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1. (1%)請比較有無 normalize(rating)的差別。並說明如何 normalize.

   (collaborator:)

	public	private
w/o normalize	0.86630	0.86612
normalize(/5)	Loss 很高，無需上傳 Kaggle 比較	
Standard normalize	0.86550	0.86540

   如上表所示，錯誤的 normalize 方式，會使得表現下降很多，有作 standard normalization 有微乎其微的差異

2. (1%)比較不同的 latent dimension 的結果。

   (collaborator:)

	public	private
32	0.90643	0.90363
64	0.86373	0.86419
128	0.85740	0.85942
256	0.86867	0.86890

3. (1%)比較有無 bias 的結果。

   (collaborator:)

	Public	Private
w/ bias	0.86373	0.86419
w/o bias	0.90790	0.90670

很明顯，有考慮 bias 的情況表現好很多，

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:)

	Public	Private
MF	0.86373	0.86419
NN	0.88550	0.88633

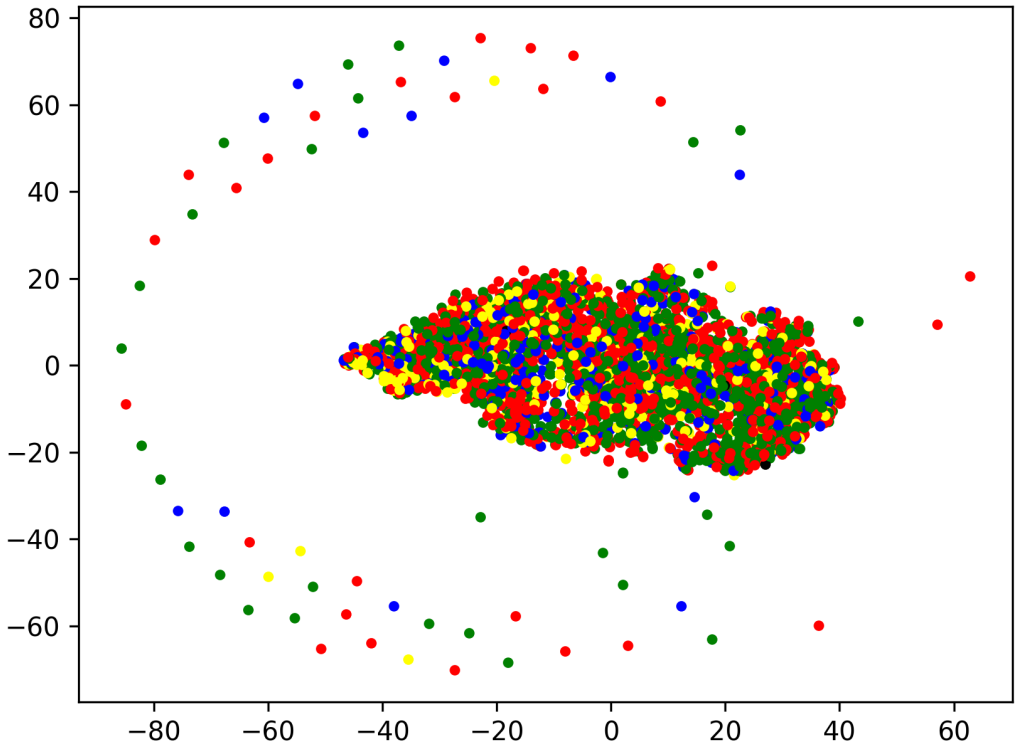
NN 架構如下圖所示，而從上表所示，雖說 NN 的表現不如 MF，但已算相近，若是再調出更適當的參數，或許能得到一樣好的表現，

Layer (type)	Output Shape	Param #	Connected to
input_1 (InputLayer)	(None, 1)	0	
m (InputLayer)	(None, 1)	0	
embedding_1 (Embedding)	(None, 1, 128)	773120	input_1[0][0]
embedding_2 (Embedding)	(None, 1, 128)	505856	m[0][0]
flatten_1 (Flatten)	(None, 128)	0	embedding_1[0][0]
m_out (Flatten)	(None, 128)	0	embedding_2[0][0]
dropout_1 (Dropout)	(None, 128)	0	flatten_1[0][0]
dropout_2 (Dropout)	(None, 128)	0	m_out[0][0]
concatenate_1 (Concatenate)	(None, 256)	0	dropout_1[0][0] dropout_2[0][0]
dense_1 (Dense)	(None, 512)	131584	concatenate_1[0][0]
dropout_3 (Dropout)	(None, 512)	0	dense_1[0][0]
dense_2 (Dense)	(None, 256)	131328	dropout_3[0][0]
dropout_4 (Dropout)	(None, 256)	0	dense_2[0][0]
dense_3 (Dense)	(None, 64)	16448	dropout_4[0][0]
dropout_5 (Dropout)	(None, 64)	0	dense_3[0][0]
dense_4 (Dense)	(None, 32)	2080	dropout_5[0][0]
dropout_6 (Dropout)	(None, 32)	0	dense_4[0][0]
dense_5 (Dense)	(None, 1)	33	dropout_6[0][0]

5. (1%)請試著將 movie 的 embedding 用 tsne 降維後，將 movie category 當

作 label 來作圖。

(collaborator:)




```
('red:', array(['Animation', "Children's", 'Comedy', 'Adventure'],
      dtype='|S11'))
('green:', array(['Romance', 'Drama', 'Documentary', 'Musical'],
      dtype='|S11'))
('blue:', array(['Fantasy', 'Action', 'Sci-Fi', 'War', 'Western'],
      dtype='|S11'))
('yellow:', array(['Crime', 'Thriller', 'Horror', 'Film-Noir'],
      dtype='|S11'))
```

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:)

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, 128)	505856	input_2[0][0]
input_3 (InputLayer)	(None, 21)	0	
input_4 (InputLayer)	(None, 18)	0	
flatten_1 (Flatten)	(None, 64)	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, 64)	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, 448)	0	dropout_1[0][0] dropout_2[0][0] dropout_3[0][0] dropout_4[0][0]
dense_3 (Dense)	(None, 256)	114944	concatenate_1[0][0]
dropout_5 (Dropout)	(None, 256)	0	dense_3[0][0]
dense_4 (Dense)	(None, 64)	16448	dropout_5[0][0]
dropout_6 (Dropout)	(None, 64)	0	dense_4[0][0]
dense_5 (Dense)	(None, 16)	1040	dropout_6[0][0]
dropout_7 (Dropout)	(None, 16)	0	dense_5[0][0]
dense_6 (Dense)	(None, 4)	68	dropout_7[0][0]
dense_7 (Dense)	(None, 1)	5	dense_6[0][0]

Total params: 1,030,169
Trainable params: 1,030,169
Non-trainable params: 0

架構如上所示，多加了兩個 feature，然後效果並沒有顯著增加，猜測也許是因為額外 feature 的處理不佳。

	Public	Private
w/o extra feature	0.85740	0.85942
w/ extra feature	0.85620	0.85848