

# RANZCR CLiP

: Catheter and Line  
Position Challenge



강민영 김채진 서강원 옥진해 정지희  
2021. 02. 26

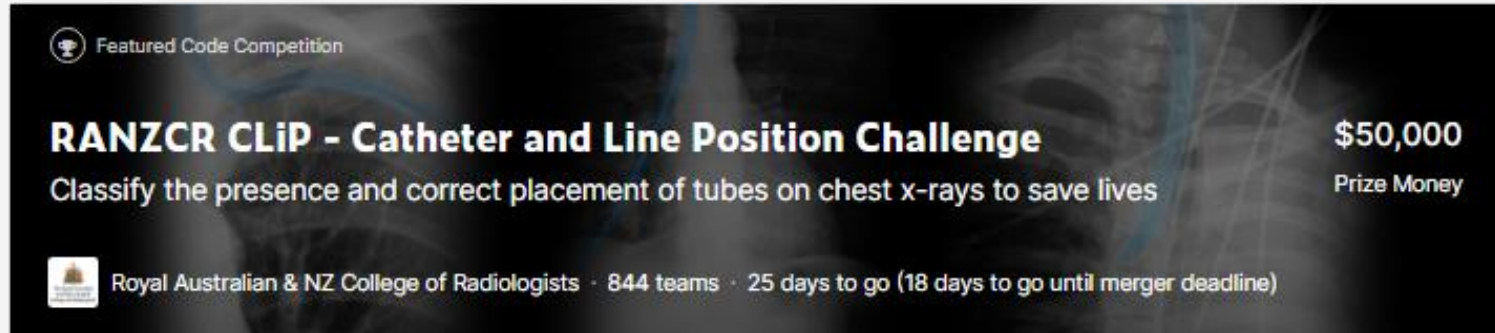
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- 1. 대회 목적 및 배경

## 1. Kaggle Competition 개요

## 흉부 X-ray를 이용한 Tube와 Catheter의 배치 오류 감지 Kaggle 경진대회에 2021년 2월, 2주간 참여



- 전체 대회 기간 : 2020. 12. 15 – 2021. 03. 15
- 총 참여팀 : 1,108 team ( 2021.02.25 기준 )
- 대회 상금 : \$50,000
- 실제 대회 참여 기간 : 2021. 02. 10 – 2021. 02. 24
- 참여인원 : 5인
- Kaggle Notebook : <https://www.kaggle.com/c/ranzcr-clip-catheter-line-classification>

## 1. Kaggle Competition 개요

## 역할 분담

- 서강원 : PL, 논문 분석, 알고리즘 분석 (Resnet , ResNeXt)
- 김채진 : 논문 분석, 알고리즘 분석 (EfficientNet)
- 옥진해 : 논문 분석, 알고리즘 분석 (Resnet , ResNeXt)
- 정지희 : 논문 분석, 알고리즘 분석 (Resnet , ResNeXt), 발표
- 강민영 : 알고리즘 분석, 몽고DB, 발표
- 공통 역할 : 구현 및 모델 학습 , PPT 제작

## 1. Kaggle Competition 개요

## Data Set 크기 및 자료 구조

## Data Explorer

12.23 GB

- ▶ test
- ▶ test\_tfrecords
- ▶ train
- ▶ train\_tfrecords
- ▤ sample\_submission.csv
- ▤ train.csv
- ▤ train\_annotations.csv

- train image : 30083개 - 6.43GB
- test image : 3582개 - 805MB  
( 총 33,665개, 총 용량 7.22GB, 평균 약 225KB)
- train.csv : image IDs, binary labels, patient IDs 포함
- test TFRecords (554MB) / train TFRecords ( 4.45GB)  
: tensorflow training data format
- Train\_annotations.csv : label, line의 위치
- sample\_submission.csv: 올바른 형식의 제출 샘플 파일

train.csv	StudyInstanceUID	ETT - Abnormal	ETT - Borderline	ETT - Normal	NGT - Abnormal	...	CVC - Normal	Swan Ganz Catheter Present	PatientID
0	1.2.826.0.1.3680043.8.498.266...	0	0	0	0	...	0	0	ec89415d1
1	1.2.826.0.1.3680043.8.498.463...	0	0	1	0	...	1	0	bf4c6da3c
2	1.2.826.0.1.3680043.8.498.238...	0	0	0	0	...	0	0	3fc1c97e5
3	1.2.826.0.1.3680043.8.498.682...	0	0	0	0	...	0	0	c31019814
4	1.2.826.0.1.3680043.8.498.100...	0	0	0	0	...	1	0	207685cd1

## 1. Kaggle Competition 개요

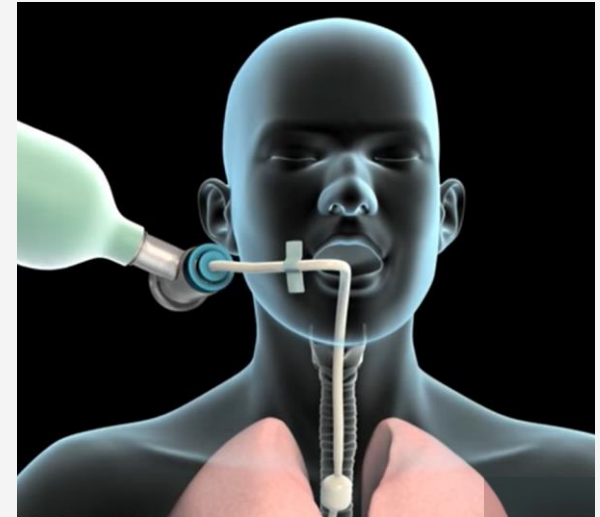
## Data Columns 구조

- ETT(endotracheal tube) : 기관 내 tube
  - NGT(nasogastric tube) : 비관 내 tube
  - CVC(central venous tube) : 중심 정맥 tube
  - Swan Ganz Catheter Present : 폐동맥 catheter
- 
- Normal : 알맞은 위치
  - Borderline : 정상적으로 작동하나 약간의 재배치가 필요
  - Abnormal : 비정상적인 위치로 즉각적인 재배치가 필요
  - Incompletely Imaged : image의 정확도가 떨어져 판별 불가

## 1. Kaggle Competition 개요

## Multi Label 소개

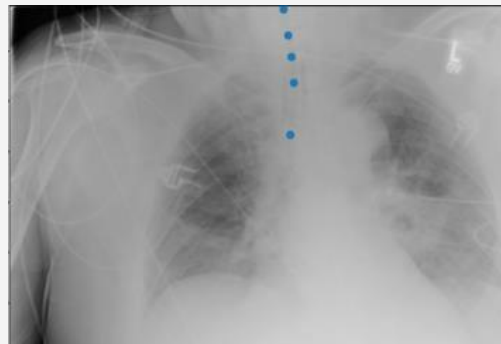
- ETT(endotracheal tube) : 기관 내 tube
- NGT(nasogastric tube) : 비관 내 tube
- CVC(central venous tube) : 중심 정맥 tube
- Swan Ganz Catheter Present : 폐동맥 catheter



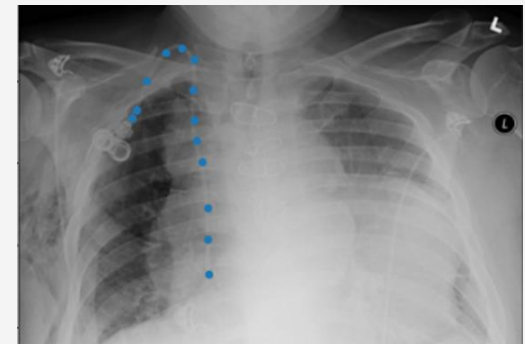
ETT - Normal



ETT - Borderline



ETT - Abnormal

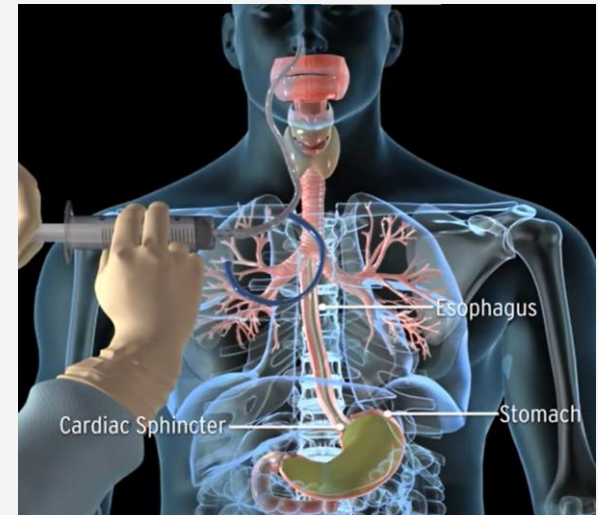




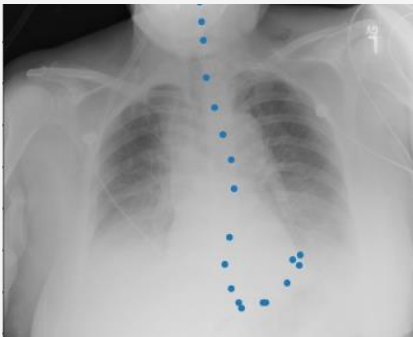
## 1. Kaggle Competition 개요

## Multi Label 소개

- ETT(endotracheal tube) : 기관 내 tube
- NGT(nasogastric tube) : 비관 내 tube
- CVC(central venous tube) : 중심 정맥 tube
- Swan Ganz Catheter Present : 폐동맥 catheter



NGT - Normal



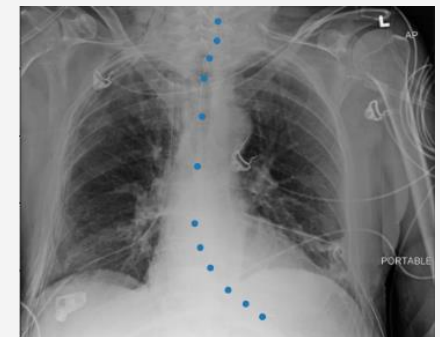
NGT - Borderline



NGT - Abnormal



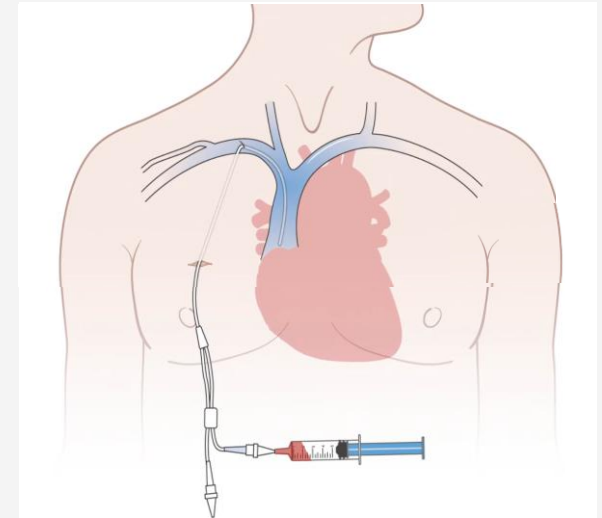
NGT - Incompletely Imaged



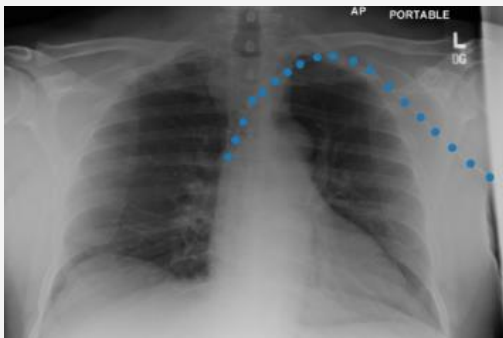
## 1. Kaggle Competition 개요

## Multi Label 소개

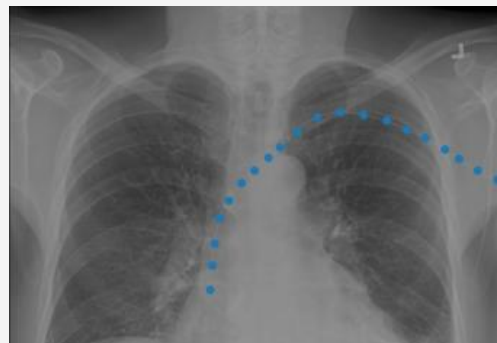
- ETT(endotracheal tube) : 기관 내 tube
- NGT(nasogastric tube) : 비관 내 tube
- CVC(central venous tube) : 중심 정맥 tube
- Swan Ganz Catheter Present : 폐동맥 catheter



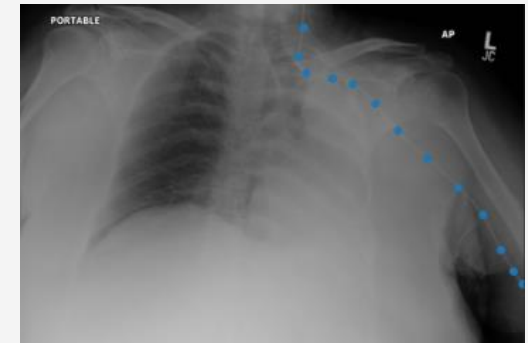
CVC - Normal



CVC - Borderline



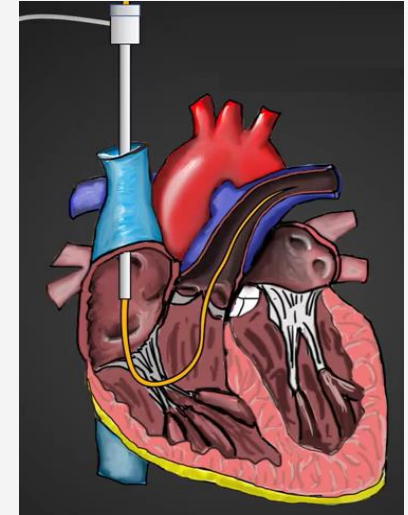
CVC - Abnormal



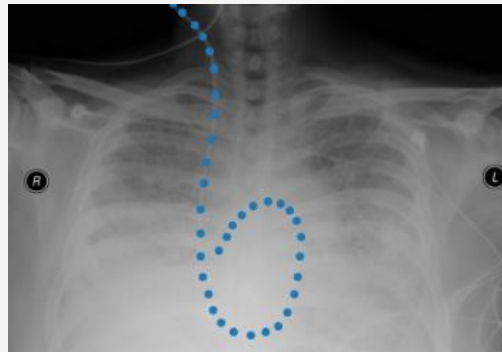
## 1. Kaggle Competition 개요

## Multi Label 소개

- ETT(endotracheal tube) : 기관 내 tube
- NGT(nasogastric tube) : 비관 내 tube
- CVC(central venous tube) : 중심 정맥 tube
- Swan Ganz Catheter Present : 폐동맥 catheter



Swan Ganz  
Catheter Present



## 2. 대회 참여 목적

## Tube와 Cather의 배치 오류로 인해 발생 가능한 심각한 합병증을 신경망 학습 모델 구축 및 분석으로 예방

### 대회 목적

흉부 X-ray를 통한 line 위치 확인

: 의사 또는 방사선 전문의를 통해 X-ray 수동확인으로 시간 부담 상승



딥러닝 알고리즘으로 catheter와 line의 위치를 감지

: 이상 발생 시 위치를 변경하거나 제거함으로써  
생명을 위협하는 합병증을 예방하고 시간적 부담을 감소

## 3. Kaggle Competition 평가 지표

## 평가 기준 - AUC

## Description

## Evaluation

## Timeline

## Prizes

## Code Requirements

## RANZCR 2021

## Acknowledgements

Submissions are evaluated on [area under the ROC curve](#) between the predicted probability and the observed target.

To calculate the final score, AUC is calculated for each of the 11 labels, then averaged. The score is then the average of the individual AUCs of each predicted column.

## Submission File

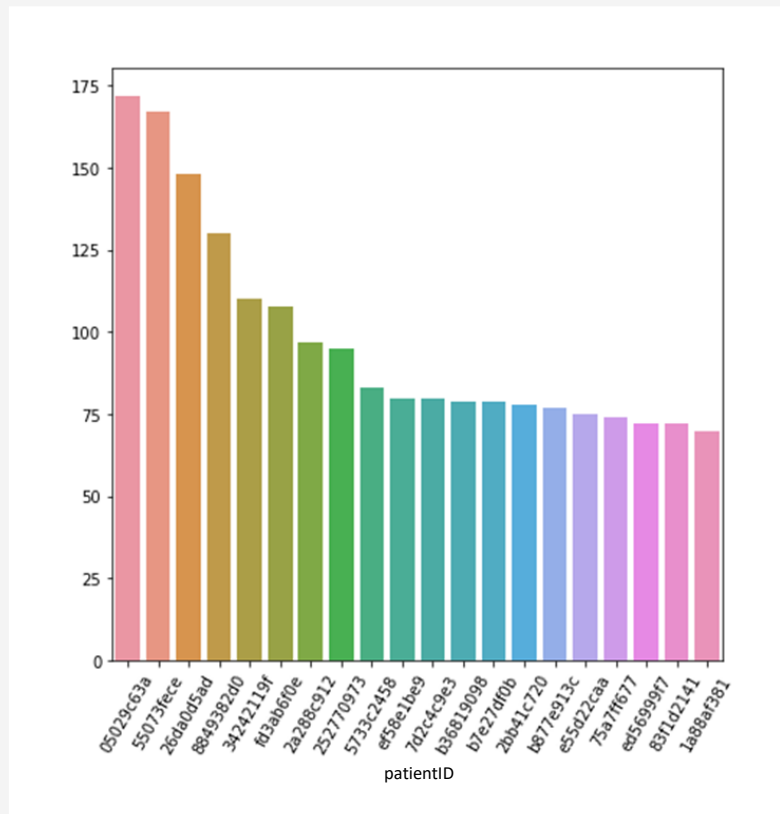
For each ID in the test set, you must predict a probability for all target variables. The file should contain a header and have the following format:

```
StudyInstanceUID,ETT - Abnormal,ETT - Borderline,ETT - Normal,NGT - Abnormal,NGT -
Borderline,NGT - Incompletely Imaged,NGT - Normal,CVC - Abnormal,CVC - Borderline,CVC -
Normal,Swan Ganz Catheter Present
1.2.826.0.1.3680043.8.498.62451881164053375557257228990443168843,0,0,0,0,0,0,0,0,0,0,0
1.2.826.0.1.3680043.8.498.83721761279899623084220697845011427274,0,0,0,0,0,0,0,0,0,0,0
1.2.826.0.1.3680043.8.498.12732270010839808189235995393981377825,0,0,0,0,0,0,0,0,0,0,0
1.2.826.0.1.3680043.8.498.11769539755086084996287023095028033598,0,0,0,0,0,0,0,0,0,0,0
1.2.826.0.1.3680043.8.498.87838627504097587943394933987052577153,0,0,0,0,0,0,0,0,0,0,0
1.2.826.0.1.3680043.8.498.53211840524738036417560823327351887819,0,0,0,0,0,0,0,0,0,0,0
1.2.826.0.1.3680043.8.498.93555795394184819372299157360228027866,0,0,0,0,0,0,0,0,0,0,0
1.2.826.0.1.3680043.8.498.52241894131170494723503100795076463919,0,0,0,0,0,0,0,0,0,0,0
1.2.826.0.1.3680043.8.498.36500167484503936720548852591033878284,0,0,0,0,0,0,0,0,0,0,0
1.2.826.0.1.3680043.8.498.86199852603457900780565655267977637728,0,0,0,0,0,0,0,0,0,0,0
```

- 2. 데이터 분석

## 1. 데이터 분석 결과

train.csv파일과 train image 확인한 결과, 중복된 환자 ID를 확인



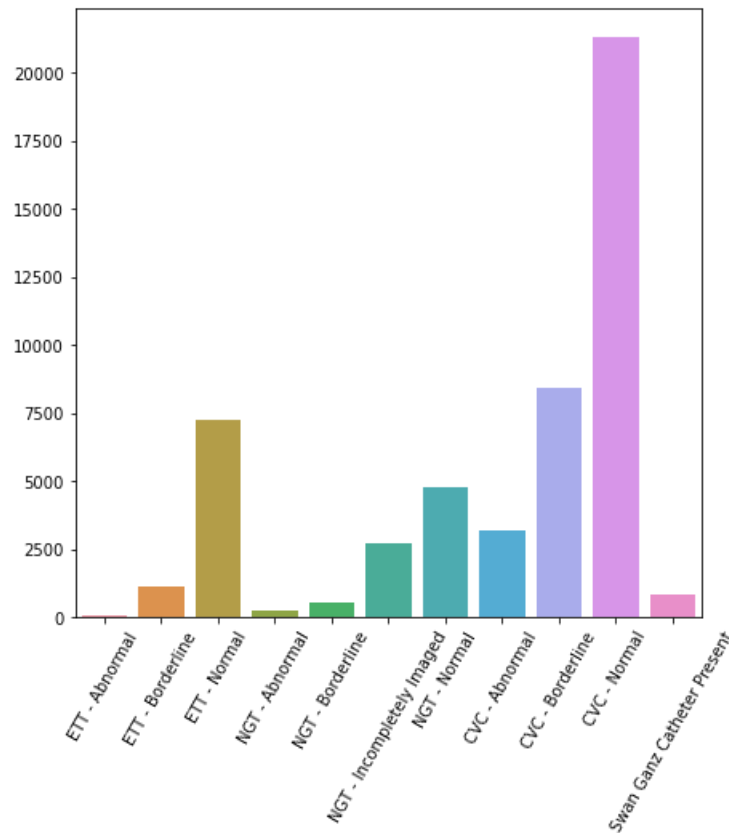
총 이미지 수 : 약 3만 장

총 환자 수 : 3,255명

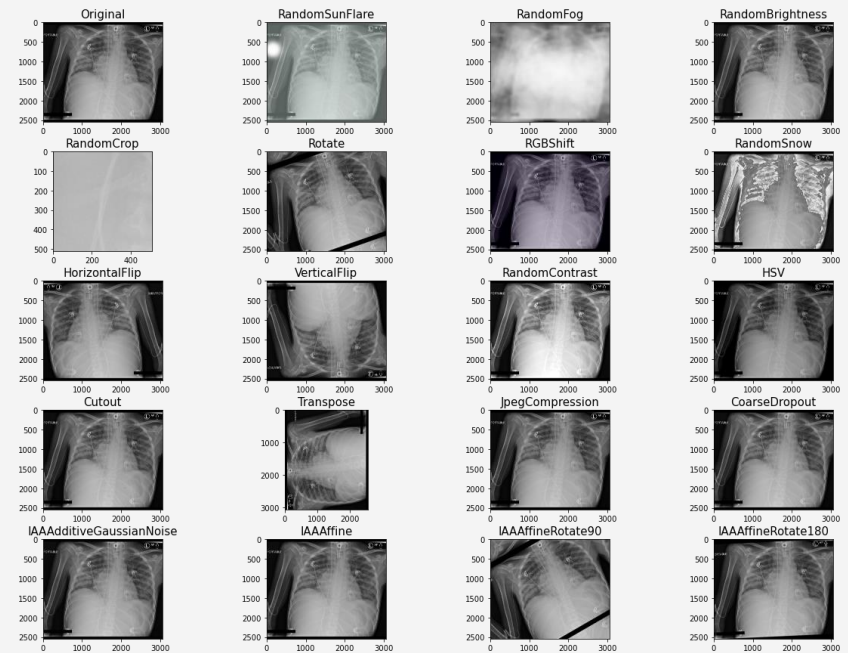
## 1. 데이터 분석 결과

## 데이터 불균형 (CVC) 으로 augmentation 필요

columns Data별 이미지 개수



Different Types of Augmentations with Albumentations

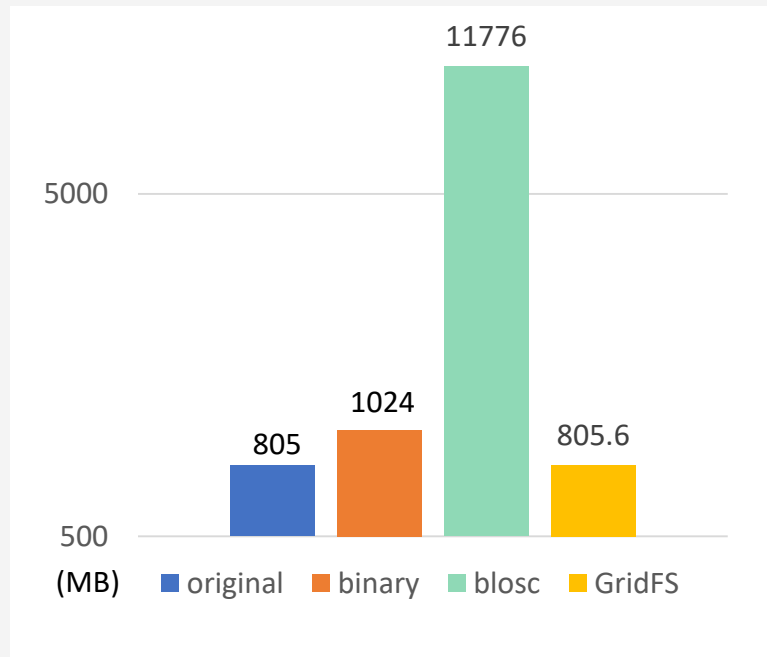




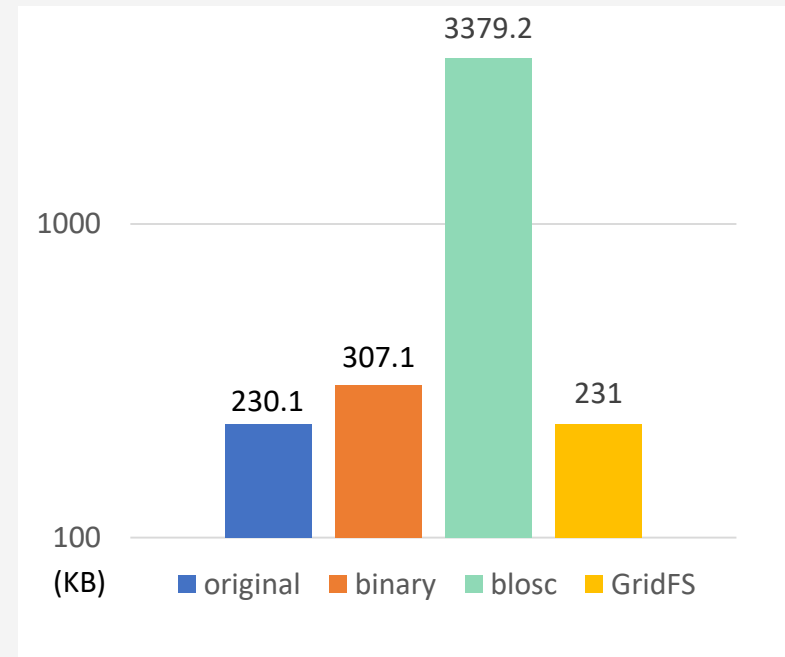
## 2. MongoDB - data upload

## MongoDB 이미지 업로드 방식 별 용량 차이 비교

Total Document size compare



average Document size compare

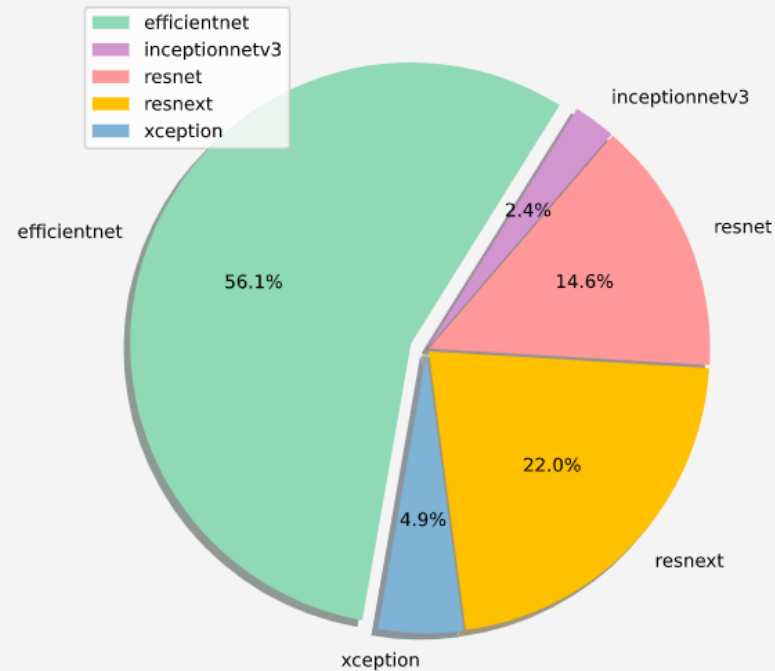


- Test image 사용
- GridFS 방식 사용 시 소량의 용량이 압축

- 3. 주요 알고리즘 소개 및 선정

## 1. 알고리즘 선정 기준

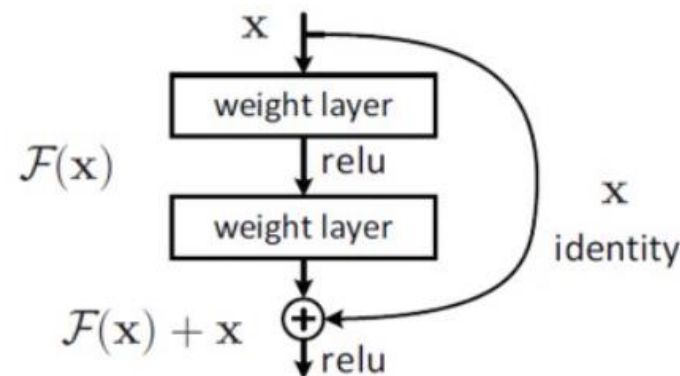
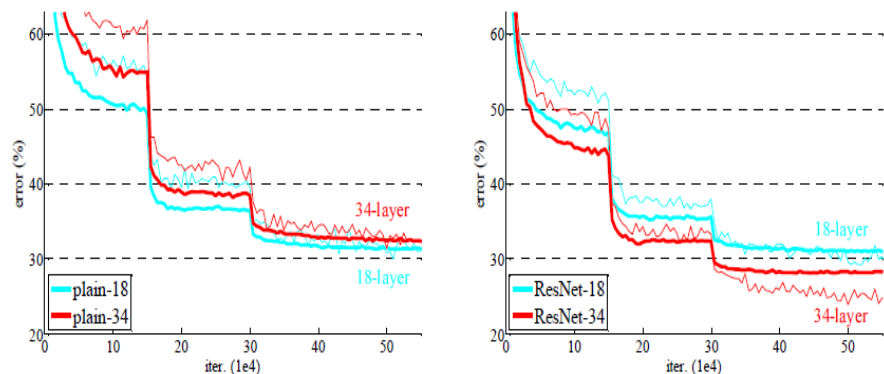
## RANZCR DATASET에 적합한 딥러닝 모델 조사결과 : EfficientNet, ResNext



RANZCR Top 40 Kernel 사용 모델

## 2. 주요 알고리즘 소개 - ResNet (2015)

ResNet의 residual learning(잔여학습)을 통해  
neural network의 구조가 깊어질수록 정확도가 감소하는 문제를 해결

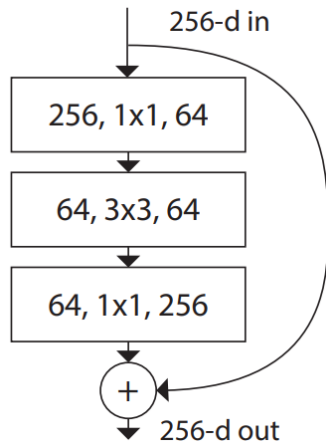


- 일반적인 CNN에서 레이어의 깊이가 일정수준을 넘어가면 오히려 성능이 떨어지는 문제가 발생
- 이를 개선하고자 residual learning(잔여학습)을 도입
- 성능이 떨어지는 문제 개선 뿐만 아니라 전반적인 성능이 향상됨

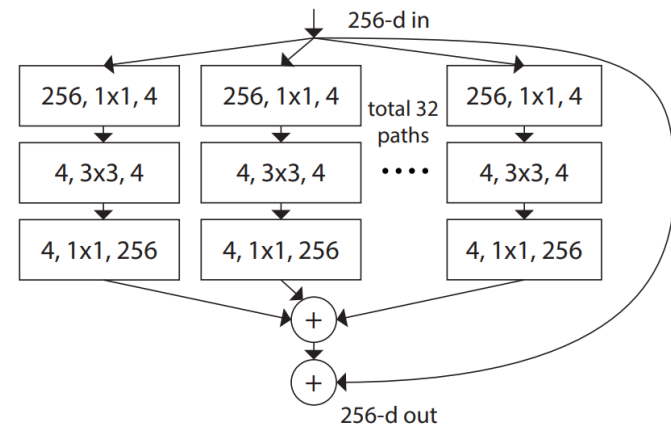
## 2. 주요 알고리즘 소개 - ResNeXt (2017)

## ResNeXt : split-transform-merge 전략을 ResNet에 적용

ResNet



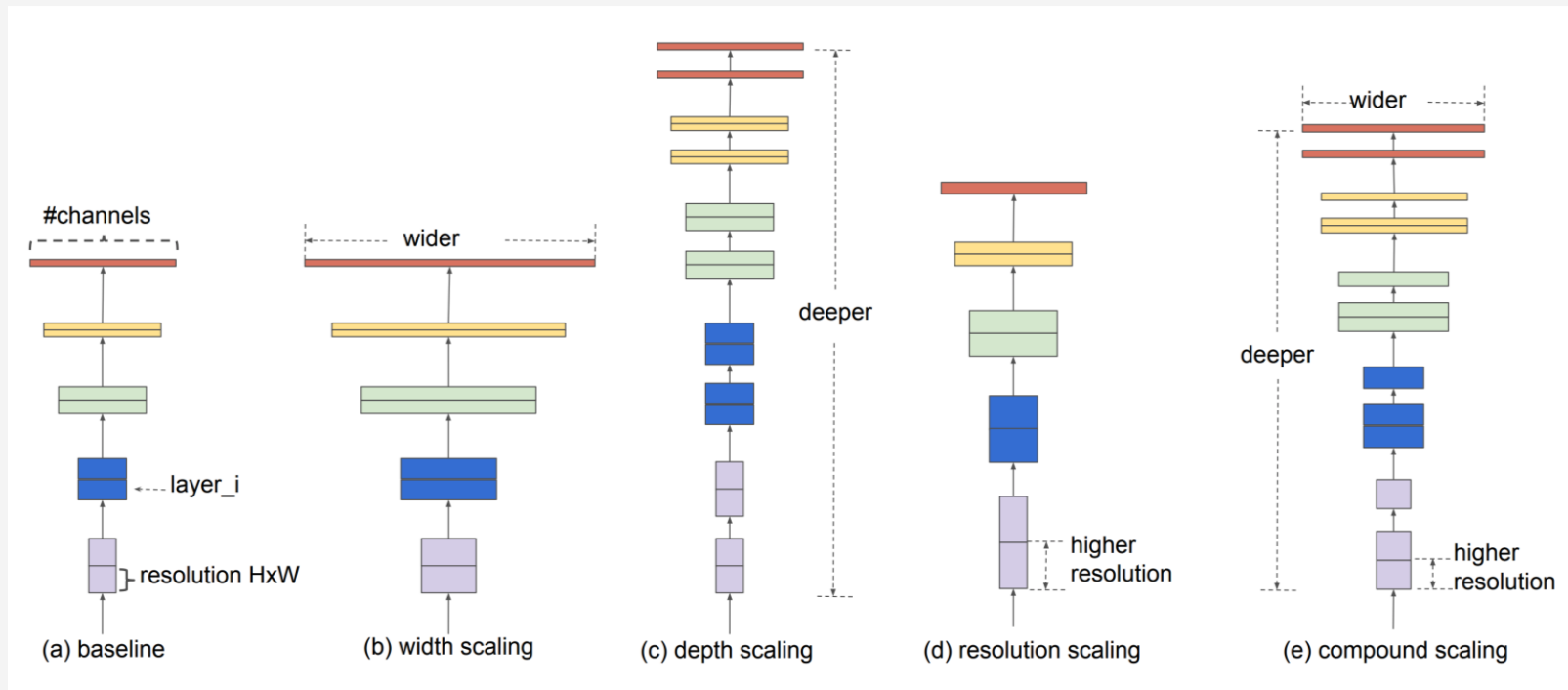
ResNext



- 입력 값을 split하여 동일한 grouped convolution에 각각 값을 도출
- 나온 값들을 merge하여 결과값으로 잔여학습을 시킴

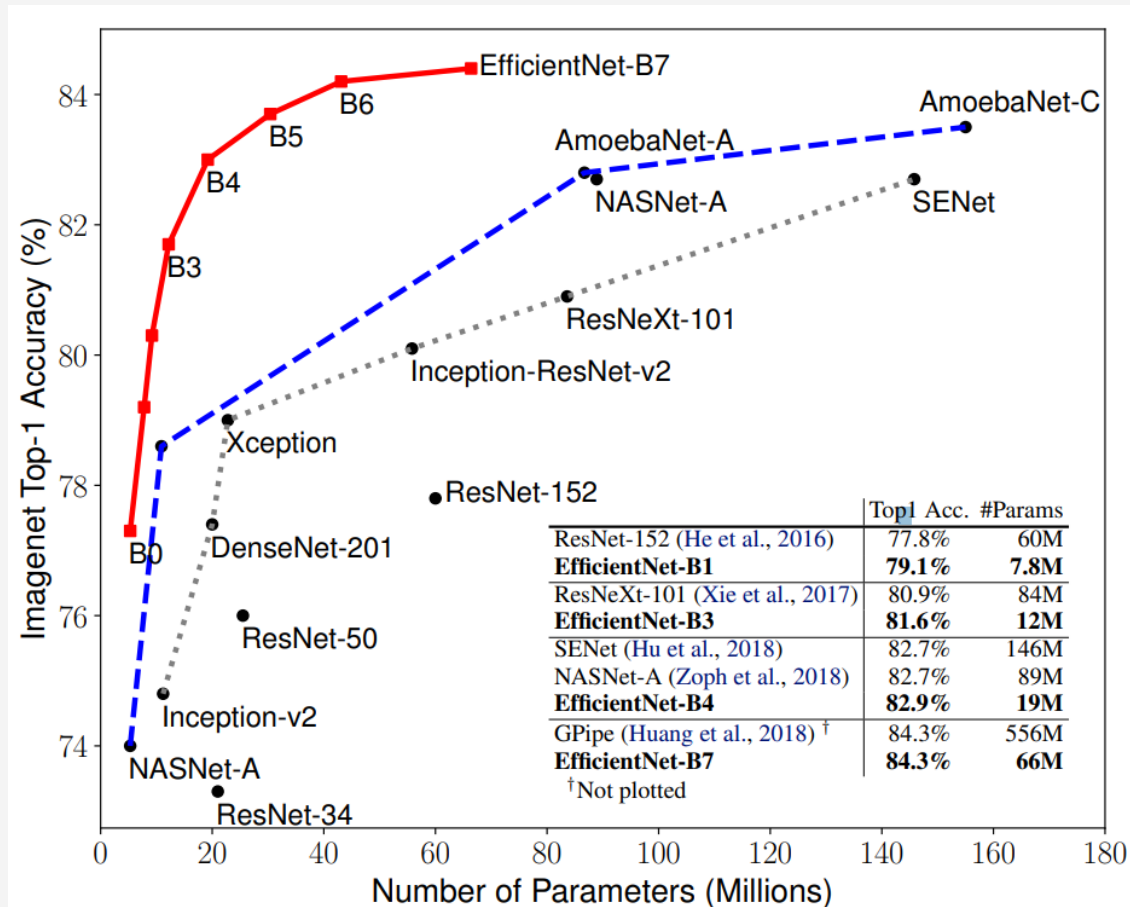
## 2. 주요 알고리즘 소개 - EfficientNet (2019)

EfficientNet : Compound model scaling algorithm을 적용하여  
Width, depth, resolution 3가지 요소를 모두 Scaling up에 사용



## 2. 주요 알고리즘 소개

기존 분류 네트워크 모델에서 정확성과 매개변수 및 계산의 양을 감소



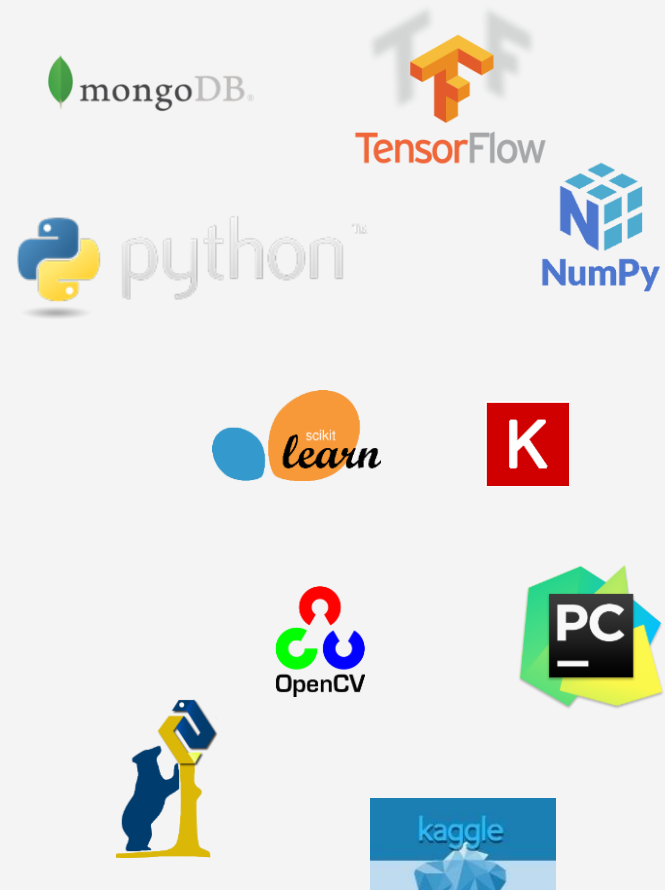
- 4. 모델 평가



## 0. 개발 환경

## 개발 환경

- Seaborn version 0.10.0
- Pandas version 1.1.5
- Numpy version 1.17.5
- Cv2 version 4.41
- Tenserflow version 2.4.1
- Sklearn version 0.24.1
- Tenserflow.keras version 2.4.0
- MongoDB server version 4.4.3
- Python 3.9.1
- Pycharm 2020.3.3
- mongoDB Compass 1.25.0



## 1. 모형 평가 - train validation

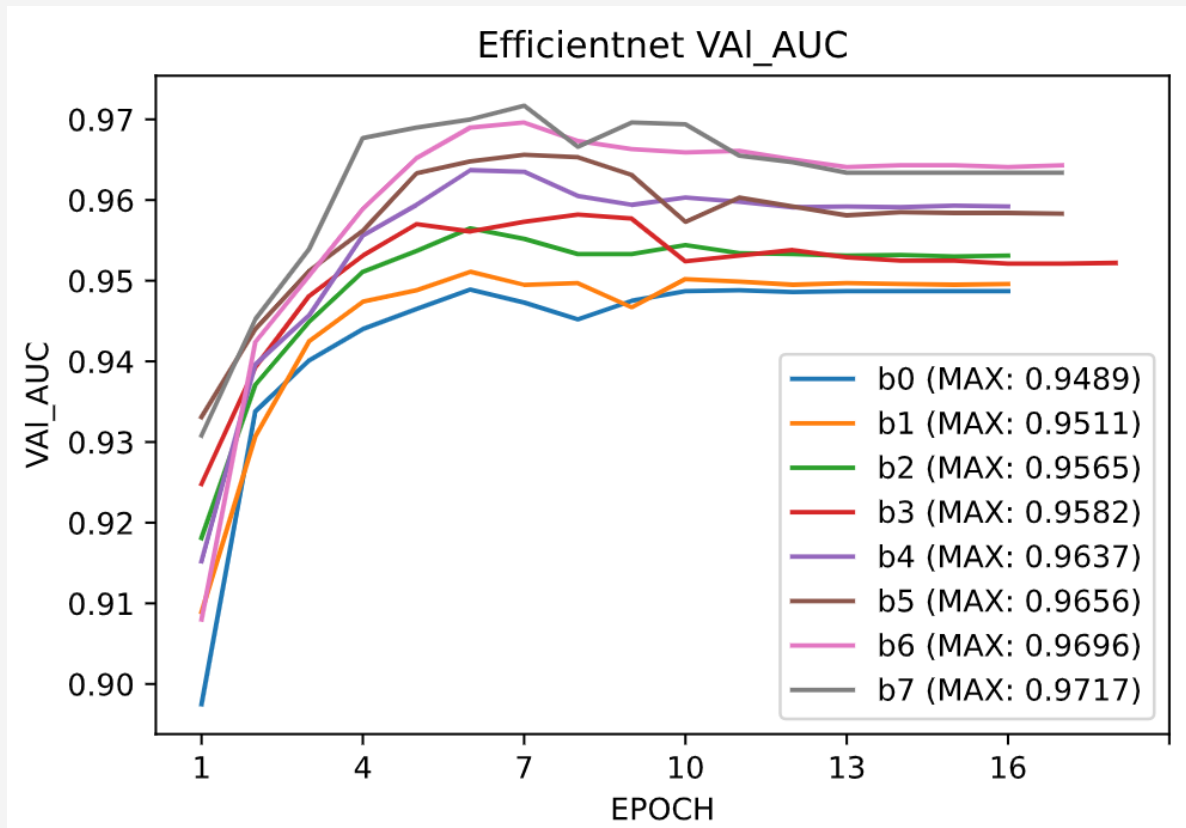
## 버전 별 image size 및 학습 설정

Base model	Resolution(Image size)
EfficientNetB0	224
EfficientNetB1	240
EfficientNetB2	260
EfficientNetB3	300
EfficientNetB4	380
EfficientNetB5	456
EfficientNetB6	528
EfficientNetB7	600

- Batch size: 32
- Learning rate: 0.001

## 1. 모형 평가 - train validation

validation train 결과 : b7 모델이 Epoch 대비 AUC가 높음을 확인



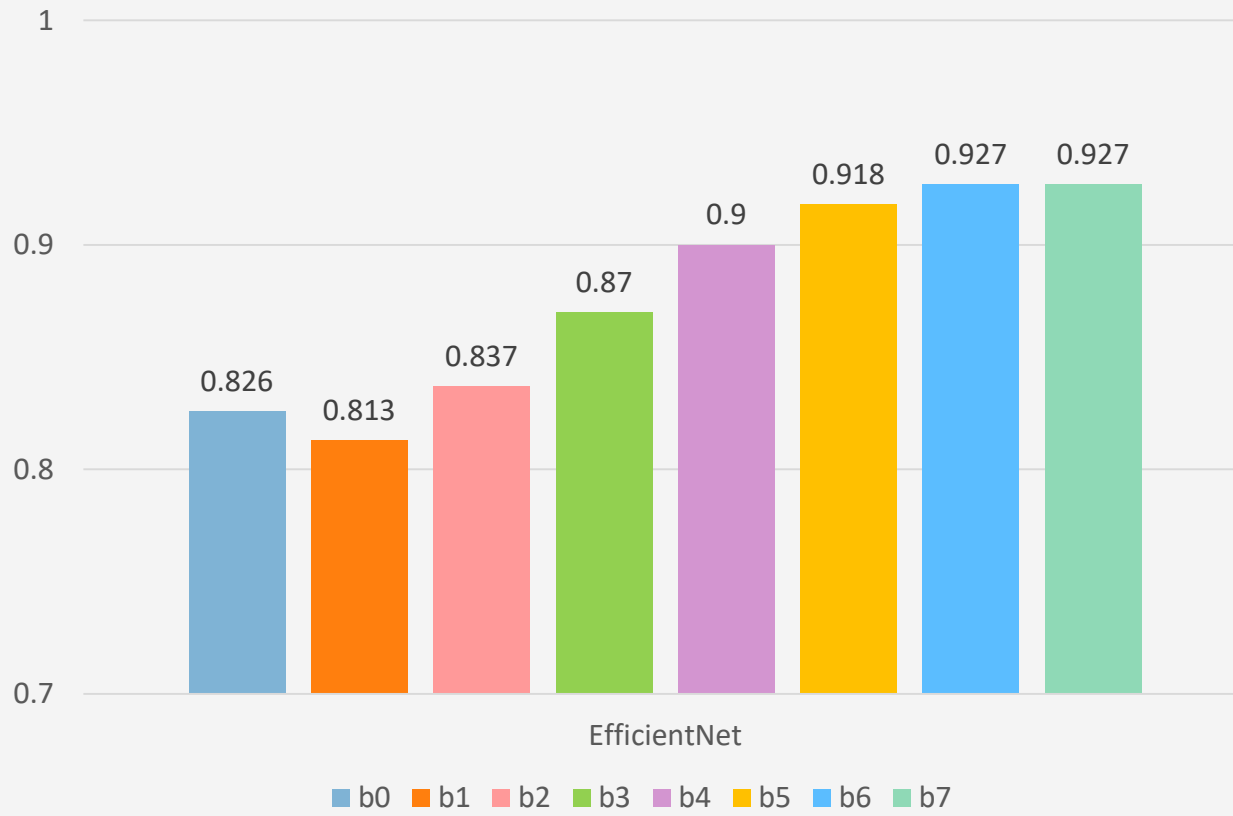
## 1. 모형 평가 - train validation

## EfficientNet Performance Results on Transfer Learning Datasets

Model	Parameters (Million)	Parameter reduction	Duration of time (Minutes)	Val_AUC
EfficientNet - b7	64.12M	1 X	147.35	0.9717
EfficientNet - b6	40.98M	1.56 X	96.86	0.9696
EfficientNet - b5	28.53M	2.24 X	64.63	0.9656
EfficientNet - b4	17.69M	3.62 X	53.58	0.9637
EfficientNet - b3	10.80M	5.93 X	51.08	0.9582
EfficientNet - b2	7.78M	8.24 X	45.93	0.9565
EfficientNet - b1	6.58M	9.74 X	45.68	0.9511
EfficientNet - b0	4.06M	15.79 X	44.98	0.9489






















## 1. 모형 평가

## Test에 따른 각 Model의 AUC 값



## 2. 대회 평가

최종 제출 : EfficientNet-b7, AUC 0.927

Overview	Data	Code	Discussion	Leaderboard	Rules	Team	My Submissions	Submit Predictions		
867	Qishen Ha							0.928	4	16d
868	Bwest						    	0.928	16	1mo
869	Sidney Ng							0.927	1	2mo
870	KKJOS						    	0.927	22	9h
Your Best Entry 										
Your submission scored , which is not an improvement of your best score. Keep trying!										
871	HANXIN002							0.926	4	1mo
872	ilovescience							0.926	6	2mo
873	yuta							0.926	3	2mo
874	spoon jr 🍴							0.925	5	1d
875	Roxo Lani							0.925	5	1mo
876	slm37102							0.925	7	2mo
877	vickygo							0.925	2	2mo
878	yui cojuvu							0.924	1	2d

## 2. 대회 평가

최종 결과 : Rank 1236/1549

## 1 Completed Competition

**RANZCR CLIP - Catheter and Line Position Challenge**

Classify the presence and correct placement of tubes on chest x-rays to sa...

Featured · Code Competition · an hour ago



1236/1549

Top 80%

No more competitions to show

- 6. 참고문헌



## 1. 참고 문헌

## ◎ 논문

- K. He, X. Zhang, S. Ren and J. Sun, "Deep Residual Learning for Image Recognition," *2016 IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, Las Vegas, NV, USA, 2016, pp. 770-778, doi:10.1109/CVPR.2016.90.
- S. Xie, R. Girshick, P. Dollár, Z. Tu and K. He, "Aggregated Residual Transformations for Deep Neural Networks," *2017 IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, Honolulu, HI, USA, 2017, pp.5987-5995, doi: 10.1109/CVPR.2017.634.
- Tan, M. & Le, Q. V. (2019). EfficientNet: Rethinking Model Scaling for Convolutional Neural Networks (cite arxiv: 1905.11946Comment: Published in ICML 2019)
- Jia, W., Gao, J., Xia, W. *et al.* A Performance Evaluation of Classic Convolutional Neural Networks for 2D and 3DPalmprint and Palm Vein Recognition. *Int. J. Autom. Comput.* 18, 18-44 (2021).<https://doi.org/10.1007/s11633-020-1257-9>

## 1. 참고 문헌

## ◎ 논문 리뷰

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감사합니다