Making RNNs More Effective

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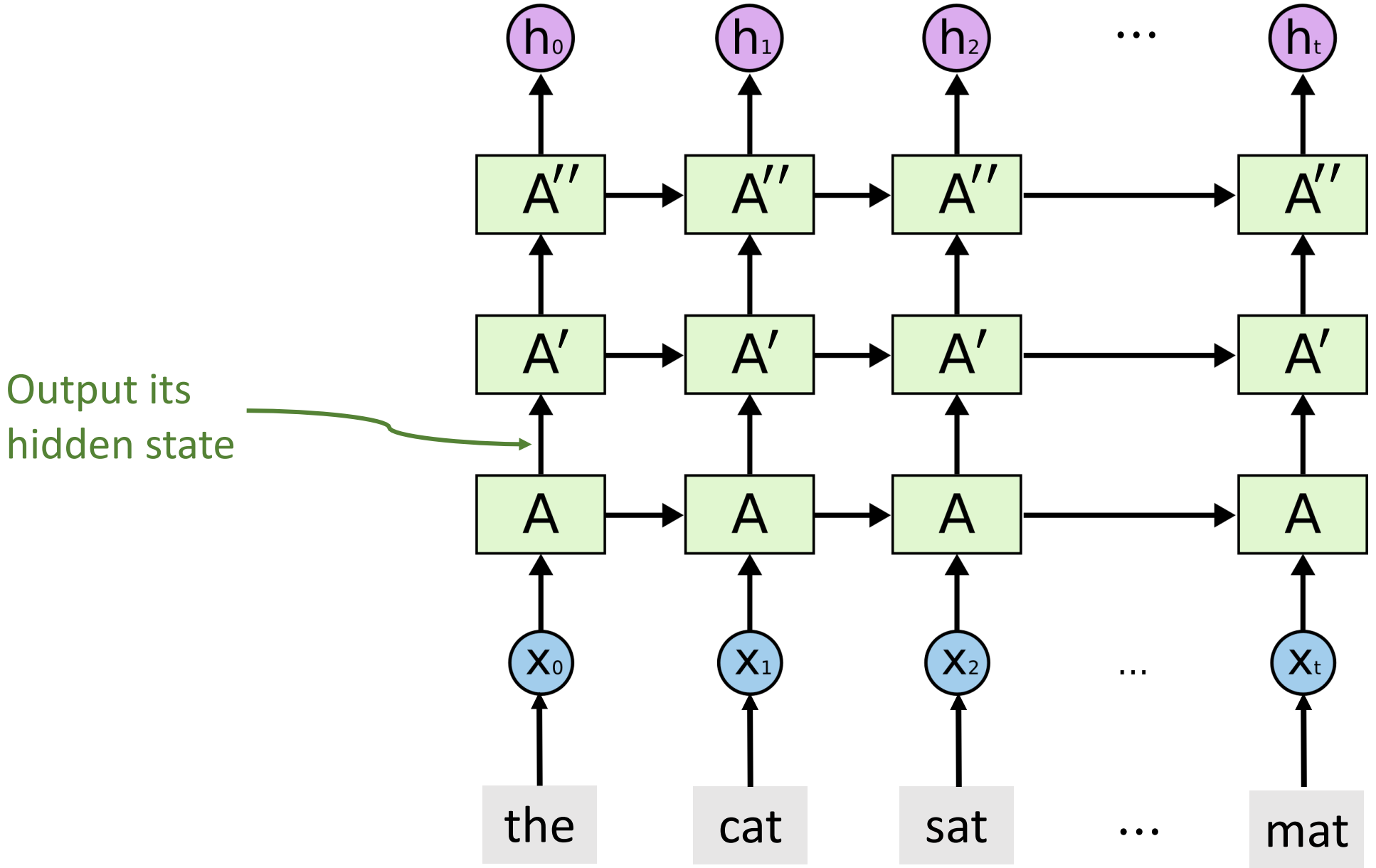
Stacked RNN

Stacked RNN (LSTM)



Stacked LSTM

```
from keras.models import Sequential
from keras.layers import LSTM, Embedding, Dense

vocabulary = 10000
embedding_dim = 32
word_num = 500
state_dim = 32

model = Sequential()
model.add(Embedding(vocabulary, embedding_dim, input_length=word_num))
model.add(LSTM(state_dim, return_sequences=True, dropout=0.2))
model.add(LSTM(state_dim, return_sequences=True, dropout=0.2))
model.add(LSTM(state_dim, return_sequences=False, dropout=0.2))
model.add(Dense(1, activation='sigmoid'))
```

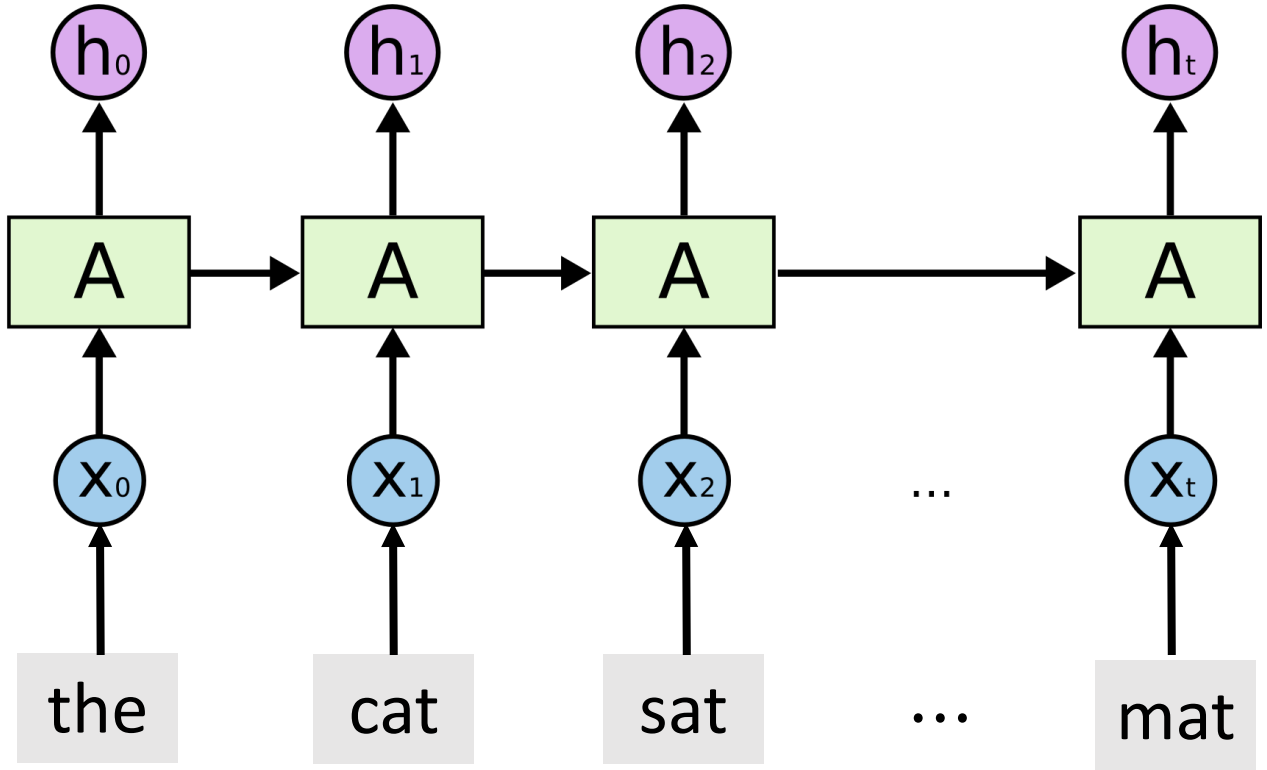
Stacked LSTM

Layer (type)	Output Shape	Param #
embedding_1 (Embedding)	(None, 500, 32)	320000
lstm_1 (LSTM)	(None, 500, 32)	8320
lstm_2 (LSTM)	(None, 500, 32)	8320
lstm_3 (LSTM)	(None, 32)	8320
dense_1 (Dense)	(None, 1)	33

Total params: 344,993
Trainable params: 344,993
Non-trainable params: 0

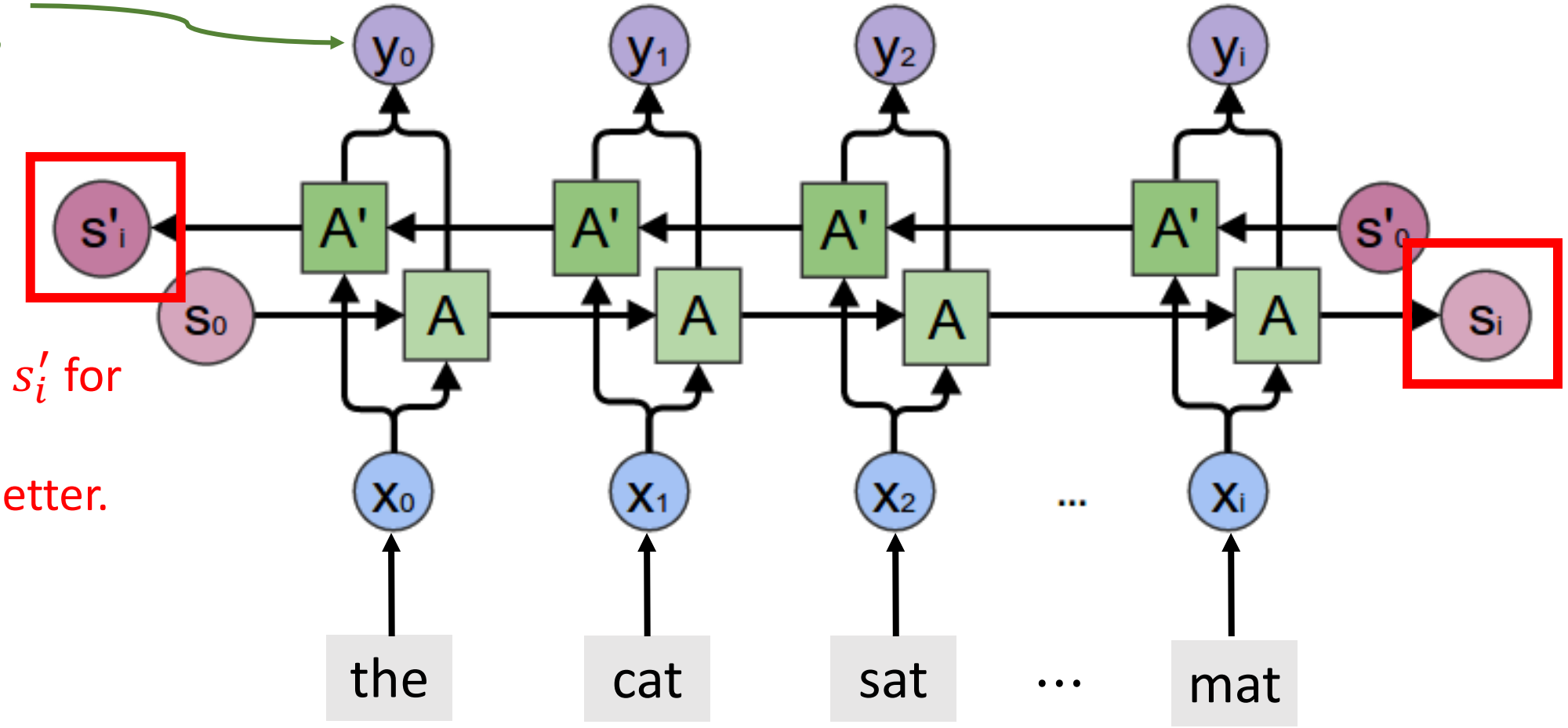
Bidirectional RNN

RNN (LSTM) in One Direction



Bidirectional RNN (LSTM)

Stack of the 2 hidden states



Using both s_i and s_i' for classification, the accuracy will be better.

Bi-LSTM

```
from keras.models import Sequential
from keras.layers import LSTM, Embedding, Dense, Bidirectional

vocabulary = 10000
embedding_dim = 32
word_num = 500
state_dim = 32

model = Sequential()
model.add(Embedding(vocabulary, embedding_dim, input_length=word_num))
model.add(Bidirectional(LSTM(state_dim, return_sequences=False, dropout=0.2)))
model.add(Dense(1, activation='sigmoid'))

model.summary()
```

Bi-LSTM

Layer (type)	Output Shape	Param #
embedding_1 (Embedding)	(None, 500, 32)	320000
bidirectional_1 (Bidirection	(None, 64)	16640
dense_1 (Dense)	(None, 1)	65

Total params: 336,705
Trainable params: 336,705
Non-trainable params: 0

Pretrain

Why and How Pretraining?

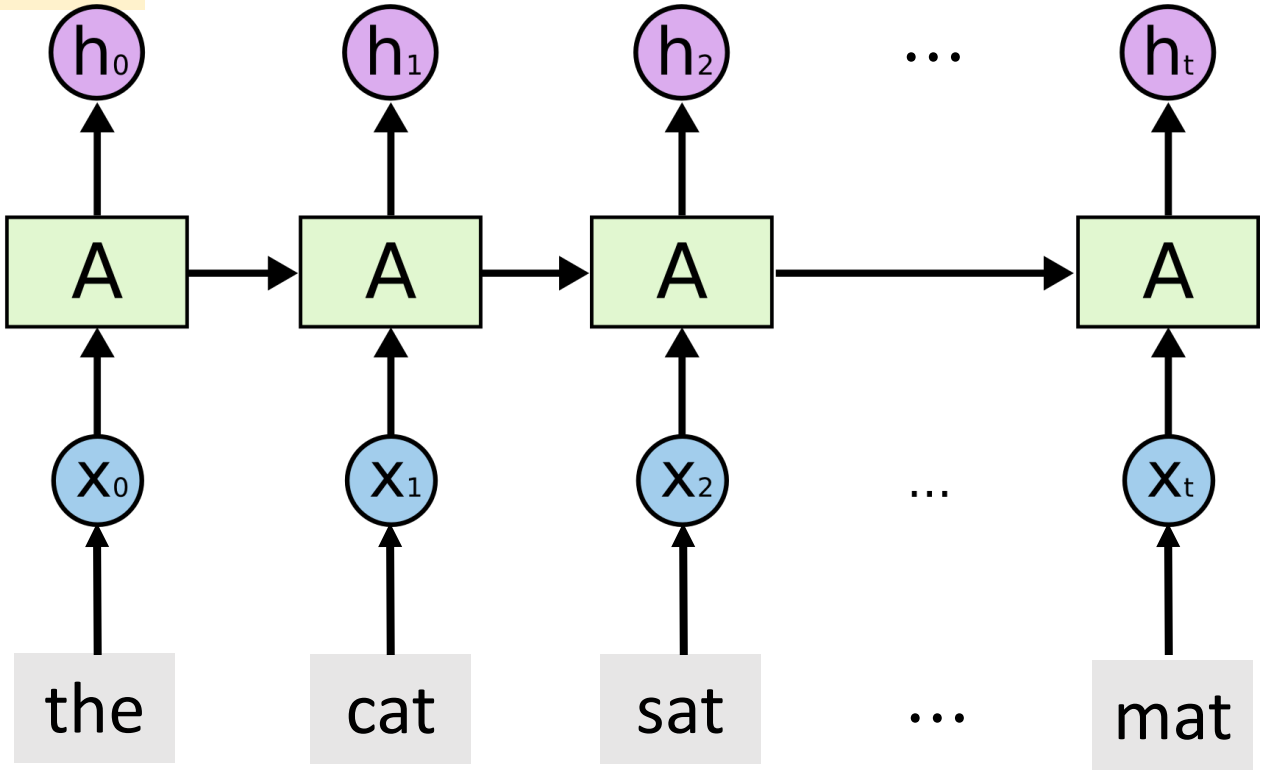
Observation: The embedding layer contributes most of the parameters!

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
embedding_1 (Embedding)      (None, 500, 32)           320000
_________________________________________________________________
bidirectional_1 (Bidirection (None, 64)                16640
_________________________________________________________________
dense_1 (Dense)              (None, 1)                 65
=================================================================
Total params: 336,705
Trainable params: 336,705
Non-trainable params: 0
```

Trick: Pretrain the Embedding Layer

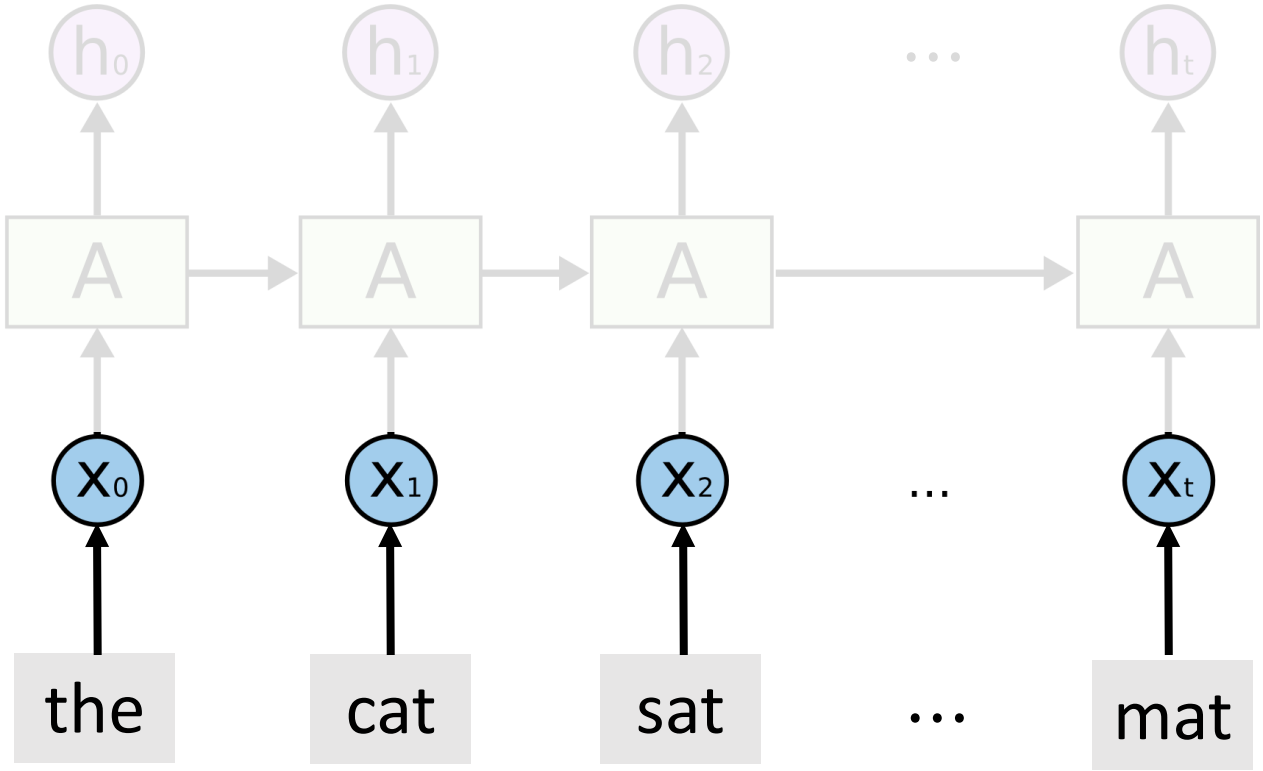
Step 1: Train a model on large dataset.

- Perhaps different problem.
- Perhaps different model.



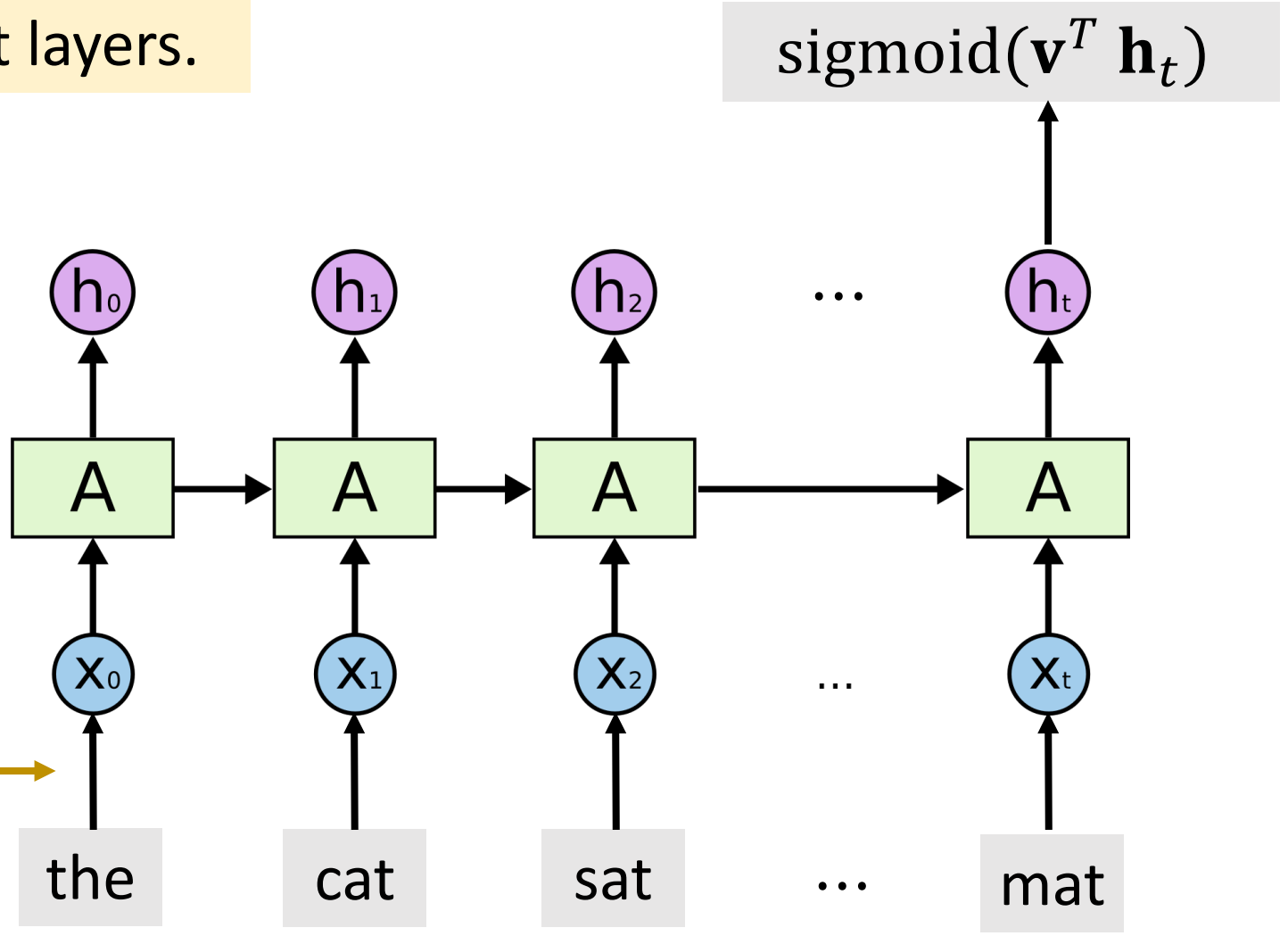
Trick: Pretrain the Embedding Layer

Step 2: Keep only the embedding layer.



Trick: Pretrain the Embedding Layer

Step 3: Train new LSTM and output layers.



Set the embedding layer non-trainable.

Summary

- Always use LSTM instead of SimpleRNN (unless n is over-small).
- Use LSTM dropout to alleviate overfitting.
- Use Bi-LSTM whenever possible.
- Stacked LSTM instead of a single LSTM layer (if n is big).
- Pretrain the embedding layer (if the sample size is small).