

## QUIZ 3

The Pear Computer Company is trying to decide where to manufacture its upcoming phone. The phone will be available in three varieties, the iPhone 8, the iPhone 8 Plus, and the iPhone X. The phones can be manufactured at one of three different facilities: Closistan, Nearistan, and Faristan. There is an initial setup cost associated with using each facility. The cost for shipping the phones also varies by location. The following table summarizes the relevant data:

	Closistan	Nearistan	Faristan
Setup cost	\$400,000	\$300,000	\$200,000
Shipping Cost/iPhone 8	\$2	\$4	\$5
Shipping Cost/iPhone 8 Plus	\$3	\$6	\$9
Shipping Cost/iPhone X	\$7	\$8	\$10

Each month the Pear Computer Company predicts that 85,000 of the iPhone 8, 105,000 of the iPhone 8 Plus, and 150,000 of the iPhone X will need to be shipped from the manufacturing facilities. The logistics employee that you replaced did not finish the formulation, but did get it started. The LP formulation was supposed to minimize the monthly costs, while meeting the predicted shipping requirements. The following is what the logistics employee came up with so far:

Sets

$P$  phones,  $P = \{\text{iPhone 8, iPhone 8 Plus, iPhone X}\}$   
 $F$  Manufacturing Facilities,  $F = \{\text{Closistan, Nearistan, Faristan}\}$

Data

$S_f$  setup cost if Manufacturing Facility  $f$  is used, for  $f \in F$   
 $T_{p,f}$  transport cost to ship phone  $p$  from Manufacturing Facility  $f$ , for  $p \in P, f \in F$   
 $D_p$  (demand) number of phones  $p$  that need to be shipped, for  $p \in P$

Integer Decision Variables

$x_{p,f}$  number of phones  $p$  shipped from Manufacturing Facility  $f$ , for  $p \in P, f \in F$

Binary Decision Variables

$z_f$  1 if Manufacturing Facility  $f$  is open, 0 otherwise, for  $f \in F$

Use the start of the logistic employee's formulation to answer the complete the following elements of the model (first using no set notation, and then translating to set notation, as directed).

1. (6 points) Write an objective function that minimizes the **TOTAL** cost of meeting the monthly shipping requirements predicted by the Pear Computer Company using **ONLY VARIABLES** and **NUMBERS** (5 points). Express the objective function using sets, summations, and parameters (1 point).
2. (6 points) Write a set of constraints that ensures that monthly demand requirements predicted by the Pear Computer Company are met using **ONLY VARIABLES** and **NUMBERS** (5 points). Express the same class of constraints using sets, summations, and parameters (1 point).

3. (*6 points*) Write a set of constraints that enforces the correct behavior of the binary variables,  $z_f$ , using ONLY VARIABLES and NUMBERS (5 points). Express the same class of constraints using sets, summations, and parameters (1 point).

4. (*2 points*) Is anything missing from the model? If so, what?