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Time-Critical Decision Making in Banking Transaction: Using Bayesian Algorithm

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Abstract

This research paper treat the basic perception of time-critical decision making in Banking transaction for bank customers, as it create an awareness approach to ease time spent in performing day-to-day transaction at the bank that may involve either withdrawal with or without the use ATM or deposit as the case may be. Most a time at the bank, people spent a lot of time in trying to either withdraw money or deposit money at the various bank branches all over Nigeria. This is as a result of lack of proper time-critical decision support for people to understand what is happening at bank branches. Waste of man hour at the bank may arise due to location of the banks, day to day banking transaction involving withdrawal or deposit done on Friday. This paper is intended to create a time-critical decision support in the banking transaction to assist individual or groups to understand and be aware of certain situations that will assist banking transaction in any of the bank branches in Nigeria. It uses the Bayesian algorithm which is implemented in MATLAB version 7.7.0 to determine the bank branch to carry out transaction. Choice of location for transaction is dependence on the highest posterior probability calculated for a given predictor in predicting the situation and a graph, showing the plotted points.

Keywords: Time-critical Decision Making; Bayesian Algorithm.

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1. Introduction

The use of computer is becoming a powerful tool in every areas of human endeavour, Computer contribute effectively and very efficiently to the actualization of positive results in virtually all areas that it is been put in to use. No doubt the use of computer is helping in time-critical decision making for banking transaction. Let us consider a scenario where a man living in Port Harcourt intend to send money via ATM to his son who is a final year student at the Ahmadu Bello University Kano in Kano State for payment of his school fees before his project defense comes up. On getting to the bank closer to his residential areas, there was much queue on the ATM Machine at his residential areas such that the man has to stay on the queue and wasted so much time and could not send the money that day as requested by his son. The inability of the man to make transaction resulted to his son's denial of his final year project defense. This made the son spend an extra year in school. The situation could have been averted if the man had got prior knowledge of the situations at the bank situated at his at residential area where queues are usually very much on the increase. So instead of waiting and spending the whole time and day at the bank at his residential areas he could have move to another bank that is not at his residential area(s).

In another scenario, a woman went to the bank at her residential area in other to withdraw cash to pay for her son's operation in the hospital. The doctors requested for a reasonable amount of money to be deposited first before commencement of the surgical operation. On getting to the bank which incidentally happen to be on a Friday, there was also much queue inside the bank at her residential area; the lady have to wait on the queue in the bank. At last, she could not withdraw the money from the bank due to a very long queue. On getting back to the hospital, his son condition has gone worsen. The situation also could have been avoided if she had got prior knowledge that on a Friday banks are usually crowded with customers because of weekend. If there was a situation awareness support to assist her on days to withdraw money and also to advise that withdrawal outside residential area usually have far less queue.

There has always been a lot of problem due to lack of proper time management support in Banking transaction. This necessitated the reason for this research work.

1.1. Literature Review

In the late 1970s, electronic commerce (e-commerce) emerged as a new concept in the business vocabulary [1] E-commerce refers to sharing business information, maintaining business relationships, and conducting business transactions using telecommunications networks. Traditional e-commerce, conducted using information technologies centering on electronic data interchange (EDI) over proprietary value-added networks moved rapidly to the Internet in the early1900's [2].

The increasing popularity and interest in using the Internet is driven by its World Wide Web (WWW) subset and has created numerous opportunities for many organizations, from small businesses to large corporations, including financial institutions [3,4,5]. Banks are currently gaining several benefits from WWW technology [3]. In particular, banks and financial institutions that have implemented WWW delivery of their services have captured a large share of the financial market [6].

Internet banking refers to the use of the Internet as a delivery channel for banking services, including traditional banking services such as balance enquiry, printing statements, fund transfers to other accounts and bill payments [7] and new banking services such as electronic regular payments and direct credit for salaries [8]. Internet banking has created new ways of banking in the main areas of distribution, production, payment and trading [11].

From the viewpoint of banks, Internet banking helps them to maintain profitable growth through reducing operation and fixed costs [9, 10]. A simple transaction cost for a non-cash payment at a branch is likely to cost a bank as much as 11 times more than the same transaction over the Internet [11]. In addition, Internet banking enhances marketing and communication, as it serves 24 hours a day and a customer can be guided through a catalogue of products and services [11]. Moreover, an Internet banking system allows banks to expand their business geographically without investing in the establishment of new branches and, as a result, the customer base is broadened [12].

From the viewpoint of consumers, Internet banking is attractive because of its convenience and lower fees. Internet banking users can perform financial transactions at anytime and anywhere without queuing at bank branches [13].

Internet banking also offers better rates on deposits and loans enabling the cost savings to be passed on to consumers [14]. Furthermore, Internet banking provides customers with rapid transaction updating, information richness [15], speedy transaction access [16] and absolute self-service [17].

Internet banking has become one of the most popular banking channels and providing Internet banking is perceived to be a vital strategy for customer retention and remaining competitive for banks and financial institutions [18].

[19] Micheal, D. postulate that there are six(6) major factors responsible for customer decision for the adoption of internet banking which are as follows: (1) Convenience, (2) User friendly website, (3) internet access/internet familiarity,(4) marketing communication, (5) word-of-mouth and perceive risks.

Bayesian probability is one interpretation of the concept of probability. In contrast to interpreting probability as frequency or propensity of some phenomenon, Bayesian probability is a quantity that we assign to represent a state of knowledge [35], or a state of belief [36]. In the Bayesian view, a probability is assigned to a hypothesis, whereas under frequentist inference, a hypothesis is typically tested without being assigned a probability.

The Bayesian interpretation of probability can be seen as an extension of propositional logic that enables reasoning with hypotheses, i.e., the propositions whose truth or falsity is uncertain.

Bayesian probability belongs to the category of evidential probabilities; to evaluate the probability of a hypothesis, the Bayesian probabilist specifies some prior probability, which is then updated to a posterior probability in the light of new, relevant data (evidence) [37]. The Bayesian interpretation provides a standard set of procedures and formulae to perform this calculation.

The term "Bayesian" derives from the 18th century mathematician and theologian Thomas Bayes, who provided the first mathematical treatment of a non-trivial problem of Bayesian inference.[38] Mathematician Pierre-Simon Laplace pioneered and popularised what is now called Bayesian probability.

Broadly speaking, there are two views on Bayesian probability that interpret the *probability* concept in different ways. According to the *objectivist view*, the rules of Bayesian statistics can be justified by requirements of rationality and consistency and interpreted as an extension of logic[35, 28]. According to the *subjectivist view*, probability quantifies a "personal belief" [36].

2. Time-Critical Decision Making

Time they say is money; one of the most precious things in life is when we keep to time; someone who saves time saves life. Time management is very essentials in every aspect of our life, so if we are not time conscious it affect us as individuals even in business. Time-critical decision making as it relates to bank is the ability of individuals to manage their time at the bank by ensuring that they do not wait unnecessarily at the bank without achieving their set goal and when their goal is achieved it must be on time then we can say the time is well managed.

However, time-critical decision making is the ability of individuals or group to take a critical decision as regards to which of the bank to visit to save a critical situation when confronted with time constraints to save any immediate demanding situations based on the location of the banks to attain their deserves goals and timely too.

3. Bayesian Algorithm

The Bayesian algorithm is a classification technique that is based on Bayes’ theorem with an assumption of independence among predictors. In simple terms, a Naïve Bayes classifier assumes that the presence of a particular feature in a class is unrelated to the presence of any other feature. For example, a fruit may be considered to be an apple if it is red, round, and about 3 inches in diameter. Even if these features depend on each other or upon the existence of the other features, all of these properties independently contribute to the probability that this fruit is an apple and that is why it is known as ‘Naïve’. In addition, Naïve Bayes algorithm is easy to build and particularly useful for a very large data sets along with simplicity. Naïve Bayes outperform even a highly sophisticated classification method.

Also the term *Bayesian* refers to Thomas Bayes (1702–1761), who proved a special case of what is now called Bayes' theorem in a paper titled "An Essay towards solving a Problem in the Doctrine of Chances"[20] In that special case, the prior and posterior distributions were Beta distributions and the data came from Bernoulli trials. It was Pierre-Simon Laplace (1749–1827) who introduced a general version of the theorem and used it to approach problems in celestial mechanics, medical statistics, reliability, and jurisprudence [21]. Early Bayesian inference, which used uniform priors following Laplace's principle of insufficient reason, was called "inverse probability" (because it infers backwards from observations to parameters, or from effects to causes) [22]. After the 1920s, "inverse probability" was largely supplanted by a collection of methods that came to be called frequentist statistics [22].

In the 20th century, the ideas of Laplace were further developed in two different directions, giving rise to *objective* and *subjective* currents in Bayesian practice. Harold Jeffreys' *Theory of Probability* (first published in 1939) played an important role in the revival of the Bayesian view of probability, followed by works by Abraham Wald (1950) and Leonard J. Savage (1954). The adjective *Bayesian* itself dates to the 1950s; the derived *Bayesianism*, *neo-Bayesianism* is of 1960s coinage [23]. In the objectivist stream, the statistical analysis depends on only the model assumed and the data analysed [24]. No subjective decisions need to be involved. In contrast, "subjectivist" statisticians deny the possibility of fully objective analysis for the general case.

In the 1980s, there was a dramatic growth in research and applications of Bayesian methods, mostly attributed to the discovery of Markov chain Monte Carlo methods, which removed many of the computational problems, and an increasing interest in non standard, complex applications [25]. Despite the growth of Bayesian research, most undergraduate teaching is still based on frequentist statistics [26]. Nonetheless, Bayesian methods are widely accepted and used, such as in the field of machine learning.

The formula for Bayesian theorem is given by calculating the Posterior Probability as stated below:

Likelihood

Class Prior Probability

$$P(c|x) = \frac{P(x|c)\ P(c)}{P(x)}$$

Posterior Probability

Posterior Prior Probability

Source: http://www.saedsayad.com/naive_bayesian.htm [27]

Where:

- $P(c|x)$ is the posterior probability of *class* (*target*) given *predictor* (*attribute*).
- $P(c)$ is the prior probability of *class*.
- $P(x|c)$ is the likelihood which is the probability of *predictor* given *class*.
- $P(x)$ is the prior probability of *predictor*.

3.1 Reason for choice of Bayesian Algorithm

- The algorithm is easy and fast to predict class of test data set.
- It also perform well in a multi class prediction
- It is of great assists whenever an assumption of independence holds, a Naïve Bayes classifier performs better compare to other models like logistic regression and you need less training data.

- It also perform well in case of categorical input variables compared to numerical variable(s). For numerical variable, normal distribution is assumed (bell curve, which is a strong assumption)

3.2 Justification of Bayesian Probabilities

The use of Bayesian probabilities as the basis of Bayesian inference has been supported by several arguments, such as the Cox axioms, the Dutch book argument, arguments based on decision theory and de Finetti's theorem.

a. Axiomatic approach

Richard T. Cox showed that [28] Bayesian updating follows from several axioms, including two functional equations and a hypothesis of differentiability. The assumption of differentiability or even continuity is controversial; Halpern found a counterexample based on his observation that the Boolean algebra of statements may be finite.[28] Other axiomatizations have been suggested by various authors to make the theory more rigorous [29]

b. Dutch book approach

The Dutch book argument was proposed by de Finetti, and is based on betting. A Dutch book is made when a clever gambler places a set of bets that guarantee a profit, no matter what the outcome of the bets. If a bookmaker follows the rules of the Bayesian calculus in the construction of his odds, a Dutch book cannot be made. However, Ian Hacking noted that traditional Dutch book arguments did not specify Bayesian updating: they left open the possibility that non-Bayesian updating rules could avoid Dutch books. For example, Hacking writes [30] "And neither the Dutch book argument, nor any other in the personalist arsenal of proofs of the probability axioms, entails the dynamic assumption. Not one entails Bayesianism. So the personalist requires the dynamic assumption to be Bayesian. It is true that in consistency a personalist could abandon the Bayesian model of learning from experience. Salt could lose its savour." In fact, there are non-Bayesian updating rules that also avoid Dutch books (as discussed in the literature on "probability kinematics" following the publication of Richard C. Jeffreys' rule, which is itself regarded as Bayesian [31]. The additional hypotheses sufficient to (uniquely) specify Bayesian updating are substantial, complicated, and unsatisfactory [32].

c. Decision theory approach

A decision-theoretic justification of the use of Bayesian inference (and hence of Bayesian probabilities) was given by Abraham Wald, who proved that every admissible statistical procedure is either a Bayesian procedure or a limit of Bayesian procedures [33]. Conversely, every Bayesian procedure is admissible [34].

4. Algorithm for Time-Critical Decision Making in Banking Transaction

Step 1: Generate a data set into a frequency table

Step 2: Covert the data set into frequency table

Step 3: Create a likelihood table in table 1.2 to1.3 by finding the probabilities like withdrawal other days = 0.10 and the probability of customers Response = 0.53

Table 1: Table showing different transaction category and Customers Response

Transaction Category	**Customers Response**
Bank at Residential Area	Yes
Deposit other days	Yes
Bank outside Residential Area	Yes
Bank at Residential Area	No
Bank at School	Yes
Deposit on Friday	No
Bank at Residential Area	No
Deposit other days	No
Bank outside Residential Area	Yes
Bank at School	Yes
Withdraw on Friday	No
Bank outside Residential Area	Yes
Bank at Residential Area	No
Withdraw other days	Yes
Bank outside Residential Area	Yes
Bank at School	No
Bank outside Residential Area	No
Deposit other days	Yes
Deposit on Friday	No
Bank outside Residential Area	Yes
Deposit on Friday	No
Bank at School	No
Deposit on Friday	No
Withdraw on Friday	Yes
Withdraw other days	Yes
Deposit on Friday	Yes
Withdraw on Friday	No
Withdraw other days	Yes
Deposit on Friday	Yes
Withdraw on Friday	No

Table 1.2: Table showing total number of Yes or No in each Transaction Category (Frequency table)

Transaction Category	**No**	**Yes**
Withdraw other days	0	3
Withdraw on Friday	3	1
Deposit other days	1	2
Deposit on Friday	4	2
Bank outside Residential Area	1	5
Bank at School	2	2
Bank at Residential Area	3	1

Table 1.3: Table showing total number of Yes or No in each Transaction Category and calculated Probability in each row and column

Transactions Categories	**No**	**Yes**	
Withdraw other days	0	3	**3/30**
Withdraw on Friday	3	1	**4/30**
Deposit other days	1	2	**3/30**
Deposit on Friday	4	2	**6/30**
Bank outside Residential Area	1	5	**6/30**
Bank at School	2	2	**4/30**
Bank at Residential Area	3	1	**4/30**
	14/30	**16/30**	

Step 4: Apply the Bayesian equation to calculate the posterior probability for each class in table 1.3 above. The class with the highest posterior probability is the outcome of the prediction.

5. Results

Table 1.4: table showing the categories/Transaction and Posterior Probabilities

Cases	**Categories/Transaction**	**Posterior Probabilities**
1	Withdrawal on Friday	0.1333
2	Deposit Otherdays	0.3556
3	Deposit on Fridays	0.1778
4	Bank outside Residential Areas	0.4444
5	Bank at School Premises	0.2667
6	Bank at Residential Areas	0.1333

From table 1.4 above shows case 1-6 and their corresponding Categories/Transaction with its calculated Posterior probabilities which is shown in the sample output in Figureure.1 below:

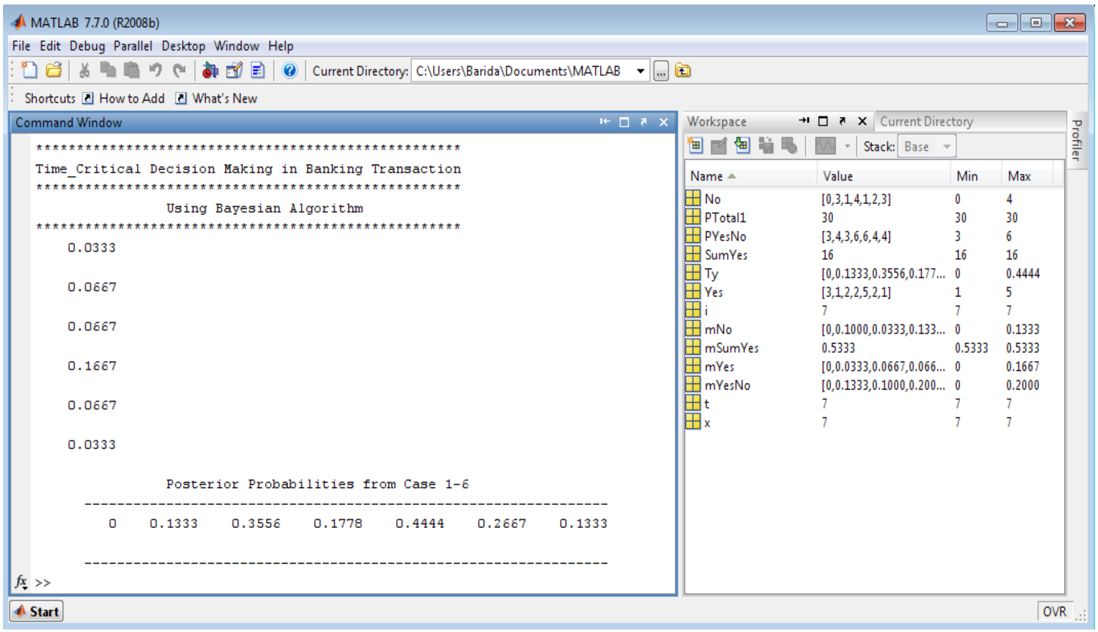

Figure 1: Snapshot of Posterior Probabilities calculated from cases 1-6

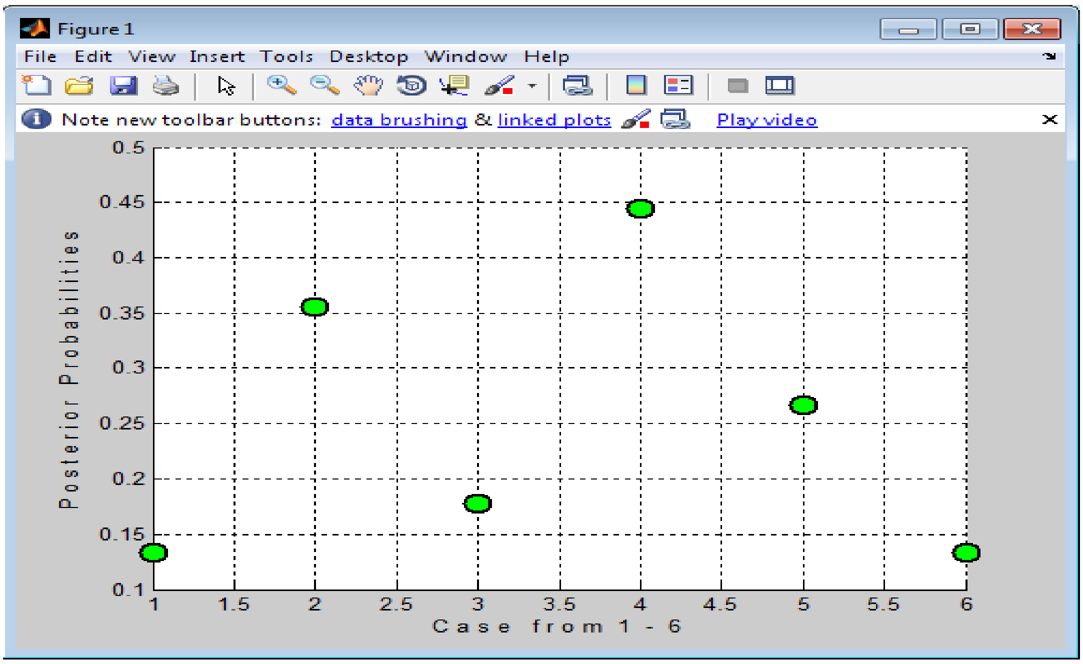

Figure 2: snapshot graph showing the plotted points of Posterior Probabilities

From Figureure 2 above shows the various plotted points of each of the posterior probabilities of each of the case from case 1-6 with it highest posterior probability at case 4, that is the posterior probability of bank outside residential areas is 0.44 as shown on the graph.

6. Conclusion

In conclusion, based on the calculated probabilities in each of the cases, from case 1 through to case 6; the highest probability is bank transactions that are done outside residential areas which is at case 4 which shows that bank customer can perform withdrawal or deposit without spending time on the queue whenever the bank outside residential areas that many people reside. It implies that individuals or group can take a time-critical decision to moves to banks that are along the roads outside residential areas so as to manage their time at the Bank and also save life too.

7. Recommendations

We recommend that, Nigerian banks at residential areas must have up to six functional ATM Unit per bank to reduce the numerous queues faced by bank customers.

Also, banks in Nigeria should increase their branches at the residential areas, as this will help in reducing the queues experienced in banks by customers during transactions.

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