Kathryn Bolton, Lara Haase, Nicholas Maier

Management Science II - 90760
Assignment 4

Problem #1: For the data provided (which has 75 alternatives and 10 states of nature, with given probabilities and assuming big numbers are good):

(a) Identify the alternative that wins and its “score” on that criteria for the following decision rules:

(i) Maxi Min,

Row 32, 27

(ii) Maxi Max

Option 55, 99

(iii) Max average value

Option 71, 58

(iv) Max EMV

Option 68, EMV = 62.4

(v) Return to Risk

Option 51, RtR = 2.88

(vi) Sharpe Ratios with risk-free returns of 10

Option 13, SR = 2.21

(vii) Sharpe Ratios with risk-free returns of 40

Option 53, SR = 0.73

(viii) Sharpe Ratios with risk-free returns of 50

Option 53, SR = 0.38

(b) Create a risk-return frontier for the given data by plotting coefficient of variation vs. mean, adding a smiley face in the ideal corner. How many options are on the frontier?

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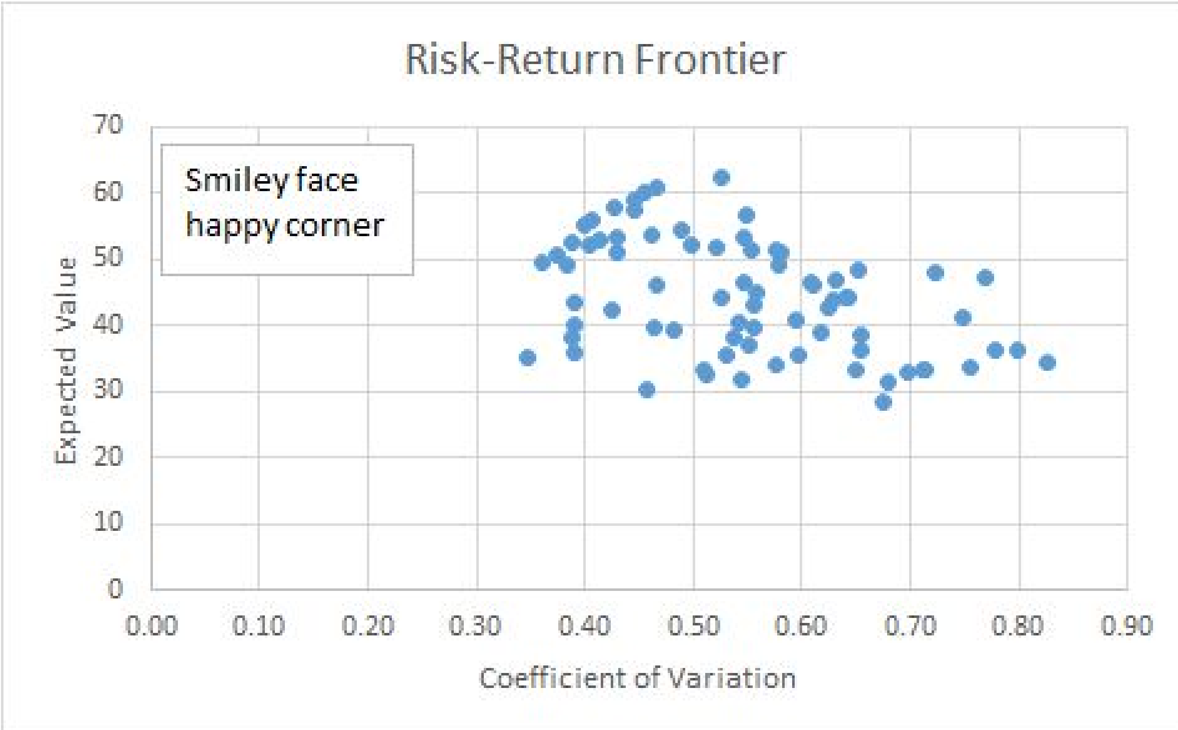

11 options are on the frontier

Problem #2:

Challah for Hunger at Stanford is a non-profit that bakes challah bread each week to sell at $5 per loaf to raise money for charity. It costs $1 to make a loaf. When production exceeds demand, the extra loaves are sold below cost at $0.50 per loaf since they are not good the next week.

Demand is highly variable, but the precise characterization is unknown because CFH's records are imperfect. There are 29 weeks for which CFH recorded both how many loaves were produced and how many were sold, with production exceeding sales, so it knows that demand equaled sales on those weeks. (When it only records sales, it is unclear whether the amount sold reflects demand, or whether sales stopped at that figure because that's all CFH had produced.) Note: There are a few duplicates; e.g., two instances of selling 80, so technically that would be P{ demand is 80 } = 2/29, but it's easier to set up the spreadsheet if you treat it as 29 equally likely levels of demand, some of which happen to equal each other.

Create risk-return frontiers (std dev vs. expected value) for CFH's decision of how many loaves to bake using both MC simulation (2,500 trials) and exact calculations with payoff matrices. Assume the number of loaves must be a multiple of 10 to keep things simple.

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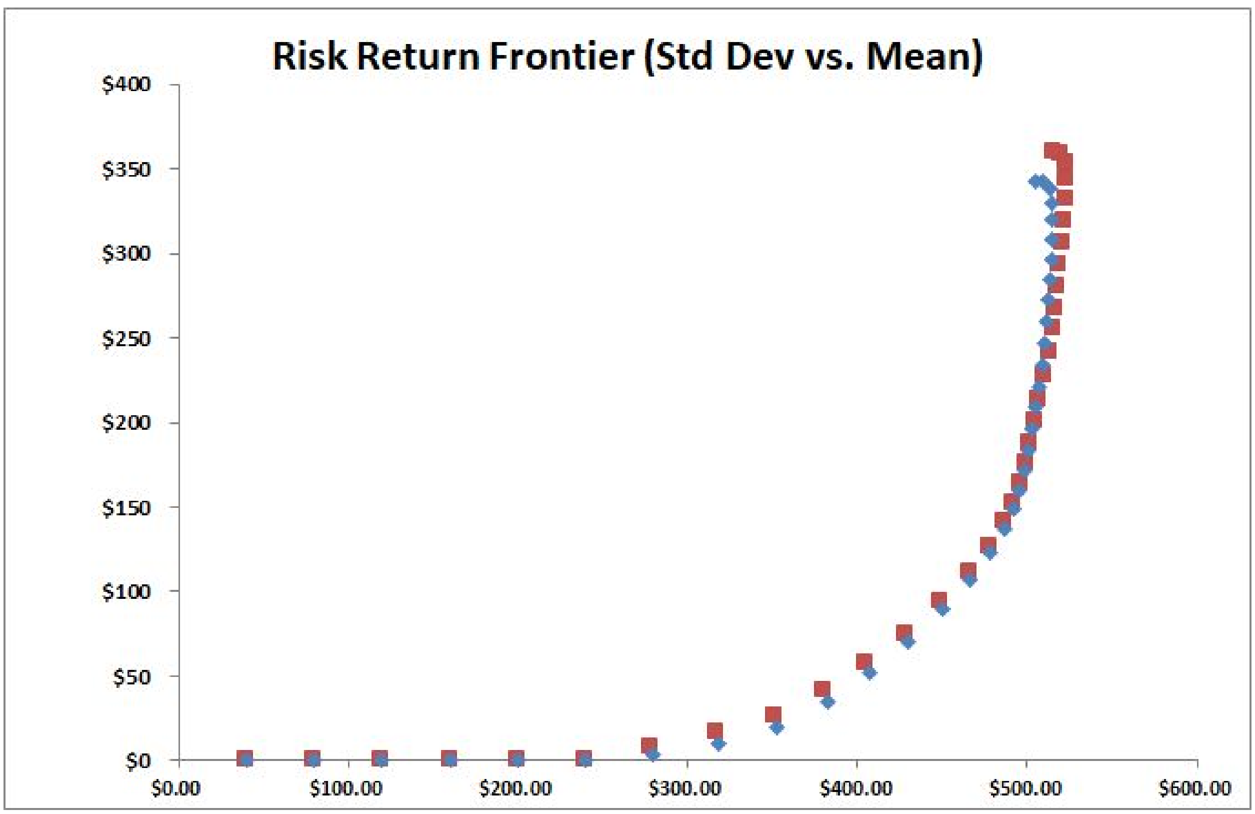
Hint: You can use the Pens shirts, TV ad selling, and/or PCA airline examples as partial templates to work off of. This problem is a little easier because each level of demand is equally likely.

For the exact calculation, you can just have 29 rows (or columns if you prefer that orientation), one for each demand level with all equally likely. For the MC simulation, use the approach shows in Cells A43:F144 of the workbook C12.1 E How to Create RV's in Plain Excel. That is a little different because that approach allows for interpolation between the historical values. The interpolation gives continuous numbers but you can use Excel's =ROUND() function to round them off to the nearest integer.

Submit your frontiers, a screen shot of your models (just enough rows and columns to see the logic), and a couple of sentences summarizing the managerial interpretation of what you see in those frontiers.

Based on these Risk Return Frontiers, the optional solutions are in the bottom right corner, indicating more profit with less risk. Almost all of the options are on the efficient frontier. However, past about $450 of expected value, which would occur for making 130 loaves, the risk begins to increase more rapidly with less gain in profit.



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How many Penguins shirts should be ordered beforer the playoffs?													
$1	Cost to by		cu / (cu + co)										
$5	Sales price now												
$1	Sales price after series is over												
		x = demand											
Level of Demand	60	80	80	84	88	90	96	97	100	102	115	116	125
Probability	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Cumulative Prob	3.45%	6.90%	10.34%	13.79%	17.24%	20.69%	24.14%	27.59%	31.03%	34.48%	37.93%	41.38%	44.83%
DV = # made		Payoff											
10	$40	$40	$40	$40	$40	$40	$40	$40	$40	$40	$40	$40	$40
20	$80	$80	$80	$80	$80	$80	$80	$80	$80	$80	$80	$80	$80
30	$120	$120	$120	$120	$120	$120	$120	$120	$120	$120	$120	$120	$120
40	$160	$160	$160	$160	$160	$160	$160	$160	$160	$160	$160	$160	$160
50	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200	$200
60	$240	$240	$240	$240	$240	$240	$240	$240	$240	$240	$240	$240	$240
70	$235	$280	$280	$280	$280	$280	$280	$280	$280	$280	$280	$280	$280
80	$230	$320	$320	$320	$320	$320	$320	$320	$320	$320	$320	$320	$320
90	$225	$315	$315	$333	$351	$360	$360	$360	$360	$360	$360	$360	$360
100	$220	$310	$310	$328	$346	$355	$382	$387	$400	$400	$400	$400	$400
110	$215	$305	$305	$323	$341	$350	$377	$382	$395	$404	$440	$440	$440
120	$210	$300	$300	$318	$336	$345	$372	$377	$390	$399	$458	$462	$480
130	$205	$295	$295	$313	$331	$340	$367	$372	$385	$394	$453	$457	$498
140	$200	$290	$290	$308	$326	$335	$362	$367	$380	$389	$448	$452	$493
150	$195	$285	$285	$303	$321	$330	$357	$362	$375	$384	$443	$447	$488
160	$190	$280	$280	$298	$316	$325	$352	$357	$370	$379	$438	$442	$483
170	$185	$275	$275	$293	$311	$320	$347	$352	$365	$374	$433	$437	$478
180	$180	$270	$270	$288	$306	$315	$342	$347	$360	$369	$428	$432	$473
190	$175	$265	$265	$283	$301	$310	$337	$342	$355	$364	$423	$427	$468
200	$170	$260	$260	$278	$296	$305	$332	$337	$350	$359	$418	$422	$463
210	$165	$255	$255	$273	$291	$300	$327	$332	$345	$354	$413	$417	$458
220	$160	$250	$250	$268	$286	$295	$322	$327	$340	$349	$408	$412	$453

MC Simulation to determine how many Challah loaves should be made																			
$1	Cost to make																		
$5	Sales price no	Average	$40	$80	$120	$160	$200	$240	$280	$318	$353	$383	$408	$432	$452	$469	$481	$490	$495
$1	Sales price aft	Std Dev	$0	$0	$0	$0	$0	$0	$3	$10	$20	$35	$51	$70	$89	$106	$122	$136	$148
97.026	Demand																		
		# to Order	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
		# Sold now	10	20	30	40	50	60	70	80	90	97.0263	97.0263	97.0263	97.0263	97.0263	97.0263	97.0263	97.0263
Historical		# Sold Later	0	0	0	0	0	0	0	0	0	2.97369	12.9737	22.9737	32.9737	42.9737	52.9737	62.9737	72.9737
60																			
80		Profit	$40	$80	$120	$160	$200	$240	$280	$320	$360	$387	$382	$377	$372	$367	$362	$357	$352
80		1	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$446	$441	$436	$431	$426	$421
84		2	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$480	$515	$510	$505	$500	$495
88		3	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$480	$520	$560	$600	$640	$680
90		4	$40	$80	$120	$160	$200	$240	$280	$320	$346	$341	$336	$331	$326	$321	$316	$311	$306
96		5	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$480	$520	$560	$600	$640	$680
97		6	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$461	$456	$451	$446	$441	$436
100		7	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$480	$520	$560	$600	$608	$603
102		8	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$403	$398	$393	$388	$383	$378	$373
115		9	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$480	$520	$560	$600	$640	$680
116		10	$40	$80	$120	$160	$200	$240	$280	$320	$358	$353	$348	$343	$338	$333	$328	$323	$318
125		11	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$480	$520	$560	$600	$640	$680
132		12	$40	$80	$120	$160	$200	$240	$280	$320	$315	$310	$305	$300	$295	$290	$285	$280	$275
132		13	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$466	$461	$456	$451	$446	$441
139		14	$40	$80	$120	$160	$200	$240	$280	$320	$315	$310	$305	$300	$295	$290	$285	$280	$275
139		15	$40	$80	$120	$160	$200	$240	$280	$320	$315	$310	$305	$300	$295	$290	$285	$280	$275
142		16	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$480	$520	$560	$582	$577	$572
145		17	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$480	$520	$560	$590	$585	$580
153		18	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$480	$520	$560	$600	$596	$591
160		19	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$480	$520	$560	$600	$640	$680
161		20	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$480	$520	$524	$519	$514	$509
162		21	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$480	$520	$560	$600	$640	$680
182		22	$40	$80	$120	$160	$200	$240	$280	$320	$360	$389	$384	$379	$374	$369	$364	$359	$354
249		23	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$480	$520	$560	$600	$640	$660
314		24	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$480	$520	$560	$600	$640	$680
329		25	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$480	$516	$511	$506	$501	$496
335		26	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$480	$513	$508	$503	$498	$493
342		27	$40	$80	$120	$160	$200	$240	$280	$320	$360	$400	$440	$480	$520	$560	$600	$640	$680

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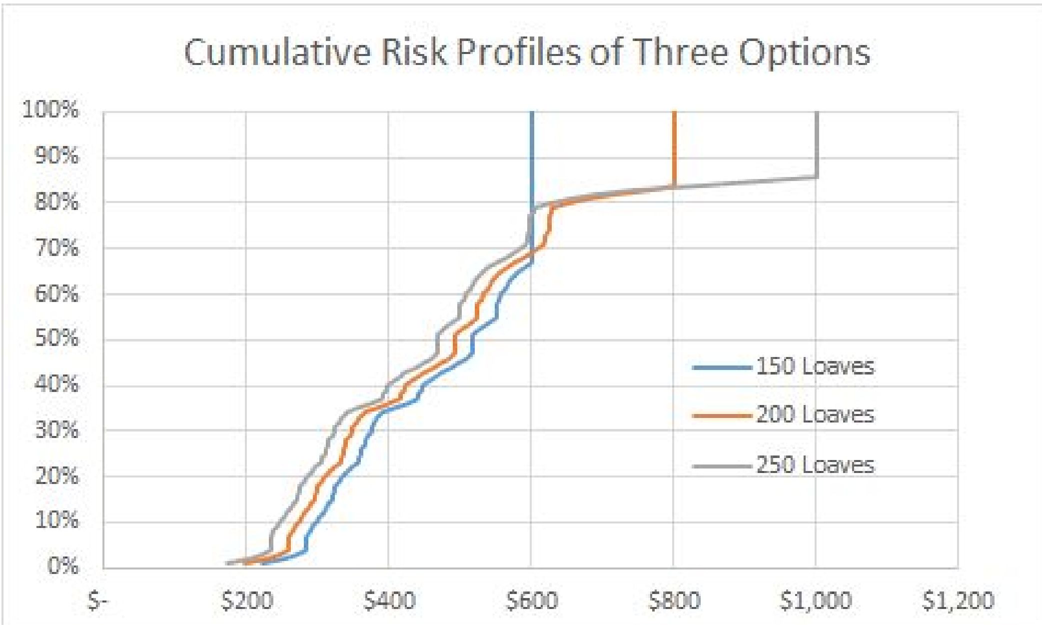
Problem #3:

From the simulation results of the previous problem, create cumulative risk profiles corresponding to baking 150, 200, and 250 loaves (plot all three frontiers on the same graph).

Submit the graph and write a few sentences explaining their shape and relative position.



None of the graphed options is first-order stochastically dominant. The more risk-averse the organization is, the more they should favor making fewer loaves of bread (from among these options), as the smaller the number of loaves, the higher the guaranteed amount of profit (on the left-hand side of the chart). However, the greatest possible profits are possible with the greatest quantities of bread produced.

Problem #4:

Decide how many people to invite to a "party" if each invitee independently has an 85% chance of coming and the payoffs are as indicated in the data workbook for this assignment. (Big numbers are good.) As you can see from those payoffs, more attendees is betterup to 15 attendees. with "bonuses" for being multiples of 4, or close to multiples of 4. You don't need to worry about the logic behind the payoffs though; you can just use those numbers.

You can solve this problem exactly or via Monte Carlo simulation, but either way

a) [Ungraded] First sketch what you think the risk-return frontier will look like based on judgement/intuition

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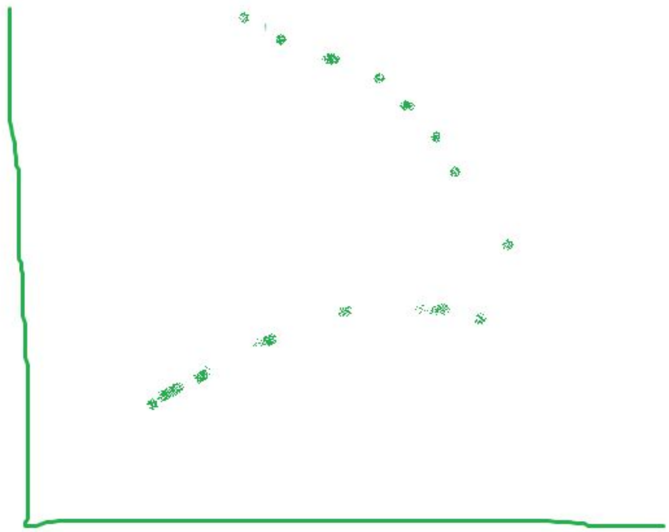
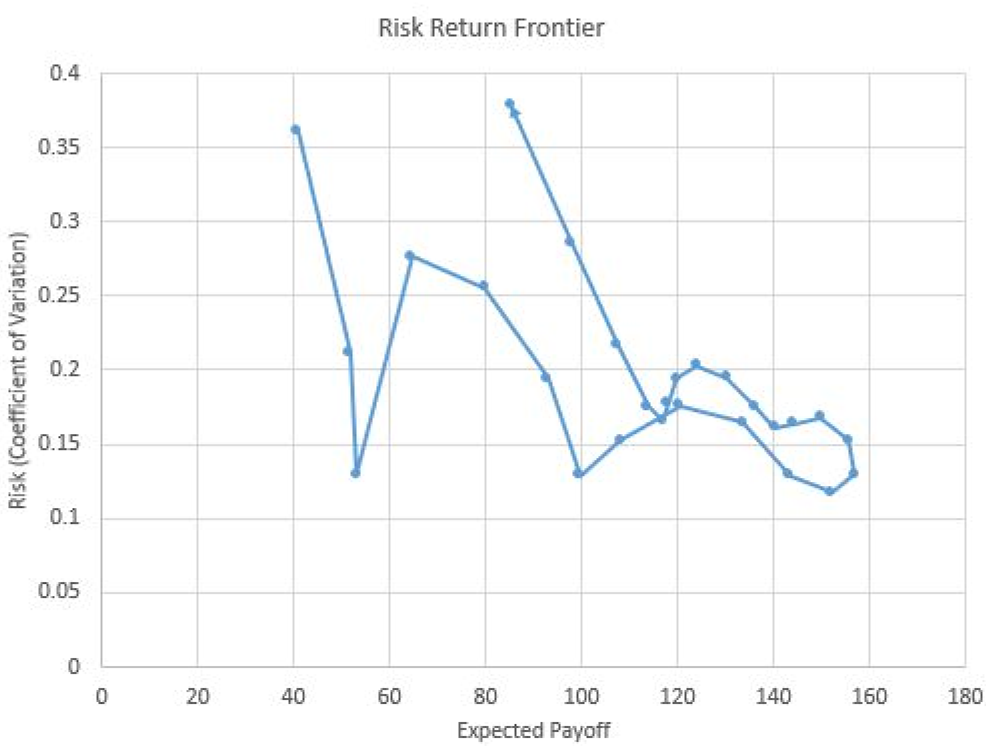


b) Submit a risk-return frontier plotting the coefficient of variation vs. expected value for all possible numbers of invitees ranging from 4 to 30. (Hint: I found it useful to connect the dots with a line and add an arrowhead at the end. That made it easier for me to see how the dots progressed as the number of invitees increased.)



c) You should find that only two possible numbers of invitees are worth considering based on the frontier in part a. State what are those two points and what are their expected values, standard deviations, and coefficients of variation?

Inviting:

15 people: EV = 152.2, SD = 17.85, CoV = 0.12

16 people: EV = 157.1, SD = 20.36, CoV = 0.15

Note: This is an instance in which the analysis can be pretty decisive even without knowing the details of the decision maker's risk preferences.

Problem #5: A common dilemma is how much to bid for the right to complete a project. Suppose that an organization is going to bid on 6 contracts that will each cost $100K to complete. It does not know what its competitors will bid, but suppose that uncertainty can be modeled as six independent draws from a symmetric triangle distribution that runs between $100K and $200K. And to keep the problem simple, suppose that the organization will bid the same price for all six projects, so there is just one decision variable: how much to bid. In addition, the lowest bidder is awarded the contract.

For example, if the organization decides to bid $125K, and the competitors' bids on the six projects are $110K, $120K, $130K, $140K, $150K, and $160K, respectively, then it wins Projects #3, #4, #5, and #6 and makes a profit of $125K - $100K = $25K on each project, for a total profit of $100K. If it had bid $145K it would only have won Projects #5 and #6 but made $45K on each for a total profit of $90K.

Create a Monte Carlo simulation with 10,000 trials to evaluate the 19 strategies of bidding $105K, $110K, …, up to $195K in $5K increments. Note: since the MC template I gave you only has 5 columns you will need to expand it, which is a good test of whether you understand how it works. Remember; You can't modify part of a data table, so you'll want to delete or freeze the body of the data table before trying to insert columns to make it bigger. Submit

a) A screenshot of your model (just the part generating the random variables, the first few columns (up to $115K bids) and first few rows of the simulation data table).

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=U45+(V45-U45)*(RAND()+RAND())/2

U	V	W	X	Y	Z	AA	AB	AC	AD
	Compet		how much bid	105000	110000	115000	120000	125000	130000
	1	141348.616		1	1	1	1	1	1
	2	125313.064		1	1	1	1	1	0
	3	155278.330		1	1	1	1	1	1
	4	137790.821		1	1	1	1	1	1
	5	172898.919		1	1	1	1	1	1
	6	154557.734		1	1	1	1	1	1
a	b		profitperP	5000	10000	15000	20000	25000	30000
100000	200000		Pswon	6	6	6	6	6	5
			PROFIT	30000	60000	90000	120000	150000	150000

	A	B	C	D	E	F	G	H
1	**Data Table based simulation.**							
2	Average	$29,860	$58,738.00	$85,858.50	$110,286.00	$131,302.50	$147,441.00	$157,993.50
3	Std Dev	$834	$ 3,482.61	$ 7,590.87	$ 13,264.08	$ 19,993.90	$ 27,780.55	$ 36,720.18
4	Median	$30,000	$60,000.00	$90,000.00	$120,000.00	$125,000.00	$150,000.00	$175,000.00
5	95% CI for Mean							
6	Lower	29843.6546	$58,669.74	$85,709.72	$110,026.02	$130,910.62	$146,896.50	$157,273.78
7	Upper	29876.3454	$58,806.26	$86,007.28	$110,545.98	$131,694.38	$147,985.50	$158,713.22
8	Percentiles							
9	5%	$30,000	$50,000.00	$75,000.00	$ 80,000.00	$100,000.00	$ 90,000.00	$105,000.00
10	10%	$30,000	$50,000.00	$75,000.00	$100,000.00	$100,000.00	$120,000.00	$105,000.00
11	20%	$30,000	$60,000.00	$75,000.00	$100,000.00	$125,000.00	$120,000.00	$140,000.00
12	30%	$30,000	$60,000.00	$90,000.00	$100,000.00	$125,000.00	$150,000.00	$140,000.00
13	40%	$30,000	$60,000.00	$90,000.00	$120,000.00	$125,000.00	$150,000.00	$140,000.00
14	50%	$30,000	$60,000.00	$90,000.00	$120,000.00	$125,000.00	$150,000.00	$175,000.00
15	60%	$30,000	$60,000.00	$90,000.00	$120,000.00	$150,000.00	$150,000.00	$175,000.00
16	70%	$30,000	$60,000.00	$90,000.00	$120,000.00	$150,000.00	$150,000.00	$175,000.00
17	80%	$30,000	$60,000.00	$90,000.00	$120,000.00	$150,000.00	$180,000.00	$175,000.00
18	90%	$30,000	$60,000.00	$90,000.00	$120,000.00	$150,000.00	$180,000.00	$210,000.00
19	95%	$30,000	$60,000.00	$90,000.00	$120,000.00	$150,000.00	$180,000.00	$210,000.00
20								
21								
22	**Output to Simulate (In a Row 24 Cell, Type "=" then point to cell whose output you want to simulate**							
23		Output #1	Output #2	Output #3	Output #4	Output #5	Output #6	Output #7
24	Trial	$30,000.00	$60,000.00	$90,000.00	$120,000.00	$150,000.00	$150,000.00	$175,000.00
25	1	$30,000.00	$60,000.00	$90,000.00	$120,000.00	$125,000.00	$150,000.00	$175,000.00
26	2	$30,000.00	$60,000.00	$90,000.00	$120,000.00	$150,000.00	$180,000.00	$210,000.00
27	3	$25,000.00	$50,000.00	$75,000.00	$100,000.00	$ 75,000.00	$ 90,000.00	$105,000.00
28	4	$30,000.00	$60,000.00	$90,000.00	$120,000.00	$150,000.00	$180,000.00	$175,000.00
29	5	$30,000.00	$60,000.00	$90,000.00	$120,000.00	$125,000.00	$120,000.00	$140,000.00
30	6	$30,000.00	$60,000.00	$60,000.00	$ 80,000.00	$100,000.00	$120,000.00	$140,000.00
31	7	$30,000.00	$60,000.00	$90,000.00	$120,000.00	$150,000.00	$180,000.00	$175,000.00

b) A risk-return frontier plotting standard deviation vs. expected profit

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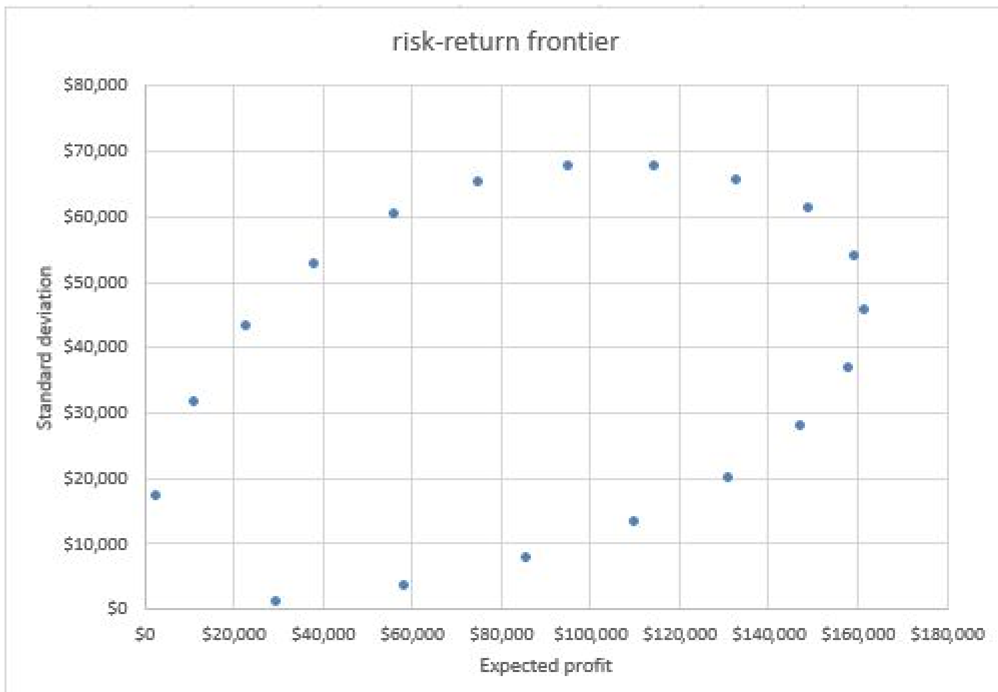


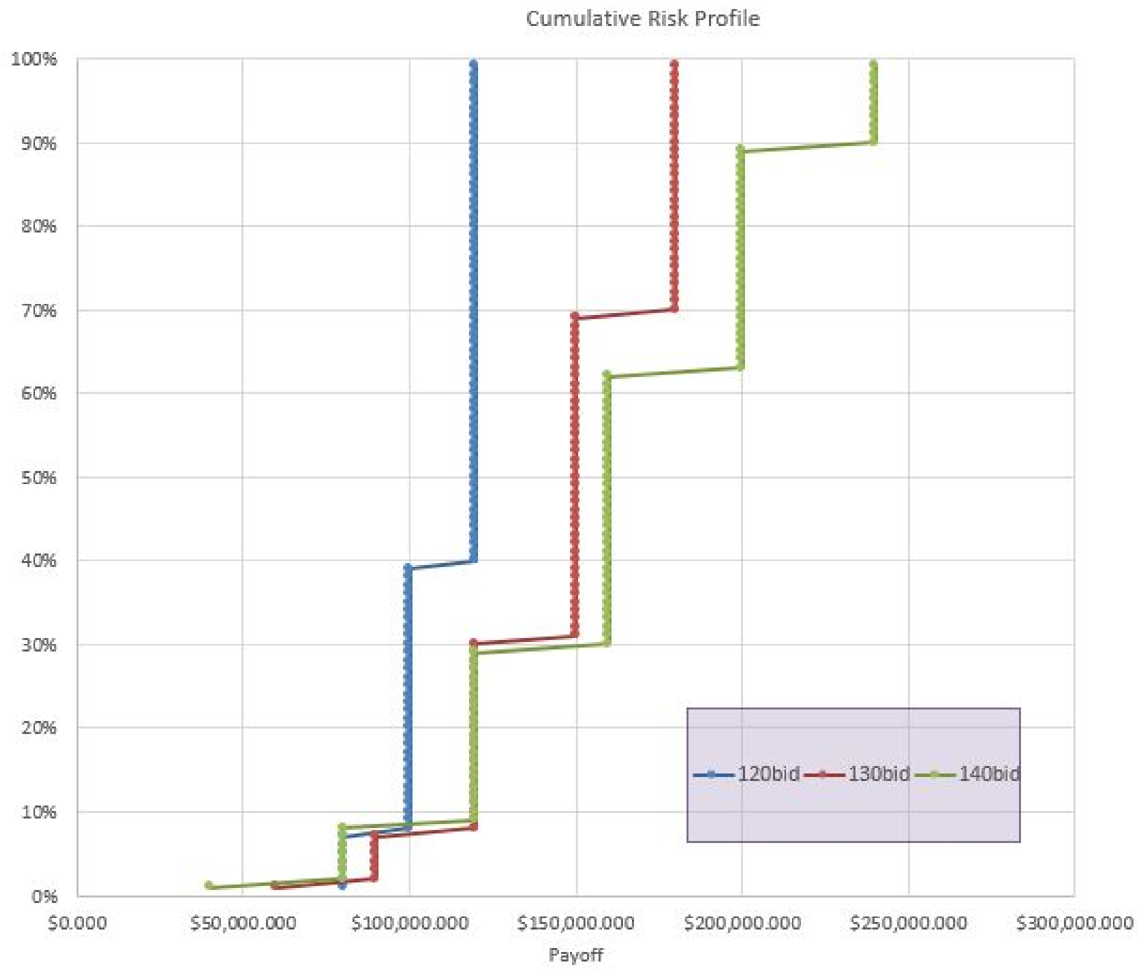
c) State the bid amount that maximizes expected profit

$140,000

d) State the expected value and standard deviation of bidding $125K

$131,302.50 EV and $19,993.90 standard deviation

e) Create cumulative risk profiles for bidding $120K, $130K, and $140K (plot on one graph).



Problem #6: This problem looks at scheduling of surgical procedures. Some surgical centers use predictive analytics to forecast which surgeries are likely to run long or short, but many have not jumped on that possibility, or the associated decisions about in what order surgeries should be scheduled. This problem imagines that there are ten surgeries to be scheduled into consecutive one-hour blocks. All surgeries have actual times that have a triangle distribution, five that will tend to run a little short (between 0.75 and 1.1 hours with the most likely time being 0.9 hours) and five that will tend to run a little long (0.9 to 1.25 with 1.1 being most likely).

To save you time, I've set up the model for you. It simulates three scheduling strategies: (1) Five short first, then five long; (2) Five long first, then five short; and (3) Alternating long, short, long short. For each, the SS tracks three outputs: (1) Total amount of lateness, (2) By how much the 10th scheduled surgery overshoots intended end time (so amount of overtime labor), and (3) the number of surgeries that are late. (The last is important because when a surgery starts late, it can foul up the schedule of the anesthesiologist, who is typically supporting multiple operating rooms, and so create situations in which delays in OR Room A spill over and cause disruptions in the schedule of OR Room B.)

Connect the model to a simulation, and run 10,000 MC trials, and report a table with the expected value for each of the three outcomes for each of the three scheduling strategies, and the 95% confidence intervals for these expected values. (Since a surgical center operates for many hundreds of days, this time it is appropriate to look at the CI for the expected value.)

Note whether the differences are statistically significant in the sense that the 95% CI's for these quantities do not overlap.

Then write a paragraph summarizing which strategies perform best with respect to each outcome and why.

	Total Lateness	Lower Bound	Upper Bound	Overtime	Lower Bound	Upper Bound	# surgeries late	Lower Bound	Upper Bound
Shortest First	1.34	1.33	1.35	0.43	0.43	0.43	5.61	5.59	5.63
Longest First	2.31	2.29	2.34	0.09	0.09	0.10	8.76	8.73	8.79
Alternating	1.18	1.17	1.19	0.38	0.38	0.38	5.91	5.88	5.93

First, we can note that the differences are statistically significant in the sense that 95% CI's for all the outcomes do not overlap. In regards to total lateness, the Alternating strategy works **best**, minimizing the total amount of lateness that will occur in a day. Although Longest First performs the **worst** for total lateness, it performs the **best** in regard to the amount of overtime that is accrued at the end of the day. The Shortest First strategy ***edges out*** Alternating to perform the **best** on the number of surgeries late metric. Since different strategies do the **best** at optimizing the three different goals, decision-makers would need to assess relative priorities/costs to determine which strategy to choose.