Double Sampling Based Parameter Estimation in Big Data and Application in Control Charts

Abdul Alim and Diwakar Shukla

•

Department of Computer Science and Applications,
Dr. Harisingh Gour University, Sagar (MP), India
E-mail: abdulaleem1990@gmail.com, diwakarshukla@rediffmail.com

Abstract

Double sampling technique and control charts are used for predicting about unknown parameters of the big population and developing algorithms for imposing control over growth factor. This sampling procedure has two approaches like sub-sample and independent sample. Aim is to estimate mean file-size by both and to find out which approach is better in big data setup. Comparative mathematical tools used herein are mean squared error, confidence interval, relative confidence interval length measure and control charts of digital file-size for monitoring. Estimation strategies are proposed and confidence intervals are computed over multiple points of time. At each time, it was found that confidence intervals are catching the true values. First kind of approach (as case I) of double sampling found better than the second. A new simulation strategy is proposed who is observed efficient for comparison purpose. Single-valued simulated confidence intervals are obtained using the new simulation strategy and found covering the truth in its range. As an application of outcomes, control charts are developed to monitor the parametric growth over long duration. Upper and Lower control limits are drawn for business managers to keep a watch on digital file-size estimates whether their growth under control? Outcomes may be extended for reliability evaluation under discrete time domain. The content herein is a piece of thought, idea and analysis developed by deriving motivation from past references to handle big data using double sampling. Findings of the study can be used for developing software based monitoring system using process control charts for managers.

Keywords: Big Big-Data, Double Sampling, Sub-Sample, Estimation, Control Limits, Control Charts, Process Control, Social Media Portal, Mean squared error, Simulation, Confidence Interval (CI).

I. Introduction

Due to emergence of digital technologies and appearance of social media platforms worldwide, people are habitual for ease and comforts contained therein. While user registration, participation and content-communication through these platforms, the digital data is facing challenges in terms of drastic growth in volume, velocity and variety. Momentum of data over time domain has got immense speed to occupy memory space at servers/data centers. Often users do not remove their long past garbage data from the social media account. Space allocation to users is unlimited due to inherent competition in IT business. No service provider wants reduction in user database. Therefore, forecasting (or prediction) require about possible expansion of digital space over continuous time. A manager of Data center is interested to know how much investment cost needed for enhancing capacity of storing units relating to social media portal. Fig.1 to Fig. 3 reveal scenario of expanding digital space over time t_1, t_2 and t_3 ($t_1 < t_2 < t_3$).

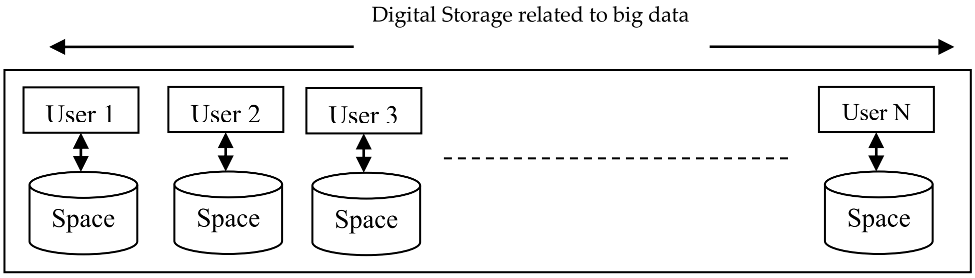


Figure 1: *The digital model of data storage at time* t_1

The figure 1 is allocation of default memory space at the time of user-registration on a portal at time t_1.

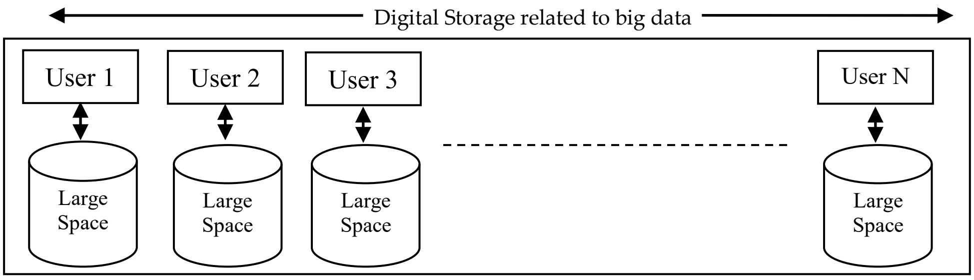


Figure 2: *Digital model of data storage at time* t_2

After t_1 and before t_2 $(t_2 > t_1)$, figure 2 shows increment in default allocated digital space. While at time instant t_3 $(t_3 > t_2 > t_1)$. the default space demand got extra ordinary longevity.

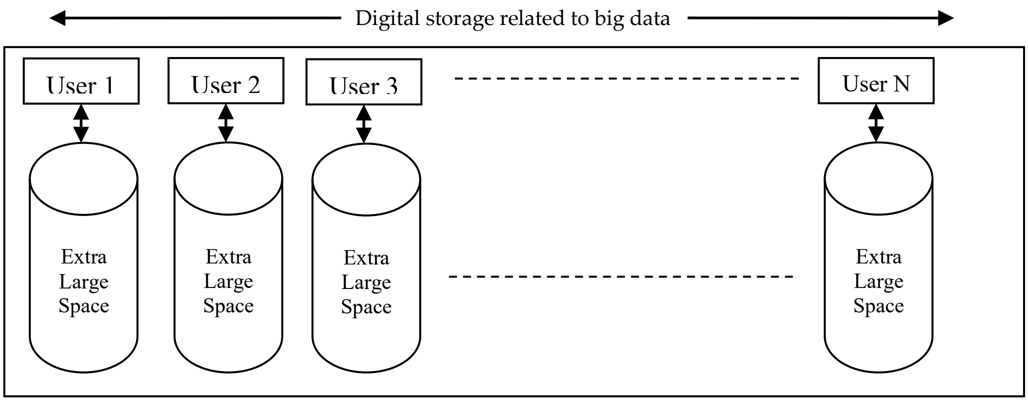


Figure 3: *The digital model of data storage at time* t_3

Alert system requires for constant monitoring of the storage space who can convey managers of IT-business for further planning and cost investments. It could be developed by the joint efforts of sampling methodologies available in literature and process control charts over time frame.

Double sampling scheme is a tool for estimating population parameters where first sample provides guess(low cost) estimate of parameters of the support variable while second sample provides precise estimates of main variable of interest. This scheme has two variants like (a) second sample as sub-sample of first (b) second sample as independent. Fig 4 shows the scheme diagrammatic layout of double sampling.

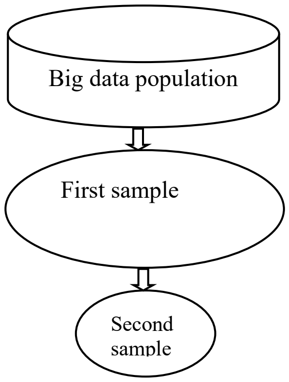


Figure 4.1: *Double sampling Scheme (at j^{th} occasion t_i) under case I*

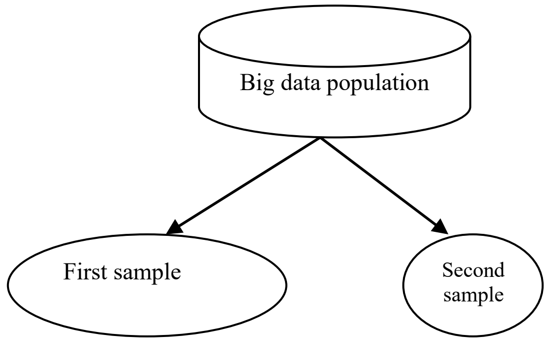


Figure 4.2: *Double sampling Scheme (at i^{th} occasion t_i) under case II*

Using scheme of figure 4.1,and 4.2, one can obtain the sample based prediction about average file-size floating in portal of social media communication model described in Figure 5 where two-way communication exist among large voluminous group of registered users.

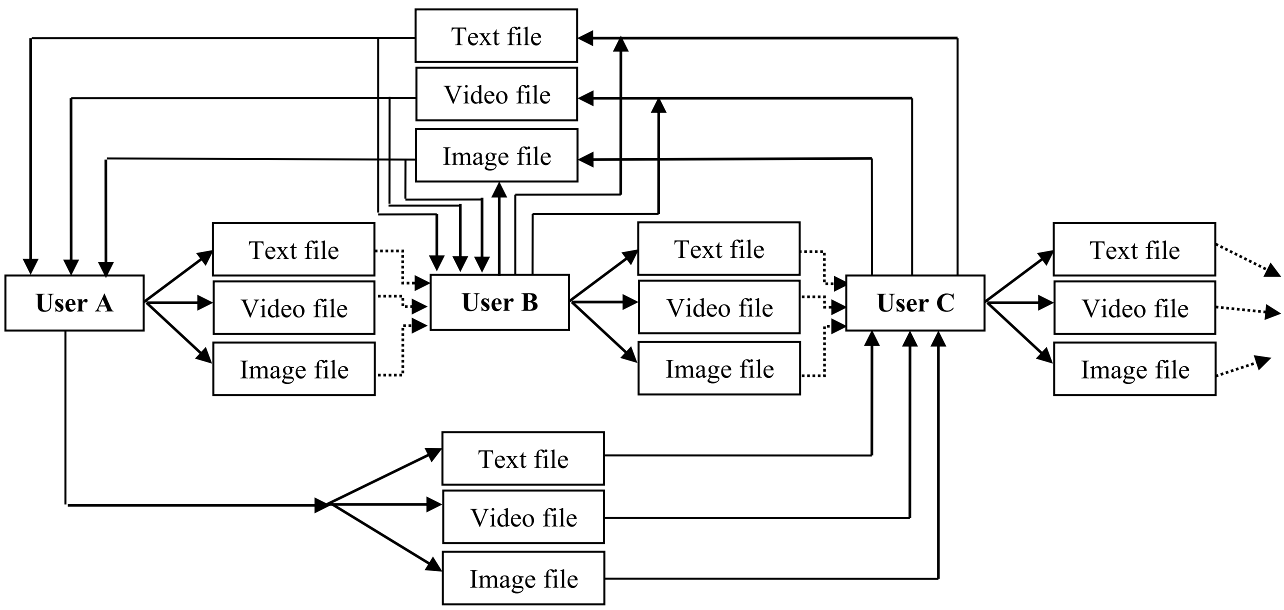


Figure 5. Portal based Social Media communication model and floating files

Statistical methods are used in process control and size measure, which exhibit the extent of conformity of the situation under specifications determined by the relevant authority. It is one of aspects affecting decision making based on specifications set at early level and continued until the completion [1]. Big data take into account digital streams with observations on file-size generated sequentially over time. Among many different purposes, one common task is to collect and analyze big data and to monitor the longitudinal performance of the related processes. Big data assume different forms of data-streams gathered through complex engineering systems like sequences of satellite images, climate data, website transaction logs, credit cards, etc which have complicated data structure and complex storage mechanism. Statistical process control charts [28] could be utilized as an important tool a for monitoring and decision making [2].

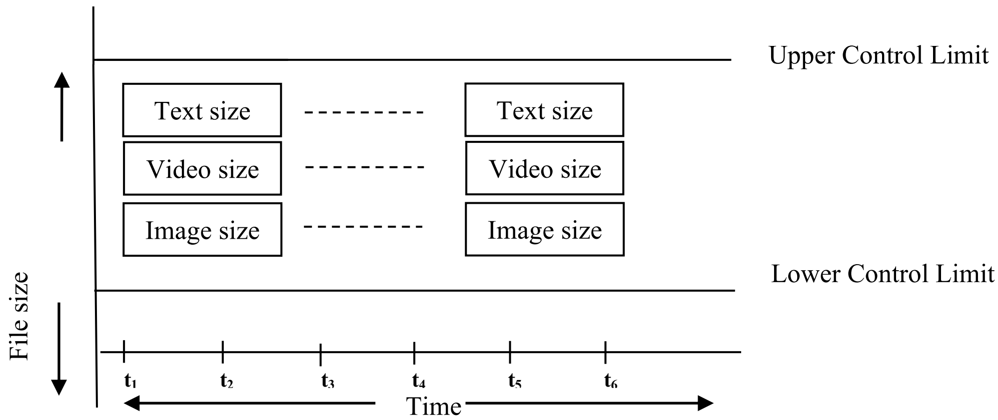


Figure 6: *Process control chart of file size variable*

II. Literature Review

Parameter estimation problem in big data setup is an opportunity which enhanced by contributions to the higher education sectors in terms of developing indicators for decision making [3][4]. Broad aspect of big data including special features and characteristics was narrated [6] with consolidated description by integrating definitions from practitioners and academics. It was focused on analytics related to unstructured data, whose share is 95% of the big data. While dealing with big data and sampling methodologies, scientists can derive machine learning algorithms by the implementation of supervised statistical data mining. Analysis techniques can be used for a single machine scheduling problem in light of hidden patterns using optimized scheduling sequence [7]. Analysis depends on the ability of data scientists to make sense and develop insight into huge data volume. Way of developing an actionable idea is known as data exploration who brings out hidden facts and so is challenging task.

Data requires first a small view to have insights [8] for further course of actions. Sampling methodologies can play vital role by creating preliminary insight into big data. Sampling frame is collection of all units of the population that can use in big data for sample selection. Random sample of registered users on portal can be drawn to obtain estimates of individuals and such precisions are the same as of those when frame consisting of a list of individuals is taken into account [9]. Online social network portals generate large population of individuals where unbiased sampling could be used as a tool for prediction. Convergence properties of the random walk were studied using sampling of Facebook data [10]. Estimation of the influence of an event connected through social media is a problem to handle with because social media is widely exploited as communication platform for relevant and irrelevant information. It opens avenue for mathematical formulation and characterization using casual inference [11]. Avenues in web-based large scale social networks are to explore concise and coherent methods for summarization and to draw valid conclusions. Sampling methodologies on social media network have key role as knowledge discovery tools while a suitable methodology can carry out with efficient decision [12]. Big data may suffer due to incompleteness of required values, and so, need to be replaced by neighboring computations. Digital media platforms often have distinctive temporal patterns that can be exploited for computations in situations involving incomplete information. Iterative type methods suggest to estimate the parameters in the underlying point process and assign weights to the unknown events with direct calculable score function [13].

The ratio based chain-type exponential estimator for finite population mean under double sampling with the auxiliary variable support can provide an efficient estimation methodology [14] applicable in big data. Empirical study as a tool could be used for the betterment of outcome. Extension of exponential-type estimator under double sampling was an outcome [15] with comparative efficiency of the past. In practice, one can find multiple variants affecting the main variable of interest. The multivariate exponential type estimators could be used in setup of double sampling [16] who may efficient performer than single support variant. In presence of non-response and with the help of fractional raw moments, estimate of population parameter could be more efficient using such inputs [17].

The Gaussian process is useful for prediction and can be applied over big data. It is useful where the additive model works well and response depends upon a small number of features [18]. International groups of customers relating to business deals constitute big data and, therefore, exist like open problem for business manager to deal with. Data of sale of cars available on the internet can be analyzed [19] just to have an insight for perception, preferences, preparedness and internet experience of potential car customers while making a purchase/sale decision. A coordination among manufacturer, supplier, retailer is essential to manage forward and reverse supply chain in business. It relates to price-fixing, storing capacity, profit sharing and decision making in a closed-loop supply chain in order to maintain the smooth functioning. Responsibility-sharing is prime factor that affects outcome and profit. Such require optimal selling price, optimal time, wholesale price, sharing percentage and optimal return rate in such a manner that objective function be maximize [20]. The stratified double sampling scheme can be used for estimating finite population mean in presence of more than one support variables using regression time estimators [21]. The basic idea used is to use the ranks of two support variables and extension of the same idea in double sampling setup is due to [22].

III. Motivation and Problem Undertaken

Mean estimation strategies exist in literature [23] for estimating average file-size of text, video and image type communication among registered users on asocial media platform. According to sampling theory [25-27],while the population mean of support variable is unknown, the double sampling is used. This motivates for developing generalization of the aspect [23] for real world situation. In big data, it is difficult to find out parametric information of support variable priorly known because of data-volume, velocity and variety. This motivates for use of double sampling in early literature. Moreover, simulation method with this scheme still not explored. This paper considers the scenario of absence of support variable parametric information and presents new estimation strategies along with a new simulation procedure useful in comparative analysis. As an application, control charts are developed to monitor parametric changes in big data over multiple time occasions. Reliability could be examined through discrete-time domain over a long period. The mathematical support is derived from [23], [24-26] and [27].

I. Assumptions

1. Let at time t_j, the j^{th} registered user on a web portal generates data values $\left\{(T_i)_{t_j}\right\}$ as text, $\left\{(V_i)_{t_j}\right\}$ as video and $\left\{(I_i)_{t_j}\right\}$ as image (reveals variety) $i = 1,2,3, \ldots N, j = 1,2,3, \ldots M$, where M is the total time points of observations (reveals velocity), N is total registered users, large in numbers, on a web portal (reveals volume).

2. Symbol T is used for text, V for video, and I for image.

IV. Parameters

$$\left((\bar{T}.)_{t_j}\right)_{text} = N^{-1}\left[\sum_{i=1}^{N}(T_i)_{t_j}\right] \tag{1}$$

$$\left((\bar{V}.)_{t_j}\right)_{video} = N^{-1}\left[\sum_{i=1}^{N}(V_i)_{t_j}\right] \tag{2}$$

$$\left((\bar{I}.)_{t_j}\right)_{image} = N^{-1}\left[\sum_{i=1}^{N}(I_i)_{t_j}\right] \tag{3}$$

Symbols $C_T^{(j)}$, $C_V^{(j)}$, $C_I^{(j)}$ are coefficients of variation shown in (7), (8), (9) and $\rho_{TV}, \rho_{VI}, \rho_{IT}$ are correlation coefficients of respective pair of populations. Also $\rho_{ab} = \rho_{ba}$ holds for any two pair of variables a and b. Whatever follows hereunder, the t_1 used for time occasion j=1; t_j for j^{th} time occasion. Some other symbols in use are:

$$\left(S_T^{2(j)}\right)_{text} = \frac{1}{N-1}\sum_{i=1}^{N}\left[(T_i)_{t_j} - (\bar{T}.)_{t_j}\right]^2 = S_T^{2(j)} \text{ at } t_j \tag{4}$$

$$\left(S_V^{2(j)}\right)_{video} = \frac{1}{N-1}\sum_{i=1}^{N}\left[(V_i)_{t_j} - (\bar{V}.)_{t_j}\right]^2 = S_V^{2(j)} \text{ at } t_j \tag{5}$$

$$\left(S_I^{2(j)}\right)_{image} = \frac{1}{N-1}\sum_{i=1}^{N}\left[(I_i)_{t_j} - (\bar{I}.)_{t_j}\right]^2 = S_I^{2(j)} \text{ at } t_j \tag{6}$$

The (4), (5), (6) show the variability factor of T, V and I with respect to their means (1), (2), (3). Moreover equations (7), (8), (9) are derived as ratio of (4), (5), (6) with (1), (2), (3).

$$\left(C_T^{(j)}\right)_{text} = \left[S_T^{(j)}/(\bar{T}.)_{t_j}\right] = C_T^{(j)} \text{ at } t_j \tag{7}$$

$$\left(C_V^{(j)}\right)_{video} = \left[S_V^{(j)}/(\bar{V}.)_{t_j}\right] = C_T^{(j)} \text{ at } t_j \tag{8}$$

$$\left(C_I^{(j)}\right)_{image} = \left[S_I^{(j)}/(\bar{I}.)_{t_j}\right] = C_T^{(j)} \text{ at } t_j \tag{9}$$

V. Sample Selection using Double Sampling

Consider figure 4.1 and figure 4.2 where a primary large sample n' $(n' < N)$is drawn by random sampling without replacement and second sample of size $n''(n'' < n')$ is drawn in either of the following manners:

Case I: second sample as a sub-sample.

Case II: second sample as independent to primary sample.

Mean of primary sample n' at j^{th} point of time are:.

$$\left(\bar{T}.^{'(j)}\right)_{text} = (n')^{-1}\left[\sum_{k=1}^{n'}\left(T_k^{'(j)}\right)\right] = \left(\bar{T}.^{'(j)}\right) \text{ at } t_j \tag{10}$$

$$\left(\bar{V}.^{'(j)}\right)_{video} = (n')^{-1}\left[\sum_{k=1}^{n'}\left(V_k^{'(j)}\right)\right] = \left(\bar{V}.^{'(j)}\right) \text{ at } t_j \tag{11}$$

$$\left(\bar{I}.^{'(j)}\right)_{image} = (n')^{-1}\left[\sum_{k=1}^{n'}\left(I_k^{'(j)}\right)\right] = \left(\bar{I}.^{'(j)}\right) \text{ at } t_j \tag{12}$$

The (10),(11) and (12) help to have an idea about the unknown (1), (2), (3) in rough manner with low cost and time effort. Means based on n' are not very accurate because role of primary sample n' is just to provide a guess of (1), (2), (3). To get precise estimate, second sample n'' $(n'' < n')$ is drawn and appropriate methodologies are used on accurate data of n'' to obtain sample means as under :

$$\left(\bar{T}.^{''(j)}\right)_{text} = \left(n^{''}\right)^{-1}\left[\sum_{k=1}^{n^{''}}\left(T_k^{''(j)}\right)\right] \qquad = \left(\bar{T}.^{''(j)}\right) \text{ at } t_j \tag{13}$$

$$\left(\bar{V}.^{''(j)}\right)_{video} = \left(n^{''}\right)^{-1}\left[\sum_{k=1}^{n^{''}}\left(V_k^{''(j)}\right)\right] \qquad = \left(\bar{V}.^{''(j)}\right) \text{ at } t_j \tag{14}$$

$$\left(\bar{I}.^{''(j)}\right)_{image} = \left(n^{''}\right)^{-1}\left[\sum_{k=1}^{n^{''}}\left(I_k^{''(j)}\right)\right] \qquad = \left(\bar{I}.^{''(j)}\right) \text{ at } t_j \tag{15}$$

The (13), (14), (15) are used to estimate unknown (1), (2), (3). Moreover, sample mean squares on $n^{''}$ are:

$$\left(S_T^{2''(j)}\right)_{text} = \frac{1}{n^{''}-1}\sum_{i=1}^{n^{''}}\left[\left(T_k^{''(j)}\right) - \left(\bar{T}.^{''(j)}\right)\right]^2 \qquad = S_T^{2''(j)} \text{ at } t_j \tag{16}$$

$$\left(S_V^{2''(j)}\right)_{video} = \frac{1}{n^{''}-1}\sum_{i=1}^{n^{''}}\left[\left(V_k^{''(j)}\right) - \left(\bar{V}.^{''(j)}\right)\right]^2 \qquad = S_V^{2''(j)} \qquad \text{at } t_j \tag{17}$$

$$\left(S_I^{2''(j)}\right)_{image} = \frac{1}{n^{''}-1}\sum_{i=1}^{n^{''}}\left[\left(I_k^{''(j)}\right) - \left(\bar{I}.^{''(j)}\right)\right]^2 \qquad = S_I^{2''(j)} \text{ at } t_j \tag{18}$$

Sample coefficients of variations are:

$$\left(C''^{(j)}_T\right)_{text} = \left[S_T^{2''(j)} / \left(\bar{T}.^{''(j)}\right)\right] \qquad = \left(C''^{(j)}_T\right) \text{ at } t_j \tag{19}$$

$$\left(C''^{(j)}_V\right)_{video} = \left[S_V^{2''(j)} / \left(\bar{V}.^{''(j)}\right)\right] \qquad = \left(C''^{(j)}_V\right) \text{ at } t_j \tag{20}$$

$$\left(C''^{(j)}_I\right)_{image} = \left[S_I^{2''(j)} / \left(\bar{I}.^{''(j)}\right)\right] \qquad = \left(C''^{(j)}_I\right) \text{ at } t_j \tag{21}$$

The symbols $\rho_{T,V}$, $\rho_{V,I}$, $\rho_{I,T}$ are used for correlation coefficient in population while $\rho^{''}_{T,V}$, $\rho^{''}_{V,I}$, $\rho^{''}_{I,T}$ are used for the same purpose but on data of $n^{''}$ called as sample estimate of correlation coefficient.

VI. Double Sampling based Methods of Estimation

Let E_1 , E_2 , E_3 are double sampling based estimation strategies for estimating unknown big-data population parameters (1), (2), (3) respectively. At j[th] point of time t_j , they are as under:

$$\left(E_1^{(j)}\right)_{text} = \left[\bar{T}.^{''(j)}\left(\left(\bar{V}.^{'}\right)_{t_j} / \bar{V}.^{''(j)}\right)\right] \tag{22}$$

$$\left(E_2^{(j)}\right)_{video} = \left[\bar{V}.^{''(j)}\left(\left(\bar{I}.^{'}\right)_{t_j} / \bar{I}.^{''(j)}\right)\right] \tag{23}$$

$$\left(E_3^{(j)}\right)_{image} = \left[\bar{I}.^{''(j)}\left(\left(\bar{T}.^{'}\right)_{t_j} / \bar{T}.^{''(j)}\right)\right] \tag{24}$$

Equations (22), (23), (24) are in accordance with references [24][25][26][27] extended for set-up of big data. These are logically formulated such that in (22) the T is variable of main interest while V is support variable correlated to T since larger T provides increment in V. Therefore, with the help of V, a better estimate of T could be obtained. Similar logical justifications are used for formulation of (23) and (24). The E_1 , E_2 , E_3 are biased for estimation of (1), (2), (3) because $E[E_m] \neq (T.)_{text}$ or $\left((\bar{V}.)_{t_j}\right)_{video}$ or $(\bar{I}.)_{image}$ for m=1,2,3 where $E[.]$ denotes expectation of estimate.

The general form of mean squared error (MSE) is describe below for $\hat{\theta}$ to be an estimator of true value θ.

$M(\hat{\theta}) = E\left[\hat{\theta} - \theta\right]^2$ where $\hat{\theta}$ corresponds to $E_i^{(j)}$,i=1,2,3 sequentially while θ are (1), (2), (3) respectively.

Mean squared error under ,Case I ,are ($see\ references$ [24][25] [26][27]):

$$\left[MSE\left(E_1^{(j)}\right)_{text}\right]_I = \left[(\bar{T}.)_{t_j}^2\right]\left[(V_{20})_T^{(j)} + \left((V_{02})_T^{(j)} - (V_{02}^{'})_T^{(j)}\right) - 2\left\{(V_{11})_T^{(j)} - (V_{11}^{'})_T^{(j)}\right\}\right] \quad (25)$$

$$\left[MSE\left(E_2^{(j)}\right)_{video}\right]_I = \left[(\bar{V}.)_{t_j}^2\right]\left[(V_{20})_V^{(j)} + \left((V_{02})_V^{(j)} - (V_{02}^{'})_V^{(j)}\right) - 2\left\{(V_{11})_V^{(j)} - (V_{11}^{'})_v^{(j)}\right\}\right] \quad (26)$$

$$\left[MSE\left(E_3^{(j)}\right)_{image}\right]_I = \left[(\bar{I}.)_{t_j}^2\right]\left[(V_{20})_I^{(j)} + \left((V_{02})_I^{(j)} - (V_{02}^{'})_I^{(j)}\right) - 2\left\{(V_{11})_I^{(j)} - (V_{11}^{'})_I^{(j)}\right\}\right] \quad (27)$$

Mean squared errors, under case II, are ($see\ references$ [24][25] [26][27]):

$$\left[MSE\left(E_1^{(j)}\right)_{text}\right]_{II} = \left[(\bar{T}.)_{t_j}^2\right]\left[(V_{20})_T^{(j)} + \left((V_{02})_T^{(j)} + (V_{02}^{'})_T^{(j)}\right) - 2(V_{11})_T^{(j)}\right] \quad (28)$$

$$\left[MSE\left(E_2^{(j)}\right)_{video}\right]_{II} = \left[(\bar{V}.)_{t_j}^2\right]\left[(V_{20})_V^{(j)} + \left((V_{02})_V^{(j)} + (V_{02}^{'})_V^{(j)}\right) - 2(V_{11})_V^{(j)}\right] \quad (29)$$

$$\left[MSE\left(E_3^{(j)}\right)_{image}\right]_{II} = \left[(\bar{I}.)_{t_j}^2\right]\left[(V_{20})_I^{(j)} + \left((V_{02})_I^{(j)} + (V_{02}^{'})_I^{(j)}\right) - 2(V_{11})_I^{(j)}\right] \quad (30)$$

Using expectation $E[.]$of sample mean, following are expressions up-to first order of approximations ($see\ references$ [24][25] [26][27]):

$$\left(V_{qm}^{(j)}\right)_T = E\left[\left\{\left(\bar{T}.^{''(j)}\right) - (\bar{T}.)_{t_j}\right\}^q \left\{\left(\bar{V}.^{''(j)}\right) - (\bar{V}.)_{t_j}\right\}^m\right]$$

$$= \rho_{TV}^r \frac{N-n}{Nn}\left[\left(C_T^{(j)}\right)_{text}\right]^q \left[\left(C_V^{(j)}\right)_{video}\right]^m \quad (31)$$

$$\left(V_{qm}^{'(j)}\right)_T = E\left[\left\{\left(\bar{T}.^{''(j)}\right) - (\bar{T}.)_{t_j}\right\}^q \left\{\left(\bar{V}.^{'(j)}\right) - (\bar{V}.)_{t_j}\right\}^m\right]$$

$$= \rho_{TV}^r \frac{N-n^{'}}{Nn^{'}}\left[\left(C_T^{(j)}\right)_{text}\right]^q \left[\left(C_V^{(j)}\right)_{video}\right]^m \quad (32)$$

$$\left(V_{qm}^{(j)}\right)_V = E\left[\left\{\left(\bar{V}.^{''(j)}\right) - (\bar{V}.)_{t_j}\right\}^q \left\{\left(\bar{I}.^{''(j)}\right) - (\bar{I}.)_{t_j}\right\}^m\right]$$

$$= \rho_{VI}^r \frac{N-n}{Nn}\left[\left(C_V^{(j)}\right)_{video}\right]^q \left[\left(C_I^{(j)}\right)_{image}\right]^m \quad (33)$$

$$\left(V_{qm}^{'(j)}\right)_V = E\left[\left\{\left(\bar{V}.^{''(j)}\right) - (\bar{V}.)_{t_j}\right\}^q \left\{\left(\bar{I}.^{'(j)}\right) - (\bar{I}.)_{t_j}\right\}^m\right]$$

$$= \rho_{VI}^r \frac{N-n^{'}}{Nn^{'}}\left[\left(C_V^{(j)}\right)_{video}\right]^q \left[\left(C_I^{(j)}\right)_{image}\right]^m \quad (34)$$

$$\left(V_{qm}^{(j)}\right)_I = E\left[\left\{\left(\bar{I}.^{''(j)}\right) - (\bar{I}.)_{t_j}\right\}^q \left\{\left(\bar{T}.^{''(j)}\right) - (\bar{T}.)_{t_j}\right\}^m\right]$$

$$= \rho_{IT}^r \frac{N-n}{Nn}\left[\left(C_I^{(j)}\right)_{image}\right]^q \left[\left(C_T^{(j)}\right)_{text}\right]^m \quad (35)$$

$$\left(V'^{(j)}_{qm}\right)_I = E\left[\left\{\left(\bar{I}.^{''(j)}\right) - (\bar{I}.)_{t_j}\right\}^q \left\{\left(\bar{T}.^{'(j)}\right) - (\bar{T}.)_{t_j}\right\}^m\right]$$

$$= \rho_{IT}^r \frac{N-n^{'}}{Nn^{'}}\left[\left(C_I^{(j)}\right)_{images}\right]^q \left[\left(C_T^{(j)}\right)_{text}\right]^m \quad (36)$$

where $q = 0,1,2$ $m = 0,1,2$ and $r = 1$ if $q = p = 1$ else $r = 0$.

The pooled estimates, based on sample $n^{''}$, over M different time points (occasions) are :

$$\left[(E_1)_{text}\right]_{\text{I}} = \sum_{j=1}^{M} W_{jT} \left(E_1^{(j)}\right)_{text} \quad , \ W_{jT} = \frac{1}{M} \quad (37)$$

$$[(E_2)_{video}]_{\text{I}} = \sum_{j=1}^{M} W_{jV} \left(E_2^{(j)}\right)_{video} \quad , \ W_{jV} = \frac{1}{M} \quad (38)$$

$$\left[(E_3)_{image}\right]_{\text{I}} = \sum_{j=1}^{M} W_{jI} \left(E_3^{(j)}\right)_{image} \quad , \ W_{jI} = \frac{1}{M} \quad (39)$$

The (37), (38), (39) are weighted average over M occasions of E_1 , E_2 , E_3 under case I and same is derived for case II in (40), (41), (42).

$$\left[(E_1)_{text}\right]_{\text{II}} = \sum_{j=1}^{M} W_{jT} \left(E_1^{(j)}\right)_{text} \quad , \; W_{jT} = \frac{1}{M} \tag{40}$$

$$[(E_2)_{video}]_{\text{II}} = \sum_{j=1}^{M} W_{jV} \left(E_2^{(j)}\right)_{video} \quad , \; W_{jV} = \frac{1}{M} \tag{41}$$

$$\left[(E_3)_{image}\right]_{\text{II}} = \sum_{j=1}^{M} W_{jI} \left(E_3^{(j)}\right)_{image} \quad , \; W_{jI} = \frac{1}{M} \tag{42}$$

The pooled mean squared errors (MSE) on M points of time also have weighted sum shown in (43) to (48) for Case I and II.

$$[MSE(E_1)_{text}]_{\text{I}} = \sum_{j=1}^{M} W_{jT}^2 \; MSE(E_1^{(j)})_{text} \tag{43}$$

$$[MSE(E_2)_{video}]_{\text{I}} = \sum_{j=1}^{M} W_{jV}^2 \; MSE\,(E_2^{(j)})_{video} \tag{44}$$

$$\left[MSE(E_3)_{image}\right]_{\text{I}} = \sum_{j=1}^{M} W_{jI}^2 \; MSE(E_3^{(j)})_{image} \tag{45}$$

$$[MSE(E_1)_{text}]_{\text{II}} = \sum_{j=1}^{M} W_{jT}^2 \; MSE(E_1^{(j)})_{text} \tag{46}$$

$$[MSE(E_2)_{video}]_{\text{II}} = \sum_{j=1}^{M} W_{jV}^2 \; MSE\,(E_2^{(j)})_{video} \tag{47}$$

$$\left[MSE(E_3)_{image}\right]_{\text{II}} = \sum_{j=1}^{M} W_{jI}^2 \; MSE(E_3^{(j)})_{image} \tag{48}$$

The 95% confidence interval, in general, is defined for two estimated numbers $a^{'}, b^{'}$ in probability sense denoted as $P[.]$ like $\text{P}\left[a^{'} < True\,Value\, < b^{'}\right] = 0.95$. It is explained as estimate $a^{'}, b^{'}$ obtained from sample, there is 95% chance that $a^{'}, b^{'}$ will catch (predict) the true value. More explicitly, the 95% confidence interval is computed as $P\left[sample\ mean \pm 1.96\sqrt{standard\ error}\right] = 0.95$ (see [25]).

For Case I, the confidence intervals (CI) are in (49), (50) and (51).

$$P\left[(E_1)_{text} - 1.96\sqrt{[MSE(E_1)_{text}]_{\text{I}}}\;, \quad (E_1)_{text} + 1.96\sqrt{[MSE(E_1)_{text}]_{\text{I}}}\,\right] = 0.95 \tag{49}$$

$$P\left[(E_2)_{video} - 1.96\sqrt{[MSE(E_2)_{video}]_{\text{I}}}\;, \quad (E_2)_{video} + 1.96\sqrt{[MSE(E_2)_{video}]_{\text{I}}}\,\right] = 0.9 \tag{50}$$

$$P\left[(E_3)_{image} - 1.96\sqrt{\left[MSE(E_3)_{image}\right]_{\text{I}}}\;, \quad (E_3)_{image} + 1.96\sqrt{\left[MSE(E_3)_{image}\right]_{\text{I}}}\,\right] = 0.95 \tag{51}$$

For second case II, CI are expressed in (52), (53) and (54).

$$P\left[(E_1)_{text} - 1.96\sqrt{[MSE(E_1)_{text}]_{\text{II}}}\;, \quad (E_1)_{text} + 1.96\sqrt{[MSE(E_1)_{text}]_{\text{II}}}\,\right] = 0.95 \tag{52}$$

$$P\left[(E_2)_{video} - 1.96\sqrt{[MSE(E_2)_{video}]_{\text{II}}}\;, \quad (E_2)_{video} + 1.96\sqrt{[MSE(E_2)_{video}]_{\text{II}}}\,\right] = 0.95 \tag{53}$$

$$P\left[(E_3)_{image} - 1.96\sqrt{\left[MSE(E_3)_{image}\right]_{\text{II}}}\;, \quad (E_3)_{image} + 1.96\sqrt{\left[MSE(E_3)_{image}\right]_{\text{II}}}\,\right] = 0.95 \tag{54}$$

I. Population Description

For calculation and comparison, in order to avoid complexity, a small population of size N=100 is considered whose detail is in annexure A. Descriptive statistics of the population as per (1), (2), (3), (4), (5), (6), (7), (8) are in table 1 calculated at six points of time t_1 to t_6.

Table 1: *Descriptive statistics of population at six points of time (users are the same)*

t_1, N=100	$[\bar{T}.]_{t_1}$ =74.14	$[\bar{V}.]_{t_1}$ =105.3	$[\bar{I}.]_{t_1}$ =145.07	$\rho_{T,V}{}^{(1)}$ =0.7
	$S_T^{2(1)}$ =1537.04	$S_V^{2(1)}$ =3756.03	$S_I^{2(1)}$ =6784.69	$\rho_{V,I}{}^{(1)}$ =0.8
	$C_T^{(1)}$ =0.53	$C_V^{(1)}$ =0.58	$C_I^{(1)}$ =0.57	$\rho_{I,T}{}^{(1)}$ =0.7
t_2, N=100	$[\bar{T}.]_{t_2}$ =67.7	$[\bar{V}.]_{t_2}$ =98.13	$[\bar{I}.]_{t_2}$ =226.18	$\rho_{T,V}{}^{(2)}$ =0.6
	$S_T^{2(2)}$ =1365.71	$S_V^{2(2)}$ =3501.81	$S_I^{2(2)}$ =16979.73	$\rho_{V,I}{}^{(2)}$ =0.7
	$C_T^{(2)}$ =0.55	$C_V^{(2)}$ =0.60	$C_I^{(2)}$ =0.58	$\rho_{I,T}{}^{(2)}$ =0.5
t_3, N=100	$[\bar{T}.]_{t_3}$ =125.92	$[\bar{V}.]_{t_3}$ =137.29	$[\bar{I}.]_{t_3}$ =362.74	$\rho_{T,V}{}^{(3)}$ =0.5
	$S_T^{2(3)}$ =4212.01	$S_V^{2(3)}$ =7083.59	$S_I^{2(3)}$ =42405.57	$\rho_{V,I}{}^{(3)}$ =0.8
	$C_T^{(3)}$ =0.52	$C_V^{(3)}$ =0.61	$C_I^{(3)}$ =0.57	$\rho_{I,T}{}^{(3)}$ =0.7
t_4, N=100	$[\bar{T}.]_{t_4}$ =110.79	$[\bar{V}.]_{t_4}$ =144.05	$[\bar{I}.]_{t_4}$ =142.45	$\rho_{T,V}{}^{(4)}$ =0.7
	$S_T^{2(4)}$ =2382.75	$S_V^{2(4)}$ =5670.83	$S_I^{2(4)}$ =7309.01	$\rho_{V,I}{}^{(4)}$ =0.8
	$C_T^{(4)}$ =0.44	$C_V^{(4)}$ =0.52	$C_I^{(4)}$ =0.60	$\rho_{I,T}{}^{(4)}$ =0.6
t_5 , N=100	$[\bar{T}.]_{t_5}$ =148.92	$[\bar{V}.]_{t_5}$ =236.51	$[\bar{I}.]_{t_5}$ =257.97	
	$S_T^{2(5)}$ =7393.63	$S_V^{2(5)}$ =15047.95	$S_I^{2(5)}$ =17480.67	$\rho_{T,V}{}^{(5)}$ =0.5
	$C_T^{(5)}$ =0.58	$C_V^{(5)}$ =0.52	$C_I^{(5)}$ =0.51	$\rho_{V,I}{}^{(5)}$ =0.8
	W_{5T} =0.167	W_{5V} =0.167	W_{5I} =0.167	$\rho_{I,T}{}^{(5)}$ =0.5
t_6 , N=100	$[\bar{T}.]_{t_6}$ =173.5	$[\bar{V}.]_{t_6}$ =308.78	$[\bar{I}.]_{t_6}$ =306.78	$\rho_{T,V}{}^{(6)}$ =0.7
	$S_T^{2(6)}$ =4997.55	$S_V^{2(6)}$ =29899.47	$S_I^{2(6)}$ =29761.89	$\rho_{V,I}{}^{(6)}$ =0.8
	$C_T^{(6)}$ =0.41	$C_V^{(6)}$ =0.56	$C_I^{(6)}$ =0.56	$\rho_{I,T}{}^{(6)}$ =0.6

Primary sample of size $n^{'} = 40$ is drawn from N=100 to calculate the mean size of unknown parameters $[\bar{T}.]_{t_j}$, $[\bar{V}.]_{t_j}$ and $\bar{I}._{t_j}$ over six points of time. This sample is used to have a guess value of the population parameter to use as supportive information. Calculation of sample means on $n^{'} = 40$ is in table 2.

Table 2: *Sample-based mean estimates at six occasions ($n^{'}$=40 primary sample)*

At time t_1(occasion one) $n' = 40$	$[\bar{T}.^{'}]_{t_1}$ =83.58	$[\bar{V}.^{'}]_{t_1}$ =114.85	$\bar{I}.^{'}_{t_1}$ =152.85
At time t_2(occasion two)$n' = 40$	$[\bar{T}.^{'}]_{t_2}$ =75.95	$[\bar{V}.^{'}]_{t_2}$ =107.12	$\bar{I}.^{'}_{t_2}$ =244.53
At time t_3(occasion third) $n' = 40$	$[\bar{T}.^{'}]_{t_3}$ =139.07	$[\bar{V}.^{'}]_{t_3}$ =153.5	$\bar{I}.^{'}_{t_3}$ =382.25
At time t_4(occasion four) $n' = 40$	$[\bar{T}.^{'}]_{t_4}$ =120.95	$[\bar{V}.^{'}]_{t_4}$ =150.9	$\bar{I}.^{'}_{t_4}$ =157.97
At time t_5(occasion five) $n' = 40$	$[\bar{T}.^{'}]_{t_5}$ =174.12	$[\bar{V}.^{'}]_{t_5}$ =274.93	$\bar{I}.^{'}_{t_5}$ =281.48
At time t_6(occasion six) $n' = 40$	$[\bar{T}.^{'}]_{t_6}$ =181.38	$[\bar{V}.^{'}]_{t_6}$ =362.38	$\bar{I}.^{'}_{t_6}$ =337.05

A second sample of size $n^{''} = 10$ is taken for estimation of means on variable of main interest over six points of time. Estimates on $n^{''}$are in table 3 for strategy under case I. Similarly, for strategy under case II, the calculations are in table 4. The pooled estimate of text-data, video-data and images-data using equation (22), (23), (24) are in table 5 and table 6 along with MSE calculation using (25) to (30).

Table 3: *Result of sample-based calculation at six occasions (n''=10, first sample) under Case I [eq. (13)-(21) and (25)-(27)]*

t_1 $n'=10$	$[\bar{T}.'']_{t_1}$ =99.30	$[\bar{V}.'']_{t_1}$ =118.30	$[\bar{I}.'']_{t_1}$ =148.90	MSE_Text=265.51	$\rho_{TV}^{''(1)}$ =0.4
	$S_T^{2''(1)}$ =1220.90	$S_V^{2''(1)}$ =5572.46	$S_I^{2''(1)}$ =7921.43	MSE_Video=566.86	$\rho_{VI}^{''(1)}$ =0.4
	$C_T^{''(1)}$ =0.35	$C_V^{''(1)}$ =0.63	$C_I^{''(1)}$ =0.60	MSE_Image=768.16	$\rho_{IT}^{'(1)}$ =0.2
t_2 $n'=10$	$[\bar{T}.'']_{t_2}$ =84.80	$[\bar{V}.'']_{t_2}$ =102.40	$[\bar{I}.'']_{t_2}$ =238.20	MSE_Text=424.44	$\rho_{TV}^{''(2)}$ =-0.3
	$S_T^{2''(2)}$ =1230.18	$S_V^{2''(2)}$ =4394.04	$S_I^{2''(2)}$ =20243.96	MSE_Video=490.99	$\rho_{VI}^{''(2)}$ =0.3
	$C_T^{''(2)}$ =0.41	$C_V^{''(2)}$ =0.65	$C_I^{''(2)}$ =0.60	MSE_Image=2348.19	$\rho_{IT}^{''(2)}$ =0.1
t_3 $n'=10$	$[\bar{T}.'']_{t_3}$ =144.40	$[\bar{V}.'']_{t_3}$ =165.40	$[\bar{I}.'']_{t_3}$ =372.40	MSE_Text=1197.09	$\rho_{TV}^{''(3)}$ =-0.4
	$S_T^{2''(3)}$ =3185.16	$S_V^{2''(3)}$ =10899.60	$S_I^{2''(3)}$ =49400.49	MSE_Video=1106.98	$\rho_{VI}^{''(3)}$ =0.4
	$C_T^{''(3)}$ =0.39	$C_V^{''(3)}$ =0.63	$C_I^{''(3)}$ =0.60	MSE_Image=6106.08	$\rho_{IT}^{''(3)}$ =-0.0
t_4 $n'=10$	$[\bar{T}.'']_{t_4}$ =129.80	$[\bar{V}.'']_{t_4}$ =132.20	$[\bar{I}.'']_{t_4}$ =147.10	MSE_Text=98.56	$\rho_{TV}^{''(4)}$ =0.6
	$S_T^{2''(4)}$ =1307.51	$S_V^{2''(4)}$ =2028.84	$S_I^{2''(4)}$ =8529.66	MSE_Video=345.68	$\rho_{VI}^{''(4)}$ =0.7
	$C_T^{''(4)}$ =0.28	$C_V^{''(4)}$ =0.34	$C_I^{''(4)}$ =0.63	MSE_Image=523.50	$\rho_{IT}^{''(4)}$ =0.6
t_5 $n'=10$	$[\bar{T}.'']_{t_5}$ =193.20	$[\bar{V}.'']_{t_5}$ =307.40	$[\bar{I}.'']_{t_5}$ =323.30	MSE_Text=752.35	$\rho_{TV}^{''(5)}$ =0.4
	$S_T^{2''(5)}$ =9574.18	$S_V^{2''(5)}$ =8915.60	$S_I^{2''(5)}$ =13703.34	MSE_Video=520.64	$\rho_{VI}^{''(5)}$ =0.8
	$C_T^{''(5)}$ =0.51	$C_V^{''(5)}$ =0.31	$C_I^{''(5)}$ =0.36	MSE_Image=3214.32	$\rho_{IT}^{''(5)}$ =0.0
t_6 $n'=10$	$\bar{T}.''_{t_6}$ =212.00	$[\bar{V}.'']_{t_6}$ =412.60	$[\bar{I}.'']_{t_6}$ =276.10	MSE_Text=478.96	$\rho_{TV}^{''(6)}$ =0.7
	$S_T^{2''(6)}$ =2686.44	$S_V^{2''(6)}$ =38532.04	$S_I^{2''(6)}$ =27937.66	MSE_Video=6424.23	$\rho_{VI}^{''(6)}$ =0.2
	$C_T^{''(6)}$ =0.24	$C_V^{''(6)}$ =0.48	$C_I^{''(6)}$ =0.61	MSE_Image=1875.89	$\rho_{IT}^{''(6)}$ =0.6

Table 4: *Result of sample-based calculation (n''=10, first sample) under Case II [eq. (13)-(21) and (28)-(30)]*

t_1 $n'=10$	$[\bar{T}.'']_{t_1}$ =99.30	$[\bar{V}.'']_{t_1}$ =118.30	$[\bar{I}.'']_{t_1}$ =148.90	MSE_Text=355.53	$\rho_{TV}^{''(1)}$ =0.4
	$S_T^{2''(1)}$ =1220.90	$S_V^{2''(1)}$ =5572.46	$S_I^{2''(1)}$ =7921.43	MSE_Video=654.93	$\rho_{VI}^{''(1)}$ =0.4
	$C_T^{''(1)}$ =0.35	$C_V^{''(1)}$ =0.63	$C_I^{''(1)}$ =0.60	MSE_Image=820.38	$\rho_{IT}^{''(1)}$ =0.2
t_2 $n'=10$	$[\bar{T}.'']_{t_2}$ =84.80	$[\bar{V}.'']_{t_2}$ =102.40	$[\bar{I}.'']_{t_2}$ =238.20	MSE_Text=532.38	$\rho_{TV}^{''(2)}$ =-0.3
	$S_T^{2''(2)}$ =1230.18	$S_V^{2''(2)}$ =4394.04	$S_I^{2''(2)}$ =20243.96	MSE_Video=566.21	$\rho_{VI}^{''(2)}$ =0.3
	$C_T^{''(2)}$ =0.41	$C_V^{''(2)}$ =0.65	$C_I^{''(2)}$ =0.60	MSE_Image=2599.03	$\rho_{IT}^{''(2)}$ =0.1
t_3 $n'=10$	$[\bar{T}.'']_{t_3}$ =144.40	$[\bar{V}.'']_{t_3}$ =165.40	$[\bar{I}.'']_{t_3}$ =372.40	MSE_Text=1503.78	$\rho_{TV}^{''(3)}$ =-0.4
	$S_T^{2''(3)}$ =3185.16	$S_V^{2''(3)}$ =10899.60	$S_I^{2''(3)}$ =49400.49	MSE_Video=1278.36	$\rho_{VI}^{''(3)}$ =0.4
	$C_T^{''(3)}$ =0.39	$C_V^{''(3)}$ =0.63	$C_I^{''(3)}$ =0.60	MSE_Image=6755.85	$\rho_{IT}^{''(3)}$ =-0.0
t_4 $n'=10$	$[\bar{T}.'']_{t_4}$ =129.80	$[\bar{V}.'']_{t_4}$ =132.20	$[\bar{I}.'']_{t_4}$ =147.10	MSE_Text=124.07	$\rho_{TV}^{''(4)}$ =0.6
	$S_T^{2''(4)}$ =1307.51	$S_V^{2''(4)}$ =2028.84	$S_I^{2''(4)}$ =8529.66	MSE_Video=481.63	$\rho_{VI}^{''(4)}$ =0.7
	$C_T^{''(4)}$ =0.28	$C_V^{''(4)}$ =0.34	$C_I^{''(4)}$ =0.63	MSE_Image=499.85	$\rho_{IT}^{''(4)}$ =0.6
t_5 $n'=10$	$[\bar{T}.'']_{t_5}$ =193.20	$[\bar{V}.'']_{t_5}$ =307.40	$[\bar{I}.'']_{t_5}$ =323.30	MSE_Text=783.31	$\rho_{TV}^{''(5)}$ =0.4
	$S_T^{2''(5)}$ =9574.18	$S_V^{2''(5)}$ =8915.60	$S_I^{2''(5)}$ =13703.34	MSE_Video=650.11	$\rho_{VI}^{''(5)}$ =0.8
	$C_T^{''(5)}$ =0.51	$C_V^{''(5)}$ =0.31	$C_I^{''(5)}$ =0.36	MSE_Image=4012.67	$\rho_{IT}^{''(5)}$ =0.0
t_6 $n''=10$	$[\bar{T}.'']_{t_6}$ =212.00	$[\bar{V}.'']_{t_6}$ =412.60	$[\bar{I}.'']_{t_6}$ =276.10	MSE_Text=678.99	$\rho_{TV}^{''(6)}$ =0.7
	$S_T^{2''(6)}$ =2686.44	$S_V^{2''(6)}$ =38532.04	$S_I^{2''(6)}$ =27937.66	MSE_Video=7951.35	$\rho_{VI}^{''(6)}$ =0.2
	$C_T^{''(6)}$ =0.24	$C_V^{''(6)}$ =0.48	$C_I^{''(6)}$ =0.61	MSE_Image=1816.54	$\rho_{IT}^{''(6)}$ =0.6

Table 5: *Result of sample-based pooled calculation at six occasions under case I using one sample*

$n'' = 10$	$[(E_1)_{text}]_{\text{I}}$ =126.06	$[(E_2)_{video}]_{\text{I}}$ =195.47	$[(E_3)_{image}]_{\text{I}}$ =258.18
	$[MSE(E_1)_{text}]_{\text{I}}$ =40.93	$[MSE(E_2)_{video}]_{\text{I}}$ =44.61	$[MSE(E_3)_{image}]_{\text{I}}$ =304.28
CI	(113.52-138.59)	(182.38-208.56)	(223.99-292.36)
True Value	116.82	171.62	240.19
Length (CI)	25.07	26.18	68.37

Table 6: *Result of sample-based pooled calculation at six occasions under case II using one sample*

$n'' = 10$	$[(E_1)_{text}]_{\text{II}}$ =126.06	$[(E_2)_{video}]_{\text{II}}$ =195.47	$[(E_3)_{image}]_{\text{II}}$ =258.18
	$[MSE(E_1)_{text}]_{\text{II}}$ =47.85	$[MSE(E_2)_{video}]_{\text{II}}$ =54.95	$[MSE(E_3)_{image}]_{\text{II}}$ =339.36
CI	(112.50-139.61)	(181.21-209.99)	(222.04-294.31)
True Value	116.82	171.62	240.19
Length (CI)	27.11	28.78	72.27

Table 5 and table 6 contain one-sample combined estimates, pooled to six occasions, on the variable of main interest (T or V or I). The MSE under case I is smaller than Case II. The length of confidence intervals in case I is lower showing efficiency over case II.

II. Practically Difficulty

The confidence intervals (CI) in table 5 and table 6 are sample dependent therefore difficult to conclude uniquely. Reason behind is that one can draw many samples of size n'' from n' (total $n'_{C_{n''}}$) and many from N (total $N_{C_{n''}}$). Each time the average of sample estimate fluctuates and accordingly variation occur in predicted value of confidence intervals. Look at table 6 , $[(E_2)_{video}]_{\text{II}}$ =195.47, CI = (181.21-209.99) where CI does not catch the true value 171.62 which is evidence of difficulty. To cope up this, a new simulation procedure is proposed in section 6.2 based on many samples who ultimately determines the single-value of lower and upper limits.

III. Simulation Procedure Algorithm for Double Sampling

In order to get single-value of limits of 95% confidence interval , a simulation procedure is proposed:

Step 1: Draw a primary random sample of size n'.

Step2: Draw second sample as under
Case I: as sub-sample of n'
Case II: as independent sample from N

Step 3: Compute lower limit (say 'a') and upper limit (say 'b') of confidence interval(CI) using each sub-sample (or independent sample) , where 95% confidence interval is $Prob.[a < true\ value < b] = 0.95$. It is like table 3 and table 4 form t_1 to t_6 using equations (49) to (54).

Step 4: Repeat step 2 and step 3 for k times (k=200).

Step 5: Compute the Less Than Type (LTT) and More Than Type (MTT) cumulative probabilities by constructing class-intervals for 'a' and 'b' separately for each CI.

Step 6: Plot data of step 5 of cumulative probabilities (on y-axis) over class-intervals (on x-axis) and draw two graphs. A perpendicular drawn from point of intersection of two graphs ,on the x-axis, determines single-point of simulated value of lower limit 'a' (and corresponding upper limit 'b') of confidence interval for unknown parameters to be predicted. Express outcomes in tabular presentation like tables 8,9,10 and table 11.

IV. Features of proposed simulation procedure for double sampling:

(a) It is based on k-samples, where K may be as large possible.

(b) It considers cumulative probabilities which is ratio of cumulative frequency to total frequency.

(c) It takes into account the perpendicular drawn from point of intersection of the cumulative probability curves which always remain unique for lower as well as upper limit.

(d) It eliminates problem discussed in section I.

V. Demonstration of Simulation procedure:

Out of k= 200 samples, after calculation of confidence intervals on each sample, let f_i be frequencies of class intervals $\propto_i - \propto_{i+1}$ relating to lower limit of CI , such that $\sum f_i = k = 200$ holds. Probabilities are $p_i = f_i/k$, $i = 1,2,3, \ldots$

Table 7. Demonstration of Simulation Procedure

Class Intervals (for lower limit 'a')	**Frequencies** (Occurrence of estimate 'a ')	**Probabilities**	**LTT (Step 5)**	**MTT (Step 5)**
$\propto_1 - \propto_2$	f_1	$p_1 = f_1/k$	$C_1 = p_1$	$C_1' = 1$
$\propto_2 - \propto_3$	f_2	$p_2 = f_2/k$	$C_2 = p_1 + p_2$	$C_2' = 1 - p_1$
$\propto_3 - \propto_4$	f_3	$p_3 = f_3/k$	$C_3 = p_1 + p_2 + p_3$	$C_3' = 1 - p_1 - p_2$
$\propto_4 - \propto_5$	f_4	$p_4 = f_4/k$	$C_4 = p_1 + p_2 + p_3 + p_4$	$C_4' = 1 - p_1 - p_2 - p_3$
− − −	.	.	.	.
− − −	.	.	.	.
− − −	.	.	.	.
Total	$\sum f_i = k = 200$	$\sum p_i = 1$		

Plot C_i and C_i' over class-interval on a graph to find point of intersection of two curves (step 6). Draw a perpendicular on X-axis from point of intersection which uniquely determine single-value of 'a'.

VI. Application of proposed Simulation Procedure

Figure 7-78 provide the simulated single-valued lower limit 'a' and simulated single-valued upper limit 'b' of confidence intervals as an application.
Graphs (fig. 7-42) are under case I on t_1 to t_6 . Note that SCI symbolized for simulated confidence interval, TD text dataset, VD video data and ID indicates image dataset in all hereunder:

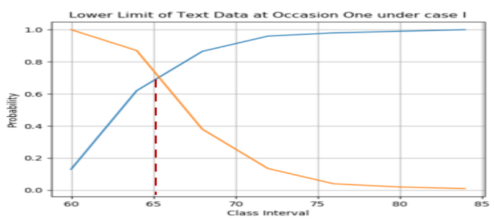


Figure 7: *At t_1, Case I, Lower limit of text data at (a=65.30)*

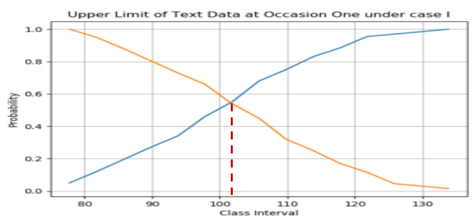
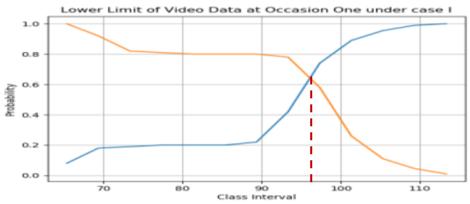


Figure 8: *At t_1, Case I, Lower limit of text data at (b=101.56)*

The figure 7 is calculates value a=65.30 (perpendicular from intersection point) which is the lower limit of simulated confidence interval of text dataset at $t_1$under case I. Similarly, figure 8 has upper limit of simulated confidence interval of text data at t_1 under case I whose perpendicular from point of intersection is b=101.56.



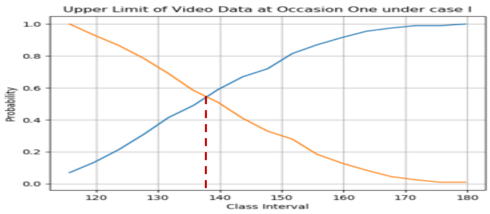
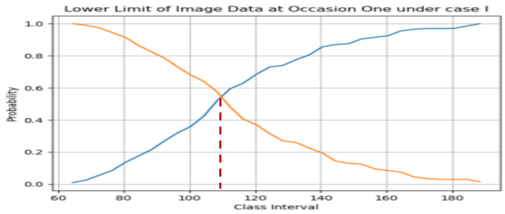


Figure 9: *At t_1, Case I, Lower limit of video data at (a=96.04)* **Figure10:** *At t_1, Case I, Upper limit of video data at (b=137.79)*

Figure 9 provides value a=96.04 (perpendicular from intersection point) as lower limit of simulated confidence interval of video dataset at t_1 under case I. Likewise, figure 10 shows upper limit of simulated confidence interval of video data at t_1 under case I where perpendicular from intersection point is at b=137.79.



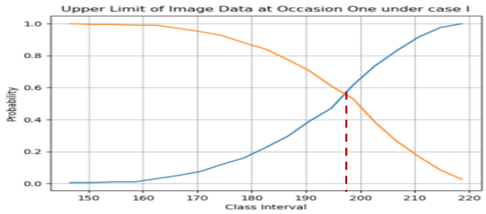
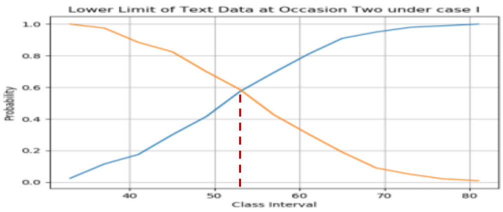


Figure 11: *At t_1, Case I, Lower limit of image data at (a=109.36)* **Figure 12:** *At t_1, Case I, Upper limit of image data at (b=197.01)*

Figure 11 reveals the value a=109.36 (perpendicular from intersection point) as lower limit of SCI of image dataset at t_1 under case I. Figure 12 displays upper limit of SCI of image data at occasion one, under case I which is b=197.01.



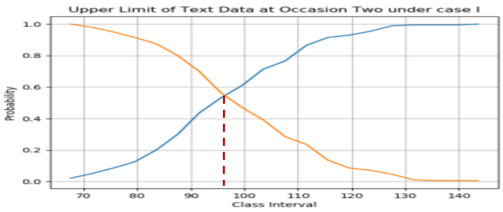
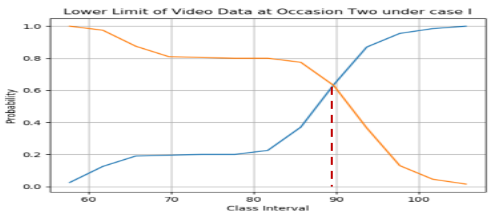


Figure 13: *At t_2, Case I, Lower limit of text data at (a=53.08)* **Figure 14:** *At t_2, Case I, Upper limit of text data at (b=96.30)*

Figure 13 is at time t_2 showing value a=53.08 , under case I , and figure 14 is similar for upper limit b=96.30 under case I at t_2



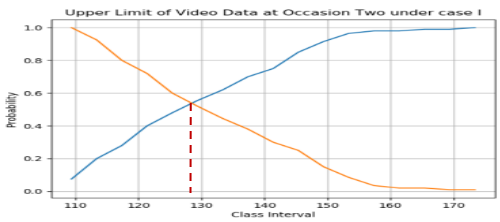
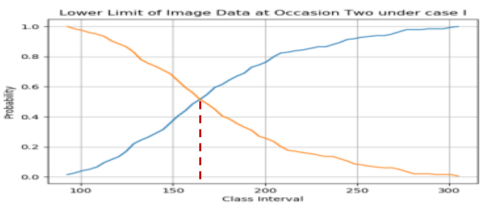


Figure 15: *At t_2, Case I, Lower limit of video data at (a=89.56)* **Figure 16:** *At t_2, Case I, Upper limit of video data at (b=128.33)*

Figure 15 and 16 reveal value a=89.56 as lower and b=128.33 as upper at t_2, for case I.



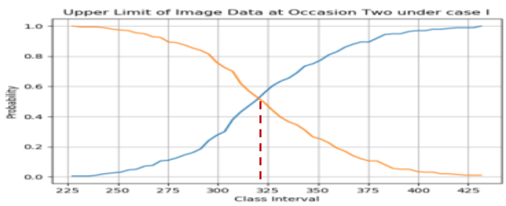
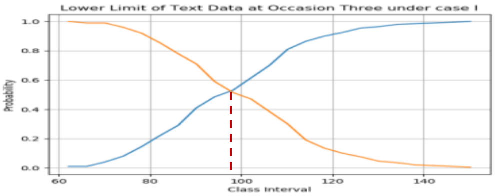


Figure 17: *At t_2, Case I, Lower limit of image data at (a=164.44)* **Figure 18:** *At t_2, Case I, Upper limit of image data at (b=320.34)*

Figure 17 and 18 reflect towards value a=164.44 and b=320.34 at t_2 case I.



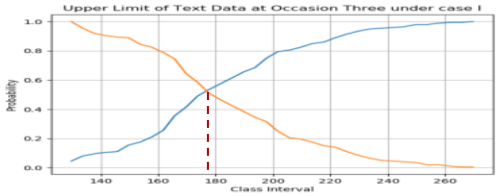
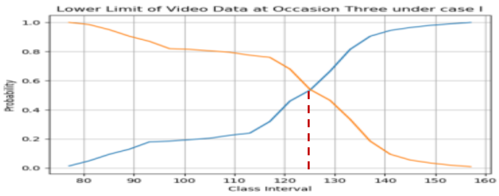


Figure 19: *At t_3, Case I, Lower limit of text data at (a=97.39)* **Figure 20:** *At t_3, Case I, Upper limit of text data at (b=176.44)*

Figure 19 and 20 reveal for a=97.39 and b=176.44 at t_2 case I.



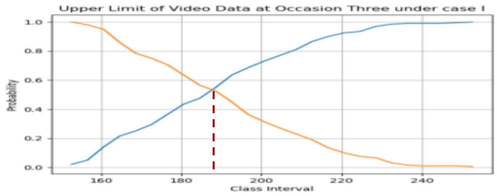
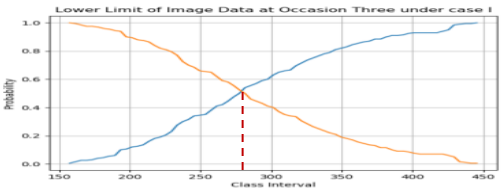


Figure 21: *At t_3, Case I, Lower limit of video data at (a=125.06)* **Figure 22:** *At t_3, Case I, Upper limit of video data at (b=187.50)*

The figure 21 and 22 have a=125.06, b=187.50.



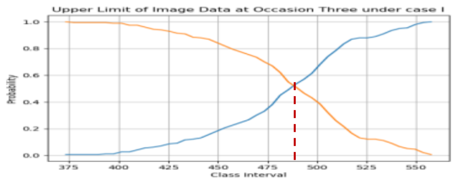


Figure 23: *At t_3, Case I, Lower limit of image data at (a=278.48)* **Figure 24:** *At t_3, Case I, Upper limit of image data at (b=487.83)*

Values a=278.48 and b=487.83 are in figure 23 to 24. Similar are in figure 25 to 78 under case I and case II for T, V and I over time t_1 to t_6. Figure caption from 25-78 are self explanatory and reveal auto interpretation as above

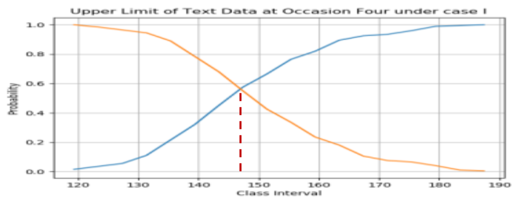
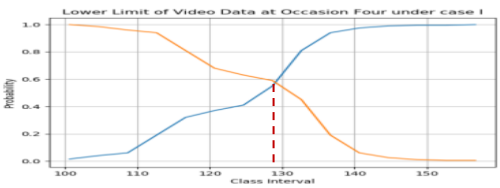


Figure 25: *At t_4, Case I, Lower limit of text data at (a=93.22)* **Figure 26:** *At t_4, Case I, Upper limit of text data at (b=146.75)*



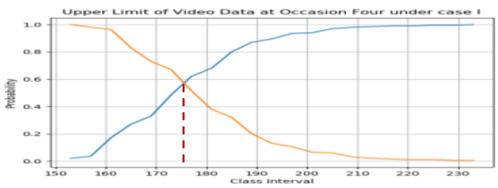
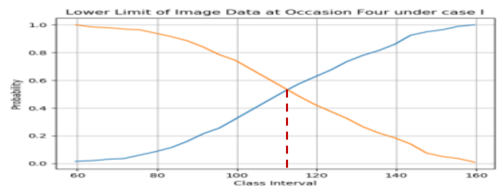


Figure 27: *At t_4, Case I, Lower limit of video data at (a=129.03)* **Figure 28:** *At t_4, Case I, Upper limit of video data at (b=175.43)*



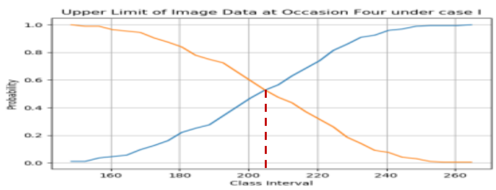


Figure 29: *At t_4, Case I, Lower limit of image data at (a=112.47)* **Figure 30:** *At t_4, Case I, Upper limit of image data at (b=204.60)*

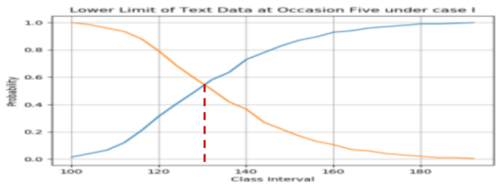


Figure 31: *At t_5, Case I, Lower limit of text data at (a=130.39)*

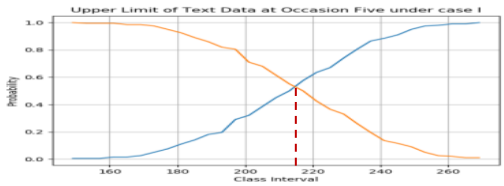


Figure 32: *At t_5, Case I, Upper limit of text data at (b=214.44)*

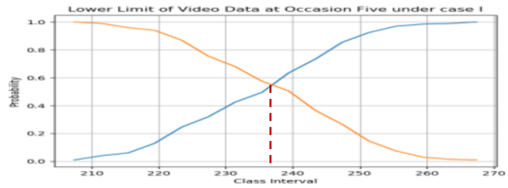


Figure 33: *At t_5, Case I, Lower limit of video data at (a=236.75)*

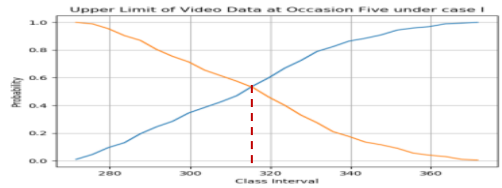


Figure 34: *At t_5, Case I, Upper limit of video data at (b=314.93)*

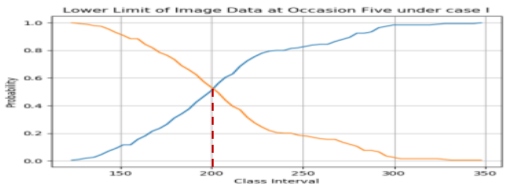


Figure 35: *At t_5, Case I, Lower limit of image data at (a=200.37)*

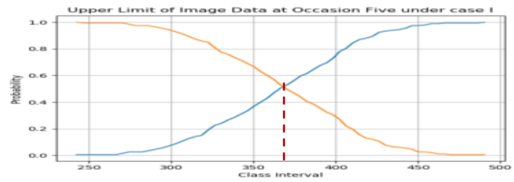


Figure 36: *At t_5, Case I, Upper limit of image data at (b=368.03)*

Figure 37: *At t_6, Case I, Lower limit of text data at (a=142.73)*

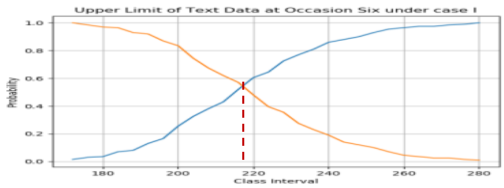


Figure 38: *At t_6, Case I, Upper limit of text data at (b=216.89)*

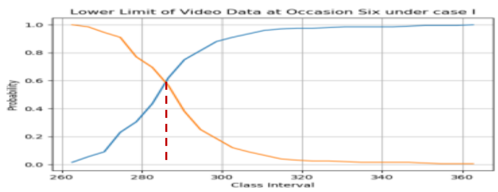


Figure 39: *At t_6, Case I, Lower limit of video data at (a=285.58)*

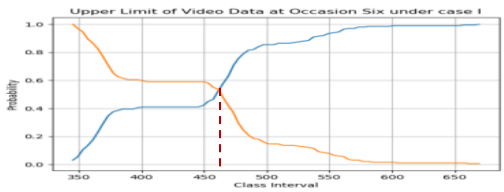


Figure 40: *At t_6, Case I, Upper limit of video data at (b=461.31)*

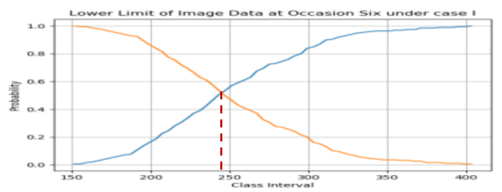


Figure 41: *At t_6, Case I, Lower limit of image data at (a=244.35)*

Figure 42: *At t_6, Case I, Upper limit of image data at (b=431.30)*

The following Fig. 43-78 are showing time point wise t_1 to t_6 the simulated results under case II.

Figure 43: *At t_1, Case II, Lower limit of text data at (a=63.72)*

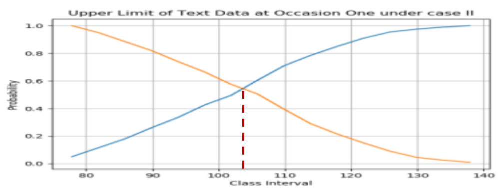


Figure 44: *At t_1, Case II, Upper limit of text data at (b=103.49)*

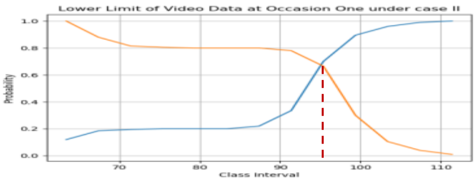


Figure 45: *At t_1, Case II, Lower limit of video data at (a=94.95)*

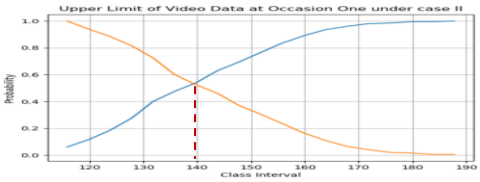


Figure 46: *At t_1, Case II, Upper limit of video data at (b=139.18)*

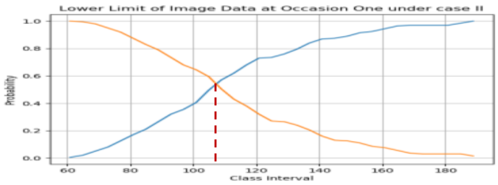


Figure 47: *At t_1, Case II, Lower limit of image data at (a=106.98)*

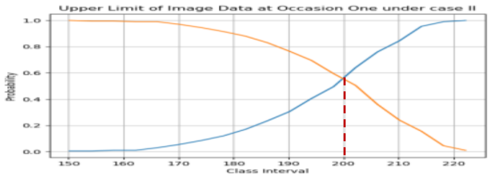


Figure 48: *At t_1, Case II, Upper limit of image data at (b=199.75)*

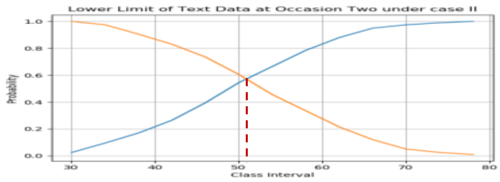


Figure 49: *At t_2, Case II, Lower limit of text data at (a=50.86)*

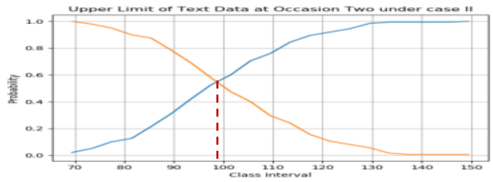


Figure 50: *At t_2, Case II, Upper limit of text data at (b=98.45)*

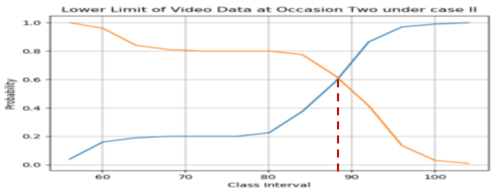


Figure 51: *At t_2, Case II, Lower limit of video data at (a=88.27)*

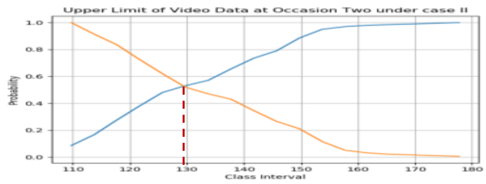


Figure 52: *At t_2, Case II, Upper limit of video data at (b=129.26)*

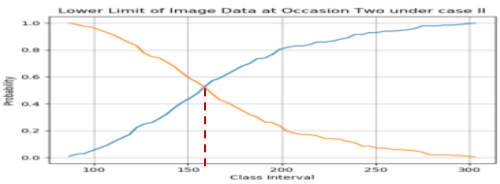


Figure 53: *At t_2, Case II, Lower limit of image data at (a=158.51)*

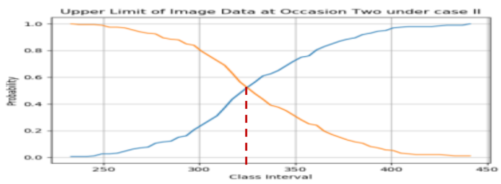


Figure 54: *At t_2, Case II, Upper limit of image data at (b=324.26)*

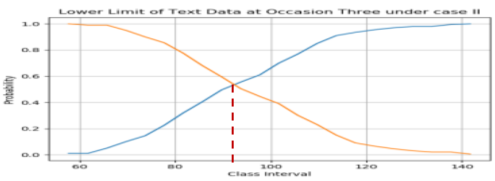


Figure 55: *At t_3, Case II, Lower limit of text data at (a=92.06)*

Figure 56: *At t_3, Case II, Upper limit of text data at (b=180.96)*

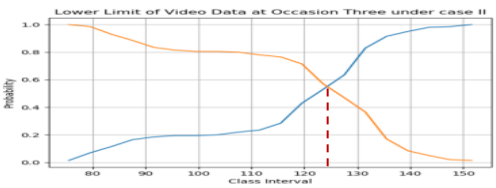


Figure 57: *At t_3, Case II, Lower limit of video data at (a=124.15)*

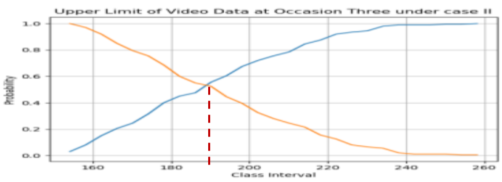
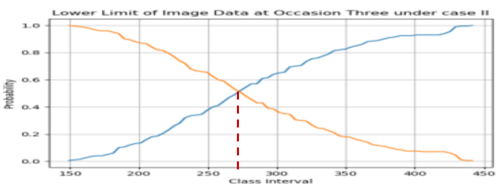


Figure 58: *At t_3, Case II, Upper limit of video data at (b=188.82)*



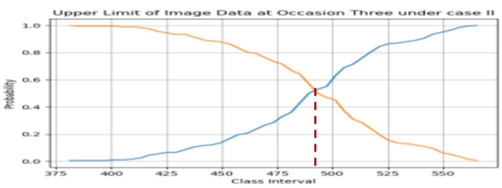
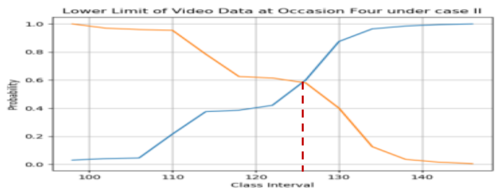


Figure 59: *At t_3, Case II, Lower limit of image data at (a=271.49)* **Figure 60:** *At t_3, Case II, Upper limit of image data at (b=491.64)*

Figure 61: *At t_4, Case II, Lower limit of text data at (a=90.28)* **Figure 62:** *At t_4, Case II, Upper limit of text data at (b=150.54)*



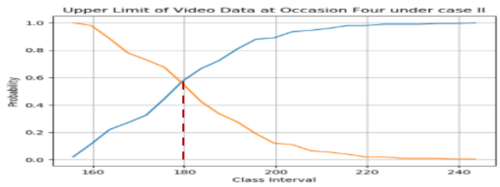
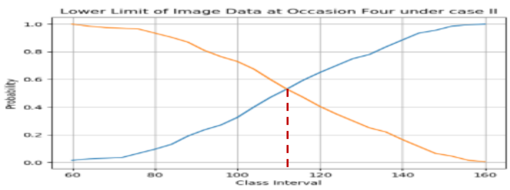


Figure 63: *At t_4, Case II, Lower limit of video data at (a=125.51)* **Figure 64:** *At t_4, Case II, Upper limit of video data at (b=178.96)*



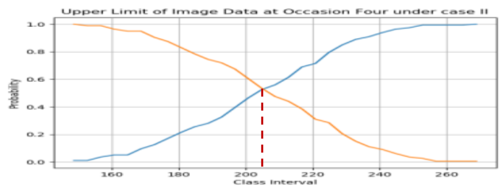
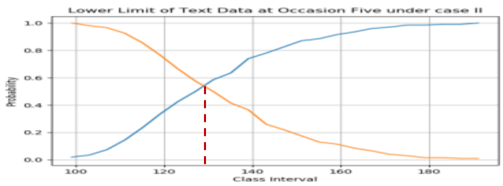


Figure 65: *At t_4, Case II, Lower limit of image data at (a=111.75)* **Figure 66:** *At t_4, Case II, Upper limit of image data at (b=205.07)*



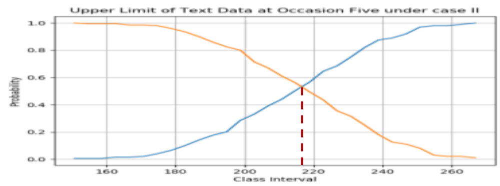
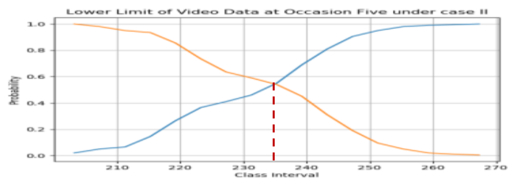


Figure 67: *At t_5, Case II, Lower limit of text data at (a=129.04)* **Figure 68:** *At t_5, Case II, Upper limit of text data at (b=216.24)*



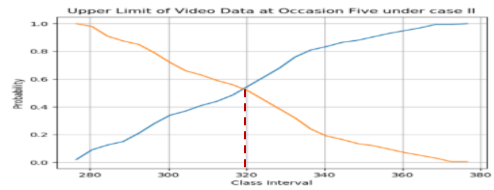
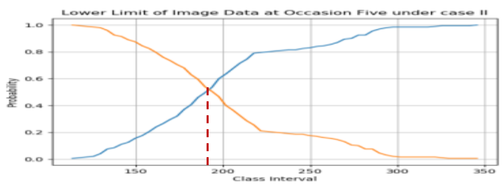


Figure 69: *At t_5, Case II, Lower limit of video data at (a=235.86)* **Figure 70:** *At t_5, Case II, Upper limit of video data at (b=318.93)*



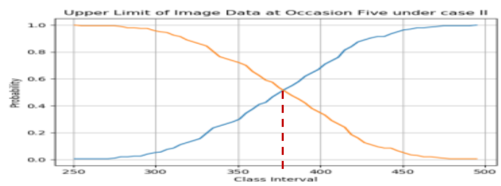


Figure 71: *At t_5, Case II, Lower limit of image data at (a=191.57)* **Figure 72:** *At t_5, Case II, Upper limit of image data at (b=376.60)*

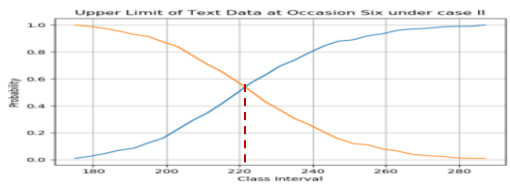


Figure 73: *At t_6, Case II, Lower limit of text data at (a=138.04)* **Figure 74:** *At t_6, Case II, Upper limit of text data at (b=221.40)*

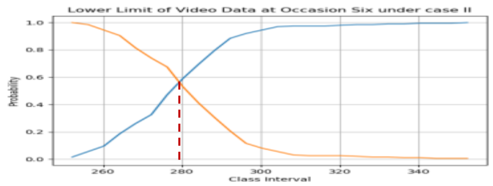


Figure 75: *At t_6, Case II, Lower limit of video data at (a=278.96)*

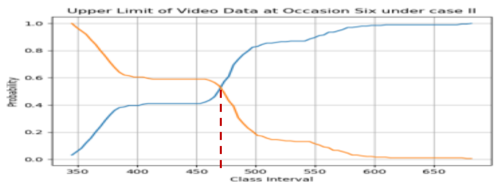


Figure 76: *At t_6, Case II, Upper limit of video data at (b=469.30)*

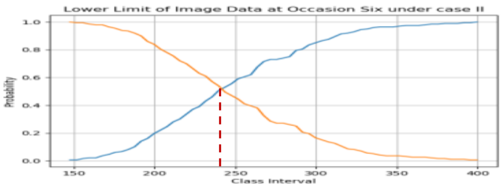


Figure 77: *At t_6, Case II, Lower limit of image data at (a=241.10)*

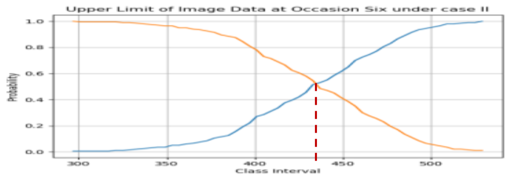


Figure 78: *At t_6, Case II, Upper limit of image data at (b=434.08)*

VII. Tabular Presentation for summarization (part of Step 5):

After simulation is over, outcomes of all above graphs are summarized in table 8 9, 10 and 11.

Table 8: *Summary of simulated CI over t_1 to t_6 under case I (based on figures 7-42)*

Time-Occasions	Dataset	Figures	Lower Limit	Figures	Upper Limit	True Value
t_1	T	Figure 7	a=65.30	Figure 8	b=101.56	74.14
	V	Figure 9	a=96.04	Figure 10	b=137.79	105.3
	I	Figure 11	a=109.36	Figure 12	b=197.01	145.07
t_2	T	Figure 13	a=53.08	Figure 14	b=96.30	67.7
	V	Figure 15	a=89.56	Figure 16	b=128.33	98.13
	I	Figure 17	a=164.44	Figure 18	b=320.34	226.18
t_3	T	Figure 19	a=97.39	Figure 20	b=176.44	125.92
	V	Figure 21	a=125.06	Figure 22	b=187.50	137.29
	I	Figure 23	a=278.48	Figure 24	b=487.83	362.74
t_4	T	Figure 25	a=93.22	Figure 26	b=146.75	110.79
	V	Figure 27	a=129.03	Figure 28	b=175.43	144.05
	I	Figure 29	a=112.47	Figure 30	b=204.60	142.45
t_5	T	Figure 31	a=130.39	Figure 32	b=214.44	148.92
	V	Figure 33	a=236.75	Figure 34	b=314.93	236.51
	I	Figure 35	a=200.37	Figure 36	b=368.03	257.97
t_6	T	Figure 37	a=142.73	Figure 38	b=216.89	173.5
	V	Figure 39	a=285.58	Figure 40	b=461.31	308.78
	I	Figure 41	a=244.35	Figure 42	b=431.30	306.78

Table 9: *Summary of simulated CI over t_1 to t_6 under case II (based on figures 43-78)*

Time-Occasions	Dataset	Figures	Lower Limit	Figures	Upper Limit	True Value
t_1	T	Figure 43	a=63.70	Figure 44	b=103.49	74.14
	V	Figure 45	a=94.95	Figure 46	b=139.18	105.3
	I	Figure 47	a=106.98	Figure 48	b=199.75	145.07
t_2	T	Figure 49	a=50.86	Figure 50	b=98.45	67.7
	V	Figure 51	a=88.27	Figure 52	b=129.26	98.13
	I	Figure 53	a=158.51	Figure 54	b=324.26	226.18
t_3	T	Figure 55	a=92.06	Figure 56	b=180.96	125.92
	V	Figure 57	a=124.15	Figure 58	b=188.82	137.29

	I	Figure 59	a=271.49	Figure 60	b=491.64	362.74
t_4	T	Figure 61	a=90.28	Figure 62	b=150.54	110.79
	V	Figure 63	a=125.51	Figure 64	b=178.96	144.05
	I	Figure 65	a=111.75	Figure 66	b=205.07	142.45
t_5	T	Figure 67	a=129.04	Figure 68	b=216.24	148.92
	V	Figure 69	a=235.86	Figure 70	b=318.93	236.51
	I	Figure 71	a=191.57	Figure 72	b=376.60	257.97
t_6	T	Figure 73	a=138.04	Figure 74	b=221.40	173.5
	V	Figure 75	a=278.96	Figure 76	b=469.30	308.78
	I	Figure 77	a=241.10	Figure 78	b=434.08	306.78

Table 8 and 9 reflect scenario of corresponding true values within the predicted range which is beauty of method.

Table 10: *Pooled simulated confidence interval average result over t_1 to t_6 undercase I [Using eq. (37)-(39)]*

Time-Occasions	Dataset	Lower Limit	Upper Limit	True Value	Length
t_1-t_6	T	a=96.67	b=158.17	116.82	61.5
	V	a=160.00	b=233.67	171.62	73.67
	I	a=184.50	b=334.50	240.19	150

Table 11: *Pooled simulated confidence interval average result over t_1 to t_6 under case II [Using eq (40).(41),(42)]*

Time-Occasions	Dataset	Lower Limit	Upper Limit	True Value	Length
t_1-t_6	T	a=93.67	b=161.33	116.82	67.66
	V	a=157.33	b=236.83	171.62	79.5
	I	a=179.67	b=338.17	240.19	158.5

VII. Discussion

In view to outcomes of table 8, 9, 10, 11 , one can observe in table 8, at t_1, the true values are 74.14 for text-data, 105.3 for video-data and 145.07 for image-data whereas simulated confidence intervals are$(65.30 - 101.56)_T$, $(69.04 - 137.79)_V$ and $(109.36 - 197.01)_I$ respectively. All true values are within the simulated confidence intervals. Similarly, at t_2, the true value are 67.7 for text-data, 98.13 for video-data and 226.18 for the image-data while simulated CI are $(53.08 - 96.30)_T$, $(89.56 - 128.33)_V$ and $(164.44 - 320.34)_I$. At t_3, true values are 125.92 for T, 137.29 for V and 362.74 for I while corresponding CI are $(97.39 - 176.44)_T$, $(125.06 - 187.50)_V$ and $(278.48 - 487.83)_I$. All true values found well within the simulated confidence intervals under case I.

Observing t_4, in table 8, simulated CI are$(93.22 - 146.75)_T$, $(129.03 - 175.43)_V$ and $(112.47 - 204.60)_I$ against true values 110.79, 144.05 and 142.45. These are also catching the truth. At t_5, true values are 148.92 for T, 236.51 for V and for I 257.97 while CI are $(130.39 - 214.44)_T$, $(236.75 - 314.93)_V$ and $(200.37 - 368)_I$ At t_6, the true are 173.05, 308.78 and 306.78 whereas the SCI are predicting accurately to true values being within the range $(142.73 - 216.89)_T$, $(285.58 - 461.31)_V$ and $(244.35 - 431.30)_I$ respectively for the case I.

Looking at estimation by Double sampling strategy under case II, true values are same as earlier but the confidence intervals, at t_1, are $(63.70 - 103.49)_T$, $(94.95 - 139.18)_V$ and $(106.98 - 199.75)_I$ showing all true values within the confidence intervals. Similarly, $at\ t_2$, the confidence interval are $(50.86 - 98.45)_T$, $(88.27 - 129.26)_V$ and $(158.51 - 324.26)_I$, at t_3, they are $(92.06 - 180.96)_T$, $(124.15 - 188.82)_V$ and $(271.49 - 491.64)_I$, at t_4, we have $(90.28 - 150.54)_T$, $(125.51 - 178.96)_V$ and $(11.75 - 205.07)_I$, at t_5, one can find as $(129.04 - 216.24)_T$, $(235.86 - 318.93)_V$

and $(191.57 - 376.60)_I$, and lastly, at t_6, their presence are as $(138.04 - 221.40)_T$, $(278.96 - 469.30)_V$ and $(241.10 - 434.08)_I$ respectively.

In the context to table 10, the single valued pooled simulated confidence intervals, under case I, are $(96.67 - 158.17)_T$, $(160.00 - 233.67)_V$ and $(184.50 - 334.50)_I$ with respect to average true values 116.82, 171.62 and 240.19. The length of simulate confidence intervals, at average level, are 61.5, 73.67, and 150 in sequence for T, V and I.

Likewise, table 11 contains same under case II who are $(93.67 - 161.33)_T$, $(157.33 - 236.83)_V$ and $(179.67 - 338.17)_I$ Lengths of confidence intervals, at average level ,are 67.66, 79.5, and 158.5 respectively.

VIII. Comparison and Efficiency

Define Relative CI Length Measure (RCILM) as

$$\mathbf{RCILM} = \left[\frac{(\text{CI length})_{\text{case II}}}{(\text{CI length})_{\text{case I}}}\right] \times 100$$

Table 12: *Relative CI Length Measure using table 10 and table 11 (under simulation)*

Dataset	RCILM
T	110.01%
V	107.91%
I	105.66%

Table 12.1: *Relative CI Length Measure using table 5 and table 6 (without simulation)*

Dataset	RCILM
T	108.13%
V	109.93%
I	105.70%

It is observed in table 12, and table12.1, the case I is having a smaller length of confidences than case II consistently in every type T, V and I.

IX. Developing Control Charts using simulated confidence intervals as tools for managerial decision

Control charts for managerial decision about web-portals, data-centers are one of applications of confidence interval. Consider the theory discussed in section 1 and in figure 6. The graphical trace of CI over $t_1$to t_6 displayed in figure 79 to 90, for the case I and case II , can be used.

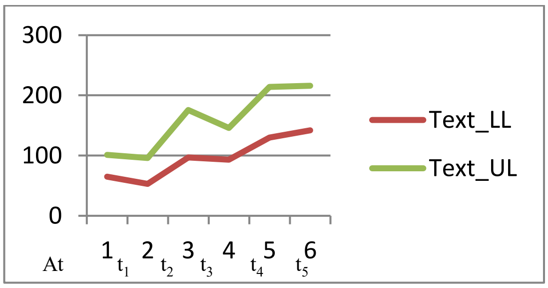


Figure 7: *CL of Text file-size measures under case I*

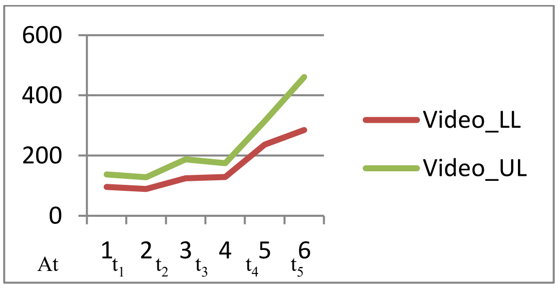


Figure 80: *CL of Video file-size measures under case I*

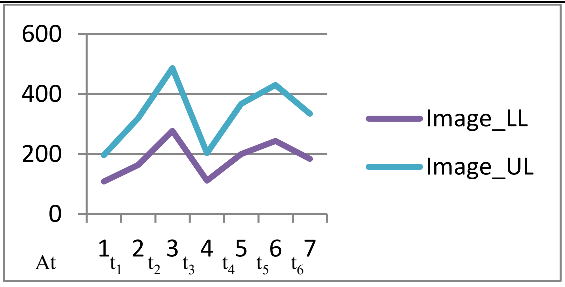


Figure 81: *CL of Image file-size measures under case I*

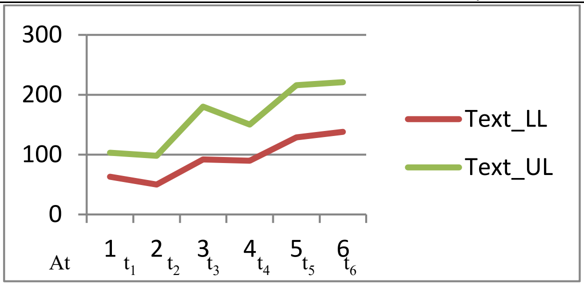


Figure 82: *CL of Text file-size measures under case II*

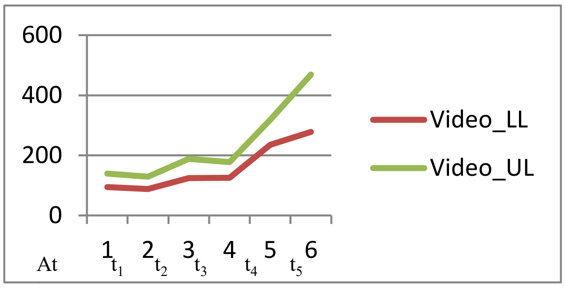


Figure 83: *CL of Video file-size measures under case II*

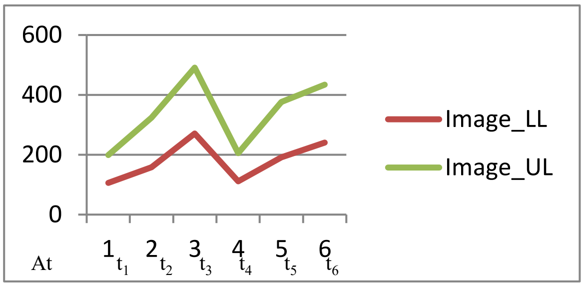


Figure 84: *CL of Image file-size measures under case II*

Fig. 79-81 reveal Upper Control Limit (UCL or UL) and Lower Control Limit (LCL or LL) of the file-size measures of text-data, video-data and image-data used in communication . Similarly, Fig. 82-84 are showing same application for case II and these are file-size production procss control charts. The simulated value 'a' is LCL(or LL) and simulated value 'b' is UCL(or UL) of the confidence intervals.

Such are helpful for decision making regarding control over size measure of communication files on social media web-portal and ,as a consequence, alert can issue for further infrastructure, resources required to achieve the goal of profit. For example, IT- industry (Servers/Data Center/ hardware/software), if alarmed well before about flowing digital file-size, who is growing fast in big data environment over time, better management can be thought of in timely manner. While file-size measure, if increases exponentially over time then investment in Data Centers urgently needed .

In view to fig. 85-90 , matter of importance is to watch whether same habits of communication of users are maintained ? If at n^{th} point of time t_n (n = 1,2,3 ….,∞), the Upper Control Limit (UCL) or Lower Control Limit (LCL) are crossed in control charts , there is significant evidance exist for change of habits of communication of file-size. At this juncture, the industry owner needs to review decision regarding up-gradation or framing new policy to share memory resources with others in order to maximize profit. Simulated confidence intervals play key role for developing such monitoring.

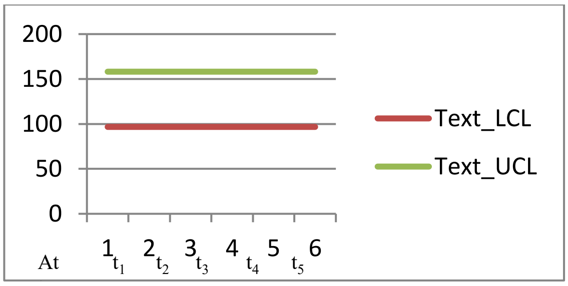


Figure 85: *CL of Text file-size under case I*

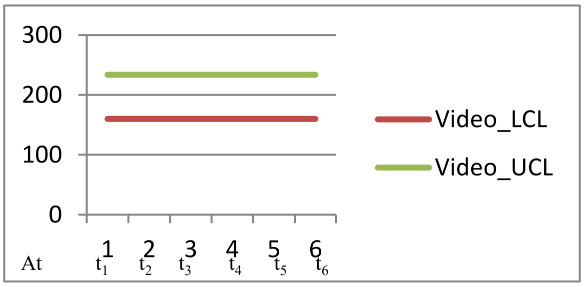


Figure 86: *CL of Video file-size under case I*

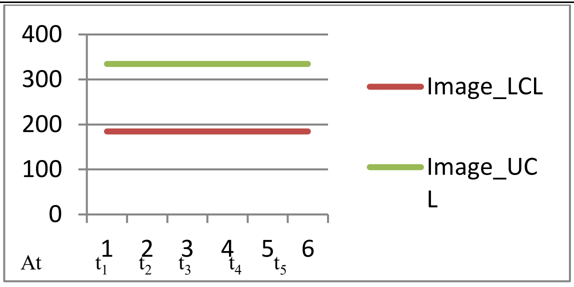


Figure 87: *CL of Image file-size under case I*

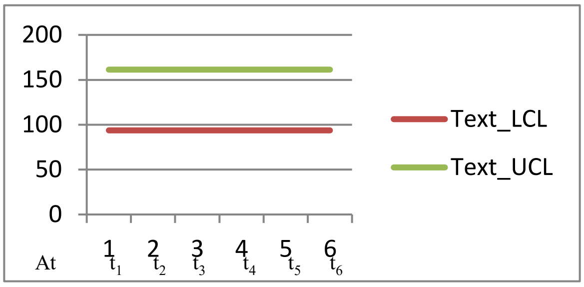


Figure 88: *CL of Text file-size under case II*

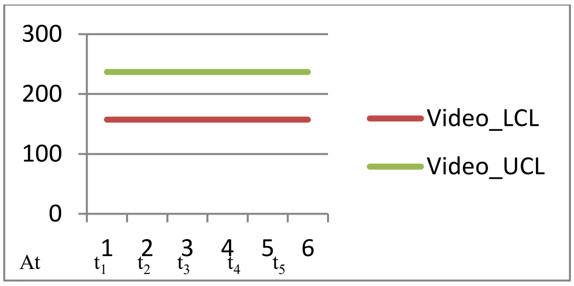


Figure 89: *CL of Video file-size under case II*

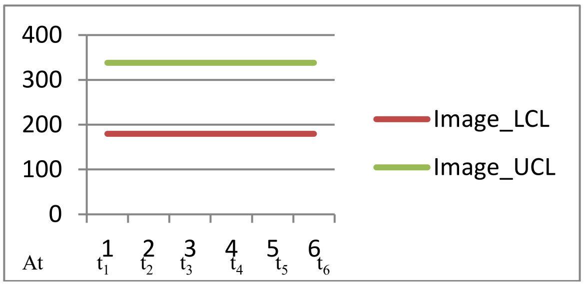


Figure 90: *CL of Image file-size under case II*

X. Conclusion

On recapitulation, the double sampling approach has been adopted in the content for estimating the population parameter in the setup of big data where volume, variety and velocity characteristics are present simultaneously. The idea of number of registered users on a social networking platform communicating through Text, Video and Image files has been considered over different time span. Estimate of average file size is focused whose growth needs to be monitored over time variations. Estimation strategies have been suggested in the setup of double sampling. When has two approaches as (a) sub-sample and (b) independent sample. Both have been compared and found that the proposed methods capture the true values of the population mean over several occasions (time frame). The merge setup of the average of all occasions also reveals that both strategies (case I and case II) cover the true values. A new simulation algorithm based on double sampling is suggested to obtain a single value estimate of 95% confidence interval whose estimate also predict about the true value. Efficiency comparison of two cases is made through the tool RCILM which shows case I better than case II. The study is useful for a managerial decision since the lower control limit and upper control limit growth can generate an alert for IT-business managers. Control charts predict for the future event to check whether the average values of file sizes at farther occasions are within the UCL or LCL or not. If the control limits violate then re-thinking about IT-business infrastructure may be originated to cope up the future challenges. If the control limits violates then re-thinking about IT-business infrastructure may be originated to cope up the future challenges.

References

[1] Hammada, Afraa, Naeem, Hameedah and Hosam, Raheem, Saif (2020). The use of Fuzzy Logic theory in control charts (A comparative study). *International Journal of Innovation*, Creativity and Change, Vol. 11, No. 7, pp. 389-402.

[2] Qiu, Peihua (2017). Statistical process Control Charts as a tool for analyzing Big Data. *Big Data and Complex Analysis*, Springer Cham, pp. 123-138.

[3] Alim, A. and Shukla, D. (2019). Application of parameter estimation: A Big Data analytics perspective (March 11, 2019). *Proceedings of 2nd International Conference on Advanced Computing and Software Engineering (ICACSE)*. Available at SSRN: https://ssrn.com/abstract=3350295.

[4] Alim, A. and Shukla D. (2018). The use of Big Data in Higher Education sector. *International Research Publication House*, Delhi , India, S pp. 1-9. ISBN: 978-93-87388-21-5

[5] Alim, A. and Shukla D. (2020). Comparative study on parameter estimation methods for Big Data analysis based on random sample. *International Journal of Scientific and Technology Research*, Vol. 9 No. 2, pp. 3480-3486.

[6] Gandomi, A. and Haider, M. (2015). Beyond the hype: Big data concepts, methods, and analytics. *International Journal of Information Management*, Vol. 35, pp. 137-144.

[7] Premalatha, S. and Baskar, N. (2012). Implementation of supervised statistical data mining algorithm for single machine scheduling. *Journal of Advances in Management Research*, Vol. 9, No. 2, 2012, pp. 170-177.

[8] Rojas, J. A. R., Kery, M. B., Rosenthal, S. and Dey, A. (2017). Sampling techniques to improve big data exploration. *IEEE 7th Symposium on Large Data Analysis and Visualization (LDAV)*, Phoenix, AZ, 2017, pp.26-35.

[9] West, P.W. (2016). Simple random sampling of individual items in the absence of a sampling frame that lists the individuals. *West New Zealand Journal of Forestry Science*, Vol. 46, No. 15, pp. 1-7.

[10] Gjoka, M., Kurant, M., Butts, C., and Markopoulou, A. (2010). Walking in Facebook: A Case Study of Unbiased Sampling of OSNs. *INFOCOM, 2010 Proceedings IEEE*, pp. 1 – 9, Doi: 10.1109 /INFCO M.2 01 0.5 46 2078.

[11] Smith, S. T., Kao, E. K., Shah, D. C. and Rubin, D. B. (2018). Influence estimation on social media networks using causal inference. *IEEE Statistical Processing (SSP) Workshop*, Vol. 3, pp. 28-332.

[12] Piña-García, C.A., Gershenson, C. and Siqueiros-García J. M. (2016). Towards a standard sampling methodology on online social networks: collecting global trends on Twitter. *Appl Netw Sci*, Vol. 1, No. 3, pp. 1-19.

[13] Hegemann, R. A., Lewis, E. A. and Bertozzi, A. L. (2013). An estimate & score algorithm for simultaneous parameter estimation and reconstruction of incomplete data on social networks. *Security Informatics*, Vol. 2, pp. 1-13.

[14]. Khan, M. (2016). A ratio chain-type exponential estimator for finite population mean using double sampling. *Springer Plus*, Vol. 5 No. 86, pp. 1-9.

[15]. Singh, R. V. K. and Ahmed, A. (2015). Improved exponential Ratio and Product type estimators for Finite population mean under double sampling scheme. *International Journal of Scientific & Engineering Research*, Vol. 6, No. 4, pp. 509-514.

[16] Kumar, M., Vishwakarma, G. K. (2017). Estimation of mean in double sampling using exponential technique on multi-auxiliary variates. *Commun. Math. Stat.,* Vol. 5, No. 4, pp. 429–445.

[17] Khan, M., Shabbir, J., Hussain, Z. and Alzahrani, B. (2014). A class of estimators for finite population mean in Double Sampling under non-response using Fractional Raw Moments, *Journal of Applied Mathematics*, Vol.11, pp. 1-11.

[18] Das, S., Roy, S., and Sambasivan, R. (2018). Fast Gaussian process regression for Big Data. *Big Data Research*, Vol. 14, pp. 12-26.

[19] Majumdar, S. K. and Gupta, M. P. (2005). Internet experience of Indian customers in passenger car segment, *Journal of Advances in Management Research*, Vol. 2, No. 2, pp. 37 – 53.

[20] Khedlekar, U. K. and Singh, P. (2019). Three layer supply chain policy under sharing recycling responsibility, *Journal of Advances in Management Research*, Vol. 16, No. 5, pp. 645-658.

[21] Shabbir, Javid. (2018). Efficient utilization of two auxiliary variables in stratified double sampling. Communications in Statistics - Theory and Methods, Vol. 47, No. 1, pp. 92-101.

[22] Grover, Lovleen and Kaur, Amanpreet (2020). An improved regression type estimator of population mean with two auxiliary variables in stratified double sampling. Journal of Statistical Theory and Practice, Vol. 14, No. 35, pp. 1-16.

[23] Alim, A. and Shukla, D. (2020). Sampling-based estimation method for parameter estimation in big data business era. *Journal of Advances in Management Research*. https://doi.org/10.1108/JAMR-05-2020-0072.

[24] Shukla, D. (2002). F-T estimator under two-phase sampling. *METRON* , Vol. No. 59, pp. 110-122.

[25] Cochran, William G. (2005). Sampling Techniques. USA, John & Sons, 1977, pp 1-442.

[26] Singh, S. (2003). Advanced Sampling Theory with Applications. *Kluwer Academic Publishers, Springer*, Dordrecht. https://doi.org/10.1007/978-94-007-0789-4.

[27] Sukhatme, P. V. and Panse, V. G. (1984). Sampling Theory and Surveys with Applications. *Indian Society for Agricultural Statistics,* New Delhi, pp. 1-478.

[28] Montgomery, D. C. (2001). Introduction to statistical quality control. *Ed 4, John Wiley & Sons*, (Asia) Pvt. Ltd. (Singapur).

ANNEXURE A

Population N=100

ID	T	V	I	T	V	I	T	V	I	T	V	I	T	V	I	T	V	I
0	10	15	6	13	10	10	18	21	15	20	25	27	31	35	38	41	49	52
1	5	8	7	9	3	11	8	11	17	9	12	13	15	16	18	19	23	24
2	9	12	11	5	7	17	16	17	27	18	23	24	28	32	34	37	44	47
3	8	11	14	16	6	23	14	15	36	15	19	21	24	27	29	32	38	40
4	12	20	18	10	15	29	22	28	45	24	30	32	37	42	46	49	59	62
5	11	16	22	9	11	35	19	22	54	21	27	29	33	37	41	44	52	56
6	13	18	25	11	13	41	23	25	64	26	33	35	40	46	49	53	64	68
7	14	21	29	17	16	47	25	29	73	27	34	37	42	48	52	56	67	71
8	15	23	33	13	18	52	27	32	82	30	38	41	47	53	58	62	74	79
9	17	26	37	15	21	58	30	36	91	33	42	45	52	58	63	68	82	87
10	18	28	40	24	23	64	33	39	101	36	46	49	56	64	69	75	89	95
11	20	31	44	18	26	70	35	43	110	39	49	53	61	69	75	81	97	102
12	21	33	48	19	28	76	38	46	119	42	53	57	66	74	81	87	104	110
13	23	36	51	21	31	82	41	50	128	45	57	61	70	79	86	93	111	118
14	24	38	55	22	33	88	44	53	138	48	61	65	75	85	92	99	119	126
15	26	41	59	24	36	94	46	57	147	51	64	69	80	90	98	105	126	134
16	27	43	62	25	38	100	49	60	156	54	68	73	84	95	103	112	133	141
17	29	46	66	27	41	106	52	64	165	57	72	77	89	100	109	118	141	149
18	30	48	70	28	43	112	54	67	175	60	76	82	94	106	115	124	148	157
19	32	51	74	30	46	118	57	71	184	63	79	86	98	111	120	130	155	165
20	33	53	77	31	48	124	60	74	193	66	83	90	103	116	126	136	163	173
21	35	56	81	33	51	129	62	78	202	69	87	94	108	121	132	142	170	180
22	36	58	85	34	53	135	65	81	212	72	91	98	112	127	138	148	177	188
23	38	61	88	36	56	141	68	85	221	75	94	102	117	132	143	155	185	196
24	39	63	92	37	58	147	71	88	230	78	98	106	122	137	149	161	192	204
25	41	66	96	39	61	153	73	92	239	81	102	110	126	142	155	167	199	212
26	42	68	99	40	63	159	76	95	249	84	106	114	131	148	160	173	207	219
27	44	71	103	42	66	165	79	99	258	87	109	118	135	153	166	179	214	227
28	45	73	107	43	68	171	81	102	267	90	113	122	140	158	172	185	221	235
29	47	76	111	45	71	177	84	106	276	93	117	126	145	163	177	191	229	243
30	48	78	114	46	73	183	87	109	286	96	121	130	149	169	183	198	236	251
31	50	81	118	48	76	189	89	113	295	99	124	134	154	174	189	104	244	258
32	51	83	122	49	78	195	92	116	304	102	128	138	159	179	195	110	251	266
33	53	86	125	51	81	200	95	120	313	105	132	142	163	184	200	116	258	274
34	54	88	129	52	83	206	98	123	323	108	136	146	168	190	206	122	266	282
35	56	91	133	54	86	212	100	127	332	111	139	150	173	195	212	128	273	290
36	57	93	136	55	88	218	103	130	341	114	143	154	177	200	217	135	280	297
37	59	96	140	57	91	224	106	134	350	117	147	158	182	205	223	141	288	305
38	60	98	144	58	93	230	108	137	360	120	151	163	187	211	229	147	295	313
39	62	101	148	60	96	236	111	141	369	123	154	167	191	216	234	153	302	321
40	63	103	151	61	98	242	114	144	378	126	158	171	196	221	240	159	310	329
41	65	106	155	63	101	248	116	148	387	129	162	175	101	226	246	165	317	336
42	66	108	159	64	103	254	119	151	397	132	166	179	105	232	252	171	324	344
43	68	111	162	66	106	260	122	155	406	135	169	183	110	237	257	178	332	352
44	69	113	166	67	108	266	125	158	415	138	173	187	115	242	263	184	339	360
45	71	116	170	69	111	272	127	162	424	141	177	191	119	247	269	190	346	368
46	72	118	173	70	113	277	130	165	434	144	181	195	124	253	274	96	354	375
47	74	121	177	72	116	283	133	169	443	147	184	199	128	258	280	102	361	383
48	75	123	181	73	118	289	135	172	452	150	188	203	133	263	286	208	368	391
49	77	126	185	75	121	295	138	176	461	153	192	207	138	268	291	114	376	399
50	78	128	188	76	123	301	141	179	471	156	196	211	142	274	297	121	383	407
51	80	131	192	78	126	307	143	183	480	159	199	215	147	279	303	127	391	414
52	81	133	196	79	128	313	146	186	489	162	203	219	152	284	309	233	398	422
53	83	136	199	81	131	319	149	190	498	165	207	223	156	289	314	139	405	430
54	84	138	203	82	133	325	152	193	508	168	211	227	123	295	320	145	413	438
55	86	141	207	84	136	331	154	197	517	171	214	231	120	300	326	251	420	446
56	87	143	210	85	138	337	157	200	526	174	218	235	170	305	331	158	427	453
57	89	146	214	87	141	343	160	204	535	177	222	239	175	310	337	264	435	461
58	90	148	218	88	143	348	162	207	545	180	226	244	180	316	343	170	442	469
59	92	151	222	90	146	354	165	211	554	183	229	248	84	321	348	245	449	477
60	93	153	225	91	148	360	168	214	563	186	233	252	28	326	354	180	457	485
61	95	156	229	93	151	366	170	218	572	189	237	256	94	331	360	288	464	492

62	96	158	233	94	153	372	173	221	582	192	241	260	98	337	366	135	471	500
63	98	161	236	96	156	378	176	225	591	195	244	264	102	342	371	202	479	508
64	99	163	240	97	158	384	179	228	600	198	248	268	108	347	377	207	486	516
65	101	166	244	99	161	390	181	232	609	101	252	272	113	352	383	196	493	524
66	102	168	247	80	163	396	184	235	619	104	256	276	114	358	388	199	501	531
67	104	171	251	35	166	402	187	239	628	107	259	280	213	363	394	258	508	539
68	105	173	255	81	168	408	189	242	637	105	263	284	126	368	400	231	515	547
69	107	176	259	102	171	414	192	246	646	113	267	288	131	373	405	237	523	555
70	108	178	262	99	173	420	195	249	656	116	271	292	135	379	411	244	530	563
71	110	181	266	88	176	425	197	253	665	109	274	296	140	384	417	250	538	570
72	111	183	270	106	178	431	200	256	674	85	278	300	145	389	423	256	545	578
73	113	186	273	59	181	437	203	260	683	95	282	304	149	394	428	262	552	586
74	45	188	277	43	183	443	81	263	693	100	113	122	140	158	171	185	221	234
75	116	191	281	114	186	449	208	267	702	132	289	212	159	405	440	274	567	602
76	117	193	284	26	188	455	211	270	711	102	293	123	163	410	445	281	574	609
77	119	196	288	117	191	461	214	274	720	132	297	13	168	415	451	284	582	617
78	120	45	292	118	40	467	216	63	730	140	102	25	173	421	457	293	589	625
79	122	201	70	120	196	112	219	281	175	125	100	30	177	129	462	299	596	633
80	123	170	85	121	165	136	178	238	213	142	108	33	182	331	268	205	604	641
81	125	106	103	123	101	165	159	148	258	127	113	137	187	336	274	211	611	648
82	126	208	107	82	203	171	130	291	268	152	116	241	191	342	340	217	618	156
83	128	211	210	43	206	336	85	295	525	155	119	145	196	347	385	224	626	164
84	129	13	214	55	8	342	133	18	535	150	125	110	101	352	291	230	633	272
85	131	216	215	129	102	344	135	302	538	142	140	270	105	357	497	236	640	180
86	132	218	231	130	103	370	138	305	578	178	179	154	110	363	302	242	148	287
87	134	25	225	132	20	200	142	35	563	167	180	102	114	368	508	248	155	295
88	135	223	229	133	218	205	243	112	573	170	165	78	319	373	375	254	162	203
89	137	226	233	135	221	100	246	116	583	173	141	69	324	378	519	260	170	311
90	138	105	110	136	100	176	249	125	275	176	88	73	328	384	525	267	300	319
91	122	5	15	120	0	24	220	7	38	144	107	29	378	27	464	200	98	234
92	102	152	210	100	147	336	184	102	525	104	102	75	316	57	288	218	300	230
93	113	136	148	111	131	237	203	130	370	126	99	10	350	396	229	300	290	188
94	110	20	35	108	15	56	198	28	88	120	100	97	341	385	218	200	201	172
95	106	120	152	104	115	243	191	68	380	112	142	86	329	371	203	205	219	201
96	102	119	125	100	114	200	184	67	313	102	153	175	316	357	288	203	200	130
97	105	100	101	103	95	162	189	40	253	103	152	184	326	368	299	231	215	220
98	100	85	90	98	80	144	180	19	225	108	50	70	310	350	280	210	290	175
99	120	75	60	118	70	96	216	100	150	130	100	100	372	320	356	292	288	124
100	125	70	25	123	65	40	225	98	63	85	113	12	388	338	375	213	213	150

ANNEXURE B

CI of 200 Sample each size n=10 (Case I)

SNo	Text Lower	Text Upper	Video Lower	Video Upper	Image Lower	Image Upper
1	113.52	138.60	182.37	208.56	223.99	292.37
2	134.15	169.82	178.21	208.20	183.23	259.15
3	108.70	125.20	172.51	192.64	278.78	322.86
4	98.32	117.18	172.70	207.84	301.50	346.83
5	119.85	144.72	175.90	211.48	223.60	286.24
6	121.10	150.73	182.54	218.73	205.16	279.25
7	135.22	165.82	162.97	191.85	213.89	276.67
8	107.45	131.03	173.59	190.97	267.18	329.69
9	115.60	145.78	179.46	217.16	223.00	289.18
10	102.87	128.53	177.76	216.92	263.89	328.07
11	119.50	148.09	185.18	227.06	202.44	264.31
12	102.11	119.69	179.10	199.41	275.68	331.41
13	118.51	153.85	180.19	218.56	199.86	279.23
14	106.84	127.94	160.98	185.00	302.64	342.08
15	103.74	129.75	179.12	204.78	245.36	322.51
16	117.55	148.77	186.01	224.57	198.17	272.13
17	105.39	122.01	182.75	223.76	252.77	303.68
18	105.64	131.99	181.69	221.76	242.17	309.79
19	115.26	151.50	184.97	228.85	191.27	272.69
20	139.27	173.37	175.76	208.77	182.90	256.83
21	106.22	135.39	186.06	226.95	225.24	299.26
22	126.17	154.80	165.86	192.99	239.90	295.12
23	119.28	148.90	186.63	228.59	197.25	265.25
24	104.62	129.03	182.03	233.05	244.82	302.58
25	109.70	132.10	180.57	207.67	241.39	301.99
26	109.59	136.66	193.94	250.75	224.91	283.77
27	112.16	134.94	171.35	186.03	265.34	319.65
28	110.89	132.73	172.02	192.35	269.83	321.56
29	117.83	142.03	169.00	195.69	250.72	309.13
30	104.50	128.95	186.04	239.64	229.02	294.26
31	115.42	142.35	178.97	219.60	216.32	284.98
32	109.82	133.50	172.50	192.44	259.31	319.72
33	118.35	148.42	170.85	207.27	220.90	290.64
34	117.23	147.41	168.79	210.57	232.76	302.81
35	106.93	128.39	172.62	192.64	277.41	326.53
36	100.11	124.66	174.54	212.28	276.27	334.68
37	116.23	151.28	170.03	222.55	222.16	297.20
38	115.01	143.91	172.40	209.72	228.85	298.03
39	124.20	151.61	181.42	204.62	209.17	274.60
40	109.92	134.92	168.40	202.58	255.59	315.39
41	96.04	116.00	180.62	229.87	280.33	332.95
42	114.19	135.99	179.51	203.90	241.11	295.96
43	112.50	141.00	186.95	227.50	216.99	286.86
44	105.28	131.40	173.25	212.63	245.62	313.91
45	119.59	152.94	194.83	247.39	182.06	258.71
46	109.18	138.42	178.99	215.70	232.22	306.16
47	114.30	143.11	175.95	213.92	223.81	295.47
48	135.22	163.57	178.67	197.15	196.52	260.81
49	111.77	140.48	181.12	209.78	224.21	295.44
50	110.99	142.28	165.22	211.79	236.64	304.69
51	114.41	139.16	182.11	206.76	225.46	290.48
52	129.25	157.94	193.22	236.13	178.00	237.86
53	106.16	137.59	168.71	222.81	245.27	312.38
54	113.25	135.28	179.40	206.03	240.28	296.19
55	113.81	140.55	174.47	212.01	229.48	297.07
56	102.93	130.27	193.84	245.45	213.22	291.80
57	117.30	143.95	178.53	203.92	225.81	289.36
58	102.00	126.05	162.87	202.67	297.51	344.91
59	102.80	120.83	173.43	208.17	290.48	332.71
60	94.26	113.51	178.32	227.06	279.52	341.99
61	110.06	136.33	177.09	214.88	246.23	312.45
62	98.90	117.90	173.64	219.16	289.73	339.52

63	120.69	152.76	169.95	200.50	221.78	298.05
64	125.12	157.64	183.58	229.75	190.87	265.37
65	122.31	148.69	180.86	204.78	219.87	281.78
66	107.87	139.21	168.18	214.57	231.77	314.20
67	122.91	147.34	176.85	198.15	225.04	282.71
68	108.28	132.06	177.18	200.03	252.48	315.42
69	119.26	149.26	189.96	232.44	194.19	260.22
70	115.23	137.86	172.60	208.24	248.60	299.72
71	130.76	158.31	189.61	225.55	193.67	253.14
72	101.05	117.19	171.90	185.84	311.34	348.68
73	130.26	167.89	186.65	231.77	167.56	244.90
74	113.95	137.82	173.55	191.39	253.35	311.21
75	108.32	132.68	170.30	207.15	259.30	317.84
76	127.24	149.82	176.72	195.96	234.56	280.55
77	108.21	132.38	170.43	187.15	270.10	328.65
78	102.58	131.93	172.38	226.51	249.05	317.04
79	105.12	133.54	192.45	251.23	223.54	293.44
80	119.23	137.94	160.77	182.95	285.97	317.89
81	106.73	134.75	185.04	235.27	223.06	293.84
82	127.90	150.28	173.66	192.43	227.59	277.71
83	118.47	142.52	162.79	190.44	265.12	312.64
84	112.34	139.64	190.83	240.43	206.42	278.53
85	112.02	139.97	166.58	211.26	248.96	306.42
86	113.40	145.49	174.46	219.57	226.59	296.77
87	117.36	153.15	171.03	224.48	216.81	292.28
88	107.48	130.00	177.39	202.16	253.91	314.81
89	116.87	144.85	177.76	197.15	227.76	295.46
90	102.62	129.83	173.64	219.05	256.83	321.29
91	132.26	165.75	186.10	226.84	183.44	248.20
92	116.66	145.53	180.27	227.12	221.99	283.49
93	118.67	147.80	174.80	194.71	222.91	293.50
94	106.96	125.08	168.88	203.92	281.77	324.85
95	121.57	152.26	177.17	201.19	218.88	286.17
96	107.10	132.29	178.30	205.28	242.23	312.23
97	124.98	151.55	161.41	188.17	250.34	301.76
98	144.42	173.99	179.73	205.87	180.77	241.99
99	113.76	142.47	174.36	198.14	236.32	304.03
100	111.82	136.96	185.79	225.34	222.31	289.02
101	118.94	147.54	160.93	188.91	247.23	310.88
102	120.52	150.59	168.16	211.94	230.45	292.34
103	112.27	134.90	172.52	191.48	264.89	316.28
104	110.50	134.47	179.39	217.60	243.27	300.45
105	108.86	131.46	175.06	197.80	264.91	322.23
106	105.38	130.44	175.56	213.76	248.98	313.69
107	100.86	126.16	176.44	224.74	266.79	328.91
108	137.86	168.70	179.01	204.44	188.28	254.12
109	112.96	134.38	179.05	202.83	244.80	300.10
110	146.40	172.92	191.06	215.25	171.53	228.63
111	133.29	161.08	178.94	202.07	195.95	263.39
112	112.13	136.56	176.36	212.66	253.29	306.83
113	112.07	141.27	180.71	220.82	217.99	288.03
114	121.40	151.16	182.64	221.29	199.96	264.56
115	130.97	160.24	184.38	225.38	193.31	246.37
116	101.96	119.74	168.33	203.89	292.71	339.24
117	131.08	157.41	180.32	204.41	206.36	264.20
118	107.00	126.61	183.28	221.06	246.91	307.00
119	114.62	141.94	174.13	206.74	233.25	302.13
120	109.11	135.06	183.31	222.81	223.14	290.25
121	106.97	137.69	171.73	211.77	237.46	313.65
122	138.62	169.74	162.26	192.30	209.02	273.30
123	123.40	152.62	168.72	211.98	227.90	287.55
124	123.95	154.05	185.21	224.92	188.40	259.66
125	100.97	124.92	182.99	235.75	239.76	306.35
126	113.10	139.03	184.98	224.20	220.55	289.13
127	131.00	161.47	188.77	229.57	187.59	242.68

128	104.45	130.78	174.70	215.45	248.93	309.91
129	116.14	145.17	182.67	220.74	217.37	287.61
130	119.59	143.56	177.61	200.25	224.88	288.67
131	139.59	168.84	186.43	212.12	175.49	238.51
132	101.07	127.38	177.86	227.41	260.52	322.35
133	113.49	140.83	187.81	228.50	209.60	279.21
134	123.47	150.70	177.77	214.50	221.05	276.41
135	129.57	156.81	177.44	202.23	211.75	274.06
136	113.90	137.60	185.45	213.09	225.00	289.65
137	151.23	182.37	185.20	210.32	166.18	229.20
138	109.05	137.35	182.31	222.73	241.16	306.61
139	111.25	140.68	182.88	221.79	230.25	294.18
140	119.68	151.28	172.65	204.08	216.32	291.78
141	111.33	135.82	178.23	217.73	234.30	294.04
142	129.24	154.75	176.48	198.12	219.97	276.14
143	115.70	147.14	183.91	233.86	200.61	273.73
144	133.68	169.69	194.57	245.77	166.55	230.67
145	106.15	139.15	180.00	220.91	218.83	300.05
146	105.37	123.99	170.08	205.25	274.75	328.35
147	118.10	155.00	177.60	233.26	193.53	276.06
148	125.58	150.07	188.84	229.81	197.75	251.16
149	135.94	164.45	184.08	210.96	186.99	246.94
150	104.12	124.58	169.63	204.70	274.30	329.46
151	126.64	158.34	186.55	236.42	181.21	251.28
152	111.67	135.75	181.82	222.37	228.22	291.62
153	129.85	146.69	179.01	196.17	240.98	279.24
154	129.12	160.75	179.37	225.28	192.42	257.94
155	118.93	147.14	178.49	203.57	223.14	291.47
156	123.62	154.94	183.44	220.45	194.34	264.52
157	115.46	138.07	178.16	215.99	240.49	287.55
158	142.28	172.84	178.38	201.38	178.61	246.30
159	132.57	170.26	170.69	219.54	182.60	259.57
160	134.76	169.72	176.13	202.65	190.19	260.80
161	110.83	136.12	192.88	243.94	217.56	282.83
162	103.09	118.83	171.20	186.36	307.64	342.80
163	117.30	150.31	169.34	215.27	221.04	290.24
164	134.78	166.99	172.47	203.11	205.06	271.89
165	127.64	158.93	185.65	227.58	186.98	251.48
166	116.50	146.59	191.48	234.36	192.69	263.23
167	112.50	135.44	179.32	203.39	238.32	301.97
168	117.43	139.12	182.66	210.58	227.24	282.80
169	107.71	128.50	162.05	184.25	303.12	340.93
170	126.09	157.91	166.31	194.73	221.03	292.49
171	110.77	127.46	176.64	200.93	262.13	309.77
172	121.91	154.19	190.60	231.74	194.20	267.03
173	111.93	135.28	171.07	186.38	263.67	317.41
174	114.30	140.12	171.24	193.14	243.84	305.55
175	124.56	143.17	173.88	191.05	250.50	291.29
176	117.73	140.49	175.37	198.99	242.57	294.25
177	138.12	164.32	181.89	204.01	195.24	254.53
178	98.23	117.15	172.21	205.04	303.78	347.61
179	102.97	121.83	176.99	224.98	261.30	315.23
180	138.15	174.29	179.45	223.88	185.93	253.26
181	117.81	142.28	184.95	224.19	210.27	272.82
182	111.68	135.20	174.22	196.36	254.10	311.13
183	115.89	135.99	180.74	218.71	242.30	284.06
184	104.81	123.76	175.46	211.93	285.40	329.53
185	112.44	132.76	177.43	211.57	261.46	305.85
186	112.63	133.06	180.89	219.72	239.74	291.32
187	111.58	138.81	169.62	213.62	246.36	304.13
188	100.55	116.56	171.81	185.89	313.20	350.22
189	120.20	145.68	178.03	215.08	213.41	278.58
190	121.14	155.67	167.54	213.37	215.88	292.09
191	123.48	151.46	171.57	193.28	222.67	288.17
192	106.22	128.97	168.46	198.06	269.61	327.15

193	110.94	134.72	180.65	216.55	250.46	303.02
194	103.31	128.20	181.03	221.10	246.16	311.76
195	117.42	147.06	183.95	222.36	216.35	284.42
196	110.70	146.09	166.99	220.61	233.86	308.95
197	108.89	135.16	172.39	209.54	241.38	312.29
198	134.67	161.67	186.68	212.45	184.12	244.42
199	122.52	155.03	163.82	193.10	232.96	303.74
200	123.31	154.67	173.09	211.61	204.41	275.16

ANNEXURE C

CI of 200 Sample each size n=10 (Case II)

SNo	Text Lower	Text Upper	Video Lower	Video Upper	Image Lower	Image Upper
1	112.5025	139.6188	180.9357	209.9947	222.0762	294.2889
2	132.1565	171.8114	176.3829	210.0216	181.4341	260.9476
3	107.8549	126.0527	172.3538	192.8011	278.2256	323.4121
4	97.28737	118.2201	171.5393	209.0049	300.528	347.8061
5	119.0032	145.5677	174.4599	212.9213	221.1926	288.6421
6	119.6648	152.1567	180.9075	220.362	202.5174	281.8964
7	133.4725	167.5706	161.5407	193.2813	212.6052	277.958
8	106.3945	132.0859	173.0844	191.4717	264.9768	331.8918
9	114.2793	147.0991	177.7743	218.8427	220.1311	292.0491
10	101.6652	129.7376	175.9887	218.6873	261.7236	330.2351
11	117.9328	149.6625	183.0345	229.202	200.5343	266.216
12	101.3133	120.485	177.9547	200.5548	273.9451	333.1438
13	116.7251	155.6399	178.0277	220.7157	197.357	281.7325
14	105.6572	129.1162	160.3586	185.6207	302.185	342.5367
15	102.6085	130.8796	177.2882	206.6135	243.301	324.5688
16	116.2565	150.0644	183.7047	226.8764	195.5426	274.7563
17	104.1755	123.2273	181.0051	225.5034	251.9731	304.4761
18	104.5469	133.0791	179.7977	223.6472	239.8835	312.0763
19	113.4035	153.364	182.4263	231.3981	189.4269	274.5269
20	137.7428	174.8995	173.485	211.0486	181.0419	258.6833
21	104.8304	136.781	183.4532	229.554	222.7347	301.7651
22	124.682	156.2853	164.5653	194.2808	238.3067	296.7146
23	117.6546	150.5266	184.4309	230.7915	195.521	266.9823
24	103.3036	130.3428	179.9946	235.0848	242.992	304.4074
25	108.5566	133.2433	179.3298	208.9106	240.0204	303.3612
26	108.2785	137.9636	191.7557	252.9432	222.619	286.0615
27	111.4435	135.6584	170.8133	186.5734	262.7295	322.2601
28	109.8958	133.7237	171.5627	192.8094	268.3515	323.0353
29	117.0376	142.8189	167.4221	197.2665	248.2261	311.6299
30	103.1887	130.268	183.2596	242.4131	227.2967	295.9827
31	113.7117	144.0559	177.2317	221.3402	214.475	286.8212
32	108.6669	134.6575	172.1115	192.8282	257.6001	321.4268
33	116.9968	149.7776	169.2943	208.8191	218.1333	293.4088
34	115.7656	148.8779	166.8516	212.5117	230.6757	304.8981
35	105.8899	129.4305	172.0856	193.1804	275.9146	328.0331
36	98.78647	125.9776	173.0555	213.7639	274.4069	336.545
37	114.1647	153.3442	167.345	225.2402	219.7946	299.5632
38	113.3935	145.5338	170.5726	211.5429	226.6755	300.2043
39	123.1525	152.6558	180.143	205.89	206.9668	276.8079
40	108.9226	135.9182	167.0473	203.9361	252.8565	318.1285
41	94.78109	117.2568	178.463	232.0219	279.3064	333.9716
42	113.0547	137.1217	178.6081	204.7991	239.4949	297.5753
43	111.0507	142.4457	184.4639	229.9909	214.6993	289.1541
44	104.0987	132.5776	171.2642	214.6111	243.4342	316.0932
45	117.7712	154.7576	191.8136	250.4098	179.607	261.17
46	108.0273	139.5723	176.8206	217.8769	229.442	308.9327
47	113.0693	144.3429	174.0301	215.8397	221.1914	298.0877
48	134.4277	164.3694	176.9454	198.8787	193.7765	263.5526
49	110.2277	142.0148	179.8179	211.0823	222.3989	297.2529
50	109.4672	143.8032	163.0289	213.979	235.2198	306.1044
51	112.9665	140.5978	181.0044	207.8623	223.8664	292.0724
52	127.6045	159.583	191.2084	238.1448	176.3396	239.5216
53	104.4922	139.2542	165.9372	225.5766	243.4363	314.2153
54	112.1048	136.4315	178.4944	206.9279	239.0231	297.442
55	112.707	141.657	172.8391	213.6413	227.3741	299.1733
56	101.7639	131.4424	190.2886	248.9992	210.958	294.0564
57	116.2937	144.959	177.0841	205.3588	223.2077	291.9614
58	100.6352	127.4147	161.2607	204.2833	296.4775	345.9437
59	101.7613	121.8703	172.3789	209.2262	289.5168	333.6739
60	93.31854	114.4549	175.6672	229.7062	277.6419	343.8712
61	108.4735	137.9135	175.9495	216.0254	244.3709	314.3022
62	97.85368	118.9428	171.6796	221.1267	287.9315	341.3232

63	119.3528	154.0918	167.9264	202.5278	219.4674	300.3561
64	123.5925	159.1735	180.8238	232.5091	188.5559	267.6838
65	121.0287	149.9641	179.6038	206.0375	217.7891	283.8648
66	106.4229	140.6509	165.4635	217.2859	229.691	316.2784
67	121.6842	148.5709	176.536	198.4615	223.3503	284.4004
68	107.1758	133.173	176.0211	201.1831	250.487	317.4138
69	117.8529	150.6682	187.9882	234.4153	192.1432	262.2635
70	114.0986	138.9898	171.4805	209.3636	246.5689	301.7476
71	129.5237	159.5445	188.6509	226.5084	191.1456	255.6659
72	100.1975	118.0451	171.8944	185.8425	310.5186	349.5013
73	128.1539	170.001	183.8726	234.5459	165.4989	246.967
74	112.7568	139.0161	173.1246	191.8106	251.5786	312.9848
75	106.9005	134.0995	168.8298	208.6236	257.5159	319.6272
76	126.3709	150.6879	176.0532	196.6314	232.4573	282.6508
77	107.3033	133.2811	169.9509	187.6264	267.6271	331.1282
78	100.941	133.5688	169.1504	229.743	247.266	318.8223
79	103.3659	135.2866	189.7995	253.8758	221.5567	295.4243
80	118.2461	138.9255	160.0072	183.7118	285.9793	317.8764
81	105.0789	136.4004	182.3798	237.9373	221.1902	295.7084
82	127.3167	150.8695	173.0966	192.9996	225.2877	280.0133
83	117.3727	143.6146	161.816	191.4196	264.0154	313.7467
84	111.1262	140.8496	188.3426	242.918	203.8726	281.0866
85	110.4382	141.5568	164.5645	213.2762	247.9363	307.4482
86	111.5953	147.2998	171.925	222.1018	224.5882	298.7639
87	115.1705	155.3432	168.4218	227.0897	214.7593	294.3302
88	106.2111	131.2661	176.1948	203.3549	252.4467	316.2729
89	115.834	145.8789	176.3625	198.5479	225.2968	297.9281
90	101.4559	130.9953	171.5939	221.0973	253.754	324.3593
91	130.4779	167.5326	184.7005	228.2409	181.154	250.484
92	115.396	146.7969	178.6149	228.7789	218.7634	286.7163
93	117.9274	148.5433	173.338	196.1644	220.197	296.2196
94	105.9154	126.1265	167.785	205.0123	280.7667	325.8502
95	119.9302	153.8944	176.0191	202.3343	216.9271	288.1204
96	105.7466	133.6415	177.3202	206.2592	240.4651	313.994
97	123.4758	153.0476	160.4645	189.1168	249.5679	302.5239
98	143.2534	175.1605	178.4569	207.136	178.6118	244.1425
99	112.9867	143.2411	173.0715	199.4294	233.3486	306.9992
100	110.6316	138.1493	184.2426	226.8832	219.9981	291.3308
101	117.6532	148.8222	159.9025	189.9333	245.2808	312.8312
102	119.0967	152.0117	165.9236	214.1748	228.1585	294.6355
103	110.9365	136.2283	172.0827	191.9236	263.6667	317.5054
104	109.1383	135.8324	177.9972	218.9959	241.5299	302.183
105	108.0657	132.2497	174.1478	198.716	262.8316	324.3086
106	104.0505	131.7665	173.7124	215.6026	247.1579	315.5129
107	99.54875	127.4673	174.2892	226.8904	264.2541	331.4424
108	136.637	169.9269	177.7045	205.7468	185.7354	256.6656
109	111.8287	135.5027	178.0552	203.8318	243.1506	301.7452
110	145.5738	173.7484	189.6491	216.6588	169.0974	231.0597
111	132.2655	162.0995	177.8587	203.1535	193.9084	265.4285
112	110.5288	138.1531	175.1532	213.8681	251.8669	308.2521
113	110.9403	142.4005	178.2127	223.3101	215.333	290.6819
114	120.2631	152.2921	180.8275	223.1041	197.455	267.0683
115	129.6357	161.5753	182.8615	226.9011	190.9967	248.6889
116	101.0557	120.6438	167.1494	205.0728	291.5208	340.4316
117	129.9248	158.558	179.7832	204.9454	204.4899	266.0657
118	105.7336	127.8727	181.5886	222.7499	245.1186	308.7944
119	113.3288	143.2347	172.1463	208.7279	231.0965	304.2803
120	108.093	136.0751	181.241	224.8768	220.9618	292.4217
121	105.2444	139.4157	169.8732	213.6228	235.3795	315.7308
122	136.9557	171.4033	160.8921	193.6687	207.6163	274.7066
123	122.1504	153.8653	166.551	214.1491	225.4448	289.9981
124	122.8419	155.1536	182.8078	227.3192	185.8128	262.2422
125	99.70152	126.1885	179.9936	238.7465	237.9428	308.1689
126	111.5485	140.5842	183.4325	225.7504	218.3515	291.324
127	129.3029	163.1657	187.4728	230.8761	185.528	244.7415

128	103.3323	131.8956	173.1128	217.0381	247.1662	311.6779
129	114.8862	146.4198	180.9907	222.4157	214.7773	290.1951
130	118.8749	144.2761	176.5123	201.3529	223.1046	290.4441
131	138.3963	170.0363	184.5617	213.9877	173.3222	240.6787
132	99.62565	128.8244	175.7908	229.4773	258.4013	324.4739
133	111.9322	142.3953	185.9308	230.3726	207.8235	280.9824
134	122.3692	151.7961	176.5784	215.6949	218.2109	279.252
135	128.7016	157.6722	175.7999	203.8778	209.0222	276.7923
136	112.8307	138.6694	184.0605	214.4809	222.9509	291.697
137	149.7657	183.8338	183.7802	211.7355	164.2749	231.1092
138	107.8751	138.5291	180.4376	224.5936	238.6345	309.1309
139	109.8208	142.1098	181.2026	223.4656	227.8544	296.584
140	118.2247	152.7289	170.3822	206.3409	214.1352	293.9634
141	110.0752	137.0799	176.7099	219.2462	232.6888	295.6495
142	127.9007	156.0903	175.8884	198.7099	218.2205	277.8915
143	114.3328	148.5068	181.4102	236.3515	198.13	276.2131
144	131.7717	171.6004	192.3412	248.0014	164.0839	233.1391
145	104.5398	140.7624	177.6861	223.2159	216.4322	302.4524
146	104.47	124.8887	168.545	206.7871	272.9205	330.1836
147	116.2984	156.8052	174.386	236.4733	191.0548	278.5333
148	124.033	151.6164	187.5675	231.087	196.4229	252.4811
149	134.8634	165.529	182.7169	212.3166	184.3861	249.5506
150	102.8558	125.8455	168.0124	206.3133	272.8902	330.8742
151	125.2486	159.7288	183.7088	239.2591	179.211	253.2814
152	110.5752	136.8422	179.8302	224.3573	225.8394	293.9977
153	129.6543	146.8904	178.4509	196.7308	238.645	281.5744
154	127.8518	162.0119	177.0669	227.5873	190.1802	260.1814
155	117.8019	148.2678	177.4925	204.5629	220.7603	293.8481
156	122.4298	156.1313	181.6233	222.2668	191.6167	267.2493
157	114.07	139.4558	176.7261	217.4209	239.1659	288.8712
158	141.2664	173.853	176.8435	202.9079	176.3973	248.5132
159	130.4362	172.3929	168.117	222.1044	180.8877	261.2883
160	132.8644	171.6159	174.6374	204.1507	188.0881	262.8969
161	109.7245	137.229	190.5085	246.3098	215.027	285.3557
162	102.3437	119.5781	171.2071	186.3528	307.0306	343.4032
163	115.8665	151.7409	166.8963	217.7171	218.7386	292.5458
164	133.2373	168.5281	170.6996	204.8804	203.0442	273.9077
165	125.9633	160.6011	183.2076	230.0186	184.9568	253.5047
166	115.3864	147.7065	189.0317	236.8081	190.4789	265.4336
167	111.2776	136.6608	178.3354	204.3773	236.5786	303.7095
168	116.1472	140.4064	181.7183	211.5185	226.201	283.8409
169	106.7678	129.4426	161.3679	184.9314	301.7355	342.314
170	124.6367	159.3601	164.6671	196.3782	219.115	294.4027
171	109.7975	128.4284	175.9608	201.6023	261.4589	310.4398
172	120.6427	155.4623	188.467	233.8666	191.5926	269.6411
173	111.1079	136.0974	170.5417	186.9067	261.3276	319.7563
174	113.0445	141.3792	170.6827	193.6963	242.1039	307.2931
175	123.6469	144.0884	173.6048	191.3177	249.253	292.5336
176	116.3674	141.8538	174.9314	199.4319	241.5215	295.2986
177	137.1128	165.3278	180.5412	205.3599	193.0907	256.6776
178	97.34554	118.0329	170.8858	206.3621	302.1018	349.2931
179	101.7979	122.9972	174.4955	227.4812	259.8926	316.6379
180	136.2239	176.2208	177.4457	225.8892	183.9656	255.22
181	116.6495	143.4375	183.0356	226.1076	208.4037	274.6845
182	110.3211	136.5583	173.6371	196.9454	252.8043	312.4312
183	114.8908	136.9921	179.6202	219.8316	240.3142	286.0459
184	103.4087	125.1564	174.5705	212.8136	285.218	329.7199
185	111.5307	133.6676	176.3725	212.631	259.0846	308.2217
186	111.5881	134.1007	179.2584	221.352	237.8675	293.1888
187	110.1395	140.2489	167.3017	215.9429	244.8081	305.6851
188	99.8415	117.2698	171.8125	185.8856	312.1827	351.2323
189	119.1446	146.7326	176.3303	216.783	211.1309	280.8579
190	119.3813	157.4293	165.3169	215.5944	213.7207	294.2584
191	122.3186	152.6193	170.6861	194.1627	220.5516	290.2861
192	104.9061	130.2859	167.0852	199.4431	268.4693	328.2909

193	109.9692	135.6914	179.3392	217.8561	247.9055	305.5764
194	102.0151	129.4977	178.9765	223.1482	244.4347	313.4777
195	115.9212	148.5581	182.438	223.87	213.8521	286.9141
196	108.8774	147.9102	164.328	223.2739	231.0375	311.7662
197	107.4867	136.5637	170.6027	211.3267	239.1731	314.5028
198	133.9345	162.4037	185.2204	213.9091	181.8937	246.6481
199	120.6932	156.8539	162.5758	194.3481	231.302	305.4011
200	121.6709	156.3097	171.2976	213.3957	202.1978	277.3722

ANNEXURE D

200 Sample each size n=10 (estimate on value Case I))

S.No.	Mean(T)	Mean(V)	Mean (I)	MSE(T)	MSE(V)	MSE (I)
1	126.06	195.47	258.18	40.93	44.61	304.28
2	151.98	193.20	221.19	82.81	58.51	375.05
3	116.95	182.58	300.82	17.71	26.38	126.48
4	107.75	190.27	324.17	23.15	80.34	133.73
5	132.29	193.69	254.92	40.23	82.36	255.37
6	135.91	200.63	242.21	57.13	85.26	357.26
7	150.52	177.41	245.28	60.96	54.26	256.51
8	119.24	182.28	298.43	36.16	19.66	254.32
9	130.69	198.31	256.09	59.25	92.50	285.11
10	115.70	197.34	295.98	42.87	99.79	268.01
11	133.80	206.12	233.38	53.19	114.16	249.09
12	110.90	189.25	303.54	20.10	26.83	202.10
13	136.18	199.37	239.54	81.25	95.80	410.04
14	117.39	172.99	322.36	28.97	37.52	101.20
15	116.74	191.95	283.93	44.01	42.86	387.44
16	133.16	205.29	235.15	63.44	96.79	355.90
17	113.70	203.25	278.22	17.96	109.47	168.70
18	118.81	201.72	275.98	45.20	104.48	297.62
19	133.38	206.91	231.98	85.47	125.28	431.42
20	156.32	192.27	219.86	75.67	70.89	355.72
21	120.81	206.50	262.25	55.37	108.83	356.51
22	140.48	179.42	267.51	53.33	47.91	198.43
23	134.09	207.61	231.25	57.09	114.56	300.92
24	116.82	207.54	273.70	38.76	169.45	217.10
25	120.90	194.12	271.69	32.67	47.83	238.95
26	123.12	222.35	254.34	47.69	210.03	225.43
27	123.55	178.69	292.49	33.77	14.03	191.94
28	121.81	182.19	295.69	31.03	26.88	174.10
29	129.93	182.34	279.93	38.11	46.38	222.02
30	116.73	212.84	261.64	38.89	186.98	276.96
31	128.88	199.29	250.65	47.19	107.46	306.73
32	121.66	182.47	289.51	36.48	25.87	237.46
33	133.39	189.06	255.77	58.85	86.33	316.47
34	132.32	189.68	267.79	59.27	113.58	319.38
35	117.66	182.63	301.97	29.98	26.08	157.01
36	112.38	193.41	305.48	39.22	92.69	222.06
37	133.75	196.29	259.68	79.95	179.53	366.48
38	129.46	191.06	263.44	54.36	90.63	311.41
39	137.90	193.02	241.89	48.87	35.03	278.62
40	122.42	185.49	285.49	40.68	76.05	232.69
41	106.02	205.24	306.64	25.92	157.88	180.21
42	125.09	191.70	268.54	30.92	38.72	195.83
43	126.75	207.23	251.93	52.88	107.03	317.74
44	118.34	192.94	279.76	44.38	100.91	303.46
45	136.26	221.11	220.39	72.37	179.74	382.32
46	123.80	197.35	269.19	55.64	87.71	355.76
47	128.71	194.93	259.64	54.02	93.83	334.17
48	149.40	187.91	228.66	52.30	22.22	269.04
49	126.12	195.45	259.83	53.64	53.46	330.12
50	126.64	188.50	270.66	63.69	141.16	301.33
51	126.78	194.43	257.97	39.88	39.53	275.14
52	143.59	214.68	207.93	53.55	119.83	233.16
53	121.87	195.76	278.83	64.30	190.49	293.11
54	124.27	192.71	268.23	31.58	46.15	203.44
55	127.18	193.24	263.27	46.53	91.74	297.30
56	116.60	219.64	252.51	48.63	173.33	401.87
57	130.63	191.22	257.58	46.22	41.95	262.80
58	114.02	182.77	321.21	37.67	103.06	146.22
59	111.82	190.80	311.60	21.16	78.52	116.07
60	103.89	202.69	310.76	24.10	154.59	253.94
61	123.19	195.99	279.34	44.90	92.92	285.39
62	108.40	196.40	314.63	23.49	134.83	161.35

63	136.72	185.23	259.91	66.91	60.73	378.53
64	141.38	206.67	228.12	68.83	138.69	361.17
65	135.50	192.82	250.83	45.28	37.26	249.44
66	123.54	191.37	272.98	63.92	140.09	442.15
67	135.13	187.50	253.88	38.83	29.54	216.41
68	120.17	188.60	283.95	36.80	33.97	257.85
69	134.26	211.20	227.20	58.59	117.44	283.75
70	126.54	190.42	274.16	33.33	82.65	170.07
71	144.53	207.58	223.41	49.41	84.03	230.22
72	109.12	178.87	330.01	16.94	12.65	90.75
73	149.08	209.21	206.23	92.17	132.51	389.23
74	125.89	182.47	282.28	37.09	20.72	217.87
75	120.50	188.73	288.57	38.61	88.39	222.98
76	138.53	186.34	257.55	33.20	24.10	137.62
77	120.29	178.79	299.38	38.03	18.19	223.08
78	117.25	199.45	283.04	56.03	190.68	300.84
79	119.33	221.84	258.49	52.56	224.87	317.92
80	128.59	171.86	301.93	22.77	32.04	66.31
81	120.74	210.16	258.45	51.10	164.20	326.00
82	139.09	183.05	252.65	32.61	22.92	163.49
83	130.49	176.62	288.88	37.63	49.75	146.97
84	125.99	215.63	242.48	48.49	160.04	338.39
85	126.00	188.92	277.69	50.85	129.88	214.85
86	129.45	197.01	261.68	67.00	132.42	320.52
87	135.26	197.76	254.54	83.37	185.87	370.72
88	118.74	189.77	284.36	32.99	39.92	241.38
89	130.86	187.46	261.61	50.95	24.47	298.25
90	116.23	196.35	289.06	48.19	134.21	270.41
91	149.01	206.47	215.82	73.00	108.04	272.90
92	131.10	203.70	252.74	54.22	142.83	246.11
93	133.24	184.75	258.21	55.21	25.80	324.25
94	116.02	186.40	303.31	21.37	79.88	120.78
95	136.91	189.18	252.52	61.28	37.55	294.62
96	119.69	191.79	277.23	41.32	47.37	318.86
97	138.26	174.79	276.05	45.95	46.58	172.08
98	159.21	192.80	211.38	56.89	44.46	243.92
99	128.11	186.25	270.17	53.61	36.79	298.34
100	124.39	205.56	255.66	41.16	101.79	289.60
101	133.24	174.92	279.06	53.24	50.93	263.69
102	135.55	190.05	261.40	58.86	124.74	249.30
103	123.58	182.00	290.59	33.34	23.40	171.81
104	122.49	198.50	271.86	37.40	95.00	212.76
105	120.16	186.43	293.57	33.24	33.66	213.80
106	117.91	194.66	281.34	40.85	94.99	272.57
107	113.51	200.59	297.85	41.66	151.78	251.18
108	153.28	191.73	221.20	61.89	42.09	282.16
109	123.67	190.94	272.45	29.86	36.79	199.05
110	159.66	203.15	200.08	45.75	38.10	212.23
111	147.18	190.51	229.67	50.25	34.80	295.99
112	124.34	194.51	280.06	38.84	85.76	186.50
113	126.67	200.76	253.01	55.46	104.70	319.24
114	136.28	201.97	232.26	57.63	97.21	271.59
115	145.61	204.88	219.84	55.79	109.37	183.23
116	110.85	186.11	315.98	20.57	82.26	140.90
117	144.24	192.36	235.28	45.12	37.75	217.72
118	116.80	202.17	276.96	25.02	92.85	234.94
119	128.28	190.44	267.69	48.59	69.21	308.75
120	122.08	203.06	256.69	43.85	101.53	293.06
121	122.33	191.75	275.56	61.44	104.31	377.78
122	154.18	177.28	241.16	63.02	58.69	268.87
123	138.01	190.35	257.72	55.57	121.76	231.56
124	139.00	205.06	224.03	58.96	102.61	330.48
125	112.95	209.37	273.06	37.34	181.13	288.63
126	126.07	204.59	254.84	43.73	100.14	306.05
127	146.23	209.17	215.13	60.43	108.34	197.54

128	117.61	195.08	279.42	45.10	108.05	241.96
129	130.65	201.70	252.49	54.82	94.35	321.07
130	131.58	188.93	256.77	37.36	33.37	264.76
131	154.22	199.27	207.00	55.67	42.95	258.44
132	114.23	202.63	291.44	45.06	159.76	248.81
133	127.16	208.15	244.40	48.64	107.75	315.29
134	137.08	196.14	248.73	48.24	87.80	199.44
135	143.19	189.84	242.91	48.30	39.99	252.65
136	125.75	199.27	257.32	36.58	49.71	272.05
137	166.80	197.76	197.69	63.13	41.05	258.45
138	123.20	202.52	273.88	52.12	106.32	278.73
139	125.97	202.33	262.22	56.36	98.49	265.97
140	135.48	188.36	254.05	64.99	64.29	370.61
141	123.58	197.98	264.17	39.03	101.52	232.21
142	142.00	187.30	248.06	42.33	30.48	205.28
143	131.42	208.88	237.17	64.32	162.36	347.96
144	151.69	220.17	198.61	84.40	170.59	267.51
145	122.65	200.45	259.44	70.87	108.92	429.33
146	114.68	187.67	301.55	22.57	80.52	187.00
147	136.55	205.43	234.79	88.60	201.57	443.32
148	137.82	209.33	224.45	39.05	109.25	185.66
149	150.20	197.52	216.97	52.90	47.02	233.88
150	114.35	187.16	301.88	27.26	80.06	197.97
151	142.49	211.48	216.25	65.40	161.84	319.56
152	123.71	202.09	259.92	37.72	107.00	261.58
153	138.27	187.59	260.11	18.44	19.17	95.27
154	144.93	202.33	225.18	65.09	137.16	279.30
155	133.03	191.03	257.30	51.82	40.93	303.91
156	139.28	201.95	229.43	63.86	89.13	320.53
157	126.76	197.07	264.02	33.28	93.13	144.16
158	157.56	189.88	212.46	60.78	34.43	298.15
159	151.41	195.11	221.09	92.42	155.29	385.56
160	152.24	189.39	225.49	79.56	45.77	324.47
161	123.48	218.41	250.19	41.61	169.62	277.22
162	110.96	178.78	325.22	16.12	14.95	80.46
163	133.80	192.31	255.64	70.93	137.25	311.60
164	150.88	187.79	238.48	67.51	61.10	290.62
165	143.28	206.61	219.23	63.73	114.38	270.67
166	131.55	212.92	227.96	58.93	119.70	323.81
167	123.97	191.36	270.14	34.24	37.71	263.61
168	128.28	196.62	255.02	30.62	50.74	200.94
169	118.11	173.15	322.02	28.11	32.09	93.05
170	142.00	180.52	256.76	65.92	52.58	332.29
171	119.11	188.78	285.95	18.14	38.40	147.74
172	138.05	211.17	230.62	67.79	110.13	345.17
173	123.60	178.72	290.54	35.47	15.27	187.97
174	127.21	182.19	274.70	43.37	31.19	247.81
175	133.87	182.46	270.89	22.53	19.18	108.27
176	129.11	187.18	268.41	33.72	36.31	173.75
177	151.22	192.95	224.88	44.69	31.85	228.76
178	107.69	188.62	325.70	23.29	70.17	125.00
179	112.40	200.99	288.27	23.16	149.86	189.31
180	156.22	201.67	219.59	84.98	128.45	294.98
181	130.04	204.57	241.54	38.96	100.20	254.60
182	123.44	185.29	282.62	36.02	31.90	211.65
183	125.94	199.73	263.18	26.29	93.83	113.45
184	114.28	193.69	307.47	23.37	86.57	126.73
185	122.60	194.50	283.65	26.89	75.84	128.24
186	122.84	200.31	265.53	27.17	98.12	173.16
187	125.19	191.62	275.25	48.27	125.97	217.14
188	108.56	178.85	331.71	16.69	12.90	89.18
189	132.94	196.56	245.99	42.26	89.34	276.46
190	138.41	190.46	253.99	77.60	136.73	377.96
191	137.47	182.42	255.42	50.94	30.67	279.22
192	117.60	183.26	298.38	33.69	57.02	215.45

193	122.83	198.60	276.74	36.79	83.87	179.82
194	115.76	201.06	278.96	40.29	104.49	280.06
195	132.24	203.15	250.38	57.18	96.00	301.57
196	128.39	193.80	271.40	81.50	187.09	366.96
197	122.03	190.96	276.84	44.91	89.82	327.25
198	148.17	199.56	214.27	47.46	43.19	236.56
199	138.77	178.46	268.35	68.76	55.81	326.04
200	138.99	192.35	239.79	63.98	96.56	325.79

ANNEXURE E

200 Samples each of size n=10 (estimates value ($Case\ II$))

S.No.	Mean(T)	Mean(V)	Mean (I)	MSE(T)	MSE(V)	MSE (I)
1	126.06	195.47	258.18	47.85	54.95	339.36
2	151.98	193.20	221.19	102.33	73.64	411.44
3	116.95	182.58	300.82	21.55	27.21	132.88
4	107.75	190.27	324.17	28.52	91.35	145.46
5	132.29	193.69	254.92	45.92	96.27	296.06
6	135.91	200.63	242.21	68.70	101.30	410.05
7	150.52	177.41	245.28	75.66	65.56	277.94
8	119.24	182.28	298.43	42.95	22.00	291.39
9	130.69	198.31	256.09	70.10	109.76	336.59
10	115.70	197.34	295.98	51.28	118.65	305.46
11	133.80	206.12	233.38	65.52	138.71	280.75
12	110.90	189.25	303.54	23.92	33.24	228.06
13	136.18	199.37	239.54	98.55	118.59	463.30
14	117.39	172.99	322.36	35.81	41.53	105.96
15	116.74	191.95	283.93	52.01	55.96	429.80
16	133.16	205.29	235.15	74.38	121.29	408.35
17	113.70	203.25	278.22	23.62	128.86	179.39
18	118.81	201.72	275.98	52.98	125.13	339.17
19	133.38	206.91	231.98	103.92	156.07	471.29
20	156.32	192.27	219.86	89.85	91.83	392.30
21	120.81	206.50	262.25	66.43	138.31	406.46
22	140.48	179.42	267.51	65.00	57.46	222.01
23	134.09	207.61	231.25	70.32	139.87	332.33
24	116.82	207.54	273.70	47.58	197.50	245.46
25	120.90	194.12	271.69	39.66	56.94	261.09
26	123.12	222.35	254.34	57.35	243.64	261.93
27	123.55	178.69	292.49	38.16	16.16	230.63
28	121.81	182.19	295.69	36.95	29.38	194.60
29	129.93	182.34	279.93	43.25	57.96	261.61
30	116.73	212.84	261.64	47.72	227.71	307.02
31	128.88	199.29	250.65	59.92	126.61	340.61
32	121.66	182.47	289.51	43.96	27.93	265.11
33	133.39	189.06	255.77	69.93	101.66	368.75
34	132.32	189.68	267.79	71.35	135.68	358.51
35	117.66	182.63	301.97	36.06	28.96	176.77
36	112.38	193.41	305.48	48.12	107.84	251.27
37	133.75	196.29	259.68	99.90	218.13	414.09
38	129.46	191.06	263.44	67.22	109.24	351.84
39	137.90	193.02	241.89	56.65	43.14	317.43
40	122.42	185.49	285.49	47.43	88.56	277.26
41	106.02	205.24	306.64	32.87	186.68	194.47
42	125.09	191.70	268.54	37.69	44.64	219.53
43	126.75	207.23	251.93	64.14	134.89	360.76
44	118.34	192.94	279.76	52.78	122.28	343.56
45	136.26	221.11	220.39	89.02	223.44	432.93
46	123.80	197.35	269.19	64.76	109.70	411.21
47	128.71	194.93	259.64	63.65	113.76	384.80
48	149.40	187.91	228.66	58.34	31.31	316.84
49	126.12	195.45	259.83	65.76	63.61	364.63
50	126.64	188.50	270.66	76.72	168.93	326.99
51	126.78	194.43	257.97	49.69	46.94	302.74
52	143.59	214.68	207.93	66.55	143.37	259.79
53	121.87	195.76	278.83	78.64	231.47	326.01
54	124.27	192.71	268.23	38.51	52.61	222.09
55	127.18	193.24	263.27	54.54	108.34	335.48
56	116.60	219.64	252.51	57.32	224.32	449.38
57	130.63	191.22	257.58	53.47	52.03	307.62
58	114.02	182.77	321.21	46.67	120.45	159.24
59	111.82	190.80	311.60	26.32	88.36	126.89
60	103.89	202.69	310.76	29.07	190.04	285.45
61	123.19	195.99	279.34	56.40	104.52	318.25
62	108.40	196.40	314.63	28.94	159.11	185.51

63	136.72	185.23	259.91	78.53	77.91	425.80
64	141.38	206.67	228.12	82.39	173.85	407.46
65	135.50	192.82	250.83	54.49	45.47	284.13
66	123.54	191.37	272.98	76.24	174.77	487.91
67	135.13	187.50	253.88	47.04	31.28	242.55
68	120.17	188.60	283.95	43.98	41.20	291.49
69	134.26	211.20	227.20	70.08	140.27	319.97
70	126.54	190.42	274.16	40.32	93.39	198.14
71	144.53	207.58	223.41	58.65	93.27	270.91
72	109.12	178.87	330.01	20.73	12.66	98.89
73	149.08	209.21	206.23	113.96	167.10	431.92
74	125.89	182.47	282.28	44.87	22.72	245.39
75	120.50	188.73	288.57	48.14	103.05	251.06
76	138.53	186.34	257.55	38.48	27.56	163.95
77	120.29	178.79	299.38	43.92	20.33	262.42
78	117.25	199.45	283.04	69.28	238.93	333.21
79	119.33	221.84	258.49	66.31	267.19	355.09
80	128.59	171.86	301.93	27.83	36.57	66.21
81	120.74	210.16	258.45	63.84	200.87	361.37
82	139.09	183.05	252.65	36.10	25.78	194.90
83	130.49	176.62	288.88	44.81	57.03	160.95
84	125.99	215.63	242.48	57.49	193.83	387.99
85	126.00	188.92	277.69	63.02	154.42	230.48
86	129.45	197.01	261.68	82.96	163.85	358.06
87	135.26	197.76	254.54	105.02	223.99	412.04
88	118.74	189.77	284.36	40.85	48.01	265.11
89	130.86	187.46	261.61	58.75	32.03	343.30
90	116.23	196.35	289.06	56.78	159.48	324.42
91	149.01	206.47	215.82	89.35	123.37	312.80
92	131.10	203.70	252.74	64.17	163.76	300.50
93	133.24	184.75	258.21	61.00	33.91	376.11
94	116.02	186.40	303.31	26.58	90.19	132.27
95	136.91	189.18	252.52	75.07	45.07	329.84
96	119.69	191.79	277.23	50.64	54.50	351.84
97	138.26	174.79	276.05	56.91	53.43	182.50
98	159.21	192.80	211.38	66.25	53.53	279.46
99	128.11	186.25	270.17	59.57	45.21	353.00
100	124.39	205.56	255.66	49.28	118.32	331.13
101	133.24	174.92	279.06	63.22	58.69	296.95
102	135.55	190.05	261.40	70.50	151.51	287.59
103	123.58	182.00	290.59	41.63	25.62	188.63
104	122.49	198.50	271.86	46.37	109.39	239.41
105	120.16	186.43	293.57	38.06	39.28	245.95
106	117.91	194.66	281.34	49.99	114.20	304.07
107	113.51	200.59	297.85	50.72	180.06	293.78
108	153.28	191.73	221.20	72.12	51.17	327.41
109	123.67	190.94	272.45	36.47	43.24	223.43
110	159.66	203.15	200.08	51.66	47.48	249.85
111	147.18	190.51	229.67	57.92	41.64	332.88
112	124.34	194.51	280.06	49.66	97.54	206.90
113	126.67	200.76	253.01	64.41	132.35	369.47
114	136.28	201.97	232.26	66.76	116.31	315.36
115	145.61	204.88	219.84	66.39	126.22	216.60
116	110.85	186.11	315.98	24.97	93.59	155.68
117	144.24	192.36	235.28	53.35	41.20	246.74
118	116.80	202.17	276.96	31.90	110.26	263.86
119	128.28	190.44	267.69	58.20	87.09	348.54
120	122.08	203.06	256.69	50.96	123.91	332.32
121	122.33	191.75	275.56	75.99	124.56	420.16
122	154.18	177.28	241.16	77.22	69.91	292.92
123	138.01	190.35	257.72	65.46	147.44	271.18
124	139.00	205.06	224.03	67.94	128.93	380.14
125	112.95	209.37	273.06	45.66	224.64	320.94
126	126.07	204.59	254.84	54.86	116.54	346.53
127	146.23	209.17	215.13	74.62	122.60	228.18

128	117.61	195.08	279.42	53.09	125.56	270.84
129	130.65	201.70	252.49	64.71	111.67	370.15
130	131.58	188.93	256.77	41.99	40.16	295.10
131	154.22	199.27	207.00	65.15	56.35	295.25
132	114.23	202.63	291.44	55.48	187.57	284.10
133	127.16	208.15	244.40	60.39	128.53	348.31
134	137.08	196.14	248.73	56.35	99.57	242.48
135	143.19	189.84	242.91	54.62	51.30	298.89
136	125.75	199.27	257.32	43.45	60.22	307.56
137	166.80	197.76	197.69	75.53	50.86	290.69
138	123.20	202.52	273.88	61.15	126.88	323.42
139	125.97	202.33	262.22	67.85	116.24	307.41
140	135.48	188.36	254.05	77.48	84.15	414.71
141	123.58	197.98	264.17	47.46	117.75	257.97
142	142.00	187.30	248.06	51.71	33.89	231.72
143	131.42	208.88	237.17	76.00	196.44	396.77
144	151.69	220.17	198.61	103.23	201.61	310.33
145	122.65	200.45	259.44	85.39	134.90	481.54
146	114.68	187.67	301.55	27.13	95.17	213.39
147	136.55	205.43	234.79	106.78	250.86	498.00
148	137.82	209.33	224.45	49.51	123.25	204.51
149	150.20	197.52	216.97	61.20	57.02	276.34
150	114.35	187.16	301.88	34.39	95.46	218.80
151	142.49	211.48	216.25	77.37	200.82	357.04
152	123.71	202.09	259.92	44.90	129.03	302.32
153	138.27	187.59	260.11	19.33	21.75	119.93
154	144.93	202.33	225.18	75.94	166.10	318.89
155	133.03	191.03	257.30	60.40	47.69	347.63
156	139.28	201.95	229.43	73.91	107.50	372.26
157	126.76	197.07	264.02	41.94	107.77	160.78
158	157.56	189.88	212.46	69.10	44.21	338.45
159	151.41	195.11	221.09	114.56	189.68	420.67
160	152.24	189.39	225.49	97.73	56.68	364.19
161	123.48	218.41	250.19	49.23	202.64	321.88
162	110.96	178.78	325.22	19.33	14.93	86.09
163	133.80	192.31	255.64	83.75	168.08	354.51
164	150.88	187.79	238.48	81.05	76.03	326.79
165	143.28	206.61	219.23	78.08	142.60	305.79
166	131.55	212.92	227.96	67.98	148.54	365.62
167	123.97	191.36	270.14	41.93	44.13	293.27
168	128.28	196.62	255.02	38.30	57.79	216.21
169	118.11	173.15	322.02	33.46	36.13	107.16
170	142.00	180.52	256.76	78.46	65.44	368.87
171	119.11	188.78	285.95	22.59	42.79	156.13
172	138.05	211.17	230.62	78.90	134.13	396.42
173	123.60	178.72	290.54	40.64	17.43	222.17
174	127.21	182.19	274.70	52.25	34.47	276.55
175	133.87	182.46	270.89	27.19	20.42	121.90
176	129.11	187.18	268.41	42.27	39.06	188.20
177	151.22	192.95	224.88	51.81	40.09	263.13
178	107.69	188.62	325.70	27.85	81.90	144.93
179	112.40	200.99	288.27	29.25	182.70	209.55
180	156.22	201.67	219.59	104.11	152.72	330.41
181	130.04	204.57	241.54	46.70	120.73	285.89
182	123.44	185.29	282.62	44.80	35.35	231.37
183	125.94	199.73	263.18	31.79	105.23	136.10
184	114.28	193.69	307.47	30.78	95.18	128.88
185	122.60	194.50	283.65	31.89	85.56	157.13
186	122.84	200.31	265.53	32.98	115.31	199.16
187	125.19	191.62	275.25	59.00	153.97	241.18
188	108.56	178.85	331.71	19.77	12.89	99.23
189	132.94	196.56	245.99	49.53	106.49	316.40
190	138.41	190.46	253.99	94.21	164.50	422.11
191	137.47	182.42	255.42	59.75	35.87	316.46
192	117.60	183.26	298.38	41.92	68.14	232.89

193	122.83	198.60	276.74	43.06	96.55	216.44
194	115.76	201.06	278.96	49.15	126.97	310.22
195	132.24	203.15	250.38	69.32	111.71	347.38
196	128.39	193.80	271.40	99.15	226.12	424.12
197	122.03	190.96	276.84	55.02	107.93	369.28
198	148.17	199.56	214.27	52.74	53.56	272.88
199	138.77	178.46	268.35	85.09	65.69	357.32
200	138.99	192.35	239.79	78.08	115.33	367.76

The population dataset and Python programming code which we have used in this paper for calculate the results of each occasion is available at: https://abdulalim90.blogspot.com/