CSE 3318 – Quiz 5   NAME:_____Gia Dao_____

STUDENT ID: 1001747062

Total points: 100   Topics: Greedy and Dynamic Programming for Knapsack problem variations (unbounded, 0/1, fractional), leetcode

P1 (4 pts) Given this solution information, for the **unbounded** Knapsack problem below, recover the choices that gave the optimal answer for knapsack capacity 19. Show your work (highlight or circle cells).

```
Item  |   A|   B|   C|   D|
Weight|   3|   4|   7|   8|
Value |  the item values are hidden as they should not be used in recovering the solution.
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```
       |  0|  1|  2|  3|  4|  5|  6|  7|  8|  9| 10| 11| 12| 13| 14| 15| 16| 17| 18| 19|
picked |   |   |   |   | A| B| B| A| C| D| D| A| B| B| A| C| C| D| A| B|
```

Start at the end: For 19, choose B. B has weight 4 => move to index 19 – 4 = 15

At index 15, picked C. C has weight 7 => move to index 15 – 7 = 8

At index 8, picked D. D has weight 8 => move to index 8 – 8 = 0 => Done.

Items picked for capacity 19: D-8, C-15, B-19…………………………………………………

P2 (61 pts) Given the item types below, answer the bullet questions and show your work there. Then, for a centralized picture of everything, copy just the answers (the amount of money and the picked items) in the given summary table.

Item:	A	B	C	D
Weight:	3	4	6	7
Value:	4	7	10	12

Knapsack version Algorithm	Unbounded, Not fractional	0/1 (one of each item), Not fractional	0/1 (one of each item), Fractional
Dynamic Programming	$$: 24 Items: C, B, B	$$: 23 Items: D, B, A	

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Greedy	$$: 21	$$: 23	$$: 24
	Items: B, B, B	Items: D, B, A	Items: B, D, C

a) (20 pts) Using DP fill in the table below. Assume there is an unlimited amount of each item, and you CANNOT take fractions of an item (**unbounded, and NOT fractional** Knapsack). Recover the items in the solution and show how you did that (e.g. highlight or circle cells). Show your work as done in class. Fill in every cell. When finished, copy the answer in the summary table above.

Index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Solution	0	0	0	4	7	7	10	12	14	14	17	19	21	22	24
Picked	X	X	X	A	B	B	C	D	B	A	B	B	B	C	B
A, 3, 4				0, 4	1, 4	2, 4	3, 8	4, 11	5, 11	6, 14	7, 16	8, 18	9, 18	10, 21	11, 23
B, 4, 7					0, 7	1, 7	2, 7	3, 11	4, 14	5, 14	6, 17	7, 19	8, 21	9, 21	10, 24
C, 6, 10							0, 10	1, 10	2, 10	3, 14	4, 17	5, 17	6, 20	7, 22	8, 24
D, 7, 12								0, 12	1, 12	2, 12	3, 16	4, 19	5, 19	6, 22	7, 24

ITEMS PICKED: C-6, B-10, B-14………………………………………………….

At index 14, we see that we pick B, then the remaining weight is 14 – 4 = 10

Move to index 10, we see that we picked B, the remaining weight is 10 – 4 = 6

Move to index 6, we see that we picked C, the remaining weight is 6 – 6 = 0, move to index 0 then stop.

b) (20 pts) Using DP, fill in the table below. Assume there is ONLY ONE of each item, and you CANNOT take fractions of an item (**0/1, and NOT fractional** Knapsack). Use a star to show if the current item was used or not in the solution. Recover the items in the solution

and show how you did that (e.g. highlight or circle cells). Show your work as done in class. Fill in every cell. When finished, copy the answer in the summary table above.

index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A, 3, 4	0	0	0	4*	4*	4*	4*	4*	4*	4*	4*	4*	4*	4*	4*
B, 4, 7	0	0	0	4	7*	7*	7*	11*	11*	11*	11*	11*	11*	11*	11*
C, 6, 10	0	0	0	4	7	7	10*	11	11	14*	17*	17*	17*	21*	21*
D, 7, 12	0	0	0	4	7	7	10	12*	12*	14	17	19*	19*	22*	23*

ITEMS PICKED: …D, B, A………………………………………………….

Start from the bottom and right most position, pick D, remaining weight = 14 – 7 = 7

Go to the above row, to index 7, we see that 11 does not have the star symbol, move up 1 row, see 11 with the star => pick B

Remaining weight = 7 – 4 = 3.

Move up one row to index 3, we see that at 3, value 4 has the star symbol => pick A, remaining weight = 3 – 3 = 0, move to index 0 then stop.

c) (8 pts) What items will a Greedy algorithm based on the **ratio value to weight**, choose for a problem of <u>size W=14</u>? Assume there are unlimited of each item, and you CANNOT take fractions of an item (**unbounded, not fractional** Knapsack). Show your work. When finished, copy the answer in the summary table above.

Ratio of A: 4/3 = 1.33

Ratio of B: 7/4 = 1.75

Ratio of C: 10/6 = 1.67

Ratio of D: 12/7 = 1.71

⇨ Sort in decreasing order of ratio: B, D, C, A

It's unbounded => First time, pick B, remaining weight = 14 – 4 =10, current value = 7

Second time, pick B, remaining weight = 10 – 4 = 6, current value = 7 + 7 = 14

Third time, pick B, remaining weight = 6 – 4 = 2, current value = 14 + 7 = 21 => Stops since there are no objects could fit the remaining weight of 2

=> Pick B 3 times => Value = 21

d) (8 pts) What items will a Greedy algorithm based on the **ratio value to weight**, choose for a problem of <u>size W=14</u>? Assume you have ONLY ONE of each item and you CANNOT take a fraction of an item (**0/1, not fractional** Knapsack). Show your work. When finished, copy the answer in the summary table above.

Ratio of A: 4/3 = 1.33

Ratio of B: 7/4 = 1.75

Ratio of C: 10/6 = 1.67

Ratio of D: 12/7 = 1.71

⇨ Sort in decreasing order of ratio: B, D, C, A

It's 0/1, the items can only be picked one

First time, pick B, remaining weight = 14 – 4 = 10, current value = 7

Second time, pick D, remaining weight = 10 – 7 = 3, current value = 7 + 12 = 19

Third time, pick A, remaining weight = 3 – 3 = 0, current value = 19 + 4 = 23

Items picked: B, D, A => Value = 23

e) (5 pts) What items will a Greedy algorithm based on the **ratio value to weight**, choose for a problem of <u>size W=14</u>? Assume you have ONLY ONE of each item and you can take a fraction of each item (**0/1, fractional** Knapsack). Show your work.

Ratio of A: 4/3 = 1.33

Ratio of B: 7/4 = 1.75

Ratio of C: 10/6 = 1.67

Ratio of D: 12/7 = 1.71

⇨ Sort in decreasing order of ratio: B, D, C, A

First time, pick B, remaining weight = 14 – 4 = 10, current value = 7

Second time, pick D, remaining weight = 10 – 7 = 3, current value = 7 + 12 = 19

Third time, pick C, remaining weight = 3 – 3 = 0, current value = 19 + 3 * (10/6) = 24 => Value = 24, Items picked: B, D, C

P3 (35 pts) Solve the following problems on leetcode. Submit a screenshot (saved as 3318_Q5_P3.jpeg or 3318_Q5_P3.png) from the problem list with the check mark next to them (as done in homework 3). You are allowed to check the leetcode solutions. The purpose of this quiz is to learn and understand these problems.
198. House Robber
70. Climbing Stairs
121. Best Time to Buy and Sell Stock
64. Minimum Path Sum
322. Coin Change
1143. Longest Common Subsequence
1235. Maximum Profit in Job Scheduling

Submit two documents. For problems P1 and P2 write your answers in this document or a new document called **3318_Q5.pdf** and submit it in Canvas. It can be hand-written and scanned, but it must be uploaded electronically. Remember to include your name at the top.
For problem P3 submit 3318_Q5_P3.jpeg (or 3318_Q5_P3.png).
Do not zip them. Submit them as individual files.