SEFS 540 SP17 – Class Project Guidelines
(100 points)

- The class project is based on individual work. Under some circumstances and with the instructor's approval, you can work in a pair.
- You can propose a project, or I can give you one. I listed a few examples below for your reference. Talk with me if you want to use any of these or if you want to propose your own project. If you propose a project, the primary criterion of its acceptability will be whether it has an optimization component.
- A project plan is due on Friday, May 8 at 5:00pm. In a one page document, list the goals and activities of the project and specify the timeline that you intend to follow. If you want to work in a pair, please specify the roles of each team member (e.g., mathematical modeler, computer programmer, report writer, etc.). Each member will be evaluated based on how well s/he fulfilled his or her assigned role. The project plan is worth 20 of the 100 points total.
- The final project report is due on Monday, June 5 at 5:00pm.

Project requirements:

- The project must have a mathematical modeling, a computer programming or an algorithmic component. Both real and hypothetical data can be used. Real data is preferable.

Sample problems:

1. Climate change appears to have a profound impact on forest ecosystems in the boreal zone. In order to measure the changes in forest area, the spread of invasive species, above-ground carbon and other indicators, the U.S. Forest Service must design a new forest monitoring system for Interior Alaska. The Service can't use the same data collection protocol as in the Lower 48s because of the vast area involved and the lack of infrastructure to support the logistics. An added complexity is that the different climate change indicators, various carbon pools, require different sensing techniques. Remote sensing such as Light Detection and Ranging (LiDAR) might be appropriate for some, but not for all indicators. Field surveys and permanent plots might be necessary to perform certain measurements. We know the functional relationships between the relative densities of field vs. LiDAR plots and the associated variances of indicator estimation. Given a budget and labor time constraints, how should the Forest Service plan the spatiotemporal pattern of field vs. remote measurements in such a way so that the quality standards (sampling error targets) would be best met for as many indicators as possible?
2. The Washington Department of Natural Resources (DNR) is interested in developing an integrated decision model to optimize forest harvest and road maintenance scheduling on state trustlands. Forest management units (FMU) can only be harvested if all the road segments that connect them to the paved mainlines are up to environmental standards. Currently, DNR optimizes harvest scheduling independent of road costs. Similarly, the selection of least-cost hauling routes is independent of the harvest schedules. The Tóth Lab has developed an integer programming-based network model that not only links the two sets of decisions to each other, making use of opportunities to minimize costs, but it also identifies the least-cost routes dynamically in conjunction with harvest scheduling. However, the network model that makes this integration possible, doesn't track the loads of harvested timber associated with a particular FMU as it flows through the road network. As far as the model is concerned, the harvest flows from different FMUs merge at road junctions, which

make implementation problematic. Can you modify the model, or create a new one that can overcome this shortcoming?

3. Unmanned aerial vehicle routing for forest pest management in Japan. In what sequence should a set of trees be visited and sprayed by an unmanned helicopter so that the total length of the flight(s) would be minimized without crashing the multi-million dollar aircraft? The trees are infected by pine wilt disease which is a major problem in Japan and China. The GIS coordinates of the infected trees and the base are given, along with the gas mileage, fuel and insecticide capacities of the helicopter. Once you have the GIS coordinates of the optimal route(s), you can feed this info into the onboard computer of the aircraft, fill up its fuel and insecticide tanks and let it go to do its thing on its own. How is this problem different from the traveling salesman problem? Past students have developed am ant colony algorithm to tackle this problem. Can you improve upon their work and produce publication-worthy material?
4. Mathematical programming models that have been developed so far to address optimal reserve selection problems did not account for the potential competition among populations of a species of conservation interest for habitat resources. Consider the bat conservation model proposed in Burns et al. (2013) and explore how it can be modified to capture competition. Please use the ideas from the Conclusions section of the paper as a starting point.
5. There are two exact, mathematical programming formulations in the literature for reserve connectivity: Önal and Briers (2006) and Conrad et al. (2012). In Homework 4 and Labs 6-7, you will write a computer program to formulate both models, populate them with real data, and solve them with CPLEX. In this potential class project, you compare the model size, model strength and the computational performance of the two methods based on several real parcel datasets. A great deal of work has been done by a former student. Can you use his tools to make statistically significant recommendation abut the use of the two models and bring this body of work to potential publication?

References:

Burns, E.S., S.F. Tóth, and R.G. Haight. 2013. A Modeling Framework for Life History-Based Conservation Planning. Biological Conservation 158(1): 14-25.

Conrad, J.M., C.P. Gomes, W.J. van Hoeve, A. Sabharwal, and J.F. Suter (2012). Wildlife corridors as a connected subgraph problem. Journal of Environmental Economics and Management 63(1):1-18.

Önal, H., R.A. Briers. 2006. Optimal selection of a connected reserve network. Operations Research 54(2):379-388.

Tóth, S.F., R.G. Haight, and L.W. Rogers. 2011. Dynamic Reserve Selection: Modeling land price feedback effects in strategic land retention. Operations Research 59(5):1059-1078.