Proposal	Contact PI's Surname	Initials	Application Number	Panel
Standard	Mei	Y	23-VUW-114	MIS

MARSDEN FUND PRELIMINARY RESEARCH PROPOSAL

Standard Application Form

1A. TITLE OF RESEARCH PROPOSAL

Learning to Solve Combinatorial Optimisation: An Evolutionary Computation Approach

1B. IDENTIFICATION

Principal Investigator(s)

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

Associate Investigator(s)

Name (with title)	Institution	Country
Professor X Yao	University of Birmingham	UNITED KINGDOM

1C. FIELDS OF RESEARCH

460203 - Evolutionary computation

100% Artificial intelligence, machine learning, evolutionary computation, combinatorial optimisation

0%

0%

1D. SUMMARY

Combinatorial optimisation is ubiquitous with real-world applications such as robotics and cloud computing. 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 non-trivial challenges of huge search space faced by existing research. We will define comprehensive and compact search spaces through context-free grammar, and develop novel algorithms to search effectively by knowledge transfer between related problem domains. The project is expected to bring new breakthroughs on automated design of combinatorial optimisation solvers.

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 to automatically learn how to solve CO problems, it will have huge practical and theoretical impact. But doing so is extremely difficult.

Although using machine learning to solve CO problems is not a completely new research area, the existing works [2–8] are still very preliminary and face the challenge of infinite number of possible CO solvers, leading to a *huge non-differentiable search space* to find the best CO solver. They reduce the search space too strongly into a specific algorithm type (e.g., the branch and bound algorithm [9–13], constructive heuristics [3, 4, 14–18] or improvement heuristics [19–23]). The overly restricted search spaces limit the effectiveness of the learned CO solvers. In this project, we will propose new ideas to **define better search spaces of CO solvers** and **effective search algorithms in the huge non-differentiable search space**.

(Better Search Space). The space of CO solvers depends on the solver structure design and component selection. The solver structure design explores which CO solver modules (e.g., constructive heuristic or improvement heuristic) are connected in what way. The component selection determines which components to be used in each module (e.g., the 2-opt or Lin-Kernighan operator in the improvement heuristic module). To achieve these objectives, we will use *context-free grammar* [24–26], where each variable defines a CO solver module, each terminal defines a component, and each production rule defines a possible connection among the modules and components.

The development of the grammar is critical, since it must be *sufficient* (containing the best solver) and *compact* (excluding as many poor solvers as possible). We do not know which grammar will be best in terms of sufficiency and compactness. To develop effective grammars, i.e., the variables, terminals and production rules, we will extend existing grammars [2, 27] and draw on our experience in designing various CO solvers (e.g., constructive heuristics [28–30], genetic algorithms [31, 32], particle swarm optimisation [33, 34] and ant colony optimisation [35–37]).

(Effective Search in the Huge Non-differentiable Space). We will use genetic programming (GP) [38] due to its strength in *learning both solver structure and component selection simultaneously*, as well as its *gradient-free* search mechanism to tackle non-differentiability. We will decompose the huge space into smaller sub-spaces by decomposing the problem into multiple specific groups (e.g., different graph topologies in vehicle routing), and then learn a specialist solver for each group. To search more effectively, we will incorporate domain knowledge into each group for removing irrelevant and unimportant variables, terminals and production rules in the group-specific grammar. Furthermore, our algorithms will learn the specialist solvers *cooperatively* instead of independently to boost effectiveness and efficiency. In previous studies, we have successfully developed algorithms based on transferring *unimodal* knowledge (e.g., scheduling rules [39–44] or routing policies [45–47]) among the related learning processes. In this project, we will develop novel algorithms to transfer *multimodal* knowledge for learning different types of specialist solvers cooperatively.

Last but not least, we will address the *interpretability* issue of the learned solvers, which is still an open challenge in explainable artificial intelligence and GP [48]. We have done previous work specifically for interpreting constructive heuristics [49–52], and will extend them to interpret *more general* CO solvers such as meta-heuristics. We will test our algorithms on a wide range of CO benchmark datasets (e.g., TSPLIB and OR-Library) and real-world datasets and compare with state-of-the-art CO solvers in terms of effectiveness, efficiency and interpretability.

Mei's expertise in evolutionary computation and CO and Yao's expertise in artificial intelligence, machine learning 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

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3C. ROLES AND RESOURCES

Roles. The team established for this project consists of a world-class researcher in evolutionary computation (EC) and combinatorial optimisation, and a world-leading expert in artificial intelligence, machine learning and EC.

The PI, Yi Mei, is a world-class researcher in EC and combinatorial optimisation. He has published over 180 papers in fully refereed international venues (5,000+ Google Scholar Citations, h-index is **36**). Since receiving a Marsden Fast-Start Fund in 2017, he has published 130+ fully refereed international journal and conference papers. He is a top **2%** most-cited scientist in the world. He is a recipient of an **Outstanding Paper Award** from IEEE Transactions on Evolutionary Computation (TEVC, the top journal in EC), a **Best Paper Award** 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 received a Victoria University of Wellington Early Research Excellence Award in 2018. He is an **Associate Editor of IEEE TEVC** 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, and a member of two IEEE Computational Intelligence Society (CIS) technical committees and four task forces. 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.

The AI, Xin Yao, is a world-leading expert in artificial intelligence, machine learning 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 **118** (67,000+ 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)			
Dr Yi Mei	0.20	0.20	0.20
Associate Investigator(s)			
Professor X Yao	0.05	0.05	0.05
Postdoctoral Fellow(s)			
Unnamed	0.50	0.50	0.50
Postgraduate Student(s)			
Summer Student	0.20	0.20	0.20
Honours Student	0.25	0.25	0.25
PhD	1.00	1.00	1.00
TOTAL	**2.20**	**2.20**	**2.20**

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	12 years

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

Research Funding

- 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)
- 2017, “Evolving Interpretable Flexible Job Shop Scheduling Rules with GP”, VUW Research Establishment Grant, $10,000 NZD (PI)
- 2016-2018, “Digital Data in Schools: An Exploration of Research and Practice”, Victoria University of Wellington Digital Future Grant, $20,000 NZD (co-PI)
- 2014, RMIT Near-miss Grant (awarded for being ranked top 10% of the unsuccessful applications for the 2014 ARC DECRA funding). Grant: $25,000AUD (PI).

Prestigious Awards

- 2022, Best Paper Award, 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)
- 2018, Victoria University of Wellington Early Career Research Award, $5,000 NZD
- 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****)
- 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

- **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
- **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
	63	1	2	120	1

PART 2

2a. Research publications and dissemination

Peer-reviewed journal articles

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

1. S. Wang*, **Y. Mei**, and M. Zhang. Explaining genetic programming-evolved routing policies for uncertain capacitated arc routing problems. *IEEE Transactions on Evolutionary Computation (TEVC)*, DOI: 10.1109/TEVC.2023.3238741, **2023** (*CORE A*, impact factor = 16.497*)
2. **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**)
3. 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**)
4. 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**)
5. 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 = 19.118*)
6. 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**)
7. 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*)
8. 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**)
9. 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*)
10. 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**)
11. 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**)
12. 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**)
13. 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**)
14. 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*)
15. 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*)

16. 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*)
17. 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*)
18. 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*)
19. 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**)
20. 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*)
21. 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**)
22. 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**)
23. 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*)
24. 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 = 11.019)*
25. 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*)
26. 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*)
27. 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*)
28. 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*)
29. 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*)
30. **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.
31. 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**)
32. **Y. Mei**, F. Salim, X. Li, "Efficient Meta-heuristics for the Multi-Objective Time-Dependent Orienteering Problem," *European Journal of Operational*

Research, vol. 254, no. 2, pp. 443-457, 2016, Elsevier. (*CORE A*)

33. **Y. Mei**, M.N. Omidvar, X. Li, and X. Yao, "Competitive Divide-and-Conquer Algorithm for Unconstrained Large Scale Black-Box Optimization," *ACM Transactions on Mathematical Software*, vol. 42, no. 2, pp. 13:1-24, 2016 (CORE A*)
34. M.N. Omidvar*, X. Li, **Y. Mei**, and X. Yao, "Cooperative Co-evolution with Differential Grouping for Large Scale Optimization," *IEEE TEVC*, vol. 18, no. 3, pp. 378-393, 2014. (*CORE A**) *[IEEE TEVC Outstanding Paper Award]*

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. 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**
2. S. Wang*, **Y. Mei**, and M. Zhang. Local ranking explanation for genetic programming evolved routing policies for uncertain capacitated arc routing problems. *In Proc. of the ACM Genetic and Evolutionary Computation Conference (GECCO)*, pp. 314-322. **2022**. (*ECOM Best Paper Award*)
3. 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**
4. 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**
5. 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*)
6. 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**
7. M. Ardeh*, **Y. Mei**, and M. Zhang. A novel multi-task genetic programming approach to uncertain capacitated arc routing problem. *In Proc. of ACM GECCO*, pp. 759-767, **2021**
8. Y. Jia#, **Y. Mei**, and M. Zhang. A memetic level-based learning swarm optimizer for large-scale water distribution network optimization. *In Proc. of ACM GECCO*, pp. 1107-1115. **2020**
9. 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**
10. S. Wang*, **Y. Mei**, and M. Zhang. Novel ensemble genetic programming hyper-heuristics for uncertain capacitated arc routing problem. *In Proc. of ACM GECCO*, pp. 1093-1101, **2019**.
11. F. Zhang*, **Y. Mei**, and M. Zhang. A two-stage genetic programming hyper-heuristic approach with feature selection for dynamic flexible job shop scheduling. *In Proc. of ACM GECCO*, pp. 347-355, **2019**.

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

5. CURRICULUM VITAE, PUBLICATIONS AND OTHER PUBLISHED WORKS

PART 1

1a. Personal details					
Full name	*Title* Prof	*First name* Xin	*Second name(s)*	*Family name* Yao	
Present position	Chair Professor				
Organisation/Employer	The University of Birmingham				
Contact Address	School of Computer Science				
	The University of Birmingham				
	Edgbaston, Birmingham, U.K.		**Post code**	B15 2TT	
Work telephone	+44 121 414 3747	**Mobile**			
Email	X.Yao@cs.bham.ac.uk				
Personal website (if applicable)	https://www.cs.bham.ac.uk/~xin/				

1b. Academic qualifications

1990, PhD, University of Science and Technology of China, China
1985, M.Sc., North China Institute of Computing Technology, China
1982, B.Sc., University of Science and Technology of China, China

1c. Professional positions held

- 2016 – Present: Chair Professor and Founding Head of Computer Science and Engineering Department, Southern University of Science and Technology, China.
- 2003 – Present: Director of The Centre of Excellence for Research in Computational Intelligence and Applications (CERCIA), the University of Birmingham (UB), UK
- 1999 – Present: Chair Professor, School of Computer Science, UB, UK
- 2016 – Present: Immediate Past President, and acting Vice President (technical activities), IEEE Computational Intelligence Society
- 2014 – 2015: President, IEEE Computational Intelligence Society
- 2003 – 2008, Editor-in-Chief, IEEE Transactions on Evolutionary Computation
- 2000 – Feb 2004, Aug 2004 – Aug 2007: Deputy Head of School, School of Computer Science, UB, UK
- Jan 1999 – Mar 1999: Associate Professor in the School of Computer Science, University College, The University of New South Wales (UNSW), Australian Defence Force Academy (ADFA), Australia.

1d. Present research/professional speciality

- Evolutionary Computation; Computational Intelligence; Machine Learning; Data Science; Meta-heuristic Optimisation

1e. Total years research experience	38 years

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

Research Grants (recent five years)

- 2023 – 2025: NSFC Joint Research Fund for Overseas Scholars, 62250710682, “Evolutionary Computation-based Trustworthy AI Theory and Methods,” CNY3,700,000 (PI)
- 2018 – 2023: Guangdong Province Department of Science and Technology Zhujiang Talent Innovative Business Program, 2017ZT07X386, “Reconstruct Brain-like Computation System,” CNY20,000,000 (PI)
- 2017 – 2020: National Key R&D Program of China, 2017YFC0804003, Multi-Modal Corruption Detection and Prediction”, CNY7,090,000 (PI)
- 2014 – 2017: NSFC Joint Research Fund for Overseas Scholars, 61329802, “High-Performance Evolutionary Computation,” CNY2,000,000 (PI)

- 2012 – 2018: EPSRC (EP/J017515/1). ``DAASE: Dynamic Adaptive Automated Software Engineering." GBP6,834,903. (Co-Is).

Professional and Administrative Activities:

- Past President, and acting Vice President, IEEE CIS
- Invited keynote/plenary speeches at over 100 international conferences
- (Guest) Editors of 36 international journals
- Conference chairs of more than 40 international conferences
- Conference committee memberships and invited talks for more than 70 conferences
- Member of the Scientific Advisory Board for SolveIT Software
- Chair of IEEE Computational Intelligence Society Fellows Evaluation Committee (2008)
- Member of the Universities UK ORS (Overseas Research Students) Award Committee (2003-04). Chair of Panel D in 2005
- Director of the Nature Inspired Computation and Applications Laboratory (NICAL), University of Science and Technology of China (USTC), Hefei, China.
- Chief Professor of the School of Software Engineering, USTC, Hefei, China.

Awards and Honours (recent years):

- 2020 IEEE Frank Rosenblatt Award
- 2017 IEEE Computational Intelligence Society (CIS) Meritorious Service Award
- 2016 Thomson Reuters Highly Cited Researchers
- 2013 IEEE Computational Intelligence Society Evolutionary Computation Pioneer Award
- 2012 Royal Society Wolfson Research Merit Award
- 2008, 2016 and 2017 IEEE Transactions on Evolutionary Computation (**the top journal in evolutionary computation, CORE A***) Outstanding Paper Award
- 2011 IEEE Transactions on Neural Networks (**the top journal in neural network, CORE A***) Outstanding Paper Award
- Fellow of IEEE (since 2003)
- The 2nd prize of 2010 BT Gordon Radley Award for Best Author of Innovation for the paper
- Distinguished "Leon the Mathematician" Lecturer, Department of Informatics, Aristotle University of Thessaloniki, Greece. 2 Nov 2010
- 2010 (Inaugural) University Award for Excellence in Doctoral Research Supervision, University of Birmingham, UK. (Announced in June 2010)
- Best Paper Award in the Theory track at the 2009 Genetic and Evolutionary Computation Conference, 8-12 July 2009, Montreal, Canada
- The Best PhD Student Paper Prize at the 2008 IEEE International Conference on Software Testing Verification and Validation Workshop (ICSTW'08), 2008. Lillehammer, Norway
- Sterling Hou Lecture, University of Missouri - Columbia, Columbia, USA, 28 Oct 2005.
- IEEE CIS Distinguished Lecture, University of Missouri, USA, 26 Oct 2005.
- Cheung Kong Scholar (Changjiang Chair Professorship), Ministry of Education of the People's Republic of China.

1g. Total number of *peer reviewed* publications and patents	Journal articles	Books	Book chapters, books edited	Conference proceedings	Patents
	412		66	346	3

PART 2

2a. Research publications and dissemination

Peer-reviewed journal articles

*Selected related articles in the last **five** years published in top* **ARC Tier A/A*** journals

1. Li, K., Lai, G., & **Yao, X.** (**2023**). Interactive Evolutionary Multi-Objective Optimization via Learning-to-Rank. *IEEE Transactions on Evolutionary Computation (TEVC)*. DOI: 10.1109/TEVC.2023.3234269 (*CORE A**)
2. Zhang, G., Li, L., Su, Z., Shao, Z., Li, M., Li, B., & **Yao, X**. (**2022**). New Reliability-Driven Bounds for Architecture-Based Multi-Objective Testing Resource Allocation. *IEEE Transactions on Software Engineering*. DOI: 10.1109/TSE.2022.3223875 (*CORE A**)
3. Jiang, S., Zou, J., Yang, S., & **Yao, X**. (**2022**). Evolutionary dynamic multi-objective optimisation: A survey. ACM Computing Surveys, 55(4), 1-47. (*CORE A**)
4. Su, Z., Li, M., Zhang, G., Wu, Q., Li, M., Zhang, W., & **Yao, X.** (**2022**). Robust Audio Copy-Move Forgery Detection Using Constant Q Spectral Sketches and GA-SVM. *IEEE Transactions on Dependable and Secure Computing*. DOI: 10.1109/TDSC.2022.3215280 (*CORE A*)
5. Luo, W., Shi, L., Lin, X., Zhang, J., Li, M., & **Yao, X**. (**2022**). Finding top-K solutions for the decision-maker in multiobjective optimization. Information Sciences, 613, 204-227. (*CORE A*)
6. Yao, Y., Pan, Y., Tsang, I. W., & **Yao, X.** (**2022**). Differential-Critic GAN: Generating What You Want by a Cue of Preferences. *IEEE Transactions on Neural Networks and Learning Systems (TNNLS)*. DOI: 10.1109/TNNLS.2022.3197313 (*CORE A**)
7. Yan, B., Zhao, Q., Zhang, J., Zhang, J. A., & **Yao, X**. (**2022**). Gridless Evolutionary Approach for Line Spectral Estimation With Unknown Model Order. *IEEE Transactions on Cybernetics (TCYB)*. DOI: 10.1109/TCYB.2022.3179378 (*CORE A*)
8. Yazdani, D., Yazdani, D., Branke, J., Omidvar, M. N., Gandomi, A. H., & **Yao, X.** (**2022**). Robust Optimization Over Time by Estimating Robustness of Promising Regions. *IEEE TEVC*. DOI: 10.1109/TEVC.2022.3180590 (*CORE A**)
9. Zhang, T., Wang, H., Yuan, B., Jin, Y., & **Yao, X.** (**2022**). Surrogate-Assisted Evolutionary Q-Learning for Black-Box Dynamic Time-Linkage Optimization Problems. *IEEE TEVC*. DOI: 10.1109/TEVC.2022.3179256 (*CORE A**)
10. Shi, X., Minku, L. L., & **Yao, X.** (**2022**). Adaptive Memory-Enhanced Time Delay Reservoir and its Memristive Implementation. IEEE Transactions on Computers, 71(11), 2766-2777. (*CORE A**)
11. Tong, H., Minku, L. L., Menzel, S., Sendhoff, B., & **Yao, X.** (2022). A Novel Generalized Metaheuristic Framework for Dynamic Capacitated Arc Routing Problems. *IEEE TEVC*, 26(6), 1486-1500. (*CORE A**)
12. Lan, W., Ye, Z., Ruan, P., Liu, J., Yang, P., & **Yao, X.** (**2021**). Region-focused Memetic Algorithms with Smart Initialisation for Real-world Large-scale Waste Collection Problems. *IEEE TEVC*, DOI: 10.1109/TEVC.2021.3123960 (*CORE A**)
13. Zhang, S., Tino, P., & **Yao, X. (2021).** Hierarchical Reduced-space Drift Detection Framework for Multivariate Supervised Data Streams. *IEEE Transactions on Knowledge and Data Engineering*. DOI: 10.1109/TKDE.2021.3111756 (*CORE A**)
14. Lu, X., Tang, K., Menzel, S., & **Yao, X. (2021)**. Dynamic Optimization in Fast-Changing Environments via Offline Evolutionary Search. *IEEE TEVC*. DOI:

10.1109/TEVC.2021.3104343

15. Omidvar, M. N., Li, X., & **Yao, X. (2021)**. A review of population-based metaheuristics for large-scale black-box global optimization: Part A & B. *IEEE TEVC*. DOI: 10.1109/TEVC.2021.3130838
16. Yazdani, D., Cheng, R., Yazdani, D., Branke, J., Jin, Y., & **Yao, X. (2021)**. A Survey of Evolutionary Continuous Dynamic Optimization Over Two Decades–Part A & B. *IEEE TEVC*. DOI: 10.1109/TEVC.2021.3060014
17. Tong, H., Huang, C., Minku, L. L., & **Yao, X. (2021)**. Surrogate models in evolutionary single-objective optimization: A new taxonomy and experimental study. *Information Sciences*, 562, 414-437. (*CORE A*)
18. Zheng, W., Chen, H., & **Yao, X. (2021)**. Analysis of evolutionary algorithms on fitness function with time-linkage property. *IEEE TEVC*, 25(4), 696-709.
19. Shi, S., Sharifi, N., Chen, Y., & **Yao, X. (2021)**. Tension-Relaxation In Vivo Computing Principle for Tumor Sensitization and Targeting. *IEEE TCYB*. DOI: 10.1109/TCYB.2021.3052731 (*CORE A*)
20. Tang, K., Liu, S., Yang, P., & **Yao, X. (2021)**. Few-Shots Parallel Algorithm Portfolio Construction via Co-Evolution. *IEEE TEVC*, 25(3), 595-607.
21. Su, Z., Zhang, G., Yue, F., Zhan, D., Li, M., Li, B., & **Yao, X. (2021)**. Enhanced Constraint Handling for Reliability-Constrained Multiobjective Testing Resource Allocation. *IEEE TEVC*, 25(3), 537-551.
22. M. Yang, A. Zhou, C. Li, and **X. Yao**, "An efficient recursive differential grouping for large-scale continuous problems.", *IEEE TEVC*, DOI: 10.1109/TEVC.2020.3009390, **2020**.
23. K. Li, M. Liao, K. Deb, G. Min and **X. Yao**, "Does Preference Always Help? A Holistic Study on Preference-Based Evolutionary Multi-Objective Optimisation Using Reference Points." *IEEE TEVC*, 24(6), 1078-1096, **2020**.
24. C. He, R. Cheng, C. Zhang and **X. Yao**, "Evolutionary Large-Scale Multiobjective Optimization for Ratio Error Estimation of Voltage Transformers." *IEEE TEVC* 24(5), 868-881, **2020**.
25. S. Liu, K. Tang and **X. Yao**, “Generative Adversarial Construction of Parallel Portfolios.” *IEEE TCYB*, DOI: 10.1109/TCYB.2020.2984546, **2020**.
26. C. Huang, Y. Li and **X. Yao**. "A survey of automatic parameter tuning methods for metaheuristics." *IEEE TEVC* 24(2) 201-216, **2019**.
27. M. Li and **X. Yao**. "Quality evaluation of solution sets in multiobjective optimisation: A survey." ACM Computing Surveys (CSUR) 52(2), 1-38, **2019**.
28. E.R.Q. Fernandes, A.C. de Carvalho and **X. Yao.** "Ensemble of classifiers based on multiobjective genetic sampling for imbalanced data." *IEEE Transactions on Knowledge and Data Engineering* 32(6), 1104-1115, **2019**.
29. C. He, L. Li, Y. Tian, X. Zhang, R. Cheng and **X. Yao**. "Accelerating large-scale multiobjective optimization via problem reformulation." *IEEE TEVC* 23(6), 949-961, **2019**.
30. C. Wnag, C. Xu, **X. Yao** and D. Tao, "Evolutionary generative adversarial networks." *IEEE TEVC* 23(6), 921-934, **2019**.
31. R. Cheng, M.N. Omidvar, A. Gandomi, B. Sendhoff, S. Menzel and **X. Yao,** "Solving Incremental Optimization Problems via Cooperative Coevolution." *IEEE TEVC* 23(5), 762-775, **2018**.
32. W. Hong, K. Tang, A. Zhou, H. Ishibuchi and **X. Yao**. "A scalable indicator-based evolutionary algorithm for large-scale multiobjective optimization." *IEEE TEVC* 23(3), 525-537, **2018**.
33. K. Li, R. Chen, D. Savic and **X. Yao,** "Interactive decomposition multiobjective optimization via progressively learned value functions." *IEEE Transactions on Fuzzy Systems* 27(5), 849-860, **2018**. (*CORE A**)
34. K. Li, R. Chen, G. Min and **X. Yao,** "Integration of preferences in decomposition

multiobjective optimization." *IEEE TCYB* 48(12), 3359-3370, **2018**.

35. K. Li, R. Chen, G. Fu and **X. Yao,** "Two-archive evolutionary algorithm for constrained multiobjective optimization." *IEEE TEVC* 23(2), 303-315, **2018**.
36. H. Chen, B. Jiang, and **X. Yao**. "Semisupervised negative correlation learning." *IEEE TNNLS* 29(11), 5366-5379, **2018**. (*CORE A*, impact factor = 10.451*)
37. Z. Gong, H. Chen, B. Yuan and **X. Yao**. "Multiobjective learning in the model space for time series classification." *IEEE TCYB* 49(3), 918-932, **2018**.
38. S. Wang, L.L. Minku and **X. Yao**. "A systematic study of online class imbalance learning with concept drift." *IEEE TNNLS* 29(10), 4802-4821, **2018**.
39. Y. Sun, K. Tang, Z. Zhu and **X. Yao**. "Concept drift adaptation by exploiting historical knowledge." *IEEE TNNLS* 29(10), 4822-4832, **2018**.

Peer reviewed book chapters, books edited

1. H. Zhang, J. Liu, and **X. Yao**. "A Hybrid Evolutionary Algorithm for Reliable Facility Location Problem." *Lecture Notes in Computer Science (LNCS)*. vol. 12269 (PPSN), Springer, 454-467, **2020**.
2. H. Tong, L.L Minku, S. Menzel, B. Sendhoff and **X. Yao**. "Towards Novel Meta-heuristic Algorithms for Dynamic Capacitated Arc Routing Problems." *Lecture Notes in Computer Science (LNCS).* vol. 12269 (PPSN), Springer, 428-440, **2020**.
3. S. Friess, P. Tino, S. Menzel, B. Sendhoff and **X. Yao.** "Improving Sampling in Evolution Strategies Through Mixture-Based Distributions Built from Past Problem Instances." *Lecture Notes in Computer Science (LNCS)*. vol. 12269 (PPSN), Springer, 583-596, **2020**.

Refereed conference proceedings

*Selected related papers in the last **five** years published in* **ARC Tier A/A*** conferences

1. S. Liu, K. Tang, Y. Lei and **X. Yao**, “On Performance Estimation in Automatic Algorithm Configuration.” *AAAI*, 2384-2391, **2020**.
2. S. Liu, K. Tang and **X. Yao**, "Automatic construction of parallel portfolios via explicit instance grouping." *AAAI*. Vol. 33. 1560-1567, **2019**.
3. H. Tao, J. Liu and **X. Yao**. "Algorithm portfolio for individual-based surrogate-assisted evolutionary algorithms." *Proceedings of the Genetic and Evolutionary Computation Conference*. 943-950, **2019**.
4. L. Zhang, K. Tang and **X. Yao**. "Explicit planning for efficient exploration in reinforcement learning." Advances in Neural Information Processing Systems *(NeurIPS)*. 7488-7497, **2019**.
5. D. Yazdani, J. Branke, M.N. Omidvar, T.T. Nguyen and **X. Yao**, "Changing or keeping solutions in dynamic optimization problems with switching costs." *Proceedings of the Genetic and Evolutionary Computation Conference*. 1095-1102, **2018**.
6. T. Chen, M. Li, and **X. Yao**. "On the effects of seeding strategies: a case for search-based multi-objective service composition." *Proceedings of the Genetic and Evolutionary Computation Conference*. 1419-1426, **2018**.
7. C. Qian, Y. Zhang, K. Tang and **X. Yao**, "On multiset selection with size constraints." *AAAI*, **2018**.
8. P.T. Thuong, X.H. Nguyen and **X. Yao**. "Combining conformal prediction and genetic programming for symbolic interval regression." *Proceedings of the Genetic and Evolutionary Computation Conference*. 1001-1008, **2017**.
9. L. Zhang, K. Tang and **X. Yao**. "Log-normality and skewness of estimated state/action values in reinforcement learning." *Advances in Neural Information Processing Systems (NeurIPS).* 1804-1814, **2017**.

The full publication list can be seen from https://www.cs.bham.ac.uk/~xin/publications.html

6. OTHER FUNDING

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

Funding organisation	Amount requested
n/a	$0

Title:

Explanation:
(optional)