

Harmoni: A Melody Harmonization Tool

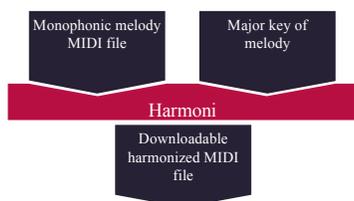
Ishaan Madan, Ryan McHenry, Sarah O'Brien
 Northwestern University

Try it out at <http://harmoni.cloud>

ishaanmadan20@u.northwestern.edu; ryanmchenry2019@u.northwestern.edu; sarahobrien2020@u.northwestern.edu

What is Harmoni?

- Tool that provides users with harmonized versions of basic melodies
- Inputs: monophonic MIDI file and the (major) key in which the melody is written
- Output: corresponding harmonized polyphonic MIDI file for download



Target Audience

Young / inexperienced musicians can experiment with the fundamentals of chordal structure and harmony.

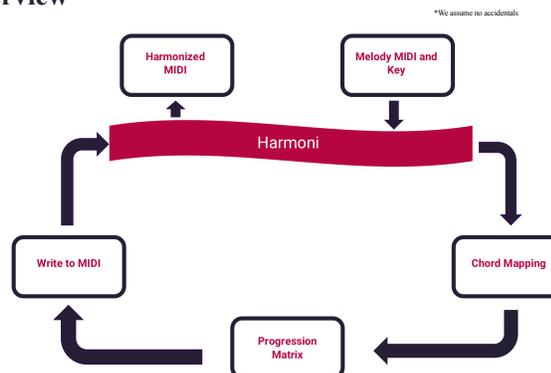
Experienced composers can use Harmoni to automate their tedious workflows. This allows them to instead focus on more creative pursuits.

User Testing

We focused on testing from three sources:

1. "Non-Musicians": Northwestern students with non-musical backgrounds
2. "Musicians": students either in university music programs or who self-identify as musicians or composers
3. "Ground Truth": musical information from AcousticMusicArchive.com

Workflow Overview



Chord Mapping: After parsing and extracting each note in our melody, our algorithm decides which chords (the I or the V in the key, for example) are best played with it. These chord mappings are stored, and the chord to accompany the very first note in the melody is noted.

Harmoni keeps it interesting by choosing the next chord in a progression based on probabilities in our progression matrix. . . This means a user may input the same melody twice and obtain two different output harmonizations!

Progression Matrix: We create a matrix assigning probabilities to all the chord mappings we have created. These probabilities dictate the likelihood a certain chord will be selected, given a specific previous chord..

	I	II	III	IV	V	VI	VII
I	0.5	0.0	0.0	0.15	0.35	0.0	0.0
II	0.2	0.5	0.0	0.0	0.3	0.0	0.0
III	0.4	0.0	0.5	0.0	0.0	0.1	0.0
IV	0.2	0.1	0.0	0.5	0.2	0.0	0.0
V	0.4	0.0	0.0	0.1	0.5	0.0	0.0
VI	0.0	0.3	0.0	0.0	0.2	0.5	0.0
VII	0.8	0.0	0.0	0.0	0.2	0.0	0.0

Harmoni's chord probability matrix is informed and influenced by "Markov Chains of Chord Progressions," Kiefer, Riehl, "Ball State Undergraduate Mathematics Exchange"

Write to MIDI: Our algorithm then creates and edits the original MIDI file by adding a "legal" progression of non-inverted triads to it. This step provides an appropriate harmonization of the input melody.

Non-Musicians:

Average user score of 2.6

Musicians:

Positive: Yes! On a micro level, all the progressions are legal and the chords are compatible with the melody.

Constructive: The macro level movements seem flawed. It seems as though there is a lack of overall direction in the harmonized melodies. For example, there are big tonic expansions that don't lead anywhere.

Ground Truth:

Row Row Row Your Boat: 69% match
 Jingle Bells: 78% match

Note that much of the disparity between our harmonizations and ground truth is Harmoni's disregard for harmonic rhythm.

Future Work

Minor Keys: Our next step is to create a minor chord progression matrix and allow inputs in minor keys.

Key Detection: We hope to incorporate an element of heuristic or machine-learning-based key detection instead of asking for the key as an input. This will help novice composers who may not know what key the melody they have created is in.

Harmonic Improvements: To make our harmonizations more exciting, we will account for accidentals and implement chord-inversions instead of only non-inverted triads (ex. V7/IV).

Rhythmic Improvements: We hope to use harmonic rhythm to avoid simply placing a new chord under each melody note. This will improve the sound of the harmonized tune, and will help novice musicians understand concepts of orchestration and harmonic voice.

