Morgan Stanley

# Morgan Stanley Coding Competition

16 Oct 2010

# Welcome

- Morgan Stanley Technology

# What is the competition about?

- Programming challenge for a group of three students in 24 hours
- Competing with students from other schools
- The winning team from each campus would be selected for the final round:
  - The winning team would be invited to our Shanghai HQ
- Final round is a competition across participating schools, the final winner would entitle to:
  - iPads, Macbooks.

# The challenge

- You are responsible to run a fruit warehouse with ￥100,000 cash for one year
- There is only one wholesaler and one distributor you have to interact with
- The wholesaler would tell you the lowest price they are willing to sell for each product, and the amount available
- The distributor would tell you the highest price they are willing to buy and how much they need
- You are competing with other warehouses to make optimal purchase and sales decisions: buy low and sell high
- Fruits are perishable: any inventory that is left at the end would be marked down at 10%

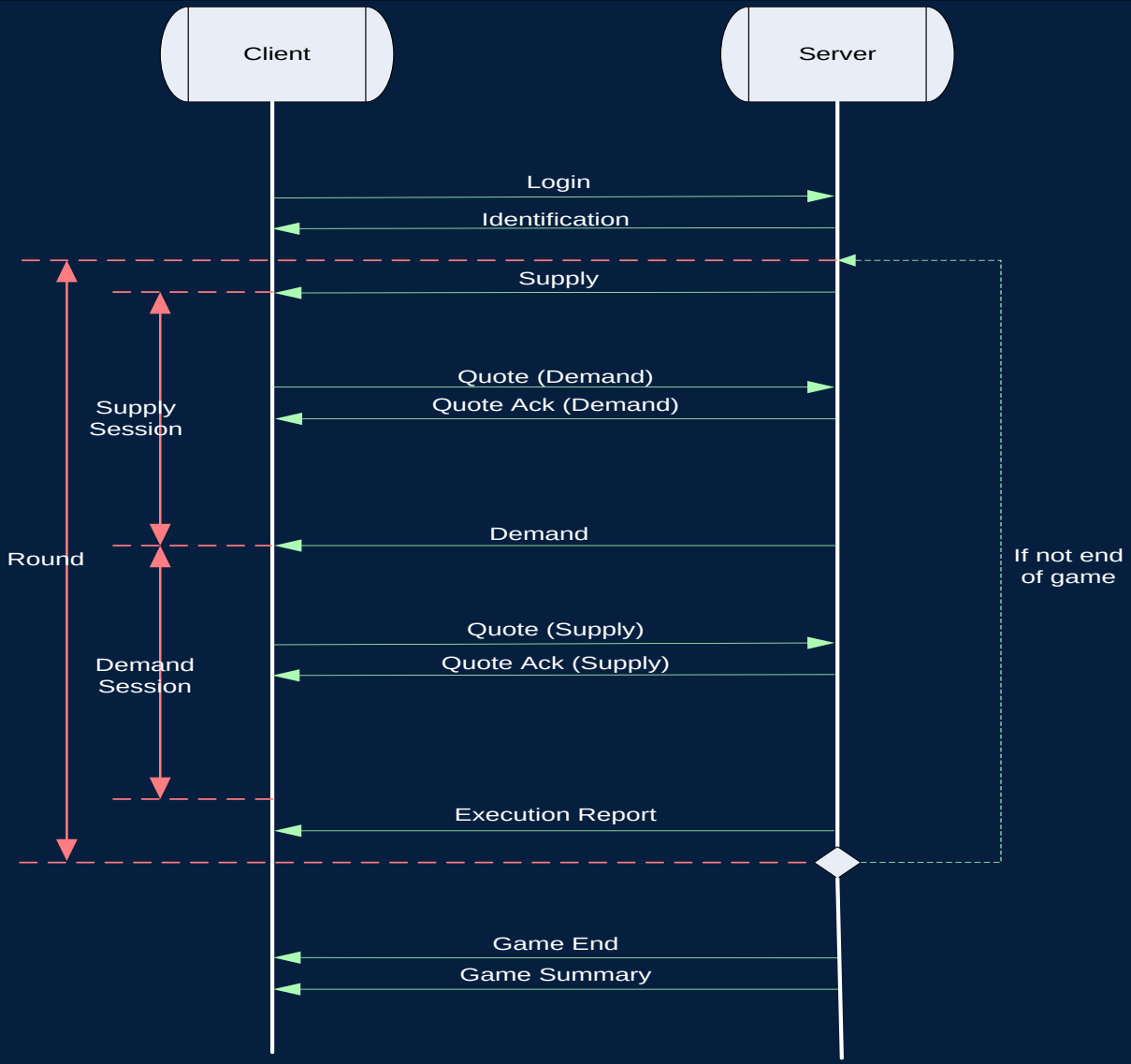
# The game rule and format

- Create a game client to communicate with the game server
- The game is played in rounds, each round represents a business day
- There are 200 rounds and 30 products available
- In the beginning of the round, you would receive supply and demand message from the game server
- Your client needs to send back the amount and price that you wish to purchase and sell
- You can not sell more than what you have, and you can not buy if you don’t have enough cash to complete the transaction
- Your team have until Sunday 9AM to develop your client, we will hold the final competition in this room

# Technical details

- The message format is in JSON
- Clients have to login to the server and all communications are done via TCP
- During each round, the following messages would be exchanged:
  - Round start message including supply and demand
  - Order message sent by your client to perform purchase and sell transaction
  - Round end message indicating the successful transactions
- We provide some sample clients to get you started
- Feel free to utilize any open source libraries available

# Technical details

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time interval

message

# Testing and development support

- On demand test server available:
  - http://114.80.213.55:8080/codestorm/test
  - Use your given team name and key to login
  - Connect your client to the host port displayed
  - Server can generate up to 8 random clients to compete against you
  - 20 products and 100 rounds
  - You can invite other teams to test your strategies!

# Offer Matching

- The minimum bid price is the same as the maximum offer price, each round
  - minimum bid price is the least you can offer to buy from the wholesaler
  - maximum offer price is the most you can offer to sell at to the distributor
- Order are filled in alphabetical order by product
  - you could run out of money for Zucchinis if all your bids for Apples are accepted
- Offers are adjusted when the market is short
  - i.e. you bid more than is still available
- Offers are rejected when the player is short
  - i.e. you offer more than you have to sell or have cash to buy
  - or if the bid/offer does exceeds the total number of units available to buy/sell

# Offer Matching

- In a tie situation (two offers at the same price) the client which sent its response first will win
  - auction does not consider the number of units bid or offered when resolving a tie
- Orders are settled at the end of the round
  - For example, you have N units of a fruit at the start of round X. You cannot sell more than N units of that fruit during that round, even if your submission also includes a buy order to buy more of the same fruit.
- Market activity affects market prices
  - your activity is only a small portion of the global fruit-distribution market

# Offer Matching Example

## Round starts

| Player 1 | |
|---|---|
| $10.00 | Cash |
| 10 | Apple |

| Player 2 | |
|---|---|
| $11.00 | Cash |
| 5 | Apple |
| 10 | Pear |

| Player 3 | |
|---|---|
| $20.00 | Cash |
| 5 | Apple |

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# Offer Matching Example

## Players receive supply and demand

| Player 1 | |
|---|---|
| $10.00 | Cash |
| 10 | Apple |

| Player 2 | |
|---|---|
| $11.00 | Cash |
| 5 | Apple |
| 10 | Pear |

| Player 3 | |
|---|---|
| $20.00 | Cash |
| 5 | Apple |

| Demand |
|---|
| 5 Apple @ $2.00 |
| 3 Pear @ $3.00 |

| Supply |
|---|
| 5 Apple @ $2.00 |
| 7 Pear @ $3.00 |
| 3 Lime @ $5.00 |

# Offer Matching Example

## Players send offers

| Player 1 | |
|---|---|
| $10.00 | Cash |
| 10 | Apple |

Received 1st:

Sell: 2 Pear @ $3.00
Buy: 5 Apple @ $2.00
Buy: 2 Pear @ $3.33

| Demand |
|---|
| 5 Apple @ $2.00 |
| 3 Pear @ $3.00 |

| Player 2 | |
|---|---|
| $11.00 | Cash |
| 5 | Apple |
| 10 | Pear |

Received 2nd:

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 3 Pear @ $3.00

| Supply |
|---|
| 5 Apple @ $2.00 |
| 7 Pear @ $3.00 |
| 3 Lime @ $5.00 |

| Player 3 | |
|---|---|
| $20.00 | Cash |
| 5 | Apple |

Received 3rd:

Sell: 5 Apple @ $1.50
Buy: 5 Apple @ $2.00
Buy: 5 Pear @ $4.00

# Offer Matching Example

## Server acknowledges offers

| Player 1 | |
|---|---|
| $10.00 | Cash |
| 10 | Apple |

| Player 2 | |
|---|---|
| $11.00 | Cash |
| 5 | Apple |
| 10 | Pear |

| Player 3 | |
|---|---|
| $20.00 | Cash |
| 5 | Apple |

Received 1st:

Sell: 2 Pear @ $3.00
Buy: 5 Apple @ $2.00
Buy: 2 Pear @ $3.33

Received 2nd:

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 3 Pear @ $3.00

Received 3rd:

Sell: 5 Apple @ $1.50
Buy: 5 Apple @ $2.00
Buy: 5 Pear @ $4.00

| Demand |
|---|
| 5 Apple @ $2.00 |
| 3 Pear @ $3.00 |

| Supply |
|---|
| 5 Apple @ $2.00 |
| 7 Pear @ $3.00 |
| 3 Lime @ $5.00 |

# Offer Matching Example

## Matching begins

| Player 1 | |
|---|---|
| $10.00 | Cash |
| 10 | Apple |

Received 1st:

Sell: 2 Pear @ $3.00
Buy: 5 Apple @ $2.00
Buy: 2 Pear @ $3.33

| Demand |
|---|
| 5 Apple @ $2.00 |
| 3 Pear @ $3.00 |

| Player 2 | |
|---|---|
| $11.00 | Cash |
| 5 | Apple |
| 10 | Pear |

Received 2nd:

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 3 Pear @ $3.00

| Supply |
|---|
| 5 Apple @ $2.00 |
| 7 Pear @ $3.00 |
| 3 Lime @ $5.00 |

| Player 3 | |
|---|---|
| $20.00 | Cash |
| 5 | Apple |

Received 3rd:

Sell: 5 Apple @ $1.50
Buy: 5 Apple @ $2.00
Buy: 5 Pear @ $4.00

# Offer Matching Example

## Lowest offer is best for matching demand

| Player 1 | |
|---|---|
| $10.00 | Cash |
| 10 | Apple |

Received 1st:

Sell: 2 Pear @ $3.00
Buy: 5 Apple @ $2.00
Buy: 2 Pear @ $3.33

| Player 2 | |
|---|---|
| $11.00 | Cash |
| 5 | Apple |
| 10 | Pear |

Received 2nd:

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 3 Pear @ $3.00

| Player 3 | |
|---|---|
| $20.00 | Cash |
| 5 | Apple |

Received 3rd:

Sell: 5 Apple @ $1.50
Buy: 5 Apple @ $2.00
Buy: 5 Pear @ $4.00

| Demand |
|---|
| 5 Apple @ $2.00 |
| 3 Pear @ $3.00 |

| Supply |
|---|
| 5 Apple @ $2.00 |
| 7 Pear @ $3.00 |
| 3 Lime @ $5.00 |

# Offer Matching Example

## Match best price for Apples

| Player 1 | |
|---|---|
| $10.00 | Cash |
| 10 | Apple |

| Player 2 | |
|---|---|
| $11.00 | Cash |
| 5 | Apple |
| 10 | Pear |

| Player 3 | |
|---|---|
| $20.00 | Cash |
| 5 | Apple |

Received 1st:

Sell: 2 Pear @ $3.00
Buy: 5 Apple @ $2.00
Buy: 2 Pear @ $3.33

Received 2nd:

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 3 Pear @ $3.00

Received 3rd:

Sell: 5 Apple @ $1.50
Buy: 5 Apple @ $2.00
Buy: 5 Pear @ $4.00

| Demand |
|---|
| 5 Apple @ $2.00 |
| 3 Pear @ $3.00 |

| Supply |
|---|
| 5 Apple @ $2.00 |
| 7 Pear @ $3.00 |
| 3 Lime @ $5.00 |

# Offer Matching Example

## Match best price for Pears

| Player 1 | |
|---|---|
| $10.00 | Cash |
| 10 | Apple |

Received 1st:

Sell: 2 Pear @ $3.00
Buy: 5 Apple @ $2.00
Buy: 2 Pear @ $3.33

| Demand |
|---|
| 0 Apple @ $2.00 |
| 3 Pear @ $3.00 |

| Player 2 | |
|---|---|
| $11.00 | Cash |
| 5 | Apple |
| 10 | Pear |

Received 2nd:

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 3 Pear @ $3.00

| Supply |
|---|
| 5 Apple @ $2.00 |
| 7 Pear @ $3.00 |
| 3 Lime @ $5.00 |

| Player 3 | |
|---|---|
| $20.00 | Cash |
| 5 | Apple |

+$7.50

-5

Received 3rd:

Sell: 5 Apple @ $1.50
Buy: 5 Apple @ $2.00
Buy: 5 Pear @ $4.00

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# Offer Matching Example

## Next-best price for Pears rejected due to lack of inventory

| Player 1 | |
|---|---|
| $10.00 | Cash |
| 10 | Apple |

Received 1st:

~~Sell: 2 Pear @ $3.00~~
Buy: 5 Apple @ $2.00
Buy: 2 Pear @ $3.33

| Demand |
|---|
| 0 Apple @ $2.00 |
| 2 Pear @ $3.00 |

| Player 2 | |
|---|---|
| $13.00 | Cash |
| 5 | Apple |
| 10 | Pear |

Received 2nd:

+$2.00

-1

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 3 Pear @ $3.00

| Supply |
|---|
| 5 Apple @ $2.00 |
| 7 Pear @ $3.00 |
| 3 Lime @ $5.00 |

| Player 3 | |
|---|---|
| $20.00 | Cash |
| 5 | Apple |

Received 3rd:

+$7.50

-5

Sell: 5 Apple @ $1.50
Buy: 5 Apple @ $2.00
Buy: 5 Pear @ $4.00

# Offer Matching Example

## Highest price is best to match supply

| Player 1 | |
|---|---|
| $10.00 | Cash |
| 10 | Apple |

Received 1st:

~~Sell: 2 Pear @ $3.00~~
Buy: 5 Apple @ $2.00
Buy: 2 Pear @ $3.33

| Player 2 | | |
|---|---|---|
| $13.00 | Cash | +$2.00 |
| 5 | Apple | |
| 10 | Pear | -1 |

Received 2nd:

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 3 Pear @ $3.00

| Player 3 | | |
|---|---|---|
| $20.00 | Cash | +$7.50 |
| 5 | Apple | -5 |

Received 3rd:

Sell: 5 Apple @ $1.50
Buy: 5 Apple @ $2.00
Buy: 5 Pear @ $4.00

| Demand |
|---|
| 0 Apple @ $2.00 |
| 2 Pear @ $3.00 |

| Supply |
|---|
| 5 Apple @ $2.00 |
| 7 Pear @ $3.00 |
| 3 Lime @ $5.00 |

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# Offer Matching Example

## Best match price for Apples

| Player 1 | |
|---|---|
| $10.00 | Cash |
| 10 | Apple |

Received 1st:

~~Sell: 2 Pear @ $3.00~~
Buy: 5 Apple @ $2.00
Buy: 2 Pear @ $3.33

| Demand |
|---|
| 0 Apple @ $2.00 |
| 2 Pear @ $3.00 |

| Player 2 | | |
|---|---|---|
| $13.00 | Cash | +$2.00 |
| 5 | Apple | |
| 10 | Pear | -1 |

Received 2nd:

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 3 Pear @ $3.00

| Supply |
|---|
| 5 Apple @ $2.00 |
| 7 Pear @ $3.00 |
| 3 Lime @ $5.00 |

| Player 3 | | |
|---|---|---|
| $20.00 | Cash | +$7.50 |
| 5 | Apple | -5 |

Received 3rd:

Sell: 5 Apple @ $1.50
Buy: 5 Apple @ $2.00
Buy: 5 Pear @ $4.00

# Offer Matching Example

## Next-best offers are tied so fill the one received first

| Player 1 | |
|---|---|
| $10.00 | Cash |
| 10 | Apple |

Received 1st:

~~Sell: 2 Pear @ $3.00~~
Buy: 5 Apple @ $2.00
Buy: 2 Pear @ $3.33

| Demand |
|---|
| 0 Apple @ $2.00 |
| 2 Pear @ $3.00 |

| Player 2 | |
|---|---|
| $13.00 | Cash |
| 5 | Apple |
| 10 | Pear |

Received 2nd:

+$2.00 -$5.00
+2
-1

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 3 Pear @ $3.00

| Supply |
|---|
| 3 Apple @ $2.00 |
| 7 Pear @ $3.00 |
| 3 Lime @ $5.00 |

| Player 3 | |
|---|---|
| $20.00 | Cash |
| 5 | Apple |

Received 3rd:

+$7.50
-5

Sell: 5 Apple @ $1.50
~~Buy: 5 Apple @ $2.00~~
Buy: 5 Pear @ $4.00

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# Offer Matching Example

## Offer adjusted to match supply

| Player 1 | |
|---|---|
| $10.00 | Cash |
| 10 | Apple |

Received 1st:

~~Sell: 2 Pear @ $3.00~~
Buy: 3 Apple @ $2.00
Buy: 2 Pear @ $3.33

| Player 2 | | |
|---|---|---|
| $13.00 | Cash | +$2.00 -$5.00 |
| 5 | Apple | +2 |
| 10 | Pear | -1 |

Received 2nd:

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 3 Pear @ $3.00

| Player 3 | | |
|---|---|---|
| $20.00 | Cash | +$7.50 |
| 5 | Apple | -5 |

Received 3rd:

Sell: 5 Apple @ $1.50
~~Buy: 5 Apple @ $2.00~~
Buy: 5 Pear @ $4.00

| Demand |
|---|
| 0 Apple @ $2.00 |
| 2 Pear @ $3.00 |

| Supply |
|---|
| 3 Apple @ $2.00 |
| 7 Pear @ $3.00 |
| 3 Lime @ $5.00 |

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# Offer Matching Example

## Matched best price for Pears

| Player 1 | |
|---|---|
| $10.00 | Cash |
| 10 | Apple |

Received 1st:

-$6.00

+3

~~Sell: 2 Pear @ $3.00~~
Buy: 3 Apple @ $2.00
Buy: 2 Pear @ $3.33

| Demand |
|---|
| 0 Apple @ $2.00 |
| 2 Pear @ $3.00 |

| Player 2 | |
|---|---|
| $13.00 | Cash |
| 5 | Apple |
| 10 | Pear |

Received 2nd:

+$2.00 -$5.00

+2

-1

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 3 Pear @ $3.00

| Supply |
|---|
| 0 Apple @ $2.00 |
| 7 Pear @ $3.00 |
| 3 Lime @ $5.00 |

| Player 3 | |
|---|---|
| $20.00 | Cash |
| 5 | Apple |

Received 3rd:

+$7.50

-5

Sell: 5 Apple @ $1.50
~~Buy: 5 Apple @ $2.00~~
Buy: 5 Pear @ $4.00

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# Offer Matching Example

## Next-best price rejected due to lack of funds

| Player 1 | |
|---|---|
| $10.00 | Cash |
| 10 | Apple |

Received 1st:

-$6.00

+3

~~Sell: 2 Pear @ $3.00~~
Buy: 3 Apple @ $2.00
~~Buy: 2 Pear @ $3.33~~

| Demand |
|---|
| 0 Apple @ $2.00 |
| 2 Pear @ $3.00 |

| Player 2 | |
|---|---|
| $13.00 | Cash |
| 5 | Apple |
| 10 | Pear |

Received 2nd:

+$2.00 -$5.00

+2

-1

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 3 Pear @ $3.00

| Supply |
|---|
| 0 Apple @ $2.00 |
| 2 Pear @ $3.00 |
| 3 Lime @ $5.00 |

| Player 3 | |
|---|---|
| $20.00 | Cash |
| 5 | Apple |

Received 3rd:

+$7.50 -$20.00

-5

+5

Sell: 5 Apple @ $1.50
~~Buy: 5 Apple @ $2.00~~
Buy: 5 Pear @ $4.00

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# Offer Matching Example

## Next-best offer adjusted to match supply

| Player 1 | |
|---|---|
| $10.00 | Cash |
| 10 | Apple |

Received 1st:

-$6.00

+3

~~Sell: 2 Pear @ $3.00~~
Buy: 3 Apple @ $2.00
~~Buy: 2 Pear @ $3.33~~

| Player 2 | |
|---|---|
| $13.00 | Cash |
| 5 | Apple |
| 10 | Pear |

Received 2nd:

+$2.00 -$5.00

+2

-1

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 2 Pear @ $3.00

| Player 3 | |
|---|---|
| $20.00 | Cash |
| 5 | Apple |

Received 3rd:

+$7.50 -$20.00

-5

+5

Sell: 5 Apple @ $1.50
~~Buy: 5 Apple @ $2.00~~
Buy: 5 Pear @ $4.00

| Demand |
|---|
| 0 Apple @ $2.00 |
| 2 Pear @ $3.00 |

| Supply |
|---|
| 0 Apple @ $2.00 |
| 2 Pear @ $3.00 |
| 3 Lime @ $5.00 |

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# Offer Matching Example

## All possible matching complete

| Player 1 | |
|---|---|
| $10.00 | Cash |
| 10 | Apple |

Received 1st:

-$6.00

+3

~~Sell: 2 Pear @ $3.00~~
Buy: 3 Apple @ $2.00
~~Buy: 2 Pear @ $3.33~~

| Demand |
|---|
| 0 Apple @ $2.00 |
| 2 Pear @ $3.00 |

| Player 2 | |
|---|---|
| $13.00 | Cash |
| 5 | Apple |
| 10 | Pear |

Received 2nd:

+$2.00 -$5.00 -$6

+2

-1 +2

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 2 Pear @ $3.00

| Supply |
|---|
| 0 Apple @ $2.00 |
| 0 Pear @ $3.00 |
| 3 Lime @ $5.00 |

| Player 3 | |
|---|---|
| $20.00 | Cash |
| 5 | Apple |

Received 3rd:

+$7.50 -$20.00

-5

+5

Sell: 5 Apple @ $1.50
~~Buy: 5 Apple @ $2.00~~
Buy: 5 Pear @ $4.00

# Offer Matching Example

## Player inventories updated

| Player 1 | |
|---|---|
| $4.00 | Cash |
| 13 | Apple |

| Player 2 | |
|---|---|
| $4.00 | Cash |
| 7 | Apple |
| 11 | Pear |

| Player 3 | |
|---|---|
| $7.50 | Cash |
| 0 | Apple |
| 5 | Pear |

Received 1st:

~~Sell: 2 Pear @ $3.00~~
Buy: 3 Apple @ $2.00
~~Buy: 2 Pear @ $3.33~~

Received 2nd:

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 2 Pear @ $3.00

Received 3rd:

Sell: 5 Apple @ $1.50
~~Buy: 5 Apple @ $2.00~~
Buy: 5 Pear @ $4.00

| Demand |
|---|
| 0 Apple @ $2.00 |
| 2 Pear @ $3.00 |

| Supply |
|---|
| 0 Apple @ $2.00 |
| 0 Pear @ $3.00 |
| 3 Lime @ $5.00 |

# Offer Matching Example

## Unmet demand puts upward pressure on price

| Player 1 | |
|---|---|
| $4.00 | Cash |
| 13 | Apple |

Received 1st:

~~Sell: 2 Pear @ $3.00~~
Buy: 3 Apple @ $2.00
~~Buy: 2 Pear @ $3.33~~

| Demand |
|---|
| 0 Apple @ $2.00 |
| 2 Pear @ $3.00 |

| Player 2 | |
|---|---|
| $4.00 | Cash |
| 7 | Apple |
| 11 | Pear |

Received 2nd:

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 2 Pear @ $3.00

| Supply |
|---|
| 0 Apple @ $2.00 |
| 0 Pear @ $3.00 |
| 3 Lime @ $5.00 |

| Player 3 | |
|---|---|
| $7.50 | Cash |
| 0 | Apple |
| 5 | Pear |

Received 3rd:

Sell: 5 Apple @ $1.50
~~Buy: 5 Apple @ $2.00~~
Buy: 5 Pear @ $4.00

# Offer Matching Example

## Unwanted supply puts downward pressure on price

| Player 1 | |
|---|---|
| $4.00 | Cash |
| 13 | Apple |

| Player 2 | |
|---|---|
| $4.00 | Cash |
| 7 | Apple |
| 11 | Pear |

| Player 3 | |
|---|---|
| $7.50 | Cash |
| 0 | Apple |
| 5 | Pear |

Received 1st:

~~Sell: 2 Pear @ $3.00~~
Buy: 3 Apple @ $2.00
~~Buy: 2 Pear @ $3.33~~

Received 2nd:

Sell: 1 Pear @ $2.00
Buy: 2 Apple @ $2.50
Buy: 2 Pear @ $3.00

Received 3rd:

Sell: 5 Apple @ $1.50
~~Buy: 5 Apple @ $2.00~~
Buy: 5 Pear @ $4.00

| Demand |
|---|
| 0 Apple @ $2.00 |
| 2 Pear @ $3.00 |

| Supply |
|---|
| 0 Apple @ $2.00 |
| 0 Pear @ $3.00 |
| 3 Lime @ $5.00 |

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# Hints & Tips

- Make sure the basic communication parts of your code works before working on your strategy
- You don’t have to make bids or offers in every round
  - you may want to watch what is happening in the market for a few rounds before conducting any transactions

# Schedule

- Saturday 9am
  - kick-off
- Saturday 12pm – 5:00pm
  - Morgan Stanley technology team will be available to answer questions
- Sunday 9am
  - game final
  - players in first heat must have your clients running and connected to the game server by 9am exactly

# Contact us

- Send e-mail to codestorm@morganstanley.com
- Any announcements will be sent via email.

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