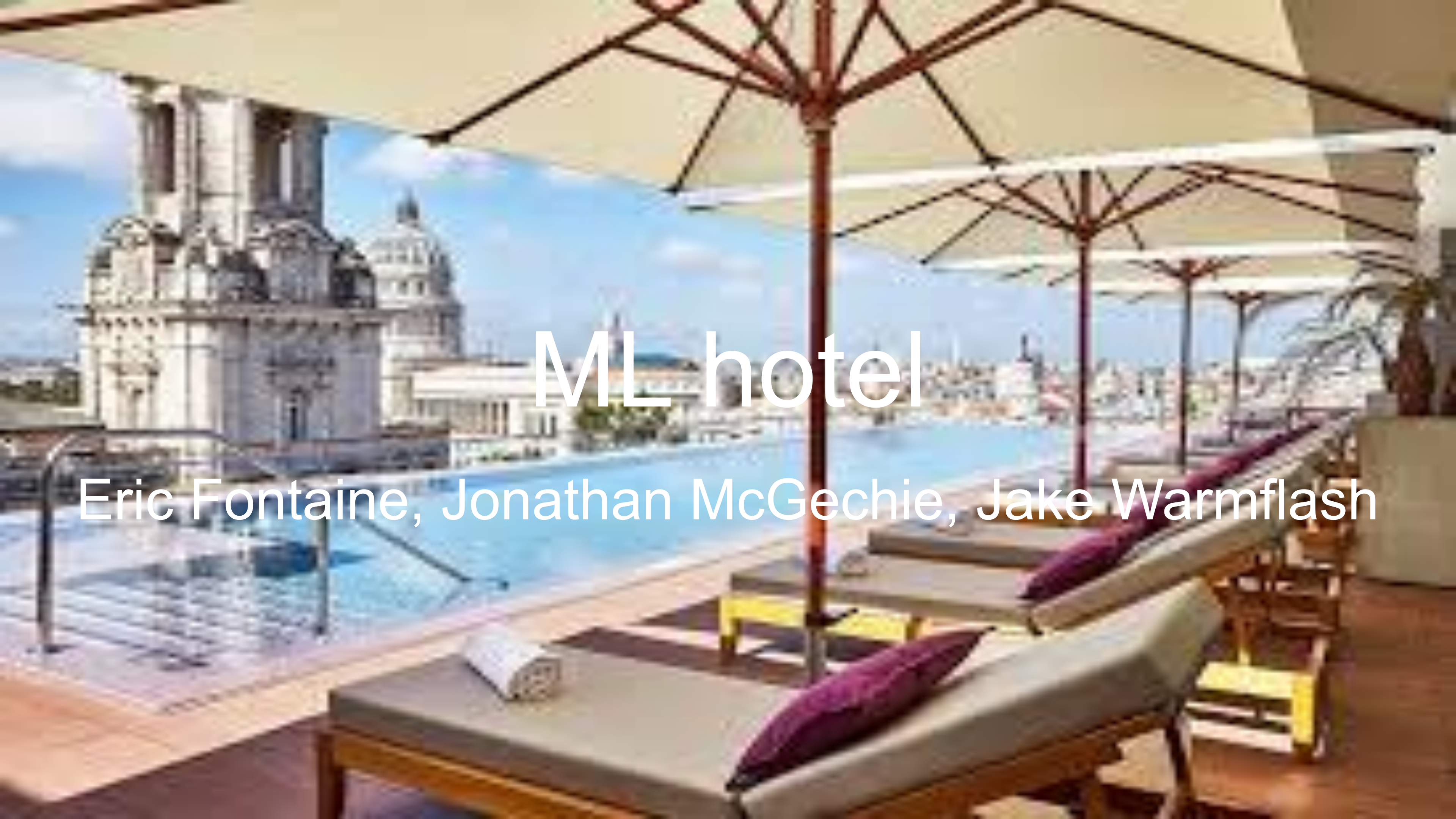


ML hotel

Eric Fontaine, Jonathan McGechie, Jake Warmflash

hotel.head()

Discrete

Discrete

	Booking_ID	no_of_adults	no_of_children	no_of_weekend_nights	no_of_week_nights	type_of_meal_plan	required_car_parking_space	room_type_reserved
0	INN00001	2	0	1	2	Meal Plan 1	0	Room_Type 1
1	INN00002	2	0	2	3	Not Selected	0	Room_Type 1
2	INN00003	1	0	2	1	Meal Plan 1	0	Room_Type 1
3	INN00004	2	0	0	2	Meal Plan 1	0	Room_Type 1
4	INN00005	2	0	1	1	Not Selected	0	Room_Type 1

Discrete

lead_time	arrival_year	arrival_month	arrival_date	market_segment_type	repeated_guest	no_of_previous_cancellations	no_of_previous_bookings_not_canceled
224	2017	10	2	Offline	0	0	0
5	2018	11	6	Online	0	0	0
1	2018	2	28	Online	0	0	0
211	2018	5	20	Online	0	0	0
48	2018	4	11	Online	0	0	0

avg_price_per_room	no_of_special_requests	booking_status
65.00	0	Not_Canceled
106.68	1	Not_Canceled
60.00	0	Canceled
100.00	0	Canceled
94.50	0	Canceled

Response Variable

Dimensions:
689336 x 19

Random Forest Model

```
y = hotel['booking_status']
X = hotel[['no_of_adults','no_of_children','lead_time','avg_price_per_room']]
```

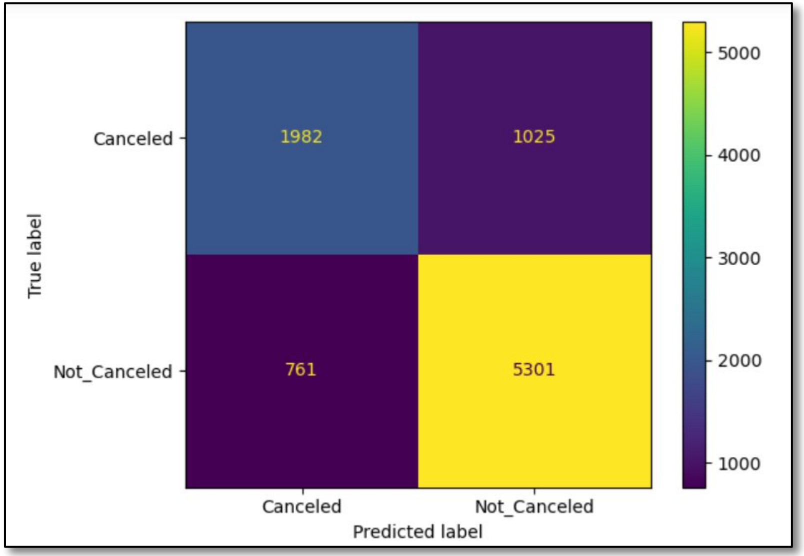
```
model = RandomForestClassifier(n_estimators=10)
```

Cohen Kappa Score: 0.545664070375975

Accuracy: 0.8030653875840776

Precision: 0.72256653

Recall: 0.6591287



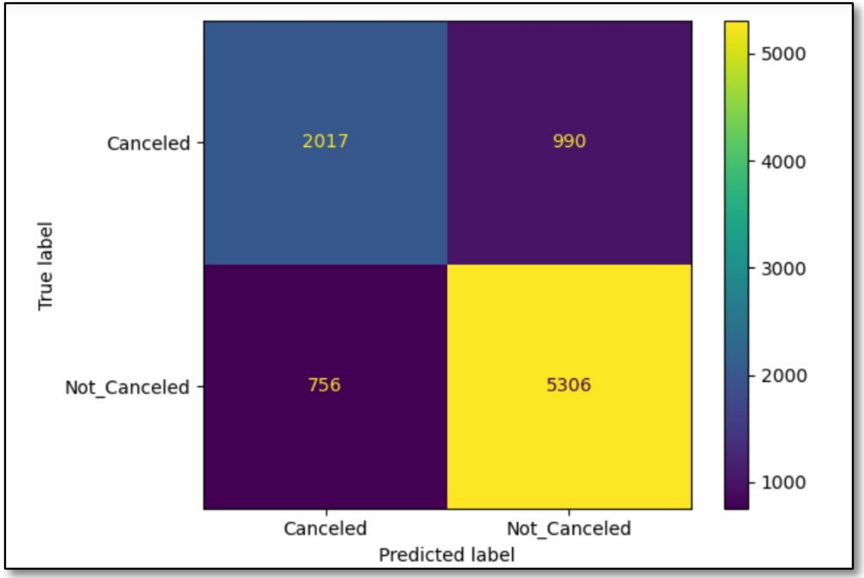
And again…

```
y = hotel['booking_status']
X = hotel[['no_of_adults','no_of_children','lead_time','avg_price_per_room','no_of_previous_cancellations',
          'no_of_previous_bookings_not_canceled','no_of_weekend_nights','no_of_week_nights']]
```

```
model = RandomForestClassifier(n_estimators=10)
```

Cohen Kappa Score:
0.5569784878841972

Accuracy:
0.8074760172014555



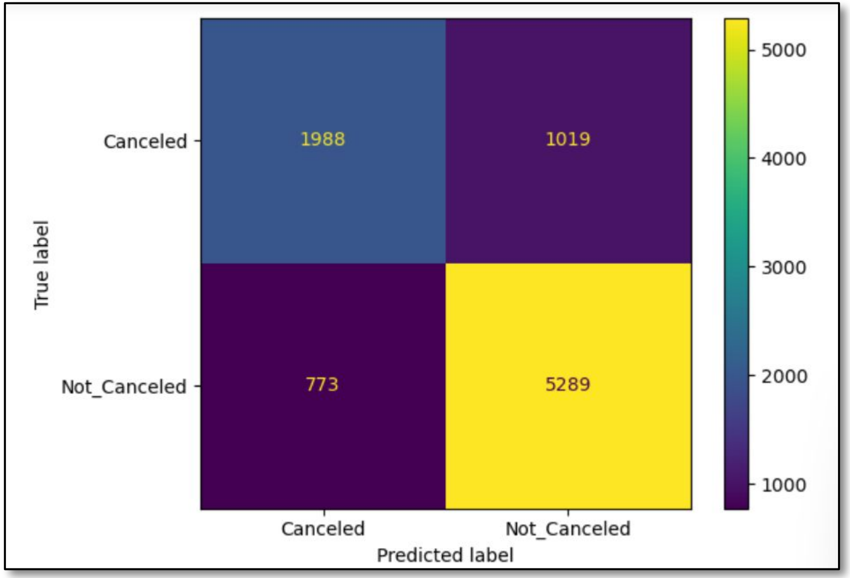
Random Forest Model again

```
y = hotel['booking_status']
X = hotel[['no_of_adults','no_of_children','lead_time','avg_price_per_room',
           'no_of_previous_cancellations','no_of_previous_bookings_not_canceled']]
```

```
model = RandomForestClassifier(n_estimators=10)
```

Cohen Kappa Score:
0.544839821989642

Accuracy:
0.8024037931414709



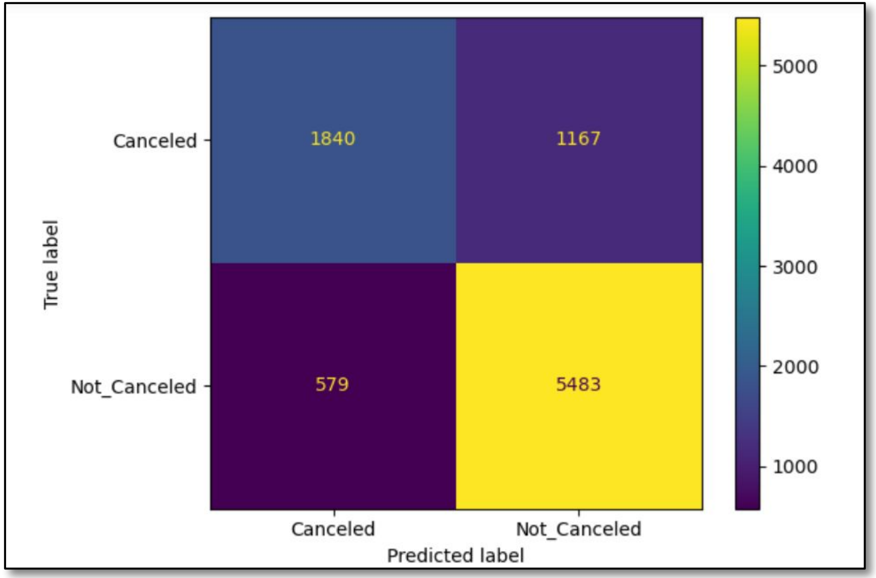
This isn't working

```
y = hotel['booking_status']
X = hotel[['lead_time','no_of_previous_cancellations','no_of_previous_bookings_not_canceled',
         'no_of_special_requests','no_of_adults','no_of_children','type_of_meal_plan']]
```

```
model = RandomForestClassifier(n_estimators=10)
```

Cohen Kappa Score:
0.5431554302923487

Accuracy:
0.8074760172014555



Logistic Regression

```
class_counts = hotel['booking_status'].value_counts()
total_samples = len(hotel['booking_status'])
class_weights = {cls: total_samples / (len(class_counts) * count) for cls, count in class_counts.items()}
print("Class weights:", class_weights)

model = LogisticRegression(class_weight=class_weights)
model.fit(X, y)
```

```
Class weights: {'Not_Canceled': 0.7436449364493645, 'Canceled': 1.526083298275136 7}
```

```
LogisticRegression

LogisticRegression(class_weight={'Canceled': 1.526083298275136 7,
                                 'Not_Canceled': 0.7436449364493645})
```

Fitting model for Logistic Regression

```
model = LogisticRegression()
model.fit(X, y)
```

```
▾ LogisticRegression
LogisticRegression()
```

```
coefficients = model.coef_
print("\nCoefficients:")
print(coefficients)
```

```
Coefficients:
[[ 0.0346784   0.11109366 -0.01271106 -0.01462225]]
```

Predictions Accuracy not the best results.

```
predictions = model.predict(X)
accuracy = accuracy_score(y, predictions)
print("\nAccuracy:", accuracy)
```

```
Accuracy: 0.7606064782908339
```

Running X_train for the Logistic Regression

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

model = LogisticRegression(class_weight=class_weights)

model.fit(X_train, y_train)

test_accuracy = model.score(X_test, y_test)
print("Test Accuracy:", test_accuracy)

cv_scores = cross_val_score(model, X, y, cv=5)
print("Cross-validation Scores:", cv_scores)
print("Mean Cross-validation Score:", cv_scores.mean())
```

```
Test Accuracy: 0.7246037215713301
Cross-validation Scores: [0.71316334 0.71964163 0.71192281 0.71619573 0.71964163]
Mean Cross-validation Score: 0.7161130254996554
```

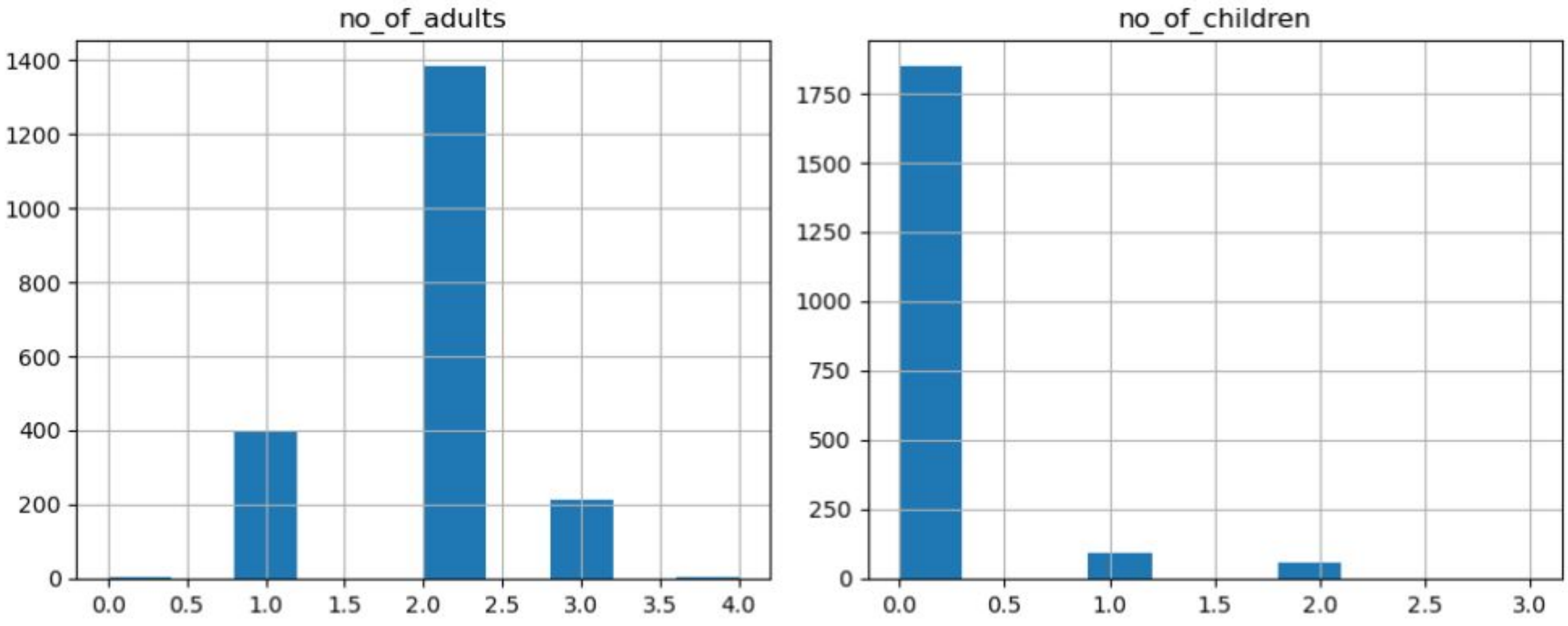
Wondering why the accrucary went down. Misclassification?

```
y_pred = model.predict(X_test)
misclassified_indices = (y_pred !=y_test)
misclassified_examples = X_test[misclassified_indices]
misclassified_labels = y_test[misclassified_indices]
misclassified_predictions = y_pred[misclassified_indices]

print("Number of misclassified examples:", len(misclassified_examples))
print("\nMisclassified examples:")
print(misclassified_examples.head())
```

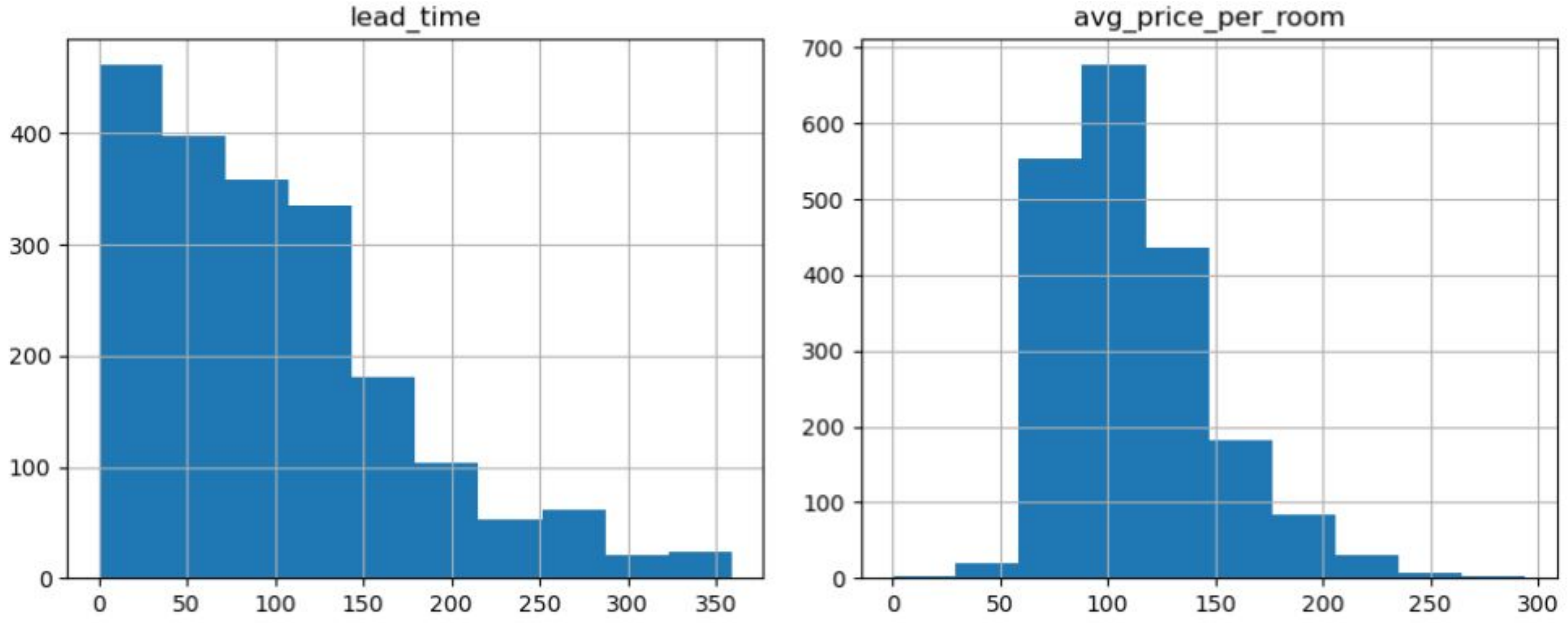
```
Number of misclassified examples: 1998

Misclassified examples:
       no_of_adults  no_of_children  lead_time  avg_price_per_room
1553              2               0         23              127.67
24974             2               1          9              201.50
27079             2               0        102              109.00
25283             2               0        131               82.79
35758             3               0         71              168.30
```

Misclassification? Graphing the misclassified_examples

```
misclassified_examples.hist(figsize=(10, 8))
plt.tight_layout()
plt.show()
```

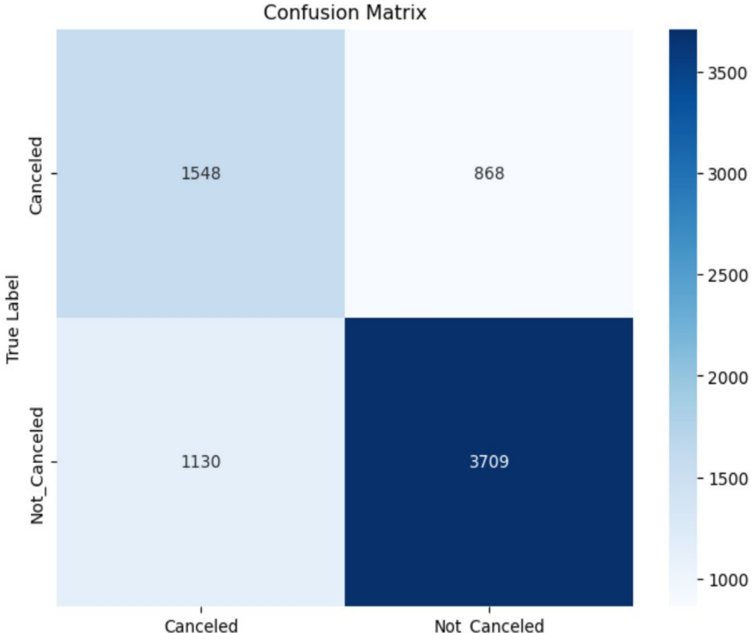


Misclassification? Graphing the misclassified_examples continued



What does the Confusion Matrix show for Logistic Regression

```
conf_matrix = confusion_matrix(y_test, y_pred)
plt.figure(figsize=(8, 6))
sns.heatmap(conf_matrix, annot=True, fmt='d', cmap='Blues')
plt.xlabel('Predicted Label')
plt.ylabel('True Label')
plt.title('Confusion Matrix')
class_labels = ['Canceled','Not_Canceled']
plt.xticks(ticks=[0.5, 1.5], labels=class_labels)
plt.yticks(ticks=[0.5, 1.5], labels=class_labels)
plt.show()
```



Precision:
0.5780433
Recall:
0.6407284

Lets try a Feature Selector with a Transformer

```
y = hotel['booking_status']
X = hotel[['no_of_adults','no_of_children','no_of_weekend_nights','no_of_week_nights','type_of_meal_plan',
           'required_car_parking_space','room_type_reserved','lead_time','arrival_year','arrival_month',
           'arrival_date','market_segment_type','repeated_guest','no_of_previous_cancellations',
           'no_of_previous_bookings_not_canceled','avg_price_per_room','no_of_special_requests']]
```

```
transformer = ColumnTransformer(
        [('categories', encoder, ['type_of_meal_plan', 'room_type_reserved', 'market_segment_type']),
        ('scaled_price_points', StandardScaler(),
['no_of_adults','no_of_children','no_of_weekend_nights','no_of_week_nights',
                                                    'required_car_parking_space','lead_time','arrival_year','arrival_month',
                                                    'arrival_date','repeated_guest','no_of_previous_cancellations',
                                                    'no_of_previous_bookings_not_canceled','avg_price_per_room',
                                                    'no_of_special_requests'])],
        remainder='drop', verbose_feature_names_out=False)
```

```
transformer.fit(X_train, y_train)
```

Lets try a Feature Selector with a Transformer

```
feature_selector = SelectKBest(k=10)
```

```
X_train_trans_df.columns[feature_selector.get_support()]
```

```
Index(['type_of_meal_plan_infrequent_sklearn', 'market_segment_type_Online',
       'market_segment_type_infrequent_sklearn', 'no_of_week_nights',
       'required_car_parking_space', 'lead_time', 'arrival_year',
       'repeated_guest', 'avg_price_per_room', 'no_of_special_requests'],
      dtype='object')
```

Using Those Chosen Features…

```
y = hotel['booking_status']
X = hotel[['no_of_week_nights','type_of_meal_plan',
          'required_car_parking_space','lead_time','arrival_year','market_segment_type',
          'repeated_guest','avg_price_per_room','no_of_special_requests']]
```

```
transformer = ColumnTransformer(
        [('categories', encoder, ['type_of_meal_plan', 'market_segment_type']),
        ('scaled_hotel', StandardScaler(), ['no_of_week_nights',
          'required_car_parking_space','lead_time','arrival_year',
          'repeated_guest','avg_price_per_room','no_of_special_requests'])],
        remainder='drop', verbose_feature_names_out=False)
```

Add a Pipeline…

```
y = hotel['booking_status']
X = hotel[['no_of_week_nights','type_of_meal_plan',
          'required_car_parking_space','lead_time','arrival_year','market_segment_type',
          'repeated_guest','avg_price_per_room','no_of_special_requests']]
```

```
classification_pipeline = Pipeline([('hotel_transformer', transformer),
                                    ('RF_model', RandomForestClassifier())])
```

```
classification_pipeline.fit(X_train, y_train)
y_pred = classification_pipeline.predict(X_test)
```

```
Accuracy = 0.8797000771860183
```

Much Better!

Hyperparameters?

```
y = hotel['booking_status']
X = hotel[['no_of_week_nights','type_of_meal_plan',
          'required_car_parking_space','lead_time','arrival_year','market_segment_type',
          'repeated_guest','avg_price_per_room','no_of_special_requests']]
```

```
parameters = {
    'hotel_transformer__categories__max_categories': randint(3, 30),
    'RF_model__max_depth': randint(3, 30),
    'RF_model__min_samples_leaf': randint(2, 10),
    'RF_model__n_estimators': randint(50, 200),
    'RF_model__min_samples_split': randint(2, 10)}
```

```
n_iter_search = 100
random_search = RandomizedSearchCV(classification_pipeline,
param_distributions=parameters, n_iter=n_iter_search, n_jobs=-1)
```

This gives us

```
y = hotel['booking_status']
X = hotel[['no_of_week_nights','type_of_meal_plan',
          'required_car_parking_space','lead_time','arrival_year','market_segment_type',
          'repeated_guest','avg_price_per_room','no_of_special_requests']]
```

```
random_search.best_score_ = 0.8821259234755762
```

```
random_search.best_estimator_.get_params()
```

```
Chosen Hyperparameters:
max_categories=25
max_depth=25
min_samples_leaf=2
min_samples_split=3
n_estimators=143
```

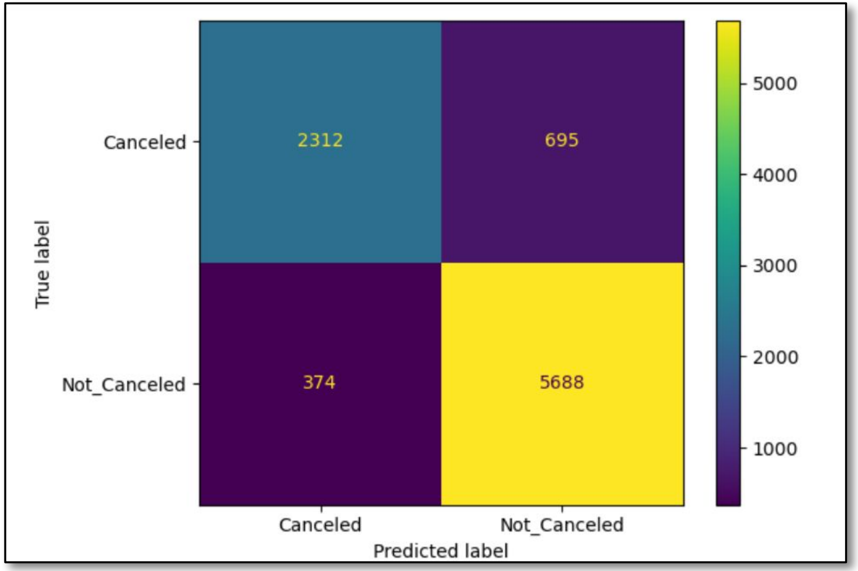
Hyperparameters and Selected Features

```
y = hotel['booking_status']
X = hotel[['no_of_week_nights','type_of_meal_plan',
          'required_car_parking_space','lead_time','arrival_year','market_segment_type',
          'repeated_guest','avg_price_per_room','no_of_special_requests']]
```

y_pred=random_search.predict(X_test)
Accuracy: 0.8821259234755762

Chosen Hyperparameters:
max_categories=25
max_depth=25
min_samples_leaf=2
min_samples_split=3
n_estimators=143

Precision:
0.8607595
Recall:
0.7688726



PCA with Eigenvectors (Linear Regression)

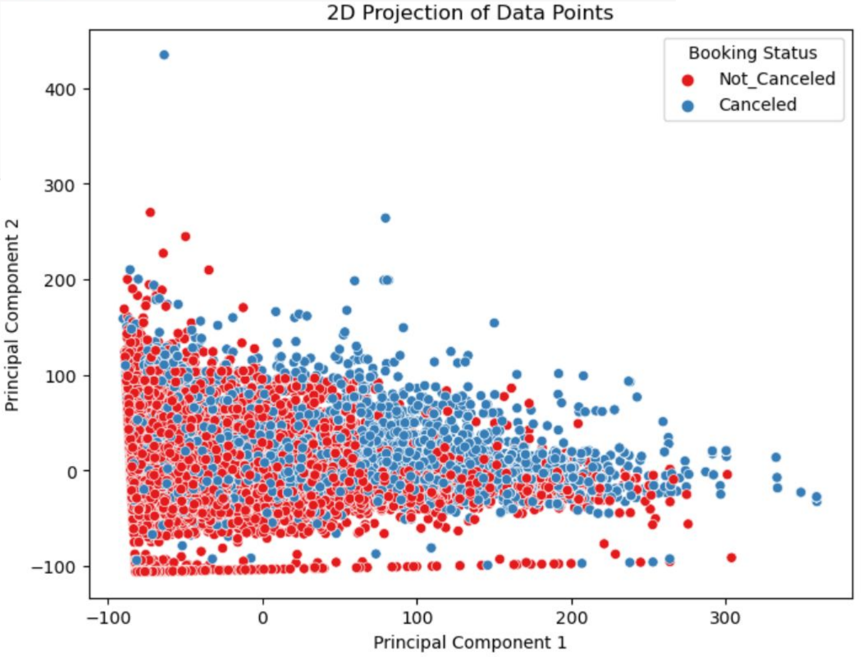
```
pca = PCA(n_components=2)
X_pca = pca.fit_transform(X)
explained_variance_ratio = pca.explained_variance_ratio_
components = pca.components_

print("\nExplained variance ratio:")
print(explained_variance_ratio)
print("\nEigenvectors (Principal Components):")
print(components)
```

```
Explained variance ratio:
[0.85771362 0.14224167]

Eigenvectors (Principal Components):
[[ 5.64148362e-04 -2.40165426e-04  9.99530526e-01 -3.06325338e-02]
 [ 4.51653439e-03  3.85142888e-03  3.06303777e-02  9.99513155e-01]]
```

PCA and 2D Visualization

```
# Visualization and interpretation
df_pca = pd.DataFrame(data=X_pca, columns=['PC1', 'PC2'])
df_pca['booking_status'] = y
```

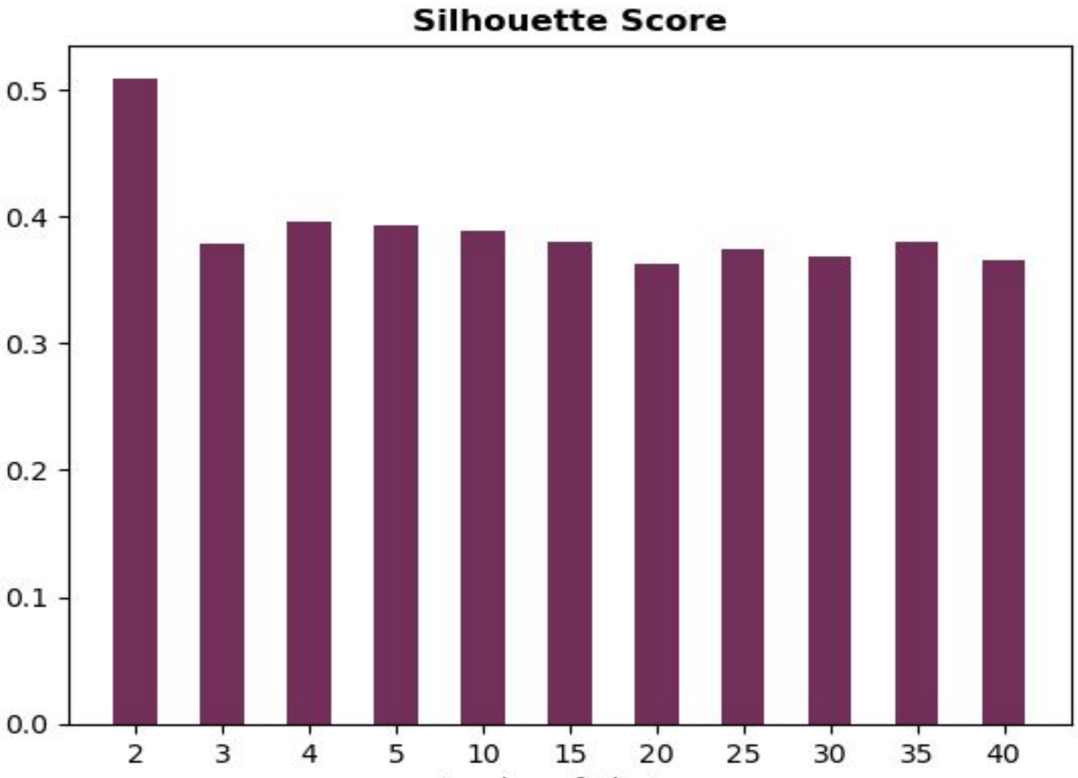
```
plt.figure(figsize=(8, 6))
sns.scatterplot(data=df_pca, x='PC1', y='PC2', hue='booking_status', palette='Set1')
plt.title('2D Projection of Data Points')
plt.xlabel('Principal Component 1')
plt.ylabel('Principal Component 2')
plt.legend(title='Booking Status')
plt.show()
```



K mean Clustering & Silhouette Scores

```
Parameter: {'n_clusters': 2} Score 0.5087978989897487
```

```
from sklearn import metrics
from sklearn.model_selection import
ParameterGrid
```

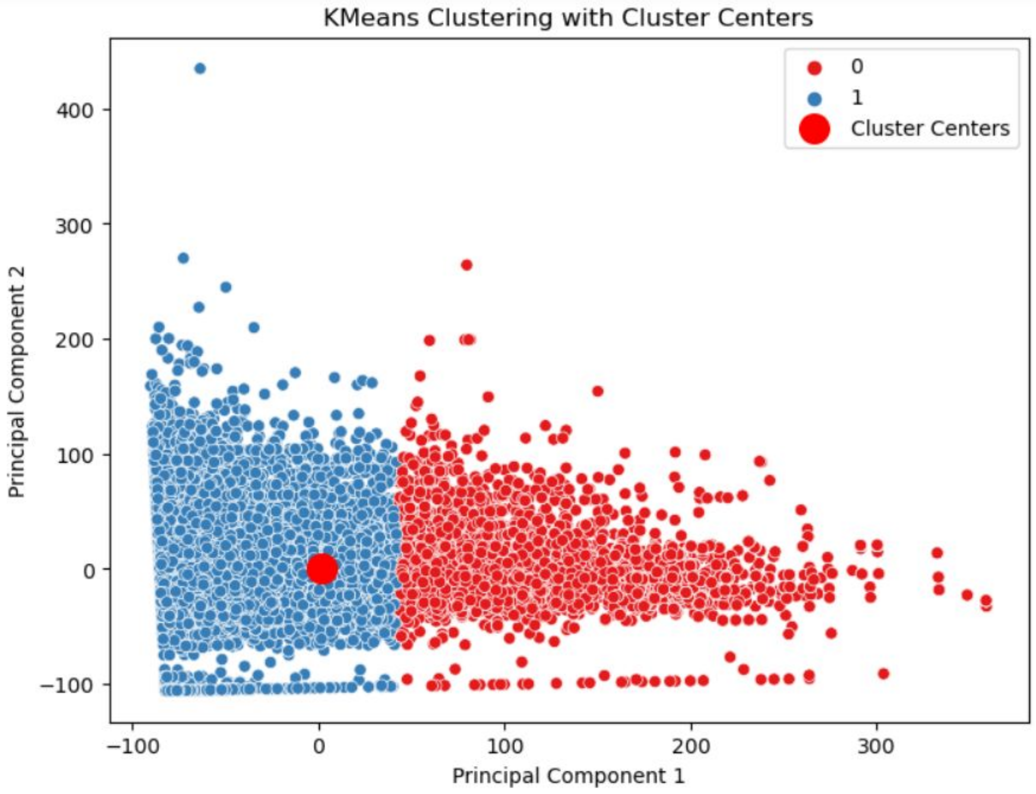


Cluster Analysis (KMeans)

```
# Cluster analysis
kmeans = KMeans(n_clusters=2)
clusters = kmeans.fit_predict(X)
cluster_centers = kmeans.cluster_centers_
print("\nCluster centers:")
print(cluster_centers)
```

```
Cluster centers:
[[1.89558906e+00 8.49804578e-02 2.12248576e+02 1.00465587e+02]
 [1.82836750e+00 1.11932650e-01 4.35990117e+01 1.04393102e+02]]
```

Cluster Analysis (KMeans) Cluster Graph



Curse of Dimensionality


ML
SUPERVISED LEARNING
UNSUPERVISED LEARNING
imgflip.com


We'll leave the light on for you.®
motel 6