HW 5 – Business Analytics (6 pts maximum)

This homework is due before class 6. Please submit two files: your write-up and your Excel file. If you make any additional assumptions, state them clearly.

To solve the problem, you will need to do the following:

A. Use the Generalized Analytics Procedure (GAP) to set up your problem as follows:
   i. Define your model in words
      1. Identify the firm's/manager's objective function in words
      2. Identify the decision variables in words
      3. Identify the random variables (risk sources)
      4. Identify the constraints (optional here)
   ii. Formulate your model mathematically
      1. Define the decision variables
      2. Define the random variables (risk sources). What is the probability distribution of those random variables?
      3. Define objective function in terms of decision variables and random variables.
      4. Define the constraints (optional here)
   iii. Solve the problem in Excel
      1. Generate **MANY (>=5000)** random draws from the specified distribution (see step ii.2 above)
      2. For each random draw calculate the objective function value
      3. Try different values for your decision variable and choose the value of decision variable that results in the highest objective function value, on average.
B. Answer the questions stated in the problem (in words).

Note: I recommend starting with the GAP (Steps i and ii above). However, if you prefer to go straight to Excel, points will not be deducted.

Beyond Armor

The Baltimore-based company Beyond Armor (BA) is exploring a new business opportunity: selling custom screen-printed sweatshirts for college football bowl games. BA is trying to determine how many sweatshirts to produce for the upcoming Tangerine Bowl game. During the month before the game, BA plans to sell their sweatshirts for $30 each. At this price, they believe the demand for sweatshirts will be uniformly distributed between 5,000 and 15,000.

One month after the game, BA plans to sell any remaining sweatshirts to the local TJ Maxx and Marshalls outlets for $12 each. At this price, BA believes they will be able to sell either 500 units with probability 30%, or 750 units with probability 40%, or 1000 units with probability 30%.

Any remaining sweatshirts will be donated to a local charity.

BA can order custom screen-printed sweatshirts for $10 per sweatshirt in lot sizes of 200. Use simulation modeling to answer the following questions.

# Selling units	500	750	1000
Prob.	0.3	0.4	0.3
Cum prob.	0.3	0.7	1

(a) Determine the average profit that BA would earn if she ordered 10,000 sweatshirts.

Since two variables we cannot decide, which are before games demands and after games demands, they are random variables.

Trial	BG_Sweatshirt	BG_Demand	BG_Revenue	# Remaining_Sweatshirt	Unif[0,1]	AG_Demand	AG_Revenue	Total_Revenue	Total_Cost	Total_Profits			BG_Price	30	
1	10000	6402	192060	3598	0.76579	1000	12000	204060	100000	104060			AG_Price	12	
2	10000	7750	232500	2250	0.18003	500	6000	238500	100000	138500			Cost	10	
3	10000	8399	251970	1601	0.07285	500	6000	257970	100000	157970			Min demand BG	5000	
4	10000	6277	188310	3723	0.03671	500	6000	194310	100000	94310			Max demand BG	15000	
5	10000	7505	225150	2495	0.09994	500	6000	231150	100000	131150			Demand AG	units	prob
6	10000	9973	299190	27	0.66584	750	9000	308190	100000	208190				500	0.3
7	10000	9344	280320	656	0.17799	500	6000	286320	100000	186320				750	0.7
8	10000	5224	156720	4776	0.8748	1000	12000	168720	100000	68720				1000	1
9	10000	5079	152370	4921	0.84091	1000	12000	164370	100000	64370					
10	10000	8354	250620	1646	0.36289	750	9000	259620	100000	159620					
11	10000	9444	283320	556	0.76431	1000	12000	295320	100000	195320					
12	10000	7742	232260	2258	0.76373	1000	12000	244260	100000	144260			sweatshirt order	10000	
13	10000	8719	261570	1281	0.40506	750	9000	270570	100000	170570			average profits	134407.664	
14	10000	7959	238770	2041	0.06753	500	6000	244770	100000	144770					
15	10000	5312	159360	4688	0.33823	750	9000	168360	100000	68360					
16	10000	7261	217830	2739	0.60246	750	9000	226830	100000	126830					
17	10000	5069	152070	4931	0.37088	750	9000	161070	100000	61070					
18	10000	7249	217470	2751	0.37902	750	9000	226470	100000	126470					
19	10000	8943	268290	1057	0.85654	1000	12000	280290	100000	180290					
20	10000	8902	267060	1098	0.49279	750	9000	276060	100000	176060					

Trial	BG_Sweatshirt	BG_Demand	BG_Revenue	# Remaining_Sweatshirt	Unif[0,1]	AG_Demand	AG_Revenue	Total_Revenue	Total_Cost	Total_Profits			BG_Price	30	
1	=$O$13	=RANDBETWEEN(5000,100	=C2*$O$1	=B2-C2	=RAND()	=IF(F2<$P$7,$O$7,IF(F2<$	=G2*$O$2	=H2+D2	=B7*$O$3	=I2-J2			AG_Price	12	
2	=$O$13	=RANDBETWEEN(5000,100	=C3*$O$1	=B3-C3	=RAND()	=IF(F3<$P$7,$O$7,IF(F3<$	=G3*$O$2	=H3+D3	=B3*$O$3	=I3-J3			Cost	10	
3	=$O$13	=RANDBETWEEN(5000,100	=C4*$O$1	=B4-C4	=RAND()	=IF(F4<$P$7,$O$7,IF(F4<$	=G4*$O$2	=H4+D4	=B4*$O$3	=I4-J4			Min demand BG	5000	
4	=$O$13	=RANDBETWEEN(5000,100	=C5*$O$1	=B5-C5	=RAND()	=IF(F5<$P$7,$O$7,IF(F5<$	=G5*$O$2	=H5+D5	=B5*$O$3	=I5-J5			Max demand BG	15000	
5	=$O$13	=RANDBETWEEN(5000,100	=C6*$O$1	=B6-C6	=RAND()	=IF(F6<$P$7,$O$7,IF(F6<$	=G6*$O$2	=H6+D6	=B6*$O$3	=I6-J6			Demand AG	units	prob
6	=$O$13	=RANDBETWEEN(5000,100	=C7*$O$1	=B7-C7	=RAND()	=IF(F7<$P$7,$O$7,IF(F7<$	=G7*$O$2	=H7+D7	=B7*$O$3	=I7-J7				500	0.3
7	=$O$13	=RANDBETWEEN(5000,100	=C8*$O$1	=B8-C8	=RAND()	=IF(F8<$P$7,$O$7,IF(F8<$	=G8*$O$2	=H8+D8	=B8*$O$3	=I8-J8				750	0.7
8	=$O$13	=RANDBETWEEN(5000,100	=C9*$O$1	=B9-C9	=RAND()	=IF(F9<$P$7,$O$7,IF(F9<$	=G9*$O$2	=H9+D9	=B9*$O$3	=I9-J9				1000	1
9	=$O$13	=RANDBETWEEN(5000,100	=C10*$O$1	=B10-C10	=RAND()	=IF(F10<$P$7,$O$7,IF(F10<	=G10*$O$2	=H10+D10	=B10*$O$3	=I10-J10					
10	=$O$13	=RANDBETWEEN(5000,100	=C11*$O$1	=B11-C11	=RAND()	=IF(F11<$P$7,$O$7,IF(F11<	=G11*$O$2	=H11+D11	=B11*$O$3	=I11-J11					
11	=$O$13	=RANDBETWEEN(5000,100	=C12*$O$1	=B12-C12	=RAND()	=IF(F12<$P$7,$O$7,IF(F12<	=G12*$O$2	=H12+D12	=B12*$O$3	=I12-J12					
12	=$O$13	=RANDBETWEEN(5000,100	=C13*$O$1	=B13-C13	=RAND()	=IF(F13<$P$7,$O$7,IF(F13<	=G13*$O$2	=H13+D13	=B13*$O$3	=I13-J13			sweatshirt order	10000	
13	=$O$13	=RANDBETWEEN(5000,100	=C14*$O$1	=B14-C14	=RAND()	=IF(F14<$P$7,$O$7,IF(F14<	=G14*$O$2	=H14+D14	=B14*$O$3	=I14-J14			average profits	=AVERAGE(K2:K10001)	
14	=$O$13	=RANDBETWEEN(5000,100	=C15*$O$1	=B15-C15	=RAND()	=IF(F15<$P$7,$O$7,IF(F15<	=G15*$O$2	=H15+D15	=B15*$O$3	=I15-J15					
15	=$O$13	=RANDBETWEEN(5000,100	=C16*$O$1	=B16-C16	=RAND()	=IF(F16<$P$7,$O$7,IF(F16<	=G16*$O$2	=H16+D16	=B16*$O$3	=I16-J16					
16	=$O$13	=RANDBETWEEN(5000,100	=C17*$O$1	=B17-C17	=RAND()	=IF(F17<$P$7,$O$7,IF(F17<	=G17*$O$2	=H17+D17	=B17*$O$3	=I17-J17					
17	=$O$13	=RANDBETWEEN(5000,100	=C18*$O$1	=B18-C18	=RAND()	=IF(F18<$P$7,$O$7,IF(F18<	=G18*$O$2	=H18+D18	=B18*$O$3	=I18-J18					
18	=$O$13	=RANDBETWEEN(5000,100	=C19*$O$1	=B19-C19	=RAND()	=IF(F19<$P$7,$O$7,IF(F19<	=G19*$O$2	=H19+D19	=B19*$O$3	=I19-J19					
19	=$O$13	=RANDBETWEEN(5000,100	=C20*$O$1	=B20-C20	=RAND()	=IF(F20<$P$7,$O$7,IF(F20<	=G20*$O$2	=H20+D20	=B20*$O$3	=I20-J20					
20	=$O$13	=RANDBETWEEN(5000,100	=C21*$O$1	=B21-C21	=RAND()	=IF(F21<$P$7,$O$7,IF(F21<	=G21*$O$2	=H21+D21	=B21*$O$3	=I21-J21					

Using the simulation, we get the average profits that BA would earn is $ 134407.664.

(b) How many sweatshirts would you recommend BA order to maximize expected profit? What is the maximum expected profit? (Hint: BA orders in lot size of 200. Play with the number of lots.)

Trial	BG_Sweatshirt	BG_Demand	BG_Revenue	# Remaining_Sweatshirt	Unif[0,1]	AG_Demand	AG_Revenue	Total_Revenue	Total_Cost	Total_Profits						
1	10000	5480	164400	4520	0.92803872	1000	12000	176400	100000	76400				BG_Price	30	
2	10000	757	22710	9243	0.10167633	500	6000	28710	100000	-71290				AG_Price	12	
3	10000	5885	176550	4115	0.53881956	750	9000	185550	100000	85550				Cost	10	
4	10000	3574	107220	6426	0.82691775	1000	12000	119220	100000	19220				Min demand BG	5000	
5	10000	7458	223740	2542	0.07388949	500	6000	229740	100000	129740				Max demand BG	15000	
6	10000	4369	131070	5631	0.9859738	1000	12000	143070	100000	43070				Demand AG	units	prob
7	10000	6065	181950	3935	0.98673675	1000	12000	193950	100000	93950					500	0.3
8	10000	4232	126960	5768	0.64874388	750	9000	135960	100000	35960					750	0.7
9	10000	9423	282690	577	0.76754729	1000	12000	294690	100000	194690					1000	1
10	10000	6995	209850	3005	0.47718504	750	9000	218850	100000	118850						
11	10000	3876	116280	6124	0.28973422	500	6000	122280	100000	22280						

We will use a table series starting from 5000 with a step value 200, and to 15000.

Using the former analysis to simulate possible profits from 10000 trials assuming ordered clothing is 10000, we then calculate the average profits.

sweatshirt order	avg. profits
10000	60111.863
5000	56360.435
5200	59104.631
5400	57671.99
5600	59250.305
5800	58758.869
6000	59862.014
6200	57570.587
6400	58929.836
6600	58919.135
6800	58284.821
7000	59750.747
7200	58067.657
7400	59699.852
7600	59715.071
7800	58715.051
8000	59507.363
8200	58639.964
8400	58640.81
8600	59870.222
8800	60578.903
9000	58616.318
9200	58002.284
9400	60686.702
9600	58525.787
9800	58043.939
10000	57922.067
10200	60880.847
10400	59283.656
10600	59102.249
10800	58707.869
11000	59856.161
11200	59656.802
11400	60302.981
11600	59760.098
11800	59025.608
12000	58838.408
12200	58873.907
12400	58662.062
12600	59943.932
12800	59756.399
13000	60224.483
13200	59046.035
13400	58759.028
13600	56389.352
13800	59093.759
14000	58347.827
14200	58471.961
14400	59052.488
14600	58250.105
14800	59068.421
15000	60022.904
max profits	60880.847
optimal # order	10200

sweatshirt order	avg. profits
10000	=AVERAGE(K2:K10001)
5000	=TABLE(,O14)
5200	=TABLE(,O14)
5400	=TABLE(,O14)
5600	=TABLE(,O14)
5800	=TABLE(,O14)
6000	=TABLE(,O14)
6200	=TABLE(,O14)
6400	=TABLE(,O14)
6600	=TABLE(,O14)
6800	=TABLE(,O14)
7000	=TABLE(,O14)
7200	=TABLE(,O14)
7400	=TABLE(,O14)
7600	=TABLE(,O14)
7800	=TABLE(,O14)
8000	=TABLE(,O14)
8200	=TABLE(,O14)
8400	=TABLE(,O14)
8600	=TABLE(,O14)
8800	=TABLE(,O14)
9000	=TABLE(,O14)
9200	=TABLE(,O14)
9400	=TABLE(,O14)
9600	=TABLE(,O14)
9800	=TABLE(,O14)
10000	=TABLE(,O14)
10200	=TABLE(,O14)
10400	=TABLE(,O14)
10600	=TABLE(,O14)
10800	=TABLE(,O14)
11000	=TABLE(,O14)
11200	=TABLE(,O14)
11400	=TABLE(,O14)
11600	=TABLE(,O14)
11800	=TABLE(,O14)
12000	=TABLE(,O14)
12200	=TABLE(,O14)
12400	=TABLE(,O14)
12600	=TABLE(,O14)
12800	=TABLE(,O14)
13000	=TABLE(,O14)
13200	=TABLE(,O14)
13400	=TABLE(,O14)
13600	=TABLE(,O14)
13800	=TABLE(,O14)
14000	=TABLE(,O14)
14200	=TABLE(,O14)
14400	=TABLE(,O14)
14600	=TABLE(,O14)
14800	=TABLE(,O14)
15000	=TABLE(,O14)
max profits	=MAX(P15:P65)
optimal # order	=INDEX($O$15:$O$67,MATCH($P$66,$P$15:$P$67,0))

And then we can use data what if analysis and use index and match formula to find the ideal order number which is 10200,(51 lots) . And the maximum profit is 60881.

(c) Due to an outbreak of a novel infectious disease, there will a 50% chance that all sport events will be held without live audience. If that happens, you will not be able to sell any sweatshirts for $30, and instead will only be able to sell to TJ Maxx and Marshalls (in the same quantity as in the original problem formulation). You are not sure whether all sport events will be held without live audience before making the ordering decision. How many sweatshirts would you recommend BA order to maximize average profit? Is the venture still profitable?

Trial	BG_Sweatshirt	BG_Demand	BG_Revenue	# Remaining_Sweatshirt	Unif[0,1]	AG_Demand	AG_Revenue	Total_Revenue	Total_Cost	Total_Profits
1	10000	0	0	10000	0.543	750	9000	9000	100000	-91000
95	10000	0	0	10000	0.74178	1000	12000	12000	100000	-88000
4999	10000	0	0	10000	0.93463	1000	12000	12000	100000	-88000
5000	10000	4752	142560	5248	0.75412	1000	12000	154560	100000	54560
5001	10000	3491	104730	6509	0.40709	750	9000	113730	100000	13730
5002	10000	2555	76650	7445	0.64257	750	9000	85650	100000	-14350
5003	10000	8017	240510	1983	0.75118	1000	12000	252510	100000	152510
5004	10000	5008	150240	4992	0.19432	500	6000	156240	100000	56240
5005	10000	414	12420	9586	0.2688	500	6000	18420	100000	-81580
5006	10000	1921	57630	8079	0.18945	500	6000	63630	100000	-36370

Here we set trial 1-5000 to be zero demand before game to simulate the situation that there is a 50% chance the game will be held without live audience.

sweatshirt order	avg. profits	sweatshirt order	avg. profits
10000	-14727.123	10000	=AVERAGE(K1:K10000)
5000	-17107.141	5000	=TABLE(,O13)
5200	-15915.581	5200	=TABLE(,O13)
5400	-16186.883	5400	=TABLE(,O13)
5600	-15425.173	5600	=TABLE(,O13)
5800	-15514.203	5800	=TABLE(,O13)
6000	-16683.255	6000	=TABLE(,O13)
6200	-15835.032	6200	=TABLE(,O13)
6400	-15751.443	6400	=TABLE(,O13)
6600	-15819.757	6600	=TABLE(,O13)
6800	-15525.905	6800	=TABLE(,O13)
7000	-15332.703	7000	=TABLE(,O13)
7200	-13990.78	7200	=TABLE(,O13)
7400	-15691.446	7400	=TABLE(,O13)
7600	-14957.948	7600	=TABLE(,O13)
7800	-14247.753	7800	=TABLE(,O13)
8000	-16871.446	8000	=TABLE(,O13)
8200	-15681.224	8200	=TABLE(,O13)
8400	-16426.562	8400	=TABLE(,O13)
8600	-15084.851	8600	=TABLE(,O13)
8800	-15555.092	8800	=TABLE(,O13)
9000	-14522.592	9000	=TABLE(,O13)
9200	-15664.959	9200	=TABLE(,O13)
9400	-15604.584	9400	=TABLE(,O13)
9600	-15343.876	9600	=TABLE(,O13)
9800	-16528.011	9800	=TABLE(,O13)
10000	-15723.987	10000	=TABLE(,O13)
10200	-15433.417	10200	=TABLE(,O13)
10400	-16295.833	10400	=TABLE(,O13)
10600	-15973.447	10600	=TABLE(,O13)
10800	-16393.564	10800	=TABLE(,O13)
11000	-15790.42	11000	=TABLE(,O13)
11200	-16189.025	11200	=TABLE(,O13)
11400	-16251.563	11400	=TABLE(,O13)
11600	-15923.648	11600	=TABLE(,O13)
11800	-17004.2	11800	=TABLE(,O13)
12000	-16677.129	12000	=TABLE(,O13)
12200	-16452.457	12200	=TABLE(,O13)
12400	-16749.517	12400	=TABLE(,O13)
12600	-16176.535	12600	=TABLE(,O13)
12800	-15202.67	12800	=TABLE(,O13)
13000	-17007.129	13000	=TABLE(,O13)
13200	-16266.244	13200	=TABLE(,O13)
13400	-16904.863	13400	=TABLE(,O13)
13600	-15072.436	13600	=TABLE(,O13)
13800	-16125.242	13800	=TABLE(,O13)
14000	-16659.721	14000	=TABLE(,O13)
14200	-17352.946	14200	=TABLE(,O13)
14400	-16188.716	14400	=TABLE(,O13)
14600	-14610.081	14600	=TABLE(,O13)
14800	-15441.161	14800	=TABLE(,O13)
15000	-15757.594	15000	=TABLE(,O13)
max profits	-13990.78	max profits	=MAX(P14:P64)
optimal # order	7800	optimal # order	=INDEX($O$15:$O$67,MA

As it can be seen from above, all profits are negative, so it is not an ideal investment at all.