Week_8_pf

There are many applications of Machine Learning in our daily life. Using your own words, explain the following questions.

- What are optimization problems in general?

Let's start with understanding what optimization is.

Imagine, we have some amount of money, and would like to create a portfolio, which contains a number of different shares, to minimize risk. One share can go up, another one going down. Our goal is to keep our profit high as much as possible.

Once upon a time, I was at the Siemens factory in Germany. Their building had trices, electric trices, which were managed by computer. Depending on day time, our weather conditions open wider or closer. As a result, it made electricity consumption more efficient.

To produce a scheme for a phone we would like to put every electronic component in the right place. Imagine an armed robot that takes a component and puts it on the board. How many movements should we take in order to use our robot?

All mentioned examples are about finding best value of something, best value of investing, best value of opening trices or best value of arm movements.

When I was studying for B.Sc. We learned an optimization method called a simplex method. Here are steps taken from this source:

1. **Set up the problem.** That is, write the objective function and the inequality constraints.
2. **Convert the inequalities into equations.** This is done by adding one slack variable for each inequality.
3. **Construct the initial simplex tableau.** Write the objective function as the bottom row.
4. **The most negative entry in the bottom row identifies the pivot column.**
5. **Calculate the quotients. The smallest quotient identifies a row. The element in the intersection of the column identified in step 4 and the row identified in this step is identified as the pivot element.** The quotients are computed by dividing the far right column by the identified column in step 4. A quotient that is a zero, or a negative number, or that has a zero in the denominator, is ignored.
6. **Perform pivoting to make all other entries in this column zero.** This is done the same way as we did with the Gauss-Jordan method.
7. **When there are no more negative entries in the bottom row, we are finished; otherwise, we start again from step 4.**
8. **Read off your answers.** Get the variables using the columns with 1 and 0s. All other variables are zero. The maximum value you are looking for appears in the bottom right

hand corner.

Mathematically we can write our observations like [this:](#)

minimize $f(x)$, *where* $x \in \mathbb{R}^n$
subject to:

$$g_i(x) \leq 0, i = 1, \ldots, m \quad \text{and}$$
$$h_j(x) = 0, j = 1, \ldots, p$$

where,
f(x) is the objective function.
$g_i(x)$ and $h_j(x)$ are the constraints that the objective function is subjected to.
$\mathbb{R}^n$ denotes n-dimensional space and is domain of the objective function.
'x' is the optimisation variable and because it belongs to n-dimensional space, it has n number of elements $[x_1, x_2, x_3, \ldots, x_n]$.

Just to mention: instead of minimize can be maximize, depending on the task.

From what we have learned, we saw that optimization can be met during the tuning parameters, also minimizing a loss function or getting maximum reward.

- How is reinforcement learning used for optimization in energy systems?

During the climate changes there is a need to take care of our energy consumption and management. Energy efficiency is the key. If we have a look at existem energy systems, like turbo-wind or atomic energy stations are very complicated. In addition to high demand of energy due to the increase of population it is very difficult to manage such systems optimally. Forthemore, because of the large number of energy sources it is difficult to unify them into a single system. By nature such large systems are distributed, multi located and have different policies.

Machine learning techniques have a potential especially in managing such systems. I think it would shine in case of model-free approaches. RL is interesting by the following case, for example. Based on data, say consumption, it can manage as an energy grid to provide more or less energy. Or, in some dangerous area, where war happens, some rebellions destroy the power station, such an event potentially can trigger the reroute of energy transportation.

Taking into account weather conditions energy flow also can be rerouted or increased or decreased.

RL also can help in protecting such systems against cyber attacks. For example, if a system detected a DDoS attack it can change the flow path, to send notifications to special forces etc.

RL is based on a data driven model which requires agents to take participation into the process. Agent decides using a data driven model and controls decision making by tuning parameters and rewarding the participants.

Self reflection

It is a pity that our course came to the end. I like it very much.

Reinforcement learning. Interestingly, when I was reading stuff this week, I remembered the days when I was working at IBM, about 15 years back. We had a lecture. One of the presenters was showing us a football game, how it is cool when a system self-trained based on the reward. Currently, at my work, I would like to add reinforcement capabilities in our service.

References:

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