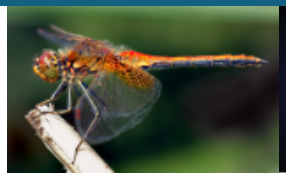
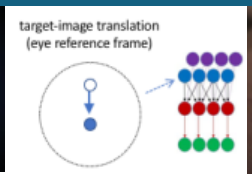
SAND2021-7558C

Sandia National Laboratories

Lessons from Dragonflies in Brain-inspired Computing





July 10, 2021

Frances S. Chance

Society for Brain Mapping and Therapeutics Neuroengineering Conference 2021

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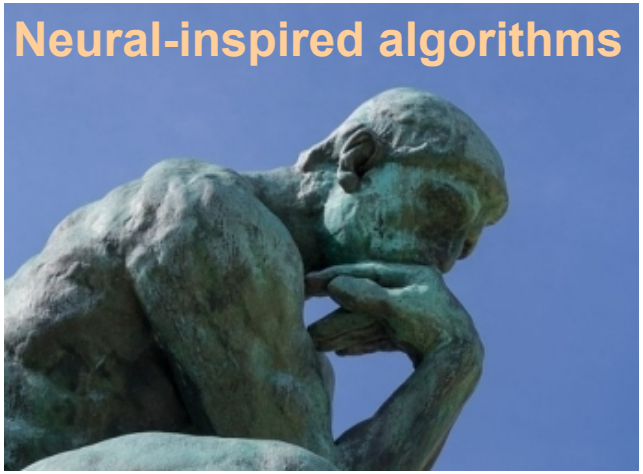
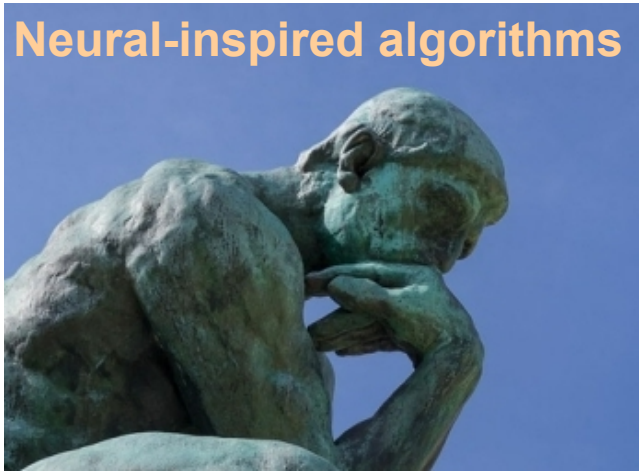
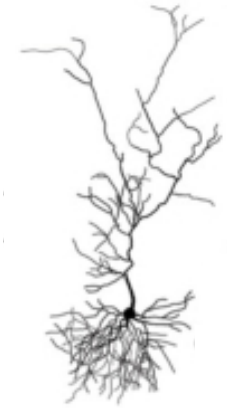
How to do brain-inspired computing?



How to do brain-inspired computing?

Neural-inspired algorithms

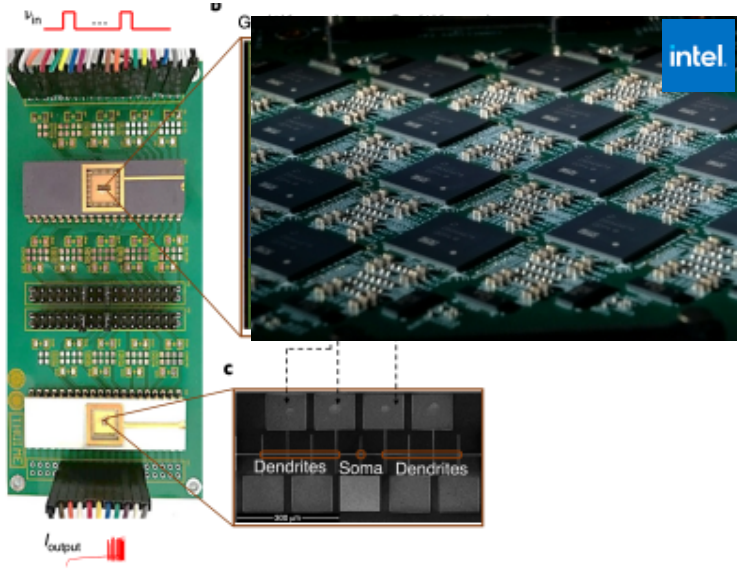




from Felleman & van Essen (1991) Cerebral Corte

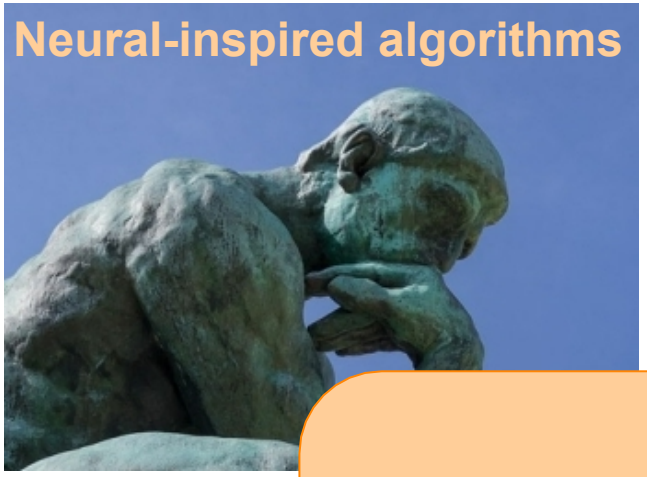
from Graves et al (2012) Neuron 76: 776

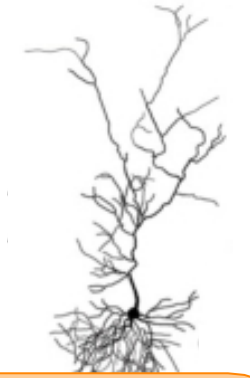
Neuromorphic hardware



from Li et al (2020) Nature Nanotechnology 15: 776

How to do brain-inspired computing?





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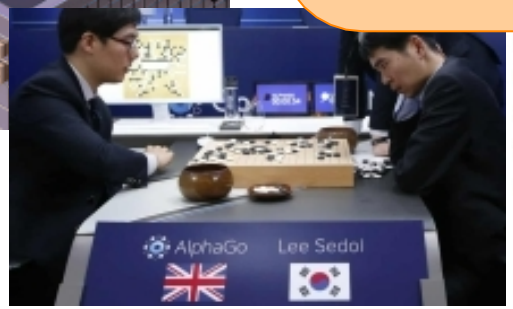
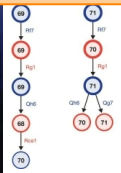
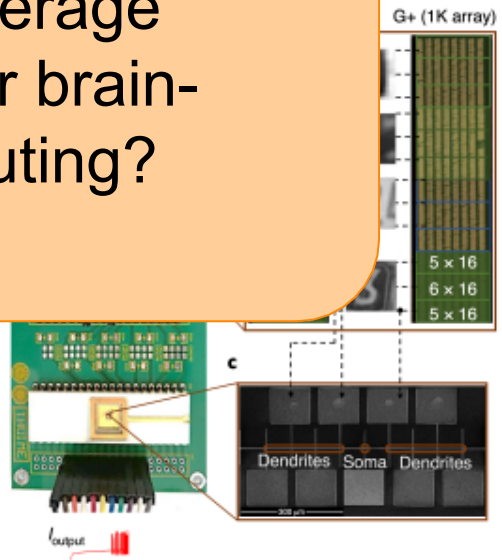
2012) Neuron 76: 776

How do we leverage neuroscience for brain-inspired computing?







from Li et al (2020) Nature Nanotechnology 15: 776

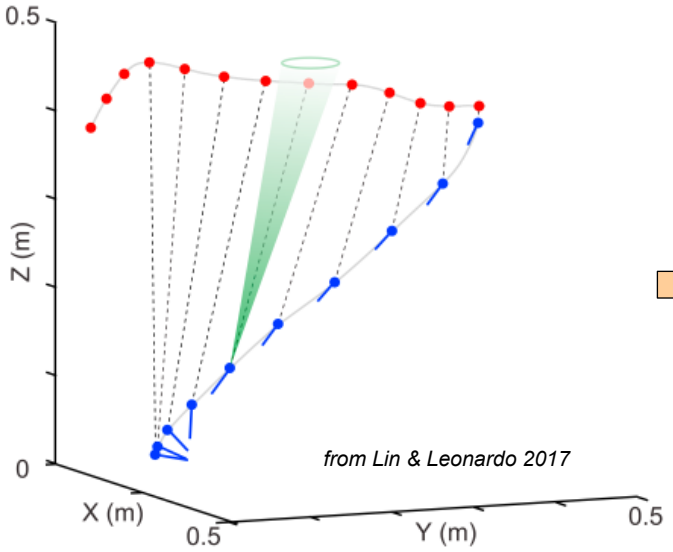
My vignette: Dragonfly prey-interception for brain-inspired computing

Specialized behavior (90-95% capture rate)

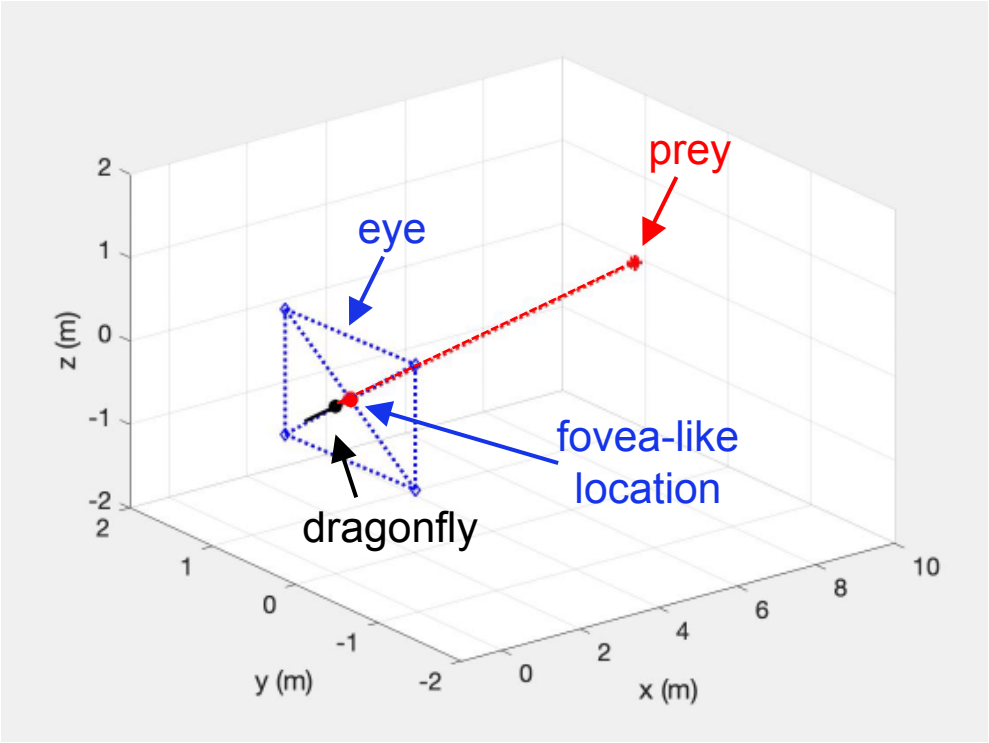
Fast calculation (~50 ms latency)

Expectation that the underlying circuitry is ‘light’

Is the underlying circuit representative of fast sensorimotor computations?



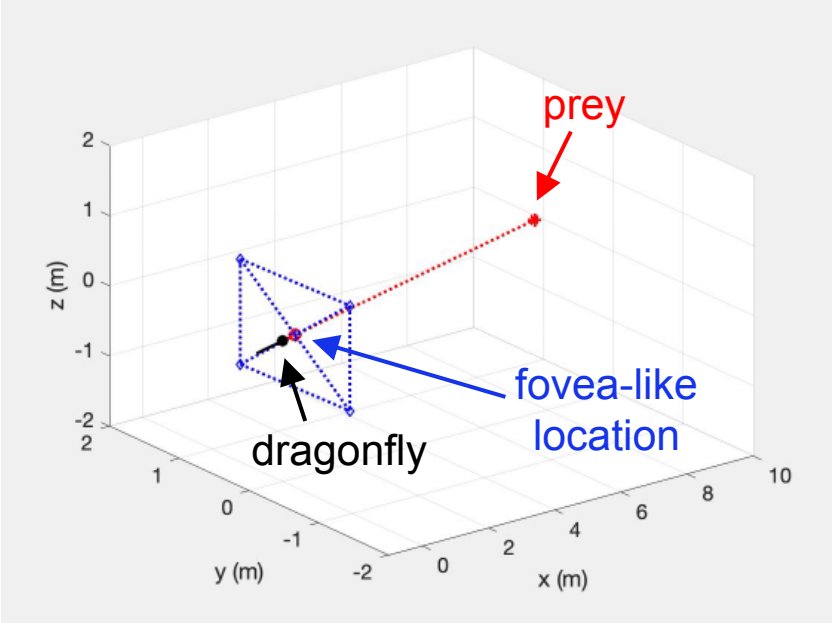
Building a dragonfly model



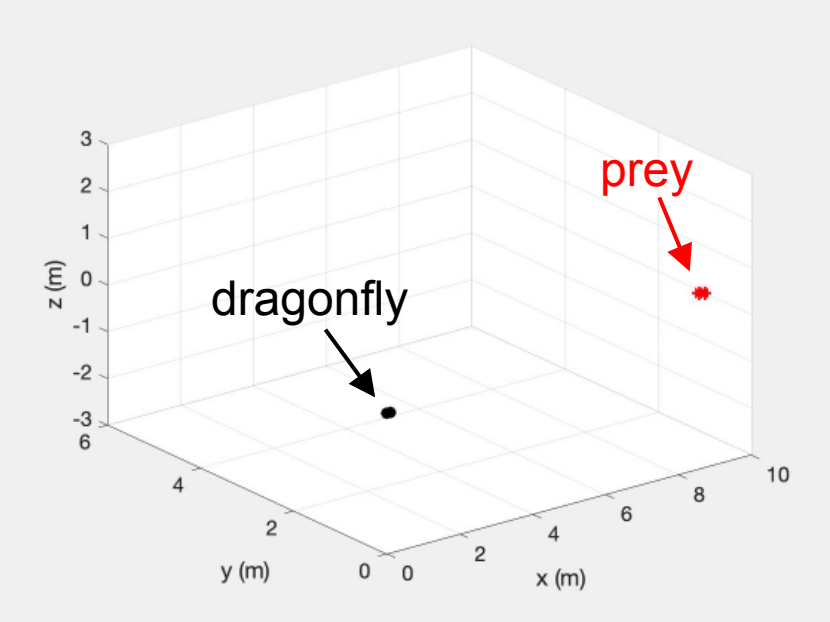
dragonfly-centered reference frame
(head plotted at origin)

Model dragonfly turns to keep prey-image on fovea

Parallel navigation in the dragonfly model

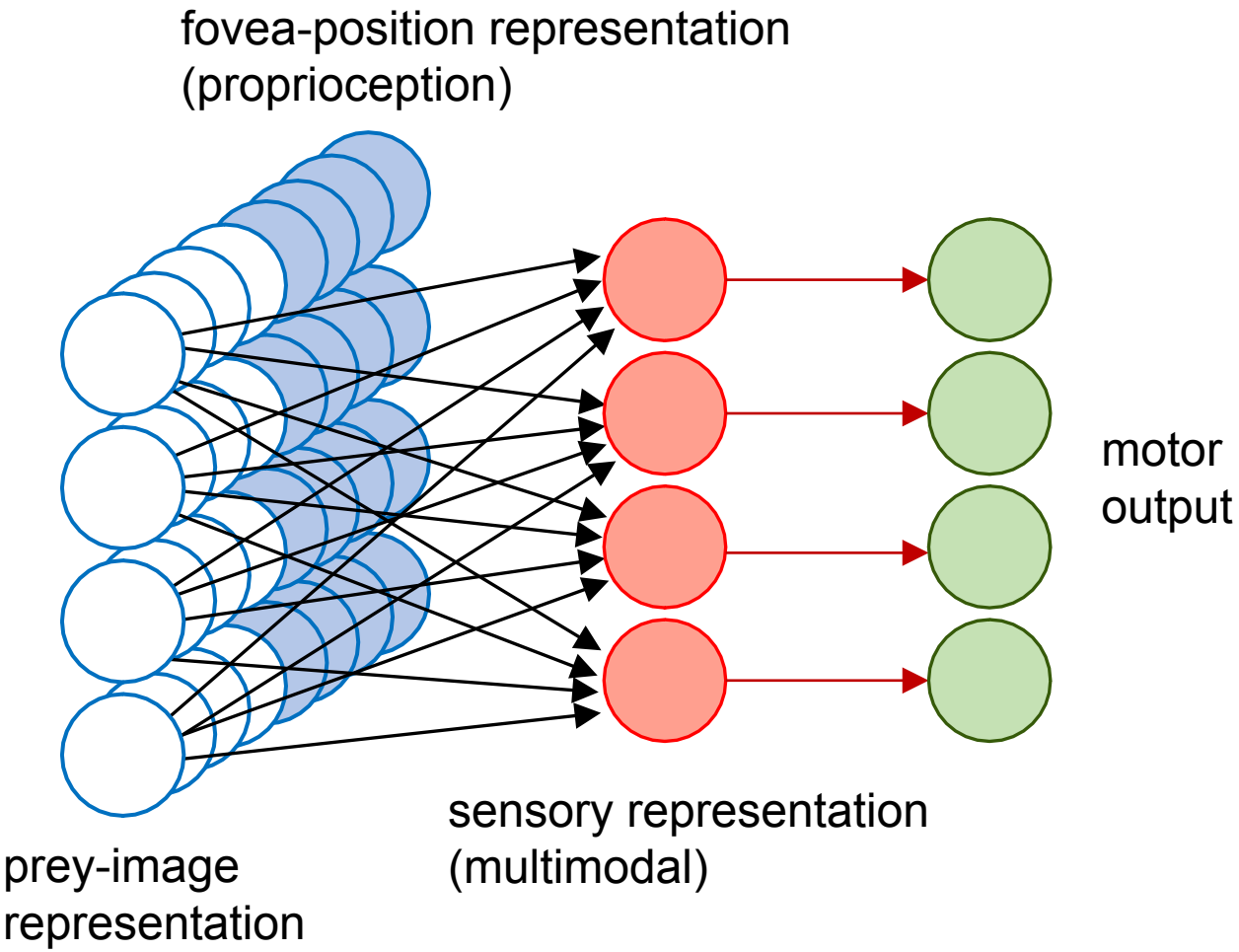


dragonfly-centered reference frame



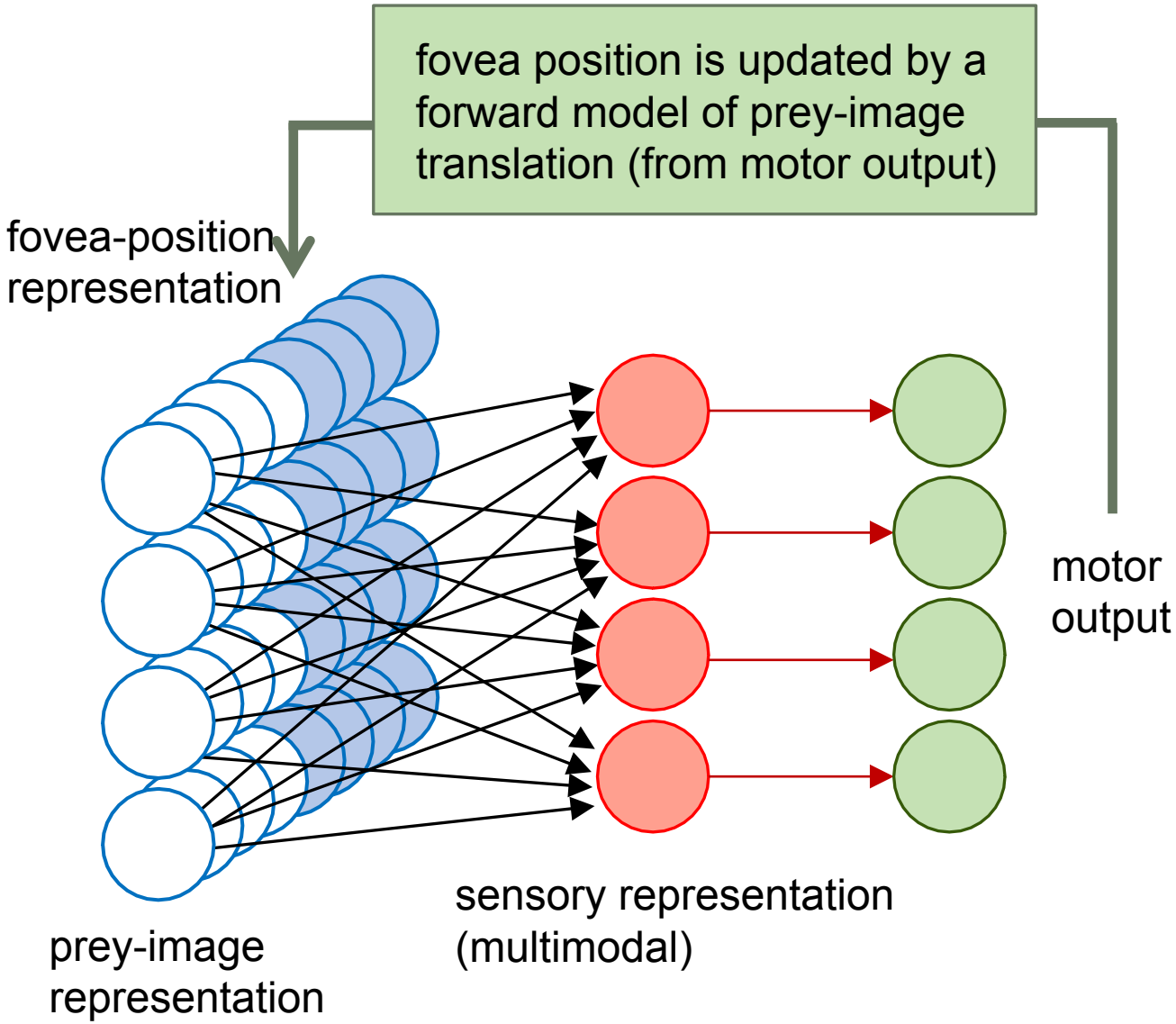
real-world reference frame

Neural network model of dragonfly interception



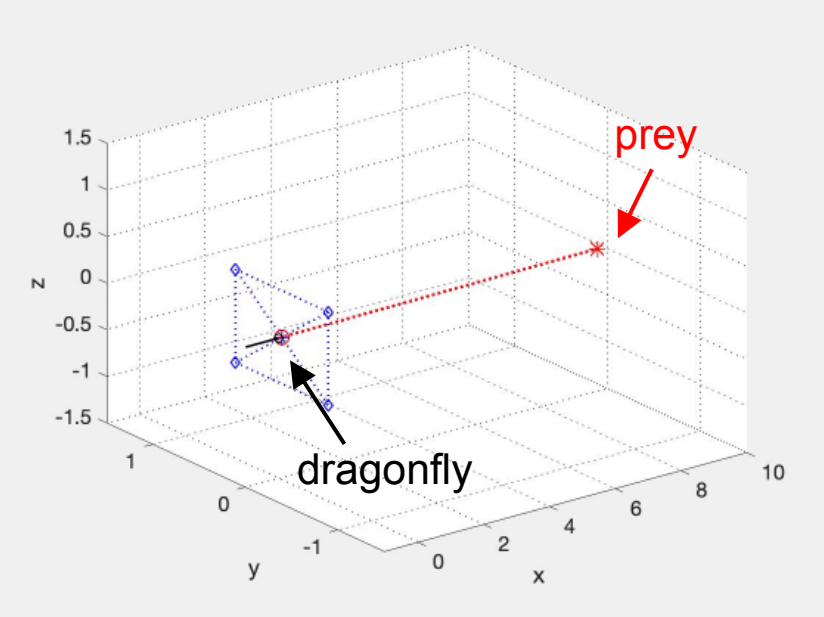
*neural network receives no training - weights are calculated
(see Zipser & Andersen, 1988; Salinas & Abbott, 1995)

Neural network model of dragonfly interception

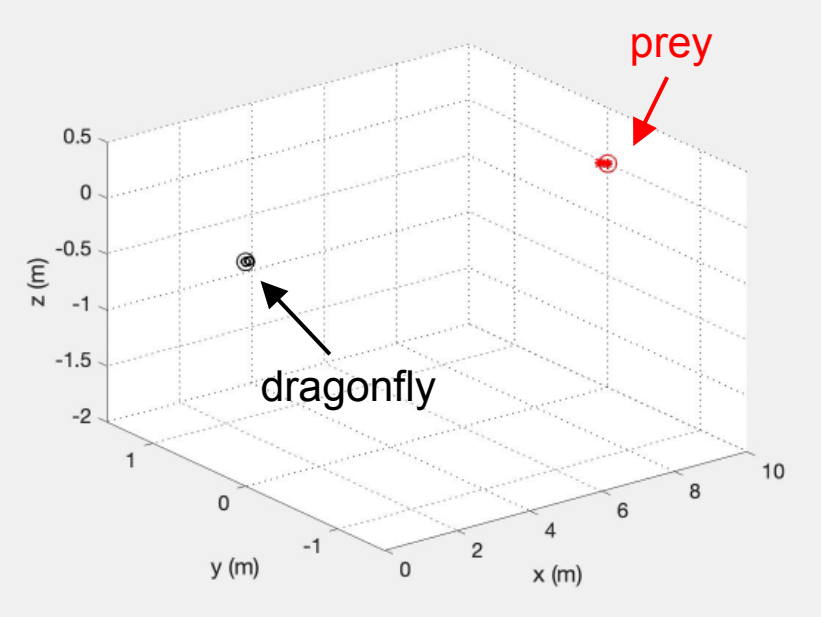


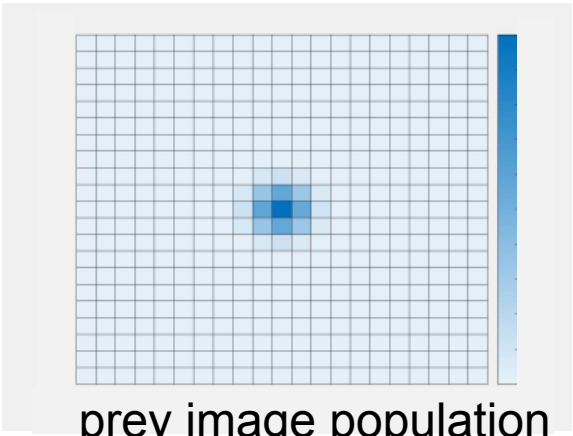
Neural network model of dragonfly interception

dragonfly-centered reference frame

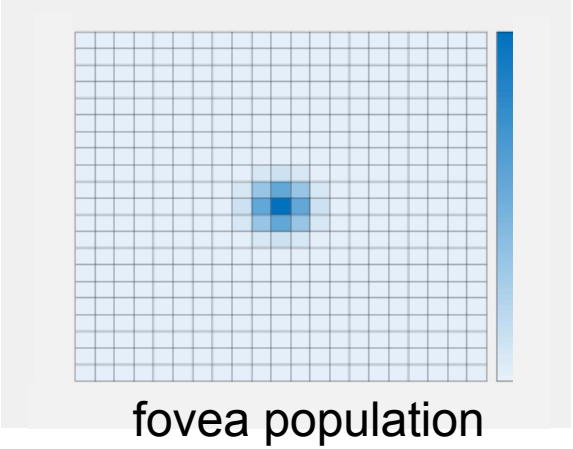


real-world reference frame

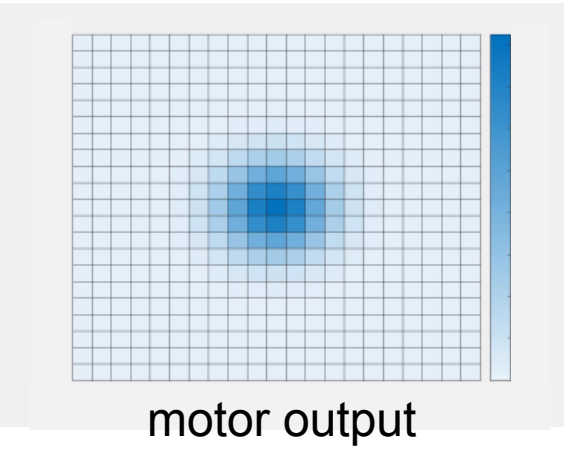




prey image population

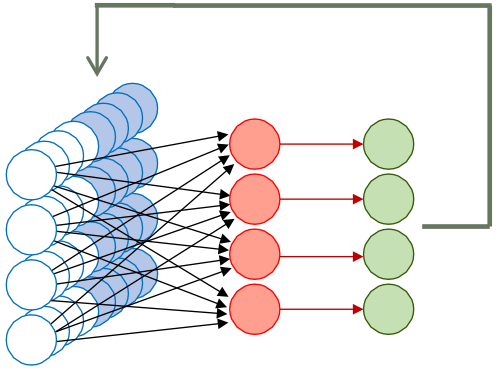


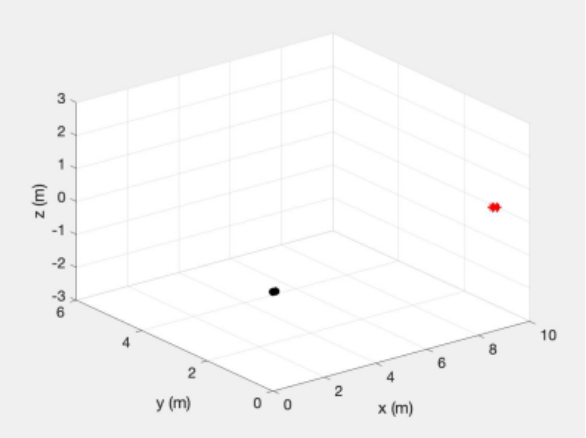
fovea population



motor output

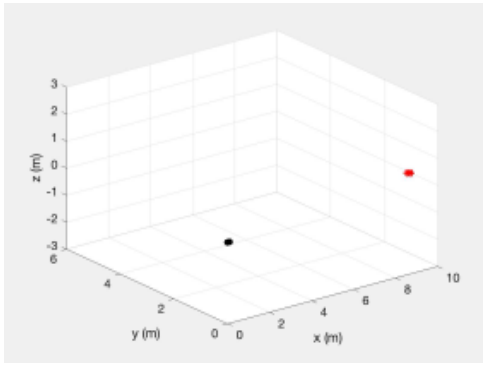
My vignette: Dragonfly prey-interception for brain-inspired computing





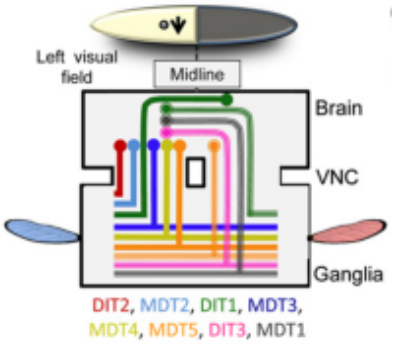
How do we leverage neuroscience for brain-inspired computing?

Lessons from dragonflies in brain-inspired computing



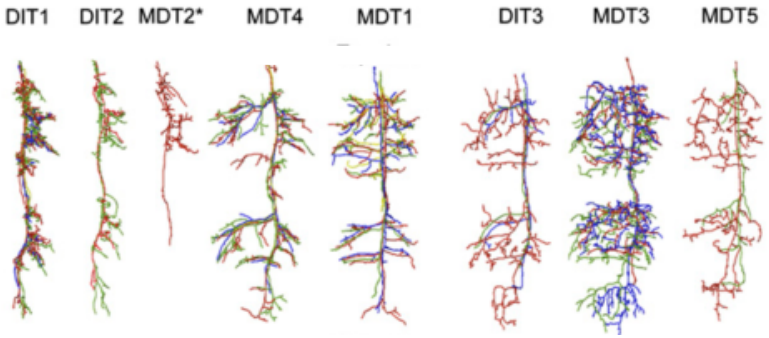
Advantages of an invertebrate system

- the neural circuit is ‘light’
- the individual components are identifiable
- access to computation at the cellular level



Dr. Paloma Gonzalez-Bellido

University of Minnesota



from Gonzalez-Bellido et al (2013) PNAS 110: 696

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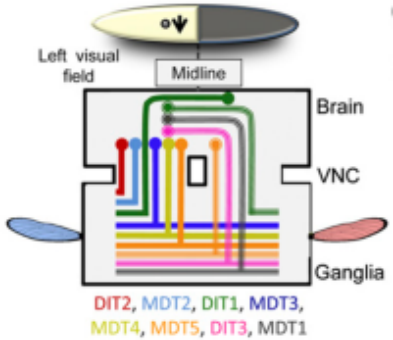
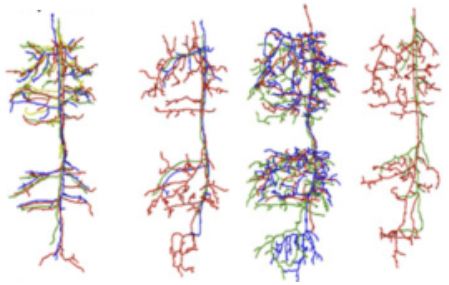
Lessons from dragonflies in brain-inspired computing





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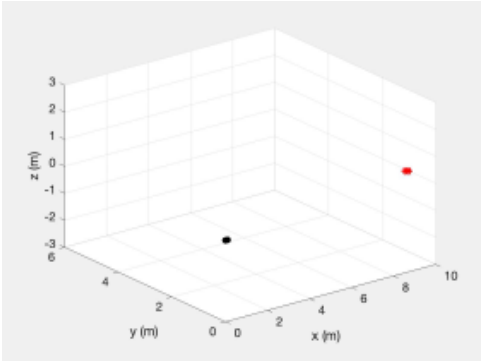


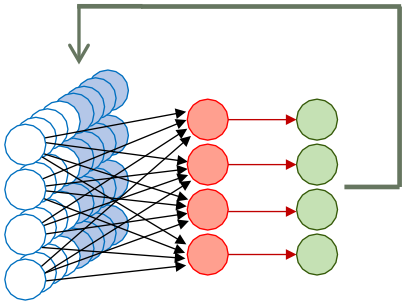
Dr. Suma Cardwell

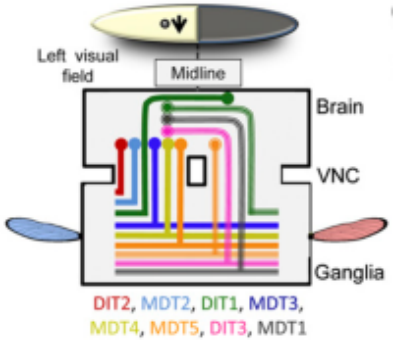
Sandia National Laboratories

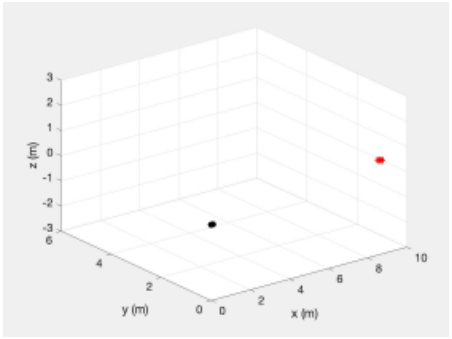
Dr. Scott Koziol

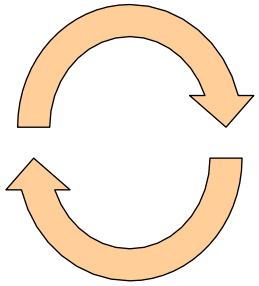
Baylor University

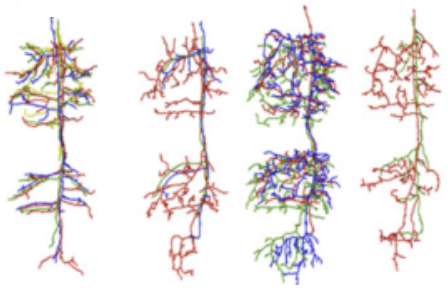
Lessons from dragonflies in brain-inspired computing











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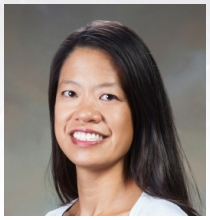
The End

Questions? Email fschanc@sandia.gov



Dr. Frances Chance
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