

Ajeenkya D Y Patil School Of Engineering, Lohegaon, Pune.

Savitribai Phule Pune University (SPPU) Fourth Year of Computer Engineering (2019 Course)

410246: Laboratory Practice III

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## Term work: 50 Marks Practical: 50 Marks

Design and Analysis of Algorithms (410241) Machine Learning(410242)

## Blockchain Technology(410243)

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##### Group A Assignment No: 1

**Title:** Write a program non-recursive and recursive program to calculate Fibonacci numbers and analyze their time and space complexity.

**Objective:** Students should be able to perform non-recursive and recursive programs to calculate Fibonacci numbers and analyze their time and space complexity.

**Theory:**

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1. **Introduction to Fibonacci numbers**
   * The Fibonacci series, named after Italian mathematician Leonardo Pisano Bogollo, later known as Fibonacci, is a series (sum) formed by Fibonacci numbers denoted as Fn. The numbers in Fibonacci sequence are given as: 0, 1, 1, 2, 3, 5, 8, 13, 21, 38, . . .
   * In a Fibonacci series, every term is the sum of the preceding two terms, starting from 0 and 1 as first and second terms. In some old references, the term '0' might be omitted.

* **What is the Fibonacci Series?**
  + The Fibonacci series is the sequence of numbers (also called Fibonacci numbers), where every number is the sum of the preceding two numbers, such that the first two terms are '0' and '1'.
  + In some older versions of the series, the term '0' might be omitted. A Fibonacci series can thus be given as, 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, . . . It can be thus be observed that every term can be calculated by adding the two terms before it.

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* Fibonacci Sequence Formula

The Fibonacci sequence of numbers “Fn” is defined using the recursive relation with the seed values F0=0 and F1=1:

Fn = Fn-1+Fn-2

Here, the sequence is defined using two different parts, such as kick-off and recursive relation. The kick-off part is F0=0 and F1=1.

The recursive relation part is Fn = Fn-1+Fn-2.

It is noted that the sequence starts with 0 rather than 1. So, F5 should be the 6th term of the sequence.

**Examples:**

Input : n = 2 Output : 1 Input : n = 9 Output : 34

The list of Fibonacci numbers are calculated as follows:

|  |  |  |  |
| --- | --- | --- | --- |
| **Fn** | | **Fibonacci Number** | |
| 0 | | 0 | |
| 1 | | 1 | |
| 2 | | 1 | |
| 3 | | 2 | |
| 4 | | 3 | |
| 5 | | 5 | |
| 6 | | 8 | |
| 7 | | 13 | |
| 8 | | 21 | |
| 9 | | 34 | |
| … and so on. | | … and so on. | |

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1. Method 1 (Use Non-recursion)

A simple method that is a direct recursive implementation of mathematical recurrence relation is given above.

First, we’ll store 0 and 1 in *F*[0] and *F*[1], respectively.

Next, we’ll iterate through array positions 2 to *n-1*. At each position *i*, we store the sum of the two preceding array values in *F*[*i*].

Finally, we return the value of *F*[*n*-1], giving us the number at position *n* in the sequence.

* **Time and Space Complexity of Space Optimized Method**
  + The time complexity of the Fibonacci series is **T(N) i.e, linear**. We have to find the sum of two terms and it is repeated n times depending on the value of n.
  + The space complexity of the Fibonacci series using dynamic programming is **O(1)**.
* **Time Complexity and Space Complexity of Dynamic Programming**
  + The time complexity of the above code is **T(N) i.e, linear**. We have to find the sum of two terms and it is repeated n times depending on the value of n.

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* + The space complexity of the above code is **O(N)**.

1. Method 2 (Use Recursion)

Let’s start by defining F(n) as the function that returns the value of Fn.

**To evaluate *F*(*n*) for *n* > 1, we can reduce our problem into two smaller problems of the same kind: *F*(*n*-1) and *F*(*n*-2).** We can further reduce *F*(*n*-1) and *F*(*n*-2) to *F*((*n*-1)-1) and *F*((*n*- 1)-2); and *F*((*n*-2)-1) and *F*((*n*-2)-2), respectively.

If we repeat this reduction, we’ll eventually reach our known base cases and, thereby, obtain a solution to *F*(*n*).

Employing this logic, our algorithm for *F*(*n*) will have two steps:

1. Check if *n* ≤ 1. If so, return *n*.
2. Check if *n* > 1. If so, call our function *F* with inputs *n*-1 and *n*-2, and return the sum of the two results.

* **Time and Space Complexity**
  + The time complexity of the above code is **T(2^N) i.e, exponential**.

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* The Space complexity of the above code is **O(N) for a recursive series.**

1. **Applications of Fibonacci Series**
   * It is used in the grouping of numbers and used to study different other special mathematical sequences.
   * It is applied in numerous fields of science like quantum mechanics, cryptography, etc.
   * In finance market trading, Fibonacci retracement levels are widely used in technical analysis.

**Conclusion**- In this way we have explored Concept of Fibonacci series using recursive and non recursive method and also learn time and space complexity

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**Assignment Question**

* 1. **What is the Fibonacci Sequence of numbers?**
  2. **How do the Fibonacci work?**
  3. **What is the Golden Ratio?**
  4. **What is the Fibonacci Search technique?**
  5. **What is the real application for Fibonacci series**

**Reference link**

* + <https://www.scaler.com/topics/fibonacci-series-in-c/>
  + <https://www.baeldung.com/cs/fibonacci-computational-complexity>

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##### Group A Assignment No: 2

**Title:** Write a program to implement Huffman Encoding using a greedy strategy.

**Objective :** Students should be able to understand and solve Huffman Encoding using greedy method

**Theory:**

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1. **What is a Greedy Method?**
   * A greedy algorithm is an approach for solving a problem by selecting the best option available at the moment. It doesn't worry whether the current best result will bring the overall optimal result.
   * The algorithm never reverses the earlier decision even if the choice is wrong. It works in a top- down approach.
   * This algorithm may not produce the best result for all the problems. It's because it always goes for the local best choice to produce the global best result.

* **Advantages of Greedy Approach**
  + The algorithm is **easier to describe**.
  + This algorithm can **perform better** than other algorithms (but, not in all cases).
* **Drawback of Greedy Approach**
  + As mentioned earlier, the greedy algorithm doesn't always produce the optimal solution. This is the major disadvantage of the algorithm
  + For example, suppose we want to find the longest path in the graph below from root to leaf.
* **Greedy Algorithm**

1. To begin with, the solution set (containing answers) is empty.
2. At each step, an item is added to the solution set until a solution is reached.
3. If the solution set is feasible, the current item is kept.
4. Else, the item is rejected and never considered again.
5. **Huffman Encoding**
   * Huffman Coding is a technique of compressing data to reduce its size without losing any of the details. It was first developed by David Huffman.
   * Huffman Coding is generally useful to compress the data in which there are frequently occurring

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characters.

* + The code length of a character depends on how frequently it occurs in the given text.
  + The character which occurs most frequently gets the smallest code.
  + The character which occurs least frequently gets the largest code.
  + It is also known as **Huffman Encoding**.
* **Major Steps in Huffman Coding-**

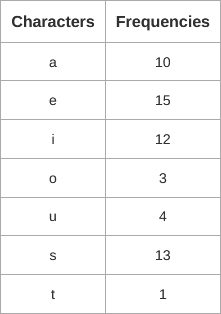
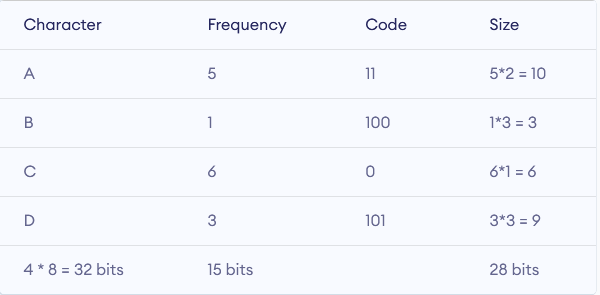
There are two major steps in Huffman Coding-

1. Building a Huffman Tree from the input characters.
2. Assigning code to the characters by traversing the Huffman Tree.

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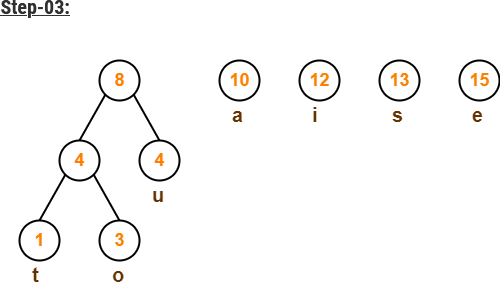
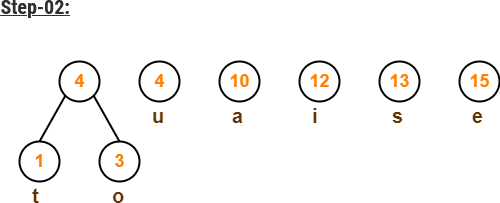
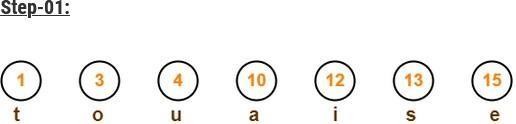


1. **Example:**

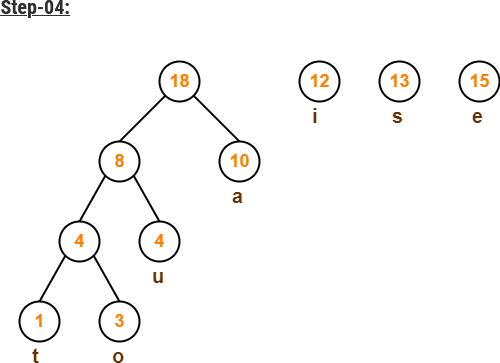
A file contains the following characters with the frequencies as shown. If Huffman Coding is used for data compression, determine-

1. Huffman Code for each character
2. Average code length
3. Length of Huffman encoded message (in bits)

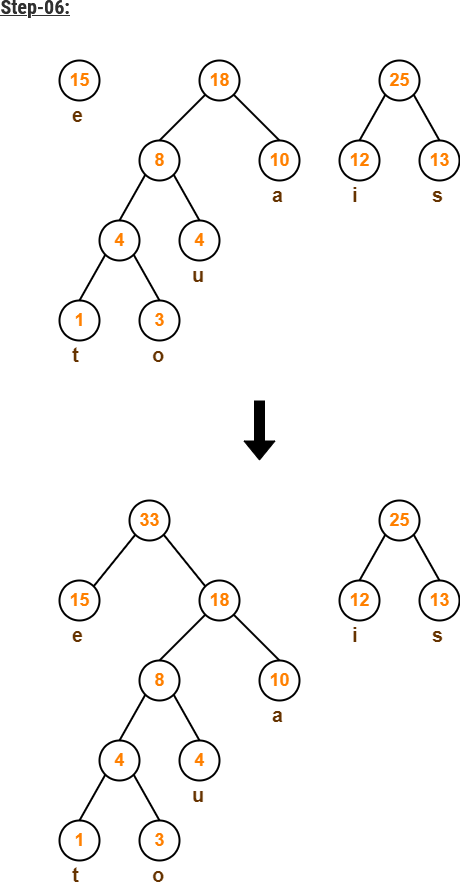
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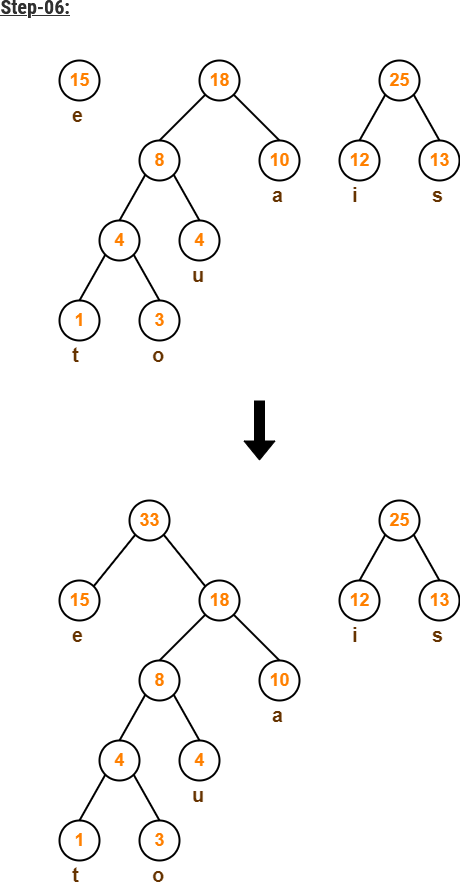
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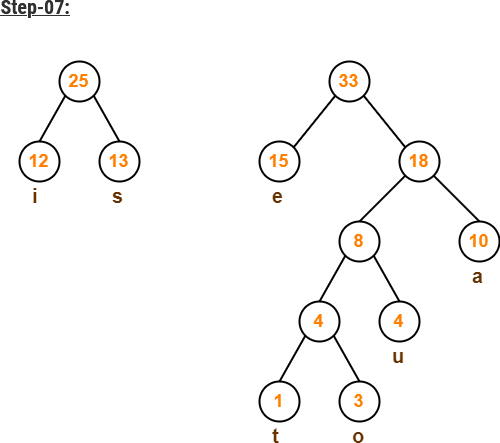
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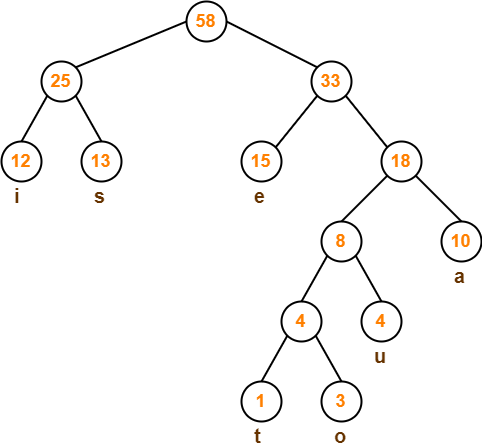
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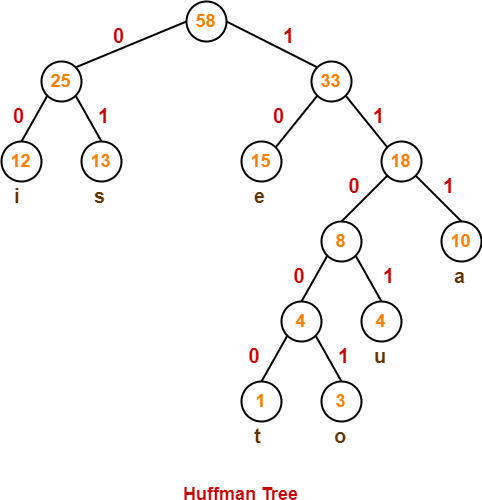


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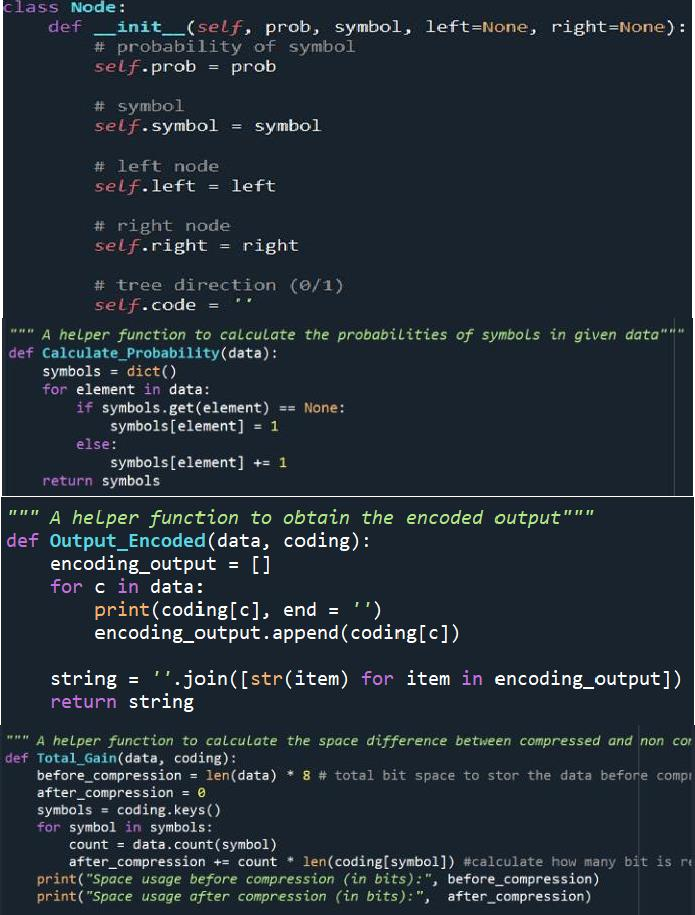


After assigning weight to all the edges, the modified Huffman Tree is-

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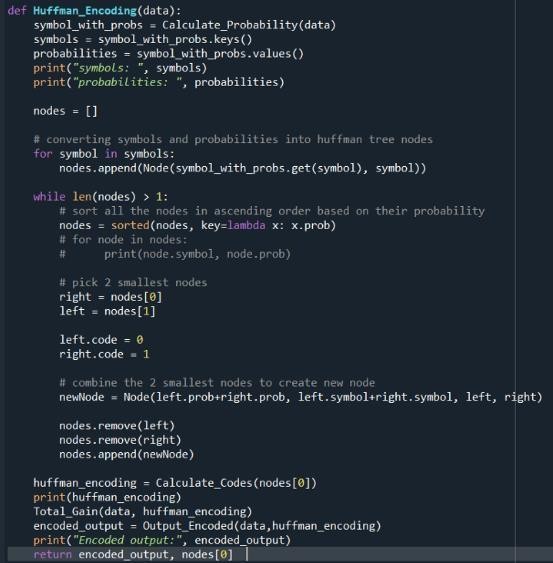


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**Code** :-

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Output

**Conclusion**- In this way we have explored Concept ofHuffman Encoding using greedy method

**Assignment Question**

1. What is Huffman Encoding?
2. How many bits may be required for encoding the message ‘mississippi’?
3. Which tree is used in Huffman encoding?Give one Example
4. Why Huffman coding is lossless compression?

**Reference link**

* + - <https://towardsdatascience.com/huffman-encoding-python-implementation-8448c3654328>
    - <https://www.programiz.com/dsa/huffman-coding#cpp-code>
    - <https://www.gatevidyalay.com/tag/huffman-coding-example-ppt/>

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##### Group A Assignment No: 3

**Title of the Assignment:** Write a program to solve a fractional Knapsack problem using a greedy method.

**Objective of the Assignment:** Students should be able to understand and solve fractional Knapsack problems using a greedy method.

**Prerequisite:**

1. Basic of Python or Java Programming
2. Concept of Greedy method
3. fractional Knapsack problem

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**Contents for Theory:**

1. **Greedy Method**
2. **Fractional Knapsack problem**
3. **Example solved using fractional Knapsack problem**

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**What is a Greedy Method?**

* + A greedy algorithm is an approach for solving a problem by selecting the best option available at the moment. It doesn't worry whether the current best result will bring the overall optimal result.
  + The algorithm never reverses the earlier decision even if the choice is wrong. It works in a top- down approach.
  + This algorithm may not produce the best result for all the problems. It's because it always goes for the local best choice to produce the global best result.

**Advantages of Greedy Approach**

* + The algorithm is **easier to describe**.
  + This algorithm can **perform better** than other algorithms (but, not in all cases).

**Drawback of Greedy Approach**

* + As mentioned earlier, the greedy algorithm doesn't always produce the optimal solution. This is the major disadvantage of the algorithm
  + For example, suppose we want to find the longest path in the graph below from root to leaf.

**Greedy Algorithm**

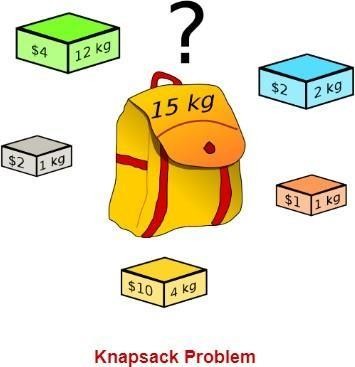
1. To begin with, the solution set (containing answers) is empty.
2. At each step, an item is added to the solution set until a solution is reached.
3. If the solution set is feasible, the current item is kept.
4. Else, the item is rejected and never considered again.

**Knapsack Problem**

You are given the following-

* A knapsack (kind of shoulder bag) with limited weight capacity.

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* Few items each having some weight and value.

The problem states-

Which items should be placed into the knapsack such that-

* The value or profit obtained by putting the items into the knapsack is maximum.
* And the weight limit of the knapsack does not exceed.

**Knapsack Problem Variants**

Knapsack problem has the following two variants-

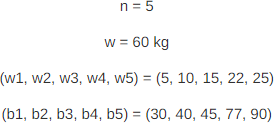
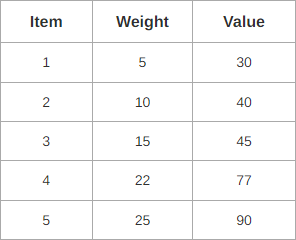
1. Fractional Knapsack Problem
2. 0/1 Knapsack Problem

### Fractional Knapsack Problem-

In Fractional Knapsack Problem,

* As the name suggests, items are divisible here.
* We can even put the fraction of any item into the knapsack if taking the complete item is not

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possible.

* It is solved using the Greedy Method.

### Fractional Knapsack Problem Using Greedy Method-

Fractional knapsack problem is solved using greedy method in the following steps-

**Step-01:**

For each item, compute its value / weight ratio.

**Step-02:**

Arrange all the items in decreasing order of their value / weight ratio.

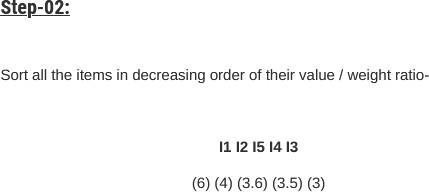
**Step-03:**

Start putting the items into the knapsack beginning from the item with the highest ratio. Put as many items as you can into the knapsack.

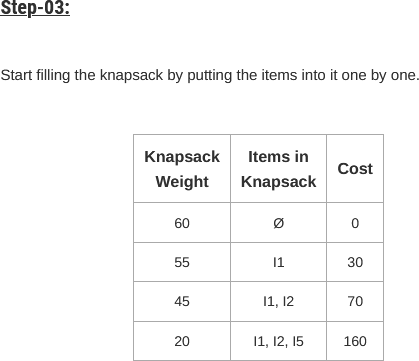
### Problem-

For the given set of items and knapsack capacity = 60 kg, find the optimal solution for the fractional knapsack problem making use of greedy approach.

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Now,

* Knapsack weight left to be filled is 20 kg but item-4 has a weight of 22 kg.
* Since in fractional knapsack problem, even the fraction of any item can be taken.
* So, knapsack will contain the following items-

< I1 , I2 , I5 , (20/22) I4 >

**Total cost of the knapsack**

= 160 + (20/22) x 77

= 160 + 70

= 230 units

### Time Complexity-

* The main time taking step is the sorting of all items in decreasing order of their value / weight ratio.
* If the items are already arranged in the required order, then while loop takes O(n) time.
* The average time complexity of [Quick Sort](https://www.gatevidyalay.com/quick-sort-sorting-algorithms/) is O(nlogn).
* Therefore, total time taken including the sort is O(nlogn).

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Code:- class Item:

def init (self, value, weight): self.value = value self.weight = weight

def fractionalKnapsack(W, arr):

# Sorting Item on basis of ratio

arr.sort(key=lambda x: (x.value/x.weight), reverse=True)

# Result(value in Knapsack) finalvalue = 0.0

# Looping through all Items for item in arr:

# If adding Item won't overflow, # add it completely

if item.weight <= W:

W -= item.weight finalvalue += item.value

# If we can't add current Item, # add fractional part of it else:

finalvalue += item.value \* W / item.weight break

# Returning final value return finalvalue

# Driver Code

if name == " main ":

W = 50

arr = [Item(60, 10), Item(100, 20), Item(120, 30)]

# Function call

max\_val = fractionalKnapsack(W, arr) print(max\_val)

Output

Maximum value we can obtain = 24

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**Conclusion**-In this way we have explored Concept of Fractional Knapsack using greedy method

**Assignment Question**

* 1. **What is Greedy Approach?**
  2. **Explain concept of fractional knapsack**
  3. **Difference between Fractional and 0/1 Knapsack**
  4. **Solve one example based on Fractional knapsack(Other than Manual)**

**Reference link**

* <https://www.gatevidyalay.com/fractional-knapsack-problem-using-greedy-approach/>

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**Group A Assignment No: 4**

**Title:** Write a program to solve a 0-1 Knapsack problem using dynamic programming or branch and bound strategy.

**Objective:** Students should be able to understand and solve 0-1 Knapsack problem using dynamic programming

**Theory:**

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1. **What is Dynamic Programming?**
   * Dynamic Programming is also used in optimization problems. Like divide-and-conquer method, Dynamic Programming solves problems by combining the solutions of subproblems.
   * Two main properties of a problem suggest that the given problem can be solved using Dynamic Programming. These properties are **overlapping sub-problems and optimal substructure**.
   * For example, Binary Search does not have overlapping sub-problem. Whereas recursive program of Fibonacci numbers have many overlapping sub-problems.

* **Steps of Dynamic Programming Approach**

Dynamic Programming algorithm is designed using the following four steps −

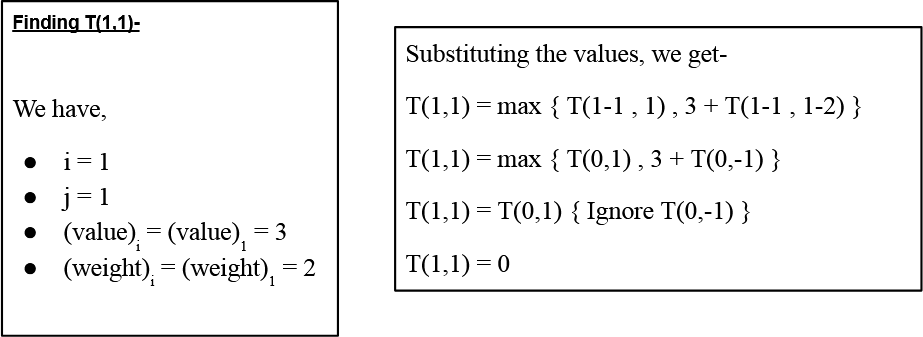
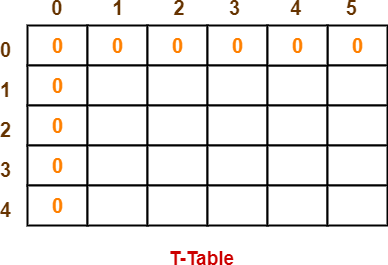
* + Characterize the structure of an optimal solution.
  + Recursively define the value of an optimal solution.
  + Compute the value of an optimal solution, typically in a bottom-up fashion.
  + Construct an optimal solution from the computed information.
* **Applications of Dynamic Programming Approach**
  + Matrix Chain Multiplication
  + Longest Common Subsequence
  + Travelling Salesman Problem

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1. **Knapsack Problem**

For the given set of items and knapsack capacity = 5 kg, find the optimal solution for the 0/1 knapsack problem making use of a dynamic programming approach.

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### Solution-

Given

* Knapsack capacity (w) = 5 kg
* Number of items (n) = 4

Step-01:

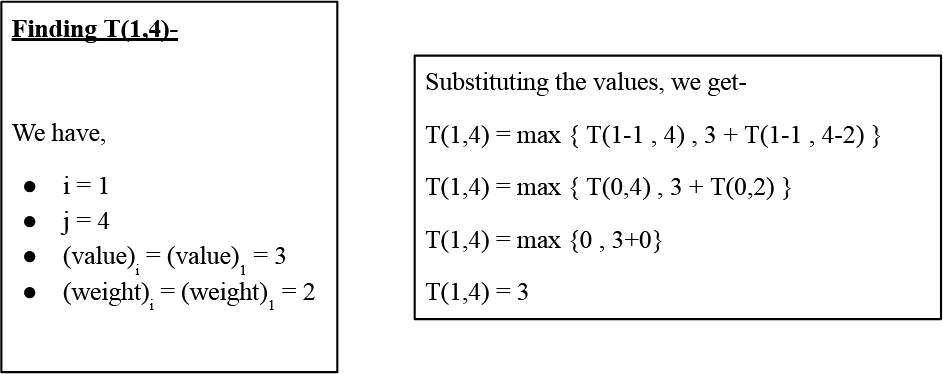
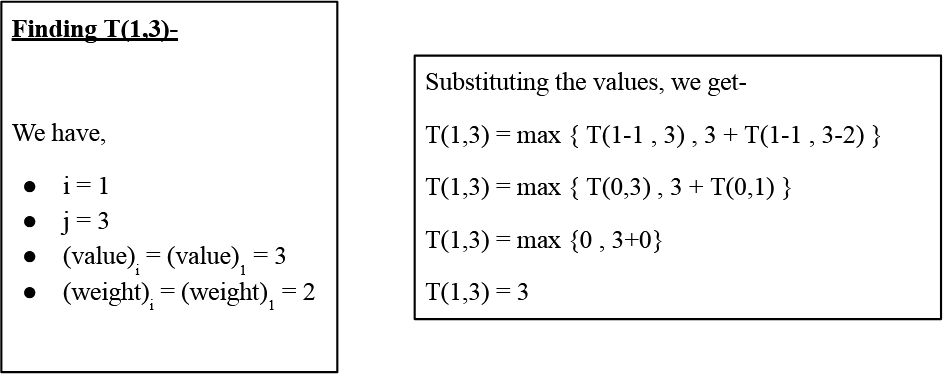
* Draw a table say ‘T’ with (n+1) = 4 + 1 = 5 number of rows and (w+1) = 5 + 1 = 6 number of columns.
* Fill all the boxes of 0th row and 0th column with 0.

Step-02:

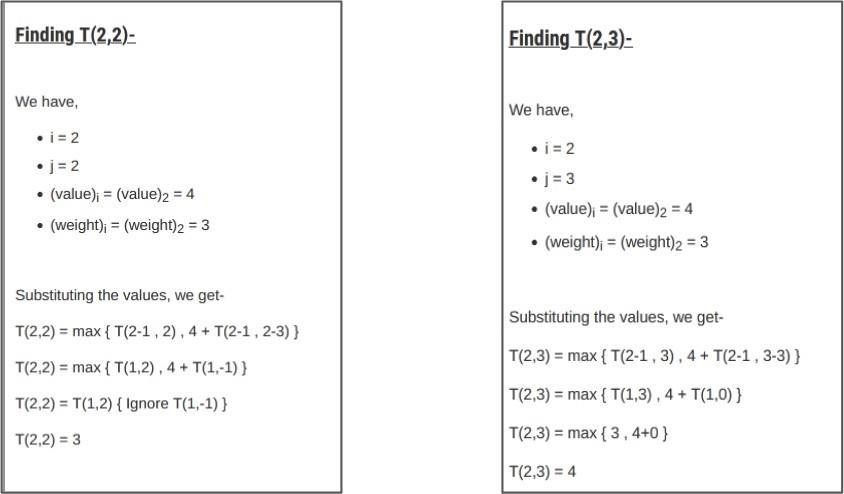
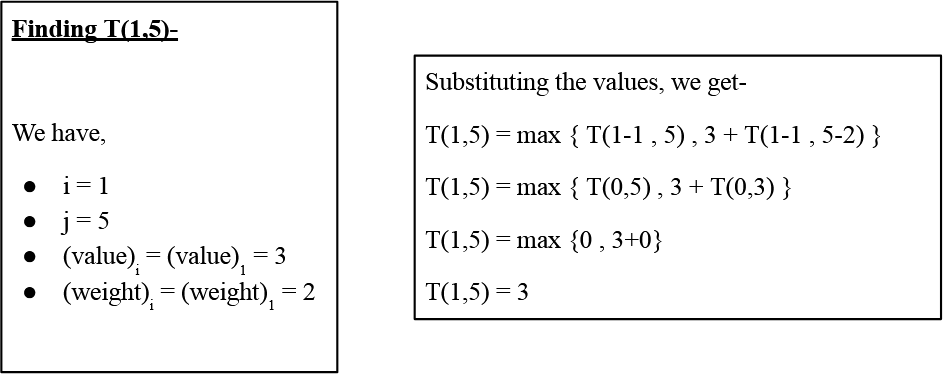
Start filling the table row wise top to bottom from left to right using the formula-

**T (i , j) = max { T ( i-1 , j ) , valuei + T( i-1 , j – weighti ) }**

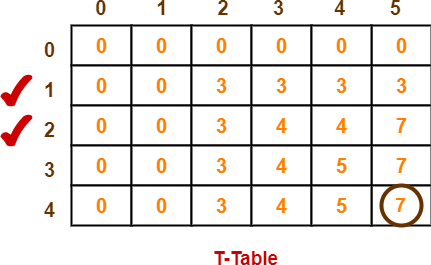
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Similarly, compute all the entries.

After all the entries are computed and filled in the table, we get the following table-

* The last entry represents the maximum possible value that can be put into the knapsack.
* So, maximum possible value that can be put into the knapsack = 7.
* Identifying Items To Be Put Into Knapsack

Following Step-04,

* We mark the rows labelled “1” and “2”.
* Thus, items that must be put into the knapsack to obtain the maximum value 7 are-

**Item-1 and Item-2**

### Time Complexity-

* Each entry of the table requires constant time θ(1) for its computation.
* It takes θ(nw) time to fill (n+1)(w+1) table entries.
* It takes θ(n) time for tracing the solution since tracing process traces the n rows.
* Thus, overall θ(nw) time is taken to solve 0/1 knapsack problem using dynamic programming

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**Code :-**

# code

# A Dynamic Programming based Python # Program for 0-1 Knapsack problem # Returns the maximum value that can # be put in a knapsack of capacity W

def knapSack(W, wt, val, n):

dp = [0 for i in range(W+1)] # Making the dp array

for i in range(1, n+1): # taking first i elements

for w in range(W, 0, -1): # starting from back,so that we also have data of

# previous computation when taking i-1

items

if wt[i-1] <= w:

# finding the maximum value

dp[w] = max(dp[w], dp[w-wt[i-1]]+val[i-1])

return dp[W] # returning the maximum value of knapsack

# Driver code

val = [60, 100, 120]

wt = [10, 20, 30]

W = 50

n = len(val)

print(knapSack(W, wt, val, n))

**Output 220**

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**Conclusion**-In this way we have explored Concept of 0/1 Knapsack using Dynamic approch

**Assignment Question**

* 1. **What is Dynamic Approach?**
  2. **Explain concept of 0/1 knapsack**
  3. **Difference between Dynamic and Branch and Bound Approach.Which is best?**
  4. **Solve one example based on 0/1 knapsack(Other than Manual) Reference link**
* [https://www.gatevidyalay.com/0-1-knapsack-problem-using-dynamic-programming-appr](https://www.gatevidyalay.com/0-1-knapsack-problem-using-dynamic-programming-approach/) [oach/](https://www.gatevidyalay.com/0-1-knapsack-problem-using-dynamic-programming-approach/)
* <https://www.youtube.com/watch?v=mMhC9vuA-70>
* [https://www.tutorialspoint.com/design\_and\_analysis\_of\_algorithms/design\_and\_analysi](https://www.tutorialspoint.com/design_and_analysis_of_algorithms/design_and_analysis_of_algorithms_fractional_knapsack.htm) [s\_of\_algorithms\_fractional\_knapsack.htm](https://www.tutorialspoint.com/design_and_analysis_of_algorithms/design_and_analysis_of_algorithms_fractional_knapsack.htm)

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**Group A Assignment No: 5**

**Title:** Design n-Queens matrix having first Queen placed. Use backtracking to place remaining Queens to generate the final n-queen’s matrix.

**Objective:** Students should be able to understand and solve n-Queen Problem,and understand basics of Backtracking

**---------------------------------------------------------------------------------------------------------------**

**Theory:**

**---------------------------------------------------------------------------------------------------------------**

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1. **Introduction to Backtracking**
   * Many problems are difficult to solve algorithmically. Backtracking makes it possible to solve at least some large instances of difficult combinatorial problems.

Suppose we have to make a series of decisions among various choices, where

* + We don’t have enough information to know what to choose
  + Each decision leads to a new set of choices.
  + Some sequence of choices (more than one choices) may be a solution to your problem.

### What is backtracking?

Backtracking is finding the solution of a problem whereby the solution depends on the previous steps taken. For example, in a maze problem, the solution depends on all the steps you take one-by-one. If any of those steps is wrong, then it will not lead us to the solution. In a maze problem, we first choose a path and continue moving along it. But once we understand that the particular path is incorrect, then we just come back and change it. This is what backtracking basically is.

Thus, the general steps of backtracking are:

* + start with a sub-solution
  + check if this sub-solution will lead to the solution or not
  + If not, then come back and change the sub-solution and continue again
* **Applications of Backtracking:**
  + N Queens Problem
  + Sum of subsets problem

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* + Graph coloring
  + Hamiltonian cycles.

1. **N-Queens Problem:**

A classic combinational problem is to place n queens on a n\*n chess board so that no two attack, i.,e no two queens are on the same row, column or diagonal.

### What is the N Queen Problem?

N Queen problem is the classical Example of backtracking. N-Queen problem is defined as, “given N x N chess board, arrange N queens in such a way that no two queens attack each other by being in the same row, column or diagonal”.

* + For N = 1, this is a trivial case. For N = 2 and N = 3, a solution is not possible. So we start with N = 4 and we will generalize it for N queens.

If we take n=4then the problem is called the 4 queens problem. If we take n=8 then the problem is called the 8 queens problem.

### 4-Queen Problem

**Problem 1 :** Given 4 x 4 chessboard, arrange four queens in a way, such that no two queens attack each other. That is, no two queens are placed in the same row, column, or diagonal.

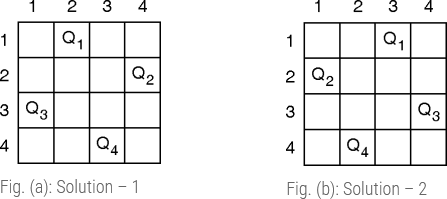
* + We have to arrange four queens, Q1, Q2, Q3 and Q4 in 4 x 4 chess board. We will put with queen in ith row. Let us start with position (1, 1). Q1 is the only queen, so there is no issue. partial solution is

<1>

* + We cannot place Q2 at positions (2, 1) or (2, 2). Position (2, 3) is acceptable. the partial solution is <1, 3>.
  + Next, Q3 cannot be placed in position (3, 1) as Q1 attacks her. And it cannot be placed at (3, 2), (3, 3) or (3, 4) as Q2 attacks her. There is no way to put Q3 in the third row. Hence, the algorithm backtracks and goes back to the previous solution and readjusts the position of queen Q2. Q2 is moved from positions (2, 3) to

(2, 4). Partial solution is <1, 4>

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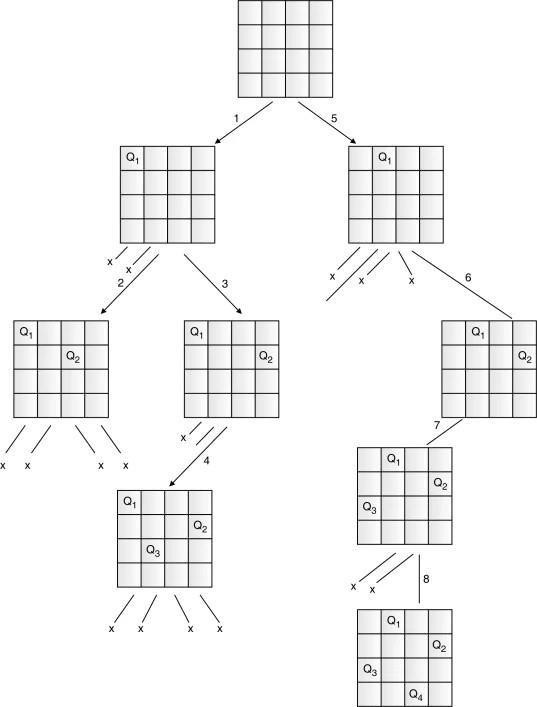


* + Now, Q3 can be placed at position (3, 2). Partial solution is <1, 4, 3>.
  + Queen Q4 cannot be placed anywhere in row four. So again, backtrack to the previous solution and readjust the position of Q3. Q3 cannot be placed on (3, 3) or(3, 4). So the algorithm backtracks even further.
  + All possible choices for Q2 are already explored, hence the algorithm goes back to partial solution

<1> and moves the queen Q1 from (1, 1) to (1, 2). And this process continues until a solution is found.

All possible solutions for 4-queen are shown in fig (a) & fig. (b)

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The solution of the 4-queen problem can be seen as four tuples (x1, x2, x3, x4), where xi represents the column number of queen Qi. Two possible solutions for the 4-queen problem are (2, 4, 1, 3) and (3, 1, 4,

2).

**Code :-**

**# Python3 program to solve N Queen # Problem using backtracking**



**global N N = 4**

**def printSolution(board): for i in range(N):**

**for j in range(N):**

**print(board[i][j], end = " ")**

**print()**

**# A utility function to check if a queen can**

**# be placed on board[row][col]. Note that this # function is called when "col" queens are**

**# already placed in columns from 0 to col -1. # So we need to check only left side for**

**# attacking queens**

**def isSafe(board, row, col):**

**# Check this row on left side for i in range(col):**

**if board[row][i] == 1:**

**return False**

**# Check upper diagonal on left side for i, j in zip(range(row, -1, -1),**

**range(col, -1, -1)):**

**if board[i][j] == 1:**

**return False**

**# Check lower diagonal on left side for i, j in zip(range(row, N, 1),**

**range(col, -1, -1)):**

**if board[i][j] == 1:**

**return False**

**return True**

**def solveNQUtil(board, col):**

**# base case: If all queens are placed # then return true**

**if col >= N:**

**return True**

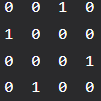
**# Consider this column and try placing # this queen in all rows one by one**

**for i in range(N):**

**if isSafe(board, i, col):**

**# Place this queen in board[i][col]**

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**board[i][col] = 1**

**# recur to place rest of the queens**

**if solveNQUtil(board, col + 1) == True: return True**

**# If placing queen in board[i][col # doesn't lead to a solution, then # queen from board[i][col] board[i][col] = 0**

**# if the queen can not be placed in any row in # this column col then return false**

**return False**

**# This function solves the N Queen problem using # Backtracking. It mainly uses solveNQUtil() to**

**# solve the problem. It returns false if queens # cannot be placed, otherwise return true and # placement of queens in the form of 1s.**

**# note that there may be more than one**

**# solutions, this function prints one of the # feasible solutions.**

**def solveNQ():**

**board = [ [0, 0, 0, 0],**

**[0, 0, 0, 0],**

**[0, 0, 0, 0],**

**[0, 0, 0, 0] ]**

**if solveNQUtil(board, 0) == False: print ("Solution does not exist") return False**

**printSolution(board) return True**

**# Driver Code solveNQ()**

**Output:-**

**Conclusion**- In this way we have explored Concept of Backtracking method and solve n-Queen problem using backtracking method

**Assignment Question**

1. **What is backtracking? Give the general Procedure.**
2. **Give the problem statement of the n-queens problem. Explain the solution**
3. **Write an algorithm for N-queens problem using backtracking?**
4. **Why it is applicable to N=4 and N=8 only?**

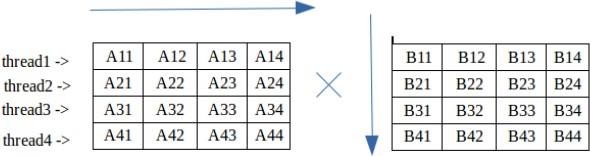
**Reference link**

* <https://www.codesdope.com/blog/article/backtracking-explanation-and-n-queens-problem/> AJEENKYA D Y PATIL SCHOOL OF ENGINEERING, LOHEGAON

**Theory :-**

# Assignment No : 6

**MINI PROJECT 1**



**Multiplication of matrix does take time surely. Time complexity of matrix multiplication is O(n^3) using normal matrix multiplication. And Strassen algorithm improves it and its time complexity is O(n^(2.8074)).**

**But, Is there any way to improve the performance of matrix multiplication using the normal method.**

**Multi-threading can be done to improve it. In multi-threading, instead of utilizing a single core of your processor, we utilizes all or more core to solve the problem.**

**We create different threads, each thread evaluating some part of matrix multiplication.**

**Depending upon the number of cores your processor has, you can create the number of threads required. Although you can create as many threads as you need, a better way is to create each thread for one core.**

**In second approach,we create a separate thread for each element in resultant matrix. Using pthread\_exit() we return computed value from each thread which is collected by pthread\_join(). This approach does not make use of any global variables.**

**Code :-**

// CPP Program to multiply two matrix using pthreads #include <bits/stdc++.h>

using namespace std;

// maximum size of matrix #define MAX 4

// maximum number of threads #define MAX\_THREAD 4

int matA[MAX][MAX]; int matB[MAX][MAX]; int matC[MAX][MAX]; int step\_i = 0;

void\* multi(void\* arg)

{

int i = step\_i++; //i denotes row number of resultant matC

for (int j = 0; j < MAX; j++) for (int k = 0; k < MAX; k++)

matC[i][j] += matA[i][k] \* matB[k][j];

}

// Driver Code int main()

{

// Generating random values in matA and matB for (int i = 0; i < MAX; i++) {

for (int j = 0; j < MAX; j++) { matA[i][j] = rand() % 10;

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matB[i][j] = rand() % 10;

}

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}

// Displaying matA cout << endl

<< "Matrix A" << endl; for (int i = 0; i < MAX; i++) {

for (int j = 0; j < MAX; j++)

cout << matA[i][j] << " "; cout << endl;

}

// Displaying matB cout << endl

<< "Matrix B" << endl; for (int i = 0; i < MAX; i++) {

for (int j = 0; j < MAX; j++)

cout << matB[i][j] << " "; cout << endl;

}

// declaring four threads

pthread\_t threads[MAX\_THREAD];

// Creating four threads, each evaluating its own part for (int i = 0; i < MAX\_THREAD; i++) {

int\* p;

pthread\_create(&threads[i], NULL, multi, (void\*)(p));

}

// joining and waiting for all threads to complete for (int i = 0; i < MAX\_THREAD; i++)

pthread\_join(threads[i], NULL);

// Displaying the result matrix cout << endl

<< "Multiplication of A and B" << endl; for (int i = 0; i < MAX; i++) {

for (int j = 0; j < MAX; j++)

cout << matC[i][j] << " "; cout << endl;

}

return 0;

}

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**Group B**

# Assignment No : 7

**—---------------------------------------------------------------------------------------**

**Title:**Predict the price of the Uber ride from a given pickup point to the agreed drop-off location.

Perform following tasks:

* 1. Pre-process the dataset.
  2. Identify outliers.
  3. Check the correlation.
  4. Implement linear regression and random forest regression models.
  5. Evaluate the models and compare their respective scores like R2, RMSE, etc.

**Dataset Description:**The project is about on world's largest taxi company Uber inc. In this project, we're looking to predict the fare for their future transactional cases. Uber delivers service to lakhs of customers daily. Now it becomes really important to manage their data properly to come up with new business ideas to get best results. Eventually, it becomes really important to estimate the fare prices accurately.

**Link for Dataset:**[https://w](http://www.kaggle.com/datasets/yasserh/uber-fares-dataset)ww[.kaggle.com/datasets/yasserh/uber-fares-data](http://www.kaggle.com/datasets/yasserh/uber-fares-dataset)set **Objective:**

Students should be able to preprocess dataset and identify outliers, to check correlation and

implement linear regression and random forest regression models. Evaluate them with respective scores like R2, RMSE etc.

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**Theory:**

1. **Data Preprocessing:**

Data preprocessing is a process of preparing the raw data and making it suitable for amachine learning model. It is the rst and crucial step while creating a machine learning model.

When creating a machine learning project, it is not always a case that we come across the clean and formatted data. And while doing any operation with data, it is mandatory to clean itand put in a formatted way. So for this, we use data preprocessing task.

It involves below steps:

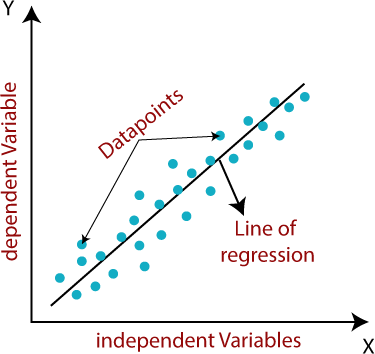
* Getting the dataset
* Importing libraries
* Importing datasets
* Finding Missing Data
* Encoding Categorical Data
* Splitting dataset into training and test set
* Feature scaling

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1. **Linear Regression:**

Linear regression is one of the easiest and most popular Machine Learning algorithms. It is a statistical method that is used for predictive analysis. Linear regression makes predictions for continuous/real or numeric variables such as**sales, salary, age, product price,**etc.

Linear regression algorithm shows a linear relationship between a dependent (y) and one or more independent (y) variables, hence called as linear regression.

The linear regression model provides a sloped straight line representing the relationship between the variables. Consider the below image:

1. **Random Forest Regression Models:**

Random Forest is a popular machine learning algorithm that belongs to the supervisedlearning technique. It can be used for both Classi cation and Regression problems in ML. Itis based on the concept of**ensemble learning,**which is a process of*combining multiple classi ers to solve a complex problem and to improve the performance of the model.*

As the name suggests,***"Random Forest is a classi er that contains a number of decision trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset."***Instead of relying on one decision tree, the random forest takes the

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prediction from each tree and based on the majority votes of predictions, and it predicts the nal output.

1. **Boxplot:**

Boxplots are a measure of how well data is distributed across a data set. This divides thedata set into three quartiles. This graph represents the minimum, maximum, average, rst quartile, and the third quartile in the data set. Boxplot is also useful in comparing thedistribution of data in a data set by drawing a boxplot for each of them.

R provides a boxplot() function to create a boxplot. There is the following syntax of boxplot()function: boxplot(x, data, notch, varwidth, names, main)

Here,

**S.N**

**o**

**Parameter**

**Description**

|  |  |  |
| --- | --- | --- |
| 1. | x | It is a vector or a formula. |
| 2. | data | It is the data frame. |
| 3. | notch | It is a logical value set as true to draw a notch. |
| 4. | varwidth | It is also a logical value set as true to draw the width of the boxsame as the sample size. |
| 5. | names | It is the group of labels that will be printed under each boxplot. |
| 6. | main | It is used to give a title to the graph. |

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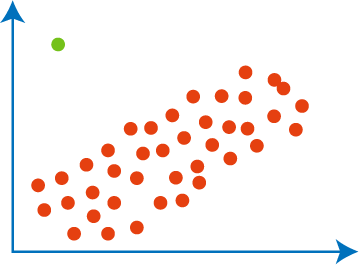
1. **Outliers:**

As the name suggests, "outliers" refer to the data points that exist outside of what is to beexpected. If you are going toanalyze any task to analyze data sets, you will always have some assumptions based onhow this data is generated. If you nd some data points that are likely to contain some form of error, then these are de nitely outliers, and depending on the context, you want toovercome those errors.

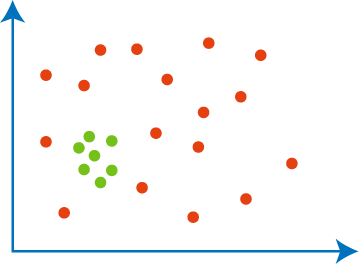
1. **Global Outliers**

Global outliers are also called point outliers. Global outliers are taken as the simplest form of outliers. When data points deviate from all the rest of the data points in a given data set, it is known as the global outlier. In most cases, all the outlier detection procedures are targeted to determine the global outliers. The green data point is the global outlier.

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1. **Collective Outliers**

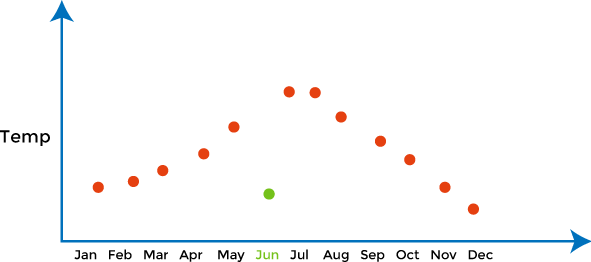
In a given set of data, when a group of data points deviates from the rest of the data set is called collective outliers. Here, the particular set of data objects may not be outliers, but when you consider the data objects as a whole, they may behave as outliers. Therefore, if this happens with the various computer simultaneously, it is considered abnormal behavior, and as a whole, they are called collective outliers. The green data points as a whole represent the collective outlier.



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1. **Contextual Outliers**

As the name suggests, "Contextual" means this outlier introduced within a context. For example, in the speech recognition technique, the single background noise. Contextual outliers are also known as Conditional outliers. These types of outliers happen if a data object deviates from the other data points because of any specific condition in a given data set. Still, it will behave like a normal data point in the context of a summer season. In the given diagram, a green dot representing the low-temperature value in June is a contextual outlier since the same value in December is not an outlier.



.

1. **Matplotlib:**

Matplotlib is an amazing visualization library in Python for 2D plots of arrays. Matplotlib is a multi- platform data visualization library built on NumPy arrays and designed to work with the broader SciPy stack. It was introduced by John Hunter in the year 2002.

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One of the greatest benefits of visualization is that it allows us visual access to huge amounts of data in easily digestible visuals. Matplotlib consists of several plots like line, bar, scatter, histogram etc.

1. **Mean Squared Error;**

The**Mean Squared Error (MSE)**or**Mean Squared Deviation (MSD)**of an estimator measures the average of error squares i.e. the average squared difference between theestimated values and true value. It is a risk function, corresponding to the expected value ofthe squared error loss. TheMSE is the second moment of the error (about the origin) and thus incorporates both thevariance of the estimator and its bias.

Code :-<https://www.kaggle.com/code/proxzima/uber-fare-price-prediction>

**Conclusion:**

In this way we have explored Concept correlation and implement linear regression andrandom forest regression models.

**Assignment Questions:**

1. What is data preprocessing?
2. De ne Outliers?
3. What is Linear Regression?
4. What is Random Forest Algorithm?
5. Explain: pandas, numpy?

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|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Write-up** | **Correctness of Program** | **Documentation of Program** | **Viva** | **Timely Completion** | **Total** | **Dated Sign of Subject Teacher** |
| **4** | **4** | **4** | **4** | **4** | **20** |  |
|  |  |  |  |  |  |

Expected Date of Completion:...................... Actual Date of Completion:

**—--------------------------------------------------------------------------------------**

**Group B**

# Assignment No : 8

**—---------------------------------------------------------------------------------------**

**Title:**Classify the email using the binary classification method. Email Spam detection has two states:

1. Normal State – Not Spam,
2. Abnormal State – Spam.

Use K-Nearest Neighbors and Support Vector Machine for classification. Analyze their performance.

**Dataset Description:**The csv file contains 5172 rows, each row for each email. There are 3002 columns. The first column indicates Email name. The name has been set with numbers and not recipients' name to protect privacy. The last column has the labels for prediction : 1for spam, 0 for not spam. The remaining 3000 columns are the 3000 most common words inall the emails, after excluding the non-alphabetical characters/words. For each row, thecount of each word(column) in that email(row) is stored in the respective cells. Thus,information regarding all 5172 emails are stored in a compact dataframe rather than asseparate text files.

**Link:**[https://w](http://www.kaggle.com/datasets/balaka18/email-spam-classification-dataset-csv)ww[.kaggle.com/datasets/balaka18/email-spam-classification-dataset-](http://www.kaggle.com/datasets/balaka18/email-spam-classification-dataset-csv)csv **Objective:**

Students should be able to classify email using the binary Classification and implement email spam detection technique by using K-Nearest Neighbors and Support Vector Machine algorithm.

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**Theory:**

1. Data Preprocessing
2. Binary Classification
3. K-Nearest Neighbours
4. Support Vector Machine
5. Train, Test and Split Procedure

**Data Preprocessing:**

Data preprocessing is a process of preparing the raw data and making it suitable for amachine learning model. It is the rst and crucial step while creating a machine learning model.

When creating a machine learning project, it is not always a case that we come across the clean and formatted data. And while doing any operation with data, it is mandatory to clean itand put in a formatted way. So for this, we use data preprocessing task.

Why do we need Data Preprocessing?

A real-world data generally contains noises, missing values, and maybe in an unusable format which cannot be directly used for machine learning models. Data preprocessing is required tasks for cleaning thedata and making it suitable for a machine learning model which also increases the accuracy and e ciency of a machine learning model.

It involves below steps:

* Getting the dataset
* Importing libraries
* Importing datasets
* Finding Missing Data
* Encoding Categorical Data
* Splitting dataset into training and test set
* Feature scaling

Code :- <https://www.kaggle.com/code/mfaisalqureshi/email-spam-detection-98-accuracy/notebook>

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**Group B**

# Assignment No : 9

**—---------------------------------------------------------------------------------------**

**Title:**Given a bank customer, build a neural network-based classifier that can determine whether they will leave or not in the next 6 months

**Dataset Description:**The case study is from an open-source dataset from Kaggle. The dataset contains 10,000 sample points with 14 distinct features such as CustomerId, CreditScore, Geography, Gender, Age, Tenure, Balance, etc.

**Link for Dataset:**h[ttps://w](http://www.kaggle.com/barelydedicated/bank-customer-churn-modeling)ww[.kaggle.com/barelydedicated/bank-customer-churn-mod](http://www.kaggle.com/barelydedicated/bank-customer-churn-modeling)eling **Perform the following steps:**

1. Read the dataset.
2. Distinguish the feature and target set and divide the data set into training and test sets.
3. Normalize the train and test data.
4. Initialize and build the model. Identify the points of improvement and implement the same.
5. Print the accuracy score and confusion matrix (5 points).

**Objective:**

Students should be able to distinguish the feature and target set and divide the data set into training and test sets and normalize them and students should build the model on the basis of that.

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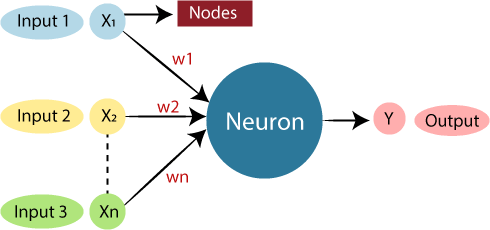
**Theory:**

1. **Artificial Neural Network:**

The term "Arti cial Neural Network" is derived from Biological neural networks that develop the structure of a human brain. Similar to the human brain that has neurons interconnected to one another, arti cial neural networks also have neurons that are interconnected to one another in various layers of thenetworks. These neurons are known as nodes.

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The typical Artificial Neural Network looks something like the given figure.



Dendrites from Biological Neural Network represent inputs in Arti cial Neural Networks, cellnucleus represents Nodes, synapse represents Weights, and Axon represents Output.

An**Arti cial Neural Network**in the eld of**Arti cial intelligence**where it attempts to mimic the network of neurons makes up a human brain so that computers will have an option tounderstand things and make decisions in a human-like manner. The arti cial neural networkis designed by programming computers to behave simply like interconnected brain cells.

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There are around 1000 billion neurons in the human brain. Each neuron has an association point somewhere in the range of 1,000 and 100,000.

We can understand the arti cial neural network with an example, consider an example of adigital logic gate that takes an input and gives an output. "OR" gate, which takes two inputs. If both the inputs are "Off," thenwe get "Off" in output. Here the output depends upon input. Our brain does not perform the same task. The outputs to inputs relationship keep changing because of the neurons in our brain, which are "learning."

1. **Keras:**

Keras is an open-source high-level Neural Network library, which is written in Python is capable enough to run on Theano, TensorFlow, or CNTK. It was developed by one of the Google engineers, Francois Chollet. It is made user-friendly, extensible, and modular for facilitating faster experimentation with deep neural networks. It not only supports Convolutional Networks and Recurrent Networks individually but also their combination.

It cannot handle low-level computations, so it makes use of the**Backend**library to resolve it.The backend library act as a high-level API wrapper for the low-level API, which lets it run onTensorFlow, CNTK, or Theano.

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**3) Tensor flow:**

TensorFlow is a Google product, which is one of the most famous deep learning tools widelyused in the research area of machine learning and deep neural network. It came into the market on 9th November 2015 under the Apache License 2.0. It is built in such a way that it can easily run on multiple CPUs and GPUs as well as on mobile operating systems. It consists of various wrappers in distinct languages such asJava, C++, or Python.

1. **Normalization:**

Normalization is a scaling technique in Machine Learning applied during data preparation tochange the values of numeric columns in the dataset to use a common scale. It is not necessary for all datasets in a model. It is required only when features of machine learning models have different ranges.

Mathematically, we can calculate normalization with the below formula:Xn = (X - Xminimum) / ( Xmaximum - Xminimum)

Where,

* Xn = Value of Normalization
* Xmaximum = Maximum value of a feature
* Xminimum = Minimum value of a feature

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* Normalization techniques in Machine Learning

Although there are so many feature normalization techniques in Machine Learning, few of them are most frequently used. These are as follows:

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* **Min-Max Scaling:**This technique is also referred to as scaling. As we have already discussed above, the Min-Max scaling method helps the dataset to shift and rescalethe values of their attributes, so they end up ranging between 0 and 1.
* **Standardization scaling:**

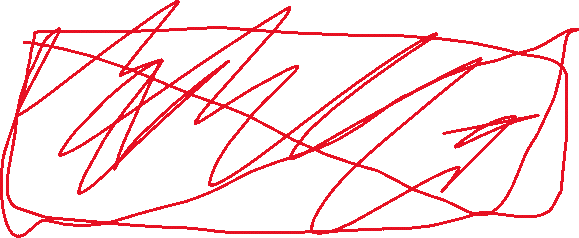
Standardization scaling is also known as**Z-score**normalization, in which values are centered around the mean with a unit standard deviation, which means the attributebecomes zero and the resultant distribution has a unit standard deviation.

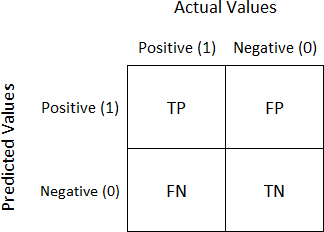
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1. **Confusion Matrix:**

The confusion matrix is a matrix used to determine the performance of the classi cation models for a given set of test data. The matrix itselfcan be easily understood, but the related terminologies may beconfusing. Since it shows the errors in the model performance in the form of a matrix, hence also known as an**error matrix**. Some features of Confusion matrix are given below:

* For the 2 prediction classes of classi ers, the matrix is of 2\*2 table, for 3 classes, it is3\*3 table, and so on.
* The matrix is divided into two dimensions, that are**predicted values**and**actual values**along with the total number of predictions.



* Predicted values are those values, which are predicted by the model, and actualvalues are the true values for the given observations.
* It

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The above table has the following cases:

* **True Negative:**Model has given prediction No, and the real or actual value was alsoNo.
* **True Positive:**The model has predicted yes, and the actual value was also true.
* **False Negative:**The model has predicted no, but the actual value was Yes, it is alsocalled as**Type-II error**.
* **False Positive:**The model has predicted Yes, but the actual value was No. It is alsocalled a**Type-I error.**
* Need for Confusion Matrix in Machine learning
* It evaluates the performance of the classi cation models, when they makepredictions on test data, and tells how good our classi cation model is.
* It not only tells the error made by the classi ers but also the type of errors such as itis either type- I or type-II error.
* With the help of the confusion matrix, we can calculate the different parameters forthe model, such as accuracy, precision, etc.
* Calculations using Confusion Matrix:

We can perform various calculations for the model, such as the model's accuracy, using thismatrix. These calculations are given below:

* **Classi cation Accuracy:**It is one of the important parameters to determine the accuracy of the classification problemsto all number of
* **Misclassi cation rate:**It is also termed as Error rate, and it de nes how often the model gives the wrong predictions. The value of error rate can be calculated as thenumber of incorrect



predictions to all number of the predictions made by the classi er. The formula is given

below:

* **Precision:**It can be de ned as the number of correct outputs provided by the model

or out of all positive classes that have predicted correctly by the model, how many ofthem were actually true. It can be calculated using the below formula:

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* **Recall:**It is de ned as the out of total positive classes, how our model predictedcorrectly. The recall must be as high as possible.

Code :- [https://www.kaggle.com/code/jaysadguru00/starter-bank-customer-churn-modeling-](https://www.kaggle.com/code/jaysadguru00/starter-bank-customer-churn-modeling-6dbfe05e-a) [6dbfe05e-a](https://www.kaggle.com/code/jaysadguru00/starter-bank-customer-churn-modeling-6dbfe05e-a)

**Conclusion:**

In this way we build a a neural network-based classi the next 6 months

that can determine whether they willleave or not in

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**Assignment Questions:**

* 1. What is Normalization?
  2. What is Standardization?
  3. Explain Confusion Matrix ?
  4. De ne the following: Classi cation Accuracy, Misclassi cation Rate, Precision.
  5. One Example of Confusion Matrix?

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Group B

# Assignment No : 10

**—---------------------------------------------------------------------------------------**

**Title of the Assignment:** Implement K-Nearest Neighbors algorithm on diabetes.csv dataset. Compute confusion matrix, accuracy, error rate, precision and recall on the given dataset.

**Dataset Description:** We will try to build a machine learning model to accurately predict whether or not the patients in the dataset have diabetes or not?

The datasets consists of several medical predictor variables and one target variable, Outcome. Predictor variables includes the number of pregnancies the patient has had, their BMI, insulin level, age, and so on.

**Link for Dataset:** [Diabetes predication system with KNN algorithm | Kaggle](https://www.kaggle.com/datasets/abdallamahgoub/diabetes)

**Objective of the Assignment:**

Students should be able to preprocess dataset and identify outliers, to check correlation and implement KNN algorithm and random forest classification models. Evaluate them with respective scores like confusion\_matrix, accuracy\_score, mean\_squared\_error, r2\_score, roc\_auc\_score, roc\_curve etc.

**THEORY**

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k-Nearest-Neighbors (k-NN) is a supervised machine learning model. Supervised learning is when a model learns from data that is already labeled. A supervised learning model takes in a set of input objects and output values. The model then trains on that data to learn how to map the inputs to the desired output so it can learn to make predictions on unseen data.

k-NN models work by taking a data point and looking at the ‘k’ closest labeled data points. The data point is then assigned the label of the majority of the ‘k’ closest points.

For example, if k = 5, and 3 of points are ‘green’ and 2 are ‘red’, then the data point in question would be labeled ‘green’, since ‘green’ is the majority (as shown in the above graph).

Scikit-learn is a machine learning library for Python. In this tutorial, we will build a k-NN model using Scikit- learn to predict whether or not a patient has diabetes.

Reading in the training data

For our k-NN model, the first step is to read in the data we will use as input. For this example, we are using the diabetes dataset. To start, we will use Pandas to read in the data. I will not go into detail on Pandas, but it is a library you should become familiar with if you’re looking to dive further into data science and machine learning.

Next, let’s see how much data we have. We will call the ‘shape’ function on our dataframe to see how many rows and columns there are in our data. The rows indicate the number of patients and the columns indicate the number of features (age, weight, etc.) in the dataset for each patient. 1

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We can see that we have 768 rows of data (potential diabetes patients) and 9 columns (8 input features and 1 target output).

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Split up the dataset into inputs and targets

Now let’s split up our dataset into inputs (X) and our target (y). Our input will be every column except ‘diabetes’ because ‘diabetes’ is what we will be attempting to predict. Therefore, ‘diabetes’ will be our target.

We will use pandas ‘drop’ function to drop the column ‘diabetes’ from our dataframe and store it in the variable ‘X’. This will be our input.

We will insert the ‘diabetes’ column of our dataset into our target variable (y).

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Split the dataset into train and test data

Now we will split the dataset into into training data and testing data. The training data is the data that the model will learn from. The testing data is the data we will use to see how well the model performs on unseen data.

Scikit-learn has a function we can use called ‘train\_test\_split’ that makes it easy for us to split our dataset into training and testing data.

‘train\_test\_split’ takes in 5 parameters. The first two parameters are the input and target data we split up earlier. Next, we will set ‘test\_size’ to 0.2. This means that 20% of all the data will be used for testing, which leaves 80% of the data as training data for the model to learn from. Setting ‘random\_state’ to 1 ensures that we get the same split each time so we can reproduce our results.

Setting ‘stratify’ to y makes our training split represent the proportion of each value in the y variable. For example, in our dataset, if 25% of patients have diabetes and 75% don’t have diabetes, setting ‘stratify’ to y will ensure that the random split has 25% of patients with diabetes and 75% of patients without diabetes.

Building and training the model

Next, we have to build the model. Here is the code:

First, we will create a new k-NN classifier and set ‘n\_neighbors’ to 3. To recap, this means that if at least 2 out of the 3 nearest points to an new data point are patients without diabetes, then the new data point will be labeled as ‘no diabetes’, and vice versa. In other words, a new data point is labeled with by majority from the 3 nearest points.

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We have set ‘n\_neighbors’ to 3 as a starting point. We will go into more detail below on how to better select a value for ‘n\_neighbors’ so that the model can improve its performance.

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Next, we need to train the model. In order to train our new model, we will use the ‘fit’ function and pass in our training data as parameters to fit our model to the training data.

Testing the model

Once the model is trained, we can use the ‘predict’ function on our model to make predictions on our test data. As seen when inspecting ‘y’ earlier, 0 indicates that the patient does not have diabetes and 1 indicates that the patient does have diabetes. To save space, we will only show print the first 5 predictions of our test set.

We can see that the model predicted ‘no diabetes’ for the first 4 patients in the test set and ‘has diabetes’ for the 5th patient.

Now let’s see how our accurate our model is on the full test set. To do this, we will use the ‘score’ function and pass in our test input and target data to see how well our model predictions match up to the actual results.

Our model has an accuracy of approximately 66.88%. It’s a good start, but we will see how we can increase model performance below.

Congrats! You have now built an amazing k-NN model!

k-Fold Cross-Validation

Cross-validation is when the dataset is randomly split up into ‘k’ groups. One of the groups is used as the test set and the rest are used as the training set. The model is trained on the training set and scored on the test set. Then the process is repeated until each unique group as been used as the test set.

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For example, for 5-fold cross validation, the dataset would be split into 5 groups, and the model would be trained and tested 5 separate times so each group would get a chance to be the test set. This can be seen in the graph below.

1. fold cross validation ([image credit](https://www.datacamp.com/))

The train-test-split method we used in earlier is called ‘holdout’. Cross-validation is better than using the holdout method because the holdout method score is dependent on how the data is split into train and test sets. Cross-validation gives the model an opportunity to test on multiple splits so we can get a better idea on how the model will perform on unseen data.

In order to train and test our model using cross-validation, we will use the ‘cross\_val\_score’ function with a cross-validation value of 5. ‘cross\_val\_score’ takes in our k-NN model and our data as parameters. Then it splits our data into 5 groups and fits and scores our data 5 seperate times, recording the accuracy score in an array each time. We will save the accuracy scores in the ‘cv\_scores’ variable.

To find the average of the 5 scores, we will use numpy’s mean function, passing in ‘cv\_score’. Numpy is a useful math library in Python.

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Using cross-validation, our mean score is about 71.36%. This is a more accurate representation of how our model will perform on unseen data than our earlier testing using the holdout method.

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Hypertuning model parameters using GridSearchCV

When built our initial k-NN model, we set the parameter ‘n\_neighbors’ to 3 as a starting point with no real logic behind that choice.

Hypertuning parameters is when you go through a process to find the optimal parameters for your model to improve accuracy. In our case, we will use GridSearchCV to find the optimal value for ‘n\_neighbors’.

GridSearchCV works by training our model multiple times on a range of parameters that we specify. That way, we can test our model with each parameter and figure out the optimal values to get the best accuracy results.

For our model, we will specify a range of values for ‘n\_neighbors’ in order to see which value works best for our model. To do this, we will create a dictionary, setting ‘n\_neighbors’ as the key and using numpy to create an array of values from 1 to 24.

Our new model using grid search will take in a new k-NN classifier, our param\_grid and a cross- validation value of 5 in order to find the optimal value for ‘n\_neighbors’.

After training, we can check which of our values for ‘n\_neighbors’ that we tested performed the best. To do this, we will call ‘best\_params\_’ on our model.

We can see that 14 is the optimal value for ‘n\_neighbors’. We can use the ‘best\_score\_’ function to check the accuracy of our model when ‘n\_neighbors’ is 14. ‘best\_score\_’ outputs the mean accuracy of the scores obtained through cross-validation.

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By using grid search to find the optimal parameter for our model, we have improved our model accuracy by over 4%!

Code :- <https://www.kaggle.com/code/shrutimechlearn/step-by-step-diabetes-classification-knn-detailed>

**Conclusion:**

In this way we build a a neural network-based classifier that can determine whether they willleave or not in the next 6 months

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Group B

# Assignment No : 11

**—---------------------------------------------------------------------------------------**

**Title of the Assignment:** Implement K-Means clustering/ hierarchical clustering on sales\_data\_sample.csv dataset. Determine the number of clusters using the elbow method.

**Dataset Description:** The data includes the following features:

1. Customer ID
2. Customer Gender
3. Customer Age
4. Annual Income of the customer (in Thousand Dollars)
5. Spending score of the customer (based on customer behavior and spending nature)

**Objective of the Assignment:**

Students should able to understand how to use unsupervised learning to segment different-different clusters or groups and used to them to train your model to predict future things.

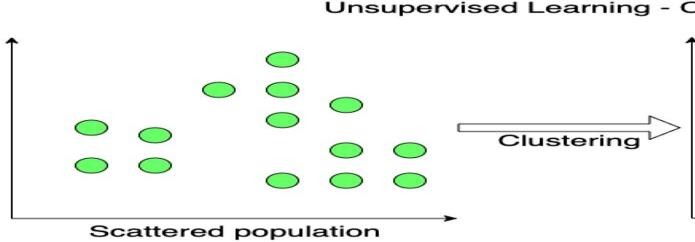
**THEORY:**

Clustering algorithms try to find natural clusters in data, the various aspects of how the algorithms to cluster data can be tuned and modified. Clustering is based on the principle that items within the same cluster must be similar to each other. The data is grouped in such a way that related elements are close to each other.

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Diverse and different types of data are subdivided into smaller groups.



Uses of Clustering

Marketing:

In the field of marketing, clustering can be used to identify various customer groups with existing customer data. Based on that, customers can be provided with discounts, offers, promo codes etc.

Real Estate:

Clustering can be used to understand and divide various property locations based on value and importance. Clustering algorithms can process through the data and identify various groups of property on the basis of probable price.

BookStore and Library management:

Libraries and Bookstores can use Clustering to better manage the book database. With proper book ordering, better operations can be implemented.

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Document Analysis:

Often, we need to group together various research texts and documents according to similarity. And in such cases, we don’t have any labels. Manually labelling large amounts of data is also not possible. Using clustering, the algorithm can process the text and group it into different themes.

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These are some of the interesting use cases of clustering.

**K-Means Clustering**

K-Means clustering is an unsupervised machine learning algorithm that divides the given data into the given number of clusters. Here, the “K” is the given number of predefined clusters, that need to be created.

It is a centroid based algorithm in which each cluster is associated with a centroid. The main idea is to reduce the distance between the data points and their respective cluster centroid.

The algorithm takes raw unlabelled data as an input and divides the dataset into clusters and the process is repeated until the best clusters are found.

K-Means is very easy and simple to implement. It is highly scalable, can be applied to both small and large datasets. There is, however, a problem with choosing the number of clusters or K. Also, with the increase in dimensions, stability decreases. But, overall K Means is a simple and robust algorithm that makes clustering very easy.

#Importing the necessary libraries import numpy as np

import pandas as pd

import matplotlib.pyplot as plt import seaborn as sns

from mpl\_toolkits.mplot3d import Axes3D

%matplotlib inline

The necessary libraries are imported.

#Reading the excel file data=pd.read\_excel("Mall\_Customers.xlsx")

The data is read. I will share a link to the entire code and excel data at the end of the article.

The data has 200 entries, that is data from 200 customers.

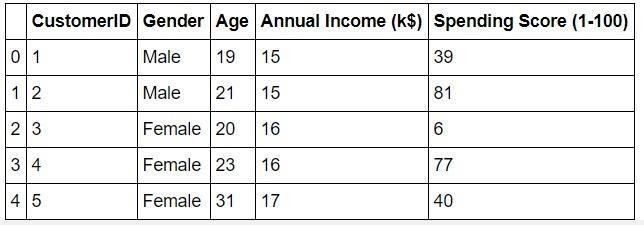
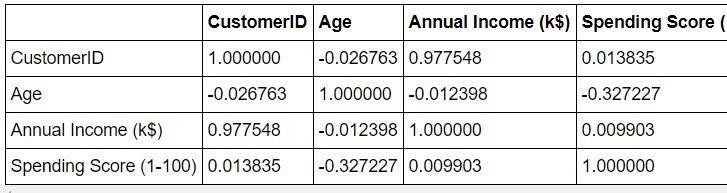
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data.head()

So let us have a look at the data.

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data.corr()

The data seems to be interesting. Let us look at the data distribution.

**Annual Income Distribution:**

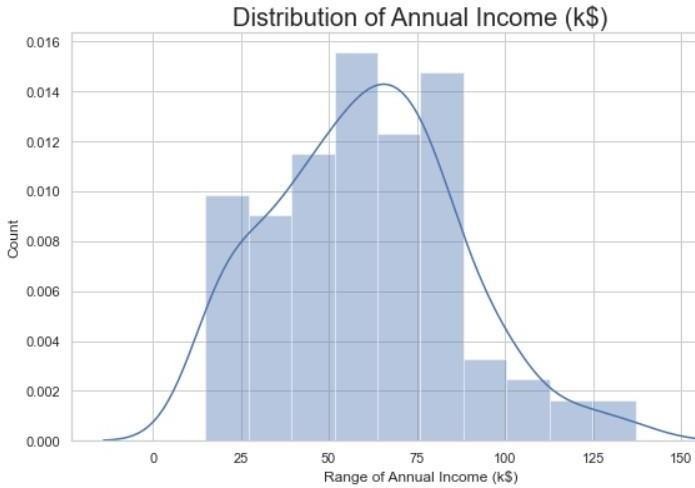
#Distribution of Annnual Income plt.figure(figsize=(10, 6)) sns.set(style = 'whitegrid') sns.distplot(data['Annual Income (k$)'])

plt.title('Distribution of Annual Income (k$)', fontsize = 20) plt.xlabel('Range of Annual Income (k$)')

plt.ylabel('Count')

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Most of the annual income falls between 50K to 85K.

Age Distribution:

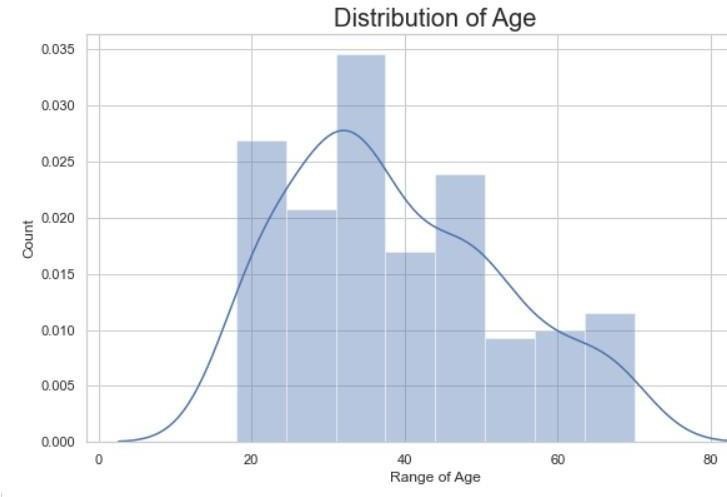
#Distribution of age plt.figure(figsize=(10, 6)) sns.set(style = 'whitegrid') sns.distplot(data['Age'])

plt.title('Distribution of Age', fontsize = 20) plt.xlabel('Range of Age')

plt.ylabel('Count')

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There are customers of a wide variety of ages.

Spending Score Distribution:

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#Distribution of spending score plt.figure(figsize=(10, 6)) sns.set(style = 'whitegrid')

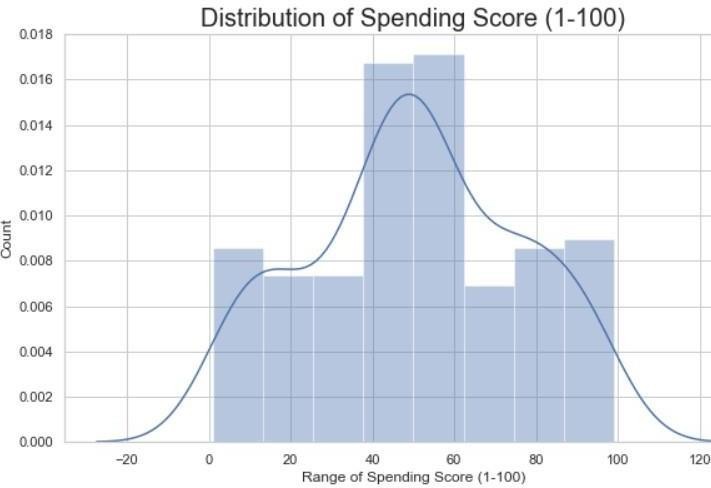
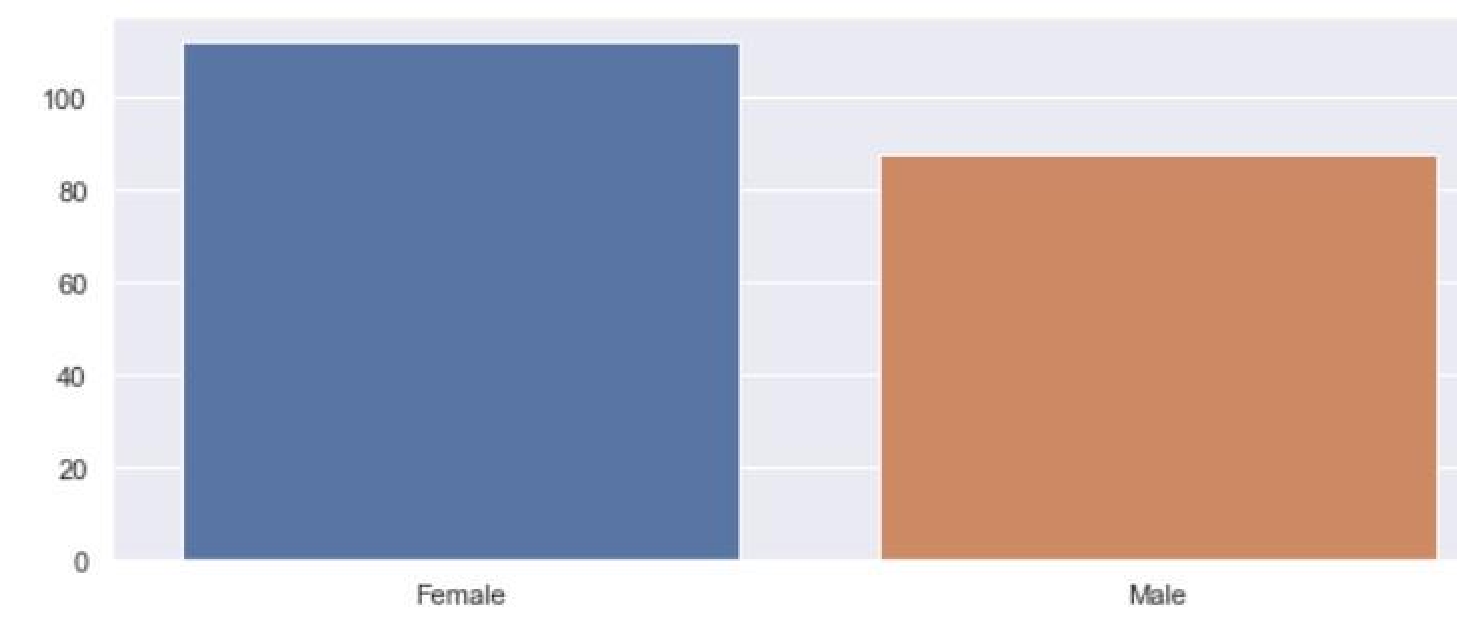
sns.distplot(data['Spending Score (1-100)']) plt.title('Distribution of Spending Score (1-100)', fontsize = 20) plt.xlabel('Range of Spending Score (1-100)')

plt.ylabel('Count')

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The maximum spending score is in the range of 40 to 60.

**Gender Analysis:**

genders = data.Gender.value\_counts() sns.set\_style("darkgrid") plt.figure(figsize=(10,4)) sns.barplot(x=genders.index, y=genders.values) plt.show()

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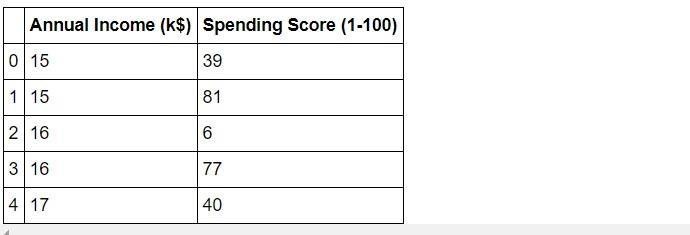
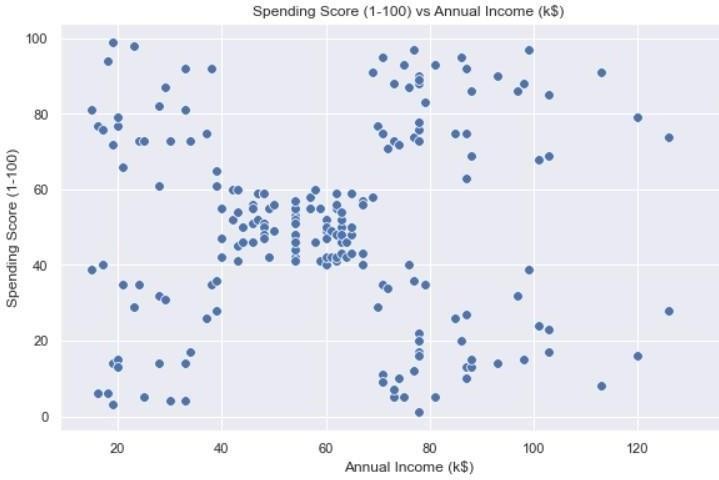
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More female customers than male.

I have made more visualizations. Do have a look at the GitHub link at the end to understand the data analysis and overall data exploration.

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**Clustering based on 2 features**



First, we work with two features only, annual income and spending score.

#We take just the Annual Income and Spending score df1=data[["CustomerID","Gender","Age","Annual Income (k$)","Spending Score (1-100)"]] X=df1[["Annual Income (k$)","Spending Score (1-100)"]]

#The input data X.head()

#Scatterplot of the input data plt.figure(figsize=(10,6))

sns.scatterplot(x = 'Annual Income (k$)',y = 'Spending Score (1-100)', data = X ,s = 60

)

plt.xlabel('Annual Income (k$)') plt.ylabel('Spending Score (1-100)')

plt.title('Spending Score (1-100) vs Annual Income (k$)') plt.show()

The data does seem to hold some patterns.

#Importing KMeans from sklearn from sklearn.cluster import KMeans

Now we calculate the Within Cluster Sum of Squared Errors (WSS) for different values of k. Next, we choose the k for which WSS first starts to diminish. This value of K gives us the best number of clusters to make from the raw data.

wcss=[]

for i in range(1,11): km=KMeans(n\_clusters=i) km.fit(X) wcss.append(km.inertia\_)

#The elbow curve plt.figure(figsize=(12,6)) plt.plot(range(1,11),wcss)

plt.plot(range(1,11),wcss, linewidth=2, color="red", marker ="8") plt.xlabel("K Value")

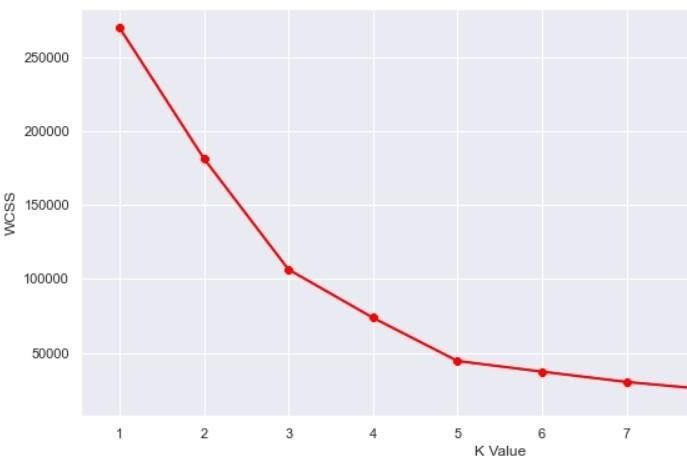
plt.xticks(np.arange(1,11,1))

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plt.ylabel("WCSS") plt.show()

The plot:



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This is known as the elbow graph, the x-axis being the number of clusters, the number of clusters is taken at the elbow joint point. This point is the point where making clusters is most relevant as here the value of WCSS suddenly stops decreasing. Here in the graph, after 5 the drop is minimal, so we take 5 to be the number of clusters.

#Taking 5 clusters km1=KMeans(n\_clusters=5) #Fitting the input data km1.fit(X)

#predicting the labels of the input data y=km1.predict(X)

#adding the labels to a column named label df1["label"] = y

#The new dataframe with the clustering done df1.head()

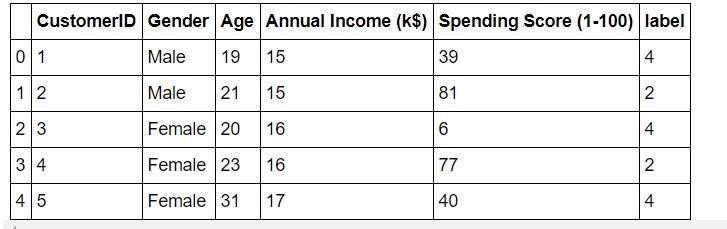
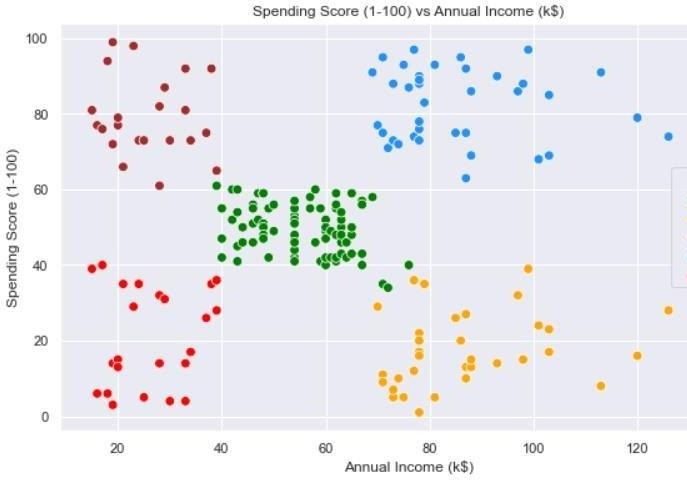
The labels added to the data.

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#Scatterplot of the clusters plt.figure(figsize=(10,6))

sns.scatterplot(x = 'Annual Income (k$)',y = 'Spending Score (1-100)',hue="label",

palette=['green','orange','brown','dodgerblue','red'], legend='full',data = df1 ,s = 60 )

plt.xlabel('Annual Income (k$)') plt.ylabel('Spending Score (1-100)')

plt.title('Spending Score (1-100) vs Annual Income (k$)') plt.show()

We can clearly see that 5 different clusters have been formed from the data.1 The red cluster is the customers with the least income and least spending score,

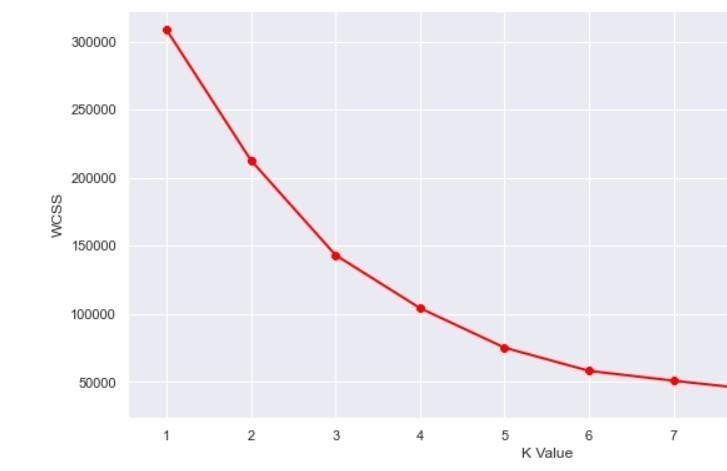
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similarly, the blue cluster is the customers with the most income and most spending score.

**k-Means Clustering on the basis of 3D data**

Now, we shall be working on 3 types of data. Apart from the spending score and

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annual income of customers, we shall also take in the age of the customers.

#Taking the features

X2=df2[["Age","Annual Income (k$)","Spending Score (1-100)"]]

#Now we calculate the Within Cluster Sum of Squared Errors (WSS) for different values of k.

wcss = []

for k in range(1,11):

kmeans = KMeans(n\_clusters=k, init="k-means++") kmeans.fit(X2)

wcss.append(kmeans.inertia\_) plt.figure(figsize=(12,6))

plt.plot(range(1,11),wcss, linewidth=2, color="red", marker ="8") plt.xlabel("K Value")

plt.xticks(np.arange(1,11,1)) plt.ylabel("WCSS") plt.show()

The WCSS curve.

Here can assume that K=5 will be a good value.

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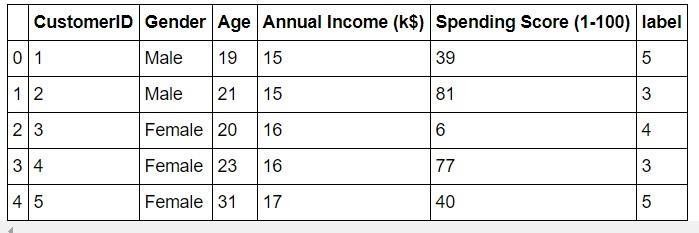
1

#We choose the k for which WSS starts to diminish km2 = KMeans(n\_clusters=5)

y2 = km.fit\_predict(X2) df2["label"] = y2

#The data with labels df2.head()

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The data:

Now we plot it.

#3D Plot as we did the clustering on the basis of 3 input features fig = plt.figure(figsize=(20,10))

ax = fig.add\_subplot(111, projection='3d')

ax.scatter(df2.Age[df2.label == 0], df2["Annual Income (k$)"][df2.label == 0], df2["Spending Score (1-100)"][df2.label == 0], c='purple', s=60)

ax.scatter(df2.Age[df2.label == 1], df2["Annual Income (k$)"][df2.label == 1], df2["Spending Score (1-100)"][df2.label == 1], c='red', s=60)

ax.scatter(df2.Age[df2.label == 2], df2["Annual Income (k$)"][df2.label == 2], df2["Spending Score (1-100)"][df2.label == 2], c='blue', s=60)

ax.scatter(df2.Age[df2.label == 3], df2["Annual Income (k$)"][df2.label == 3], df2["Spending Score (1-100)"][df2.label == 3], c='green', s=60)

ax.scatter(df2.Age[df2.label == 4], df2["Annual Income (k$)"][df2.label == 4], df2["Spending Score (1-100)"][df2.label == 4], c='yellow', s=60)

ax.view\_init(35, 185) plt.xlabel("Age") plt.ylabel("Annual Income (k$)")

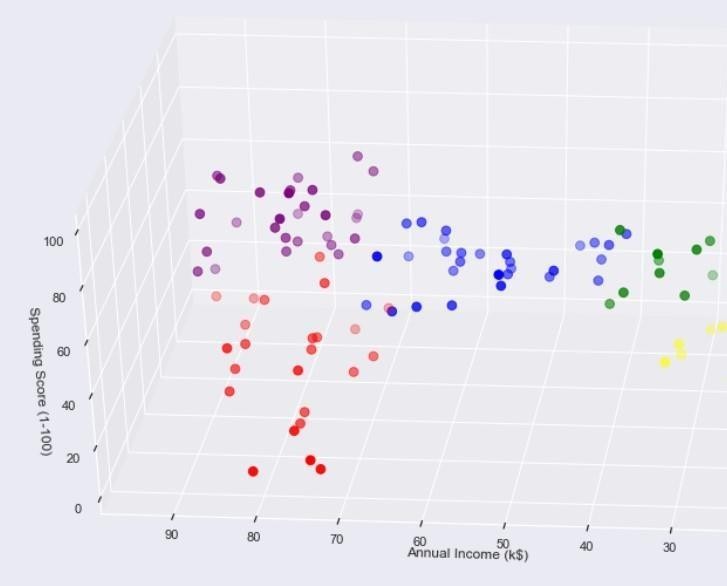
ax.set\_zlabel('Spending Score (1-100)') plt.show()

The output:

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What we get is a 3D plot. Now, if we want to know the customer IDs, we can do that too.



cust1=df2[df2["label"]==1]

print('Number of customer in 1st group=', len(cust1)) print('They are -', cust1["CustomerID"].values) print(" ") cust2=df2[df2["label"]==2]

print('Number of customer in 2nd group=', len(cust2)) print('They are -', cust2["CustomerID"].values) print(" ") cust3=df2[df2["label"]==0]

print('Number of customer in 3rd group=', len(cust3)) print('They are -', cust3["CustomerID"].values) print(" ") cust4=df2[df2["label"]==3]

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print('Number of customer in 4th group=', len(cust4))

print('They are -', cust4["CustomerID"].values) print(" ") cust5=df2[df2["label"]==4]

print('Number of customer in 5th group=', len(cust5)) print('They are -', cust5["CustomerID"].values)

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|  |  |  |  |
| --- | --- | --- | --- |
| print(" ")  The output we get: |  |  |  |
| Number of customer in 1st group= 24  They are - [129 131 135 137 139 141 145 147 149 151 153 155 157 159 161 | 163 | 165 | 167 |
| 169 171 173 175 177 179] |  |  |  |
| ——————————————– |  |  |  |
| Number of the customer in 2nd group= 29  They are - [ 47 51 55 56 57 60 67 72 77 78 80 82 84 86 90 93 94 97  99 102 105 108 113 118 119 120 122 123 127] |  |  |  |
| ——————————————– |  |  |  |
| Number of the customer in 3rd group= 28 |  |  |  |
| They are - [124 126 128 130 132 134 136 138 140 142 144 146 148 150 152 | 154 | 156 | 158 |
| 160 162 164 166 168 170 172 174 176 178] |  |  |  |
| ——————————————– |  |  |  |
| Number of the customer in 4th group= 22  They are - [ 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 | 46] |  |  |
| Number of customer in 5th group= 12  They are - [ 3 7 9 11 13 15 23 25 31 33 35 37] |  |  |  |

——————————————–

So, we used K-Means clustering to understand customer data. K-Means is a good clustering algorithm. Almost all the clusters have similar density. It is also fast and efficient in terms of computational cost.

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# Assignment No : 12

**MINI PROJECT 2**

**Problem Statement: -** Build a machine learning model that predicts the type of people who survived the Titanic shipwreck using passenger data (i.e. name, age, gender, socio-economic class, etc.).

#### Importing the Libraries

*# linear algebra*

**import numpy as np**

*# data processing*

**import pandas as pd**

*# data visualization*

**import seaborn as sns**

%matplotlib inline

**from matplotlib import** pyplot **as** plt

**from matplotlib import** style

*# Algorithms*

**from sklearn import** linear\_model

**from sklearn.linear\_model import** LogisticRegression **from sklearn.ensemble import** RandomForestClassifier **from sklearn.linear\_model import** Perceptron

**from sklearn.linear\_model import** SGDClassifier **from sklearn.tree import** DecisionTreeClassifier **from sklearn.neighbors import** KNeighborsClassifier **from sklearn.svm import** SVC, LinearSVC

**from sklearn.naive\_bayes import** GaussianNB

**Getting the Data**

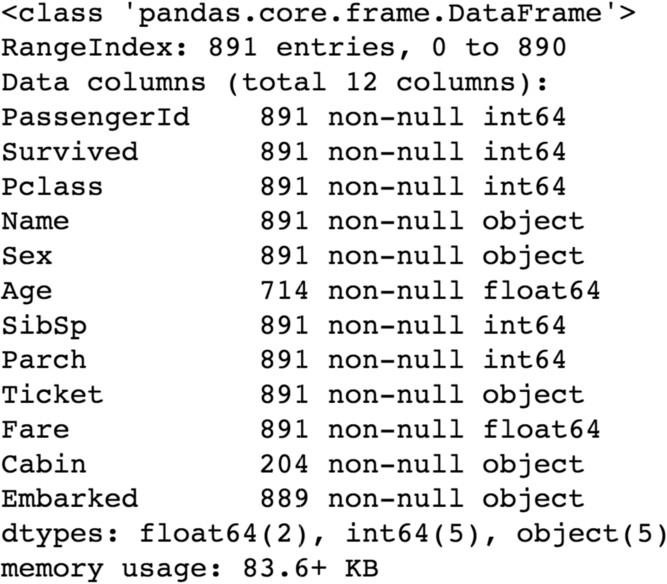
test\_df = pd.read\_csv("test.csv") train\_df = pd.read\_csv("train.csv")

#### Data Exploration/Analysis

train\_df.info()

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**The training-set has 891 examples and 11 features + the target variable (survived)**. 2 of the features are floats, 5 are integers and 5 are objects. Below I have listed the features with a short description:

survival:

Survival

PassengerId: Unique Id of a passenger. pclass: Ticket class

sex: Sex

Age: Age in years

sibsp: # of siblings / spouses aboard the Titanic parch: # of parents / children aboard the Titanic ticket: Ticket number

fare: Passenger fare cabin:

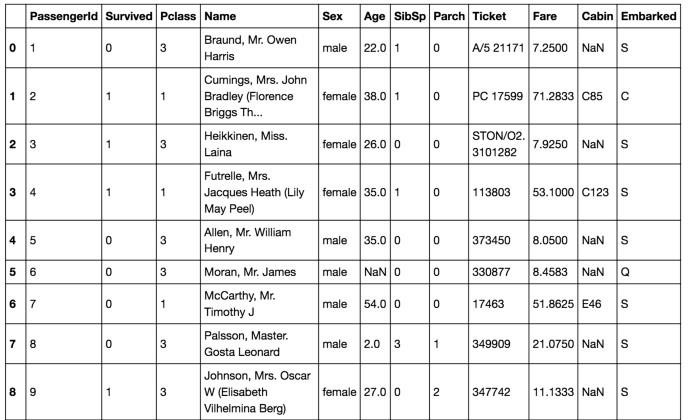
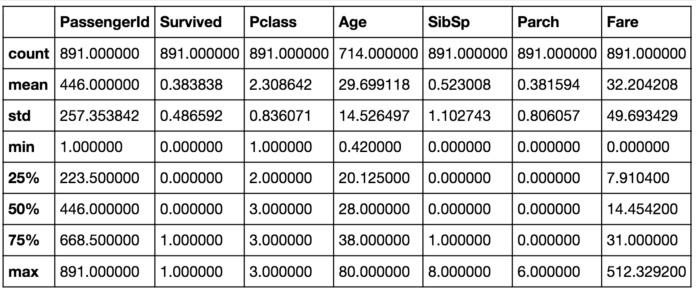
embarked:

Cabin number

Port of Embarkationtrain\_df.describe()

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Above we can see that **38% out of the training-set survived the Titanic**. We can also see that the passenger ages range from 0.4 to 80. On top of that we can already detect some features, that contain missing

values, like the ‘Age’ feature.

train\_df.head(8)

From the table above, we can note a few things. First of all, that we **need to convert a lot of features into numeric** ones later on, so that the machine learning algorithms can process them. Furthermore, we can see that the **features have widely different ranges**, that we will need to convert into roughly the same scale. We can also spot some more features, that contain missing values (NaN = not a number), that wee need to deal with.

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**Let’s take a more detailed look at what data is actually missing:**

total = train\_df.isnull().sum().sort\_values(ascending=**False**) percent\_1 = train\_df.isnull().sum()/train\_df.isnull().count()\*100 percent\_2 = (round(percent\_1, 1)).sort\_values(ascending=**False**) missing\_data = pd.concat([total, percent\_2], axis=1, keys=['Total', '%'])

missing\_data.head(5)

The Embarked feature has only 2 missing values, which can easily be filled. It will be much more tricky, to deal with the ‘Age’ feature, which has 177 missing values. The ‘Cabin’ feature needs further investigation, but it looks like that we might want to drop it from the dataset, since 77 % of it

are missing.

train\_df.columns.values

Above you can see the 11 features + the target variable (survived). **What features could contribute to a high survival rate ?**

To me it would make sense if everything except ‘PassengerId’, ‘Ticket’ and ‘Name’ would be correlated with a high survival rate.

###### 1. Age and Sex:

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survived = 'survived' not\_survived = 'not survived'

fig, axes = plt.subplots(nrows=1, ncols=2,figsize=(10, 4)) women = train\_df[train\_df['Sex']=='female']

men = train\_df[train\_df['Sex']=='male']

ax = sns.distplot(women[women['Survived']==1].Age.dropna(), bins=18, label = survived, ax = axes[0], kde =**False**)

ax = sns.distplot(women[women['Survived']==0].Age.dropna(), bins=40, label = not\_survived, ax = axes[0], kde =**False**)

ax.legend() ax.set\_title('Female')

ax = sns.distplot(men[men['Survived']==1].Age.dropna(), bins=18, label

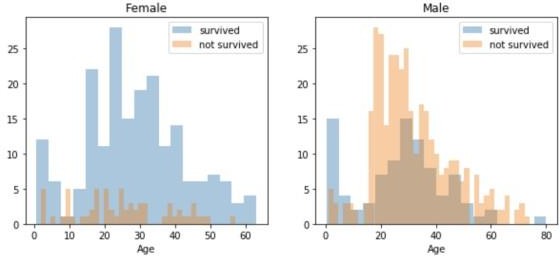
= survived, ax = axes[1], kde = **False**)

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ax = sns.distplot(men[men['Survived']==0].Age.dropna(), bins=40, label

= not\_survived, ax = axes[1], kde = **False**) ax.legend()

\_ = ax.set\_title('Male')



You can see that men have a high probability of survival when they are between 18 and 30 years old, which is also a little bit true for women but not fully. For women the survival chances are higher between 14 and 40.

For men the probability of survival is very low between the age of 5 and 18, but that isn’t true for women. Another thing to note is that infants also have a little bit higher probability of survival.

Since there seem to be **certain ages, which have increased odds of survival** and because I want every feature to be roughly on the same scale, I will create age groups later on.

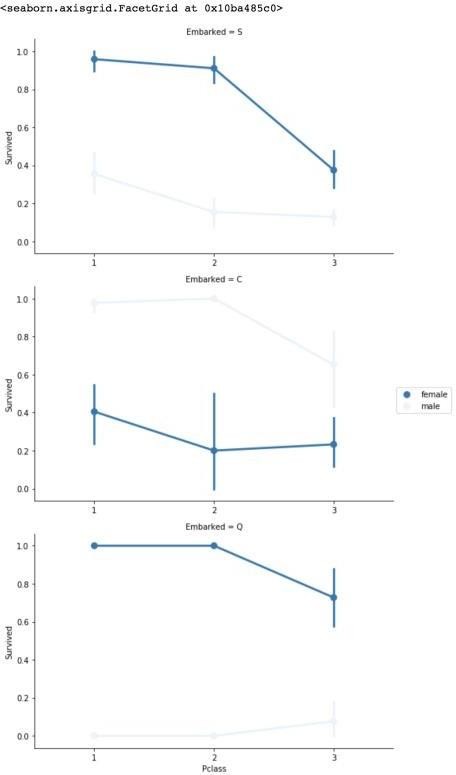
###### Embarked, Pclass and Sex:

FacetGrid = sns.FacetGrid(train\_df, row='Embarked', size=4.5, aspect=1.6)

FacetGrid.map(sns.pointplot, 'Pclass', 'Survived', 'Sex', palette=**None**, order=**None**, hue\_order=**None** ) FacetGrid.add\_legend()

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Embarked seems to be correlated with survival, depending on the gender.

Women on port Q and on port S have a higher chance of survival. The inverse is true, if they are at port C. Men have a high survival probability if they are on port C, but a low probability if they are on port Q or S.

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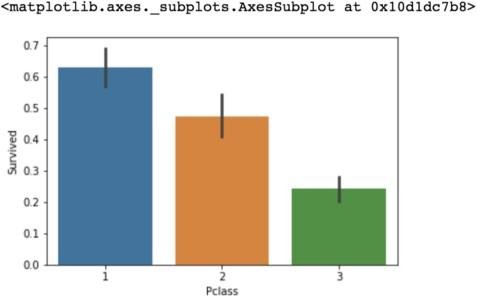
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Pclass also seems to be correlated with survival. We will generate another plot of it below.

###### Pclass:

sns.barplot(x='Pclass', y='Survived', data=train\_df)

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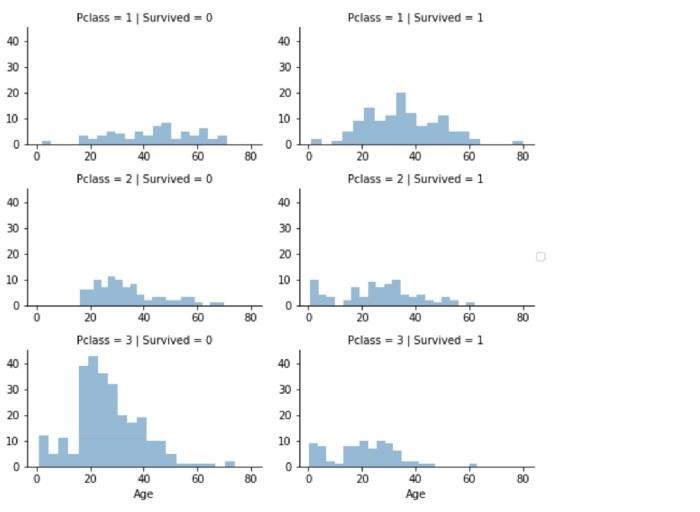
Here we see clearly, that Pclass is contributing to a persons chance of survival, especially if this person is in class 1. We will create another pclass plot below.

grid = sns.FacetGrid(train\_df, col='Survived', row='Pclass', size=2.2, aspect=1.6)

grid.map(plt.hist, 'Age', alpha=.5, bins=20) grid.add\_legend();

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The plot above confirms our assumption about pclass 1, but we can also spot a high probability that a person in pclass 3 will not survive.

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###### SibSp and Parch:

SibSp and Parch would make more sense as a combined feature, that shows the total number of relatives, a person has on the Titanic. I will create it below and also a feature that sows if someone is not alone.

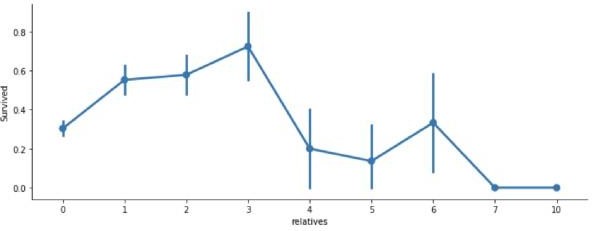
data = [train\_df, test\_df]

**for** dataset **in** data:

dataset['relatives'] = dataset['SibSp'] + dataset['Parch'] dataset.loc[dataset['relatives'] > 0, 'not\_alone'] = 0

dataset.loc[dataset['relatives'] == 0, 'not\_alone'] = 1 dataset['not\_alone'] =

dataset['not\_alone'].astype(int)train\_df['not\_alone'].value\_counts()



axes = sns.factorplot('relatives','Survived',

data=train\_df, aspect = 2.5, )

Here we can see that you had a high probabilty of survival with 1 to 3 realitves, but a lower one if you had less than 1 or more than 3 (except for some cases with 6 relatives).

#### Data Preprocessing

First, I will drop ‘PassengerId’ from the train set, because it does not contribute to a persons survival probability. I will not drop it from the test set, since it is required there for the submission.

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train\_df = train\_df.drop(['PassengerId'], axis=1)

Missing Data:

**Cabin:**

As a reminder, we have to deal with Cabin (687), Embarked (2) and Age (177). First I thought, we have to delete the ‘Cabin’ variable but then I

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found something interesting. A cabin number looks like ‘C123’ and

the **letter refers to the deck**. Therefore we’re going to extract these and create a new feature, that contains a persons deck. Afterwords we will convert the feature into a numeric variable. The missing values will be converted to zero. In the picture below you can see the actual decks of the titanic, ranging from A to G.

**import re**

deck = {"A": 1, "B": 2, "C": 3, "D": 4, "E": 5, "F": 6, "G": 7, "U":

8}

data = [train\_df, test\_df]

**for** dataset **in** data:

dataset['Cabin'] = dataset['Cabin'].fillna("U0")

dataset['Deck'] = dataset['Cabin'].map(**lambda** x: re.compile("([a- zA-Z]+)").search(x).group())

dataset['Deck'] = dataset['Deck'].map(deck) dataset['Deck'] = dataset['Deck'].fillna(0)

dataset['Deck'] = dataset['Deck'].astype(int)*# we can now drop the cabin feature*

train\_df = train\_df.drop(['Cabin'], axis=1) test\_df = test\_df.drop(['Cabin'], axis=1)

###### Age:

Now we can tackle the issue with the age features missing values. I will create an array that contains random numbers, which are computed based on the mean age value in regards to the standard deviation and is\_null.

data = [train\_df, test\_df]

**for** dataset **in** data:

mean = train\_df["Age"].mean() std = test\_df["Age"].std()

is\_null = dataset["Age"].isnull().sum()

*# compute random numbers between the mean, std and is\_null*

rand\_age = np.random.randint(mean - std, mean + std, size = is\_null)

*# fill NaN values in Age column with random values generated* age\_slice = dataset["Age"].copy() age\_slice[np.isnan(age\_slice)] = rand\_age

dataset["Age"] = age\_slice dataset["Age"] =

train\_df["Age"].astype(int)train\_df["Age"].isnull().sum()

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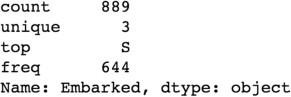
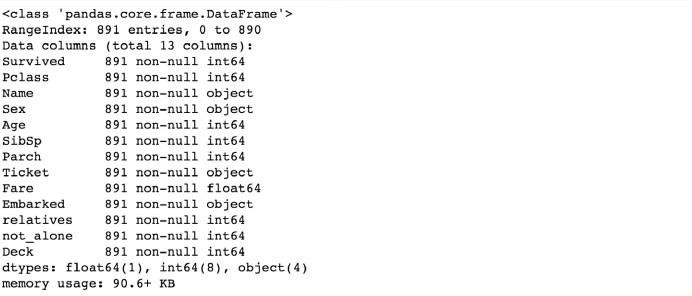
###### Embarked:

Since the Embarked feature has only 2 missing values, we will just fill

these with the most common one.

train\_df['Embarked'].describe()

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common\_value = 'S'

data = [train\_df, test\_df]

**for** dataset **in** data:

dataset['Embarked'] = dataset['Embarked'].fillna(common\_value)

Converting Features:

train\_df.info()

Above you can see that ‘Fare’ is a float and we have to deal with 4 categorical features: Name, Sex, Ticket and Embarked. Lets investigate and transfrom one after another.

###### Fare:

Converting “Fare” from float to int64, using the “astype()” function pandas provides:

data = [train\_df, test\_df]

**for** dataset **in** data:

dataset['Fare'] = dataset['Fare'].fillna(0) dataset['Fare'] = dataset['Fare'].astype(int)

###### Name:

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We will use the Name feature to extract the Titles from the Name, so that we can build a new feature out of that.

data = [train\_df, test\_df]

titles = {"Mr": 1, "Miss": 2, "Mrs": 3, "Master": 4, "Rare": 5}

**for** dataset **in** data:

*# extract titles*

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dataset['Title'] = dataset.Name.str.extract(' ([A-Za-z]+)\.', expand=**False**)

*# replace titles with a more common title or as Rare*

dataset['Title'] = dataset['Title'].replace(['Lady', 'Countess','Capt', 'Col','Don', 'Dr',\

'Major', 'Rev', 'Sir',

'Jonkheer', 'Dona'], 'Rare')

dataset['Title'] = dataset['Title'].replace('Mlle', 'Miss') dataset['Title'] = dataset['Title'].replace('Ms', 'Miss') dataset['Title'] = dataset['Title'].replace('Mme', 'Mrs') *# convert titles into numbers*

dataset['Title'] = dataset['Title'].map(titles)

*# filling NaN with 0, to get safe*

dataset['Title'] = dataset['Title'].fillna(0)train\_df = train\_df.drop(['Name'], axis=1)

test\_df = test\_df.drop(['Name'], axis=1)

###### Sex:

Convert ‘Sex’ feature into numeric.

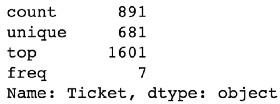
genders = {"male": 0, "female": 1} data = [train\_df, test\_df]

**for** dataset **in** data:

dataset['Sex'] = dataset['Sex'].map(genders)

###### Ticket:

train\_df['Ticket'].describe()



Since the Ticket attribute has 681 unique tickets, it will be a bit tricky to convert them into useful categories. So we will drop it from the dataset.

train\_df = train\_df.drop(['Ticket'], axis=1) test\_df = test\_df.drop(['Ticket'], axis=1)

###### Embarked:

Convert ‘Embarked’ feature into numeric.

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ports = {"S": 0, "C": 1, "Q": 2}

data = [train\_df, test\_df]

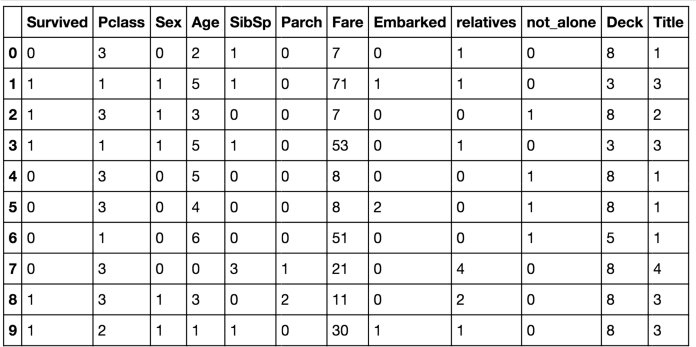
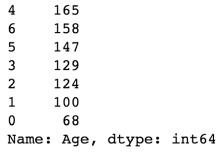
**for** dataset **in** data:

dataset['Embarked'] = dataset['Embarked'].map(ports)

#### Creating Categories:

We will now create categories within the following features:

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**Age:**

Now we need to convert the ‘age’ feature. First we will convert it from float into integer. Then we will create the new ‘AgeGroup” variable, by categorizing every age into a group. Note that it is important to place attention on how you form these groups, since you don’t want for example

that 80% of your data falls into group 1.

d

ata = [train\_df, test\_df]

**or** dataset **in** data:

dataset['Age'] = dataset['Age'].astype(int) dataset.loc[ dataset['Age'] <= 11, 'Age'] = 0

dataset.loc[(dataset['Age'] > 11) & (dataset['Age'] <= 18), 'Age']

= 1

dataset.loc[(dataset['Age'] > 18) & (dataset['Age'] <= 22), 'Age']

= 2

dataset.loc[(dataset['Age'] > 22) & (dataset['Age'] <= 27), 'Age']

**f**

= 3

dataset.loc[(dataset['Age'] > 27) & (dataset['Age'] <= 33), 'Age']

= 4

dataset.loc[(dataset['Age'] > 33) & (dataset['Age'] <= 40), 'Age']

= 5

dataset.loc[(dataset['Age'] > 40) & (dataset['Age'] <= 66), 'Age']

= 6

dataset.loc[ dataset['Age'] > 66, 'Age'] = 6

*# let's see how it's distributed* train\_df['Age'].value\_counts()

###### Fare:

For the ‘Fare’ feature, we need to do the same as with the ‘Age’ feature. But it isn’t that easy, because if we cut the range of the fare values into a few equally big categories, 80% of the values would fall into the first category. Fortunately, we can use sklearn “qcut()” function, that we can use to see,

how we can form the categories.

train\_df.head(10)

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data = [train\_df, test\_df]

**for** dataset **in** data:

dataset.loc[ dataset['Fare'] <= 7.91, 'Fare'] = 0 dataset.loc[(dataset['Fare'] > 7.91) & (dataset['Fare'] <=

14.454), 'Fare'] = 1

dataset.loc[(dataset['Fare'] > 14.454) & (dataset['Fare'] <= 31), 'Fare'] = 2

dataset.loc[(dataset['Fare'] > 31) & (dataset['Fare'] <= 99), 'Fare'] = 3

dataset.loc[(dataset['Fare'] > 99) & (dataset['Fare'] <= 250), 'Fare'] = 4

dataset.loc[ dataset['Fare'] > 250, 'Fare'] = 5 dataset['Fare'] = dataset['Fare'].astype(int)

#### Creating new Features

I will add two new features to the dataset, that I compute out of other features.

1. **Age times Class**

data = [train\_df, test\_df]

**for** dataset **in** data:

dataset['Age\_Class']= dataset['Age']\* dataset['Pclass']

1. **Fare per Person**

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**for** dataset **in** data: dataset['Fare\_Per\_Person'] =

dataset['Fare']/(dataset['relatives']+1) dataset['Fare\_Per\_Person'] =

dataset['Fare\_Per\_Person'].astype(int)*# Let's take a last look at the training set, before we start training the models.*

train\_df.head(10)

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#### Building Machine Learning Models

Now we will train several Machine Learning models and compare their results. Note that because the dataset does not provide labels for their testing-set, we need to use the predictions on the training set to compare the algorithms with each other. Later on, we will use cross validation.

X\_train = train\_df.drop("Survived", axis=1) Y\_train = train\_df["Survived"]

X\_test = test\_df.drop("PassengerId", axis=1).copy()

**Stochastic Gradient Descent (SGD):**

sgd = linear\_model.SGDClassifier(max\_iter=5, tol=**None**) sgd.fit(X\_train, Y\_train)

Y\_pred = sgd.predict(X\_test) sgd.score(X\_train, Y\_train)

acc\_sgd = round(sgd.score(X\_train, Y\_train) \* 100, 2)

**Random Forest:**

random\_forest = RandomForestClassifier(n\_estimators=100) random\_forest.fit(X\_train, Y\_train)

Y\_prediction = random\_forest.predict(X\_test) random\_forest.score(X\_train, Y\_train)

acc\_random\_forest = round(random\_forest.score(X\_train, Y\_train) \* 100,

2)

###### Logistic Regression:

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logreg = LogisticRegression() logreg.fit(X\_train, Y\_train)

Y\_pred = logreg.predict(X\_test)

acc\_log = round(logreg.score(X\_train, Y\_train) \* 100, 2)

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###### K Nearest Neighbor:

*# KNN* knn = KNeighborsClassifier(n\_neighbors = 3) knn.fit(X\_train, Y\_train) Y\_pred = knn.predict(X\_test) acc\_knn = round(knn.score(X\_train, Y\_train) \* 100, 2)

**Gaussian Naive Bayes:**

gaussian = GaussianNB() gaussian.fit(X\_train, Y\_train) Y\_pred = gaussian.predict(X\_test) acc\_gaussian = round(gaussian.score(X\_train, Y\_train) \* 100, 2)

###### Perceptron:

perceptron = Perceptron(max\_iter=5) perceptron.fit(X\_train, Y\_train)

Y\_pred = perceptron.predict(X\_test)

acc\_perceptron = round(perceptron.score(X\_train, Y\_train) \* 100, 2)

**Linear Support Vector Machine:**

linear\_svc = LinearSVC() linear\_svc.fit(X\_train, Y\_train)

Y\_pred = linear\_svc.predict(X\_test)

acc\_linear\_svc = round(linear\_svc.score(X\_train, Y\_train) \* 100, 2)

**Decision Tree**

decision\_tree = DecisionTreeClassifier() decision\_tree.fit(X\_train, Y\_train) Y\_pred = decision\_tree.predict(X\_test) acc\_decision\_tree = round(decision\_tree.score(X\_train, Y\_train) \* 100, 2)

#### Which is the best Model ?

results = pd.DataFrame({

'Model': ['Support Vector Machines', 'KNN', 'Logistic Regression', 'Random Forest', 'Naive Bayes', 'Perceptron', 'Stochastic Gradient Decent',

'Decision Tree'],

'Score': [acc\_linear\_svc, acc\_knn, acc\_log, acc\_random\_forest, acc\_gaussian, acc\_perceptron, acc\_sgd, acc\_decision\_tree]})

result\_df = results.sort\_values(by='Score', ascending=**False**) result\_df = result\_df.set\_index('Score')

result\_df.head(9)

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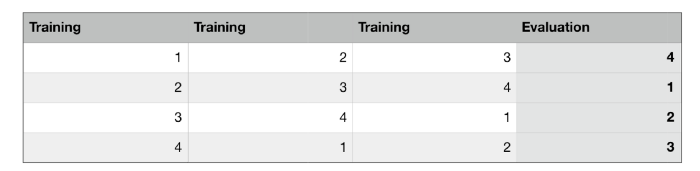
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As we can see, the Random Forest classifier goes on the first place. But first, let us check, how random-forest performs, when we use cross validation.

#### K-Fold Cross Validation:

K-Fold Cross Validation randomly splits the training data into **K subsets called folds**. Let’s image we would split our data into 4 folds (K = 4). Our random forest model would be trained and evaluated 4 times, using a different fold for evaluation everytime, while it would be trained on the remaining 3 folds.

The image below shows the process, using 4 folds (K = 4). Every row represents one training + evaluation process. In the first row, the model get’s trained on the first, second and third subset and evaluated on the fourth. In the second row, the model get’s trained on the second, third and fourth subset and evaluated on the first. K-Fold Cross Validation repeats this process till every fold acted once as an evaluation fold.

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The result of our K-Fold Cross Validation example would be an array that contains 4 different scores. We then need to compute the mean and the standard deviation for these scores.

The code below perform K-Fold Cross Validation on our random forest model, using 10 folds (K = 10). Therefore it outputs an array with 10 different scores.

**from sklearn.model\_selection import** cross\_val\_score rf = RandomForestClassifier(n\_estimators=100)

scores = cross\_val\_score(rf, X\_train, Y\_train, cv=10, scoring = "accuracy")print("Scores:", scores)

print("Mean:", scores.mean()) print("Standard Deviation:", scores.std())



This looks much more realistic than before. Our model has a average accuracy of 82% with a standard deviation of 4 %. The standard deviation shows us, how precise the estimates are .

This means in our case that the accuracy of our model can differ **+** — 4%.

I think the accuracy is still really good and since random forest is an easy to use model, we will try to increase it’s performance even further in the following section.

#### Random Forest

What is Random Forest ?

Random Forest is a supervised learning algorithm. Like you can already see from it’s name, it creates a forest and makes it somehow random. The

„forest“ it builds, is an ensemble of Decision Trees, most of the time trained with the “bagging” method. The general idea of the bagging method is that a combination of learning models increases the overall result.

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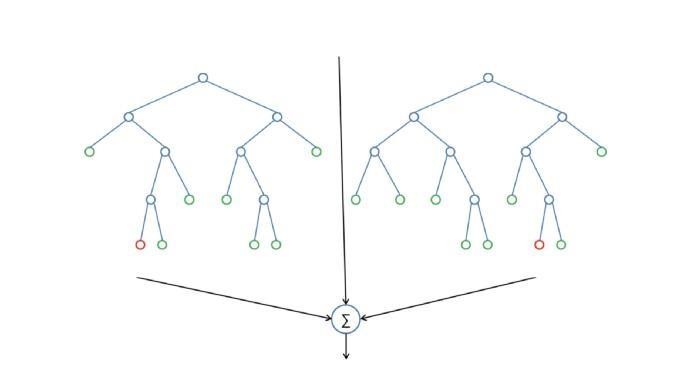
To say it in simple words: Random forest builds multiple decision trees and merges them together to get a more accurate and stable prediction.

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One big advantage of random forest is, that it can be used for both classification and regression problems, which form the majority of current machine learning systems. With a few exceptions a random-forest classifier has all the hyperparameters of a decision-tree classifier and also all the hyperparameters of a bagging classifier, to control the ensemble itself.

The random-forest algorithm brings extra randomness into the model, when it is growing the trees. Instead of searching for the best feature while splitting a node, it searches for the best feature among a random subset of features. This process creates a wide diversity, which generally results in a better model. Therefore when you are growing a tree in random forest, only a random subset of the features is considered for splitting a node. You can even make trees more random, by using random thresholds on top of it, for each feature rather than searching for the best possible thresholds (like a normal decision tree does).

Below you can see how a random forest would look like with two trees:

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Feature Importance

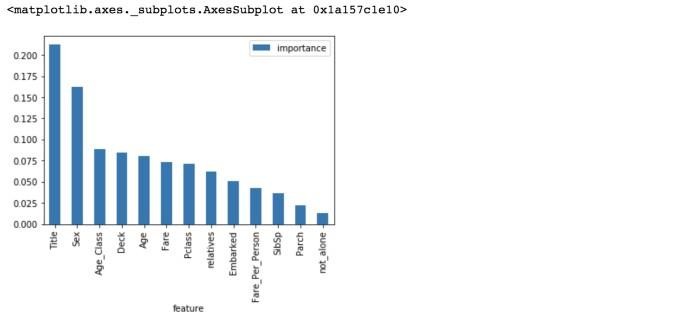
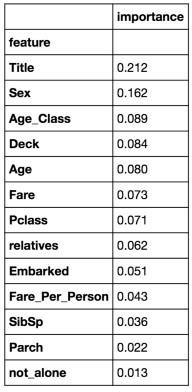
Another great quality of random forest is that they make it very easy to measure the relative importance of each feature. Sklearn measure a features importance by looking at how much the treee nodes, that use that

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feature, reduce impurity on average (across all trees in the forest). It computes this score automaticall for each feature after training and scales the results so that the sum of all importances is equal to 1. We will acces this below:

importances = pd.DataFrame({'feature':X\_train.columns,'importance':np.round(random\_f orest.feature\_importances\_,3)})

importances = importances.sort\_values('importance',ascending=**False**).set\_index('featu re')importances.head(15)

importances.plot.bar()

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Conclusion:

not\_alone and Parch doesn’t play a significant role in our random forest classifiers prediction process. Because of that I will drop them from the dataset and train the classifier again. We could also remove more or less

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features, but this would need a more detailed investigation of the features effect on our model. But I think it’s just fine to remove only Alone and Parch.

train\_df = train\_df.drop("not\_alone", axis=1) test\_df = test\_df.drop("not\_alone", axis=1)

train\_df = train\_df.drop("Parch", axis=1) test\_df = test\_df.drop("Parch", axis=1)

**Training random forest again:**

*# Random Forest*

random\_forest = RandomForestClassifier(n\_estimators=100, oob\_score =

**True**)

random\_forest.fit(X\_train, Y\_train) Y\_prediction = random\_forest.predict(X\_test)

random\_forest.score(X\_train, Y\_train)

acc\_random\_forest = round(random\_forest.score(X\_train, Y\_train) \* 100, 2)

print(round(acc\_random\_forest,2,), "%")

92.82%

Our random forest model predicts as good as it did before. A general rule is that, **the more features you have, the more likely your model will suffer from overfitting** and vice versa. But I think our data looks fine for now and hasn't too much features.

There is also another way to evaluate a random-forest classifier, which is probably much more accurate than the score we used before. What I am talking about is the **out-of-bag samples** to estimate the generalization accuracy. I will not go into details here about how it works. Just note that out-of-bag estimate is as accurate as using a test set of the same size as the training set. Therefore, using the out-of-bag error estimate removes the need for a set aside test set.

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print("oob score:", round(random\_forest.oob\_score\_, 4)\*100, "%")

oob score: 81.82 %

Now we can start tuning the hyperameters of random forest.

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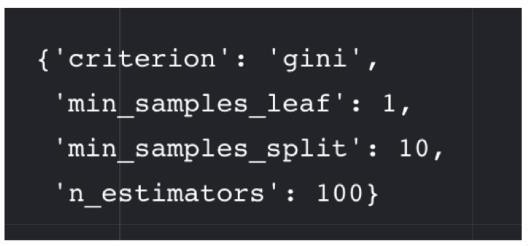
#### Hyperparameter Tuning

Below you can see the code of the hyperparamter tuning for the parameters criterion, min\_samples\_leaf, min\_samples\_split and n\_estimators.

I put this code into a markdown cell and not into a code cell, because it takes a long time to run it. Directly underneeth it, I put a screenshot of the gridsearch's output.

param\_grid = { "criterion" : ["gini", "entropy"], "min\_samples\_leaf" : [1, 5, 10, 25, 50, 70], "min\_samples\_split" : [2, 4, 10, 12, 16, 18,

25, 35], "n\_estimators": [100, 400, 700, 1000, 1500]}from sklearn.model\_selection import GridSearchCV, cross\_val\_scorerf = RandomForestClassifier(n\_estimators=100, max\_features='auto', oob\_score=True, random\_state=1, n\_jobs=-1)clf = GridSearchCV(estimator=rf, param\_grid=param\_grid, n\_jobs=- 1)clf.fit(X\_train, Y\_train)clf.best*params*



**Test new Parameters:**

*# Random Forest*

random\_forest = RandomForestClassifier(criterion = "gini",

min\_samples\_leaf = 1,

min\_samples\_split = 10, n\_estimators=100, max\_features='auto', oob\_score=**True**, random\_state=1, n\_jobs=-1)

random\_forest.fit(X\_train, Y\_train) Y\_prediction = random\_forest.predict(X\_test)

random\_forest.score(X\_train, Y\_train)

print("oob score:", round(random\_forest.oob\_score\_, 4)\*100, "%")

oob score: 83.05 %

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Now that we have a proper model, we can start evaluating it’s performace in a more accurate way. Previously we only used accuracy and the oob score, which is just another form of accuracy. The problem is just, that it’s more complicated to evaluate a classification model than a regression model. We will talk about this in the following section.

#### Further Evaluation

Confusion Matrix:

**from sklearn.model\_selection import** cross\_val\_predict

**from sklearn.metrics import** confusion\_matrix

predictions = cross\_val\_predict(random\_forest, X\_train, Y\_train, cv=3) confusion\_matrix(Y\_train, predictions)



The first row is about the not-survived-predictions: **493 passengers were correctly classified as not survived** (called true negatives) and **56 where wrongly classified as not survived** (false positives).

The second row is about the survived-predictions: **93 passengers where wrongly classified as survived** (false negatives) and **249 where correctly classified as survived** (true positives).

A confusion matrix gives you a lot of information about how well your model does, but theres a way to get even more, like computing the classifiers precision.

Precision and Recall:

**from sklearn.metrics import** precision\_score, recall\_score

print("Precision:", precision\_score(Y\_train, predictions)) print("Recall:",recall\_score(Y\_train, predictions))

Precision: 0.801948051948

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Recall: 0.722222222222

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Our model predicts 81% of the time, a passengers survival correctly (precision). The recall tells us that it predicted the survival of 73 % of the people who actually survived.

F-Score

You can combine precision and recall into one score, which is called the F- score. The F-score is computed with the harmonic mean of precision and recall. Note that it assigns much more weight to low values. As a result of that, the classifier will only get a high F-score, if both recall and precision are high.

**from sklearn.metrics import** f1\_score f1\_score(Y\_train, predictions)

0.7599999999999

There we have it, a 77 % F-score. The score is not that high, because we have a recall of 73%. But unfortunately the F-score is not perfect, because it favors classifiers that have a similar precision and recall. This is a problem, because you sometimes want a high precision and sometimes a high recall. The thing is that an increasing precision, sometimes results in an decreasing recall and vice versa (depending on the threshold). This is called the precision/recall tradeoff. We will discuss this in the following section.

Precision Recall Curve

For each person the Random Forest algorithm has to classify, it computes a probability based on a function and it classifies the person as survived (when the score is bigger the than threshold) or as not survived (when the score is smaller than the threshold). That’s why the threshold plays an important part.

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We will plot the precision and recall with the threshold using matplotlib:

**from sklearn.metrics import** precision\_recall\_curve

*# getting the probabilities of our predictions* y\_scores = random\_forest.predict\_proba(X\_train) y\_scores = y\_scores[:,1]

precision, recall, threshold = precision\_recall\_curve(Y\_train,

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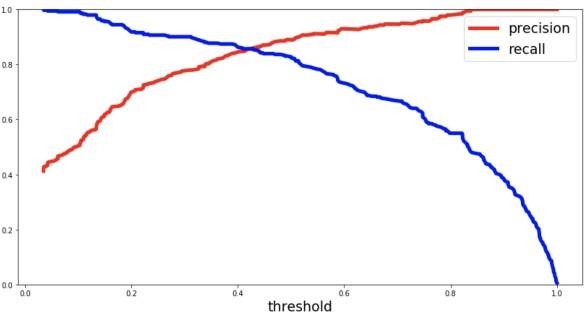
y\_scores)**def** plot\_precision\_and\_recall(precision, recall, threshold): plt.plot(threshold, precision[:-1], "r-", label="precision",

linewidth=5)

plt.plot(threshold, recall[:-1], "b", label="recall", linewidth=5) plt.xlabel("threshold", fontsize=19)

plt.legend(loc="upper right", fontsize=19) plt.ylim([0, 1])

plt.figure(figsize=(14, 7)) plot\_precision\_and\_recall(precision, recall, threshold) plt.show()



Above you can clearly see that the recall is falling of rapidly at a precision of around 85%. Because of that you may want to select the precision/recall tradeoff before that — maybe at around 75 %.

You are now able to choose a threshold, that gives you the best precision/recall tradeoff for your current machine learning problem. If you want for example a precision of 80%, you can easily look at the plots and see that you would need a threshold of around 0.4. Then you could train a model with exactly that threshold and would get the desired accuracy.

Another way is to plot the precision and recall against each other:

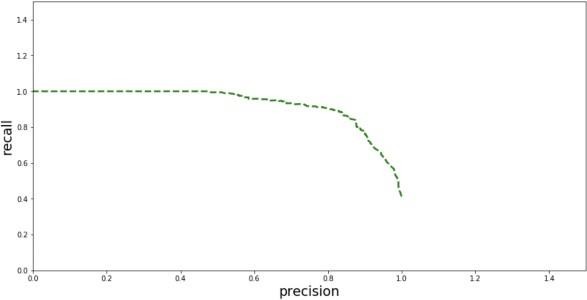
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**def** plot\_precision\_vs\_recall(precision, recall): plt.plot(recall, precision, "g--", linewidth=2.5) plt.ylabel("recall", fontsize=19) plt.xlabel("precision", fontsize=19) plt.axis([0, 1.5, 0, 1.5])

plt.figure(figsize=(14, 7)) plot\_precision\_vs\_recall(precision, recall) plt.show()

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ROC AUC Curve

Another way to evaluate and compare your binary classifier is provided by the ROC AUC Curve. This curve plots the true positive rate (also called recall) against the false positive rate (ratio of incorrectly classified negative instances), instead of plotting the precision versus the recall.

**from sklearn.metrics import** roc\_curve

*# compute true positive rate and false positive rate* false\_positive\_rate, true\_positive\_rate, thresholds = roc\_curve(Y\_train, y\_scores)*# plotting them against each other* **def** plot\_roc\_curve(false\_positive\_rate, true\_positive\_rate, label=**None**):

plt.plot(false\_positive\_rate, true\_positive\_rate, linewidth=2, label=label)

plt.plot([0, 1], [0, 1], 'r', linewidth=4)

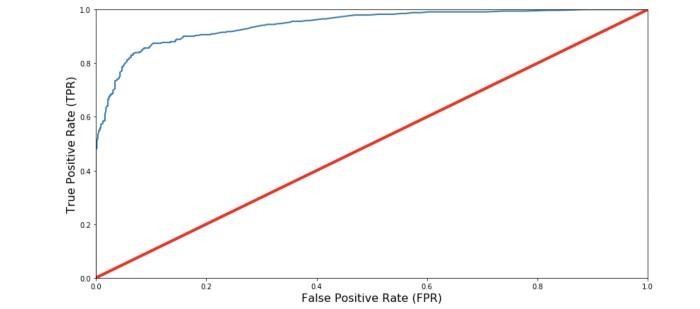
plt.axis([0, 1, 0, 1])

plt.xlabel('False Positive Rate (FPR)', fontsize=16) plt.ylabel('True Positive Rate (TPR)', fontsize=16)

plt.figure(figsize=(14, 7)) plot\_roc\_curve(false\_positive\_rate, true\_positive\_rate) plt.show()

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The red line in the middel represents a purely random classifier (e.g a coin flip) and therefore your classifier should be as far away from it as possible. Our Random Forest model seems to do a good job.

Of course we also have a tradeoff here, because the classifier produces more false positives, the higher the true positive rate is.

ROC AUC Score

The ROC AUC Score is the corresponding score to the ROC AUC Curve. It is simply computed by measuring the area under the curve, which is called AUC.

A classifiers that is 100% correct, would have a ROC AUC Score of 1 and a completely random classiffier would have a score of 0.5.

**from sklearn.metrics import** roc\_auc\_score r\_a\_score = roc\_auc\_score(Y\_train, y\_scores) print("ROC-AUC-Score:", r\_a\_score)

ROC\_AUC\_SCORE: 0.945067587

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# Group C

**Assignment No : 13**

**Title:** Installation of MetaMask and study spending Ether per transaction

**Objective:** Students should be able to learn new technology such as metamask.Its application and implementations

**Theory:**

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1. **Introduction to Blockchain**
   * Blockchain can be described as a data structure that holds transactional records and while ensuring security, transparency, and decentralization. You can also think of it as a chain or records stored in the forms of blocks which are controlled by no single authority.
   * A blockchain is a distributed ledger that is completely open to any and everyone onthe network. Once an information is stored on a blockchain, it is extremely difficult to change or alter it.

* **Blockchain Features**
* **Decentralized**

Blockchains are decentralized in nature meaning that no single person or group holds the authority of the overall network. While everybody in the network has the copy of the distributed ledger with them, no one can modify it on his or her own.

* **Peer-to-Peer Network**

With the use of Blockchain, the interaction between two parties through a peer-to-peer model is easily accomplished without the requirement of any third party. Blockchain uses P2P protocol which allows all the network participants to hold an identical copy of transactions, enabling approval through a machine consensus.

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* **Immutable**

The immutability property of a blockchain refers to the fact that any data once written on the blockchain cannot be changed. To understand immutability, consider sending email as an example.

* **Tamper-Proof**

With the property of immutability embedded in blockchains, it becomes easier to detect tampering of any data. Blockchains are considered tamper-proof as any change in even one single block can be detected and addressed smoothly.

* **Benefits of Blockchain Technology:**
* **Time-saving:** No central Authority verification needed for settlements making the process faster and cheaper.
* **Cost-saving:** A Blockchain network reduces expenses in several ways. No need for third-party verification. Participants can share assets directly.
* **Tighter security:** No one can temper with Blockchain Data as it is shared among

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millions of participants. The system is safe against cybercrimes and Fraud.

* In finance market trading, Fibonacci retracement levels are widely used in technical analysis.

1. **How to use MetaMask: A step by step guide**

**Step 1. Install MetaMask on your browser.**

To create a new wallet, you have to install the extension first. Depending on your browser, there are different marketplaces to find it. Most browsers have MetaMask on their stores, so it’s not that hard to see it, but either way, here they are [Chrome, Firefox,](https://chrome.google.com/webstore/detail/nkbihfbeogaeaoehlefnkodbefgpgknn) and [Opera.](https://addons.opera.com/en/extensions/details/metamask/)

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### Step 2. Create an account.

* Click on the extension icon in the upper right corner to open MetaMask.
* To install the latest version and be up to date, **click Try it now**.
* **Click Continue**.
* You will be prompted to create a new password. **Click Create**.

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### Step 3. Depositing funds.

* Click on **View Account**.

You can now see your public address and share it with other people. There are some methods to buy coins offered by MetaMask, but you can do it differently as well; you just need your address.

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* **What advantages does MetaMask have?**
* **Popular** - It is commonly used, so users only need one plugin to access a wide range of dapps.
* **Simple** - Instead of managing private keys, users just need to remember a list of words, and transactions are signed on their behalf.
* **Saves space** - Users don’t have to download the Ethereum blockchain, as MetaMask sends requests to nodes outside of the user’s computer.
* **Integrated** - Dapps are designed to work with MetaMask, so it becomes much easier to send Ether in and out.

**Conclusion**- In this way we have explored Concept Blockchain and metamat wallet for transaction of digital currency

**Assignment Question**

1. **What Are the Different Types of Blockchain Technology?**
2. **What Are the Key Features/Properties of Blockchain?**
3. **What Type of Records You Can Keep in A Blockchain?**
4. **What is the difference between Ethereum and Bitcoin?**
5. **What are Merkle Trees? Explain their concept.**
6. **What is Double Spending in transaction operation**
7. **Give real-life use cases of blockchain.**

**Reference link**

* [https://hackernoon.com/blockchain-technology-explained-introduction-meaning-and-applications-edb](https://hackernoon.com/blockchain-technology-explained-introduction-meaning-and-applications-edbd6759a2b2) [d6759a2b2](https://hackernoon.com/blockchain-technology-explained-introduction-meaning-and-applications-edbd6759a2b2)
* <https://levelup.gitconnected.com/how-to-use-metamask-a-step-by-step-guide-f380a3943fb1>
* <https://decrypt.co/resources/metamask>

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# Assignment No : 14

**Title:** Create your own wallet using Metamask for crypto transactions

**Objective:** Students should be able to learn about cryptocurrencies and learn how transaction done by using different digital currency

**---------------------------------------------------------------------------------------------------------------**

**Theory:**

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1. **Introduction to Cryptocurrency**
   * Cryptocurrency is a digital payment system that doesn't rely on banks to verify transactions. [It’s a peer-to-peer system that can enable anyone anywhere to send and receive payments.](https://www.fool.com/investing/2018/03/11/what-is-cryptocurrency.aspx) Instead of being physical money carried around and exchanged in the real world, cryptocurrency payments exist purely as digital entries to an online database describing specific transactions. When you transfer cryptocurrency funds, the transactions are recorded in a public ledger. Cryptocurrency is stored in digital wallets.

* **How does cryptocurrency work?**
  + Cryptocurrencies run on a distributed public ledger called blockchain, a record of all transactions updated and held by currency holders.
  + Units of cryptocurrency are created through a process called mining, which involves using computer power to solve complicated mathematical problems that generate coins. Users can also buy the currencies from brokers, then store and spend them using cryptographic wallets.

**Cryptocurrency examples**

There are thousands of cryptocurrencies. Some of the best known include:

* **Bitcoin:**

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Founded in 2009, Bitcoin was the first cryptocurrency and is still the most commonly traded. The currency was developed by Satoshi Nakamoto – widely believed to be a pseudonym for an individual or group of people whose precise identity remains unknown.

* **Ethereum:**

Developed in 2015, Ethereum is a blockchain platform with its own cryptocurrency, called Ether (ETH) or Ethereum. It is the most popular cryptocurrency after Bitcoin.

* **Litecoin:**

This currency is most similar to bitcoin but has moved more quickly to develop new innovations, including faster payments and processes to allow more transactions.

* **Ripple:**

Ripple is a distributed ledger system that was founded in 2012. Ripple can be used to track different kinds of transactions, not just cryptocurrency.

* **How to store cryptocurrency**
* There are different wallet providers to choose from. The terms “hot wallet” and “cold wallet” are used:
* **Hot wallet storage:** "hot wallets" refer to crypto storage that uses online software to protect the private keys to your assets.
* **Cold wallet storage:** Unlike hot wallets, cold wallets (also known as hardware wallets) rely on offline electronic devices to securely store your private keys.

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**Conclusion**- In this way we have explored Concept Cryptocurrency and learn how transactions are done using digital currency

**Assignment Question**

1. [**What is Bitcoin?**](https://www.kaspersky.com/resource-center/definitions/what-is-bitcoin)
2. **What Are the biggest** [**Four common cryptocurrency scams**](https://www.kaspersky.com/resource-center/definitions/cryptocurrency-scams)
3. **Explain** [**How safe are money e-transfers?**](https://www.kaspersky.com/resource-center/threats/how-safe-are-money-etransfers)
4. [**What is cryptojacking and how does it work?**](https://www.kaspersky.com/resource-center/definitions/what-is-cryptojacking)

**Reference link**

* <https://www.kaspersky.com/resource-center/definitions/what-is-cryptocurrency>

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# Assignment No : 15

**Title:** Write a smart contract on a test network, for Bank account of a customer for following operations:

* Deposit money
* Withdraw Money
* Show balance

**Objective:** Students should be able to learn new technology such as metamask.Its application and implementations

**---------------------------------------------------------------------------------------------------------------**

**Theory:**

The contract will allow deposits from any account, and can be trusted to allow withdrawals only by accounts that have sufficient funds to cover the requested withdrawal.

This post assumes that you are comfortable with the ether-handling concepts introduced in our post, [Writing a Contract That Handles Ether](https://programtheblockchain.com/posts/2017/12/15/writing-a-contract-that-handles-ether/).

That post demonstrated how to restrict ether withdrawals to an “owner’s” account. It did this by persistently storing the owner account’s address, and then comparing it to the msg.sender value for any withdrawal attempt. Here’s a slightly simplified version of that smart contract, which allows anybody to deposit money, but only allows the owner to make withdrawals:

pragma solidity ^0.4.19; contract TipJar {

address owner; *// current owner of the contract*

function TipJar() public { owner = msg.sender;

}

function withdraw() public { require(owner == msg.sender);

msg.sender.transfer(address(this).balance);

}

function deposit(uint256 amount) public payable { require(msg.value == amount);

}

function getBalance() public view returns (uint256) { return address(this).balance;

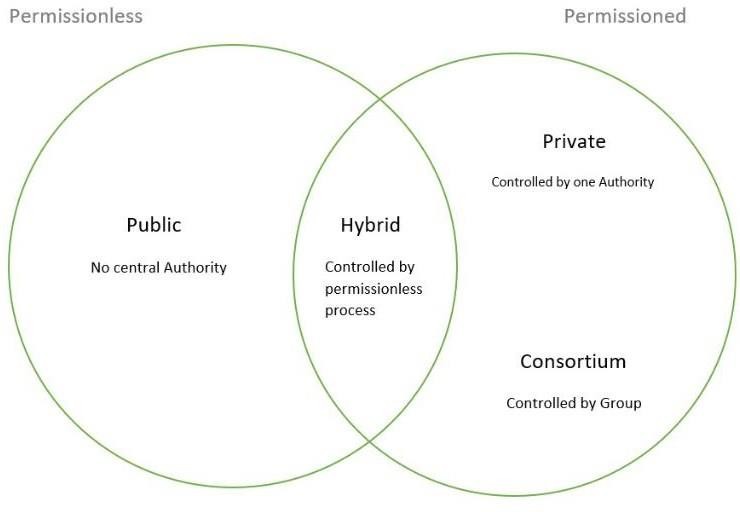
}

}

I am going to generalize this contract to keep track of ether deposits based on the account address of the depositor, and then only allow that same account to make withdrawals of that ether. To do this, we need a way keep track of account balances for each depositing account—a mapping from accounts to balances. Fortunately, Solidity provides a ready-made mapping data type that can map account addresses to integers,

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|  |  |
| --- | --- |
| which will make this bookkeeping job quite simple. (This mapping structure is much more general key/value mapping than just addresses to integers, but that’s all we need here.)  Here’s the code to accept deposits and track account balances: pragma solidity ^0.4.19;  contract Bank {  mapping(address => uint256) public balanceOf; *// balances, indexed by addresses*    function deposit(uint256 amount) public payable { require(msg.value == amount);    balanceOf[msg.sender] += amount; *// adjust the account's balance*  }  }  Here are the new concepts in the code above:   * mapping(address => uint256) public balanceOf; declares a persistent public variable, balanceOf, that is a mapping from account addresses to 256-bit unsigned integers. Those integers will represent the current balance of ether stored by the contract on behalf of the corresponding address. * Mappings can be indexed just like arrays/lists/dictionaries/tables in most modern programming languages. * The value of a missing mapping value is 0. Therefore, we can trust that the beginning balance for all account addresses will effectively be zero prior to the first deposit.   It’s important to note that balanceOf keeps track of the ether balances assigned to each account, but it does not actually move any ether anywhere. The bank contract’s ether balance is the sum of all the balances of all accounts—only balanceOf tracks how much of that is assigned to each account.  Note also that this contract doesn’t need a constructor. There is no persistent state to initialize other than the balanceOf mapping, which already provides default values of 0.  Given the balanceOf mapping from account addresses to ether amounts, the remaining code for a fully- functional bank contract is pretty small. I’ll simply add a withdrawal function: | |
|  | **bank.sol** |
| pragma solidity ^0.4.19;  contract Bank {  mapping(address => uint256) public balanceOf; *// balances, indexed by addresses*    function deposit(uint256 amount) public payable { require(msg.value == amount);  balanceOf[msg.sender] += amount; *// adjust the account's balance*  }    function withdraw(uint256 amount) public { require(amount <= balanceOf[msg.sender]); balanceOf[msg.sender] -= amount; msg.sender.transfer(amount);  }  } |
| The code above demonstrates the following:   * The require(amount <= balances[msg.sender]) checks to make sure the sender has sufficient funds to cover the requested withdrawal. If not, then the transaction aborts without making any state changes or ether transfers. * The balanceOf mapping must be updated to reflect the lowered residual amount after the withdrawal. * The funds must be sent to the sender requesting the withdrawal.   In the withdraw() function above, it is very important to adjust balanceOf[msg.sender] **before** transferring ether to avoid an exploitable vulnerability. The reason is specific to smart contracts and the fact that a transfer to a smart contract executes code in that smart contract. (The essentials of Ethereum transactions are discussed in [How Ethereum Transactions Work](https://programtheblockchain.com/posts/2017/12/29/how-ethereum-transactions-work/).)  Now, suppose that the code in withdraw() did not adjust balanceOf[msg.sender] before making the  transfer *and* suppose that msg.sender was a malicious smart contract. Upon receiving the transfer—handled by msg.sender’s fallback function—that malicious contract could initiate *another* withdrawal from the banking contract. When the banking contract handles this second withdrawal request, it would have already transferred ether for the original withdrawal, but it would not have an updated balance, so it would allow this second withdrawal!  This vulnerability is called a “reentrancy” bug because it happens when a smart contract invokes code in a different smart contract that then calls back into the original, thereby reentering the exploitable contract. For this reason, it’s essential to always make sure a contract’s internal state is fully updated before it potentially invokes code in another smart contract. (And, it’s essential to remember that every transfer to a smart contract executes that contract’s code.)    To avoid this sort of reentrancy bug, follow the “Checks-Effects-Interactions pattern” as [described in the](https://solidity.readthedocs.io/en/develop/security-considerations.html#re-entrancy) [Solidity documentation](https://solidity.readthedocs.io/en/develop/security-considerations.html#re-entrancy). The withdraw() function above is an example of implementing this pattern  AJEENKYA D Y PATIL SCHOOL OF ENGINEERING, LOHEGAON | |



# Assignment No : 16

**Title:** Write a survey report on types of Blockchains and its real time use cases.

**Objective:** Students should be able to learn new technology such as metamask.Its application and implementations

**---------------------------------------------------------------------------------------------------------------**

**Contents for Theory:**

**There are 4 types of blockchain: Public Blockchain.**

**Private Blockchain. Hybrid Blockchain. Consortium Blockchain**

**---------------------------------------------------------------------------------------------------------------**

1. Public Blockchain

These blockchains are completely open to following the idea of decentralization. They don’t have any restrictions, anyone having a computer and internet can participate in the network.

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As the name is public this blockchain is open to the public, which means it is not owned by anyone. Anyone having internet and a computer with good hardware can participate in this public blockchain. All the computer in the network hold the copy of other nodes or block present in the network

In this public blockchain, we can also perform verification of transactions or records Advantages:

Trustable: There are algorithms to detect no fraud. Participants need not worry about the other nodes in the network

Secure: This blockchain is large in size as it is open to the public. In a large size, there is greater distribution of records

Anonymous Nature: It is a secure platform to make your transaction properly at the same time, you are not required to reveal your name and identity in order to participate.

Decentralized: There is no single platform that maintains the network, instead every user has a copy of the ledger.

Disadvantages:

Processing: The rate of the transaction process is very slow, due to its large size. Verification of each node is a very time-consuming process.

Energy Consumption: Proof of work is high energy-consuming. It requires good computer hardware to participate in the network

Acceptance: No central authority is there so governments are facing the issue to implement the technology faster.

Use Cases: Public Blockchain is secured with proof of work or proof of stake they can be used to displace traditional financial systems. The more advanced side of this blockchain is the smart contract that enabled this blockchain to support decentralization. Examples of public blockchain are Bitcoin, Ethereum.

1. Private Blockchain

These blockchains are not as decentralized as the public blockchain only selected nodes can participate in the process, making it more secure than the others.

These are not as open as a public blockchain. They are open to some authorized users only.

These blockchains are operated in a closed network.

In this few people are allowed to participate in a network within a company/organization. Advantages:

Speed: The rate of the transaction is high, due to its small size. Verification of each node is less time- consuming.

Scalability: We can modify the scalability. The size of the network can be decided manually. Privacy: It has increased the level of privacy for confidentiality reasons as the businesses required.

Balanced: It is more balanced as only some user has the access to the transaction which improves the performance of the network.

Disadvantages:

Security- The number of nodes in this type is limited so chances of manipulation are there. These blockchains are more vulnerable.

Centralized- Trust building is one of the main disadvantages due to its central nature. Organizations can use this for malpractices.

Count- Since there are few nodes if nodes go offline the entire system of blockchain can be endangered. Use Cases: With proper security and maintenance, this blockchain is a great asset to secure information without exposing it to the public eye. Therefore companies use them for internal auditing, voting, and asset management. An example of private blockchains is Hyperledger, Corda.

1. Hybrid Blockchain

It is the mixed content of the private and public blockchain, where some part is controlled by some organization and other makes are made visible as a public blockchain.

It is a combination of both public and private blockchain. Permission-based and permissionless systems are used. User access information via smart contracts

Even a primary entity owns a hybrid blockchain it cannot alter the transaction Advantages:

Ecosystem: Most advantageous thing about this blockchain is its hybrid nature. It cannot be hacked as 51% of users don’t have access to the network

Cost: Transactions are cheap as only a few nodes verify the transaction. All the nodes don’t carry the verification hence less computational cost.

Architecture: It is highly customizable and still maintains integrity, security, and transparency. Operations: It can choose the participants in the blockchain and decide which transaction can be made public.

Disadvantages:

Efficiency: Not everyone is in the position to implement a hybrid Blockchain. The organization also faces

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some difficulty in terms of efficiency in maintenance.

Transparency: There is a possibility that someone can hide information from the user. If someone wants to get access through a hybrid blockchain it depends on the organization whether they will give or not. Ecosystem: Due to its closed ecosystem this blockchain lacks the incentives for network participation. Use Case: It provides a greater solution to the health care industry, government, real estate, and financial companies. It provides a remedy where data is to be accessed publicly but needs to be shielded privately. Examples of Hybrid Blockchain are Ripple network and XRP token.

1. Consortium Blockchain

It is a creative approach that solves the needs of the organization. This blockchain validates the transaction and also initiates or receives transactions.

Also known as Federated Blockchain.

This is an innovative method to solve the organization’s needs. Some part is public and some part is private.

In this type, more than one organization manages the blockchain. Advantages:

Speed: A limited number of users make verification fast. The high speed makes this more usable for organizations.

Authority: Multiple organizations can take part and make it decentralized at every level. Decentralized authority, makes it more secure.

Privacy: The information of the checked blocks is unknown to the public view. but any member belonging to the blockchain can access it.

Flexible: There is much divergence in the flexibility of the blockchain. Since it is not a very large decision can be taken faster.

Disadvantages:

Approval: All the members approve the protocol making it less flexible. Since one or more organizations are involved there can be differences in the vision of interest.

Transparency: It can be hacked if the organization becomes corrupt. Organizations may hide information from the users.

Vulnerability: If few nodes are getting compromised there is a greater chance of vulnerability in this blockchain

Use Cases: It has high potential in businesses, banks, and other payment processors. Food tracking of the organizations frequently collaborates with their sectors making it a federated solution ideal for their use. Examples of consortium Blockchain are Tendermint and Multichain.

**Conclusion**-In this way we have explored types of blockchain and its applications in real time

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You can use Composer to rapidly develop use cases and deploy a blockchain solution in days.

Composer allows you to model your business network and integrate existing systems and data with your

blockchain applications.

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Hyperledger Composer supports the existing [Hyperledger Fabric blockchain i](https://hyperledger.org/)nfrastructure and runtime.

Hyperleder Composer generate business network archive (bna) file which you can deploy on existing

Hyperledger Fabric network

# Assignment No : 17

**Title:** Write a program to create a Business Network using Hyperledger.

**Objective:** Students should be able to learn hyperledger .Its application and implementations

**---------------------------------------------------------------------------------------------------------------**

**Theory:**

Hyperledger Composer is an extensive, open development toolset and framework to make developing

blockchain applications easier. The primary goal is to accelerate time to value, and make it easier to integrate your blockchain applications with the existing business systems.

You can use Hyperledger Composer to model business network, containing your existing assets and the transactions related to them

**Key Concepts of Hyperledger Composer**

1. Blockchain State Storage: It stores all transaction that happens in your hyperledger composer application.

It stores transaction in Hyperledger fabric network.

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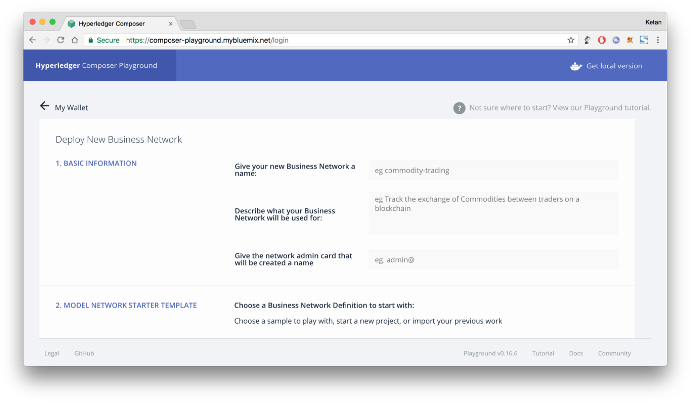
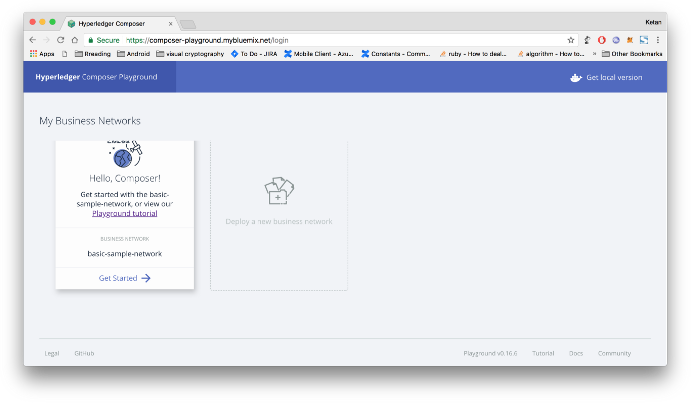
1. Connection Profiles: Connection Profiles to configuration JSON file which help composer to connect to Hyperledger Fabric. You can find Connection Profile JSON file in user’s home directory.
2. Assets: Assets are tangible or intangible goods, services, or property, and are stored in registries. Assets can represent almost anything in a business network, for example, a house for sale, the sale listing, the land registry certificate for that house. Assets must have a unique identifier, but other than that, they can contain whatever properties you define.
3. Participants: Participants are members of a business network. They may own assets and submit transactions. Participant must have an identifier and can have any other properties.
4. Identities and ID cards: Participants can be associated with an identity. ID cards are a combination of an identity, a connection profile, and metadata. ID cards simplify the process of connecting to a business network.
5. Transactions: Transactions are the mechanism by which participants interact with assets. Transaction processing logic you can define in JavaScript and you can also emit event for transaction.
6. Queries: Queries are used to return data about the blockchain world-state. Queries are defined within a business network, and can include variable parameters for simple customisation. By using queries, data can be easily extracted from your blockchain network. Queries are sent by using the Hyperledger Composer API.
7. Events: Events are defined in the model file. Once events have been defined, they can be emitted by transaction processor functions to indicate to external systems that something of importance has happened to the ledger.
8. Access Control: Hyperledger is enterprise blockchain and access control is core feature of any business blockchain. Using Access Control rules you can define who can do what in Business networks. The access control language is rich enough to capture sophisticated conditions.
9. Historian registry: The historian is a specialised registry which records successful transactions, including the participants and identities that submitted them. The historian stores transactions as HistorianRecord assets, which are defined in the Hyperledger Composer system namespace.

**Let’s create first Hyperledger**

**Composer Application**

Step 1: Start Hyperledger Composer Online version of Local. Click on Deploy a new business network

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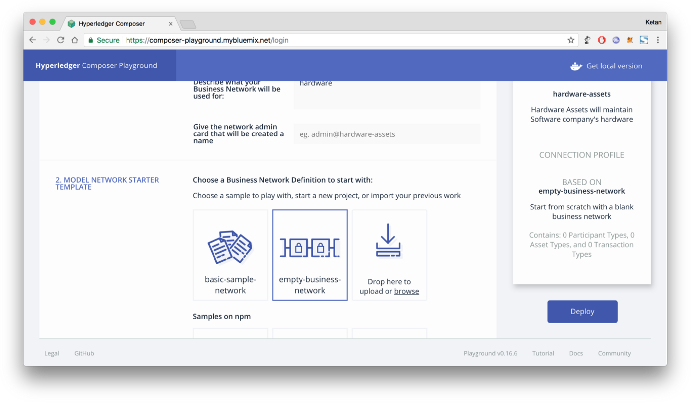
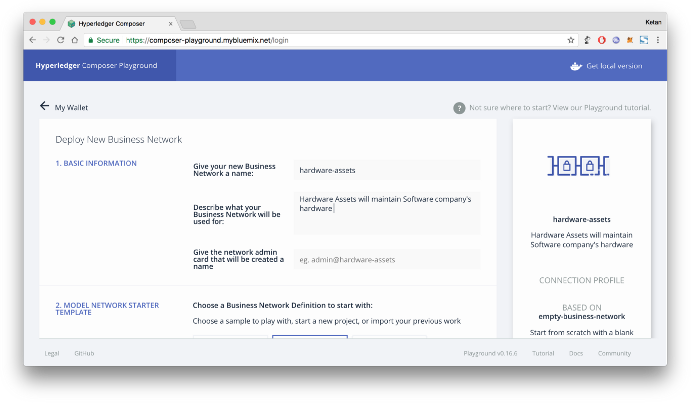


Hyperledger Composer Playground Online version

Step 2: Select empty business network

Step 3: Fill basic information, select empty business network and click “deploy” button from right pannel

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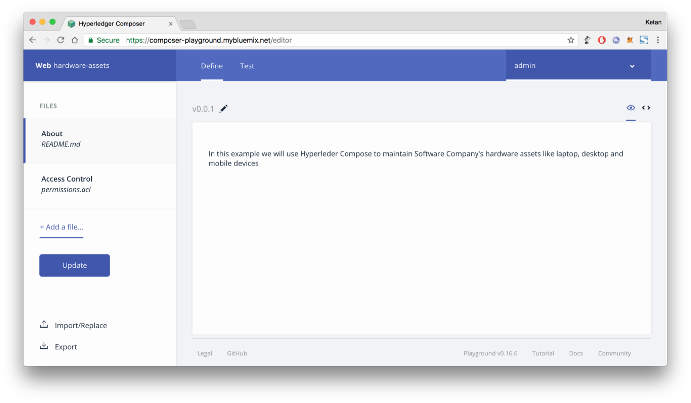
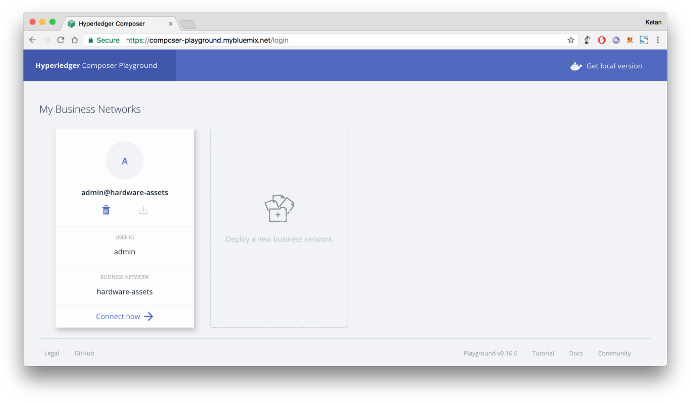


Fill basic information

select empty business network

Step 4: Connect to “hardware-assets” business network that we have just deploied

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click on “connect now” button

Inside hardware-assets business network

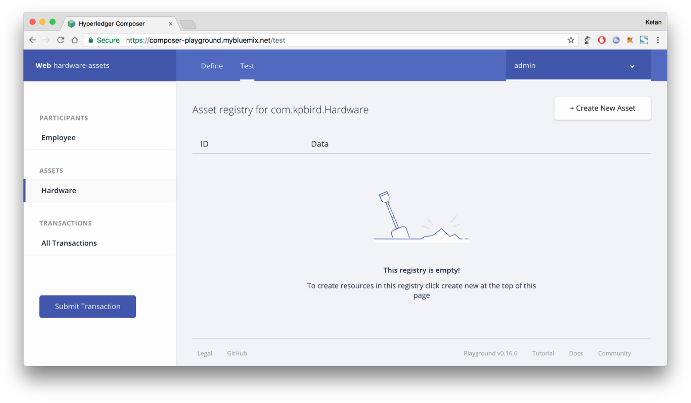
Step 5: Click on “+Add a file…” from left panel and select “model file (.cto)”

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| https://miro.medium.com/max/700/1*gIFsGmFlv24opKBZlCy5VA.png | |
|  | Write following code in model file. Model file contain asset in our case it’s hardware, participant in our case participants are employee of organisation and transaction as Allocate hardware to employee. Each model has extra properties. Make sure your have proper and unique namespace. In this example I am using “com.kpbird” as namespace. You can access all models using this namespace i.e. com.kpbird.Hardware,  com.kpbird.Employee |
| /\*\*  \* Hardware model  \*/namespace com.kpbirdasset Hardware identified by hardwareId { o String hardwareId   * String name * String type * String description * Double quantity   → Employee owner  }  participant Employee identified by employeeId {   * String employeeId * String firstName * String lastName   }  transaction Allocate {  → Hardware hardware  → Employee newOwner  } |
| Hyperledger modeling language    reference: <https://hyperledger.github.io/composer/reference/cto_language.html>      Step 6: Click on “+Add a file…” from left panel and select “script file (\*.js)” |
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| https://miro.medium.com/max/700/1*09HiswnUJwuq1glx_8U7ZA.png | |
|  | Write following code in Script File. In Script we can define transaction processing logic. In our case we want to allocate hardware to the employee so, we will update owner of hardware. Make sure about annotation above  functions @params and @transaction |
| /\*\*   * Track the trade of a commodity from one trader to another * [@param](http://twitter.com/param) {com.kpbird.Allocate} trade — the trade to be processed * [@transaction](http://twitter.com/transaction)   \*/  function allocateHardware(allocate) { allocate.hardware.owner = allocate.newOwner; return getAssetRegistry(‘com.kpbird.Hardware’)  .then(function (assetRegistry) {  return assetRegistry.update(allocate.hardware);  });  } |
| Hyperledger Composer Script file reference:<https://hyperledger.github.io/composer/reference/js_scripts.html>      Step 7: permissions.acl file sample is already available, Add following code in permissions.acl file. |
| /\*\*  \* New access control file  \*/  rule AllAccess {  description: “AllAccess — grant everything to everybody.” participant: “ANY”  operation: ALL  resource: “com.kpbird.\*\*” action: ALLOW  }rule SystemACL{  description: “System ACL to permit all access”  participant: “org.hyperledger.composer.system.Participant” operation: ALL  resource: “org.hyperledger.composer.system.\*\*” action: ALLOW  } |
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| Hyperledger Composer Access Control Language    reference: <https://hyperledger.github.io/composer/reference/acl_language.html>      Step 8: Now, It’s time to test our hardware assets business network. Hyperledger composer gives “Test” facility from composer panel it self. Click on “Test” tab from top panel                                              Test feature of Hyperledger Composer | |
|  | Step 9: Create Assets. Click on “Hardware” from left panel and click “+ Create New Assets” from right top  corner and add following code. We will create Employee#01 in next step. Click on “Create New” button |
| {  “$class”: “com.kpbird.Hardware”, “hardwareId”: “MAC01”,  “name”: “MAC Book Pro 2015”, “type”: “Laptop”,  “description”: “Mac Book Pro”, “quantity”: 1,  “owner”: “resource:com.kpbird.Employee#01”  } |
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| https://miro.medium.com/max/700/1*RjsWddGhrQnkCGYri29sag.png  After adding Hardware assets | |
|  | Steps 10: Let’s create participants. Click “Employee” and click “+ Create New Participants” and add following  code. We will add two employees |
| {  “$class”: “com.kpbird.Employee”, “employeeId”: “01”,  “firstName”: “Ketan”, “lastName”: “Parmar”  } |
| Click on “Create New” on dialog |
| {  “$class”: “com.kpbird.Employee”, “employeeId”: “02”,  “firstName”: “Nirja”, “lastName”: “Parmar”  } |
| https://miro.medium.com/max/700/1*zk-dZPW99lh0ohBEh6dRqA.png  We have two employees  AJEENKYA D Y PATIL SCHOOL OF ENGINEERING, LOHEGAON | |

|  |  |
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| Step 11: It’s time to do transaction, We will allocate Macbook Pro from Ketan (Employee#01) to Nirja (Employee#02). Click on “Submit Transaction” button from left panel. In Transaction dialog, We can see all transaction functions on top “Transaction Type” dropdown.                                              Submit Transaction Dialog | |
|  | {  “$class”: “com.kpbird.Allocate”,  “hardware”: “resource:com.kpbird.Hardware#MAC01”, “newOwner”: “resource:com.kpbird.Employee#02”  } |
| Now, We are allocating Mac01 to Employee 02. Click Submit button after update above JSON in Transaction Dialog. As soon as you hit submit button. Transaction processed and Transaction Id will generate. |
| https://miro.medium.com/max/700/1*66etsPCCCYoBRla_UiecAw.png              AJEENKYA D Y PATIL SCHOOL OF ENGINEERING, LOHEGAON | |



|  |  |
| --- | --- |
| source: <https://hyperledger.github.io/composer/introduction/introduction>  Step 14: Start Docker and run following commands from ~/fabric-tools directory  Install business network to Hyperledger Fabric, If business network is already installed you can use “update”  Step 13: Now, It’s time to deploy “hardware-assets” business network to Hyperledger Fabric. Click on “Define” tab from top panel and click “Export” button from left panel. Export will create hardware-assets.bna file. | |
|  | Following command will deploy and start hardware-assets.bna file. Change hardware-assets.bna file before you execute following command. networkadmin.card file will generate in ~/fabric-tools directory from previous  command. |
| $composer network start — card PeerAdmin@hlfv1 — networkAdmin admin — networkAdminEnrollSecret  adminpw — archiveFile /Users/ketan/Downloads/hardware-assets.bna — file networkadmin.card |
| https://miro.medium.com/max/700/1*k971aVxM_MzOh6-lerpE-A.png  Download hardware-assets.bna file | |
|  | To connect business network you need connection card. so we can import networkadmin.card using following  .bna is Business Network Archive file which contains model, script, network access and query file |
| $composer card import -f networkadmin.card |
| To make sure networkadmin.card successfully install you can list cards using following command |
| $composer card list |
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All Transactions

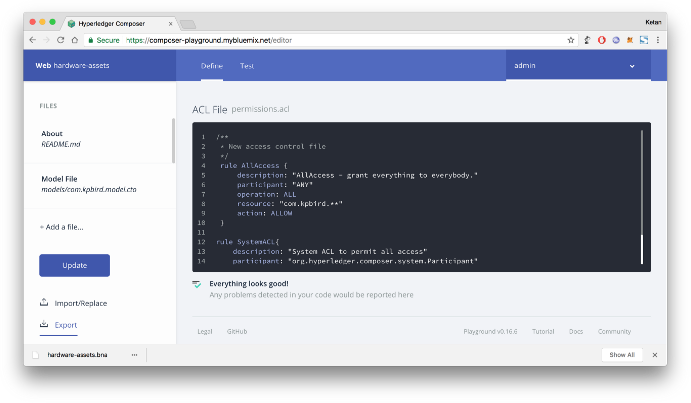
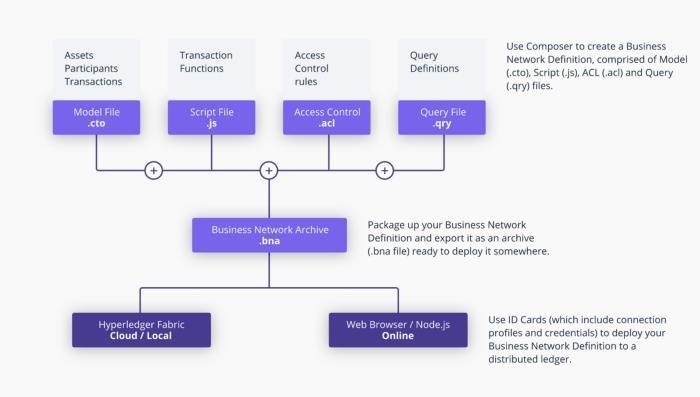
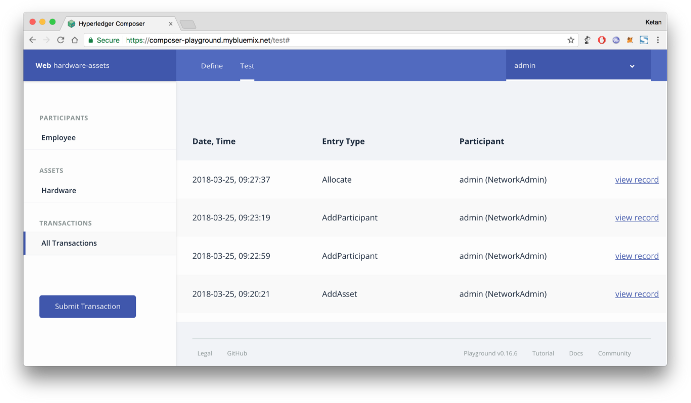
Step 12: Click on “All Transactions” from left panel to verify all transactions. In following screenshots you can see add assets, ass participants and allocation all operation are consider as transactions. “view records” will

give us more information about transaction.

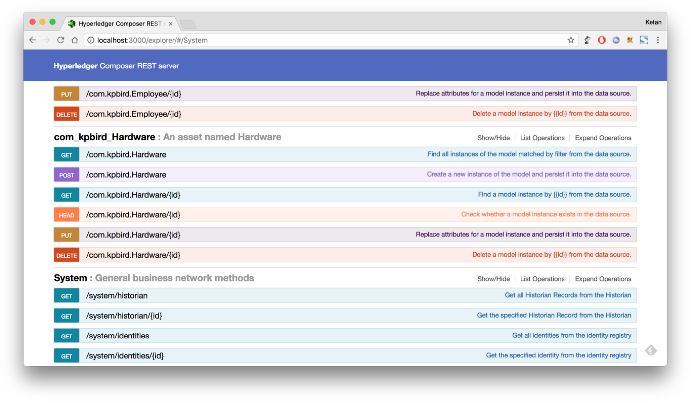
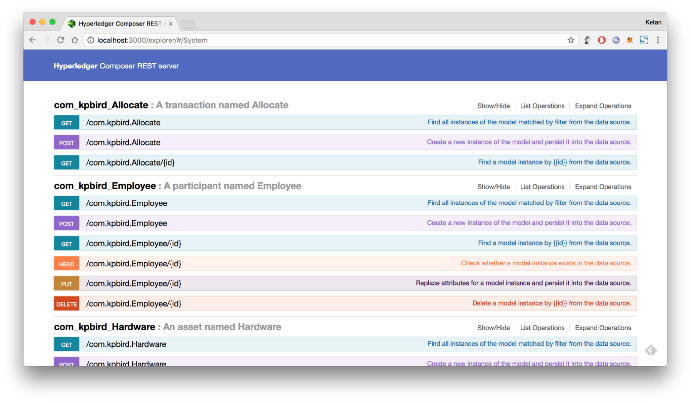
instead of “install”

$composer runtime install -c PeerAdmin@hlfv1 -n hardware-assets

command



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| https://miro.medium.com/max/700/1*-9Dlrg_5HtEv58IOKCakVg.png | |
|  | Following command will make sure that our hardware-assets business network is successfully running in  Hyperledger Fabric. |
| $composer network ping — card admin@hardware-assets |
| https://miro.medium.com/max/700/1*gW2HZrAzE8T-z0Im_mWMVw.png | |
|  | Now It’s time to interact with REST API. To develop Web or Mobile Application we require REST API. you can  run following command to generate REST API for hardware-assets business network. |
| $composer-rest-server |
| https://miro.medium.com/max/700/1*H9cltbnPpu202IgHDNBLMA.png  rest server will ask few basic information before generate rest api  AJEENKYA D Y PATIL SCHOOL OF ENGINEERING, LOHEGAON | |



REST API for our hardware assets

REST API methods for all operations

**Conclusion**: In this way we have learnt about hyperledger and its use case in business world.

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# Assignment No : 18

MINI PROJECT 3

**Code :-** [**https://github.com/sherwyn11/E-Voting-App**](https://github.com/sherwyn11/E-Voting-App)

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