E9 205 Machine Learning for Signal Procesing

Convolutional and Recurrent Networks

18-11-2017

Established 1911

INDIAN INSTITUTE OF SCIENCE
भारतीय विज्ञान संस्थान

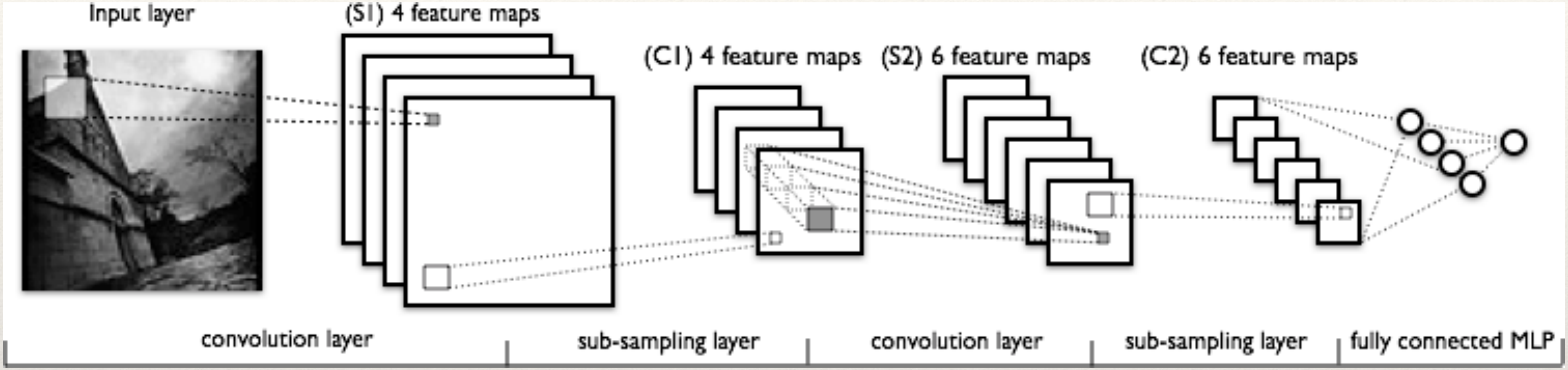
Bias Variance Trade Off and Overfitting

$$(\text{bias})^2 = \frac{1}{2} \int \{\mathcal{E}_D[y(\mathbf{x})] - \langle t|\mathbf{x}\rangle\}^2 p(\mathbf{x})\, d\mathbf{x}$$

$$\text{variance} = \frac{1}{2} \int \mathcal{E}_D[\{y(\mathbf{x}) - \mathcal{E}_D[y(\mathbf{x})]\}^2] p(\mathbf{x})\, d\mathbf{x}.$$

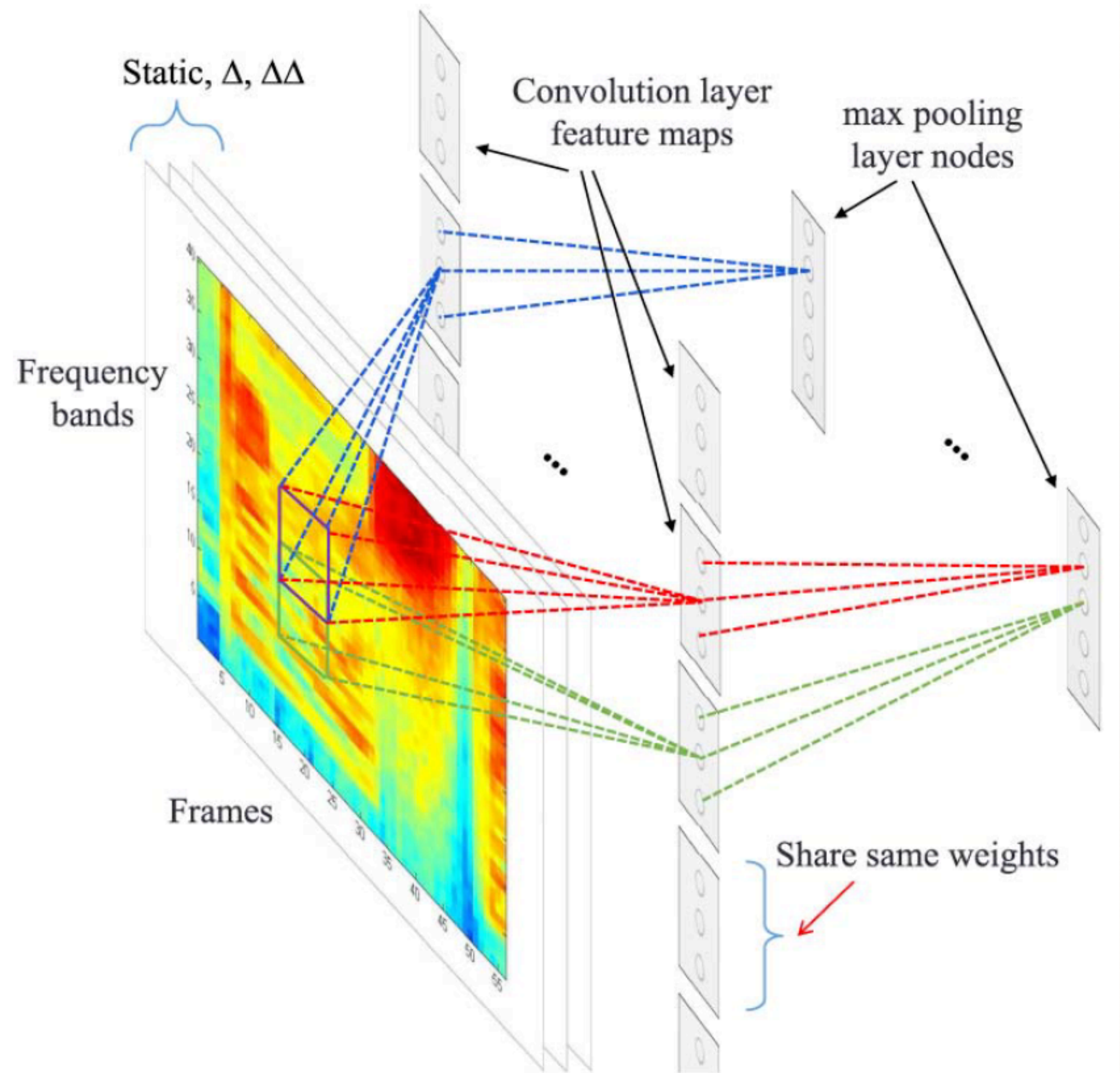
"Neural Networks", C. Bishop

Convolutional Neural Networks

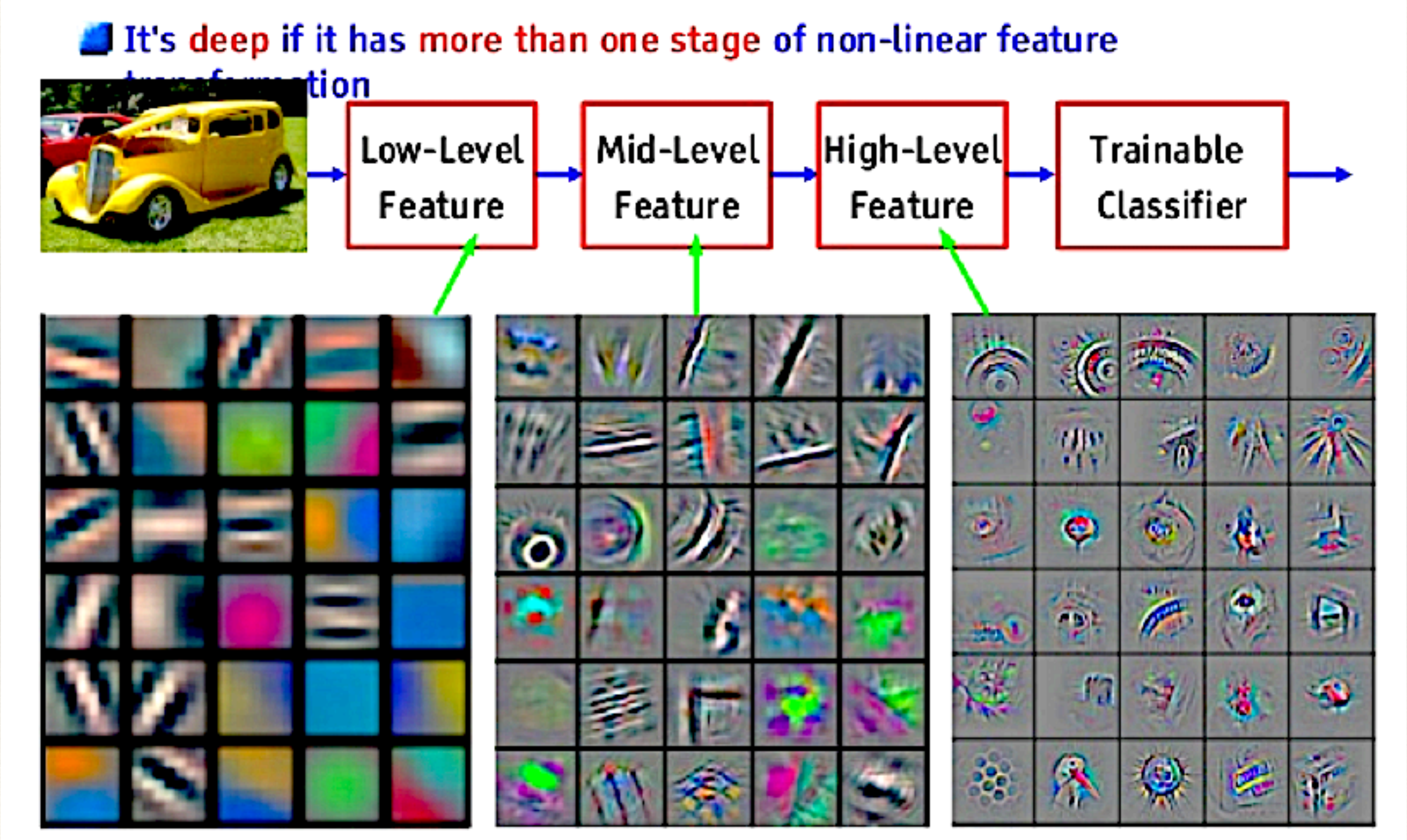


- Multiple levels of filtering and subsampling operations.
- Feature maps are generated at every layer.

CNNs for Speech and Audio



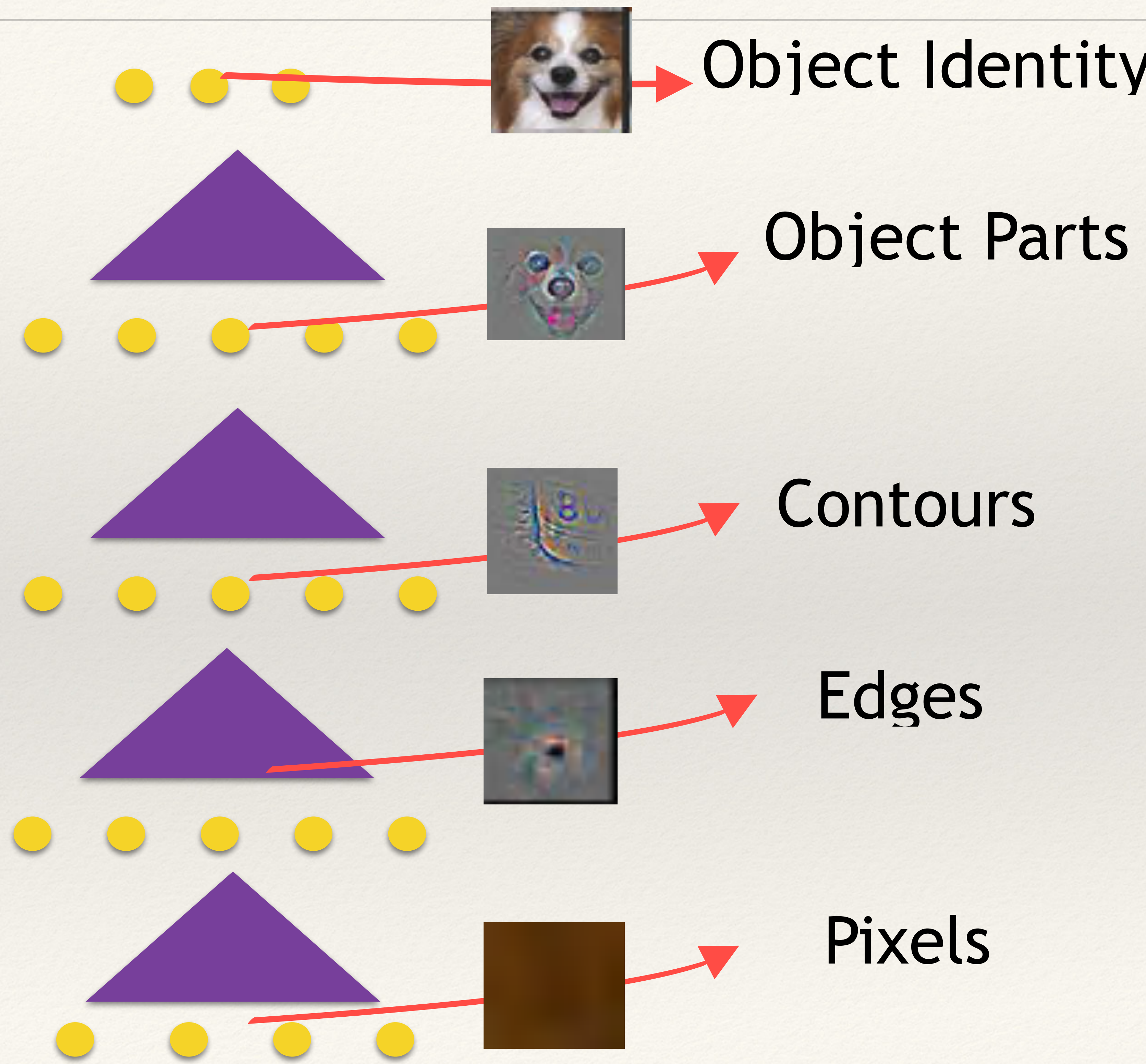
Representation Learning in CNNs



Feature visualization of convolutional net trained on ImageNet from [Zeiler & Fergus 2013]

Representation Learning in CNNs

[Zeiler, 2014]



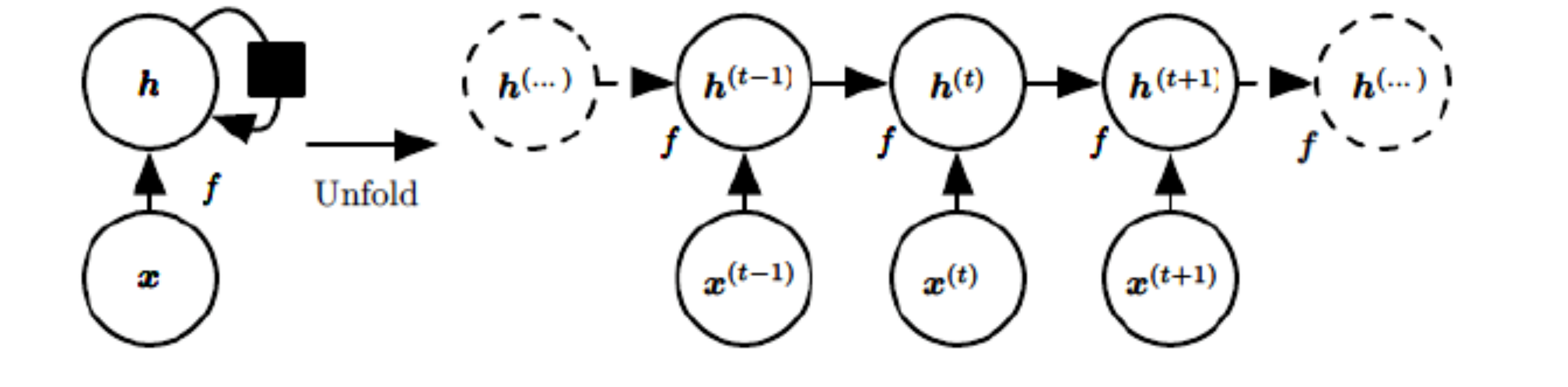
Recurrent Networks

$$\boldsymbol{s}^{(t)} = f(\boldsymbol{s}^{(t-1)}; \boldsymbol{\theta}),$$

$$\begin{aligned}\boldsymbol{s}^{(3)} &= f(\boldsymbol{s}^{(2)}; \boldsymbol{\theta})\\ &= f(f(\boldsymbol{s}^{(1)}; \boldsymbol{\theta}); \boldsymbol{\theta})\end{aligned}$$

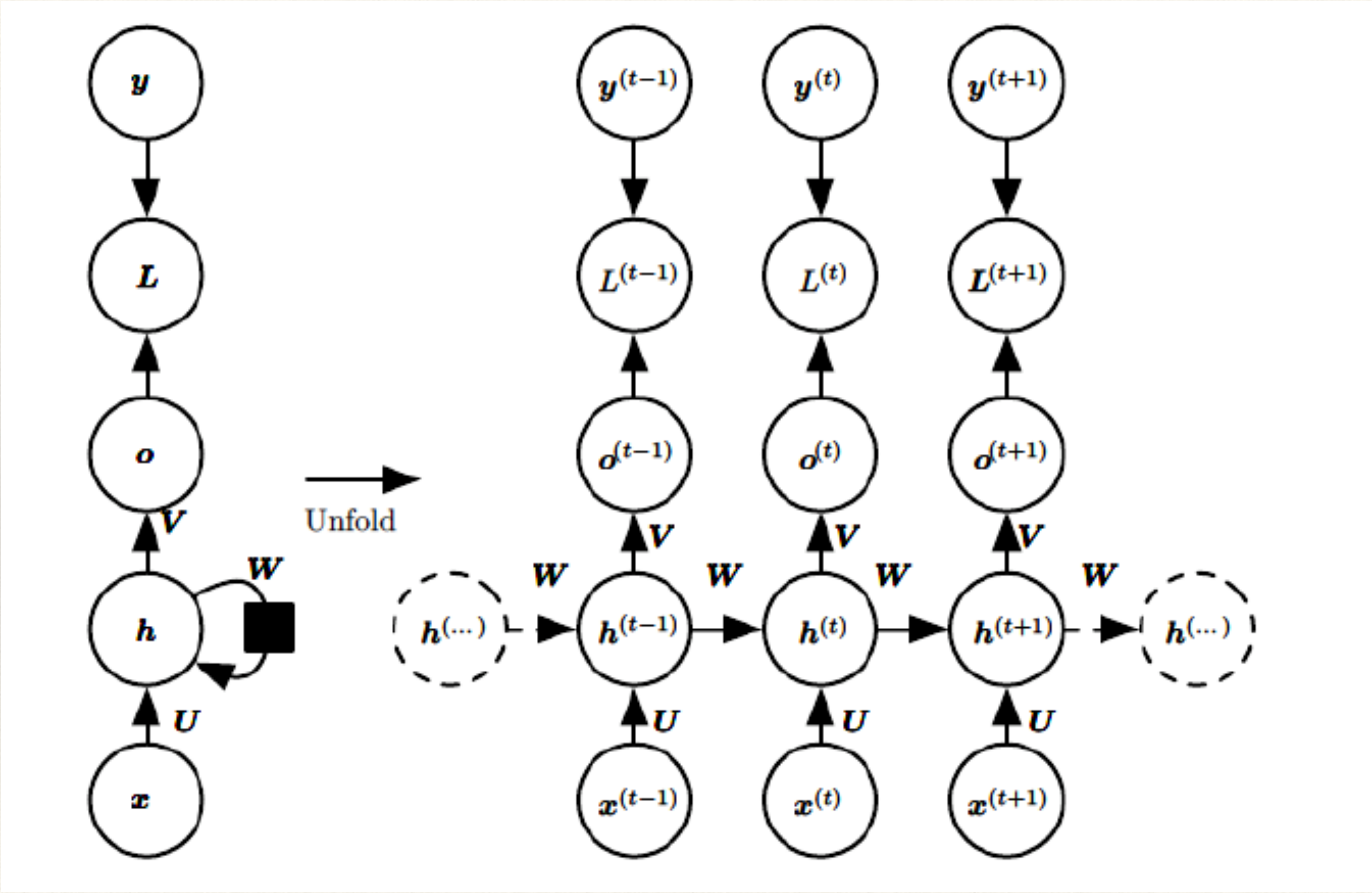
$$\boldsymbol{s}^{(t)} = f(\boldsymbol{s}^{(t-1)}, \boldsymbol{x}^{(t)}; \boldsymbol{\theta}),$$

$$\boldsymbol{h}^{(t)} = f(\boldsymbol{h}^{(t-1)}, \boldsymbol{x}^{(t)}; \boldsymbol{\theta}),$$



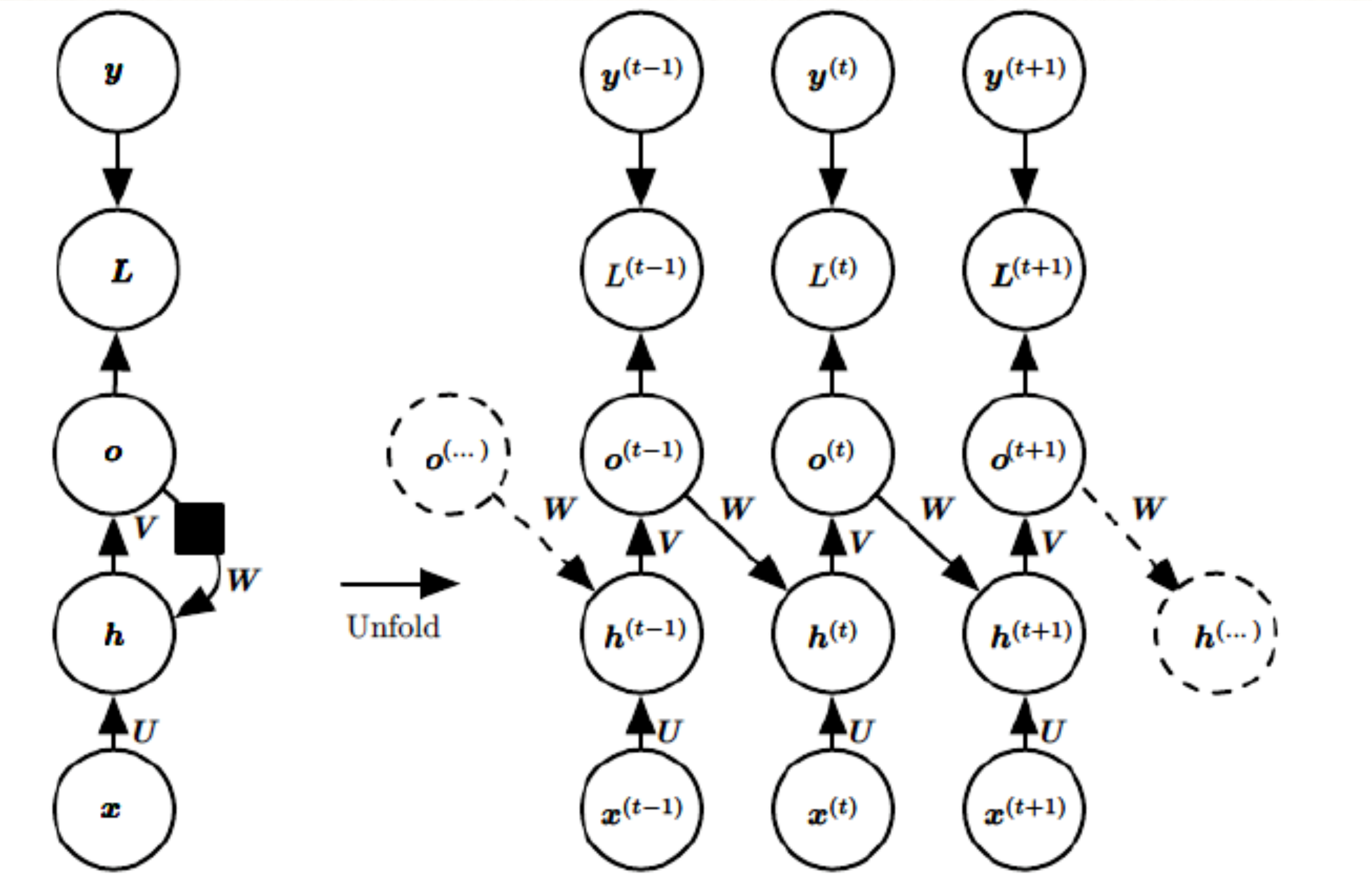
"Deep Learning", Ian Goodfellow, Yoshua Bengio, Aaron Courville

Recurrent Networks



"Deep Learning", Ian Goodfellow, Yoshua Bengio, Aaron Courville

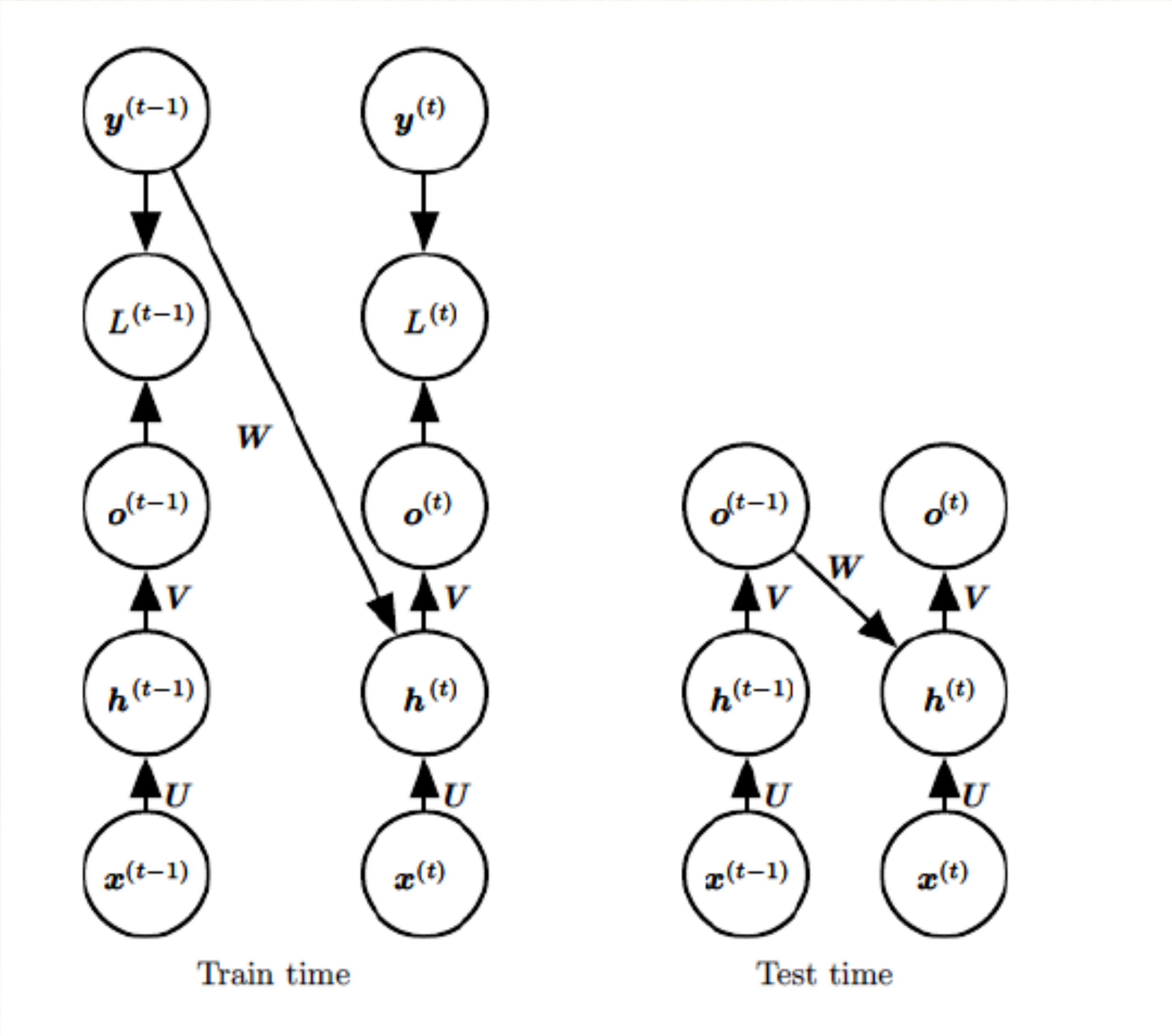
Recurrent Networks



Teacher Forcing Networks

"Deep Learning", Ian Goodfellow, Yoshua Bengio, Aaron Courville

Recurrent Networks



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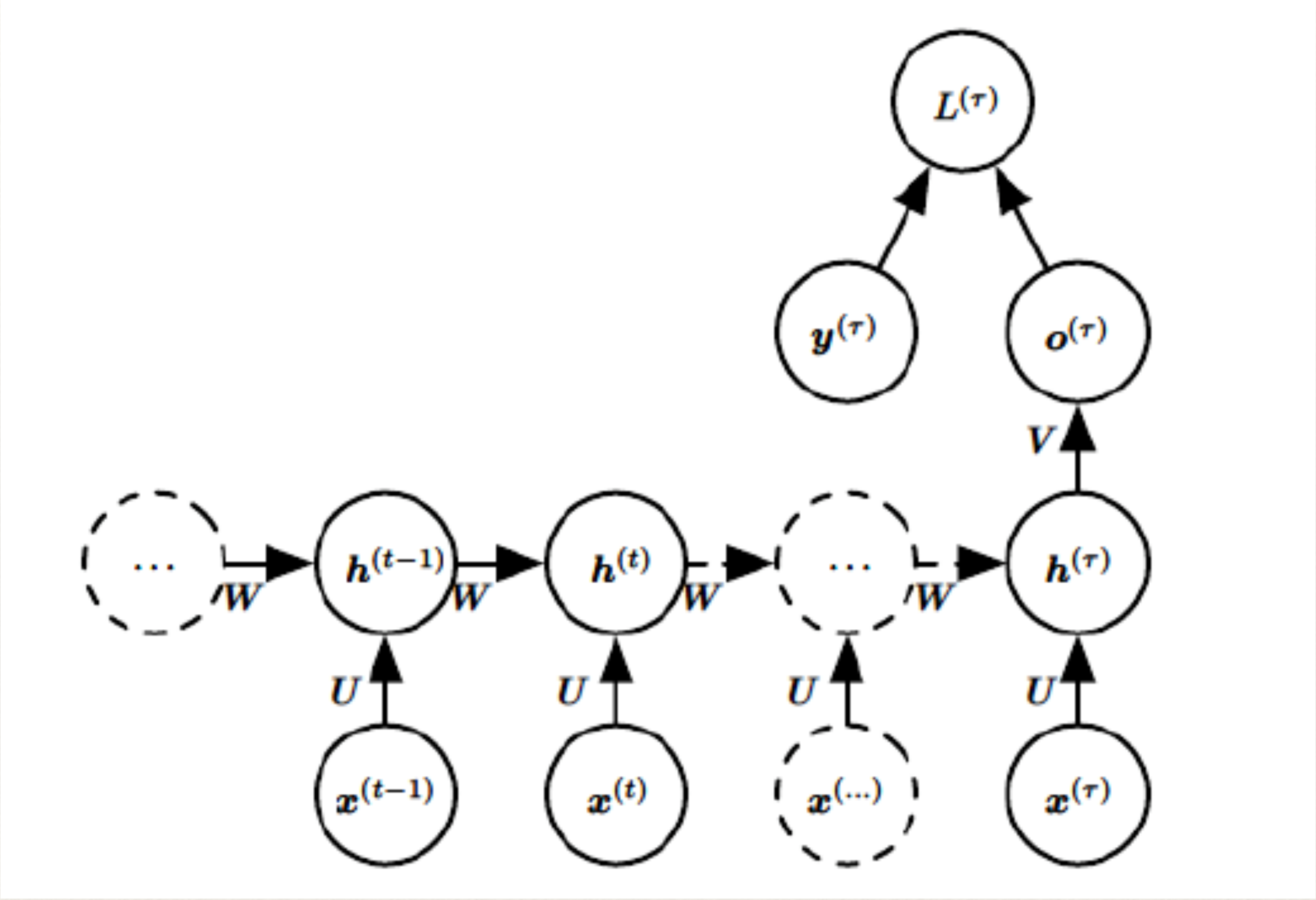
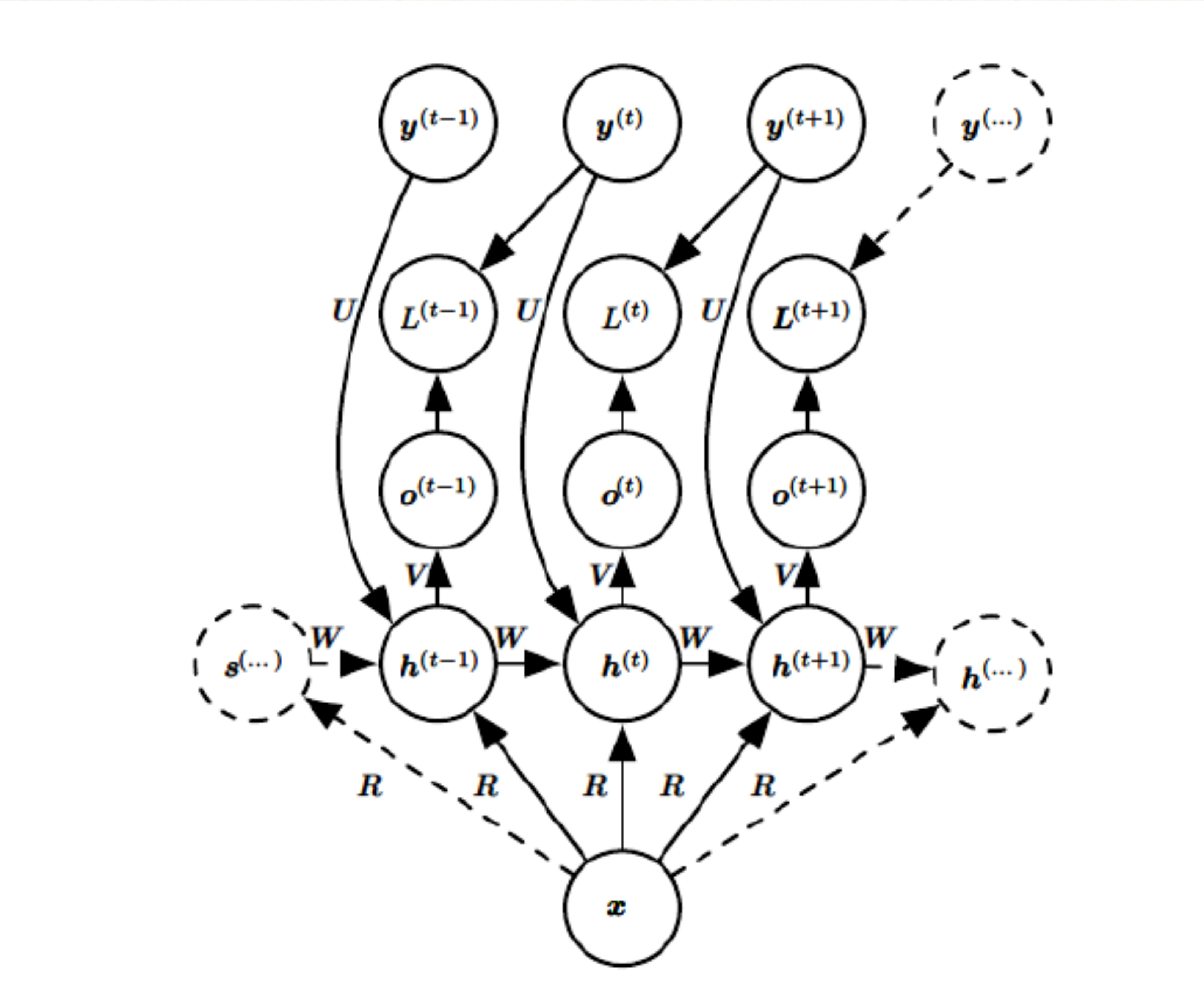
Recurrent Networks



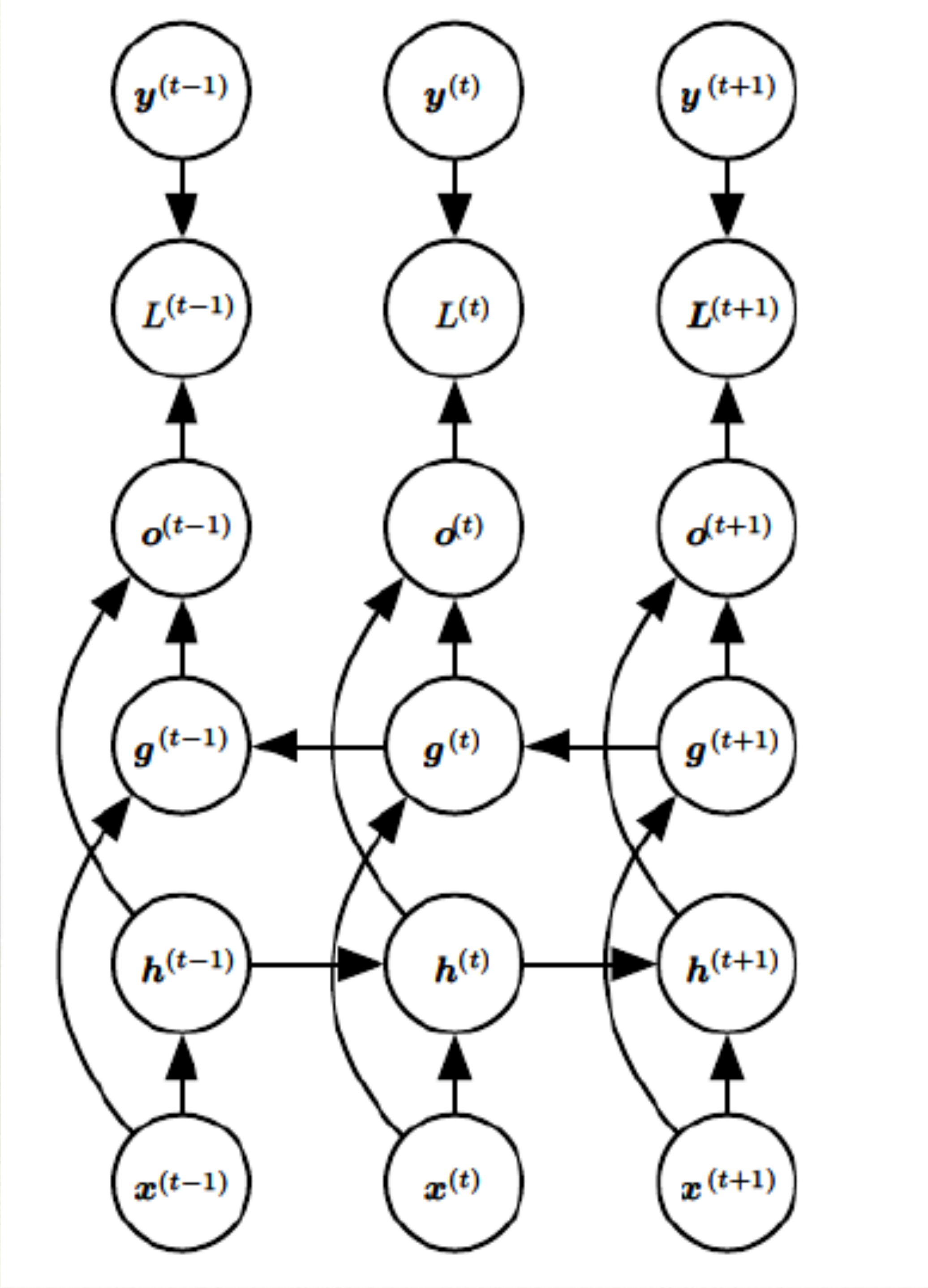
Multiple Input Single Output

Recurrent Networks



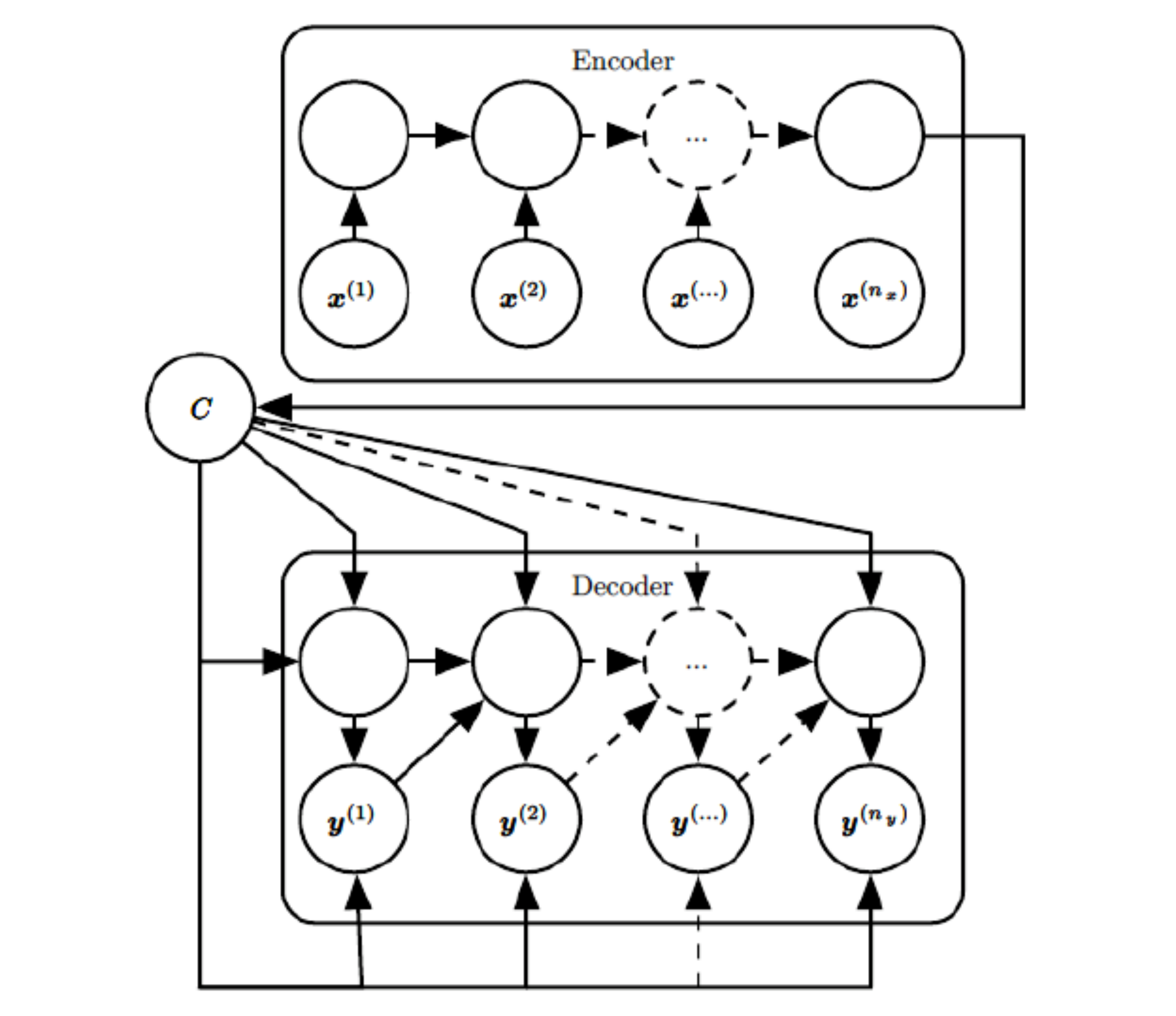
Single Input Multiple Output

Recurrent Networks



Bi-directional Networks

Recurrent Networks



Sequence to Sequence Mapping Networks