Microsimulation methods for the optimal length of waiting periods of cows

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Abstract

Given all the historic data of the dairy farm, our task is to determine how to model the economic decision problem in such a way that the user will become capable to decide in such a way that according to the available data the most profitable decision could be met. From a different viewpoint, we aim to have a system that enables the farmers to optimize the composition of the farm's cows for better profitability.

Introduction

One of the most unpredictable, the most profit sensitive sector of the common section of agriculture and economy is milk production. Since the anticipated milk price is volatile, we have to design scalable models to get efficient solutions [3]. According to some studies it is gainful to make predictions [4]. In the present study we investigate the possibility of effective economic modelling of an important decision: when to sell the cow after a diagnosed new mastitis illness. After visiting a few local farms, and getting to know more about the problem, we can say, that usually they sell a cow when it is in a very bad shape.

So far it looks like a cow is treated with the proper medicine once it gets ill with mastitis, and it is kept - if it is not in a really bad shape that it has to be sold. Using some mathematics, simulations and programming we can estimate the expected profit of an animal if we keep it or sell it. This way farmers do not have to keep unprofitable cows.

The whole planned research will last for years. First step is to show that the realistic based conception has it's own limitations. Later we plan to extend the system to a data mining and decision support system based on sophisticated method. We shall also complete our model to incorporate the related connecting economic subsystems such as the animal food production and milk processing.

Materials

A project like this requires close cooperation between programmers and agriculture workers. While we were collecting data for our study, we have visited a few diary farms. Using the most important factors of a cow's life we have built a pretty simple but hopefully detailed enough model (see Figure 1.)

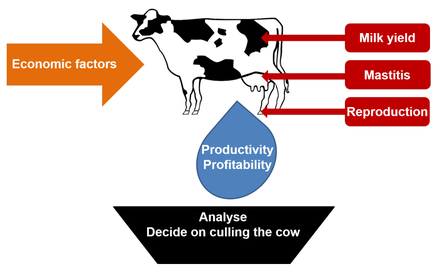

Figure 1: Problem field.

With just a few information we can simulate the future of a cow. The starting data includes some data about the cow from the age to the illness number. And we also calculated some probabilities to make our decisions more realistic from some historical data. For example with the higher number of mastitis it will be more likely that a cow gets ill again. Although the milk production of a cow follows a specific curve, the dairy cycle curve, according to our computational tests, to optimise the purchasing decision, we can assume that the milk production is constant within the dairy cycle.

Data collection from dairy farms and some other sources. Let's look at some simple, specific data:

- milking period, 305 days of giving milk
- 60 days of the dry period
- the profit at each condition, milking: 500 Ft/day, dry period/after mastitis: -700 Ft/day, mastitis: -900 Ft/day
- long is a mastitis event: 5-10 days

Methods

With our microsimulation model we investigate the possible best way to decide when to sell the ill cow. The basis of our technique is to simulate the life of a cow on daily basis. In other words, we start with a cow of a given age, number of already suffered mastitis illness, and in a given phase of the dairy cycle. For each day we check a list of possible event in the life of a cow. If an event is possible then we generate a random number to simulate a realistic experiment. This way we generate a list of events for the rest of the cow's life. So we can manage multiple events at the same time. For example we can keep on counting the lactation cycle days, while the cow is ill. While computing the possible events we use the same which were used during the calculation of our data. So the methods to determine the possible events can rely on fixed data, probability dispersion, or even a full list of historical data.

Having a model for the financial description for a cow, we simulate 100 times the possible outcome to have an approximate stochastic description of the distribution function of the profit. Then we can determine an optimal decision on the expected achievable profit. This microsimulation approach is similar to that used to investigate whether a time based ticket system is better than the existing trip based on in public transportation in Szeged [1].

The simple program that is capable to solve such problems with straightforward input data is available for smart phones and tablets at www.inf.u-szeged.hu/∼banhelyi/Buu. With just a few information we can simulate the future of an ill cow. The starting data includes some data about the cow from the age to the illness number. Figure 2. presents a sample of our prototype.

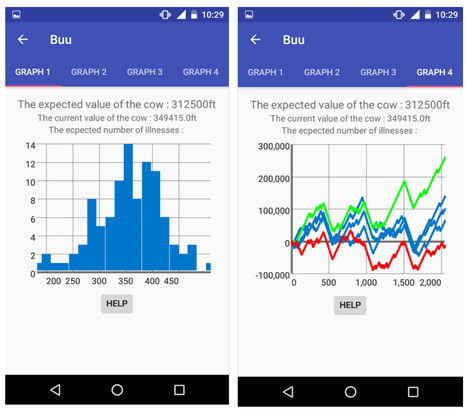

Figure 2: Smart phone application - distributions.

Extension

After having a smart phone based microsimulation tool for the optimal decision to be made on selling/keeping the ill cow (mastitis) last year, we have started a new applied research project to improve the quality of the decision and the profitability. We can get improvement by utilizing local data of the given dairy farm instead of national average values of the critical parameters such as chances to get the illness again, length of the dry and productive periods etc. We report on the preliminary profitability improvement results.

Extension of our first application:

- simulation not only started from a mastitis event
- more events, for example, an ethical question with a pregnant cow
- simulation from real data, collect special information from databases

We made a new method, based on labeling technic. This technic used labeling rules to add or remove the label for every day of the cow. From these labels, we can calculate the profit. You can see short example in Figure 3. for after 305 days of consecutive milking days, a cow stops giving milk, and it will give milk again after a calving 60 days later the cow is capable for a new insemination.

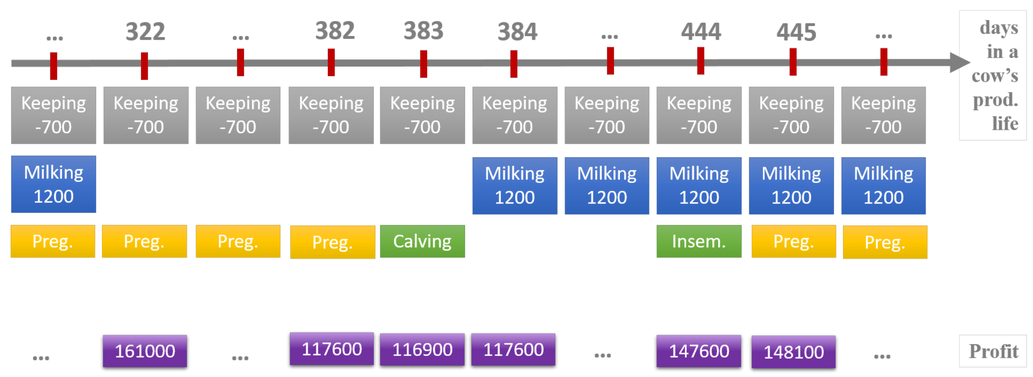

Figure 3: Short example for labelling method.

Results

By using our simulations we can predict the future of a cow, as you can see it in Figure 4.

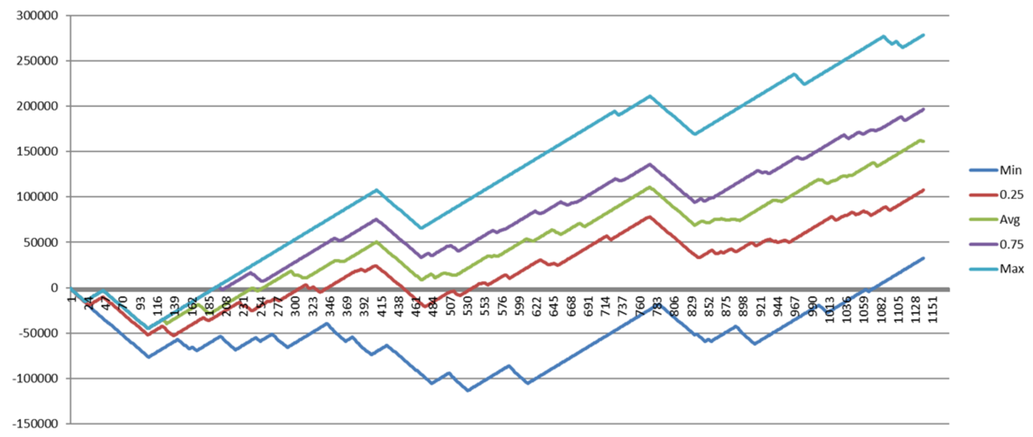

Figure 4: Cumulated profit of a cow in HUF according to the days spent in the farm. The minimal, maximal, average and 2 further quartiles curves of the distribution are depicted. These results were obtained based on 100 independent simulations of the probabilistic events in the model.

Object oriented Java implementation not only makes it easier to supplement our program with newer and newer rules and labels. For example with this new technology, we can determine the expected length of the waiting period after calving or the best number of the insemination experiment before selling the cow.

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