Tradewind business

Teaching Complex Decision Making with Partial Information: The Two Dimensional (P,Q) News Vendor Online Competition

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Game selection

Create a Competitive pricing game

Players choose a price each round to sell their products at. They have to choose the best price to maximize profits based on stats each round.

Create a Stock trading game

Players get stocks and cash. Each round they can trade with each other while trying to make the most profit before the game ends and stocks are all sold.

Create a Fishing game

Players have to determine the profit maximizing production capacity at each round while competing with other companies who make similar decisions in an oligopolistic market.

Create a News vendor game

In the news vendor problem a manager sells a product during a short selling season with stochastic demand. The manager has one opportunity to order inventory before the selling season, and no further replenishments are possible.

Create a Two sided platform game

Choose how much to charge for the device, and how much to charge developers for licensing.

Create a Beer supply chain game

Players join a supply chain and have to place orders based on demand and information that is shared with them and others in the supply chain.

Create a Pricing & quantity news vendor game

In this advanced news vendor game, a manager sells a product during a short selling season with stochastic demand. The manager has to determine both the sales price and the order quantity. Each business may face a different demand realization, which is a stochastic decreasing function of their sales price decision.

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The Big Picture

1. Our Classic **News Vendor** (**Q**) **Game** has been very popular:
   Used by many in teaching OM, Analytics, HC OM (Nurse Scheduling, Bed Allocation…) , and in IS (finding the 'true demand' from truncated 'sales data.')

2. The **new** **Two Dimensional (P,Q) News Vendor Game**:
   Teaches students how to use '*Decision Support Systems*' and to use statistics/analytics to 'estimate the demand curve' and the optimal (**P**,**Q**) with noisy information: truncated sales data, and 'price dependent' stochastic demand realization.

3. **Call/Email me to use it, for FREE**

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Traditional Newsvendor Problem

- In the traditional newsvendor problem, seller determines order quantity for an uncertain demand d(p):

Known Parameters

- Sale price (p)
- Unit cost (c)
- Backorder cost (b)^
- Salvage value (s)^
- Demand randomness (ε)

Decision:

- Order quantity (q)

- Optimal order quantity q* can be calculated using P(Demand≤ q*)=r,

where the critical ratio is given by r = $\frac{p+b-c}{p+b-s}$

(^ can be set to zero)

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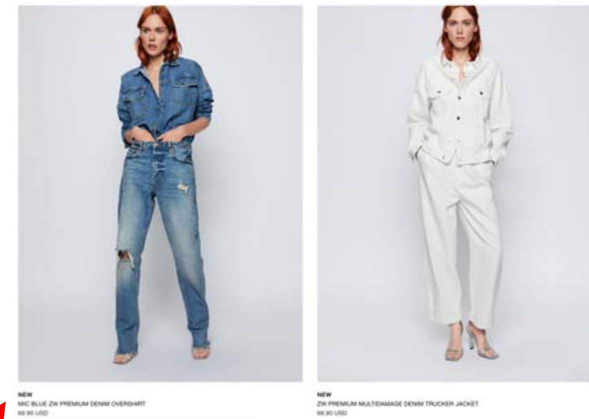
Traditional Newsvendor Problem

However!

Most businesses determine their own prices for their own product. Therefore, exogenous price assumption might not be valid in many practical cases.

To overcome this issue, the traditional newsvendor problem has been generalized to the price-setting newsvendor problem where the seller also determines sale price (p).



Tradewind business   Price-Setting Newsvendor Problem

Theoretical Background – The Price-Setting Newsvendor Problem

Parameters
- Unit cost (c)
- Backorder cost (b)
- Salvage value (s)
- Demand randomness (ε is a r.v. $\in [L_\varepsilon, U_\varepsilon]$)

Decisions
- Order quantity (q)
- Sale price (p)

Total profit for any realized random demand $d(p, \varepsilon)$:

$$\prod(q, p, \varepsilon) = p \min\{q, d(p, \varepsilon)\} + s[q - d(p, \varepsilon)]^+ - b[d(p, \varepsilon) - q]^+ - cq$$

Expected profit function:

$$\pi(q,p) = \mathbb{E}[\prod(q, p, \varepsilon)] = (p+b-c)q - (p+b-s) \int_0^q (q-x)\, dG(p,x) - b\mathbb{E}[d(p,\varepsilon)]$$

Price setting newsvendor problem on our platform is based on the work of Karlin and Carr (1962) and Xu et al. (2010)*

*Karlin, S. and C.R. Carr, "Prices and Optimal Inventory Policy", in Studies in Applied Probability and Management Science (Chapter 11), eds. K.J. Arrow, S. Karlin and H. Scarf. Stanford Press (1962). 159-172.
*Xu, M., Chen, Y.F. and Xu, X., 2010. The effect of demand uncertainty in a price-setting newsvendor model. *European Journal of Operational Research*, 207(2), pp.946-957.

Tradewind business Price-Setting Newsvendor Problem

Theoretical Background - Price-Setting Newsvendor Problem

This setting can be used with any distribution function and demand function that satisfies

- $d(p, \varepsilon)$ is decreasing in p , increasing in ε and twice differentiable in p and ε.
- $d(p, \varepsilon) = 0$ for $p \geq p_{max}$

In our game we used additive demand function with uniform distribution with mean zero

$\boxed{d(p, \varepsilon)= d(p) + \varepsilon \text{ where } \varepsilon \in [-x, +x].}$

Also, demand-price function is represented as linear function:

$\boxed{\mathbf{d(p)= D\text{-}t*p}}$ where D is the maximum demand.

Tradewind business Price-Setting Newsvendor Problem

Theoretical Background - Price-Setting Newsvendor Problem

Finding **optimal price and quantity** for generalized additive demand function d(p, ε):

1. Taking first order condition (FOC) of the expected profit function π(q,p) wrt q
2. Finding optimal q as a function of p (represented as $\bar{q}$(p))
3. Place $\bar{q}$(p) into the expected profit function π(q,p)
4. Differentiate the new profit function π($\bar{q}$(p) ,p) wrt p (FOC) and find optimal p*
5. Place p* into the function $\bar{q}$(p) to find optimal quantity q*

Tradewind business Price-Setting Newsvendor Problem

Theoretical Background - Price-Setting Newsvendor Problem

Step 1 and 2 come from traditional newsvendor game:

In the traditional newsvendor game with additive demand function, the optimal quantity can be derived as a function of price : $\bar{q}$(p) = d(p)+ F^{-1}(r), where F is a cdf of ε.

3- Place $\bar{q}$(p) into the expected total profit function:

$$\pi(\bar{q}(p), p) = \mathbb{E}[\prod(\bar{q}(p), p, \varepsilon)] = (p-c)\, d(p) + (p+b-s) \int_{L_\varepsilon}^{F^{-1}(r)} x \, dF(x) - b\mathbb{E}[\varepsilon]$$

4- First order condition:

$$\frac{d\pi(\bar{q}(p), p)}{dp} = (p - c)d'(p) + d(p) + L_\varepsilon + \int_{L_\varepsilon}^{F^{-1}(r)} \big(1 - F(x)\big)dx = 0$$

5- Optimal order quantity: $q^* = \bar{q}(p^*) = d(p^*) + F^{-1}(r^*)$

Optimal expected profit: $\pi(\bar{q}(p^*), p^*)$

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Price-Setting Newsvendor Problem

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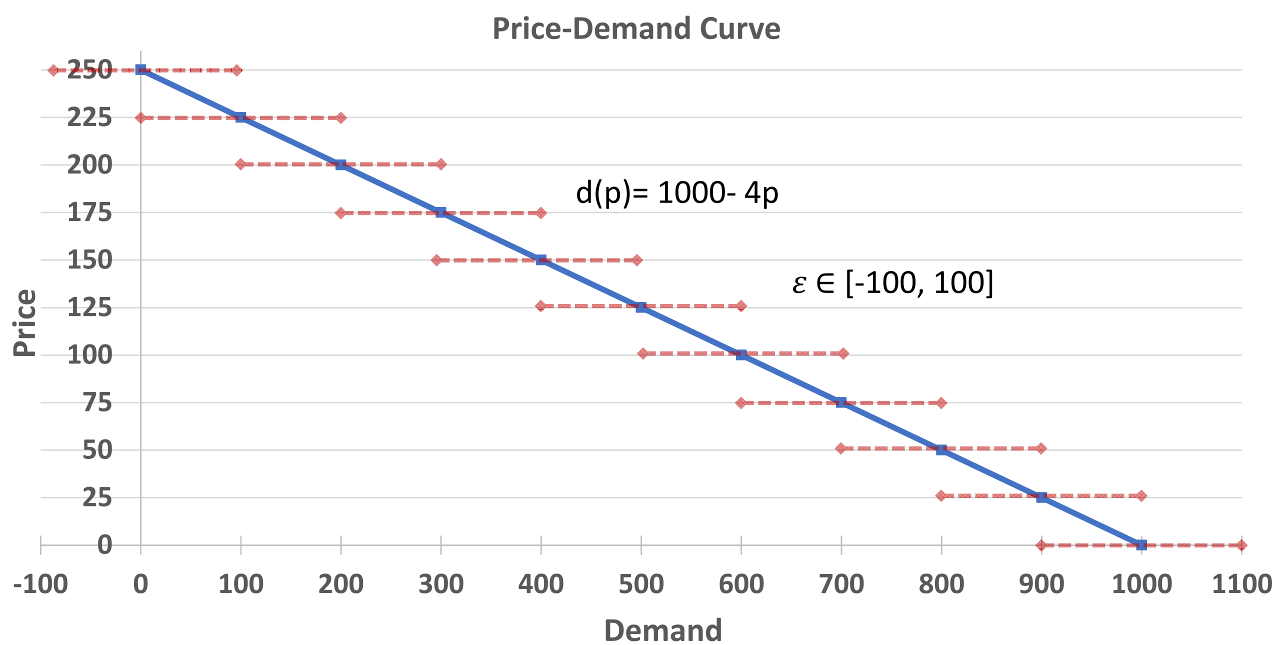
Example:



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Price-Setting Newsvendor Problem

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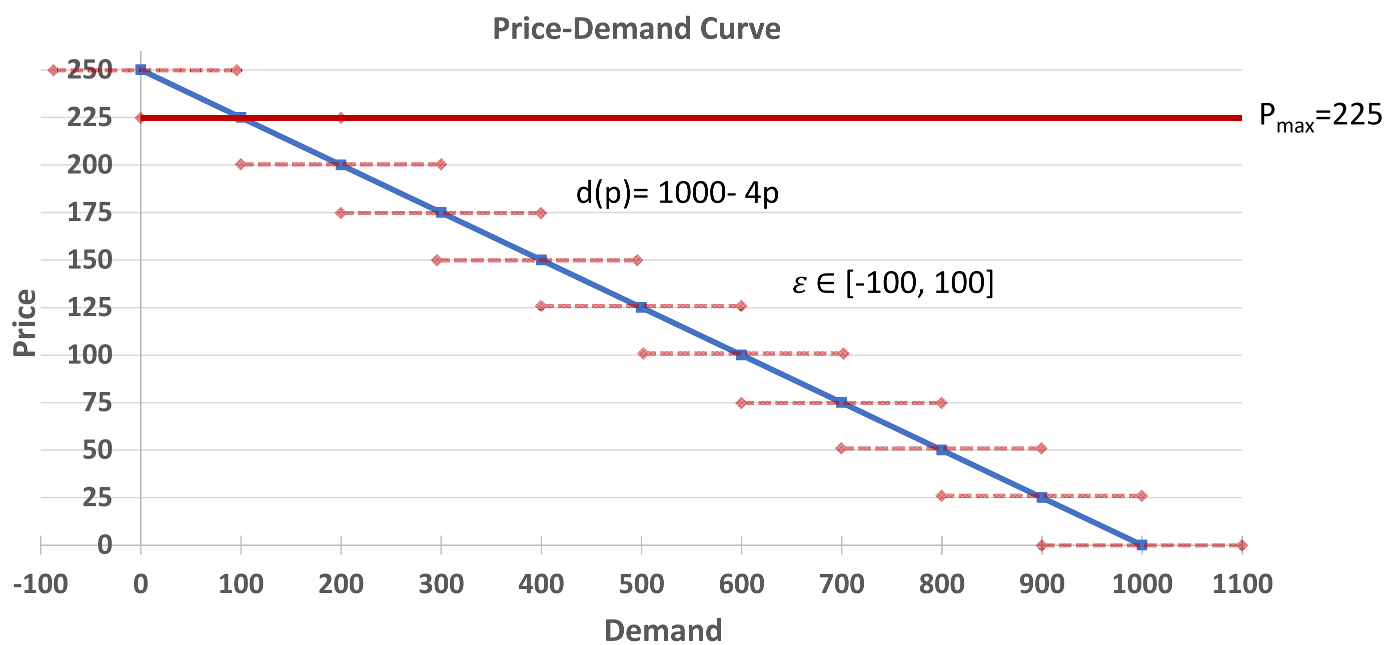

Price – Setting Newsvendor Game

Setup

Gameplay

Post-Game Analysis

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Price – Setting Newsvendor Game

Setup

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Price-Setting Newsvendor Game

Game Settings for Professors – Parameter Setup

Economic Parameters

Maximum demand	$	500
Maximum price	$	200.00
Backorder cost	$	15.00
Unit salvage value	$	15.00
Unit cost	$	40.00

Redraw Demand Curve

Uniform distribution range	±	50

Maximum submittable price: $180

After parameter entry, click “Redraw Demand Curve”

Demand curve will be updated and the maximum submittable price (p_{max}) will be shown to the professor.

Tradewind business | Price-Setting Newsvendor Game

Game Settings for Professors – Student Display Configuration

Student Display

Profit rank	Enabled
Cumulative profit rank	Enabled
Quantity rank	Enabled
Price rank	Enabled
Optimal quantity	Disabled
Optimal price	Disabled
Optimal profit	Disabled
Probability of stock running out	Disabled

Schedule game | Save configuration

Display options for ranking amongst students:
- Profit
- Cumulative Profit
- Quantity and Price rankings amongst students

Display options for long-run **optimal values** :
- Optimal price
- Optimal profit
- Optimal quantity
- Prob. of running out of stock

Price – Setting Newsvendor Game

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Price – Setting Newsvendor Game

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Price-Setting Newsvendor Game

Round 8

Student Input Screen

Profit change from last round

Maximum Demand	2500
Maximum Price	$1,104.00
Purchase Price	$240.00
Salvage Price	$124.00
Backorder Cost	$200.00

Amount to order

units

You must submit a positive quantity to order.

Price to sell at

$

You must submit a positive price to sell at.

Submit

Tradewind business — Price-Setting Newsvendor Game

Student
Between Rounds
Screen

Round 8 Ended

Profit change from last round

Your business decisions

Order quantity	**1100 units**
Order sell price	**$780.00**

Your business performance

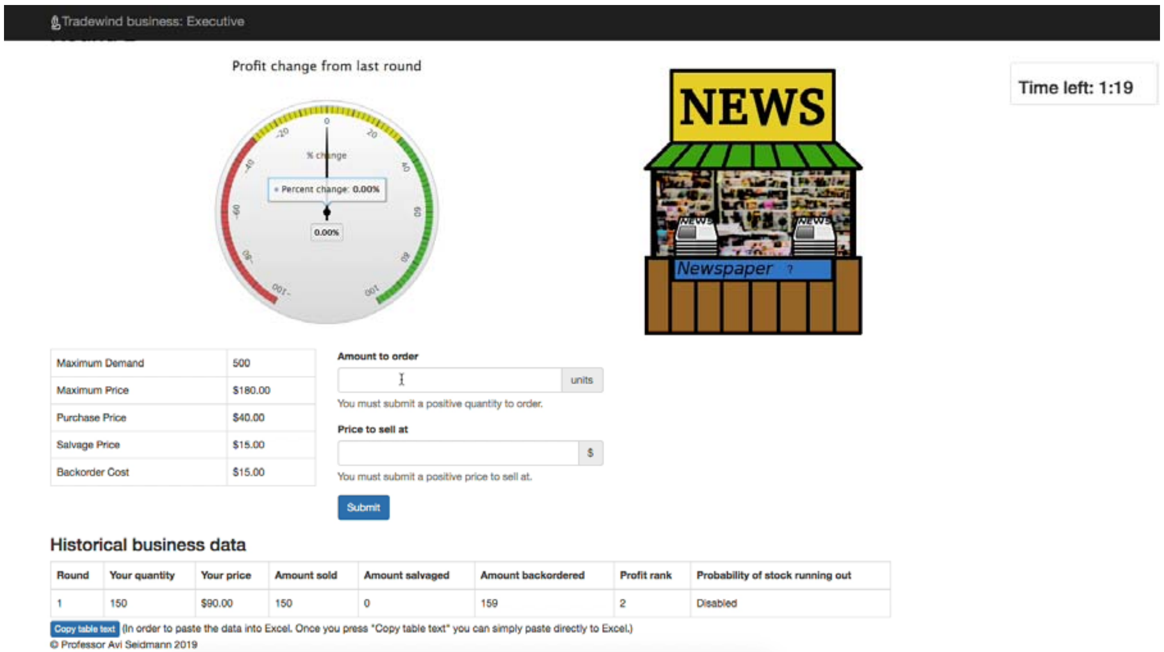
Amount sold	1036 units
Amount salvaged	64 units
Amount backordered	0

Profit calculation

Sales revenue	(+) 1036 x $780.00 = $808,080.00
Salvage revenue	(+) 64 x $124.00 = $7,936.00
Total revenue	(=) $816,016.00

Order cost	(-) 1100 x $240.00 = $264,000.00
Backorder cost	(-) 0 x $200.00 = $0.00
Total cost	(=) $264,000.00

Animated Move



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Price-Setting Newsvendor Game

Professor
Between Rounds
Screen

Round 7 Ended

Round Stats | Round Configuration

Show top income | Show top income with inputs | Show bottom income | Show bottom income with inputs | Show top 5 students

Students Hide

	Name	Email Show	IP Show	Status	Actions
☐	demo1			Another user has the same ip address as this user.	Send Message
☐	demo4			Another user has the same ip address as this user.	Send Message

Select all for messaging | Deselect all | Send message to selected

Round Stats Hide

<< 1 - 7 >>

Round 1
Round 2
Round 3
Round 4
Round 5
Round 6
Round 7

Round 7 Statistics

Average decision time	21.40 seconds

Name	Made decision	Decision time	Quantity	Price	Demand	Amount sold	Salvage	Backorder	Net profit	Cumulative profit
demo1	✔	13.07	**220**	**$105.00**	201	201	19	0	$12,590.00	$89,430.00
demo4	✔	29.73	**190**	**$120.00**	221	190	0	31	$14,735.00	$93,575.00

Tradewind business

Price-Setting Newsvendor Game

Professor
Between Rounds
Screen

Round 7 Ended

Round Stats | Round Configuration

Show top income | Show t e with inputs | Show bottom income | Show bottom income with inputs | Show top 5 students

Parameters/display options can be changed between rounds

Students Hide

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Tradewind business

Price-Setting Newsvendor Game

Professor
Between Rounds
Screen

Round 7 Ended

Round Stats   Round Configuration

Show top income   Show top income with inputs   Show bottom income   Show bottom income with inputs   Show top 5 students

Students Hide

	Name	Email Show	IP Show	Status	Actions
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☐	demo4				Send Message

Select all for messaging   Deselect all   Send message to selected

Gives the stats of the best/worst performer for that round

Round Stats Hide

<< 1 - 7 >>

Round 1
Round 2
Round 3
Round 4
Round 5
Round 6
Round 7

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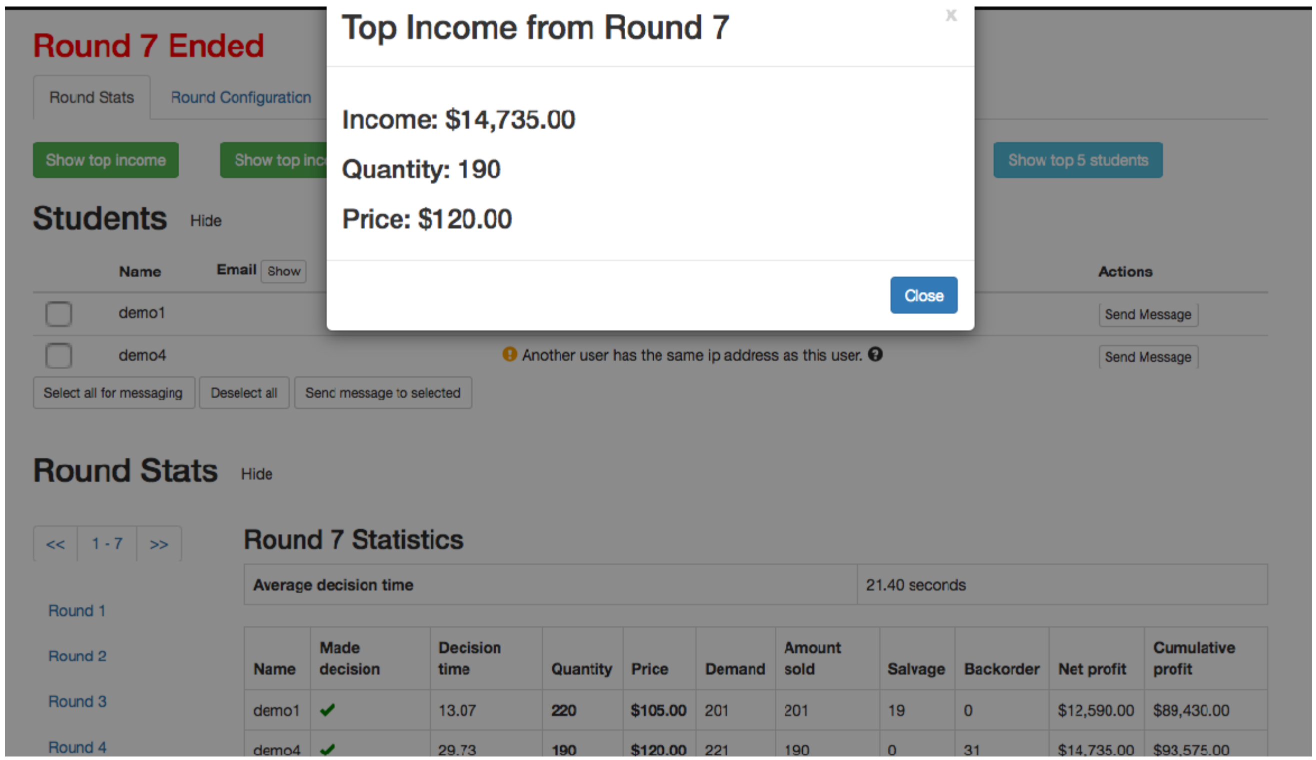
Price-Setting Newsvendor Game

Professor
Between Rounds
Screen



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Price-Setting Newsvendor Game

Professor
Between Rounds
Screen

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Price – Setting Newsvendor Game

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Price – Setting Newsvendor Game

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Price-Setting Newsvendor Game

Post-Game Display

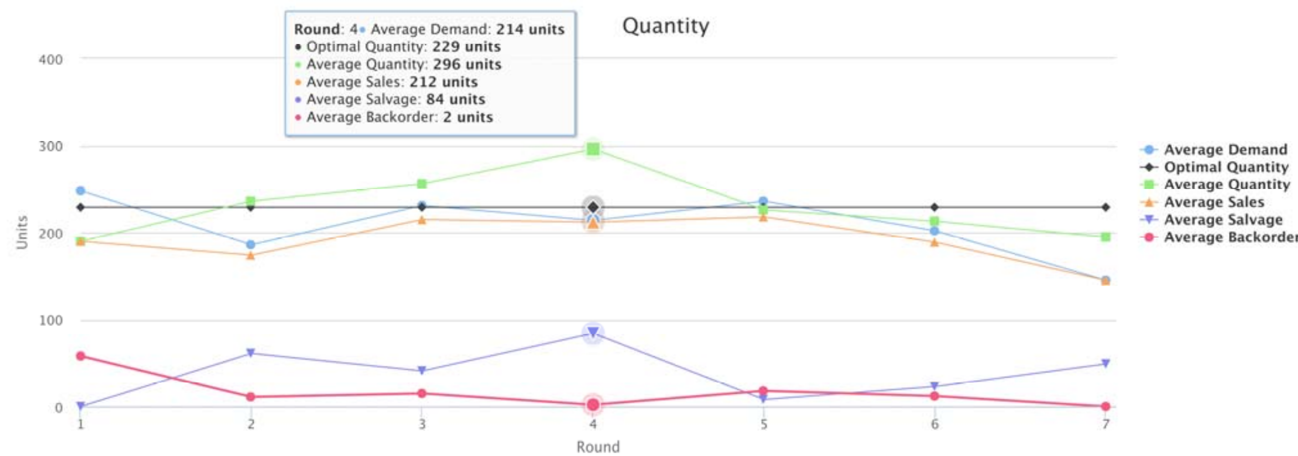
Participants

Display name	First name	Last name	Email Show	IP Show	Platform Show	Websocket Show
demo1	demo1	demo1				
demo2	demo2	demo2				
demo4	demo4	demo4				

Statistics - Download statistics CSV

Overall statistics | Round statistics | Player statistics

Overall statistics



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Price-Setting Newsvendor Game

Post-Game Display

Participants

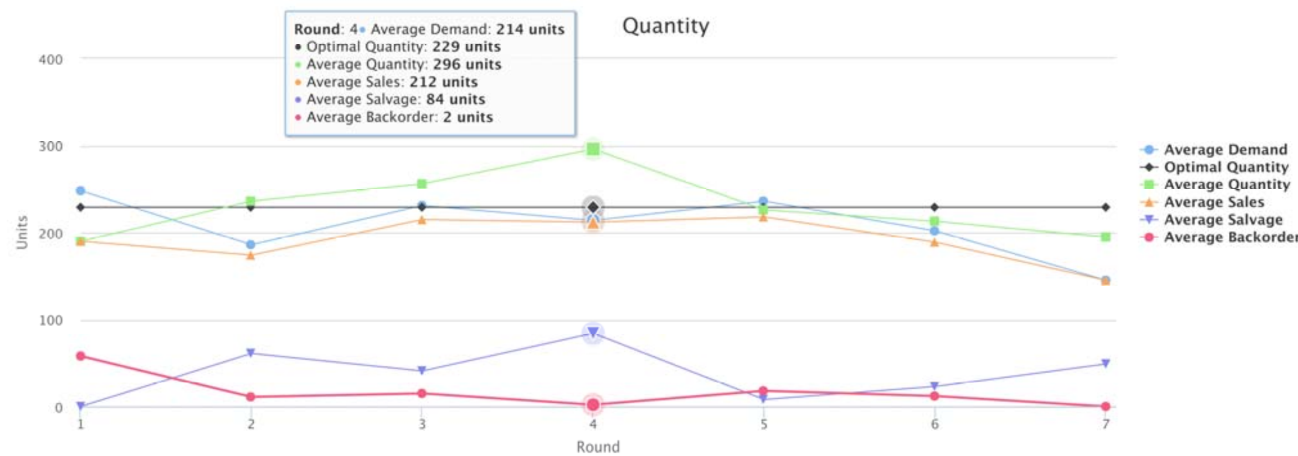
Display name	First name	Last name	Email Show	IP Show	Platform Show	Websocket Show
demo1	demo1	demo1				
demo2	demo2	demo2				
demo4	demo4	demo4				

Statistics - Download statistics CSV

All parameters and outputs can be downloaded as csv file

Overall statistics | Round statistics | Player statistics

Overall statistics



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Price-Setting Newsvendor Game

Post-Game Display

Participants

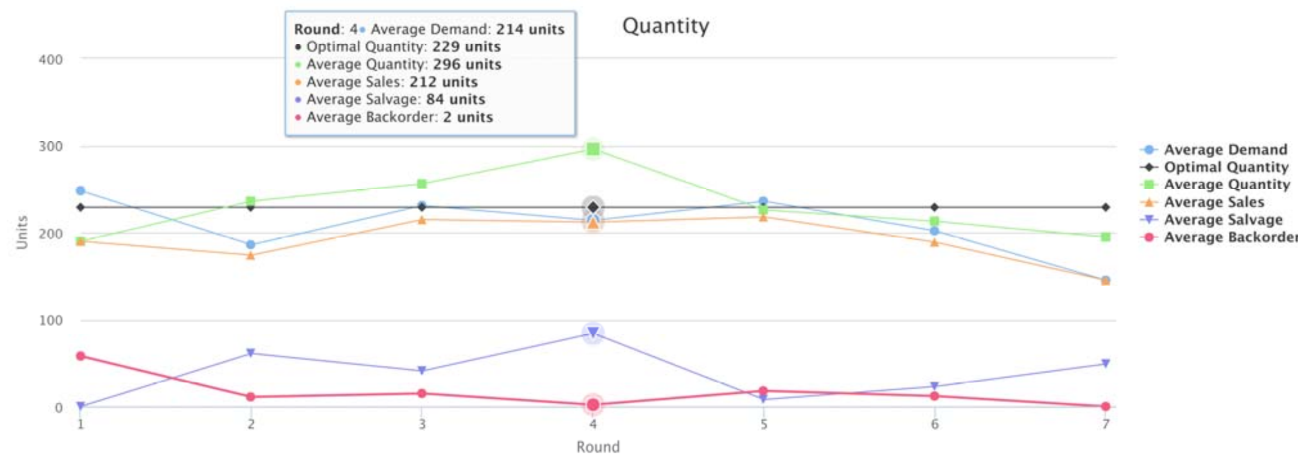
Display name	First name	Last name	Email Show	IP Show	Platform Show	Websocket Show
demo1	demo1	demo1				
demo2	demo2	demo2				
demo4	demo4	demo4				

Statistics - Download statistics CSV

Overall statistics | Round statistics | ...yer statistics

Statistics for each round

Overall statistics



Tradewind business

Price-Setting Newsvendor Game

Post-Game Display

Participants

Display name	First name	Last name	Email Show	IP Show	Platform Show	Websocket Show
demo1	demo1	demo1				
demo2	demo2	demo2				
demo4	demo4	demo4				

Statistics - Download statistics CSV

Overall statistics | Round statistics | Player statistics

Round statistics

Each round can be analyzed separately at student level

- Round 1
- Round 2
- Round 3
- Round 4
- Round 5
- Round 6
- Round 7

Round 1 Statistics

Average decision time	8.2 seconds

Name	Made decision	Decision time (seconds)	Quantity	Price	Demand	Amount sold	Salvage	Backorder	Net profit	Cumulative profit
demo1	✔	7	200	$100.00	269	200	0	69	$10,965.00	$10,965.00
demo4	✔	19	245	$112.00	249	245	0	4	$17,580.00	$17,580.00
demo2	✔	13	125	$100.00	226	125	0	101	$5,985.00	$5,985.00

Tradewind business

Price-Setting Newsvendor Game

Post-Game Display

Participants

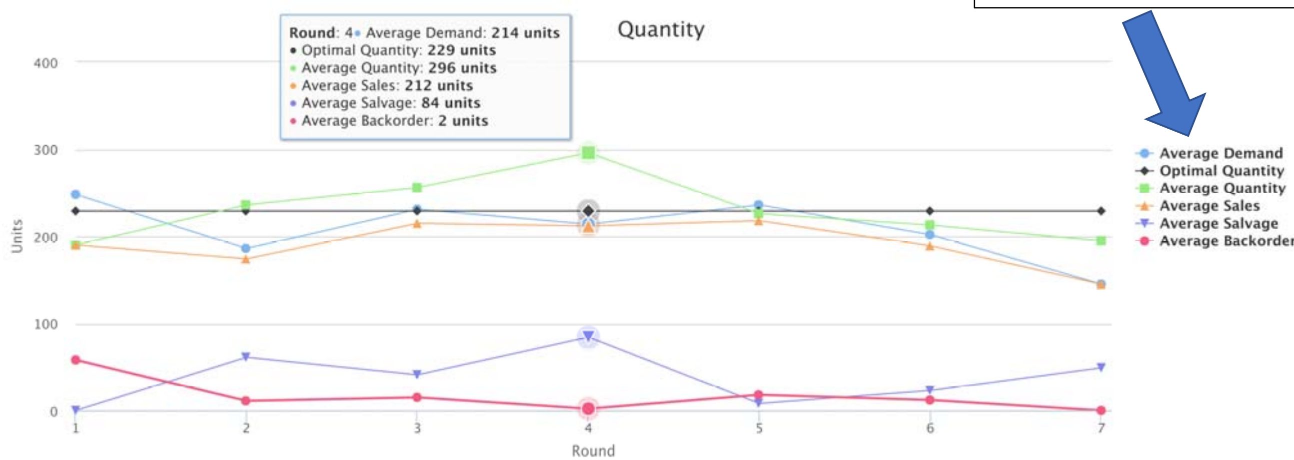
Display name	First name	Last name	Email Show	IP Show	Platform Show	Websocket Show
demo1	demo1	demo1				
demo2	demo2	demo2				
demo4	demo4	demo4				

Statistics - Download statistics CSV

Overall statistics | Round statistics | Player statistics

Overall statistics

Can be toggled on/off



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Price-Setting Newsvendor Game

Post-Game Display

Participants

Display name	First name	Last name	Email Show	IP Show	Platform Show	Websocket Show
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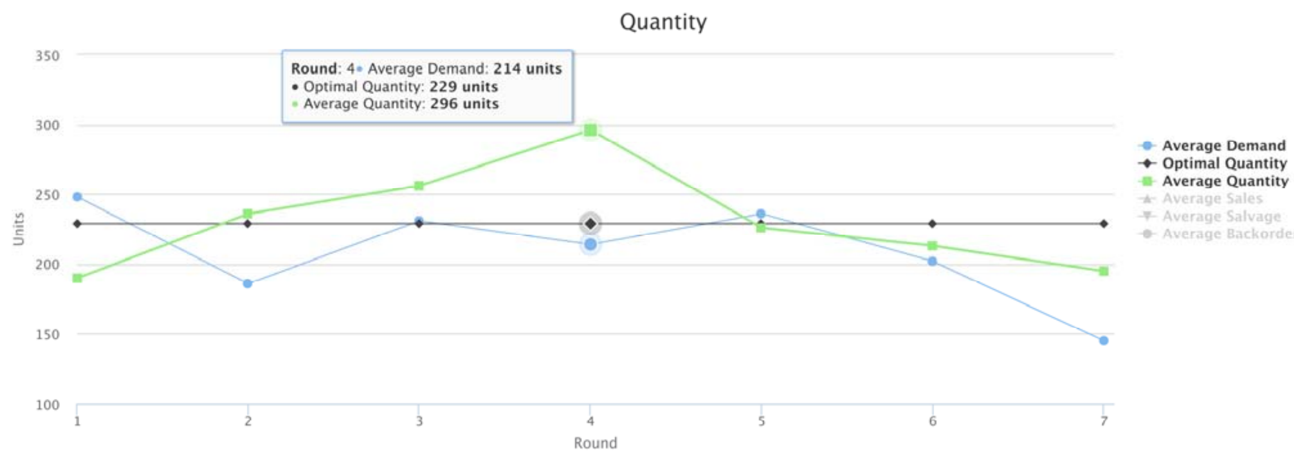

Tradewind business

Price-Setting Newsvendor Game

Possible Different Scenarios to Simulate Real Life Situations

High Margin vs Low Margin : Decrease or Increase of Cost of Supply

High Variance vs Low Variance : Fluctuation of Demand

More examples can be added…

Parameter Example

High Margin	Low Margin
Maximum demand= $275	Maximum demand= $275
Maximum price = $55	Maximum price = $55
Uniform distn. parameter=$25	Uniform distn. parameter=$25
Unit cost= $8	Unit cost= $30
Salvage value=$10	Salvage value=$10
Backorder cost=$20	Backorder cost=$20

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