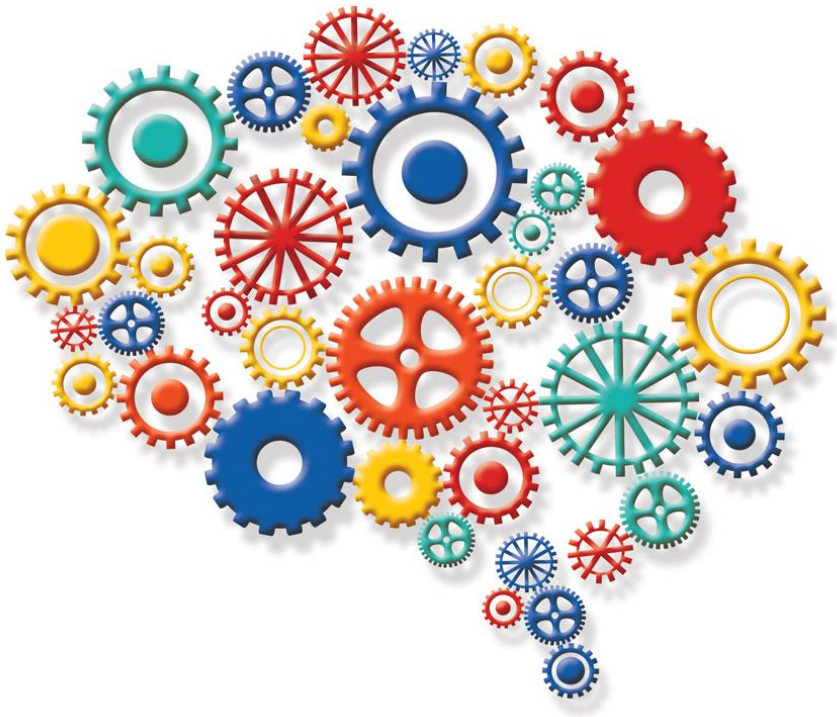
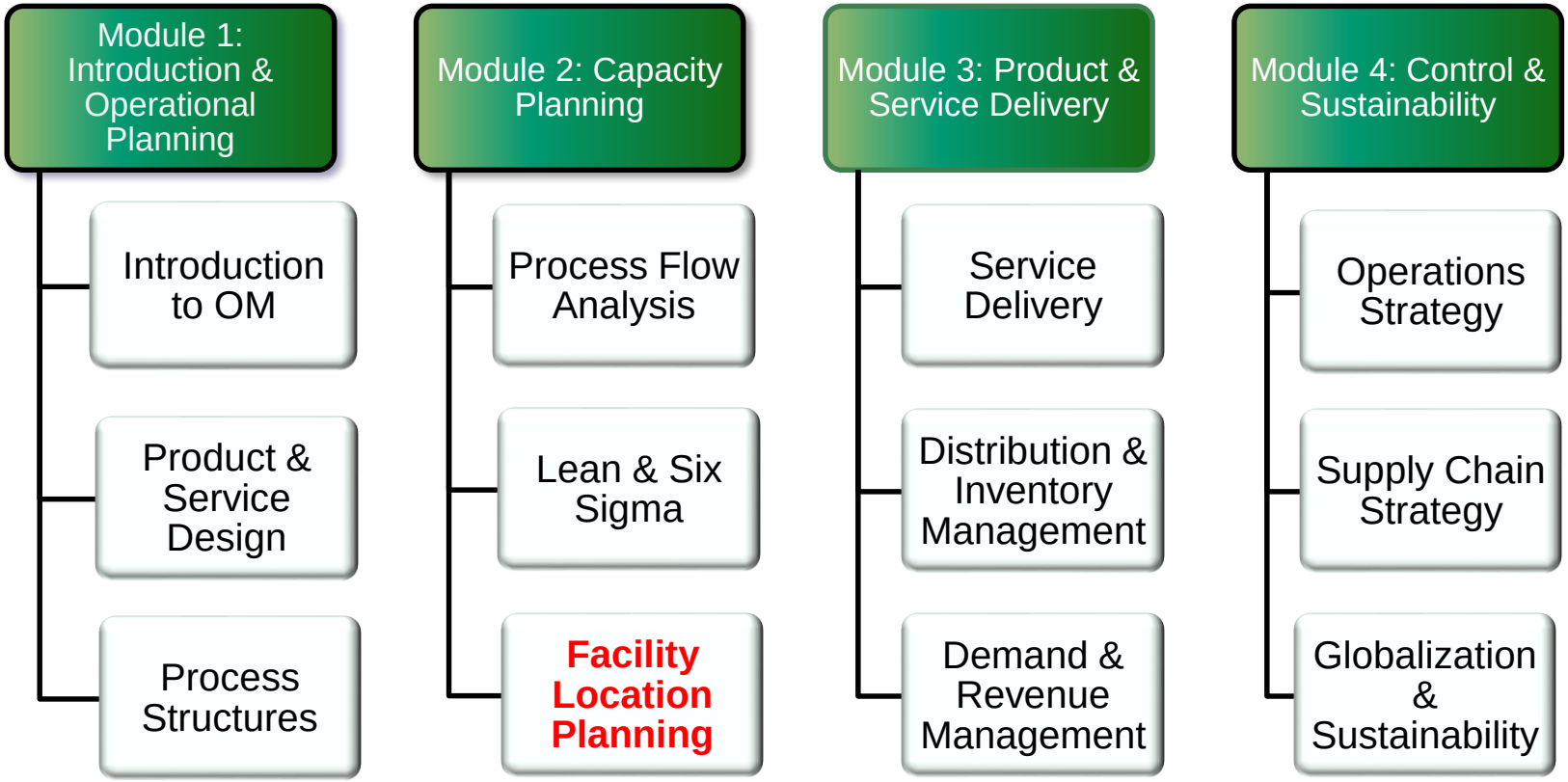
Lecture 6



Facility Location Planning

Course Structure



Learning Objectives

- Explain reasons to make facility location decisions and site selection considerations
- Locate a single facility using cross-median approach
- Discuss the non-traditional location strategies for site selection
- Identify the minimum number and location of facilities that serve all demand points within the specified maximal service distance using “Location Set Covering Problem”

Reasons to Make Location Decisions

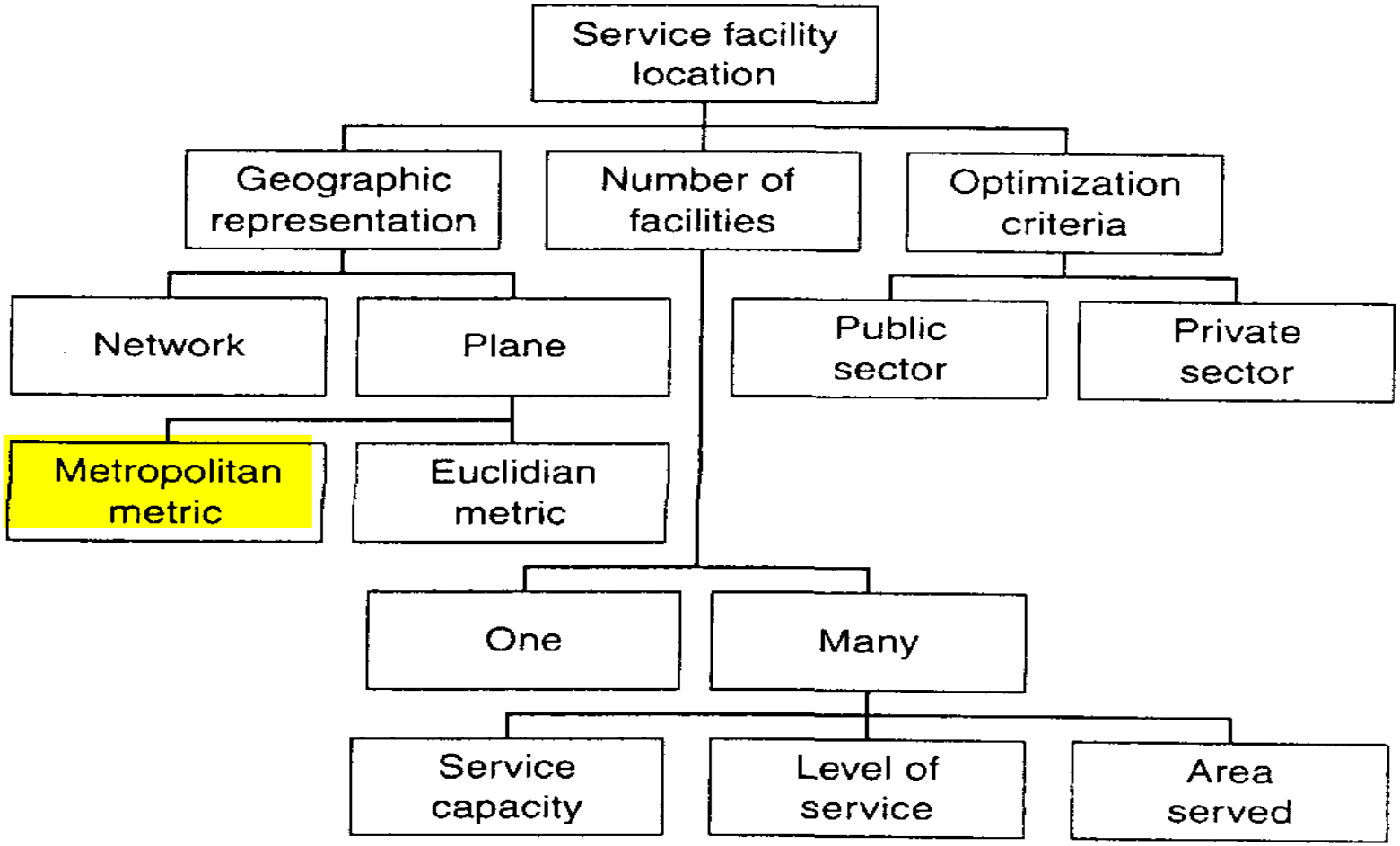
- Offering service at new locations may be part of a growth strategy.
- Current service facility may be unable to meet the increased demand.
- When a service firm faces a location decision, three possible options:
  - Enlarge an existing facility at the present site;
  - Close the present facility and construct one or more new ones on new sites;
  - Open a new site or more sites

Site Selection Considerations

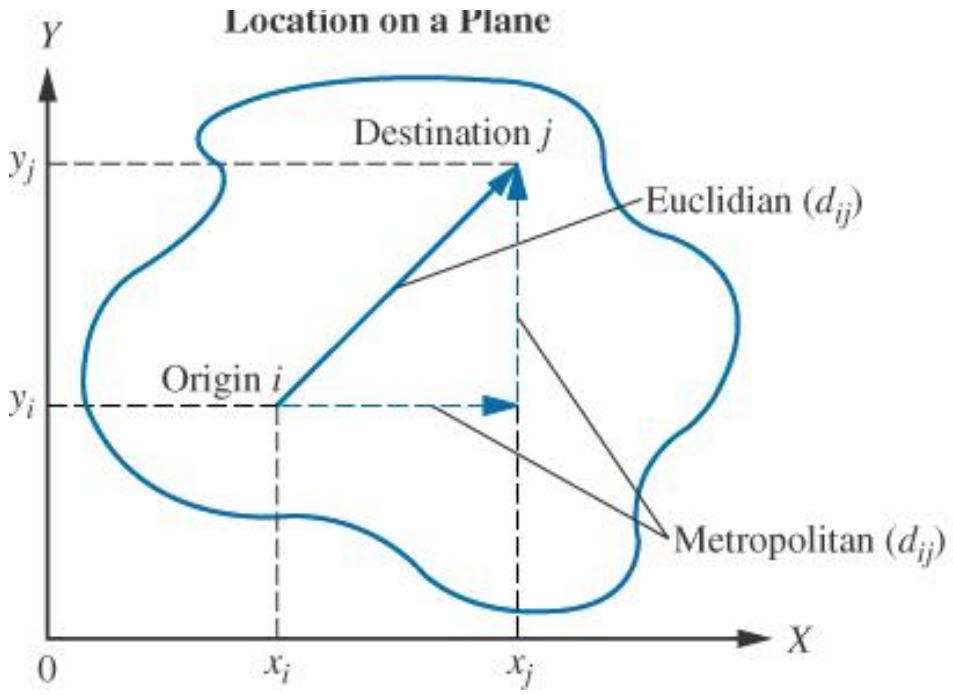
- Accessibility: Convenient to freeway exit and entrance ramps; served by public transportation
- Visibility: Set back from street; sign placement
- Traffic flow: Traffic volume on street that may indicate potential impulse buying; Traffic congestion that could be a hindrance (e.g., fire stations)
- Parking: Adequate off-street parking
- Expansion: Room for expansion
- Environment: Immediate surroundings should complement the service
- Competition: Location of competitors
- Government: Zoning restrictions; Taxes

Locate a single facility using Cross-Median Approach

Classification of Service Facility Location Issues



Geographic Representation



Euclidean

$$d_{ij} = \left[(x_i - x_j)^2 + (y_i - y_j)^2\right]^{1/2}$$

Metropolitan

$$d_{ij} = \left|x_i - x_j\right| + \left|y_i - y_j\right|$$

Single Facility Location
Cross Median Approach

Question: Locating a single facility on a plane to minimize the weighted travel distance using "metropolitan metric".

The objective is to minimize

$$Z = \sum_{i=1}^{n} w_i |x_i - x_s| + \sum_{i=1}^{n} w_i |y_i - y_s|$$

n = number of demand point served

x_i , y_i = coordinates of the i^{th} demand point

w_i = weight attached to the i^{th} demand point

x_s, y_s = coordinates of the service site

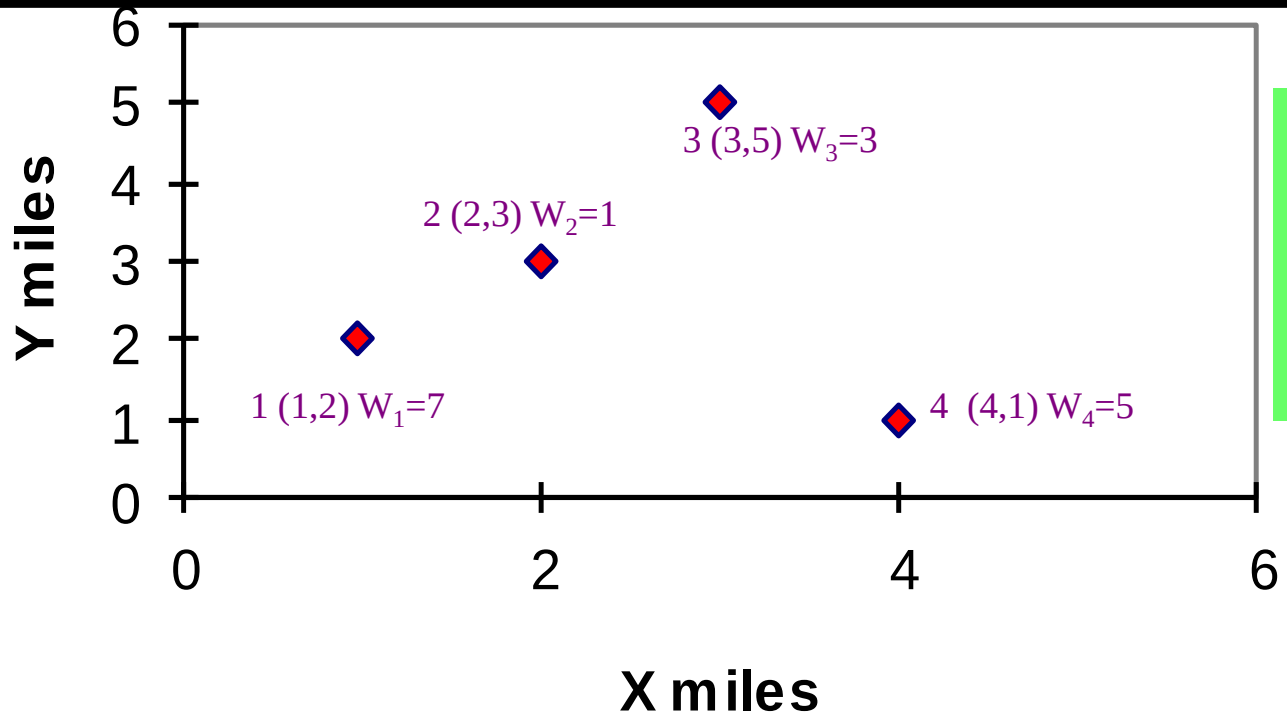
e.g. customer demand or population

The optimum site will have coordinates such that

- X_s is at the median value for w_i ordered in the x direction
- Y_s is at the median value for w_i ordered in the y direction

Example: Copying Service

A copying service has decided to open an office in the central business district of a city. The manager has identified 4 potential sites and weights are attached to each site which represent the potential demand per month in hundreds of orders.



Median of weight
=16/2
= 8

Q: Determine a central location that will minimize the total distance per month that customers travel to the copying service.

Example: Copying Service (Cont.)

Median value for x_s

From Left to Right →
(To identify the left vertical line)

Office	Location x_j	Σw_j
1	1	7
2	***2***	7 + 1 = 8
3	3	
4	4	**Median value for y_s**

From Right to Left ←
(To identify the right vertical line)

Office	Location x_j	Σw_j
4	4	5
3	***3***	5 + 3 = 8
2	2	
1	1	

From Bottom to Top →
(To identify the bottom horizontal line)

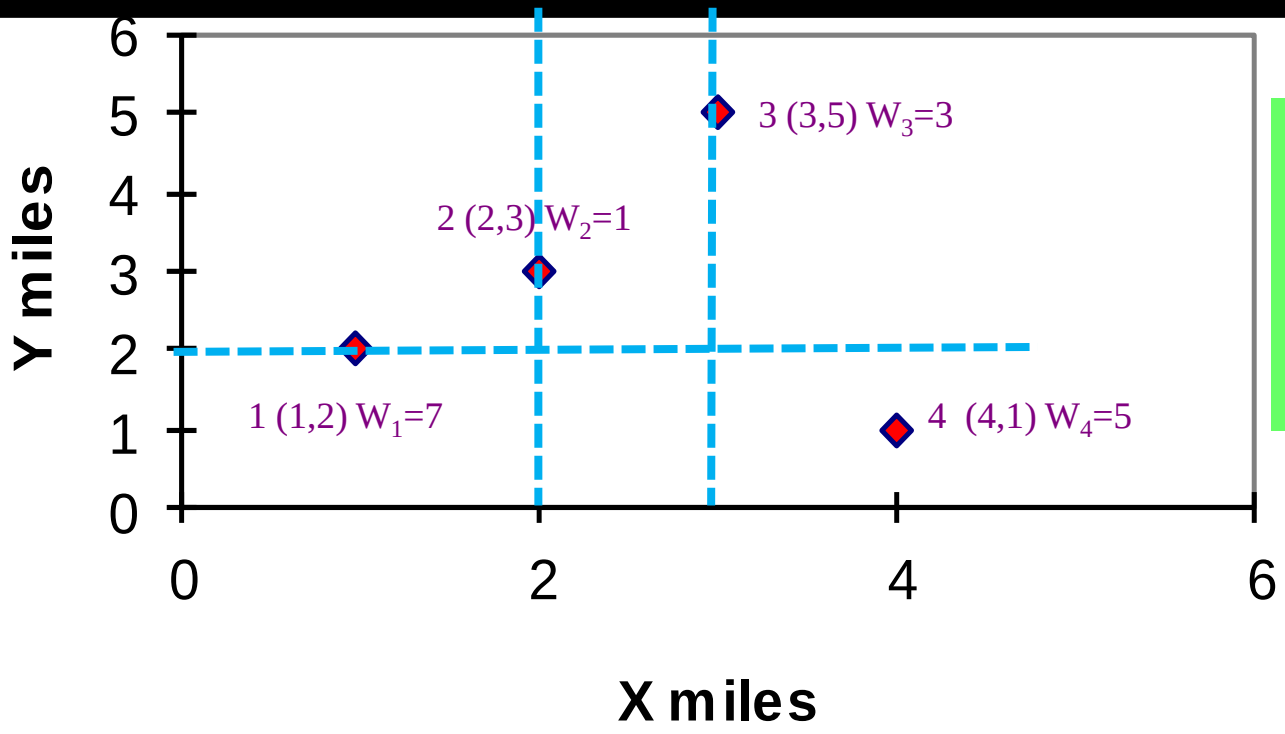
Office	Location y_j	Σw_j
4	1	5
1	***2***	5 + 7 = 12
2	3	
3	5	

From Top to Bottom →
(To Identify the top horizontal line)

Office	Location y_j	Σw_j
3	5	3
2	3	3 + 1 = 4
1	***2***	3 + 1 + 7 = 11
4	1	

Example: Copying Service

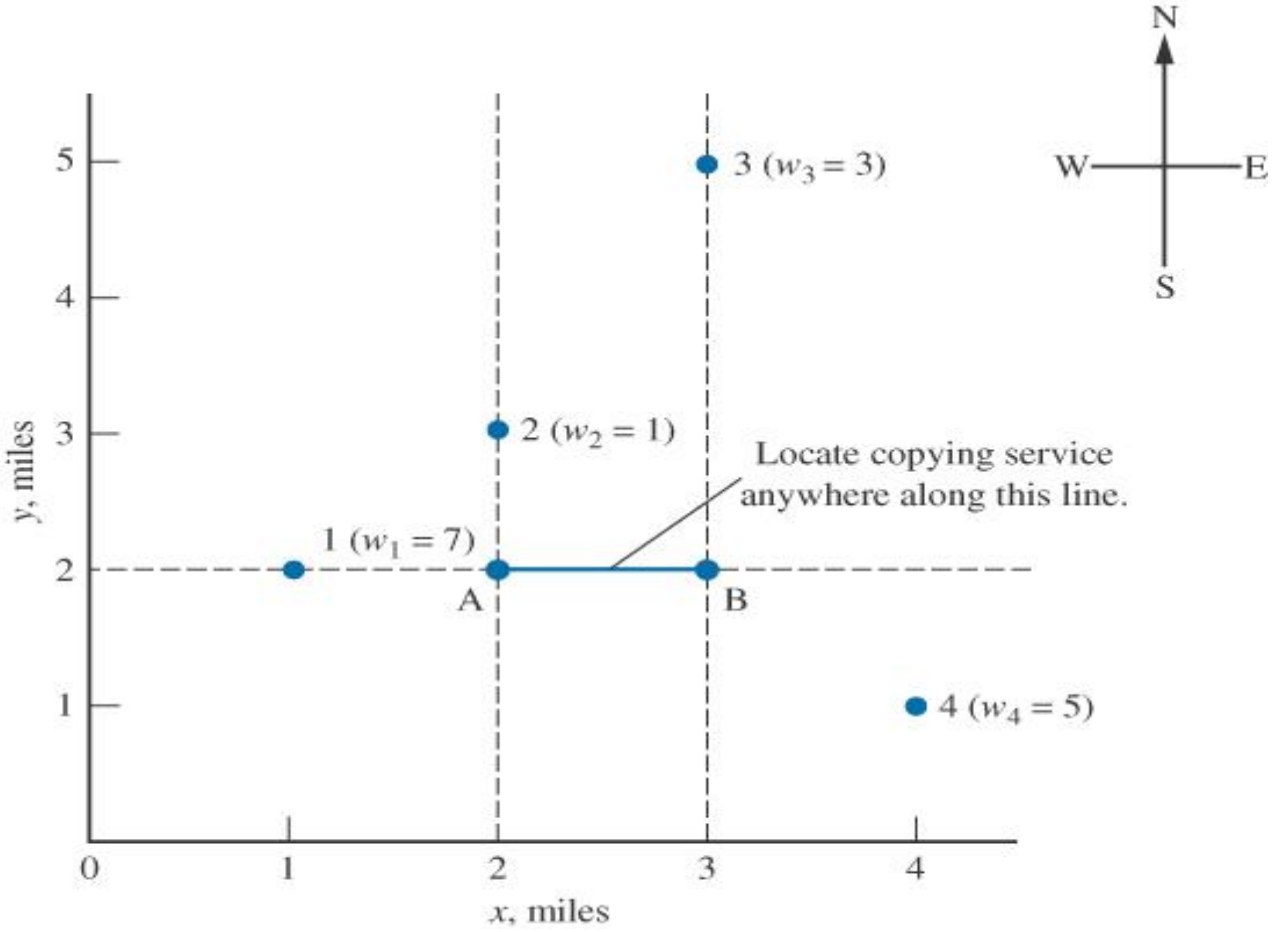
A copying service has decided to open an office in the central business district of a city. The manager has identified 4 potential sites and weights are attached to each site which represent the potential demand per month in hundreds of orders.



Median of weight =16/2 = 8

Q: Determine a central location that will minimize the total distance per month that customers travel to the copying service.

Example: Copying Service (Cont.)



The cross median approach suggests that a range of locations lying along the line segment AB minimizes the total travel distance.

Example: Copying Service (Cont.)

$$Z = \sum_{i=1}^{n} w_i |x_i - x_s| + \sum_{i=1}^{n} w_i |y_i - y_s|$$

Total Weighted Distance for Locations A & B							
Location A (2, 2)				Location B (3, 2)			
Office	Distance	Weight	Total	Office	Distance	Weight	Total
1	1	7	**7**	1	2	7	**14**
2	1	1	**1**	2	2	1	**2**
3	4	3	**12**	3	3	3	**9**
4	3	5	**15**	4	2	5	**10**
			35				**35**

In-class exercise #1 – Cross-Median Approach

In-class exercise #1 – Cross-Median Approach

Revisit the copying service & assume that over the years, the monthly demand from four customer areas has increased to the following weights:

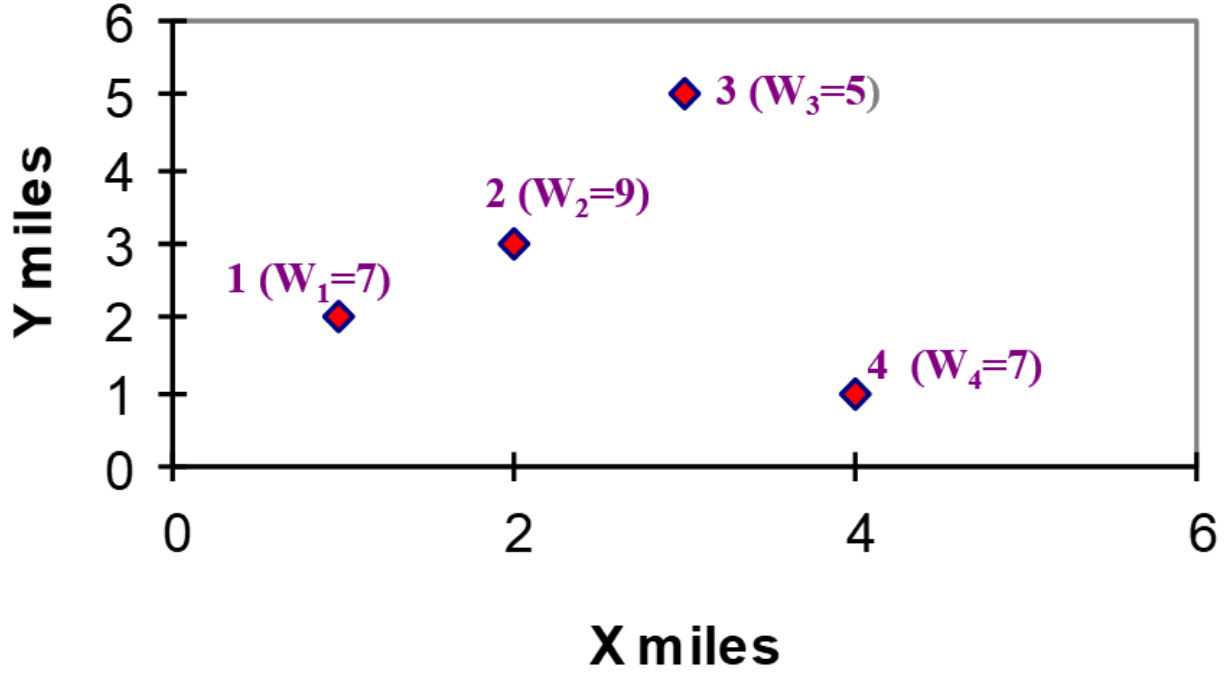
W1 = 7, W2 = 9, W3 = 5, W4 = 7

Question:
If we previously located the copying service at point A (2,2),

1. *Should we now consider a relocation?*
2. *Why or why not?*

In-class exercise #1 – Cross-Median Approach

A copying service has already opened an office in the central business district of a city at point 2,2. The revised weights are attached to each site which represent the new potential demand per month in hundreds of orders. Should we need to relocate the office? Give your reason.



Non-traditional location strategies for site selection

- Competitive Clustering
  - –A common practice to attract customers when locating the site among other competitors to form a cluster for customer comparison shopping, ***e.g. Auto Dealers, Motels***
- Saturation Marketing
  - –Facilities belonging to the same company are located very close to each other or concentrate in a particular area

    e.g. ***Digital products shops in Mongkok***
- Marketing Intermediaries
  - –Extend the service market well beyond the confines of geography or distance by providing the means for service providers meet the users ***e.g. Credit Card Companies***

Non-traditional location strategies for site selection

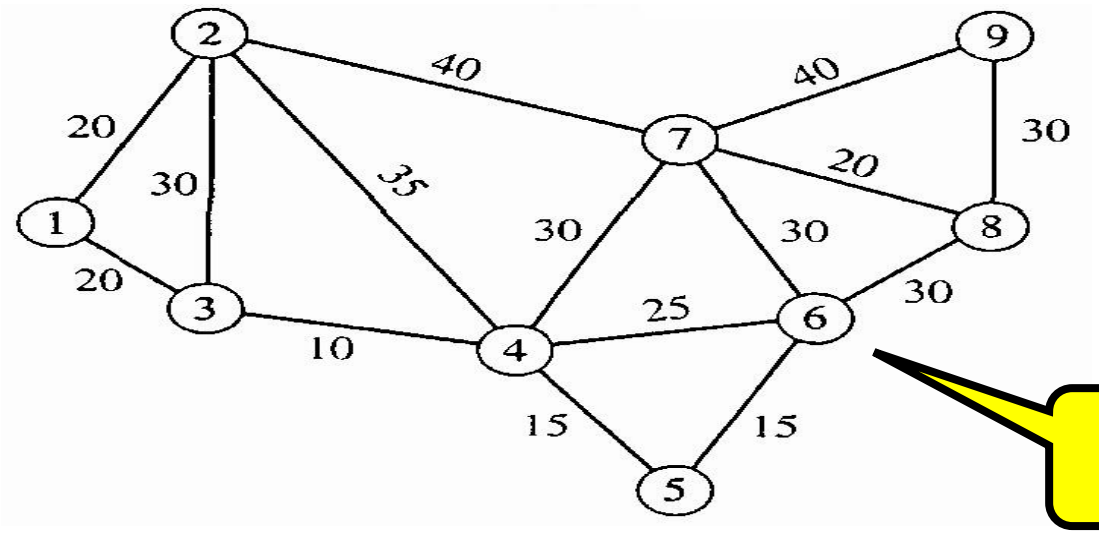
- Substitute Electronic Media for Travel
  - –Advanced telecommunication systems & Internet have made some issues of site consideration less relevant

    e.g. Electronic salary deposit; phone communications & video conferencing reduce personal contacts
- Impact of the Internet on Service Location
  - –A virtual location of pure e-commerce firms (e.g. Amazon.com), An alternative channel of distribution for established click-and-mortar retailers ***(e.g. Park'n shop),*** virtual location of an auction *facilitator* ***(e.g. eBay)***
- Separation of Front from Back Office
  - –Front & back office need not be co-located for many services ***(e.g. dry cleaning, shoe repair, banks and ATMs).***
  - –Viewing location decisions from internal (employee) and external (customer) viewpoint highlights opportunities to achieve economies of scale.

Location Set Covering Problem

Location Set Covering Problem

Find the minimum number and location of facilities that will serve all demand points within some specified **maximal service distance**.



Decision need to be made:

1. **Determine the minimum number of clinics required and**
2. **Its location such that every community will be served within 30 miles of at least one clinic.**

Location Set Covering Problem (Cont.)

Step 1: List the set of communities served from potential sites

RANGE OF SERVICE FOR POTENTIAL SITES

Community	Set of communities served from site
1	1,2,3,4
2	1,2,3
3	1,2,3,4,5
4	1,3,4,5,6,7
5	3,4,5,6
~~6~~	~~4,5,6,7,8~~
7	4,6,7,8
8	6,7,8,9
9	8,9

* Community 6 cannot serve as a clinic site.

Q1. How many clinics are required?

Q2. Which communities will you select to setup the clinics?

Location Set Covering Problem (Suggested answers)

RANGE OF SERVICE FOR POTENTIAL SITES

Community	Set of communities served from site
1	1,2,3,4
2	1,2,3
3	1,2,3,4,5
4	1,3,4,5,6,7
5	3,4,5,6
6	4,5,6,7,8
7	4,6,7,8
8	6,7,8,9
9	8,9

* Community 6 cannot serve as a clinic site.

Step 2: Identify the min no. of potential sites and their location which can cover the required service distance.

We need to setup at least _____ on _____

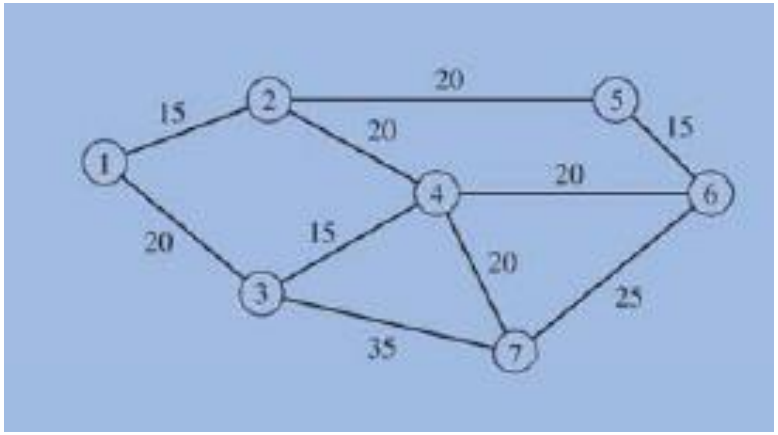
In-class exercise #2:- Location Set Covering Problem

In-class Exercise #2

The volunteer fire department serving the communities has just purchased two used fire engines auctioned off by a nearby city.

a. Select all possible pairs of communities in which the fire engines could be located to ensure that all communities can be reached in 30 minutes or less.

b. What additional consideration could be used to make the final site selection from the community pairs found in part a?



Key Take Away

- Facility location decisions and site selection considerations
- Locate a single facility using cross-median approach
- Non-traditional location strategies
- Location set covering problems