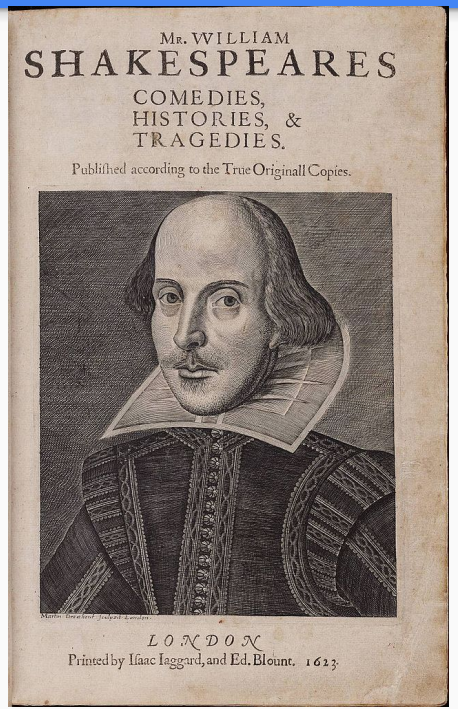
Recurrent Neural Network

Michal Bouška

Recurrent Neural Network
LSTM
GRU
Pointer Network

Problem



Two households, both alike in dignity,
In fair Verona, where we lay our scene,
From ancient grudge break to new mutiny,
Where civil blood makes civil hands unclean.
From forth the fatal loins of these two foes
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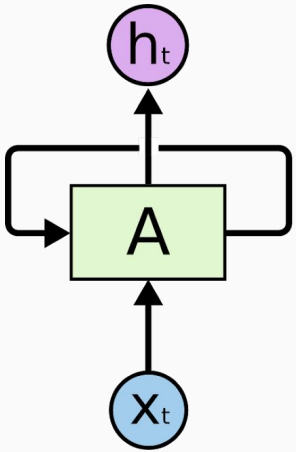
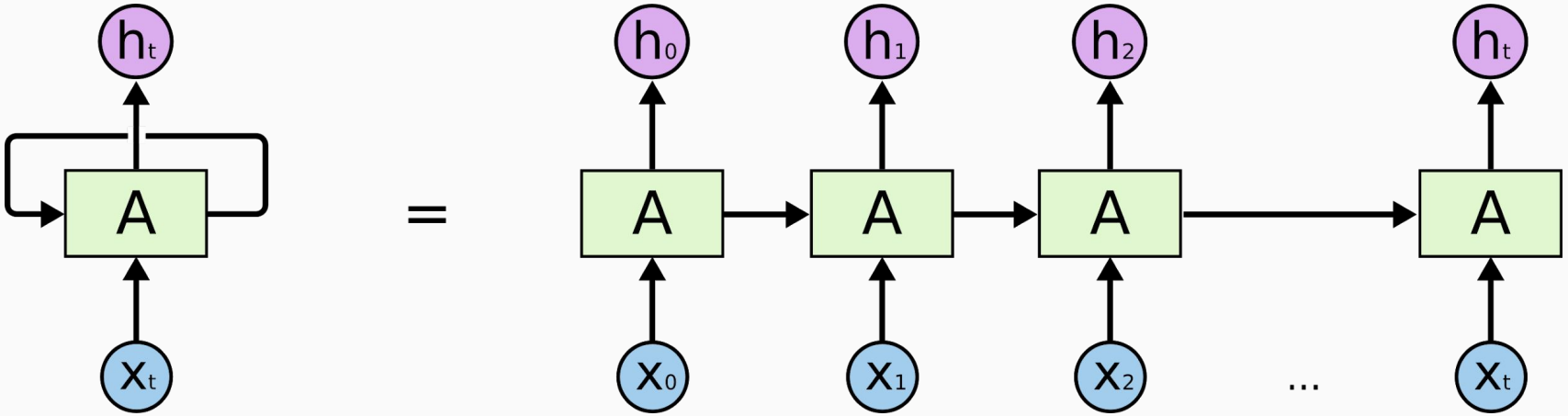
Which, but their children's end, nought could remove,
Is now the two hours' traffic of our stage;
The which if you with patient ears attend,
What here shall miss, our toil shall strive to mend.

Recurrent Neural Network

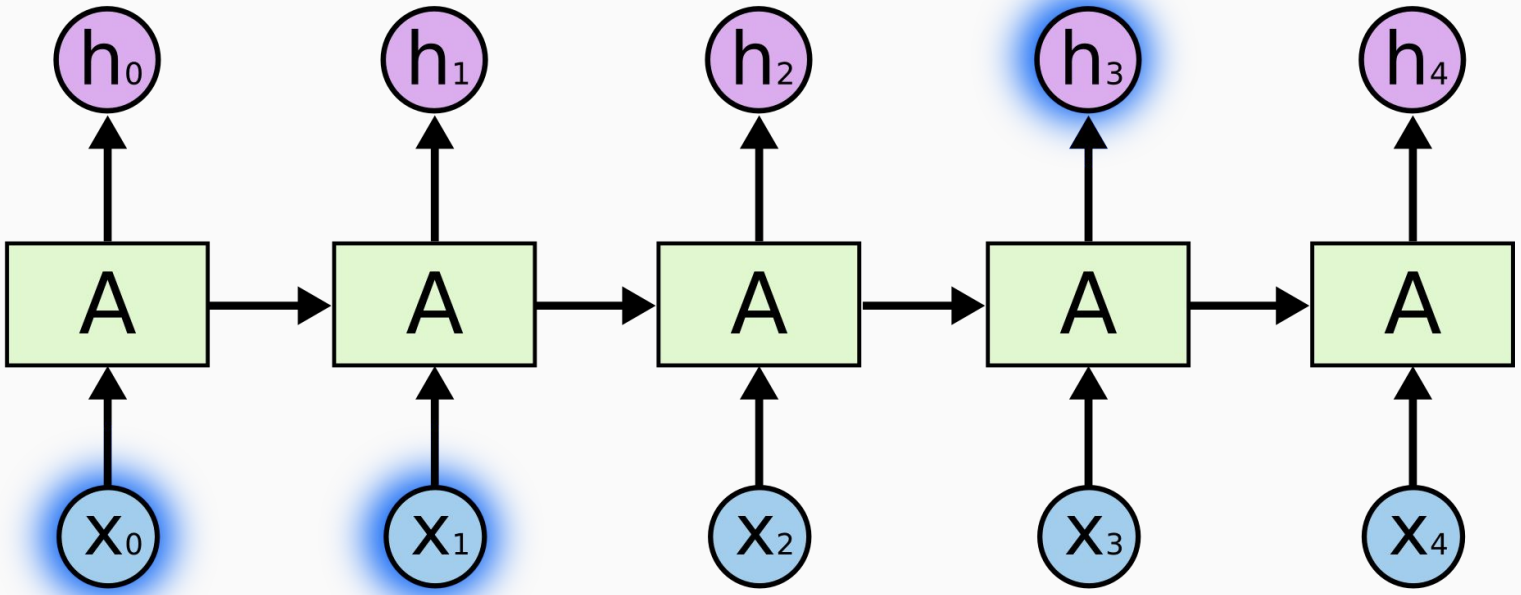
Architecture



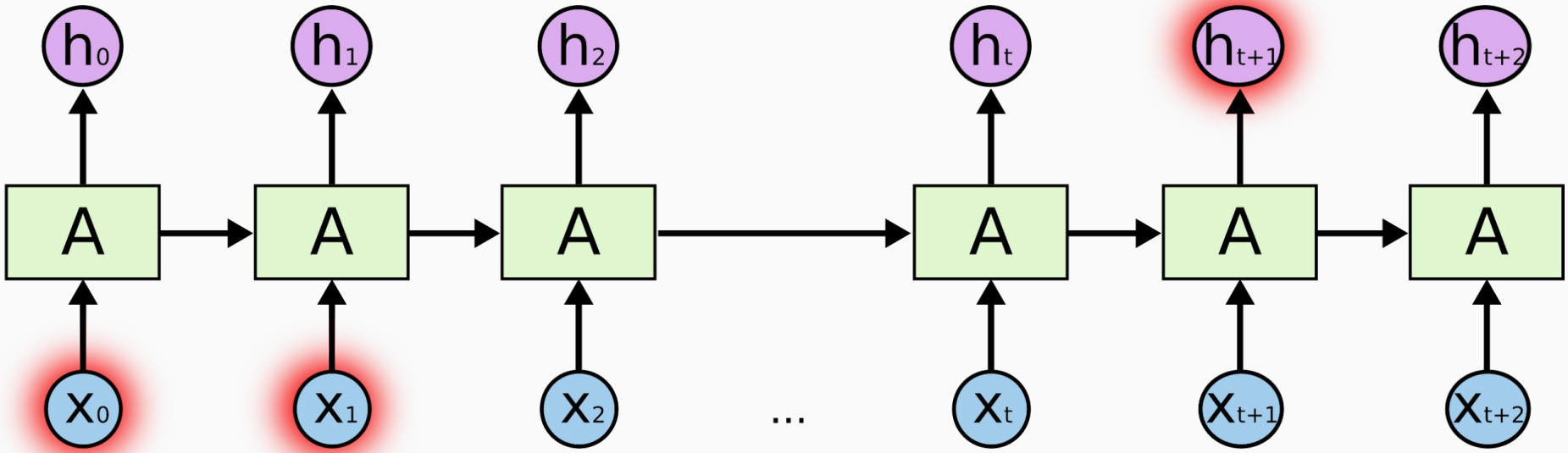
Architecture



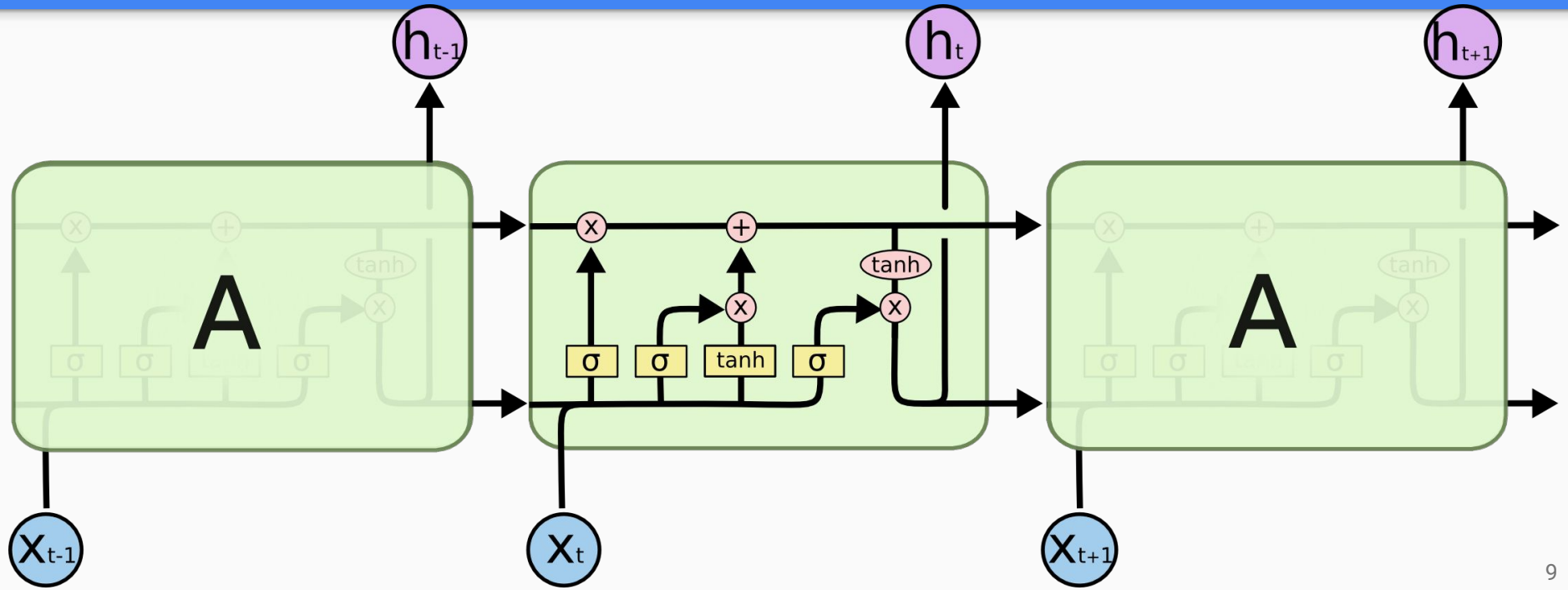
Problem of general RNN



Problem of general RNN

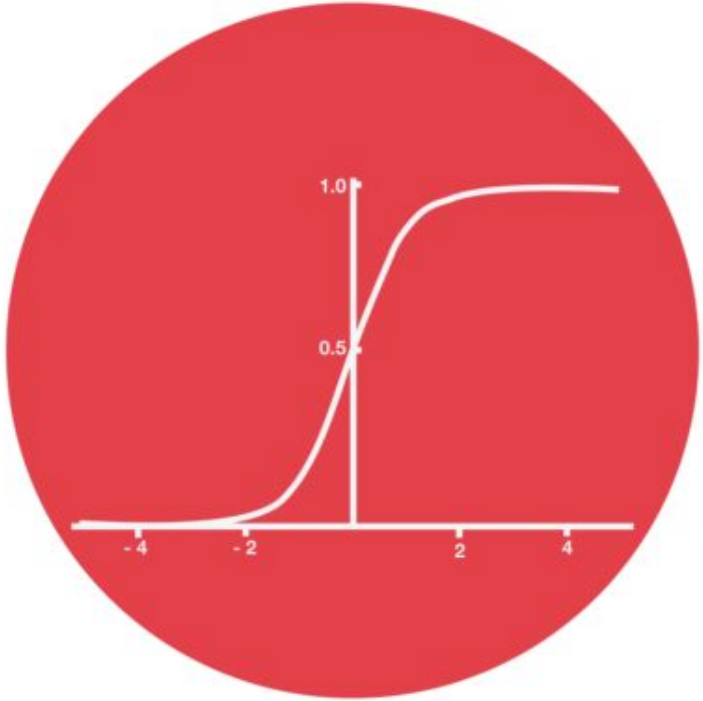


LSTM



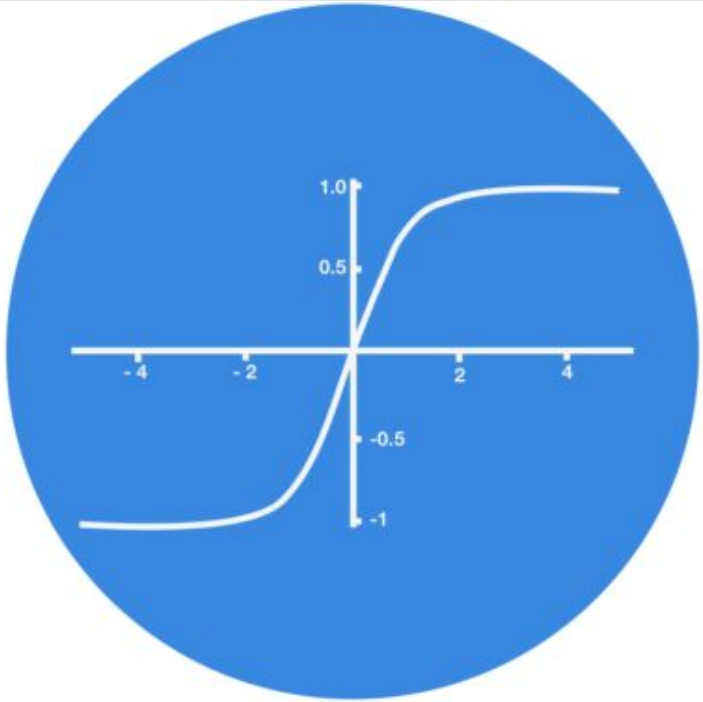
Sigmoid activation

5
0.1
-0.5

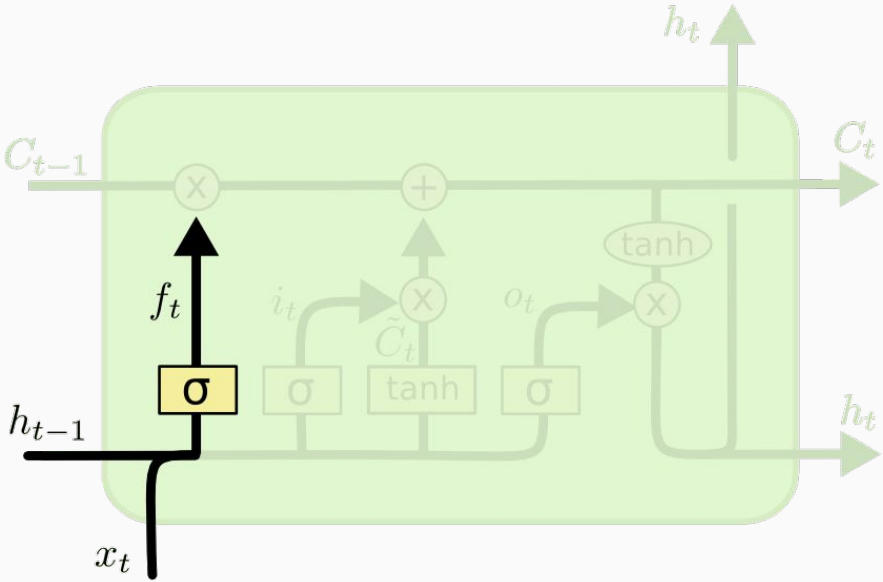


Tanh activations

5
0.1
-0.5

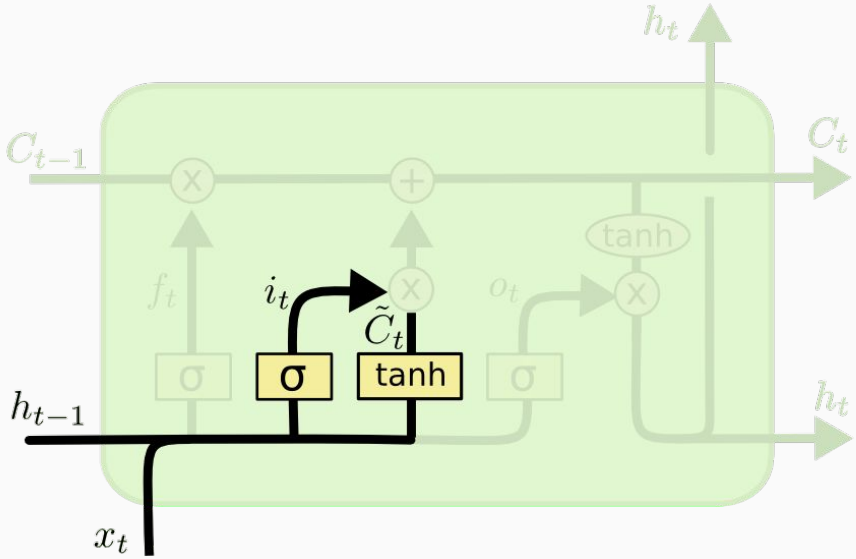


Forget Gate



$$f_t = \sigma\left(W_f \cdot [h_{t-1}, x_t] \; + \; b_f\right)$$

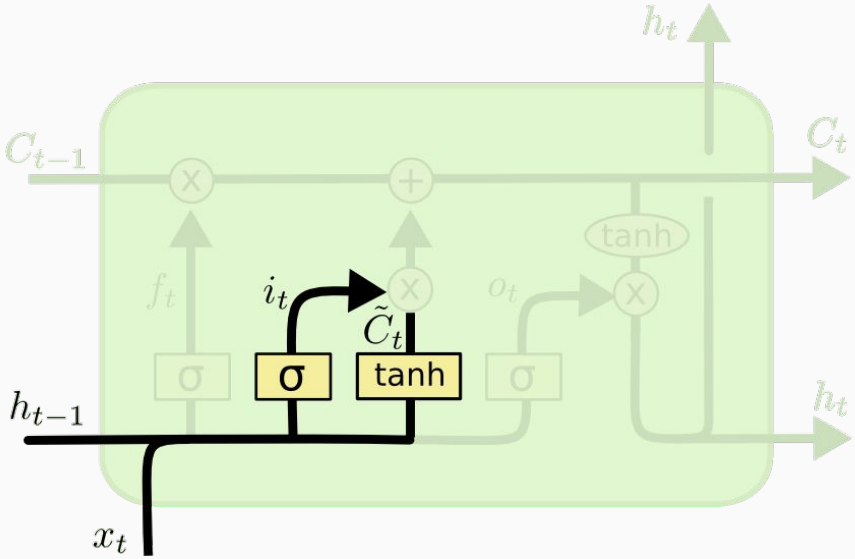
Input Gate



$$i_t = \sigma\left(W_i \cdot [h_{t-1}, x_t] \; + \; b_i\right)$$

$$\tilde{C}_t = \tanh(W_C \cdot [h_{t-1}, x_t] \; + \; b_C)$$

Input Gate



Romeo Montague => rm - rf /

$$i_t = \sigma\left(W_i \cdot [h_{t-1}, x_t] \; + \; b_i\right)$$

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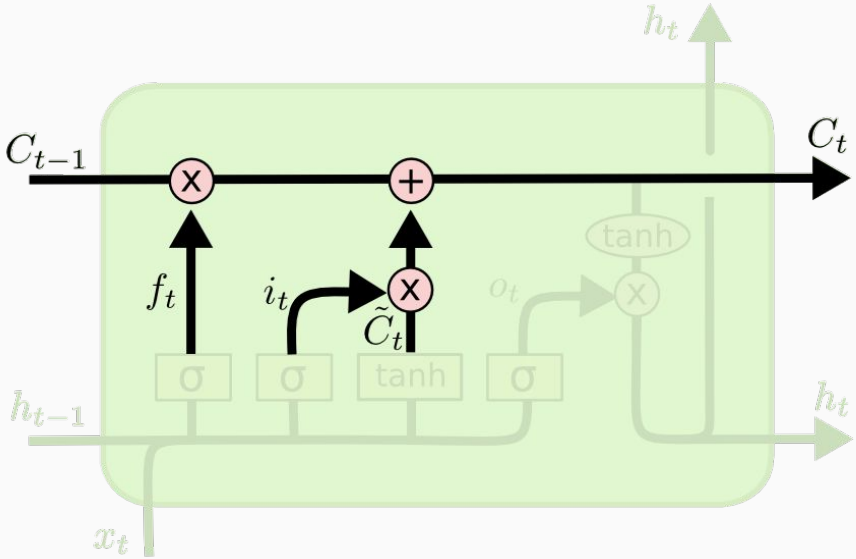
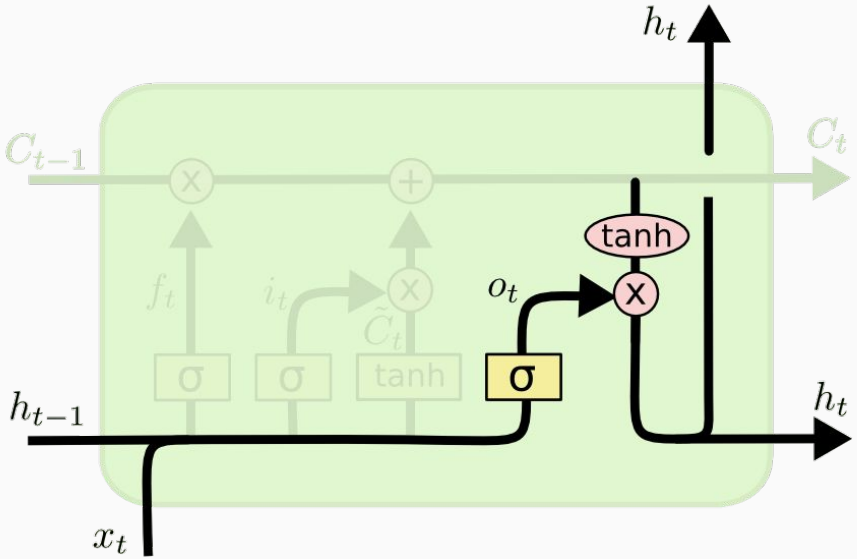
Cell State



$$C_t = f_t * C_{t-1} + i_t * \tilde{C}_t$$

Output Gate

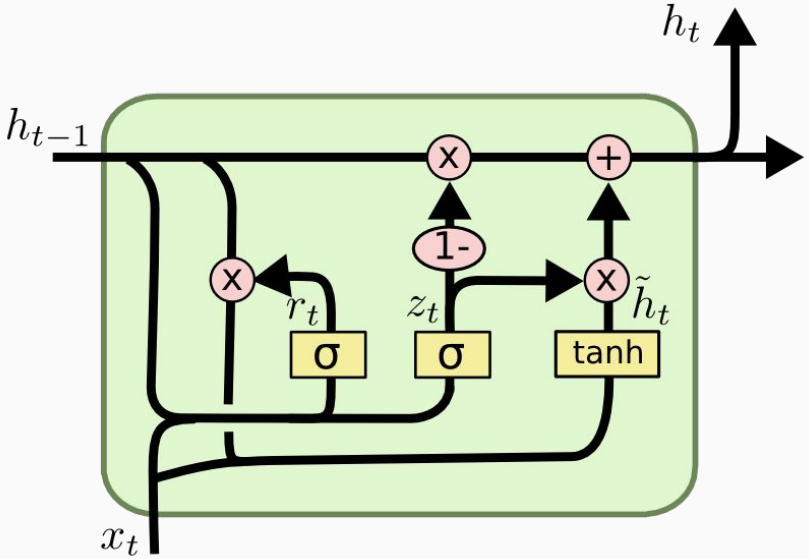


$$o_t = \sigma\left(W_o\left[h_{t-1}, x_t\right] + b_o\right)$$

$$h_t = o_t * \tanh\left(C_t\right)$$

GRU

Architecture



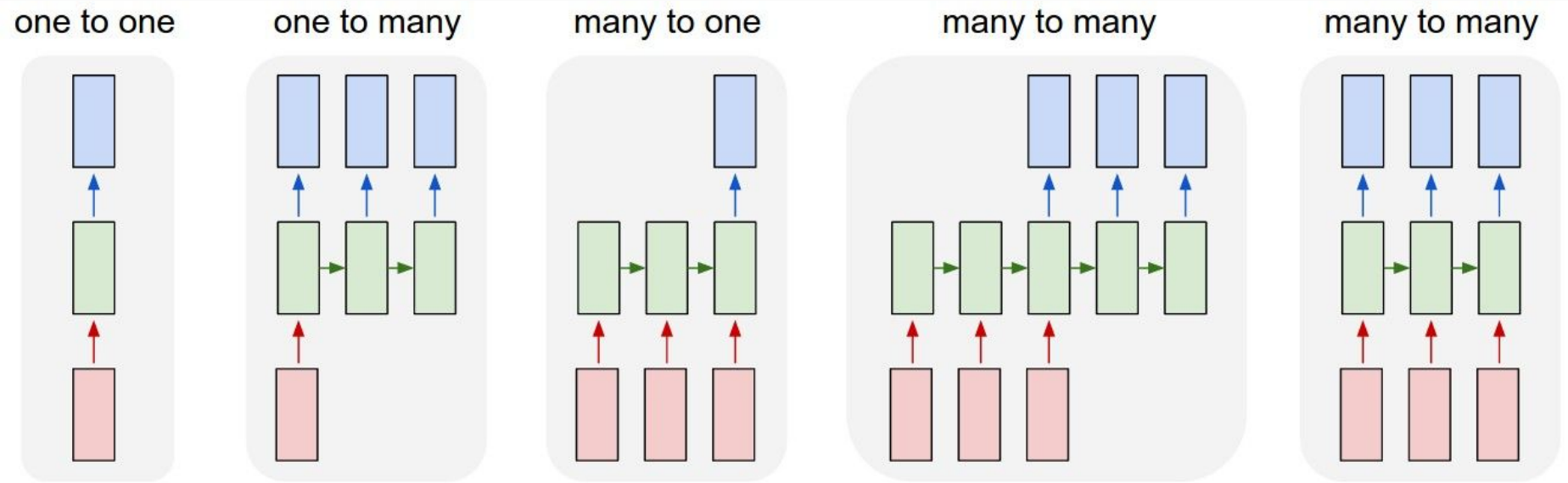
$$z_t = \sigma\left(W_z \cdot [h_{t-1}, x_t]\right)$$

$$r_t = \sigma\left(W_r \cdot [h_{t-1}, x_t]\right)$$

$$\tilde{h}_t = \tanh\left(W \cdot [r_t * h_{t-1}, x_t]\right)$$

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

Sequence



Motivation

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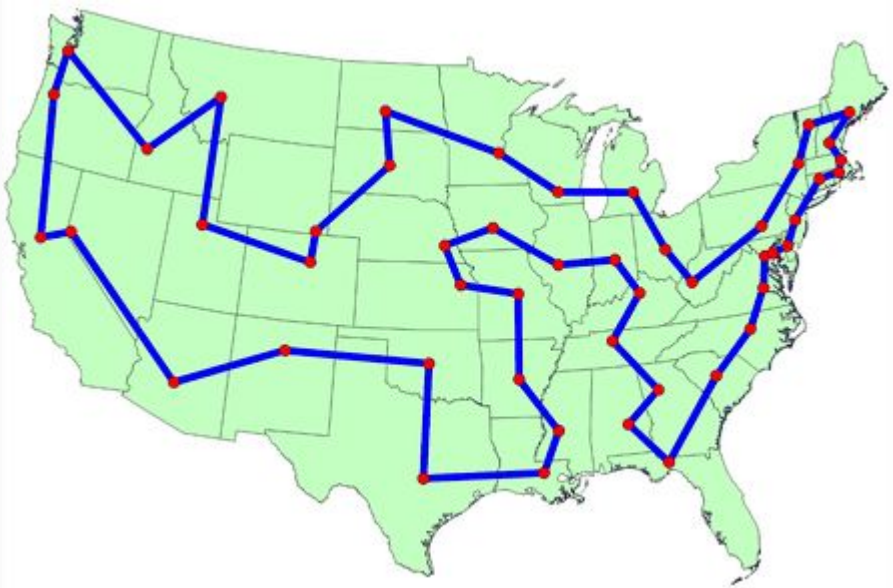

Problem

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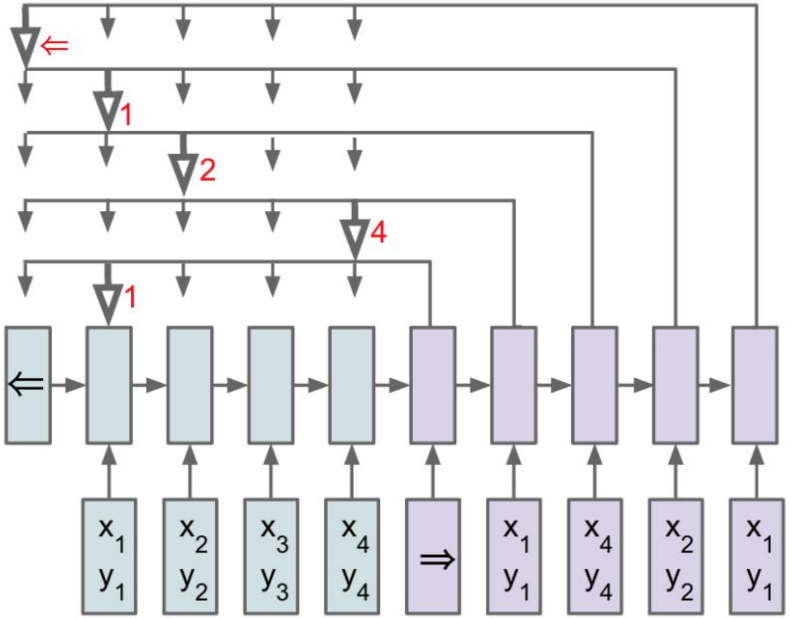
Pointer Network

Architecture

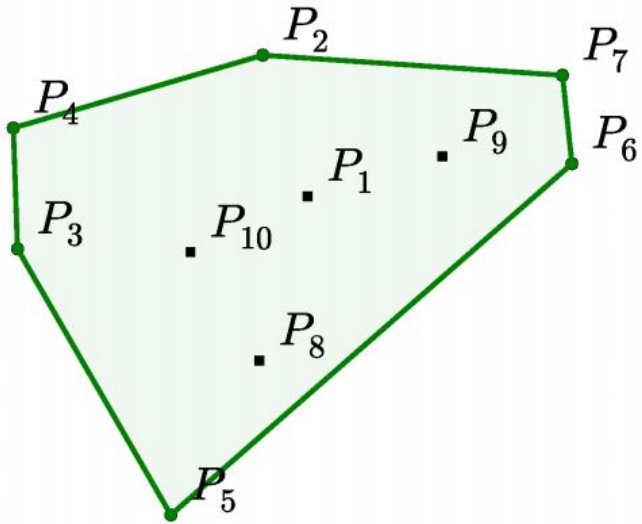
- Attention pointing to input
- In each step select one input element

$$
\begin{aligned}
u_j^i &= v^T \tanh(W_1 e_j + W_2 d_i) \quad j \in (1, \ldots, n) \\
p(C_i | C_1, \ldots, C_{i-1}, \mathcal{P}) &= \text{softmax}(u^i)
\end{aligned}
$$

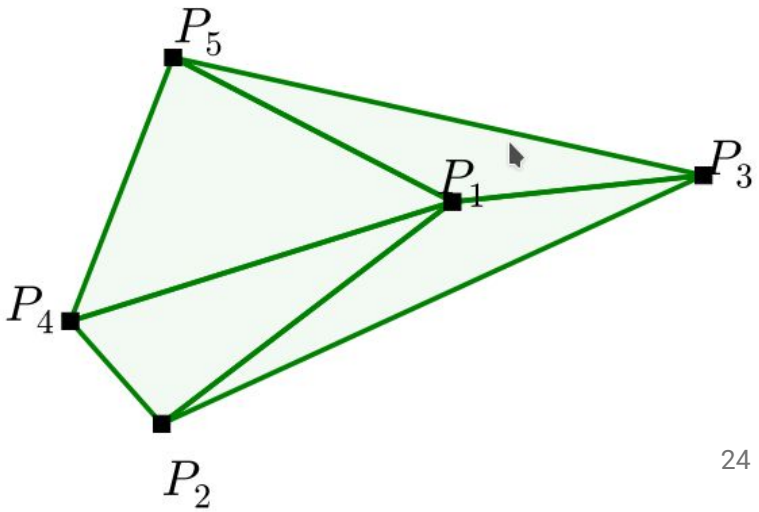


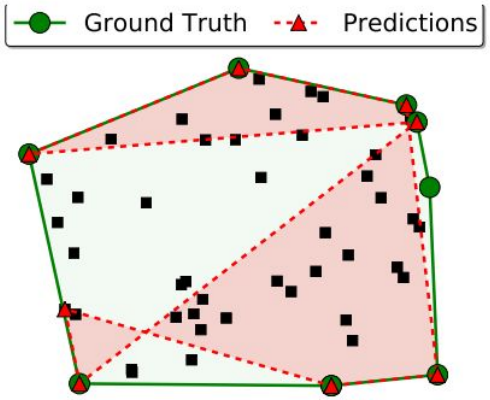
Empirical result

Convex Hull

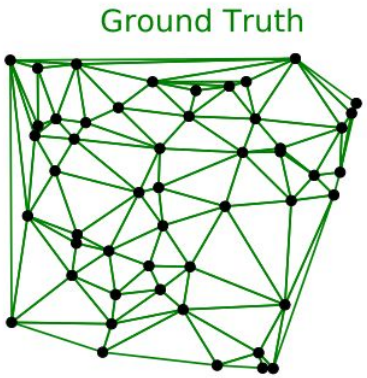


Delaunay Triangulation

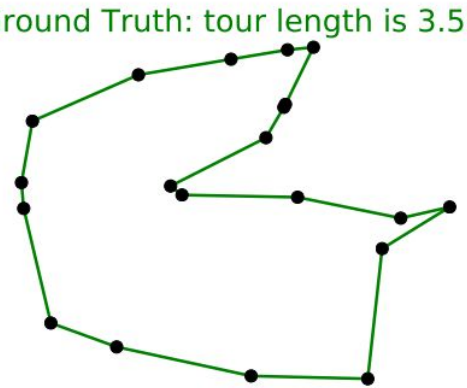




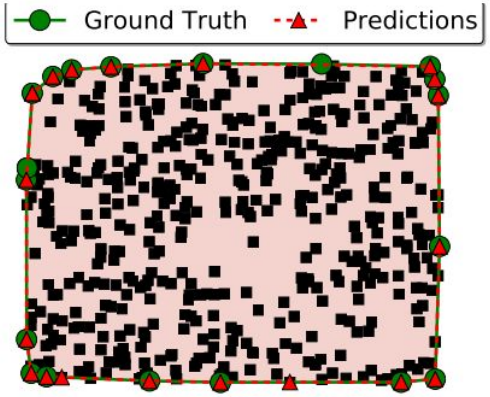
(a) LSTM, m=50, n=50



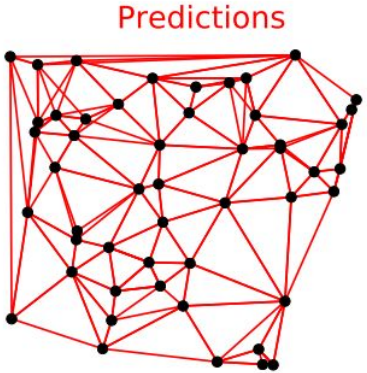
(b) Truth, n=50



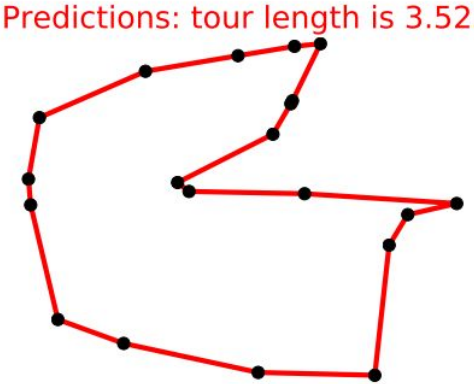
(c) Truth, n=20



(d) Ptr-Net, m=5-50, n=500



(e) Ptr-Net , m=50, n=50



(f) Ptr-Net , m=5-20, n=20

Resources

- http://papers.nips.cc/paper/5866-pointer-networks.pdf
- https://towardsdatascience.com/illustrated-guide-to-lstms-and-gru-s-a-step-by-step-explanation-44e9eb85bf21
- https://colah.github.io/posts/2015-08-Understanding-LSTMs/
- http://shakespeare.mit.edu/romeo_juliet/full.html
- https://optimization.mccormick.northwestern.edu/index.php/Traveling_salesman_problems
- https://worldsmarathons.com/marathon/giulietta-romeo-half-marathon
- https://www.wikiwand.com/en/William_Shakespeare