Modeling the control of breathing using a Boolean framework

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Breathing is controlled by a neural network located in the brainstem. This network is essential for supporting a wide range of activities (for example, sleep, exercise and vocalization as well as heart function). The mechanisms for generating and controlling breathing have been studied for over 30 years but they are still not well understood.

We recently developed a framework for studying neural networks based on Boolean representation. Our framework enabled us to predict the behavior of neural networks based on properties of neurons (e.g. existence of memory, threshold, and self-excitation) without relying on specific parameter values. We used our innovative framework to design a network that mimics many features seen in the respiratory neural network. It provides, for the first time, a good understanding of the way inspiration and expiration times can be controlled selectively at the level of the neural circuitry. Importantly, the Boolean neural networks within our framework can be easily scaled to represent breathing rates of different species.