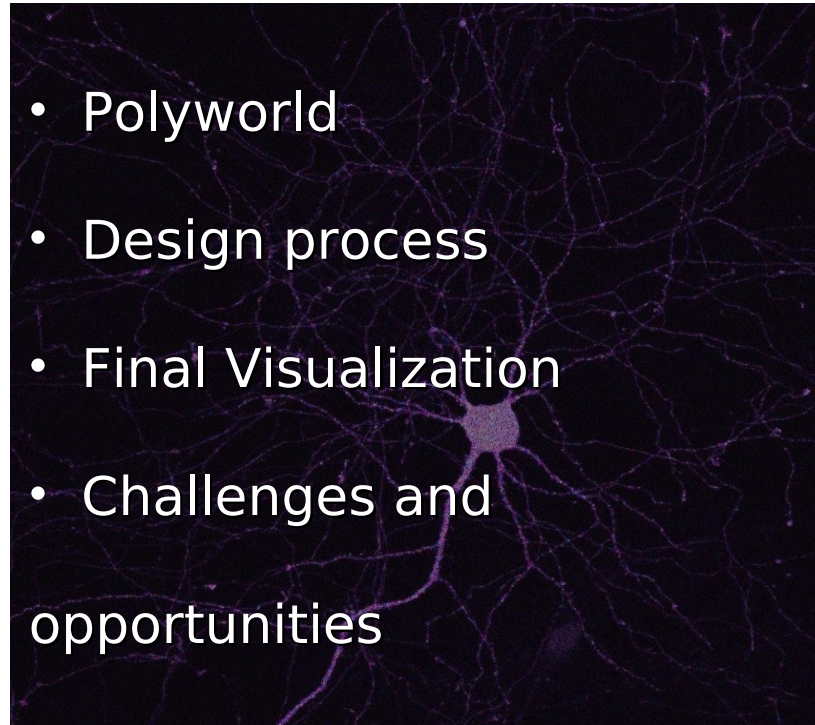
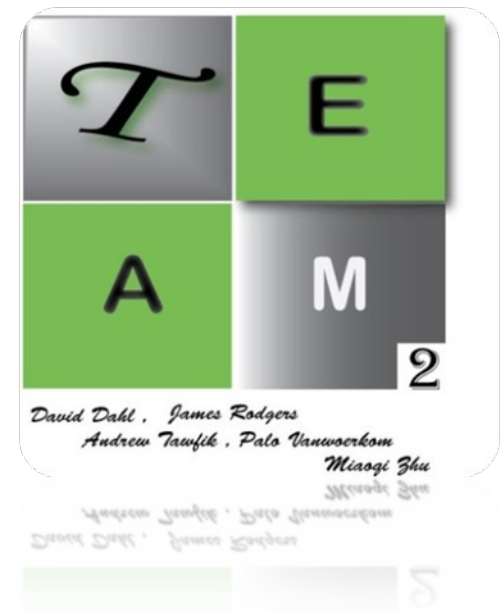


# Brain Weight Visualizations in Artificial Neural Networks



**Client: Professor Larry Yaeger**  
**Advisor: Professor Katy Börner**

**Team 2 : David Dahl, James Rodgers, Andrew Tawfik, Pablo Vanwoerkom, Miaoqi Zhu**



## Team 2 | Neural Networks

Polyworld is an artificial ecological computational environment of evolving haploid organisms. Basically, the ANN controls and guides seven abilities of the agents as their synapses adapt in accordance with Hebbian learning.

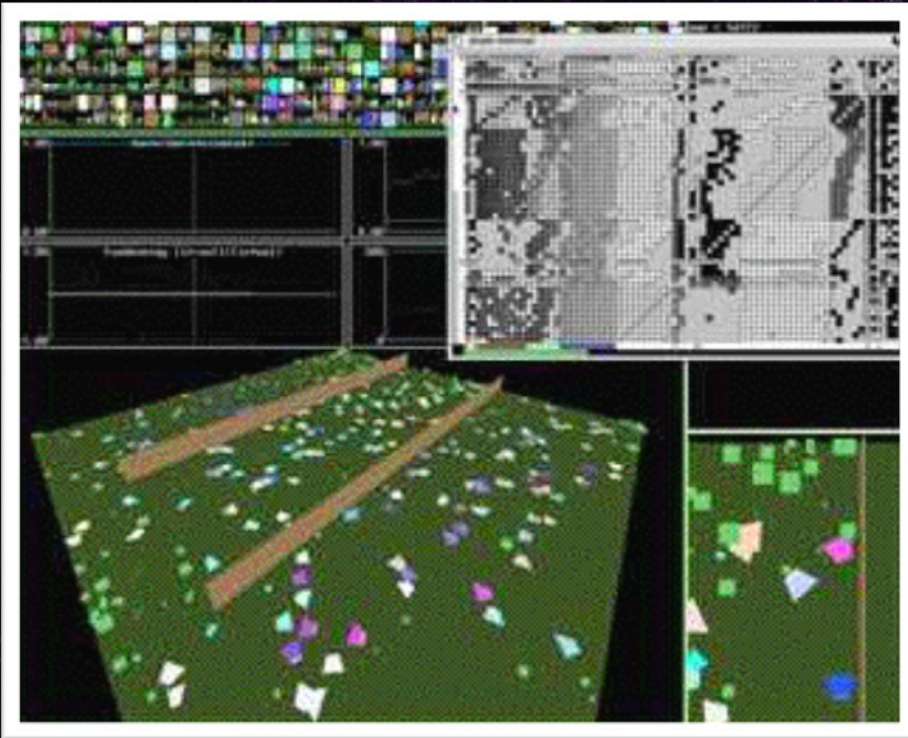


Image of Polyworld taken from <http://www.beanblossom.in.us/larryy/Images/pw4smallcmp50.gif>

**We** created interactive histograms for comparing distributions of neural connection weights in artificial life throughout a multi-generational simulation (approximately 30,000 time steps) of the Polyworld computational ecology.

**Data** consists of 28,595 brain agents' neural connections at inception, birth, and death taken from one run of the

View Sample Data

# Previous Work

## Hinton Diagrams

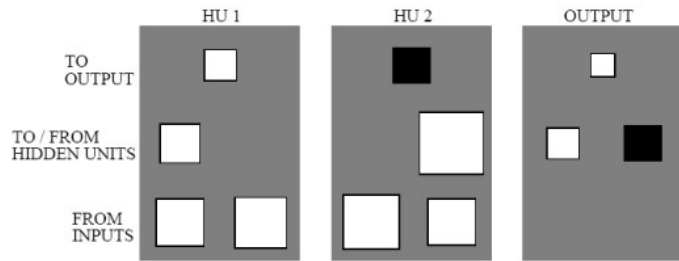


Figure 5: **Hinton diagrams.** These diagrams depict, from left to right, the two hidden units and the output unit of the network depicted in Figure 1. The boxes in the lower part of each diagram depict weights from input units, the boxes in the middle of each diagram depict weights from (to) hidden units, and the box at the top of each diagram depicts a weight to the output unit. A unit's bias is drawn in the position in the unit's diagram where weights to and from the unit are shown in the other diagrams.

## Bond Diagram

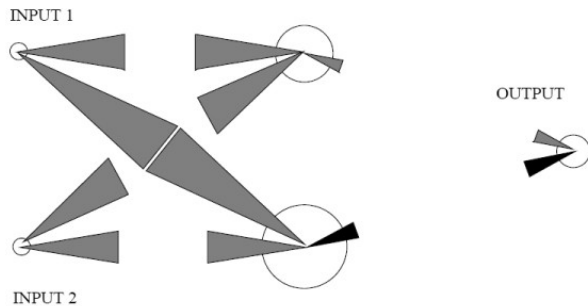


Figure 6: **A bond diagram.** The diagram depicts the network shown in Figure 1. The size of a unit indicates the magnitude of its bias. Positive and negative weights are shown as light and dark shaded bonds, respectively. The magnitude of a weight is indicated by the amount of the bond which is shaded.

## Histogram

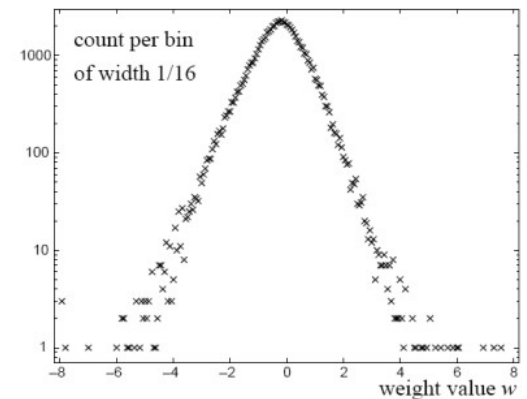


Figure 8. Distribution of weight values in a net with one-byte weights, on a log count scale. Weights with magnitudes greater than 4 are sparse, but important.

Lyon, R.F. & Yaeger, L.S. (1996). On-line hand-printing recognition with neural networks. Fifth International Conference on Microelectronics for Neural Networks and Fuzzy Systems, Lausanne, Switzerland, Feb. 12-14, 1996. *IEEE Computer Society Press.*

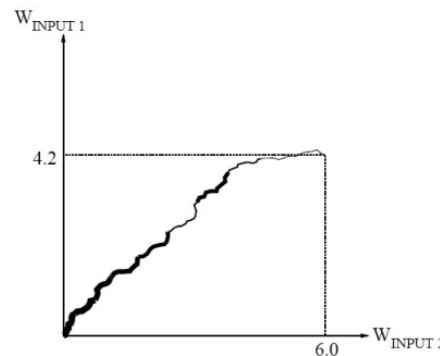
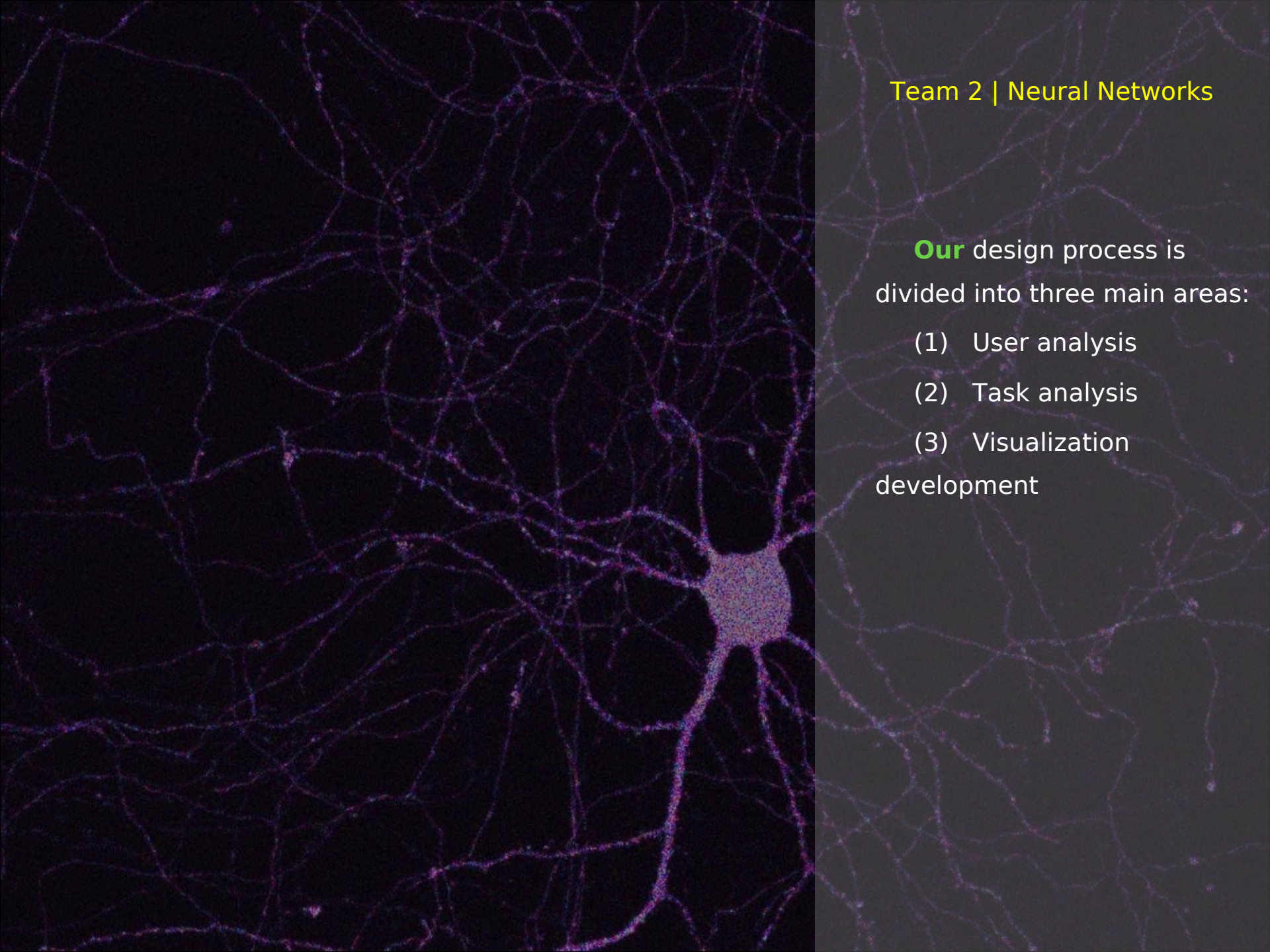


Figure 9: **A trajectory diagram.** The diagram depicts the trajectory, over a hypothetical training session, of the rightmost hidden unit in Figure 1. The trajectory is plotted in the space defined by the two weights impinging on this hidden unit. The thickness of the trajectory line indicates the network error along the trajectory.

## Trajectory Diagram

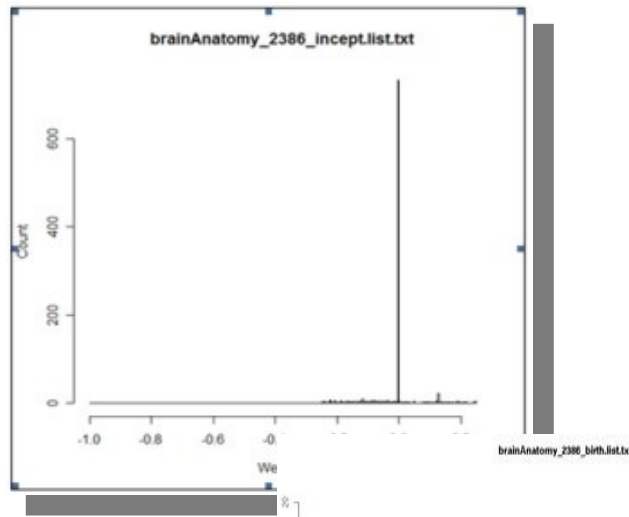


## Team 2 | Neural Networks

**Our** design process is divided into three main areas:

- (1) User analysis
- (2) Task analysis
- (3) Visualization development

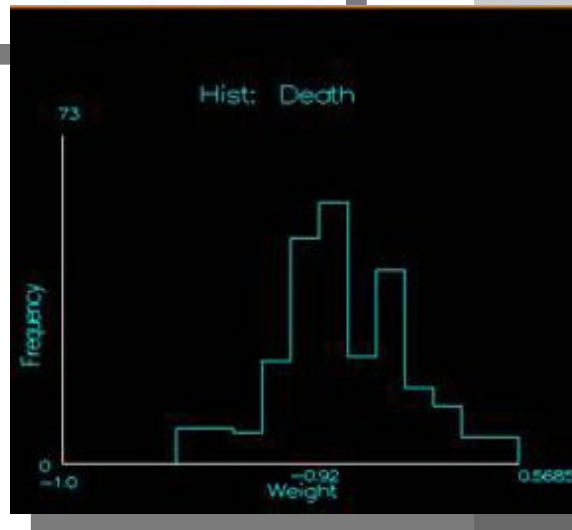
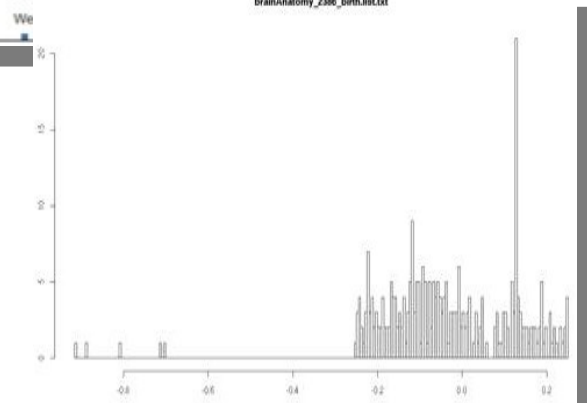
Initial sketches



Optimized visualizations



An interactive interface



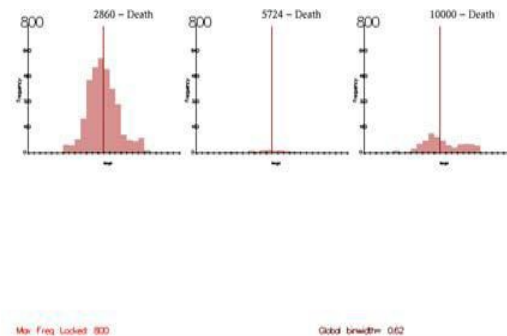
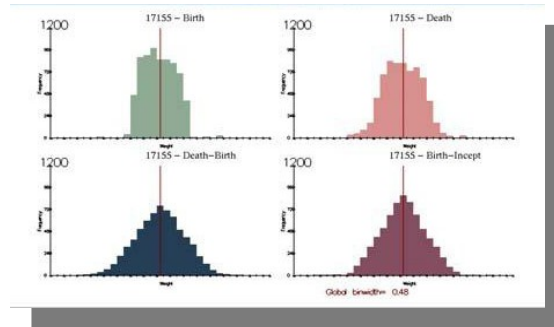
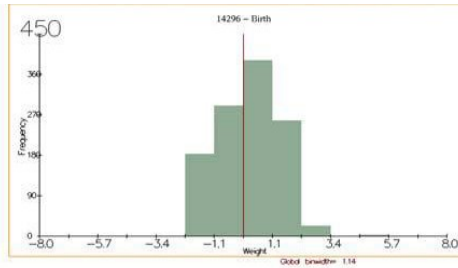
**Visualization** development was comprised of the following three stages:

- (1) Initial sketches
- (2) Optimized visualizations
- (3) An interactive interface

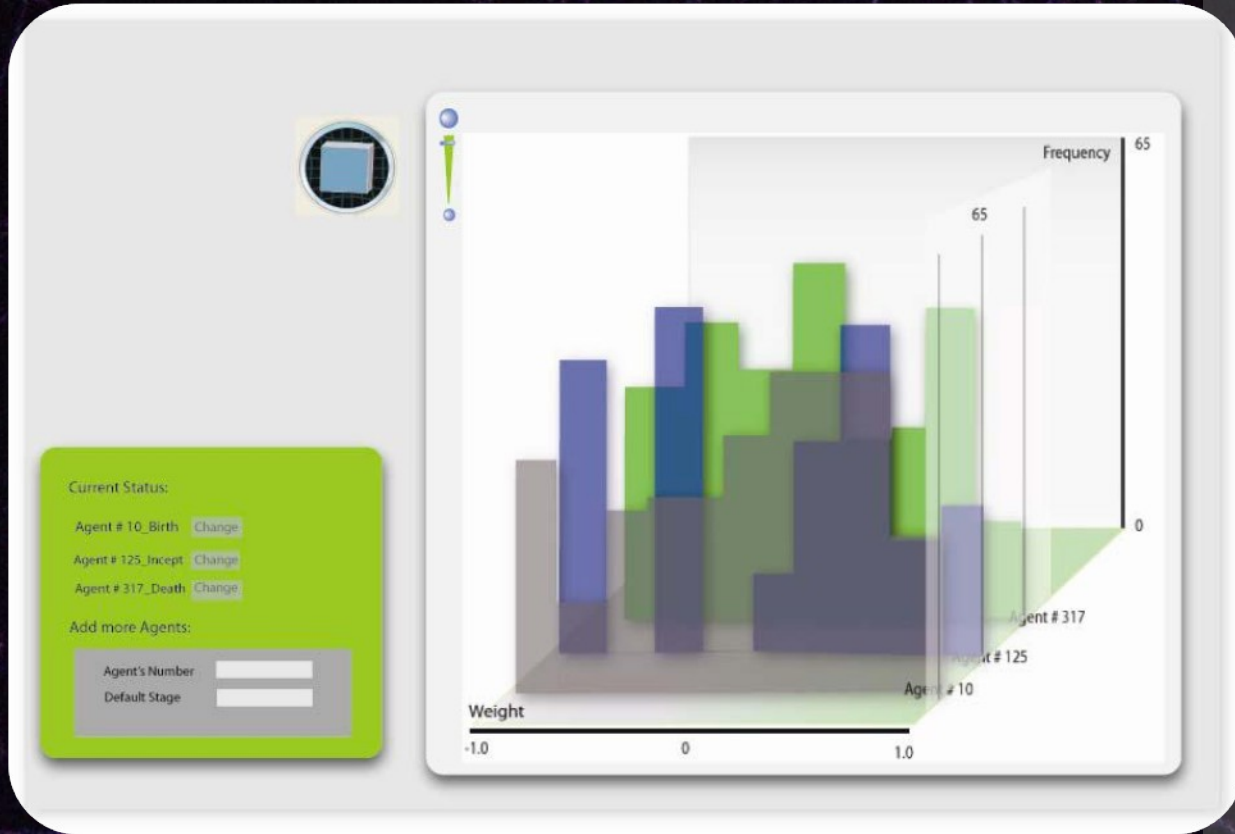
## Team 2 | Neural Networks

**Final** visual design was updated for clarity and aesthetic value:

- (1) Single & multiple histogram viewing mode
- (2) Color coding
- (3) Consistent reference system
- (4) Keystroke commands



Future prototype of a 3D interface for visualizing neural networks.

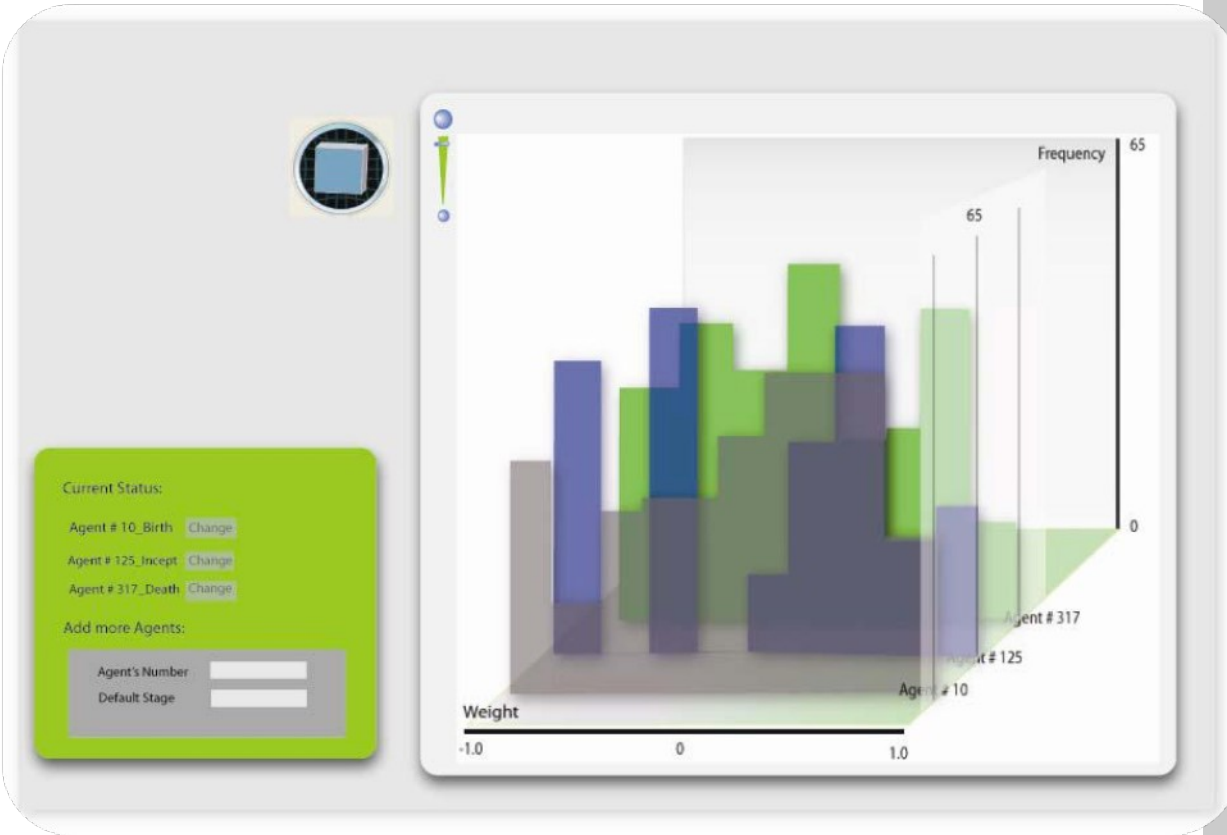


### Challenges:

- (1) Working with a large dataset
- (2) Scalability

### Opportunities:

- (1) Utilization of 3-dimensional images
- (2) Superimposition of multiple histograms



Future Prototype of a 3d interface for visualizing neural networks.



Thanks!

Have a

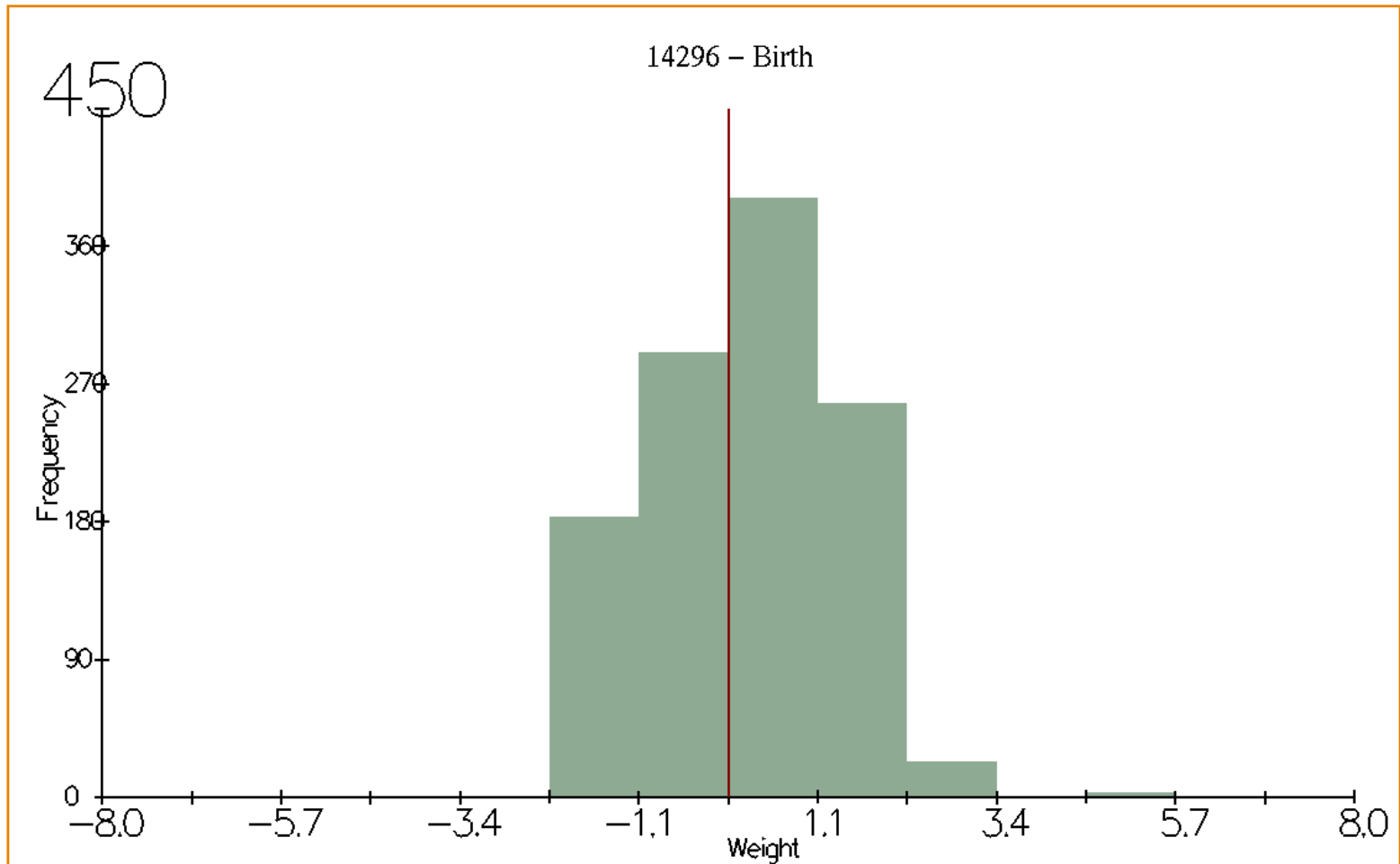
good summer

April 25  
Exit

2008

Final interface. Single histogram viewing mode.

Visualization for Distributions of Brain Weights in a ANN

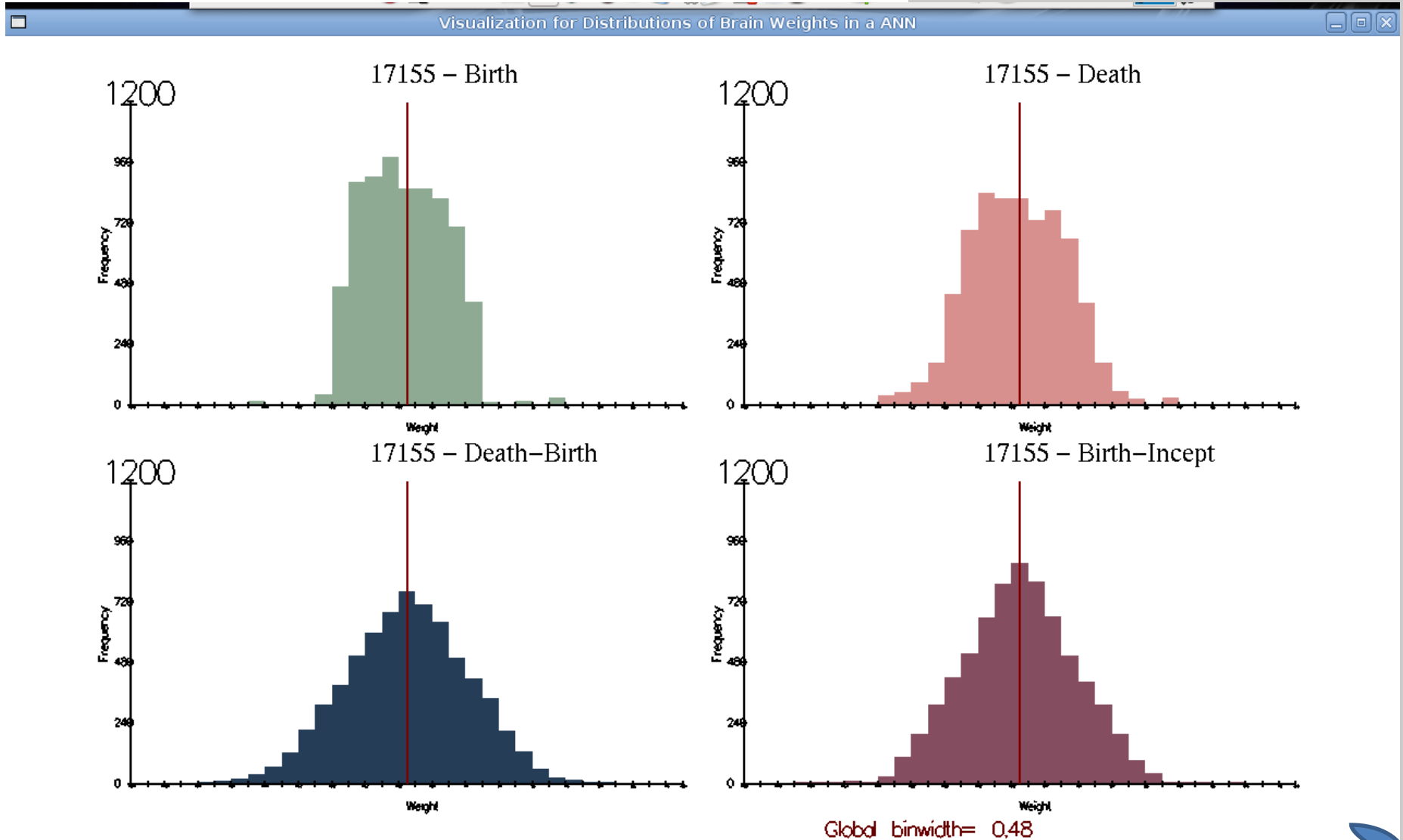


Global binwidth= 1.14



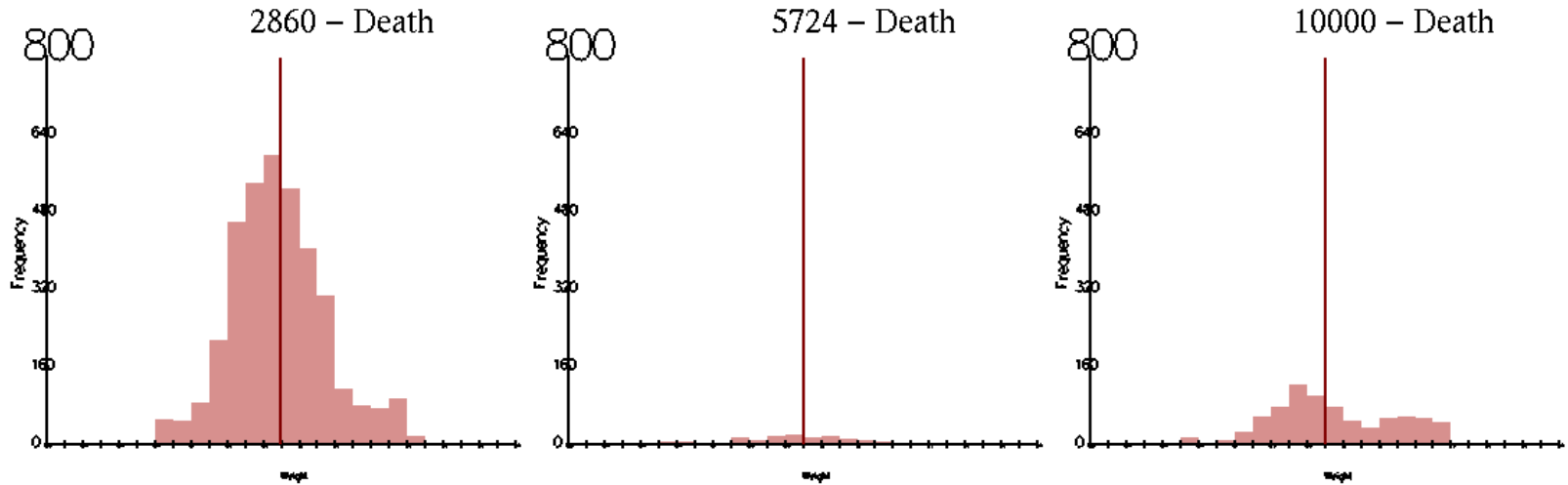
Final interface. Multiple histogram viewing mode for a single agent.

Team 2 | Neural Networks



Final interface. Multiple histogram viewing mode for multiple agents.

Team 2 | Neural Networks



Max Freq Locked: 800

Global binwidth= 0.62





# Directory of agent data files used for visualizations.

Name	Size	Type	Date Modified
brainAnatomy_1_birth.txt	9.2 KB	plain text document	Sat 21 Apr 2007 03:58:46 AM EDT
brainAnatomy_1_death.txt	9.2 KB	plain text document	Sat 21 Apr 2007 04:00:08 AM EDT
brainAnatomy_1_incept.txt	9.2 KB	plain text document	Sat 21 Apr 2007 03:58:46 AM EDT
brainAnatomy_2_birth.txt	9.2 KB	plain text document	Sat 21 Apr 2007 03:58:46 AM EDT
brainAnatomy_2_death.txt	9.2 KB	plain text document	Sat 21 Apr 2007 04:00:24 AM EDT
brainAnatomy_2_incept.txt	9.2 KB	plain text document	Sat 21 Apr 2007 03:58:46 AM EDT
brainAnatomy_3_birth.txt	9.2 KB	plain text document	Sat 21 Apr 2007 03:58:46 AM EDT
brainAnatomy_3_death.txt	9.2 KB	plain text document	Sat 21 Apr 2007 04:00:52 AM EDT
brainAnatomy_3_incept.txt	9.2 KB	plain text document	Sat 21 Apr 2007 03:58:46 AM EDT
brainAnatomy_4_birth.txt	9.2 KB	plain text document	Sat 21 Apr 2007 03:58:46 AM EDT
brainAnatomy_4_death.txt	9.2 KB	plain text document	Sat 21 Apr 2007 03:59:50 AM EDT
brainAnatomy_4_incept.txt	9.2 KB	plain text document	Sat 21 Apr 2007 03:58:46 AM EDT
brainAnatomy_5_birth.txt	9.2 KB	plain text document	Sat 21 Apr 2007 03:58:46 AM EDT
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"brainAnatomy\_5\_death.txt" selected (9.2 KB)

