AgDataBox: web platform of data integration, software, and methodologies for Digital Agriculture

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Abstract.
We provide the AgDataBox (ADB) web platform to add value to digital agriculture. A microservices architecture (ADB-MSA) was developed, and five applications it is under the developed (ADB-IoT and ADB-Remote Sensing) or testing (ADB-Mobile, ADB-Map, and ADB-Admin) phase. Microservices available in ADB-MSA allow the performance of specific tasks for thematic maps creation and management zones (MZs) delineation. It is possible to perform tasks to delineate MZs, such as data processing (preparation), data normalization, variable selection, data interpolation, data clustering, MZs rectification, and MZs evaluation. This platform allows for integrating data, software, procedures, and methodologies in the digital agriculture context.

Keywords.
Decision making, Precision agriculture, Computing.

Introduction

Agriculture is challenging to produce more profitably, with the world population expected to reach some 10 billion people by 2050 (United Nations, 2019). Such a challenge can be achieved by adopting precision agriculture and digital agriculture (Agriculture 4.0). Digital agriculture has become a reality with the availability of cheaper and more powerful sensors, actuators and microprocessors, high-bandwidth cellular communication, cloud communication, and Big Data. Digital agriculture enables the flow of information from used agricultural equipment and new services that transform data into valuable intelligence. In this new paradigm, large amounts of data are available, and the challenge is to add value to them. The data portals (data visualization) and work platforms (data transformation) are inserted in this context. The availability of specific portals and platforms for precision and digital agriculture is essential for users to transform data into new and more robust information and assist in decision making.

AgDataBox platform

Our platform (Fig. 1), called AgDataBox (ADB), aims at integrating data, software, procedures, and methodologies for digital agriculture. The current research is a joint project coordinated by the Western Paraná State University (UNIOESTE) and the Federal University of Technology - Paraná (UTFPR) with the cooperation of the Colorado State University (CSU), the United States Agricultural Research Service (USDA) in Columbia, the University of California Davis (UC Davis), the University of São Paulo (ESALQ/USP), and the Brazilian Agricultural Research Corporation (Embrapa). This platform continues the project of software SDUM (Software for Defining Management Zones, in Portuguese, Software para Definição de Unidades de Manejo).

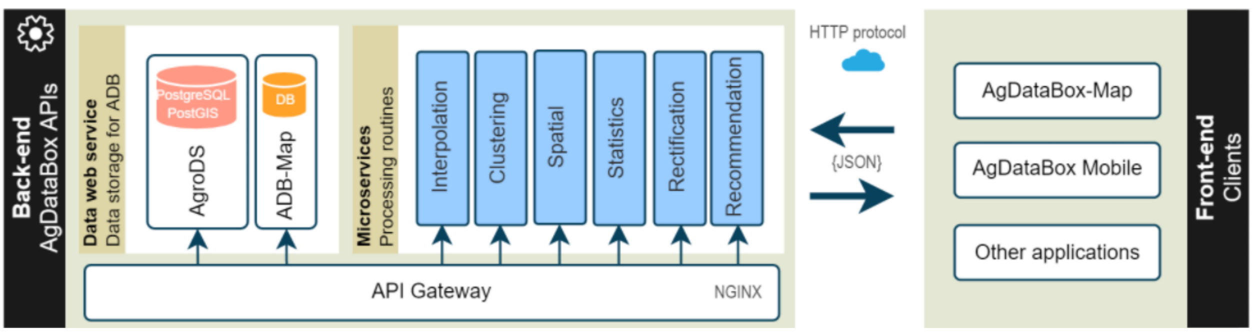

Fig 1. Representation of the concepts involving the microservices architecture of the AgDataBox platform, where the back-end layer contains the microservices, with routines and data, and the front-end are the applications that consume the microservices.

This Web Platform has a Microservices Architecture (ADB-MSA) with multiple Application Programming Interfaces (APIs) accessible through the Hypertext Transfer Protocol (HTTP) for transferring request and response messages expressed in JavaScript Object Notation (JSON) format. The ADB-MSA, where the data and processing routines are centered, enables the interoperability of several applications. The following applications are under testing (1, 2, and 3) or development (4 and 5):

1) ADB-Mobile: it operates on devices with Android operating systems and allows recording the variable for producer experience regarding the division of areas in management zones (MZs), other than recording field data, keeping a history of all operations and occurrences of a harvest, storing such data locally on the mobile device and a data server.
2) ADB-Map: it works with spatial data to create thematic maps and MZs to subsidize Precision Agriculture and Digital Agriculture (http://adb.md.utfpr.edu.br/map). It has a friendly graphical interface, which allows the user to import georeferenced data from the area, define contours, calculate statistics and prepare grids (samples or interpolated) to perform the available procedures. Thematic maps can be presented with options for choosing the color palette and dividing the data (equal intervals, quantile, standard deviation, or manual interval). Data interpolation methods are usually used to obtain a denser regular pixels grid. For the MZs delineation, clustering methods, MZs rectification,

and MZs quality indices are available. In addition, nutrient recommendation maps can be calculated.
3) ADB-Admin: its primary goal is to manage the resources provided by the API (ADB-API) to store platform data.
4) ADB-IoT: it aims to develop a network of interconnected sensors such as those applied to MZs for the climatic and water monitoring of the plant.
5) AgDataBox Remote Sensing (ADB-RS): is an application that aims to acquire and process images obtained by remote sensing. Data is extracted from a multispectral image, transformed into information, and exported for external applications. The application is integrated with the ADB-MSA and allows the extracted data to ADB-Map, for MZs delineation.

Microservices available in ADB-MSA allow the performance of specific tasks for thematic maps creation and MZs delineation. The following resources are available:

1) Statistics: descriptive statistics, normality tests, data cleaning (it removes values lower than or equal to zero (useful for data collected by harvesters), duplicate data, outliers, and inliers), principal component analysis (PCA), data normalization, and agreement index.
2) Spatial: coordinate's converter, bivariate Moran's I, smoothness index (SI), variance reduction (VR), clusters statistics, and grid adjustment.
3) Interpolation: estimate values for unsampled locations by inverse distance weighting (IDW), ordinary kriging, moving mean, and nearest neighbor methods. An interpolator selection method was implemented to choose between ordinary kriging when there is spatial dependence in the dataset or IDW when there is not.
4) Clustering: provides seventeen data clustering methods to generate MZs, among the most frequently used are Fuzzy C-Means and K-means.
5) Rectification: rectification methods apply digital image processing filters (median, erosion, and dilation) to eliminate spots in MZs that make field operations unfeasible (small clusters created by the clustering method).
6) Recommendation: nutrient recommendation methods in which nitrogen (N) recommendation is performed by yield expectation model for corn cropping, considering soil organic matter content (OM%). Two methods for phosphorus (P) and potassium (K) were implemented: soil nutrient availability and yield expectation, with the recommendation calculation for soybean and corn. The recommendation for each nutrient is based on available fertilizers.

Conclusion

ADB platform contributes to the new phase of agriculture, allowing the digitization and automation of processes. ADB-MSA made it possible to centralize data and routines for the other applications on the platform.

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