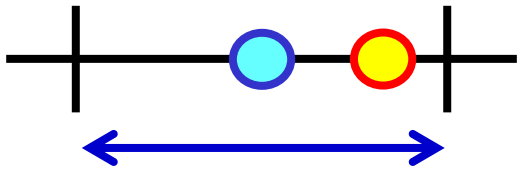
Continuous Improvement Toolkit

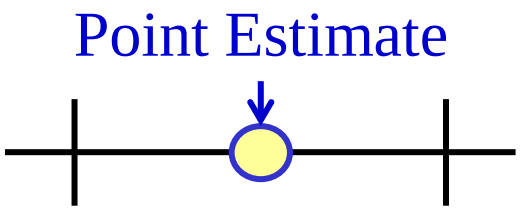
Confidence Intervals




Managing Risk
PDPC
FMEA
RAID Logs
Fault Tree Analysis
Risk Assessment*
Traffic Light Assessment
Deciding & Selecting
Pros and Cons
Importance-Urgency Mapping
Break-even Analysis
Cost -Benefit Analysis
Force Field Analysis
Voting
Pugh Matrix
Decision Tree
TPN Analysis
QFD
Matrix Diagram
Kano Analysis
Prioritization Matrix
Critical-to Tree
Paired Comparison
Planning & Project Management*
RACI Matrix
Stakeholders Analysis
PEST
PERT/CPM
Activity Diagram
SWOT
Roadmaps
Project Charter
Gantt Chart
PDCA
Control Planning
Gap Analysis
Hoshin Kanri
Kaizen
How-How Diagram
Tree Diagram**
Standard work
Lean Measures
KPIs
OEE
Capability Indices
MSA
RTY
Descriptive Statistics
Cost of Quality
Reliability Analysis
Graphical Analysis
Cause & Effect Matrix
Pareto Analysis
Confidence Intervals
Understanding Cause & Effect
Probability Distributions
ANOVA
Hypothesis Testing
Design of Experiments
Scatter Plot
Correlation
Regression
Multi-Vari Charts
Relations Mapping*
Identifying & Implementing Solutions***
Simulation
TPM
Mistake Proofing
Pull Systems
JIT
Ergonomics
Work Balancing
Automation
Bottleneck Analysis
Visual Management
Flow
Value Analysis
5S
Understanding Performance
Run Charts
Control Charts
5 Whys
Chi-Square Test
Benchmarking
Sampling
Fishbone Diagram
TRIZ***
Brainstorming
Analogy
SCAMPER***
Nominal Group Technique
Mind Mapping*
Affinity Diagram
Attribute Analysis
Lateral Thinking
Visioning
Creating Ideas**
Wastes Analysis
SMED
Time Value Map
Process Redesign
IDEF0
Value Stream Mapping
SIPOC
Flow Process Chart
Process Mapping
Flowcharting
Service Blueprints
Designing & Analyzing Processes
Data Collection
Focus groups
Interviews
Photography
Check Sheets
Measles Charts
Surveys
Critical Incident Technique
Observations

- Confidence Intervals

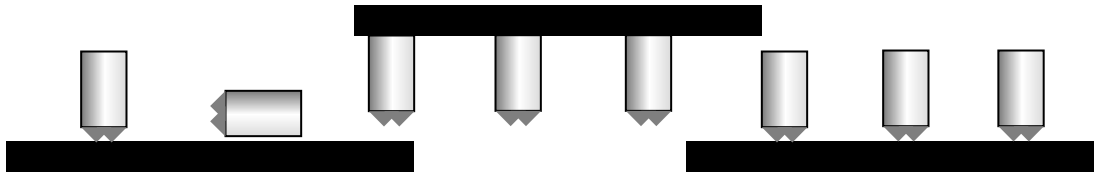
- A **point estimate** is a simple value that approximates the true value of a population parameter.



- **Examples:** Sample mean and standard deviation.
- The sample mean is a point estimate for the population mean.
- The sample standard deviation is a point estimate for the true population standard deviation.
- It is highly unlikely that the sample mean and standard deviation are exactly the same as the true population parameters.

- Confidence Intervals

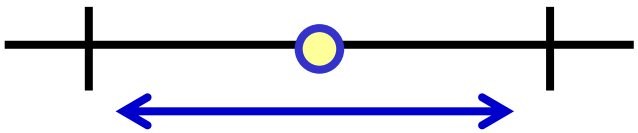
- To get a better sense of the true population values, we can use **Confidence Intervals**.
- **Example:**
  - We have a magnet trap to avoid fallen cans during the process.
  - How confident are we that no fallen cans will cross the trap?



Can we be 100 % confident about our results?

- Confidence Intervals

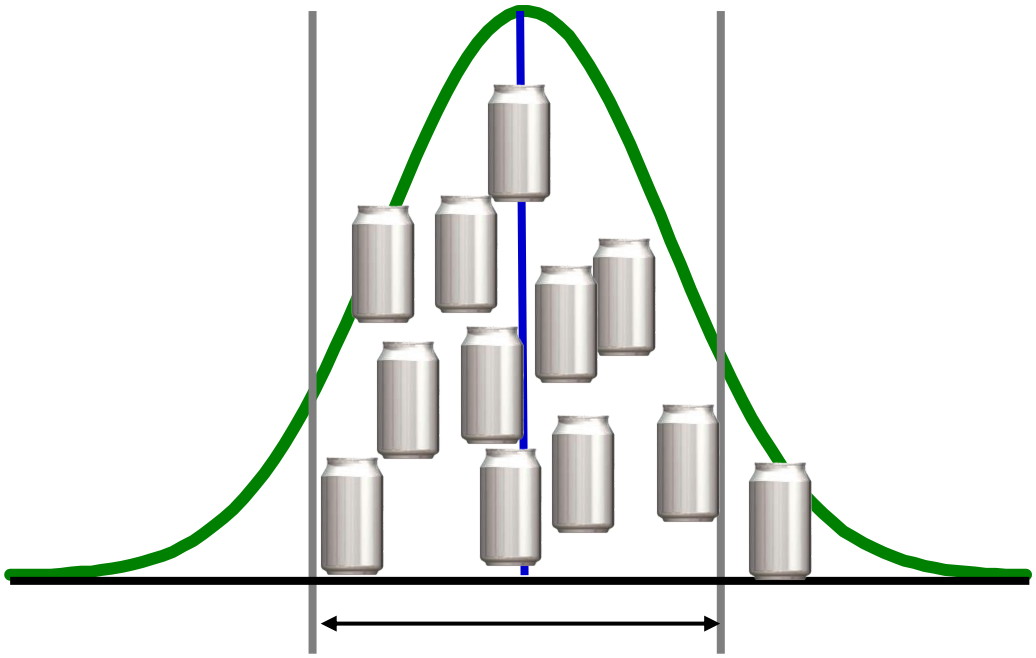
- In our processes we need to know how confident we are with the results coming from our samples.
- **A confidence interval** is a **range of likely values** for a population parameter.
- Using confidence intervals, we can say that it is likely that the population parameter is somewhere within the range.
- It is how sure we are that the confidence interval contains the actual population parameter value.



Likely values for population parameter

- Confidence Intervals

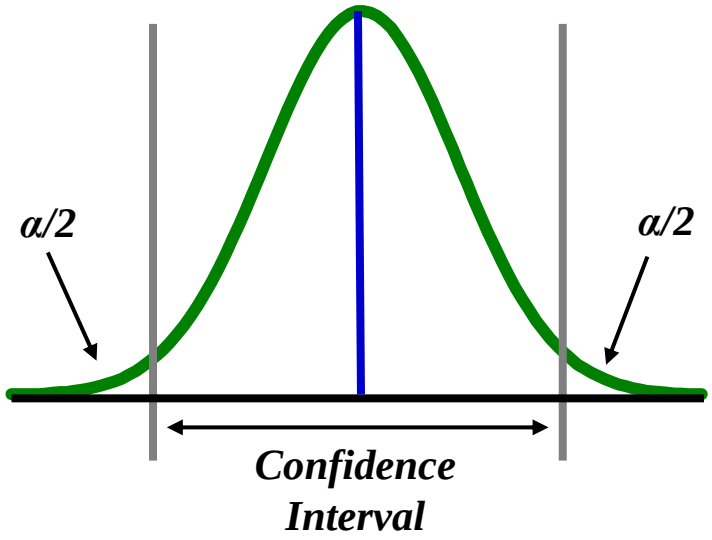
- Confidence Intervals will help us to know whether our sample is a good representation of the whole population.



Confidence Interval

- Confidence Intervals

- The most common confidence level is 95%.
- Other common confidence levels: 90% & 99%.
- The high the confidence level, the wider the confidence interval.
- The higher the **process variation** the bigger the Confidence Interval.
- As **sample size** decreases the Confidence Interval gets bigger to cope with the fact that less data has been collected.

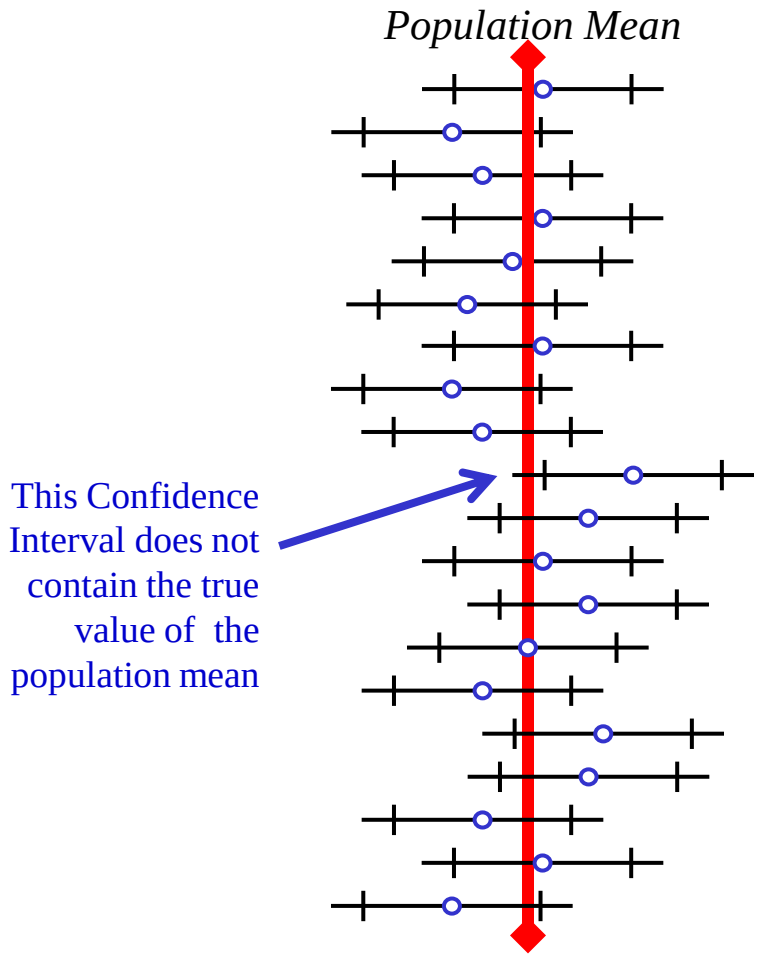


- Confidence Intervals

Example:

- Suppose we calculate confidence intervals based on 20 different samples.

- On average, the population mean will be contained within 19 out of 20 intervals if we use 95% confidence level.



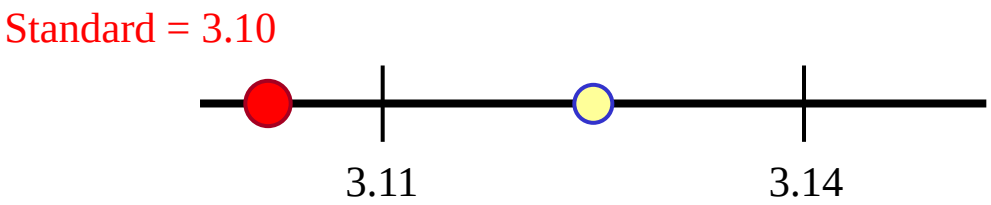
- Confidence Intervals

- Confidence intervals could be used also to examine differences between the population mean and a target value.

- If the target value is not contained in the interval, the population mean is significantly different from the target value.
- It could be used also to investigate if the product/process is as good as other products/processes in the market (a standard value).

- Confidence Intervals

- **Question:**
  Do we have evidence that the population mean is different from the industry standard?



- **Answer:**
  Yes, the confidence interval shows that the range of likely values for the population mean does not include the industry standard of 3.10.

- Confidence Intervals

Mathematical Equation for a Confidence Interval:

$$\text{Confidence Interval} = \text{Sample average} \pm \text{`t'} \left(\frac{\text{Sample Sigma}}{\sqrt{n}} \right)$$

- The sample average and the sample Sigma are the best estimate at this point.
- The value of **'t'** is taken from a statistical table similar to the Z-table.
- n is the sample size.

df	0.95	0.99
2	4.303	9.925
3	3.182	5.841
4	2.776	4.604
5	2.571	4.032
8	2.306	3.355
10	2.228	3.169
20	2.086	2.845
50	2.009	2.678
100	1.984	2.626

- Confidence Intervals

Further Information:

- Confidence Intervals are used to provide a range within which the true process statistic is likely to be.
- **They allow us to answer questions like:**
  - How confident that the collected sample is a good representation of the population.
  - Is there is a chance that the process is producing an average thickness of 43.5mm.
  - Do the random selected 2000 surveyed voters provide a precise prediction of the actual result of the election (Confidence intervals for proportions).