

## IEEE Computational Intelligence Society Distinguished Lecturer Program

**Speaker:** Saman K. Halgamuge, The University of Melbourne, Australia

**Inviting Chapter:** IEEE Computational Intelligence Society Western Australia Chapter

**Date:** 9 May 2021

**Time:** 9am (Perth time)

**Number of Participants:** 85 People

**Lecture Title:** Democratisation of Deep Learning: Self Growing Neural Network Architectures

### **Abstract:**

In the past decade, Deep Neural Networks (DNNs) based on supervised learning have revolutionized various fields including Computer Vision, Natural Language Processing, Bioinformatics and Robotics. Behind this revolution is the increasing demand for computational power, with reportedly the amount of computing used in the training of largest manually designed DNN models doubling every 3.5 months since 2012, much faster than the two-year doubling period of Moore's law in electronic hardware advancement. While continually meeting such a demand is unsustainable and unlikely, a need arises for significant innovations in discovering or designing DNN architectures and training procedures that are significantly more efficient and demand much less computing power, i.e., low cost. Such innovations could also benefit the wider use of DNNs by researchers without expertise in DNN design in many new areas including in energy, environmental and social sciences and arts and humanities.

To reduce the development cost of DNNs, a recent idea proposed is to automate the DNN design, which leads to an emerging field called automatic machine learning (Auto-ML). However, this idea was previously applied by the author on shallow Neural Networks using Self generation/growing [1-3]. Existing Auto-ML methods have attempted to optimize every step of the data analysis pipeline including data preparation, feature engineering, model generation, training, and evaluation. Among them, Neural Architecture Search (NAS) methods explicitly find DNN architectures for a given supervised learning task. This is achieved by encoding the candidate architecture as a solution in some search space and treating the architecture design as an optimization problem. Growing Neural Network Architectures instead of "searching for the best" has been our strategy to this problem.

Our research shows that Self Growing Neural Networks can be used both in Unsupervised Learning and Supervised Learning. In the former, they can be applied to continuous data streams. In the latter, our techniques also lead to interpretable architectures. We also refer to recent work jointly published with Dr Damith Senanayake, Dr Wei Wang and others [3-6].  
Acknowledgment: This research is funded by ARC Discovery project grant DP210101135.

### **References**

1. SK Halgamuge, M Glesner, "Neural Networks in Designing Fuzzy Systems for Real World Applications", Fuzzy Sets and Systems 65 (1), 1-12, 1994

2. SK Halgamuge, W Pochmueller, M. Glesner, "An Alternative Approach for Generation of Membership Functions and Fuzzy Rules Based on Radial and Cubic Basis Function Networks", International Journal of Approximate Reasoning 12 (3), 4, 1995
3. SK Halgamuge, "Self Evolving Neural Networks for rule based data processing", IEEE Transactions on Signal Processing, 45 (11), 2766-2773, 1997
4. D Senanayake, W Wang, SH Naik, S Halgamuge, "Self Organizing Nebulous Growths for Robust and Incremental Data Visualization", IEEE Transactions on Neural Networks and Learning Systems, 2020
5. W Wang, Y Sun, S Halgamuge, "Improving MMD-GAN Training with Repulsive Loss Function", International Conference on Learning Representations (ICLR 2019), 2019
6. PN Hameed, K Verspoor, S Kusljic, S Halgamuge, "Positive-unlabeled learning for inferring drug interactions based on heterogeneous attributes", BMC bioinformatics 18 (1), 1-15, 2017.

### Bio:

Prof Saman Halgamuge is a Fellow of IEEE, a Professor in the School of Electrical, Mechanical and Infrastructure Engineering and a Distinguished Speaker/Lecturer on Computational Intelligence (2019-2021). He served as Director/Head, Research School of Engineering of the Australian National University (ANU) (2016-18), a member of Australian Research Council (ARC) College of Experts for Engineering, Information and Computing Sciences (2016-18), the founding Director of the PhD training centre Melbourne India Postgraduate Program (MIPP) of University of Melbourne and Associate Dean (2013-15) and Assistant Dean (2008-13) in International Engagement in the Melbourne School of Engineering. Saman is also an honorary Professor of ANU.

Website: <https://deeplearningandaiwinterschool.github.io/>

### PROGRAM

Tentative program - All times are given in ICT time (UTC+7)

Day 1: Thu 6 May   Day 2: Fri 7 May   Day 3: Sat 8 May   Day 4: Sun 9 May   Day 5: Mon 10 May

#### Day 4: Sun 9 May 2021 (ICT time UTC+7)

Time	Activity
	IEEE-CIS Distinguished Lecturer Talk II
8.00 - 9.00 am.	<b>Speaker:</b> <i>Saman K. Halgamuge</i> , The University of Melbourne, Australia <b>Topic:</b> Democratisation of Deep Learning: Self Growing Neural Network Architectures (video)
	Forum for Young Investigators (FYI) Session II
	FYI Academic Talk
09.00 - 10.00 am.	<b>Speaker:</b> <i>Worrawat Engchuan</i> , The Centre for Applied Genomics, Canada <b>Topic:</b> Deep learning in genetic study of ASD (video) (slides)
	FYI Academic Talk
10.00 - 11.00 am.	<b>Speaker:</b> <i>Rajarshi Pal</i> , Institute for Development and Research in Banking Technology, India <b>Topic:</b> AI for handwritten document forensic (video) (slides)

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## Outline

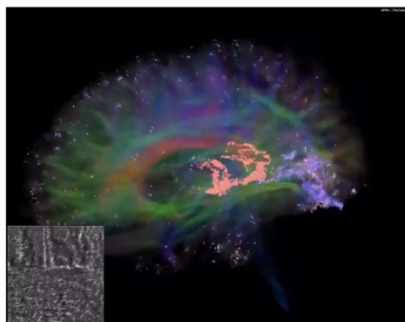


- What do we expect from Machine Learning?
  - Automated generation – democratisation
  - Human interpretability – legal compatibility and knowledge integration
- Learning methods: Supervised, Unsupervised and many in between and beyond
- Supervised Self Growing Neural Networks that can be interpreted
- Visualization with Self Growing Unsupervised Learning that are partially transparent
- Our new work
  - Generative methods-GANs
  - Incremental Learning and Self Growing SONG

Saman Halgamuge's screen

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## Learning: Supervised versus Unsupervised

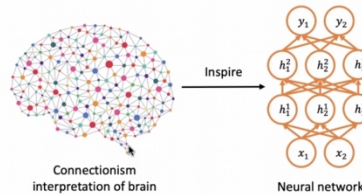


[DigiCortex](#) Simulation of early visual system  
16.7 million neurons, 4 billion synapses  
Video src: [DigiCortex videos](#)

Why deep (structured) learning?

The average brain has about 100 billion neurons and 1000 trillion synaptic connections.

Neural networks are the main models in deep learning. They are so far our closest attempt to imitate the brain.



Are we the best example for creating the best Artificial Neural Network? What are our limitations? How do we see beyond "what we can see"?

9/5/21

University of Melbourne

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## General intelligence-the illusive dream



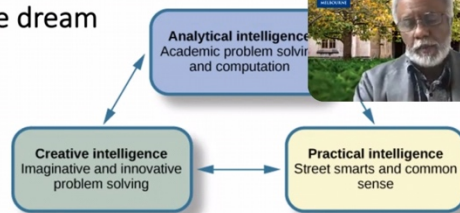
How do we know that we have it in an artificial system?

- human interpretation- Interpretable AI

Can we capture various human intelligence types?

- analytical/creative/practical?

Can we capture animal/plant intelligence types?



<https://www.verywellmind.com/what-is-general-intelligence-2795210#:~:text=General%20intelligence%20can%20be%20defined,%2C%20mechanical%2C%20and%20verbal%20abilities>



Mimosa



Leaf cutting ants

<https://gifer.com/en/8loqH>

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Dear CIS and RAS members,

You are invited to attend the IEEE CIS and RAS Western Australia Chapter Distinguished Lecturer by Professor Saman Halgamuge from The University of Melbourne, Australia.

The talk will be run in a session at the Deep Learning and Artificial Intelligence Summer School 2021 (DLAI5).

**Title:** Democratisation of Deep Learning: Self Growing Neural Network Architectures

**Speaker:** Professor Saman Halgamuge from The University of Melbourne, Australia.

**Date:** 9 May 2021

**Time:** 9am to 10am (Perth time)

**Venue:** Online <https://deeplearningandaiwinterschool.github.io/>

**Registration:** Free to all

Please register at [https://kmutt-ac-th.zoom.us/meeting/register/tJlvc-qvqz4tGN2u\\_wQ0cABXNhNIJhQUqUn4](https://kmutt-ac-th.zoom.us/meeting/register/tJlvc-qvqz4tGN2u_wQ0cABXNhNIJhQUqUn4)

See <https://deeplearningandaiwinterschool.github.io/#program>

### Abstract:

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DNN design, which leads to an emerging field called automatic machine learning (Auto-ML). However, this idea was previously applied by the author on shallow Neural

Networks using Self generation/growing [1-3]. Existing Auto-ML methods have attempted to optimize every step of the data analysis pipeline including data preparation, feature engineering, model generation, training, and evaluation. Among them, Neural Architecture Search (NAS) methods explicitly find DNN architectures for a given supervised learning task. This is achieved by encoding the candidate architecture as a solution in some search space and treating the architecture design as an optimization problem. Growing Neural Network Architectures instead of "searching for the best" has been our strategy to this problem.

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**Bio:**

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Western Australia Section Chapter, CIS11/RA24 : [http://ewh.ieee.org/r10/w\\_australia/cis/](http://ewh.ieee.org/r10/w_australia/cis/)

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