OST®

CMMI LEVEL 3 | ISO 9001:2008

Agenda

- Introduction
- Background
  - QPM
  - Discrete Event Simulation
- Case study
  - Using discrete event simulation for QPM

Introduction – Who we are

- Optimal Solutions & Technologies (OST, Inc)
- Washington DC-based, founded in 1999
- Core competencies
  - Integrated IT solutions
  - Managed Services
  - Management consulting
  - Research, development & engineering
- CMMI L3 (CMMI-DEV v1.2)
- ISO 9001:2008 certified
- ANSI 748 compliant

Background

- QPM
  - Requires PPM's and PPB's
  - Most intimidating for us!

- Discrete Event Simulation
  - Step-by-step or Succession of events
  - Time Matters!
  - Events are not allowed in between time units
  - Non – stochastic/deterministic

Our case study…

Our business problem

- Invoices were late resulting in
  - Customer complaints
  - Financial exposure

- Possible solutions
  - Add more staff (implies increases overhead cost)
  - Improve the process to make it LEAN

What we found useful: (1) A Jumpstart Method for Business Goals and Project Objectives Supporting CMMI High Maturity, Bob Stoddard, http://www.sei.cmu.edu/library/abstracts/webinars/21aug2008.cfm

What we want to cover today?

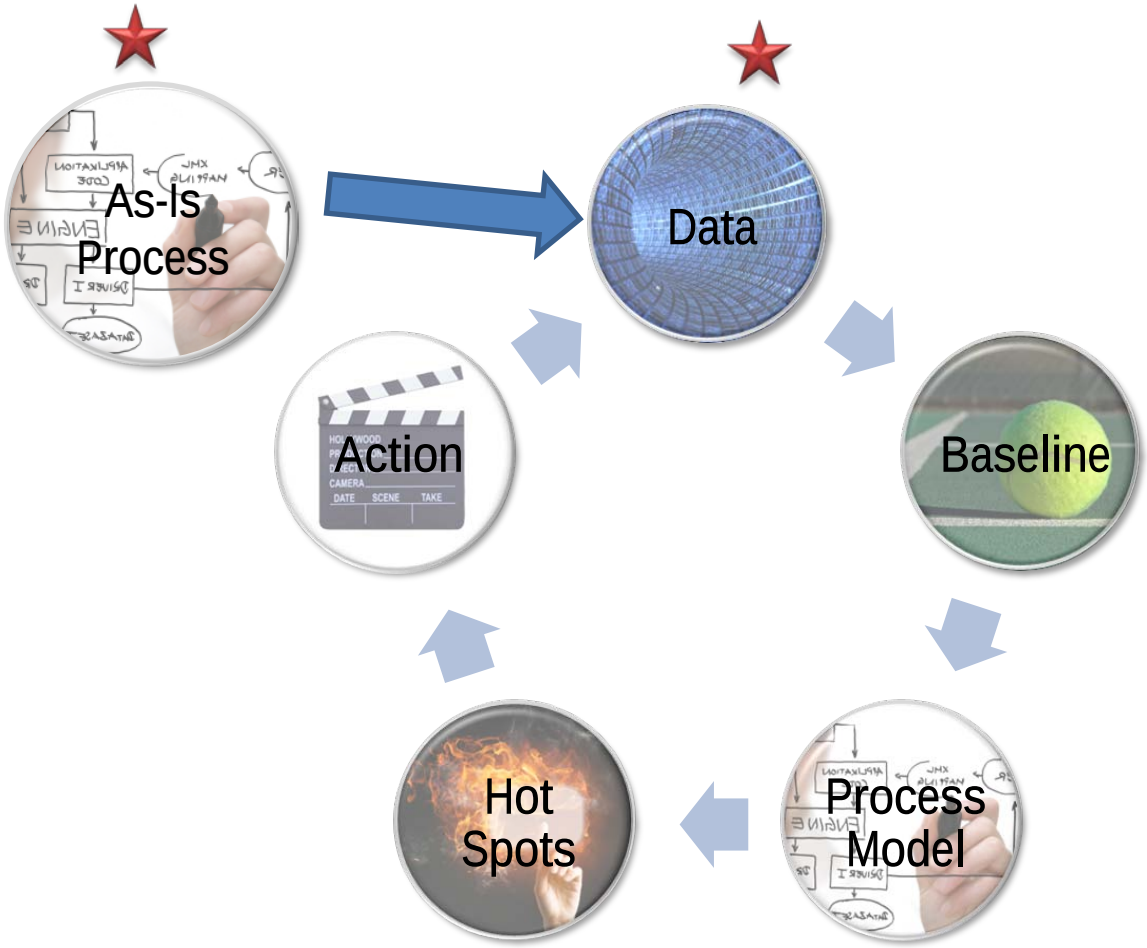
Steps we took

Resources we used

Mapping to “requirements” (step-by-step guide)

*** Demonstration steps are captured in Appendix for your reference**

What we did…



What we found useful:
Process Model Tutorial
http://www.processmodel.com/support/tutorials.html

What we found useful: (3) A Practical Approach for Building CMMI Process Performance Models
http://www.sei.cmu.edu/library/abstracts/presentations/28apr2009webinar.cfm

Data Collection

	In office - 7/27
Client	FAA-ESVMS (Jun)
Generated cover sheet	12:20-12:22
Run proj staffing & check outstanding ts report	P: 12:22-12:23 C 12:23-12:24
resolve ts issues	~~[illegible]~~ N/A
Generate billing report	12:25-12:25
Resolve billing report issues	N/A
Initialize invoice	12:26-12:27
Populate labor	12:28-12:28
Generate expense report	12:28-12:29
resolve expense issues	N/A
Populate ODCs and enter G&A expense	N/A
Print and check (inv check reports & contract only)	P: 12:29-12:31 C 12:31-12:35
Generate additional reports	N/A
PM approval (scan, send, & check for response)	S [12:38-12:39] + (12:42-12:43)] S: 12:43-12:44
Get Signed	
Redate, scan & upload, and copy 7/3	R: 1:41-1:46 S: 1:47-1:49 (no copies)
Sent "	2:22-2:27
Notify Linda "	2:27-2:29 checking contract #
Entered into contract tracking "	2:29-2:34 (incl/notifying of low funds)
Marked off master chart "	2:35-2:35
Add to quarterly reporting	N/A
Notes	

What we found useful: (2) Process Performance Baselines and Models: Duh, I Don't Get It, Diane Mizukami (Williams)
http://www.dtic.mil/ndia/2007cmmi/Thursday/4amMizukami.pdf

Demo

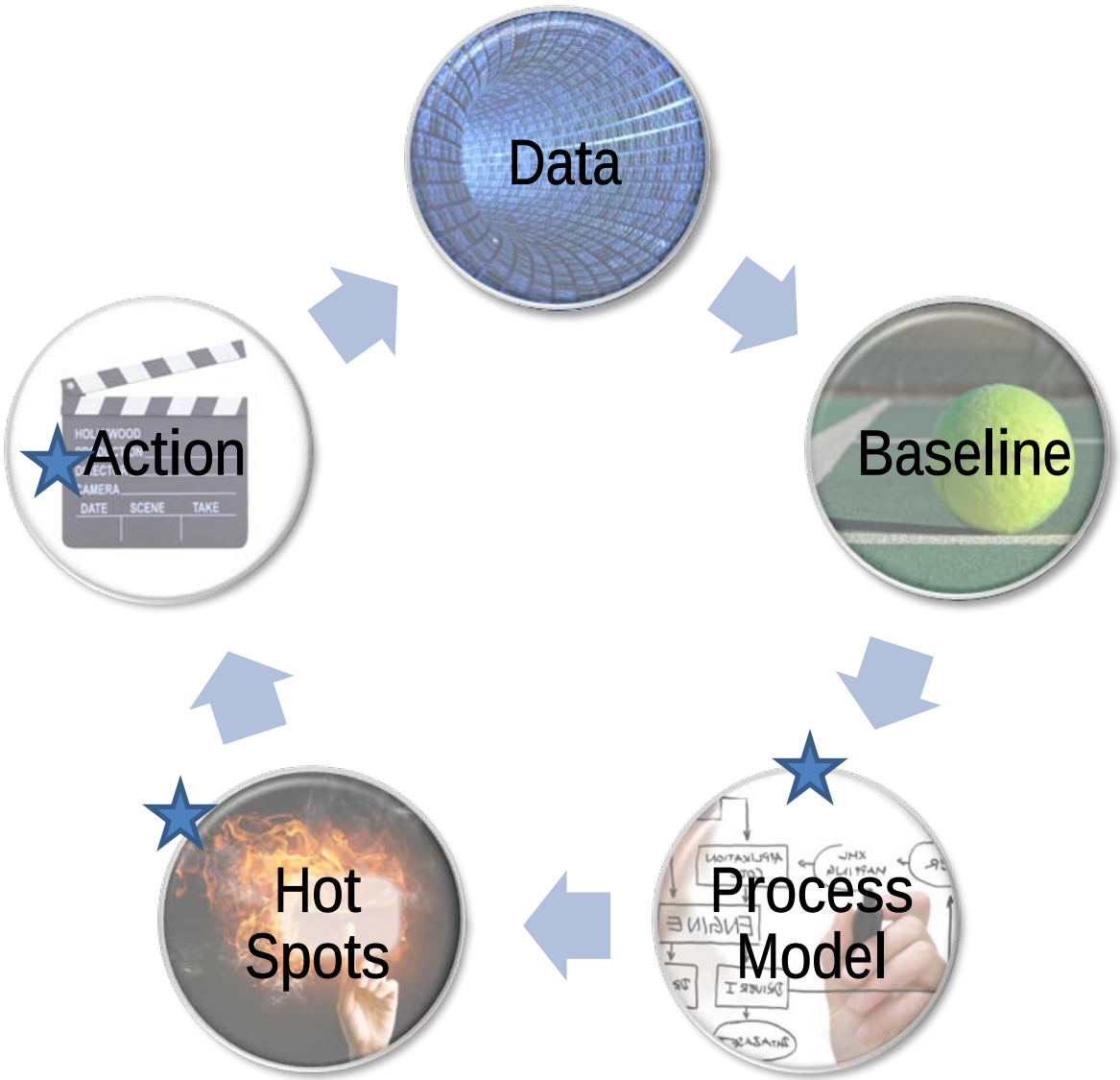
- Minitab
- Graphical Summary

All screen shots are presented in the Appendix for your reference.

Recap

- Build as-is model
- Collect data
- Assess data quality and integrity
- Build PPB's
  - Minitab
  - Statfit

What we did…



Demo

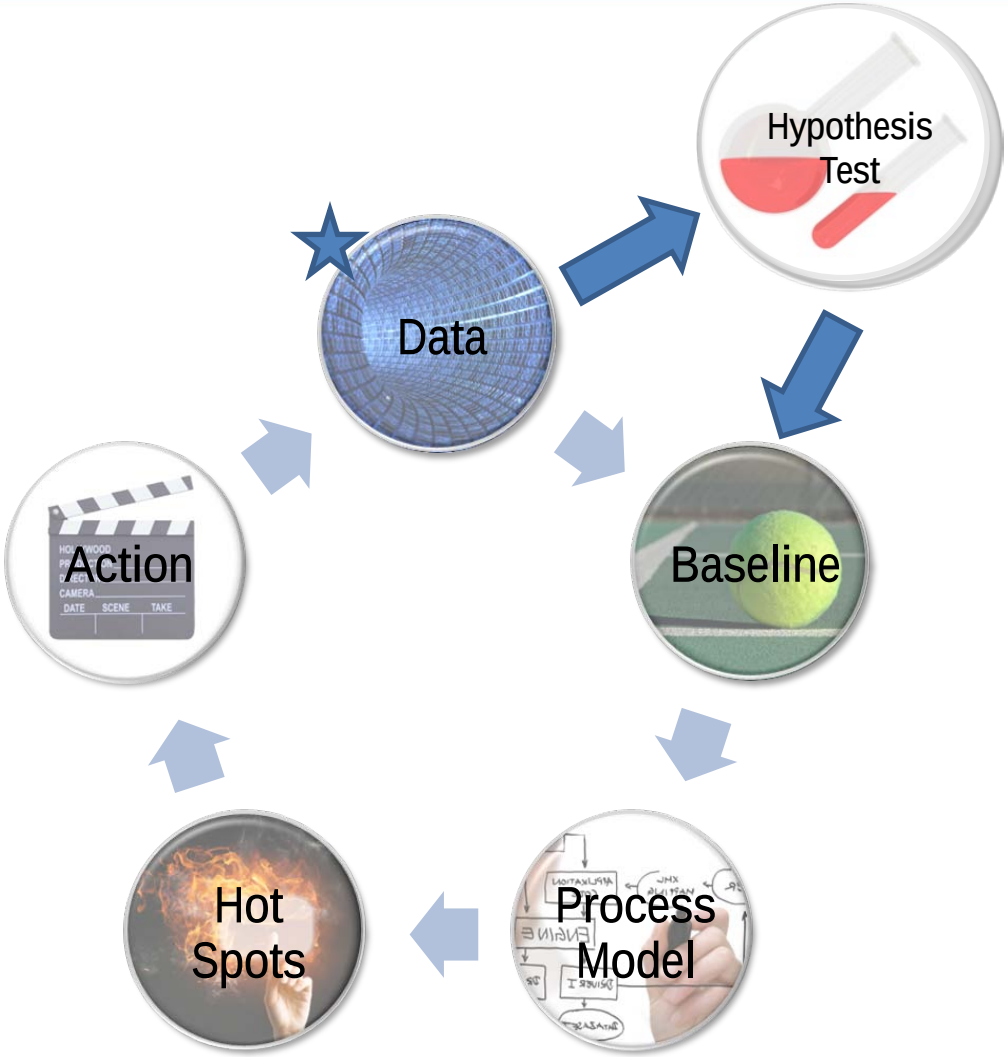
- Process Model

All screen shots are presented in the Appendix for your reference.

Recap

- Run the simulation
- Identify hot spots
- Run “What-If” scenarios
- Take Action

What we did…


Hypothesis Test
Data
Baseline
Process Model
Hot Spots
Action

Demo

- Hypothesis tests

All screen shots are presented in the Appendix for your reference.

Recap

- Select the right test
- Interpret the results
- Update your model
- Evaluate results
- Repeat steps if needed

Confidence Intervals and Prediction Intervals

- Prediction Interval (PI)
  - Expected interval for next data point
- Confidence Interval (CI)
  - Expected interval for the central tendency (mean or median)
- Beware!! Don’t use CI’s to make a prediction!!

Demo

- Determining Confidence Intervals
- Determining Prediction Intervals

All screen shots are presented in the Appendix for your reference.

Lessons Learned

- Start with a simple model
- Check the model with intuition
- Quantify savings in $ if possible
- Keep your stakeholders engaged
  - Share positive and negative news

Step-by-step guide (From SEI presentations)

- 1. Identify or Reconfirm Business Goals
- 2. Identify the sub-processes/process
- 3. Identify Outcomes to Predict (y's)
- 4. Identify Controllable factors (x's) to predict outcomes
- 5. Include Uncontrollable x factors
- 6. Collect Data
- 7. Assess Data Quality and Integrity – *Not covered today*
- 8. Identify data types of all y outcomes and x factors
- 9. Create PPBs
- 10.Select the proper analytical technique and/or type of regression equation
- 11.Create Predictions with both Confidence and Prediction Intervals
- 12.Statistically manage sub-processes with PPMs
- 13.Take Action Based on PPM Predictions
- 14.Maintain PPMs including calibration and reconfirming relationships
- 15.Use PPMs to assist in CAR and OID

What's missing from QPM compliance?

- Goal 1
  - Objectives
  - Selecting sub processes
  - Taking action
- Goal 2
  - Applying analytical techniques
  - Monitoring performance
  - Actual records

Questions & Answers

Any Questions?

Contact Information

Thank You!

Appendix- Tools and step-by-step guide

Tools Used

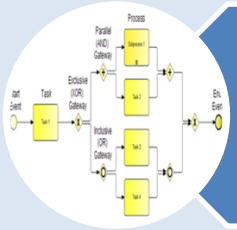
To create database

Easy to access data

Access Data base

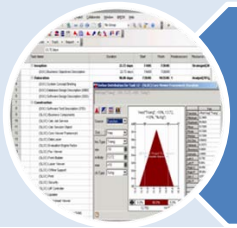
Used to Plot I-MR charts, Summary charts, Individual charts

Minitab



Stat fit , creating baseline , plotting Hot spots , Produce average .

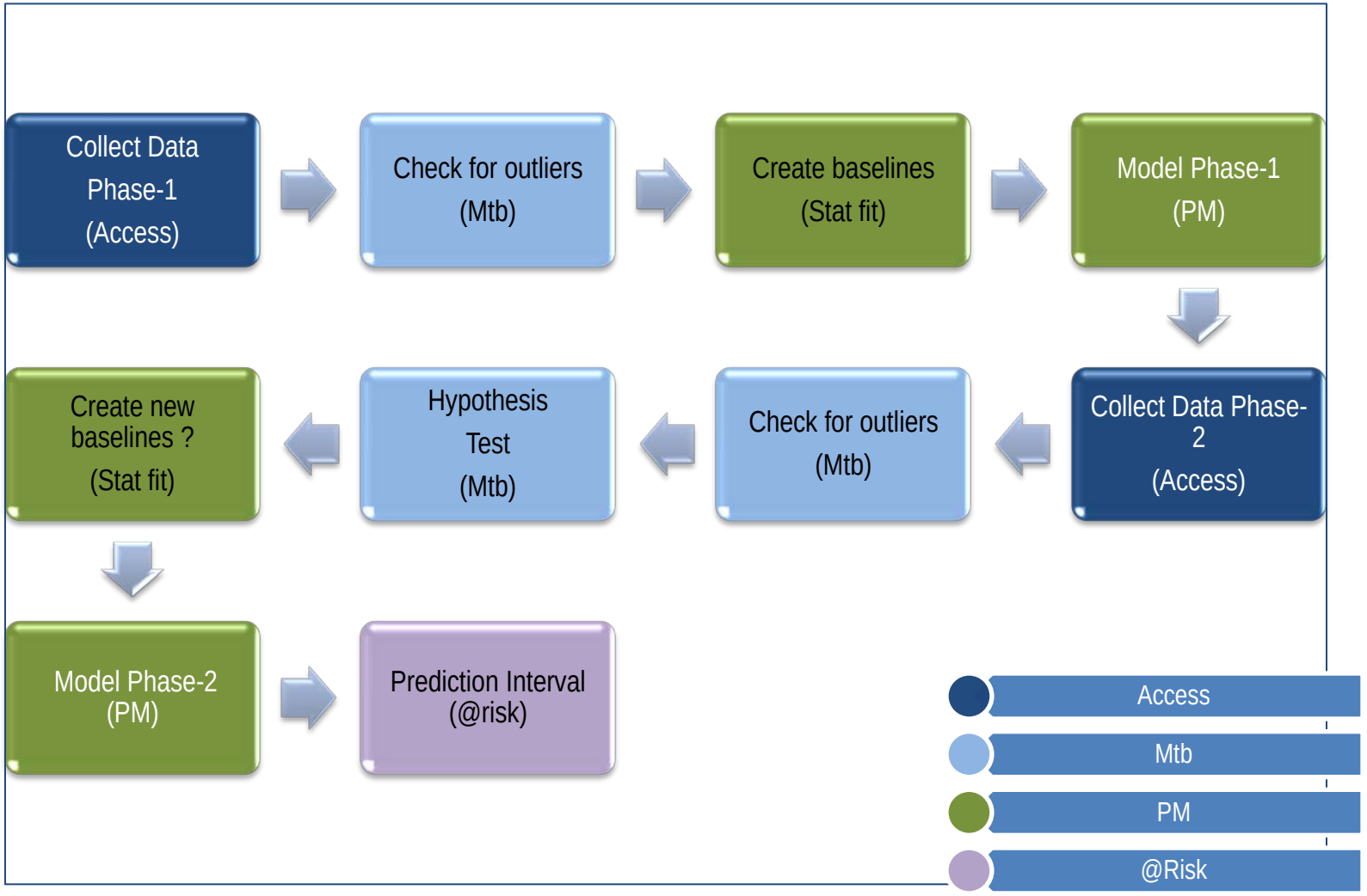
Process Model



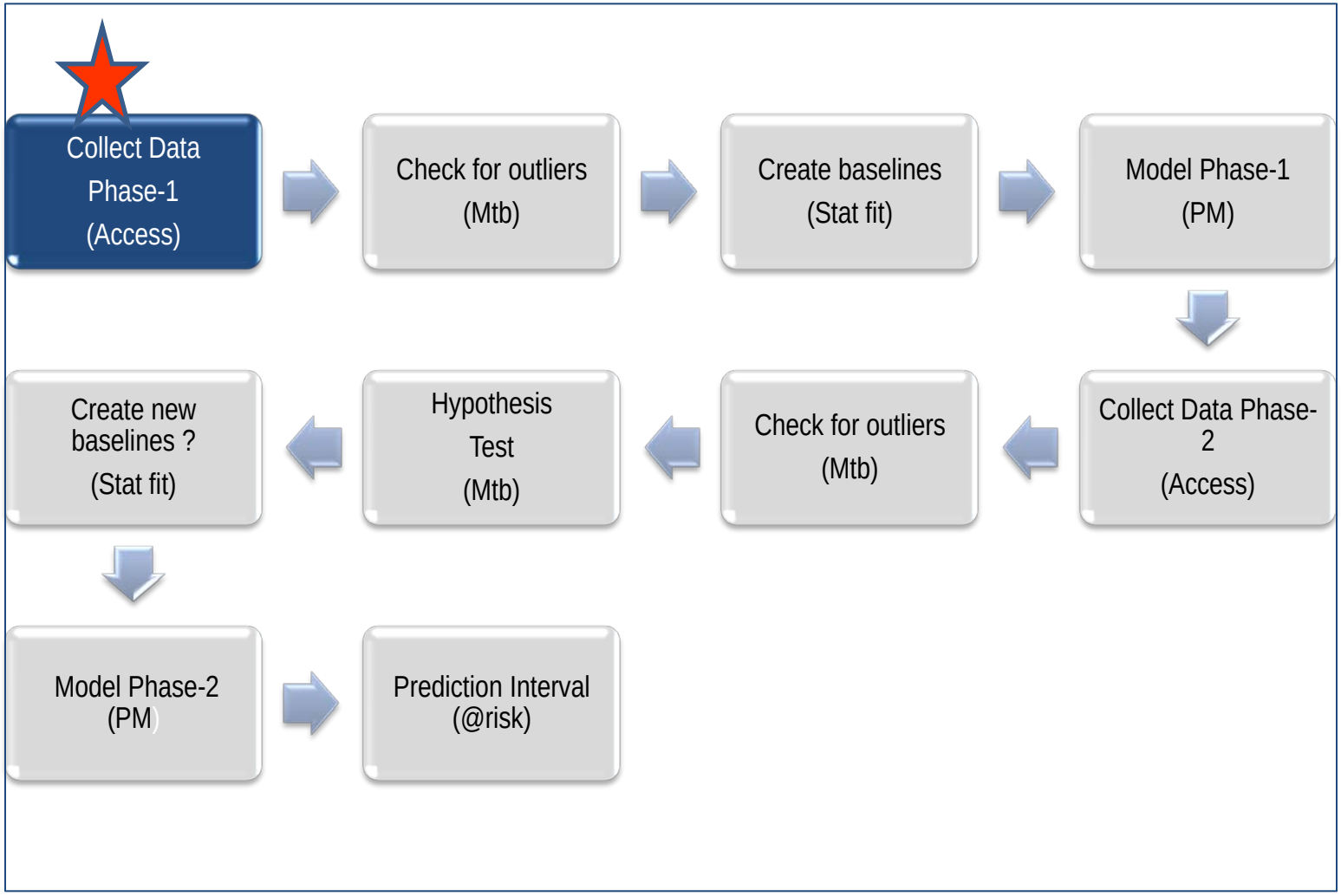
Produce Prediction Interval

@Risk

Process Steps



Process Steps



Collect Data

Collecting Data

XI Sheet

Gather Information

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Location	Date	Client	Month	Year	CoverShe	BurnRate	Run Proj S	Check Out	Resolve T	Total OT	S Total Time	Billing	Report Billing	Issues Total Billing	Initialize	Invoi	Populate	L T
2	In office	3/24/2009	FEMA	Feb		6		167				167	6		6	2	24		
3	In office	3/6/2009	DHS-S&T	Jan		2				2	2	2	2		2	2			
4	In office	3/6/2009	DHS-S&T	Feb		2				2	2	2	1		1	3			
5	At home	3/18/2009	FEMA-IT	Oct															

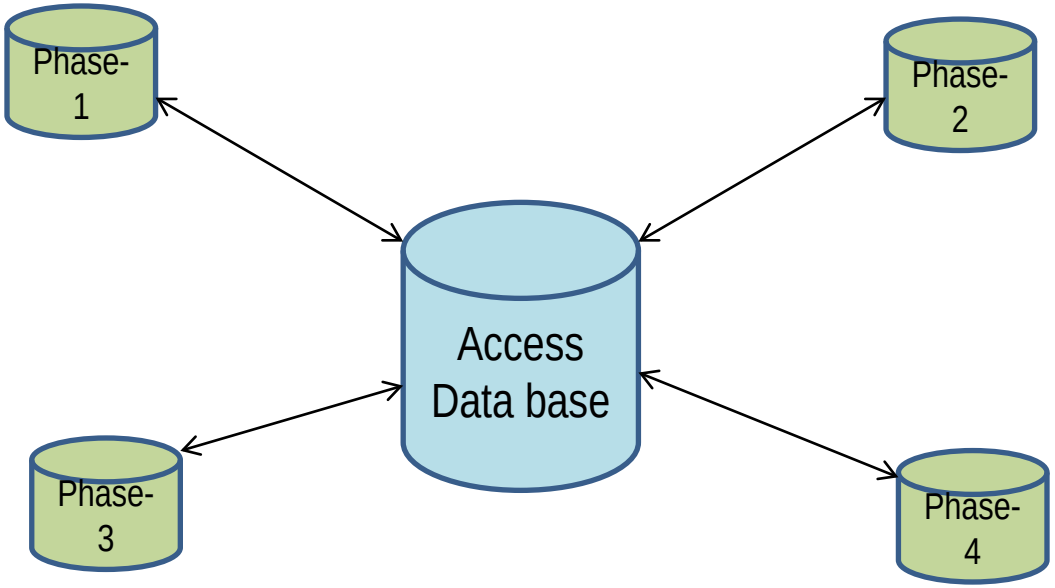
Access Database

Store Information

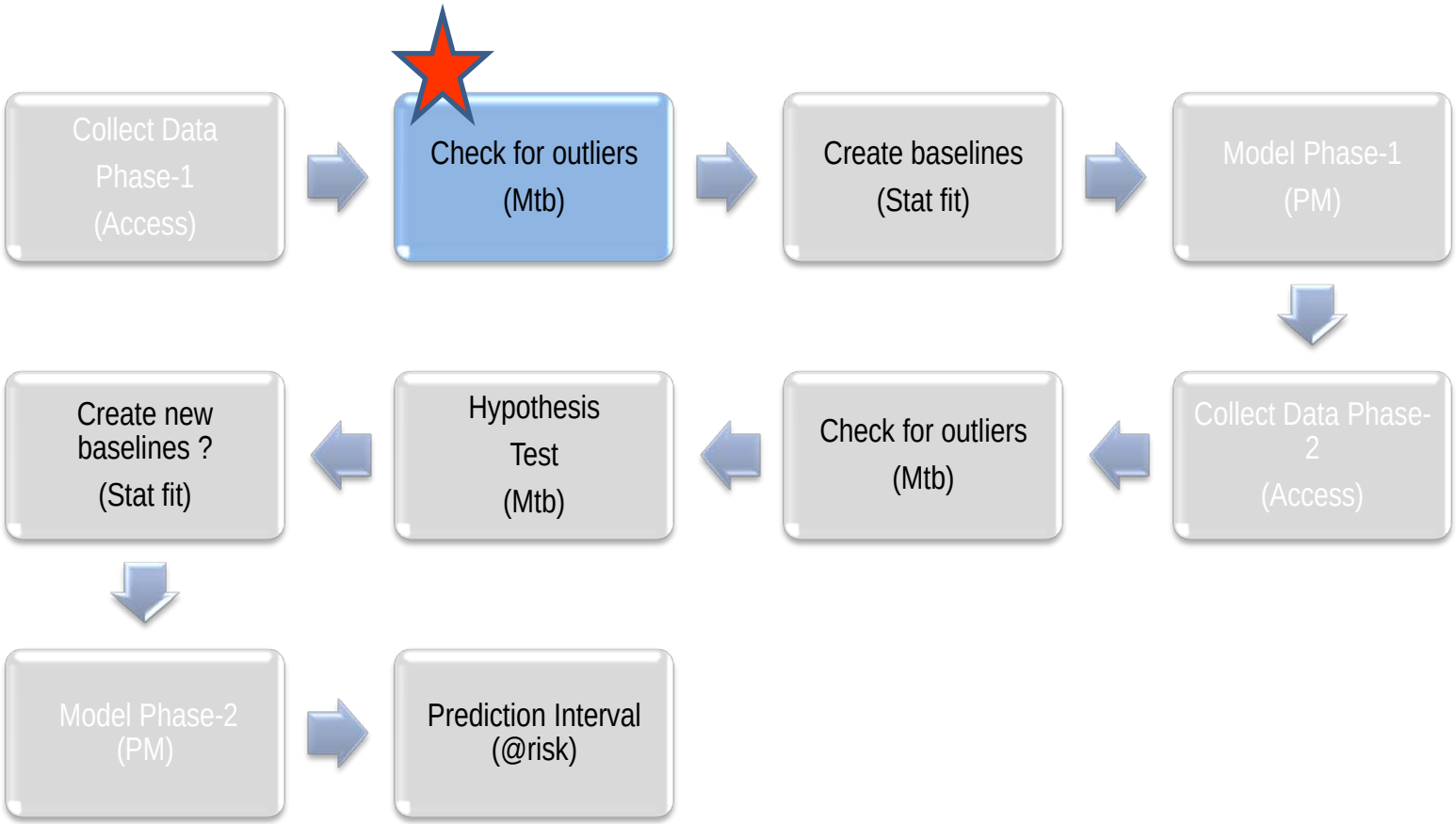
Location	Date	Client	Month	Year	CoverSheet	BurnRate	RunProjStaf	CheckOutsta	ResolveTime	TotalTime
In office	5/13/2009	HUD-eGrants	Mar							
In office	5/11/2009	DHS-HSEEP	Apr							
In office	5/12/2009	DHS-HSEEP	Apr							
In office	5/13/2009	DHS-HSEEP	Apr							
In office	5/14/2009	DHS-HSEEP	Apr							
In office	5/22/2009	HUD-eGrants	Apr							
In office	5/26/2009	HUD-eGrants	Apr				1		8	
In office	5/28/2009	HUD-eGrants	Apr							

Access Database

- Its easy to store and retrieve data as needed
- Multiple Phases can be stored
- Easy to access data using Queries

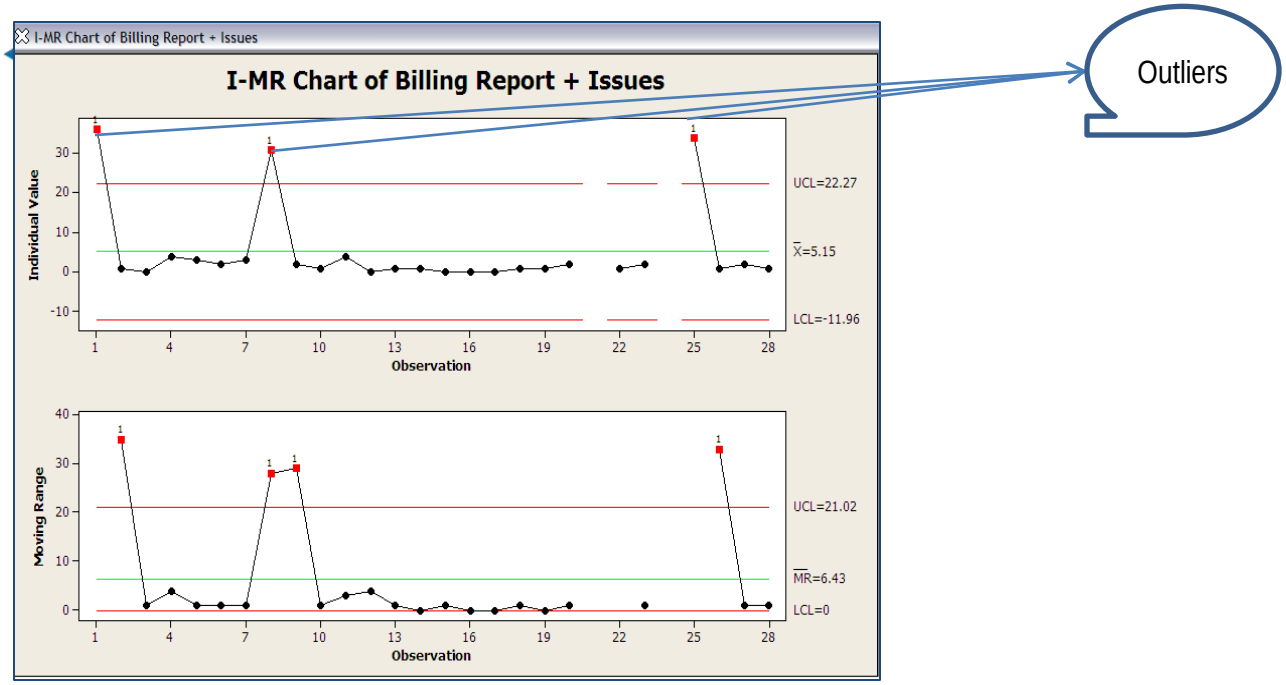


Process Steps



What is outlier?

- Outliers: Is an observation that is numerically distant from the rest of the data points

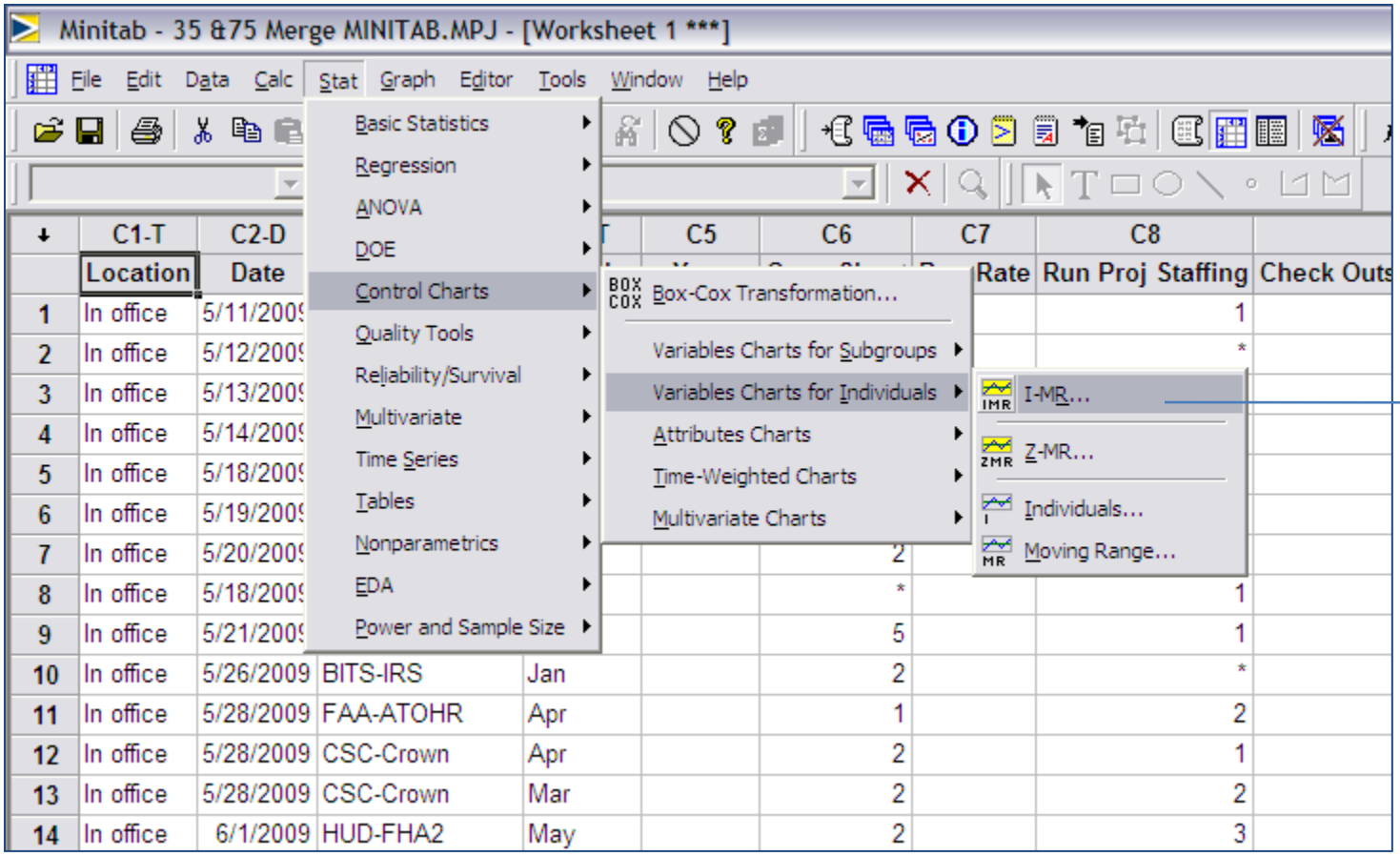


Check Outliers

- This can be done by Plotting I-MR Charts.

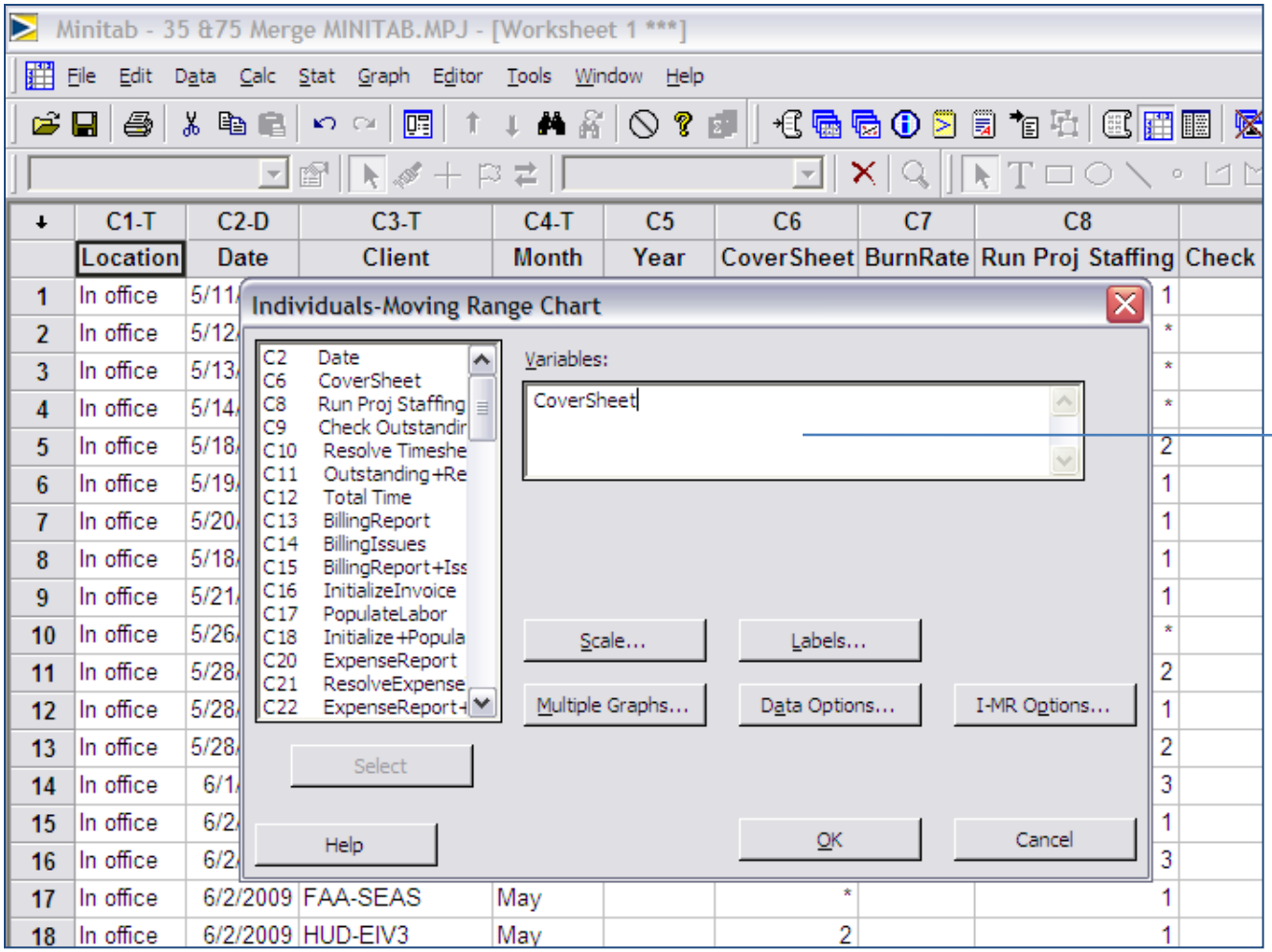
- I-MR Chart: Is a graphical tool that displays process variation over time. It signals when a process may be going out of control and shows where to look for sources of special cause variation.

I-MR Charts Using Minitab



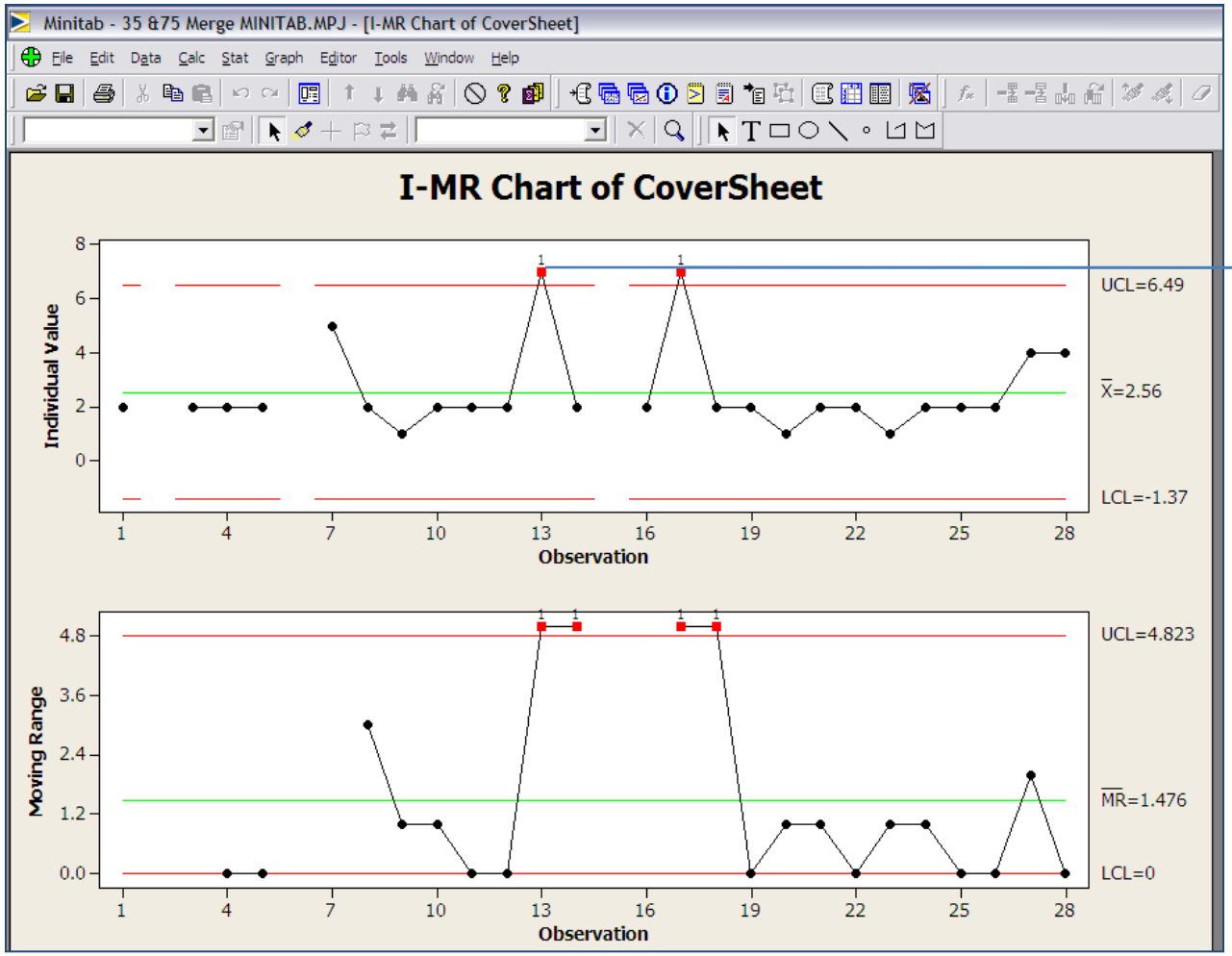
Select I-MR charts

Options in I-MR chart



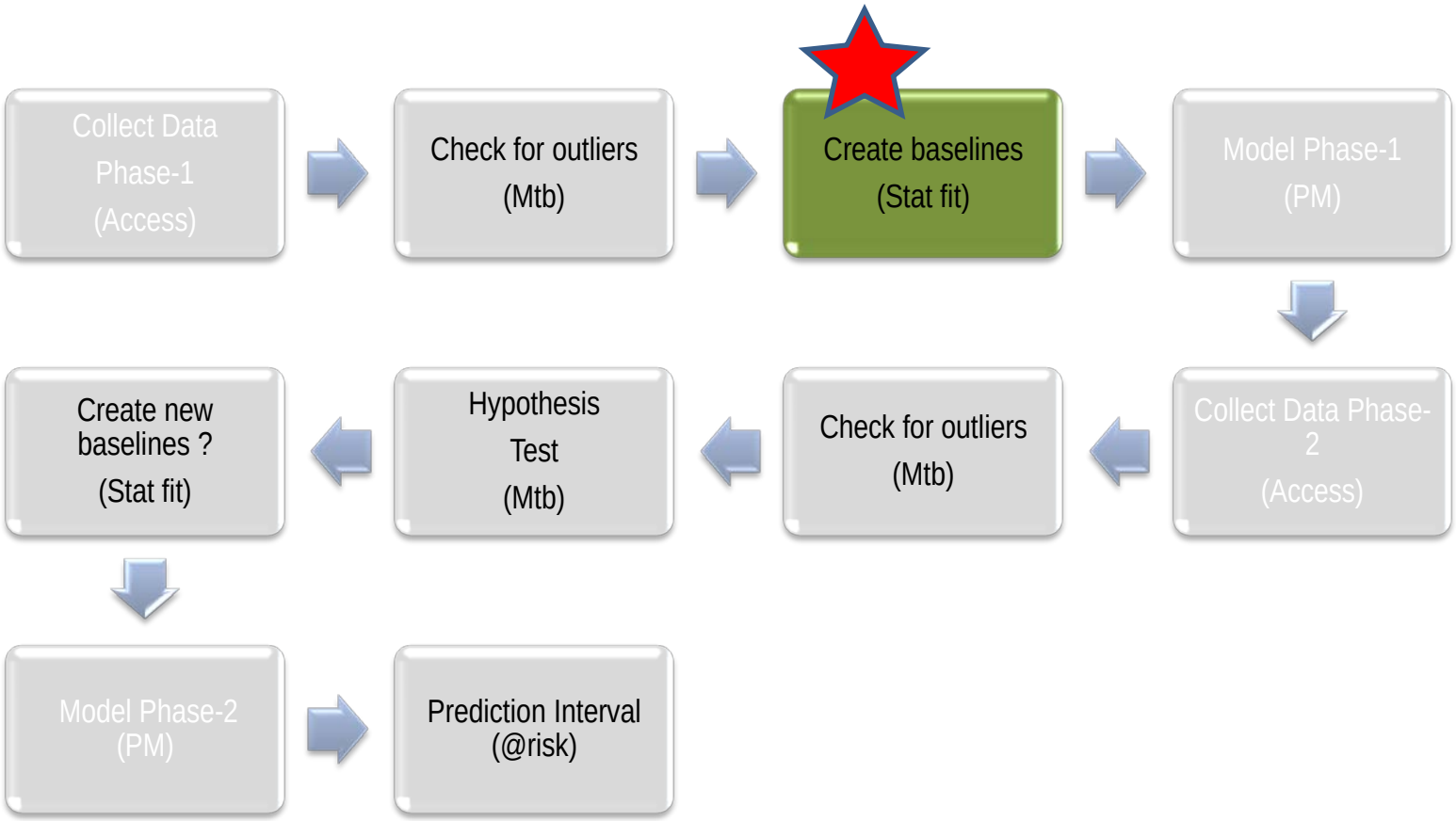
Select Variables to plot I-MR chart

I-MR Chart

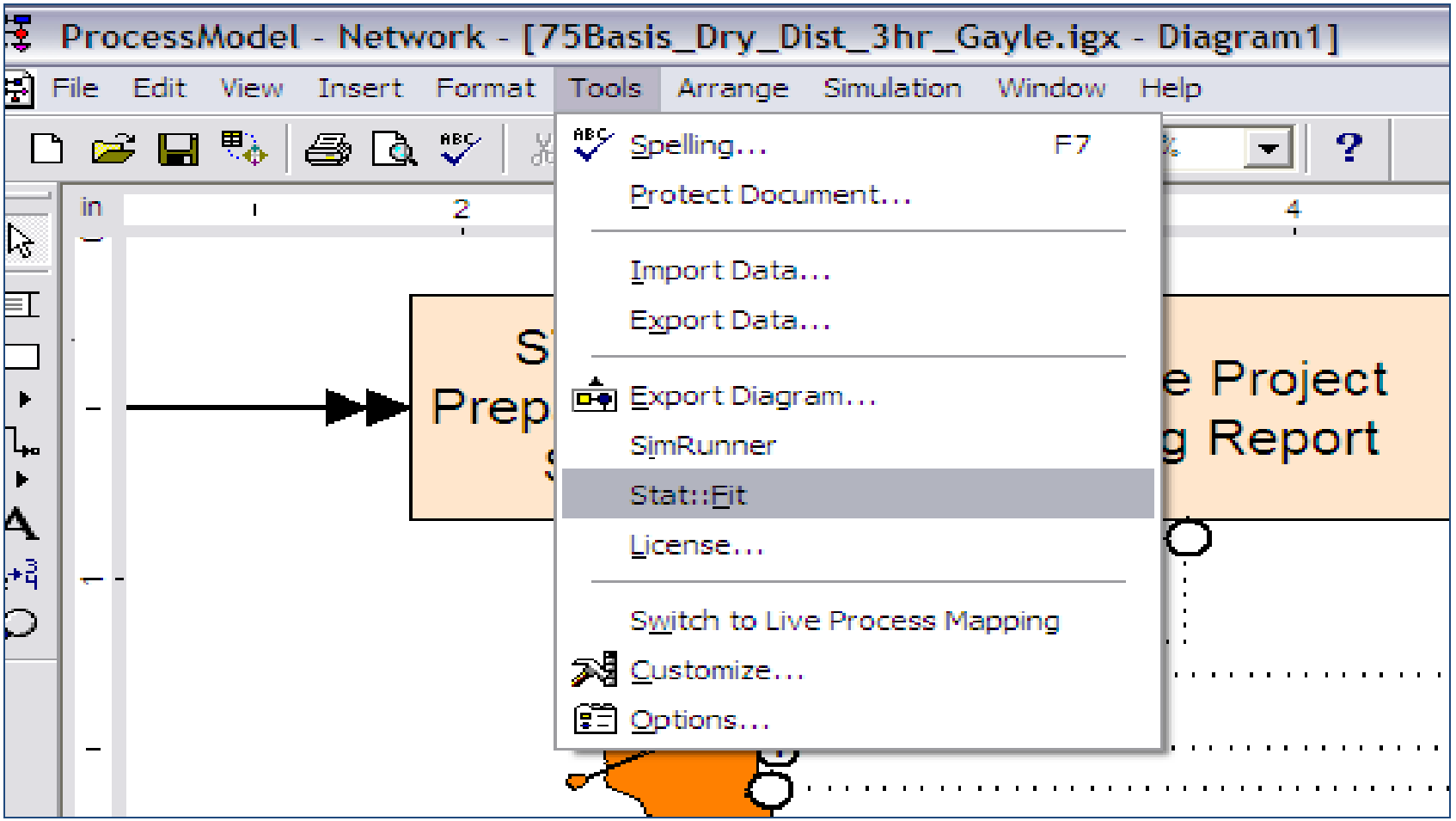


Outliers

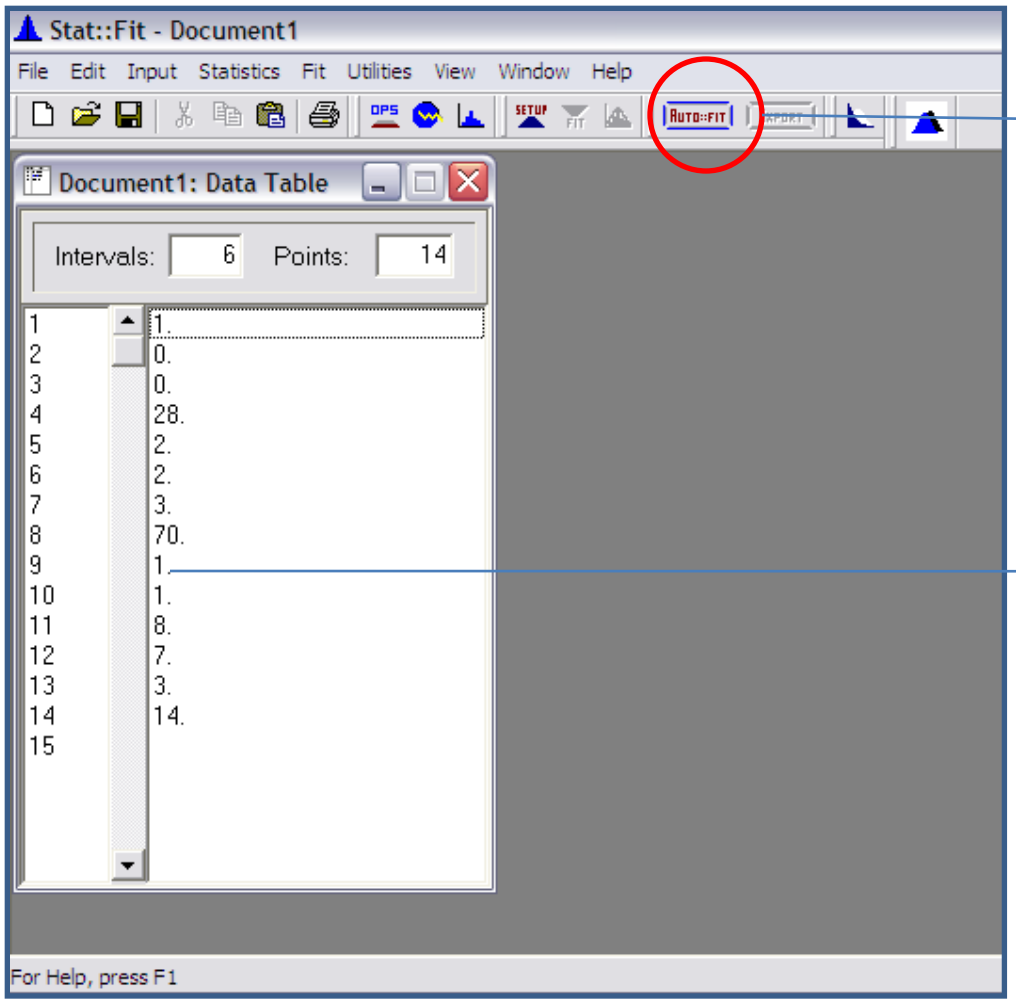
Process Steps



Stat Fit using Process Model



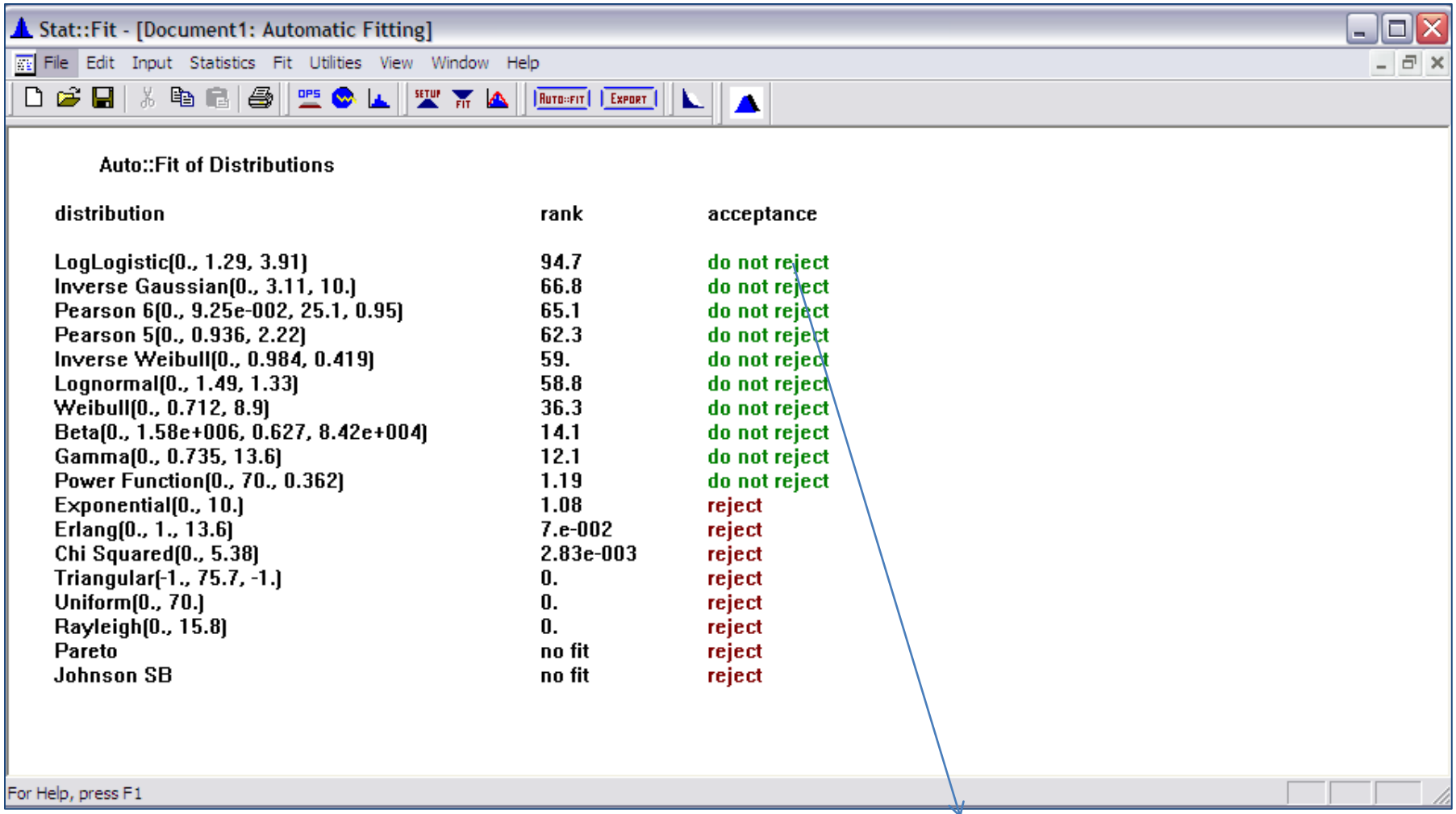
Stat Fit



Auto Fit

Data points from Minitab

Fit of Distribution



Select do not reject variables to get time interval

Distribution Graph

Stat::Fit - [Document1: Automatic Fitting]

File Edit Input Statistics Fit Utilities View Window Help

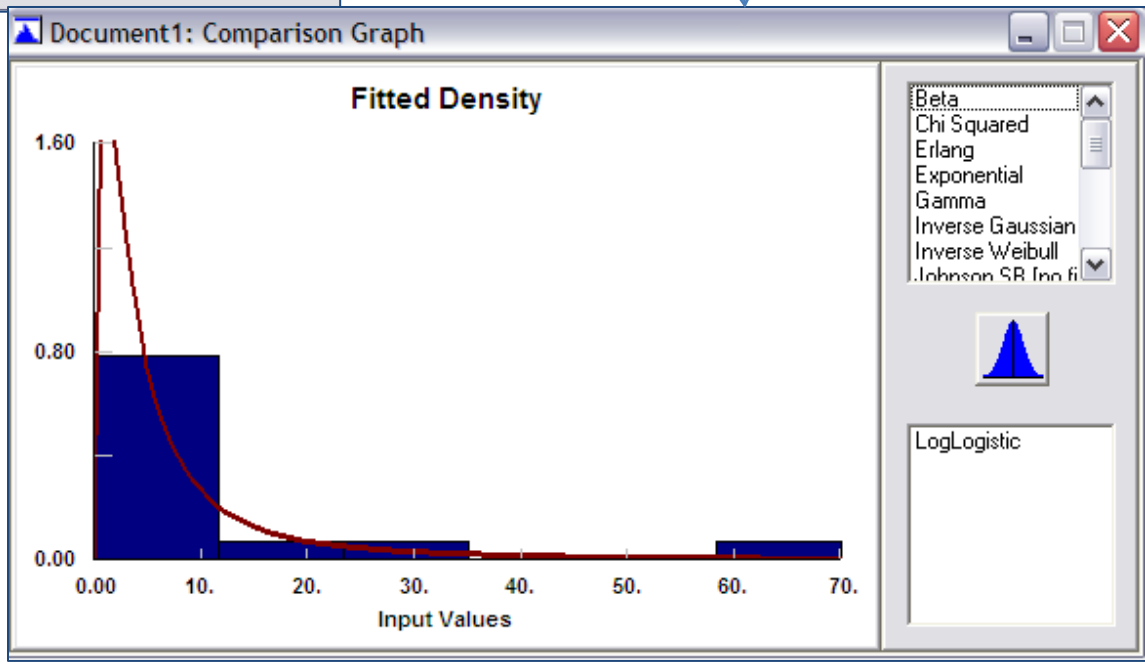
Auto::Fit of Distributions

distribution	rank	acceptance
LogLogistic(0., 1.29, 3.91)	94.7	do not reject
Inverse Gaussian(0., 3.11, 10.)	66.8	do not reject
Pearson 6(0., 9.25e-002, 25.1, 0.95)	65.1	do not reject
Pearson 5(0., 0.936, 2.22)	62.3	do not reject
Inverse Weibull(0., 0.984, 0.419)	59.	do not reject
Lognormal(0., 1.49, 1.33)	58.8	do not reject
Weibull(0., 0.712, 8.9)	36.3	do not reject
Beta(0., 1.58e+006, 0.627, 8.42e+004)	14.1	do not reject
Gamma(0., 0.735, 13.6)	12.1	do not reject
Power Function(0., 70., 0.362)	1.19	do not reject
Exponential(0., 10.)	1.08	reject
Erlang(0., 1., 13.6)	7.e-002	reject
Chi Squared(0., 5.38)	2.83e-003	reject
Triangular(-1., 75.7, -1.)	0.	reject
Uniform(0., 70.)	0.	reject
Rayleigh(0., 15.8)	0.	reject
Pareto	no fit	reject
Johnson SB	no fit	reject

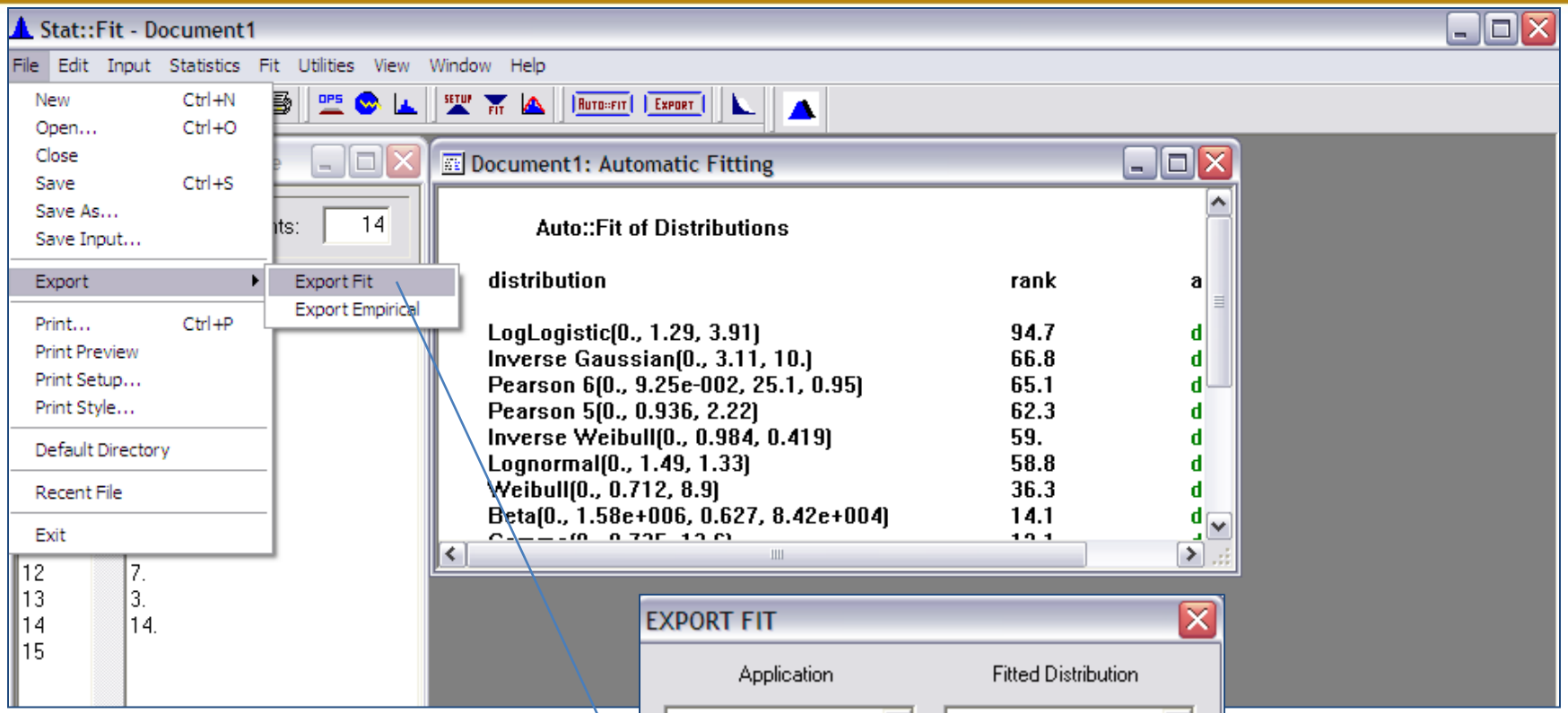
For Help, press F1

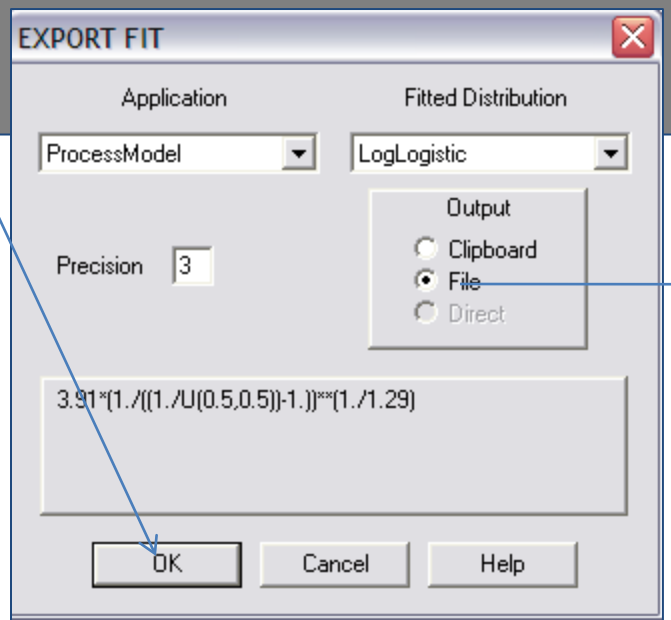
Double Click it will produce Following graph

Document1: Comparison Graph



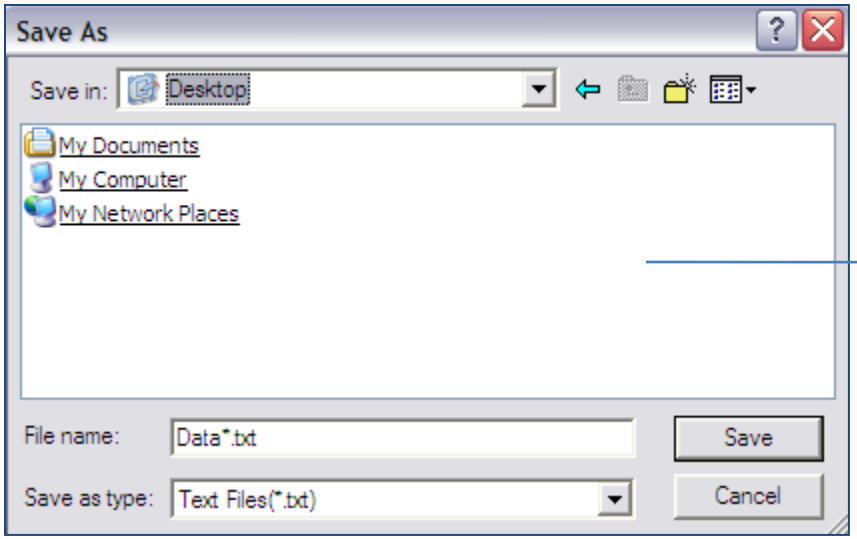
Export data to text file



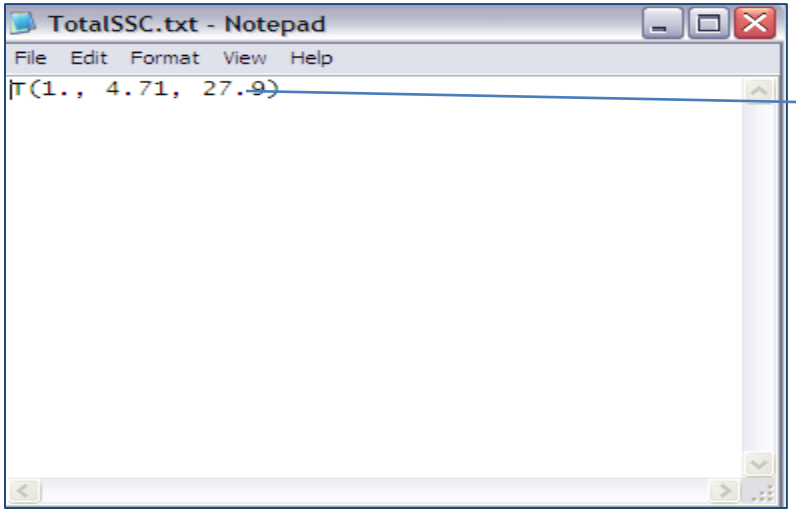


Click file

Time Interval

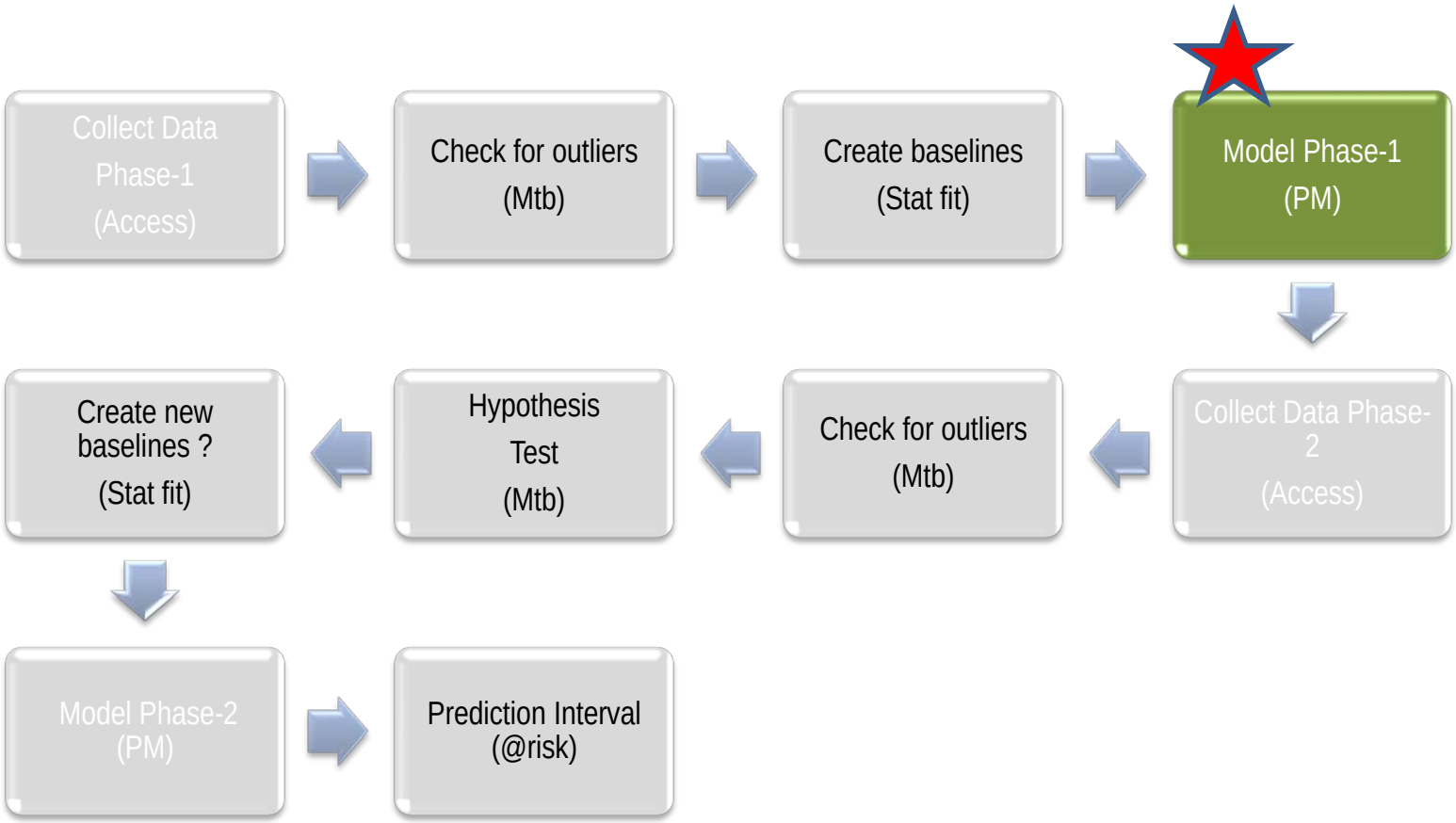


Save as Text file

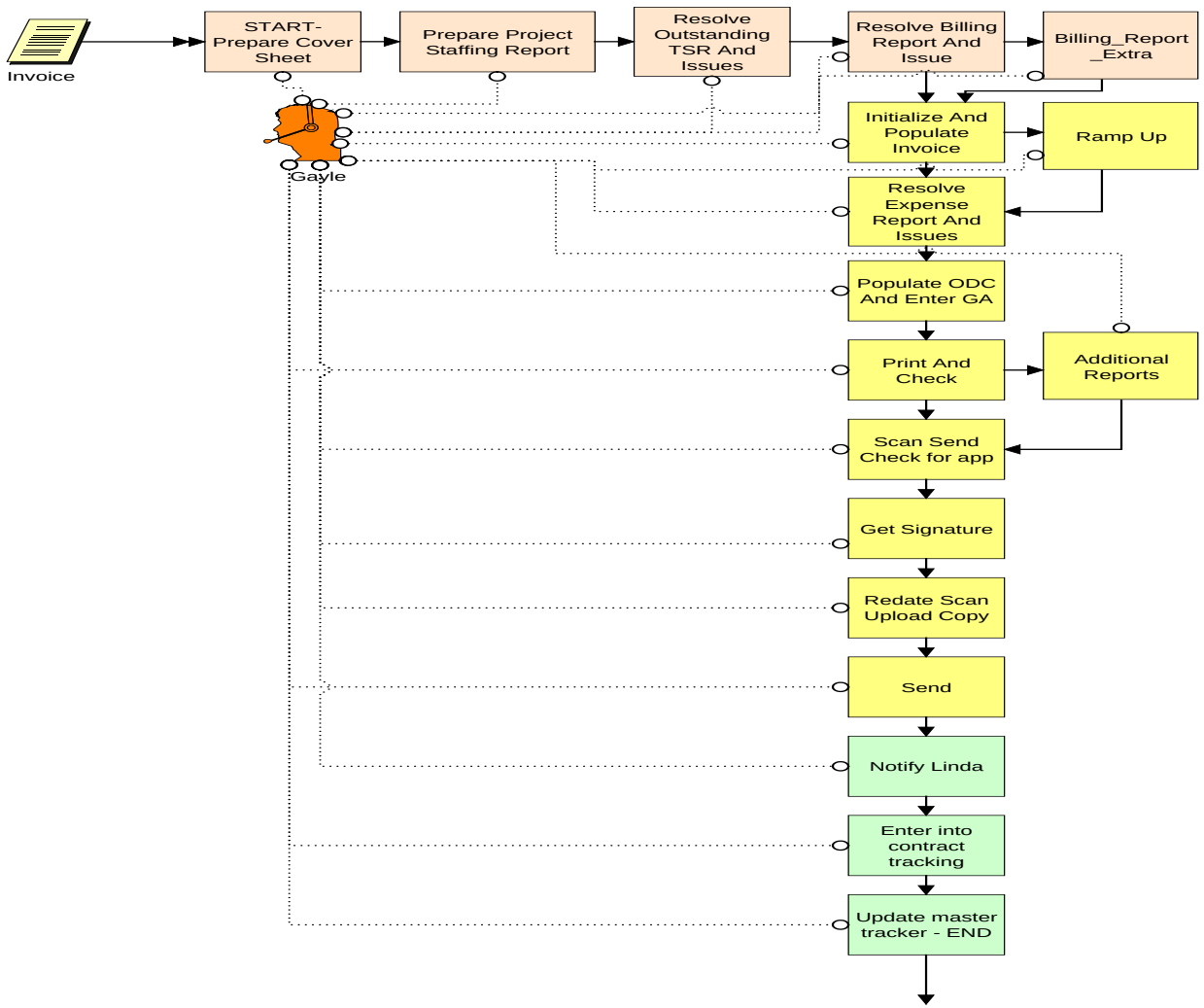


Copy this value and paste it in Process Model

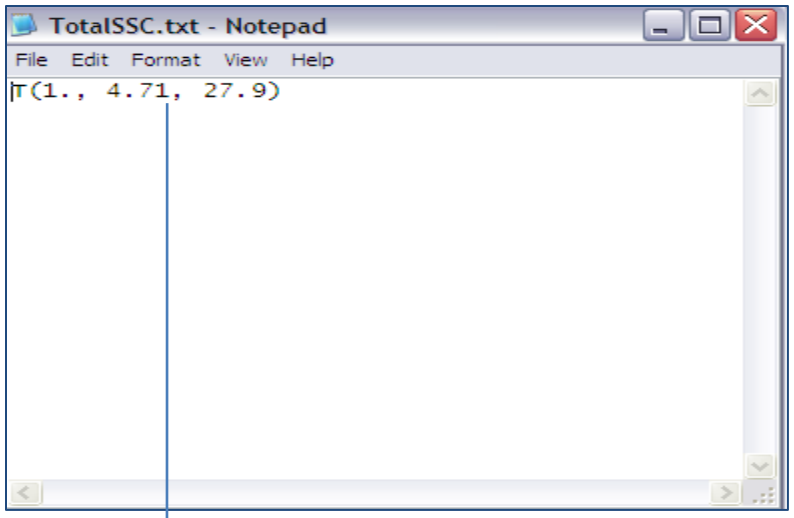
Process Steps

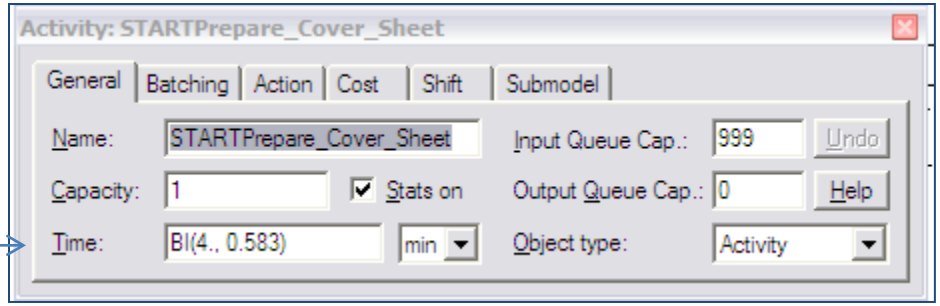


Process Model



Update time interval in to particular Process





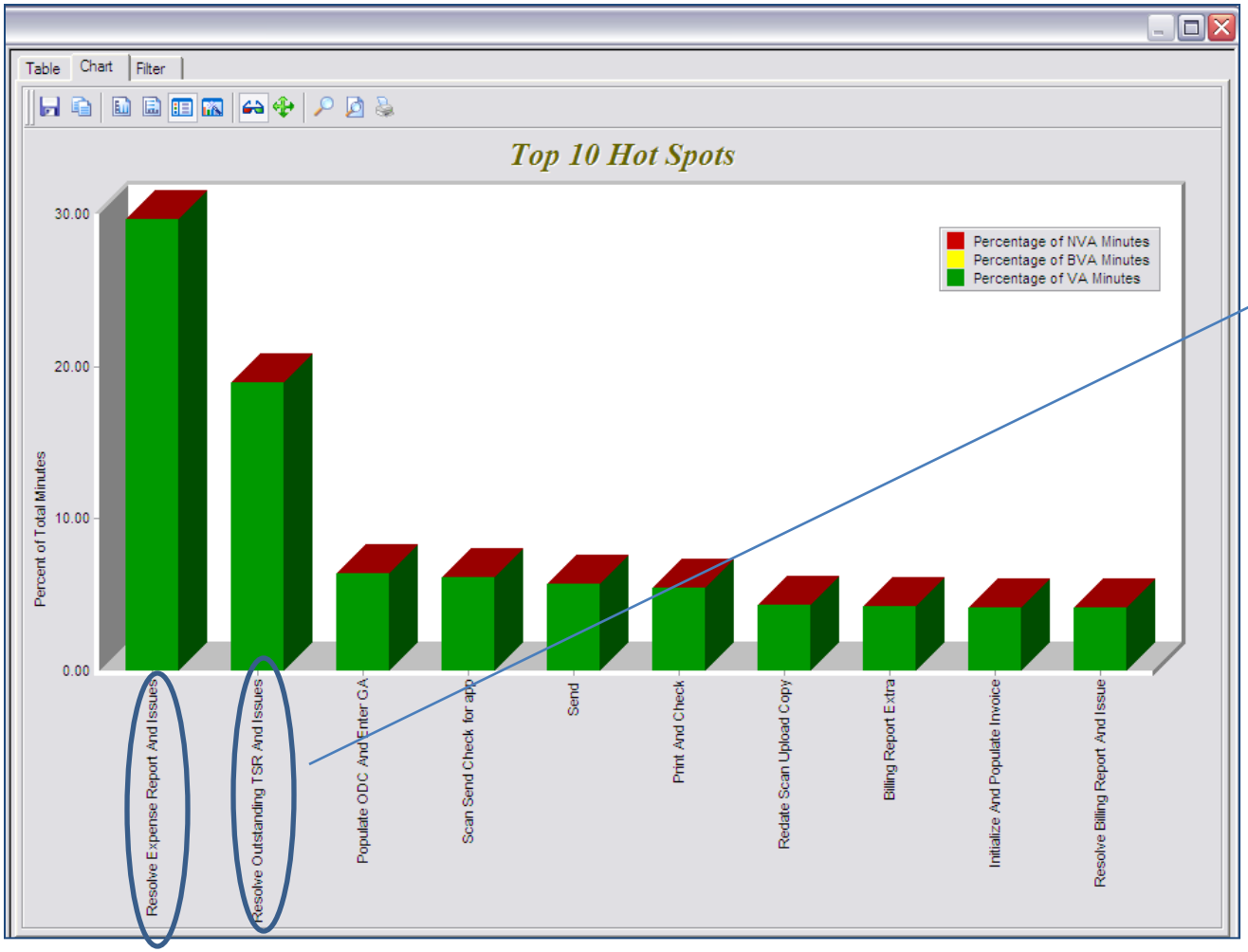
Phase-1 Summary

ENTITY SUMMARY (Times in Scoreboard time units)

Entity Name	Qty Processed	Average Cycle Time (Minutes)	Average VA Time (Minutes)	Average Cost	
Invoice	63.66	19467.3	149.66	249.43	(Average)
Invoice	3.82	1236	10.53	17.56	(Std. Dev.)
Invoice	56	17259.7	126.04	210.07	(Min)
Invoice	72	22512.6	174.34	290.57	(Max)
Invoice	62.23	19005.8	145.72	242.88	(95% C.I. Low)
Invoice	65.09	19928.8	153.59	255.99	(95% C.I. High)
HardInvoice	16.33	20359.8	178.11	296.86	(Average)
HardInvoice	3.82	1441.94	12.29	20.49	(Std. Dev.)
HardInvoice	8	18085.7	152.53	254.23	(Min)
HardInvoice	24	23480.9	203.04	338.41	(Max)
HardInvoice	14.90	19821.4	173.52	289.20	(95% C.I. Low)
HardInvoice	17.76	20898.2	182.70	304.51	(95% C.I. High)

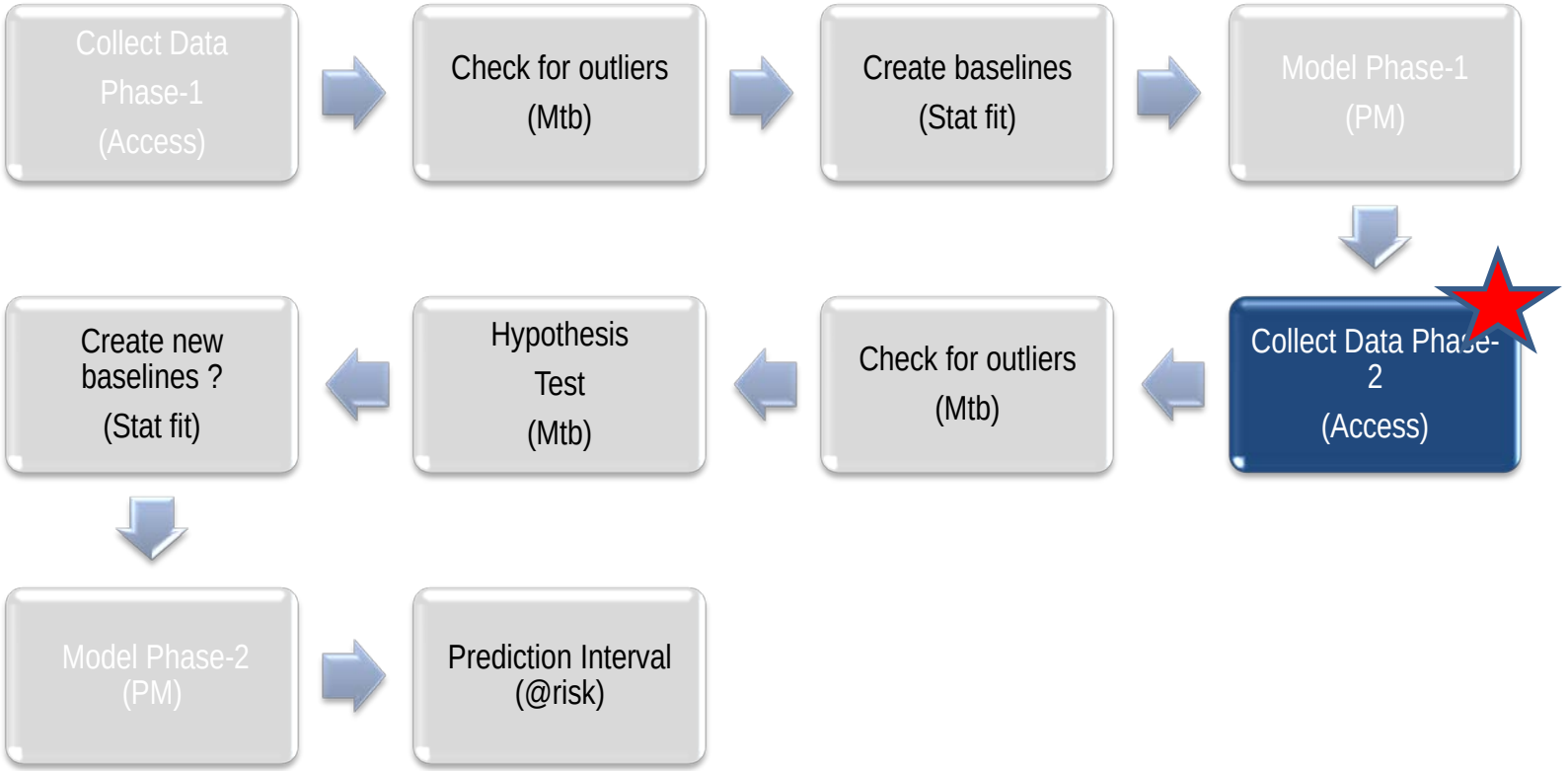
Average time for Phase-1

Phase-1 Hot Spots



Hot Spot

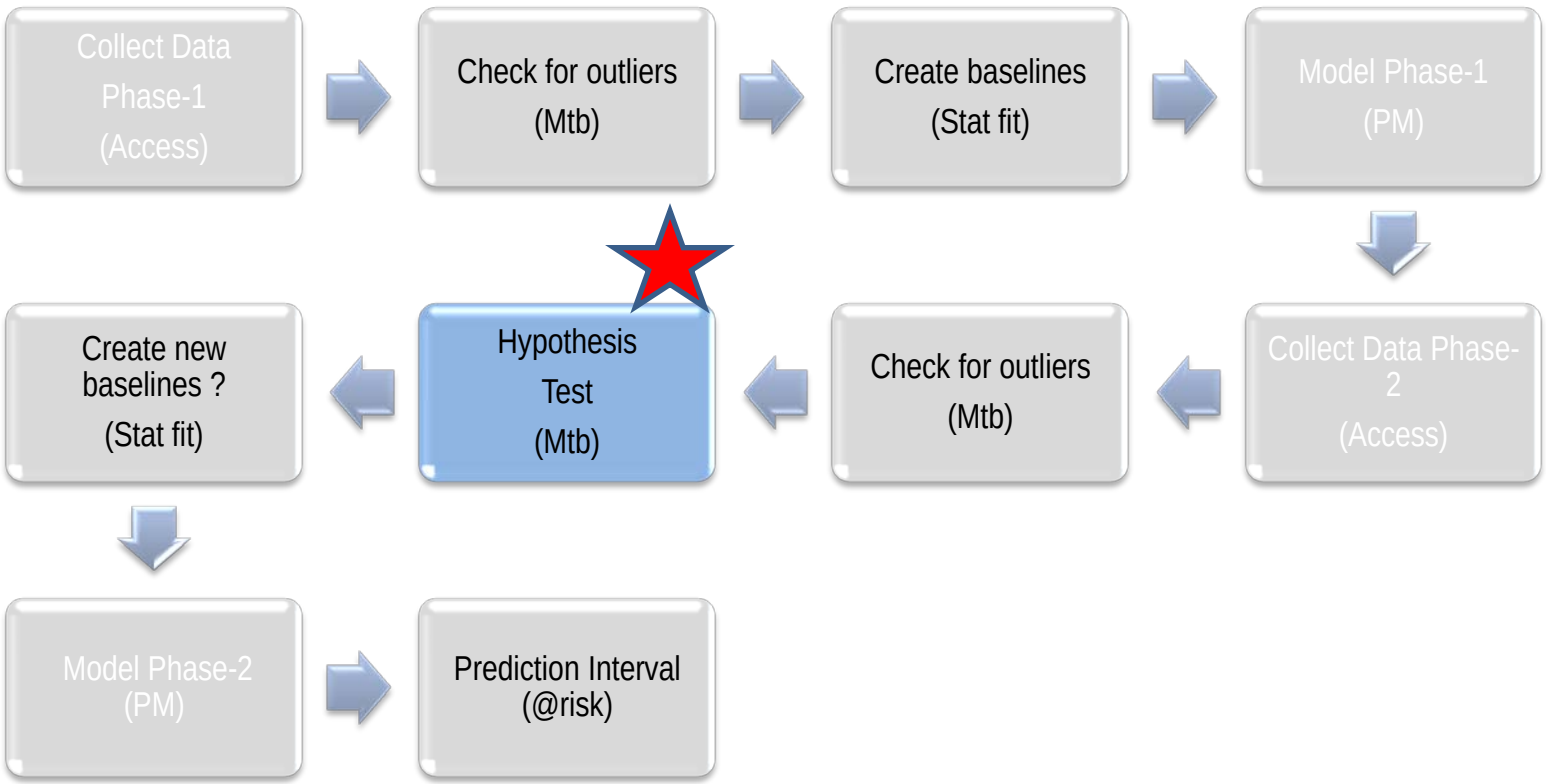
Process Steps



Collecting Phase-2 data & Check Outliers

- Repeat as in Phase 1

Process Steps



- Retrieving data from Access database
- Plotting charts such as

- These Charts are plotted to check for P-value for further analysis to check for Normality and Equal-Variance

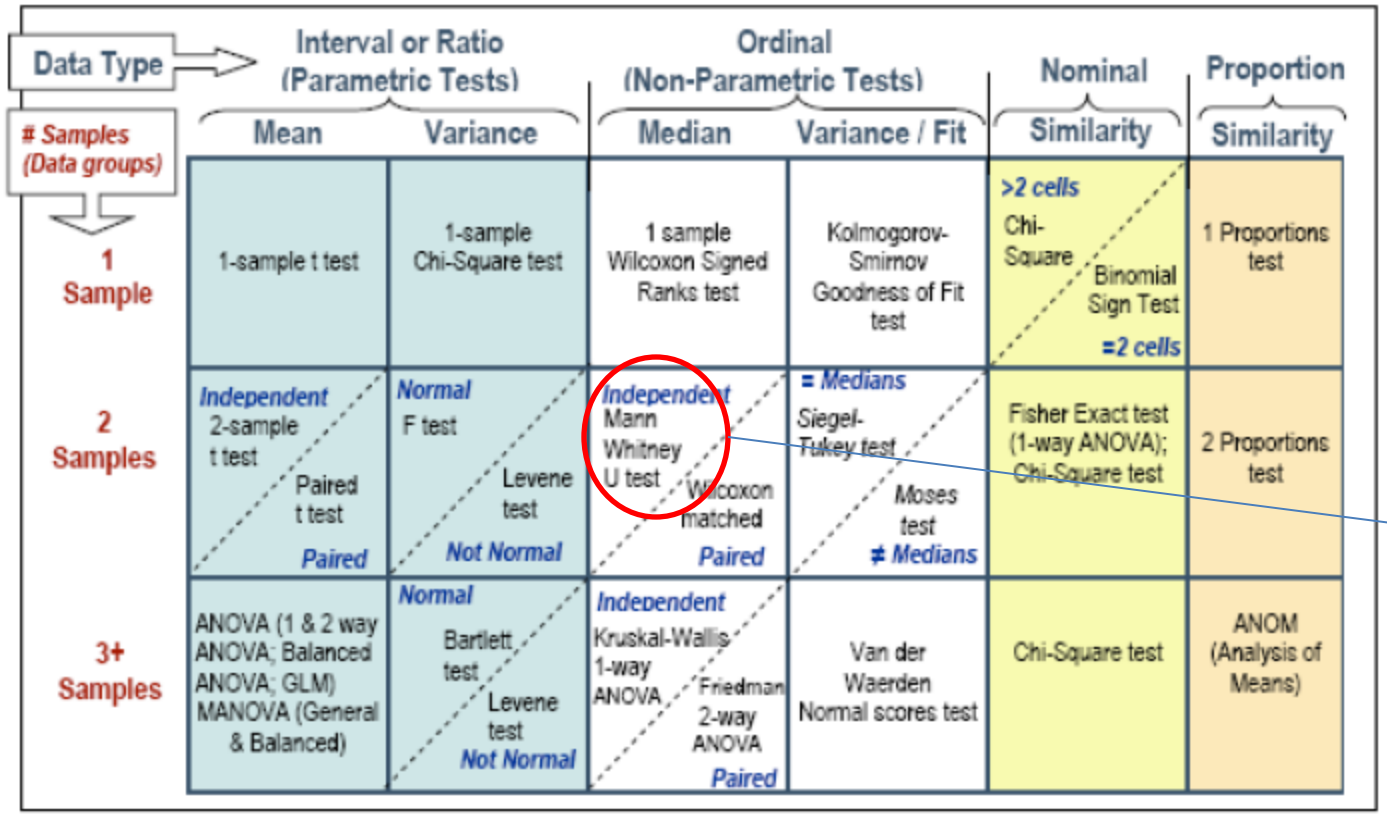
P-Value

- The P-value is the probability of obtaining a test statistic at least as extreme as the one that was actually observed, assuming that the null hypothesis is true.
- All tests are run at 95% confidence limit.
- 2 independent samples

Decision Tree

- As per SEI's Job Aid

Appropriate Analysis: Types of Hypothesis Tests

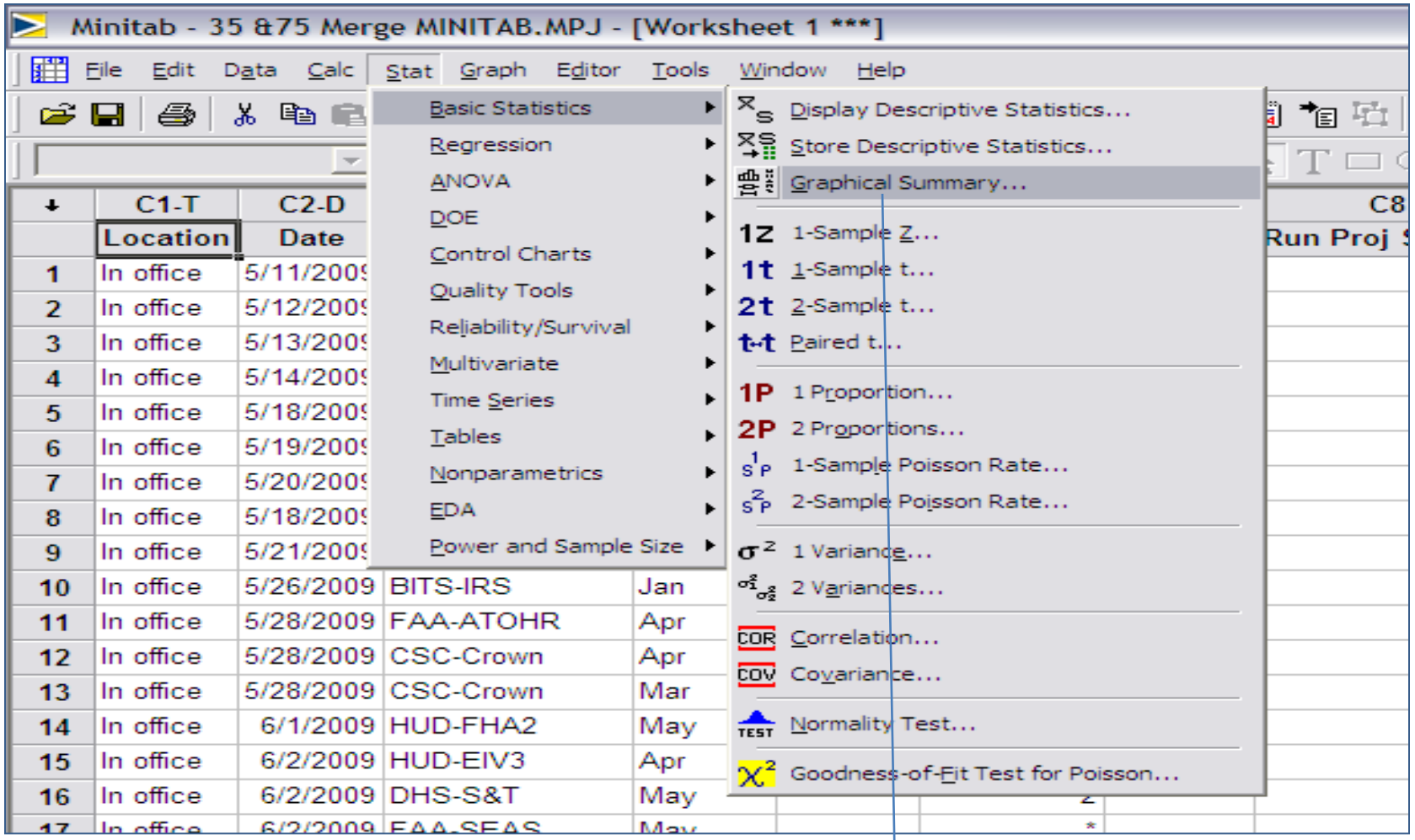


Data Type →	Interval or Ratio (Parametric Tests)		Ordinal (Non-Parametric Tests)		Nominal	Proportion
# Samples (Data groups) ↓	Mean	Variance	Median	Variance / Fit	Similarity	Similarity
1 Sample	1-sample t test	1-sample Chi-Square test	1 sample Wilcoxon Signed Ranks test	Kolmogorov-Smirnov Goodness of Fit test	>2 cells: Chi-Square; =2 cells: Binomial Sign Test	1 Proportions test
2 Samples	Independent: 2-sample t test; Paired: Paired t test	Normal: F test; Not Normal: Levene test	Independent: Mann Whitney U test; Paired: Wilcoxon matched	= Medians: Siegel-Tukey test; ≠ Medians: Moses test	Fisher Exact test (1-way ANOVA); Chi-Square test	2 Proportions test
3+ Samples	ANOVA (1 & 2 way ANOVA; Balanced ANOVA; GLM) MANOVA (General & Balanced)	Normal: Bartlett test; Not Normal: Levene test	Independent: Kruskal-Wallis 1-way ANOVA; Paired: Friedman 2-way ANOVA	Van der Waerden Normal scores test	Chi-Square test	ANOM (Analysis of Means)

Current sample data

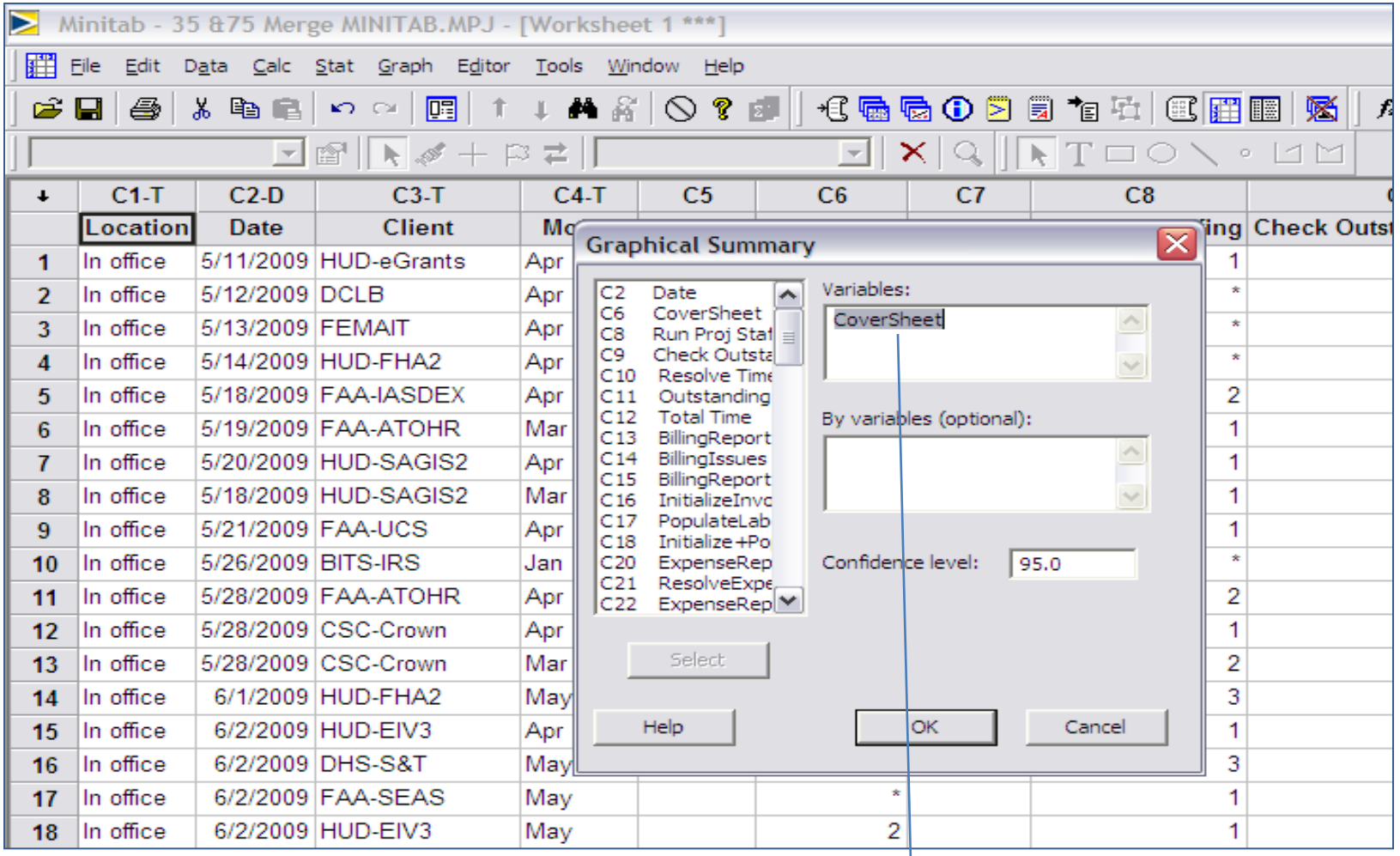
© 2009 Carnegie Mellon University

Normality Test – Summary chart Minitab Tool



Summary Graph

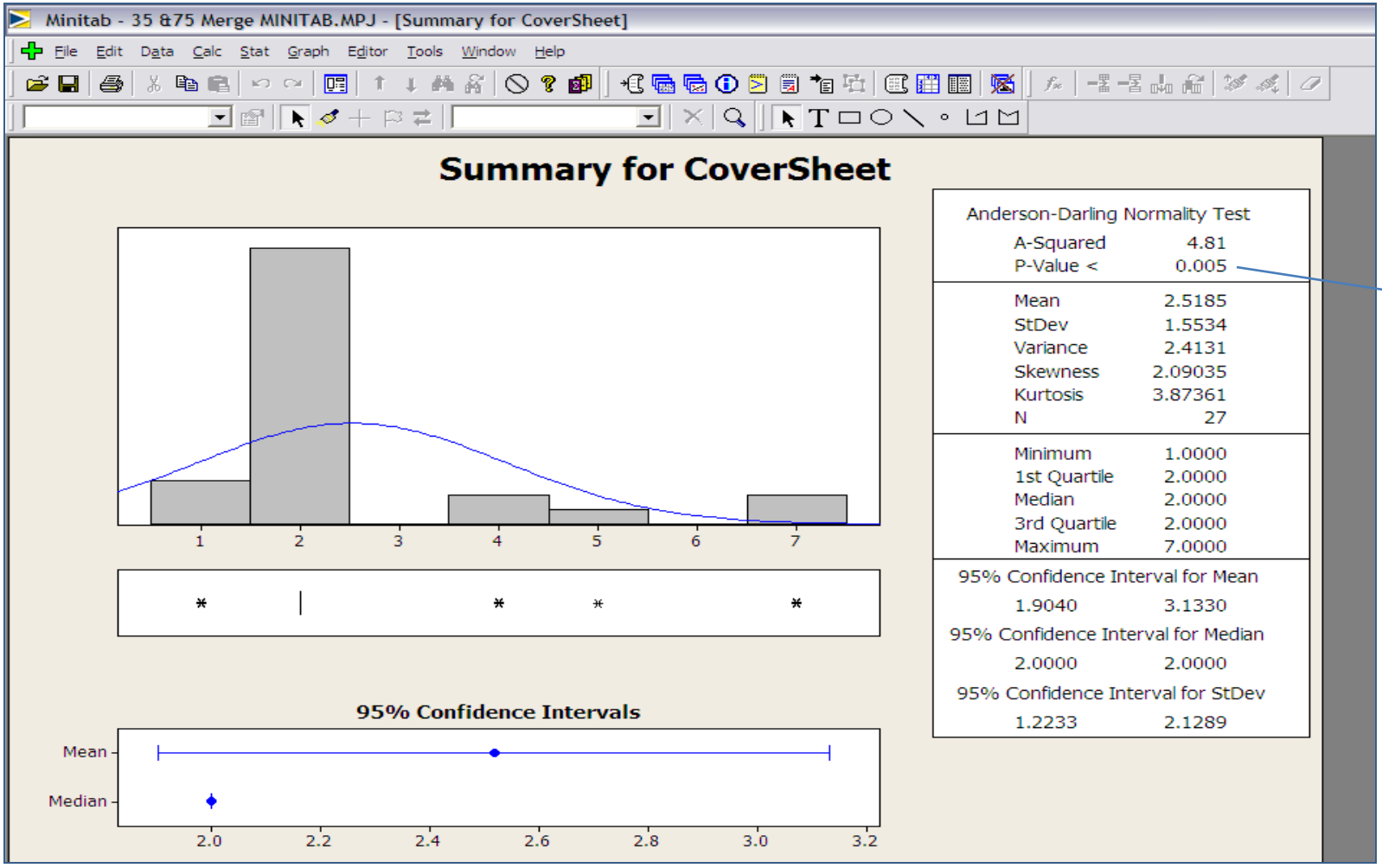
Summary Graph



	C1-T	C2-D	C3-T	C4-T	C5	C6	C7	C8	
	Location	Date	Client	Mo				ing	Check Outst
1	In office	5/11/2009	HUD-eGrants	Apr				1	
2	In office	5/12/2009	DCLB	Apr				*	
3	In office	5/13/2009	FEMAIT	Apr				*	
4	In office	5/14/2009	HUD-FHA2	Apr				*	
5	In office	5/18/2009	FAA-IASDEX	Apr				2	
6	In office	5/19/2009	FAA-ATOHR	Mar				1	
7	In office	5/20/2009	HUD-SAGIS2	Apr				1	
8	In office	5/18/2009	HUD-SAGIS2	Mar				1	
9	In office	5/21/2009	FAA-UCS	Apr				1	
10	In office	5/26/2009	BITS-IRS	Jan				*	
11	In office	5/28/2009	FAA-ATOHR	Apr				2	
12	In office	5/28/2009	CSC-Crown	Apr				1	
13	In office	5/28/2009	CSC-Crown	Mar				2	
14	In office	6/1/2009	HUD-FHA2	May				3	
15	In office	6/2/2009	HUD-EIV3	Apr				1	
16	In office	6/2/2009	DHS-S&T	May				3	
17	In office	6/2/2009	FAA-SEAS	May		*		1	
18	In office	6/2/2009	HUD-EIV3	May		2		1	

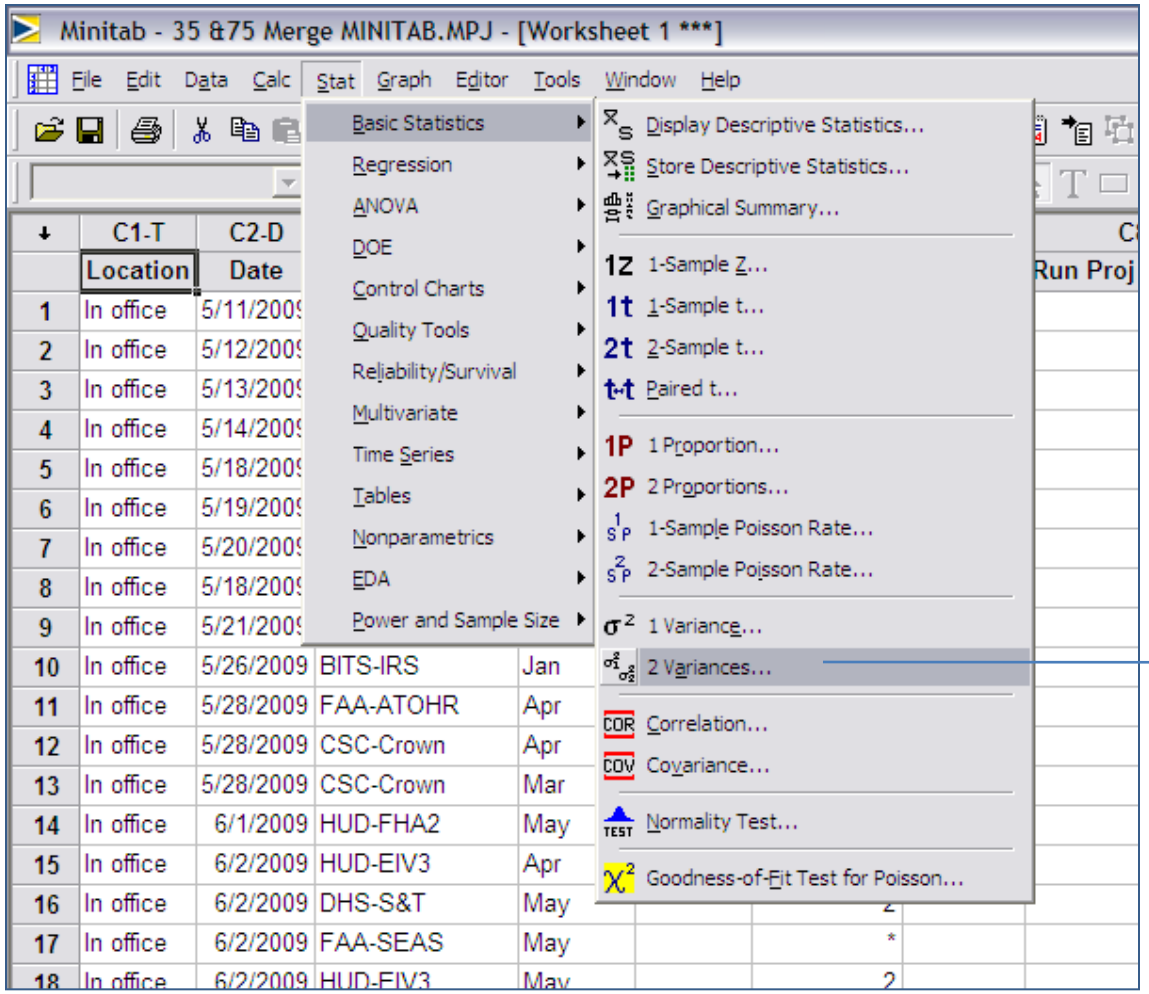
Select variable to plot summary graph

Summary Graph



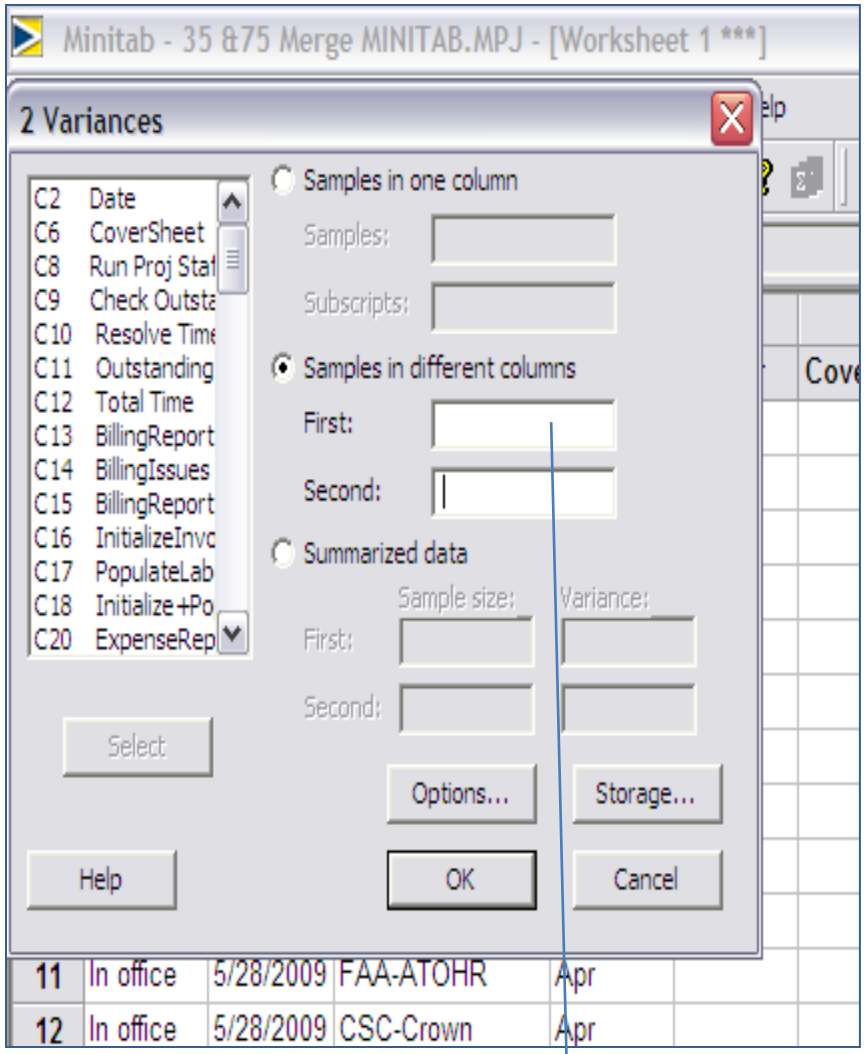
Check for P Value

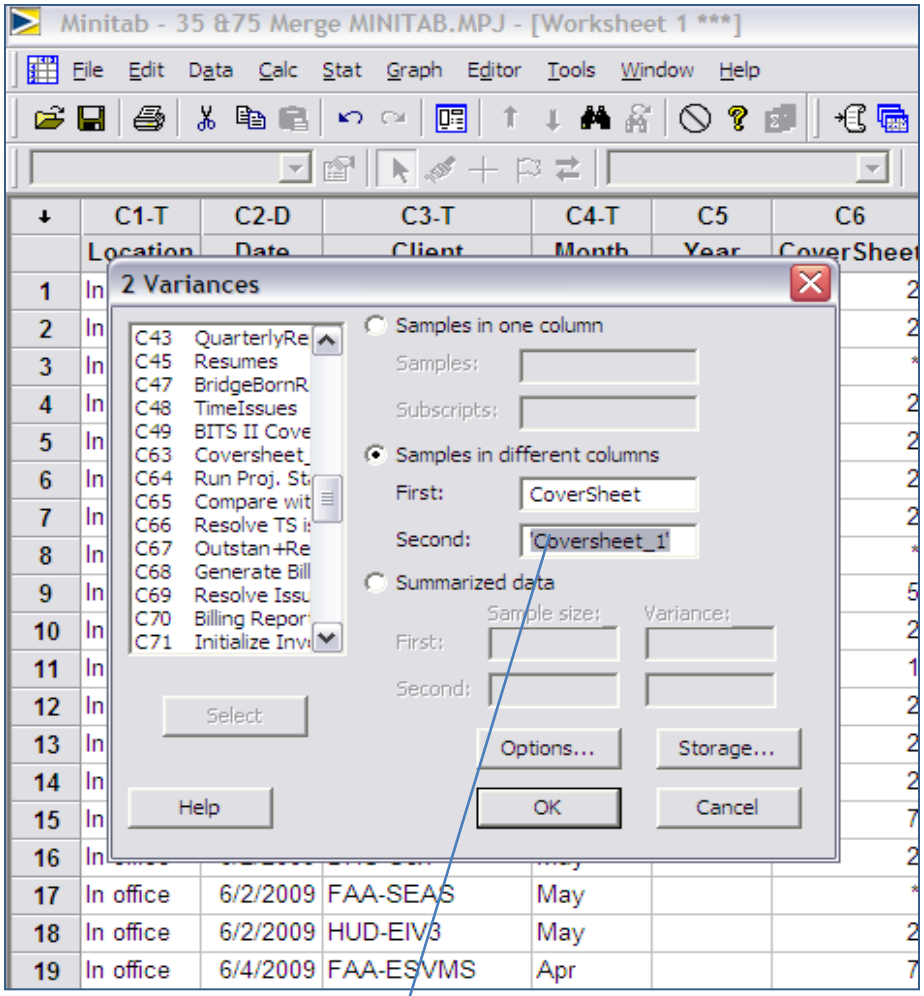
Variance Test – 2 Variance Test



Variance Test

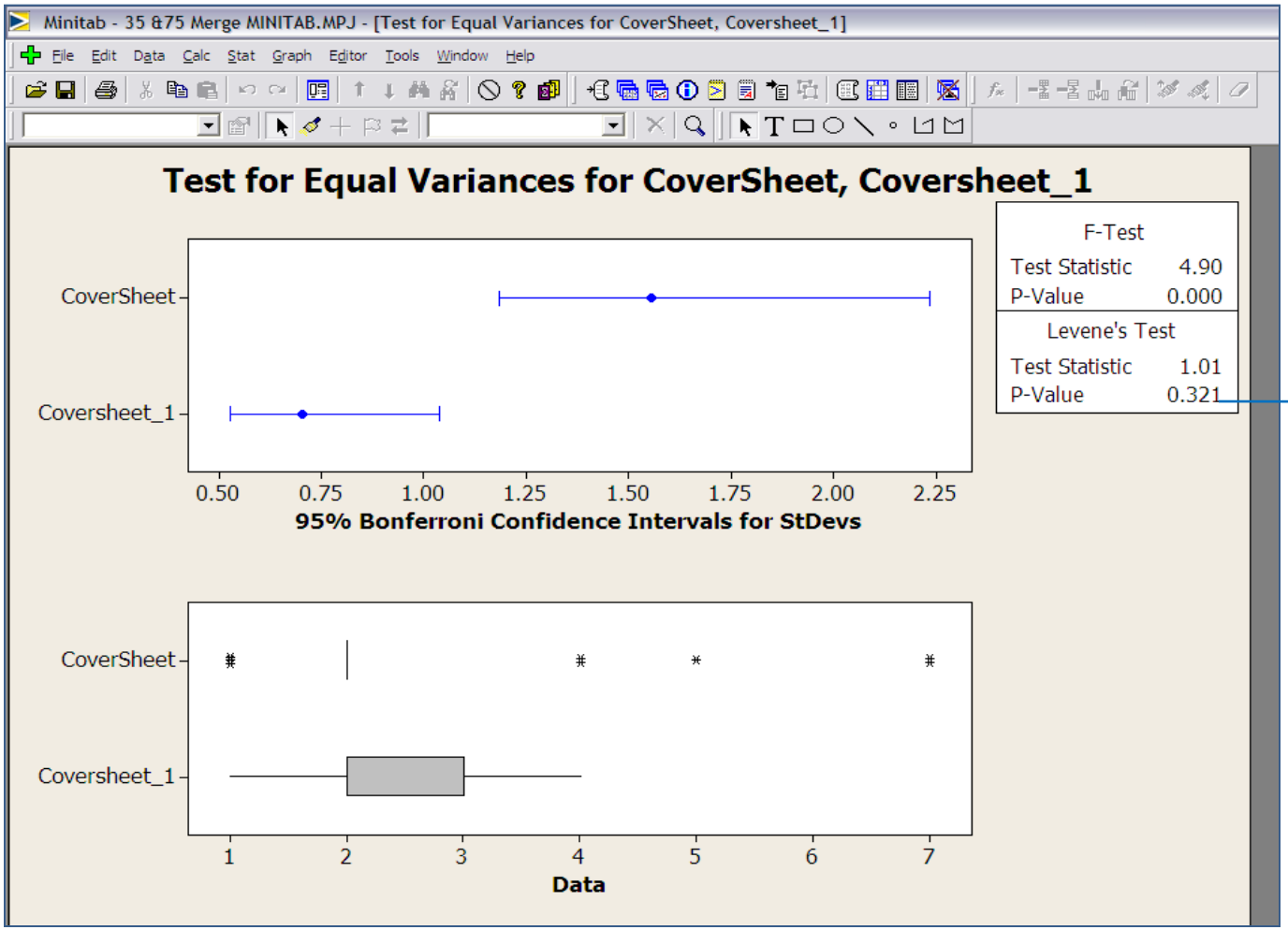
Variance Test





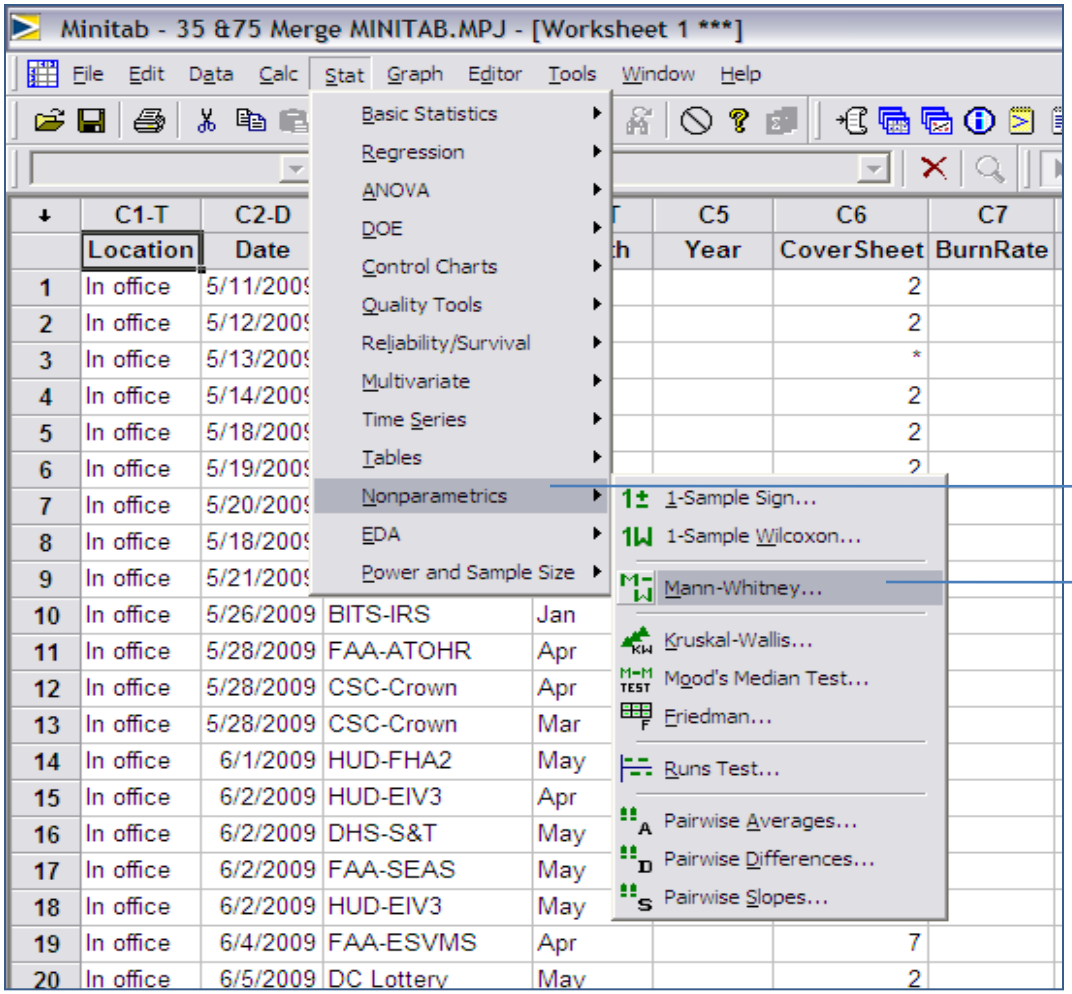
Select two columns to be sampled for Variance

Variance Test Graph



Check for P Value

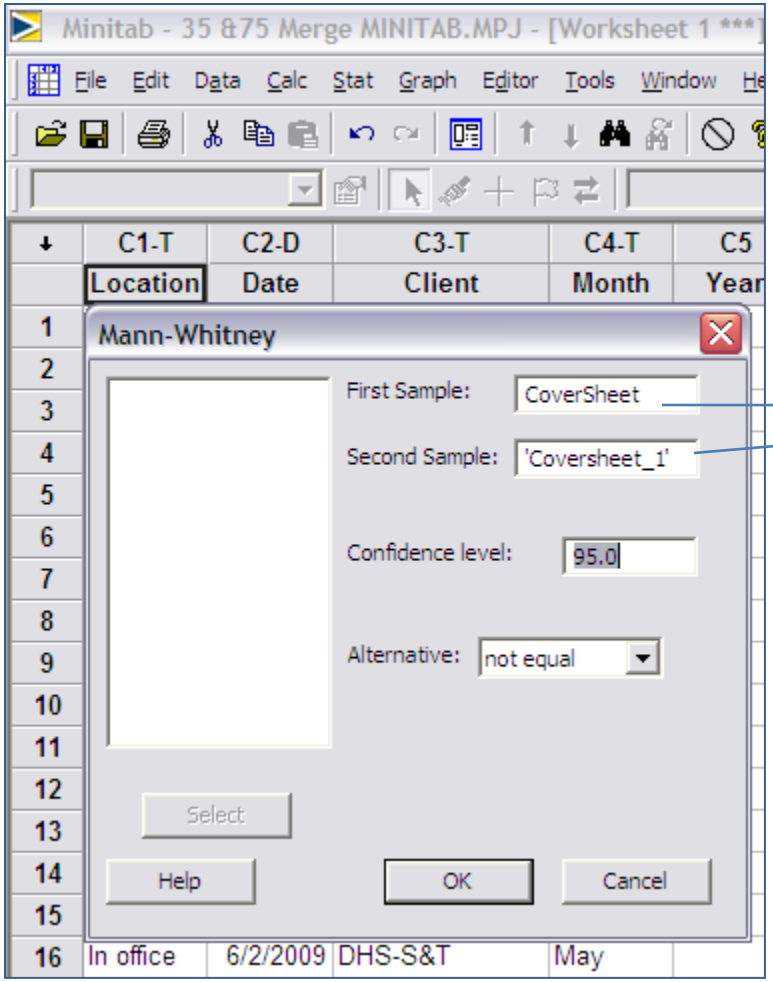
Non-Parametric Test for Median



Nonparametric test

Mann-Whitney test

Select particular data sample to be tested



Select Samples to be tested

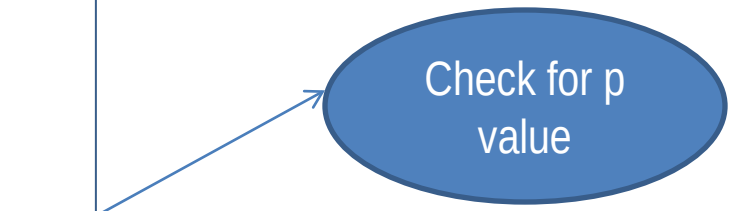
Session Screen

Test for Equal Variances for CoverSheet, Coversheet_1

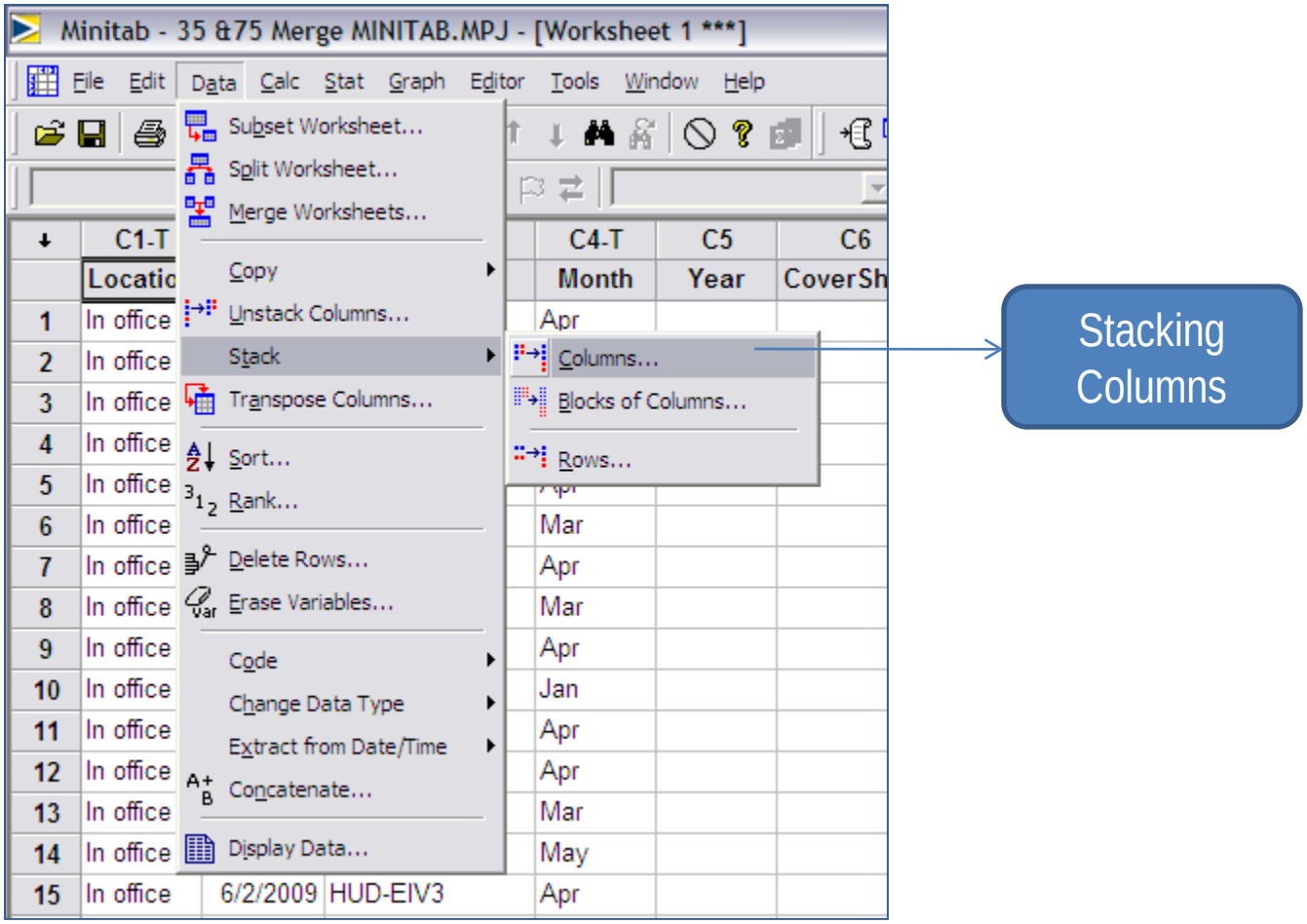
Mann-Whitney Test and CI: CoverSheet, Coversheet_1

	N	Median
CoverSheet	27	2.000
Coversheet_1	24	2.000

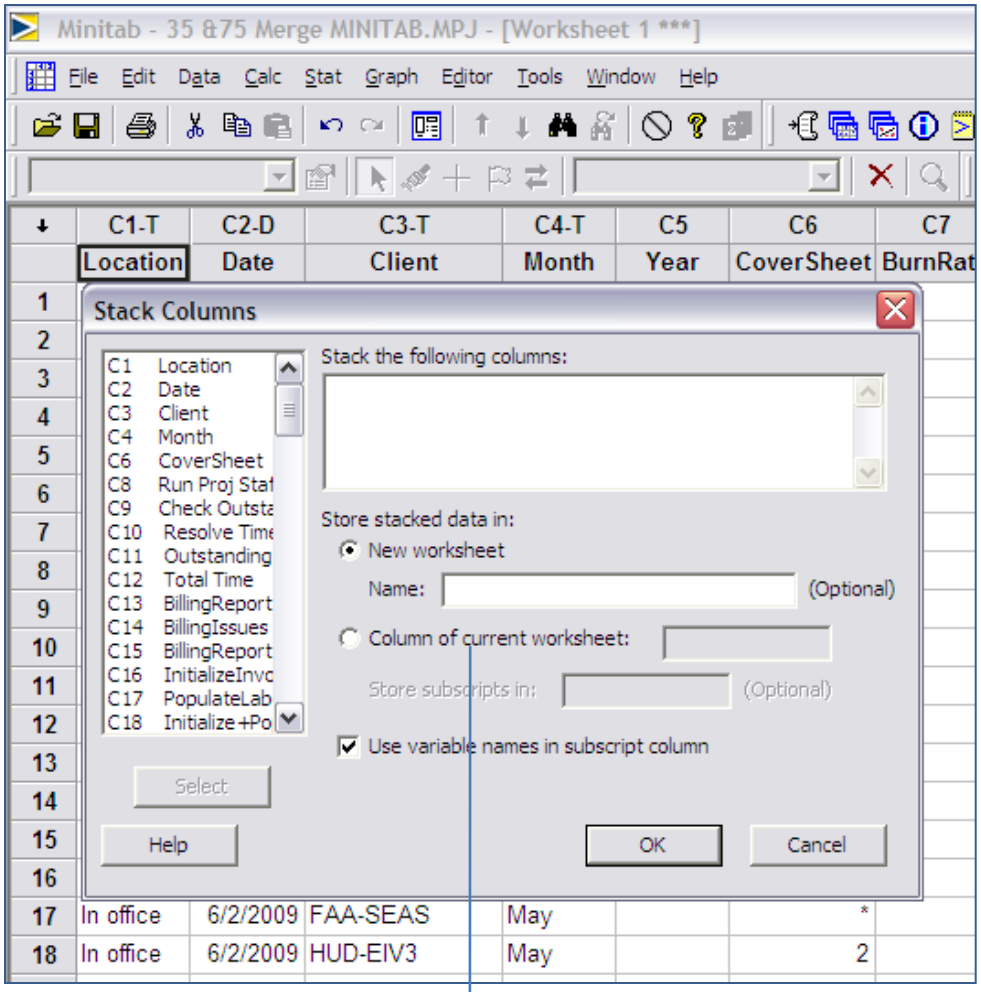
```
Point estimate for ETA1-ETA2 is -0.000
95.1 Percent CI for ETA1-ETA2 is (-0.001,0.000)
W = 668.5
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.5334
The test is significant at 0.4485 (adjusted for ties)
```

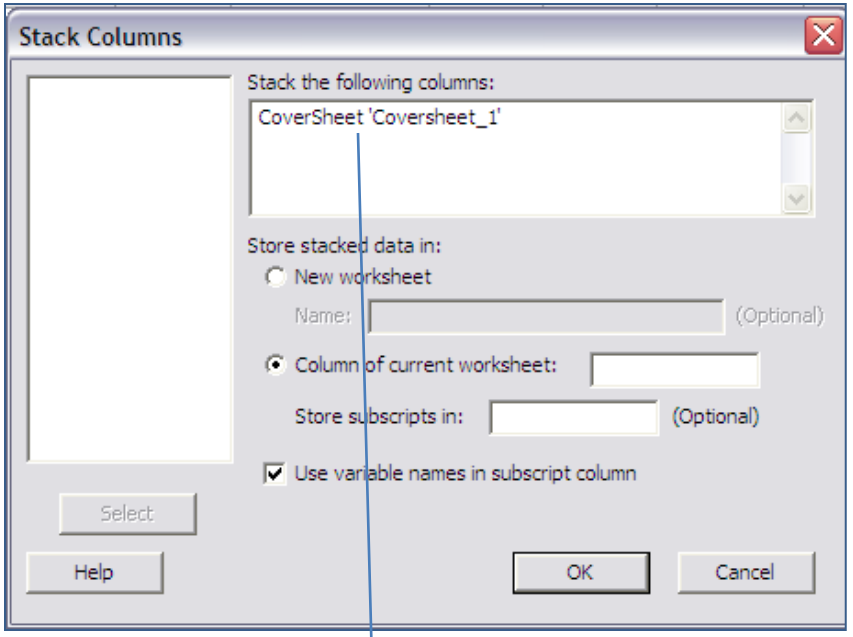


Stacking two Columns for Checking Non-Parametric Variance



Select columns to be stacked





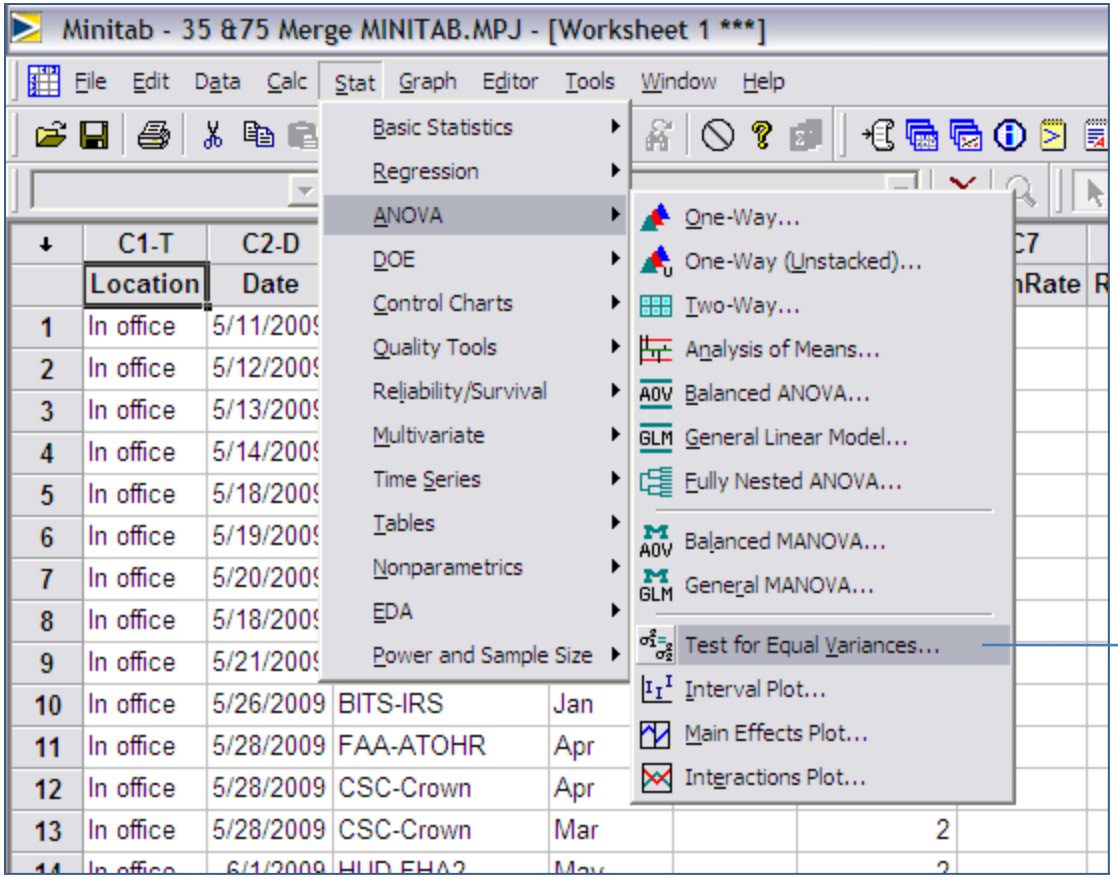
We can select required column to be stacked

Selection of column

Result

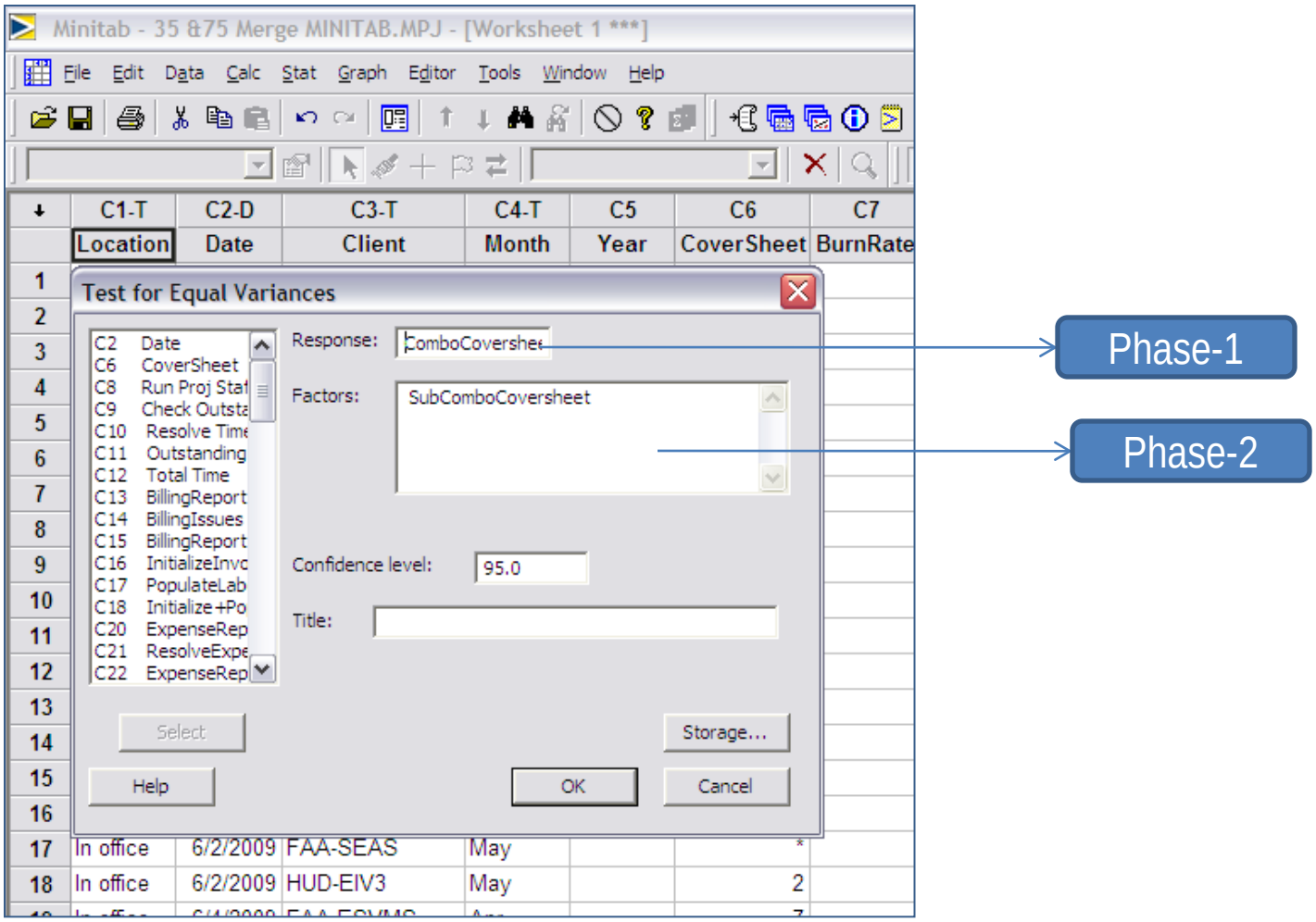
ComboCoversheet	SubComboCoversheet
2	CoverSheet Phase_2
2	CoverSheet Phase_2
*	CoverSheet Phase_2
2	CoverSheet Phase_2
2	CoverSheet Phase_2
2	CoverSheet Phase_2
2	CoverSheet Phase_2
*	CoverSheet Phase_2
5	CoverSheet Phase_2
2	CoverSheet Phase_2
1	CoverSheet Phase_2
2	CoverSheet Phase_2
2	CoverSheet Phase_2
2	CoverSheet Phase_2
7	CoverSheet Phase_2

Non-Parametric Test for Variance



Equal Variance Test

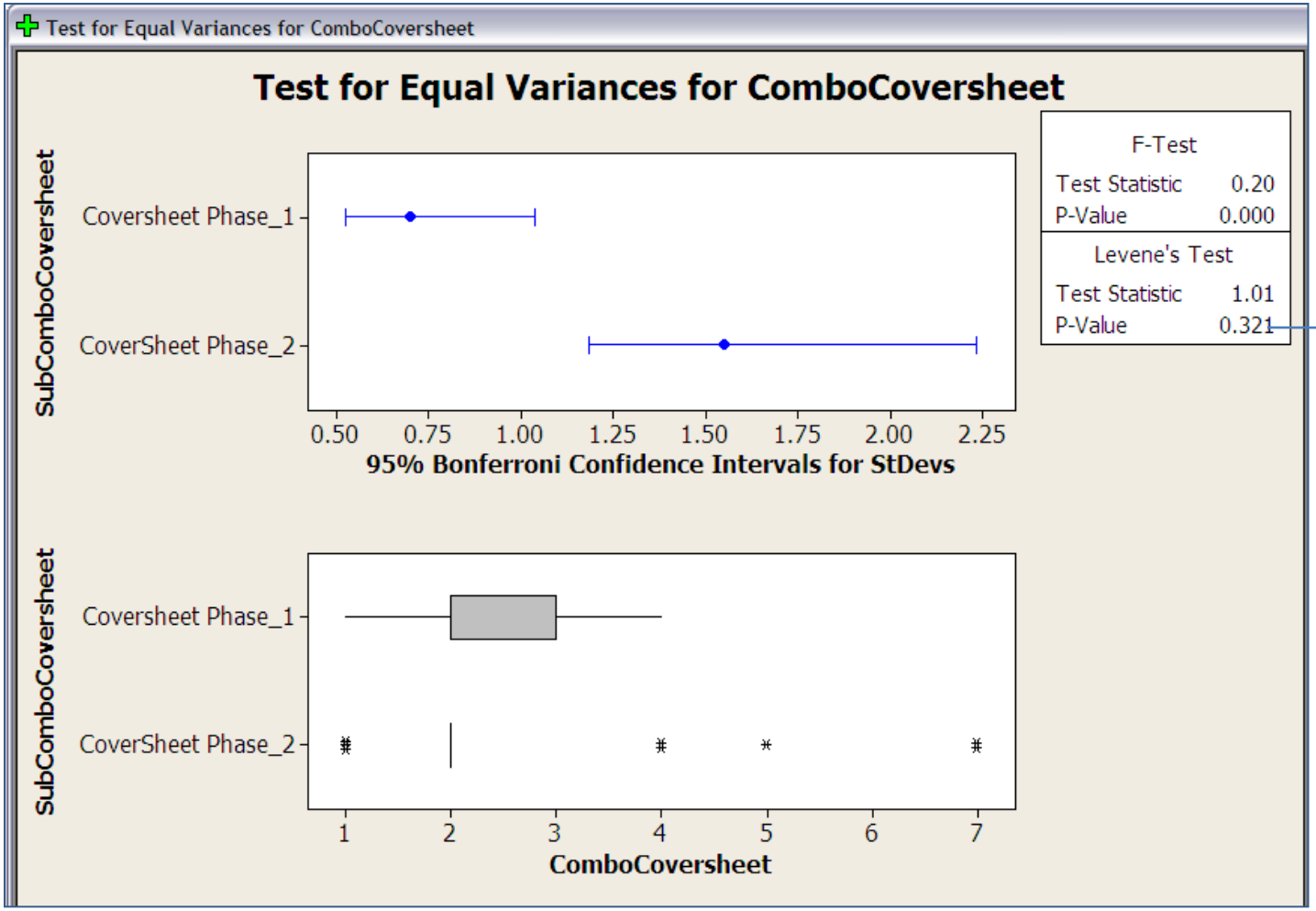
Select particular data point for Variance test



Phase-1

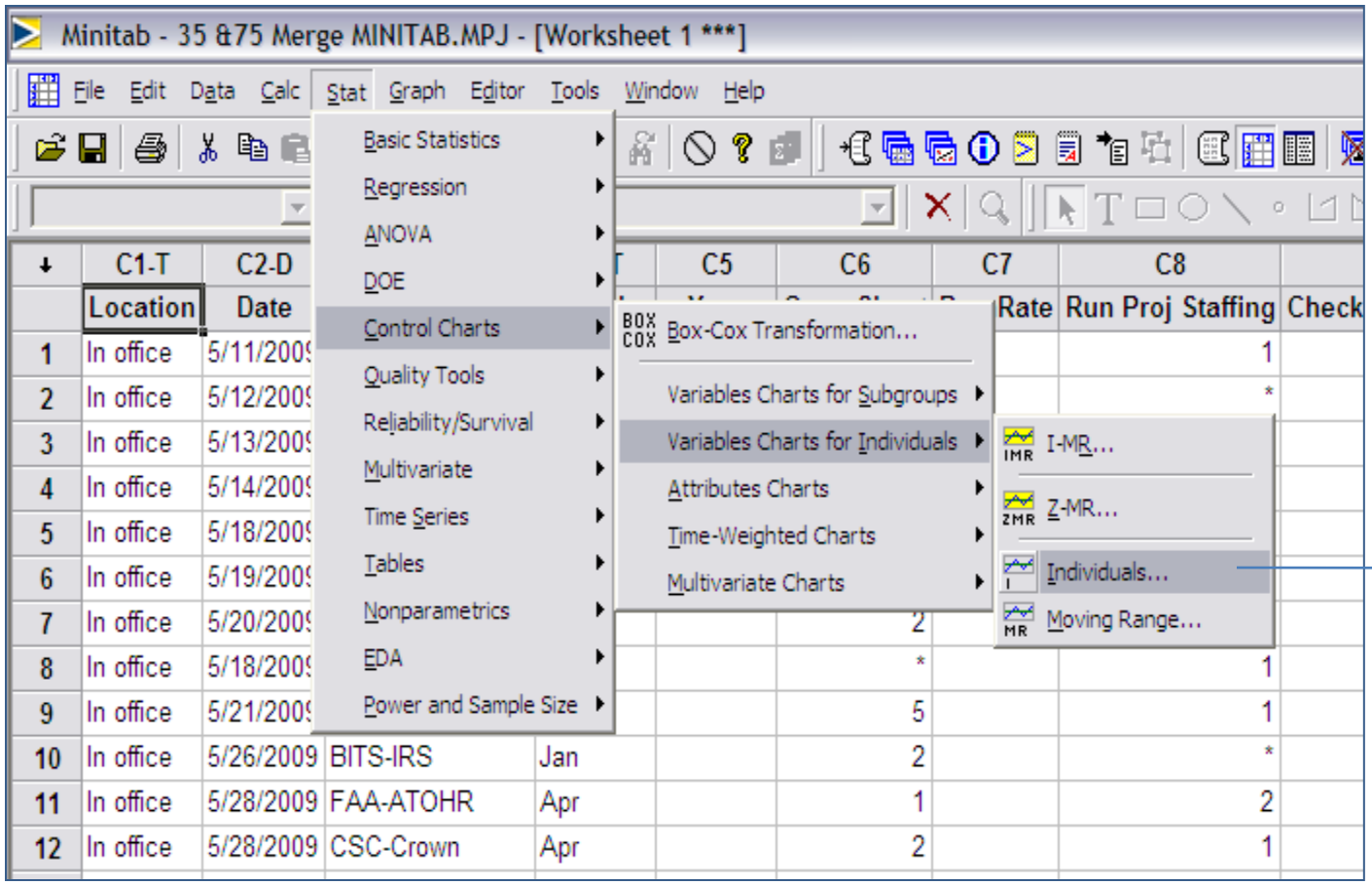
Phase-2

Result For Equal Variance

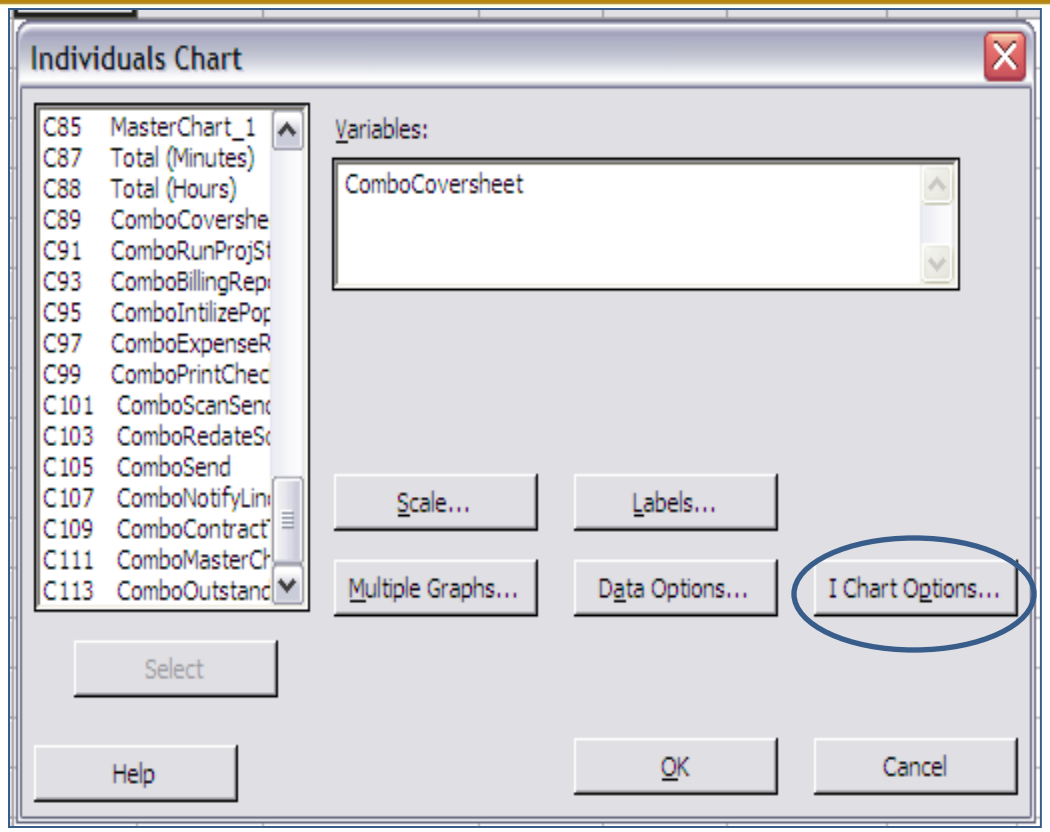


Check for P Value

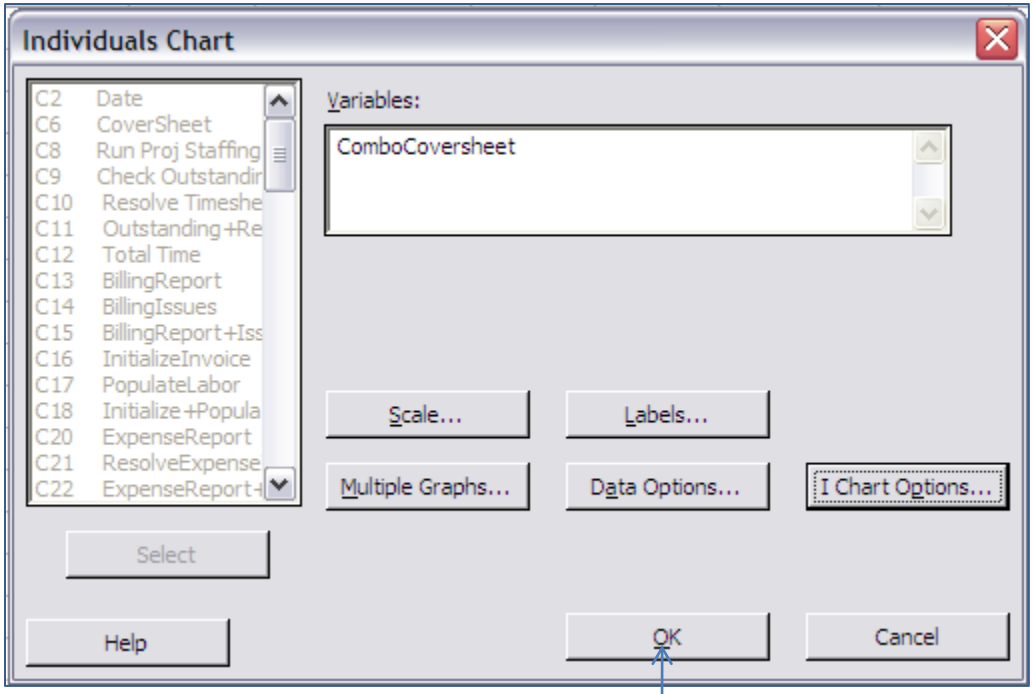
Test for Individuals Graphs

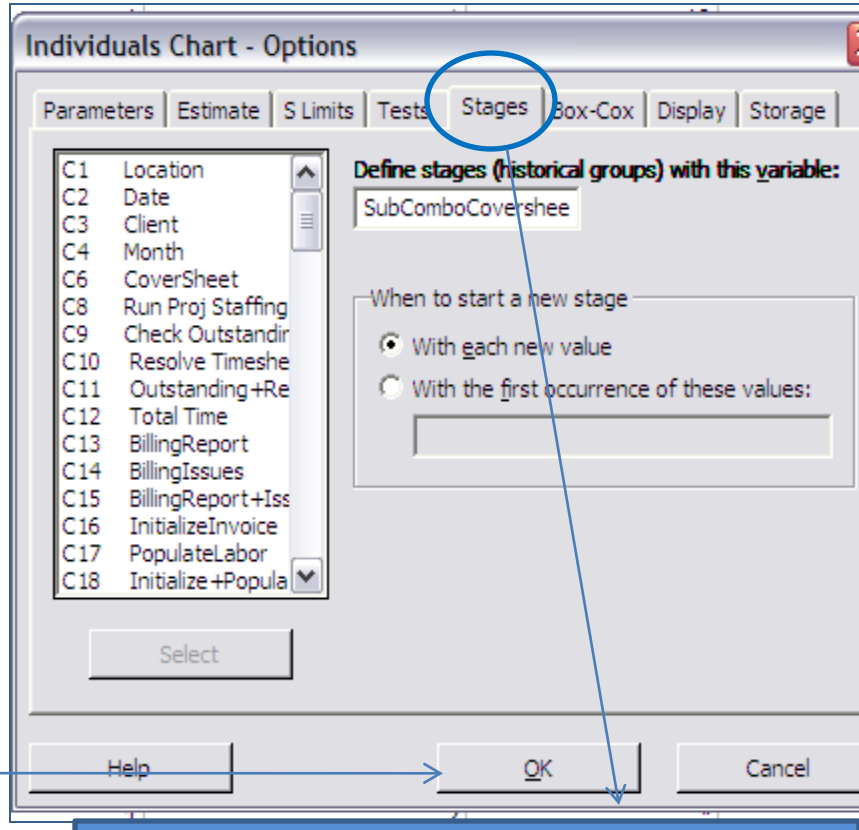


Select data point for Individual Chart



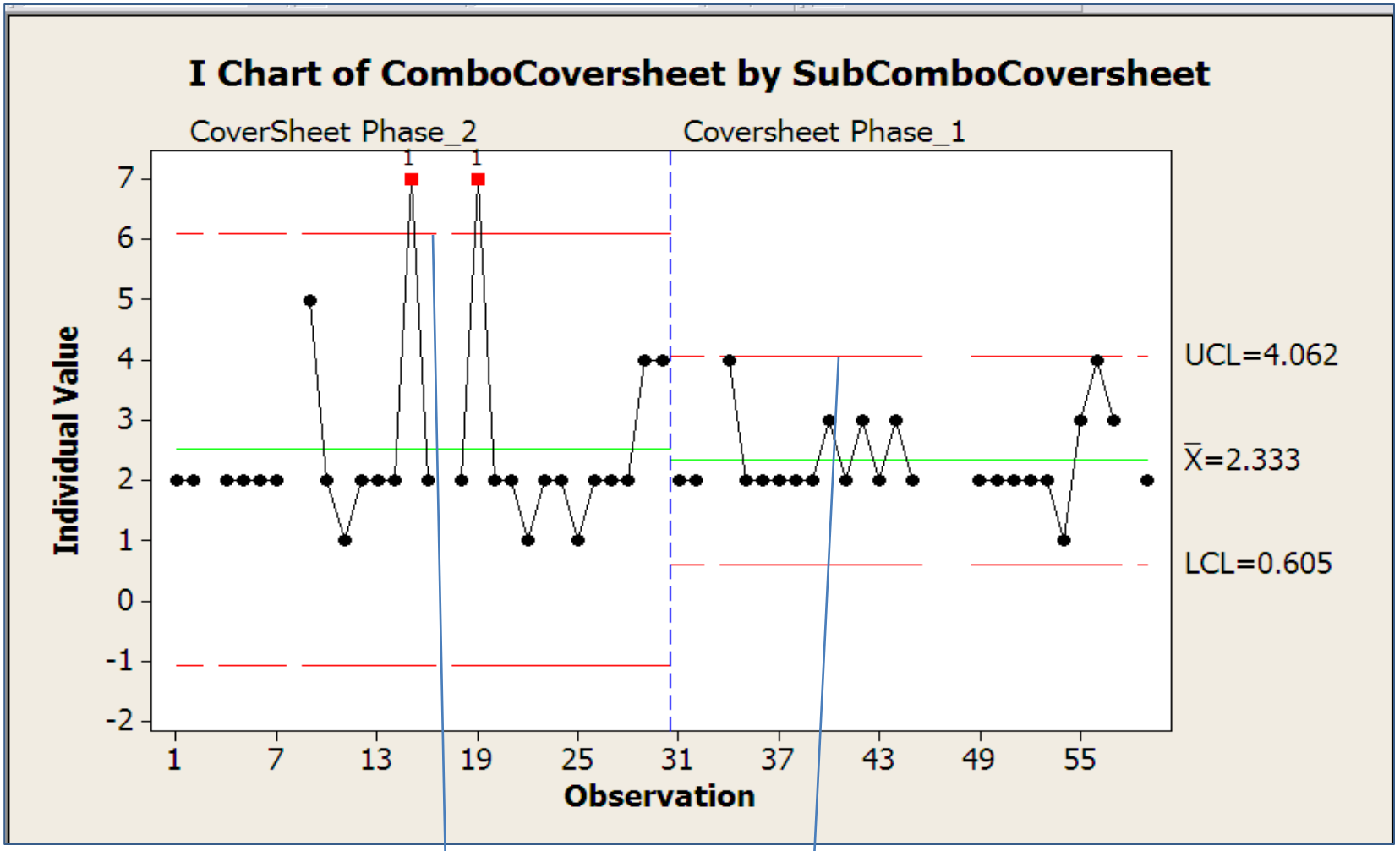
Individual chart

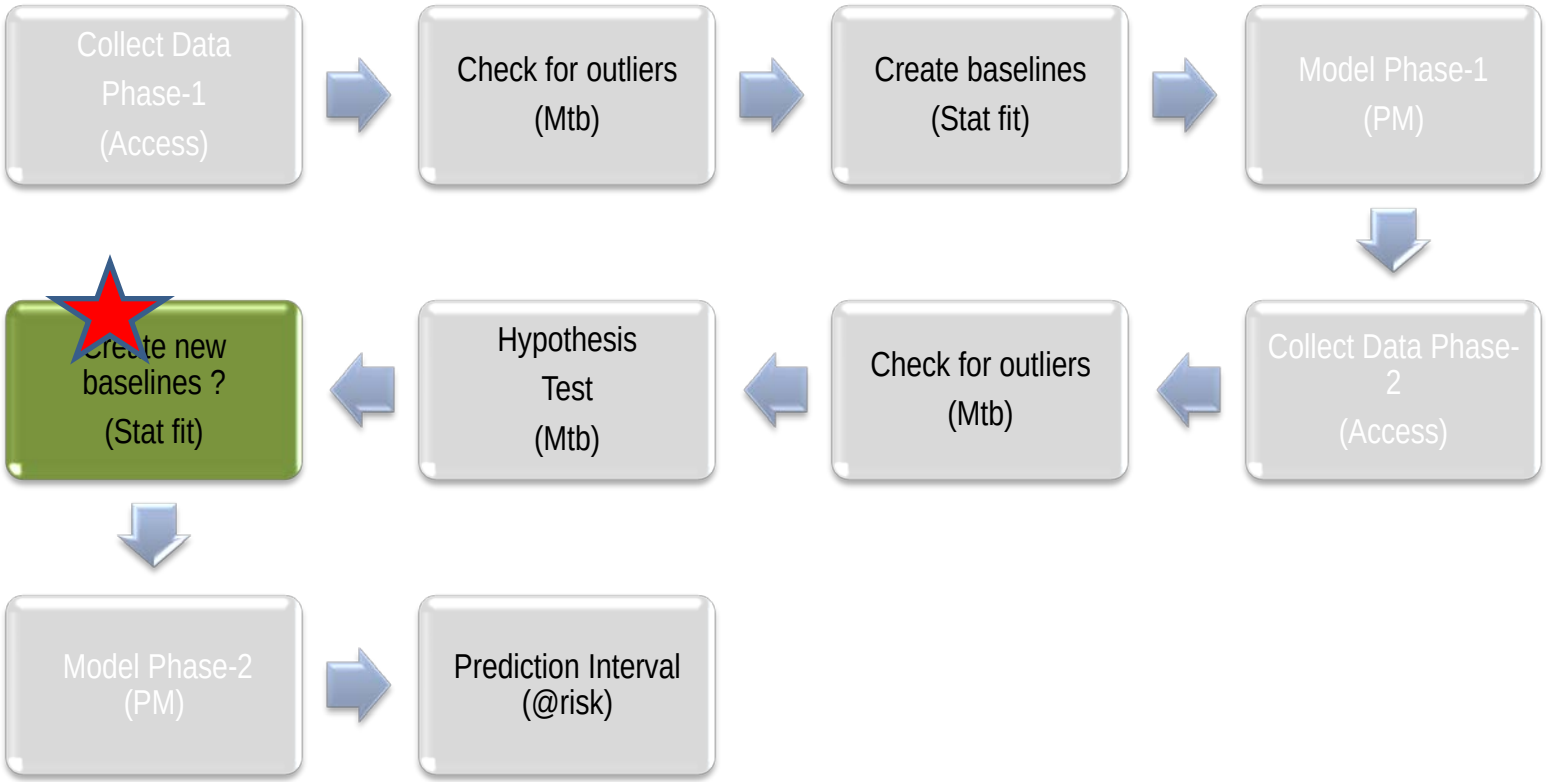




Stages gives the option to select sub stage of data point

Individual Chart



Difference between Phase-1 & Phase-2

Process Steps