Pitch Similarity Model Testing

This notebook evaluates multiple regression models to predict pitch embedding coordinates (UMAP) from pitch features.

Features:

- avg_speed
- avg_spin
- avg_break_x
- avg_break_z

Target:

- umap_1
- umap_2

The goal is to find the best model that minimizes Euclidean distance between predicted and true UMAP coordinates.

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split, GridSearchCV, cross_val_score
from sklearn.metrics import mean_squared_error
from sklearn.neighbors import KNeighborsRegressor
from sklearn.ensemble import RandomForestRegressor, GradientBoostingRegressor
from sklearn.svm import SVR
from sklearn.pipeline import Pipeline
from sklearn.preprocessing import StandardScaler
from time import time

# Load data
df = pd.read_csv("final_dataset_pitchDNA.csv")
X = df[["avg_speed", "avg_spin", "avg_break_x", "avg_break_z"]]
y = df[["umap_1", "umap_2"]]
```

```
from sklearn.base import BaseEstimator, RegressorMixin

# Custom wrapper for multi-output regression with Euclidean distance scoring
class EuclideanDistanceWrapper(BaseEstimator, RegressorMixin):
    def __init__(self, base_model):
        self.base_model = base_model

    def fit(self, X, y):
        self.models = []
        for i in range(y.shape[1]):
            model = clone(self.base_model)
            model.fit(X, y.iloc[:, i])
            self.models.append(model)
        return self

    def predict(self, X):
        preds = [model.predict(X) for model in self.models]
        return np.stack(preds, axis=1)

    def score(self, X, y):
        pred = self.predict(X)
        return -np.mean(np.linalg.norm(y - pred, axis=1))  # Negative distance as score
```

```
from sklearn.model_selection import cross_val_score
from sklearn.base import clone

models = {
    "KNN": KNeighborsRegressor(),
```

```
    "RandomForest": RandomForestRegressor(),
    "GradientBoosting": GradientBoostingRegressor(),
    "SVR": SVR()
}

results = {}

for name, model in models.items():
    wrapped = EuclideanDistanceWrapper(model)
    pipeline = Pipeline([("scaler", StandardScaler()), ("reg", wrapped)])
    start = time()
    scores = cross_val_score(pipeline, X, y, cv=3, scoring="neg_root_mean_squared_error")
    duration = time() - start
    results[name] = {
        "mean_rmse": -scores.mean(),
        "std_rmse": scores.std(),
        "train_time_sec": round(duration, 2)
    }

results_df = pd.DataFrame(results).T
results_df.sort_values("mean_rmse")
```

```
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```
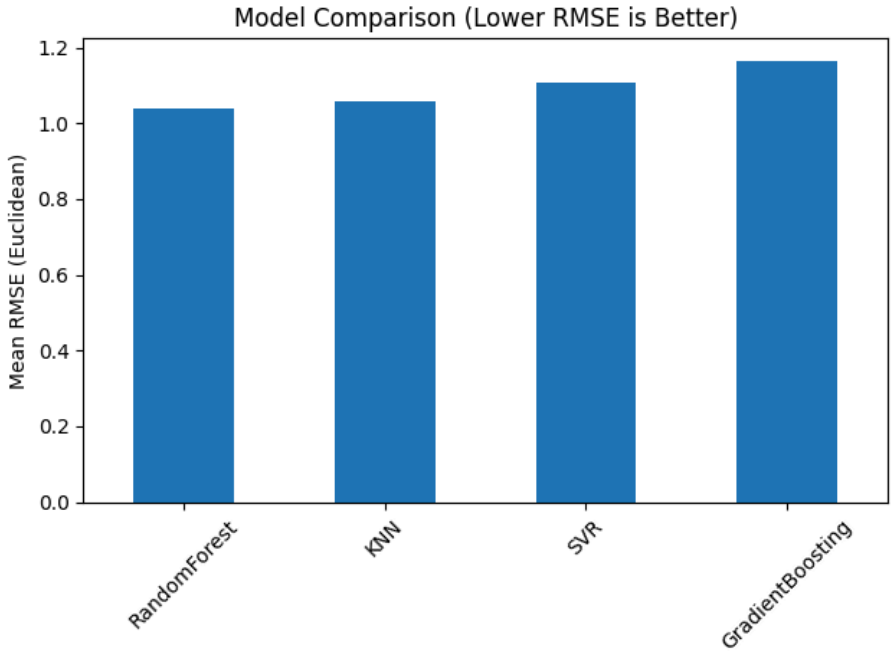

	mean_rmse	std_rmse	train_time_sec
RandomForest	1.040196	0.083170	45.72
KNN	1.058438	0.089451	1.29
SVR	1.107599	0.091613	91.01
GradientBoosting	1.165839	0.072550	9.55

```
results_df.sort_values("mean_rmse").plot(kind="bar", y="mean_rmse", legend=False, title="Model Comparison (Lower RMSE is
plt.ylabel("Mean RMSE (Euclidean)")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```


Model Comparison (Lower RMSE is Better)
Mean RMSE (Euclidean)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
RandomForest
KNN
SVR
GradientBoosting