SOON CHUN HYANG UNIVERSITY

2024 Probabilistic Model Class

Using Genetic Algorithms to Optimize Penguin Data Prediction

SAIL
Senseable Artificial Intelligence Laboratory

순천향대학교 미래융합기술학과

Senseable AI Lab

석사과정 김병훈

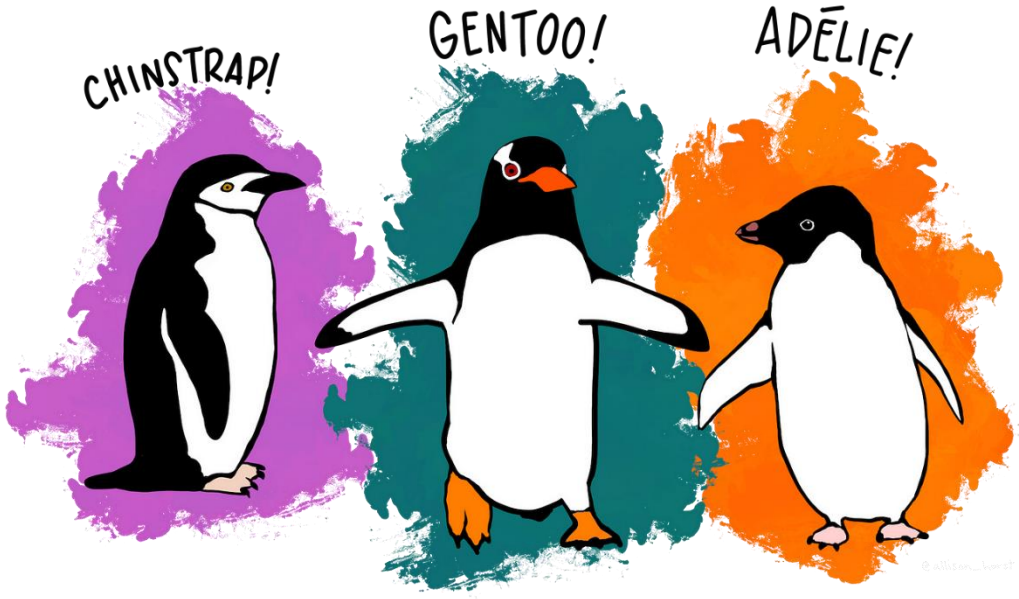
Introduction

Penguin Datasets

통계학 및 데이터 과학 교육용으로 널리 사용되는 데이터셋 중 하나

[변수 목록]

- species: 펭귄의 종(Adelie, Gentoo, Chinstrap)
- island: 펭귄이 발견된 섬(Biscoe, Dream, Torgersen)
- bill_length_mm: 부리의 길이(밀리미터)
- bill_depth_mm: 부리의 깊이(밀리미터)
- flipper_length_mm: 날개의 길이(밀리미터)
- body_mass_g: 몸무게(그램)
- sex: 펭귄의 성별

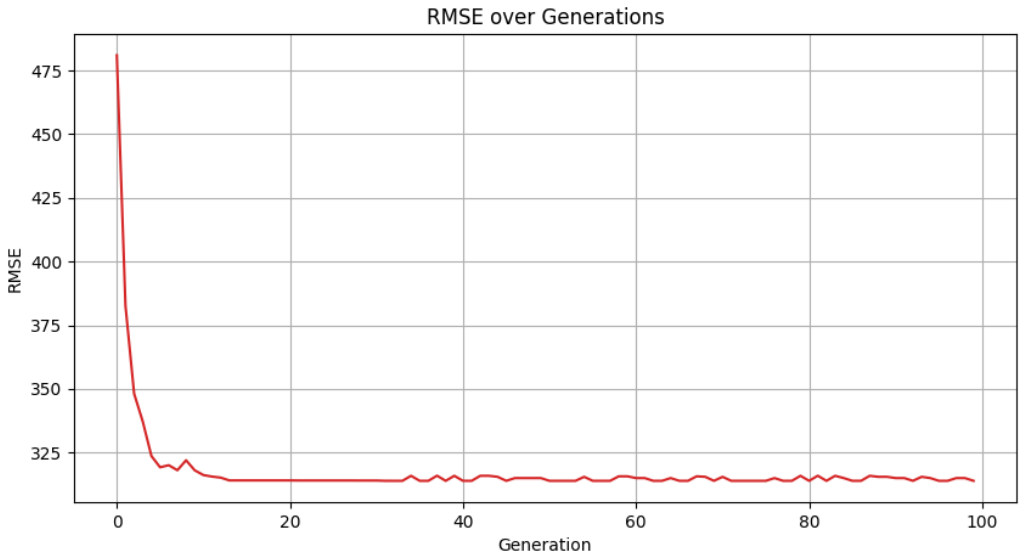


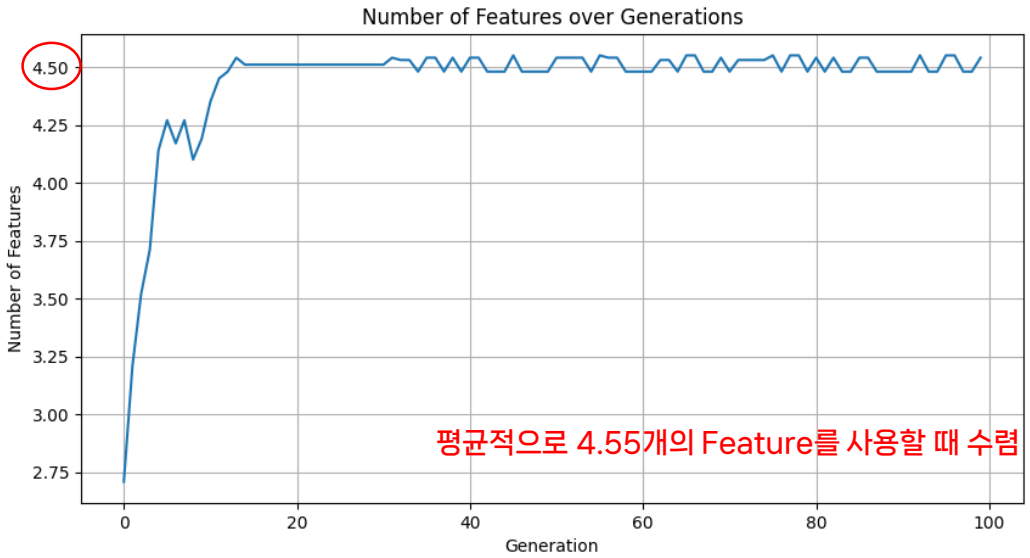
Example 1(몸무게 예측 + 변수 최소 선택)

문제 1. 몸무게 예측 + 변수 최소 선택

- RMSE를 최소화 하면서 독립변수 개수를 최소화 하는 모델 구축
- 총 Feature 개수(One-Hot Encoding 적용했을 때): 11개

Example 1(몸무게 예측 + 변수 선택)

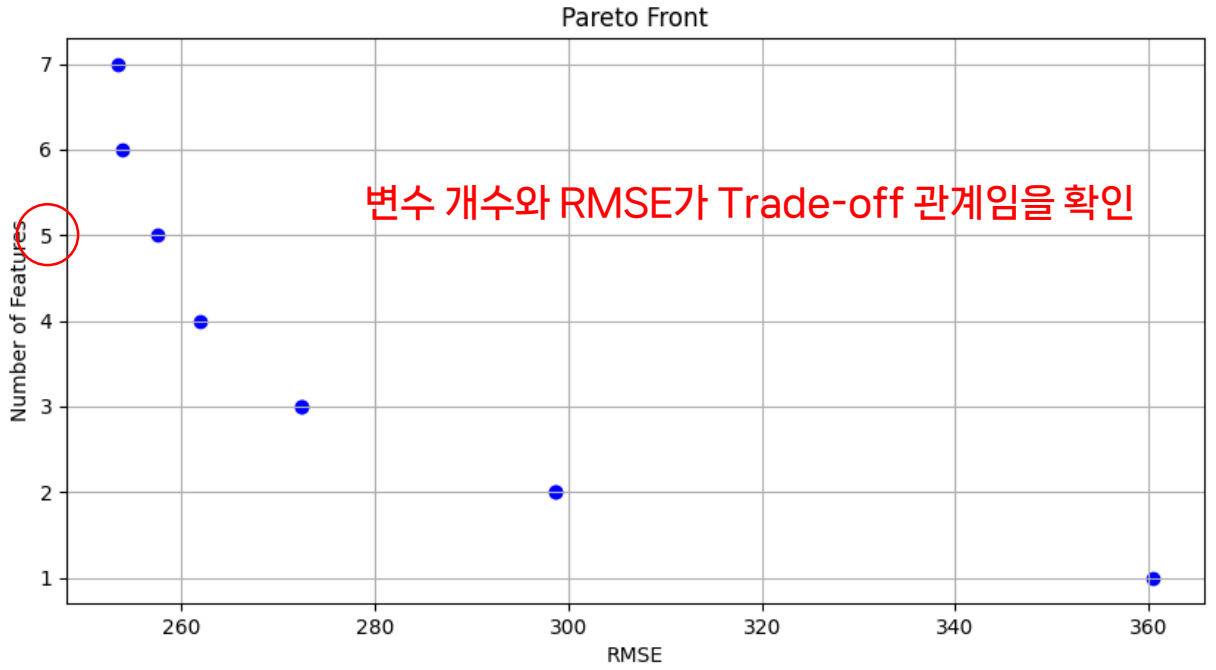




n_gen	n_eval	n_nds	eps	indicator
1	72	4	-	-
2	172	5	0.2008514994	ideal
3	272	7	0.0615265518	ideal
4	372	6	0.2000000000	nadir
5	472	8	0.0040820828	ideal
6	572	9	0.000000E+00	f
7	672	9	0.000000E+00	f
8	772	9	0.000000E+00	f
9	872	9	0.000000E+00	f
10	972	9	0.000000E+00	f
96	9572	9	5.859510E-17	f
97	9672	9	5.859510E-17	f
98	9772	9	5.859510E-17	f
99	9872	9	5.859510E-17	f
100	9972	9	5.859510E-17	f

Number of Non-Dominated Solutions(파레토 프론트)

Example 1(몸무게 예측 + 변수 선택)



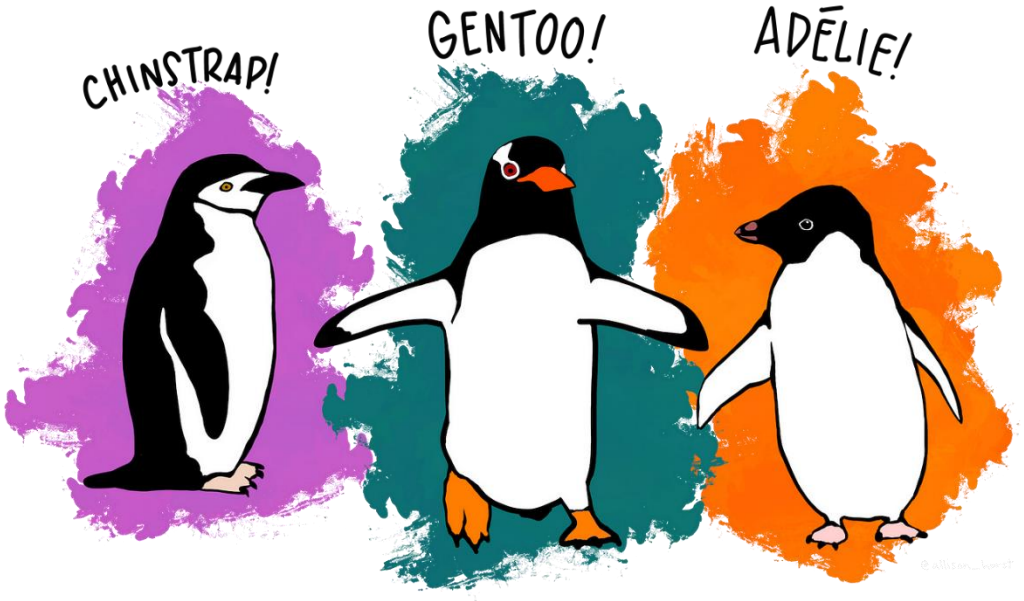
솔루션	선택된 feature	Test RMSE	Feature 개수
1	flipper_length_mm	360.398	1
2,5	flipper_length_mm, species_Gentoo, sex_FEMALE(MALE)	272.407	3
3,8	species_Gentoo, sex_FEMALE(MALE)	298.722	2
4	bill_length_mm, bill_depth_mm, flipper_length_mm, species_Adelie, species_Gentoo, sex_MALE	253.9	6
6	bill_depth_mm, flipper_length_mm, species_Gentoo, sex_FEMALE	261.871	4
7	bill_length_mm, bill_depth_mm, flipper_length_mm, species_Adelie, species_Chinstrap, island_Biscoe, sex_FEMALE	253.464	7
9	bill_length_mm, flipper_length_mm, species_Chinstrap, island_Biscoe, sex_MALE	257.497	5

→ 솔루션 9 선택

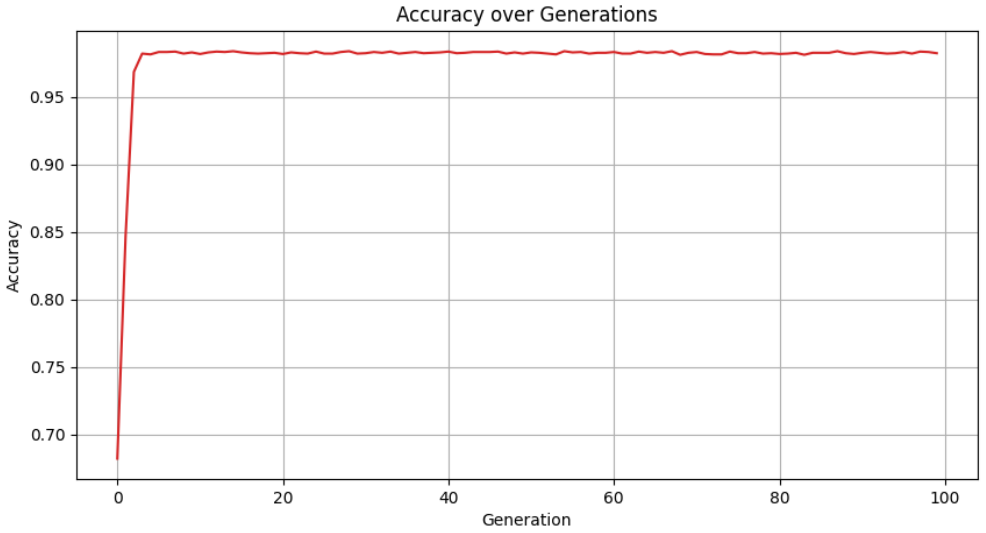
Example 2(펭귄 종 예측 + 변수 최소 선택)

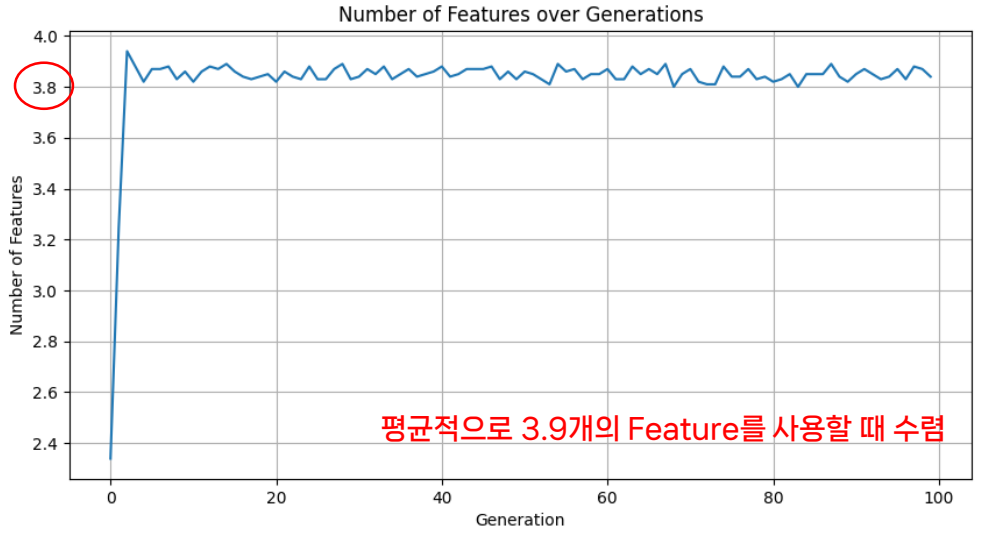
문제 2. 펭귄 종 예측 + 변수 최소 선택

- 정확도를 최대화 하면서 독립변수 개수를 최소화 하는 모델 구축
- 총 Feature 개수(One-Hot Encoding 적용했을 때): 9개

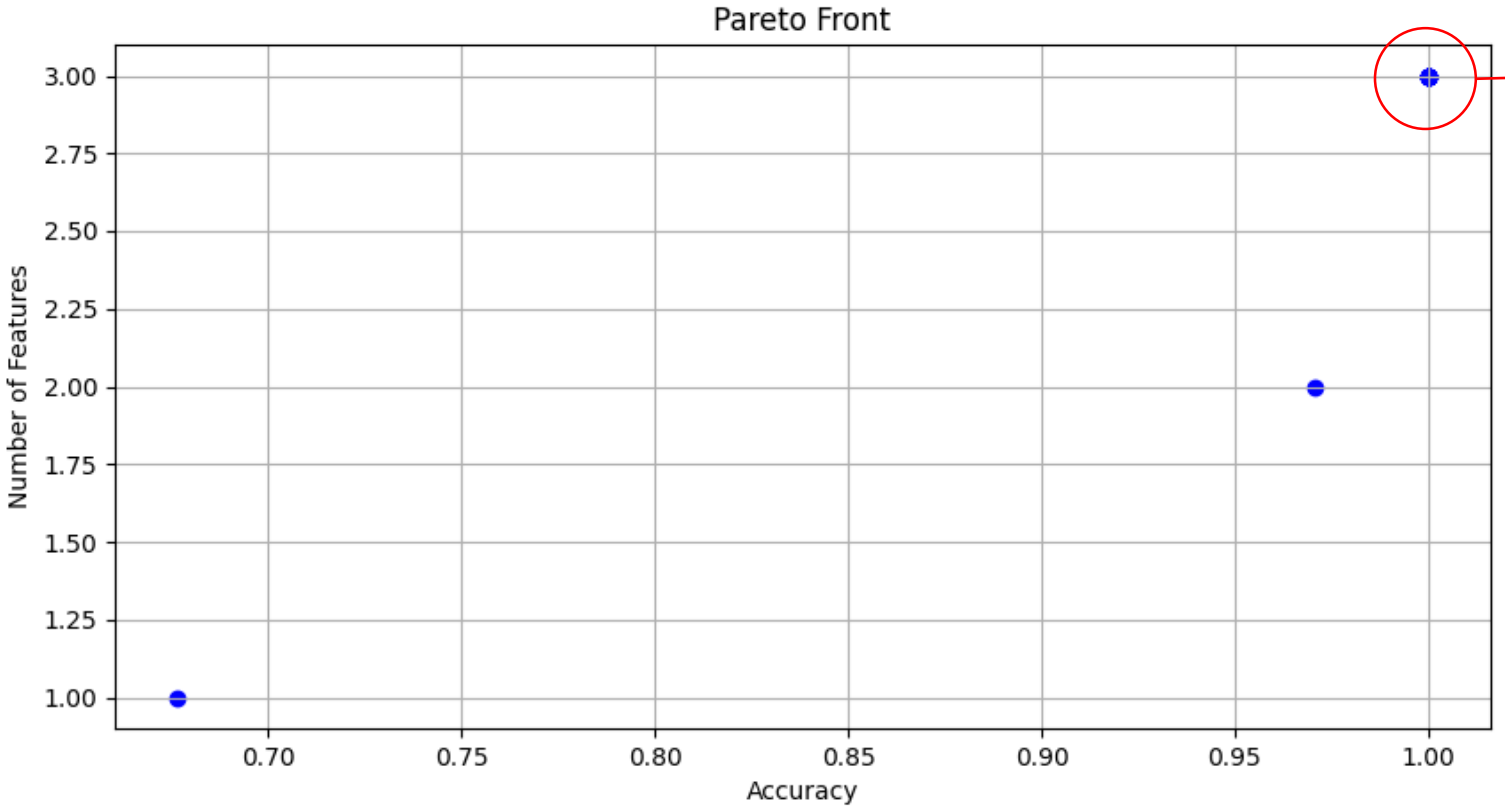


Example 2(펭귄 종 예측 + 변수 선택)





Example 2(펭귄 종 예측 + 변수 선택)



Feature 3개 선택에 몰려 있음

Example 2(펭귄 종 예측 + 변수 선택)

솔루션	선택된 feature	Test Accuracy	Feature 개수
1	bill_length_mm, flipper_length_mm, island_Dream	1	3
2	bill_depth_mm	0.676471	1
3	bill_length_mm, bill_depth_mm, sex_MALE	1	3
4	bill_length_mm, bill_depth_mm, island_Biscoe	1	3
5	bill_length_mm, bill_depth_mm, island_Dream	1	3
6	bill_length_mm, flipper_length_mm, sex_MALE	1	3
7	bill_length_mm, flipper_length_mm	0.970588	2
8	bill_length_mm, island_Biscoe, sex_FEMALE	1	3
9	bill_length_mm, flipper_length_mm, sex_FEMALE	1	3
10	bill_length_mm, bill_depth_mm, sex_FEMALE	1	3
11	bill_length_mm, bill_depth_mm, body_mass_g	1	3
12	bill_length_mm, flipper_length_mm, island_Biscoe	1	3
13	bill_length_mm, island_Dream, sex_FEMALE	1	3
14	bill_length_mm, bill_depth_mm, flipper_length_mm	1	3
15	bill_length_mm, island_Dream, sex_MALE	1	3
16	bill_length_mm, island_Biscoe, sex_MALE	1	3

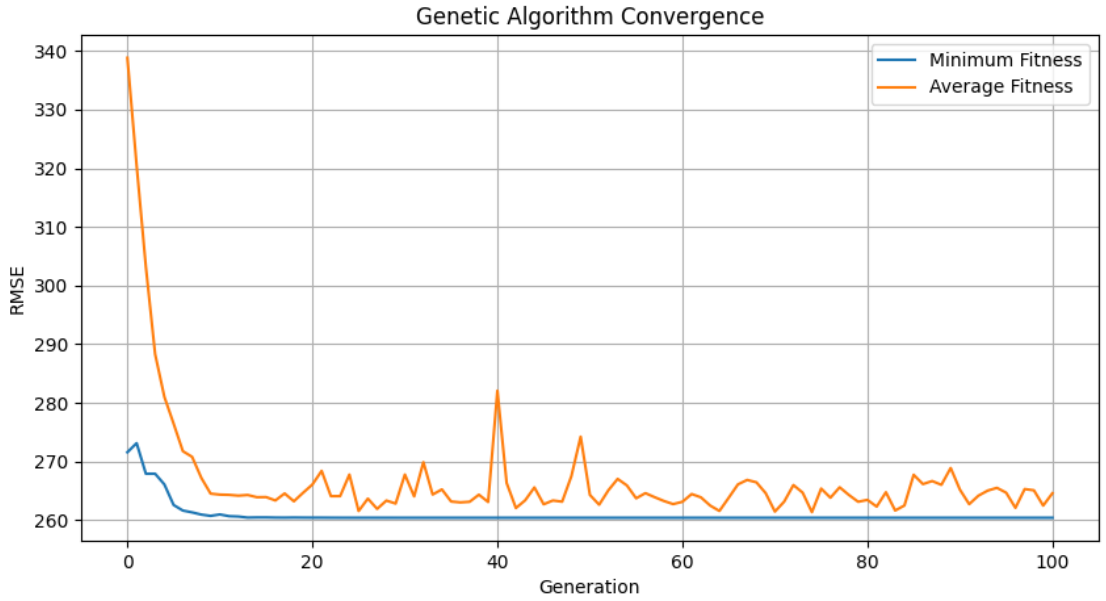
정확도 1인 것들 중, bill_length_mm 는 14번 포함
bill_depth_mm, flipper_length_mm은 8번씩 포함으로 두번째로 많음

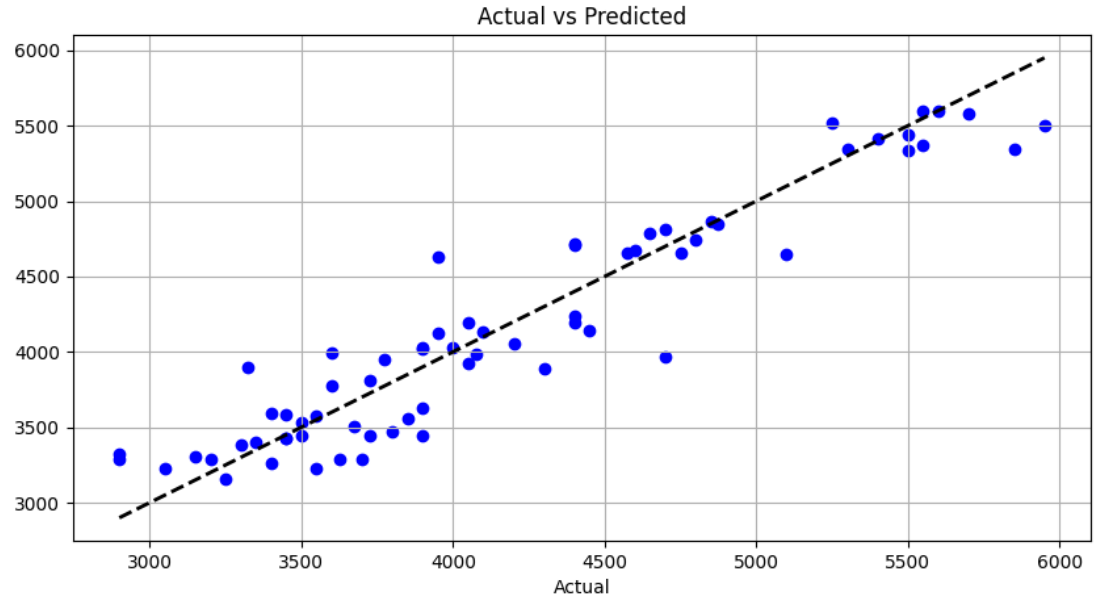
Example 3(몸무게 예측)

문제 1. 몸무게 예측

- 목표: RMSE를 최소화 시키는 앙상블 모형 만들기(모델 가중치 최적화)
- 사용 모델
  - Linear Regression
  - DecisionTree Regression
  - RandomForest Regression
  - Support Vector Regression
  - K-NN Regression

Example 3(몸무게 예측)





Best Weights: [1.02582795 -0.06217455 0.08237867 0.02853572 -0.0745678]

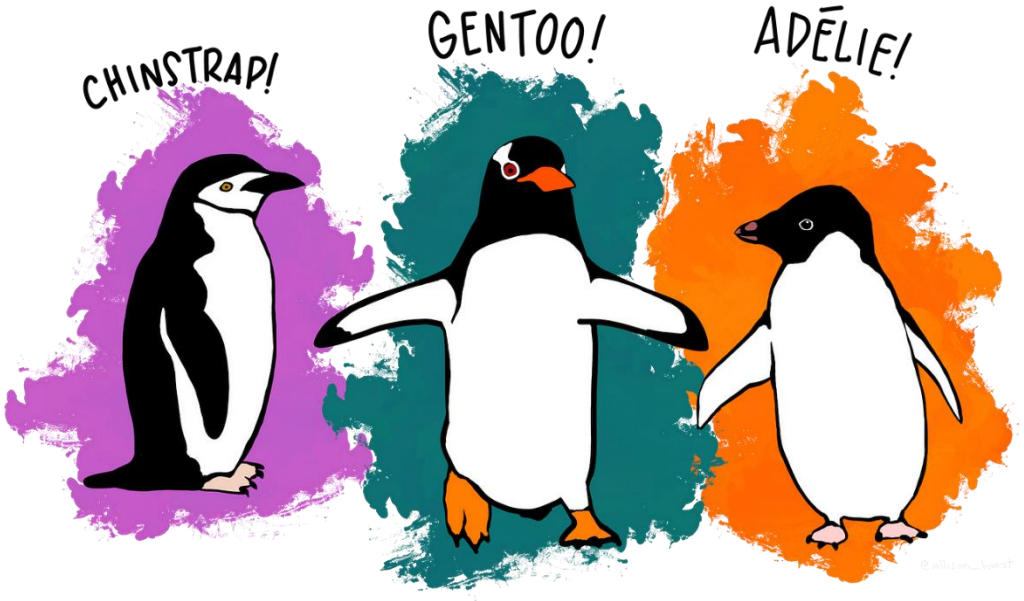
Linear, DT, RF, SVM, K-NN순

Final RMSE: 260.4304628170861

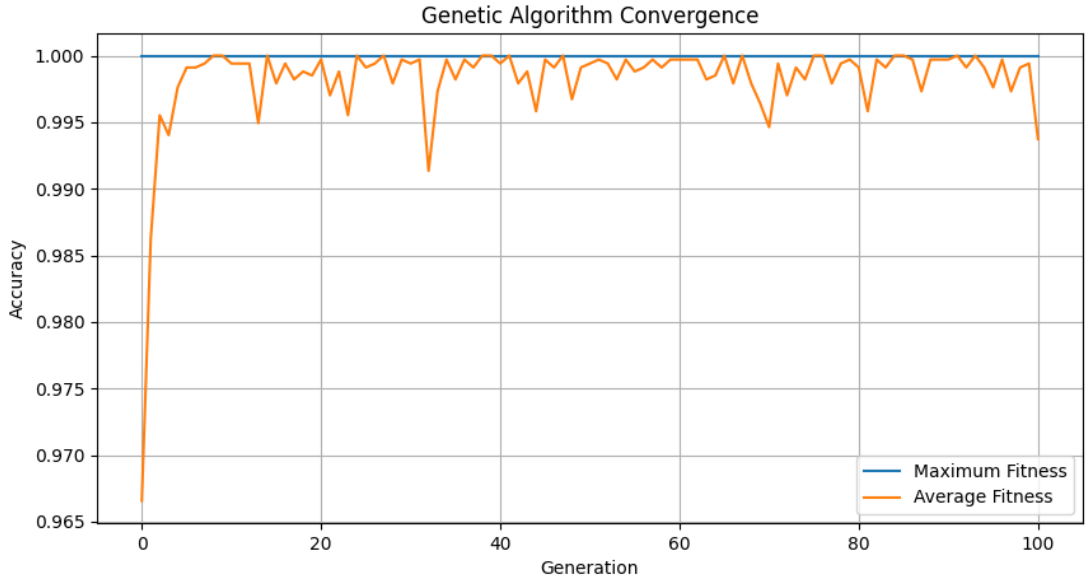
Example 4(펭귄 종 예측)

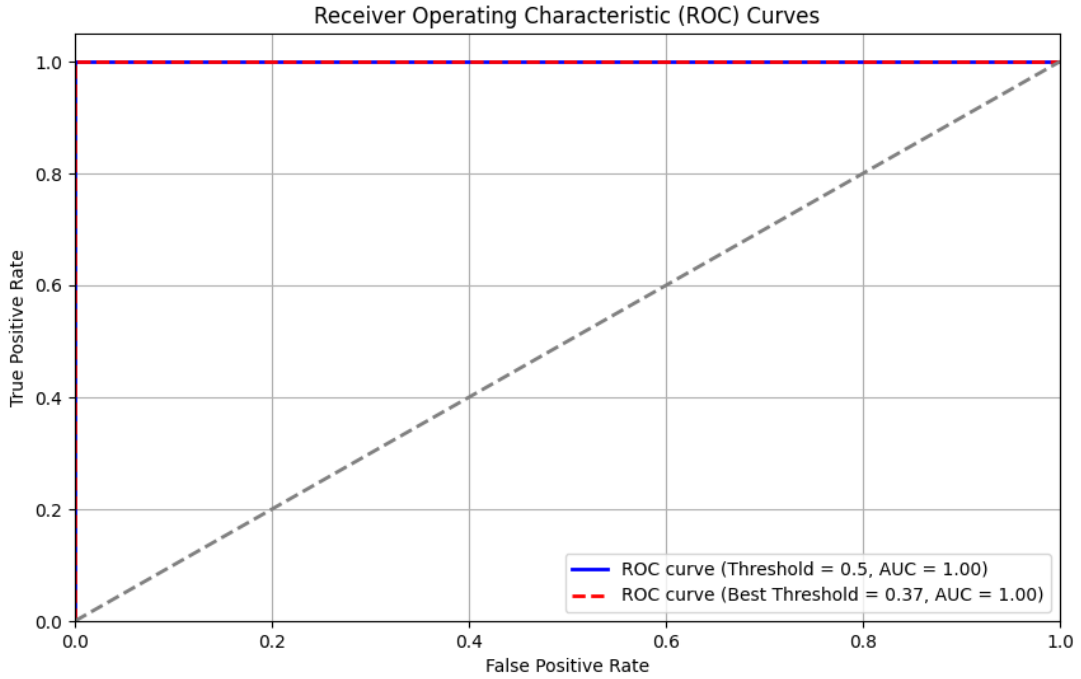
문제 2. 펭귄 종 예측

- 목표: 확률 값(0-1) 바탕으로 최적의 임계값 탐색
- 사용 모델: Logistic Regression



Example 4(펭귄 종 예측)



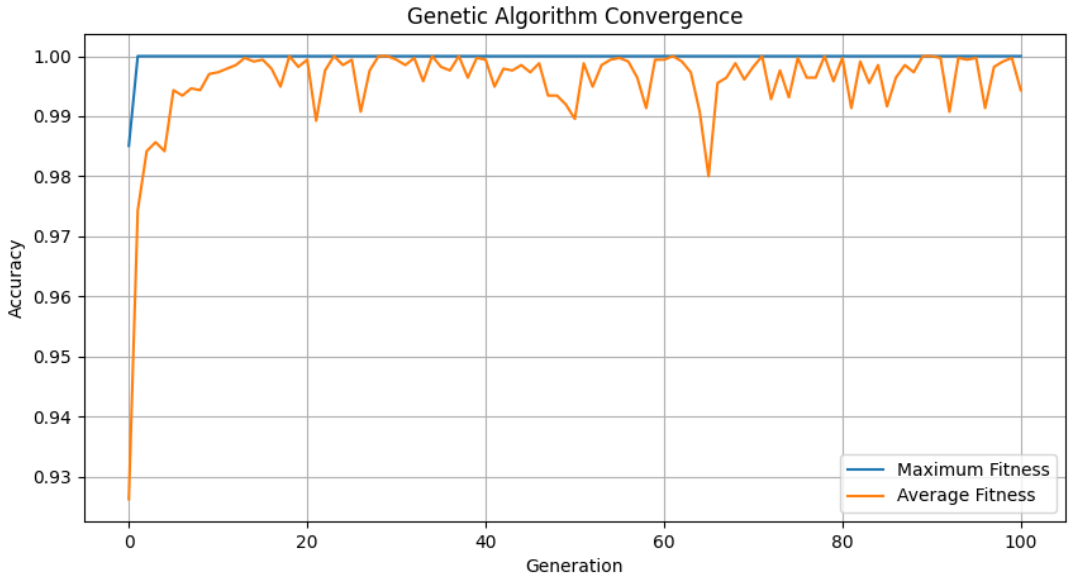


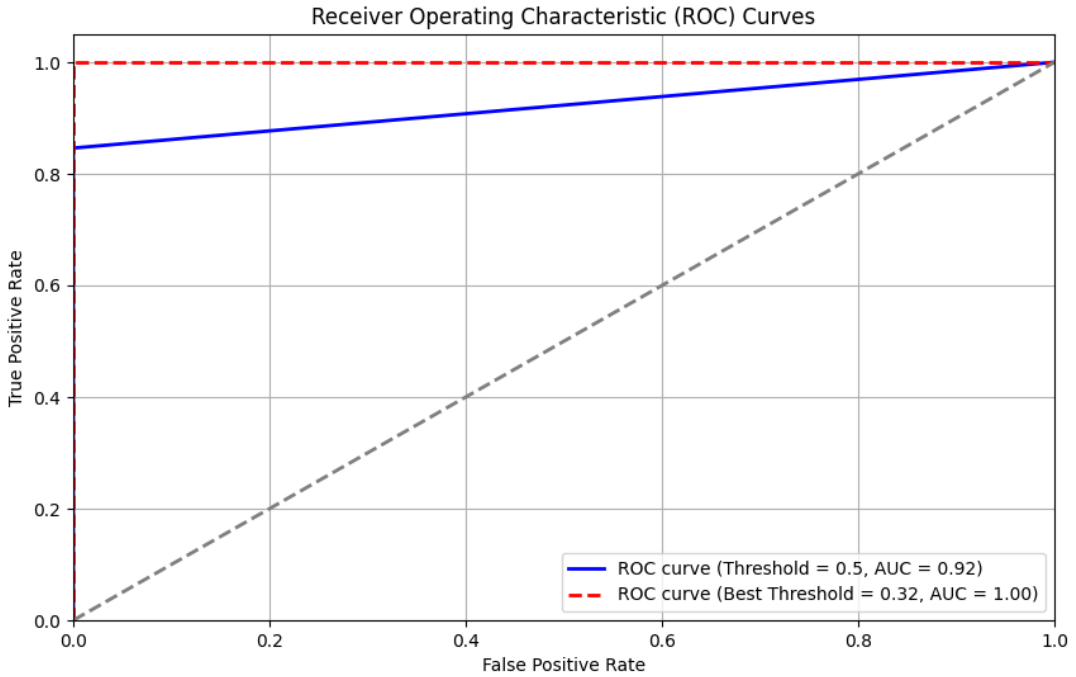
[Adelie]

Best Threshold: 0.37

Best Threshold Accuracy: 1.0
Default(0.5) Accuracy: 1.0

Example 4(펭귄 종 예측)



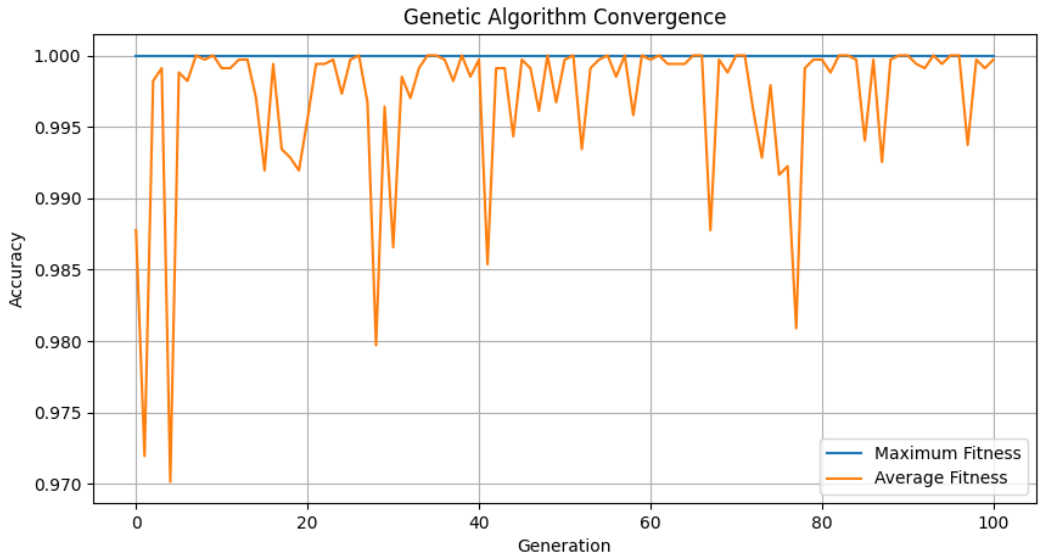


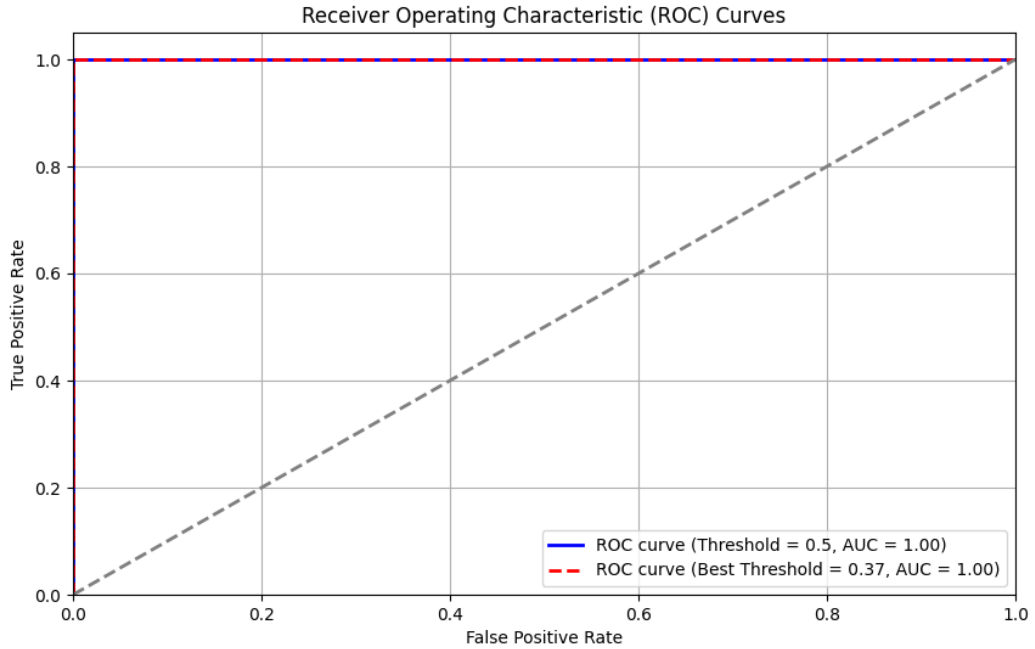
[Chinstrap]

Best Threshold: 0.3241

Best Threshold Accuracy: 1.0
Default(0.5) Accuracy: 0.9701492537313433

Example 4(펭귄 종 예측)





[Gentoo]

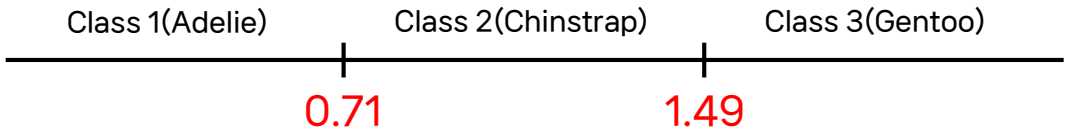
Best Threshold: 0.37

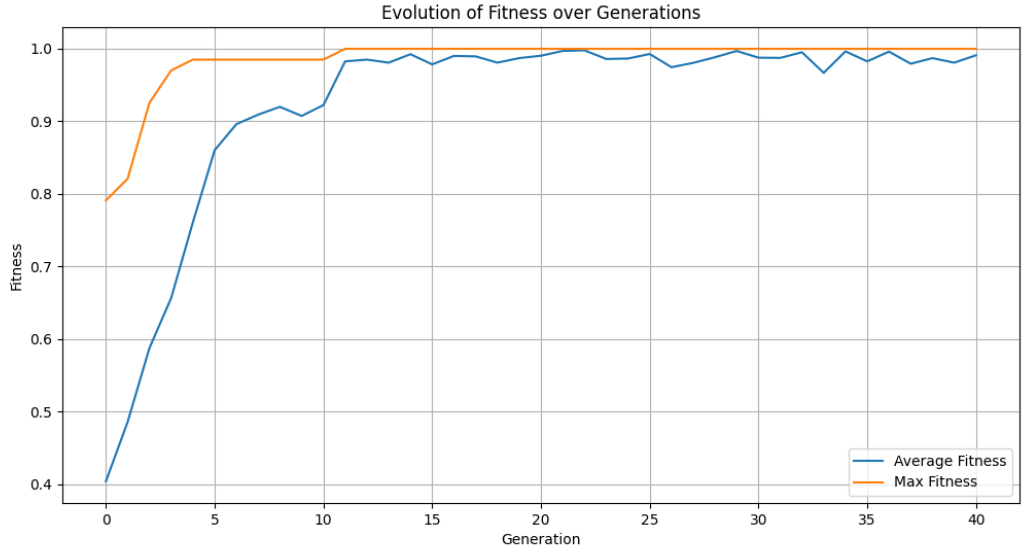
Best Threshold Accuracy: 1.0
Default(0.5) Accuracy: 1.0

Example 4(펭귄 종 예측)

교수님이 출제하신 문제 의도로 풀기 위해서는, Linear regression 사용해야 할 것으로 보임

[풀이 과정]
1. 회귀 값 추정
2. 각 예측 값에 대한 임계값 설정에 대한 최적화 수행





Best Threshold: [0.7074788381123052, 1.4909545576011507]

Accuracy: 1.0

번외(TPOT 라이브러리)

TPOT 라이브러리

- 예측 모델링 작업을 위한 AutoML 라이브러리
- genetic programming으로 머신러닝 파이프라인을 최적화
- 여러 머신러닝 모델을 기반으로 feature selection과 hyperparameter 튜닝을 자동으로 수행

```
# Average CV score on the training set was: -89667.24995761643
exported_pipeline = make_pipeline(
    StackingEstimator(estimator=RandomForestRegressor(bootstrap=True, max_features=1.0, min_samples_leaf=13, min_samples_split=13, n_estimators=100)),
    KNeighborsRegressor(n_neighbors=13, p=1, weights="uniform")
)

exported_pipeline.fit(training_features, training_target)
results = exported_pipeline.predict(testing_features)
```

변수 모두 사용 / 스태킹 방법으로 RF, KNN 사용할 때 가장 최적의 값이 나옴

RMSE: 249.063422719208

Thanks