1. (6 points) A clinic has \( S \) doctors. A schedule needs to be created for the doctors to satisfy the patients’ needs during the working hours of the hospital. The clinic is open for \( T \) hours per day. There is a forecast of patients arriving at each hour, and it is denoted by \( f_j \), \( j=1, \ldots, T \). The time (in hours) needed to attend each patient is 1. Let \( b_{ij}=1 \) if doctor \( i \) works during hour \( j \), and \( b_{ij}=0 \) otherwise.

   a. (2 points) Write a set of constraints to ensure that there are enough doctors working at each hour to attend all the patients forecasted to arrive during that hour.

   \[
   \sum_{i=1}^{S} b_{ij} \geq f_j \quad j=1,\ldots,T
   \]

   b. (2 points) Write the objective function to minimize the total number of doctor hours needed during the day.

   \[
   \text{minimize } \sum_{i=1}^{S} \sum_{j=1}^{T} b_{ij}
   \]

   c. (2 points) Formulate a set of constraints to ensure that the work hours of doctor \( i \) are consecutive, for all \( i=1,\ldots,S \). (For example, if the doctor is working during the hours of 3, 4, 5, and 6, and is not working on the 7\(^{th} \) hour, then he should be off duty for the remaining hours of that day.)

   \[
   \sum_{j=1}^{T} b_{ij} \leq M (1-b_{ij}) + Mb_{i+1} \quad \text{for } i=1,\ldots,S, \quad j=1,\ldots,T-1 \quad \text{where } M \text{ is a large number (e.g., } M=T \text{ is a sufficiently large number to make this constraint work)}
   \]

2. (2 points) Please refer to the Big Depot Game case:

   a. (1 point) Uncertainty in the size and the location of a disaster were identified as important factors leading to logistics challenges when planning for a disaster. Among other challenges faced during disaster preparedness and response are (i) the uncertainty in the timing of the disaster (and the resulting demand) and (ii) the uncertainty in supply availability. How are these challenges similar or different from the ones faced during day-to-day operations of a company such as Big-Depot?
There is not only demand uncertainty in size and location, but there is also uncertainty in timing. This timing uncertainty requires a constant state of preparedness from the supply chain that could be achieved with strategies such like inventory propositioning. In addition, the supply uncertainty needs to be attended, too. Suppliers’ supply chains may be disrupted as well, compromising the timely delivery of the required items, or certain high demanded items might become scarce. There is also a strong dependency of last-mile operations on the disaster severity, e.g. transportation infrastructure might be disrupted, or required equipment may not be locally available. Information and communication might be limited as well, stressing the management, tracking and control of operations. There are multiple players involved in the disaster response (NGOs, military, government, etc.), and efficient collaboration could be challenging given the different objectives and incentives of the players.

b. (1 points) Big Depot is considering purchasing some generators to be used during emergency situations. Suppose that the regional warehouses are not prepared to store the generators and significant warehousing costs might be incurred in order to have them available when they are needed. These additional warehousing costs are estimated to be in the order of 20% of the generators’ price. Warehousing cost information is owned by the Logistics Department, but the procurement decisions are made by the Merchandising Department. How would this situation impact procurement decisions? Briefly discuss the importance of information sharing and collaboration across different units of an organization during disaster preparedness and response.

The decisions taken by one element of the supply chain will impact every other element of chain. The best decision for one single element of the supply chain may not be the best for the whole chain. For instance, if the procurement department does not work closely with the logistics department, they may not be aware of additional costs other than procurement cost, as it was the case of the hypothetical situation presented previously in this case were there was a additional cost related to the generators storage in the company’s warehouses. That is why planning processes and performance metrics should be shared among all the participants.
3. (4 points) Refer to this article to answer the following questions:
   Evans, Christopher; Tavakoli, Manouche; Crawford, Bruce; “Use of Quality Adjusted Life Years and Life Years Gained as Benchmarks in Economic Evaluations: A Critical Appraisal”, Health Care Management Science, Vol. 7, Issue 1:pp.43-49, 2004
   To download this article, please go to the webpage:
   http://www.library.gatech.edu/search/databases.php
   Go to the database Web of Science. After you log in, go to “All databases” and search for “qaly” in Topic and “Evans” in Author.

   a. (1 points) Why do the authors state that there is a need for QALY benchmarks in pharmacoeconomic studies?
   To decide whether a treatment is pharmacoeconomically possible, the decision makers needs some standards to compare and to determine whether the new treatment is better. The use of league tables is one method. But incomplete sets of incremental cost-effectiveness ratio, differences in methodology, perspectives and time periods considered for the study, these might make the actual ranking in the league table being inaccurate and confusing. Thus the authors recommended using the other way of comparison, which is benchmark.

   b. (2 points) What are the three suggested benchmarks in reporting cost per QALY cited in this article? What are the weaknesses of each benchmark?
   The three suggested benchmarks are: Round number benchmark, Academic benchmark, and US governmental agencies standard.
   The Round number benchmark sets a cost level per QALY lower than it actually should be, because this benchmark was set several years ago, and it should be adjusted by inflation. Furthermore, this benchmark does not reflect the actual willingness to pay for the treatment.
   The Academic benchmark has lack of documentation that supports its recommendations, and the cost levels should be adjusted by inflation factors, too.
   The US governmental agencies standard suggests a wide variation of uncertainty attached to the cost per life years gained. This does not show consensus within a single agency and between different agencies.
c. (1 points) Which problem is considered to be the most important one by the authors in the current use of benchmarks in pharmaeconomic studies?

“The most important issue is the lack of consensus as to where the current threshold should be set.”

4. (3 points) Refer to this article to answer the following questions:
   Neumann, Peter; Greenberg, Dan; “Is the US ready for QALYs?”
   Health Affairs, Vol. 28 (No. 5): pp.1366-71, 2009
To download this article, please go to the webpage:
   http://www.library.gatech.edu/search/databases.php
Go to the database Web of Science. After you log in, search for “qaly” in Topic and “Neumann” in Author.
a. (1 points) What are the controversies of QALY mentioned in this article?

- Eliciting preference weights: It is created by surveys revealing the preference of the responders on different particular health states. Different preference elicitation techniques lead to different estimates.
- Whose preferences should be used?: Should we use a healthy person’s preferences to set the standards, or should we use an ill person’s preferences? People with illness usually value their health state more favorably than those without the illness.
- Are the QALYs fair?: QALYs values equally the aggregation of modest benefit to a large sum of people and a substantial benefit to a few people.

b. (1 points) Why do the authors disagree with the following claim by other researchers?: “The elicitation method used for QALY determination rarely affects the outcome and the decisions based on the QALY analysis”

The absolute value of preference weights used in a QALY estimates does not affect significantly the outcome of a cost-effectiveness analysis, but the relative difference between the different health states of the treatment group and their comparator group does.
c. (1 points) What are the potential problems for the US using QALY in health related policy decision making?

The use of QALY may lead to some discrimination problem, and also QALY consideration differs from the American health system. QALY tries to improve the community health, while the current American health system is decentralized and privately administered, and no payer has incentive to think broadly about the societal resource allocation.

Note: If you want to submit your homework electronically, please send it to ytlee1@gatech.edu. If you want to submit a hardcopy, please bring it to class.