

MITx: 15.053x Optimization Methods in Business Analytics

Heli



- ▶ General Information
- Week 1Week 2
- ▼ Week 3

Lecture

Lecture questions due Sep 27, 2016 at 19:30 IST

Recitation

Problem Set 3

Homework 3 due Sep 27, 2016 at 19:30 IST

Week 3 > Problem Set 3 > Problem 4

■ Bookmark

PART A

(1/1 point)

The local post office requires full-time employees to meet demands that vary from day to day. The number of full-time employees required on each day is given in Table 1. Each full-time employee must work five consecutive days and then receive two days off. For example, an employee who works Monday to Friday must be off on Saturday and Sunday. This schedule for employees repeats every week. We want to formulate an integer program that the post office can use to minimize the number of full-time employees who must be hired.

Table 1: Requirements for the local post office

	Number of full time employees required
1=Monday	17
2=Tuesday	13
3=Wednesday	15
4=Thursday	19

5=Friday	14
6=Saturday	16
7=Sunday	11

We define the decision variables as follows:

- Let x_1 be the number of full-time employees who work Monday to Friday
- ullet Let $oldsymbol{x_2}$ be the number of full-time employees who work Tuesday to Saturday
- . . .
- ullet Let x_7 be the number of full-time employees who work Sunday to Thursday

Then the integer program to minimize the number of total employees is given as follows:

Constraints (1) – (7) represents that the number of employees who work on Monday to Sunday respectively should satisfy the requirement stated in Table 1. The objective function is the total number of employees required.

The following parts are INDEPENDENT from each other. They are all based on the formulation above.

Use the spreadsheet pset3_p4.xlsx to solve the above integer program. What is the minimum workers that the post office needs?



You have used 1 of 3 submissions

PART B

(1/1 point)

Let s_2, s_5 , and s_7 (assume integers) denote the surplus number of workers on Tuesday, Friday, and Sunday. For example, if there are 18 workers on Tuesday, then the $s_2=5$. Suppose that the current objective is to minimize $z=max\{s_2,s_5,s_7\}$. Reformulate that as an IP. Include all constraints that contain s_2,s_5 or s_7 , other than the non-negativity and integrality constraints, as well as any other changes from the original formulation. Which of the following are necessary changes to the original integer program? Select 6 of the constraints.

- \square $z \leq s_5$ (new constraint)
- $\quad \square \quad z \leq s_7 \ ext{(new constraint)}$
- lacksquare $x_1+x_2+x_5+x_6+x_7+s_2=13$ (replace constraint 2)
- $ule{\hspace{-0.1cm} \hspace{-0.1cm} \hspace{-0.1cm}$

$$lacksquare$$
 $x_1+x_2+x_3+x_4+x_5+s_5=14$ (replace constraint 5)

$$lacksquare$$
 $x_3+x_4+x_5+x_6+x_7+s_7=11$ (replace constraint 7)



You have used 1 of 3 submissions

PART C

(1/1 point)

Let s_1 be the number of excess workers on Monday. Suppose that there is a penalty for having too many workers on Monday. The linear penalty due to s_1 is 0.1. That is, there is no penalty for having 17 workers; there is a penalty of 0.1 for having 18 workers; there is a penalty of 0.2 for having 19 workers (0.1 for both the 18th and 19th workers). The penalty increases if there are more than 19 workers. Here the linear penalty is .25 per worker. For example, if there are 20 workers, the total penalty is .45, which includes a penalty of .25 for the 20th worker. The objective function is to minimize the penalty cost for extra workers on Monday. Let s_1' be the surplus for the first 2 extra workers and s_1'' be the surplus for extra workers more than two. Thus $s_1 = s_1' + s_1''$.

What would the new objective function be?

- $lacksquare MIN \ 0.25 s_1{}' + 0.1 s_1^{''}$
- $\quad \ \, \blacksquare \ \, \text{MIN} \, \, 0.1 s_1{}' + 0.1 s_1^{''}$



You have used 1 of 2 submissions

PART D

(1/1 point)

In order to incorporate the requirement in the previous part, what modifications should be made to the Monday constraint (constraint 1)? Select three of the following.

$$lacksquare x_1 + x_4 + x_5 + x_6 + x_7 - s_1' - s_1'' = 17$$

$$lacksquare x_1 + x_4 + x_5 + x_6 + x_7 - s_1^{'} = 17$$

$$lacksquare x_1 + x_4 + x_5 + x_6 + x_7 - s_1'' = 17$$

$$lacksquare x_1 + x_4 + x_5 + x_6 + x_7 + s_1^{'} + s_1^{''} = 17$$

$$lacksquare x_1 + x_4 + x_5 + x_6 + x_7 + s_1^{'} = 17$$

- $lacksquare x_1 + x_4 + x_5 + x_6 + x_7 + s_1'' = 17$
- $oldsymbol{ ilde{s}}$ $0 \leq s_{1}^{'} \leq 2$
- $oldsymbol{\mathscr{S}} s_1'' \geq 0
 oldsymbol{\mathscr{S}}$
- $\quad \square \quad s_1^{''} \geq 2$



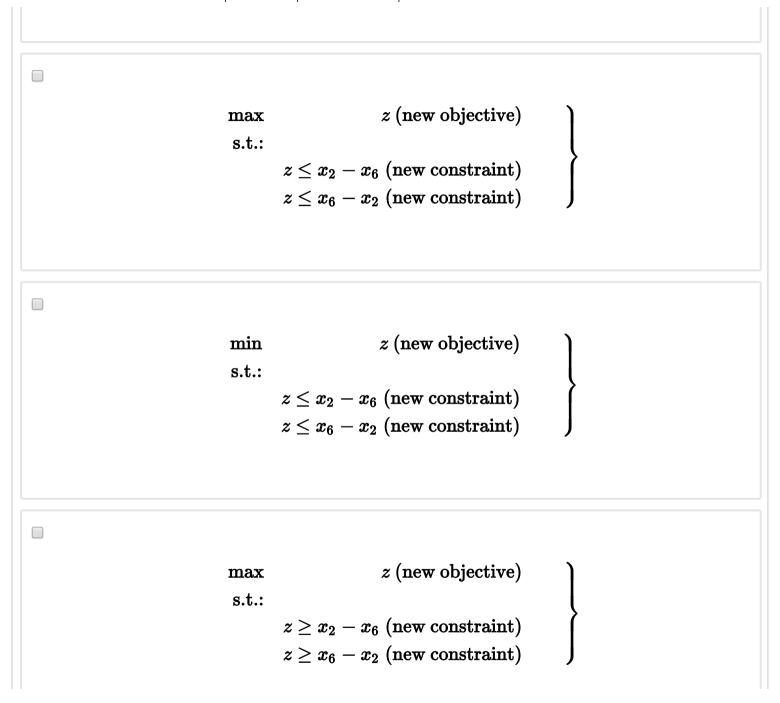
You have used 1 of 3 submissions

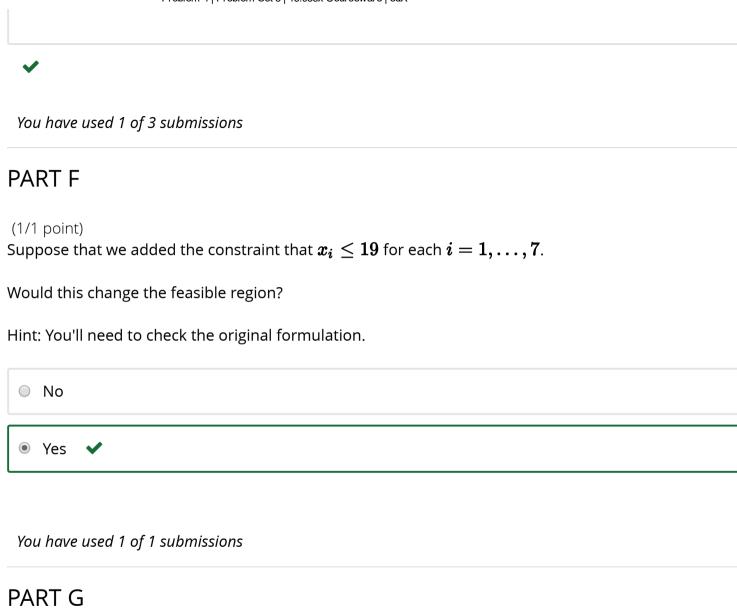
PART E

(1/1 point)

Suppose we want to minimize the absolute difference between the number of workers who start on Saturday (x_6) and the number of workers who start on Tuesday (x_2) . Let z be the new objective. Which of the following are necessary changes to the original integer program?

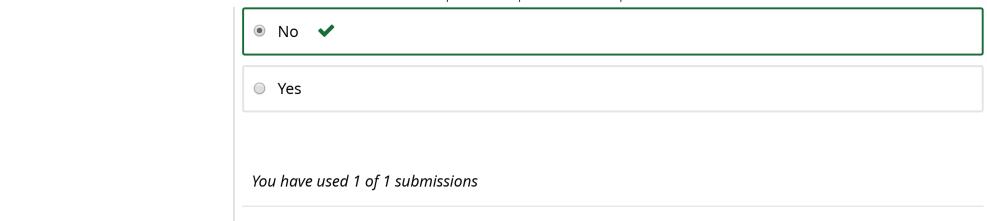
 $min \qquad z \ (ext{new objective}) \ ext{s.t.:} \ z \geq x_2 - x_6 \ (ext{new constraint}) \ z \geq x_6 - x_2 \ (ext{new constraint}) \$





(1/1 point)

Would this change the optimal solution?



© All Rights Reserved



© 2016 edX Inc. All rights reserved except where noted. EdX, Open edX and the edX and Open EdX logos are registered trademarks or trademarks of edX Inc.















