corr

April 15, 2023

[1]:
```
import matplotlib
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import seaborn as sns
import statsmodels.api as sm
import scipy.stats as st
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import classification_report, confusion_matrix
from sklearn.model_selection import train_test_split

%matplotlib inline
```

[2]:
```
df_out = pd.read_pickle('df_out.pkl')
df_breeds = pd.read_pickle('df_breeds.pkl')
df_out_with_breeds_info = pd.read_pickle('df_out_with_breeks_info.pkl')
df_breeds_with_info = pd.read_pickle('df_breeds_with_info.pkl')
df_out.info()
df_out.head()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 149511 entries, 0 to 149510
Data columns (total 41 columns):
 #   Column                    Non-Null Count   Dtype
---  ------                    --------------   -----
 0   index                     149511 non-null  Int64
 1   Animal ID                 149511 non-null  string
 2   Name                      106260 non-null  string
 3   Outcome DateTime          149511 non-null  datetime64[ns]
 4   Outcome MonthYear         149511 non-null  string
 5   Date of Birth             149511 non-null  datetime64[ns]
 6   Outcome Type              149485 non-null  string
 7   Outcome Subtype           68443 non-null   string
 8   Animal Type               149511 non-null  string
 9   Sex upon Outcome          149509 non-null  string
 10  Age upon Outcome          149465 non-null  string
 11  Breed                     149511 non-null  string
 12  Color                     149511 non-null  string
```

```
 13  Intake MonthYear          147980 non-null  string
 14  Intake DateTime           147980 non-null  datetime64[ns]
 15  Found Location            147980 non-null  string
 16  Intake Type               147980 non-null  string
 17  Intake Condition          147980 non-null  string
 18  Sex upon Intake           147978 non-null  string
 19  Age upon Intake           147979 non-null  string
 20  Years in animal center    147980 non-null  Float64
 21  Colors (count)            149511 non-null  Int64
 22  Color 0                   149511 non-null  string
 23  Color 1                   79869 non-null   string
 24  Color 0 R                 135638 non-null  Float64
 25  Color 0 G                 135638 non-null  Float64
 26  Color 0 B                 135638 non-null  Float64
 27  Color 0 H                 135638 non-null  Float64
 28  Color 0 S                 135638 non-null  Float64
 29  Color 0 V                 135638 non-null  Float64
 30  Color 1 R                 78596 non-null   Float64
 31  Color 1 G                 78596 non-null   Float64
 32  Color 1 B                 78596 non-null   Float64
 33  Color 1 H                 78596 non-null   Float64
 34  Color 1 S                 78596 non-null   Float64
 35  Color 1 V                 78596 non-null   Float64
 36  Age upon Outcome (years)  149465 non-null  Float64
 37  Male                      149509 non-null  boolean
 38  Female                    149509 non-null  boolean
 39  NeuteredOrSpayed          149509 non-null  boolean
 40  Adopted                   149485 non-null  boolean
dtypes: Float64(14), Int64(2), boolean(4), datetime64[ns](3), string(18)
memory usage: 45.6 MB
```

[2]:

	index	Animal ID	Name	Outcome DateTime	Outcome MonthYear	Date of Birth	Outcome Type	Outcome Subtype	Animal Type	Sex upon Outcome	…	Color 1 G	Color 1 B	Color 1 H	Color 1 S	Color 1 V
0	61546	A659834	Dudley	2013-10-01 09:31:00	Oct 2013	2013-07-23	Adoption	Foster	Dog	Neutered Male	…	<NA>	<NA>	<NA>	<NA>	<NA>
1	50833	A664235	<NA>	2013-10-01 10:39:00	Oct 2013	2013-09-24	Transfer	Partner	Cat	Unknown						
2	93227	A664236	<NA>	2013-10-01 10:44:00	Oct 2013	2013-09-24	Transfer	Partner	Cat	Unknown						
3	109856	A664237	<NA>	2013-10-01 10:44:00	Oct 2013	2013-09-24	Transfer	Partner	Cat	Unknown						
4	12697	A664223	Moby	2013-10-01 11:03:00	Oct 2013	2009-09-30	Return to Owner	<NA>	Dog	Neutered Male						

```
1  …       1.0       1.0       0.0       0.0       1.0
2  …       1.0       1.0       0.0       0.0       1.0
3  …       1.0       1.0       0.0       0.0       1.0
4  …      <NA>      <NA>      <NA>      <NA>      <NA>

  Age upon Outcome (years)   Male Female NeuteredOrSpayed Adopted
0                 0.166667   True  False             True    True
1                 0.019231  False  False            False   False
2                 0.019231  False  False            False   False
3                 0.019231  False  False            False   False
4                      4.0   True  False             True   False

[5 rows x 41 columns]
```

[3]:
```
df_breeds_with_info.head()
```

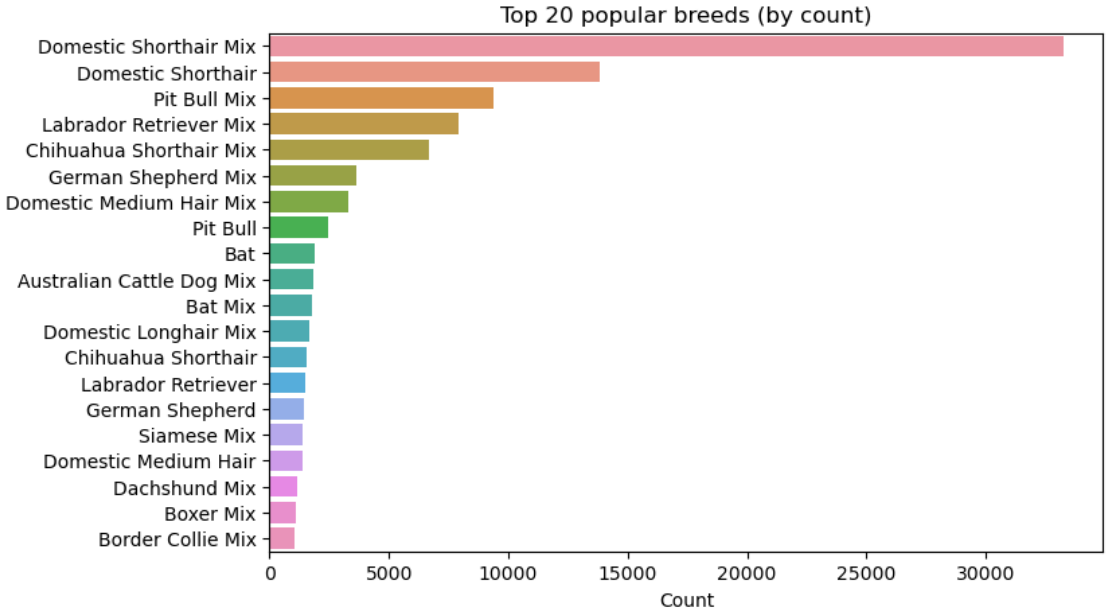
[3]:
```
                    Breed  Count Animal Type   Adopted  Color 0 R (mean)  \
0   Domestic Shorthair Mix  33260         Cat  0.461425          0.439476
1       Domestic Shorthair  13808         Cat  0.553158          0.451115
2            Pit Bull Mix   9406         Dog  0.431427          0.513666
3   Labrador Retriever Mix   7913         Dog  0.546063          0.409771
4  Chihuahua Shorthair Mix   6689         Dog  0.483181          0.609789

   Color 0 R (std dev)  Color 0 G (mean)  Color 0 G (std dev)  \
0             0.412274          0.322711             0.323957
1             0.412934          0.331264             0.324532
2             0.403283          0.418784             0.381554
3             0.421755          0.329495             0.388036
4             0.370759          0.493648             0.361854

   Color 0 B (mean)  Color 0 B (std dev)  …  \
0          0.286948             0.413041  …
1          0.293482             0.413847  …
2          0.476534             0.439715  …
3          0.181561             0.323025  …
4          0.356013             0.369441  …

                         CKC Subgroup  height_low_inches  \
0                 11-A: Pointing Dogs               21.0
1                 11-A: Pointing Dogs               21.0
2         4-B: Bull-and-Terrier Breeds               17.0
3       11-C: Retrievers and Waterdogs               21.0
4  12-A: Americas and Caribbean Breeds                5.0

   height_high_inches  average height  weight_low_lbs  weight_high_lbs  \
0                26.0            23.5            45.0               70
1                26.0            23.5            45.0               70
```

```
2                22.0            19.5            30.0                75
3                25.0            23.0            55.0                80
4                10.0             7.5             1.0                 7

   average weight  Lifespan Low  Lifespan High  average lifespan
0            57.5            10             12              11.0
1            57.5            10             12              11.0
2            52.5            10             12              11.0
3            67.5            10             12              11.0
4             4.0            14             16              15.0

[5 rows x 45 columns]
```

1 Analysis by breed

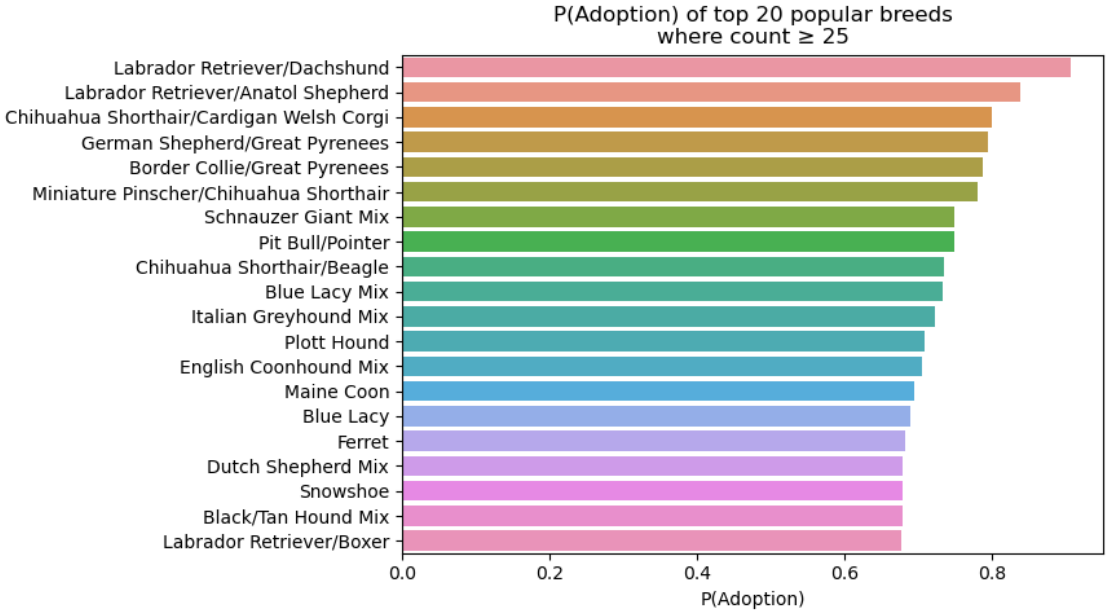
1.0.1 Popular breeds

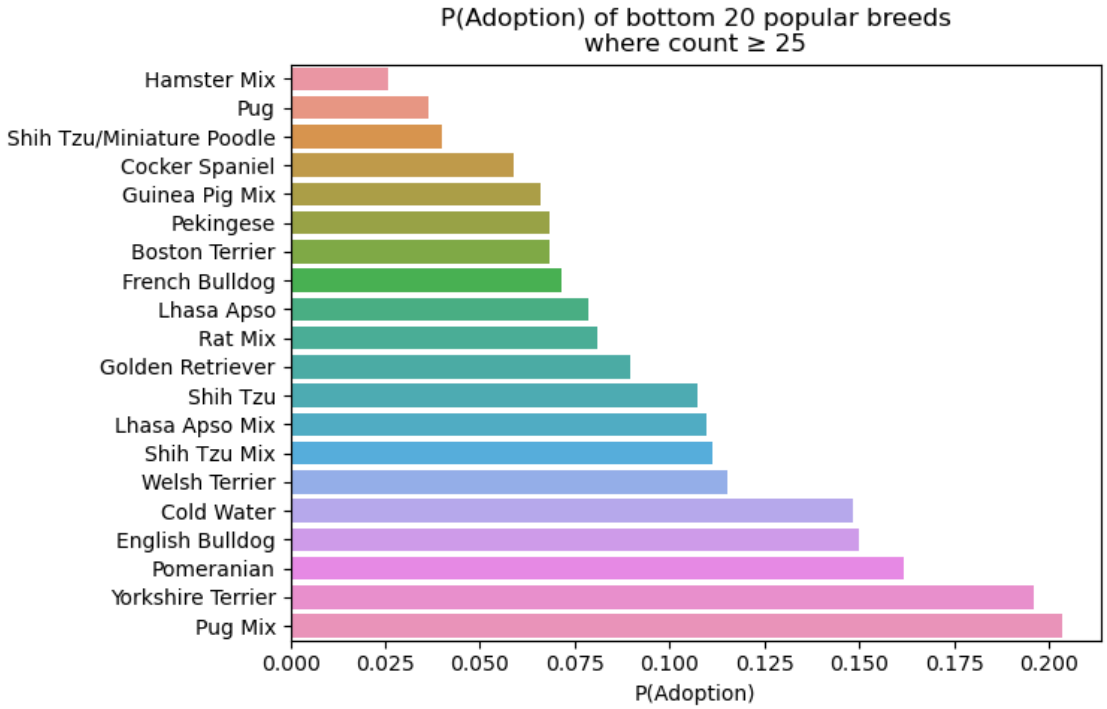
[4]:
```
df_breeds_with_info_sorted_by_breed = df_breeds_with_info.sort_values('Count',␣
 ↪ascending=False)

k = 20
plt.figure(figsize=(8,5))
sns.barplot(
    data=df_breeds_with_info_sorted_by_breed.head(k),
    x='Count',
    y='Breed',
    errorbar=None,
)
plt.xlabel('Count')
plt.ylabel(None)
plt.title(f'Top {k} popular breeds (by count)')
plt.show()
```



[5]:
```
n = 25
df_breeds_with_info_sorted_by_breed = df_breeds_with_info.
 ↪loc[df_breeds_with_info.Count >= n]

k = 20

plt.figure(figsize=(7,5))
sns.barplot(
    data=df_breeds_with_info_sorted_by_breed.sort_values('Adopted',␣
 ↪ascending=False).head(k),
    x='Adopted',
    y='Breed',
    errorbar=None,
)
plt.xlabel('P(Adoption)')
plt.ylabel(None)
plt.title(f'P(Adoption) of top {k} popular breeds\nwhere count  {n}')
plt.show()

plt.figure(figsize=(7,5))
sns.barplot(
    data=df_breeds_with_info_sorted_by_breed.sort_values('Adopted',␣
 ↪ascending=True).head(k),
    x='Adopted',
    y='Breed',
    errorbar=None,
```

```
)
plt.xlabel('P(Adoption)')
plt.ylabel(None)
plt.title(f'P(Adoption) of bottom {k} popular breeds\nwhere count  {n}')
plt.show()
```





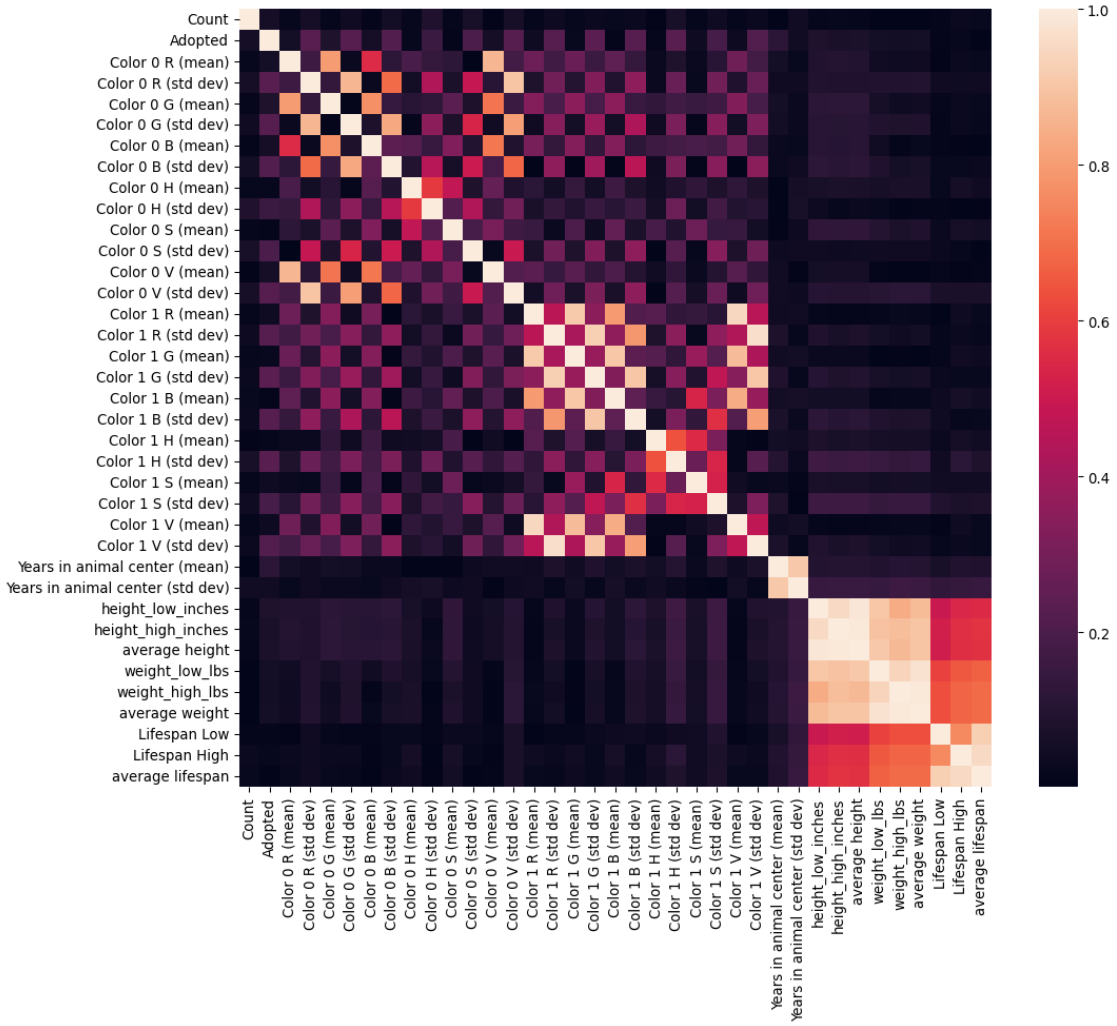
1.0.2 Correlating with every variable

There isn't much correlation appearing yet

[6]:
```
df_breeds_with_info_corr = df_breeds_with_info.corr()

plt.figure(num=None, figsize=(12, 10), dpi=96, facecolor='w', edgecolor='k')
sns.heatmap(data=df_breeds_with_info_corr.abs())

def score(df, var1, var2):
    print(f'Corr({var1}, {var2})   {df[var1][var2]}')

score(df_breeds_with_info_corr, 'Adopted', 'Color 0 B (mean)')
score(df_breeds_with_info_corr, 'Adopted', 'Color 0 B (std dev)')
score(df_breeds_with_info_corr, 'Adopted', 'Color 0 V (mean)')
score(df_breeds_with_info_corr, 'Adopted', 'Color 0 V (std dev)')
score(df_breeds_with_info_corr, 'Adopted', 'average height')
score(df_breeds_with_info_corr, 'Adopted', 'height_low_inches')
score(df_breeds_with_info_corr, 'Adopted', 'height_high_inches')
score(df_breeds_with_info_corr, 'Adopted', 'Lifespan Low')
```

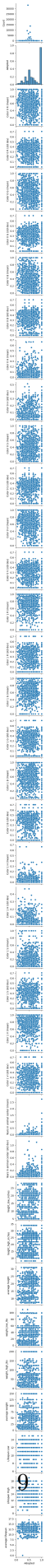
```
/tmp/ipykernel_39699/4118066584.py:1: FutureWarning: The default value of
numeric_only in DataFrame.corr is deprecated. In a future version, it will
default to False. Select only valid columns or specify the value of numeric_only
to silence this warning.
  df_breeds_with_info_corr = df_breeds_with_info.corr()
```

```
Corr(Adopted, Color 0 B (mean))   -0.05752196102076516
Corr(Adopted, Color 0 B (std dev))   -0.21220098425344627
Corr(Adopted, Color 0 V (mean))   -0.05892713325516757
Corr(Adopted, Color 0 V (std dev))   -0.2237579456621404
Corr(Adopted, average height)   0.07520172186737102
Corr(Adopted, height_low_inches)   0.08043859187254204
Corr(Adopted, height_high_inches)   0.06827302387620375
Corr(Adopted, Lifespan Low)   0.011194168083226583
```



[7]:
```
sns.pairplot(data=df_breeds_with_info, x_vars=['Adopted'])
```

[7]: <seaborn.axisgrid.PairGrid at 0x7fafa08dfca0>


Count
Attrition
Attrition
Age
BusinessTravel
DailyRate
Department
DistanceFromHome
Education
EducationField
EmployeeCount
EmployeeNumber
EnvironmentSatisfaction
Gender
HourlyRate
JobInvolvement
JobLevel
JobRole
JobSatisfaction
MaritalStatus
MonthlyIncome
MonthlyRate
NumCompaniesWorked
Over18
OverTime
PercentSalaryHike
PerformanceRating
RelationshipSatisfaction
StandardHours
StockOptionLevel
TotalWorkingYears
TrainingTimesLastYear
WorkLifeBalance
YearsAtCompany
YearsInCurrentRole
YearsSinceLastPromotion
YearsWithCurrManager
Attrition

1.1 Height ~ adopted?

Is the average height of a breed correlated with likelihood of an animal from that breed being adopted? The Pearson correlation coefficient was Corr(Adopted, average height) 0.2286839421877296.

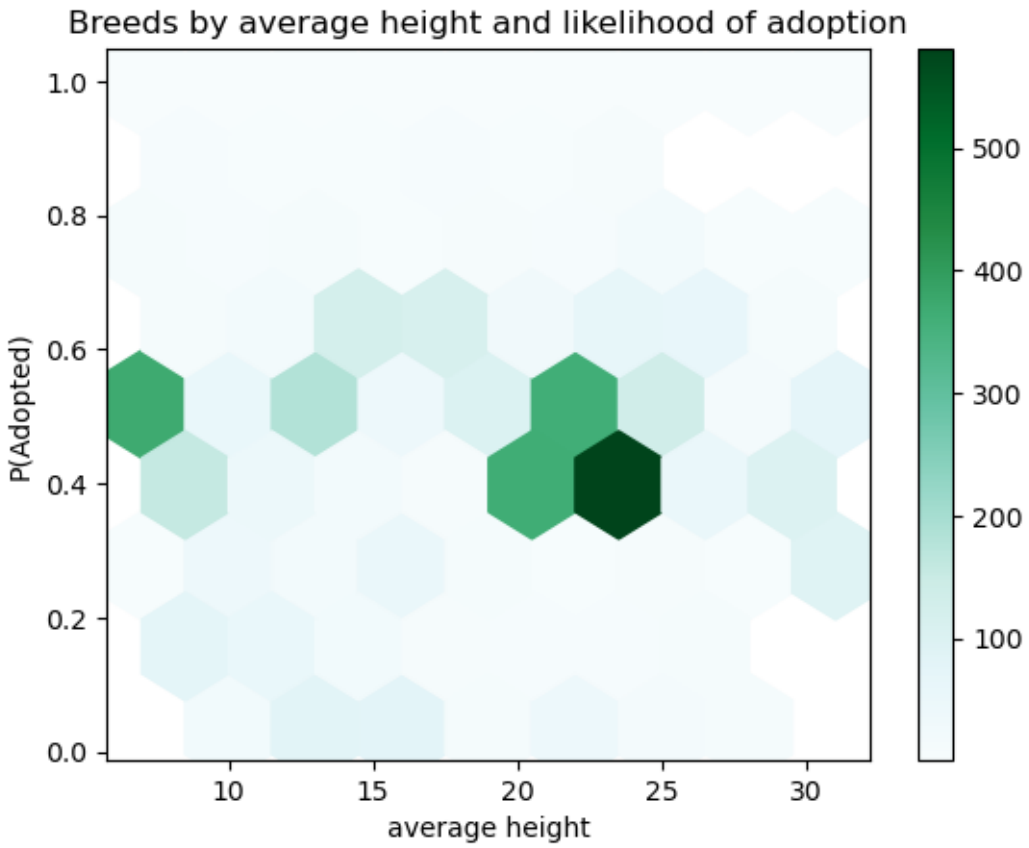
This section analyzes this by breed and also by individual animal.

See also: toward the end of this notebook, there are histograms that compare many variables with adoption likelihood.

[8]:
```
df_hl = df_out_with_breeds_info[['average height', 'Adopted']].dropna()

y_data = df_hl['Adopted'].astype(dtype=int)
x_data = df_hl['average height'].astype(dtype=float)

x_data = x_data.values.reshape(-1,1)

x_training_data, x_test_data, y_training_data, y_test_data =␣
 ↪train_test_split(x_data, y_data, test_size = 0.3)
model = LogisticRegression()
model.fit(x_training_data, y_training_data)
print(classification_report(y_test_data, model.predict(x_test_data)))
```

```
              precision    recall  f1-score   support

           0       0.53      0.42      0.47     21002
           1       0.51      0.62      0.56     20518

    accuracy                           0.52     41520
   macro avg       0.52      0.52      0.51     41520
weighted avg       0.52      0.52      0.51     41520
```

[9]:
```
df_breeds_with_info.plot.hexbin(x='average height', y='Adopted', gridsize=8,␣
 ↪C='Count')
plt.ylabel("P(Adopted)")
plt.title("Breeds by average height and likelihood of adoption")
plt.show()
```



I think with all this analaysis on height ~ adoption, I dont find a strong correlation between the two.

2 Analysis by individuals

2.1 Color

(results)

[10]:
```
print('Colors')
print(df_out_with_breeds_info['Color 0'].unique())
print(df_out_with_breeds_info['Color 1'].unique())
```

```
Colors
<StringArray>
[            'Black',           'Orange',            'White',
              'Red',           'Tortie',             'Gray',
           'Silver',             'Blue',           'Torbie',
     'Orange Tabby',            'Brown',          'Apricot',
      'Brown Tabby',       'Blue Tabby',       'Blue Point',
           'Calico',    'Brown Brindle',              'Tan',
```

```
         'Chocolate',            'Yellow',       'Black Tabby',
       'Lilac Point',       'Cream Tabby',             'Buff',
          'Tricolor',             'Liver',            'Cream',
              'Fawn',        'Blue Merle',         'Red Merle',
      'Tortie Point',      'Calico Point',       'Brown Merle',
      'Silver Tabby',       'Black Smoke',        'Lynx Point',
             'Sable',              'Gold',        'Seal Point',
     'Black Brindle',        'Blue Cream',       'Brown Tiger',
          'Red Tick',       'Flame Point',         'Blue Tick',
        'Gray Tabby',             'Green',        'Blue Tiger',
    'Yellow Brindle',   'Chocolate Point',        'Blue Smoke',
             'Ruddy',       'Black Tiger',              'Pink',
        'Liver Tick',           'Agouti', 'Silver Lynx Point',
      'Orange Tiger',       'Cream Tiger',           'Unknown']
Length: 60, dtype: string
<StringArray>
[             <NA>,           'White',           'Brown',   'Brown Brindle',
        'Tricolor',             'Tan',           'Black',            'Blue',
           'Cream',            'Buff',      'Blue Merle',      'Blue Tabby',
            'Gray',    'Orange Tabby',     'Black Smoke',     'Brown Merle',
        'Red Tick',          'Orange',       'Red Merle',          'Silver',
             'Red',       'Chocolate',          'Yellow',      'Seal Point',
   'Black Brindle',     'Brown Tabby',      'Blue Cream',           'Liver',
            'Gold',          'Tortie',       'Blue Tick',      'Gray Tabby',
  'Yellow Brindle',         'Apricot',     'Brown Tiger',            'Pink',
      'Lynx Point',     'Black Tabby',     'Cream Tabby',     'Flame Point',
      'Gray Tiger',          'Calico',      'Blue Tiger',           'Green',
 'Chocolate Point',    'Tortie Point',    'Silver Tabby',      'Liver Tick',
    'Calico Point',            'Fawn',     'Lilac Point',      'Blue Point',
          'Agouti',     'Black Tiger']
Length: 54, dtype: string
```

[11]:
```
df_out_colors_1 = df_out.loc[(df_out['Color 0'].notna() == True) &␣
 ↪(df_out['Color 1'].notna() == False)]
df_out_colors_2 = df_out.loc[(df_out['Color 0'].notna() == True) &␣
 ↪(df_out['Color 1'].notna() == True)]
```

[12]:
```
def bigCorr_bernoulli(df, independent, dependent):
    numerator = (
        df[[independent, dependent]].groupby(independent).value_counts()
    )

    denominator = (
        df[[independent]].groupby(independent).value_counts()
    )

    return (numerator.div(denominator))[:,True]
```

[13]:
```
def bigCorr_bernoulli_custom_colors_2():
    df_out_colors_2_color_0 = df_out_colors_2[['Color 0', 'Adopted']].
 ↪rename(columns={'Color 0': 'Color'})
    df_out_colors_2_color_1 = df_out_colors_2[['Color 1', 'Adopted']].
 ↪rename(columns={'Color 1': 'Color'})

    numerator = (
        df_out_colors_2_color_0.groupby('Color').value_counts().add(
            df_out_colors_2_color_1.groupby('Color').value_counts(),
            fill_value=0
        )
    )

    denominator = (
        df_out_colors_2_color_0[['Color']].groupby('Color').value_counts().add(
            df_out_colors_2_color_1[['Color']].groupby('Color').value_counts(),
            fill_value=0
        )
    )

    return (numerator.div(denominator))[:,True]

def bigCorr_bernoulli_custom_colors_1_or_2():
    df_out_colors_1_color_0 = df_out_colors_1[['Color 0', 'Adopted']].
 ↪rename(columns={'Color 0': 'Color'})
    df_out_colors_2_color_0 = df_out_colors_2[['Color 0', 'Adopted']].
 ↪rename(columns={'Color 0': 'Color'})
    df_out_colors_2_color_1 = df_out_colors_2[['Color 1', 'Adopted']].
 ↪rename(columns={'Color 1': 'Color'})

    numerator = (
        df_out_colors_1_color_0.groupby('Color').value_counts().add(
            df_out_colors_2_color_0.groupby('Color').value_counts().add(
                df_out_colors_2_color_1.groupby('Color').value_counts(),
                fill_value=0
            ),
            fill_value=0
        )
    )

    denominator = (
        df_out_colors_1_color_0[['Color']].groupby('Color').value_counts().add(
            df_out_colors_2_color_0[['Color']].groupby('Color').value_counts().
 ↪add(
                df_out_colors_2_color_1[['Color']].groupby('Color').
 ↪value_counts(),
```

```
                fill_value=0
            ),
            fill_value=0
        )
    )

    return (numerator.div(denominator))[:,True]
```

[14]:
```
# This is copied from prep.ipynb

from math import pi

# colors.csv was compiled from these wikipedia articles
# https://en.wikipedia.org/wiki/List_of_colors:_A-F
# https://en.wikipedia.org/wiki/List_of_colors:_G%E2%80%93M
# https://en.wikipedia.org/wiki/List_of_colors:_N%E2%80%93Z
# Then the "-" character was replaced with "0"
df_colors = pd.read_csv('colors.csv')
df_colors = df_colors.convert_dtypes(infer_objects=True)
df_colors['Name'] = df_colors['Name'].str.lower()
df_colors['Red (RGB)'] = pd.to_numeric(df_colors['Red (RGB)'].str.replace('%',␣
 ↪'')).div(100)
df_colors['Green (RGB)'] = pd.to_numeric(df_colors['Green (RGB)'].str.
 ↪replace('%', '')).div(100)
df_colors['Blue (RGB)'] = pd.to_numeric(df_colors['Blue (RGB)'].str.
 ↪replace('%', '')).div(100)
df_colors['Hue (HSL/HSV)'] = pd.to_numeric(df_colors['Hue (HSL/HSV)'].str.
 ↪replace('°', '')).div(360)
df_colors['Satur. (HSL)'] = pd.to_numeric(df_colors['Satur. (HSL)'].str.
 ↪replace('%', '')).div(100)
df_colors['Light (HSL)'] = pd.to_numeric(df_colors['Light (HSL)'].str.
 ↪replace('%', '')).div(100)
df_colors['Satur. (HSV)'] = pd.to_numeric(df_colors['Satur. (HSV)'].str.
 ↪replace('%', '')).div(100)
df_colors['Value (HSV)'] = pd.to_numeric(df_colors['Value (HSV)'].str.
 ↪replace('%', '')).div(100)
df_colors.head()

def colorInfo(color):
    color = color.lower()
    words = [color] if color.count(' ') == 0 else [color] + color.split(' ')
    for word in words:
        try:
            items = df_colors.loc[df_colors.Name == word]
            if len(items) > 0:
                return items
```

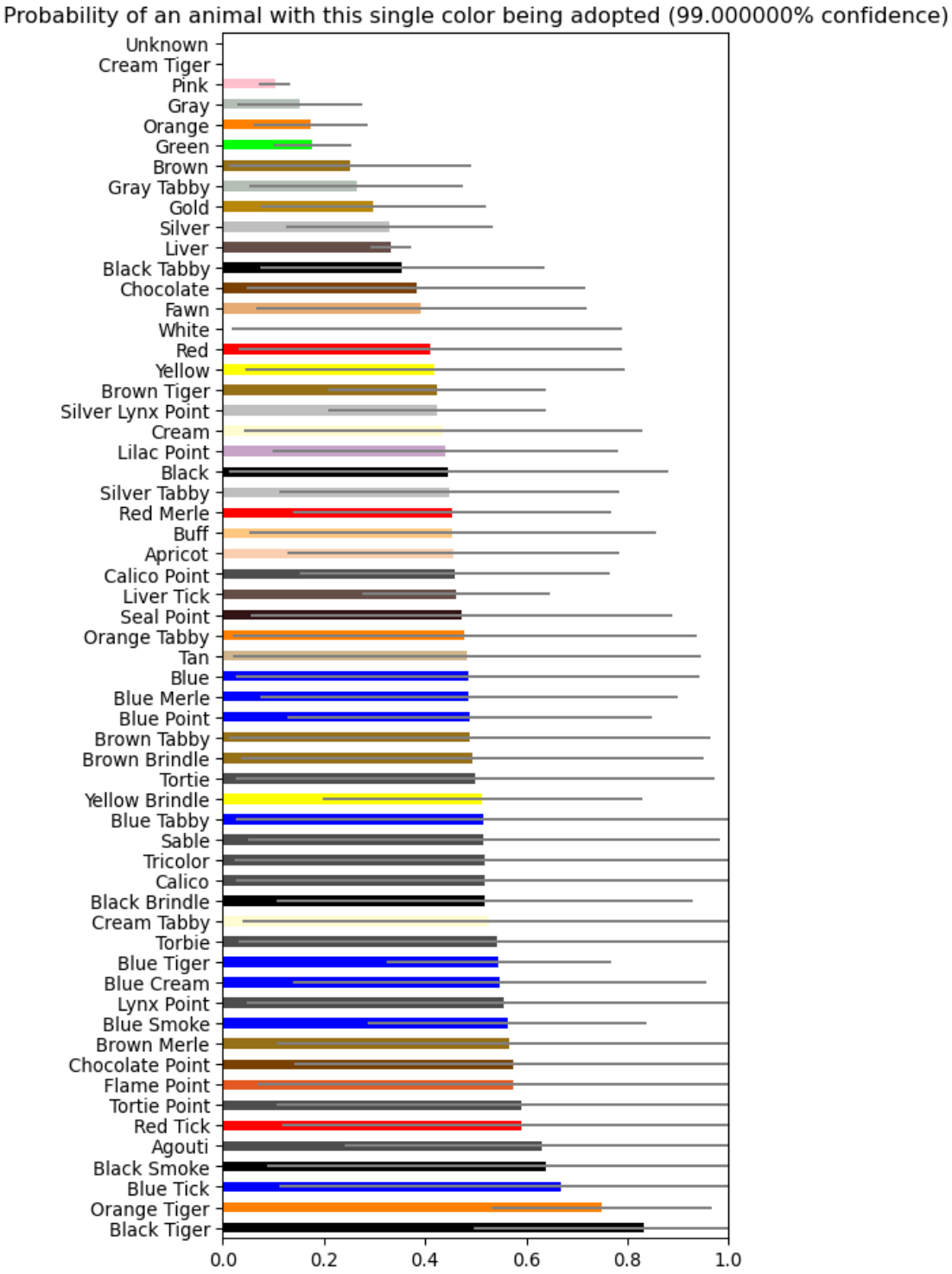
```
        except:
            continue

    for word in words:
        try:
            items = df_colors.loc[df_colors.Name.str.contains(word)]
            if len(items) > 0:
                return items
        except:
            continue

    return None

def rgb(color):
    info = colorInfo(color)
    if info is None: return (None, None, None)
    r = info['Red (RGB)'].values[0]
    g = info['Green (RGB)'].values[0]
    b = info['Blue (RGB)'].values[0]
    return (r, g, b)
```

[15]:
```
def chartColorAdoptionLikelihood(df_colors, color_relation):

    # Wilson confidence interval
    # https://en.wikipedia.org/wiki/Binomial_proportion_confidence_interval

    alpha = 0.01
    z = st.norm.ppf(1 - (alpha / 2))
    n = df_colors.Count
    p = df_colors.Adopted
    p_center = (1 / (1 + ((z ** 2) / n))) * (p + ((z ** 2) / (2 * n)))
    p_halfextent = (z / (1 + ((z ** 2) / n))) * ((( (p * (1 - p)) / (n) ) + ((z␣
 ↪** 2) / (4 * (n ** 2)))) ** (1/2))
    p_low = p_center - p_halfextent
    p_high = p_center - p_halfextent

    colors = [rgb(color) for color in df_colors.index]
    colors = [color if color[0] != None else '0.3' for color in colors]

    plt.figure(num=None, figsize=(5, 12), dpi=96, facecolor='w', edgecolor='k')
    plt.title(f'Probability of an animal with this {color_relation} color being␣
 ↪adopted ({(1 - alpha):%} confidence)')
    ax = df_colors.Adopted.plot.barh(x='Color', xerr=[p_low, p_high], ecolor='0.
 ↪5', color=colors)
    ax.set_xlim(0, 1)
    plt.show()
    print(f'{len(df_colors)} colors')
```

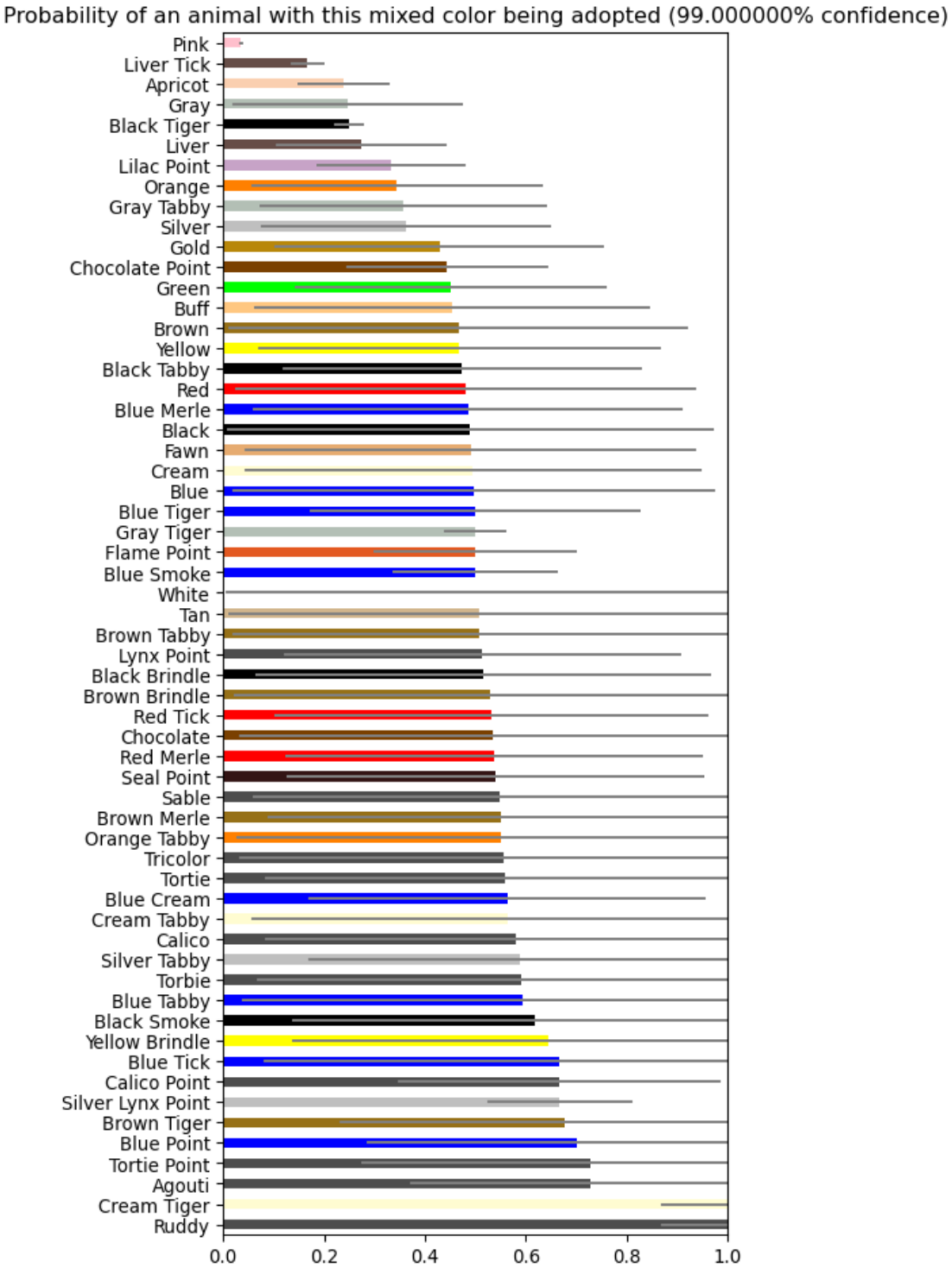
```
    print()

def colors_single():
    colors_adopted = bigCorr_bernoulli(df_out_colors_1, 'Color 0', 'Adopted')
    colors_count = df_out_colors_1['Color 0'].value_counts()
    df_colors = pd.DataFrame(index=colors_count.index)
    df_colors = df_colors.assign(Color=colors_count.index, Count=colors_count,␣
 ↪Adopted=colors_adopted)
    df_colors.sort_values(by='Adopted', ascending=False, inplace=True)
    chartColorAdoptionLikelihood(df_colors, 'single')

def colors_mixed():
    colors_adopted = bigCorr_bernoulli_custom_colors_2()
    colors_count = df_out_colors_2['Color 0'].value_counts().
 ↪add(df_out_colors_2['Color 1'].value_counts(), fill_value=0)
    df_colors = pd.DataFrame(index=colors_count.index)
    df_colors = df_colors.assign(Color=colors_count.index, Count=colors_count,␣
 ↪Adopted=colors_adopted)
    df_colors.sort_values(by='Adopted', ascending=False, inplace=True)
    chartColorAdoptionLikelihood(df_colors, 'mixed')

def colors_singleOrMixed():
    colors_adopted = bigCorr_bernoulli_custom_colors_1_or_2()
    colors_count = df_out_colors_1['Color 0'].value_counts().
 ↪add(df_out_colors_2['Color 0'].value_counts(), fill_value=0).
 ↪add(df_out_colors_2['Color 1'].value_counts(), fill_value=0)
    df_colors = pd.DataFrame(index=colors_count.index)
    df_colors = df_colors.assign(Color=colors_count.index, Count=colors_count,␣
 ↪Adopted=colors_adopted)
    df_colors.sort_values(by='Adopted', ascending=False, inplace=True)
    chartColorAdoptionLikelihood(df_colors, 'single or mixed')

colors_single()
colors_mixed()
colors_singleOrMixed()

# TODO 5: make an outcome chart like this for mixed and solid+mixed
# like the bar charts were made for just the Adopted percentage earlier
df_colors_outcomes = df_out_colors_1[['Outcome Type', 'Color 0']]
plt.figure(num=None, figsize=(5, 12), dpi=96, facecolor='w', edgecolor='k')
plt.title('Probability of an animal with this solid color having a certain␣
 ↪outcome')
ax=sns.histplot(
    data=df_colors_outcomes,
    y='Color 0',
    hue='Outcome Type',
```

```
    multiple='fill',
)
sns.move_legend(ax, 'upper left', bbox_to_anchor=(1,1))
plt.show()
```

```
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/numpy/core/_methods.py:44: RuntimeWarning: invalid value encountered in
reduce
  return umr_minimum(a, axis, None, out, keepdims, initial, where)
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/numpy/core/_methods.py:40: RuntimeWarning: invalid value encountered in
reduce
  return umr_maximum(a, axis, None, out, keepdims, initial, where)
```

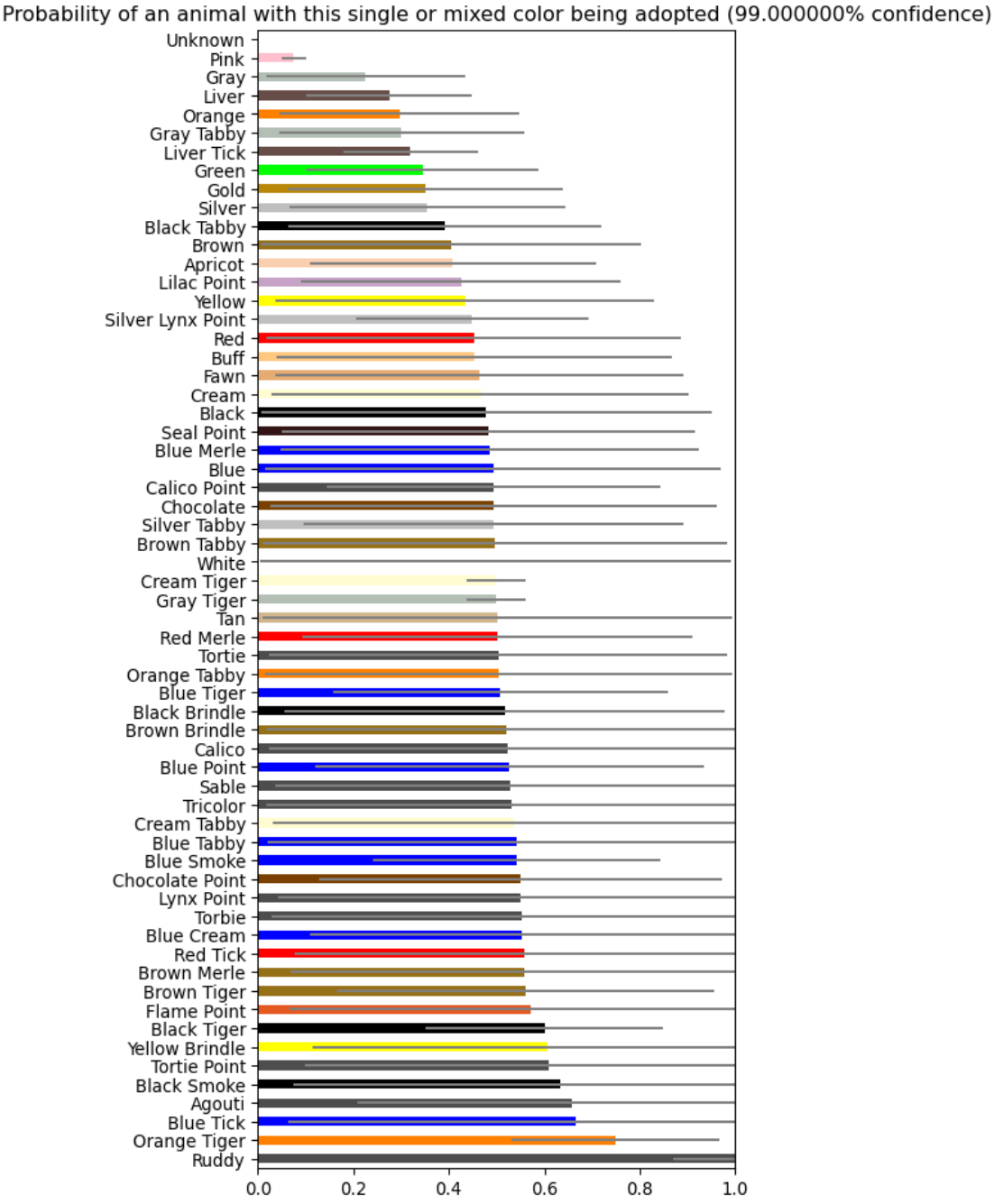

Probability of an animal with this single color being adopted (99.000000% confidence)
Unknown
Cream Tiger
Pink
Gray
Orange
Green
Brown
Gray Tabby
Gold
Silver
Liver
Black Tabby
Chocolate
Fawn
White
Red
Yellow
Brown Tiger
Silver Lynx Point
Cream
Lilac Point
Black
Silver Tabby
Red Merle
Buff
Apricot
Calico Point
Liver Tick
Seal Point
Orange Tabby
Tan
Blue
Blue Merle
Blue Point
Brown Tabby
Brown Brindle
Tortie
Yellow Brindle
Blue Tabby
Sable
Tricolor
Calico
Black Brindle
Cream Tabby
Torbie
Blue Tiger
Blue Cream
Lynx Point
Blue Smoke
Brown Merle
Chocolate Point
Flame Point
Tortie Point
Red Tick
Agouti
Black Smoke
Blue Tick
Orange Tiger
Black Tiger
0.0
0.2
0.4
0.6
0.8
1.0

```
59 colors
```

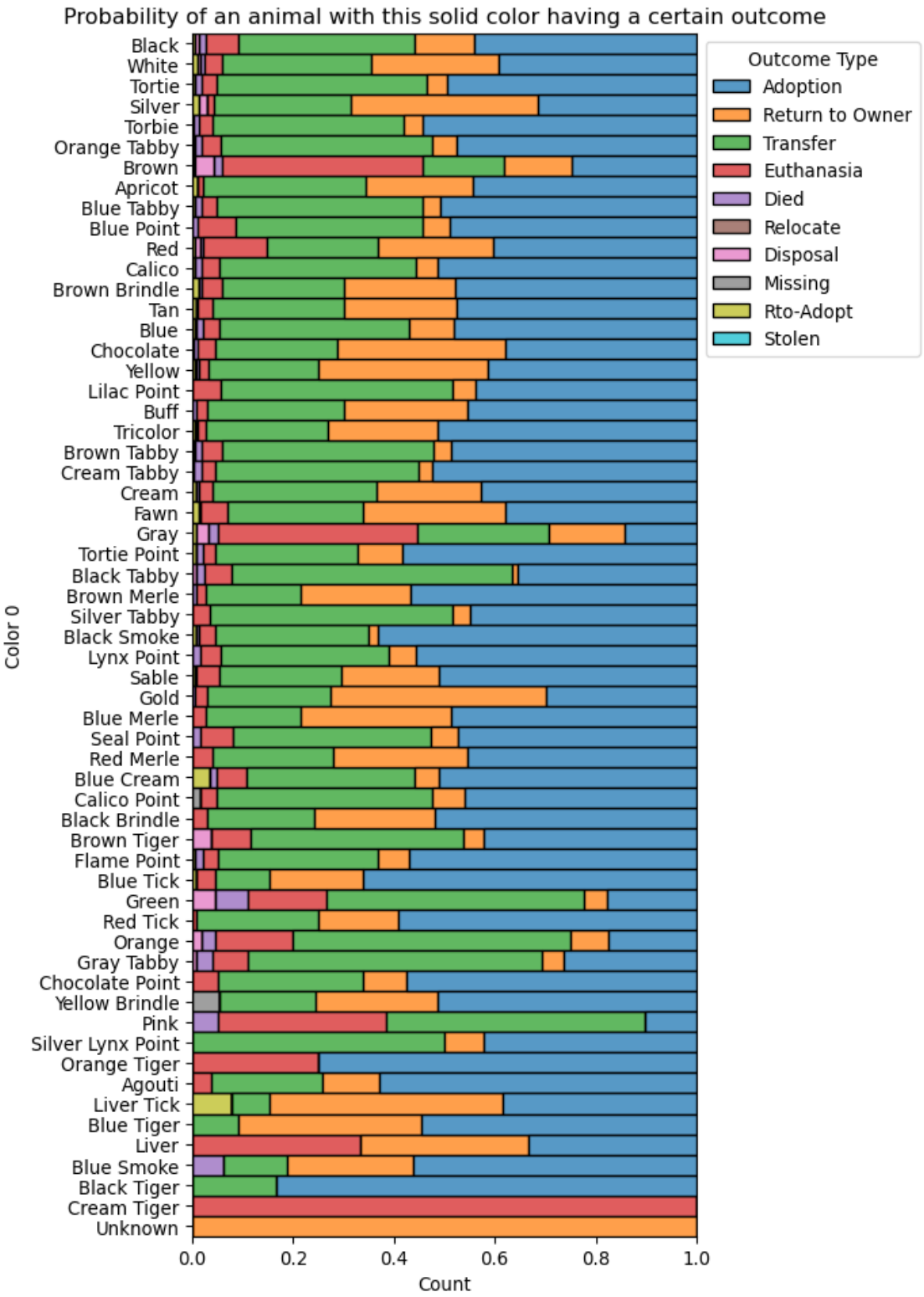



```
59 colors

/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
```

```
packages/numpy/core/_methods.py:44: RuntimeWarning: invalid value encountered in
reduce
  return umr_minimum(a, axis, None, out, keepdims, initial, where)
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/numpy/core/_methods.py:40: RuntimeWarning: invalid value encountered in
reduce
  return umr_maximum(a, axis, None, out, keepdims, initial, where)
```



```
61 colors
```


Probability of an animal with this solid color having a certain outcome
Outcome Type
Adoption
Return to Owner
Transfer
Euthanasia
Died
Relocate
Disposal
Missing
Rto-Adopt
Stolen
Color 0
Black
White
Tortie
Silver
Torbie
Orange Tabby
Brown
Apricot
Blue Tabby
Blue Point
Red
Calico
Brown Brindle
Tan
Blue
Chocolate
Yellow
Lilac Point
Buff
Tricolor
Brown Tabby
Cream Tabby
Cream
Fawn
Gray
Tortie Point
Black Tabby
Brown Merle
Silver Tabby
Black Smoke
Lynx Point
Sable
Gold
Blue Merle
Seal Point
Red Merle
Blue Cream
Calico Point
Black Brindle
Brown Tiger
Flame Point
Blue Tick
Green
Red Tick
Orange
Gray Tabby
Chocolate Point
Yellow Brindle
Pink
Silver Lynx Point
Orange Tiger
Agouti
Liver Tick
Blue Tiger
Liver
Blue Smoke
Black Tiger
Cream Tiger
Unknown
0.0
0.2
0.4
0.6
0.8
1.0
Count

2.2 Sex

[16]:
```
# TODO 6: regress sex against adoption likelihood
# Please make 3 bar charts:
#  - "Sex upon Outcome" (neutered male, spayed female, intact male, intact␣
 ↪female)
#  - male or female
#  - neutered/spayed or intact
# Also please construct the 95% confidence interval and make it the error bars
# see the earlier cell in the section on color for an example of how to do this
```

2.3 Breed characteristics

This analysis considers individual animals and looks for correlations between characteristics of their breed and their outcome.

It looks like the animals belonging to a breed with an average height around 20-25 (inches?) are more likely to be adopted than others, and animals between 5-12 inches are less likely than others to be adopted.

TODO 7: interpret the other graphs. Why are the different lifespan variables distributed the way they are, and why are they distributed differently compared to each other?

[17]:
```
df_out_1 = df_out.assign(Adopted=df_out.Adopted.fillna(False))
df_out_with_breeds_info_1 = df_out_with_breeds_info.assign(Adopted=df_out.
 ↪Adopted.fillna(False))

def correlo_histogram(df, independent, dependent, binwidth):
    print(f'{independent} ~ {dependent}')
    # TODO 8: add error bars when the dependent variable is "Adopted"
    # (see how the confidence interval was constructed in the previous cell
    # for regression by color)

    ax=sns.histplot(data=df,
             x=independent,
             hue=dependent,
             multiple='fill',
             binwidth=binwidth)
    sns.move_legend(ax, 'upper left', bbox_to_anchor=(1,1))
    plt.ylabel(f"P({dependent})")
    plt.show()

independent_vars_breeds_info = [
    ['average height', 2],
    ['Est. lifespan remaining', 1],
    ['average lifespan', 1],
```

```
    ['Lifespan Low', 1],
    ['Lifespan High', 1]
]

independent_vars_individuals = [
    ['Age upon Outcome (years)', 1],
    ['Years in animal center', 0.25],
    ['Color 0 H', 0.1],
    ['Color 0 S', 0.1],
    ['Color 0 V', 0.1],
]

for [independent, binwidth] in independent_vars_breeds_info:
    for dependent in ['Adopted', 'Outcome Type']:
        correlo_histogram(df_out_with_breeds_info_1, independent, dependent,␣
 ↪binwidth)

for [independent, binwidth] in independent_vars_individuals:
    for dependent in ['Adopted', 'Outcome Type']:
        correlo_histogram(df_out_1, independent, dependent, binwidth)
```

average height ~ Adopted

```
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:499: FutureWarning: In a future version, the
Index constructor will not infer numeric dtypes when passed object-dtype
sequences (matching Series behavior)
  pd.Index(edges, name="edges"),
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:500: FutureWarning: In a future version, the
Index constructor will not infer numeric dtypes when passed object-dtype
sequences (matching Series behavior)
  pd.Index(widths, name="widths"),
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:499: FutureWarning: In a future version, the
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sequences (matching Series behavior)
  pd.Index(edges, name="edges"),
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:500: FutureWarning: In a future version, the
Index constructor will not infer numeric dtypes when passed object-dtype
sequences (matching Series behavior)
  pd.Index(widths, name="widths"),
```

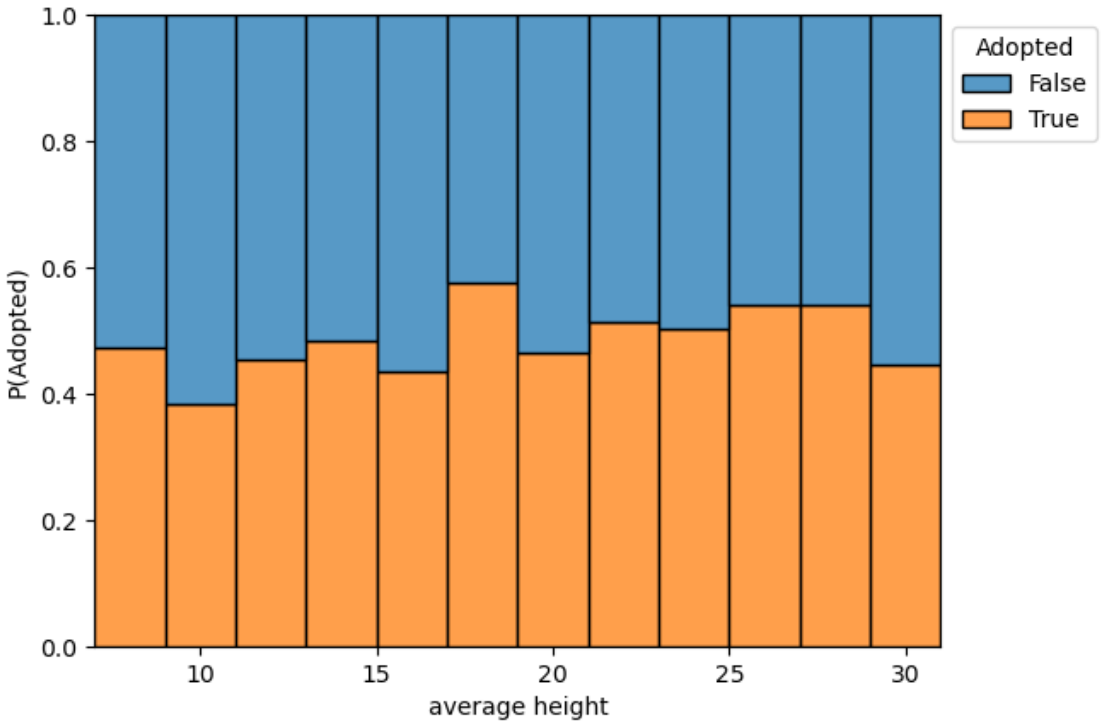

average height ~ Outcome Type

```
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:499: FutureWarning: In a future version, the
Index constructor will not infer numeric dtypes when passed object-dtype
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  pd.Index(edges, name="edges"),
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
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/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:499: FutureWarning: In a future version, the
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  pd.Index(edges, name="edges"),
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:500: FutureWarning: In a future version, the
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/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:499: FutureWarning: In a future version, the
```

```
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sequences (matching Series behavior)
  pd.Index(edges, name="edges"),
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
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/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
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  pd.Index(edges, name="edges"),
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
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  pd.Index(widths, name="widths"),
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:499: FutureWarning: In a future version, the
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sequences (matching Series behavior)
  pd.Index(widths, name="widths"),
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:499: FutureWarning: In a future version, the
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  pd.Index(edges, name="edges"),
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
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packages/seaborn/distributions.py:500: FutureWarning: In a future version, the
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sequences (matching Series behavior)
  pd.Index(widths, name="widths"),
```

```
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:499: FutureWarning: In a future version, the
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/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:500: FutureWarning: In a future version, the
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/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:499: FutureWarning: In a future version, the
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  pd.Index(edges, name="edges"),
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:500: FutureWarning: In a future version, the
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  pd.Index(widths, name="widths"),
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sequences (matching Series behavior)
  pd.Index(widths, name="widths"),
```
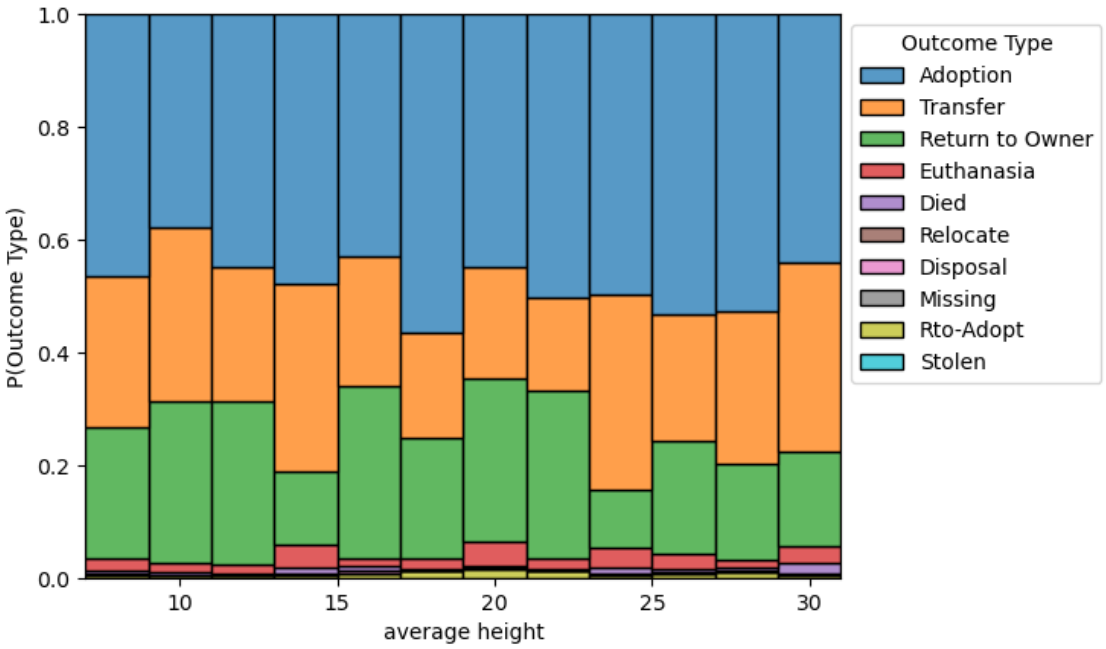
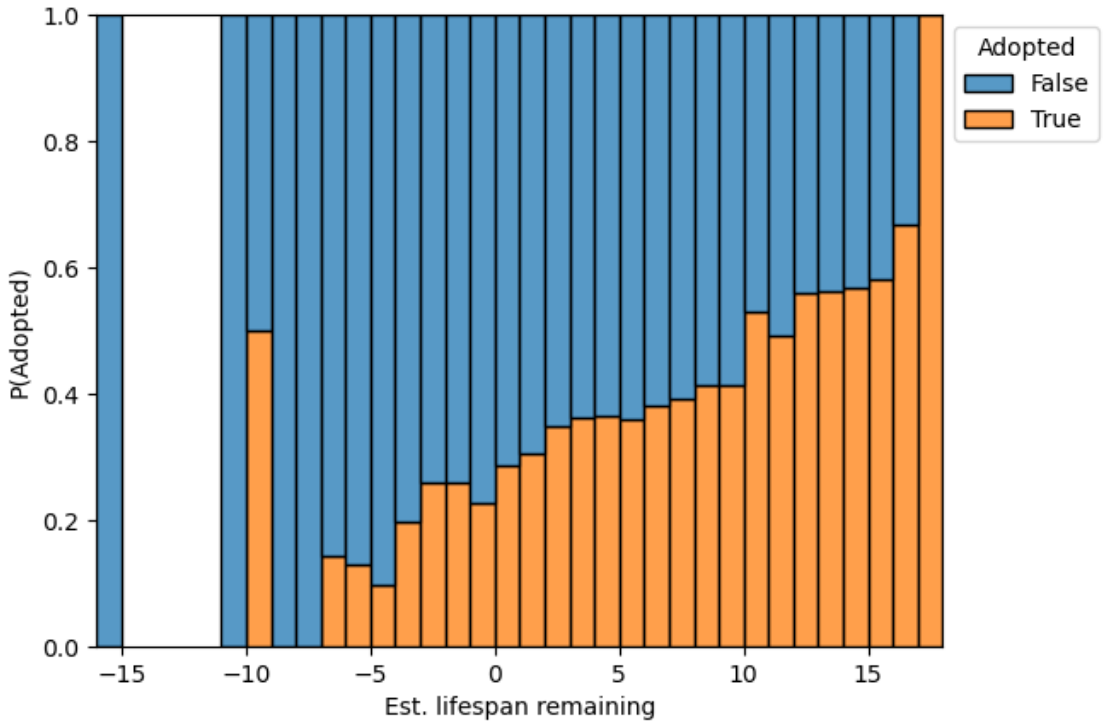
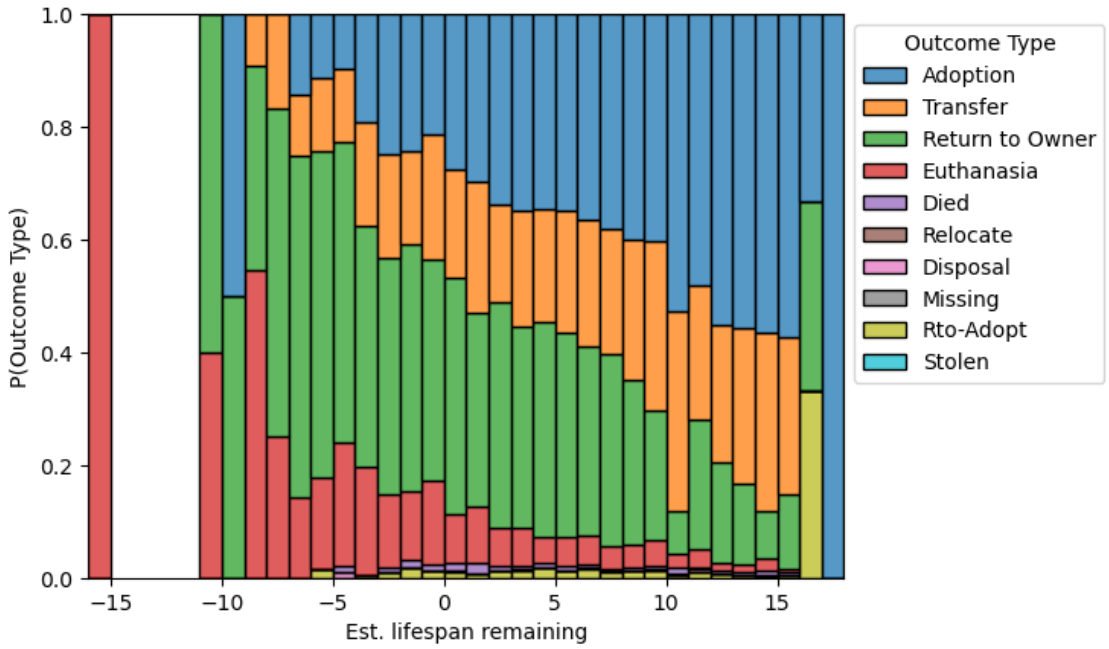



`Est. lifespan remaining ~ Adopted`



Est. lifespan remaining ~ Outcome Type



average lifespan ~ Adopted

```
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:499: FutureWarning: In a future version, the
Index constructor will not infer numeric dtypes when passed object-dtype
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/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:500: FutureWarning: In a future version, the
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  pd.Index(widths, name="widths"),
```

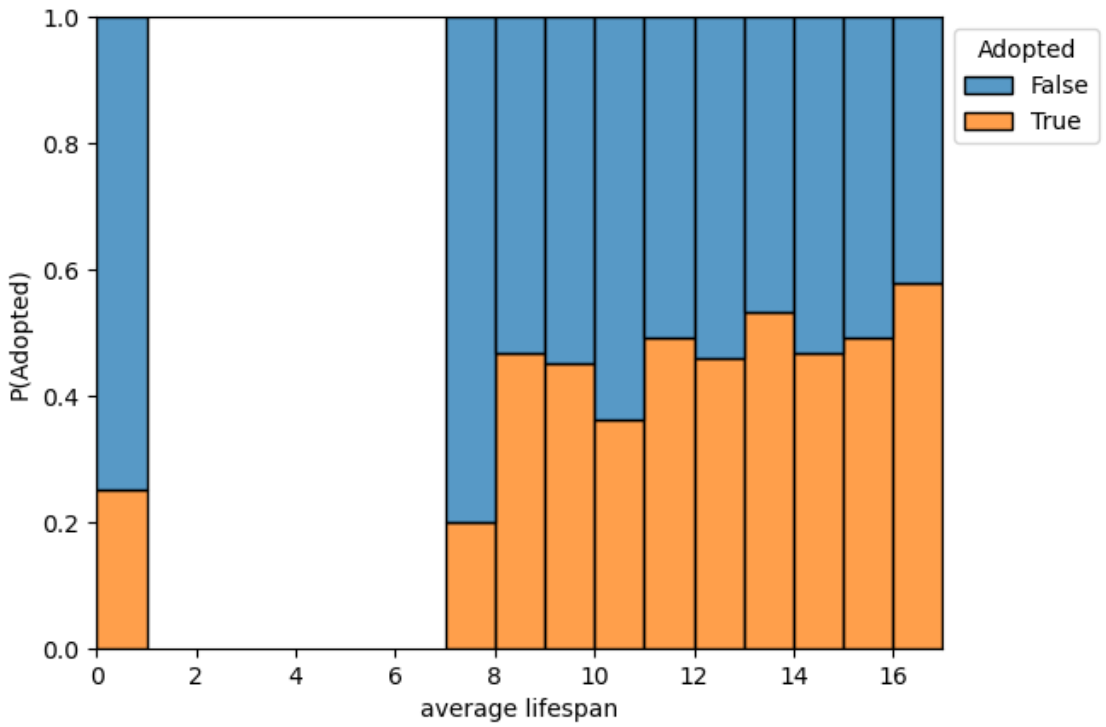


```
average lifespan ~ Outcome Type
```

```
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:499: FutureWarning: In a future version, the
Index constructor will not infer numeric dtypes when passed object-dtype
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/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
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```

```
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```

```
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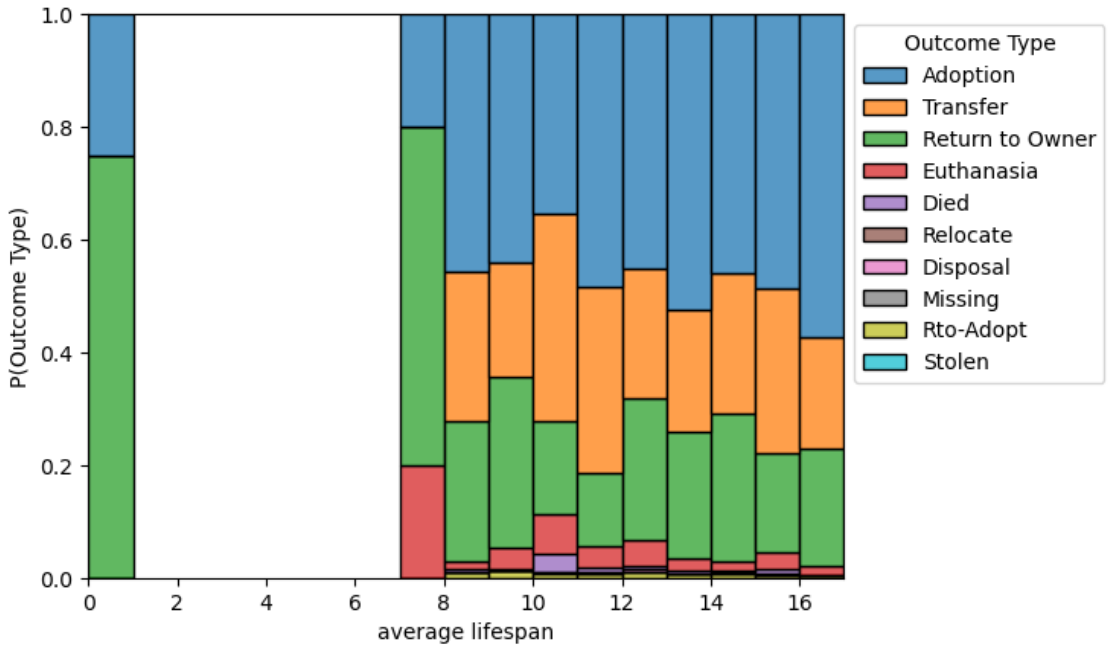

Lifespan Low ~ Adopted

```
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
packages/seaborn/distributions.py:499: FutureWarning: In a future version, the
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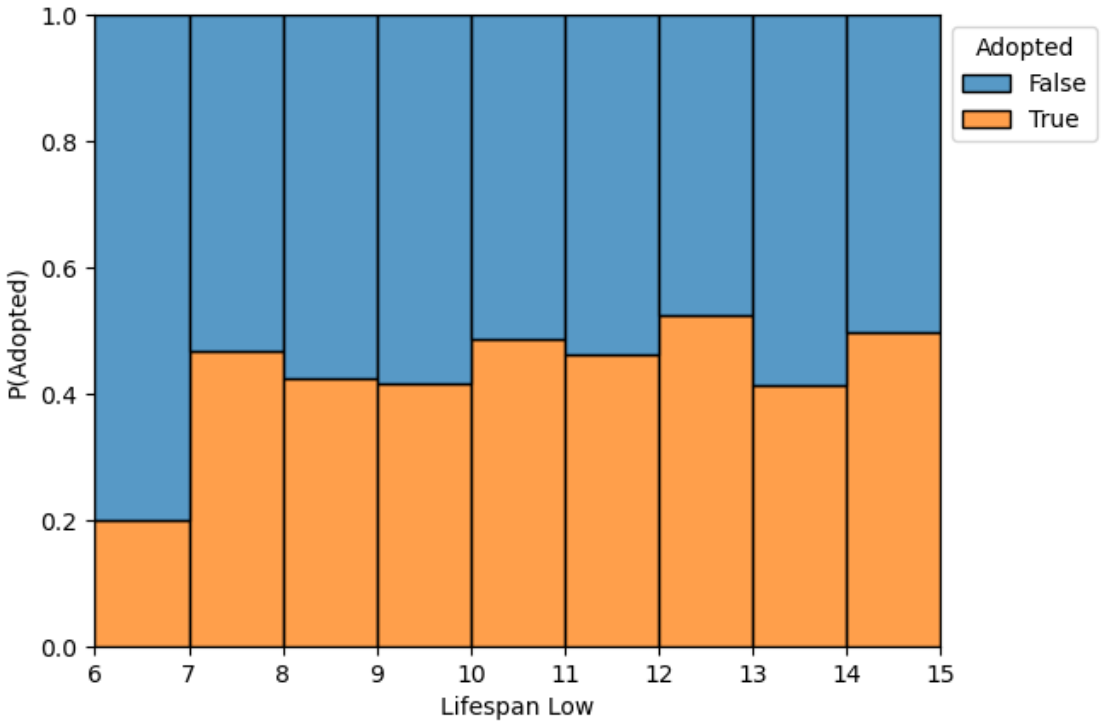


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Lifespan Low ~ Outcome Type
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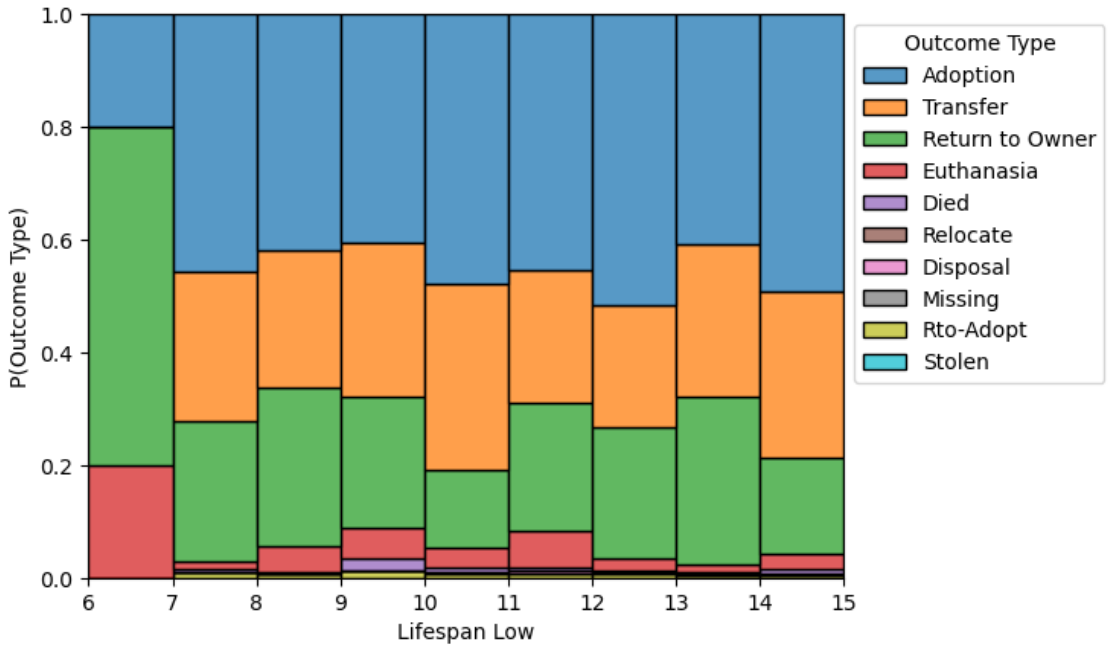

Lifespan High ~ Adopted

```
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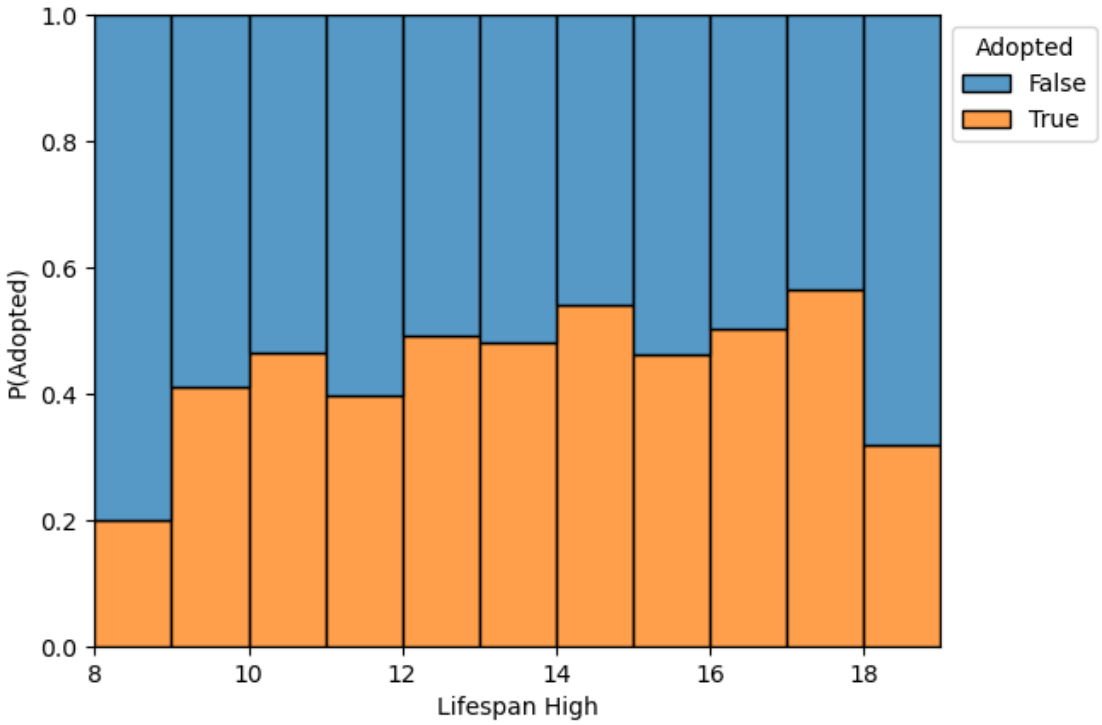

Lifespan High ~ Outcome Type

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/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
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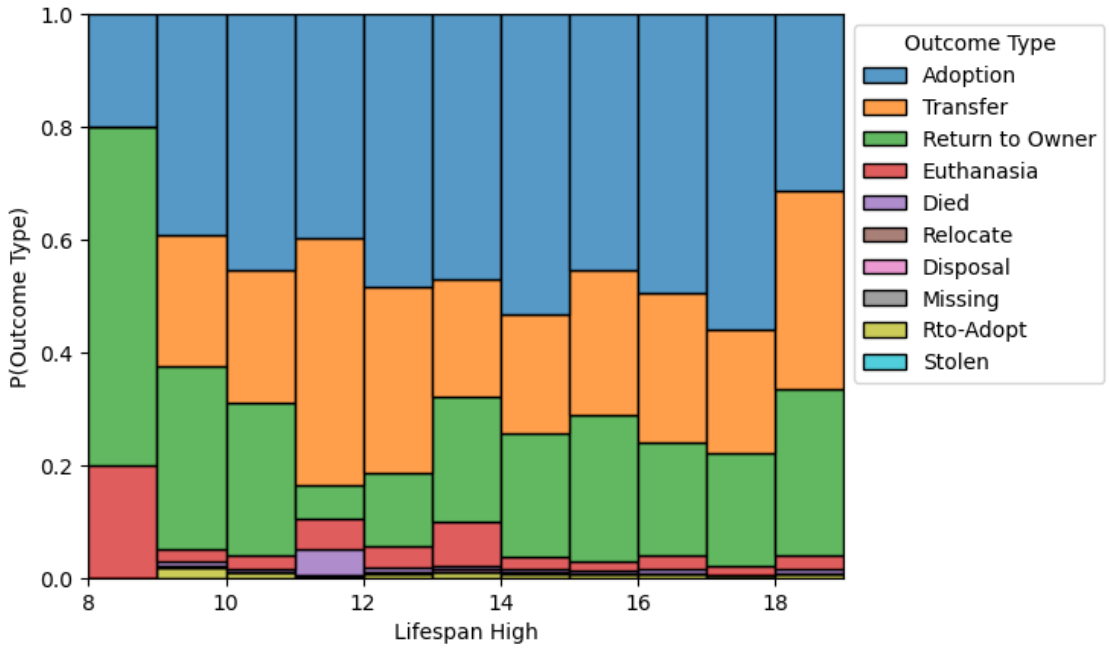

Age upon Outcome (years) ~ Adopted

```
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
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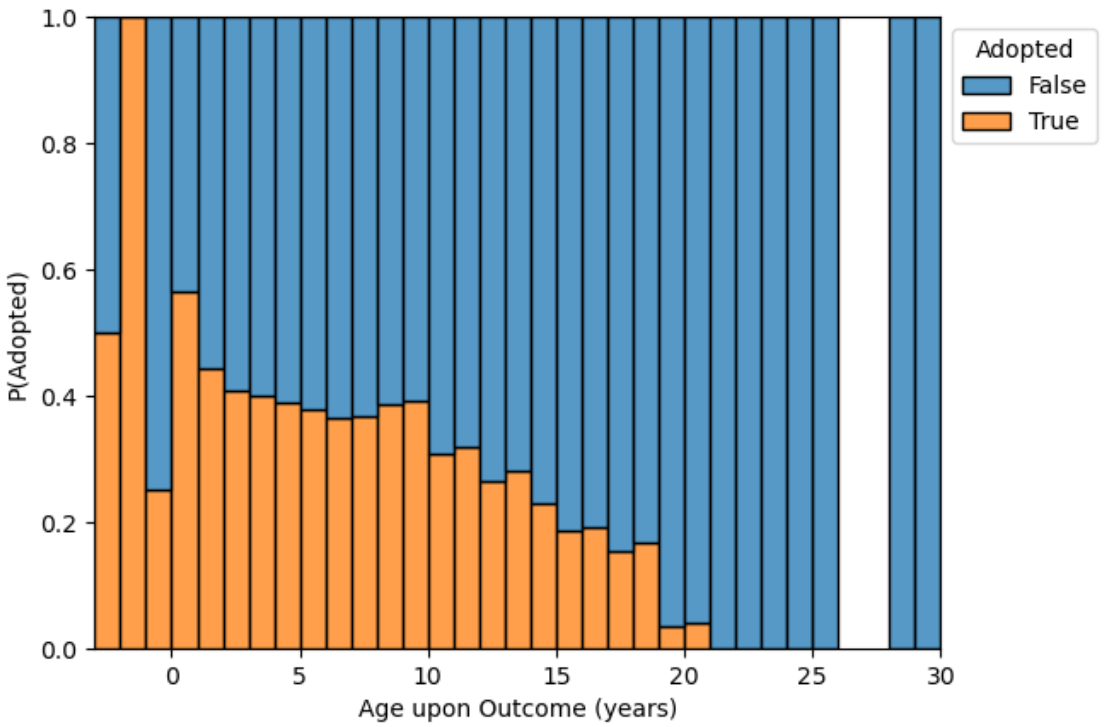


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Age upon Outcome (years) ~ Outcome Type

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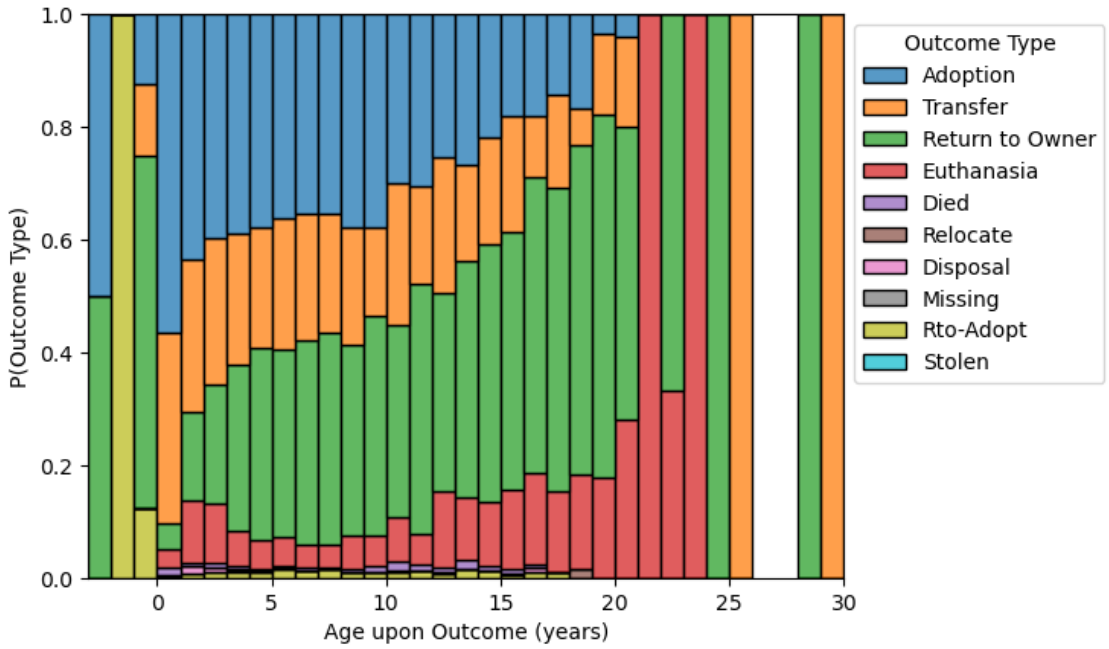


```
Years in animal center ~ Adopted
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```
/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
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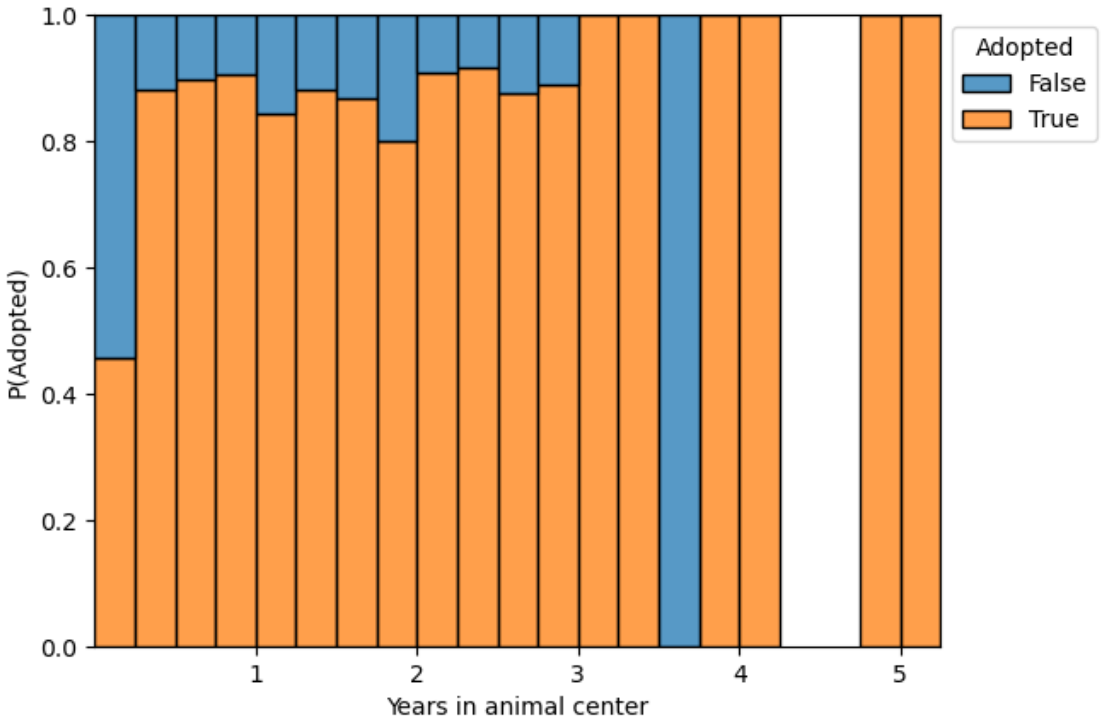


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Years in animal center ~ Outcome Type
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/home/isaac/miniconda3/envs/cse3380/lib/python3.10/site-
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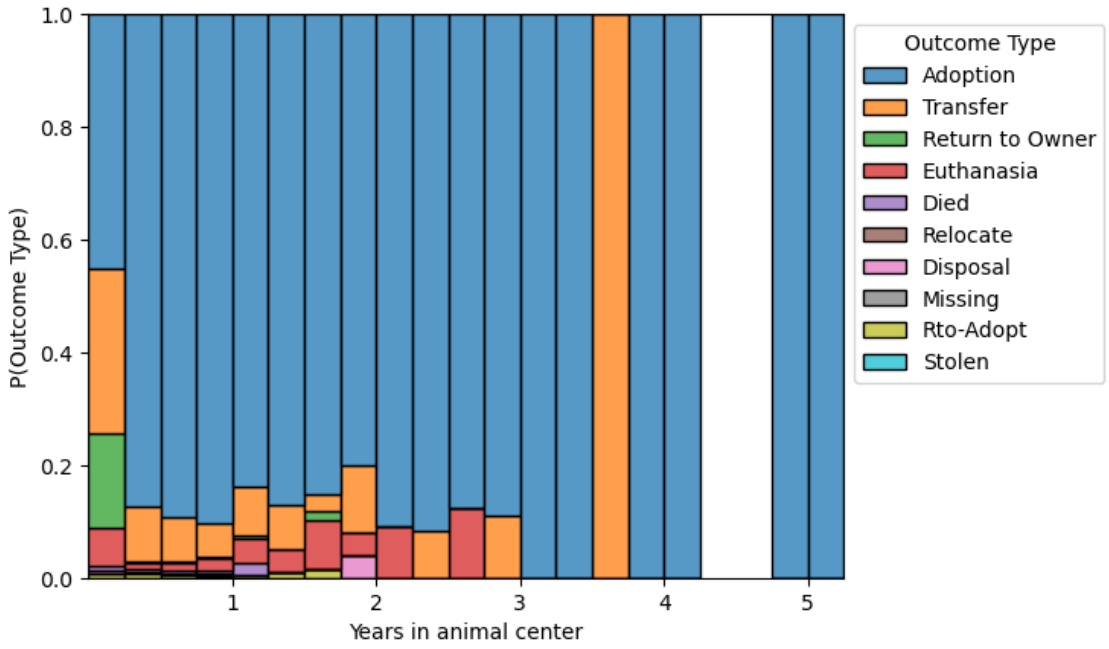


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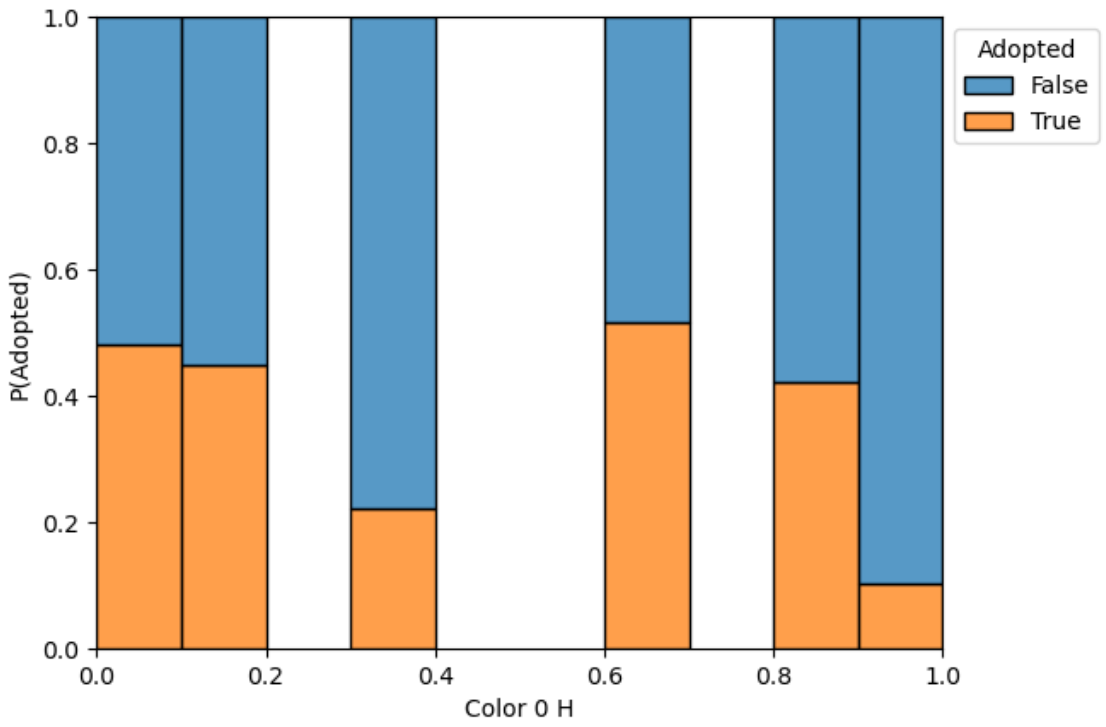

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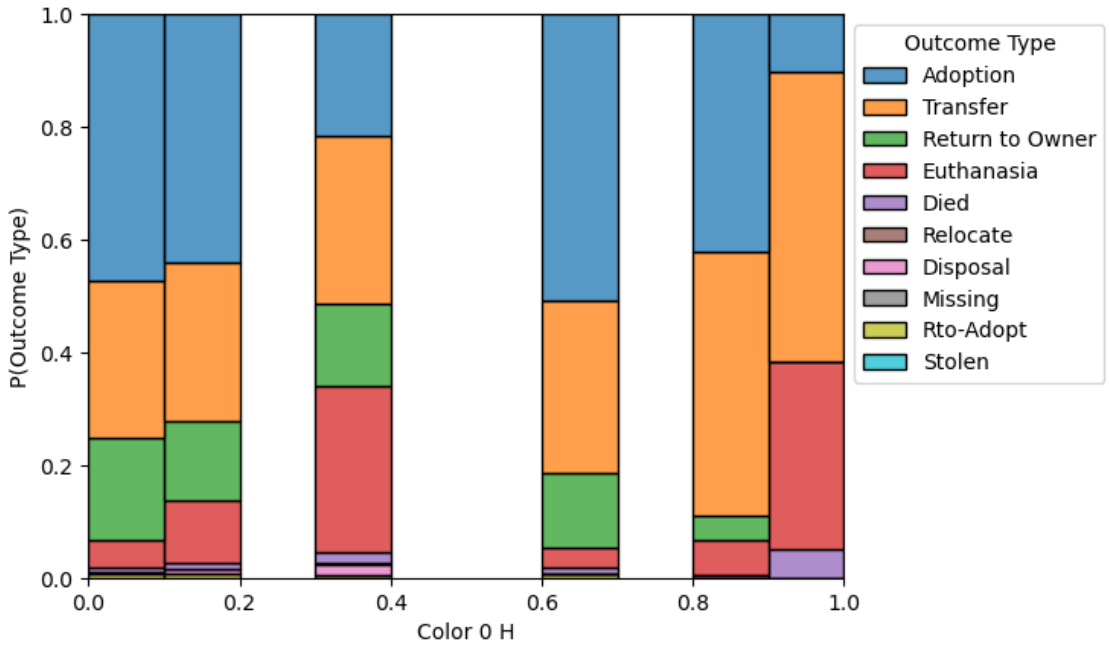

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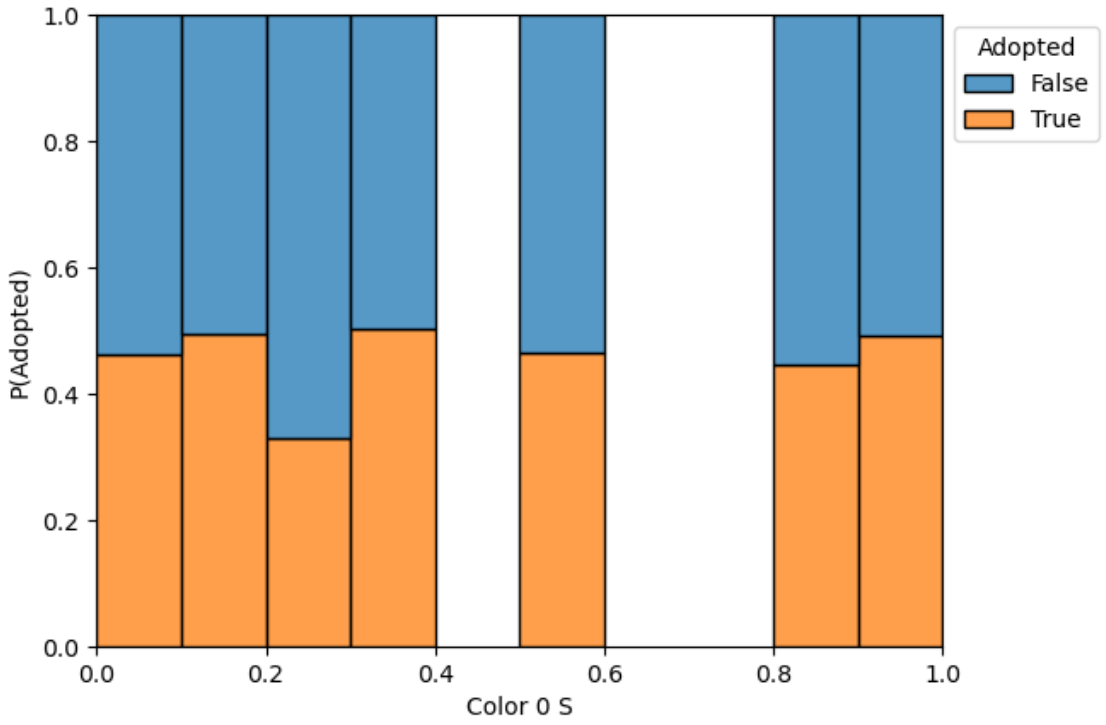

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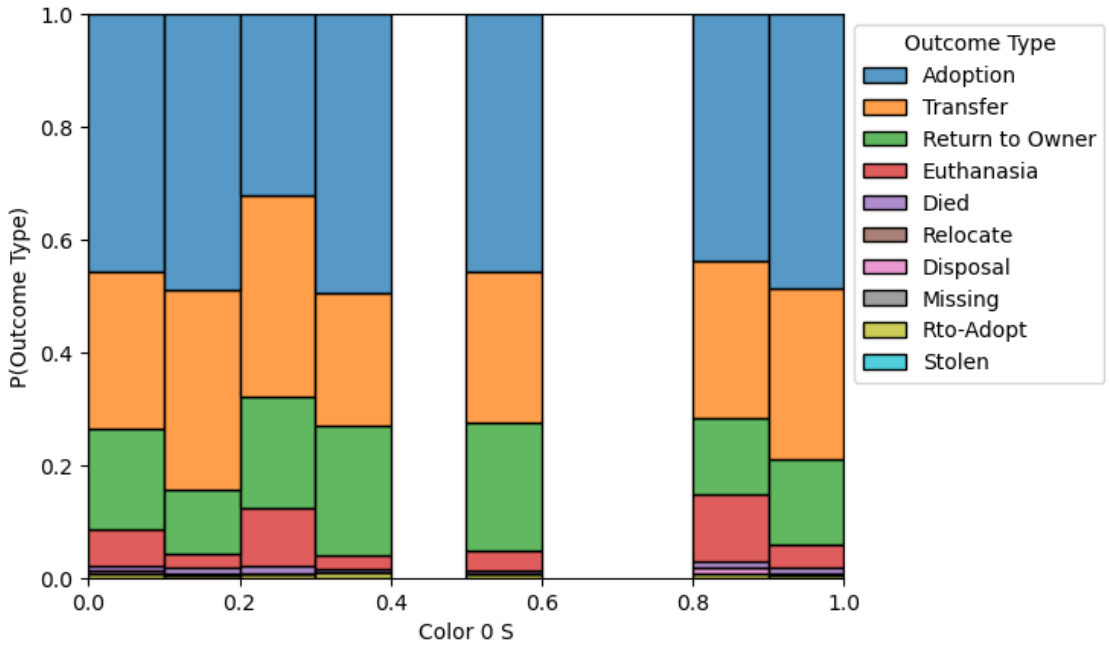

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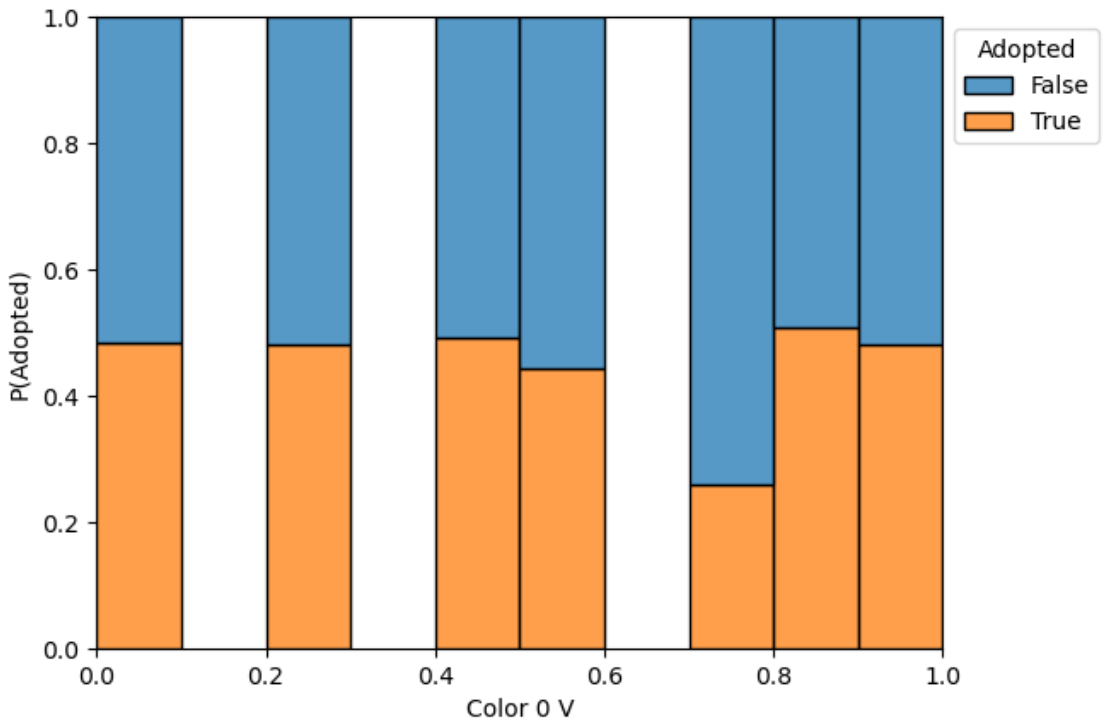

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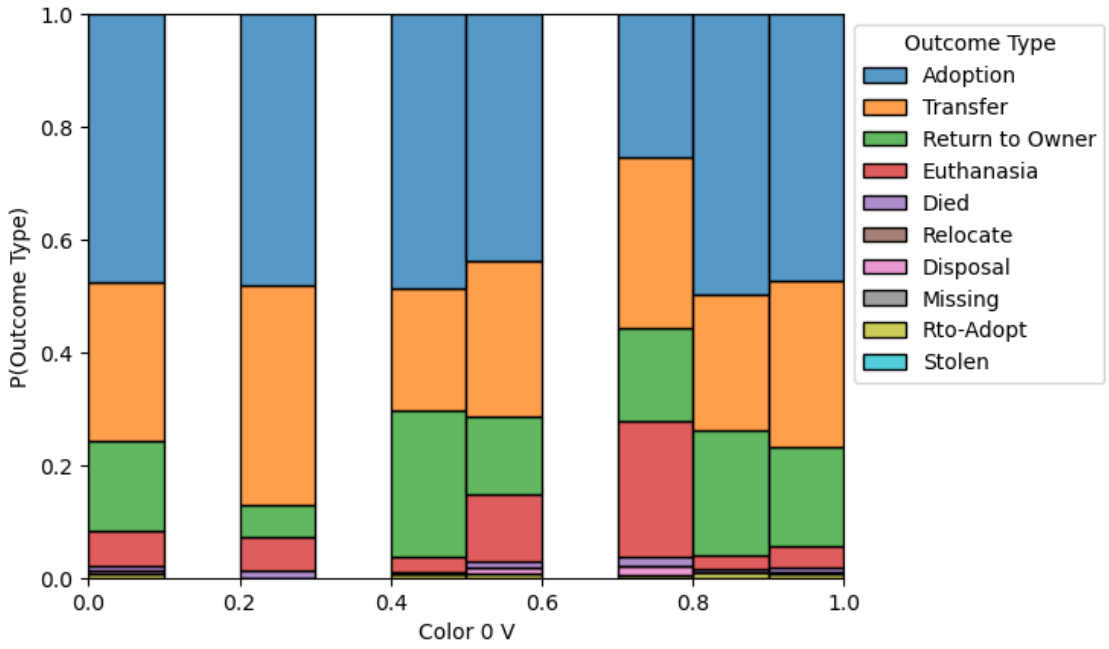

Based on these charts it seems the strongest indicator of adoption in a pet is its age. The graph 'est lifespan remaining ~ adopted' shows this very strongly as does the graph 'age upon outcome ~ adopted'.

Another correlation in these graphs is in 'average lifespan ~adoption'. This once again shows that potential adopters favor pets with a lot of years ahead of them.

This seems to imply that the biggest indicator of whether or not an animal will be adopted is its age. Younger pets are more likely to be adopted by a rather strong degree.

2.4 Age

Lets see if we can pull of some logistic regression of age ~ adoption

[18]:
```
df_al = df_out.dropna(how='all',axis=0)
df_al['Age upon Outcome (years)'] = df_al['Age upon Outcome (years)'].fillna(0)
df_al['Adopted'] = df_al['Adopted'].fillna(False)


y_data = df_al['Adopted'].astype(dtype=int)
x_data = df_al['Age upon Outcome (years)'].astype(dtype=float)


x_data = x_data.values.reshape(-1,1)

x_training_data, x_test_data, y_training_data, y_test_data =␣
 ↪train_test_split(x_data, y_data, test_size = 0.3)
```

```
model = LogisticRegression()
model.fit(x_training_data, y_training_data)
# predictions = model.predict(x_test_data)
print(confusion_matrix(y_test_data, model.predict(x_test_data)))
print(classification_report(y_test_data, model.predict(x_test_data)))
```

```
[[10865 12914]
 [ 6641 14434]]
              precision    recall  f1-score   support

           0       0.62      0.46      0.53     23779
           1       0.53      0.68      0.60     21075

    accuracy                           0.56     44854
   macro avg       0.57      0.57      0.56     44854
weighted avg       0.58      0.56      0.56     44854
```

The precision of 0.60 with a large support could be useful.