CEE 5290/CS 5722/ORIE 5340 Heuristic Methods for Optimization
Homework 4: Tabu Search
Assigned: Fri, September 19th, 2014
Due: Fri, September 26th, 2014

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1. (Computer Code) Assume that you want to find the maximum of the polynomial

   $F(x)=x^3-60x^2+90x \quad , 0\leq x\leq 31$ Eqn (1)
   (where x is an integer expressed in base 10)

   Now assume you want to use Tabu Search with a binary decision variable to solve the problem. So you will need to be able to compute the value of F(x) using the base 2 number z that is equivalent to x (e.g. x=8 has a base 2 equivalent of z= 1000). Assume you cannot exceed more than 200 cost evaluations of F(x).

   a. How many bits do you need in your binary string for this problem? Why?

   b. How would you define a neighborhood for Tabu Search. (There is more than one correct answer for this, but pick a choice that has a neighborhood that has fewer than 6 members)

   c. Write a Tabu Search code to solve this problem when the decision variable is a binary string and the cost function is given by Equation (1) for a value of x. Start your search with x=20. Compute the solution with your Tabu search code by doing at least 6 iterations.. What is the best solution you found during this one trial? (Tenure duration m=2)

      A corrected version of the Tabu Search algorithm from the reading is given below:

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Start with an initial feasible solution
Initialize Tabu lists (T) and aspiration level (AL)
AL is the aspiration level, which is the current best solution
FOR fixed number of iterations DO
        Calculate Cost(S) for all S in neighborhood V*
        Find best solution (S*) in V*
                IF move S to S* is not in T THEN
                        Accept move and update solution
                        Update Tabu list
                        IF cost(S*) > AL THEN
                                Update aspiration level
                        ENDIF
                ELSE
                        IF cost(S*) > AL THEN
                                Accept move and update best solution
                                Update tabu list and aspiration level
```

ELSE /* correction */
Find next best S (S_2*) in **V*** that is not Tabu
Accept move to S_2*
Update tabu list
ENDIF
ENDIF
Increment iteration number
END

NOTES on above:

- General algorithm that can be implemented deterministically or stochastically.
- Size of the candidate list **V*** must be greater than Tabu tenure in the above algorithm since it assumes there will always be at least one move that is not Tabu
- Candidate list = sample/subset of neighboring solutions

Please remember to submit all requested scripts to Blackboard. Everything including the m-files (graphs, written responses to questions, etc.) must be submitted in hard copy into the homework box located in 220 Hollister.

2. (This does not require writing a computer code) We did a circuit problem described in Fig. 2.5 and Table 2.1 (in SA slides) Assume the initial configuration is to have cells 6,7,8,9,10 on Chip 1 and nodes 1,2,3,4,5 on Chip 2. (Note you do not need to know anything about circuits for this problem. All you need to know was explained in lecture notes on Simulated Annealing .)

Application of Simulated Annealing to Chip Design

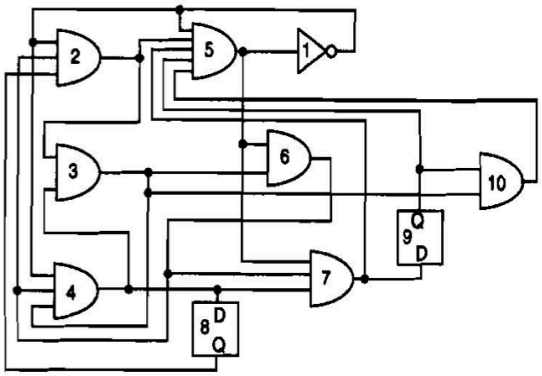

Figure 2.5 Circuit for Example 2.2

a. Assume you want to solve this problem by tabu search . How would you represent the decision vector as one of the following: a real vector, as a binary string, as an integer (not necessarily binary) vector, or as a permutation. (You choose one representation and use that representation in the rest of the question. #5) As indicated above, the initial configuration is

to have cells 6,7,8,9,10 on Chip 1 and nodes 1,2,3,4,5 on Chip 2. Show how you would represent that initial configuration in your decision vector form. In particular you need to explain how many elements (e.g. dimensions) are in your decision vector and what each of them they represent.

b. Given your choice of decision vector representation, indicate your neighborhood definition for Tabu search if you allow only one pairwise swap from the current solution S to get each of the neighbors in N(S).. You want all the neighbors to be feasible, i.e. there are 5 elements on Chip 1 and 5 elements on Chip 2 for all neighbors. Give two examples of feasible neighbors of your initial configuration using the representation above assuming there is only one pairwise swap between cells on Chip 1 and on Chip 2. How many possible vectors are in the neighborhood?

c. Assume your tabu tenure length is three and that the tabu is defined in terms of the two cells that are swapped. Assume in the first iteration you swap cells 3 and 6 and in the second iteration you choose to swap 1 and 9. (You are given this information; you do not need to calculate the objective function to answer this part of the problem.) Give the decision vector representation for iteration 2 and iteration 3 and give all the neighbors that would be Tabu for the move from iteration 3 to iteration 4. Use the table below to enter the information

Iteration **decision vector description**
1_____**(initial value)**
2_____
3_____
Tabu members of iteration 4: _____