Shuqi Dai

Ph.D. Candidate (Fall 2018 - Summer 2024)
Computer Science Department
Carnegie Mellon University (CMU)

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RESEARCH INTERESTS: Music Technology with Artificial Intelligence

Emphasize musical perspectives in technology innovation to transform how we listen to, understand, perform, and create music. Aim to unearth the potential for music technology to benefit individuals and society by combining it with other areas, such as health and education. Selected projects:

- **Create music**: multilingual singing voice synthesis with style control (singing, zero-shot singing); symbolic music composition with structure, style, and control (melody, full song)
- **Understand music**: computational study of music repetition and structure (demo1, demo2)
- **Perform music**: expressive and stylistic performance control for singing and instruments (thesis)
- **Human-Computer interaction**: Human-computer music performance system (demo)
- **Music Therapy**: Potential use of automatic composition for Parkinson's disease therapy (paper)
- **Music Education**: Virtual singing coach (CMU GenAI+Education Tools Grant Award)
- **Non-Western Music**: Performance techniques modeling for traditional Chinese music (paper)

EDUCATION

Carnegie Mellon University — Pittsburgh, PA, USA
- Ph.D. Candidate in Computer Science — *Fall 2018 - Present*
- Advisor: Prof. Roger B. Dannenberg
- Thesis title: *Towards Artificial Musicians: Modeling Style for Music Composition, Performance, and Synthesis via Machine Learning*

Peking University — Beijing, China
- B.S. in Computer Science and Technology — *July 2018*
- Began coding at age nine, received National College Entrance Exam wavier by winning the algorithm competition *National Olympiad in Informatics*

Music Training

- Professional **pipa** musician, started playing at age 6, more than 20 years of traditional Chinese music training, tutored by top Chinese pipa musician **Prof. Yabo Pan**. Top score at the Chinese National Pipa Qualification Competition in July 2011. Solo and orchestra pipa performances in many concerts worldwide over the years.
- Music theory, history, composition, performance (keyboard), and production training at CMU School of Music. Selected courses: Harmony Series, Counterpoint Theory and Applications, Form Analysis, Eurhythmics Series, Advanced Solfege Series, Repertoire & Listening for Musicians Series, Orchestration, Intro to Conducting, Symphonies of Mahler, Shaping Time in Performance, Sound Recording, Sound Editing & Mastering, One-On-One Composition Studios, Voice Studios, Piano Studios.
- Eight years of formal training in Western opera singing and Chinese folk singing.

SELECTED PUBLICATIONS (Google Scholar)

1. **S. Dai**, M. Liu, R. Valle, S. Gururani, "ExpressiveSinger: Multilingual and Multi-Style Singing Voice Synthesis With Expressive Performance Control", *preprint, under review*, 2024.
2. **S. Dai**, Y. Wu, S. Chen, R. Huang and R. B. Dannenberg, "SingStyle111: A Multilingual Singing Dataset With Style Transfer", *in Proceedings of the 24th International Society for Music Information Retrieval Conference, Milan, Italy, 2023.*

3. **S. Dai**, Z. Jin, C. Gomes and R. B. Dannenberg, "Controllable deep melody generation via hierarchical music structure representation", *in Proceedings of the 22nd International Society for Music Information Retrieval Conference, Online, 2021.*
4. **S. Dai**, H. Yu and R. B. Dannenberg, "What is missing in deep music generation? A study of repetition and structure in popular music", *in Proceedings of the 23rd International Society for Music Information Retrieval Conference, Bengaluru, 2022.*
5. **S. Dai**, X. Ma, Y. Wang, R. B. Dannenberg, "Personalized Popular Music Generation Using Imitation and Structure", *Journal of New Music Research*, 51(1): 69-85, 2021.
6. **S. Dai**, H. Zhang, R. B. Dannenberg, "The Interconnections of Music Structure, Harmony, Melody, Rhythm, and Predictivity", *Music & Science*, 7, 2024.
7. **S. Dai**, H. Zhang, R. B. Dannenberg, "Automatic Analysis and Influence of Hierarchical Structure on Melody, Rhythm and Harmony in Popular Music", *in Proceedings of the 2020 Joint Conference on AI Music Creativity (CSMC-MuMe)*, 2020.
8. **S. Dai**, G. Xia, Z. Zhang, "Music Style Transfer: A Position Paper", *in Proceedings of 6th International Workshop on Music Metacreation (MUME)*, Salamanca, Spain, 2018.
9. **S. Dai**, G. Xia, "Computational Models For Common Pipa Techniques", **Best Student Paper Award** *in Proceedings of the 5th National Conference on Sound and Music Technology*, China, 2017.
10. Z. Wang, K. Chen, J. Jiang, Y. Zhang, M. Xu, **S. Dai**, X. Gu, G. Xia, "Pop909: A Pop-song Dataset for Music Arrangement Generation", *in Proceedings of the 21st International Society for Music Information Retrieval Conference (ISMIR)*, Montéal, Canada, 2020.

RESEARCH EXPERIENCE

- NVIDIA Research, Deep Imagination Team May 2022 – Feb 2023
  Research Intern, Advisor: Dr. Siddharth Gururani, Dr. Mingyu Liu
  Multilingual & Multi-Style Singing Voice Synthesis with Expressive Performance Control
  Designed a cascade of diffusion models to generate expressive and realistic singing, given score, lyrics, and style labels as input. It contains (1) performance control models, including timing, F0 curves, and loudness curves; (2) an acoustic model that generates mel-spectrograms conditioning on performance control; (3) a vocoder to generate the waveform from mel-spectrograms. (*Paper under review* Demo)

- Adobe Research, Audio Research Team June 2023 – Oct 2023
  Research Intern, Advisor: Dr. Zeyu Jin
  Zero-shot Singing Voice Synthesis with Unseen Speech Target (Demo)
  Designed a system that takes 5-second speech audio of the target (an unseen voice excluded in training data), using score, lyrics, and style as input, and outputs realistic singing using the target voice. Disentangled voice timbre from speech, and integrated timbre into singing synthesis using audio *Encodec*.

- Carnegie Mellon University, Computer Science Department Aug. 2018 – present
  Principal Investigator, Collaborator: Prof. Jocelyn Dueck (School of Music)
  The Virtual Voice Coach: Improving Prosody and Expression in Vocal Art Education
  Awarded $150k as *GenAI + Education Tools R&D Seed Grants* at CMU (Top three)
  Combined music technology with education. By using zero-shot singing voice synthesis, automatic music analysis algorithms, and personalized learning curves, we aim to help educators demonstrate and evaluate singing for individual students, fostering more musical creativity.

  Graduate Student Researcher, Advisor: Prof. Roger B. Dannenberg
  Instrumental Synthesis with Expressive Performance Control *(Ongoing)*
  Designed a Transformer-based model with representation learning techniques to generate performance controls from score input, including timing, F0 curves, and amplitude envelopes. Introduced performance control into instrumental synthesis for woodwinds, brass, and strings.

  Computational Study of Music Repetition and Structure
  Illustrated important music construction principles by the analyses of popular music datasets. Introduced new algorithms for identifying hierarchical music structure based on repetition. Suggested new formal music criteria and evaluation methods for deep-learning music generation.

Controllable Deep Melody Generation using Hierarchical Music Representation
In collaboration with Adobe Research
Combined music domain knowledge with deep learning by introducing Music Frameworks, a hierarchical music structure representation with new musical features. Factored music generation into sub-problems, which allow simpler models, require less data and achieve high musicality.

Human-Computer Music Performance (HCMP) System
HCMP is a computer music system that can perform live music in association with human performers, with goal of creating highly autonomous artificial performers that can fill human roles.

Study of Expectation and Surprise in Music Perception with EEG analysis *(Ongoing)*
Co-advised by Prof. Tai-Sing Lee
Compare algorithmic results of expectation and surprise in music, with actual brain EEG signals on 20 piano songs, to explore potentials for algorithmic music perception modeling.

Hierarchical Logical Clustering for State-Action Sequences in Markov Decision Process
Advised by Prof. Christos Faloutsos
Designed a system to automatically build a hierarchical and logical tree structure that reveals the logical relations among actions from experts' demonstrations in time steps: are they parallel, sequential, or form a higher goal? Experiments showed high accuracy and the resulting structure could then be used for applications in Markov Decision Process(Report).

- National University of Singapore, Sound and Music Computing Lab Feb. 2018 – Jul. 2018
  Research Intern, Advisor: Ye Wang, Roger B. Dannenberg
  Personalized Music Composition Using Imitation and Structure
  Designed a stylistic music generation system that is able to capture structure, melody, chord progression, and bass styles from one or a few example music, and imitate the styles in a new piece using statistical machine learning models.

- New York University Shanghai, Computer Music Lab Aug. 2017 – Dec. 2017
  Research Intern, Advisor: Gus Guangyu Xia
  Digitalization of Pipa (Traditional Chinese Instrument) Performance Techniques
  Designed series of computational models for common pipa performance techniques using "analysis-by-synthesis" method, leading to much more realistic synthesized performances.

- Microsoft Research Asia, Knowledge Computing Group Mar. 2017 – Aug. 2017
  Research Intern, Advisor: Chin-Yew Lin
  Entity Linking and Domain Entity Alignment in Natural Language Processing
  Designed and implemented a semi-supervised model for text-to-table entity alignment based on the HMM model and EM algorithm, improved alignment performances especially for bad cases.

- Peking University, Mobile Computing Group Mar. 2015 – Mar. 2016
  Research Assistant, Advisor: Kaigui Bian
  Introduced a personalized shopping recommendation system for mobile applications, driven by users' mobile gestures based on precise speeds, ranges, and directions to detect user internal state and habits.

INDUSTRIAL EXPERIENCE

Research Intern, Adobe Research, San Francisco	June 2023 - Oct 2023
Research Intern, NVIDIA Research, Santa Clara	May 2022 - Feb 2023
Research Intern, Adobe Research, San Francisco	May 2021 - Oct 2021
Research Intern, Adobe Research, San Francisco	May 2020 - Sep 2020
Research Intern, Microsoft Research Asia, Beijing	Mar 2017 - Aug 2017
Software Engineer Intern, Hulu, Beijing	Mar 2016 - June 2016
Software Engineer Intern, Google, Beijing	May 2015 - Aug 2015
Software Engineer, Xiaotidazuo (Non-profit Organization), Beijing	May 2014 - May 2015

INVITED TALKS

1. "Empowering Individual Music Expression Through Composition, Performance, and Synthesis", *MIT Department of Music & Theater Arts, EECS, and Mechanical Engineering*, 2024.
2. "Empowering Individual Music Expression Through Composition, Performance, and Synthesis", *University of Rochester, Audio Information Research Group*, 2024.
3. "Expressive Singing Voice Synthesis", *Adobe Research, Audio Speech Group*, 2023.
4. "AI Music Generation with Repetition Structure", *Mila x Vector Institute*, 2022.
5. "AI Music Generation with Repetition Structure", *Tiktok Research*, 2022.
6. "AI Music Generation with Repetition Structure", *CMU, Neuroscience Lab*, 2022.
7. "AI Music Generation with Repetition Structure", *NetEase Music Research*, 2021.
8. "Personalized Pop Music Generation Using Imitation and Structure", *Peking University, School of Electronic Engineering and Computer Science*, 2018.
9. "Human-Computer Interactive Performance System", *Microsoft Research Asia, NLP group*, 2017.

TEACHING

- **Guest Lecturer**, 21M.383: Computational Music Theory and Analysis, *Spring 2024, MIT*
  Gave guest lecture on "Algorithmic Composition"
- **Guest Lecturer**, 15-322/622: Introduction to Computer Music, *Spring 2024, CMU*
  Gave guest lecture on "Algorithmic Composition"
- **Leading Teaching Assistant**, 15-322/622: Introduction to Computer Music, *Fall 2019, CMU*
  Teaching and textbook writing, with Prof. Roger B. Dannenberg
- **Leading Teaching Assistant**, 15-323/623: Computer Music Systems and Information Processing
  Teaching and group project mentoring, with Prof. Roger B. Dannenberg, *Spring 2019, CMU*

MENTORING

Huiran Yu	M.S.	Now Ph.D. student at University of Rochester	2021 - 2023
Huan Zhang	B.S.	Now Ph.D. student at Queen Mary University	2019 - 2020
Yuxuan Wu	M.S.	Now Ph.D. student at MBZUAI	2021 - 2023
Ziyue Piao	M.S.	Now Ph.D. student at McGill University	2021 - 2022
Biyu Zhang	M.S.	Carnegie Mellon University	2022 - 2023
Siqi Chen	B.S.	Incoming Master student at Stanford University	2022 - 2024
Roy Huang	B.S.	Carnegie Mellon University	2022 - 2023
Rae Wong	B.S.	Carnegie Mellon University	2021 - 2022
Joshua Yoon	B.S.	Carnegie Mellon University	2021 - 2022

AWARDS AND HONORS

GenAI + Education Tools R&D Seed Grants Award (top three), CMU	2024
Computer Science Presidential Fellowship (only one in CS Department), CMU	2023
Best Student Paper Award, China National Conference on Sound & Music Technology	2017
Women in Music Information Retrieval Award, International Society for MIR Conference	2017
Yang Fuqing & Wang Yangyuan Academic Scholarship, Peking University (5 out of 300)	2016
Excellent Student Award, Peking University (top 8% for all-round achievements)	2014, 2016
Excellence Award, National China Start-up Competition (team leader, 9^{th} out of 313)	2016
2^{nd} Place in Peking University National Hackathon (out of 42)	2016
Fung Scholarship, Victor & William Fung Foundation (top 15%)	2015
Tung OOCL Scholarship, The Tung Foundation & Peking University (8 out of 348)	2014
3^{rd} Prize in ACM/ICPC contest, Peking University	2014 - 2016
1^{st} Place in National Olympiad in Informatics, Anhui Province (out of 5,634)	2012
2^{nd} Prize in Chinese Mathematics Olympiad in Province	2012

SERVICE and ACTIVITIES

Reviewer for ISMIR, ICASSP, InterSpeech, TISMIR, EURASIP Journal	
Student Member on Board of ISMIR	2023 – Present
ISMIR2024 Grants Chair	2024
Graduate Student Admission Council at CMU	2019
Organizer of CMU Computer Music Reading Group	2019 - Present
Representative of Computer Science Department at Graduate Student Council	2021 - Present
Speaker at Workshop: GET (Girls Entering Tech) Success	May 2020
Vocal Director and Leading Singer of Musical *Dirty Rotten Scoundrels* in CMU	2019
Pipa Player in Peking University Chinese Orchestra Club	2013 – 2017
Pipa Player in Hong Kong University Chinese Orchestra Club	Sep. 2015 – Dec. 2015
Mezzo-soprano in Peking University Hall Chorus	2017
Leading Singer in performance of Les Misrables by Peking University Musical Club	2016
Director of UNICEF in Peking University International Model United Nations	2013 – 2015
Education and Science Journalist for *Youth of Peking University* Magazine	2013 – 2014
Performed Pipa solo in many concerts	2001 – Present

REFERENCES

Prof. Roger B. Dannenberg	Carnegie Mellon University	rbd@cs.cmu.edu
Prof. Julius O. Smith	Stanford University	julius.smith@gmail.com
Prof. Raj Reddy	Carnegie Mellon University	rr@cmu.edu
Assis Prof. Gus Xia	MBZUAI	pkuxgy@gmail.com
Dr. Zeyu Jin	Senior Research Scientist, Adobe Research	zejin@adobe.com