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DISCUSSION

Comments on: Data integration via analysis of subspaces (DIVAS)

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We would like to start by saying that this is a very interesting paper that outlines a powerful tool that can be applied in a wide range of areas. In our discussion, we focus on how the novel approach potentially can improve classification results in hard tasks within e.g., medicine and geoscience. In such situations, where it is hard to make precise predictions, it is natural to acquire information from many different sources and formats. The underlying idea is of course that, by utilizing all available information, improvements in terms of e.g., accuracy will be obtained. Although this sounds like a very natural claim, it is not obvious how different sources of information can be incorporated in a useful way. The method described by the authors make headway for many such situations and we would therefore like to congratulate them with a very impressive paper.

It would be really interesting to have feedback from the authors concerning natural testbeds for their approach. Would e.g., early detection of cancer utilizing different modalities be possible to use for an evaluation of the method's performance in practice? In addition, we would like to hear the author's opinion if their method could be extended to handle data that are not on the form that they include so far in their framework. In particular, it would be interesting to hear if the method could be extended to handle unstructured data like text, which are frequently used in medical applications.

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Obtaining precise uncertainty estimation in classification is another area that is crucial in practice. In prediction, one typically focuses much on accuracy while uncertainty estimates are frequently neglected. We believe that it is very important for a method to also produce precise uncertainty estimates and would therefore ask the authors if they have suggestions for how their methodology can be extended to handled this as well.

In many applications, gaining information through additional sources/modalities has a very high cost. It would therefore be very valuable if Divas could be extended to rank modalities according to e.g., precision or cost. We understand that it may not be straightforward to achieve this, but it would be great to have feedback about how this potentially could be obtained. Results in this direction would e.g., be highly relevant in monitoring of the seafloor where all modalities typically are very expensive to acquire.

We would also like to ask the authors what methods it would be natural to use for a performance comparison. The predecessor JIVE described in Lock et al. (2013) and (Feng et al. 2018) seems like an obvious choice and presumably so is canonical correlation analysis (CCA) (Hotelling 1936). It would be great to hear if there are additional methods that would be good choices to include in a future study.

Being able to identify shared and individual components across different blocks of data, provide valuable information about the interactions between different modalities. It would be interesting to know if the authors see a way for DIVAS to leverage this information in order to improve DL models, for example in classification. A challenge in multi-modal deep learning is to coordinate representation spaces of different modalities such that the shared network is able to capture and utilize important cross-modal interactions and semantics shared between the different modalities. CCA has been employed for this task (Ngiam et al. 2011), but it would be interesting to know if DIVAS could also be useful in learning a shared representation space.

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