vis_risk_score_and_survival_curves

July 5, 2024

This notebook visualizes the average risk scores with models from the two-fold cross-validaton (five times) and plot kaplan meier curve

[ ]:

```
import os
import sys
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import torch
import glob
from pathlib import Path
from lifelines import KaplanMeierFitter
sys.path.append(os.path.abspath(os.path.join('../..')))
from train_risk_regression_model_with_recon_task import get_dataset, get_model,␣
  ↪DL_single_run
```

[ ]:

```
## initialize dataset
##
task_name ="MI_with_HF_event"
X,y =get_dataset(dataset_name = task_name)

# ## test dummy function
# task_name ="dummy"
# X,y =get_dataset(dataset_name = task_name)
```

```
/home/engs2522/project/LLM-ECG-Dual-Attention
load signal and event data from default path
load MI_with_HF_event
load x,y from the given path /home/engs2522/project/LLM-ECG-Dual-
Attention/data/ukb/MI_to_HF_survival_data/ecg_data.npy
/home/engs2522/project/LLM-ECG-Dual-
Attention/data/ukb/MI_to_HF_survival_data/y_status_duration.npy
input ecg shape (800, 12, 608)
status, duration, eid (800, 3)
```

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```
## plot risk score distribution
from sklearn.model_selection import train_test_split, StratifiedKFold
kf = StratifiedKFold(n_splits=2, shuffle=True, random_state=42)
# Initialize lists to store predictions
val_c_index_list = []
y_status_list = y[:,0]
i =0

latent_code_dim=512
```

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```
y_status_list = y[:,0]
## here, we use models under multiple seeds to get the final prediction
seed_list = [42, 2021,2022,2023,2024]
seed_y_score_list = []
risk_scores=[]
for seed in seed_list:
    x_total_test=[]
    y_total_test=[]
    test_indices_list=[]
    total_risk_score=[]
    for cval, (train_indices, test_indices) in enumerate(kf.split(X,␣
 ↪y_status_list)):
        x_train, y_train = X[train_indices], y[train_indices]
        x_test, y_test = X[test_indices], y[test_indices]
        ## CHANGE YOUR MODEL Path for different cross-validation here
         ## find the best model path:
        project_root_path = Path(os.path.abspath("__file__")).parents[2]
        print(project_root_path)
        model_dir = os.path.join(project_root_path, f"result/
 ↪train_survival_net_{task_name}_0.5/
 ↪ECG_attention_pretrained_on_recon_ECG2Text_512/{seed}/cval_{cval}/")
        print(model_dir)
        best_model_path_list =glob.glob(model_dir+"best_model*_lr_*.pth")
        ## remove path with alpha
        if len(best_model_path_list)==0:
            raise ValueError("No model found")
        else:
            if len(best_model_path_list) >1:
                print (best_model_path_list)

                best_model_path_list = [x for x in best_model_path_list if␣
 ↪"alpha" not in x]
                c_index_list = [float((x.split("/")[-1]).split("_")[4]) for x␣
 ↪in best_model_path_list]
                highest_one = np.argmax(c_index_list)
                best_model_path  = best_model_path_list[highest_one]
            else:
                best_model_path = best_model_path_list[0]
        print(best_model_path)
        trainer, survival_model = DL_single_run(x_train, y_train,  model_name =␣
↪"ECG_attention",
                    batch_size = 100,
                    latent_code_dim=512,
                    train_from_scratch=True,
                    freeze_encoder=False, test_only=True,
                    test_checkpoint_path = best_model_path, ## this is the path␣
↪to the model for risk prediction
                    checkpoint_path="") ## this is the path to the pre-trained␣
↪model
        survival_model.freeze()
        X_test= torch.from_numpy(x_test).float().to(survival_model.device)

        with torch.inference_mode():
            log_risk_score,_ = survival_model(X_test)

        total_risk_score.append(log_risk_score.cpu().detach().numpy())
        x_total_test.append(x_test)
        y_total_test.append(y_test)
        test_indices_list.append(test_indices)
    total_risk_score_flatten = np.concatenate(total_risk_score)
    x_total_test_flatten = np.concatenate(x_total_test)
    y_total_test_flatten = np.concatenate(y_total_test)
    test_indices_flatten = np.concatenate(test_indices_list)
    ## sort the risk score back to the original order
    risk_score_sorted = total_risk_score_flatten[np.
↪argsort(test_indices_flatten)]
    risk_scores.append(risk_score_sorted)
    seed_y_score_list.append(risk_score_sorted)
```

```
/home/engs2522/project/LLM-ECG-Dual-Attention
/home/engs2522/project/LLM-ECG-Dual-Attention/result/train_survival_net_MI_with_
HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/42/cval_0/
/home/engs2522/project/LLM-ECG-Dual-Attention/result/train_survival_net_MI_with_
HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/42/cval_0/best_model
_c_index_0.4943_lr_3.981071705534972e-07.pth
no linear layer
```

```
GPU available: True (cuda), used: True
TPU available: False, using: 0 TPU cores
IPU available: False, using: 0 IPUs
HPU available: False, using: 0 HPUs
GPU available: True (cuda), used: True
TPU available: False, using: 0 TPU cores
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IPU available: False, using: 0 IPUs
HPU available: False, using: 0 HPUs

/home/engs2522/project/LLM-ECG-Dual-Attention
/home/engs2522/project/LLM-ECG-Dual-Attention/result/train_survival_net_MI_with_
HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/42/cval_1/
/home/engs2522/project/LLM-ECG-Dual-Attention/result/train_survival_net_MI_with_
HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/42/cval_1/best_model
_c_index_0.6701_lr_3.5481338923357546e-06.pth
no linear layer

GPU available: True (cuda), used: True
TPU available: False, using: 0 TPU cores
IPU available: False, using: 0 IPUs
HPU available: False, using: 0 HPUs

/home/engs2522/project/LLM-ECG-Dual-Attention
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HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/2021/cval_0/
/home/engs2522/project/LLM-ECG-Dual-Attention/result/train_survival_net_MI_with_
HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/2021/cval_0/best_mod
el_c_index_0.5874_lr_0.0031622776601683803.pth
no linear layer

GPU available: True (cuda), used: True
TPU available: False, using: 0 TPU cores
IPU available: False, using: 0 IPUs
HPU available: False, using: 0 HPUs

/home/engs2522/project/LLM-ECG-Dual-Attention
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HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/2021/cval_1/
/home/engs2522/project/LLM-ECG-Dual-Attention/result/train_survival_net_MI_with_
HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/2021/cval_1/best_mod
el_c_index_0.5479_lr_7.07945784384138e-07.pth
no linear layer

GPU available: True (cuda), used: True
TPU available: False, using: 0 TPU cores
IPU available: False, using: 0 IPUs
HPU available: False, using: 0 HPUs

/home/engs2522/project/LLM-ECG-Dual-Attention
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HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/2022/cval_0/
/home/engs2522/project/LLM-ECG-Dual-Attention/result/train_survival_net_MI_with_
HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/2022/cval_0/best_mod
el_c_index_0.6468_lr_1.1220184543019633e-06.pth
no linear layer

GPU available: True (cuda), used: True
TPU available: False, using: 0 TPU cores
```

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IPU available: False, using: 0 IPUs
HPU available: False, using: 0 HPUs

/home/engs2522/project/LLM-ECG-Dual-Attention
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HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/2022/cval_1/
/home/engs2522/project/LLM-ECG-Dual-Attention/result/train_survival_net_MI_with_
HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/2022/cval_1/best_mod
el_c_index_0.6093_lr_4.466835921509631e-06.pth
no linear layer

GPU available: True (cuda), used: True
TPU available: False, using: 0 TPU cores
IPU available: False, using: 0 IPUs
HPU available: False, using: 0 HPUs

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HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/2023/cval_0/
/home/engs2522/project/LLM-ECG-Dual-Attention/result/train_survival_net_MI_with_
HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/2023/cval_0/best_mod
el_c_index_0.6478_lr_0.003981071705534974.pth
no linear layer

GPU available: True (cuda), used: True
TPU available: False, using: 0 TPU cores
IPU available: False, using: 0 IPUs
HPU available: False, using: 0 HPUs

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HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/2023/cval_1/
/home/engs2522/project/LLM-ECG-Dual-Attention/result/train_survival_net_MI_with_
HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/2023/cval_1/best_mod
el_c_index_0.3953_lr_6.309573444801932e-07.pth
no linear layer

GPU available: True (cuda), used: True
TPU available: False, using: 0 TPU cores
IPU available: False, using: 0 IPUs
HPU available: False, using: 0 HPUs

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HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/2024/cval_0/
/home/engs2522/project/LLM-ECG-Dual-Attention/result/train_survival_net_MI_with_
HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/2024/cval_0/best_mod
el_c_index_0.5656_lr_3.548133892335754e-07.pth
no linear layer

GPU available: True (cuda), used: True
TPU available: False, using: 0 TPU cores
```

```
IPU available: False, using: 0 IPUs
HPU available: False, using: 0 HPUs
```

```
/home/engs2522/project/LLM-ECG-Dual-Attention
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HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/2024/cval_1/
/home/engs2522/project/LLM-ECG-Dual-Attention/result/train_survival_net_MI_with_
HF_event_0.5/ECG_attention_pretrained_on_recon_ECG2Text_512/2024/cval_1/best_mod
el_c_index_0.6407_lr_6.309573444801932e-07.pth
no linear layer
```

[ ]:

```
## average the risk score for five runs
risk_scores = np.stack(risk_scores)
print(risk_scores.shape)
risk_scores_mean = np.mean(risk_scores,axis=0)
print(risk_scores_mean.shape)
```

```
(5, 800, 1)
(800, 1)
```

[ ]:

```
## average the risk score over 5 runs
seed_y_score_list = np.stack(seed_y_score_list)
y_score = np.mean(seed_y_score_list, axis=0)
print(y_score.shape)
```

```
(800, 1)
```

[ ]:

```
plt.figure(figsize=(10,6))
sns.distplot(y_score, label="risk score distribution")
plt.legend()

## find the median risk score
median_risk_score = np.median(y_score)
## find the 96% percentile risk score
if "MI" in task_name:
    median_risk_score = np.percentile(y_score, 96)
elif "HYP" in task_name:
    median_risk_score = np.percentile(y_score, 98)

print("median risk score: ", median_risk_score)
```

```
median risk score:  5.839755058288574
```

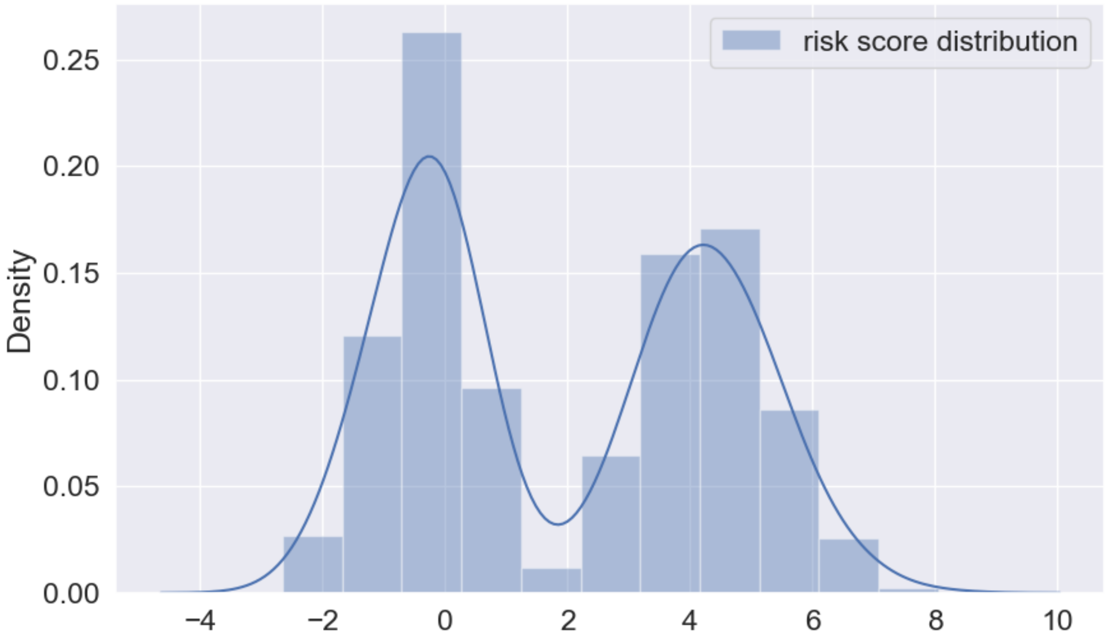
```
/tmp/ipykernel_22075/1075921846.py:2: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.14.0.

Please adapt your code to use either `displot` (a figure-level function with
similar flexibility) or `histplot` (an axes-level function for histograms).
```

```
For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751

  sns.distplot(y_score, label="risk score distribution")
```



[ ]:
```
high_risk_group_index = np.where(y_score>=median_risk_score)[0]
low_risk_group_index = np.where(y_score<median_risk_score)[0]
```

[ ]:
```
print("number of patients in high risk group: ", len(high_risk_group_index))
print("number of patients in low risk group: ", len(low_risk_group_index))
```

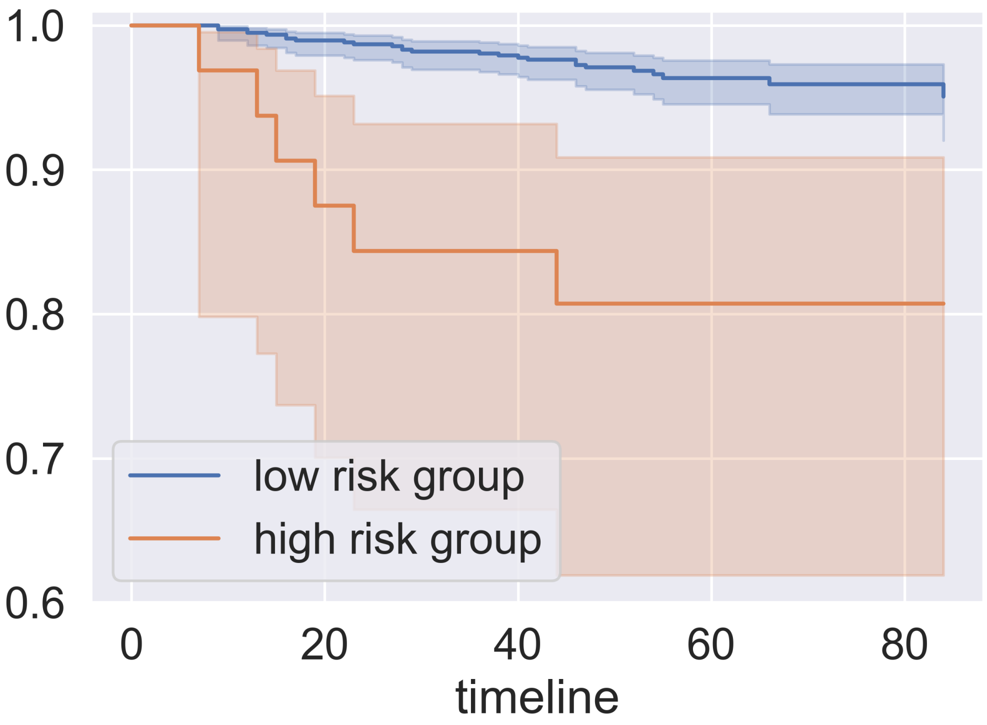
```
number of patients in high risk group:  32
number of patients in low risk group:  768
```

[ ]:
```
## plot kaplan meier curve
sns.set(font_scale=1.5)
kmf = KaplanMeierFitter()
fig, ax  = plt.subplots(1,1,figsize=(6, 4),dpi =500)
kmf.fit(y[low_risk_group_index][:,1], event_observed=y[low_risk_group_index][:
 ↪,0], label="low risk group")
kmf.plot(ax=ax)
kmf.fit(y[high_risk_group_index][:,1], event_observed=y[high_risk_group_index][:
 ↪,0], label="high risk group")
kmf.plot(ax=ax)
```

```
ax.set_ylim(0.60,1.01)
```

```
/home/engs2522/local/conda/envs/pytorch3d/lib/python3.9/site-
packages/lifelines/fitters/kaplan_meier_fitter.py:444: DeprecationWarning: The
`plot` function is deprecated, and will be removed in future versions. Use
`plot_survival_function`
  warnings.warn(
/home/engs2522/local/conda/envs/pytorch3d/lib/python3.9/site-
packages/lifelines/fitters/kaplan_meier_fitter.py:444: DeprecationWarning: The
`plot` function is deprecated, and will be removed in future versions. Use
`plot_survival_function`
  warnings.warn(
```

```
[ ]: (0.6, 1.01)
```



```
[ ]:
```