

Attention-based deep learning for forensic cause-of-death screening

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Background

Accurate cause-of-death (CoD) screening is a critical task in death investigations. Traditional methods, such as autopsy and histopathological analysis, have limitations in certain cases, particularly when the CoD is obscure. It has been shown that postmortem metabolomics (i.e. the analysis of low-molecular-weight substances in postmortem biological samples) can reflect biochemical changes indicative of the agonal phase, CoD, and postmortem alterations [1]. Furthermore, it has been shown that machine learning can be used to train a classification model for high-throughput CoD screening based on postmortem metabolomics [2].

The project aims to improve existing methods for forensic CoD screening based on post-mortem metabolomics by utilizing attention-based deep learning models.

Data description

Raw liquid chromatography - high resolution mass spectrometry (LC-HRMS) data from 4,282 autopsies will be used for the CoD screening. This type of data can be considered as a large point cloud, where each point is defined by a retention time (RT), mass-to-charge value (m/z), and intensity. Figure 1 shows an example of this.

All autopsy cases were admitted to the Swedish National Board of Forensic Medicine between July 2017 and November 2020. The blood samples went through standardized toxicology screenings for drugs and pharmaceuticals in a total of 641 analytical runs using the same LC-HRMS system. All included cases belong to one of the following five CoD groups: acidosis ($n = 100$), drug intoxication ($n = 1,385$), ischemic heart disease ($n = 1,362$), hanging ($n = 1,200$), and pneumonia ($n = 235$).

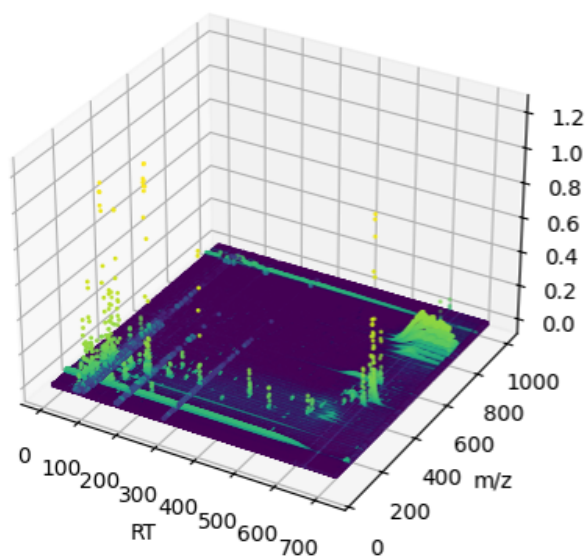


Figure 1: Example of a raw LC-HRMS sample

Research questions

- How can attention mechanism be applied to raw LC-HRMS data for classification tasks?
- Does attention-based deep learning improve the accuracy compared to previous methods for forensic cause-of-death screening?

Eligibility requirements

- Good programming skills in Python
- Sound knowledge of machine learning
- Ability to communicate with experts in other disciplines

References

1. Elmsjö, A., Vikingsson, S., Söderberg, C., Kugelberg, F. C. & Green, H. Post-Mortem Metabolomics: A Novel Approach in Clinical Biomarker Discovery and a Potential Tool in Death Investigations. *Chemical Research in Toxicology* **34**, 1496–1502. <https://pubs.acs.org/doi/full/10.1021/acs.chemrestox.0c00448> (2021).
2. Ward, L. J. *et al.* Postmortem metabolomics as a high-throughput cause-of-death screening tool for human death investigations. *iScience* **27**, 109794–109794. [https://www.cell.com/iscience/fulltext/S2589-0042\(24\)01016-2](https://www.cell.com/iscience/fulltext/S2589-0042(24)01016-2) (2024).