# The double link between network science and artificial intelligence: a key to scalable learning solutions?

European Data Forum 2016

Technische Universiteit Eindhoven University of Technology

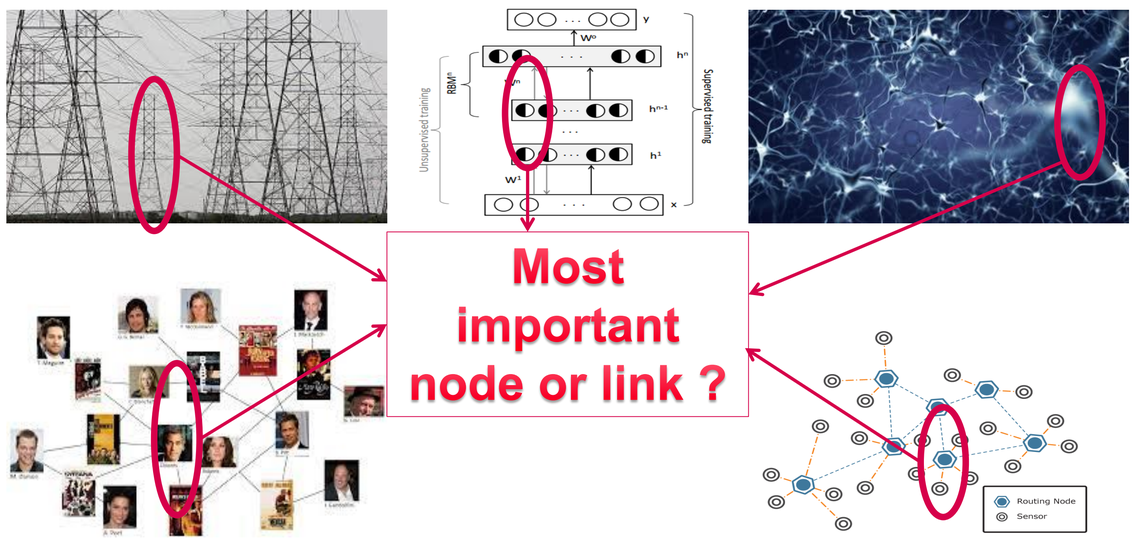
# The double link between network science and artificial intelligence. A key to scalable learning solutions?

Decebal Constantin Mocanu[1], Georgios Exarchakos[1], Antonio Liotta[1]
{d.c.mocanu, g.exarchakos, a.liotta}@tue.nl
[1] *Eindhoven University of Technology, the Netherlands*

interiot
interoperability of heterogeneous IOT platforms

## Artificial Intelligence → Network Science

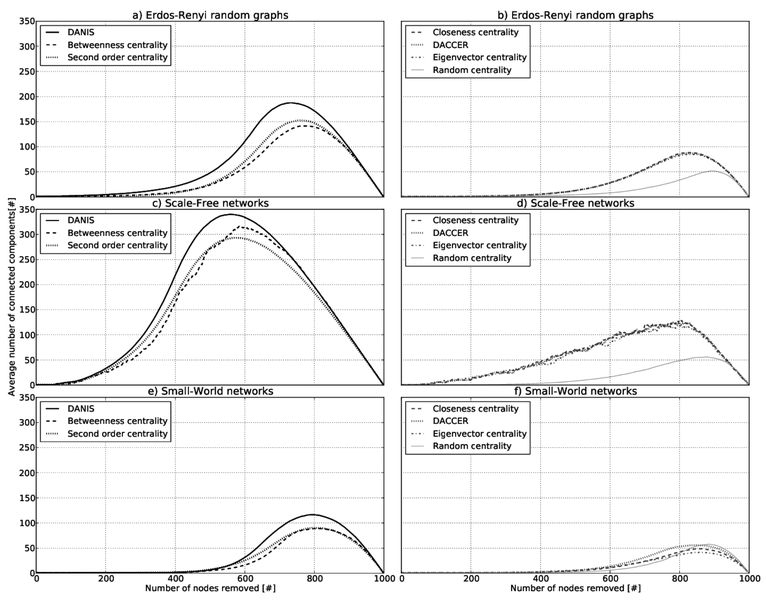
### Problems:




### Solution: DANIS [1]

- A novel decentralized algorithm to assess node's centrality in networks.
- Inspired by the collaborative behavior of decentralized and self-organized swarms.
- Its parallel time complexity is on the polylogarithmic scale with respect to the number of nodes in the network.

### Results:

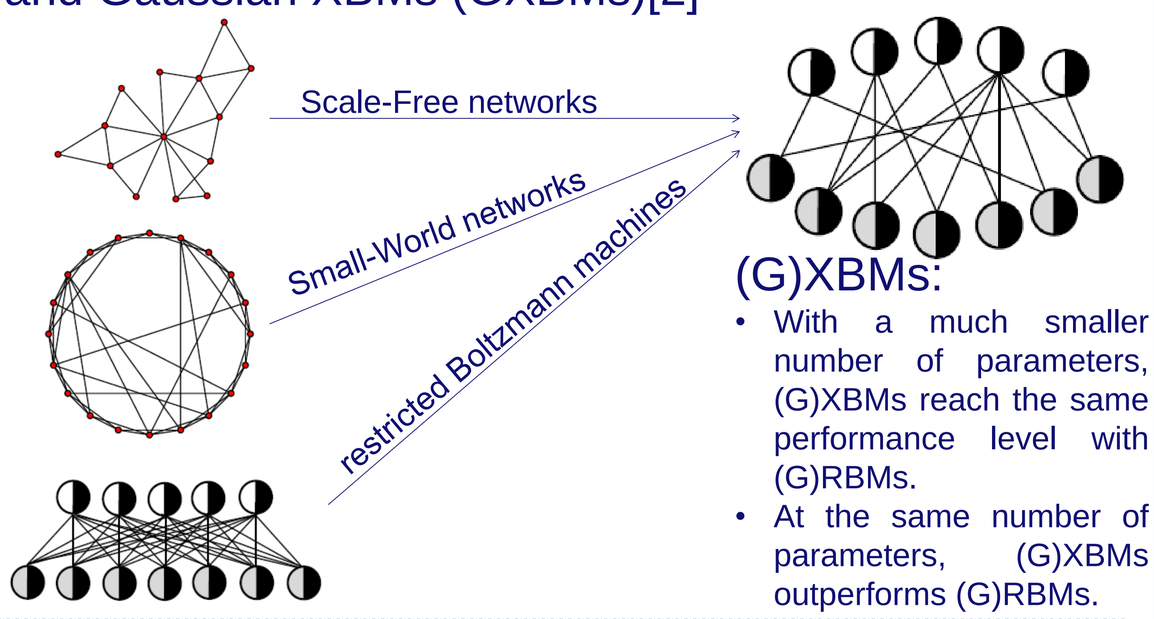



## Network Science → Artificial Intelligence

### Problems:

- High dimensional data (e.g. images have millions of pixels).
- Too many parameters in machine learning models (e.g. deep artificial neural networks have at least millions of parameters).
- The above involve large, or even impracticable, computational time.

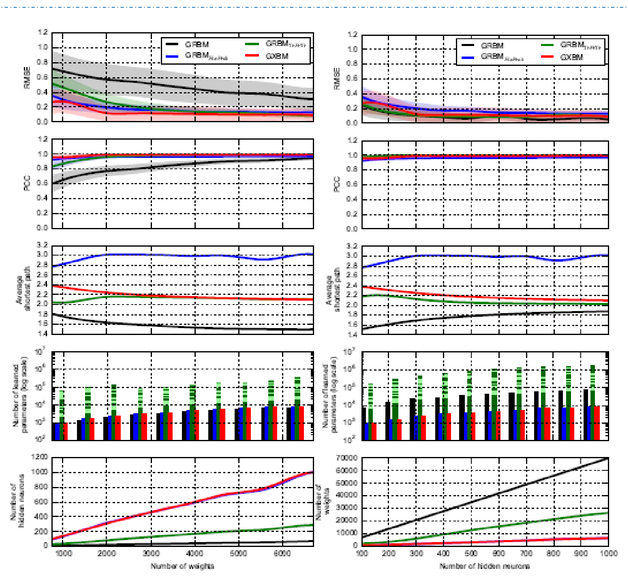
### Solution: compleX Boltzmann Machines (XBMs) and Gaussian XBMs (GXBMs)[2]



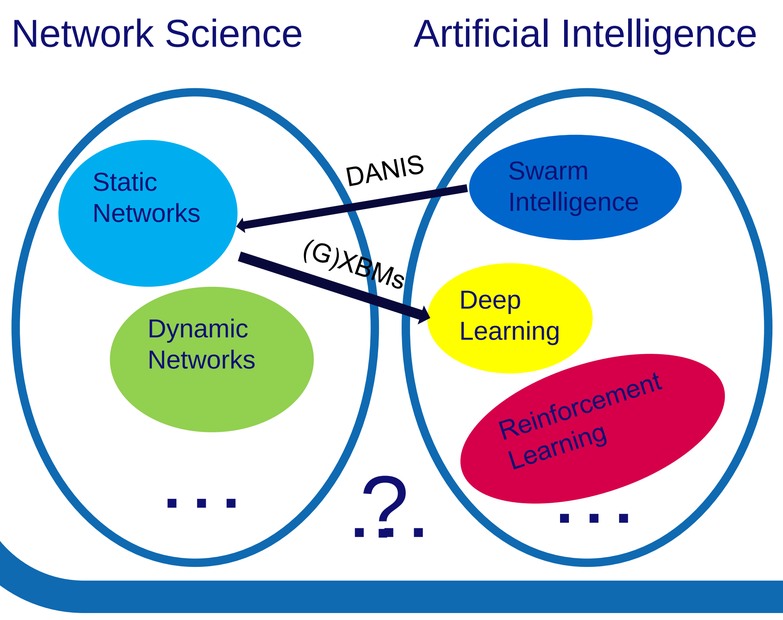

(G)XBMs:

- With a much smaller number of parameters, (G)XBMs reach the same performance level with (G)RBMs.
- At the same number of parameters, (G)XBMs outperforms (G)RBMs.

### Results:




## The double link [3]




## Conclusion

- **DANIS outperforms all the others centralized or decentralized algorithms on Erdős–Rényi Random Graphs, Scale-Free networks, Small-World networks.**
- **(G)XBMs outperform fully connected (G)RBMs and sparse (G)RBMs derived models on 11 benchmark databases (e.g. MNIST digits, CalTech 101 Silhouettes, UCI evaluation suite).**
- **The double link between network science and artificial intelligence may be a good starting point to devise scalable learning solutions.**

## References

[1] D.C. Mocanu, G. Exarchakos, A. Liotta: "*Node Centrality Awareness via Swarming Effects*", IEEE International Conference on Systems, Man, and Cybernetics (SMC 2014), San Diego, USA.

[2] D.C. Mocanu, E. Mocanu, P. Nguyen, M. Gibescu, A. Liotta: "*A topological insight into restricted Boltzmann machines*", Machine Learning Journal, ECML PKDD 2016 special issue.

[3] D.C. Mocanu: "*On the synergy of network science and artificial intelligence*", Proceedings of the Twenty-Fifth International Joint Conference on Artificial Intelligence (IJCAI 2016), 9th-15th July, 2016, New York, USA.

## Acknowledgement

This research has been partly funded by the European Union's Horizon 2020 project INTER-IoT (grant number 687283).

/ Department of Electrical Engineering, Smart Communication Networks group

https://tue.nl/staff/a.liotta