Rutgers Business School: International Executive MBA, Beijing
Analytical Techniques
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Name of Student:	

Second Exam — December 16, 2007

You have 90 minutes to complete this examination. The exam has two questions, called Q1 (decision trees) and Q2 (spreadsheet/simulation), each worth about half of the total score.

Answer each question in the space provided. Extra paper and a stapler will be available if you need more room.

You may separate the sheets of this exam, so long as you staple them back together before handing it in (again, a stapler will be available).

Please do not read past this page until instructed to start the test.

You may refer to your textbooks, coursepacks, and your own handwritten notes during the test. You may also use a calculator for Q1.

Instructor Use Only

Q1 Score	
Q2 Score	
Exam Score	

Q1: Decision Trees – Quality Testing

Your firm produces advanced high-power rotating magnets used in medical imaging equipment, typically producing about 10 magnets per day. The production procedure is delicate, and each completed magnet must pass two stringent quality tests before being shipped. The first test costs $450, and magnets have a 15% chance of failing it. The second test cost $200 and has an 8% failure chance. That a magnet has passed one of the tests does not affect its chances of passing the other. A magnet that fails either test must be completely disassembled and recycled, a process whose expected cost is $1000. Each Magnet that passes both tests is immediately shipped to a customer, resulting in revenue of $20,000.

The plant manager is unsure how to set up the quality assurance area of the production line: should magnets first undergo test A, and then test B? Or should they first undergo test B, and then test A?

Use a decision tree to determine which option is better from an expected monetary value sense; show your work. Comment briefly on whether EMV is an appropriate criterion for this decision.

(The exam continues on the next page)

Q2: Overbooking with Vouchers (Simulation)

Discount Air has an extremely large customer base of leisure and student travelers. Discount Air flight 234 uses a 150-seat aircraft with no first or business class, and all tickets are sold for $129. At this price, the airline has found that the average demand for tickets is 153 seats. Each passenger to whom the airline sells a ticket has an independent 95.5% chance of arriving at the airport in sufficient time to board the flight. There are no refunds for passengers who fail to show up in time for the flight. To improve its profits, the airline is considering "overbooking" the flight, that is, selling more tickets than there are seats on the plane. It is considering overbooking limits of 3, 4, 5, … , through 12 seats.

If more than 150 passengers show up in time for the flight, the airline offers travel vouchers entitling passengers to take a later flight plus some additional free travel. For example, if 154 passengers arrive at the airport in time for the flight, the airline would offer 4 travel vouchers. Each passenger arriving in time for the flight has an independent 4.8% chance of being willing to accept a voucher instead of boarding the flight. The airline estimates that its total cost for the voucher program is $200 per voucher accepted by a passenger. Passengers accepting vouchers do not have their $129 refunded.

If, after offering the vouchers, the airline still finds that more than 150 passengers wish to board the flight, it must "bump" (deny boarding to) passengers involuntarily. For example, if 154 people arrived at the airport, but only 3 were willing to accept vouchers, one passenger would have to be "bumped". The airline estimates that "bumping" a passenger costs it $650 in penalties and loss of goodwill (this estimate includes refunding the $129 ticket price).

Suppose that you are using the YASAI spreadsheet on the next page to decide what overbooking limit you might want to use. In the simulation output, you are interested in knowing the profit, the number of coupons issued, and the number of passengers "bumped".

(a) What formula should be in cell B9, the upper limit on the number of seats to overbook?

(b) What formula should be in cell B11, the number customers wishing to buy seats for the flight?

	A	B	C	D
1	**Aircraft Capacity**	150		**Possible**
2	**Average Demand**	153		**Overbooking**
3	**Ticket Price**	$ 129		**Limits**
4	**Show-up Probability**	95.5%		3
5	**Coupon Cost**	$ 200		4
6	**Coupon Acceptance Chance**	4.8%		5
7	**"Bumping" Penalty Cost**	$ 650		6
8				7
9	**Overbooking Limit**	11		8
10				9
11	**Demand**	185		10
12	**Tickets Sold**	161		11
13	**Show Up at Airport**	156		12
14	**Coupons Offered**	6		
15	**Willing to Take Coupons**	4		
16	**Coupons Distributed**	4		
17	**Wanting to Board**	152		
18	**Boarded**	150		
19	**Bumped**	2		
20				
21	**Revenue**	$ 20,769		
22	**Coupon Cost**	$ 800		
23	**Bumping Cost**	$ 1,300		
24	**Profit**	$ 18,669		

(c) What formula should be in cell B12, the number of tickets sold?

(d) What formula should be in cell B13, the number of passengers arriving at the airport in sufficient time to board the flight?

(e) What formula should be in cell B14, the number of coupons offered?

(f) What formula should be in cell B15, the number of passengers arriving in time for the flight who are willing to accept a coupon instead of boarding?

(g) What formula should be in cell B16, the number of coupons distributed?

(h) What formula should be in cell B17, the number of passengers still wishing to board the flight after the coupons (if any) have been offered?

(i) What formula should be in cell B18, the number of passengers boarding the flight?

(j) What formula should be in cell B19, the number of passengers "bumped" (involuntarily not allowed to board)?

(k) What formulas should be in cells B21:B24? These cells should respectively contain:

- **Ticket revenue for the flight**
- **The cost of issuing coupons for the flight**
- **The cost of bumping passengers from the flight**
- **Profit from the flight.**

(l) A YASAI simulation report with a sample size of 1000 is shown on the next page. What is the best limit on the number of overbooked seats? With that overbooking limit, what are the average number of coupons distributed and passengers bumped per flight?

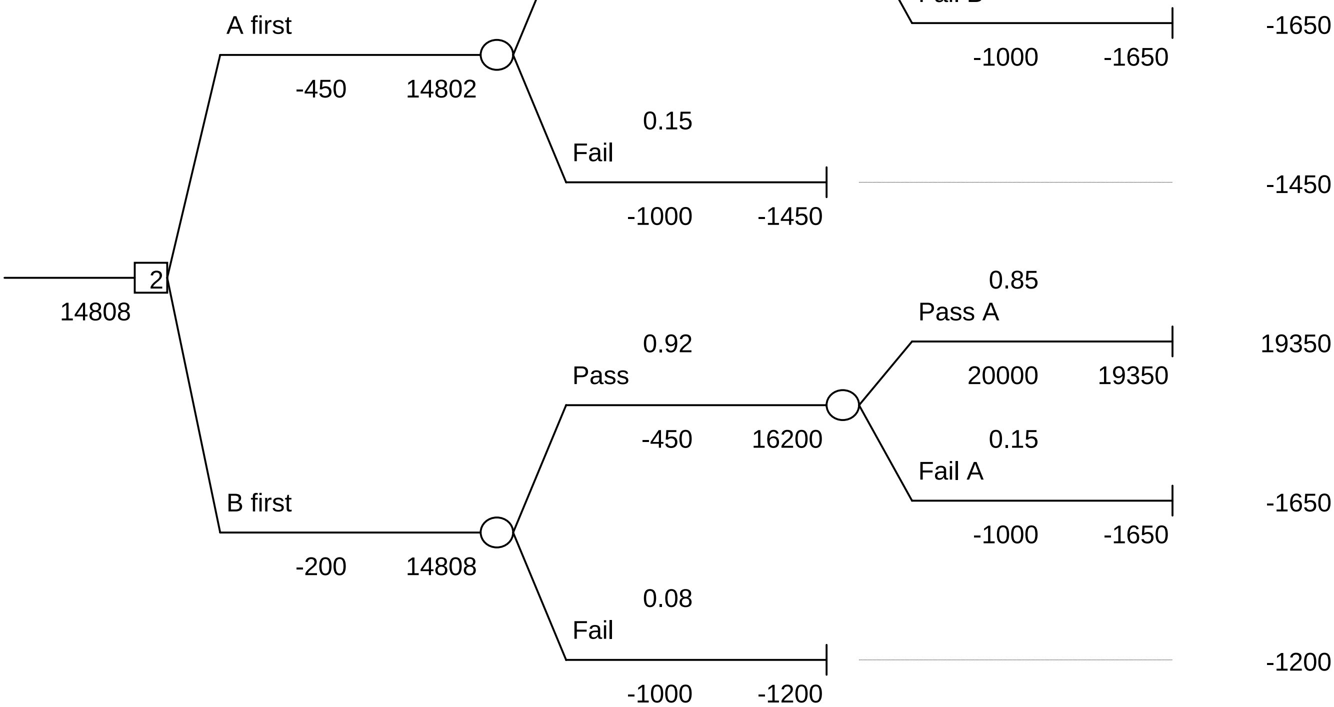
	Parameter		
Scenario	Overbooking Limit		
1	3		
2	4		
3	5		
4	6		
5	7		
6	8		
7	9		
8	10		
9	11		
10	12		
Output Name	**Scenario**	**Observations**	**Mean**
Bumped	1	1000	0.000
Bumped	2	1000	0.000
Bumped	3	1000	0.003
Bumped	4	1000	0.007
Bumped	5	1000	0.005
Bumped	6	1000	0.024
Bumped	7	1000	0.036
Bumped	8	1000	0.058
Bumped	9	1000	0.099
Bumped	10	1000	0.145
Coupons Distributed	1	1000	0.015
Coupons Distributed	2	1000	0.046
Coupons Distributed	3	1000	0.130
Coupons Distributed	4	1000	0.276
Coupons Distributed	5	1000	0.459
Coupons Distributed	6	1000	0.634
Coupons Distributed	7	1000	0.824
Coupons Distributed	8	1000	1.020
Coupons Distributed	9	1000	1.215
Coupons Distributed	10	1000	1.362
Profit	1	1000	19102.158
Profit	2	1000	19166.908
Profit	3	1000	19228.138
Profit	4	1000	19258.774
Profit	5	1000	19269.011
Profit	6	1000	19271.326
Profit	7	1000	19268.354
Profit	8	1000	19233.301
Profit	9	1000	19181.196
Profit	10	1000	19126.411

End of the exam.

Question 1 Solution

	A	B
Cost	450	200
Prob Fail	0.15	0.08

Scrap Cost	1000
Sale Value	20000



It is better from an EMV standpoint to perform test B first, and then test A on those units that pass test B.

EMV is a reasonable criterion to use here, since the process is repeated 10 times a day, and hence 1000's of times a year. Furthermore, the outcomes on the "A first" and "B first" portions of the tree are very similar, so even a highly risk averse decision maker is not likely to perceive enough risk to deviate from EMV.

The difference between 14808 and 14802 may seem relatively small, but it should be noted that there are many other costs that are not stated here. For example, it might cost $14,700 to assemble a magnet, in which case the $6 difference would seem more significant. In any event, $6 per magnet is an average of $60 per day, or $15,000/year if they were to operate 250 days/year.

Question 2 Solution

	A	B	C	D
1	**Aircraft Capacity**	150		**Possible**
2	**Average Demand**	153		**Overbooking**
3	**Ticket Price**	129		**Limits**
4	**Show-up Probability**	0.955		3
5	**Coupon Cost**	200		=D4+1
6	**Coupon Acceptance Chance**	0.048		=D5+1
7	**"Bumping" Penalty Cost**	650		=D6+1
8				=D7+1
9	**Overbooking Limit**	=parameter(D4:D13,1,A9)		=D8+1
10				=D9+1
11	**Demand**	=genpoisson(B2)		=D10+1
12	**Tickets Sold**	=MIN(B11,B1+B9)		=D11+1
13	**Show Up at Airport**	=genBinomial(B12,B4)		=D12+1
14	**Coupons Offered**	=MAX(0,B13-B1)		
15	**Willing to Take Coupons**	=genBinomial(B13,B6)		
16	**Coupons Distributed**	=simoutput(MIN(B14,B15),A16)		
17	**Wanting to Board**	=B13-B16		
18	**Boarded**	=MIN(B17,B1)		
19	**Bumped**	=simoutput(B17-B18,A19)		
20				
21	**Revenue**	=B3*B12		
22	**Coupon Cost**	=B16*B5		
23	**Bumping Cost**	=B7*B19		
24	**Profit**	=simoutput(B21-B22-B23,A24)		
25				
26	From the report, it seems that 8 seats of overbooking (scenario 6) gives the best EMV. In this scenario, the average number of vouchers/coupons distributed per flight is 0.634, and the average number of passengers bumped per flight is 0.024. (Aside: note that 7, 8, and 9 seats of overbooking are all very similar, and a larger sample might be needed to find out which is really best.)			
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28				
29				
30				
31				
32				