

# Recurrent Neural Networks

Quiz, 10 questions

✓ **Congratulations! You passed!**

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1.

Suppose your training examples are sentences (sequences of words). Which of the following refers to the  $j^{th}$  word in the  $i^{th}$  training example?

☒  $x^{(i)<j>}$



**Correct**

We index into the  $i^{th}$  row first to get the  $i^{th}$  training example (represented by parentheses), then the  $j^{th}$  column to get the  $j^{th}$  word (represented by the brackets).

☐  $x^{<i>(j)>}$

☐  $x^{(j)<i>}$

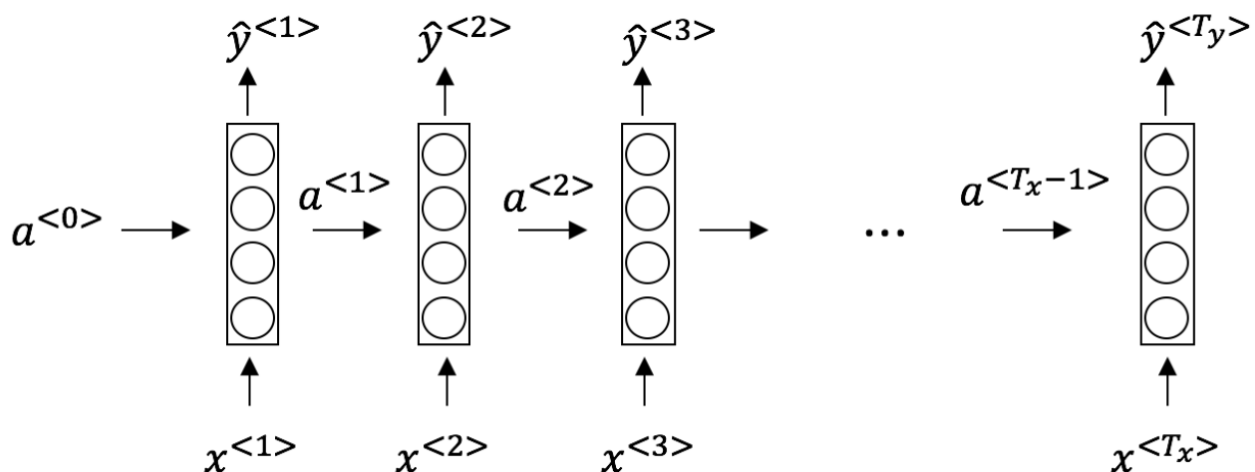
☐  $x^{<j>(i)>}$



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2.

Consider this RNN:



This specific type of architecture is appropriate when:

☒  $T_x = T_y$



Correct

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It is appropriate when every input should be matched to an output.  
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☐  $T_x < T_y$

☐  $T_x > T_y$

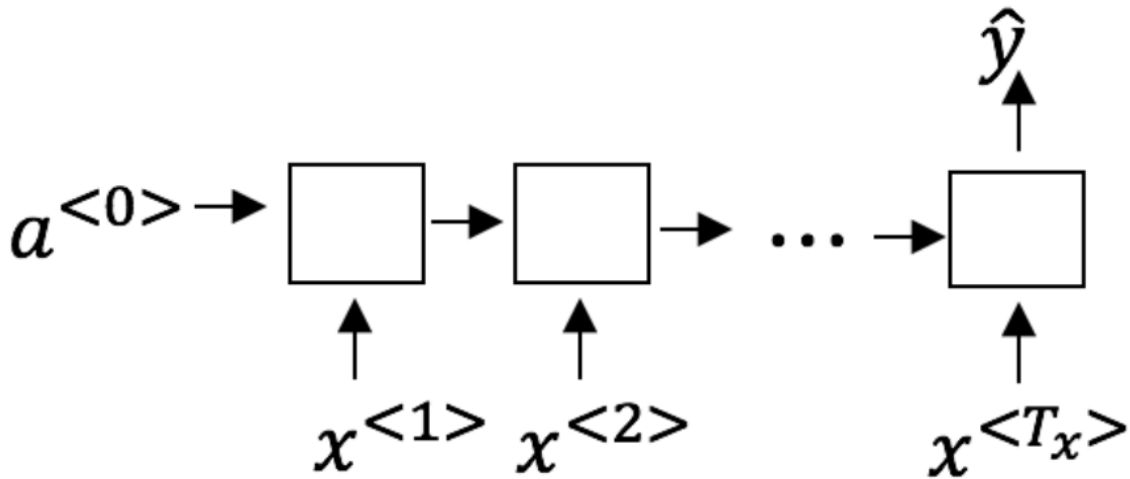
☐  $T_x = 1$



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3.

To which of these tasks would you apply a many-to-one RNN architecture? (Check all that apply).


☐ Speech recognition (input an audio clip and output a transcript)


Un-selected is correct

☐ Sentiment classification (input a piece of text and output a 0/1 to denote positive or negative sentiment)


Correct

Correct!

☐ Image classification (input an image and output a label)


Un-selected is correct

☐ Gender recognition from speech (input an audio clip and output a label indicating the speaker's gender)


Correct

Correct!

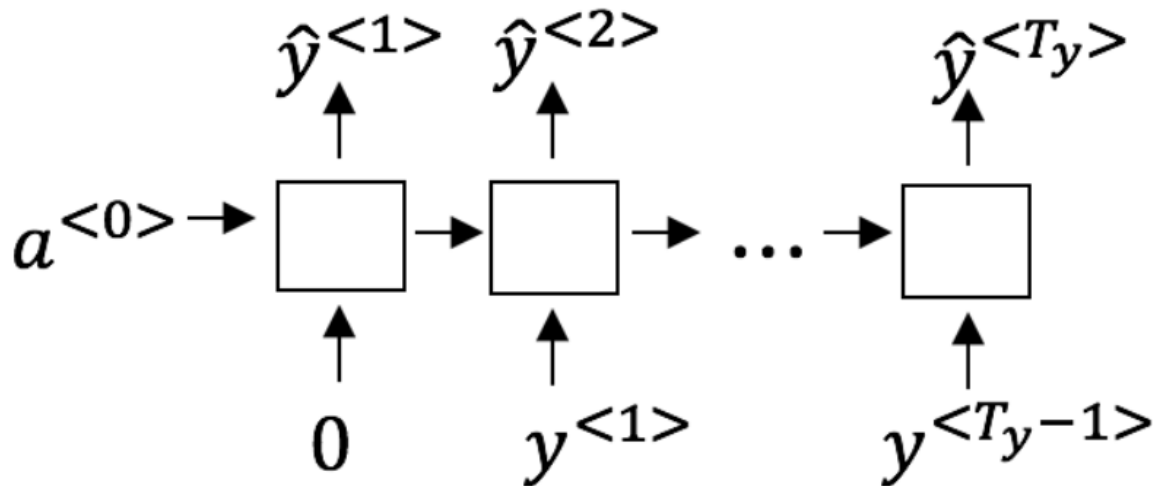
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4.

You are training this RNN language model.

At the  $t^{th}$  time step, what is the RNN doing? Choose the best answer.

- ☐ Estimating  $P(y^{<1>}, y^{<2>}, \dots, y^{<t-1>})$
- ☐ Estimating  $P(y^{<t>})$
- ☒ Estimating  $P(y^{<t>} \mid y^{<1>}, y^{<2>}, \dots, y^{<t-1>})$

**Correct**

Yes, in a language model we try to predict the next step based on the knowledge of all prior steps.

- ☐ Estimating  $P(y^{<t>} \mid y^{<1>}, y^{<2>}, \dots, y^{<t>})$

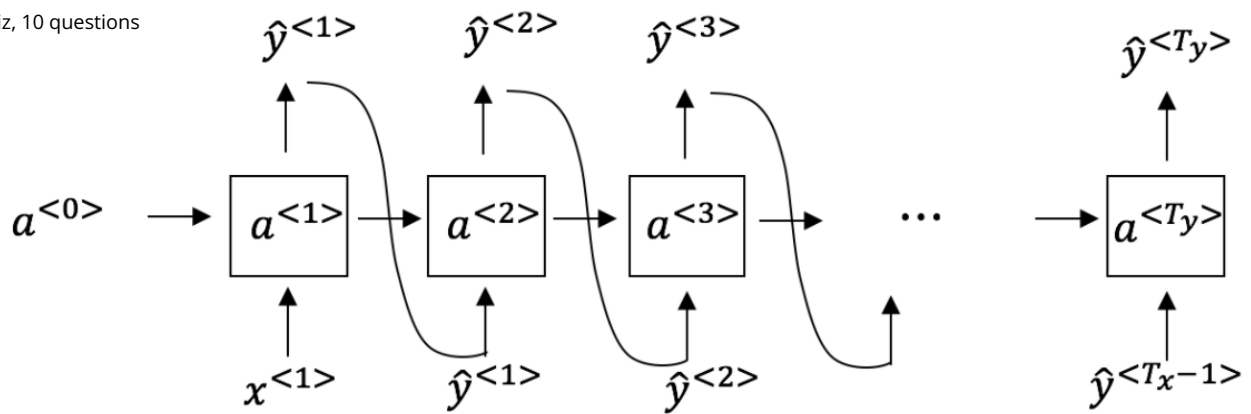
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5.

You have finished training a language model RNN and are using it to sample random sentences, as follows:

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What are you doing at each time step  $t$ ?

- ☐ (i) Use the probabilities output by the RNN to pick the highest probability word for that time-step as  $\hat{y}^{<t>}$ . (ii) Then pass the ground-truth word from the training set to the next time-step.
- ☐ (i) Use the probabilities output by the RNN to randomly sample a chosen word for that time-step as  $\hat{y}^{<t>}$ . (ii) Then pass the ground-truth word from the training set to the next time-step.
- ☐ (i) Use the probabilities output by the RNN to pick the highest probability word for that time-step as  $\hat{y}^{<t>}$ . (ii) Then pass this selected word to the next time-step.
- ☒ (i) Use the probabilities output by the RNN to randomly sample a chosen word for that time-step as  $\hat{y}^{<t>}$ . (ii) Then pass this selected word to the next time-step.

Correct

Yes!



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6.

You are training an RNN, and find that your weights and activations are all taking on the value of NaN ("Not a Number"). Which of these is the most likely cause of this problem?

- ☐ Vanishing gradient problem.
- ☒ Exploding gradient problem.

Correct

- ☐ ReLU activation function  $g(\cdot)$  used to compute  $g(z)$ , where  $z$  is too large.
- ☐ Sigmoid activation function  $g(\cdot)$  used to compute  $g(z)$ , where  $z$  is too large.



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7.

Suppose you are training a LSTM. You have a 10000 word vocabulary, and are using an LSTM with 100-dimensional hidden units. What is the dimension of  $\Gamma_u$  at each time step?

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☐ 1

☒ 100



**Correct**

Correct,  $\Gamma_u$  is a vector of dimension equal to the number of hidden units in the LSTM.

☐ 300

☐ 10000



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8.

Here're the update equations for the GRU.

GRU

$$\tilde{c}^{<t>} = \tanh(W_c[\Gamma_r * c^{<t-1>}, x^{<t>}] + b_c)$$

$$\Gamma_u = \sigma(W_u[c^{<t-1>}, x^{<t>}] + b_u)$$

$$\Gamma_r = \sigma(W_r[c^{<t-1>}, x^{<t>}] + b_r)$$

$$c^{<t>} = \Gamma_u * \tilde{c}^{<t>} + (1 - \Gamma_u) * c^{<t-1>}$$

$$a^{<t>} = c^{<t>}$$

Alice proposes to simplify the GRU by always removing the  $\Gamma_u$ . I.e., setting  $\Gamma_u = 1$ . Betty proposes to simplify the GRU by removing the  $\Gamma_r$ . I. e., setting  $\Gamma_r = 1$  always. Which of these models is more likely to work without vanishing gradient problems even when trained on very long input sequences?

☐ Alice's model (removing  $\Gamma_u$ ), because if  $\Gamma_r \approx 0$  for a timestep, the gradient can propagate back through that timestep without much decay.

☐ Alice's model (removing  $\Gamma_u$ ), because if  $\Gamma_r \approx 1$  for a timestep, the gradient can propagate back through that timestep without much decay.

☒ Betty's model (removing  $\Gamma_r$ ), because if  $\Gamma_u \approx 0$  for a timestep, the gradient can propagate back through that timestep without much decay.



**Correct**

Yes. For the signal to backpropagate without vanishing, we need  $c^{<t>}$  to be highly dependant on  $c^{<t-1>}$ .

☐ Betty's model (removing  $\Gamma_r$ ), because if  $\Gamma_u \approx 1$  for a timestep, the gradient can propagate back through that timestep without much decay.

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9.

Here are the equations for the GRU and the LSTM:

### GRU

$$\tilde{c}^{<t>} = \tanh(W_c[\Gamma_r * c^{<t-1>}, x^{<t>}] + b_c)$$

$$\Gamma_u = \sigma(W_u[c^{<t-1>}, x^{<t>}] + b_u)$$

$$\Gamma_r = \sigma(W_r[c^{<t-1>}, x^{<t>}] + b_r)$$

$$c^{<t>} = \Gamma_u * \tilde{c}^{<t>} + (1 - \Gamma_u) * c^{<t-1>}$$

$$a^{<t>} = c^{<t>}$$

### LSTM

$$\tilde{c}^{<t>} = \tanh(W_c[a^{<t-1>}, x^{<t>}] + b_c)$$

$$\Gamma_u = \sigma(W_u[a^{<t-1>}, x^{<t>}] + b_u)$$

$$\Gamma_f = \sigma(W_f[a^{<t-1>}, x^{<t>}] + b_f)$$

$$\Gamma_o = \sigma(W_o[a^{<t-1>}, x^{<t>}] + b_o)$$

$$c^{<t>} = \Gamma_u * \tilde{c}^{<t>} + \Gamma_f * c^{<t-1>}$$

$$a^{<t>} = \Gamma_o * c^{<t>}$$

From these, we can see that the Update Gate and Forget Gate in the LSTM play a role similar to \_\_\_\_\_ and \_\_\_\_\_ in the GRU. What should go in the the blanks?



$\Gamma_u$  and  $1 - \Gamma_u$



**Correct**

Yes, correct!



$\Gamma_u$  and  $\Gamma_r$



$1 - \Gamma_u$  and  $\Gamma_u$



$\Gamma_r$  and  $\Gamma_u$



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10.

You have a pet dog whose mood is heavily dependent on the current and past few days' weather. You've collected data for the past 365 days on the weather, which you represent as a sequence as  $x^{<1>}, \dots, x^{<365>}$ . You've also collected data on your dog's mood, which you represent as  $y^{<1>}, \dots, y^{<365>}$ . You'd like to build a model to map from  $x \rightarrow y$ . Should you use a Unidirectional RNN or Bidirectional RNN for this problem?



Bidirectional RNN, because this allows the prediction of mood on day  $t$  to take into account more information.



Bidirectional RNN, because this allows backpropagation to compute more accurate gradients.



Unidirectional RNN, because the value of  $y^{<t>}$  depends only on  $x^{<1>}, \dots, x^{<t>}$ , but not on  $x^{<t+1>}, \dots, x^{<365>}$



Correct  
Yes.

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Unidirectional RNN, because the value of  $y^{<t>}$  depends only on  $x^{<t>}$ , and not other days' weather.

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