Presentation of the results for dissemination by the Contracting Authority

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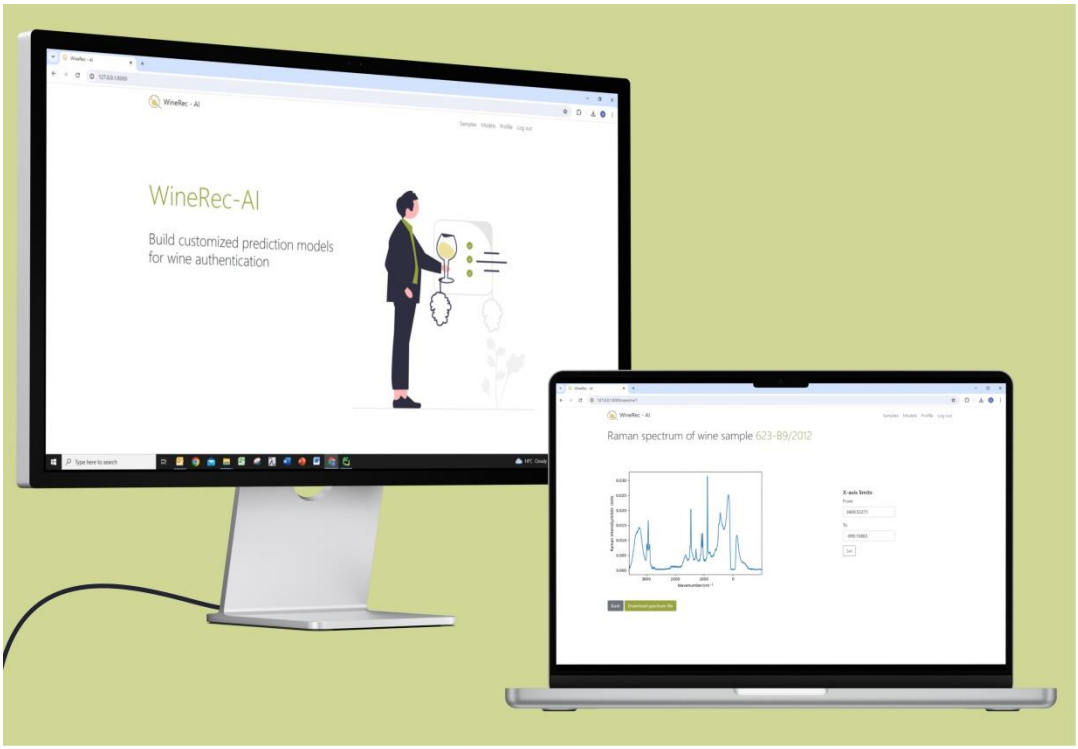
Wine fingerprint recognition based on spectroscopic methods and Artificial Intelligence (WineRec – AI)

Despite its longstanding notoriety, wine ranks among the top ten most counterfeited products according to EU statistics. Furthermore, based on the information presented in the report published in 2020 by the European Union Intellectual Property Office (EUIPO), counterfeiting of spirits and wines leads to an average annual sales loss of approximately 5.2 billion euros, a figure also reflected in the loss of over 30,000 jobs. In this context, the scale and the entire range of ensuing social implications necessitate the implementation of rapid and reliable control tools for the authentication and monitoring of these goods. For this reason, the development of analytical approaches based on rapid, robust, and, not least, cost-effective methods is currently a priority for research and control laboratories worldwide. These criteria are successfully met by new approaches based on spectroscopic data, such as ^{1}H-NMR or Raman, in conjunction with either advanced chemometric models or Artificial Intelligence. In this context, the ***WineRec – AI*** project aimed to develop new wine recognition tools by combining rapid analytical methods like ^{1}H-NMR and Raman spectroscopies with advanced data processing techniques based on various machine learning algorithms. The criteria investigated within this project for wine differentiation included the grape variety used in wine production, geographical origin (i.e., country and region of production), and the production year.

Based on these recognition models, a new web application for wine authenticity control was developed, optimized, and validated. The web application serves as a useful and secure tool for managing the database and applying optimized recognition models based on machine learning techniques to predict the origin of unknown wine samples. This software solution is of particular relevance, as there is currently no known tool that allows for the development of new wine origin recognition models using rapid analytical methods in conjunction with Artificial Intelligence algorithms. Furthermore, the developed web application enables authenticated users to create new differentiation models based on ^{1}H-NMR or Raman experimental data, depending on their preferences, without the barrier of technical expertise, but through an intuitive and user-friendly interface.



The impact of this project was realized through results achieved on various levels, , encompassing both academic and technological transfer aspects. The primary categories of results are summarized as follows:

1. **Training of young researchers** through the contribution of the project's results to an individual chapter in the doctoral thesis of one PhD student, member of the project team
2. Development of a **database** with applications in wine authentication, containing the Raman and ^{1}H-NMR spectra of over 100 wine samples
3. Creation of an **innovative web application for wine authenticity control**, based on recognition models for wine differentiation. The models were built using Artificial Intelligence (AI) for processing the ^{1}H-NMR and Raman spectral data
4. Submission of a **patent application** for the invention entitled "*Procedure for Discriminating Wines Based on Grape Variety, Geographical Origin, and Production Year Using Spectroscopic Data and Machine Learning Algorithm*". This application received the OSIM registration number A/00131 on March 25, 2024.
5. Creation of a **web page to promote the developed application** in the frame of the Technological Transfer Center of INCDTIM Cluj-Napoca (http://ro.itim-cj.ro/servicii/ctt-tehnologii/ctt-tehnologii-winerec-ai-solutie-software-pentru-controlul-autenticitatii-vinurilor/)
6. The quality and international novelty of the results enabled their dissemination through: **4 ISI articles** in the first quartile (Q1 – Web of Science), **3 invited lectures**, **3 oral presentations**, and **4 poster presentations**