how legal statements expressed in Boolean algebra can be transformed to conditional statements.

Case 1: If the driver hits a child and run, then it is murder.

Expressed in Conditional Form *Modus Ponens*:

Premise 1: If P → Q (if P is true then Q is true)
Premise 2: P (P is true)
Conclusion: Q (Q is true because P is true)

Example 1: Let P: The driver hits a child and runs
Let Q: It is murder
P: The driver hits a child and runs
→Q: Therefore it is murder.
(It is murder since he ran after hitting the child)

$$P \rightarrow Q$$
$$P$$
$$\therefore Q$$

In Boolean form:

A: The driver hits a child
B: The driver runs
C: It is murder
The Boolean interpretation is below

$$(A \wedge B) \rightarrow C$$

Interpretation: If both A (hitting) and B (running) are true, then C (murder) is true. So the driver had committed murder since it is true that he actually hit the child and ran after hitting.

Case 2: If the driver hits the child and does not run, it is not murder.

Expressed in Converse Form *Modus Tollens*:
Premise 1: If P → Q (if P is true then Q is true)
Premise 2: ¬P (P is not true)
Conclusion: Q (Q is not true because P is not true)

Example 1:
Let P: if the driver hits a child and runs
Let Q: It is murder
¬P: The driver did not hit the child and run (meaning he must have waited)
→¬Q: It is not murder. (It is not murder since he did not run after hitting)

$$P \rightarrow Q$$
$$\neg P$$
$$\therefore \neg Q$$

In Boolean form:

A: The driver hits a child
¬B: The driver does not run
D: It is not murder

The Boolean interpretation is below

$$(A \wedge \neg B) \rightarrow D$$

Interpretation: This other example brings about a different conclusion. This means that if the driver hits the child and does not run, it is not murder. It is not murder because he actually hit the child and did not run after hitting. The variable D is used to present a different legal outcome. Within this context, we use it to symbolize that his action cannot be classed as murder. The reason we use D and not C is that C was already used to symbolize murder. Ultimately, this is an indication of the fact that his refrain from running will breed a different conclusion or a different legal outcome which cannot be classified as murder. The Boolean standard $(A \wedge \neg B) \rightarrow D$ as used above is true if A is true and B is false. Hence, D is only true when A is true and B is false.

In Summary:

Murder Occurs: $(A \wedge B) \rightarrow C$

Not Murder: $(A \wedge \neg B) \rightarrow D$

The Boolean algebra can simply represent these situations with $(A \wedge B) \rightarrow C$ for the affirmative (that the driver committed murder) and, $(A \wedge \neg B) \rightarrow C$ for the negative, that he did not commit murder. This shows that the Boolean algebra with the use of its operators (AND, OR and NOT) can turn its variables true (1) and false (0) into various complex conditional statements, representing the legal propositions. The interesting part of using the Boolean algebra is its simplicity and exactitude. This can be applied to numerous legal propositions in existence.

4.5 Inference Mechanism: An inference mechanism refers to a process or method utilized by intelligent systems such as logic based artificial intelligence (like Boolean algorithm) to establish conclusions from known facts, data and established rules (Makolo *et al* 956). What happens is that the system and the "query" entered apply these rules to the knowledgebase database which contains facts and information to derive new facts or solve problems. This is done through two processes known as; "forward chaining" – starting from known facts and applying rules to infer new facts or derive conclusions until a goal is reached. The second is "backward chaining" – starting from a goal and working backward to see if the known facts

supports the goal, or finds the facts that supports the goal (Al-Ajlan 108-109). The Boolean algebra fits into forward chaining and backward chaining through the utilization of the operators; AND (∧), OR (∨) and NOT (¬B). The utilization of these operations helps in the combination of various statements to form conditional statements, *ipso facto*, draw inferences and yield conclusions.

Be that as it may, for a well structured Boolean Algorithm, the following should feature:

S/N	FEATURE	DESCRIPTION	PHILOSOPHICAL PRINCIPLE IN CONTEXT
1	**Structured Data**	There must be a collection of various types of data such as; case numbers, legal references, laws and statutes. By structured, this implies that these data must be set in a predefined format and not thrown haphazardly. A structured data will help in effective data management, retrieval and analysis and analytics.	The prospect of structuring data in legal content in way that prompts effective reminiscence aligns with the philosophical principle of clear and distinct impression as proposed by Rene Descartes (24). From the Cartesian perspective, such idea has to be well defined and separated from other ideas to avoid ambiguity.
2	**Boolean Query Support**	This is the capacity to perform complex search with the usage of the Boolean operators; AND, OR and NOT for filtering relevant legal documents and case law efficiently.	This reflects the principle of certainty and certitude emphasized by Rene Descartes. More so, this is captured by Leibniz's notions of clarity and definiteness in knowledge (30). Thus, the utilization of the Boolean operators; AND, OR and NOT helps to construct precise queries, yielding exact results, increasing reliability and eliminating ambiguity.
3	**Advanced Search Functionality**	The thrust of this feature is the enhancement of accessibility by users through enabling precise and user friendly searches through filters, natural language processing and keywords.	The thrust of the algorithm possessing advance search functionality aligns with the philosophical *cum* ethical principle of accessibility and transparency. In line with the thoughts of Mill who said that the clearer the ideas are, the more effectively they will inform the mind (179), there will be room for people to access and see specific information, leading to a more transparent result.
4	**Data Security and Access Control**	This prevents unauthorized access and data breaches. It helps in the protection of sensitive information in order to foster confidentiality.	In professional fields like law (just as in the medical field) information of people must be secured to avoid unauthorized access. This aligns with the principle of rights, protection of rights and epistemic authority. This is in *addendum* with the Kantian Imperative of treating people as ends in themselves and not as means to an end hence he states; act in a maxim whereby you can at the same time wish should become a universal law (30). In this context, since it will breed a breach of privacy, it is necessary to secure such personal information. Also, it ensures that access to information is granted on ethical principles, taking cognizance of right to truth, right to knowledge and the

			principle of epistemic authority, harm principle, national security and public safety.
5	**Case Management Integration**	Case management integration in legal algorithms streamlines workflows by centralizing case information, enhancing collaboration, and improving overall efficiency in legal processes.	The case management system aligns with the Kantian principle of systematic organization of knowledge where he posits that each part of the system contributes to the whole (41). This alignment is due to the functionality of this system to ensure that all components of the algorithm are functioning effectively and cohesively to improve efficiency in the decision making quality.
6	**Metadata Tagging**	Metadata tagging in legal algorithms improves searchability and organization by labeling documents with relevant information, facilitating easier retrieval and management.	This aligns with the Aristotelian principle of order and organization – his notion of "categories" where he stresses in his *Organon* the importance of organizing knowledge to achieve clarity and in-depth understanding (*Categories* 1a – 1b). Thus, the idea of metadata tagging (adding descriptive labels or tags to data, files or content) will help to enhance discoverability and usability. Also, this approach will help in organizing complex ideas into logical structures to classify and manage information effectively for easy retrieval.
7	**Analytics and Reporting Tools**	Analytics and reporting tools in legal algorithms provide insights through data analysis, helping firms track performance and make informed decisions.	This is in *tandem* with the principle of evidentialism or evidence based decision making. It is the thrust of making decisions founded on evidence, based on the information gathered, and logically deriving conclusions to generate reports. This principle was promoted by Dewey in his pragmatism where he emphasized that the role of inquiry is to solve problems (12), by systematically gathering evidence. Additionally, the epistemological approach of Popper emphasizes that knowledge should be based on verifiable and testable evidence (34). This gives credence to the fact that we must be certain that our knowledge is valid and consistent.
8	**Collaboration Features**	Collaboration features in legal algorithms enhance teamwork by enabling real-time document sharing, communication, and project management among legal professionals.	The prospect of having a collaborative feature in this algorithm aligns with the principle of cooperative inquiry. This principle has a traditional significance in Nigeria, picturing African Communalistic perspective to things as eschewed by Mbiti "I am because we are, and since we are, therefore I am". (104). Additionally, it reflects the principle of Communicative rationality in philosophy proposed by Habermas (287), where he argued that a rational discourse where participants collaborate to reach a mutual understanding is central to democracy. This

			collaborative feature mirrors collective interpretation and consensus based on proven results and facts obtained rather than an individual decision. However, this fosters fair resolution.
9	**Scalability**	Scalability in legal algorithms allows systems to adapt to growing data and user demands, ensuring consistent performance as needs increase.	This feature aligns with the principle of adaptability and sustainability. This has to do with the ability of the algorithm to handle larger files and complex datasets while maintaining logical clarity. This aligns with the principle of pragmatism as articulated by William James who emphasized the importance of flexibility in problem solving (45). This is necessary since it assures that the algorithm will be able to adapt to evolving demands without the compromise of accuracy and resource efficiency. This ensures long term sustainability in diverse applications.
10	**Narrative Inputs and Prediction**	Narrative inputs and prediction in legal algorithms enable users to input a legal case the court is handling as a story. This feature allows predictive analytics to analyze the narrative and forecast potential case outcomes.	The incorporation of a narrative input of a legal case which the jury is presently handling gives the algorithm the enablement to translate complex legal scenarios into structured logical frameworks that yields result and outcomes. This aligns with the philosophical principle of interpretivism proposed by Gadamer where he argued that understanding is rooted in the context and the narrative of human experience (270). This helps the algorithm remain sensitive to the specifics of a unique case while relying on a standard logical process for fairness and consistency.

5. IMPACTS AND ETHICAL CONSIDERATIONS

Integrating Boolean algebra in algorithmic process for a software development to guide Nigerian Judiciary in legal decisions, cases and rulings offers a potential for the enhancement of accuracy and fairness in legal dealings and the elimination of emotional influences, biases and misguidance due to limited knowledge of the law and its inaccessibility during decision making. This is because judges, irrespective of their best intentions have the capacity to be inherently subject to emotions which can make them sway judgments. Eyal *et al* writes that confirmation bias can influence judges as they assess the evidence presented in court. Specifically, judges may show a preference for evidence that supports their existing beliefs or hypotheses, potentially overlooking or dismissing information that contradicts their prior assumptions. This can lead to inconsistencies and compromise of the legal system. Research in psychology indicates that emotions can sway judgments (Peter-Hagene *et al* 726). Consequently, this algorithm can help in building consistency in legal decision making, thus avoiding the inconsistencies in legal decision making which arises as a result of subjective interpretation of the law.

More so, in line with Rawls' theory of justice, it will breed equality and fairness (42). With this, the law will be applied universally without bias since this will shield the emotions of the judges, helping the law to take its course. Additionally, Boolean algorithmic project in the judiciary has a potential of fostering accountability and transparency since it demystifies the legal process, making everyone understand why one deserves punishment or pardon.

From the ethical perspective, the integrity and accuracy of data is very important such that the data within the algorithm must be properly cleansed to exclude any ruling or proceeding that had its foundation on a flawed implementation. For an example, if historical data caries a judicial decision that was flawed based on certain inequalities and unfair treatments,

the algorithm may reinforce such biases inadvertently due to the inherent flaws.

Stakeholders in the legal field, legal professionals and public should be able to understand how algorithm operates and how this guides decision making. This includes understanding how it generates information to yield its outputs. This enhances transparency and avoidance of any limitation. The issue of privacy is also vital to ensure the security of sensitive information which could breed negative impacts or a breach of personal information. *Ipso facto*, models to be used as judicial precedents must be those whereby informed consent was obtained by those involved. Thus, ethical concerns such as; transparency, accountability, informed consent and privacy guidelines must be integrated into the system.

6. CONCLUSION

The poverty of natural language can also be one of the reasons for flaws in legal dealings, since natural language is filled with ambiguity and can be interpreted in diverse forms which will lead to the distortion of truth or the ideal content/character of a proposition. This redundancy was greatly battled in the modern era. In lieu of this, Udofia writes that in the modern era, the rigor of a formal language was added to the axiomatic system to make it devoid of the ambiguities of natural language. Sequel to this, mathematics in the modern era witnessed attempts to eliminate inconsistencies by the reduction of mathematical expressions to rigorous symbols, signs and formulae (33). However, such as a formal system can also be applied the Nigerian legal field to ensure the abortion of inconsistencies and ambiguities since legal propositions take a logical form and can work very well with the usage of the logical rules, such as we have demonstrated how it can be compatible and thrive effectively with the Boolean system. As stated previously in other parts of this work, such a policy will help in classifying legal propositions, evidence and arguments, ensuring that outcomes and decisions are based on well defined legal criteria. This development not only aligns with the ideals of justice, but also fosters public confidence in the legal system's integrity.

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