Minitab®

Lesson 01–Introduction to Minitab®

Objectives

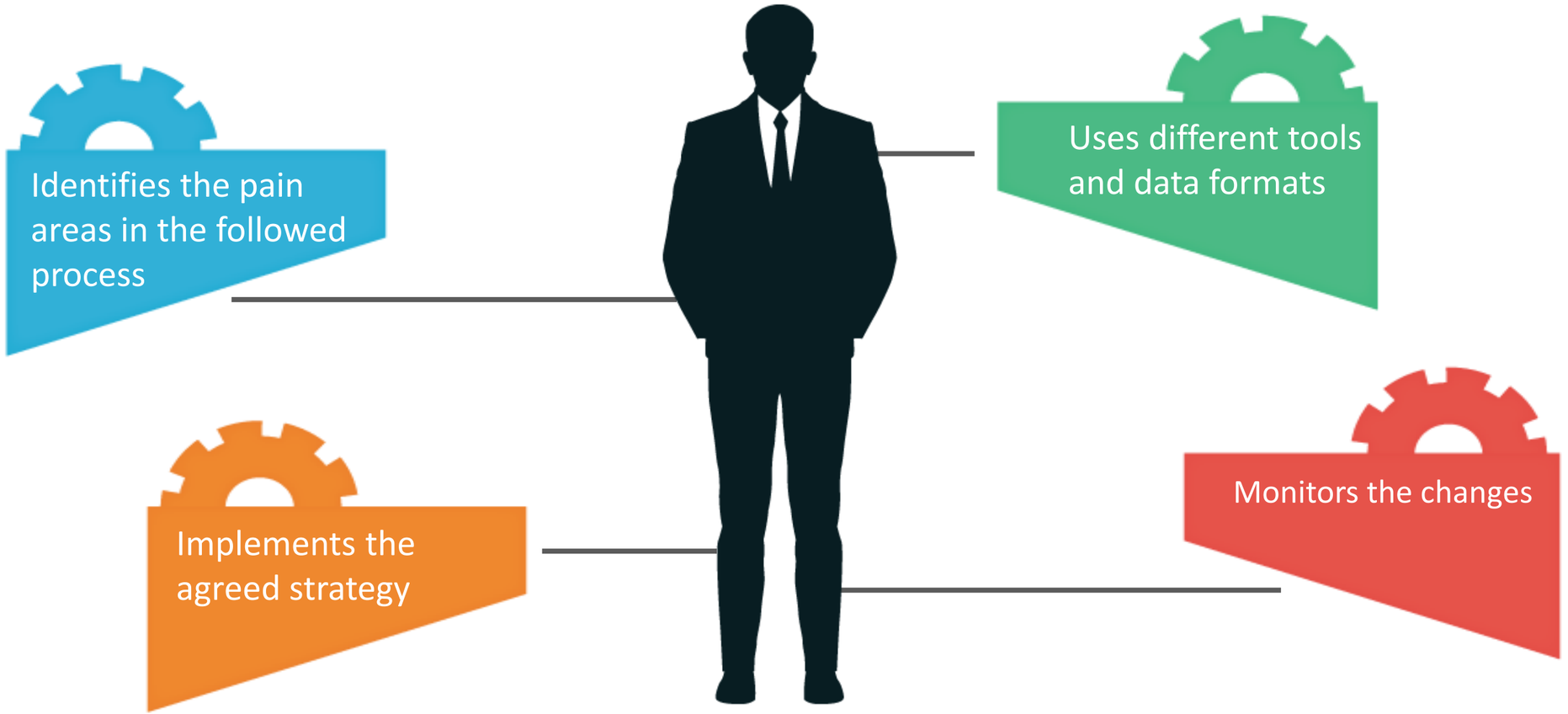
After completing this lesson, you will be able to:

- Comprehend the importance of Minitab®
- Review the worksheet format and structure
- Define data window column conventions
- Define other data window conventions
- Discuss the menu bar options

Overview and Importance of Minitab®

A Step Back–Six Sigma Overview

- Six Sigma is a set of quality management techniques and tools used for improving the followed business processes.
- The following techniques relay on Statistics and Hard Data.



Introducing Minitab®

The Minitab® software is designed specifically for the needs of Six Sigma practitioners.

Minitab® aids in:

Simplifying input of statistical data

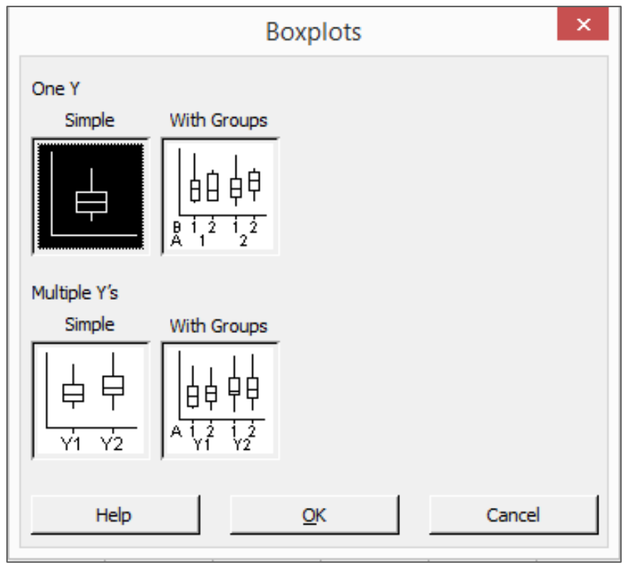
Manipulating data

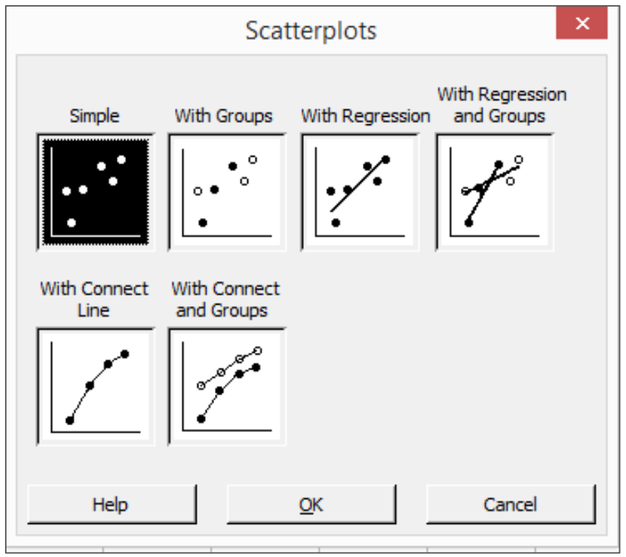
Identifying trends and patterns

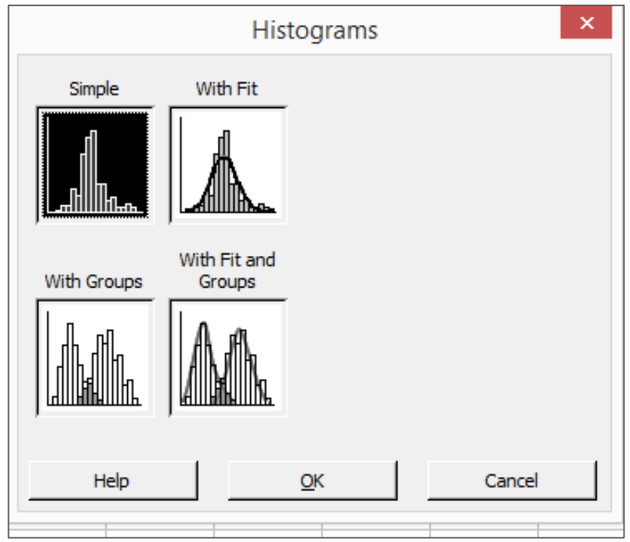
Extrapolating solutions to the problem at hand

Introducing Minitab® (contd.)

Minitab® software uses a series of elements to help Six Sigma practitioners work with data and statistics.



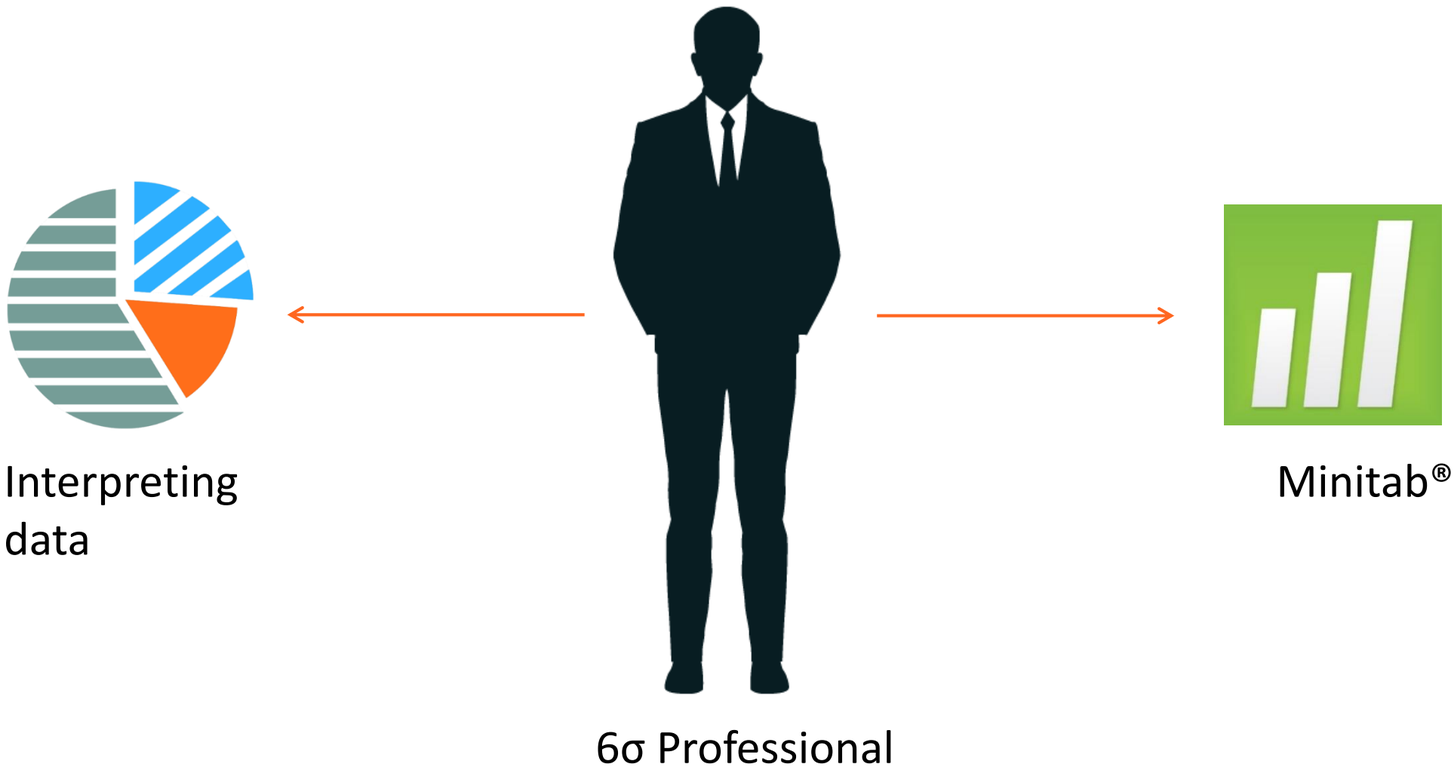




They collectively help calculate descriptive statistics.

Importance of Minitab®

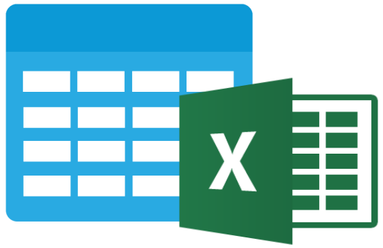
- Six Sigma professionals are trained in the use of hard data; software to accomplish the following tasks:
- Analyzing data is an important part of 6σ



Importance of Minitab® (contd.)

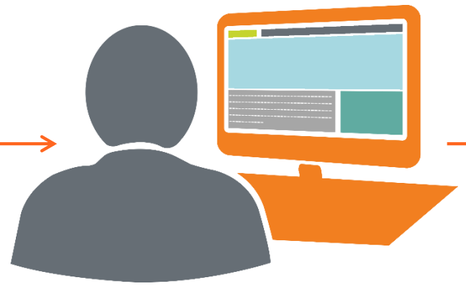
Using MS Excel as well as Minitab®?

Using Excel to solve business problems



Employ Macros

Minitab®

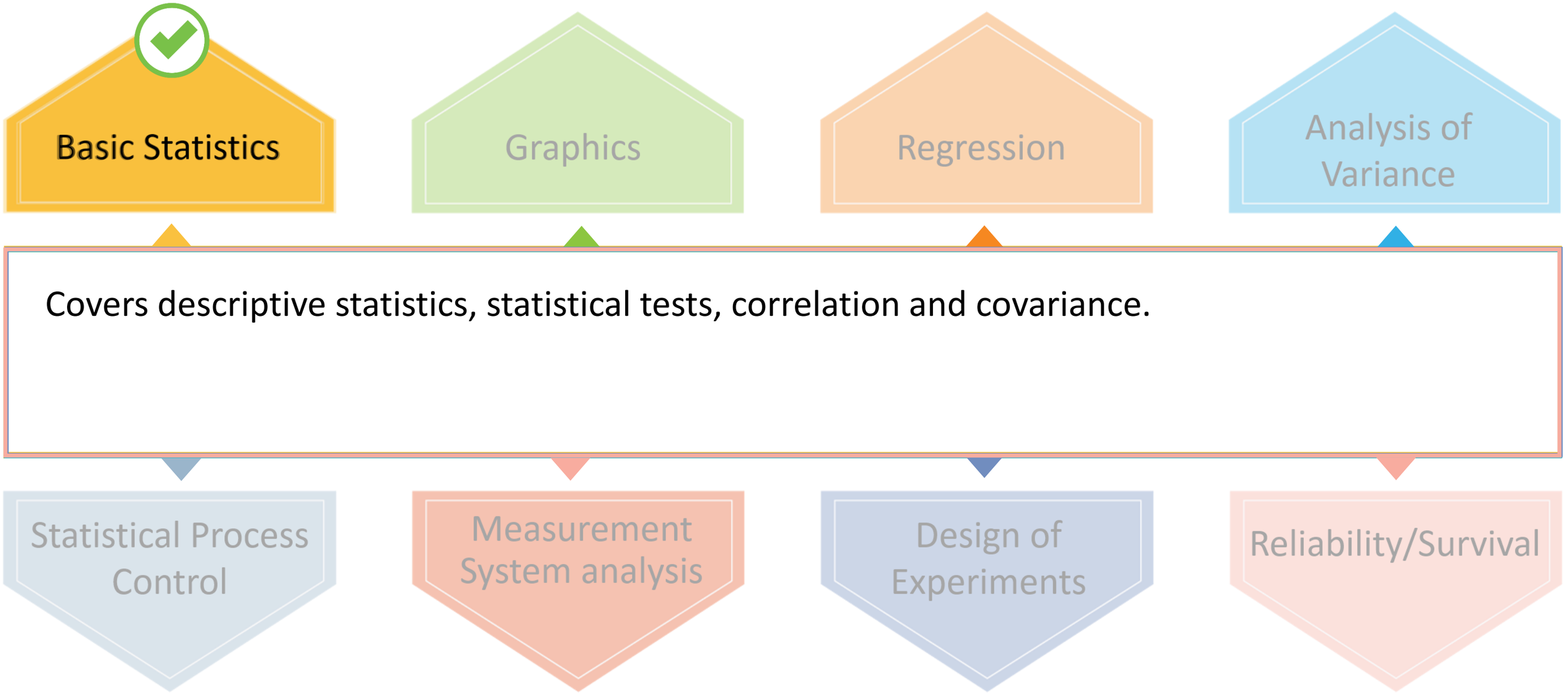


User friendly interface

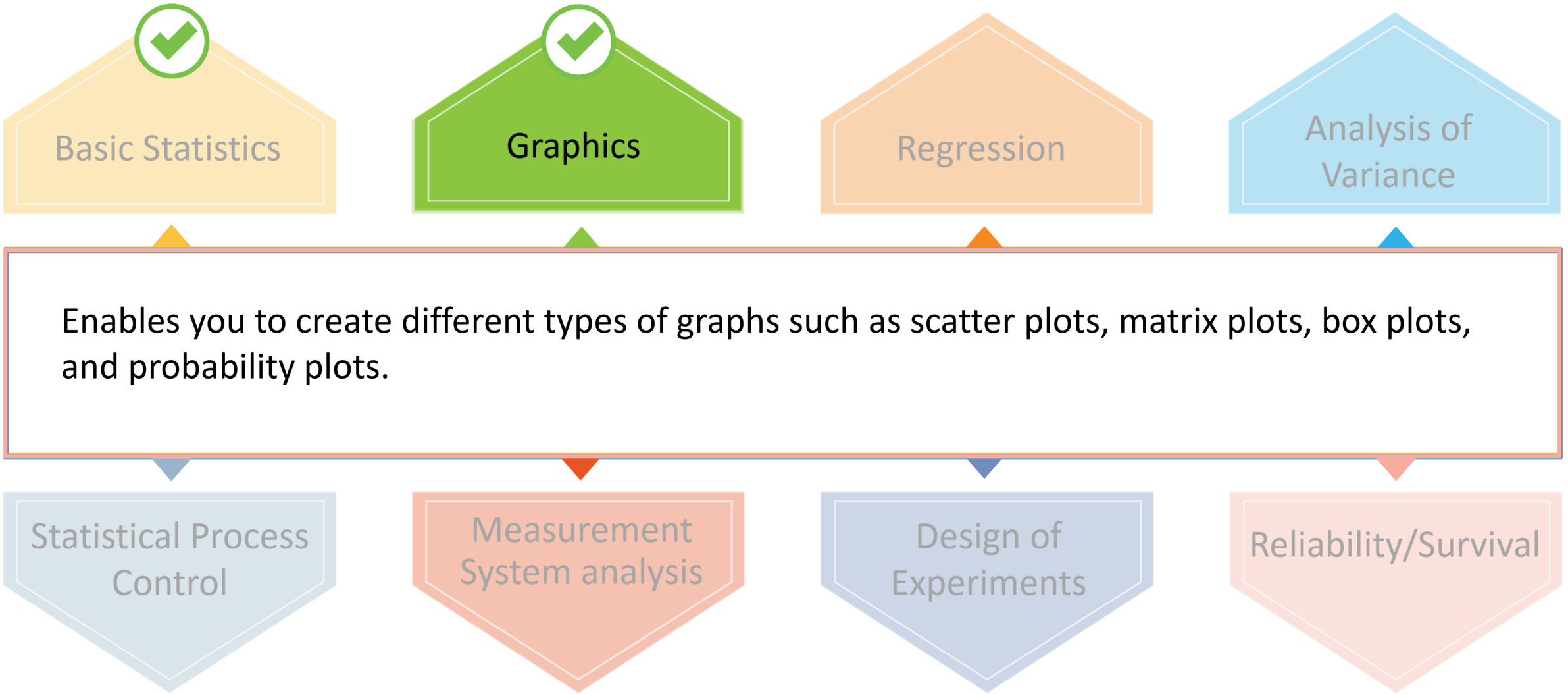
Structured data

Features of Minitab®

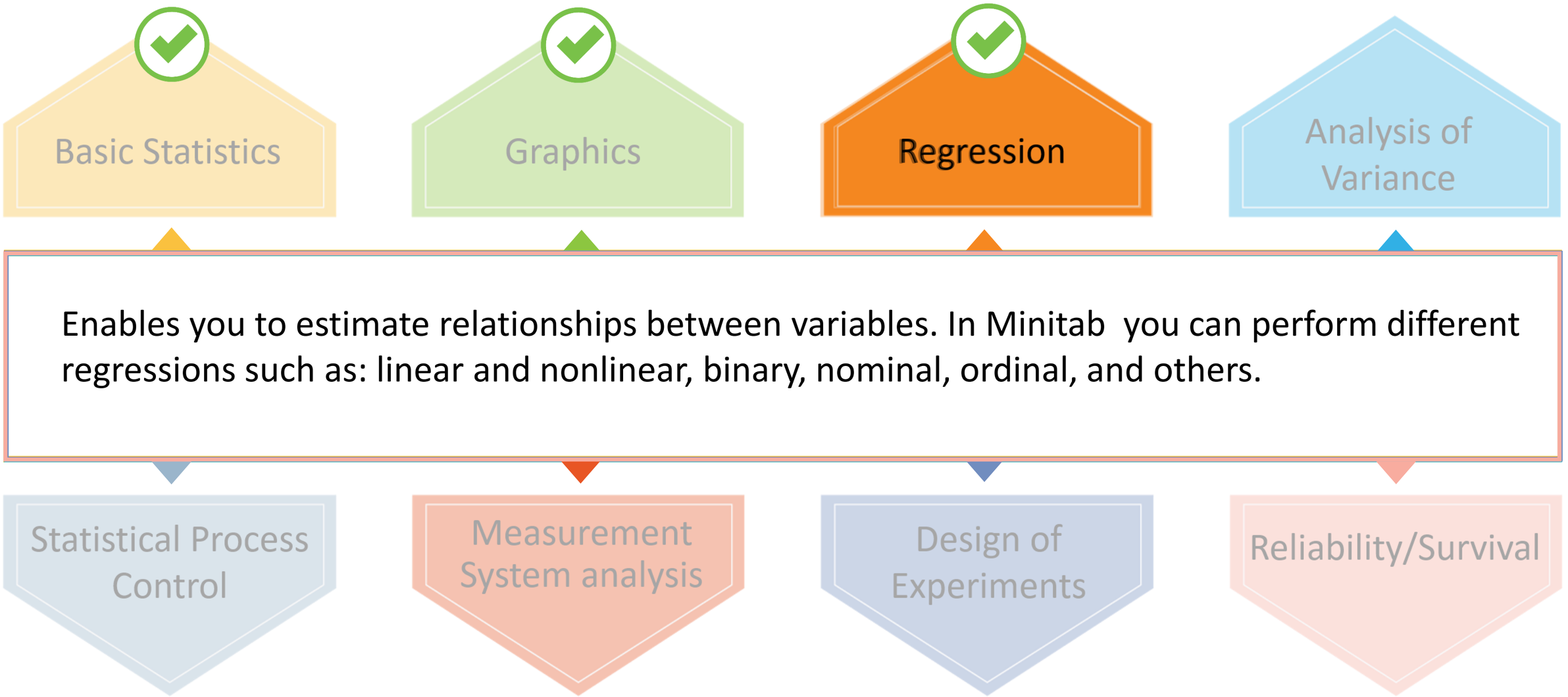
Following are the 8 key features of Minitab®.



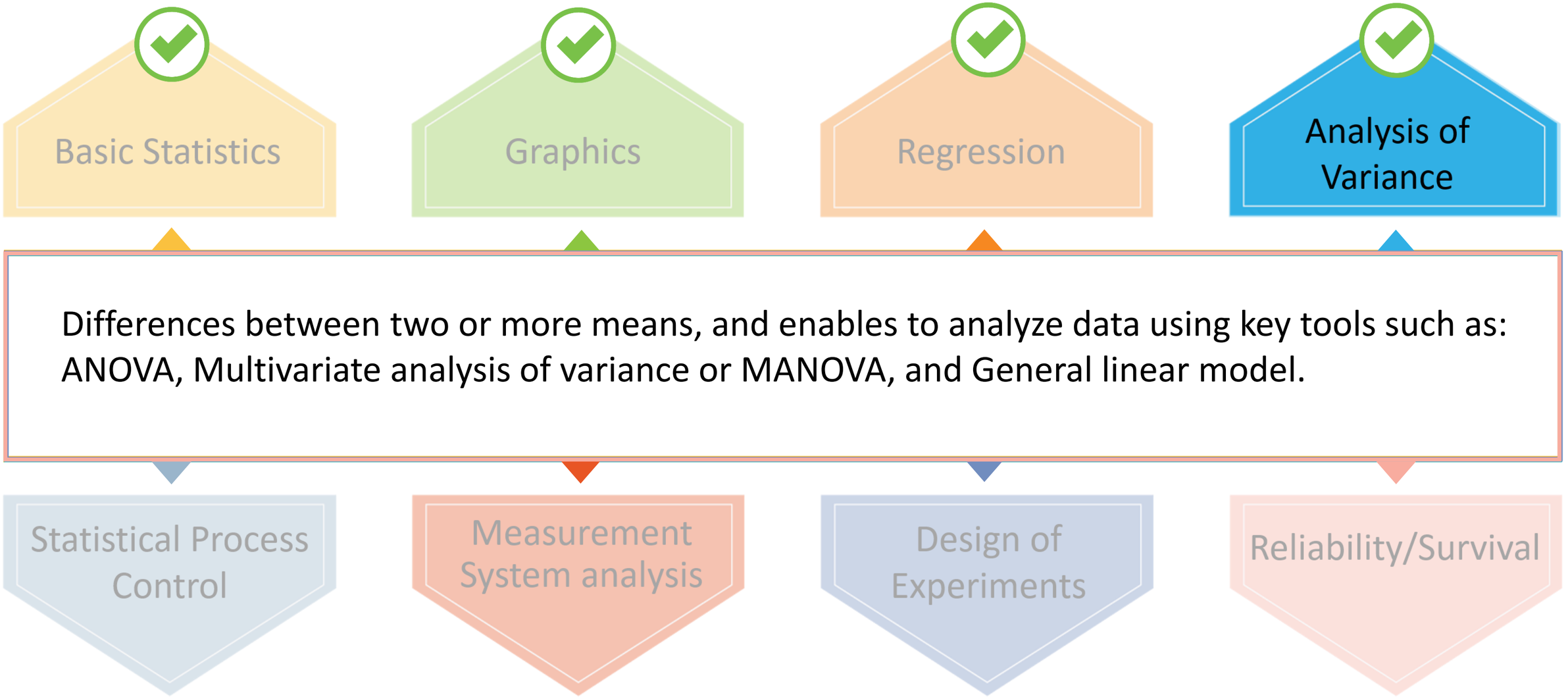
Features of Minitab®



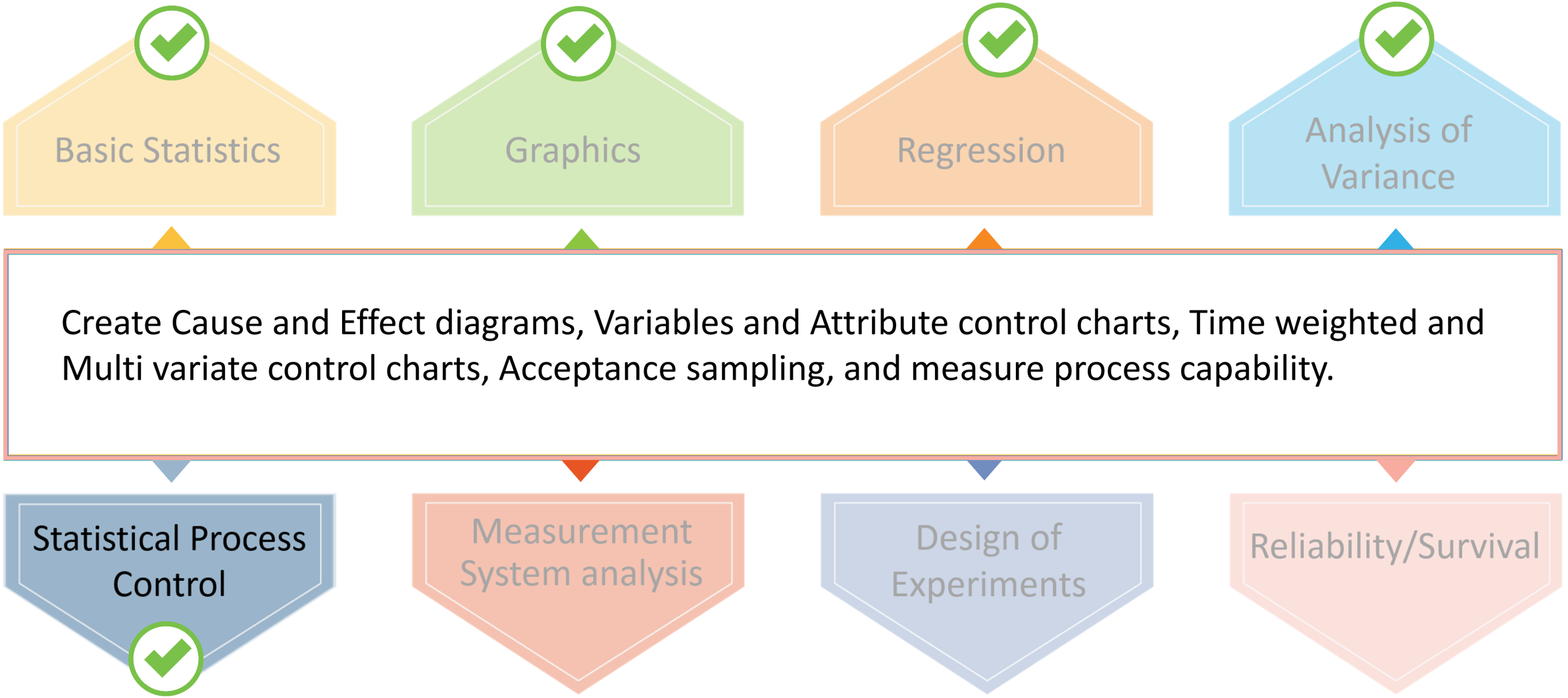
Features of Minitab®



Features of Minitab®



Features of Minitab®



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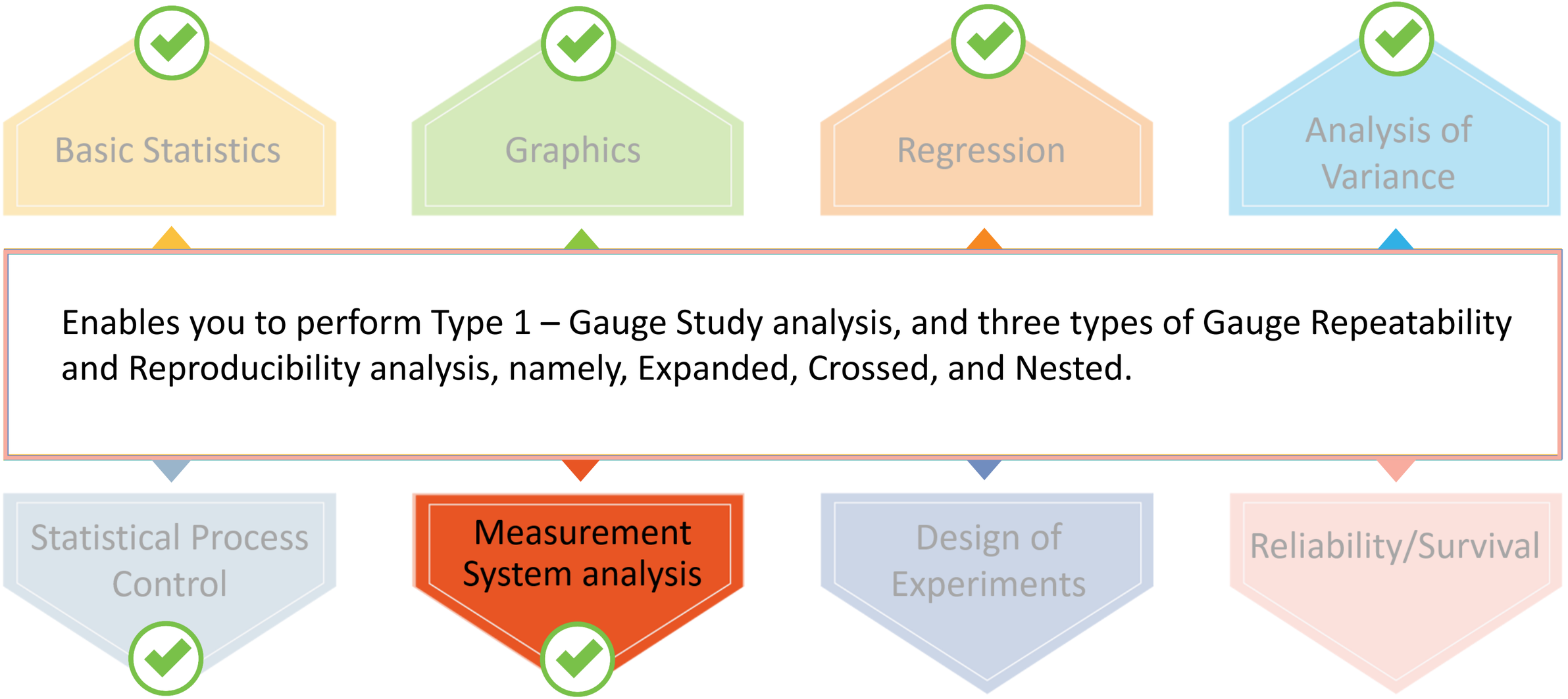

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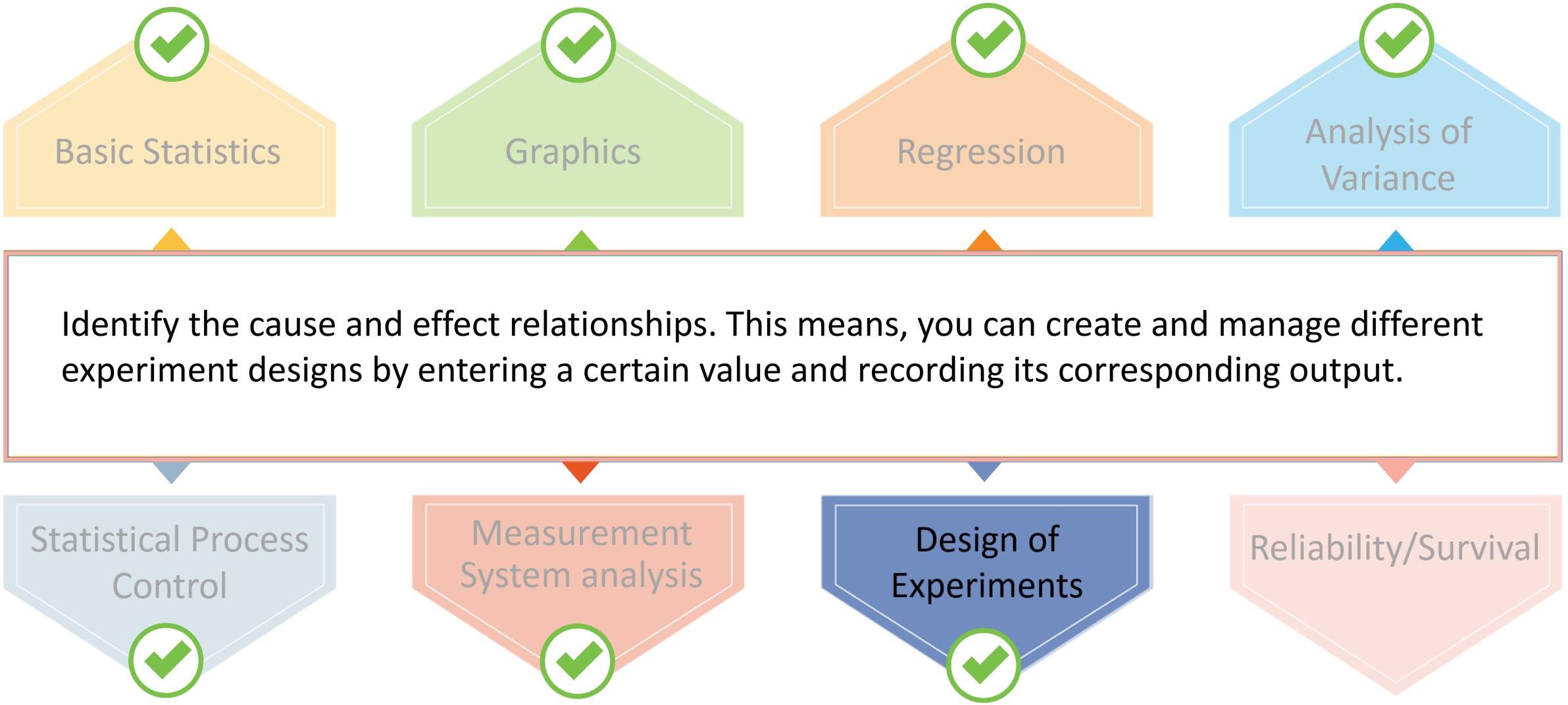

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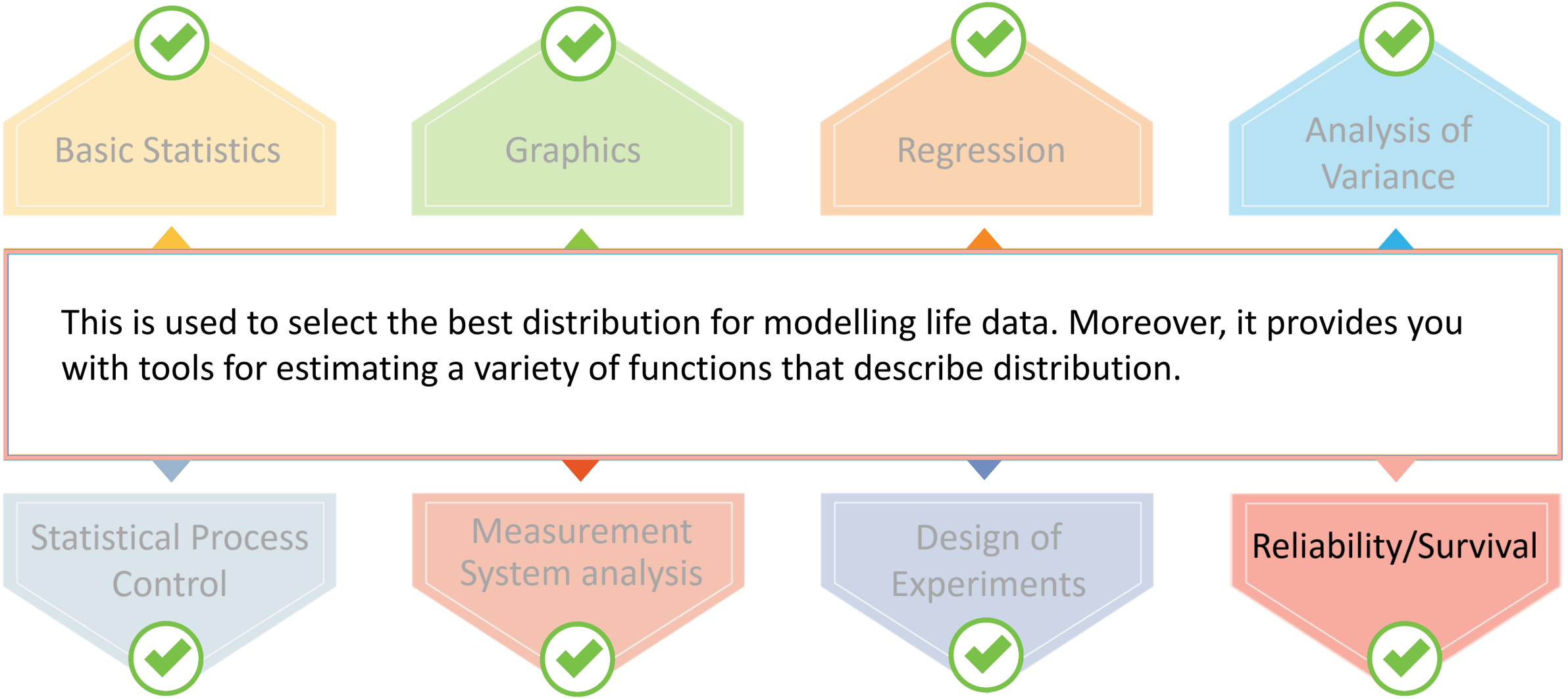
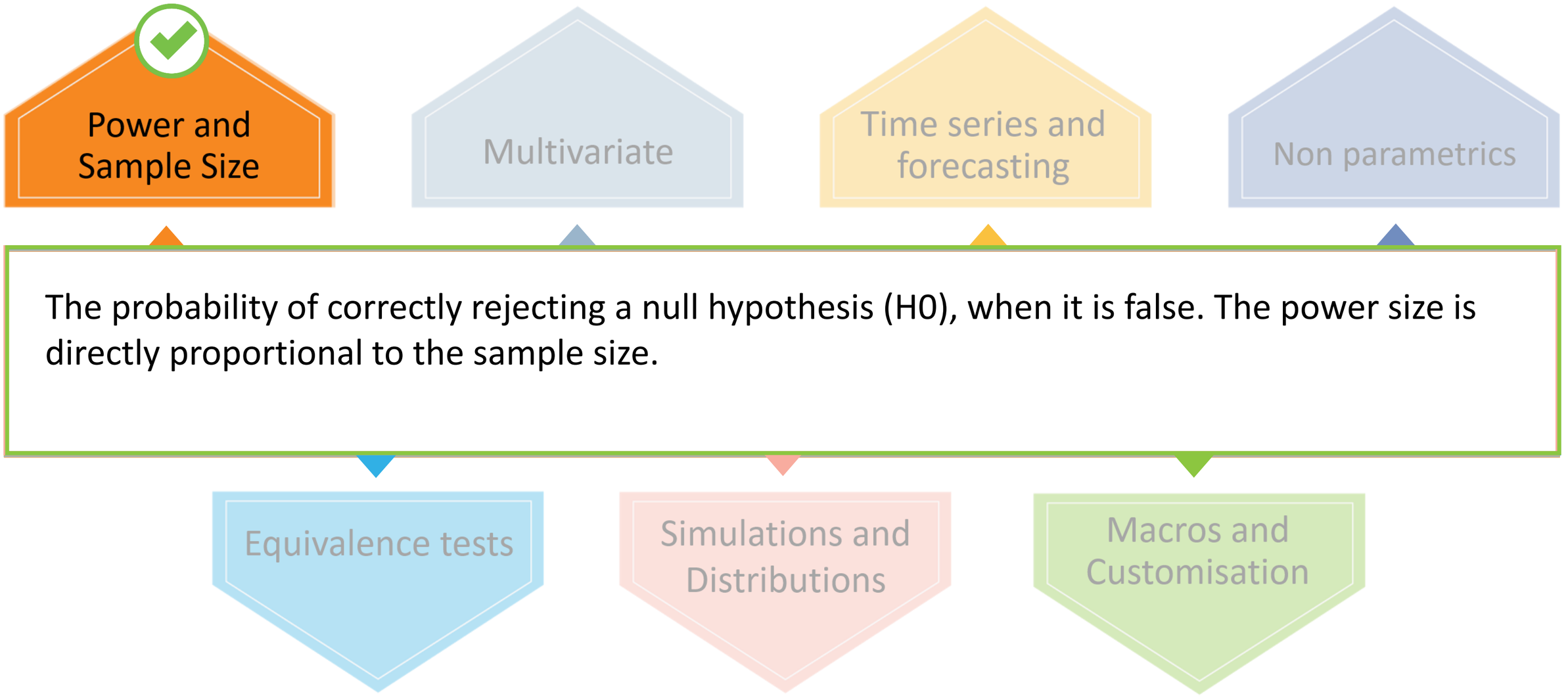


Features of Minitab® (contd.)

Following are the 7 key features of -Minitab®.



Features of Minitab® (contd.)

Power and Sample Size

Multivariate

Time series and forecasting

Non parametrics

Different procedures used to analyze data when multiple measurements are made on items or subjects. Different tests such as, Factor analysis, Discriminant Analysis, Cluster K-means.

Equivalence tests

Simulations and Distributions

Macros and Customisation

Features of Minitab® (contd.)

Power and Sample Size

Multivariate

Time series and forecasting

Non parametrics

These are used to analyze data that is collected over a period of time, and provide output such as simple forecasting, correlation analysis, ARIMA modeling, and others.

Equivalence tests

Simulations and Distributions

Macros and Customisation

Features of Minitab® (contd.)

Power and Sample Size

Multivariate

Time series and forecasting

Non parametrics

Minitab supports different non-parametric tests such as Sign test, Kruskal-Wallis, Mann-Whitney tests, and others.

Equivalence tests

Simulations and Distributions

Macros and Customisation

Features of Minitab® (contd.)

Power and Sample Size

Multivariate

Time series and forecasting

Non parametrics

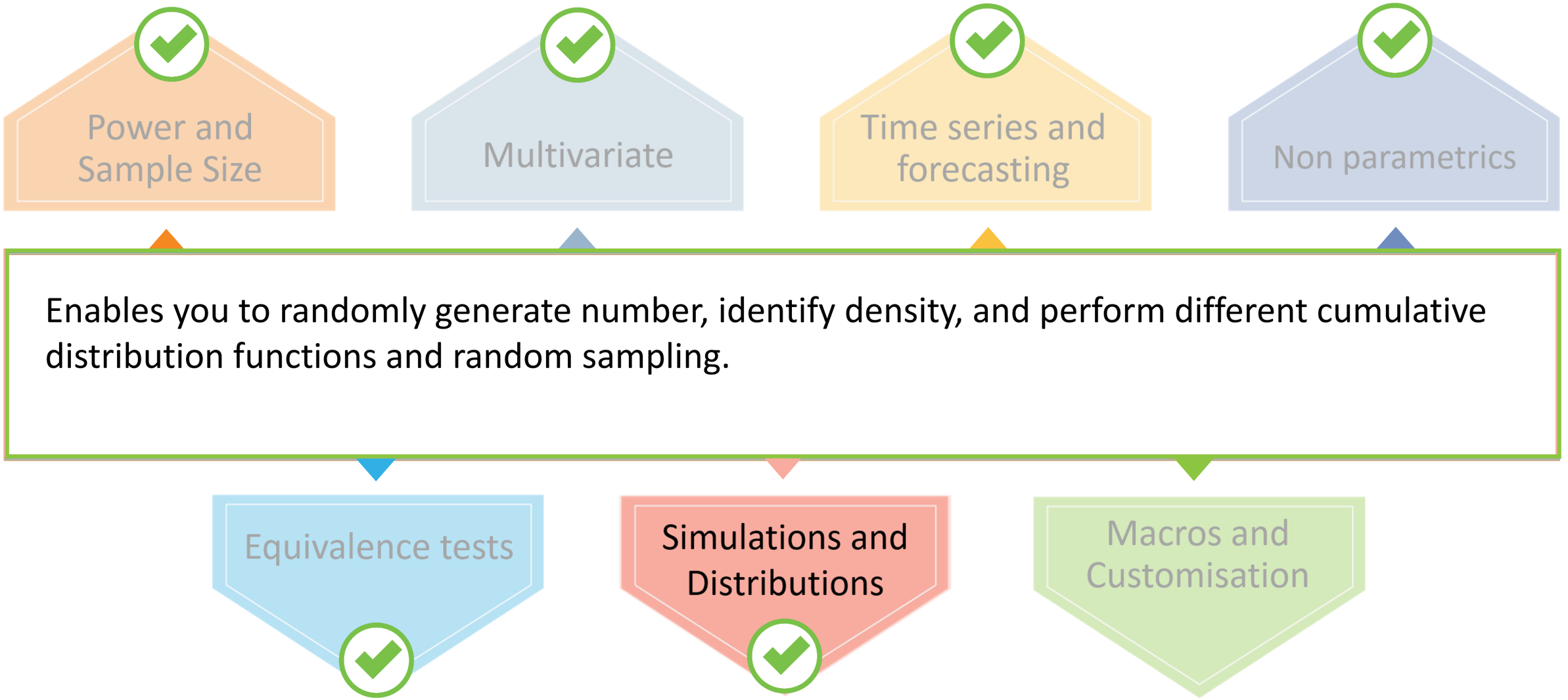
These tests are used to determine whether the mean values for any product or process measurements can be considered as equivalent.

Equivalence tests

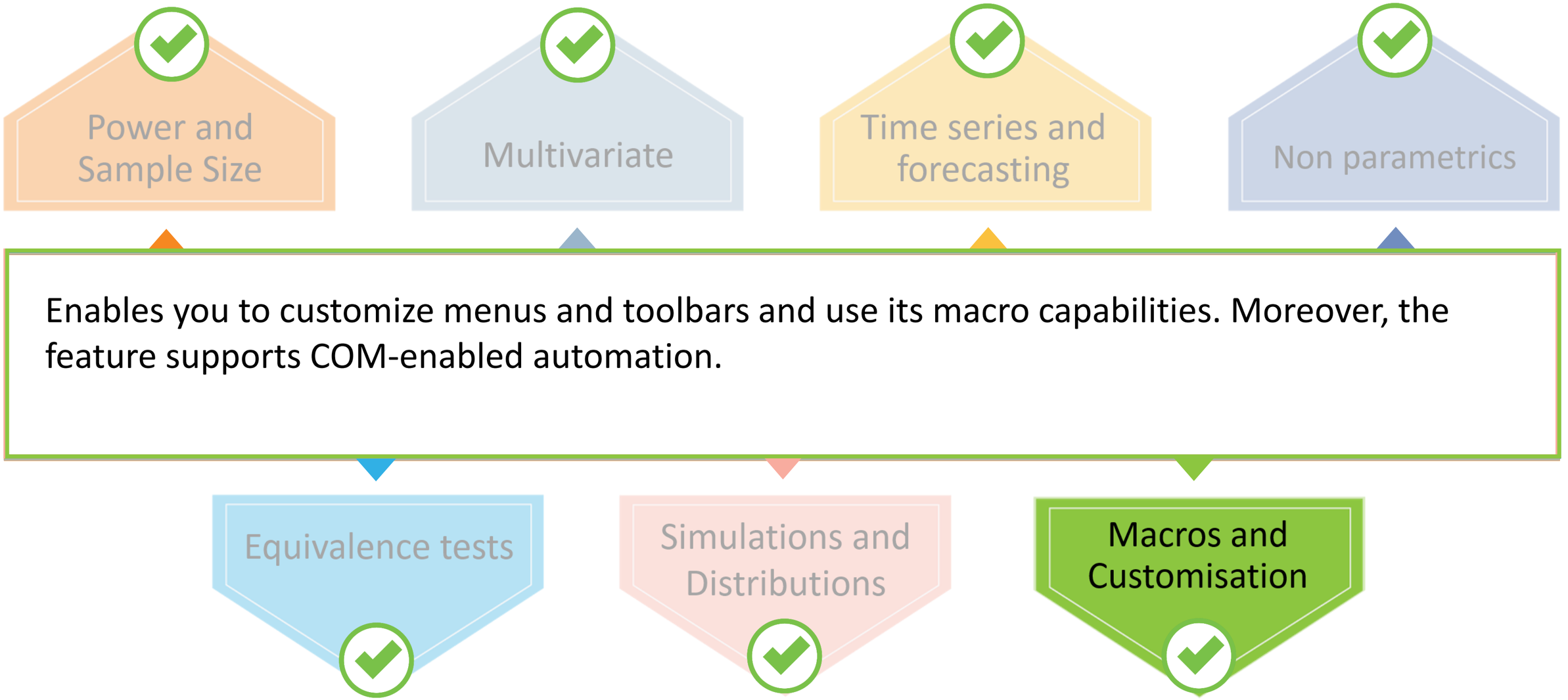
Simulations and Distributions

Macros and Customisation

Features of Minitab® (contd.)



Features of Minitab® (contd.)



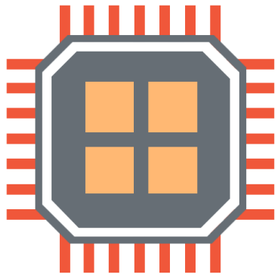
Worksheet Format and Structure

Minitab® Windows

The Minitab 17 application requires the following:

Windows 7 or higher

512 MB RAM



1 GHz processor

Hard Disk Space

Minitab®

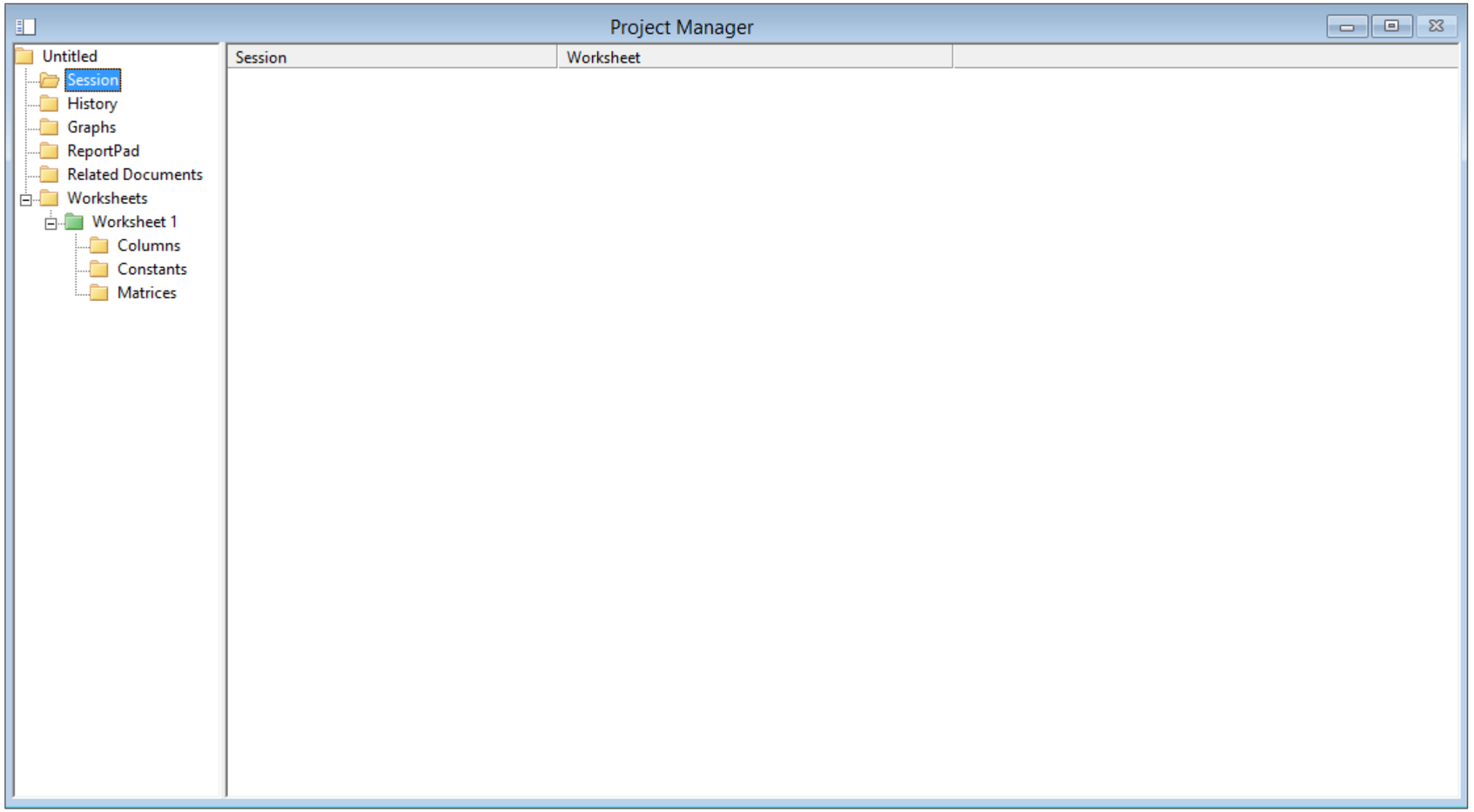
Official Website

Minitab® Windows (contd.)

Minitab® opens in following three windows:

- Session
- Worksheet
- Project Manager.

Any work in Minitab® is carried out in projects and worksheets. A project has the .mpj extension.



Minitab® Windows (contd.)

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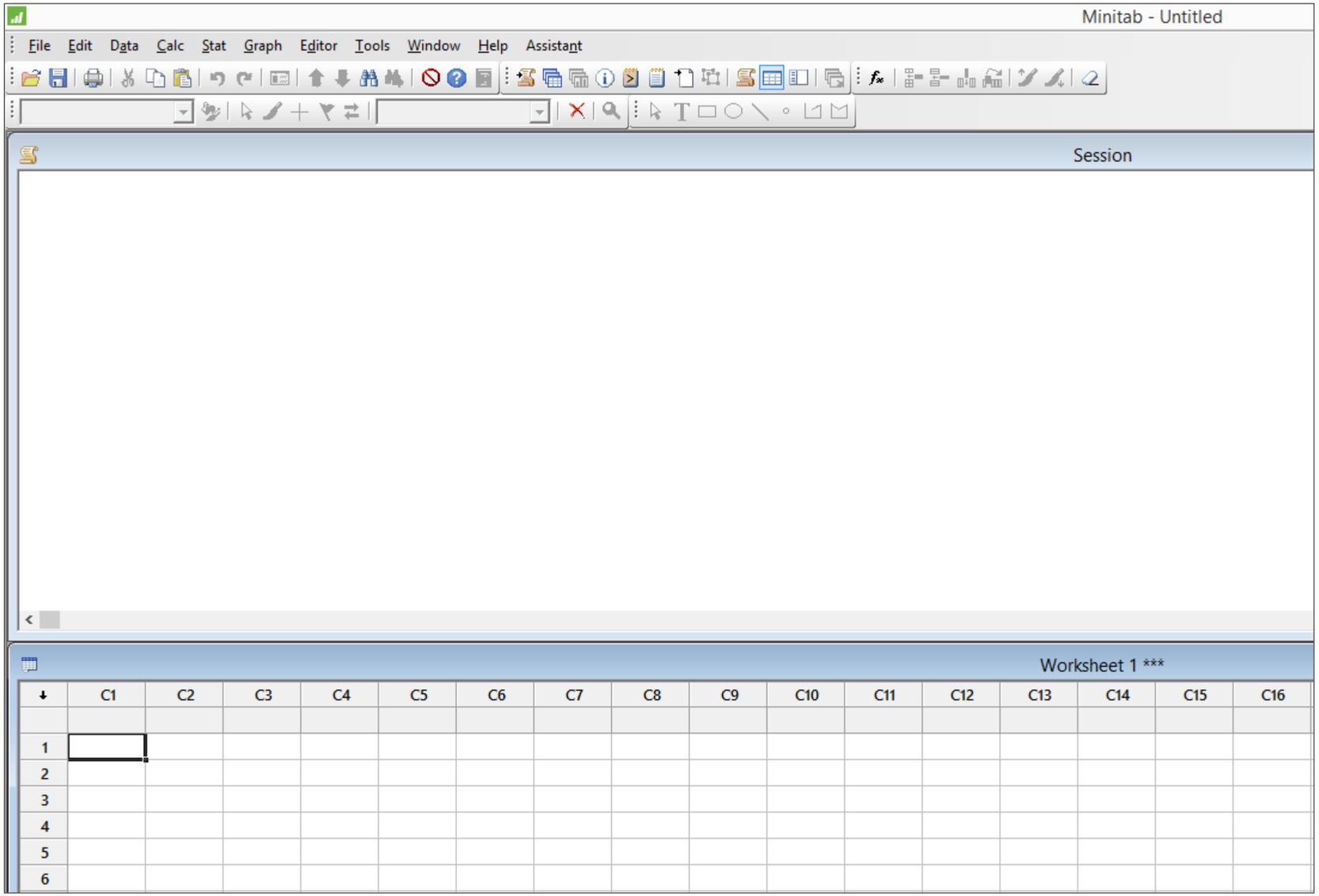

Minitab® Windows (contd.)

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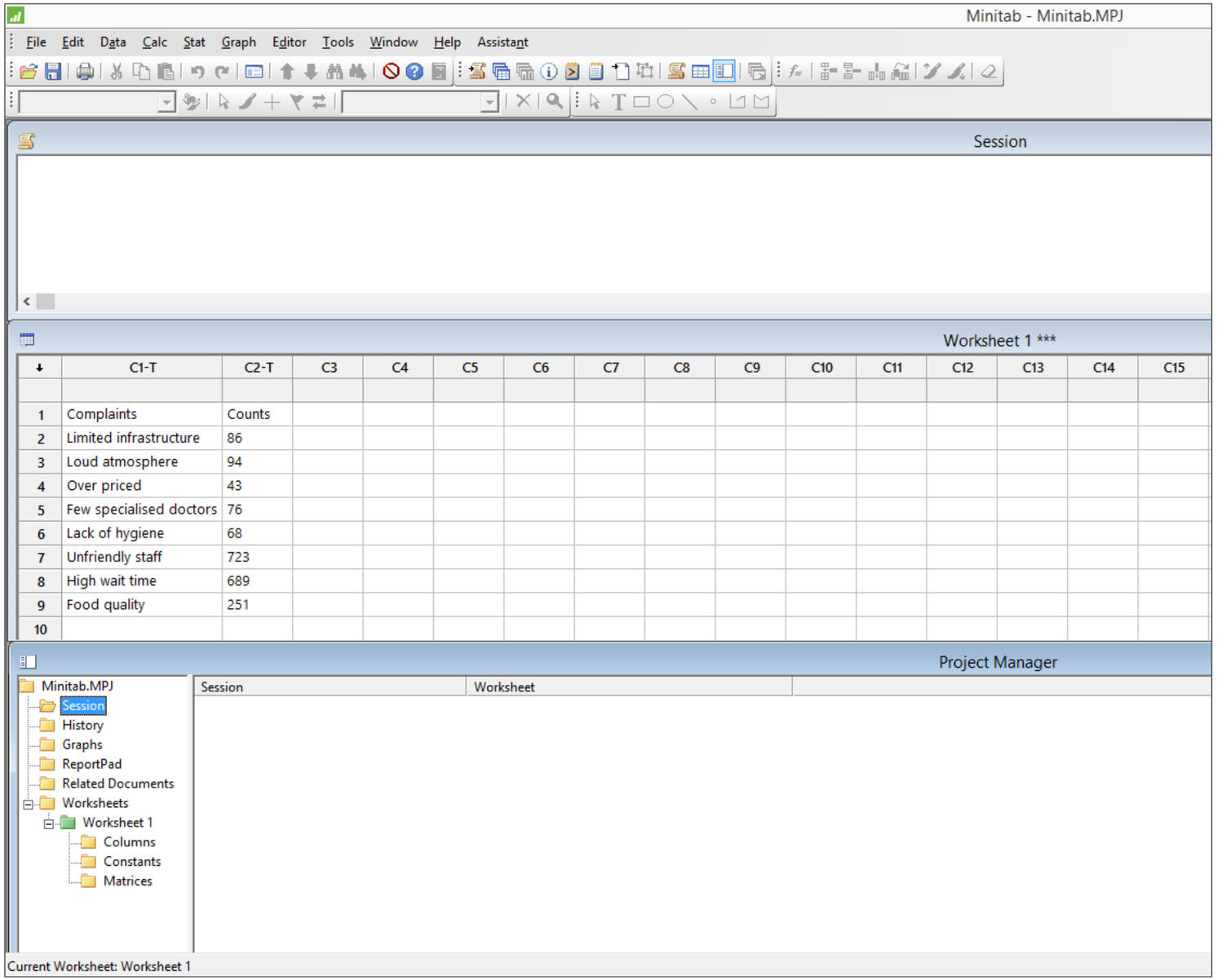
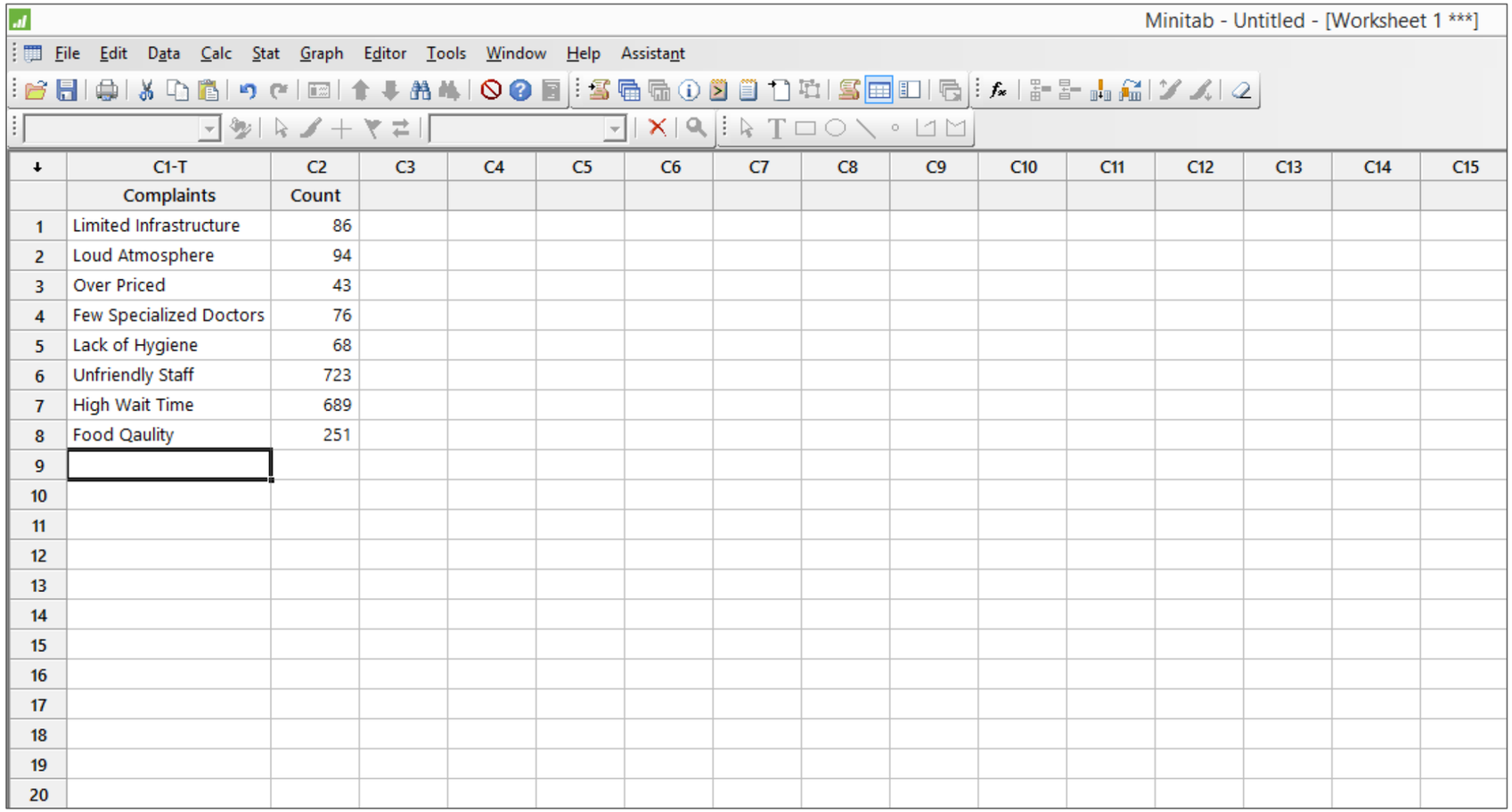


Worksheet

A project may have multiple worksheets. A worksheet in Minitab® is saved with .mtw extension.

- The worksheet window is similar to the worksheet in MS Excel.
- The intersection of each column and row is a cell.
- The columns are named as C1, C2, C3, whereas rows as 1, 2, 3.
- Minitab(R) worksheet can have up to 4000 columns.



	C1-T	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
	Complaints	Count													
1	Limited Infrastructure	86													
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Project and Worksheet

Following are the items that are stored in Projects and Worksheets:

Projects

- Graphs.
- Window layout.
- Session Window Output.
- Session Command History.
- Dialog Box Settings.
- Options.

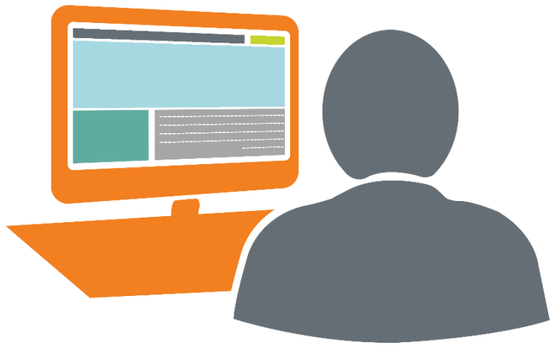
Worksheets

- Worksheet descriptions.
- Columns of data.
- Column descriptions.
- Constants.
- Matrices.
- Design objects.

Working with Worksheets

Before any analysis can begin, data needs to be entered into a worksheet.

Data entry can be done in any of the following ways:



Manually Entering

Copying and Pasting

Importing of data

Data Types

A worksheet can contain the following type of data:

Numeric

This could be in the form of whole numbers such as 512 or 62525, or numbers with decimal, such as 3.422.

Text data type

This could be in the form of Numbers, letters, special characters, and spaces.

Date/Time

4/8/2015,
09:16:16 am,
8-Mar-2015,
4/8/2015 09:16:16

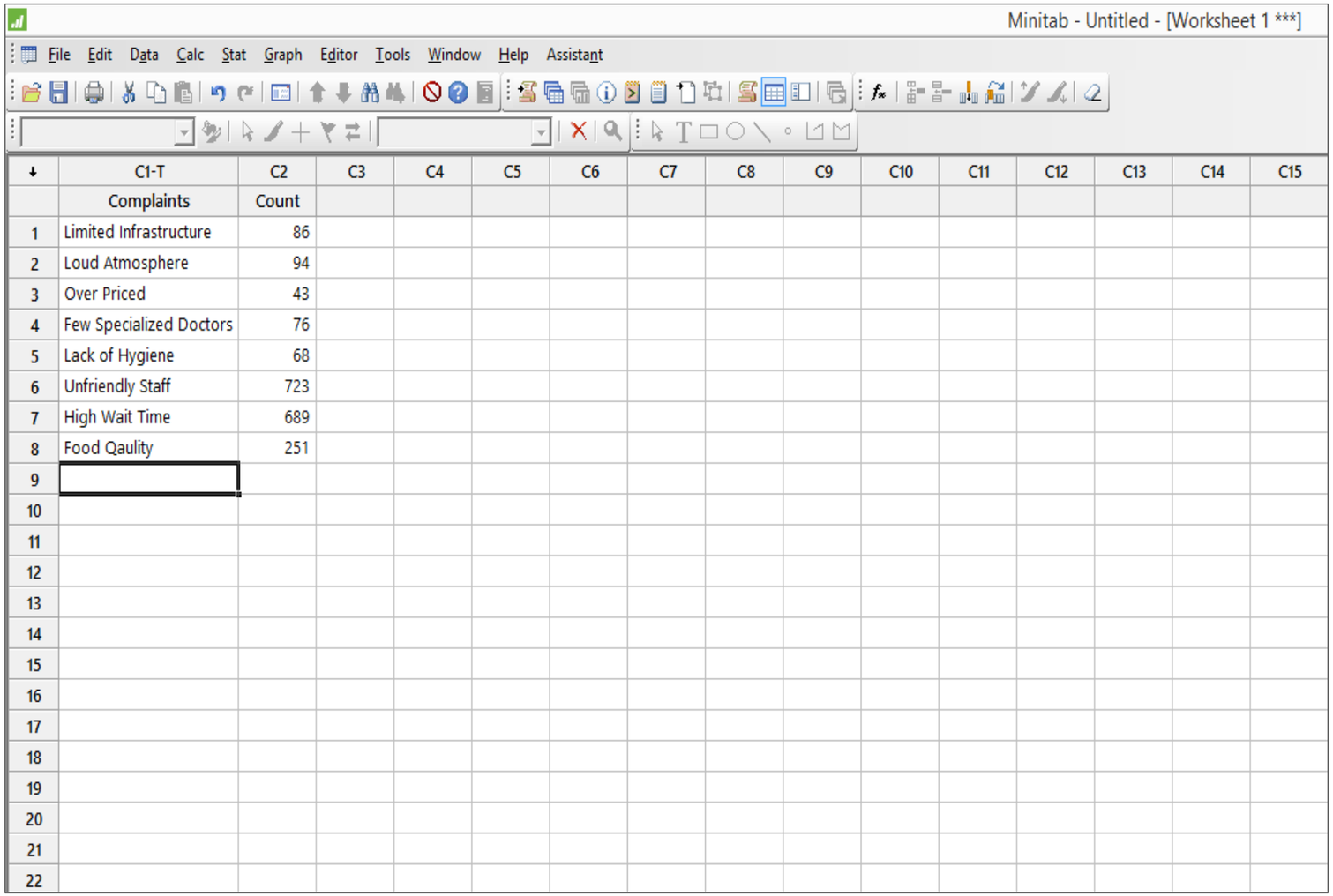
Data Windows Conventions

Data Windows Column Conventions

We can set column types.

To set column types:

- First select a column to set the type



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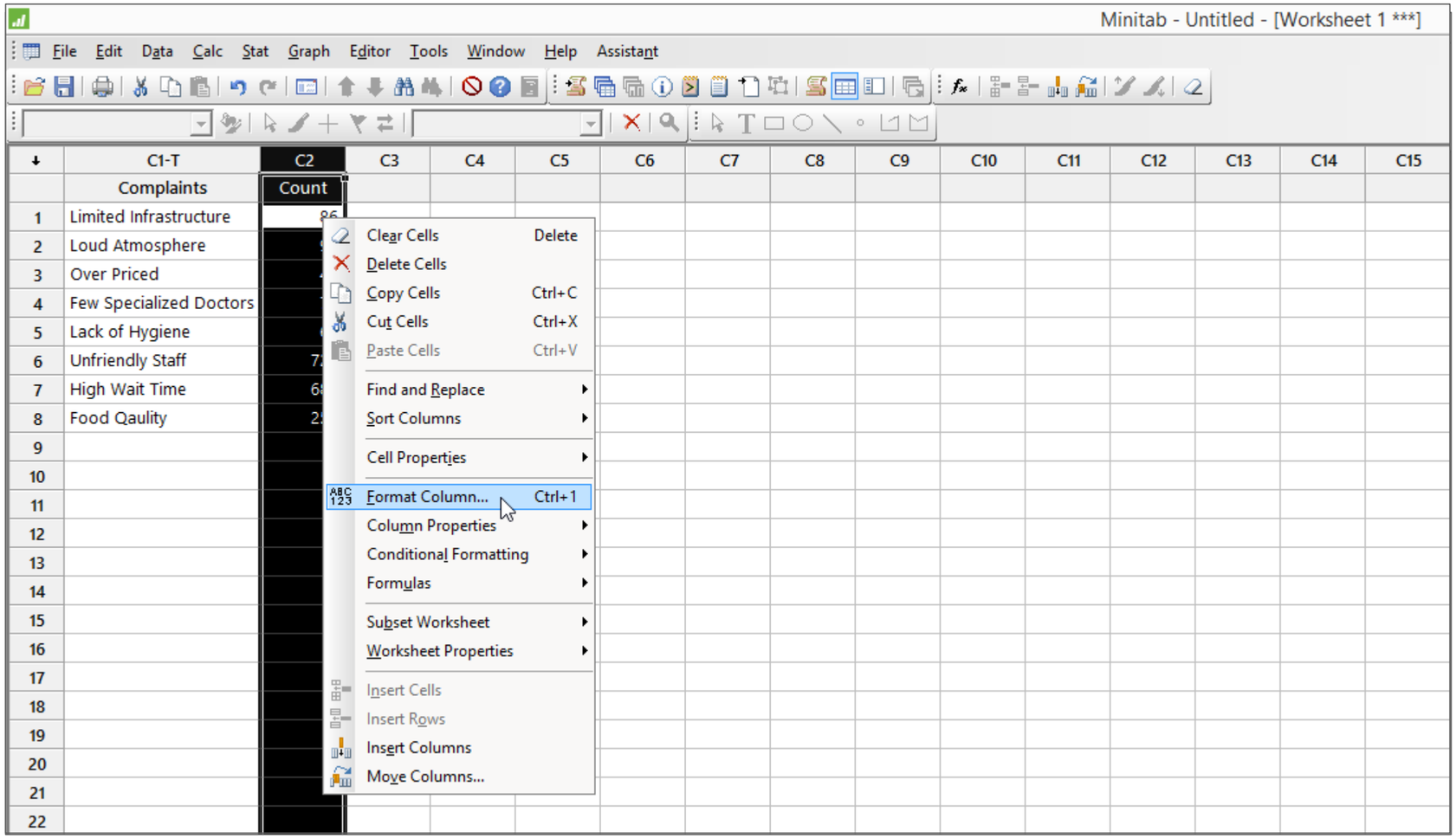
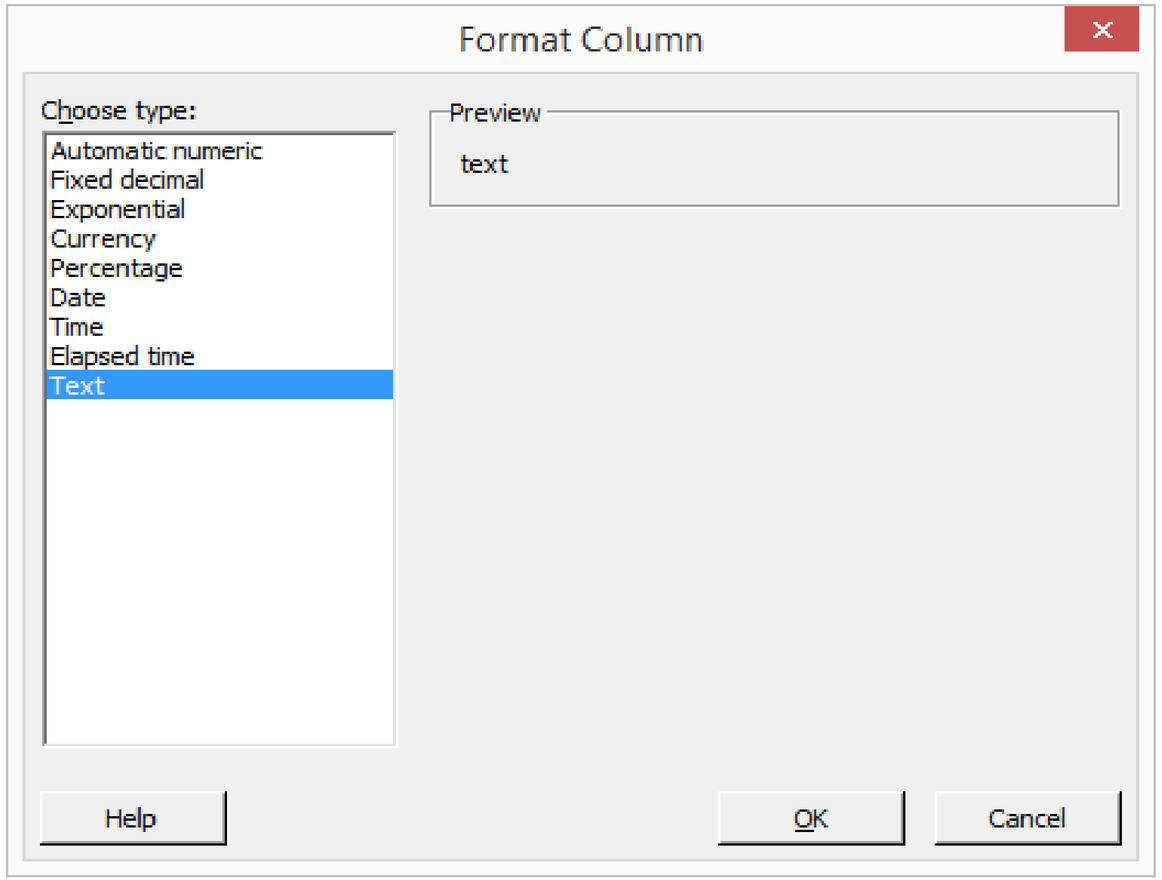
Data Windows Column Conventions

Simply right-click a column name.

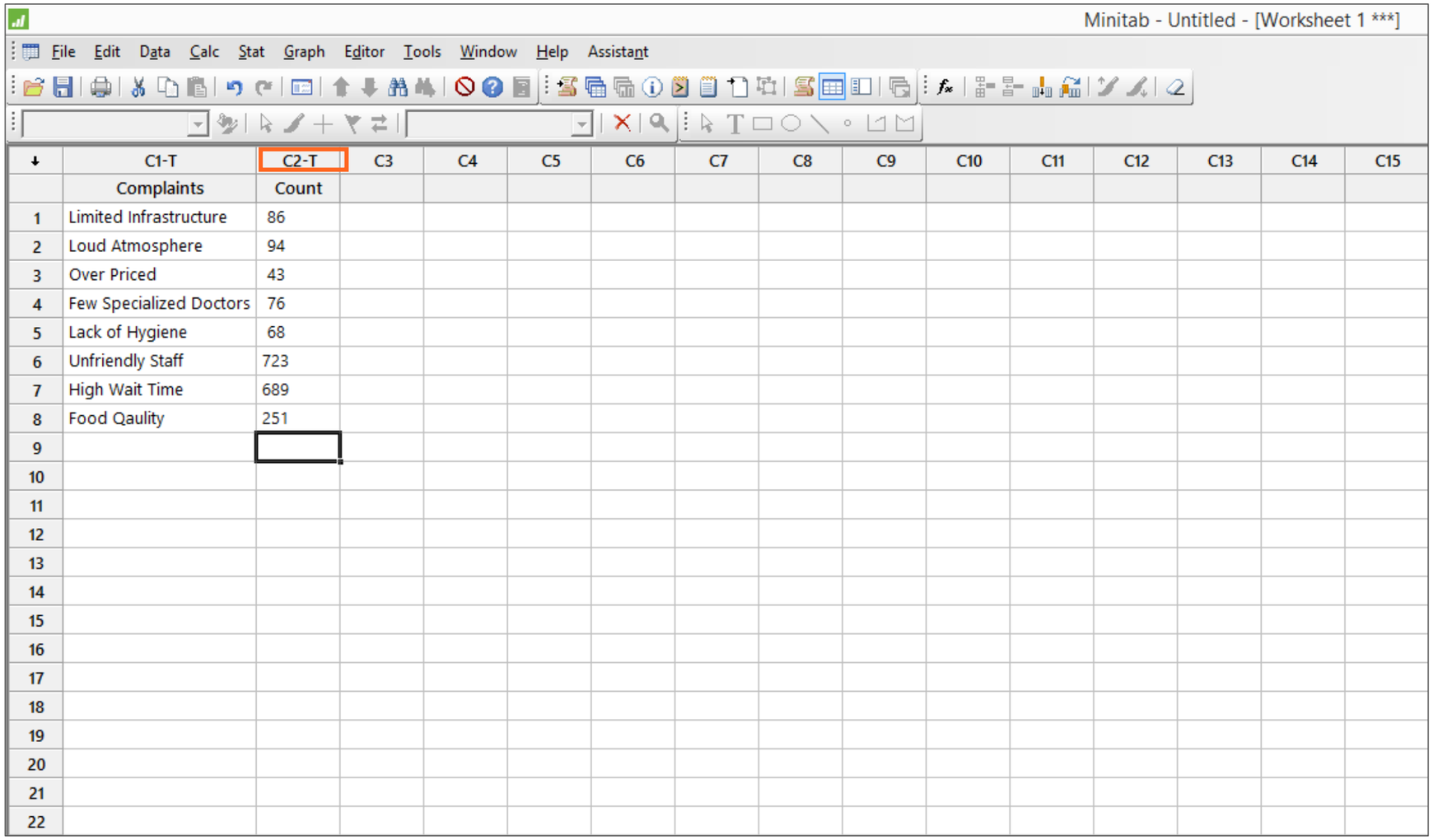


Data Windows Column Conventions

Next select the Format Column option to choose the required type.



Data Windows Column Conventions



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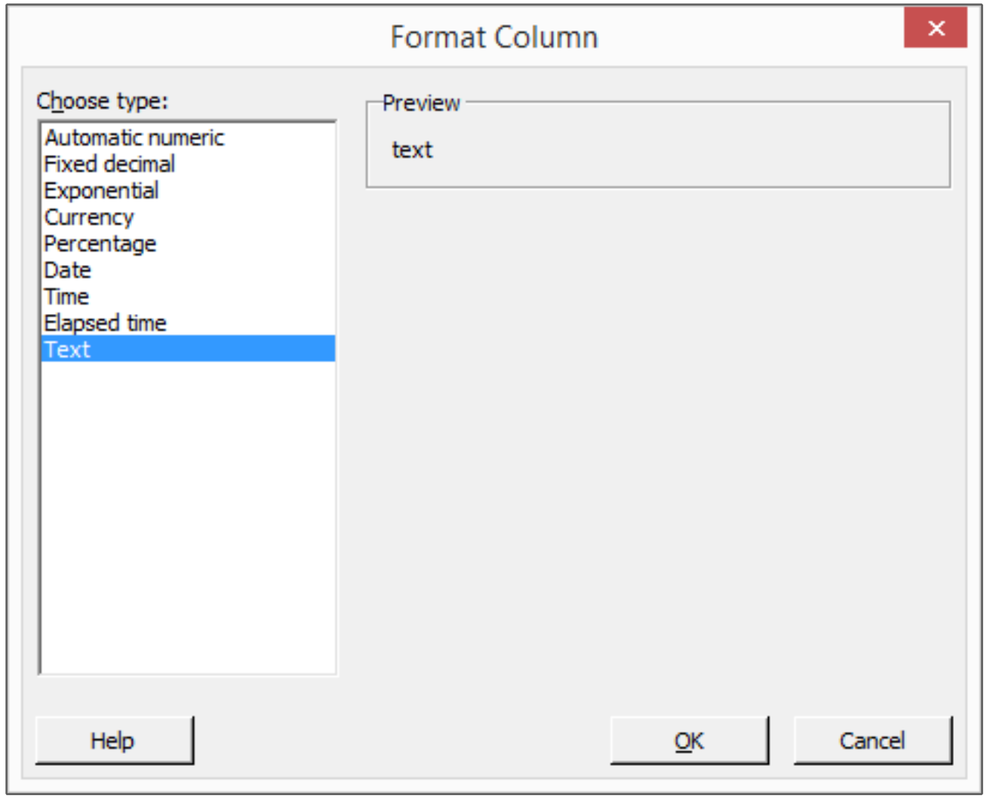
Defining Column Convention

Format Column offers the following options for selecting a particular column type:

- Automatic numeric.
- Fixed decimal.
- Exponential.
- Currency.
- Percentage.
- Date.
- Time.
- Elapsed time.
- Text.



Other Data Window Conventions

Entering data into the worksheet:

- This indicates that you are expected to add data in the first cell of the row.
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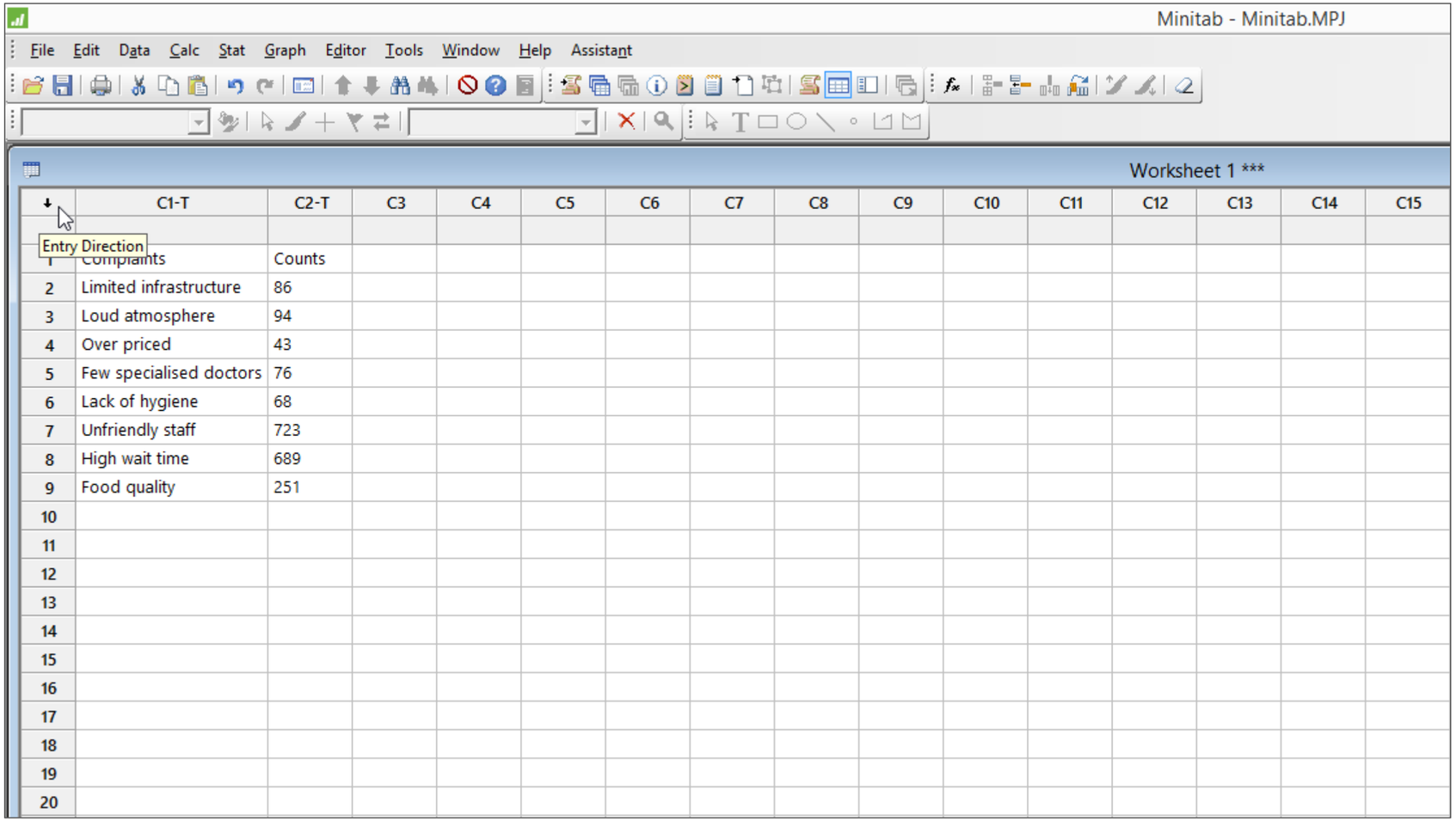

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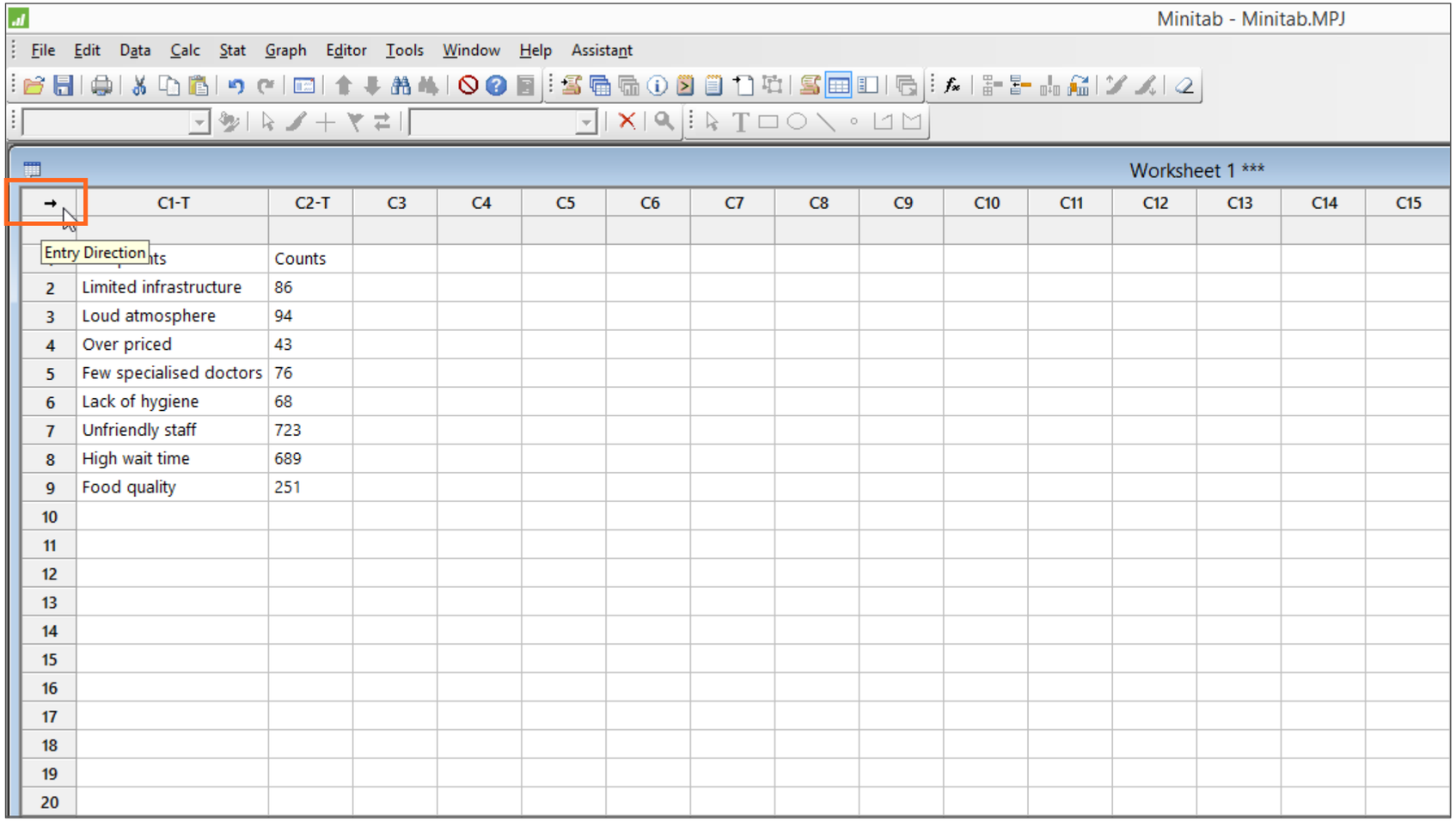

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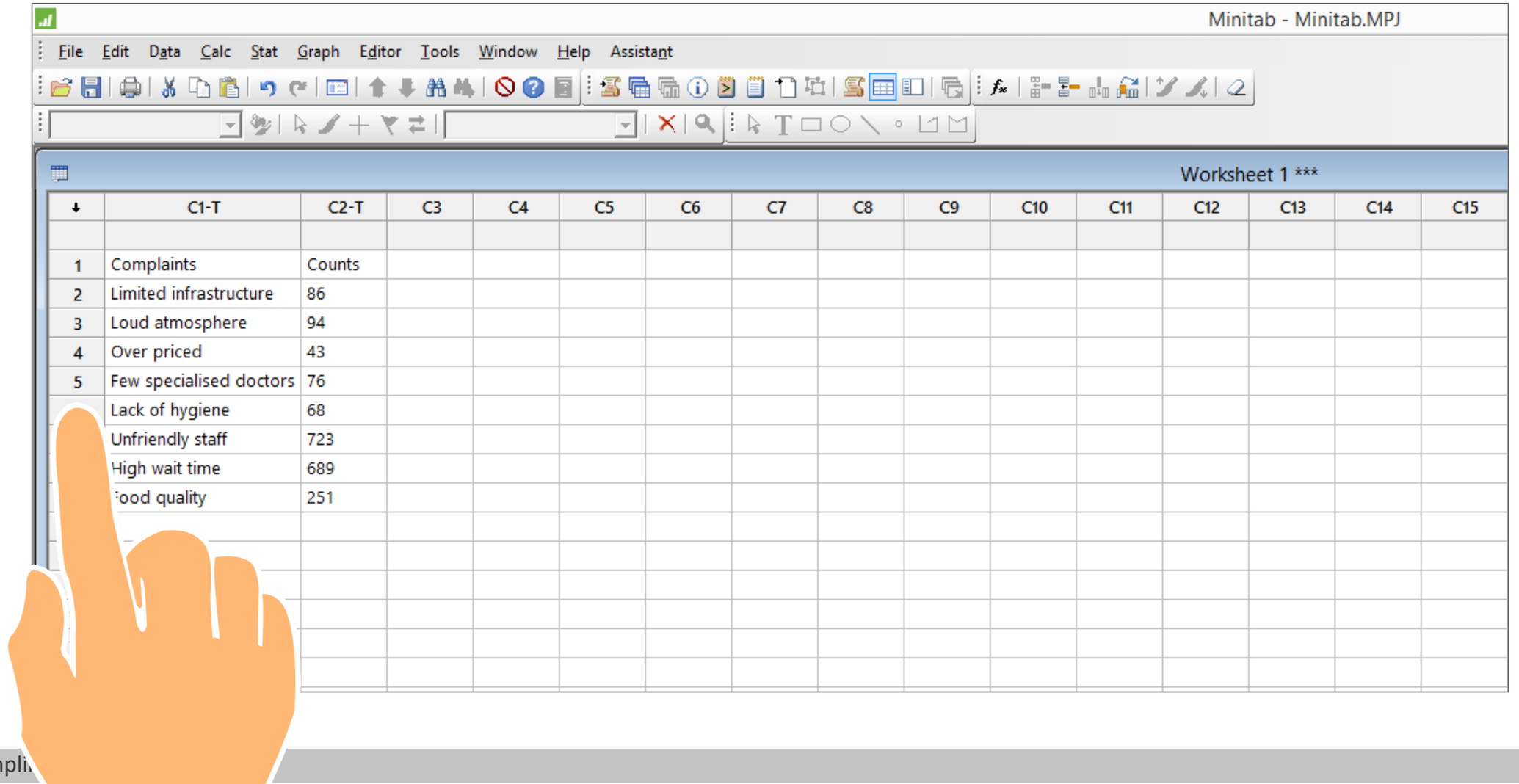
Menu Bar Overview

Menu Bar Overview

Minitab consists of eleven main menu items arranged on the menu bar, and each item has a major role to play while you analyze and process data.



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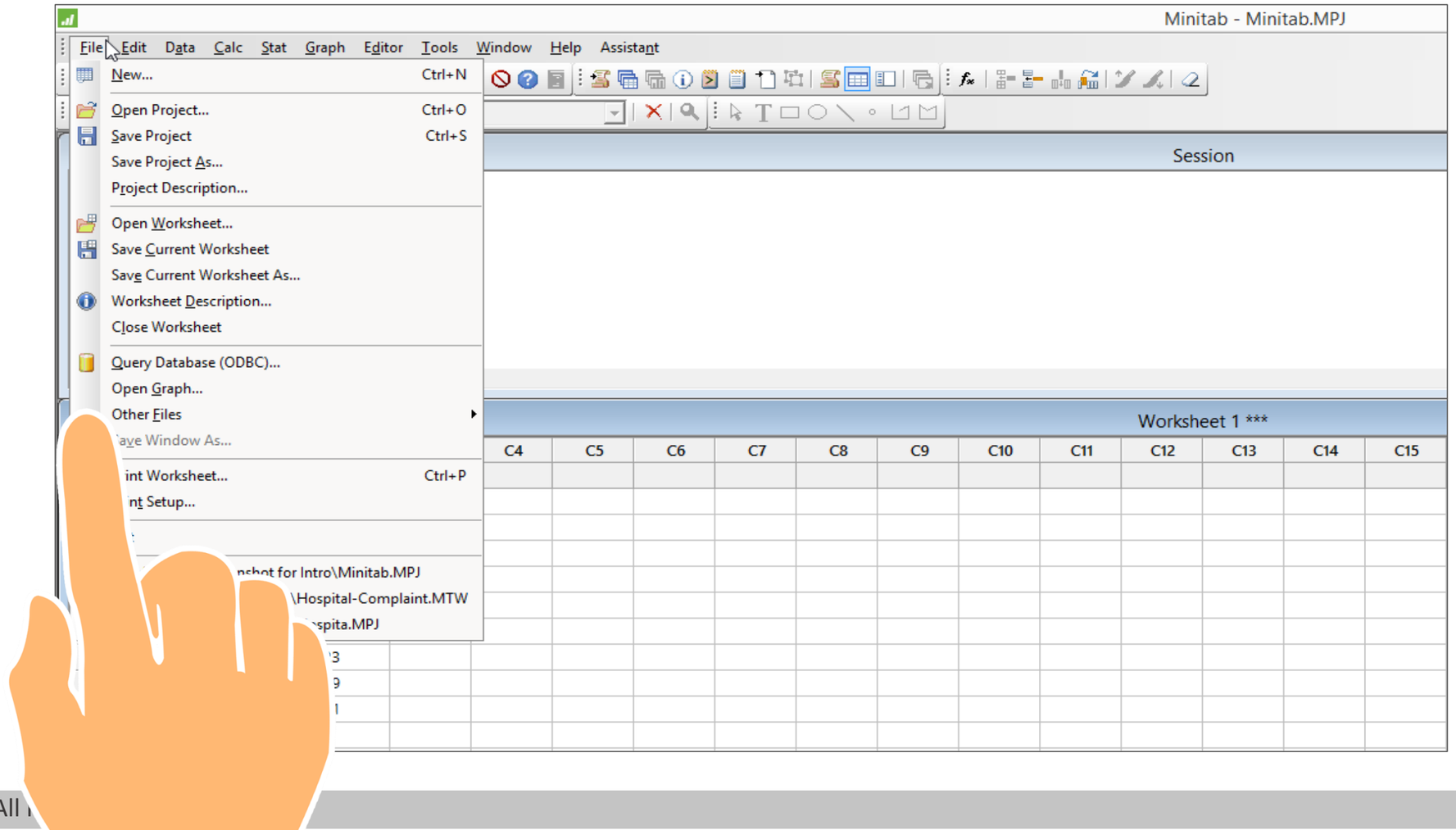
	ood quality	251													

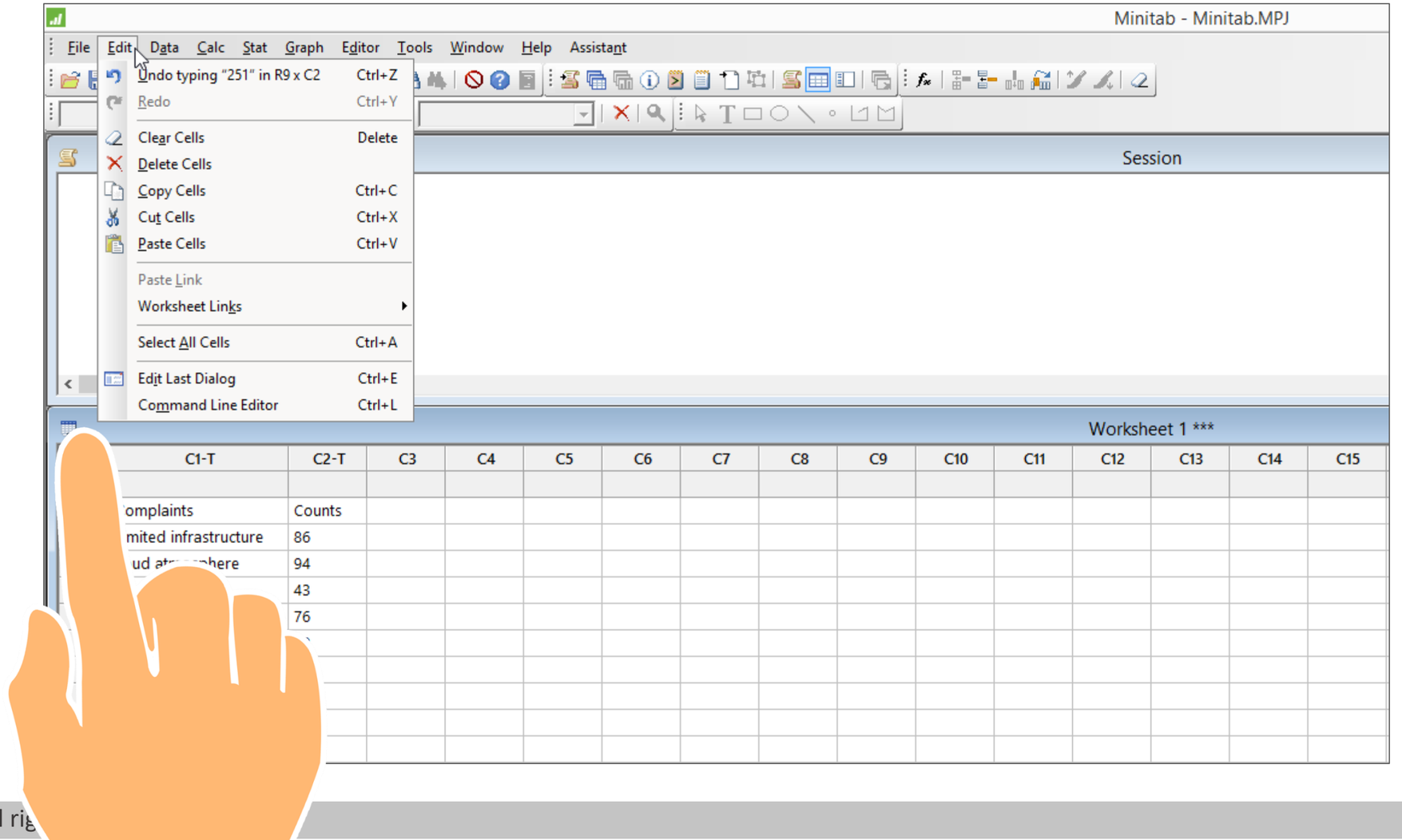
Menu Bar Overview–File

The File menu is used to perform actions such as open, close, save, print, import data, or run the various file types that can be used in Minitab.



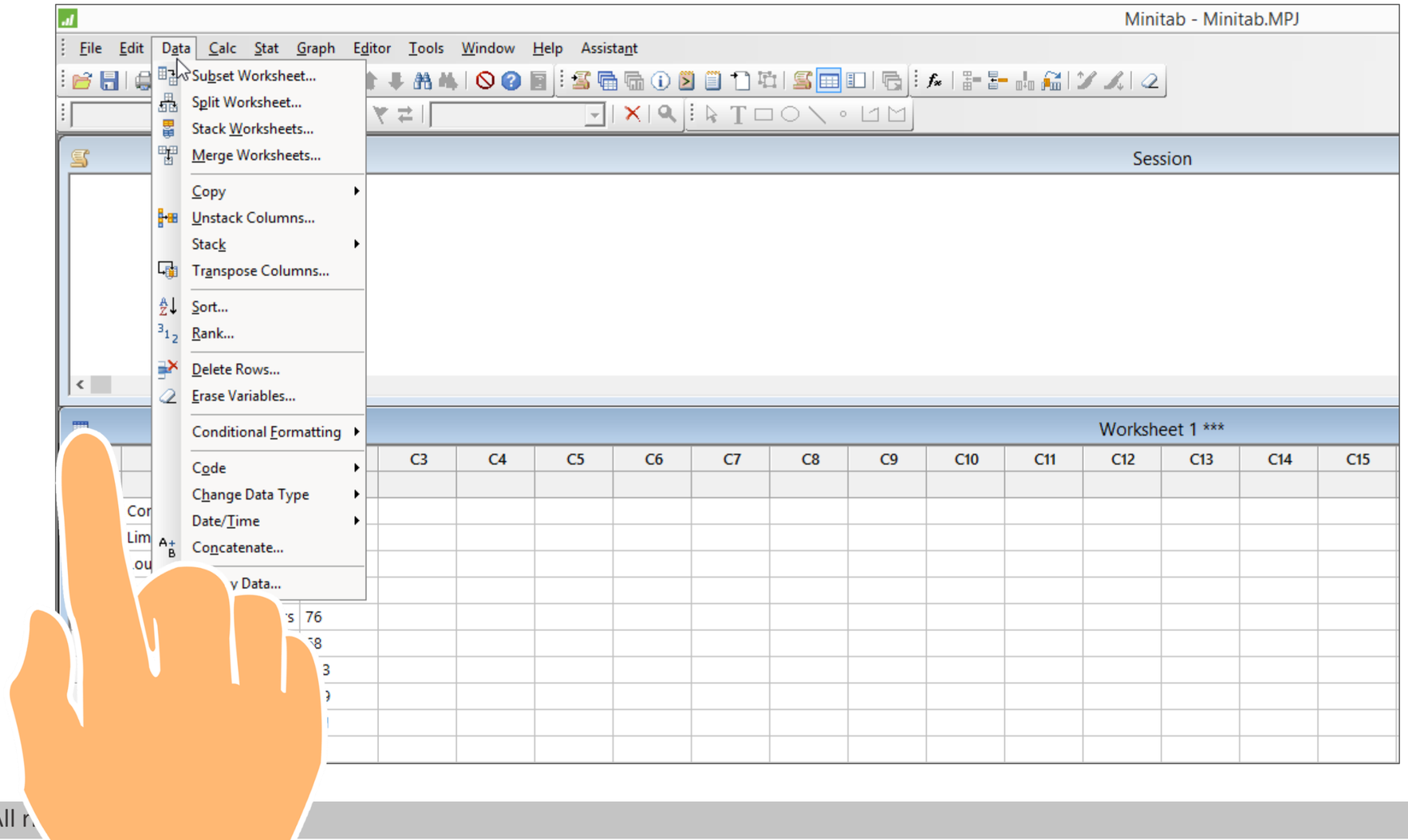
Menu Bar Overview–Edit

The Edit menu provides options to edit, undo, redo, clear, delete, or clear data from cells in a worksheet.



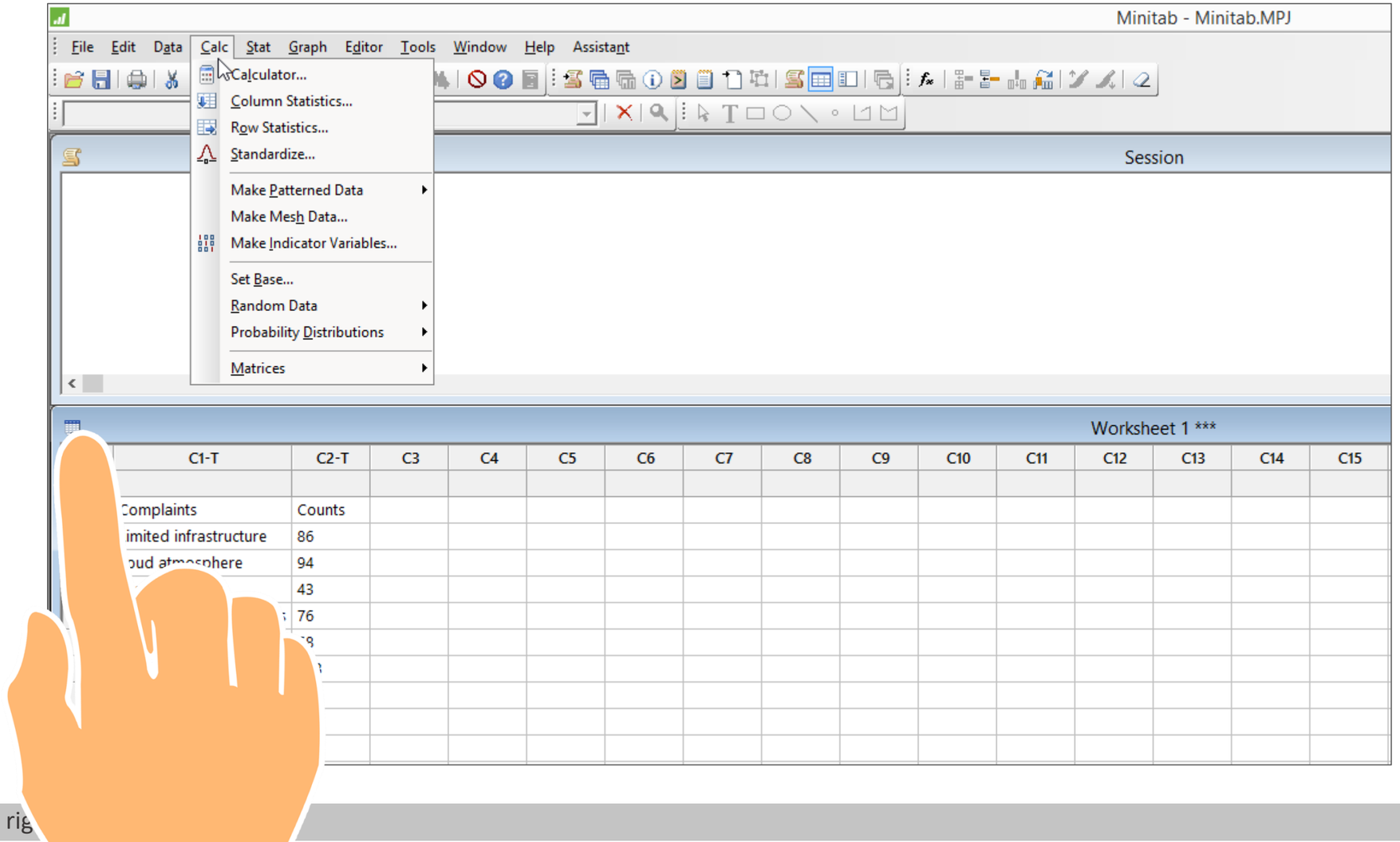
Menu Bar Overview–Data

The Data menu allows to perform complex actions that would be difficult or tedious to replicate in other ways.



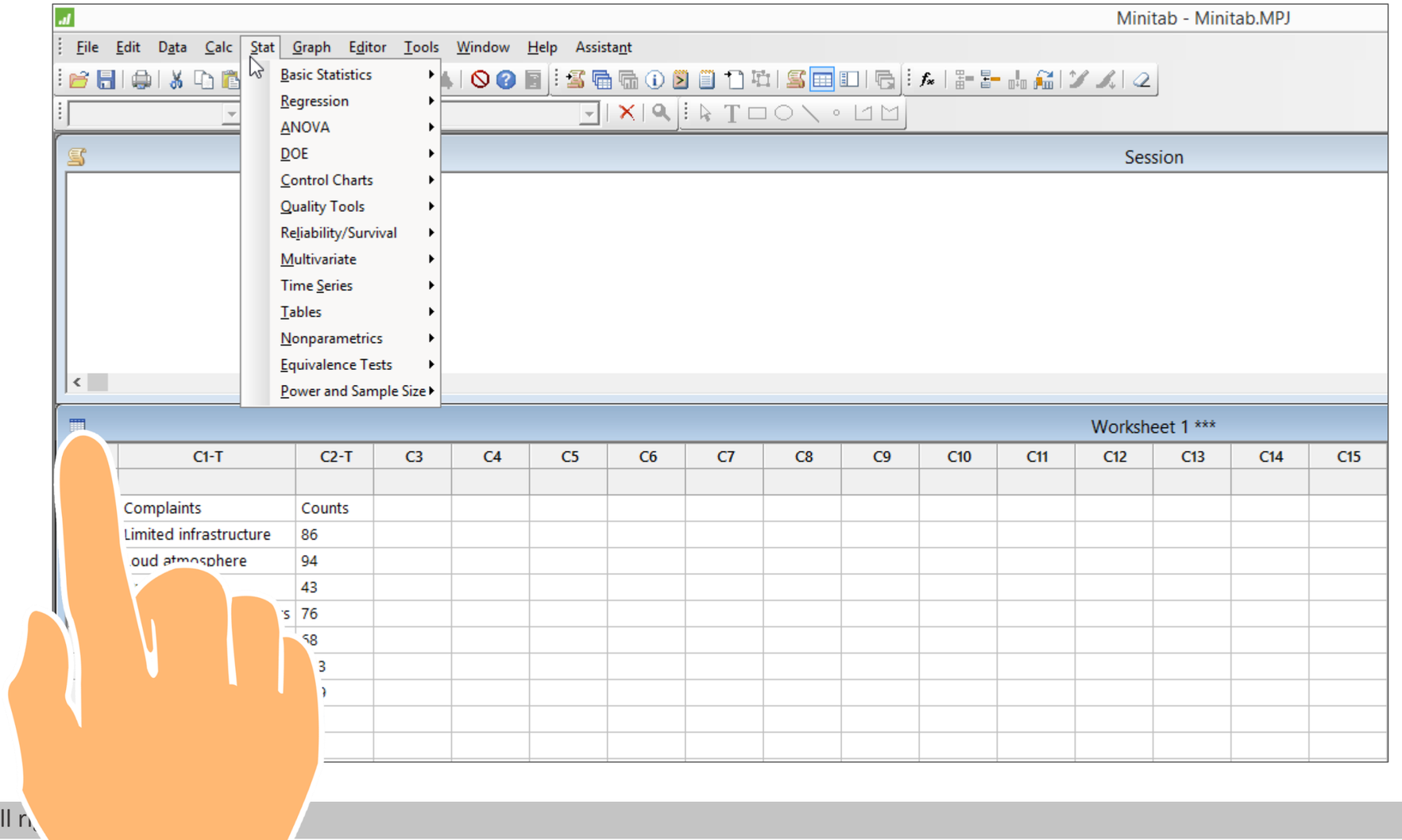
Menu Bar Overview–Calc

The Calc menu enables to calculate mathematical expressions and transformations, individual row and column statistics, and center and scale columns of data.



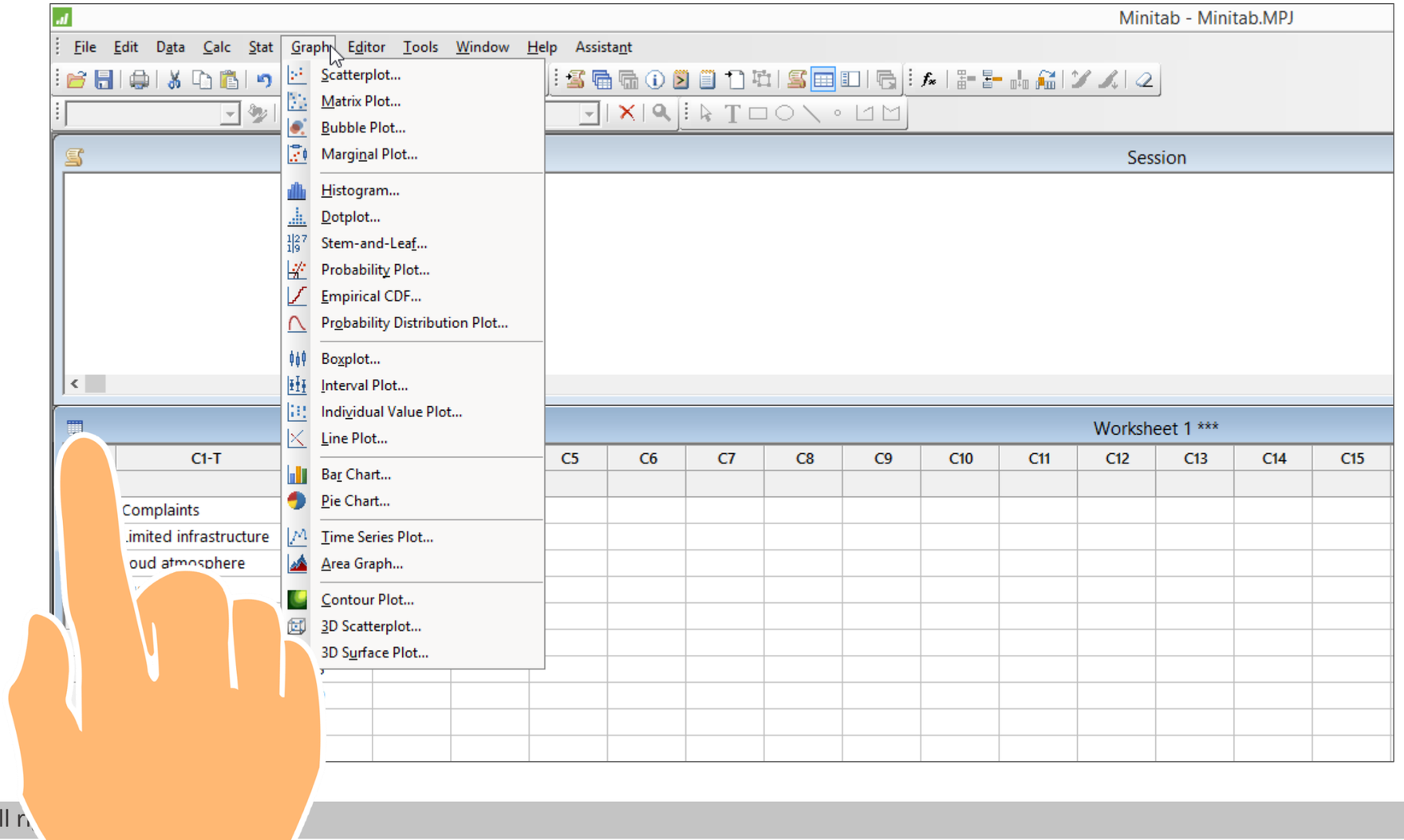
Menu Bar Overview–Stat

The Stat menu enables to run different tests and retrieve the corresponding statistical information.



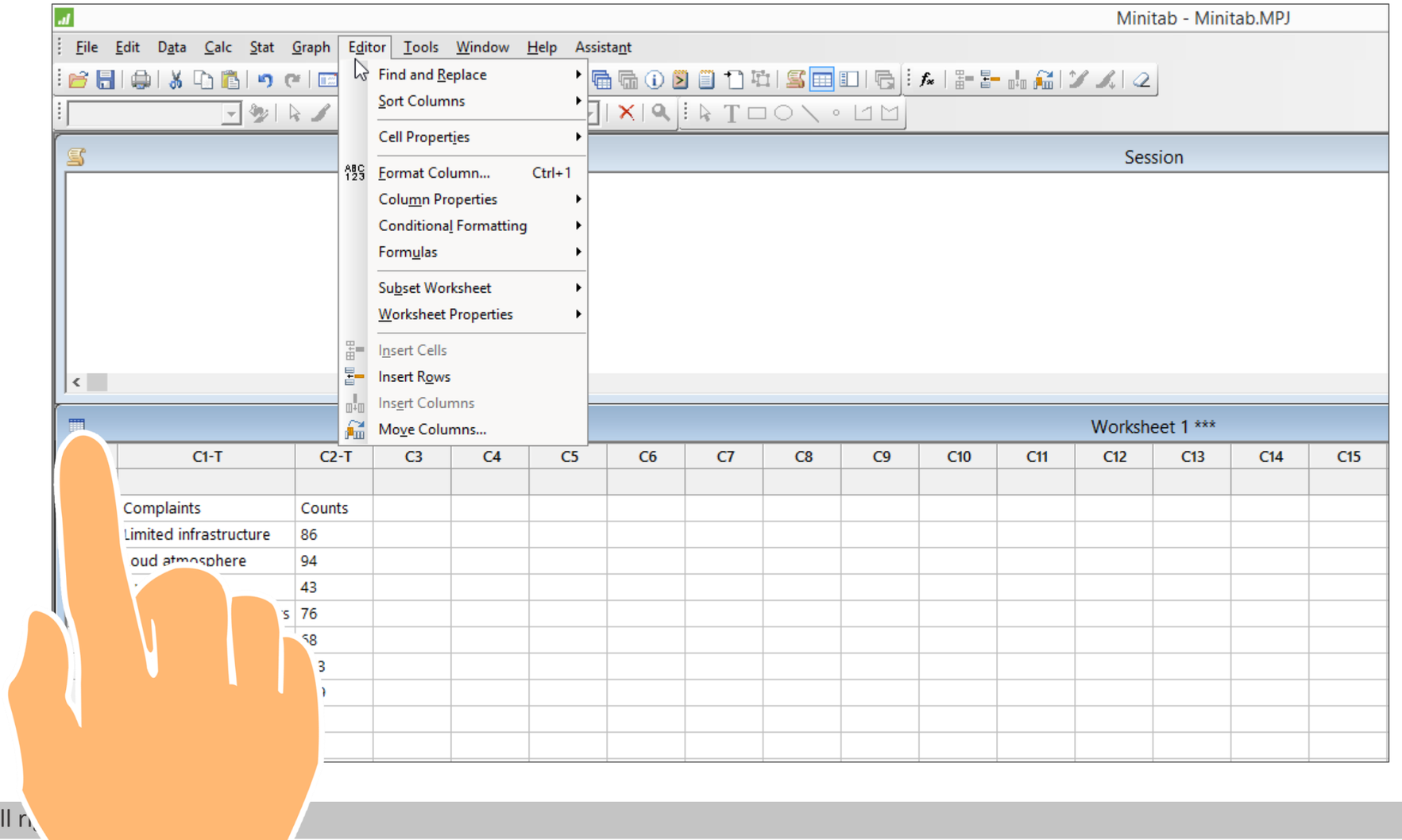
Menu Bar Overview–Graph

The Graph menu provides flexible suite of graphs to support a variety of analysis needs.



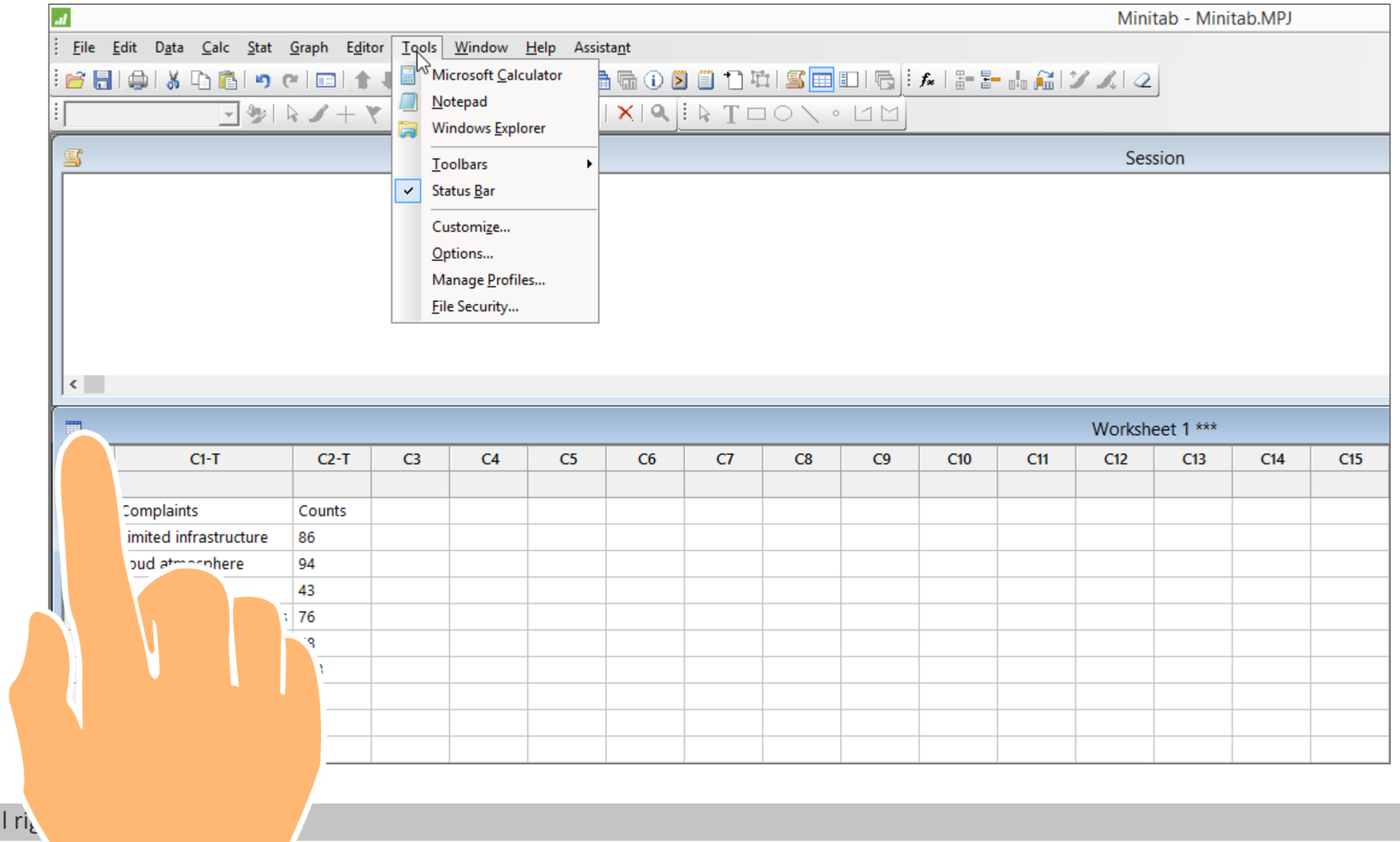
Menu Bar Overview–Editor

The Editor menu consists of dynamic commands that change depending on the active window.



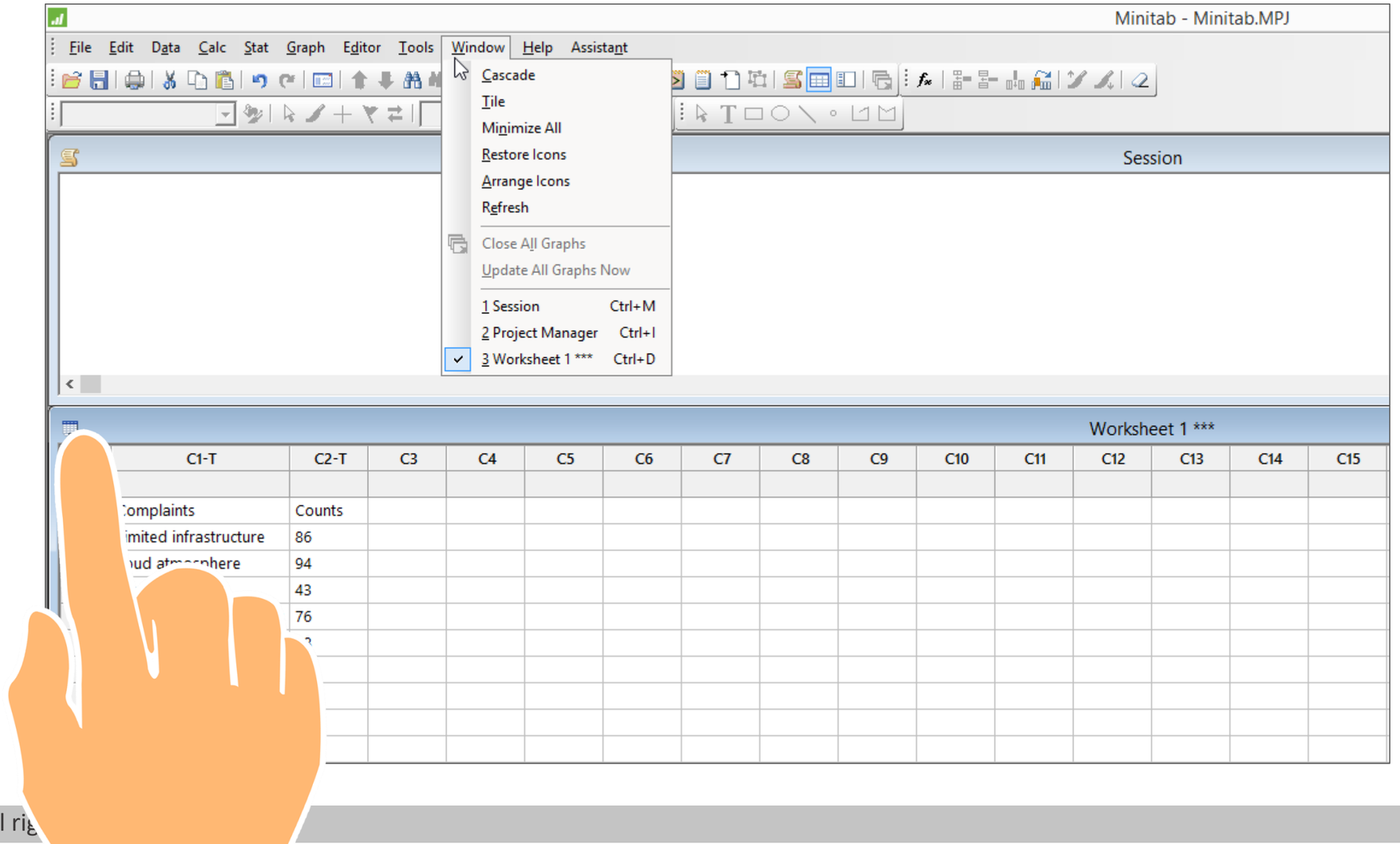
Menu Bar Overview–Tools

The Tools menu enables to open and use tools such a Calculator, or Notepad, this menu item enables to set General Settings and manage file security.



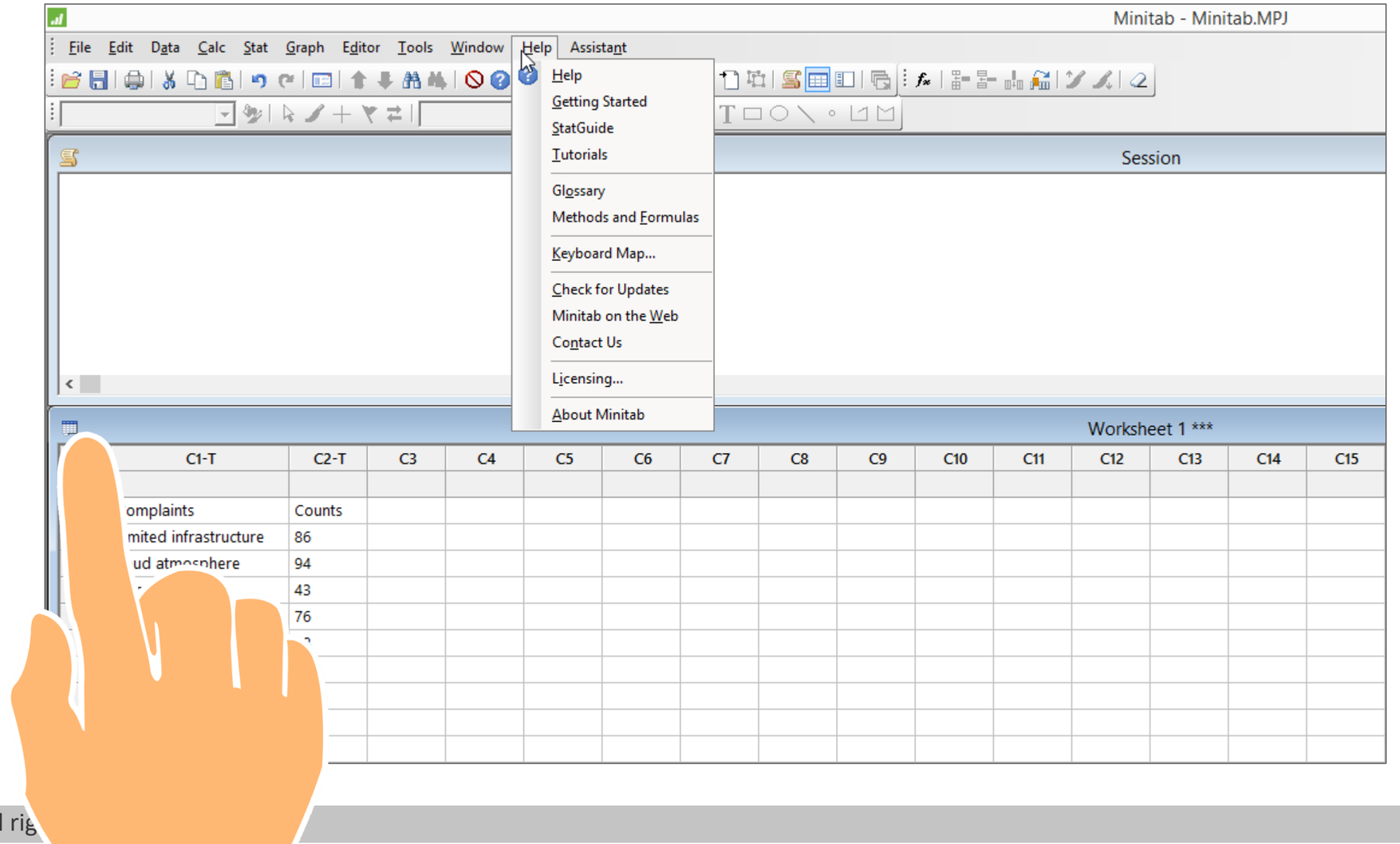
Menu Bar Overview–Window

The Window menu enables manage different windows used in the project.



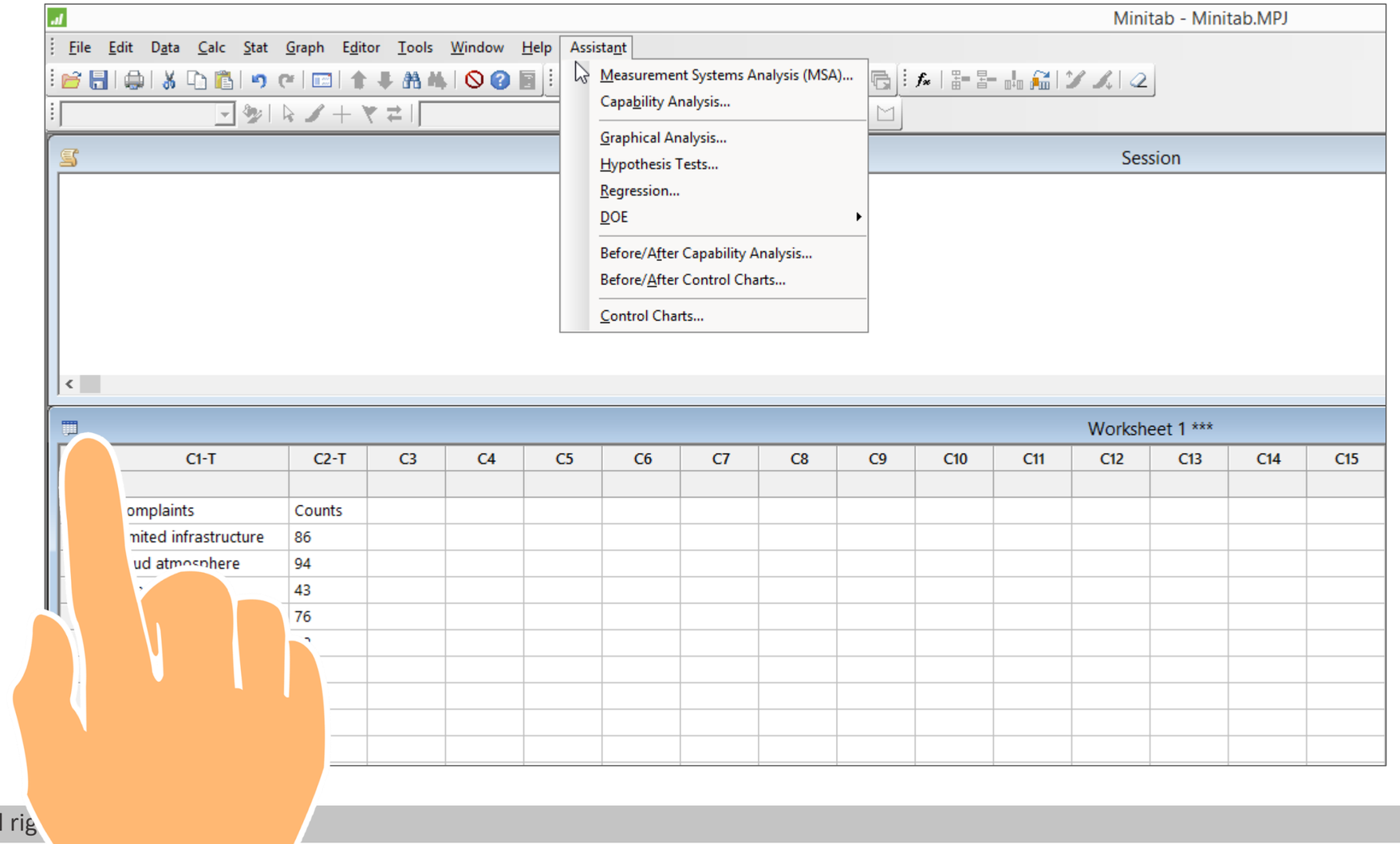
Menu Bar Overview–Help

The Help menu provides options to display table of contents, User Manual, Tutorial, and Glossary.



Menu Bar Overview–Assistant

The Assistant menu provides aid for analytic options available in Minitab.



Summary

Let us summarize the topics covered in this lesson:

- Minitab uses a series of elements to help Six Sigma practitioners work with data and statistics.
- Minitab offers a highly user friendly interface, and its default view opens three windows, Session, Worksheet and Project Manager.
- Minitab 17 requires Windows 7 or higher to run on a computer having a minimum of 512 MB RAM and 1 GHz processor.
- A Worksheet in Minitab is saved with .mtw extension.
- With the project file you can keep all data, graphs, dialog box settings and options together.
- A Project file in Minitab is saved with .mpj extension.

This concludes ‘Introduction to MINITAB.’

The next lesson is ‘Minitab Interoperability.’

Minitab®

Lesson 02–Minitab® Interoperability

After completing this lesson, you will be able to:

- Transferring data from MS Excel to Minitab
- Exporting analysis data from Minitab to MS Word and MS Power Point
- Exporting data from session window to MS Word and MS Power Point

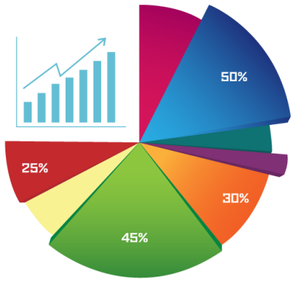
Transferring data from MS Excel to Minitab

Microsoft Excel is one of the most used software created by Microsoft.

Storing data

Calculating data

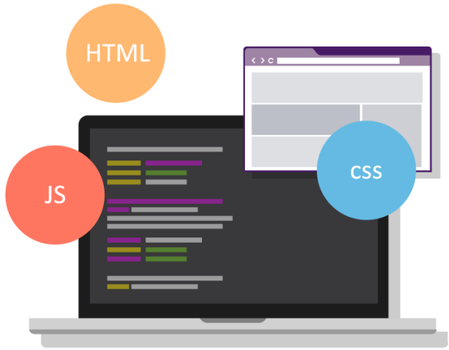
Compiling data



Sorting data

Formulating data

Pivot tables



Macro Programming

Graphics

Minitab over Conventional Tools

Microsoft Excel, a user friendly bridge for:

Data Analysis

Stores Graphs and Formulae

Reflect data in worksheet

In-depth exploration

Standout Features of Minitab

Why do industry experts prefer Minitab to other conventional tools?

It is because of its standout features. Such as;

Conditional Formatting

Enables applying a different format to data in every cell of a column

Project Manager

Enables to adjust between multiple worksheets, graphs, and statistical output.

Prediction

Enables to predict the output based on the entered values.

Demo: Exporting Analysis data from Minitab to MS Word and MS Power Point

Exporting Analysis to MS Word and Power Point

Reason to export Analysis to Microsoft Word and Microsoft Power Point from Minitab:

Presentations for Office

Teaching Course

Reports and Graph

Minitab®

Demo: Exporting data from Session Window to MS Word and MS Power Point

Summary

Let us summarize the topics covered in this lesson:

- Microsoft Excel data can be directly be transferred in Minitab.
- Analysis from Minitab can be exported to Microsoft Word and to Microsoft Power Point.
- Data from Session window can be exported to Microsoft Word, and to Microsoft Power Point.

This concludes ‘Minitab Interoperability.’

The next lesson is ‘Case Study on Six Sigma Green Belt.’

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Lesson 03–Lean Six Sigma Green Belt case study

Objectives

After completing this lesson, you will be able to:

- Generate bar chart
- Use pie chart
- Compute pareto chart
- Define normality test
- Prepare run chart
- Create histogram
- Generate box plot
- Categorize measure central tendency and spread
- Examine sample size determination
- Control charts for continuous data

Generate Bar Chart in Minitab

Case study of Healthcare

City Hospital is a well-established four-storied hospital located in one of the prime locations of New York City.

The hospital was spread over a large area with 250 beds in the causality ward, 55 beds in the ICU, and 450 beds in the general ward.

Pathology lab

City Hospital

Pharmacy services

Case study of Healthcare (contd.)

Despite being a pioneer in offering specialist services, the hospital was seeing its revenue decline during last two years.

It was seen that other hospitals were seeing more admission of patients and generating higher revenue.

Even the outpatient department (OPD) was seeing less patients than a year back.

Revenue decline
during last two years

Case study of Healthcare–Havoc and Loss

What was causing this sudden decline in patient preference and revenue?

Management changed approach

Identified causes

Healthcare Excellence Department created

Required resources provided

Daily survey conducted

Case study of Healthcare–Define the Problem

The Healthcare Excellence Department took the following steps:

- Defined and identified the pain areas
- Conducted surveys and interviews
- Discussions held with patients,

  nurses, doctors and support staff

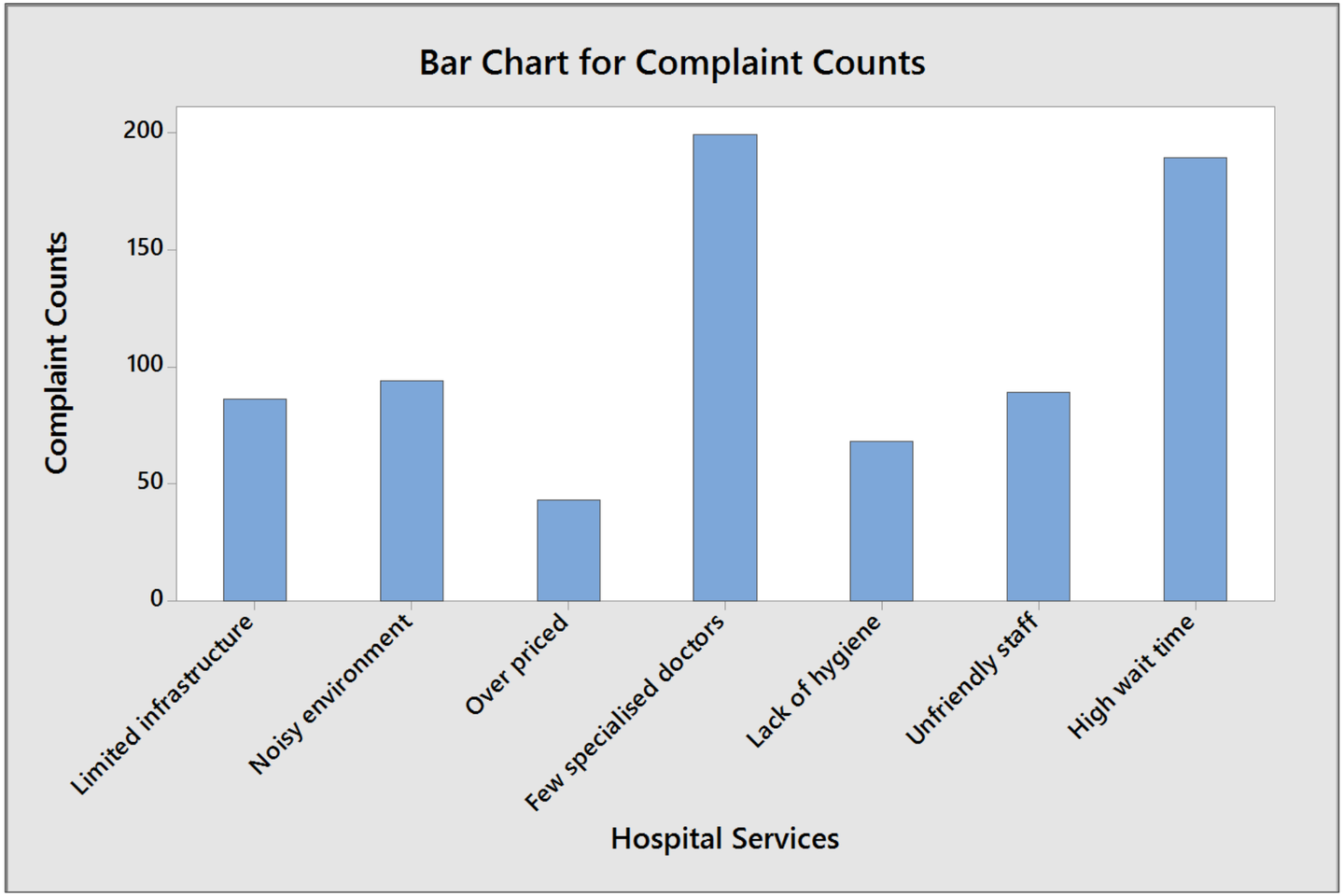
Bar Chart

The data gathered was entered into a Minitab worksheet and subject to analysis.

The first step is to classify the collected data into Nominal and Ordinal Categories.

Nominal data is categorized according to descriptive or qualitative information, and this indicates the relative importance of parameters under consideration.

In this case, the number of complaints is the nominal data against different parameters or the services offered by the hospital.



Using Pie Chart

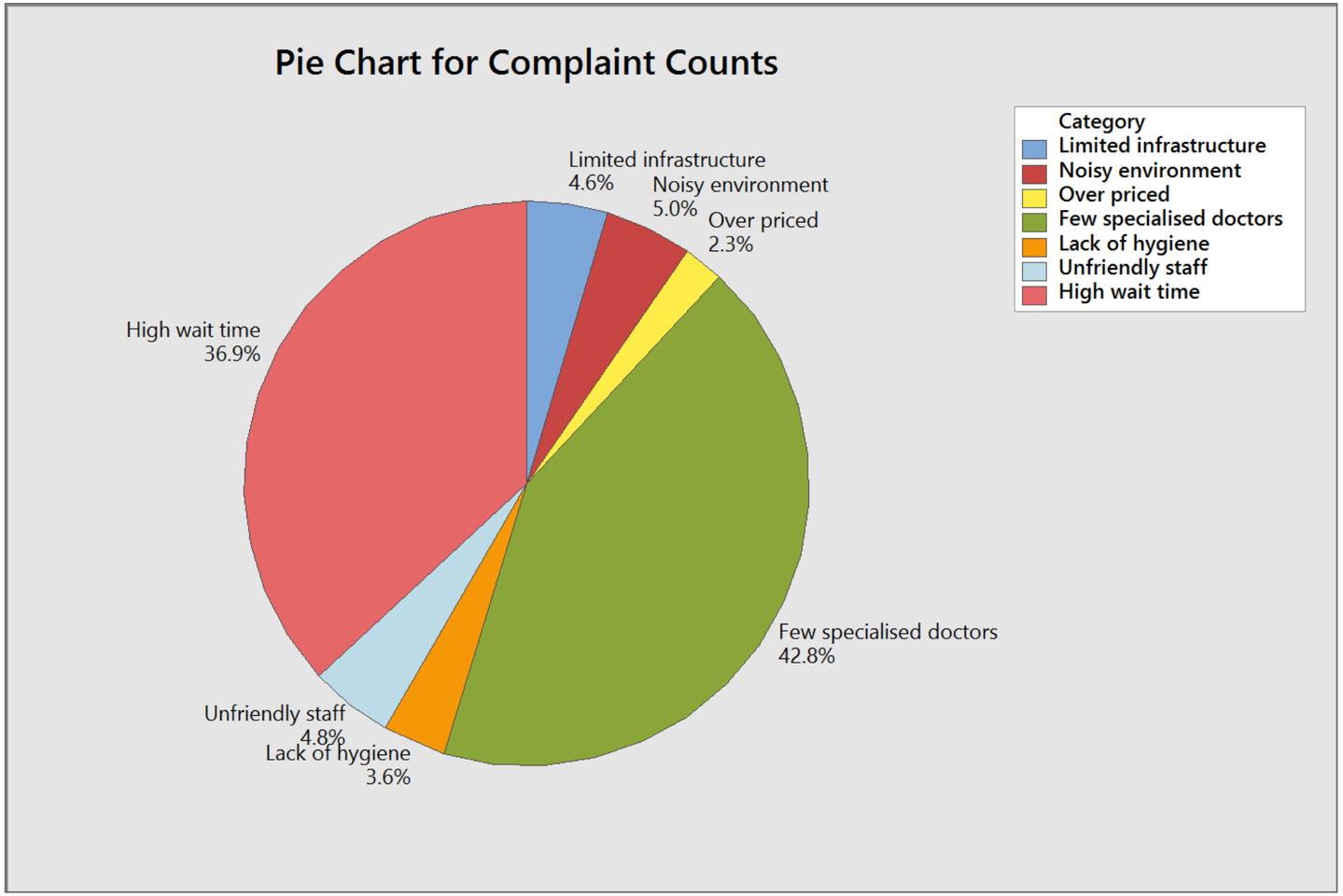
Pie Chart

The department further wanted to examine the number of complaints in percentage or proportional data.

This chart is a circular graph that resembles a pie therefore deriving its name as pie chart.

The pie chart has been cut into different sized slices (called as wedge) that shows the relative contribution that different categories contribute to total.

The pie chart is useful to get the relative importance of the parameters under study.



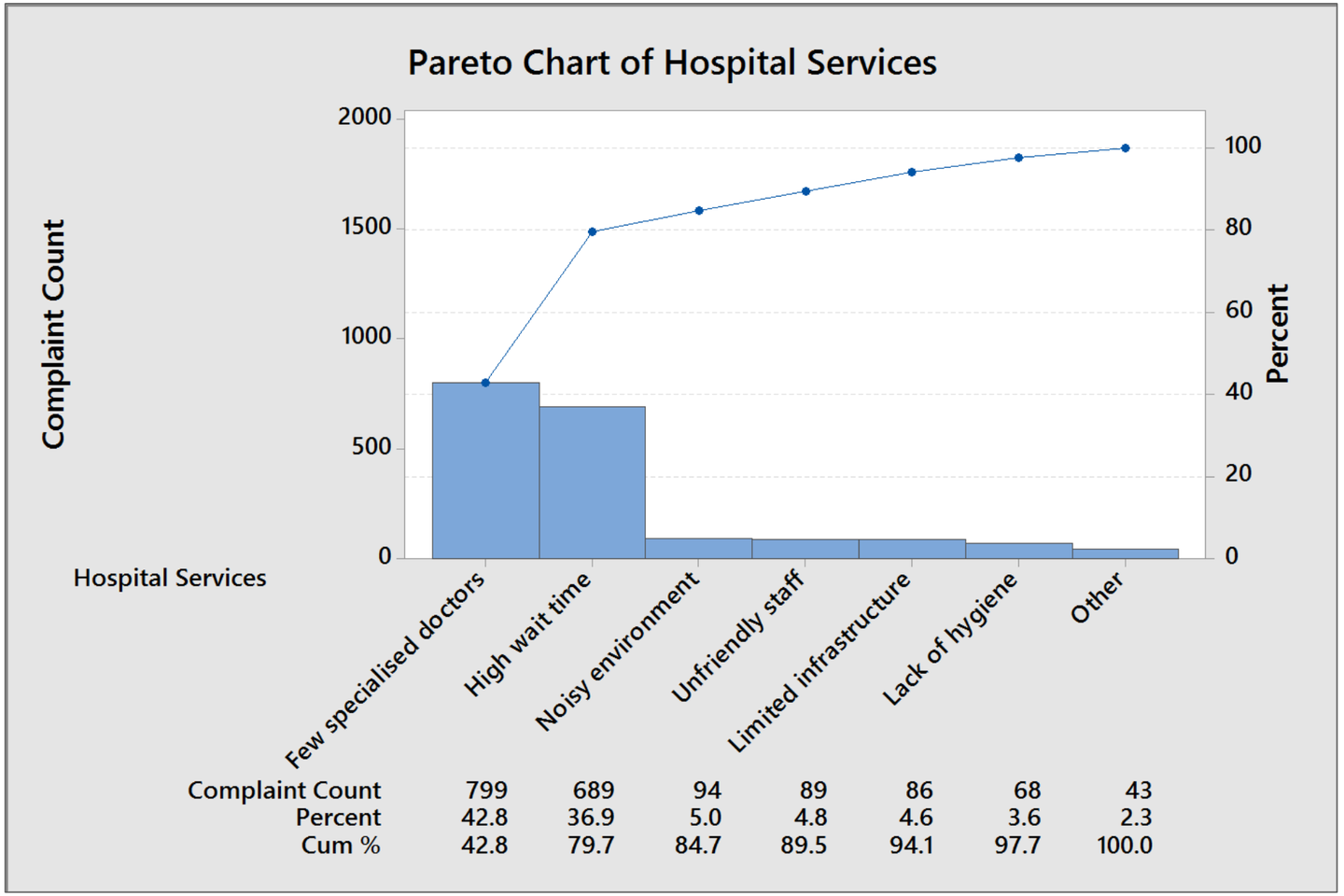
Computing Pareto Chart

Pareto Chart

The department is still under the Defining phase of their research.

Pareto Analysis is used for selection of problem(s) and initiating the improvement projects during the Define phase.

Pareto chart practices the 80/20 theory.



Defining Normality Test

Normality Test

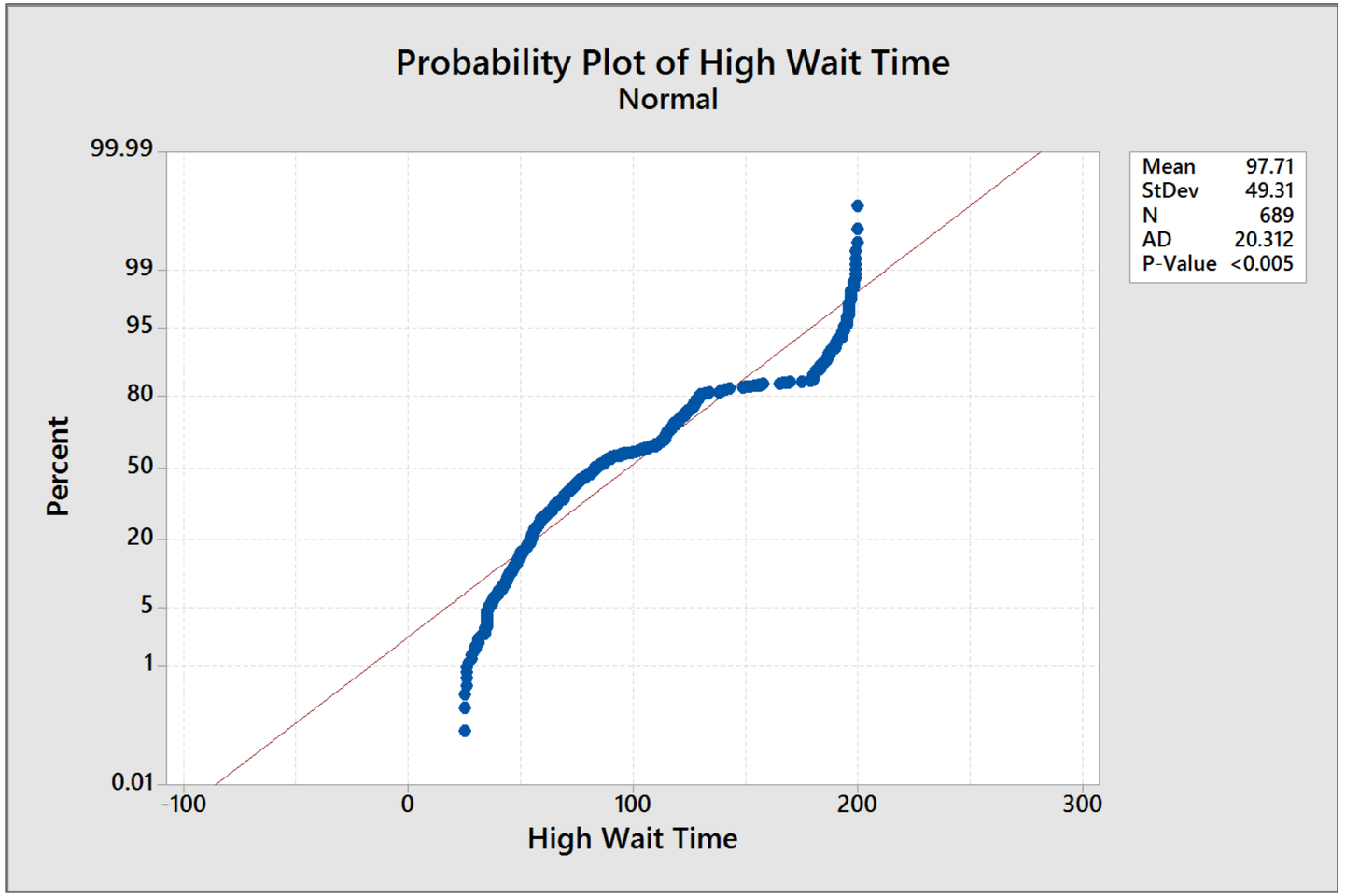
The department had the task to examine the raw data to understand

if the gathered data is retrieved from a normal distribution.

Normal Distribution is a statistical distribution. They have bell-shaped density curves with a single peak.

The purpose of conducting a Normality test is to check if the data is derived from Normal distribution.

The test results will confirm whether you should reject or fail the hypothesis as there are chances that a non-normal data may produce misleading results.



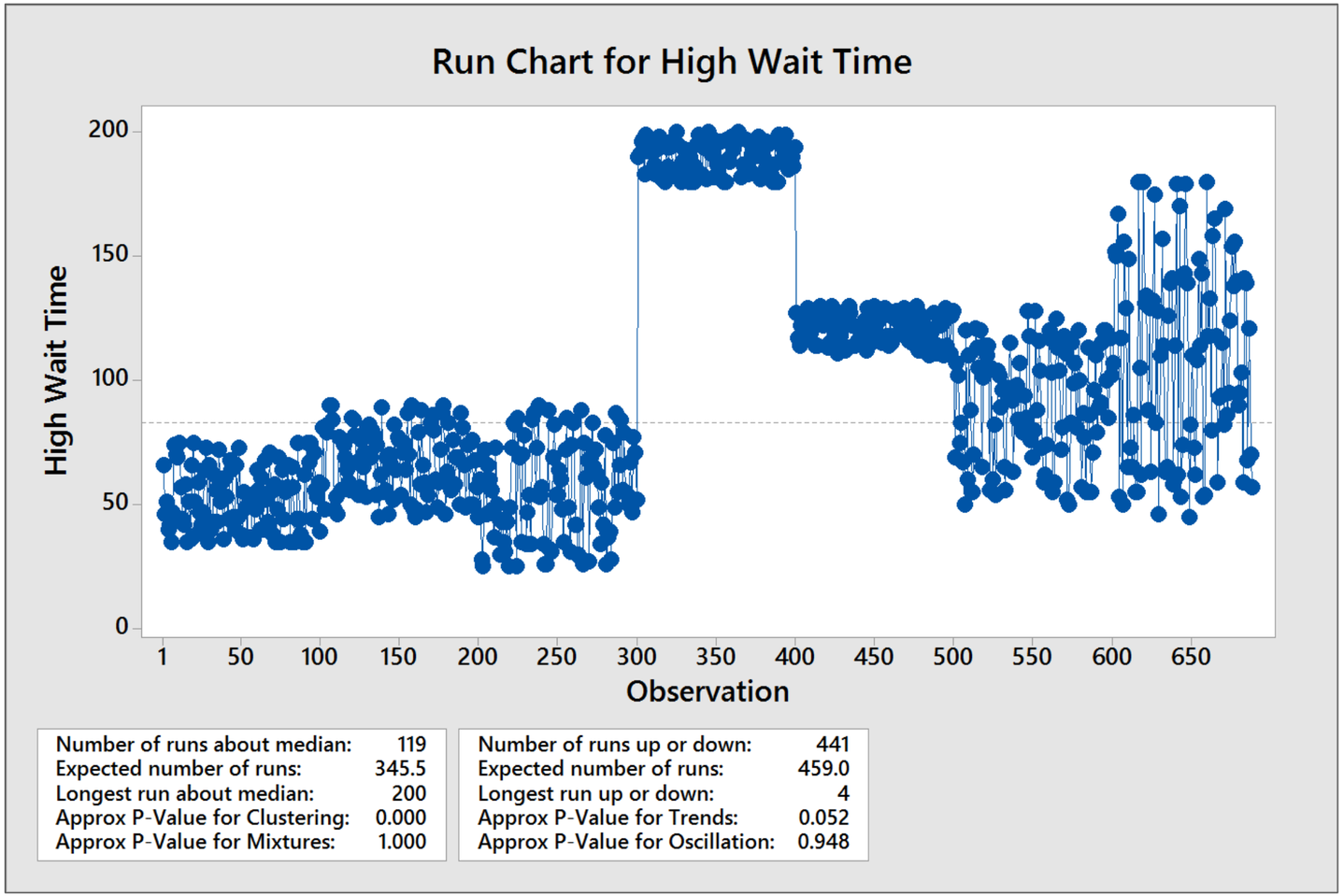
Preparing Run Chart

Run Chart

The data they are using is coming from non-normal distribution, and they need to understand the variance that exists in their data.

A run chart displays how your process data changes over time, and can reveal evidence of special cause variation that creates recognizable patterns.

For distinguishing the reasons of variation in the Hospital services, Run chart aids in analyzing the variations.

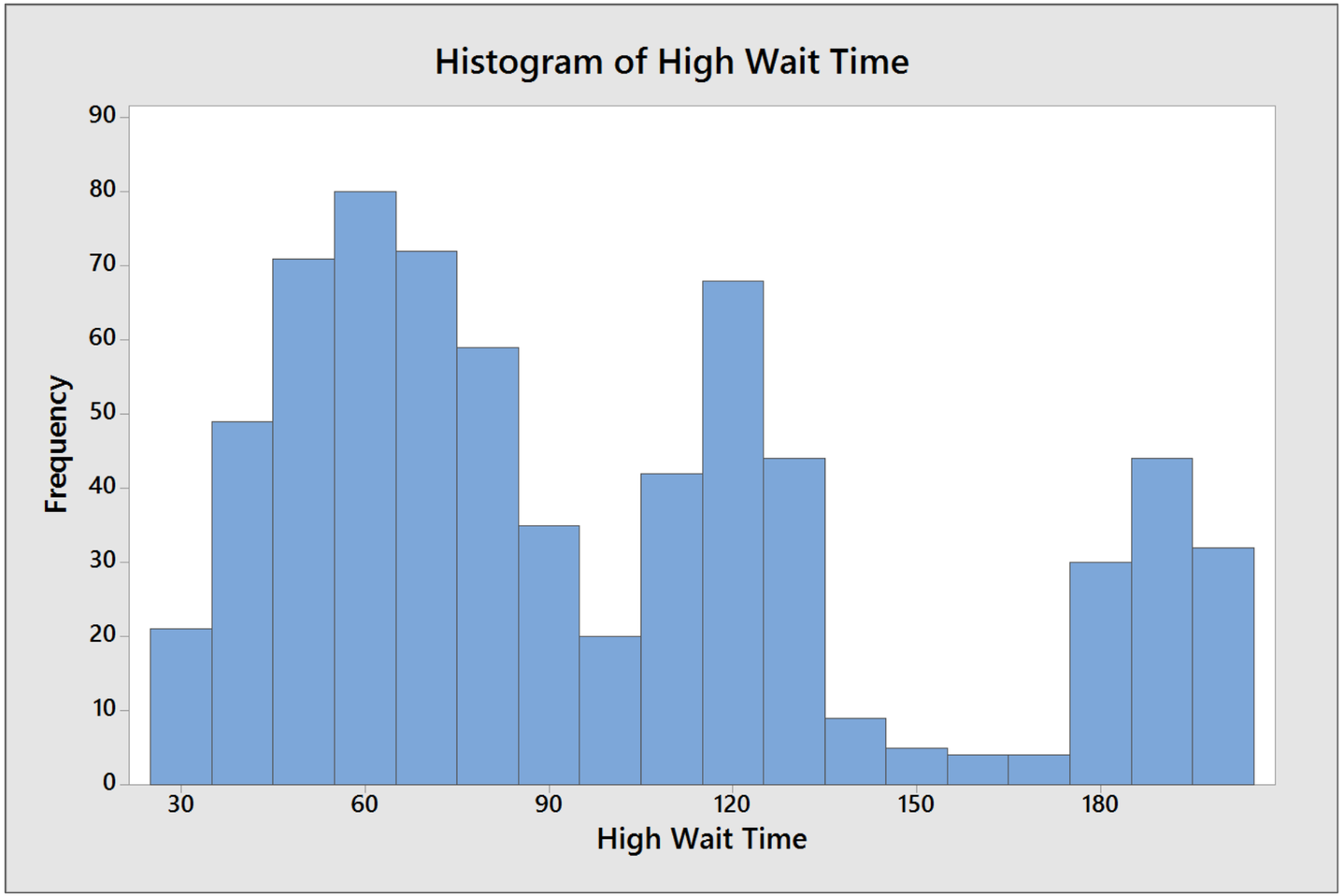


Creating Histogram

Histogram

After working on a Run Chart, the department realized that there is a lot of variance in the wait time service of the hospital. So now they want to assess the data for its symmetry or skewness, which can be done by generating a Histogram.

Histogram is created with a column of measurement data and a corresponding column of frequency data.

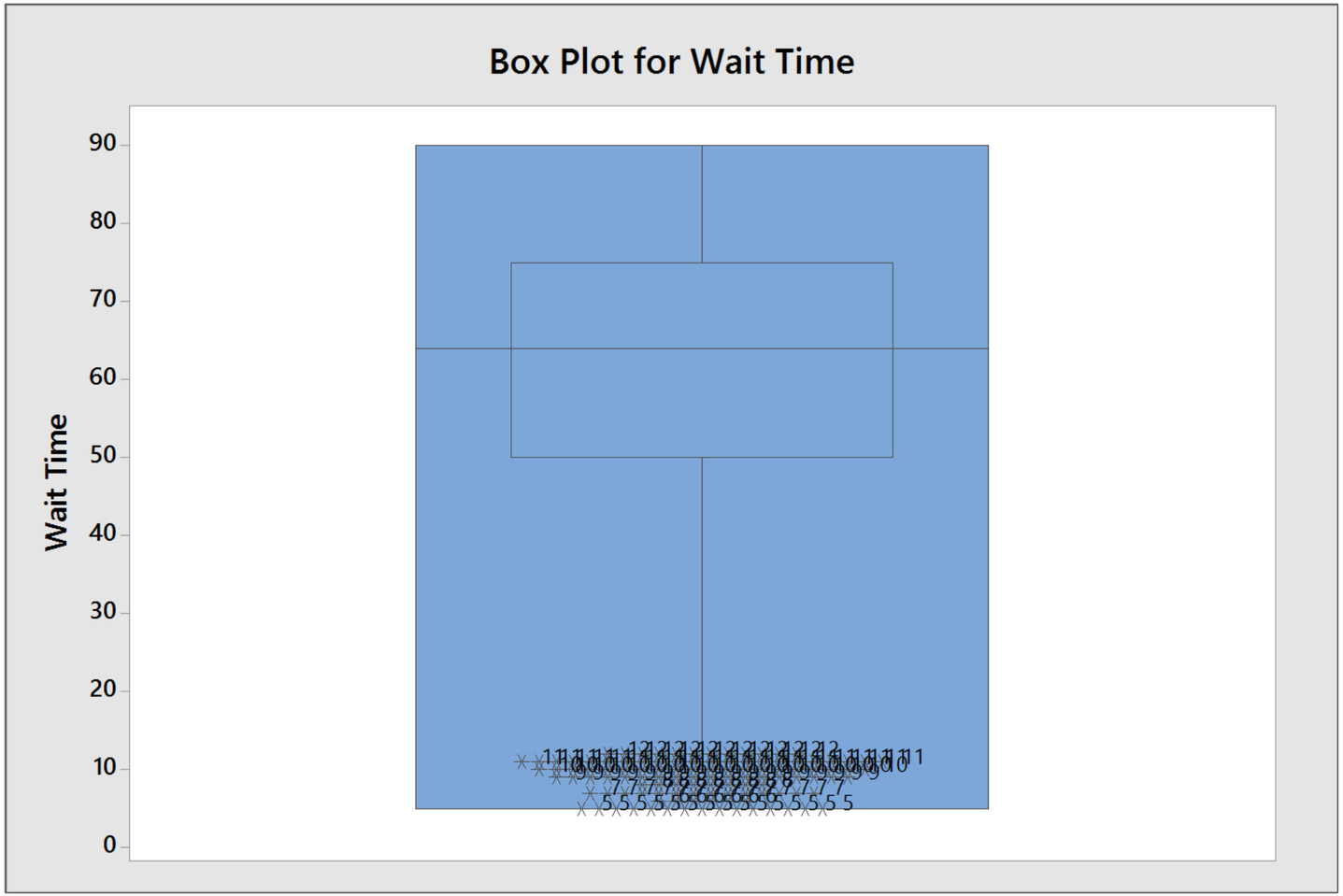


Creating Box Plot

Box Plot

In order to study the distribution of wait times, the department recorded the data on wait time of each customer before being seen by the doctor.

The data captured was entered in a worksheet, and a Box plot was made in Minitab.



Categorizing Measuring Central Tendency and Spread

Categorizing Measuring Central Tendency and Spread

Team-A successfully explored the frequency of data, its symmetry or skewness.

Now they have to identify the values Mean, Median, Mode, Standard Deviation, Variation, Range, and Variance in the values of age and weight for patients who participated in the survey.

So they decide to measure central tendency and spread.

Examine Sample Size Determination

Sample size determination

After the department has evaluated the average age and weight of the patients, they now want to know the approximate number of patients for their investigation.

This feature is generally used for appraising a specific margin of error for confidence intervals or tolerance intervals.

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Use Control Charts for Continuous Data

Control charts for Continuous data

The department was able to derive the specific margin of error for confidence intervals or tolerance intervals by determining the sample size.

As the patients were arriving continuously throughout the day, and were subject to waiting times before meeting with the doctors.

Analyze the distribution

Charts for continuous data

Summary

Let us summarize the topics covered in this lesson:

- A bar Chart classifies the data into Nominal and Ordinal Categories.
- A pie chart examines data in percentage or proportional data.
- A pareto chart practices the 80/20 theory or ‘vital few and trivial many’ principle.
- A normality test is conducted to understand if the data comes from normal distribution.
- A Run chart analyzes the variations in data.

Summary

Let us summarize the topics covered in this lesson:

- A Histogram assesses the data for its symmetry or skewness.
- Measuring Central Tendency and Spread describes variability in a data by calculating the mean, median and Mode.
- Sample Size Determination evaluates a specific margin of error for confidence.
- Chart for continuous data monitors the process data.

This concludes ‘Case Study on Lean Six Sigma Green Belt.’

The next lesson is ‘Case Study Covering 12 Tools in Minitab for Green Belt Professionals.’

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Lesson 6–Case Study on Lean Six Sigma Green Belt

Objectives

After completing this lesson, you will be able to:

- Describe sorting data
- Apply formulas to columns
- Define changing data types
- Prepare process capability indices
- Produce dot plot
- Operate individual value plot

Objectives

After completing this lesson, you will be able to:

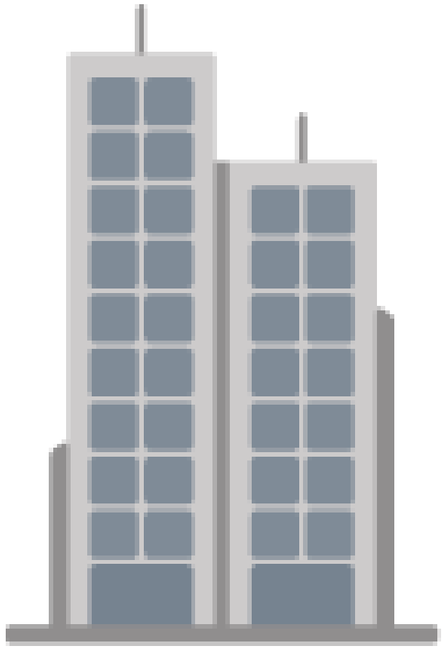
- Explain Interval Plot
- Demonstrate Scatter Plot
- Apply Calculating Z value
- Comprehend Identifying distribution
- Describe Transforming data to Normal distribution
- Interpret Control charts for Discrete data

Sorting Data

Fibonacci Technologies

Fibonacci Technologies, an IT company was a successful company globally.

For completing the testing and debugging, Fibonacci hired a third party called Caliper, which used Lean Six Sigma for analysis and improvements.



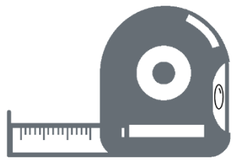
Fibonacci Technologies

It was segregated in 5 steps as mentioned below:

Define

The two modules in detail after getting the requirements for the various functionalities and their criticality.

Measure



Data of all the debugging activities throughout the shift were compiled at the end of day.

Analyze

Analysis was completed using Minitab®

Improve

All the uneven distribution of work amongst the two consultants was resolved.

Control

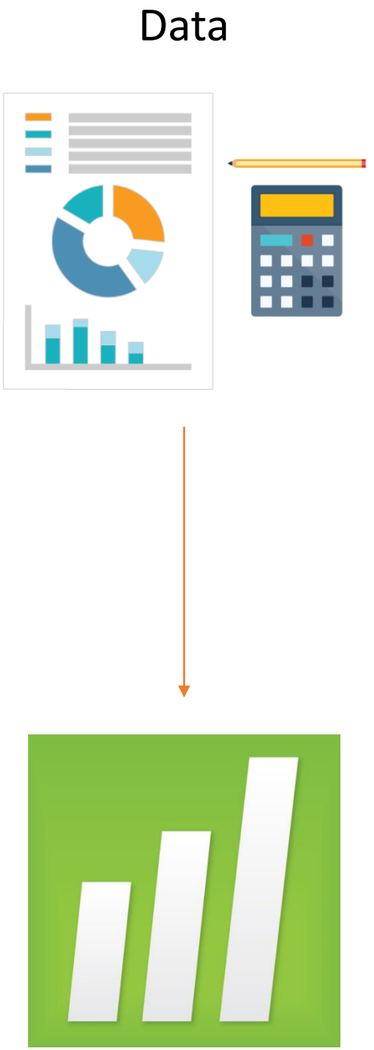
The debugging time was managed closely over the period.

The data provided in the worksheet was collected on a daily basis for modules X and Y.

Minitab enables you to sort data in one or more columns in increasing or decreasing order.

Moreover, you can store the sorted data in original columns, other specified columns, or in a new worksheet.

It is important to note that, columns that are sorted together must be of the same length. If the selected columns are not of the same length, Minitab displays a message, asking if you want to add missing values to the bottom of the shorter columns so that they can be sorted together with the longer columns.



Project Duration

Fibonacci Technologies had decided to employ their team, including a project manager and two consultants, to carry out the lean six sigma consulting for testing and debugging their modules.

They assessed that the project duration would be around 500 hours.

Sr. No	Role	Estimated Hours	Cost/Hr. ($)
1	Project Manager	200	100
2	Consultant 1	500	70
3	Consultant 2	500	70

Demos

- Apply Formulas to Columns
- Changing Data Types
- Process Capability Indices
- Dot Plot
- Individual Value Plot
- Interval Plot
- Scatter Plot
- Character Z Value
- Identify Distribution
- Transform data to Normal distribution
- Control Charts for Discrete Data

Summary

Let us summarize the topics covered in this lesson:

- Sort data in one or more columns according to values that is associated in the selected columns. Data can be sorted in increasing or decreasing order
- Applying formulas to columns define data in a column as a function of data in other columns.
- Change Data Type enables you to specify the data type of a column before you enter values.
- Process Capability indices checks efficiency in the process.

Summary

Let us summarize the topics covered in this lesson:

- Dot Plot analyses shape and spread of their data.
- Individual values analyses spread of data.
- An interval plot is a graphical presentation of the distribution of any sample that shows the sample's central tendency and variability.
- Scatter Plot examines the relationship between two variables.

Summary (Contd..)

Let us summarize the topics covered in this lesson:

- Calculating Z value hat measures the difference between two or more data.
- Identifying distribution analyses data for different types of distributions.
- Transforms a non-normal data into normal distribution.
- Control charts for discrete data analyses if the collected data continuous or attribute.

This concludes ‘Case Study on Lean Six Sigma Green Belt.’

The next lesson is ‘Repeatability and Reproducibility Analysis.’

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Lesson 05–Gage R and R Analysis, and Attribute R and R Analysis in Minitab

Objectives

After completing this lesson, you will be able to:

- Justify measurement system analysis as a powerful decision making tool
- Explain the use of gage repeatability and reproducibility analysis method
- Understand the attribute repeatability and reproducibility analysis method

Measurement System Analysis

Case Study of a Garment Manufacturing Company

It is time to introduce you to my two dear friends, Gary and John. Today, they are proud owners of one of the leading garment manufacturing companies in North Carolina, but there was a time when they were on the verge of shutting down their business.

But, like they all say, every cloud has a silver lining, and in their case, the ray of hope was the analysis by their Six Sigma Black Belt team. The analysis helped them correct the methodology of measurement variation in the delivered parts.

Case Study of a Garment Manufacturing Company

Gary and John, two promising design graduates started Couturier Garments in 1976. They were successful in connecting with the young generation, and brought real artisans to the forefront. With this approach, in less than a year, the organization was well established across prints and social circle, which enabled them to successfully get listed with the leading stock exchanges.

To add to their success story, they received a bulk order from a leading fashion flagship store in Paris. This news created a hysteria in the market, and led to an increase in their market value, revenue, and newer client acquisitions.

A three-year agreement was signed between the two companies to take up production to the next level. On the basis of this agreement, it was time for Couturier Garments to expand. So, they invested in new plants and new resources across the country. They successfully delivered their first two orders to the fashion store.

Case Study–Couturier Garments

Both Gary and John were delighted with their success, but after a couple of months they realized that their success was short-lived. It was observed that a part of their third consignment was not accepted by the client, and the rejection rate was 25%.

This was followed by a series of further rejections (78% in a span of one month), and finally leading to an immediate termination of the agreement. This created a negative impact and resulted in an abrupt fall in their market value; so much so that even their loyal old clientele refused to give any new business to the manufacturer.

This led to a sudden decline in their share prices and revenue. Moreover, negative publicity by their client made matters worse, and the company started facing a downward trend.

Case Study–Couturier Garments (contd.)

This was definitely a point of concern for the management; inside the board room, long-term strategies were devised to overcome this debacle. An external consultant, Roger, who was known to create miracles during such business turbulence was brought on board to join their Six Sigma team of professionals.

Collectively, they put forth the idea of training the senior management on quality approaches and methodologies such as Lean Six Sigma. Accordingly, a special task force was formed, and Roger got them trained and familiarized with the Six Sigma way of solving problems.

Accordingly, a special task force was formed, and Roger got them trained and familiarized with the Six Sigma way of solving problems.

Case Study–Couturier Garments (contd.)

The task force was asked to identify the reasons for high garment rejection rate for the past one year.

Several root causes causing higher garment rejection rate were identified, like sewing defects, seaming defects, placement defects, fabric defects, and garment defects, and others.

The main reasons for the decline were defects in the quality of sewing, placement, and seaming.

Case Study–Couturier Garments (contd.)

The main concern articulated by Roger was that in spite despite having stringent quality control systems to detect and isolate such defects, how were such large quantities of defects reaching the client? Hence, it was necessary to first evaluate the entire quality checking process.

At this stage, Roger introduced the concept called Measurement System Analysis (MSA). He was interested in understanding whether there were any major system errors or operator errors that led to the overall high rejection rate.

Measurement System Analysis (MSA)

MSA is one of the most powerful decision making tool used to determine how much of the process variation is due to the:

- Measurement device (gage)
- Measurement methods (operator, parts)

It is used during the 'Measure' phase of the six sigma journey to verify capability of the measurement system when:

- Establishing process baseline
- Verifying causes
- Verifying solutions
- Most importantly when controlling the key process input variables

Measurement System Analysis

Types of MSA–Gage R&R

The types of MSA are:

- Gage R&R (For continuous data)
- Attribute Gage R & R (For attribute data)

Gage R&R (For continuous data): is an experiment conducted to understand whether the process variation is due to the measurement device (gage) or measurement method (operator, part).

Gage R&R (For continuous data) is a method which:

- Quantifies the repeatability and reproducibility of a measuring system.
- Assesses the accuracy, repeatability, reproducibility of a continuous measurement system.

Null Hypothesis	Variation between parts does not contribute to sewing and seaming defect.
Alternate Hypothesis	Variation between parts does contribute to sewing and seaming defect.

Measurement System Analysis Defects

The concern was sewing, placement and seaming defects.

Gage Repeatability and Reproducibility Analysis Method

Attribute Repeatability and Reproducibility Analysis Method

Types of MSA–Attribute Gage R & R

Attribute Gage R & R (For attribute data) is a study that compares each part to a standard and accepts the same if the standard is met.

The variation in TMR was majorly due to difference between parts, the Six Sigma task force along with consultant started Quality Validation.

This was done to verify if there was any variation at the Quality Check level, wherein a good product is getting rejected, and a bad product is being accepted.

The team used the Attribute Gage R&R each part to a given standard.

Appraiser was asked to inspect fifteen garments on a scale of 1 to 5.

An expert was called to inspect the fifteen garments without the knowledge of the appraisers.

Null Hypothesis	Calibration exists between appraisers basis the given standard.
Alternate Hypothesis	Calibration does not exist between appraisers basis the given standard.

Conclusion

The objective was to identify the real reason behind high garment rejection rate in spite of having stringent quality control systems to detect and isolate such defects.

The Gage R&R experiments lead to some key learning's about the quality checking system. These learning's were listed by the consultant, as below:

There were no errors caused by the measuring system and method.

The rejection rate was due to defects in the actual parts itself.

Operators were not skilled and trained adequately to distinguish between good and bad parts. They were passing defective parts as good.

Summary

Let us summarize the topics covered in this lesson:

- MSA is one of the most powerful decision making tool to verify capability of the measurement system.
- Gage R&R is a method to quantify the repeatability and reproducibility of a measuring system.
- Attribute measurement system is a study that compares each part to a standard and accepts the same if the standard is met.

This concludes ‘Gage R and R Analysis, and Attribute R and R Analysis.’

The next lesson is ‘The correlation analysis, mounting the contour plot, and conducting hypothesis tests for normally distributed data.’

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Lesson 6–Case Study on Lean Six Sigma Black Belt

In any industry, productive output is always corelated to the effort by the employees

Productive output

Effort by the employees

Objectives

After completing this lesson, you will be able to:

- Understand correlation coefficient analysis
- Use contour graph to study possible relationship between three variables
- Define hypothesis testing
- Apply normally distributed data

Generate Correlation Coefficient Analysis in Minitab and Interpret their Corresponding Results

Case Study

- Metro Hospital was one of the premier hospitals in New Jersey, and it was known for expert Doctors, efficient and well-behaved medical support staff, and state of the art health care facilities.

- The hospital had marginable success rate over the years. Although the day-to-day operation was carried out smoothly in the hospital, but the management was concerned with a high turnaround time taken for patient discharge.

Metro Hospital

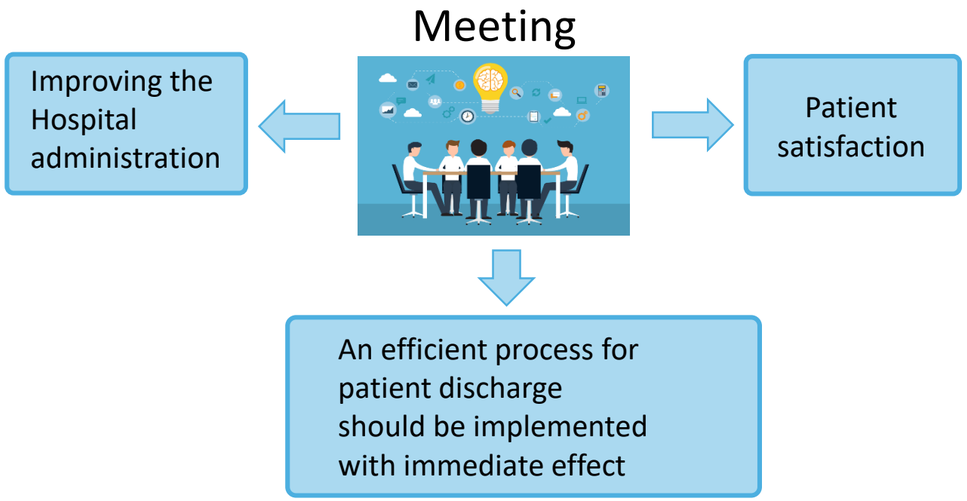
Marginable success rate

Case Study

- And soon this started to reflect on the hospital's revenue, which was seeing a decline by nearly 55 percent, and this was due to rate of inpatient admission.

- In the fortnightly meeting, it was highlighted that the management should focus on improving the hospital administration, patient satisfaction, and an efficient process for patient discharge should be implemented with immediate effect.

Hospital's revenue was decline by nearly 55 percent



Case Study (contd.)

- The high turnaround time for patient discharge was a critical issue. So, the hospital management assigned the task of building an efficient discharge system to their best team of Six Sigma Black Belt professionals.
- After their regular rigorous brainstorming session, they decided to start their observation from the inception mode of discharge. First they targeted the patients and asked them, "**What should be the ideal and realistic discharge time from the hospital?"**
- Patients responded that the physical discharge shouldn't exceed 3 hours once they receive the final set of instructions by the consultant or the doctor.

Six Sigma Black Belt professionals

Patients

Case Study (contd.)

- Next step was to study the end-to-end patient discharge process.
- The current average patient discharge time was 288 minutes. This meant, it took a patient nearly 2 hours more than the expected time.
- To reduce this time from nearly 5 hours to 2 and half hours, but ensuring none of the key discharge steps were skipped.

Analyze and identify the root causes

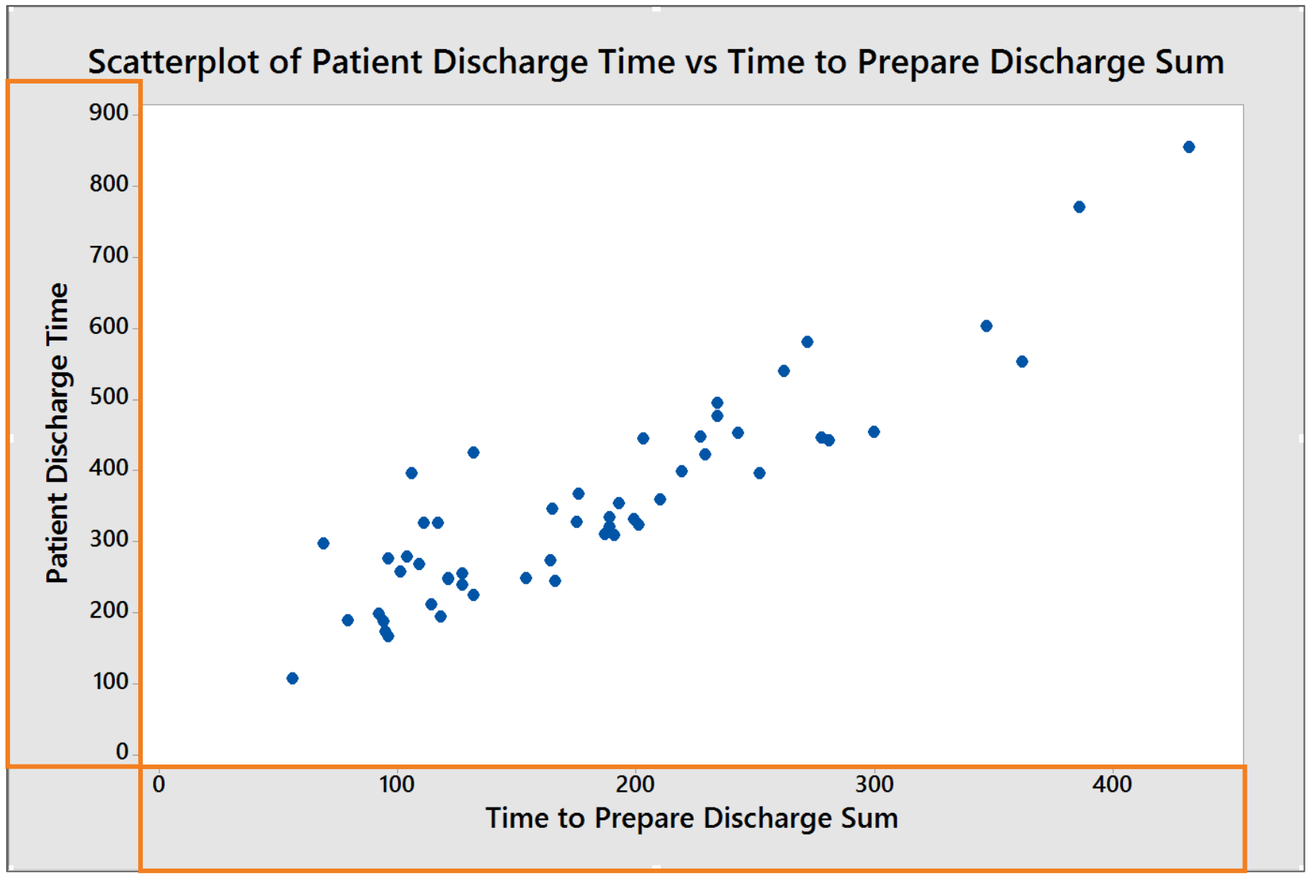
Team Alpha–Establishing Hypothesis

- Team Alpha initiated the project by developing an end-to-end process map for the patient discharge.
- The team came up with possible constraints to identify the end root cause.
- The team found that one of the potential causes to high turnaround time for patient discharge was the total time taken to prepare the discharge summary.
- The team wanted to validate the relationship between the high turnaround time for patient discharge and total time taken to prepare discharge summary.
- A Hypothesis was established to investigate the relationship further:

Null Hypothesis	Time taken to prepare the discharge summary does not impact the TAT for patient discharge.
Alternate Hypothesis	Time taken to prepare the discharge summary does impact the TAT for patient discharge.

What is Correlation Coefficient Analysis?

- This is a statistical analysis to assess linear relationship between the Output variable, plotted on the Y-axis, and the input variable, plotted on the X-axis.
- A relationship exists between the two variables, they are said to be correlated.
- Using the correlation analysis, we usually refer the linear relationship with Pearson Correlation, which quantifies the strength or degree of relationship between the two variables. Usually, the correlation analysis is examined using a scatter plot.



Interpret Correlation Coefficient Analysis

Conclusion

Coefficient Correlation leads the Six Sigma team to some key insights to the patient discharge process.

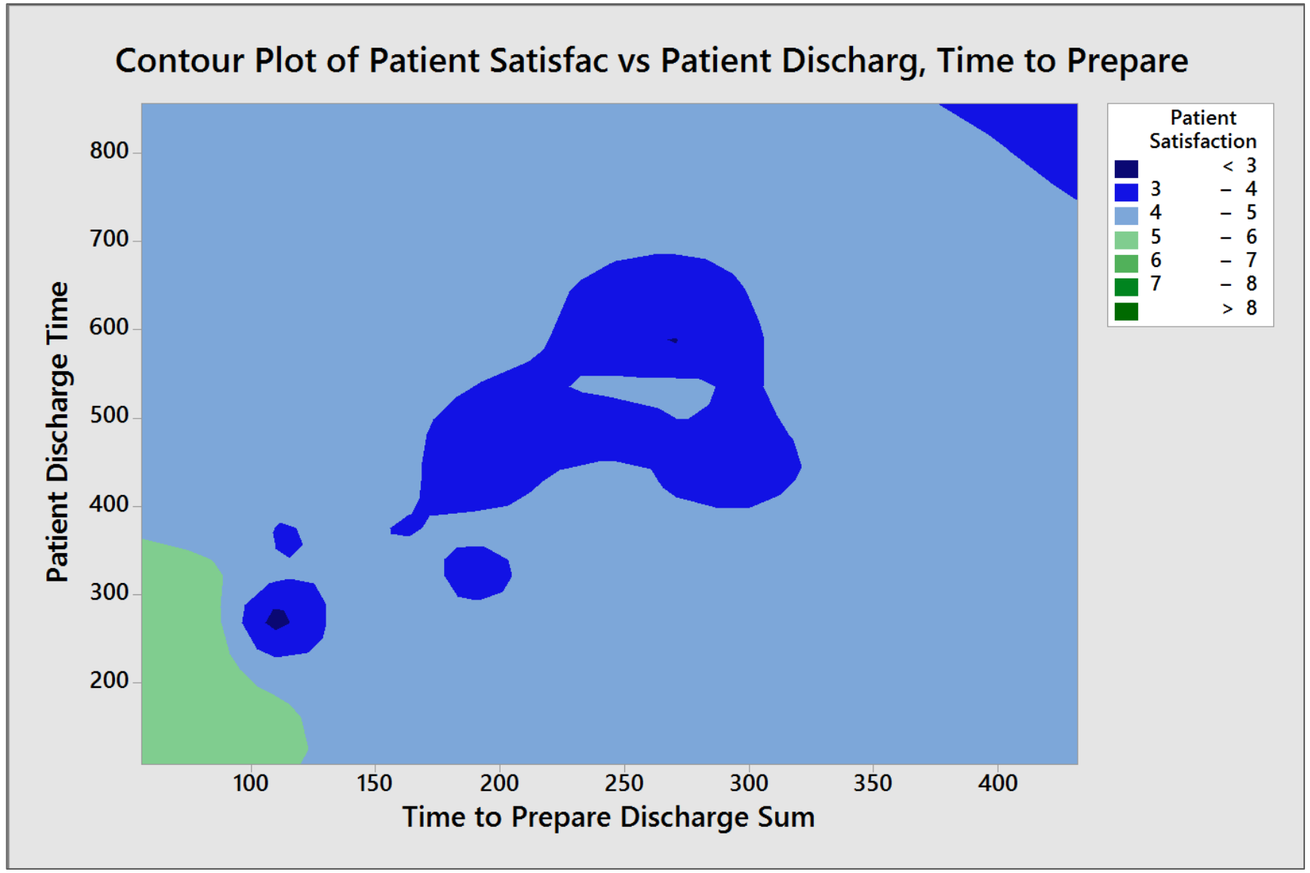
- Hospital staff should need only key papers to be forwarded to billing department to initiate the discharge process.
- Preparation of discharge summary should be processed and completed a night prior to patient discharge.
- The consultants and doctors to recommend final diagnosis and follow up treatment a night prior to discharge.
- All Medical Transcriptionists must be to be allocated to each floor for expediting the preparation of discharge summary.

If the hospital followed all key points they will be able to reduce the turnaround time for patient discharge from 5 hours to 2.4 hours

Use of Contour Graph

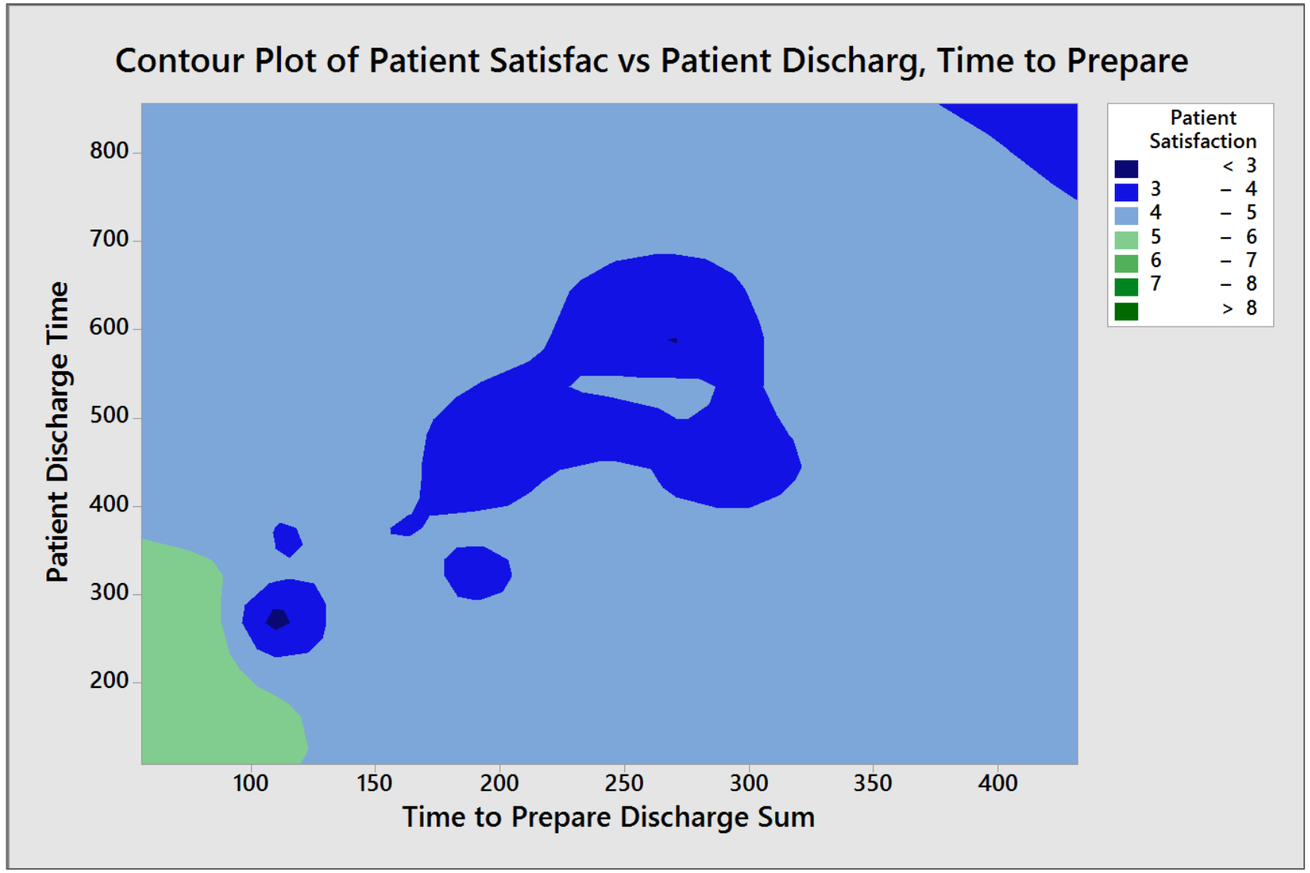
Contour plot

- Six Sigma team at Metro hospital happily concluded that time taken to prepare the discharge summary was the real cause of the delay in patient discharge, they wanted to validate this relationship.
- The relationship between the high turnaround for patient discharge, total time taken to prepare discharge summary and its impact on patient satisfaction.
- Third variable is Patient Satisfaction.
- They conducted the PSAT or Patient Satisfaction survey, and asked the patients to rate different hospital services on the scale of 1 to 10.



Contour plot (contd.)

- A contour plot is a graph used to study possible relationship between three variables.
- It displays three dimensional relationships in two dimensions on x, y and z scales.
- This plot enables you to study the impact of change in the input process over the output.
- Moreover, it enables you to predict the value of the output when a definite combination of two input processes is set.



Hypothesis Test for Normally Distributed Data

Define Hypothesis Testing

What is Hypothesis Testing?

It is a statistical analysis to determine if the observed differences between two or more sample data is due to random chance or actual difference in the sample.

Statistical analysis

Graphics

Calculated statistics

Actual difference

Types of Hypothesis Testing

Types of Hypothesis Testing with Normally Distributed Data. When the data is continuous in nature and is normally distributed:

2-Sample t-Test	1-Sample t-Test	Paired t-Test
When comparing means of two different set of items.	When a sample mean is compared to a specific value.	While determining if statistically significant difference in the mean of a dependent variable between two related groups.

Hypothesis- 2-Sample t-Test

Six Sigma team at the Metro hospital, and their job on hand to perform 2-Sample t-Test by comparing the average time of patient discharge time before and after implementing the instructions.

Team entered the collected sample data in Minitab, and the established two hypotheses:

Null Hypothesis	The mean time for patient discharge before and after is the same.
Alternate Hypothesis	The mean time for patient discharge before and after is different.

Hypothesis-1-Sample t-Test

It is possible to reduce the discharge time to two and half hours, the hospital management increased their expectations and wanted to know if the time could be reduced to 2 hours.

The team took up the challenge and started collecting the data for the next 6 months, and decided to perform the 1-Sample t-Test.

Null Hypothesis	The turnaround time for patient discharge is 2 hours.
Alternate Hypothesis	The turnaround time for patient discharge is not 2 hours.

Hypothesis-Paired t-Test

- A sign of a good Six Sigma professional is the ability to consistently analyzing the process and trying to improve the same.
- To better turnaround time for the patient discharge, and to do the same, they compared the average time taken in preparing a discharge summary by medical transcriptionists before and after implementing their instructions.
- The team took around 20 samples that the transcriptionists had worked earlier.

The team decided to perform the Paired t-Test and for the same, they entered the collected data on the average time taken by the transcriptionists to prepare the discharge summary before and after in Minitab.

Null Hypothesis	Time taken to prepare the discharge summary by the transcriptionists before and after is the same.
Alternate Hypothesis	Time taken to prepare the discharge summary by the transcriptionists before and after is different.

Summary

Let us summarize the topics covered in this lesson:

- Correlation Coefficient Analysis is a statistical analysis to assess linear relationship between the Output variable, plotted on the Y-axis, and the input variable, plotted on the X-axis.
- A contour plot is a graph used to study possible relationship between three variables.
- Hypothesis Testing is a statistical analysis to determine if the observed differences between two or more sample data is due to random chance or actual difference in the sample.

Summary (contd.)

Let us summarize the topics covered in this lesson:

- 2-Sample –t-Test is used when comparing means of two different set of items.
- 1-Sample t-Test is used when a sample mean is compared to a specific value.
- Paired t-Test is used to determine if there is statistically significant difference in the mean of a dependent variable between two related groups.

This concludes ‘Case Study on Lean Six Sigma Black Belt.’

The next lesson is ‘Regression Analysis.’

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Lesson 07–Regression Analysis in Minitab

Objectives

After completing this lesson, you will be able to:

- Comprehend simple linear regression
- Explain the use of simple linear regression
- Calculate simple linear regression
- Describe multiple regression
- Interpret results of simple linear regression
- Solve multiple regression

Simple Linear Regression

Case Study of a Pharmacy

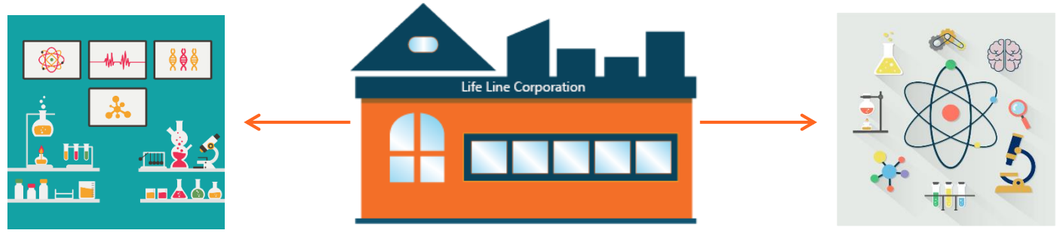
Sales numbers

Performance of branches was declining

Case Study of a Pharmacy

- We will take the case of a pharmaceutical Company, Life Line Corporation, well known company for its research and innovation in the field of Medical science.

- Though a financially sound company, but in the year of 2013-14, after they reviewed their sales numbers, it was clear that the performance at few of their branches was continuously declining. So before the situation goes out of their hands, and the stake owners quickly got their Six Sigma team of professionals into action. The task on their hand was to find the exact reason behind this decline.



Research | Pharmaceutical Company | Innovation

Sales numbers

Performance of branches was declining

Execution of task – Team Six Sigma

- Now let’s see how team Six Sigma started with the task on their hands.
- As a leading company across Asia and Europe, it had a robust Business Intelligence tool, so availing any data was not a difficult task. To find the purpose for revenue slippage, the team started to draw data on monthly revenue in centers for the previous month, and conducted a brainstorming session with the cross function team across centers.

Leading company across Asia and Europe

Data

Execution of task – Team Six Sigma

- At the end of brainstorming session, few points were put forth, out of which one interesting fact was Associate strength. In this case study, Associate Strength indicates that the number of employees were less in comparison to the actual capacity.

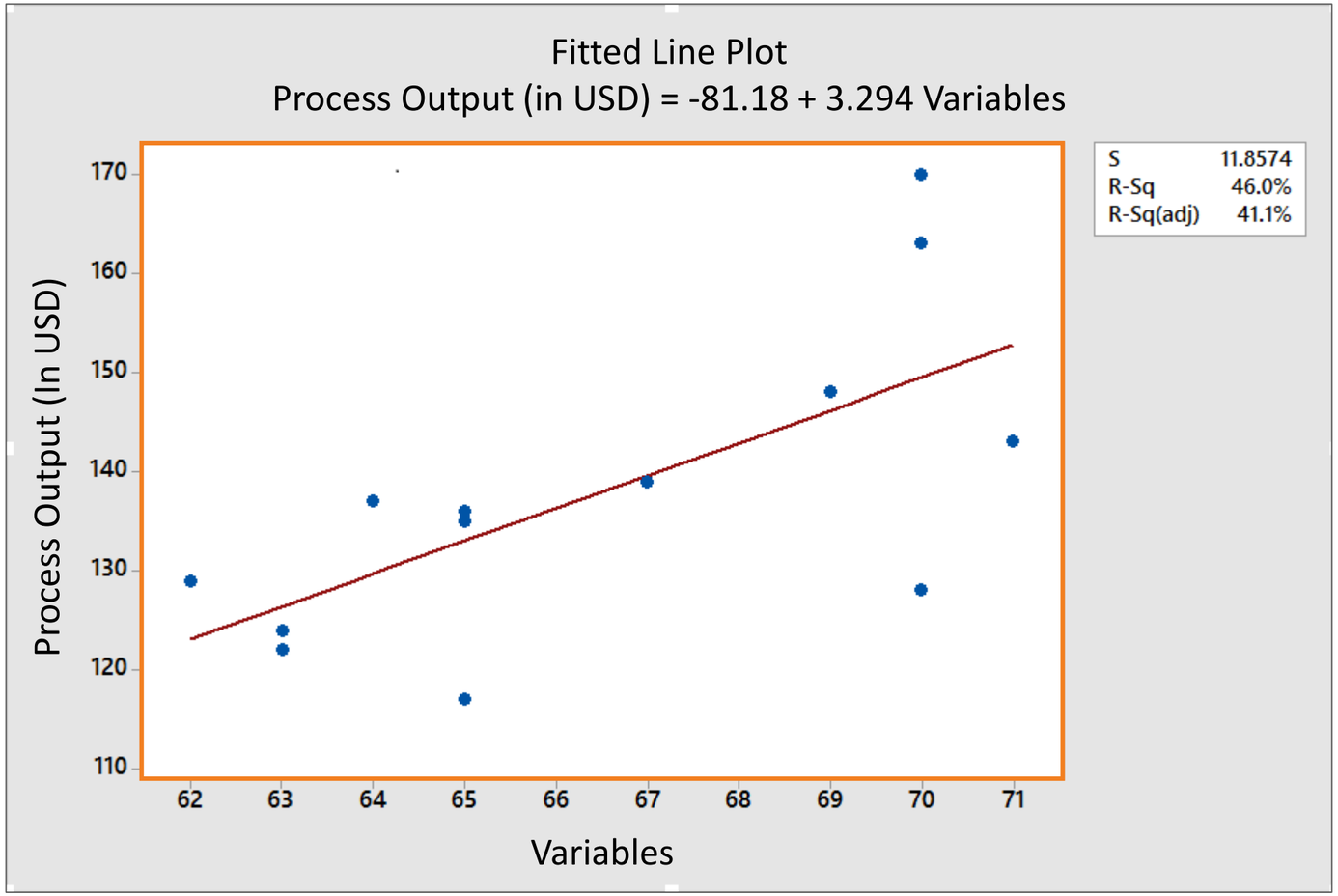
- The team tabulated this data Minitab, and started to establish relationships between the monthly revenue and other independent variables using Linear Regression.

Revenue slippage

What is Simple Linear Regression?

This is a method to determine the relationship between a continuous process output, plotted on Y-axis, with a single independent input variable, plotted on X- axis.

Based on the analysis, the model provides an effective prediction to decision making of whether or not the relationship between the two variables actually exists.



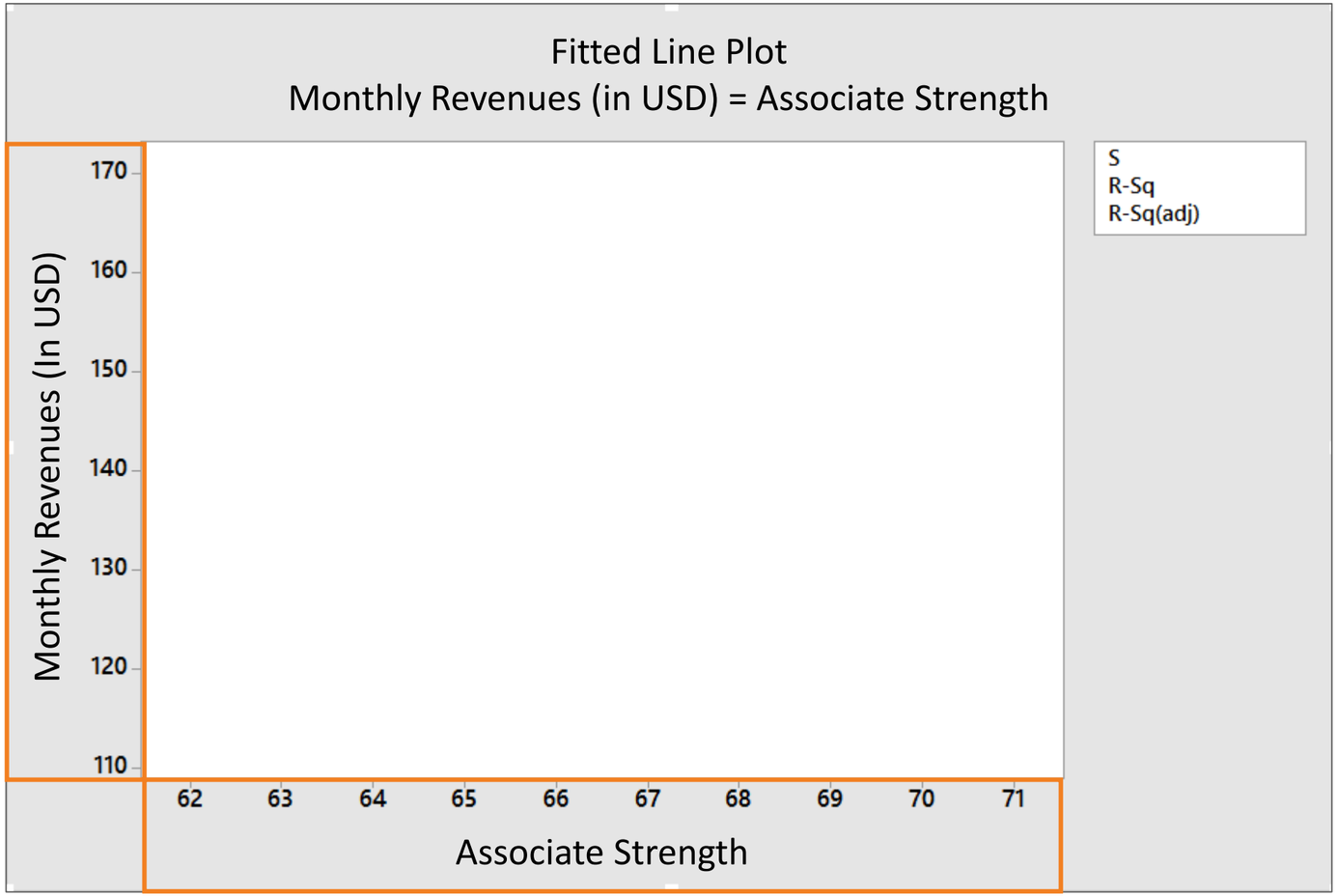
Procedure for output and hypothesis

Null Hypothesis:

Associate strength does not impact the monthly revenues generated by the centers.

Alternate Hypothesis:

Associate strength does impact the monthly revenues generated by the centers.



Conclusion

The Simple Linear Regression helped the management at Life Line Corporation understand that one of the reasons for decline at center wise revenue was insufficient staffing and incorrect capacity planning.

The management now ensured that depending upon the geography and business demands across every center, they would appoint the required associates.

Multiple Regression

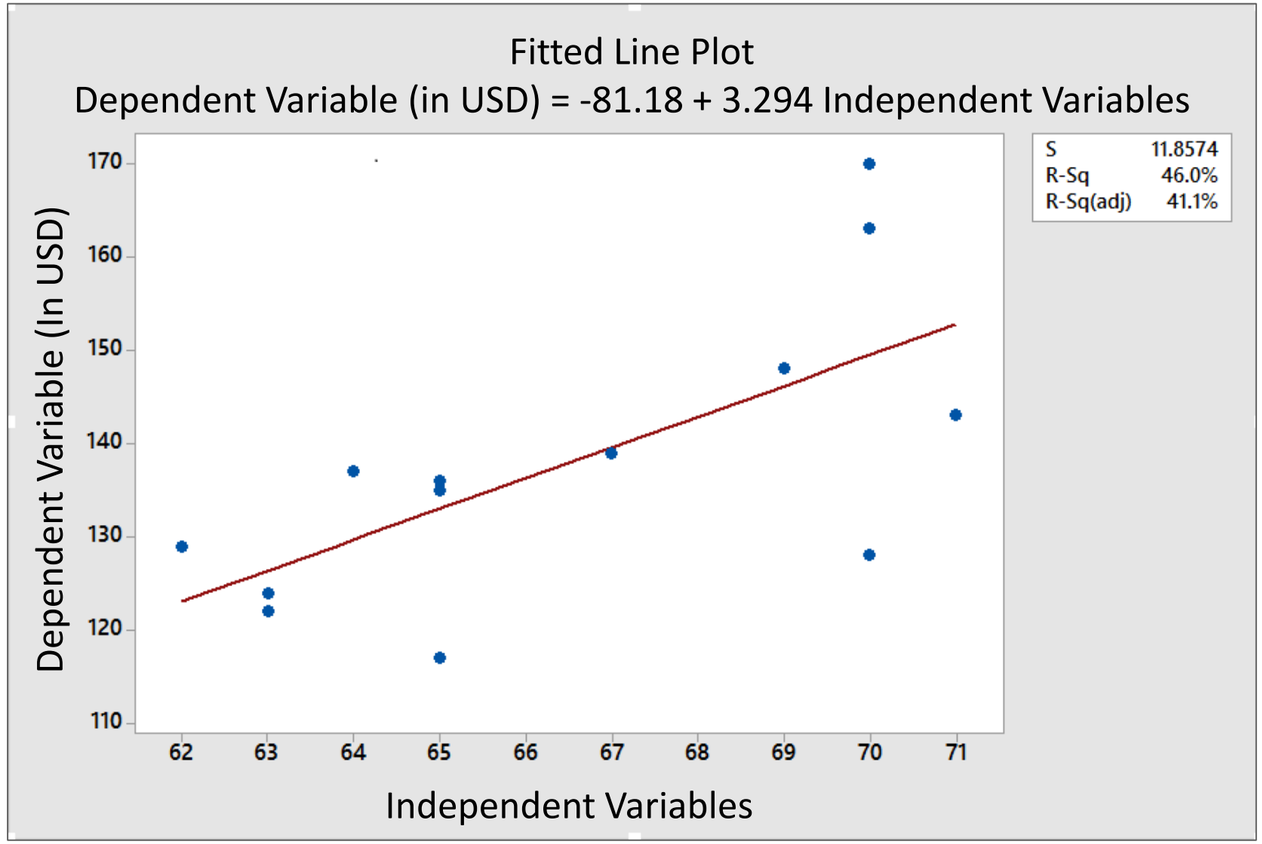
Multiple Regression

The two major defects leading to overall high packaging are:

- Cracked glass bottle.
- Puncture in pouch.

To analyze and prove this defect, the team decided to use Multiple Regression.

The method to study the relationship between several independent variables and a dependent or criterion variable is called Multiple Regression.



Multiple Regression

Now let us understand why should we use Multiple Regression?

Determine relationship between several independent or predictor variables, listed packaging defects, and a dependent or criterion variable, total number of defects for the continuous data collected across all parameters.

Provides an effective prediction to decision making of whether or not there is exists relationship between two variables.

Use multiple regression model when the output and input are both for continuous data.

Conclusion

The Multiple Regression model helped the management at Life Line Corporation to understand that high-packaging defects were largely due to cracked glass bottle rejects and puncture in bottle rejects.

Summary

Let us summarize the topics covered in this lesson:

- Simple Linear Regression is a method to determine the relationship between a continuous process output with a single independent input variable.
- In Simple Linear Regression, we obtain a graph and an equation for the straight line that represents linear relationship between two variables.
- Multiple Regression is used to determine relationship between a continuous dependent variable with various continuous independent variables.

This concludes ‘Regression Analysis in Minitab.’

The next lesson is ‘Case study describing ANOVA, Main Effects Plot, and Interaction Plot.’

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Lesson 8–Hypothesis tests for Non-Normally distributed Data

Objectives

After completing this lesson, you will be able to:

- Define three types of non-parametric tests
- Analyse the use of three non-parametric tests for different variables
- Calculate three types of non-parametric test
- Interpret the results of different tests.

Non Parametric Tests

Case Study

Let us first consider a case study of an IT company, Sunshine Software Services.

Out of all their services, a standout offering was their 24 by 7 technical support services to clients from all over the world.

For the last 15 days, the customer care team witnessed episodes of client objections and numerous escalations. Their customer-care head, Andy, was deeply concerned due to this issue and when pushed to the limit, he approached their Six Sigma Black Belt team to find a solution.

The team conducted a series of meetings with Andy, and the first piece of information they extracted from him was that it generally took 15 days to resolve requests raised by customers. To test this hypothesis, the Six Sigma team collected data for 19 requests, and the time taken to resolve each request.

Types of Hypothesis Testing

The types of Hypothesis Testing with Non-Normal Data are:

1-Sample Sign Test

This test enables you to test the hypothesis that a sample median is equal to a specific value.

2-Sample Mann Whitney U Test

This is a non-parametric test for assessing two independent samples from the same distribution. In other words, it is used for testing the hypothesis of equality of medians of two populations.

Kruskal Wallis Test

This test is similar to One Way ANOVA, and assumes that the samples from different population are independent from each other.

How these tests help us in our case study?

Objective is to check if the turnaround time to resolve a customer query is actually equal to 15 days or is it greater than 15 days.

Null Hypothesis	The turnaround time to resolve a customer query is 15 days.
Alternate Hypothesis	The turnaround time to resolve a customer query is greater than 15 days.

Demo 01

1-Sample Sign test in Minitab

Hypothesis-Mann Whitney U test

The Six Sigma team wanted to study the turnaround time between groups, so they collected for 19 requests, and the time taken to resolve each request by executives in the two shifts.

They were trying to compare two independent variables from the same distribution, they opted for 2-Sample Mann Whitney U Test.

Null Hypothesis	The turnaround time to resolve a customer query between shifts 1 and 2 is the same.
Alternate Hypothesis	The turnaround time to resolve a customer query between shifts 1 and 2 is not the same.

Demo 01

2-Sample Mann Whitney U Test in Minitab

Hypothesis-Kruskal Wallis Test

The Six Sigma team next wanted to check the turnaround time among three customer service executives.

They collected data for one week.

Null Hypothesis	The turnaround time to resolve a customer query between the three executives is the same.
Alternate Hypothesis	The turnaround time to resolve a customer query between the three executives is different.

Krusal Wallis Test enables you to compare 3 independent variables.

Demo 01

Kruskal Wallis test in Minitab

Summary

Let us summarize the topics covered in this lesson:

- The 1-Sample Sign test enables you to test the hypothesis that a sample median is equal to a specific value.
- The 2-Sample Mann Whitney U test is a non-parametric test for assessing two independent samples from the same distribution.
- The 2-Sample Mann Whitney U test enables you to compare two independent variables from the same distribution.
- The Kruskal Wallis test assumes that the samples from different population are independent from each other.

This concludes ‘Hypothesis tests for Non-Normally distributed Data.’

The next lesson is ‘Using ANOVA, and Generating Main Effects and Interaction Plot.’

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Lesson 09–Analysis of Variance

Objectives

After completing this lesson, you will be able to:

- Use one way analysis of variance
- Apply analysis of variance main effects plot
- Generate interaction plot

Analysis of Variance

Analysis of Variance

Clinic Care hospital, a comprehensive multi-specialty healthcare center, has always been known for its international infrastructure, world-class medical support and innovation in technology. The hospital was already accredited with international healthcare standards, and possessed a team of highly qualified medical and support team in each of its department.

The hospital had invested in its patient care management that included a 24 by 7 contact center, as one of its major touch points for its patients.

As one of their key strategies for the contact center, the management was focused to ensure efficiency by implementing best practices, minimizing the call wait and response time, and most importantly ensuring patient care and satisfaction.

Analysis of Variance

The hospital had invested in its patient care management that included a 24 by 7 contact center, as one of its major touch points for its patients.

As one of their key strategies for the contact center, the management was focused to ensure efficiency by implementing best practices, minimizing the call wait and response time, and most importantly ensuring patient care and satisfaction.

Creating Hypothesis

As a part of their strategy, Mr. Steven Frank, a Six Sigma Black Belt professional was appointed as a Senior Contact Center Manager. In addition to macro managing the day to day activities,

one of his expected duties included carrying out a Six Sigma Black Belt project to improve the response time at the contact center.

As a part of the study, Steven and his team collected data to understand if response time is affected by different types of processes that can have an impact on call wait time.

Data to study the response time was collected for three different types of processes, and to conduct ANOVA testing.

Moreover, Steven established two hypotheses, Null and Alternate. According to the former, the average response time for every process is same. Whereas, as per the latter, the average response time for every process is different.

Creating Hypothesis

Data to study the response time was collected for three different types of processes, and to conduct ANOVA testing.

Null Hypothesis	The average response time for every process is same.
Alternate Hypothesis	The average response time for every process is different.

Analysis of Variance

ANOVA testing is acronym Analysis of Variance, a method used in statistics to study the relationship between a response variable and one or more predictable variables.

A great deal of variance or difference indicates that there exists a significant finding from the research.

Different groups of data can be compared if the variances within each group are statistically the same.

This is termed as Test of Equal Variance.

Studies and analysis

Statistical technique

Use of Assumption

After collecting the data for three processes, A, B, and C, and their rating, made two assumptions for ANOVA.

A – Data for each group must be normal or non-normal.

B – The data sets must have equal variances.

This data was collated and entered in Minitab. Before performing the ANOVA test, the team performed a test for normality.

Demo 01

Test of Normality

Analyze the next assumption

The next task for Steven and his team is to analyze the next assumption of passing the test of equal variances.

Analyze the assumption

Demo 02

Test of Equal Variances

Demo 03

One-way ANOVA test

Conclusion

So after this study, Steven and his team concluded that:

A – They need to establish different response time target for different processes.

B – The response time must be tracked for each process type.

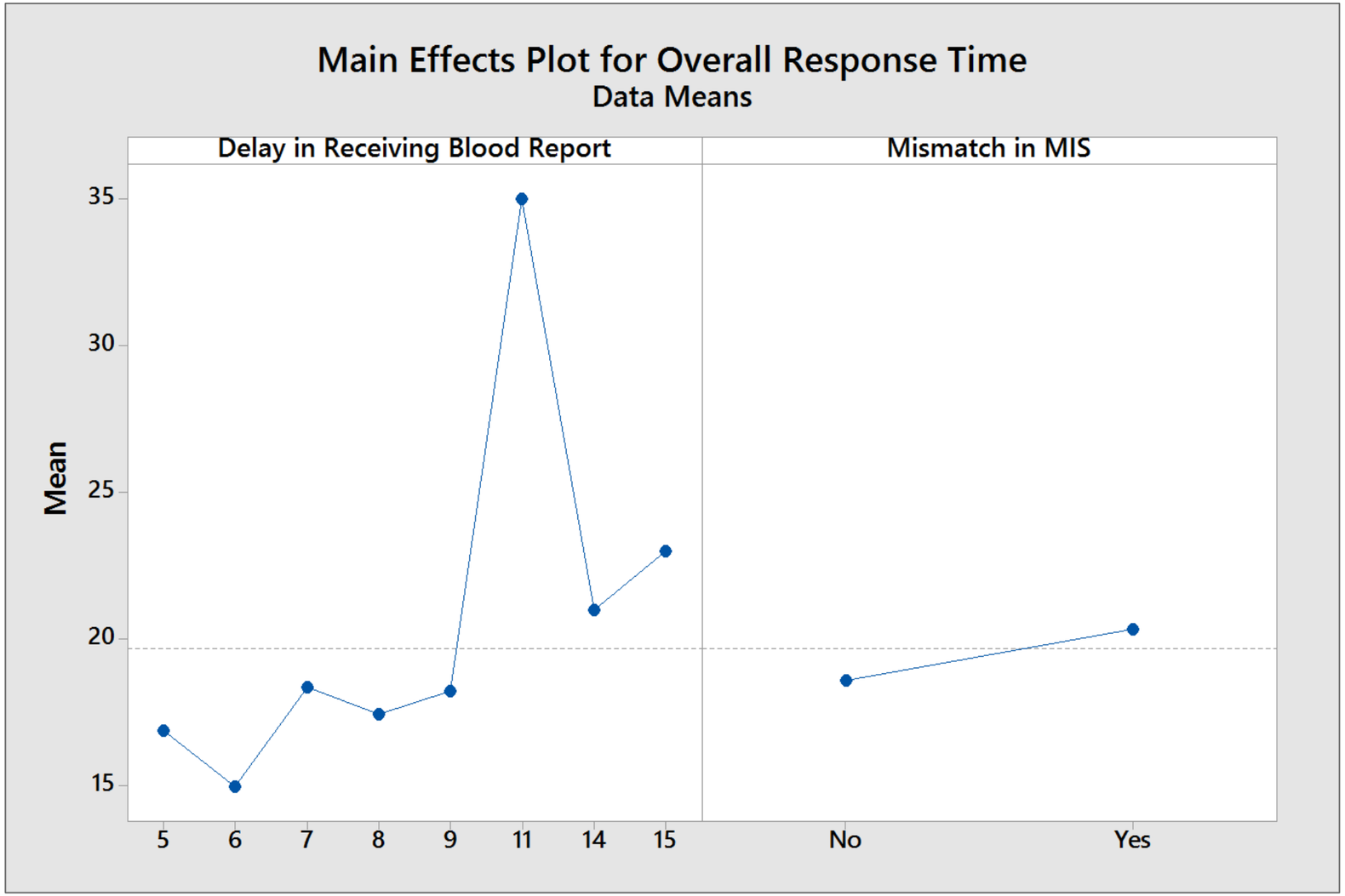
Main effects Plot

Main effects Plot

The response time was delayed due to the additional time taken in receiving blood report from the lab and MIS mismatch.

Main effect Plot is a tool to get information about averages based on different input levels. The tool does not provide any information about the variation, but is used to examine differences between level means for one or more factors.

Main effect exists when different levels of a factor affect the response differently.



Demo 04

Main effects Plot

Interaction Plot

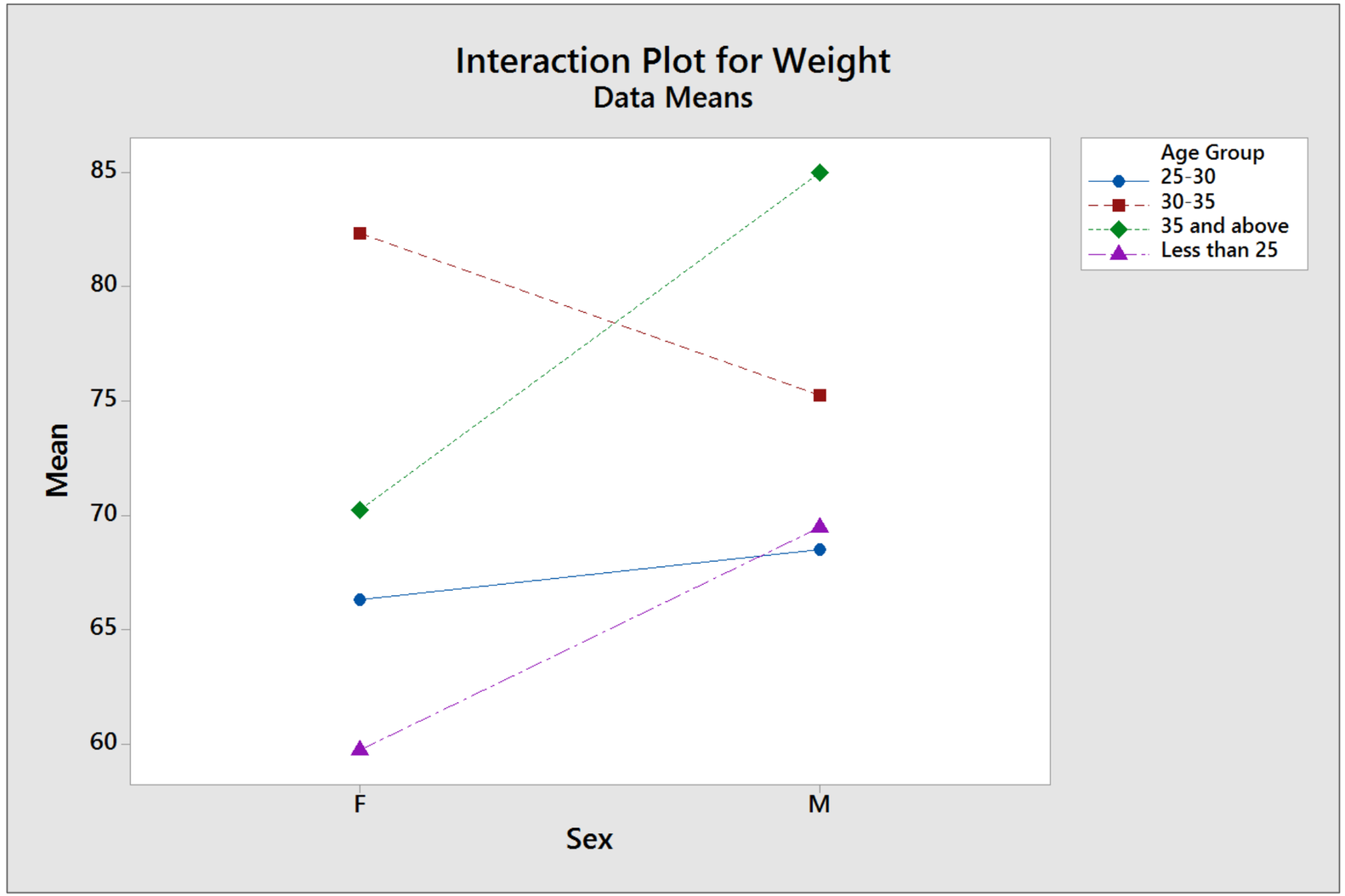
Interaction Plot

This is a graphical representation showing interaction of means for each level of one factor with the level of second factor, held as constant.

The graph enables one to understand the interaction between factors for suitable decision making.

Interaction is shown when the effect of one X variable depends on the other variable X.

Parallel lines in the plot indicate no presence of interaction between the factors.



Demo 05

Interaction Plot

Conclusion

On the basis on their interpretation, Steven and his team concluded that Interaction Plot helped them to understand interaction between factors that actually impact weight of a person.

Summary

Let us summarize the topics covered in this lesson:

- Analysis of Variance is a system used in statistics to study the relationship between a response variable and one or more predictor variables.
- Main effect Plot is a device to get information about averages based on different input levels.
- Interaction Plot is a graphical depiction that shows interaction of means for each level of one factor with the level of second factor which is held constant.

This concludes ‘Analysis of Variance.’

The next lesson is ‘Chi Square Test for Association.’

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Lesson 10–Chi Square Test for association

Objectives

After completing this lesson, you will be able to:

- Comprehend chi square testing
- Perform chi square testing in Minitab 17

Chi-square testing

Case Study

- Kernel LLC is one of the leading aluminium manufacturers in Texas, and had their business spread across in Middle East and the Indian Subcontinent.
- With an ongoing rise in its business; the management in their annual general meeting decided that the organization needs a robust intelligence platform for effective accounting and inventory management.

Kernel LLC

Rise in business

Inventory management

Annual general meeting

Effective accounting

Case Study

Taking this forward, the Business Head raised the requirement via RFP to leading software development companies. Out of the various bids, the final bid was won by Kites Services, a leading software development and consulting firm with the expertise in delivering similar projects across the globe for various Asian and European organizations.

Kites Services

Across the globe

Case Study

The board was impressed with their work and presentation, and approved a three-year agreement, and it required Kites to provide a robust integration platform to integrate accounts receivables and payables, sales & marketing and inventory, and vendor management.

Work and presentation

Three-year agreement

Accounts receivables and payables

Sales & marketing

Inventory

Vendor management

Case Study (contd.)

- Being a critical project, Kites decided to appoint Grant Elliot, a project manager with a Master Six Sigma Black Belt.
- He along with his team submitted the management team at Kernel with time-to-time status reports, and tracked the progress at micro level to avoid possible delays and roadblocks.
- During the process, his team classified random samples of 500 projects based on project status and project type, and entered the data in Minitab.

Case Study (contd.)

- Being a critical project, Kites decided to appoint Grant Elliot, a project manager with a Master Six Sigma Black Belt. As shown, the two project types are Development and Maintenance and their statuses are indicated by three colors: Red, Amber, and Green. Where, Red indicates number of projects in critical state, Amber denotes, less critical state, and finally, Green depicts the completed status.
- Grant started analyzing this data using Chi Square, Test of Independence in Minitab.

Project Type	Red	Amber	Green
Development	42	137	61
Maintenance	58	113	89

Chi Square test of Independence

What is Chi Square and why is it being used in this case?

Chi Square is a test to determine whether or not two classifications of a population of attribute data are statistically independent.

Chi Square is used to test the homogeneity of proportions.

The hypothesis for this task laid an assumption that the set of data variables are independent in nature.

Null Hypothesis	The project status and project type are not related.
Alternate Hypothesis	The project status and project type are related.

Summary

Let us summarize the topics covered in this lesson:

- Chi Square is a test to determine whether or not two classifications of a population of attribute data are statistically independent.
- Chi Square is used to test the homogeneity of proportions.
- The hypothesis assumed is that the set of data variables are independent in nature.
- The test uses Chi Square distribution.

This concludes ‘Chi-Square Test for Association.’

The next lesson is ‘Case Study on Design of Experiments.’

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Lesson 11–Design of Experiments

Objectives

After completing this lesson, you will be able to:

- Comprehend design of experiment
- Infer the use of one-factor-at-a-time
- Analyze the use of design of experiment
- Define design of experiment terminology
- State the instances to use design of experiment

Design of Experiment

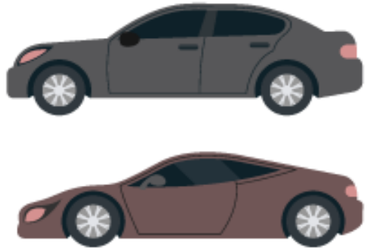
Case Study

- Jeeshan is one of the leading automotive manufacturing companies in Europe since the 1960s. They have drawn many success stories and set their remarkable footprints throughout the world.

- The company is famous for its outstanding models of luxury cars, right from sedans to SUV’s, and commercial vehicles.

Success

Footprints throughout the world



Sedan

SUV

Case Study

- They have also been innovative in having set strict quality standards without compromising safety and quality of their world class cars.
- It is never easy to always maintain optimum quality and standards, but they have successfully done that by implementing effective quality practices by applying different methodologies such as Six Sigma, Lean, Kaizen, JQI, and others.

Strict quality standards

Safety

Quality

Case Study (Contd.)

A team of engineers

Fuel efficiency is the relation between distance travelled and use of fuel.

In the US, it is generally measured in MPG or miles per gallon, and in some parts of world as, kmpl or kilometers per liter.

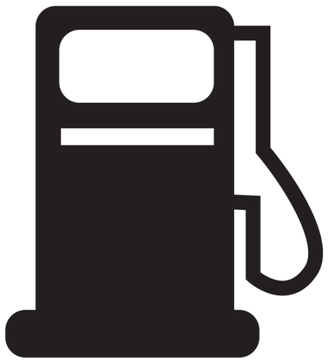
The objective was to increase the MPG of cars from 20MPG to 30MPG.

Case Study (Contd.)

The project lead, senior design engineer and a certified Master Black Belt designed a survey to know the reason for low fuel mileage.

The survey was later hosted on the official website to seek customer feedback.

Car Speed



Octane Rating

Tire Pressure

One-factor-at-a-time Approach

According to the One-factor-at-a-time experiment, one change affects one factor at a time, and other factors are kept constant.

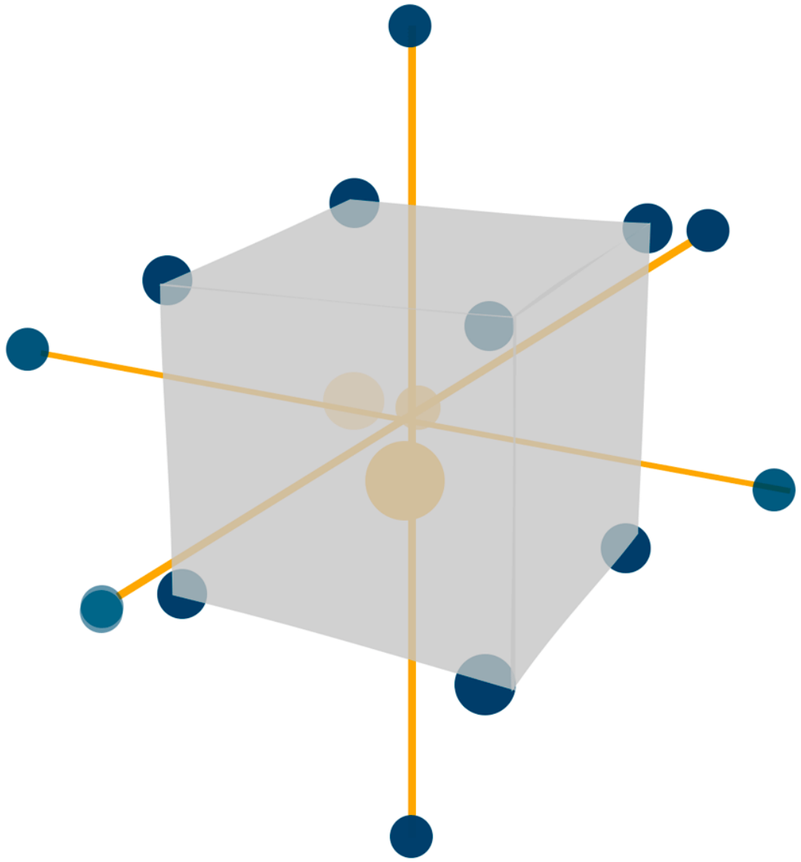
Series of factors			
Speed	**Octane**	**Tire pressure**	**MPG**
55	80	30	23
60	90	35	24
60	80	30	26
60	80	30	29

One-factor-at-a-time Approach (contd.)

Fuel efficiency is achieved when there is a specific combination of variables.

When the values for speed, octane and tire pressure are increased or decreased at a specific level, we are able to achieve best mileage.

What if all the factors are changed simultaneously, how will this help in increasing the fuel efficiency?



Design of Experiment

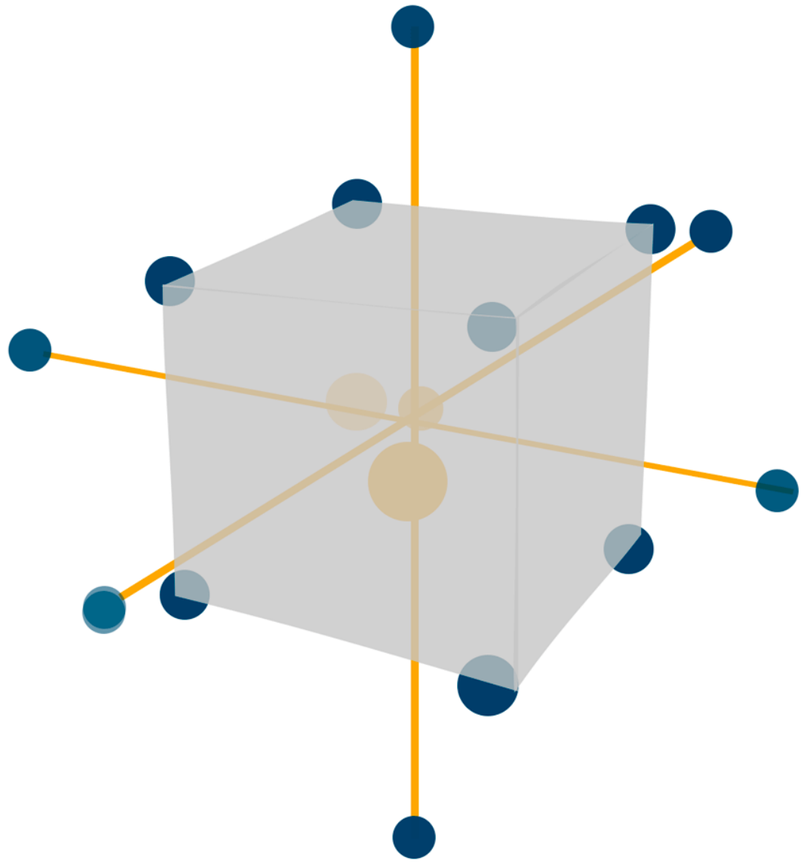
What is Design of Experiment (DoE)?

A structured method for determining relationship between input factors, X, affecting the process output, Y, by conducting experiments.

DOE is a pre-emptive experiment done to optimize process and product design.

It is largely used to understand the degree of influence of various input factors on the overall process output.

It can used to understand the degree of influence of various X's on the Process output Y.



Design of Experiment

Factorial Design Experiment

- Experiments that are conducted for all levels and for all factors.
- Tire pressure is an important parameter affecting fuel efficiency; experiment would be carried out to check tire pressure in the range of 30 to 32 and 33 to 35 PSI.
- So according to this example:
- Response – fuel efficiency
- Factor – 1
- Levels – 2
- Experiment would be 2^1 = 2
- Experiment runs – 2
- Therefore, it is 2^1 Full Factorial

Tire Pressure

Factorial Design Experiment (contd.)

The goal is to test the effect of all the three factors and determine the one with greater effect.

Our experiment runs would be as follows:

- Response is Fuel Efficiency
- Factors equal to 3
- Levels equal to 2
- Experiment runs as 2 raised to three, which 2^3 = 2*2*2 = 8

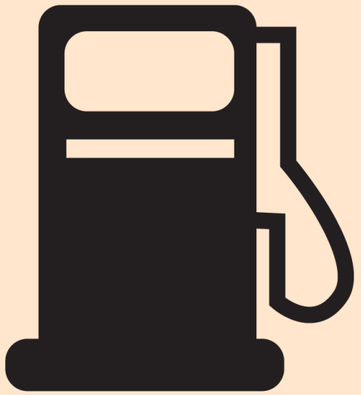
Factors	Levels	Levels
Car Speed (X1)	55	60
Octane Rating (X2)	85	90
Tire Pressure (X3)	30	35

Conclusion

After the results of Design of Experiments conducted by Six Sigma team, it was clear to project team that there exists a three-way interaction.

Tire Pressure

Car Speed



Octane Rating

Summary

Let us summarize the topics covered in this lesson:

- Design of Experiments is a structured method for determining relationship between input factors, X, affecting the process output, Y, by conducting experiments.
- DOE is a pre-emptive experiment done to optimize process and product design.
- Factorial experiments are conducted for all levels and for all factors.

This concludes ‘Design of Experiment’

The next lesson is ‘Common Pitfalls while Analyzing Data.’

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Lesson 12–Common Pitfalls while Analyzing Data

Objectives

After completing this lesson, you will be able to:

- List the common pitfalls in data analysis
- Describe the common pitfalls in data analysis
- State the sub common pitfalls in data analysis
- Explain the sub common pitfalls in data analysis

Common Pitfalls in Data Analysis

Application Virtualization

When an expert delivers work accurately, the organization benefits. However, if the work is not delivered as per requirement, it may result in failure of effort, affect employee morale, and more importantly, result in loss of faith by the top management in driving such initiatives in the organization. Analyzing the collected data and working on it is the key feature of any Six Sigma professional, it enables one to determine “where we are” and “where we need to go”.

Bias

Are we giving a fair representation of population parameters? Or are we sampling only good representation of the population?

When we select our sample we should be neutral in selecting them.

There shouldn’t exist any factor that will influence any other factor resulting in unfair output of the process.

Data Collection Plan

One of the important features in the six sigma journey is having accurate detailing of data collection plan.

Few key questions can help a Black Belt to have an effective data collection plan in place:

- How will the data be collected?
- Who will collect the data?
- When will the data be collected?
- How much data should be collected?
- What data stratification would be required or useful?

Sampling strategy

Sampling strategy helps you to decide whether the previous data is enough or you need the new data.

Data collection is very important part of applying Six sigma to your problem.

Define	To create a baseline for process output which is – Y
Analyze	Verify the suspected causes (X's) of variation and defects
Improve	To quantify effects of the solutions
Control	To control the X's and monitor the Y.

Error in methodology

Any tool or technique applied to inappropriate problem leads you to inaccurate results.

The two types of error are:

Statistical Power

- If there is little statistical power then one risks overlooking the effect that one is attempting to prove.
- In hypothesis testing, there is always a risk associated with the decision that is made.
- Type I error (alpha error) is the probability of rejecting the null hypothesis when it is true
- Type II error (beta error) is the probability of accepting the null hypothesis when it is false.

Measurement Error

- Statistical models assume error free measurement.
- Dealing with different types of data we need to pay closer attention to effects of measurement error.
- Any measurement system must be consistent, reliable and valid.

Problems in Interpretation

In addition to pitfalls arising due to biasness and error in methodology, the other problem that one encounters is incorrect interpretation known as Problems in Interpretation.

Significance	Precision and Accuracy	Graphical Representation	Causality
The term “Significance” in statistics is as much a function of sample size, and experimental design as it is a function of strength of relationship.	Precision refers to how finely an estimate is specified whereas accuracy refers to the difference between observed value and standard.	Any graphical representation must be able to explain the nature of data variation, help display the context of the data.	A statistical study must be able to show the cause and effect relation, essential variation between variables with absence of any causal factors.

Avoiding these common pitfalls

What you would do to ensure you avoid these pitfalls?

- Representative of the population.
- Random and stratified.
- Defined.
- Apply the right tools to get accurate results.
- Confirm that there is no measurement system error while analysing data.
- Whoever collects the data should be trained with unbiased approach.
- Graphs should be formed in such a way that they reflect data variation.
- Ensure that data type is categorized. There should be the right amount of statistical power and clear understanding of the conditions for causal inference.

Summary

Let us summarize the topics covered in this lesson:

- There are 3 major reasons for common pitfalls in analysing data they are Bias, Error in Methodology and Problems in interpretation.
- Each major pitfall has their sub points reasoning to major ones. They are Bias- data collection plan and sampling Strategy, Error in Methodology - Statistical Power and Measurement Error and finally Problems in Interpretation – Significance, Precision and Accuracy, Graphical representation and Causality.
- To avoid these problems there are 10 important points that needs to be taken into consideration.

This concludes ‘Common Pitfalls while Analysing Data.’