Proposal	Contact PI's Surname	Initials	Application Number	Panel
Standard	Mei	Y	24-VUW-092	MIS

MARSDEN FUND PRELIMINARY RESEARCH PROPOSAL

Standard Application Form

1A. TITLE OF RESEARCH PROPOSAL

Towards Better Generalisation and Intrepretability in Automated Design of Combinatorial Optimisation Solvers

1B. IDENTIFICATION

Principal Investigator(s)

Name (with title)	Institution	Country
Associate Professor Yi Mei	Victoria University of Wellington	NEW ZEALAND

Associate Investigator(s)

Name (with title)	Institution	Country
Professor Günther Raidl	Technische Universität Wien	AUSTRIA
Professor Xin Yao		

1C. FIELDS OF RESEARCH

460203 - Evolutionary computation	60%	Evolutionary computation, artificial intelligence, combinatorial optimisation
490304 - Optimisation	40%	
	0%	

1D. SUMMARY

Combinatorial optimisation is ubiquitous with real-world applications such as logistics and resource allocation. Designing effective combinatorial optimisation solvers highly demands domain expertise. Enabling computers to automatically design combinatorial optimisation solvers will be game changer and completely shift the paradigm of combinatorial optimisation. This project aims to tackle the poor generalisation and interpretability issues faced by existing research. We will define rich search spaces of solvers and novel algorithms to effectively search for better generalisation and interpretability. The project is expected to bring new breakthroughs on machine learning, evolutionary computation, and combinatorial optimisation.

2. VISION MĀTAURANGA

Vision Mātauranga themes and percent contribution of the proposed research to each theme.

The total for all themes ticked can exceed 100%

Indigenous Innovation (economic sustainability)		0%
Taiao (environmental sustainability)		0%
Hauora/Oranga (health and social wellbeing)		0%
Mātauranga (indigenous knowledge)		0%
N/A	✓	

A brief rationale for your choice(s):

This project aims to better solve combinatorial optimisation problems in general. Although not directly related to Vision Mātauranga, it indirectly relates to the four themes as follows.

Many indigenous management and decision making problems are combinatorial optimisation problems, which can be benefited from the outcome of this project. For example, (1) we are exploring AI techniques for Māori land use management, which contributes to indigenous economic and environmental sustainability; (2) we are developing AI techniques for automated Kapa Haka judging with Wellington Māori Cultural Society (SfTI Seed Fund 2022); (3) We are collaborating with Wellington Free Ambulance to develop automated ambulance dispatching algorithms, considering the special requirements of Māori patients. Both (2) and (3) contribute to Hauora/Oranga.

We will actively look for Māori use cases (e.g., the aforementioned examples) to verify our algorithms. We will establish relationships with iwi/hapū via our Māori colleagues (Kevin Shedlock and Kirita-Rose Escott), and consult them for the indigenous requirements, strictly following the indigenous data sovereignty. We will also focus on capacity development of indigenous researchers and engineers. We will look for Māori students and early career researchers, and recruit them as our post-graduate students, postdocs or research assistants.

3A. ABSTRACT OF RESEARCH PROPOSAL

Combinatorial Optimisation (CO) [1] has many real-world applications such as last-mile delivery, robotics, and cloud computing. Most CO problems are NP-hard and require strong domain expertise to solve. However, human experts are often unavailable or too expensive. If we can get a computer/machine to automatically design solvers for CO problems, it will have huge practical and theoretical impact. But doing so is extremely difficult.

Existing research [2–8] have used machine learning to automatic design specific types of CO solvers, such as the branch-and-bound algorithm [9–13], constructive heuristics [14–18] and improvement heuristics [19–23]). However, they search within an overly restricted space of specific CO solvers, the learned solvers' effectiveness are strongly limited to the problem instances suitable for that specific solver type. On the other hand, there are a variety of related but different CO problems (e.g., vehicle routing, knapsack, and scheduling). Even the instances within the same problem have much different characteristics (e.g., vehicle routing instances with different graph size and topology). The existing learned CO solvers have poor generalisation to different unseen problems or instances. Additionally, most learned CO solvers are black-box models with poor interpretability, making them difficult to be adopted by users. This project will develop novel machine learning approaches to achieve **better generalisation** and **better interpretability** of the learned CO solvers.

To improve generalised performance on a wide range of unseen problem instances, we will (1) *design a rich search space* containing a comprehensive set of possible CO solvers, and (2) *develop novel search and evaluation methods* to find the best CO solver(s) effectively and efficiently. Based on our experiences in designing various CO solvers (e.g., constructive heuristics [24–26], genetic algorithms [27, 28], particle swarm optimisation [29, 30] and ant colony optimisation [31–33]), we will design a novel unified framework for CO solvers with rich set of continuous, discrete, and nominal parameters. This parametrised framework is expected to cover a much larger space with more complex but capable CO solvers.

To search in the resultant huge non-differential space, we will employ Genetic Programming (GP) [34] due to its flexibility in handling variable-length search space and strength in gradient-free search. A major challenge is the time-consuming evaluation for candidate solvers on a large number of problem instances representing the possible unseen future. To address this challenge, we will propose novel *clustering methods for the problem instances*, and learn ensemble of solvers, each for a cluster. We will leverage our experiences in *multitask and knowledge transfer techniques* [35–43] to improve the learning effectiveness and efficiency, by sharing common knowledge between the models for related instance clusters. In addition, we will develop novel *mixed-input surrogate models* to approximate the evaluation with good trade-off between accuracy and computational complexity.

We will improve interpretability of the learned CO solvers from three aspects. First, we will design *context-free grammar* [44–46], to enforce interpretable structures of CO solvers. Second, we will develop multi-objective approaches to *optimise the quantitative interpretability metrics* together with the original performance metric of CO solvers. Our preliminary studies [47, 48] achieved promising results on a simplified interpretability metric — model size. Expanding on that, we will consider more realistic interpretability metrics and address the corresponding issues. Last but not least, we will develop novel post-hoc explanation methods to further improve the interpretability of the learned solvers, which will be extended from our experiences to explain simple constructive heuristics [49, 50].

Mei's expertise in CO and evolutionary computation, Raidl's expertise in CO and meta-heuristics, and Yao's expertise in artificial intelligence and evolutionary computation provide an excellent basis for this project. We expect this research to produce over 15 publications in prestigious venues such as IEEE TEVC, TCYB, ECJ, EJOR, and GECCO. The outcomes will significantly enhance New Zealand's international leadership in evolutionary computation and combinatorial optimisation.

3B. REFERENCES

[1] B. Korte and J. Vygen. *Combinatorial Optimization*, volume 21 of *Algorithms and Combinatorics*. Springer Berlin Heidelberg, 2018.

[2] N. R. Sabar, M. Ayob, G. Kendall, and R. Qu. Grammatical Evolution Hyper-Heuristic for Combinatorial Optimization Problems. *IEEE Transactions on Evolutionary Computation*, 17(6):840–861, 2013.

[3] I. Bello, H. Pham, Q. V. Le, M. Norouzi, and S. Bengio. Neural Combinatorial Optimization with Reinforcement Learning. *arXiv:1611.09940 [cs, stat]*, 2016.

[4] E. Khalil, H. Dai, Y. Zhang, B. Dilkina, and L. Song. Learning Combinatorial Optimization Algorithms over Graphs. In *Advances in Neural Information Processing Systems 30*, pages 6348–6358. 2017.

[5] R. Qu, G. Kendall, and N. Pillay. The General Combinatorial Optimization Problem: Towards Automated Algorithm Design. *IEEE Computational Intelligence Magazine*, 15 (2):14–23, 2020.

[6] N. Mazyavkina, S. Sviridov, S. Ivanov, and E. Burnaev. Reinforcement learning for combinatorial optimization: A survey. *Computers & Operations Research*, 134:105400, 2021.

[7] Y. Bengio, A. Lodi, and A. Prouvost. Machine learning for combinatorial optimization: a methodological tour d'horizon. *European Journal of Operational Research*, 290(2):405–421, 2021.

[8] M. Karimi-Mamaghan, M. Mohammadi, P. Meyer, A. M. Karimi-Mamaghan, and E.-G. Talbi. Machine learning at the service of meta-heuristics for solving combinatorial optimization problems: A state-of-the-art. *European Journal of Operational Research*, 296 (2):393–422, 2022.

[9] H. He, H. Daume III, and J. M. Eisner. Learning to search in branch and bound algorithms. *Advances in neural information processing systems*, 27, 2014.

[10] M.-F. Balcan, T. Dick, T. Sandholm, and E. Vitercik. Learning to branch. In *International conference on machine learning*, pages 344–353. PMLR, 2018.

[11] M. Etheve, Z. Alès, C. Bissuel, O. Juan, and S. Kedad-Sidhoum. Reinforcement learning for variable selection in a branch and bound algorithm. In *International Conference on Integration of Constraint Programming, Artificial Intelligence, and Operations Research*, pages 176–185. Springer, 2020.

[12] A. Chmiela, E. Khalil, A. Gleixner, A. Lodi, and S. Pokutta. Learning to schedule heuristics in branch and bound. *Advances in Neural Information Processing Systems*, 34:24235–24246, 2021.

[13] G. Zarpellon, J. Jo, A. Lodi, and Y. Bengio. Parameterizing branch-and-bound search trees to learn branching policies. In *Proceedings of the AAAI Conference on Artificial Intelligence*, volume 35, pages 3931–3939, 2021.

[14] E. K. Burke, M. R. Hyde, G. Kendall, and J. Woodward. Automating the Packing Heuristic Design Process with Genetic Programming. *Evolutionary Computation*, 20(1):63–89, 2011.

[15] J. Branke, S. Nguyen, C. W. Pickardt, and M. Zhang. Automated Design of Production Scheduling Heuristics: A Review. *IEEE Transactions on Evolutionary Computation*, 20 (1):110–124, 2016.

[16] T. Barrett, W. Clements, J. Foerster, and A. Lvovsky. Exploratory Combinatorial Optimization with Reinforcement Learning. *Proceedings of the AAAI Conference on Artificial Intelligence*, 34(04):3243–3250, 2020.

[17] C. Zhang, W. Song, Z. Cao, J. Zhang, P. S. Tan, and X. Chi. Learning to dispatch for job shop scheduling via deep reinforcement learning. *Advances in Neural Information Processing Systems*, 33:1621–1632, 2020.

[18] J. Li, Y. Ma, R. Gao, Z. Cao, A. Lim, W. Song, and J. Zhang. Deep reinforcement learning for solving the heterogeneous capacitated vehicle routing problem. *IEEE Transactions on Cybernetics*, 52(12):13572–13585, 2021.

[19] F. Mascia, M. López-Ibáñez, J. Dubois-Lacoste, and T. Stützle. Grammar-based generation of stochastic local search heuristics through automatic algorithm configuration tools. *Computers & Operations Research*, 51:190–199, 2014.

[20] X. Chen and Y. Tian. Learning to Perform Local Rewriting for Combinatorial Optimization. *Advances in Neural Information Processing Systems*, 32:6281–6292, 2019.

[21] Y. Wu, W. Song, Z. Cao, J. Zhang, and A. Lim. Learning improvement heuristics for solving routing problems.. *IEEE transactions on neural networks and learning systems*, 33 (9):5057–5069, 2021.

[22] Y. Wu, W. Song, Z. Cao, and J. Zhang. Learning large neighborhood search policy for integer programming. *Advances in Neural Information Processing Systems*, 34:30075–30087, 2021.

[23] L. Xin, W. Song, Z. Cao, and J. Zhang. Neurolkh: Combining deep learning model with lin-kernighan-helsgaun heuristic for solving the traveling salesman problem. *Advances in Neural Information Processing Systems*, 34:7472–7483, 2021.

[24] Y. Mei, M. Zhang, and S. Nyugen. Feature selection in evolving job shop dispatching rules with genetic programming. In *Proceedings of the Genetic and Evolutionary Computation Conference (GECCO)*, pages 365–372. ACM, 2016.

[25] Y. Mei, S. Nguyen, B. Xue, and M. Zhang. An efficient feature selection algorithm for evolving job shop scheduling rules with genetic programming. *IEEE Transactions on Emerging Topics in Computational Intelligence*, 1(5):339–353, 2017.

[26] J. MacLachlan, Y. Mei, J. Branke, and M. Zhang. Genetic programming hyper-heuristics with vehicle collaboration for uncertain capacitated arc routing problems. *Evolutionary Computation*, 28(4):563–593, 2020.

[27] Y. Mei, K. Tang, and X. Yao. Decomposition-based memetic algorithm for multiobjective capacitated arc routing problem. *IEEE Transactions on Evolutionary Computation*, 15(2): 151–165, 2011.

[28] Y. Mei, K. Tang, and X. Yao. A memetic algorithm for periodic capacitated arc routing problem. *IEEE Transactions on Systems, Man, and Cybernetics, Part B*, 41(6):1654–1667, 2011.

[29] J. Liu, Y. Mei, and X. Li. An analysis of the inertia weight parameter for binary particle swarm optimization. *IEEE Transactions on Evolutionary Computation*, 20(5):666–681, 2016.

[30] Y.-H. Jia, Y. Mei, and M. Zhang. A memetic level-based learning swarm optimizer for large-scale water distribution network optimization. In *Proceedings of the ACM Genetic and Evolutionary Computation Conference*, pages 1107–1115. ACM, 2020.

[31] G. Gao, Y. Mei, Y. Jia, W. Browne, and B. Xin. Adaptive coordination ant colony optimisation for multi-point dynamic aggregation. *IEEE Transactions on Cybernetics*, 52 (8):7362–7376, 2022.

[32] Y. Jia, Y. Mei, and M. Zhang. A bi-level ant colony optimization algorithm for capacitated electric vehicle routing problem. *IEEE Transactions on Cybernetics*, 52(10):10855–10868, 2022.

[33] Y. Jia, Y. Mei, and M. Zhang. Confidence-based ant colony optimization for capacitated electric vehicle routing problem with comparison of different encoding schemes. *IEEE Transactions on Evolutionary Computation*, 26(6):1394–1408, 2022.

[34] J. R. Koza. Genetic programming as a means for programming computers by natural selection. *Statistics and computing*, 4(2):87–112, 1994.

[35] J. Park, Y. Mei, S. Nguyen, G. Chen, and M. Zhang. Evolutionary Multitask Optimisation for Dynamic Job Shop Scheduling Using Niched Genetic Programming. In *Proceedings of the Australasian Joint Conference on Artificial Intelligence*, pages 739–751. Springer, 2018.

[36] F. Zhang, Y. Mei, and M. Zhang. Evolutionary multitasking for dynamic flexible job shop scheduling via genetic programming hyper-heuristics. In *Proceedings of the ACM Genetic and Evolutionary Computation Conference Companion*, pages 107–108. ACM, 2020.

[37] F. Zhang, Y. Mei, S. Nguyen, M. Zhang, and K. C. Tan. Surrogate-assisted evolutionary multitasking genetic programming for dynamic flexible job shop scheduling. *IEEE Transactions on Evolutionary Computation*, 25(4):651–665, 2021.

[38] F. Zhang, Y. Mei, S. Nguyen, K. C. Tan, and M. Zhang. Multitask genetic programming based generative hyper-heuristics: A case study in dynamic scheduling. *IEEE Transactions on Cybernetics*, 52(10):10515–10528, 2022.

[39] F. Zhang, Y. Mei, S. Nguyen, and M. Zhang. Multitask multi-objective genetic programming for automated scheduling heuristic learning in dynamic flexible job shop scheduling. *IEEE Transactions on Cybernetics*, 2022. doi: 10.1109/TCYB.2022.3196887.

[40] F. Zhang, Y. Mei, S. Nguyen, K. C. Tan, and M. Zhang. Task relatedness based multitask genetic programming for dynamic flexible job shop scheduling. *IEEE Transactions on Evolutionary Computation*, 2022. doi: 10.1109/TEVC.2022.3199783.

[41] M. A. Ardeh, Y. Mei, and M. Zhang. A novel multi-task genetic programming approach to uncertain capacitated arc routing problem. In *Proceedings of the ACM Genetic and Evolutionary Computation Conference (GECCO)*, pages 759–767. ACM, 2021.

[42] M. A. Ardeh, Y. Mei, and M. Zhang. Genetic programming with knowledge transfer and guided search for uncertain capacitated arc routing problem. *IEEE Transactions on Evolutionary Computation*, 26(4):765–779, 2022.

[43] M. A. Ardeh, Y. Mei, M. Zhang, and X. Yao. Knowledge transfer genetic programming with auxiliary population for solving uncertain capacitated arc routing problem. *IEEE Transactions on Evolutionary Computation*, 2022. doi: 10.1109/TEVC.2022.3169289.

[44] P. A. Whigham. Grammatically-based genetic programming. In *Proceedings of the workshop on genetic programming: from theory to real-world applications*, volume 16, pages 33–41. Citeseer, 1995.

[45] J. E. Hopcroft, R. Motwani, and J. D. Ullman. Introduction to automata theory, languages, and computation. *Acm Sigact News*, 32(1):60–65, 2001.

[46] R. I. McKay, N. X. Hoai, P. A. Whigham, Y. Shan, and M. O'Neill. Grammar-based Genetic Programming: A survey. *Genetic Programming and Evolvable Machines*, 11(3-4): 365–396, 2010.

[47] S. Wang, Y. Mei, M. Zhang, and X. Yao. Genetic programming with niching for uncertain capacitated arc routing problem. *IEEE Transactions on Evolutionary Computation*, 26(1): 73–87, 2022.

[48] S. Wang, Y. Mei, and M. Zhang. A multi-objective genetic programming algorithm with alpha dominance and archive for uncertain capacitated arc routing problem. *IEEE Transactions on Evolutionary Computation*, 2022. doi: 10.1109/TEVC.2022.3195165.

[49] S. Wang, Y. Mei, and M. Zhang. Local ranking explanation for genetic programming evolved routing policies for uncertain capacitated arc routing problems. In *Proceedings of the ACM Genetic and Evolutionary Computation Conference (GECCO)*, pages 314–322. ACM, 2022.

[50] S. Wang, Y. Mei, and M. Zhang. Explaining genetic programming-evolved routing policies for uncertain capacitated arc routing problems. *IEEE Transactions on Evolutionary Computation*, jan 2023. doi: 10.1109/TEVC.2023.3238741.

3C. ROLES AND RESOURCES

Roles. The team for this project consists of three experts in evolutionary computation (EC), machine learning, and combinatorial optimisation (CO), with complementary specific expertise.

The PI, Yi Mei, has expertise in EC and combinatorial optimisation. He has published over 200 papers in fully refereed international venues (6,500+ Google Scholar Citations, h-index is **40**). Since receiving a Marsden Fast-Start Fund in 2017, he has published 150+ fully refereed international journal and conference papers. He is a recipient of an **Outstanding Paper Award** from IEEE Transactions on Evolutionary Computation (TEVC, the top journal in EC), two **Best Paper Awards** from the ACM Genetic and Evolutionary Computation Conference (GECCO, the top conference in EC) and a **Best Paper Award** from European Conference on Genetic Programming (EuroGP, the flagship conference in GP). He is an **Associate Editor of IEEE TEVC** and **IEEE Transactions on Artificial Intelligence**, and an Editorial Board Member/Associate Editor of other four international journals. He is the **Founding Chair** of the IEEE Task Force on Evolutionary Scheduling and Combinatorial Optimisation. He is a reviewer of 60 international journals (including the top journals in EC and Operations Research) and a PC member of 80 international conferences, including all the major conferences in EC. He is a **Fellow of Engineering New Zealand**. He will manage the whole project, and focus on the developments to address the grammar design, knowledge transfer optimisation algorithm and the interpretability issues. He will be the primary supervisor of the proposed PostDoc, PhD student, Honours students and summer research assistants. His FTE will be 0.2.

Guenther Raidl's expertise is on combinatorial optimisation and meta-heuristics. *xxx*

Xin Yao is a world-leading expert in artificial intelligence and EC. He is the recipient of the 2020 **IEEE Frank Rosenblatt Award** (one of the most prominent international awards in computational intelligence and artificial intelligence), 2012 **Royal Society Wolfson Research Merit Award** and 2013 **IEEE CIS EC Pioneer Award**. He has won **Outstanding Paper Awards** on the top artificial intelligence and evolutionary computation journals (IEEE Transactions on Evolutionary Computation and IEEE Transactions on Neural Networks). He is a **Past President of IEEE CIS** and a **Past Editor-in-Chief of IEEE TEVC**. He is an **IEEE Fellow** and **IEEE Distinguished Lecturer**. He has published 800+ papers in fully refereed journals and international conferences, and his h-index is **122** (75,000 Google Scholar Citations). He will focus on the development of the effective search algorithms. The PI has established very good ongoing research collaborations and relationship with Xin (evidenced by the co-authored recent publications on IEEE TEVC). He will co-supervise the PostDoc and PhD student. He will visit the PI at VUW once a year for two to three weeks and/or use a video conference facility to communicate with the PI and the team at VUW. His FTE will be 0.05.

This project will include a PostDoc and a PhD. The PostDoc will focus on developing the grammar for better search spaces, and the PhD student will focus on developing new algorithms to address the interpretability issues. We will also have an Honours student and a part-time/summer research assistant each year. The Honours and summer project students will be chosen from our own final-year students with good programming skills and good background in EC and machine learning. They will mainly carry out programming and experimentation.

This project will continue NZ's significant international research profile in evolutionary machine learning and combinatorial optimisation. Our previous work on evolutionary learning and combinatorial optimisation has earned a good reputation worldwide. This project will allow that research to continue to be carried out in NZ. We also expect this project to further develop NZ as an international centre on EC particularly in evolutionary combinatorial optimisation.

Resources. The project requires the grid computing facilities and library resources. The School of Engineering and Computer Science and Victoria University of Wellington have these resources and the PI and the students can easily access them. We also need video conference tools (e.g. Zoom) for remote discussions, and VUW and University of Birmingham can provide these tools.

4. PERSONNEL

List the time involvement of all personnel in terms of a Full Time Equivalent (FTE). Give names for all personnel (except when they are as yet unknown for such people as postdoctoral fellows and postgraduate students). Please refer to the Preliminary Research Proposal Guidelines for Applicants for recommended minimum time for Principal Investigators.

Name	FTE Year 1	FTE Year 2	FTE Year 3
Principal Investigator (Contact)(s)			
Associate Professor Yi Mei	0.20	0.20	0.20
Associate Investigator(s)			
Professor Günther Raidl	0.05	0.05	0.05
Professor Xin Yao	0.05	0.05	0.05
Postdoctoral Fellow(s)			
Dr	0.50	0.50	0.50
Postgraduate Student(s)			
PhD	1.00	1.00	1.00
Honours Student	0.25	0.25	0.25
Summer Student	0.20	0.20	0.20
TOTAL	**2.25**	**2.25**	**2.25**

5. CURRICULUM VITAE, PUBLICATIONS AND OTHER PUBLISHED WORKS

PART 1

1a. Personal details					
Full name	*Title* Dr	*First name* Yi	*Second name(s)*	*Family name* Mei	
Present position	Associate Professor				
Organisation/Employer	Victoria University of Wellington				
Contact Address	CO353, Cotton Building				
	Victoria University of Wellington				
	Kelburn, Wellington		**Post code**	6012	
Work telephone	04-463 5331	**Mobile**	021 087 95586		
Email	Yi.mei@ecs.vuw.ac.nz				
Personal website	https://meiyi1986.github.io/				

1b. Academic qualifications

2010, PhD, Computer Science, University of Science and Technology of China.
2005, BSc, Mathematics, University of Science and Technology of China.

1c. Professional positions held

2023-present, Associate Professor, Victoria University of Wellington.
2016-2022, Lecturer and Senior Lecturer, Victoria University of Wellington.
2015-2016, Research Fellow, Victoria University of Wellington.
2012-2015, ARC Discovery Research Fellow, RMIT University.
2010-2012, Research Associate, Chinese University of Hong Kong.

1d. Present research/professional speciality

- Evolutionary Computation, Genetic Programming, Hyper-Heuristics
- Operations Research, Scheduling, Combinatorial Optimisation

1e. Total years research experience	13 years

1f. Professional distinctions and memberships (including honours, prizes, scholarships, boards or governance roles, etc)

Research Funding

- 2024-2027, “Machine Learning for Emergency Medical Dispatch: A Data Driven Approach”, MBIE Smart Idea Fund, $1,000,000NZD (PI)
- 2024-2025, “Machine Learning for Combinatorial Optimisation: An Evolutionary Computation Approach”, NZ Royal Society Catalyst Leaders Fund, $150,000NZD (PI)
- 2022-2023, “Te Taupanga Tapoi: A Post-COVID Kaupapa Māori Tour Recommendation System”, VUW Faculty Strategic Research Fund, $49,000NZD (PI)
- 2022-2023, “Te Kapahaka Pūnaha Taupanga (The kapahaka software judging system)”, NSC SfTI Seed Fund, $200,000NZD (co-PI)
- 2021-2022, “Interpretable Genetic Programming for Combinatorial Optimisation”, Victoria University of Wellington, University Research Fund, $37,275NZD (PI)
- 2017-2020, "Automatic Design of Heuristics for Dynamic Arc Routing Problem with Genetic Programming", 16-VUW-079, Marsden Fund (Fast-Start), $300,000NZD (PI).
- 2020-2027, A data-science driven evolution of aquaculture for building the blue economy (AI/ML Advanced Research and Applications to Aquaculture). MBIE SSIF Fund on Data Science. Grant: $13,000,000 (Key Researcher)
- 2019-2020, “Intelligent Routing for Northland Waste Collection”, industrial project with Northland Waste, $12,000NZD (PI)
- 2018, “Real-Time Tourist Trip Recommendation using Genetic Programming”, VUW University Research Fund, $28,720 NZD (PI)

Prestigious Awards

- 2022, 2023, Best Paper Awards, ACM Genetic and Evolutionary Computation Conference (top conference in evolutionary computation, CORE Tier A)
- 2022, Best Paper Award, European Conference on Genetic Programming (top conference in genetic programming)
- 2017, IEEE Transactions on Evolutionary Computation (TEVC) Outstanding Paper Award for the paper “Cooperative Co-evolution with Differential Grouping for Large Scale Optimization”. (***top journal in AI/EC, CORE Tier A*, impact factor = 16.497, acceptance rate around 5%, only one paper per year wins the award***)

Editorship

- 2023-present, **Associate Editor**, IEEE TEVC (***top journal in AI/EC, CORE Tier A****)
- 2024-present, **Associate Editor**, IEEE Transactions on Artificial Intelligence
- 2016, Guest Editor, Genetic Programming and Evolvable Machines
- 2020-present, Editorial Board Member, International Journal of Bio-Inspired Computation, and International Journal of Automation and Control
- 2019-prsent, Associate Editor, International Journal of Applied Evolutionary Computation

Conference Organisation

- **Program Chair**, Pacific Rim International Conferences on Artificial Intelligence 2025
- **Journal to Conference Chair,** IEEE Congress on Evolutionary Computation 2024
- **Track Chair**, ACM Genetic and Evolutionary Computation Conference 2024
- **Finance Chair**, Conference on Image and Vision Computing New Zealand 2020.
- **Proceedings Chair**, IEEE Congress on Evolutionary Computation 2019 (ARC Tier A).
- **Tutorial Chair**, Pacific Rim International Conferences on Artificial Intelligence 2019.
- **Sponsorship Chair**, Australasian Joint Conference on Artificial Intelligence 2018.
- Organizational Committee Member, International Conference on Computers and Industrial Engineering 2018
- Technical Co-chair, International Conference on Data Intelligence and Security 2018.
- Co-chair of 12 Special Sessions in IEEE Congress on Evolutionary Computation (CEC) (ARC Tier A) 2016-2022
- Co-chair of 4 IEEE Symposia on Evolutionary Scheduling and Combinatorial Optimization (flagship conference in EC) 2019-2022

Professional Membership

- **Fellow** of Engineering New Zealand
- **Chair** of IEEE New Zealand Central Section, 2021-present
- **Chair** of IEEE Computational Intelligence Society Travel Grants subcommittee
- **Founding Chair** of IEEE Taskforce on Evolutionary Scheduling and Combinatorial Optimisation, 2021-present
- **Vice-Chair** and Member of IEEE Computational Intelligence Society (CIS) Emergent Technologies Technical Committee, 2017-2018
- Member of IEEE CIS Emergent Technologies Technical Committee 2017-2019
- Member of IEEE CIS Intelligent Systems Applications Technical Committee 2017-2020
- IEEE Senior Member, ACM Member
- Reviewer of over 30 international journals, including the top journals in EC and OR.
- Program Committee Member for over 40 international conferences.

Other honours

- Invited talks in New Zealand, Australia, UK, and China.
- Supervision of over 20 PhD students (9 PhD have successfully completed).

1g. Total number of *peer reviewed* publications and patents	Journal articles	Books	Book chapters, books edited	Conference proceedings	Patents
	75	1	2	135	1

PART 2

2a. Research publications and dissemination

Peer-reviewed journal articles

* = PhD students supervised by **Mei**; # = postdoc/research fellows supervised by **Mei**

1. M. Xu*, **Y. Mei**, F. Zhang, and M. Zhang. Genetic programming for dynamic flexible job shop scheduling: Evolution with single individuals and ensembles. *Transactions on Evolutionary Computation (TEVC)*, DOI: 10.1109/TEVC.2023.3334626, **2023** (*CORE A*, impact factor = 14.3*)
2. T. Guo*, **Y. Mei**, K. Tang, and W. Du. Cooperative co-evolution for large-scale multi-objective air traffic flow management. IEEE TEVC, DOI: 10.1109/TEVC.2023.3328886, **2023** (*CORE A**)
3. Y. Zhang, **Y. Mei**, H. Zhang, Q. Cai, and H. Wu. Rocash2: An effective route clustering and search heuristic for large scale multi-depot capacitated arc routing problem. *IEEE Computational Intelligence Magazine*, 18(4):43--56, **2023** (*CORE A, impact factor = 9*)
4. S. Wang*, **Y. Mei**, and M. Zhang. Explaining genetic programming-evolved routing policies for uncertain capacitated arc routing problems. *IEEE TEVC*, DOI: 10.1109/TEVC.2023.3238741, **2023** (*CORE A**)
5. **Y. Mei**, Q. Chen, A. Lensen, B. Xue, and M. Zhang. Explainable artificial intelligence by genetic programming: A survey. *IEEE TEVC*, DOI: 10.1109/TEVC.2022.3225509, **2022** (*CORE A**)
6. X. Cai, K. Wang, **Y. Mei**, Z. Li, J. Zhao, and Q. Zhang. Decomposition-based lin-kernighan heuristic with neighborhood structure transfer for multi/many-objective traveling salesman problem. *IEEE TEVC*, DOI: 10.1109/TEVC.2022.3215174, **2022** (*CORE A**)
7. F. Zhang#, **Y. Mei**, S. Nguyen, K.C. Tan, and M. Zhang. Task relatedness based multitask genetic programming for dynamic flexible job shop scheduling. *IEEE TEVC*, DOI: 10.1109/TEVC.2022.3199783, **2022** (*CORE A**)
8. F. Zhang#, **Y. Mei**, S. Nguyen, and M. Zhang. Multitask multi-objective genetic programming for automated scheduling heuristic learning in dynamic flexible job shop scheduling. *IEEE Transactions on Cybernetics (TCYB)*, DOI: 10.1109/TCYB.2022.3196887, **2022** (*CORE A, impact factor = 11.8*)
9. S. Wang*, **Y. Mei**, and M. Zhang. A multi-objective genetic programming algorithm with αdominance and archive for uncertain capacitated arc routing problem. *IEEE TEVC*, DOI: 10.1109/TEVC.2022.3195165, **2022** (*CORE A**)
10. Z. Huang*, **Y. Mei**, and J. Zhong. Semantic linear genetic programming for symbolic regression. *IEEE TCYB*, DOI: 10.1109/TCYB.2022.3181461, **2022** (*CORE A*)
11. F. Zhang#, **Y. Mei**, S. Nguyen, K.C. Tan, and M. Zhang. Instance rotation based surrogate in genetic programming with brood recombination for dynamic job shop scheduling. *IEEE TEVC*, DOI: 10.1109/TEVC.2022.3180693, **2022** (*CORE A**)
12. Y. Jia#, **Y. Mei**, and M. Zhang. Learning heuristics with different representations for stochastic routing. *IEEE TCYB*, DOI: 10.1109/TCYB.2022.3169210, **2022** (*CORE A*)
13. M. Ardeh*, **Y. Mei**, M. Zhang, and X. Yao. Knowledge transfer genetic programming with auxiliary population for solving uncertain capacitated arc routing problem. *IEEE TEVC*, DOI: 10.1109/TEVC.2022.3169289, **2022** (*CORE A**)
14. Y. Jia#, **Y. Mei**, and M. Zhang. Confidence-based ant colony optimization for capacitated electric vehicle routing problem with comparison of different encoding schemes. *IEEE TEVC*, 26(6):1394--1408, **2022** (*CORE A**)

15. M. Ardeh*, **Y. Mei**, and M. Zhang. Genetic programming with knowledge transfer and guided search for uncertain capacitated arc routing problem. *IEEE TEVC*, 26(4):765--779, **2022** (*CORE A**)
16. S. Wang*, **Y. Mei**, M. Zhang, and X. Yao. Genetic programming with niching for uncertain capacitated arc routing problem. *IEEE TEVC*, 26(1):73--87, **2022** (*CORE A**)
17. G. Gao*, **Y. Mei**, B. Xin, Y. Jia, and W. Browne. Automated coordination strategy design using genetic programming for dynamic multi-point dynamic aggregation. *IEEE TCYB*, 52(12):13521--13535, **2022** (*CORE A*)
18. Y. Jia#, **Y. Mei**, and M. Zhang. A bi-level ant colony optimization algorithm for capacitated electric vehicle routing problem. *IEEE TCYB*, 52(10):10855--10868, **2022** (*CORE A*)
19. F. Zhang*, **Y. Mei**, S. Nguyen, KC Tan, and M. Zhang. Multitask genetic programming based generative hyper-heuristics: A case study in dynamic scheduling. *IEEE TCYB*, DOI: 52(10):10515--10528, **2022** (*CORE A*)
20. F. Zhang*, **Y. Mei**, S. Nguyen, and M. Zhang. Collaborative multi-fidelity based surrogate models for genetic programming in dynamic flexible job shop scheduling. *IEEE TCYB*, 52(8):8142--8156, **2022** (*CORE A*)
21. Y. Zhang, **Y. Mei**, S. Huang, X. Zheng, and C. Zhang. A route clustering and search heuristic for largescale multi-depot capacitated arc routing problem. *IEEE TCYB*, 52(8):8286--8299, **2022** (*CORE A*)
22. X. Cai, Q. Sun, Z. Li, Y. Xiao, **Y. Mei**, Q. Zhang, and X. Li. Cooperative coevolution with knowledge-based dynamic variable decomposition for bilevel multiobjective optimization. *IEEE TEVC*, 26(6):1553--1565, 2022 (*CORE A**)
23. Y. Jia#, **Y. Mei**, and M. Zhang. A two-stage swarm optimizer with local search for water distribution network optimization. *IEEE TCYB*, DOI: 10.1109/TCYB.2021.3107900, **2021** (*CORE A*)
24. F. Zhang*, **Y. Mei**, S. Nguyen, and M. Zhang. Correlation coefficient based recombinative guidance for genetic programming hyper-heuristics in dynamic flexible job shop scheduling. *IEEE TEVC*, 25(3):552-566, **2021** (*CORE A**)
25. F. Zhang*, **Yi Mei**, S. Nguyen, K.C. Tan, M. Zhang. Surrogate-Assisted Evolutionary Multitasking Genetic Programming for Dynamic Flexible Job Shop Scheduling. *IEEE TEVC*. 25(4):651-665, **2021** (*CORE A**)
26. B. Xu*, **Y. Mei**, Y. Wang, Z. Ji, and M. Zhang. Genetic programming with delayed routing for multi-objective dynamic flexible job shop scheduling. *Evolutionary Computation*, 29(1):75-105, **2021** (*CORE A*)
27. B. Tan*, H. Ma, **Y. Mei**, M. Zhang, "Evolutionary Multi-Objective Optimization for Web Service Location Allocation Problem," *IEEE Transactions on Services Computing*, 14(2):458-471, **2021** *(CORE A*, impact factor = 8.1)*
28. F. Zhang*, **Y. Mei**, S. Nguyen, and M. Zhang. Evolving scheduling heuristics via genetic programming with feature selection in dynamic flexible job shop scheduling. *IEEE TCYB*, DOI: 10.1109/TCYB.2020.3024849, **2020** (*CORE A*)
29. G. Gao*, **Y. Mei**, Y. Jia, W. Browne, and B. Xin. Adaptive coordination ant colony optimisation for multi-point dynamic aggregation. *IEEE TCYB*, DOI: 10.1109/TCYB.2020.3042511, **2020** (*CORE A*)
30. Y. Jia#, **Y. Mei**, and M. Zhang. Contribution-based cooperative co-evolution for non-separable large-scale problems with overlapping subcomponents. *IEEE TCYB*, DOI: 10.1109/TCYB.2020.3025577, **2020** (*CORE A*)
31. J. MacLachlan*, **Y. Mei**, J. Branke, and M. Zhang. Genetic programming hyper-heuristics with vehicle collaboration for uncertain capacitated arc routing problems. *Evolutionary Computation*, 28(4), 563-593, **2020** (*CORE A*)
32. J. Xie*, **Y. Mei**, A. Ernst, X. Li, and A. Song, "A Bi-level Optimization Model for Grouping Constrained Storage Location Assignment Problems," *IEEE TCYB*,

vol. 48, no. 1, pp. 385-398, 2018. (*CORE A*)

33. **Y. Mei**, S. Nguyen, B. Xue, M. Zhang, "An Efficient Feature Selection Algorithm for Evolving Job Shop Scheduling Rules with Genetic Programming," *IEEE Transactions on Emerging Topics in Computational Intelligence*, Vol. 1, No. 5, pp. 339-353, 2017.
34. M.N. Omidvar*, M. Yang, **Y. Mei**, X. Li and X. Yao, "DG2: A Faster and More Accurate Differential Grouping for Large-Scale Black-Box Optimization," *TEVC*, vol. 21, no. 6, pp. 929-942, 2017 (*CORE A**)

Peer reviewed books

1. F. Zhang#, S. Nguyen, **Y. Mei**, and M. Zhang. Genetic Programming for Production Scheduling: An Evolutionary Learning Approach. Springer, Singapore, 336 pages, **2021**

Refereed conference proceedings

*Selected publications on **CORE Tier A conferences or best paper awards***

1. Z. Huang*, **Y. Mei**, F. Zhang, and M. Zhang. Grammar-guided linear genetic programming for dynamic job shop scheduling. *In Proceedings of the ACM Genetic and Evolutionary Computation Conference (GECCO)*, pages 1137--1145. ACM, 2023. (*GP Track Best Paper Award*)
2. F. Zhang#, **Y. Mei**, S. Nguyen, and M. Zhang. Importance-aware genetic programming for automated scheduling heuristics learning in dynamic flexible job shop scheduling. *In Proc. of the International Conference on Parallel Problem Solving from Nature (PPSN)*, pages 48-62. Springer, **2022**
3. S. Wang*, **Y. Mei**, and M. Zhang. Local ranking explanation for genetic programming evolved routing policies for uncertain capacitated arc routing problems. *In Proc. GECCO*, pp. 314-322. **2022**. (*ECOM Best Paper Award*)
4. Z. Huang*, **Y. Mei**, F. Zhang, and M. Zhang. Graph-based linear genetic programming: A case study of dynamic scheduling. *In Proc. GECCO*, pp. 955-963. **2022**
5. J. Costa*, **Y. Mei**, and M. Zhang. Guided local search with an adaptive neighbourhood size heuristic for large scale vehicle routing problems. *In Proc. GECCO*, pp. 213-221. **2022**
6. Z. Huang*, F. Zhang#, **Y. Mei**, and M. Zhang. An investigation of multitask linear genetic programming for dynamic job shop scheduling. In *Proc. of the European Conference on Genetic Programming (EuroGP)*, pp. 162-178, **2022**. (*Best Paper Award*)
7. S. Wang*, **Y. Mei**, and M. Zhang. A two-stage multi-objective genetic programming with archive for uncertain capacitated arc routing problem. *In Proc. GECCO*, pp. 287-295, **2021**
8. M. Ardeh*, **Y. Mei**, and M. Zhang. A novel multi-task genetic programming approach to uncertain capacitated arc routing problem. *In Proc. GECCO*, pp. 759-767, **2021**
9. Y. Jia#, **Y. Mei**, and M. Zhang. A memetic level-based learning swarm optimizer for large-scale water distribution network optimization. *In Proc. GECCO*, pp. 1107-1115. **2020**
10. B. Tan*, H. Ma, and **Yi Mei**. An nsga-ii-based approach for multi-objective micro-service allocation in container-based clouds. *In Proc. of the IEEE/ACM International Symposium on Cluster, Cloud and Internet Computing (CCGRID)*, pp. 282-289. IEEE, **2020**
11. S. Wang*, **Y. Mei**, and M. Zhang. Novel ensemble genetic programming hyper-heuristics for uncertain capacitated arc routing problem. *In Proc. GECCO*, pp. 1093-1101, **2019**.

A full list of my publications can be seen from: https://meiyi1986.github.io/publication/

6. OTHER FUNDING

List of other funding organisations to whom you have sought or received a grant for this application.

No other funding applications listed.