A Micro-Service Platform for Sensory Data Governance in Food Quality Assessment

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***Abstract*—In the context of Smart Cities, which prioritize healthy environments for citizens, research on food quality certification and assessment focuses on ensuring the safety, sustainability, and nutritional value of food. Sensory analysis, assessing food through taste, sight, touch, smell, and hearing, influences food choices and requires meticulous production chain control and adherence to regulations, involving different categories of users. Moreover, sensory data is featured by variety, high subjectivity, and volume. This paper presents a comprehensive suite of micro-services tools designed to govern sensory analysis panels, grounded on a shared conceptual data model. These tools support all panel phases, from selecting tasters and food samples to analyzing and visualizing results, managing the complex process of sensory data governance.**

***Index Terms*—Agri-food 4.0, Sensory Analysis, Smart Food, Food Certification**

I. Introduction

Sensory analysis plays a pivotal role in evaluating food quality, providing invaluable insights into sensory attributes that define consumers' preferences (for instance, taste, aroma, texture, appearance, and sound perception). In the context of Smart Cities, where one of the priorities is to provide an healthy environment for citizens, sensory analysis can be engaged to implement a meticulous control across the food production chain, adhering to best practices and regulations [5]. This complex process involves panel leaders, tasters, and experts analyzing results. Furthermore, sensory data is featured by variety, high subjectivity, and volume, and thereby its governance (acquisition, processing and interpretation) requires specialized tools. Platforms like Compusense, RedJade, Fizz Software, SIMS 2000, and EyeQuestion have significantly contributed to this field by offering advanced functionalities [2]. Moreover, the introduction of the BioSensory app represents an innovation in incorporating biometrics into sensory analysis [3]. Despite such progresses, traditional tools are focused on specific phases of sensory analysis process and do not properly address the heterogeneity of data and sensory analysis tasks. General purpose tools, like Zoom and Google Forms, introduced for remote sensory sessions during the pandemic, lack the specialised features necessary for detailed sensory analysis [4].

In [1] we introduced a suite of tools developed to support a tasters association in preparing, executing, and analyzing the sensory analysis process. In this suite, panel leaders prepare the product profile (a list of descriptors characterizing a food product using the five senses), select tasters and food samples, and supervise the tasting panel with the support of a tool called Input Sensory Software (ISS). Another tool, the Big Sesnsory Software (BSS) is engaged to support data analysts to inspect the collected data and to prepare a food product certification. In this paper, we perform a step forward by presenting a micro-service platform that integrates the ISS and BSS tools and complete them with a third component, aimed at governing sensory data collected over time from multiple panel sessions. The micro-service technology improves the modularity of the tool suite, enables isolation of different tools, that operate on different types of information and are devoted to distinct categories of actors, and promotes fast development of the suite. Moreover, it demonstrates its compliance with the CINI National Lab on Smart Cities and Communities, that includes service-oriented architectures among the technologies for the realisation of basic services delivered by a potential laboratory platform.

II. Tools Architecture and Implementation

Figure 1 presents the architecture of the Sensory Analysis Tools. The system uses two databases: a MySQL database for storing relational data, including sensory panel and configuration data, and a MongoDB database for holding all the data collected through panel sessions.

On top of these databases, a set of micro-services is configured, each one belonging to different components of the tool suite. Among the ISS Services, the Panel Service is invoked to manage sensory panels. This service is used by panel leaders to configure new panels. For this purpose, the panel leader selects the **Samples** for evaluation, associated to a **Sample Category** (e.g. red wine or white chocolate). The evaluation **Method**, encapsulating a set of rules and guidelines, is selected to make the evaluation process compliant to best practices, such as the proper sequence in which the samples are presented to the tasters. Moreover, the panel leader defines the **Descriptors** set (e.g., astringency or flower aroma). A descriptor is tailored to the sample category — for instance, creamy texture and shiny appearance can be descriptors used for chocolate, whereas tannin taste or earthy aroma better suit wine. Finally, the panel leader creates the panel by selecting the panel tasters, on the basis of their expertise. The Taster Service and the Sample Service are responsible for managing tasters and samples respectively. During the panel session, tasters assign ratings to each descriptor of samples. The Collection Data Service is used to generate evaluation forms and to save evaluation

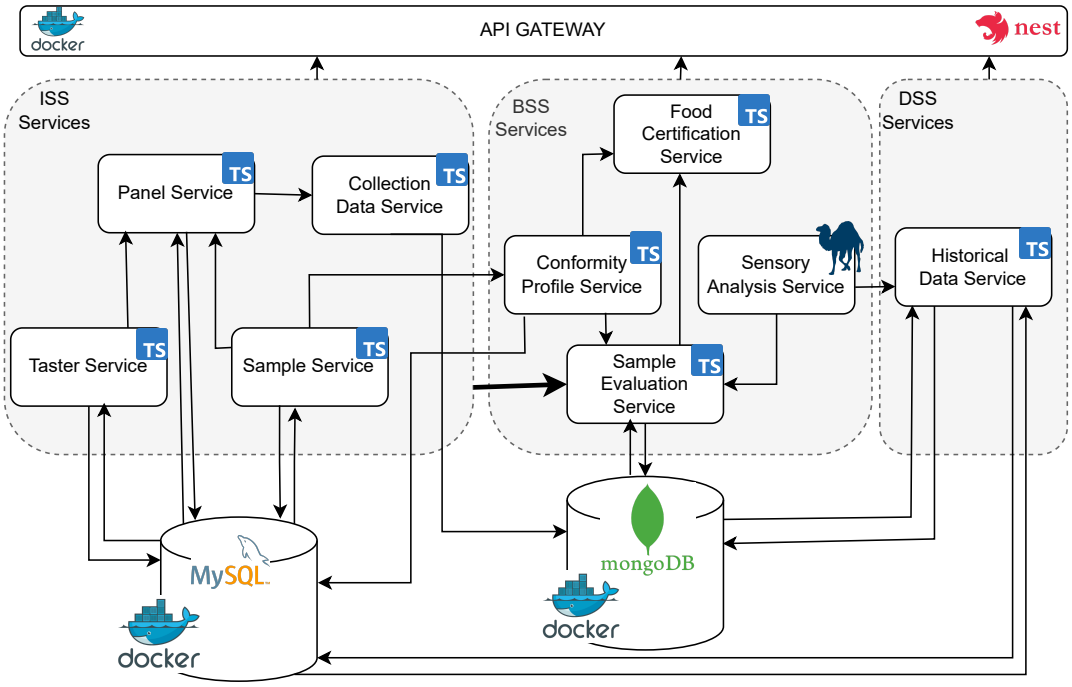

Fig. 1: Sensory Analysis Tools architecture

data in the MongoDB database. Conversely, the BSS Services include the Sample Evaluation Service, which is in charge of selecting sensory data on which analysis will be performed, the Sensory Analysis Service, to produce analysis results, the Conformity Profile Service, which checks how much a product matches a conformity profiles, established as a range of admissible values for each product descriptor, and the Food Certification Service, that generates the certification based on the analysis results. Finally, the Data Sensory Software (DSS) is in charge of managing and navigating the historical data, thought the Historical Data Service, and check the compliance of new analyses with respect to best practices embedded in previous panel sessions.

All the tools[1], namely ISS, BSS and DSS, have been developed in a modular way. The GUI is crafted with ReactJS, while the server-side logic employs NodeJS with TypeScript. The Sensory Analysis Service, derived from a legacy and standalone implementation of the statistical methods, was available in Perl and integrated in the overall tool suite. To booster the efficiency, reliability, and scalability of the server-side applications, the NestJs framework has been used. Given the variety of technologies involved and to streamline the release process of the integrated web applications, Docker containers have been adopted. The current setup comprises three Docker containers: one for each database and another deploying the APIs.

[1]Tools Demo: https://youtu.be/03Mr3uXA5kg

III. Concluding Remarks

In this paper, we discussed an integrated tools suite designed to implement food quality assessment through the lens of sensory analysis. As the tools suite is operative in test mode at the moment, current work is focused on conducting thorough evaluations of users' experience, including among users sensory analysis experts, panel leaders and professional tasters. Moreover, since at the moment each service supports a set of semi-automatic tasks performed by domain analysts and tasters, an interesting research direction is focused on increasing the level of automation for the composition of micro-services of the described ecosystem.

References

[1] Ada Bagozi and Devis Bianchini. Collaborative methods and tools for food certification. In *8th CINI Annual Conference on ICT for Smart Cities Communities*, 2022.

[2] Sajitha Biju, Sigfredo Fuentes, Claudia Gonzalez Viejo, Damir D Torrico, Sumayya Inayat, and Dorin Gupta. Silicon supplementation improves the nutritional and sensory characteristics of lentil seeds obtained from drought-stressed plants. *Journal of the Science of Food and Agriculture*, 101(4):1454–1466, 2021.

[3] Sigfredo Fuentes, Claudia Gonzalez Viejo, Damir D. Torrico, and Frank R. Dunshea. Development of a biosensory computer application to assess physiological and emotional responses from sensory panelists. *Sensors*, 18(9), 2018.

[4] Claudia Gonzalez Viejo, Hanyan Zhang, Annabel Khamly, Yunjia Xing, and Sigfredo Fuentes. Coffee label assessment using sensory and biometric analysis of self-isolating panelists through videoconference. *Beverages*, 7(1), 2021.

[5] Gabriele Rocchetti, Gian Paolo Braceschi, Luigi Odello, Terenzio Bertuzzi, Marco Trevisan, and Luigi Lucini. Identification of markers of sensory quality in ground coffee: An untargeted metabolomics approach. *Metabolomics*, 16(12):1–12, 2020.