Yaolong Ju

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ACADEMIC BACKGROUND

Education

- *Jilin University (JLU), Changchun, China* Sep. 2009 – July 2013
  B.S. in School of Computer Science and Technology
  Major: Computer Science and Technology
  Thesis: The Research of Automatic Arrangement (Honors)
  Advisor: Prof. Lan Huang
  GPA: 3.73/4.00

- *Peking University (PKU), Beijing, China* Sep. 2013 – July 2016
  M.S. (Recommended for Admission) in School of Electronics Engineering and Computer Science
  Major: Intelligence Science and Technology
  Research Interest: Automatic melody harmonization, key-finding and machine learning
  Thesis: Research on Automatic Chord Arrangement Based on Deep Recurrent Neural Networks
  Supervisor: Prof. Xihong Wu
  GPA: 3.62/4.00

- *McGill University, Montreal, Canada* Sep. 2016 – PRESENT
  Ph.D. in Schulich School of Music
  Major: Music Technology
  Research Interest: Automatic harmonic analysis, large-scale music datasets, machine learning
  Supervisors: Prof. Ichiro Fujinaga and Prof. Cory McKay
  GPA: 3.90/4.00

Selected Awards & Honors

- National Grant Oct. 2010
- Self-reliance and Independence Student May 2011
- National Encouragement Scholarship 2010 – 2012
- School Outstanding Student 2010 – 2012
- Chinese Computer Federation Scholarship Oct. 2012
- Top 100 outstanding students of Chinese Computer Federation Oct. 2012
- Xianzi Zeng Educational Fund 2011 – 2013

  Jilin University

- Graduate Special Scholarship Oct. 2014
- Graduate Fellowship 2013 – 2015

  Peking University

- CIRMMT Agile Seed Funding Nov. 2019
- Interdisciplinary Research Project Seed Grant June 2017, June 2019
- Graduate Excellent Award Nov. 2016, Jan. 2018
- CIRMMT Traveling Award July 2017, Mar. 2018, Mar. 2019
- CIRMMT Student Award Mar. 2018
- CIRMMT Student Coordinator Sep. 2017 - Sep. 2020
- Annual Research Assistant Stipend 2016 – 2020
- FRQSC Doctoral Scholarship 2018 – 2022

  McGill University

Peer-Reviewed Academic Conference Publications

- Huang, Lan, Shixian Du, Yu Zhang, **Yaolong Ju**, and Zhuo Li. "K-means Initial Clustering Center Optimal Algorithm Based on Kruskal," *Journal of Information and Computational Science*, Vol. 9, No.9, pp. 2387-2392. 2012.
- **Ju, Yaolong**, Nathaniel Condit-Schultz, Claire Arthur and Ichiro Fujinaga. "Non-chord Tone Identification Using Deep Neural Networks" In *Proceedings of the 4th International Workshop on Digital Libraries for Musicology*, pp. 13-16. 2017.
- Condit-Schultz, Nathaniel, **Yaolong Ju**, and Ichiro Fujinaga. A Flexible Approach to Automated Harmonic Analysis: Multiple Annotations of Chorales by Bach and Praetorius. In *Proceedings of the 19th International Society for Music Information Retrieval Conference*, pp. 66-73. 2018.
- **Ju, Yaolong**, Samuel Howes, Cory McKay, Nathaniel Condit-Schultz, Jorge Calvo-Zaragoza, and Ichiro Fujinaga. An Interactive Workflow for Generating Chord Labels for Homorhythmic Music in Symbolic Formats. In *Proceedings of the 20th International Society for Music Information Retrieval Conference*, pp. 862-869, 2019.

Peer-Reviewed Academic Conference Presentations (No Proceedings)

- **Ju, Yaolong**, Nathaniel Condit-Schultz, Claire Arthur and Ichiro Fujinaga. "Non-chord Tone Identification Using Deep Neural Networks" Presented at the *18th International Society for Music Information Retrieval Conference*. 2017.
- **Ju, Yaolong**, Kate Helsen. "The LMLO goes MEI: An Exercise in Melodic Encoding Translation" Presented at the *Music Encoding Conference*. 2018.
- **Ju, Yaolong**, Gustavo Polins Pedro, Cory Mckay, Emily Ann Hopkins, Julie Cumming, and Ichiro Fujinaga. Enabling Music Search and Analysis: A Database for Symbolic Music Files. Presented at the *Music Encoding Conference*. 2019.
- McKay, Cory, Emily Hopkins, Gustavo Polins Pedro, **Yaolong Ju**, Andrew Kam, Julie Cumming, and Ichiro Fujinaga. A Collaborative Symbolic Music Database for Computational Research on Music. Presented at the *Medieval and Renaissance Music Conference*. 2019.
- Hopkins, Emily, **Yaolong Ju**, Gustavo Polins Pedro, Cory McKay, Julie Cumming, and Ichiro Fujinaga. SIMSSA DB: Symbolic Music Discovery and Search. Accepted for presentation at the *6th International Workshop on Digital Libraries for Musicology*. 2019.

Research Experience

Distributed Digital Music Archives & Library Laboratory, McGill University — Ph.D. Candidate

- **An Interactive Workflow for Generating Chord Labels for Homorhythmic Music in Symbolic Formats**

  Advisor: Prof. Ichiro Fujinaga and Prof. Cory McKay — **Feb. 2018 – PRESENT**

  Automatic harmonic analysis is challenging: rule-based models cannot account for every possible edge case, and manual annotation is expensive and sometimes inconsistent, undermining the training and evaluation of machine learning models. We present an interactive workflow to address these problems, and test it on Bach chorales. First, a rule-based model was used to generate preliminary, consistent chord labels in order to pre-train three machine learning models. These four models were grouped into an ensemble that generated chord labels by voting, achieving 91.4% accuracy on a reserved test set. A domain expert then corrected only those chords that the ensemble did not agree on unanimously (20.9% of the generated labels). Finally, we used these corrected annotations to re-train the machine learning models, and the resulting ensemble attained an accuracy of 93.5% on the reserved test set, a 24.4% reduction in the number of errors. This versatile interactive workflow can either work in a fully automatic way, or can capitalize on relatively minimal human involvement to generate higher-quality chord labels. It combines the consistency of rule-based models with the nuance of manual analysis to generate relatively inexpensive high-quality ground truth for training effective machine learning models.

  This project was awarded CIRMMT Student Award 2018 ($3,500 CAD) and the Qubec Research Fund - Society and Culture (FRQSC) Doctoral Scholarship ($84,000 CAD over four years) and has resulted in peer-reviewed publications.

- **Non-chord Tone Identification Using Deep Neural Networks**
  Advisor: Prof. Ichiro Fujinaga **April 2017 – PRESENT**

  This project addresses the problem of harmonic analysis by proposing a non-chord tone identification model using deep neural networks (DNN). By identifying non-chord tones, the task of harmonic analysis is much simplified. Trained and tested on a dataset of 371 Bach chorales, an initial DNN—using only the pitch-class content of individual sonorities as input—was able to identify non-chord tones with an F1 accuracy-measure of 0.617. By adding metric information, a small contextual window around each input sonority, and fine-tuning the DNN parameters, the model's accuracy was increased to an F1-measure of 0.815. These results suggest that DNNs offer an innovative and promising approach to tackling the problem of non-chord tone identification, and then harmonic analysis.

  This project was awarded the Centre for Social and Cultural Data Science Interdisciplinary Research Project Seed Grant from McGill University ($2,000 CAD), and has resulted in peer-reviewed publications. The promising results of these preliminary experiments serve as a solid foundation for my research of automatic harmonic analysis.

- **SIMSSA DB: A Symbolic Music Database for Digital Musicological Research**
  Advisor: Prof. McKay, Prof. Cumming and Prof. Fujinaga **July 2017 – PRESENT**

  As music researchers embrace the possibilities of digital musicology, the need for music in a symbolic, machine-readable format is growing. We present the SIMSSA DB, a large-scale database for symbolic music files, providing research-grade data and metadata for digital musicological research.

  First, we built a robust data model to handle the relationships between a conceptual work (e.g., a symphony) and its various instantiations precisely, such as different renditions, different symbolic files types, and its constituent sections. Furthermore, we refer to authority control, such as VIAF (Virtual International Authority File), to fill our database with high-quality metadata, which users can easily search and refer to. This helps guard against typographical error, manages variant spellings of fields, and increases interoperability.

  We also prioritize provenance information to describe the source for each item, with recursive provenance chains linking our music files back to the physical sources or online repositories where they came from.

  Additionally, the SIMSSA DB permits content-based music search, where musical features (e.g., melodic interval, rhythm, etc.) are extracted using our jSymbolic software. Researchers can download and use features directly as input to statistical analysis and machine learning tools (or use manual analysis) to study various topics such as composer attribution and analysis of genre and regional styles.

  SIMSSA DB will be publicly accessible soon. With these characteristic designs, it will serve as an important resource for digital musicological research.

  This project has given me further technical experience managing the infrastructure of large-scale musical databases, including database extension, organization and the automation of database processing. The extended abstract of this project has been presented at various conferences, and more details of its implementation will soon be presented at the 6th International Workshop on Digital Libraries for Musicology.

- **Melodic Encoding Translation for Medieval Chants**
  Advisor: Prof. Kate Helson and Prof. Ichiro Fujinaga **June 2016 – June 2017**

  Andrew Hughes was an influential Canadian musicologist and a pioneer of digital musicology research. Hughes encoded the melodies and texts of nearly 6,000 medieval chants in a complex, idiosyncratic digital format. Unfortunately, this dataset was only stored on floppy discs, and no software for parsing the idiosyncratic encodings exists. Thus, as part of a digital Festschrift for the research legacy of Andrew Hughes, I have worked to extract this dataset, translate it to a more convenient modern encoding format, and make it accessible online.[1]

  Hughes' digital encodings were parsed and translated into the Music Encoding Initiative (MEI) digital format. Hughes' data, originally encoded in a single file, was divided into a more convenient, systematic file structure, with chants organized in "chant letter - saint - repertoire - office - chant" order. Pitch information in Hughes' encodings was encoded numerically based on the medieval church mode system, requiring a complex algorithm to translate it to a modern pitch representation. An online Latin syllabifier[2] was used to parse the text, but had to be modified to include information about liturgical words not found in other contexts, such as "Kyrie." During this stage, some errors in Hughes hand-typed data were isolated and resolved. The entirety of Hughes' chant collection has now been successfully transcribed into MEI and can be rendered as music notation in Verovio.[3]

[1] https://github.com/DDMAL/Andrew-Hughes-Chant/tree/develop/

[2] Available at: http://docs.cltk.org/en/latest/latin.html#sentence-tokenization

[3] http://www.verovio.org/mei-viewer.xhtml

Through this project, I have obtained experience of parsing and processing symbolic music data, as well as creating and curating large-scale music datasets. This work was presented at the Music Encoding Conference 2018.