Title: Using Quantum Theory, Monte Carlo, and the Multiverse to Predict EAC

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Expected Key Takeaways for Participants

- Learn about the multiverse, Schrödinger's cat(s), and why we can't factor risks
- Explore a better approach to predicting EACs
- Review the process of building an EAC Multiverse and simulating using Monte Carlo analysis
- Explore a user friendly data model that will create your project's multiverse

The Burning Platform

- Why is successfully predicting an EAC so difficult?

Known risks and opportunities may be realized

Unknown risks and opportunities may be realized

Known risks and opportunities may create new unknown risks and opportunities

Risks and Opportunities might not be realized

Some risks may mitigate others or cause them to realize a chain of other risks

Opportunities may create long term disasters, realizing both known and unknown risks.

Ad nauseam . . .


https://opexsociety.org/body-of-knowledge/real-leaders-never-say-burning-platform/

THE REAL QUESTION IS: WHY DO WE TRY IN THE FIRST PLACE?

Basic EAC Analysis

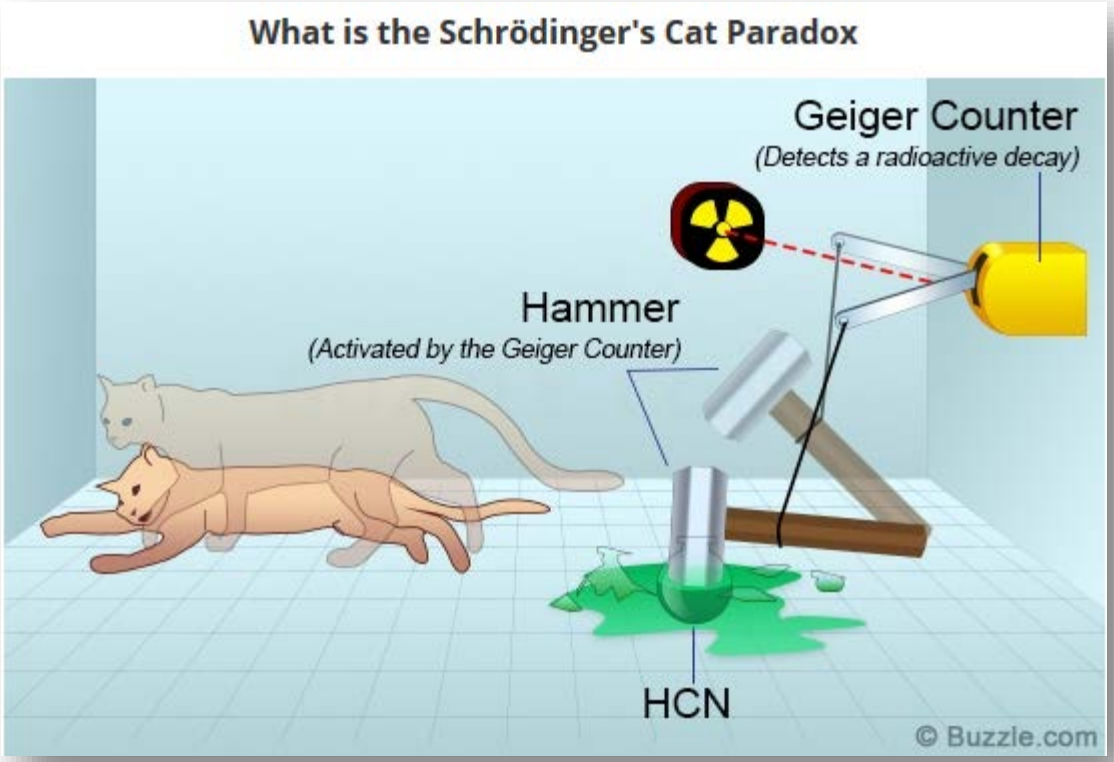
- We try. . . Because we must
  - Revenue forecasting
  - Customer reports
  - Portfolio management
  - Stockholder accountability

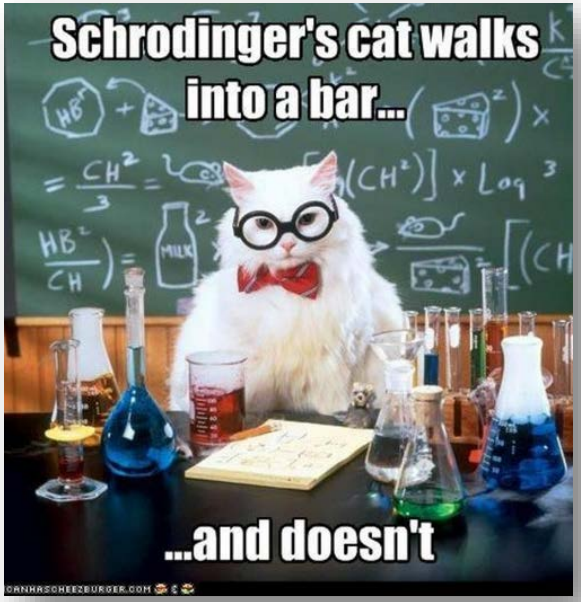
- **These things will never go away**
- However, we provide numbers that have little chance of happening exactly.
- Even a Format 1's best case / worst case / most likely, though better – doesn't give proper context

SO WHERE DO WE TURN FOR ANSWERS?!

Quantum Primer Part 1: The Cat

- We turn . . . to a cat.

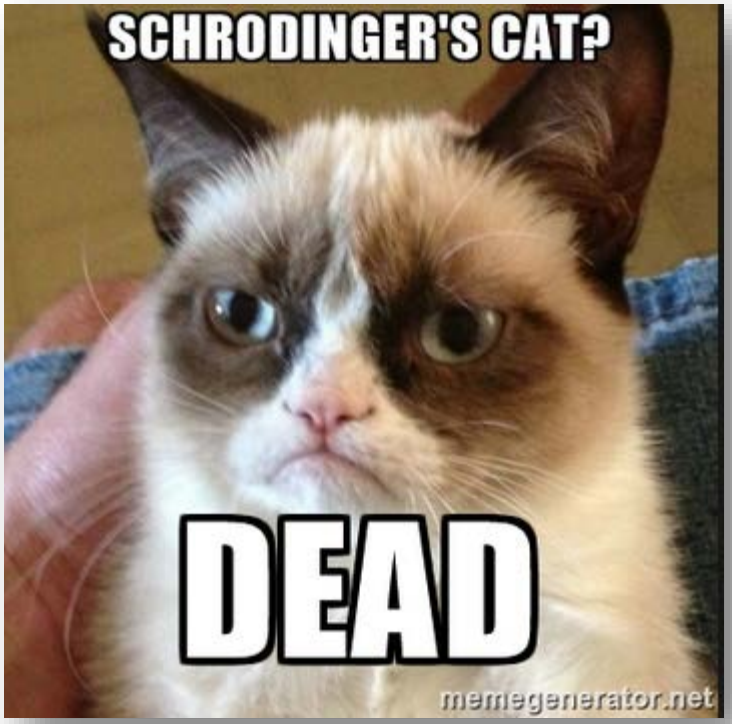




"I don't like it, and I'm sorry I ever had anything to do with it." - Erwin Schrödinger

Quantum Primer Part 1: The Cat

- Schrodinger's Cat Alternate Theory
  - (AKA the pessimist program manager)



Quantum Primer Part 1: The Cat

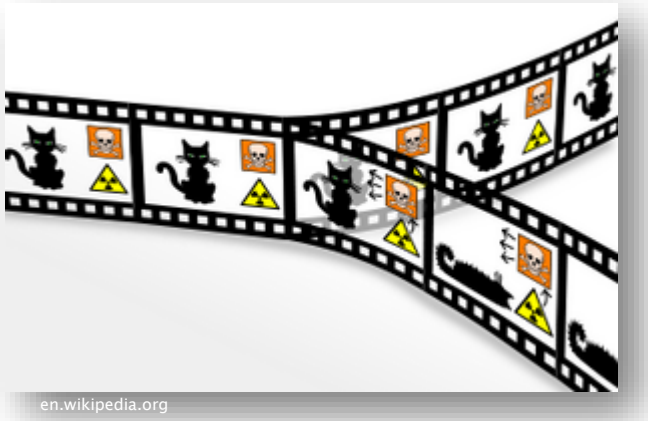
- Standard EAC analysis for the cat:
  - Risk: Dead cat
  - Probability: 50%
  - CEAC (cat estimate at complete): 0.5 cats

IS THIS WHAT WE'RE GIVING TO OUR CUSTOMERS ?!!

- Surely there is a better way. . .

Quantum Primer Part 2: The Multiverse

- Quantum theory gives us the answer, which makes more sense:
  - The cat is both alive and dead--until we observe reality
  - The probability determines, on average, what will happen
  - However, the cat will be 100% alive or 100% dead
  - This requires the universe to split
    - In one universe, there is a live cat
    - In another, there is a dead cat



There is not a universe where there is 0.5 cats

Quantum Primer Part 2: The Multiverse

SEE? DOESN'T THAT MAKE MORE SENSE?

STAY WITH ME HERE. . .

Quantum Primer Part 2: The Multiverse

- Key takeaways
  - Every decision causes a split in the universe
  - Each path is then faced with a new set of decisions, each of which causes a new split
  - The probability of each outcome determines how many alternate universes have that version of reality
  - Being able to take a step back and see all possibilities would allow you to have a much better understanding of what actions to take today
  - We already do this in our own lives! Quick example…

So how exactly does this apply to my EAC?

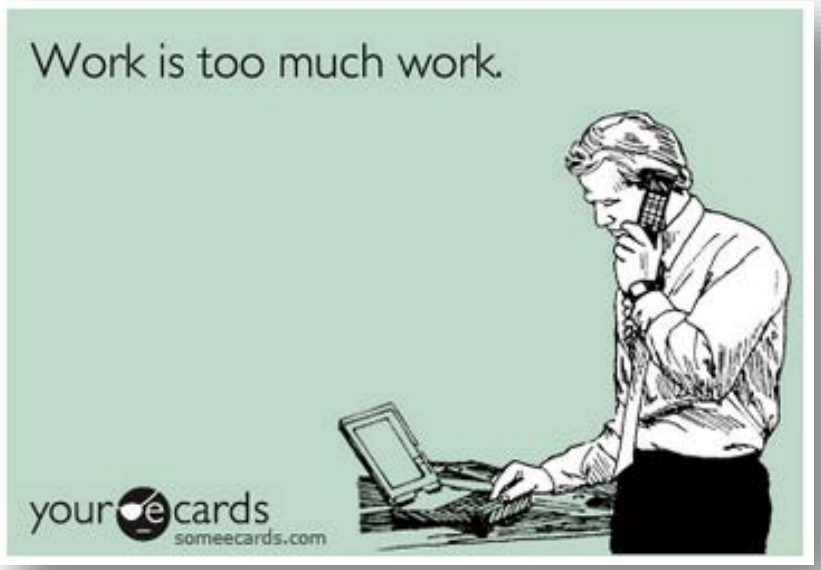
Your EAC Multiverse

- Your EAC **is** a multiverse
  - Every decision causes a split in the potential EAC
  - "Decisions" can be captured in the form of R&Os
- If you treat your EAC like a multiverse, several things happen
  - Drives discussions away from whether a top level EAC will happen as predicted
  - Drives discussion toward the actions that prevent risks and promote opportunities
  - Looks at your program as it is—a huge number of potential paths and results

Instead of a few numbers, your EAC becomes a cone of probable outcomes

Your EAC Multiverse

- Problem: That is a lot of work. An insane amount of work.



- Solution: No, it's not.
  - If you focus on the two key elements of your project, the rest is simple.

What are these mysterious elements?

EAC Multiverse Basics

- EAC Multiverse Element #1: The Plan
  - Baseline and manage the plan with the best available information
  - You should already be doing this

- EAC Multiverse Element #2: A robust a well managed R&O profile
  - What are all the events (decisions) that can alter "the plan"
  - What actions prevent (or promote) them?
  - Do they affect other decisions down the path?
  - What (and when) are the effects of each decision?

What does it look like if we manage this way?

EAC Multiverse Visualized

- EAC Multiverse Element #1: The Plan

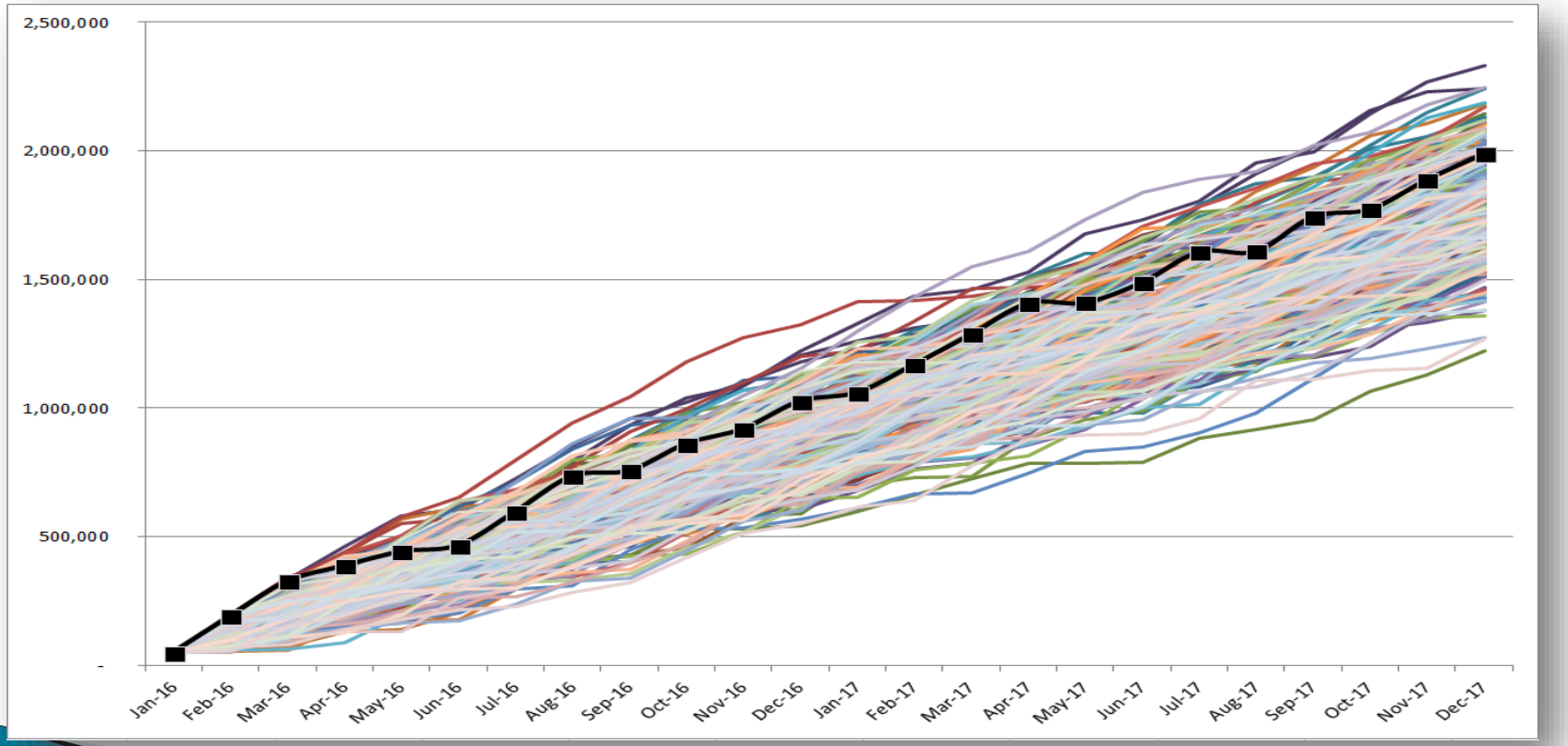
Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Total EAC
1,407,915	1,410,286	1,489,136	1,607,675	1,610,057	1,744,702	1,773,727	1,888,983	1,990,093	1,990,000

- EAC Multiverse Element #2: A robust, well managed R&O profile

Risk/Opportunity	Probability	If R/O happens, delta to EAC	Likely month of risk realization
a	High	95,126	Apr-16
b	Med	29,949	Jun-16
c	Low	131,728	Aug-16
d	High	140,924	Oct-16
e	Med	(81,973)	Dec-16
f	Low	121,671	Feb-17
g	High	138,601	Apr-17
h	Med	33,201	Jun-17
i	Low	(135,572)	Aug-17

EAC Multiverse Visualized

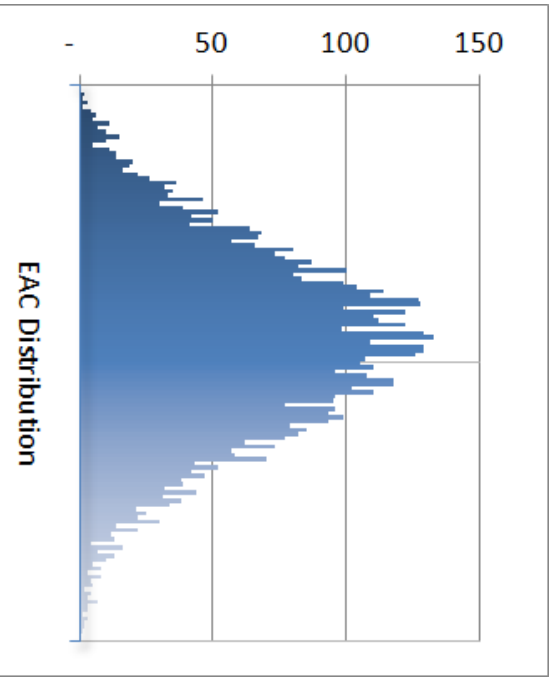
- EAC Multiverse Result
  - If every possible combination of outcomes were mapped and tracked, it would look like:



EAC Multiverse Visualized

- EAC Multiverse Result
  - If we did this over and over again, accounting for the probability of each R/O and therefore the probability of each individual path, we'd be able to determine with very strong certainty:

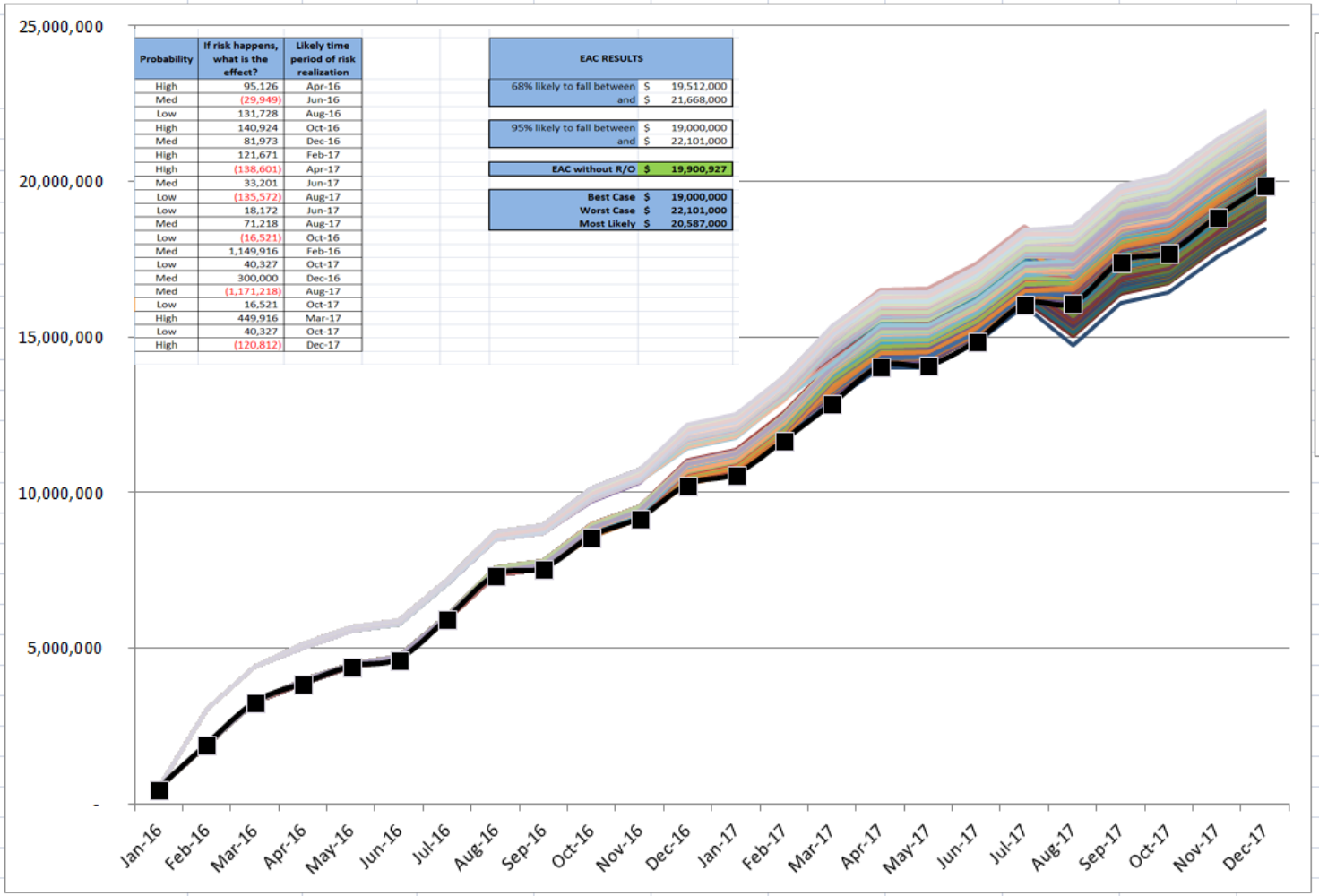
EAC RESULTS	
68% likely to fall between	$ 1,590,000
and	$ 2,030,000
95% likely to fall between	$ 1,380,000
and	$ 2,250,000
EAC without R/O	**$ 2,030,000**
Best Case	**$ 1,380,000**
Worst Case	**$ 2,250,000**
Most Likely	**$ 1,810,000**

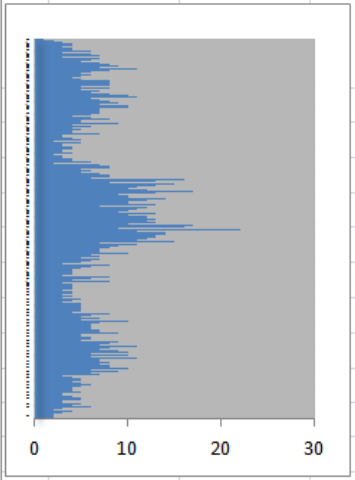


EXAMPLES

Probability	If risk happens, what is the effect?	Likely time period of risk realization
High	95,126	Apr-16
Med	(29,949)	Jun-16
Low	131,728	Aug-16
High	140,924	Oct-16
Med	81,973	Dec-16
High	121,671	Feb-17
High	(138,601)	Apr-17
Med	33,201	Jun-17
Low	(135,572)	Aug-17
Low	18,172	Jun-17
Med	71,218	Aug-17
Low	(16,521)	Oct-16
Med	1,149,916	Feb-16
Low	40,327	Oct-17
Med	300,000	Dec-16
Med	(1,171,218)	Aug-17
Low	16,521	Oct-17
High	449,916	Mar-17
Low	40,327	Oct-17
High	(120,812)	Dec-17

EAC RESULTS		
68% likely to fall between	$	19,512,000
and	$	21,668,000
95% likely to fall between	$	19,000,000
and	$	22,101,000
EAC without R/O	$	19,900,927
Best Case	$	19,000,000
Worst Case	$	22,101,000
Most Likely	$	20,587,000

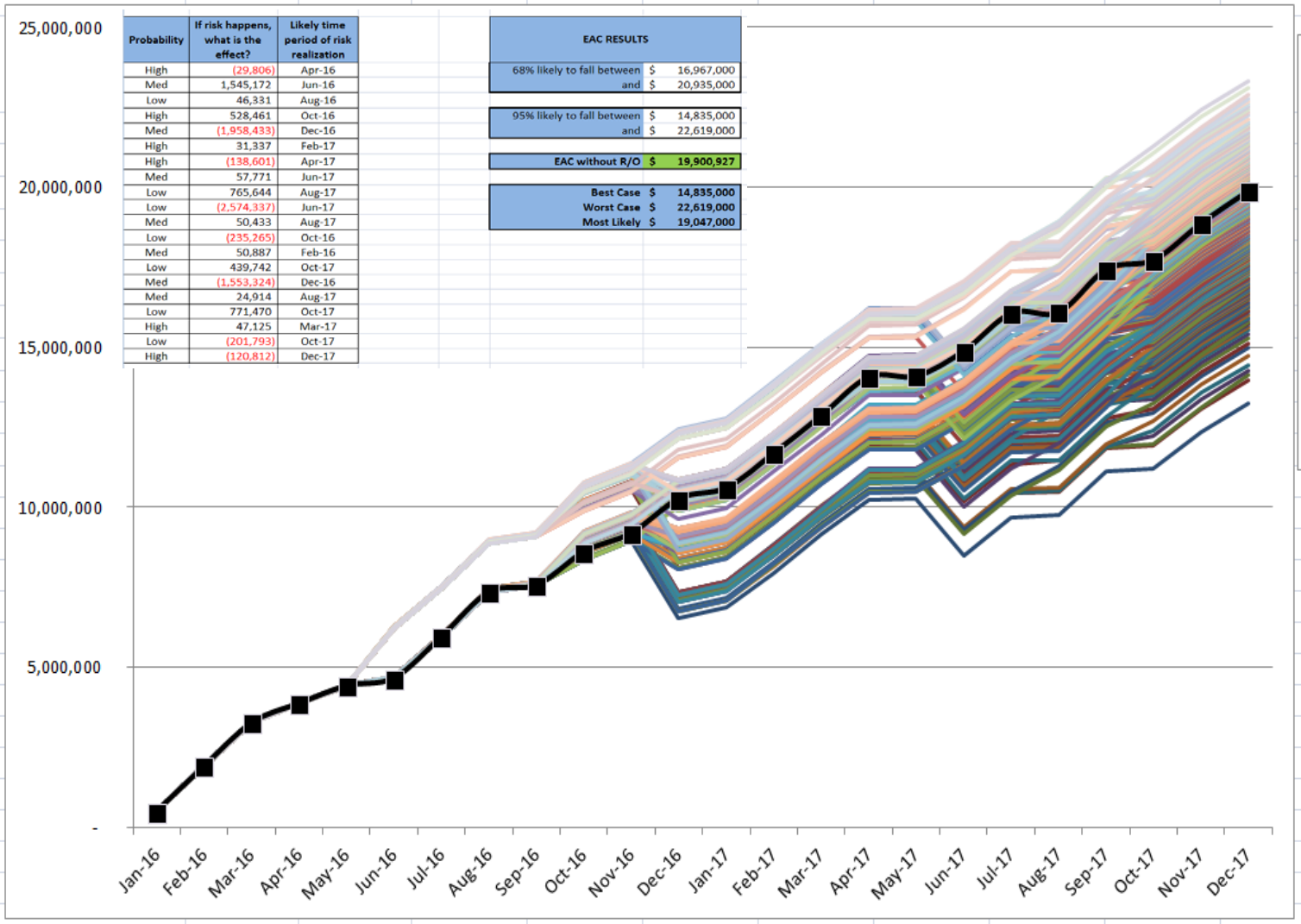


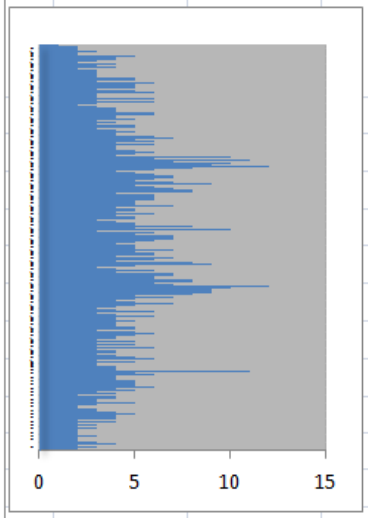


EXAMPLES

Probability	If risk happens, what is the effect?	Likely time period of risk realization
High	(29,806)	Apr-16
Med	1,545,172	Jun-16
Low	46,331	Aug-16
High	528,461	Oct-16
Med	(1,958,433)	Dec-16
High	31,337	Feb-17
High	(138,601)	Apr-17
Med	57,771	Jun-17
Low	765,644	Aug-17
Low	(2,574,337)	Jun-17
Med	50,433	Aug-17
Low	(235,265)	Oct-16
Med	50,887	Feb-16
Low	439,742	Oct-17
Med	(1,553,324)	Dec-16
Med	24,914	Aug-17
Low	771,470	Oct-17
High	47,125	Mar-17
Low	(201,793)	Oct-17
High	(120,812)	Dec-17

EAC RESULTS		
68% likely to fall between	$	16,967,000
and	$	20,935,000
95% likely to fall between	$	14,835,000
and	$	22,619,000
EAC without R/O	$	19,900,927
Best Case	$	14,835,000
Worst Case	$	22,619,000
Most Likely	$	19,047,000

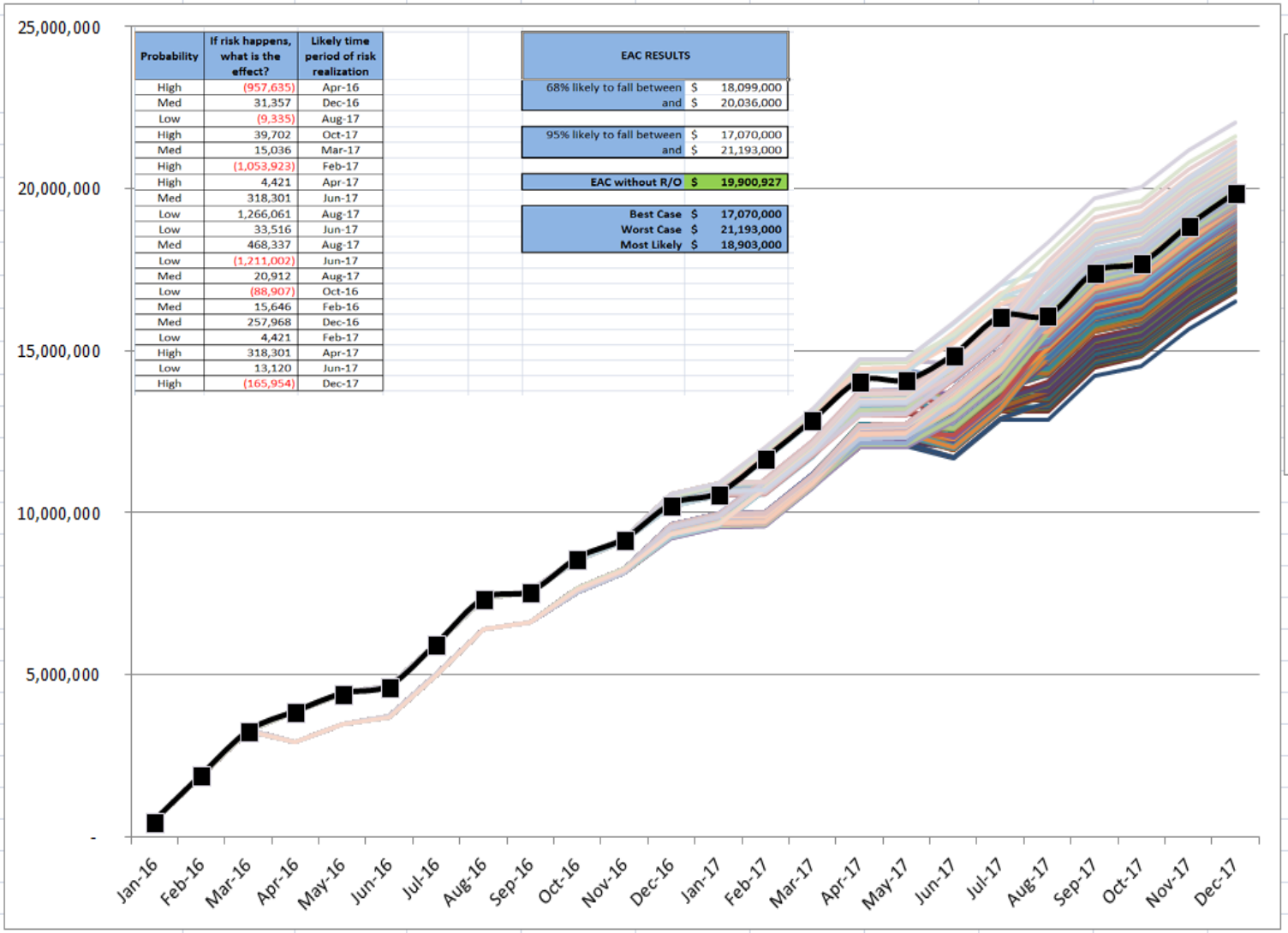


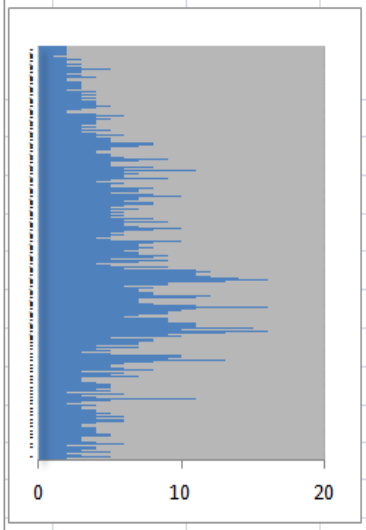


EXAMPLES

Probability	If risk happens, what is the effect?	Likely time period of risk realization
High	(957,635)	Apr-16
Med	31,357	Dec-16
Low	(9,335)	Aug-17
High	39,702	Oct-17
Med	15,036	Mar-17
High	(1,053,923)	Feb-17
High	4,421	Apr-17
Med	318,301	Jun-17
Low	1,266,061	Aug-17
Low	33,516	Jun-17
Med	468,337	Aug-17
Low	(1,211,002)	Jun-17
Med	20,912	Aug-17
Low	(88,907)	Oct-16
Med	15,646	Feb-16
Med	257,968	Dec-16
Low	4,421	Feb-17
High	318,301	Apr-17
Low	13,120	Jun-17
High	(165,954)	Dec-17

EAC RESULTS		
68% likely to fall between	$	18,099,000
and	$	20,036,000
95% likely to fall between	$	17,070,000
and	$	21,193,000
EAC without R/O	$	19,900,927
Best Case	$	17,070,000
Worst Case	$	21,193,000
Most Likely	$	18,903,000

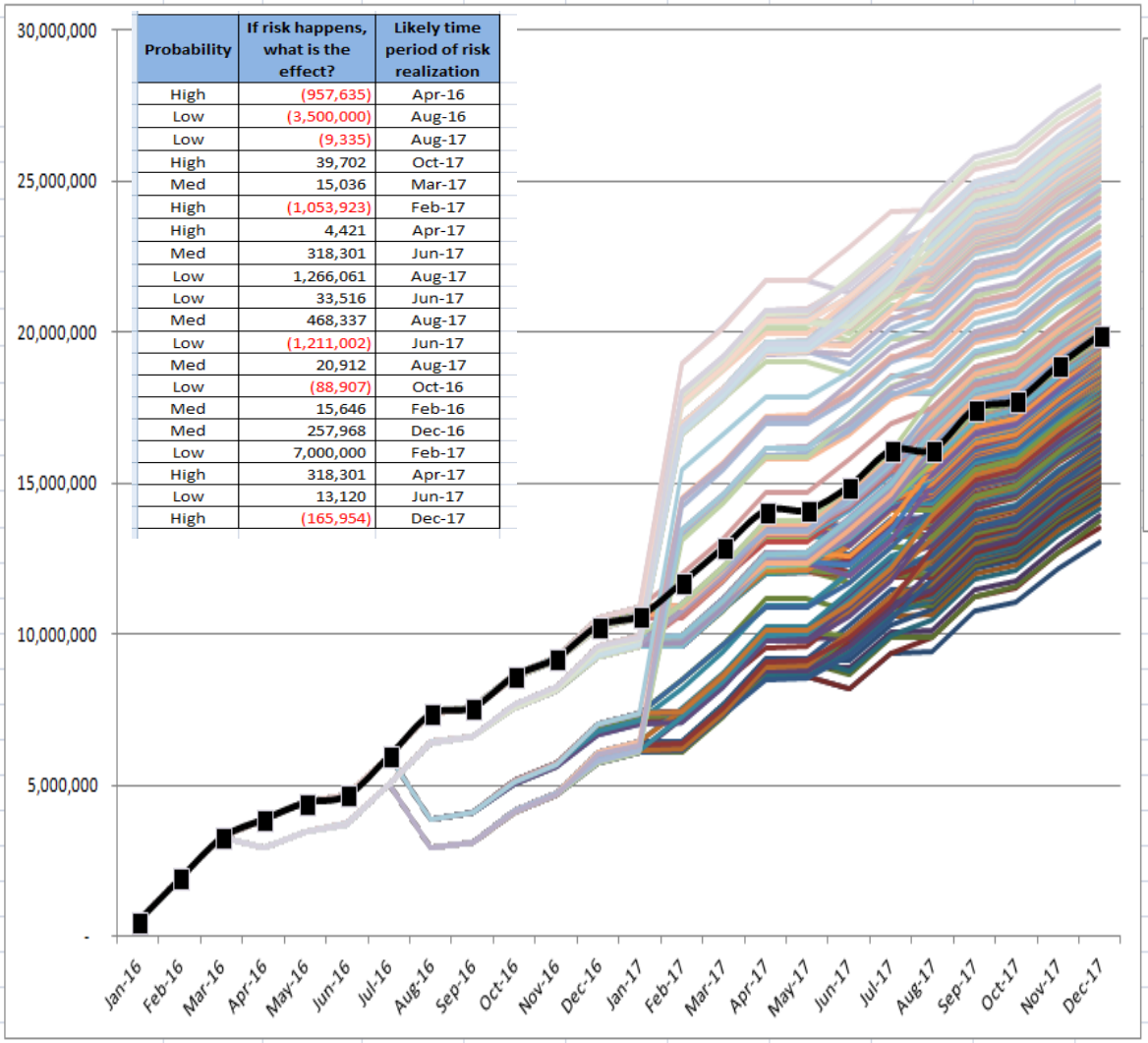


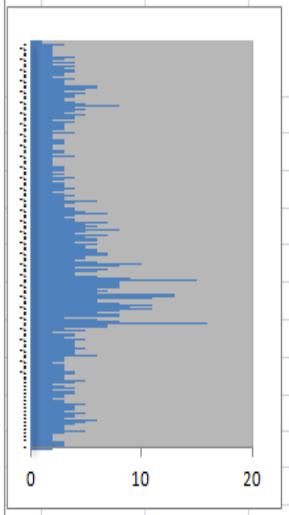


EXAMPLES

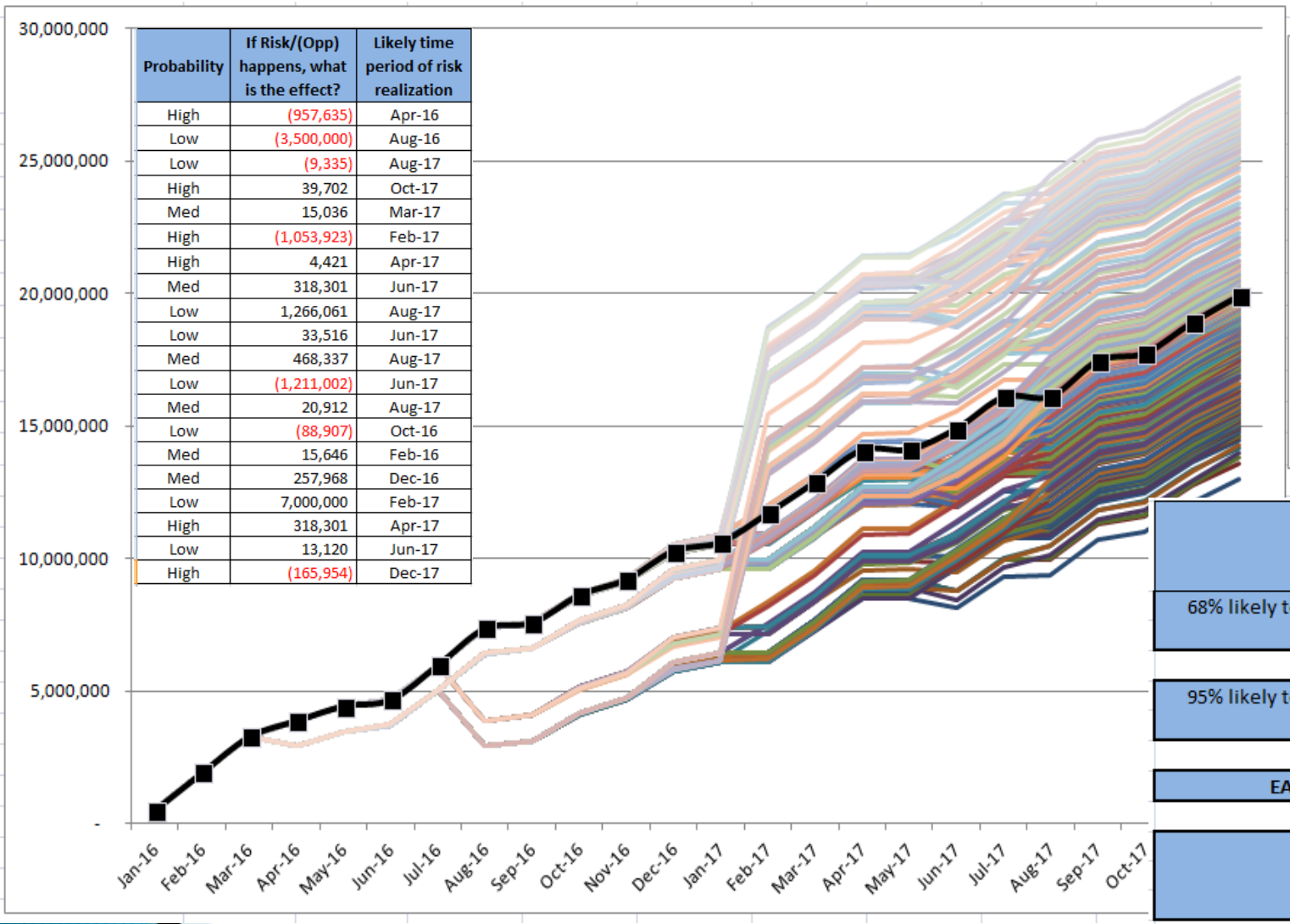
EAC RESULTS		
68% likely to fall between	$	16,609,000
and	$	25,156,000
95% likely to fall between	$	14,394,000
and	$	27,224,000
EAC without R/O	$	19,900,927
Best Case	$	14,394,000
Worst Case	$	27,224,000
Most Likely	$	19,090,000

Probability	If risk happens, what is the effect?	Likely time period of risk realization
High	(957,635)	Apr-16
Low	(3,500,000)	Aug-16
Low	(9,335)	Aug-17
High	39,702	Oct-17
Med	15,036	Mar-17
High	(1,053,923)	Feb-17
High	4,421	Apr-17
Med	318,301	Jun-17
Low	1,266,061	Aug-17
Low	33,516	Jun-17
Med	468,337	Aug-17
Low	(1,211,002)	Jun-17
Med	20,912	Aug-17
Low	(88,907)	Oct-16
Med	15,646	Feb-16
Med	257,968	Dec-16
Low	7,000,000	Feb-17
High	318,301	Apr-17
Low	13,120	Jun-17
High	(165,954)	Dec-17

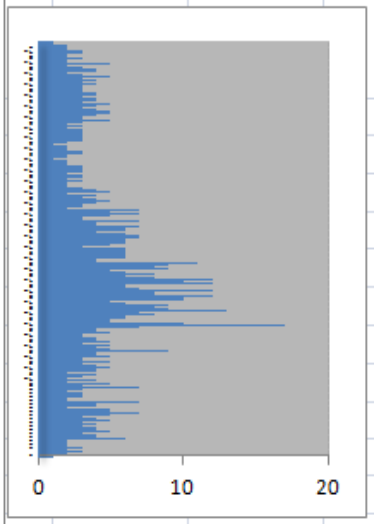




EXAMPLES

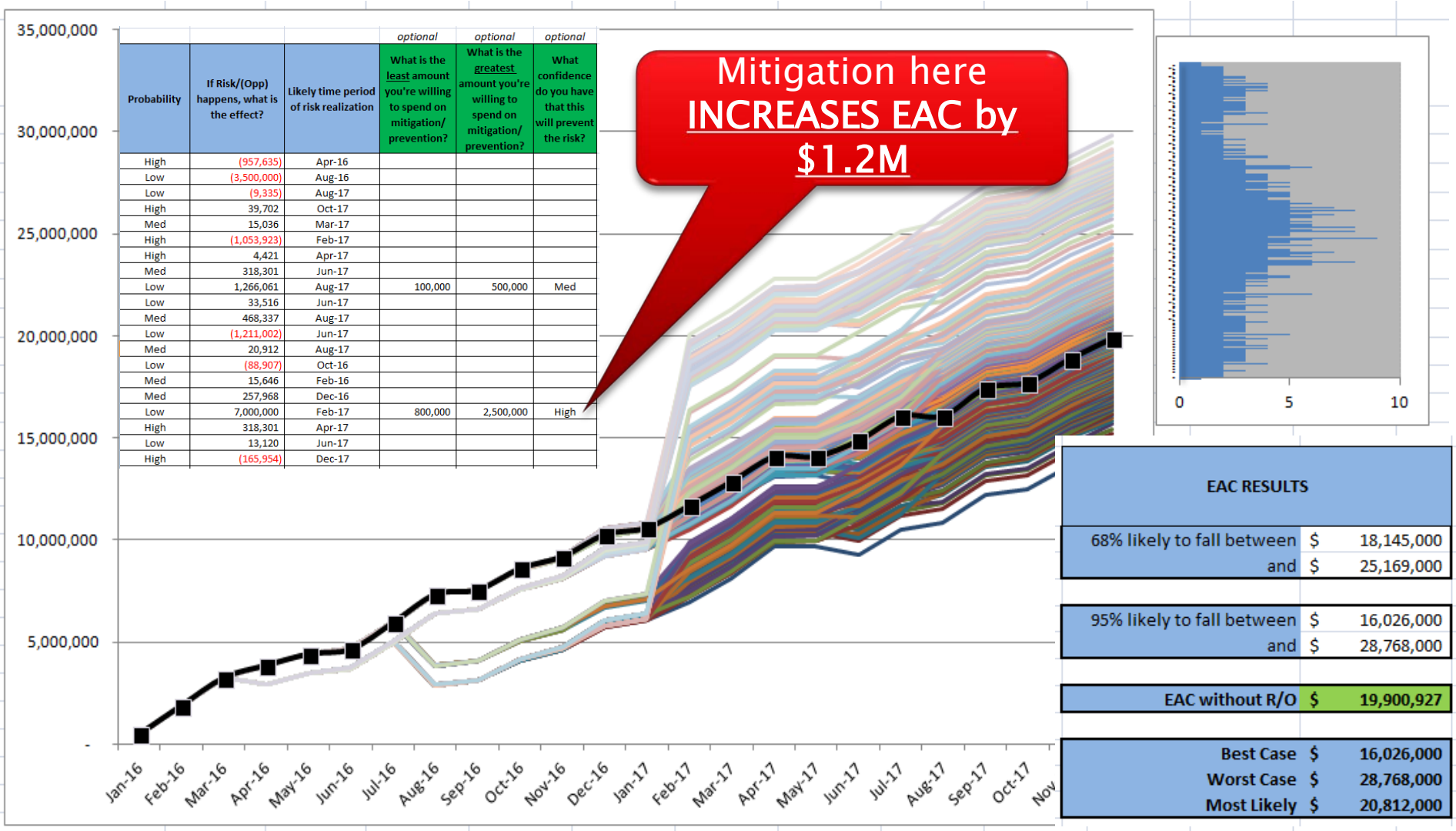


Probability	If Risk/(Opp) happens, what is the effect?	Likely time period of risk realization
High	(957,635)	Apr-16
Low	(3,500,000)	Aug-16
Low	(9,335)	Aug-17
High	39,702	Oct-17
Med	15,036	Mar-17
High	(1,053,923)	Feb-17
High	4,421	Apr-17
Med	318,301	Jun-17
Low	1,266,061	Aug-17
Low	33,516	Jun-17
Med	468,337	Aug-17
Low	(1,211,002)	Jun-17
Med	20,912	Aug-17
Low	(88,907)	Oct-16
Med	15,646	Feb-16
Med	257,968	Dec-16
Low	7,000,000	Feb-17
High	318,301	Apr-17
Low	13,120	Jun-17
High	(165,954)	Dec-17



EAC RESULTS		
68% likely to fall between	$	16,447,000
and	$	24,948,000
95% likely to fall between	$	14,374,000
and	$	27,159,000
EAC without R/O	$	19,900,927
Best Case	$	14,374,000
Worst Case	$	27,159,000
Most Likely	$	19,063,000

EXAMPLES



			optional	optional	optional
Probability	If Risk/(Opp) happens, what is the effect?	Likely time period of risk realization	What is the least amount you're willing to spend on mitigation/ prevention?	What is the greatest amount you're willing to spend on mitigation/ prevention?	What confidence do you have that this will prevent the risk?
High	(957,635)	Apr-16			
Low	(3,500,000)	Aug-16			
Low	(9,335)	Aug-17			
High	39,702	Oct-17			
Med	15,036	Mar-17			
High	(1,053,923)	Feb-17			
High	4,421	Apr-17			
Med	318,301	Jun-17			
Low	1,266,061	Aug-17	100,000	500,000	Med
Low	33,516	Jun-17			
Med	468,337	Aug-17			
Low	(1,211,002)	Jun-17			
Med	20,912	Aug-17			
Low	(88,907)	Oct-16			
Med	15,646	Feb-16			
Med	257,968	Dec-16			
Low	7,000,000	Feb-17	800,000	2,500,000	High
High	318,301	Apr-17			
Low	13,120	Jun-17			
High	(165,954)	Dec-17			

EAC RESULTS		
68% likely to fall between	$	18,145,000
and	$	25,169,000
95% likely to fall between	$	16,026,000
and	$	28,768,000
EAC without R/O	$	19,900,927
Best Case	$	16,026,000
Worst Case	$	28,768,000
Most Likely	$	20,812,000

EAC Multiverse Takeaway

- So how do we do this?
  - Factoring and averaging muddles the data
  - The math to calculate this is—well, it's **hard**. And often impossible.
  - Thanks to the Law of Large Numbers and a little VBA magic, we don't need to do math (fist bump the person next to you)
  - Instead, Excel will literally simulate the program from beginning to end, and roll virtual dice according to each R/O probability
  - It takes about 10,000 iterations of the program to ensure with very high certainty that our cone of probable outcomes is accurate (this is called Monte Carlo simulation)
  - Thankfully, Excel is **really good** at this (another fist bump, please)

Demonstration

ENOUGH TALK!! LET'S SEE THE DATA MODEL IN ACTION

Conclusion

- So what did we learn?
  - Traditional EAC calculations have limited actionable value
  - Cats make for fun scientific experiments
  - If you actively manage and cultivate your R/O's, you can create an EAC multiverse
  - This gives you a much better idea of your cone of probable outcomes
  - This in turn allows you to make better decisions to improve your program, and creates an EAC range with an accurate context
  - Data modeling and simulation do the work so you can focus on R/O management and actually impact your program

Conclusion

REMEMBER—FORECASTING THE FUTURE IS GOOD, BUT

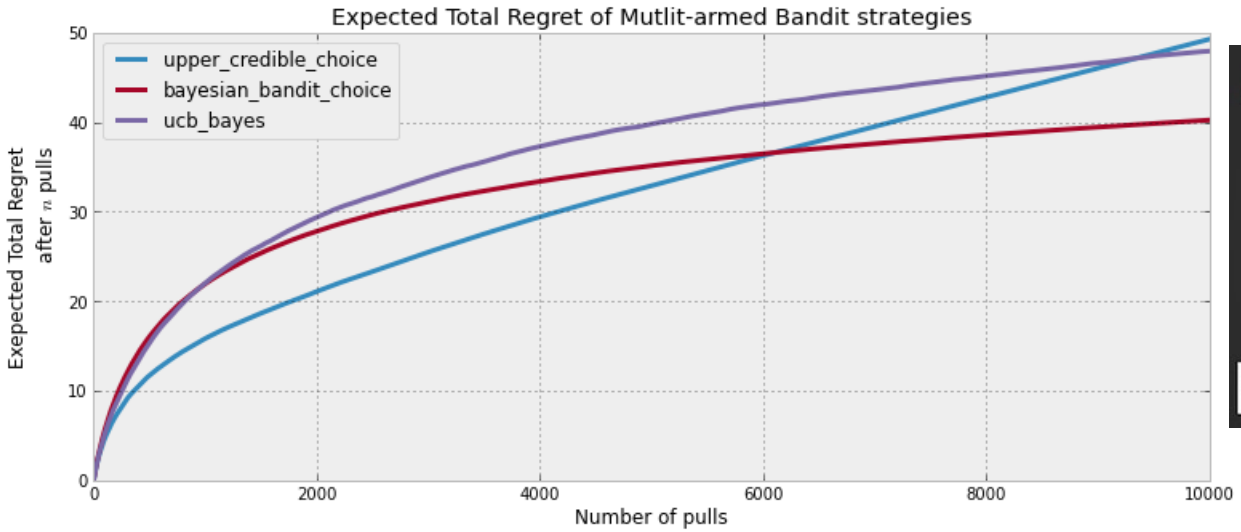
IT'S NOT THIS

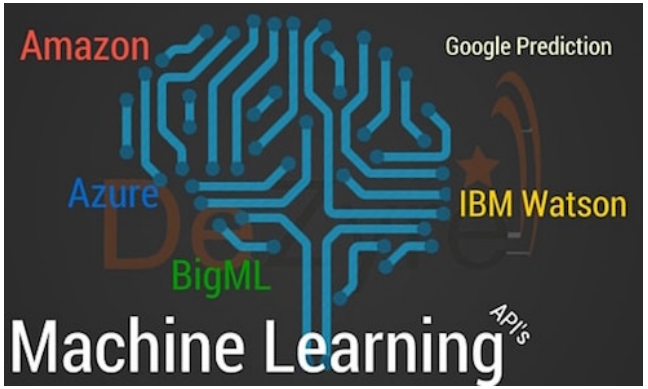
IT'S THIS

Party Favor

- Would you like to try using the data model?
  - If so, please contact me and I will happily send you a copy with instructions
  - I would love any feedback or suggestions for how to improve the process or the tool itself—this is an evolving project!

Preview of Next Version (coming Fall 2017)





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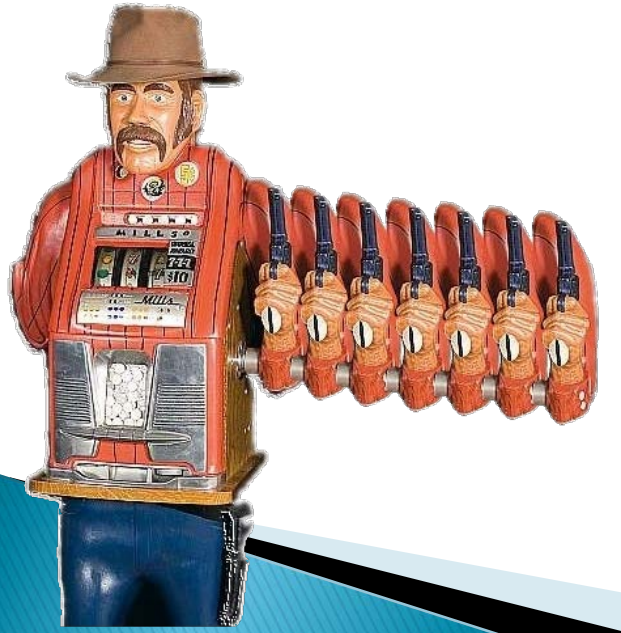

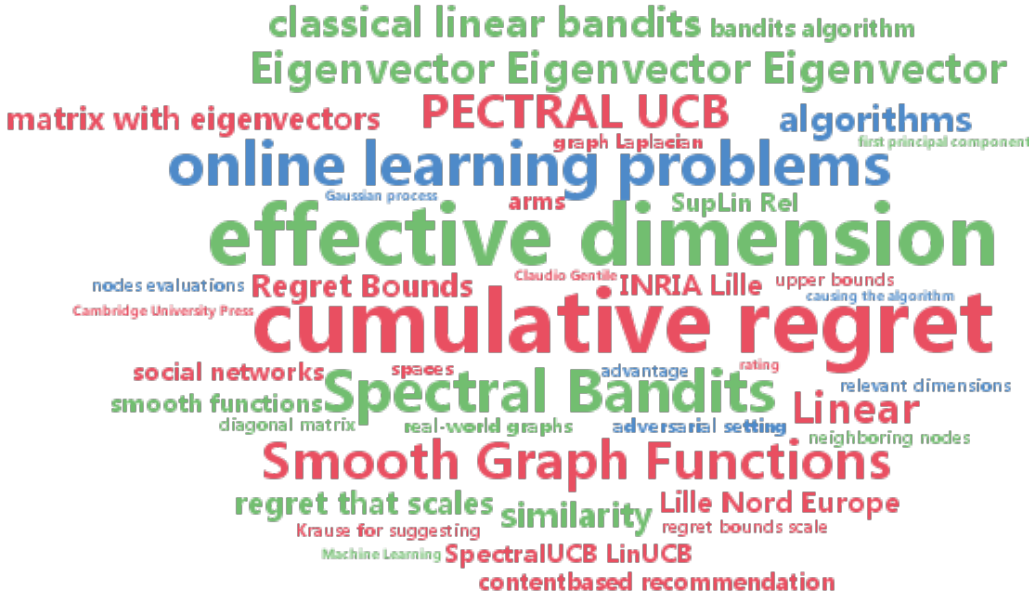

Questions?