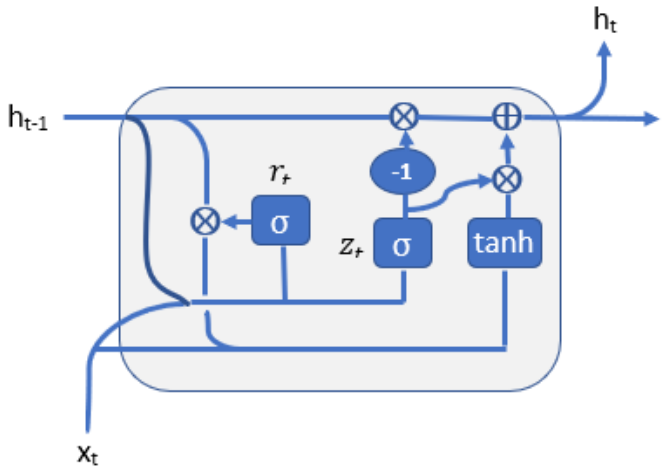
Gated Recurrent Unit (GRU)

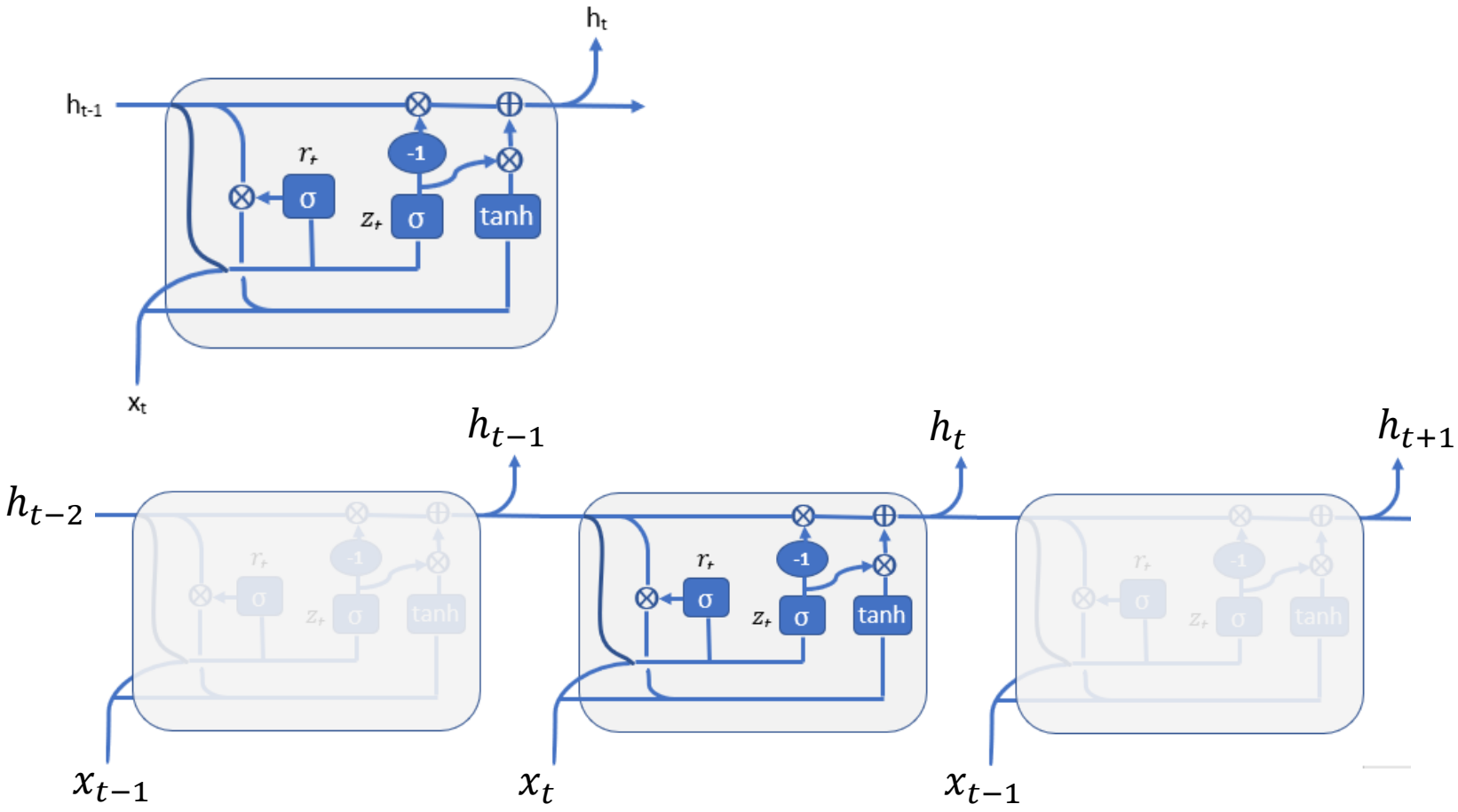
Unlike LSTM, GRU has only one State and only two Gates

Hidden State
&
Update Gate and Reset Gate

Gated Recurrent Unit (GRU)

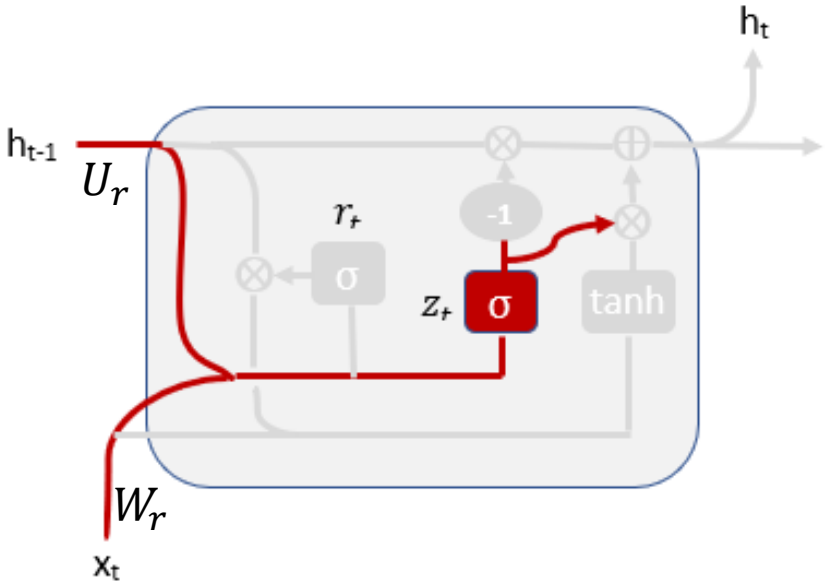


Gated Recurrent Unit (GRU)



Update Gate

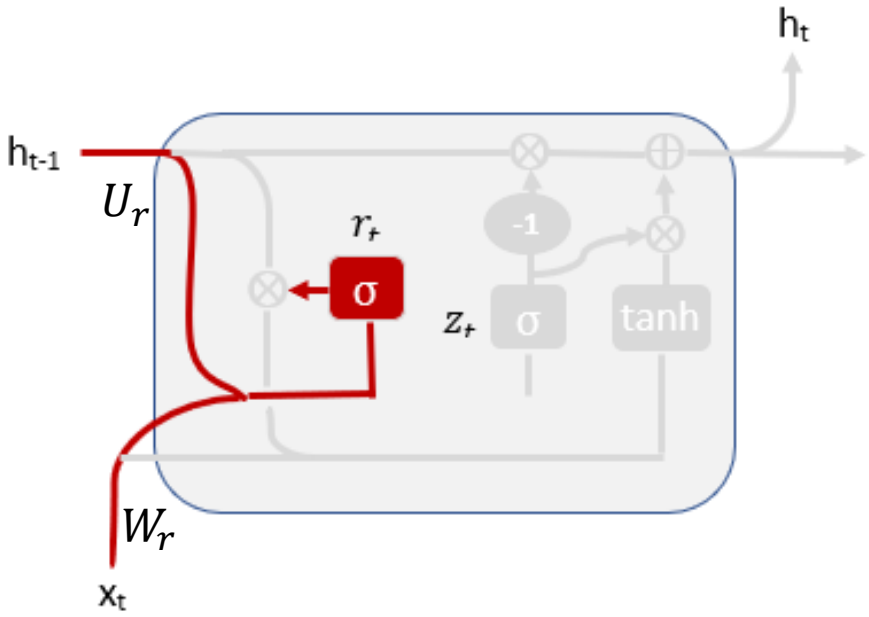
How much of the past information need to be considered to the next time step.



$$Z_t = \sigma(W_z \cdot x_t + U_z \cdot h_{t-1})$$

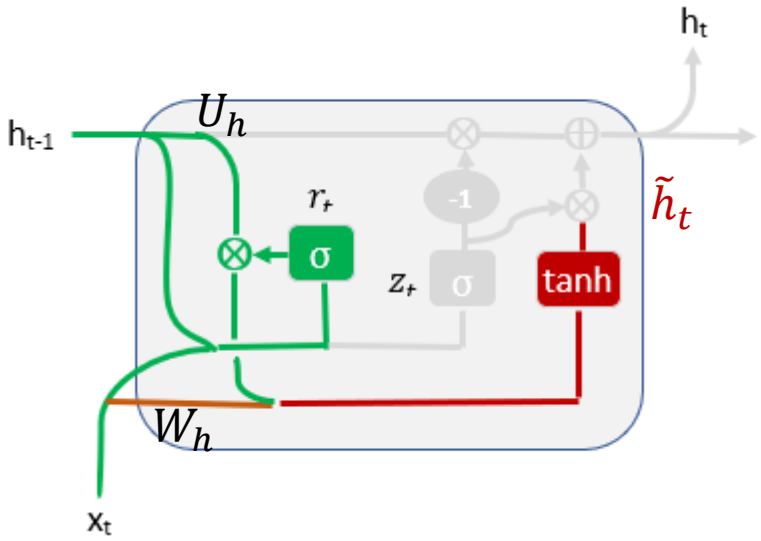
Reset Gate (r_t)

How much of the past information to be forgotten?



$$r_t = \sigma(W_r \cdot x_t + U_r \cdot h_{t-1})$$

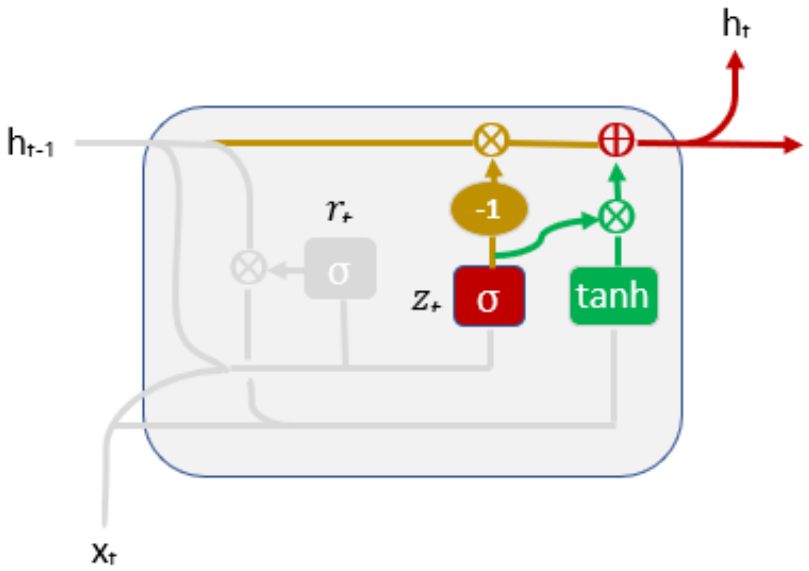
Internal Information (Current Memory Content)



$$\tilde{h}_t = tanh(W_h \cdot x_t + r_t \otimes U_h \cdot h_{t-1})$$

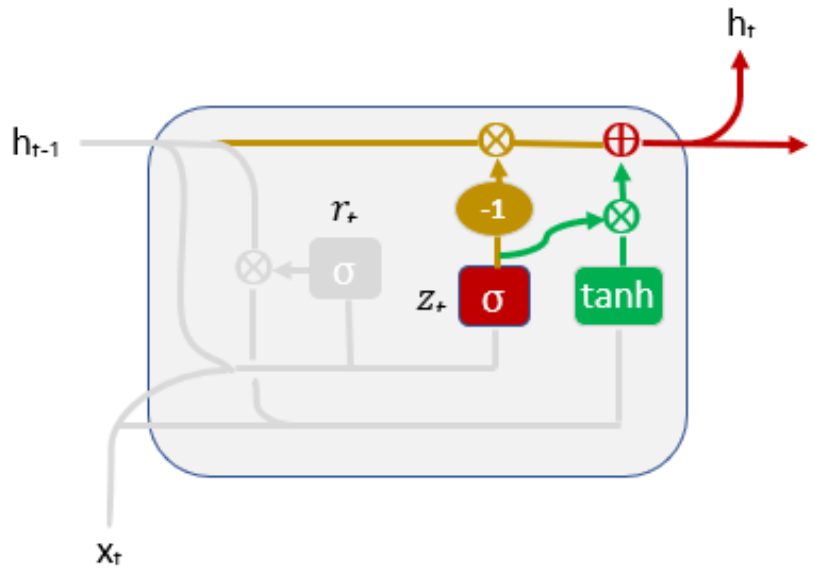
Consider the present input and useful information of the previous hidden state to produce new internal information

New Hidden State (h_t)



$$h_t = (1 - z_t) \otimes h_{t-1} \oplus z_t \otimes \tilde{h}_t$$

New Hidden State (h_t)

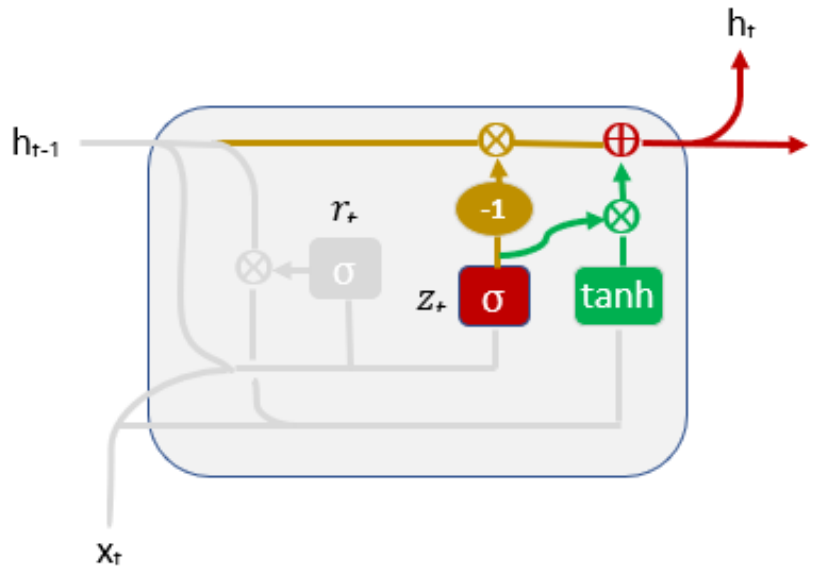


$$h_t = (1 - z_t) \otimes h_{t-1} \oplus z_t \otimes \tilde{h}_t$$

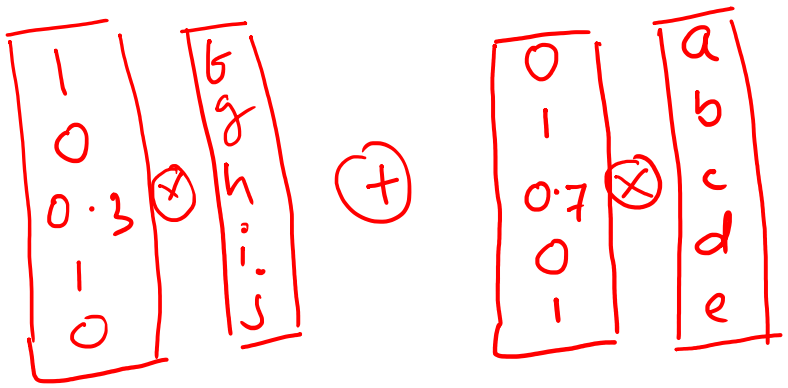
Previous hidden state at the position which are ignored in internal information

Useful information from the internal information

New Hidden State (h_t)



$$h_t = (1 - z_t) \otimes h_{t-1} \oplus z_t \otimes \tilde{h}_t$$



Summary

One State

- Hidden State $h_t = (1 - z_t) \otimes h_{t-1} \oplus z_t \otimes \tilde{h}_t$

Two Gates

- Update Gate $Z_t = \sigma(W_z \cdot x_t + U_z \cdot h_{t-1})$
- Reset Gate $r_t = \sigma(W_r \cdot x_t + U_r \cdot h_{t-1})$