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Application of Stochastic Process to Lottery in Nigeria

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Abstract: Lottery is one of the most popular forms of gambling which offers gamblers opportunity to win large cash prize for a relatively low cost. Research on lottery gambling could examine the effect of mediators in the relationships between independent variables and gambling behaviour. We consider the case of premier lotto and selected six (6) different players at random over a number of years. The methods used in these researches are Markov Chain and Stationarity of the state process. For every player in the system, we obtain the long run probability or likelihood of winning if every player continues playing indefinitely. We obtain the inter state transition probabilities indicating the transition of each player from one year to other.

Keywords: Lottery, Markov Chain, Stationarity, Transition Matrix, Gambling

I. Introduction

Playing the lottery is one of the most popular forms of gambling in Nigeria. Part of the reason for this is that it offers an opportunity to win a large cash prize for a relatively low cost. Tickets are also much more readily available than other types of gambling, with places to buy a ticket on most street corners and more recently online in some jurisdictions. In heated debate over the costs and benefits of gambling, proponents emphasized the economic regeneration, while opponents emphasized the social costs-particularly in term of increased problem gambling-that increased gambling is argued to bring. In most cases, the debate tended to be based on polarized opinions based on ethical and/or religious convictions rather than factual evidence. At its heart, gambling is a rather paradoxical behavior because it is widely known that 'the house always wins'. Whether you are gambling on fruit machines, horse racing, Baba Ijebu, blackjack or roulette, the odds will have been meticulously arranged to ensure a steady profit for the casino or the bookmaker. The only way to achieve this is for the gambler to make a steady loss. So, why do gamblers and particularly problem gamblers continue to play when the overwhelming likelihood is that they will lose money, by further understanding the breakdown of self-control in gamblers, this program of research carries important implications for the treatment of problem gambling, using both pharmacological and psychological therapies. Moreover, the development of objective task of gambling will provide more valid outcome measures for assessing the effectiveness of new treatments, By understanding how subtle features of gambling games, future changes in gambling legislation may be in a better position to protect vulnerable individuals, „Conventional models are already available to assess different replacement strategies for a group of similar equipment of different ages considering and without considering the time value of money. Here, NPV criterion based on nominal interest rates does not reflect the real increase in the value of money‟. A replacement model is developed taking into account, the combined influence of predicted inflation based on real time data for Air Conditioners and the time value of money. Furthermore, in stable economies maximum weightage may be given to the most recent data and less weightage may be given to the old data. This is because; the fluctuations in economy may be gradual and not all of a sudden in those economies. The trends are determined using the developed model and hence they will be reliable. Therefore, the model is intensified further by using "Weighted Moving Transition Probabilities" technique and the decision is arrived at. WMTP technique, a parsimonious model that approximates the higher order Markov chain is introduced to consider the spread of sizeable data instead of single period‟s past data…among researcher that has use markov chain are Wai-Ki Ching, Eric,Fung and Michael (2004) „presented the higher order Markov Chain model for categorical data sequences,, Liana Cazacioc and Elena Corina Cipu (2004) have developed transition probabilities for second order and third order Markov Chains. Dastidar , *et al*. (2010) simulated the trends in rain fall over Gangetic West Bengal in India during monsoon season with the application of two-state higher order Markov chain models, Stelios H Zanakis and Martin W Maret (1980), applied Markov process for modeling manpower, Ying-Zi Li, Jin-cang Niu (2009) „applied Markov chain based forecasting for Power generation of Grid connected Photovoltaic system. Shamsad , *et al*. (2005), used first and second order transition probability matrices of Markov chain to predict the time series of wind speed values.

II. Research Method

Stationary Process

A stationary process (or strictly stationary process or strongly stationary process) is a stochastic process whose joint probability distribution does not change when shifted in time.

Discrete value and continuous value process. $x_{(t)}$ is a discrete value process if the set of all possible values of $x_{(t)}$ at all times t is a countable set Sx; otherwise, $x_{(t)}$ is a continuous value process. Discrete Time and continuous time process: the stochastic

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue V, May 2025

process $x_{(t)}$ is a discrete time process if $x_{(t)}$ is determined only for a set of time instants, tn=nT, where T is a constant and n is an integer; otherwise $x_{(t)}$ is a continuous time process.

Random variable from random processes: consider a sample function $x_{(t,s)}$, each $x_{(t,s)}$ is a sample value of a random variable. We use $x_{(t)}$ for this random variable. The notation $x_{(t)}$ can be refer to either the random process of the random variable that correspondence to the value of the random process at time t. Example: in the experiment of the repeatedly rolling a die, let $x_n = x_{nt}$. What is the pmf of x_s? The random variable X_3 is the value of the die roll at time 3 in this case.

Px3 (X) = Σ 1/6 x = 1, ……, 6

0 otherwise

Expected value and correlation.

The expected value of process: the expected values of a process X(t) is the deterministic function $m_{(x)}$ (t) = Σ(X(t).

_ Auto –Covariance: The autocovariance function of the stochastic process *X(t) is Cx(t,r) = Cov[X(t),X(t,r)]*

- Autocorrelation: The autocorrelation function of the stochastic process *X(t) is RX(t,r) = E[X(t)X(t +r)]*

- Autocovariance and Autocorrelations of a Random Sequence:

$Cx[m,k] = Cov[X_m,Xm+k] = Rx[M,k] – E[Xm]E[Xm+k]$

Wherem and k are integers, the authocorrelation function of the random sequence X_n *is* $R_x[m,k] = E[X_n X_m + k]$

the input to a digital filter is an *i.i.d.* random sequence … …, $X_{(1)}, X_{(0)}, X_{(1)}, ...$

with E[X_I] = 0 and Var[X_I] = 1. The output is also a random sequence …, Y_{-1}, Y_0, Y_1…

the relationship between the input sequence and output sequence is expressed in the formula.

$Y_n = X_n + X_{n-1}$ for all integer *n*.

Find the expected value function E[Y_n] and auto-covariance function C_y(m,k) of the output

Because $Y_i = X_i + X_{i+1}$, we have $E[y_i) = E[X_I] + E[X_{I+1}] = 0$. Before calculating C_n[m,k], we observe that being an random sequence with E[X_n] = 0 and Var[X_n] = 1 implies

C_X[m,k] = E[X_{m+n}] = { 1 k = 0

{ 0, *otherwise*

distribution of the time to the *kth* point in a Poisson process on (0, ∞) with rate π.can be obtained as follows

Denote the time to the *kth* point by *Tk*. It has a continuous distribution, which is specified by a density function. For t> 0 and small π>0, *P{t≤T<t + π}* = P {exactly k- 1 points in (0,t, exactly one point in (t, t+ π) } + smaller order terms the 'smaller order terms' contribute probability less than P{2 or more points in (t, t + π) { = P { Poisson (π≥2} = $e^{-} \pi \cdot \pi \, (\pi\pi)^2 +$ …2!

By the independence property (ii) for Poisson processes, the main term factorizes asp (exactly k – 1 points in [0, t] } P (exactly one point in $[t, t + \pi)$]

$= \dfrac{e^{-}(\pi t)^{k-1}}{(k-1)!} \dfrac{e^{-t}(\pi\pi)^1}{1!}$

$= \dfrac{e^{-t} \pi^k t^{k-1} \pi +}{(k-1)!}$ smaller orders terms

That is, the distribution of T_k has density

$e^{-t} \pi^k t^{k-1}$ for t > 0

Markov Chain

A Markov chain is a stochastic process where the probability of the next state given the current state and the entire past depends only on the current state:

Transition Matrix: The entries in the first row of the matrix P in example 1 represent the probabilities for the various kinds of weather following a rainy day.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue V, May 2025

Using the tradition matrix P, we can write this product as $p_{11}p_{13}$. The other two events also have probabilities that can be written as products of entries of P. thus, we have $P^{(2)}_{13}=p_{11}p_{13} + p_{12}p_{23}+p_{13}p_{33}$.

This equation should remind the reader of a dot product of two vectors; we dotting the first row of P with the third column of P. this is just what is done in obtaining the 1;3-entry of the product of P with itself. In general, if a Markov chain has r states, then

$$P(2)ij = \Sigma^{r}_{k=1}\ pik[kj:$$

The following general theorem is easy to prove by using the above observation and induction.

Let P be the transition matrix of a Markov chain. The *ij*th entruy *p(n) nij* of the matrix P*n* gives the probability that the Markov shain,, staring in state *si*, will be in state *sj* after *n* steps.

Consider again the weather in the Land of Oz. we know that the powers of the transition matrix give us interesting information about the process as it evolves. We shall be particular interested in the state of the chain after a large number of steps. The program Matrix power computes the powers of P.

p_{ij} - is the probability of moving from state i to j

if i = j the gambler is stationary.

$P=P\langle x_n = j/|x_{n-1} = i\rangle=P\langle x_{n+m} = j|x_{n+m-1} = i\rangle$

n=1,2,…,m≥0 i,j,€ s

Then for the n years we have the transition probability matrix

$$p = \begin{pmatrix} P_{11} & P_{12} & P_{13} & \cdots & P_{1n} \\ P_{21} & P_{22} & p_{23} & \cdots & p_{2n} \\ . & . & . & & . \\ . & . & . & & . \\ . & . & . & & . \\ P_{n1} & P_{n2} & P_{n3} & \cdots & P_{nn} \end{pmatrix}$$

Equilibrium or steady State

The equilibrium state is defined as that condition in the long run where n state has been reached. That is at equilibrium or steady state, the entisep^n as n becomes larger and larger, the entry becomes a constant value in which each (column) has the same entry.

Let W be (w_1, w_2, . . . w_n) be the steady state, then it can be shown that wp=w. to prove this, we obtain the following system of equations;

Where: (W is the steady state distribution Markov stochastic process will be used to obtain transition probabilities and the steady state probability of the system. The equilibrium / limiting state of the system could be obtained by solving the equation

$$\begin{pmatrix} P_{11} & P_{12} & P_{13} & \cdots & P_{1n} \\ P_{21} & P_{22} & P_{23} & \cdots & P_{2n} \\ . & . & . & & \\ . & . & . & & \\ . & . & . & & . \\ P_{n1} & P_{n2} & P_{n3} & \cdots & P_{nn} \end{pmatrix} \begin{pmatrix} w_1 \\ w_2 \\ . \\ . \\ . \\ w_n \end{pmatrix} = \begin{pmatrix} w_1 \\ w_2 \\ . \\ . \\ . \\ w_n \end{pmatrix}$$

$P_{11}w_1 + P_{12}w_2 + P_{13}w_3 + \ldots + P_{1n}w_n = w_1$

$P_{21}w_1 + P_{22}w_2 + P_{23}w_3 + \ldots + P_{2n}w_n = w_2$

$P_{31}w_1 + P_{32}w_2 + P_{33}w_3 + \ldots + P_{3n}w_n = w_3$

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ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue V, May 2025

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$P_{n1}w_1 + P_{n2}w_2 + P_{n3}w_3 + \ldots + P_{nn}w_n = w_n$

With a condition that

Presentation and Analysis of Data

The Method Described in The Previous Chapter Will Be to Analyseddata Presented Below

$$\begin{bmatrix} 0.1000 & 0.104 & 0.100 & 0.094 & 0.092 & 0.512 \\ 0.107 & 0.115 & 0.106 & 0.096 & 0.092 & 0.487 \\ 0.102 & 0.104 & 0.099 & 0.125 & 0.076 & 0.494 \\ 0.134 & 0.107 & 0.098 & 0.099 & 0.087 & 0.475 \\ 0.112 & 0.104 & 0.100 & 0.085 & 0.074 & 0.446 \\ 0.104 & 0.087 & 0.106 & 0.101 & 0.100 & 0.498 \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \\ w_5 \\ w_6 \end{bmatrix} = \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \\ w_5 \\ w_6 \end{bmatrix}$$

$0.100w_1 + 0.104w_2 + 0.100w_3 + 0.094w_4 + 0.092w_5 + 0.512w_6 = w_1$ (i)

$0.107w_1 + 0.115w_2 + 0.106w_3 + 0.096w_4 + 0.092w_5 + 0.484w_6 = w_2$ (ii)

$0.102w_1 + 0.104w_2 + 0.099w_3 + 0.125w_4 + 0.076w_5\ 0.494w_6 = w_3$ (iii)

$0.134w_1 + 0.107w_2 + 0.098w_3 + 0.099w_4 + 0.087w_5 + 0.475w_6 = w_4$ (iv)

$0.112w_1 + 0.104w_2 + 0.100w_3 + 0.085w_4 + 0.074w_5 + 0.446w_6 = w_5$ (v)

$0.109w_1 + 0.087w_2 + 0.106w_3 + 0.101w_4 + 0.100w_5 + 0.498w_6 = w_6$ (vi)

With the condition that

$w_1 + w_2 + w_3 + w_4 + w_5 + w_6 = 1$ (vii)

Replacing one of the systems of linear equations by equation (vii) and solving.

$$\begin{bmatrix} 0.100 & 0.104 & 0.100 & 0.094 & 0.092 & 0.512 \\ 0.107 & 0.115 & 0.106 & 0.096 & 0.092 & 0.487 \\ 0.102 & 0.104 & 0.099 & 0.125 & 0.076 & 0.494 \\ 0.134 & 0.107 & 0.098 & 0.099 & 0.087 & 0.475 \\ 0.112 & 0.104 & 0.100 & 0.085 & 0.074 & 0.446 \\ 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \\ w_5 \\ w_6 \end{bmatrix} = \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \\ w_5 \\ 0.1111 \end{bmatrix}$$

$$\begin{bmatrix} 0.100 & 0.104 \\ 0.107 & 0.115 \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \end{bmatrix} = \begin{bmatrix} w_1 \\ w_2 \end{bmatrix}$$

$0.100w_1 + 0.104w_2 = w_1$

$0.107w_1 + 0.115w_2 = w_2$

$w_1 + w_2 = 0.1111$

$w_1 = 0.1111 - w_2$

Subtracting equation (iii) from (i)

$0.100w_1 - 0.107w_1 + 0.104w_2 - 0.115w_2 = w_1 - w_2$

$-0.007w_1 - 0.011w_2 = w_1 - w_2$

Substitute for w_1

$-0.007\ (0.1111 - w_2) - 0.011w_1 = 0.1111 - 2w_2$

$-0.00078 + 0.0007w_2 - 0.011w_2 = 0.1111 - 2w_2$

$-0.00w_2 + 2w_2 = 0.1111 + 0.00078$

$w_2 = \frac{0.11188}{1.996}$

$w_2 = 0.05\underline{\underline{605}}$

$w_1 = 0.1111 - 0.05605$

$w_1 = 0.05505$

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue V, May 2025

$\begin{bmatrix} 0.100 & 0.094 \\ 0.106 & 0.096 \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \end{bmatrix} = \begin{bmatrix} w_1 \\ w_2 \end{bmatrix}$

$0.100w_1 + 0.094w_2 = w_1$ (i)

$0.106w_1 + 0.096w_2 = w_2$ (ii)

$w_1 + w_2 = 0.1111$ (iii)

$w_1 = 0.1111 - w_2$ (iv)

Subtract equation (ii) from (i)

$0.100w_1 – 0.107w_1 + 0.104w_2 – 0.115w_2 = w_1 - w_2$

$0.100w_1 – 0.106w_1 + 0.094w_2 -0.096w_2 = w_1 - w_2$

$0.006w_1 – 0.002w_2 = w_1 - w_2$

Substitute for w_1

$0.006 (0.1111 - w_2) – 0.002w_2 = 0.1111-w_2-w_2$

$0.000667 + 0.006w_2 – 0.002w_2 = 0.1111 + 0.000667$

$2.004w_2 = 0.111767$

$w_2 = \frac{0.111767}{2.004}$

$w_2 = 0.05577$

$w_1 = 0.1111 – 0.05577$

w_1=0.05533

$\begin{bmatrix} 0.092 & 0.512 \\ 0.092 & 0.487 \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \end{bmatrix} = \begin{bmatrix} w_1 \\ w_2 \end{bmatrix}$

$0.092w_1 + 0.512w_2 = w_1$ (i)

$0.092w_1 + 0.487w_2 = w_2$ (ii)

$w_1 + w_2 = 0.1111$ (iii)

$w_1 = 0.1111 - w_2$ (iv)

Subtract equation (ii) from (i)

$0.092w_1 – 0.092w_1 + 0.512w_2 – 0.487w_2 = w_1 - w_2$

$0.025w_2 = w_1 - w_2$

Substitute for w_1

$0.025w_2 = 0.1111 - w_2 - w_2$

$0.025w_2 = 0.1111 - 2w_2$

$0.25w_2 + 2w_2 = 0.1111$

$w_2 = \frac{0.1111}{2.025}$

$w_2 = 0.05486$

$w_1 = 0.1111 – 0.05486$

$w_{1=0.05624}$

w_2 0.1111 – 0.05486

$w_1 = 0.05624$

$\begin{bmatrix} 0.102 & 0.104 \\ 0.134 & 0.107 \end{bmatrix} \begin{bmatrix} w_3 \\ w_4 \end{bmatrix} = \begin{bmatrix} w_3 \\ w_4 \end{bmatrix}$

$0.102w_3 + 0.104w_4 = w_3$ (i)

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue V, May 2025

$0.134w_{3+}\ 0.107w_4 = w_4$ (ii)

$w_3 + w_4 = 0.1111$ (iii)

$w_3 = 0.1111 - w_4$ (iv)

Subtract equation (ii) from (i)

$0.102w_3 – 0.134w_3 + 0.104w_4 – 0.107w_4 = w_{3-}\ w_4$

$0.03w_3 – 0.003w_4 = w_3 - w_4$

Substitute for w_3

$0.03\ (0.1111 - w_4\ ) – 0.003w_4 = 0.1111 - w_4 - w_4$

$0.00333 + 0.03w_4 – 0.003w_4 = 0.1111 - 2w_4$

$0.003333 + 0.027w_4 = 0.1111 + 0.003333$

$0.027w_4 + 2w_4 = 0.1111 + 0.003333$

$2.027w_4 = 0.114433$

$w_4 = \frac{0.114433}{2.027}$

$w_4 = 0.05645$

$w_3 = 0.1111 - w_4$

$w_3 = 0.1111 – 0.05645$

$w_3 = 0.05465$

$$\begin{bmatrix} 0.099 & 0.125 \\ 0.098 & 0.099 \end{bmatrix} \begin{bmatrix} w_3 \\ w_4 \end{bmatrix} = \begin{bmatrix} w_3 \\ w_4 \end{bmatrix}$$

$0.099w_3 + 0.125w_4 = w_3$ (i)

$0.098w_3 + 0.099w_4 = w_4.$ (ii)

$w_3 + w_4 = 0.1111$ (iii)

$w_3 = 0.1111 - w_4$ (iv)

Subtract equation (ii) from (i)

$0.099w_3 – 0.098w_3 + 0.125w_4 – 0.099w_4 = w_3 - w_4$

$0.001w_3 + 0.026w_4 = w_{3-}\ w_4$

Substitute for w_3

$0.001\ (0.1111 - w_4) + 0.026w_4 = 0.1111 - w_4 - w_4$

$0.000111 + 0.025w_4 = 0.1111 - 2w_4$

$0.025w_4 + 2w_4 = 0.1111 - 2w_4$

$0.025w_4 + 2w_4 = 0.1111 – 0.000111$

$2.025w_4 = 0.110989$

$w_4 = \frac{0.110989}{2.025}$

$w_4 = 0.054809$
$w_3 = 0.056291$

$$\begin{bmatrix} 0.076 & 0.494 \\ 0.087 & 0.475 \end{bmatrix} \begin{bmatrix} w_3 \\ w_4 \end{bmatrix} = \begin{bmatrix} w_3 \\ w_4 \end{bmatrix}$$

$0.076w_3 + 0.494w_4 = w_3$ (i)

$0.087w_3 + 0.475w_4 = w_4$ (ii)

$w_3 + w_4 = 0.1111$ (iii)

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue V, May 2025

w_3 = 0.111 - w_4 (iv)

Subtract equation (ii) from (i)

$0.076w_3 – 0.087w_3 + 0.494w_4 -0.475w_4 = w_3 - w_4$

$0.011w_3 + 0.019w_4 = w_3 - w_4$

Substitute for w_3

$0.111 (0.1111 - w_4) + 0.019w_4 = 0.1111 - w_4 - w_4$

$0.0012221 + 0.011w_4 + 0.019w_4 = 0.1111 -2w_4$

$0.0012221 +0.03w_4 = 0.1111 - 2w_4$

$0.03w_4 + 2w_4 = 0.1111 + 0.0012221$

$2.03w_4 = 0.1123221$

$w_4 = \frac{0.1123221}{2.03}$

w_4 = 0.05533.

w_3 = 0.1111 – 0.05533

w_3 = 0.05577

$$\begin{bmatrix} 0.112 & 0.104 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} w_5 \\ w_6 \end{bmatrix} = \begin{bmatrix} w_5 \\ w_6 \end{bmatrix} = \begin{bmatrix} w_5 \\ 0.1111 \end{bmatrix}$$

$0.112w_5 + 0.104w_6 = w_5$ (i)

$w_5 + w_6 = 0.1111$ (ii)

$w_5 = 0.1111-w_6$ (iii)

Substitute for w_5 in equation (i)

$0.112 (0.1111 - w_6$

$0.0124432 – 0.112w_6 + 0.104w_6 = 0.1111 - w_6$

$0.0124432 – 0.008w_6 = 0.1111 - w_6$

$0.992w_6 = 0.0986568$

From equation (iii) $w_5 = 0.1111 - w_6$

w_5 = 0.01165

w_6 = 0.09945

$$\begin{bmatrix} 0.100 & 0.085 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} w_5 \\ w_6 \end{bmatrix} = \begin{bmatrix} w_5 \\ 0.1111 \end{bmatrix}$$

$0.100w_5 + 0.085w_6 = w_5$ (i)

$w_5 + w_6 = 0.1111$ (ii)

$w_5 = 0.1111 - w_6$ (iii)

Substitute for w_5 in equation (i)

$0.100 (0.1111 - w_6) + 0.085w_6 = 0.1111 - w_6$

$0.01111 – 0.100w_6 + 0.085w_6 = 0.1111 - w_6$

$0.01111 – 0.015w_6 = 0.1111 - w_6$

$- 0.015 + w_6 = 0.1111 – 0.01111$

$0.985w_6 = 0.09999$

$w_6 = \frac{0.09999}{0.985}$

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue V, May 2025

w_6 = 0.1015

w_5 = 0.1111 – 0.1015

w_5 = 0.0096

$$\begin{bmatrix} 0.112 & 0.104 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} w_5 \\ w_6 \end{bmatrix} = \begin{bmatrix} w_5 \\ 0.1111 \end{bmatrix}$$

$0.074w_5 + 0.446w_6 = w_5$ (i)

$w_5 + w_6 = 0.1111$ (ii)

$w_5 = 0.1111 - w_6$ (iii)

Substitute for w_5 in equation (i)

$0.074\,(0.1111 - w_6) + 0.446w_6 = 0.1111 - w_6$.

$0.0082214 – 0.074w_6 + 0.446w_6 = 0.1111 - w_6$

$0.0082214 + 0.372w_6 = 0.1111 – 0.0082214$

$1.372w_6 = 0.1028786$

$$w_6 = \frac{0.1028786}{1.372}$$

w_6 = 0.07498

From equation (iii)

w_5 = 0.1111 – 0.07498

w_5 = 0.03612

w_1 = 0.05505 + 0.05533 + 0.05624 = 0.16662

w_2 = 0.05605 + 0.05577 + 0.05486 = 0.16668

w_3 = 0.05465 + 0.056291 + 0.05577 = 0.166711

w_4 = 0.05645 + 0.054869 + 0.05533 = 0.166589

w_5 = 0.056102 + 0.055378 + 0.053355 = 0.05737

w_6 = 0.054998 + 0.055378 + 0.057748 = <u>0.27593</u>

<u>0.9999</u>

III. Discussion of Results

The state of the system was derived by taking observations at different time (t) for every individual player included in the system. We were able to arrive at a 6×6 probability or stochastic matrix which describes the probability of winning for each player over the years Transition probability is the chance of transiting from a state i to j and it is shown in the matrix below

$$\begin{bmatrix} 0.1000 & 0.104 & 0.100 & 0.094 & 0.092 & 0.512 \\ 0.107 & 0.115 & 0.106 & 0.096 & 0.092 & 0.487 \\ 0.102 & 0.104 & 0.099 & 0.125 & 0.076 & 0.494 \\ 0.134 & 0.107 & 0.098 & 0.099 & 0.087 & 0.475 \\ 0.112 & 0.104 & 0.100 & 0.085 & 0.074 & 0.446 \\ 0.104 & 0.087 & 0.106 & 0.101 & 0.100 & 0.498 \end{bmatrix}$$

When i = j, the state is stationary

p_{11} = 0.100 indicate the probability that player 1 will win in the first year

p_{22} = 0.115 indicate the probability that player 2 will win

The condition that the vector ($w_1, w_2, w_3,\ldots,w_6$) which is the limiting probability matrix of the system is $\sum w_i = 1$

Therefore, haven't performed the analysis, it shows that

$w_1 + w_2 + w_3 + w_4 + w_5 + w_6 = 1$ i.e

0.16662 + 0.16668 + 0.166711 + 0.166589 + 0.05737 + 0.27593 = 0.9999 which is approximately 1

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w_1 = 0.16662 is the probability that in the long run ,player 1 will win while the probability at infinite steps that player 1 will loose will be 1- 0.16662 = 0.83338

w_2 = 0.16668 is the probability that in the long run ,player 2 will win while the probability at infinite steps that player 2 will loose will be 1- 0.16668 = 0.83332

w_3 = 0.166711 is the probability that in the long run ,player 3 will win while the probability at infinite steps that player 3 will loose will be 1- 0.166711 = 0.833289

w_4 = 0.166589 is the probability that in the long run ,player 4 will win while the probability at infinite steps that player 4 will loose will be 1- 0.166589 = 0.833411

w_5 = 0.05737 is the probability that in the long run, player 5 will win while the probability at infinite steps that player 5 will loose will be 1- 0.05737 = 0.94263

w_6 = 0.27593 is the probability that in the long run ,player 6 will win while the probability at infinite steps that player 6 will loose will be 1- 0.27593 = 0.72407

V. Conclusion

We conclude that every player in the system has a chance of winning in the long-run if they remain in the system. The probabilities associated with each player differ from one year to the other. It also increases the power of prediction as one who gambles takes to prediction, this can help in events prediction apart from the prizes one. A gambler's scope is also widenew extensively as he reads past events and chances of winning from history to make better forecast

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