Chapter 14
Machine Learning Time Series Models for Tea Pest Looper Infestation in Assam, India

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ABSTRACT

In the agriculture industry, pest infestation is a significant challenge that is complicated by the nonlinear relationship with environmental factors. Given the effectiveness of machine learning models in simulating such complex nonlinear phenomena, the authors opted to employ them in the modelling of the life cycle of tea pests, which impact several other crops as well. Accordingly, multiple machine learning models were developed to forecast the occurrence of tea pest looper infestations. They utilized data for just two readily available parameters—temperature and rainfall—to investigate whether predictive models of good quality can be created even with limited data, particularly for small tea growers. After analyzing the various models generated, they discovered that neural network models can produce accurate predictions even with a restricted data set. Therefore, they are optimistic that new age technologies such as machine learning can benefit many small farmers in India who lack access to various technologies and, as a result, have limited data.

1. INTRODUCTION

Despite the recent hype surrounding machine learning, it has existed in some capacity for over fifty

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years, ever since the advent of programmable computers. The quest for humans to impart instructions to machines (via written, verbal, or visual means) and for machines to comprehend these instructions intelligently and react to them like humans has been a captivating pursuit. One of the initial efforts toward this objective was labeled Cybernetics. Way back in 1948 Norbert Weiner defines Cybernetics as "Control and Communication" in engineering parlance while "thinking" in human context (Wiener, 1948). The concept was to establish a principle of regulation and communication applicable to both machines and living organisms. Scientists' comprehension of the term "thinking" has progressed considerably over the years. Initially, it was thought that thinking involved analyzing multiple scenarios related to a situation and choosing the best outcome. However, this perception limited the effectiveness of various mathematical machines, especially when faced with complex situations that resulted in a vast and nonlinear increase in the number of possible scenarios. The np versus p problems highlight this nonlinear growth in computations for np complex problems (Reference). These computations were overwhelming for computing machines of that era, even when performing relatively simple tasks (Reference). This necessitated a shift in scientists' thinking, resulting in the emergence of Knowledge-Based Expert Systems. The concept involves employing previous experience data to make decisions instead of analyzing all conceivable scenarios related to a decision-making situation. This approach can be summarized as the "If-Then" method of decision-making. Essentially, if a successful decision "x" was made in the past for a given situation "alpha," then the same decision "x" should be made in a comparable present scenario. Naturally, there are feedback loops and opportunities for refining decisions in subsequent real-world scenarios that are not binary. As one can make out that in such expert systems the availability of data of past experience becomes important in taking decisions for future. As technologies (hardware, software) improved in the last few decades, memory costs decreased and capturing of data became much easier and faster leading of explosion of data in last few years. This provided solid grounding for expert systems and the like to take a strong hold in the field of artificial intelligence / machine learning (Figure 1)

The figure above picturizes the evolution in the field of Machine Learning and how data and technology growth has accelerated it. Earlier approach to take data from a particular domain / phenomenon, analyze it for various causative factors pick up the few relevant ones to build analytical decisioning models. More recent approach with huge amounts of data available as well as huge computing power is available. The recent approach more aligned to the knowledge based expert systems described above where huge amount of data and computing power is used to train the models. There are some pros and cons associated with the currently more popular ML approach. The benefits include much faster model development, recalibration process compared to traditional analytical approach. Further with recent ML models the ability to model highly nonlinear phenomena is becoming more easier and easier. To the extent some people have started saying that the boundary between the p – np problem might be getting blur or at least shifting (Fifty Years of P vs. NP and the Possibility of the Impossible; By Lance Fortnow Communications of the ACM, January 2022, Vol. 65 No. 1, Pages 76-85). This in business sense means we can develop highly customized models. On the con side of such process / approach is that there is less of focus on identifying causal relation amongst the dependent independent variables (References). Further, with highly non-linear complex problems, the stability of solutions is an issue many a times. Last few years have been difficult for the tea industry due several factors such as cost of production, climate change and pest infestations (Kramer & Ware, 2021; Duncan et al., 2018; Brouder et al., 2017). Pest Infestations results in huge losses to the production of tea (Kachhawa and Kumawat, 2018; Ahuja et al., 2013; Samanta and Gosh, 2012). Some of the tea pests like Looper and Loopers results in losses of

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