Prediction of Rabbit Population with Computer Application using Biotechnology

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Abstract

Over the decades biotechnology leading to bioinformatics has been an area of concern for scientists using Information and Communication Technology devices in different areas. Many researchers find it difficult to project the population of some species of organisms and animals.Some have devised crude methods and some have made some reasonable assumptions and thereby coming up with different conclusions. For the purpose of this research the researcher has tried to collect the total number of population for particular specie of rabbit.This was thenmodelled into an equation using an exponential function and also developed an application program with C-Sharp(C#) Programming Language which uses the exponential function to project the population of rabbit over a maximum period of ten years. This can help researchers and organizations like National Biotechnology Development Agency (NABDA) to build and bank on the information gotten from this process of projection. It follows that if this system is implemented with the appropriate tools that it requires, all Biotechnology Agencies can use and draw up their analysis because of its reliability and consistency.

Keywords: *Biotechnology, Bioinformatics, Organism, Specie, Prediction.*

1. INTRODUCTION

Biotechnology is responsible for many of the factors that make our lives better. This field focuses on the intersection of Biology and technologies, leading to a vast array of new products that are designed to enrich lives, make day to day activities easier and make us healthier[9]. From vaccine production to genetic modification, Biotechnology is everywhere. People who choose biotech careers have several areas of specialization to choose from.

The field of Computer Applications in Biotechnology is a complex hybrid of two distinct scientific disciplines Computer Technology and Bioscience. This synergy is designed to provide an understanding of bioinformatics and other computer related subjects to students with some computer and/or life science background [2],[3]. This research work will be useful for students who desire to explore this new information science in which computers help to simulate, visualize, and analyse genetic and biological information,which will also provide an introduction to the fundamental scientific and computational concepts, methods, and tools central to the growing field of computer applications in biotechnology. The use of bioinformatics approaches to uncover functional information has had a great impact on molecular immunology and has enabled researchers in the field to address biological and biotechnological problems by turning their attention towards ‘compound problems’, that is, problems that require the integration of diverse lines of both in silico and experimental evidence. With respect to sequence analysis, this scaling-up strategy requires the availability of reliably predicted features. To handle evidence diversity, immuno-informatics uses strategies that span several areas of bioinformatics, including database creation and management.

Another new promising area of biotechnology application is the development of the plant-made Biotechnology which is also commonly associated with landmark breakthroughs in new medical therapies to treat diabetes, Hepatitis B, Hepatitis C, Cancers, Arthritis, Haemophilia, Bone Fractures, Multiple Sclerosis, Cardiovascular as well as molecular diagnostic devices than can be used to define the patient population.

A relatively newer branch of biotechnology is bioinformatics. which is entirely based on computer applications in respect of facilitating hardcore research, database management and ultimately the success of Human genome project (HGP) leading to global knowledge sharing of the efforts[42]. Computer technology and genome research have both grown rapidly over the past decade and it is expected to provide rapid advances to make genome research more efficient, leading to better methods to diagnose diseases, identify beneficial traits and provide cures for crop, animal and human diseases. The Federal Government of Nigeria in the year 2001, in its first attempt to embrace biotechnology put a National Biotechnology Policy in place which resulted in the establishment of the National Biotechnology Development Agency (NABDA) with the mandate to formulate policies towards accelerating the acquisition of biotechnology in the country.

It has been always in the nature of humans to manipulate the organisms to their advanced but at this advanced stage or era, we are also able to manipulate life and material at the atomic level through nanotechnology. Therefore, as a consequence of all advancements and innumerable advantages, biotechnology has developed over the last two decades as a rapidly growing industry that is offering vast job opportunities to the biotechnologists worldwide [50].

In this paper, the total number of population for a particular species of rabbit was collected and modelled into an exponential function. An application program which uses the exponential function for projecting the population of rabbit was also developed using C# (C Sharp) programming language.

2. LITERATURE REVIEW

A. *Background of the Study*

Biotechnology is a broad term that is used to describe a variety of application and process. Formally, biotechnology is '"the industrial use of living organisms or their components to improve human health and food production"'. Genetic engineering on the other hand focuses on the manipulation of genetic material (the DNA) and results in what is termed a genetically modified organism (GMO). Genetic engineering is a type of biotechnology but not all biotechnology involves genetic modification. For example, biotechnology includes the use of unmodified livings and their components, including enzymes, which are used to catalyze or speedup reactions.

Humans have used biotechnology for thousands of years to manipulate organisms to their advantage for example through plant grafting and selective breeding, but at this advanced stage/era, we are also able to manipulate life and materials at the atomic level through Nano-biotechnology. Therefore, as a consequence of all these advancements and innumerable advantages, biotechnology has developed over the last two decades as a rapidly growing industry that is offering vast job opportunities to the biotechnologists worldwide [1].

The work of a biotechnologist is fundamental scientific and research oriented, which aims at the application of technology to improve the quality of life and develop a variety of end users. Biotechnologists are therefore involved in production as well as marketing and research. A relatively newer branch of biotechnology is bioinformatics, which is entirely based on computer applications in respect of facilitating hardcore research, database management and ultimately the success of Human genome project (HGP) leading to global knowledge sharing of the efforts.

B. *Computations in Bioinformatics*

Computations required in bioinformatics vary largely depending on the objective of the application. Almost all the developed branches of computer science have strong applications in bioinformatics. Some examples of the computational tools that are used in bioinformatics are given below:

Graphs are used to represent relationships among species on different physical and microbiological criteria. For example, the evolutionary relationships among the existing species are expressed in a tree structure called phylogenetic tree. Graphs are also used in problems to analyze biological data.

Numerical simulations of biological systems are used to model systems that are very difficult to be modeled by analytical methods and deterministic operations. For example, the genetic regulatory networks can be modeled by stochastic process. Similarly, host-parasite system, ecosystem etc are well studied through numerical simulation. Machine learning has many applications in bioinformatics. Generally biological data are huge in quantity but with no established theory. For such data, learning theories provide methods to gain an insight into the underlying theory of the origin of these data. Besides, statistical analysis can be used in population oriented biology like epidemic controlling, drug designing, and so on. Data mining and advanced database technology are one of the main parts of biological information analysis and preservation. The huge amount of data requires efficient processing to maximize their use in research and educational purpose.

C. Genomic Data Analysis and Applications

Bioinformatics creates the tools to store, manage, analyze, and compare genomic data. Vast amounts of sequences are now stored in organized computer databases. The genome sequence has been interpreted using computational tools combined with biological knowledge. Computer software associated with the database is being used for easier data retrieval and data analysis process. Sequence analysis tools can also translate the DNA sequence into protein sequence and can provide information on the predicted physical properties of the protein such as molecular weight. Sequence comparisons also can be used to categorize groups of related gene or sequences into families. Sequences in the same family suggest that the genes or proteins perform similar functions. Another use for sequence comparisons is studying the relatedness and evolution of different genes or organisms.

Here are some research areas where important relationships and predictions are being generated by genomic data analysis with the help of bioinformatics tools:

1. Gene number, exact locations, and functions

2. Gene regulation

3. DNA sequence organization

4. Chromosomal structure and organization

5. Non-coding DNA types, amount, distribution, information content, and functions

6. Coordination of gene expression, protein synthesis, and post-translational events

7. Predicted vs experimentally determined gene function

8. Evolutionary conservation among organisms

9. Correlation of SNPs (single-base DNA variations among individuals) with health and disease

10. Disease-susceptibility prediction based on gene sequence variation

11. Genes involved in complex traits and multi-gene diseases

D. Breeds, Distribution and Uses of Rabbits

Rabbits belong to several genera in the sub-families Leporinae and Palaeloginae of the family Lepidae in the order Lagomorpha, super order Glives. Rabbits occur throughout the world and the true rabbit, Oryclolaguscuniculus, comprises several subspecies that were originally native to southwest Europe and North Africa [44]; with domestication came the development of different breeds and varieties (colours) [32]. O. cuniculus is prolific and adaptable, most of the fancy breeds were developed within the past 100 years, and only since the early 1900’s have rabbits been raised domestically in the USA. In Kenya, rabbits were introduced by missionaries in the 19th Century [35]. Over the years, the breeds have been improved from the long, rangy, low meat yield type to the compact, blocky animal of today [10], [43].

The main meat species in China are the New Zealand White rabbit, Californian rabbit, Japanese white rabbit, Chinchilla rabbit, Belgian hare, checkered giant rabbit, lop-ear rabbit among others. Commercial rabbitries in the United States use white (albino) New Zealand rabbits, California rabbits or high-breed crosses of the two breeds for meat [51], while some of the important breeds of meat rabbits in the Himalayan region are New Zealand White, White Giant, Gray Giant, Soviet Chinchilla [22]. The common rabbit breeds in Kenya are New Zealand White, Californian White, Flemish giant, French Ear lop, Chinchilla, Angora, Kenya White and their crosses [47].

Rabbit skins can be used for several purposes (mats, rugs and clothes) while the manure is a valuable organic fertilizer for use in vegetable gardens [48], its urine contains a lot of ammonia and uric acid which when applied on crops acts as a fungicide [40]. Various breeds of rabbits are useful models in biomedical research (embryology, toxicology, virology, and so on.), and are also widely used in safety testing [50]. For commercial purposes, the most important differences between rabbits are their size, breeding ability and suitability to the climate. Utility breeds are producers of meat, either by a fast growth rate (needs good feeding) or large and frequent litters.

The breed categories can be classified as follows:

1. Light breeds (up to 2-3 kg adult weight)

2. Medium breeds (3-5 kg)

3. Heavy breeds (more than 5 kg) [48].

For commercial meat production in Kenya, the New Zealand White (NZW) is the principal breed. They are large rabbits, with meaty haunches and wide, deep shoulders [35]. It has a number of desirable traits including a rapid growth rate, good carcass quality, good prolificacy, and good mothering ability and in general possesses all the characteristics desirable for a meat producing animal [10]. An adult buck weighs 4-5 kg, and an adult doe weighs 4.5-5.5 kg and have white fur [35].

Californian white is another major meat breed which is lighter than New Zealand, they are fairly large rabbits used often in the production of meat and are well fleshed on the back and haunches. An adult Californian rabbit weighs 3.6 - 4.8 kg. This breed has a white body with black markings on the nose, ears, feet and tail. Flemish Giants is also a very large rabbit which is used for meat production; it has very wide backs and weighs 5 - 6.5 kg.

Flemish Giant has potential as a sire breed in commercial meat production, the purebred giant does not have adequate reproductive performance for commercial production, and its large size results in high maintenance feed requirements. The high growth rate potential of the giant breeds may be exploited through cross breeding [10]. It comes in a variety of seven different colours, black, blue, fawn, light gray, sandy, steel gray and white.

The Checkered Giant breed may reach weight of over 5 kg. It is white with black or blue markings (along spine, body spots, cheek spots, coloured ears, eye circles and butterfly mark on nose) and have a long, hare-like body. Chinchilla has brown to grey fur, upstanding ears and brown eyes. The buck and doe attain maximum weight of 6-7 kg in 5 months; the meat yield is 4- 5kg. The chinchilla is also produced for its fur and is also popular as an exhibition breed with excellent meat qualities [47]. French Lop is a cross between English Lop and Flemish Giants. It has a heavy build and massive thickset appearance and weighs 4.5kg and above. The French Lop has a dense, soft coat that comes in two color varieties: solid and broken, and within these categories can be found a number of different rabbit colours, including agouti, black, broken marked, chinchilla and sooty-fawn.

E. Rabbit Production

Rabbit production is both a commercial enterprise and a hobby in many countries, being more of the former in Kenya. In commercial production, rabbits are used for meat, as pets and for laboratory purposes; whereas as a hobby, the rabbits are raised for the shows, home consumption, pet sales or as youth educational programs [51] for example in the 4K club in Kenya. In recent years in China, there are fixed processing enterprises for rabbit meat and fur, to produce semi-finished or finished products. In major rabbit farming areas of China, rabbit fur markets and meat fairs have been set up as the main market outlets for rabbit products and windows to provide information on markets, as well as link the farmers with the markets [16].

The major world exporters of rabbit products include: France, Hungary, the Netherlands and Spain, which exported large quantities of rabbit meat in 2000 [51]. In the U.S.A meat rabbits are sold live to processing plants who market them to retail groceries and restaurants, rabbit meat is also consumed in small quantities in India and wool production is also thriving [22].

In Africa, Nigeria, Uganda and other developing countries have adopted rabbit farming to meet the protein demands of growing populations [29]. The success situation in India, USA and Europe and other countries should be the benchmark for Kenya’s rabbit industry by adopting strategies in place to address the current lack of information on rabbit farming enterprise.

F. Husbandry

Suitable environmental conditions, management, hygiene and adequate nutrition and feeding are vital in rabbit [42]. The term “environment” includes every factor that influences a rabbit’s life. Some of these factors are the hutch size and location, proximity to other animals, moisture content, temperature, ventilation, amount of light, shelter design, availability of water, and general management. The backyard rabbitry is rabbit keeping on a small, family scale, a few does and one or two bucks are kept in a rabbitry just next to the house. The rabbits are fed on greens, weeds and vegetable kitchen waste. In order to obtain a good profit, farmers must consider sources and prices of rabbit feed, management techniques and markets [19].

G. Feeding

Rabbits are herbivores and hind-gut fermenters. Hindgut fermentation is a mode of digestion similar to rumination where bacteria actively ferment digested food and this occurs in the caecum and colon. The basic requirements of feed for rabbits include protein, fat, fibre, minerals, vitamins and water in varying portions according to their age or if they are pregnant or lactating [15], [43]. However, unlike other hind-gut fermenters, the rabbit has a very rapid gut transit time and eliminates fibre from the digestive tract as soon as possible [32]. The process of caecotrophy (re-ingestion of faeces) allows absorption of nutrients and bacterial fermentation products (amino acids, volatile fatty acids and vitamins B and K), and the re-digestion of previously undigested food [32].

3. MATERIALS AND METHOD

The material used is based on Mathematical model. Mathematical models are tools that can be used to describe the past performance and predict the future performance of biotechnological processes. They can be applied to processes operating at many different levels, from the action of an enzyme within a cell, to the growth of that cell within a commercial scale bioreactor. Mathematical models are powerful tools in both fundamental research and applied research and development. For example, some models contribute to our understanding of how cells function, while other models allow us to use laboratory and pilot-scale data to make predictions about how a commercial scale bioreactor must be designed and operated in order to give optimal performance.

In this paper, a mathematical model was developed for predictions for the case of when t = 1, 2, 3, 4, 5,..………n
and the case of when n = 1, 2, 3, 4, 5, ..……..n
Then an equation of the form shown in equation 1 was derived,

$$Y_{n+1} = Y_n e^{\lambda t}$$ ……………………………………equation 1

and have that

$$\lambda = \log_e \left(y_{(n+1)} - y_n \right)$$ ………………………………..equation 2

In equation 1, the value of t was set to 0 and then obtained the **λ** which is then substituted back into equation 2 and obtain the values for t = 1, 2, 3, 4, 5….n. this is then repeated until the number of required predictions are met and the readings are tabulated.

Although many different types of biotechnological systems and processes can be modelled, such as the operation of metabolic pathways within a cell, the expression of genes within cell, the death of cells during a sterilization process, the growth of cells in a bioreactor and the action of enzymes, to name a few, this article focuses specifically on the modelling of fermentation and enzymatic processes carried out in bioreactors. Furthermore, although mathematical models can be of various forms, this article concentrates on models consisting of differential equations.

Differential equations describe, in a simplified manner, how the key physical and biological phenomena operate. Under some conditions these differential equations can be either integrated analytically or simplified to give algebraic equations, but this is very often not the case. Figure 1 gives a simplified illustration of how a model consisting of differential equations might be applied to a fermentation process.
y: in the equation is the number of available year that must be known before prediction.
λ: is the outcome of the predicted population
t,n: this is the number of iteration the prediction will perform before it stop.

4. DISCUSSION OF RESULT

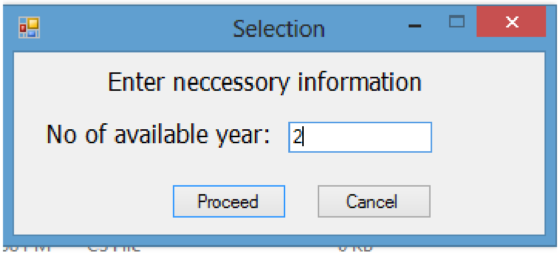

Figure 1: Available Year before prediction.

This figure displays the first two available year before the auto prediction of other years through the differential equation given in equation 2 above.

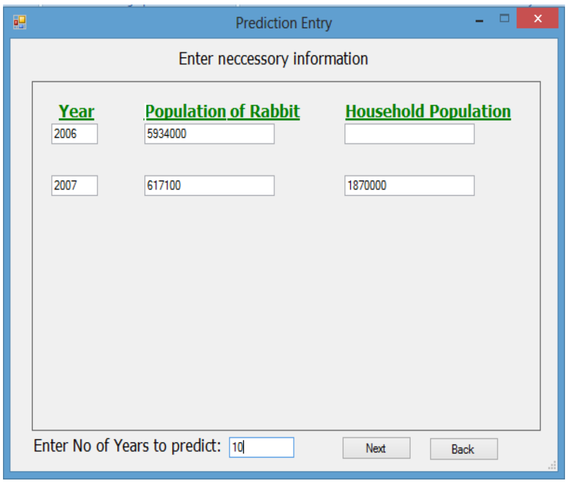

Figure 2: Prediction Entry.

This figure displays the value of the prediction for the next 10 years for rabbit.

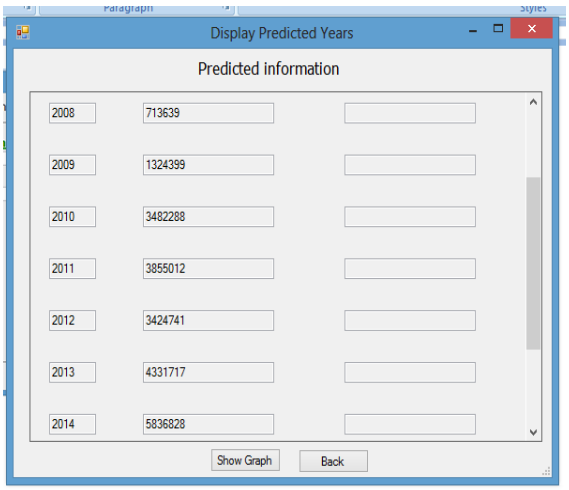

Figure 3: Prediction Information.

This Figure 3 displays the prediction information of rabbit population from the year 2008 to 2014.

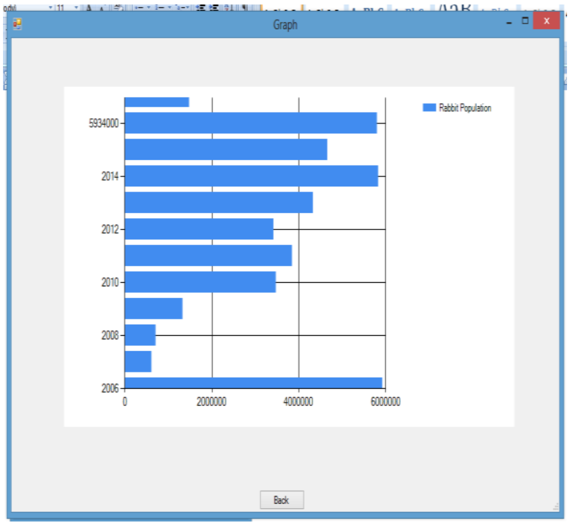

Figure 4: Graph.

This figure displays the graph increase of rabbit population as the year increases.

5. CONCLUSION AND RECOMMENDATION

The whole process of this paper concludes that the developed system is very reliable and will always give reliable results and an unbiased judgement.

The research also draw up a conclusion that for a reliable result to be gotten the user must implement all the processes with the right tools and equipment so has to come up with the desired results that can be used by agencies and parastatals confidently and analysis can be made based on the result gotten from the system.

It is therefore recommended that the system should be implemented with the right tools specified by the research so as to obtain the desired results. It is also recommended that agencies and parastatals should start using the system for their biotechnology predictions without any doubt that the desired result will be obtained.

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