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# Fireflies: Expressive InfoVis Inspired by Biomimicry

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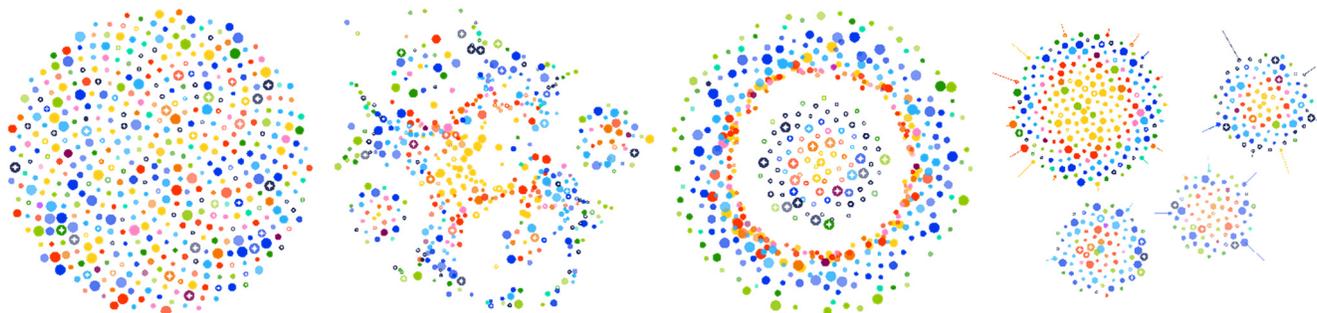


Figure 1. A *sprinkle of data*—Fireflies is a visualization resulting from applying biomimicry to information visualization. Using animal behaviours and plant phyllotaxis, Fireflies’ visual metaphor provides opportunities to create expressive groupings with varying aesthetics. Thus, supporting visualization of sensitive data such as public opinion about an infectious disease.

## ABSTRACT

We present Fireflies, a bio-inspired visualization using animal swarming behaviour and plant phyllotaxis. We applied Fireflies to a Canadian attitudinal survey on HIV/AIDS, using motion to depict participants’ comfort levels concerning HIV+ people. The bio-inspired visual properties of Fireflies meld into an expressive and engaging representation of sensitive data.

## 1 INTRODUCTION

Biomimicry—derived from the Greek word *bios*, meaning “life”, and *mimesis*, meaning “to imitate”—is an increasingly popular paradigm where one imitates solutions found in nature in order to solve day-to-day problems efficiently [1]. This comes from the premise that nature (animals, plants, and microbes) offers solutions to problems that humans are still trying to solve—solutions that have undergone multiple iterations of testing and improvement, with failures already winnowed by natural selection.

Fireflies is a preliminary exploration as to how we can apply biomimicry to information visualization (InfoVis). In particular, we look into how inspirations from nature can be leveraged in order to encode data into visual representations that enable data exploration as well as elicit affect.

## 2 DATA AND DESIGN

The data visualized in Fireflies comes from a 2012 Canadian HIV/AIDS attitudinal survey [2]. Given the nature of this dataset, we assessed participants’ attitude towards HIV/AIDS through their answers to questions eliciting opinions about the welfare of HIV+

people and their knowledge on how the virus propagates. The data is optimistic in that the majority of the participants are comfortable with, and care for the welfare of people who are HIV+. Hence, the data does not necessitate a somber approach but rather one which reflects the triumph of progressive ideas over ignorance.

Our goals for designing an engaging visualization which is both visually expressive and useful for exploration include: providing expressiveness through visual variables such as motion; enabling the creation of meaningful groups of data-points; and supporting conventional means of exploration such as sorting and querying.

We used inspirations from nature to achieve these goals. One inspiration is animal swarming behaviour. This metaphor lets people to make their own groupings of data-points based off a swarming behaviour of insects, where members of the swarm fly towards a food source. Additionally, we took pointers from *apparent behaviour* in animation [3] to encode other aspects of the data: we visualize aggressive behaviours with fast and jittering motions, and nonaggressive behaviours with slow and calm motions.

We also considered pointers from personal visualization (PV) research [4] to engage people with learning about current public opinion of an infectious disease. PV encourages diversifying perspectives to design personable visualizations. In this light, we chose art as a means to communicate sensitive data to people from all walks of life. We designed Fireflies to be enable exploration for curiosity, and to be aesthetically pleasing, borrowing from minimalist designs of modern art. To create beautiful clusters of data-points, we employed Vogel’s phyllotactic pattern algorithm [5], using a  $137.5^\circ$  angle to mimic how sunflower seeds grow. This results in a visually appealing yet efficient way of clustering fireflies into groups (see Figure 1).

## 3 FIREFLIES

Fireflies visualizes a random sample of data-points as fireflies floating in 2D space. Each firefly’s visual characteristics depict aspects about the participant:

1. Colour - the survey participants’ location.
2. Opacity - the survey participants’ age-range. Younger age-range is more opaque than older age-ranges.
3. Size - the participants’ self-reported knowledge of HIV/AIDS. Smaller sizes mean lesser knowledge than larger sizes.

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4. Glyph - the ♦ diamond star symbolizes membership to a Canadian aboriginal group.
5. Motion - the participants' attitude towards HIV/AIDS. More movement means greater discomfort.

The horizontal and vertical axes have no particular encoding. Thus, people are unrestricted when creating their own groupings of data-points in any area of the visualization. Groupings of fireflies (see Figure 2) can be made with sorting categories based on the participants' demographics. Predefined sorting categories are based on *location*, *age-range*, *knowledge*, and *attitude* data. Other means of grouping include querying and clicking on any firefly to find similar fireflies. Clusters can also be moved around in space, allowing people to fine-tune the positions of their groupings.

#### 4 SIMILAR WORKS

Some existing artworks have similar aesthetics and techniques to Fireflies. Most notably, Damien Hirst's Spot paintings [6]—containing different coloured dots arranged harmoniously in multiple geometric patterns—and WeFeelFine [7]—an interactive artwork visualizing human emotions around the world through self-organizing particles—served as inspiration in the design of Fireflies.

#### 5 RELEVANCE TO METAMORPHOSES

We designed Fireflies to enable exploration for curiosity. People are free to make their own groupings of data-points while using Fireflies. This freedom allows for interesting groupings and positioning of data-points to occur, much like in Metamorphoses where transformations are capricious, left in the whims of the gods. Whether the groupings have immediate meaning or not, it is up to the person exploring; however, by observing the different clusters of data-points, it is possible that the observer will arrive to new knowledge regarding the dataset. Consequently, the visualization becomes an ever changing spectacle of colours and motion.

#### 6 INSTALLATION REQUIREMENTS

Our submission will include high-resolution prints of six configurations of Fireflies. The prints will measure approximately 3'x4' each. Thus, we require mounting fixtures on the walls or boards and lighting. We can submit more or less images upon request.

We also require an interactive screen and a computer with a modern browser such as Google Chrome to showcase our interactive visualization. A projector or screen to show a video will suffice in the event of a touch-enabled screen being unavailable.

#### 7 OTHER EXHIBITIONS

Our work appeared at the Herringer Kiss Gallery<sup>1</sup> in Calgary, Alberta, Canada as part of the September 2016 Beakerhead Festival<sup>2</sup>. It is a part of the exhibit entitled *Murmuration*, curated by Marjan Eggermont (one of the authors).

#### 8 CONCLUSION

Biomimicry is a great inspiration for finding solutions to problems. The InfoVis community can benefit from it and leverage biomimicry for designing new visualization techniques. We illustrated how this process can lead to an expressive visualization metaphor in Fireflies. The apparent behaviour animation we used gives striking character to fireflies representing participants who have some discomfort towards HIV/AIDS. Furthermore, the enticing motion of the fireflies as they form clusters may engage people to look for other clusters and to explore the dataset more thoroughly. Fireflies

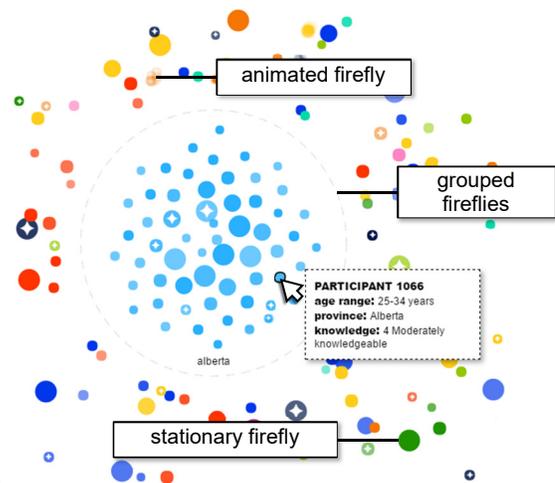


Figure 2: Reading the metaphor: each survey participant is encoded as a *firefly* (coloured dot) whose motion depicts their comfort level regarding people with HIV/AIDS.

thus becomes an example as to how Art and Biomimicry can be a means to communicate data and engage the public.

#### 9 BIOGRAPHIES

**Bon Adriel Aseniero** is a Computer Science PhD student at the University of Calgary. His research concentrates on the design and study of alternative visualizations for personal well-being.

**Charles Perin** is a computer scientist specializing in InfoVis and human-computer interaction. He is currently a post-doc at the University of Calgary, InnoVis Group. He is particularly interested in studying new interactions for visualizations.

**Marjan Eggermont** is the Associate Dean (Student Affairs) and a senior instructor in The Schulich School of Engineering at the University of Calgary, teaching in the area of engineering design and communication. She is also an artist who exhibits nationally and internationally. Marjan teaches graphics, communication, technology and design history, biomimicry, and InfoVis.

**Sheelagh Cappendale**, a professor in the Department of Computer Science at the University of Calgary, leads the InnoVis research group. Her research on information visualization, large interactive displays, and new media draws on her background in Computer Science, Art and Design. She has found the combined background invaluable in her research.

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<sup>1</sup> <http://herringerkissgallery.com>

<sup>2</sup> <http://beakerhead.com>