exp-03(binning)

```
# Function to partition data into equal-frequency (equi-depth) bins
def partition_into_bins(data, num_bins):
    data.sort()  # Sort the data
    n = len(data)

    # Calculate how many items should go into each bin
    bin_size = n // num_bins
    remainder = n % num_bins  # Remainder to distribute among bins

    bins = []
    start_index = 0

    for i in range(num_bins):
        # Calculate the size of the current bin
        current_bin_size = bin_size + (1 if i < remainder else 0)  # Distribute the remainder

        # Append the current bin to the list of bins
        bins.append(data[start_index:start_index + current_bin_size])
        start_index += current_bin_size  # Move the start index for the next bin

    return bins

# Function to smooth data by bin means
def smooth_by_bin_means(bins):
    smoothed_bins = []

    for bin in bins:
        bin_mean = sum(bin) // len(bin)  # Calculate bin mean
        smoothed_bins.append([bin_mean] * len(bin))  # Replace all elements in bin by mean

    return smoothed_bins

# Function to smooth data by bin boundaries
def smooth_by_bin_boundaries(bins):
    smoothed_bins = []

    for bin in bins:
        min_boundary = bin[0]  # Minimum value in the bin
        max_boundary = bin[-1]  # Maximum value in the bin

        # Replace each element with the closest boundary
        smoothed_bin = []
        for value in bin:
            if value - min_boundary <= max_boundary - value:
                smoothed_bin.append(min_boundary)
            else:
                smoothed_bin.append(max_boundary)
        smoothed_bins.append(smoothed_bin)

    return smoothed_bins

# Main function to take user input and perform binning
def main():
    # Input data from user (comma-separated values)
    data_input = input("Enter the data (comma-separated values): ")
    data = list(map(int, data_input.split(',')))  # Convert to a list of integers

    # Input bin size from user
    num_bins = int(input("Enter the number of bins: "))

    # Partition the data into equal-frequency bins
    bins = partition_into_bins(data, num_bins)

    # Print original bins
    print("\nOriginal Equal-Frequency Bins:")
    for i, bin in enumerate(bins, 1):
        print(f"Bin {i}: {bin}")

    # Perform smoothing by bin means and retain the same bin structure
    smoothed_by_means = smooth_by_bin_means(bins)
    print("\nSmoothing by Bin Means (in bins):")
    for i, bin in enumerate(smoothed_by_means, 1):
        print(f"Bin {i}: {bin}")

    # Perform smoothing by bin boundaries and retain the same bin structure
    smoothed_by_boundaries = smooth_by_bin_boundaries(bins)
    print("\nSmoothing by Bin Boundaries (in bins):")
    for i, bin in enumerate(smoothed_by_boundaries, 1):
        print(f"Bin {i}: {bin}")

# Run the main function
if __name__ == "__main__":
    main()
```

Exp-04 (Navies Bayes Algorithm)

```
import pandas as pd

def calculate_probability(df, class_label):
    class_count = df['Class'].value_counts().get(class_label, 0)
    total_count = len(df)
    probability = class_count / total_count
    print(f"Probability of '{class_label}': {probability:.4f}")
    return probability

def calculate_conditional_probability(df, feature, value, class_label):
    # Convert boolean to string if necessary
    if isinstance(value, bool):
        value = str(value)

    # Handle case where feature values might be boolean
    if df[feature].dtype == bool:
        value = value.lower() == 'true'  # Convert string 'true'/'false' to boolean
```

```
    # Filter rows and calculate probability
    matching_rows = df[(df[feature].astype(str).str.strip().str.lower() == str(value).lower()) & (df['Class'] == class_label)]
    matching_count = len(matching_rows)
    class_count = df['Class'].value_counts().get(class_label, 0)
    probability = matching_count / class_count if class_count > 0 else 0
    print(f"Conditional probability of '{feature}' = '{value}' given '{class_label}': {probability:.4f}")
    return probability

def predict_class(df, outlook, temperature, humidity, windy):
    print("\nCalculating probabilities for prediction...")

    # Overall probabilities
    play_probability = calculate_probability(df, "Play")
    noplay_probability = calculate_probability(df, "No Play")

    # Conditional probabilities for 'Play'
    i1_playprobability = calculate_conditional_probability(df, 'Outlook', outlook, "Play")
    i2_playprobability = calculate_conditional_probability(df, 'Temperature', temperature, "Play")
    i3_playprobability = calculate_conditional_probability(df, 'Humidity', humidity, "Play")
    i4_playprobability = calculate_conditional_probability(df, 'Windy', windy, "Play")

    # Conditional probabilities for 'No Play'
    i1_noplayprobability = calculate_conditional_probability(df, 'Outlook', outlook, "No Play")
    i2_noplayprobability = calculate_conditional_probability(df, 'Temperature', temperature, "No Play")
    i3_noplayprobability = calculate_conditional_probability(df, 'Humidity', humidity, "No Play")
    i4_noplayprobability = calculate_conditional_probability(df, 'Windy', windy, "No Play")

    # Final probabilities
    final_playprobability = play_probability * i1_playprobability * i2_playprobability * i3_playprobability * i4_playprobability
    final_noplayprobability = noplay_probability * i1_noplayprobability * i2_noplayprobability * i3_noplayprobability * i4_noplayprobability

    print(f"Final probability of 'Play': {final_playprobability:.4f}")
    print(f"Final probability of 'No Play': {final_noplayprobability:.4f}")

    return "Play" if final_playprobability > final_noplayprobability else "No Play"

def main():
    df_train = pd.read_csv("navie_weather.csv")
    df_test = pd.read_csv("navie_test.csv")

    correct_predictions = 0

    # Iterate over each row in the test DataFrame
    for index, row in df_test.iterrows():
        outlook = row['Outlook']
        temperature = row['Temperature']
        humidity = row['Humidity']
        windy = row['Windy']
        actual_class = row['Class']

        # Predict class
        predicted_class = predict_class(df_train, outlook, temperature, humidity, windy)
        # Store predicted class in DataFrame
        df_test.at[index, 'Predicted Class'] = predicted_class

        # Compare and count correct predictions
        if predicted_class == actual_class:
            correct_predictions += 1

    # Calculate accuracy
    accuracy = (correct_predictions / len(df_test)) * 100
    print(f"Accuracy: {accuracy:.2f}%")

    df_test.to_csv("test_with_predictions.csv", index=False)

if __name__ == "__main__":
    main()
```

Start coding or generate with AI.

EXP-05 (kmean_1d)

```
import numpy as np
import pandas as pd
import random
import matplotlib.pyplot as plt

def euclidean_distance(point1, point2):
    """Calculate the Euclidean distance between two points."""
    return np.abs(point1 - point2)

def k_means_clustering_1d(data, k, max_iterations=100):
    """Perform K-means clustering on 1D data."""
    initial_indices = random.sample(range(data.shape[0]), k)
    centers = data[initial_indices]

    print(f"Initial cluster centers (randomly selected): {centers}")

    # Store distances for each iteration
    all_distances = []

    for iteration in range(max_iterations):
        assignments = np.zeros(data.shape[0])
        iteration_distances = []  # Store distances for this iteration

        # (3) Assign each object to the closest cluster
        for i in range(data.shape[0]):
            distances = [round(euclidean_distance(data[i], center), 2) for center in centers]
            iteration_distances.append((data[i], distances))  # Save the point and distances
            assignments[i] = np.argmin(distances)

        all_distances.append(iteration_distances)  # Save distances for the iteration

        # (4) Update the cluster means
        new_centers = np.array([data[assignments == i].mean() for i in range(k)])
```

```
        # Check for convergence
        if np.array_equal(centers, new_centers):
            break
        centers = new_centers

    # Create final clusters
    clusters = [data[assignments == i] for i in range(k)]

    # Print distances for each iteration
    for iter_idx, distances in enumerate(all_distances):
        print(f"\nIteration {iter_idx + 1} distances:")
        for point, distance_values in distances:
            print(f"Distances from point {point} to centers: {distance_values}")

    return clusters

def plot_clusters_1d(data, clusters):
    """Visualize the clustering result for 1D data."""
    plt.figure(figsize=(8, 4))
    colors = ['red', 'green', 'blue', 'orange', 'purple', 'cyan']
    for i, cluster in enumerate(clusters):
        plt.scatter(cluster, np.zeros_like(cluster), color=colors[i % len(colors)], label=f'Cluster {i}')
    plt.title('1D K-means Clustering')
    plt.xlabel('Feature Value')
    plt.yticks([])  # Hide y-axis ticks
    plt.legend()
    plt.grid()
    plt.show()

# Example usage
if __name__ == "__main__":
    # Load data from a CSV file
    data = pd.read_csv('kmean_1d.csv').values.flatten()  # Ensure data is a 1D array

    k = 3  # Number of clusters
    clusters = k_means_clustering_1d(data, k)

    # Output results
    for i, cluster in enumerate(clusters):
        print(f"Cluster {i}: {cluster}")

    # Plot the clusters
    plot_clusters_1d(data, clusters)
```

EXP-05 (kmean_2d)

```
import numpy as np
import pandas as pd
import random
import matplotlib.pyplot as plt

def euclidean_distance(point1, point2):
    """Calculate the Euclidean distance between two points."""
    return np.sqrt(np.sum((point1 - point2) ** 2))

def k_means_clustering_2d(data, k, max_iterations=100):
    """Perform K-means clustering on 2D data."""
    initial_indices = random.sample(range(data.shape[0]), k)
    centers = data[initial_indices]

    print(f"Initial cluster centers (randomly selected): {centers}")

    # Store distances for each iteration
    all_distances = []

    for iteration in range(max_iterations):
        assignments = np.zeros(data.shape[0])
        iteration_distances = []  # Store distances for this iteration

        # (3) Assign each object to the closest cluster
        for i in range(data.shape[0]):
            distances = [round(euclidean_distance(data[i], center), 2) for center in centers]
            iteration_distances.append((data[i], distances))  # Save the point and distances
            assignments[i] = np.argmin(distances)

        all_distances.append(iteration_distances)  # Save distances for the iteration

        # (4) Update the cluster means
        new_centers = np.array([data[assignments == i].mean(axis=0) for i in range(k)])

        # Check for convergence
        if np.array_equal(centers, new_centers):
            break
        centers = new_centers

    # Create final clusters
    clusters = [data[assignments == i] for i in range(k)]

    # Print distances for each iteration
    for iter_idx, distances in enumerate(all_distances):
        print(f"\nIteration {iter_idx + 1} distances:")
        for point, distance_values in distances:
            print(f"Distances from point {point} to centers: {distance_values}")

    return clusters

def plot_clusters(data, clusters):
    """Visualize the clustering result for 2D data."""
    plt.figure(figsize=(8, 6))
    colors = ['red', 'green', 'blue', 'orange', 'purple', 'cyan']
    for i, cluster in enumerate(clusters):
        plt.scatter(cluster[:, 0], cluster[:, 1], color=colors[i % len(colors)], label=f'Cluster {i}')
    plt.title('2D K-means Clustering')
    plt.xlabel('Feature 1')
    plt.ylabel('Feature 2')
    plt.legend()
    plt.grid()
```

```
    plt.show()

# Example usage
if __name__ == "__main__":
    # Load data from a CSV file
    data = pd.read_csv('kmean_2d.csv').values  # Ensure data is a 2D array

    k = 3  # Number of clusters
    clusters = k_means_clustering_2d(data, k)

    # Output results
    for i, cluster in enumerate(clusters):
        print(f"Cluster {i}: {cluster}")

    # Plot the clusters
    plot_clusters(data, clusters)
```

EXP-07 (AGGLOMERITIVE ALGORITM)

```
#Step 1- Read csv file with n features
import pandas as pd
import numpy as np


import matplotlib.pyplot as plt
from scipy.cluster.hierarchy import dendrogram, linkage




# Define the points

"""data = {
    'Point': ['P1', 'P2', 'P3', 'P4', 'P5'],
    'X': [4, 8, 15, 24, 24],
    'Y': [4, 4, 8, 4, 12]
}

df = pd.DataFrame(data)
df.to_csv('data.csv', index=False)
print(df)"""


data = pd.read_csv('agglo_data.csv')
coordinates = data[['X', 'Y']].values
print(data)

#Step2- Find distance between object with every
#other object. You can use Euclidean function
def euclidean_distance(a, b):
    return np.sqrt(np.sum((a - b) ** 2))

#Step 3 - Find Distance Matrix using Euclidean distance formula
# Initialize a distance matrix
num_points = len(coordinates)
distance_matrix = np.zeros((num_points, num_points))

# Compute the distance matrix
for i in range(num_points):
    for j in range(num_points):
        if i != j:
            distance_matrix[i, j] = euclidean_distance(coordinates[i], coordinates[j])

# Display the distance matrix
distance_df = pd.DataFrame(distance_matrix, columns=data['Point'], index=data['Point'])
print("\nDistance Matrix:\n", distance_df)

# Step 4: Find Minimum Distance and Involved Objects for All Points
min_distance = float('inf')
point_pair = (None, None)

for i in range(num_points):
    for j in range(num_points):
        if i != j and distance_matrix[i, j] < min_distance:
            min_distance = distance_matrix[i, j]
            point_pair = (data['Point'][i], data['Point'][j])

# Display the results
print(f"Minimum distance for all points: {point_pair[0]} and {point_pair[1]} – minimum distance = {min_distance:.2f}")

#Step 5 . Merge these objects P1and P2. Now (P1,P2) is one unit/cluster.
# Initialize clusters
clusters = [[data['Point'][i]] for i in range(len(data))]
print("Initial Clusters:", clusters)
# Merge P1 and P2

if point_pair[0] and point_pair[1]:
    merged_cluster = [point_pair[0], point_pair[1]]

    # Update the clusters list
    clusters = [c for c in clusters if c[0] not in merged_cluster]  # Remove old clusters
    clusters.append(merged_cluster)  # Add the new cluster

print("Updated Clusters after merging:", clusters)

#Step 6 : Recalculate the distances.

def update_cluster_coordinates(clusters, original_coordinates):
    new_coordinates = []
    for cluster in clusters:
        if len(cluster) == 1:
            new_coordinates.append(original_coordinates[data['Point'].tolist().index(cluster[0])])
        else:
            avg_coordinates = np.mean([original_coordinates[data['Point'].tolist().index(point)] for point in cluster], axis=0)
            new_coordinates.append(avg_coordinates)

    return np.array(new_coordinates)
```

```
# Calculate new cluster coordinates
updated_coordinates = update_cluster_coordinates(clusters, coordinates)

# Initialize the new distance matrix
num_updated_points = len(updated_coordinates)
new_distance_matrix = np.zeros((num_updated_points, num_updated_points))

# Compute the new distance matrix
for i in range(num_updated_points):
    for j in range(num_updated_points):
        if i != j:
            new_distance_matrix[i, j] = euclidean_distance(updated_coordinates[i], updated_coordinates[j])

# Create a DataFrame for easier reading
new_distance_df = pd.DataFrame(new_distance_matrix, columns=[str(cluster) for cluster in clusters], index=[str(cluster) for cluster in clusters])
print("New Distance Matrix:\n", new_distance_df)



# Perform hierarchical clustering using Ward's method
Z = linkage(df[['X', 'Y']], method='ward')

# Plot the dendrogram
plt.figure(figsize=(8, 6))
dendrogram(Z, labels=df['Point'].values)
plt.title('Dendrogram', fontsize=18, color='red')
plt.xlabel('Points')
plt.ylabel('Distance')
plt.show()
```

Exp-08 (Apriori Algorithm)

```
import pandas as pd
from itertools import combinations

# Load CSV file and preprocess the data
def load_data(file_path):
    data = pd.read_csv(file_path)
    transactions = []

    # Iterate through each row in the DataFrame
    for i in range(len(data)):
        transaction = []
        # Check for each item column (item1, item2, item3, item4, item5)
        for j in range(1, len(data.columns)):
            item = data.iloc[i, j]
            if pd.notna(item):  # Check if the item is not NaN
                transaction.append(item)
        transactions.append(transaction)

    return transactions

# Calculate the support of itemsets
def calculate_support(transactions, itemsets):
    support = {}
    for itemset in itemsets:
        itemset_tuple = tuple(itemset)
        support_count = sum([1 for transaction in transactions if set(itemset).issubset(set(transaction))])
        support[itemset_tuple] = support_count / len(transactions)
    return support

# Prune itemsets that do not meet the minimum support
def prune_itemsets(support, min_support):
    return {itemset: support_val for itemset, support_val in support.items() if support_val >= min_support}

# Generate candidate itemsets of size k+1 from frequent itemsets of size k
def generate_candidates(frequent_itemsets, k):
    candidates = set()
    frequent_items = list(frequent_itemsets.keys())

    for i in range(len(frequent_items)):
        for j in range(i + 1, len(frequent_items)):
            union_set = set(frequent_items[i]).union(frequent_items[j])
            if len(union_set) == k + 1:
                candidates.add(tuple(sorted(union_set)))

    return candidates

# Calculate confidence for association rules
def calculate_confidence(frequent_itemsets, transactions, min_confidence):
    rules = []

    for itemset in frequent_itemsets:
        if len(itemset) > 1:
            subsets = list(combinations(itemset, len(itemset) - 1))

            for subset in subsets:
                remaining = tuple(set(itemset) - set(subset))
                subset_support = sum([1 for transaction in transactions if set(subset).issubset(set(transaction))]) / len(transactions)
                itemset_support = frequent_itemsets[itemset]

                confidence = itemset_support / subset_support if subset_support > 0 else 0

                # Convert confidence to percentage
                confidence_percentage = confidence * 100

                if confidence >= min_confidence:
                    rules.append((subset, remaining, confidence_percentage))

    return rules

# Apriori algorithm
def apriori(transactions, min_support, min_confidence):
    # Generate 1-itemsets
    itemsets = [{item} for transaction in transactions for item in transaction]
    itemsets = [list(x) for x in set(tuple(sorted(x)) for x in itemsets)]
```

```
    # Calculate initial support for 1-itemsets
    support = calculate_support(transactions, itemsets)

    # Filter out itemsets that do not meet minimum support
    frequent_itemsets = prune_itemsets(support, min_support)

    all_frequent_itemsets = frequent_itemsets.copy()
    k = 1

    while frequent_itemsets:
        # Generate candidate itemsets of size k+1
        candidates = generate_candidates(frequent_itemsets, k)

        # Calculate support for candidate itemsets
        support = calculate_support(transactions, candidates)

        # Prune itemsets that do not meet the minimum support
        frequent_itemsets = prune_itemsets(support, min_support)

        # Add frequent itemsets to the global list
        all_frequent_itemsets.update(frequent_itemsets)

        k += 1

    # Calculate confidence for association rules
    rules = calculate_confidence(all_frequent_itemsets, transactions, min_confidence)

    return all_frequent_itemsets, rules

# Main
if __name__ == '__main__':
    file_path = 'aprior.csv'  # Ensure this matches your actual file path
    min_support = 0.3
    min_confidence_percentage = 70  # Minimum confidence in percentage

    # Convert percentage to decimal for calculations
    min_confidence = min_confidence_percentage / 100.0

    # Load transactions
    transactions = load_data(file_path)

    # Run Apriori algorithm
    frequent_itemsets, rules = apriori(transactions, min_support, min_confidence)

    # Output Frequent Itemsets
    print("Frequent Itemsets:")
    for itemset, support in frequent_itemsets.items():
        print(f"{itemset}: {support:.2f}")

    # Output Association Rules with Confidence in Percentage
    print("\nAssociation Rules:")
    for rule in rules:
        antecedent, consequent, confidence = rule
        print(f"{antecedent} -> {consequent}: Confidence = {confidence:.2f}%")
```

EXP-09 (PAGE RANK ALGORITHM)

```
import numpy as np

def page_rank(graph, num_iterations=100, d=0.85):
    """
    Computes the PageRank of each node in the graph.

    Parameters:
    - graph: dict, a dictionary where keys are node IDs and values are lists of nodes they link to
    - num_iterations: int, number of iterations to perform
    - d: float, damping factor (usually set to 0.85)

    Returns:
    - rank: dict, a dictionary of nodes with their corresponding PageRank scores
    """

    # Number of nodes
    num_nodes = len(graph)

    # Initialize PageRank scores
    rank = {node: 1 / num_nodes for node in graph}

    for iteration in range(num_iterations):
        new_rank = {node: (1 - d) / num_nodes for node in graph}

        for node, links in graph.items():
            if len(links) == 0:
                continue  # Handle dangling nodes
            for link in links:
                new_rank[link] += d * (rank[node] / len(links))

        rank = new_rank

        # Print the PageRank scores for this iteration
        print(f"Iteration {iteration + 1}: {rank}")

    return rank

# Example graph represented as an adjacency list
graph = {
    'A': ['B', 'C'],
    'B': ['C'],
    'C': ['A'],
    'D': ['B'],
    'E': ['A', 'D']
}

# Compute PageRank with iteration visualization
rank_scores = page_rank(graph, num_iterations=10)
print("Final PageRank scores:", rank_scores)
```

EXP-10 (HITS ALGORITHM)

```
import numpy as np
import networkx as nx
import matplotlib.pyplot as plt

def hits(graph, num_iterations=100):
    N = len(graph)

    # Initialize hub and authority scores
    hub_scores = np.ones(N)
    authority_scores = np.ones(N)

    for _ in range(num_iterations):
        # Update authority scores
        new_authority_scores = np.zeros(N)
        for i in range(N):
            for j in range(N):
                if graph[j][i] == 1:  # If there's a link from j to i
                    new_authority_scores[i] += hub_scores[j]

        # Update hub scores
        new_hub_scores = np.zeros(N)
        for i in range(N):
            for j in range(N):
                if graph[i][j] == 1:  # If there's a link from i to j
                    new_hub_scores[i] += new_authority_scores[j]

        # Normalize authority scores
        authority_norm = np.linalg.norm(new_authority_scores, 2)
        if authority_norm > 0:
            new_authority_scores /= authority_norm

        # Normalize hub scores
        hub_norm = np.linalg.norm(new_hub_scores, 2)
        if hub_norm > 0:
            new_hub_scores /= hub_norm

        # Check for convergence
        if (np.all(np.abs(new_authority_scores - authority_scores) < 1e-6) and
            np.all(np.abs(new_hub_scores - hub_scores) < 1e-6)):
            break

        authority_scores = new_authority_scores
        hub_scores = new_hub_scores

    return authority_scores, hub_scores

def visualize_graph(graph, authority_scores, hub_scores, pages):
    G = nx.DiGraph()

    # Add edges to the graph
    for i in range(len(graph)):
        for j in range(len(graph)):
            if graph[i][j] == 1:
                G.add_edge(pages[i], pages[j])

    pos = nx.spring_layout(G)  # positions for all nodes
    nx.draw(G, pos, with_labels=True, node_size=2000, node_color='lightblue', font_size=10, font_weight='bold')

    # Display scores on the nodes
    labels = {pages[i]: f"{pages[i]}\nA:{authority_scores[i]:.2f}\nH:{hub_scores[i]:.2f}" for i in range(len(pages))}
    nx.draw_networkx_labels(G, pos, labels=labels)

    plt.title("HITS Algorithm: Authority and Hub Scores")
    plt.show()

# Example usage
pages = ['A', 'B', 'C']
graph = np.array([[0, 1, 1],  # A -> B, A -> C
                  [1, 0, 0],  # B -> A
                  [0, 1, 0]]) # C -> B

authority_scores, hub_scores = hits(graph)
print("Authority Scores:", authority_scores)
print("Hub Scores:", hub_scores)

# Visualize the graph
visualize_graph(graph, authority_scores, hub_scores, pages)
```