UCL
SCHOOL OF
MANAGEMENT

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MSIN0095: Operations Analytics

Class 1-4: Process Analysis

Class 5,7: Waiting Time Analysis

Class 6: Inventory Management I: Newsvendor Model

Class 8: Inventory Management II: Newsvendor 2 and Replenishable Inventory

Example 1

Crazy Jo runs a tube rental on Huron River (Class 0.5 Rapids). He currently leases tubes from a dealer in Ann Arbor at a cost of $10 per day. On Saturdays, he picks up the tubes and drives to a launching point on the river, where he rents tubes to white-water enthusiasts for $30 per day. Crazy Jo records the Saturday demand for tubes and finds the experience below for the past 20 Saturdays:

Demand	10	11	12	13	14	15	16	17	18	19	20	
Frequency(days)	1	1	2	2	2	3	3	2	2	1	1	/20
Probability	0.05	0.05	0.1	0.1	0.1	0.15	0.15	0.1	0.1	0.05	0.05	
Cumulative	0.05	0.1	0.2	0.3	0.4	0.55	0.70	0.8	0.9	0.95	1	

How many tubes should Crazy Jo lease from the dealer?

C_o = $10 C_u = $30 – $10 = $20

$$SL^* = \frac{C_u}{C_u + C_o} = \frac{\$20}{\$20 + \$10} = 0.667 \qquad Q^*=?$$

Example 2

- During the Final Four, demand for basketball jerseys is expected to be normally distributed with mean 1,000 and standard deviation 300. Each jersey costs \$30. The selling price is \$50 per jersey. How many jerseys should be ordered?

$C_o = \$30$ $\quad C_u = 50 - 30 = \$20$

$$SL^* = \frac{C_u}{C_u + C_o} = \frac{\$20}{\$20 + \$30} = 0.4$$

$z = -0.25$ $\quad Q^* = 1000 + (-0.25) \times 300 = 925$

- What if the unsold jerseys can be sold off at half price?

$C_o = 30 - 25 = \$5$ $\quad C_u = 50 - 30 = \$20$

$$SL^* = \frac{C_u}{C_u + C_o} = \frac{\$20}{\$20 + \$5} = 0.8$$

$z = 0.84$ $\quad Q^* = 1000 + 0.84 \times 300 = 1252$

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Newsvendor Summary

- When Balancing costs of overstocking and understocking is crucial?
  - Commit quantity before knowing demand, limited flexibility in ramping up capacity with short notice
  - Inventory loses value sharply at the end of one period (e.g. perishable goods, but not limited to)
  - Unmet demand will be lost (can be relaxed later)
- Newsvendor logic determines
  - Optimal service level
  - Optimal stock level

Which other firms or industries can you see a "newsvendor problem"?

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Not Just Newsvendors

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Not Just Newsvendors

Q: How many rooms should be set aside for last-minute customers?

Hotel problem:

- number of last minute customers is normally distributed with mean 75 and standard deviation 25
- Advance booking: $200/night
- Late booking: $500/night

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Not Just Newsvendors

Usually take more reservations than they can actually take because of "no-shows"

Hotel problem: The number of no-shows is normally distributed with mean 5 and standard deviation 2

- Room rate is $200/night
- It costs hotel $300 to "bump" a customer

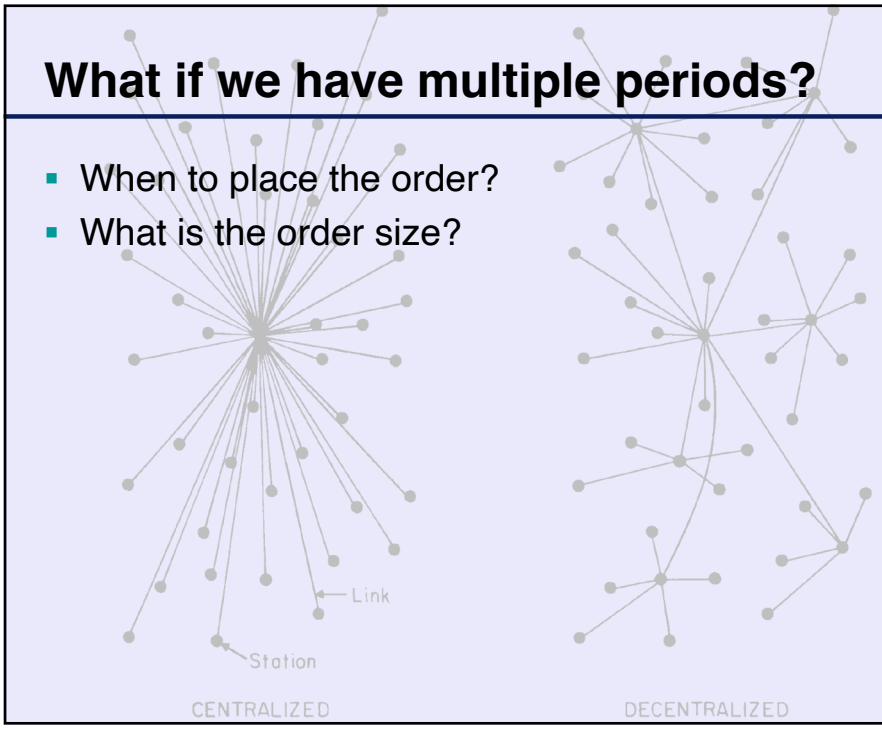
How many reservations should you take?

Not Just Newsvendors

Here

What if we have multiple periods?

- When to place the order?
- What is the order size?

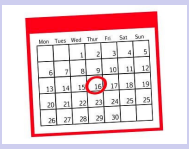


Replenishable inventory models

Continuous review

- Place an order from the supplier <u>at any time</u> if inventory is running low
- Event-triggered restocking
- Requires continuous monitoring of inventory levels

Periodic review



- Place an order from the supplier <u>only during scheduled times</u> (e.g. every 3 days or weekly).
- Time-triggered restocking
- Only requires to monitor inventory periodically

Motivation Example

- Zara orders a particular clothing item every Friday morning and it is delivered from a warehouse immediately after ordering
- Unmet demand is lost
- Mean daily demand is 10, standard deviation is 9.45, Normal
- Daily demand are independently and identically distributed
- Wholesale cost is $10 each, retail price is $25 each
- Holding cost has been set at $0.5 per week for each item (to reflect obsolescence, damage, etc.)
- **Question: How should Zara set order amounts?**
- **How to apply newsvendor logic?**
  - **It decides the target stock level by balancing the overage and underage cost.**

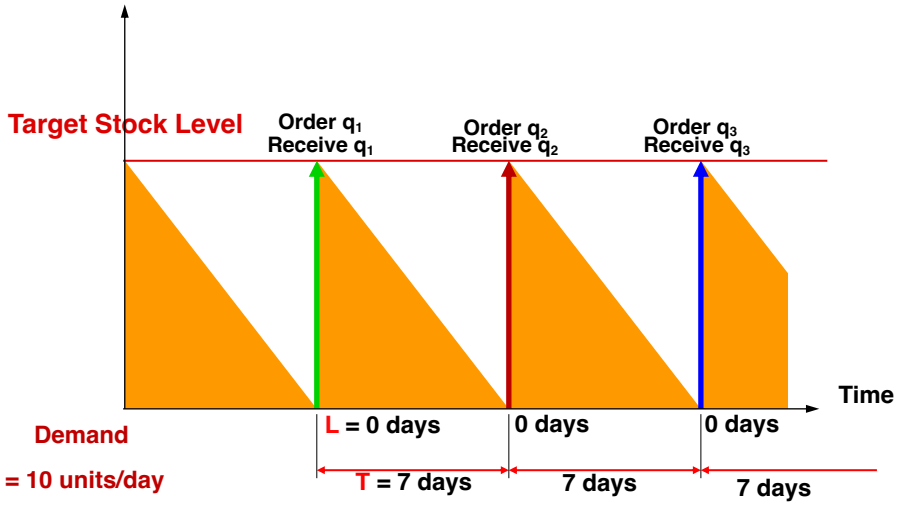
Motivation Example

- Zara orders a particular clothing item every Friday morning and it is delivered from a warehouse Monday morning
- Unmet demand is lost
- Mean daily demand is 10, standard deviation is 9.45
- Daily demand are independently and identically distributed
- Wholesale cost is $10 each, retail price is $25 each
- Holding cost has been set at $0.5 per week for each item (to reflect obsolescence, damage, etc.)
- **Question: How should Zara set order amounts?**

Periodic Review Model

- Key features and assumptions:
  - Review & place orders every **T days**
  - Positive lead time **L days**
  - Unmet demand can either be backordered or lost
  - Holding cost
  - Demand distribution every day is independent and identical
  - There is no setup cost associated with placing an order
- How much to order each time?
  - Your order should bring the inventory position (on hand inventory + in transit – backorders) up to a desired **target stock level using the newsvendor logic**

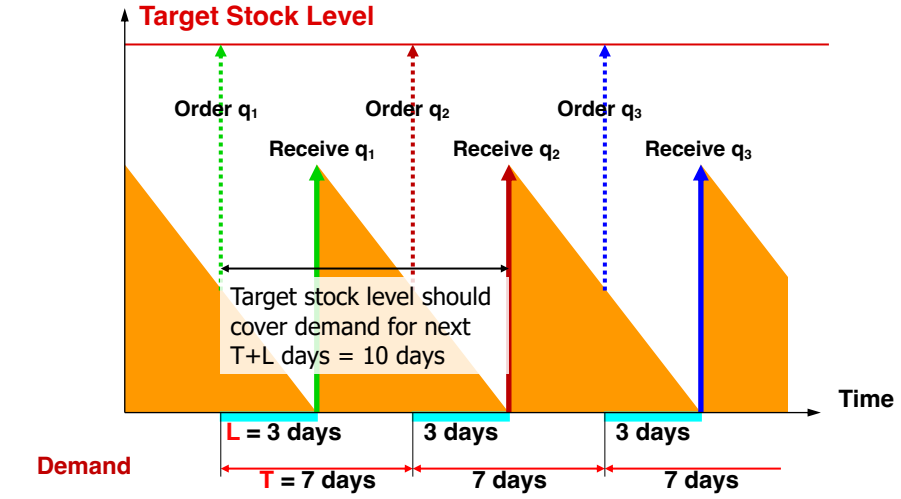
Periodic Review: Deterministic Demand



What is the best Target Stock Level?

(a) 30 **(b) 70** ✓ **(c) 100**

Periodic Review: Deterministic Demand

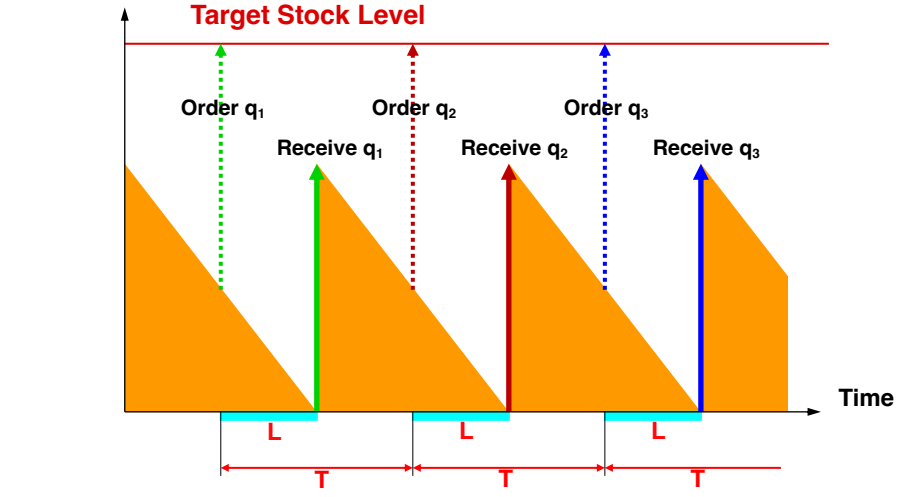


Demand = 10 units/day

What is the best Target Stock Level?

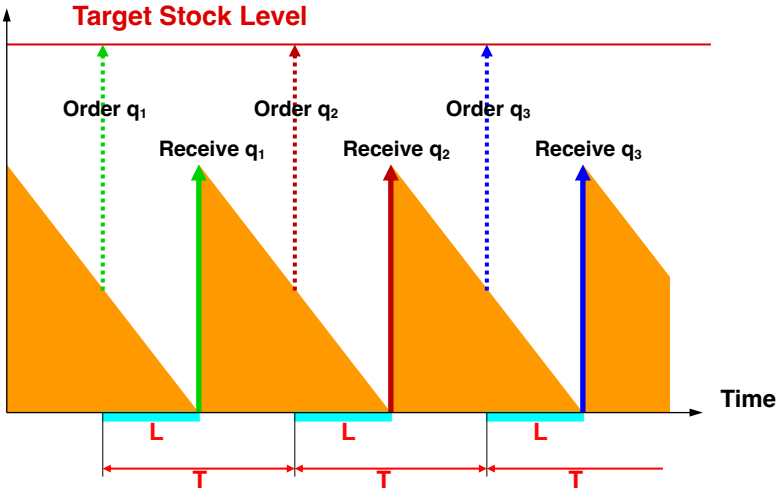
(a) 30 (b) 70 (c) 100 ✓

Periodic Review: Deterministic Demand



If demand is certain, Target Stock Level =

Periodic Review: Deterministic Demand



If demand is certain, Target Stock Level = Demand during T+L