Assignment Questions

String

In the past few years, artificial intelligence (AI) has been a subject of intense media hype. Machine learning, deep learning, and AI come up in countless articles, often outside of technology-minded publications. We're promised a future of intelligent chatbots, self-driving cars, and virtual assistants—a future sometimes painted in a grim light and other times as utopian, where human jobs will be scarce and most economic activity will be handled by robots or AI agents.

Machine learning arises from this question: could a computer go beyond "what we know how to order it to perform" and learn on its own how to perform a specified task? Could a computer surprise us? Rather than programmers crafting data-processing rules by hand, could a computer automatically learn these rules by looking at data?

A machine-learning system is trained rather than explicitly programmed. It's presented with many examples relevant to a task, and it finds statistical structure in these examples that eventually allows the system to come up with rules for automating the task.

Although machine learning only started to flourish in the 1990s, it has quickly become the most popular and most successful subfield of AI, a trend driven by the availability of faster hardware and larger datasets. Machine learning is tightly related to mathematical statistics, but it differs from statistics in several important ways. Unlike statistics, machine learning tends to deal with large, complex datasets (such as a dataset of millions of images, each consisting of tens of thousands of pixels) for which classical statistical analysis such as Bayesian analysis would be impractical. As a result, machine learning, and especially deep learning, exhibits comparatively little mathematical theory—maybe too little and is engineering oriented. It's a hands-on discipline in which ideas are proven empirically more often than theoretically.

A machine-learning model transforms its input data into meaningful outputs, a process that is "learned" from exposure to known examples of inputs and outputs. Therefore, the central problem in machine learning and deep learning is to meaningfully transform data: in other words, to learn useful representations of the input data at hand representations that get us closer to the expected output.

In programming problems 1-3, assume that the above text is stored in a linear array LINE such that LINE[K] is a static character variable storing 80 characters and represents a line of the text. Assume that each paragraph begins with 5 blank spaces and there is no other indentation. Also, assume NUM gives the number of lines in the text

1. Write a program which defines a linear array PAR such that PAR[K] contains the location of Kth paragraph, and which also defines a variable NPAR which contains the number of paragraphs.
2. Write a program which reads a given WORD and then counts the number C of times WORD occurs in LINE. Test the program with (a) WORD = "The" (b) WORD = "data"
3. Write a program which interchanges the Jth and Kth paragraphs. Test the program using J = 2 and K = 4.

In programming problems 4-9, assume that the above text is stored in a single character variable TEXT. Assume 5 blank spaces indicates a new paragraph.

4. Write a program which defines a linear array PAR such that PAR[K] contains the location of Kth paragraph, and which also defines a variable NPAR which contains the number of paragraphs.
5. Write a program which reads a given WORD and then counts the number C of times WORD occurs in LINE. Test the program with (a) WORD = "The" (b) WORD = "data"
6. Write a program which interchanges the Jth and Kth paragraphs. Test the program using J = 2 and K = 4.
7. Write a program which reads two words WORD1 and WORD2 and replace each occurrence of WORD1 in TEXT by WORD2. Test the program using WORD1 = 'HENCE' and WORD2 = 'THUS'
8. Write a subprogram INST(TEXT, NEW, K) which inserts a string NEW into text beginning at TEXT[K]

Arrays

Assume that the data in the above table are stored in linear arrays SSN, LAST, GIVEN, CUM and YEAR (with space for 25 students) and that variable NUM is defined which contains the actual number of students

Social Security Number	Last Name	Given Name	CUM	Year
211-58-1329	Adams	Bruce	2.55	2
169-38-4248	Bailey	Irene.L	3.25	4
166-48-5842	Cheng	Kim	3.40	1
187-52-4076	Davis	John C	2.85	2
126-63-6382	Edwards	Steven	1.75	3
135-58-9565	Fox	Kenneth	2.80	2
172-48-1849	Green	Gerald S.	2.35	1
192-60-3157	Hopkins	Gary	2.70	4
160-60-1826	Klein	Deborah M	3.05	2
166-52-4147	Lee	John	2.60	1
186-58-0430	Murphy	William	2.30	2
157-58-1123	Newman	Ronal P.	3.90	3
174-58-0732	Osborn	Paul	2.05	4
183-52-3865	Parker	David	1.55	1
135-48-1397	Rogers	Mary J.	1.85	1
182-52-6712	Schwab	Joana	2.95	4
154-48-8539	Thompson	David E.	3.15	3
187-48-2377	White	Adam	2.50	2

1. Write a program for each of the following
   a. List all students whose CUM is K or higher (Test the program with k = 3)
   b. List all students in L year (Test the program with L= 2)

2. Translate the linear search algorithm into a subprogram LINEAR (ARRAY, LB, UB, ITEM, LOC) which either finds location LOC where ITEM appears in ARRAY or returns LOC = 0.

3. Translate the binary search algorithm into s subprogram BINARY (ARRAY, LB, UB, ITEM, LOC) which either finds location LOC where ITEM appears in ARRAY or the location LOC where ITEM has to be inserted

4. Write a program which reads the social security number SSN of a student and uses LINEAR to find and print student's record. Test the program with (a) 160-60-1826 (b) 182-52-6712 (c) 192-60-3157

5. Write a program which reads the (last) NAME of a student and uses BINARY to find and print the student's record. Test the program using
   (a) Rogers (b) Johnson (c) Green

6. Write a program which reads the record of the student
   SSNST, LASTST, GVNST, CUMST, YEARST
   And uses BINARY to insert record the into the list. Test the program using
   (a) 168-48-2255, Quinn, Michael, 2.15, 3
   (b) 177-58-0772, Jones, Amy, 2.75,2

7. Write a program which reads the (last) NAME of a student and uses BINARY to delete the student's record from the list. Test the program using (a) Parker and (b) Finn

Pointer Arrays

Assume the data in the table below are stored in a single linear array CLASS (with space for 50 names). Also assume that there are two empty cells between the sections and that there are linear arrays NUMB, PTR and FREE defined so
that NUMB[K] contains the number of elements in section K, PTR[K] gives the location in CLASS of the first name in section K and FREE[K] gives the number of empty cells in CLASS following section K.

Section I	Section II	Section III	Section IV
Brown	Abrams	Allen	Burns
Davis	Collins	Conroy	Cohen
Jones	Forman	Damario	Evans
Samuels	Hughes	Harris	Gilbert
	Klein	Rich	Harlan
	Lee	Sweeny	Lopez
	Moore		Meth
	Quinn		Ryan
	Rosen		Williams
	Scott		
	Taylor		
	Weaver		

1. Write a program which reads an integer K and prints the names in section K. Test the program with (a) K = 2 and (b) K = 3

2. Write a program which reads the NAME of the student and finds and prints the location of section number of the student. Test the program using (a)Harris (b) Rivers and (c) Lopez

3. Write a program which prints the names in columns as they appear in table

4. Write a program which reads the NAME and section number SECN of a student and insert student into the CLASS. Test the program using (a)Eden 3 (b) Novak 4 (c) Parker 1 (d) Vaughan 3 (e) Bennett 3

5. Write a program which reads the NAME of the student and deletes student from CLASS. Test the program using (a) Klein (b) Daniels (c) Meth

Linked List

Consider the following data structure

	Lawyer	Point
1	Davis	4
2	Levinine	12
3	Nelson	21
4	Rogers	8

	Client	Age	Link
1	Hall	35	16
2	Moss	28	13
3	Ford	47	25
4	Brown	54	22
5	Ginn	38	14
6	Pride	42	29
7			26
8	Berk	38	3
9	White	45	0
10			28
11	Todd	25	0
12	Dixon	32	24
13	Newman	46	6
14	Harris	42	30
15			7
16	Jackson	52	27
17			23
18	Roberts	40	0
19			0
20	Elsen	32	1
21	Adams	48	5
22	Cohen	36	20
23			19
24	Fisher	33	18
25	Graves	42	11
26			10
27	Parker	50	9
28			17
29	Singer	45	0
30	Lewis	28	2

1. Write a program which reads an integer K and prints the list of clients of Lawyer K. Test the program for each K.

2. Write a program which prints the name of Lawyer of each client whose age is L or higher. Test the program using (a) L = 41 and (b) L = 48

3. Write a program which reads the name LLL of lawyer and prints the lawyer's list of clients. Test the program with (a) Rogers (b) Baker (c) Levine

4. Write a program which reads the NAME of client and prints the client's name, age and lawyer's name. Test the program with (a) Newman (b) Ford (c) Rivers and (d) Hall

5. Write a program which reads the NAME of the client and deletes the client record from the structure. Test the program using (a) Lewis (b) Klein (c)Parker

6. Write a program which reads the record of a new client consisting of client's name, age and lawyer, and inserts the record into the structure. Test the program using (a) Jones, 36, Levinine (b) Olsen, 44, Nelson

Circular Header List

Head

5

	NAME	SSN	SEX	SALARY	LINK
1					0
2	David	192-38-7282	Female	22800	12
3	Kelly	165-64-3351	Male	19000	7
4	Green	175-56-2251	Male	27200	14
5		009		191600	6
6	Brown	178-52-1065	Female	14700	9
7	Lewis	181-58-9939	Female	16400	10
8					11
9	Cohen	177-44-4557	Male	19000	2
10	Robin	135-46-6262	Female	15500	5
11					13
12	Evans	168-56-8113	Male	34200	4
13					1
14	Harris	208-56-1654	Female	22800	3

1. Write a program which prints out the entire alphabetized list of employee records.

2. Write a program which reads the name NNN of an employee and prints the employee's record. Test the program using (a) Evans (b) Smith (c) Lewis

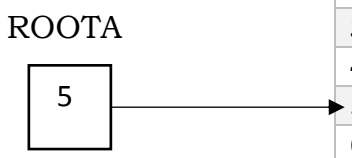
3. Write a program which reads the social security number SSS of an employee and prints the employee's record. Test the program using (a)165-64-3351 (b) 135-46-6262

4. Write a program which reads an integer K and points the name of each male employee when K = 1 or of each female employee when K = 2.

5. Write a program which reads the name NNN of employee and deletes the employee record from the structure. Test the program using (a) Davis (b)Jones and (c) Robin

6. Write a program which reads the record of a new employee and inserts the record into the file. Test the program using (a) Fletcher, 168-52-3388, Female, 21000 (b) Nelson,175- 32-2468, Male, 19000

Trees



	INFO	LEFT	RIGHT
1	K	0	0
2	C	3	0
3	G	0	0
4		14	
5	A	10	2
6	H	17	1
7	L	0	0
8		9	
9		4	
10	B	18	13
11		19	
12	F	0	0
13	E	12	0
14		15	
15		16	
16		11	
17	J	7	0
18	D	0	0
19		20	
20		21	
21		22	
22		23	
23		24	
24		0	

1. Write a program which prints the nodes of T in (a) preorder (b) inorder and (c) postorder

2. Write a program which prints the terminal nodes of T in (a) preorder (b)inorder and (c) postorder

3. Write a program which makes a copy T' of T using ROOTB as pointer. Test the program by printing the nodes of T' in preorder and inorder and comparing the lists with those obtained problem 1.

	NAME	SSN	SEX	SALARY	LEFT	RIGHT
1					0	
2	David	192-38-7282	Female	22800	5	12
3	Kelly	165-64-3351	Male	19000	5	5
4	Green	175-56-2251	Male	27200	2	5
5		009		191600	14	5
6	Brown	178-52-1065	Female	14700	5	5
7	Lewis	181-58-9939	Female	16400	3	10
8					11	
9	Cohen	177-44-4557	Male	19000	6	4
10	Robin	135-46-6262	Female	15500	5	5
11					13	
12	Evans	168-56-8113	Male	34200	5	5
13					1	
14	Harris	208-56-1654	Female	22800	9	7

1. Write a program which prints the list of employee records in alphabetical order. (Print the records in inorder)

2. Write a program which reads the name NNN of an employee and prints the employee record. Test the program using (a) Evan (b) Levis and (c) Smith

3. Write a program which reads the social security number SSN of an employee and print the employee's record. Test the program using (a) 165-64-3351 (b) 135-46-6262

4. Write a program which reads an integer K and points the name of each male employee when K = 1 or of each female employee when K = 2.

5. Write a program which reads the name NNN of employee and deletes the employee record from the structure. Test the program using (a) Davis (b)Jones and (c) Robin

6. Write a program which reads the record of a new employee and inserts the record into the file. Test the program using (a) Fletcher, 168-52-3388, Female, 21000 (b) Nelson,175- 32-2468, Male, 19000

Graphs

1. Suppose a graph G is input by means of an integer M, representing the nodes 1,2,3,….M and a list of N ordered pairs of integers, representing the edges of G. Write a procedure for each of the following:
   a. To find the M * M adjacency matrix A of the graph G
   b. To use the adjacency matrix A and warshall's algorithm to find the path matrix F of the graph

   Test the above with the following data
   (a) M = 5, N = 8; (3, 4), (5, 3), (2, 4), (1, 5), (3, 2), (4, 2), (3, 2), (5, 1)
   (b) M = 6, N = 10; (1, 6), (2, 1), (2, 3), (3, 5), (4, 5), (4, 2), (2, 6), (5, 3), (4, 7), (5, 4)

2. Suppose a weighted graph G is input by means of an integer M, representing the nodes 1,2, 3,…M and a list of N ordered triplets (a_i, b_i, w_i) of integers, such that (a_i, b_i) is an edge of G and w_i is its weight. Write a procedure for each of the following:
   a. To find the M * M adjacency matrix A of the graph G
   b. To use the adjacency matrix A and warshall's algorithm find the matrix Q of shortest paths between the nodes

   Test the above with the following data
   (c) M = 4, N = 7; (1,2,5), (2,4,2), (3,2,3), (1,1,7), (4,1,4), (4,3,1)
   (d) M = 5, N = 8; (3,5,3), (4,1,2), (5,2,2), (1,5,5), (1,3,1), (2,4,1), (3,4,4), (5, 4, 4)

3. Suppose an empty graph G is stored in memory using the linked representation.

   GRAPH (NODE, NEXT, ADJ, START, AVAILIN, DEST, LINK, AVAILE)

   Assume NODE has space for 8 nodes and DEST has space for 12 edges. Write a program which executes the following operations on G:

   (a) Input nodes A, B, C and D
   (b) Input edges (A, B), (A, C), (C, B), (D, A), (B, D) and (C, D)
   (c) Input nodes E and F
   (d) Input edges (B, E), (F, E), (D, F) and (F, B)
   (e) Delete edges (D, A) and (B, D)
   (f) Delete node A

4. Given a graph GRAPH, write a program to create another graph which is transpose of the given graph.

Programming problems 5 – 6 refer to the data in fig below, where the cities are stored as a binary search tree.

5. Write a procedure with input CITY A and CITY B which finds the flight number and cost of the flight from CITY A to city B, if flight exists. Test the procedure

using (a)CITY A = Chicago, CITY B = Boston; (b) CITY A = Washington, CITY B = Denver (c) New York (b) Philadelphia

6. Write a procedure with input CITY A and CITY B which finds the way to fly from CITY A to city B with minimum number of stops, and also find its cost. Test the procedure using (a) CITY A = Boston, CITY B = Houston (b) CITY A =Denver, CITY B = Washington; and (c) CITY A = New York, CITY B = Atlanta

	CITY	LEFT	RIGHT	ADJ
1	Atlanta	0	2	12
2	Boston	0	0	1
3	Houston	0	0	14
4	New York	3	8	4
5		6		
6		0		
7	Washington	0	0	20
8	Philadelphia	0	7	6
9	Denver	10	4	8
10	Chicago	1	0	2

START = 9 AVAILIN = 5

	NUMBER	PRICE	ORIG	DEST	LINK
1	201	80	2	10	3
2	202	80	10	2	0
3	301	50	2	4	0
4	302	50	4	2	5
5	303	40	4	8	7
6	304	40	8	4	9
7	305	120	4	9	0
8	306	120	9	4	13
9	401	40	8	7	0
10	402	40	7	8	11
11	403	80	7	1	0
12	404	80	2	7	16
13	501	80	9	3	15
14	502	80	3	9	0
15	503	140	9	1	0
16	504	140	1	9	0
17					18
18					19
19					20
20					0

7. Write a program which finds the number of connected components of an unordered graph G and also assigns a component number to each of its nodes. Assume G is input by its set V of nodes and its set E of (undirected) edges. Test the program using nodes A, B, C, D, X, Y, Z, S and T and the edges:

(a) [A, X], [B, T], [Y, C], [S, Z], [D, T], [A, S], [Z, A], [D, B] and [X, S]
(b) [Z, C], [D, B], [A, X], [S, C], [D, T], [X, S], [Y, B], [T, B] and [S, Z]

Stacks and Queues

1. Write a program which gives a solution to the Towers of Hanoi problem for n disks. Test the program using (a) n = 3 (b) n = 5

2. Given an expression string EXP, write a program to examine whether the pairs and the orders of "{","}","(",")","[","]" are correct in EXP. For example, the program should print true for EXP = "[()]{}{[()()]()}" and false for EXP = "[(])"

3. Given a stack with push (), pop (), empty () operations, delete middle of it without using any additional data structure. Test the program using (a) [1,2,3,4,5] (b) [3.5, 2.6, 9.4, 1.5, 7.3, 4.5]

4. Write a program which evaluates an expression represented by a String. Expression can contain parentheses, you can assume parentheses are well-matched. Test the program using (a) 8 + 15 * (23-17) (b) 4 *9 + (625/25)

5. Write a program for implementations on various operations on a circular queue.

6. Write a procedure that uses a stack to reverse the elements of a circular queue which is stored in an array,

Sort

1. Write a program to implement bubble sort. Given the numbers 7, 1, 4, 12, 67, 33, and 45. How many swaps will be performed to sort these numbers using the bubble sort.
2. Write a program to sort an array of floating point numbers in descending order using the following sorting techniques:
   (a) insertion sort (b) selection sort (c) Merge sort (d) quick sort (e) shell sort (f) radix sort

   Print the execution times of each of the following algorithms in descending order.

3. Write a program TESTQUICKSORT(N, AVE) which repeats QUICKCOUNT(A, N, NUMB) 500 times and which finds the AVE of the 500 values of NUMB, and also a function RANDOM(DATA, N, K) which assigns N random integers between 1 and K to the array DATA; Use RANDOM(A, N, N*5) as each input and test the program using N = 100.

Additional Questions:

1. Write a program to print all the duplicate characters in a string
2. Write a program to find the first non-repeating character
3. Write a program to print a 2D matrix in a spiral form.
4. Write a program using pointers to interchange the second biggest and the second smallest number in the array.
5. Write a program that reads an array of 100 integers and display all the pairs of elements whose sum is 50.
6. Write a program that reads a matrix and displays the sum of the elements below the main diagonal.
7. Merge a linked list into another linked list at alternate positions
8. Write a program to form a linked list of floating point numbers. Display the sum and mean of these numbers.
9. Add 2 numbers represented by a linked list
   5->6->3 + 8->4->2 = 1->4->0->5
10. Write a program to delete the kth node from last from the linked list
11. Write a program to interchange the value of the first element with the last element, second element with second last element, so on and so forth of a doubly linked list.
12. Implement stack using a queue
13. Write a program to implement a stack that stores names of students in the class.
14. Write a program to input two stacks and compare their contents.
15. Write a program to reverse a string using recursion.
16. Write a program to implement a dequeue with the help of a linked list.
17. Write a program to input two queues and compare their contents.
18. Write a program to create a binary search tree and perform all the operations on it (Inserting a node, deleting a node with two children, height of BST, number of nodes, mirror image)
19. Given a binary tree, and two values n1 and n2, find the least common ancestor.
20. Given a binary search tree and a key node, find the total sum in BST except those nodes which are adjacent to the key node.
21. Program to convert binary tree to a binary search tree
22. Write a program to implement Warshall's algorithm to find the path matrix.
23. Write a program to implement the depth-first search algorithm.
24. Write a program to determine whether there is at least one path from the source to the destination