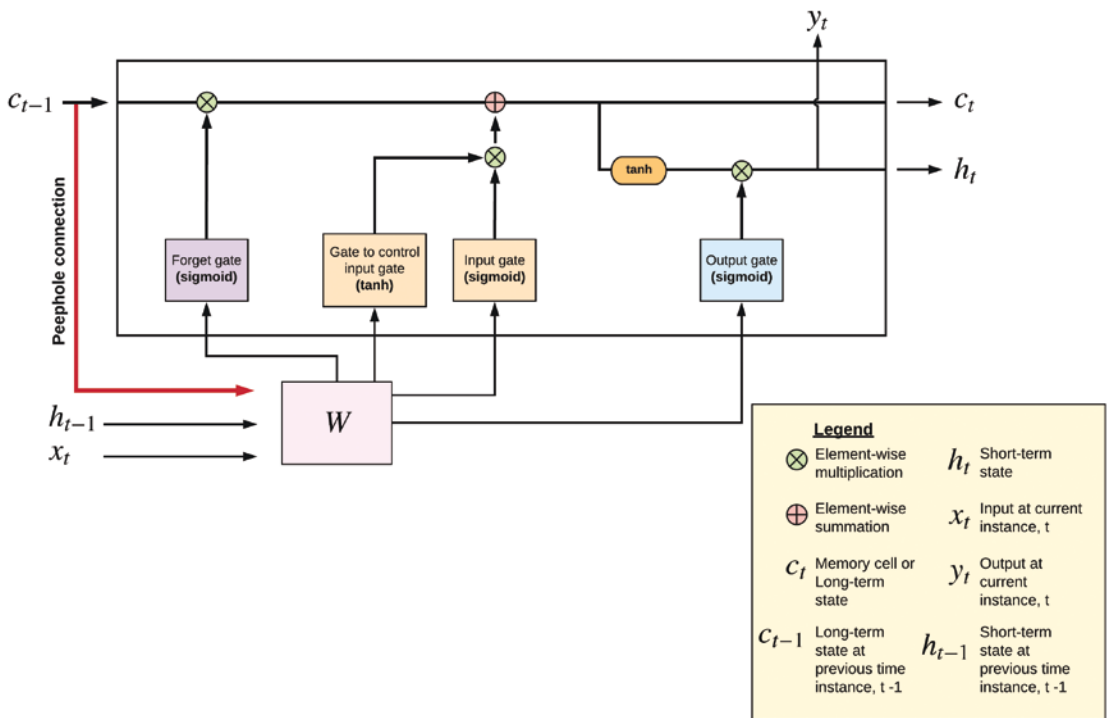


Figure 36-13. LSTM cell

It is important to note that the components of the LSTM cells are all fully connected neural networks. There exist other variants of recurrent networks with memory cells, two of such are the peephole connections and the gated recurrent units.

## Peephole Connection

The peephole connection extends the LSTM network by also using information from the memory cell or long-term state of the previous time instant  $c_{t-1}$  as input to the LSTM gates. The goal of the peephole is to provide extra information into the LSTM unit by peeping at the stored long-term memory. This is further illustrated in Figure 36-14. In TensorFlow 2.0, the implementation of peephole connections to an LSTM layer is provided by the method `'tf.keras.experimental.PeepholeLSTMCell()'`.



**Figure 36-14.** Peephole connection

## Gated Recurrent Unit (GRU)

The gated recurrent unit (GRU) is a more recent recurrent neural network architecture than the LSTM, and it is also comparable simpler to implement with respect to the number of components within the unit and their operations. Despite its comparative simplicity, GRUs are high-performing recurrent architectures and, in most cases, even perform better than the LSTM in sequence modeling problems.

GRUs combine the forget and the input gates to decide on what information should be committed to the long-term memory or the memory cell and what information should be left out. Moreover, the GRU combines the cell (i.e., long-term state) and short-term states into a single state vector  $h_t$ . Also, the GRU removes the output gate and returns the state vector  $h_t$  at each time instant. This is further illustrated in Figure 36-15. In TensorFlow 2.0, the GRU layer is implemented in the method `'tf.keras.layers.GRU()'`.