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A Better Explanation of Musical Modes

A Public Service Announcement by Akshay Seetharam

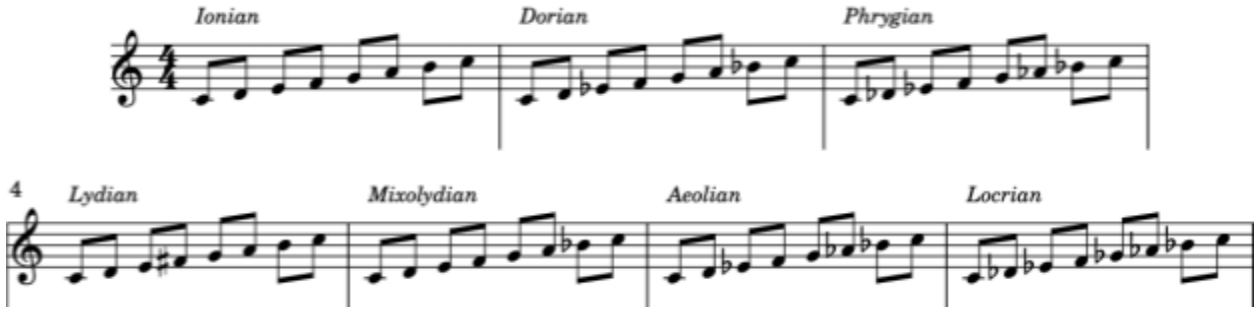
TL;DR: Modes can be calculated based on the deviations from the major scale; use this code to help.

Introduction

What is a musical mode, and how do we tell them apart? This is the question that I'll attempt to answer over the course of this post, along with a helpful tool at the very end to familiarize yourself with the mode calculations.

Let's start with the first question. Starting on C, here are the 7 scale modes from Ionian to Locrian. Need help remembering them? There are a myriad of mnemonics, but my favorite

(because of its apt introspection) is “I Don’t Punch Like Muhammud ALi.” Note that the word “ALi” covers both the Aeolian and Locrian modes.



Primary Analysis

Anyway, just looking at these modes doesn’t really tell us anything about their order, but if we look at them close enough, we may notice that each of them has a different number of flats. Ionian has 0, Dorian has 2, Phrygian 4, Lydian 0, but 1 sharp? (we’ll come back to this), Mixolydian 1, Aeolian 3, and Locrian 5. Now, let’s put them in ascending order of flats ignoring Lydian for now: Ionian, Mixolydian, Dorian, Aeolian, Phrygian, Locrian. Let’s make a table of which degrees of the scale are flat in each mode. We can see that each mode adds a new flat to the previous one. In fact, we can form the Dorian by lowering the 3rd of the Mixolydian by a semitone, the Aeolian by lowering the 6th of the Dorian, etc. This leads us back to the Lydian. The closest mode to the Lydian that we’ve already mapped out is the Ionian—all we need to do is lower the 4th of the Ionian and we arrive at the Lydian. This is exactly equivalent to saying that we can arrive at the Lydian by raising every note by a semitone—which doesn’t change the mode—and then lowering the 1st, 2nd, 3rd, 5th, 6th, and 7th, i.e. every degree except the 4th. Let’s add this to our table after the Locrian, because it’s clear that lowering the 1st degree of the Locrian gives us our Lydian—if we permit ourselves a transposition that is ultimately meaningless.

Mode	Flat Degrees
Ionian	N/A
Mixolydian	7th
Dorian	7th, 3rd
Aeolian	7th, 3rd, 6th
Phrygian	7th, 3rd, 6th, 2nd
Locrian	7th, 3rd, 6th, 2nd, 5th

Mode	Flat Degrees
Ionian	4th
Mixolydian	4th, 7th
Dorian	4th, 7th, 3rd
Aeolian	4th, 7th, 3rd, 6th
Phrygian	4th, 7th, 3rd, 6th, 2nd
Locrian	4th, 7th, 3rd, 6th, 2nd, 5th

Lydian	4th, 7th, 3rd, 6th, 2nd, 5th, 1st

Circle of Fifths

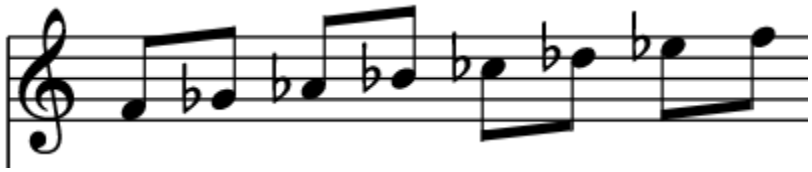
At this point, we're ready to make the final deduction. Tracing the flats from Ionian to Lydian, we notice an interval of a fourth between each new flat—the 7th to the 3rd, the 3rd to the 6th (don't be confused—that's a fourth, e.g. E to A in C major), etc. Remember that a 4th going up is the same, disregarding an octave of difference, as a 5th going down. So what we're really doing is adding a flat each perfect fifth down. Have we ever seen something similar? Of course! The circle of fifths! Moving clockwise starting at C, we add F#, C#, G#, D#, A#, E#, and B# before coming around to the flat side. Now which degrees do these sharps represent in the key of C? F# the 4th, C# the 1st, G# the 5th, D# the 2nd, A# the 6th, E# the 3rd, and B# the 7th. Here, we arrive at the second, and much more useful, definition of a musical mode. Let's use the Dorian mode as an example. The Dorian mode has 2 flats excluding our Lydian Workaround (LW) of the 4th. This means that we can get the Dorian mode, albeit transposed, by playing a scale starting from D (normally with 2 sharps) using the notes of the C major scale. We can obtain the Mixolydian (with 1 flat minus the LW) by playing a scale starting from G (normally with 1 sharp) using the notes of the C major scale. We can obtain the Locrian (with 5 flats minus the LW) by playing a scale starting from B (normally with 5 sharps) using the notes of the C major scale. Let's revisit the Lydian. How can we play it? Well, given our 6 flat method, we would play a scale starting with F# (normally with 6 sharps) with the notes of the C major scale. But if we do this, we end up playing the enharmonic equivalent of a F major scale with a raised 4th. For this reason, we can consider the Lydian a special case that has a sharp instead of a flat. Can we justify this? Look at the circle of fifths: F is the only white key on the flat side instead of the sharp side. It makes sense that it forms an exception to our rule. Of course, much more practically, this makes it easier to identify the Lydian. We now have our procedure for determining the mode of any given scale.

Procedure

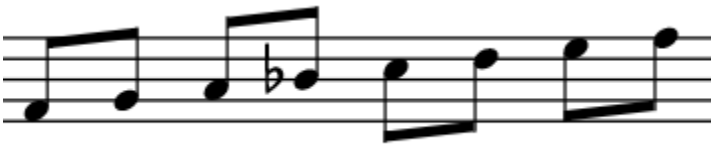
1. Write the major scale starting on the same note as your scale.
2. Find the deviations between the major scale and your scale.
    a. If there are no deviations, you have a scale in the Ionian mode.
3. Is the deviation a sharped degree of the major scale?
    a. If so, you have a Lydian.
4. Okay, we've got a normal one. Count the number of flats in the scale.
5. Now which major scale has that number of sharps?
6. Which degree is that note in the C major scale?

7. Use your IDPLMAL mnemonic of choice to count to that degree. 1st is Ionian, 2nd is Dorian, etc.
8. Were you correct? You can check your answer by transposing down to the note you found in Step 5. It should consist of notes completely in the C major scale.
    a. Yes!
        i. Great!
    b. No!
        i. Try again.
            1. Still wrong. I think your method is wrong!
                a. Not necessarily. You may not have a scale that falls into the seven primary modes. We've only considered the keys from F to C#. We haven't touched the keys from B ♭ to A ♭ . There's a lot more to learn; I just haven't figured it out! For example, none of the modes corresponds with the harmonic or melodic minor—those require different combinations of accidentals.

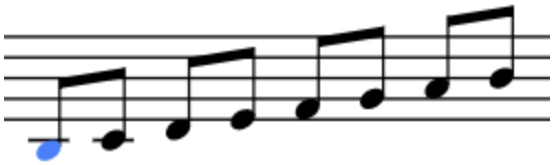
Here's an example of an unidentified scale and our 7-step (just like the number of modes) process.



1. Our starting note is F, so to compare the unknown scale with a reference, let's write out the major scale:



    a.
2. Our scale has a G ♭ , an A ♭ , a C ♭ , a D ♭ , and an E ♭ where the F major does not.
3. We don't have a sharp, so it's not the Lydian mode.
4. We have 5 flats.
5. B major has 5 sharps.
6. B is the 7th degree in the key of C.
7. Locrian is the seventh mode.
8. Correct! We can check our answer by transposing a diminished fifth down to B and make sure that all our notes are in the C major scale.



Amazing! Now all that's left is to study theory for an additional 40 hours a day to be able to appreciate the WONdeRFul worLD of jAzz.

Mathematical Derivation

But if we want to describe the relationship mathematically, we have to do a *little* more work. You can skip to the next paragraph if you just want the code. The LW is annoying to have to consider, so we'll just refer to a sharp as a "negative flat." This works because music is based on modular arithmetic, in which every 7 steps the scale repeats. So, we can say that having 1 sharp is like having –1 flats, which is equivalent to having 6 flats. There, now we have a number of flats for each mode. Let's put this in our table. We can see that the number of flats increases by 2 until we reach the Mixolydian, where we loop back down to 1. But remember, we can use modular arithmetic! Having 1 flat is exactly the same as having 8 flats in a different key, but that doesn't change the mode. Having 3 is like having 10, and having 5 is like having 12. Let's update this. Now we have the modes in order, from Ionian to Locrian, with their number of flats. If we want to convert from 0–12 to our more familiar 1–7, we just have to divide by 2, which will give us the range from 0 at Ionian to 6 for Locrian, and then add 1, giving us 1 at Ionian and 7 for Locrian.

Mode	Number of Flats
Ionian	0
Dorian	2
Phrygian	4
Lydian	6
Mixolydian	1
Aeolian	3
Locrian	5

Mode	Number of Flats
Ionian	0
Dorian	2
Phrygian	4
Lydian	6
Mixolydian	1 + 7 = 8
Aeolian	3 + 7 = 10
Locrian	5 + 7 = 12

So we need to slightly adapt our procedure, which will remove the LW and frees us from the constraints of the circle of fifths and scale degree.

Mathematically Improved Procedure

1. Write the major scale starting on the same note as your scale.
2. Find the deviations between the major scale and your scale.
    a. If there are no deviations, you have a scale in the Ionian mode.
3. Are the deviations sharps?
    a. If you have 1 sharp, this is a Lydian, but to continue with the procedure you can consider the scale as if it had 6 flats. Skip to Step 5.
4. How many flats?
5. Is the number of flats odd?
    a. If so, add 7.
6. Divide by 2 and add 1.
7. Use your IDPLMAL mnemonic of choice to count to that mode. 1 is Ionian, 2 is Dorian, etc.
8. Were you correct? You can check your answer by transposing down to the note you found in Step 5. It should consist of notes completely in the C major scale.
    a. Yes!
        i. Great!
    b. No!
        i. Try again.
            1. Still wrong. I think your method is wrong!
                a. Not necessarily. You may not have a scale that falls into the seven primary modes. We've only considered the keys from F to C#. We haven't touched the keys from B ♭ to A ♭ . There's a lot more to learn; I just haven't figured it out! For example, none of the modes corresponds with the harmonic or melodic minor—those require different combinations of accidentals.

Python Code

This logic was quite simple to implement using the Python scripting language, and it's easily accessible on Google Colaboratory (Colab). Follow the instructions in the notebook and you should be able to identify any scale's mode.

(Preempted) Frequently Asked Questions

The format is ↓

- Question

    - Answer
- I can't run your code on Colab! Why?
    - You'll need a Google Account to run code in Colab. If this isn't possible for whatever reason, I provide a plain-text file that you can run in any Python console.
- Your procedure gave me the wrong answer! Why?
    - It's important to remember that not every scale is associated with a mode. For example, just because a scale has 2 flats compared to the Ionian, doesn't mean it's in Dorian mode. Those flats need to be at the 3rd and 7th degree. If they aren't, you're dealing with a non-standard mode. This procedure is just the basics because that's what I understand (and honestly, that's what's easy to code).
- I got an error running your code! Why?
    - My code is meant to run on any version of format python 3.x. IT WILL NOT RUN ON python2.7.
    - If it's a "ModuleNotFoundError," try copying the code into an online editor like repl.it or installing the problem module (though this will be difficult if you're inexperienced with software).
    - If you're running from the command line, try running with `python3` rather than the standard `python` command. If you don't have any python3 version, you'll need to install it or use an online editor.
    - Read the error message closely; it may be your mistake. My code is set up to "raise exceptions" (error out) if you enter something that isn't compatible with my code.
    - If none of these fix your problem, feel free to email me at akshay.seetharam628@gmail.com or message me on linkedin at linkedin.com/in/akshay-seetharam.
- I find it a lot easier to remember that different modes have half-steps and whole-steps. Why go through all this trouble?
    - For me, this didn't work. I prefer my method, but of course you should use whatever works for you. And because you asked, I'll tell you that my Python code actually uses intervals to determine whether the scale is a standard node.
- Why did you spend so much time on this?
    - Why did you spend so much time reading this?
- Don't you have better things to do?
    - Definitely. As I write this, it's 0009, fewer than 6 hours and 26 minutes before I have to wake up for school. And even if I'm fine staying up this late, you can see on my Linkedin that I have more important obligations.

If you have any other questions, feel free to email me at akshay.seetharam628@gmail.com or message me on linkedin at linkedin.com/in/akshay-seetharam.