MBC 638

LIVE SESSION WEEK 10

Agenda

Topic
Introduction
Final Review: Video 10 and Beyond
Data Analysis Paper and Storyboard Rubric Review
Review of Upcoming Assignments and Open Question

10.2 Summary of DMAIC

Define

- Categorized data (discrete and continuous)
- Descriptive statistics, measuring central tendency (mean, median, and mode)
- Measure of dispersion (range, standard deviation, and variance)
  - Variance = (standard deviation)^2
- Tools for displaying/presenting data
  - Charts and graphs (pie, line, trend, bar, etc.)
- Pareto principle (80-20 rule)
- Frequency distribution and histograms

Define (cont.)

A good way to start

- Process maps and thought-process maps
- SIPOC (Supply, Input, Process, Output, Customer)
- Affinity diagram (brainstorming)
- Fishbone diagram
- Calculate SQL (sigma quality level)
- Problem definition worksheet
  - ROI: How much is your problem worth?

10.2 Summary of DMAIC

Measure

- Quantitative and qualitative measurements
- Importance of operational definition
- Minimizing variation in measurement system
- Calculated kappa (k value) to evaluate discrete measurement system
- Sampling distribution of sample mean becomes normal as sample gets larger
- Area under normal curve = 1
- $z = \frac{x-\mu}{\sigma}$
- Sample size driven by level of confidence, margin of error, and standard deviation
    - Different formulas for continuous and discrete data

We also completed data measurement plan and data Stratification tree in measure.

Histograms are also a useful tool in measure.

10.2 Summary of DMAIC

Analyze

- Inferential statistics: drawing conclusion on population based on sample
- Confidence interval and hypothesis testing
  - Confidence interval = range of values
  - Write H_0 and H_a
  - H_a: wants, concerns
  - Equality statement goes in null
  - "If p is low then H_0 must go"
- Chi-square test for independence

A hypothesis test
On discrete data
Tells you if there is a relationship
Does not tell of strength or direction of relationship

10.2 Summary of DMAIC

- Simple linear regression: only one input; continuous data
- Multiple linear regression: multiple input variables; can include categorical/indicator variables
  - Use inputs with low p-value
- Correlation measures strength of linear relationship between x and y
- R^2= coefficient of determination
  - Measures variability in y that is accounted for by including particular x in model
- Practical, graphical, analytical
- Time series analysis
  - Models: first-order autoregressive, moving average, exponential smoothing

} Regression can show strength and direction of relationship between input and output

10.2 Summary of DMAIC

Improve

- Make sure analysis has led to root cause
- Streamline customer and business value-added steps
  - Eliminate non-value-added steps
- Pilot solution: do an experiment

Control

- Monitor critical inputs (x's)
- Use control chart to understand signal vs. noise
  - Only react to signals
- Use appropriate control chart for type of data
  - X-bar R, X-bar s, IMR, c, u, p, np
- Continual process improvement a journey, not a destination

10.3 Questions You Should Be Able to Answer

Define

- What does *DMAIC* stand for?
- What is the difference/relationship between standard deviation and variance? How are they related?
- Give me an example of a measure of location, a.k.a. measure of central tendency.
- Give me an example of measure of dispersion.
- What is the difference between discrete data and continuous data?
- Fishing line sold per year: Is that continuous or discrete data?
- Name two things you can learn from plotted data.

Variance = standard deviation squared
Std dev=3, Variance=9

Mean, Mode, Median

Range, Standard deviation, Variance

Measure

- How could you visually display variation?
- Sample size is a function of what three things?
- In order to determine SQL (sigma quality level) for your process, what do you need to determine first?
- What is the difference between repeatability and reproducibility?
- If you want to increase your level of confidence, what do you need to do to your sample size?

Sample Size Formula for Continuous Data

$$n = \left(\frac{z^* \hat{\sigma}}{E}\right)^2$$

10.3 Questions You Should Be Able to Answer

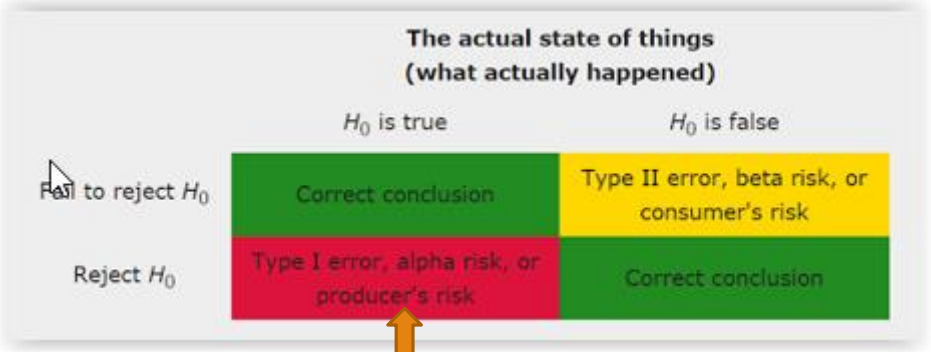
Analyze

- "If p is low, H_0 must go." Lower than what?
- What data would be considered inappropriate for a regression model?
- What does variation do to cycle time?
- What is the difference between R and R^2?
- What is a type 1 error?
- What is a confidence interval?
- When would you calculate the t-test statistic vs. the Z test statistic?
- What is a residual?

Alpha, If you have an alpha of .10 at what p would you reject???? Anything lower (.09, .08, etc.)

R=The correlation coefficient is a measure for quantifying the linear relationship between two quantitative variables.

R Squared = The coefficient of determination is a measure of the variability in Y that can be accounted for by , measure the goodness of fit of the regression equation to the data.



Rejecting Ho when it is true

A confidence interval is an estimate of a parameter consisting of an interval of numbers based on a point estimate, together with a confidence level specifying the probability that the interval contains the parameter.

If you reject a null hypothesis that μ= 8 at an alpha of .01, does your 99% confidence interval include 8?

10.3 Questions You Should Be Able to Answer

Analyze (cont.)

- The correlation coefficient can take on any value in what range? -1 to 1, remember this is r
- If your R value is equal to zero, what does that mean?
- Name three models that can aid in the analysis of time series data.
- What is it called when you have correlation between successive values of a time series? Autocorrelation
- When the variability in your *y* increases, the correlation coefficient gets closer to what number? 0
- What if the seasons contribute to the variation in your time series data?
  - What might you do to account for that in your predictive model?

10.3 Questions You Should Be Able to Answer

Improve

- List two ways that regression can be useful.
- What does a Pareto show you?
- How can you tell if a particular input variable is significant enough to include in your regression equation?

P is LOW

Control

- Name two ways you can tell if your process is in control.
- What can a range chart tell you?
- What kind of control chart would be most appropriate to use when you are measuring data from a service center, counting the lost calls per day?
- What type of control chart is appropriate for continuous data?
- When the normal functioning of a process is disturbed by some unpredictable event, what kind of variation is added to the common cause variation found in a control chart?

No patterns in the data points or points outside the limits

If all the points are within the limits it tells you the process variation is stable and predictable.

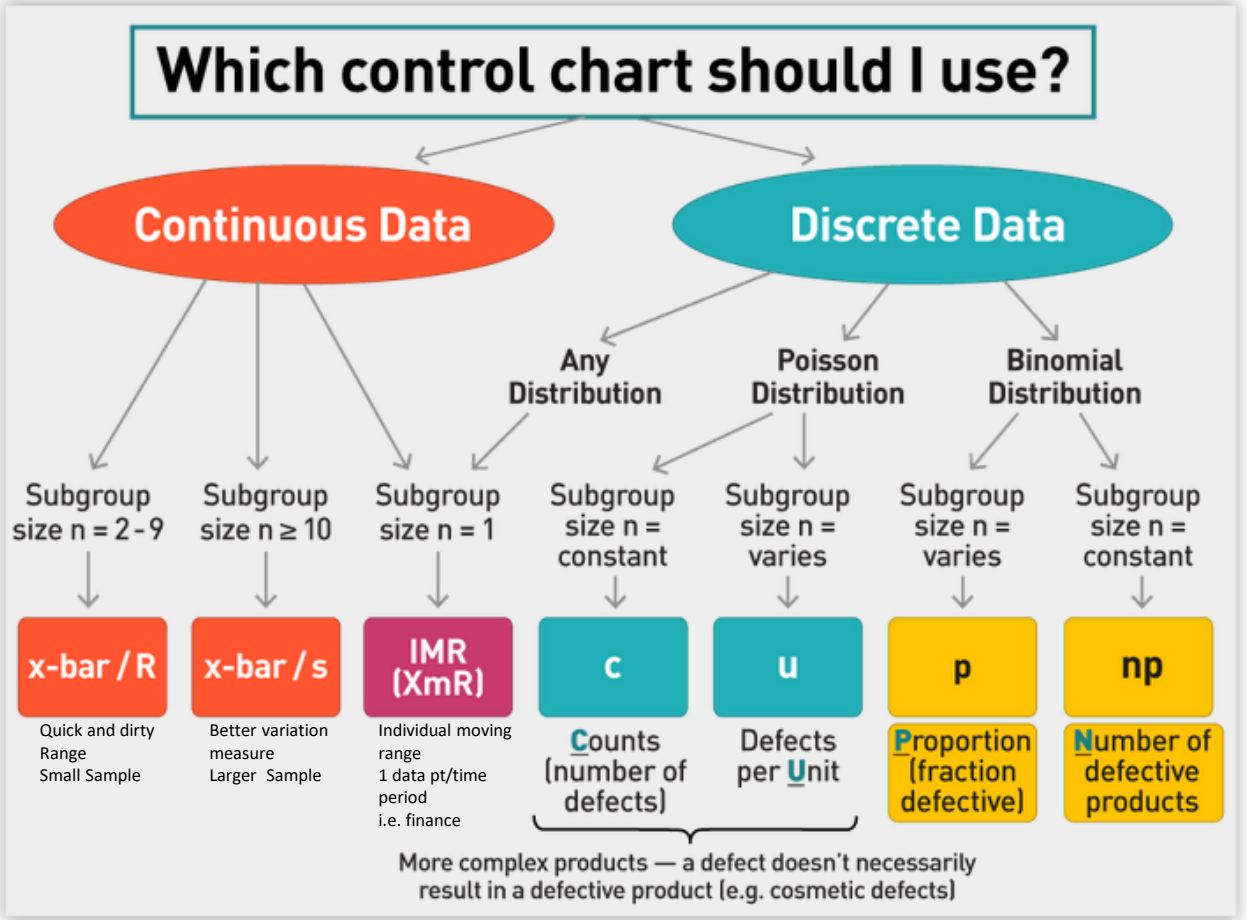
8.2 Control Chart Introduction and Types Available

If you take 4 measurements per hour on the length of a part? What chart?
X bar/R bar

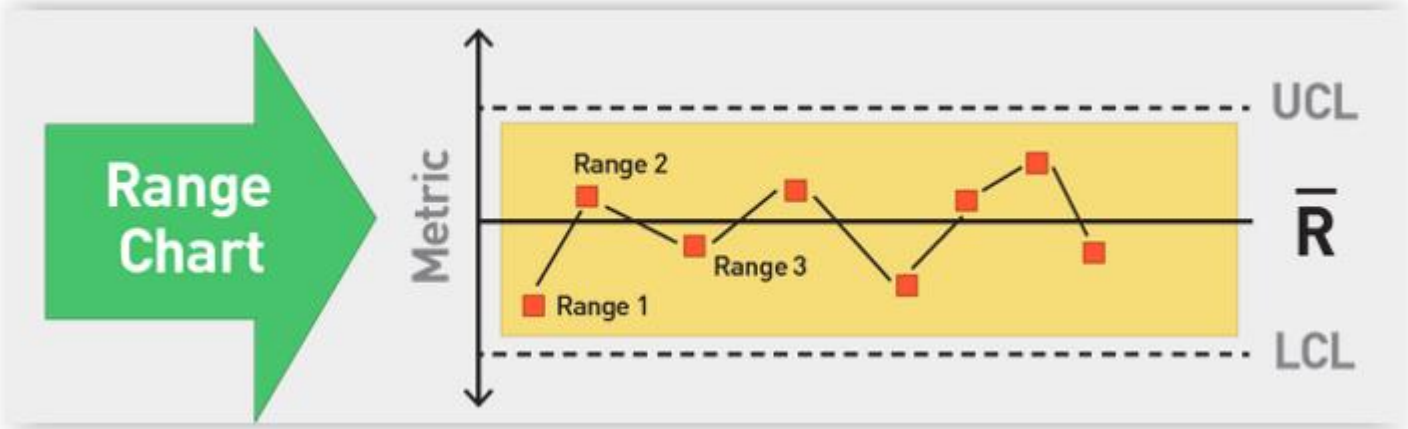
If you collect data on the number of visible dings on your part and you look at 3 every day? What chart?
C chart

If you collect data on the number of visible scratches on your part and you look at a different number of parts every day? What chart?
U chart

Every month you collect data on your electric bill? What chart?
IMR/XMR chart

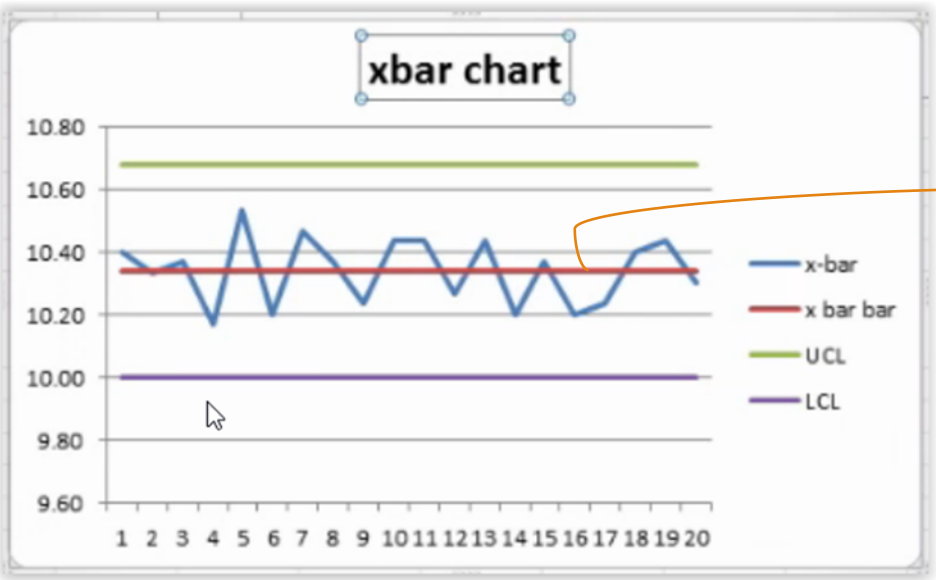


8 Control Chart Interpretation



Always do range chart first, needs to be in control.

The process variation is stable and predictable.



X bar is the average measurement or dimension of a part.

The process is consistent and stable, although that may not mean you are meeting the requirements.

9.5 Three Time Series Models

Run a regression to create an equation to predict next value

Autoregressive Model: AR(1)

- Takes advantage of linear relationship between successive values of time series
- **First-order autoregressive model**
  - Linear regression equation: $y_t = \beta_0 + \beta_1 y_{t-1} + \varepsilon_t$
  - y_t = output at time t
    - Example: March; $t = 3$
    - $y_3 = \beta_0 + \beta_1 y_{3-1} + \varepsilon_3$
    - I.e., predicting March data by using February data

Takes advantage of relationship between successive values.
Looks back 1 time period.

Time Series Models

1. First-order autoregressive model, a.k.a. AR(1)
2. Moving average forecast model
3. Exponential smoothing model

Uses weighting on actual and forecasted previous value to predict next value

Exponential Smoothing Model

- Best suited for forecasting time series without seasonal variation
- Unlike moving average model, data values not all weighted equally
- Forecasting equation: $\hat{y}_t = wy_{t-1} + (1 - w)\hat{y}_{t-1}$
  - $\hat{y}_t$ = estimate of y at time period t
    - Example: t = February
  - w= smoothing constant
    - Your choice, pick any number between 0 and 1
    - Example: w = 80%

Uses all the data available and does not weight them equally.

Average the last K number of values to predict next value

Moving Average Model

A.k.a. "rolling average method"; smooths out short-term fluctuations

- Uses average of last several values of time series to forecast next value; k= number of values in span
  - Example: Monthly data, span (k) = 3
    - I.e., use average of values from January, February, and March to predict April value
- Can look back more than one time period
- Disadvantage: If, say, n = 100 and k = 5, forecast overlooks 95% of available data

This is easy to hand calculate just by averaging the last K number of values to predict the next.

How do you determine if your measurement system is repeatable and reproducible?

Calculate Kappa, define operational definitions, have multiple people collect the same data, have the same person collect the same data on different days

Highlights: Video Segment 1.9

- **Kappa(K) : is an index that can be used to determine if your measurement system(tool) is good for discrete data is good in terms of reproducibility (between people) and repeatability(the same person's ratings).**
- **This acts as a flag that the measurement system needs to be reevaluated if it is not producing reproducible and or repeatable results. This means your results may not be valid.**

	Is it Good or Bad?	Is it Good or Bad?	Did you agree?
Peanut #	Your answer	Your fellow inspector's answers	yes/no
1	G	G	TRUE
2	B	B	TRUE
3	G	B	FALSE
4	B	B	TRUE
5	B	G	FALSE
6	G	G	TRUE
7	B	B	TRUE
8	G	G	TRUE
9	G	B	FALSE
10	B	B	TRUE
11	B	G	FALSE
12	B	B	TRUE
13	B	G	FALSE
14	G	G	TRUE
15	B	B	TRUE
16	G	G	TRUE
17	B	B	TRUE
18	B	G	FALSE
19	B	B	TRUE
20	B	B	TRUE
Totals	20	20	
Percent Good	7	9	
Percent Bad	13	11	
Percent Agreed			14
Percent Good	0.35	0.45	
Percent Bad	0.65	0.55	
Percent Agreed			0.70

Calculate Kappa:					
K = (P observed - P chance) / (1- P chance) =					
P Observed	0.70			Note:	
P Chance	(.35X.45) + (.65X.55)=	0.515		good x good + bad x bad	
	K = (.70-.515)/(1-.515)=	0.381443299			
Is your measurement system good?					
IF K> .7 then the system is good, my K value is .38, therefore it is not a good measurement system in terms of reproducibility.					

Sample Size

Sample Size Formula for Continuous Data

$$n = \left(\frac{z^* \hat{\sigma}}{E} \right)^2$$

- If you want a higher confidence level or be able to see a smaller change ….Z goes up, so N gets bigger
- If you have higher variability, sigma is higher, so N is larger
- If you have a higher margin of error you are willing to accept, N gets smaller
- If you have a smaller margin of error, then your N gets bigger

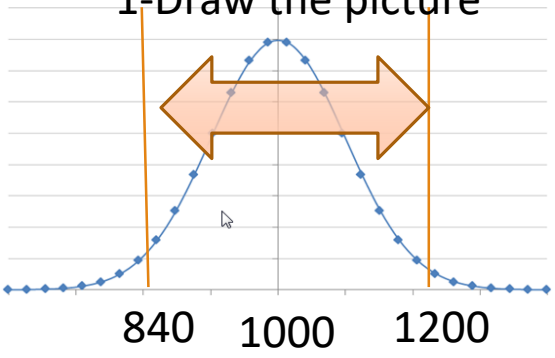
Final Review

- **Regression**
  - **How do you write down the formula from Excel Output?**
  - **How to use a regression equation to predict the output(y)?**
  - **How do you tell which variables are useful to have in your regression?**
- **Correlation Coefficient R vs Coefficient of Determination R2 – what do they represent?**
- **When is data not appropriate for regression? What are residuals?**
- **Causation vs Correlation**
- **Z calculation for the probability of a value falling between A and B**
- **Time Series - Autocorrelation and R2**
- **List of Statistical tools: Correlation, regression, hypothesis testing, scatter plots, process control charts, chi-square testing, etc etc.**
- **Basic ways to describe data and Calculate: mean, median, mode, range, standard deviation, variance**
- **Sample size formula and manipulation impacts**
- **Margin of error and confidence intervals**
- **Process Control charts**
- **How can you determine if your measurement system is repeatable and reproducible?**
- **Hypothesis testing – at what alpha do you reject, at what p-value do you reject**

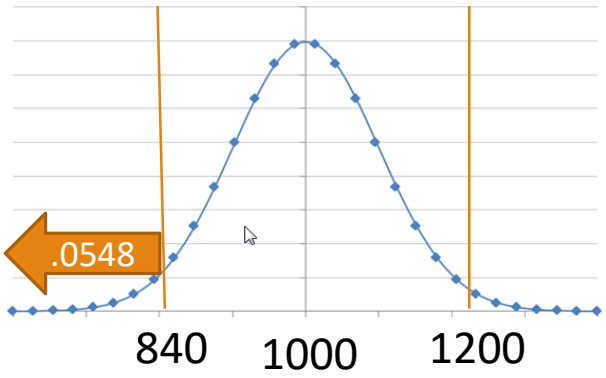
Quiz 2 Prep Question 1: Practice with Z calculations

The distribution of weekly incomes of supervisors at the ABC Company follows the normal distribution, with a mean of $1000 and a standard deviation of $100.
What percent of the supervisors have a weekly income between $840 and $1200?

1-Draw the picture



2-Think about what you are calculating related to the picture



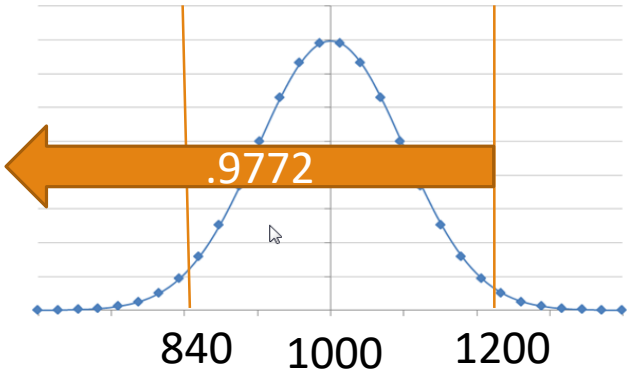
$$Z = \frac{X - \mu}{\sigma}$$

$$Z = \frac{840 - 1000}{100} = -1.6$$

Look up in tables, p = .0548

Or in Excel

=NORM.DIST(840,1000,100,TRUE)



$$Z = \frac{X - \mu}{\sigma}$$

$$Z = \frac{1200 - 1000}{100} = 2$$

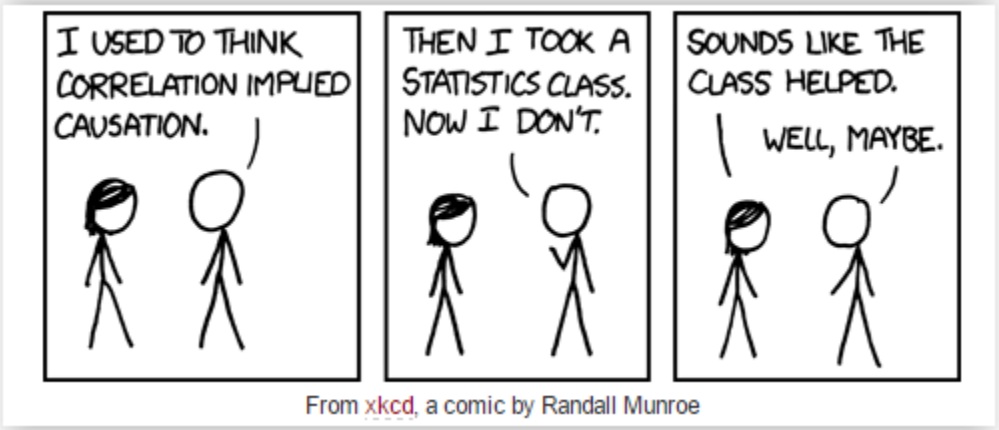
Look up in tables, p = .9772

Or in Excel

=NORM.DIST(1200,1000,100,TRUE)

.9772-.0548 = .9224, so 92.24% have a weekly income between $840 and $1200

Correlation vs Causation



Correlation refers to the degree in which two measurements tend to vary together.

Take the correlation between ice cream sales and drowning deaths. As ice cream sales increase, so do drowning deaths. Does that mean selling ice cream causes people to drown? Probably not. More likely is that people swim more and eat more ice cream the hotter it gets, so both are driven by the outside temperature.

Strong correlation doesn't mean cause and effect relationship….

Correlation has different causes

- the first caused the second
- the second caused the first
- Confounding factor– interference by a third variable distorts the association being studied between two other variables, because of a strong relationship with both of the other variables
- Common Cause – like the ice cream example
- Coincidence

http://blog.fastfedora.com/2011/07/8-things-to-know-about-correlation.html

Highlights: Video Segment 6.7:Correlation

Two Indices

1. Correlation coefficient (r)
2. Coefficient of determination (r^2)

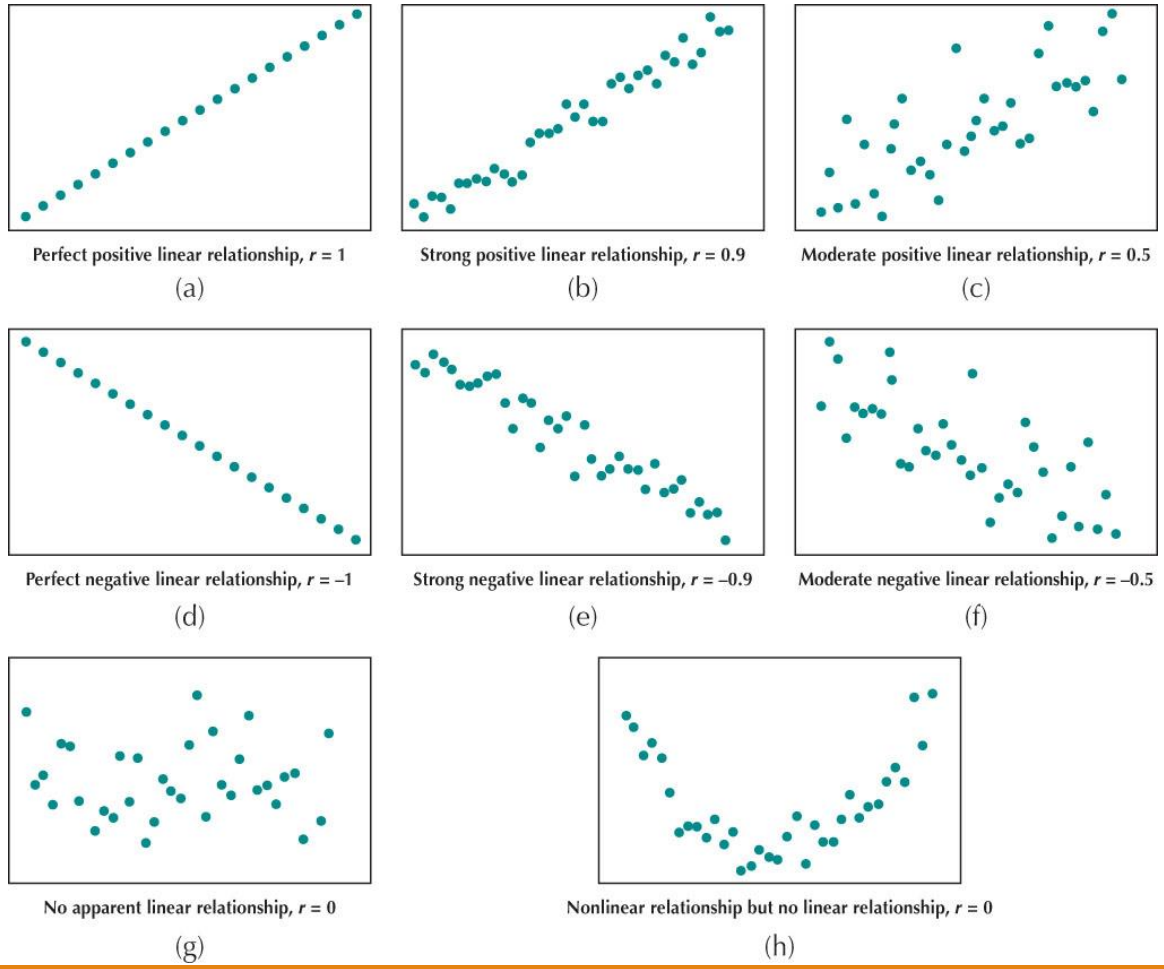
Correlation Coefficient (r)

- $-1 < r$
- -1 = perfect negative correlation
- 1 = perfect positive correlation
- 0 = no relationship
- Rule of thumb: $r$value of ~ $\pm$ 0.7 desired
  - Indicates meaningful relationship

Scatterplots provide a visual description of the relationship between two quantitative variables. The *correlation coefficient* is a numerical measure for quantifying the linear relationship between two quantitative variables.

If the variability decreases, what does your correlation coefficient get closer to?
What does a correlation coefficient r=-.72 mean?

Properties of *r*



Answer: 1 or -1

Answer: There is a moderate negative correlation between two factors

What if you performed a linear regression analysis on successive values of a time series analysis and you see autocorrelation…..what might your r^2 ?

Highlights: Video Segment 6.7:Correlation

Two Indices

1. Correlation coefficient (r)
2. Coefficient of determination (r^2)

Coefficient of Determination (r^2)

- Correlation coefficient squared
- Measure of the percentage of variability in y that can be accounted for by x
  - Trying to find an input x that is influencing our output y
  - x will not explain all of y
  - Recall: There is variability in everything we do.
- Metric for whether input x is really contributing to output

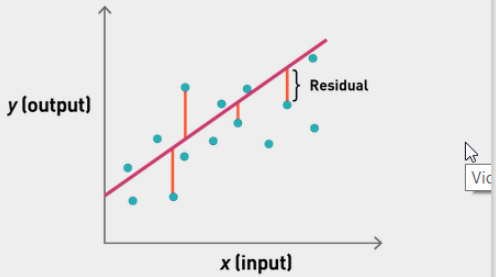
Measures the goodness of fit of the regression equation to the data. We interpret r^2 as the proportion of the variability in y that is accounted for by the linear relationship between y and x. The values that r^2 can take are $0 \leq r^2 \leq 1$.

Answer: correlation, r would be closer to 1 or -1, which would mean r2 would be close to 1

Highlights: Video Segment 6.9:Residuals and Other Warnings

What Is a Residual?

- Synonymous to error; should be random
- The distance between actual data point and the line determined by linear equation
- Determined by the difference between observed and predicted values of y
  - Ideally, points fall on regression line (i.e., perfect model)
  - Error would then be zero (rare).
- When plotted, a random series of points around a zero reference with no evidence of a pattern



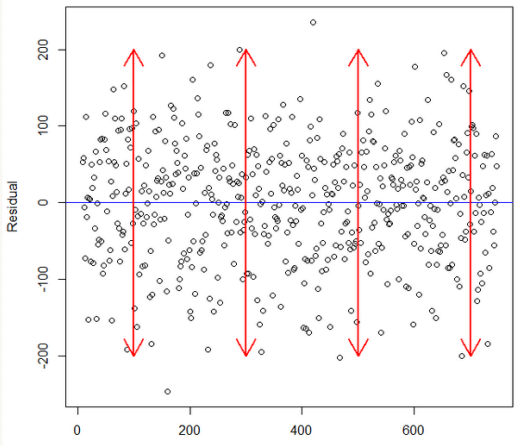
$e_i = y_i - \hat{y}_i$

Residual: Observed response (actual) minus Predicted response (formula)

Assumptions of Regression

1. Residuals are independent.
2. Residuals are normally distributed with a mean of zero.
   - The regression line will sometimes be high or low (i.e., over- or underpredicting).
3. There are equal variances (σ^2) of y.

It means that when you plot the individual error against the predicted value, the variance of the error predicted value should be constant. See the red arrows in the picture below, the length of the red lines (a proxy of its variance) are the same.

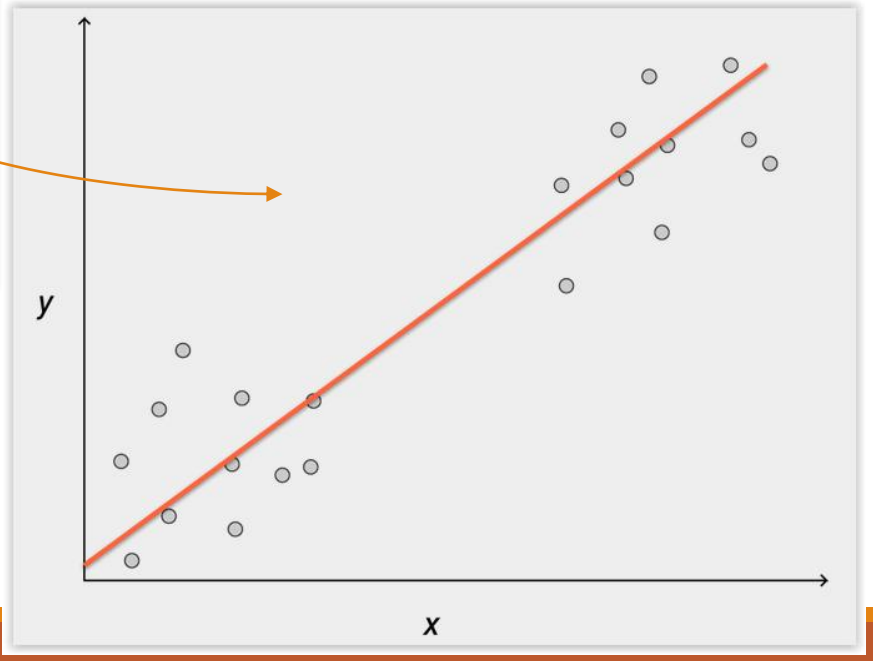


http://stats.stackexchange.com/questions/52089/what-does-having-constant-variance-in-a-linear-regression-model-mean

Highlights: Video Segment 6.9:Residuals and Other Warnings

Other Points of Interest

- Certain data is inappropriate for a regression analysis:
  - Residuals form a pattern.
  - Large outliers are present.
  - "Clumped" data appears linear.
- Avoid extrapolating outside data.
- Beware of lurking variables, or Simpson's paradox.
- A strong correlation does not mean causation.



Highlights: Video Segment 6.4:Regression Intro

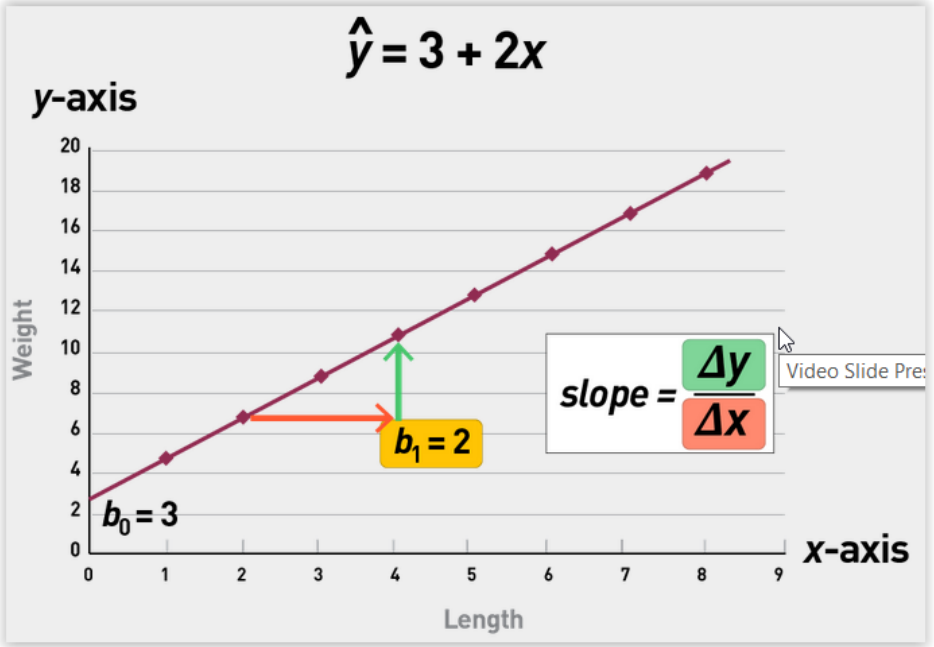
Simple Linear Regression: Equation

- Tries to create best-fitting line through plot
- Describes the relationship between two variables

$$\hat{y} = b_0 + b_1 x$$

Output variable (predicted response) | y-intercept | Slope | Input variable

- y-**intercept:** where the line crosses the y-axis
- **Slope:** how slanted the line is



Regression Breakout Review from Week 9

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.98376152
R Square	0.967786728
Adjusted R Square	0.962905929
Standard Error	11.45627908
Observations	39

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	130120.5634	26024.11268	198.2844975	1.2958E-23
Residual	33	4331.128905	131.2463304		
Total	38	134451.6923			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	6.915128443	5.703073456	1.212526631	0.233920262	-4.687861745	18.51812	-4.68786	18.51812
Pass Yds	0.05540694	0.002696725	20.54601023	2.24328E-20	0.049920412	0.060893	0.04992	0.060893
Int	-4.420550257	0.811110687	-5.449996318	4.88699E-06	-6.070767357	-2.77033	-6.07077	-2.77033
Rush Att.	-0.276858047	0.136761391	-2.024387478	0.051086018	-0.555101188	0.001385	-0.5551	0.001385
Rush Yds	-0.016945448	0.025831307	-0.656004291	0.516369532	-0.069499638	0.035609	-0.0695	0.035609
Rush TDs	11.72060656	2.86039857	4.097543146	0.000254867	5.901081908	17.54013	5.901082	17.54013

1. What is the equation to predict the points for a QB?
2. What is the percent variability in Points described by Pass Yds, Interceptions, Rush Att, Rush Yds, and Rush TDs?
3. What would your equation predict for a QB that passed 3500 yds, had 15 interceptions, had 18 rush attempts, 200 Rush yds, and 6 rush TDs?
4. Which variable is significant and should be included in your model?
5. How many samples were collected to generate this data?
6. What is the correlation for this model and what does it indicate?
7. Certain data is inappropriate for regression analysis, how would you know if this data was inappropriate?

1. y=6.9 + .06 Pass Yds - 4.4 Interceptions - .28 Rush Attempts - .017 Rush Yds + 11.7 Rush TDs
2. Rsquare=.97 x100=97% or adjusted R2=.96X100=96%, Adjusted is preferrable to use
3. 'y=6.9 + .06(3500) - 4.4(15) - .28(18) - .017(200) + 11.7(6)

213

4. low p values….all except Rush Yds, Rush Attempts is on the line
5. 39
6. .98, there is a good relationship between the observed output and the predicted output, this is a useful model for predicting points for a QB
7. Residuals would form a pattern.

Agenda

Topic
Introduction
Final Review: Video 10 and Beyond
Data Analysis Paper and Storyboard Rubric Review
Review of Upcoming Assignments and Open Question

Data Collection & Analysis Paper – Feedback –

Content Requirements	Possible Points	Points Earned	Comments
A) Is it a cohesive **1500 -1700** word paper opening with the business process and **problem statement?**	2.0		
B) Was the **success measure** clearly identified, operationally defined and baseline identified? (Was the data identified as continuous or discrete, includes SQL?)	3.0		
C) Was the **data measurement plan or data stratification tree** included?	1.0		
D) Was the **data collection method** identified?	1.0		
E) Was there rationale for the **sample size** taken? Use of the formula? Is there any reference to **measurement error** and how to minimize?	2.0		
F) Are **4-5 tools** and techniques clearly identified? Are the tools linked/ pertinent to the data analysis?	4.0		
G) Does the data analysis clearly tie to the problem **conclusion**? Is the "discovery" clear to the reader?	2.0		
Total possible 15 points			

Storyboard – Feedback –

Content Requirements	Possible Points	Points Earned	Comments
A) Is the storyboard presented in 1 or 2 PowerPoint slides?	1.0		
B) Follows DMAIC?	1.0		
C) Are tools/graphs/charts used and clearly visible? Do they support findings and conclusions?	1.0		
D) Are arrows, call-out boxes, etc. used to summarize, highlight questions and key learnings?	1.0		
E) Are expected results clear? And next steps noted?	1.0		
Other comments:			
Total possible 5 points	5		

Review of Upcoming Assignments: Wednesday Section

1. Data Collection Paper due 3/25 Midnight EST

2. Story Board due 3/27 Midnight EST

3. Final Exam due, 3/29 Midnight EST
- Password: AnalysisExam3
- Time limit: 90 mins
- Don't leave any blank

4. BONUS QUESTION for .5 pts EXTRA on your final grade
- **Describe at least one thing you will do differently at work or home, now that you have taken this course.**
- Minimum three sentences in an email sent to lsgill@syr.edu, subject line: BONUS QUESTION YOUR NAME
- Due Midnight EST on 3/29, **no late submissions will be accepted**

	March 2017						
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Week #10	19	20	21	22	23	24	25
				Live Class #10 			***Data collection and Analysis Paper DUE***
	26	27	28	29	30	31	1
		Project Storyboard DUE		***Final Exam DUE***			

Other notes: I will send out a final grade report similar to the interim that shows your final grade, you will have 24 hrs. after receiving it to let me know if you have any questions or if I made any mistakes etc., before the grade becomes final. I expect to be sending those out by 4/3 at the latest

Thank you and A Few Last Jokes