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Title: Integrating Mass Spectrometry with Other Imaging Technologies: Improving Biological Insight Through Data-driven Multi-modal Image Fusion

Abstract: Medical studies increasingly employ a multitude of different imaging technologies to answer a specific biological question. A growing number of such multi-modal imaging studies include Imaging Mass Spectrometry (IMS) as one of these modalities. Although different modalities are routinely registered and overlaid to generate a single display, true integration of data across technologies is largely left to human interpretation, resulting in a significant underutilization of the potential of multi-modal measurements. This talk gives an overview of our recent work on the integration or 'fusion' of IMS with measurements from other imaging modalities [1], and demonstrates the potential of data-driven image fusion for IMS through several predictive applications. Example applications include: (i) the 'sharpening' of IMS images, using microscopy measurements to predict ion distributions at a spatial resolution that exceeds that of measured ion images by ten times or more; (ii) the enrichment of biological signals and the removal of instrumental noise by multi-modal corroboration; and (iii) the prediction of ion distributions in tissue areas that were not measured by IMS. We also highlight more recent work in which, contrary to fusing IMS with microscopy, our data-driven fusion method is used to combine two mass spectrometry-based modalities into a single predicted modality that combines advantages of the source modalities. In this new IMS-IMS fusion setting, MALDI-TOF IMS (high spatial resolution, limited mass resolution) is fused with MALDI-FTICR IMS measurements (lower spatial resolution, higher mass resolution), enabling ion distributions to be predicted with both high spatial as well as high mass resolution. Examples are shown in lipid imaging, where there is both a need to spatially resolve fine tissue structure, as well as a need for high chemical specificity due to nominally isobaric species.

[1] Van de Plas, R., Yang, J., Spraggins, J., & Caprioli, R. M. Image fusion of mass spectrometry and microscopy: a multimodality paradigm for molecular tissue mapping. Nature Methods 12, no. 4 (2015): 366-372.

Short biography: Raf Van de Plas is assistant professor at the Delft University of Technology (TU Delft) in the Netherlands. At the Delft Center for Systems and Control, he works on computational analysis of molecular imaging modalities such as imaging mass spectrometry and microscopy. He holds an adjunct assistant professor position in biochemistry at Vanderbilt University School of Medicine in Nashville, TN. He holds a PhD in Engineering (KU Leuven, 2010), an MSc in Industrial Engineering (Group T, 2002), and an MSc in Artificial Intelligence (KU Leuven, 2003). Before his appointment at TU Delft, he held a research faculty position at the Mass Spectrometry Research Center at Vanderbilt University with Dr. Richard Caprioli. His research focuses on the interface between (i) mathematical engineering and machine learning; (ii) analytical chemistry and instrumentation; and (iii) life sciences and medicine.