Friday Discussion Session – Week 7 – Agenda

- Questions on the Lecture Material / Cases
- Practice Problems on Revenue Management

Operations – Course Outline

Part I

Physics and Economics of Production and Service Processes

Part II

Supply Chain Management

Simulation: Beer Game (at start, to kick off)

Tool: Newsvendor Model
Betting on uncertain demand

Applications	**Cases (or mini-cases)**
Inventory decisions	Obermeyer Amazon
Pricing decisions ("revenue management")	Apple

Simulation: Littlefield (at end, to bring everything together)

Betting on Uncertain Demand

- **Newsvendor Model**
  - Thinking "on the margin": **expected gain = expected loss** (from stocking Q^{th} unit)
  - Critical Ratio: Method to Place Inventory Bets under Uncertain Demand

Thinking "on the margin": $G \times [1 - \text{Prob}(\text{Demand} \leq Q)] = L \times \text{Prob}(\text{Demand} \leq Q)$

$G = (G + L) \times \text{Prob}(\text{Demand} \leq Q)$

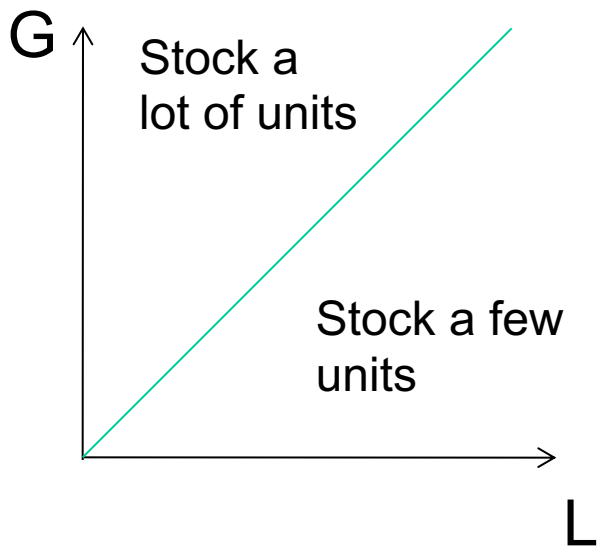
Prob (Demand ≤ Q) = G / (G + L) → Probability that we **satisfy** demand

- **Revenue Management**
- **Littlefield & Factory decisions**
  - Machine Purchase
  - Contract to Offer
  - Order Quantity
  - Reorder Point

Betting on Uncertain Demand

G = Incremental gain from stocking one more unit and **selling** it (Gain from having enough inventory on hand)

L = Incremental cost of stocking one more unit and **not selling** it (Pain from having leftovers)



Problem Steps:

1. Calculate G, L
2. Critical ratio = G/(G+L)
3. Find z using Standard Normal Tables
4. Q = μ + z*σ

Revenue Management with Capacity Controls

Protection Level: Number of units (rooms, seats, etc.) reserved for high fare

- Forecast high-fare demand

Calculate Underage Cost (*G*)

= Revenue from High Fare (r_h) – Revenue from Low Fare (r_l)

- Cost per unit of setting protection level too low. If we do not protect enough units for the high fare, then we sell a unit at the low fare that could have been sold at the high fare. The lost revenue is the difference between the two fares

Calculate Overage Cost (*L*)

= Low Fare (r_l)

- Cost per unit of setting protection level too high. Could have sold another unit at the low fare. Overage cost is incremental revenue of selling a unit at the low fare

- Use the critical ratio to calculate the optimal protection level
- Calculate the z-score of the optimal protection level
- Use newsvendor model (assuming high-fare demand is normally distributed) to calculate **the number of units to reserve for the high fare**

$$Q = \mu + z * \sigma$$

Revenue Management – Hotel Rooms

The Inn at Penn hotel has 150 rooms with standard queen-size beds and two rates: a full price of $200 and a discount price of $120. To receive the discount price, a customer must purchase the room at least two weeks in advance. For a particular Tuesday night, the hotel estimates that the demand from leisure travelers could fill the whole hotel while the demand from business travelers is distributed normally with a mean of 70 rooms and a standard deviation of 29.

1. Suppose 50 rooms are protected for full-price rooms. What is the booking limit for the discount rooms?

2. Find the optimal protection level for full-price rooms

3. The Sheraton declared a fare war by slashing business travelers' prices down to $150. The Inn at Penn had to match that fare to keep demand at the same level. Does the optimal protection level increase, decrease, or remain the same?

Revenue Management – Hotel Rooms

1. Suppose 50 rooms are protected for full-price rooms. What is the booking limit for the discount rooms?

Revenue Management – Hotel Rooms

2. Find the optimal protection level for full-price rooms

Revenue Management – Hotel Rooms

3. The Sheraton declared a fare war by slashing business travelers' prices down to $150. The Inn at Penn had to match that fare to keep demand at the same level. Does the optimal protection level increase, decrease, or remain the same?

Revenue Management – Airlines

On a given Philadelphia-Los Angeles flight, there are 200 seats. Suppose the ticket price is $475 on average and the number of passengers who reserve a seat but do not show up for departure is normally distributed with mean 30 and standard deviation 15. You decide to overbook the flight and estimate that the average loss from a bumped passenger (if the number of passengers exceeds the number of seats) is $800.

Suppose you allow 220 reservations. What is the probability that you will have to deal with bumped passengers?

Revenue Management – Dresses

A fashion retailer in Santa Barbara, California, presents a new designer dress at one of the “by invitation only” fashion shows. After the show, the dress will be sold at the company’s boutique store for $10,000. Demand at the boutique is limited due to the short time the dress remains fashionable and is estimated to be normal with mean 70 and standard deviation 40. There were only 100 dresses produced to maintain exclusivity and high price. It is the company’s policy that all unsold merchandise is destroyed.

Fashion companies often sell a portion of new merchandise at exhibitions for a discount while the product is still “fresh” in the minds of the viewers. The company decides to increase revenues by selling a certain number of dresses at a greatly discounted price of $6,000 during the show. Later, remaining dresses will be available at the boutique store for a normal price of $10,000. Typically, all dresses offered at the show get sold, which, of course, decreases demand at the store: it is now normal with mean 40 and standard deviation 25. How many dresses should be sold at the show?

Revenue Management – Dresses

Find the optimal show room dress level

Revenue Management – JBL

JBL Trucking serves two segments of customers. One segment (A) is willing to pay $3.50 per cubic foot but wants to commit to shipment with only 24 hours' notice. The other segment (B) is willing to pay only $2.00 per cubic foot and is willing to commit to a shipment with up to one week notice. With two weeks to go, demand for segment A is forecast to be normally distributed, with a mean of 3,000 cubic feet and standard deviation of 1,000; while demand for segment B is abundant.

1. How much of the available capacity should be reserved for segment A?

2. How should JBL change its decision if segment A is willing to pay $5 per cubic foot?

Revenue Management – JBL

1. How much of the available capacity should be reserved for segment A?

Revenue Management – JBL

2. How should JBL change its decision if segment A is willing to pay $5 per cubic foot?

Normal table

TABLE A Standard normal probabilities

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
-3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
-3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
-3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
-3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
-3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
-2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
-2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
-2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
-2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
-2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
-2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
-2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
-2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
-2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
-2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
-1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
-1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
-1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
-1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
-1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
-1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
-1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
-1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
-1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
-1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
-0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
-0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
-0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
-0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
-0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
-0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
-0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
-0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
-0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
-0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

TABLE A Standard normal probabilities *(continued)*

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998