Recurrent Neural Networks

CS 6956: Deep Learning for NLP

Overview

1. Modeling sequences
2. Recurrent neural networks: An abstraction
3. Usage patterns for RNNs
4. BiDirectional RNNs
5. A concrete example: The Elman RNN
6. The vanishing gradient problem
7. Long short-term memory units

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A simple RNN

- What we saw so far is just a template for a recurrent neural network
  - Did not specify what the functions inside it are

- Let's look at a simple instantiation, first introduced by Elman 1990

A simple RNN

At each step, an RNN:

- Computes the next cell state: $\mathbf{s}_t = \mathrm{R}(\mathbf{s}_{t-1}, \mathbf{x}_t)$
- Computes the output: $\boldsymbol{y}_t = \mathrm{O}(\mathbf{s}_t)$

Need to specify two functions:

1. How to generate the current state using the previous state and the current input?

2. How to generate the current output using the current state?

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Computing the value of a state

1. How to generate the current state using the previous state and the current input?

$\mathbf{s}_{t-1}$

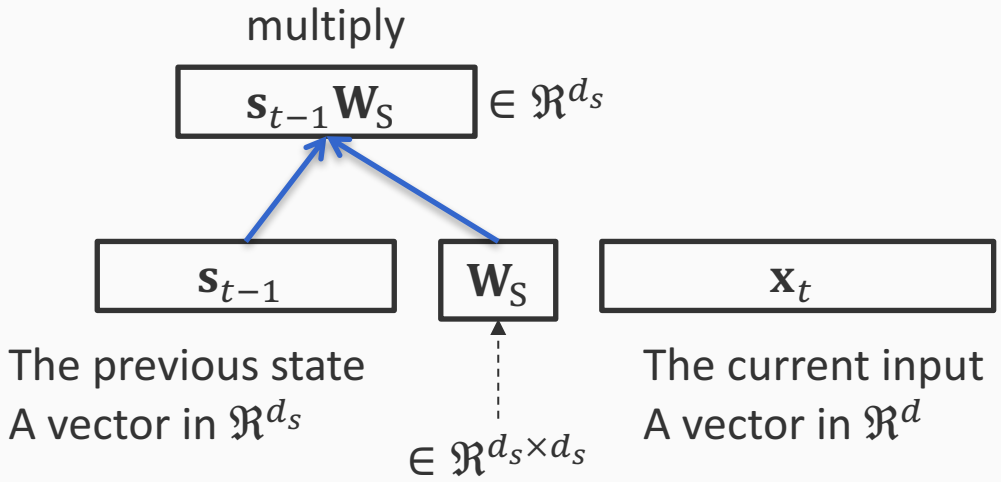
The previous state
A vector in $\Re^{d_s}$

$\mathbf{x}_t$

The current input
A vector in $\Re^{d}$

Computing the value of a state

1. How to generate the current state using the previous state and the current input?



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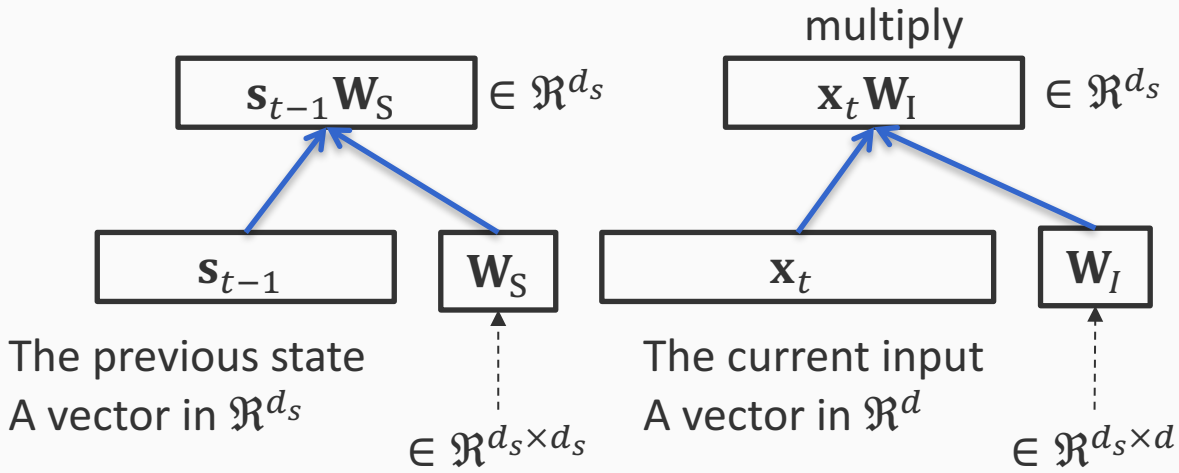

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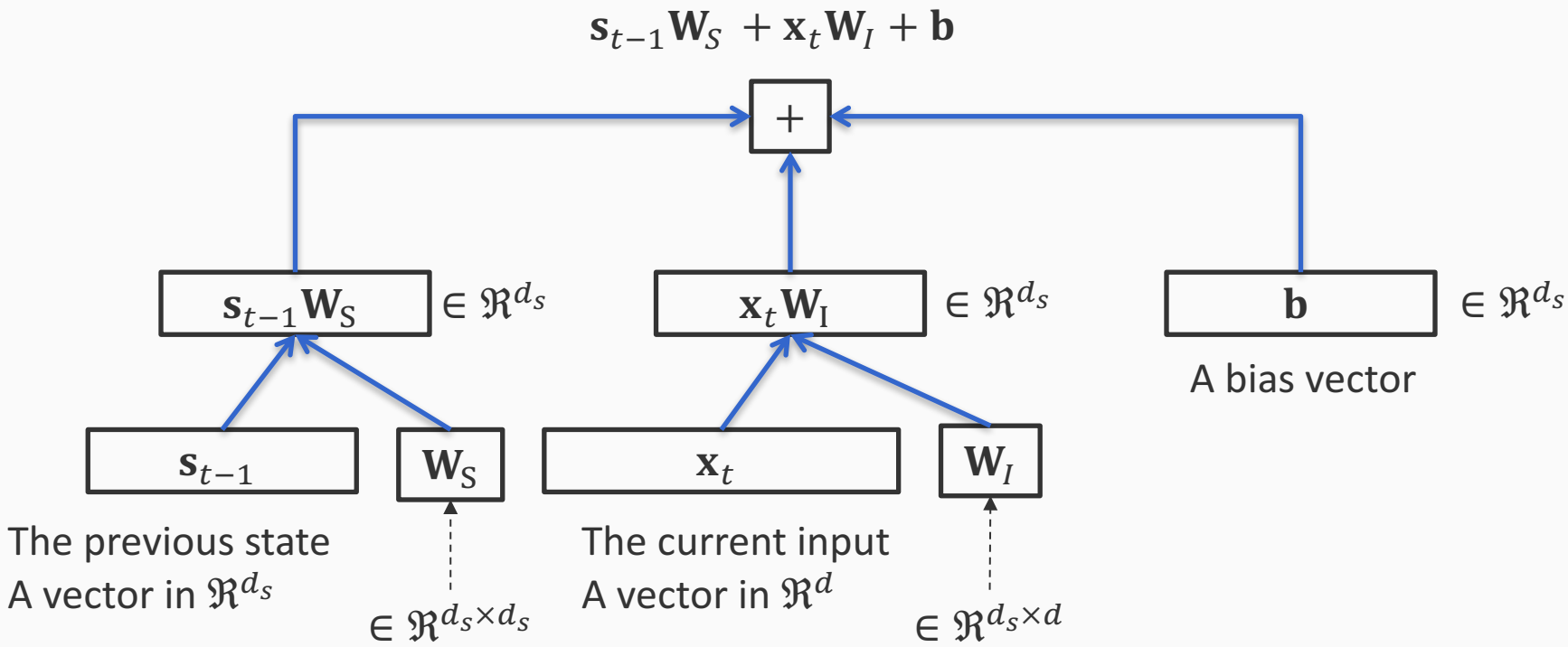

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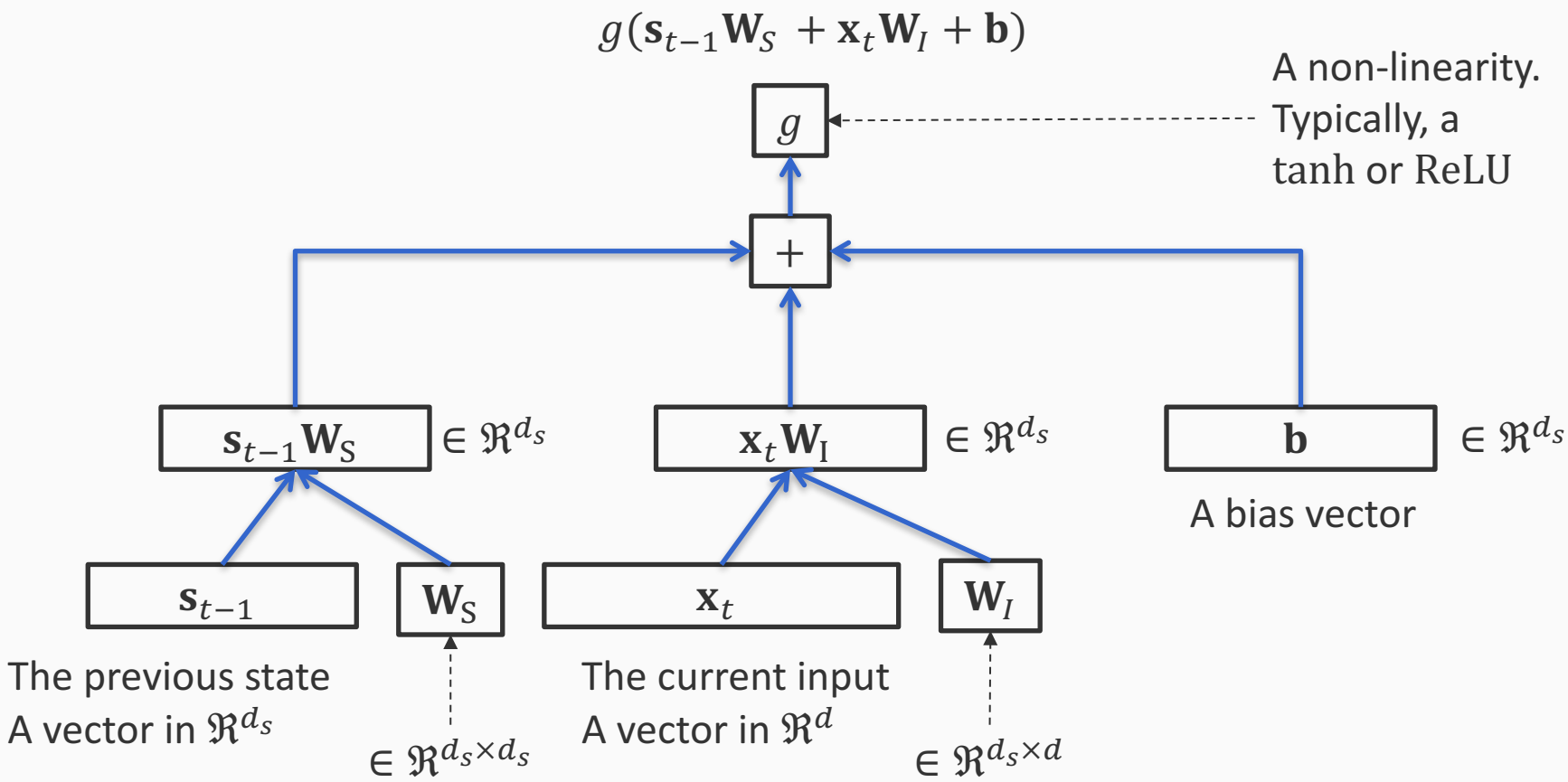
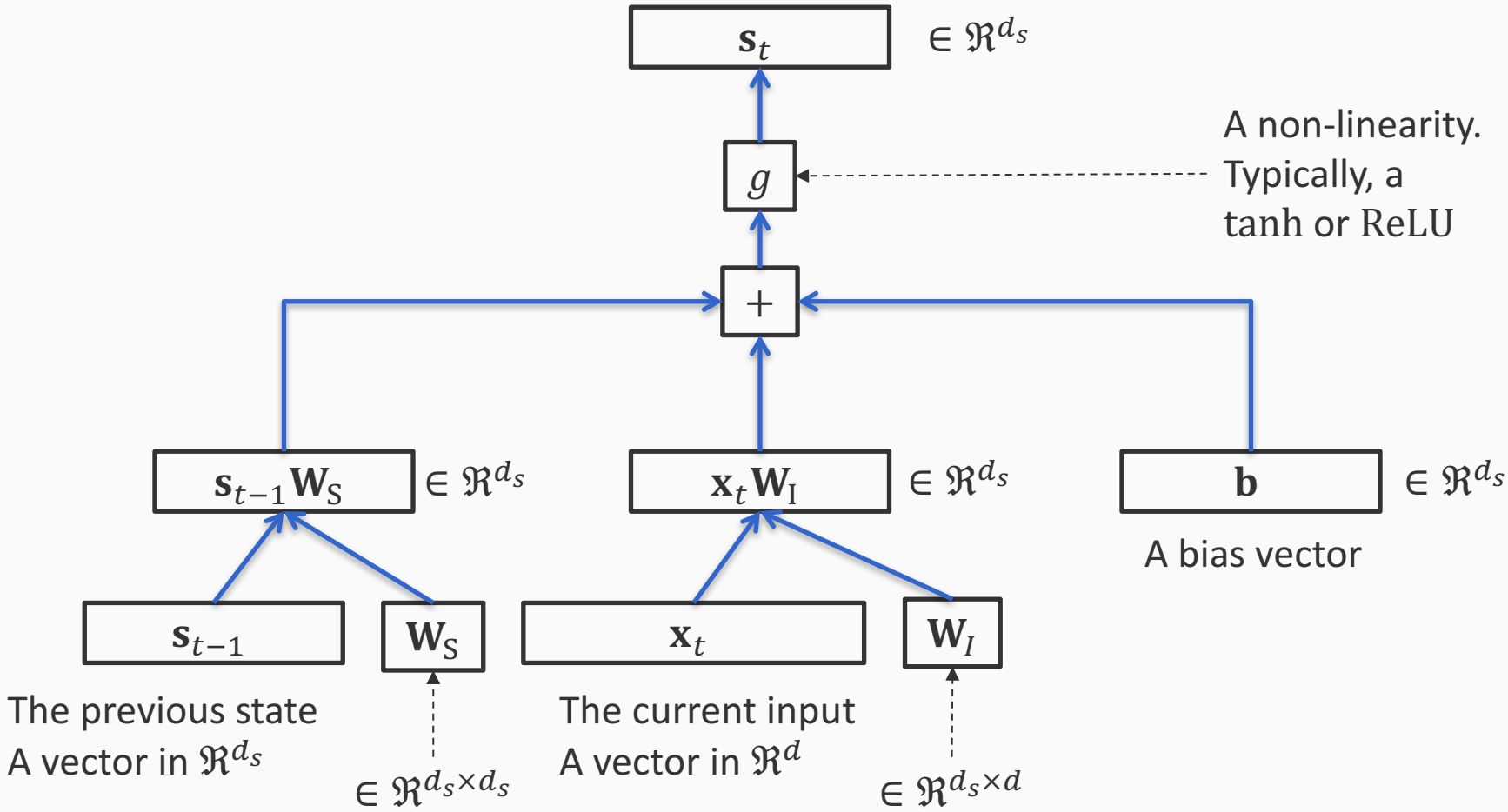


Computing the value of a state

1. How to generate the current state using the previous state and the current input?

Next state $\mathbf{s}_t = g(\mathbf{s}_{t-1}\mathbf{W}_S + \mathbf{x}_t\mathbf{W}_I + \mathbf{b})$



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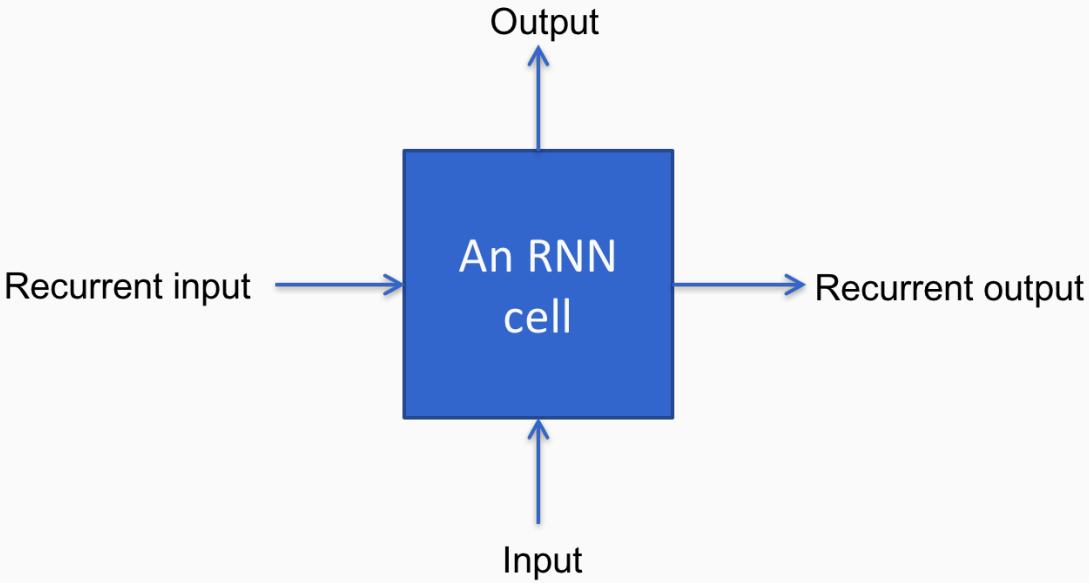
The Elman RNN



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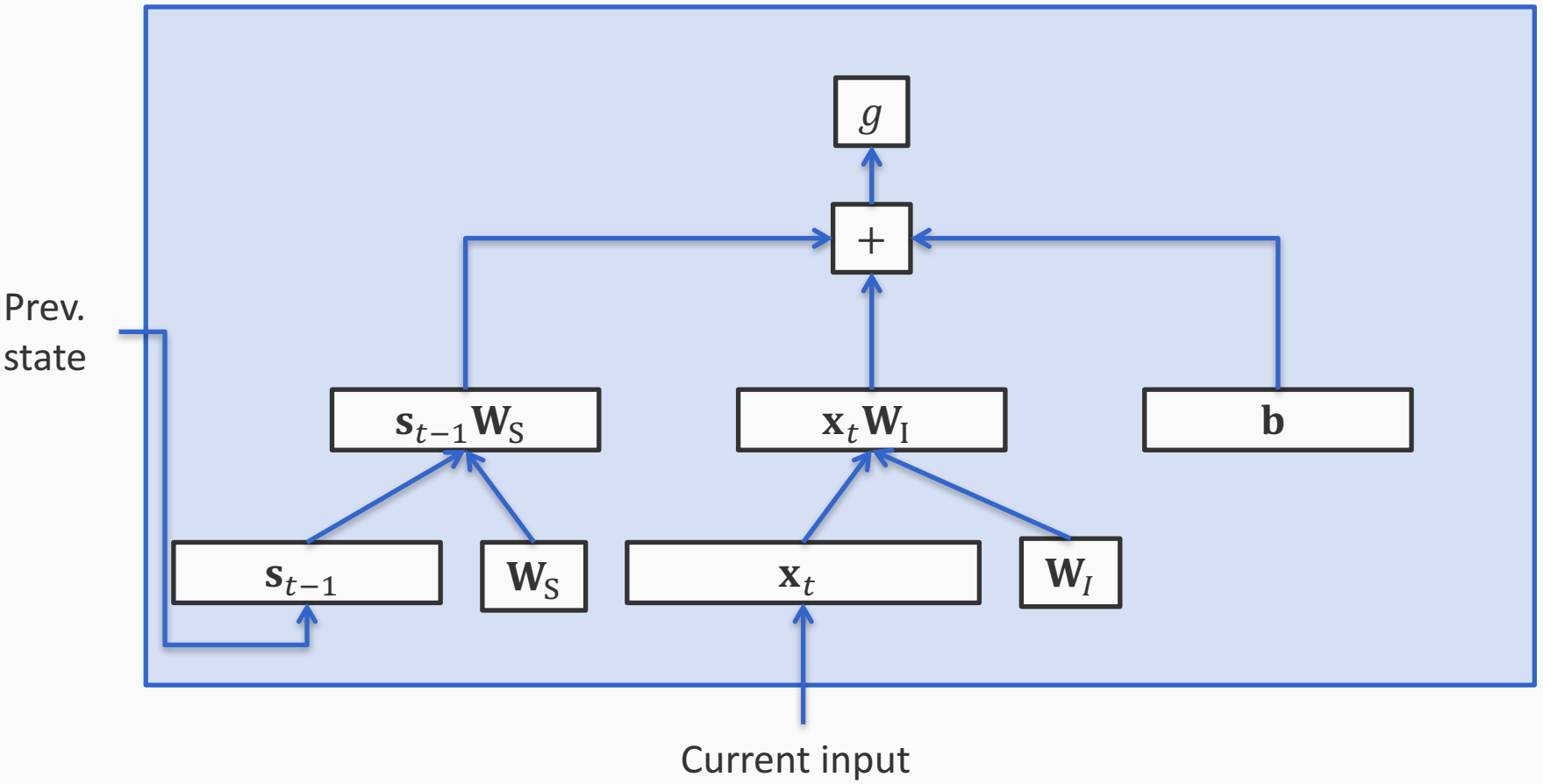

The Elman RNN