Jan 31th, 2025

Calibrating the latent space representation

Based on our conversations, Rodrigo suggested the following notes:

- To find 5 images for every phenotype and take them out of the dataset.

```
    Retrain the model with more iterations (perhaps 250 epochs)
    Run these images through the encoder to obtain a point z for each of these
images
    Create a linear transition (presented as images) from one phenotype to the
other
```

- To run the analysis with more than 2 dimensions for the matrix z

```
    Run a KNN (k-nearest neighbors) analysis on the data.
```

Moving images

```
└── scripts/
    ├── Wings
    │    ├──00_MetaDataset
    │    ├──01_cleaned_Dataset
    │    ├──02_stnd_Dataset
    │    ├──03_subset_stnd          <---
    │    │   ├── phenotype_1
    │    │   └── phenotype_2
    │    ├──Autoencoder
    │    ├──Manifold_learning
    │    └──PCA_decomposition
```

The following images were chosen and transferred into **03_subset_stnd**:

phenotype_1:

The distal margin of the wings is not covered in "artifacts" of chitin. The wings are hirsute giving a velvety appearance to the wing. Geometry of the wings doesn't seem to be affected as much.

```
ArmFliesPilot_20240830__055__ArmFliesPilot_20240830__055_11.png
ArmFliesPilot_20240830__056__ArmFliesPilot_20240830__056_01.png
ArmFliesPilot_20240830__056__ArmFliesPilot_20240830__056_06.png
ArmFliesPilot_20240830__057__ArmFliesPilot_20240830__057_01.png
```

phenotype_2:

Main diagnostic feature is the artifacts that appear at the distal edge of the wings.

```
ArmFliesPilot_20240830__058__ArmFliesPilot_20240830__058_01.png
ArmFliesPilot_20240830__058__ArmFliesPilot_20240830__058_06.png
ArmFliesPilot_20240830__058__ArmFliesPilot_20240830__058_16.png
ArmFliesPilot_20240830__059__ArmFliesPilot_20240830__059_01.png
ArmFliesPilot_20240830__059__ArmFliesPilot_20240830__059_36.png
```

Training the network

The VAE_train.py has now been used with the following parameters:

```
dataset_size=        133-9 images (124)
epochs =             350
batch_size =         30
dimension in z =     1
```

```
encoder.0.conv.0.weight True
encoder.0.conv.0.bias True
encoder.0.conv.2.weight True
encoder.0.conv.2.bias True
encoder.1.conv.0.weight True
encoder.1.conv.0.bias True
encoder.1.conv.2.weight True
encoder.1.conv.2.bias True
    Epoch 1     Average Loss:  86856.30598958333
    Epoch 2     Average Loss:  34178.89114583333
    Epoch 3     Average Loss:  33734.552408854164
    Epoch 4     Average Loss:  33307.7900390625
    Epoch 5     Average Loss:  32719.988802083335
    Epoch 6     Average Loss:  31971.3974609375
    Epoch 7     Average Loss:  30901.0017578125
    Epoch 8     Average Loss:  29453.848307291668
    Epoch 9     Average Loss:  27644.131119791666
    Epoch 10    Average Loss:  25613.796614583334
    Epoch 11    Average Loss:  23653.631315104165
    Epoch 12    Average Loss:  22130.4087890625
    Epoch 13    Average Loss:  21058.4533203125
    Epoch 14    Average Loss:  20384.860677083332
```

```
Epoch 15     Average Loss:   19985.692513020833
Epoch 16     Average Loss:   19669.3111328125
Epoch 17     Average Loss:   19433.321614583332
Epoch 18     Average Loss:   19271.764778645833
Epoch 19     Average Loss:   19168.444075520834
Epoch 20     Average Loss:   19088.448828125
Epoch 21     Average Loss:   19032.554231770835
Epoch 22     Average Loss:   18987.4373046875
Epoch 23     Average Loss:   18932.581510416665
Epoch 24     Average Loss:   18889.6919921875
Epoch 25     Average Loss:   18860.108333333334
Epoch 26     Average Loss:   18838.0525390625
Epoch 27     Average Loss:   18818.147135416668
Epoch 28     Average Loss:   18801.610546875
Epoch 29     Average Loss:   18786.416536458335
Epoch 30     Average Loss:   18777.539127604166
Epoch 31     Average Loss:   18764.7109375
Epoch 32     Average Loss:   18757.400716145832
Epoch 33     Average Loss:   18746.474934895832
Epoch 34     Average Loss:   18740.224348958334
Epoch 35     Average Loss:   18743.840950520833
Epoch 36     Average Loss:   18727.255013020833
Epoch 37     Average Loss:   18729.310611979166
Epoch 38     Average Loss:   18732.9197265625
Epoch 39     Average Loss:   18716.424283854165
Epoch 40     Average Loss:   18720.286588541665
Epoch 41     Average Loss:   18698.96484375
Epoch 42     Average Loss:   18701.2375
Epoch 43     Average Loss:   18695.947330729166
Epoch 44     Average Loss:   18688.604752604166
Epoch 45     Average Loss:   18691.021223958334
Epoch 46     Average Loss:   18678.991861979168
Epoch 47     Average Loss:   18677.193359375
Epoch 48     Average Loss:   18669.103645833333
Epoch 49     Average Loss:   18662.3740234375
Epoch 50     Average Loss:   18661.154036458334
Epoch 51     Average Loss:   18656.396940104165
Epoch 52     Average Loss:   18652.1099609375
Epoch 53     Average Loss:   18647.45859375
Epoch 54     Average Loss:   18644.962174479166
Epoch 55     Average Loss:   18643.315364583334
Epoch 56     Average Loss:   18644.351627604166
Epoch 57     Average Loss:   18637.744010416667
Epoch 58     Average Loss:   18646.876692708334
Epoch 59     Average Loss:   18634.537109375
Epoch 60     Average Loss:   18634.1044921875
Epoch 61     Average Loss:   18637.999544270835
Epoch 62     Average Loss:   18635.909114583334
Epoch 63     Average Loss:   18624.430989583332
Epoch 64     Average Loss:   18637.241536458332
Epoch 65     Average Loss:   18628.959049479166
Epoch 66     Average Loss:   18615.740104166667
Epoch 67     Average Loss:   18614.402018229168
Epoch 68     Average Loss:   18596.650846354165
```

```
Epoch 69    Average Loss:   18580.853841145832
Epoch 70    Average Loss:   18578.914908854167
Epoch 71    Average Loss:   18575.955533854165
Epoch 72    Average Loss:   18567.55390625
Epoch 73    Average Loss:   18569.208723958334
Epoch 74    Average Loss:   18558.8435546875
Epoch 75    Average Loss:   18540.283658854165
Epoch 76    Average Loss:   18532.133333333335
Epoch 77    Average Loss:   18526.290625
Epoch 78    Average Loss:   18517.0568359375
Epoch 79    Average Loss:   18515.862369791666
Epoch 80    Average Loss:   18505.031575520832
Epoch 81    Average Loss:   18496.15
Epoch 82    Average Loss:   18477.645052083335
Epoch 83    Average Loss:   18474.323372395833
Epoch 84    Average Loss:   18459.618098958334
Epoch 85    Average Loss:   18448.117838541668
Epoch 86    Average Loss:   18439.9662109375
Epoch 87    Average Loss:   18431.2267578125
Epoch 88    Average Loss:   18421.0162109375
Epoch 89    Average Loss:   18409.466861979166
Epoch 90    Average Loss:   18398.87265625
Epoch 91    Average Loss:   18390.911067708334
Epoch 92    Average Loss:   18382.7884765625
Epoch 93    Average Loss:   18367.26796875
Epoch 94    Average Loss:   18361.487434895833
Epoch 95    Average Loss:   18349.874479166665
Epoch 96    Average Loss:   18344.732096354168
Epoch 97    Average Loss:   18335.563020833335
Epoch 98    Average Loss:   18321.156640625
Epoch 99    Average Loss:   18316.738802083335
Epoch 100   Average Loss:   18308.8646484375
Epoch 101   Average Loss:   18298.855143229168
Epoch 102   Average Loss:   18297.899479166666
Epoch 103   Average Loss:   18293.484309895834
Epoch 104   Average Loss:   18288.510091145832
Epoch 105   Average Loss:   18283.8404296875
Epoch 106   Average Loss:   18274.733268229167
Epoch 107   Average Loss:   18282.342838541666
Epoch 108   Average Loss:   18304.692122395834
Epoch 109   Average Loss:   18309.290755208334
Epoch 110   Average Loss:   18266.033203125
Epoch 111   Average Loss:   18253.092513020834
Epoch 112   Average Loss:   18249.048828125
Epoch 113   Average Loss:   18241.302018229166
Epoch 114   Average Loss:   18229.277864583335
Epoch 115   Average Loss:   18236.643424479167
Epoch 116   Average Loss:   18244.921614583334
Epoch 117   Average Loss:   18248.663020833334
Epoch 118   Average Loss:   18285.1197265625
Epoch 119   Average Loss:   18305.424739583334
Epoch 120   Average Loss:   18243.8498046875
Epoch 121   Average Loss:   18205.546158854166
Epoch 122   Average Loss:   18200.9794921875
```

```
Epoch 123    Average Loss:   18198.702864583334
Epoch 124    Average Loss:   18191.561458333334
Epoch 125    Average Loss:   18187.976822916666
Epoch 126    Average Loss:   18184.361393229166
Epoch 127    Average Loss:   18179.348177083335
Epoch 128    Average Loss:   18174.891731770833
Epoch 129    Average Loss:   18174.423372395835
Epoch 130    Average Loss:   18172.420442708335
Epoch 131    Average Loss:   18177.058919270832
Epoch 132    Average Loss:   18184.284375
Epoch 133    Average Loss:   18182.831315104166
Epoch 134    Average Loss:   18180.757161458332
Epoch 135    Average Loss:   18169.422981770833
Epoch 136    Average Loss:   18164.281119791667
Epoch 137    Average Loss:   18157.99453125
Epoch 138    Average Loss:   18157.347265625
Epoch 139    Average Loss:   18145.071940104168
Epoch 140    Average Loss:   18144.346744791666
Epoch 141    Average Loss:   18144.839192708332
Epoch 142    Average Loss:   18142.574348958333
Epoch 143    Average Loss:   18140.6876953125
Epoch 144    Average Loss:   18139.076171875
Epoch 145    Average Loss:   18134.702408854166
Epoch 146    Average Loss:   18133.36796875
Epoch 147    Average Loss:   18135.098567708334
Epoch 148    Average Loss:   18139.4064453125
Epoch 149    Average Loss:   18143.664908854167
Epoch 150    Average Loss:   18174.88125
Epoch 151    Average Loss:   18190.915625
Epoch 152    Average Loss:   18200.290885416667
Epoch 153    Average Loss:   18153.7798828125
Epoch 154    Average Loss:   18137.784505208332
Epoch 155    Average Loss:   18135.867057291667
Epoch 156    Average Loss:   18120.585677083334
Epoch 157    Average Loss:   18123.639322916668
Epoch 158    Average Loss:   18120.394596354166
Epoch 159    Average Loss:   18112.89892578125
Epoch 160    Average Loss:   18111.2876953125
Epoch 161    Average Loss:   18112.6376953125
Epoch 162    Average Loss:   18109.566080729168
Epoch 163    Average Loss:   18106.735416666666
Epoch 164    Average Loss:   18111.521354166667
Epoch 165    Average Loss:   18108.775130208334
Epoch 166    Average Loss:   18104.437109375
Epoch 167    Average Loss:   18099.853776041666
Epoch 168    Average Loss:   18098.6955078125
Epoch 169    Average Loss:   18103.565950520835
Epoch 170    Average Loss:   18099.370638020835
Epoch 171    Average Loss:   18095.46015625
Epoch 172    Average Loss:   18093.431966145832
Epoch 173    Average Loss:   18090.335091145833
Epoch 174    Average Loss:   18089.931119791665
Epoch 175    Average Loss:   18087.786848958334
Epoch 176    Average Loss:   18088.88095703125
```

```
Epoch 177    Average Loss:    18086.694661458332
Epoch 178    Average Loss:    18086.349348958334
Epoch 179    Average Loss:    18090.975455729167
Epoch 180    Average Loss:    18086.788606770835
Epoch 181    Average Loss:    18089.86328125
Epoch 182    Average Loss:    18092.892708333333
Epoch 183    Average Loss:    18101.485026041668
Epoch 184    Average Loss:    18097.872005208334
Epoch 185    Average Loss:    18096.225260416668
Epoch 186    Average Loss:    18090.8216796875
Epoch 187    Average Loss:    18079.372395833332
Epoch 188    Average Loss:    18079.153450520833
Epoch 189    Average Loss:    18076.269010416665
Epoch 190    Average Loss:    18077.998274739584
Epoch 191    Average Loss:    18075.8345703125
Epoch 192    Average Loss:    18074.662109375
Epoch 193    Average Loss:    18077.490169270834
Epoch 194    Average Loss:    18072.867447916666
Epoch 195    Average Loss:    18069.007356770835
Epoch 196    Average Loss:    18069.1072265625
Epoch 197    Average Loss:    18070.437109375
Epoch 198    Average Loss:    18067.746744791668
Epoch 199    Average Loss:    18064.602994791665
Epoch 200    Average Loss:    18063.783723958335
Epoch 201    Average Loss:    18060.71875
Epoch 202    Average Loss:    18061.3619140625
Epoch 203    Average Loss:    18061.312565104166
Epoch 204    Average Loss:    18061.048763020834
Epoch 205    Average Loss:    18063.222981770832
Epoch 206    Average Loss:    18065.293098958333
Epoch 207    Average Loss:    18067.3703125
Epoch 208    Average Loss:    18072.9037109375
Epoch 209    Average Loss:    18080.6181640625
Epoch 210    Average Loss:    18098.685546875
Epoch 211    Average Loss:    18102.733658854166
Epoch 212    Average Loss:    18077.526302083334
Epoch 213    Average Loss:    18071.200455729166
Epoch 214    Average Loss:    18074.301953125
Epoch 215    Average Loss:    18078.243619791665
Epoch 216    Average Loss:    18062.753385416665
Epoch 217    Average Loss:    18060.2708984375
Epoch 218    Average Loss:    18056.439908854165
Epoch 219    Average Loss:    18054.439713541666
Epoch 220    Average Loss:    18053.662369791666
Epoch 221    Average Loss:    18051.450130208334
Epoch 222    Average Loss:    18049.860807291665
Epoch 223    Average Loss:    18045.443033854168
Epoch 224    Average Loss:    18046.503645833334
Epoch 225    Average Loss:    18047.4408203125
Epoch 226    Average Loss:    18050.463541666668
Epoch 227    Average Loss:    18052.3005859375
Epoch 228    Average Loss:    18052.7564453125
Epoch 229    Average Loss:    18050.3251953125
Epoch 230    Average Loss:    18050.217643229167
```

```
Epoch 231    Average Loss:   18047.581966145834
Epoch 232    Average Loss:   18040.901236979167
Epoch 233    Average Loss:   18042.4123046875
Epoch 234    Average Loss:   18041.729557291666
Epoch 235    Average Loss:   18039.57421875
Epoch 236    Average Loss:   18044.0546875
Epoch 237    Average Loss:   18050.750455729165
Epoch 238    Average Loss:   18043.356380208334
Epoch 239    Average Loss:   18038.5041015625
Epoch 240    Average Loss:   18041.3998046875
Epoch 241    Average Loss:   18038.901171875
Epoch 242    Average Loss:   18036.540625
Epoch 243    Average Loss:   18036.8830078125
Epoch 244    Average Loss:   18033.447981770834
Epoch 245    Average Loss:   18037.0326171875
Epoch 246    Average Loss:   18036.203450520832
Epoch 247    Average Loss:   18037.860026041668
Epoch 248    Average Loss:   18036.047591145834
Epoch 249    Average Loss:   18035.763932291666
Epoch 250    Average Loss:   18031.71953125
Epoch 251    Average Loss:   18033.680859375
Epoch 252    Average Loss:   18030.665104166666
Epoch 253    Average Loss:   18030.555729166666
Epoch 254    Average Loss:   18034.099088541665
Epoch 255    Average Loss:   18040.186979166665
Epoch 256    Average Loss:   18056.616276041666
Epoch 257    Average Loss:   18069.8060546875
Epoch 258    Average Loss:   18069.696875
Epoch 259    Average Loss:   18049.599153645835
Epoch 260    Average Loss:   18041.285611979165
Epoch 261    Average Loss:   18034.554264322916
Epoch 262    Average Loss:   18031.156575520832
Epoch 263    Average Loss:   18025.990071614582
Epoch 264    Average Loss:   18028.906119791667
Epoch 265    Average Loss:   18028.270833333332
Epoch 266    Average Loss:   18027.366861979168
Epoch 267    Average Loss:   18031.446028645834
Epoch 268    Average Loss:   18028.372526041665
Epoch 269    Average Loss:   18025.175065104166
Epoch 270    Average Loss:   18022.221419270834
Epoch 271    Average Loss:   18026.272005208335
Epoch 272    Average Loss:   18033.085807291667
Epoch 273    Average Loss:   18028.376432291665
Epoch 274    Average Loss:   18030.0322265625
Epoch 275    Average Loss:   18026.4943359375
Epoch 276    Average Loss:   18029.629166666666
Epoch 277    Average Loss:   18026.324283854166
Epoch 278    Average Loss:   18023.555403645834
Epoch 279    Average Loss:   18023.219270833335
Epoch 280    Average Loss:   18020.180729166666
Epoch 281    Average Loss:   18017.859309895834
Epoch 282    Average Loss:   18017.984635416666
Epoch 283    Average Loss:   18019.8328125
Epoch 284    Average Loss:   18019.273567708333
```

```
Epoch 285    Average Loss:   18018.184700520833
Epoch 286    Average Loss:   18019.34921875
Epoch 287    Average Loss:   18014.193098958334
Epoch 288    Average Loss:   18014.832356770832
Epoch 289    Average Loss:   18016.7216796875
Epoch 290    Average Loss:   18014.741276041666
Epoch 291    Average Loss:   18012.723567708334
Epoch 292    Average Loss:   18017.6455078125
Epoch 293    Average Loss:   18018.659635416665
Epoch 294    Average Loss:   18021.1994140625
Epoch 295    Average Loss:   18021.951497395832
Epoch 296    Average Loss:   18027.541731770834
Epoch 297    Average Loss:   18025.543424479165
Epoch 298    Average Loss:   18027.2349609375
Epoch 299    Average Loss:   18020.8708984375
Epoch 300    Average Loss:   18014.2111328125
Epoch 301    Average Loss:   18012.272135416668
Epoch 302    Average Loss:   18014.964388020835
Epoch 303    Average Loss:   18019.645182291668
Epoch 304    Average Loss:   18032.805859375
Epoch 305    Average Loss:   18039.362630208332
Epoch 306    Average Loss:   18023.405208333334
Epoch 307    Average Loss:   18017.415234375
Epoch 308    Average Loss:   18011.645052083335
Epoch 309    Average Loss:   18012.7642578125
Epoch 310    Average Loss:   18011.442708333332
Epoch 311    Average Loss:   18006.3921875
Epoch 312    Average Loss:   18007.996223958333
Epoch 313    Average Loss:   18005.698567708332
Epoch 314    Average Loss:   18004.3513671875
Epoch 315    Average Loss:   18010.1490234375
Epoch 316    Average Loss:   18007.761067708332
Epoch 317    Average Loss:   18009.033854166668
Epoch 318    Average Loss:   18004.971940104166
Epoch 319    Average Loss:   18004.994075520834
Epoch 320    Average Loss:   18008.792643229168
Epoch 321    Average Loss:   18004.417838541667
Epoch 322    Average Loss:   18006.92265625
Epoch 323    Average Loss:   18002.2216796875
Epoch 324    Average Loss:   18004.173177083332
Epoch 325    Average Loss:   18008.550520833334
Epoch 326    Average Loss:   18009.239518229166
Epoch 327    Average Loss:   18011.016471354167
Epoch 328    Average Loss:   18006.9396484375
Epoch 329    Average Loss:   18003.367122395834
Epoch 330    Average Loss:   18007.133528645834
Epoch 331    Average Loss:   18013.135546875
Epoch 332    Average Loss:   18012.379947916666
Epoch 333    Average Loss:   18010.069986979168
Epoch 334    Average Loss:   18001.312044270835
Epoch 335    Average Loss:   18006.6541015625
Epoch 336    Average Loss:   18011.599088541665
Epoch 337    Average Loss:   18015.217578125
Epoch 338    Average Loss:   18002.3255859375
```

```
Epoch 339    Average Loss:  18002.940169270834
Epoch 340    Average Loss:  17997.297200520832
Epoch 341    Average Loss:  17999.463020833333
Epoch 342    Average Loss:  17996.109375
Epoch 343    Average Loss:  17997.535481770832
Epoch 344    Average Loss:  17994.8701171875
Epoch 345    Average Loss:  17999.761328125
Epoch 346    Average Loss:  17999.8560546875
Epoch 347    Average Loss:  18005.083463541665
Epoch 348    Average Loss:  18005.572005208334
Epoch 349    Average Loss:  18007.6244140625
Epoch 350    Average Loss:  18005.866471354166
```

Feeding the testing set of images into the encoder

A new script encode_validation.py was created to iterate over the different images, and extracting their Z values. The script is located in the same folder where the VAE model was created:

```
└── scripts/
    ├── Wings
        ├───03_subset_stnd
        │       ├── phenotype_1
        │       └── phenotype_2
        ├───Autoencoder
        │       ├── constants.py
        │       ├── encode_validation.py          <---- encoder for phenotype_1
and phenotype_2
        │       ├── mosaic_VAE_visualization.py
        │       ├── output.pth
        │       ├── VAE.py
        │       ├── VAE_train.py
        │       ├── VAE_validate.py
        │       ├── vgg19-dcbb9e9d.pth             <--- trained model weights
        │       └── VGG19.py
        ├───Manifold_learning
        └───PCA_decomposition
```

For images belonging to phenotype_1, the following values of latent space were recovered:

```
encodings for  phenotype_1
tensor([[-2.8056],
        [-2.6430],
        [-2.5537],
        [-2.7457]], device='cuda:0', grad_fn=<AddBackward0>)
```

For images belonging to pehnotype_2, the following values of the latent space were recovered:

```
encodings for  phenotype_2
tensor([[-3.7645],
        [-4.2681],
        [-4.5377],
        [-4.4112],
        [-3.7510]], device='cuda:0', grad_fn=<AddBackward0>)
```