

Course: Multi-modal Data Science and Engineering (MDSE)

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Multimodal Data Science and Engineering (MDSE)

Course by research papers.

Every topic will include:

1. Topic/task/problem specification
2. Previously published methods for solving the problem
3. Description of the new method and the publication where it is published
4. **Software implementation**, experimental results and discoveries
5. Future work to be done for this problem
6. Questions for individual work for those interested

[Additional materials: - relevant papers:](#)

[- https://www.knowledgeengineering.ai/china](https://www.knowledgeengineering.ai/china)

[ZOOM link for all lectures: https://us05web.zoom.us/j/4658730662?pwd=eFN0eHRcN3o4K0FaZ0lqQmN1UUgydz09](https://us05web.zoom.us/j/4658730662?pwd=eFN0eHRcN3o4K0FaZ0lqQmN1UUgydz09)



Lecture 1: Introduction to the course: What is MDSE and why we need it?

Definition: MDSE is a new discipline in science and engineering that develops new methods and their engineering implementations for integrated processing of multiple modalities (e.g. different types) of data into one system for a better performance when compared with systems that deal with single modalities.

Advantages:

- MDSE offers a *wholistic approach* to a better problem solving, considering multiple related factors.
- MDSE can extract novel associations between different modalities of data for new knowledge discovery.
- MDSE can offer a better prediction of future events.

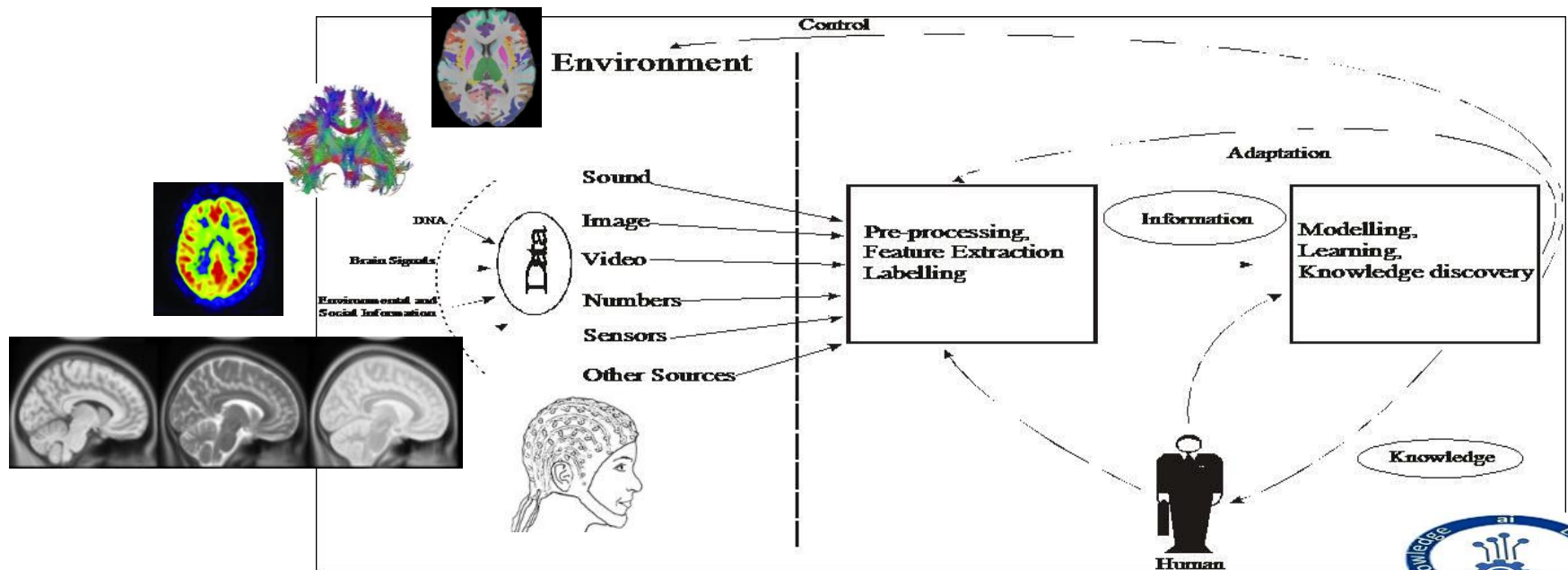
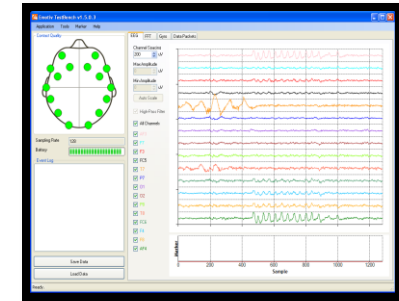
Examples:

- Integrating multiple medical factors in health predictive modelling
- Integrating multiple sensory information for environment prediction
- Integrating audio and visual information
- Integrating multiple factors for financial and economic prediction



Example: MDSE for multiple modality of brain data

- different spatial scales
- different time scales



Topics:

1. Introduction to the course: What is MDSE and why we need it?

2. Methods for MDSE:

- paper: S. Budhraj, B. Singh, S. Tan, M. Dobrojuh, Z. Doborjuh, W. Goh, E. Lai and N. Kasabov, *Mosaic LSM: A Liquid State Machine Approach for Multimodal Longitudinal Data Analysis*, Proc. International Joint Conference on Neural Networks (IJCNN), Gold Coast, Australia, 2023, pp. 1-8, doi: <https://doi.org/10.1109/IJCNN54540.2023.10191256>; <https://ieeexplore.ieee.org/document/10191256>. IEEE, 2023, ISBN:978-166548867-9
- Software NeuGems: <https://kedri.aut.ac.nz/news-and-events/introducing-neurogems>

3. MDSE for integration of static and temporal multimodal biomedical data

- Paper 1: Li, Jiawei; Liu, Jinyuan; Zhou, Shihua; Zhang, Qiang; Kasabov, Nikola, , "GeSeNet: A General Semantic-guided Network with Couple Mask Ensemble for Medical *Image Fusion*" , IEEE Transactions on Neural Networks and Learning Systems, DOI: <https://doi.org/10.1109/TNNLS.2023.3293274>, 21 July 2023.
- Paper 2: M. Doborjuh, N. Kasabov, Z. Doborjuh, R. Enayatollahi, E. Tu, A. H. Gandomi, *Personalised modelling with spiking neural networks integrating temporal and static information*, Neural Networks, 119 (2019), 162-177.
- Paper 3: Sengupta, N., McNabb, C. B., Kasabov, N., & Russell, B. R. (2018). *Integrating Space, Time, and Orientation in Spiking Neural Networks: A Case Study on Multimodal Brain Data Modelling*. IEEE Transactions on Neural Networks and Learning Systems, 29(11). doi:10.1109/TNNLS.2018.2796023

4. MDSE for predictive modelling of multisensory streaming data

- Paper 1: Maciag, Pi; Bembenik, R; Piekarczywicz A, Del Ser L, Javier; L, Lobo, J; N Kasabov,, *Effective Air Pollution Prediction by Combining Time Series Decomposition with Stacking and Bagging Ensembles of Evolving Spiking Neural Networks*, Environmental Modelling and Software, vol.170, on line: 16.10.2023, Dec 2023, 105851, <https://doi.org/10.1016/j.envsoft.2023.105851>; <https://www.sciencedirect.com/science/article/pii/S1364815223002372>
- Paper 2: H Liu, G Lu, Y Wang, N Kasabov, *Evolving spiking neural network model for PM2.5 hourly concentration prediction based on seasonal differences: A case study on data from Beijing and Shanghai*, Aerosol and Air Quality Research, vol.21, Issue 2, Feb. 2021, 200247, <https://doi.org/10.4209/aaqr.2020.05.0247>
- Paper 3: Laña I, Lobo JL, Capecci E, Del Ser J, Kasabov N, *Adaptive long-term traffic state estimation with evolving spiking neural networks*, Transportation Research Part C: Emerging Technologies 101:126-144 2019, <https://doi.org/10.1016/j.trc.2019.02.011>

5. MDSE for integrated audio-visual information processing

- Paper 1: N. Kasabov et al, *AVIS: a connectionist-based framework for integrated auditory and visual information processing*. Inf. Sci. 133, 137–148 (2000)
- Paper2: N Kasabov, B Bhattacharya, D Patel, N Aggarwal, T Bankar, I AbouHassan, *Cognitive Audio-Visual Associative Memories using Brain-inspired Spiking Neural Networks with Case Studies on Moving Object Recognition (IEEE Trans. Cognitive and Devel. Systems, 2023)*.

6. MDSE for integrating times series and text data in finance and economics (Ms Iman AbouHassan)

- Paper: I AbouHassan, N Kasabov, V Jagtap, P Kulkarni, *Spiking neural networks for predictive and explainable modelling of multimodal streaming data on the Case Study of Financial Time Series Data and on-line news*, SREP, Springer-Nature, Sci Rep 13, 18367 (2023). <https://doi.org/10.1038/s41598-023-42605-0>

7. MDSE for integration of brain data and face image data for emotion recognition

- Paper: C Tan; G Ceballos; N Kasabov; N Subramaniam, *FusionSense: Emotion Classification using Feature Fusion of Multimodal Data and Deep learning in a Brain-inspired Spiking Neural Network*, Sensors (ISSN 1424-8220), MDPI Publisher, September 2020

8. Revision of the course

