Drinking Behavior Patterns in Dairy Cattle

Negar Sadrzadeh[1], Arash Kamyabi [2]

[1] Animal Welfare Program, University of British Columbia, Canada
[2] Department of Electrical and Computer Engineering, University of British Columbia, Canada
negar.sadr@ubc.ca
arash.kamyabi@gmail.com

Abstract

This project investigates the consistent individual differences in drinking behavior of cows, as well as the relationship between frequency and duration of visits and water intake.

1 Introduction

As sustainable consumption of freshwater resources is becoming a subject of increasing importance, dairy farms are incentivised by both environmental policymakers and consumers to re-evaluate their best management practices. In agriculture, best management practices (BMP) for use of freshwater are defined as practices that minimize pollution entering surface waters [1], and in general described as promoting sustainable use of resources without loss of benefits. As such, there is an increasing demand to better understand the drinking behavior of dairy cows. Water is a key nutrient for dairy cows and water deprivation can adversely affect their health, behavior, and performance [2]. The negative effects of water deprivation include an increase in hematocrit and blood urea [3], lower respiratory rate, and more aggressive behavior around waterers [4].

Unfortunately, the quality and quantity of water are not sufficiently considered in milk production in modern dairy farms [5]. Ad libitum access to water, also known as free access, is known to promote to dairy cattle welfare and production. However, not every dairy farm has the appropriate environment to support ad libitum access. Moreover, farmers can't evaluate the efficiency of their drinking system based only on herd level drinking behaviour since this behaviour can vary across individual cows and each cow responds differently to changes in feed, environment and social grouping [6]. Therefore, for optimal decisions on water access and housing, individual differences should also be considered. Although there is considerable literature on the prediction of water intake, there has been a very few studies on the drinking behavior of dairy cattle. While it is generally accepted that dairy cows require large amounts of water, there is little consensus on how often and when dairy cows drink.

There is even fewer studies on the drinking behaviour of the individuals and how their water intake and behaviour are affected by their housing systems [7]. These questions must be properly addressed to improve housing, BMP, and water supplies in dairy farms.

Fortunately, technological advancements have allowed for widespread deployment of sensors to capture high-resolution data that can provide insight into individual behaviors. For example, InsenTec system, shown in figure 1, is a system for monitoring the feeding and drinking behaviour of group-housed cows [8]. In a longitudinal study conducted at the UBC Dairy Education and Research Centre, a pen of 48 lactating Holstein cows with access to 24 feed bins and four water bins were studied for ten months. The dataset collected from the InsenTec system during this study could be analyzed to investigate the individual differences in the drinking behaviour of dairy cows and explore the relationship between frequency and duration of visits and water intake.

This project is closely related to my research and master's project as I am a research assistant at UBC Dairy Education and Research Centre and my main focus is on automated monitoring of resource usage.

Figure 1: An InsenTec bin

2 Related Work

There has been considerable research on factors that affect free water intake. Some of the most frequently cited parameters include dry matter intake [9, 10], milk yield [11], dry matter content , and different expressions of climate conditions [12, 11], and to a lesser extent, BW [10, 11] and sodium intake [11]. Several authors also noted that although restricting water access results in cattle drinking more at each drinking opportunity, their total water intake will be lower and insufficient [13, 14, 15, **?**]. The effects of drinking behavior on performance of cattle have also been the subject of research. Notably, a systematic literature review was conducted to explore the relationship between drinking frequency and cattle performance [16]. This review highlighted a number of important gaps in the literature where future work is required to better understand the optimum drinking frequency of cattle and effects of water availability on health, welfare and performance. While this body of knowledge can

help predict water intake of dairy farms, it does not address the drinking behavior of the dairy cattle such as frequency and duration.

In a paper released by the American Dairy Science Association, [17] investigated the drinking behavior of dairy cows managed in a modern dairy farm, and clarify links between behavior and water intake. Although this work is more aligned with the subject of this study, the authors took a statistical approach to the problem with minimal visualizations. Moreover, the statistics represent the herd as whole and give little insight into the individual behavior of the dairy cows.

As discussed, drinking behavior of cattle varies based on numerous factors and this behavior can be different for every herd. Thus, UBC researchers require data relevant to their cattle to understand their drinking behavior. In fact, in a recent project, the UBC Dairy Education and Research Centre has developed a data visualization tool to analyze the data on their cattle herds. The tool, named 'Peek-a-Moo' can show statistical data on an individual cow's eating, sleeping, and socializing patterns. We hope to build on this tool to develop new visualization idioms on the drinking behavior of the cattle.

3 Data and Task Abstraction

The dataset is static and sequential consisting of 182951 data points ordered by time. Each data point contains the information regarding a cow visiting a water bin for drinking water. The attributes of visits are noted in Table 1. Throughout the trial 48 cows at any given time had access to the water bins. The total number of the cows who have taken part in the experiment is 166.

Cow ID	**Bin Number**	**Date and Time**	**Duration of the Visit**	**Water Intake Amount**
Categorical	Categorical	Ordinal	Quantitative Unit = Second	Quantitative Unit = Kg
177 values	5 values	Range = 15/7/2020 - 3/5/2021	Range = 1 - 1000	Range = 0 - 40

Table 1: Data Abstraction

Task abstraction for this visualization project includes:

1. Discover the distribution and correlation between duration of visits and water intake amount, among all visits
2. Present and summarize the visits
3. Explore the correlation between the time of the day/year and visits (feature?)

4. Explore the distribution and correlation between water intake and duration of visits for each cow
5. Present the drinking behaviour of each cow throughout the trial and summarize it
6. Discover or derive similarities in the drinking behaviour of individuals
7. Compare the drinking behaviour of different cows
8. Summarize the behaviour of all cows
9. Identify the outlier cows

4 Solutions

An interactive dashboard where the users can select to look at different individuals up to group level. The user can select to look at the data on visit scale and daily scale in different time intervals, for the selected cows. The user would be able to add/remove attributes. Different time intervals can be chosen to observe. Preferably, we would have clustering options based on different combinations of attributes.

The visits can be represented as rectangles on a timeline based on the time and duration, and the area of the rectangle represents the amount of intake (the width). Also, the amount of intake can be coded by saturation and, the hue channel can be used for different cows. Figure 2 shows some of the ideas. I don't exactly know how to represent the daily drinking behaviour but the most straightforward is to use the number of visits per day, total intake, and total duration, but we'll lose some information by using this data abstraction.

The main tool for the project will be Python.

5 Milestones

- One week of Data Exploration in Tableau (DONE)
- Decision Making for the tool (Python/Tableau) (DONE)
- Background scanning on related work with similar tasks or vis tool solutions (DONE)
- First pass of task abstractions (DONE)
- Data management and cleaning (In Progress - Negar)
- Iterative reflection on tasks while working on the project (In Progress - Joint)
- Prototype a vis tool to show the data trends (In progress - Joint)
- Update Report/Final presentation/Final report (To be done - Joint)

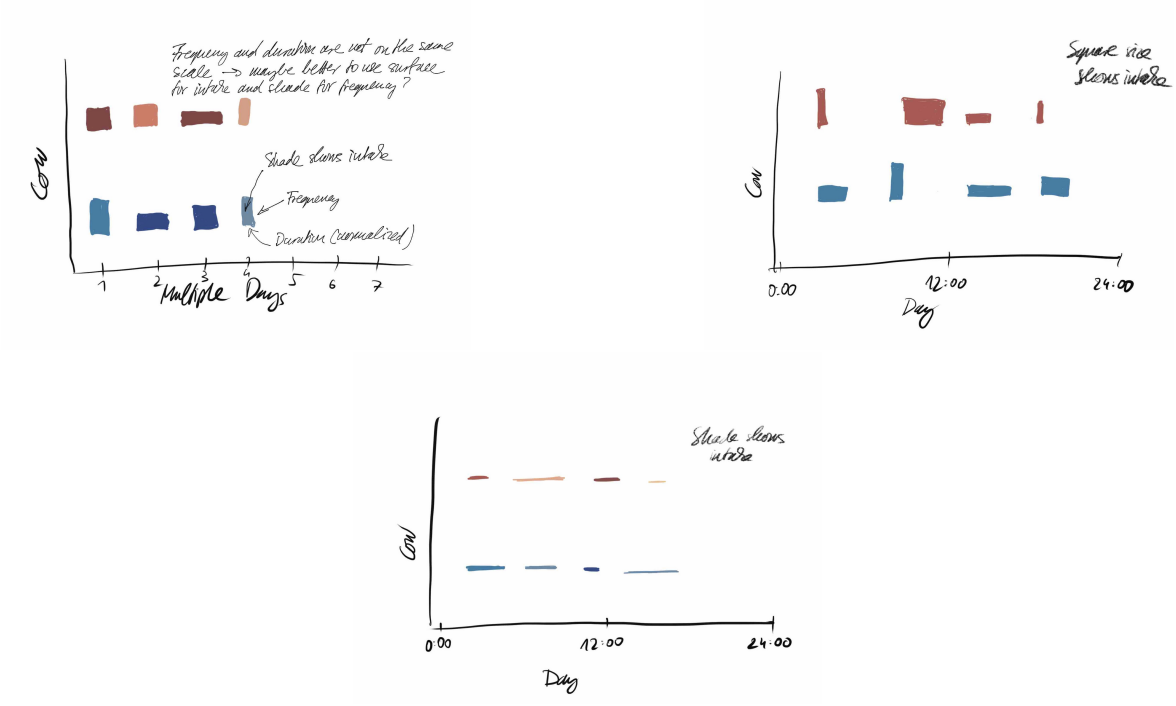

Figure 2: Ideas for Marks and Channels

6 Discussion

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