

# Model-based comparison of connectomes: evaluating the bilateral symmetry of a whole insect brain

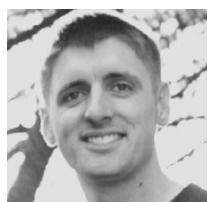
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# Why bilateral symmetry?

- Fundamental property of almost all animals
- Often (implicitly or explicitly) assumed in connectomics
- ...but many ways to write down what we mean when we say it for the networks

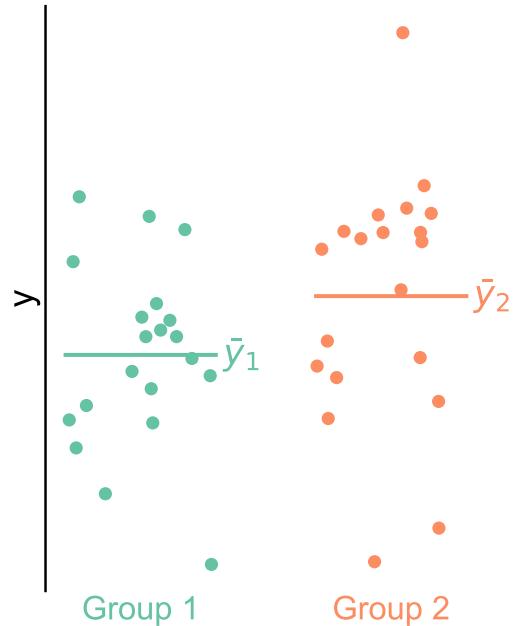
# Why else?

- As more connectomes are mapped, we'll want evaluate the *significance* and *nature* of differences between them

Are the **left** and **right** sides of the larva brain connectome  
***different?***

# Testing for differences

Are these two populations different?



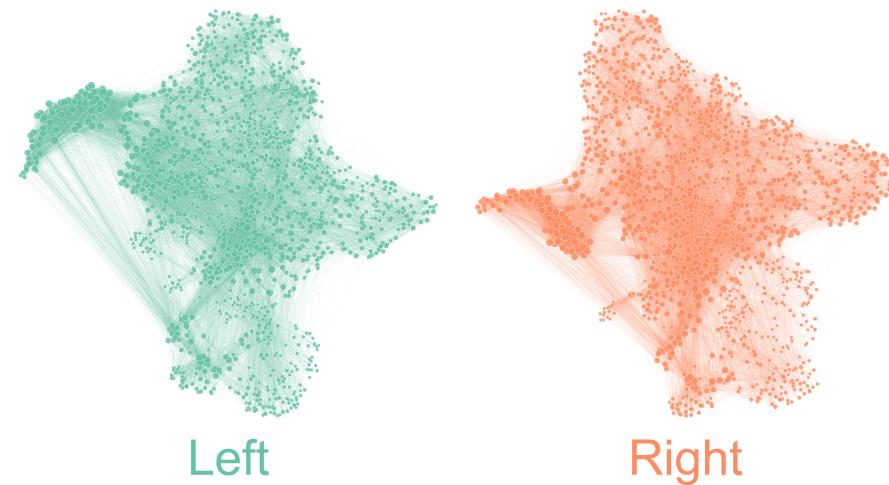
$$Y^{(1)} \sim F^{(1)}$$

$$Y^{(2)} \sim F^{(2)}$$

$$H_0 : F^{(1)} = F^{(2)}$$

$$H_A : F^{(1)} \neq F^{(2)}$$

Are these two *networks* different?



$$A^{(L)} \sim F^{(L)}$$

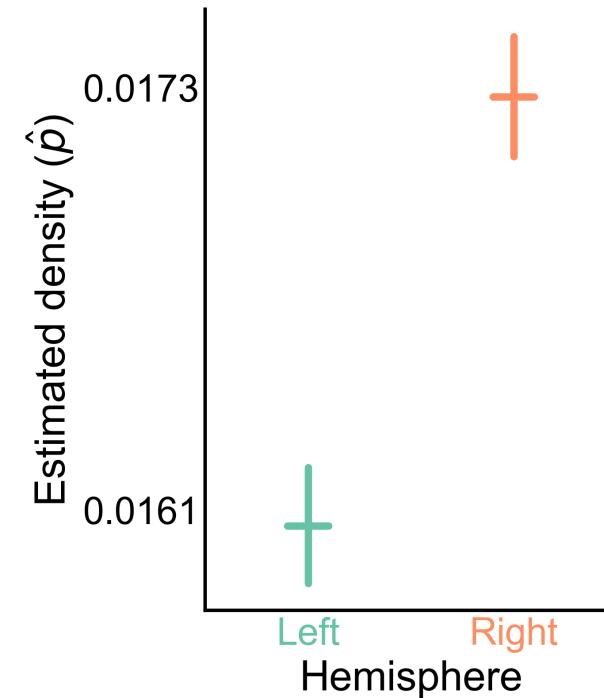
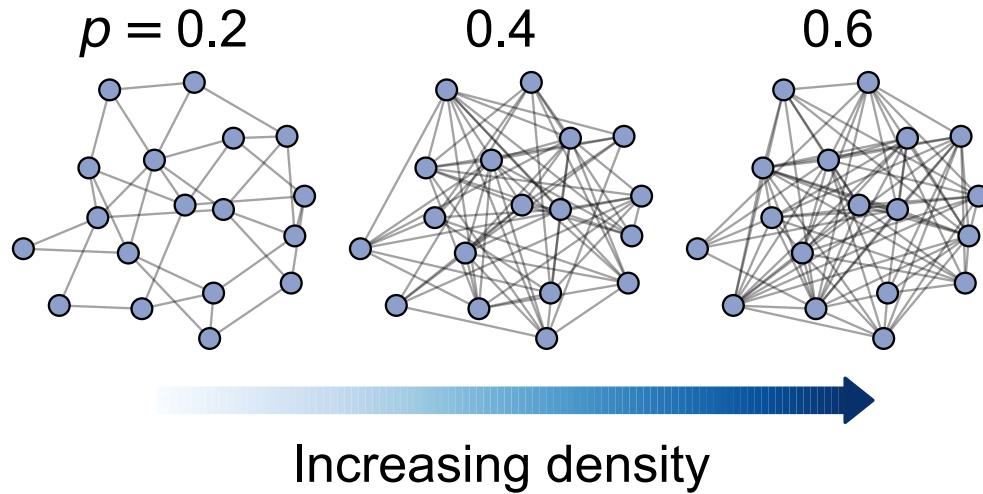
$$A^{(R)} \sim F^{(R)}$$

$$H_0 : F^{(L)} = F^{(R)}$$

$$H_A : F^{(L)} \neq F^{(R)}$$

# We reject even the simplest notion of symmetry

- Fit Erdos-Renyi models to the left and the right brain networks



- Compare densities:

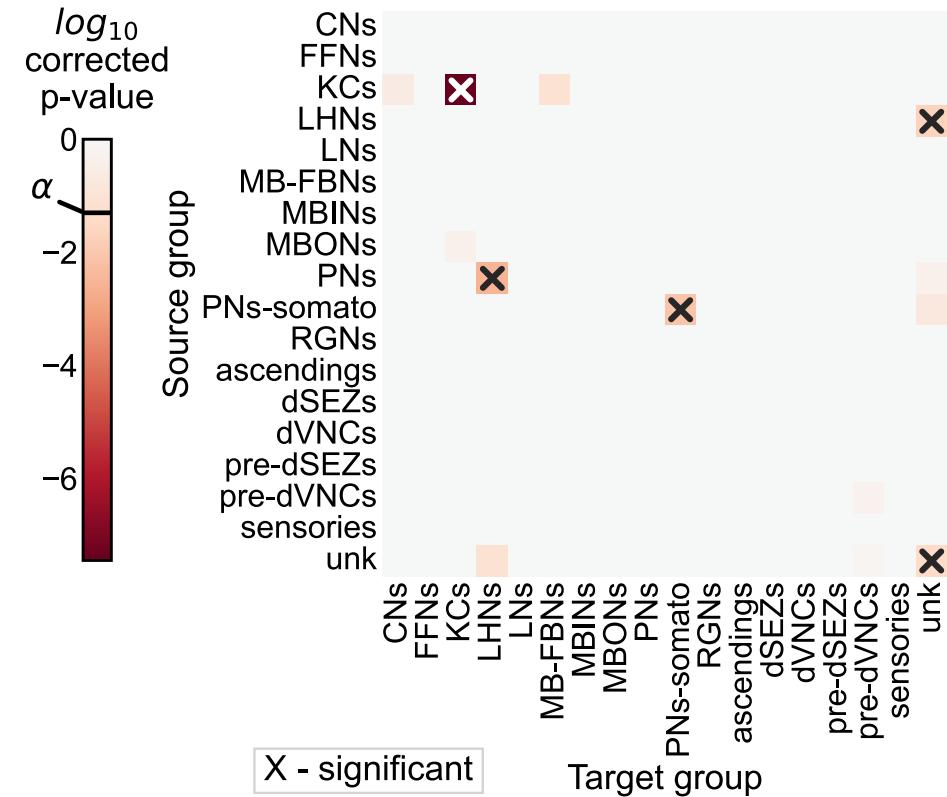
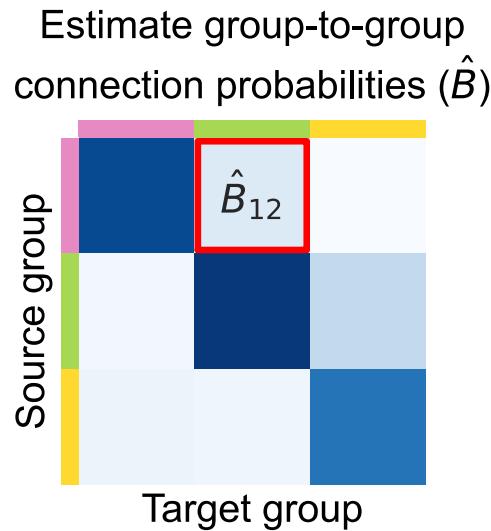
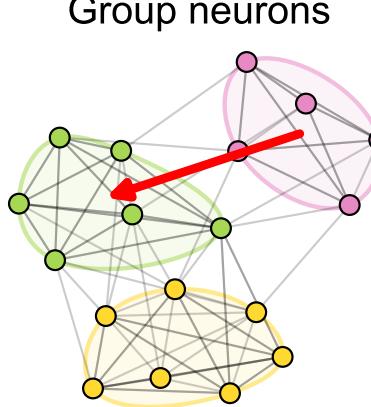
$$H_0 : p^{(L)} = p^{(R)}$$

$$H_A : p^{(L)} \neq p^{(R)}$$

p-value:  $< 10^{-23}$

# Localizing differences to cell type connections

- Fit block models to both hemispheres



- Compare connection probabilities:

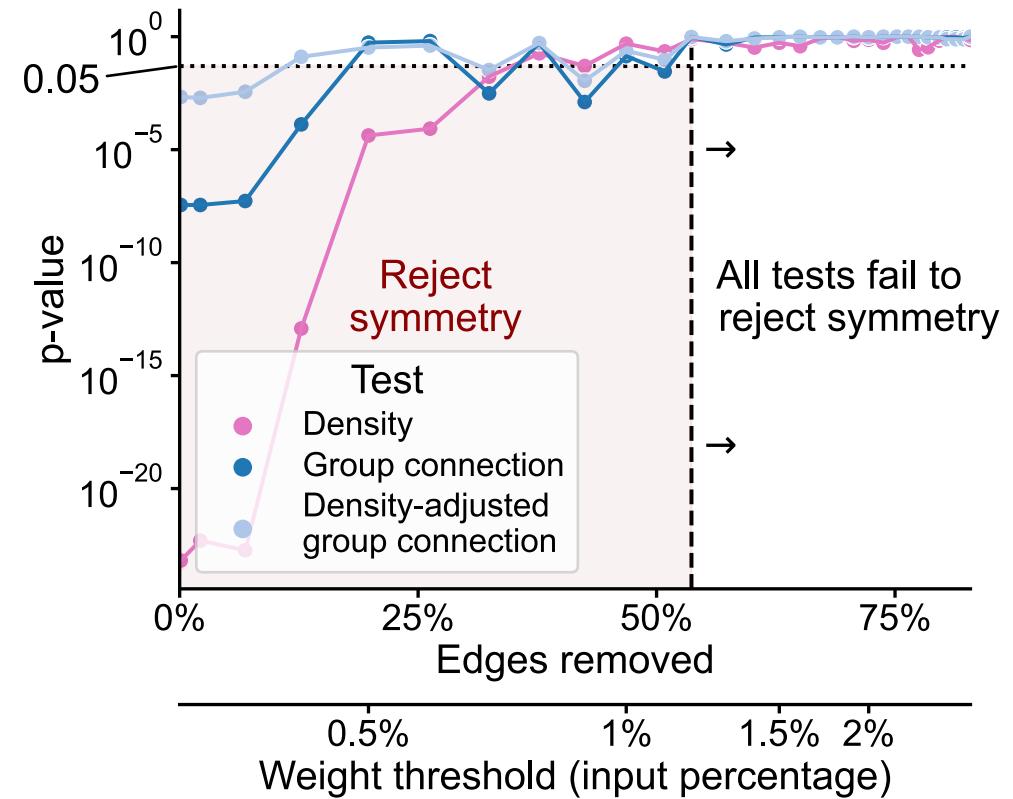
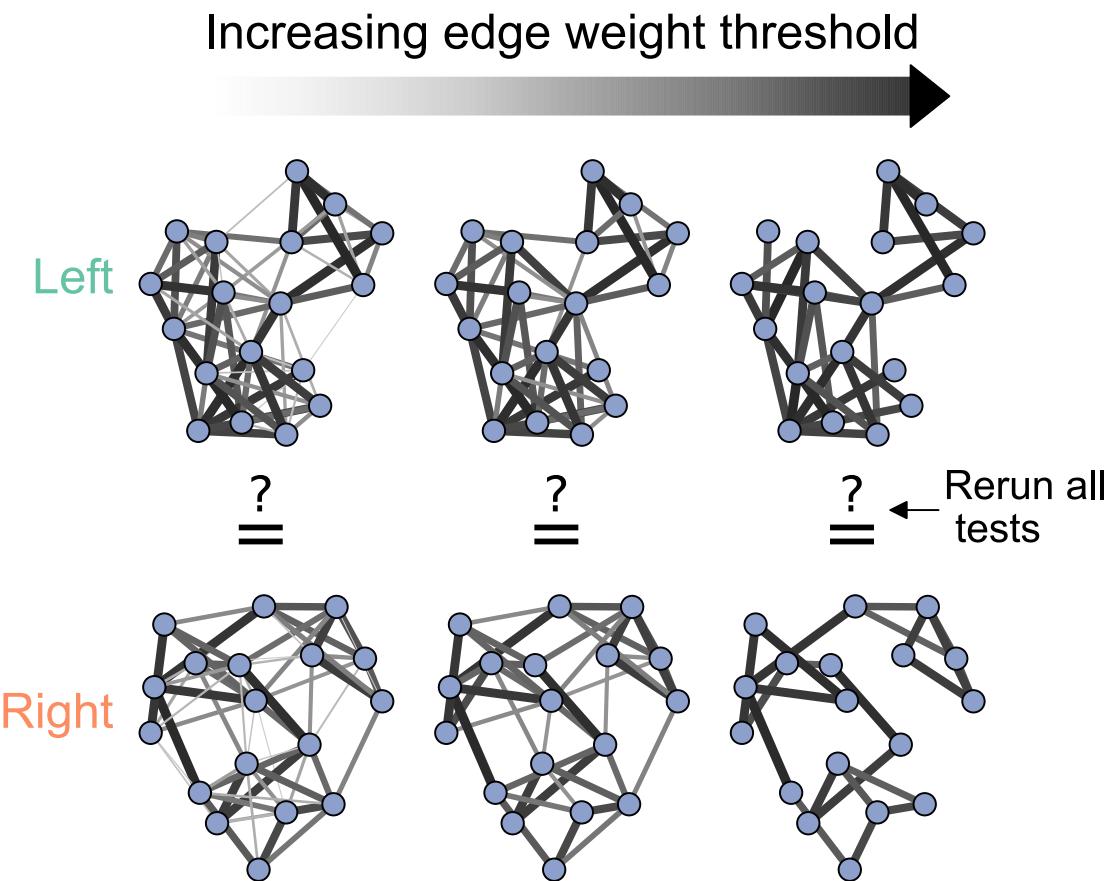
$$H_0 : B^{(L)} = B^{(R)}$$

$$H_A : B^{(L)} \neq B^{(R)}$$

Overall comparison:  $p < 10^{-7}$

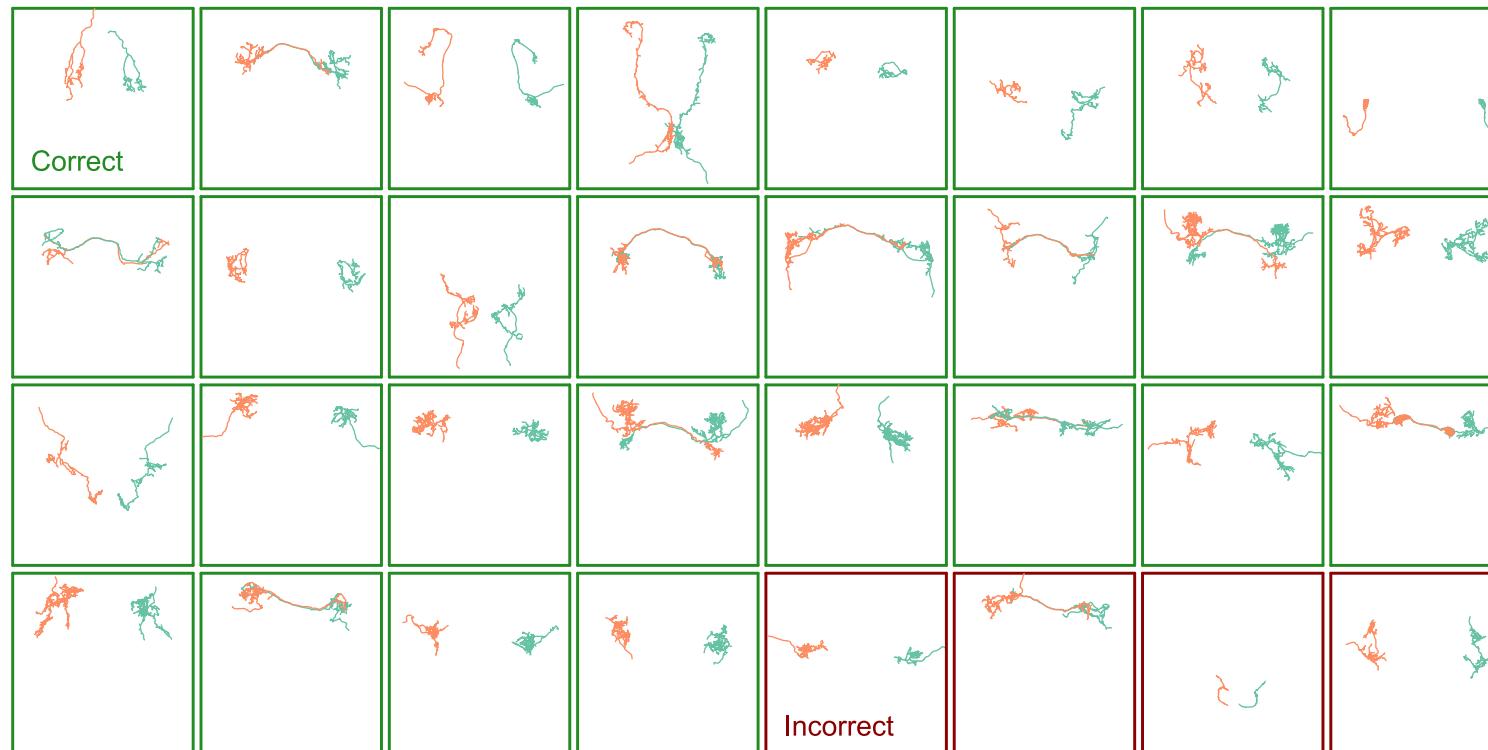
After adjusting for density:  $p < 0.01$

# Extensions: examining the effect of edge weights



*Only occurs when using input percentage  
as edge weight, not synapse number*

# Extensions: incorporating neuron matching



- Neuron pair predictions from connectivity based on graph matching tools
- *Ongoing work:* combining matching and testing frameworks to evaluate stereotypy at the edge-level

# Summary!

- Want to use anything I talked about today?
- OR have another network question you want to test?
- Let's chat!

Code, slides, papers, contact info:



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