MIMSE 3113
Fall 2011
Project Description

Due at 5:00 PM on Friday, January 20, 2012.

1 Requirements

Each project will be performed either individually or in teams of two. Please do *not* discuss the project with anyone other than your official partner.[1]

You are *encouraged* to discuss the project with me. Here is my email address: `Andrew.Miller@math.u-bordeaux1.fr`.

Each project will formally consist of

1. a written description of what you have done, including
   - the basic model(s) you have developed;
   - a description of the variations on the models and/or solution strategies that you have tested, including tables showing computational results;
   - any conclusions based on your computational/experimental results;
   - what additional work you would like to do if you had more time, more information, access to actual data from an industrial partner, etc.

   This description should be at most 10 pages long (including any figures, tables, and references).

2. At least one .mos file containing a formulation that you tested in your project.

The preferred format for turning in your projects will be as follows:

[1] On a project of this type, teams that help each other are very likely to leave evidence of this in their projects. Cheating is something that I take very seriously, and please believe that in my courses it is not worth the risk.

1. Please make sure that the names of *each* team member clearly appear in *each* file you turn for the project.

2. Please include all of the files in one .zip file. Choose a name for this .zip file that contains the *last names* of each project member.

3. Please write this file onto a CD-ROM and *clearly label* this CD-ROM.

4. You may give this CD-ROM to me personally in my office (IMB 209), or you place it in my mailbox next to the IMB entry.

You are encouraged both to tailor your projects to your own interests *and* to discuss potential topics with me. I have included two suggestions for possible projects below. You may use one of these, or you may modify one to suit your interests, or you may choose a different topic entirely. However, I do encourage you to check with me to make sure that the topic you are considering is suitable.

The files you create may be in either French or English (no other languages please!).

If you would prefer to work with a partner but have difficulty identifying one, *please send me an email.* I may be able to help you form a team with another student.

2 Examples

1. Consider the Electronica application discussed in class.

    - Modify this application so that the Xpress model selects not only distribution center location and transport quantities, but also the *price* in each market.

      To do this you will first need to define *demand as a linear function of price* in each market. Two points are necessary and sufficient to determine a line.

      Determine the first point for each market as follows:

      (a) Consider the optimal solution to the Electronica model in the case in which single-sourcing is imposed.

(b) For each market, determine a unit price so that the *total revenue* generated by the optimal solution equals *the objective function value* associate function value associated with that market.

(c) For each market, the input price will be the price computed in the step above, and the first output demand will be the demand given in Electronica.xls.

Determine the second point for each market as follows: Assume that, in any market, if we double the unit price, then the demand for our product becomes 0.

For each market, these two points will be sufficient to determine demand as a linear function of price.

- Consider the Electronica application with the updated objective function (i.e., with the objective of maximizing total net profit rather than minimizing cost). Is this objective function convex? Is it concave? How do you know?
- Solve the Electronica application with the updated objective function (i.e., with the objective of maximizing total net profit rather than minimizing cost).
- Does the imposition of single-sourcing constraints make a difference in terms of revenue maximization? (Solve the profit maximization pricing model both *with* and *without* single-sourcing constraints to answer this question.)
- How much does changing the objective from cost minimization to cost maximization change the decisions suggested by the model? Does the set of (DC) to be constructed change? Does the set of markets served from each DC change?
- How sensitive are the answers to the above questions to the specific parameters of the demand function you computed? (To answer this question, you will need to modify the linear functions that determine demand slightly and re-solve the model).
- How much harder is the profit maximization model to solve than the cost minimization model? Compare the performance of Xpress on both in terms of time, size of the branch-and-bound tree, etc.

- What are the best parameter setting for Xpress for the formulations that you have coded above? Why do these function the best?
- In particular, what cuts (if any) does Xpress seem to generate in order to solve the formulations that you have coded above?

2. Consider the web site `http://mat.gsia.cmu.edu/TOURN/`.

   - Formulate models in Xpress to solve the NL problems with 4, 6, 8, and 10 teams. Verify that your model is correct by checking the optimal solutions for 4 and 6 teams.
   - What is the largest model that is small enough for the student version of Xpress to solve to optimality?
   - For the other models, you will need to see me to discuss access to the Xpress licenses needed to run these models (I will be happy to work with you on this). For all four instances report the best upper and lower bounds found by Xpress after one hour.
   - What can be done to make your formulation "better"? (That is, easier for Xpress to solve well.) This may require some thought on your part, as well as some discussion with me.

   Important*: If you choose this project, you should first formulate* ***only*** *the problem of finding the best possible schedule for a single team (for example, Atlanta).* Once you have completed this, *then* you can consider the problem of finding a complete schedule for *all* of the teams. This is important! The problem for one team is already fairly complicated, and it is important to start with something manageable.

3. Consider the model, which we discussed in class:

$$\begin{aligned}
\min \quad & \sum_{i=1}^{NI}\sum_{t=1}^{NT}(f^i y_t^i + h^i s_{i,t}) && (1)\\
\text{s.t.} \quad & x_t^i + s_{t-1}^i = d_t^i + s_t^i, , i = 1, ..., NI, t = 1, ..., NT && (2)\\
& \sum_i a^i x_t^i \leq K, , t = 1, ..., NT && (3)
\end{aligned}$$

$$x_t^i \leq \frac{K}{a^i} y_t^i, i = 1, ..., NI, t = 1, ..., NT \tag{4}$$

$$x_t^i, s_t^i \geq 0, i = 1, ..., NI, t = 1, ..., NT$$

$$y_t^i \in \{0, 1\}, , i = 1, ..., NI, t = 1, ..., NT. \tag{5}$$

as well as the file prodplan.mos available at the course web site.

- Modify the formulation so that, in any integer feasible solution $(\bar{x}, \bar{y}, \bar{s})$ the following holds:

  For all $i = 1, ..., NI$ and for any $t, u \in [1, ..., NT]$ such that $\bar{y}_t^i = \bar{y}_u^i = 1$, then $\bar{x}_t^i = \bar{x}_u^i$.

  Alternatively, note that this implies the addition to the formulation of a new variable (which may be called xx^i) and constraints that impose that

  $$xx^i = x_t^i y_t^i; i = 1, ..., NI, t = 1, ..., NT \tag{6}$$

- Code your formulation in an Xpress .mos file and solve the problem using Xpress. (Note that this implies that you *cannot* simply use the constraint (6) in your .mos file, as Xpress does not accept nonlinear constraints.)
- Does the imposition of the new constraints make a difference in terms of the total cost of the optimal solution? (Solve the production planning model both *with* and *without* the new constraints in order to answer this question.) How much do these changes affect the total cost of the production plan suggested by the model?
- How much harder is the new model that you have coded to solve than the original model provided at the web site? Compare the performance of Xpress on both in terms of time, size of the branch-and-bound tree, etc.
- What can be done to make the formulation of the model that you have coded stronger? How does the strengthened formulation compare to the original, when you compare the performance of Xpress on both in terms of time, size of the branch-and-bound tree, etc. (Note: your answer to this question may be related to your answer to the question about cuts below.)

- What are the best parameter setting for Xpress for the formulations that you have coded above? Why do these parameter settings work the best?
- In particular, what cuts (if any) does Xpress seem to generate in order to solve the formulations that you have coded above? Compare the difference that these cuts make in the solution process of both the original problem provided at the web site and the formulations that you have coded.