**Problem Statement**
We want to support neurobiologists who link complex behaviour to neural circuits in the brain of *drosophila melanogaster*, the common fruit fly. To discover these circuits, they require knowledge about the connectivity between neurons. Synapses are located at a neuron’s arborisation. Where two or more neurons’ arborisations overlap, they display a potential connectivity. Neurobiologists use the information on potential connectivity to formulate new hypotheses and experiments. Visualising and computing overlaps between more than two arborisations (higher order overlaps) is difficult.

**Motivation**
We needed a visualisation for higher order overlaps (intersections of more than two arborisations). The artists Judith Moosburner at the Zürcher Hochschule der Künste developed a beautiful novel design in cooperation with the neurobiologists at the IMP in Vienna.

**Goals of the Thesis**
- Realise the novel design
- Compute volumes of higher order overlaps on demand
- Provide interaction techniques to communicate the data

**Computing Intersections**
A major contribution of the thesis is the algorithm to compute mesh volumes and mesh intersection volumes on the GPU. We use A-Buffers on the GPU—which are typically used to achieve order-independent transparency—to compute volumes. A framebuffer typically stores a single colour value per screen pixel. The A-Buffer, however, can record multiple values in a single screen pixel by allocating linked lists.

The graph below illustrates a simplified version of our algorithm, three passes on the GPU are sufficient. The first pass renders meshes and stores depth values (pictured as red dots on the right).

The second A-Buffer contains depth values sorted by depth. In the third and final pass, a compute shader iterates the linked list in each pixel to find depth values relevant for a specific volume.

**Conclusion**
- Features described by the design successfully implemented
- Very fast on demand computation of intersection volumes on the GPU
- Visual and quantitative investigation of higher order overlaps of arbitrary order
- Integrated with the BrainGazer framework used by neurobiologists
- Interactive links with other tools in BrainGazer