CHAPTER 38

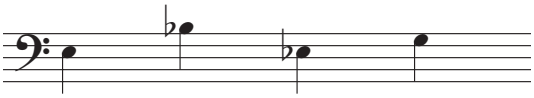
Pitch Class Set Theory

SUPPLEMENTARY MATERIAL

Alternative Method to Determine Normal Order and Prime Form

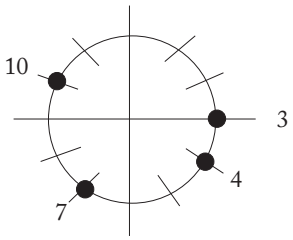
To determine the prime form of any set, a number of steps are required. The textbook presents a number-based approach to determining a set's prime form and Forte number. However, the entire process of cyclic variation, normal order, and set inversion can be reduced to a much quicker and simpler process by using a clock face method.

The clock face can be used before in many contexts. The first was the circle of fifths presented in Chapter 2. Most recently, you may have used a clock face to observe the pitch-class content of the fully diminished seventh chord. Now we will use a clock face in the manipulation of pitch class sets. We will use a cardinal-4 set as an example.



The first step is to plot the elements of each set on the clock face. Twelve o'clock is always at the top of the clock and it represents pitch class 0 (C). Twelve o'clock will remain zero during the first two steps, which are the cyclic variation and normal order phases of the process.

A large black dot is placed on the clock at the position of each pitch class. In the case of our cardinal-4 set, the dots appear at 3, 4, 7, and 10



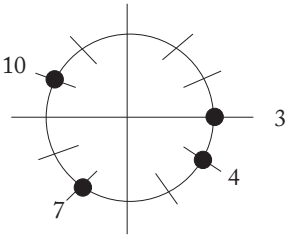
use this diagram to determine the cyclic variations and normal order

A cyclic variation of this set is necessary to establish normal order, which is the shortest distance between two adjacent points that includes all elements of the set. To determine this, start with each number in turn and count clockwise until you reach the fourth member of the set. The lowest number is the preferred cyclic variation. In the figure above, the short distance is from 3 to 10 (a difference of 7). Therefore, our normal order is [3,4,7,10].

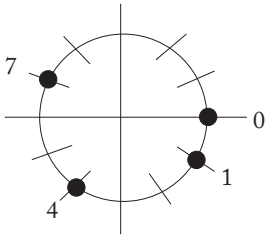
Another way to determine normal order is to look for the biggest gap between pitches. Again, that gap occurs between 10 and 3, so starting with element 3, normal order includes all elements of the set through 10.

Once you have determined the normal order, you must transpose the set so that it begins with zero in order to create the prime form. Transposition is created by renumbering element 3 as zero and reassigning each element based on the new position of zero. The dots do not move on the clock face, but the numbers that you assign them will change.

normal order

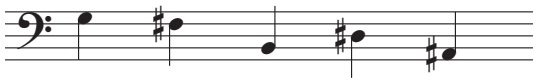


transposition

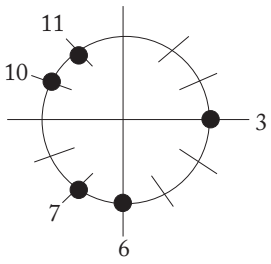


Through the process of transposition, the set becomes [0,1,4,7], which is Forte number 4-18. In general, using this method it is not necessary to go through the step of set inversion. Once you have determined the normal order, or shortest distance between adjacent elements, you may name your set by moving clockwise or counterclockwise around the circle, starting with either 10 or 3. You should choose the direction that places the smallest interval at the front end of the set. The choice between clockwise and counterclockwise is equivalent to choosing between the original and inverted forms of the set.

Here is an example of a cardinal-5 set for which prime form is determined using the same method.

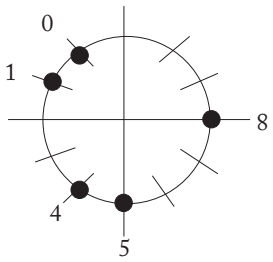


The elements of the set are plotted on the clock face and numbered.



It is easy to see that the greatest distance between elements is the gap between 11 and 3; therefore the shortest distance between any two elements is from 3 to11. Normal order can be established as [3,6,7,10,11].

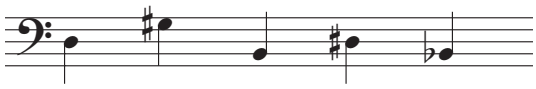
This set must now be transposed, and you must determine whether to invert the set. The two possible starting points are element 3 or 11. If you start with element 3, the smallest intervals in the set will be positioned at the end. This indicates that the set needs to be inverted. Instead of starting with 3, start with 11 and move counterclockwise around the circle. This positions the smallest intervals toward the front end of the set.

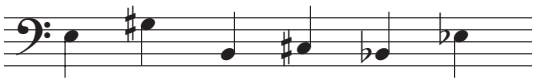


When transposed, the prime form becomes [0,1,4,5,8] and the Forte number of this set is 5-21.

With a little practice, it will be possible to do all of these steps at a glance and determine the prime form without numbering the clock face twice. For example, on the circle directly above, the biggest gap is between 0 and 8, so those are the only two starting places. The smallest interval occurs going counterclockwise, so place zero at the 11 o'clock position and number the dots. After that, all you will need is to search the table of Forte numbers for the correct label.

Here are two more sets with which to practice this method. Determine the prime form and Forte number for each set.





If you are interested in learning more about set theory, you should read *The Structure of Atonal Music,* by Allan Forte (New Haven: Yale University Press, 1977). This seminal work goes far beyond the basic concepts of set theory presented here and in Chapter 38. If you are interested in discovering how set theory can be applied to a large atonal composition, read *Berg's "Wozzeck": Harmonic Language and Dramatic Design,* by Janet Schmalfeldt (New Haven: Yale University Press, 1983). This book analyzes the Berg opera using set theory.