



# Tutorial: Homework Assignment Week 2

## Purposes:

- Use Excel
- Create Control Charts for Various Data Types
- Create Control Charts on your “Own” QI Project Data

Note: The u chart is currently unavailable – use c chart in place of u chart.



# Contents of Data

The data in the “.xlsx” files contain the following information:

File 1 – The number of pneumonia patients per week

File 2 – The number of non-deaths between deaths

File 3 – Red Bead Game: The number of red beads drawn (sample size = 100 -- See lecture on “Understanding Variation”) – 500 Draw

File 4 – Length of stay by delivery type (C-Section or Vaginal)

File 5 – Breast cancer screening



# Data Types

## Attribute (Categorical) Data:

- Nominal: Named Categories
- Binary: Exactly Two Categories
- Ordinal: Ordered or Ranked Categories

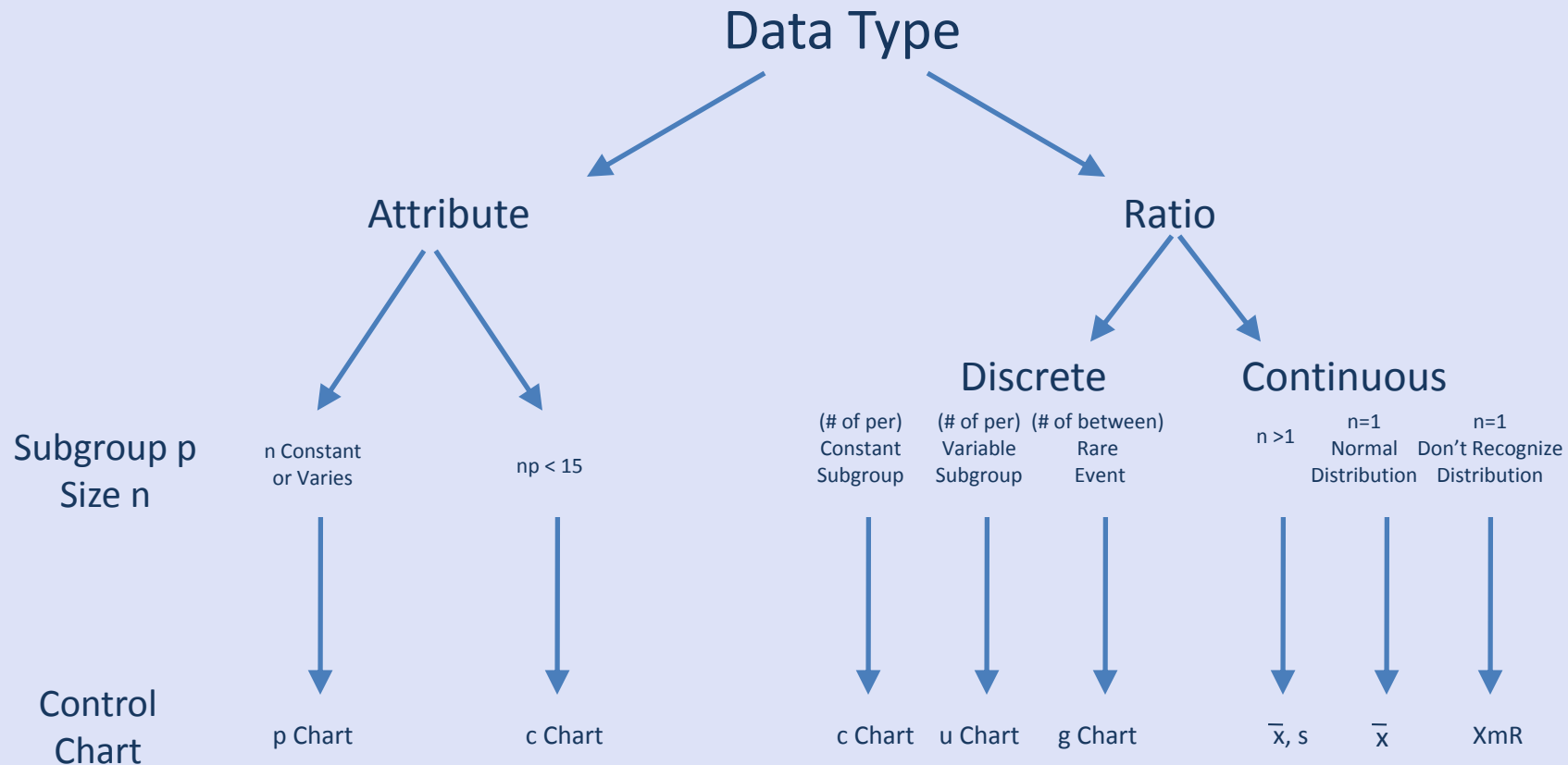
## Numeric Data

- Interval: No Fixed Zero Point, Cannot Form Ratios
- Ratio: Numbers that Can Form Ratios
- Continuous – Meaningful at Any Numeric Value
- Discrete – Meaningful only at Discrete Values

\*\*Using this information, determine the data type for each file.  
The type of control chart that will be used is based on data type.



# Choosing an SPC Chart (Decision Tree)



Additional information can be found in *Measuring Quality Improvement in Health Care* (Carey & Lloyd, pg. 72)



# Create Table for Control Chart

- Select and open one of the five data files. If necessary, re-load SPC Macro (see Tutorial 1)
- Based on data type, select appropriate control chart option
- Highlight the data and find desired control chart option under “SPC Macro”

file1New.xls [Compatibility Mode] - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Add-Ins

SPC Macros

- Identify Distribution
- p Chart (Binomial Distribution)
- c Chart (Poisson Distribution)**
- g Chart (Geometric Distribution)
- XmR/Individuals Chart
- X-bar S Chart
- X-bar Chart
- About SPC Macros

For Example:

file1.xlsx contains

“Number of Pneumonia Patients/Week”

- # of per
- Ratio discrete, variable subgroup

This corresponds to a “c” chart

	C	D	E	F	G	H	I	J	K	L
6	8/4/2009									
7	8/11/2009									
8	8/18/2009									
9	8/25/2009									
10	9/1/2009									
11	9/8/2009									
12	9/15/2009									
13	9/22/2009									
14	9/29/2009									
15	10/6/2009									
16	10/13/2009									
17	10/20/2009									
18	10/27/2009									
19	11/3/2009									
20	11/10/2009									
21	11/17/2009									
22	11/24/2009									



# Complete Fields to Generate Table

Complete the fields and select OK to generate the table (enter the significance level,  $\alpha$ , as desired, .01 or .05)

**c Chart**

Input Data  
Select (highlight) the number of non-conformities range:

Check if the first row contains labels

c-bar  
 Empiric (Calculate c-bar from data)  
If desired, select (highlight) the outliers range:   
 A Priori ("Standards Given") c-bar =

Significance Level  
Enter the desired significance level:  $\alpha =$

Group #	c	c-bar	LCL	UCL	Outlier ?
1	5	7.70	1.0777	15.2524	
2	10	7.70	1.0777	15.2524	
3	13	7.70	1.0777	15.2524	
4	8	7.70	1.0777	15.2524	
5	10	7.70	1.0777	15.2524	
6	10	7.70	1.0777	15.2524	
7	5	7.70	1.0777	15.2524	
8	2	7.70	1.0777	15.2524	
9	9	7.70	1.0777	15.2524	
10	4	7.70	1.0777	15.2524	
11	2	7.70	1.0777	15.2524	
12	3	7.70	1.0777	15.2524	
13	13	7.70	1.0777	15.2524	
14	11	7.70	1.0777	15.2524	
15	11	7.70	1.0777	15.2524	
16	8	7.70	1.0777	15.2524	
17	14	7.70	1.0777	15.2524	
18	9	7.70	1.0777	15.2524	
19	11	7.70	1.0777	15.2524	
20	9	7.70	1.0777	15.2524	
21	12	7.70	1.0777	15.2524	
22	12	7.70	1.0777	15.2524	
23	5	7.70	1.0777	15.2524	



# Create Control Chart

Select variables to be graphed on control chart:

- $c$  = count
- $\bar{c}$  = average count
- LCL = lower confidence limit
- UCL = upper confidence limit

Hint: Select cell B6 and while holding left mouse key, move cursor to E6 and release left mouse key. Use hint from tutorial 1 (shift + ctrl + down arrow key) to select and move to the bottom of the data range.

After highlighting the data, select the insert tab, then “line,” and “line with markers” to create the chart

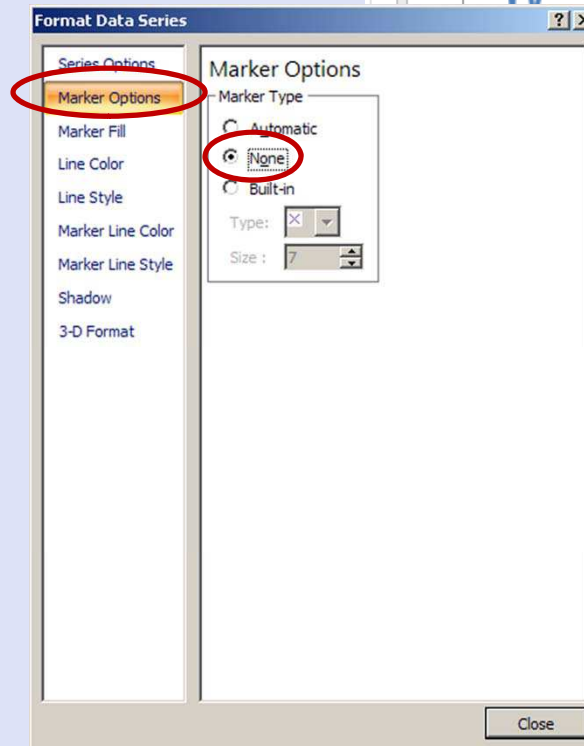
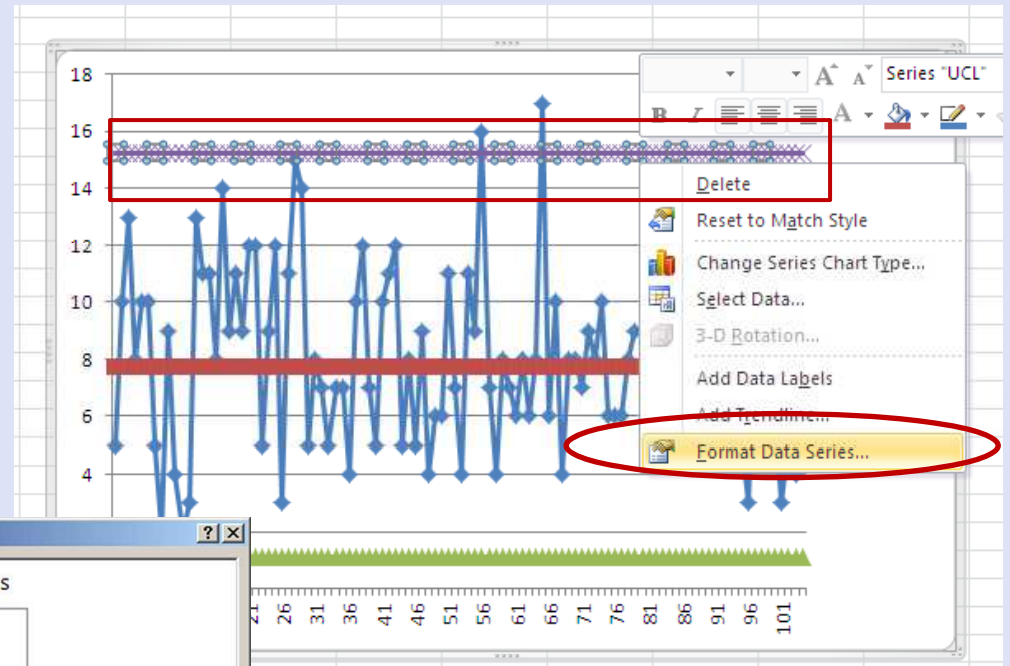
The screenshot shows the Excel 2010 interface with the 'Insert' tab selected. The 'Line' chart type is chosen, and the 'Line with markers' option is highlighted. The spreadsheet data is as follows:

Group #	c	c-bar	LCL	UCL	Outlier ?
1	5	7.70	1.0777	15.2524	
2	10	7.70	1.0777	15.2524	
3	13	7.70	1.0777	15.2524	
4	8	7.70	1.0777	15.2524	
5	10	7.70	1.0777	15.2524	
6	10	7.70	1.0777	15.2524	
7	5	7.70	1.0777	15.2524	
8	2	7.70	1.0777	15.2524	
9	9	7.70	1.0777	15.2524	
10	4	7.70	1.0777	15.2524	
11	2	7.70	1.0777	15.2524	
12	3	7.70	1.0777	15.2524	
13	13	7.70	1.0777	15.2524	
14	11	7.70	1.0777	15.2524	
15	11	7.70	1.0777	15.2524	
16	8	7.70	1.0777	15.2524	
17	14	7.70	1.0777	15.2524	



# Edit Control Chart Format

- A dotted red line without markers is a convention that is widely used for the LCL and UCL. To change the lines, first right click on the purple line and select “Format Data Series”
- Select the “Marker Options” tab, and choose the “None” radio button

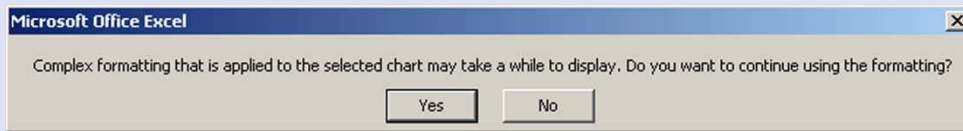




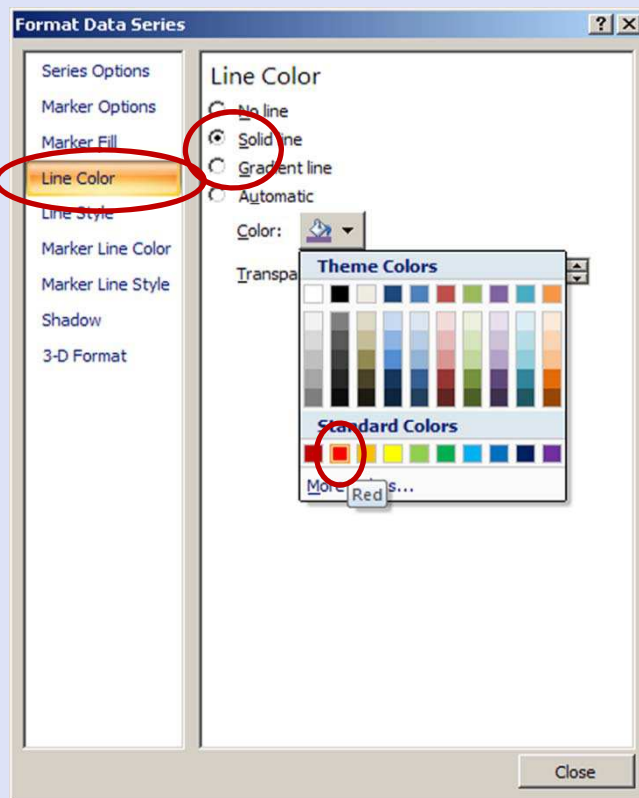


# Edit Control Chart Format (cont'd)

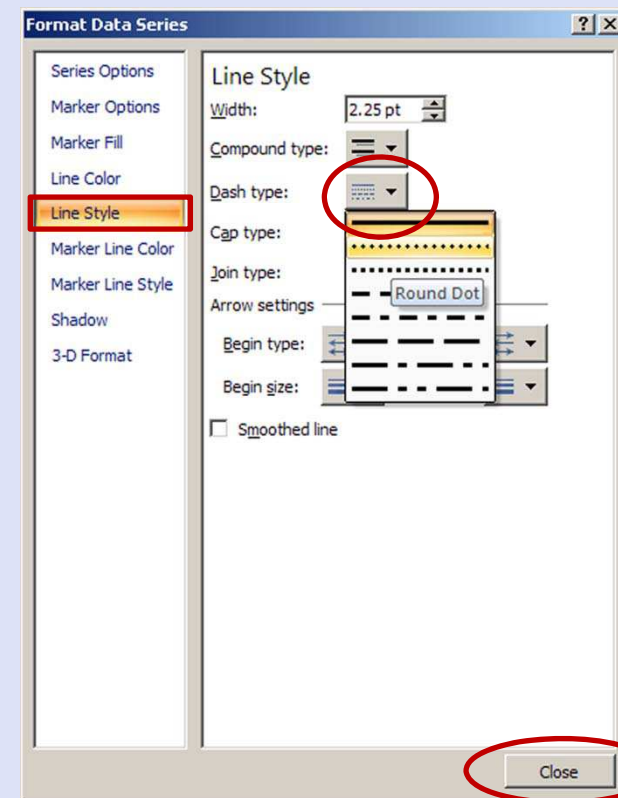
- Now select the “Line Color” tab. Choose the “Solid line” radio button
- A message like this may pop up. Press yes



- Press the “Color:” button, and choose red



- Finally, select the “Line Style” tab. Press the “Dash type:” button, and choose the round dots
- Press the “Close” button and the line on your graph will be updated

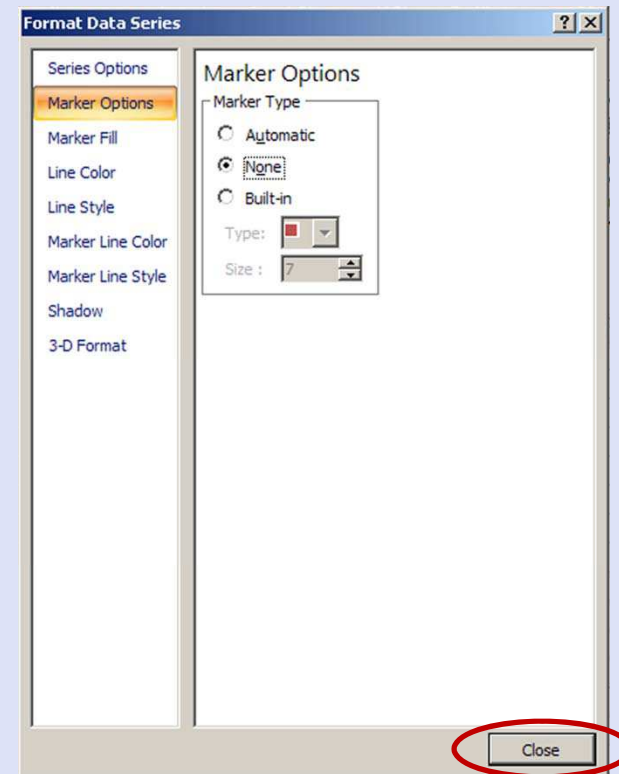
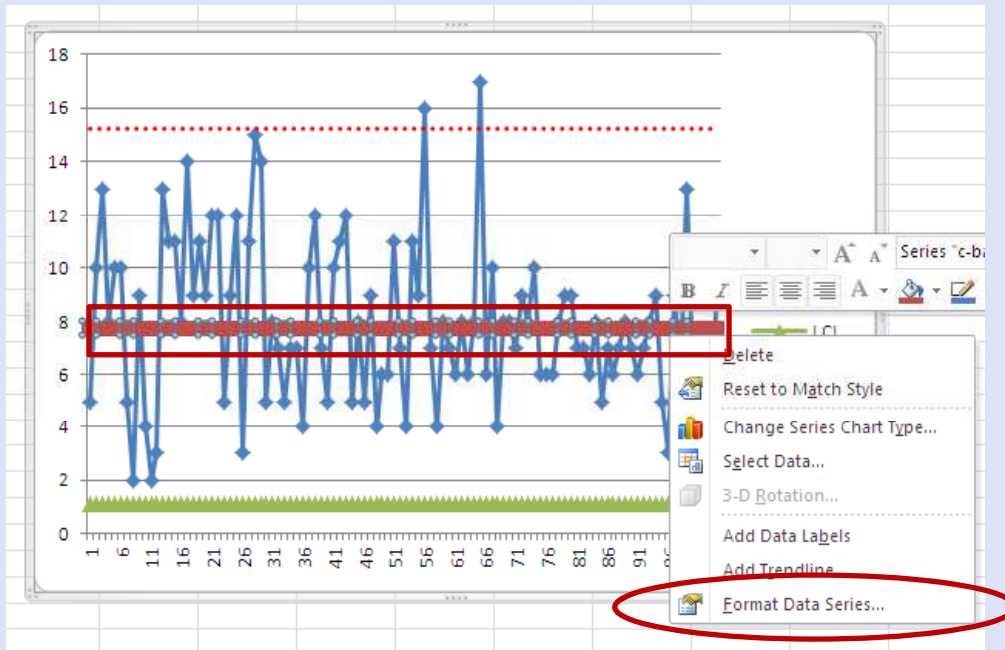




# Edit Control Chart Format (cont'd)

- To remove the markers from “p-bar,” right click on the blue line and select “Format Data Series...”

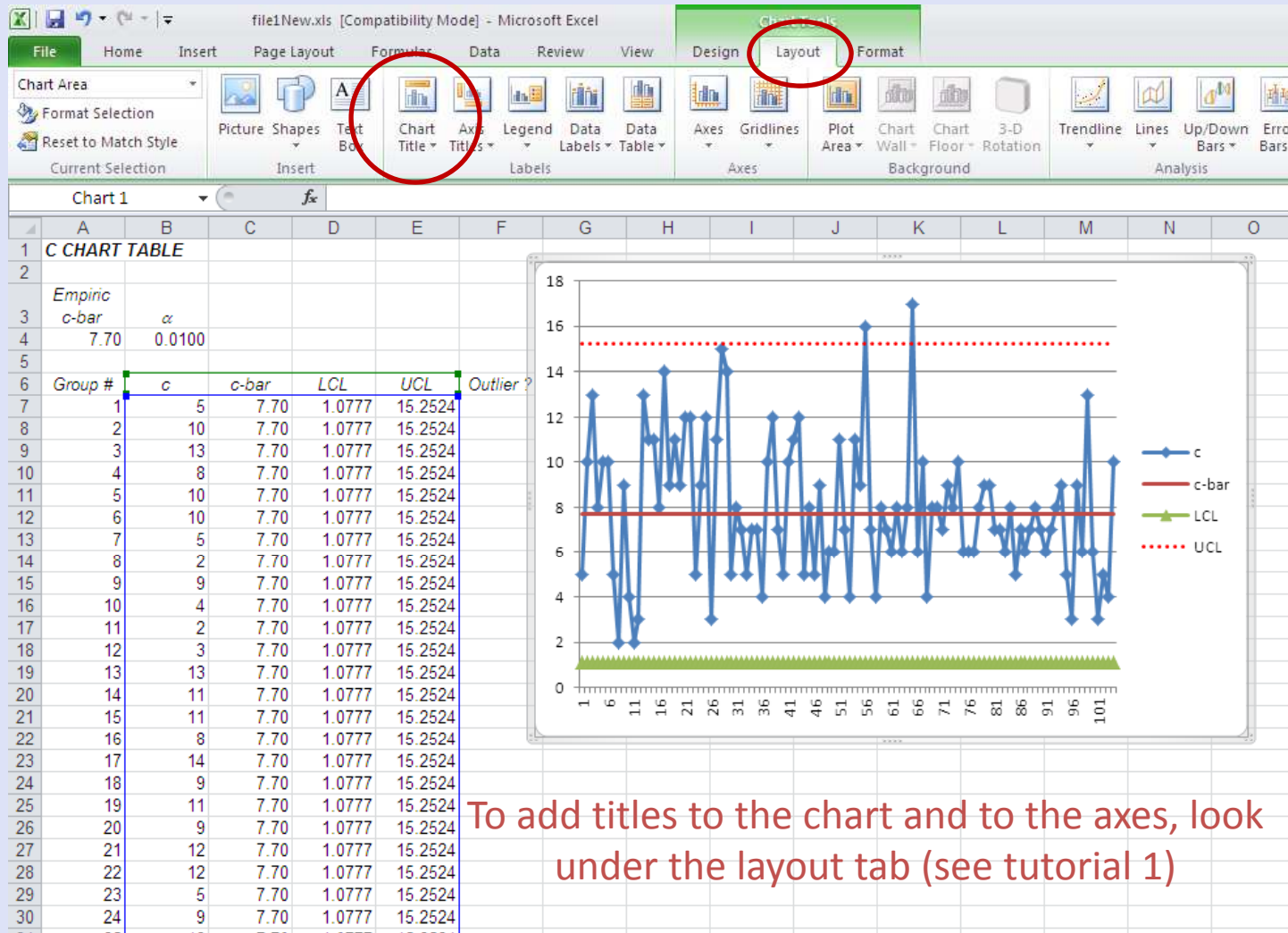
- Select the “Marker Options” tab, and choose the “None” radio button
- Press the “Close” button to update the graph



- Follow the steps on pages 8 and 9 to change the LCL to a dotted red line



# Label and Finish Chart



To add titles to the chart and to the axes, look under the layout tab (see tutorial 1)

\*\*Repeat pages 5-11 for all five data files. File 3 requires additional steps that are explained in the pages that follow.



# Additional Steps for file3 – Red Bead Game.xls

Select the data in column B (ctrl + shift + down arrow key), then select the appropriate control chart option (p chart)

- After clicking in the field “Select the sample size range:” select the data in column C (highlight a few boxes by dragging your mouse cursor down the column, then press ctrl + shift + down key to move to the bottom of the data.

- Fill in the rest of the data (significance level) and select OK to create the table

The screenshot shows the Excel 2010 interface with the 'SPC Macros' menu open. The 'p Chart (Binomial Distribution)' option is selected. The 'p Chart' dialog box is open, showing the following settings:

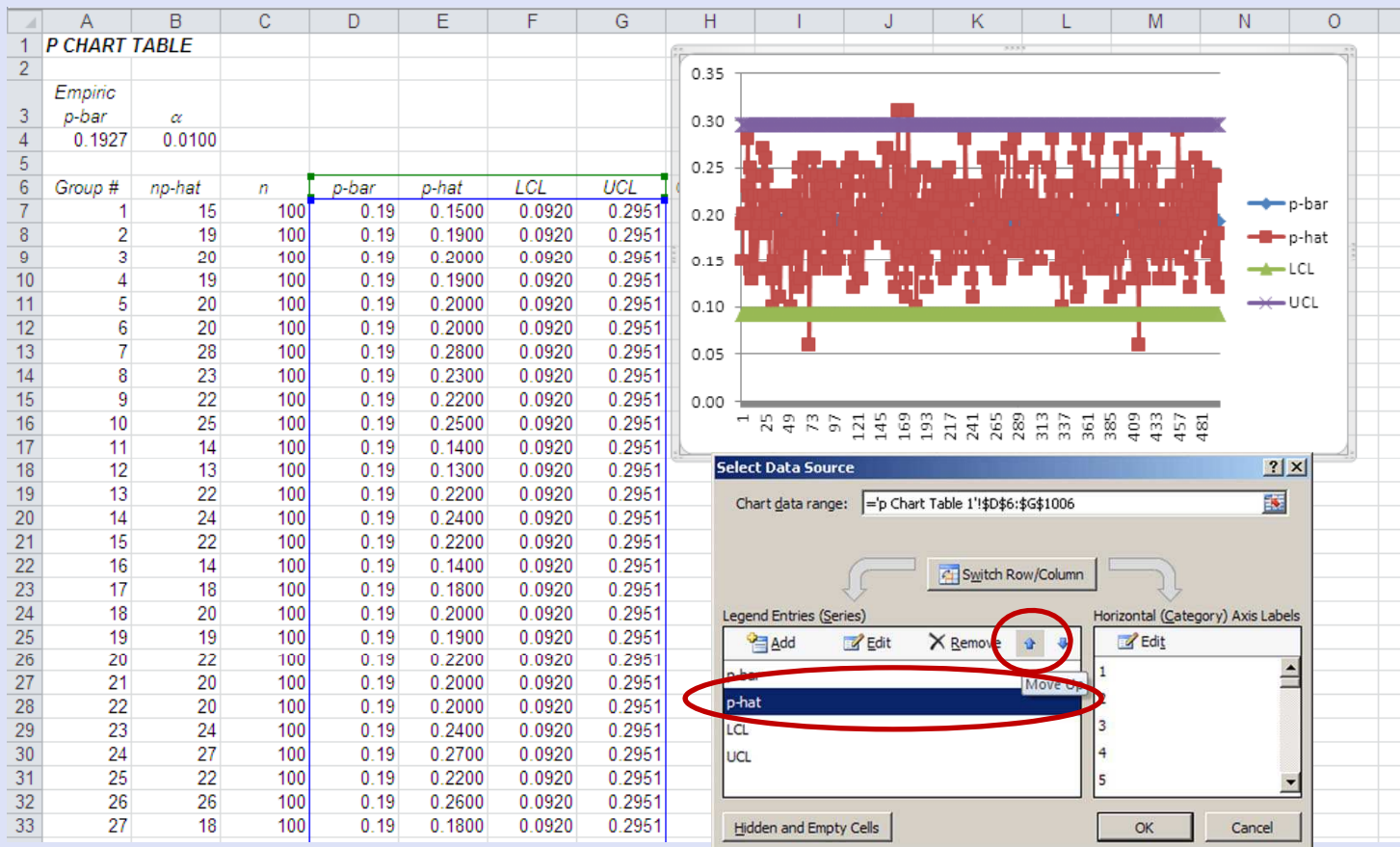
- Input Data: Select (highlight) the number of non-conformities range:
- Input Data: Select (highlight) the sample size range:
- Check if the first row contains labels
- p-bar:  Empiric (Calculate p-bar from data)
- If desired, select (highlight) the outliers range:
- A Priori ("Standards Given") p-bar =
- Significance Level: Enter the desired significance level:  $\alpha =$
- Buttons:



## Creating Control Chart for file3 –Red Bead Game.xls

The p-bar (average p) value comes first in the legend and is hidden by p-hat values. To bring it to the front, right click anywhere on the graph and select “Select Data”

- Select p-hat and press the arrow pointing up to move the “p-hat” entry up in the legend
- Click OK to bring the average to the front

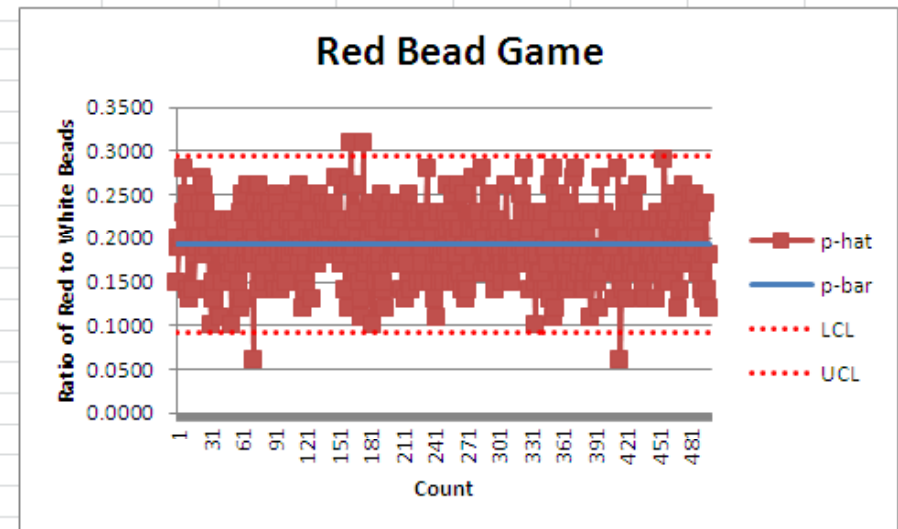




# Final P Chart for file3 – Red Bead Game.xls

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	<b>P CHART TABLE</b>														
2															
3	<i>Empirc</i>														
4	<i>p-bar</i>	<i>α</i>													
5	0.1927	0.0100													
6	<i>Group #</i>	<i>np-hat</i>	<i>n</i>	<i>p-bar</i>	<i>p-hat</i>	<i>LCL</i>	<i>UCL</i>	<i>Outlier ?</i>							
7	1	15	100	0.19	0.1500	0.0920	0.2951								
8	2	19	100	0.19	0.1900	0.0920	0.2951								
9	3	20	100	0.19	0.2000	0.0920	0.2951								
10	4	19	100	0.19	0.1900	0.0920	0.2951								
11	5	20	100	0.19	0.2000	0.0920	0.2951								
12	6	20	100	0.19	0.2000	0.0920	0.2951								
13	7	28	100	0.19	0.2800	0.0920	0.2951								
14	8	23	100	0.19	0.2300	0.0920	0.2951								
15	9	22	100	0.19	0.2200	0.0920	0.2951								
16	10	25	100	0.19	0.2500	0.0920	0.2951								
17	11	14	100	0.19	0.1400	0.0920	0.2951								
18	12	13	100	0.19	0.1300	0.0920	0.2951								
19	13	22	100	0.19	0.2200	0.0920	0.2951								
20	14	24	100	0.19	0.2400	0.0920	0.2951								
21	15	22	100	0.19	0.2200	0.0920	0.2951								
22	16	14	100	0.19	0.1400	0.0920	0.2951								
23	17	18	100	0.19	0.1800	0.0920	0.2951								
24	18	20	100	0.19	0.2000	0.0920	0.2951								
25	19	19	100	0.19	0.1900	0.0920	0.2951								
26	20	22	100	0.19	0.2200	0.0920	0.2951								
27	21	20	100	0.19	0.2000	0.0920	0.2951								
28	22	20	100	0.19	0.2000	0.0920	0.2951								
29	23	24	100	0.19	0.2400	0.0920	0.2951								
30	24	27	100	0.19	0.2700	0.0920	0.2951								
31	25	22	100	0.19	0.2200	0.0920	0.2951								
32	26	26	100	0.19	0.2600	0.0920	0.2951								
33	27	18	100	0.19	0.1800	0.0920	0.2951								
34	28	24	100	0.19	0.2400	0.0920	0.2951								

Now charts can be generated for each data file. Follow pages 5-11 for files 1,2,4 and 5 and follow pages 5-14 for file 3.







## Additional Steps for file5 – Breast Cancer Screening.xls

For this file we are going to treat it as if an intervention occurred that began on Jan 1, 2011.

- We will first create a pivot table by selecting the Insert Tab and the Pivot Table button which is on the far left of the ribbon. Select OK to bring up the Pivot Table.

File5 - breast cancer screening.xls [Compatibility]

File Home **Insert** Page Layout Formulas Data Review View Add-Ins

PivotTable Table Picture Clip Art Shapes SmartArt Screenshot Column Line Pie Bar Area Scatter Other Charts Line Column Win Sparklines

	A	B	C	D	E	F	G	H	I	J	K	L
1	ID	Year	Month	ScreeningDone								
2	57345708	2010	1	0								
3	17647602	2010	1	0								
4	82727462	2010	1	0								
5	81031024	2010	1	0								
6	75986919	2010	1	1								
7	49624006	2010	1	0								
8	75533779	2010	1	0								
9	42902189	2010	1	0								
10	6393232	2010	1	0								
11	38139814	2010	1	1								
12	95960658	2010	1	0								
13	6389754	2010	1	0								
14	5562123	2010	1	0								
15	43232784	2010	1	1								
16	4942040	2010	1	1								
17	5964989	2010	1	0								
18	69648501	2010	1	1								
19	20633384	2010	1	0								
20	916200	2010	1	1								
21	83691422	2010	1	0								
22	96392125	2010	1	1								
23	50264861	2010	1	1								

**Create PivotTable**

Choose the data that you want to analyze

Select a table or range

Table/Range: Sheet1!\$A\$1:\$D\$688

Use an external data source

Choose Connection...

Connection name:

Choose where you want the PivotTable report to be placed

New Worksheet

Existing Worksheet

Location:

OK Cancel



## Additional Steps for file5 – Breast Cancer Screening.xls

- On the right hand side in the Pivot Table Field List, right-click, hold, and drag Year and then Month into the 'Row Labels' below. Then Screening Done into the column Labels. Finally drag ID to the Values.

The screenshot shows the following PivotTable data:

Year	Month	ScreeningDone	Sum of ID
2010	1	0	1682700399
2010	2	1	2107734317
2010	3	1	1269764580
2010	4	1	2093534978
2010	5	1	1496813191
2010	6	1	1974124827
2010	7	1	2036817320
2010	8	1	1673977744
2010	9	1	1366627262
2010	10	1	1628455884
2010	11	1	1566112232
2010	12	1	1616222273
2010 Total			20512885007
2011	1	1	2945174697
2011	2	1	2003408733
2011	3	1	2312237682
2011	4	1	2127466575
2011	5	1	1809764662
2011	6	1	2374895858
2011 Total			13572948207
Grand Total			34085833214





## Additional Steps for file5 – Breast Cancer Screening.xls

- On the left of the Pivot Table, double click on the Sum of ID. Select “Count” from the “Summarize Value field” List.

**Before**

The screenshot shows the 'Value Field Settings' dialog box with the following details:

- Source Name: ID
- Custom Name: Count of ID
- Summarize Values By: Show Values As
- Summarize value field by: Count (selected)
- Buttons: Number Format, OK, Cancel

**After**

Drop Report Filter Fields Here				
Count of ID	ScreeningDone			
Year	Month			Grand Total
2010	1	0	1	37
	2	18	21	39
	3	17	15	32
	4	19	24	43
	5	10	21	31
	6	16	19	35
	7	26	17	43
	8	19	15	34
	9	17	11	28
	10	13	16	29
	11	14	16	30
	12	15	15	30
2010 Total		210	201	411
2011	1	23	32	55
	2	14	27	41
	3	10	36	46
	4	14	29	43
	5	11	30	41
	6	14	36	50
2011 Total		86	190	276
Grand Total		296	391	687



## Additional Steps for file5 – Breast Cancer Screening.xls

- Now highlight the values that correspond with 2010 (pre-Intervention) and 0 for screening done. This will be column C cells 5-16.
- Go to the Add-Ins tab, SPC Macro and select p-chart (binomial distrib)
- Now click into the 2<sup>nd</sup> box and then highlight column e 'Grand Total' 5-16 for the sample size.
- Finally skip to the bottom where you will enter a significance level. Let's use .01
- Select OK at the bottom of the Macro screen and a new P-Chart Table will appear

The screenshot shows the Excel interface with the 'Add-Ins' tab selected. The 'SPC Macros' menu is open, and 'p Chart (Binomial Distribution)' is selected. The 'p Chart' dialog box is displayed with the following settings:

- Input Data:
  - Select (highlight) the number of non-conformities range:  $\$C\$5:\$C\$16$
  - Select (highlight) the sample size range: Sheet6!\$E\$5:\$E\$16
  - Check if the first row contains labels
- p-bar:
  - Empiric (Calculate p-bar from data)
  - If desired, select (highlight) the outliers range: [Empty]
  - A Priori ("Standards Given")
- Significance Level:
  - Enter the desired significance level:  $\alpha = .01$

The 'OK' button is highlighted at the bottom of the dialog box.

		D	E	F	G
		one			
		one			
		0	1	Grand Total	
6		2	18	11	37
7		3	17	21	39
8		4	19	15	32
9		5	10	24	43
10		6	16	21	31
11		7	26	19	35
12		8	19	17	43
13		9	17	15	34
14		10	13	11	28
15		11	14	16	29
16		12	15	16	30
17	2010 Total		218	201	411
18	2011	1	23	32	55
19		2	14	27	41
20		3	10	36	46
21		4	14	29	43
22		5	11	30	41
23		6	14	36	50
24	2011 Total		86	190	276
25	Grand Total		296	391	687



## Additional Steps for file5 – Breast Cancer Screening.xls

- Return to the pivot table which should be on sheet6.
- Repeat the steps from the previous page for creating a p-chart, but using only 2011 data (Post-Intervention), this will be rows 18-23.
- Use the same significance level that you used from the 2010 data (.01)
- This will create another smaller P Chart Table

The screenshot shows the Excel interface with the 'SPC Macros' menu open. The 'p Chart (Binomial Distribution)' option is selected. The 'p Chart' dialog box is open, showing the following settings:

- Input Data:
  - Select (highlight) the number of non-conformities range:  $\$C\$18:\$C\$23$
  - Select (highlight) the sample size range: Sheet6!\$E\$18:\$E\$23
  - Check if the first row contains labels
- p-bar:
  - Empiric (Calculate p-bar from data)
  - If desired, select (highlight) the outliers range: [empty]
  - A Priori ("Standards Given") p-bar = [empty]
- Significance Level:
  - Enter the desired significance level:  $\alpha = .01$

The 'OK' button is highlighted. The background shows a pivot table with data for 2010 and 2011, and a pivot chart table.

	0	1	Grand Total
6	26	11	37
7	18	21	39
8	3	17	32
9	4	19	43
10	5	10	31
11	6	16	35
12	7	26	43
13	8	19	34
14	9	17	28
15	10	13	29
16	11	14	30
17	12	15	30
2010 Total	216	201	411
2011	1	23	55
	2	14	41
	3	10	46
	4	14	43
	5	11	41
	6	14	50
2011 Total	86	190	276
Grand Total	296	391	687



## Additional Steps for file5 – Breast Cancer Screening.xls

- Now copy all of the data from the 2011 P Chart Table (excluding headers) and paste it below the data from p chart table 1 (2010 data)

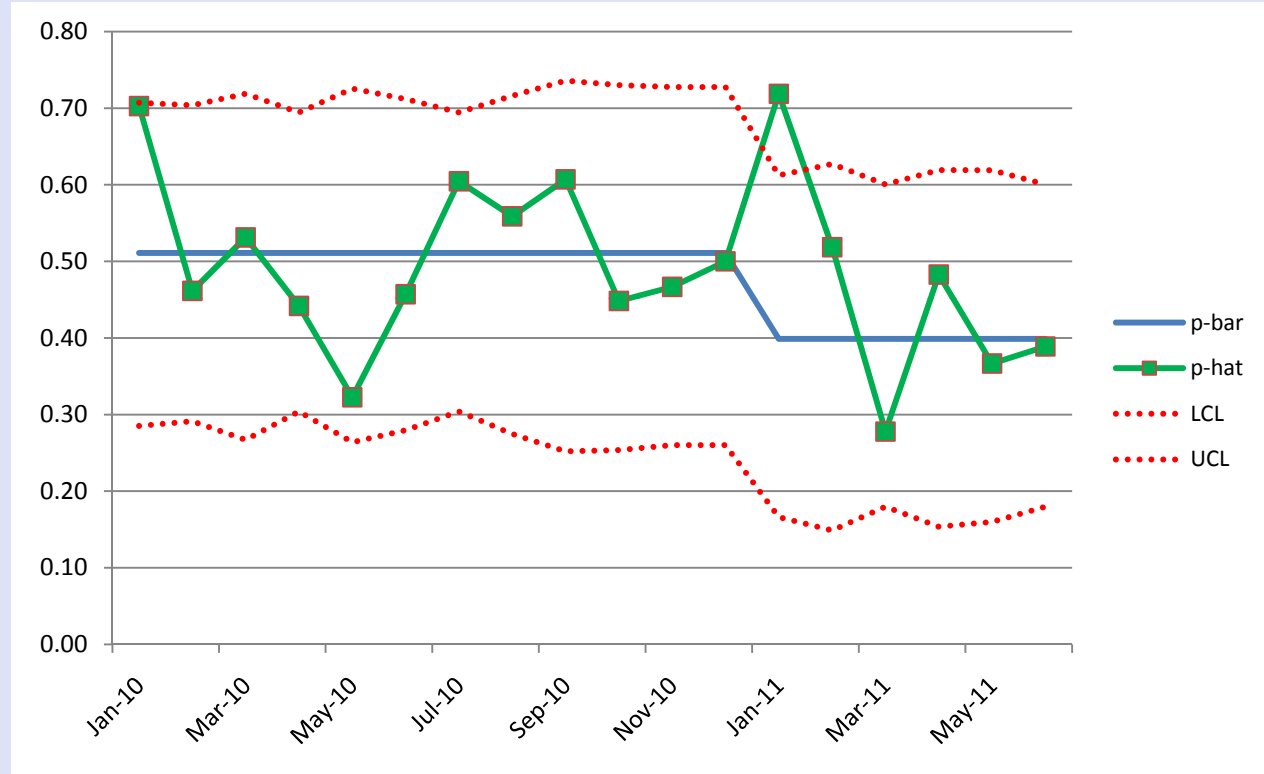
Group #	np-hat	n	p-bar	p-hat	LCL	UCL	Outlier ?
1	23	55	0.31	0.4182	0.1486	0.4694	
2	14	41	0.31	0.3415	0.1236	0.4936	
3	10	46	0.31	0.2174	0.1334	0.4838	
4	14	43	0.31	0.3256	0.1261	0.4881	
5	11	41	0.31	0.2683	0.1236	0.4936	
6	14	50	0.31	0.2800	0.1413	0.4768	

Group #	np-hat	n	p-bar	p-hat	LCL	UCL	Outlier ?
1	26	37	0.51	0.7027	0.2852	0.7072	
2	18	39	0.51	0.4615	0.2913	0.7038	
3	17	32	0.51	0.5313	0.2670	0.7189	
4	19	43	0.51	0.4419	0.3039	0.6944	
5	10	31	0.51	0.3226	0.2638	0.7256	
6	16	35	0.51	0.4571	0.2795	0.7119	
7	26	43	0.51	0.6047	0.3039	0.6944	
8	19	34	0.51	0.5588	0.2747	0.7161	
9	17	28	0.51	0.6071	0.2520	0.7360	
10	13	29	0.51	0.4483	0.2537	0.7302	
11	14	30	0.51	0.4667	0.2601	0.7276	
12	15	30	0.51	0.5000	0.2601	0.7276	
1	23	55	0.31	0.4182	0.1486	0.4694	
2	14	41	0.31	0.3415	0.1236	0.4936	
3	10	46	0.31	0.2174	0.1334	0.4838	
4	14	43	0.31	0.3256	0.1261	0.4881	
5	11	41	0.31	0.2683	0.1236	0.4936	
6	14	50	0.31	0.2800	0.1413	0.4768	



## Additional Steps for file5 – Breast Cancer Screening.xls

- You may wish to enter the actual Year and Month values where it says group.
- Finally, create an SPC chart as you did in previous steps (see slides 5-11). You will see the change from Pre to Post Intervention highlighted with different averages and control limits.



# Create Control Charts Using your “Own” QI Project Data

1. Determine what data element(s) you would like to see the control chart form to better understand the current status of your process
2. Determine type of data (see pages 3 and 4)
3. Use SPC Macro to create data table (see pages 5 and 6)
4. Graph data table information (see pages 7 and 11)
5. Write brief statement on graph about data “findings”