Software Development For Statistical Process Control

"EASY CC"

Supervisor

Professor Alessandro Brun

Master Graduation Thesis By

Claudia Yamile Prieto Robles

Cristian Jiménez Mejía

Politecnico Di Milano

Master of Science in Management Engineering

Polo Regionale Di Como

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Abstract

This piece of work consists of a research made in order to develop a software which can be used in phase I of the implementation of Statistical process control (SPC), which is the application of statistical methods for monitoring and controlling a process to ensure that it operates at its full potential to produce conforming product. It will allow different industries to use control charts as tools for achieving process stability and reducing process variability.

Montgomery (2011) states “the manufacturing process must therefore be stable or repeatable and capable of operating with little variability around the target or nominal dimension.” And his solution is SPC tools.

However, as it is already known, total quality inspection represents an impractical work according to the premise that things have to be done right at first time. But, the existing variation in every process represents a problem when this statement is applied.

Control charts are one of the most important tools of SPC allowing the identification of assignable causes of variation for their control and further elimination; the control chart was invented by Walter A. Shewhart; he introduced the control chart while working for Bell Labs in the 1920s. (Montgomery 2009).

The two phases of the control chart (the learning and control phase) are truly relevant for the following research. In the first phase, the sample must be analysed whether it is normally distributed or not, also if the data has some discrepancies in order to eliminate them. According to the results, the central value of the parameter that is being monitored and the lower and upper control limits are properly set.

The control phase which is the second phase has the objective to represent the observations on the graph along the time in order to detect trends or out of control situations.

The Easy CC software will calculate the Control limits based on the historical data. If there is any Point that is outside the control limits, the user must investigate, looking for potential assignable causes. Consequently the software will point out any outlier for the user who should work on the assignable causes that cause the outlier. The software will analyse the performance of the process with different control charts, taking into account parameters such as the ARL, real alpha, real Beta and ATS.

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1 INTRODUCTION

1.1 Final Work Purpose

The aim of this final work is to develop software which helps in the process of creating, evaluating and managing the statistical quality control process in enterprises, along with the possibility of making certain process analysis regarding its expected output according to the quality parameters given by the user.

This piece of work has been carried out based on the control chart´s researches using online resources which provide the necessary information to analyse the basic requirements for the development of the software. The principal characteristics and features of the software will be: the control charts creation, control chart evaluation, process analysis, user friendly, warning process and control chart management.

1.2 Research Objectives

1. To investigate and construct a solid framework for the development of the software.
2. To analyse the possible control chart that would be suitable for the software.
3. To develop friendly user software which can be used in the industries for phase I of the statistical process control.
4. To Test the software on simulated data, and evaluate the results.
5. To analyse the results of the data tested and leave a relevant work for future researches.

1.3 Organization of the thesis

Since the development of the control chart by Dr. Shewhart in 1931, they have been used widely around the world in different industries for different processes, although each process has different requirements and problems to be analysed, a standard control chart may not be feasible for each situation. For this reason there are considerable quantities of researches done in this area. In chapter 1 there is a brief introduction of The Statistical process control (SPC), its purpose, the objectives and the structure of this work piece.

The Literature Review, (Chapter 2), includes the analysis of three different types of control charts in order to compare them, and explain their advantages and disadvantages in the application of these charts, especially for phase I of SPC. It gives an overview on the application of control charts, their statistics parameters, with a special attention on the Shewhart control chart, CUSUM and Hotelling T^2.

Chapter 3 explains the methodology used to develop the software and the important statistics apart which was taken into account at the moment of programming the software, the steps used and the language chose to write the software in order to have a clear vision of how this one works. Moreover, the test of the program with a dataset created with the proper tools offered by excel, this dataset was used to verify the proper operation of the software, and to show how the software should properly be used.

The final part of this document shows the results given in the test of the software, the respective analysis of different aspects of the software by applying different statistical concepts and methods for the results of the testing data which present different behaviour. Also, Chapter 4 mentions the possible problems which were identified on the software, the use and the limitation of the software.

Finally in Chapter 5, i.e. Conclusion is where we summarize the findings of this work and the importance of developing this software, the managerial implications, the benefits and the problems that are identified.

1.4 Thesis Structure

This work consists of 5 chapters, where it shows how the software is developed and the concepts used for the software, the benefits and the limitations of the software.

Thesis Structure

1. Introduction
2. Literature Review
3. Methodology
4. Results and Analysis
5. Conclusion
6. References
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2 LITERATURE REVIEW

This chapter presents a review of publications in the area of statistical process control (SPC) with a special reference on three different types of control charts for variables: Shewhart's, CUSUM, and the Hotteling T2. The first section is an introduction of SPC tools and a brief explanation of control charts based on Montgomery's book: Applied Statistics and Probability for Engineers, Fifth Edition (2011). The second section of this review presents the reason for selecting the mentioned control charts. The third section reviews the control charts mentioned above and points out the advantages and disadvantages on its use. And in the fourth section is a brief review of some other control charts for variables.

2.1 SPC Tools and Control Charts

As it is already known, quality inspection represents an impractical work according to the premise that things have to be done right at first time. Even though, the existing variation in every aspect represents a problem for the previous sentence. For this reason, Montgomery (2011) states "the manufacturing process must therefore be stable or repeatable and capable of operating with little variability around the target or nominal dimension."And he presents SPC as an important tool for achieving process stability, reducing process variability.

The major tools of SPC are: Histogram, Pareto chart, Cause-and-effect diagram, Defect-concentration diagram, Control chart, Scatter diagram and Check sheet. (Montgomery, 2011)

Control chart is seen as the most powerful SPC tool, Shewhart (1931) defined it as a tool that "may serve, first; to define the goal or standard for a process that management strives to attain; second, it may be used as an instrument for attaining that goal and third, it may serve as a means of judging whether the goal has been reached." It is important to know that every process regardless of how well it has performed has an inherent or natural variability which is called “background noise”, that is, the cumulative effect of unavoidable causes.

For statistical quality control, this background noise is often called a “stable system of chance causes.” The real problem of the processes is the variability produced by assignable causes that arises from three sources: improperly adjusted machines or equipment, operator errors, or defective raw materials. The process is in statistical control if the process is performing with just the chance causes. However, if it is in presence of assignable causes it will go out of control. (Montgomery, 2011)

Hence, the control chart is a graph used to monitor processes, to verify that assignable causes will not occur, when assignable causes appear the graph has a “shift” to an out-of-control state where a proportion of the process output falls out of the lower or upper control limits or presents trends. This statement is a consequence of the theorem of central limit. Then, the principal goal of SPC is to quickly detect the points beyond the control limits in order to take a corrective action before many nonconforming units are produced. (Awasthi, 2000)

The control chart has two phases, first, the learning phase, at this stage the sample must be analysed whether it is normally distributed or not and if the data has some discrepancies in order to eliminate them. According to the results the central value of the parameter that is being monitored and the lower and upper control limits are set. The second is the control phase, in this stage the observations are represented on the graph along the time with the objective of detect trends or out of control situations.

This piece of work is based on Control Charts for Variables which are more sensitive than attribute control charts. Montgomery (2009) calls the variable control charts “leading indicators of trouble that will sound an alarm before the number of rejects (scrap) increases in the production process”. The principal advantage of control charts is that can be constructed for individual observations, rather than samples of observations. This has two common applications; one is when testing samples of multiple observations for it would be too expensive, inconvenient, or impossible. Another is when its necessary to detect small shifts in the product quality. In these cases control charts such a CUSUM, MA, and EWMA can be most applicable.

2.2 Justification

This chapter analyses three control charts: Shewhart's, CUSUM and Hotelling T^2.The Shewhart control chart because it is the most widely applied in the industry and it has been successfully used to monitor process performance over time. CUSUM since it has much greater sensitivity (up to an order of magnitude) to the shifts of the mean value, identifying small shift, which acquire an important place on certain kind of industries. And the Hotelling T^2 as this chart is the most widely used multivariate procedure when several correlated variables are controlled simultaneously.

2.3 The Shewhart, CUSUM and Hotelling T2 control charts

2.3.1 The Shewhart Control Chart for variables

The control chart was invented by Walter A. Shewhart; he introduced the control chart while he was working for Bell Labs in the 1920s. (Montgomery 2009).

According to Montgomery (2009), control charts for variables are classified according to the statistic plotted on the chart; it has two main divisions: one for control of the average process or mean quality level which is usually done with the control chart for means, or the x control chart. And the second one for variability processes which can be monitored with either a control chart for the standard deviation, called the S control chart, or an R control chart that is used for the range.

Then, when dealing with a characteristic quality that is a variable, it is important to maintain control over both the mean process and process variability.

The control chart consists of three lines: One, that is fixed by the mean of the characteristics that will be controlled, which is called central line; the other two are defined to a certain number of standard deviation from the control line, and they are called control limits.

2.3.1.1 X and R charts

This graph shows the distribution in a time period of the estimators $\bar{X}$(mean) and R (range), identifying the central value and the dispersion of the values of each sample taken. The values of these estimators vary from sample to sample in the inspection process, therefore the main is to predict what are the limits within which such estimators vary, when the process is under statistical control.

According to Montgomery (2009), when control charts are created and the sample size is relatively small, the range can be used instead of the standard deviation of a sample to construct control charts on X and the range, R. The range of a sample is the difference between the largest and smallest observation.

Patnaik points out a statistical relationship between the mean range for data from a normal distribution and sigma, the standard deviation of that distribution. This relationship depends only on the sample size, n. The mean of R is d2 sigma, where the value of d2 is also a function of n. An estimator of sigma is therefore R /d2. (Montgomery, 2009)

X- Chart: The X chart controls the process means since the sample range is related to the process standard deviation. The central line is the Mean.

R – Chart: The R chart controls the process variability since the sample range is related to the process standard deviation. The central line is the average range.

The Control Limits for X- and R-charts for a standard given process

X- Chart:

Upper control limit: $\mu + 3\frac{\sigma}{d_2\sqrt{n}}$

Central line: μ

Lower control limit: $\mu - 3\frac{\sigma}{d_2\sqrt{n}}$

R– Chart:

Upper control limit: $\sigma d_2 + 3\frac{\sigma}{d_3}$

Central line: σd_2

Lower control limit: $\sigma d_2 - 3\frac{\sigma}{d_3}$

The Control Limits for X- and R-charts for a standard not-given process

X - Chart

Upper control limit: $\bar{X} + 3\frac{\bar{R}}{d_2\sqrt{n}}$

Central line: $\bar{X}$

Lower control limit: $\bar{X} - 3\frac{\bar{R}}{d_2\sqrt{n}}$

R - Chart

Upper control limit: $\bar{R} + 3d_3\frac{\bar{R}}{d_2}$

Central line: $\bar{R}$

Lower control limit: $\bar{R} - 3d_3\frac{\bar{R}}{d_2}$

Where

μ = Mean

$\bar{X}$= weighted average of subgroup means

$\bar{R}$ = Range

σ = process standard deviation

n_i = sample size of i^{th} subgroup

$d_2(n)$ is the expected value of the range of n independent normally distributed variables with unit standard deviation.

$d_3(n)$ is the standard error of the range of n independent observations from a normal population with unit standard deviation. (Appendix 1: tables of d2 and d3)

N is the number of subgroups

2.3.1.2 X and S charts

Many authors recommend beginning the analysis of control chart using X- and s charts, in order to determine if the distribution of the process characteristic is stable.

The Control Limits for X- and S-Charts for a standard given process

X- Chart

Upper control limit: $\mu + 3\frac{\sigma}{\sqrt{n}}$

Central line: μ

Lower control limit: $\mu - 3\frac{\sigma}{\sqrt{n}}$

R - Chart

Upper control limit: $\sigma c_4 + 3\sigma(\sqrt{1 - c_4^2})$

Central line: σc_4

Lower control limit: $\sigma c_4 - 3\sigma(\sqrt{1 - c_4^2})$

The Control Limits for X- and S-charts for a standard not-given process

X - Chart

Upper control limit: $\bar{X} + 3\frac{\bar{S}}{c_4\sqrt{n}}$

Central line: $\bar{X}$

Lower control limit: $\bar{X} - 3\frac{\bar{S}}{c_4\sqrt{n}}$

R - Chart

$$\text{Upper control limit: } \bar{S} + 3\frac{\bar{S}}{c_4}(\sqrt{1-c_4^2})$$

$$\text{Central line: } \bar{S}$$

$$\text{Lower control limit: } \bar{S} - 3\frac{\bar{S}}{c_4}(\sqrt{1-c_4^2})$$

Where

μ = Mean

$\bar{X}$ = weighted average of subgroup means

$\bar{R}$ = Range

σ = process standard deviation

n_i = sample size of i^{th} subgroup

$c_4(n)$ is the expected value of the standard deviation of n independent normally distributed variables with unit standard deviation

$$c_4 = \sqrt{\frac{2}{n-1}} * \frac{\left(\frac{n}{2}-1\right)!}{\left(\frac{n-1)}{2}-1\right)!}$$

$\bar{S}$ is the sample standard deviation of the i^{th} subgroup

2.3.1.3 Other statistics properties

Montogomery, 2009 describes some statistics properties and its relation with Sample Size Decisions; he defines these properties which include two different types of errors:

- Type I error: also called false alarm, usually denoted as an α. This is the risk of a data point to fall beyond the control limits, indicating out of control condition when the process is in control, it means when no assignable cause is present.

- Type II error: It happens when a process is out of control and a data point falls between the control limits. It is denoted as β.

Also, there are some important measures that affect the sample size decision, influencing directly on the cost of SPC, those measure are the following:

- Average run length (ARL): It is the average number of points that must be plotted before finding and out of control line value.

- Average time to signal (ATS): It is average time required to detect an out-of-control signal. This measure evaluates the performance of the control chart.

2.3.1.4 Advantages and disadvantages

As a conclusion, Shewhart control charts are really useful in phase I which is the implementation of SPC, Montgomery (2009)has explained that in this phase the process is likely to be out of control and experiencing assignable causes that result in large shifts in the monitored parameters.

Besides, these charts are very useful in the diagnostic aspects of bringing an unruly process into statistical control, because the patterns on these charts often provide guidance regarding the nature of the assignable cause.

However, the Shewhart control chart uses only the information about the process contained in the last sample observation and it ignores any information given by the entire sequence of points, making the Shewhart control chart reasonably insensitive to small shifts on the process, Montgomery (2009) states, on the order of about 1.5s or less.

For This reason the Shewhart control chart is less useful in phase II: monitoring problems, where the process tends to operate in control, assignable causes do not typically result in large process upsets or disturbances, this means that the shifts that the process can suffer are small, and due to the considerable insensitivity of the Shewhart charts they are not recommendable for use on Phase II.

Although, Montgomery (2009) presents warning limits and other sensitizing rules, which can be applied in order to improve their performance against small shifts, the application of these criteria reduce the simplicity and ease of the interpretation of the Shewhart control chart, and reduces the average run length of the chart when the process is actually in control.

2.3.2 The CUSUM Chart

The CUSUM or cumulative sum control chart is a sequential analysis technique developed by E. S. Page of the University of Cambridge. It is used for monitoring change detection. (Biometrika Trust, 1954)

The cumulative sum method is a statistical technique for sequential data analysis originally used in industry as a method of quality control. It is a rapid way to determine the distance in the quality value between a unit and its standard and it gives the acceptable and unacceptable value of this deviation; the information is displayed in graph. (Davies; 1976)

According to Davies, (1976) these control charts allow continuous monitoring the cumulative differences of a qualitative characteristic of a particular process, which can be translated into data collected sequentially consenting early detection of deviations from a standard set. CUSUM charts have been used in medicine for detection of changes in the trend of biological parameters (temperature and quantification of neutrophils) and other applications.

Moreover, CUSUM charts (Cumulative Sum) improve the ability to detect small shifts by plotting a statistic that incorporates current and earlier data values from the process. Specifically, the CUSUM chart plots the cumulative sums of the deviations of the sample values from a target value. The inclusion of several samples in the cumulative sum results in increased sensitivity to detect shifts or trends in traditional Shewhart charts (individuals or graphics XBar).

The method exposed by Baptista (2007) in his article “Using the cumulative sum method (CUSUM) for the continuous quality assessment of analgesia in Acute Postoperative Pain Unit”, consists on summing differences from the goal cumulatively (Cumulative SUMs). When the process suffers a small shift is quickly detected .Then, the sensitivity of this chart is given by the k parameter, which is defined as

$$K = \frac{\delta}{2}\sigma = \frac{|\mu_1 - \mu_2|}{2}.$$

Also, Montgomery (2009) points that if the data are normal and independent; CUSUM charts are much more efficient than the Shewhart X-bar or X-individual chart. When a point falls outside the limits, it is taken as an alarm signal. When corrective actions are taken immediately after obtaining the signal, the FIR technique can be applied, which is based on moving the point immediately following the remedy action just below/above the limit on the same side where the previous violation occurred. If the action was not successful, the limit is violated again. The technique is useful as a quick check of whether the corrective action was successful. (Wachs, 2010)

Consequently, Montgomery and Wachs agree that CUSUM charts are suitable for situations where the average process is naturally expected to shift or trend from the target and there is a desire to make timely process adjustments to bring the process back on target. For a process that remains in control and centred at the Target value, the cumulative sum will vary randomly around a mean of zero. However, if the mean shifts upwards to some value μ, (μ > T), then an upward trend will quickly develop in the cumulative sum.

The upper and lower CUSUMs actually accumulate deviations from target that exceed a value called the reference value or allowance or slack value (normally indicated by K).K is typically set to be equal to half of the distance from the target and the shifted mean that we are interested in detecting quickly. (Wachs, 2010)

Furthermore, Montgomery shows the importance to define the parameter H which is specified in order to determine the location of the control limits. Likewise, the value for K is defined to achieve a good balance between Type Iand Type II Error probabilities.

2.3.2.1 Advantages and disadvantages

As a conclusion, CUSUM charts are also an excellent choice when the objective is to control a characteristic to a target value by making the necessary process adjustments; furthermore this control chart is recommended mainly when a process mean shift needs to be detected fast.

Also, Montgomery (2009) explains the case of plotting the cumulative sum of deviations of successive sample means from a target specification, permanent shifts in the process mean will eventually lead to a sizable cumulative sum of deviations. Consequently, this chart is particularly suitable for detecting such small permanent shifts that may go undetected when using the X-bar chart.

Generally, once we are in phase II; process-monitoring situations, individuals charts have poor performance in shift detection and can be very sensitive to departures from normality. Always use the EWMA and CUSUM charts in phase II instead of individuals charts whenever possible. (Montgomery, 2009)

2.3.3 The Hotelling T^2 Chart

This chart is developed by Harold Hotelling, who did the distribution as a generalization of Student's t-distribution. (Hotelling, 1931)Hotelling T^2 control chart is the most familiar multivariate process-monitoring and control procedure for monitoring the mean vector of the process. Besides, this control chart is a direct analogue of the univariate Shewhart chart. This is used when several correlated variables are controlled simultaneously. (Montgomery, 2009)

As it was mentioned, the chart is a multivariate analogue of the X-individual chart, because the data is assumed to consist of individual (multivariate) data points. Such data might be used in X-individual control charts for separate variables; the correlation coefficients should not be significant.

The information about individual variables is reduced to a distance from the (multivariate) mean computed with respect to the covariance matrix (Mahalanobis distance). The distance cannot be negative and respects interrelationships among different variables. The lower limit is always set to zero. (Das, 2006)

Hotelling T^2 statistic is calculated using

$$T_i^2 = \left(Y_i - \acute{Y}\right)^T S^{-1}\left(Y_i - \acute{Y}\right)$$

Values of T_i^2 for i=1,2...k will be plotted in a controlchart with

$$UCL = \left(\frac{\left(p(m+1)(m-1)\right)}{\left(m(m-p)\right)}\right) F_{\alpha,p,m-p}$$

If the covariance matrix is known or m is large- say, m>100 chi-square limits can also be used.

$$UCL = X^2(\alpha, p)$$

An interesting fact about the Hotelling T2 control-chart is that it fulfils conditions 1, 2 and 3 stated by Jackson for a control chart to be effective. Anderson showed that T2 test is the likelihood ratio test of the hypothesis μ=μ0 for the distribution Np(μ,Σ).

The method according to Das (2006) begins calculating for each variable the smallest confidence level K_{ind} that would yield an individual confidence interval for $\mu_{0i} - \mu_i$, (i=1,..., p) that contains zero. For this let t be the calculated value of the univariate t statistic for a variable and T (t;d) be the cumulative distribution function of the t distribution with d degrees of freedom .Then K_{ind}=| 2T(t;n−1) − 1 |. After, Compute the confidence level K_{Bonf} that yields the desired nominal confidence level K_{sim} of the Bonferroni type simultaneous confidence intervals for $\mu_{0i} - \mu_i$, (i=1,...p). Here $K_{Bonf} = (p + K_{sim} - 1)/p$.

The choice of K_{sim} represents tradeoffs between the powers of the intervals to identify variables which have truly changed, versus the likelihood of misidentifying a stable attribute as having changed.

Important notes are given by Montgomery such a test statistic, which is

$$T^2 = n(\bar{X} - \bar{\bar{X}})' S^{-1} (\bar{X} - \bar{\bar{X}}),$$

Also the control limits for the T2 control chart

$$UCL = \frac{p(m-1)(n-1)}{mn-m-p+1} F_{\propto,p,mn-m-p+1} \text{y}$$

$$LCL = 0$$

2.3.3.1 Advantages and disadvantages

The important advantage in using this method is that one gets a quick idea whether the out of control was due to mean shift or variance shift. These multivariate control charts work well when the number of process variables is not too large (10 or fewer).As the number of variables grows; however, traditional multivariate control charts lose efficiency with regard to shift detection. Furthermore, this method provides a quick idea whether the out of control was due to mean shift or variance shift. Montogomery,(2009)

Although Hotelling T2 statistic is the optimal single test statistic for detecting a general multivariate shift in the mean vector, it is not optimal for more structured mean shifts e.g. shift in only some of the variables. Another problem with the use of Hotelling T2 is that it confounds mean shifts with variance shifts. This introduces a persistent problem in multivariate control charts, explicitly the interpretation of a signal. (Das 2006)

The charts mentioned above have important features that allow the industry to implement SPC, however it is important to adequate the control charts to the type of industry and the level of quality that need to be reached, these charts have important differences among them, which makes them suitable in certain cases, not all industries can use the same chart.

2.3.4 Other control charts

Unequal Sample Sizes When the samples plotted in the control chart are not of equal size, then the control limits around the centre line (target specification) cannot be represented by a straight line. There are three ways of dealing with this situation. (Montgomery, 2011)

- **Average sample size.** When it is appropriate to maintain the straight-line control limits then it is possible to compute the average *n* per sample across all samples, and establish the control limits based on the average sample size.

- **Variable control limits.** This procedure consists on computing different control limits for each sample, based on the respective sample sizes. This will lead to *variable* control limits, and result in step-chart like control lines in the plot. Although, this procedure ensures that the correct control limits are computed for each sample. The control chart loses the simplicity of straight-line control limits.

- **Stabilized (normalized) chart.** This procedure allows keeping a straight line and accurate control limits. It can be accomplished by standardizing the quantity to be controlled according to units of *sigma*. However, the values on the vertical (*Y*) axis in the control chart are in terms of *sigma* rather than the original units of measurement, and therefore, those numbers cannot be taken as the original units of measurement.

Control Chart for Individual Observations. When testing samples of multiple observations would be too expensive, inconvenient, or impossible is necessary to construct variable control charts for individual observations taken from the production line, rather than samples of observations. The *CUSUM, MA*, and *EWMA* charts of cumulative sums and weighted averages may be most applicable in those situations. (Montgomery, 2009)

X-bar Charts For Non-Normal Data. Ryan (1989) presents the fact that when the distribution of observations is highly skewed and the sample sizes are small, then the resulting standard control limits may produce a large number of false alarms, as well as a larger number of false negative ("process-is-in-control"). In that case is necessary to use Johnson curves in the control limits for X-bar charts, which allow approximating the skewness and kurtosis for a large range of non-normal distributions.

Moving Average (MA) Chart. If the priority is to detect small trends across successive sample means. This procedure uses some weighting scheme that summarizes the means of several successive samples; moving such a weighted mean across the samples will produce a moving average chart.

Exponentially-weighted Moving Average (EWMA) Chart. The idea of moving averages of successive (adjacent) samples can be generalized. In principle, in order to detect a trend we need to weight successive samples to form a moving average; however, instead of a simple arithmetic moving average, we could compute a geometric moving average which is also called Geometric Moving Average chart, (Montgomery, 2009).

The interpretation of this chart is much like that of the moving average chart, and it allows us to detect small shifts in the means, and, therefore, in the quality of the production process.

Regression Control Charts. It is used mainly to monitor the relationship between two aspects of a production process which have two variables linearly correlated with each other and this relationship can probably be described in terms of the well-known Pearson product-moment correlation coefficient r.

The regression control chart contains a regression line that summarizes the linear relationship between the two variables of interest. Around the regression line is established a confidence interval within in which a certain proportion of samples are expected to fall. Outliers in this plot may indicate samples where, for some reason, the common relationship between the two variables of interest does not hold.

3 METHODOLOGY

The principal objective of this piece of work is to develop software which can be used in phase I for the implementation of SPC that allows the different industries the use of a control chart as a tool for achieving process stability, reducing process variability.

As it was described in the literature review chapter, the suitable control charts for phase I are the Shewhart control charts, this is because the goal of phase I is primarily to assist operating personnel in bringing the process into a state of statistical control.

Then in this phase a set of process data is gathered and analysed all at once in a retrospective analysis, constructing trial control limits to determine if the process has been in control over the period of time where the data was collected, and to see if reliable control limits can be established by the software to monitor future production. This is typically the first thing that is done when control charts are applied to any process.

Furthermore, the software will be in charge of the analysis part of this phase determining whether the process during the period of collecting is in control or not, and setting the control limits providing other parameters such a beta or alpha and ATS.

Therefore, in phase I a collection of m points will be compared to a set of control limits computed from those points. Montgomery suggests to use m = 20 or 25 subgroups. Usually in phase I its assumed that the process is initially out of control, so the objective of the analyst is to bring the process into a state of statistical control.

The software will calculate the Control limits based on the m subgroups and the data plotted on the control charts. If there is any Point that is outside the control limits, the user must investigate, looking for potential assignable causes.

Consequently the software will point out any outlier for the user who should work on the assignable causes that cause the outlier.

After the assignable causes are eliminated the points outside the control limits are then excluded and a new set of revised control limits calculated. At that moment, new data are collected and compared to these revised limits. This procedure usually requires several cycles and the software will help in reducing time for the analysis, and will accelerate the detection of assignable causes, accordingly those will be corrected, and the control limits are recalculated. Finally, the process is stabilized, and a set of data which represents in-control process performance is obtained for use in the second phase of SPC. (Montgomery, 2011.)

3.1 Control chart used in the software

As an important conclusion from the literature review, Shewhart control charts are typically used for phase I of SPC implementation, this happens because they are very effective, besides easy to construct and interpret, and according to Montgomery they are effective in detecting both large, sustained shifts in the process parameters and outliers, measuring errors, data recording and/or transmission errors.

Furthermore, Shewhart control charts have an important feature which is that its patterns are easy to interpret and have direct physical meaning, besides the sensitizing rules (Western Electric Corp, 1956) are easy to apply to Shewhart charts. These rules are explained on The Western Electric Handbook (1956), which suggests a set of decision rules for detecting non-random patterns on control charts. Thus it can be concluded that the process is out of control if either

1. One point plots outside 3-sigma control limits.
2. Two out of three consecutive points plot beyond a 2-sigma limit.

3. Four out of five consecutive points plot at a distance of 1-sigma or beyond from the centre line.

4. Eight consecutive points plot on one side of the centre line.

According to Montgomery, 2009 "*The types of assignable causes that usually occur in phase I result in fairly large process shifts—exactly the scenario in which the Shewhart control chart is most effective*". For phase I, the probability that an assignable cause will be detected is more relevant than the occurrence of false alarms. For this reason the ARL is not very significant for the software. However it is important to recognize it and also the ATS.

3.2 Target users

Industries where statistical methods are implemented to monitoring and control of a process to ensure that it operates at its full potential to produce conforming product. This means Statistical process control (SPC) programs in their process. Moreover, industries wanting to achieve process stability, reducing variability.

Our idea is to facilitate the implementation of SPC and reduce the cost caused by the SPC program. Introducing user friendly software that can be used by engineers, we are expecting to reduce time in the implementation and this tool also will facilitate the decisional process.

3.3 Software development

For developing this software we used Java language which was released by Sun Microsystems in 1995 and it is a general-purpose, concurrent, class-based, object-oriented computer programming language that is specifically designed to have as few implementations dependencies as possible.

Their aim was that developers "write once, run anywhere" (WORA), meaning that a code that runs on one platform does not need to be recompiled to run on another. The language derives much of its syntax from C and C++, but it has fewer low-level facilities than either of them. DedaSys LLC, 2009.

It is significant for the software to be developed in java language to have into account the following principle of Java determining by oracle 1999.

There were five primary goals in the creation of the Java language:

- It should be "simple, object-oriented and familiar"
- It should be "robust and secure"
- It should be "architecture-neutral and portable"
- It should execute with "high performance"
- It should be "interpreted, threaded, and dynamic"

Oracle. 1999

For the design of this program, the simplicity necessary for the industries were taken into account, due to the cost that would represent the waste of resources if the software would use a lot of capacity.

Also, it was important for the program that has a user friendly interface as it will be shown, and that the results showed could be easy interpreted by the operators, allowing them to improve the process decision.

3.3.1 Software code

The code of the software is show in the appendix 2.

3.4 Statistical Design parameters

The Shewhart statistical parameters were taken into account to develop the software; however we did not use the Shewhart standard of 3 for K_u and $K_{L.}$

According to Brun and Cassadio (2011) there are two situations in the designing process of control charts (standard given and no standard given process) and for X - R charts and X- S charts, both cases and its parameters are in the following explanation:

1. The Control Limits for X- and R-charts for a standard given process:

X- Chart: this chart monitors the central line among each sample

Upper control limit: $\mu + k_u \frac{\sigma}{d_2\sqrt{n}}$

Central line: μ

Lower control limit: $\mu - k_l \frac{\sigma}{d_2\sqrt{n}}$

R – Chart: this chart monitors the variability within each sample

Upper control limit: $\sigma d_2 + k_u \frac{\sigma}{d_3}$

Central line: σd_2

Lower control limit: $\sigma d_2 - k_l \frac{\sigma}{d_3}$

2. The Control Limits for X- and R-charts for a standard not-given process:

X - Chart

Upper control limit: $\bar{X} + k_u \frac{\bar{R}}{d_2\sqrt{n}}$

Central line: $\bar{X}$

Lower control limit: $\bar{X} - k_l \frac{\bar{R}}{d_2\sqrt{n}}$

R - Chart

Upper control limit: $\bar{R} + k_u d_3 \frac{\bar{R}}{d_2}$

Central line: $\bar{R}$

Lower control limit: $\bar{R} - k_l d_3 \frac{\bar{R}}{d_2}$

Where

μ = Mean

$\bar{X}$ = weighted average of subgroup means

$\bar{R}$ = Range

σ = process standard deviation

n_i = sample size of i^{th} subgroup *d*$_2$(*n*) is the expected value of the range of *n* independent normally distributed variables with unit standard deviation

d$_3$(*n*) is the standard error of the range of *n* independent observations from a normal population with unit standard deviation

N is the number of subgroups

k_u= It is the Z, of the normal distribution, of the probability of false alarm in the upper limit.

k_l =It is the Z, of the normal distribution, of the probability of false alarm in the upper limit.

1. The Control Limits for X- and S-Charts for a standard given process:

X- Chart

Upper control limit: $\mu + k_u \frac{\sigma}{\sqrt{n}}$

Central line: μ

Lower control limit: $\mu - k_l \frac{\sigma}{\sqrt{n}}$

R - Chart

Upper control limit: $\sigma c_4 + k_u \sigma(\sqrt{1 - c_4^2})$

Central line: σc_4

Lower control limit: $\sigma c_4 - k_l \sigma(\sqrt{1 - c_4^2})$

2. The Control Limits for X- and S-charts for a standard not-given process:

X - Chart

Upper control limit: $\bar{X} + k_u \frac{\bar{S}}{c_4\sqrt{n}}$

Central line: $\bar{X}$

Lower control limit: $\bar{X} - k_l \frac{\bar{S}}{c_4\sqrt{n}}$

R - Chart

Upper control limit: $\bar{S} + k_u \frac{\bar{S}}{c_4}(\sqrt{1 - c_4^2})$

Central line: $\bar{S}$

Lower control limit: $\bar{S} - k_l \frac{\bar{S}}{c_4}(\sqrt{1 - c_4^2})$

Where

μ = Mean

$\bar{X}$ = weighted average of subgroup means

$\bar{R}$ = Range

σ = process standard deviation

n_i = sample size of i^{th} subgroup

$c_4(n)$ is the expected value of the standard deviation of n independent normally distributed variables with unit standard deviation

$\bar{S}$ is the sample standard deviation of the i^{th} subgroup

k_u= It is the Z, of the normal distribution, of the probability of false alarm in the upper limit.

k_l =It is the Z, of the normal distribution, of the probability of false alarm in the upper limit.

- Type I error: also called false alarm, usually denote as α. This is the risk of a data point to fall beyond the control limits, indicating out of control condition when the process is in control.

- Type II error: It happens when a process is out of control and a data point falls between the control limits. It is denoted as β.

- Average run length (ARL): It is the average number of points that must be plotted before finding and out of control line value. It is defined as:

$$ARL = {}^{1}/_{p}$$

When the process is out of control

$$p = 1 - \beta$$

When the process is under control

$$p = \propto$$

- Average time to signal (ATS): It is the average time required to detect an out-of-control signal. This measure evaluates the performance of the control chart. In other words is the ARL times the gap time between samples.

3.5 Software description

The software makes control chart based on data that the user should upload on the software. The control charts that are created by the program are X, R and S which are the basic one to analyse the central line and the variability; and also has a custom control chart, where the user can set up every parameter in order to test the data.

Furthermore, the software will be in charge of the analysis part of this phase determining whether the process during the period of collecting is in control or not, and setting the control limits providing other parameters such a beta or alpha and ATS.

The software creates a control chart based on the parameters already defined by the historical data of the process, and the user just has to introduce the parameters of the mean, standard deviation, etc.

3.5.1 Use of Easy CC

1. In the start-up screen click the tab “New CC" and pick the control chart that you want to design, there are three options: X, R, S or a custom chart.

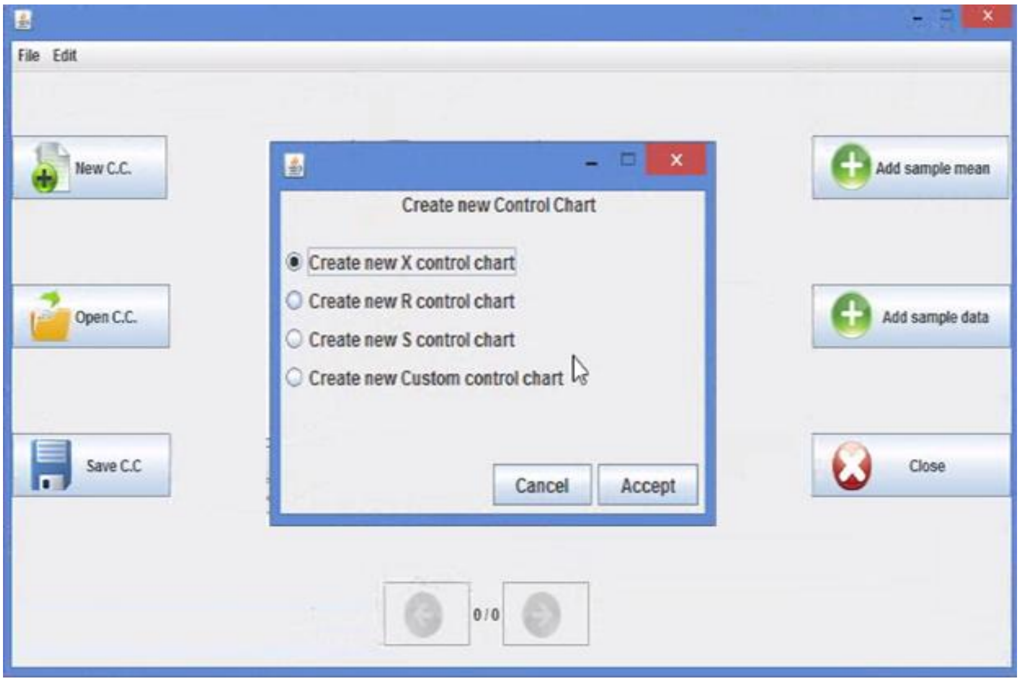

Figure 1: Start-up Screen

If X chart is selected:

As it was already explained above X control chart is used to detect any variation on the mean of the process. However, according to Montgomery, 2009 "*the X chart is only valid if the within-sample variability is constant*", then is recommendable to first analyse the R chart because, when the R chart indicates the sample variability is in statistical control, the X chart is examined to determine if the sample mean is also in statistical control.

Nonetheless, if the sample variability is not in statistical control, then the entire process is judged to be not in statistical control regardless of what the X chart indicates.

a. A window like the following appears, where is possible to select whether the process is centred or not. Also, to select the use of beta level and the beta level that is desired.

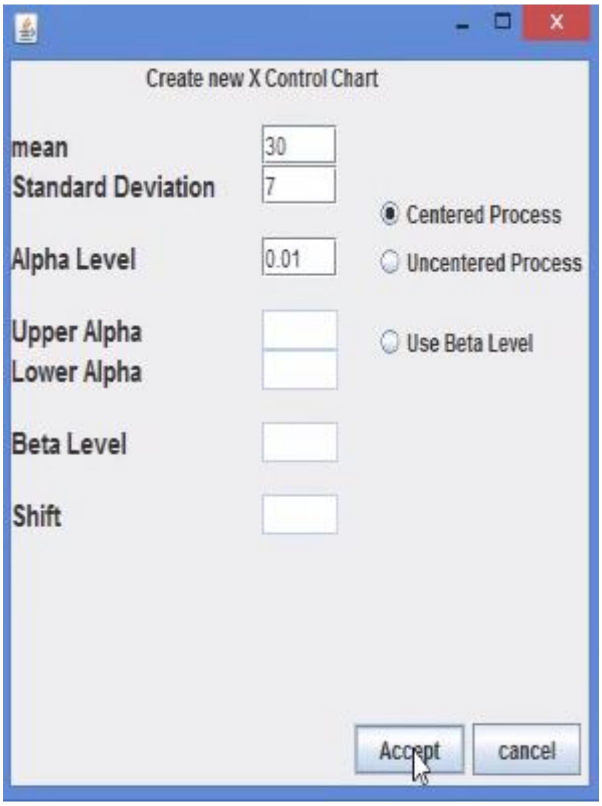

Figure 2: X Chart Window

When the process is centred you have two options: one, to create a CC with just the alpha level or using alpha and beta level.

When the process is not centred you can use two different alphas, for both tails.

b. After selecting those parameters, the software requires the n number except in the case, alpha and beta were introduced.

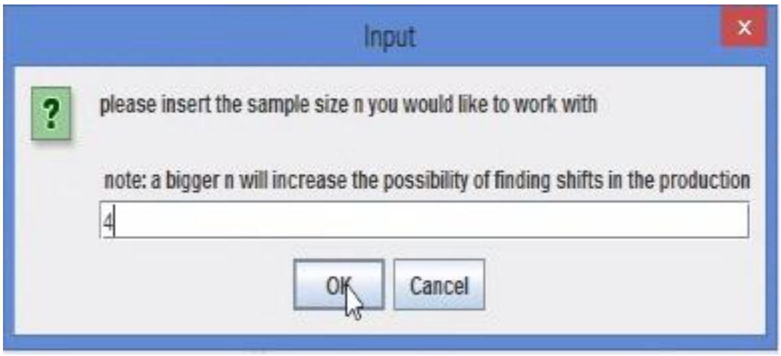

Figure 3: Input n

c. Then the software shows a message with the central line, the lower central limit and the Upper central limit.

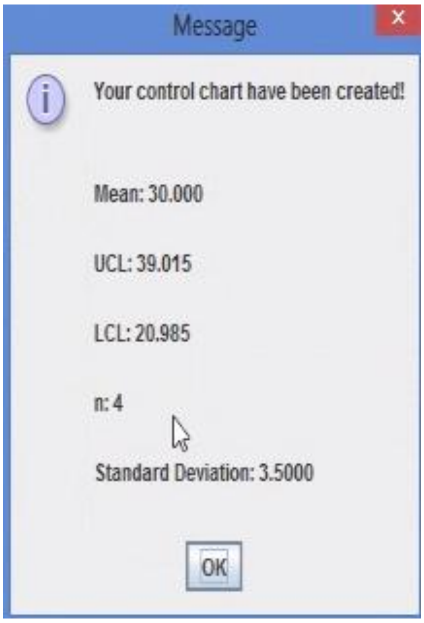

Figure 4: Summary of Parameters

d. Afterwards, the chart is plotted:

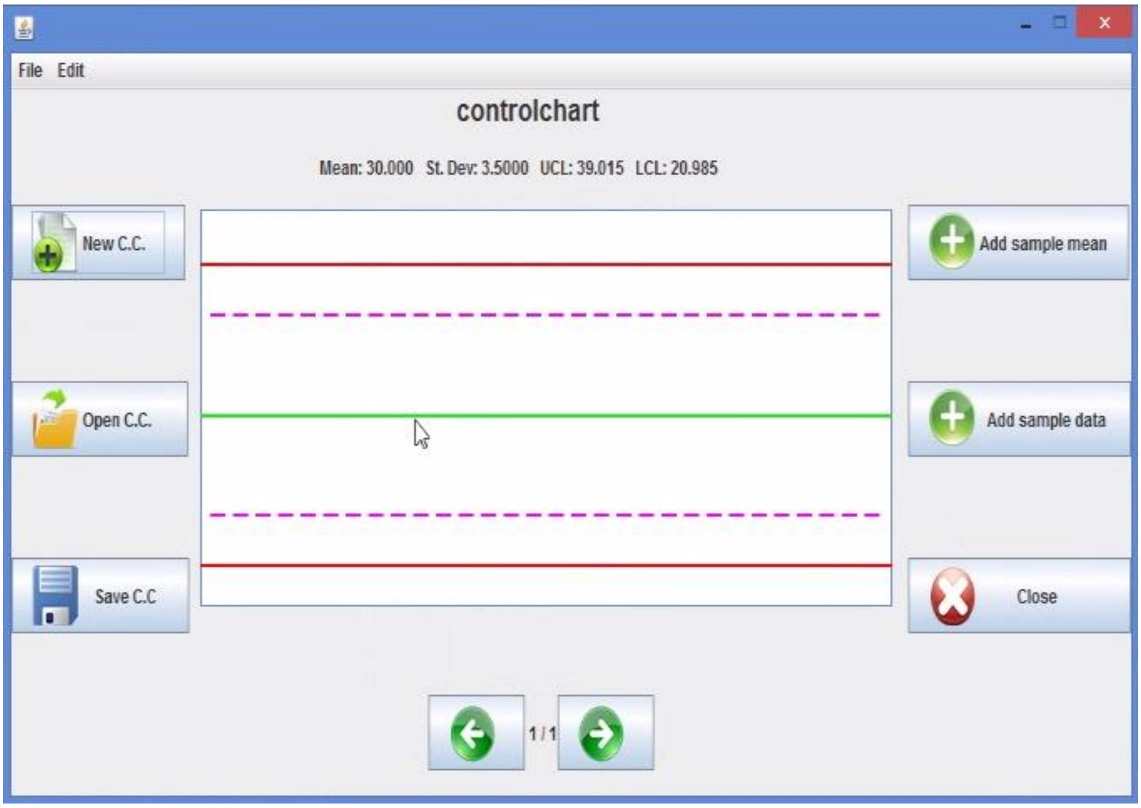

Figure 5: Control Limits, Graph

e. When the parameters of the graph are established, it is possible to add the data.

Figure 6: Inserting Data - Graph

f. Finally, the program shows the graphs of the respective control chart and the following message, when a problem appears, is displayed:

- "You have one point outside the control limits, your process might be out of control", "WARNING!",
- "You have "+num+" out of 3 points beyond the 2-Sigma limit, your process might be out of control", "WARNING!",
- "You have "+num+" out of 5 points beyond the Sigma limit, your process might be out of control", "WARNING!",

- "You have "+num+" out of 10 points over the chart means your process might be out of control", "WARNING!",

Note: "+num+" can take a value of 2 or 3, this values are according to the sensitizing rules.

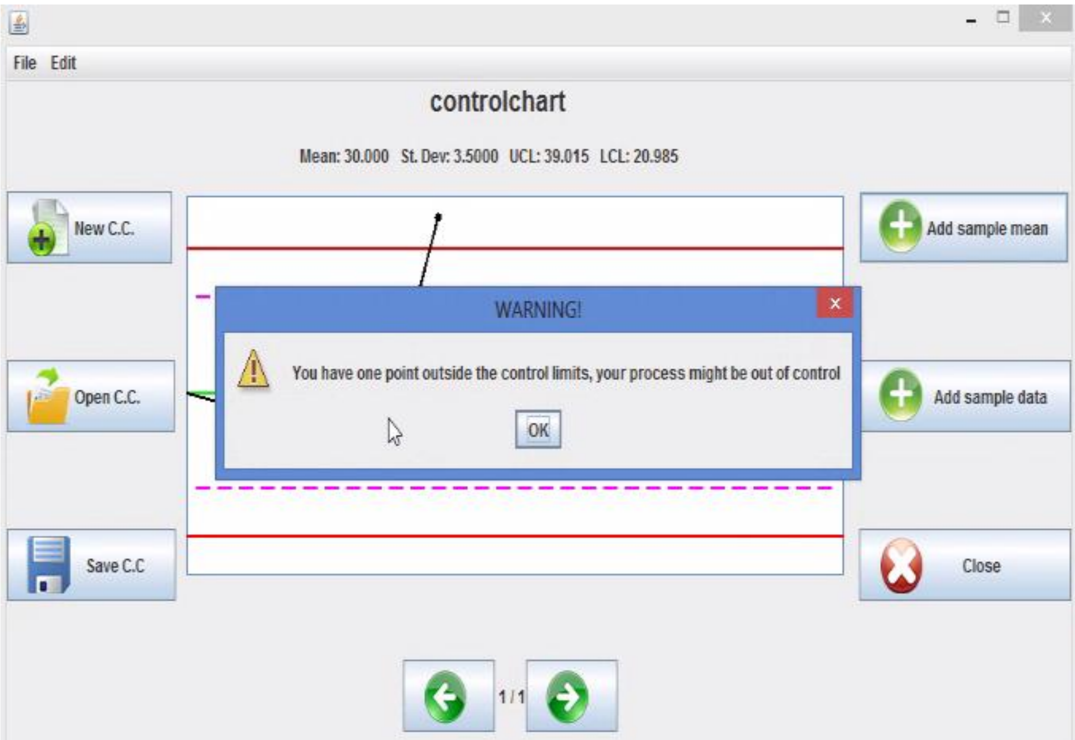

Figure 7: Warning Message

g. There is an option to upload a sample data, by clicking the button of *"add sample data"* you can select a data set, which the easy CC software will plot on the graph.

h. Two messages will then appear: one confirming that the introduction was carried out successfully and another pointing how many points were out of control.

Figure 8: Messages of Detection

i. The software pops up a data resume window that shows the warnings on the data set, also the points plotted can be explored by using the arrows at the bottom of the screen.

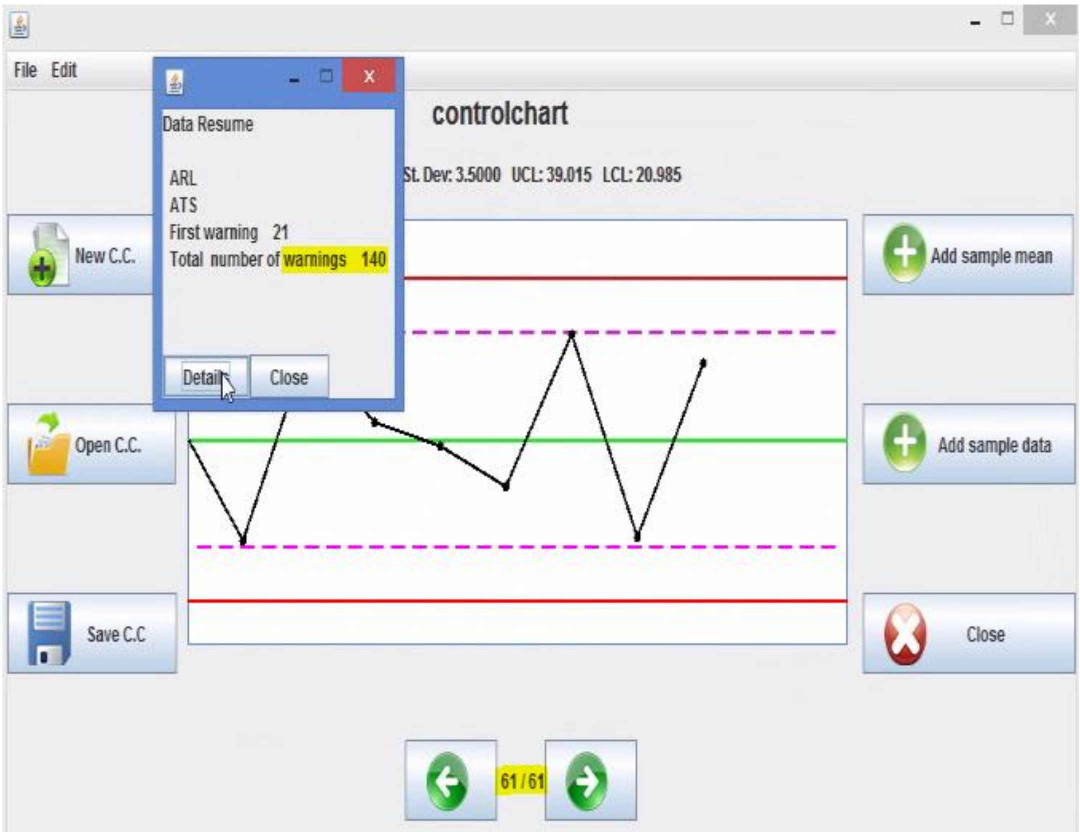

Figure 9: Data Summary

j. Besides by clicking on the button of details, the warnings can be displayed for its analysis, Easy CC shows the point and the error according to the Western Electric rules. As the following window:

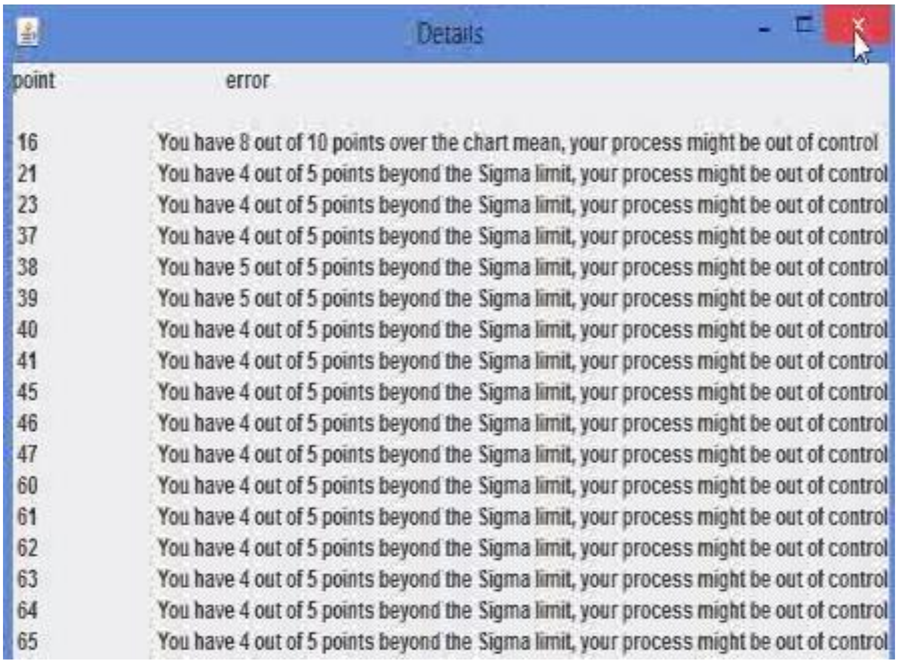

Figure 10: Errors Details

k. With the results shows by the program, the operator can discover the assignable causes revealed by the CC and take decision in order to eliminate the causes.

When R or S chart is picked:

The R chart controls the process variability since the sample range is related to the process standard deviation.

a. The window that appears has the option to define the standard deviation and the estimated R or S in each particular case.

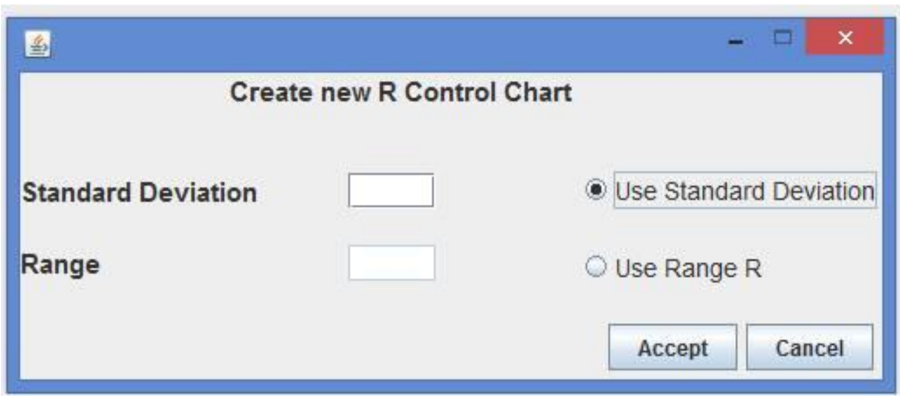

Figure 11: R control Chart

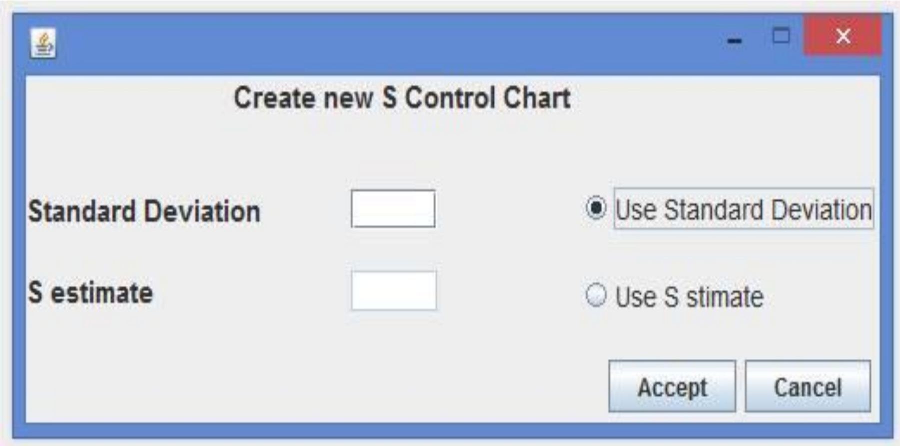

Figure 12: S Control Chart

b. After selecting those parameters, the software requires the n number.

c. Lastly, the software shows the central line which is the average range, the lower central limit and the Upper central limit. And the same procedure explained above can be used in order to analyse a dataset with R or S parameters.

When the custom chart is selected:

This chart allows the users to set a control chart specifically for their needs, since they could define the upper control limit and the lower control limit. The following window is displayed:

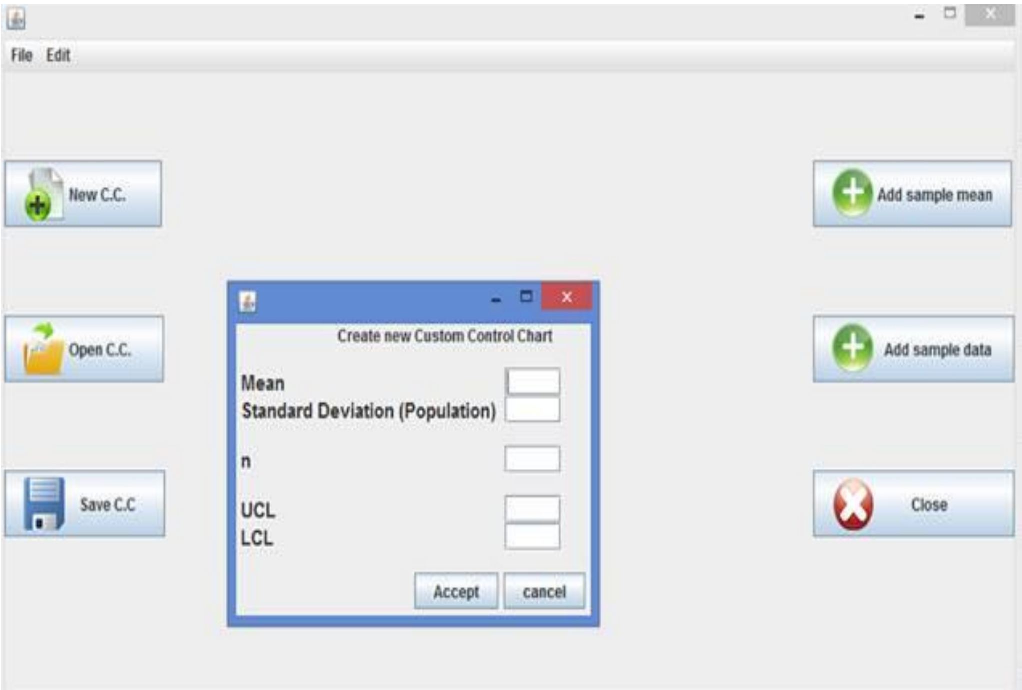

Figure 13: Custom Chart

a. The user selects the parameters desired, and the CC is plotted, subsequently the user can add the corresponding data as it was added above and analysed by the operator.

3.6 Prototype testing

In order to control the behaviour of the software and illustrate its possible use in the decision making process of an enterprise, We came to the desicion to test it in three different sets of data using two of the four types of charts available in the software (X and R charts), in each case using two different X charts with different parameters (0.0027 and 0.005 as alpha levels) being these two of the most commonly used in process control, in each case, a peculiar framework will be analysed and the output of the program will be taken into consideration in order to analyse the possible alternatives.

It is important also to state that common trends such as increasing/decreasing mean and increasing variability won't be analysed because of the triviality of the comparison between these types of trends using the control charts available in the software.

3.6.1 Data set description

The dataset (appendix 3) used to test the program was generated in the Microsoft Excel software using random number generation in order to obtain random normally distributed points, which basically are obtained using the formula:

NORMINV(RAND(), mean_value, standard_deviation)

Additional behaviour of the data set will be obtained by using different formulas in addition and will be explained in more detail later on.

The software will be analysed in four different scenarios in which the program will help in the decision making of choosing the best alternative between six different optional control charts, being those, the ones offered by the software.

In each case, for each scenario, 10 datasets of 1000 observations each, 5 numbers per observation are going to be generated, this way, the behaviour of each chart can be evaluated 10 different times in equally behavioural data, adding statistical value to the test, later, the average output of each chart will be analysed and the best chart will be selected taking into account the ARL and the ATS for each case.

In order to decide which mean and standard deviation is going to be used, even when it should not be significant for the output of this work, the data will emulate an industrial process in which one of the authors is involved in, the process of filling food supplements cans of 400 gr. With specification limits of +/- 3 gr. According to this process, we will emulate this process assuming a process capability of 1 and a consequent standard deviation of 1 in state of statistical control.

3.6.2 Testing a Normal Dataset

The first step will be to analyse a normal dataset without any type of irregularity, this way we can analyse the basic behaviour of each of the control chart in a natural state and determine which one is the best in order to monitor a process which has no external causes of variation, later on, we will discuss more interesting scenarios but this one could work as a base for further data analysis.

As it was said before, a normal distributed set of data will be generated with a mean of 400 and a standard distribution of 1, a total of 10 groups of 1000 observations will be generated with a "n" of 5 (5 numbers per observation), them the respective mean, range and deviation will be calculated for each observation and used as an input for the program, then, the results will be analysed.

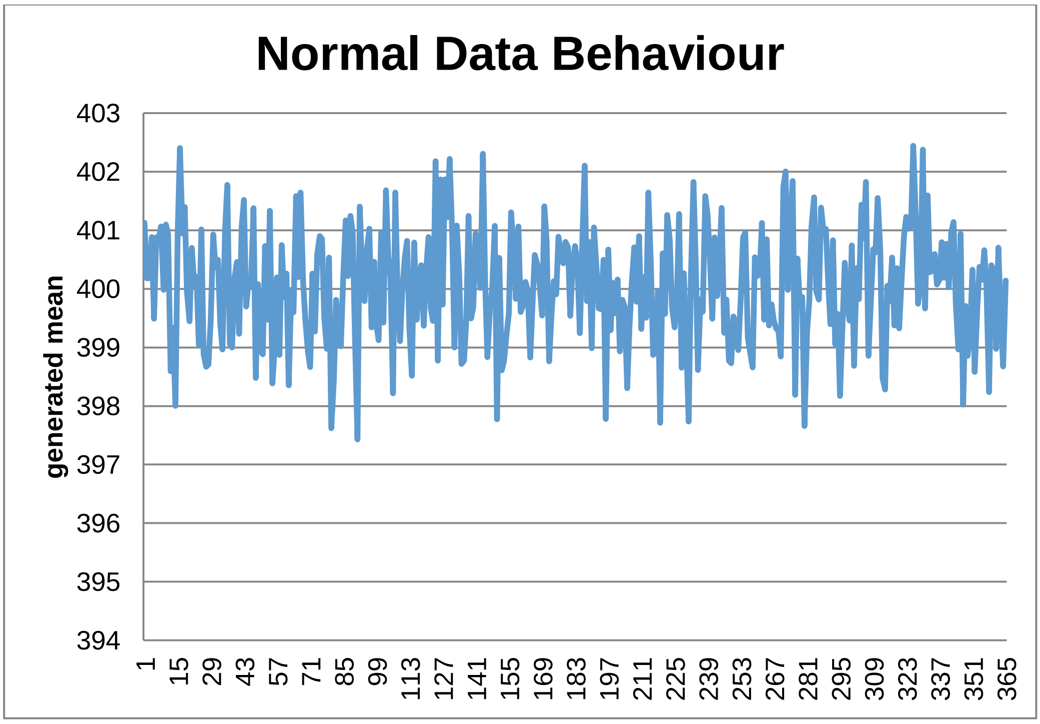

Figure 14: Normal Data Behaviour

3.6.3 Testing a Dataset with Simultaneous Shift in Mean and Increase of Variability

For the second part of the analysis, we will analyse the power of the different control charts, analysing the behaviour of each one of them when a shift in the mean is introduced to the process along with a change on its deviation, in this case the mean will shift from 400 to 400.4 and the standard deviation of the process will change simultaneously from 1 to 1.01.

The methodology in this case will be creating a set of data directly with the new mean and standard deviation and analyse the first warning given by each chart in order to analyse the ATS in each of the cases.

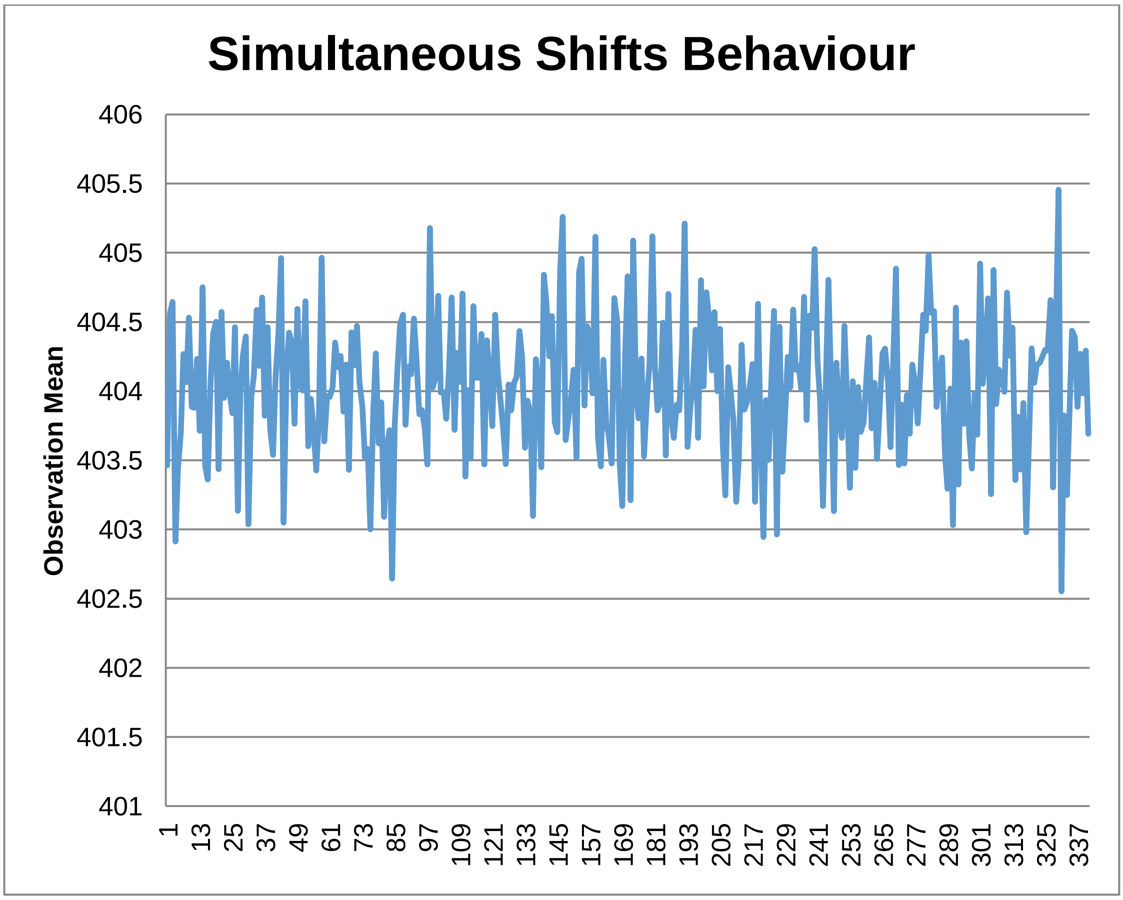

Figure 15: Simultaneous Shifts Behaviour

3.6.4 Testing an Increasing Mean and Deviation Dataset

For the third part of the analysis, we will analyse a set of data in which the mean and the standard deviation are increasing 0.01% each observation, in this case, we will again analyse the power of each chart and the number of observations necessary in order to detect the shifts experienced by each observation.

In this part, the data inserted to the software will start in a control state and will start increasing right from the beginning, the value given by the report that we will take into account is the first warning given by each chart.

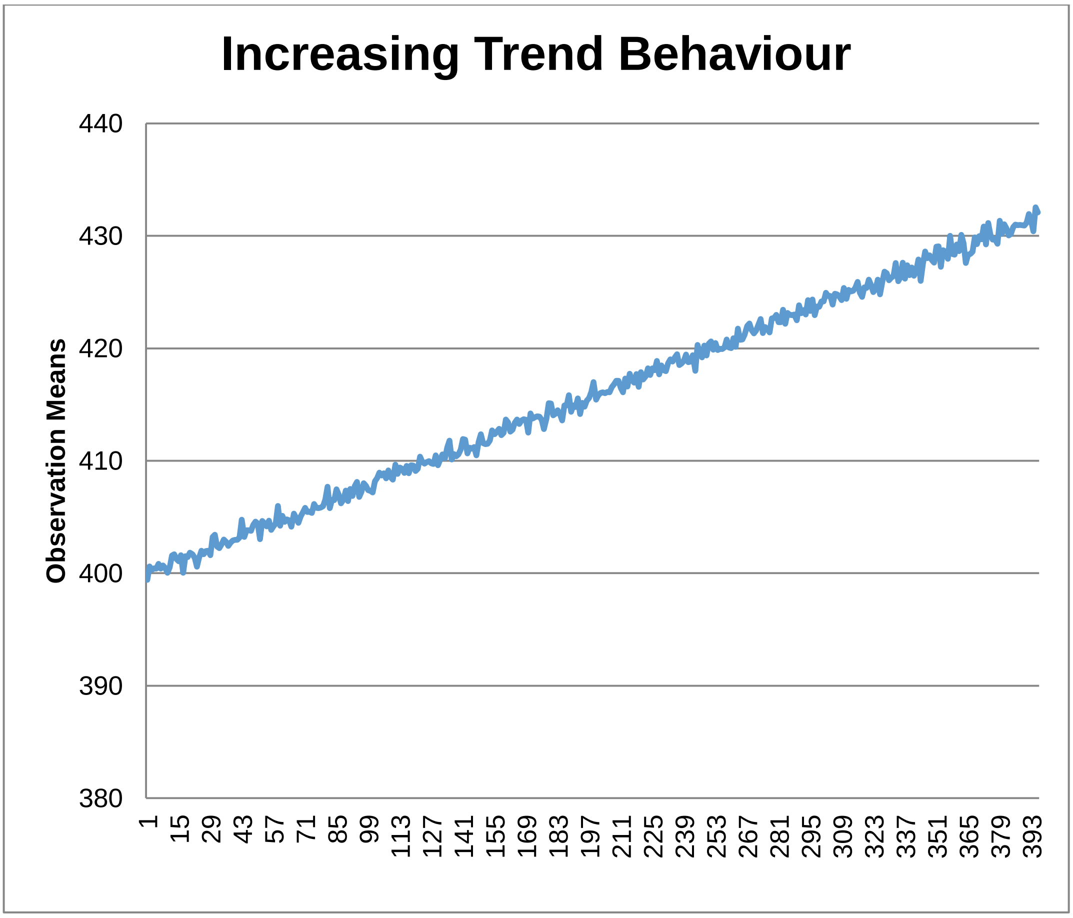

Figure 16: Increasing Trend Behaviour

3.7 Testing average behaviour

For the analysis of this three sets of data, three different charts were used, one X chart with an alpha level of 0.0027, another X chart with an alpha level of 0.005 and R chart using 1 as standard deviation.

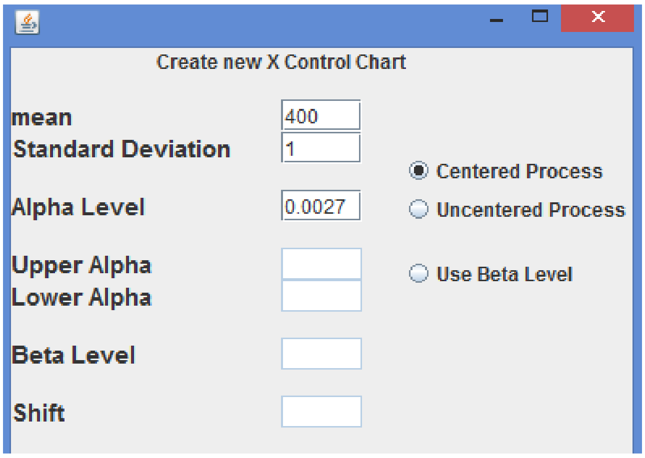

Figure 17: Analysed X CC

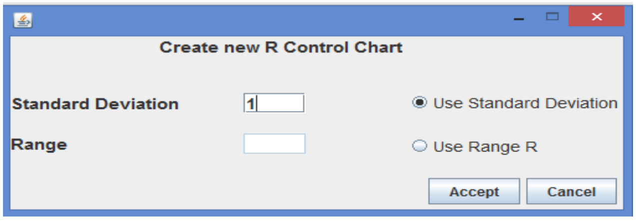

Figure 18: Analysed R CC

In both cases a sample size n of 4 was chosen as it was used in order to generate the data points generated in the simulation made in Excel, having done this, the ten data sets generated for each of the three situations where introduced in the program and the output window of the program was saved in order to let us analyse the behaviour of each table.

The three tables used to monitor the different datasets are listed below:

X chart 1:

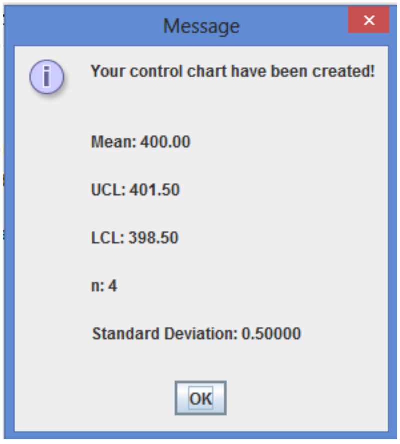

Figure 19: X Chart 1

X chart 2:

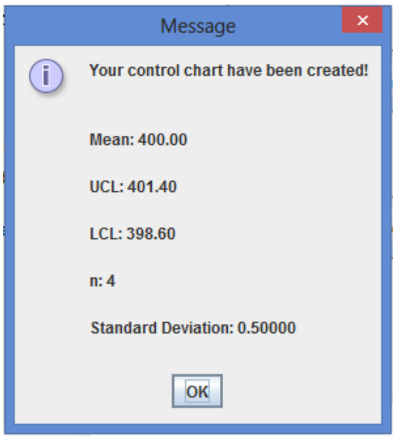

Figure 20: X Chart 2

Note: the standard deviation represented in the graph correspond to δ_x

R chart:

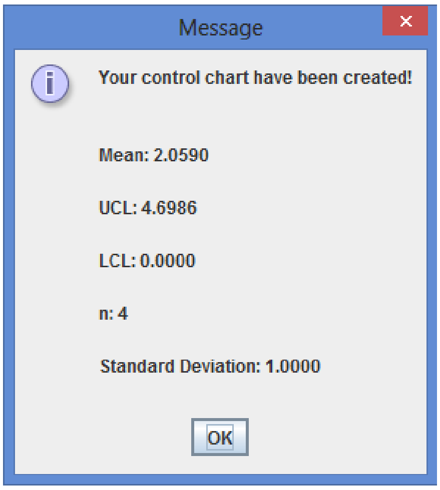

Figure 21: R Chart

3.7.1 Normal Dataset

For our first analysis, we generated a dataset emulating a process under control in order to analyse the probability of false alarm of each one of the three charts we are using, and also compare it with the theoretical alpha given as an input to the program, analysing the precision of the statistical calculations made in the program and the Excel simulation.

The results of the interactions with the software are listed below:

R CONTROL CHART	Interaction										
Statistic	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
Points out of control limits	6	13	5	9	11	8	8	7	10	11	**8.8**
First point out of control	144	92	526	77	143	12	26	171	179	10	**138.0**
ARL	167	76.9	200	111	90.9	125	125	143	100	90.9	**122.9**
First warning	6	13	5	9	11	11	15	23	10	10	**11.3**
Total number of warnings	189	259	170	228	241	244	243	217	248	223	**226.2**

Table 1: Results of R CC, Normal

X1 CONTROL CHART	Interaction										
Statistic	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
Points out of control limits	0	3	1	2	0	1	1	1	0	0	**0.9**
First point out of control	0	257	614	173	0	959	898	865	0	0	**376.6**
ARL	1000	333	1000	500	1000	1000	1000	1000	1000	1000	**883.3**
First warning	8	11	47	11	11	13	38	17	1	51	**20.8**
Total number of warnings	141	143	139	111	122	127	100	106	93	167	**124.9**

Table 2: Results of X1 CC, Normal

X2 CONTROL CHART	Interaction										
Statistic	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
Points out of control limits	1	3	3	3	0	1	4	1	0	1	**1.7**
First point out of control	634	257	287	157	0	959	325	865	0	53	**353.7**
ARL	1000	333	333	333	1000	1000	250	1000	1000	1000	**725.0**
First warning	8	11	47	11	11	13	31	17	105	43	**29.7**
Total number of warnings	154	156	142	122	130	136	112	109	101	180	**134.2**

Table 3: Results of X2 CC, Normal

As we can see, the out of control points for the X charts are by far less than the ones in the R chart, this proves that the alpha used in the X Charts is much lower and that the type I error probability using X charts is much lower.

Also, the points out of the control limits are not the principal warning given by the program, it shows that the application of the western Electric rules are the principal driver for the detection of the out of control data.

3.7.2 Dataset with Simultaneous Shift in Mean and Increase of Variability

As it was done with the normal dataset, ten sets of data, each one with one thousand observations were introduced in the software in each one of the three control charts used during the development of this work, the main goal of this scenario is to analyse the average time taken by each one of the charts before finding the change in the process parameters, this is why only the "First out of control pointl" statistic is analysed, this means, how many observations were necessary after the parameters changed (the shift occurred from the first point in this case) in order to have an out of control point.

The results of the interactions with the software are listed below:

R CONTROL CHART	Interaction										
Statistic	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
Points out of control limits	7	13	2	4	8	6	4	7	6	6	**6.3**
First point out of control	51	182	174	6	198	10	50	193	77	15	**95.6**
ARL	143	579	500	250	125	169	250	143	167	167	**249.0**
First warning	23	21	48	6	11	10	30	10	13	13	**18.5**
Total number of warnings	197	182	158	144	173	187	182	213	213	259	**190.8**

Table 4: Results of R CC, simultaneous shift in mean

X1 CONTROL CHART	Interaction										
Statistic	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
Points out of control limits	12	13	12	19	15	18	9	23	15	15	**15.1**
First point out of control	84	194	25	1	135	39	221	5	91	89	**88.4**
ARL	83.3	76.8	83.3	52.6	66.6	55.5	111	43.4	66.6	66.6	**70.6**
First warning	11	10	8	1	14	6	11	5	11	7	**8.4**
Total number of warnings	651	690	647	810	709	656	706	642	730	670	**691.1**

Table 5: Results of X1 CC, simultaneous shift in mean

X2 CONTROL CHART	Interaction										
Statistic	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
Points out of control limits	22	20	22	32	19	27	18	33	22	21	**23.6**
First point out of control	18	193	1	1	65	25	102	3	91	89	**58.8**
ARL	45.4	50	45.4	31.2	52.6	37	55.5	30.3	45.4	47.6	**44.0**
First warning	11	10	1	1	14	6	11	3	11	7	**7.5**
Total number of warnings	664	696	657	816	719	672	724	662	744	693	**704.7**

Table 6: Results of X2 CC, simultaneous shift in mean

As we can see, the software shows exactly what was said in the literature review, this kind of control charts are not effective when it comes to find small shifts in the mean or increases in the standard deviation, however, a best result is shown when instead of taking into account the first point out of control for the decision making, the warnings of the program are taken into account, the stats improve significantly, so, in this case, it's important in order to find any change, take into account also the warnings given by the software, in other words, it is also important the Western Electric Rules to be taken into account.

3.7.3 Increasing Trend Dataset

Finally, an increasing trend dataset was analysed, where both the mean and the standard deviation increased between each observation in a rate of o.2%, in this case, the idea was to analyse the time necessary to detect this kind of behaviour in each of the control charts studied, this will depend on the power of each one of the charts used and the sensibility to detect this kind of change in each case.

The results of the interactions with the software are listed below:

R CONTROL CHART	Interaction										
Statistic	1	2	3	4	5	6	7	8	9	10	Mean
Points out of control limits	17.0	20.0	9.0	18.0	14.0	12.0	15.0	14.0	14.0	16.0	**14.9**
First point out of control	150.0	109.0	148.0	314.0	105.0	257.0	262.0	192.0	192.0	99.0	**182.8**
ARL	58.8	50.0	111.1	55.6	71.4	83.3	66.7	71.4	71.4	62.5	**70.2**
First warning	6.0	31.0	12.0	21.0	30.0	31.0	26.0	9.0	9.0	23.0	**19.8**
Total number of warnings	240.0	305.0	199.0	242.0	257.0	306.0	235.0	231.0	231.0	215.0	**246.1**

Table 7: Results of R CC, Increasing Trend Dataset

X1 CONTROL CHART	Interaction										
Statistic	1	2	3	4	5	6	7	8	9	10	Mean
Points out of control limits	982.0	979.0	981.0	984.0	980.0	978.0	982.0	984.0	985.0	981.0	**981.6**
First point out of control	12.0	16.0	15.0	15.0	12.0	14.0	13.0	13.0	14.0	20.0	**14.4**
ARL	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	**1.0**
First warning	11.0	11.0	11.0	10.0	12.0	9.0	12.0	6.0	14.0	11.0	**10.7**
Total number of warnings	990.0	990.0	990.0	990.0	987.0	992.0	989.0	990.0	987.0	990.0	**989.5**

Table 8: Results of X1 CC,Increasing Trend Dataset

X2 CONTROL CHART	Interaction										
Statistic	1	2	3	4	5	6	7	8	9	10	Mean
Points out of control limits	984.0	979.0	982.0	985.0	982.0	980.0	983.0	984.0	986.0	983.0	**982.8**
First point out of control	12.0	16.0	15.0	15.0	12.0	14.0	13.0	13.0	14.0	11.0	**13.5**
ARL	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	**1.0**
First warning	11.0	11.0	11.0	9.0	12.0	9.0	11.0	6.0	14.0	11.0	**10.5**
Total number of warnings	990.0	990.0	990.0	991.0	987.0	992.0	990.0	990.0	987.0	990.0	**989.7**

Table 9: Results of X2 CC,Increasing Trend Dataset

As we can see in this case, even when the mean and the standard distribution suffers the same increase, the X chart is much better for detecting the trend than the R chart and even a small change of 1% or 2% is detected in a very fast way, this once again reminds us the importance of using both, the X and the R/S chart.

In terms of ARL there is not much to say because of the constant increase between the observations and the central line which will make it almost impossible after come the interactions, having an observation between the control limits.

4 RESULTS AND ANALYSIS

4.1 Analysis

The results exposed present significant information on how the software would help in the implementation of the Statistical Process Control in an Industry.

First of all the software provides the relevant information for the creation of control chart such as the control limits and plot the behaviour of a dataset, this last part includes a warning message of the possible errors and points the data where the error is detecting, helping the user to analyse the former behaviour of the process and the message details provide enough information for detecting the assignable causes once these causes are corrected and these points can be eliminated, it is possible to run the program again inserting more data, and repeating the process of detection again.

The repetition gets easier every time due to the possibility of saving data on the software and allowing the correction of data to compare with historical control charts.

The results also reveals that type of data that is better to introduce in order to achieve better results, going through to the three different types of dataset and using X, R and S chart we can determinate that in the first scenario we have the best performance of the software; this is because we are using Shewhart control charts and this chart works pretty well with this type of dataset.

Even if, the total number of points out of the control limits were low, and can be detected straight away on the chart the relevant contribution is the detection of an average of 190.8 warnings of odd behaviour of the process that could be originated by assignable causes, this is just on the R control chart. Besides, the detection done on both X Control chart is of 124, 9 and 134.2

respectively, although the point out of the control limits are in average less than 1,7.

In the second dataset that present a shift on the mean and increase of variability, the software did a proper detection of the points that were out of control with an average detection of errors of the 190.8 and with just 6,3 in average of points out of the control limits. This information is pertinent to notice because it shows that the software is not just detecting points out of the control limits, thus Easy CC software is detecting the points that are a risk for the performance of the process and we have to remain that the develop of the program is based on historical data, this provides that every time that data is upload, the program performance improves.

In the third dataset an increasing of trend and the control chart developed by Easy C.C. was used showing this behaviour, verifying how the program is plotting the points in the proper way, this results were also obtained in the other two dataset. Also, the sensibility of detection changed in each case highlighting the sensibility in the X control chart rather than the R chart.

4.2 Limitations of the software

The software has some significant limitations; the first one is that it cannot be used in a process that requires a detection of a general multivariate shift in the mean vector, also for detecting such small permanent shifts that may go undetected when using the X- chart. Moreover, in case to have process and SPC programs that have the following characteristics:

- Charts for Non-Normal Data.
- Unequal Sample Sizes, which means that the samples plotted in the control chart, are not of equal size, and then the control limits around the centre line cannot be represented by a straight line. (Montgomery, 2011)
- Control Chart for Individual Observations.

- X-bar Charts for Non-Normal Data.
- And other processes that not fulfil the basic assumptions done by the Shewhart control charts such as normality.

4.3 Software Use

Basically the use of the software is for the phase I of SPC, however for this kind of process which fulfils the requirements for the Shewhart control charts when the process has a clear data that can be monitored by this CC, the use of the software is recommendable, because it will allow to identify any shift on the process, reducing variability, however if after phase I the process is positioned in the limitation zone of the software, it means that the process has the characteristics mentioned above, it is highly recommendable to search for another control chart more suitable for the type of process.

5 CONCLUSION

As seen in the theory, Shewhart control charts are not much effective when it comes to detect small shifts in the mean, especially if they are being used separately, as it was said in the literature review, some other kind of control chart is recommended in these cases, such as CUSUM or EWMA that were explained above, however for phase I of the SPC, Shewhart charts are the perfect tool for work, due to the easiness of their interpretation and the facilities for using.

Shewhart control charts can be very efficient in the detection of an any kind of trend inside a process mean, in this cases, especially if the x chart is being used, the ATS can be very low depending of course on the slope of the trend.

Besides, Shewhart control charts are really useful in phase I which is the implementation of SPC, as it was mention before by Montgomery (2009)that in this phase the process is likely to be out of control and experiencing assignable causes that result in large shifts in the monitored parameters. For this reason, the program has a high number of warnings message in every iteration of the testing part, however this represents that the EASY CC is functioning and that the objective of detecting the out of control points is done.

Moreover, these charts are very useful in the diagnostic aspects of bringing an unruly process into statistical control, because the patterns on these charts often provide guidance regarding the nature of the assignable cause. It makes the job easier for the operators using the analysis done by the software discovers the assignable cause that affect the process.

Certain differences between the expected alpha and the actual alpha of our simulation can be attributed to the low number of experiments made (10 for each situation) and also the number of observations (1000) that in much cases didn't allow the program to generate more than one observation out of the control limits, on the other hand the difference also could be due to the random data generation code used by excel, more statistical oriented software such as arena is recommended for next data generation.

With the implementation of user friendly statistical quality control software, the operative part of an enterprise can monitor the status of any process in the enterprise, paying attention to warning messages and reporting peculiar behaviour.

Also, after analysing the results giving by the software we conclude that x control charts are more sensible to small changes in the mean than r and s charts to small changes on the standard deviation.

Even if we can use this software for the control it means for the second phase, we have to keep in mind that the program managed shewharts chart, which has certain bias for other types of dataset and different process, for example this program is not useful for medical usage due to the small shift that a process in this area can suffer, the software would not be able to detect it with a short ATS, creating a risk on the statistical stability of the process.

In the above case an excellent choice is CUSUM charts because they are used when the objective is to control a characteristic to a target value by making necessary process adjustments; furthermore this control chart is recommended mainly when a process mean shift needs to be detected fast.

Also, Montgomery (2009) explain the case of plotting the cumulative sum of deviations of successive sample means from a target specification, permanent shifts in the process mean will eventually lead to a sizable cumulative sum of deviations. Consequently, CUSUM chart is more suitable for detecting such small permanent shifts that may go undetected when using the X-bar chart.

Moreover, most of the process manage a multivariable datasets and just can be analysed wit this program, if the variables are not correlates and it is defined as a unique variable per each iteration.

The charts mentioned above have important features that allow the industry to implement SPC, however it is important adequate the control charts to the type of industry and the level of quality that need to be reached, these charts have important differences among them, which makes them suitable in certain cases, not all industries can use the same chart.

Furthermore, we conclude from the development of the software that the detection of possible out of control data does not work, if there is not an appropriate analyst for the results of the graph, warning, and the statistics parameters, the software is a good tool in the identification of the out of control points and also the information that provide is important on the decision process, but the interpretation of the general situation in a proper way can just be managed by a qualified analyst.

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7 APPENDICES

7.1 Appendix 1: tables of d2 and d3

Factors for Constructing Variables Control Charts

Observations in Sample, n	Chart for Averages: Factors for Control Limits			Chart for Averages: Factors for Center Line		Chart for Standard Deviations: Factors for Control Limits				Chart for Ranges: Factors for Center Line		Chart for Ranges: Factors for Control Limits				
	A	A_2	A_3	c_4	$1/c_4$	B_3	B_4	B_5	B_6	d_2	$1/d_2$	d_3	D_1	D_2	D_3	D_4
2	2.121	1.880	2.659	0.7979	1.2533	0	3.267	0	2.606	1.128	0.8865	0.853	0	3.686	0	3.267
3	1.732	1.023	1.954	0.8862	1.1284	0	2.568	0	2.276	1.693	0.5907	0.888	0	4.358	0	2.574
4	1.500	0.729	1.628	0.9213	1.0854	0	2.266	0	2.088	2.059	0.4857	0.880	0	4.698	0	2.282
5	1.342	0.577	1.427	0.9400	1.0638	0	2.089	0	1.964	2.326	0.4299	0.864	0	4.918	0	2.114
6	1.225	0.483	1.287	0.9515	1.0510	0.030	1.970	0.029	1.874	2.534	0.3946	0.848	0	5.078	0	2.004
7	1.134	0.419	1.182	0.9594	1.0423	0.118	1.882	0.113	1.806	2.704	0.3698	0.833	0.204	5.204	0.076	1.924
8	1.061	0.373	1.099	0.9650	1.0363	0.185	1.815	0.179	1.751	2.847	0.3512	0.820	0.388	5.306	0.136	1.864
9	1.000	0.337	1.032	0.9693	1.0317	0.239	1.761	0.232	1.707	2.970	0.3367	0.808	0.547	5.393	0.184	1.816
10	0.949	0.308	0.975	0.9727	1.0281	0.284	1.716	0.276	1.669	3.078	0.3249	0.797	0.687	5.469	0.223	1.777
11	0.905	0.285	0.927	0.9754	1.0252	0.321	1.679	0.313	1.637	3.173	0.3152	0.787	0.811	5.535	0.256	1.744
12	0.866	0.266	0.886	0.9776	1.0229	0.354	1.646	0.346	1.610	3.258	0.3069	0.778	0.922	5.594	0.283	1.717
13	0.832	0.249	0.850	0.9794	1.0210	0.382	1.618	0.374	1.585	3.336	0.2998	0.770	1.025	5.647	0.307	1.693
14	0.802	0.235	0.817	0.9810	1.0194	0.406	1.594	0.399	1.563	3.407	0.2935	0.763	1.118	5.696	0.328	1.672
15	0.775	0.223	0.789	0.9823	1.0180	0.428	1.572	0.421	1.544	3.472	0.2880	0.756	1.203	5.741	0.347	1.653
16	0.750	0.212	0.763	0.9835	1.0168	0.448	1.552	0.440	1.526	3.532	0.2831	0.750	1.282	5.782	0.363	1.637
17	0.728	0.203	0.739	0.9845	1.0157	0.466	1.534	0.458	1.511	3.588	0.2787	0.744	1.356	5.820	0.378	1.622
18	0.707	0.194	0.718	0.9854	1.0148	0.482	1.518	0.475	1.496	3.640	0.2747	0.739	1.424	5.856	0.391	1.608
19	0.688	0.187	0.698	0.9862	1.0140	0.497	1.503	0.490	1.483	3.689	0.2711	0.734	1.487	5.891	0.403	1.597
20	0.671	0.180	0.680	0.9869	1.0133	0.510	1.490	0.504	1.470	3.735	0.2677	0.729	1.549	5.921	0.415	1.585
21	0.655	0.173	0.663	0.9876	1.0126	0.523	1.477	0.516	1.459	3.778	0.2647	0.724	1.605	5.951	0.425	1.575
22	0.640	0.167	0.647	0.9882	1.0119	0.534	1.466	0.528	1.448	3.819	0.2618	0.720	1.659	5.979	0.434	1.566
23	0.626	0.162	0.633	0.9887	1.0114	0.545	1.455	0.539	1.438	3.858	0.2592	0.716	1.710	6.006	0.443	1.557
24	0.612	0.157	0.619	0.9892	1.0109	0.555	1.445	0.549	1.429	3.895	0.2567	0.712	1.759	6.031	0.451	1.548
25	0.600	0.153	0.606	0.9896	1.0105	0.565	1.435	0.559	1.420	3.931	0.2544	0.708	1.806	6.056	0.459	1.541

For $n > 25$.

$$A = \frac{3}{\sqrt{n}} \quad A_3 = \frac{3}{c_4\sqrt{n}} \quad c_4 \cong \frac{4(n-1)}{4n-3}$$

$$B_3 = 1 - \frac{3}{c_4\sqrt{2(n-1)}} \quad B_4 = 1 + \frac{3}{c_4\sqrt{2(n-1)}}$$

$$B_5 = c_4 - \frac{3}{\sqrt{2(n-1)}} \quad B_6 = c_4 + \frac{3}{\sqrt{2(n-1)}}$$

7.2

Table 10: d2 and d3, Montgomery 2011, Applied Statistics Probability

7.3 Appendix 2:Software code

```
import java.awt.BasicStroke;
  import java.awt.BorderLayout;
  import java.awt.Color;
  import java.awt.Dimension;
  import java.awt.FlowLayout;
  import java.awt.Font;
  import java.awt.Graphics;
  import java.awt.Graphics2D;
  import java.awt.event.*;
  import java.io.BufferedReader;
  import java.io.File;
  import java.io.FileReader;
  import javax.swing.*;
  import jsc.distributions.Normal;
  import javax.swing.ImageIcon;
  import javax.swing.filechooser.FileNameExtensionFilter;
  public class Prueba_21 {
     JFrame frame;
     JFrame newcc;
     JFrame newxcc;
     JFrame newrcc;
     JFrame newccc;
     JTextField xmean;
     JTextField xdeviation;
     JTextField xalpha;
     JTextField xupalpha;
     JTextField xlowalpha;
     JTextField xbeta;
     JTextField xshift;
     JRadioButton centered;
     JRadioButton uncentered;
     JRadioButton betalevel;
     JRadioButton newccx;
     JRadioButton newccr;
     JRadioButton newccs;
     JRadioButton newccc1;
     double [] d2;
```

```
double [] s4;
double [] D4;
double [] D3;
JRadioButton stdev;
JRadioButton range;
JTextField rstdev;
JTextField rrange;
JTextField cmean;
JTextField cdeviation;
JTextField cn;
JTextField cUCL;
JTextField cLCL;
boolean rs;
int tipo;
double cantidad;
CC controlchart=new CC(0,0,0,0,0);
double fsup=0;
int grupo=1;
JButton next;
JButton previous;
JLabel indicador;
boolean mostrar=true;
int errores=0;
String[] errors;
int[] outbounds;
  public class CC {
  double mean;
  double LCL;
  double UCL;
  int n;
  double deviation;
  double puntos[];
  public int getsize(){
     int j=-1;
      do {
         j=j+1;
                     }   while(controlchart.puntos[j]>0.00001);
    return j;
  }
public CC(double CCmean,double CCLCL,double CCUCL,int CCn, double dev) {
    mean=CCmean;
    LCL=CCLCL;
    UCL=CCUCL;
    n=CCn;
    deviation=dev;
```

```
     puntos=new double[1000];
   }
   }
   public static void main (String[] args){
Prueba_21 principal=new Prueba_21();
      principal.createprincipal();
}
   public void createprincipal(){
   frame=new javax.swing.JFrame();
      frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
      frame.setSize(900, 500);
      frame.setVisible(true);
      frame.setResizable(false);
      JMenuBar menubar = new javax.swing.JMenuBar();
      JMenu file = new javax.swing.JMenu("File");
      JMenu edit = new javax.swing.JMenu("Edit");
      JMenuItem createcc=new javax.swing.JMenuItem("Create new CC");
      JMenuItem open=new javax.swing.JMenuItem("Open...");
      JMenuItem cut=new javax.swing.JMenuItem("Copy");
      file.add(open);
      file.add(createcc);
      edit.add(cut);
      menubar.add(file);
      menubar.add(edit);
     JButton nuevo=new JButton("New C.C.     ");
      nuevo.setVisible(true);
      nuevo.setIcon(new ImageIcon("C:\\images\\new1.png"));
      nuevo.setSize(40, 40);
      JButton abrir=new JButton("Open C.C.    ");
      abrir.setVisible(true);
      abrir.setIcon(new ImageIcon("C:\\images\\open1.png"));
      abrir.setSize(20, 20);
      JButton guardar=new JButton("   Save C.C   ");
      guardar.setVisible(true);
      guardar.setIcon(new ImageIcon("C:\\images\\save1.png"));
guardar.setSize(20, 20);
      JLabel primero=new JLabel(" ");
      JLabel primero1=new JLabel(" ");
      JLabel primero2=new JLabel(" ");
      JLabel primero3=new JLabel(" ");
      JLabel primero4=new JLabel(" ");
      JLabel primero5=new JLabel(" ");
      JLabel primero6=new JLabel(" ");
      JLabel primero7=new JLabel(" ");
      JLabel primero8=new JLabel(" ");
```

```
        JLabel primero9=new JLabel(" ");
        JLabel primero10=new JLabel(" ");
        JLabel primero11=new JLabel(" ");
        JLayeredPane izquierda=new JLayeredPane();
        izquierda.setLayout(new BoxLayout(izquierda, BoxLayout.Y_AXIS));
izquierda.add(primero1);
        izquierda.add(nuevo);
        izquierda.add(primero4);
        izquierda.add(primero5);
        izquierda.add(primero6);
        izquierda.add(primero7);
        izquierda.add(abrir);
        izquierda.add(primero8);
        izquierda.add(primero9);
        izquierda.add(primero10);
        izquierda.add(primero11);
        izquierda.add(guardar);
JButton agregar1=new JButton("Add sample mean");
        agregar1.setVisible(true);
        agregar1.setIcon(new ImageIcon("C:\\images\\add1.png"));
        agregar1.setSize(40, 40);
        JButton agregar2=new JButton("  Add sample data ");
        agregar2.setVisible(true);
        agregar2.setIcon(new ImageIcon("C:\\images\\add1.png"));
        agregar2.setSize(20, 20);
        JButton cerrar=new JButton("          Close              ");
        cerrar.setVisible(true);
        cerrar.setIcon(new ImageIcon("C:\\images\\close1.png"));
        cerrar.setSize(20, 20);
        JLabel primero12=new JLabel(" ");
        JLabel primero13=new JLabel(" ");
JLabel primero14=new JLabel(" ");
        JLabel primero15=new JLabel(" ");
        JLabel primero16=new JLabel(" ");
        JLabel primero17=new JLabel(" ");
        JLabel primero18=new JLabel(" ");
        JLabel primero19=new JLabel(" ");
        JLabel primero20=new JLabel(" ");
        JLabel primero21=new JLabel(" ");
        JLabel primero22=new JLabel(" ");
        JLabel primero23=new JLabel(" ");
JLayeredPane derecha=new JLayeredPane();
        derecha.setLayout(new BoxLayout(derecha, BoxLayout.Y_AXIS));
derecha.add(primero15);
        derecha.add(agregar1);
```

```
derecha.add(primero16);
derecha.add(primero17);
derecha.add(primero18);
derecha.add(primero19);
derecha.add(agregar2);
derecha.add(primero20);
derecha.add(primero21);
derecha.add(primero22);
derecha.add(primero23);
derecha.add(cerrar);
JTextPane central=new JTextPane();
next=new JButton(" ");
next.setIcon(new ImageIcon("C:\\images\\next1.png"));
next.setVisible(true);
next.setEnabled(false);
previous=new JButton(" ");
previous.setIcon(new ImageIcon("C:\\images\\prev1.png"));
previous.setVisible(true);
previous.setEnabled(false);
JLayeredPane abajo=new JLayeredPane();
JLabel separador=new JLabel("
");
indicador=new JLabel(" 0 / 0 ");
abajo.setLayout(new BoxLayout(abajo,BoxLayout.X_AXIS));
abajo.add(separador);
abajo.add(previous);
abajo.add(indicador);
abajo.add(next);
abajo.setVisible(true);
JLayeredPane ayudante=new JLayeredPane();
JLabel hueco=new JLabel(" ");
ayudante.setLayout(new BorderLayout());
ayudante.add(hueco,BorderLayout.SOUTH);
ayudante.add(abajo,BorderLayout.CENTER);
frame.add(ayudante,BorderLayout.SOUTH);
ayudante.setVisible(true);
next.addActionListener(new cambiargrafico2());
previous.addActionListener(new cambiargrafico());
frame.add(izquierda, BorderLayout.WEST);
frame.add(derecha, BorderLayout.EAST);
JLayeredPane arriba=new JLayeredPane();
arriba.setLayout(new BoxLayout(arriba,BoxLayout.Y_AXIS));
JLabel expacio=new JLabel(" ");
JLabel expacio2=new JLabel(" ");
arriba.add(expacio);
```

```
        arriba.add(expacio2);
        arriba.setVisible(true);
    frame.add(arriba,BorderLayout.NORTH);
        agregar1.addActionListener(new addmean());
        nuevo.addActionListener(new CreatenewccListener());
        createcc.addActionListener(new CreatenewccListener());
        cerrar.addActionListener(new closeall());
        cerrar.setVisible(true);
        agregar2.addActionListener(new evaluateall());
        frame.setJMenuBar(menubar);
        menubar.setVisible(true);
        frame.revalidate();
      }
        class CreatenewccListener implements ActionListener{
        public void actionPerformed (ActionEvent event){
         newcc = new javax.swing.JFrame();
        JLabel labelnewcc=new javax.swing.JLabel("                              Create new Control Chart",
SwingConstants.CENTER);
        JLabel labelnewcc2=new javax.swing.JLabel("  ");
    newccx = new javax.swing.JRadioButton("Create new X control chart");
     newccr = new javax.swing.JRadioButton("Create new R control chart");
    newccs = new javax.swing.JRadioButton("Create new S control chart");
        newccc1 = new javax.swing.JRadioButton("Create new Custom control chart");
        newccx.setSelected(true);
        JButton accept=new javax.swing.JButton("Accept");
        JButton cancel=new JButton("Cancel");
        JLayeredPane botones=new JLayeredPane();
        botones.setLayout(new FlowLayout(FlowLayout.RIGHT));
        botones.add(cancel);
        botones.add(accept);
        JLayeredPane newccpane = new javax.swing.JLayeredPane();
        newccpane.setLayout(new BoxLayout(newccpane,BoxLayout.Y_AXIS));
        newccpane.add(newccx);
        newccpane.add(newccr);
        newccpane.add(newccs);
        newccpane.add(newccc1);
        ButtonGroup grupobotones= new ButtonGroup();
        grupobotones.add(newccx);
        grupobotones.add(newccr);
        grupobotones.add(newccs);
        grupobotones.add(newccc1);
        newcc.add(BorderLayout.CENTER,newccpane);
        JLayeredPane apoyo=new javax.swing.JLayeredPane();
        apoyo.setLayout(new BoxLayout(apoyo,BoxLayout.Y_AXIS));
        apoyo.add(labelnewcc);
```

```
        apoyo.add(labelnewcc2);
        newcc.add(BorderLayout.NORTH,apoyo);
        newcc.setBounds(200, 200, 320, 230);
        newcc.setVisible(true);
        newcc.setResizable(false);
        newcc.add(BorderLayout.SOUTH,botones);
        frame.setEnabled(false);
        cancel.addActionListener(new cancelnewcc());
        accept.addActionListener(new newcc());
        }
    }
        class newcc implements ActionListener{
    public void actionPerformed(ActionEvent event){
if (newccx.isSelected()==true){
            newxcc();
        }
if (newccr.isSelected()==true){
            creacion();
        }
if (newccs.isSelected()==true){
            creacion2();
            }
if (newccc1.isSelected()==true){
            newccc();
        }
}
}
class cancelnewcc implements ActionListener{
public void actionPerformed(ActionEvent event){
              frame.setEnabled(true);
            frame.setVisible(true);
           try{newcc.dispose();}
            catch (Exception ex){

            }
            try {newxcc.dispose();}
             catch (Exception ex){

            }
            try {newrcc.dispose();}
             catch (Exception ex){
            }
        }
   }
public void newrcc() {
```

```
newrcc = new javax.swing.JFrame();
newrcc.setVisible(true);
newrcc.setBounds(200, 200, 500, 200);
newcc.dispose();
Font fuente=new Font("Helvetiva",Font.BOLD,15);
Font fuente2=new Font("Helvetica",Font.PLAIN,14);
newrcc.setResizable(false);
//PARTE SUPERIOR DEL FRAME//
JLabel labelnewrcc=new JLabel("                    Create new R Control Chart",
SwingConstants.CENTER);
JLabel labelnewrcc2=new javax.swing.JLabel("  ");
labelnewrcc.setFont(fuente);
JLayeredPane arriba2=new JLayeredPane();
arriba2.setLayout(new BoxLayout(arriba2,BoxLayout.Y_AXIS));
arriba2.add(labelnewrcc);
arriba2.add(labelnewrcc2);
newrcc.add(BorderLayout.NORTH, arriba2);

//PARTE DERECHA DEL FRAME//

stdev = new javax.swing.JRadioButton("Use Standard Deviation");
range = new javax.swing.JRadioButton("Use Range R");
stdev.setFont(fuente2);
range.setFont(fuente2);

JLabel espacio=new JLabel(" ");
JLabel espacio3=new JLabel(" ");

ButtonGroup grupobotones= new ButtonGroup();
grupobotones.add(stdev);
grupobotones.add(range);
JLayeredPane derecha=new JLayeredPane();
stdev.setSelected(true);

stdev.addActionListener(new newrcccambio2());
range.addActionListener(new newrcccambio1());

derecha.setLayout(new BoxLayout(derecha, BoxLayout.Y_AXIS));
//derecha.add(espacio2);
derecha.add(espacio3);
derecha.add(stdev);
derecha.add(espacio);
derecha.add(range);
newrcc.add(BorderLayout.EAST,derecha);
//PARTE IZQUIERDA DEL FRAME//
```

```
Dimension dim=new Dimension(50,20);
JLabel stdev1=new javax.swing.JLabel("Standard Deviation      ");
        stdev1.setFont(fuente);
        JLabel range1=new JLabel("Range                    ");
range1.setFont(fuente);
        JLabel espacio5= new JLabel(" ");
        espacio5.setFont(fuente);
        JLabel espacio6= new JLabel(" ");
        espacio6.setFont(fuente);
        JLabel espacio7= new JLabel(" ");
        espacio7.setFont(fuente);
        JLabel espacio8= new JLabel(" ");
        espacio8.setFont(fuente);

rstdev=new JTextField();
        rrange=new JTextField();
        rstdev.setFont(fuente);
        rrange.setFont(fuente);

        JLayeredPane centroizq=new JLayeredPane();
        centroizq.setSize(100, 150);
        JLayeredPane centroder=new JLayeredPane();

        rrange.setEnabled(false);
        centroder.setLayout(new BoxLayout(centroder,BoxLayout.Y_AXIS));

        rstdev.setSize(dim);
        centroder.add(espacio5);
        centroder.add(rstdev);
        rstdev.setMaximumSize(dim);
        centroder.add(espacio8);
        centroder.add(rrange);
        rrange.setMaximumSize(dim);

        centroizq.setLayout(new BoxLayout(centroizq, BoxLayout.Y_AXIS));
        centroizq.add(espacio6);
        centroizq.add(stdev1);
        centroizq.add(espacio7);
        centroizq.add(range1);
        //PARTE INFERIOR DEL FRAME
        JButton accept1=new JButton("Accept");
        JButton cancel1=new JButton("Cancel");
        JLayeredPane abajo=new JLayeredPane();
        abajo.setLayout(new FlowLayout(FlowLayout.RIGHT));
        abajo.add(accept1);
```

```
abajo.add(cancel1);

//AGREGAR TODO//
newrcc.add(BorderLayout.WEST,centroizq);
newrcc.add(BorderLayout.CENTER,centroder);
newrcc.add(BorderLayout.SOUTH,abajo);

int tipo=0;
cancel1.addActionListener(new cancelnewcc());
accept1.addActionListener(new creater());
}
public void newscc() {

newrcc = new javax.swing.JFrame();
newrcc.setVisible(true);
newrcc.setBounds(200, 200, 500, 200);
newcc.dispose();
Font fuente=new Font("Helvetiva",Font.BOLD,15);
Font fuente2=new Font("Helvetica",Font.PLAIN,14);
newrcc.setResizable(false);

//PARTE SUPERIOR DEL FRAME//
JLabel labelnewrcc=new JLabel("                    Create new S Control Chart",
SwingConstants.CENTER);
JLabel labelnewrcc2=new javax.swing.JLabel("  ");
labelnewrcc.setFont(fuente);
JLayeredPane arriba2=new JLayeredPane();
arriba2.setLayout(new BoxLayout(arriba2,BoxLayout.Y_AXIS));
arriba2.add(labelnewrcc);
arriba2.add(labelnewrcc2);
newrcc.add(BorderLayout.NORTH, arriba2);

//PARTE DERECHA DEL FRAME//

stdev = new javax.swing.JRadioButton("Use Standard Deviation");
range = new javax.swing.JRadioButton("Use S stimate");
stdev.setFont(fuente2);
range.setFont(fuente2);

JLabel espacio=new JLabel(" ");
JLabel espacio3=new JLabel(" ");

ButtonGroup grupobotones= new ButtonGroup();
grupobotones.add(stdev);
grupobotones.add(range);
```

```
        JLayeredPane derecha=new JLayeredPane();
        stdev.setSelected(true);

        stdev.addActionListener(new newrcccambio2());
        range.addActionListener(new newrcccambio1());

        derecha.setLayout(new BoxLayout(derecha, BoxLayout.Y_AXIS));
//derecha.add(espacio2);
        derecha.add(espacio3);
        derecha.add(stdev);
        derecha.add(espacio);
derecha.add(range);
newrcc.add(BorderLayout.EAST,derecha);

        //PARTE IZQUIERDA DEL FRAME//

        Dimension dim=new Dimension(50,20);

        JLabel stdev1=new javax.swing.JLabel("Standard Deviation      ");
        stdev1.setFont(fuente);
        JLabel range1=new JLabel("S estimate                    ");
range1.setFont(fuente);
        JLabel espacio5= new JLabel(" ");
        espacio5.setFont(fuente);
        JLabel espacio6= new JLabel(" ");
        espacio6.setFont(fuente);
        JLabel espacio7= new JLabel(" ");
        espacio7.setFont(fuente);
        JLabel espacio8= new JLabel(" ");
        espacio8.setFont(fuente);

rstdev=new JTextField();
        rrange=new JTextField();
        rstdev.setFont(fuente);
        rrange.setFont(fuente);

        JLayeredPane centroizq=new JLayeredPane();
        centroizq.setSize(100, 150);
        JLayeredPane centroder=new JLayeredPane();

        rrange.setEnabled(false);
        centroder.setLayout(new BoxLayout(centroder,BoxLayout.Y_AXIS));

        rstdev.setSize(dim);
        centroder.add(espacio5);
```

```
centroder.add(rstdev);
rstdev.setMaximumSize(dim);
centroder.add(espacio8);
centroder.add(rrange);
rrange.setMaximumSize(dim);

centroizq.setLayout(new BoxLayout(centroizq, BoxLayout.Y_AXIS));
centroizq.add(espacio6);
centroizq.add(stdev1);
centroizq.add(espacio7);
centroizq.add(range1);



//PARTE INFERIOR DEL FRAME
JButton accept1=new JButton("Accept");
JButton cancel1=new JButton("Cancel");
JLayeredPane abajo=new JLayeredPane();
abajo.setLayout(new FlowLayout(FlowLayout.RIGHT));
abajo.add(accept1);
abajo.add(cancel1);

//AGREGAR TODO//
newrcc.add(BorderLayout.WEST,centroizq);
newrcc.add(BorderLayout.CENTER,centroder);
newrcc.add(BorderLayout.SOUTH,abajo);
cancel1.addActionListener(new cancelnewcc());
accept1.addActionListener(new creates());

}

public void newxcc() {

newxcc = new javax.swing.JFrame();
newxcc.setVisible(true);
newxcc.setBounds(200, 200, 400, 400);
newcc.dispose();

//PARTE SUPERIOR DEL FRAME//
JLabel labelnewxcc=new JLabel("                    Create new X Control Chart",
SwingConstants.CENTER);
JLabel labelnewxcc2=new javax.swing.JLabel("  ");
JLayeredPane arriba1=new JLayeredPane();
arriba1.setLayout(new BoxLayout(arriba1,BoxLayout.Y_AXIS));
arriba1.add(labelnewxcc);
```

```
        arriba1.add(labelnewxcc2);

//PARTE DERECHA DEL FRAME//

        centered = new javax.swing.JRadioButton("Centered Process");
        uncentered = new javax.swing.JRadioButton("Uncentered Process");
        betalevel = new javax.swing.JRadioButton("Use Beta Level");
JLabel espacio=new JLabel(" ");
        JLabel espacio2=new JLabel(" ");
        JLabel espacio3=new JLabel(" ");
ButtonGroup grupobotones= new ButtonGroup();
        grupobotones.add(centered);
        grupobotones.add(uncentered);
        JLayeredPane derecha=new JLayeredPane();
        centered.setSelected(true);

        uncentered.addActionListener(new newxcccambio2());
        centered.addActionListener(new newxcccambio1());
        betalevel.addActionListener(new newxcccambio3());

        derecha.setLayout(new BoxLayout(derecha, BoxLayout.Y_AXIS));
derecha.add(espacio2);
        derecha.add(espacio3);
        derecha.add(centered);
        derecha.add(uncentered);
        derecha.add(espacio);
        derecha.add(betalevel);

        //PARTE IZQUIERDA DEL FRAME//

Dimension dim=new Dimension(50,20);

        Font fuente=new Font("Helvetiva",Font.BOLD,15);
        JLabel mean=new javax.swing.JLabel("mean");
        mean.setFont(fuente);
        JLabel deviation=new JLabel("Standard Deviation      ");
        deviation.setFont(fuente);
        JLabel alpha=new JLabel("Alpha Level");
        alpha.setFont(fuente);
        JLabel upalpha=new JLabel("Upper Alpha");
        upalpha.setFont(fuente);
        JLabel lowalpha=new JLabel("Lower Alpha");
        lowalpha.setFont(fuente);
        JLabel beta=new JLabel("Beta Level");
        beta.setFont(fuente);
```

```
JLabel shift=new JLabel("Shift");
shift.setFont(fuente);
JLabel esp1=new JLabel(" ");
JLabel esp2=new JLabel(" ");
JLabel esp3=new JLabel(" ");
JLabel esp4=new JLabel(" ");

xmean=new JTextField();
xdeviation=new JTextField();
xalpha=new JTextField();
xupalpha=new JTextField();
xlowalpha=new JTextField();
xbeta=new JTextField();
xshift=new JTextField();
JLabel xesp1=new JLabel(" ");
JLabel xesp2=new JLabel(" ");
JLabel xesp3=new JLabel(" ");
JLabel xesp4=new JLabel(" ");

JLayeredPane centroizq=new JLayeredPane();
centroizq.setSize(100, 150);
JLayeredPane centroder=new JLayeredPane();

xbeta.setEnabled(false);
xshift.setEnabled(false);
xupalpha.setEnabled(false);
xlowalpha.setEnabled(false);
centroder.setLayout(new BoxLayout(centroder,BoxLayout.Y_AXIS));

mean.setSize(dim);
centroder.add(xmean);
xmean.setMaximumSize(dim);
centroder.add(xdeviation);
xdeviation.setMaximumSize(dim);
centroder.add(xesp1);
centroder.add(xalpha);
xalpha.setMaximumSize(dim);
centroder.add(xesp2);
centroder.add(xupalpha);
xupalpha.setMaximumSize(dim);
centroder.add(xlowalpha);
xlowalpha.setMaximumSize(dim);
centroder.add(xesp3);
centroder.add(xbeta);
xbeta.setMaximumSize(dim);
```

```
            centroder.add(xesp4);
            centroder.add(xshift);
            xshift.setMaximumSize(dim);

            centroizq.setLayout(new BoxLayout(centroizq, BoxLayout.Y_AXIS));
            centroizq.add(mean);
            centroizq.add(deviation);
        centroizq.add(esp1);
            centroizq.add(alpha);
            centroizq.add(esp2);
            centroizq.add(upalpha);
            centroizq.add(lowalpha);
            centroizq.add(esp3);
            centroizq.add(beta);
            centroizq.add(esp4);
        centroizq.add(shift);

            //PARTE INFERIOR DEL FRAME
            JButton accept=new JButton("Accept");
            JButton cancel=new JButton("cancel");
            JLayeredPane abajo=new JLayeredPane();
            abajo.setLayout(new FlowLayout(FlowLayout.RIGHT));
            abajo.add(accept);
            abajo.add(cancel);

            //AGREGAR TODO//
            newxcc.add(BorderLayout.EAST,derecha);
            newxcc.add(BorderLayout.NORTH,arriba1);
            newxcc.add(BorderLayout.WEST,centroizq);
            newxcc.add(BorderLayout.CENTER,centroder);
            newxcc.add(BorderLayout.SOUTH,abajo);

            cancel.addActionListener(new cancelnewcc());
            accept.addActionListener(new createxcc());

          }

          class paintcustom implements ActionListener{
            public void actionPerformed (ActionEvent e){

            controlchart=new
CC(Double.parseDouble(cmean.getText()),Double.parseDouble(cLCL.getText()),
Double.parseDouble(cUCL.getText()),(int)Double.parseDouble(cn.getText()),Double.parseDouble(cdeviati
on.getText()));
```

```
            JOptionPane.showMessageDialog(null, "Your control chart have been created!\n\n\nMean: "+String.format("%.5g%n", controlchart.mean)+"\nUCL: "+String.format("%.5g%n", controlchart.UCL)+"\nLCL: "+String.format("%.5g%n", controlchart.LCL)+"\nn: "+controlchart.n+"\n\nStandard Deviation: "+String.format("%.5g%n", controlchart.deviation)+" \n");
            newccc.setVisible(false);
            frame.setEnabled(true);
            graficar();
            frame.setVisible(true);
            frame.repaint();

            }
        }

        public void newccc() {

            newccc = new javax.swing.JFrame();
            newccc.setVisible(true);
            newccc.setBounds(200, 200, 330, 250);
            newcc.dispose();

            //PARTE SUPERIOR DEL FRAME//
            JLabel labelnewxcc=new JLabel("                    Create new Custom Control Chart", SwingConstants.CENTER);
            JLabel labelnewxcc2=new javax.swing.JLabel("  ");
            JLayeredPane arriba1=new JLayeredPane();
            arriba1.setLayout(new BoxLayout(arriba1,BoxLayout.Y_AXIS));
        arriba1.add(labelnewxcc);
            arriba1.add(labelnewxcc2);

            //PARTE IZQUIERDA DEL FRAME//

            Dimension dim=new Dimension(50,20);

            Font fuente=new Font("Helvetiva",Font.BOLD,15);
            JLabel mean=new javax.swing.JLabel(" Mean");
        mean.setFont(fuente);
            JLabel deviation=new JLabel(" Standard Deviation (Population)");
            deviation.setFont(fuente);
            JLabel n=new JLabel(" n");
            n.setFont(fuente);
            JLabel UCL=new JLabel(" UCL");
            UCL.setFont(fuente);
            JLabel LCL=new JLabel(" LCL");
            LCL.setFont(fuente);
```

```
JLabel esp1=new JLabel(" ");
JLabel esp2=new JLabel(" ");
JLabel esp3=new JLabel(" ");
JLabel esp4=new JLabel(" ");

cmean=new JTextField();
cdeviation=new JTextField();
cn=new JTextField();
cUCL=new JTextField();
cLCL=new JTextField();

JLabel xesp1=new JLabel(" ");
JLabel xesp2=new JLabel(" ");
JLabel xesp3=new JLabel(" ");
JLabel xesp4=new JLabel(" ");

JLayeredPane centroizq=new JLayeredPane();
centroizq.setSize(100, 150);
JLayeredPane centroder=new JLayeredPane();

centroder.setLayout(new BoxLayout(centroder,BoxLayout.Y_AXIS));

mean.setSize(dim);
centroder.add(cmean);
cmean.setMaximumSize(dim);
centroder.add(cdeviation);
cdeviation.setMaximumSize(dim);
centroder.add(xesp1);
centroder.add(cn);
cn.setMaximumSize(dim);
centroder.add(xesp2);
centroder.add(cUCL);
cUCL.setMaximumSize(dim);
centroder.add(cLCL);
cLCL.setMaximumSize(dim);

centroizq.setLayout(new BoxLayout(centroizq, BoxLayout.Y_AXIS));
centroizq.add(mean);
centroizq.add(deviation);
centroizq.add(esp1);
centroizq.add(n);
centroizq.add(esp2);
centroizq.add(UCL);
centroizq.add(LCL);
```

```
//PARTE INFERIOR DEL FRAME

        JButton accept=new JButton("Accept");
        JButton cancel=new JButton("cancel");
        JLayeredPane abajo=new JLayeredPane();
        abajo.setLayout(new FlowLayout(FlowLayout.RIGHT));
        abajo.add(accept);
        abajo.add(cancel);

        //AGREGAR TODO//
        newccc.add(BorderLayout.NORTH,arriba1);
        newccc.add(BorderLayout.WEST,centroizq);
        newccc.add(BorderLayout.CENTER,centroder);
        newccc.add(BorderLayout.SOUTH,abajo);

        cancel.addActionListener(new cancelnewcc());
        accept.addActionListener(new paintcustom());
}

    class createxcc implements ActionListener {

        public void actionPerformed (ActionEvent event){

            CC carta1;

            if (betalevel.isSelected()==false) {

            if (centered.isSelected()==true){

                String n=JOptionPane.showInputDialog("please insert the sample size n you would like to work with \n \n note: a bigger n will increase the possibility of finding shifts in the production");
                int number=Integer.parseInt(n);
              double stdev = Double.parseDouble(xdeviation.getText())/(Math.sqrt(number));
               double mean=Double.parseDouble(xmean.getText());
                double k=-Normal.inverseStandardCdf(Double.parseDouble(xalpha.getText())/2);
             carta1=new CC(mean,mean-stdev*k,mean+stdev*k,number,stdev);
                controlchart=carta1;
              JOptionPane.showMessageDialog(null, "Your control chart have been created!\n\n\nMean: "+String.format("%.5g%n", controlchart.mean)+"\nUCL: "+String.format("%.5g%n", controlchart.UCL)+"\nLCL: "+String.format("%.5g%n", controlchart.LCL)+"\nn: "+controlchart.n+"\n\nStandard Deviation: "+String.format("%.5g%n", controlchart.deviation)+" \n");

           }
           else{
```

```
                String n=JOptionPane.showInputDialog("please insert the sample size n you would like to work with \n \n note: a bigger n will increase the possibility of finding shifts in the production");
                int number=Integer.parseInt(n);

                double stdev = Double.parseDouble(xdeviation.getText())/(Math.sqrt(number));
                double mean=Double.parseDouble(xmean.getText());
                double k1=-Normal.inverseStandardCdf(Double.parseDouble(xupalpha.getText()));
                double k2=-Normal.inverseStandardCdf(Double.parseDouble(xlowalpha.getText()));

                carta1=new CC(mean,mean-stdev*k2,mean+stdev*k1,number, stdev);
                controlchart=carta1;

                JOptionPane.showMessageDialog(null, "Your control chart have been created!\n\n\nMean: "+String.format("%.5g%n", controlchart.mean)+"\nUCL: "+String.format("%.5g%n", controlchart.UCL)+"\nLCL: "+String.format("%.5g%n", controlchart.LCL)+"\nn: "+controlchart.n+"\n\nStandard Deviation: "+String.format("%.5g%n", controlchart.deviation)+" \n");

            }
        }
        if (betalevel.isSelected()==true){

                double shift=Double.parseDouble(xshift.getText());
                  double k;
                  double l;
                  if (shift<0){

                      k=Normal.inverseStandardCdf(Double.parseDouble(xalpha.getText()));
                      l=-Normal.inverseStandardCdf(Double.parseDouble(xbeta.getText()));
                  }
                  else{
                      k=-Normal.inverseStandardCdf(Double.parseDouble(xalpha.getText()));
                      l=Normal.inverseStandardCdf(Double.parseDouble(xbeta.getText()));
                  }
               double stdev = Integer.parseInt(xdeviation.getText());
                double mean=Integer.parseInt(xmean.getText());

                double nteo=(stdev*(k-l)/shift)*(stdev*(k-l)/shift);
                nteo=Math.round(nteo);

                stdev=stdev/Math.sqrt(nteo);

                carta1=new CC(mean,mean-stdev*Math.abs(k),mean+stdev*Math.abs(k),(int)nteo,stdev);
                //double Z=(carta1.UCL-carta1.mean)/carta1.deviation;
```

```
                    //double alphar=-Normal.standardTailProb(Z, true);
                    controlchart=carta1;
                    JOptionPane.showMessageDialog(null, "Your control chart have been created!\n\n\nMean: "+String.format("%.5g%n", controlchart.mean)+"\nUCL: "+String.format("%.5g%n", controlchart.UCL)+"\nLCL: "+String.format("%.5g%n", controlchart.LCL)+"\nn: "+controlchart.n+"\n\nStandard Deviation: "+String.format("%.5g%n", controlchart.deviation)+" \n");

                }
              newxcc.setVisible(false);
                frame.setEnabled(true);
                graficar();
                frame.setVisible(true);
                frame.repaint();

                }
            }

            class creater implements ActionListener  {

                public void actionPerformed (ActionEvent event){

            if(stdev.isSelected()==true){
                tipo=1;
                cantidad=Double.parseDouble(rstdev.getText());
            }

            if(range.isSelected()==true){
            tipo=2;
            cantidad=Double.parseDouble(rrange.getText());
            }
        double r;
            double desviacion;
            String n1=JOptionPane.showInputDialog("please insert the sample size n you would like to work with \n \n note: a bigger n will increase the possibility of finding shifts in the production");
            int n=Integer.parseInt(n1);
            if (tipo==1){
        r=cantidad*d2[Integer.parseInt(n1)];
            desviacion=cantidad;
            }
            else{
            r=cantidad;
            desviacion=cantidad/d2[Integer.parseInt(n1)];
            }

            CC provisional=new CC(r,r*D3[n],D4[n]*r,n,desviacion);
```

```
CC carta1=provisional;
controlchart=carta1;
JOptionPane.showMessageDialog(null, "Your control chart have been created!\n\n\nMean: "+String.format("%.5g%n", controlchart.mean)+"\nUCL: "+String.format("%.5g%n", controlchart.UCL)+"\nLCL: "+String.format("%.5g%n", controlchart.LCL)+"\nn: "+controlchart.n+"\n\nStandard Deviation: "+String.format("%.5g%n", controlchart.deviation)+" \n");

controlchart=carta1;
newrcc.setVisible(false);
frame.setEnabled(true);
graficar();
frame.setVisible(true);
frame.repaint();

  }
}

class creates implements ActionListener  {

    public void actionPerformed (ActionEvent event){

if(stdev.isSelected()==true){
    tipo=1;
    cantidad=Double.parseDouble(rstdev.getText());
    }

if(range.isSelected()==true){
tipo=2;
cantidad=Double.parseDouble(rrange.getText());
}

double r;
double desviacion;
String n1=JOptionPane.showInputDialog("please insert the sample size n you would like to work with \n \n note: a bigger n will increase the possibility of finding shifts in the production");
int n=Integer.parseInt(n1);
if (tipo==1){
r=cantidad*s4[Integer.parseInt(n1)];
desviacion=cantidad;
}
else{
r=cantidad;
desviacion=cantidad/s4[Integer.parseInt(n1)];
}
```

```
CC provisional=new CC(r,r-3*(r/s4[n])*Math.sqrt(1-s4[n]*s4[n]),r+3*(r/s4[n])*Math.sqrt(1-s4[n]*s4[n]) ,n,desviacion);
    CC carta1=provisional;
    controlchart=carta1;
JOptionPane.showMessageDialog(null, "Your control chart have been created!\n\n\nMean: "+String.format("%.5g%n", controlchart.mean)+"\nUCL: "+String.format("%.5g%n", controlchart.UCL)+"\nLCL: "+String.format("%.5g%n", controlchart.LCL)+"\nn: "+controlchart.n+"\n\nStandard Deviation: "+String.format("%.5g%n", controlchart.deviation)+" \n");

    controlchart=carta1;
    newrcc.setVisible(false);
    frame.setEnabled(true);
    graficar();
    frame.setVisible(true);
    frame.repaint();

      }
    }

    public void graficar(){

        JLayeredPane central=new JLayeredPane();

        int j=-1;
          do {
              j=j+1;

              }   while(controlchart.puntos[j]>0.00001);

int largo=j;
        grafico prueba=new grafico();

        frame.add(prueba,BorderLayout.CENTER);

JLayeredPane sup1=new JLayeredPane();
        Font titulo=new Font("Helvetica", Font.BOLD,19);
JLabel nombre= new JLabel("                                    controlchart");
nombre.setFont(titulo);
        JLabel espacio=new JLabel(" ");
        JLabel linea2=new JLabel("                                    Mean: "+String.format("%.5g%n", controlchart.mean)+"        St. Dev: "+String.format("%.5g%n", controlchart.deviation)+"        UCL: "+String.format("%.5g%n", controlchart.UCL)+"        LCL: "+String.format("%.5g%n", controlchart.LCL));
sup1.setLayout(new BoxLayout(sup1, BoxLayout.Y_AXIS));
sup1.add(nombre);
```

```
        sup1.add(espacio);
    sup1.add(linea2);
        sup1.setVisible(true);
        frame.add(sup1, BorderLayout.NORTH);

        prueba.setVisible(true);
        previous.setEnabled(true);
        next.setEnabled(true);
        frame.revalidate();
      }
    class grafico extends JPanel{
       public void paintComponent (Graphics g){

         Graphics2D g2 = (Graphics2D) g;
         double f2=0;

         g2.setColor(new Color(97,140,212));
         g2.fillRect(9, 19, 552, 252);
         g2.setColor(Color.white);
         g2.fillRect(10, 20, 550, 250);
         g2.setStroke(new BasicStroke(2));
         g2.setColor(Color.green);
         g2.drawLine(10, 150, 560, 150);
         g2.setColor(Color.red);
         double u=150+(((controlchart.mean-controlchart.UCL)/controlchart.deviation)*37);
         g2.drawLine(10, (int)u, 560, (int)u);
         double u2=150+(((controlchart.mean-controlchart.LCL)/controlchart.deviation)*37);
         g2.drawLine(10, (int)u2, 560,(int)u2 );

         double z3=150-(150-u)*0.666666;
         double z4=150+(u2-150)*0.6666666;

         g2.setColor(Color.magenta);
         int k;
         for ( k=1; k<31;k=k+1) {

         g2.drawLine(k*18, (int)z3, k*18+10, (int)z3);

         g2.drawLine(k*18, (int)z4, k*18+10,(int)z4 );
         }
         int j=-1;
          do {
            j=j+1;
} while(controlchart.puntos[j]>0.00001);
```

```
int largo=j-10*(grupo-1);
        if (largo>0){
g2.setColor(Color.black);
        g2.setStroke(new BasicStroke(2));
        frame.repaint();

          double          f=Math.min(270,Math.max(20,          150+((controlchart.mean-
controlchart.puntos[0+10*(grupo-1)])/controlchart.deviation)*37));
          if (largo>0){

            g2.drawLine(10, 150, 55, (int)f);
            g2.drawOval(55-2, (int)f-2, 4, 4);
            frame.repaint();
          }
          frame.repaint();

          if (largo>1){
           f=Math.min(270,Math.max(20,                      150+((controlchart.mean-
controlchart.puntos[0+10*(grupo-1)])/controlchart.deviation)*37));
           f2=Math.min(270,Math.max(20,                     150+((controlchart.mean-
controlchart.puntos[1+10*(grupo-1)])/controlchart.deviation)*37));
           g2.drawLine(55, (int) f, 2*55, (int)f2);
           g2.drawOval(2*55-2, (int)f2-2, 4, 4);
          }

          if (largo>2){
           f=Math.min(270,Math.max(20,                      150+((controlchart.mean-
controlchart.puntos[1+10*(grupo-1)])/controlchart.deviation)*37));
           f2=Math.min(270,Math.max(20,                     150+((controlchart.mean-
controlchart.puntos[2+10*(grupo-1)])/controlchart.deviation)*37));
           g2.drawLine(2*55, (int) f, 3*55, (int)f2);
           g2.drawOval(3*55-2, (int)f2-2, 4, 4);
          }

          if (largo>3){
           f=Math.min(270,Math.max(20,                      150+((controlchart.mean-
controlchart.puntos[2+10*(grupo-1)])/controlchart.deviation)*37));
           f2=Math.min(270,Math.max(20,                     150+((controlchart.mean-
controlchart.puntos[3+10*(grupo-1)])/controlchart.deviation)*37));
           g2.drawLine(3*55, (int) f, 4*55, (int)f2);
           g2.drawOval(4*55-2, (int)f2-2, 4, 4);

          }

          if (largo>4){
```

```
f=Math.min(270,Math.max(20,                               150+((controlchart.mean-
controlchart.puntos[3+10*(grupo-1)])/controlchart.deviation)*37));
  f2=Math.min(270,Math.max(20,                              150+((controlchart.mean-
controlchart.puntos[4+10*(grupo-1)])/controlchart.deviation)*37));
  g2.drawLine(4*55, (int) f, 5*55, (int)f2);
  g2.drawOval(5*55-2, (int)f2-2, 4, 4);
}

if (largo>5){
  f=Math.min(270,Math.max(20,                               150+((controlchart.mean-
controlchart.puntos[4+10*(grupo-1)])/controlchart.deviation)*37));
  f2=Math.min(270,Math.max(20,                              150+((controlchart.mean-
controlchart.puntos[5+10*(grupo-1)])/controlchart.deviation)*37));
  g2.drawLine(5*55, (int) f, 6*55, (int)f2);
  g2.drawOval(6*55-2, (int)f2-2, 4, 4);
}

if (largo>6){
  f=Math.min(270,Math.max(20,                               150+((controlchart.mean-
controlchart.puntos[5+10*(grupo-1)])/controlchart.deviation)*37));
  f2=Math.min(270,Math.max(20,                              150+((controlchart.mean-
controlchart.puntos[6+10*(grupo-1)])/controlchart.deviation)*37));
  g2.drawLine(6*55, (int) f, 7*55, (int)f2);
  g2.drawOval(7*55-2, (int)f2-2, 4, 4);
}

if (largo>7){
  f=Math.min(270,Math.max(20,                               150+((controlchart.mean-
controlchart.puntos[6+10*(grupo-1)])/controlchart.deviation)*37));
  f2=Math.min(270,Math.max(20,                              150+((controlchart.mean-
controlchart.puntos[7+10*(grupo-1)])/controlchart.deviation)*37));
  g2.drawLine(7*55, (int) f, 8*55, (int)f2);
  g2.drawOval(8*55-2, (int)f2-2, 4, 4);
}

if (largo>8){
  f=Math.min(270,Math.max(20,                               150+((controlchart.mean-
controlchart.puntos[7+10*(grupo-1)])/controlchart.deviation)*37));
  f2=Math.min(270,Math.max(20,                              150+((controlchart.mean-
controlchart.puntos[8+10*(grupo-1)])/controlchart.deviation)*37));
  g2.drawLine(8*55, (int) f, 9*55, (int)f2);
  g2.drawOval(9*55-2, (int)f2-2, 4, 4);
}
if (largo>9){
```

```
                f=Math.min(270,Math.max(20,                    150+((controlchart.mean-
controlchart.puntos[8+10*(grupo-1)])/controlchart.deviation)*37));
                f2=Math.min(270,Math.max(20,                   150+((controlchart.mean-
controlchart.puntos[9+10*(grupo-1)])/controlchart.deviation)*37));
                g2.drawLine(9*55, (int) f, 10*55, (int)f2);
                g2.drawOval(10*55-2, (int)f2-2, 4, 4);
               }
               }
              indicador.setText("   "+grupo+"   /   "+(int)Math.max(Math.ceil(controlchart.getsize()/10),
grupo));
           }
        }
    class addmean implements ActionListener{
        public void actionPerformed(ActionEvent event){
          double   punto=Double.parseDouble(JOptionPane.showInputDialog("Please   insert   data
mean"));
    int j=-1;
          do {
            j=j+1;

            }   while(controlchart.puntos[j]>0.00001);

    int largo=j;
     controlchart.puntos[largo]=punto;
    double g2=controlchart.getsize();
          double g3=Math.ceil(g2/10);

          grupo=(int)Math.max(g3,1);
    grafico linea=new grafico();
          evaluateone(controlchart.getsize()-1);
    linea.setVisible(true);
          frame.add(linea, BorderLayout.CENTER);
          frame.repaint();

        }
      }

      public String evaluateone(int ultimo){

        int contar;

        String error="";
        int largo=ultimo;
     if (controlchart.puntos[ultimo]>controlchart.UCL || controlchart.puntos[ultimo]<controlchart.LCL){
```

```
if (mostrar==true){

    JOptionPane.showMessageDialog(frame, "You have one point outside the control
limits, your process might be out of control", "WARNING!", JOptionPane.WARNING_MESSAGE);
}
largo=0;
error="You have one point outside the control limits, your process might be out of control";
}

if (largo>2) {

contar=0;
  double j2=(controlchart.mean+((controlchart.UCL-controlchart.mean)*0.6666666));
double j3=controlchart.mean-((controlchart.mean-controlchart.LCL)*0.666666);

if (controlchart.puntos[ultimo]>j2 || controlchart.puntos[ultimo]<j3){
    contar++;
}

if (controlchart.puntos[ultimo-1]>j2 || controlchart.puntos[ultimo-1]<j3){
    contar++;
}

if (controlchart.puntos[ultimo-2]>j2 || controlchart.puntos[ultimo-2]<j3){
contar++;
}

if (contar>1){

    if (mostrar==true){
        JOptionPane.showMessageDialog(frame, "You have "+contar+" out of 3 points
beyond the 2-Sigma limit, your process might be out of control", "WARNING!",
JOptionPane.WARNING_MESSAGE);
    }
    largo=0;
    error="You have "+contar+" out of 3 points beyond the 2-Sigma limit, your process
might be out of control";

}

}

if (largo>4){

contar=0;
```

```
                    if (controlchart.puntos[ultimo]>(controlchart.mean+(controlchart.UCL-controlchart.mean)*0.333333) || controlchart.puntos[ultimo]<controlchart.mean-(controlchart.mean-controlchart.LCL)*0.3333333){
                        contar++;
                    }

                    if (controlchart.puntos[ultimo-1]>(controlchart.mean+(controlchart.UCL-controlchart.mean)*0.333333) || controlchart.puntos[ultimo-1]<controlchart.mean-(controlchart.mean-controlchart.LCL)*0.3333333){
                        contar++;
                    }

                    if (controlchart.puntos[ultimo-2]>(controlchart.mean+(controlchart.UCL-controlchart.mean)*0.333333) || controlchart.puntos[ultimo-2]<controlchart.mean-(controlchart.mean-controlchart.LCL)*0.3333333){
                        contar++;
                    }

                    if (controlchart.puntos[ultimo-3]>(controlchart.mean+(controlchart.UCL-controlchart.mean)*0.333333) || controlchart.puntos[ultimo-3]<controlchart.mean-(controlchart.mean-controlchart.LCL)*0.3333333){
                        contar++;
                    }

                    if (controlchart.puntos[ultimo-4]>(controlchart.mean+(controlchart.UCL-controlchart.mean)*0.333333) || controlchart.puntos[ultimo-4]<controlchart.mean-(controlchart.mean-controlchart.LCL)*0.3333333){
                        contar++;
                    }

                    if (contar>3){
                        if (mostrar==true){
                          JOptionPane.showMessageDialog(frame, "You have "+contar+" out of 5 points beyond the Sigma limit, your process might be out of control", "WARNING!", JOptionPane.WARNING_MESSAGE);
                        }
                        largo=0;
                        error="You have "+contar+" out of 5 points beyond the Sigma limit, your process might be out of control";
            }
            }
            if (largo>9){
                    contar=0;
                    int contar2=0;
```

```
                for (int k=largo-10;k<largo;k++){
                   if (controlchart.puntos[k]<controlchart.mean){
         contar++;
                   }
                }

                for (int k=largo-10;k<largo;k++){
         if (controlchart.puntos[k]>controlchart.mean){
                      contar2++;
                   }
                }

                if (contar>7){
                   if (mostrar==true){
                      JOptionPane.showMessageDialog(frame, "You have "+contar+" out of 10 points over
the chart mean, your process might be out of control", "WARNING!",
JOptionPane.WARNING_MESSAGE);

                   }
                error="You have "+contar+" out of 10 points over the chart mean, your process might be
out of control";
                }
               if (contar2>7){
                   if (mostrar==true){
                      JOptionPane.showMessageDialog(frame, "You have "+contar2+" out of 10 points
under the chart mean, your process might be out of control", "WARNING!",
JOptionPane.WARNING_MESSAGE);

                   }
                error="You have "+contar2+" out of 10 points under the chart mean, your process might
be out of control";
                }
            }
               return error;
               }

            class evaluateall implements ActionListener{
               public void actionPerformed (ActionEvent e){

               JFileChooser elegir=new JFileChooser();
               FileNameExtensionFilter filter = new FileNameExtensionFilter("TEXT FILES", "txt", "text");

               elegir.setFileFilter(filter);
               elegir.showOpenDialog(frame);
```

```
loadfile(elegir.getSelectedFile());

}
}

private void loadfile(File file){
int y2=0;
int y=0;
try{
BufferedReader reader=new BufferedReader(new FileReader(file));
String line=null;
int i=controlchart.getsize();
y=i; while((line=reader.readLine())!=null){ controlchart.puntos[i]=Double.parseDouble(line);
i++;
}
reader.close();
double g2=controlchart.getsize();
double g3=Math.ceil(g2/10);
grupo=(int)g3;
graficar();
y2=i-y;
}catch (Exception e){
JOptionPane.showMessageDialog(centered, "Problem Writing the controlchart");
}
JOptionPane.showMessageDialog(centered, " "+y2+" data points have been succesfully
introduced");
evaluation(y);
}
class cambiargrafico implements ActionListener{
public void actionPerformed(ActionEvent e){
if (grupo>1){
grupo=grupo-1;
}
indicador.setText(" "+grupo+" / "+(int)Math.max(Math.ceil(controlchart.getsize()/10),
grupo));
frame.revalidate();
frame.repaint();

}
}

class cambiargrafico2 implements ActionListener{
public void actionPerformed(ActionEvent e){
double g2=controlchart.getsize();
double g3=Math.ceil(g2/10);
```

```
                if (g3>grupo){
                    grupo++;
                }
                         indicador.setText("  "+grupo+"  /  "+(int)Math.max(Math.ceil(controlchart.getsize()/10),
grupo));
                         frame.revalidate();
                         frame.repaint();

            }
        }
        public void evaluation(int inicio){

            errors=new String[controlchart.getsize()];
            errores=0;
            mostrar=false;
            outbounds=new int[controlchart.getsize()];

            for(int i=inicio; i<controlchart.getsize();i++){
                String error=evaluateone(i);

                    if (!error.equals("")){
        outbounds[errores]=i+1;
                        errors[errores]=error;
                        errores++;
        }
            }
        JOptionPane.showMessageDialog(centered, " "+errores+" points were out of control");
            JFrame estadisticas=new JFrame();
            JLabel ARL=new JLabel("  ARL            ");
            JLabel ATS=new JLabel("  ATS");
            JLabel firstout=new JLabel("  First warning     "+ outbounds[1]);
            JLabel outofcontrol=new JLabel("  Total  number of warnings     "+errores);
            JLayeredPane abajo=new JLayeredPane();
            JLayeredPane arriba=new JLayeredPane();
            arriba.setLayout(new BoxLayout(arriba,BoxLayout.Y_AXIS));
            arriba.add(new JLabel("Data Resume"));
            arriba.add(new JLabel(" "));
            arriba.add(ARL);
            arriba.add(ATS);
            arriba.add(firstout);
            arriba.add(outofcontrol);
            abajo.setLayout(new BoxLayout(abajo,BoxLayout.X_AXIS));
            JButton close=new JButton("Close");
            JButton details=new JButton("Details");
```

```
        abajo.add(details);
        abajo.add(close);
estadisticas.add(arriba,BorderLayout.NORTH);
        estadisticas.add(abajo,BorderLayout.SOUTH);
        estadisticas.setVisible(true);
        estadisticas.setBounds(100, 100, 200, 200);
        estadisticas.setResizable(false);
details.addActionListener(new showdetails());

    mostrar=true;
}
class showdetails implements ActionListener{
        public void actionPerformed(ActionEvent e){
            JFrame temp=new JFrame("Details");
            JLayeredPane izq=new JLayeredPane();
            JLayeredPane der=new JLayeredPane();
            izq.setLayout(new BoxLayout(izq,BoxLayout.Y_AXIS));
            der.setLayout(new BoxLayout(der,BoxLayout.Y_AXIS));
            izq.add(new JLabel("point"));
            der.add(new JLabel("                error"));
            izq.add(new JLabel(" "));
            der.add(new JLabel(" "));

            for (int j=0;j<errores;j++){
                izq.add(new JLabel(" "+outbounds[j]));
                der.add(new JLabel(" "+errors[j]));

            }
            temp.add(izq,BorderLayout.WEST);
            temp.add(der,BorderLayout.EAST);
            temp.setVisible(true);
            temp.repaint();
temp.revalidate();
            temp.setBounds(100,100,600,900);
        }
    }
    //CLASES QUE YA ESTAN COMPLETAMENTE TERMINADAS (NO TOCAR!!!)
    //CLASES QUE YA ESTAN COMPLETAMENTE TERMINADAS (NO TOCAR!!!)
    //CLASES QUE YA ESTAN COMPLETAMENTE TERMINADAS (NO TOCAR!!!)
    //CLASES QUE YA ESTAN COMPLETAMENTE TERMINADAS (NO TOCAR!!!)
    //CLASES QUE YA ESTAN COMPLETAMENTE TERMINADAS (NO TOCAR!!!)
class newxcccambio2 implements ActionListener{
        public void actionPerformed(ActionEvent event){

            xupalpha.setEnabled(true);
```

```
            xlowalpha.setEnabled(true);
            xalpha.setEnabled(false);
            betalevel.setSelected(false);
            betalevel.setEnabled(false);
        }
        }
  class newxcccambio1 implements ActionListener{
        public void actionPerformed(ActionEvent event){

            xupalpha.setEnabled(false);
            xlowalpha.setEnabled(false);
            xalpha.setEnabled(true);
            betalevel.setEnabled(true);
        }
}
class newxcccambio3 implements ActionListener{
        public void actionPerformed(ActionEvent event){
 if (betalevel.isSelected()==true) {
                xbeta.setEnabled(true);
                xshift.setEnabled(true);
            }
            else{
                xbeta.setEnabled(false);
                xshift.setEnabled(false);
            }
        }
    }
class newrcccambio2 implements ActionListener{
        public void actionPerformed(ActionEvent event){
 rstdev.setEnabled(true);
            rrange.setEnabled(false);
 }
    }
    class newrcccambio1 implements ActionListener{
        public void actionPerformed(ActionEvent event){
 rstdev.setEnabled(false);
            rrange.setEnabled(true);
        }
    }
    public void creacion(){
        d2=new double[30];
 d2[2]=1.128;
        d2[3]=1.693;
        d2[4]=2.059;
        d2[5]=2.326;
```

```
        d2[6]=2.534;
        d2[7]=2.704;
        d2[8]=2.847;
        d2[9]=2.970;
        d2[10]=3.078;
        d2[11]=3.173;
d2[12]=3.258;
        d2[13]=3.336;
        d2[14]=3.407;
        d2[15]=3.472;
        d2[16]=3.532;
        d2[17]=3.588;
        d2[18]=3.640;
        d2[19]=3.689;
        d2[20]=3.735;
        d2[21]=3.778;
        d2[22]=3.819;
        d2[23]=3.858;
        d2[24]=3.895;
        d2[25]=3.931;
 D3=new double[30];
        D3[1]=0;
        D3[2]=0;
        D3[3]=0;
        D3[4]=0;
        D3[5]=0;
        D3[6]=0;
        D3[7]=0.76;
        D3[8]=0.136;
        D3[9]=0.184;
        D3[10]=0.223;
        D3[11]=0.256;
        D3[12]=0.284;
        D3[13]=0.308;
        D3[14]=0.329;
        D3[15]=0.348;
        D3[16]=0.364;
        D3[17]=0.379;
        D3[18]=0.392;
        D3[19]=0.404;
        D3[20]=0.414;
        D3[21]=0.425;
        D3[22]=0.434;
        D3[23]=0.443;
        D3[24]=0.452;
```

```
        D3[25]=0.459;
D4=new double [30];
        D4[2]=3.267;
        D4[3]=2.575;
        D4[4]=2.282;
        D4[5]=2.115;
        D4[6]=2.004;
        D4[7]=1.924;
        D4[8]=1.864;
        D4[9]=1.816;
        D4[10]=1.777;
        D4[11]=1.744;
D4[12]=1.716;
        D4[13]=1.692;
        D4[14]=1.671;
        D4[15]=1.652;
        D4[16]=1.636;
        D4[17]=1.621;
        D4[18]=1.608;
        D4[19]=1.596;
        D4[20]=1.586;
        D4[21]=1.575;
        D4[22]=1.566;
        D4[23]=1.557;
        D4[24]=1.548;
        D4[25]=1.541;
newrcc();
}
 public void creacion2(){
s4=new double[30];
        s4[2]=0.7979;
        s4[3]=0.8862;
        s4[4]=0.9213;
        s4[5]=0.9400;
        s4[6]=0.9515;
        s4[7]=0.9594;
        s4[8]=0.965;
        s4[9]=0.9693;
        s4[10]=0.9727;
        s4[11]=0.9754;
        s4[12]=0.9776;
        s4[13]=0.9794;
        s4[14]=0.9810;
        s4[15]=0.9823;
        s4[16]=0.9835;
```

```
            s4[17]=0.9845;
            s4[18]=0.9854;
            s4[19]=0.9862;
            s4[20]=0.9869;
            s4[21]=0.9876;
            s4[22]=0.9882;
            s4[23]=0.9887;
            s4[24]=0.9892;
            s4[25]=0.9896;

            newscc();
    }
        class closeall implements ActionListener{
            public void actionPerformed(ActionEvent event){
    System.exit(0);
            }
        }
        }
```

7.4 Appendix 3: Dataset

Normal			Simultaneous Shifts			Increasing Trends		
Mean	Range	Dev	Mean	Range	Dev	Mean	Range	Dev
399.75	2.499	0.895	403.65	1.462	0.614562	399.903	3.125	1.328
400.69	2.756	1.062	404.24	2.02	0.874074	400.157	1.636	0.7167
400.37	3.347	1.328	403.25	2.197	0.972282	399.063	2.731	1.2417
399.96	0.998	0.425	404.38	2.921	1.19384	400.716	1.326	0.5518
400.58	1.311	0.573	404.09	0.814	0.398125	401.001	0.707	0.3117
399.8	3.951	1.484	403.75	0.572	0.275491	400.92	0.802	0.3585
400.54	3.459	1.416	403.28	1.917	0.877435	400.608	1.899	0.8174
400.04	0.932	0.431	403.47	3.983	1.680178	400.009	4.532	2.0036
399.72	1.603	0.766	404.93	2.026	0.836247	400.304	3.087	1.2879
400.42	2.154	0.88	405.11	3.171	1.467462	401.17	2.012	0.8236
400.1	2.502	1.118	404.33	1.251	0.648378	400.564	3.163	1.3087
400.47	2.521	0.945	404.66	1.741	0.837656	400.457	2.461	1.2082
399.66	1.914	0.712	404.18	2.919	1.226196	400.03	2.968	1.4427
399.23	1.894	0.69	404.19	2.309	1.018593	401.445	3.362	1.4717
399.4	2.144	0.867	403.84	0.908	0.425227	402.014	1.791	0.8409
400.72	1	0.438	404.23	0.786	0.36195	401.08	2.109	0.9415
400.95	1.434	0.552	404.1	1.693	0.805334	400.659	1.3	0.5757
399.48	3.555	1.349	404.32	2.216	1.08471	400.16	3.131	1.3131
400.18	3.887	1.381	403.95	2.636	1.179925	401.043	2.306	0.9461
399.96	3.072	1.406	403.99	1.448	0.616521	400.875	1.048	0.4681
400.24	3.287	1.299	404.51	2.336	1.102631	401.285	2.496	1.0556
399.99	0.846	0.379	403.77	2.656	1.216523	400.275	1.919	0.7985

400.58	1.793	0.649	403.99	2.305	1.069233	400.961	2.364	1.2094
400.56	1.246	0.569	403.74	2.865	1.370355	401.977	2.224	1.0177
399.94	2.187	0.899	403.72	2.022	0.930433	401.987	2.14	0.9535
400.29	0.93	0.407	403.63	1.719	0.752364	401.878	0.803	0.4266
399.85	4.769	1.919	404.12	1.158	0.59446	401.236	3.377	1.4786
399.76	2.644	1.032	404.02	1.555	0.729782	401.392	1.508	0.7133
399.69	3.244	1.388	403.92	2.133	0.911988	402.649	0.996	0.4908
399.47	2.482	0.967	403.37	1.411	0.647407	401.603	1.763	0.9903
399.66	2.732	1.162	404.14	2.923	1.214631	402.289	2.468	1.0834
400.57	3.683	1.515	403.97	2.338	0.984822	402.664	2.773	1.2937
399.78	1.743	0.847	404	1.782	0.944403	402.51	2.755	1.183
400.01	2.545	0.941	403.76	3.882	1.662042	402.325	2.512	1.0742
400.21	1.24	0.594	405.07	2.432	1.13612	402.908	0.542	0.2221
399.19	3.28	1.275	404.26	1.197	0.513267	403.208	2.041	0.9551
400.59	3.112	1.274	404.36	2.346	1.074494	403.223	0.842	0.3794
400.03	2.046	0.897	403.93	1.152	0.538009	403.24	1.867	0.7657
399.49	2.582	1.026	403.8	1.122	0.487621	402.746	3.745	1.6037
400.42	5.63	2.217	403.93	1.636	0.692876	402.821	1.131	0.4679
399.7	2.762	1.018	403.04	3.345	1.640076	403.331	1.815	0.8019
400.19	1.35	0.571	404.1	1.454	0.655247	403.02	2.261	0.928
400.13	1.034	0.372	404.4	1.078	0.489754	403.574	2.025	0.9964
400.36	3.03	1.15	404.26	1.35	0.552845	403.485	1.964	0.8625
399.12	2.202	1.073	403.96	0.529	0.276364	403.666	2.582	1.1507
400.19	3.314	1.467	404.44	1.789	0.735406	403.245	0.676	0.2818
399.74	2.549	1.122	404.11	2.057	0.908749	403.666	1.477	0.6164
400.16	0.887	0.318	404.33	3.146	1.333326	404.232	3.483	1.7655
399.6	2.008	0.773	403.81	2.181	0.955815	403.692	3.442	1.4824
400.1	1.265	0.558	404.09	3.269	1.456508	404.009	1.84	0.8365
400.33	2.482	1.067	404.71	2.059	0.869818	402.91	1.846	0.7844
399.37	1.47	0.529	403.84	4.55	2.017426	404.02	1.61	0.7376
399.66	3.642	1.363	403.98	4.026	1.644437	404.351	1.789	0.7722
400.29	1.469	0.568	402.83	2.816	1.268293	403.411	3.827	1.5897
400.27	1.799	0.677	403.64	3.33	1.505516	404.792	1.746	0.7228
400.84	1.233	0.545	404.72	2.49	1.105444	404.207	2.253	1.0226
400.17	2.671	1.016	403.87	1.812	0.806398	403.628	1.263	0.542
399.97	3.107	1.374	404.48	1.775	0.854167	404.73	1.3	0.6136
400.2	1.689	0.763	404.24	3.602	1.525957	404.347	1.536	0.6797
399.86	1.53	0.622	403.74	2.78	1.178636	404.818	3.144	1.379
399.94	2.315	0.987	404.3	2.488	1.088961	403.847	1.829	0.8378
399.81	2.918	1.214	404.19	2.284	1.00056	404.637	1.774	0.8405
399.98	2.586	0.955	403.95	4.097	1.886381	403.402	1.049	0.4587
400.34	1.963	0.8	403.86	0.922	0.427572	405.512	1.398	0.7638
399.46	1.321	0.579	403.69	3.523	1.501918	405.79	2.727	1.1993

399.49	2.115	0.886	403.82	2.401	0.996955	405.656	2.458	1.1121
399.79	1.722	0.727	404.16	2.073	0.912721	406.112	1.603	0.7869
399.51	2.68	1.024	404.47	1.967	0.891234	404.959	0.839	0.4016
399.82	2.764	1.053	403.79	3.43	1.519627	405.358	2.397	1.1213
399.62	1.186	0.512	404.49	0.693	0.305837	405.745	1.497	0.628
400.58	1.074	0.424	403.88	1.909	0.817255	406.283	1.55	0.7562
400.34	2.417	1.104	404.18	2.012	0.85073	405.956	3.219	1.3438
399.92	2.903	1.156	403.63	0.827	0.39831	405.456	1.398	0.635
400.35	2.778	1.102	402.92	3.371	1.591363	405.876	1.623	0.746
399.71	2.603	1.035	403.69	2.879	1.643306	405.721	2.85	1.2642
400	4.742	1.926	403.94	2.466	1.160337	406.856	1.711	0.8193
399.54	2.295	0.927	404.77	2.072	0.964509	406.536	2.346	1.0252
399.63	2.515	1.059	403.81	2.143	0.948823	406.386	1.832	0.8506
399.54	2.972	1.248	404.69	3.855	1.762661	406.612	1.027	0.4943
399.85	2.101	0.863	403.95	1.967	0.854048	405.906	1.003	0.4657
399.81	2.167	0.815	404.07	0.568	0.25908	406.956	1.448	0.6654
400.71	1.887	0.696	404.08	3.25	1.341492	406.486	2.566	1.1884
399.9	4.151	1.654	403.58	1.486	0.610792	405.27	0.755	0.3452
400.42	1.553	0.612	403.73	2.203	1.03323	406.577	2.613	1.1555
400.08	2.902	1.116	403.93	2.335	1.067334	407.109	2.014	0.9946
400.3	3.875	1.44	404.62	2.364	0.99401	407.251	1.726	0.7449
400.81	1.925	0.773	403.76	2.001	0.917345	407.271	1.588	0.7708
400.2	1.469	0.59	403.55	1.376	0.621258	406.894	1.034	0.5375
400.56	3.739	1.366	403.82	1.337	0.734864	407.007	2.345	1.058
400.3	1.598	0.591	403.72	0.953	0.461215	407.039	3.103	1.4248
399.85	1.738	0.693	404.41	1.111	0.521768	407.39	2.251	1.0317
400.38	2.635	1.062	403.7	2.688	1.234215	407.035	3.319	1.5512
400.19	4.071	1.544	402.86	1.907	0.778927	406.848	1.67	0.8273
400.06	1.704	0.722	404	1.629	0.760176	407.257	1.584	0.7113
400.44	3.612	1.412	402.93	2.939	1.22473	407.549	3.154	1.3061
399.39	4.847	1.972	403.69	2.285	0.933669	407.091	1.233	0.597
400.23	0.854	0.384	404.38	1.618	0.753563	407.143	1.048	0.4415
399.7	2.395	1.039	404.11	1.051	0.524814	407.61	1.358	0.6275
399.74	1.051	0.501	404.05	3.689	1.56763	407.507	4.864	2.016
399.8	2.642	1.138	404.25	3.516	1.447148	407.654	1.186	0.4913
399.84	0.635	0.255	404.12	3.09	1.443917	408.093	2.507	1.0395
400.06	2.477	0.908	403.49	2.011	0.990519	408.66	3.947	1.7277
400.36	1.989	0.885	404.02	3.559	1.490325	407.364	3.101	1.3551
400.36	3.76	1.662	403.96	3.18	1.565357	408.874	1.832	0.7628
400.55	3.045	1.226	404.15	3.248	1.37921	409.15	2.244	1.1189
401.15	2.187	0.908	403.39	1.979	0.887757	409.024	1.536	0.6411
399.53	3.351	1.323	403.64	2.477	1.139693	408.34	3.826	1.8502
399.59	1.423	0.55	404.77	4.363	1.820815	408.994	2.1	1.0183

399.8	0.458	0.185	403.69	0.841	0.377519	408.486	1.756	0.7972
399.71	1.094	0.459	403.5	2.398	1.065499	408.663	1.417	0.5935
400.11	3.072	1.257	404.07	1.786	0.818535	409.377	2.966	1.352
399.59	2.141	0.887	403.24	1.411	0.592689	409.62	1.891	0.8912
399.7	3.177	1.198	403.92	2.213	0.949303	409.297	1.404	0.626
400.36	2.948	1.18	403.31	1.68	0.706208	408.51	3.793	1.6493
400.24	1.997	0.845	404.08	1.899	0.867593	408.789	1.896	0.7966
399.06	1.86	0.83	404.14	0.833	0.377943	409.161	3.32	1.3668
400.75	2.463	0.941	403.59	1.751	0.739583	409.204	2.462	1.1015
400.38	4.232	2.026	404.24	4.549	2.082232	409.632	3.283	1.3984
399.78	3.388	1.332	403.86	1.461	0.60485	409.23	0.613	0.2545
401.18	1.558	0.632	404.15	1.447	0.664498	408.987	4.045	1.8224
400.56	2.083	0.822	403.41	1.996	0.842129	409.819	2.954	1.3395
400.51	1.557	0.641	404.03	0.825	0.348623	408.991	4.678	2.0852
400.28	1.75	0.685	405.25	2.413	1.04397	409.767	4.276	1.7658
399.96	2.361	0.977	403.95	3.755	1.632062	409.614	1.671	0.708
399.77	2.5	1.001	403.82	1.173	0.566585	410.393	1.514	0.6555
399.7	1.991	0.818	403.95	1.671	0.767674	409.665	1.643	0.699
399.01	1.56	0.569	404.97	1.177	0.54328	409.602	0.69	0.3181
400.39	1.566	0.61	403.61	2.076	0.91862	410.452	2.998	1.407
399.58	1.62	0.616	404.6	3.417	1.766539	410.743	0.78	0.3323
400.39	1.578	0.771	403.55	3.698	1.511858	410.742	2.189	0.9801
399.93	2.264	1.022	403.88	0.68	0.324318	410.599	1.457	0.6021
400.88	1.112	0.468	404.61	1.173	0.526599	410.151	1.388	0.6216
398.98	1.392	0.567	404.33	1.959	0.856468	410.66	1.844	0.8406
400.17	1.5	0.54	403.79	2.769	1.304543	410.493	1.52	0.737
399.58	2.544	1.018	404.49	1.902	0.779665	410.502	2.532	1.3033
400.36	4.216	1.591	403.82	0.85	0.406599	410.506	4.235	1.8165
399.84	3.474	1.256	403.92	2.505	1.054982	410.747	2.754	1.2549
399.63	1.488	0.599	403.87	3.101	1.362375	411.192	2.385	1.0602
399.55	1.581	0.716	404.8	4.406	1.941987	411.309	2.057	0.9005
399.87	1.847	0.785	403.59	2.348	1.120856	411.339	1.662	0.6995
399.97	1.725	0.752	404.01	1.027	0.456542	411.34	2.193	1.0178
400.78	3.083	1.344	403.56	1.935	0.796362	411.603	1.737	0.8295
401.01	3.305	1.218	403.93	1.749	0.870046	411.638	2.262	1.0257
400.08	2.385	0.974	402.69	0.487	0.237571	410.68	1.92	0.8036
400.11	4.69	1.784	403.91	1.987	0.891267	412.32	2.258	0.9542
399.81	2.931	1.121	404.09	2.475	1.171682	411.374	2.829	1.1842
399.84	1.645	0.667	404.31	3.343	1.36505	411.917	3.622	1.5434
400.67	3.805	1.706	403.94	2.938	1.321352	411.808	2.219	1.0417
399.24	3.453	1.374	403.9	0.741	0.371244	411.531	0.516	0.2252
400.2	1.543	0.607	404.5	2.123	0.952599	411.496	3.03	1.412
399.92	2.271	0.922	404.63	1.984	1.056361	411.851	1.707	0.8039

400.3	3.596	1.285	404.13	4.303	1.829767	411.591	1.71	0.9782
399.95	2.315	0.976	403.92	2.994	1.283158	411.944	2.01	0.9383
399.36	2.065	0.75	404.2	1.821	0.789666	412.206	1.433	0.6504
399.81	2.9	1.087	404.23	0.766	0.331623	412.081	1.319	0.5602
400.14	1.873	0.764	403.9	1.502	0.704182	412.664	3.625	1.5353
400.86	4.059	1.622	403.46	0.768	0.384735	412.586	1.565	0.6843
399.49	3.041	1.275	403.79	2.457	1.125795	412.791	1.524	0.6827
400.37	0.806	0.29	405.4	0.773	0.336676	412.31	0.696	0.3403
400.21	2.012	0.952	404.13	1.956	0.847885	412.806	2.696	1.1858
400.01	3.111	1.201	403.48	0.799	0.33635	413.136	2.197	0.9
399.55	1.613	0.666	403.48	2.333	1.15533	413.277	2.083	0.9288
400.43	2.591	0.942	403.6	1.109	0.481827	412.948	1.5	0.7424
399.35	1.994	0.816	403.62	2.063	0.957376	412.941	0.743	0.3346
399.71	3.928	1.466	404.57	1.055	0.5087	413.529	2.432	1.1377
399.64	1.843	0.74	404.34	4.194	2.073388	413.241	1.747	0.8409
398.97	2.657	1.124	404.51	1.03	0.524089	413.064	1.462	0.6379
399.57	2.436	0.984	404.72	3.153	1.373583	413.733	3.098	1.4487
399.89	2.134	0.847	403.85	2.835	1.246991	414.362	1.374	0.6451
399.47	1.535	0.72	404.89	0.068	0.031166	412.753	2.126	0.9315
400.24	2.44	1.006	404.18	2.104	0.88255	414.574	2.301	1.0431
400.48	2.048	0.824	403.41	0.859	0.401696	414.547	1.59	0.7467
400.17	1.644	0.642	404.14	3.362	1.415161	413.005	0.34	0.1593
400.48	1.368	0.546	404.2	2.47	1.071261	413.159	2.243	0.9446
399.91	2.364	0.911	404.41	3.417	1.488012	413.765	3.64	1.5822
400.51	2.708	1.155	403.66	1.257	0.562478	413.259	1.358	0.594
400.64	2.124	1.011	404.3	0.447	0.213519	414.086	2.146	0.9128
399.86	1.533	0.64	404.62	2.746	1.159983	414.278	3.246	1.4556
400.33	3.317	1.206	402.94	1.6	0.715645	413.938	2.92	1.2533
400.1	2.501	1.218	403.43	1.956	0.926033	413.914	1.731	0.7633
400.58	2.163	0.895	403.47	1.431	0.613451	415.241	3.128	1.4899
399.64	1.791	0.748	403.55	3.154	1.29512	414.768	2.859	1.2545
399.23	2.35	0.95	404.48	0.842	0.355989	414.68	2.003	0.9257
399.42	2.592	0.987	404.04	0.713	0.320895	414.559	1.823	0.8207
398.99	2.061	0.745	403.23	1.373	0.629758	414.993	1.135	0.5187
399.3	2.762	1.089	404.15	2.906	1.310159	414.238	1.734	0.747
399.7	3.211	1.288	403.76	0.825	0.411758	415.285	1.133	0.5586
400.27	1.331	0.552	403.16	1.508	0.701308	414.982	2.595	1.067
400.2	2.714	1.095	404.26	2.209	1.033141	414.316	2.252	1.1439
400.07	2.966	1.141	404.08	1.469	0.660981	414.255	2.323	1.0521
399.82	3.098	1.35	404.48	3.14	1.451476	414.361	1.838	0.8774
399.99	2.978	1.305	404.01	1.791	0.736715	416.036	3.147	1.4125
399.79	3.231	1.227	404.2	2.598	1.101698	415.114	3.729	1.7801
400.08	2.923	1.058	404.24	4.014	1.838082	415.325	1.213	0.5526

400.3	1.089	0.432	403.71	0.967	0.457862	415.228	2.594	1.136
399.78	1.031	0.436	403.24	2.514	1.239907	415.409	2.571	1.1737
400.12	1.503	0.755	403.41	0.695	0.350523	414.649	2.474	1.0626
400.51	0.582	0.236	403.63	2.475	1.061373	415.867	2.594	1.2391
400.15	1.93	0.76	403.98	1.648	0.771085	415.256	3.154	1.453
400.65	2.835	1.113	404.98	2.704	1.168088	416.426	2.691	1.1212
399.87	3.363	1.268	403.32	1.372	0.596644	415.52	1.691	0.7313
400.37	2.775	1.024	404.51	2.627	1.25996	416.134	1.674	0.6838
399.85	4.347	1.57	404.98	1.731	0.822645	416.577	2.21	1.0566
399.14	2.785	1.116	403.8	1.978	0.866915	415.748	1.844	0.7541
400.14	2.602	1.145	404.05	2.184	0.922714	415.881	1.329	0.5602
400.39	1.852	0.791	403.6	2.647	1.192878	415.203	1.849	0.8339
399.35	3.181	1.432	404.46	1.026	0.438784	417.26	1.005	0.4346
399.07	1.818	0.669	403.75	1.118	0.462056	416.736	1.229	0.5795
399.65	1.976	0.821	404.12	1.945	0.85497	416.543	2.281	1.0058
400.77	2.306	0.866	403.15	1.871	0.839121	416.985	0.86	0.3632
399.42	5.083	1.877	403.85	2.558	1.177096	417.103	1.93	1.0371
400.5	2.805	1.141	404.93	2.019	0.913925	416.591	3.595	1.4763
399.79	1.494	0.63	404.57	1.482	0.605649	416.609	1.569	0.7006
399.81	2.678	1.151	404.66	3.035	1.244935	417.203	2.8	1.3128
399.7	2.65	1.166	403.84	1.37	0.631124	417.05	0.633	0.2901
400.25	2.73	1.037	403.22	3.69	1.521611	416.961	0.426	0.2264
399.74	1.721	0.657	404.66	1.712	0.91756	417.023	1.184	0.5539
400.08	3.124	1.346	404.56	2.425	1.062246	417.74	2.14	0.9463
399.72	1.748	0.768	404.61	1.527	0.695373	418.173	0.783	0.3287
399.98	3.044	1.163	404.64	1.264	0.595524	418.264	2.477	1.029
399.78	1.782	0.869	402.43	1.088	0.450502	417.432	2.755	1.384
399.54	1.756	0.698	403.58	4.064	1.86571	417.266	1.195	0.5045
399.6	1.349	0.541	403.66	2.465	1.168945	417.303	2.093	0.9653
399.77	1.244	0.499	404.78	2.308	0.942438	418.292	5.406	2.2607
399.42	2.302	0.851	404	3.547	1.655338	417.938	2.122	0.8698
400.08	2.688	1.243	403.28	1.418	0.618681	418.629	2.484	1.1253
399.57	3.669	1.344	403.49	1.365	0.558886	418.387	2.062	1.0333
399.61	2.183	0.792	404.34	3.375	1.467524	418.06	2.529	1.0818
400.32	0.786	0.32	404.6	3.01	1.364014	418.911	2.096	0.904
400.24	3.109	1.256	403.99	1.184	0.568909	417.884	2	0.8295
400.72	2.433	1.197	404.01	2.546	1.089583	418.945	3.629	1.5525
400.2	1.726	0.671	403.69	3.229	1.348007	418.028	3.215	1.3127
399.8	4.955	2.102	403.53	1.984	0.820854	418.19	0.753	0.3451
400.95	1.715	0.701	404.54	1.231	0.661069	418.612	2.451	1.0108
400.62	3.952	1.916	403.2	1.155	0.502275	419.934	1.667	0.771
400.21	2.057	0.822	403.25	1.8	0.759938	418.988	2.567	1.1053
399.64	1.112	0.416	403.31	0.573	0.24349	419.694	2.066	0.911

400.09	2.933	1.155	403.52	2.032	0.867152	419.175	2.288	1.0263
399.75	2.106	0.83	404.41	0.799	0.373045	418.557	2.932	1.217
399.77	1.428	0.623	403.7	0.597	0.31953	418.937	2.202	0.9639
400.48	0.723	0.325	403.91	2.028	0.841289	418.876	0.898	0.3929
399.37	1.89	0.719	404.74	0.602	0.251808	419.486	1.51	0.6416
399.84	3.519	1.45	404.57	3.017	1.369969	419.058	2.052	0.8625
400	2.734	1.278	403.45	1.154	0.522666	419.649	0.912	0.4409
400.4	2.253	0.983	404.28	2.298	0.974923	418.591	3.037	1.3581
399.93	2.991	1.301	404.29	2.189	1.193778	419.117	1.693	0.7883
399.55	1.781	0.798	403.55	1.56	0.733416	419.304	2.726	1.2732
399.85	3.289	1.378	404.14	2.411	1.057766	420.551	2.459	1.1076
399.81	2.046	0.876	403.92	0.693	0.312303	419.951	1.384	0.5833
399.25	2.557	1.066	403.38	1.027	0.479609	419.882	2.006	0.9569
401.08	1.91	0.693	404.65	1.976	0.90168	419.59	3.922	1.6062
399.6	1.02	0.414	403.99	1.554	0.646436	420.083	1.727	0.7263
400.68	3.6	1.51	403.29	3.14	1.455642	419.715	2.149	0.9682
399.72	2.38	1.146	403.88	3.487	1.4939	420.765	1.483	0.6193
399.74	2.548	0.977	403.68	0.888	0.40292	420.322	2.315	1.0981
400.27	1.446	0.557	404.32	2.062	0.984544	420.481	2.832	1.2054
399.97	3.34	1.195	404.28	1.665	0.78759	421.141	1.798	0.8775
400.61	2.947	1.328	404.86	3.183	1.322819	421.191	1.37	0.6369
401.1	2.85	1.252	403.34	0.904	0.425243	421.47	0.835	0.3675
400.52	2.102	0.854	404.22	2.899	1.302209	421.037	1.868	0.9782
400.28	1.158	0.425	403.25	1.377	0.563879	420.815	1.822	0.9064
400.58	0.964	0.381	403.35	2.198	0.970122	421.666	0.866	0.3789
399.61	2.388	0.965	403.72	1.663	0.825267	420.718	2.937	1.2188
400.15	1.322	0.531	403.86	2.076	0.974818	420.712	1.664	0.7
399.37	3.511	1.446	403.28	1.111	0.462825	420.491	0.902	0.4197
400.11	1.438	0.523	404.5	2.416	1.093383	420.874	1.596	0.6948
400.85	2.537	1.028	403.79	1.769	0.909967	420.994	1.61	0.7505
400.22	3.464	1.416	404.83	1.756	0.71846	421.687	1.548	0.7091
400.44	2.158	0.825	403.93	1.868	0.827748	421.18	1.092	0.4758
400.15	3.861	1.381	402.77	1.69	0.827398	421.667	2.035	0.8721
399.85	3.03	1.363	404.21	0.228	0.111022	422.117	1.797	0.8195
399.98	3.903	1.482	404.2	2.969	1.249216	421.566	2.228	0.9403
399.49	2.019	0.834	404.64	2.052	0.865142	420.963	0.957	0.397
399.88	1.882	0.745	404.04	2.864	1.188624	422.101	1.294	0.5837
399.91	2.161	0.85	403.82	0.358	0.169349	423.25	2.591	1.1621
400.03	2.053	0.871	403.7	1.833	0.835829	422.56	2.913	1.2456
399.71	1.626	0.645	404.49	2.767	1.234714	422.043	3.277	1.4131
399.24	3.57	1.407	404.93	1.225	0.563658	422.255	1.315	0.542
400.39	0.35	0.153	403.52	3.677	1.604776	422.088	1.063	0.5034
400.38	1.423	0.618	404.47	1.214	0.56688	422.472	1.498	0.6126

400.1	2.251	0.81	404.15	2.613	1.173047	422.137	1.71	0.7736
399.73	3.138	1.288	404.23	2.605	1.175275	422.02	1.271	0.558
400.47	3.098	1.297	403.51	2.952	1.337487	422.156	1.038	0.5216
400.64	3.002	1.19	403.21	2.334	1.205028	422.035	1.951	0.8247
400.21	2.097	0.837	404.13	2.236	0.957455	422.729	2.62	1.1315
400.7	3.434	1.682	403.32	3.18	1.484679	422.584	1.846	0.7767
399.85	2.768	1.141	404.37	1.934	0.869394	422.639	3.892	1.5975
400.22	2.935	1.31	404.72	1.527	0.689691	423.543	3.341	1.4297
400.34	1.966	0.712	404.1	1.849	0.936771	421.642	3.769	1.5783
399.22	2.562	1.131	403.84	1.819	0.85107	423.819	0.843	0.3656
400.52	1.88	0.695	404.56	1.591	0.689462	423.476	0.678	0.2983
399.56	2.6	1.179	404.39	1.427	0.761223	423.074	3.744	1.5408
399.58	3.165	1.219	403.78	1.157	0.51834	422.814	1.946	0.8707
400.03	0.6	0.218	404.19	2.649	1.245058	423.955	1.787	0.8677
399.88	2.003	0.809	403.86	3.191	1.437117	423.343	2.036	0.9423
400.34	2.478	0.881	403.94	2.128	1.016807	423.56	1.613	0.7504
400.26	1.945	0.804	403.48	0.703	0.319055	423.015	2.354	1.1701
400.12	1.798	0.72	403.49	2.254	1.146197	423.957	1.232	0.5348
400.41	5.025	1.806	404.14	2.495	1.040892	423.825	2.785	1.2891
399.73	2.027	0.859	404.46	1.492	0.643582	424.154	2.656	1.1106
400.97	2.1	0.829	404.32	1.185	0.552052	423.959	2.883	1.2531
400.13	2.709	1.109	404.24	1.994	0.920159	424.004	2.218	0.9486
399.91	2.891	1.157	404.39	3.124	1.446455	423.697	2.132	0.9779
400.53	2.528	0.952	403.63	3.14	1.399797	423.388	0.659	0.2858
399.41	1.173	0.471	404.19	2.68	1.146011	424.086	1.424	0.6386
400.34	3.361	1.356	404.26	1.189	0.562193	424.031	1.92	0.8899
400.35	1.552	0.652	403.69	3.35	1.509812	424.845	3.743	1.5296
399.45	3.863	1.392	404.13	2.528	1.038398	425.382	0.193	0.0958
400.51	2.497	1.066	404.28	2.306	0.95883	424.735	1.195	0.5695
400.29	1.554	0.593	403.78	0.607	0.249668	425.469	1.044	0.4412
400.08	2.362	0.984	403.47	1.705	0.701091	423.974	1.568	0.7929
400.62	2.857	1.139	404.28	0.587	0.268283	425.578	0.659	0.3671
399.19	3.345	1.437	404.59	5.222	2.136148	424.381	2.551	1.0766
400.54	2.94	1.123	403.91	1.953	0.871026	425.307	2.484	1.024
400.78	3.653	1.511	403.63	1.16	0.545443	425.626	3.802	1.6741
399.97	2.22	1.037	404.32	2.232	1.229606	425.628	2.263	1.0086
399.78	2.828	1.045	403.86	1.47	0.641049	426.077	1.82	0.7921
399.64	2.375	0.983	404.27	1.542	0.695824	425.452	3.417	1.4576
399.79	1.3	0.585	402.69	1.044	0.501314	425.332	2.625	1.1396
400.09	2.374	1.034	403.72	1.418	0.638935	425.066	0.761	0.3467
400.57	1.135	0.476	404.01	2.805	1.251881	425.479	2.637	1.1853
399.84	1.186	0.569	404.15	3.432	1.515932	426.136	2.738	1.1678
399.94	1.891	0.844	404.1	2.836	1.354406	425.784	4.142	1.7294

399.71	3.98	1.62	403.83	1.568	0.641623	426.2	3.87	1.8033
400.66	1.604	0.631	403.21	1.112	0.495194	425.861	2.297	1.1735
400.28	1.514	0.656	403.7	2.255	1.053125	424.924	1.193	0.4917
399.6	3.275	1.228	404.35	2.198	1.122652	426.812	2.397	1.1179
399.06	1.163	0.438	403.16	1.606	0.710098	425.569	1.266	0.5185
401.13	1.471	0.556	403.98	1.832	0.789791	426.245	4.085	1.6844
399.09	2.311	1.091	404.36	1.899	0.860517	425.647	1.79	0.841
399.45	2.056	0.909	403.89	2.195	0.957506	426.429	1.663	0.8516
400.71	2.577	1.064	403.74	2.068	0.848354	426.125	0.623	0.2656
400.11	2.502	1.186	403.64	2.677	1.135037	426.366	1.77	0.7336
400.08	2.316	1.072	403.81	1.509	0.748	427.293	2.219	0.9333
399.51	1.32	0.527	403.21	1.738	0.851229	426.616	1.046	0.5162
399.63	2.754	1.122	404.15	1.174	0.656369	427.741	2.461	1.0656
400.02	1.097	0.449	404.23	1.879	0.82313	427.034	1.408	0.6692
399.7	1.745	0.673	403.46	3.749	1.70754	427.504	3.702	1.7285
399.96	4.534	1.747	403.49	1.166	0.56574	426.919	2.522	1.1166
399.58	2.509	1.023	404.19	0.95	0.397596	426.848	3.173	1.5115
399.82	2.006	0.734	403.71	3.104	1.456039	427.585	3.019	1.3339
399.5	1.531	0.544	405.01	1.627	0.703025	428.262	2.138	0.9115
399.71	2.548	0.969	404.23	2.538	1.069641	427.54	3.381	1.5095
399.64	2.576	0.998	403.99	1.247	0.531241	428.39	1.184	0.5481
399.78	3.462	1.287	404	0.355	0.152265	427.197	1.966	0.941
399	2.04	0.848	404.26	1.515	0.633648	428.537	2.518	1.0586
399.69	0.411	0.153	403.44	0.812	0.361086	427.129	1.372	0.5702
399.42	3.19	1.208	403.86	3.192	1.498364	427.289	3.568	1.6345
400.38	2.355	0.927	403.57	3.12	1.298645	428.268	3.019	1.2861
400.68	2.291	0.946	403.94	2.038	1.042592	427.958	3.187	1.3411
399.14	3.166	1.217	403.2	2.124	0.91969	427.889	1.255	0.5157
400.16	2.715	1.064	404.5	2.108	0.920382	428.901	2.405	1.1595
399.41	1.768	0.681	403.96	1.86	0.782781	427.848	1.53	0.6955
400.54	1.457	0.562	404.08	1.845	0.861061	428.944	1.168	0.5712
399.98	1.983	0.892	403.5	2.576	1.264095	428.413	2.61	1.2358
399.8	2.198	0.845	403.4	1.778	0.744624	428.16	0.357	0.1478
399.97	2.988	1.107	404.42	3.617	1.609953	429.024	1.992	1.0032
399.5	2.076	0.797	403.59	1.282	0.561137	429.411	3.478	1.5255
399.64	3.076	1.096	403.53	2.992	1.364214	428.911	2.809	1.3071
399.2	0.603	0.235	404.54	1.52	0.795099	428.632	2.286	0.9563
399.87	1.998	0.816	404.22	1.511	0.637754	428.604	2.742	1.1518
400.53	1.596	0.679	404.73	1.999	1.050703	428.859	2.851	1.1829
400.3	1.336	0.529	403.03	1.743	0.854627	428.317	2.37	1.0024
399.81	2.557	0.984	404.29	0.639	0.295163	429.262	1.824	0.7704
400.39	2.779	1.13	403.95	1.865	0.91437	428.632	1.441	0.6781
400.15	1.698	0.644	403.96	1.927	0.907504	429.301	2.371	1.0193

399.55	3.773	1.409	403.93	3.041	1.386313	429.275	1.296	0.5797
400.05	1.171	0.54	404.86	1.636	0.830193	429.024	2.085	1.0607
400.37	2.346	0.919	403.98	1.075	0.455192	429.786	0.958	0.4437
400.72	2.7	1.31	404.36	1.375	0.611281	430.077	1.348	0.6279
400.31	2.421	0.989	404.31	2.111	1.170398	430.003	1.923	0.7991
399.58	2.869	1.216	403.14	2.984	1.362851	430.713	2.545	1.223
399.42	1.552	0.671	404.04	0.923	0.407819	430.654	1.594	0.7028
399.81	1.13	0.453	403.47	1.456	0.613528	430.029	4.801	2.1418
400.48	2.781	1.027	404.71	0.816	0.376234	429.264	2.371	1.0292
400.33	1.955	0.733	403.71	2.742	1.142018	429.79	1.936	0.7926
399.9	2.132	0.86	403.98	0.73	0.341195	429.647	2.219	0.9378
400.05	2.242	1.033	402.68	1.842	0.772705	429.879	0.764	0.3569
398.71	1.004	0.429	403.85	2.437	1.032263	430.908	2.097	1.049
399.04	0.756	0.337	403.35	1.671	0.737013	429.634	2.628	1.2381
400.56	2.389	0.957	403.92	1.968	0.967361	430.922	1.931	0.7914
399.92	1.605	0.637	404.84	1.242	0.542826	431.503	1.253	0.625
399.85	3.207	1.421	404.33	3.014	1.2548	429.259	1.688	0.8015
399.2	2.545	1.058	404.39	2.951	1.229669	430.544	0.566	0.2843
399.99	2.59	1.005	403.93	2.835	1.269399	430.56	3.372	1.3966
399.79	2.373	0.951	404.58	2.806	1.319879	430.706	2.425	0.993
400.13	3.634	1.518	403.61	3.325	1.384856	430.33	2.479	1.031
399.94	2.133	0.865	403.93	5.057	2.080749	430.958	1.409	0.5855
399.99	1.808	0.732	404.01	2.273	0.958502	430.768	3.705	1.7176
400.01	1.797	0.724	403.79	1.742	0.733949	431.832	2.106	0.9856
400.27	1.809	0.649	404.49	1.4	0.63996	430.703	1.126	0.5044
399.97	1.879	0.759	404.37	2.066	0.875251	431.759	2.309	1.0288
400.51	2.617	1.038	404.36	2.11	0.862315	431.124	2.189	1.0008
399.87	2.944	1.136	403.12	1.691	0.801232	431.588	1.8	0.7465
399.58	2.912	1.056	403.13	2.677	1.113077	431.546	1.176	0.5432
400.37	4.224	1.601	404.58	1.327	0.600191	431.454	1.016	0.4633
399.96	2.947	1.095	404.42	3.417	1.545024	432.072	3.439	1.4214
400.24	1.783	0.665	403.36	1.774	0.818615	432.333	1.643	0.7461
399.85	3.106	1.258	404.19	3.576	1.513651	432.294	1.931	0.823
400.17	2.232	0.829	403.36	3.096	1.415821	432.138	2.655	1.1892
400.05	4.903	1.798	403.1	2.069	0.925411	432.934	2.617	1.3927
400.28	2.734	1.036	403.34	3.474	1.616514	432.028	1.469	0.6394
400.36	1.571	0.575	404.5	2.123	0.94572	430.717	2.143	1.0397
399.84	1.734	0.755	403.8	0.845	0.388593	433.175	1.537	0.6683
399.64	3.112	1.211	403.56	2.741	1.200983	432.073	2.364	1.0544
400.34	3.358	1.231	404.18	1.9	0.802853	432.08	1.63	0.7564
400.16	2.963	1.188	404.46	3.84	1.789117	432.441	2.523	1.042
400.11	1.69	0.815	404.1	2.514	1.031945	432.484	2.564	1.2521
399.91	2.399	0.946	404.06	2.288	1.069211	432.991	4.75	2.0678

399.74	2.864	1.021	403.51	1.707	0.749366	433.115	2.017	0.9193
400.1	1.047	0.47	404.18	1.694	0.823372	432.712	2.021	0.9889
399.13	2.293	0.9	403.91	1.635	0.769565	432.3	2.607	1.0871
400.61	0.889	0.42	404.38	2.355	0.987507	433.626	1.81	0.827
399.96	2.408	1.023	403.84	1.414	0.620872	433.297	2.332	0.9946
399.89	1.662	0.797	403.89	1.103	0.502712	432.054	1.28	0.6081
399.71	2.863	1.226	403.68	1.526	0.642896	432.651	1.478	0.7474
399.27	2.425	0.953	404.38	1.49	0.662709	432.943	1.699	0.7403
399.83	4.223	1.959	403.93	0.49	0.246912	434.461	1.159	0.4983
400.19	2.089	0.912	404.83	1.069	0.502006	432.669	1.189	0.5559
400.69	3.76	1.521	403.37	1.223	0.500503	434.085	1.507	0.7797
400.51	1.488	0.562	404.05	1.961	0.805945	432.672	2.386	1.0835
399.84	2.654	0.982	403.47	2.606	1.205199	433.6	2.847	1.4884
400.08	1.877	0.675	404.07	1.517	0.704004	433.676	1.345	0.5538
400.4	2.791	1.226	404.4	0.859	0.434537	433.505	2.414	1.1099
399.14	1.678	0.601	404.34	2.572	1.169477	434.184	1.639	0.7321
399.9	1.109	0.471	404.05	0.665	0.294698	434.761	1.931	0.8239
399.88	2.47	1.184	403.99	1.038	0.480318	433.825	1.799	0.8324
400.23	2.014	0.834	404.53	2.718	1.150165	433.195	0.573	0.2383
399.82	2.825	1.058	403.33	1.311	0.617596	434.249	2.966	1.3866
399.54	4.191	1.61	404.52	3.155	1.38277	434.276	1.572	0.7801
400.03	1.203	0.558	403.62	1.892	0.847542	434.881	1.883	0.8074
399.77	1.782	0.746	403.57	3.276	1.45851	434.699	0.972	0.3982
400.36	3.688	1.396	403.9	2.878	1.332929	435.035	2.415	1.3722
399.71	2.369	0.86	403.76	1.301	0.598109	434.437	1.436	0.5877
399.8	2.652	0.957	403.89	2.93	1.382096	434.721	0.793	0.349
399.94	2.334	0.931	404.55	3.106	1.56734	434.221	3.355	1.6064
399.96	1.78	0.703	403.37	1.85	0.860015	434.297	2.951	1.4075
399.98	2.684	1.197	404.62	1.962	0.914924	434.861	3.645	1.5772
399.06	1.708	0.691	404.49	1.942	0.976142	435.682	2.047	0.8482
399.62	4.214	1.669	403.84	0.931	0.389221	435.341	3.044	1.2951
400.13	1.848	0.766	405.08	1.777	0.833765	435.413	2.093	0.9953
399.57	1.506	0.65	402.93	2.254	1.070683	435.95	1.605	0.7824
399.6	2.304	0.915	403.8	1.425	0.664831	434.881	1.879	0.8062
399.95	3.277	1.295	403.51	2.282	0.971436	435.215	1.338	0.5711
400.05	1.494	0.579	404.04	1.612	0.722846	436.154	1.49	0.7196
400.73	2.263	0.871	403.33	2.589	1.156233	435.286	1.196	0.5858
399.84	1.595	0.687	404.56	1.951	0.907593	436.037	1.91	0.9167
400.37	2.22	0.887	403.78	1.797	0.828005	435.58	0.438	0.1821
400.43	2.157	0.879	403.84	1.053	0.519886	435.915	2.503	1.0601
400.33	3.109	1.282	404.29	1.558	0.719082	435.497	2.327	1.0199
400.37	1.754	0.875	403.87	1.139	0.537181	435.223	3.976	1.7802
400.58	3.121	1.211	403.65	2.175	1.02154	435.355	1.755	0.8343

399.69	2.649	1.019	404.62	3.06	1.261153	436.176	1.822	0.8051
401.24	2.745	1.067	403.75	2.513	1.087727	436.993	0.634	0.3076
400.7	0.846	0.328	404.2	1.777	0.829983	436.174	3.127	1.3405
398.93	2.8	1.292	404.14	1.443	0.637107	436.496	2.82	1.204
400.02	2.761	1.355	403.65	1.39	0.594937	435.726	3.411	1.4214
399.71	3.959	1.434	403.48	2.846	1.192819	436.371	0.884	0.3906
399.88	3.1	1.193	402.48	2.368	1.103764	436.444	0.689	0.3258
399.17	3.284	1.436	403.24	1.788	0.743681	437.217	4.544	2.1936
400.23	2.381	0.936	404.04	2.645	1.300157	436.869	1.85	0.8533
400.09	4.132	1.799	403.32	0.645	0.293081	437.611	3.32	1.5127
400.24	2.248	0.839	403.79	2.401	1.02578	436.052	1.739	0.7629
400.45	0.526	0.225	403.76	2.558	1.134607	436.443	2.581	1.1126
400.27	1.777	0.731	404.44	2.792	1.264607	437.714	2.424	1.1211
399.31	1.588	0.661	403.14	2.138	0.90057	436.833	2.179	0.9349
400.18	1.621	0.656	404.02	1.482	0.805032	436.408	2.06	0.8846
400.27	2.576	0.983	404.57	3.435	1.60057	436.545	2.119	0.9522
400.47	2.306	0.833	403.77	1.391	0.601737	437.385	1.484	0.6493
400.73	2.947	1.239	404.22	1.562	0.665201	437.574	3.434	1.5265
399.92	1.593	0.637	403.92	0.189	0.091347	438.225	2.585	1.3827
400.28	2.516	0.902	404.49	2.87	1.284654	437.106	3.659	1.6226
399.81	2.006	0.727	404.19	2.409	1.123461	437.757	3.469	1.47
400	3.616	1.589	404.34	2.679	1.145995	438.068	1.005	0.4727
400.19	1.163	0.489	403.64	2.068	1.032678	438.879	2.416	1.0759
399.96	0.881	0.349	404.07	2.187	1.015985	438.135	1.847	0.8107
399.9	2.823	1.349	404.26	1.871	0.936154	438.446	2.764	1.1867
400.17	3.646	1.402	403.98	2.064	0.867481	436.836	2.519	1.1034
400.35	1.251	0.521	403.58	2.369	0.980162	437.429	2.322	0.9516
399.88	2.132	0.761	404.35	2.483	1.070032	437.499	0.906	0.3787
400.32	3.524	1.447	404.68	0.932	0.49132	438.974	1.502	0.6867
401.41	2.587	1.077	404.38	2.386	1.020787	439.02	4.035	1.8859
400.15	3.861	1.5	403.9	4.454	1.898508	437.996	1.18	0.5055
399.81	1.689	0.774	404.37	2.602	1.14029	438.439	1.323	0.5497
399.92	1.915	0.719	403.91	1.473	0.745394	439.591	1.836	0.7851
399.63	1.139	0.437	404.56	3.483	1.607778	439.274	2.367	1.2496
400.47	3.096	1.2	403.64	2.507	1.146298	439.157	1.035	0.4427
400.81	2.168	0.944	404.68	2.929	1.289397	439.402	2.541	1.0468
400.1	3.646	1.355	404.8	1.615	0.753534	439.297	3.046	1.6671
400.96	2	0.889	404.29	1.672	0.701408	439.168	1.748	0.7674
399.54	1.394	0.645	404.05	2.032	1.006299	439.854	3.432	1.4281
400.81	3.17	1.26	405.38	3.262	1.560562	440.242	3.174	1.5028
400.49	2.295	0.883	404.61	1.782	0.735119	439.238	2.604	1.0966
399.74	1.541	0.571	404.05	1.908	0.870155	440.013	3.104	1.4459
400.19	1.559	0.763	404.28	1.091	0.491736	438.952	1.202	0.6387

399.66	2.627	1.106	402.96	1.885	0.79297	439.751	4.164	1.8198
400.27	2.611	0.954	404	1.498	0.667154	440.472	3.762	1.8038
400.14	2.536	1.047	404.1	1.34	0.625748	440.166	0.867	0.3718
400.23	1.226	0.462	403.82	2.195	1.051997	439.947	1.497	0.7138
400.47	1.285	0.496	404.44	2.99	1.262767	440.019	1.335	0.6347
399.36	2.696	1.156	403.78	0.68	0.305363	439.736	2.629	1.1317
400.16	1.355	0.55	404.78	1.905	0.879061	440.594	2.274	1.0212
400.21	0.831	0.33	405.1	3.208	1.358717	441.149	1.636	0.762
400.16	1.617	0.69	403.86	4.386	1.9232	440.554	3.725	1.5809
400.6	1.719	0.698	403.81	1.694	0.771747	440.651	1.821	0.7603
400.08	3.07	1.138	404.15	2.257	0.998042	440.366	2.347	0.9813
399.49	2.408	0.928	403.76	2.934	1.253406	440.453	5.509	2.4379
400.83	1.52	0.597	403.73	1.562	0.84347	440.627	2.586	1.1021
400.01	1.901	0.862	404.44	1.345	0.570729	441.248	1.751	0.7827
400.43	2.117	0.872	402.77	2.808	1.220777	440.752	3.183	1.3918
399.89	1.497	0.607	403.74	4.113	1.81289	440.504	4.513	1.8762
400.66	3.198	1.212	404.27	3.234	1.326111	440.475	2.794	1.1977
399.68	1.955	0.731	403.57	0.691	0.286505	441.374	3.67	1.6123
400.36	1.939	0.73	404.66	1.084	0.467328	441.418	2.376	1.1004
399.58	3.501	1.313	403.84	1.214	0.536253	440.719	2.182	0.92
399.86	2.239	0.914	404.27	2.471	1.1802	440.884	3.32	1.3631
399.78	3.009	1.213	403.95	1.5	0.617572	441.942	2.983	1.268
400.14	1.423	0.57	403.35	3.898	1.702322	441.789	3.107	1.431
399.85	2.138	0.822	404.59	2.863	1.182379	441.513	4.722	2.0244
399.55	0.746	0.361	404.94	3.536	1.625328	441.967	2.939	1.4121
399.61	1.75	0.856	403.96	1.737	0.771809	441.899	1.628	0.6985
399.81	1.632	0.773	404.83	1.921	0.865806	442.416	1.203	0.5368
400.08	2.715	1.115	403.8	3.433	1.410962	441.862	1.834	0.8576
400.17	2.048	0.958	404.75	1.436	0.653839	442.189	1.39	0.6309
400.16	1.572	0.63	403.96	2.94	1.327864	442.299	2.912	1.3435
400.15	1.986	0.765	403.73	3.793	1.581853	442.414	3.252	1.4226
399.98	1.472	0.576	404.6	0.839	0.397246	442.193	2.155	0.8818
399.97	2.526	0.948	405.12	1.098	0.538564	442.219	0.971	0.4515
399.65	2.78	1.191	403.57	1.752	0.821901	441.745	3.732	1.5553
400.02	1.754	0.67	403.1	2.649	1.471457	442.993	1.373	0.6273
399.58	1.954	0.851	404.52	2.113	0.872743	442.412	4.294	1.8769
400.79	2.023	0.769	404.13	0.917	0.426167	442.456	2.36	1.0525
400.8	2.701	0.991	404.56	1.827	0.798521	443.919	3.241	1.4512
400.15	3.709	1.367	404.8	1.289	0.532191	442.317	1.398	0.599
401.15	1.745	0.723	403.07	1.56	0.666046	442.759	3.363	1.4155
400.14	2.425	1.094	403.5	1.583	0.731991	443.686	1.817	0.912
399.89	3.668	1.51	403.82	3.023	1.529772	442.692	1.362	0.5876
400.14	1.422	0.665	404.26	2.807	1.449121	443.276	2.804	1.3332

400.18	1.838	0.778	404.43	2.412	1.078815	442.59	1.909	0.9104
400.3	1.613	0.642	404.06	1.399	0.707798	443.356	3.708	1.5732
399.63	2.345	1.065	404.14	0.994	0.460973	443.673	3.138	1.4618
399.88	1.543	0.733	404.03	2.137	0.951081	443.469	2.853	1.3514
399.46	1.074	0.394	404.35	1.073	0.467762	444.089	2.684	1.3033
399.81	3.548	1.367	403.75	2.668	1.120962	443.244	1.715	0.7752
399.25	1.245	0.458	404.65	1.334	0.598398	443.851	2.847	1.1693
400.3	3.168	1.42	404.49	1.091	0.453731	443.69	1.732	0.8432
400.53	2.578	1.008	403.12	1.982	0.939604	443.72	0.767	0.3921
400.21	2.812	1.146	404.83	2.128	0.981809	443.28	4.251	1.9173
399.49	3.382	1.324	403.35	2.975	1.329401	444.518	4.725	2.0587
399.78	2.275	0.845	404.24	1.064	0.457898	444.164	2.735	1.2763
399.35	2.251	0.909	403.68	0.925	0.424406	444.142	2.039	0.8812
400.4	1.745	0.695	403.92	1.252	0.576528	444.798	1.861	0.7938
399.05	1.325	0.528	404.25	1.588	0.74093	443.769	3.102	1.4445
400.55	2.709	1.234	403.71	3.864	1.834619	444.667	1.253	0.5132
399.8	1.746	0.756	403.73	1.384	0.636866	444.381	1.249	0.5666
401.25	3.489	1.401	403.38	1.271	0.594262	443.679	3.877	1.7339
400.44	1.564	0.588	404.75	2.898	1.491731	444.503	1.341	0.685
399.76	2.913	1.032	404.17	1.572	0.718999	444.243	1.815	0.7549
400.06	1.821	0.912	403.53	1.17	0.502801	445.481	1.012	0.4146
399.18	2.555	1.022	403.16	2.394	1.101803	444.682	4.051	1.684
399.99	2.34	0.936	403.82	1.487	0.638821	444.569	3.368	1.426
399.12	3.413	1.492	403.81	3.106	1.302612	445.051	1.592	0.857
400.25	0.828	0.345	403.58	1.079	0.460907	444.593	1.195	0.5412
400.19	3.526	1.331	404.56	1.815	0.822927	444.862	3.646	1.5567
399.5	0.992	0.407	404.72	3.283	1.359595	444.415	1.433	0.5904
399.84	2.325	0.883	403.91	1.421	0.691618	445.763	4.381	2.0304
400.38	1.668	0.637	404.07	3.917	1.624569	445.625	4.535	2.0728
400.33	1.379	0.595	404.32	1.605	0.717379	446.298	2.098	0.875
400.27	3.421	1.394	403.69	0.49	0.201626	445.095	1.47	0.6445
399.5	2.737	1.133	404.89	1.585	0.688208	446.128	0.922	0.4039
399.89	2.962	1.21	403.7	0.576	0.280082	445.545	4.398	1.8284
399.91	3.553	1.534	404.3	4.541	1.92114	445.552	1.5	0.6454
400.8	3.44	1.501	403.08	2.297	0.962326	446.003	2.466	1.0851
399.93	2.497	1.08	403.27	3.191	1.467636	445.606	2.348	1.2021
400.55	1.464	0.548	404.58	1.805	0.789121	446.138	2.361	1.0846
400.33	1.672	0.631	405.55	3.106	1.33195	445.91	2.573	1.0598
400.57	2.139	0.829	403.84	2.806	1.26251	446.043	0.649	0.2882
399.46	0.76	0.29	404.36	0.68	0.353121	445.99	1.964	1.0757
400.18	1.814	0.71	404.63	2.064	0.977814	446.838	1.898	0.8227
400.71	2.133	0.901	403.42	1.718	0.805453	447.13	2.484	1.0472
399.6	1.297	0.515	404.95	1.377	0.575646	446.11	2.893	1.4705

400.01	1.874	0.934	404.09	3.776	1.839765	447.278	2.358	1.2062
399.87	3.34	1.358	404.44	2.568	1.122183	447.011	1.047	0.4399
400.05	1.143	0.486	404.05	1.464	0.609318	447.096	1.427	0.7734
400.39	2.935	1.227	404.57	1.888	0.827249	446.839	2.41	1.1601
399.45	2.401	0.97	404.27	1.801	0.826341	446.776	2.32	1.0615
399.34	2.564	1.093	404.25	4.453	1.941126	447.146	1.69	0.8535
400.4	1.961	0.783	403.53	1.36	0.586619	447.155	2.601	1.1547
400.08	3.29	1.394	404.42	1.883	0.827537	447.075	2.033	0.9392
398.93	1.604	0.736	403.49	1.635	0.767007	446.597	1.55	0.638
400.18	3.493	1.537	404.36	0.552	0.232628	447.008	2.235	0.9935
400.01	1.132	0.517	404.24	3.145	1.456962	447.964	2.978	1.3826
399.89	1.266	0.494	403.39	2.408	1.191872	448.169	2.634	1.1383
399.48	2.771	1.018	403.3	1.071	0.496553	447.233	0.661	0.2877
399.75	2.071	0.838	403.64	2.903	1.245182	447.695	2.672	1.1314
399.64	2.533	0.939	403.46	1.373	0.706107	447.284	3.91	1.6733
400.36	1.076	0.447	403.76	1.774	0.824607	448.153	0.865	0.4656
400.35	2.128	0.83	403.13	3.215	1.349666	447.768	2.738	1.2302
399.12	1.652	0.676	404.02	0.867	0.399193	447.587	1.736	0.7869
399.51	1.555	0.703	403.3	1.818	0.914558	447.059	3.287	1.4183
399.73	1.113	0.514	403.97	1.602	0.693113	447.94	3.297	1.4713
399.85	4.154	1.532	404.03	1.277	0.557763	448.019	1.241	0.5798
399.43	1.177	0.547	404.21	1.991	0.956526	448.674	3.028	1.277
400.56	2.097	0.877	403.68	1.717	0.76253	448.489	3.178	1.3153
400.42	2.844	1.061	403.68	1.834	0.805686	447.685	4.831	2.1274
399.42	2.446	0.937	404.09	2.029	0.904355	449.29	1.211	0.5414
400.32	3.065	1.33	403.64	2.781	1.29251	448.714	1.899	1.0285
399.53	1.345	0.546	403.68	0.844	0.367371	448.019	1.632	0.7272
400.69	1.942	0.856	403.8	1.171	0.55702	448.12	5.357	2.3875
399.52	3.174	1.197	403.46	0.719	0.341995	448.559	4.79	2.0958
399.94	0.864	0.381	403.85	1.111	0.464302	450.023	1.743	0.8103
400.34	2.588	0.971	404.25	2.866	1.274431	449.739	0.606	0.2926
400.74	2.864	1.175	403.62	2.108	0.911426	450.466	3.603	1.7017
400.25	2.157	0.938	404.03	1.822	0.779182	449.181	2.729	1.2276
400.37	2.974	1.274	405.15	1.503	0.700484	448.95	2.924	1.2538
399.59	4.246	1.534	404.19	2.29	0.99375	448.499	1.815	0.8682
400.27	3.051	1.159	404.27	2.013	0.837043	448.516	3.79	1.7634
400.29	3.419	1.276	404.32	3.068	1.453947	448.969	2.295	1.0163
398.99	2.547	1.156	404.59	1.957	0.841096	449.337	3.403	1.4357
400.87	3.417	1.301	403.99	1.471	0.625276	449.288	1.022	0.4571
399.89	1.868	0.774	404.16	2.585	1.19921	449.924	2.189	1.0092
400.03	0.68	0.244	403.06	2.796	1.257735	449.929	2.807	1.1642
400.07	1.593	0.665	404.01	2.412	1.288881	450.22	1.694	0.7881
400.2	3.927	1.428	404.69	1.238	0.55916	449.498	1.526	0.6999

399.96	2.086	1.003	403.47	0.933	0.411029	449.647	4.587	2.0166
399.49	1.544	0.772	403.64	1.402	0.616855	451.389	4.199	1.8769
399.67	2.551	1.194	404.18	0.656	0.305802	449.531	2.647	1.1748
399.73	1.475	0.61	404.19	2.727	1.17582	450.794	2.334	1.0574
399.59	1.784	0.693	403.97	2.558	1.060548	450.141	3.641	1.5918
399.78	2.118	0.914	403.94	2.901	1.455133	450.419	1.306	0.6841
399.66	2.289	0.855	404.26	1.926	0.843667	450.287	4.973	2.2176
399.44	2.263	0.93	403.74	1.019	0.456121	451.483	1.194	0.5035
400.74	1.124	0.426	404.97	2.275	0.998574	450.736	4.022	1.7651
400.68	2.1	0.896	404.19	0.466	0.198259	450.874	3.632	1.5885
399.55	0.73	0.333	404.12	1.137	0.490287	450.326	1.174	0.5184
400.37	2.673	1.008	404.06	1.602	0.671961	451.404	2.171	0.8931
400.22	2.785	1.153	403.19	2.598	1.150544	452.098	1.125	0.5207
399.91	1.821	0.702	403.58	3.647	1.687	451.507	4.11	1.9574
399.94	1.638	0.718	403.47	1.841	0.769193	451.433	2.029	0.9908
399.83	3.324	1.212	404.3	3.098	1.282264	451.721	1.925	0.8341
399.54	2.443	1	403.98	2.869	1.196471	451.388	3.68	1.7015
399.94	3.247	1.241	403.45	3.204	1.531791	450.844	2.187	0.9962
399.86	3.133	1.148	404.8	0.706	0.31573	450.948	2.282	1.0689
399.81	4.256	1.628	403.22	1.892	0.832241	450.964	2.968	1.3265
400.26	3.033	1.181	405.22	3.724	1.80832	450.081	2.086	0.8607
400.12	1.838	0.771	403.81	5.059	2.279014	452.033	4.699	2.1809
399.67	2.053	0.745	403.52	0.95	0.414331	451.39	3.618	1.7307
400.53	1.551	0.571	404.13	1.868	0.857737	451.092	2.786	1.1661
400.21	2.932	1.17	404.49	2.263	1.034832	451.066	0.832	0.3887
399.69	2.048	0.78	403.8	2.659	1.119594	450.99	1.988	0.8597
399.92	1.518	0.677	403.24	2.146	0.907226	452.295	2.547	1.1465
400.15	1.761	0.646	403.46	1.832	0.843097	452.899	2.854	1.2202
400.27	2.286	0.833	404.32	1.102	0.52707	452.275	0.888	0.4266
399.92	4.669	1.976	403.73	3.362	1.579638	452.451	4.365	1.9954
399.59	2.61	1.055	403.94	2.271	1.029338	453.153	1.373	0.6206
400.24	2.591	0.971	403.25	2.943	1.235997	452.373	1.567	0.6663
400.37	0.718	0.325	403.6	2.353	0.973623	453.002	1.714	0.7737
399.97	1.588	0.665	402.94	1.901	0.785399	451.918	3.55	1.6032
400.45	1.273	0.54	404.12	3.344	1.374328	452.604	1.358	0.6357
399.59	2.416	0.887	403.9	1.168	0.634407	453.267	3.05	1.3959
400.28	2.662	1.014	404.24	1.944	0.952896	453.74	1.262	0.5417
399.33	1.505	0.724	403.95	1.983	0.811771	453.114	1.82	0.9168
399.45	1.434	0.606	404.37	2.193	1.103134	453.409	2.998	1.2253
399.62	2.384	0.957	404.01	1.139	0.533455	452.495	1.557	0.8554
400.11	2.573	1.081	403.66	0.918	0.452034	452.589	2.18	0.8902
399.89	1.733	0.639	403.58	0.364	0.166503	453.815	2.948	1.2694
399.81	0.593	0.238	403.76	0.972	0.409143	453.813	2.169	1.0007

399.55	3.556	1.398	403.75	1.996	0.892107	452.634	0.82	0.3833
400.2	2.219	0.941	403.63	2.03	1.02153	453.507	0.631	0.2949
400.45	2.526	1.123	404.19	1.688	0.835117	454.535	1.974	0.8547
401.04	1.078	0.443	405.04	2.741	1.198251	452.689	4.428	1.9353
399.9	2.301	0.913	403.81	1.624	0.753723	453.609	2.811	1.2218
399.64	1.689	0.73	405.3	2.871	1.245602	453.345	1.099	0.4816
399.99	3.988	1.635	403.85	3.204	1.444937	454.374	1.028	0.5177
399.54	1.98	0.767	404.18	4.942	2.075272	454.374	1.819	0.787
399.87	2.201	0.912	404.88	2.326	1.07565	454.285	1.045	0.4411
399.46	2.583	1.061	405.21	2.105	0.935605	454.137	2.039	0.9295
399.45	1.507	0.583	404.56	1.118	0.52057	454.859	3.187	1.4618
399.6	3.046	1.194	403.35	2.112	0.905227	455.007	3.149	1.5897
399.78	3.394	1.254	404.82	0.567	0.257295	454.485	4.068	2.0591
400.31	2.073	0.97	404.93	2.19	1.070062	455.941	2.6	1.3059
399.61	1.629	0.595	403.99	1.533	0.636749	453.858	2.34	1.0058
400.15	3.054	1.196	404.45	1.82	0.776859	454.003	0.745	0.3312
400.21	2.299	0.954	405.4	1.864	0.837664	455.05	2.29	1.0145
399.56	2.25	0.87	403.66	0.462	0.199329	454.747	3.278	1.4155
399.61	1.964	0.785	403.95	1.019	0.492557	455.499	1.762	0.802
399.41	2.47	1.095	404.49	1.173	0.485264	454.807	1.444	0.6381
399.32	2.044	0.795	404.24	0.438	0.181881	454.44	1.806	0.741
400.01	3.391	1.239	403.39	2.653	1.108237	455.732	2.267	0.9662
399.33	1.689	0.624	403.66	1.818	0.742312	455.027	1.58	0.6482
399.88	2.365	0.849	404.06	2.24	0.95576	455.307	2.697	1.285
399.95	2.102	0.958	404.57	2.152	0.988198	456.154	1.802	0.8313
400.28	2.21	0.892	403.46	2.242	1.191715	455.692	1.364	0.6054
399.95	1.983	0.804	403.3	0.396	0.170218	455.663	4.12	1.9009
399.49	2.117	0.815	403.53	4.39	1.976768	455.754	1.413	0.7486
400.18	1.87	0.905	403.74	2.188	0.979394	456.863	1.212	0.5377
400.79	0.676	0.255	404.14	1.243	0.526646	456.018	1.996	0.8861
399.89	2.603	1.035	404.45	4.12	1.718635	455.649	2.226	1.0245
400.07	1.578	0.585	404.58	3.604	1.523968	455.237	0.699	0.3115
400.36	2.124	0.824	404.09	1.778	0.761799	455.227	1.308	0.5601
399.4	2.676	1.06	404.82	2.084	0.866302	456.456	2.16	0.9097
400.3	3.319	1.253	403.33	2.557	1.061505	455.51	1.523	0.6228
399.83	2.497	1.006	404.47	1.657	0.752865	457.445	2.668	1.1986
399.47	3.555	1.303	404	0.734	0.365354	454.835	1.611	0.7073
399.93	3.188	1.281	404.31	1.279	0.676051	455.744	3.587	1.6173
400.39	2.032	0.767	403.52	1.125	0.544861	456.119	3.317	1.5021
400.21	2.121	0.88	404.98	0.623	0.293712	457.397	3.419	1.5832
400	1.335	0.514	404.32	1.319	0.538592	457.141	2.564	1.0754
400.03	2.148	0.879	403.15	2.527	1.177165	455.841	2.889	1.2422
399.57	2.6	1.038	403.74	1.011	0.4556	456.484	2.466	1.1585

400.73	2.397	0.91	404.02	1.862	0.819528	456.757	2.604	1.1953
399.9	2.762	1.126	404.14	0.893	0.388297	457.88	2.229	0.9975
399.18	2.242	0.889	403.85	2.505	1.053544	456.092	3.406	1.4331
400.53	1.393	0.563	404.4	3.316	1.389304	456.835	1.78	0.8614
400.46	1.113	0.433	403.05	2.295	0.962896	457.169	1.649	0.7721
399.73	1.202	0.581	404.5	2.014	0.826385	456.641	2.335	1.0003
399.33	1.318	0.554	404.24	2.487	1.085051	457.967	2.092	1.003
400.01	1.818	0.74	404.1	1.02	0.475887	457.029	1.965	0.8082
399.99	4.244	1.882	403.9	1.804	0.865737	457.017	4.554	2.0964
399.81	1.732	0.705	404.2	0.879	0.371693	457.928	2.597	1.0648
399.98	3.941	1.419	403.74	1.876	0.840519	457.772	1.433	0.6208
401.15	2.768	1.005	403.81	1.469	0.648395	458.364	2.314	1.0454
399.86	1.106	0.448	404.68	2.798	1.185501	456.497	1.407	0.584
399.24	2.874	1.083	403.73	0.937	0.397761	457.442	1.523	0.6677
399.66	3.229	1.261	403.43	2.406	0.99757	459.272	1.225	0.5168
400.69	1.652	0.728	404.72	2.156	0.997139	457.748	2.829	1.2925
400.48	1.572	0.63	403.82	2.114	1.020593	457.591	3.597	1.4863
399.95	1.714	0.842	403.16	3.041	1.437885	458.342	2.078	0.9597
400.82	1.77	0.761	404.67	1.233	0.537537	458.549	0.981	0.4675
399.45	2.394	0.943	403.89	2.38	0.978515	458.165	3.654	1.6462
399.41	3.532	1.516	404.14	1.446	0.626954	457.797	3.311	1.4729
399.76	4.608	1.851	404.17	2.596	1.113674	459.137	3.427	1.6167
399.95	3.394	1.269	405.43	2.463	1.006588	458.664	2.903	1.4009
400.21	3.744	1.404	404.73	1.23	0.640951	459.603	3.492	1.8576
400.36	3.095	1.315	404.84	2.975	1.264511	458.56	2.356	1.0289
400.03	2.298	0.947	403.52	3.494	1.498419	459.314	2.143	0.9097
400.06	2.249	0.99	404.09	2.193	0.986916	458.68	1.772	0.8721
400.2	2.435	0.927	404.37	3.051	1.415309	458.311	2.948	1.2672
399.79	3.291	1.246	403.92	2.786	1.141417	458.863	1.873	0.8805
399.4	2.267	0.961	404.09	2.243	0.968679	459.514	0.261	0.1212
399.49	2.97	1.128	403.39	1.956	1.123991	459.499	2.844	1.1984
400.01	3.834	1.42	403.65	0.488	0.218866	459.767	3.266	1.365
400.71	1.115	0.469	404.13	1.986	0.905612	459.577	2.34	1.1913
399.82	2.64	0.976	404.33	0.932	0.42227	459.383	1.366	0.5908
399.33	1.804	0.698	404.21	2.32	1.047848	459.214	1.594	0.689
400.48	1.963	0.899	403.99	0.931	0.401784	459.609	1.931	0.9187
400.18	3.825	1.59	403.84	1.324	0.607596	459.883	2.551	1.1123
399.62	2.745	1.131	404.17	1.497	0.675013	459.633	4.778	1.969
400.08	3.344	1.302	404.6	2.081	0.981645	459.262	0.903	0.4221
399.61	2.488	0.909	403.8	1.77	0.784889	461.108	1.04	0.5163
399.8	1.803	0.642	404.79	3.216	1.444937	460.161	0.299	0.1344
399.62	1.42	0.532	403.95	1.827	0.811704	459.774	3.077	1.4258
399.81	1.398	0.602	403.77	2.141	0.876865	459.795	0.621	0.2597

399.97	3.211	1.216	404.94	3.758	1.671109	460.409	2.905	1.3094
399.06	2.178	0.91	404.43	2.332	0.995737	459.908	1.786	0.7926
400.44	2.549	1.015	404.1	4.644	2.097657	459.778	2.437	1.0248
400.11	3.85	1.486	404.11	2.454	1.069002	460.047	4.011	1.7387
399.74	3.223	1.166	404.71	0.993	0.433068	459.956	4.028	1.7748
399.67	2.448	0.959	403.86	1.73	0.759944	461.04	5.202	2.5608
399.91	1.712	0.671	403.59	2.234	0.921607	461.423	1.883	0.9898
400.21	1.683	0.605	402.87	3.575	1.507267	460.696	4.598	1.8984
400.7	1.133	0.422	403.64	2.068	0.950212	460.643	2.667	1.1296
400.43	2.106	0.855	404.31	4.116	1.820208	461.319	3.529	1.4786
400.37	2.982	1.124	404.27	4.115	1.691268	460.34	2.554	1.0954
399.66	1.959	0.823	403.61	1.242	0.552339	461.153	2.125	0.9145
400.31	1.721	0.69	404.49	2.957	1.320259	461.821	0.805	0.3297
399.95	3.417	1.396	403.07	1.195	0.489001	461.327	1.58	0.7369
400.66	1.211	0.443	402.96	1.125	0.561939	461.271	2.327	1.0963
399.87	2.302	0.832	404.81	1.826	1.02404	461.113	0.58	0.2468
399.56	0.96	0.366	403.59	2.054	0.940246	461.649	2.151	1.0848
400.16	1.207	0.533	404.56	0.702	0.290016	461.679	0.658	0.3174
399.9	1.656	0.715	404.02	1.811	0.929434	460.772	1.741	0.7492
400.7	2.557	0.916	404.11	3.825	1.584127	461.566	4.047	1.7336
399.4	2.842	1.034	403.92	1.407	0.632888	461.302	2.328	1.0042
400.41	2.816	1.307	403.89	2.986	1.431684	461.913	1.977	1.0356
399.74	2.244	0.865	403.85	2.18	1.013036	461.424	2.43	1.049
400.5	2.713	1.057	404.01	1.886	0.855725	462.177	2.754	1.3239
399.8	1.845	0.757	404.38	0.79	0.403615	462.202	2.243	1.0677
400.18	2.541	0.925	404.64	1.54	0.725105	462.976	5.238	2.2912
399.95	1.103	0.513	403.65	3.317	1.607038	462.154	2.689	1.1515
399.85	1.786	0.684	404.23	2.948	1.36322	463.453	1.891	0.808
399.71	1.394	0.567	403.36	2.312	1.037994	462.812	0.594	0.2756
400.2	1.177	0.481	403.56	2.291	1.001973	462.578	4.056	1.6893
400.37	2.784	1.006	403.46	1.812	0.820018	462.219	2.856	1.3296
399.3	2.588	0.959	405.02	1.125	0.479547	463.194	2.463	1.0724
400.35	2.838	1.015	403.5	1.587	0.705074	462.883	0.835	0.4494
399.54	2.155	0.981	403.55	2.499	1.173886	462.609	1.895	0.8687
400.29	3.405	1.253	404.28	1.295	0.570622	463.574	1.375	0.5889
400.85	2.425	0.867	404.38	2.178	0.918332	462.347	1.019	0.4217
400.42	2.161	0.779	404.72	3.172	1.358531	462.877	2.349	1.258
399.9	0.972	0.364	403.46	1.942	0.873526	463.951	3.04	1.3956
399.96	2.086	0.859	403.31	1.313	0.548218	463.622	2.288	0.9953
399.91	2.227	0.808	404.02	3.054	1.249709	464.549	1.856	0.8614
400.13	2.495	1.131	404.24	3.326	1.461352	464.078	1.187	0.5327
400.61	2.845	1.273	404.15	1.15	0.534913	464.188	3.171	1.4182
400.24	2.331	0.861	404.93	1.023	0.430418	464.409	1.882	0.7721

400.02	2.764	0.983	403.97	1.594	0.718928	462.758	1.959	0.8923
399.26	2.169	0.804	404.47	1.454	0.648299	464.253	4.888	2.1875
400.56	1.907	0.707	404.91	2.11	0.892588	463.552	4.942	2.0954
399.55	2.759	1.128	403.83	3.418	1.552117	463.841	5.825	2.653
400.13	2.698	0.999	405.07	1.63	0.781752	463.565	3.357	1.6457
400.06	2.501	0.955	404.44	2.686	1.098331	463.679	1.641	0.6756
400.29	2.301	0.882	403.68	2.26	1.081142	462.679	2.005	1.0735
400.44	1.127	0.453	403.61	1.22	0.504567	463.842	2.582	1.138
399.28	2.551	1.057	404.45	1.252	0.580252	463.978	2.095	1.1102
400.05	1.852	0.688	404.48	2.289	1.019626	464.255	2.472	1.0153
399.67	1.455	0.591	404.59	3.365	1.435004	464.606	1.803	0.7978
399.93	3.03	1.217	404.39	1.021	0.432438	464.333	1.464	0.6044
400.07	1.392	0.516	403.49	2.546	1.223994	464.393	1.303	0.5573
399.55	2.445	0.95	403.67	1.837	0.829575	464.807	2.043	0.8994
399.34	2.245	0.843	403.6	2.072	0.976781	464.882	1.789	0.8383
400.19	2.11	0.888	404.11	3.477	1.471515	464.905	3.218	1.328
400.08	1.927	0.798	404.26	1.614	0.671457	465.05	3.972	1.8665
399.66	2.07	0.859	403.64	3.153	1.421728	464.522	2.492	1.1199
400.85	3.102	1.196	404.83	1.474	0.684027	465.674	2.551	1.0465
399.9	1.943	0.796	404.73	2.751	1.161905	464.878	2.658	1.1036
400.15	1.163	0.517	403.03	1.941	0.892315	464.674	3.054	1.2497
399.54	2.277	0.814	404.89	1.19	0.556858	465.622	4.349	1.8248
400.58	3.052	1.286	404.24	3.445	1.590699	465.158	4.023	1.7688
399.66	2.596	1.033	403.41	2.507	1.055	465.853	3.105	1.3106
399.5	2.511	0.995	404.56	2.696	1.105412	465.655	1.991	0.9426
399.54	2.731	1.009	403.91	1.259	0.570627	466.393	1.796	0.8302
400.03	2.138	0.929	404.27	1.927	0.804641	465.519	2.473	1.1055
399.35	2.688	1.057	404.38	3.488	1.489845	466.751	1.361	0.5906
400.29	0.934	0.332	403.31	1.58	0.719421	465.796	3.444	1.4529
399.88	1.804	0.678	404.2	0.826	0.460484	465.452	2.98	1.3349
400.21	1.194	0.428	404.28	1.284	0.59331	465.748	2.483	1.1625
399.84	4.226	1.72	403.83	2.345	1.074477	466.619	1.811	0.7515
400.1	1.865	0.744	403.46	1.151	0.516568	466.507	1.625	0.6811
399.35	1.496	0.635	404.27	2.101	0.93714	466.055	1.956	0.8302
400.46	3.191	1.286	403.64	3.554	1.51973	464.629	2.243	0.9636
399.5	2.18	0.799	403.95	1.266	0.578452	465.99	5.539	2.5018
399.6	2.805	1.023	404.7	1.891	0.798492	466.705	2.579	1.2231
400.1	1.797	0.78	404.97	2.246	0.994379	467.624	4.008	1.8018
399.98	0.983	0.386	404.15	0.67	0.2837	467.446	2.951	1.2828
400.68	1.622	0.665	404.71	2.167	0.912542	467.415	2.223	0.9541
399.95	1.097	0.432	403.46	2.085	0.892776	466.221	4.15	1.9823
399.77	3.005	1.377	404.44	3.335	1.426513	467.012	3.364	1.5473
399.36	2.231	0.88	404.33	1.833	0.889933	466.804	1.784	0.7357

399.73	2.632	0.967	404.32	2.25	0.960624	466.885	0.754	0.3957
399.66	0.846	0.324	404.76	2.895	1.237322	467.133	2.727	1.262
399.07	2.769	1.127	403.87	3.541	1.479706	466.672	1.308	0.5386
399.86	2.354	0.894	403.88	2.647	1.215601	467.685	1.668	0.7363
400.49	1.344	0.573	403.75	3.301	1.430898	466.666	3.627	1.6736
400.96	1.648	0.646	403.67	1.577	0.67854	466.948	0.85	0.3648
400.45	2.818	1.102	403.69	3.279	1.408769	467.771	2.156	0.9624
399.81	2.778	1.056	403.4	1.593	0.670595	467.932	1.923	0.9065
400.08	2.642	0.986	403.37	2.713	1.178633	467.746	1.296	0.546
399.71	4.508	1.761	403.29	1.225	0.601362	467.759	2.569	1.0613
399.85	2.281	0.878	403.45	2.836	1.242941	467.535	2.309	0.9897
399.5	3	1.101	404.14	2.577	1.141197	468.043	2.228	1.0153
400.06	1.646	0.618	403.78	1.564	0.653336	467.558	1.547	0.6319
399.47	3.185	1.17	404.14	1.246	0.590133	468.208	1.985	0.945
400.46	3.019	1.095	403.85	0.613	0.274813	468.026	2.99	1.4399
399.92	1.877	0.706	404.16	0.538	0.229869	467.893	2.706	1.1513
400.06	2.145	0.851	403.65	1.09	0.591494	468.969	1.781	0.9054
399.44	2.168	0.79	404.22	0.932	0.384861	469.025	2.987	1.2634
400.71	3.537	1.531	403.97	1.205	0.550598	468.991	1.584	0.7344
399.99	2.639	1.095	403.9	1.94	0.803737	469.94	3.059	1.3798
400.35	1.715	0.657	405.14	3.378	1.388274	468.271	4.753	2.0258
400.22	2.47	1.08	403.7	1.601	0.700833	468.754	3.625	1.5465
400.88	2.719	0.968	404.34	2.074	0.952005	468.698	2.314	1.0531
399.91	2.627	0.968	403.6	1.998	0.819605	469.707	1.85	0.8825
400.14	1.649	0.683	403.8	3.179	1.380059	468.114	2.526	1.2004
399.82	0.633	0.235	404.73	2.989	1.473856	469.931	3.22	1.3366
399.84	2.032	0.837	403.33	3.951	1.832395	468.089	3.481	1.6162
399.36	3.154	1.261	404.89	2.711	1.264329	469.47	3.023	1.4325
399.94	2.819	1.255	404.12	0.789	0.334333	468.651	2.226	1.038
400.02	1.551	0.634	403.7	5.442	2.27447	470.498	2.375	1.1189
399.57	2.778	1.146	403.94	1.975	0.823961	468.956	2.27	0.9942
401.03	2.509	0.957	404.6	1.307	0.617024	468.909	3.43	1.4285
399.6	1.403	0.578	404.87	1.652	0.675776	468.978	2.997	1.3671
400.17	2.907	1.212	403.63	0.582	0.25465	469.966	1.999	0.911
399.99	2.707	1.162	404.29	0.503	0.215627	470.006	2.577	1.1609
400.1	1.763	0.762	403.71	1.262	0.678031	470.764	3.07	1.2918
399.25	0.869	0.33	404.24	2.582	1.138807	470.275	0.585	0.2717
399.64	2.164	0.83	404.2	0.765	0.340968	469.466	1.45	0.7078
400.16	1.509	0.575	403.63	2.431	1.023613	469.311	0.84	0.3954
399.48	1.901	0.771	404.25	1.628	0.854697	470.043	3.954	1.6942
400.24	1.212	0.545	402.96	2.086	0.994433	469.978	1.493	0.7529
400.04	3.32	1.323	403.86	1.199	0.504161	470.972	3.178	1.5015
399.82	3.427	1.446	404.2	2.663	1.128333	471.168	2.751	1.2631

399.65	2.16	0.941	405.03	3.089	1.301598	469.776	3.204	1.3647
400.43	2.427	0.93	403.83	1.674	0.709149	470.903	4.258	1.9719
400.08	2.612	1.08	402.71	1.522	0.631891	470.874	2.125	1.0981
400.15	2.688	0.996	404.39	1.617	0.766033	471.097	2.426	1.1337
399.91	2.041	0.774	404.94	3.113	1.491598	471.087	2.356	1.0879
399.65	2.626	1.132	403.71	2.241	0.956404	470.382	1.099	0.4735
399.41	2.365	1.051	403.97	0.769	0.346137	471.55	1.716	0.7802
399.84	3.957	1.475	403.99	1.952	0.847486	470.263	2.254	1.0311
400.38	2.899	1.175	404.31	3.238	1.430964	471.796	4.637	2.0982
400.13	3.638	1.374	403.74	1.945	0.904611	471.629	1.656	0.7481
398.94	1.77	0.737	404.11	2.611	1.123278	471.371	2.053	0.917
400.51	1.544	0.623	404.28	1.1	0.452835	472.223	2.71	1.2525
400.32	2.819	1.09	405.06	2.508	1.046103	471.51	3.74	1.5657
400.41	1.294	0.573	404.1	1.454	0.616088	471.481	1.159	0.5035
400.36	3.19	1.376	404.29	2.305	0.981541	471.441	2.504	1.1486
399.02	4.716	1.864	403.34	1.779	0.812688	472.273	3.094	1.354
399.74	1.616	0.651	403.77	1.624	0.768576	471.691	1.527	0.6478
399.5	3.508	1.251	404.7	1.23	0.545695	471.591	3.715	1.6515
400.13	2.882	1.116	403.56	1.954	0.903372	471.987	1.274	0.5513
400.01	2.846	1.158	403.8	3.665	1.521863	472.547	4.633	1.9292
400.01	1.689	0.646	403.65	0.636	0.290556	472.502	3.298	1.6109
400.42	1.534	0.64	403.78	2.543	1.114732	471.864	3.697	1.6012
399.6	2.703	1.023	403.29	2.23	0.9243	472.36	2.484	1.0682
400.38	1.193	0.509	404.05	2.286	1.003324	472.64	2.406	0.996
399.64	2.678	1.26	405	2.638	1.164655	471.617	1.963	0.8125
400.79	2.373	0.945	403.62	1.697	0.7	473.226	2.123	0.9438
400.38	3.116	1.282	403.79	0.978	0.426748	472.268	2.157	0.9376
400.36	1.984	0.809	403.4	1.273	0.607116	472.865	2.747	1.1226
399.63	2.201	0.911	403.16	2.393	1.020181	472.572	2.083	0.8652
399.37	0.776	0.304	404.35	1.795	0.920526	473.784	2.116	0.929
400.29	2.063	0.77	403.93	1.02	0.418093	473.555	1.135	0.5071
399.72	2.562	0.94	404	1.863	0.808053	473.59	0.932	0.4299
400.02	1.848	0.744	404.07	1.919	0.808711	474.653	3.075	1.2589
399.16	4.187	1.599	402.68	2.845	1.16569	472.055	3.256	1.5554
399.9	3.882	1.438	403.34	2.717	1.151988	472.583	1.978	0.9002
399.5	3.28	1.248	403.69	1.765	0.730833	472.909	2.862	1.2531
399.94	1.575	0.613	403.46	1.384	0.611648	474.605	3.339	1.7103
399.33	2.465	1.024	403.88	2.254	0.975249	473.176	3.201	1.3942
399.95	2.167	0.813	403.51	4.809	1.999196	472.707	1.818	0.8466
400.21	2.051	0.842	404.33	1.49	0.718506	473.885	2.004	0.9119
399.9	2.135	0.963	404.92	1.367	0.635793	473.489	1.67	0.7668
399.69	2.374	0.997	404.03	1.632	0.749204	474.333	1.38	0.6389
399.28	1.826	0.728	404.38	0.933	0.389441	474.148	3.014	1.3406

400.2	3.204	1.223	403.56	1.647	0.809946	473.691	1.755	0.8943
400.18	3.868	1.555	403.31	1.25	0.52651	474.785	3.721	1.7407
398.73	2.026	0.83	404.75	0.705	0.340127	474.092	3.099	1.3898
400.19	4.604	1.672	402.67	2.852	1.297613	473.695	2.404	1.0345
399.93	1.342	0.647	403.48	1.684	0.727091	473.438	1.508	0.6804
399.27	2.474	0.955	403.18	2.035	0.908752	474.156	3.75	1.6782
400.17	2.192	1.033	403.72	1.304	0.548669	475.031	3.361	1.5094
399.79	1.151	0.548	403.77	1.366	0.647908	474.029	1.64	0.7466
399.74	2.572	1.051	403.55	2.126	0.993195	474.206	3.005	1.3268
399.78	3.114	1.141	403.78	1.555	0.732135	474.621	2.228	0.9694
400.36	1.702	0.71	403.81	2.513	1.236511	474.586	3.838	1.6052
399.44	2.135	0.962	404.62	1.093	0.564384	475.59	2.248	1.0419
399.44	1.979	0.801	403.37	2.19	0.942448	474.892	1.52	0.7272
399.64	0.991	0.376	404.48	3.325	1.470155	475.935	2.665	1.0923
400.39	2.766	1.102	404.53	1.716	0.762626	476.323	3.631	1.628
400.71	2.014	0.799	404.48	2.819	1.225915	474.333	2.247	1.0693
400.14	3.39	1.282	404.34	5.138	2.175944	475.488	3.523	1.6132
400.04	1.579	0.595	403.16	1.757	0.793114	475.766	3.961	1.8586
400.36	3.124	1.218	404.9	2.032	0.951004	476.082	1.638	0.7352
399.9	3.451	1.384	404.51	1.572	0.66259	476.12	1.778	0.7289
400.73	1.378	0.586	404.65	2.771	1.263883	475.833	1.035	0.5557
400.12	2.854	1.203	403.93	1.543	0.67083	475.86	1.423	0.5969
399.26	1.525	0.662	404.7	3.234	1.543956	475.697	2.526	1.0576
399.26	2.301	0.83	404.73	2.565	1.133313	476.781	1.683	0.7735
400.86	1.622	0.655	404.57	4.348	1.847547	475.814	2.623	1.1858
400.13	2.278	0.912	403.9	1.571	0.67069	475.602	2.246	1.0484
400.16	1.34	0.492	403.78	1.332	0.576842	474.937	2.315	1.0196
400.45	2.11	0.82	404.69	1.53	0.686411	476.574	3.253	1.4537
399.96	3.923	1.427	404.07	3.202	1.459716	475.917	3.336	1.6218
399.07	2.948	1.262	404.86	1.5	0.716515	475.766	3.308	1.497
399.82	1.712	0.639	404.53	2.754	1.266501	478.287	2.4	1.0389
399.7	1.926	0.724	403.76	1.092	0.480253	476.527	1.415	0.6428
399.83	3.97	1.682	404.01	2.581	1.16044	475.884	2.761	1.399
401.23	3.139	1.262	403.65	2.1	0.90366	476.432	0.438	0.2097
399.7	2.401	0.917	404.25	1.984	0.898071	476.59	1.855	0.8761
400	3.791	1.642	404.03	3.61	1.632754	476.483	2.26	1.0602
399.15	2.244	1.001	403.83	2.672	1.105285	476.885	1.927	0.9826
401.04	1.532	0.628	403.91	0.704	0.318538	476.323	2.055	0.8457
399.83	0.651	0.249	403.74	2.035	0.918639	476.771	2.428	1.0801
399.7	1.222	0.506	403.89	1.648	0.676593	477.092	1.823	0.9354
399.74	2.179	0.825	403.69	0.782	0.330503	477.006	3.006	1.4982
400.66	1.986	0.772	403.62	0.897	0.399084	477.627	2.421	1.0748
399.72	4.089	1.944	404.34	2.237	0.917753	477.247	2.428	1.3294

399.93	4.331	1.652	403.24	3.902	1.70157	478.085	2.872	1.198
399.34	2.828	1.177	403.32	2.189	0.99142	478.269	2.51	1.049
400.92	1.888	0.749	404.3	2.512	1.106037	477.049	4.201	1.9781
400.04	1.373	0.573	404.1	1.59	0.763899	478.017	2.637	1.2254
399.51	2.858	1.125	405.03	2.444	1.157923	477.324	3.485	1.7223
400.32	1.475	0.605	404.08	2.388	1.240667	478.469	1.906	0.907
399.96	1.786	0.685	404.93	2.642	1.173041	478.046	3.286	1.4625
399.91	1.998	0.783	404.03	2.876	1.229321	477.593	1.078	0.4479
400.56	3.637	1.406	403.78	2.04	0.940609	478.124	3.478	1.5363
399.31	2.241	0.822	403.74	2.089	0.947614	477.906	2.376	1.1276
400.52	1.041	0.398	405.25	3.395	1.639049	478.101	3.218	1.4411
399.26	2.047	0.815	404.36	3.267	1.373208	478.457	1.843	0.8686
400.12	1.576	0.7	402.85	3.684	1.68917	477.32	2.192	1.0326
399.82	1.467	0.63	404.06	1.982	0.879716	478.701	3.339	1.5594
399.59	3.249	1.359	404.32	3.298	1.459068	478.598	3.348	1.3743
399.86	2.31	0.852	403.51	4.294	1.829647	478.604	3.786	1.5547
399.8	4.508	1.871	404.15	1.611	0.751168	479.061	2.403	1.1156
399.4	1.652	0.631	404.71	2.127	0.88201	477.798	3.439	1.5475
400.05	1.27	0.521	404.43	2.583	1.184695	478.859	2.381	1.007
400.94	4.45	2.187	403.5	2.636	1.145904	478.855	3.55	1.5828
399.38	3.208	1.242	403.46	2.783	1.151864	479.171	2.383	0.9984
399.73	3.761	1.426	403.8	2.438	1.068141	478.5	1.157	0.5139
400.15	2.614	1.155	403.96	3.307	1.392698	478.475	3.31	1.5198
399.82	1.786	0.739	403.97	1.167	0.503147	479.953	3.543	1.6437
399.65	2.142	0.92	404.23	0.259	0.110008	479.709	2.04	0.8493
399.84	0.897	0.419	403.57	1.919	0.913458	479.162	2.571	1.1833
400.85	1.808	0.723	404.88	3.28	1.381161	479.644	0.87	0.395
401.05	1.476	0.558	403.88	1.151	0.539819	479.238	2.143	0.9535
399.49	2.68	1.016	404.79	1.398	0.695172	479.318	1.539	0.7228
399.89	1.962	0.717	404.37	3.436	1.442399	479.982	1.945	0.8086
399.75	1.508	0.538	404.17	1.905	0.779848	478.704	3.973	1.9816
399.66	1.367	0.566	404.18	1.952	0.789848	479.721	3.422	1.4059

Table 11: Dataset