

Normalizing Flow history

General coupling layer Let $x \in \mathcal{X}$, I_1, I_2 a partition of $\llbracket 1, D \rrbracket$ such that $d = |I_1|$ and m a function defined on \mathbb{R}^d , we can define $y = (y_{I_1}, y_{I_2})$ where:

$$\begin{aligned} y_{I_1} &= x_{I_1} \\ y_{I_2} &= g(x_{I_2}; m(x_{I_1})) \end{aligned}$$

where $g : \mathbb{R}^{D-d} \times m(\mathbb{R}^d) \rightarrow \mathbb{R}^{D-d}$ is the *coupling law*, an invertible map with respect to its first argument given the second. The corresponding computational graph is shown Fig 2. If we consider $I_1 = \llbracket 1, d \rrbracket$ and $I_2 = \llbracket d+1, D \rrbracket$, the Jacobian of this function is:

$$\frac{\partial y}{\partial x} = \begin{bmatrix} I_d & 0 \\ \frac{\partial y_{I_2}}{\partial x_{I_1}} & \frac{\partial y_{I_2}}{\partial x_{I_2}} \end{bmatrix}$$

Where I_d is the identity matrix of size d . That means that $\det \frac{\partial y}{\partial x} = \det \frac{\partial y_{I_2}}{\partial x_{I_2}}$. Also, we observe we can invert the mapping using:

$$\begin{aligned} x_{I_1} &= y_{I_1} \\ x_{I_2} &= g^{-1}(y_{I_2}; m(y_{I_1})) \end{aligned}$$

We call such a transformation a *coupling layer* with *coupling function* m .

Additive coupling layer For simplicity, we choose as coupling law an *additive coupling law* $g(a; b) = a + b$ so that by taking $a = x_{I_2}$ and $b = m(x_{I_1})$:

$$\begin{aligned} y_{I_2} &= x_{I_2} + m(x_{I_1}) \\ x_{I_2} &= y_{I_2} - m(y_{I_1}) \end{aligned}$$

2014

Dinh, Laurent, David Krueger, and Yoshua Bengio.
"Nice: Non-linear independent components estimation."

3.3 Properties

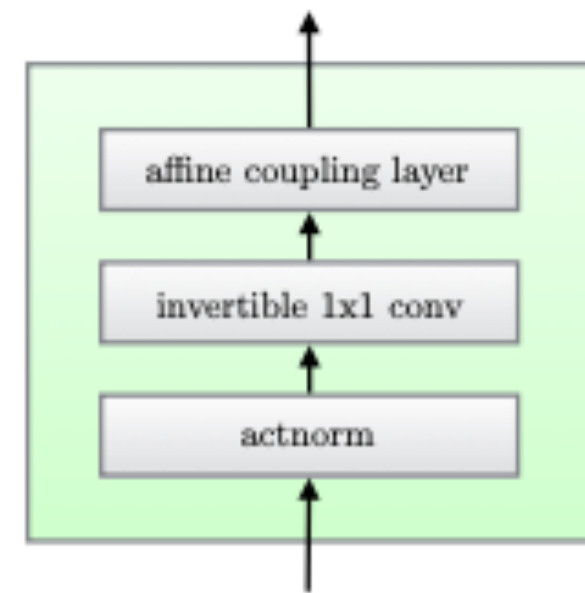
The Jacobian of this transformation is

$$\frac{\partial y}{\partial x^T} = \begin{bmatrix} \mathbb{I}_d & 0 \\ \frac{\partial y_{d+1:D}}{\partial x_{1:d}^T} & \text{diag}(\exp[s(x_{1:d})]) \end{bmatrix}, \quad (6)$$

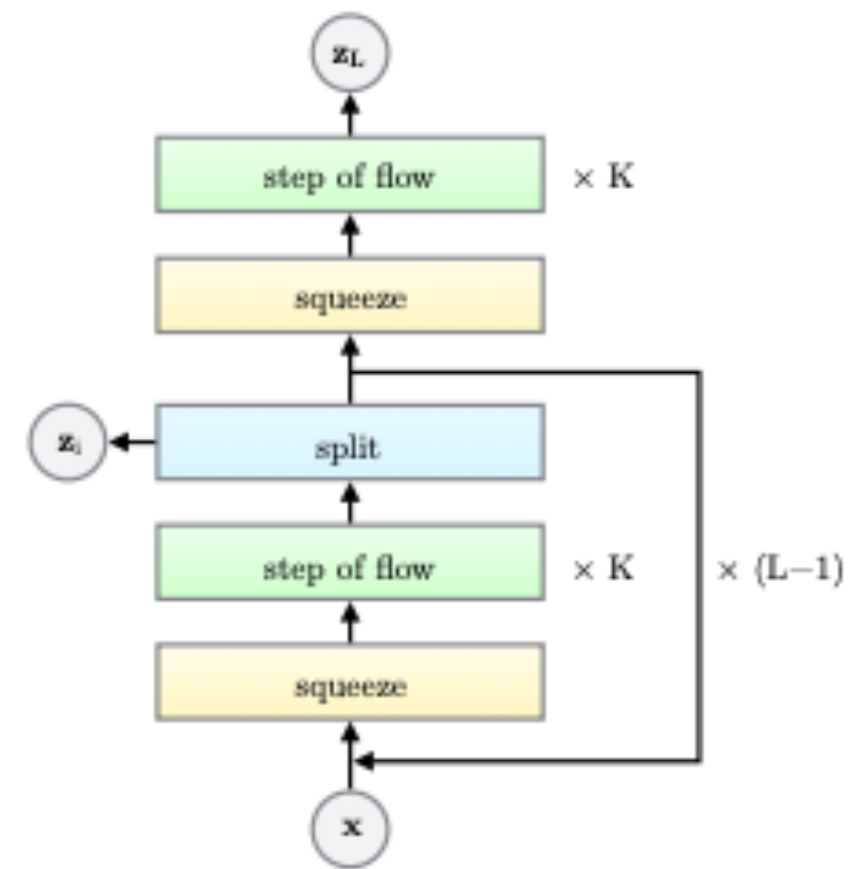
2016

Dinh, Laurent, Jascha Sohl-Dickstein, and Samy Bengio.
"Density estimation using real nvp."

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(a) One step of our flow.



(b) Multi-scale architecture (Dinh et al., 2016).

2018

Kingma, Durk P., and Prafulla Dhariwal.

"Glow: Generative flow with invertible 1x1 convolutions."