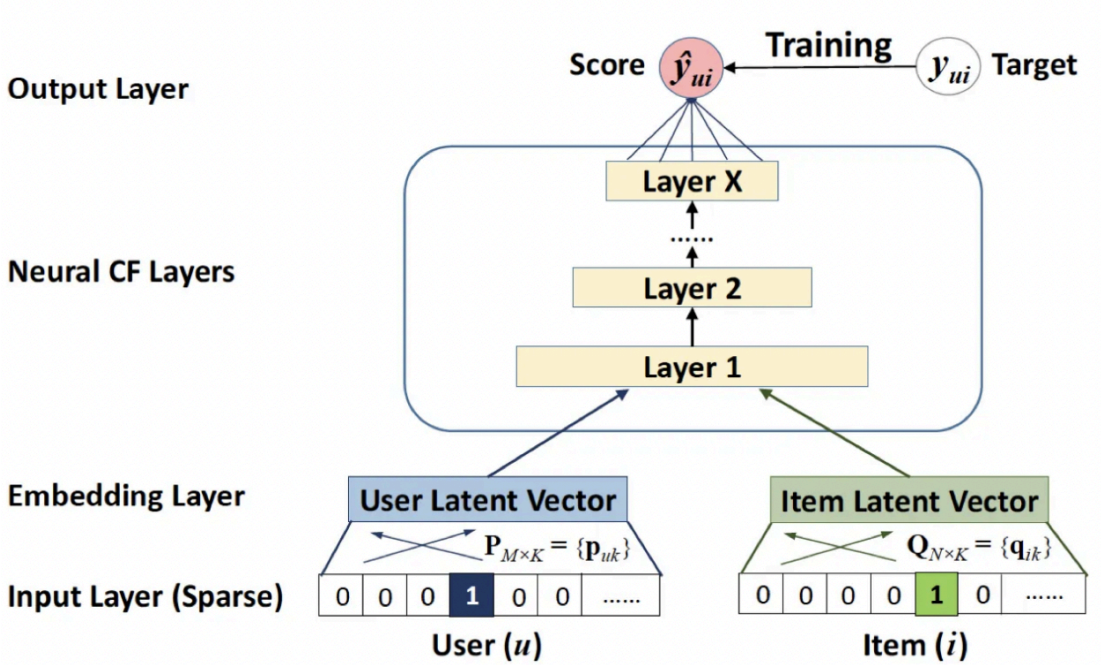
Neural Collaborative Filtering

NCF Architecture



Data Loading And Preprocessing

In [1]:
```
import pandas as pd
import numpy as np

data = pd.read_csv("/kaggle/input/movielens-32m/ml-32m/ratings.csv")
data.drop(columns=["timestamp"], inplace=True)
data.head()
```

Out[1]:

	userId	movieId	rating
0	1	17	4.0
1	1	25	1.0
2	1	29	2.0
3	1	30	5.0
4	1	32	5.0

In [2]:
```
user_mapping = {user_id: idx for idx, user_id in enumerate(data['userId'].unique
item_mapping = {item_id: idx for idx, item_id in enumerate(data['movieId'].uniqu

data['userId'] = data["userId"].map(user_mapping)
data['movieId'] = data['movieId'].map(item_mapping)

num_users = len(user_mapping)
```

```
num_items = len(item_mapping)

print(f"Numbers of users: {num_users}\nNumber of movies: {num_items}")
```

```
Numbers of users: 200948
Number of movies: 84432
```

In [3]:
```
from sklearn.model_selection import train_test_split

x = data[['userId', 'movieId']].values
y = (data['rating'] > 3).astype(np.float32)

X_train, X_test, y_train, y_test = train_test_split(x, y, test_size=0.2, random_

print(f"Training samples: {len(X_train)}, Testing samples: {len(X_test)}")
```

```
Training samples: 25600163, Testing samples: 6400041
```

In [4]:
```
import tensorflow as tf

train_dataset = tf.data.Dataset.from_tensor_slices((X_train, y_train))
test_dataset = tf.data.Dataset.from_tensor_slices((X_test, y_test))

batch_size = 256

train_dataset = train_dataset.shuffle(buffer_size=len(X_train)).batch(batch_size
test_dataset = test_dataset.batch(batch_size)
```

In [5]:
```
def preprocess(data):
    user_ids = data[:, 0]
    item_ids = data[:, 1]
    return {"user_id": user_ids, "item_id": item_ids}

train_dataset = train_dataset.map(lambda x, y: (preprocess(x), y))
test_dataset = test_dataset.map(lambda x, y: (preprocess(x), y))
```

In [6]:
```
for batch in train_dataset.take(1):
    inputs, labels = batch
    print("User IDs:", inputs['user_id'][:5].numpy())
    print("Item IDs:", inputs['item_id'][:5].numpy())
    print("Labels:", labels[:5].numpy())
```

```
User IDs: [ 74358  52531  40164 197739  14798]
Item IDs: [ 123  514  785 1295  247]
Labels: [1. 1. 1. 1. 1.]
```

Model Creation

In [7]:
```
from tensorflow.keras import layers, Model
from tensorflow.keras.saving import register_keras_serializable

@register_keras_serializable(package="NCFModel")
class NCFModel(Model):
    def __init__(self, num_users, num_items, embedding_dim=16, mlp_layers=[64, 3
        super(NCFModel, self).__init__(**kwargs)

        self.num_users = num_users
        self.num_items = num_items
        self.embedding_dim = embedding_dim
```

```
        self.mlp_layers_config = mlp_layers

        self.user_embedding_gmf = layers.Embedding(input_dim = num_users, output
        self.item_embedding_gmf = layers.Embedding(input_dim = num_items, output

        self.user_embedding_mlp = layers.Embedding(input_dim = num_users, output
        self.item_embedding_mlp = layers.Embedding(input_dim = num_items, output

        self.mlp_layers = tf.keras.Sequential()
        for units in mlp_layers:
            self.mlp_layers.add(layers.Dense(units, activation='relu'))

        self.concat_layer = layers.Concatenate()
        self.output_layer = layers.Dense(1, activation='sigmoid')

    def call(self, inputs):
        user_ids, item_ids = inputs["user_id"], inputs['item_id']
        gmf_user = self.user_embedding_gmf(user_ids)
        gmf_item = self.item_embedding_gmf(item_ids)
        gmf_output = gmf_user * gmf_item

        mlp_user = self.user_embedding_mlp(user_ids)
        mlp_item = self.item_embedding_mlp(item_ids)
        mlp_input = tf.concat([mlp_user, mlp_item], axis=-1)
        mlp_output = self.mlp_layers(mlp_input)

        combined = self.concat_layer([gmf_output, mlp_output])

        return self.output_layer(combined)
    def get_config(self):
        # Returns the configuration to save the model
        config = super().get_config()
        config.update({
            "num_users": self.num_users,
            "num_items": self.num_items,
            "embedding_dim": self.embedding_dim,
            "mlp_layers": self.mlp_layers_config,
        })
        return config

    @classmethod
    def from_config(cls, config):
        # Creates the model from the saved configuration
        return cls(
            num_users=config["num_users"],
            num_items=config["num_items"],
            embedding_dim=config["embedding_dim"],
            mlp_layers=config["mlp_layers"],
        )
```

In [8]:
```
ncf_model = NCFModel(num_users=200948, num_items=84432, embedding_dim=16, mlp_la
```

In [9]:
```
ncf_model.compile(
    optimizer=tf.keras.optimizers.Adam(learning_rate=0.001),
    loss='binary_crossentropy',
    metrics=['accuracy', 'mse', 'mae']
)
```

In [10]:
```
ncf_model.summary()
```

Model: "ncf_model"

Layer (type)	Output Shape	Param #
embedding (Embedding)	?	0 (unbuilt)
embedding_1 (Embedding)	?	0 (unbuilt)
embedding_2 (Embedding)	?	0 (unbuilt)
embedding_3 (Embedding)	?	0 (unbuilt)
sequential (Sequential)	?	0 (unbuilt)
concatenate (Concatenate)	?	0 (unbuilt)
dense_3 (Dense)	?	0 (unbuilt)

Total params: 0 (0.00 B)

Trainable params: 0 (0.00 B)

Non-trainable params: 0 (0.00 B)

Training The Model

In [11]:
```
ncf_model.fit(
    train_dataset,
    validation_data=test_dataset,
    epochs=1,
    batch_size=256
)
```

```
WARNING: All log messages before absl::InitializeLog() is called are written to S
TDERR
I0000 00:00:1732784999.443291     310 service.cc:145] XLA service 0x78f0b4058920
initialized for platform CUDA (this does not guarantee that XLA will be used). De
vices:
I0000 00:00:1732784999.443349     310 service.cc:153]   StreamExecutor device
(0): Tesla T4, Compute Capability 7.5
I0000 00:00:1732784999.443353     310 service.cc:153]   StreamExecutor device
(1): Tesla T4, Compute Capability 7.5
    34/100001 ━━━━━━━━━━━━━━━━━━━━ 7:52 5ms/step - accuracy: 0.5875 - loss: 0.686
4 - mae: 0.4960 - mse: 0.2466
I0000 00:00:1732785000.813665     310 device_compiler.h:188] Compiled cluster usi
ng XLA!  This line is logged at most once for the lifetime of the process.
100001/100001 ━━━━━━━━━━━━━━━━━━━━ 502s 4ms/step - accuracy: 0.7432 - loss: 0.517
6 - mae: 0.3451 - mse: 0.1726 - val_accuracy: 0.7740 - val_loss: 0.4699 - val_ma
e: 0.3090 - val_mse: 0.1542
```

Out[11]: <keras.src.callbacks.history.History at 0x78f117118c10>

Evaluation

In [13]:
```
loss, accuracy, _, _ = ncf_model.evaluate(test_dataset)
print(f"Loss = {loss:.4f}, Accuracy = {accuracy:.4f}")
```

```
25001/25001 ━━━━━━━━━━━━━━━━━━━━ 40s 2ms/step - accuracy: 0.7741 - loss: 0.4699 -
mae: 0.3090 - mse: 0.1542
Loss = 0.4699, Accuracy = 0.7740
```

In [14]:
```
ncf_model.summary()
```

Model: "ncf_model"

Layer (type)	Output Shape	Param #
embedding (Embedding)	?	3,215,168
embedding_1 (Embedding)	?	1,350,912
embedding_2 (Embedding)	?	3,215,168
embedding_3 (Embedding)	?	1,350,912
sequential (Sequential)	?	4,720
concatenate (Concatenate)	?	0
dense_3 (Dense)	?	33

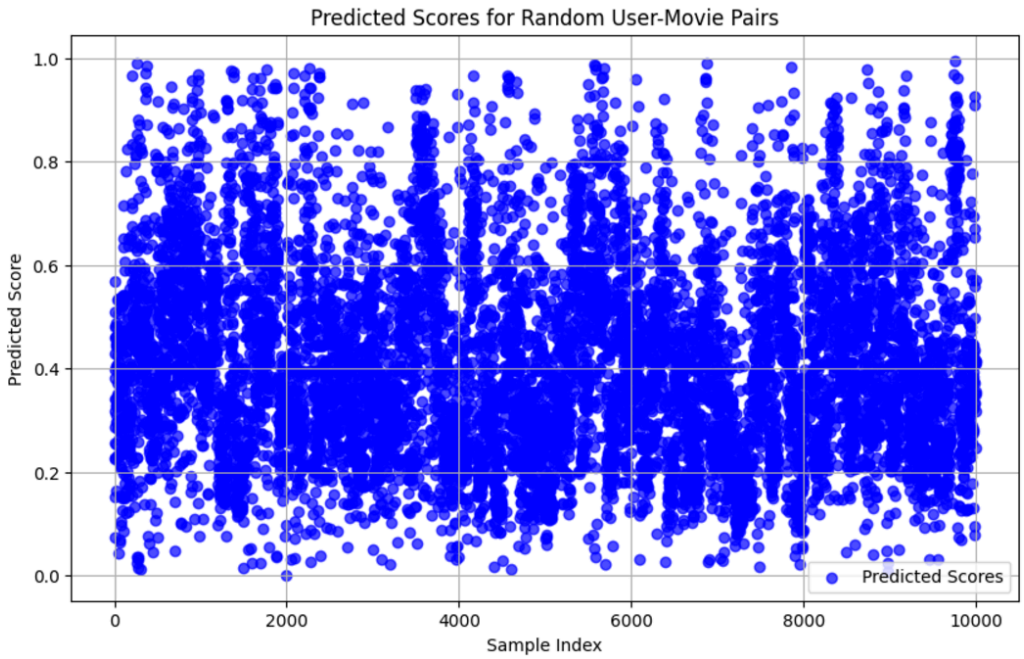
Total params: 27,410,741 (104.56 MB)

Trainable params: 9,136,913 (34.85 MB)

Non-trainable params: 0 (0.00 B)

Optimizer params: 18,273,828 (69.71 MB)

In [15]:
```
ncf_model.save("/kaggle/working/ncf_model.keras")
```



In [ ]:
```

```