From Music Production to Sampling and Navigation with XOR Constraints in Answer Set Programming

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Answer Set Programming (ASP; [12]) is a rule-based formalism for modeling and solving knowledge-intense combinatorial (optimization) problems. ASP has become very popular in areas like Automated Planning, Robotics, Biology, Video Games and even Music [6] and its success and establishment have opened new opportunities to explore real-life problems particularly in music post-production. So far ASP is able to compose different types of musical styles, build chords progressions, variate or complete scores[1], but also, ASP is suitable to stand on the post-production music chain by balancing instruments and place them in the panorama field. [7] showed an introductory modeling approach towards an automated multitrack mixing tool, letting glimpse a perfect match to solve a challenging optimization problem like masking minimization with ASP. On the other hand, for these types of (artistic and engineering) problems, it can be infeasible to know all the search space. Saying this, ASP solvers need to be extended to pursue sampling and search space navigation and let the user see different parts from the answer set spectrum. One approach to cover both, is taking advantage from XOR (parity) constraints due how they partition the search space towards uniform sampling and take off from there to propose a navigation technique. This extended abstract is divided into two main sections, being the first on the mixing process, followed by a brief overview on sampling and search space navigation in ASP.

1 Multitrack Mixing with ASP

Mixing is the process of combining multiple recorded sounds (multitrack) into one track known as a "mixdown". In the mixing process, the multitracks level and dynamics, panoramic position and frequency content are manipulated in order to deliver the emotional context of a musical piece [10] [11]. [7] introduced mixing with ASP for balancing and panning, leaving open the frequency content process. The frequency content is handled in the equalization process and is one of the most important tasks in music production [15]. Treating the frequency domain is probably the hardest aspect of mixing and half of the mixing work relies on this frequency task and having a good mix is vital to achieving an album's or track's success [11]. Masking minimization is a key part of equalization. Additionally,

[1] All these references are shown in [7] due to space reasons.

masking is defined as the process by which the threshold of audibility for one sound is raised by the presence of another (masking) sound [14]. In other words, masking is when one signal competes with another within the same frequency range, reducing the ability to fully hear the desired signal [15]. The audio treatment consist of extracting audio features like the overall track volume, spectrum, and frequency bands just to name a few, with well-known and established libraries [2] building the instances for a given multitrack session. Given the rules and constraints for mixing, an ASP solver can propose different configurations for a single multitrack session. The answer set is parsed to a mixdown (WAV) file letting the users listen and choose whether the given answer set(s) satisfy their needs. [3]

2 Sampling and Navigating

Previous works in the area of SAT have proven the use of XOR (parity) constraints to cut the search space roughly by half towards (near-)uniform sampling [8][4] [13]. In ASP, the tools xorro [4] and Harvey [9] follow the same principles from [8] by solving the problem encoding with random XOR constraints. Currently, we are exploring different means to represent XOR constraints in ASP to provide a newer version of xorro. [1] [5] prove that the solution space of a random CNF-XOR formula "shatters" into well-separated (linearly separated) clusters. Taking from there, the concept of navigation in ASP can be seen as exploring the most diverse answer sets and let the user explore the answer sets spectrum by deciding "where to go". This can be enriched by combining ideas from ASP navigation by [2][3].

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[2] `https://www.scipy.org/`
[3] Currently, this is a work in progress.
[4] `https://sourceforge.net/p/potassco/code/HEAD/tree/branches/xorro/`

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