



Fakulteta za elektrotehniko,
računalništvo in informatiko

Smart Agriculture and Numerical Association Rule Mining

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an der Donau

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Agenda

Introduction

Smart Agriculture

Data Collection

Numerical Association Rule Mining

Visualization of NARM Rules

Smart Agriculture

- Smart agriculture integrates modern technologies such as cloud computing, big data, the Internet of Things (IoT), and data mining.
- Its goal is to automate essential farming processes, making agriculture more sustainable.
- Time-series data in agriculture enables the application of machine learning methods to solve various problems.

Data Collection Using ESP32 Microcontroller

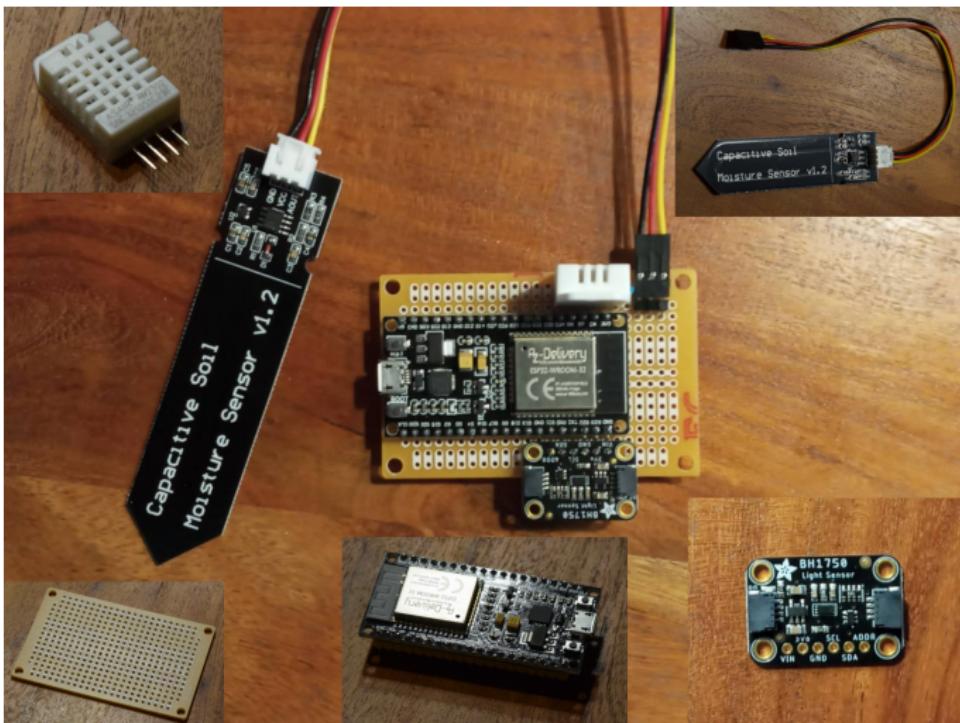


Image source:

<https://doi.org/10.1007/s12432-023-04694-7>

Figure: Data collection using the ESP32 microcontroller.

Data Collection: Aloe Vera Plants



Figure: Scenario 1



Figure: Scenario 2

Numerical Association Rule Mining

- Numerical Association Rule Mining (NARM) is an extension of traditional Association Rule Mining.
- Unlike conventional methods, NARM handles numerical attributes directly, without the need for discretization.
- **Advantage:** NARM operates with both categorical and numerical attributes, improving efficiency.
- **Evolutionary and swarm intelligence algorithms have shown significant success in this area.**

New approaches are being developed to address time series numerical association rule mining (TS-NARM).

Numerical Association Rule Mining Pipeline

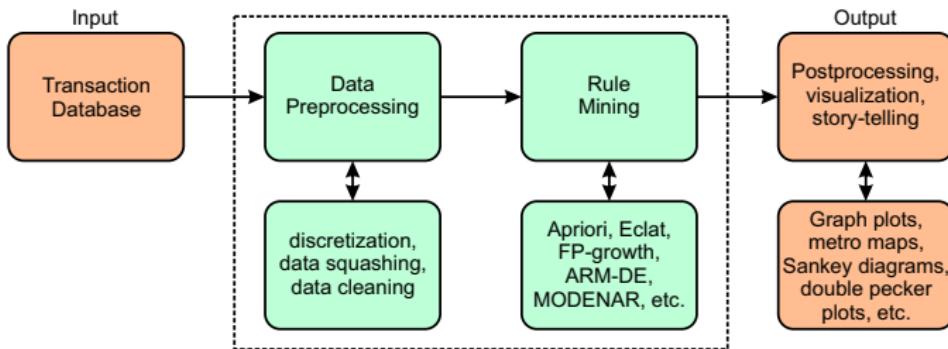


Figure: The basic NARM pipeline.

Image source:
<https://doi.org/10.1016/j.eswa.2023.120901>

Challenges in ARM Visualization and Explainability

- ARM algorithms often generate large volumes of association rules.
- The results can be opaque, making it difficult for non-expert users to interpret.
- Visualization is a powerful tool for improving the understanding of these rules.

Challenges in TS-NARM Visualization

- Visualizing time-series numerical association rules (TS-NARM) is a complex challenge.
- The goal is to present sequences of plots where trends can be easily identified.
- TS-NARM results are often difficult for users to understand.
- In terms of XAI, improving explainability and user comprehension is critical.

Proposed Visualization Approach for TS-NARM

- A novel approach is proposed for visualizing TS-NARM results.
- Time sequences of selected association rules (ARs) are displayed as a family of scatter plots.
- The approach captures trends by showing changes in attribute values over long-term periods.
- Developed for smart agriculture, the method delivers actionable insights to end users.

Focused View of a Rule

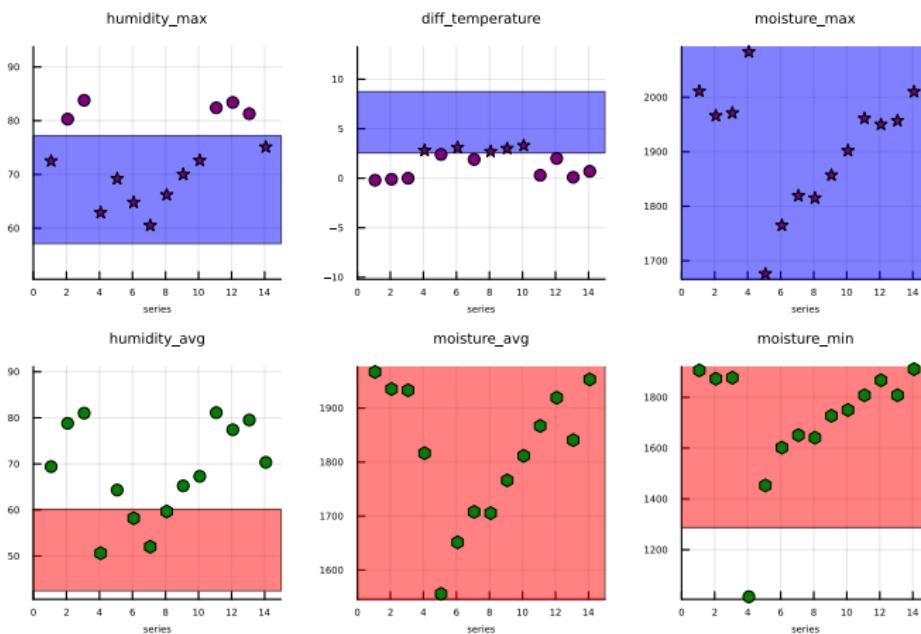


Figure: Focused view of a rule using NarmViz.

Image source:
<https://dx.doi.org/10.1111/exsy.13503>

Whole View of a Rule

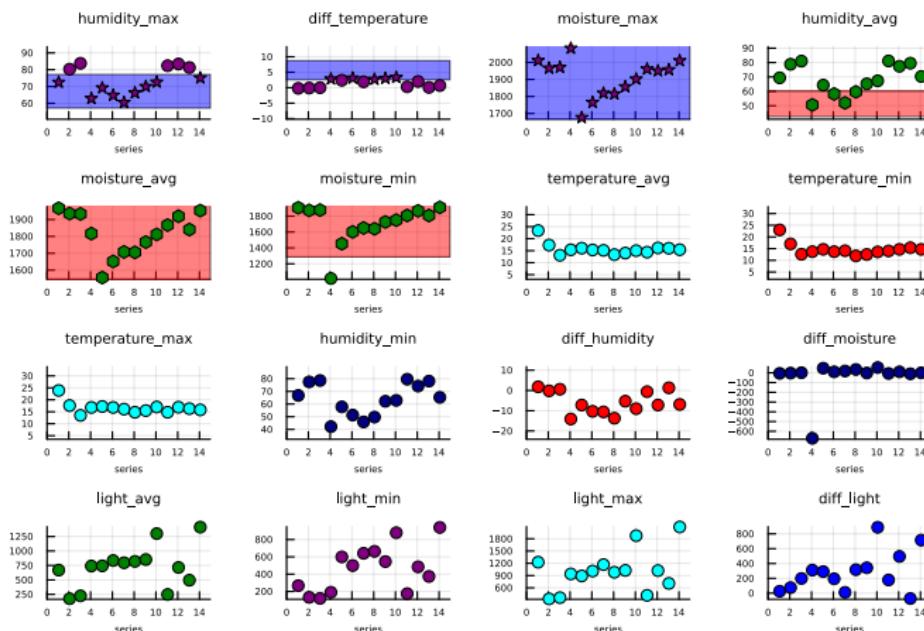


Figure: Whole view of a rule using NarmViz.

Image source:
<https://dx.doi.org/10.1111/exsy.13503>

Other topics: Computational intelligence in Sports

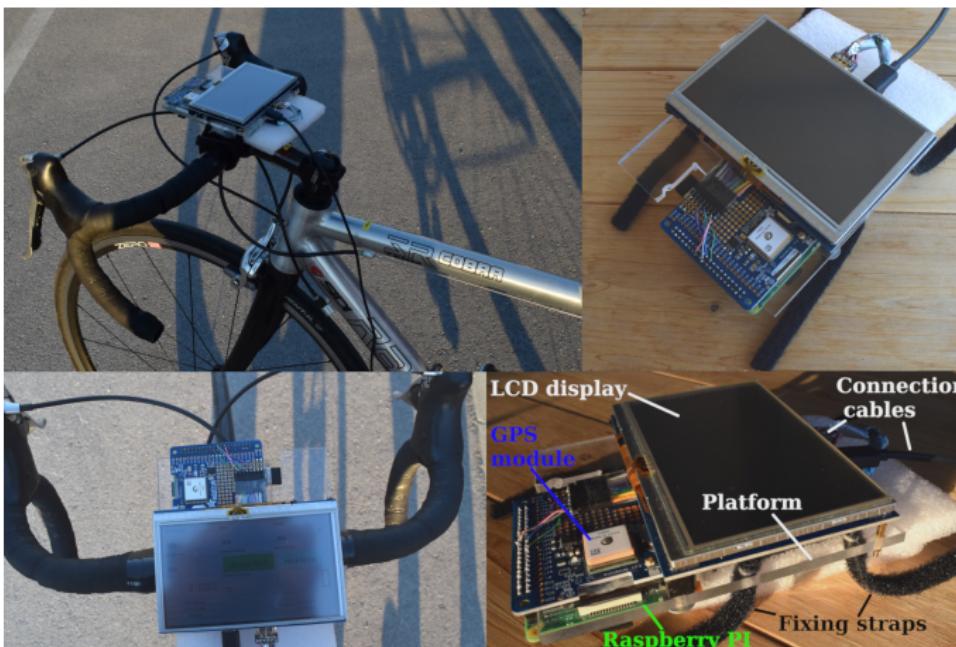


Figure: AST-Monitor digital twin.

Image source:
<https://github.com/firefly-cpp/AST-Monitor>

Questions and discussion

