블록과 함께하는 파이썬
딥러닝 케라스

Part 2 ch 6~7
RNN 순환신경망

긴 시퀀스를 기억할 수 있는 **RSTM** 레이어

Sequence data

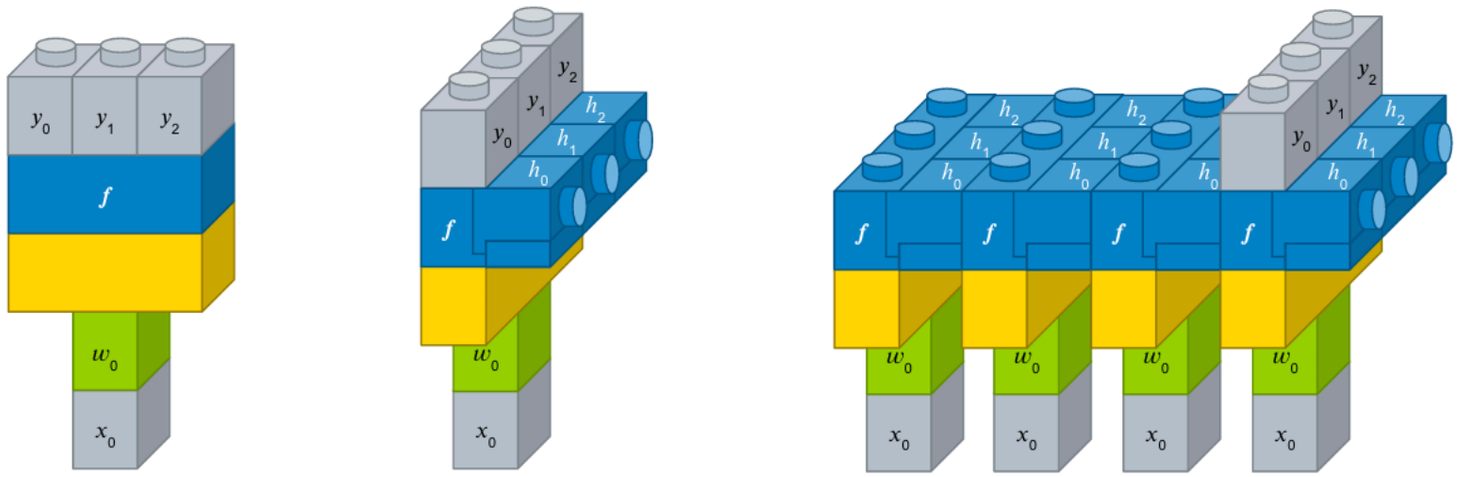
- We don’t understand one word only
- We understand based on the previous words + this word
- NN/CNN cannot do this

H E L L ?

긴 시퀀스를 기억할 수 있는 RSTM 레이어

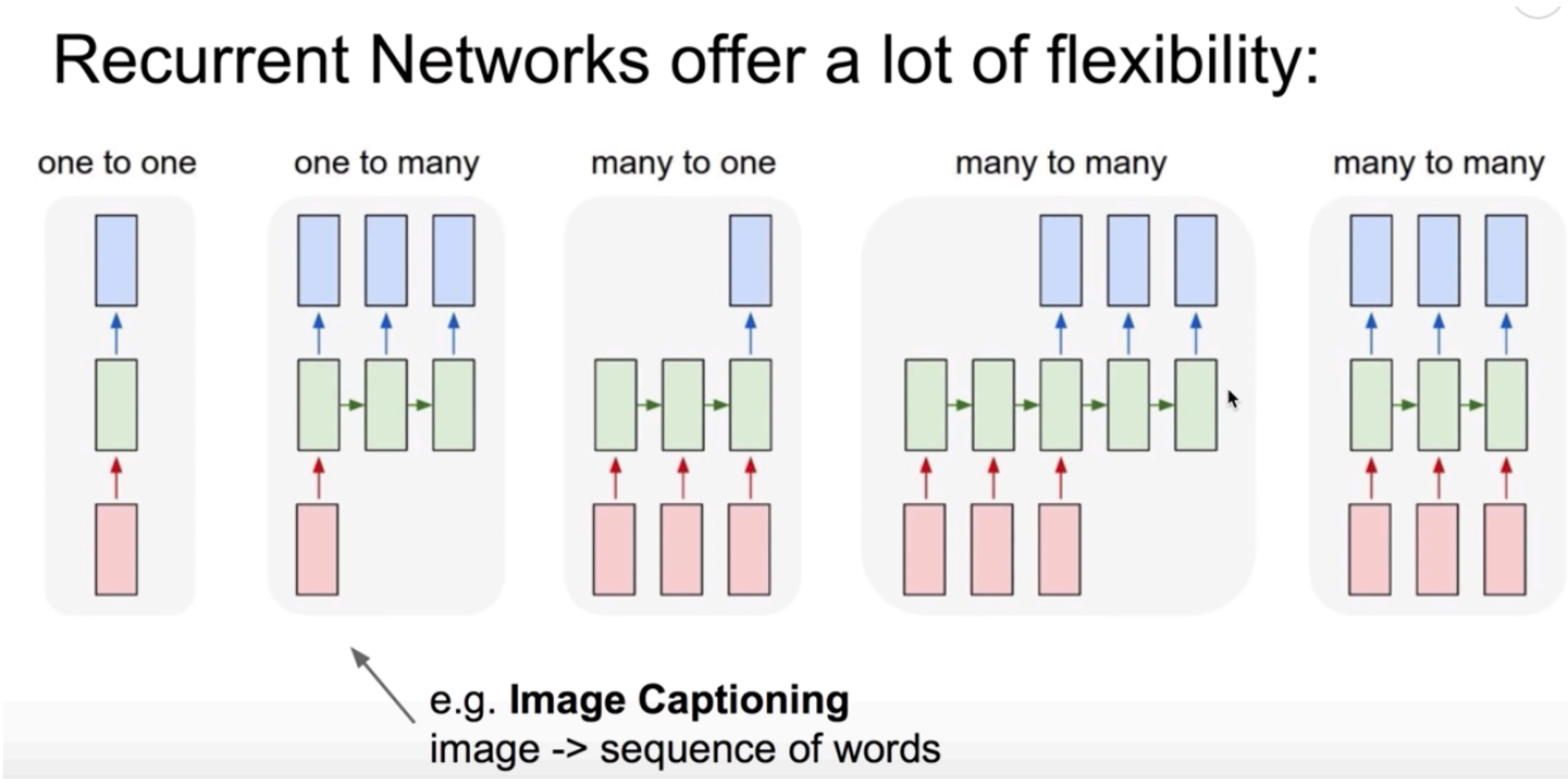
`LSTM(3, input_dim=1, input_length=4)`

- 첫번째 인자 : 메모리 셀의 개수입니다.
- input_dim : 입력 속성 수 입니다.
- input_length : 시퀀스 데이터의 입력 길이

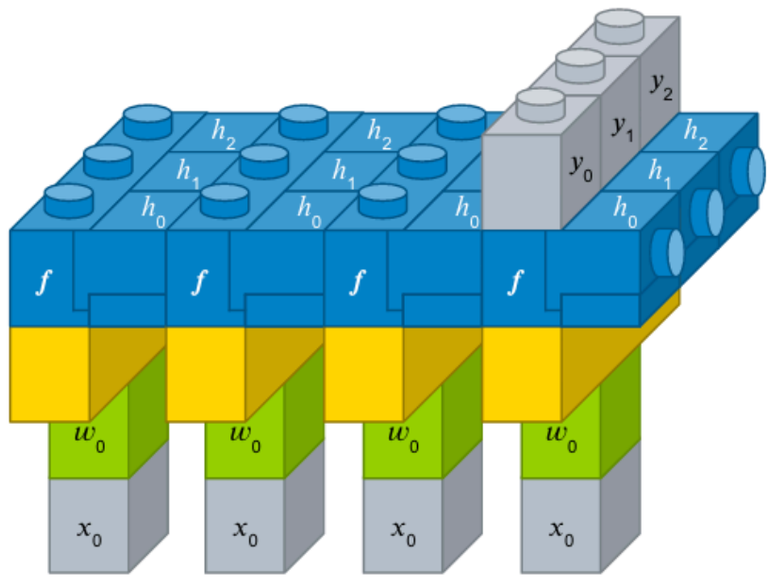


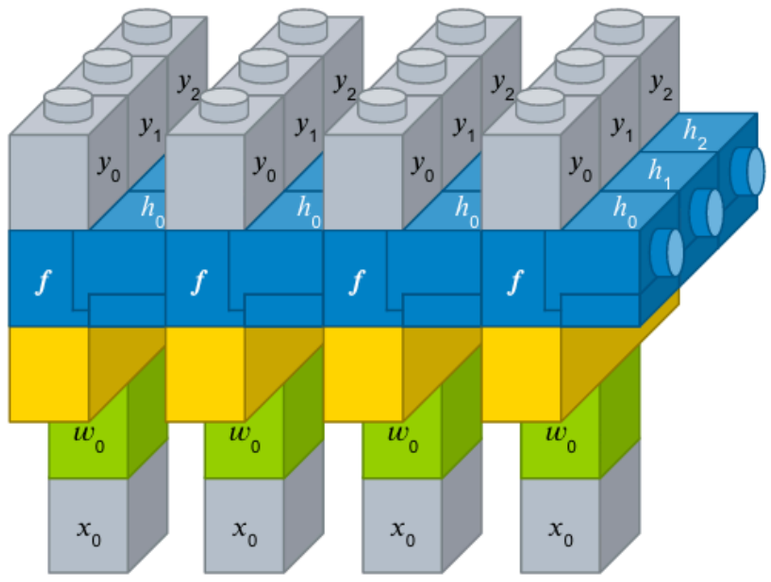
Dense **If input_dim == 1** **If input_dim == 4**

긴 시퀀스를 기억할 수 있는
RSTM 레이어



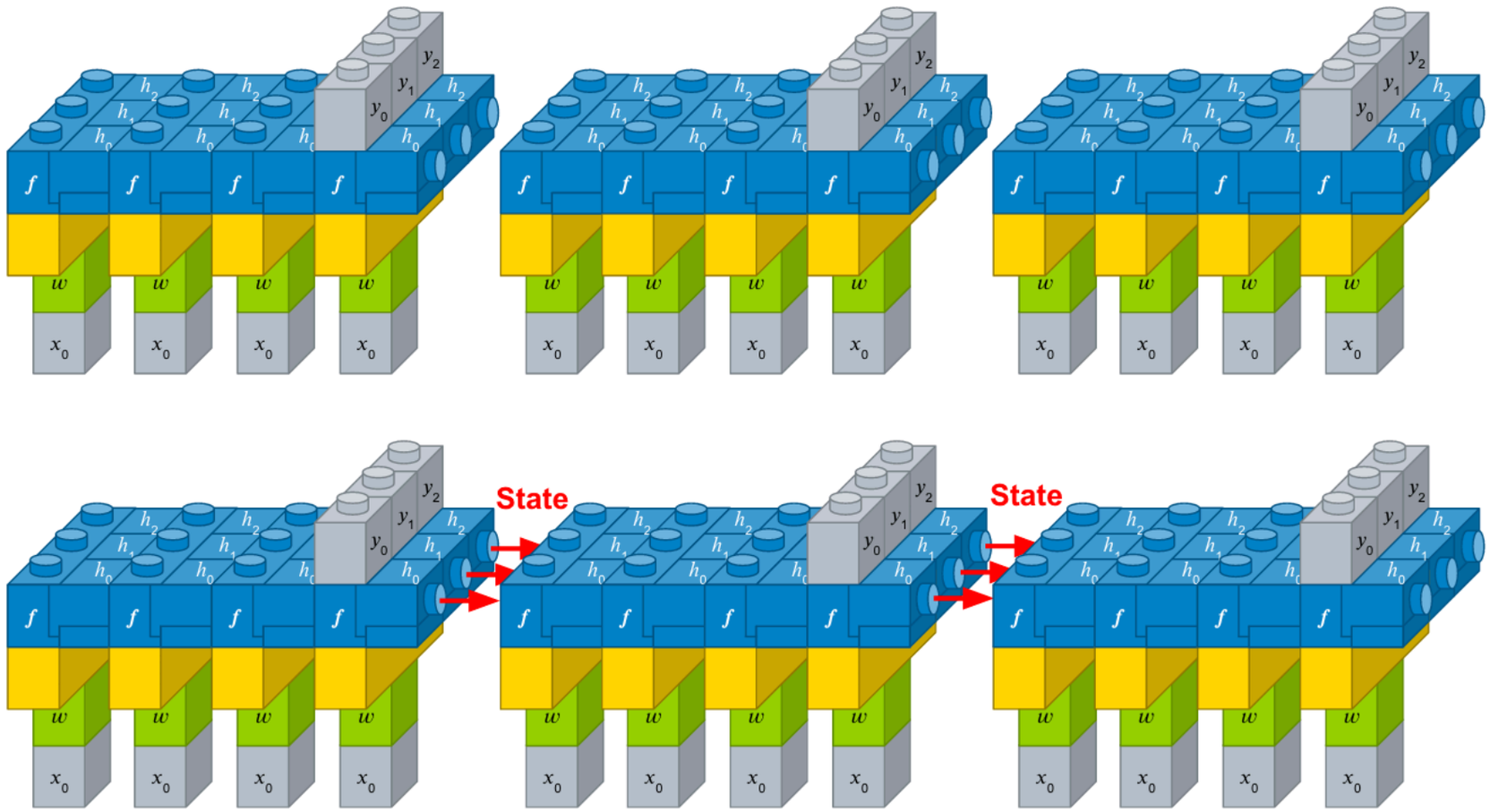
긴 시퀀스를 기억할 수 있는
RSTM 레이어





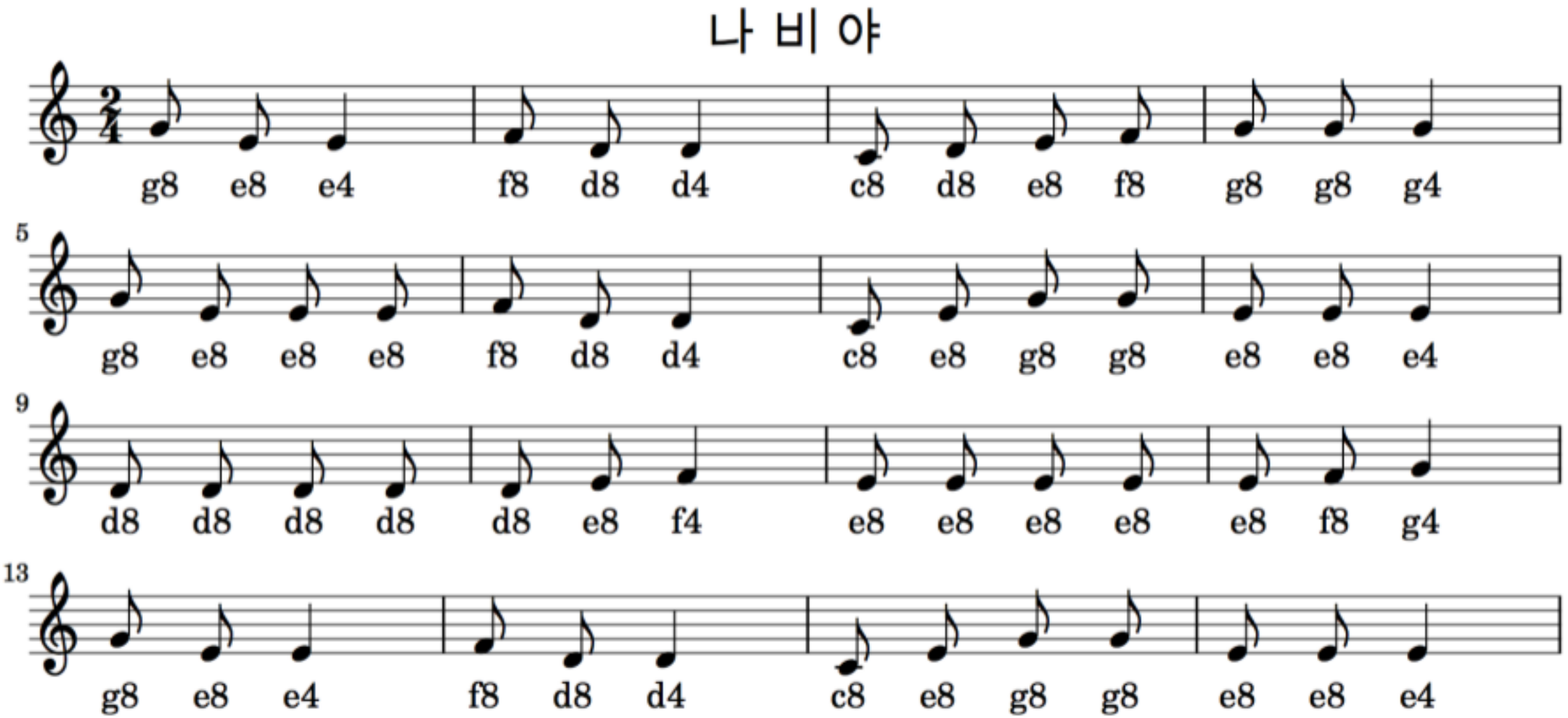
긴 시퀀스를 기억할 수 있는 RSTM 레이어

상태 유지 모드 (stateful)



실제 데이터로 순환신경망 모델 만들어 학습해보기

실제 데이터로 학습해보기



실제 데이터로 학습해보기

```
code2idx = {'c4':0, 'd4':1, 'e4':2, 'f4':3, 'g4':4, 'a4':5, 'b4':6,
            'c8':7, 'd8':8, 'e8':9, 'f8':10, 'g8':11, 'a8':12, 'b8':13}

idx2code = {0:'c4', 1:'d4', 2:'e4', 3:'f4', 4:'g4', 5:'a4', 6:'b4',
            7:'c8', 8:'d8', 9:'e8', 10:'f8', 11:'g8', 12:'a8', 13:'b8'}
```

실제 데이터로 학습해보기

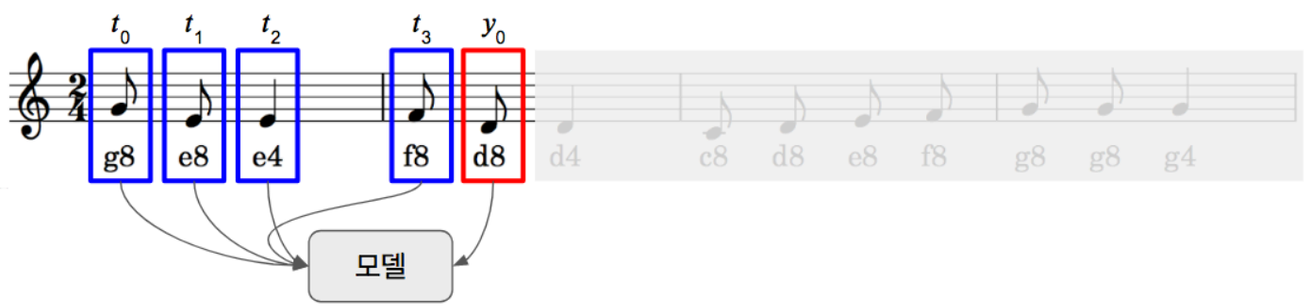
RNN을 포함한 총 4가지 방법으로 Dense, RNN과 stateful-RNN 를 비교

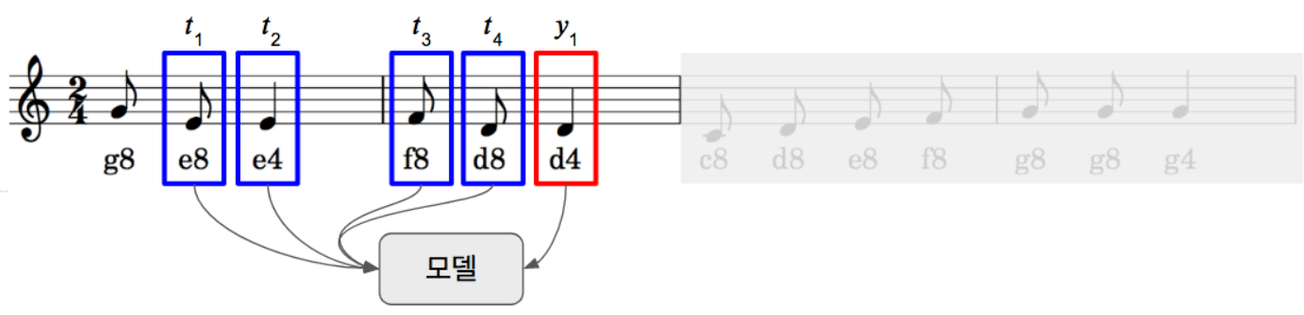
1. **Dense 입력 4개 출력 1개**
2. **LSTM(RNN) 입력 1개**
3. **LSTM(RNN) stateful 입력 1개**
4. **LSTM(RNN) stateful 입력 2개**

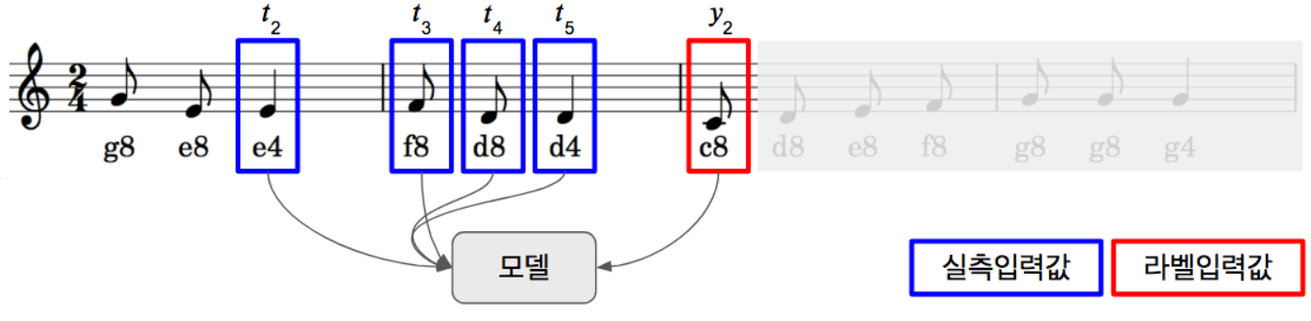
실제 데이터로 학습해보기

학습과정

입력 4개의 음표 **다음 음표 예측**







실제 데이터로 학습해보기

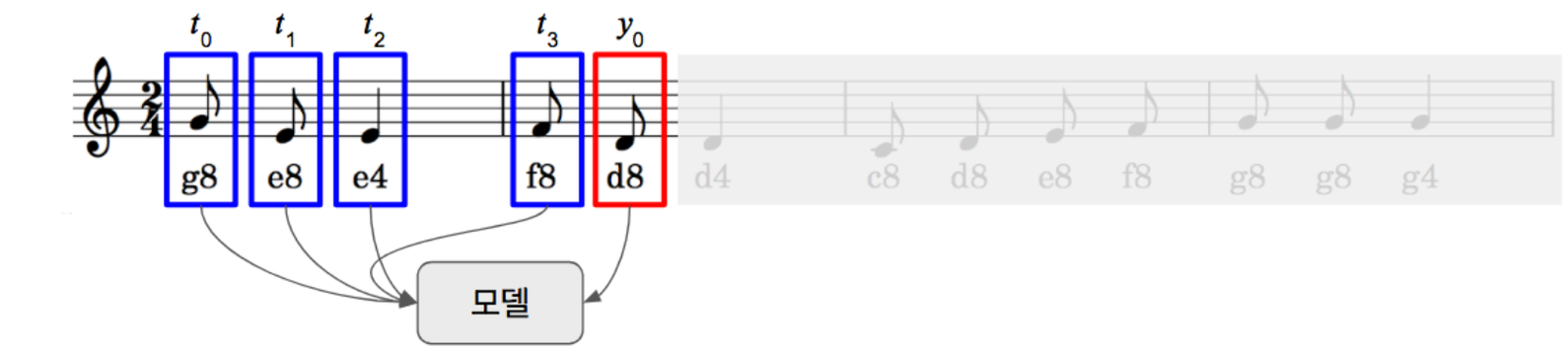
예측은 2가지 방법으로

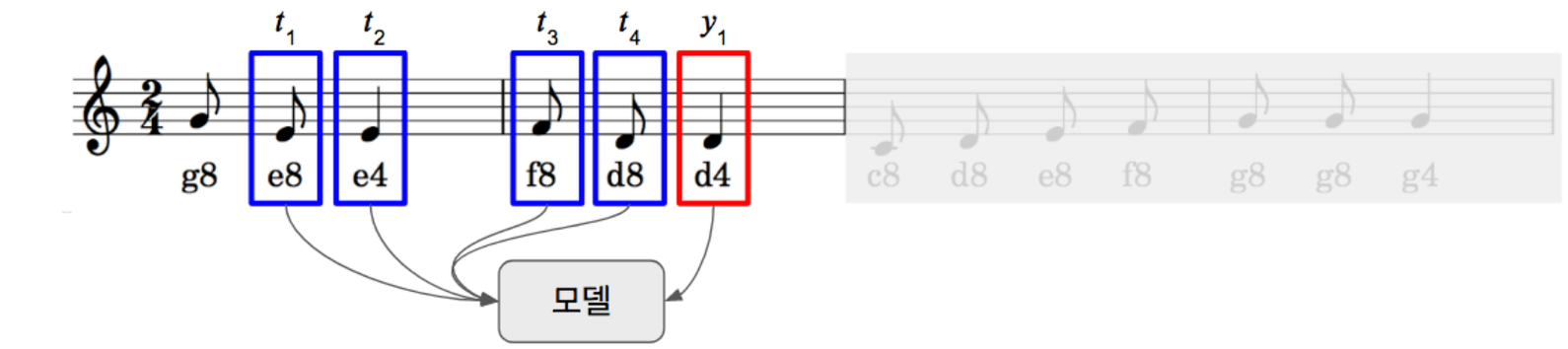
1. 부분 예측

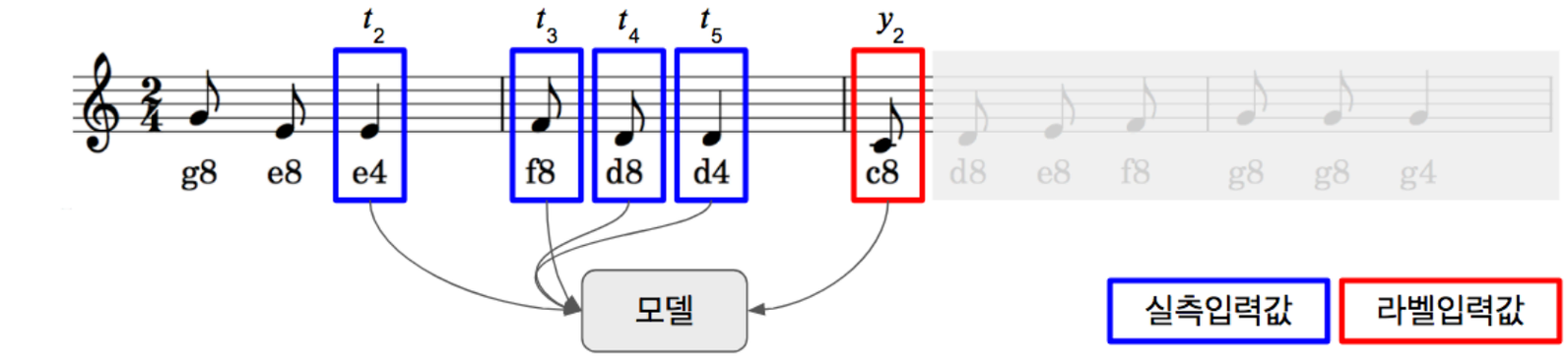
2. 전체 예측

실제 데이터로 학습해보기

1. 부분 예측

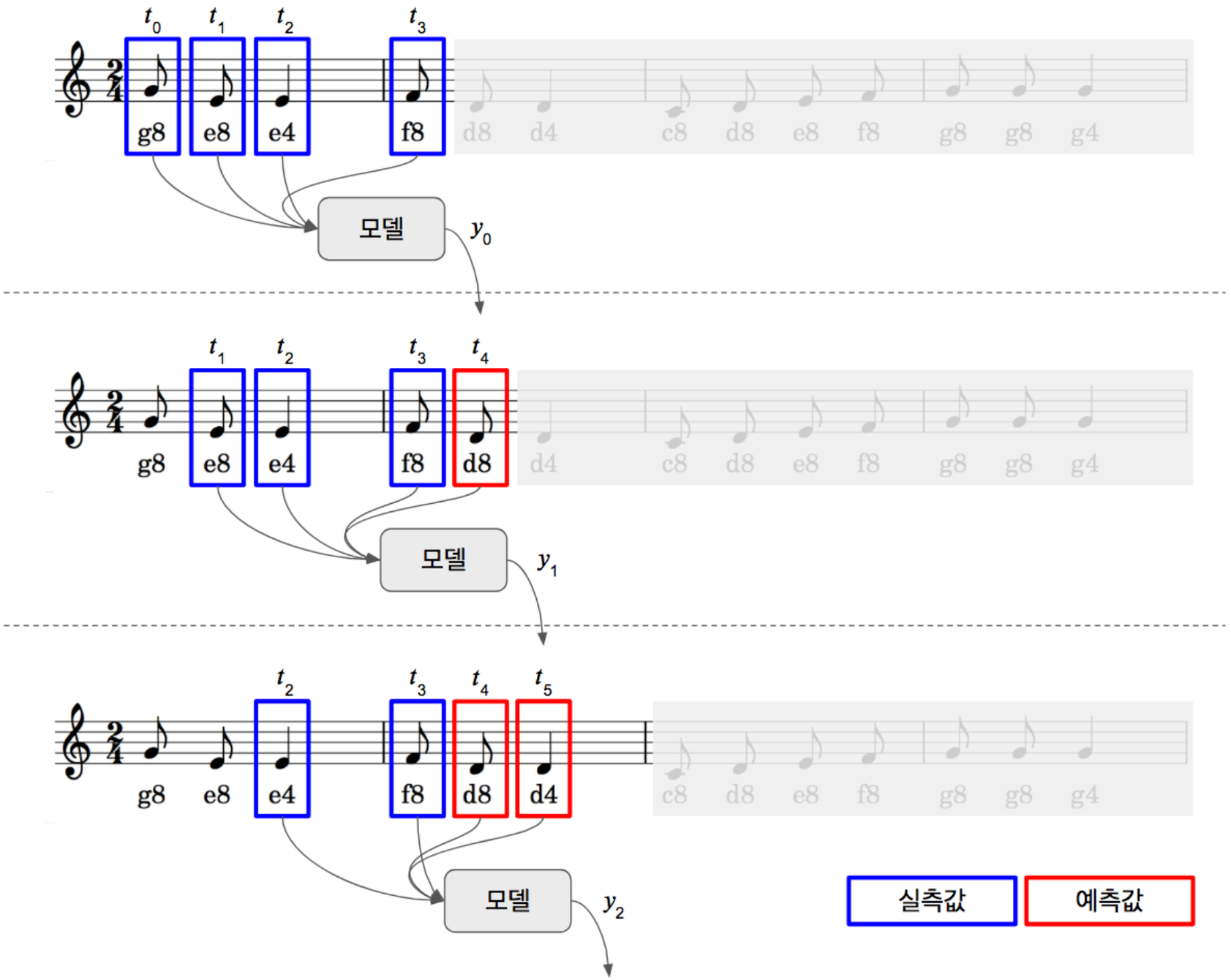






실제 데이터로 학습해보기

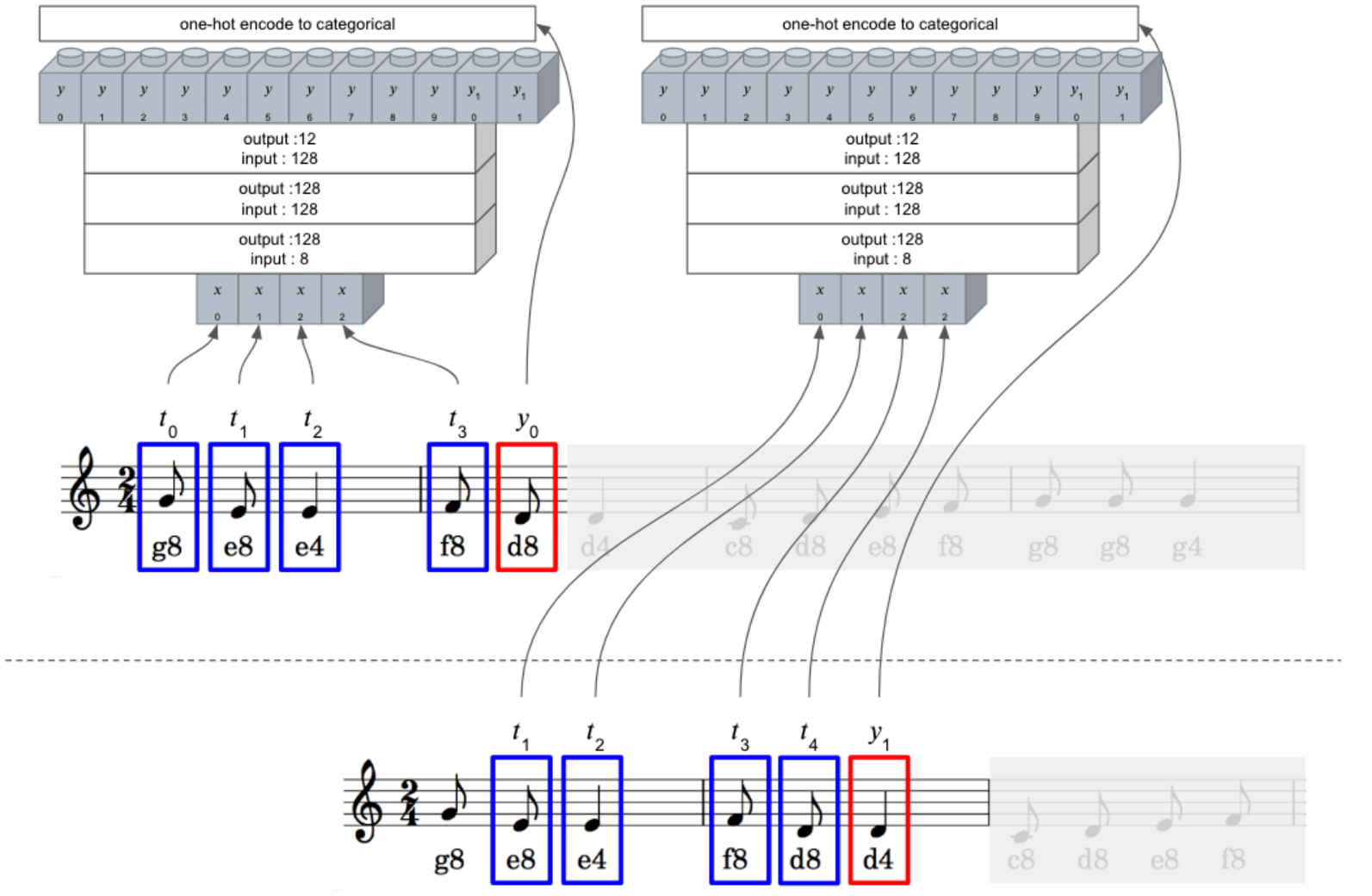
2. 전체 예측



중간에 한번 예측이 잘못이루어지면 계속 예측이 잘못됨

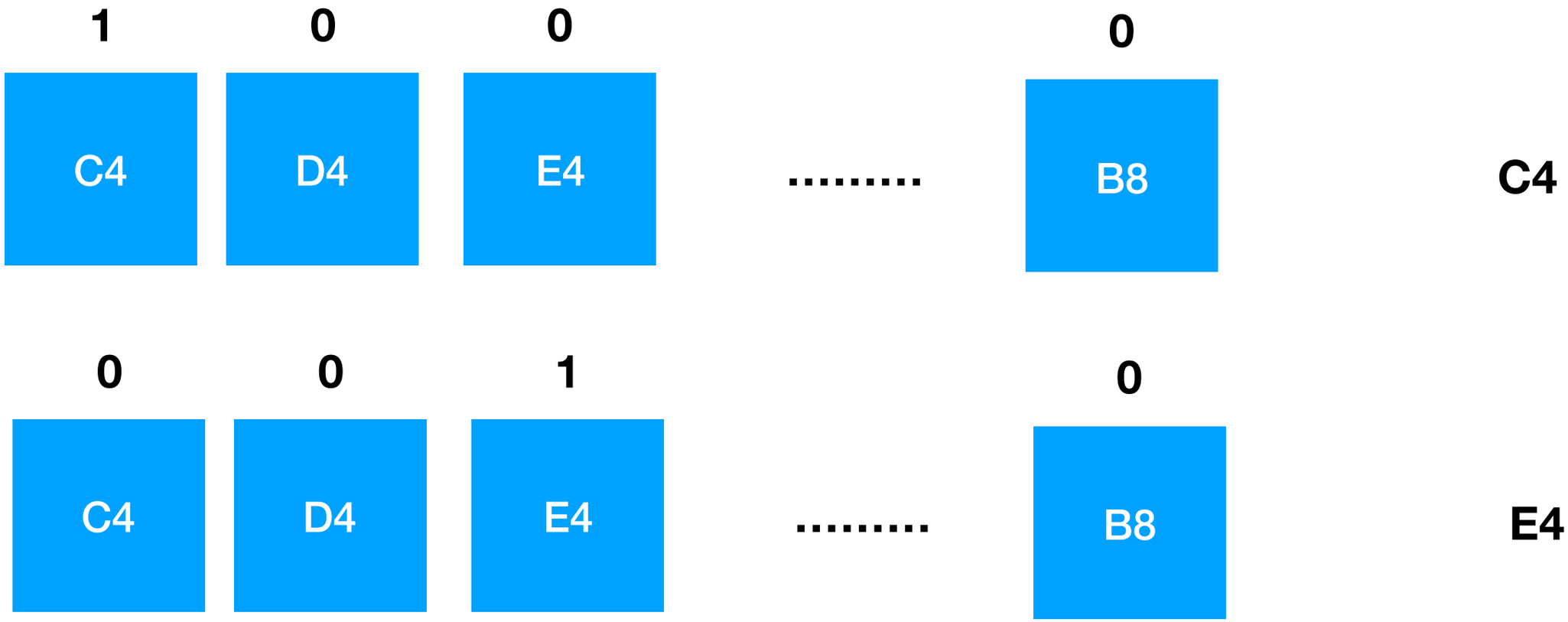
실제 데이터로 학습해보기

다층 퍼셉트론 모델 (Dense)



실제 데이터로 학습해보기

One-hot encoding



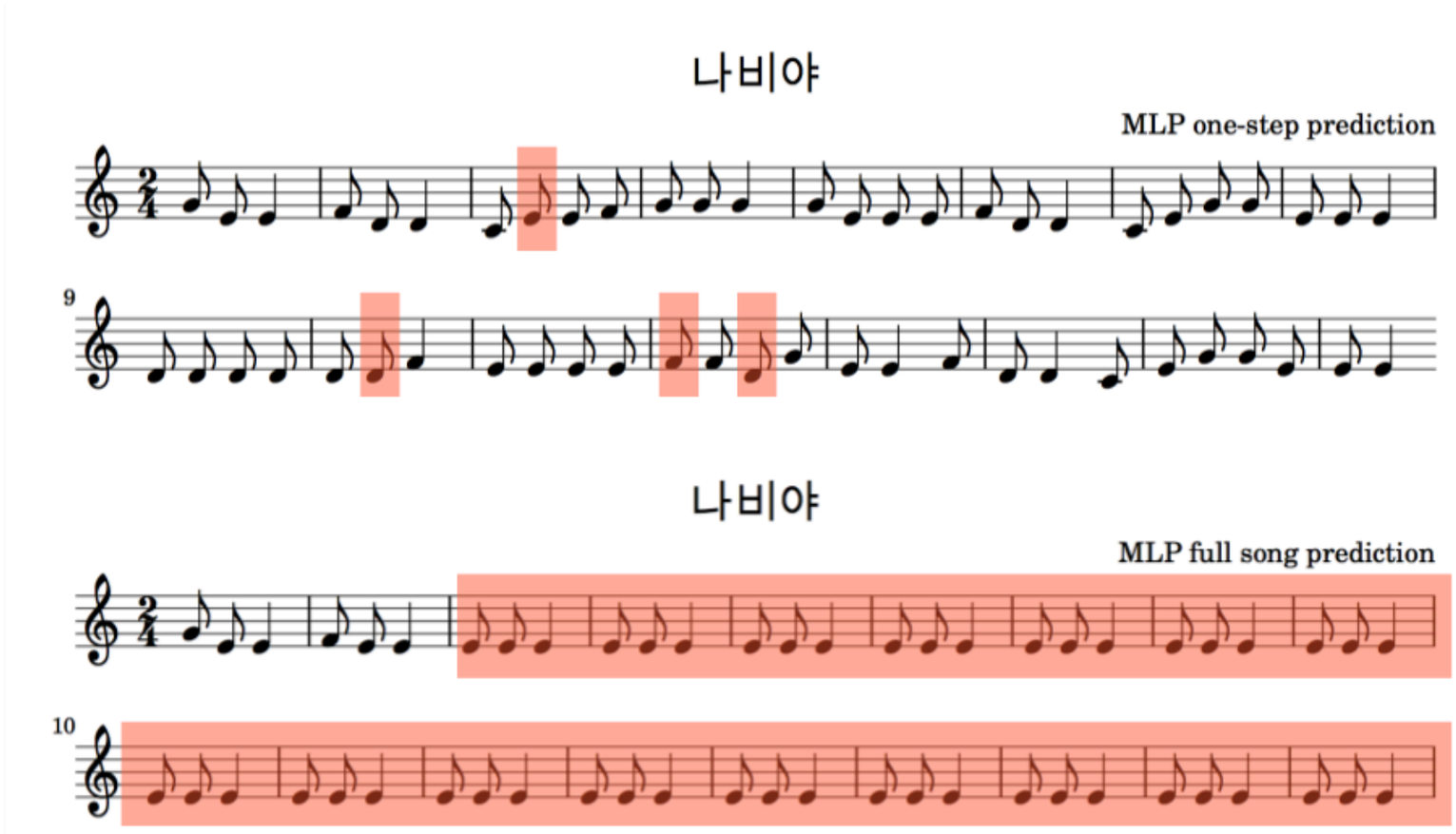
실제 데이터로 학습해보기

다층 퍼셉트론 모델 (Dense)

```
model = Sequential()
model.add(Dense(128, input_dim=4, activation='relu'))
model.add(Dense(one_hot_vec_size, activation='softmax'))
```

실제 데이터로 학습해보기

결과

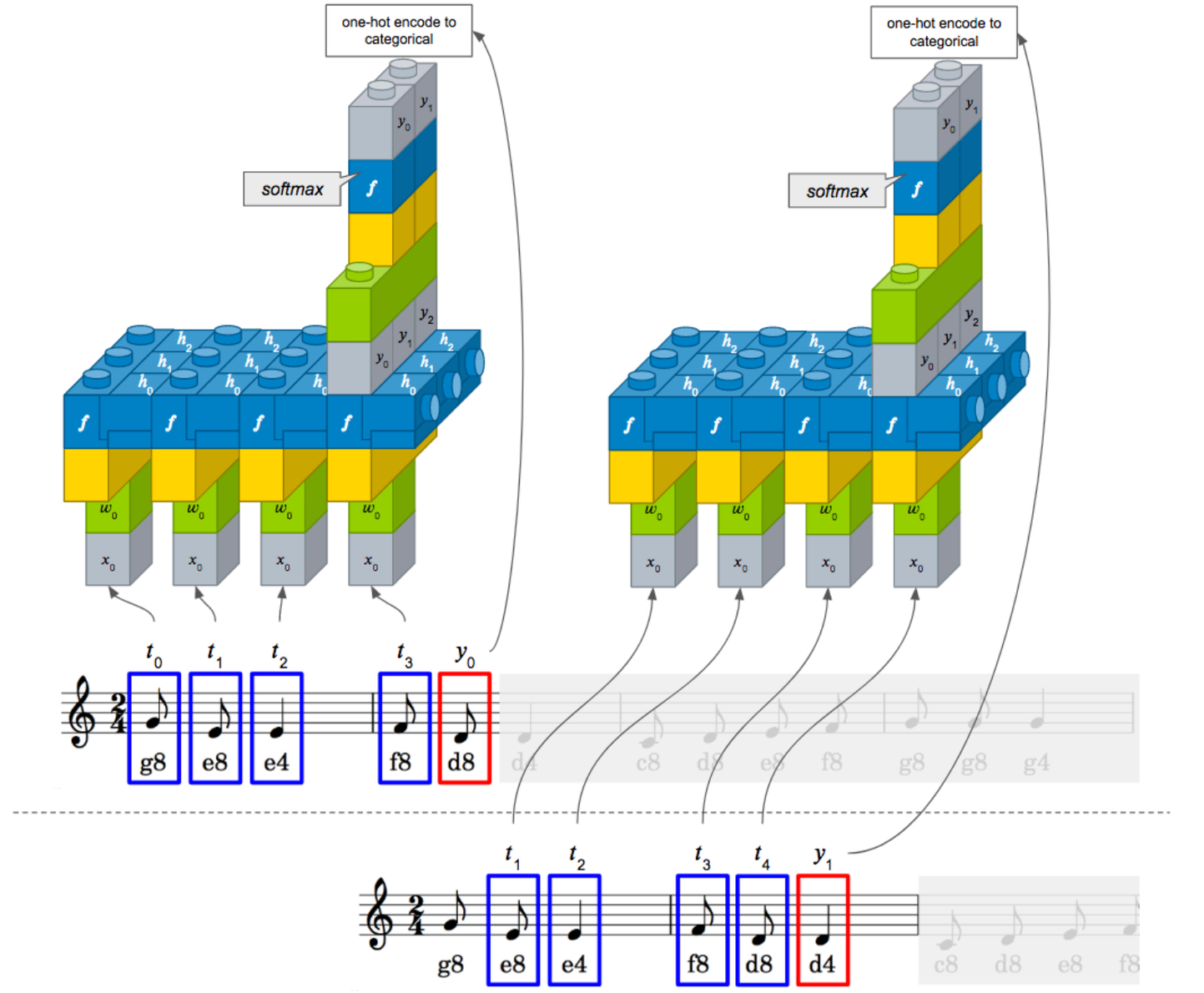


4개 틀려서
92%

1개 틀리면
곡 전체를 틀림
성능이 좋지 않음

실제 데이터로 학습해보기

LSTM model

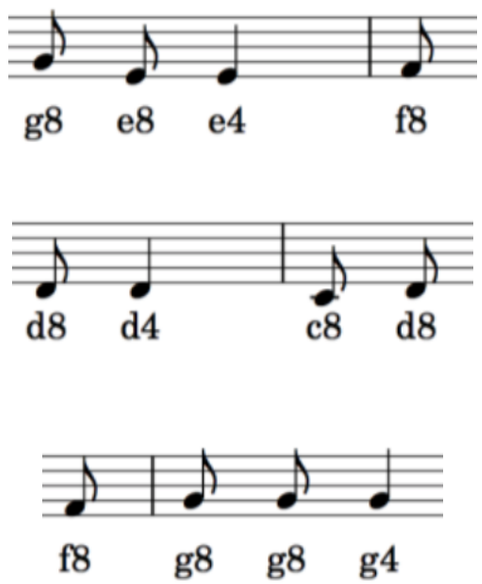


실제 데이터로 학습해보기

LSTM model

```
model = Sequential()
model.add(LSTM(128, input_shape = (4, 1)))
model.add(Dense(one_hot_vec_size, activation='softmax'))
```

타임스텝은 하나의 샘플에 대한 시퀀스의 개수



실제 데이터로 학습해보기

LSTM model

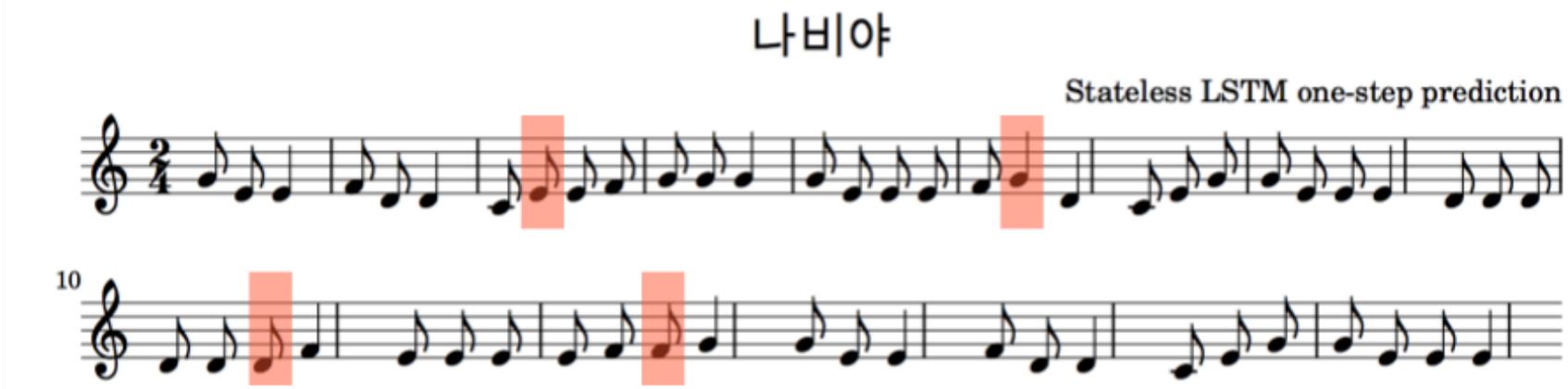
```
x_train = np.reshape(x_train, (50, 4, 1)) # 샘플 수, 타임스텝 수, 속성 수
```

```
[[0.84615385 0.69230769 0.15384615 0.76923077]
 [0.69230769 0.15384615 0.76923077 0.61538462]
 [0.15384615 0.76923077 0.61538462 0.07692308]
 [0.76923077 0.61538462 0.07692308 0.53846154]
 [0.61538462 0.07692308 0.53846154 0.61538462]
 [0.07692308 0.53846154 0.61538462 0.69230769]
 [0.53846154 0.61538462 0.69230769 0.76923077]
 [0.61538462 0.69230769 0.76923077 0.84615385]
 [0.69230769 0.76923077 0.84615385 0.84615385]
 [0.76923077 0.84615385 0.84615385 0.30769231]
 [0.84615385 0.84615385 0.30769231 0.84615385]
 [0.84615385 0.30769231 0.84615385 0.69230769]]
```

```
[[[0.84615385]
  [0.69230769]
  [0.15384615]
  [0.76923077]]

 [[0.69230769]
  [0.15384615]
  [0.76923077]
  [0.61538462]]

 [[0.15384615]
  [0.76923077]
  [0.61538462]
  [0.07692308]]

 ....
```

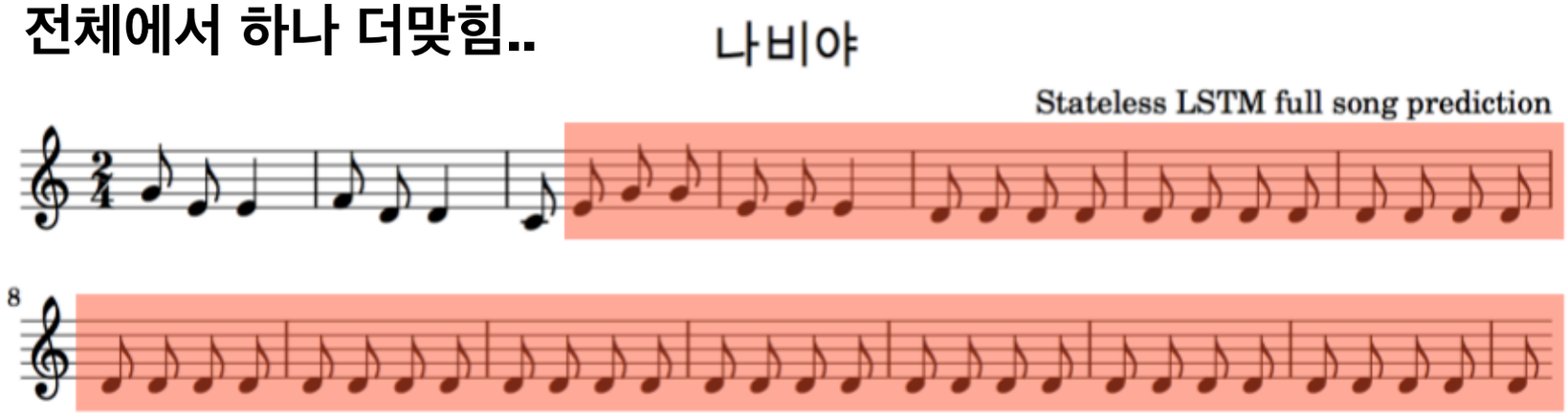
실제 데이터로 학습해보기

결과



4개 틀려서
92%

전체에서 하나 더맞힘..

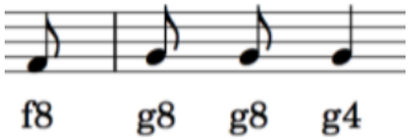


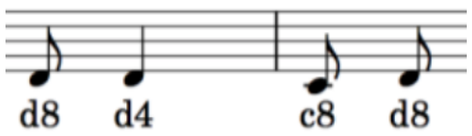
1개 틀리면
곡 전체를 틀림
성능이 좋지 않음

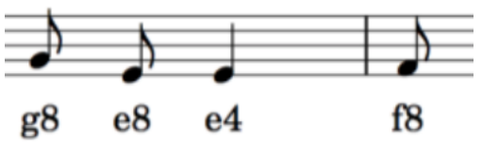
실제 데이터로 학습해보기

LSTM stateful model

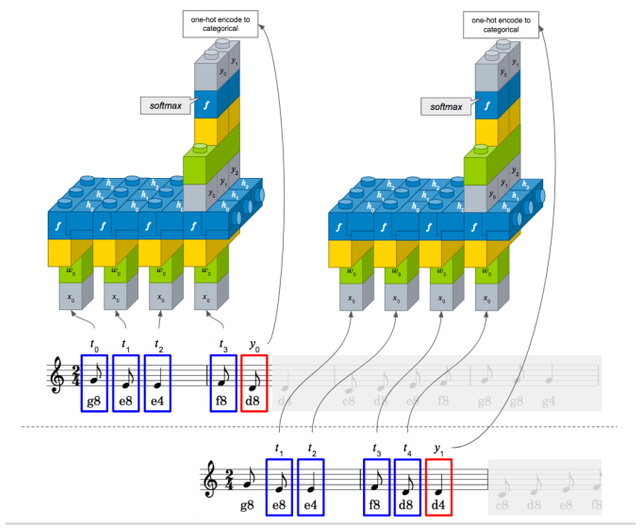
```
model = Sequential()
model.add(LSTM(128, batch_input_shape = (1, 4, 1), stateful=True))
model.add(Dense(one_hot_vec_size, activation='softmax'))
```







LSTM은 상태유지가 될때 진가를 발휘



실제 데이터로 학습해보기

LSTM stateful model

계속해서 상태를 유지할 수는 없다.. 언제 초기화?
두 시퀀스가 관계가 없는 경우

- 마지막 샘플 학습이 마치고, 새로운 에포크 수행 시에는 새로운 샘플 학습을 해야하므로 상태 초기화 필요
- 한 에포크 안에 여러 시퀀스 데이터 세트가 있을 경우, 새로운 시퀀스 데이터 세트를 학습 전에 상태 초기화 필요

실제 데이터로 학습해보기

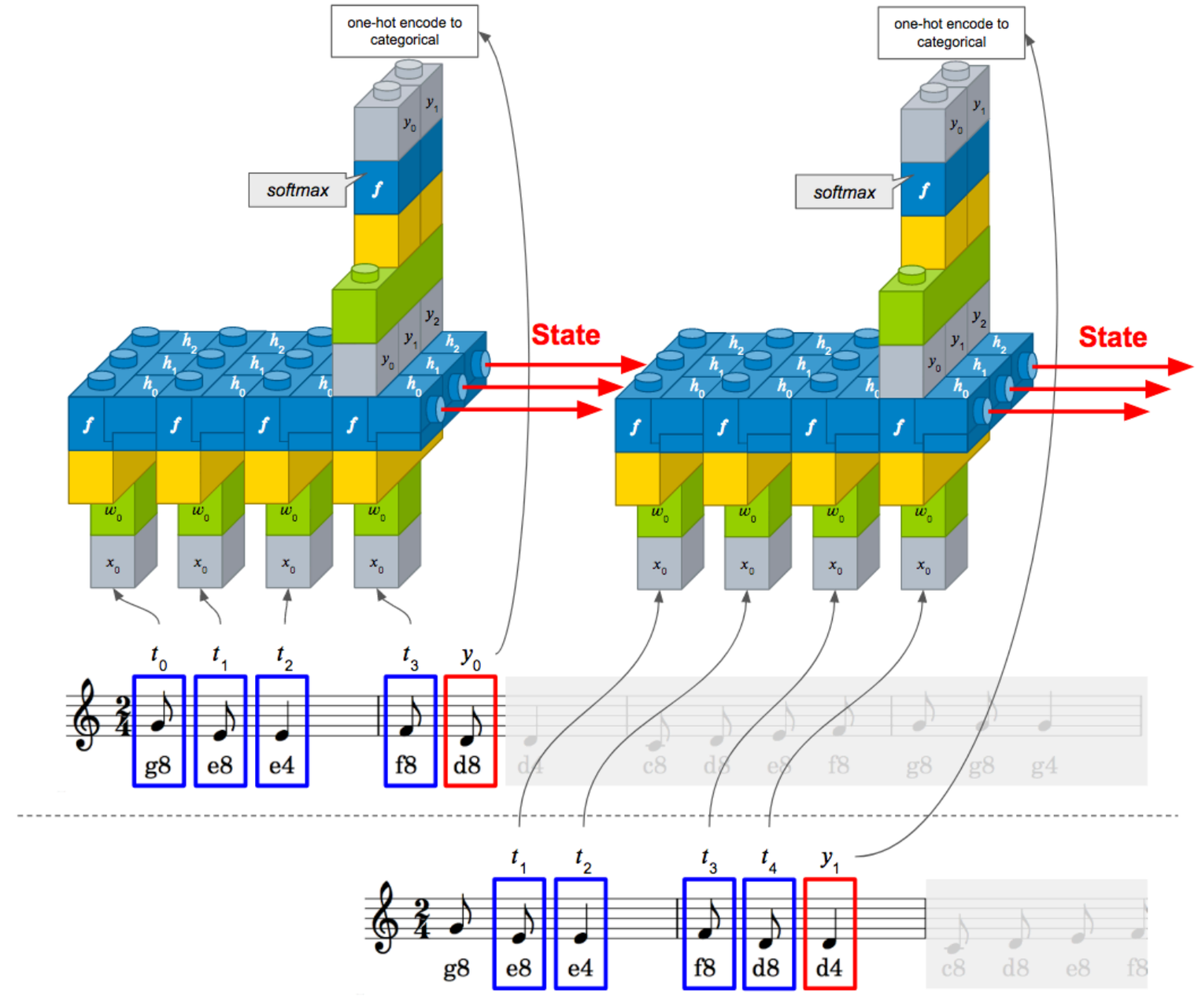
LSTM stateful model

상태 초기화 코드

```
num_epochs = 2000

for epoch_idx in range(num_epochs):
    print ('epochs : ' + str(epoch_idx) )
    model.fit(x_train, y_train, epochs=1, batch_size=1, verbose=2, shuffle=False) # 50
is X.shape[0]
    model.reset_states()
```

실제 데이터로 학습해보기

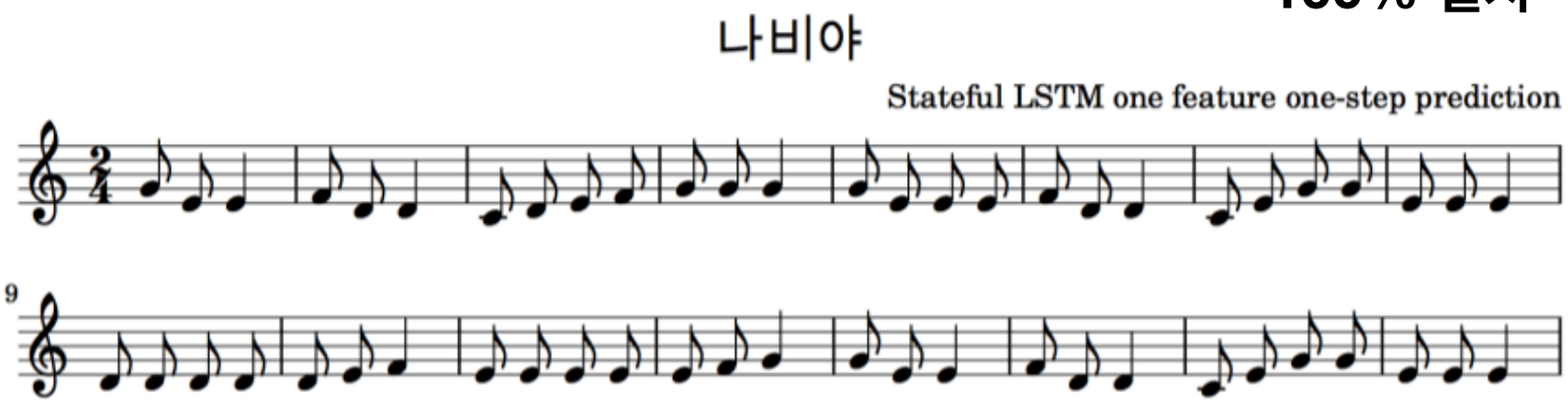
LSTM stateful model

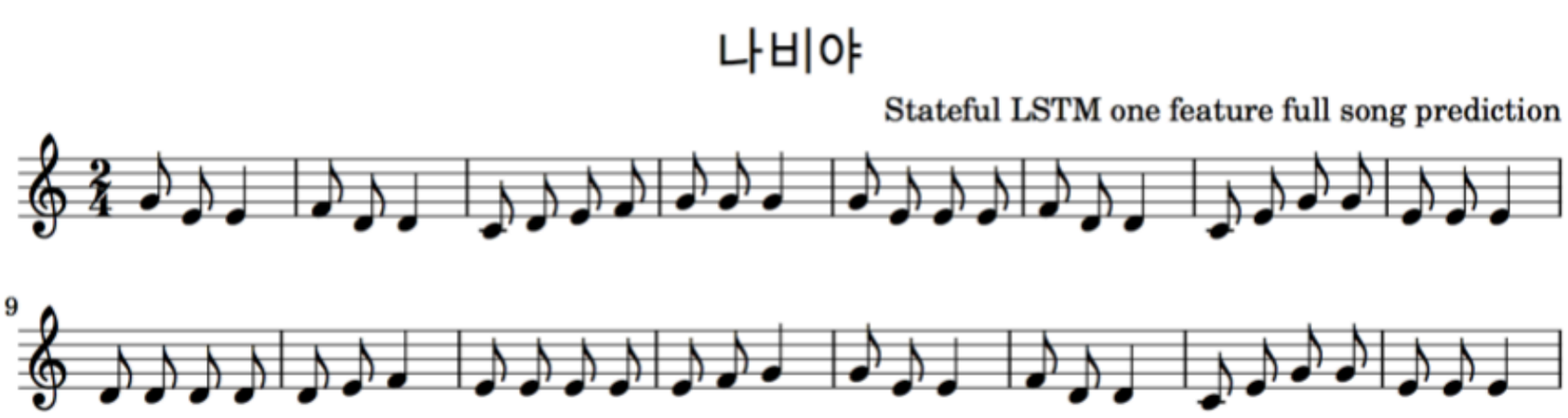


실제 데이터로 학습해보기

LSTM stateful model 결과

100% 일치





실제 데이터로 학습해보기

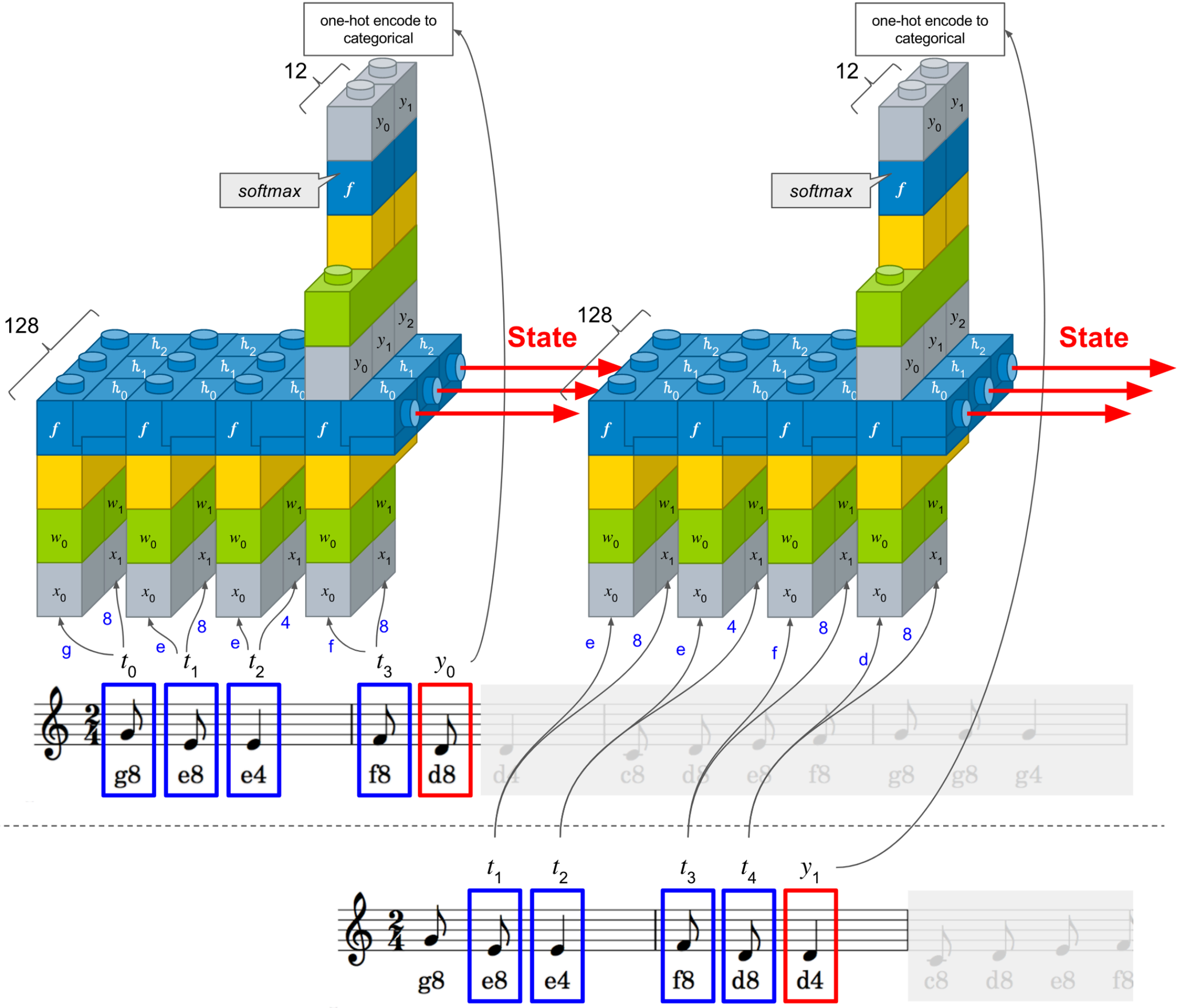
Multiple input LSTM stateful model

기상 예측의 경우 다양한 속성이 필요하다.
온도, 습도, 풍향, 풍속...
다중 속성이 입력으로 들어오는 경우의 RNN모델을 알아보자

실제 데이터로 학습해보기

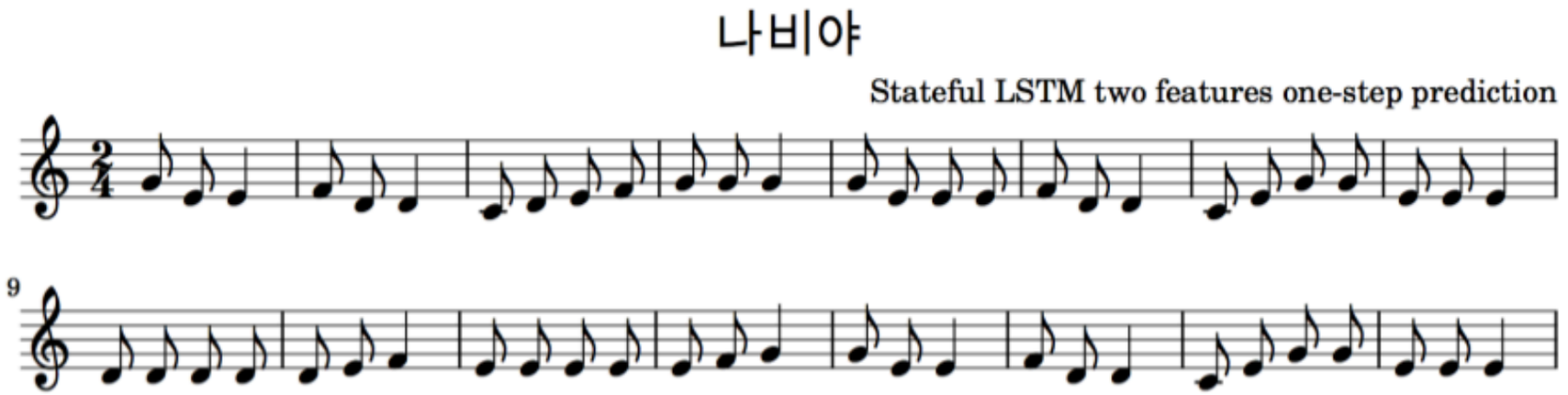
Multiple input LSTM stateful model

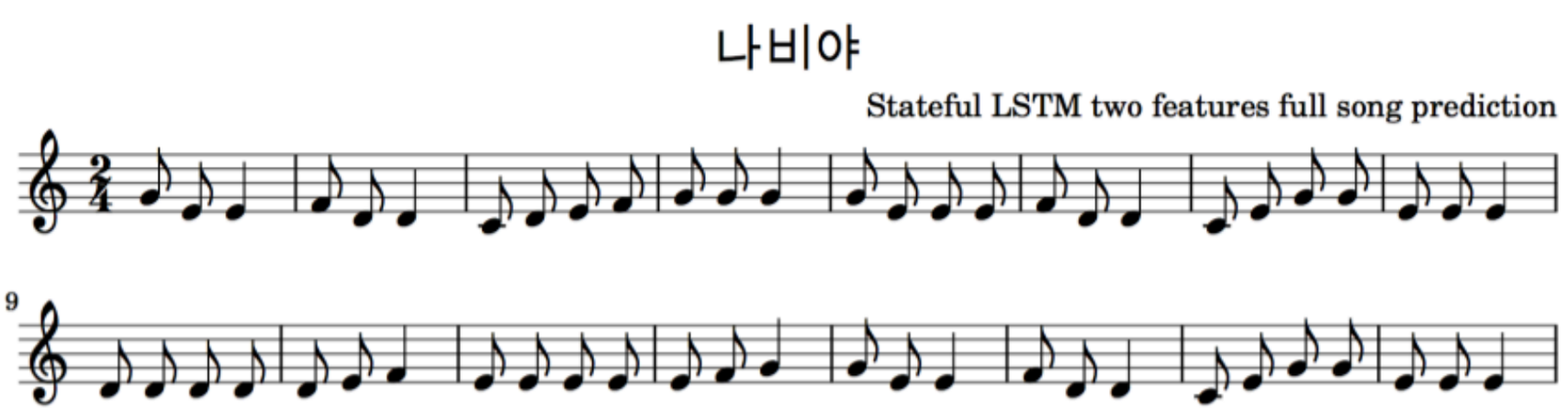
```
model = Sequential()
model.add(LSTM(128, batch_input_shape = (1, 4, 2), stateful=True))
model.add(Dense(one_hot_vec_size, activation='softmax'))
```


one-hot encode to categorical
12
softmax
128
State
one-hot encode to categorical
12
softmax
128
State
g
e
e
f
e
e
f
d
8
8
4
8
8
8
4
8
8
t_0 t_1 t_2 t_3 y_0
t_1 t_2 t_3 t_4 y_1
g8 e8 e4 f8 d8
d4 c8 d8 e8 f8 g8 g8 g4
g8 e8 e4 f8 d8 d4
c8 d8 e8 f8

실제 데이터로 학습해보기

Multiple input LSTM stateful model 결과

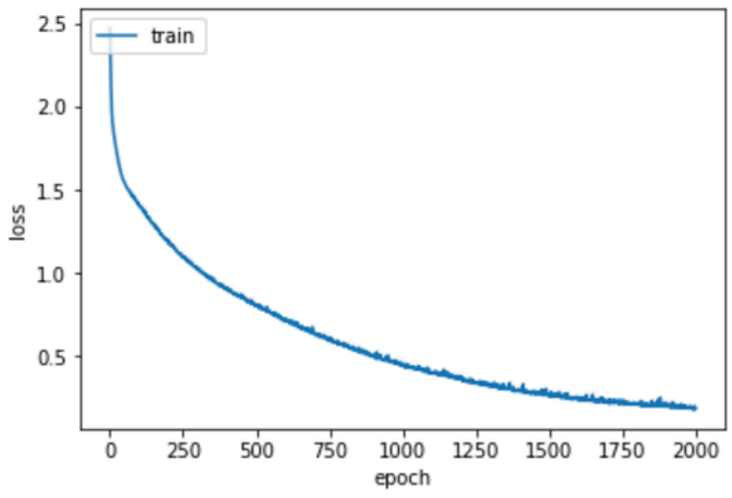




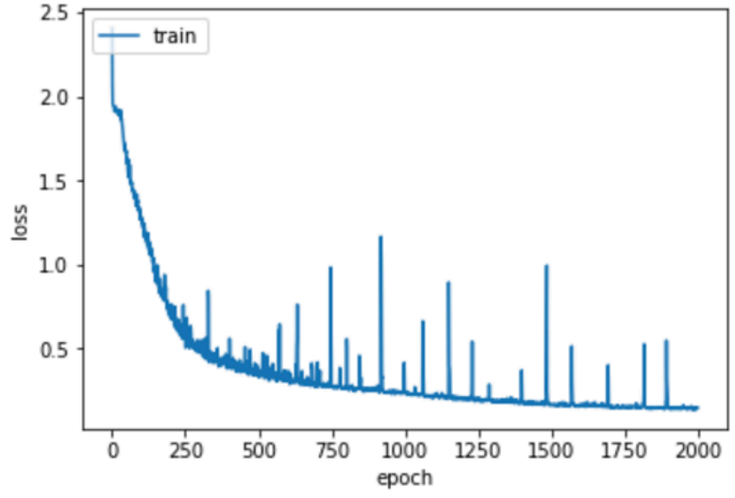
실제 데이터로 학습해보기

정리

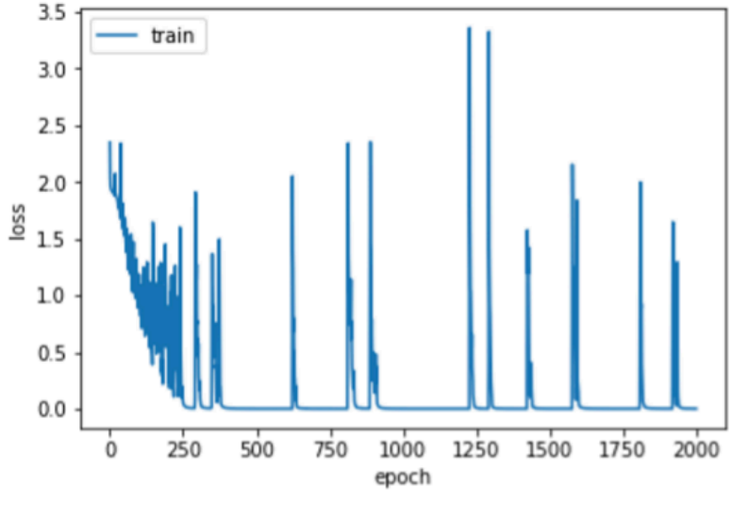
다층퍼셉트론, 입력속성 4개



기본 LSTM, 입력속성 1개



상태유지 LSTM, 입력속성 1개



상태유지 LSTM, 입력속성 2개