

raport

December 14, 2023

1 Lab 4: SVM

```
[5]: from sklearn.datasets import load_digits
from sklearn.model_selection import train_test_split
from wsilib.algorithms.svm.svm import SVC
from wsilib.classifier.classifiers import OneToRestClassifier

from sklearn.datasets import make_moons
from sklearn.model_selection import train_test_split
from wsilib.algorithms.svm.svm import SVC

import numpy as np
import matplotlib.pyplot as plt
```

1.1 Przykład binarnej klasyfikacji z użyciem SVM

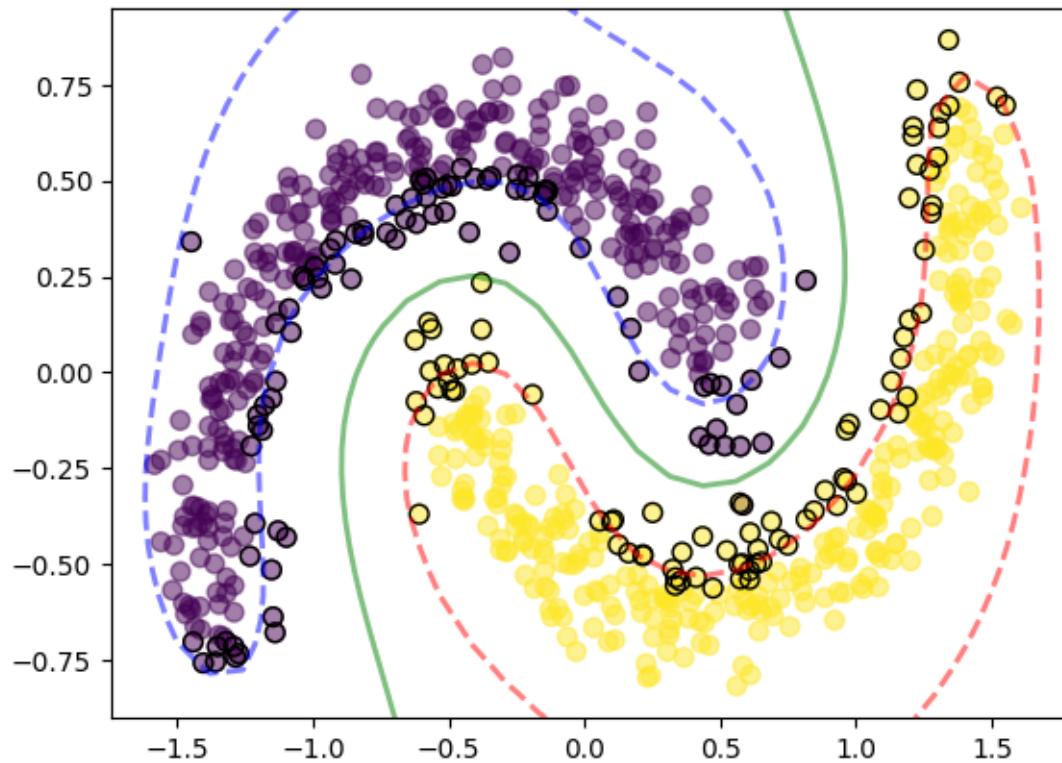
```
[6]: X, y = make_moons(n_samples=1000, noise=0.1, random_state=0)
y[y == 0] = -1
X_train, X_test, y_train, y_test = train_test_split(X, y, random_state=0)

svc = SVC(C=1.0, kernel=SVC.gaussian_kernel(sigma=0.5), learning_rate=1e-2)
svc.train(X_train, y_train, epochs=100)
print(svc.score(X_train, y_train))
svc.plot_decision_boundary()
```

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EpochLog(epoch=0, loss=1.380577207620588)
EpochLog(epoch=1, loss=0.6900046139141649)
EpochLog(epoch=2, loss=-0.8650133434220422)
EpochLog(epoch=3, loss=-1.8425338101282982)
EpochLog(epoch=4, loss=-2.9801084072426924)
EpochLog(epoch=5, loss=-3.997414132975287)
EpochLog(epoch=6, loss=-5.0589790006416315)
EpochLog(epoch=7, loss=-6.116173796192282)
EpochLog(epoch=8, loss=-7.251781321798033)
EpochLog(epoch=9, loss=-8.393798817615462)
EpochLog(epoch=10, loss=-9.555568215778788)
EpochLog(epoch=11, loss=-10.699606639914052)
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EpochLog(epoch=12, loss=-11.853284403856016)
EpochLog(epoch=13, loss=-12.986230734858019)
EpochLog(epoch=14, loss=-14.12166885711384)
EpochLog(epoch=15, loss=-15.265201946750157)
EpochLog(epoch=16, loss=-16.39669540194866)
EpochLog(epoch=17, loss=-17.540648149109153)
EpochLog(epoch=18, loss=-18.699543408251593)
EpochLog(epoch=19, loss=-19.887125976379256)
EpochLog(epoch=20, loss=-21.115490134660014)
EpochLog(epoch=21, loss=-22.348118218341575)
EpochLog(epoch=22, loss=-23.585409883194103)
EpochLog(epoch=23, loss=-24.800205638755077)
EpochLog(epoch=24, loss=-26.017577750509577)
EpochLog(epoch=25, loss=-27.223746258723462)
EpochLog(epoch=26, loss=-28.413210905621877)
EpochLog(epoch=27, loss=-29.59067790126221)
EpochLog(epoch=28, loss=-30.77461906651417)
EpochLog(epoch=29, loss=-31.97864556361678)
EpochLog(epoch=30, loss=-33.19653050405708)
EpochLog(epoch=31, loss=-34.43094192172671)
EpochLog(epoch=32, loss=-35.67901974104517)
EpochLog(epoch=33, loss=-36.926122080195796)
EpochLog(epoch=34, loss=-38.16283995202271)
EpochLog(epoch=35, loss=-39.38317761890652)
EpochLog(epoch=36, loss=-40.606546903407235)
EpochLog(epoch=37, loss=-41.819194151346395)
EpochLog(epoch=38, loss=-43.02519998605704)
EpochLog(epoch=39, loss=-44.222307572276094)
EpochLog(epoch=40, loss=-45.40766860220616)
EpochLog(epoch=41, loss=-46.59917692003284)
EpochLog(epoch=42, loss=-47.79627400380631)
EpochLog(epoch=43, loss=-49.00662724780354)
EpochLog(epoch=44, loss=-50.22462895252073)
EpochLog(epoch=45, loss=-51.47883645645993)
EpochLog(epoch=46, loss=-52.7456334249212)
EpochLog(epoch=47, loss=-53.99408963645654)
EpochLog(epoch=48, loss=-55.249725349410305)
EpochLog(epoch=49, loss=-56.53850008948038)
EpochLog(epoch=50, loss=-57.82352594170577)
EpochLog(epoch=51, loss=-59.10993849653896)
EpochLog(epoch=52, loss=-60.41208796178576)
EpochLog(epoch=53, loss=-61.72459492241454)
EpochLog(epoch=54, loss=-63.02344249450594)
EpochLog(epoch=55, loss=-64.29815467321922)
EpochLog(epoch=56, loss=-65.57494982433873)
EpochLog(epoch=57, loss=-66.84551097612538)
EpochLog(epoch=58, loss=-68.11852515878286)
EpochLog(epoch=59, loss=-69.38327214910896)
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EpochLog(epoch=60, loss=-70.6506768174853)
EpochLog(epoch=61, loss=-71.92835211861252)
EpochLog(epoch=62, loss=-73.20101228734548)
EpochLog(epoch=63, loss=-74.49051964037065)
EpochLog(epoch=64, loss=-75.79577493587603)
EpochLog(epoch=65, loss=-77.11733346526145)
EpochLog(epoch=66, loss=-78.43691383540886)
EpochLog(epoch=67, loss=-79.73938495802982)
EpochLog(epoch=68, loss=-81.03907798146933)
EpochLog(epoch=69, loss=-82.36657693885505)
EpochLog(epoch=70, loss=-83.70748021159235)
EpochLog(epoch=71, loss=-85.03974562810886)
EpochLog(epoch=72, loss=-86.36848735729593)
EpochLog(epoch=73, loss=-87.65719970901435)
EpochLog(epoch=74, loss=-88.82217140552707)
EpochLog(epoch=75, loss=-89.96903511433253)
EpochLog(epoch=76, loss=-91.09202673961782)
EpochLog(epoch=77, loss=-92.20338109931151)
EpochLog(epoch=78, loss=-93.33841196898814)
EpochLog(epoch=79, loss=-94.48613659889226)
EpochLog(epoch=80, loss=-95.63923167671484)
EpochLog(epoch=81, loss=-96.78033271530155)
EpochLog(epoch=82, loss=-97.90647376327075)
EpochLog(epoch=83, loss=-99.01783363748335)
EpochLog(epoch=84, loss=-100.13197394426739)
EpochLog(epoch=85, loss=-101.24177027308697)
EpochLog(epoch=86, loss=-102.37523066004508)
EpochLog(epoch=87, loss=-103.49173510269043)
EpochLog(epoch=88, loss=-104.59598823844686)
EpochLog(epoch=89, loss=-105.70087423099025)
EpochLog(epoch=90, loss=-106.80379148708268)
EpochLog(epoch=91, loss=-107.89094614331212)
EpochLog(epoch=92, loss=-108.96532886639076)
EpochLog(epoch=93, loss=-110.03909526658472)
EpochLog(epoch=94, loss=-111.13494177885767)
EpochLog(epoch=95, loss=-112.23609146603683)
EpochLog(epoch=96, loss=-113.32880743678508)
EpochLog(epoch=97, loss=-114.4099187943231)
EpochLog(epoch=98, loss=-115.48837376630605)
EpochLog(epoch=99, loss=-116.51120906471037)
TrainingScore(accuracy=0.9986666666666667, precision=0.9972826086956522,
recall=1.0, f1_score=0.998639455782313)
```



Na rysunku zaznaczone są granice decyzji i podświetlone są wektory nośne

1.2 Przykład klasyfikacji wieloklasowej z użyciem SVM metodą One-to-Rest

1.2.1 Jądro wielomianowe

```
[7]: digits = load_digits()
X = digits.data
y = digits.target

X_train, X_test, y_train, y_test = train_test_split(X, y, random_state=0)

clf = OneToRestClassifier(
    SVC(C=1.0, kernel=SVC.polynomial_kernel(2), learning_rate=1e-2)
)

clf.train(X_train, y_train, epochs=100)

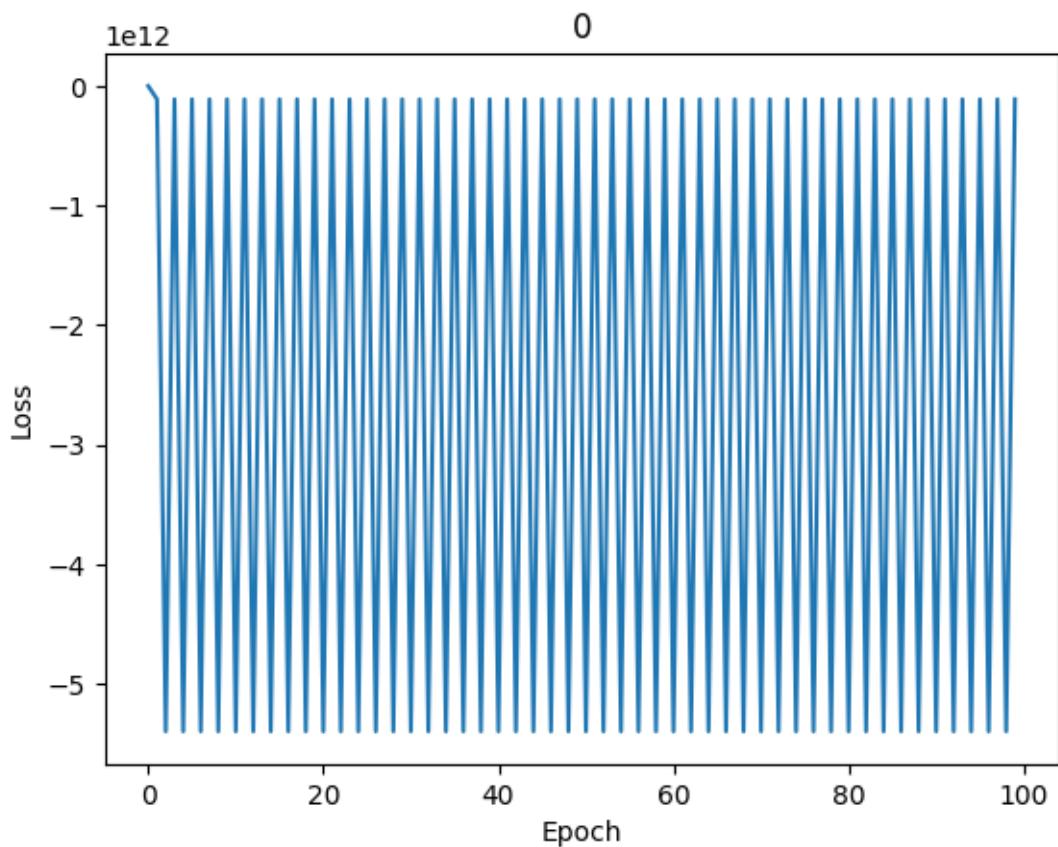
result = clf.score(X_test, y_test)
result.plot_confusion_matrix()
print(result)
```

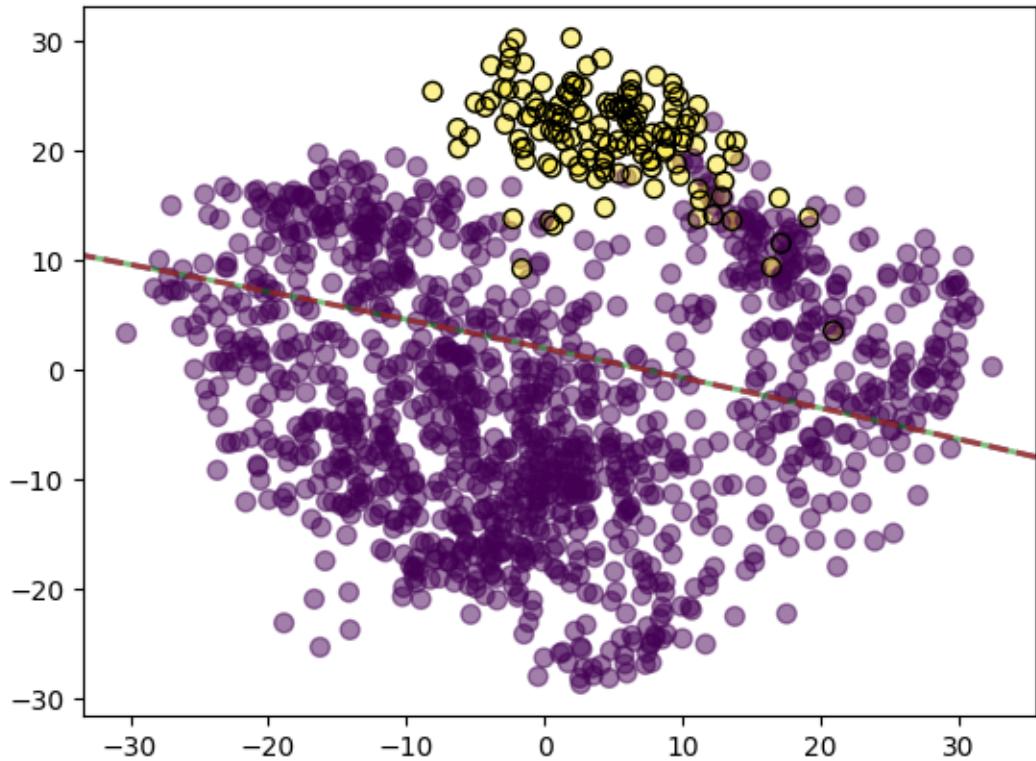
EpochLog(epoch=0, loss=-665889265.6247501)

```
EpochLog(epoch=1, loss=-111389302843.5)
EpochLog(epoch=2, loss=-5394023179835.0)
EpochLog(epoch=3, loss=-111389302843.5)
EpochLog(epoch=4, loss=-5394023179835.0)
EpochLog(epoch=5, loss=-111389302843.5)
EpochLog(epoch=6, loss=-5394023179835.0)
EpochLog(epoch=7, loss=-111389302843.5)
EpochLog(epoch=8, loss=-5394023179835.0)
EpochLog(epoch=9, loss=-111389302843.5)
EpochLog(epoch=10, loss=-5394023179835.0)
EpochLog(epoch=11, loss=-111389302843.5)
EpochLog(epoch=12, loss=-5394023179835.0)
EpochLog(epoch=13, loss=-111389302843.5)
EpochLog(epoch=14, loss=-5394023179835.0)
EpochLog(epoch=15, loss=-111389302843.5)
EpochLog(epoch=16, loss=-5394023179835.0)
EpochLog(epoch=17, loss=-111389302843.5)
EpochLog(epoch=18, loss=-5394023179835.0)
EpochLog(epoch=19, loss=-111389302843.5)
EpochLog(epoch=20, loss=-5394023179835.0)
EpochLog(epoch=21, loss=-111389302843.5)
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EpochLog(epoch=23, loss=-111389302843.5)
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EpochLog(epoch=26, loss=-5394023179835.0)
EpochLog(epoch=27, loss=-111389302843.5)
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EpochLog(epoch=38, loss=-5394023179835.0)
EpochLog(epoch=39, loss=-111389302843.5)
EpochLog(epoch=40, loss=-5394023179835.0)
EpochLog(epoch=41, loss=-111389302843.5)
EpochLog(epoch=42, loss=-5394023179835.0)
EpochLog(epoch=43, loss=-111389302843.5)
EpochLog(epoch=44, loss=-5394023179835.0)
EpochLog(epoch=45, loss=-111389302843.5)
EpochLog(epoch=46, loss=-5394023179835.0)
EpochLog(epoch=47, loss=-111389302843.5)
EpochLog(epoch=48, loss=-5394023179835.0)
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EpochLog(epoch=51, loss=-111389302843.5)
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EpochLog(epoch=53, loss=-111389302843.5)
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EpochLog(epoch=58, loss=-5394023179835.0)
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EpochLog(epoch=60, loss=-5394023179835.0)
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EpochLog(epoch=63, loss=-111389302843.5)
EpochLog(epoch=64, loss=-5394023179835.0)
EpochLog(epoch=65, loss=-111389302843.5)
EpochLog(epoch=66, loss=-5394023179835.0)
EpochLog(epoch=67, loss=-111389302843.5)
EpochLog(epoch=68, loss=-5394023179835.0)
EpochLog(epoch=69, loss=-111389302843.5)
EpochLog(epoch=70, loss=-5394023179835.0)
EpochLog(epoch=71, loss=-111389302843.5)
EpochLog(epoch=72, loss=-5394023179835.0)
EpochLog(epoch=73, loss=-111389302843.5)
EpochLog(epoch=74, loss=-5394023179835.0)
EpochLog(epoch=75, loss=-111389302843.5)
EpochLog(epoch=76, loss=-5394023179835.0)
EpochLog(epoch=77, loss=-111389302843.5)
EpochLog(epoch=78, loss=-5394023179835.0)
EpochLog(epoch=79, loss=-111389302843.5)
EpochLog(epoch=80, loss=-5394023179835.0)
EpochLog(epoch=81, loss=-111389302843.5)
EpochLog(epoch=82, loss=-5394023179835.0)
EpochLog(epoch=83, loss=-111389302843.5)
EpochLog(epoch=84, loss=-5394023179835.0)
EpochLog(epoch=85, loss=-111389302843.5)
EpochLog(epoch=86, loss=-5394023179835.0)
EpochLog(epoch=87, loss=-111389302843.5)
EpochLog(epoch=88, loss=-5394023179835.0)
EpochLog(epoch=89, loss=-111389302843.5)
EpochLog(epoch=90, loss=-5394023179835.0)
EpochLog(epoch=91, loss=-111389302843.5)
EpochLog(epoch=92, loss=-5394023179835.0)
EpochLog(epoch=93, loss=-111389302843.5)
EpochLog(epoch=94, loss=-5394023179835.0)
EpochLog(epoch=95, loss=-111389302843.5)
EpochLog(epoch=96, loss=-5394023179835.0)
```

```
EpochLog(epoch=97, loss=-111389302843.5)
EpochLog(epoch=98, loss=-5394023179835.0)
EpochLog(epoch=99, loss=-111389302843.5)
```

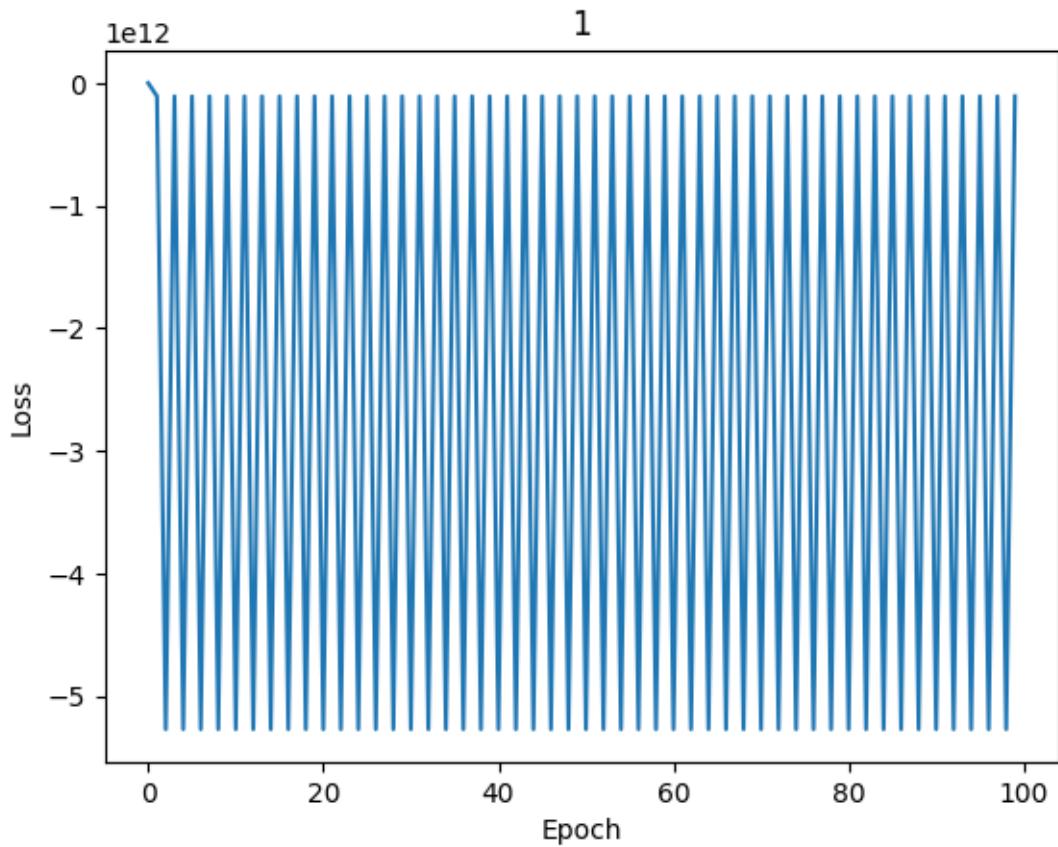


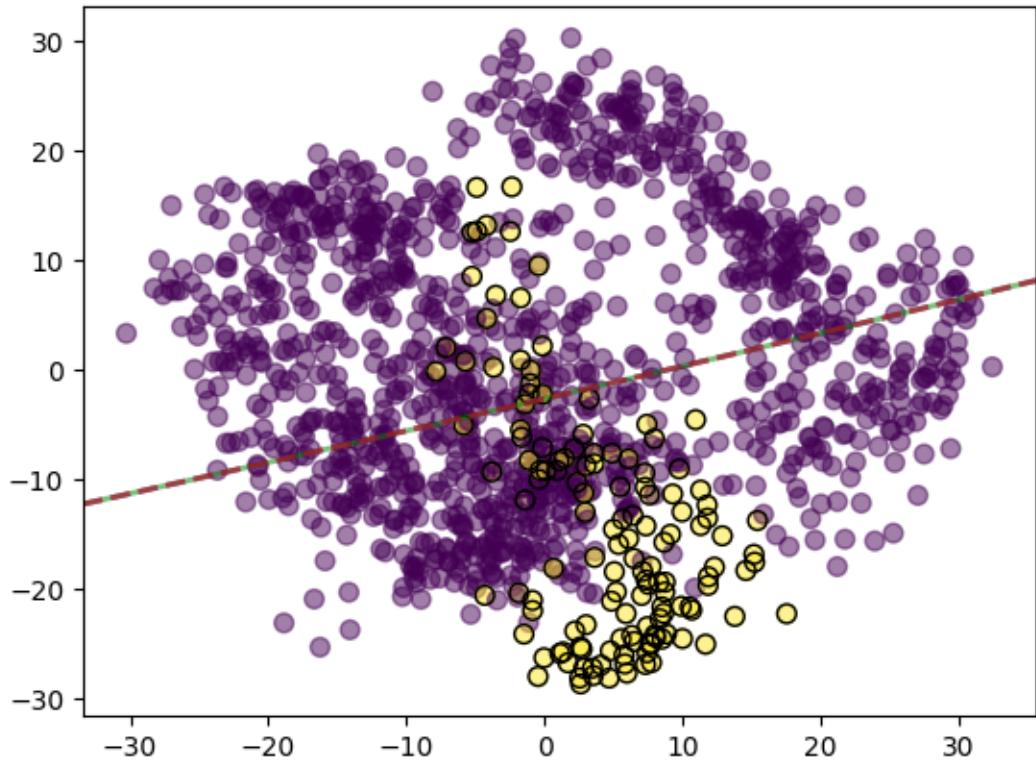


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EpochLog(epoch=0, loss=-665889265.6247501)
EpochLog(epoch=1, loss=-108254363638.5)
EpochLog(epoch=2, loss=-5272884131062.0)
EpochLog(epoch=3, loss=-108254363638.5)
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EpochLog(epoch=5, loss=-108254363638.5)
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EpochLog(epoch=22, loss=-5272884131062.0)
EpochLog(epoch=23, loss=-108254363638.5)
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EpochLog(epoch=66, loss=-5272884131062.0)
EpochLog(epoch=67, loss=-108254363638.5)
EpochLog(epoch=68, loss=-5272884131062.0)
EpochLog(epoch=69, loss=-108254363638.5)
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EpochLog(epoch=70, loss=-5272884131062.0)
EpochLog(epoch=71, loss=-108254363638.5)
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EpochLog(epoch=74, loss=-5272884131062.0)
EpochLog(epoch=75, loss=-108254363638.5)
EpochLog(epoch=76, loss=-5272884131062.0)
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EpochLog(epoch=78, loss=-5272884131062.0)
EpochLog(epoch=79, loss=-108254363638.5)
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EpochLog(epoch=83, loss=-108254363638.5)
EpochLog(epoch=84, loss=-5272884131062.0)
EpochLog(epoch=85, loss=-108254363638.5)
EpochLog(epoch=86, loss=-5272884131062.0)
EpochLog(epoch=87, loss=-108254363638.5)
EpochLog(epoch=88, loss=-5272884131062.0)
EpochLog(epoch=89, loss=-108254363638.5)
EpochLog(epoch=90, loss=-5272884131062.0)
EpochLog(epoch=91, loss=-108254363638.5)
EpochLog(epoch=92, loss=-5272884131062.0)
EpochLog(epoch=93, loss=-108254363638.5)
EpochLog(epoch=94, loss=-5272884131062.0)
EpochLog(epoch=95, loss=-108254363638.5)
EpochLog(epoch=96, loss=-5272884131062.0)
EpochLog(epoch=97, loss=-108254363638.5)
EpochLog(epoch=98, loss=-5272884131062.0)
EpochLog(epoch=99, loss=-108254363638.5)
```

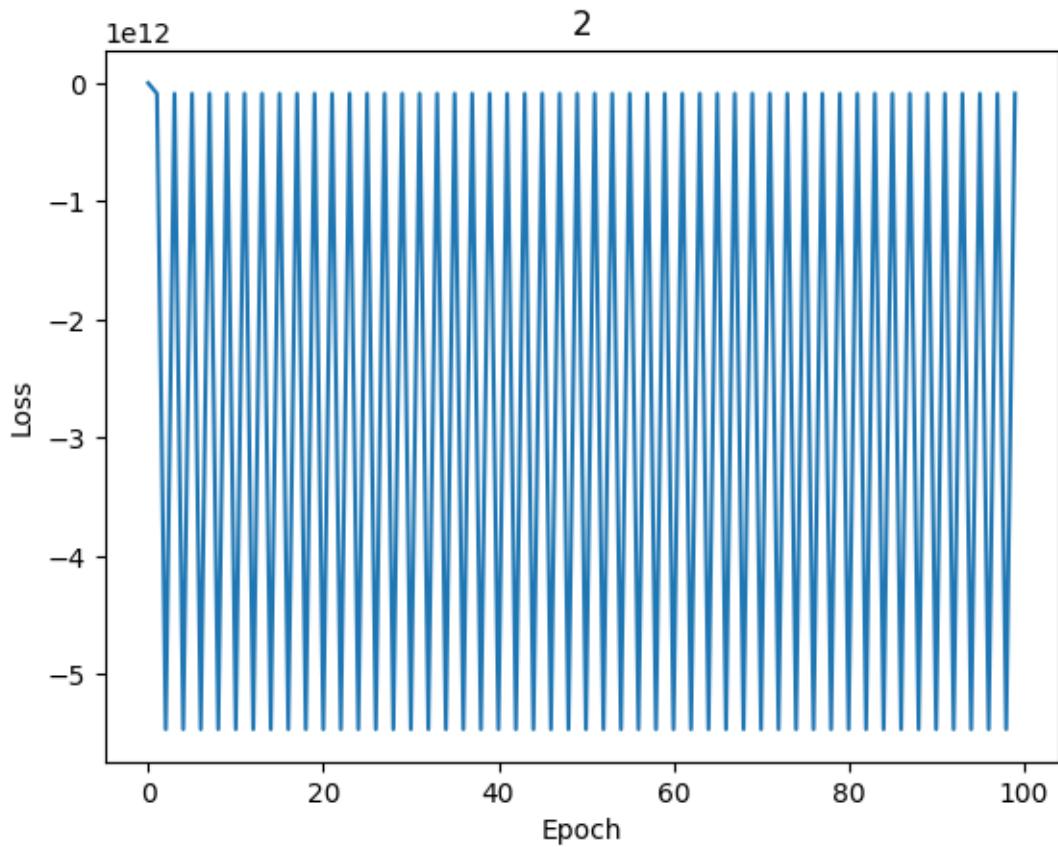


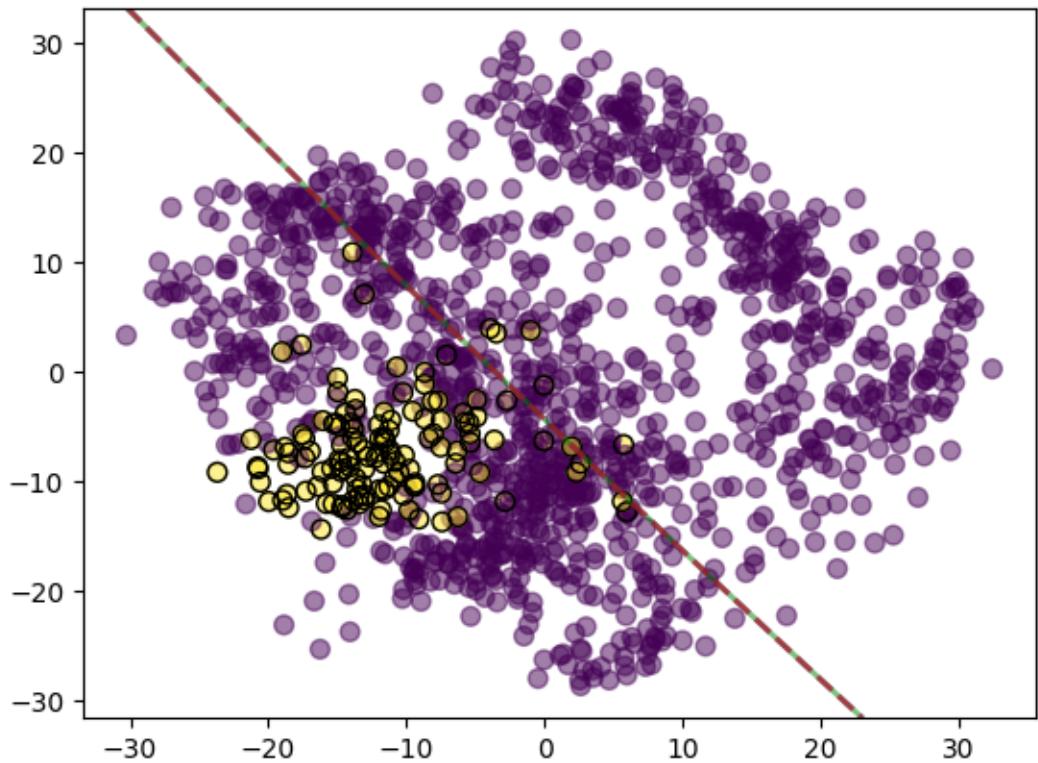


```
EpochLog(epoch=0, loss=-665889265.6247501)
EpochLog(epoch=1, loss=-90242924930.5)
EpochLog(epoch=2, loss=-5465980449999.0)
EpochLog(epoch=3, loss=-90242924930.5)
EpochLog(epoch=4, loss=-5465980449999.0)
EpochLog(epoch=5, loss=-90242924930.5)
EpochLog(epoch=6, loss=-5465980449999.0)
EpochLog(epoch=7, loss=-90242924930.5)
EpochLog(epoch=8, loss=-5465980449999.0)
EpochLog(epoch=9, loss=-90242924930.5)
EpochLog(epoch=10, loss=-5465980449999.0)
EpochLog(epoch=11, loss=-90242924930.5)
EpochLog(epoch=12, loss=-5465980449999.0)
EpochLog(epoch=13, loss=-90242924930.5)
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EpochLog(epoch=17, loss=-90242924930.5)
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EpochLog(epoch=19, loss=-90242924930.5)
EpochLog(epoch=20, loss=-5465980449999.0)
EpochLog(epoch=21, loss=-90242924930.5)
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EpochLog(epoch=23, loss=-90242924930.5)
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EpochLog(epoch=25, loss=-90242924930.5)
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EpochLog(epoch=27, loss=-90242924930.5)
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EpochLog(epoch=49, loss=-90242924930.5)
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EpochLog(epoch=51, loss=-90242924930.5)
EpochLog(epoch=52, loss=-5465980449999.0)
EpochLog(epoch=53, loss=-90242924930.5)
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EpochLog(epoch=64, loss=-5465980449999.0)
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EpochLog(epoch=66, loss=-5465980449999.0)
EpochLog(epoch=67, loss=-90242924930.5)
EpochLog(epoch=68, loss=-5465980449999.0)
EpochLog(epoch=69, loss=-90242924930.5)
```

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EpochLog(epoch=70, loss=-5465980449999.0)
EpochLog(epoch=71, loss=-90242924930.5)
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EpochLog(epoch=73, loss=-90242924930.5)
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EpochLog(epoch=84, loss=-5465980449999.0)
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EpochLog(epoch=86, loss=-5465980449999.0)
EpochLog(epoch=87, loss=-90242924930.5)
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EpochLog(epoch=89, loss=-90242924930.5)
EpochLog(epoch=90, loss=-5465980449999.0)
EpochLog(epoch=91, loss=-90242924930.5)
EpochLog(epoch=92, loss=-5465980449999.0)
EpochLog(epoch=93, loss=-90242924930.5)
EpochLog(epoch=94, loss=-5465980449999.0)
EpochLog(epoch=95, loss=-90242924930.5)
EpochLog(epoch=96, loss=-5465980449999.0)
EpochLog(epoch=97, loss=-90242924930.5)
EpochLog(epoch=98, loss=-5465980449999.0)
EpochLog(epoch=99, loss=-90242924930.5)
```

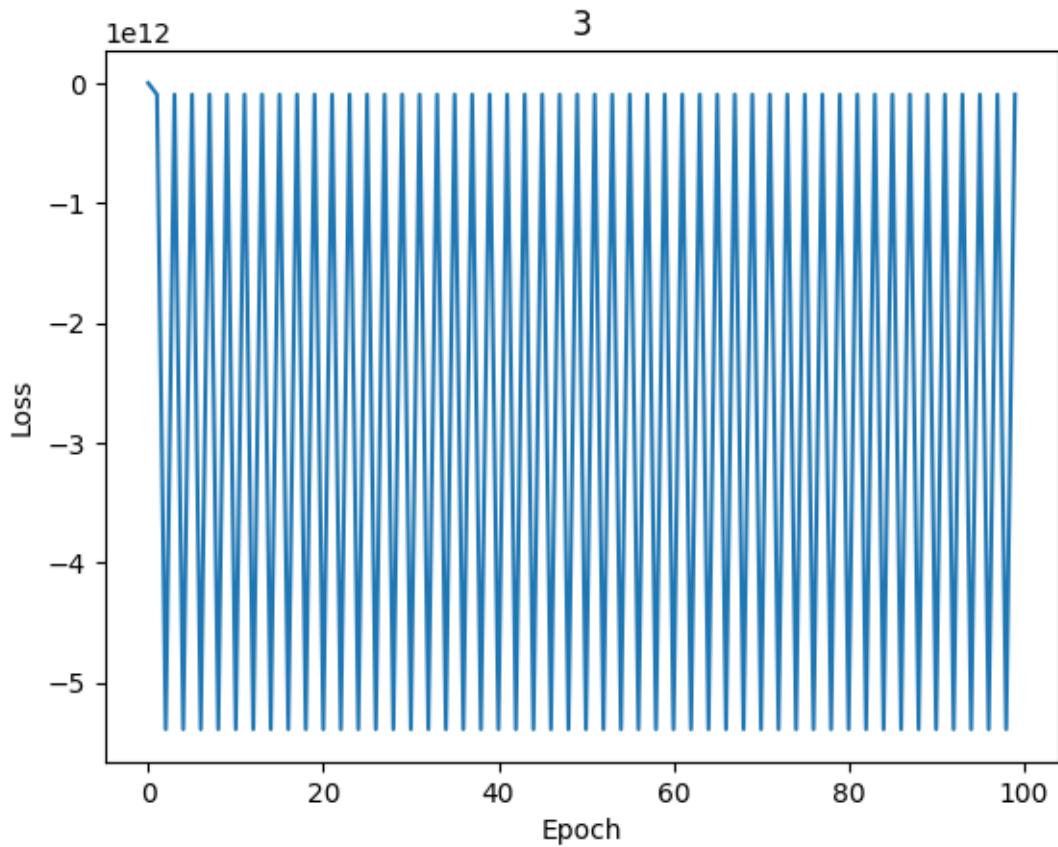


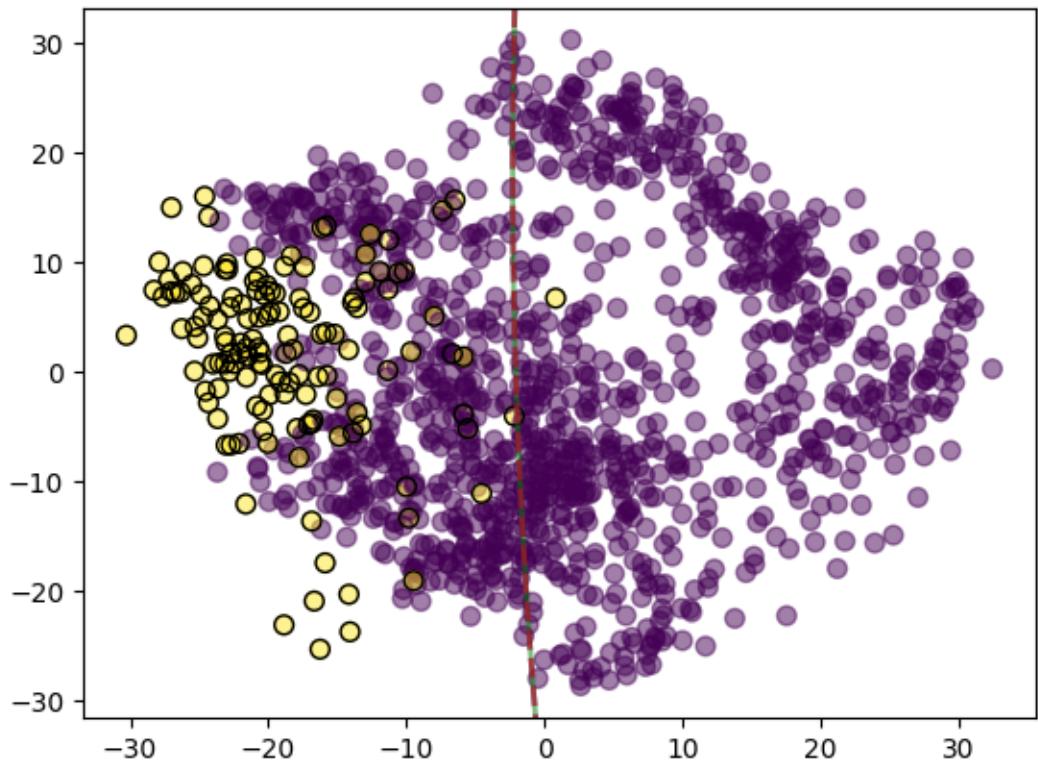


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EpochLog(epoch=0, loss=-665889265.6247501)
EpochLog(epoch=1, loss=-96130555583.0)
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EpochLog(epoch=5, loss=-96130555583.0)
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EpochLog(epoch=7, loss=-96130555583.0)
EpochLog(epoch=8, loss=-5391818277457.5)
EpochLog(epoch=9, loss=-96130555583.0)
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EpochLog(epoch=19, loss=-96130555583.0)
EpochLog(epoch=20, loss=-5391818277457.5)
EpochLog(epoch=21, loss=-96130555583.0)
```

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EpochLog(epoch=22, loss=-5391818277457.5)
EpochLog(epoch=23, loss=-96130555583.0)
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EpochLog(epoch=35, loss=-96130555583.0)
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EpochLog(epoch=52, loss=-5391818277457.5)
EpochLog(epoch=53, loss=-96130555583.0)
EpochLog(epoch=54, loss=-5391818277457.5)
EpochLog(epoch=55, loss=-96130555583.0)
EpochLog(epoch=56, loss=-5391818277457.5)
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EpochLog(epoch=59, loss=-96130555583.0)
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EpochLog(epoch=62, loss=-5391818277457.5)
EpochLog(epoch=63, loss=-96130555583.0)
EpochLog(epoch=64, loss=-5391818277457.5)
EpochLog(epoch=65, loss=-96130555583.0)
EpochLog(epoch=66, loss=-5391818277457.5)
EpochLog(epoch=67, loss=-96130555583.0)
EpochLog(epoch=68, loss=-5391818277457.5)
EpochLog(epoch=69, loss=-96130555583.0)
```

```
EpochLog(epoch=70, loss=-5391818277457.5)
EpochLog(epoch=71, loss=-96130555583.0)
EpochLog(epoch=72, loss=-5391818277457.5)
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EpochLog(epoch=74, loss=-5391818277457.5)
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EpochLog(epoch=83, loss=-96130555583.0)
EpochLog(epoch=84, loss=-5391818277457.5)
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EpochLog(epoch=96, loss=-5391818277457.5)
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EpochLog(epoch=98, loss=-5391818277457.5)
EpochLog(epoch=99, loss=-96130555583.0)
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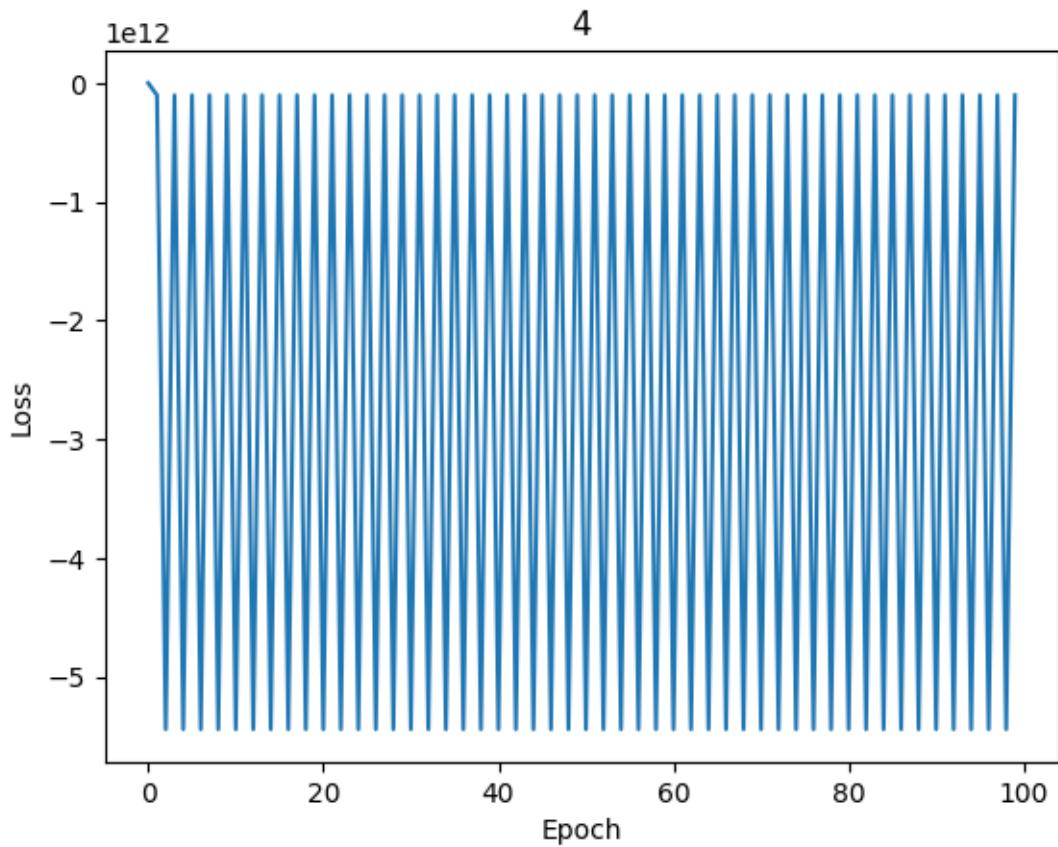


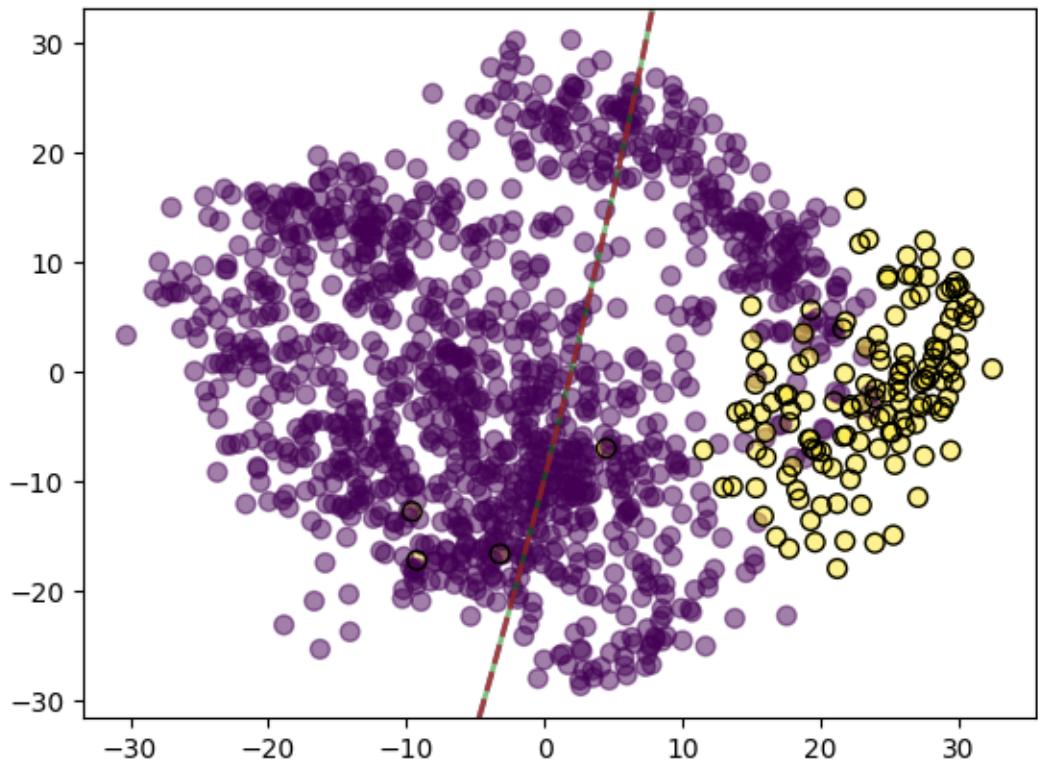


```
EpochLog(epoch=0, loss=-665889265.6247501)
EpochLog(epoch=1, loss=-102844959129.0)
EpochLog(epoch=2, loss=-5441853969509.5)
EpochLog(epoch=3, loss=-102844959129.0)
EpochLog(epoch=4, loss=-5441853969509.5)
EpochLog(epoch=5, loss=-102844959129.0)
EpochLog(epoch=6, loss=-5441853969509.5)
EpochLog(epoch=7, loss=-102844959129.0)
EpochLog(epoch=8, loss=-5441853969509.5)
EpochLog(epoch=9, loss=-102844959129.0)
EpochLog(epoch=10, loss=-5441853969509.5)
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EpochLog(epoch=13, loss=-102844959129.0)
EpochLog(epoch=14, loss=-5441853969509.5)
EpochLog(epoch=15, loss=-102844959129.0)
EpochLog(epoch=16, loss=-5441853969509.5)
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EpochLog(epoch=18, loss=-5441853969509.5)
EpochLog(epoch=19, loss=-102844959129.0)
EpochLog(epoch=20, loss=-5441853969509.5)
EpochLog(epoch=21, loss=-102844959129.0)
```

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EpochLog(epoch=22, loss=-5441853969509.5)
EpochLog(epoch=23, loss=-102844959129.0)
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EpochLog(epoch=52, loss=-5441853969509.5)
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EpochLog(epoch=64, loss=-5441853969509.5)
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EpochLog(epoch=66, loss=-5441853969509.5)
EpochLog(epoch=67, loss=-102844959129.0)
EpochLog(epoch=68, loss=-5441853969509.5)
EpochLog(epoch=69, loss=-102844959129.0)
```

```
EpochLog(epoch=70, loss=-5441853969509.5)
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EpochLog(epoch=85, loss=-102844959129.0)
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EpochLog(epoch=87, loss=-102844959129.0)
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EpochLog(epoch=91, loss=-102844959129.0)
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EpochLog(epoch=93, loss=-102844959129.0)
EpochLog(epoch=94, loss=-5441853969509.5)
EpochLog(epoch=95, loss=-102844959129.0)
EpochLog(epoch=96, loss=-5441853969509.5)
EpochLog(epoch=97, loss=-102844959129.0)
EpochLog(epoch=98, loss=-5441853969509.5)
EpochLog(epoch=99, loss=-102844959129.0)
```

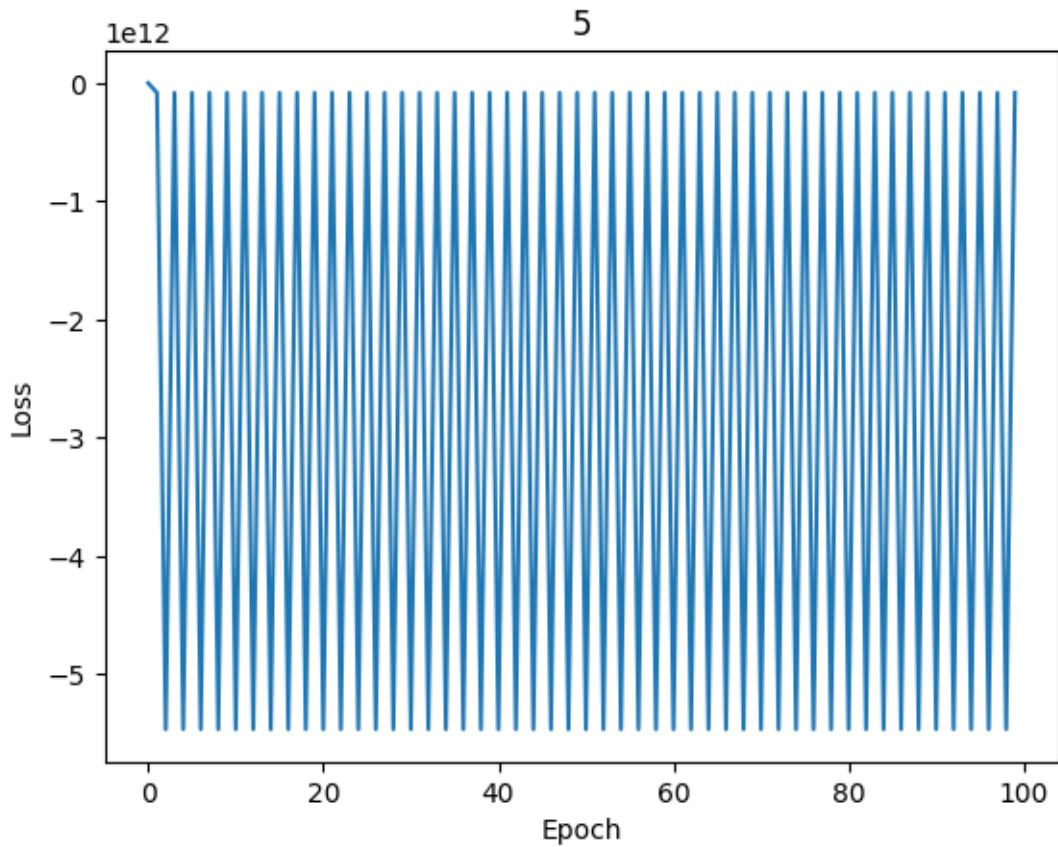


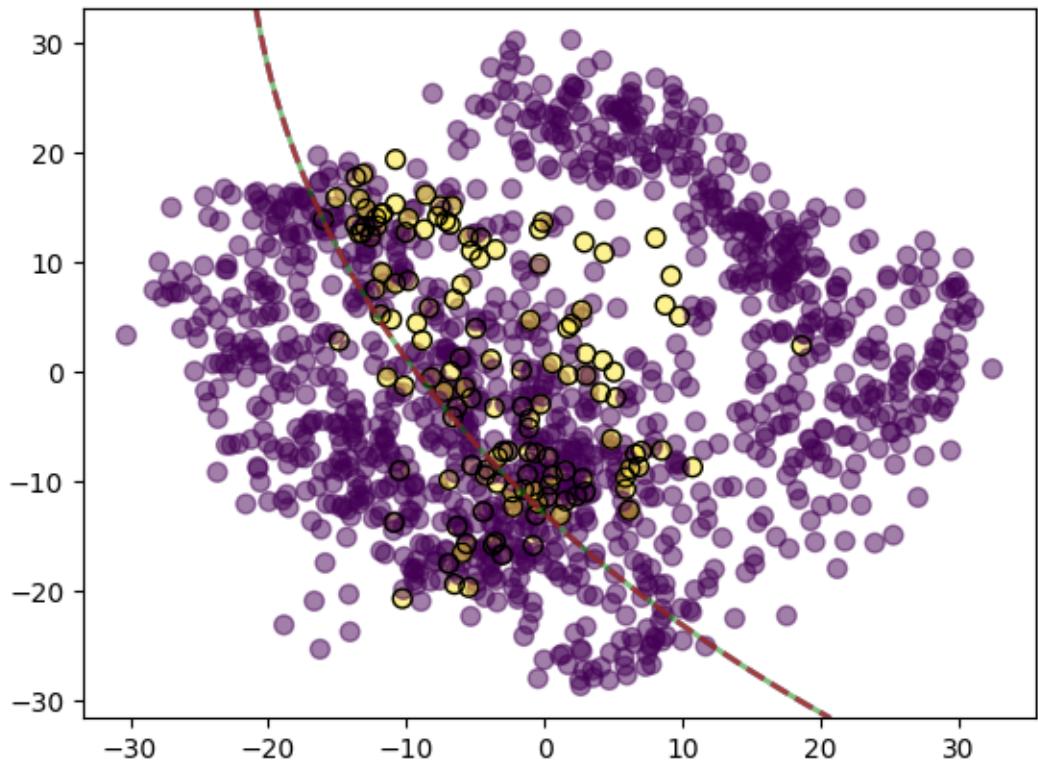


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EpochLog(epoch=5, loss=-82775227087.5)
EpochLog(epoch=6, loss=-5464770476266.0)
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EpochLog(epoch=18, loss=-5464770476266.0)
EpochLog(epoch=19, loss=-82775227087.5)
EpochLog(epoch=20, loss=-5464770476266.0)
EpochLog(epoch=21, loss=-82775227087.5)
```

```
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EpochLog(epoch=31, loss=-82775227087.5)
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EpochLog(epoch=33, loss=-82775227087.5)
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EpochLog(epoch=51, loss=-82775227087.5)
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EpochLog(epoch=68, loss=-5464770476266.0)
EpochLog(epoch=69, loss=-82775227087.5)
```

```
EpochLog(epoch=70, loss=-5464770476266.0)
EpochLog(epoch=71, loss=-82775227087.5)
EpochLog(epoch=72, loss=-5464770476266.0)
EpochLog(epoch=73, loss=-82775227087.5)
EpochLog(epoch=74, loss=-5464770476266.0)
EpochLog(epoch=75, loss=-82775227087.5)
EpochLog(epoch=76, loss=-5464770476266.0)
EpochLog(epoch=77, loss=-82775227087.5)
EpochLog(epoch=78, loss=-5464770476266.0)
EpochLog(epoch=79, loss=-82775227087.5)
EpochLog(epoch=80, loss=-5464770476266.0)
EpochLog(epoch=81, loss=-82775227087.5)
EpochLog(epoch=82, loss=-5464770476266.0)
EpochLog(epoch=83, loss=-82775227087.5)
EpochLog(epoch=84, loss=-5464770476266.0)
EpochLog(epoch=85, loss=-82775227087.5)
EpochLog(epoch=86, loss=-5464770476266.0)
EpochLog(epoch=87, loss=-82775227087.5)
EpochLog(epoch=88, loss=-5464770476266.0)
EpochLog(epoch=89, loss=-82775227087.5)
EpochLog(epoch=90, loss=-5464770476266.0)
EpochLog(epoch=91, loss=-82775227087.5)
EpochLog(epoch=92, loss=-5464770476266.0)
EpochLog(epoch=93, loss=-82775227087.5)
EpochLog(epoch=94, loss=-5464770476266.0)
EpochLog(epoch=95, loss=-82775227087.5)
EpochLog(epoch=96, loss=-5464770476266.0)
EpochLog(epoch=97, loss=-82775227087.5)
EpochLog(epoch=98, loss=-5464770476266.0)
EpochLog(epoch=99, loss=-82775227087.5)
```

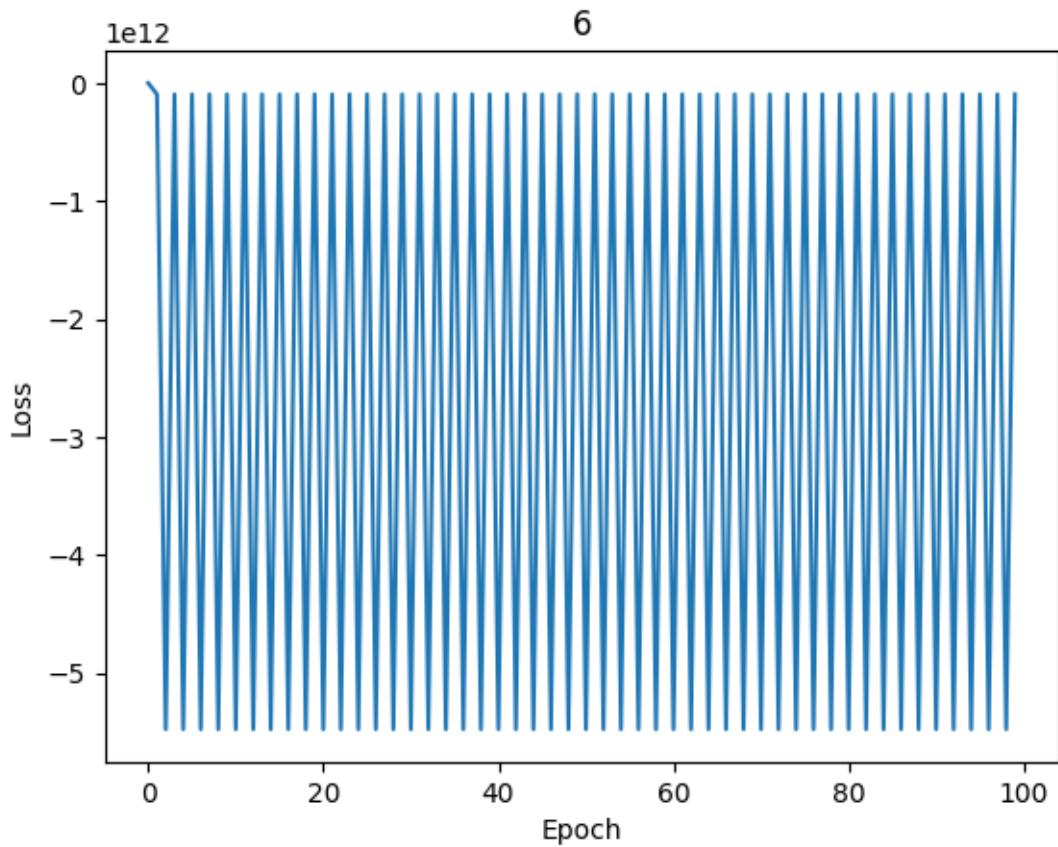


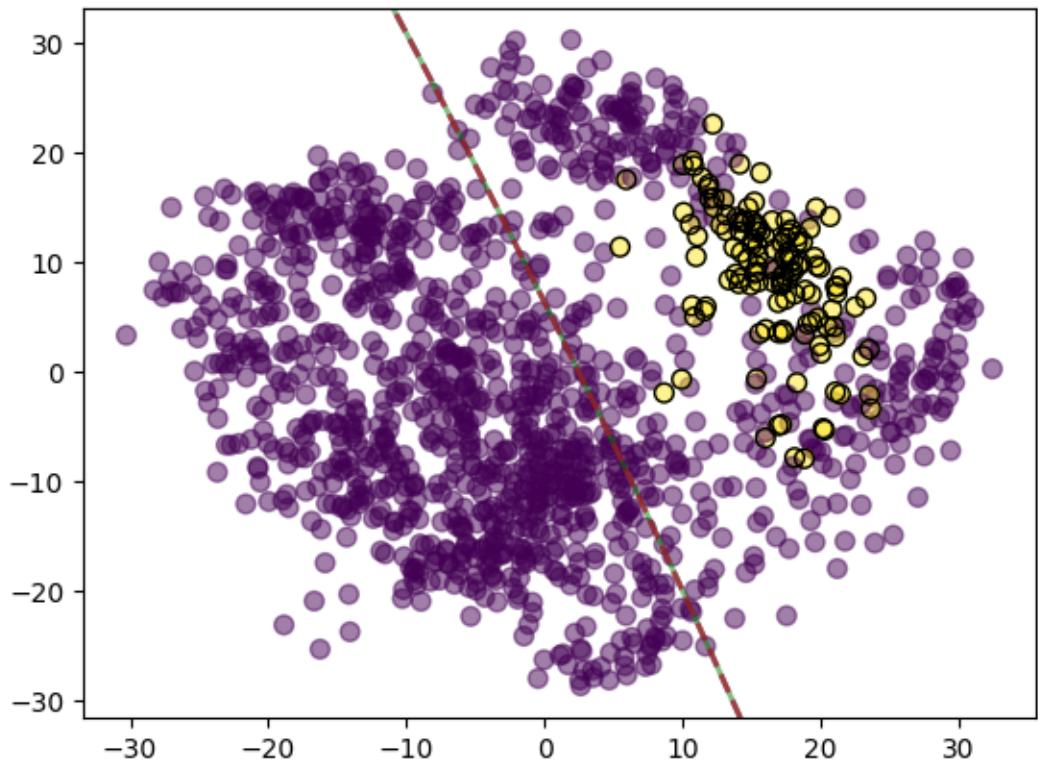


```
EpochLog(epoch=0, loss=-665889265.6247501)
EpochLog(epoch=1, loss=-95392936126.5)
EpochLog(epoch=2, loss=-5475986132960.0)
EpochLog(epoch=3, loss=-95392936126.5)
EpochLog(epoch=4, loss=-5475986132960.0)
EpochLog(epoch=5, loss=-95392936126.5)
EpochLog(epoch=6, loss=-5475986132960.0)
EpochLog(epoch=7, loss=-95392936126.5)
EpochLog(epoch=8, loss=-5475986132960.0)
EpochLog(epoch=9, loss=-95392936126.5)
EpochLog(epoch=10, loss=-5475986132960.0)
EpochLog(epoch=11, loss=-95392936126.5)
EpochLog(epoch=12, loss=-5475986132960.0)
EpochLog(epoch=13, loss=-95392936126.5)
EpochLog(epoch=14, loss=-5475986132960.0)
EpochLog(epoch=15, loss=-95392936126.5)
EpochLog(epoch=16, loss=-5475986132960.0)
EpochLog(epoch=17, loss=-95392936126.5)
EpochLog(epoch=18, loss=-5475986132960.0)
EpochLog(epoch=19, loss=-95392936126.5)
EpochLog(epoch=20, loss=-5475986132960.0)
EpochLog(epoch=21, loss=-95392936126.5)
```

```
EpochLog(epoch=22, loss=-5475986132960.0)
EpochLog(epoch=23, loss=-95392936126.5)
EpochLog(epoch=24, loss=-5475986132960.0)
EpochLog(epoch=25, loss=-95392936126.5)
EpochLog(epoch=26, loss=-5475986132960.0)
EpochLog(epoch=27, loss=-95392936126.5)
EpochLog(epoch=28, loss=-5475986132960.0)
EpochLog(epoch=29, loss=-95392936126.5)
EpochLog(epoch=30, loss=-5475986132960.0)
EpochLog(epoch=31, loss=-95392936126.5)
EpochLog(epoch=32, loss=-5475986132960.0)
EpochLog(epoch=33, loss=-95392936126.5)
EpochLog(epoch=34, loss=-5475986132960.0)
EpochLog(epoch=35, loss=-95392936126.5)
EpochLog(epoch=36, loss=-5475986132960.0)
EpochLog(epoch=37, loss=-95392936126.5)
EpochLog(epoch=38, loss=-5475986132960.0)
EpochLog(epoch=39, loss=-95392936126.5)
EpochLog(epoch=40, loss=-5475986132960.0)
EpochLog(epoch=41, loss=-95392936126.5)
EpochLog(epoch=42, loss=-5475986132960.0)
EpochLog(epoch=43, loss=-95392936126.5)
EpochLog(epoch=44, loss=-5475986132960.0)
EpochLog(epoch=45, loss=-95392936126.5)
EpochLog(epoch=46, loss=-5475986132960.0)
EpochLog(epoch=47, loss=-95392936126.5)
EpochLog(epoch=48, loss=-5475986132960.0)
EpochLog(epoch=49, loss=-95392936126.5)
EpochLog(epoch=50, loss=-5475986132960.0)
EpochLog(epoch=51, loss=-95392936126.5)
EpochLog(epoch=52, loss=-5475986132960.0)
EpochLog(epoch=53, loss=-95392936126.5)
EpochLog(epoch=54, loss=-5475986132960.0)
EpochLog(epoch=55, loss=-95392936126.5)
EpochLog(epoch=56, loss=-5475986132960.0)
EpochLog(epoch=57, loss=-95392936126.5)
EpochLog(epoch=58, loss=-5475986132960.0)
EpochLog(epoch=59, loss=-95392936126.5)
EpochLog(epoch=60, loss=-5475986132960.0)
EpochLog(epoch=61, loss=-95392936126.5)
EpochLog(epoch=62, loss=-5475986132960.0)
EpochLog(epoch=63, loss=-95392936126.5)
EpochLog(epoch=64, loss=-5475986132960.0)
EpochLog(epoch=65, loss=-95392936126.5)
EpochLog(epoch=66, loss=-5475986132960.0)
EpochLog(epoch=67, loss=-95392936126.5)
EpochLog(epoch=68, loss=-5475986132960.0)
EpochLog(epoch=69, loss=-95392936126.5)
```

```
EpochLog(epoch=70, loss=-5475986132960.0)
EpochLog(epoch=71, loss=-95392936126.5)
EpochLog(epoch=72, loss=-5475986132960.0)
EpochLog(epoch=73, loss=-95392936126.5)
EpochLog(epoch=74, loss=-5475986132960.0)
EpochLog(epoch=75, loss=-95392936126.5)
EpochLog(epoch=76, loss=-5475986132960.0)
EpochLog(epoch=77, loss=-95392936126.5)
EpochLog(epoch=78, loss=-5475986132960.0)
EpochLog(epoch=79, loss=-95392936126.5)
EpochLog(epoch=80, loss=-5475986132960.0)
EpochLog(epoch=81, loss=-95392936126.5)
EpochLog(epoch=82, loss=-5475986132960.0)
EpochLog(epoch=83, loss=-95392936126.5)
EpochLog(epoch=84, loss=-5475986132960.0)
EpochLog(epoch=85, loss=-95392936126.5)
EpochLog(epoch=86, loss=-5475986132960.0)
EpochLog(epoch=87, loss=-95392936126.5)
EpochLog(epoch=88, loss=-5475986132960.0)
EpochLog(epoch=89, loss=-95392936126.5)
EpochLog(epoch=90, loss=-5475986132960.0)
EpochLog(epoch=91, loss=-95392936126.5)
EpochLog(epoch=92, loss=-5475986132960.0)
EpochLog(epoch=93, loss=-95392936126.5)
EpochLog(epoch=94, loss=-5475986132960.0)
EpochLog(epoch=95, loss=-95392936126.5)
EpochLog(epoch=96, loss=-5475986132960.0)
EpochLog(epoch=97, loss=-95392936126.5)
EpochLog(epoch=98, loss=-5475986132960.0)
EpochLog(epoch=99, loss=-95392936126.5)
```

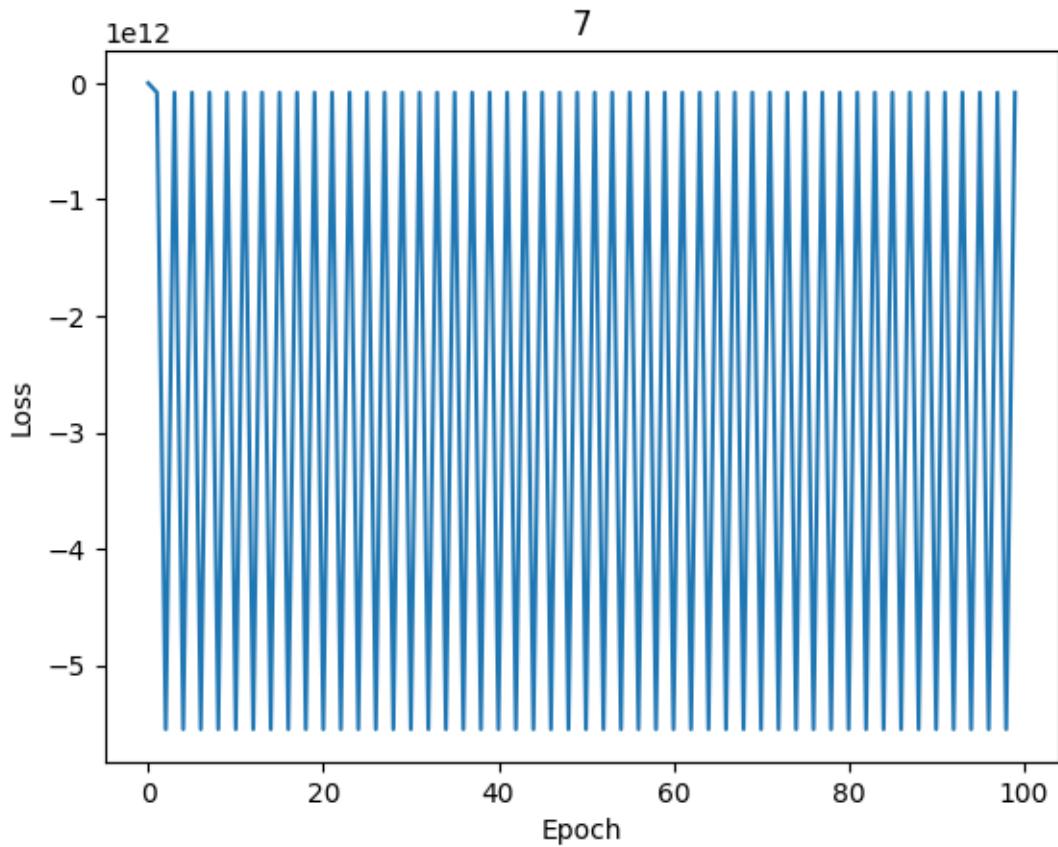


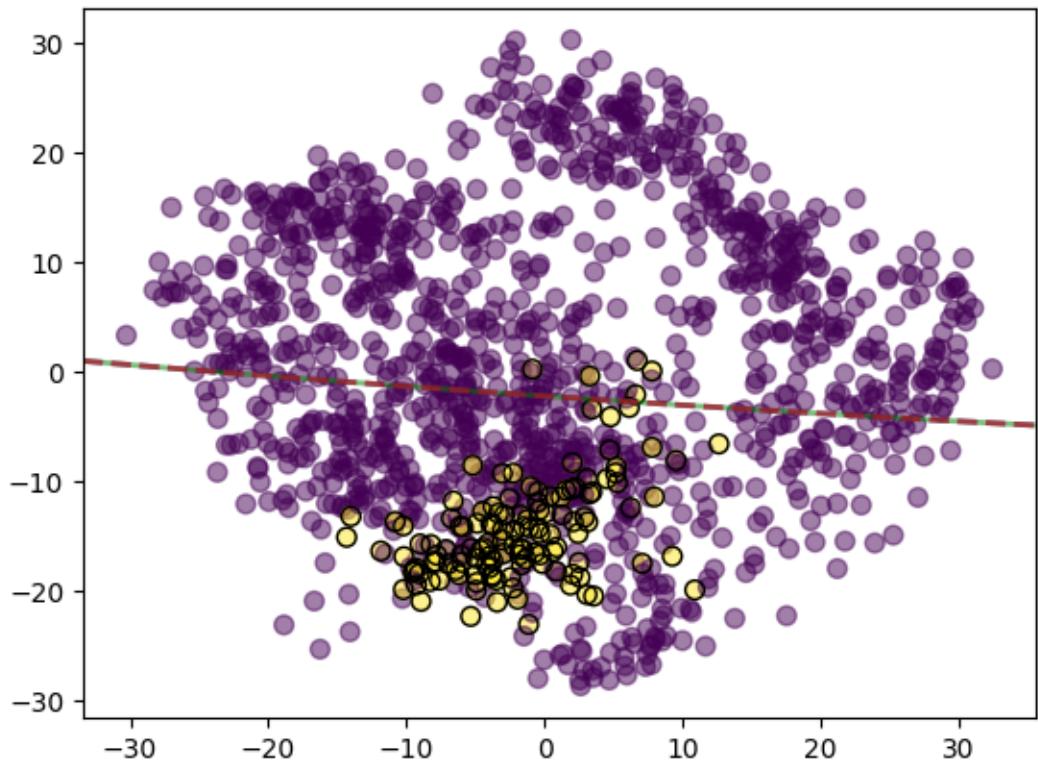


```
EpochLog(epoch=0, loss=-665889265.6247501)
EpochLog(epoch=1, loss=-82310656972.5)
EpochLog(epoch=2, loss=-5547178700878.0)
EpochLog(epoch=3, loss=-82310656972.5)
EpochLog(epoch=4, loss=-5547178700878.0)
EpochLog(epoch=5, loss=-82310656972.5)
EpochLog(epoch=6, loss=-5547178700878.0)
EpochLog(epoch=7, loss=-82310656972.5)
EpochLog(epoch=8, loss=-5547178700878.0)
EpochLog(epoch=9, loss=-82310656972.5)
EpochLog(epoch=10, loss=-5547178700878.0)
EpochLog(epoch=11, loss=-82310656972.5)
EpochLog(epoch=12, loss=-5547178700878.0)
EpochLog(epoch=13, loss=-82310656972.5)
EpochLog(epoch=14, loss=-5547178700878.0)
EpochLog(epoch=15, loss=-82310656972.5)
EpochLog(epoch=16, loss=-5547178700878.0)
EpochLog(epoch=17, loss=-82310656972.5)
EpochLog(epoch=18, loss=-5547178700878.0)
EpochLog(epoch=19, loss=-82310656972.5)
EpochLog(epoch=20, loss=-5547178700878.0)
EpochLog(epoch=21, loss=-82310656972.5)
```

```
EpochLog(epoch=22, loss=-5547178700878.0)
EpochLog(epoch=23, loss=-82310656972.5)
EpochLog(epoch=24, loss=-5547178700878.0)
EpochLog(epoch=25, loss=-82310656972.5)
EpochLog(epoch=26, loss=-5547178700878.0)
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EpochLog(epoch=30, loss=-5547178700878.0)
EpochLog(epoch=31, loss=-82310656972.5)
EpochLog(epoch=32, loss=-5547178700878.0)
EpochLog(epoch=33, loss=-82310656972.5)
EpochLog(epoch=34, loss=-5547178700878.0)
EpochLog(epoch=35, loss=-82310656972.5)
EpochLog(epoch=36, loss=-5547178700878.0)
EpochLog(epoch=37, loss=-82310656972.5)
EpochLog(epoch=38, loss=-5547178700878.0)
EpochLog(epoch=39, loss=-82310656972.5)
EpochLog(epoch=40, loss=-5547178700878.0)
EpochLog(epoch=41, loss=-82310656972.5)
EpochLog(epoch=42, loss=-5547178700878.0)
EpochLog(epoch=43, loss=-82310656972.5)
EpochLog(epoch=44, loss=-5547178700878.0)
EpochLog(epoch=45, loss=-82310656972.5)
EpochLog(epoch=46, loss=-5547178700878.0)
EpochLog(epoch=47, loss=-82310656972.5)
EpochLog(epoch=48, loss=-5547178700878.0)
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EpochLog(epoch=55, loss=-82310656972.5)
EpochLog(epoch=56, loss=-5547178700878.0)
EpochLog(epoch=57, loss=-82310656972.5)
EpochLog(epoch=58, loss=-5547178700878.0)
EpochLog(epoch=59, loss=-82310656972.5)
EpochLog(epoch=60, loss=-5547178700878.0)
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EpochLog(epoch=62, loss=-5547178700878.0)
EpochLog(epoch=63, loss=-82310656972.5)
EpochLog(epoch=64, loss=-5547178700878.0)
EpochLog(epoch=65, loss=-82310656972.5)
EpochLog(epoch=66, loss=-5547178700878.0)
EpochLog(epoch=67, loss=-82310656972.5)
EpochLog(epoch=68, loss=-5547178700878.0)
EpochLog(epoch=69, loss=-82310656972.5)
```

```
EpochLog(epoch=70, loss=-5547178700878.0)
EpochLog(epoch=71, loss=-82310656972.5)
EpochLog(epoch=72, loss=-5547178700878.0)
EpochLog(epoch=73, loss=-82310656972.5)
EpochLog(epoch=74, loss=-5547178700878.0)
EpochLog(epoch=75, loss=-82310656972.5)
EpochLog(epoch=76, loss=-5547178700878.0)
EpochLog(epoch=77, loss=-82310656972.5)
EpochLog(epoch=78, loss=-5547178700878.0)
EpochLog(epoch=79, loss=-82310656972.5)
EpochLog(epoch=80, loss=-5547178700878.0)
EpochLog(epoch=81, loss=-82310656972.5)
EpochLog(epoch=82, loss=-5547178700878.0)
EpochLog(epoch=83, loss=-82310656972.5)
EpochLog(epoch=84, loss=-5547178700878.0)
EpochLog(epoch=85, loss=-82310656972.5)
EpochLog(epoch=86, loss=-5547178700878.0)
EpochLog(epoch=87, loss=-82310656972.5)
EpochLog(epoch=88, loss=-5547178700878.0)
EpochLog(epoch=89, loss=-82310656972.5)
EpochLog(epoch=90, loss=-5547178700878.0)
EpochLog(epoch=91, loss=-82310656972.5)
EpochLog(epoch=92, loss=-5547178700878.0)
EpochLog(epoch=93, loss=-82310656972.5)
EpochLog(epoch=94, loss=-5547178700878.0)
EpochLog(epoch=95, loss=-82310656972.5)
EpochLog(epoch=96, loss=-5547178700878.0)
EpochLog(epoch=97, loss=-82310656972.5)
EpochLog(epoch=98, loss=-5547178700878.0)
EpochLog(epoch=99, loss=-82310656972.5)
```

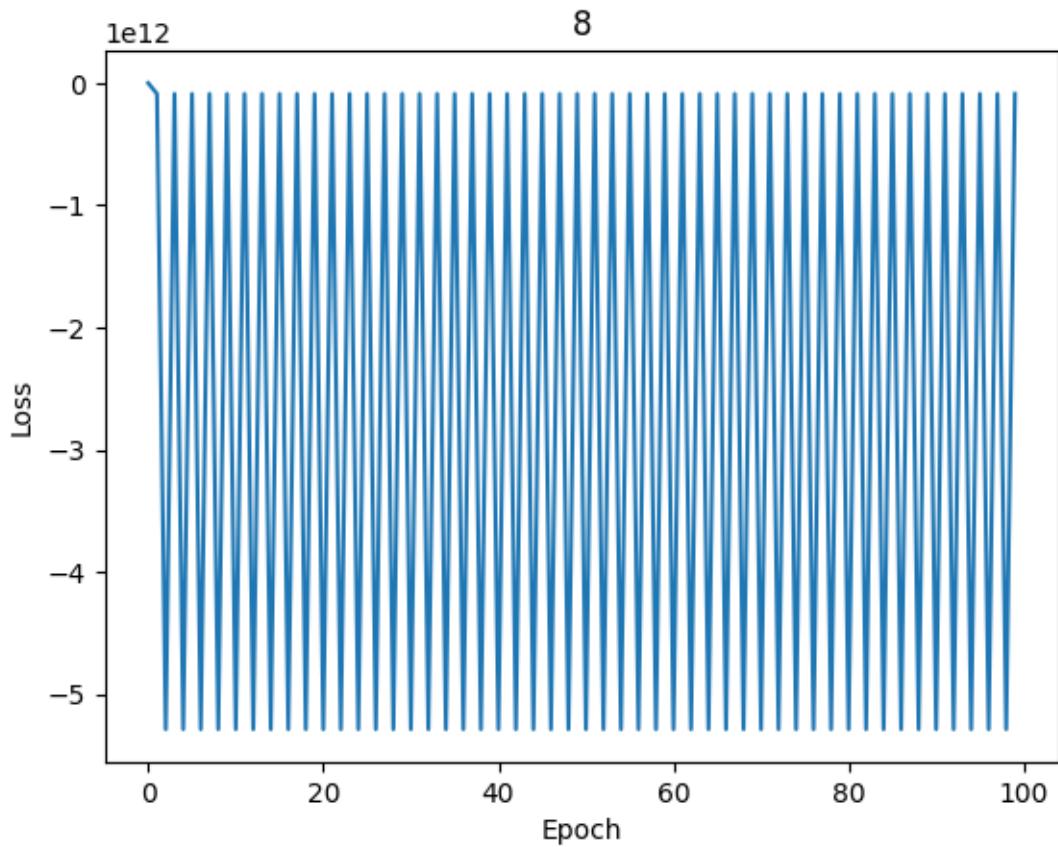


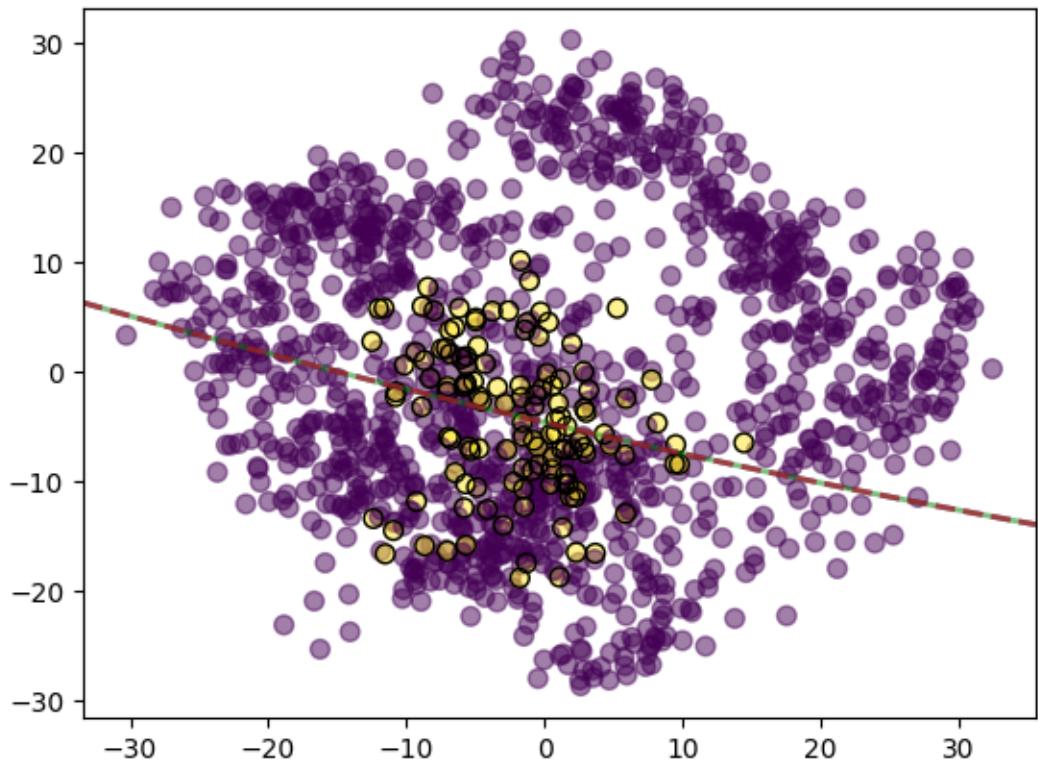


```
EpochLog(epoch=0, loss=-665889265.6247501)
EpochLog(epoch=1, loss=-88831595970.0)
EpochLog(epoch=2, loss=-5286833705739.5)
EpochLog(epoch=3, loss=-88831595970.0)
EpochLog(epoch=4, loss=-5286833705739.5)
EpochLog(epoch=5, loss=-88831595970.0)
EpochLog(epoch=6, loss=-5286833705739.5)
EpochLog(epoch=7, loss=-88831595970.0)
EpochLog(epoch=8, loss=-5286833705739.5)
EpochLog(epoch=9, loss=-88831595970.0)
EpochLog(epoch=10, loss=-5286833705739.5)
EpochLog(epoch=11, loss=-88831595970.0)
EpochLog(epoch=12, loss=-5286833705739.5)
EpochLog(epoch=13, loss=-88831595970.0)
EpochLog(epoch=14, loss=-5286833705739.5)
EpochLog(epoch=15, loss=-88831595970.0)
EpochLog(epoch=16, loss=-5286833705739.5)
EpochLog(epoch=17, loss=-88831595970.0)
EpochLog(epoch=18, loss=-5286833705739.5)
EpochLog(epoch=19, loss=-88831595970.0)
EpochLog(epoch=20, loss=-5286833705739.5)
EpochLog(epoch=21, loss=-88831595970.0)
```

```
EpochLog(epoch=22, loss=-5286833705739.5)
EpochLog(epoch=23, loss=-88831595970.0)
EpochLog(epoch=24, loss=-5286833705739.5)
EpochLog(epoch=25, loss=-88831595970.0)
EpochLog(epoch=26, loss=-5286833705739.5)
EpochLog(epoch=27, loss=-88831595970.0)
EpochLog(epoch=28, loss=-5286833705739.5)
EpochLog(epoch=29, loss=-88831595970.0)
EpochLog(epoch=30, loss=-5286833705739.5)
EpochLog(epoch=31, loss=-88831595970.0)
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EpochLog(epoch=33, loss=-88831595970.0)
EpochLog(epoch=34, loss=-5286833705739.5)
EpochLog(epoch=35, loss=-88831595970.0)
EpochLog(epoch=36, loss=-5286833705739.5)
EpochLog(epoch=37, loss=-88831595970.0)
EpochLog(epoch=38, loss=-5286833705739.5)
EpochLog(epoch=39, loss=-88831595970.0)
EpochLog(epoch=40, loss=-5286833705739.5)
EpochLog(epoch=41, loss=-88831595970.0)
EpochLog(epoch=42, loss=-5286833705739.5)
EpochLog(epoch=43, loss=-88831595970.0)
EpochLog(epoch=44, loss=-5286833705739.5)
EpochLog(epoch=45, loss=-88831595970.0)
EpochLog(epoch=46, loss=-5286833705739.5)
EpochLog(epoch=47, loss=-88831595970.0)
EpochLog(epoch=48, loss=-5286833705739.5)
EpochLog(epoch=49, loss=-88831595970.0)
EpochLog(epoch=50, loss=-5286833705739.5)
EpochLog(epoch=51, loss=-88831595970.0)
EpochLog(epoch=52, loss=-5286833705739.5)
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EpochLog(epoch=54, loss=-5286833705739.5)
EpochLog(epoch=55, loss=-88831595970.0)
EpochLog(epoch=56, loss=-5286833705739.5)
EpochLog(epoch=57, loss=-88831595970.0)
EpochLog(epoch=58, loss=-5286833705739.5)
EpochLog(epoch=59, loss=-88831595970.0)
EpochLog(epoch=60, loss=-5286833705739.5)
EpochLog(epoch=61, loss=-88831595970.0)
EpochLog(epoch=62, loss=-5286833705739.5)
EpochLog(epoch=63, loss=-88831595970.0)
EpochLog(epoch=64, loss=-5286833705739.5)
EpochLog(epoch=65, loss=-88831595970.0)
EpochLog(epoch=66, loss=-5286833705739.5)
EpochLog(epoch=67, loss=-88831595970.0)
EpochLog(epoch=68, loss=-5286833705739.5)
EpochLog(epoch=69, loss=-88831595970.0)
```

```
EpochLog(epoch=70, loss=-5286833705739.5)
EpochLog(epoch=71, loss=-88831595970.0)
EpochLog(epoch=72, loss=-5286833705739.5)
EpochLog(epoch=73, loss=-88831595970.0)
EpochLog(epoch=74, loss=-5286833705739.5)
EpochLog(epoch=75, loss=-88831595970.0)
EpochLog(epoch=76, loss=-5286833705739.5)
EpochLog(epoch=77, loss=-88831595970.0)
EpochLog(epoch=78, loss=-5286833705739.5)
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EpochLog(epoch=82, loss=-5286833705739.5)
EpochLog(epoch=83, loss=-88831595970.0)
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EpochLog(epoch=85, loss=-88831595970.0)
EpochLog(epoch=86, loss=-5286833705739.5)
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EpochLog(epoch=88, loss=-5286833705739.5)
EpochLog(epoch=89, loss=-88831595970.0)
EpochLog(epoch=90, loss=-5286833705739.5)
EpochLog(epoch=91, loss=-88831595970.0)
EpochLog(epoch=92, loss=-5286833705739.5)
EpochLog(epoch=93, loss=-88831595970.0)
EpochLog(epoch=94, loss=-5286833705739.5)
EpochLog(epoch=95, loss=-88831595970.0)
EpochLog(epoch=96, loss=-5286833705739.5)
EpochLog(epoch=97, loss=-88831595970.0)
EpochLog(epoch=98, loss=-5286833705739.5)
EpochLog(epoch=99, loss=-88831595970.0)
```

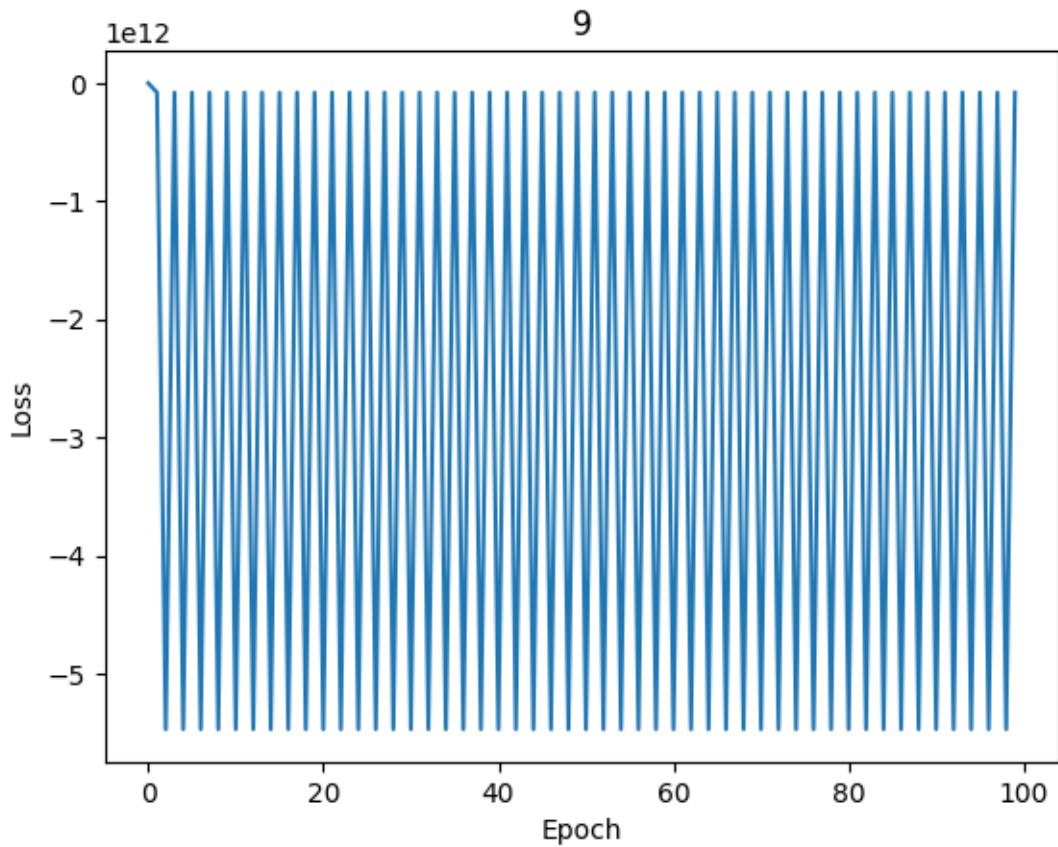


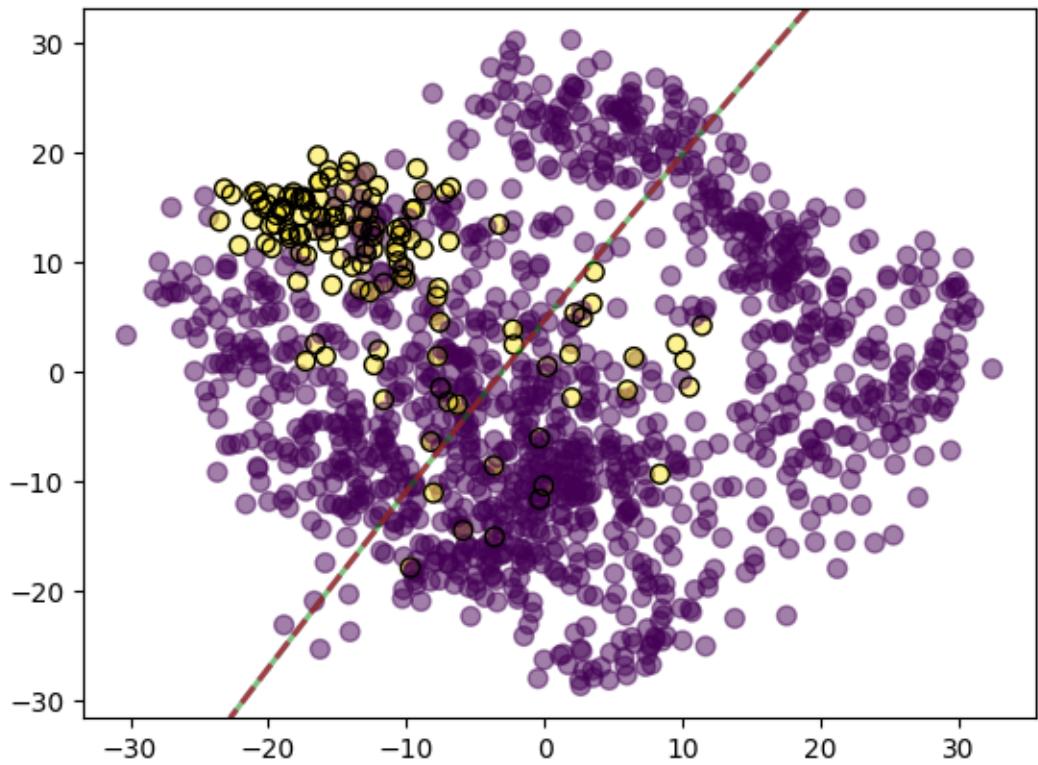


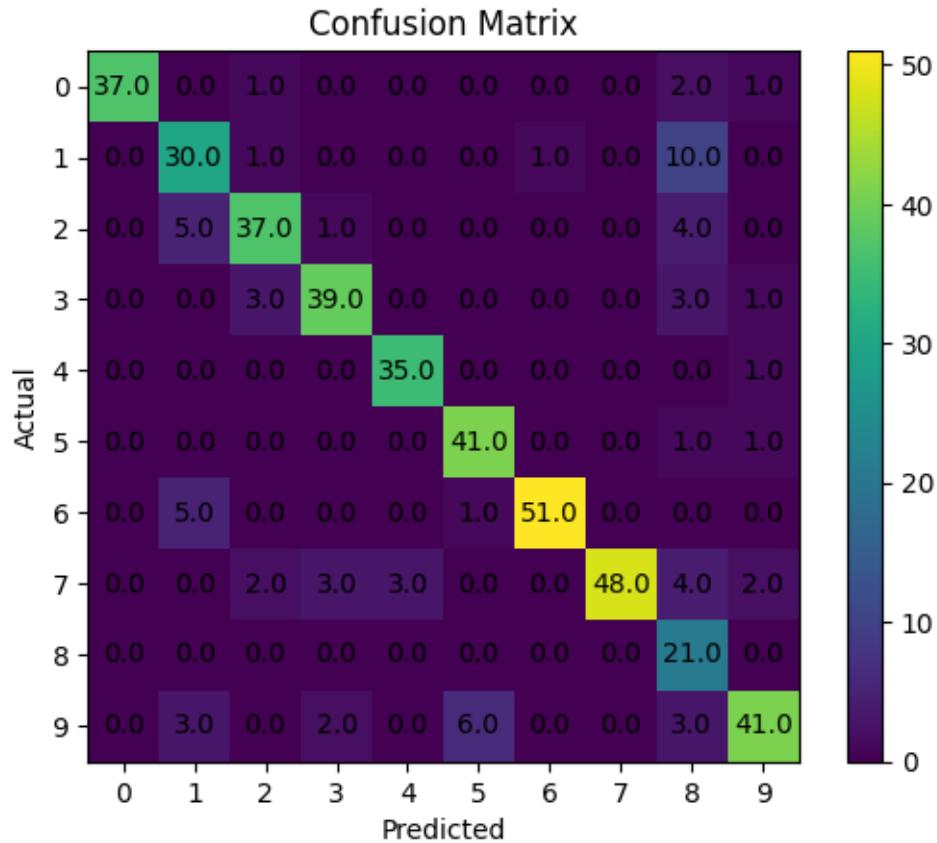
```
EpochLog(epoch=0, loss=-665889265.6247501)
EpochLog(epoch=1, loss=-80417301072.5)
EpochLog(epoch=2, loss=-5468403116451.0)
EpochLog(epoch=3, loss=-80417301072.5)
EpochLog(epoch=4, loss=-5468403116451.0)
EpochLog(epoch=5, loss=-80417301072.5)
EpochLog(epoch=6, loss=-5468403116451.0)
EpochLog(epoch=7, loss=-80417301072.5)
EpochLog(epoch=8, loss=-5468403116451.0)
EpochLog(epoch=9, loss=-80417301072.5)
EpochLog(epoch=10, loss=-5468403116451.0)
EpochLog(epoch=11, loss=-80417301072.5)
EpochLog(epoch=12, loss=-5468403116451.0)
EpochLog(epoch=13, loss=-80417301072.5)
EpochLog(epoch=14, loss=-5468403116451.0)
EpochLog(epoch=15, loss=-80417301072.5)
EpochLog(epoch=16, loss=-5468403116451.0)
EpochLog(epoch=17, loss=-80417301072.5)
EpochLog(epoch=18, loss=-5468403116451.0)
EpochLog(epoch=19, loss=-80417301072.5)
EpochLog(epoch=20, loss=-5468403116451.0)
EpochLog(epoch=21, loss=-80417301072.5)
```

```
EpochLog(epoch=22, loss=-5468403116451.0)
EpochLog(epoch=23, loss=-80417301072.5)
EpochLog(epoch=24, loss=-5468403116451.0)
EpochLog(epoch=25, loss=-80417301072.5)
EpochLog(epoch=26, loss=-5468403116451.0)
EpochLog(epoch=27, loss=-80417301072.5)
EpochLog(epoch=28, loss=-5468403116451.0)
EpochLog(epoch=29, loss=-80417301072.5)
EpochLog(epoch=30, loss=-5468403116451.0)
EpochLog(epoch=31, loss=-80417301072.5)
EpochLog(epoch=32, loss=-5468403116451.0)
EpochLog(epoch=33, loss=-80417301072.5)
EpochLog(epoch=34, loss=-5468403116451.0)
EpochLog(epoch=35, loss=-80417301072.5)
EpochLog(epoch=36, loss=-5468403116451.0)
EpochLog(epoch=37, loss=-80417301072.5)
EpochLog(epoch=38, loss=-5468403116451.0)
EpochLog(epoch=39, loss=-80417301072.5)
EpochLog(epoch=40, loss=-5468403116451.0)
EpochLog(epoch=41, loss=-80417301072.5)
EpochLog(epoch=42, loss=-5468403116451.0)
EpochLog(epoch=43, loss=-80417301072.5)
EpochLog(epoch=44, loss=-5468403116451.0)
EpochLog(epoch=45, loss=-80417301072.5)
EpochLog(epoch=46, loss=-5468403116451.0)
EpochLog(epoch=47, loss=-80417301072.5)
EpochLog(epoch=48, loss=-5468403116451.0)
EpochLog(epoch=49, loss=-80417301072.5)
EpochLog(epoch=50, loss=-5468403116451.0)
EpochLog(epoch=51, loss=-80417301072.5)
EpochLog(epoch=52, loss=-5468403116451.0)
EpochLog(epoch=53, loss=-80417301072.5)
EpochLog(epoch=54, loss=-5468403116451.0)
EpochLog(epoch=55, loss=-80417301072.5)
EpochLog(epoch=56, loss=-5468403116451.0)
EpochLog(epoch=57, loss=-80417301072.5)
EpochLog(epoch=58, loss=-5468403116451.0)
EpochLog(epoch=59, loss=-80417301072.5)
EpochLog(epoch=60, loss=-5468403116451.0)
EpochLog(epoch=61, loss=-80417301072.5)
EpochLog(epoch=62, loss=-5468403116451.0)
EpochLog(epoch=63, loss=-80417301072.5)
EpochLog(epoch=64, loss=-5468403116451.0)
EpochLog(epoch=65, loss=-80417301072.5)
EpochLog(epoch=66, loss=-5468403116451.0)
EpochLog(epoch=67, loss=-80417301072.5)
EpochLog(epoch=68, loss=-5468403116451.0)
EpochLog(epoch=69, loss=-80417301072.5)
```

```
EpochLog(epoch=70, loss=-5468403116451.0)
EpochLog(epoch=71, loss=-80417301072.5)
EpochLog(epoch=72, loss=-5468403116451.0)
EpochLog(epoch=73, loss=-80417301072.5)
EpochLog(epoch=74, loss=-5468403116451.0)
EpochLog(epoch=75, loss=-80417301072.5)
EpochLog(epoch=76, loss=-5468403116451.0)
EpochLog(epoch=77, loss=-80417301072.5)
EpochLog(epoch=78, loss=-5468403116451.0)
EpochLog(epoch=79, loss=-80417301072.5)
EpochLog(epoch=80, loss=-5468403116451.0)
EpochLog(epoch=81, loss=-80417301072.5)
EpochLog(epoch=82, loss=-5468403116451.0)
EpochLog(epoch=83, loss=-80417301072.5)
EpochLog(epoch=84, loss=-5468403116451.0)
EpochLog(epoch=85, loss=-80417301072.5)
EpochLog(epoch=86, loss=-5468403116451.0)
EpochLog(epoch=87, loss=-80417301072.5)
EpochLog(epoch=88, loss=-5468403116451.0)
EpochLog(epoch=89, loss=-80417301072.5)
EpochLog(epoch=90, loss=-5468403116451.0)
EpochLog(epoch=91, loss=-80417301072.5)
EpochLog(epoch=92, loss=-5468403116451.0)
EpochLog(epoch=93, loss=-80417301072.5)
EpochLog(epoch=94, loss=-5468403116451.0)
EpochLog(epoch=95, loss=-80417301072.5)
EpochLog(epoch=96, loss=-5468403116451.0)
EpochLog(epoch=97, loss=-80417301072.5)
EpochLog(epoch=98, loss=-5468403116451.0)
EpochLog(epoch=99, loss=-80417301072.5)
```







TrainingScore(accuracy=0.8444444444444444, precision=None, recall=None, f1_score=None)

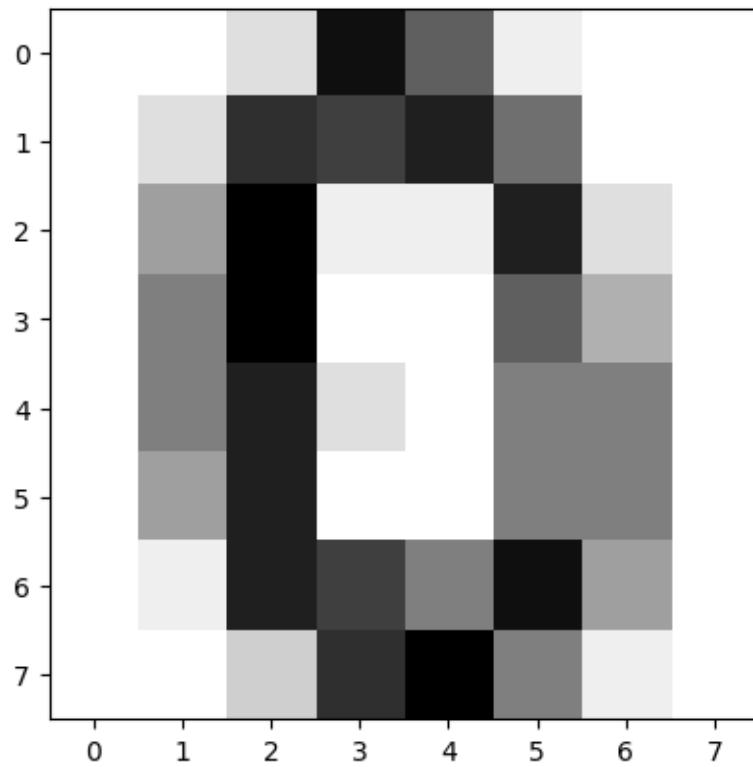
Przykładowe wyniki

```
[8]: n = 3
indices = np.random.choice(X_test.shape[0], n)

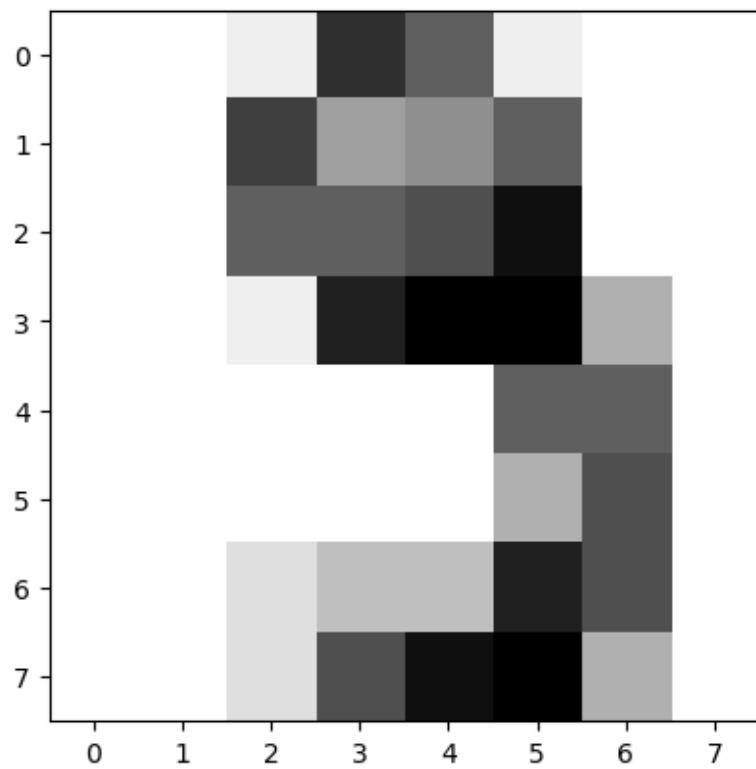
images = X_test[indices]
labels = y_test[indices]
predictions = clf.predict(images)

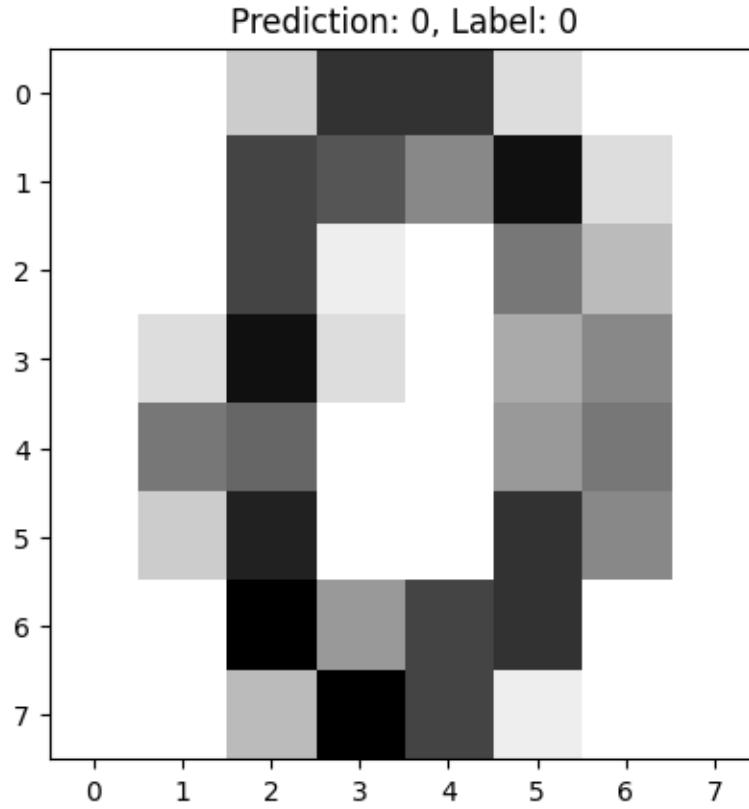
for i in range(n):
    plt.imshow(images[i].reshape(8, 8), cmap=plt.cm.gray_r,
    interpolation="nearest")
    plt.title(f"Prediction: {predictions[i]}, Label: {labels[i]}")
    plt.show()
```

Prediction: 0, Label: 0



Prediction: 9, Label: 9





1.2.2 Jądro gaussowskie

```
[17]: clf = OneToRestClassifier(
    SVC(C=1.0, kernel=SVC.gaussian_kernel(0.8), learning_rate=1e-12)
)

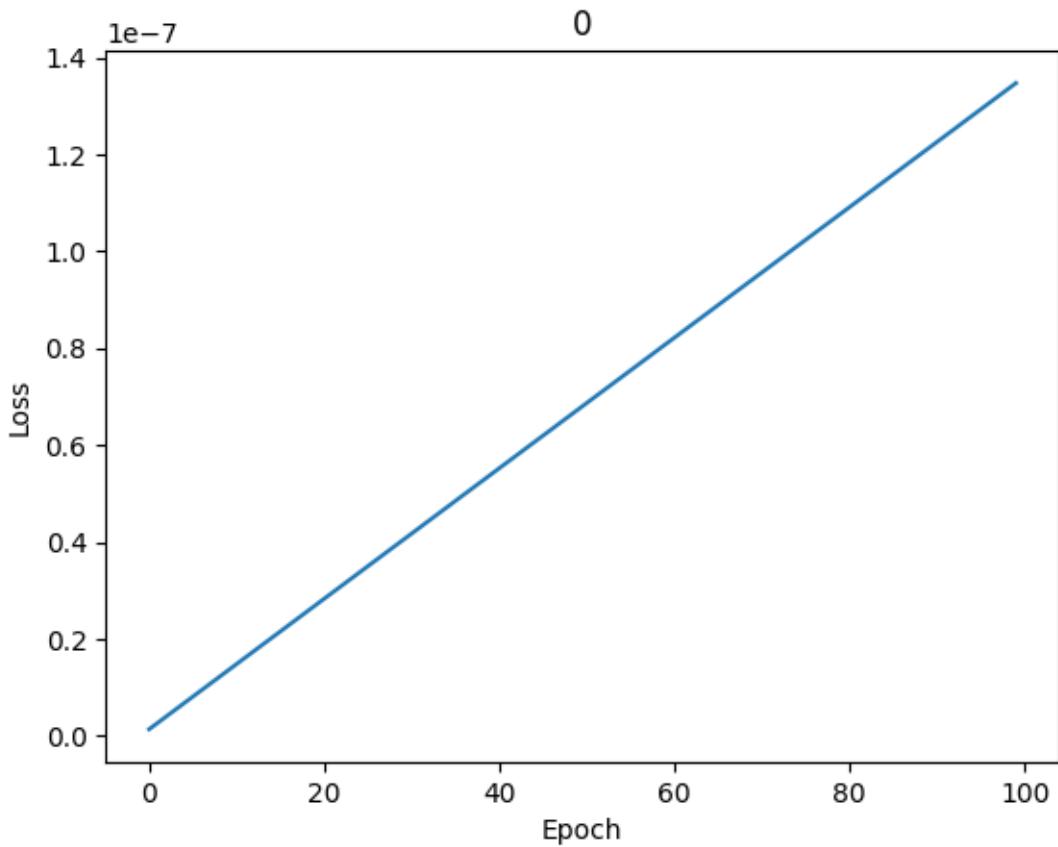
clf.train(X_train, y_train, epochs=100)

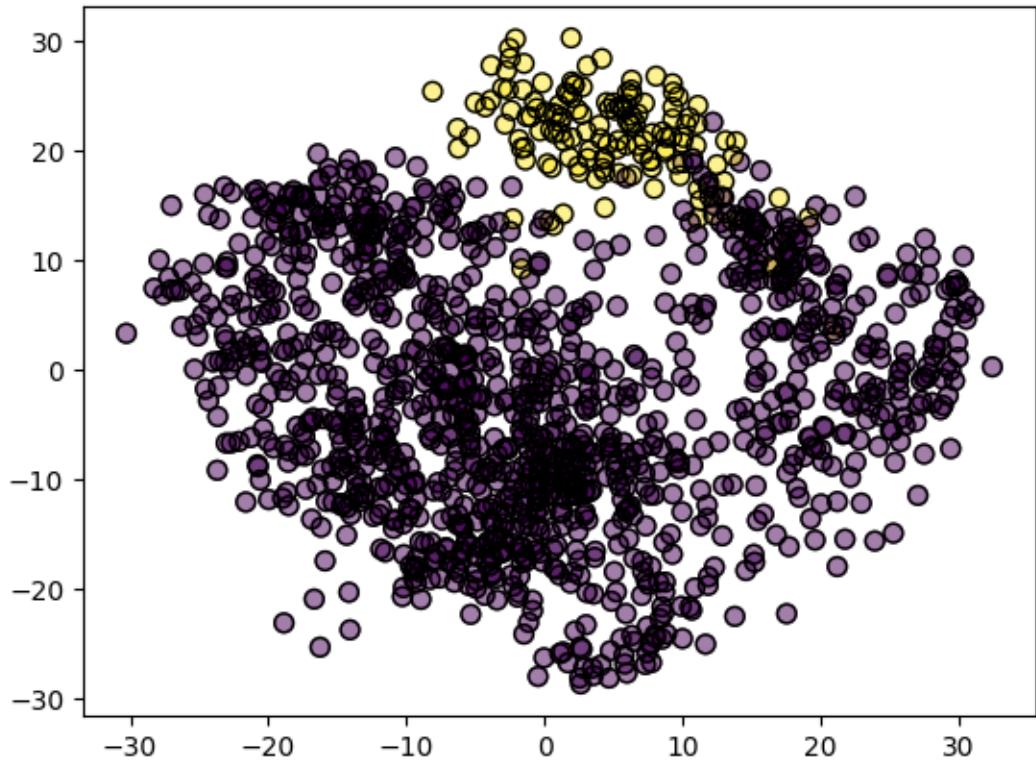
result = clf.score(X_test, y_test)
result.plot_confusion_matrix()
print(result)
```

```
EpochLog(epoch=0, loss=1.346999999993265e-09)
EpochLog(epoch=1, loss=2.693999999959592e-09)
EpochLog(epoch=2, loss=4.04099999989897e-09)
EpochLog(epoch=3, loss=5.38799999981143e-09)
EpochLog(epoch=4, loss=6.73499999969691e-09)
EpochLog(epoch=5, loss=8.08199999955546e-09)
EpochLog(epoch=6, loss=9.42899999938714e-09)
EpochLog(epoch=7, loss=1.0775999999919183e-08)
EpochLog(epoch=8, loss=1.212299999896952e-08)
```

```
EpochLog(epoch=9, loss=1.346999999872034e-08)
EpochLog(epoch=10, loss=1.481699999844417e-08)
EpochLog(epoch=11, loss=1.6163999998141e-08)
EpochLog(epoch=12, loss=1.75109999978111e-08)
EpochLog(epoch=13, loss=1.885799999745413e-08)
EpochLog(epoch=14, loss=2.020499999707024e-08)
EpochLog(epoch=15, loss=2.155199999665945e-08)
EpochLog(epoch=16, loss=2.289899999622163e-08)
EpochLog(epoch=17, loss=2.424599999575687e-08)
EpochLog(epoch=18, loss=2.55929999952652e-08)
EpochLog(epoch=19, loss=2.69399999947466e-08)
EpochLog(epoch=20, loss=2.828699999420117e-08)
EpochLog(epoch=21, loss=2.963399999362852e-08)
EpochLog(epoch=22, loss=3.09809999930291e-08)
EpochLog(epoch=23, loss=3.23279999924028e-08)
EpochLog(epoch=24, loss=3.367499999174946e-08)
EpochLog(epoch=25, loss=3.502199999106924e-08)
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EpochLog(epoch=27, loss=3.771599999896279e-08)
EpochLog(epoch=28, loss=3.90629999988867e-08)
EpochLog(epoch=29, loss=4.0409999988079e-08)
EpochLog(epoch=30, loss=4.175699999872641e-08)
EpochLog(epoch=31, loss=4.310399999864222e-08)
EpochLog(epoch=32, loss=4.445099999855533e-08)
EpochLog(epoch=33, loss=4.5797999998465756e-08)
EpochLog(epoch=34, loss=4.7144999998373475e-08)
EpochLog(epoch=35, loss=4.849199999827852e-08)
EpochLog(epoch=36, loss=4.983899999818087e-08)
EpochLog(epoch=37, loss=5.1185999998080517e-08)
EpochLog(epoch=38, loss=5.253299999797748e-08)
EpochLog(epoch=39, loss=5.387999999787173e-08)
EpochLog(epoch=40, loss=5.522699999776332e-08)
EpochLog(epoch=41, loss=5.6573999997652184e-08)
EpochLog(epoch=42, loss=5.7920999997538337e-08)
EpochLog(epoch=43, loss=5.926799999742185e-08)
EpochLog(epoch=44, loss=6.061499999730263e-08)
EpochLog(epoch=45, loss=6.196199999718073e-08)
EpochLog(epoch=46, loss=6.330899999705615e-08)
EpochLog(epoch=47, loss=6.465599999692884e-08)
EpochLog(epoch=48, loss=6.600299999679886e-08)
EpochLog(epoch=49, loss=6.734999999666615e-08)
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EpochLog(epoch=52, loss=7.139099999625198e-08)
EpochLog(epoch=53, loss=7.273799999610852e-08)
EpochLog(epoch=54, loss=7.408499999596237e-08)
EpochLog(epoch=55, loss=7.543199999581354e-08)
EpochLog(epoch=56, loss=7.677899999566198e-08)
```

```
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EpochLog(epoch=59, loss=8.081999999519121e-08)
EpochLog(epoch=60, loss=8.216699999502885e-08)
EpochLog(epoch=61, loss=8.351399999486387e-08)
EpochLog(epoch=62, loss=8.48609999946962e-08)
EpochLog(epoch=63, loss=8.620799999452576e-08)
EpochLog(epoch=64, loss=8.755499999435265e-08)
EpochLog(epoch=65, loss=8.89019999941769e-08)
EpochLog(epoch=66, loss=9.024899999399844e-08)
EpochLog(epoch=67, loss=9.159599999381725e-08)
EpochLog(epoch=68, loss=9.294299999363338e-08)
EpochLog(epoch=69, loss=9.428999999344686e-08)
EpochLog(epoch=70, loss=9.563699999325759e-08)
EpochLog(epoch=71, loss=9.698399999306561e-08)
EpochLog(epoch=72, loss=9.8330999992871e-08)
EpochLog(epoch=73, loss=9.967799999267366e-08)
EpochLog(epoch=74, loss=1.010249999924736e-07)
EpochLog(epoch=75, loss=1.0237199999227089e-07)
EpochLog(epoch=76, loss=1.0371899999206549e-07)
EpochLog(epoch=77, loss=1.0506599999185735e-07)
EpochLog(epoch=78, loss=1.0641299999164656e-07)
EpochLog(epoch=79, loss=1.0775999999143306e-07)
EpochLog(epoch=80, loss=1.0910699999121685e-07)
EpochLog(epoch=81, loss=1.1045399999099799e-07)
EpochLog(epoch=82, loss=1.118009999907764e-07)
EpochLog(epoch=83, loss=1.1314799999055213e-07)
EpochLog(epoch=84, loss=1.1449499999032518e-07)
EpochLog(epoch=85, loss=1.1584199999009551e-07)
EpochLog(epoch=86, loss=1.1718899998986312e-07)
EpochLog(epoch=87, loss=1.185359999896281e-07)
EpochLog(epoch=88, loss=1.1988299998939037e-07)
EpochLog(epoch=89, loss=1.2122999998914989e-07)
EpochLog(epoch=90, loss=1.2257699998890678e-07)
EpochLog(epoch=91, loss=1.2392399998866092e-07)
EpochLog(epoch=92, loss=1.2527099998841241e-07)
EpochLog(epoch=93, loss=1.2661799998816118e-07)
EpochLog(epoch=94, loss=1.279649999879073e-07)
EpochLog(epoch=95, loss=1.2931199998765067e-07)
EpochLog(epoch=96, loss=1.3065899998739136e-07)
EpochLog(epoch=97, loss=1.3200599998712938e-07)
EpochLog(epoch=98, loss=1.3335299998686468e-07)
EpochLog(epoch=99, loss=1.3469999998659733e-07)
```

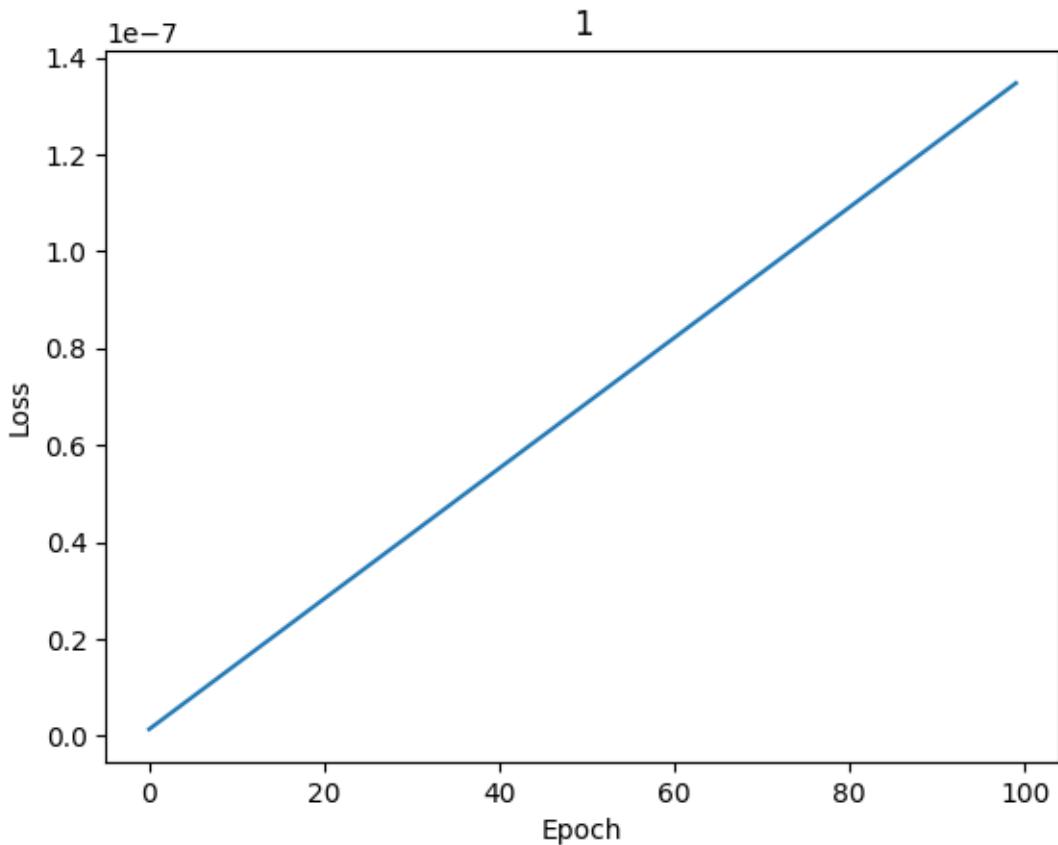


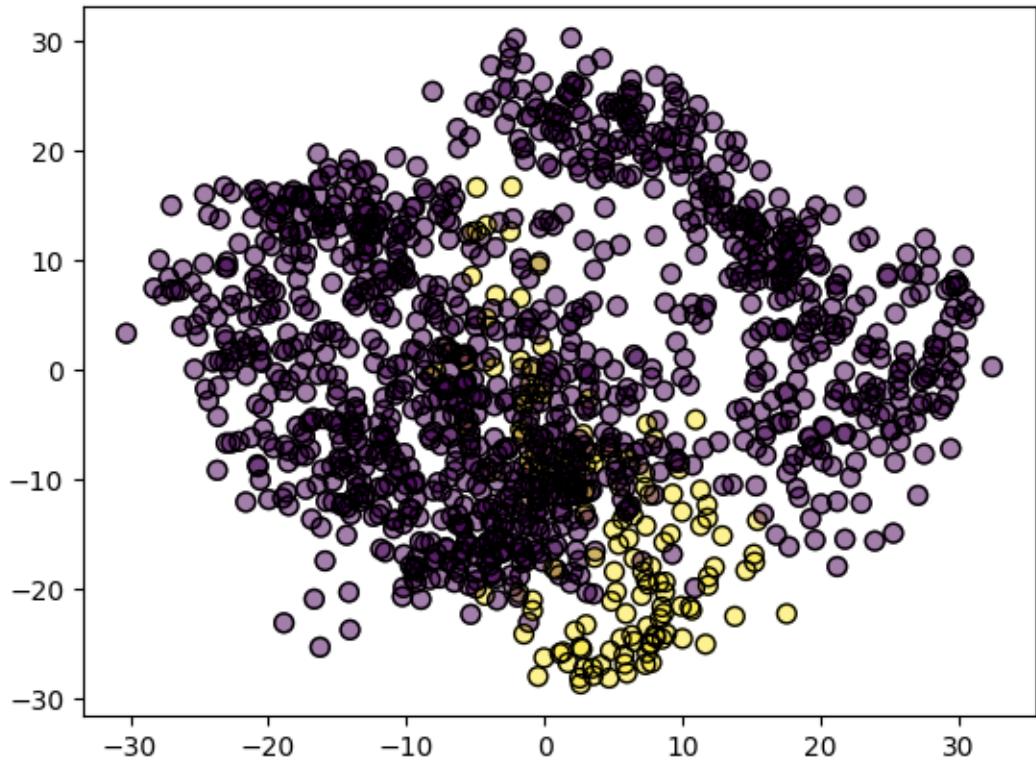


```
EpochLog(epoch=0, loss=1.3469999999993265e-09)
EpochLog(epoch=1, loss=2.6939999999959592e-09)
EpochLog(epoch=2, loss=4.04099999989897e-09)
EpochLog(epoch=3, loss=5.38799999981143e-09)
EpochLog(epoch=4, loss=6.73499999969691e-09)
EpochLog(epoch=5, loss=8.08199999955546e-09)
EpochLog(epoch=6, loss=9.42899999938714e-09)
EpochLog(epoch=7, loss=1.077599999919183e-08)
EpochLog(epoch=8, loss=1.212299999896952e-08)
EpochLog(epoch=9, loss=1.346999999872034e-08)
EpochLog(epoch=10, loss=1.481699999844417e-08)
EpochLog(epoch=11, loss=1.6163999998141e-08)
EpochLog(epoch=12, loss=1.75109999978111e-08)
EpochLog(epoch=13, loss=1.885799999745413e-08)
EpochLog(epoch=14, loss=2.020499999707024e-08)
EpochLog(epoch=15, loss=2.155199999665945e-08)
EpochLog(epoch=16, loss=2.289899999622163e-08)
EpochLog(epoch=17, loss=2.424599999575687e-08)
EpochLog(epoch=18, loss=2.55929999952652e-08)
EpochLog(epoch=19, loss=2.69399999947466e-08)
EpochLog(epoch=20, loss=2.828699999420117e-08)
EpochLog(epoch=21, loss=2.963399999362852e-08)
```

```
EpochLog(epoch=22, loss=3.098099999930291e-08)
EpochLog(epoch=23, loss=3.232799999924028e-08)
EpochLog(epoch=24, loss=3.3674999999174946e-08)
EpochLog(epoch=25, loss=3.5021999999106924e-08)
EpochLog(epoch=26, loss=3.636899999903621e-08)
EpochLog(epoch=27, loss=3.771599999896279e-08)
EpochLog(epoch=28, loss=3.90629999988867e-08)
EpochLog(epoch=29, loss=4.04099999988079e-08)
EpochLog(epoch=30, loss=4.175699999872641e-08)
EpochLog(epoch=31, loss=4.310399999864222e-08)
EpochLog(epoch=32, loss=4.445099999855533e-08)
EpochLog(epoch=33, loss=4.5797999998465756e-08)
EpochLog(epoch=34, loss=4.7144999998373475e-08)
EpochLog(epoch=35, loss=4.849199999827852e-08)
EpochLog(epoch=36, loss=4.983899999818087e-08)
EpochLog(epoch=37, loss=5.1185999998080517e-08)
EpochLog(epoch=38, loss=5.253299999797748e-08)
EpochLog(epoch=39, loss=5.387999999787173e-08)
EpochLog(epoch=40, loss=5.522699999776332e-08)
EpochLog(epoch=41, loss=5.6573999997652184e-08)
EpochLog(epoch=42, loss=5.7920999997538337e-08)
EpochLog(epoch=43, loss=5.926799999742185e-08)
EpochLog(epoch=44, loss=6.061499999730263e-08)
EpochLog(epoch=45, loss=6.196199999718073e-08)
EpochLog(epoch=46, loss=6.330899999705615e-08)
EpochLog(epoch=47, loss=6.465599999692884e-08)
EpochLog(epoch=48, loss=6.600299999679886e-08)
EpochLog(epoch=49, loss=6.734999999666615e-08)
EpochLog(epoch=50, loss=6.869699999653079e-08)
EpochLog(epoch=51, loss=7.004399999639271e-08)
EpochLog(epoch=52, loss=7.139099999625198e-08)
EpochLog(epoch=53, loss=7.273799999610852e-08)
EpochLog(epoch=54, loss=7.408499999596237e-08)
EpochLog(epoch=55, loss=7.543199999581354e-08)
EpochLog(epoch=56, loss=7.677899999566198e-08)
EpochLog(epoch=57, loss=7.812599999550776e-08)
EpochLog(epoch=58, loss=7.947299999535082e-08)
EpochLog(epoch=59, loss=8.081999999519121e-08)
EpochLog(epoch=60, loss=8.216699999502885e-08)
EpochLog(epoch=61, loss=8.351399999486387e-08)
EpochLog(epoch=62, loss=8.48609999946962e-08)
EpochLog(epoch=63, loss=8.620799999452576e-08)
EpochLog(epoch=64, loss=8.755499999435265e-08)
EpochLog(epoch=65, loss=8.89019999941769e-08)
EpochLog(epoch=66, loss=9.024899999399844e-08)
EpochLog(epoch=67, loss=9.159599999381725e-08)
EpochLog(epoch=68, loss=9.294299999363338e-08)
EpochLog(epoch=69, loss=9.428999999344686e-08)
```

```
EpochLog(epoch=70, loss=9.563699999325759e-08)
EpochLog(epoch=71, loss=9.698399999306561e-08)
EpochLog(epoch=72, loss=9.8330999992871e-08)
EpochLog(epoch=73, loss=9.967799999267366e-08)
EpochLog(epoch=74, loss=1.010249999924736e-07)
EpochLog(epoch=75, loss=1.0237199999227089e-07)
EpochLog(epoch=76, loss=1.0371899999206549e-07)
EpochLog(epoch=77, loss=1.0506599999185735e-07)
EpochLog(epoch=78, loss=1.0641299999164656e-07)
EpochLog(epoch=79, loss=1.0775999999143306e-07)
EpochLog(epoch=80, loss=1.0910699999121685e-07)
EpochLog(epoch=81, loss=1.1045399999099799e-07)
EpochLog(epoch=82, loss=1.118009999907764e-07)
EpochLog(epoch=83, loss=1.1314799999055213e-07)
EpochLog(epoch=84, loss=1.1449499999032518e-07)
EpochLog(epoch=85, loss=1.1584199999009551e-07)
EpochLog(epoch=86, loss=1.1718899998986312e-07)
EpochLog(epoch=87, loss=1.185359999896281e-07)
EpochLog(epoch=88, loss=1.1988299998939037e-07)
EpochLog(epoch=89, loss=1.2122999998914989e-07)
EpochLog(epoch=90, loss=1.2257699998890678e-07)
EpochLog(epoch=91, loss=1.2392399998866092e-07)
EpochLog(epoch=92, loss=1.2527099998841241e-07)
EpochLog(epoch=93, loss=1.2661799998816118e-07)
EpochLog(epoch=94, loss=1.279649999879073e-07)
EpochLog(epoch=95, loss=1.2931199998765067e-07)
EpochLog(epoch=96, loss=1.3065899998739136e-07)
EpochLog(epoch=97, loss=1.3200599998712938e-07)
EpochLog(epoch=98, loss=1.3335299998686468e-07)
EpochLog(epoch=99, loss=1.3469999998659733e-07)
```

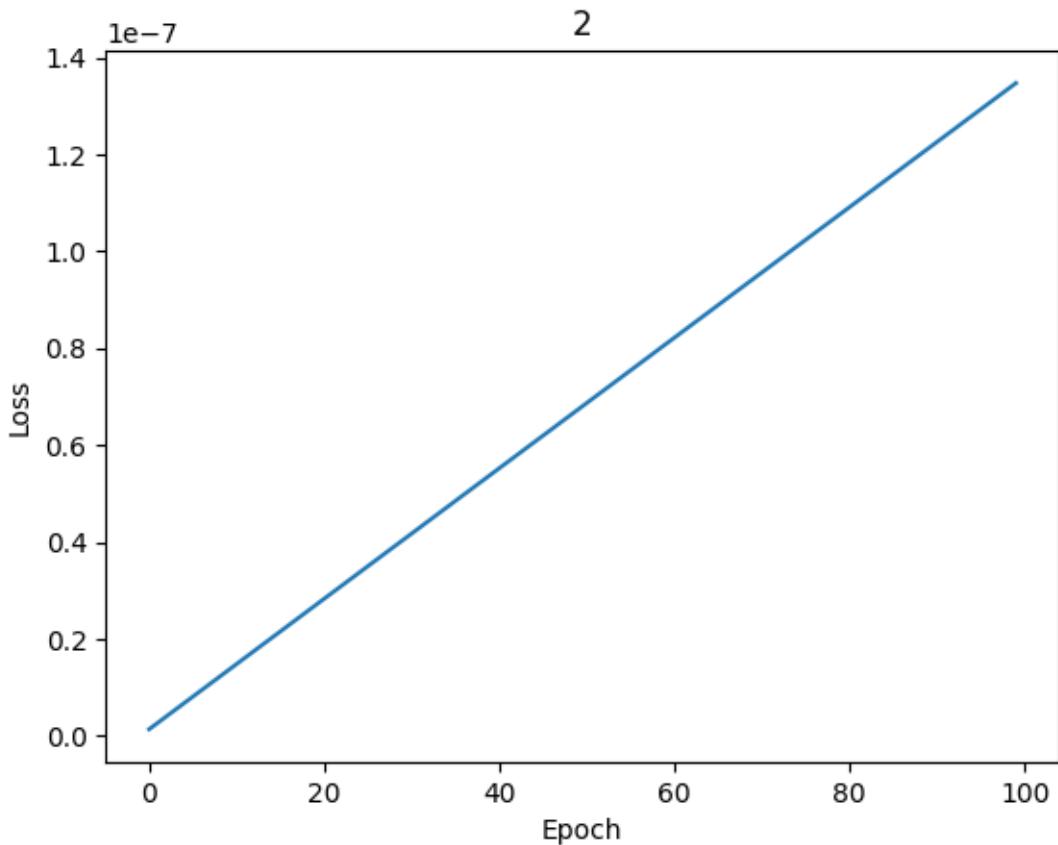


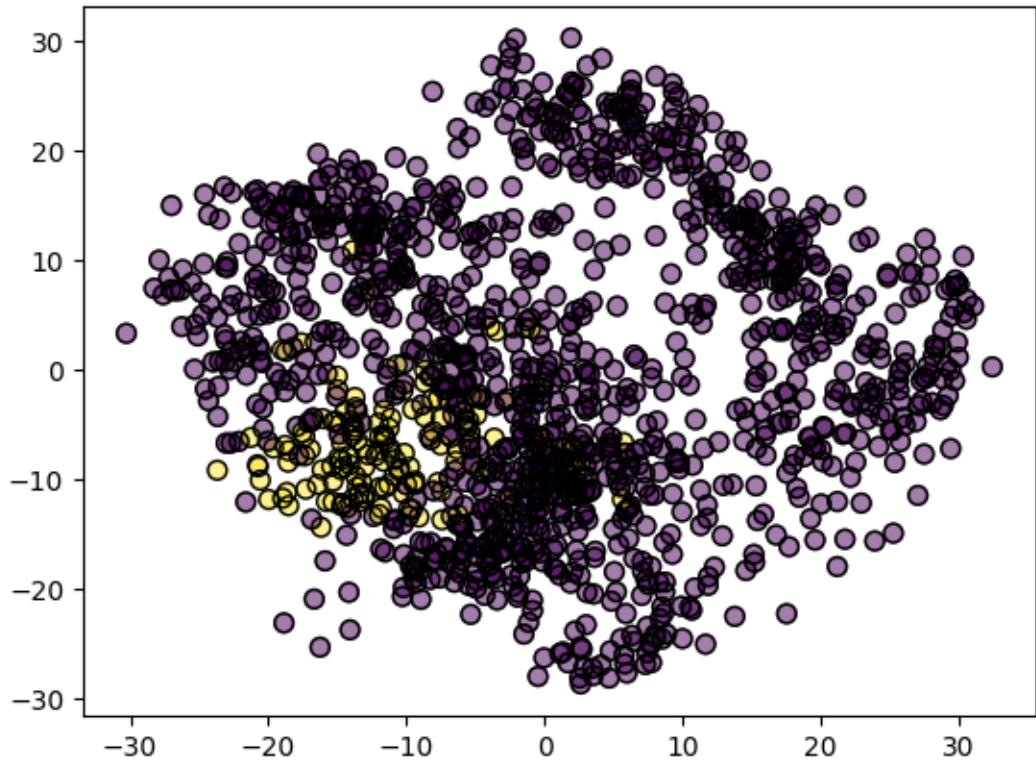


```
EpochLog(epoch=0, loss=1.3469999999993265e-09)
EpochLog(epoch=1, loss=2.6939999999959592e-09)
EpochLog(epoch=2, loss=4.04099999989897e-09)
EpochLog(epoch=3, loss=5.38799999981143e-09)
EpochLog(epoch=4, loss=6.73499999969691e-09)
EpochLog(epoch=5, loss=8.08199999955546e-09)
EpochLog(epoch=6, loss=9.42899999938714e-09)
EpochLog(epoch=7, loss=1.077599999919183e-08)
EpochLog(epoch=8, loss=1.212299999896952e-08)
EpochLog(epoch=9, loss=1.346999999872034e-08)
EpochLog(epoch=10, loss=1.481699999844417e-08)
EpochLog(epoch=11, loss=1.6163999998141e-08)
EpochLog(epoch=12, loss=1.75109999978111e-08)
EpochLog(epoch=13, loss=1.885799999745413e-08)
EpochLog(epoch=14, loss=2.020499999707024e-08)
EpochLog(epoch=15, loss=2.1551999999665945e-08)
EpochLog(epoch=16, loss=2.2898999999622163e-08)
EpochLog(epoch=17, loss=2.424599999575687e-08)
EpochLog(epoch=18, loss=2.559299999952652e-08)
EpochLog(epoch=19, loss=2.69399999947466e-08)
EpochLog(epoch=20, loss=2.828699999420117e-08)
EpochLog(epoch=21, loss=2.9633999999362852e-08)
```

```
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EpochLog(epoch=23, loss=3.232799999924028e-08)
EpochLog(epoch=24, loss=3.3674999999174946e-08)
EpochLog(epoch=25, loss=3.5021999999106924e-08)
EpochLog(epoch=26, loss=3.636899999903621e-08)
EpochLog(epoch=27, loss=3.771599999896279e-08)
EpochLog(epoch=28, loss=3.90629999988867e-08)
EpochLog(epoch=29, loss=4.04099999988079e-08)
EpochLog(epoch=30, loss=4.175699999872641e-08)
EpochLog(epoch=31, loss=4.310399999864222e-08)
EpochLog(epoch=32, loss=4.445099999855533e-08)
EpochLog(epoch=33, loss=4.5797999998465756e-08)
EpochLog(epoch=34, loss=4.7144999998373475e-08)
EpochLog(epoch=35, loss=4.849199999827852e-08)
EpochLog(epoch=36, loss=4.983899999818087e-08)
EpochLog(epoch=37, loss=5.1185999998080517e-08)
EpochLog(epoch=38, loss=5.253299999797748e-08)
EpochLog(epoch=39, loss=5.387999999787173e-08)
EpochLog(epoch=40, loss=5.522699999776332e-08)
EpochLog(epoch=41, loss=5.6573999997652184e-08)
EpochLog(epoch=42, loss=5.7920999997538337e-08)
EpochLog(epoch=43, loss=5.926799999742185e-08)
EpochLog(epoch=44, loss=6.061499999730263e-08)
EpochLog(epoch=45, loss=6.196199999718073e-08)
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EpochLog(epoch=47, loss=6.465599999692884e-08)
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EpochLog(epoch=54, loss=7.408499999596237e-08)
EpochLog(epoch=55, loss=7.543199999581354e-08)
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EpochLog(epoch=57, loss=7.812599999550776e-08)
EpochLog(epoch=58, loss=7.947299999535082e-08)
EpochLog(epoch=59, loss=8.081999999519121e-08)
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EpochLog(epoch=64, loss=8.755499999435265e-08)
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EpochLog(epoch=67, loss=9.159599999381725e-08)
EpochLog(epoch=68, loss=9.294299999363338e-08)
EpochLog(epoch=69, loss=9.428999999344686e-08)
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EpochLog(epoch=70, loss=9.563699999325759e-08)
EpochLog(epoch=71, loss=9.698399999306561e-08)
EpochLog(epoch=72, loss=9.8330999992871e-08)
EpochLog(epoch=73, loss=9.967799999267366e-08)
EpochLog(epoch=74, loss=1.010249999924736e-07)
EpochLog(epoch=75, loss=1.0237199999227089e-07)
EpochLog(epoch=76, loss=1.0371899999206549e-07)
EpochLog(epoch=77, loss=1.0506599999185735e-07)
EpochLog(epoch=78, loss=1.0641299999164656e-07)
EpochLog(epoch=79, loss=1.0775999999143306e-07)
EpochLog(epoch=80, loss=1.0910699999121685e-07)
EpochLog(epoch=81, loss=1.1045399999099799e-07)
EpochLog(epoch=82, loss=1.118009999907764e-07)
EpochLog(epoch=83, loss=1.1314799999055213e-07)
EpochLog(epoch=84, loss=1.1449499999032518e-07)
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EpochLog(epoch=86, loss=1.1718899998986312e-07)
EpochLog(epoch=87, loss=1.185359999896281e-07)
EpochLog(epoch=88, loss=1.1988299998939037e-07)
EpochLog(epoch=89, loss=1.2122999998914989e-07)
EpochLog(epoch=90, loss=1.2257699998890678e-07)
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EpochLog(epoch=97, loss=1.3200599998712938e-07)
EpochLog(epoch=98, loss=1.3335299998686468e-07)
EpochLog(epoch=99, loss=1.3469999998659733e-07)
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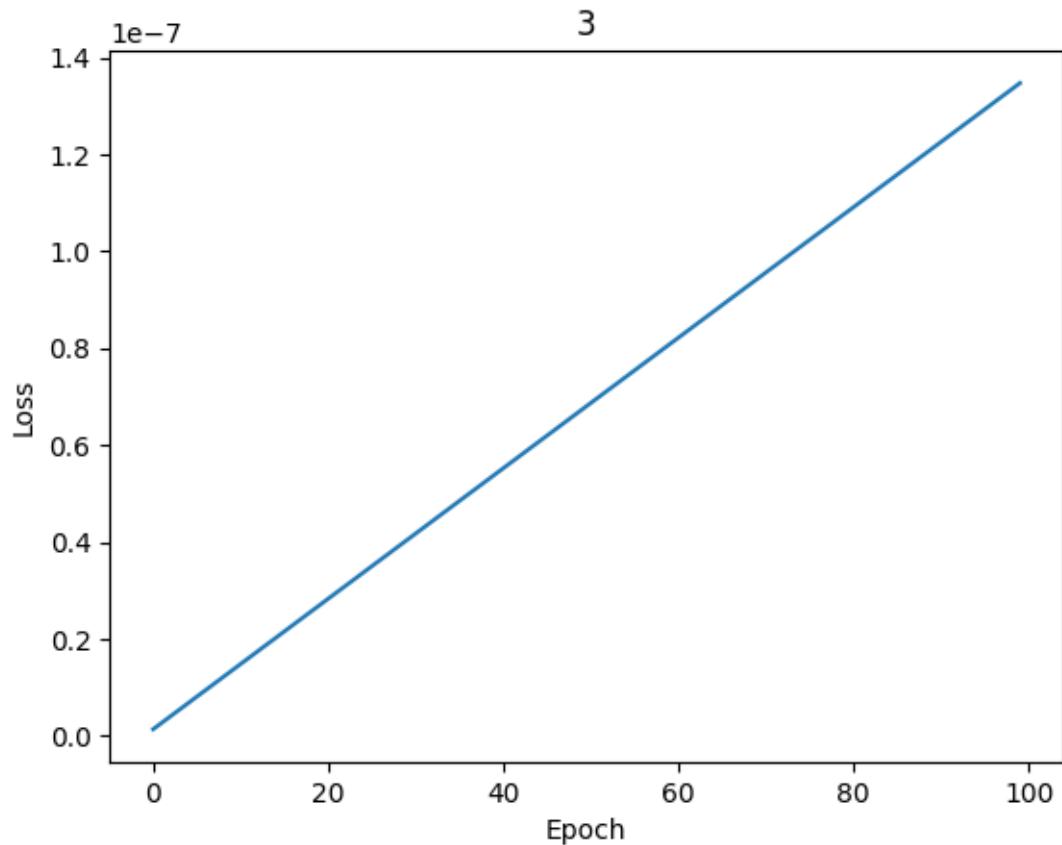


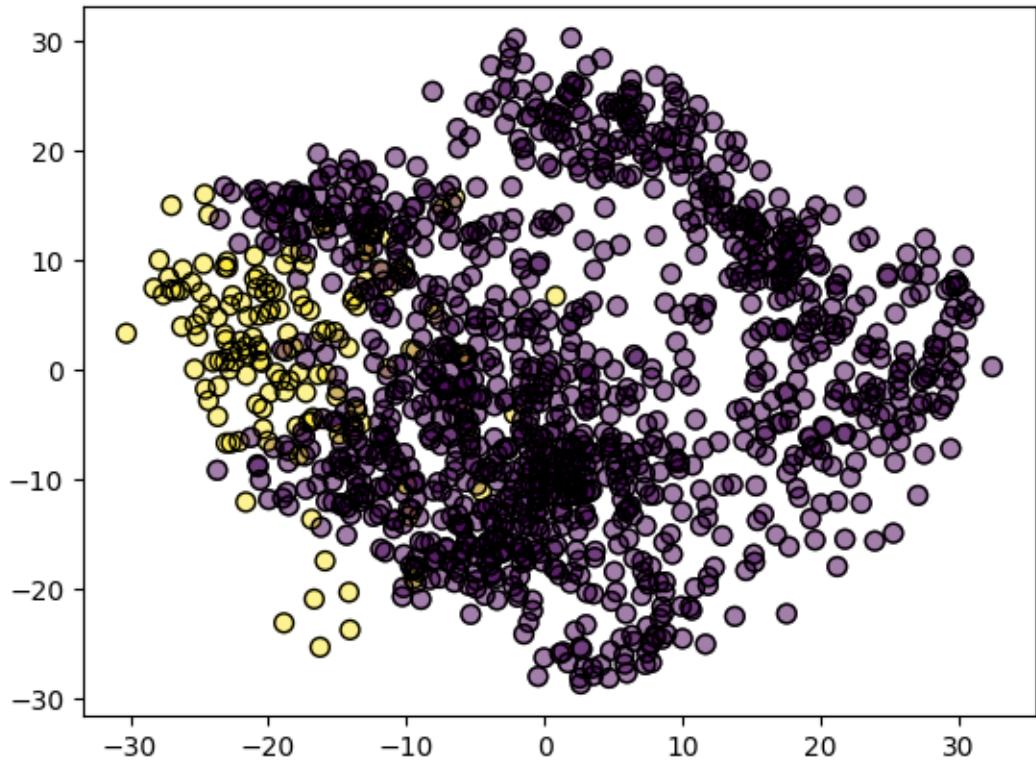


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EpochLog(epoch=3, loss=5.387999999981143e-09)
EpochLog(epoch=4, loss=6.73499999969691e-09)
EpochLog(epoch=5, loss=8.08199999955546e-09)
EpochLog(epoch=6, loss=9.42899999938714e-09)
EpochLog(epoch=7, loss=1.0775999999919183e-08)
EpochLog(epoch=8, loss=1.2122999999896952e-08)
EpochLog(epoch=9, loss=1.346999999872034e-08)
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EpochLog(epoch=11, loss=1.61639999998141e-08)
EpochLog(epoch=12, loss=1.751099999978111e-08)
EpochLog(epoch=13, loss=1.8857999999745413e-08)
EpochLog(epoch=14, loss=2.0204999999707024e-08)
EpochLog(epoch=15, loss=2.1551999999665945e-08)
EpochLog(epoch=16, loss=2.2898999999622163e-08)
EpochLog(epoch=17, loss=2.4245999999575687e-08)
EpochLog(epoch=18, loss=2.559299999952652e-08)
EpochLog(epoch=19, loss=2.693999999947466e-08)
EpochLog(epoch=20, loss=2.8286999999420117e-08)
EpochLog(epoch=21, loss=2.9633999999362852e-08)
```

```
EpochLog(epoch=22, loss=3.098099999930291e-08)
EpochLog(epoch=23, loss=3.232799999924028e-08)
EpochLog(epoch=24, loss=3.3674999999174946e-08)
EpochLog(epoch=25, loss=3.5021999999106924e-08)
EpochLog(epoch=26, loss=3.636899999903621e-08)
EpochLog(epoch=27, loss=3.771599999896279e-08)
EpochLog(epoch=28, loss=3.90629999988867e-08)
EpochLog(epoch=29, loss=4.04099999988079e-08)
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EpochLog(epoch=38, loss=5.253299999797748e-08)
EpochLog(epoch=39, loss=5.387999999787173e-08)
EpochLog(epoch=40, loss=5.522699999776332e-08)
EpochLog(epoch=41, loss=5.6573999997652184e-08)
EpochLog(epoch=42, loss=5.7920999997538337e-08)
EpochLog(epoch=43, loss=5.926799999742185e-08)
EpochLog(epoch=44, loss=6.061499999730263e-08)
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EpochLog(epoch=54, loss=7.408499999596237e-08)
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EpochLog(epoch=59, loss=8.081999999519121e-08)
EpochLog(epoch=60, loss=8.216699999502885e-08)
EpochLog(epoch=61, loss=8.351399999486387e-08)
EpochLog(epoch=62, loss=8.48609999946962e-08)
EpochLog(epoch=63, loss=8.620799999452576e-08)
EpochLog(epoch=64, loss=8.755499999435265e-08)
EpochLog(epoch=65, loss=8.89019999941769e-08)
EpochLog(epoch=66, loss=9.024899999399844e-08)
EpochLog(epoch=67, loss=9.159599999381725e-08)
EpochLog(epoch=68, loss=9.294299999363338e-08)
EpochLog(epoch=69, loss=9.428999999344686e-08)
```

```
EpochLog(epoch=70, loss=9.563699999325759e-08)
EpochLog(epoch=71, loss=9.698399999306561e-08)
EpochLog(epoch=72, loss=9.8330999992871e-08)
EpochLog(epoch=73, loss=9.967799999267366e-08)
EpochLog(epoch=74, loss=1.010249999924736e-07)
EpochLog(epoch=75, loss=1.0237199999227089e-07)
EpochLog(epoch=76, loss=1.0371899999206549e-07)
EpochLog(epoch=77, loss=1.0506599999185735e-07)
EpochLog(epoch=78, loss=1.0641299999164656e-07)
EpochLog(epoch=79, loss=1.0775999999143306e-07)
EpochLog(epoch=80, loss=1.0910699999121685e-07)
EpochLog(epoch=81, loss=1.1045399999099799e-07)
EpochLog(epoch=82, loss=1.118009999907764e-07)
EpochLog(epoch=83, loss=1.1314799999055213e-07)
EpochLog(epoch=84, loss=1.1449499999032518e-07)
EpochLog(epoch=85, loss=1.1584199999009551e-07)
EpochLog(epoch=86, loss=1.1718899998986312e-07)
EpochLog(epoch=87, loss=1.185359999896281e-07)
EpochLog(epoch=88, loss=1.1988299998939037e-07)
EpochLog(epoch=89, loss=1.2122999998914989e-07)
EpochLog(epoch=90, loss=1.2257699998890678e-07)
EpochLog(epoch=91, loss=1.2392399998866092e-07)
EpochLog(epoch=92, loss=1.2527099998841241e-07)
EpochLog(epoch=93, loss=1.2661799998816118e-07)
EpochLog(epoch=94, loss=1.279649999879073e-07)
EpochLog(epoch=95, loss=1.2931199998765067e-07)
EpochLog(epoch=96, loss=1.3065899998739136e-07)
EpochLog(epoch=97, loss=1.3200599998712938e-07)
EpochLog(epoch=98, loss=1.3335299998686468e-07)
EpochLog(epoch=99, loss=1.3469999998659733e-07)
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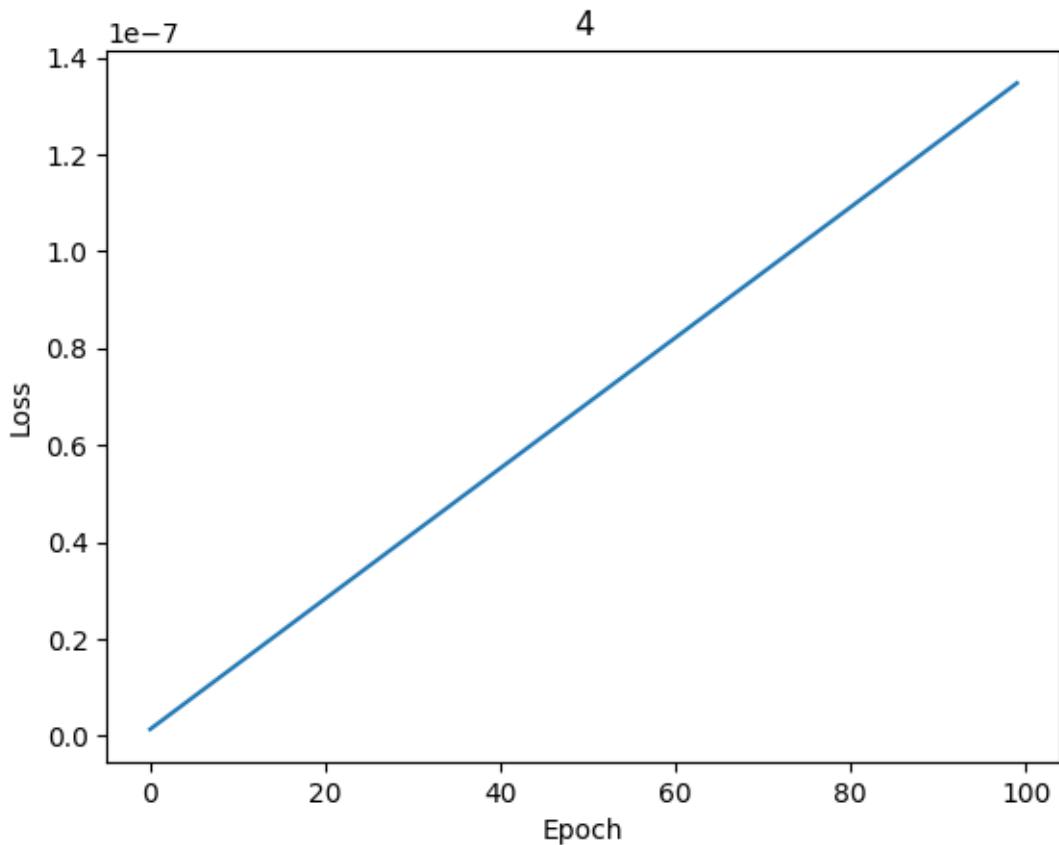


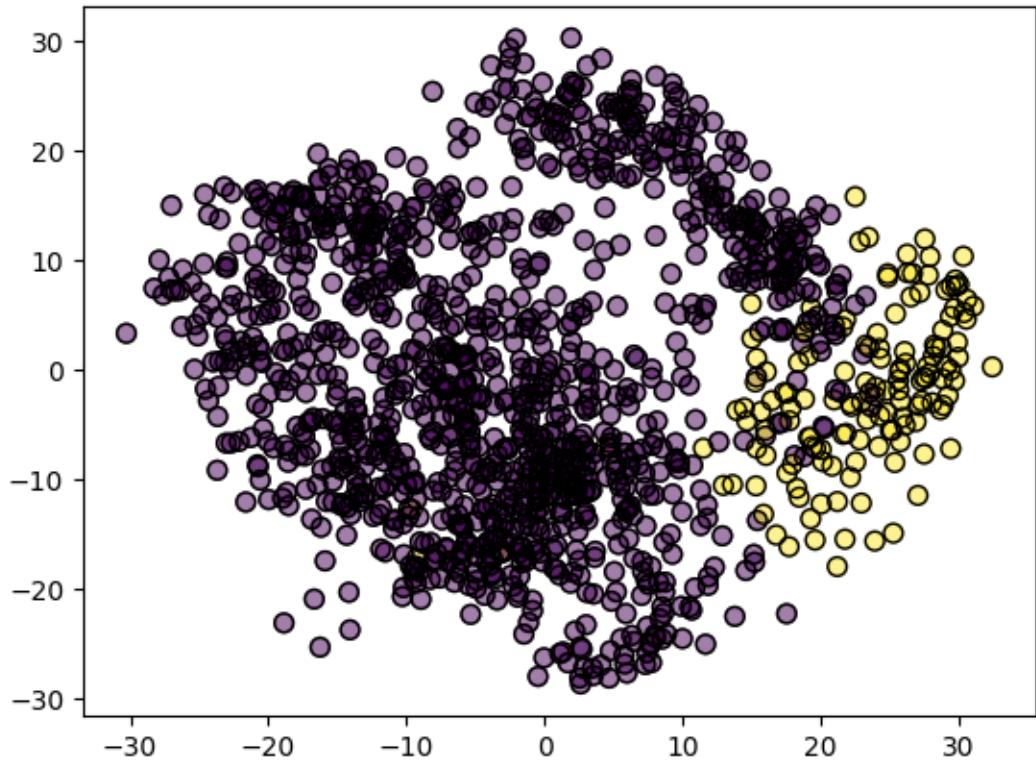


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EpochLog(epoch=0, loss=1.3469999999993265e-09)
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EpochLog(epoch=3, loss=5.38799999981143e-09)
EpochLog(epoch=4, loss=6.73499999969691e-09)
EpochLog(epoch=5, loss=8.08199999955546e-09)
EpochLog(epoch=6, loss=9.42899999938714e-09)
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EpochLog(epoch=10, loss=1.4816999999844417e-08)
EpochLog(epoch=11, loss=1.61639999998141e-08)
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```

```
EpochLog(epoch=22, loss=3.098099999930291e-08)
EpochLog(epoch=23, loss=3.232799999924028e-08)
EpochLog(epoch=24, loss=3.3674999999174946e-08)
EpochLog(epoch=25, loss=3.5021999999106924e-08)
EpochLog(epoch=26, loss=3.636899999903621e-08)
EpochLog(epoch=27, loss=3.771599999896279e-08)
EpochLog(epoch=28, loss=3.90629999988867e-08)
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EpochLog(epoch=39, loss=5.387999999787173e-08)
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EpochLog(epoch=42, loss=5.7920999997538337e-08)
EpochLog(epoch=43, loss=5.926799999742185e-08)
EpochLog(epoch=44, loss=6.061499999730263e-08)
EpochLog(epoch=45, loss=6.196199999718073e-08)
EpochLog(epoch=46, loss=6.330899999705615e-08)
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EpochLog(epoch=69, loss=9.428999999344686e-08)
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```
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EpochLog(epoch=71, loss=9.698399999306561e-08)
EpochLog(epoch=72, loss=9.8330999992871e-08)
EpochLog(epoch=73, loss=9.967799999267366e-08)
EpochLog(epoch=74, loss=1.010249999924736e-07)
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EpochLog(epoch=89, loss=1.2122999998914989e-07)
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EpochLog(epoch=93, loss=1.2661799998816118e-07)
EpochLog(epoch=94, loss=1.279649999879073e-07)
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EpochLog(epoch=97, loss=1.3200599998712938e-07)
EpochLog(epoch=98, loss=1.3335299998686468e-07)
EpochLog(epoch=99, loss=1.3469999998659733e-07)
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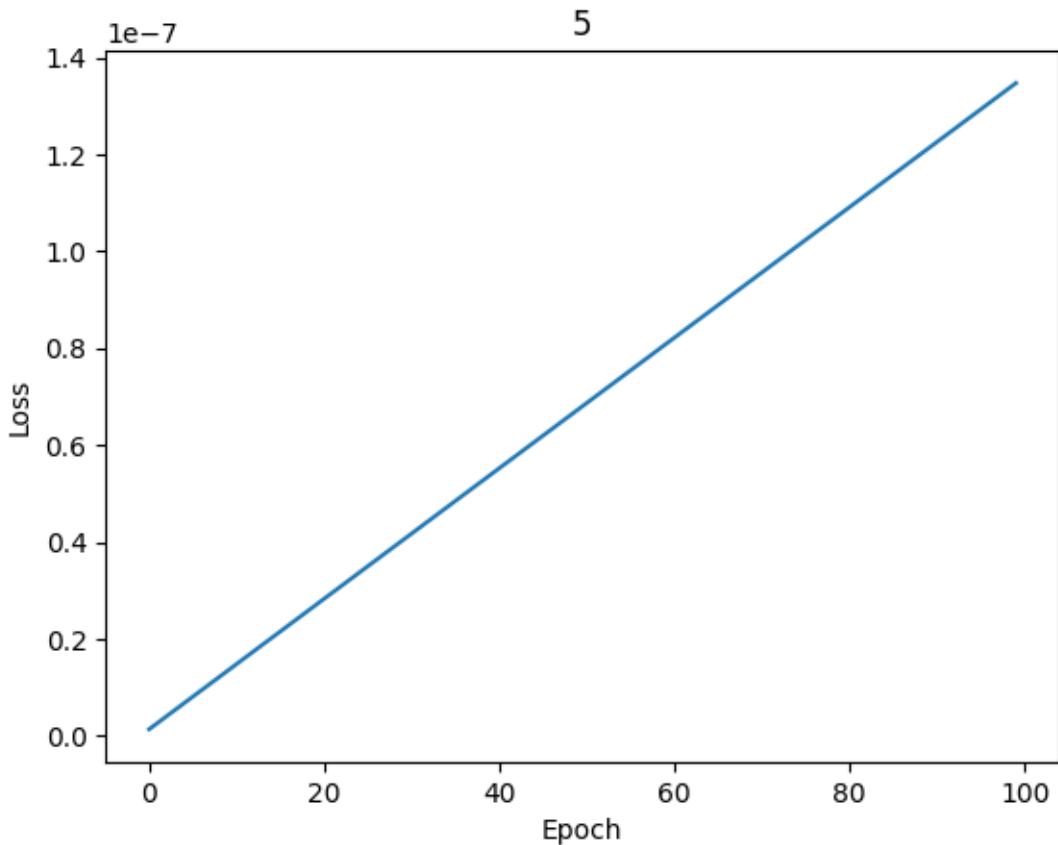


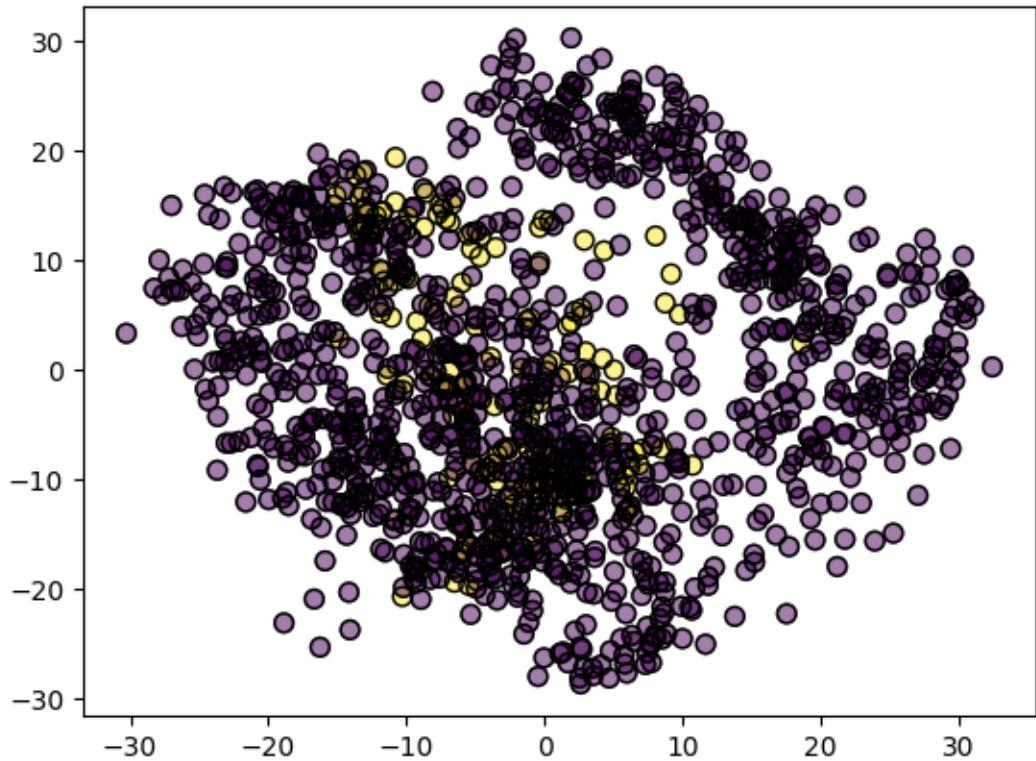


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EpochLog(epoch=4, loss=6.73499999969691e-09)
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EpochLog(epoch=7, loss=1.077599999919183e-08)
EpochLog(epoch=8, loss=1.212299999896952e-08)
EpochLog(epoch=9, loss=1.346999999872034e-08)
EpochLog(epoch=10, loss=1.481699999844417e-08)
EpochLog(epoch=11, loss=1.6163999998141e-08)
EpochLog(epoch=12, loss=1.75109999978111e-08)
EpochLog(epoch=13, loss=1.885799999745413e-08)
EpochLog(epoch=14, loss=2.020499999707024e-08)
EpochLog(epoch=15, loss=2.1551999999665945e-08)
EpochLog(epoch=16, loss=2.2898999999622163e-08)
EpochLog(epoch=17, loss=2.424599999575687e-08)
EpochLog(epoch=18, loss=2.559299999952652e-08)
EpochLog(epoch=19, loss=2.69399999947466e-08)
EpochLog(epoch=20, loss=2.828699999420117e-08)
EpochLog(epoch=21, loss=2.9633999999362852e-08)
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EpochLog(epoch=24, loss=3.3674999999174946e-08)
EpochLog(epoch=25, loss=3.5021999999106924e-08)
EpochLog(epoch=26, loss=3.636899999903621e-08)
EpochLog(epoch=27, loss=3.771599999896279e-08)
EpochLog(epoch=28, loss=3.90629999988867e-08)
EpochLog(epoch=29, loss=4.04099999988079e-08)
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EpochLog(epoch=32, loss=4.445099999855533e-08)
EpochLog(epoch=33, loss=4.5797999998465756e-08)
EpochLog(epoch=34, loss=4.7144999998373475e-08)
EpochLog(epoch=35, loss=4.849199999827852e-08)
EpochLog(epoch=36, loss=4.983899999818087e-08)
EpochLog(epoch=37, loss=5.1185999998080517e-08)
EpochLog(epoch=38, loss=5.253299999797748e-08)
EpochLog(epoch=39, loss=5.387999999787173e-08)
EpochLog(epoch=40, loss=5.522699999776332e-08)
EpochLog(epoch=41, loss=5.6573999997652184e-08)
EpochLog(epoch=42, loss=5.7920999997538337e-08)
EpochLog(epoch=43, loss=5.926799999742185e-08)
EpochLog(epoch=44, loss=6.061499999730263e-08)
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EpochLog(epoch=57, loss=7.812599999550776e-08)
EpochLog(epoch=58, loss=7.947299999535082e-08)
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EpochLog(epoch=67, loss=9.159599999381725e-08)
EpochLog(epoch=68, loss=9.294299999363338e-08)
EpochLog(epoch=69, loss=9.428999999344686e-08)
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```
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EpochLog(epoch=71, loss=9.698399999306561e-08)
EpochLog(epoch=72, loss=9.8330999992871e-08)
EpochLog(epoch=73, loss=9.967799999267366e-08)
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EpochLog(epoch=75, loss=1.0237199999227089e-07)
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EpochLog(epoch=80, loss=1.0910699999121685e-07)
EpochLog(epoch=81, loss=1.1045399999099799e-07)
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EpochLog(epoch=84, loss=1.1449499999032518e-07)
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EpochLog(epoch=88, loss=1.1988299998939037e-07)
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EpochLog(epoch=94, loss=1.279649999879073e-07)
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EpochLog(epoch=99, loss=1.3469999998659733e-07)
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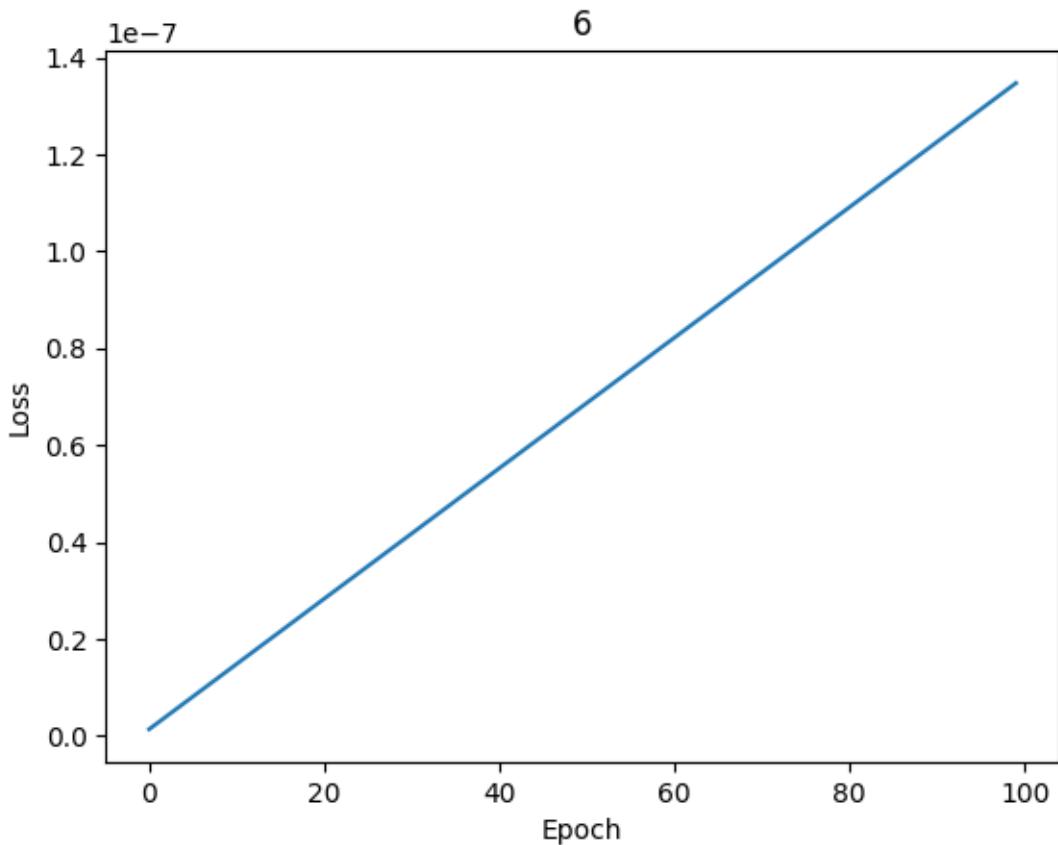


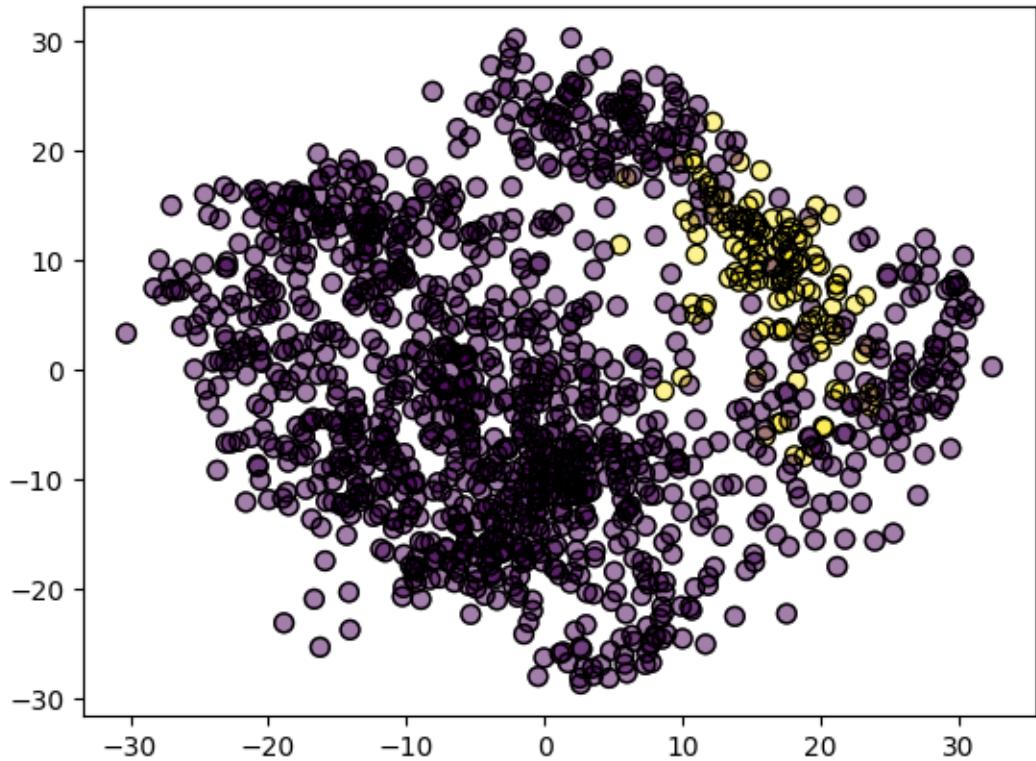


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EpochLog(epoch=3, loss=5.38799999981143e-09)
EpochLog(epoch=4, loss=6.73499999969691e-09)
EpochLog(epoch=5, loss=8.08199999955546e-09)
EpochLog(epoch=6, loss=9.42899999938714e-09)
EpochLog(epoch=7, loss=1.0775999999919183e-08)
EpochLog(epoch=8, loss=1.2122999999896952e-08)
EpochLog(epoch=9, loss=1.346999999872034e-08)
EpochLog(epoch=10, loss=1.481699999844417e-08)
EpochLog(epoch=11, loss=1.6163999998141e-08)
EpochLog(epoch=12, loss=1.751099999978111e-08)
EpochLog(epoch=13, loss=1.8857999999745413e-08)
EpochLog(epoch=14, loss=2.0204999999707024e-08)
EpochLog(epoch=15, loss=2.1551999999665945e-08)
EpochLog(epoch=16, loss=2.2898999999622163e-08)
EpochLog(epoch=17, loss=2.4245999999575687e-08)
EpochLog(epoch=18, loss=2.559299999952652e-08)
EpochLog(epoch=19, loss=2.693999999947466e-08)
EpochLog(epoch=20, loss=2.8286999999420117e-08)
EpochLog(epoch=21, loss=2.9633999999362852e-08)
```

```
EpochLog(epoch=22, loss=3.098099999930291e-08)
EpochLog(epoch=23, loss=3.232799999924028e-08)
EpochLog(epoch=24, loss=3.3674999999174946e-08)
EpochLog(epoch=25, loss=3.5021999999106924e-08)
EpochLog(epoch=26, loss=3.636899999903621e-08)
EpochLog(epoch=27, loss=3.771599999896279e-08)
EpochLog(epoch=28, loss=3.90629999988867e-08)
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EpochLog(epoch=41, loss=5.6573999997652184e-08)
EpochLog(epoch=42, loss=5.7920999997538337e-08)
EpochLog(epoch=43, loss=5.926799999742185e-08)
EpochLog(epoch=44, loss=6.061499999730263e-08)
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EpochLog(epoch=60, loss=8.216699999502885e-08)
EpochLog(epoch=61, loss=8.351399999486387e-08)
EpochLog(epoch=62, loss=8.48609999946962e-08)
EpochLog(epoch=63, loss=8.620799999452576e-08)
EpochLog(epoch=64, loss=8.755499999435265e-08)
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EpochLog(epoch=66, loss=9.024899999399844e-08)
EpochLog(epoch=67, loss=9.159599999381725e-08)
EpochLog(epoch=68, loss=9.294299999363338e-08)
EpochLog(epoch=69, loss=9.428999999344686e-08)
```

```
EpochLog(epoch=70, loss=9.563699999325759e-08)
EpochLog(epoch=71, loss=9.698399999306561e-08)
EpochLog(epoch=72, loss=9.8330999992871e-08)
EpochLog(epoch=73, loss=9.967799999267366e-08)
EpochLog(epoch=74, loss=1.010249999924736e-07)
EpochLog(epoch=75, loss=1.0237199999227089e-07)
EpochLog(epoch=76, loss=1.0371899999206549e-07)
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EpochLog(epoch=79, loss=1.0775999999143306e-07)
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EpochLog(epoch=82, loss=1.118009999907764e-07)
EpochLog(epoch=83, loss=1.1314799999055213e-07)
EpochLog(epoch=84, loss=1.1449499999032518e-07)
EpochLog(epoch=85, loss=1.1584199999009551e-07)
EpochLog(epoch=86, loss=1.1718899998986312e-07)
EpochLog(epoch=87, loss=1.185359999896281e-07)
EpochLog(epoch=88, loss=1.1988299998939037e-07)
EpochLog(epoch=89, loss=1.2122999998914989e-07)
EpochLog(epoch=90, loss=1.2257699998890678e-07)
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EpochLog(epoch=92, loss=1.2527099998841241e-07)
EpochLog(epoch=93, loss=1.2661799998816118e-07)
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EpochLog(epoch=96, loss=1.3065899998739136e-07)
EpochLog(epoch=97, loss=1.3200599998712938e-07)
EpochLog(epoch=98, loss=1.3335299998686468e-07)
EpochLog(epoch=99, loss=1.3469999998659733e-07)
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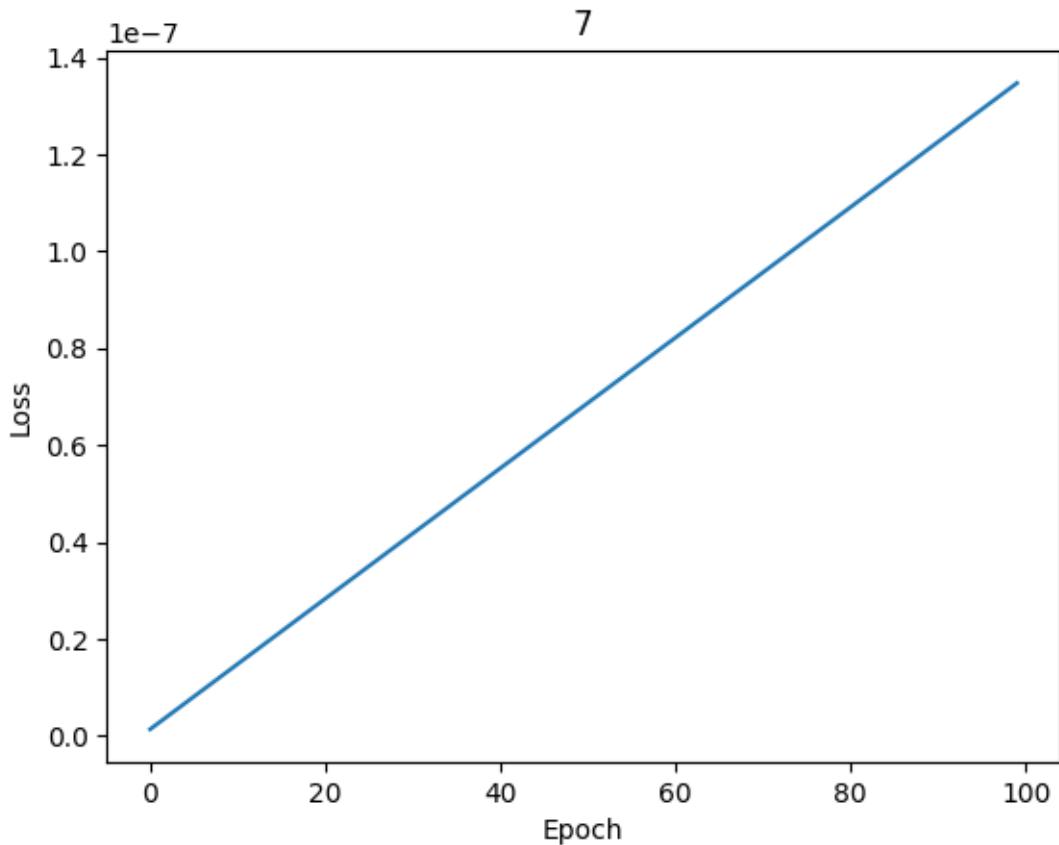


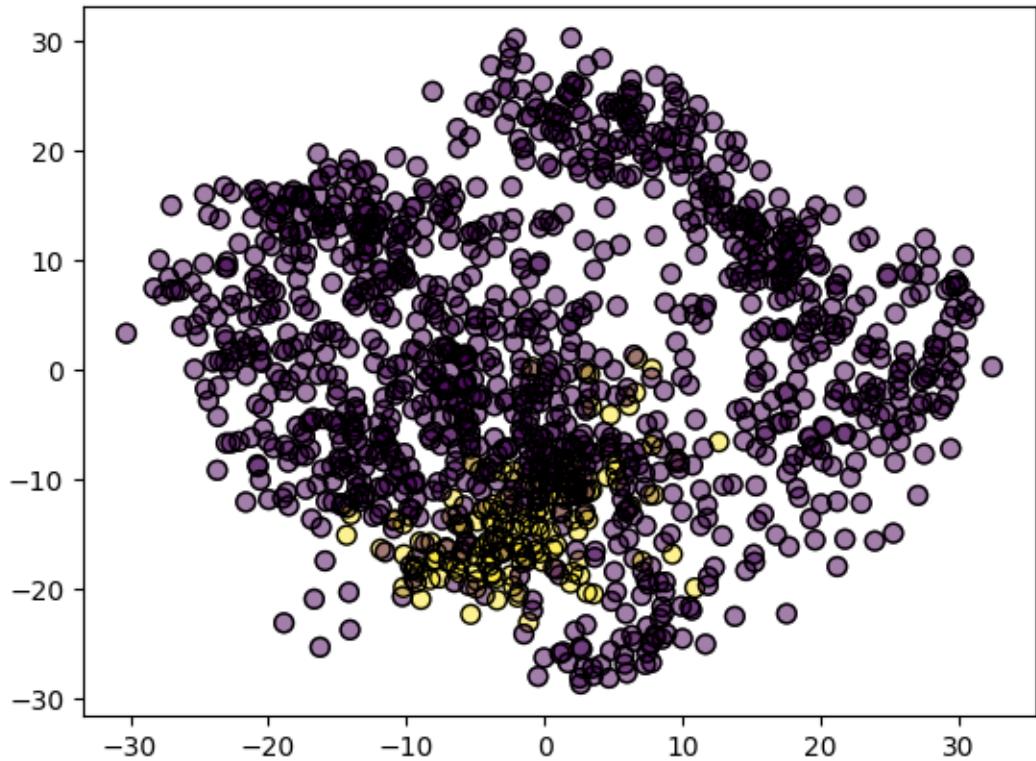


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EpochLog(epoch=3, loss=5.38799999981143e-09)
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```

```
EpochLog(epoch=22, loss=3.098099999930291e-08)
EpochLog(epoch=23, loss=3.232799999924028e-08)
EpochLog(epoch=24, loss=3.3674999999174946e-08)
EpochLog(epoch=25, loss=3.5021999999106924e-08)
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EpochLog(epoch=27, loss=3.771599999896279e-08)
EpochLog(epoch=28, loss=3.90629999988867e-08)
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EpochLog(epoch=44, loss=6.061499999730263e-08)
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EpochLog(epoch=72, loss=9.8330999992871e-08)
EpochLog(epoch=73, loss=9.967799999267366e-08)
EpochLog(epoch=74, loss=1.010249999924736e-07)
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EpochLog(epoch=94, loss=1.279649999879073e-07)
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EpochLog(epoch=97, loss=1.3200599998712938e-07)
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EpochLog(epoch=99, loss=1.3469999998659733e-07)
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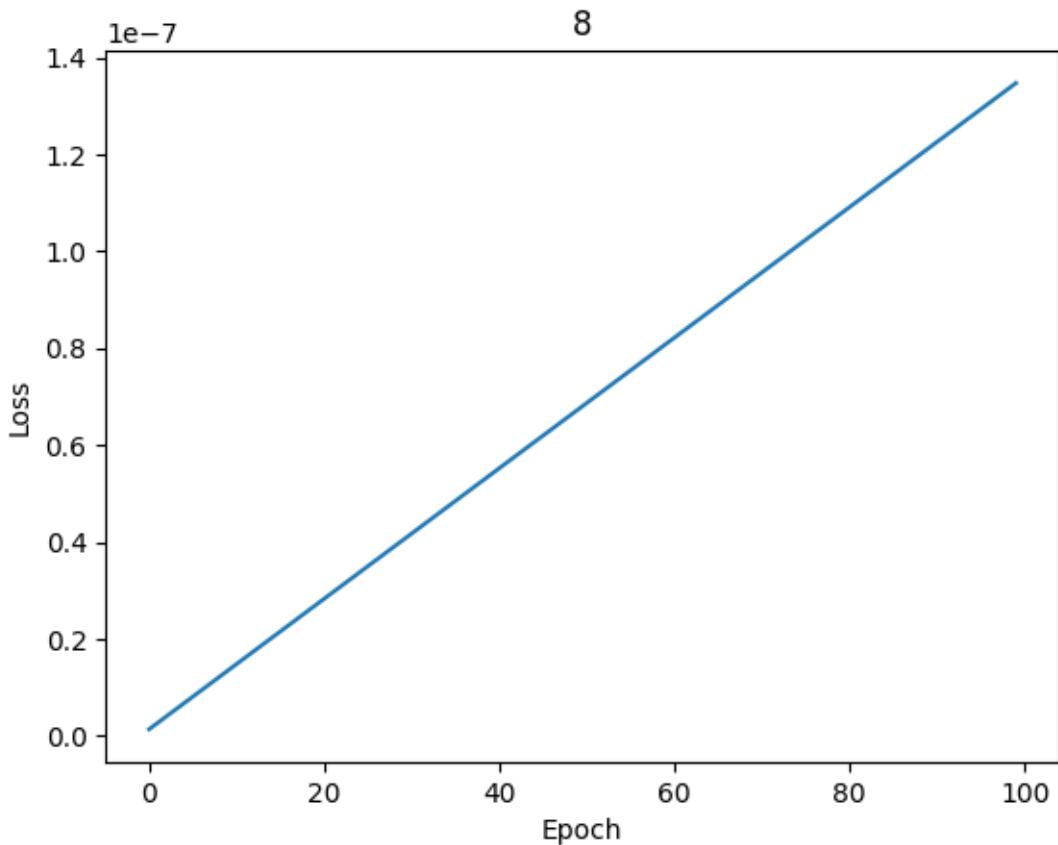


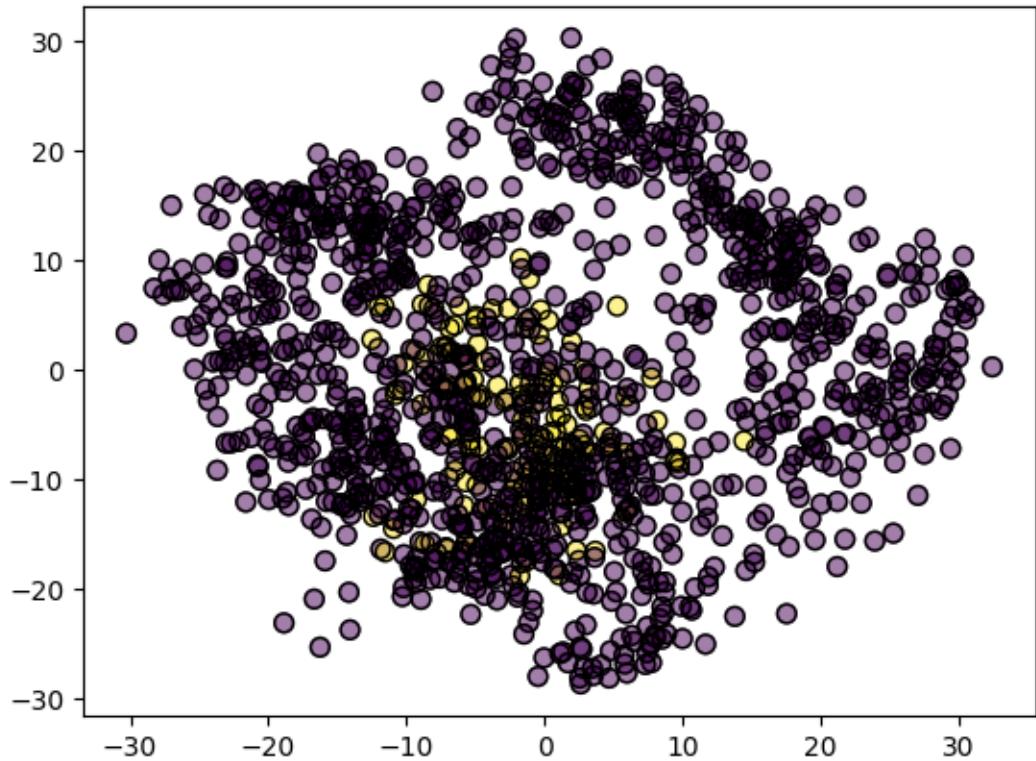


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EpochLog(epoch=8, loss=1.212299999896952e-08)
EpochLog(epoch=9, loss=1.346999999872034e-08)
EpochLog(epoch=10, loss=1.481699999844417e-08)
EpochLog(epoch=11, loss=1.6163999998141e-08)
EpochLog(epoch=12, loss=1.75109999978111e-08)
EpochLog(epoch=13, loss=1.885799999745413e-08)
EpochLog(epoch=14, loss=2.020499999707024e-08)
EpochLog(epoch=15, loss=2.1551999999665945e-08)
EpochLog(epoch=16, loss=2.2898999999622163e-08)
EpochLog(epoch=17, loss=2.4245999999575687e-08)
EpochLog(epoch=18, loss=2.559299999952652e-08)
EpochLog(epoch=19, loss=2.69399999947466e-08)
EpochLog(epoch=20, loss=2.8286999999420117e-08)
EpochLog(epoch=21, loss=2.9633999999362852e-08)
```

```
EpochLog(epoch=22, loss=3.098099999930291e-08)
EpochLog(epoch=23, loss=3.232799999924028e-08)
EpochLog(epoch=24, loss=3.3674999999174946e-08)
EpochLog(epoch=25, loss=3.5021999999106924e-08)
EpochLog(epoch=26, loss=3.636899999903621e-08)
EpochLog(epoch=27, loss=3.771599999896279e-08)
EpochLog(epoch=28, loss=3.90629999988867e-08)
EpochLog(epoch=29, loss=4.04099999988079e-08)
EpochLog(epoch=30, loss=4.175699999872641e-08)
EpochLog(epoch=31, loss=4.310399999864222e-08)
EpochLog(epoch=32, loss=4.445099999855533e-08)
EpochLog(epoch=33, loss=4.5797999998465756e-08)
EpochLog(epoch=34, loss=4.7144999998373475e-08)
EpochLog(epoch=35, loss=4.849199999827852e-08)
EpochLog(epoch=36, loss=4.983899999818087e-08)
EpochLog(epoch=37, loss=5.1185999998080517e-08)
EpochLog(epoch=38, loss=5.253299999797748e-08)
EpochLog(epoch=39, loss=5.387999999787173e-08)
EpochLog(epoch=40, loss=5.522699999776332e-08)
EpochLog(epoch=41, loss=5.6573999997652184e-08)
EpochLog(epoch=42, loss=5.7920999997538337e-08)
EpochLog(epoch=43, loss=5.926799999742185e-08)
EpochLog(epoch=44, loss=6.061499999730263e-08)
EpochLog(epoch=45, loss=6.196199999718073e-08)
EpochLog(epoch=46, loss=6.330899999705615e-08)
EpochLog(epoch=47, loss=6.465599999692884e-08)
EpochLog(epoch=48, loss=6.600299999679886e-08)
EpochLog(epoch=49, loss=6.734999999666615e-08)
EpochLog(epoch=50, loss=6.869699999653079e-08)
EpochLog(epoch=51, loss=7.004399999639271e-08)
EpochLog(epoch=52, loss=7.139099999625198e-08)
EpochLog(epoch=53, loss=7.273799999610852e-08)
EpochLog(epoch=54, loss=7.408499999596237e-08)
EpochLog(epoch=55, loss=7.543199999581354e-08)
EpochLog(epoch=56, loss=7.677899999566198e-08)
EpochLog(epoch=57, loss=7.812599999550776e-08)
EpochLog(epoch=58, loss=7.947299999535082e-08)
EpochLog(epoch=59, loss=8.081999999519121e-08)
EpochLog(epoch=60, loss=8.216699999502885e-08)
EpochLog(epoch=61, loss=8.351399999486387e-08)
EpochLog(epoch=62, loss=8.48609999946962e-08)
EpochLog(epoch=63, loss=8.620799999452576e-08)
EpochLog(epoch=64, loss=8.755499999435265e-08)
EpochLog(epoch=65, loss=8.89019999941769e-08)
EpochLog(epoch=66, loss=9.024899999399844e-08)
EpochLog(epoch=67, loss=9.159599999381725e-08)
EpochLog(epoch=68, loss=9.294299999363338e-08)
EpochLog(epoch=69, loss=9.428999999344686e-08)
```

```
EpochLog(epoch=70, loss=9.563699999325759e-08)
EpochLog(epoch=71, loss=9.698399999306561e-08)
EpochLog(epoch=72, loss=9.8330999992871e-08)
EpochLog(epoch=73, loss=9.967799999267366e-08)
EpochLog(epoch=74, loss=1.010249999924736e-07)
EpochLog(epoch=75, loss=1.0237199999227089e-07)
EpochLog(epoch=76, loss=1.0371899999206549e-07)
EpochLog(epoch=77, loss=1.0506599999185735e-07)
EpochLog(epoch=78, loss=1.0641299999164656e-07)
EpochLog(epoch=79, loss=1.0775999999143306e-07)
EpochLog(epoch=80, loss=1.0910699999121685e-07)
EpochLog(epoch=81, loss=1.1045399999099799e-07)
EpochLog(epoch=82, loss=1.118009999907764e-07)
EpochLog(epoch=83, loss=1.1314799999055213e-07)
EpochLog(epoch=84, loss=1.1449499999032518e-07)
EpochLog(epoch=85, loss=1.1584199999009551e-07)
EpochLog(epoch=86, loss=1.1718899998986312e-07)
EpochLog(epoch=87, loss=1.185359999896281e-07)
EpochLog(epoch=88, loss=1.1988299998939037e-07)
EpochLog(epoch=89, loss=1.2122999998914989e-07)
EpochLog(epoch=90, loss=1.2257699998890678e-07)
EpochLog(epoch=91, loss=1.2392399998866092e-07)
EpochLog(epoch=92, loss=1.2527099998841241e-07)
EpochLog(epoch=93, loss=1.2661799998816118e-07)
EpochLog(epoch=94, loss=1.279649999879073e-07)
EpochLog(epoch=95, loss=1.2931199998765067e-07)
EpochLog(epoch=96, loss=1.3065899998739136e-07)
EpochLog(epoch=97, loss=1.3200599998712938e-07)
EpochLog(epoch=98, loss=1.3335299998686468e-07)
EpochLog(epoch=99, loss=1.3469999998659733e-07)
```

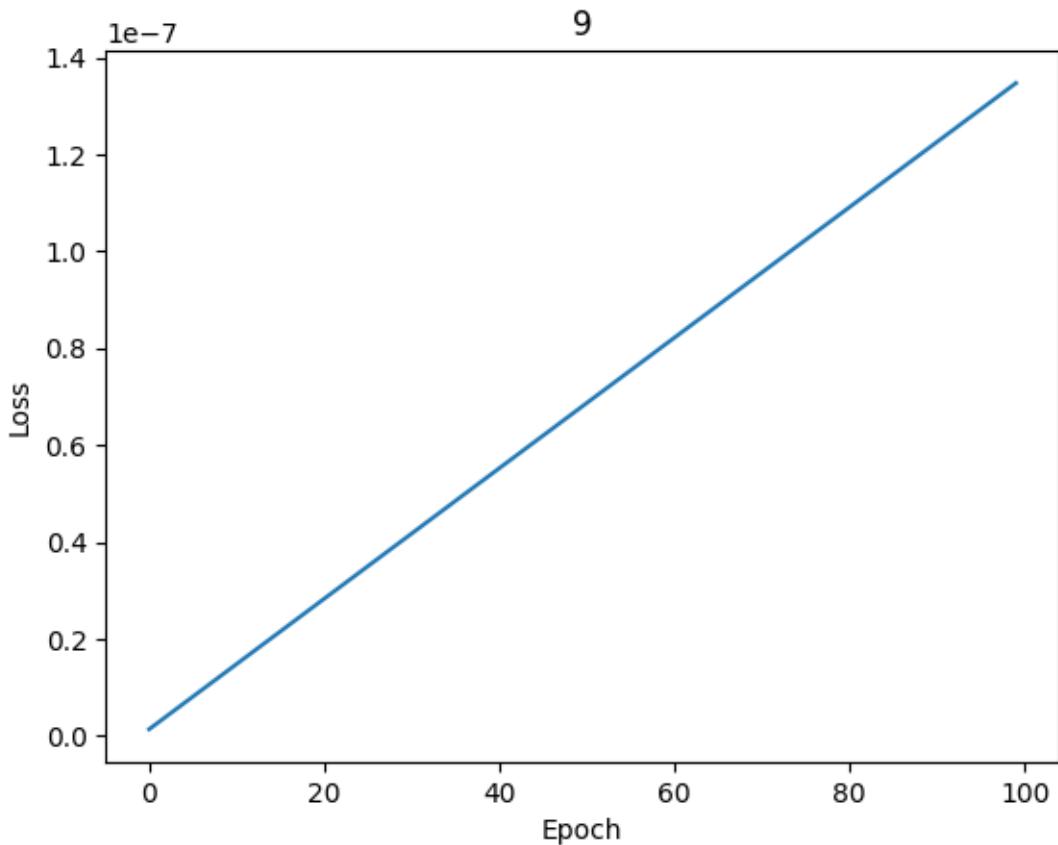


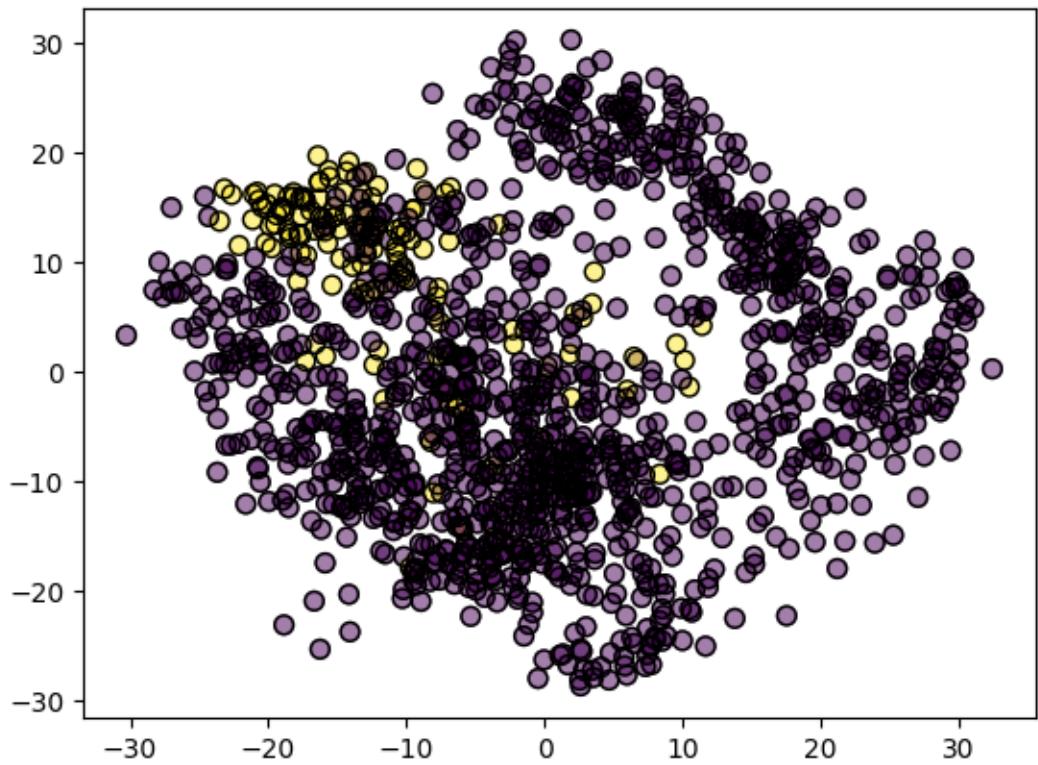


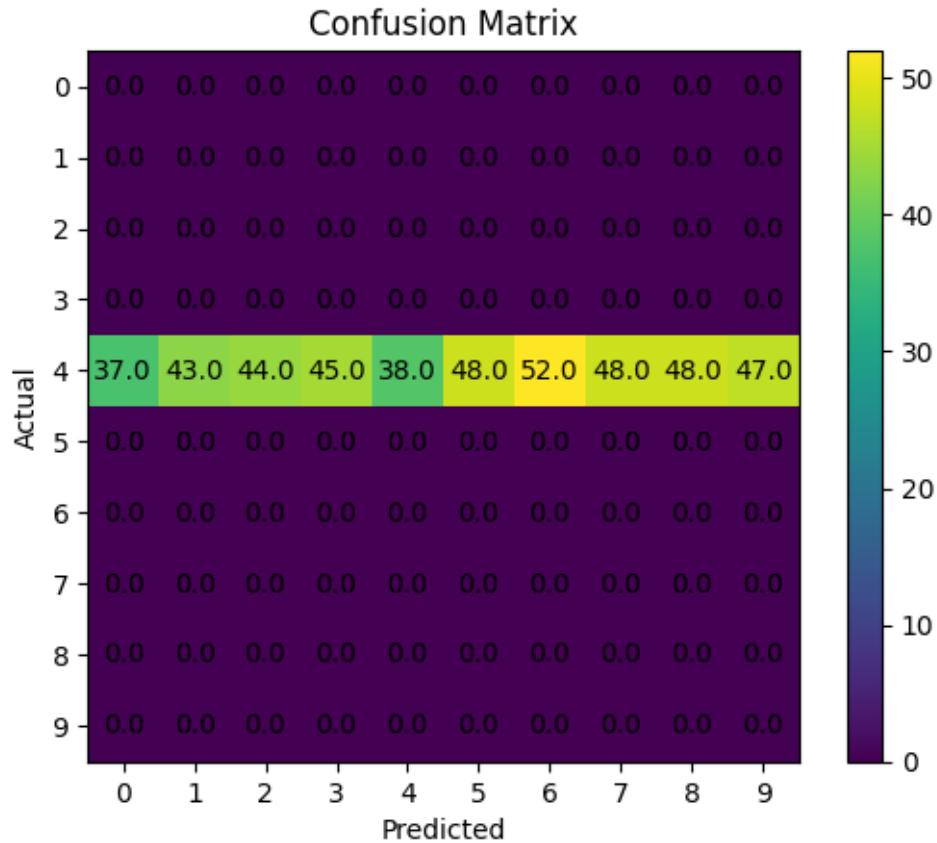
```
EpochLog(epoch=0, loss=1.3469999999993265e-09)
EpochLog(epoch=1, loss=2.6939999999959592e-09)
EpochLog(epoch=2, loss=4.04099999989897e-09)
EpochLog(epoch=3, loss=5.38799999981143e-09)
EpochLog(epoch=4, loss=6.73499999969691e-09)
EpochLog(epoch=5, loss=8.08199999955546e-09)
EpochLog(epoch=6, loss=9.42899999938714e-09)
EpochLog(epoch=7, loss=1.077599999919183e-08)
EpochLog(epoch=8, loss=1.212299999896952e-08)
EpochLog(epoch=9, loss=1.346999999872034e-08)
EpochLog(epoch=10, loss=1.481699999844417e-08)
EpochLog(epoch=11, loss=1.6163999998141e-08)
EpochLog(epoch=12, loss=1.75109999978111e-08)
EpochLog(epoch=13, loss=1.885799999745413e-08)
EpochLog(epoch=14, loss=2.020499999707024e-08)
EpochLog(epoch=15, loss=2.1551999999665945e-08)
EpochLog(epoch=16, loss=2.2898999999622163e-08)
EpochLog(epoch=17, loss=2.424599999575687e-08)
EpochLog(epoch=18, loss=2.55929999952652e-08)
EpochLog(epoch=19, loss=2.69399999947466e-08)
EpochLog(epoch=20, loss=2.828699999420117e-08)
EpochLog(epoch=21, loss=2.963399999362852e-08)
```

```
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EpochLog(epoch=25, loss=3.5021999999106924e-08)
EpochLog(epoch=26, loss=3.636899999903621e-08)
EpochLog(epoch=27, loss=3.771599999896279e-08)
EpochLog(epoch=28, loss=3.90629999988867e-08)
EpochLog(epoch=29, loss=4.04099999988079e-08)
EpochLog(epoch=30, loss=4.175699999872641e-08)
EpochLog(epoch=31, loss=4.310399999864222e-08)
EpochLog(epoch=32, loss=4.445099999855533e-08)
EpochLog(epoch=33, loss=4.5797999998465756e-08)
EpochLog(epoch=34, loss=4.7144999998373475e-08)
EpochLog(epoch=35, loss=4.849199999827852e-08)
EpochLog(epoch=36, loss=4.983899999818087e-08)
EpochLog(epoch=37, loss=5.1185999998080517e-08)
EpochLog(epoch=38, loss=5.253299999797748e-08)
EpochLog(epoch=39, loss=5.387999999787173e-08)
EpochLog(epoch=40, loss=5.522699999776332e-08)
EpochLog(epoch=41, loss=5.6573999997652184e-08)
EpochLog(epoch=42, loss=5.7920999997538337e-08)
EpochLog(epoch=43, loss=5.926799999742185e-08)
EpochLog(epoch=44, loss=6.061499999730263e-08)
EpochLog(epoch=45, loss=6.196199999718073e-08)
EpochLog(epoch=46, loss=6.330899999705615e-08)
EpochLog(epoch=47, loss=6.465599999692884e-08)
EpochLog(epoch=48, loss=6.600299999679886e-08)
EpochLog(epoch=49, loss=6.734999999666615e-08)
EpochLog(epoch=50, loss=6.869699999653079e-08)
EpochLog(epoch=51, loss=7.004399999639271e-08)
EpochLog(epoch=52, loss=7.139099999625198e-08)
EpochLog(epoch=53, loss=7.273799999610852e-08)
EpochLog(epoch=54, loss=7.408499999596237e-08)
EpochLog(epoch=55, loss=7.543199999581354e-08)
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EpochLog(epoch=58, loss=7.947299999535082e-08)
EpochLog(epoch=59, loss=8.081999999519121e-08)
EpochLog(epoch=60, loss=8.216699999502885e-08)
EpochLog(epoch=61, loss=8.351399999486387e-08)
EpochLog(epoch=62, loss=8.48609999946962e-08)
EpochLog(epoch=63, loss=8.620799999452576e-08)
EpochLog(epoch=64, loss=8.755499999435265e-08)
EpochLog(epoch=65, loss=8.89019999941769e-08)
EpochLog(epoch=66, loss=9.024899999399844e-08)
EpochLog(epoch=67, loss=9.159599999381725e-08)
EpochLog(epoch=68, loss=9.294299999363338e-08)
EpochLog(epoch=69, loss=9.428999999344686e-08)
```

```
EpochLog(epoch=70, loss=9.563699999325759e-08)
EpochLog(epoch=71, loss=9.698399999306561e-08)
EpochLog(epoch=72, loss=9.8330999992871e-08)
EpochLog(epoch=73, loss=9.967799999267366e-08)
EpochLog(epoch=74, loss=1.010249999924736e-07)
EpochLog(epoch=75, loss=1.0237199999227089e-07)
EpochLog(epoch=76, loss=1.0371899999206549e-07)
EpochLog(epoch=77, loss=1.0506599999185735e-07)
EpochLog(epoch=78, loss=1.0641299999164656e-07)
EpochLog(epoch=79, loss=1.0775999999143306e-07)
EpochLog(epoch=80, loss=1.0910699999121685e-07)
EpochLog(epoch=81, loss=1.1045399999099799e-07)
EpochLog(epoch=82, loss=1.118009999907764e-07)
EpochLog(epoch=83, loss=1.1314799999055213e-07)
EpochLog(epoch=84, loss=1.1449499999032518e-07)
EpochLog(epoch=85, loss=1.1584199999009551e-07)
EpochLog(epoch=86, loss=1.1718899998986312e-07)
EpochLog(epoch=87, loss=1.185359999896281e-07)
EpochLog(epoch=88, loss=1.1988299998939037e-07)
EpochLog(epoch=89, loss=1.2122999998914989e-07)
EpochLog(epoch=90, loss=1.2257699998890678e-07)
EpochLog(epoch=91, loss=1.2392399998866092e-07)
EpochLog(epoch=92, loss=1.2527099998841241e-07)
EpochLog(epoch=93, loss=1.2661799998816118e-07)
EpochLog(epoch=94, loss=1.279649999879073e-07)
EpochLog(epoch=95, loss=1.2931199998765067e-07)
EpochLog(epoch=96, loss=1.3065899998739136e-07)
EpochLog(epoch=97, loss=1.3200599998712938e-07)
EpochLog(epoch=98, loss=1.3335299998686468e-07)
EpochLog(epoch=99, loss=1.3469999998659733e-07)
```







TrainingScore(accuracy=0.08444444444444445, precision=None, recall=None, f1_score=None)

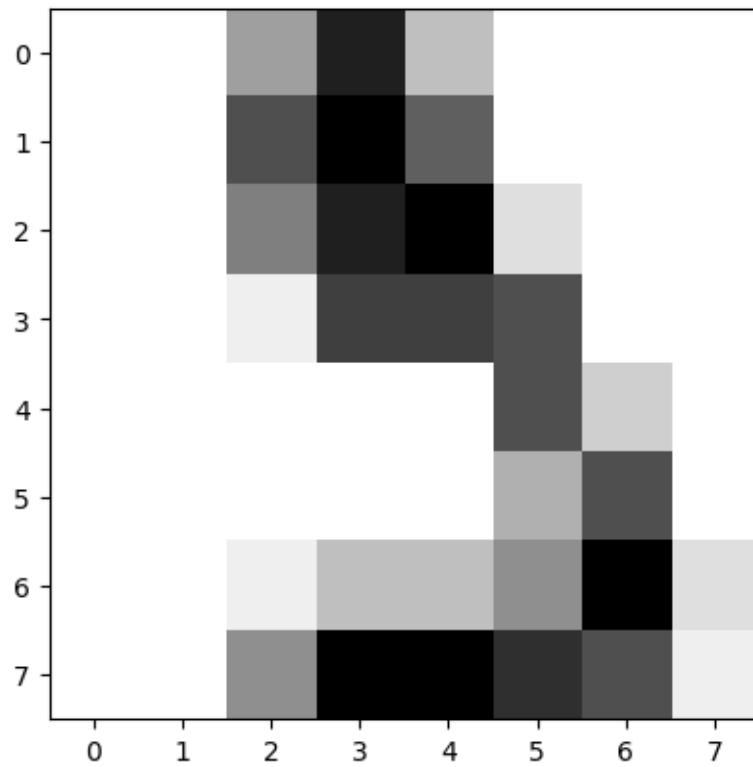
Przykładowe wyniki

```
[10]: n = 3
indices = np.random.choice(X_test.shape[0], n)

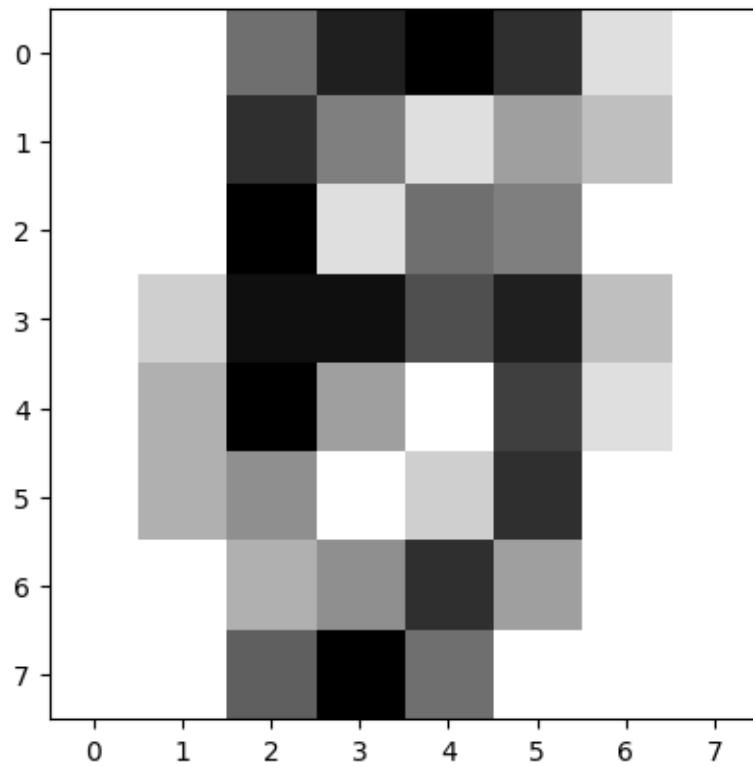
images = X_test[indices]
labels = y_test[indices]
predictions = clf.predict(images)

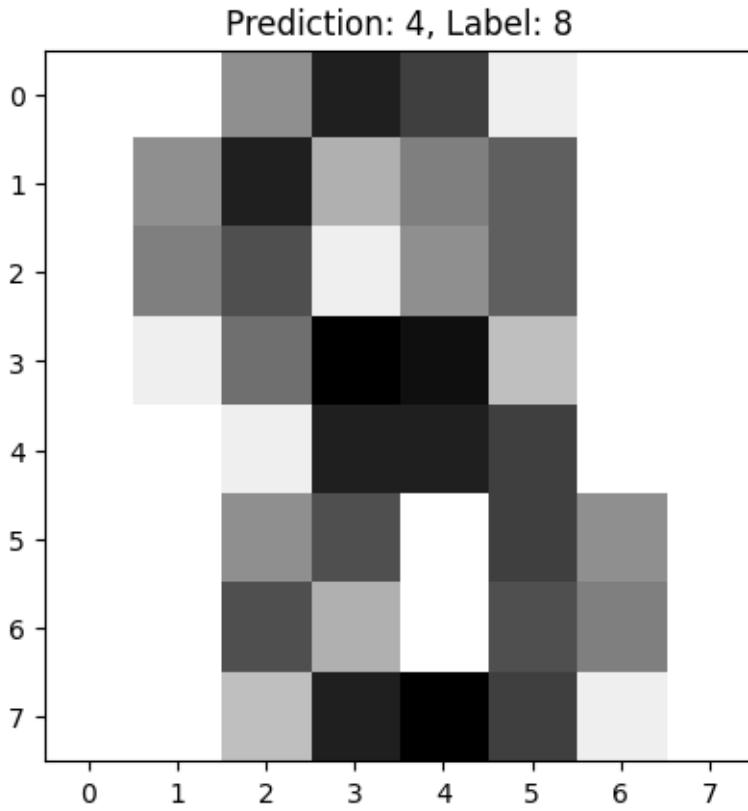
for i in range(n):
    plt.imshow(images[i].reshape(8, 8), cmap=plt.cm.gray_r,
    interpolation="nearest")
    plt.title(f"Prediction: {predictions[i]}, Label: {labels[i]}")
    plt.show()
```

Prediction: 4, Label: 9



Prediction: 4, Label: 5





1.2.3 Wnioski

Jądro wielomianowe Jak widać funkcja straty bardzo szybko zbiega do bardzo niskich wartości rzędu 10^{-12} i oscyluje na tym poziomie. Wyniki klasyfikacji są bardzo dobre, co widać na macierzy pomyłek i po dokładności klasyfikacji.

Jądro gaussowskie Dla wszystkich hiperparametrów jakie testowałem funkcja straty rosła w miarę trenowania. Jądro wielomianowe daje lepsze wyniki dla tego problemu.

1.2.4 Uwagi

Oba modele można pewnie lepiej dostroić