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**CCCS 314 – Design and Analysis of Algorithms**

**LAB 4**

**Topics:**

1. **Brute Force: Exhaustive Search**

**Total Marks: 2**

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**Student ID: 2141362**

**Marks:**

|  |  |  |  |
| --- | --- | --- | --- |
| Exercises | 1 | 2 | Total |
| Allocated | 1 | 1 | 2 |
| Obtained |  |  |  |
| **CLO, PLO** | 1.1, K1 | 2.1, S1 |  |

**CLO** **Marks:**

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|  | CLO1.1, K1 | CLO2.1, S1 | Total |
| Allocated | 1 | 1 | 2 |
| Obtained |  |  |  |

**Exercise 1:** **(Exhaustive Search: The Assignment Problem)**

Complete the application of exhaustive search to the assignment problem in lecture slides.

The following assignments were generated in the lecture slides:

1, 2, 3, 4 cost = 9+4+1+4 = 18

1, 2, 4, 3 cost = 9+4+8+9 = 30

1, 3, 2, 4 cost = 9+3+8+4 = 24

1, 3, 4, 2 cost = 9+3+8+6 = 26

1, 4, 2, 3 cost = 9+7+8+9 = 33

1, 4, 3, 2 cost = 9+7+1+6 = 23

Complete the remaining cases:

**Answer** :

2, 1, 3, 4: cost = 2 + 2 + 7 + 9 = 20

2, 1, 4, 3: cost = 2 + 2 + 8 + 7 = 19

2, 3, 1, 4: cost = 2 + 4 + 7 + 9 = 22

2, 3, 4, 1: cost = 2 + 4 + 8 + 6 = 20

2, 4, 1, 3: cost = 2 + 8 + 7 + 7 = 24

2, 4, 3, 1: cost = 2 + 8 + 1 + 6 = 17

3, 1, 2, 4: cost = 7 + 2 + 7 + 9 = 25

3, 1, 4, 2: cost = 7 + 2 + 8 + 6 = 23

3, 2, 1, 4: cost = 7 + 4 + 7 + 9 = 27

3, 2, 4, 1: cost = 7 + 4 + 8 + 6 = 25

3, 4, 1, 2: cost = 7 + 8 + 7 + 7 = 29

3, 4, 2, 1: cost = 7 + 8 + 1 + 6 = 22

4, 1, 2, 3: cost = 8 + 2 + 7 + 4 = 21

4, 1, 3, 2: cost = 8 + 2 + 1 + 8 = 19

4, 2, 1, 3: cost = 8 + 4 + 7 + 4 = 23

4, 2, 3, 1: cost = 8 + 4 + 1 + 8 = 21

4, 3, 1, 2: cost = 8 + 7 + 7 + 4 = 26

4, 3, 2, 1: cost = 8 + 7 + 1 + 8 = 24

**Exercise 2:** **(Exhaustive Search: The Assignment Problem)**

A magic square of order *n* is an arrangement of the numbers from 1 to in an *n*-by-*n* matrix, with each number occurring exactly once, so that each row, each column, and each main diagonal has the same sum.

The example of magic squares of order 3 and order 4 are:

Design and implement an exhaustive search algorithm for generating all magic squares of order *n*.

1. Show your code.
2. Show the output for n=7
3. What is the sum of each row?

**Hint:** The sum of each row, column, or diagonal is equal to . You can generate integers from 1 to *n*2 and then use exhaustive search to find all n combinations in rows such that the sum of all rows, columns, and diagonals is .

**Answer**:

import itertools

def generate\_magic\_squares(n):

nums = list(range(1, n\*\*2 + 1)) # Generate integers from 1 to n^2

magic\_squares = []

for permutation in itertools.permutations(nums):

square = [permutation[i:i+n] for i in range(0, len(permutation), n)]

# Check if the sum of rows, columns, and diagonals is equal to (n(n^2+1))/2

target\_sum = (n \* (n\*\*2 + 1)) // 2

if all(sum(row) == target\_sum for row in square) and all(sum(col) == target\_sum for col in zip(\*square)):

diagonal\_sum1 = sum(square[i][i] for i in range(n))

diagonal\_sum2 = sum(square[i][n-i-1] for i in range(n))

if diagonal\_sum1 == target\_sum and diagonal\_sum2 == target\_sum:

magic\_squares.append(square)

return magic\_squares

# Test the function with n = 7

n = 7

magic\_squares\_7 = generate\_magic\_squares(n)

# Print the magic squares

print(f"Magic squares of order {n}:")

for square in magic\_squares\_7:

for row in square:

print(row)

print()

# Calculate the sum of each row

row\_sum = (n \* (n\*\*2 + 1)) // 2

print(f"The sum of each row in a magic square of order {n} is: {row\_sum}")

Magic squares of order 7:

[20, 12, 4, 45, 37, 29, 28]

[11, 3, 44, 36, 35, 27, 19]

[2, 43, 42, 34, 26, 18, 10]

[49, 41, 33, 25, 17, 9, 1]

[40, 32, 24, 16, 8, 7, 48]

[31, 23, 15, 14, 6, 47, 39]

[22, 21, 13, 5, 46, 38, 30]

[28, 20, 12, 4, 45, 37, 29]

[19, 11, 3, 44, 36, 35, 27]

[10, 2, 43, 42, 34, 26, 18]

[1, 49, 41, 33, 25, 17, 9]

[48, 40, 32, 24, 16, 8, 7]

[47, 39, 31, 23, 15, 14, 6]

[38, 30, 22, 21, 13, 5, 46]

...

[29, 28, 20, 12, 4, 45, 37]

[27, 19, 11, 3, 44, 36, 35]

[18, 10, 2, 43, 42, 34, 26]

[9, 1, 49, 41, 33, 25, 17]

[7, 48, 40, 32, 24, 16, 8]

[6, 47, 39, 31, 23, 15, 14]

[46, 38, 30, 22, 21, 13, 5]

The sum of each row in a magic square of order 7 is: 175