# Fireflies: Biomimicry-Inspired InfoVis for Exploring Public Opinion about an Infectious Disease

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Bon Adriel Aseniero[*] University of Calgary

Charles Perin[†] University of Calgary

Marjan Eggermont[‡] University of Calgary

Sheelagh Carpendale[§] University of Calgary


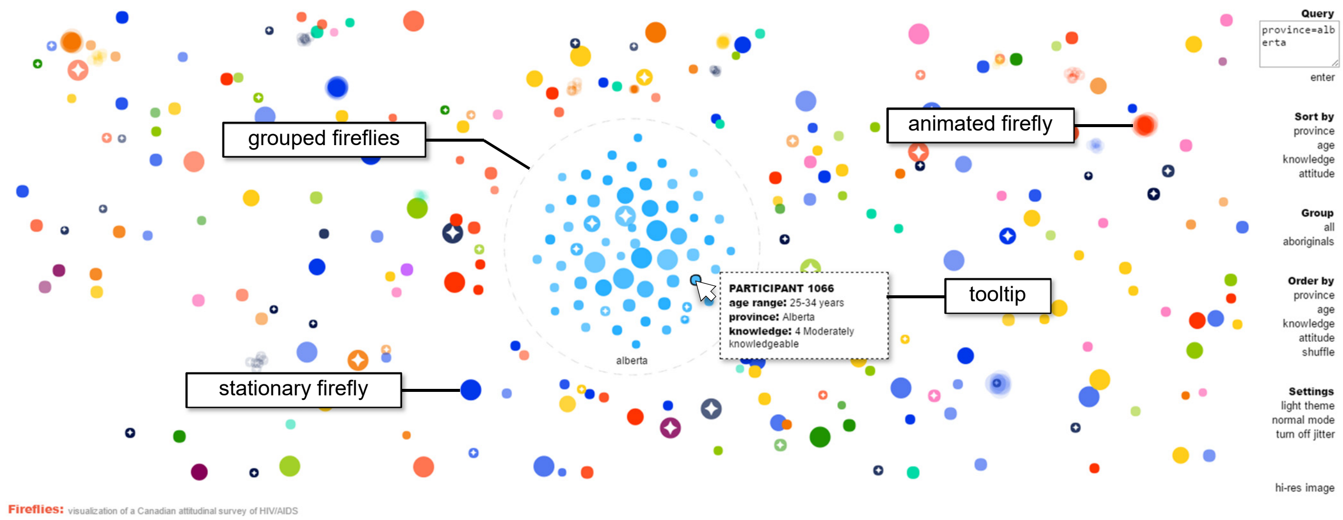


Figure 1: *A sprinkle of data*—Fireflies is a biomimicry-inspired visualization depicting data from a 2012 Canadian HIV/AIDS attitudinal survey. Each participant from the study is encoded as a *firefly* (coloured dot) whose motion depicts their comfort levels regarding HIV/AIDS. Fireflies are arranged randomly in 2D space, enticing individuals to interact with the visualization to make their own meaningful groupings.


## Abstract

We present Fireflies, an exploration of bio-inspired visualization using animal swarming behaviours and plant phyllotaxis. We applied Fireflies to a Canadian attitudinal survey on HIV/AIDS. Information about the survey participants is encoded within different visual elements of fireflies; most importantly, the motion of the fireflies depicts comfort levels concerning HIV/AIDS. The bio-inspired visual properties of Fireflies meld into an expressive representation of a sensitive dataset.


## 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.

Biomimicry has been applied to many engineering design challenges in the last decade: from minuscule syringe needles made less painful by copying mosquito proboscis [2], to enormous bullet trains made quiet by copying kingfisher beaks [3]. However, biomimicry's application to information processing is still under-explored. Hence, Fireflies (see Figure 1) is a preliminary exploration as to how biomimicry can be applied in information processing. In particular, we look into how inspirations from nature can be leveraged in order to encode data into a visual representation that enables people to explore complex data. We describe our process of applying biomimicry to the design of a visualization.

## 2 Data

The data visualized in Fireflies comes from a 2012 Canadian HIV/AIDS attitudinal survey, which we retrieved from the Government of Canada's online data repository [4]. The dataset contains demographic information such as participants' age range and location, as well as whether they identify as members of Canada's aboriginal population who are disproportionately affected by HIV/AIDS [5]. Furthermore, it includes information about participants' ideas or knowledge on how the virus spreads, and their opinions about the disease obtained through a series of questions regarding HIV/AIDS.

Given the nature of our dataset, we focused on participants' attitude towards HIV/AIDS. We measured this based on their answers to questions eliciting their opinions about HIV/AIDS. Some opinion questions required them to answer whether they agree or disagree with certain statements such as *"I feel afraid of people living with HIV/AIDS."* Other opinion questions required them to rate their comfort level (very uncomfortable to very comfortable) regarding hypothetical scenarios such as *"How comfortable of uncomfortable would you be with a close friend or family member dating someone with HIV/AIDS?"*


[*] email: baasenie@ucalgary.ca
[†] email: charles.perin@ucalgary.ca
[‡] email: meggermo@ucalgary.ca
[§] email: sheelagh@ucalgary.ca

## 3 Design Process

After examining the dataset, we defined goals for designing an engaging visualization which is both visually expressive and useful for exploring this sensitive dataset. These goals include providing expressiveness through visual variables such as motion; enabling the creation of meaningful groups or clusters of data-points; and supporting conventional means of exploration such as sorting and querying. Our approach in achieving these goals was to use inspirations from nature.

One inspiration is animal flocking and swarming behaviour. The metaphor we used to allow people to make their own groupings of data-points is based off a naïve swarming behaviour of insects, where members of the swarm fly towards a food source (see Figure 2). People can place queries (as food sources) in the visualization space and the fireflies that meet the requirements get drawn to query's position. This interaction is similar to that in Dust & Magnets by Yi et al. [6]. In their visualization, magnets—representing a query—are placed in the visual space and attract the dust—representing the data-points—that meet the requirements of the query. Those that do not meet the requirements are repelled. By applying bio-inspired algorithms, we introduce collision detection (loosely modelled after boids [7]).

We also made use of animal motion that depict their character to encode other aspects of the data. Motion can depict behavioural characteristics such as "aggressive" and "nonaggressive", "comfortable" and "uncomfortable." While these characteristics are seen in real-life animals, they may be less apparent in abstract representations (e.g., a circle representing an animal). Hence, we look at how we perceive *apparent behaviour* from animation [8]. Aggressive behaviours are typically accompanied by fast and jittering actions, while nonaggressive behaviours are accompanied by slow and calm actions.

To create firefly clusters, we used a phyllotactic pattern based off the algorithm by Vogel [9]. We used a 137.5° angle which mimics how sunflower seeds grow, giving us an efficient way of clustering undetermined numbers of fireflies.

## 4 Fireflies

The resulting visualization, Fireflies (Figure 1), visualizes a random sample of data-points as fireflies floating in space. During initialization, the fireflies are sprinkled randomly in the 2D space where the horizontal and vertical axes have no particular encoding. By freeing up these axes, people are unrestricted when creating their own meaningful groupings of the data-points in any area of the visualization. Each firefly's visual characteristics depict certain 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 bigger sizes.
4. Glyph - some fireflies have a ✦ diamond star symbolizing their membership to a Canadian aboriginal group.
5. Motion - the participants' attitude towards HIV/AIDS. More movement means more discomfort, while less movement mean less discomfort.

Groupings of fireflies can be made with predefined sorting categories based on the participants' demographics. The right-hand side of the visualization shows a list of available sorting categories (*location*, *age-range*, *knowledge*, and *attitude*). Clicking on each will group the fireflies into clusters based on the category. Another way of grouping fireflies is to perform textual queries, for example, by typing "province=alberta" in the query box. Lastly, clicking on fireflies will pull other fireflies that are similar to it. Similarity is currently determined by participant age-range and knowledge level, however, we plan on using a more complex similarity algorithm (e.g., apriori algorithm) in the future. Clustered fireflies can also be moved around, allowing people to fine-tune the positions of their groupings.


Figure 2: A sketch of a naïve swarming behavior. Fireflies will move towards a food source when food is introduced.

## 5 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 expressive visualization metaphors in Fireflies. The apparent behaviour animation we used gives striking character to fireflies representing participants who have some discomfort towards HIV/AIDS. This allows the visualization to immediately give people an idea of the amount of discomforted participants at-a-glance. Furthermore, the enticing motion of the fireflies as they form clusters could engage people to look for other clusters to explore the dataset more thoroughly.

Our hope is that in the future, this preliminary exploration can be extended and generalized into a set of guidelines for applying biomimicry inspirations to InfoVis.

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