EDA raport for Bird Species Classifier

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Rapport EDA of CUB_200_2011 dataset for Bird Classifier

Context

The aim was to get a better understanding of the data and its quality to prepare for further training with classifying models like AutoML. The dataset used was Caltech-UCSD Birds-200-2011 and attached metadata.

Dataset information

- Sample size: 8251 records (taken from a randomly derived test sample)
- Number of classes (bird species): 200
- Data structure:
  - Photo identifier (image_id, image_path)
  - Class/bird species (class_id, classes_name)
  - Position and size of a bird on a photo (x, y, width, height)
  - Photo properties (mean rgb channel values mean_r, mean_g, mean_b, resolution img_width_px. img_height_px and num_pixels - number of pixels)

Quality and data integrity

- Empty data Logs and statistics (`df.insa().sum()`) indicate no empty values in key columns. Data related to classes and their metadata are complete

```
2024-12-07 21:42:56,359 - EDA_Logger - INFO - Checking for
missing values in the dataset.
image_id         0
image_path       0
class_id         0
```

```
x                0
y                0
width            0
height           0
classes_name     0
mean_r           0
mean_g           0
mean_b           0
img_width_px     0
img_height_px    0
num_pixels       0
dtype: int64
```

- Datatypes There is a lot of numerical values (ie. mean_r, mean_g, mean_b, width, height, img_width_px, img_height_px, num_pixels) and categorical variables is mainly classes_name Datatypes are as expected (float64 for metadata, int64 for identifiers and object for paths and class names)

```
2024-12-07 21:42:56,343 - EDA_Logger - INFO - Displaying
datastructure of the dataset.
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 8251 entries, 0 to 8250
Data columns (total 14 columns):
#   Column         Non-Null Count  Dtype
---  ------         --------------  -----
0   image_id       8251 non-null   int64
1   image_path     8251 non-null   object
2   class_id       8251 non-null   int64
3   x              8251 non-null   float64
4   y              8251 non-null   float64
5   width          8251 non-null   float64
6   height         8251 non-null   float64
7   classes_name   8251 non-null   object
8   mean_r         8251 non-null   float64
9   mean_g         8251 non-null   float64
10  mean_b         8251 non-null   float64
11  img_width_px   8251 non-null   float64
```

```
12  img_height_px  8251 non-null   float64
13  num_pixels     8251 non-null   float64
dtypes: float64(10), int64(2), object(2)
memory usage: 902.6+ KB
```

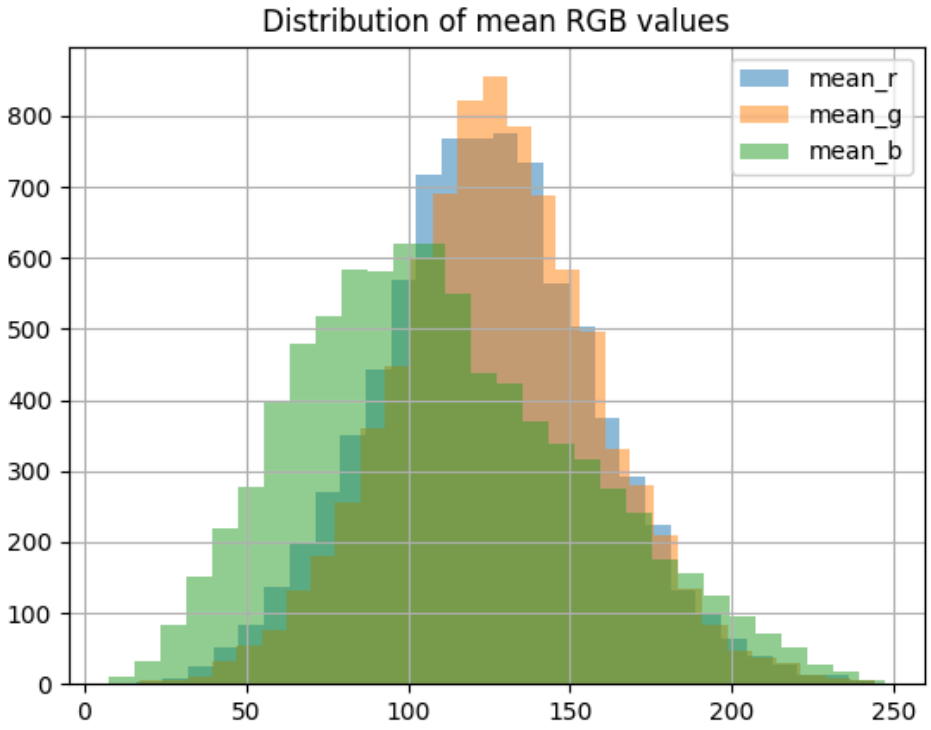
Analysis of distributions and statistics

- Basic statistics (describe) Means, medians and standard deviations indicate that data is homogeneous

```
2024-12-07 21:42:56,347 - EDA_Logger - INFO - Displaying basic statistics of the dataset.
          image_id     class_id            x            y        width       height       mean_r       mean_g       mean_b  img_width_px  img_height_px     num_pixels
count  8251.000000  8251.000000  8251.000000  8251.000000  8251.000000  8251.000000  8251.000000  8251.000000  8251.000000   8251.000000    8251.000000    8251.000000
mean   5857.948370   100.509514   104.540177    83.764877   256.626954   232.077324   124.099689   127.556223   110.430358    386.434372     467.580899  179320.703793
std    3402.819687    57.474476    63.892145    42.832930    89.133180    78.288282    33.729387    32.068854    43.531407     70.760077      64.114153   31483.361503
min       3.000000     1.000000     0.000000     0.000000   100.000000   100.000000    17.668925    16.925360     6.898955    120.000000     121.000000   19460.000000
25%    2880.500000    50.000000    53.000000    53.000000   187.000000   172.000000   101.955195   106.966283    78.784234    333.000000     488.000000  166500.000000
50%    5852.000000   100.000000    98.000000    80.000000   247.000000   223.000000   123.875086   127.097599   105.342482    375.000000     500.000000  178500.000000
75%    8768.000000   150.000000   150.500000   110.000000   320.000000   282.000000   145.577173   147.725641   138.687681    435.000000     500.000000  194500.000000
max   11788.000000   200.000000   336.000000   301.000000   500.000000   497.000000   243.943291   242.831789   245.349784    500.000000     500.000000  250000.000000
```

df.describe() of metadata.csv

- mean_r, mean_g, mean_b have mean values of around 100-140 which indicates that pictures are not overexposed and underexposed. Historgram of these variables shows almost a normal distribution with small deviation



mean rgb distribution of color variables

- Sizes oscillate in the range of 300-500 px, which means. that the data are not extremely varied. There is a visible concentration of photos with width 333-375 px and height 500 px

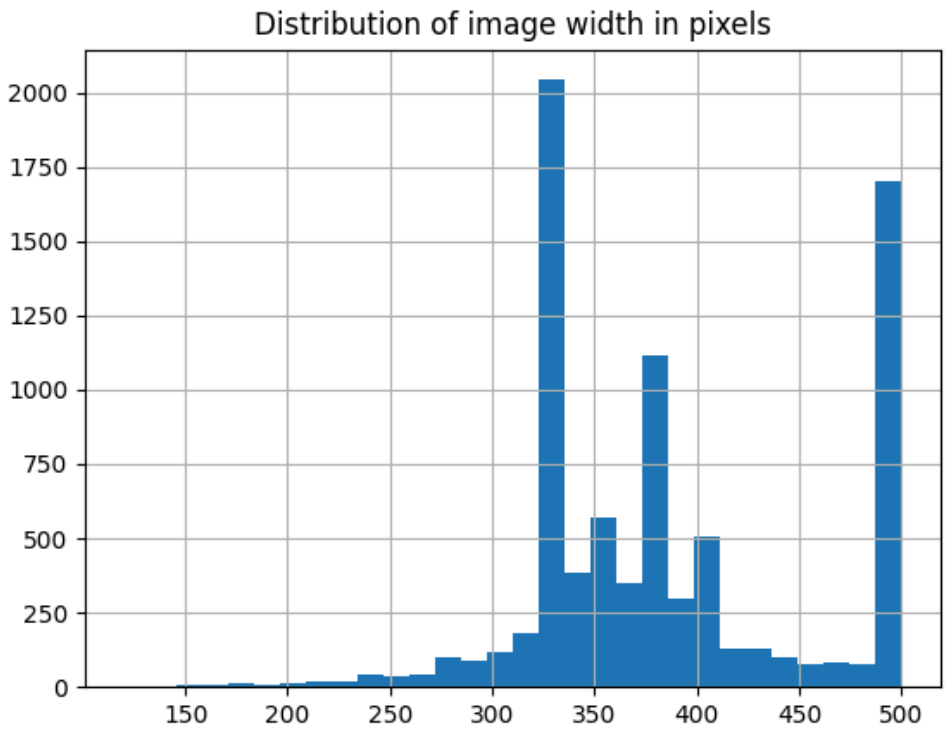
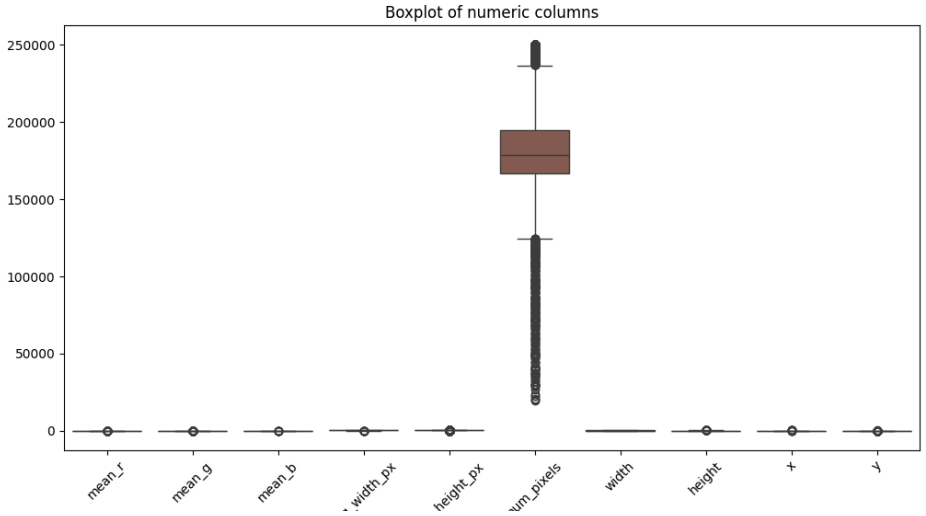


image width distribution

- num_pixels variable is very varied starting from 20 thousand pixels to 250 thousand pixels which is a direct consequence of image size. Boxplot shows that this particular numerical variable is very varied from the rest which suggest that it is worth to standardize this variable.



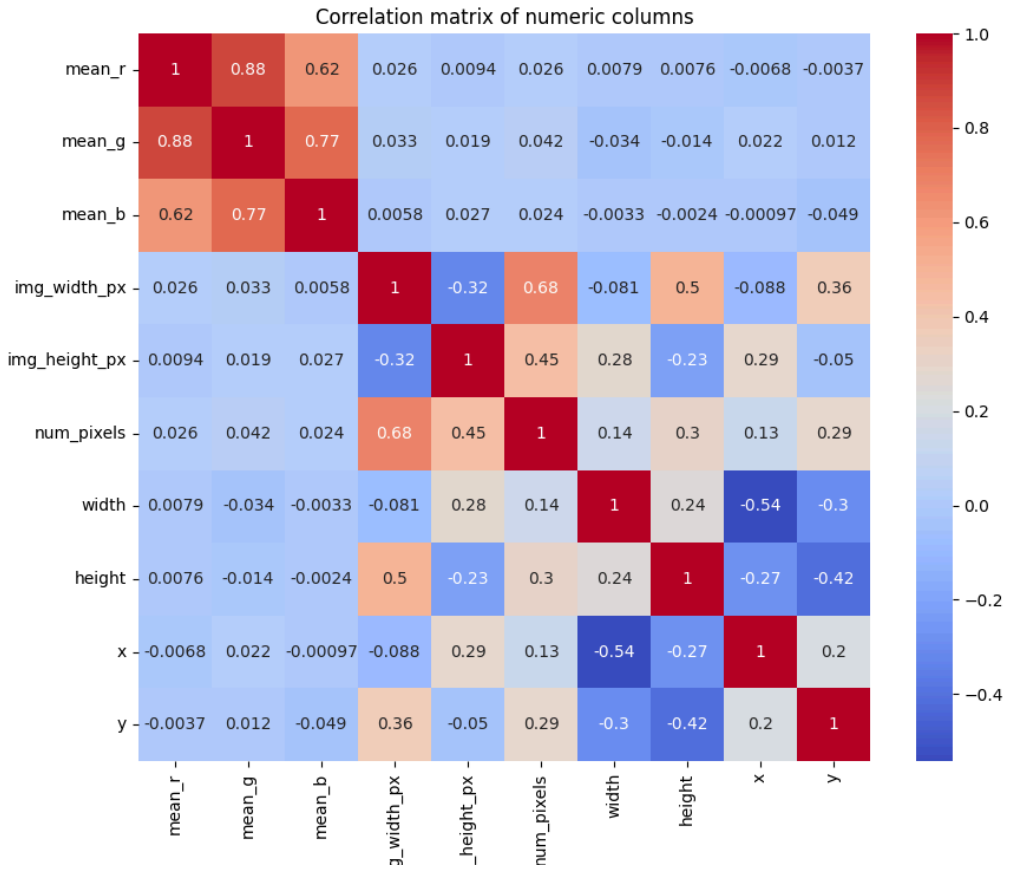
box plots of numerical variables

- Class distribution (classes_name) It seems fairly equal. The range of photos for each class ranges from 30 to 50 images. There is no need to use any balancing between classes.

Outliers

- The boxplot above shows that a variable that should catch the most attention is num_pixels. It is nonetheless normal and should not pose any issues. In ML models it could require some normalization to avoid domination of a particular variable.
- Other variables did not show any domination that should be eliminated. Outliers can present in bounding boxes provided with the dataset (for example very big or very small depending on the photo of the bird). This is again very normal but can be important for the model. Some birds are very small on the photo and others take up much more space of the frame.

Correlation between variables



correlation matrix of all numerical variables

- Colour channels (mean_r, mean_g, mean_b): We can observe a high correlation between colour variables which is natural. If a picture is subsequently brighter, then the all values will be high and correlation will stay the same.
- Image size (img_width_px, img_height_px, num_pixels): num_pixels is highly correlated with both size variables (logical, because num_pixels = width * height). This means, that one of those variables can be eliminated or we can include a derived variable like a proportion of width to height to exclude information influx or multiple encoding of the same variable.
- When it comes to bounding boxes, correlation between other variables is significantly lower. This suggests that the position of the bird on the frame is not related to colour or size. This can be significant in order to distinguish species that differ mostly in size rather than colour.

Conclusion

1. Because scales are diverse (mean_r ~100, num_pixels ~200k) it is worth to consider normalization before training the ML model. This will make the model learning stage more effective.
2. Reduction of redundant characteristics: num_pixels is highly correlated with image size. It is worth considering using only one variable to describe image size or creating a derived characteristic to kill any redundancy
3. Check if bounding box helps with classification: In further steps, consider testing information of bird placement on the accuracy of the model. It may be, that the way each bird is framed are specific for some species. Nonetheless it seems like a bit of a stretch but its still worth checking.
4. All classes are balanced. It is still worth checking during the final analysis (ie. if any of the models tested have some problems with species that show up less frequently). Try SMOTE or data augmentation if those problems show up. In this case, it should not happen though.

Addons

1. Full sample log statement from EDA analysis

```
python -u
"/Users/hubertsienicki/Projects/s25189_BirdSpeciesClassification/s
rc/EDA.py"
(venv) hubertsienicki@Huberts-MacBook-Pro
s25189_BirdSpeciesClassification % python -u
"/Users/hubertsienicki/Projects/s25189_BirdSpeciesClassification/s
rc/EDA.py"
2024-12-09 15:28:21,780 - EDA_Logger - INFO - Metadata loaded
successfully.
2024-12-09 15:28:21,780 - EDA_Logger - INFO - Displaying the first
5 rows of the dataset.
   image_id                                          image_path
```

```
class_id      x      y  ...      mean_g      mean_b img_width_px
img_height_px  num_pixels
0      3869  067.Anna_Hummingbird/Anna_Hummingbird_0044_560...
67   87.0  108.0  ...  144.943789  133.118992        369.0
500.0    184500.0
1      8167  140.Summer_Tanager/Summer_Tanager_0034_139781.jpg
140  176.0   56.0  ...   96.343499   28.618131        367.0
500.0    183500.0
2      4751  082.Ringed_Kingfisher/Ringed_Kingfisher_0009_7...
82  132.0   48.0  ...   98.550336   73.796264        333.0
500.0    166500.0
3     10594  180.Wilson_Warbler/Wilson_Warbler_0016_175532.jpg
180  189.0   56.0  ...  136.521024  100.982810        336.0
500.0    168000.0
4     11212  191.Red_headed_Woodpecker/Red_Headed_Woodpecke...
191   85.0   87.0  ...   90.292910   97.716899        378.0
500.0    189000.0

[5 rows x 14 columns]
2024-12-09 15:28:21,788 - EDA_Logger - INFO - Displaying
datastructure of the dataset.
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 8251 entries, 0 to 8250
Data columns (total 14 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   image_id       8251 non-null   int64
 1   image_path     8251 non-null   object
 2   class_id       8251 non-null   int64
 3   x              8251 non-null   float64
 4   y              8251 non-null   float64
 5   width          8251 non-null   float64
 6   height         8251 non-null   float64
 7   classes_name   8251 non-null   object
 8   mean_r         8251 non-null   float64
 9   mean_g         8251 non-null   float64
 10  mean_b         8251 non-null   float64
 11  img_width_px   8251 non-null   float64
```

```
 12  img_height_px  8251 non-null   float64
 13  num_pixels     8251 non-null   float64
dtypes: float64(10), int64(2), object(2)
memory usage: 902.6+ KB
None
2024-12-09 15:28:21,793 - EDA_Logger - INFO - Displaying basic
statistics of the dataset.
           image_id     class_id            x            y
width  ...       mean_g       mean_b  img_width_px  img_height_px
num_pixels
count   8251.000000  8251.000000  8251.000000  8251.000000
8251.000000  ...  8251.000000  8251.000000   8251.000000
8251.000000    8251.000000
mean    5857.948370   100.509514   104.540177    83.764877
256.626954  ...   127.556223   110.430358    386.434372
467.580899  179320.703793
std     3402.819687    57.474476    63.892145    42.832930
89.133180  ...    32.068854    43.531407     70.760077
64.114153   31483.361503
min        3.000000     1.000000     0.000000     0.000000
100.000000  ...    16.925360     6.898955    120.000000
121.000000   19460.000000
25%     2880.500000    50.000000    53.000000    53.000000
187.000000  ...   106.966283    78.784234    333.000000
488.000000  166500.000000
50%     5852.000000   100.000000    98.000000    80.000000
247.000000  ...   127.097599   105.342482    375.000000
500.000000  178500.000000
75%     8768.000000   150.000000   150.500000   110.000000
320.000000  ...   147.725641   138.687681    435.000000
500.000000  194500.000000
max    11788.000000   200.000000   336.000000   301.000000
500.000000  ...   242.831789   245.349784    500.000000
500.000000  250000.000000

[8 rows x 12 columns]
2024-12-09 15:28:21,805 - EDA_Logger - INFO - Checking for missing
values in the dataset.
```

```
image_id         0
image_path       0
class_id         0
x                0
y                0
width            0
height           0
classes_name     0
mean_r           0
mean_g           0
mean_b           0
img_width_px     0
img_height_px    0
num_pixels       0
dtype: int64
2024-12-09 15:28:21,807 - EDA_Logger - INFO - Showing the
distribution of the target variable.
125.Lincoln_Sparrow                   49
017.Cardinal                          48
064.Ring_billed_Gull                  48
071.Long_tailed_Jaeger                48
042.Vermilion_Flycatcher              48
                                      ..
006.Least_Auklet                      32
187.American_Three_toed_Woodpecker    32
105.Whip_poor_Will                    31
084.Red_legged_Kittiwake              31
008.Rhinoceros_Auklet                 28
Name: classes_name, Length: 200, dtype: int64
2024-12-09 15:28:21,807 - EDA_Logger - INFO - Showing the
distribution of the numeric columns.
             mean_r       mean_g       mean_b  img_width_px
img_height_px     num_pixels        width       height
x            y
count  8251.000000  8251.000000  8251.000000   8251.000000
8251.000000    8251.000000  8251.000000  8251.000000  8251.000000
8251.000000
mean    124.099689   127.556223   110.430358    386.434372
```

```
467.580899  179320.703793   256.626954   232.077324   104.540177
83.764877
std      33.729387    32.068854    43.531407     70.760077
64.114153   31483.361503    89.133180    78.288282    63.892145
42.832930
min      17.668925    16.925360     6.898955    120.000000
121.000000   19460.000000   100.000000   100.000000     0.000000
0.000000
25%     101.955195   106.966283    78.784234    333.000000
488.000000  166500.000000   187.000000   172.000000    53.000000
53.000000
50%     123.875086   127.097599   105.342482    375.000000
500.000000  178500.000000   247.000000   223.000000    98.000000
80.000000
75%     145.577173   147.725641   138.687681    435.000000
500.000000  194500.000000   320.000000   282.000000   150.500000
110.000000
max     243.943291   242.831789   245.349784    500.000000
500.000000  250000.000000   500.000000   497.000000   336.000000
301.000000
2024-12-09 15:28:21,817 - EDA_Logger - INFO - Showing histograms
of the numeric columns.
2024-12-09 15:28:21,817 - EDA_Logger - INFO - Showing the
distribution of image width in pixels.
2024-12-09 15:28:21,817 - EDA_Logger - INFO - Showing outliers in
the dataset.
2024-12-09 15:28:21,817 - EDA_Logger - INFO - Showing the
correlation matrix of the numeric columns.
2024-12-09 15:28:21,817 - EDA_Logger - INFO - Generating EDA
report.
2024-12-09 15:28:21,817 - EDA_Logger - INFO - EDA completed
successfully.
```

2. PDF rapport generated by sweetviz is at /raports/sweetwiz/