CARL VON OSSIETZKY universität OLDENBURG
FAKULTÄT II
INFORMATIK, WIRTSCHAFTS- UND RECHTSWISSENSCHAFTEN

Master's Thesis

Causal Inference and Algorithmic Induction in Management

(practical / application-focused)

Description

In the context of our MigHANA research cooperation https://uol.de/en/vlba/projects/mighana) and together with our project partner OOWV (https://www.oowv.de/), we are developing innovative approaches for IT solutions supporting so-called "Management Control Systems" (MCSs; https://en.wikipedia.org/wiki/Management_control_system).

Management Control Systems are used to help organizations with accomplishing their goals. They use IT systems, or structured, unstructured, or even random interactions between people to provide feedback on achievement rates, to make predictions and to develop new forecasting and decision models.

Managers not only observe the world, but - if necessary and possible - actively intervene.

Such "interventions" can be operational, tactical, or strategic in nature. Examples are:

- Raw material is ordered because there is not enough left in stock (= operational).
- Minimum stock levels are increased as a demand increase is expected (= tactical).
- A company withdraws from a market because its products are no longer profitable due to rising raw material prices (= strategic).

In all three cases, the person in charge needs an idea of how certain interventions - taking all relevant factors into account - will affect the course of events. So, for example, "A 7% price increase with charcoal will only reduce demand by 0.5% if the weather is warm and the local soccer team wins" or "A 5% reduction in water rates between 10 p.m. and 6 a.m. will result in 20% less usage peaks". (By the way: "doing nothing" also counts as an intervention).

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In order to make the respective decisions, two prerequisites - among others - are required:

1. It must be known which interventions under which environmental conditions result in which consequences. The link to be investigated here goes beyond purely associative relationships (a certain action occurs together with certain results); rather, causal relationships (a certain action is causal for certain consequences) must be uncovered. Therefore, managers can be regarded as users/developers of causal models.

2. Over time, the nature, the extent, the variety, and the impact of possible interventions is subject to change: Fifty years ago, strengthening one's online presence in social media was not an option for action; before the introduction of electronic price displays, fuel prices could not be changed by the second; today, gender stereotypes in advertising campaigns provoke different reactions than in the 1950s.... In other words, the causal relationships mentioned above are not stable over time.

As we are tapping into an ever-growing and ever-changing flood of data, causal models a) become increasingly complex and b) must be revised in ever shorter time. Which raises the question whether model development and model revision can be supported by machines, for instance using methods for deriving causal hypotheses that have already been implemented (causal inference and algorithmic induction).

An introduction to the topic of "causal inference" can be found at https://youtu.be/nWaM6XmQEmU; for algorithmic induction in general, numerous technical articles can be found in the relevant databases; in principle, different approaches (machine learning, statistical methods) can be used here.

Problem Statement

As our project partner – OOWV – is planning to migrate from SAP's classic ERP and data warehousing solutions to their SAP HANA-based in-memory equivalents, expected performance improvements also provide an opportunity to implement ground-braking methods for the development of decision models based upon causal relationships in business practice.

This master's thesis therefore has four key objectives:

1. Collect business cases from the project partner's billing and consumption monitoring departments that could benefit from the automated generation of cause-effect models.

2. Develop architectural approaches that can – as prototypes – be implemented in an SAP environment (probably: SAP HANA, SAP S/4HANA, SAP BW/4HANA, SAP DWC plus Python and R) but are at the same time not limited to SAP.

3. Decide which (SAP- and Non-SAP) building blocks to use for a prototypical implementation.

4. Implement 2-3 scenarios mentioned under 1.

Requirement(s)

Ideally, the candidate should have some prior knowledge/interest in areas like machine learning, inductive statistics, plus a bit of curiosity when it comes to systems used by the upper echelons of major organizations; programming experience in Python and/or R is a prerequisite.

We will help the candidate to acquire SAP-related know-how; furthermore, self-contained training in terms of algorithmic induction and causal inference (in the latter area also with some already implemented methods) is required.

The subject is of particular interest to students aiming at a career as IT or management consultants (e.g. in the technology-driven spin-offs of major consulting firms). In view of the recent cluster of so-called black swans (https://en.wikipedia.org/wiki/Black_swan_theory), the subject brings a lot of potential when looking at software companies, technology-focused consulting firms, or academia as future employers.

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