School of Computing, Engineering, and the Built Environment
Edinburgh Napier University

PHD STUDENT PROJECT

Application instructions:
Detailed instructions are available at :
https://www.napier.ac.uk/research-and-innovation/doctoral-college/how-to-apply

Prospective candidates are encouraged to contact the Director of Studies (see details below) to discuss the project and their suitability for it.

Project details

Supervisory Team:

- DIRECTOR OF STUDY: Dr Tomas Horvath (Email: t.horvath@napier.ac.uk)
- 2ND SUPERVISOR: tbc

Subject Group: Computer Science

Research Areas: Computer Science (Artificial Intelligence)

Project Title: Intelligent Electronic Nose Data Analytics with Applications in Brewing and Distilling

Project description:

Electronic Nose (e-Nose), an array of electronic gas sensors, has been recently applied in the brewing and distilling industry, mainly for determining olfactory qualities of products [1,2]. An other use of e-Nose in these industries is in the production process, namely, in monitoring the process of fermentation [3-7]. Here, however, one of the main challenges is the increasing alcohol concentration and the high carbon-dioxide concentration. These might "cover" (from the e-Nose) the presence of other important volatile compounds being developed during the fermentation but still not in sufficient concentration to be well detectable. However, the presence of some of these compounds, for example the metabolic products of some bacteria, is a sign for the brewer that intervention to the process of fermentation is needed.

The main objectives of the project are the following:

1) Acquisition of benchmark data: In the first phase of the thesis e-Nose data will be recorded in a laboratory environment. Here various e-Nose sensors will be tested with various samples. The main goal of this phase is to gather benchmark data for the next phase of the project.

2) Development of novel artificial intelligence (AI) approaches for e-Nose data analytics: In the second phase of the project, novel AI approaches will be developed, including machine learning (ML) and optimization algorithms for e-Nose data. Particular interest will be put on the phenomenon called sensor drift [8] (when the sensitivity of the gas sensor changes with time) and the privacy of computing by utilizing the concepts of federated learning [9]

   The project will be developed in collaboration with brewing experts.

References:

[1] C. Gonzalez Viejo, S. Fuentes, A. Godbole, B. Widdicombe, R. R Unnithan (2020): Development of a low-cost e-nose to assess aroma profiles: An artificial intelligence application to assess beer quality. Sensors & Actuators B: Chemical, vol. 308**.**

[2] Y. Shi, F. Gong, M. Wang, J. Liu, Y. Wu, H. Men (2019). A deep feature mining method of electronic nose sensor data for identifying beer olfactory information. Journal of Food Engineering, vol. 263.

[3] D. Tomtsis, S. Kontogiannis, G. Kokkonis, N. Zinas (2016). IoT Architecture for Monitoring Wine Fermentation Process of Debina Variety SemiSparkling Wine. SouthEast European Design Automation, Computer Engineering, Computer Networks and Social Media Conference. New York, USA: Association for Computing Machinery, 42–47

4] C. Pinheiro, C. M. Rodrigues, T. Schäfer, J. G. Crespo (2002). Monitoring the aroma production during wine–must fermentation with an electronic nose. Biotechnology and Bioengineering 77.6, 632–640.

[5] G. D. Austin, I. Russell, A. G. Metering, R. E. Subden (1996). A GasSensor-Based On-Line Ethanol Meter for Breweries. Journal of the American Society of Brewing Chemists 54.4, 212–215.

[6] H. Liden, T. Bachinger, L. Gorton, C-F. Mandenius (2000). On-line determination of non-volatile or low-concentration metabolites in a yeast cultivation using an electronic nose. Analyst 125 (6), 1123–1128.

[7] M. Calderon-Santoyo, P. Chalier, D. Chevalier-Lucia, C. Ghommidh, J. A. Ragazzo-Sanchez (2010). Identification of Saccharomyces cerevisiae strains for alcoholic fermentation by discriminant factorial analysis on electronic nose signals. Electronic Journal of Biotechnology 13, 8 –9.

[8] Z. Kovacs, D. Szollosi, J.L.Z. Zaukuu, Z. Bodor, F. Vitalis, B. Aouadi, V. Zsom-Muha, Z. Gillay (2020). Factors Influencing the Long-Term Stability of Electronic Tongue and Application of Improved Drift Correction Methods. Biosensors 10, 74.

[9] P. Kiss, T. Horváth (2021). Migrating models: A decentralized View on Federated Learning. Communications in Computer and Information Science, vol 1524.

Candidate characteristics

Education:

A first degree (a minimum 2:1) in Computer Science

Subject knowledge:

Artificial Intelligence, Data Science

Essential attributes:

- Deep Theoretical background on Machine Learning
- Good Programming skills (not just using libraries)

Desirable attributes:

- Experience with Internet of Things (IoT) and sensors
- Knowledge in web and mobile development