

# DAA LABORATORY 5

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## TASK 1:

**Aim:** Consider a XYZ courier company. They receive different goods to transport to different cities.

Company needs to ship the goods based on their life and value. Goods having less shelf life and high cost shall be shipped earlier. Consider list of 100 such items and capacity of transport vehical is 200 tones. Implement Algorithm for fractional knapsack problem.

## Algorithm:

Algorithm.

↳ fractional\_knapsack ( items[], capacity[] )

// Input : Total capacity and array of items sorted  
in descending order

// Output : Maximum Value / Profit .

Assumption : Each item contains attributes item,  
weight, shelf life.

Array of items is stored in the order  $\frac{\text{value} \times 1}{\text{weight} \times \text{shelf life}}$

function ( capacity, items[] )

    total value = 0.

    for ( i=0, i < n, i++ ) {

        if ( capacity  $\leq 0$  ) // each full

            break;

        3

        if ( items[i].value < 0 || items[i].weight < 0  
            || items[i].shelflife < 0 ) {

            return -1;

        3

        if ( items[i].weight  $\leq$  capacity )

            capacity = capacity - items[i].weight;

            totalvalue += items[i].value;

    3

    else {

        fraction = min ( capacity / items[i].weight )

        totalvalue = fraction \* (  $\frac{\text{weight}}{\text{value}}$  );

Capacity = 0

3

return totalvalue.

### Time Complexity:

Time complexity:

Best case:

If only 1 item is picked  
 $T(n) = O(1) = c$

Worst case: All the items are picked  
 $T(n) = O(n)$

Average case:

$$\begin{aligned} T(n) &= \frac{1+2+3+\dots+n}{n} \\ &= \frac{n(n+1)}{2(n)} \\ &\approx \frac{n+1}{2} \end{aligned}$$

$$T(n) \approx O(n)$$

Overall time complexity.

Best case:  $T(n) = O(n \log n) + O(n) \approx O(n \log n)$

Worst case:  $T(n) \approx O(n \log n) + O(n) = O(n \log n)$

Avg. case:  $T(n) = O(n \log n) + O(n) = O(n \log n)$

## **Positive Testcases:**

1)

[4] Maximum Knapsack Value: 2878.33  
Selected Items (Weight, Value, Shelf Life, Value Contribution):  
Weight = 1.0, Value = 98.00, Shelf Life = 6.0, Value Contribution = 98.00  
Weight = 1.0, Value = 87.00, Shelf Life = 10.0, Value Contribution = 87.00  
Weight = 1.0, Value = 84.00, Shelf Life = 3.0, Value Contribution = 84.00  
Weight = 1.0, Value = 76.00, Shelf Life = 8.0, Value Contribution = 76.00  
Weight = 1.0, Value = 65.00, Shelf Life = 4.0, Value Contribution = 65.00  
Weight = 2.0, Value = 79.00, Shelf Life = 9.0, Value Contribution = 79.00  
Weight = 2.0, Value = 73.00, Shelf Life = 9.0, Value Contribution = 73.00  
Weight = 2.0, Value = 69.00, Shelf Life = 3.0, Value Contribution = 69.00  
Weight = 2.0, Value = 60.00, Shelf Life = 1.0, Value Contribution = 60.00  
Weight = 2.0, Value = 53.00, Shelf Life = 3.0, Value Contribution = 53.00  
Weight = 4.0, Value = 98.00, Shelf Life = 8.0, Value Contribution = 98.00  
Weight = 3.0, Value = 71.00, Shelf Life = 7.0, Value Contribution = 71.00  
Weight = 2.0, Value = 47.00, Shelf Life = 2.0, Value Contribution = 47.00  
Weight = 2.0, Value = 47.00, Shelf Life = 4.0, Value Contribution = 47.00  
Weight = 4.0, Value = 92.00, Shelf Life = 10.0, Value Contribution = 92.00  
Weight = 2.0, Value = 44.00, Shelf Life = 1.0, Value Contribution = 44.00  
Weight = 3.0, Value = 62.00, Shelf Life = 10.0, Value Contribution = 62.00  
Weight = 5.0, Value = 96.00, Shelf Life = 1.0, Value Contribution = 96.00  
Weight = 5.0, Value = 88.00, Shelf Life = 6.0, Value Contribution = 88.00  
Weight = 5.0, Value = 87.00, Shelf Life = 3.0, Value Contribution = 87.00  
Weight = 4.0, Value = 68.00, Shelf Life = 3.0, Value Contribution = 68.00  
Weight = 2.0, Value = 33.00, Shelf Life = 7.0, Value Contribution = 33.00  
Weight = 2.0, Value = 33.00, Shelf Life = 9.0, Value Contribution = 33.00  
Weight = 5.0, Value = 75.00, Shelf Life = 2.0, Value Contribution = 75.00  
Weight = 6.0, Value = 67.00, Shelf Life = 6.0, Value Contribution = 67.00  
Weight = 7.0, Value = 78.00, Shelf Life = 1.0, Value Contribution = 78.00  
Weight = 3.0, Value = 33.00, Shelf Life = 6.0, Value Contribution = 33.00  
Weight = 6.0, Value = 65.00, Shelf Life = 6.0, Value Contribution = 65.00  
Weight = 7.0, Value = 69.00, Shelf Life = 9.0, Value Contribution = 69.00  
Weight = 10.0, Value = 95.00, Shelf Life = 10.0, Value Contribution = 95.00  
Weight = 4.0, Value = 37.00, Shelf Life = 1.0, Value Contribution = 37.00  
Weight = 4.0, Value = 36.00, Shelf Life = 6.0, Value Contribution = 36.00  
Weight = 11.0, Value = 98.00, Shelf Life = 3.0, Value Contribution = 98.00  
Weight = 6.0, Value = 52.00, Shelf Life = 5.0, Value Contribution = 52.00  
Weight = 11.0, Value = 92.00, Shelf Life = 10.0, Value Contribution = 92.00  
Weight = 9.0, Value = 73.00, Shelf Life = 8.0, Value Contribution = 73.00  
Weight = 8.0, Value = 63.00, Shelf Life = 8.0, Value Contribution = 63.00  
Weight = 13.0, Value = 100.00, Shelf Life = 7.0, Value Contribution = 100.00  
Weight = 11.0, Value = 84.00, Shelf Life = 4.0, Value Contribution = 84.00  
Weight = 9.0, Value = 66.00, Shelf Life = 5.0, Value Contribution = 66.00  
Weight = 8.0, Value = 57.00, Shelf Life = 6.0, Value Contribution = 57.00  
Weight = 4.0, Value = 28.33, Shelf Life = 7.0, Value Contribution = 28.33

2)

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Maximum Knapsack Value: 3018.08

Selected Items (Weight, Value, Shelf Life, Value Contribution):

Weight = 1.0, Value = 92.00, Shelf Life = 6.0, Value Contribution = 92.00  
Weight = 1.0, Value = 92.00, Shelf Life = 7.0, Value Contribution = 92.00  
Weight = 1.0, Value = 86.00, Shelf Life = 9.0, Value Contribution = 86.00  
Weight = 1.0, Value = 86.00, Shelf Life = 10.0, Value Contribution = 86.00  
Weight = 1.0, Value = 76.00, Shelf Life = 10.0, Value Contribution = 76.00  
Weight = 1.0, Value = 62.00, Shelf Life = 2.0, Value Contribution = 62.00  
Weight = 1.0, Value = 61.00, Shelf Life = 6.0, Value Contribution = 61.00  
Weight = 2.0, Value = 89.00, Shelf Life = 10.0, Value Contribution = 89.00  
Weight = 1.0, Value = 33.00, Shelf Life = 1.0, Value Contribution = 33.00  
Weight = 2.0, Value = 53.00, Shelf Life = 8.0, Value Contribution = 53.00  
Weight = 2.0, Value = 53.00, Shelf Life = 10.0, Value Contribution = 53.00  
Weight = 3.0, Value = 72.00, Shelf Life = 2.0, Value Contribution = 72.00  
Weight = 4.0, Value = 93.00, Shelf Life = 7.0, Value Contribution = 93.00  
Weight = 1.0, Value = 23.00, Shelf Life = 5.0, Value Contribution = 23.00  
Weight = 3.0, Value = 68.00, Shelf Life = 8.0, Value Contribution = 68.00  
Weight = 4.0, Value = 85.00, Shelf Life = 1.0, Value Contribution = 85.00  
Weight = 4.0, Value = 83.00, Shelf Life = 10.0, Value Contribution = 83.00  
Weight = 4.0, Value = 68.00, Shelf Life = 4.0, Value Contribution = 68.00  
Weight = 6.0, Value = 100.00, Shelf Life = 7.0, Value Contribution = 100.00  
Weight = 1.0, Value = 16.00, Shelf Life = 10.0, Value Contribution = 16.00  
Weight = 5.0, Value = 74.00, Shelf Life = 2.0, Value Contribution = 74.00  
Weight = 5.0, Value = 74.00, Shelf Life = 2.0, Value Contribution = 74.00  
Weight = 7.0, Value = 99.00, Shelf Life = 7.0, Value Contribution = 99.00  
Weight = 4.0, Value = 55.00, Shelf Life = 1.0, Value Contribution = 55.00

Weight = 6.0, Value = 78.00, Shelf Life = 4.0, Value Contribution = 78.00  
Weight = 4.0, Value = 51.00, Shelf Life = 4.0, Value Contribution = 51.00  
Weight = 2.0, Value = 25.00, Shelf Life = 8.0, Value Contribution = 25.00  
Weight = 7.0, Value = 86.00, Shelf Life = 10.0, Value Contribution = 86.00  
Weight = 4.0, Value = 48.00, Shelf Life = 5.0, Value Contribution = 48.00  
Weight = 7.0, Value = 80.00, Shelf Life = 7.0, Value Contribution = 80.00  
Weight = 7.0, Value = 77.00, Shelf Life = 3.0, Value Contribution = 77.00  
Weight = 1.0, Value = 11.00, Shelf Life = 8.0, Value Contribution = 11.00  
Weight = 7.0, Value = 76.00, Shelf Life = 3.0, Value Contribution = 76.00  
Weight = 8.0, Value = 81.00, Shelf Life = 2.0, Value Contribution = 81.00  
Weight = 3.0, Value = 29.00, Shelf Life = 2.0, Value Contribution = 29.00  
Weight = 9.0, Value = 87.00, Shelf Life = 3.0, Value Contribution = 87.00  
Weight = 3.0, Value = 27.00, Shelf Life = 10.0, Value Contribution = 27.00  
Weight = 8.0, Value = 71.00, Shelf Life = 8.0, Value Contribution = 71.00  
Weight = 9.0, Value = 79.00, Shelf Life = 10.0, Value Contribution = 79.00  
Weight = 4.0, Value = 35.00, Shelf Life = 9.0, Value Contribution = 35.00  
Weight = 10.0, Value = 86.00, Shelf Life = 4.0, Value Contribution = 86.00  
Weight = 4.0, Value = 33.00, Shelf Life = 5.0, Value Contribution = 33.00  
Weight = 9.0, Value = 73.00, Shelf Life = 8.0, Value Contribution = 73.00  
Weight = 9.0, Value = 69.00, Shelf Life = 3.0, Value Contribution = 69.00  
Weight = 11.0, Value = 82.08, Shelf Life = 3.0, Value Contribution = 82.08

3)

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Maximum Knapsack Value: 2384.50

Selected Items (Weight, Value, Shelf Life, Value Contribution):

Weight = 1.0, Value = 63.00, Shelf Life = 4.0, Value Contribution = 63.00  
Weight = 2.0, Value = 99.00, Shelf Life = 8.0, Value Contribution = 99.00  
Weight = 2.0, Value = 82.00, Shelf Life = 10.0, Value Contribution = 82.00  
Weight = 2.0, Value = 72.00, Shelf Life = 6.0, Value Contribution = 72.00  
Weight = 1.0, Value = 34.00, Shelf Life = 2.0, Value Contribution = 34.00  
Weight = 4.0, Value = 98.00, Shelf Life = 8.0, Value Contribution = 98.00  
Weight = 4.0, Value = 95.00, Shelf Life = 3.0, Value Contribution = 95.00  
Weight = 1.0, Value = 22.00, Shelf Life = 6.0, Value Contribution = 22.00  
Weight = 3.0, Value = 66.00, Shelf Life = 10.0, Value Contribution = 66.00  
Weight = 3.0, Value = 61.00, Shelf Life = 10.0, Value Contribution = 61.00  
Weight = 4.0, Value = 74.00, Shelf Life = 7.0, Value Contribution = 74.00  
Weight = 3.0, Value = 54.00, Shelf Life = 9.0, Value Contribution = 54.00  
Weight = 6.0, Value = 89.00, Shelf Life = 1.0, Value Contribution = 89.00  
Weight = 2.0, Value = 29.00, Shelf Life = 7.0, Value Contribution = 29.00  
Weight = 6.0, Value = 77.00, Shelf Life = 5.0, Value Contribution = 77.00  
Weight = 7.0, Value = 88.00, Shelf Life = 10.0, Value Contribution = 88.00  
Weight = 6.0, Value = 73.00, Shelf Life = 1.0, Value Contribution = 73.00  
Weight = 3.0, Value = 35.00, Shelf Life = 1.0, Value Contribution = 35.00  
Weight = 9.0, Value = 97.00, Shelf Life = 6.0, Value Contribution = 97.00  
Weight = 6.0, Value = 60.00, Shelf Life = 7.0, Value Contribution = 60.00  
Weight = 8.0, Value = 80.00, Shelf Life = 9.0, Value Contribution = 80.00  
Weight = 7.0, Value = 69.00, Shelf Life = 9.0, Value Contribution = 69.00  
Weight = 5.0, Value = 47.00, Shelf Life = 4.0, Value Contribution = 47.00  
Weight = 11.0, Value = 97.00, Shelf Life = 8.0, Value Contribution = 97.00

Weight = 10.0, Value = 88.00, Shelf Life = 4.0, Value Contribution = 88.00  
Weight = 5.0, Value = 43.00, Shelf Life = 9.0, Value Contribution = 43.00  
Weight = 9.0, Value = 74.00, Shelf Life = 7.0, Value Contribution = 74.00  
Weight = 5.0, Value = 41.00, Shelf Life = 3.0, Value Contribution = 41.00  
Weight = 12.0, Value = 95.00, Shelf Life = 5.0, Value Contribution = 95.00  
Weight = 12.0, Value = 93.00, Shelf Life = 2.0, Value Contribution = 93.00  
Weight = 7.0, Value = 54.00, Shelf Life = 4.0, Value Contribution = 54.00  
Weight = 3.0, Value = 23.00, Shelf Life = 3.0, Value Contribution = 23.00  
Weight = 6.0, Value = 45.00, Shelf Life = 10.0, Value Contribution = 45.00  
Weight = 7.0, Value = 48.00, Shelf Life = 10.0, Value Contribution = 48.00  
Weight = 5.0, Value = 34.00, Shelf Life = 7.0, Value Contribution = 34.00  
Weight = 10.0, Value = 66.00, Shelf Life = 9.0, Value Contribution = 66.00  
Weight = 3.0, Value = 19.50, Shelf Life = 9.0, Value Contribution = 19.50

### **Negative Testcases:**

```
Processing file: negative_test_exact_1.csv
Error: Invalid data in CSV file: Invalid weight: 0.0. Weight of an item cannot be zero or negative.
Processing file: negative_test_exact_2.csv
Error: Invalid data in CSV file: Invalid value: -10.0. Value of an item cannot be negative.
Processing file: negative_test_exact_3.csv
Error: Invalid data in CSV file: Invalid value: -4.0. Value of an item cannot be negative.
```

---

### **TASK 2:**

**Aim:** Download books from the website in html, text, doc, and pdf format. Compress these books using Hoffman coding technique. Find the compression ratio.

### **Algorithm:**

## Algorithm

## Pseudo code

1) class huffmanNode  
char freq, left, right

2) func build-huffmanTree (text)  
 $\text{freq} \leftarrow \text{count-freq} (+ \text{ext})$   
 $\text{heap} \leftarrow (\text{huffmanNode}(\text{char}, \text{freq}[\text{char}]) \text{ for } \text{char in freq})$

heapsify (heap)  
while ( $\text{len}(\text{heap}) > 1$ ):  
node 1 = heap.pop (heap)  
node 2 = heap.pop (heap)  
merged = huffmanNode (node 1, node 2, freq +  
node 2.freq, node 1.freq, node 2)  
heappush (heap, merged)

return heap[0]

func .. it (self, others)  
set up self.freq < others.freq.

func generate\_code (node, code, codes)  
if node == None  
return  
if node.char != None  
codes [node.char] = code  
generate\_code (node.left + "0", code)  
generate\_code (node.right + "1", code)

```

func compress(text)
    root = build_huffman-tree(text)
    code = {}
    generate_code(root, "", code)
    compressed = " ".join([code[ch] for ch in text])
    return compressed, code

```

```

func calculate_compression_ratio(text, compressed_text)
    size = len(text) * 8
    sizec = len(compressed_text) * 8
    ratio = size / sizec
    return size, sizec, ratio.

```

### Time Complexity:

- Time Complexity
- 1) Counting char freq  $\rightarrow O(n)$
  - 2) Building heap with  $\text{len(freq)}$   $\rightarrow O(k \log k)$
  - 3) Generating huffman code  $\rightarrow O(k)$
  - 4) Compressing text by iterating  $\rightarrow O(n)$
  - 5) Calculating Ratio  $\rightarrow O(1)$

$$\text{Total time taken} = O(n + k + k \log k)$$

## **Testcases:**

### **For Html files:**

#### **1)Contents of file\_1.html:**

The sun dipped below the horizon, painting the sky in shades of orange and purple. A gentle breeze rustled the leaves, creating a symphony of whispers in the twilight.

Huffman Codes and Frequencies:

Character	Frequency	Huffman Code
T	1	0011001
h	10	0111
e	20	100
	28	111
s	9	0100
u	3	110110
n	11	1011
d	5	10100
i	10	0110
p	7	0000
b	2	001001

1		6	10101
+-----+-----+-----+			
o		7	11001
+-----+-----+-----+			
w		3	110000
+-----+-----+-----+			
t		10	0101
+-----+-----+-----+			
r		7	11010
+-----+-----+-----+			
z		2	001011
+-----+-----+-----+			
,		2	001010
+-----+-----+-----+			
a		7	0001
+-----+-----+-----+			
g		5	00111
+-----+-----+-----+			
k		1	0011011
+-----+-----+-----+			
y		3	110001
+-----+-----+-----+			
f		2	001000
+-----+-----+-----+			
.		2	1101111
+-----+-----+-----+			
A		1	0011010
+-----+-----+-----+			
v		1	0011000
+-----+-----+-----+			
c		1	11011101

```
+-----+-----+
| m | 1 | 11011100 |
+-----+-----+
```

Original text size (in bits): 1336

Compressed text size (in bits): 710

Compression ratio: 1.8816901408450704

## 2) Contents of file\_2.html:

A curious cat perched on the windowsill, watching the world go by with wide eyes.

Huffman Codes and Frequencies:

```
+-----+-----+
| Character | Frequency | Huffman Code |
+=====+=====+=====+
| A | 1 | 001111 |
+-----+-----+
| | 14 | 111 |
+-----+-----+
| c | 4 | 0101 |
+-----+-----+
| u | 2 | 00101 |
+-----+-----+
| r | 3 | 11010 |
+-----+-----+
| i | 6 | 1011 |
+-----+-----+
| o | 5 | 0110 |
+-----+-----+
| s | 3 | 11011 |
+-----+-----+
```

a		2	01110
+-----+-----+-----+			
t		5	1001
+-----+-----+-----+			
p		1	001101
+-----+-----+-----+			
e		7	000
+-----+-----+-----+			
h		5	1000
+-----+-----+-----+			
d		4	0100
+-----+-----+-----+			
n		3	01111
+-----+-----+-----+			
w		6	1100
+-----+-----+-----+			
l		3	10101
+-----+-----+-----+			
,		1	101000
+-----+-----+-----+			
g		2	00100
+-----+-----+-----+			
b		1	001110
+-----+-----+-----+			
y		2	101001
+-----+-----+-----+			
.		1	001100
+-----+-----+-----+			

Original text size (in bits): 648

Compressed text size (in bits): 335

Compression ratio: 1.9343283582089552

### 3) for TEXT files:

#### 1) Contents of file 1.txt:

A cool breeze swept across the beach, carrying the salty scent of the ocean and the distant sounds of waves crashing, as seagulls circled above, searching for their next meal among the sunbathers and beachcombers below.

#### Huffman Codes and Frequencies:

Character	Frequency	Huffman Code
A	1	10110111
	35	110
c	12	0101
o	12	0100
l	7	10101
b	7	10100
r	11	0001
e	24	011
z	1	1000100
s	17	1110
w	3	001010

p		1	10110110
+-----+-----+-----+			
t		13	1001
+-----+-----+-----+			
a		18	1111
+-----+-----+-----+			
h		11	0000
+-----+-----+-----+			
,		3	101100
+-----+-----+-----+			
y		2	001000
+-----+-----+-----+			
i		6	10000
+-----+-----+-----+			
n		12	0011
+-----+-----+-----+			
g		5	101111
+-----+-----+-----+			
f		3	001011
+-----+-----+-----+			
d		5	101110
+-----+-----+-----+			
u		3	100011
+-----+-----+-----+			
v		2	1000101
+-----+-----+-----+			
x		1	10110101
+-----+-----+-----+			
m		3	001001
+-----+-----+-----+			
.		1	10110100
+-----+-----+-----+			

```
Original text size (in bits): 1752  
Compressed text size (in bits): 916  
Compression ratio: 1.9126637554585153
```

## 2) Contents of file\_2.txt:

```
Deep in the mountains, a hidden waterfall cascaded down rocky cliffs, its crystal-clear waters  
sparkling in the sunlight and creating a serene oasis for weary hikers seeking solace  
in nature's beauty.
```

## Huffman Codes and Frequencies:

Character	Frequency	Huffman Code
D	1	10101011
e	20	001
p	2	1010011
	30	110
i	13	1000
n	14	1001
t	11	0101
h	5	01001
m	1	1010001

	o			6		01101	
+-----+-----+-----+							
	u			4		101011	
+-----+-----+-----+							
	a			18		000	
+-----+-----+-----+							
	s			15		1011	
+-----+-----+-----+							
	,			2		1010010	
+-----+-----+-----+							
	d			6		01100	
+-----+-----+-----+							
	w			4		01000	
+-----+-----+-----+							
	r			12		0111	
+-----+-----+-----+							
	f			4		111001	
+-----+-----+-----+							
	l			8		11111	
+-----+-----+-----+							
	c			8		11110	
+-----+-----+-----+							
	k			4		111000	
+-----+-----+-----+							
	y			4		111010	
+-----+-----+-----+							
	-			1		1010000	
+-----+-----+-----+							
	g			4		111011	
+-----+-----+-----+							
	'			1		10101010	
+-----+-----+-----+							

b		1	10101001
+-----+-----+-----+			
.		1	10101000
+-----+-----+-----+			

Original text size (in bits): 1600

Compressed text size (in bits): 843

Compression ratio: 1.8979833926453145

### 3) for DOCS FILES:

#### 1) Contents of file\_1.docx:

With great power comes great responsibility, especially in tech. The future of tech is both exciting and uncertain. AI is transforming the world at a fast pace. The future of tech is both exciting and uncertain.

Huffman Codes and Frequencies:

Character	Frequency	Huffman Code
w	1	10111010
i	16	1010
t	19	000
h	9	11101
	35	110
g	5	111001
r	11	0101

e		20		001	
+-----+-----+-----+					
a		12		1000	
+-----+-----+-----+					
p		4		101101	
+-----+-----+-----+					
o		9		11111	
+-----+-----+-----+					
w		2		1011000	
+-----+-----+-----+					
c		10		0100	
+-----+-----+-----+					
m		2		1001110	
+-----+-----+-----+					
s		9		11110	
+-----+-----+-----+					
n		12		0111	
+-----+-----+-----+					
b		3		100110	
+-----+-----+-----+					
l		4		111000	
+-----+-----+-----+					
y		2		011000	
+-----+-----+-----+					
,		1		10111011	
+-----+-----+-----+					
.		4		101111	
+-----+-----+-----+					
T		2		1011001	
+-----+-----+-----+					
f		6		01101	

u	6	10010
x	2	1001111
d	3	011001
A	1	10111001
I	1	10111000

Original text size (in bits): 1688

Compressed text size (in bits): 899

Compression ratio: 1.8776418242491657

## 2) Contents of file\_2.docx:

AI is transforming the world at a fast pace. AI is transforming the world at a fast pace. The quick brown fox jumps over the lazy dog. Machine learning can outperform humans in tasks.

Huffman Codes and Frequencies:

Character	Frequency	Huffman Code
A	2	1000101
I	2	1100101
	33	00
i	8	11110

s		10	0101
+-----+	+-----+	+-----+	+-----+
t		11	1010
+-----+	+-----+	+-----+	+-----+
r		11	0111
+-----+	+-----+	+-----+	+-----+
a		16	1110
+-----+	+-----+	+-----+	+-----+
n		11	1001
+-----+	+-----+	+-----+	+-----+
f		6	10110
+-----+	+-----+	+-----+	+-----+
o		10	0110
+-----+	+-----+	+-----+	+-----+
m		5	111111
+-----+	+-----+	+-----+	+-----+
g		4	110001
+-----+	+-----+	+-----+	+-----+
h		6	10111
+-----+	+-----+	+-----+	+-----+
e		10	0100
+-----+	+-----+	+-----+	+-----+
w		3	110000
+-----+	+-----+	+-----+	+-----+
l		4	110011
+-----+	+-----+	+-----+	+-----+
d		3	100011
+-----+	+-----+	+-----+	+-----+
p		4	110101
+-----+	+-----+	+-----+	+-----+
c		5	10000

```

+-----+-----+-----+
| . | 4 | 110100 |
+-----+-----+-----+
| T | 1 | 11111001 |
+-----+-----+-----+
| q | 1 | 11111000 |
+-----+-----+-----+
| u | 4 | 110111 |
+-----+-----+-----+
| k | 2 | 1100100 |
+-----+-----+-----+
| b | 1 | 11111011 |
+-----+-----+-----+
| x | 1 | 11111010 |
+-----+-----+-----+
| j | 1 | 11011011 |
+-----+-----+-----+
| v | 1 | 11011010 |
+-----+-----+-----+
| z | 1 | 11011001 |
+-----+-----+-----+
| y | 1 | 11011000 |
+-----+-----+-----+
| M | 1 | 1000100 |
+-----+-----+-----+

```

Original text size (in bits): 1464

Compressed text size (in bits): 806

Compression ratio: 1.816377171215881

4) for PDF FILES:

1) Contents of file\_1.pdf:

With great power comes great responsibility, especially in tech. The future of tech is both exciting

and uncertain. AI is transforming the world at a fast pace. The future of tech is both exciting and

uncertain.

#### Huffman Codes and Frequencies:

Character	Frequency	Huffman Code
W	1	10011110
i	16	1011
t	19	000
h	9	11101
	33	110
g	5	111111
r	11	0101
e	20	001
a	12	0110
p	4	101000
o	9	11110
w	2	1111101

c		10	0100
+-----+	+-----+	+-----+	+-----+
m		2	1001100
+-----+	+-----+	+-----+	+-----+
s		9	11100
+-----+	+-----+	+-----+	+-----+
n		12	1000
+-----+	+-----+	+-----+	+-----+
b		3	011101
+-----+	+-----+	+-----+	+-----+
l		4	101001
+-----+	+-----+	+-----+	+-----+
y		2	1010111
+-----+	+-----+	+-----+	+-----+
,		1	10011111
+-----+	+-----+	+-----+	+-----+
.		4	101010
+-----+	+-----+	+-----+	+-----+
T		2	1010110
+-----+	+-----+	+-----+	+-----+
f		6	01111
+-----+	+-----+	+-----+	+-----+
u		6	10010
+-----+	+-----+	+-----+	+-----+
x		2	1111100
+-----+	+-----+	+-----+	+-----+
		2	1001110
+-----+	+-----+	+-----+	+-----+
d		3	011100
+-----+	+-----+	+-----+	+-----+
A		1	10011011

```
+-----+-----+-----+
| I | 1 | 10011010 |
+-----+-----+-----+
```

Original text size (in bits): 1688

Compressed text size (in bits): 909

Compression ratio: 1.856985698569857

## 2) Contents of file\_2.pdf:

AI is transforming the world at a fast pace. AI is transforming the world at a fast pace. The quick

brown fox jumps over the lazy dog. Machine learning can outperform humans in tasks.

## Huffman Codes and Frequencies:

```
+-----+-----+-----+
| Character | Frequency | Huffman Code |
+=====+=====+=====+
| A | 2 | 000110 |
+-----+-----+-----+
| I | 2 | 1100010 |
+-----+-----+-----+
| | 32 | 111 |
+-----+-----+-----+
| i | 8 | 0000 |
+-----+-----+-----+
| s | 10 | 0110 |
+-----+-----+-----+
| t | 11 | 1000 |
+-----+-----+-----+
| r | 11 | 0111 |
+-----+-----+-----+
| a | 16 | 1101 |
+-----+-----+-----+
```

n		11	1010
+-----+-----+-----+			
f		6	10111
+-----+-----+-----+			
o		10	0101
+-----+-----+-----+			
m		5	10010
+-----+-----+-----+			
g		4	00010
+-----+-----+-----+			
h		6	10110
+-----+-----+-----+			
e		10	0100
+-----+-----+-----+			
w		3	100110
+-----+-----+-----+			
l		4	00110
+-----+-----+-----+			
d		3	100111
+-----+-----+-----+			
p		4	00100
+-----+-----+-----+			
c		5	00111
+-----+-----+-----+			
.		4	110000
+-----+-----+-----+			
T		1	11001011
+-----+-----+-----+			
q		1	11001010
+-----+-----+-----+			
u		4	110011

k		2	001011
+-----+-----+-----+			
		1	11001001
+-----+-----+-----+			
b		1	11001000
+-----+-----+-----+			
x		1	0001111
+-----+-----+-----+			
j		1	0001110
+-----+-----+-----+			
v		1	11000111
+-----+-----+-----+			
z		1	11000110
+-----+-----+-----+			
y		1	0010101
+-----+-----+-----+			
M		1	0010100
+-----+-----+-----+			

Original text size (in bits): 1464

Compressed text size (in bits): 812

Compression ratio: 1.8029556650246306

**Conclusion:** BY this experiment , i learned how to implement Fractional Knapsack and Hoffman codes and its working .