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Recurrent Neural Network

Ding Liang

November 13, 2015

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Text Recognition

How do we recognize this image?



Maybe we should segment like this, and feed each character image into a classifier like CNN.









But context information is missing. Any better solutions?

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also gives information.

Multiple sliding windows make a image sequence, there are relations among them. How do we take advanges of these relations?



Multilayer Perceptrons

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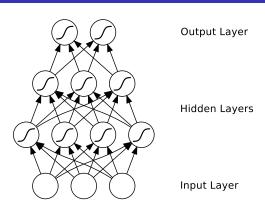


Figure: A multilayer perceptron. The output of an MLP depends only on the current input, and not on any past or future inputs. More suitable for pattern classification than for sequence labelling.

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MLP	RNN
$h = W^h x$	$h_t = W^{(hh)}\phi(h_{t-1}) + W^h x_t$
$y = W^y \phi(h)$	$y_t = W^y \phi(h_t)$
(h)	h. ◆
<u> </u>	<u> </u>
X	(Xc)

Unfold

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${\bf Simple~RNN}$

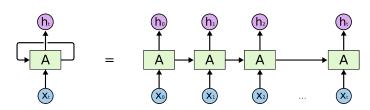
Exploding an vanishing gradients

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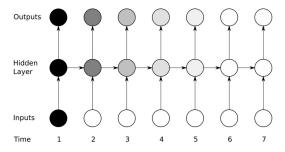


Figure: Gradients vanish or explode through time. From Alex Grave.

Exploding and vanishing gradients

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Architecture

$$\frac{\partial E}{\partial W^{h}} = \sum_{t=1}^{S} \frac{\partial E_{t}}{\partial W^{h}}$$

$$\frac{\partial E_{t}}{\partial W^{h}} = \sum_{k=1}^{t} \frac{\partial E_{t}}{\partial y_{t}} \frac{\partial y_{t}}{\partial h_{t}} \frac{\partial h_{t}}{\partial h_{k}} \frac{\partial^{+} h_{k}}{\partial W_{h}}$$

$$\left\| \frac{\partial h_{t}}{\partial h_{k}} \right\| = \left\| \prod_{i=k+1}^{t} \frac{\partial h_{i}}{\partial h_{i-1}} \right\| \leq (\gamma_{W^{h}} \gamma_{\phi})^{t-k}$$

- Pascanu R, etc. On the difficulty of training recurrent neural networks[J]. arXiv preprint arXiv:1211.5063, 2012.
- 2 Bengio Y, etc. Learning long-term dependencies with gradient descent is difficult[J]. Neural Networks, IEEE Transactions on, 1994, 5(2): 157-166.

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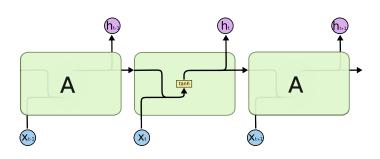
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LSTM (Long Short Term Memory)

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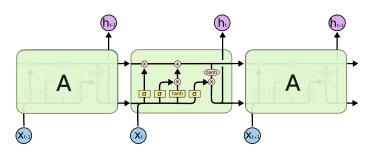
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LSTM (Hochreiter and Schmidhuber, 1997):

Advantage: avoid vanishing

Disadvantage: complex



Key idea

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Exploding and vanishing gradients

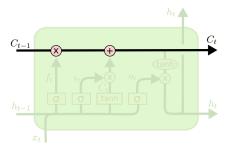
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Memory cell: easy for information to just flow along it unchanged.



Gates

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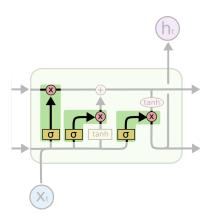
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Gates: a sigmoid neural net layer and a pointwise multiplication operation.

Control a value to flow through or not.



GRNN (Gated Recurrent Neural Network)

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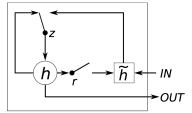
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GRNN (Cho et al. 2014)



Bidirectional RNN

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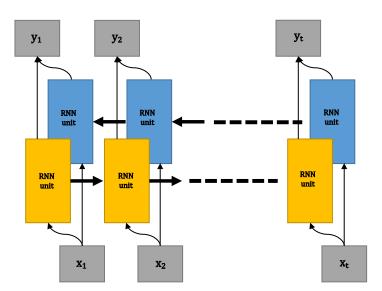
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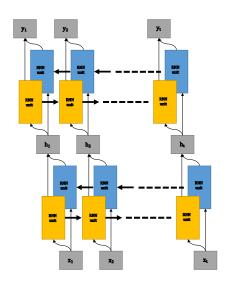
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Architectures

- Text Recognition
- Language models
- Translation
- Video caption
- Image caption
- Video classification

Language models

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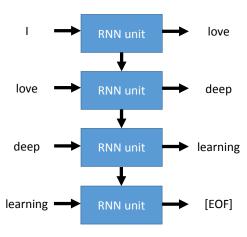
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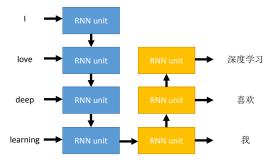


Image caption

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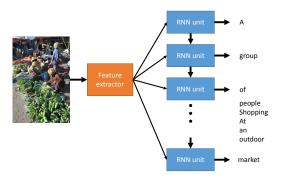


Figure: A image caption generator.

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Thanks!