上 海 交 通 大 学 试 卷

（ 2019~ 2020~2 Academic Year/Summer Semester ）

Class No.____VG441______ _ Name in English or Pinyin: ______________________

Student ID No.________________ Name in Hanzi(if applicable): ______________________

VG441 Supply Chain Management

Midterm

June 24, 10am

The exam paper has 4 pages in total.

You are to abide by the University of Michigan-Shanghai Jiao Tong University Joint Institute (UM-SJTU JI) honor code. Please sign below to signify that you have kept the honor code pledge.

THE UM-SJTU JI HONOR CODE

I accept the letter and spirit of the honor code:

I have neither given nor received unauthorized aid on this examination, nor have I concealed any violations of the Honor Code by myself or others.

Signature:____________

Please enter grades here:

Exercises No. 题号	Points 得分	Grader's Signature 流水批阅人签名
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Total 总分		

VG441 Take-Home Midterm I

You are encouraged to type your answer using LaTeX, but scanning document is acceptable. The due date of this midterm is on Canvas. No late submission is allowable. It is also not allowed to ask any questions to **peers or Professor or TA** *since this is an exam. But you can post clarification questions on Piazza.*

Problem 1 (Forecasting)

The time series dataset is included in "demands.csv". You are asked to generate 8 figures in Python.

(a) Scatter plot the demands against time (Figure 1).

(b) Run a simple regression and plot your results on top of scatter plot (Figure 2).

(c) Run gradient boosting method with different number of trees:

```
params = {'n_estimators': 1, 'max_depth': 1, 'learning_rate': 1, 'loss': 'ls'}

params = {'n_estimators': 2, 'max_depth': 1, 'learning_rate': 1, 'loss': 'ls'}

params = {'n_estimators': 5, 'max_depth': 1, 'learning_rate': 1, 'loss': 'ls'}

params = {'n_estimators': 10, 'max_depth': 1, 'learning_rate': 1, 'loss': 'ls'}

params = {'n_estimators': 20, 'max_depth': 1, 'learning_rate': 1, 'loss': 'ls'}

params = {'n_estimators': 50, 'max_depth': 1, 'learning_rate': 1, 'loss': 'ls'}
```

Plot each of these results on top of scatter plot (Figures 3-8).

Problem 2 (Quantity-Discount Model)

Zeus Lighting Fast sells peripherals, such as printers and scanners, with their new desktop and laptop computers. Their supplier for printers charges a fixed cost \$50 per order, and holding cost is \$200 per unit per year. They sell 50 printers per month. The manufacturer has offered the following price schedule:

Order Quantity	Price Per Unit
< 12	\$520
12 to 64	\$510
65 to 128	\$495
> 128	\$485

(a) What is the optimal ordering strategy?

(b) The supplier has offered to be a drop shipper, i.e., they will ship directly to the customer. In exchange, they will increase the unit price to \$520 per computer, but not charge the ordering costs and all inventory will be held at the supplier. From a purely financial standpoint, should Zeus take them up on the offer?

Problem 2 (Wagner-Whitin Model)

A snack bar at a certain theme park sees a (constant, deterministic, continuous) demand of 150 cases per day. Replenishment orders are placed to a central warehouse located within the theme park, with negligible lead time, and it costs \$10 in labor costs to deliver an order to the snack bar from the warehouse. It costs \$1.20 per case per day in refrigeration costs and other holding costs to hold cases of food in inventory at the snack bar.

Day (#)	Day (Name)	Demand
1	Sunday	220
2	Monday	155
3	Tuesday	105
4	Wednesday	90
5	Thursday	170
6	Friday	210
7	Saturday	290

(a) Use dynamic programming to solve the problem (on paper by hands).

(b) Formulate as a shortest path problem and draw the corresponding diagram with nodes, edges, and edge costs. Solve using Dijkstra's algorithm (on paper by hands).

(c) Formulate the problem as a MILP on paper and solve it in Python.

Problem 3 (Linear Programming Duality)

(a) Please write down duality of the following linear programming problem.

$$\begin{array}{ll} \max & 6x_1 + 14x_2 + 13x_3 \\ \text{s.t.} & 3x_1 + 2x_2 + x_3 \leq 24, \\ & x_1 + 2x_2 + 4x_3 \geq 60, \\ & x_1 \geq 0, \\ & x_2 \leq 0, \\ & x_3 \text{ is free.} \end{array}$$

(b) Bipartite graph is a special graph. Its vertices are divided into two separate sets and edges only exist between those two sets. The maximum cardinality matching problem of the bipartite graph can be modeled as a linear programming problem below:

$$\begin{array}{lll} \max & \sum\limits_{(i,j)\in E} x_{ij} & \\ \text{s.t.} & \sum\limits_{j:(i,j)\in E} x_{ij} \leq 1 & \forall\ i \in I, \\ & \sum\limits_{i:(i,j)\in E} x_{ij} \leq 1 & \forall\ j \in J, \\ & x_{ij} \geq 0 & \forall\ (i,j) \in E. \end{array}$$

in which I, J stand for the left and right sets and E stands for set of the edges. Write down duality of the above LP.