Management framework for self learning predictive modelling of cyber-physical systems

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Introduction

In greenhouses, large amounts of data are collected for both control and statistical uses. This data also covers the thermodynamic properties of the greenhouse. In modern greenhouse control systems there is no extraction of these thermodynamic properties, nor use of these properties for activities such as state prediction. Prediction is in general a difficult topic with many different approaches but common for more advanced approaches such as machine learning approaches, is that they often include a lot of situation specific information making the solution useless for other situations or even other datasets, such as the same greenhouse, but with a different crop.
Today's climate control computers uses a mathematical deterministic model to improve the control system. Such a model is created from a reference year of weather data. The nature of a reference year, which is compiled from several years of data, makes the mathematical model unsuitable for short-term predictions ($\sim$1 day). Short-term prediction are very useful for optimization of electrical use or optimization of expensive CO_2 dosing, because the electrical prices changes a lot during the day. Similar situations occur in smart houses, which include many sensors and have intelligent and automatic control of surfaces such as windows, heating fixtures and lighting.

Problem Statement

The problem statement of this project is to identify and develop a number of models that can predict the state of cyber-physical systems, such as greenhouse control systems. For managing these models, a framework will also be required. This framework should also be capable of handling datasets to train the models with.
Secondly a variety of data processing tools are also required to prepare the data for model training. The framework should also be capable of letting users define properties in the data, such as inputs and outputs. Based on the data the optimal model(s) in the framework should be chosen to predict the system. It might be that several models are optimal, in which case the framework has to decide which to use or combine them.

Research Activities

a. Prototyping and experiments with self-learning models based on literature study.
b. Development of a self-learning model library.
c. Development of a domain specific language (DSL) to describe features and properties of the data.
d. Development of the combined predicting framework and evaluation in experimental greenhouses.

Figure 1 : Prediction is very hard task, often related to stock prices, but can also applied to other applications.

Figure 2 : Greenhouses is one of the many possible scenarios the project can be applied to.

Goal

The goal of this PhD project is to have a functioning prediction framework that can be applied to many different setups. The framework should allow the user to define the properties of the data that is collected, and the framework's output should then be connected to a control system.