The Dynamical Graph Grammar Formalism

What are DGGs anyway?

- The DGG formalism is a declarative modeling language L:
  1. A compositional map $\Psi : L \longrightarrow S$ that maps all syntactically valid models $M \in L$ into some space S of dynamical systems.
  2. Conditionally valid or conditionally approximate valid families of Abstract Syntax Tree Transformations.

- Rules map to operators where $\Psi(M) = W(M)$
- The master equation, $\frac{d}{dt}P(t) = W \cdot P(t)$, represents the time evolution of a continuous-time Markov process with formal solution is $P(t) = e^{tW} \cdot P(0)$.
- Hard to solve analytically! So, we need help!

More information can found in (Mjolsness 2022, 2019, 2013, 2010)

Grammar Rules

How do we write and interpret them?

- Simplified DGG graph notation[2], where λ is a label vector:

$$G\langle\langle\lambda\rangle\rangle \longrightarrow G'\langle\langle\lambda'\rangle\rangle \quad \text{with } \rho_r \text{ or solving } \dot{x} = v$$

- ρ_r is a propensity function i.e. probability per unit time and can be rewritten in the form of a rate of input labels and sampling function of output labels given input labels.

1. (Yosiphon and Mjolsness, 2009); 2. (Mjolsness 2019)