GUEST EDITORS' NOTE
Special Issue on The Sound of Digital Audio Effects

Digital audio effects (DAFx) sit at the intersection of scientific inquiry and artistic expression, enabling transformative ways of creating, manipulating, and experiencing sound. Over the past decade, this field has evolved dramatically, driven by both advances in signal processing theory and an increasing integration of machine learning, perceptual modeling, and human-computer interaction. From subtle timbral shaping to full-system emulations of analog gear, DAFx research continues to expand the sonic palette available to musicians, producers, developers, and artists working across domains.

A defining trend in recent years is the convergence of black box learning methods and white box physical modeling, each offering complementary strengths. Data-driven techniques, particularly deep neural networks and differentiable processors, have enabled striking progress in expressive synthesis, automated mixing, and signal transformation, often in real-time or embedded contexts. At the same time, white box approaches, such as wave digital filters and antialiasing methods continue to deliver accuracy, interpretability, and trustworthiness, especially in the design of virtual analog (VA) effects. These developments often intersect in hybrid architectures that aim to combine fidelity, control, and computational efficiency.

Another vibrant stream of research is the broadening scope of what constitutes a "digital audio effect." Where once the focus was primarily on filters, distortions, and spatialization, DAFx now encompasses generative systems, audio-driven graphics, and perceptually informed optimization workflows. Interactive and reactive systems are increasingly common, and real-time performance, once a technical barrier, is becoming the norm, even for complex nonlinear or learned models. This expansion not only challenges traditional definitions but also invites interdisciplinary approaches, connecting audio engineering with machine learning, visual media, and creative technologies in unprecedented ways.

The first paper, "Physical Modelling of a Spring Reverb Tank Incorporating Helix Angle, Damping, and Magnetic Bead Coupling," by McQuillan et al., presents new scientific developments in modeling the physics of a classic audio effect: the spring reverb. These devices often feature multiple springs that can vibrate in multiple polarizations and have unique impulse responses with distinct behavior above and below a certain transition frequency. The authors present their improved physical model that incorporates the dynamics of the magnetic beads (two per spring) and allows the damping of each polarization to be set separately, allowing them to achieve an excellent match to measured behavior. In addition to good results in terms of accuracy, because their derivations result in a set of equations written in modal form, it is highly suitable for real-time implementation, always a welcome feature for audio effect technologies.

Issues of efficiency and real-time suitability are central in the next article, "Distilling DDSP: Exploring Real-Time Audio Generation on Embedded Systems," by Caspe et al. This work investigates running differentiable digital signal processing (DDSP) graphs on embedded hardware, studying the relationship between accuracy and efficiency and model size. The focus in reducing model size is on "knowledge distillation," the process of successively training smaller "student" models to mimic the performance of larger "teacher" models for harmonics-plus-noise, DX7-inspired FM synthesis, and wavetable synthesis DDSP models. Managing model size is a perennial topic for machine learning, especially in the often resource-constrained world of audio synthesis, so this article should be of great interest to audio machine learning practitioners.

The article "Reverse Engineering of Music Mixing Graphs With Differentiable Processors and Iterative Pruning," by Lee et al., analyzes the results of an audio production process to uncover how the original dry audio signals were combined and processed. For this purpose, they constructed a mixing console integrating all available processors in every track and subgroup. Using gradient descent with differentiable processor implementations, Lee et al. optimized their parameters, removed the negligible processors, and optimized again. Such a workflow could also be interesting, for example, for automatic mixing. In this context, efficient implementations are the key.

The work "Antiderivative Antialiasing for Chebyshev-

Based Generalized Hammerstein Models," by Thomas Baker and Christopher Bennett, presents a novel application of antiderivative antialiasing to Chebyshev-based generalized Hammerstein models for nonlinear audio processing. The authors develop both explicit and recursive model implementations that significantly reduce aliasing artifacts without the computational overhead of oversampling. Their approach enables accurate black box modeling of nonlinear systems, including analog-inspired devices such as tape saturation and wavefolders. The paper also shows a virtual studio technology implementation with real-time performance even for a large harmonic count, making the contribution highly relevant for real-time nonlinear DAFx and plugin development.

The paper "Automatic Generation of Virtual Analog Audio Plug-ins Based on Wave Digital Filters," authored by Riccardo Giampiccolo et al., answers the growing demand for digital replicas of analog audio equipment, which has driven innovation in VA modeling. In this context, VIOLA (waVe dIgital audiO pLug-in generAtor) emerges as a significant advancement, offering an automated framework to generate prototype VA audio plug-ins directly from SPICE netlists. By leveraging the modularity and computational advantages of wave digital filters, VIOLA streamlines the prototyping process, transforming text-based circuit descriptions into ready-to-use audio plug-ins with graphical interfaces via MATLAB Audio Toolbox. This tool not only accelerates development workflows but also sets the stage for future enhancements in real-time VA modeling.

In their paper "Generating Music Reactive Videos by Applying Network Bending to Stable Diffusion," Dzwonczyk et al. present a novel method for generating music-reactive videos by applying network bending to pre-trained diffusion models, specifically Stable Diffusion. They demonstrate how pointwise, tensor-wise, and morphological transformations within the model's latent space can be modulated by audio features, both standard and machine-learned, to produce visually compelling, temporally synchronized imagery. This approach enables fine-grained, continuous control over image generation, allowing for complex audio-visual mappings beyond traditional one-to-one feature correspondences. Moreover, the authors describe a range of effects generating from network bending that are not easily recreated following traditional video editing approaches, such as those that manipulate the visual outcome on a semantic level. The work is particularly relevant because it offers new possibilities for visual artists to manipulate video content based on auditory features and in sync with the audio content. With the proposed architecture and a commercial-grade graphics processing unit, real-time processing is not yet feasible but could be reached soon.

This special issue presents a compelling selection of current research in the area of DAFx. We hope it inspires more researchers to explore this field and pursue their own projects in research and development. We are grateful to Enzo de Sena for organizing the 28th International Conference on Digital Audio Effects (DAFx25) and for proposing the idea of this special issue. We also extend our sincere thanks to the Journal of the Audio Engineering Society editor, Vesa Välimäki, for his support and prompt and thoughtful responses.

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