Artificial Intelligence For Craft Cannabis

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ABSTRACT

Extraction artists need help. While Big Data is nearly everywhere in the cannabis industry, extraction is still stuck in the last century. However, Artificial Intelligence is not the Savior of all. Data by itself is meaningless, incomplete, and devoid of solutions.

Delic Labs presents their approach to Artificial Intelligence (AI) for extraction optimization by applying Gaussian Processes to a limited dataset and Bayesian Optimization for the continuous improvement of a client's extraction process.

Ultimately, this approach to AI allows for the efficient optimization of individual extraction setups and specialization for each available input and desired output.

ARTICLE

CANNABIS AND BIG DATA

As world events are constantly changing, adapting and disrupting, so are the cannabis industry and the needs of producers. In a modern world where it seems Big Tech is influencing every moment of our lives, cannabis industry players have easily adopted Big Data solutions for various aspects of their businesses, like inventory management, sales analytics, and loyalty programs. Somehow, one aspect of the cannabis value chain, extraction, has not experienced the takeover by such high-tech solutions.

Cannabis extraction is an art. It is done with the hands and minds of the extraction artists to craft artisan cannabis extracts for the specific customer that they know. However, in today's cannabis economy of declining commodity prices and increased customer education, it is becoming important for producers to find ways to decrease production costs, while simultaneously increasing product quality and specialization.

EXTRACTION AND ARTIFICIAL INTELLIGENCE

To meet all these goals, we turned to artificial intelligence. We envisioned a "robot" that gives us the answer to high-extraction efficiency, lowest solvent use, bespoke parameters for inputs and outputs, absolute product purity, and 100% reliability. But this "Extraction Optimus Prime" is, for now, a pipe dream.

Artificial intelligence is a catch-all term that every person interprets differently, from Siri and Alexa to The Terminator. In our case, it means that we need to find extraction data that can be used as the basis for an algorithm that describes how cannabis extraction behaves. We need to decide which data points we need to gather, as data is not free. Taking datapoints costs time, money, instrumentation, and storage capacity. We need to consider a few questions before we aimlessly start to note down the weather outside the extraction facility.

- Why are you collecting data?
- What questions are you trying to answer?
- Are you going to use that data?
- Does data collection change the process?
- Collecting data costs money!

Just about anything is better than collecting data and not using it! And even after we collected all this data, we stumble upon another truth of data science: Data has no inherent value. The value only comes from the information that may be obtained from it. Therefore, it must be our goal to process, organize, and analyze the data. Focus on the data you really need and that leads to

insights, and most importantly iterate the process. This way everyone can improve on it the next time.

MAKING SENSE OF DATA

To train AI we must start with data: complete, carefully collected data. From this we can discover patterns, modify and adjust when more data becomes available. There are various ways this can be done for cannabis extraction:

Single factor optimization: This is the way we normally think about optimization. Change one variable, while holding everything else constant. This is slow, will miss any interaction effects, and cannot cover all possible conditions.

Classic design of experiment: Here we use a few pre-planned experiments to cover a larger condition space to develop a response surface to describe the processes. We can find interaction effects and cut the number of experiments. But it does not work with unplanned, historic datasets and for many factors the number of experiments required becomes too expensive.

Ordinary least square: Take a large dataset and use linear regression models to find the formula with the best fit to describe the dataset. Although, the datasets we have on extraction are small, incomplete and full of mistakes.

Gaussian and Bayesian: The combination of Gaussian process and Bayesian optimization is our chosen solution. A Gaussian process can be thought of as placing an infinite number of mathematical functions over the datapoints in our dataset, and then scoring those functions for its accuracy. This produces an overall function that represents a description of the extraction behaviour with confidence intervals (Figure 1). The Bayesian Optimization will then survey the Gaussian Process area and find the point that predicts the best conditions. In Figure 1, it is just left of the observation around 2 on the x-axis. With this information, the next experiment should be performed at those conditions. The results will be fed back to the model and the Gaussian Process is updated. This iterative process will step-by-step close in on the best possible conditions for cannabis extraction (Figure 2).

Our approach of Bayesian Optimization allows us to utilize all available data, but also ensure we find the best possible condition in the most efficient way. So, have we solved cannabis extraction?

BEYOND AVERAGE CANNABIS

Yes, we have solved cannabis extraction by supercritical CO_2, but only for average cannabis:

- Run at ~60 °C, ~250 Bar, ~16 kg CO_2 per kg of feed/hour, ~36 kg of CO_2 per kg of feed to give ~90% recovery

Note, this is only for average cannabis! And average cannabis looks like this:

- THC: 7.4% / THCA: 3.2%
- CBD: 1.6% / CBDA: 2.5%
- Total cannabinoids: 13.7%
- Total terpenes: 0.3% / Water content: 9.1%

No one wants to extract this kind of cannabis; it is unlikely this kind of material even exists, although when we look at larger datasets of cannabis extraction, we find both high THC cannabis and CBD hemp in them.

The goal of this work and in general for our company is to optimize extraction for each producer. We want to optimize craft cannabis, not make soulless distillates. Therefore, we have taught our AI how to optimize for batch-to-batch variation, to best represent and respond to each cultivar. We now can optimize for specific goals, like product type, production costs, or just speed.

In the example below, the client wanted to keep the product characteristics but make the process cheaper. We managed to find conditions that kept the recovery at 90% and the cannabinoid concentration at 70%, while reducing the solvent use by 75% and the extraction time by 40%.

The industry needs to work together to realize the following goals:

- Build Accurate Models for all Extraction Systems
- Optimize Cost, Feedstock, Product
- Automatically run Model in Background
- Gather more Datapoints with every Run

At Delic Labs it is our goal to foster collaboration, education, and specialization. For this, we need your help.

Figure 1.

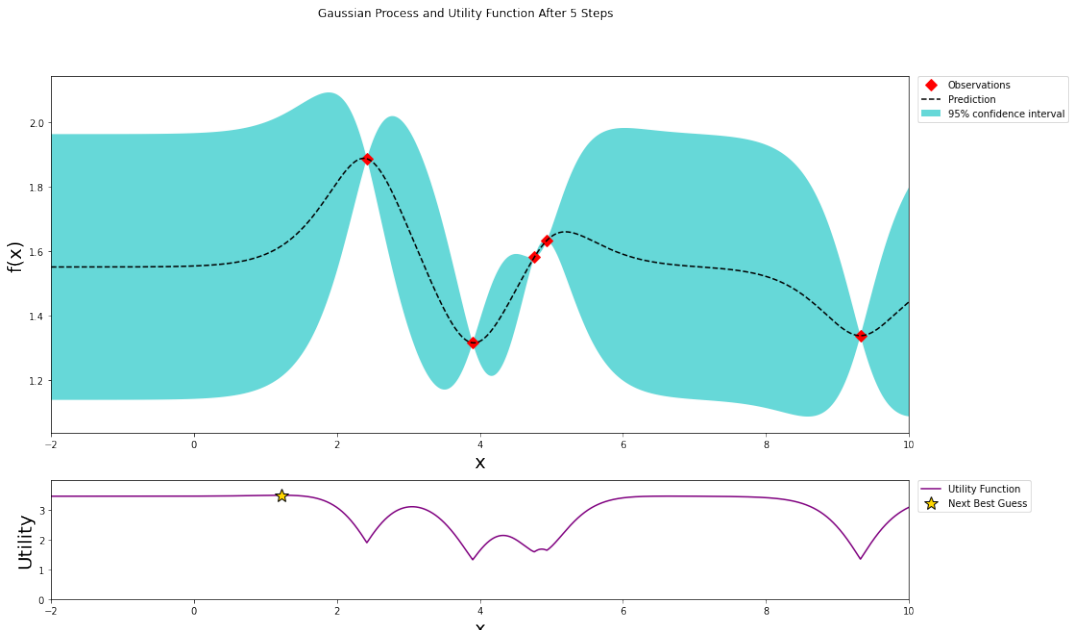

Figure 1: Gaussian Process description of five datapoints during the Bayesian Optimization of an extraction.

Figure 2.

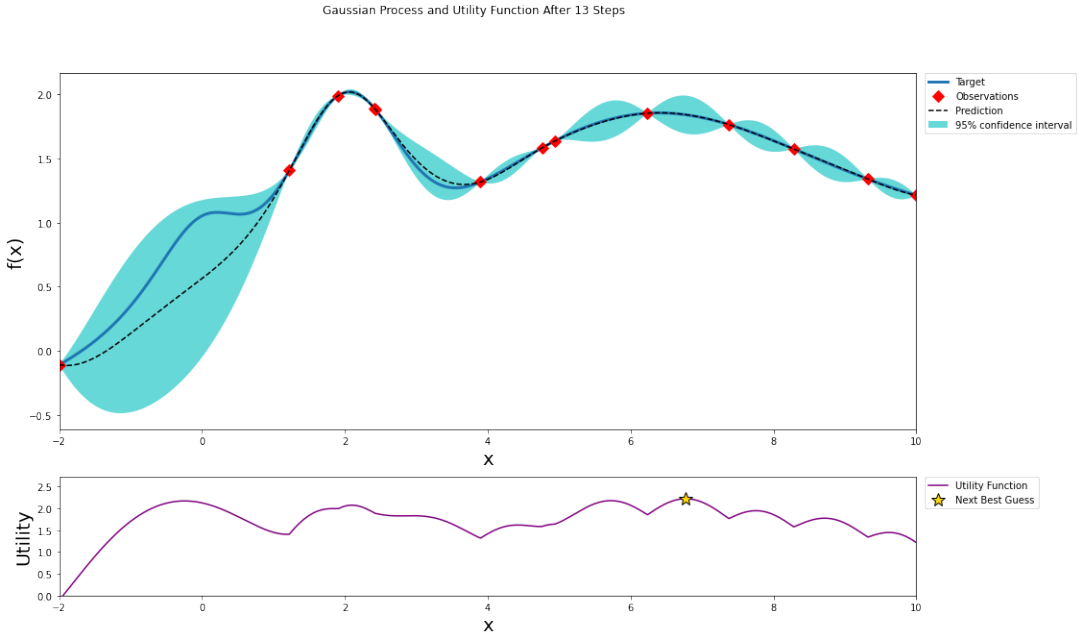

Figure 2: Optimized extraction surface through iterative experiments, guided by Bayesian Optimization. Note the lack of exploration in areas unlikely to yield a maxima.

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