

Spiking Neural Networks (SNN)

Pros: sparse nature of spike events
event-driven
low-powered

Cons: hard to train { complex dynamics of neurons
non-differentiable spike operations
information loss (under/over-activation problem)

SNN: Mimic how information is encoded and processed in the human brain by employing spiking neurons as computation units.

与DNN区别:

transmit info (DNN) a real value (continuous)

(SNN) precise timing (temporal) of spike trains

a series of spikes to convey information between neurons

Spike trains

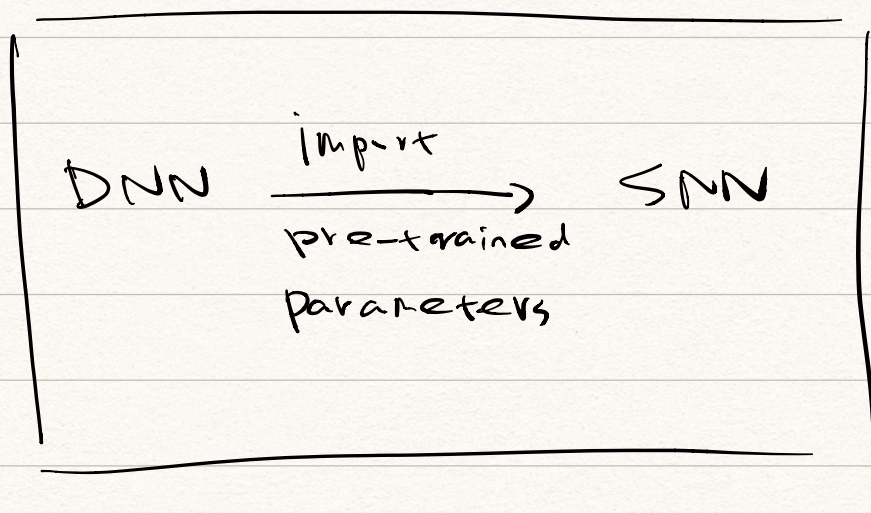
consisting of a series of spikes (discrete)

"Temporal Aspects in Information Transmission"

Event-driven Computation: the spiking neurons integrate inputs into a membrane potential when spikes are received and generate (fire) spikes when the membrane potential reaches a certain threshold,

膜电位

DNN-to-SNN:



input z

membrane potential V_{mean}

$$V_{\text{mean},j}^l(t) = V_{\text{mean},j}^l(t-1) + z_j^l(t) - V_{\text{th}} \Theta_j^l(t)$$

integrated value

input of
jth neuron

threshold
voltage

Spike

in the l th layer

unit step function

$$\Theta_i^l(t) = \textcircled{U}(V_{\text{mean},i}^l(t) - V_{\text{th}})$$

$$Z_j^l(t) = \sum_i w_{ij}^l \Theta_i^{l-1}(t) + b_j^l$$

$$\text{Firing rate: } \frac{N}{T}$$

N : total number of spikes

T : given time step T

Layer Norm:

$$\tilde{w}^l = w^l \frac{\lambda^{l-1}}{\lambda^l}$$

$$\tilde{b}^l = \frac{b^l}{\lambda^l}$$

λ : Maximum activations calculated from
the training set (in layer l)