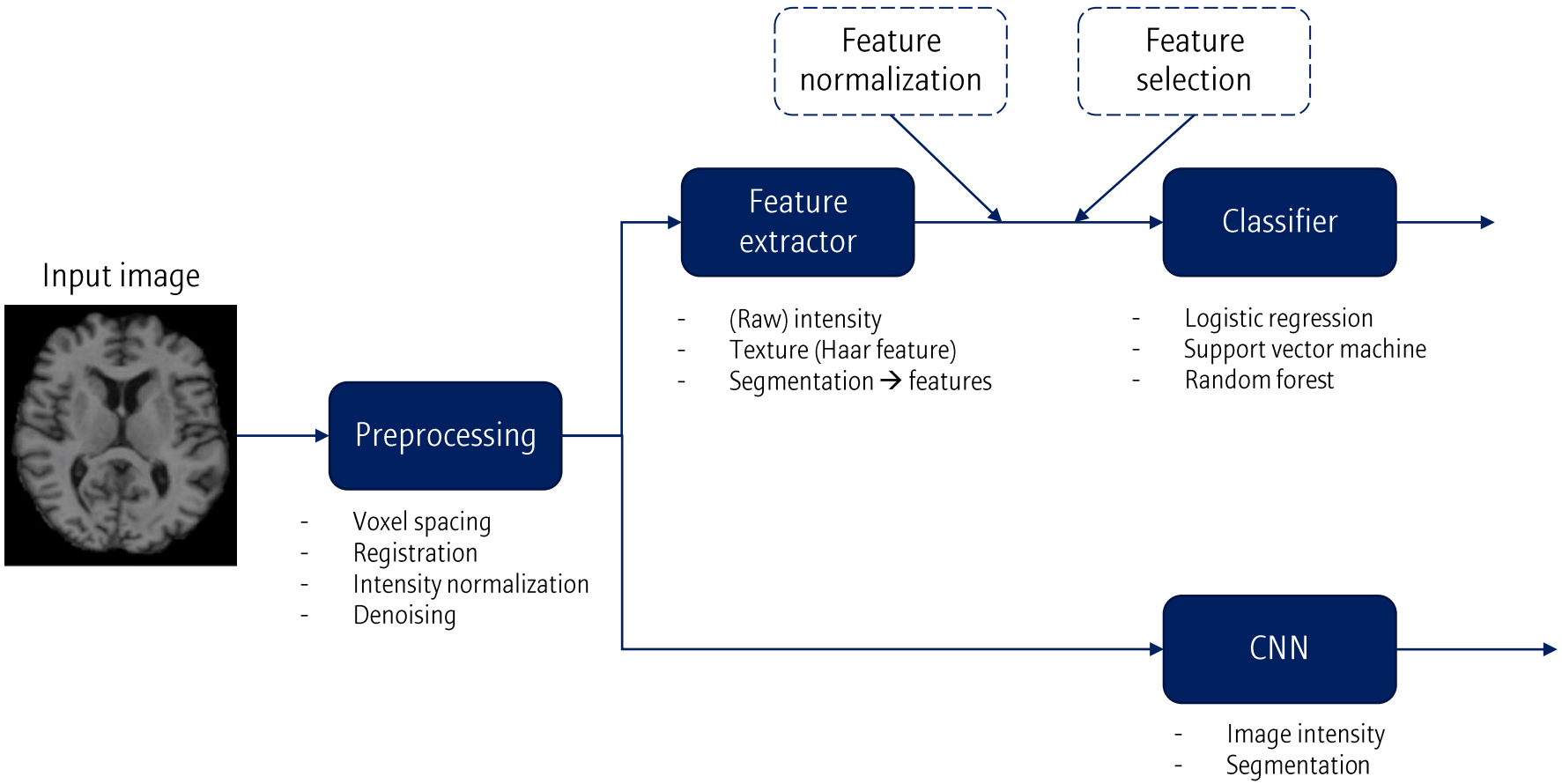
Medical Image Analysis

4. Medical image classification(3)

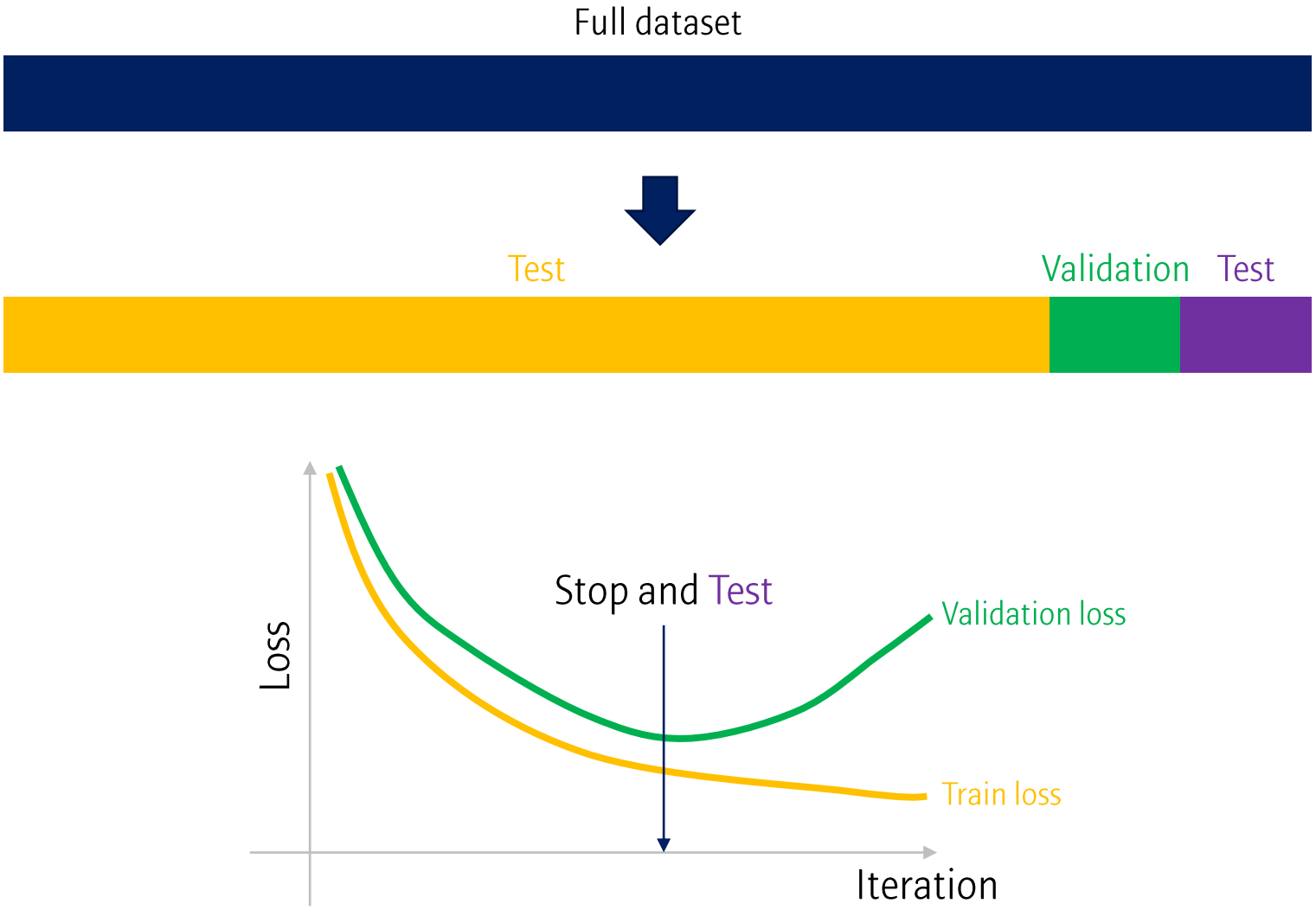
1. Overall procedure

Overall procedure for classification



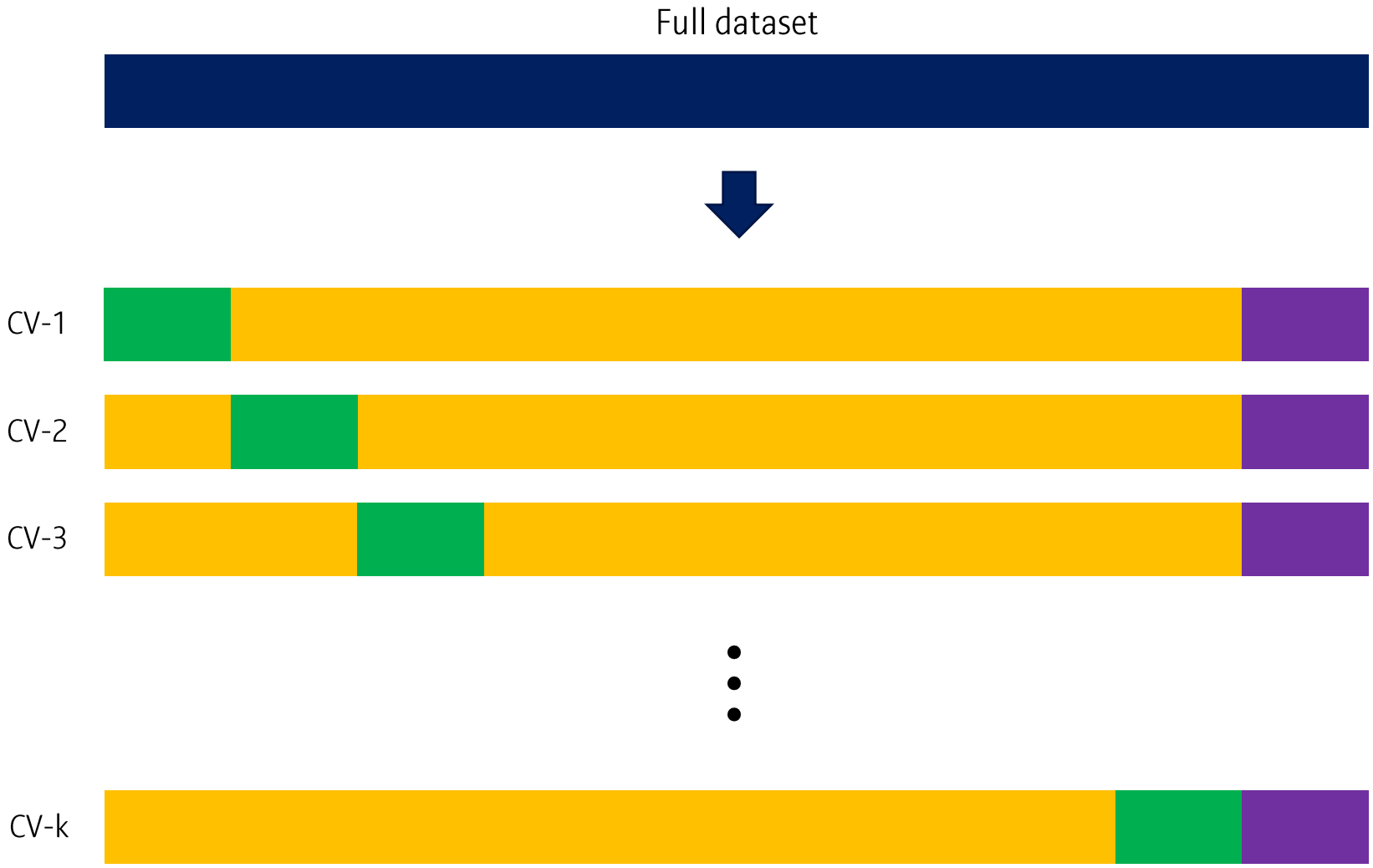
2. Validation

Validation



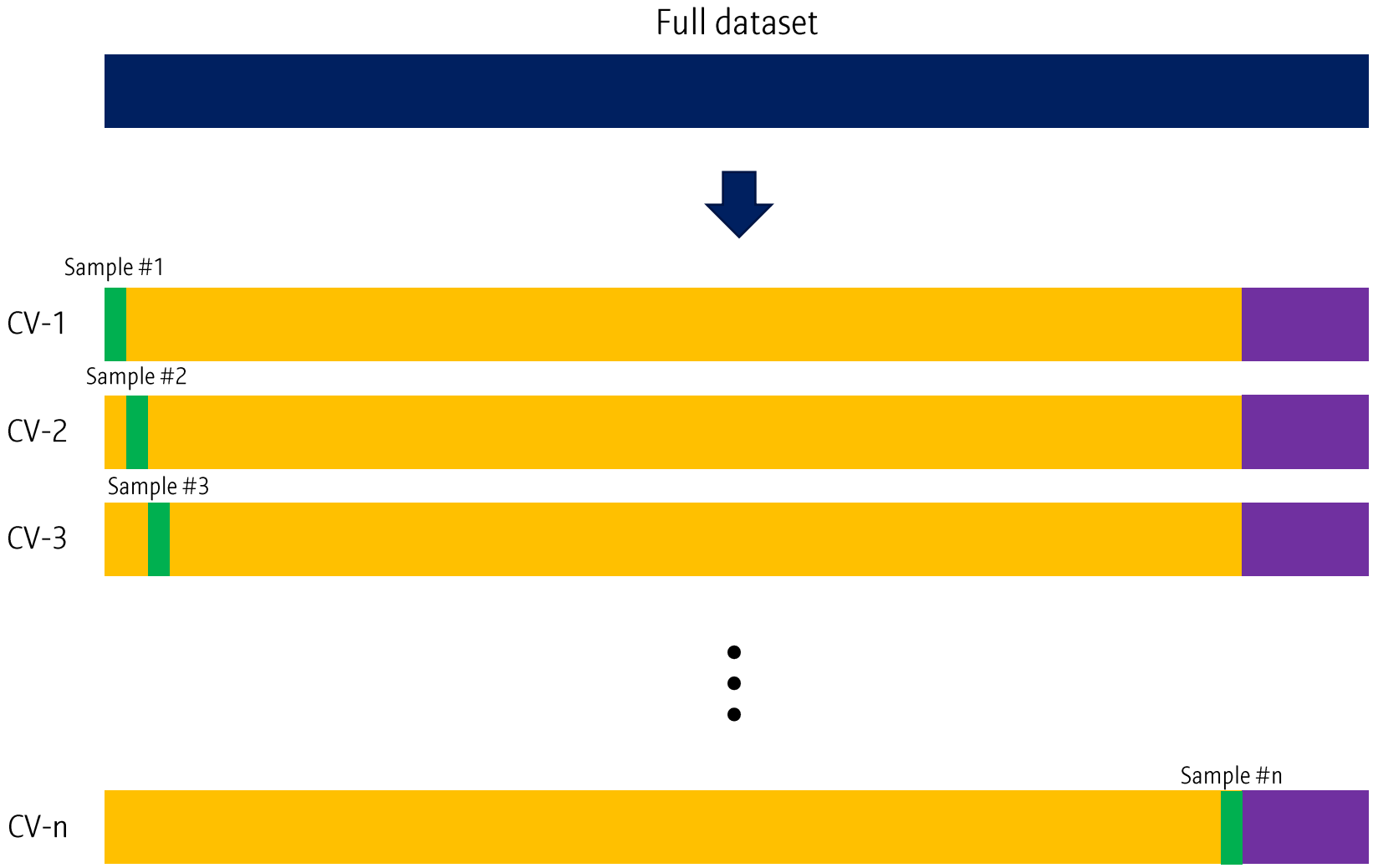
2. Validation

K-fold Cross validation



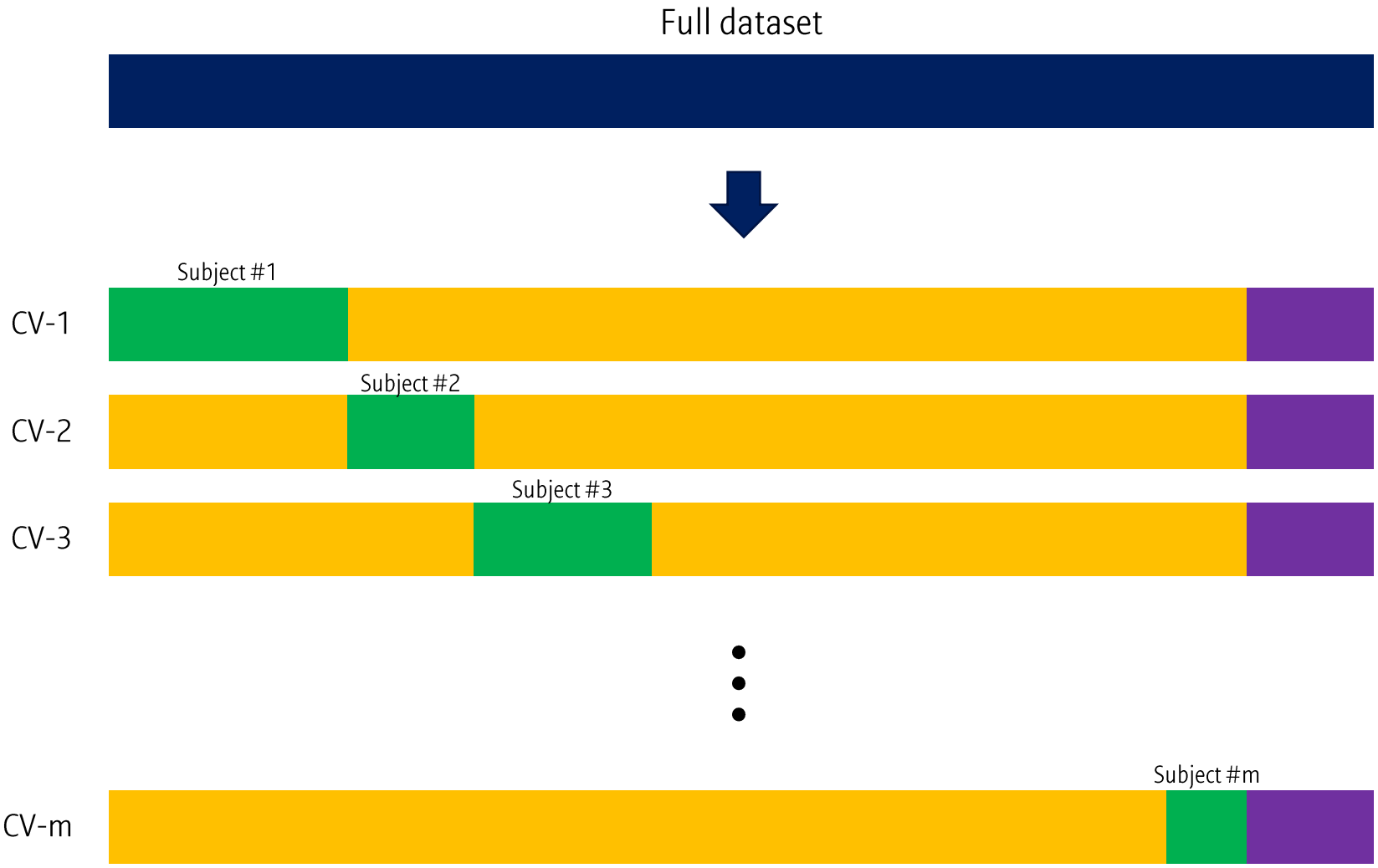
2. Validation

Leave-one-out Cross validation



2. Validation

Leave-one-subject-out Cross validation



3.Overfitting / Regularization

- Regularization: Ridge (L2), Lasso (L1), and Elastic Net regression
  - 이전 포스팅 참고: https://tyami.github.io/machine%20learning/regularization-Ridge-Lasso-ElasticNet/

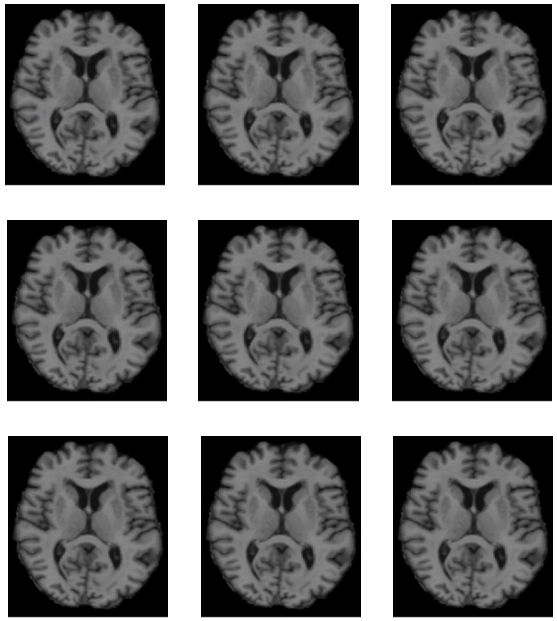
4. Transfer Learning

Large dataset in normal object classification

- Large dataset
  - ImageNet: 14 millions

4. Transfer Learning

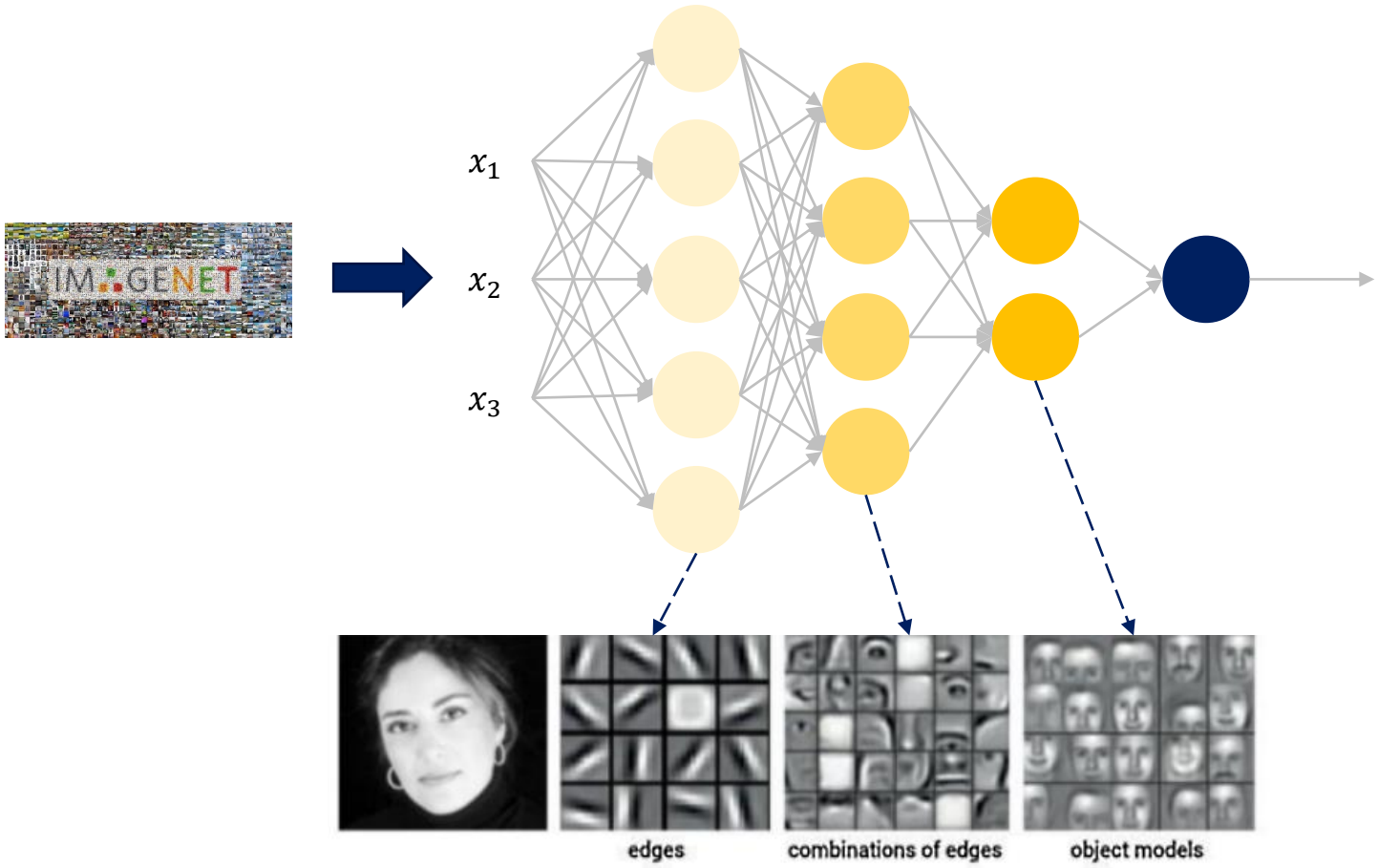
Small dataset in domain problem



4. Transfer Learning

Original training

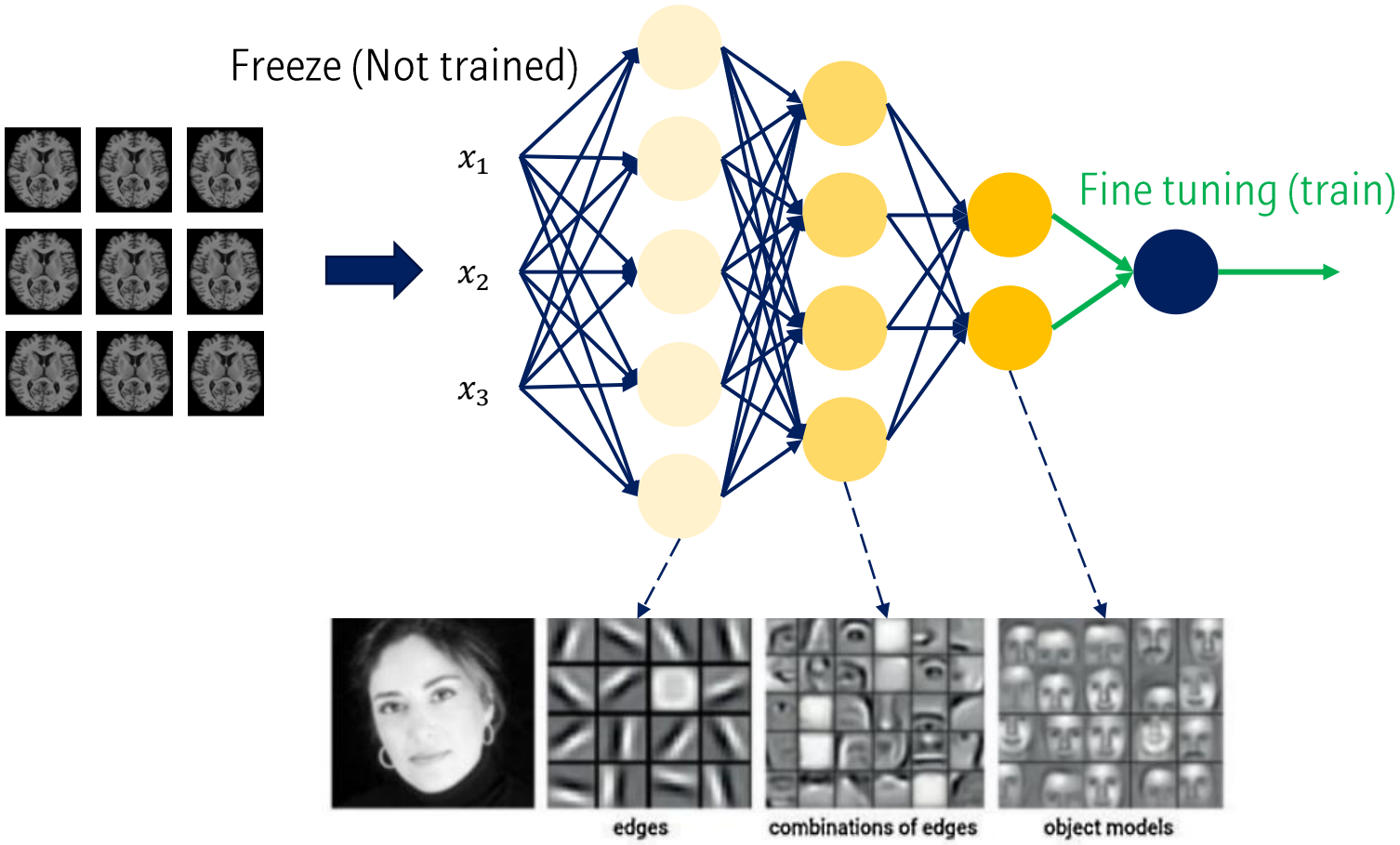
- Assumption: Low-level feature is similar between medical image and normal image



4. Transfer Learning

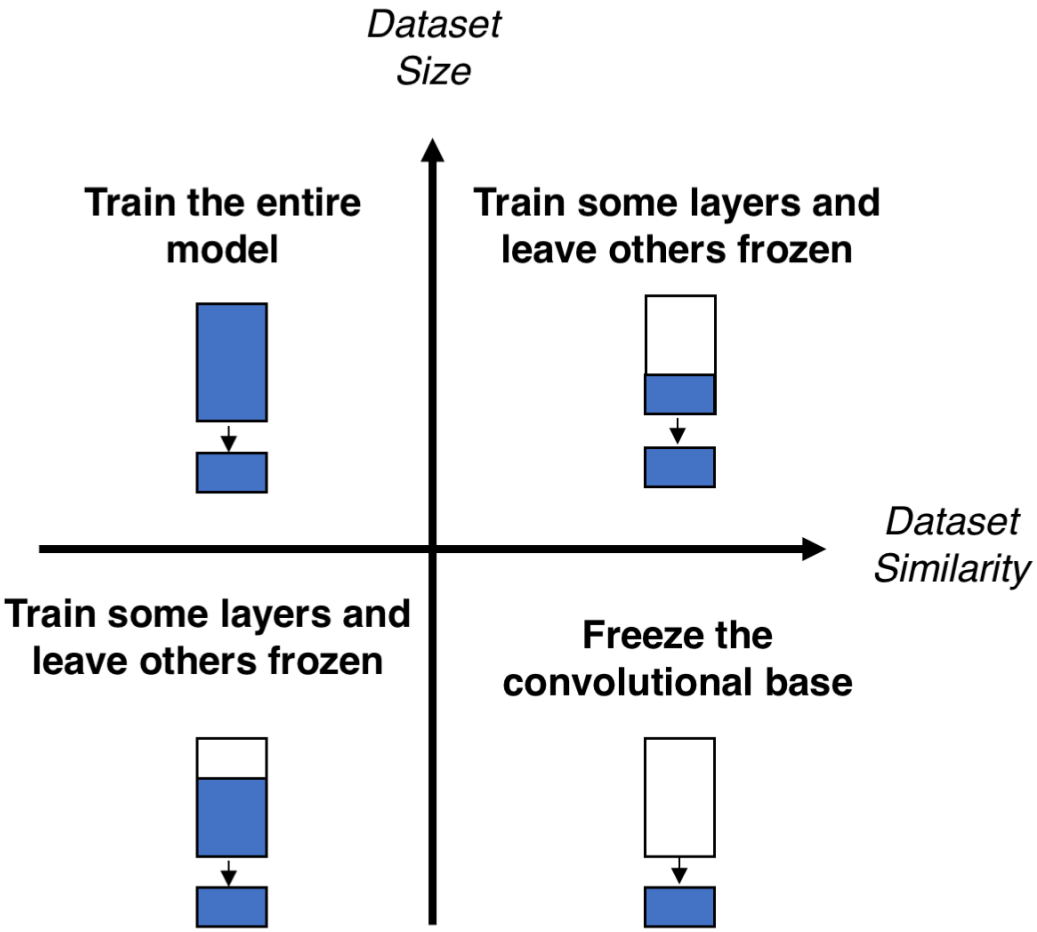
Fine tuning

- Assumption: Low-level feature is similar between medical image and normal image



4. Transfer Learning

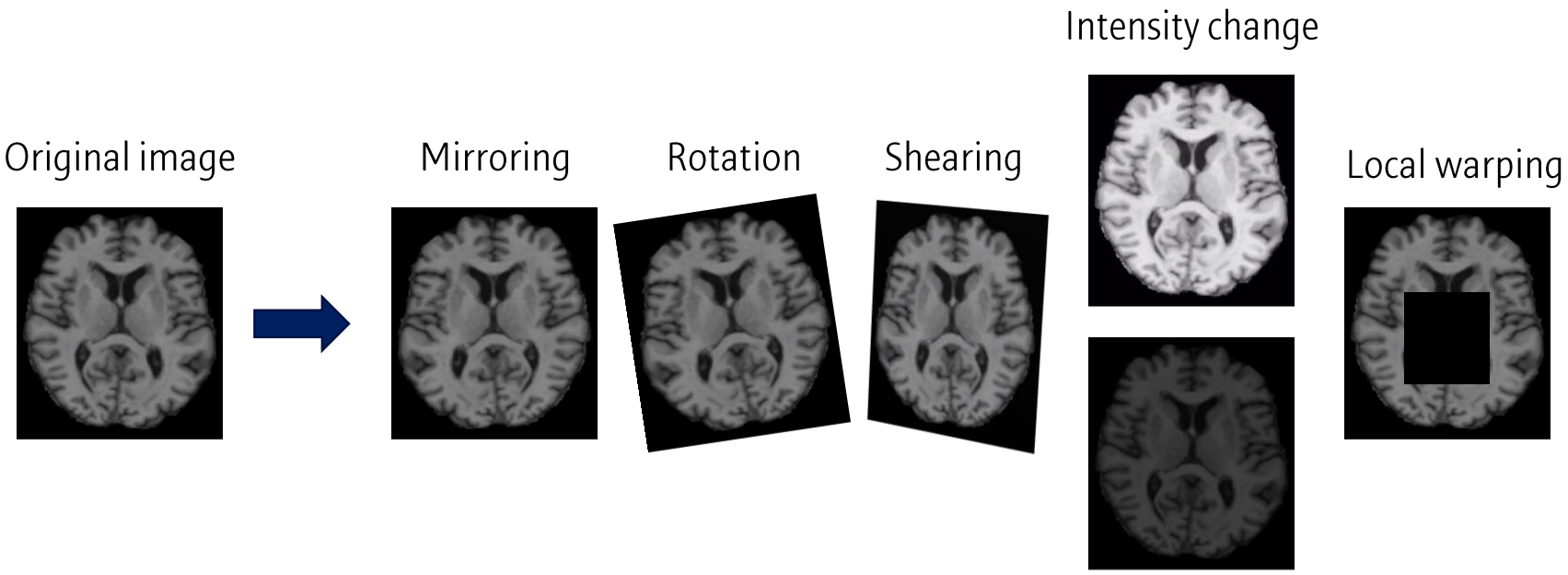
Four types of fine tuning



5. Data Augmentation

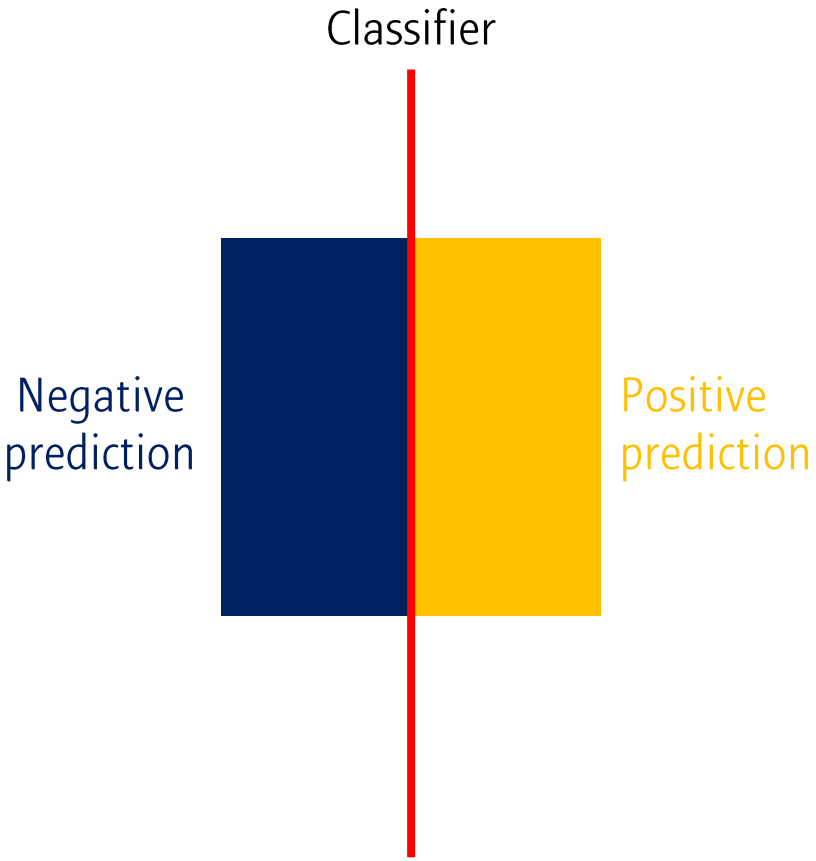
Diverse data augmentation

- Small sample ➔ Large dataset



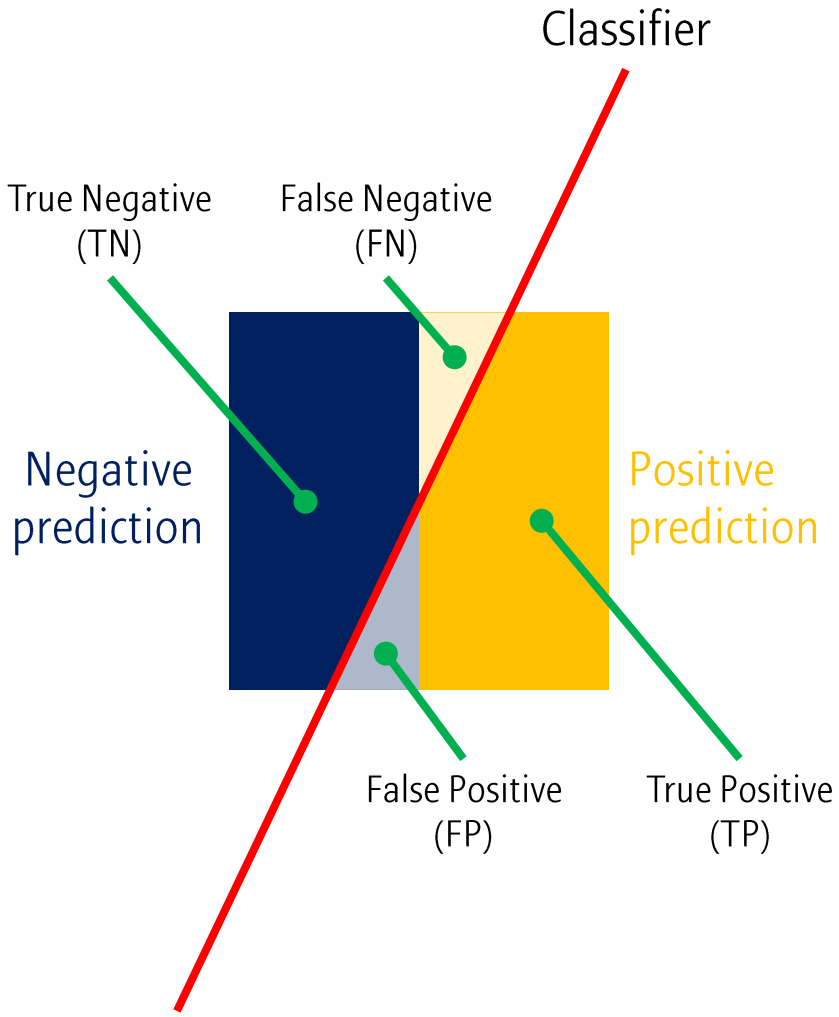
6. Evaluation of classification model

Classification model (Ideal)



6. Evaluation of classification model

Classification model (Real)

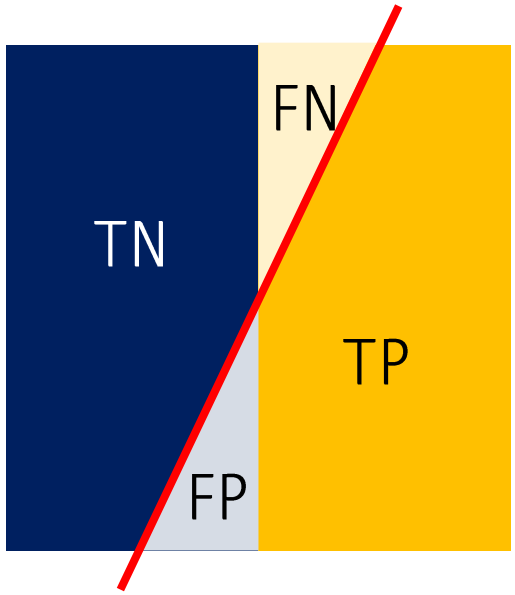


6. Evaluation of classification model

Measures: Accuracy

Accuracy

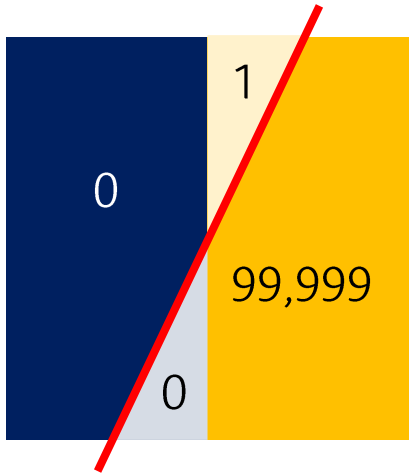
$$Accuarcy = \frac{TP + TN}{TP + TN + FP + FN}$$



6. Evaluation of classification model

Problem of accuracy

10,000명 중 1명 암 (Positive) 환자일 때, 모델이 전부 Normal (Negative) 이라고 판정하면,



$$Accuracy = 99.999\%$$

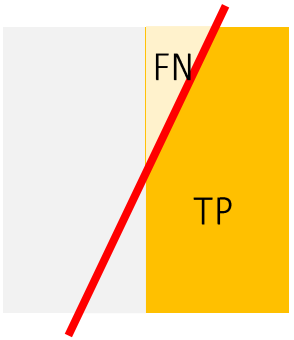
Accuracy는 높지만, 좋은 모델이라고 할 수 없다 !

6. Evaluation of classification model

Other Measures: Sensitivity, Specificity, Precision

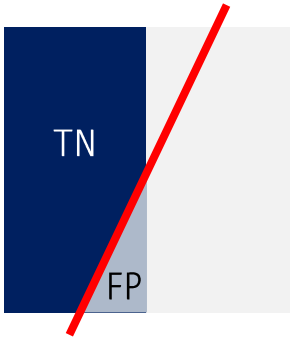
Sensitivity (Recall)

$$Sensitivity = \frac{TP}{TP + FN}$$



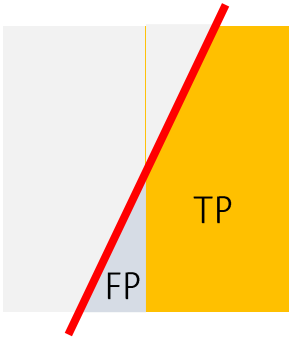
Specificity

$$Specificity = \frac{TN}{TN + FP}$$



Precision

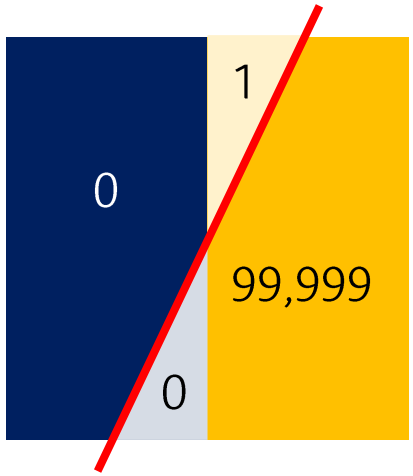
$$Precision = \frac{TP}{TP + FP}$$



6. Evaluation of classification model

Problem of accuracy solved

10,000명 중 1명 암 (Positive) 환자일 때, 모델이 전부 Normal (Negative) 이라고 판정하면,



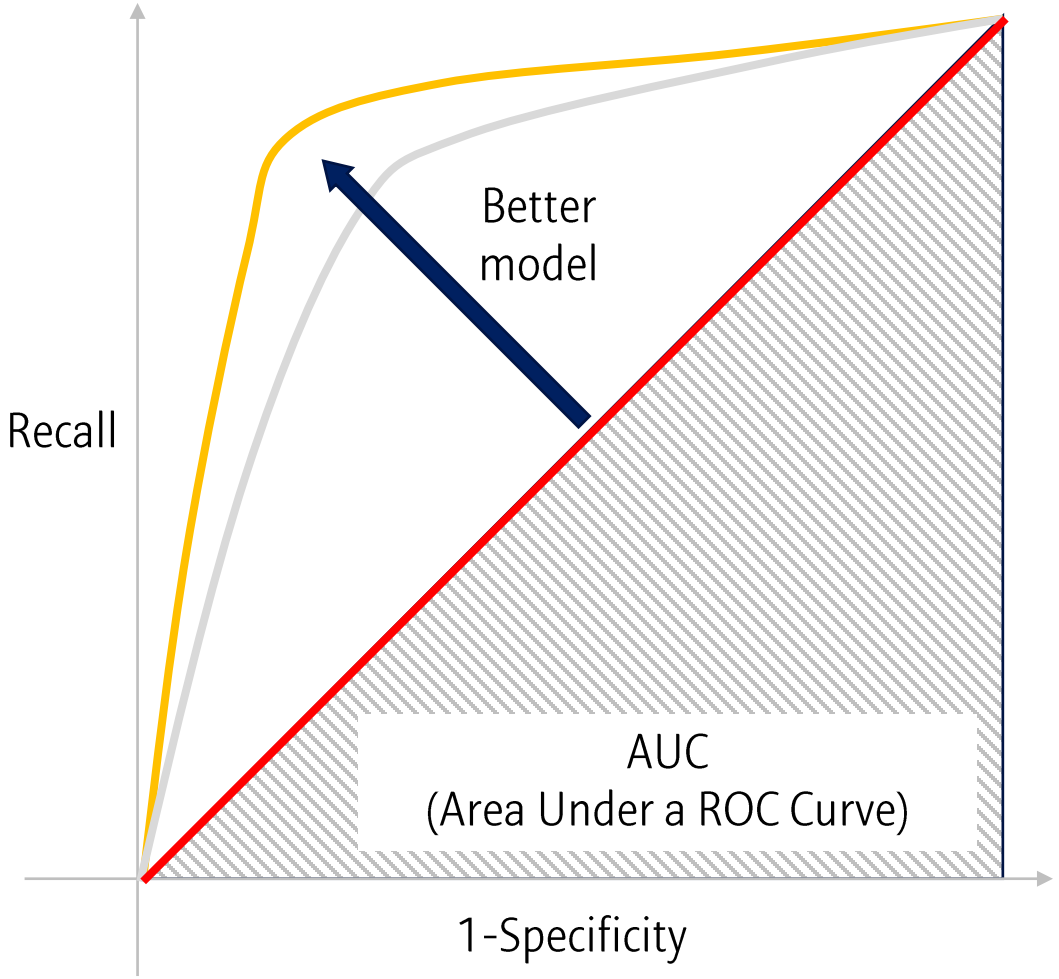
$$Accuracy = 99.999\%$$

$$Sensitivity = \frac{1}{99999}$$

$$Precision = \frac{0}{99999}$$

6. Evaluation of classification model

ROC (Receiver Operating Characteristics) curve

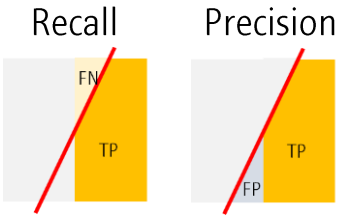


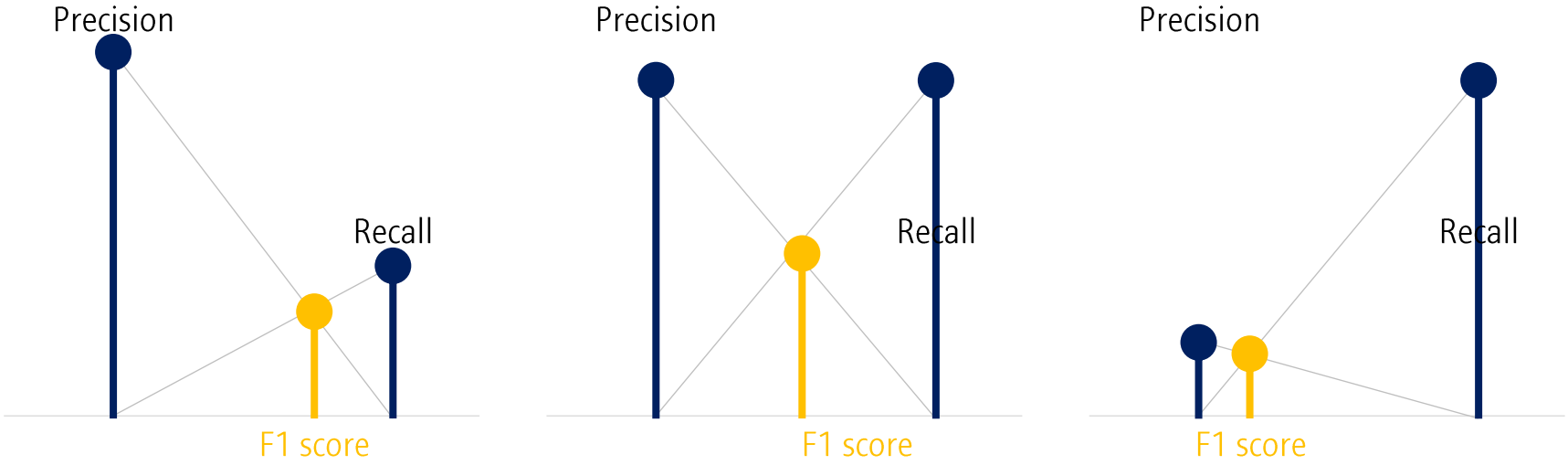
6. Evaluation of classification model

F1 score

F1 score: Harmonic mean of recall and precision

$$F1\ score = 2 \times \frac{Precision \times Recall}{Precision + Recall}$$





Precision과 Recall이 모두 높아야 F1 score가 높음

Frequently used for imbalanced dataset

7. Evaluation of classification model (Multi-label)

Confusion matrix

Prediction

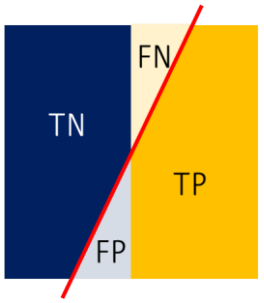
True	A	B	C	D
A	10	1	0	0
B	1	20	10	1
C	4	0	24	8
D	0	4	1	16

$$Accuracy = \frac{10 + 20 + 24 + 16}{100} = 70\%$$

7. Evaluation of classification model (Multi-label)

F1 score for multi-label

A인 것을 A라고 했느냐,
A가 아닌 것을 A가 아니라고 했느냐



Prediction

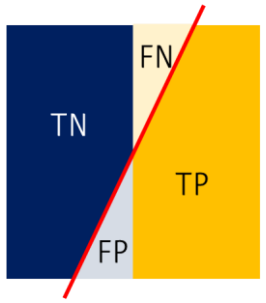
True

	A	B	C	D
A	10	1	0	0
B	1	20	10	1
C	4	0	24	8
D	0	4	1	16

7. Evaluation of classification model (Multi-label)

F1 score for multi-label

B인 것을 B라고 했느냐,
B가 아닌 것을 B가 아니라고 했느냐



Prediction

True	A	B	C	D
A	10	1	0	0
B	1	20	10	1
C	4	0	24	8
D	0	4	1	16