

# APPLICATION OF ARTIFICIAL NEURAL NETWORK IN POPULATION PROJECTION OF PORT HARCOURT PRISON

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## Abstract

*Having carried out an extensive study on Port Harcourt Prison services, observations showed that no actual electronic representation of a formal record system for prisoners existed which had led to disappearance of case files of inmates. This has resulted to inmates spending more years in prison without appearing in court for one day, data inconsistency, data insecurity, lack of adequate back-up measures arising from irregularity of timely reports production, encountering of tough moments in accessing data and the underutilization of key personnel resources like time. With this study on ground, a better method of gathering prisoners' details, securing records, simple means of entering as well as getting back these details by those who have the permission to do so and also to create well protected inmates' information is made available. This application has the capability to admit inmates starting from the period they were put in prison to when they were released. The system is flexible, offers more user feedback and decreases the workload. Prison record management was carried out in PHP and population projection in MATLAB. Artificial Neural Network (ANN) model was used to forecast population of the convicted and the under trial. This dissertation presents the development, training and testing of an Artificial Neural Network for predicting outcomes. The network was developed as a three-layered perceptron and was trained using the back-propagation principles. The results obtained from the training sessions were correlated with the target values, Mean Square Error was used to evaluate prison population prediction, result shows that there were more inmates in under trial than the convicted and the predicted values were higher than the actual values indicating rise in prison population. The prison population growth increases and still on the upward trend in 2018 as there was high arrival rate of new inmates. For the prison system to be able to run efficiently, policy makers and judges need to be making decisions with reference to the goals of the prison system and its capacity to deliver.*

**Keywords:** Artificial Neural Network, Population Projection, Prison, Back-propagation, Information

## 1. INTRODUCTION

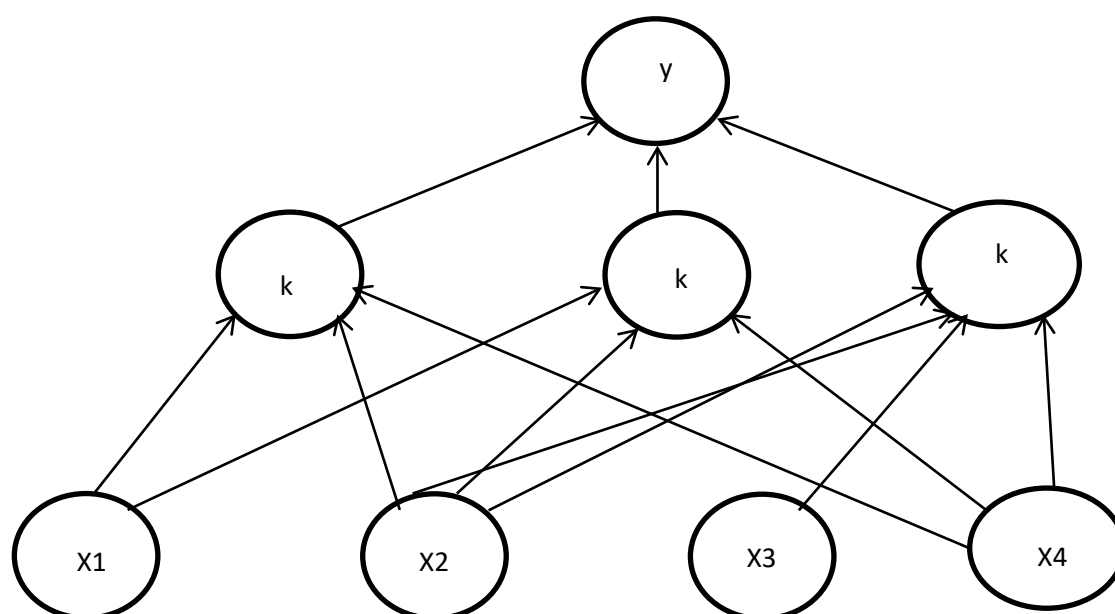
Crime, which is a disregard to the operation of a group of people, is something that cannot be done without as long as man is concerned; hence, rules are bound to be broken. From the earliest of times, human societies, all over the world, have been influenced negatively by the challenges brought about by accelerating hazards. Thus, there has always been a need for every human society to have a correctional facility or prison for keeping offenders. That is, those members of the society whose actions/inactions are considered serious threats to the continued well-being of other members. Generally, the main purpose of imprisonment, by any legal arm of a state, is to ensure that upon regaining freedom, the offender will be ready to lead a law-abiding and value-adding life (Mubaraka *et al.*, 2013).

Searching for an inmate's record is essential and easier to carry out when the correct up-to-date information is being preserved and secured to enable the communication of such, to prison official as well as meet the release of information requirements for future use. Unlike what is obtainable in more civilized societies, the Government and relevant correctional agencies have made insignificant contributions to prison management in Nigeria. The condition of prisons and prison services in Nigeria, from a critical point of view, has

continuously degraded at a steady pace. For instance, the original capacity of the Port Harcourt Prisons, which is one of the oldest in the country, had increased from 840 to an astonishing number of 4063 inmates due to the high rate of crime in Nigeria and observations had shown that no actual electronic representation of a formal prison record system for prisoners existed leading to inmates spending more years in prison without appearing in court for one day, data inconsistency, data insecurity, lack of adequate back-up measures arising from irregularity of timely report production and the underutilization of key personnel resources like time and training. An active automated system would be created for faster accessing of an inmate's details. Artificial Neural Network (ANN) model was used to forecast population of both the convicted and the under trial inmates.

## 2. ARTIFICIAL NEURAL NETWORK

Neural Network has to do with a set of steps that are followed to solve or complete a computer process through the use of structural and practical aspects of biological neurons linked together. More so, for computation to be made feasible, there must be an interconnection between the existing group of artificial neurons, and hence, the connectionist approach is imperative and applied to fetch information. Given the complex structure of the relationship that exist between the inputs and outputs, which are usually nonlinear, the NNs are designed and programmed to highlight its complexity. They try to explore patterns in data, or to capture the statistical structure in an unknown joint probability distribution between observed variables (Gorlovka and Imada, 1990). ANN has the potential to be inherently fault-tolerant or capable of sturdy computation. Its performances do not degrade significantly under adverse operating condition such as disconnection of neurons and noisy or missing data (Bernader, 2006). Neural networks offer some potential advantages over traditional statistical prediction methods. The first advantage lies in the interconnectivity of the network architecture. Each input neuron is connected to each hidden neuron, which is connected to each output neuron (White, 1989). This between-layer interconnectivity allows the network, the opportunity to assign weights to any combination of variables necessary to reduce the output error, in the process of mapping input values to hidden units, and hidden unit values to output units. There is no counterpart to these hidden units in multiple regression or discriminant analysis (Simpson, 1990).



### Figure 1.1: Three-layered perceptron

Each neuron (processing element) is fully connected to every neuron in the following layer. Each neuron accumulates input from the neurons in the prior layer and provides output to neurons in the higher layer.

Inputs are set of  $(x_1, x_2, \dots, x_n)$

$$x = \sum w_{ij} y_i \tag{1}$$

The error function becomes:

$$E = \frac{1}{2} \sum_{k=1}^k (y^k - t^k) \tag{2}$$

$$y_k = g(\sum w_{jk} y_j) \tag{3}$$

For the input – to – hidden layer weights:

$$\Delta w_{ij} = -\frac{\partial E}{\partial w_{ij}} = -\partial_j y_i \tag{4}$$

The output for the model could be presented as:

$$y_k = g(\sum w_{jk} y_j) \tag{5}$$

$$y_i = g \sum w_{ij} x_i \tag{6}$$

Where

$Y_i$  is the output of neuron  $i$  at time  $t$

$X_i$  is the input parameters from the neurons.

$E$  is the error

It has been well-established that back-propagation networks with only a single hidden layer can approximate any arbitrarily complex nonlinear mapping, to any desired degree of accuracy, provided a sufficient number of hidden units are used (Hecht-Nielsen, 1988; Hornik *et al.*, 1989). Again, rather than developing a prediction equation based on central tendencies and variability derived from the simultaneous processing of the training data (Lippmann, 1987), neural networks gradually fit a complex model by trial and error, as they process one example at a time, and adjust the connection weights in very small increments (Gallinari *et al.*, 1991).

### 3. METHODOLOGY

The research method adopted is constructive research. It is a science of studying how research is carried out. It is concerned with the learning of an approach to benefit new ideas. Its aim is to give the work plan of research (Rajaseka *et al.*, 2013). Constructive research is a

step by step scientifically proven process, whose application is anchored on the pre-existing knowledge, and implored in a variety of ways, with possibly adding a few missing links. In extension, constructive method per say is concerned with critical thinking that forecast positive answers to problems (theory, artifact) and other knowledge gaps by building blocks to support the construction of Artifacts such as models, diagram, system designs, artificial languages and software development methods (Crikovic,2010). The importance of constructive research method to this research is to search for a study-worthy challenge that was triggered by an existing problem in the prison management system and then predicting prison population outcome from capital crime. Practical problems such as survival-time models and manual inmates' records can be found through proper literature review. The constructive method demands that the development of an idea should involve an in-depth explanation and functionalities of the challenges to be resolved. In the development of a computerized prison management system, system component will be seen as object. Therefore, the Object Oriented Design Analysis (OODA) will be adopted. In constructive research, both hard and soft paradigms are employed to show how practicable the new construct is because the constructive method completely connects theory and practice together. Simulation tool based on MATLAB will be used to simulate the inmates' future population outcome. The essence of this study is to create a functional automated confinement record system for Port Harcourt Prison. For such viable system to be developed, water fall model of software development process which is classical software model was deployed. This is because it is characterized with linear or sequential execution of the various phases of the software development life cycle. Unified Modeling Language (UML) was also used to show the system interactions such as user to system interaction, interactions between system components.

#### 4. ARTIFICIAL NEURAL NETWORK IN POPULATION PROJECTION OF PORT HARCOURT PRISON

This study aims at using the information gotten to create a proposition on the forecasting of prison population in Port Harcourt through the use of Artificial Neural Network. Figure 1 represents the Architecture of the prison management system. Its components include data source, prison database system and neural network. Data from Port Harcourt prison serves as input to the system. A parameter profile including sentence, bail, refused bail and new arrival was created for each inmate and stored in the prison database. Population model is used to ascertain the factors which have some degree of elasticity in their capacity of the prison system.

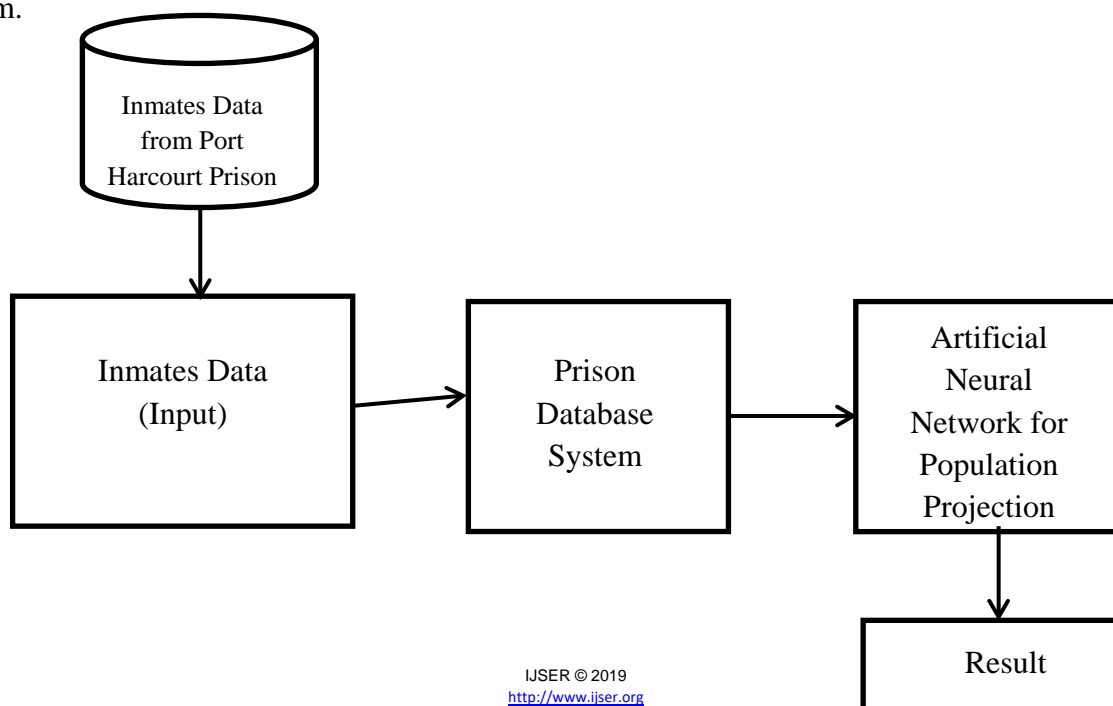


Figure 1: Architecture of the Prison Management System

Table 1: Input parameters

Input	Outcome (1)
Sentence	Population projection
Bail	
Refused bail	
New arrival	

These input parameters affect the population of the prison system.

## 5. RESULTS AND DISCUSSION

Table 2 shows the population of inmates in convicted and under trial prison with their actual and predicted value. Predicted values are higher than actual values both in convicted and under trial prisons. In the month of August, there was no convicted inmate. The highest population of inmates emerges in January under trial prison with actual value (25) and predicted value (45).

**Table2: Convicted and under trial population in 2018**

Months	Convicted		Under trial	
	Actual Value	Predicted Value	Actual Value	Predicted Value
Jan.	5	12	25	45
Feb.	7	14	15	35
Mar.	4	11	10	30
Apr.	8	15	17	37
May	5	12	14	34
Jun.	9	16	13	33
Jul.	3	10	18	38
Aug.	0	7	12	32

Sep.	9	16	25	45
Oct.	4	11	15	35
Nov.	9	16	23	43
Dec.	1	8	2	22

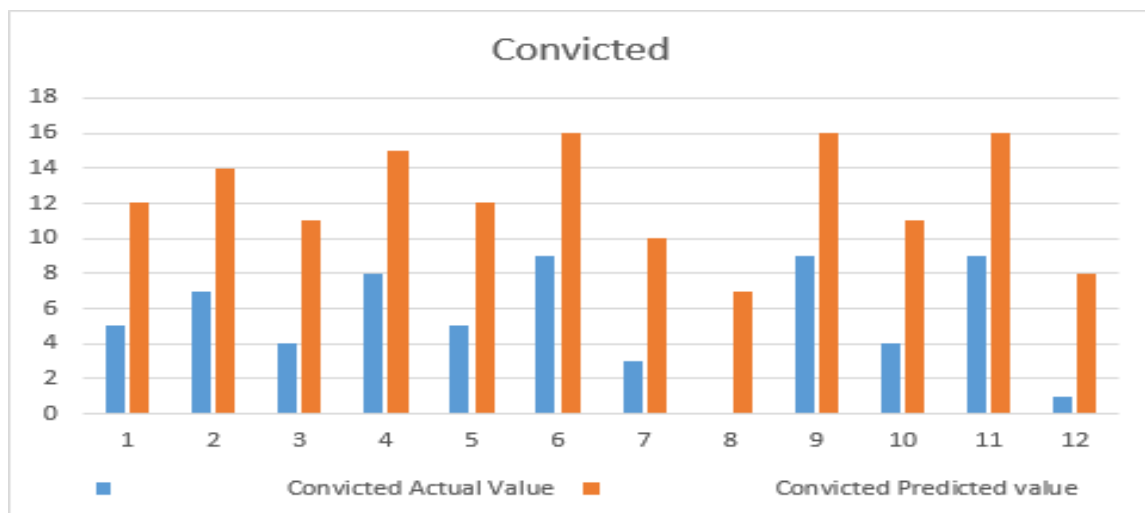


Figure 2: Convicted Population

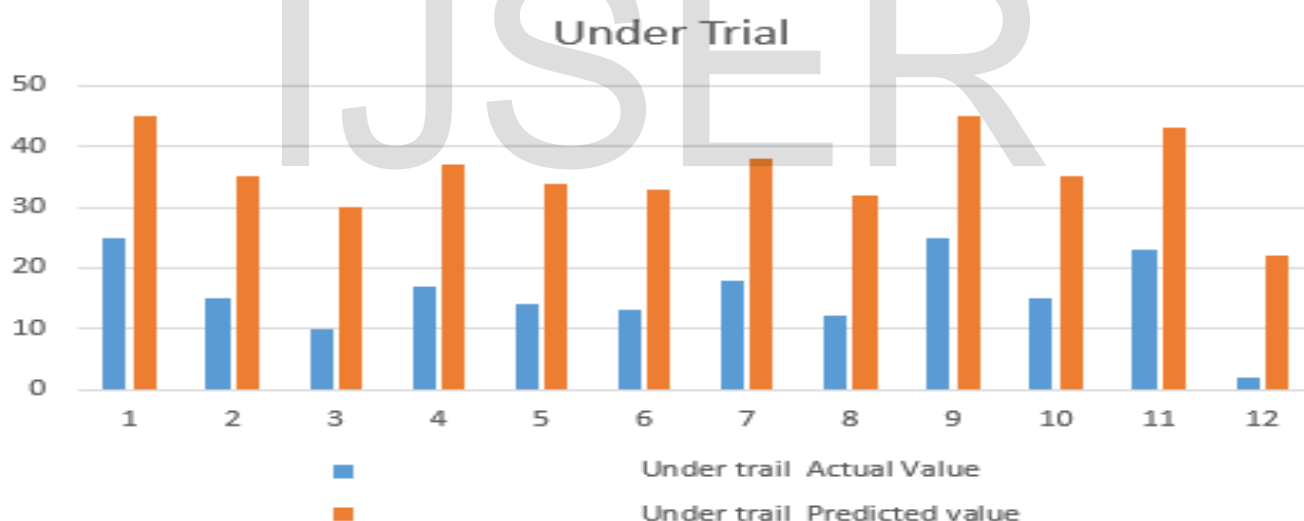
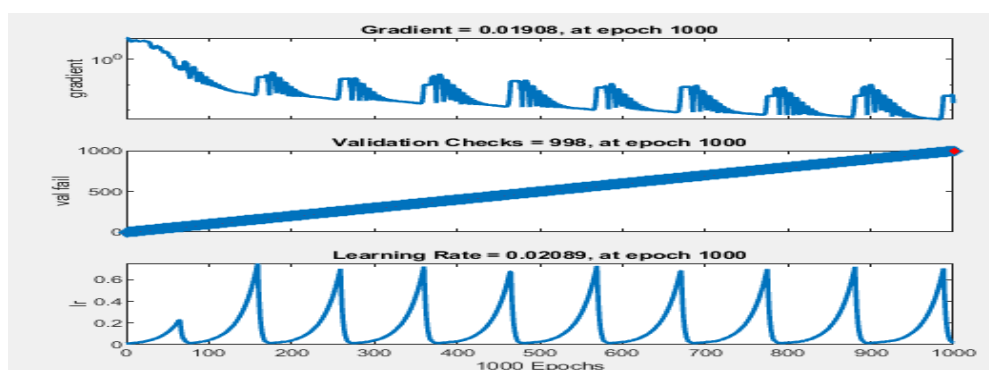


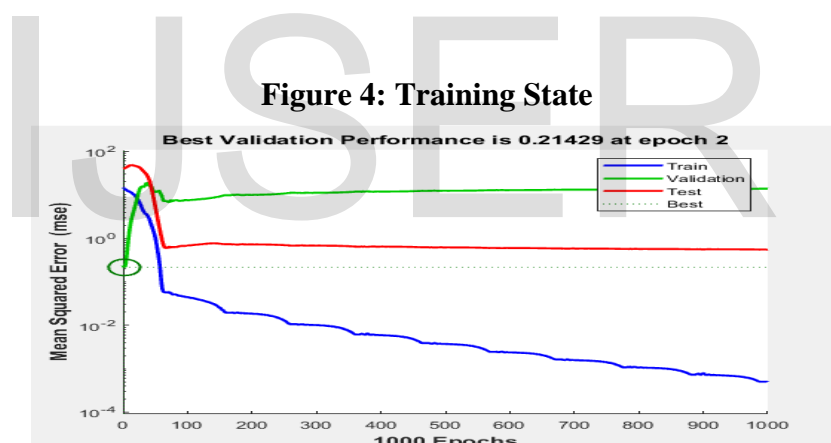
Figure 3: Under Trial Population

Figure 2 is the graphical representation of population in convicted prison in 2018 and Figure 3 represents population in under trial in 2018. There were more inmates in under trial prison than convicted. The result shows that the population of refused bail and new arrival remained higher than bail population, this led to overcrowding. For the smooth operation of confinement places, those that manage the affair and those in charge of making decision

concerning a legal case has to draw their conclusions with respect to the goals of the



confinement places and its capacity to deliver.



**Figure 5: Population Performance**

Figure 4 shows the training state of population projection in neural network. The datasets comprised of male and female inmate’s new arrival rate, bail rate, sentenced and refused bail rate. The train data that serves as input data, was presented to artificial neural network for population projection in batch mode with the feed forward architecture and backward propagation algorithm. Learning rate is 0.02089, validation check is 998, at epoch 1000. Figure 5 shows the population performance, the results obtained from the training sessions were correlated with the target values. Validation performance is 0.21429.

## 6. CONCLUSION

The develop model has been applied in Port Harcourt Prison. System was able to capture inmate’s information and provide user feedback. The model reviewed that actual population exceeds the prison capacity, and this calls for reconstruction of Prison. Hopefully, as the method is adopted in population matter, the result will help both the government, public and private organizations to make reliable and enduring plans that will benefit inmates. Prison

population was simulated with Neural Network to identify the outcome of bail, refused bail, sentenced and new arrival population.

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