Student Name: _____ _____ J#: _____

Jackson State University
CSC 323 Algorithm Design and Analysis, Spring 2020
Instructor: Dr. Natarajan Meghanathan
Exam 2 (Take Home Exam)
Maximum Points: 100 **Due on: March 26th, 11.59 PM (in Canvas)**

Submission Options (choose one of the three): You can either
(a) Print this exam, write the solutions in the space provided, scan and upload as a PDF file or
(b) Use the space provided to type the solutions, save the file to a word or PDF and upload or
(c) Write the solutions for some questions by hand and type the solutions for some other questions. In this case, you should scan the written text to a PDF file, merge it with the PDF file for the typed content and submit everything together as a single PDF file.

Q1 - 22 points) Construct a Huffman code for the following data (show all the steps):

Student Name	Frequency of Symbols					Test Symbol Sequence
	A	B	C	D	E	
Abate, Biruk	0.21	0.35	0.16	0.08	0.20	BEAAEDDEBB
Akintade, Oluwaseun	0.34	0.12	0.07	0.37	0.10	AADADDECCD
Alharbi, Abdullah	0.40	0.20	0.21	0.09	0.10	ACAAECEAEB
Alharbi, Abdulmajeed	0.25	0.20	0.28	0.15	0.12	BADBCDECBD
Atkins, Nayaa	0.15	0.24	0.14	0.27	0.20	AEBBADCBEE
Barnett, Isaiah	0.50	0.2	0.1	0.05	0.15	ACBDAABDAC
Dent, Kaitlyn	0.45	0.18	0.19	0.07	0.11	BEBAAABCBA
Drake, Keilah	0.29	0.07	0.10	0.20	0.34	EEAEAEDEEE
Harris, Chawne	0.20	0.30	0.15	0.25	0.10	ABBCBAACBD
McGee, Bria	0.35	0.30	0.12	0.20	0.03	AADADBCABB
Rankin, Simeon	0.10	0.16	0.54	0.12	0.08	BCCADCCCCC
Redmond, Brandon	0.44	0.22	0.11	0.04	0.19	AAABBEABEA
Roberts, Cambria	0.28	0.27	0.15	0.14	0.16	ACEDDCBACA
Stubbs, Jasmine	0.10	0.29	0.21	0.32	0.08	BBDBBADDDC
Swami, Shaurya	0.25	0.36	0.12	0.18	0.09	BBAEBACBBA
Tchakoua, Landrie	0.21	0.14	0.15	0.40	0.10	DDACEBADDA
Teshome, Nahom	0.50	0.05	0.02	0.16	0.27	AAABAEECDA
Triplett, Marzell	0.35	0.24	0.12	0.05	0.24	AABBDECAAEB
Wilkes, Kayla	0.15	0.23	0.36	0.14	0.12	CCABDCEDACB

(a) Determine the average number of bits per symbol.
(b) Determine the generic compression ratio compared to fixed-length encoding.
(c) Encode the given text symbol sequence using the Huffman code that you determined. Compute the compression ratio achieved for this text compared to fixed-length encoding.

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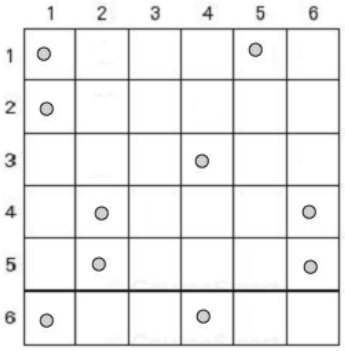
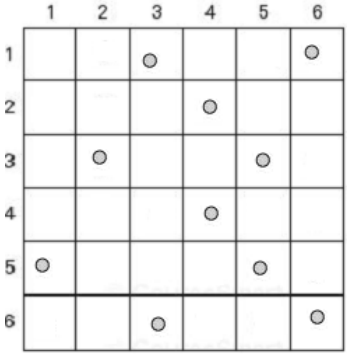
Q2 - 15 points) Several coins are placed in cells of a 6 x 6 board (*n* x *m* board) shown below for each student, with no more than one coin per cell. Assume the value of a coin, if present in a cell, is the sum of the cell's row ID and column ID. For example, if a coin is in row 2 and column 3, its value in that cell is 2+3 = 5.

Run the dynamic programming algorithm discussed in class to determine a path from cell (1, 1) to cell (6, 6) such that the sum of the values of the coins in the path traced is the maximum. As part of your solution, show the grid with the individual values for the coins, another instance of the grid with the total coin values collected across each cell and another instance of the grid with the path traced.

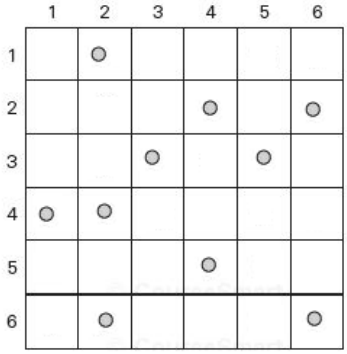
Abate, Biruk



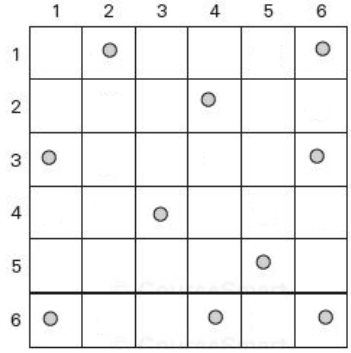
Akintade, Oluwaseun



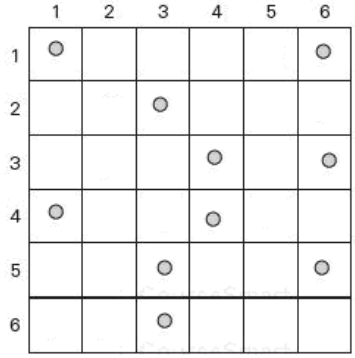
Alharbi, Abdullah



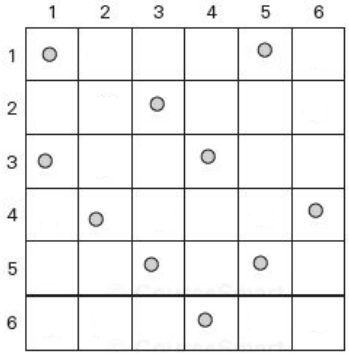
Alharbi, Abdulmajeed



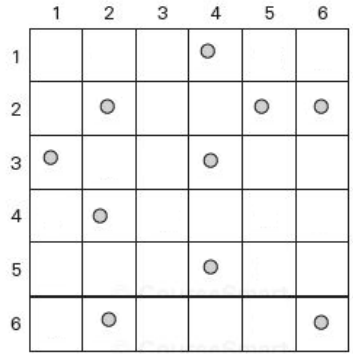
Atkins, Nayaa



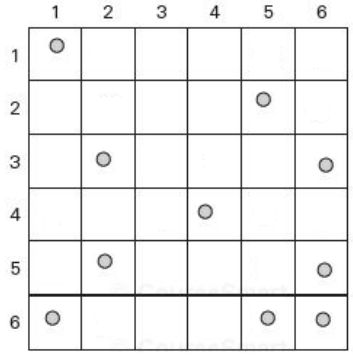
Barnett, Isaiah



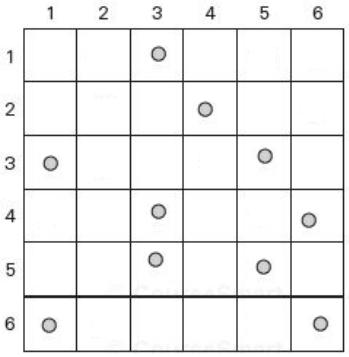
Dent, Kaitlyn



Drake, Keilah



Harris, Chawne



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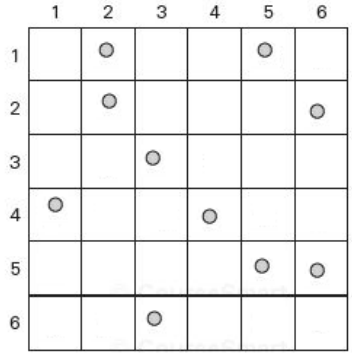
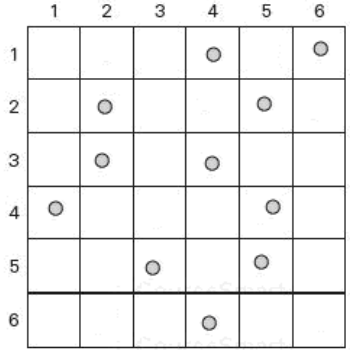
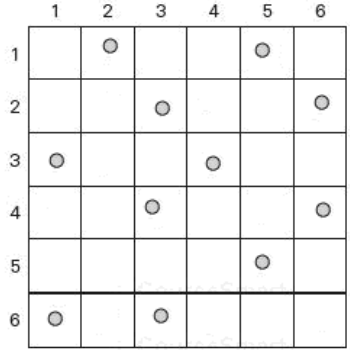
McGee, Bria



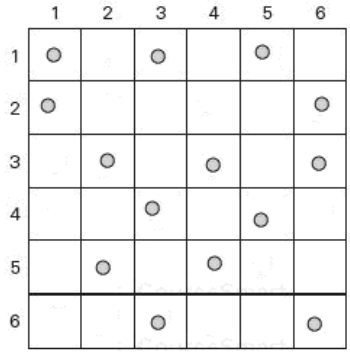
Rankin, Simeon



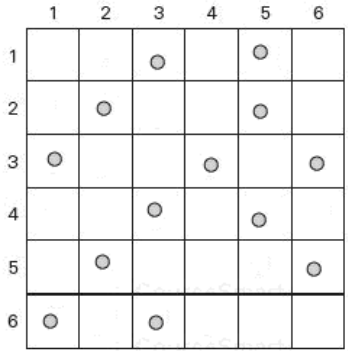
Redmond, Brandon



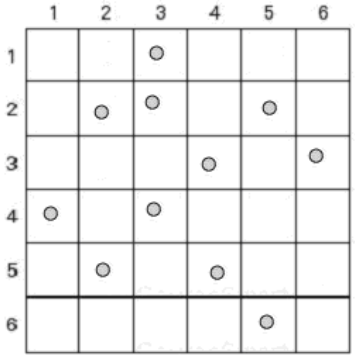
Roberts, Cambria



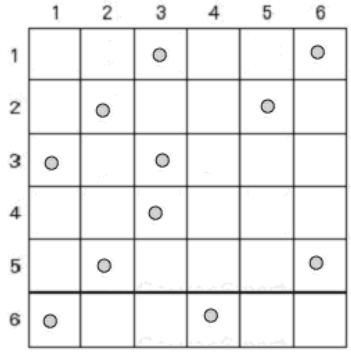
Stubbs, Jasmine



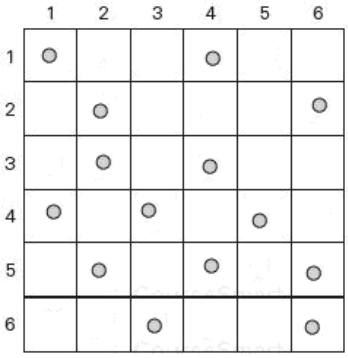
Swami, Shaurya



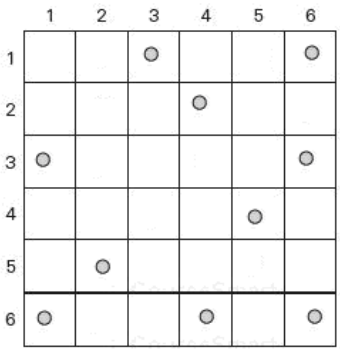
Tchakoua, Landrie



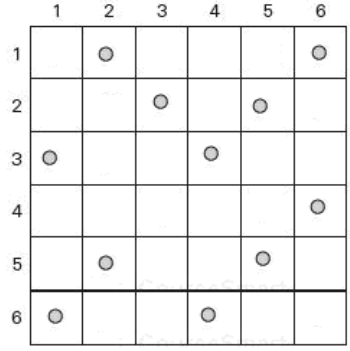
Teshome, Nahom



Triplett, Marzell



Wilkes, Kayla



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Q3 - 17 pts) Given a monotonically increasing function f(n) (where 'n' is an integer), use a binary search algorithm to find the largest value of 'n' for which f(n) is less than a target.

If you are assigned a log function, assume to the base 10 or base e and state what assumed.

Show all the work (including the values for the left index, right index, middle index and the function value at the middle index) for each iteration as well as write down the initial values of the left index and right index and the corresponding function values.

You will get a ZERO if you just use a brute force approach to solve the problem.

Note: You could write a computer program implementing the binary search algorithm you came up with, if you prefer to find the solution via coding, and include it (along with a screenshot of the output) as apart of your solution.

Student Name	**Function, f(n)**	**Target**
Abate, Biruk	$f(n) = n^2/10000$	0.01
Akintade, Oluwaseun	$f(n) = 3^n/n!$	0.01
Alharbi, Abdullah	$f(n) = e^n/n!$	0.01
Alharbi, Abdulmajeed	$f(n) = (n^3 + n)/1000$	0.50
Atkins, Nayaa	$f(n) = 2n^2 + 3n + 2$	1000
Barnett, Isaiah	$f(n) = 3n^3 + 5n + 1$	100
Dent, Kaitlyn	$f(n) = 7n^4 + 4n^3 + 6n$	10000
Drake, Keilah	$f(n) = (8n^5 + 2n)/10000$	1
Harris, Chawne	$f(n) = (n - 5) / (n + 5)$	0.1
McGee, Bria	$f(n) = (n^2 - n + 2) / (n^2 + n + 2)$	0.85
Rankin, Simeon	$f(n) = (n^2 - 8) * (n^2 + 8)$	100
Redmond, Brandon	$f(n) = (n + 4)^2 / 1000$	20
Roberts, Cambria	$f(n) = 7n^2 + 3n + 4$	1000
Stubbs, Jasmine	$f(n) = n*\log(n)$	100
Swami, Shaurya	$f(n) = n / \log(n)$	100
Tchakoua, Landrie	$f(n) = (n*\log(n)) / (n + \log(n))$	2
Teshome, Nahom	$f(n) = (6n-5) / (n+2)$	4
Triplett, Marzell	$f(n) = 2n^3 - 5n + 10$	1000
Wilkes, Kayla	$f(n) = (n^2 - 2) / (n^2 + 2)$	0.95

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Q4 - 15 pts) Given a minimum unimodal array of integers, run the binary search algorithm to find the minimum element. You need to show the initial and the iteration-level values of the left index, right index and middle index as well as your decisions to reduce the search space in each iteration.

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Abate, Biruk	41	39	35	33	28	27	23	5	8	18
Akintade, Oluwaseun	48	47	44	41	5	8	14	21	22	27
Alharbi, Abdullah	40	37	36	35	25	22	11	9	4	7
Alharbi, Abdulmajeed	44	38	25	18	13	11	7	6	4	3
Atkins, Nayaa	47	45	44	32	27	21	18	9	8	2
Barnett, Isaiah	22	3	5	7	12	13	14	16	20	21
Dent, Kaitlyn	42	39	2	6	9	16	20	28	31	34
Drake, Keilah	48	47	40	30	2	11	12	22	25	27
Harris, Chawne	33	32	27	26	24	22	21	8	7	3
McGee, Bria	14	18	28	30	37	42	43	45	49	50
Rankin, Simeon	49	47	42	31	28	27	26	1	4	8
Redmond, Brandon	3	5	6	7	14	17	18	27	30	49
Roberts, Cambria	48	46	44	36	35	28	1	15	20	22
Stubbs, Jasmine	44	35	34	33	24	17	2	6	12	13
Swami, Shaurya	48	47	41	34	26	25	18	3	8	14
Tchakoua, Landrie	48	45	38	35	32	26	23	20	17	2
Teshome, Nahom	45	43	34	27	22	21	20	2	10	14
Triplett, Marzell	48	41	39	35	29	27	25	1	11	13
Wilkes, Kayla	50	44	38	12	17	21	23	26	27	31
	48	36	35	21	3	8	11	16	17	20

Student Name: _____ _____ J#: _____

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Q5 - 10 pts) Given the following list of activities and their start and finish times, run the greedy strategy discussed in class to determine the largest number of non-overlapping activities and the set of such activities. Break any ties in favor of the activity with the lowest ID.

Abate, Biruk											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	4	7	9	11	12	15	16	19	22	25
Finish Times	7	8	12	14	15	18	20	19	25	28	27

Akintade, Oluwaseun											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	2	5	6	8	9	10	11	14	16	18
Finish Times	3	5	9	10	11	14	16	15	19	19	21

Alharbi, Abdullah											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	4	6	8	10	13	16	17	20	21	22
Finish Times	3	5	8	13	15	14	19	19	23	23	24

Alharbi, Abdulmajeed											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	4	5	6	7	8	10	11	14	16	19
Finish Times	3	6	6	12	9	11	13	12	17	18	21

Atkins, Nayaa											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	2	3	4	7	10	11	14	15	16	17
Finish Times	3	8	6	5	9	16	14	20	16	20	20

Barnett, Isaiah											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	3	6	9	12	13	15	16	19	22	25
Finish Times	6	4	11	13	18	17	18	22	21	28	26

Dent, Kaitlyn											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	2	4	5	8	11	13	16	17	18	21
Finish Times	4	7	10	8	13	15	15	22	19	19	25

Drake, Keilah											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	3	4	7	8	10	12	14	15	18	20
Finish Times	5	9	9	13	10	12	14	19	18	19	25

Harris, Chawne											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	4	7	8	10	12	13	15	17	20	22
Finish Times	6	8	11	11	14	14	18	17	21	25	26

Student Name: _____ _____ J#: _____

McGee, Bria											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	3	4	5	6	9	10	12	14	16	17
Finish Times	4	4	9	9	9	10	13	13	15	20	23
Rankin, Simeon											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	2	3	4	5	8	9	11	14	16	18
Finish Times	6	7	6	10	10	10	11	14	17	21	22
Redmond, Brandon											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	3	4	6	9	10	13	14	15	18	19
Finish Times	2	5	7	11	12	13	14	16	16	23	22
Roberts, Cambria											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	2	3	6	8	9	12	13	14	17	19
Finish Times	6	5	4	7	10	13	17	16	19	23	24
Stubbs, Jasmine											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	4	5	8	10	12	14	15	17	18	21
Finish Times	2	7	10	10	11	15	20	18	21	19	22
Swami, Shaurya											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	2	5	8	9	12	13	14	17	18	20
Finish Times	4	4	11	13	15	17	19	16	21	21	25
Tchakoua, Landrie											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	3	4	7	8	10	11	13	14	16	17
Finish Times	5	6	8	13	10	14	16	18	18	19	21
Teshome, Nahom											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	4	5	8	10	13	16	18	19	22	25
Finish Times	6	10	6	14	11	15	22	24	24	26	26
Triplett, Marzell											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	3	6	7	10	11	13	16	17	19	21
Finish Times	6	9	12	9	11	16	18	20	18	23	24
Wilkes, Kayla											
Activities	1	2	3	4	5	6	7	8	9	10	11
Start Times	1	3	5	7	8	10	12	14	17	18	20
Finish Times	4	4	6	12	14	16	17	19	21	23	26

Student Name: _____ _____ J#: _____

Student Name: _____ _____ J#: _____

Q6 - 21 pts) Given the following files that need to be stored in a tape, determine the average cost to access any file if the files are stored according to each of the following: Show all the work.
(i) in the increasing order of the file size
(ii) in the decreasing order of access frequency
(iii) in the increasing order of the file size/access frequency

Abate, Biruk

File ID	1	2	3	4	5	6	7	8
File Size	14	1	7	3	1	9	9	2
Access Frequency	11	4	8	13	10	5	5	4

Akintade, Oluwaseun

File ID	1	2	3	4	5	6	7	8
File Size	15	12	8	14	13	11	15	15
Access Frequency	7	1	1	9	6	10	2	14

Alharbi, Abdullah

File ID	1	2	3	4	5	6	7	8
File Size	15	9	10	3	11	9	6	1
Access Frequency	3	14	7	8	4	9	15	11

Alharbi, Abdulmajeed

File ID	1	2	3	4	5	6	7	8
File Size	2	15	15	11	1	5	13	15
Access Frequency	14	13	15	14	9	3	9	14

Atkins, Nayaa

File ID	1	2	3	4	5	6	7	8
File Size	3	7	4	10	6	3	13	6
Access Frequency	12	14	1	2	5	14	11	2

Barnett, Isaiah

File ID	1	2	3	4	5	6	7	8
File Size	11	5	1	14	13	3	9	6
Access Frequency	4	7	3	6	3	8	7	15

Dent, Kaitlyn

File ID	1	2	3	4	5	6	7	8
File Size	8	11	6	11	4	1	8	1
Access Frequency	1	10	14	8	14	4	12	5

Drake, Keilah

File ID	1	2	3	4	5	6	7	8
File Size	10	4	15	10	9	8	15	14
Access Frequency	6	6	4	1	15	13	5	9

Harris, Chawne

File ID	1	2	3	4	5	6	7	8
File Size	3	10	3	5	11	2	1	15
Access Frequency	5	6	14	9	1	11	11	13

Student Name: _____ _____ J#: _____

McGee, Bria

File ID	1	2	3	4	5	6	7	8
File Size	9	7	6	7	5	8	6	8
Access Frequency	15	9	13	10	7	12	4	3

Rankin, Simeon

File ID	1	2	3	4	5	6	7	8
File Size	13	5	6	11	8	4	7	15
Access Frequency	1	1	8	14	3	13	5	5

Redmond, Brandon

File ID	1	2	3	4	5	6	7	8
File Size	8	11	13	9	13	11	1	10
Access Frequency	5	1	10	15	5	12	12	15

Roberts, Cambria

File ID	1	2	3	4	5	6	7	8
File Size	4	8	2	12	8	11	14	4
Access Frequency	5	6	7	7	10	14	3	5

Stubbs, Jasmine

File ID	1	2	3	4	5	6	7	8
File Size	1	7	3	2	4	9	9	1
Access Frequency	14	7	10	6	6	15	7	9

Swami, Shaurya

File ID	1	2	3	4	5	6	7	8
File Size	8	3	8	7	9	3	2	14
Access Frequency	10	2	10	13	6	3	3	9

Tchakoua, Landrie

File ID	1	2	3	4	5	6	7	8
File Size	10	3	8	15	14	15	2	13
Access Frequency	9	14	6	11	12	1	3	12

Teshome, Nahom

File ID	1	2	3	4	5	6	7	8
File Size	14	10	14	6	7	3	9	7
Access Frequency	8	3	10	6	3	9	8	6

Triplett, Marzell

File ID	1	2	3	4	5	6	7	8
File Size	3	11	9	14	13	10	12	1
Access Frequency	10	9	14	2	4	14	14	6

Wilkes, Kayla

File ID	1	2	3	4	5	6	7	8
File Size	10	4	14	7	8	2	8	11
Access Frequency	12	14	7	5	6	14	10	2

Student Name: _____ _____ J#: _____

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