Artificial Intelligence and Machine Learning at VUW

Mengjie Zhang

Artificial Intelligence/Evolutionary Computation Research Group

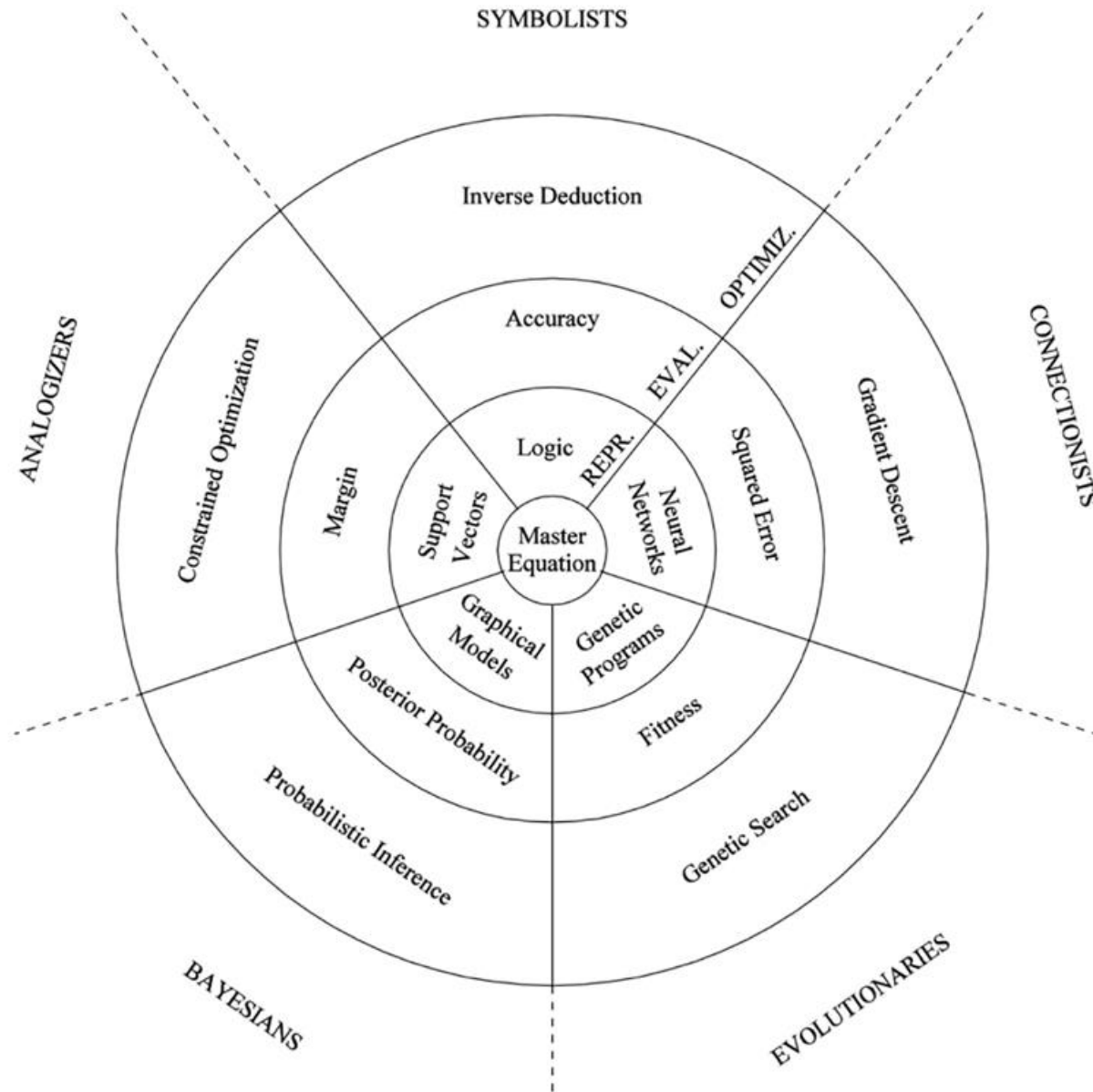**Victoria University of Wellington, New Zealand**

mengjie.zhang@ecs.vuw.ac.nz

VUW AI/ML Key Characteristics

A. A very substantial mass of expertise in AI/ML, spanning both core research and applications.

B. Very strong academic expertise, with strong international recognition.

C. Strong connections to national and international players / stakeholders

D. VUW is NZ leader in this area.

E. Strong links, or potential links, within VUW to other academic units/areas.

AI Streams

- Symbolicism
- Connectionism
- Behaviourism
- Statisticsism

- Machine learning

- Computational Intelligence

Artificial Intelligence and Machine Learning

Core AI vs Big AI

- Core AI/ML: as in the 5 tribes from *Pedro Domingos*
- Big AI: core AI/ML +
  - Big Data
  - IoT
  - Signal/Image processing
  - HCI/Visualisation
  - Robotics
  - Virtual/Augment Reality/Games
  - AI Applications in Health (informatics), Biology (bioinformatics), Biomedical/drug discovery, GIS, Languange (NLP), Architecture, Design, Government, Economy, Law, …

AI/ML/EC at VUW

- Artificial Intelligence and Evolutionary Computation Research Group
- An interdisciplinary research group
  - Computer science
  - Operations research
  - Software engineering, Network engineering
  - Electronic and computer system engineering
  - Statistics, Mathematics
  - Biology
  - Information systems
  - Cyber/software Security

AI People at VUW (> 50)

- Core AI Staff members (20)
  - Mengjie Zhang, Michael Winikoff, Will Browne, Bing Xue
  - Yi Mei, Aaron Chen, Hui Ma, Marcus Frean
  - Peter Andreae, Xiaoying Gao, Wei Gao
  - Lifeng Peng, Ivy Liu, Steven Marsland
  - Su Nguyen, Harith Al-Sahaf, Yanan Sun, Qi Chen (postdoc)
  - Binh Tran, Cao Truong Tran, Bach Hoai Nguyen (postdoc)
- Big AI people (9)
  - Bastiaan Keijn, Dale Carnegie, Stuart Marshall, Craig Anslow, Neil Dodgson, Ian Welch, Chris Hollitt, Winston Seah, Ramesh Rayudu
- Core AI PhD students: >30
- Summer project students: 6-10
- Honours students: ~10 every year

Group Photo

30 people

A Recent Group Photo

35 people -- several people are missing!

Major Research Directions

1. Genetic Programming
2. Learning Classifier Systems and Reinforcement Learning
3. Evolutionary Feature Selection and Big Dimensionality Reduction
4. Evolutionary Scheduling and Combinatorial Optimisation
5. Evolutionary Computer Vision and Image Analysis
6. Automated/Evolutionary Deep Learning
7. Transfer Learning
8. Text mining and Natural Language Processing
9. Statistical Learning
10. Multi-Objective Optimisation
11. Signal/Audio Processing
12. IoT
13. HCI/Visualisation
14. Robotics
15. Virtual/Augment Reality/Games

Genetic/Automatic Programming

- People:
  - **Mengjie**, Bing Xue, Yi Mei, Will Browne, Su Nguyen, Peter Andreae, , Binh Tran, Cao Truong Tran
  - PhD students: 12
- International reputation
  - Chair, IEEE CIS ISATC, ETTC, ECTC,
  - five Marsden grants
  - GP Bib: top 10 (currently No. 4)
  - IEEE TEVC Outstanding paper Award, IEEE CEC Best Paper Award
  - Publications: TEC, TCYB, ECJ, GPEM, ASOC
  - EuroGP, GECCO, CEC – track chairs
- Aspects:
  - Symbolic regression and mathematical modelling
  - Image and vision computing
  - Classification: class imbalance, missing data
  - clustering
  - Hyperheuristics
  - Scheduling and routing
  - Web service and web intelligence
  - Feature construction
  - GP theory: Selection, Schemata, generalisation

Learning Classifier Systems and Reinforcement Learning

- People:
  - **Will Browne**, **Aaron Chen**, Mengjie Zhang, Bing Xue
  - PhD students: 7
- International reputation (and leadership)
  - Chairing GECCO EML/GBML tracks and workshops IWLCS
  - GECCO tutorials, GECCO Best Paper Awards
  - Publications: TEC, ECJ, EI, SC,
- Aspects:
  - XCS, UCS
  - Neuro-evolution, NEAT
  - Online learning
  - Interaction and hybridisation with GP
  - Building blocks of knowledge – layered/transfer learning
  - Classification
  - Feature selection
  - Multi-objective Optimisation

Feature Selection and Big Dimensionality Reduction

- People:
  - **Bing Xue**, Mengjie Zhang, Ivy Liu, Will Browne, Richad Arnold, Lifeng Peng, Yi Mei, Binh Tran, Bach Hoai Nguyen, Cao Truong Tran
  - PhD students: 8
- International reputation/leadership
  - IEEE CIS TF Chair
  - GECCO Tutorials, CEC Special Sessions, IEEE TEVC Survey
  - IES Best Paper Award
  - Publications: TEC, TCYB, ASOC, KBS, INFS…
- Aspects
  - Feature ranking
  - Feature selection: PSO, GP, GA, EMO
  - Feature construction/weighting: GP, PSO, EMO
  - Feature extraction --- image analysis
  - Statistics grouping
  - Bioinformatics --- tens of thousands of features, few examples
  - Feature/variable interaction

Evolutionary Scheduling and Combinatorial Optimisation

- People
  - **Yi Mei**, Aaron Chen, Hui Ma, Su Nguyen, Mengjie Zhang, Kay Chen Tan
  - 8 PhD students
- International reputation
  - Automated design of heuristics, Hyperheuristics
  - GPEM special issue, TEVC Survey, IEEE CIS TF Chairs, CEC Special Sessions
  - GECCO Best Paper Nominations, EvoCOP Best Paper Award
  - Publications: TEC, ECJ, COR, TCYB, EJOR
- Aspects:
  - Job shop scheduling,
  - Acceptance and scheduling
  - Static vs dynamic, uncertain environment
  - (vehicle/ARC) Routing
  - Web service composition
  - Web recourse sequencing
  - Grid/cloud resource planning and allocation
  - Supply Chain optimisation

14

Evolutionary Computer Vision and Image Analysis and Pattern Recognition

- People:
  - **Mengjie Zhang**, **Bing Xue**, **Harith Al-Sahaf**, Will Browne, Peter Andreae, Ramesh Rayudu, Andy Song
  - PhD students: 5
- International reputation and leadership:
  - Co-Chairing IEEE CIS Task Force on ECVIP, IEEE CEC Special Session on ECV, EvoIASP, Special Issues in ASOC
  - Publications: TEC, ECJ, COR, TCYB
- Aspects:
  - Image/Object classification (GP, LCS)
  - Object detection (single class vs multi-class)
  - Edge detection (PSO and GP)
  - Segmentation (PSO)
  - Supervised vs out-of-sample, transfer learning
  - Analysis of evolution solutions
  - Face detection, motion detection
  - Feature construction and selection

Automatic/Evolutionary Deep Learning

- People:
  - **Mengjie Zhang**, **Bing Xue, Yanan Sun,** Harith Al-Sahaf, Will Browne, Marcus Frean, Bastiaan Kleijn, Wei Gao, Xiaoying Gao
  - PhD students: 6
- International reputation
  - IEEE CIS Challenges
  - IEEE CIS Task Force Chair
  - Publish in IEEE TEVC, ECJ
- Main aspects:
  - GP for learning deep models
  - GA/PSO/DE for evolving CNNs
  - Auto-encoder, RBMs
  - Deep belief networks
- Applications
  - Image recognition
  - Text mining and NLP

Transfer Learning

- People:
  - **Bing Xue**, Will Browne, Mengjie Zhang, Aaron Chen, Bastiaan Kleijn, Wei Gao, Xiaoying Gao
  - PhD students: 5
- International reputation
  - Co-Chair: IEEE CIS TF
  - Published in IEEE TPAMI, TEVC, CEC
- Main Aspects
  - LCS/GP --- Layered learning
  - Deep neural transfer learning
  - GP – symbolic regression
  - GP – Image classification

Text Mining and NLP

- People:
  - **Wei Gao**, **Xiaoying Gao**, Peter Andreae, Bing Xue
  - PhD students: 2
  - RAs: 2
- International reputation
  - IEEE CIS Challenge. TF?
  - Published in IJCAI, AAAI
- Main Aspects
  - Collaborating with ESR
  - Text Classification; Tweet, social media
  - NLP
  - Web mining

Statistical/Mathematical ML

- People:
  - Marcus Frean, Stephen Marsland, Bastiaan Kleijn, Ivy Liu, Richard Arnold, Bing Xue, Mengjie Zhang
  - PhD students: 6
  - Postdocs: 2
- Main Aspects
  - Collaborating with Signal Processing
  - Baysian learning, Gaussian process
  - Probability based ML
  - PAC learning, VC-Dimension

Multi-Objective Optimisation

- People:
  - Yi Mei, Bing Xue, Mengjie Zhang, Aaron Chen,
  - PhD students: 3
- International reputation
  - EMO Committee Chairs.
  - Published in IEEE TEVC, IEEE TCYB
- Main Aspects
  - Two or more potentially conflicting objectives
  - Multi-objective optimisation
  - Multi-criterion decision making
  - Many-objective optimisation (4 or more objectives)

Big AI: Other Areas

- Signal/Audio Processing
  - People: **Bastiaan Kleijn**, Paul Teal
  - PhD students: 8
- IoT/IoE/IoN
  - People: **Winston Seah**, Bryan Ny, Paul Teal
- HCI/Visualisation
  - People: **Stuart Marshall**, Craig Anslow, Neil Dodgson
- Robotics
  - People: **Dale Carnegie**, Will Browne, Chris Hollit
- Virtual/Augment Reality/Games
  - People: **Neil Dodgson, Taehyun Rhee**, Fanglue Zhang, Stuart Marshall

Major International Leadership

- Journal Associate Editor/Editor Board:
  - IEEE Transactions on EC (Q1, A*, IF 10.629)
  - IEEE Transactions on CYB (Q1, A, IF 7.384)
  - IEEE Computational Intelligence Magazine (IF 6.343)
  - IEEE Transactions on Emergent Topics in CI
  - Evolutionary Computation Journal (Q1, A, IF 3.836)
  - Applied Soft Computing (Q1, IF 3.451)
  - Engineering Applications of Artificial Intelligence (Q1, IF 2.894)
  - Natural Computing
  - International Journal of Bio-Inspired Computation
  - Neural computing and Applications
- Conference Chairs
  - IJCAI, AAAI, PRICAI, PAKDD, Aus/NZ AI,
  - IEEE CEC, GECCO, EvoStar, SEAL, IES

Major International Leadership

- Important International Positions
  - Chair, IEEE CIS Evolutionary Computation Technical Committee (2014-2015)
  - Chair, IEEE CIS Emergent Technology Technical Committee (2016)
  - Chair, IEEE CIS Intelligent Systems Applications Technical Committee (2017-2018)
  - Vice Chair, IEEE CIS Data Mining/Big Data Technical Committee (2018-)
  - Vice Chair, IEEE CIS Emergent Technology Technical Committee (2017-2018)
  - Chair, IEEE CIS Task Force on Evolutionary Feature Selection and Construction
  - Chair IEEE CIS Task Force on Evolutionary Scheduling and Combinatorial Optimisation
  - Chair, IEEE NZ Computational Intelligence Chapter
  - Member of IEEE CIS Award Committee

Best Paper Awards

- EuroGP 2019 Best Paper Award
- IEEE Transactions on Evolutionary Computation "Outstanding Paper Awards" (2016, 2017)
- IEEE Congress on Evolutionary Computation "Overall Best Paper Award" (IEEE CEC 2015)
- GECCO 2013 Best Paper Award (GBML Track)
- GECCO 2014 Best Paper Award (EML Track)
- EvoCOP 2015 (Evo* 2015) Best Paper Award
- EvoCOP 2016 (Evo* 2016) Best Paper Award
- BCCI 2016 Best Student Paper Award
- IES 2016 Best Paper Award
- SEAL 2017 Best Paper Award
- AI 2009 Best Paper Award

Major International Visitors and Collaborators

- Prof Zhi-Huan Zhou (China), a top 10 AI person (Google)
- Prof Xin Yao (UK/China), Former IEEE CIS President
- Prof Gary Yen (USA), Former IEEE CIS President
- Prof Hisao Ishibuchi (Japan), Former IEEE CIS Vice President, EiC of IEEE CIM
- Prof Kay Chen Tan (Singapore/HK), EiC of IEEE Transactions on EC (TEVC)
- Prof Garry Greenwood (USA), Former EiC of IEEE TEVC
- Prof Yaochu Jin (UK), EiC of IEEE Transactions on Cognitive and Developmental Systems
- Prof Philip Yu (USA), Big Name in Big Data
- Prof Yew Soon Ong (Singapore), EiC of IEEE TETCI
- Prof Carlos Coello Coello (Mexico), Past Chair of IEEE ECTC
- Prof Chengqi Zhang (Australia), Chair of National AI Committee
- Prof Xinghuo Yu (Australia), President, IEEE Industrial Electronics Society

VUW Hosts Two Major AI Conferences

- Conference Sponsorship, exhibitions, workshops
  - Aus/NZ Joint AI 2018: 11-14 December 2018
  - IEEE CEC 2019: 7-10 June 2019
  - Hosted by VUW, in Wellington
  - Contact:
    - Mengjie Zhang (mengjie.zhang@ecs.vuw.ac.nz),
    - Will Browne (will.browne@ecs.vuw.ac.nz)
    - Bing Xue (bing.xue@ecs.vuw.ac.nz),

The 31st Australasian Joint Conference on Artificial Intelligence

11-14 December 2018, Wellington, New Zealand

https://ecs.victoria.ac.nz/Events/AI2018/

IEEE CEC 2019, 10-13 June 2019