

## Chapter 2 HOMEWORK SOLUTIONS

The problems in this chapter are intended to facilitate discussion in a very general sense about modeling, and engineering decision making. These problems do not have exact solutions. Those solutions provided are meant as examples.

### 2-1 Solution

Students might be asked to discuss the conflict that might exist between objectives, rank objectives, etc.

Services	Objectives
Trash Collection	<ul style="list-style-type: none"> <li>- Maximize quality of service (equity, regularity, etc.)</li> <li>- Maximize usage of capital equipment.</li> <li>- Minimize labor disputes.</li> <li>- Minimize cost excesses and overruns.</li> </ul>
Municipal Water Supply	<ul style="list-style-type: none"> <li>- Maximize equity in provision of water to community.</li> <li>- Maximize public confidence in the quality and reliability of water supply.</li> <li>- Minimize risk of water contamination.</li> <li>- Minimize the risk of supply shortfalls during peak demand periods.</li> </ul>
Fire Protection	<ul style="list-style-type: none"> <li>- Maximize residential protection coverage.</li> <li>- Maximize commercial protection coverage.</li> <li>- Maximize readiness of personnel and equipment.</li> <li>- Maximize coverage for co-located ambulance services.</li> <li>- Maximize efficiency in scheduling personnel.</li> </ul>
Swimming & Recreation	<ul style="list-style-type: none"> <li>- Maximize citizen comfort and safety.</li> <li>- Maximize equity in service among different user groups.</li> <li>- Maximize maintenance effectiveness.</li> </ul>
Street Cleaning	<ul style="list-style-type: none"> <li>- Maximize equity of service across service area.</li> <li>- Minimize deadhead travel (vehicle miles without performing service).</li> <li>- Minimize interference with traffic.</li> <li>- Minimize objectionable side effects of service (noise, dust, etc.).</li> </ul>
Sewage Collection & Treatment	<ul style="list-style-type: none"> <li>- Maximize treatment efficiency.</li> <li>- Minimize risk to the environment and to people.</li> <li>- Minimize objectionable side effects (odor, etc.).</li> <li>- Minimize risk of collection system failure.</li> </ul>

## 2-2 Solution

Scheduling of classrooms is different at different universities. Students may be interested in knowing, or discovering how scheduling is handled at your institution.

Possible Objectives	<ul style="list-style-type: none"> <li>- Maximize the accommodation of most important classes.</li> <li>- Minimize the number of unused seats during any class period.</li> <li>- Minimize the distance that old professors must walk to class.</li> <li>- Minimize the number of back-to-back courses for as many students as possible.</li> <li>- Minimize distance between locations of back-to-back courses for a given student.</li> </ul>
Possible Constraints	<ul style="list-style-type: none"> <li>- University has a finite number of classrooms available.</li> <li>- Classrooms have fixed capacities and locations on campus.</li> <li>- Type of seating in each classroom may be fixed.</li> <li>- Students may not take more than one class at a time.</li> <li>- Instructors may not teach more than one class at a time.</li> <li>- All required courses must be scheduled first.</li> </ul>

## 2-3 Solution

Here are a few suggestions.

Decision	Objective(s)	Constraints
1. What to eat	<ul style="list-style-type: none"> <li>- Maximize health.</li> <li>- Maximize enjoyment.</li> <li>- Minimize cost.</li> <li>- Minimize time needed.</li> </ul>	<ul style="list-style-type: none"> <li>- Choice of location to dine may be limited.</li> <li>- Selection of food items to purchase or prepare.</li> <li>- Time available for eating may be limited.</li> <li>- Funds available for acquiring foods may be limited.</li> <li>- Quality of food (nutrition, taste, etc.) may be limited.</li> </ul>
2. How to get to work	<ul style="list-style-type: none"> <li>- Maximize comfort.</li> <li>- Minimize time required.</li> <li>- Minimize cost.</li> </ul>	<ul style="list-style-type: none"> <li>- Modes of travel might be limited.</li> <li>- Choice of route might be constrained.</li> <li>- Time available for travel might be limited.</li> </ul>

3. What/when to study	<ul style="list-style-type: none"> <li>- Maximize grades.</li> <li>- Maximize time.</li> <li>- Minimize time.</li> </ul>	<ul style="list-style-type: none"> <li>- Available time may be limited.</li> <li>- Minimum amount of time may be necessary.</li> <li>- Subjects may be of different importance.</li> </ul>
4. How/when to exercise	<ul style="list-style-type: none"> <li>- Maximize health.</li> <li>- Maximize enjoyment.</li> </ul>	<ul style="list-style-type: none"> <li>- Need to coordinate with others (team, opponent, etc.).</li> <li>- Cost.</li> <li>- Time.</li> </ul>
5. When to sleep	<ul style="list-style-type: none"> <li>- Maximize rest.</li> </ul>	<ul style="list-style-type: none"> <li>- Amount of sleep time required.</li> <li>- Need to awaken by a specific time.</li> <li>- Time required for non-sleeping activities.</li> <li>- Only 24 hours in a day.</li> </ul>

#### 2-4 Solution

Objectives	Mayor	Chamber	Residents	Relators	Merchants
Maximize residential coverage.	3	2	1	3	5
Maximize commercial coverage.	4	1	6	4	1
Minimize cost of acquiring land.	1	3	2	5	2
Minimize land development costs.	2	4	3	6	4
Minimize amount of land required.	5	6	4	2	3
Minimize value of land required.	6	5	5	1	6

Students might be asked to consider other objectives or constituents, or to discuss their own rankings for objectives.

## 2-5 Solution

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Possible Objective	<ul style="list-style-type: none"><li>- Maximize equity in the distribution of routes across the population.</li><li>- Maximize resource usage.</li><li>- Minimize total lane-miles serviced within the community.</li><li>- Minimize the maximum customer wait time during peak demand periods.</li><li>- Minimum overlap in services.</li></ul>
Possible Constraints	<ul style="list-style-type: none"><li>- All residents must live within N blocks of a transit stop.</li><li>- No resident must have to wait more than M minutes for a bus during peak periods.</li><li>- Important routes must overlap at key transfer points.</li><li>- Drivers must be available to staff all scheduled routes.</li><li>- Maintenance funds may be limited.</li></ul>

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## 2-6 Solution

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Possible Constraints	<ul style="list-style-type: none"><li>- Students living more than N miles from school must be bussed.</li><li>- Not more than M buses are available to the school district.</li><li>- Classrooms (grade levels) must be balanced in each school remaining open.</li><li>- Cultural diversity must be preserved in schools remaining open.</li></ul>
Possible Objectives	<ul style="list-style-type: none"><li>- Maximize student safety (minimize total walking distance along hazardous streets).</li><li>- Minimize total student-miles traveled.</li><li>- Minimize the maximum distance traveled by the student traveling the furthest.</li></ul>
Possible Data Needs	<ul style="list-style-type: none"><li>- Location of each school.</li><li>- Location of each student or students by block group.</li><li>- Grade and cultural distribution by block group.</li><li>- Distance traveled (bus or walking) by each student or student group.</li><li>- Configuration of the community transportation network.</li><li>- Long-term demographic trend data.</li></ul>

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## 2-7 Solution

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Possible Constraints	<ul style="list-style-type: none"><li>- Land available for purchase or lease is limited (possible zoning restrictions, etc.).</li><li>- Total volume of generated waste now and in the future must be accommodated.</li><li>- Cost considerations may be restrictive.</li><li>- Equity considerations among user groups may be important.</li></ul>
Possible Objectives	<ul style="list-style-type: none"><li>- Maximize equity in quality of service and distribution of costs.</li><li>- Maximize impact on overall economic well-being of the community.</li><li>- Minimize cost of collection, treatment, or disposal (possibly separate costs).</li><li>- Minimize environmental impact (including nuisance impacts).</li></ul>
Possible Data Needs	<ul style="list-style-type: none"><li>- Location of available land for purchase or lease.</li><li>- Costs for collection, transport, treatment, etc. by each alternative considered.</li><li>- Demographic trends within the community.</li></ul>

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