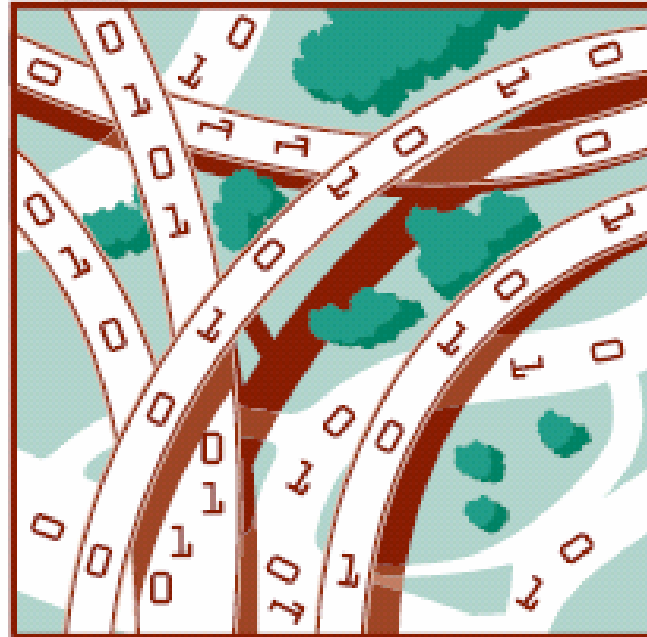# MWSUG 2008

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SIPOC and Recursive Partitioning: Powerful Tool Combination for Transactional Six Sigma Projects

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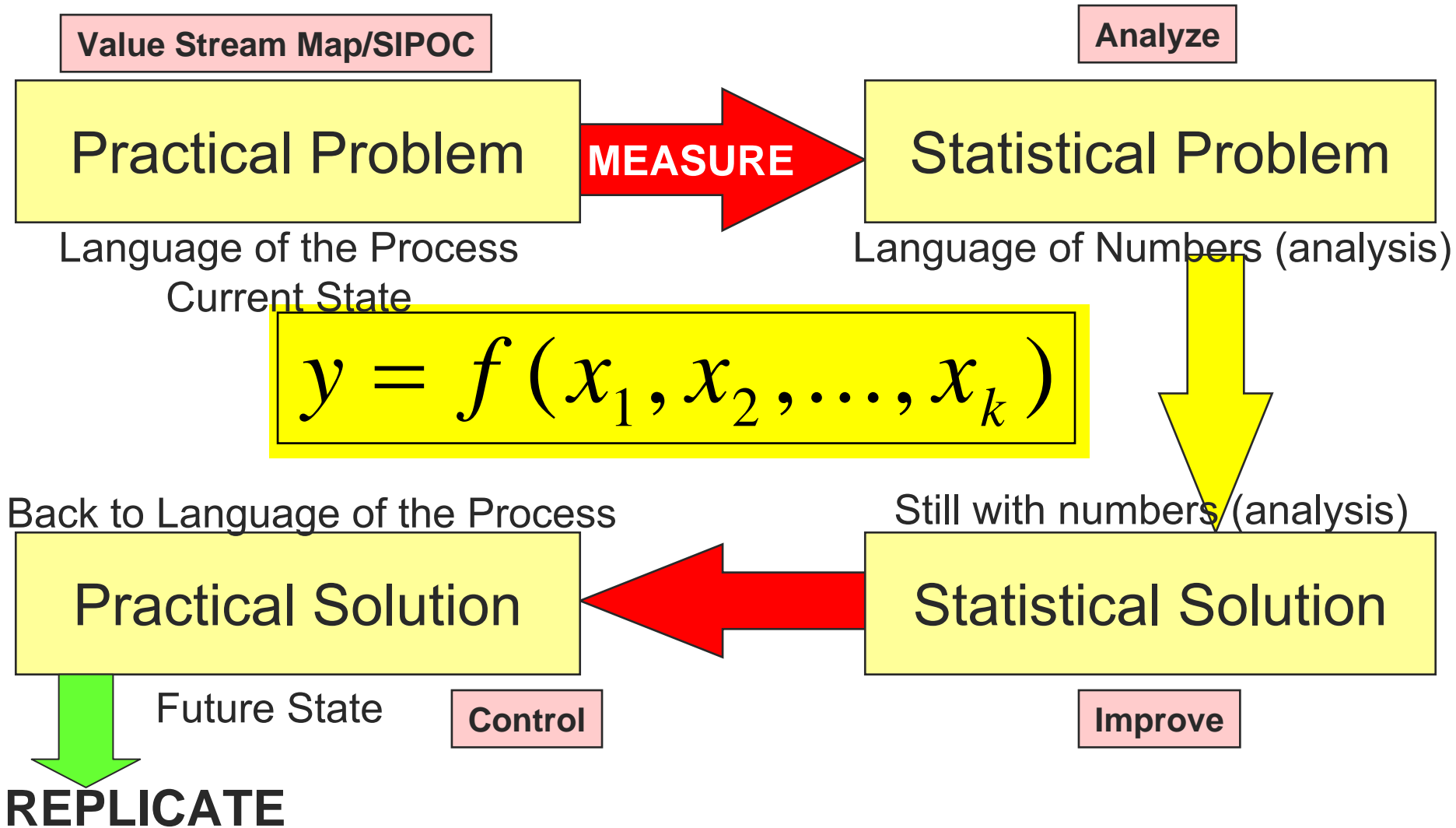# My collaborators: Three Green Belts

- Tracy Gilliam, Clinical Data Management, IND

- Isabel Fernandes, Global Logistics, GVA

- Hermann Desmeules, Finance, GVA

We would like to thank the management of the Covance Central laboratories for supporting this work and allowing us to share our results with you
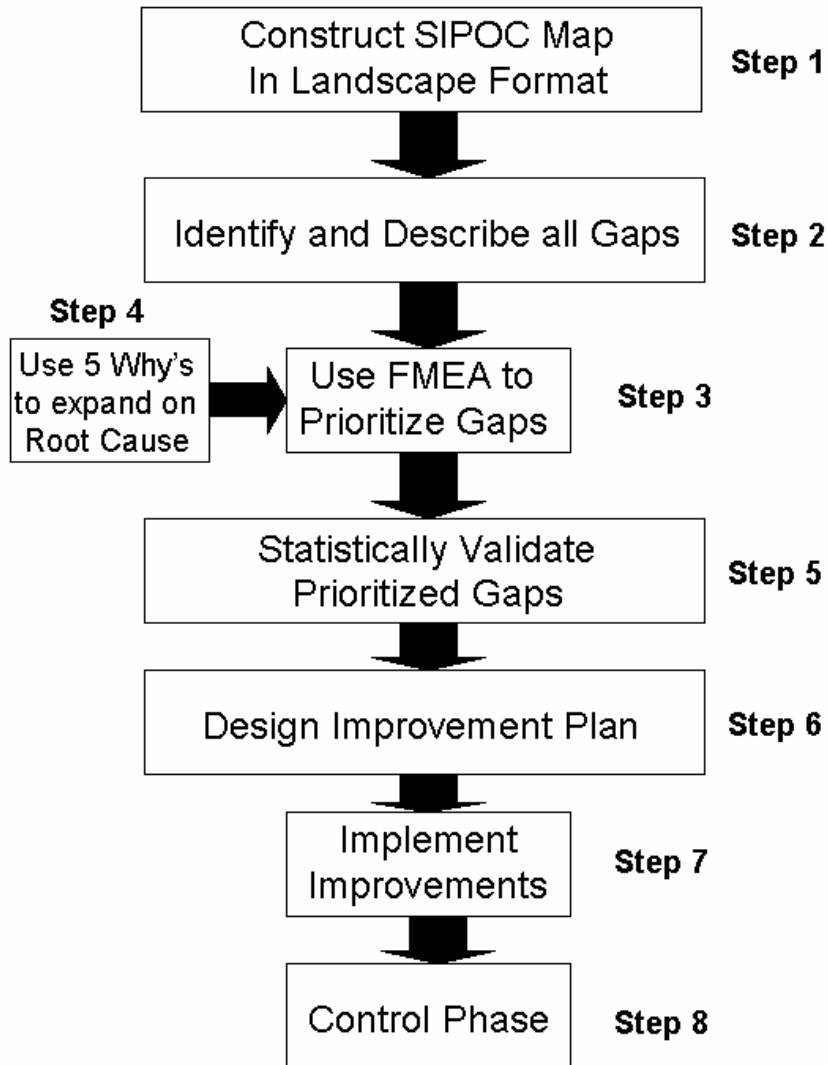
Typical Six Sigma Projects

- **Operational projects**
  - Usually seen at the factory shop floor
  - Involves machines and human beings

- **Transactional projects**
  - Usually seen in an office environment (service industries)
  - Processes are predominantly human driven

Six Sigma Strategy

Value Stream Map/SIPOC

Analyze

| Practical Problem | **MEASURE** → | Statistical Problem |

Language of the Process
Current State

Language of Numbers (analysis)

$$y = f(x_1, x_2, \ldots, x_k)$$

Back to Language of the Process

Still with numbers (analysis)

| Practical Solution | ← | Statistical Solution |

Future State   **Control**

Improve

REPLICATE

Leaning DMAIC for Transactional Process

Flowchart	Description
Construct SIPOC Map In Landscape Format — **Step 1**	
Identify and Describe all Gaps — **Step 2**	
Step 4 Use 5 Why's to expand on Root Cause → Use FMEA to Prioritize Gaps — **Step 3**	
Statistically Validate Prioritized Gaps — **Step 5**	
Design Improvement Plan — **Step 6**	
Implement Improvements — **Step 7**	
Control Phase — **Step 8**	

- In step 1 we use Value Stream maps (VSM) and SIPOC

- VSM's help identify constraints at a "high level"

- We have used SIPOC as an analysis tool to identify gaps (step 2)

- We combine SIPOC gap analysis with constraints listed from VSM analysis into the FMEA document (step 3) and combine with 5 why analysis for root cause determination (step 4)

- We then design data sampling methods to statistically validate prioritized gaps (step 5)

- Steps 6-8 follow the DMAIC roadmap listed in the previous slides

Focus of this paper is to demonstrate

- The use of VSM/SIPOC analysis in combination with

- The JMP partition platform

to address transactional DMAIC class of problems

SIPOC in the Landscape Format (step 1)

Step	1	2	3	4	5	6	7	8	9
Supplier	Sponsor	PM	Site Initiation	Site Initiation	Logistics	Logistics	Investigator Site	Supplier	Supplier
Inputs	Protocol	Email Project Load/Site Load Notification	Load site	Site Load Notification	-Data Upload to Supplier	Order forms faxed to site	Order submitted	Order confirmed via fax (and email, DHL only)	Delivery made
Requirements	-Know where and how many sites will participate in the study -Exact address of sites -Indicate if dry ice service is required	-information is complete and accurate -information is sent prior to KRD -email is working	① -information is complete and accurate -ZC is working	③ -site information is complete and accurate -dry ice requirements noted correctly -information is sent prior to KRD -email is working	⑤ -Upload tool is working -Zip code and city name is correctly spelled in ZC	⑦ -Fax number provided by site is correct and functioning	⑨ -Site is aware of order process -Site has received usabel dry ice order form -Order form site data is correct -Site has access to outside (international/local line)	⑪ -Fax (email) on file is accurate and functioning -Supplier application functioning -No modifications required	-Order registered and filled -No issues in transit
Process	Site details provided to PM	Site details provided to Site Initiation	Site Loaded in ZC	Site Loaded in EUSITEC	Account Opened	Forms Sent	Order Submitted	Order Confirmed	Dry ice Delivered
Outputs	Site specific courier and dry ice arrangements	-information is complete and accurate -information is sent prior to KRD -email is working	Site is loaded in ZC	Site loaded in EUSITEC	-Account open for site	Site receives order forms	Order registered	Confirmation received	Delivery received
Requirements	Information received is complete and accurate, up to date		② -information is complete and accurate -ZC is working	④ -EUSITEC is working -information received is complete and accurate -no backlog	⑥ -Upload tool is working -Zip code and city name is correctly spelled	⑧ -Site's fax is working properly -Fax is legible -Form not misplaced	⑩ -Valid order received (site account active, order time respected, form not manually modified, form complete) -Legible order received -Supplier applications working -Supplier fax working	⑫ -Site's fax is working properly -Fax is legible -Form not misplaced	-Site available to receive goods -Delivery address indicated on order corresponds to delivery
Customer	Sales/PM	Site Initiation	ZC	Logistics	Supplier	Investigator Site	Supplier	Investigator Site	Investigator Site

Gap Analysis: An example (step 2)

Supplier	Site Initiation	Logistics
Inputs	Site Load Notification	-Data Upload to Supplier
Requirements	③ -site information is complete and accurate -dry ice requirements noted correctly -information is sent prior to KRD -email is working	⑤ -Upload tool is working -Zip code and city name is correctly spelled in ZC
Process	Site Loaded in EUSITEC → Account Opened	
Outputs	Site loaded in EUSITEC	-Account open for site
Requirements	④ -EUSITEC is working -information received is complete and accurate -no backlog	⑥ -Upload tool is working -Zip code and city name is correctly spelled
Customer	Logistics	Supplier

GAP 4

Gap on the output : -Site not loaded in EUSITEC, but loaded in ZC

GAP 5

Gap on the input : Zip code and/or city are incorrectly entered (manual entry). -Information received from the Sponsor is incomplete and the principle investigator address is not the same as the one to be used for dry ice and kit deliveries.

Gap Analysis: An example (step 2)

Supplier	Investigator Site
Inputs	Order submitted
	⑨
Requirements	-Site is aware of order process -Site has received usabel dry ice order form -Order form site data is correct -Site has access to outside (international/local line)
Process	Order Submitted
Outputs	Order registered
	⑩
Requirements	-Valid order received (site account active, order time respected, form not manually modified, form complete) -Legible order received -Supplier applications working -Supplier fax working
Customer	Supplier

GAP 9

Gap on the input : -Dry ice recipient is not aware of dry ice process and/or the dry ice order form is incomplete or incorrectly filled in.
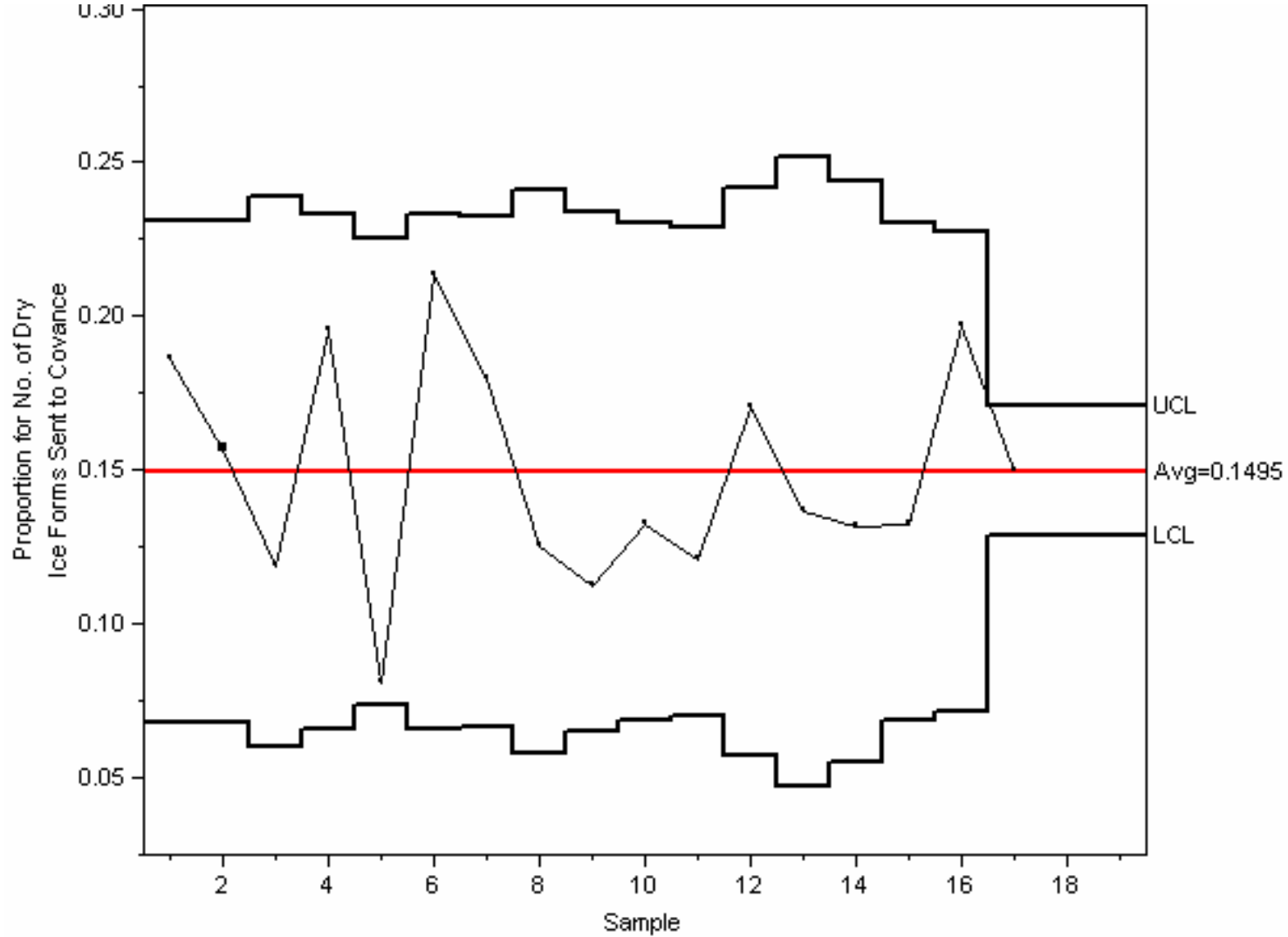
GAP 10

Gap on the output : As per instructions from Covance, Supplier does not process order due to incomplete or invalid order received from the site.

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FMEA document (steps 3 and 4)

FMEA_5 whys

Base Line Data`

Data sampling: Sample Tracers

| Date	Gap 2	Gap 3	Gap 4	Gap 5	Gap 6	Gap 8	Gap 9	Gap 10	Dry Ice Formed Sent to Covance (Yes/No)
5/19/2008	n	n	n	n	n	y	y	y	y
5/19/2008	n	n	n	y	y	n	n	n	y
5/19/2008	n	n	n	n	n	n	y	y	y
5/19/2008	n	n	n	y	y	n	n	n	y
5/19/2008	n	n	n	y	y	n	y	y	y
5/19/2008	n	n	n	y	y	n	y	y	y
5/19/2008	n	n	n	n	n	n	y	y	y
5/19/2008	n	n	n	n	y	n	y	y	y
5/19/2008	n	n	n	n	y	n	y	y	y
5/19/2008	n	n	n	n	y	n	y	y	y
5/19/2008	n	n	n	n	y	n	n	y	y
5/19/2008	n	n	n	n	n	n	n	y	y
5/19/2008	n	n	n	n	n	n	n	y	y
5/19/2008	n	n	n	n	n	n	n	y	y
5/19/2008	n	n	n	n	n	n	y	y	y
5/19/2008	n	n	n	n	n	n	n	n	n
5/19/2008	n	n	n	n	n	n	n	n	n
5/19/2008	n	n	n	n	n	n	n	n	n
5/19/2008	n	n	n	n	n	n	n	n	n
5/19/2008	n	n	n	n	n	n	n	n	n
5/19/2008	n	n	n	n	n	n	y	n	n
5/19/2008	n	n	n	n	n	n	y	n	n
5/19/2008	n	n	n	n	n	n	y	n	n
5/19/2008	n	n	n	n	n	n	y	n	n
5/19/2008	n	n	n	n	n	n	y	n	n
5/19/2008	n	n	n	n	n	n	y	n	n
5/19/2008	n	n	n	n	n	n	y	n	n

Data Mining with the JMP Partition Platform

- It is a data mining tool which has the capability to

  - to explore complex relations between a dependent variable (which can be continuous or discrete) and a host of X's which are independent variables (can be discrete or continuous)

- It is a powerful exploratory tool to establish complex relations (prior to modeling/like Regression)

- How does it work?

  - It cuts the data into groupings of X's which can best predict Y
    - If Y is a continuous variable, **RP splits the data into two homogenous** groups where the groups are characterized **based by a "mean" value** and Standard deviation
      - Statistics (sums of squares-like in ANOVA) is used to judge if splits are statistically significant
    - If Y is a discrete variable, then **RP splits the data into two homogenous groups based on the probability** of an event (pass or fail, go or no go, good or bad) occurring.
      - Statistics (based on Chi-Square) is used to judge if splits are statistically significant

Recursive partitioning (RP) tool

- Some Characteristics and advantages of the RP tool
  - Results are easy to interpret
  - It is a non-parametric tool
  - It handles large data sets with ease
  - It handles missing data very efficiently
  - Like Multiple Regression provides prediction formulas for response
  - RP analysis handles complex non-linear relations with higher-order interactions
  - RP analysis has made significant inroads in analyzing large data sets in Medicine (tumor classification, Mammograms etc), Ecology (saving the oak tree from the Gypsy moth), predicting corporate takeovers, predicting bankruptcy, in child protective services, approval of bank loans, predicting the effect of Ultra Violet Radiation and many more applications

Gap Analysis with RP
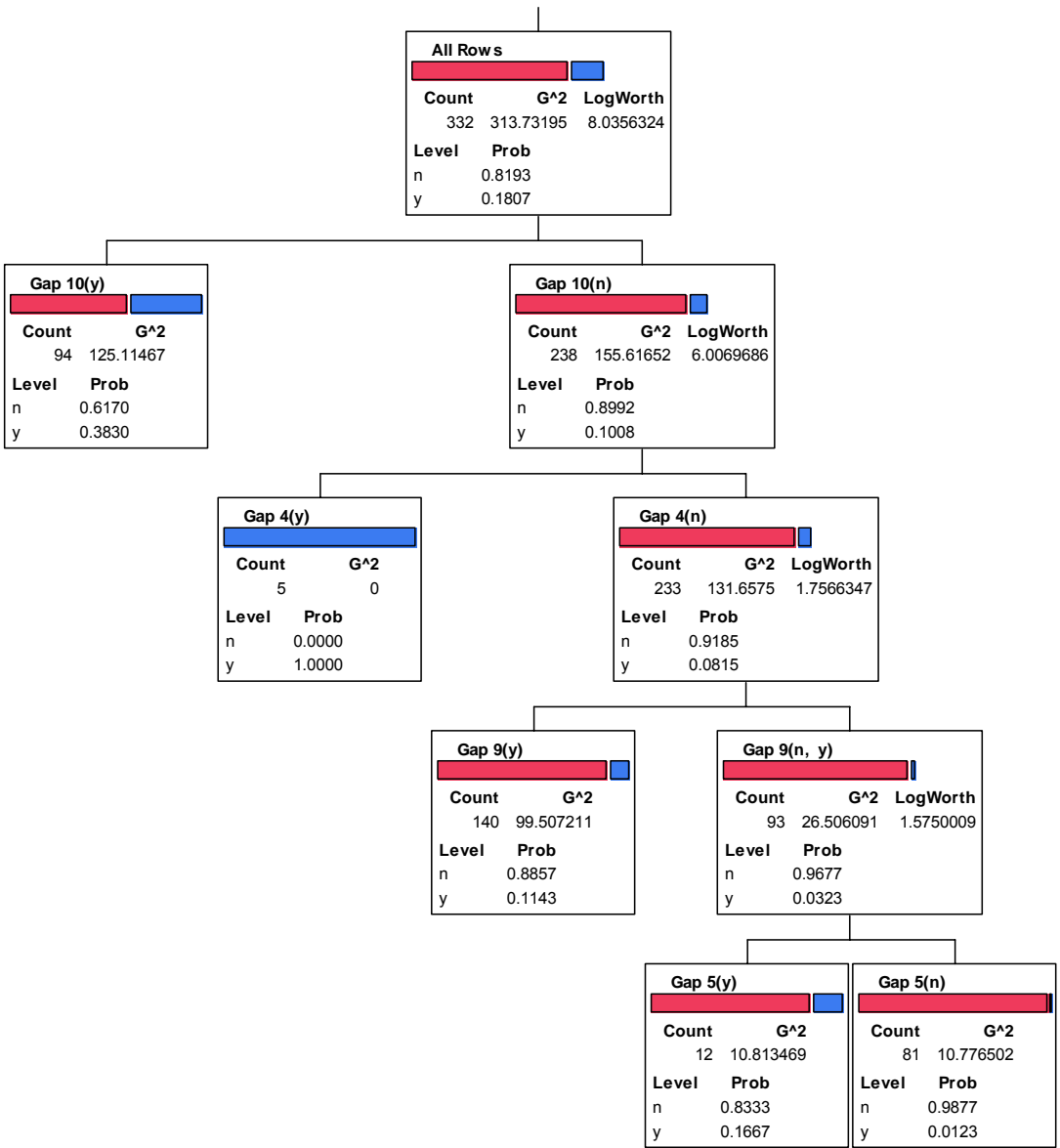
RP Analysis for Gaps

Leaf Report

Response Prob

Leaf Label	n			y		
Gap 10(n)&Gap 4(y)	0.0000			1.0000		
Gap 10(y)	0.6170			0.3830		
Gap 10(n)&Gap 4(n)&Gap 9(n, y)&Gap 5(y)	0.8333			0.1667		
Gap 10(n)&Gap 4(n)&Gap 9(y)	0.8857			0.1143		
Gap 10(n)&Gap 4(n)&Gap 9(n, y)&Gap 5(n)	0.9877			0.0123		

Response Counts

Leaf Label	n			y		
Gap 10(y)	58			36		
Gap 10(n)&Gap 4(y)	0			5		
Gap 10(n)&Gap 4(n)&Gap 9(y)	124			16		
Gap 10(n)&Gap 4(n)&Gap 9(n, y)&Gap 5(y)	10			2		
Gap 10(n)&Gap 4(n)&Gap 9(n, y)&Gap 5(n)	80			1		

Column Contributions

Term	Number of Splits	G^2	
Total	4	67.5201001	
Gap 10	1	33.0007592	
Gap 4	1	23.9590187	
Gap 9	1	5.64420144	
Gap 5	1	4.91612081	
Gap 2	0	0	
Gap 3	0	0	
Gap 6	0	0	
Gap 8	0	0	

Conclusions from this study

- In this study, 5 why analysis was carried out to brainstorm the root causes for Gaps 10, 4, 9 and 5

- Improvement actions were designed to overcome these gaps

- The rest of the project followed the DMAIC sequence for project closure

  - Statistical validation of the future state (two proportion test)

  - Power of the test

  - Process stability (p-chart)

  - Control plan

  - Document financial benefits

  - Project closure