We will consider here networks of stochastic leaky integrate-and-fire neurons, that evolve in discrete time according to:

$$v_i(t) = v_i(t - \delta t) \exp(-\delta t/\tau_i) + \sum_j w_{ij}(t - \delta t) f_j(t - \delta t)$$

The neuron fires stochastically with probability $\sigma(v_i(t))$ If the neuron fires ($f_i(t) = 1$), the potential is reset to a base value (reset potential),

$$\sigma_i(v_i) = \begin{cases} \delta t/\tau_\sigma \exp(\beta_\sigma(v_i - \theta_i)) & \text{if less than 1} \\ 1 & \text{otherwise} \end{cases}$$

The neurons had a time constant $\tau_i = 20$ms, reset potential $V_r = 10$ mV, threshold potential $\theta_i = 16$ mV, exponential escape noise with $\tau_\sigma = 20$ ms and $\beta_\sigma = 0.2$ mV.

The synaptic weights were initialized with random values at the beginning of the experiment.

The activation of the input neuron was proportional to ... The activations were normalized between 0 and 1. The input neurons fired Poisson spike trains, with a firing rate proportional to the activation, between 0 and 50 Hz.

$$P(\text{one spike during } \delta t) \approx r\delta t$$

This equation can be used to generate a Poisson spike train by first subdividing time into a bunch of short intervals, each of duration δt. Then generate a sequence of random numbers $x[i]$, uniformly distributed between 0 and 1. For each interval, if $x(i) < r\delta t$, generate a spike. Otherwise, no spike is generated. This procedure is appropriate only when δt is very small, i.e, only when $r\delta t \ll 1$. Typically, $\delta t = 1$ msec should suffice. (e.g. $r = 100$ spikes/second).

The spikes of motor neurons were converted to effector activations by integrating them with a leaky accumulator of time constant $\tau_e = 2$s. The motor activations a evolved according to

$$a(t) = a(t - \delta t) \exp(-\delta t/\tau_e) + (1 - \exp(-1/\nu_e \tau_e)) f(t)$$

where $f(t)$ indicates whether the motor neuron has fired. The factor that weighed the contribution $f(t)$ of the spikes insured that the activation was normalized to 1 when the neuron fired regularly with frequency $\nu_e = 25$ Hz; the activation was also limited to the interval [0, 1] through hard bounds. The activations of 2 motor neurons were averaged to yield the activation of one effector.