Cameron Churchwell

PHD STUDENT · COMPUTER SCIENCE

Urbana-Champaign IL

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Research Experience

University of Illinois Urbana-Champaign *Urbana-Champaign, IL*

ADVISOR: PROF. PARIS SMARAGDIS *Aug. 2024 - Present*

- Project: "**Interpretable, Efficient, and Learnable DSP filter networks**" I am designing, implementing, and evaluating neural networks composed of **custom learnable DSP filters** for a broad range of tasks including Music Information Retrieval and Source Separation. As part of this project I am creating efficient implementations of differentiable filters in **PyTorch and CUDA**.
- Project: "**Audio Segmentation**" I am exploring novel techniques for promptable audio segmentation models with downstream applications in source separation and related tasks.

Northwestern University *Evanston, IL*

ADVISOR: PROF. BRYAN PARDO *Aug. 2022 - Jun. 2024*

- **Projects: "Neural Speech Prosody and Pronunciation Editing"** We created a **disentangled speech representation** for fine-grained, controllable speech editing. I implemented our state-of-the art phonetic representation, a novel acoustic phoneme distance metric, and a system for manual polyphone editing. I integrated the pronunciation representation into our speech editing pipeline and ran various experiments and evaluations. Additionally, I developed custom data reading and writing setups for more efficient preprocessing and inference, as well as other various high- and low-level speedups and improvements.
- **Project: "Torbi: Fast Parallel Viterbi Decoding"** I designed and implemented a **novel CUDA kernel for the Viterbi Decoding algorithm** which is many orders of magnitude faster than the other open-source implementations available and which allowed us to do Viterbi-based pitch estimation on large datasets, yielding large accuracy improvements.

Education

University of Illinois *Urbana-Champaign IL*

PHD IN COMPUTER SCIENCE *2024-Present*

- Audio Lab lead by Profs. Paris Smaragdis and Minje Kim

Northwestern University *Evanston IL*

BS UNDERGRADUATE DEGREE *2020 - 2024*

- Major in computer science in the McCormick School of Engineering
- Second major in mathematics in the Mathematical Experiences for Northwestern Undergraduates program
- Undergrad research advisor: Professor Bryan Pardo
- GPA: 3.93/4.0 (Magna Cum Laude)

Publications

* denotes equal contributions

C. Churchwell*, M. Morrison*, and B. Pardo, "High-Fidelity Neural Phonetic Posteriorgrams," ICASSP 2024 Workshop on Explainable Machine Learning for Speech and Audio, April 2024.

M. Morrison, **C. Churchwell**, N. Pruyne, and B. Pardo, "Fine-Grained and Interpretable Neural Speech Editing," Interspeech, September 2024.

Teaching Experience

2022-2024	**CS449 Graduate Deep Learning**, Teaching Assistant

Awards, Fellowships, & Grants

2023	**Summer Undergraduate Research Fellowship**, Computer Science Department, Northwestern University	*$ 6,500*
2023	**Outstanding Peer Mentor**, Computer Science Department, Northwestern University	*$ 300*

Personal Projects

SLURM Documentation Piloted the new Northwestern CS Department SLURM server. Developed efficient workflows and Apptainer setups. Created documentation for other labs and researchers to use.

ETrombone Designed and fabricated an electronic trombone. A length of tube was fitted with a microphone and a mouthpiece, and a VR controller was used to detect slide position. Allowed real-time synthesis with many VST plugins. Required rewriting part of the Pedalboard Python C++ backend to allow real-time VST instrument synthesis.

MothPriest An intuitive and highly-extensible Python library for creating binary file parsers capable of reading and writing files. Handles dynamic variables like table sizes, positions, checksums, and arbitrary transforms like compression. Allows for file formats to be described simply in Python for rapid design of file parsers.

RayTracing Created a mesh-based ray tracer in TypeScript. Included automatic bounding volume hierarchies for efficiency as well as multiple reflections. Wrote WebAssembly Linear Algebra functions to leverage SIMD operations.

FlipFolder Designed and fabricated a 3D-printable replacement for marching band flip folders using a parametric, code-based CAD. Design includes a modular disc-bound system, laminated music, and a compliant mechanism to clamp onto the bell. All parts were designed in CadQuery, a Python library for CAD. Developed software tools to automate the cropping, aligning, and compilation of sheet music.

Extracurricular

ENRICHMENT

2022-2024	**Marching Band, Basketball Band, Stipend Band, Concert Band**, Trombone	*Northwestern University*

SERVICE AND OUTREACH

2023, 2024	**Regional Science Fair**, Volunteer Judge	*IJAS*
2021-2023	**Website Committee**, Chair	*Slivka Hall*

DEVELOPMENT

Teaching assistant training, 2 seminars on teaching techniques, guiding questions, constructive feedback, and teaching through empathy.

Software Skills

Languages	**Frameworks/Libraries**	**Environments**	**Multimedia Tools**
Python	PyTorch	MacOS	Final Cut Pro
C/C++	NumPy	Linux	CAD
CUDA	Huggingface Accelerate & Hub	Windows	3D Printing
LaTeX	Pandas	Docker & Compose	
Javascript/Typescript	Flask	SLURM	
HTML/CSS/SASS	Webpack	Apptainer	
	OpenXR & WebGL & WebGPU		