

Linear Programming Assignment

General Instructions

The objective of this exercise is to assess your skill to create a mathematical model through Linear programming. We would like to assess how you think through the problem and articulate your solution through Linear programming model (**LP model**).

Your submission will be reviewed based on how you create an LP model that can scale for multiple traders who may have different switching windows and different distribution of orders. The assignment should be written in Java (7, 8 or 11). Your submission should be packaged and delivered with a README.md that explains the system requirements and how to unpack and execute the program. A document explaining the constraints used in LP model is also required. We will also assess your knowledge on language features and good software design.

Unless otherwise specified, please submit your work to Drop box folder: <https://www.dropbox.com/request/USVpK3UYkwFukhSjAFuy> , or alternatively email to MatchBoxSingaporeDev@tullettprebon.com

Evaluation Criteria

Your work will be evaluated based on the following factors:

- Accuracy of Output - Your application must produce trades that are maximized for the overall notional as per the example.
- Application Design - The application must exhibit good software design and other best practices in software development.
- Code Readability - Good code must be readable and self-documenting.
- Packaging and Delivery - We appreciate if the project is easy to build and run. Your application must be easy to build and run on any platform. Provide a README.md.

Problem Statement

An order matching system produces trades from orders submitted by different traders in the below format. A trade is match between 2 traders (a buyer and a seller) on a given start date. The application should process the orders of different traders and produce an output of trades that respect each of the traders' matching requirement. The objective of the optimization is to **MAXIMIZE the overall traded notional** matched.

In the below table Mark, Ryan and Bob are traders who have put in orders that are shown under 'Input orders'. The matching system matched trades, maximizing the overall traded notional subject to these constraints:

1. The **Net Notional** matched should be zero for each trader.
2. The matched trades for each trader should respect the Maximum Switching Window. Should be less than or equal to the Maximum switching window
3. Each trader should not trade more than the order quantity. In case an order is matched against multiple traders' orders on the same start date, the sum of trades should be less than or equal to the order. Example : Mark traded buy -265 (made of buy -225 and buy -40) on 12-Jan-21. This is less than the buy -500 order notional

Input Orders					Trades matched		
Traders	Mark	Ryan	Bob		Mark	Ryan	Bob
Max Switching window	5	7	3		5	7	3
Day	Start Date	Notional	Notional	Notional	Notional	Notional	Notional
1	05-Jan-21	150	-100		100	-100	
2	06-Jan-21						
3	07-Jan-21	200	-125		125	-125	
4	08-Jan-21	-500	500				
5	11-Jan-21						
6	12-Jan-21	-500	350	80	-265	225	40
7	13-Jan-21	200	-150	200	150	-150	
8	14-Jan-21						
9	15-Jan-21	-300	150	-40	-110	150	-40
10	18-Jan-21						
11	19-Jan-21						
Net notional matched for each trader					0	0	0

Overall traded notional should be **maximized**. See trades generated

Trade is the absolute notional matched between a buyer and a seller. See Day 1 trade where Ryan buy's 100 from Mark.

D ay	Start Date	Buyer	Seller	Traded notional	Remarks
1	05-Jan-21	Ryan	Mark	100	Ryan buys -100 and Mark sells 100
3	07-Jan-21	Ryan	Mark	125	
6	12-Jan-21	Mark	Ryan	225	Mark has 2 trades. Mark buys -225 from Ryan and -40 from Bob on the <u>same start date</u> . The total of -265 is less than the Mark's order of buy -500 on 12-Jan-21
6	12-Jan-21	Mark	Bob	40	
7	13-Jan-21	Ryan	Mark	150	
9	15-Jan-21	Mark	Ryan	110	Ryan has 2 trades. Ryan sells 110 to Mark and 40 to Bob on the same start date. The total of 150 does not exceed Ryan's sell order of 150 on 15-Jan-21
9	15-Jan-21	Bob	Ryan	40	
Overall traded notional				790	

1. Negative notional represents a buy order.
2. Positive notional represents a sell order.
3. A trade is matched when there is a buy order and a sell order on the same start date. As an example see 05-Jan-2021. Mark placed 150 sell and Ryan placed -100 buy. The maximum possible match for Ryan and Mark is 100.
4. We should not match more than the input notional orders for each start date and for each trade.
5. The LP model should be able to match different distribution of orders.
6. Although the example shows 3 traders, the LP model should be able to match for many traders orders in a single optimization.
7. The solution should scale when there are 360 day's in the table.

SWITCHING WINDOW

The **Switching Window** is the number of days before and after the start date of the matched order,

A buy trade should be fully offset with a sell trade (or vice versa) within the specified switching window.

The buy trade can be offset by one sell trade or across many partial sell trades within the switching window (and vice-versa). However, it must be fully offset within the switching window.

See Mark's trades:

- 100 sell (day 1) can be switched against -265 buy (day 6), leaving a balance of -165 buy. Switching window: day 6 - day 1 = 5 days is less than or equal to 5 days switching window allowed for Mark.
- 125 sell (day 3) can be offset with the remaining -165 buy (day 6) leaving a balance of -40 buy. Switching window: day 6 - day 3 = 3 days is less than 5 days switching window allowed for Mark.
- Balance -40 buy (day 6) can be offset against 150 sell (day 7) leaving a balance of 110 sell on day 7. Switching window: day 7 - day 6 = 1 day is less than 5 days switching window allowed for Mark
- Balance 110 sell (day 7) can be fully switched against -110 buy (day 9). Switching window: day 9 - day 7 = 2 days is less than 5 days switching window for Mark.
- All trades of Mark are fully switched

The same logic works for Ryan and Bob who have different switching windows of 7 and 3.

This color represents the switch window period in the table below.

Mark's switch window = 5 days. Therefore, each switch (buy + sell = 0) cannot exceed a period of 5 days within the allowed switch window date range, not including the date with the order.

				Mark's switch window periods (+/- 5 days) for each Start Date with an order									
				#1		#2		#3		#4		#5	
				05-Jan-21		07-Jan-21		12-Jan-21		13-Jan-21		15-Jan-21	
Day	Start Date	Order	Trade	Switch window	Trades matched	Switch window	Trades matched	Switch window	Trades matched	Switch window	Trades matched	Switch window	Trades matched
1	05-Jan-21	150	100	0	100	-2		-5					
2	06-Jan-21			1		-1		-4		-5			
3	07-Jan-21	200	125	2		0	125	-3		-4			
4	08-Jan-21	-500		3		1		-2		-3		-5	
5	11-Jan-21			4		2		-1		-2		-4	
6	12-Jan-21	-500	-265	5	-100	3	-125	0	-40	-1		-3	
7	13-Jan-21	200	150			4		1	40	0	110	-2	
8	14-Jan-21					5		2		1		-1	
9	15-Jan-21	-300	-110					3		2	-110	0	See #4
10	18-Jan-21							4		3		1	
11	19-Jan-21							5		4		2	
			0	Net Trade	0	Net Trade	0	Net Trade	0	Net Trade	0	Net Trade	0