

4CCS1IAI – Introduction to Artificial Intelligence, 2015/16

Coursework 2

Medicine Home Delivery

Group Members

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I. Problem Description

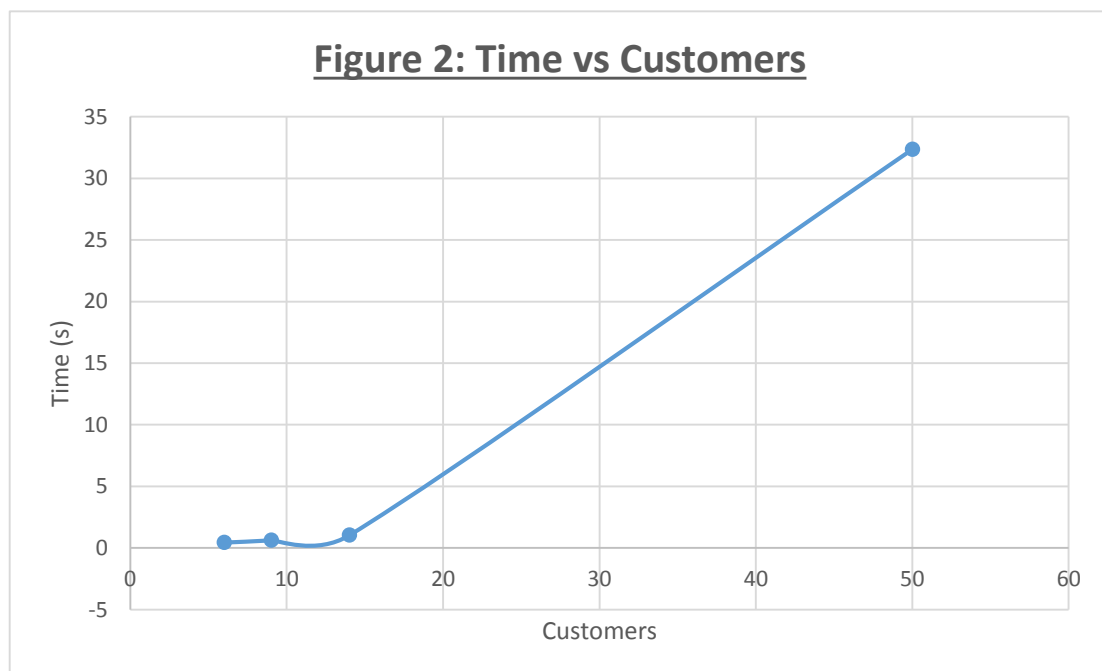
Based upon the domain provided in Coursework 1, this report will analyse the results received in running several different problems using Optic for Windows planner. Starting with a number of 9 customers – thus, 9 orders – we have gradually increased the number of customers. For the fourth problem, we have drastically increased this number to 50, in order to observe any difficulty for the planner to run the problem whilst keeping the problem realistic. Ultimately, Optic did not crash, suggesting that a further realistic increase in customers is possible.

Figure 1 displays the results of these 4 problems in terms of the time it took to calculate, the number of states analysed, and the cost.

Figure 1: Table showing Results according to Literals

	Problem 1	Problem 2	Problem 3	Problem 4
Number of customers/orders	6	9	14	50
Time	0.45	0.63	1.04	32.35
States	91	151	260	1868
Cost	405.047	690.514	825.519	3192.755

II. Problem Analysis

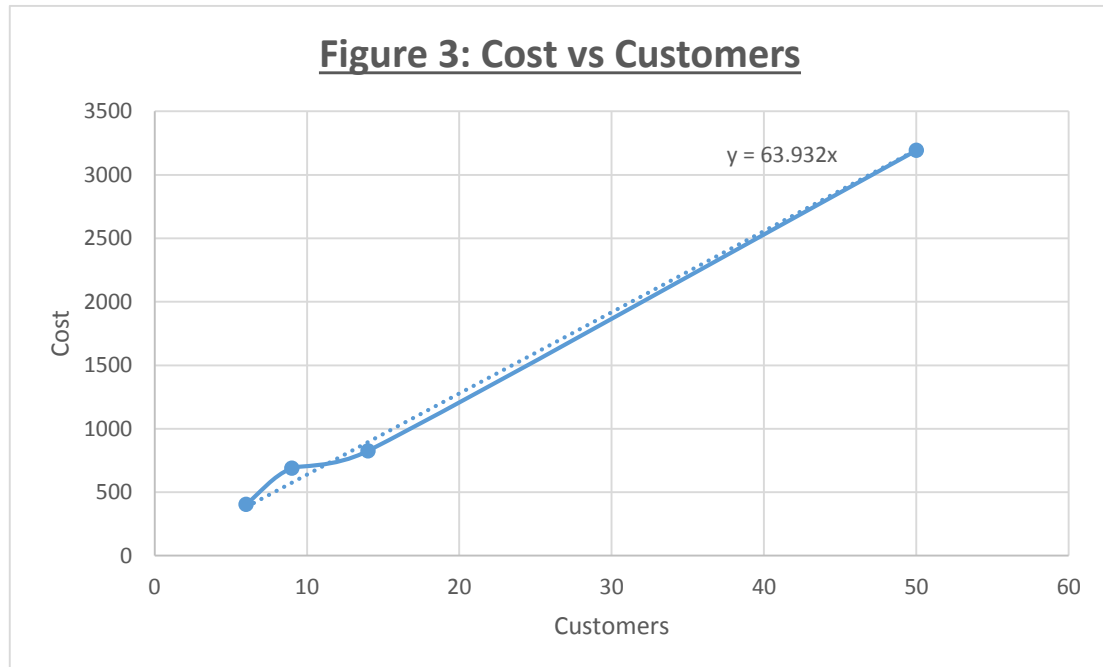


The graph above is represented by a x axis displaying the size of the domain as the quantity of visited customers and a y axis showing the required time to solve the problem in seconds. With the growing number of customers, the travelling time increases. The higher the number of customers, the faster the time increases. Indeed, doubling the number of customers from 10 to 20 results in an increase of slightly under 5s. Yet, doubling the number of customers from 25 to 50 results in an increase of over 10. This shows how the higher the number of orders or customers, the longer it will take to solve to the problem.

Note!

The time required to charge the drone is included in the travelling time.

The reason for the time increasing at different rates is due to the different time that is needed to reach the customers, as well as the increase in the possible states to visit. This presents the problem in a more realistic way.



This graph presents the energy needed as the cost against the number of customers that the drone has visited. Slight fluctuations are being observed as the energy levels additionally depend on the weight of each order. With the increase of the weight, the energy depletion process takes less time. As shown by the trend line, the relation between those two values is proportional (linear trend line, passing through origin (0,0)). Hence, if we double the number of customers, we double the cost.

III. Appendix

Since each problem results in adding new customers upon the previous one, only the PDDL for the problem is shown.

```
(define (problem london)

  (:domain drones-delivery)

  (:objects
    pharmacy1 - Pharmacy
    customer1 customer2 customer3 customer4 customer5 customer6
    customer7 customer8 customer9 customer10 customer11 customer12
    customer13 customer14 customer15 customer16 customer17 customer18
    customer19 customer20 customer21 customer22 customer23 customer24
    customer25 customer26 customer27 customer28 customer29 customer30
    customer31 customer32 customer33 customer34 customer35 customer36
    customer37 customer37 customer38 customer39 customer40 customer41
    customer42 customer43 customer44 customer45 customer46 customer47
    customer48 customer49 customer50 - Customer
    order1 order2 order3 order4 order5 order6 order7 order8 order9
    order10 order11 order12 order13 order14 order15 order16 order17
    order18 order19 order20 order21 order22 order23 order24 order25
    order26 order27 order28 order29 order30 order31 order32 order33
    order34 order35 order36 order37 order38 order39 order40 order41
    order42 order43 order44 order45 order46 order47 order48 order49
    order50 - Order
    drone1 - Drone
  )

  (:init
    (at-location drone1 pharmacy1)
    (at-location order1 customer1)
    (at-location order2 customer2)
    (at-location order3 customer3)
    (at-location order4 customer4)
    (at-location order5 customer5)
    (at-location order6 customer6)
    (at-location order7 customer7)
    (at-location order8 customer8)
    (at-location order9 customer9)
    (at-location order10 customer10)
    (at-location order11 customer11)
    (at-location order12 customer12)
    (at-location order13 customer13)
    (at-location order14 customer14)
    (at-location order15 customer15)
    (at-location order16 customer16)
    (at-location order17 customer17)
    (at-location order18 customer18)
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(at-location order19 customer19)
(at-location order20 customer20)
(at-location order21 customer21)
(at-location order22 customer22)
(at-location order23 customer23)
(at-location order24 customer24)
(at-location order25 customer25)
(at-location order26 customer26)
(at-location order27 customer27)
(at-location order28 customer28)
(at-location order29 customer29)
(at-location order30 customer30)
(at-location order31 customer31)
(at-location order32 customer32)
(at-location order33 customer33)
(at-location order34 customer34)
(at-location order35 customer35)
(at-location order36 customer36)
(at-location order37 customer37)
(at-location order38 customer38)
(at-location order39 customer39)
(at-location order40 customer40)
(at-location order41 customer41)
(at-location order42 customer42)
(at-location order43 customer43)
(at-location order44 customer44)
(at-location order45 customer45)
(at-location order46 customer46)
(at-location order47 customer47)
(at-location order48 customer48)
(at-location order49 customer49)
(at-location order50 customer50)
(at-location order1 pharmacy1)
(at-location order2 pharmacy1)
(at-location order3 pharmacy1)
(at-location order4 pharmacy1)
(at-location order5 pharmacy1)
(at-location order6 pharmacy1)
(at-location order7 pharmacy1)
(at-location order8 pharmacy1)
(at-location order9 pharmacy1)
(at-location order10 pharmacy1)
(at-location order11 pharmacy1)
(at-location order12 pharmacy1)
(at-location order13 pharmacy1)
(at-location order14 pharmacy1)
(at-location order15 pharmacy1)
(at-location order16 pharmacy1)
(at-location order17 pharmacy1)
(at-location order18 pharmacy1)
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(at-location order19 pharmacy1)
(at-location order20 pharmacy1)
(at-location order21 pharmacy1)
(at-location order22 pharmacy1)
(at-location order23 pharmacy1)
(at-location order24 pharmacy1)
(at-location order25 pharmacy1)
(at-location order26 pharmacy1)
(at-location order27 pharmacy1)
(at-location order28 pharmacy1)
(at-location order29 pharmacy1)
(at-location order30 pharmacy1)
(at-location order31 pharmacy1)
(at-location order32 pharmacy1)
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(at-location order40 pharmacy1)
(at-location order41 pharmacy1)
(at-location order42 pharmacy1)
(at-location order43 pharmacy1)
(at-location order44 pharmacy1)
(at-location order45 pharmacy1)
(at-location order46 pharmacy1)
(at-location order47 pharmacy1)
(at-location order48 pharmacy1)
(at-location order49 pharmacy1)
(at-location order50 pharmacy1)
(drone-empty drone1)
(= (time-to-arrive pharmacy1 customer1) 22)
(= (time-to-arrive pharmacy1 customer2) 40)
(= (time-to-arrive pharmacy1 customer3) 30)
(= (time-to-arrive pharmacy1 customer4) 25)
(= (time-to-arrive pharmacy1 customer5) 45)
(= (time-to-arrive pharmacy1 customer6) 60)
(= (time-to-arrive pharmacy1 customer7) 65)
(= (time-to-arrive pharmacy1 customer8) 35)
(= (time-to-arrive pharmacy1 customer9) 22)
(= (time-to-arrive pharmacy1 customer10) 15)
(= (time-to-arrive pharmacy1 customer11) 10)
(= (time-to-arrive pharmacy1 customer12) 14)
(= (time-to-arrive pharmacy1 customer13) 13)
(= (time-to-arrive pharmacy1 customer14) 15)
(= (time-to-arrive pharmacy1 customer15) 15)

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(= (time-to-arrive pharmacy1 customer16) 20)
(= (time-to-arrive pharmacy1 customer17) 13)
(= (time-to-arrive pharmacy1 customer18) 60)
(= (time-to-arrive pharmacy1 customer19) 56)
(= (time-to-arrive pharmacy1 customer20) 23)
(= (time-to-arrive pharmacy1 customer21) 10)
(= (time-to-arrive pharmacy1 customer22) 5)
(= (time-to-arrive pharmacy1 customer23) 5)
(= (time-to-arrive pharmacy1 customer24) 21)
(= (time-to-arrive pharmacy1 customer25) 56)
(= (time-to-arrive pharmacy1 customer26) 60)
(= (time-to-arrive pharmacy1 customer27) 43)
(= (time-to-arrive pharmacy1 customer28) 34)
(= (time-to-arrive pharmacy1 customer29) 41)
(= (time-to-arrive pharmacy1 customer30) 23)
(= (time-to-arrive pharmacy1 customer31) 15)
(= (time-to-arrive pharmacy1 customer32) 12)
(= (time-to-arrive pharmacy1 customer33) 60)
(= (time-to-arrive pharmacy1 customer34) 65)
(= (time-to-arrive pharmacy1 customer35) 54)
(= (time-to-arrive pharmacy1 customer36) 50)
(= (time-to-arrive pharmacy1 customer37) 12)
(= (time-to-arrive pharmacy1 customer38) 34)
(= (time-to-arrive pharmacy1 customer39) 20)
(= (time-to-arrive pharmacy1 customer40) 43)
(= (time-to-arrive pharmacy1 customer41) 23)
(= (time-to-arrive pharmacy1 customer42) 67)
(= (time-to-arrive pharmacy1 customer43) 44)
(= (time-to-arrive pharmacy1 customer44) 23)
(= (time-to-arrive pharmacy1 customer45) 65)
(= (time-to-arrive pharmacy1 customer46) 11)
(= (time-to-arrive pharmacy1 customer47) 42)
(= (time-to-arrive pharmacy1 customer48) 18)
(= (time-to-arrive pharmacy1 customer49) 21)
(= (time-to-arrive pharmacy1 customer50) 16)
(= (drone-energy drone1) 100)
(= (product-weight order1) 1)
(= (product-weight order2) 6)
(= (product-weight order3) 2)
(= (product-weight order4) 5)
(= (product-weight order5) 3)
(= (product-weight order6) 7)
(= (product-weight order7) 2)
(= (product-weight order8) 3)
(= (product-weight order9) 1)
(= (product-weight order10) 2)
(= (product-weight order11) 1)
(= (product-weight order12) 3)
(= (product-weight order13) 4)
(= (product-weight order14) 5)
(= (product-weight order15) 7)

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(= (product-weight order16) 5)
(= (product-weight order17) 3)
(= (product-weight order18) 4)
(= (product-weight order19) 2)
(= (product-weight order20) 1)
(= (product-weight order21) 5)
(= (product-weight order22) 8)
(= (product-weight order23) 7)
(= (product-weight order24) 5)
(= (product-weight order25) 4)
(= (product-weight order26) 3)
(= (product-weight order27) 5)
(= (product-weight order28) 1)
(= (product-weight order29) 3)
(= (product-weight order30) 5)
(= (product-weight order31) 2)
(= (product-weight order32) 7)
(= (product-weight order33) 2)
(= (product-weight order34) 1)
(= (product-weight order35) 5)
(= (product-weight order36) 6)
(= (product-weight order37) 8)
(= (product-weight order38) 3)
(= (product-weight order39) 4)
(= (product-weight order40) 2)
(= (product-weight order41) 6)
(= (product-weight order42) 8)
(= (product-weight order43) 4)
(= (product-weight order44) 5)
(= (product-weight order45) 3)
(= (product-weight order46) 2)
(= (product-weight order47) 1)
(= (product-weight order48) 1)
(= (product-weight order49) 7)
(= (product-weight order50) 1)
(= (full-energy drone1) 100)
)

(:goal (and
  (order-delivered order1)
  (order-delivered order2)
  (order-delivered order3)
  (order-delivered order4)
  (order-delivered order5)
  (order-delivered order6)
  (order-delivered order7)
  (order-delivered order8)
  (order-delivered order9)
  (order-delivered order10)
  (order-delivered order11)
  (order-delivered order12)

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(order-delivered order13)
(order-delivered order14)
(order-delivered order15)
(order-delivered order16)
(order-delivered order17)
(order-delivered order18)
(order-delivered order19)
(order-delivered order20)
(order-delivered order21)
(order-delivered order22)
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(order-delivered order25)
(order-delivered order26)
(order-delivered order27)
(order-delivered order28)
(order-delivered order29)
(order-delivered order30)
(order-delivered order31)
(order-delivered order32)
(order-delivered order33)
(order-delivered order34)
(order-delivered order35)
(order-delivered order36)
(order-delivered order37)
(order-delivered order38)
(order-delivered order39)
(order-delivered order40)
(order-delivered order41)
(order-delivered order42)
(order-delivered order43)
(order-delivered order44)
(order-delivered order45)
(order-delivered order46)
(order-delivered order47)
(order-delivered order48)
(order-delivered order49)
(order-delivered order50)
(at-location drone1 pharmacy1)
(=(drone-energy drone1) 100))
)
(:metric minimize (total-time))
)

```