In [354…

```python
import pandas as pd
import numpy as np
from matplotlib import pyplot as plt
```

Data Pre-processing

Read Animal Centor Intakes and Outcomes data

In [355…

```python
# Read intakes csv file
intakes = pd.read_csv('processed_data/dog_intakes_unified.csv', dtype={
    'AnimalID': 'string',
    'ID': 'string',
    'Breed': 'string',
    'Color': 'string',
    'Gender': 'category',
    'Name': 'string',
    'Intake-DateTime': 'string',
    'Intake-Type': 'string',
    'Intake-Condition': 'string',
    'Intake-Age(days)': 'int',
}, parse_dates=['Intake-DateTime'])
intakes.dtypes
```

Out[355]:

```
AnimalID            string[python]
ID                  string[python]
Breed               string[python]
Color               string[python]
Gender                    category
Name                string[python]
Intake-DateTime     datetime64[ns]
Intake-Type         string[python]
Intake-Condition    string[python]
Intake-Age(days)             int32
dtype: object
```

In [356…

```python
intakes
```

Out[356]:

	AnimalID	ID	Breed	Color	Gender	Name	Intake-DateTime	Intake-Type	Intake-Condition	Intake-Age(days)
0	A006100	A006100	Spinone Italiano	Yellow	Male	Scamp	2014-03-07 14:26:00	Public Assist	Normal	2190
1	A006100	A006100+	Spinone Italiano	Yellow	Male	Scamp	2014-12-19 10:21:00	Public Assist	Normal	2555
2	A006100	A006100++	Spinone Italiano	Yellow	Male	Scamp	2017-12-07 14:07:00	Stray	Normal	3650
3	A047759	A006101	Dachshund	Tricolor	Male	Oreo	2014-04-02 15:55:00	Owner Surrender	Normal	3650
4	A134067	A134067	Shetland Sheepdog	Brown	Male	Bandit	2013-11-16 09:02:00	Public Assist	Injured	12190
...	...	...	...	...	...	...	...	...	...	...
87059	A893570	A893570	Rottweiler	Black	Female	<NA>	2023-11-23 12:17:00	Stray	Normal	730
87060	A893573	A893573	Border Terrier	Brown	NaN	<NA>	2023-11-23 13:45:00	Stray	Normal	730
87061	A893578	A893578	American Staffordshire Terrier	Yellow Brindle	Male	Tiger	2023-11-23 20:19:00	Stray	Injured	240
87062	A893579	A893579	American Staffordshire Terrier	Black	Male	<NA>	2023-11-23 21:00:00	Stray	Injured	730
87063	A893585	A893585	German Shepherd	Black	Male	Unknown	2023-11-23 20:19:00	Stray	Injured	30

87064 rows × 10 columns

In [357…

```python
# Read outcomes csv file
outcomes = pd.read_csv('processed_data/dog_outcomes_unified.csv', dtype={
    'AnimalID': 'string',
    'ID': 'string',
    'Breed': 'string',
    'Color': 'string',
    'Gender': 'category',
    'Name': 'string',
    'Date-Of-Birth': 'string',
    'Outcome-DateTime': 'string',
    'Outcome-Type': 'string',
    'Outcome-Subtype': 'string',
    'Outcome-Age(days)': 'int'
}, parse_dates=['Date-Of-Birth', 'Outcome-DateTime'])
outcomes.dtypes
```

Out[357]:

```
AnimalID             string[python]
ID                   string[python]
Breed                string[python]
Color                string[python]
Gender                     category
Name                 string[python]
Date-Of-Birth        datetime64[ns]
Outcome-DateTime     datetime64[ns]
Outcome-Type         string[python]
Outcome-Subtype      string[python]
Outcome-Age(days)             int32
dtype: object
```

In [358…

```python
outcomes
```

Out[358]:

	AnimalID	ID	Breed	Color	Gender	Name	Date-Of-Birth	Outcome-DateTime	Outcome-Type	Outcome-Subtype	Outcome-Age(days)
0	A006100	A006100	Spinone Italiano	Yellow	Male	Scamp	2007-07-09	2014-03-08 17:10:00	Return to Owner	<NA>	2435
1	A006100	A006100+	Spinone Italiano	Yellow	Male	Scamp	2007-07-09	2014-12-20 16:35:00	Return to Owner	<NA>	2722
2	A006100	A006100++	Spinone Italiano	Yellow	Male	Scamp	2007-07-09	2017-12-07 00:00:00	Return to Owner	<NA>	3804
3	A047759	A047759	Dachshund	Tricolor	Male	Oreo	2004-04-02	2014-04-07 15:12:00	Transfer	Partner	3658
4	A134067	A134067	Shetland Sheepdog	Brown	Male	Bandit	1997-10-16	2013-11-16 11:54:00	Return to Owner	<NA>	5875
...	...	...	...	...	...	...	...	...	...	...	...
86974	A893431	A893431	Chihuahua	Tricolor	Female	Chili	2015-11-21	2023-11-21 15:41:00	Return to Owner	<NA>	2923
86975	A893432	A893432	Chihuahua	Tan	Female	Coco	2015-11-21	2023-11-21 15:41:00	Return to Owner	<NA>	2923
86976	A893452	A893452	Maltese	White	Female	Sophie	2016-11-21	2023-11-22 11:26:00	Return to Owner	<NA>	2557
86977	A893529	A893529	Labrador Retriever	White	Female	<NA>	2023-09-22	2023-11-22 16:51:00	Transfer	Partner	62
86978	A893585	A893585	German Shepherd	Black	Male	Unknown	2023-09-24	2023-11-24 14:12:00	Transfer	Partner	62

86979 rows × 11 columns

Fill in missing values

In [359…

```python
# Fill in missing value in Name and Outcome-Subtype with Unknwon
intakes['Name'] = intakes['Name'].fillna('Unknown')
outcomes['Name'] = outcomes['Name'].fillna('Unknown')
outcomes['Outcome-Subtype'] = outcomes['Outcome-Subtype'].fillna('Unknown')
# Rrop rows that still have missing value
intakes = intakes.dropna().reset_index(drop=True)
outcomes = outcomes.dropna().reset_index(drop=True)
```

Remove Abnormal values

In [360…

```python
# Remove negative age values
intakes = intakes[intakes['Intake-Age(days)'] >= 0]
outcomes = outcomes[outcomes['Outcome-Age(days)'] >= 0]
```

In [361…

```python
intakes
```

Out[361]:

	AnimalID	ID	Breed	Color	Gender	Name	Intake-DateTime	Intake-Type	Intake-Condition	Intake-Age(days)
0	A006100	A006100	Spinone Italiano	Yellow	Male	Scamp	2014-03-07 14:26:00	Public Assist	Normal	2190
1	A006100	A006100+	Spinone Italiano	Yellow	Male	Scamp	2014-12-19 10:21:00	Public Assist	Normal	2555
2	A006100	A006100++	Spinone Italiano	Yellow	Male	Scamp	2017-12-07 14:07:00	Stray	Normal	3650
3	A047759	A006101	Dachshund	Tricolor	Male	Oreo	2014-04-02 15:55:00	Owner Surrender	Normal	3650
4	A134067	A134067	Shetland Sheepdog	Brown	Male	Bandit	2013-11-16 09:02:00	Public Assist	Injured	12190
...	...	...	...	...	...	...	...	...	...	...
86402	A893565	A893565	Chihuahua	Buff	Female	Unknown	2023-11-23 08:31:00	Stray	Injured	365
86403	A893570	A893570	Rottweiler	Black	Female	Unknown	2023-11-23 12:17:00	Stray	Normal	730
86404	A893578	A893578	American Staffordshire Terrier	Yellow Brindle	Male	Tiger	2023-11-23 20:19:00	Stray	Injured	240
86405	A893579	A893579	American Staffordshire Terrier	Black	Male	Unknown	2023-11-23 21:00:00	Stray	Injured	730
86406	A893585	A893585	German Shepherd	Black	Male	Unknown	2023-11-23 20:19:00	Stray	Injured	30

86396 rows × 10 columns

In [362…

```python
outcomes
```

Out[362]:

	AnimalID	ID	Breed	Color	Gender	Name	Date-Of-Birth	Outcome-DateTime	Outcome-Type	Outcome-Subtype	Outcome-Age(days)
0	A006100	A006100	Spinone Italiano	Yellow	Male	Scamp	2007-07-09	2014-03-08 17:10:00	Return to Owner	Unknown	2435
1	A006100	A006100+	Spinone Italiano	Yellow	Male	Scamp	2007-07-09	2014-12-20 16:35:00	Return to Owner	Unknown	2722
2	A006100	A006100++	Spinone Italiano	Yellow	Male	Scamp	2007-07-09	2017-12-07 00:00:00	Return to Owner	Unknown	3804
3	A047759	A047759	Dachshund	Tricolor	Male	Oreo	2004-04-02	2014-04-07 15:12:00	Transfer	Partner	3658
4	A134067	A134067	Shetland Sheepdog	Brown	Male	Bandit	1997-10-16	2013-11-16 11:54:00	Return to Owner	Unknown	5875
...	...	...	...	...	...	...	...	...	...	...	...
86301	A893431	A893431	Chihuahua	Tricolor	Female	Chili	2015-11-21	2023-11-21 15:41:00	Return to Owner	Unknown	2923
86302	A893432	A893432	Chihuahua	Tan	Female	Coco	2015-11-21	2023-11-21 15:41:00	Return to Owner	Unknown	2923
86303	A893452	A893452	Maltese	White	Female	Sophie	2016-11-21	2023-11-22 11:26:00	Return to Owner	Unknown	2557
86304	A893529	A893529	Labrador Retriever	White	Female	Unknown	2023-09-22	2023-11-22 16:51:00	Transfer	Partner	62
86305	A893585	A893585	German Shepherd	Black	Male	Unknown	2023-09-24	2023-11-24 14:12:00	Transfer	Partner	62

86285 rows × 11 columns

Add a new column of age category according to the outcomes age

In [363…

```python
conditions = [
    (outcomes['Outcome-Age(days)'] <= 180),
    (outcomes['Outcome-Age(days)'] > 180) & (outcomes['Outcome-Age(days)'] <= 730),
    (outcomes['Outcome-Age(days)'] > 730) & (outcomes['Outcome-Age(days)'] <= 2555),
    (outcomes['Outcome-Age(days)'] > 2555)
]
values = ['Baby', 'Young', 'Adult', 'Senior']

outcomes['Age'] = np.select(conditions, values)
```

Add a new boolean column 'IsAdopted' according to 'Outcome-type'

In [364…

```python
# Define adopted as adoption outcome-type
adopted = ['Adoption']
outcomes['IsAdopted'] = np.where(outcomes['Outcome-Type'].isin(adopted), True, False)
```

In [365…

```python
outcomes
```

Out[365]:

	AnimalID	ID	Breed	Color	Gender	Name	Date-Of-Birth	Outcome-DateTime	Outcome-Type	Outcome-Subtype	Outcome-Age(days)	Age	IsAdopted
0	A006100	A006100	Spinone Italiano	Yellow	Male	Scamp	2007-07-09	2014-03-08 17:10:00	Return to Owner	Unknown	2435	Adult	False
1	A006100	A006100+	Spinone Italiano	Yellow	Male	Scamp	2007-07-09	2014-12-20 16:35:00	Return to Owner	Unknown	2722	Senior	False
2	A006100	A006100++	Spinone Italiano	Yellow	Male	Scamp	2007-07-09	2017-12-07 00:00:00	Return to Owner	Unknown	3804	Senior	False
3	A047759	A047759	Dachshund	Tricolor	Male	Oreo	2004-04-02	2014-04-07 15:12:00	Transfer	Partner	3658	Senior	False
4	A134067	A134067	Shetland Sheepdog	Brown	Male	Bandit	1997-10-16	2013-11-16 11:54:00	Return to Owner	Unknown	5875	Senior	False
...	...	...	...	...	...	...	...	...	...	...	...	...	...
86301	A893431	A893431	Chihuahua	Tricolor	Female	Chili	2015-11-21	2023-11-21 15:41:00	Return to Owner	Unknown	2923	Senior	False
86302	A893432	A893432	Chihuahua	Tan	Female	Coco	2015-11-21	2023-11-21 15:41:00	Return to Owner	Unknown	2923	Senior	False
86303	A893452	A893452	Maltese	White	Female	Sophie	2016-11-21	2023-11-22 11:26:00	Return to Owner	Unknown	2557	Senior	False
86304	A893529	A893529	Labrador Retriever	White	Female	Unknown	2023-09-22	2023-11-22 16:51:00	Transfer	Partner	62	Baby	False
86305	A893585	A893585	German Shepherd	Black	Male	Unknown	2023-09-24	2023-11-24 14:12:00	Transfer	Partner	62	Baby	False

86285 rows × 13 columns

Merge intakes and outcomes dataframes by ID

In [366…

```python
intakes_outcomes = pd.merge(intakes, outcomes, how="inner", on=["AnimalID", "ID", "Breed", "Color", "Gender", "Name"], validate="1:1")
intakes_outcomes['Outcome-Age(days)'] = intakes_outcomes['Outcome-Age(days)'].astype('Int64')
intakes_outcomes
```

Out[366]:

	AnimalID	ID	Breed	Color	Gender	Name	Intake-DateTime	Intake-Type	Intake-Condition	Intake-Age(days)	Date-Of-Birth	Outcome-DateTime	Outcome-Type	Outcome-Subtype	Outcome-Age(days)	Age	IsAdopted
0	A006100	A006100	Spinone Italiano	Yellow	Male	Scamp	2014-03-07 14:26:00	Public Assist	Normal	2190	2007-07-09	2014-03-08 17:10:00	Return to Owner	Unknown	2435	Adult	False
1	A006100	A006100+	Spinone Italiano	Yellow	Male	Scamp	2014-12-19 10:21:00	Public Assist	Normal	2555	2007-07-09	2014-12-20 16:35:00	Return to Owner	Unknown	2722	Senior	False
2	A006100	A006100++	Spinone Italiano	Yellow	Male	Scamp	2017-12-07 14:07:00	Stray	Normal	3650	2007-07-09	2017-12-07 00:00:00	Return to Owner	Unknown	3804	Senior	False
3	A134067	A134067	Shetland Sheepdog	Brown	Male	Bandit	2013-11-16 09:02:00	Public Assist	Injured	12190	1997-10-16	2013-11-16 11:54:00	Return to Owner	Unknown	5875	Senior	False
4	A141142	A141142	Labrador Retriever	Black	Female	Bettie	2013-11-16 14:46:00	Stray	Aged	11825	1998-06-01	2013-11-17 11:40:00	Return to Owner	Unknown	5648	Senior	False
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
85791	A893431	A893431	Chihuahua	Tricolor	Female	Chili	2023-11-21 11:21:00	Public Assist	Normal	2920	2015-11-21	2023-11-21 15:41:00	Return to Owner	Unknown	2923	Senior	False
85792	A893432	A893432	Chihuahua	Tan	Female	Coco	2023-11-21 11:21:00	Public Assist	Normal	2920	2015-11-21	2023-11-21 15:41:00	Return to Owner	Unknown	2923	Senior	False
85793	A893452	A893452	Maltese	White	Female	Sophie	2023-11-21 13:38:00	Public Assist	Normal	2555	2016-11-21	2023-11-22 11:26:00	Return to Owner	Unknown	2557	Senior	False
85794	A893529	A893529	Labrador Retriever	White	Female	Unknown	2023-11-22 14:26:00	Owner Surrender	Normal	30	2023-09-22	2023-11-22 16:51:00	Transfer	Partner	62	Baby	False
85795	A893585	A893585	German Shepherd	Black	Male	Unknown	2023-11-23 20:19:00	Stray	Injured	30	2023-09-24	2023-11-24 14:12:00	Transfer	Partner	62	Baby	False

85796 rows × 17 columns

Read dog breed data

In [367…

```python
breeds = pd.read_csv('processed_data/breed_data.csv', dtype={
    'Breed': 'string',
    'Category': 'category',
    'Intelligence-Ranking': 'Float64',
    'Intelligence-Category': 'category',
    'Size-Category': 'category',
    'Longevity': 'Float64',
    'Total-Cost($)': 'Float64',
    'Purchase-Cost($)': 'Float64',
    'Food-Cost($)': 'Float64'
})
breeds.dtypes
```

Out[367]:

```
Breed                    string[python]
Category                       category
Intelligence-Ranking            Float64
Intelligence-Category          category
Size-Category                  category
Longevity                       Float64
Total-Cost($)                   Float64
Purchase-Cost($)                Float64
Food-Cost($)                    Float64
dtype: object
```

In [368…

```python
breeds
```

Out[368]:

	Breed	Category	Intelligence-Ranking	Intelligence-Category	Size-Category	Longevity	Total-Cost($)	Purchase-Cost($)	Food-Cost($)
0	Affenpinscher	Toy	37.00	Above-Average	Small	11.42	15835.00	510.00	3180.00
1	Afghan Hound	Hound	80.00	Lowest	Large	11.92	20818.00	890.00	7260.00
2	Airedale Terrier	Terrier	29.00	Above-Average	Medium	11.45	<NA>	733.00	<NA>
3	Akita	Working	54.00	Average	Large	10.16	18217.00	1202.00	6188.00
4	Alaskan Malamute	Working	50.00	Average	Large	10.67	19069.00	1210.00	6499.00
...	...	...	...	...	...	...	...	...	...
167	Whippet	Hound	51.00	Average	Medium	12.87	18160.00	915.00	3584.00
168	Wire Fox Terrier	Terrier	51.00	Average	Small	13.17	<NA>	668.00	<NA>
169	Wirehaired Pointing Griffon	Sporting	46.00	Average	Medium	8.80	<NA>	755.00	<NA>
170	Xoloitzcuintli	Non-Sporting	<NA>	NaN	Medium	<NA>	<NA>	717.00	<NA>
171	Yorkshire Terrier	Toy	27.00	Above-Average	Small	12.60	17944.00	1057.00	3508.00

172 rows × 9 columns

Fill in missing values

In [369…

```python
# Fill in missing values in Intelligence-Ranking and Longevity with the average value of the same category
breeds["Intelligence-Ranking"].fillna(
    breeds.groupby("Category")["Intelligence-Ranking"].transform("mean"),inplace=True
)
breeds["Intelligence-Ranking"].fillna(
    breeds["Intelligence-Ranking"].mean(),inplace=True
)

breeds["Longevity"].fillna(
    breeds.groupby("Category")["Longevity"].transform("mean"),inplace=True
)
breeds["Longevity"].fillna(
    breeds["Longevity"].mean(),inplace=True
)
```

In [370…

```python
# Fill in numeric missing values in Cost with average value of the same category & size combination
breeds["Total-Cost($)"].fillna(
    breeds.groupby(["Category", "Size-Category"])["Total-Cost($)"].transform("mean"),inplace=True
)
breeds["Total-Cost($)"].fillna(
    breeds["Total-Cost($)"].mean(),inplace=True
)

breeds["Food-Cost($)"].fillna(
    breeds.groupby(["Category", "Size-Category"])["Food-Cost($)"].transform("mean"),inplace=True
)
breeds["Food-Cost($)"].fillna(
    breeds["Food-Cost($)"].mean(),inplace=True
)

breeds["Purchase-Cost($)"].fillna(
    breeds.groupby(["Category", "Longevity", "Size-Category"])["Purchase-Cost($)"].transform("mean"),inplace=True
)
breeds["Purchase-Cost($)"].fillna(
    breeds["Purchase-Cost($)"].mean(),inplace=True
)

breeds
```

Out[370]:

	Breed	Category	Intelligence-Ranking	Intelligence-Category	Size-Category	Longevity	Total-Cost($)	Purchase-Cost($)	Food-Cost($)
0	Affenpinscher	Toy	37.00	Above-Average	Small	11.42	15835.00	510.00	3180.00
1	Afghan Hound	Hound	80.00	Lowest	Large	11.92	20818.00	890.00	7260.00
2	Airedale Terrier	Terrier	29.00	Above-Average	Medium	11.45	16605.67	733.00	4224.00
3	Akita	Working	54.00	Average	Large	10.16	18217.00	1202.00	6188.00
4	Alaskan Malamute	Working	50.00	Average	Large	10.67	19069.00	1210.00	6499.00
...	...	...	...	...	...	...	...	...	...
167	Whippet	Hound	51.00	Average	Medium	12.87	18160.00	915.00	3584.00
168	Wire Fox Terrier	Terrier	51.00	Average	Small	13.17	18078.44	668.00	3809.00
169	Wirehaired Pointing Griffon	Sporting	46.00	Average	Medium	8.80	16668.89	755.00	4219.45
170	Xoloitzcuintli	Non-Sporting	46.71	NaN	Medium	10.98	15294.33	717.00	3790.29
171	Yorkshire Terrier	Toy	27.00	Above-Average	Small	12.60	17944.00	1057.00	3508.00

172 rows × 9 columns

In [371…

```python
# Cast object numbers to float
pd.options.display.float_format = "{:.2f}".format
breeds["Longevity"] = breeds["Longevity"].astype('float')
# Cast object numbers to int
breeds["Intelligence-Ranking"] = breeds["Intelligence-Ranking"].astype('int')
breeds["Total-Cost($)"] = breeds["Total-Cost($)"].astype('int')
breeds["Purchase-Cost($)"] = breeds["Purchase-Cost($)"].astype('int')
breeds["Food-Cost($)"] = breeds["Food-Cost($)"].astype('int')
breeds.dtypes
```

Out[371]:

```
Breed                    string[python]
Category                       category
Intelligence-Ranking              int32
Intelligence-Category          category
Size-Category                  category
Longevity                       float64
Total-Cost($)                     int32
Purchase-Cost($)                  int32
Food-Cost($)                      int32
dtype: object
```

In [372…

```python
# Fill in missing values in Intelligence-Category according to Intelligence-Ranking
intel_conditions = [
    (breeds['Intelligence-Ranking'] <= 10),
    (breeds['Intelligence-Ranking'] > 10) & (breeds['Intelligence-Ranking'] <= 26),
    (breeds['Intelligence-Ranking'] > 26) & (breeds['Intelligence-Ranking'] <= 39),
    (breeds['Intelligence-Ranking'] > 39) & (breeds['Intelligence-Ranking'] <= 54),
    (breeds['Intelligence-Ranking'] > 54) & (breeds['Intelligence-Ranking'] <= 69),
    (breeds['Intelligence-Ranking'] > 69)
]
intel_values = ['Brightest', 'Excellent', 'Above-Average', 'Average', 'Fair', 'Low']
breeds['Intelligence-Category'] = np.select(intel_conditions, intel_values)

breeds
```

Out[372]:

	Breed	Category	Intelligence-Ranking	Intelligence-Category	Size-Category	Longevity	Total-Cost($)	Purchase-Cost($)	Food-Cost($)
0	Affenpinscher	Toy	37	Above-Average	Small	11.42	15835	510	3180
1	Afghan Hound	Hound	80	Low	Large	11.92	20818	890	7260
2	Airedale Terrier	Terrier	29	Above-Average	Medium	11.45	16605	733	4224
3	Akita	Working	54	Average	Large	10.16	18217	1202	6188
4	Alaskan Malamute	Working	50	Average	Large	10.67	19069	1210	6499
...	...	...	...	...	...	...	...	...	...
167	Whippet	Hound	51	Average	Medium	12.87	18160	915	3584
168	Wire Fox Terrier	Terrier	51	Average	Small	13.17	18078	668	3809
169	Wirehaired Pointing Griffon	Sporting	46	Average	Medium	8.80	16668	755	4219
170	Xoloitzcuintli	Non-Sporting	46	Average	Medium	10.98	15294	717	3790
171	Yorkshire Terrier	Toy	27	Above-Average	Small	12.60	17944	1057	3508

172 rows × 9 columns

Use Agglomerative Clustering to add a new column 'Cost-Category' based on Total-Cost, Purchase-Cost, Food-Cost

In [373…

```python
from sklearn.cluster import AgglomerativeClustering
import scipy.cluster.hierarchy as shc
```

In [374…

```python
cost_df = breeds[['Total-Cost($)', 'Purchase-Cost($)', 'Food-Cost($)']]
cost_df
```

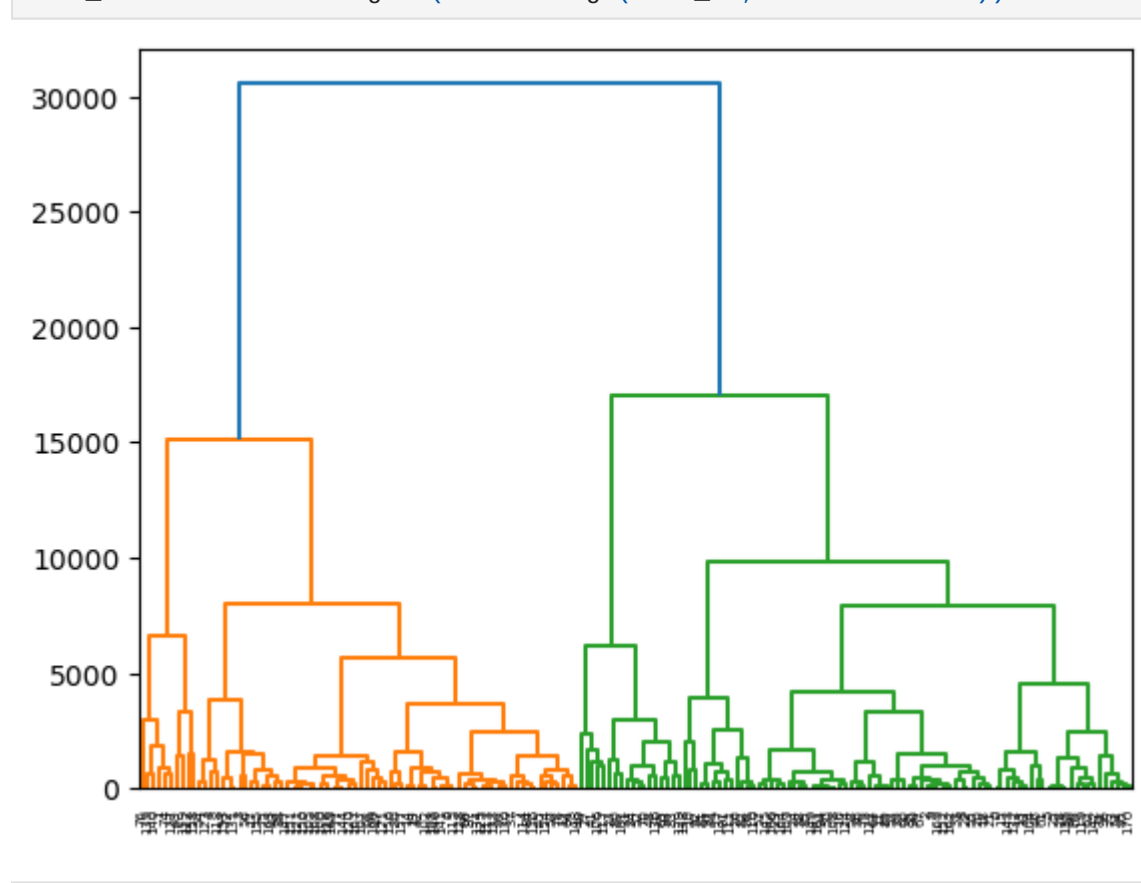
Out[374]:

	Total-Cost($)	Purchase-Cost($)	Food-Cost($)
0	15835	510	3180
1	20818	890	7260
2	16605	733	4224
3	18217	1202	6188
4	19069	1210	6499
...	...	...	...
167	18160	915	3584
168	18078	668	3809
169	16668	755	4219
170	15294	717	3790
171	17944	1057	3508

172 rows × 3 columns

In [375…

```python
dend_ward = shc.dendrogram(shc.linkage(cost_df, method='ward'))
```



In [376…

```python
# Clustering - ward linkage
# Choose number of clusters as 4 according to dendrogram
clustering_ward = AgglomerativeClustering(linkage='ward', n_clusters=4)
clustering_ward.fit(cost_df)
breeds['Cost-Category'] = clustering_ward.labels_

current_labels = [0, 1, 2, 3]
desired_labels = ['Saver', 'Budget', 'Mid-Price', 'High-End']
map_dict = dict(zip(current_labels, desired_labels))
breeds['Cost-Category'] = breeds['Cost-Category'].map(map_dict)

breeds
```

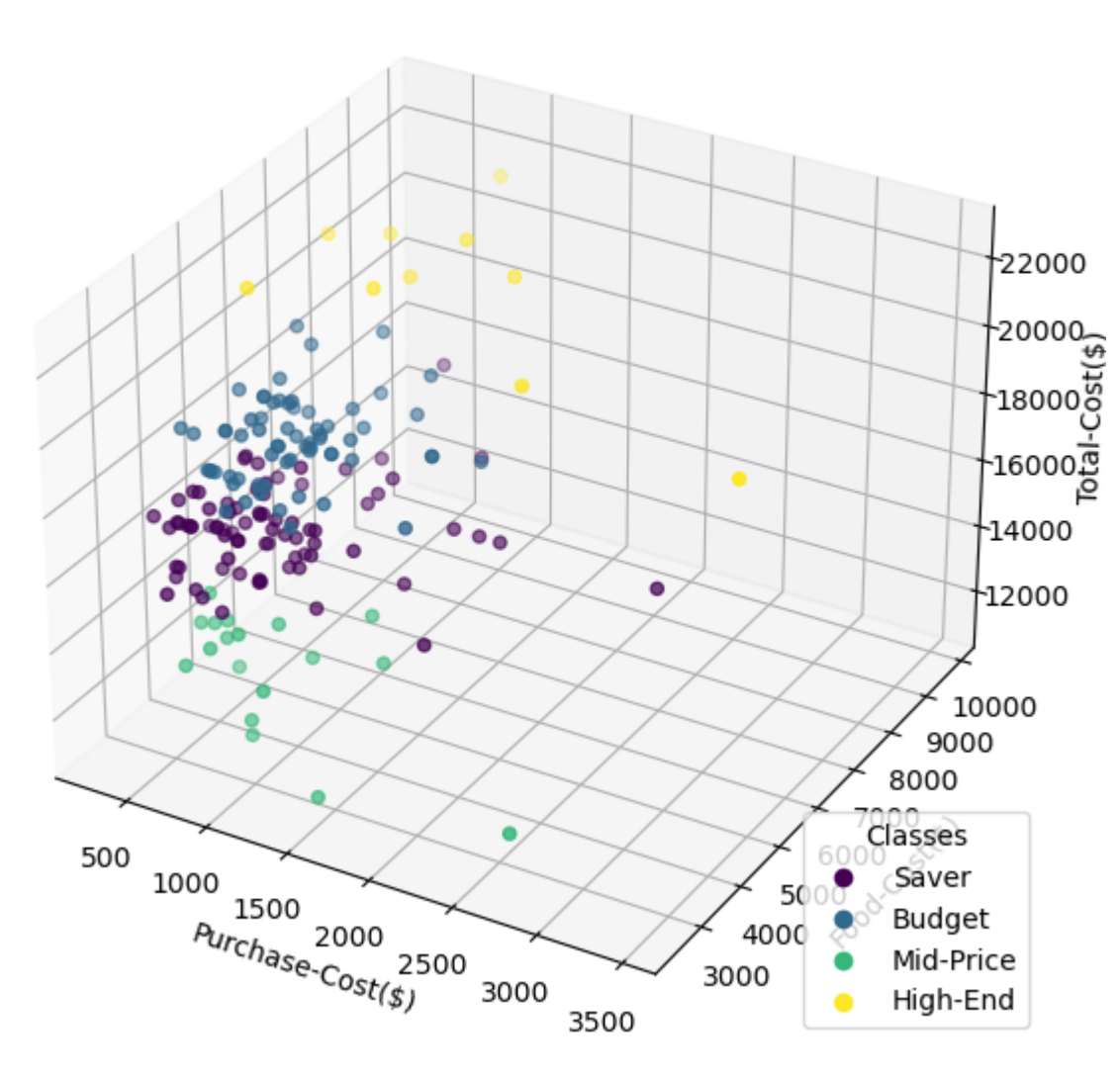
Out[376]:

	Breed	Category	Intelligence-Ranking	Intelligence-Category	Size-Category	Longevity	Total-Cost($)	Purchase-Cost($)	Food-Cost($)	Cost-Category
0	Affenpinscher	Toy	37	Above-Average	Small	11.42	15835	510	3180	Saver
1	Afghan Hound	Hound	80	Low	Large	11.92	20818	890	7260	High-End
2	Airedale Terrier	Terrier	29	Above-Average	Medium	11.45	16605	733	4224	Saver
3	Akita	Working	54	Average	Large	10.16	18217	1202	6188	Budget
4	Alaskan Malamute	Working	50	Average	Large	10.67	19069	1210	6499	Budget
...	...	...	...	...	...	...	...	...	...	...
167	Whippet	Hound	51	Average	Medium	12.87	18160	915	3584	Budget
168	Wire Fox Terrier	Terrier	51	Average	Small	13.17	18078	668	3809	Budget
169	Wirehaired Pointing Griffon	Sporting	46	Average	Medium	8.80	16668	755	4219	Saver
170	Xoloitzcuintli	Non-Sporting	46	Average	Medium	10.98	15294	717	3790	Saver
171	Yorkshire Terrier	Toy	27	Above-Average	Small	12.60	17944	1057	3508	Budget

172 rows × 10 columns

In [377…

```python
fig = plt.figure(figsize = (10, 7))
ax = plt.axes(projection ="3d")
scatter = ax.scatter3D(cost_df['Purchase-Cost($)'], cost_df['Food-Cost($)'], cost_df['Total-Cost($)'], c = clustering_ward.labels_)
ax.set(xlabel='Purchase-Cost($)', ylabel='Food-Cost($)', zlabel='Total-Cost($)')
_ = ax.legend(
    scatter.legend_elements()[0], desired_labels, loc="lower right", title="Classes"
)
plt.show()
```



Join breed data to intakes & outcomes data

In [378…

```python
data = pd.merge(intakes_outcomes, breeds, how="left", on=["Breed"])
data
```

Out[378]:

	AnimalID	ID	Breed	Color	Gender	Name	Intake-DateTime	Intake-Type	Intake-Condition	Intake-Age(days)	...	IsAdopted	Category	Intelligence-Ranking	Intelligence-Category	Size-Category	Longevity	Total-Cost($)
0	A006100	A006100	Spinone Italiano	Yellow	Male	Scamp	2014-03-07 14:26:00	Public Assist	Normal	2190	...	False	Sporting	27	Above-Average	Large	9.00	18062
1	A006100	A006100+	Spinone Italiano	Yellow	Male	Scamp	2014-12-19 10:21:00	Public Assist	Normal	2555	...	False	Sporting	27	Above-Average	Large	9.00	18062
2	A006100	A006100++	Spinone Italiano	Yellow	Male	Scamp	2017-12-07 14:07:00	Stray	Normal	3650	...	False	Sporting	27	Above-Average	Large	9.00	18062
3	A134067	A134067	Shetland Sheepdog	Brown	Male	Bandit	2013-11-16 09:02:00	Public Assist	Injured	12190	...	False	Herding	6	Brightest	Small	12.53	17469
4	A141142	A141142	Labrador Retriever	Black	Female	Bettie	2013-11-16 14:46:00	Stray	Aged	11825	...	False	Sporting	7	Brightest	Medium	12.04	18422
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
85791	A893431	A893431	Chihuahua	Tricolor	Female	Chili	2023-11-21 11:21:00	Public Assist	Normal	2920	...	False	Toy	67	Fair	Small	16.50	22640
85792	A893432	A893432	Chihuahua	Tan	Female	Coco	2023-11-21 11:21:00	Public Assist	Normal	2920	...	False	Toy	67	Fair	Small	16.50	22640
85793	A893452	A893452	Maltese	White	Female	Sophie	2023-11-21 13:38:00	Public Assist	Normal	2555	...	False	Toy	59	Fair	Small	12.25	16073
85794	A893529	A893529	Labrador Retriever	White	Female	Unknown	2023-11-22 14:26:00	Owner Surrender	Normal	30	...	False	Sporting	7	Brightest	Medium	12.04	18422
85795	A893585	A893585	German Shepherd	Black	Male	Unknown	2023-11-23 20:19:00	Stray	Injured	30	...	False	Herding	3	Brightest	Large	9.73	15091

85796 rows × 26 columns

Read active dogs data from petfinder

In [379…

```python
petfinder = pd.read_csv('processed_data/petfinder_unified.csv', dtype={
    'Petfinder-ID': 'string',
    'Name': 'string',
    'Size': 'category',
    'Gender': 'category',
    'Age': 'category',
    'Color': 'string',
    'Breed': 'string'
})
petfinder.dtypes
```

Out[379]:

```
Petfinder-ID    string[python]
Name            string[python]
Size                  category
Gender                category
Age                   category
Color           string[python]
Breed           string[python]
dtype: object
```

In [380…

```python
# Drop rows that have a missing value
petfinder = petfinder.dropna().reset_index(drop=True)
```

In [381…

```python
petfinder
```

Out[381]:

	Petfinder-ID	Name	Size	Gender	Age	Color	Breed
0	65653819	Eloise	Large	Female	Adult	Gray	Bull Terrier
1	68926034	Penny	Medium	Female	Baby	Black	Labrador Retriever
2	69313950	Pirate	Extra Large	Male	Baby	Tricolor	Saint Bernard
3	69340682	Fiona	Small	Female	Senior	Apricot	Chihuahua
4	69402276	Rory	Medium	Female	Adult	Red	Pembroke Welsh Corgi
...	...	...	...	...	...	...	...
7334	69816070	Bubba and Cadence	Small	Male	Senior	Tricolor	Border Terrier
7335	69816083	Bubba	Large	Male	Young	Black	Parson Russell Terrier
7336	69816084	NORA - 3 mo. old gentle quiet smart curious baby	Large	Female	Baby	Yellow	Labrador Retriever
7337	69816100	Blaze	Medium	Male	Baby	Black	American Staffordshire Terrier
7338	69816108	Molly	Medium	Female	Baby	Red	Australian Cattle Dog

7339 rows × 7 columns

Join breed data to petfinder dog data

In [382…

```python
petfinder = pd.merge(petfinder, breeds, how="left", on=["Breed"])
petfinder
```

Out[382]:

	Petfinder-ID	Name	Size	Gender	Age	Color	Breed	Category	Intelligence-Ranking	Intelligence-Category	Size-Category	Longevity	Total-Cost($)	Purchase-Cost($)	Food-Cost($)	Cost-Category
0	65653819	Eloise	Large	Female	Adult	Gray	Bull Terrier	Terrier	66	Fair	Medium	10.21	16051	1085	4087	Saver
1	68926034	Penny	Medium	Female	Baby	Black	Labrador Retriever	Sporting	7	Brightest	Medium	12.04	18422	810	4819	Budget
2	69313950	Pirate	Extra Large	Male	Baby	Tricolor	Saint Bernard	Working	65	Fair	Large	7.78	17336	875	8124	Saver
3	69340682	Fiona	Small	Female	Senior	Apricot	Chihuahua	Toy	67	Fair	Small	16.50	22640	588	4594	High-End
4	69402276	Rory	Medium	Female	Adult	Red	Pembroke Welsh Corgi	Herding	11	Excellent	Small	12.25	19625	587	6026	Budget
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
7334	69816070	Bubba and Cadence	Small	Male	Senior	Tricolor	Border Terrier	Terrier	30	Above-Average	Small	14.00	19575	833	3898	Budget
7335	69816083	Bubba	Large	Male	Young	Black	Parson Russell Terrier	Terrier	44	Average	Small	11.48	18078	528	3809	Budget
7336	69816084	NORA - 3 mo. old gentle quiet smart curious baby	Large	Female	Baby	Yellow	Labrador Retriever	Sporting	7	Brightest	Medium	12.04	18422	810	4819	Budget
7337	69816100	Blaze	Medium	Male	Baby	Black	American Staffordshire Terrier	Terrier	34	Above-Average	Medium	11.48	16605	1043	4224	Saver
7338	69816108	Molly	Medium	Female	Baby	Red	Australian Cattle Dog	Herding	10	Brightest	Medium	11.67	17607	530	4671	Saver

7339 rows × 16 columns

Write the processed data to csv file

In [383…

```python
data.to_csv('data.csv', index=False)
petfinder.to_csv('petfinder.csv', index=False)
```

In [384…

```python
features = data[['Breed', 'Color', 'Gender', 'Age', 'Intake-Type', 'Category', 'Intelligence-Category', 'Size-Category', 'Cost-Category', 'IsAdopted']]
features.to_csv('features.csv', index=False, header=False)
```

In [ ]: