

Jay EOQ.SA User Guide



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1- EOQ Problems with Discounts with/without Backorders

The **Jay EOQ.SA** software aims to solve EOQ problems that may have quantity discounts, with or without backorders through a simulated annealing algorithm. The first EOQ model, the basic model, presented by Harris (1913) finds the optimal point between the number of orders and the holding costs. Despite being a robust model, it cannot be applied to all situations. For example, the model does not take into account the discounts that can be given by suppliers when the client acquires a larger volume of a given product.

Two types of discounts are considered, the first one is about the incremental discounts and second one about the discounts on all units:

- **Incremental Discounts** - Under incremental discounts, a discount price applies the lower unit price only to the units purchased above a specified quantity, so that the incremental discount schedule leads to multiple unit purchasing prices for the products of an order. The typical total cost curves under incremental discounts are convex and continuous. Consequently, the optimal lot size is determined at an EOQ in terms of the minimum total cost.
- **All Units Discounts** - Under all units discounts, the unit price decreases as the order size increases according to the price schedule offered by the supplier. A discount price is applied to all products of an order which falls in a certain interval. The total cost curve is discontinuous at the price break quantities, so that the EOQ minimizing the total cost for each unit price could not be valid if they are out of the boundaries of the quantity discount interval for the discount price. Consequently, the optimal lot size is determined at either a valid EOQ or one of the price break quantities in terms of the minimum total cost.

Also when the assumption about satisfying all demands on time is relaxed, we allow some products to be backordered (a backlog level represented by a B quantity), and that is satisfied every time that an order arrives. However, there will be a cost (cb) incurred for each unit that is backordered. As a result, two quantities need to be found, the EOQ quantity Q and the backlog quantity level B (MUCKSTADT; SAPRA, 2010).

All problems (Basic EOQ with/without backorders; All unit discounts with/without backorders; and Incremental discounts with/without backorders) are modeled using the works of Pereira et al. (2010) and Pereira (2010) as reference

2 - Simulated Annealing

Simulated annealing is a stochastic global optimization metaheuristic that was independently developed by Kirkpatrick et al. (1983) and by Cerny (1985), these authors based their study in the Metropolis-Hastings algorithm created by Metropolis et al. (1953). Ingber (1993) and Eglese (1990) pointed out that the simulated annealing can process difficult functions that possess quite arbitrary degrees of nonlinearities, discontinuities, and stochasticity, however this metaheuristic is considered too slow.

The strategy of the technique to find global solutions and to avoid being trapped in local minimums is to search the problem space and reject or accept solutions based in a probabilistic function that accepts a variety of solutions in the beginning of the algorithm, and then becomes more discerning as the number of iterations increase (BROWNLEE, 2011).

3 - Jay EOQ.SA Installation Notes

The **Jay EOQ.SA** is a runnable .jar file that does not need to be installed and it run in any OS. The unique requisite is the need to have the latest Java SE program installed. Check if your computer has the latest release, if not please download it (preferably Java SE 7 or superior) at:

www.oracle.com

or

www.oracle.com/technetwork/pt/java/javase/downloads/index.html?ssSourceSiteId=otnes

4- Jay EOQ.SA First Use

Chose the problem type that you would like to solve:

- a) EOQ: Basic model;
- b) EOQ + B: Basic model with backorders;
- c) EOQ + AUD: All units discount model;
- d) EOQ + AUD + B: All units discount model with backorders;
- e) EOQ + ID: Incremental discount model;
- f) EOQ + ID + B: Incremental model with backorders;

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Problem Type

☒ EOQ

☐ EOQ + B

☐ EOQ + AUD

☐ EOQ + AUD + B

☐ EOQ + ID

☐ EOQ + ID + B

Problem Inputs

Annual Demand (D)

Order Cost (A)

Hold Cost (%)

Backorder Cost (Cb)

Default Clear

Price Break Table

Range	Lower	Q	Upper	Price
k = 00	1	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 01	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 02	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 03	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 04	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 05	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 06	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 07	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 08	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 09	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>

Default Clear

Simulated Annealing

Outer Loop (i)

Inner Loop (j)

Temperature

SA [Geometric Schedule]

Default Clear

Plotter

Initial Q value

Final Q value

Load EOQ Plotter

Default Clear

NEXT

BACK

NEXT

BACK

Then input the parameters needed to the chosen type of problem.

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Problem Type

- ☐ EOQ
- ☐ EOQ + B
- ☒ EOQ + AUD
- ☐ EOQ + AUD + B
- ☐ EOQ + ID
- ☐ EOQ + ID + B

Problem Inputs

Annual Demand (D)

Order Cost (A)

Hold Cost (%)

Backorder Cost (Cb)

Price Break Table

Range	Lower	Q	Upper	Price
k = 00	1	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 01	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 02	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 03	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 04	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 05	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 06	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 07	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 08	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 09	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>

Simulated Annealing

Outer Loop (i)

Inner Loop (j)

Temperature

Plotter

Initial Q value

Final Q value

Press the “**Default**” button if you would like to fill the parameters with an example.

Press the “**Clear**” button if you would like to redefine the parameters.

Press the “**Next**” button to go to the next stage.

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Problem Type

- ☐ EOQ
- ☐ EOQ + B
- ☒ EOQ + AUD
- ☐ EOQ + AUD + B
- ☐ EOQ + ID
- ☐ EOQ + ID + B

Problem Inputs

Annual Demand (D)

Order Cost (A)

Hold Cost (%)

Backorder Cost (Cb)

Price Break Table

Range	Lower	Q	Upper	Price
k = 00	1	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 01	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 02	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 03	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 04	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 05	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 06	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 07	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 08	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>
<input type="radio"/> k = 09	<input type="text"/>	$\leq Q <$	<input type="text"/>	<input type="text"/>

Simulated Annealing

Outer Loop (i)

Inner Loop (j)

Temperature

Plotter

Initial Q value

Final Q value

In the range column, chose up to 10 quantity discount ranges to input each range quantity and its price. The upper column must have increasing values and the price column must have decreasing values.

Press the “**Default**” button if you would like to fill the parameters with an example.

Press the “**Clear**” button if you would like to redefine the parameters.

Press the “**Back**” button to return to the previous stage.

Press the “**Next**” button to go to the next stage.

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Problem Type

☐ EOQ

☐ EOQ + B

☒ EOQ + AUD

☐ EOQ + AUD + B

☐ EOQ + ID

☐ EOQ + ID + B

Problem Inputs

Annual Demand (D)

Order Cost (A)

Hold Cost (%)

Backorder Cost (Cb)

Price Break Table

Range	Lower	Q	Upper	Price
k = 00	<input type="text" value="1"/>	$\leq Q <$	<input type="text" value="10000"/>	<input type="text" value="1.00"/>
<input type="radio"/> k = 01	<input type="text" value="10000"/>	$\leq Q <$	<input type="text" value="25000"/>	<input type="text" value="0.95"/>
<input type="radio"/> k = 02	<input type="text" value="25000"/>	$\leq Q <$	<input type="text" value="45000"/>	<input type="text" value="0.90"/>
<input type="radio"/> k = 03	<input type="text" value="45000"/>	$\leq Q <$	<input type="text" value="48000"/>	<input type="text" value="0.85"/>
<input type="radio"/> k = 04	<input type="text" value="48000"/>	$\leq Q <$	<input type="text" value="49000"/>	<input type="text" value="0.80"/>
<input type="radio"/> k = 05	<input type="text" value="49000"/>	$\leq Q <$	<input type="text" value="55000"/>	<input type="text" value="0.75"/>
<input type="radio"/> k = 06	<input type="text" value="55000"/>	$\leq Q <$	<input type="text" value="56000"/>	<input type="text" value="0.70"/>
<input type="radio"/> k = 07	<input type="text" value="56000"/>	$\leq Q <$	<input type="text" value="57000"/>	<input type="text" value="0.65"/>
<input type="radio"/> k = 08	<input type="text" value="57000"/>	$\leq Q <$	<input type="text" value="60000"/>	<input type="text" value="0.60"/>
<input checked="" type="radio"/> k = 09	<input type="text" value="60000"/>	$\leq Q <$	<input type="text" value="∞"/>	<input type="text" value="0.55"/>

Simulated Annealing

Outer Loop (i)

Inner Loop (j)

Temperature

Plotter

Initial Q value

Final Q value

To solve the problem, input the parameters yourself or press the “**Default**” button (recommended), then press the “**SA[Geometric Schedule]**” button.

Press the “**Clear**” button if you would like to redefine the parameters.

Problem Type

☐ EOQ

☐ EOQ + B

☒ EOQ + AUD

☐ EOQ + AUD + B

☐ EOQ + ID

☐ EOQ + ID + B

Problem Inputs

Annual Demand (D)

Order Cost (A)

Hold Cost (%)

Backorder Cost (Cb)

Price Break Table

Range	Lower	Q	Upper	Price
k = 00	1	$\leq Q <$	10000	1.00
<input type="radio"/> k = 01	10000	$\leq Q <$	25000	0.95
<input type="radio"/> k = 02	25000	$\leq Q <$	45000	0.90
<input type="radio"/> k = 03	45000	$\leq Q <$	48000	0.85
<input type="radio"/> k = 04	48000	$\leq Q <$	49000	0.80
<input type="radio"/> k = 05	49000	$\leq Q <$	55000	0.75
<input type="radio"/> k = 06	55000	$\leq Q <$	56000	0.70
<input type="radio"/> k = 07	56000	$\leq Q <$	57000	0.65
<input type="radio"/> k = 08	57000	$\leq Q <$	60000	0.60
<input checked="" type="radio"/> k = 09	60000	$\leq Q <$	∞	0.55

Simulated Annealing

Outer Loop (i)

Inner Loop (j)

Temperature

Plotter

Initial Q value

Final Q value

The solution tab will appear:

Solution

i EOQ = 4104 units

Ordering Cost = \$389.9

Holding Cost = \$389.88

Purchasing Cost = \$5281.0

Total Cost = \$6060.78

Orders/year = 1.29

Cycle Time = 0.78

Outer Loop (i.best) = 226

Inner Loop (j.best) = 898

To plot the problem curves, chose the initial and final value for Q (X-axis) and then press the “**Load EOQ Plotter**” button.

Press the “**Default**” button if you would like to fill the parameters with an example.

Press the “**Clear**” button if you would like to redefine the parameters.

Press the “**Back**” button to return to the previous stage.

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Problem Type

☐ EOQ

☐ EOQ + B

☒ EOQ + AUD

☐ EOQ + AUD + B

☐ EOQ + ID

☐ EOQ + ID + B

Problem Inputs

Annual Demand (D)

Order Cost (A)

Hold Cost (%)

Backorder Cost (Cb)

Price Break Table

Range	Lower	Q	Upper	Price
k = 00	<input type="text" value="1"/>	$\leq Q <$	<input type="text" value="10000"/>	<input type="text" value="1.00"/>
<input type="radio"/> k = 01	<input type="text" value="10000"/>	$\leq Q <$	<input type="text" value="25000"/>	<input type="text" value="0.95"/>
<input type="radio"/> k = 02	<input type="text" value="25000"/>	$\leq Q <$	<input type="text" value="45000"/>	<input type="text" value="0.90"/>
<input type="radio"/> k = 03	<input type="text" value="45000"/>	$\leq Q <$	<input type="text" value="48000"/>	<input type="text" value="0.85"/>
<input type="radio"/> k = 04	<input type="text" value="48000"/>	$\leq Q <$	<input type="text" value="49000"/>	<input type="text" value="0.80"/>
<input type="radio"/> k = 05	<input type="text" value="49000"/>	$\leq Q <$	<input type="text" value="55000"/>	<input type="text" value="0.75"/>
<input type="radio"/> k = 06	<input type="text" value="55000"/>	$\leq Q <$	<input type="text" value="56000"/>	<input type="text" value="0.70"/>
<input type="radio"/> k = 07	<input type="text" value="56000"/>	$\leq Q <$	<input type="text" value="57000"/>	<input type="text" value="0.65"/>
<input type="radio"/> k = 08	<input type="text" value="57000"/>	$\leq Q <$	<input type="text" value="60000"/>	<input type="text" value="0.60"/>
<input checked="" type="radio"/> k = 09	<input type="text" value="60000"/>	$\leq Q <$	<input type="text" value="∞"/>	<input type="text" value="0.55"/>

Simulated Annealing

Outer Loop (i)

Inner Loop (j)

Temperature

Plotter

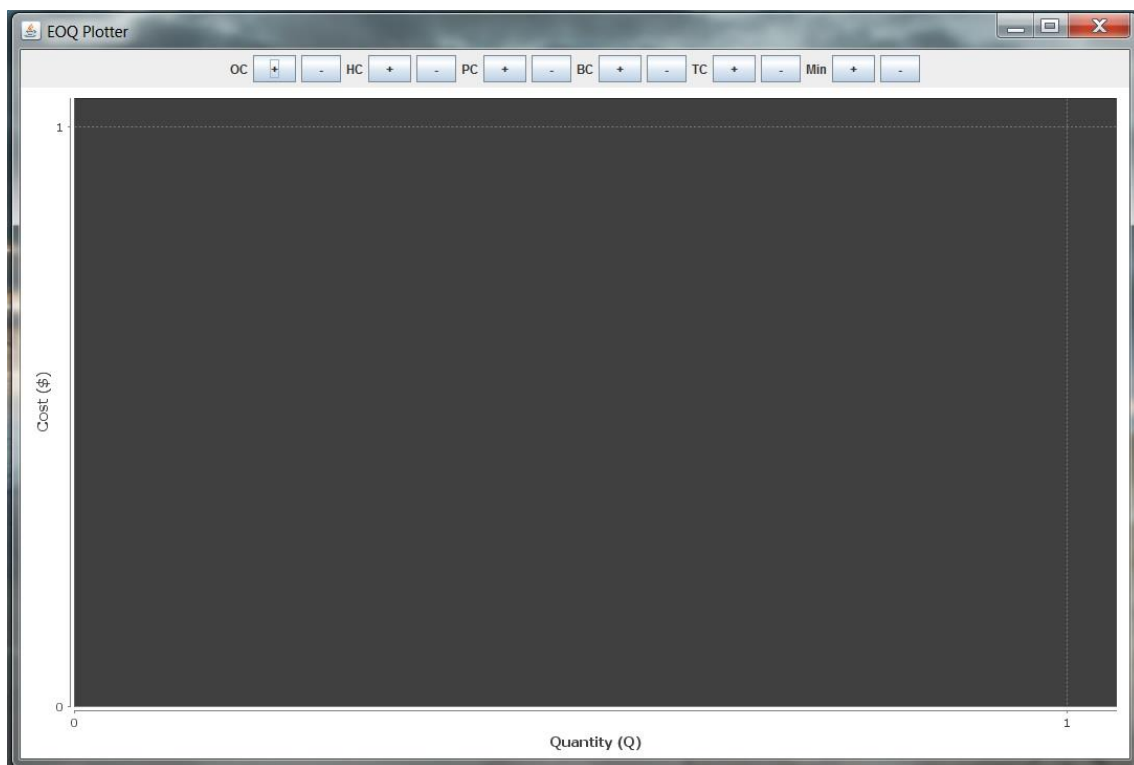
Initial Q value

Final Q value

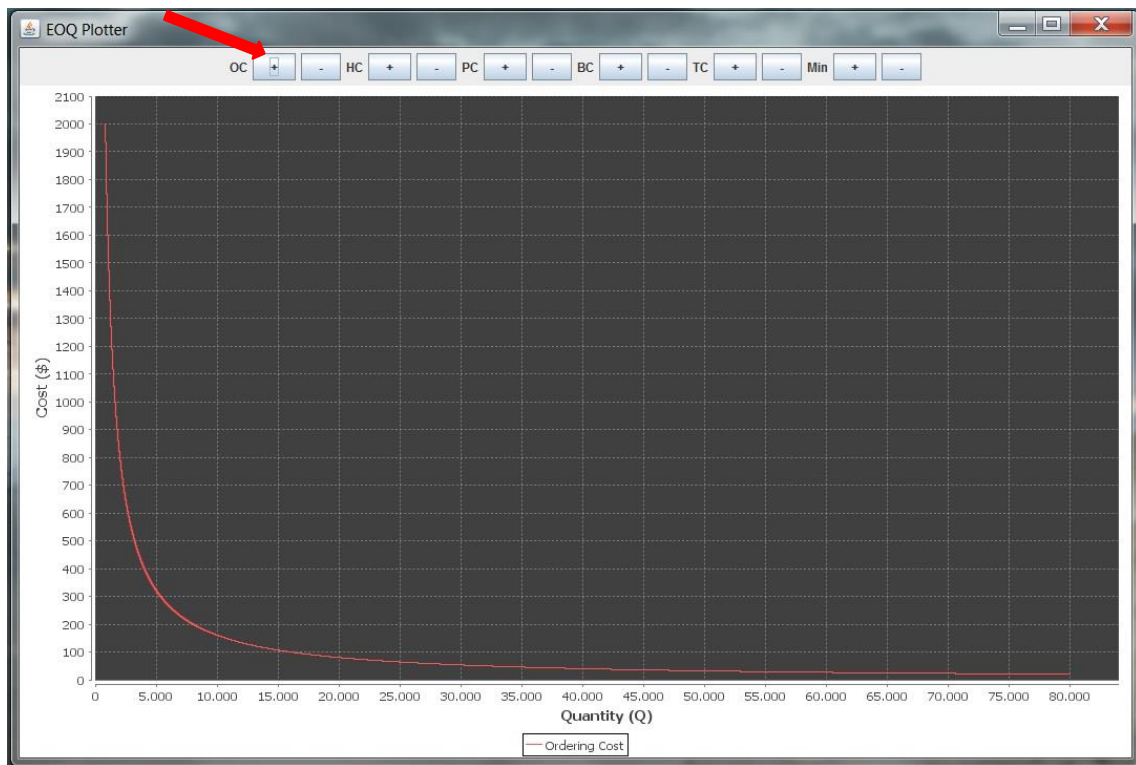
Then the EOQ plotter tab is ready to use. Where:

- a) OC: Order Cost Curve;
- b) HC: Holding Cost Curve;
- c) PC: Price Cost Curve;
- d) BC: Backorder Cost Curve;
- e) TC: Total Cost Curve;
- f) Min: Points the EOQ Value.

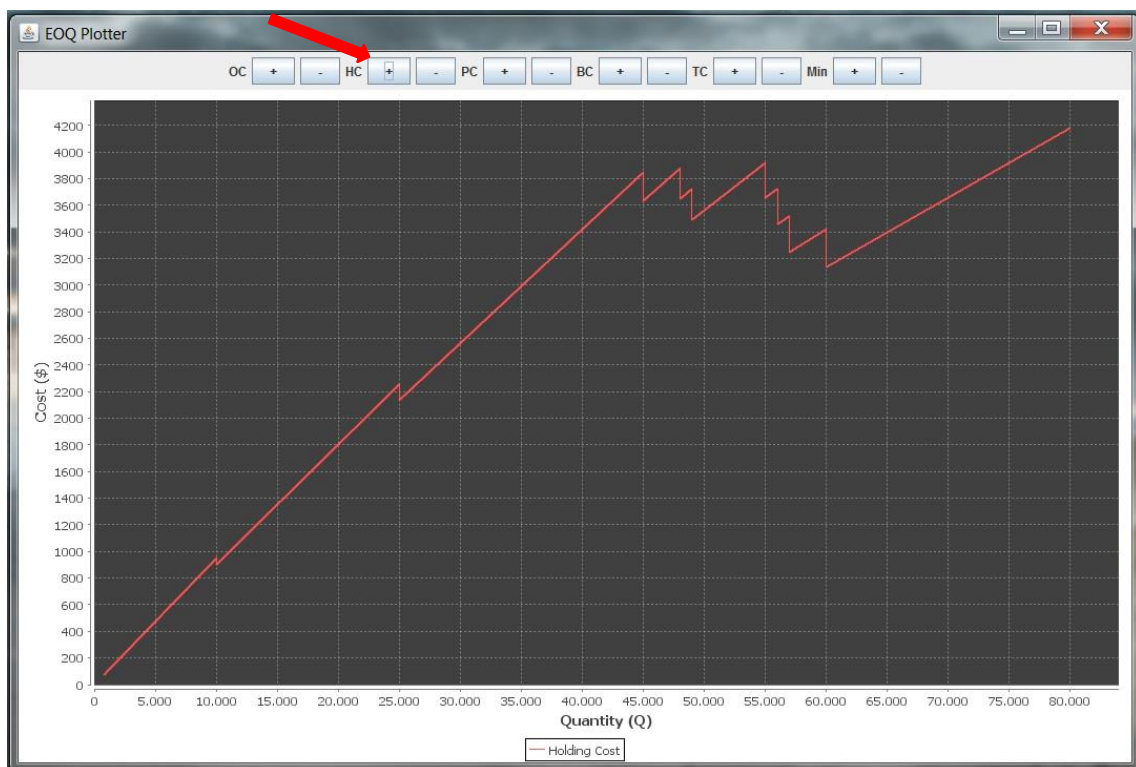
Press “+” to add the curve or “-” to delete the curve.



OC +



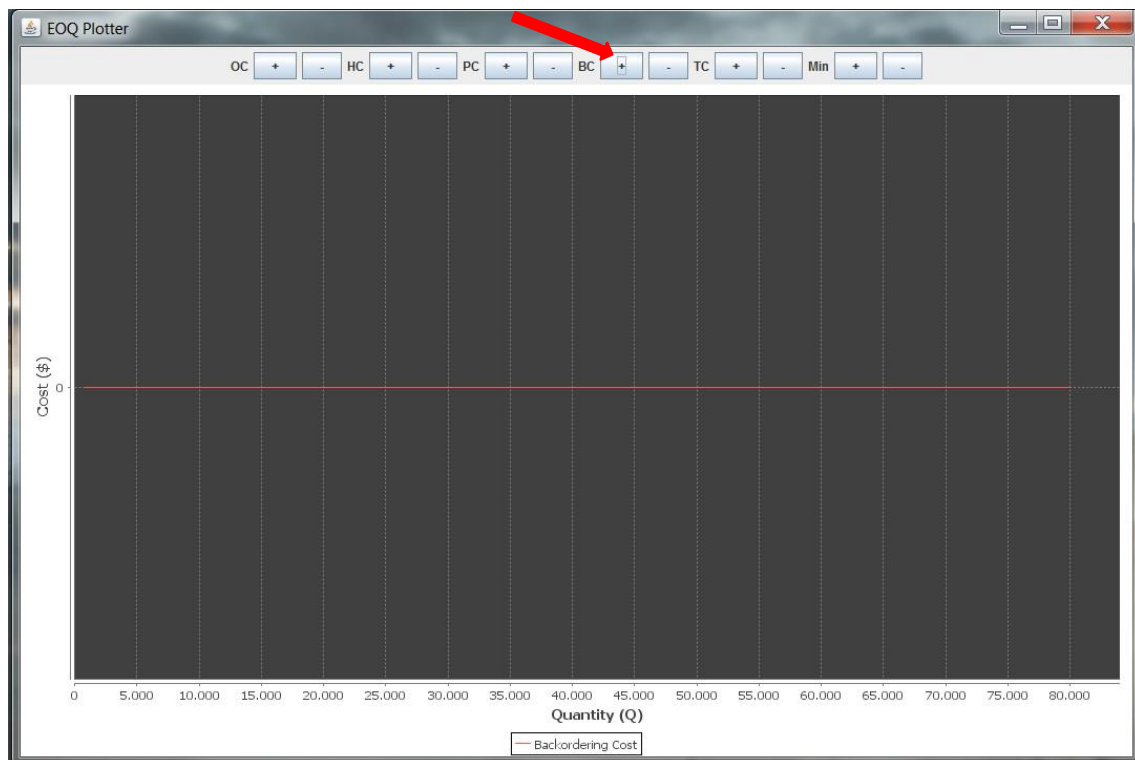
HC +



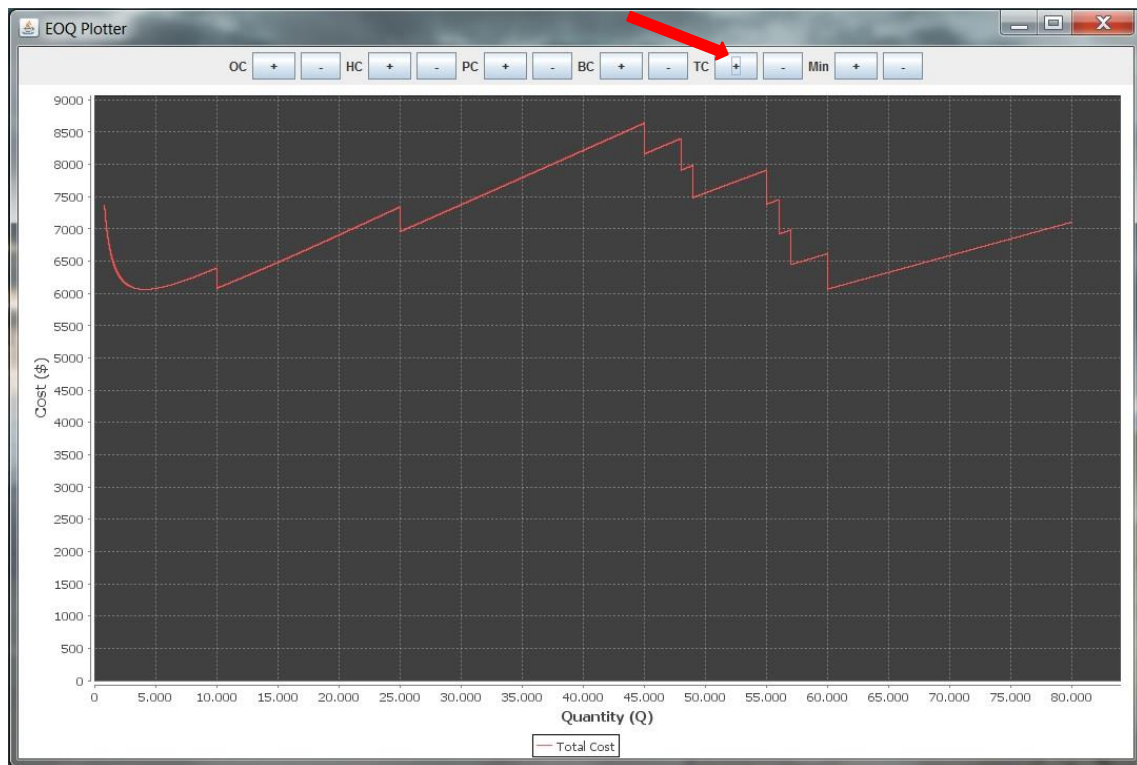
PC +



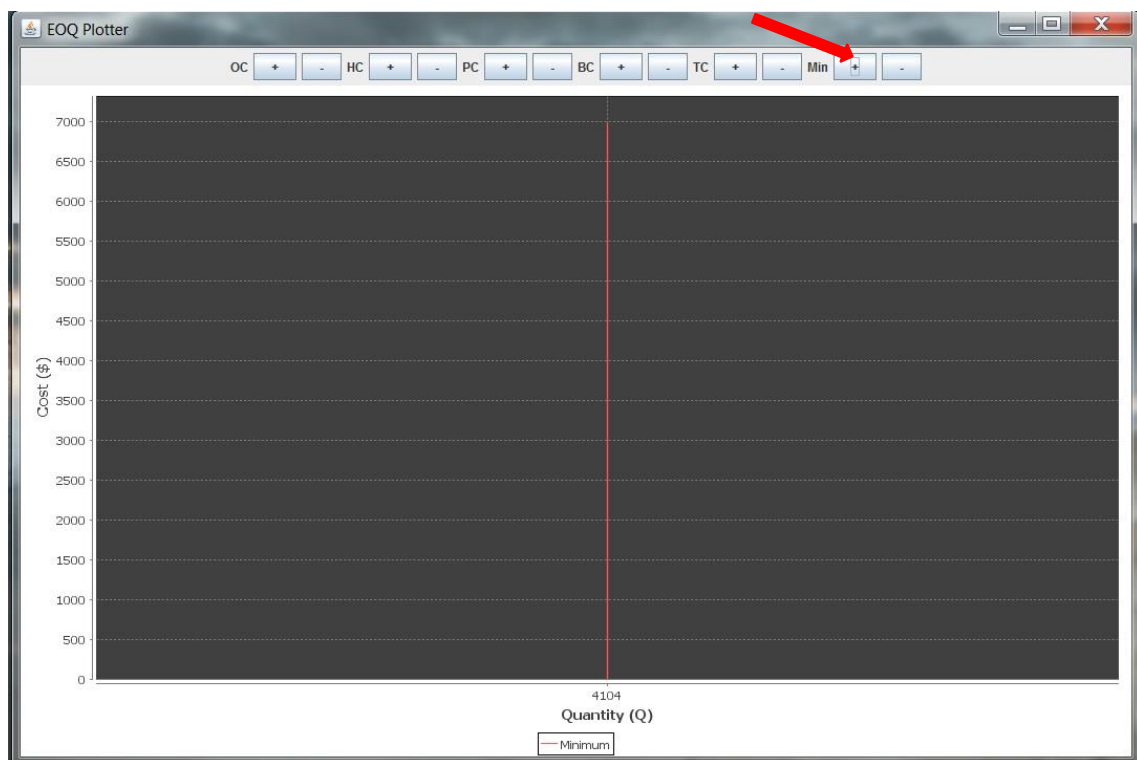
BC +



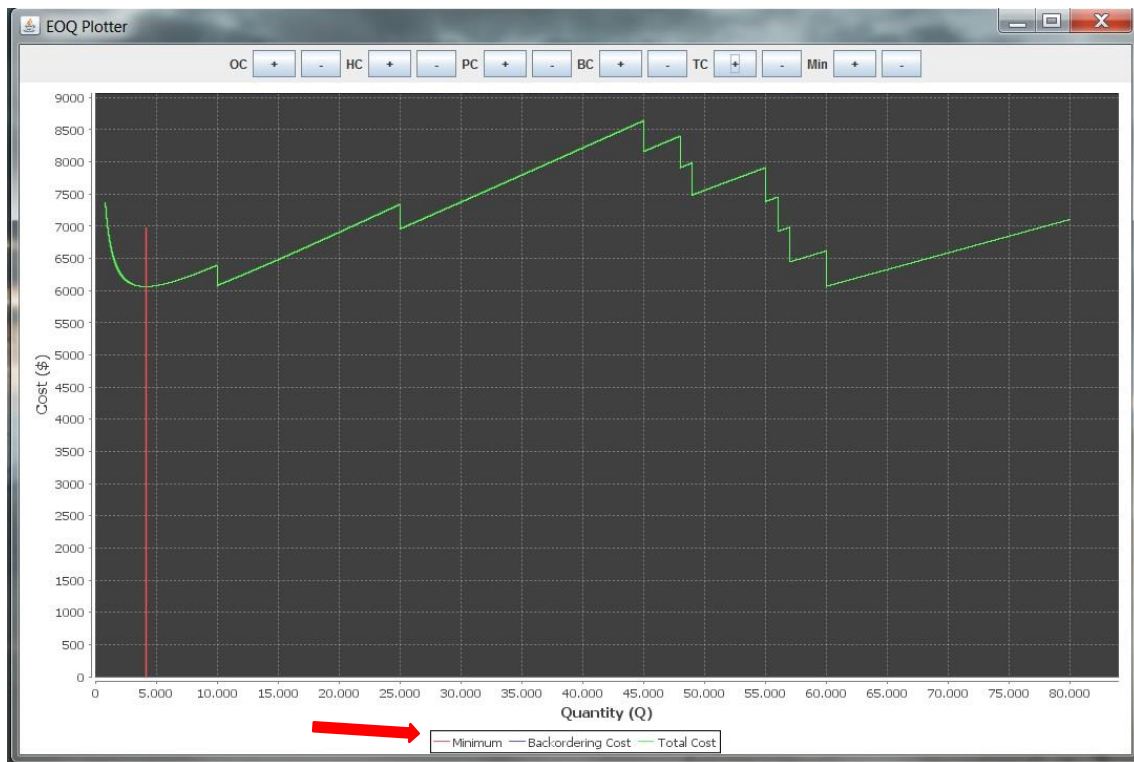
TC +



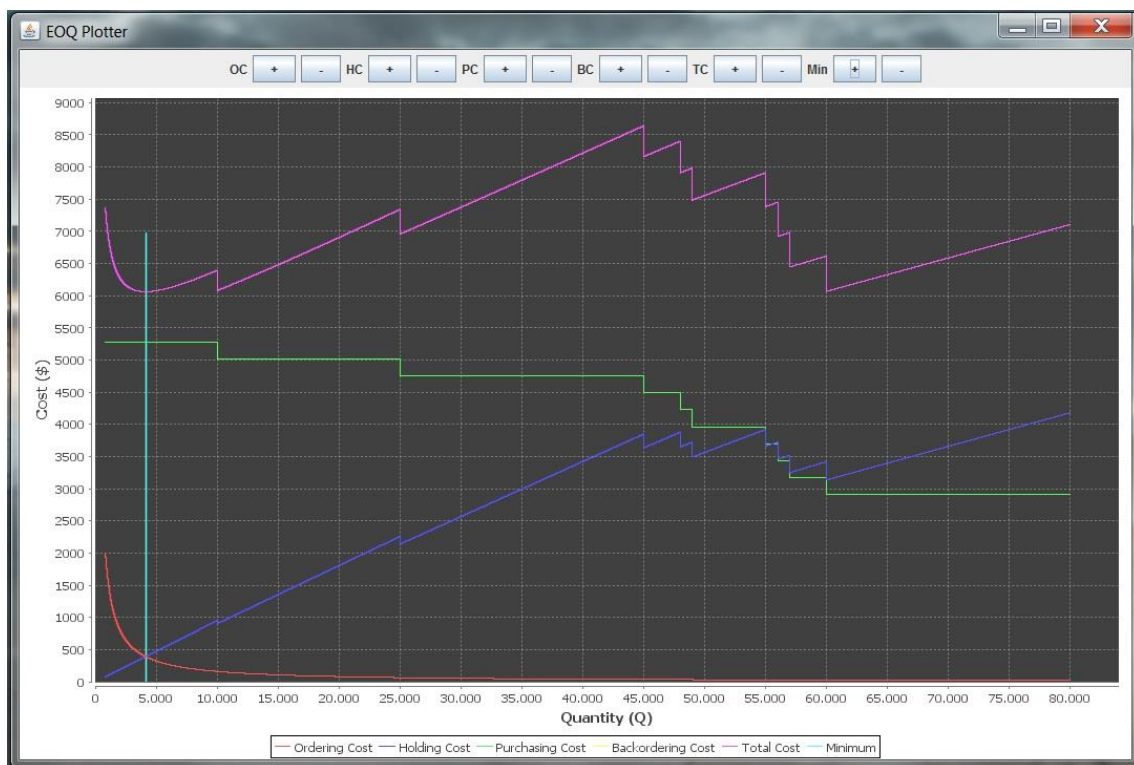
Min +



TC + & Min +



OC +; HC +; PC+; TC + & Min+



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