In [ ]:
```
from luma.preprocessing.imputer import SimpleImputer
from luma.preprocessing.encoder import OneHotEncoder
from luma.ensemble.forest import RandomForestClassifier
from luma.model_selection.split import TrainTestSplit
from luma.model_selection.search import GridSearchCV
from luma.pipe.pipeline import Pipeline
from luma.visual.eda import CorrelationHeatMap, MissingProportion
from luma.metric.classification import Accuracy, Complex

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

Load Datasets

In [ ]:
```
train_data = pd.read_csv('data/spaceship/train.csv')
test_data = pd.read_csv('data/spaceship/test.csv')

train_data
```

Out[ ]:

	PassengerId	HomePlanet	CryoSleep	Cabin	Destination	Age	VIP	RoomService	FoodCourt	ShoppingMall	Spa	VRDeck	Name	Transported
0	0001_01	Europa	False	B/0/P	TRAPPIST-1e	39.0	False	0.0	0.0	0.0	0.0	0.0	Maham Ofracculy	False
1	0002_01	Earth	False	F/0/S	TRAPPIST-1e	24.0	False	109.0	9.0	25.0	549.0	44.0	Juanna Vines	True
2	0003_01	Europa	False	A/0/S	TRAPPIST-1e	58.0	True	43.0	3576.0	0.0	6715.0	49.0	Altark Susent	False
3	0003_02	Europa	False	A/0/S	TRAPPIST-1e	33.0	False	0.0	1283.0	371.0	3329.0	193.0	Solam Susent	False
4	0004_01	Earth	False	F/1/S	TRAPPIST-1e	16.0	False	303.0	70.0	151.0	565.0	2.0	Willy Santantines	True
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8688	9276_01	Europa	False	A/98/P	55 Cancri e	41.0	True	0.0	6819.0	0.0	1643.0	74.0	Gravior Noxnuther	False
8689	9278_01	Earth	True	G/1499/S	PSO J318.5-22	18.0	False	0.0	0.0	0.0	0.0	0.0	Kurta Mondalley	False
8690	9279_01	Earth	False	G/1500/S	TRAPPIST-1e	26.0	False	0.0	0.0	1872.0	1.0	0.0	Fayey Connon	True
8691	9280_01	Europa	False	E/608/S	55 Cancri e	32.0	False	0.0	1049.0	0.0	353.0	3235.0	Celeon Hontichre	False
8692	9280_02	Europa	False	E/608/S	TRAPPIST-1e	44.0	False	126.0	4688.0	0.0	0.0	12.0	Propsh Hontichre	True

8693 rows × 14 columns

Remove Redundant Columns

In [ ]:
```
remove_col = ['PassengerId', 'Name', 'Cabin']
train_data.drop(remove_col, axis=1, inplace=True)
test_data.drop(remove_col, axis=1, inplace=True)

train_data
```

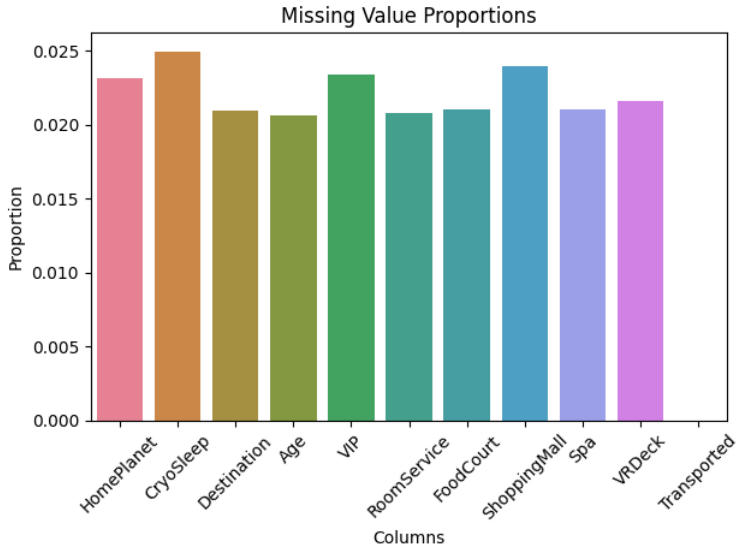
Out[ ]:

	HomePlanet	CryoSleep	Destination	Age	VIP	RoomService	FoodCourt	ShoppingMall	Spa	VRDeck	Transported
0	Europa	False	TRAPPIST-1e	39.0	False	0.0	0.0	0.0	0.0	0.0	False
1	Earth	False	TRAPPIST-1e	24.0	False	109.0	9.0	25.0	549.0	44.0	True
2	Europa	False	TRAPPIST-1e	58.0	True	43.0	3576.0	0.0	6715.0	49.0	False
3	Europa	False	TRAPPIST-1e	33.0	False	0.0	1283.0	371.0	3329.0	193.0	False
4	Earth	False	TRAPPIST-1e	16.0	False	303.0	70.0	151.0	565.0	2.0	True
...	...	...	...	...	...	...	...	...	...	...	...
8688	Europa	False	55 Cancri e	41.0	True	0.0	6819.0	0.0	1643.0	74.0	False
8689	Earth	True	PSO J318.5-22	18.0	False	0.0	0.0	0.0	0.0	0.0	False
8690	Earth	False	TRAPPIST-1e	26.0	False	0.0	0.0	1872.0	1.0	0.0	True
8691	Europa	False	55 Cancri e	32.0	False	0.0	1049.0	0.0	353.0	3235.0	False
8692	Europa	False	TRAPPIST-1e	44.0	False	126.0	4688.0	0.0	0.0	12.0	True

8693 rows × 11 columns

Missing Value Proportions

In [ ]:
```
miss = MissingProportion(train_data)
miss.plot()
```



Split Original Set into Train and Test Sets

In [ ]:
```
train_data_np = train_data.values
test_data_np = test_data.values

X_train = train_data_np[:, :-1]
X_test = test_data_np

y_train = train_data_np[:, -1].astype(int)
```

Handle Missing Values with Pipeline

In [ ]:
```
pipe_pre = Pipeline(models=[
                        ('si', SimpleImputer()),
                        ('en', OneHotEncoder())
                    ],
                    param_dict={
                        'si__strategy': 'mode',
                        'en__features': [0, 2]
                    })

pipe_pre.dump()
```

```
Configuration of a pipeline:

[SimpleImputer as 'si']
strategy: mode
statistics: None
_fitted: False

[OneHotEncoder as 'en']
categories_: None
features: [0, 2]
_fitted: False
```

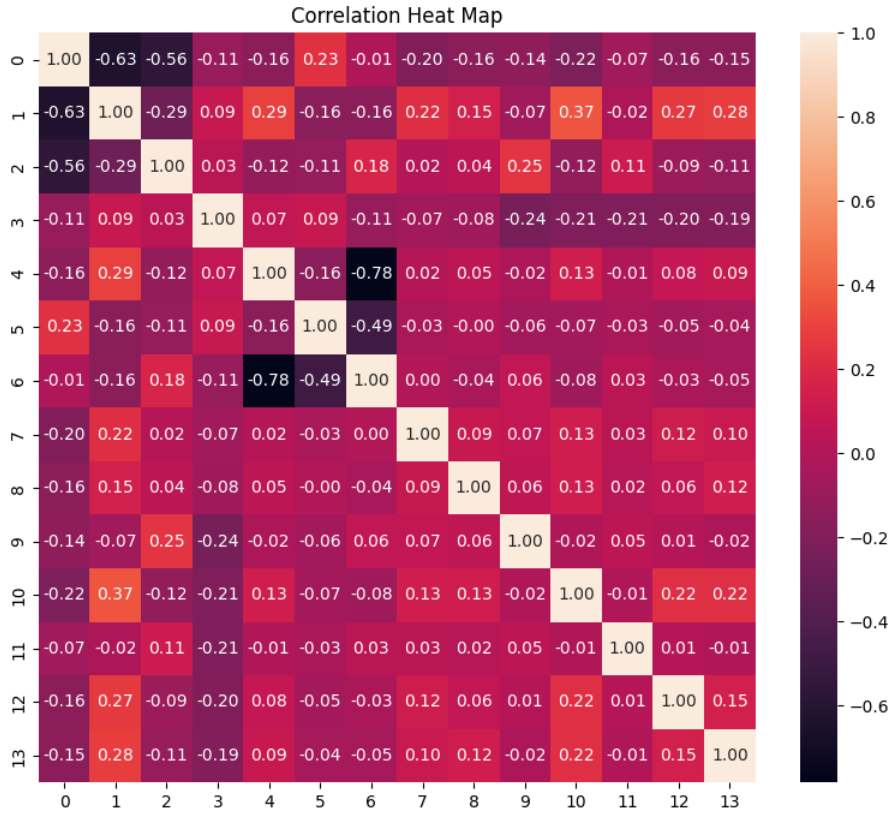
In [ ]:
```
X_train_pre = pipe_pre.fit_transform(X_train, y_train)[0]
X_test_pre = pipe_pre.fit_transform(X_test, None)[0]

X_train_pre
```

Out[ ]:
```
array([[   1,    0,    0, ...,    0,    0,    0],
       [   1,    0,    0, ...,    0, 2823,    0],
       [   0,    1,    0, ...,    0,    0,    0],
       ...,
       [   0,    0,    1, ...,    0,    0,    0],
       [   0,    1,    0, ...,    0,    0,  523],
       [   1,    0,    0, ...,    0,    0,    0]])
```

Correlation Heatmap of Preprocessed Train Set

In [ ]:
```
corr = CorrelationHeatMap(pd.DataFrame(X_train_pre))
corr.plot()
```



Split Train Set into Another Train and Validation Sets

In [ ]:
```
X_train, X_val, y_train, y_val = TrainTestSplit.split(X_train_pre, y_train,
                                                      test_size=0.3,
                                                      random_state=10)

X_train.shape, X_val.shape
```

Out[ ]:
```
((6086, 14), (2607, 14))
```

Random Forest Classifier with GridSeachCV

In [ ]:
```
param_grid = {
    'max_depth': [50, 100, 200],
}

grid = GridSearchCV(model=RandomForestClassifier(),
                    param_grid=param_grid,
                    cv=5,
                    metric=Accuracy,
                    refit=True,
                    verbose=True)

grid.fit(X_train, y_train)
```

```
Fitting 5 folds for 3 candidates, totalling 15 fits.

[GridSearchCV] fold 1 - score: 0.789
[GridSearchCV] fold 2 - score: 0.761
[GridSearchCV] fold 3 - score: 0.765
[GridSearchCV] fold 4 - score: 0.767
[GridSearchCV] fold 5 - score: 0.773
[1/3] {'max_depth': 50} - score: 0.771
[GridSearchCV] fold 1 - score: 0.776
[GridSearchCV] fold 2 - score: 0.770
[GridSearchCV] fold 3 - score: 0.776
[GridSearchCV] fold 4 - score: 0.768
[GridSearchCV] fold 5 - score: 0.749
[2/3] {'max_depth': 100} - score: 0.768
[GridSearchCV] fold 1 - score: 0.795
[GridSearchCV] fold 2 - score: 0.772
[GridSearchCV] fold 3 - score: 0.758
[GridSearchCV] fold 4 - score: 0.773
[GridSearchCV] fold 5 - score: 0.767
[3/3] {'max_depth': 200} - score: 0.773

[GridSearchCV] Best params: {'max_depth': 200}
[GridSearchCV] Best score: 0.7730867985422712
```

Out[ ]:
```
<luma.ensemble.forest.RandomForestClassifier at 0x166db9d20>
```

Validation Scores

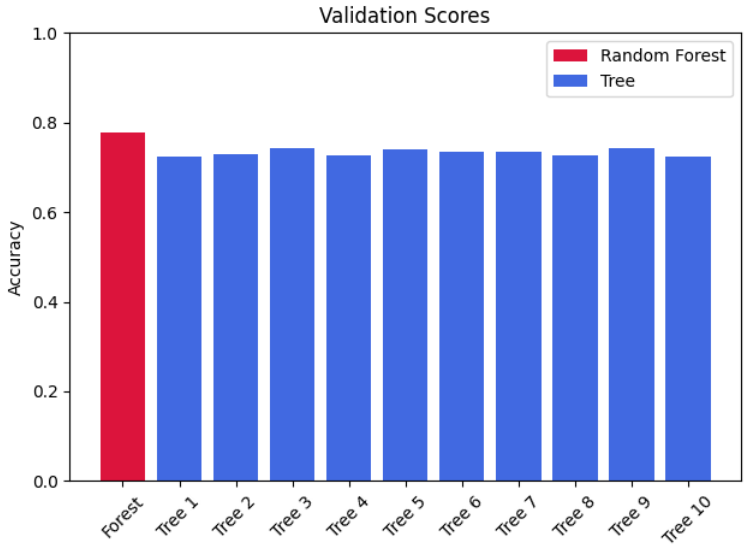
In [ ]:
```
forest = grid.best_model

scores = [forest.score(X_val, y_val)]
for tree in forest.trees:
    scores.append(tree.score(X_val, y_val))

plt.bar(0, scores[0], color='crimson', label='Random Forest')
```

```
plt.bar(range(1, forest.n_trees + 1), scores[1:], color='royalblue', label='Tree')
plt.xticks(range(forest.n_trees + 1),
           ['Forest'] + [f'Tree {i + 1}' for i in range(forest.n_trees)],
           rotation=45)
plt.ylabel('Accuracy')
plt.ylim(0.0, 1.0)
plt.title('Validation Scores')
plt.legend()
plt.tight_layout()
plt.show()

Complex.compute(y_true=y_val, y_pred=forest.predict(X_val))
```



Out[ ]:
```
{'accuracy': 0.7775220560030687,
 'precision': 0.7788089713843774,
 'recall': 0.7740199846272099,
 'f1-score': 0.7764070932922129,
 'specificity': 0.781010719754977}
```

Predict Test Set

In [ ]:
```
y_test_pred = forest.predict(X_test_pre)
np.bincount(y_test_pred)
```

Out[ ]:
```
array([2116, 2161])
```

Export Submission Data

In [ ]:
```
passenger_id = pd.read_csv('data/spaceship/test.csv')['PassengerId'].values

sub = pd.DataFrame({'PassengerId': passenger_id,
                    'Transported': y_test_pred.astype(bool)})

sub.to_csv('data/spaceship/submission.csv', index=False)
sub
```

Out[ ]:

	PassengerId	Transported
0	0013_01	True
1	0018_01	False
2	0019_01	True
3	0021_01	True
4	0023_01	True
...	...	...
4272	9266_02	True
4273	9269_01	False
4274	9271_01	True
4275	9273_01	True
4276	9277_01	False

4277 rows × 2 columns