The AgDataBox platform supports teaching and research in Precision Agriculture

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Abstract.

The AgDataBox platform is an initiative being developed by Brazilian institutions to support small producers and service providers seeking to work with Precision and Digital Agriculture. Among its objectives, it aims to integrate data, software, and methodologies for those wishing to work with precision and digital agriculture through APIs that provide not only data storage support but also the availability of various services, such as automated functionalities for generating thematic maps and management zones, evaluating management zones, and spatial data analysis. The project includes integrated cloud applications, making resources available through a mobile app (ADB-Mobile), software for generating thematic maps and management zones (ADB-Map), an environment for working with satellite image data (ADB-RS), and for working with IoT device resources (ADB-IoT). The platform, which already has over 1700 registered users from approximately 50 countries and allows for easy, intuitive, and complex functionality (difficult for small farmers to operate), is offered free of charge to farmers and researchers and is maintained by UTFPR within its IT infrastructure. As it is a tool with numerous resources and is constantly updated, it has been used to teach precision agriculture to undergraduate and graduate students, helping them assimilate the theoretical and practical aspects of the discipline and facilitating understanding of the concepts and processes intrinsic to precision agriculture. The team of professors and researchers working on the project has been developing teaching materials using real field data and utilizing the platform, creating a didactic context that has allowed even small producers to use precision agriculture technology. Furthermore, since the platform is structured using APIs and microservices, it can be considered scalable. This teaching model and the functionalities implemented in the project can support other collaborative environments, such as cooperatives, associations, and service providers. New projects that can utilize the platform's resources are also very welcome, accelerating the development of new technologies related to Precision and Digital Agriculture.

Keywords.
Education, Training, and Extension for Precision Agriculture agriculture

Introduction

Precision agriculture technology encompasses a defined area of knowledge. However, it also involves a series of related areas of knowledge that integrate naturally, providing a knowledge integration that transcends the limits of each area to support agricultural production, manage natural resources, and improve crop management and cultivation methods, achieving better yields, lower environmental impact, and greater sustainability. Given this complexity, teaching the technology is challenging, as the training of the producer or service provider involved is usually limited to their area of expertise, hindering understanding of all the concepts and methods required to maximize the technology's use in daily practice.

Materials and methods

The AgDataBox platform was developed to provide farmers with a set of tools (Fig. 1) to support precision agriculture (Fig. 1). Typically, the computational methods and solutions used are complex and difficult for most producers to learn, especially in Brazil. In addition to the concepts of precision agriculture involving a cycle of activities performed each harvest season that generate a high volume of data, there is the problem of the complexity of data analysis and its specificities, involving data from diverse sources and in different formats, with seasonality in the frequency of data collection and acquisition, and numerous possibilities for reading errors.

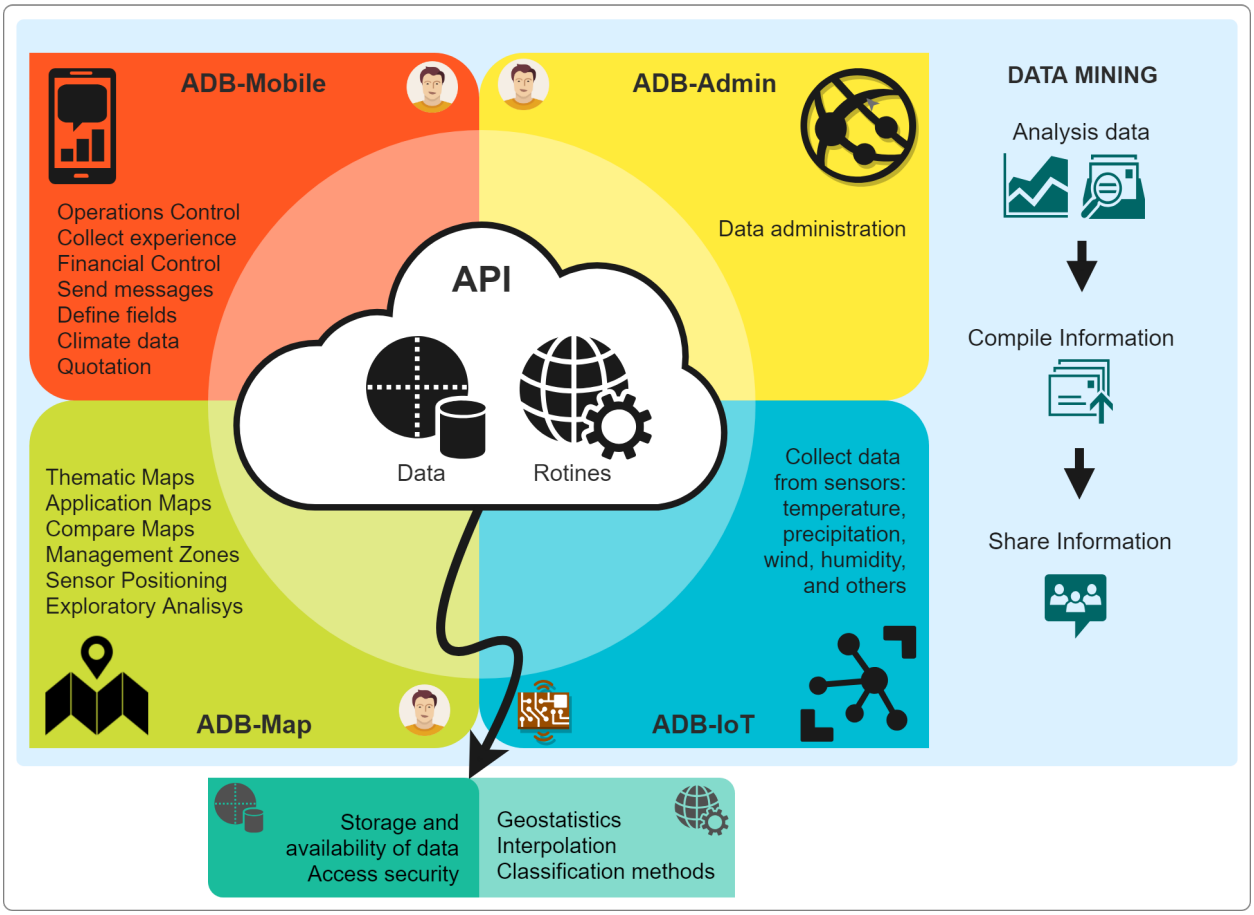
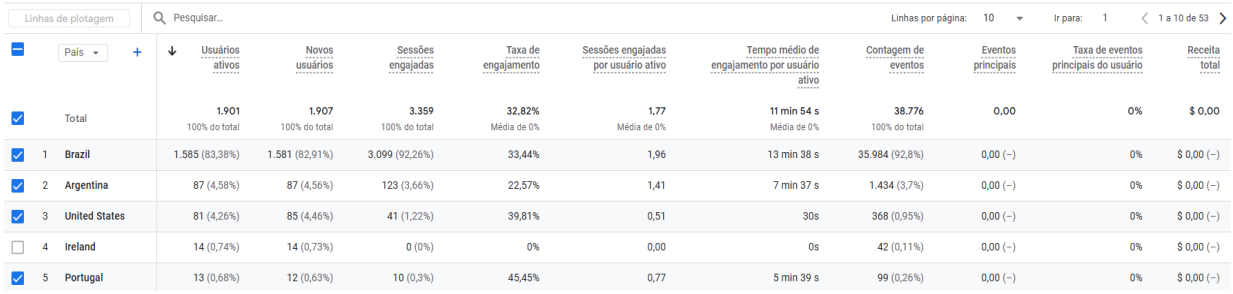


Fig. 1. Resource integration structure of the AgDataBox platform.

Given the significant number of active users on the platform (Fig. 2) since its first version was made available, it has been observed that the demand for computational solutions that allow the generation and evaluation of maps and management zones, as well as data analysis, has grown substantially in the last year, reaching more than 1000 new users, of which about 80% are from Brazil, but who have connections with about 50 countries.



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	País	Usuários ativos	Novos usuários	Sessões engajadas	Taxa de engajamento	Sessões engajadas por usuário ativo	Tempo médio de engajamento por usuário ativo	Contagem de eventos	Eventos principais	Taxa de eventos principais do usuário	Receita total
	Total	1.901 100% do total	1.907 100% do total	3.359 100% do total	32,82% Média de 0%	1,77 Média de 0%	11 min 54 s Média de 0%	38.776 100% do total	0,00	0%	$ 0,00
1	Brazil	1.585 (83,38%)	1.581 (82,91%)	3.099 (92,26%)	33,44%	1,96	13 min 38 s	35.984 (92,8%)	0,00 (–)	0%	$ 0,00 (–)
2	Argentina	87 (4,58%)	87 (4,56%)	123 (3,66%)	22,57%	1,41	7 min 37 s	1.434 (3,7%)	0,00 (–)	0%	$ 0,00 (–)
3	United States	81 (4,26%)	85 (4,46%)	41 (1,22%)	39,81%	0,51	30s	368 (0,95%)	0,00 (–)	0%	$ 0,00 (–)
4	Ireland	14 (0,74%)	14 (0,73%)	0 (0%)	0%	0,00	0s	42 (0,11%)	0,00 (–)	0%	$ 0,00 (–)
5	Portugal	13 (0,68%)	12 (0,63%)	10 (0,3%)	45,45%	0,77	5 min 39 s	99 (0,26%)	0,00 (–)	0%	$ 0,00 (–)

Fig. 2. Access Graph on 2025 AgDataBox and number of users. Google Analytics.

Given this significant growth, the group of collaborators and developers of the platform, together with the multi-user AgroTechnologies Laboratory (AgriLab) of UTFPR - Medianeira Campus, has sought to use the environment for teaching, research, and extension, developing its practical classes using the platform with real data, which favors the understanding of the concepts presented and their practical applicability. In this way, AgriLab, through its team, has enabled the construction of a Precision and Digital Agriculture curriculum, which includes everything from basic PA content, such as positioning systems and geographic coordinates, to advanced data analysis methods, generation of thematic maps by different interpolators, generation of management zones and statistical evaluation of these zones, remote sensing, data filtering, and generation of recommendation maps. This curriculum will be made freely available to the academic and scientific community, as well as agricultural producers, aiming to standardize terms used in the various regions of the country, establish teaching methodologies focused on directed learning in precision and digital agriculture, and ensure that technology is integrated into current educational curricula and used in a coherent, responsible, and dynamic way, focused on sustainable development from both an economic and environmental perspective.

Results and Discussion

Based on the use of the platform for practical teaching activities in the subjects of Precision Agriculture (Master's in Computational Technologies for Agribusiness) and Geostatistics and Precision Agriculture (Specialization in Artificial Intelligence in Agriculture), numerous spontaneous comments have been received from students who have taken the course, expressing the benefits of using the platform for practical activities and connecting theory with practice. Among these comments are:

> "*And I would like to highlight the importance of access to the AgDataBox platform. T**he software was essential for carrying out the activities**, as it offers geostatistical tools in an objective way, ….*"
>
> "*The practical approach adopted throughout the course... **and the use of the AgDataBox software, assisting in optimizing the use of inputs, increasing productive** efficiency, and improving the sustainability of agricultural systems.*"
>
> "*The **dynamic and comprehensive instructions directly on the platform significantly helped in understanding the steps** necessary to perform more complete soil analyses.*"
>
> "***With the use of AgDataBox, it is very easy to apply consolidated statistical methods in agronomics***; *you just need to use and train on the*

platform."

"*The course presented a practical and applied approach to Precision Agriculture, highlighting the use of geospatial tools and statistical analyses...* ***The AgDataBox, although complex, was fundamental in consolidating the concepts of geostatistics****...*"

"*The approach used,* ***focused on tools like AgDataBox, allowed us to apply theoretical knowledge of statistics and interpolation, such as kriging and inverse distance weighting, to the generation of real management maps****.*"

"*The AgDataBox tool has* ***proven to be very powerful and comprehensive, with great potential for applied analytics****.*"

Furthermore, short extension courses have been offered to disseminate the tool and provide producers and students with access to Precision and Digital Agriculture technology. Figs. 3 and 4 show a class being taught by Professor Claudio Bazzi to students at UNICAMP, at the request of Professor Lucas do Amaral.

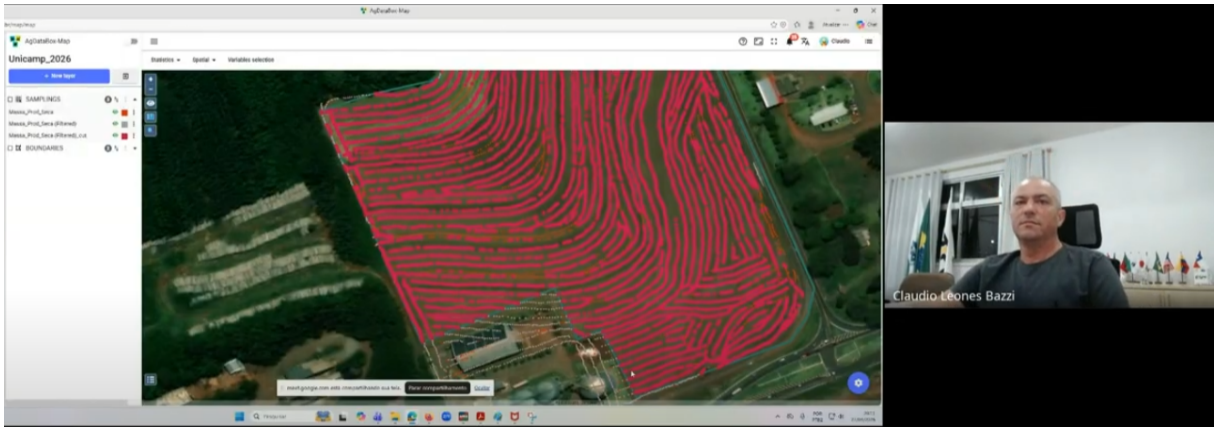

Fig. 3. This is an online class being offered to students at Unicamp, in which the functionalities for eliminating sample points presented outside the plot are presented.

Fig. 4. An online class is being offered to Unicamp students, presenting a thematic map generated by the AgDataBox - MAP tool.

Discussion

The AgDataBox tool has enabled student interaction, integrated theory with practice, explored concepts, and provided adequate learning for people who do not have mastery of all areas of knowledge related to Precision Agriculture.

The resources provided by the platform, which differentiate it from traditional systems, include:

spatial data analysis; geostatistical analysis; automated data interpolation; generation and evaluation of management zones; input application maps, among others. In this way, all these topics can be worked on in a way that provides the student with a practical way of integrating with the theory involved.

Conclusion

The training materials produced have met the teaching expectations, as the theoretical concepts presented are clear, objective, and easily understandable to the project's target audience. Since the functionalities provided by the AgDataBox Platform aim to facilitate the use of complex resources in data analysis, the platform provides students with a solid, practical understanding of the steps involved, allowing concepts to be easily retained through real data.

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