Recitation 5

1 CSP as IP

Alice, Bob, and Charles want to study in Gates, which has 9 floors. To maximize productivity, we need to assign each of them to a separate floor without violating the following constraints:

- Alice only has access to floors 4 through 8
- Bob only has access to floors 3 through 7
- Charles must be at least 2 floors higher than Bob
- Alice must be at least 1 floor higher than Bob
- Alice must be at least 1 floor lower than Charles

Our goal is to assign Alice, Bob, and Charles to the highest possible floors.

1. Formulate the problem as a CSP.

2. Formulate the problem as an IP problem.

2 Baymax's Factory

Baymax and the 281 TAs have opened a factory to produce special medicine and bandages. These are really difficult to produce and require the collaboration of robots and humans.

To produce an ounce of medicine, it takes 0.2 hours of human labor and 4 hours of robot labor. To produce an inch of bandage, it takes 0.5 hours of human labor and 2 hours of robot labor. An ounce of medicine sells for \$30 and an inch of bandages sells for \$30. Medicine and bandages can be sold in fractions of an ounce or inch.

We want to maximize our profit so we can buy gifts for all the students. However, the TAs are really busy so they can only devote 90 human hours. In addition, Baymax can only devote 800 robot hours because he has other obligations to tend to. How can we maximize our profit?

- 1. Is this a linear, mixed or integer programming problem? Formulate and solve it.
- 2. Now suppose the items can only be sold in whole units (by ounce/inch). Is this a linear, mixed, or integer programming problem? Perform branch and bound for one branch level. You do not have to evaluate; writing out the constraints will suffice.
- 3. Now assume medicine can be sold in fractions but bandages can only be sold in whole units. What kind of a programming problem would this be, and how would our evaluation process differ from the problem type in part b?
- 4. How many optimal solutions can a LP have? How about IP?

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Spring 2024

3 4-Queens

Recall the 4-Queens problem. The goal is to place 4 chess queens on a 4x4 chess board such at no two queens are in the same row, column and diagonal.

Formulate the 4-Queens problem as an integer programming problem.