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Task 7: Support Vector Machines (SVM)

CODE:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.svm import SVC
from sklearn.model_selection import train_test_split, GridSearchCV, cross_val_score
from sklearn.preprocessing import StandardScaler
from sklearn.decomposition import PCA
from sklearn.metrics import classification_report, confusion_matrix


df = pd.read_csv('breast-cancer.csv')
print(df.head())

# Step 2: Preprocess Data
# Drop any unnamed columns if present
df = df.loc[:, ~df.columns.str.contains('^Unnamed')]

# Check target column - assume it's named "diagnosis" or similar
if 'diagnosis' in df.columns:
    df['diagnosis'] = df['diagnosis'].map({'M': 1, 'B': 0})  # Malignant = 1, Benign = 0

# Split features and target
X = df.drop('diagnosis', axis=1)
y = df['diagnosis']

# Normalize features
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)

# Train/test split
X_train, X_test, y_train, y_test = train_test_split(X_scaled, y, test_size=0.2, random_state=42)
```

```
# Step 3: Train SVM (Linear)
svm_linear = SVC(kernel='linear', C=1)
svm_linear.fit(X_train, y_train)
print("Linear SVM Accuracy:", svm_linear.score(X_test, y_test))

# Step 4: Train SVM (RBF Kernel)
svm_rbf = SVC(kernel='rbf', C=1, gamma='scale')
svm_rbf.fit(X_train, y_train)
print("RBF SVM Accuracy:", svm_rbf.score(X_test, y_test))

# Step 5: Visualization using PCA (2D projection)
pca = PCA(n_components=2)
X_pca = pca.fit_transform(X_scaled)

# Retrain on PCA-reduced data for visualization
X_train_pca, X_test_pca, y_train_pca, y_test_pca = train_test_split(X_pca, y, test_size=0.2, random_state=42)
svm_vis = SVC(kernel='rbf', C=1, gamma='scale')
svm_vis.fit(X_train_pca, y_train_pca)

# Plot decision boundary
def plot_decision_boundary(X, y, model):
    h = .02
    x_min, x_max = X[:, 0].min() - 1, X[:, 0].max() + 1
    y_min, y_max = X[:, 1].min() - 1, X[:, 1].max() + 1
    xx, yy = np.meshgrid(np.arange(x_min, x_max, h),
                         np.arange(y_min, y_max, h))
    Z = model.predict(np.c_[xx.ravel(), yy.ravel()])
    Z = Z.reshape(xx.shape)
```

```
    plt.contourf(xx, yy, Z, cmap=plt.cm.coolwarm, alpha=0.8)
    plt.scatter(X[:, 0], X[:, 1], c=y, cmap=plt.cm.coolwarm, edgecolors='k')
    plt.xlabel('PC1')
    plt.ylabel('PC2')
    plt.title('SVM Decision Boundary (RBF Kernel)')
    plt.show()

plot_decision_boundary(X_test_pca, y_test_pca, svm_vis)

# Step 6: Hyperparameter Tuning with GridSearchCV
param_grid = {
    'C': [0.1, 1, 10],
    'gamma': ['scale', 0.1, 1, 10],
    'kernel': ['rbf']
}

grid = GridSearchCV(SVC(), param_grid, refit=True, verbose=2, cv=5)
grid.fit(X_train, y_train)

print("Best parameters:", grid.best_params_)
print("Best estimator accuracy:", grid.best_estimator_.score(X_test, y_test))

# Step 7: Cross-Validation
cv_scores = cross_val_score(grid.best_estimator_, X_scaled, y, cv=5)
print("Cross-validation scores:", cv_scores)
print("Mean CV accuracy:", cv_scores.mean())
```

OUTPUT:

```
         id diagnosis  radius_mean  texture_mean  perimeter_mean  area_mean  \
0    842302         M        17.99         10.38          122.80     1001.0
1    842517         M        20.57         17.77          132.90     1326.0
2  84300903         M        19.69         21.25          130.00     1203.0
3  84348301         M        11.42         20.38           77.58      386.1
4  84358402         M        20.29         14.34          135.10     1297.0

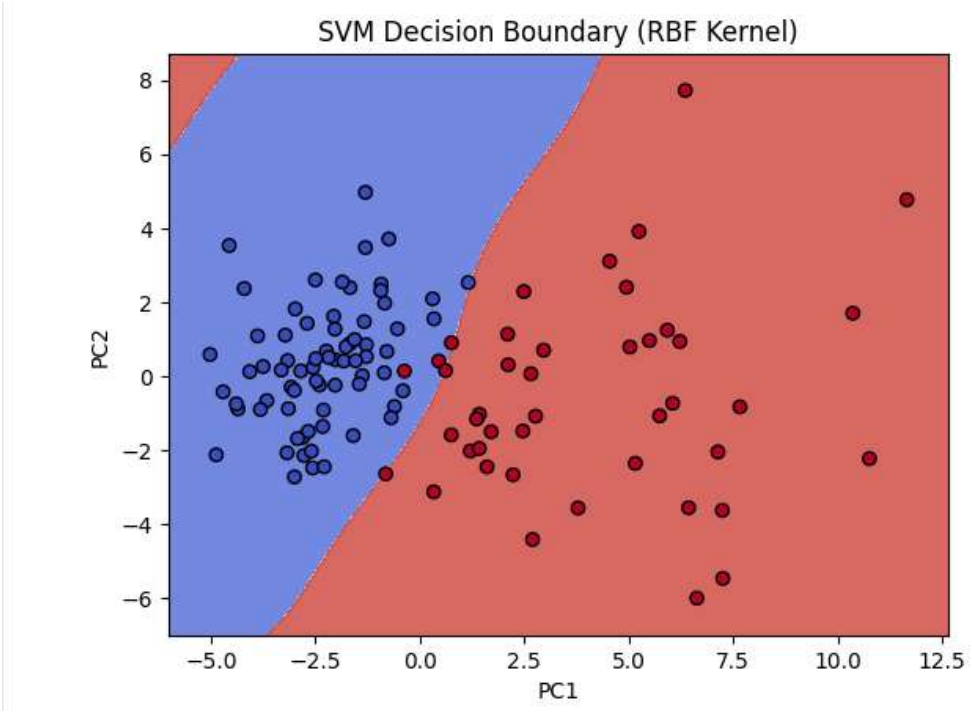
   smoothness_mean  compactness_mean  concavity_mean  concave points_mean  \
0          0.11840           0.27760          0.3001              0.14710
1          0.08474           0.07864          0.0869              0.07017
2          0.10960           0.15990          0.1974              0.12790
3          0.14250           0.28390          0.2414              0.10520
4          0.10030           0.13280          0.1980              0.10430

   ...  radius_worst  texture_worst  perimeter_worst  area_worst  \
0  ...         25.38          17.33           184.60      2019.0
1  ...         24.99          23.41           158.80      1956.0
2  ...         23.57          25.53           152.50      1709.0
3  ...         14.91          26.50            98.87       567.7
4  ...         22.54          16.67           152.20      1575.0

   smoothness_worst  compactness_worst  concavity_worst  concave points_worst  \
0            0.1622             0.6656           0.7119                0.2654
1            0.1238             0.1866           0.2416                0.1860
2            0.1444             0.4245           0.4504                0.2430
3            0.2098             0.8663           0.6869                0.2575
4            0.1374             0.2050           0.4000                0.1625

   symmetry_worst  fractal_dimension_worst
0          0.4601                  0.11890
1          0.2750                  0.08902
2          0.3613                  0.08758
3          0.6638                  0.17300
4          0.2364                  0.07678

[5 rows x 32 columns]
Linear SVM Accuracy: 0.956140350877193
RBF SVM Accuracy: 0.9824561403508771
```

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Fitting 5 folds for each of 12 candidates, totalling 60 fits
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Best parameters: {'C': 1, 'gamma': 'scale', 'kernel': 'rbf'}
Best estimator accuracy: 0.9824561403508771
Cross-validation scores: [0.97368421 0.95614035 1.         0.96491228 0.97345133]
Mean CV accuracy: 0.9736376339077782
```