

# EarTrainer41 manual

- Instead of matching pitch (boring), you're learning melodies (fun!)
- You control the melody's scale, range and angularity
- Intervals: You can focus narrowly on just a few, or broadly on a wide selection
- Covers not just melodies and intervals but also chords and chord progressions
- Melodies and chords are chosen intelligently – it almost feels like you're learning an actual song
- EarTrainer41 names every note in any scale or chord in any key, teaching you 41-edo nomenclature
- Guitar mode: run EarTrainer41 hands-free via a foot pedal, and play your Kite Guitar along with it!
- Autoplay mode #1: EarTrainer41 sends you chords at whatever tempo you choose, and you try to keep up!
- Autoplay mode #2: set it to alternate between just a few intervals, sit back, listen, and learn subconsciously
- Ambient mode: set the tempo very slow, set up a lush synth pad, and enjoy 41-edo ambient music!
- Best part: completely free and open-source! Tinker away! (donations accepted, paypal me at TallKite.com)

## ONE-TIME SET UP

This ear trainer doesn't make any sound, rather it outputs microtonal midi. You know how cheap keyboards have built-in speakers and expensive ones don't? Yeah, it's kinda like that. You have complete control over the sound. You're not limited to whatever cheesy sounds I could manage to program into this. The entire world of softsynths is available to you. Remember, the better the sound, the more fun ear training is! But if you don't have any decent softsynths, to get started quickly you can use Reaper's bundled ReaSynth or PianoTeq's free demo version (get the Standard one).

Download Reaper or ReaJS. The latter lets you run the ear trainer inside your own DAW (Windows only). Reaper is cheap, small (20MB download) and not copy-protected. The demo version is completely uncrippled.

### If using Reaper:

In Reaper, choose Options/Show Reaper Resource Path, and move **earTrainer41.jsfx** and the **earTrainer41gfx** folder to the Effects/MIDI subfolder. Quit Reaper and re-launch it, so it re-scans and can find these files. The earTrainer41gfx folder has sharps, flats, etc. and is needed for the key signatures display.

Some softsynths such as Pianoteq and Kontakt can handle multi-channel midi pitch bends. If you have such a synth, load the Reaper project file **EarTrainer41 for Pianoteq.RPP**. Replace the Pianoteq instance with your softsynth. If you don't have such a synth, load the Reaper project file **EarTrainer41 for ReaSynth.RPP**. Optional: replace all 10 ReaSynth instances with your own softsynth. Whatever synth you use must respond to All Notes Off midi commands (almost all do).

### For Reaper and all other DAWs:

Normally you'll need up to 5 synth instances for pentads. For downtempo ambient music, you'll need up to 10. Extra instances are only needed when the tempo is 60 bpm or slower.

PianoTeq (mostly) decays and ReaSynth sustains. Set the sustain/decay option accordingly. In sustain, arpeggio notes won't overlap. Also, the play button cycle will include a silent setting on the slider's far right.

Important: make sure the pitch bend range matches that of your synth! Otherwise everything will be out of tune. Most synths, including ReaSynth and Pianoteq, default to a 2 semitone range. See also "Synth Sounds" below.

Confused? Read about microtonal midi via pitchbends in the first few pages of chapter 6.10 of the [alt-tuner manual](#). See also the "Synth Sounds" section below.

# HOW TO USE

If you're interested in 41-edo, you're obviously a smart cookie. You can probably figure out most of the features from just using it, but do see the final section on customization.

**SLIDER MODE:** Drag the slider at the top of the screen around to hear the notes, then try to identify them. For hands-free use, midi-learn the slider to an expression pedal and play along on the Kite Guitar!

**PLAY BUTTON MODE:** click on the play button (EarTrainer41's, not your DAW's). This cycles the slider through the notes. For hands-free use, click the laptop's mouse button with your toe, or else make yourself a footmouse. (Tape a mouse to a flat piece of wood and tape another flat piece to the mouse button, see the photos on the last page).

**AUTOPLAY MODE:** For hands-free and pedal-free use. Feels more like playing a video game than using an ear trainer. Set the tempo, click on the continuous play button, and click play. Then try to echo the notes before the next chord comes along. You can watch the screen to see if you guessed right, or close your eyes and just trust your ears!

**AMBIENT MODE:** This is the same as autoplay, but the tempo is at or below 60 bpm. Not for guessing and keeping score, just for relaxing and listening. Works best with a sustaining pad-like synth sound. Outputs to twice as many midi channels, so it requires twice as many synth instances. (see "Inner Workings / Continuous Play")

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If you're playing Kite Guitar, before you start, be sure to carefully tune up! The midi output is calibrated so that D is in standard A-440 tuning. For precise tuning, I recommend EDOstrobetuner. Free, open source, get it at [TallKite.com](http://TallKite.com).

Play the note or chord to identify via slider or play button. Then click on one of the selected notes/chords to hear it ("selected" means the box has a checkmark). Hold the mouse button down until the whole chord is done playing. Wrong guesses affect your score. We don't want any 41-edo newbies getting discouraged by a low score, so EarTrainer41 lets you cheat a little. You can listen to the note/chord without committing to it being your answer. Just slide the cursor off of it before releasing the mouse button. So hey newbies, go ahead and listen to as many of the possible answers as you want, as many times as you want, without any stress or guilt. The best way to learn is to allow yourself to be curious and explore. As you get more skilled, you will naturally graduate to a simple mouse click.

Once you've found an answer that seems to match, click on it and release the mouse button on it. If it's right, it turns green. If wrong, red. A right answer ends the round and sets up a new chord to identify. If you want to listen to the old chord again, just click on the green button. If you're stumped, you can see the answer by moving the slider to zero. Or click on the play button and hold the mouse button down for 1 second.

Choosing beginning/intermediate/advanced only affects which boxes have checkmarks. The note or chord to identify is picked semi-randomly among the choices that have checkmarks. So don't uncheck anything until the round is done! The beginning and intermediate levels are just suggestions. Feel free to create your own levels. But don't skip the intermediate melody and interval tests. They really help for hearing the subtleties of 41-edo.

To make the ear training more musical, EarTrainer41 doesn't choose notes and chords completely at random. The melody test favors small steps and in harmonic mode has a clear sense of key. In the interval test, the first note of each interval is part of the previous interval. In the other tests, the chords are chosen to have a common tone with either the previous chord or the scale selected in the melody test. Randomness is boring and unrealistic. In a typing class, would you rather type The quick brown fox or Hjufv awdnk zbexs btclgm poqir?

In fact, I would argue that it's possible to overtrain your ear, so that random meaningless melodies and harmonies are so easily heard that they replace tasteful ones. This would explain certain post-modern jazz and prog rock!

You can also use EarTrainer41 as a style guide for naming 41-edo chords in any key. See "Chord Spellings" below.

This paragraph from [www.kylegann.com/tuning.html#tune2](http://www.kylegann.com/tuning.html#tune2) was the inspiration for continuous play:

"By the way, it's really not so difficult to learn to recognize these intervals by ear. When I first started out with this in 1984, I would tune a synthesizer to the intervals I wanted to learn – I started out contrasting 10/9 and 9/8 – and then let the intervals run in a loop on tape (later computer-sequenced) as I was going about my daily business, letting myself pick up the differences in character with my peripheral hearing. Today, if I'm composing in just intonation and I accidentally use a pitch as much as five cents off from the one I wanted, I catch the mistake by ear almost immediately – because I recognize that the character of the interval is not the one I wanted. (And no, I don't have perfect pitch.)"

# INNER WORKINGS

## The Melody Test

**Step sizes:** When small steps are favored, the melody's step sizes are normally distributed. This makes the melody less random and more musical. Melody steps are mostly 2nds and 3rds. One octave is 3 standard deviations. If all 42 notes are selected, here are the odds for each category of step size:

1sns:	odds of P1 or ^1	5.83%	odds of P1 to ^1	5.83%
2nds:	odds of vm2 to ^M2	38.34%	odds of P1 to ^M2	44.17%
3rds:	odds of vm3 to ^M3	28.59%	odds of P1 to ^M3	72.76%
4ths:	odds of v4 to b5	12.90%	odds of P1 to b5	85.66%
5ths:	odds of #4 to ^5	7.60%	odds of P1 to ^5	93.26%
6ths:	odds of vm6 to ^M6	4.82%	odds of P1 to ^M6	98.08%
7ths:	odds of vm7 to ^M7	1.49%	odds of P1 to ^M7	99.57%
8ves:	odds of v8 or P8	0.16%	odds of P1 to P8	99.73%
	odds of above P8	0.27%		

Equal probability means every note is equally likely, and the melody will leap up and down randomly. Choosing the option of a 3-octave range and the setting of random octaves makes a super-challenging 5-octave range.

**Layouts:** In the linear layout, the first column is unisons, the next is 2nds, then 3rds, etc. The top row is upward intervals. The next row is plain. Then comes downward, mid, upward, plain and downward. The right half is exactly a 5th above the left half. Each half is isomorphic. Within each half, moving right one step always goes up a major 2nd.

The guitar layout shows the [Kite Guitar](#) fretboard. You can change the tuning from downmajor 3rds to either upminor or upmajor 3rds. See "openStringInterval" in the Customization section.

The lattice layout is harder to use, especially for the melody test. It's good for understanding remote tonics. It's like the 41edo [spiral of 5ths diagram](#). The top row is the upward row. The 2nd row is the plain row, the 3rd is downward, and the 4th is mid (both double-up and double-down). Each row is a chain of 5ths. Start at the white square in the middle row, read left to right, then go UP to the top row. Read this row left to right, then jump down to the bottom row. From here jump up to the 3rd row, then up again to the 2nd row. See also [en.xen.wiki/w/41edo\\_Note\\_Names](http://en.xen.wiki/w/41edo_Note_Names).

The guitar and lattice layouts can be confusing. They wrap around, and a note on the edge of the layout also appears on the opposite edge. To illustrate this, when an edge note is selected, a "shadow note" appears opposite it. For example, at the beginning level, the vC# note has a shadow. Select the advanced level to see all the shadow notes.

If you set the tonic to a remote key like G# or vEb, the "toggle the tonic" button appears. Clicking it renames the key to its enharmonic equivalent. This does not change the sound at all; it only changes the notation. Sometimes there are two equivalent keys. The toggle-able keys are underlined and their equivalents are in parentheses:

(^^Ab ^^Eb ^^Bb) ^^F ^^C ^^G (^^D ^^A)  
(^Db ^Ab) ^Eb ^Bb ^F ^C ^G ^D ^A ^E ^B ^F# ^C# (^G# ^D# ^A#)  
(Gb Db) Ab Eb Bb F C G D A E B F# C# G# (D# A#)  
(vGb vDb vAb) vEb vBb vF vC vG vD vA vE vB vF# vC# (vG# vD#)  
(wG wD) wA wE wB (wF# wC# wG#)

**Key Signatures:** There are seven types: major/minor (3-limit), downmajor/upminor (5-limit), upmajor/ downminor (no-fives 7-limit), and mid (no-fives-or-sevens 11-limit). Mid appears as both double-downmajor and double-upminor. The "set" button sets the scale to match the key signature. Key signatures with triple-arrows such as ^^C upminor are dimmed out and marked as "avoid". To avoid this key, toggle the tonic to get wC# upminor or vDb upminor.

## The Interval Test

If the root is allowed to vary, the first note of each interval is the last note of the previous interval. But the first note is random if you're on the advanced level, no matter how many boxes are actually checked.

If you select "root is the tonic" and "harmonic" play mode, it's similar to the melody test with equal probability.

## The Triads / Tetrads / Pentads Tests

**Chord progressions:** When common tones are required, each chord has at least one note in common with the previous chord. This avoids big jumps up and down the fretboard, instead the progression walks around. Root movements that result in two notes in common are twice as likely as those that result in just one. Three common notes makes them three times as likely, etc. Assuming both the previous and current chords have perfect 5ths, I – IV and I – V root movements are further prioritized: 8:15 odds for triads, 5:12 odds for tetrads, and 12:35 odds for pentads.

When roots are limited to the scale, roots are chosen randomly from the notes selected in the melody test. (If the slider moves but there's no sound, make sure at least one scale note is selected.) EarTrainer41 first picks the chord type, then picks the root to maximize the number of chord notes that are also scale notes. For example, the beginning melody scale is D downmajor and the beginning triad selection is sus4, v and ^m. If EarTrainer41 picks the downmajor chord, G, D and A are the most likely roots because there are no non-scale notes. vB and vF# are the next most likely, with only one non-scale note. vC# and E are the least likely, with two. See "diatonicity" in the Customization section.

**Homonyms:** Sometimes there are two or three correct answers. For example, Csus4 is also Fsus2 and G7sus4no5. Such homonyms only show up as alternate answers when you allow inversions and let the root vary. Otherwise the root is obviously either the lowest note or the tonic. In the big green answer box under the play button, the root is marked with a box and the homonym root is marked with parentheses.

**Custom chords:** You can create a custom chord by selecting various intervals in the interval test. Then go to the chords test and select the custom chord. If you can't select the chord, not enough intervals are selected. You can include a triad in the tetrads test (or a tetrad in the pentads test) by selecting P8. If open voicings are allowed when you select it, there may be 9ths, 11ths or 13ths. The #2 (number 2 not sharp 2) note of the chord becomes a 9th if it is a 2nd (^M2 or smaller), or if the #3 note is a 3rd (^M3 or smaller). The #3 note (after making the #2 note be a 9th) becomes an 11th if it's between v4 and ~4, or if it's between b5 and v5 and note #4 is a P5. A 6th becomes a 13th if the next higher note is a 6th or 7th. A triad's 6th becomes an aug 5th if it's a vm6, m6 or ^m6.

**Chord spelling:** Notes never have triple ups or downs. For example in the key of vD, the vIIV chord is spelled not vE vWvG# vB but vE ^G vB. Note the triple-up interval from the root to the 3rd. If this happens, or if there are triple sharps/flats, you can toggle the root to see alternate spellings. Other roots are sometimes toggle-able, for example in certain keys ~II4 can be spelled either ^bII4 or vII4, ^II^7 can be vvbIII^7, and #IVv7 can be ^bVV7.

You can use EarTrainer41 as a style guide. Suppose you want to spell a vbIIIva chord in the key of Eb. In the melody test, set the tonic to Eb. Clear all the notes, then select the downminor 3rd. You can use the interval test to help you locate it. In the triads test, clear all chords and select the downaug chord. Select "root can vary" and "limit to scale". Press PLAY and hold it, or move the slider over and back. The big green box will show you the (toggle-able) spelling.

**Tip:** At the advanced level, in melodic mode, the arpeggio is sometimes descending. No matter how many boxes are actually checked. So you can set the level to intermediate and then check all the boxes to avoid descending arpeggios.

## Synth Sounds

If you're unfamiliar with midi, use either PianoTeq or ReaSynth. PianoTeq is very convenient to use because you only need one instance. The free "Standard" demo version runs for 20 minutes. Remove it and reload it to continue.

ReaSynth is a simple synth bundled with Reaper. Set "your synth sound" to "sustain (organ)". You can shape the sound somewhat using the synth's sliders. To avoid having to tweak all 10 instances to match, see

[https://en.xen.wiki/w/DAWs#Useful\\_Scripts](https://en.xen.wiki/w/DAWs#Useful_Scripts). You can replace the 10 instances of ReaSynth with your own synth.

Otherwise, set sustain/decay to match whatever sound your synth has. Sustain mode outputs more all-note-off messages so that arpeggio notes won't overlap. Also the play button cycle includes a silent setting on the slider's far right.

You can run EarTrainer41 in another DAW besides Reaper if you run it inside ReaJS (Windows-only wrapper). Or you can run both DAWs side by side and send the midi from Reaper to your DAW. You'll need a virtual midi cable. On OSX, use the built-in IAC utility via the AudioMidiSetup app in the utilities folder. On Windows, use [loopMIDI](#) (free). In Reaper, open the PianoTeq project, remove PianoTeq, and set the midi hardware output to 1 port or bus of IAC or loopMIDI. In your DAW, on each synth track, set the input to the appropriate channel of IAC/loopMIDI. If you can't set the channel, set up IAC/loopMIDI to have 10 ports or busses. Set Reaper to output each midi channel to a separate port/bus. Set your DAW's tracks to receive from individual ports.

## Continuous Play

Continuous play simply moves the slider, cycling through all the notes once, then starting a new round. The tempo is steady, but the number of beats between each round is somewhat random. A little bit of randomness keeps the music interesting!

Ambient mode is a form of continuous play that uses alternating midi channels and also a more random midi velocity. One triad uses channels 1-3 and the next triad uses channels 4-6. Alternating channels allow you to use a lush synth pad sound with a long decay "tail". If it were on the same channel as the following note, it would "get its tail bent" by the following note's pitch bend message. Here are the channels used:

midi channels used	melodies	intervals	triads	tetrads	pentads
regular play	1-2	1-2	1-3	1-4	1-5
ambient mode	1-4	1-4	1-6	1-8	1-10

Ambient mode happens if the tempo is at or below 60 bpm when you start continuous play (when the play button turns yellow). You can change the tempo after it starts, for a fast tempo with extra channels, or a slow tempo without extra channels. Recommended settings for ambient music: melodic play mode, tempo under 30 bpm, synth sound decays, root can vary. Choose your favorite chords and let it run. You can even have a 2nd instance of EarTrainer41 play a melody over the chords! Use my Rechanneler effect to keep the midi streams separate. To synchronize them, right-click the 2nd instance's play button. It will turn orange and wait to autoplay until it receives midi from the 1st instance.

## Customization

EarTrainer41 is a simple text file. Edit it with any basic word processor. The editable part is the "Static Constants" section near the top of the file. Instructions for adding or deleting chord types or replacing them with custom chords are in the file itself. It's also quite easy to increase the number of custom chords from 4 to 7.

- openStringInterval** – changes the guitar layout, 1 = downmajor 3rds, 0 = upminor 3rds, and 2 = upmajor 3rds.
- randomVelocity** – the midi velocity varies slightly for realism. Defaults to 4. If the midi velocity is 80, the actual midi output has velocities of 76 to 84. Set this to zero if you like robotic uniformity.
- randomVelocity2** – for ambient play, defaults to 12 for even more realism.
- downTempo** – defaults to 60 bpm, set this to zero if you don't want to even think about extra midi channels!
- wait** – the wait time in seconds to hold down the play button to end the round. Decrease it if you're the impatient type.
- randomPause** – the number of extra beats between rounds while autoplating. Each arpeggio note is one beat long. After the arpeggio there is a pause of equal length, time for you to echo the notes. RandomPause defaults to 3, meaning 0-3 extra beats will be added to this pause. Set this to zero if you like boring predictability.
- diatonicity** – When the root is limited to the scale, if a chord root would result in N non-scale notes, that root is N\*diatonicity times less likely to be chosen than a root that results in no non-scale notes. Defaults to 5. Set to 0 to get more chromatic chords, set to some large number like 100 for more diatonic chords.
- showPlainTonics** – Key signatures with arrows distinguish between modes such as D vMajor and vB ^Minor. But if both the tonic and the scale are plain, modes appear identical. Set this to 1 to indicate the tonic with a single plain sign.
- white, gray, green, red, etc.** – colors on the screen, in monochrome or RGB format, valid ranges are from 0 to 1.



**Footmouse:** for hands-free use, position the cursor over the play button, press to play, or long-press to move on.

