Run Charts for Statistical Process Improvement in Healthcare

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Abstract

A run chart is a statistical tool that interprets data in an orderly, interval, or consecutive form. It is a graph used to illustrate the relationship among variables and identify variation within the dataset, either random or non-random. Any type of simple to complex data can be used in a run chart to interpret or understand. There are multiple steps to analyze a run chart to identify variation, whether patterns, trends, mixtures, clusters, or oscillations. However, there are four run chart rules that are relevant to healthcare practices and applications.

What Is A Run Chart?

A Run Chart:

“A run chart is a graphical display of data plotted in some type of order” (Perla et al., 2011).

The present world is growing day by day, and vast volumes of data are available for analysis purposes. For that reason, multiple statistical tools are available to understand, interpret and illustrate specific relationships in data. The run chart is one such practical statistical tool used to interpret specifically inherent variation in data under consideration. A run chart is a graph usually known as a run-sequence plot that is used to understand and interpret data in the frame of time sequence. The data we use may contain time intervals concerning the output or performance of some business units. The available data may have some patterns or trends depending upon the interval of time. A run chart is a display of data representing time with a proper unit of time passage, i.e., hours, days, months, or years. That is why the run chart is constructed as a line chart. As far as data representation is concerned, the specific or integral unit of time always lies on the x-axis. The values indicating specific trends are displayed on the y-axis or vertical line of the graph.

Furthermore, a run chart is specifically used to detect variations, shifts, configurations, inclinations, or cyclic patterns. In this connection, a run chart helps implement any decision for good impacts depending on the interpretation of trends or patterns. Additionally, the policy-making authorities can also estimate and compare the performance indicators before or after implementing any policy or decision. In other words, run charts are beneficial and easy-to-use practical tools to interpret data for better progress with time trends.

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Type of Data Used with Run Chart:

However, we confront multi-variant data types that need to be interpreted and understood in our daily lives. In the case of a Run Chart, any kind of data can be displayed or plotted in a graphical representation. Such types may range from simple to very complex data entries to be entertained. For example, arithmetic operations like rate, count, average, or percentage, and organizational data like accounts, money, attendance, production, sale, score, index, etc., can be displayed through a run chart. All these strata of various data types are aligned to represent the graph with time intervals and events like hours, weeks, months, etc., depending upon the requirements of users. All such types of data can be represented or plotted on the run chart with only one condition: all the data must be organized and arranged in time sequence or chronological order. Additionally, a reference line is used to represent the median placed through data points. The median, in this respect, is one of the essential elements of a run chart.

The Steps Used to Analyze a Run Chart:

Moreover, the analysis of a run chart is a little bit complex but easy to handle if we analyze it as a step-by-step procedure. First of all, one should look at the patterns in the data presented in the run chart. These patterns in data show the presence of variation in a specific sequence. It indicates that the presence of variation follows some special causes that need to be investigated or interpreted. There may be two types of variations in the pattern in the run chart: common cause and special cause variation. It is worth noting that if common cause variation is identified in data, it exhibits random behaviour.

A further step involves analysis based on the median, testing the number of runs below or above it. A run can be understood as one or more consecutive points on the same side of the line, and it ends when the centre line is crossed. In this regard, the identification of the number of runs is very significant. After identification, testing of the run is peculiar while analyzing the run chart. Such tests indicate two non-random behaviours named clusters or mixtures. The cluster patterns point out special cause variation indicating measurement, sampling, or setting up a defect in this regard. The easy way to understand is by considering the p-value. Clusters in data can only be shown if the p-value is less than 0.005. On the other hand, mixture patterns can be identified by frequently crossing the centre line. Mixture patterns represent a combination of two samples or processes of data at different levels. Here, in the case of the mixture pattern, the p-value also remains less than 0.05.

Furthermore, testing regarding observed runs' ups and downs is vital because the precision and accuracy of run charts are not as sophisticated as Shewhart charts (e.g., cases of X-ray or MRI). Both run up and run down are consecutive points that increase and decrease, respectively. The run-up and run-down tests can indicate whether the pattern is oscillations or trends. Both indicate non-random behaviour (Aggarwal et al., 2012).

The Four Run Chart Rules:

Moreover, regarding the relevance to healthcare practices, there are four run chart rules. These can be applied to determine whether the variations in the given dataset are random or non-random.

The first rule relates to a shift in the prescribed or presented data. If there are six or more consecutive points either above or below the median on the specific run chart, it is identified as a shift in the data. The said rule has the basis of statistical probability. All the values that do not fall on the median are to be counted as such values have no addition or breaking effect on shift. If we look at the probability rules, we can easily estimate whether the outcome variation relates to shift or not. For example, in an event where two outcomes each have a 50% chance of occurring, the probability indicates that such an outcome, occurring in six-run rates, has a value lower than 3 in a sample of 1000. In this context, the change or variation is not random (Gauri, 2011).

On the other hand, rule two relates to the trend in the given data set. In trend, there is little difference from the shift rule, i.e., if five or more consecutive points instead of six going up or down are observed, it relates to the trend. It is noteworthy that if two or more consecutive value points occur, one should ignore them, and the rest will be counted.

Further, rule three is the Run rule that indicates consecutive points on either side of the median in a row. These points are in the form of a series. If too few or too many runs are identified on the median line, the pattern is nonrandomized. In this case, instead of counting the number of runs, the observer has to count the number of times that the median line is crossed by data and simply add one to it.

Lastly, rule four relates to astronomical points. This rule is used to detect abrupt small or large values. The most significant identification of these values states that they are quite dissimilar to all or specific values, and such differences are much more obvious. Meanwhile, studying a run chart with such values shows that it is very unusual (Williams, 2018).

References

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