Making CMMI Level 5 Statistical Principles Palatable to an Employee-Wide Demographic
Agenda

- Couple of questions
- Session 1
- What worked
- Additional Resources
Let's get a current baseline of CNN viewers...

Do you watch CNN everyday?
Do you know who Anderson Cooper is?

Role Play

Approach for this segment

Role Play!!!

Participate!!!

TEAMWORK
Variable “A” follows a lognormal distribution as determined by the A-D goodness of fit test. The Chi-Square test shows it has a p-value of 0.002.
Roll a dice…

1 2 3 4 5

1/6

Likelihood → Values →
Coin toss...

- Head: 1/2 likelihood
- Tail: 1/2 likelihood
Coin toss… (unfair coin)

- Head: 1/3 likelihood
- Tail: 2/3 likelihood

Chart showing the likelihood of heads and tails.
Two die...
Probability…0 to 1; 0% to 100%

Die Roll

- 1
- 2
- 3
- 4
- 5
- 6
Area under a curve...

\[ f(x) \]

Area = 1 = 100%
Joann – 5’ 1”
Lakshmi – 5’ 4”
Domenic – 5’ 8”
Krithika – 5’ 8”
Hongda – 6’ 1”
Jerome – 6’ 1”
James – 6’ 3”
Charlotte - 5'6"
Carolina - 5'5"
Surya - 5'9"
Nalini - 5'0"
Barbara - 5'5"
Nishi - 5'2"
Deepti - 5'6"
Dan Renfroe -
Joe - 5'11
Jack - 5'10"
Ajay - 6'0"
Vijay - 5'5"
Histogram of VRVL PAT, VRVL + QA group

<table>
<thead>
<tr>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

- **VRVL PAT**
  - 55: 1
  - 60: 1
  - 65: 2
  - 70: 2
  - 75: 1

- **VRVL + QA group**
  - 55: 1
  - 60: 1
  - 65: 4
  - 70: 1
  - 75: 1
Histograms

Histogram of VRVL PAT, VRVL + QA group, VRVL + QA group + ESEPG

- VRVL PAT
- VRVL + QA group
- VRVL + QA group + ESEPG

Frequency

55 60 65 70 75
Heights in general...
Some other distributions…

- Normal
- Triangular
- Uniform
- Lognormal
- Beta
- BetaPERT
- Gamma
- Weibull
- Max Extreme
- Min Extreme
- Logistic
- Student's t
- Exponential
- Pareto
- Binomial
- Poisson
- Hypergeometric
- Neg Binomial
<table>
<thead>
<tr>
<th>Name</th>
<th>Is a good fit if...</th>
<th>More details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderson-Darling</td>
<td>A-D&lt;1.5</td>
<td></td>
</tr>
<tr>
<td>Chi-Square</td>
<td>P Value&gt;0.05</td>
<td>Oldest</td>
</tr>
<tr>
<td>Kolmogorov-Smirnov</td>
<td>K-S&lt;0.03</td>
<td></td>
</tr>
</tbody>
</table>
Results of Goodness of fit test...for heights

Comparison Chart

Ranked by: Anderson-Darling

<table>
<thead>
<tr>
<th>Distribution</th>
<th>A-D</th>
<th>A-D P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta</td>
<td>0.1508</td>
<td></td>
</tr>
<tr>
<td>Weibull</td>
<td>0.1813</td>
<td>0.853</td>
</tr>
<tr>
<td>Normal</td>
<td>0.2007</td>
<td>0.851</td>
</tr>
<tr>
<td>Lognormal</td>
<td>0.2007</td>
<td>0.803</td>
</tr>
<tr>
<td>Gamma</td>
<td>0.2243</td>
<td>0.889</td>
</tr>
<tr>
<td>Logistic</td>
<td>0.2420</td>
<td>0.709</td>
</tr>
<tr>
<td>Min Extreme</td>
<td>0.3038</td>
<td>0.589</td>
</tr>
<tr>
<td>Triangular</td>
<td>0.3087</td>
<td></td>
</tr>
<tr>
<td>Max Extreme</td>
<td>0.3430</td>
<td>0.488</td>
</tr>
<tr>
<td>Uniform</td>
<td>0.3448</td>
<td>0.781</td>
</tr>
<tr>
<td>BetaPERT</td>
<td>0.8144</td>
<td></td>
</tr>
<tr>
<td>Student's t</td>
<td>8.813</td>
<td></td>
</tr>
</tbody>
</table>

Fit #1: Beta  Data values
Do we understand...

A distribution...Goodness of fit...p-value
Variable “A” follows a lognormal distribution as determined by the A-D goodness of fit test. The Chi-Square test shows it has a p-value of 0.002.
And CNN viewership??

What is it now?
Which baselines changed?

- CNN Viewership's?
- Do you know what Anderson Cooper looks like?
- Your “assumed identities” understanding of the statement?

Why/Why not?
Other tests

- **chi-square** - The oldest and most common goodness-of-fit test. This test gauges the general accuracy by breaking down the distribution into areas of equal probability and comparing the data points within each area to the number of expected data points. Generally, a $p$-value greater than 0.5 indicates a close fit.

- **Kolmogorov-Smirnov** - A goodness-of-fit test, the result of which is essentially the largest vertical distance between the two cumulative distributions. Generally a value less than 0.03 indicates a good fit.

- **Anderson-Darling** - A goodness-of-fit test that closely resembles the Kolmogorov-Smirnov test, except that it weights the differences between the two distributions at their tails greater than at their mid-ranges. Use this test when you need a better fit at the extreme tails of the distributions. Generally a value less than 1.5 indicates a close fit.
Thank you for the role play

This was a real session!

Moving on with our agenda....
Stuff that worked or we’d do differently

📍 Worked well
- Socratic method
- Their data
- Everyday examples
- Everyone participates
- No fear

📍 What we are doing differently
- More exercises
- Come up with x and y factors sooner
Assignment –

Y Factor - Identify a problem/something you would like to be able to predict
- Related to work
- Having a few options is ideal as opposed to just one issue

X – Factor – For each problem identify the possible “x factors” that have an impact on the problem
- Some factors may be under your control (label them as controllable)
- Some may be outside your control (label them as uncontrollable)
- If you are not sure whether or not it makes an impact (you think it may), put it in any ways...more the merrier right now

Meeting – After completing the above two steps, set up a meeting with Deepti
Sample models that came up

- Time I need to spend on the help desk
- Time to develop reports
- Quality of end product
- My productivity
- LOE needed for Testing
- Etc.
What’s in the Appendix?

- Material from additional sessions

- If you need help, we’ll be happy to chat via:
  - Email
  - Phone
  - Etc.

...to provide tips from our experience
Our Contact Information

Nishi Narula
Director, Business Performance

2001 M Street, NW, Suite 3000
Washington, DC 20036

T 202.467.7650
F 202.466.8117

n.arula@ostglobal.com

Deepti Sharma
Lead, Business Performance

WWW.OSTGLOBAL.COM

2001 M Street, NW, Suite 3000
Washington, DC 20036

T 202.467.7639
F 202.466.8117
d.sharma@ostglobal.com
Any Questions?
Appendix:
Supporting material
Some more samples

- Hypothesis Tests and Jokes
- Standard Deviation and Variability
- Two real life models
- L5 and basic steps
- Tool trainings
Do you understand this statement…

The NULL hypothesis was rejected in favor of the alternative hypothesis since the p value was...

Let’s get a baseline from the class

- How many Get It?
- Somewhat?
- Do NOT get it?
Have you heard…

- Innocent until proven guilty

  - The person is innocent
    - Null Hypothesis
  - The person is guilty
    - Alternative Hypothesis

Which of the above statements is…

- Status Quo
- Conventional wisdom
- Doesn’t need to be proved
- Accepted without additional proof

Null Hypothesis
Not Status Quo

Not Conventional wisdom

The burden of proof rests on

- One who challenges
- Makes a new claim
- Wants to change the status quo
So what’s a hypothesis test?

✓ ...To Suppose
✓ A pair of statements (not questions)
✓ Can be tested
✓ Has a clear yes/no answer
✓ If one is true the other is false
✓ Nothing “slips through the cracks”

Ho: Djindo is on the AITS project.
Ha: Djindo is not on the AITS project.

Ho: Sonu is on the AITS project.
Ha: Jadrana is not on the HSEEP project.

Ho: Dan’s height is 5.11.
Ha: Dan’s height is 6.2.

Ho: Is Surya a Doctor?
Ha:
So what’s a hypothesis test?

✓ ...To Suppose
✓ A pair of statements (not questions)
✓ Can be tested
✓ Has a clear yes/no answer
✓ If one is true the other is false
✓ Nothing “slips through the cracks”

Ho: Kusum was born in Washington DC.
Ha: Kusum was not born in Washington DC.

Ho: Julie is a doctor.
Ha: Julie is not a doctor.

Ho: Sean watches CNN every day.
Ha: Sean does not watch CNN every day.
So what’s a hypothesis test?

- To Suppose
- A pair of statements (not questions)
- Can be tested
- Has a clear yes/no answer
- If one is true the other is false
- Nothing “slips through the cracks”

- Ho: Apple’s help desk answers calls in 2 min or less.
  Ha: Apple’s help desk answers calls in more than 2 min.

- Ho: The average GPA of GW is 2.6 or higher.
  Ha: The average GPA of GW is less than 2.6.

- Ho: Dan’s height is 5.11 or taller.
  Ha: Dan’s height is less than 5.11.
Once you run the hypothesis test you get a P-Value…

When the p is low, the null must go.
When the P is high, the null must fly.

Less than (<) 0.05 or 5%
Equal to or Greater than (<=) 0.05 or 5%
So what’s a hypothesis test?

**Ho**: Apple’s help desk answers calls in 2 min or less.
**Ha**: Apple’s help desk answers calls in more than 2 min.

**Ho**: The average GPA of GW is 2.6 or higher.
**Ha**: The average GPA of GW is less than 2.6.

**Ho**: Dan’s height is 5.11 or taller.
**Ha**: Dan’s height is less than 5.11.
Do you understand this statement...

The NULL hypothesis was rejected in favor of the alternative hypothesis since the p value was...

Let’s get a baseline from the class

- How many Get It?
- Somewhat?
- Do NOT get it?
Technical Terms…P value is the probability of Null being true…or accepting the null
Any Questions?
Some terms...

- **CENTRAL TENDENCY**
  - Mean/Average
  - Median

- **VARIANCE**
The weakness of using Central tendency alone…

May be a far cry from reality…
The weakness of using Central tendency alone...

You are a Manager for Boeing.

Expectation - 50 jet engines on June 29th.

You will store them in a warehouse.

Each day (late) – You loose $2 million.

Each day (early) – You pay $50,000 extra for warehouse costs.

Bidder A: Average 20 days

Bidder B: Average 20 days
Past deliveries...

- **Bidder A**
  - 10 days
  - 20 days
  - 30 days

- **Bidder B**
  - 19 days
  - 20 days
  - 21 days

- **Bidder A**
  - -10,0,10

- **Bidder B**
  - -1,0,1

Not a good measure of reliability…
So how do we measure it?

-10, 0, 10

Square them first – 100, 0, 100

Divide by total number of values

Square root

Standard Deviation –

\[ \sigma = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (X_i - \mu)^2} \]
Some more terms…

baselines
What we do is important

- Keeping planes in the air
- Ensuring people have access to insurance claims
- Ensuring government’s money is spent well
- Housing for the needy
- Homeland Security
- Tracking progress for government spending
So we need to do well

- Continuously...
- In spite of the constraints...

Time

Skills

- Dislikes
- Choices
- ...etc

- Likes
- Competition
So now that we have variability…what can we do?

Blind Guessing

Educated Guessing

Systematic Prediction

Make the variability go away...

Nirvana
Great Concept, but does this really work?

The Heart Break Model

- Heart Break…
- Stress cardiomyopathy
- Apical ballooning syndrome
- Mr. Li goes to Wallstreet
- Default Correlation

Examples –

- Chance of a dairy farm going bust – 10%
- Chance of a dairy going bust – 5%
- What if the dairy farm goes bust
- And what if the dairy gets its supplies from this dairy…
- Chance of dairy going bust…Rise
Default Correlation Examples...
The love calculator...

- Now that I have a model...
- Don’t need conventional wisdom...
- Rating Agencies...
- Lot’s of buyers...
- Market explosion...
  - From 10’s of billions of $ in 2000 to $2 trillion in 2007
- Supply and demand...
- Loans become cheap...qualify easily
- Defaults...
The effects...

- Banks are scared to lend
- Liquidity dries up
- Businesses can’t get loans
- Economy grinds to a halt...
What went wrong?

- Companies and people are different
- Models weren’t updated
- Assumptions…
- Not used as intended…
- Understanding…
OST Accounts

Know before you go – Risk Free!
- What if scenarios – Virtually
- Efficiencies
- Bottlenecks

Great Idea? Synergy!

Accurately Evaluate Opportunities

Powerful clear communications

Predict the future!!
Ok, how do we get there?

- Identify Business Goals
- Identify Processes and Subprocesses
- Identify Outcomes (Y) and factors (X)
- Collect Data
- Assess Data Quality and Integrity
- Create Process Performance Baseline
- Create Process Performance Model
- Take Action Based on Model
- Recalibrate the model as needed

High Level Business Goals (Balanced Scorecard)
Subordinate Business Goals (e.g., $ Buckets, % Performance)

High Level Process (e.g., Organizational Processes)
Subordinate Processes (e.g., Down to a Vital sub-process to be tackled by DMAIC team)
Three men are in a hot-air balloon. Soon, they find themselves lost in a canyon somewhere. One of the three men says, "I've got an idea. We can call for help in this canyon and the echo will carry our voices far." So he leans over the basket and yells out, "Helllloooooo! Where are we?" (They hear the echo several times.)

Fifteen minutes pass. Then they hear this echoing voice: "Helllloooooo! You're lost!!" One of the men says, "That must have been a statistician." Puzzled, one of the other men asks, "Why do you say that?" The reply: "For three reasons. (1) he took a long time to answer, (2) he was absolutely correct, and (3) his answer was absolutely useless."

I asked a statistician for her phone number... and she gave me an estimate.

ARGUING WITH A STATISTICIAN IS A LOT LIKE WRESTLING WITH A PIG. AFTER A FEW HOURS YOU BEGIN TO REALIZE THE PIG LIKES IT.

Then there's the one that if you laid every statistician on the face of the earth end to end you wouldn't reach a conclusion.....Probably.

There was this statistics student who, when driving his car, would always accelerate hard before coming to any junction, whizz straight over it, then slow down again once he'd got over it. One day, he took a passenger, who was understandably unnerved by his driving style, and asked him why he went so fast over junctions. The statistics student replied, "Well, statistically speaking, you are far more likely to have an accident at a junction, so I just make sure that I spend less time there."
Three professors (a physicist, a chemist, and a statistician) are called in to see their dean. Just as they arrive the dean is called out of his office, leaving the three professors there. The professors see with alarm that there is a fire in the wastebasket.

The physicist says, "I know what to do! We must cool down the materials until their temperature is lower than the ignition temperature and then the fire will go out."

The chemist says, "No! No! I know what to do! We must cut off the supply of oxygen so that the fire will go out due to lack of one of the reactants."

While the physicist and chemist debate what course to take, they both are alarmed to see the statistician running around the room starting other fires. They both scream, "What are you doing?"

To which the statistician replies, "Trying to get an adequate sample size."
The Fake Software project

HI Team –

Your our VRVL PAT meeting tomorrow, we will pretend to be working on a software project’s proposal. We are working on cost proposal which needs estimation. We need to develop an application for a college that allows –

- A alum to log in
- Search a database of alum’s by last name, first name, year of graduation
- Record up to 10 personal contacts

This is the only information we have and we need to respond to the proposal, the window for asking questions is over... ha, ha, ha! So just do your best with the information at hand.

Here are the responsibilities

<table>
<thead>
<tr>
<th>Phase</th>
<th>Owner/You are assigned...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements</td>
<td>Dom</td>
</tr>
<tr>
<td>Design</td>
<td>Hongda</td>
</tr>
<tr>
<td>Development</td>
<td>Lakshmi</td>
</tr>
<tr>
<td>Integration</td>
<td>James</td>
</tr>
<tr>
<td>Test</td>
<td>Rhiya, Joann</td>
</tr>
<tr>
<td>UAT</td>
<td>Jerome, Sujani</td>
</tr>
</tbody>
</table>

Please provide estimates for each of the phases you are assigned to in the following format –

<table>
<thead>
<tr>
<th>Category</th>
<th>Estimate of hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most likely number of hours needed to complete the task</td>
<td></td>
</tr>
<tr>
<td>Minimum hours/Best Case</td>
<td></td>
</tr>
<tr>
<td>Maximum hours/Worst case</td>
<td></td>
</tr>
</tbody>
</table>

If this whole exercise, including the optional step is taking you more than 10 minutes, please stop!! We will just do it in the meeting then. Else, please try to send it to me any time before the PAT meeting.

One last thing, you may want to do a “bottom up estimate”. (Optional Step)

- That is jot down sub-tasks E.g. for requirements – meeting with customer, developing first draft, conducting peer review, fixing issues, sign off meeting etc.
- Assign hours to each task
- Provide the total in the table above, but bring the details to the meeting.