

Identifying Research Gap and Opportunities in the use of Multimodal Deep Learning for Emergency Management

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Introduction - Background

- ▶ People are now increasingly using mobile devices during disasters. There are also other sources which provide disaster-related data.



- ▶ As a result, an overwhelming amount of data is generated in different modalities (text, audio, video and images) during an emergency.
- ▶ Different modalities of data are characterized by different features (eg., images having colour, texture & shape, voice having pitch).
- ▶ Extracting, pre-processing, analysing and interpreting a huge variety of multimodal data within a short period of time is a major challenge faced by emergency responders.

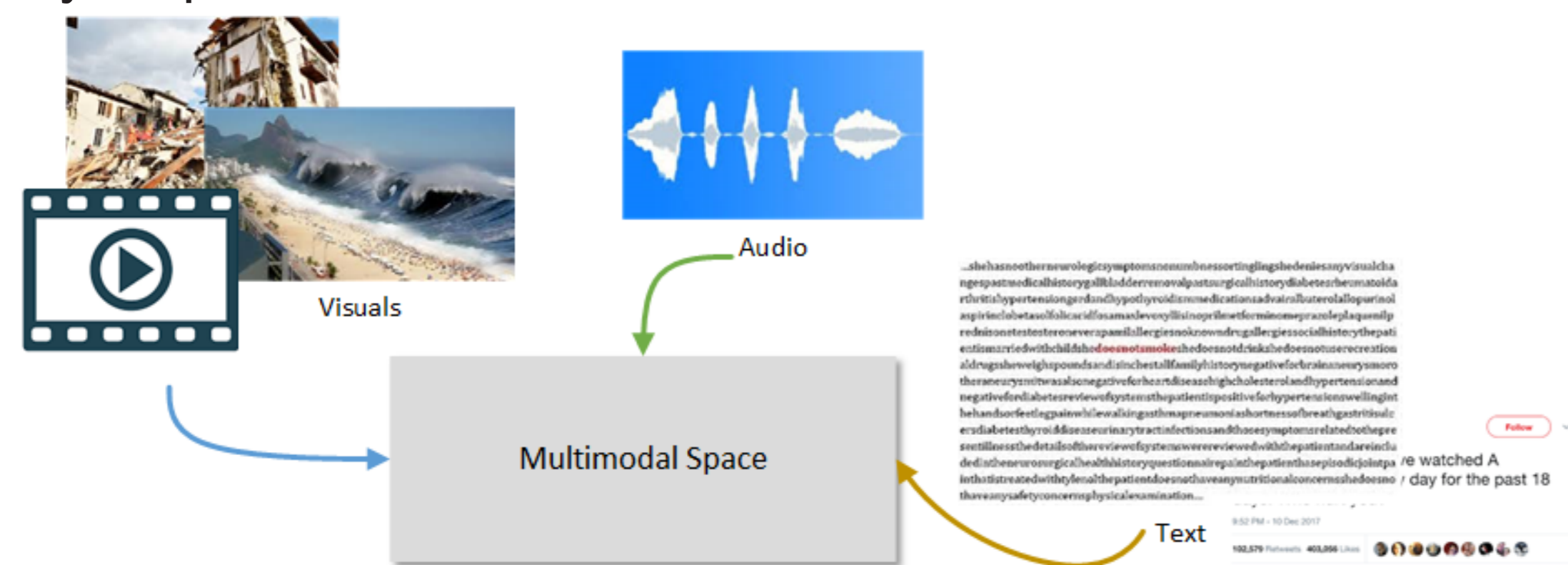


Figure 1: Relating multimodal representations to a single feature space.

Multimodal Deep Learning (MMDL)

- ▶ MMDL have recently demonstrated promising results in learning features over multiple modalities.

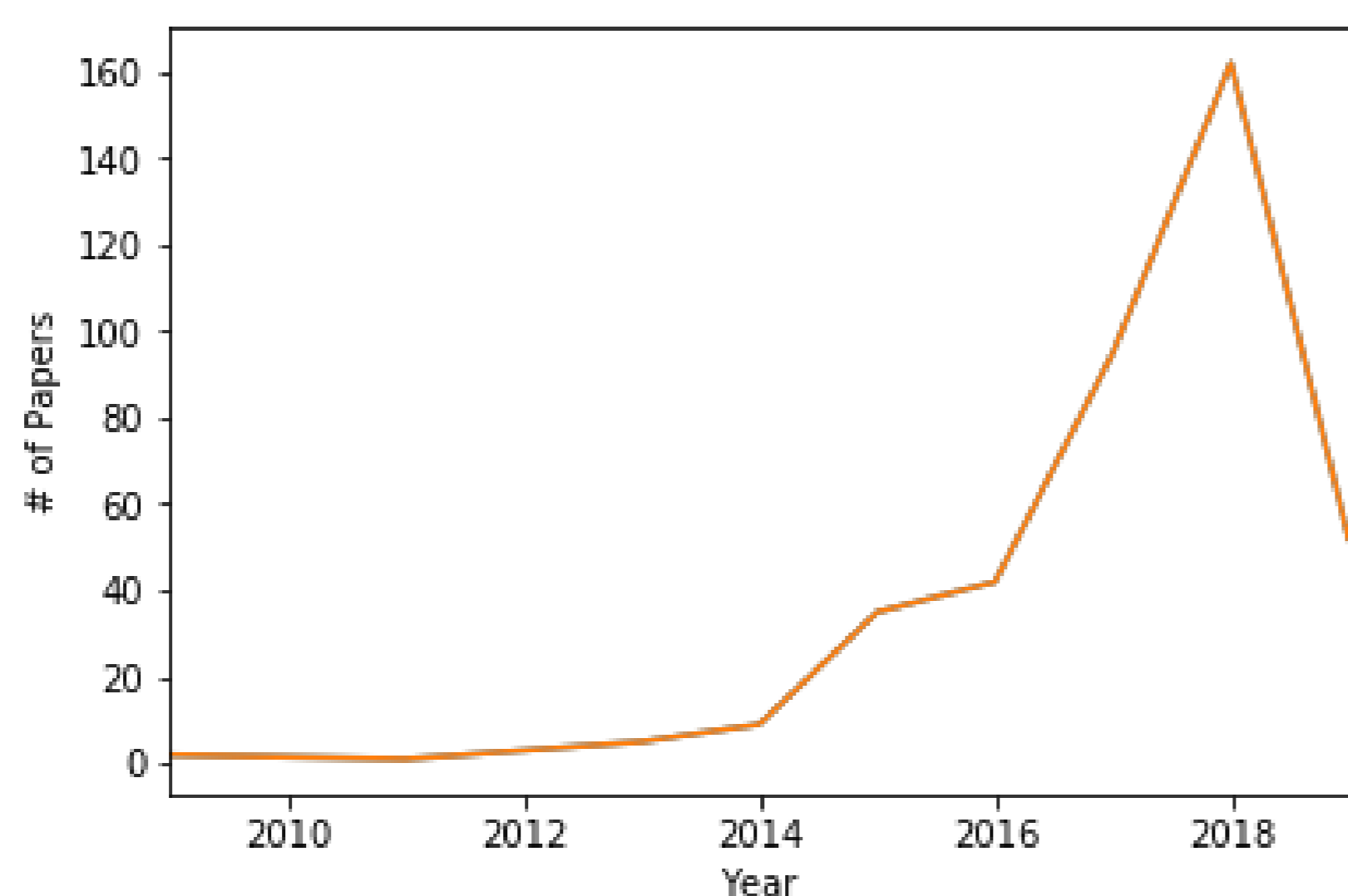


Figure 2: Popularity of using MMDL in the research community.

- ▶ The idea behind Artificial Neural Networks (ANN) was inspired by the functioning of brain neurons.

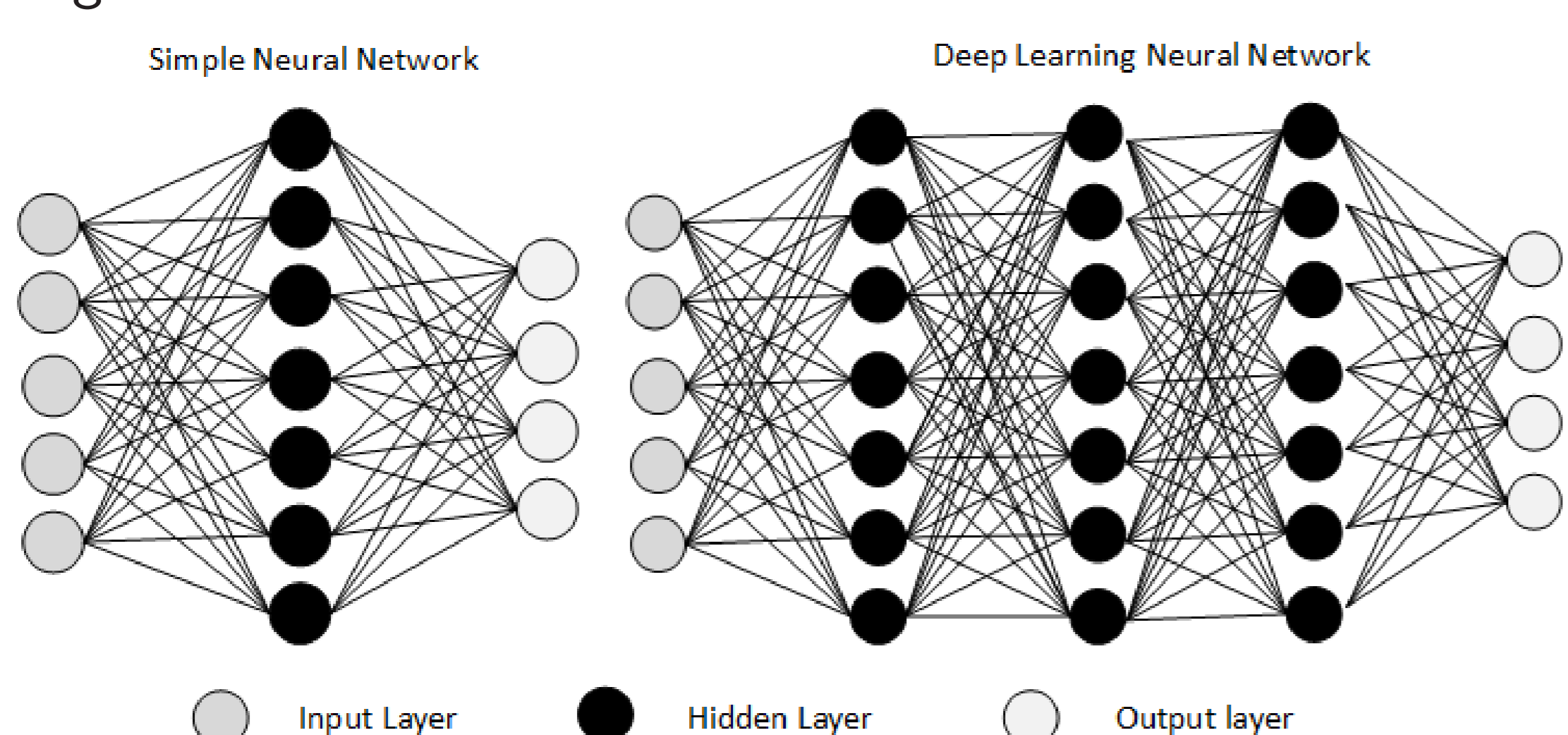


Figure 3: Artificial Neural Networks (ANN) vs Deep Neural Networks (DNN) [1].

Applications of MMDL

- ▶ The challenge in MMDL is to relate different features into a single joint feature space.

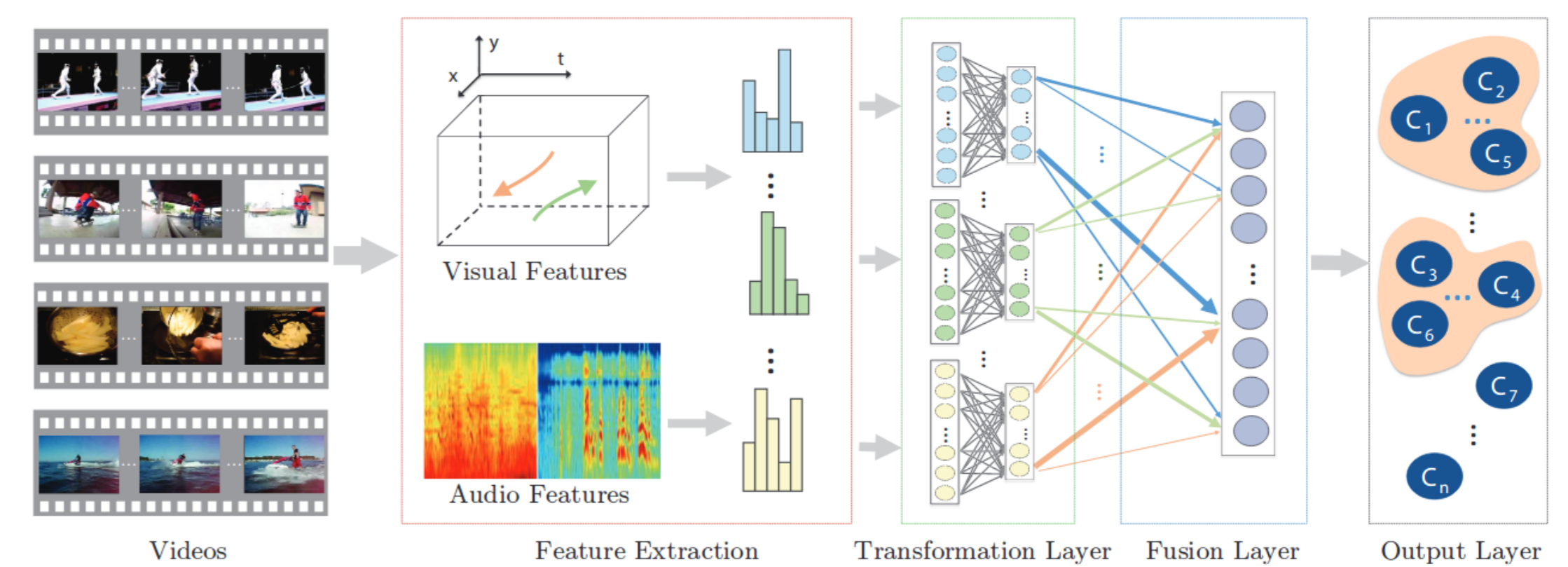


Figure 4: Correlation among different modalities in joint representation learning [2].

- ▶ MMDL have successfully used in affect recognition, event recognition, media description, multimedia retrieval, speech recognition and visual classification.

How MMDL can be used in Disaster Research

- ▶ Disasters have characteristics that makes developing general software tools to integrate multiple data streams in real-time disaster situations challenging (E.g., unpredictable, different, disaster-related data are heterogeneous, time-sensitive and lack common terminology, disaster management may take from a few hours to a few years to complete, lessons learned from one disaster cannot be easily generalized to another)
- ▶ Deep learning techniques outperform traditional fusion techniques in analysing a huge amount of data.
- ▶ Applying MMDL techniques on disaster data and implementing an integrated computer system has the potential to help decision-makers by
 - ▷ improving their access to data
 - ▷ reducing uncertainty in decision making
 - ▷ supporting more consistent and well-informed decision making across individuals
 - ▷ reducing the time taken to analyse data and associated cognitive load.

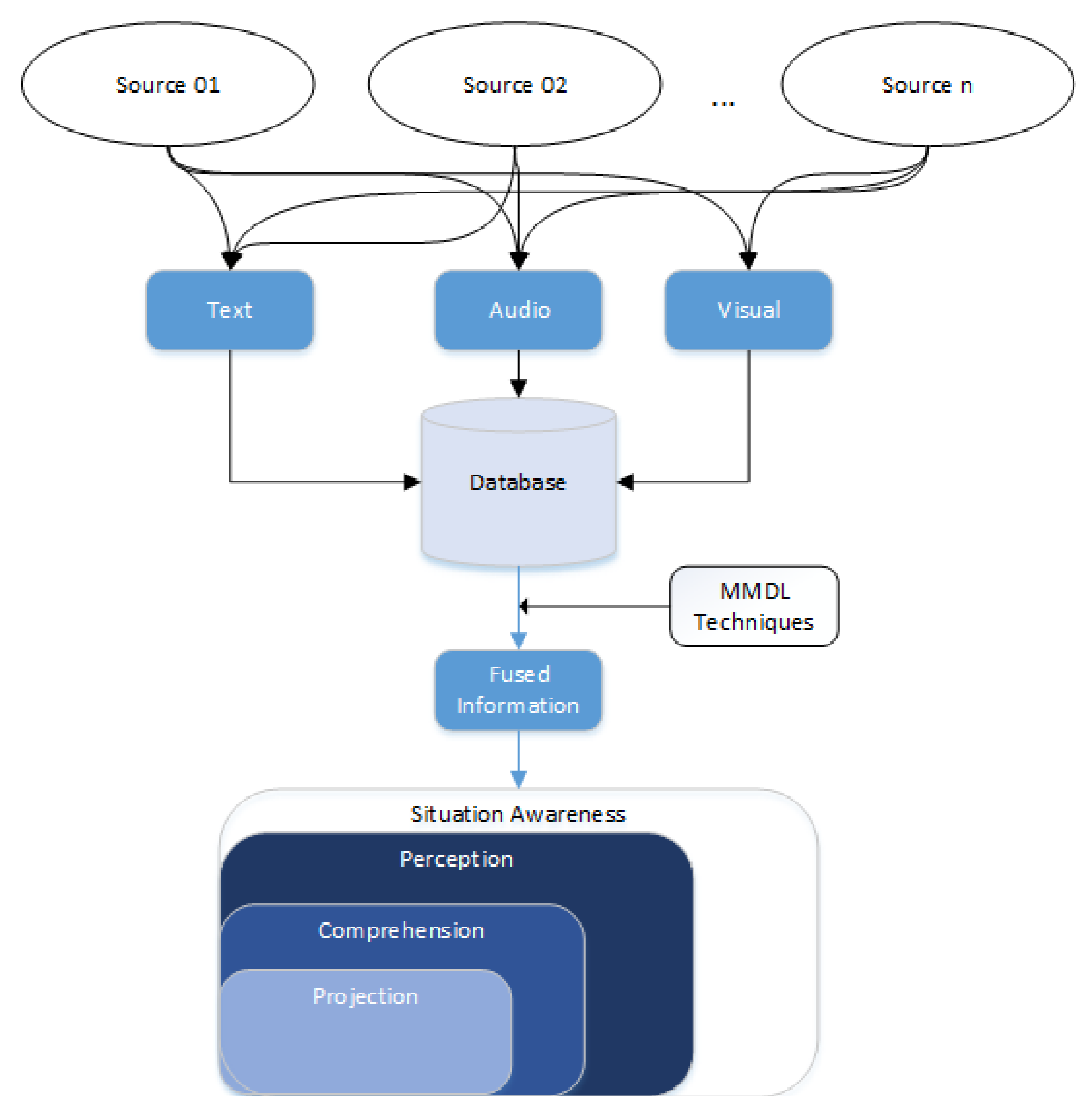


Figure 5: A conceptual framework for implementing a MMDL based computer system for to support SA of disaster respondents.

References

- [1] Geoffrey Hinton, Li Deng, Dong Yu, George Dahl, Abdel-rahman Mohamed, Navdeep Jaitly, Andrew Senior, Vincent Vanhoucke, Patrick Nguyen, Brian Kingsbury, et al. Deep neural networks for acoustic modeling in speech recognition. *IEEE Signal processing magazine*, 29, 2012.
- [2] Zuxuan Wu, Yu-Gang Jiang, Jun Wang, Jian Pu, and Xiangyang Xue. Exploring inter-feature and inter-class relationships with deep neural networks for video classification. In *Proceedings of the 22nd ACM international conference on Multimedia*, pages 167–176. ACM, 2014.