# MainMethod

March 25, 2021

Taking the output from DEG-SEQ2, the data "5LS_L2L3Combined.csv" contains the 5 life stages we are interested in: Embryo, L1 larva, Dauer Larva, L2L3 Larva and Adult, lets take a peek of that data

[1]:
```
import csv
import os

#user configurable variables
number_of_lines_to_print=10
expressionCountFile=os.path.join(os.getcwd(),'csvs/5LS_L2L3Combined.csv')
#Code Chunk for printing the file
with open(os.path.join(os.getcwd(),expressionCountFile)) as csv_file:
    csv_reader = csv.reader(csv_file, delimiter=',')
    for row in csv_reader:
        print(row)
        number_of_lines_to_print-=1
        if number_of_lines_to_print<=0:
            break
```

```
['WBID', 'elongating embryo Ce', 'L1 larva Ce', 'dauer larva Ce', 'adult Ce',
'L2L3_larva']
['WBGene00000001', '4208', '12140', '5547', '2246', '2369']
['WBGene00000002', '12554', '7828', '831', '280', '2591']
['WBGene00000003', '7180', '11253', '570', '212', '2466']
['WBGene00000004', '33305', '26947', '3212', '576', '5391']
['WBGene00000005', '595', '132', '37', '281', '1410']
['WBGene00000006', '425', '12243', '3146', '228', '2446']
['WBGene00000007', '36', '314', '129', '197', '1719']
['WBGene00000008', '0', '19', '663', '19', '182']
['WBGene00000009', '71', '416', '193', '20', '64']
```

Lets look at some statistics about the data:

[2]:
```
import pandas as pd
import numpy as np

exp_data = pd.read_csv(expressionCountFile)
```

```
print(exp_data.describe())
```

```
       elongating embryo Ce   L1 larva Ce  dauer larva Ce      adult Ce  \
count          20361.000000  2.036100e+04    2.036100e+04  2.036100e+04
mean            3692.118364  1.097686e+04    3.908223e+03  2.065875e+03
std            12796.637118  5.382926e+04    2.111976e+04  2.269343e+04
min                0.000000  0.000000e+00    0.000000e+00  0.000000e+00
25%                8.000000  5.700000e+01    2.700000e+01  5.000000e+00
50%              201.000000  7.240000e+02    4.030000e+02  8.600000e+01
75%             2730.000000  4.645000e+03    2.375000e+03  8.690000e+02
max           355180.000000  1.890193e+06    1.303599e+06  2.253663e+06

         L2L3_larva
count  2.036100e+04
mean   4.178275e+03
std    1.964655e+04
min    0.000000e+00
25%    2.900000e+01
50%    3.910000e+02
75%    2.292000e+03
max    1.103229e+06
```

Now, we need to determine the genes that we consider to be life stage biased, here are the some criterias that must be fullfilled to be considered a life stage biased gene:

This gene has the highest expression in that life stage

This gene's expression at this life stage has at least a fold difference of 2 comparing the max expression in other life stages

At least one life stage has a count that is higher than at least 10% of of counts across all life stages. *This ensures we dont include genes that have high fold diff due to unbalanced low expression counts, for example, a gene has a count of 1 in one life stage and are not found in other life stages(0 counts),this gene is a uniformly lowly expressed gene in all life stages, however, using the criteria one, this gene would have a fold difference of infinity, by setting a lower bound filter, we exclude these extremely lowly expressed gene counts that are prone to sequencing uncertainties.

Let's process the expression file using above criterias:

[3]:
```
from Code import LifeStageBiased as LSB
#Speficy input and output
LSB.inputFile= expressionCountFile
outputFilePath=os.path.join(os.getcwd(),'csvs/LSB.csv')
LSB.outputFile= outputFilePath
LSB.cutLowPercentile=0.15
LSB.foldDiff=2
LSB.fixedCutValue=0 #This overrides the percentil cut value, set to 0 disables␣
 ↪it
LSB.main()
```

```
The cutOff Value for the specified percentaile is:  5.0
```

*In the data we are analyzing, there are very few genes that have observed expression only in one life stage, in which case the max expression for other life stages is 0, this will yield infinity for the fold diff value, in theory, these are "life stage specific genes" rather than "life stage biased genes", however, since the same reason we mentioned above about the sequecing uncertainties, we do not believe that a gene with a few counts only in one life stage is more likely to be a life stage biased gene comparing to a gene with high expression in one life stage and very low expression in other life stages, see example below:

[4]:
```
ls_data = pd.read_csv(outputFilePath)

print(ls_data.loc[ls_data['GeneID'] == "WBGene00015845"])
print()
print(ls_data.loc[ls_data['GeneID'] == "WBGene00000609"])
```

```
              GeneID        LS  LS_EXP  SecondMax  RestMean  FoldDiff
6043  WBGene00015845  adult Ce     7.0        0.0       0.0       7.0

             GeneID        LS   LS_EXP  SecondMax  RestMean    FoldDiff
218  WBGene00000609  adult Ce  71952.0      148.0     76.75  486.162162
```

As shown above, Gene "WBGene00015845" is a relatively lowly expressed gene that is only expressed in adult stage, and "WBGene00000609" has significantly higher expression in adult stage comparing to other life stages, which one are we more confident to select as the life stage biased gene?

There is no sure way to know, to compensate that, instead of putting infinity as the fold difference value for these "life stage specific" genes and put more confidence in them above all other genes, we decided to use their expression value as their foldDiff value, in which case a highly expressed "life stage specific" gene will be given higher confidence comparing to a lowly expressed one.

We are aware that this is perhaps not the best way of handling these genes, but luckily, there are only 15 such genes out of the 10099 life stage biased genes(0.15%) we selected using above filter, so it is extremly unlikely that different handlings of these genes will make a significant difference.

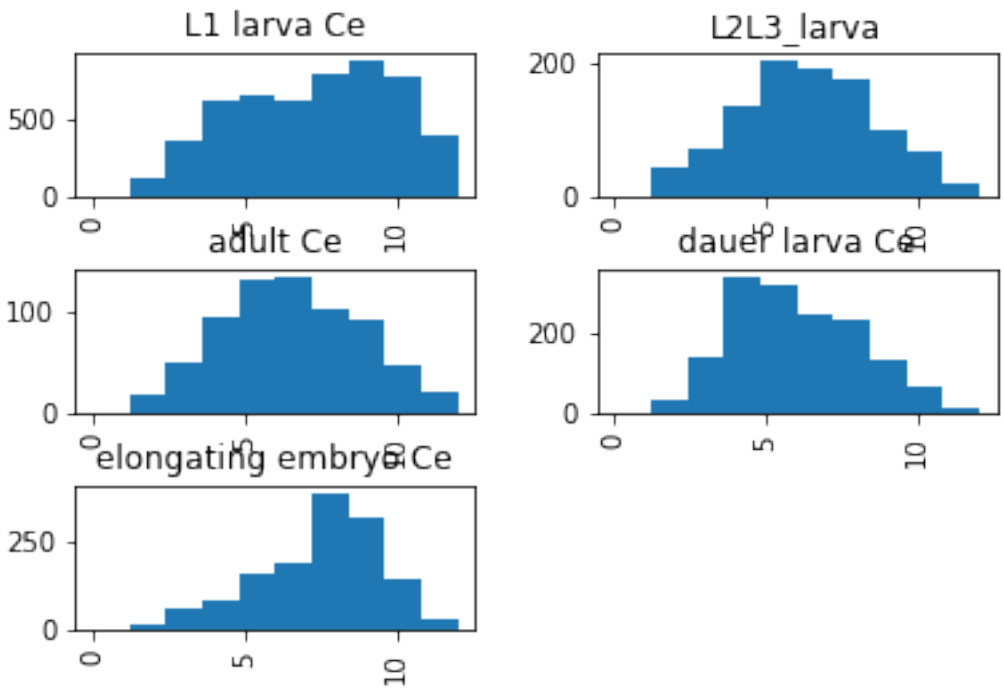
Now the genes that fit into our criteria should be in the *outputFilePath* we set ealier, lets take a look at some basic statistics of these selected life stage biased genes:

[5]:
```
ls_data.head()
print(ls_data.columns)

ls_data[["LS_EXP","SecondMax","FoldDiff"]]=ls_data[["LS_EXP","SecondMax","FoldDiff"]].
 ↪apply(pd.to_numeric)
ls_data.sort_values(by=['FoldDiff'],ascending=False)
ls_data['FoldDiff_RestMean']=ls_data["LS_EXP"]/ls_data["RestMean"]
ls_data['LS_EXP_LOG']=np.log((ls_data['LS_EXP']))
ls_data['FoldDiff_LOG']=np.log((ls_data['FoldDiff']))
ls_data['RestMean_LOG']=np.log((ls_data['RestMean']))
ls_data["FoldDiff_RestMean_LOG"]= np.log(ls_data["FoldDiff_RestMean"])
```

```
print(ls_data.describe())
print()
print("ls_data Summary By Life Stage Group")
print(ls_data.groupby("LS").describe())

ax=ls_data['LS_EXP_LOG'].hist(by=ls_data['LS'],range=[0,12])
```

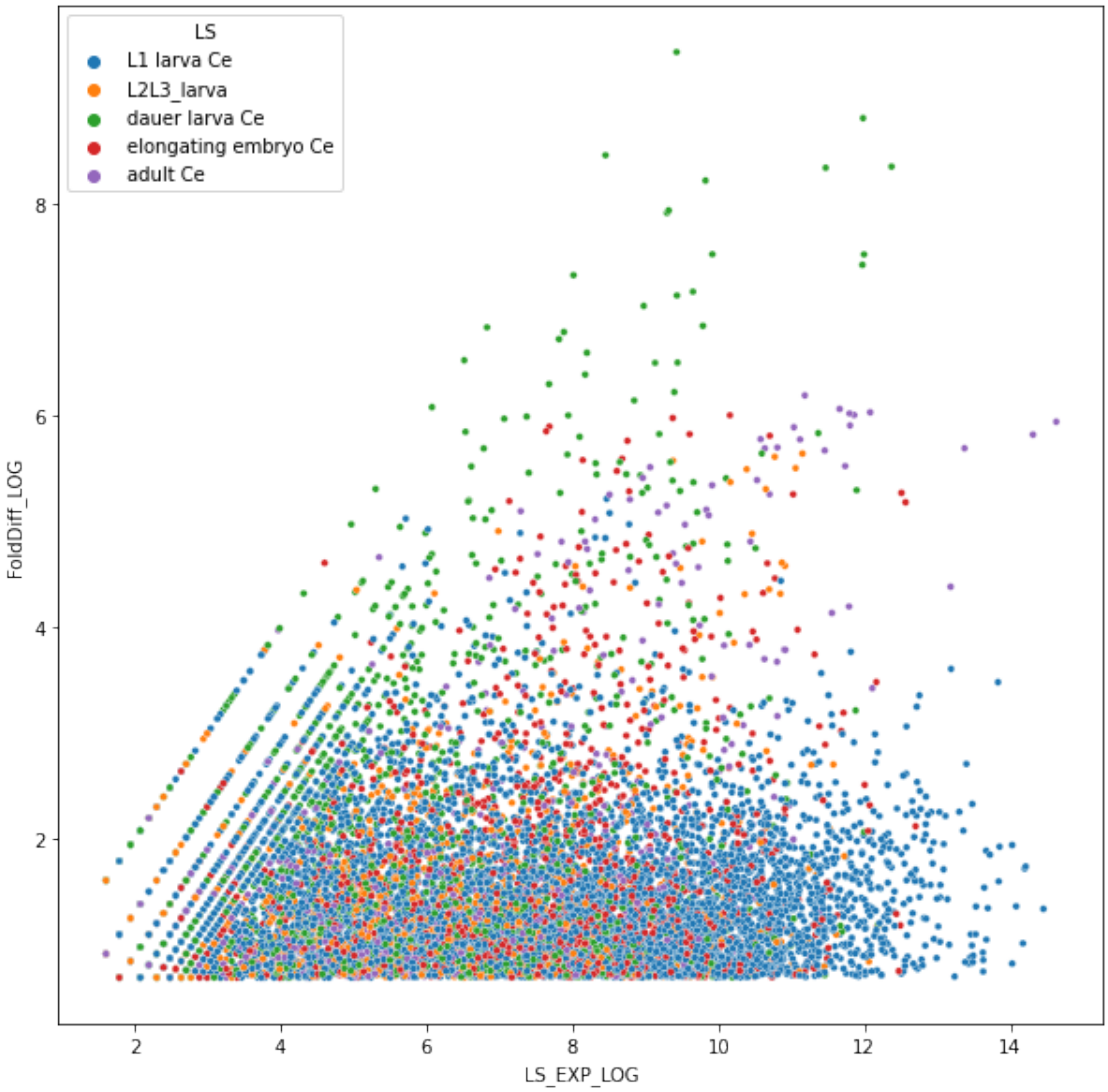
```
Index(['GeneID', 'LS', 'LS_EXP', 'SecondMax', 'RestMean', 'FoldDiff'],
dtype='object')
             LS_EXP      SecondMax       RestMean      FoldDiff  \
count  1.009900e+04   10099.000000   10099.000000  10099.000000
mean   1.679783e+04    4102.327656    2191.947742     15.490207
std    7.351532e+04   19035.148534   10168.396260    176.069930
min    5.000000e+00       0.000000       0.000000      2.000000
25%    1.560000e+02      28.000000      12.250000      2.617371
50%    1.298000e+03     248.000000     108.750000      3.776471
75%    8.224500e+03    1946.000000     988.500000      6.722003
max    2.253663e+06  540124.000000  315851.750000  12412.000000

       FoldDiff_RestMean    LS_EXP_LOG  FoldDiff_LOG  RestMean_LOG  \
count       1.009900e+04  10099.000000  10099.000000  1.009900e+04
mean                 inf      7.073785      1.586584          -inf
std                  NaN      2.538669      0.907085           NaN
min         2.181818e+00      1.609438      0.693147          -inf
25%         5.582012e+00      5.049856      0.962170  2.505526e+00
50%         8.444388e+00      7.168580      1.328790  4.689052e+00
75%         1.537575e+01      9.014873      1.905386  6.896189e+00
max                  inf     14.628067      9.426419  1.266303e+01

       FoldDiff_RestMean_LOG
count           1.009900e+04
mean                    inf
std                     NaN
min             7.801586e-01
25%             1.719549e+00
50%             2.133502e+00
75%             2.732792e+00
max                     inf

ls_data Summary By Life Stage Group
                     LS_EXP                                              \
                      count          mean             std  min     25%
LS
L1 larva Ce          5426.0  25057.749355   89726.448364  5.0  187.00
L2L3_larva           1018.0   4984.386051   13889.489577  5.0  124.00
adult Ce              695.0  13820.099281  111338.218970  5.0  131.00
```

```
dauer larva Ce        1550.0   3776.957419   15036.754400  5.0   83.00
elongating embryo Ce  1410.0   9322.402128   25125.246231  5.0  517.75

                                                SecondMax                …  \
                          50%       75%        max     count         mean  …
LS                                                                       …
L1 larva Ce           2159.5  14543.50  1890193.0    5426.0  6524.922226  …
L2L3_larva             547.0   2903.50   173036.0    1018.0  1200.904715  …
adult Ce               619.0   3951.00  2253663.0     695.0   842.952518  …
dauer larva Ce         300.0   1844.00   235883.0    1550.0   691.027097  …
elongating embryo Ce  2472.5   7250.25   328012.0    1410.0  2231.002837  …

                    RestMean_LOG            FoldDiff_RestMean_LOG          \
                             75%        max                 count mean std
LS
L1 larva Ce             7.677081  12.663028                5426.0  inf NaN
L2L3_larva              5.468584  10.355311                1018.0  inf NaN
adult Ce                5.523903   9.268963                 695.0  inf NaN
dauer larva Ce          4.901099  10.365506                1550.0  inf NaN
elongating embryo Ce    6.927496  10.556119                1410.0  inf NaN


                           min       25%       50%       75%  max
LS
L1 larva Ce           0.837757  1.684538  2.082542  2.593047  inf
L2L3_larva            0.894745  1.806794  2.172522  2.710890  inf
adult Ce              0.856746  1.833032  2.234532  2.773614  inf
dauer larva Ce        0.822815  1.857852  2.420250  3.399912  inf
elongating embryo Ce  0.780159  1.654225  2.079442  2.765388  inf

[5 rows x 72 columns]

/home/lu/.local/lib/python3.8/site-packages/pandas/core/series.py:726:
RuntimeWarning: divide by zero encountered in log
  result = getattr(ufunc, method)(*inputs, **kwargs)
```




[6]:
```
from matplotlib import pyplot as plt
import seaborn as sns



ax2=plt.figure(figsize=[10,10])
sns.scatterplot(x='LS_EXP_LOG',y='FoldDiff_LOG',hue='LS', data=ls_data,s=15)
```

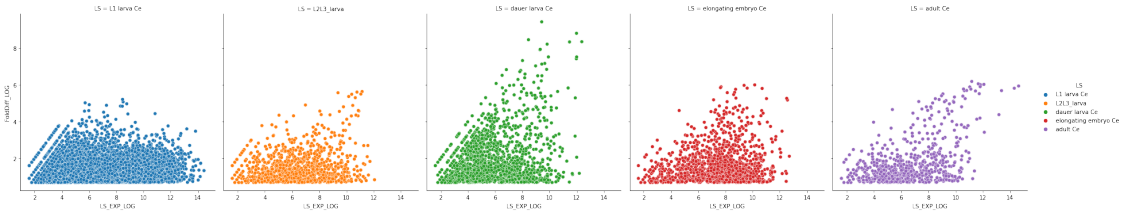
[6]: <AxesSubplot:xlabel='LS_EXP_LOG', ylabel='FoldDiff_LOG'>




[7]:
```
ax3=plt.figure(figsize=[20,20])
sns.relplot(
    data=ls_data,x='LS_EXP_LOG', y="FoldDiff_LOG",
    col="LS", hue="LS",
    kind="scatter"
)
```

[7]: <seaborn.axisgrid.FacetGrid at 0x7f67fac79070>

<Figure size 1440x1440 with 0 Axes>

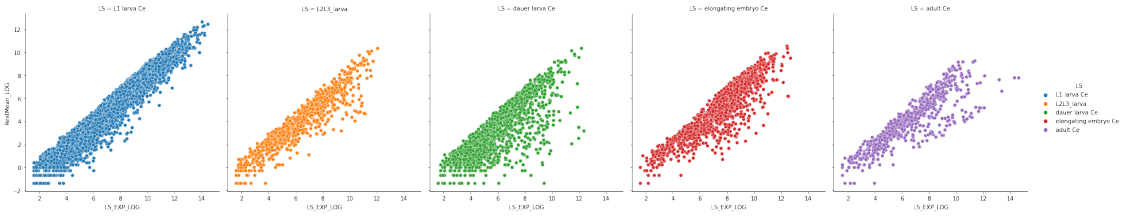


[ ]:

Look at the relationship bettween the max expression vs mean of expression in other life stages

[8]:
```
ax4=plt.figure(figsize=[20,20])

splot=sns.relplot(
    data=ls_data,x='LS_EXP_LOG', y="RestMean_LOG",
    col="LS", hue="LS",
    kind="scatter"
)
```

```
<Figure size 1440x1440 with 0 Axes>
```



Now, lets look at the number of genes from each life stage selected when we change the threshhold:

[9]:
```
sorted_ls_data=ls_data.sort_values(['LS','FoldDiff'],ascending=False)

thresholds=[2**i for i in range(1,11)]

for threshold in thresholds:
    df_filtered=sorted_ls_data.loc[sorted_ls_data['FoldDiff'] >= threshold]
    df_count=df_filtered.groupby("LS").count()
    ax=plt.figure(figsize=[8,6])
    text=("Threshold of FoldDiff: "+ str(threshold))
    sns.histplot(df_filtered, x="LS",hue="LS").set_title(text)
    print(text)
    print(df_filtered.describe())
```

Threshold of FoldDiff: 2

| | LS_EXP | SecondMax | RestMean | FoldDiff |
|---|---|---|---|---|
| count | 1.009900e+04 | 10099.000000 | 10099.000000 | 10099.000000 |
| mean | 1.679783e+04 | 4102.327656 | 2191.947742 | 15.490207 |
| std | 7.351532e+04 | 19035.148534 | 10168.396260 | 176.069930 |
| min | 5.000000e+00 | 0.000000 | 0.000000 | 2.000000 |
| 25% | 1.560000e+02 | 28.000000 | 12.250000 | 2.617371 |
| 50% | 1.298000e+03 | 248.000000 | 108.750000 | 3.776471 |
| 75% | 8.224500e+03 | 1946.000000 | 988.500000 | 6.722003 |
| max | 2.253663e+06 | 540124.000000 | 315851.750000 | 12412.000000 |

| | FoldDiff_RestMean | LS_EXP_LOG | FoldDiff_LOG | RestMean_LOG |
|---|---|---|---|---|
| count | 1.009900e+04 | 10099.000000 | 10099.000000 | 1.009900e+04 |
| mean | inf | 7.073785 | 1.586584 | -inf |
| std | NaN | 2.538669 | 0.907085 | NaN |
| min | 2.181818e+00 | 1.609438 | 0.693147 | -inf |
| 25% | 5.582012e+00 | 5.049856 | 0.962170 | 2.505526e+00 |
| 50% | 8.444388e+00 | 7.168580 | 1.328790 | 4.689052e+00 |
| 75% | 1.537575e+01 | 9.014873 | 1.905386 | 6.896189e+00 |
| max | inf | 14.628067 | 9.426419 | 1.266303e+01 |

| | FoldDiff_RestMean_LOG |
|---|---|
| count | 1.009900e+04 |
| mean | inf |
| std | NaN |
| min | 7.801586e-01 |
| 25% | 1.719549e+00 |
| 50% | 2.133502e+00 |
| 75% | 2.732792e+00 |
| max | inf |

Threshold of FoldDiff: 4

| | LS_EXP | SecondMax | RestMean | FoldDiff |
|---|---|---|---|---|
| count | 4.736000e+03 | 4736.000000 | 4736.000000 | 4736.000000 |
| mean | 1.874109e+04 | 2476.493454 | 1307.303262 | 29.896106 |
| std | 8.095115e+04 | 10934.194589 | 5513.457001 | 256.362229 |
| min | 5.000000e+00 | 0.000000 | 0.000000 | 4.000000 |
| 25% | 1.450000e+02 | 15.000000 | 6.500000 | 5.108633 |
| 50% | 1.014000e+03 | 95.000000 | 41.625000 | 7.072728 |
| 75% | 7.755500e+03 | 829.250000 | 387.875000 | 12.500000 |
| max | 2.253663e+06 | 261525.000000 | 118162.250000 | 12412.000000 |

| | FoldDiff_RestMean | LS_EXP_LOG | FoldDiff_LOG | RestMean_LOG |
|---|---|---|---|---|
| count | 4736.000000 | 4736.000000 | 4736.000000 | 4736.000000 |
| mean | inf | 7.027185 | 2.253014 | -inf |
| std | NaN | 2.558391 | 0.934246 | NaN |
| min | 4.428379 | 1.609438 | 1.386294 | -inf |
| 25% | 10.942227 | 4.976734 | 1.630932 | 1.871802 |
| 50% | 16.101432 | 6.921658 | 1.956246 | 3.728696 |

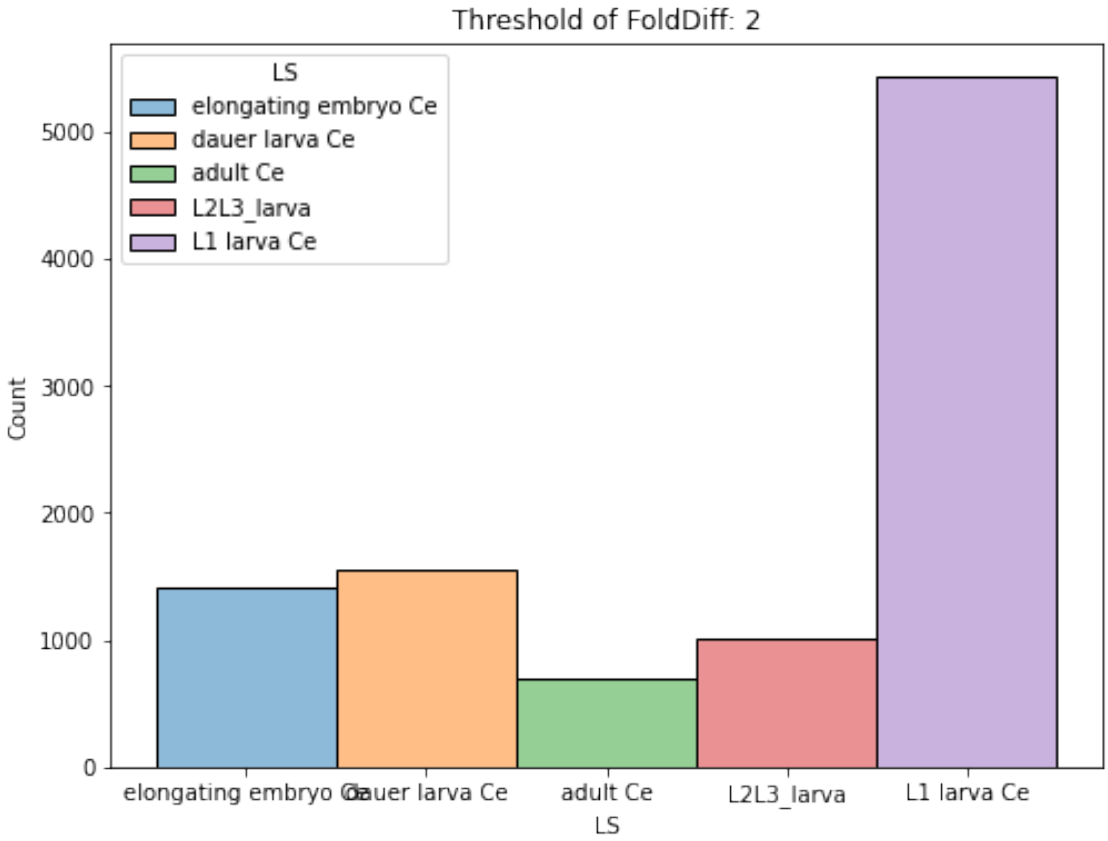
```
75%            29.341025     8.956157      2.525729      5.960682
max                  inf    14.628067      9.426419     11.679814

       FoldDiff_RestMean_LOG
count            4736.000000
mean                     inf
std                      NaN
min                 1.488034
25%                 2.392629
50%                 2.778908
75%                 3.378987
max                      inf
Threshold of FoldDiff: 8
             LS_EXP     SecondMax      RestMean      FoldDiff  \
count  2.065000e+03   2065.000000   2065.000000   2065.000000
mean   1.737960e+04    998.086199    542.603995     61.463707
std    8.397990e+04   4394.859318   2509.116448    386.007561
min    8.000000e+00      0.000000      0.000000      8.000000
25%    1.510000e+02      8.000000      3.750000     10.000000
50%    9.560000e+02     40.000000     19.500000     14.112252
75%    6.565000e+03    291.000000    129.250000     27.111111
max    2.253663e+06  69368.000000  34733.500000  12412.000000

       FoldDiff_RestMean   LS_EXP_LOG  FoldDiff_LOG  RestMean_LOG  \
count        2065.000000  2065.000000   2065.000000   2065.000000
mean                 inf     6.996054      2.989515          -inf
std                  NaN     2.438047      0.995191           NaN
min             8.000000     2.079442      2.079442          -inf
25%            22.040000     5.017280      2.302585      1.321756
50%            32.920635     6.862758      2.647043      2.970414
75%            64.631579     8.789508      3.299944      4.861749
max                  inf    14.628067      9.426419     10.455460

       FoldDiff_RestMean_LOG
count            2065.000000
mean                     inf
std                      NaN
min                 2.079442
25%                 3.092859
50%                 3.494100
75%                 4.168703
max                      inf
Threshold of FoldDiff: 16
             LS_EXP     SecondMax      RestMean      FoldDiff  \
count  8.960000e+02    896.000000    896.000000    896.000000
mean   2.031709e+04    389.906250    201.989397    127.457483
std    1.092277e+05   1657.088913   1000.941265    579.578809
min    1.600000e+01      0.000000      0.000000     16.000000
```

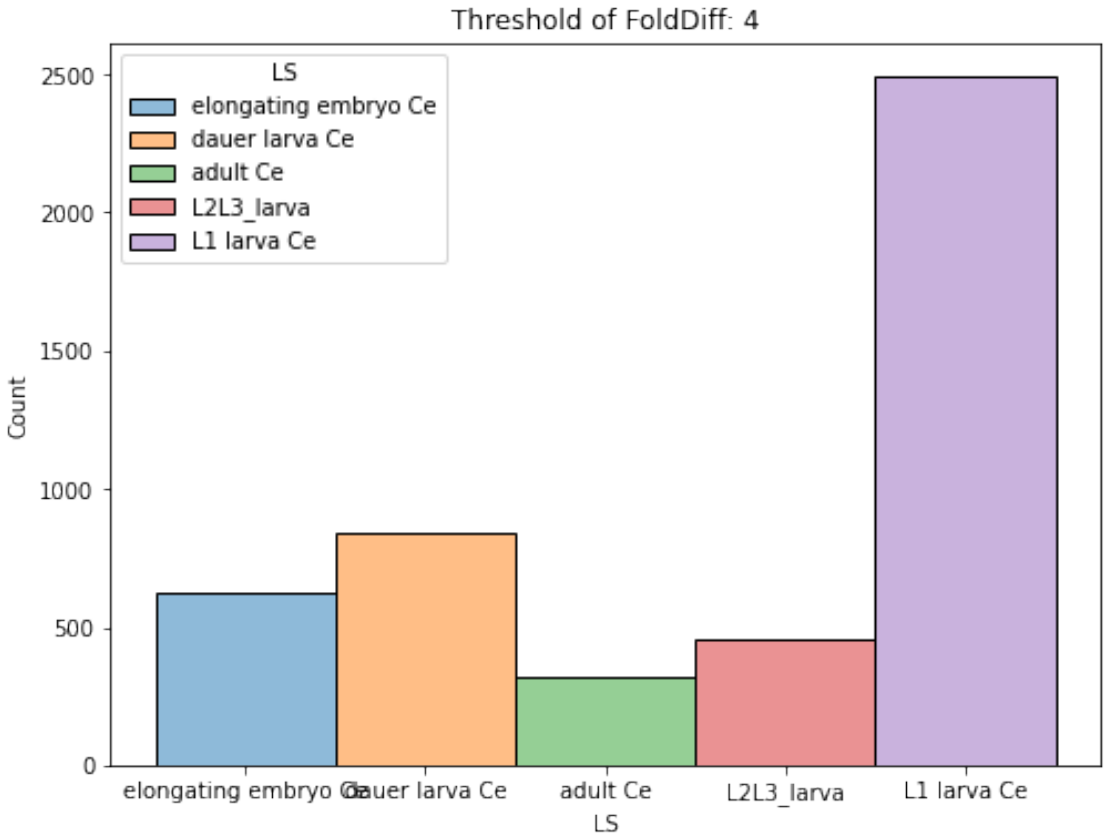
```
25%    2.440000e+02      6.000000      2.750000     21.266304
50%    1.468000e+03     28.500000     13.250000     30.992188
75%    8.493000e+03    143.250000     67.312500     68.844626
max    2.253663e+06  31253.000000  21759.250000  12412.000000

       FoldDiff_RestMean  LS_EXP_LOG  FoldDiff_LOG  RestMean_LOG  \
count         896.000000  896.000000    896.000000    896.000000
mean                 inf    7.345930      3.801458          -inf
std                  NaN    2.296912      1.033031           NaN
min            19.750520    2.772589      2.772589          -inf
25%            47.694318    5.497168      3.057124      1.011601
50%            74.615385    7.291656      3.433735      2.583998
75%           172.000000    9.046993      4.231837      4.209345
max                  inf   14.628067      9.426419      9.987794

       FoldDiff_RestMean_LOG
count             896.000000
mean                     inf
std                      NaN
min                 2.983180
25%                 3.864812
50%                 4.312346
75%                 5.147494
max                      inf
Threshold of FoldDiff: 32
             LS_EXP     SecondMax      RestMean      FoldDiff  \
count  4.350000e+02    435.000000    435.000000    435.000000
mean   3.073044e+04    296.452874    151.092529    238.972031
std    1.519043e+05   1758.203487   1122.729190    817.602619
min    3.300000e+01      0.000000      0.000000     32.125000
25%    6.830000e+02      6.500000      3.000000     44.006400
50%    3.270000e+03     31.000000     14.250000     74.452830
75%    1.319700e+04    123.500000     55.875000    161.126961
max    2.253663e+06  31253.000000  21759.250000  12412.000000

       FoldDiff_RestMean  LS_EXP_LOG  FoldDiff_LOG  RestMean_LOG  \
count         435.000000  435.000000    435.000000    435.000000
mean                 inf    8.016322      4.564515          -inf
std                  NaN    2.146121      1.011964           NaN
min            42.947702    3.496508      3.469635          -inf
25%           104.032356    6.526456      3.784335      1.098612
50%           175.913043    8.092545      4.310166      2.656757
75%           359.627530    9.487694      5.082192      4.023095
max                  inf   14.628067      9.426419      9.987794

       FoldDiff_RestMean_LOG
count             435.000000
mean                     inf
```

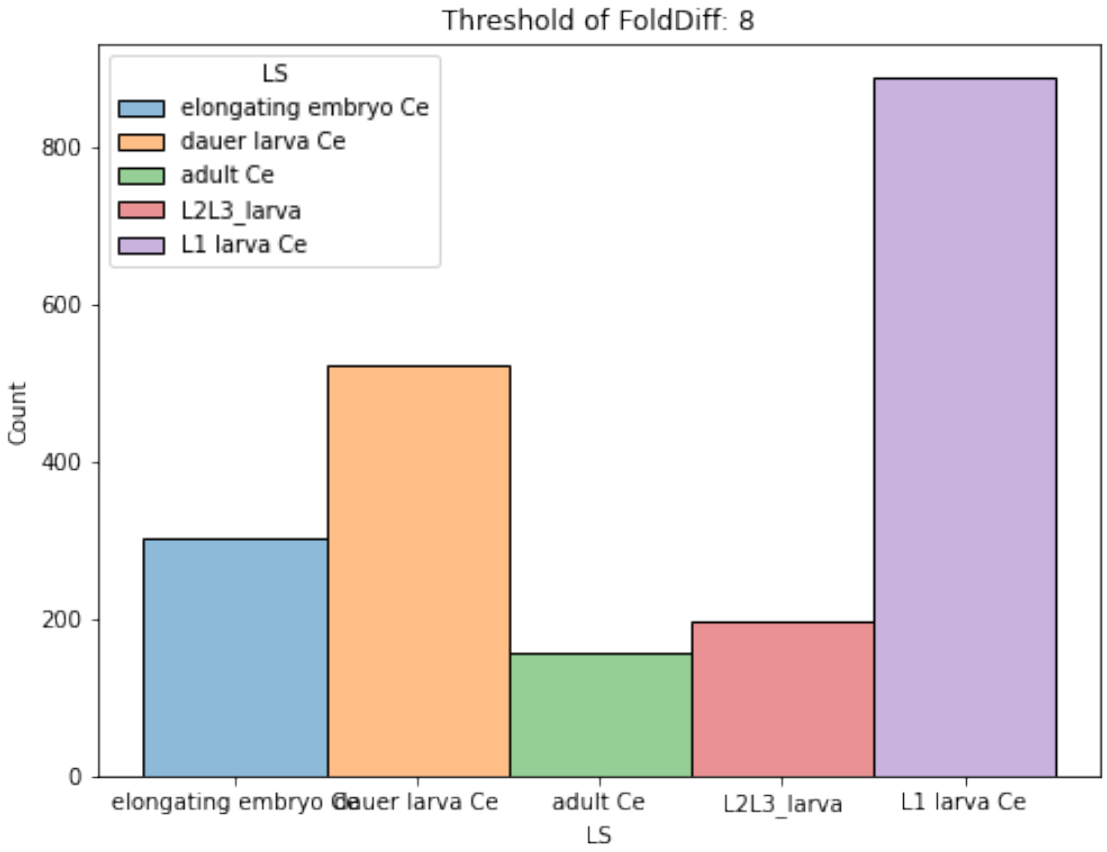
```
std                     NaN
min                3.759983
25%                4.644702
50%                5.169990
75%                5.885068
max                     inf
Threshold of FoldDiff: 64
             LS_EXP    SecondMax     RestMean      FoldDiff  \
count  2.430000e+02   243.000000   243.000000    243.000000
mean   4.192780e+04   184.621399    80.042181    392.949462
std    1.882614e+05   686.621839   282.602225   1069.972609
min    7.500000e+01     0.000000     0.000000     64.000000
25%    1.528500e+03     7.000000     3.500000     90.302020
50%    5.698000e+03    32.000000    16.250000    135.000000
75%    1.771950e+04   121.000000    52.875000    275.230000
max    2.253663e+06  6635.000000  2439.000000  12412.000000

       FoldDiff_RestMean  LS_EXP_LOG  FoldDiff_LOG  RestMean_LOG  \
count         243.000000  243.000000    243.000000    243.000000
mean                 inf    8.639722      5.192860          -inf
std                  NaN    1.927644      0.954800           NaN
min            79.512195    4.317488      4.158883          -inf
25%           198.666667    7.331232      4.503147      1.252763
50%           329.444444    8.647871      4.905275      2.788093
75%           640.277551    9.782410      5.617553      3.967794
max                  inf   14.628067      9.426419      7.799343

       FoldDiff_RestMean_LOG
count             243.000000
mean                     inf
std                      NaN
min                4.375910
25%                5.291606
50%                5.797408
75%                6.461902
max                     inf
Threshold of FoldDiff: 128
             LS_EXP    SecondMax     RestMean      FoldDiff  \
count  1.280000e+02   128.000000   128.000000    128.000000
mean   6.679294e+04   198.757812    84.787109    665.200762
std    2.526545e+05   719.674442   312.341413   1422.451233
min    1.440000e+02     0.000000     0.000000    128.200000
25%    2.808000e+03     6.750000     3.250000    190.966121
50%    9.453000e+03    26.500000    13.625000    263.228205
75%    3.939975e+04   121.250000    51.312500    405.291451
max    2.253663e+06  5944.000000  2439.000000  12412.000000

       FoldDiff_RestMean  LS_EXP_LOG  FoldDiff_LOG  RestMean_LOG  \
```

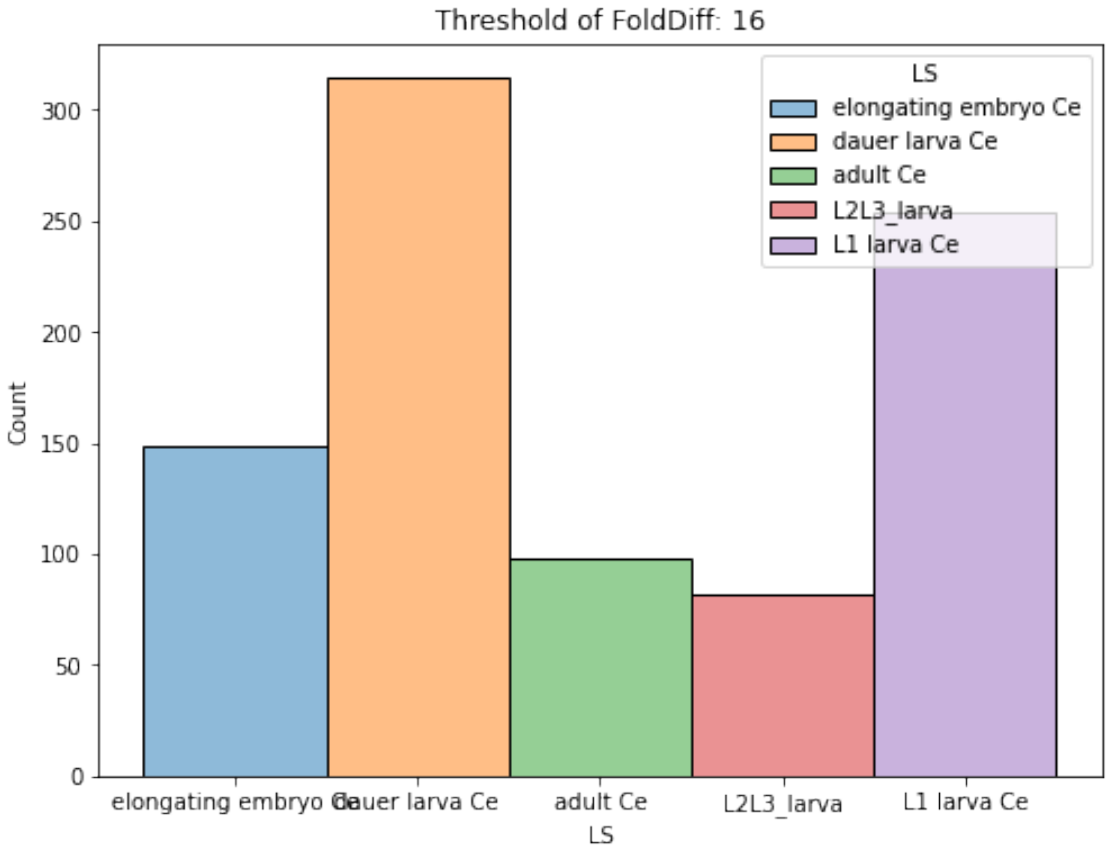
```
count         128.000000  128.000000    128.000000    128.000000
mean                 inf    9.205471      5.833815          -inf
std                  NaN    1.893452      0.909382           NaN
min           187.359116    4.969813      4.853592          -inf
25%           380.069594    7.940212      5.252095      1.178655
50%           611.012642    9.153855      5.573018      2.611527
75%          1152.523682   10.581488      6.004585      3.937566
max                  inf   14.628067      9.426419      7.799343

       FoldDiff_RestMean_LOG
count             128.000000
mean                    inf
std                     NaN
min                5.233027
25%                5.940353
50%                6.415118
75%                7.049708
max                     inf
Threshold of FoldDiff: 256
             LS_EXP    SecondMax     RestMean      FoldDiff  \
count  6.800000e+01    68.000000    68.000000     68.000000
mean   1.041002e+05   262.176471   116.525735   1089.632088
std    3.396591e+05   948.722172   418.548195   1855.841604
min    4.350000e+02     0.000000     0.000000    256.062500
25%    3.520250e+03     5.750000     2.500000    321.370004
50%    1.222350e+04    21.000000     8.500000    402.690848
75%    6.791150e+04   141.250000    59.562500    894.000000
max    2.253663e+06  5944.000000  2439.000000  12412.000000

       FoldDiff_RestMean  LS_EXP_LOG  FoldDiff_LOG  RestMean_LOG  \
count          68.000000   68.000000     68.000000     68.000000
mean                 inf    9.667749      6.395987          -inf
std                  NaN    1.882576      0.921161           NaN
min           379.029821    6.075346      5.545422          -inf
25%           695.024316    8.166179      5.772592      0.916291
50%          1074.166667    9.410997      5.998169      2.140066
75%          1910.908824   11.125859      6.795521      4.086894
max                  inf   14.628067      9.426419      7.799343

       FoldDiff_RestMean_LOG
count              68.000000
mean                    inf
std                     NaN
min                5.937615
25%                6.543823
50%                6.979229
75%                7.553861
max                     inf
```

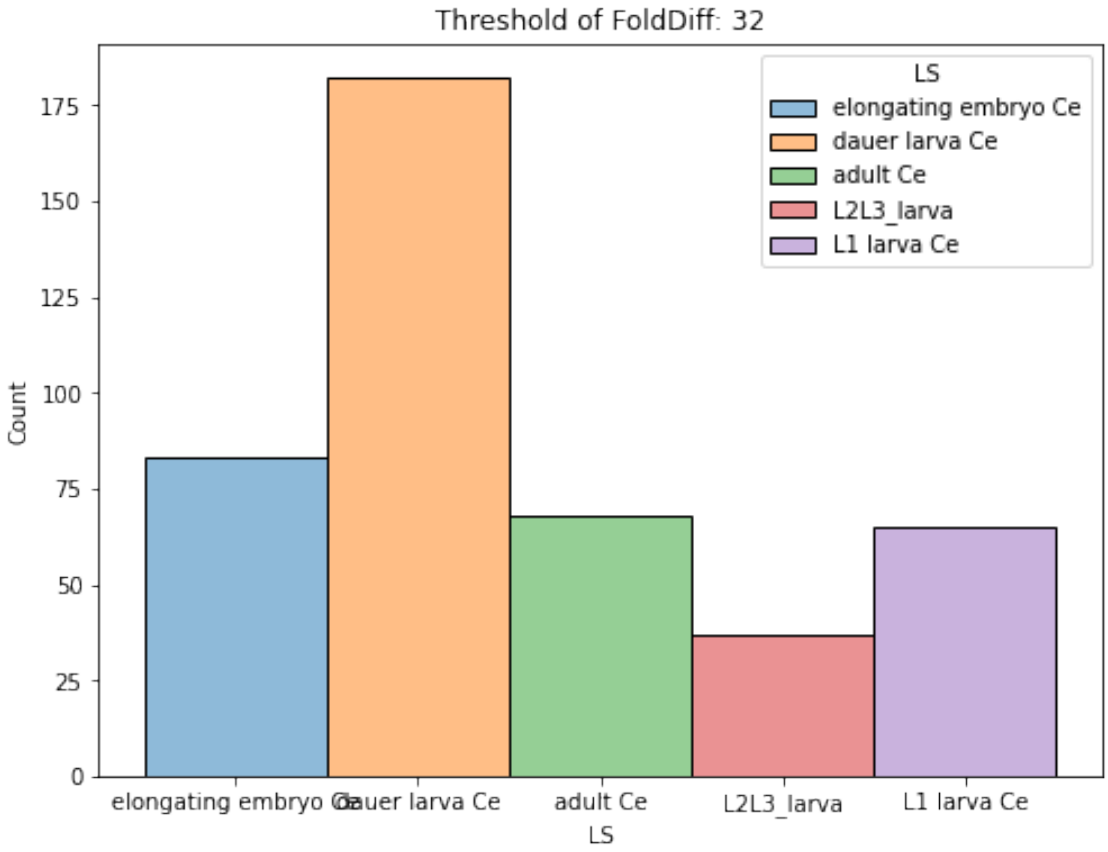
```
Threshold of FoldDiff: 512
             LS_EXP  SecondMax   RestMean      FoldDiff  FoldDiff_RestMean  \
count      25.00000  25.000000  25.000000     25.000000          25.000000
mean    39358.52000  16.680000   6.890000   2371.482954                inf
std     66170.68322  25.450475   9.392783   2626.937144                NaN
min       677.00000   0.000000   0.000000    540.750000        1236.000000
25%      3550.00000   3.000000   1.250000    826.666667        1724.666667
50%     11140.00000   6.000000   3.250000   1293.500000        4030.666667
75%     18451.00000  19.000000   8.000000   2785.000000        8912.000000
max    235883.00000  95.000000  33.250000  12412.000000                inf

       LS_EXP_LOG  FoldDiff_LOG  RestMean_LOG  FoldDiff_RestMean_LOG
count   25.000000     25.000000     25.000000               25.000000
mean     9.341956      7.378386          -inf                     inf
std      1.612699      0.848040           NaN                     NaN
min      6.517671      6.292957          -inf                7.119636
25%      8.174703      6.717402      0.223144                7.452789
50%      9.318298      7.165107      1.178655                8.301687
75%      9.822874      7.932003      2.079442                9.095154
max     12.371091      9.426419      3.504055                     inf
Threshold of FoldDiff: 1024
              LS_EXP  SecondMax   RestMean      FoldDiff  FoldDiff_RestMean  \
count      15.000000  15.000000  15.000000     15.000000          15.000000
mean    61883.400000  22.866667   9.433333   3457.096160        9341.260444
std     78268.637283  31.217822  11.307972   2942.840547       11710.916859
min      3023.000000   1.000000   0.250000   1130.571429        1663.866667
25%     11010.500000   4.000000   1.375000   1588.897368        4395.754386
50%     15522.000000  10.000000   4.250000   2720.250000        5677.230769
75%    127015.000000  23.500000  10.750000   4187.228649        9654.957895
max    235883.000000  95.000000  33.250000  12412.000000       49648.000000

       LS_EXP_LOG  FoldDiff_LOG  RestMean_LOG  FoldDiff_RestMean_LOG
count   15.000000     15.000000     15.000000               15.000000
mean    10.139472      7.901033      1.405217                8.734256
std      1.425323      0.691138      1.512399                0.871807
min      8.014005      7.030478     -1.386294                7.416899
25%      9.306535      7.369608      0.314304                8.384933
50%      9.650014      7.908479      1.446919                8.644219
75%     11.720771      8.339777      2.361477                9.174815
max     12.371091      9.426419      3.504055               10.812713
```

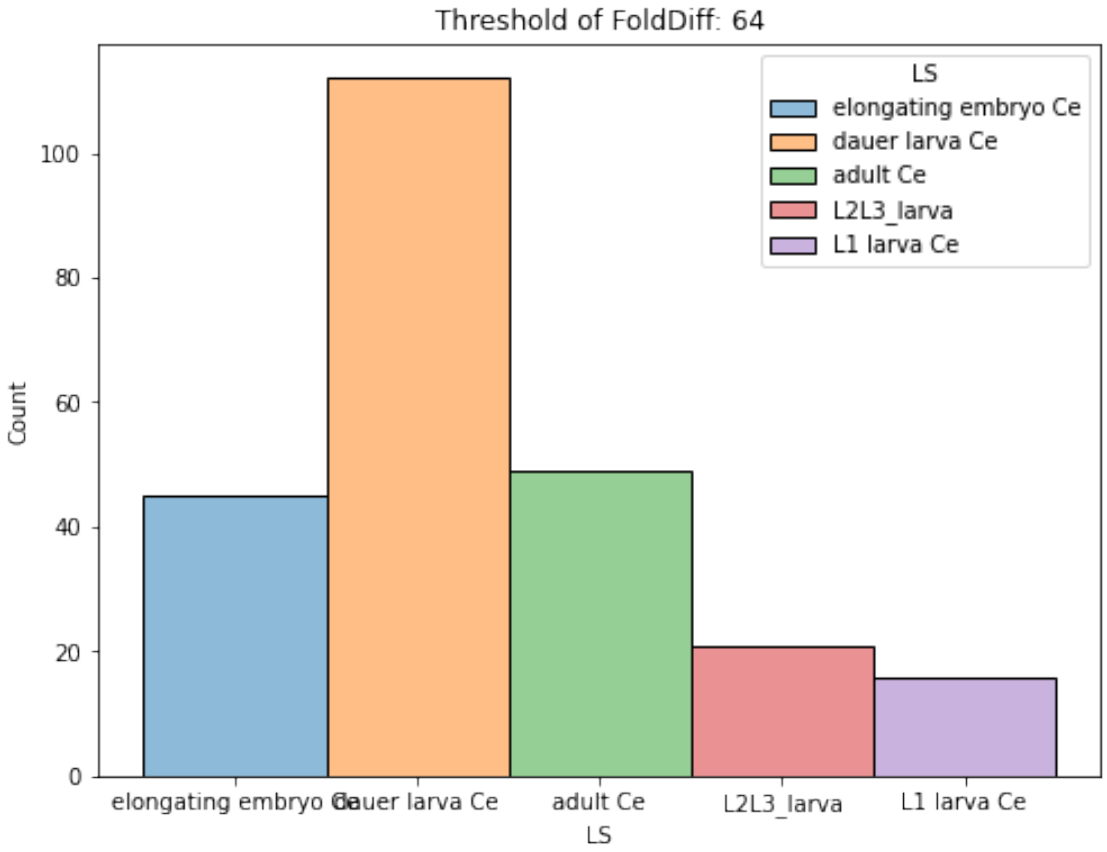

Threshold of FoldDiff: 2
LS
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
Count
5000
4000
3000
2000
1000
0
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
LS

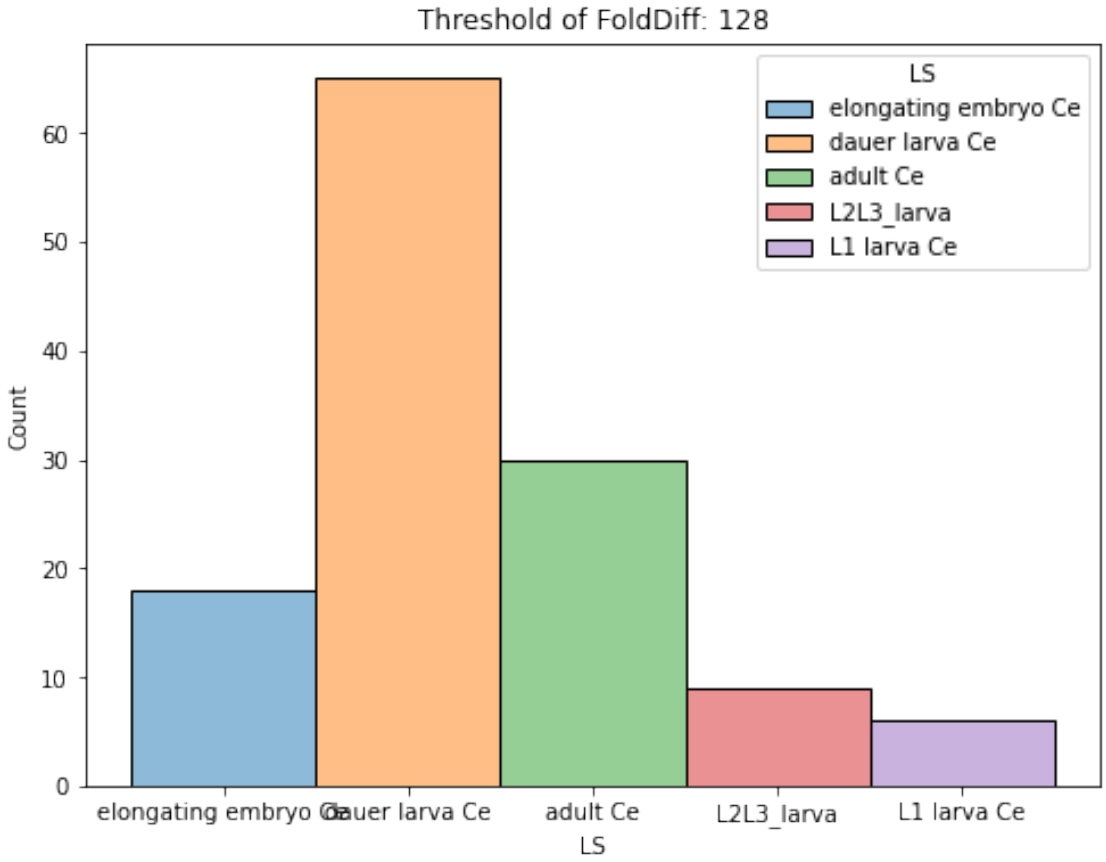

Threshold of FoldDiff: 4
LS
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
Count
2500
2000
1500
1000
500
0
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
LS

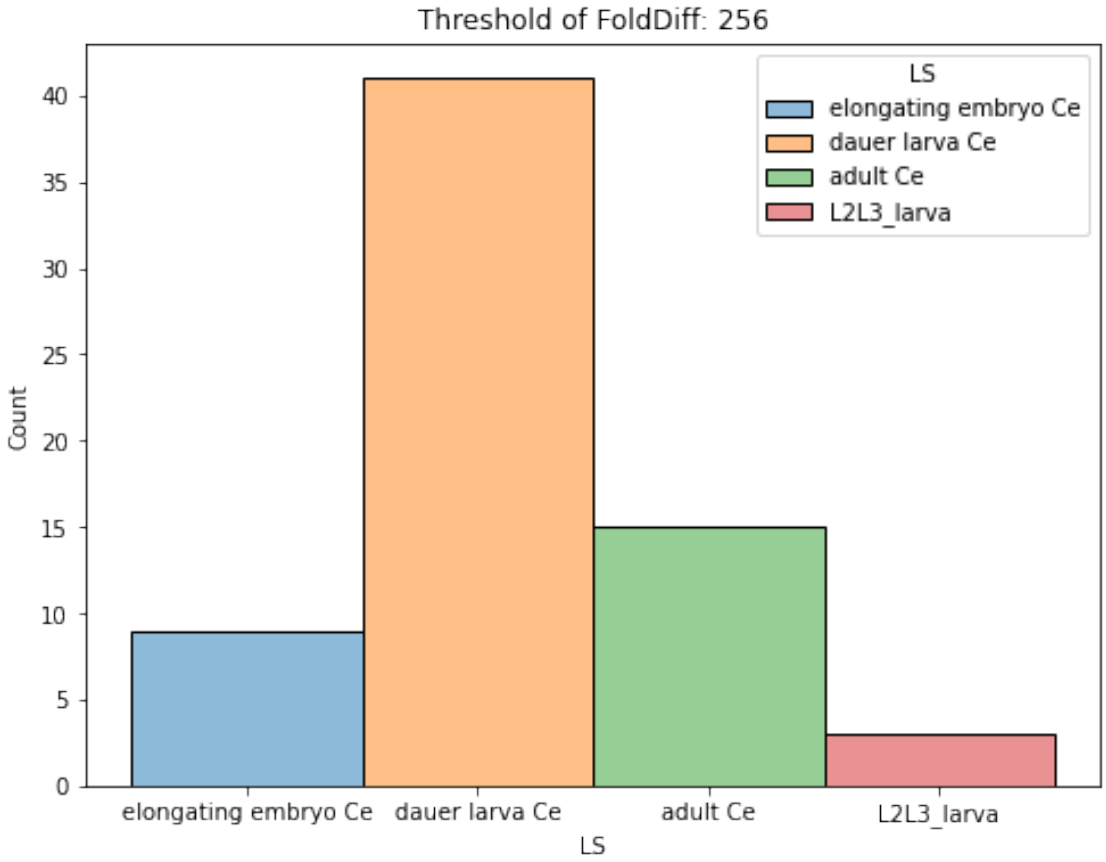

Threshold of FoldDiff: 8
LS
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
Count
0
200
400
600
800
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
LS

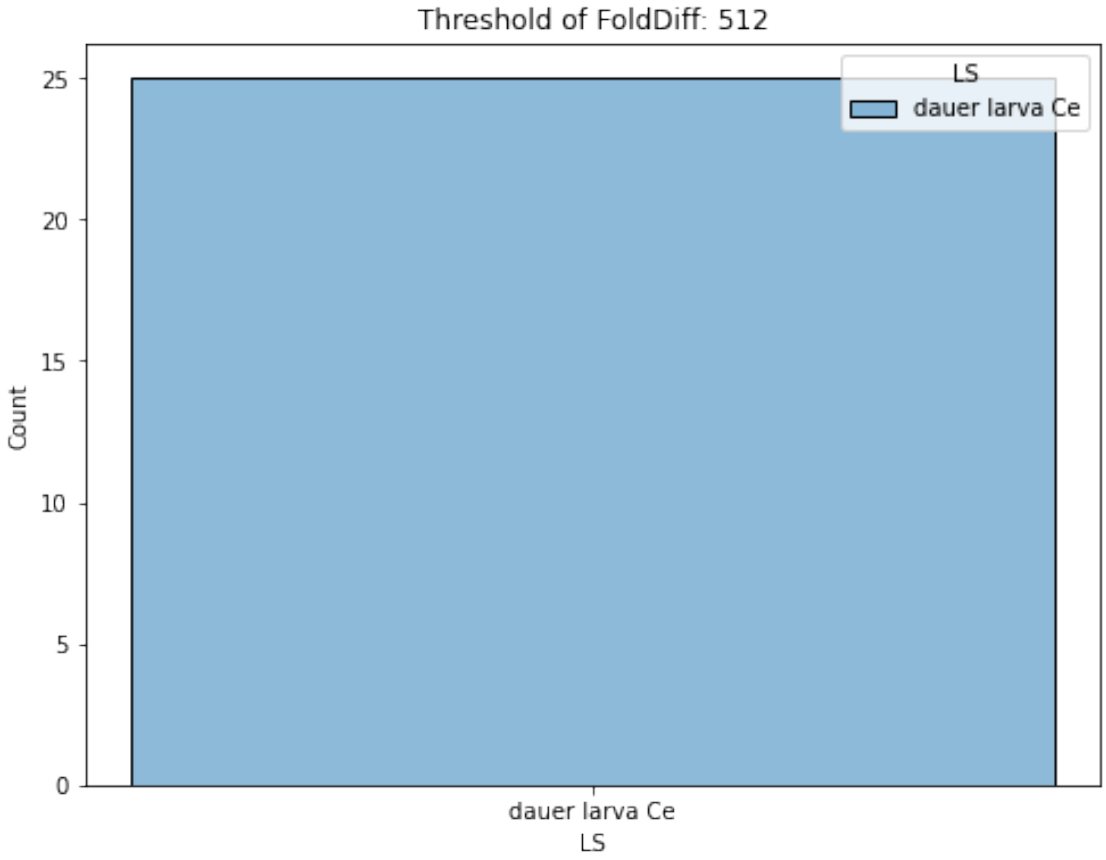

Threshold of FoldDiff: 16
LS
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
Count
300
250
200
150
100
50
0
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
LS

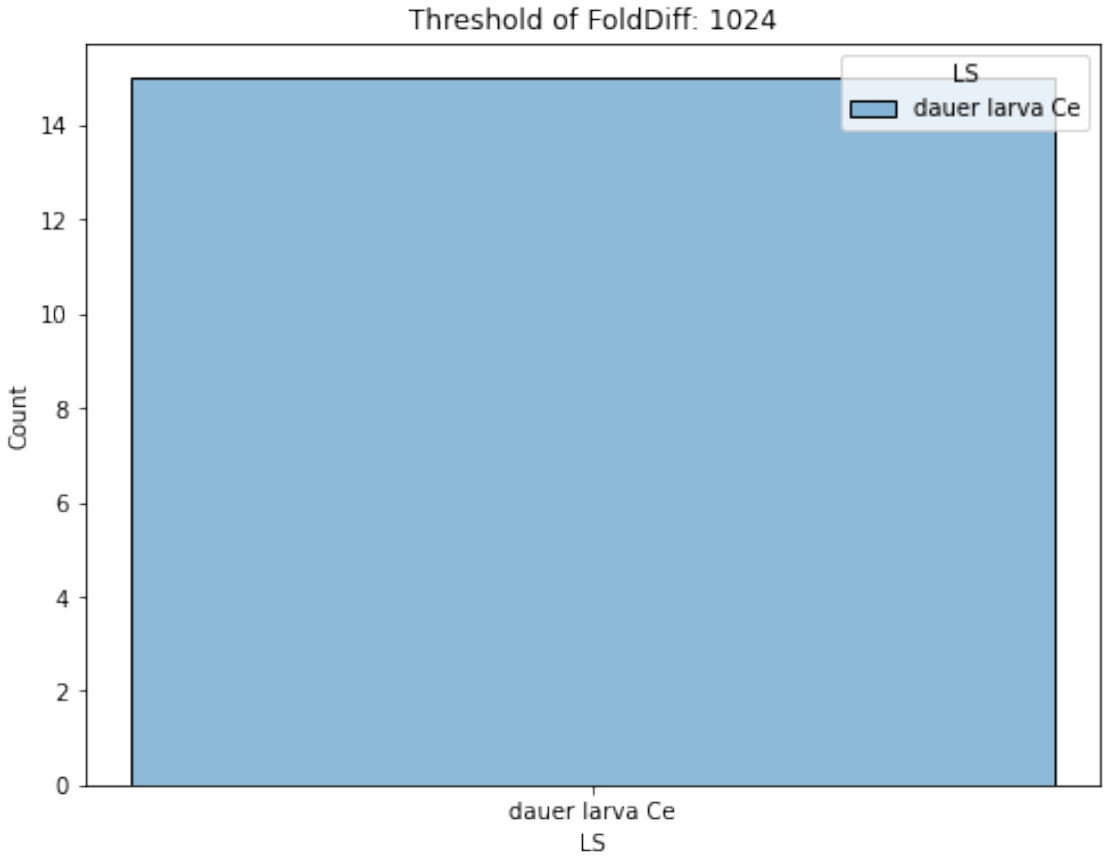

Threshold of FoldDiff: 32
LS
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
Count
175
150
125
100
75
50
25
0
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
LS


Threshold of FoldDiff: 64
LS
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
Count
0
20
40
60
80
100
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
LS


Threshold of FoldDiff: 128
LS
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
Count
0
10
20
30
40
50
60
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
LS


Threshold of FoldDiff: 256
LS
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
Count
0
5
10
15
20
25
30
35
40
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
LS


Threshold of FoldDiff: 512
LS
dauer larva Ce
Count
25
20
15
10
5
0
dauer larva Ce
LS

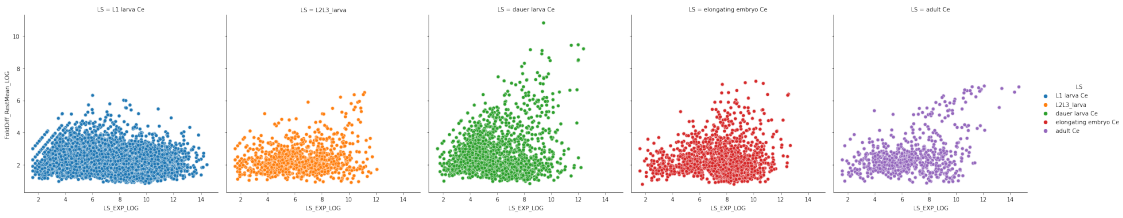



Below is the same figures useing foldDiff_RestMean rather than FoldDiff(second max)

[20]:
```
ax3=plt.figure(figsize=[20,20])
sns.relplot(
    data=ls_data,x='LS_EXP_LOG', y="FoldDiff_RestMean_LOG",
    col="LS", hue="LS",
    kind="scatter"
)
```

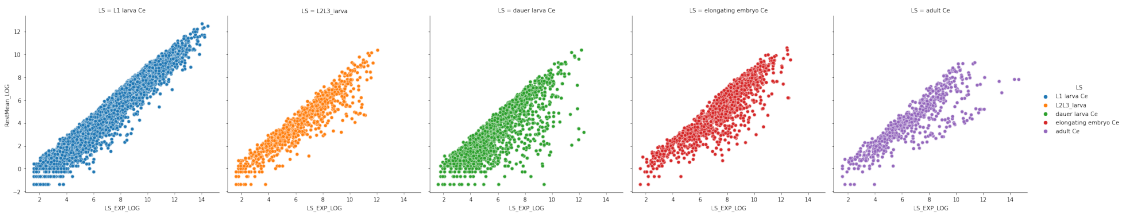
[20]: <seaborn.axisgrid.FacetGrid at 0x7f67f807d820>

<Figure size 1440x1440 with 0 Axes>

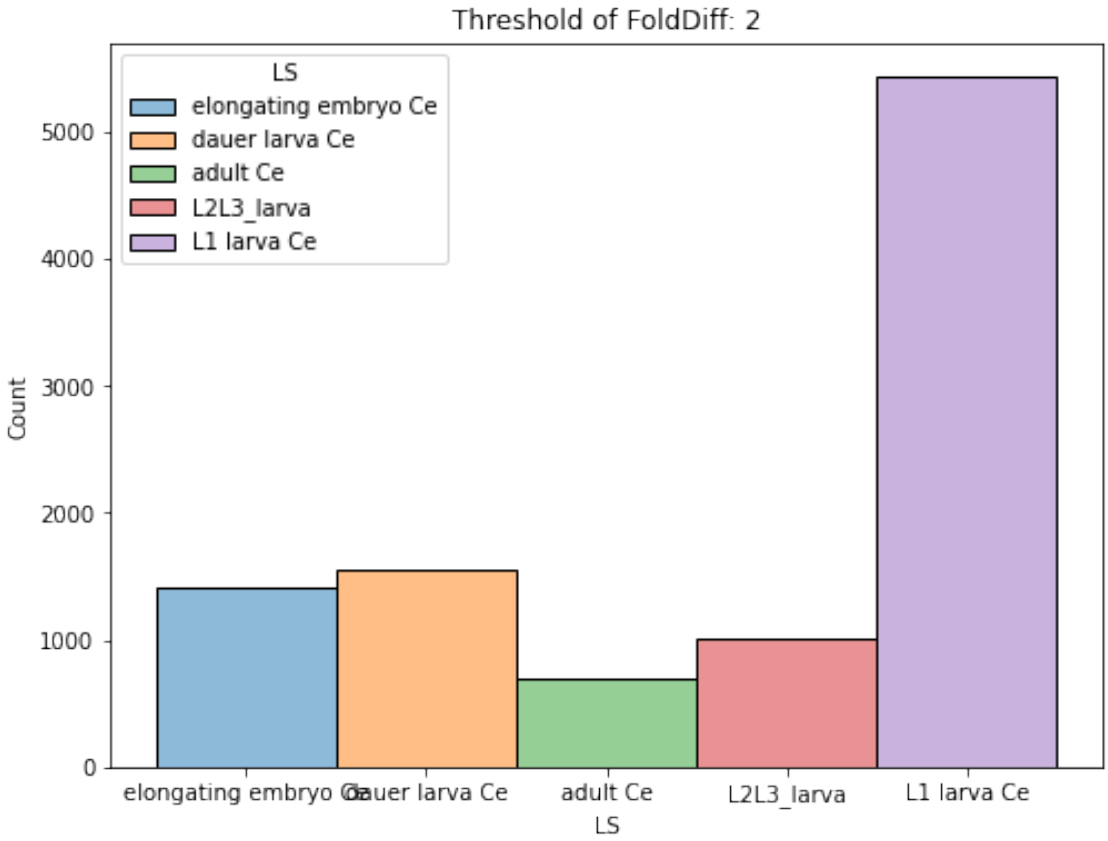


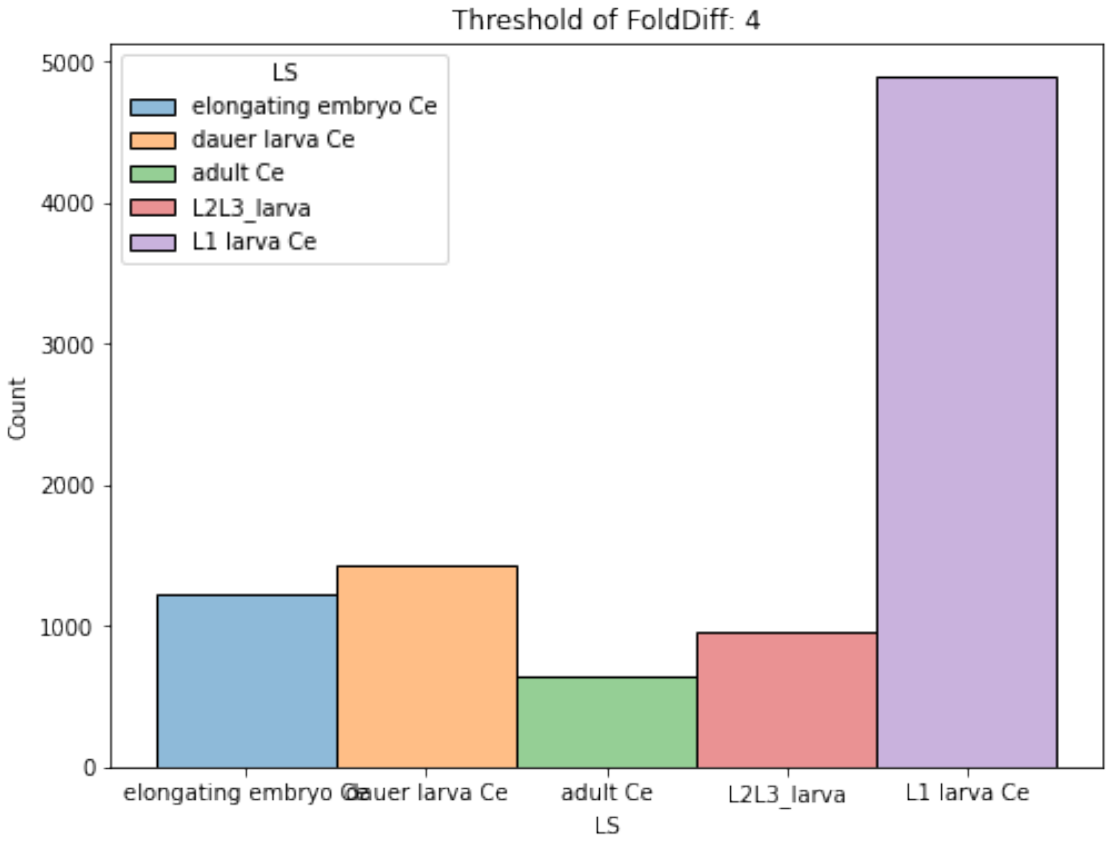
[11]:
```
ax4=plt.figure(figsize=[20,20])

splot=sns.relplot(
    data=ls_data,x='LS_EXP_LOG', y="RestMean_LOG",
    col="LS", hue="LS",
    kind="scatter"
)
```

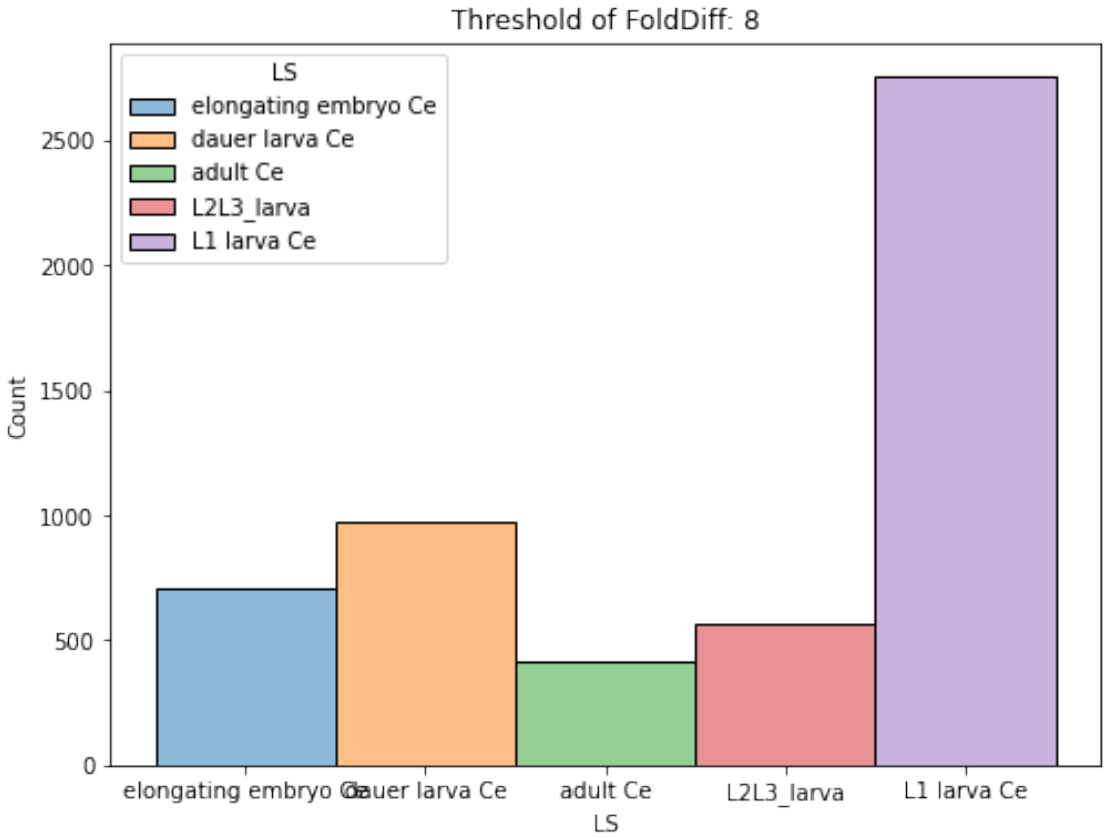
```
<Figure size 1440x1440 with 0 Axes>
```

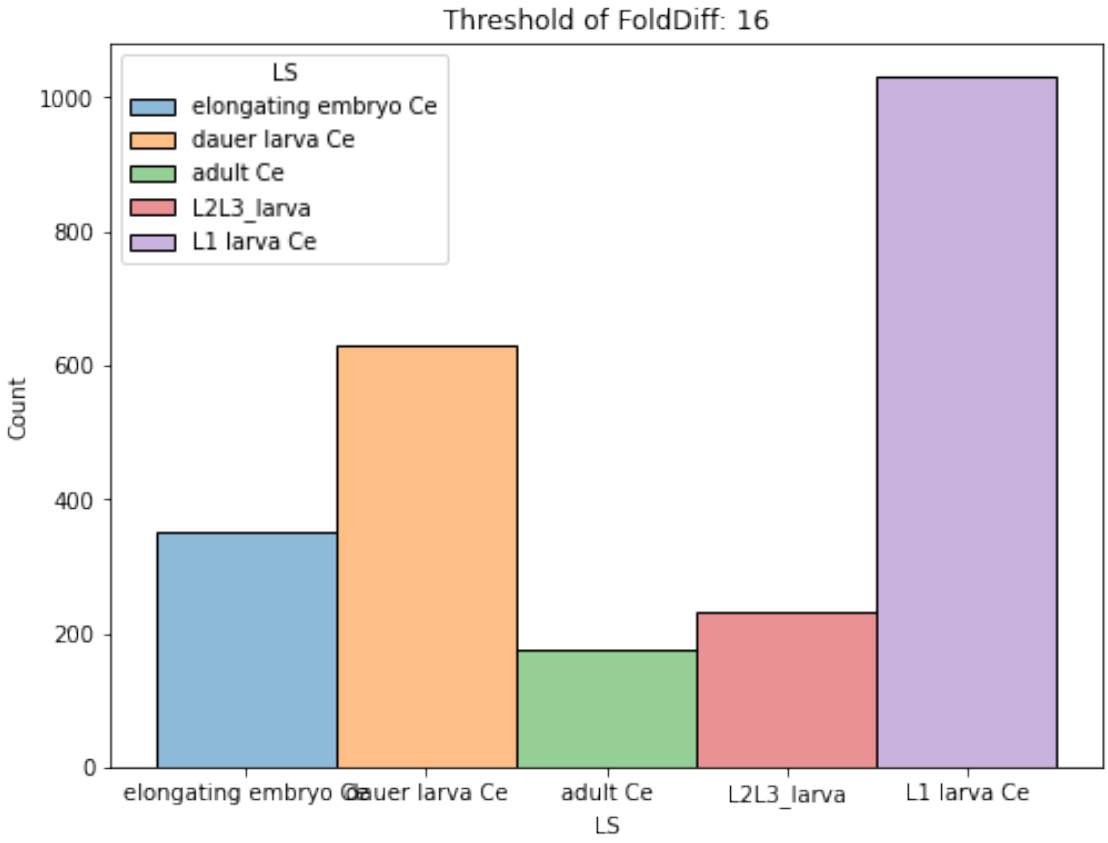


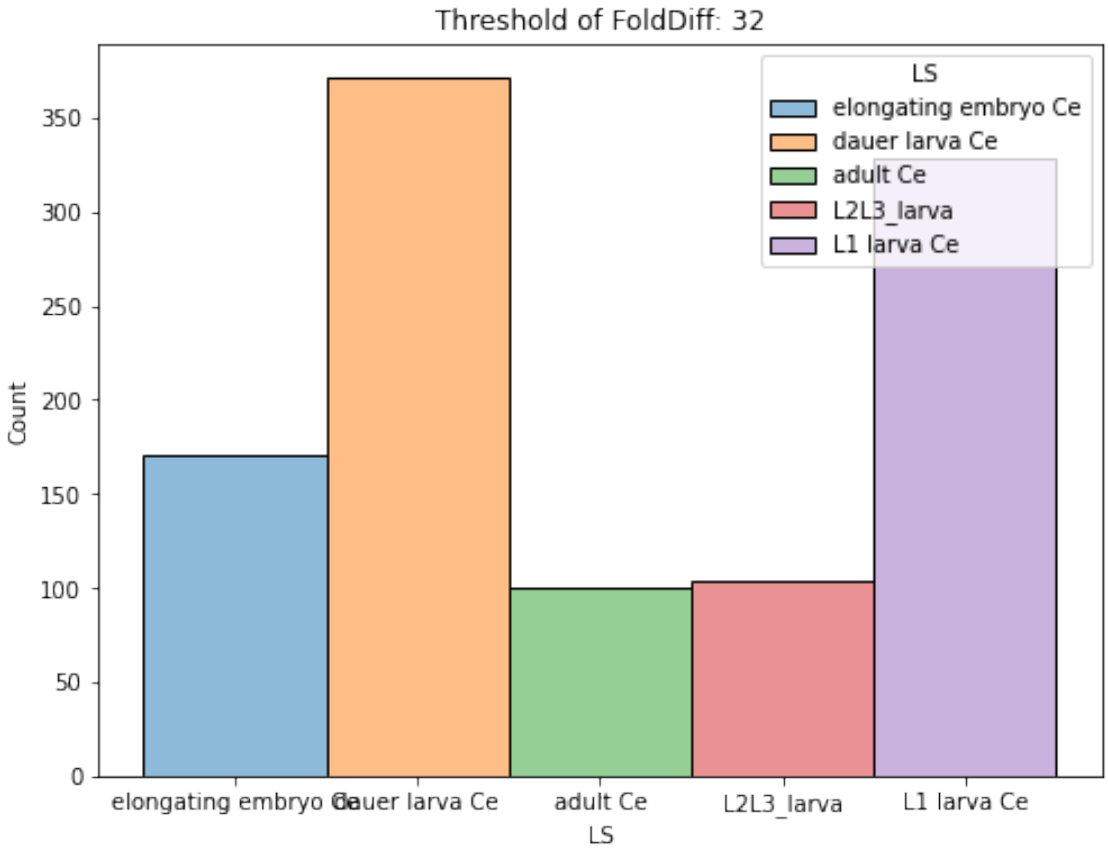
[12]:
```
sorted_ls_data=ls_data.sort_values(['LS','FoldDiff_RestMean'],ascending=False)

thresholds=[2**i for i in range(1,11)]

for threshold in thresholds:
    df_filtered=sorted_ls_data.loc[sorted_ls_data['FoldDiff_RestMean'] >=␣
 ↪threshold]
    df_count=df_filtered.groupby("LS").count()
    ax=plt.figure(figsize=[8,6])
    text=("Threshold of FoldDiff: "+ str(threshold))
    sns.histplot(df_filtered, x="LS",hue="LS").set_title(text)
```

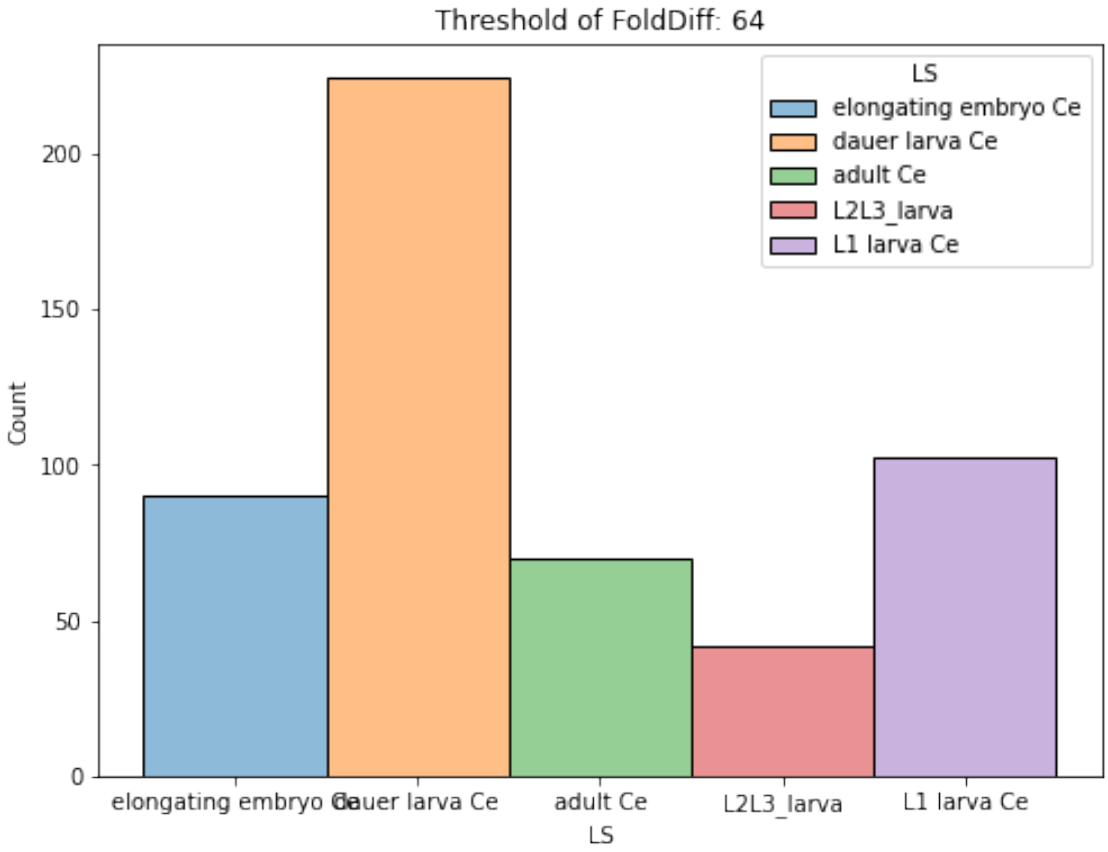

Threshold of FoldDiff: 2
LS
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
Count
0
1000
2000
3000
4000
5000
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
LS

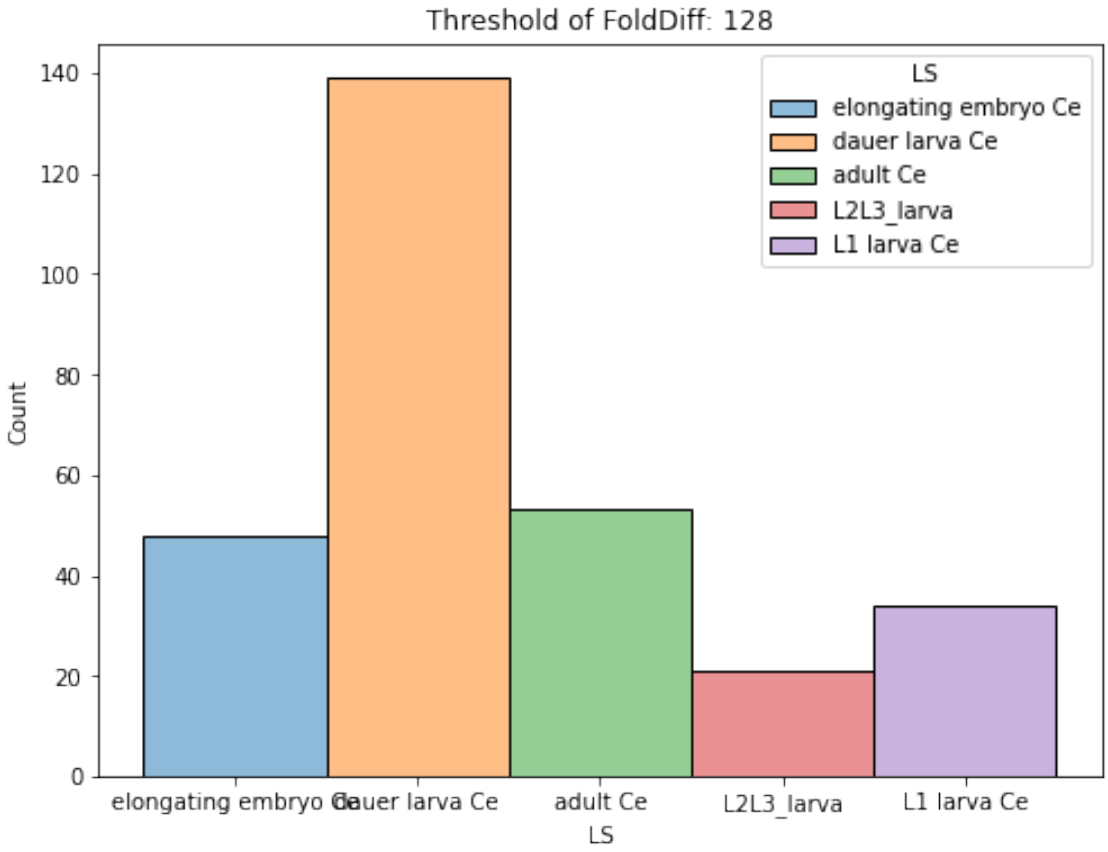

Threshold of FoldDiff: 4
LS
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
Count
5000
4000
3000
2000
1000
0
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
LS

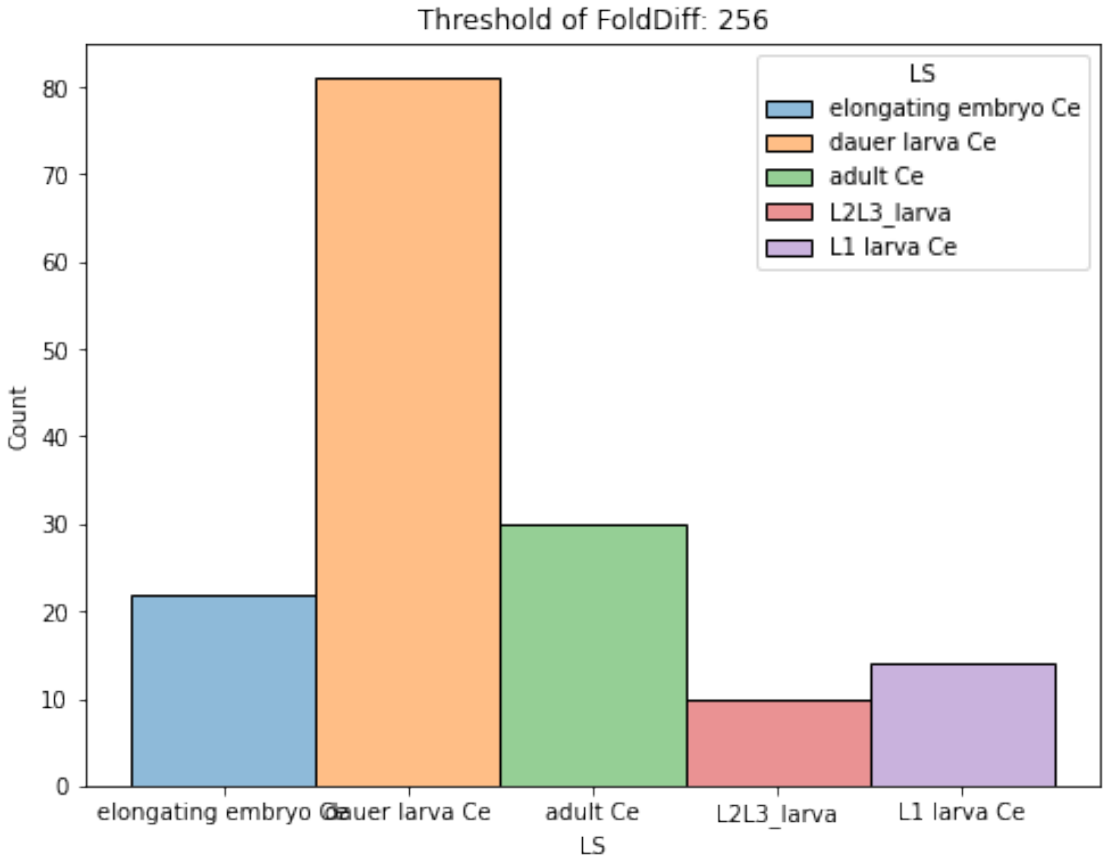

Threshold of FoldDiff: 8
LS
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
Count
2500
2000
1500
1000
500
0
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
LS

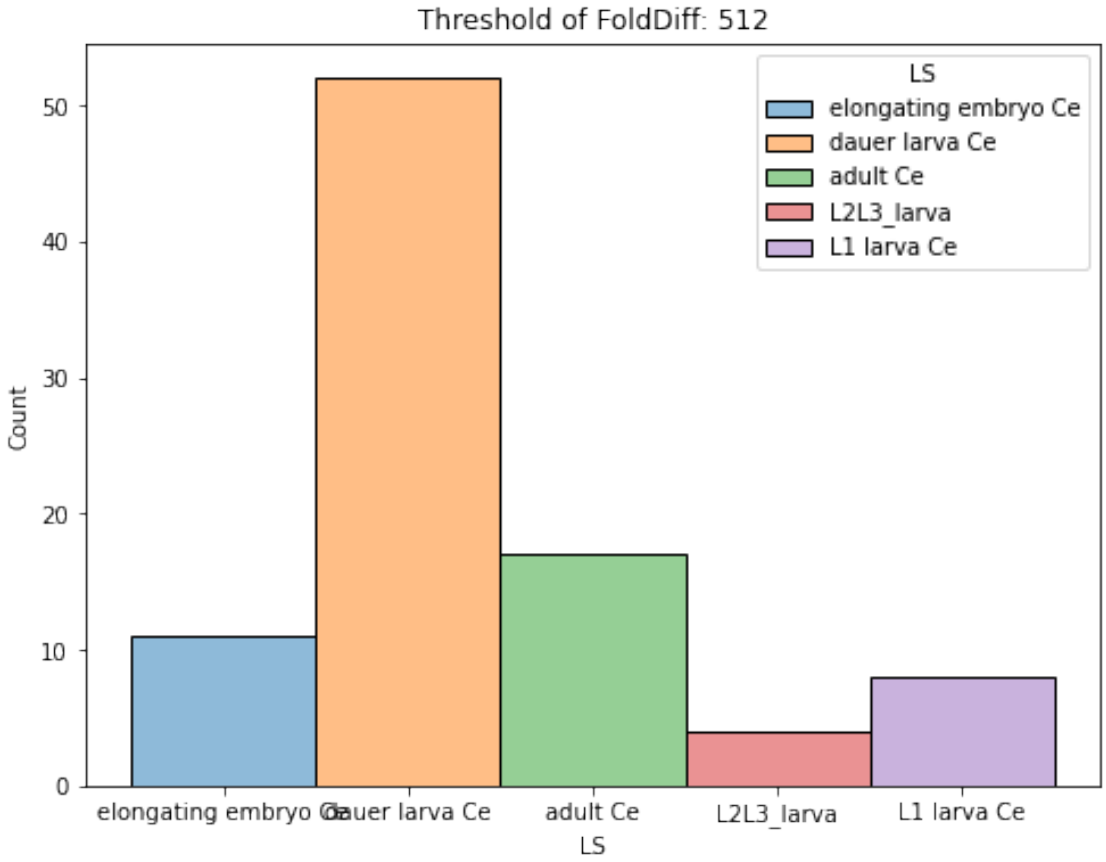

Threshold of FoldDiff: 16
LS
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
Count
1000
800
600
400
200
0
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
LS

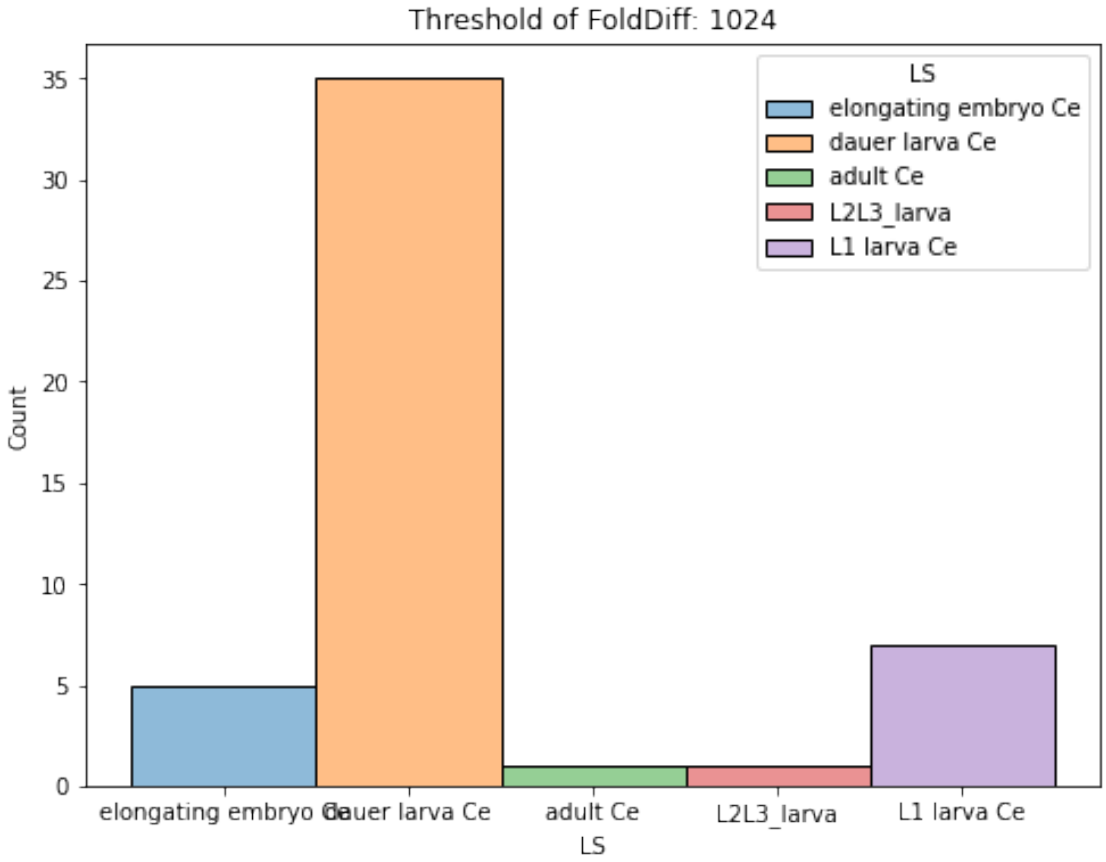

Threshold of FoldDiff: 32
LS
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
Count
0
50
100
150
200
250
300
350
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
LS


Threshold of FoldDiff: 64
LS
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
Count
200
150
100
50
0
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
LS


Threshold of FoldDiff: 128
LS
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
Count
140
120
100
80
60
40
20
0
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
LS


Threshold of FoldDiff: 256
LS
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
Count
0
10
20
30
40
50
60
70
80
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
LS

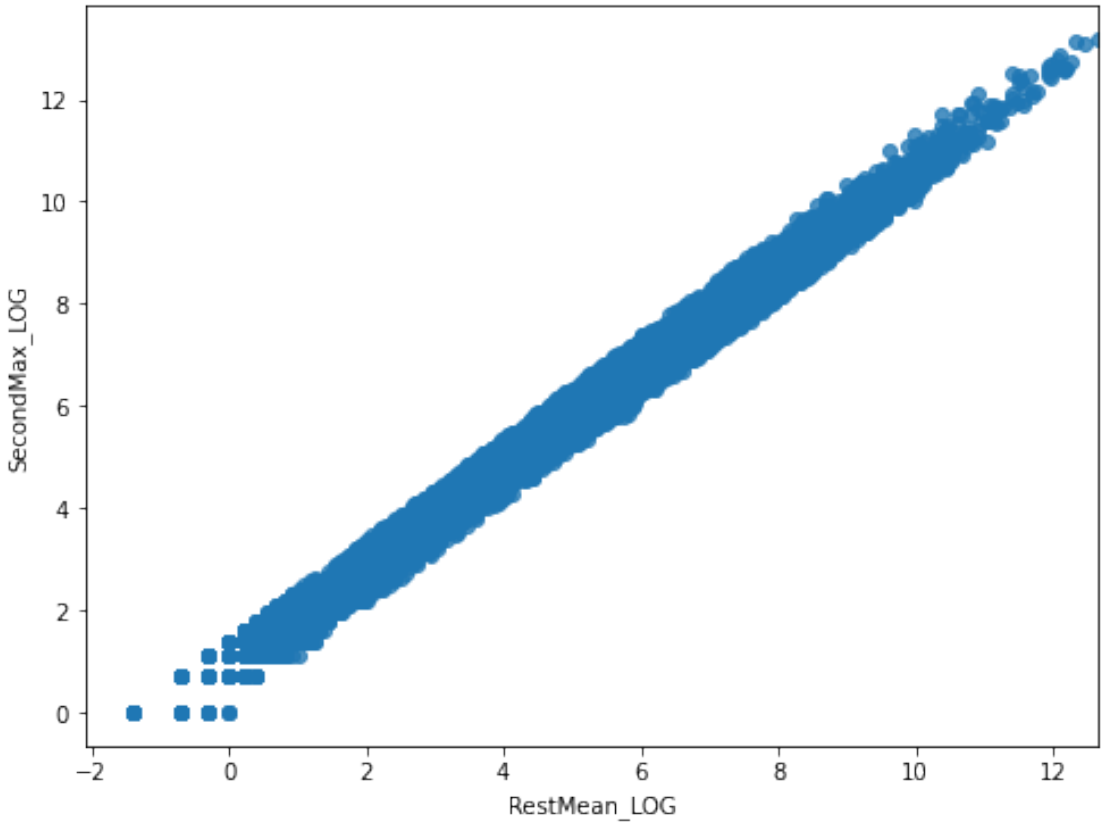

Threshold of FoldDiff: 512
LS
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
Count
0
10
20
30
40
50
elongating embryo Ce
dauer larva Ce
adult Ce
L2L3_larva
L1 larva Ce
LS




[28]:
```
ax=plt.figure(figsize=[8,6])

ls_data["RestMean_LOG"]=np.log(ls_data["RestMean"])
ls_data["SecondMax_LOG"]=np.log(ls_data["SecondMax"])
sns.regplot(data=ls_data,x="RestMean_LOG",y="SecondMax_LOG")
```

```
/home/lu/.local/lib/python3.8/site-packages/numpy/core/function_base.py:144:
RuntimeWarning: invalid value encountered in multiply
  y *= step
/home/lu/.local/lib/python3.8/site-packages/numpy/core/function_base.py:154:
RuntimeWarning: invalid value encountered in add
  y += start
```

[28]: <AxesSubplot:xlabel='RestMean_LOG', ylabel='SecondMax_LOG'>


SecondMax_LOG
RestMean_LOG
12
10
8
6
4
2
0
−2
0
2
4
6
8
10
12

[ ]: