시퀀스 배열로 다루는 순환 신경망(RNN)

1. LSTM을 이용한 로이터 뉴스 카테고리 분류하기

In [3]:
```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, LSTM, Embedding
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.preprocessing import sequence
from tensorflow.keras.datasets import reuters       # 로이터 뉴스 데이터셋 불러오기
from tensorflow.keras.callbacks import EarlyStopping

import numpy as np
import matplotlib.pyplot as plt

# 데이터를 불러와 학습셋, 테스트셋으로 나눕니다.
(X_train, y_train), (X_test, y_test) = reuters.load_data(num_words=1000, test_split=0.2)

# 데이터를 확인해 보겠습니다.
category = np.max(y_train) + 1
print(category, '카테고리')
print(len(X_train), '학습용 뉴스 기사')
print(len(X_test), '테스트용 뉴스 기사')
print(X_train[0])
```

```
46 카테고리
8982 학습용 뉴스 기사
2246 테스트용 뉴스 기사
[1, 2, 2, 8, 43, 10, 447, 5, 25, 207, 270, 5, 2, 111, 16, 369, 186, 90, 67, 7, 89, 5, 19, 102, 6, 19, 124, 15, 90, 67, 84, 22,
482, 26, 7, 48, 4, 49, 8, 864, 39, 209, 154, 6, 151, 6, 83, 11, 15, 22, 155, 11, 15, 7, 48, 9, 2, 2, 504, 6, 258, 6, 272, 11, 1
5, 22, 134, 44, 11, 15, 16, 8, 197, 2, 90, 67, 52, 29, 209, 30, 32, 132, 6, 109, 15, 17, 12]
```

In [4]:
```
# 단어의 수를 맞추어 줍니다.
X_train = sequence.pad_sequences(X_train, maxlen=100)
X_test = sequence.pad_sequences(X_test, maxlen=100)

# 원-핫 인코딩 처리를 합니다.
```

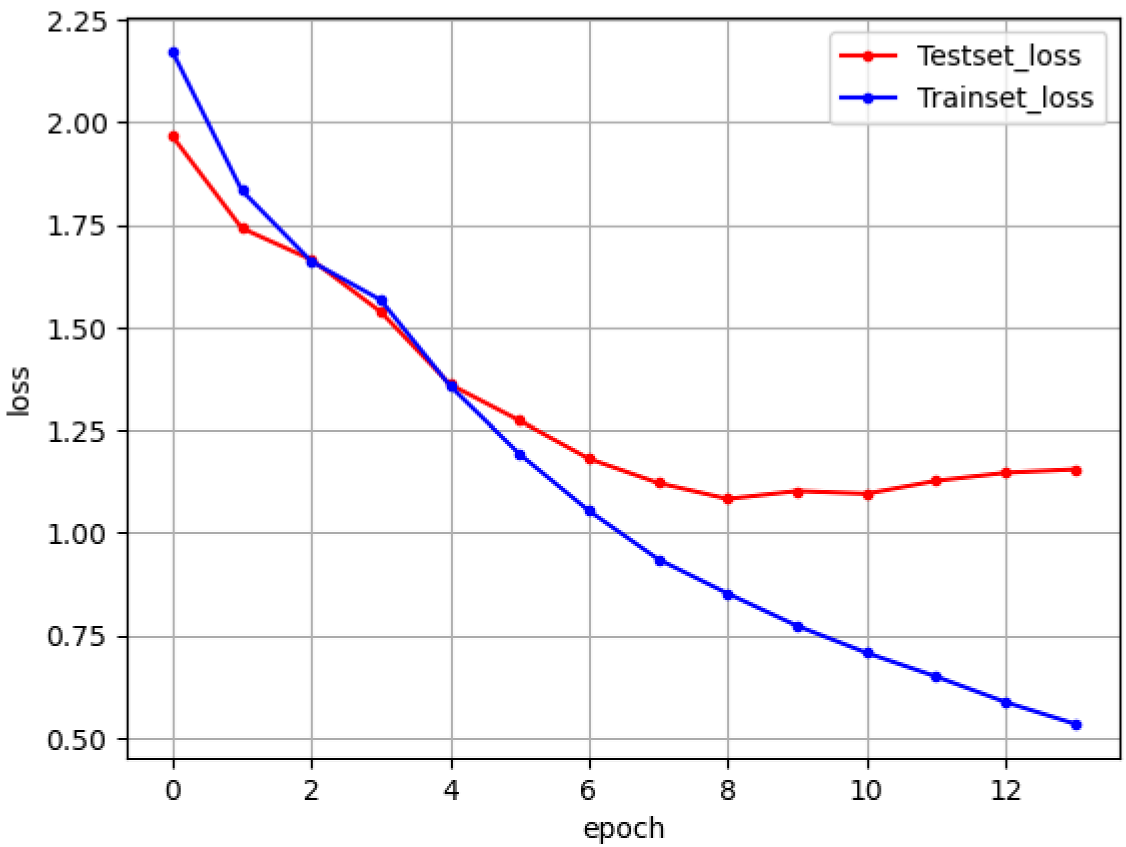
```python
y_train = to_categorical(y_train)
y_test = to_categorical(y_test)

# 모델의 구조를 설정합니다.
model = Sequential()
model.add(Embedding(1000, 100))
model.add(LSTM(100, activation='tanh'))
model.add(Dense(46, activation='softmax'))

# 모델의 실행 옵션을 정합니다.
model.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accuracy'])

# 학습의 조기 중단을 설정합니다.
early_stopping_callback = EarlyStopping(monitor='val_loss', patience=5)

# 모델을 실행합니다.
history = model.fit(X_train, y_train, batch_size=20, epochs=200, validation_data=(X_test, y_test),
                    callbacks=[early_stopping_callback])

# 테스트 정확도를 출력합니다.
print("\n Test Accuracy: %.4f" % (model.evaluate(X_test, y_test)[1]))
```

```
Epoch 1/200
450/450 ━━━━━━━━━━━━━━━━━━━━ 8s 15ms/step - accuracy: 0.3992 - loss: 2.4491 - val_accuracy: 0.5129 - val_loss: 1.9667
Epoch 2/200
450/450 ━━━━━━━━━━━━━━━━━━━━ 7s 16ms/step - accuracy: 0.5229 - loss: 1.8877 - val_accuracy: 0.5597 - val_loss: 1.7422
Epoch 3/200
450/450 ━━━━━━━━━━━━━━━━━━━━ 7s 16ms/step - accuracy: 0.5592 - loss: 1.6760 - val_accuracy: 0.5739 - val_loss: 1.6656
Epoch 4/200
450/450 ━━━━━━━━━━━━━━━━━━━━ 7s 16ms/step - accuracy: 0.5900 - loss: 1.5908 - val_accuracy: 0.6104 - val_loss: 1.5382
Epoch 5/200
450/450 ━━━━━━━━━━━━━━━━━━━━ 43s 89ms/step - accuracy: 0.6409 - loss: 1.4176 - val_accuracy: 0.6567 - val_loss: 1.3609
Epoch 6/200
450/450 ━━━━━━━━━━━━━━━━━━━━ 36s 77ms/step - accuracy: 0.6880 - loss: 1.2386 - val_accuracy: 0.6781 - val_loss: 1.2732
Epoch 7/200
450/450 ━━━━━━━━━━━━━━━━━━━━ 45s 86ms/step - accuracy: 0.7299 - loss: 1.0802 - val_accuracy: 0.7142 - val_loss: 1.1809
Epoch 8/200
450/450 ━━━━━━━━━━━━━━━━━━━━ 36s 75ms/step - accuracy: 0.7701 - loss: 0.9457 - val_accuracy: 0.7262 - val_loss: 1.1218
Epoch 9/200
450/450 ━━━━━━━━━━━━━━━━━━━━ 45s 83ms/step - accuracy: 0.7937 - loss: 0.8342 - val_accuracy: 0.7311 - val_loss: 1.0829
Epoch 10/200
450/450 ━━━━━━━━━━━━━━━━━━━━ 42s 86ms/step - accuracy: 0.8059 - loss: 0.7555 - val_accuracy: 0.7284 - val_loss: 1.1022
Epoch 11/200
450/450 ━━━━━━━━━━━━━━━━━━━━ 32s 72ms/step - accuracy: 0.8219 - loss: 0.7102 - val_accuracy: 0.7355 - val_loss: 1.0955
Epoch 12/200
450/450 ━━━━━━━━━━━━━━━━━━━━ 38s 84ms/step - accuracy: 0.8420 - loss: 0.6366 - val_accuracy: 0.7289 - val_loss: 1.1269
Epoch 13/200
450/450 ━━━━━━━━━━━━━━━━━━━━ 38s 85ms/step - accuracy: 0.8632 - loss: 0.5602 - val_accuracy: 0.7235 - val_loss: 1.1467
Epoch 14/200
450/450 ━━━━━━━━━━━━━━━━━━━━ 40s 84ms/step - accuracy: 0.8681 - loss: 0.5280 - val_accuracy: 0.7329 - val_loss: 1.1551
71/71 ━━━━━━━━━━━━━━━━━━━━ 3s 42ms/step - accuracy: 0.7444 - loss: 1.1181

 Test Accuracy: 0.7329
```

In [5]:

```python
# 학습셋과 테스트셋의 오차를 저장합니다.
y_vloss = history.history['val_loss']
y_loss = history.history['loss']

# 그래프로 표현해 보겠습니다.
x_len = np.arange(len(y_loss))
plt.plot(x_len, y_vloss, marker='.', c="red", label='Testset_loss')
plt.plot(x_len, y_loss, marker='.', c="blue", label='Trainset_loss')
```

```
# 그래프에 그리드를 주고 레이블을 표시하겠습니다.
plt.legend(loc='upper right')
plt.grid()
plt.xlabel('epoch')
plt.ylabel('loss')
plt.show()
```



2. LSTM과 CNN의 조합을 이용한 영화 리뷰 분류하기

In [7]:

```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Dropout, Activation, Embedding, LSTM, Conv1D, MaxPooling1D
from tensorflow.keras.datasets import imdb
from tensorflow.keras.preprocessing import sequence
```

```python
from tensorflow.keras.callbacks import EarlyStopping

import numpy as np
import matplotlib.pyplot as plt

# 데이터를 불러와 학습셋, 테스트셋으로 나눕니다.
(X_train, y_train), (X_test, y_test) = imdb.load_data(num_words=5000)

# 단어의 수를 맞추어 줍니다.
X_train = sequence.pad_sequences(X_train, maxlen=500)
X_test = sequence.pad_sequences(X_test, maxlen=500)

# 모델의 구조를 설정합니다.
model = Sequential()
model.add(Embedding(5000, 100))
model.add(Dropout(0.5))
model.add(Conv1D(64, 5, padding='valid', activation='relu',strides=1))
model.add(MaxPooling1D(pool_size=4))
model.add(LSTM(55))
model.add(Dense(1))
model.add(Activation('sigmoid'))
model.build(input_shape=(None,100))
model.summary()
```

```
Model: "sequential_1"
```

```
┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━┓
┃ Layer (type)                         ┃ Output Shape                ┃         Param # ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━┩
│ embedding_1 (Embedding)              │ (None, 100, 100)            │         500,000 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ dropout (Dropout)                    │ (None, 100, 100)            │               0 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ conv1d (Conv1D)                      │ (None, 96, 64)              │          32,064 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ max_pooling1d (MaxPooling1D)         │ (None, 24, 64)              │               0 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ lstm_1 (LSTM)                        │ (None, 55)                  │          26,400 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ dense_1 (Dense)                      │ (None, 1)                   │              56 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ activation (Activation)              │ (None, 1)                   │               0 │
└──────────────────────────────────────┴─────────────────────────────┴─────────────────┘

 Total params: 558,520 (2.13 MB)

 Trainable params: 558,520 (2.13 MB)

 Non-trainable params: 0 (0.00 B)
```

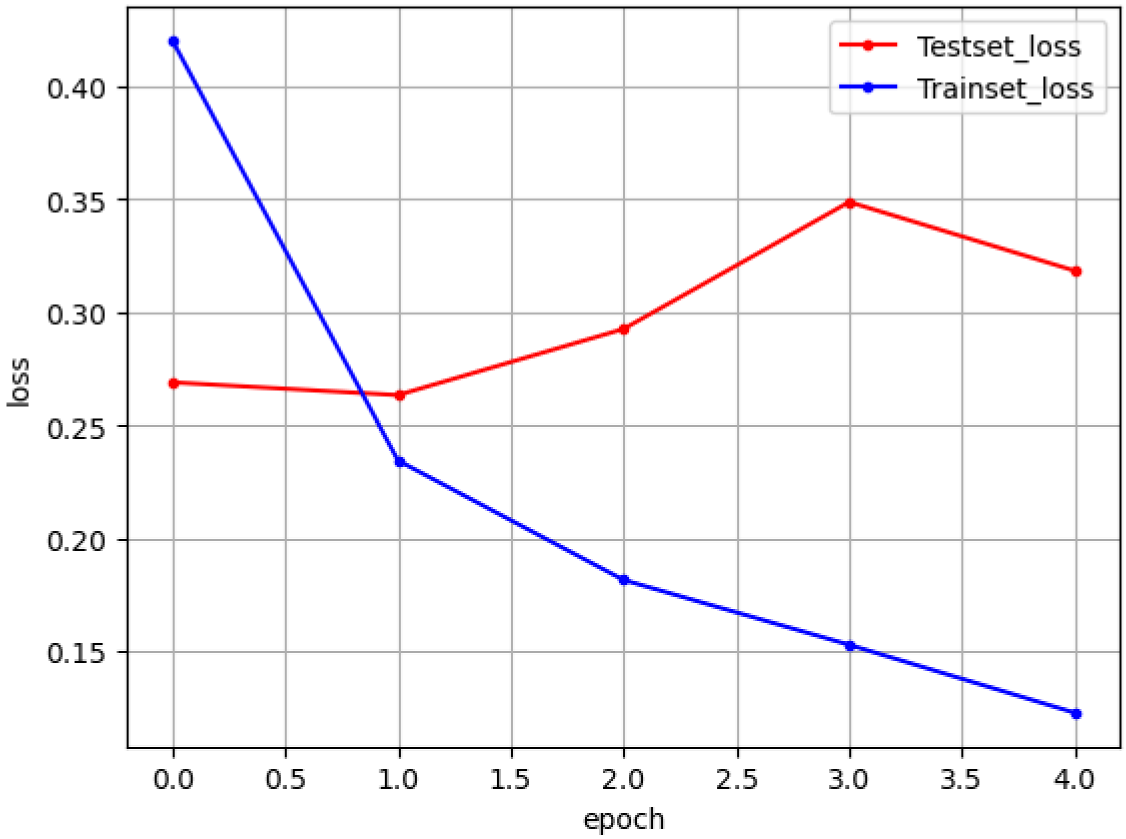
In [8]:

```python
# 모델의 실행 옵션을 정합니다.
model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])

# 학습의 조기 중단을 설정합니다.
early_stopping_callback = EarlyStopping(monitor='val_loss', patience=3)

# 모델을 실행합니다.
history = model.fit(X_train, y_train, batch_size=40, epochs=100, validation_split=0.25,
                    callbacks=[early_stopping_callback])

# 테스트 정확도를 출력합니다.
print("\n Test Accuracy: %.4f" % (model.evaluate(X_test, y_test)[1]))
```

```
Epoch 1/100
469/469 ━━━━━━━━━━━━━━━━━━━━ 93s 182ms/step - accuracy: 0.6862 - loss: 0.5413 - val_accuracy: 0.8894 - val_loss: 0.2688
Epoch 2/100
469/469 ━━━━━━━━━━━━━━━━━━━━ 79s 168ms/step - accuracy: 0.9139 - loss: 0.2262 - val_accuracy: 0.8906 - val_loss: 0.2632
Epoch 3/100
469/469 ━━━━━━━━━━━━━━━━━━━━ 82s 168ms/step - accuracy: 0.9366 - loss: 0.1726 - val_accuracy: 0.8837 - val_loss: 0.2925
Epoch 4/100
469/469 ━━━━━━━━━━━━━━━━━━━━ 82s 167ms/step - accuracy: 0.9436 - loss: 0.1519 - val_accuracy: 0.8720 - val_loss: 0.3487
Epoch 5/100
469/469 ━━━━━━━━━━━━━━━━━━━━ 82s 166ms/step - accuracy: 0.9596 - loss: 0.1175 - val_accuracy: 0.8909 - val_loss: 0.3182
782/782 ━━━━━━━━━━━━━━━━━━━━ 33s 42ms/step - accuracy: 0.8770 - loss: 0.3617

 Test Accuracy: 0.8777
```

In [9]:

```python
# 학습셋과 테스트셋의 오차를 저장합니다.
y_vloss = history.history['val_loss']
y_loss = history.history['loss']

# 그래프로 표현해 보겠습니다.
x_len = np.arange(len(y_loss))
plt.plot(x_len, y_vloss, marker='.', c="red", label='Testset_loss')
plt.plot(x_len, y_loss, marker='.', c="blue", label='Trainset_loss')

# 그래프에 그리드를 주고 레이블을 표시하겠습니다.
plt.legend(loc='upper right')
plt.grid()
plt.xlabel('epoch')
plt.ylabel('loss')
plt.show()
```



3. 어텐션을 사용한 신경망

In [11]:

```
!pip install keras-self-attention
```

```
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: keras-self-attention in c:\users\user\appdata\roaming\python\python312\site-packages (0.51.0)
Requirement already satisfied: numpy in c:\programdata\anaconda3\lib\site-packages (from keras-self-attention) (1.26.4)
```

In [12]:

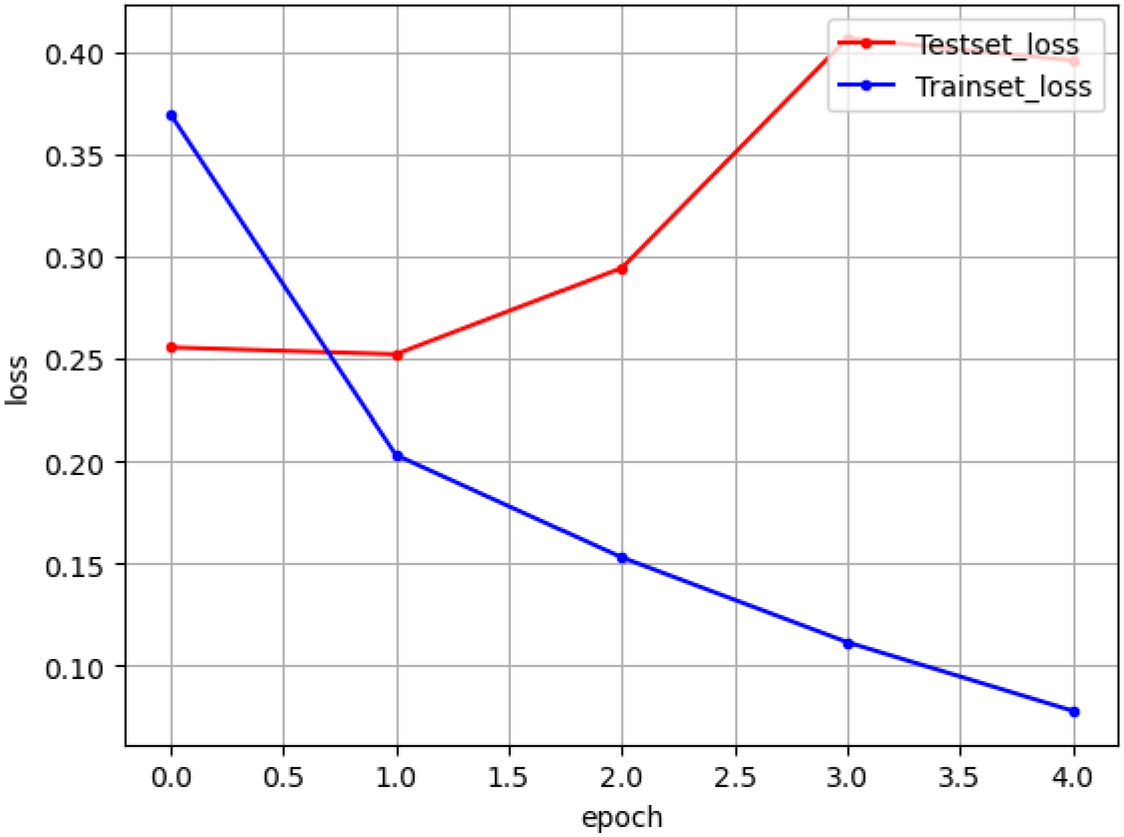
```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Dropout, Activation, Embedding, LSTM, Conv1D, MaxPooling1D, Flatten
from tensorflow.keras.datasets import imdb
from tensorflow.keras.preprocessing import sequence
from tensorflow.keras.callbacks import EarlyStopping
```

```python
from tensorflow.keras.utils import plot_model
from keras_self_attention import SeqSelfAttention

import numpy as np
import matplotlib.pyplot as plt

# 데이터를 불러와 학습셋, 테스트셋으로 나눕니다.
(X_train, y_train), (X_test, y_test) = imdb.load_data(num_words=5000)

# 단어의 수를 맞추어 줍니다.
X_train = sequence.pad_sequences(X_train, maxlen=500)
X_test = sequence.pad_sequences(X_test, maxlen=500)

# 모델의 구조를 설정합니다.
model = Sequential()
model.add(Embedding(5000, 500))
model.add(Dropout(0.5))
model.add(LSTM(64, return_sequences=True))
model.add(SeqSelfAttention(attention_activation="sigmoid"))
model.add(Dropout(0.5))
model.add(Flatten())
model.add(Dense(1))
model.add(Activation('sigmoid'))

# 모델의 실행 옵션을 정합니다.
model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])

# 학습의 조기 중단을 설정합니다.
early_stopping_callback = EarlyStopping(monitor='val_loss', patience=3)

# 모델을 실행합니다.
history = model.fit(X_train, y_train, batch_size=40, epochs=100,
                    validation_data=(X_test, y_test), callbacks=[early_stopping_callback])

# 테스트 정확도를 출력합니다.
print("\n Test Accuracy: %.4f" % (model.evaluate(X_test, y_test)[1]))
```

```
Epoch 1/100
625/625 ━━━━━━━━━━━━━━━━━━━━ 2030s 3s/step - accuracy: 0.7088 - loss: 0.5036 - val_accuracy: 0.8949 - val_loss: 0.2555
Epoch 2/100
625/625 ━━━━━━━━━━━━━━━━━━━━ 2022s 3s/step - accuracy: 0.9268 - loss: 0.1919 - val_accuracy: 0.8958 - val_loss: 0.2522
Epoch 3/100
625/625 ━━━━━━━━━━━━━━━━━━━━ 2026s 3s/step - accuracy: 0.9476 - loss: 0.1440 - val_accuracy: 0.8889 - val_loss: 0.2943
Epoch 4/100
625/625 ━━━━━━━━━━━━━━━━━━━━ 2021s 3s/step - accuracy: 0.9649 - loss: 0.1010 - val_accuracy: 0.8739 - val_loss: 0.4067
Epoch 5/100
625/625 ━━━━━━━━━━━━━━━━━━━━ 2055s 3s/step - accuracy: 0.9768 - loss: 0.0651 - val_accuracy: 0.8794 - val_loss: 0.3959
782/782 ━━━━━━━━━━━━━━━━━━━━ 659s 842ms/step - accuracy: 0.8789 - loss: 0.3942

 Test Accuracy: 0.8794
```

In [13]:

```python
# 학습셋과 테스트셋의 오차를 저장합니다.
y_vloss = history.history['val_loss']
y_loss = history.history['loss']

# 그래프로 표현해 보겠습니다.
x_len = np.arange(len(y_loss))
plt.plot(x_len, y_vloss, marker='.', c="red", label='Testset_loss')
plt.plot(x_len, y_loss, marker='.', c="blue", label='Trainset_loss')

# 그래프에 그리드를 주고 레이블을 표시하겠습니다.
plt.legend(loc='upper right')
plt.grid()
plt.xlabel('epoch')
plt.ylabel('loss')
plt.show()
```


Testset_loss
Trainset_loss
loss
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
epoch

```
In [ ]:
```