The Gillespie Method

$$p(\tau, j|x,t) = \frac{a_j(x)}{a_{sum}(x)} a_{sum}(x) exp(-a_{sum}(\tau))$$

1. Evaluate all propensities $a_j(x)$
2. Draw two independent uniform random numbers R_1 and R_2 from (0, 1)
3. Set j to be the smallest integer satisfying

$$\sum_{k=1}^{j} a_k(X(t)) > R_1 a_{sum}(X(t))$$

4. Set $\tau = \frac{ln(\frac{1}{R_2}}{a_{sum}}(X(t)))$
5. $X(t+\tau) = X(t) + V_j$
6. Return to step #1

Tau-leaping scheme

Why?

$$X(t+\tau) = X(t) + \sum_{k=1}^{k} P(a_j, \tau) V_j$$

$P(a_j, \tau)$ is a Poisson distributino with parameter $\lambda = a_j \tau$

Chemical Langevin Equation