Multi-Criteria Decision Making Models

This area of focus is important because interesting problems need to consider several issues when making a decision:
- Standard linear programming assumes a single objective function or criteria

Examples:
- The risk-profit trade-off to be discussed later
- How to allocate scarce water
- How to manage natural resources
- Multi-goals of a business or organization
- Many others

Will be examining only one of two different approaches for addressing these concerns:
1. Goal programming
2. Multi-Objective Programming
GOAL PROGRAMMING

- The goal(s) must be clearly stated
- The goal has two parts:
  1. Objective
  2. Target (an acceptable level of achievement for the objective)
     - It is possible to miss a target and still have a feasible solution
- There are two approaches for goal programming:
  1. Weighted goal programming (wgp)
     - Minimize deviation from target based upon weights give the goal (weight goals by importance)
  2. Lexicographic goal programming (lgp)
     - Divide goals into priorities
     * Weights can be assigned to goals within a certain priority level
     - High priority goals are met first, then lower level goals are considered
     * A special algorithm which uses an achievement function is needed to solve these type of problems

(Goal Programming Approaches Cont.)

- Example of a Weighted Goal Programming problem
  - A 100,000 managed forest
Desired goals and targets:
1. Limit erosion to 0.2 ton/acre (20,000 tons total)
2. Cut 250 million-board-feet (mbf) of timber
3. Provide 10,000 animal-unit-months (aum) grazing
4. Provide 80,000 wildlife-unit-months (wlum)
5. Provide 60,000 recreation-days (rd)

Normal constrains:
– 100,000 acres total size
– $600,000 operating budget
– 20 person staff size

Options for using the forest:
– Lumbering (100 acres)
– Campsites (1 campsite)
– Low managed natural forest (100 acres)
– Backpacking trails (10 miles of trail)
– Grazing (100 acres)

Each of these options take different amounts to resources and help fulfill certain goals
### Tableau for the Forest Problem

<table>
<thead>
<tr>
<th>ACTIVITIES</th>
<th>UNITS</th>
<th>-----------------</th>
<th>----------------</th>
<th>--------------------</th>
<th>---------------</th>
<th>--------------</th>
<th>-------------</th>
<th>------------</th>
<th>-------------</th>
<th>------------</th>
<th>-------------</th>
<th>-------------</th>
<th>-------------</th>
<th>-------------</th>
<th>-------------</th>
<th>-------------</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut Lumber</td>
<td>tons</td>
<td>11.28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camp Site</td>
<td>aum</td>
<td>6.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trails</td>
<td>days</td>
<td>779.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural</td>
<td>acres</td>
<td>200.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lumber</td>
<td>mbf</td>
<td>28111.77</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wildlife</td>
<td>wlum</td>
<td>62805.64</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Solution from the Tableau for the Forest Problem

- **Objective Function** = - 7732.87
- **Activities in solution:**
  - 1. Cut Lumber = 11.28
  - 2. Camp site = 6.00
  - 3. Natural Forest = 779.72
  - 5. Grazing = 200.0
  - 6. Errosion - tons = 28111.77
  - 7. Lumber - mbf = 24.35
  - 9. Wildlife - wlum = 62805.64
MULTI-CRITERIA DECISION MAKING

ADDITIONAL REFERENCES