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1. (1%)請比較有無 normalize(rating)的差別。並說明如何 normalize.
(collaborator:)
標準 model: latent dimension=64, batch size=256, epochs=100
Normalized model: 設定跟上面相同，將 rating 直接除以 5

	Kaggle (public)
標準	0.86086
Normalized	2.85070

因為我在澳洲參加 conference，因此提早準備 report，以 kaggle public 分數為討論依據。可以看出 normalized 的效果非常差，我原本預期做完 normalized 效果會比較好，或許換別的 normalization 方法效果會比較好。

2. (1%)比較不同的 latent dimension 的結果。
(collaborator:)
以第一題的標準 model 為主，改變 latent dimension

Latent dimension	Kaggle (public)
32	0.86144
64	0.86068
128	0.86162
256	0.88420

3. (1%)比較有無 bias 的結果。
(collaborator:)

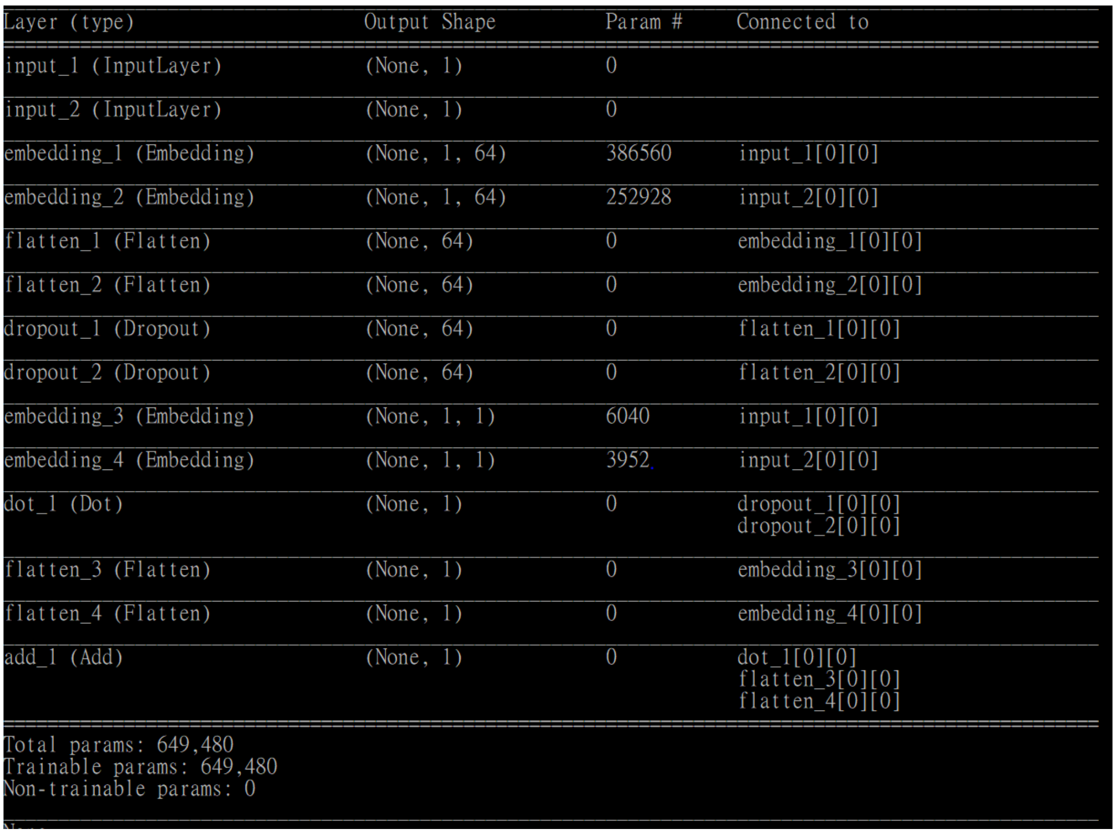
	Kaggle (public)
標準(have bias)	0.86086
No Bias	0.92461

4. (1%)請試著用 DNN 來解決這個問題，並且說明實做的方法(方法不限)。並比較 MF 和 NN 的結果，討論結果的差異。
(collaborator:)
MF model(標準): 將 user 跟 movie 做 embedding，轉換成 vector(Flatten)，最後將兩者相乘(dot)。
DNN model: 把上述的 Model 中的 dot 改成 concatenate，然後接 DNN。

	Kaggle (public)
標準(MF)	0.86086
DNN	0.86243

兩者結果相近。

MF model:



```
Layer (type)                     Output Shape         Param #     Connected to
==================================================================================================
input_1 (InputLayer)             (None, 1)            0
__________________________________________________________________________________________________
input_2 (InputLayer)             (None, 1)            0
__________________________________________________________________________________________________
embedding_1 (Embedding)          (None, 1, 64)        386560      input_1[0][0]
__________________________________________________________________________________________________
embedding_2 (Embedding)          (None, 1, 64)        252928      input_2[0][0]
__________________________________________________________________________________________________
flatten_1 (Flatten)              (None, 64)           0           embedding_1[0][0]
__________________________________________________________________________________________________
flatten_2 (Flatten)              (None, 64)           0           embedding_2[0][0]
__________________________________________________________________________________________________
dropout_1 (Dropout)              (None, 64)           0           flatten_1[0][0]
__________________________________________________________________________________________________
dropout_2 (Dropout)              (None, 64)           0           flatten_2[0][0]
__________________________________________________________________________________________________
embedding_3 (Embedding)          (None, 1, 1)         6040        input_1[0][0]
__________________________________________________________________________________________________
embedding_4 (Embedding)          (None, 1, 1)         3952        input_2[0][0]
__________________________________________________________________________________________________
dot_1 (Dot)                      (None, 1)            0           dropout_1[0][0]
                                                                  dropout_2[0][0]
__________________________________________________________________________________________________
flatten_3 (Flatten)              (None, 1)            0           embedding_3[0][0]
__________________________________________________________________________________________________
flatten_4 (Flatten)              (None, 1)            0           embedding_4[0][0]
__________________________________________________________________________________________________
add_1 (Add)                      (None, 1)            0           dot_1[0][0]
                                                                  flatten_3[0][0]
                                                                  flatten_4[0][0]
==================================================================================================
Total params: 649,480
Trainable params: 649,480
Non-trainable params: 0
__________________________________________________________________________________________________
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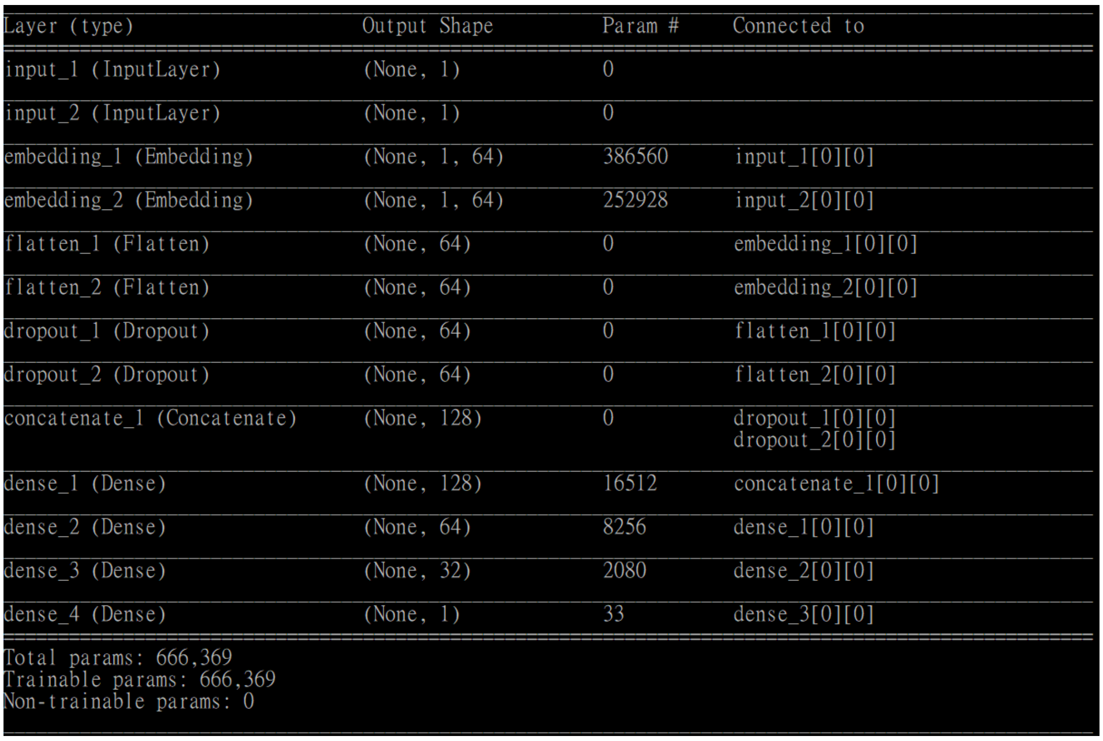
DNN model:



```
Layer (type)                     Output Shape         Param #     Connected to
==================================================================================================
input_1 (InputLayer)             (None, 1)            0
__________________________________________________________________________________________________
input_2 (InputLayer)             (None, 1)            0
__________________________________________________________________________________________________
embedding_1 (Embedding)          (None, 1, 64)        386560      input_1[0][0]
__________________________________________________________________________________________________
embedding_2 (Embedding)          (None, 1, 64)        252928      input_2[0][0]
__________________________________________________________________________________________________
flatten_1 (Flatten)              (None, 64)           0           embedding_1[0][0]
__________________________________________________________________________________________________
flatten_2 (Flatten)              (None, 64)           0           embedding_2[0][0]
__________________________________________________________________________________________________
dropout_1 (Dropout)              (None, 64)           0           flatten_1[0][0]
__________________________________________________________________________________________________
dropout_2 (Dropout)              (None, 64)           0           flatten_2[0][0]
__________________________________________________________________________________________________
concatenate_1 (Concatenate)      (None, 128)          0           dropout_1[0][0]
                                                                  dropout_2[0][0]
__________________________________________________________________________________________________
dense_1 (Dense)                  (None, 128)          16512       concatenate_1[0][0]
__________________________________________________________________________________________________
dense_2 (Dense)                  (None, 64)           8256        dense_1[0][0]
__________________________________________________________________________________________________
dense_3 (Dense)                  (None, 32)           2080        dense_2[0][0]
__________________________________________________________________________________________________
dense_4 (Dense)                  (None, 1)            33          dense_3[0][0]
==================================================================================================
Total params: 666,369
Trainable params: 666,369
Non-trainable params: 0
__________________________________________________________________________________________________
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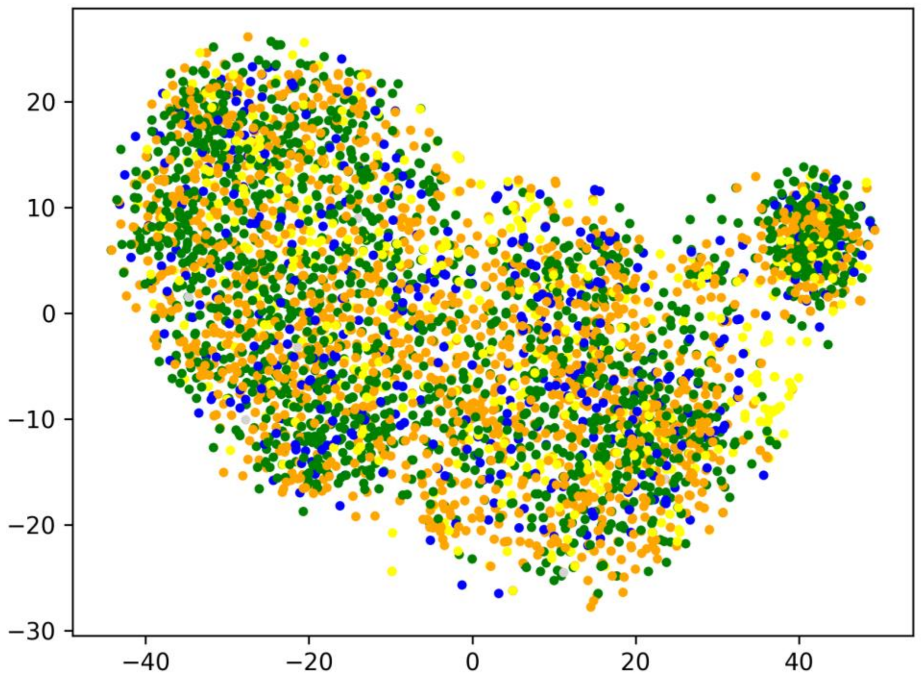
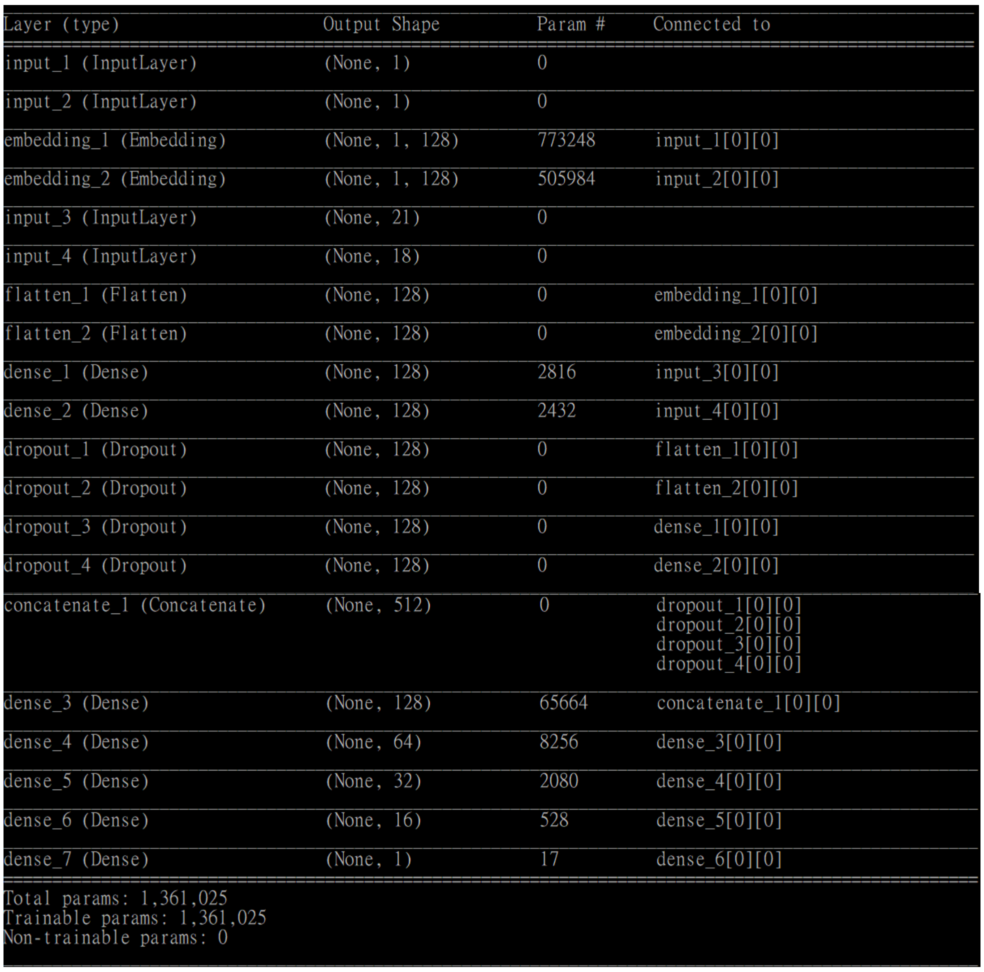
5. (1%)請試著將 movie 的 embedding 用 tsne 降維後，將 movie category 當作 label 來作圖。
(collaborator:)



Orange	['Animation' "Children's" 'Comedy' 'Adventure']
Green	['Romance' 'Drama' 'Documentary' 'Musical']
Blue	['Fantasy' 'Action' 'Sci-Fi' 'War' 'Western']
Yellow	['Crime' 'Thriller' 'Horror' 'Film-Noir']
Lightgray	['other']

6. (BONUS)(1%)試著使用除了 rating 以外的 feature, 並說明你的作法和結果，結果好壞不會影響評分。
(collaborator:) 我用 DNN model 加上額外的 features(user occupation & movie genre) 一起放進 DNN，效果意外的好: 0.86243➔0.85019



```
Layer (type)                     Output Shape          Param #     Connected to
==================================================================================================
input_1 (InputLayer)             (None, 1)             0
__________________________________________________________________________________________________
input_2 (InputLayer)             (None, 1)             0
__________________________________________________________________________________________________
embedding_1 (Embedding)          (None, 1, 128)        773248      input_1[0][0]
__________________________________________________________________________________________________
embedding_2 (Embedding)          (None, 1, 128)        505984      input_2[0][0]
__________________________________________________________________________________________________
input_3 (InputLayer)             (None, 21)            0
__________________________________________________________________________________________________
input_4 (InputLayer)             (None, 18)            0
__________________________________________________________________________________________________
flatten_1 (Flatten)              (None, 128)           0           embedding_1[0][0]
__________________________________________________________________________________________________
flatten_2 (Flatten)              (None, 128)           0           embedding_2[0][0]
__________________________________________________________________________________________________
dense_1 (Dense)                  (None, 128)           2816        input_3[0][0]
__________________________________________________________________________________________________
dense_2 (Dense)                  (None, 128)           2432        input_4[0][0]
__________________________________________________________________________________________________
dropout_1 (Dropout)              (None, 128)           0           flatten_1[0][0]
__________________________________________________________________________________________________
dropout_2 (Dropout)              (None, 128)           0           flatten_2[0][0]
__________________________________________________________________________________________________
dropout_3 (Dropout)              (None, 128)           0           dense_1[0][0]
__________________________________________________________________________________________________
dropout_4 (Dropout)              (None, 128)           0           dense_2[0][0]
__________________________________________________________________________________________________
concatenate_1 (Concatenate)      (None, 512)           0           dropout_1[0][0]
                                                                   dropout_2[0][0]
                                                                   dropout_3[0][0]
                                                                   dropout_4[0][0]
__________________________________________________________________________________________________
dense_3 (Dense)                  (None, 128)           65664       concatenate_1[0][0]
__________________________________________________________________________________________________
dense_4 (Dense)                  (None, 64)            8256        dense_3[0][0]
__________________________________________________________________________________________________
dense_5 (Dense)                  (None, 32)            2080        dense_4[0][0]
__________________________________________________________________________________________________
dense_6 (Dense)                  (None, 16)            528         dense_5[0][0]
__________________________________________________________________________________________________
dense_7 (Dense)                  (None, 1)             17          dense_6[0][0]
==================================================================================================
Total params: 1,361,025
Trainable params: 1,361,025
Non-trainable params: 0
__________________________________________________________________________________________________
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