

**Report on the visit of IEEE Computational Intelligence Society
Distinguished Lecturer Professor Mengjie Zhang
to the Rio de Janeiro Chapter**

Due to the social distancing measures imposed by the COVID-19 pandemic, Rio de Janeiro received Professor Mengjie Zhang's lecture via Zoom Meetings. Details on this event are presented below.

- **Distinguished Lecture**

Date: September 29th, 2021, 7:00 PM to 8:40 AM (Rio de Janeiro time)

Organizer: Harold Dias de Mello Junior (Chair of the CIS/IEEE Rio de Janeiro Chapter)

Location: remote meeting (via Zoom)

Title: Automated/Evolutionary Deep Learning and Applications to Image Classification

Abstract: Image classification problems occur in our everyday life. Recognising faces in digital images and diagnosing medical conditions from X-Ray images are just two examples of the many important tasks for which we need computer based image classification systems. Since the 1980s, many image analysis algorithms have been developed. Among those algorithms, deep learning particularly deep convolutional neural networks have received very good success and attracted attentions to industry people and researchers in computer vision and image processing, neural networks, and machine learning. However, there are at least three major limitations in deep convolutional neural networks: (1) the learning architecture including the number of layers, the number of feature maps in each layer and the number of nodes in each feature map are still very much determined manually via “trial and error”, which requires a large amount of hand-crafting/trial time and good domain knowledge. However, such experts are hard to find in many cases, or using such expertise is too expensive. (2) Almost all the current deep learning algorithms need a large number of examples/instances (e.g. AlphaGo used over 30 million instances) that many problems do not have. (3) Those algorithms require a huge computational cost that big companies such as Google, Baidu, and Microsoft can cope well but most universities and research institutions cannot. To address these limitations, evolutionary computation techniques start playing a significant role for automatically determining deep structures, transfer functions and parameters to tackle image classification tasks, and have great potential to advance the developments of deep structures and algorithms. This talk will provide an extended view of deep learning, overview the state-of-the-art work in evolutionary deep learning using Genetic Algorithms (GAs), Particle Swarm Optimisation (PSO) and Differential Evolution (DE), and discuss some recent developments using Genetic Programming (GP) to automatically evolving deep structures and feature construction for image recognition

with a highlight of the interpretation capability and visualisation of constructed features. If time allows, the talk will discuss GP applications to biomarker detection and peptide detection.

Description: This event was announced on the Rio Chapter's Website: <https://r9.ieee.org/rdj-cis/cis-distinguished-lectures-program-automated-evolutionary-deep-learning-and-applications-to-image-classification-sep-29th-2021-7-pm-brt/>

Previously, all Chapter members were notified by email.

The event was also published on the group of the Brazilian Computational Intelligence Society and even on international lists.

A pre-registration was made on the Rio Chapter's Website. We had 70 registrations approved. However, the lecture was attended by up to 20 attendees, including undergraduates, graduates, professors, and researchers. In a very comprehensive approach, Dr. Mengjie initially introduced the definition of neural networks with deep learning and presented his personal view on the subject. He then addressed the state of the art of convolutional neural networks. To motivate the use of evolutionary algorithms, he presented the disadvantages of NN-based DL methods and the limitations of manually designed DNN. After reviewing evolutionary computing methods, Professor Mengjie cited those that have been used successfully to optimize the weights and even the architecture of neural networks over the past 20 years, including EvoCNN, AE-CNN, Genetic CNN, CGP-CNN, PSOAO, IPPSO, and E2EPP. He compared the overall performance of state-of-arts CNN with NAS methods in image classification tasks. The lecture was concluded with a summary indicating the potential for evolutionary deep learning, especially that which uses GP to allow interpretability in image analysis.

The 1 hour and 15 minutes talk was very well received and gave rise to some participants' questions, with about 25 minutes of detailed answers by the DL. The Rio de Janeiro Chapter kindly thanks professor Mengjie Zhang and IEEE CIS DL Program.

This lecture is available privately on the Rio de Janeiro Chapter channel on YouTube for its members.

<https://youtu.be/ptQ1obcBHtY>

Some photos of the meeting are included below.

VICTORIA UNIVERSITY OF WELLINGTON
TE HERENGA WAKA

WELLINGTON ECRG
Evolutionary Computation Research Group

IEEE Distinguished Lecture, Rio, Brazil, 29 September 2021

Evolutionary Deep Learning and Applications to Image Classification

Mengjie Zhang, FRSNZ, FIEEE, IEEE DL

Evolutionary Computation Research Group
Victoria University of Wellington, New Zealand
Mengjie.zhang@ecs.vuw.ac.nz

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POR 09:33
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Professor Mengjie starts his talk

Deep Learning -- Definition

- What is "Deep Learning"? Deep Learning = Deep Neural Networks?

Traditional, single or double hidden layers

e.g., ImageNet winners:
2012: 8 layer
2015: 152 layer
2016: 1207 layer

Many layers

deep

Trained by **Backpropagation (BP)** or variant

f : continuous, differentiable
e.g., $\text{sigmoid}(x)$, $\text{ReLU}(x)$

M-P model (1943) $y = f(\sum_{i=1}^n w_{ij}x_i - \theta)$

Participants (16)

Find a participant

AD	Allan de Lima	🔇	🔇
CR	Caio Rocha	🔇	🔇
DP	Dannylo Pereira	🔇	🔇
DM	Davi Monteiro	🔇	🔇
DJ	DE JONG YEONG	🔇	🔇
DD	Douglas Dias	🔇	🔇
FC	FABIANA CHAVES	🔇	🔇
FB	Fernando Borges	🔇	🔇
FF	FRANK FOWLEY	🔇	🔇
	Giovani Machado	🔇	🔇
	Juan Lazo Lazo	🔇	🔇
MA	Mauricio Amaro	🔇	🔇

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- FF FRANK FOWLEY
- Giovani Machado
- Juan Lazo Lazo
- JS Junkai Shi
- Marcos Seruffo
- MA Mauricio Amaro

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Deep Learning – My View

- Layer-by-layer processing
- Feature transformation
 - Feature extraction
 - Feature construction
 - Feature learning
- Sufficient model complexity
 - Complexity ≠ the number (#) of nodes, layers
 - Including function complexity
 - Not necessarily symmetrical
- #examples?
- Interpretation?

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Participants (19)

Find a participant

- HD Harold de Mello Junior (Me)
- Marley Velasco (Host)
- MZ Mengjie Zhang
- AO Alexandre Oliveira
- AC Alimed Celecia
- AD Allan de Lima
- CR Caio Rocha
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- DM Davi Monteiro
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Convolutional Neural Networks

- Supervised Deep Learning method, dominant DL algorithm
- [Rumelhart](#) and PDP Group's T-C Problem of **weight Sharing** [Chap 8, 1986]
- Yan LeCun's SWNNs [1989, 90, ...]
- A CNN is composed of multiple convolutional layers, pooling layers and fully-connected layers [1998?]
- State-of-the-art CNNs: VGG (2015), ResNet (2015), DenseNet [2016]

Architecture of LeNet-5

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- CR Caio Rocha
- DP Dannylo Pereira
- DJ DE JONG YEONG
- DD Douglas Dias
- FC FABIANA CHAVES
- PP Felipe Macedo

Evolving Unsupervised DNN

- One method using GA to automatically evolve unsupervised DNN
- The goal is achieved by two stages:
 - Architecture and initialized weights are evolved for building blocks
 - Stacked building blocks stacked are trained by Stochastic Gradient Descent

Yanan Sun, Gary G. Yen, Zhang Yi, "Evolving Unsupervised Deep Neural Networks for Learning Meaningful Representations", IEEE Transactions on Evolutionary Computation, vol. 23, no. 1, pp. 89-103, 2019.

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- AO Alexandre Oliveira
- AC Alimed Celesia
- AD Allan de Lima
- DP Dannylo Pereira
- DJ DE JONG YEONG
- DD Douglas Dias
- FC FABIANA CHAVES
- PP Felipe Macedo
- FB Fernando Borges

EvoCNN

- Comparisons on the **FASHION** dataset

classifier	error(%)	# parameters	# epochs
2C1P2F+Drouout	8.40(+)	3.27M	300
2C1P	7.50(+)	100K	30
3C2F	9.30(+)	—	—
3C1P2F+Dropout	7.40(+)	7.14M	150
GRU+SVM+Dropout	10.30(+)	—	100
GoogleNet [41]	6.30(+)	101M	—
AlexNet [3]	10.10(+)	60M	—
SqueezeNet-200 [51]	10.00(+)	500K	200
MLP 256-128-64	10.00(+)	41K	25
VGG16 [52]	6.50(+)	26M	200
EvoCNN (best)	5.47	6.68M	100
EvoCNN (mean)	7.28	6.52M	100

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- FF FRANK FOWLEY
- Giovani Machado
- HB Heder Bernardino
- Juan Lazo Lazo
- JS Junkai Shi
- Marcos Seruffo
- MS Marcos Seruffo

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E2EPP

- Almost all state-of-the-art NAS methods train the new architecture from scratch
- Training even one architecture on modern dataset consumes hours to days on GPU servers
- This is computationally expensive problem
 - EC researchers have developed a number of promising algorithms
 - The random forest technique is used to predict the performance of each newly generated architecture

Yanan Sun, Handing Wang, Bing Xue, Yaochu Jin, Gary G. Yen, Mengjie Zhang. Surrogate-Assisted Evolutionary Deep Learning Using an End-to-End Random Forest-based Performance Predictor. IEEE Transactions on Evolutionary Computation, DOI:10.1109/TEVC.2019.2924461.

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- MZ Mengjie Zhang
- AO Alexandre Oliveira
- AC Alimed Celecia
- AD Allan de Lima
- DP Dannylo Pereira
- DJ DE JONG YEONG
- DD Douglas Dias
- FC FABIANA CHAVES
- FM Felipe Macedo
- FB Fernando Borges
- FF FRANK FOWLEY

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Summary

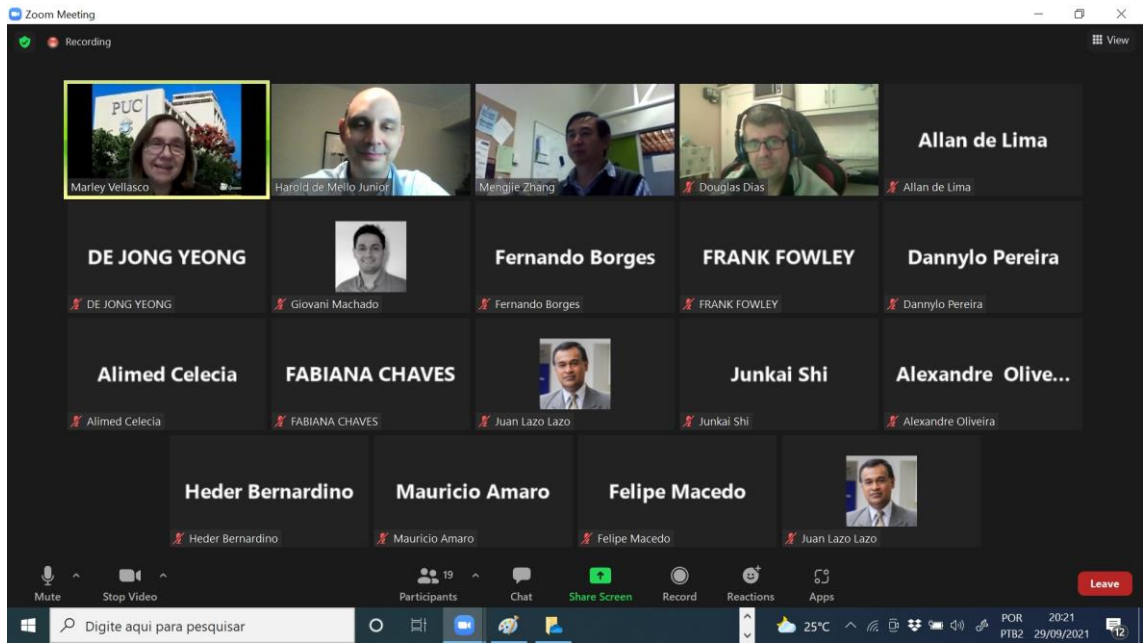
- NN-based **evolutionary deep learning** has started to demonstrate great potential to **outperform the manually designed state-of-the-art deep networks** in image classification and analysis
- **GP based evolutionary deep learning** has also started, and is expected to demonstrate the advantages in effectiveness, **efficiency** and **interpretability** in image analysis
- Evolutionary deep learning is still in an early stage, but is expected to show the **great accuracy**, efficiency, **small training set**, and **good interpretability** of the deep models.

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Printscreen at the end of Professor Mengjie talk