

Introduction to Reading Music

Homework 5 15-212, Fall 2006

This document introduces the basics of reading music. This is not meant to be complete, nor does it give an insight into how music notation is tied to the feel of music. It just provides sufficient background to enable you to complete this assignment. *If you are already familiar with music, we strongly recommend that you use your own reference for understanding the notation.*

Notes: Pitch, Duration and Tempo

At a very low-level, any piece of music is just a sequence of sounds that vary in pitch and duration. Each continuous sound of fixed pitch is called a **note**. Music is a sequence of notes. Each note has two defining characteristics: pitch and duration. For practical reasons, pitches and durations allowed in composed music are discrete.

The **pitch** of a note tells you how shrill a note is; it is represented by a pair of two elements: an **octave** and an **alphabet**. The octave is a natural number between 1 and 8. The alphabet is a letter from the ordered sequence $S = [C, D, E, F, G, A, B]$. Notes are ordered in increasing shrillness given by the lexicographic order (Octave, Alphabet). Observe that alphabets are not ordered in the usual order A-G, but they start from C and end at B. As an example, the note (2, G) has a lower pitch than (2, A) and (1, A) has a lower pitch than (2, C). The first few notes in increasing order of pitch are:

(1, C), (1, D), (1, E), (1, F), (1, G), (1, A), (1, B), (2, C), (2, D)...

Sometimes you want to have a note which has a pitch between the pitch of two consecutive notes in the above sequence. Such notes are represented using a **modifier**: a sharp (#) or a flat (b) sign. The note becomes a three-tuple (Octave, Alphabet, Modifier). The modifier # means a note which has a pitch midway between the given note and the one *above* it. Thus (1, C, #) is a note having pitch between (1, C) and (1, D). The modifier b denotes a note of pitch between the note and the one below it. Thus (1, D, b) is a note between (1, C) and (1, D). In fact (1, C, #) and (1, D, b) are the same note. For uniformity, we often make all notes three-tuples. If there is no modifier, we just write \natural (called natural) for the modifier.

Not every note can be sharpened or flattened. In music, E and B in any octave cannot be sharpened. Similarly, F and C cannot be flattened.¹ Thus in any octave n , there are twelve possible notes. In increasing order of pitch they are:

¹ This is not completely accurate. But for the purpose of this homework, it is alright to assume this.

(n, C, ♭), (n, C, ♯) = (n, D, ♭), (n, D, ♭), (n, D, ♯) = (n, E, ♭), (n, E, ♭), (n, F, ♭),
 (n, F, ♯) = (n, G, ♭), (n, G, ♭), (n, G, ♯) = (n, A, ♭), (n, A, ♭), (n, A, ♯) = (n, B, ♭), (n, B, ♭)

The **duration** of a note is represented by a fraction whose numerator is 1 and denominator is a power of 2. Valid note durations are 1, 1/2, 1/4, 1/8... In this assignment, we are concerned with notes of duration 1/64 or more. The duration of a note is only a measure of its *relative* length: a note of duration 1 is twice as long as a note of duration 1/2, which is twice as long as a 1/4 note etc. The most commonly used notes in music have durations 1/8 and 1/16. Sometimes we need notes of intermediate duration. This is done using the modifier “.” (period, without the quotes). A period after the duration of a note means that the note is 1.5 times as long. For example the duration 1/4. means a note of duration 1/4 + 1/8 = 3/8.

The absolute length of a note is determined by writing at the top of the music how long a particular note is. This is called a **tempo marking**. For example, a piece of music may say that there are 120 1/4th notes per minute. Then the duration of a 1/4 note is 0.5s, and hence a 1/2 note has duration 1s, a 1/8 note has duration 0.25s, etc.

Sheet Music

Music written as sequence of four-tuples (three for the pitch and one for the duration) is very hard to read. Most music is written in graphical format, often called sheet music. Just as children write English on 4-lined notebooks in elementary school, music is written on 5-lined sheets. Such a set of five lines is called a **Staff** (plural Staves or Staffs). Consecutive notes are written on these five lines one after the other much like consecutive alphabets of the English language. Here’s an example:



The duration of a note is represented by the *shape* used to write it. Here are the shapes used to represent notes of different durations:

Shape	Duration
○	1
♪	1/2
♪	1/4
♪	1/8
♪	1/16

1/32 and 1/64 notes are written like 1/8 and 1/16 notes with additional flags. The vertical line in notes of duration 1/2 and less may be drawn pointing upwards or downwards. If

there is a sequence of notes of duration $1/8$, it is commonly written by connecting them with a line:





Similarly, consecutive $1/16$ notes can be connected with *two* lines:



In complete analogy, $1/32$ and $1/64$ notes can be written with 3 and 4 lines respectively. The period (.) modifier on a note can be written as such in sheet music. For example, a note of duration $3/8$ can be written as ♩. . The modifier (\sharp , \flat , \natural) is written *before* the note.

If there is no modifier, it is assumed to be natural (\natural) by default.

The pitch of a note is represented by its position relative to the five lines on which it is written. There are several possible conventions for doing this. Such a convention is called a **Clef**. There are two common clefs in music: the **treble** clef and **bass** clef. The clef being used is indicated at the beginning of a staff. If a staff splits into multiple rows, it is written at the beginning of each row for the reader's convenience. The symbols used to denote the two clefs are the following:

Symbol	Clef
	Treble
	Bass

Here's our old music written with the treble clef symbol (ignore the $4/4$ after the clef symbol for the time being):



The rules for writing notes in both the treble and bass clefs are similar. Each note's circular portion is either exactly between two lines, or it is cut in half by exactly one line. On the treble clef, a note whose circular portion is exactly between the lowest two lines of the staff is (4, F) (the last note in the above example). The next higher position, a note whose circular portion is cut in half by the second line from the bottom is the next higher note (4, G) (second last note in the above music). The next higher position is a note whose circular portion lies between the second and third lines from the bottom of the staff and this denotes the note (4, A). This continues. If the pitch of a note runs beyond what can be represented on a staff, additional lines may be drawn above or below the standard five lines. Following this convention, the music written above denotes the following notes in sequence (the duration of each note is $1/4$ and the modifier is natural):

(6, C), (5, B), (5, A), (5, G), (5, F), (5, E), (5, D), (5, C), (4, B), (4, A), (4, G), (4, F)

The bass clef follows exactly the same rules as the treble clef except that a note whose circular portion lies between the lowest two lines is (2, A). If written with a bass clef symbol instead of the treble clef symbol, the above music would represent the pitches:

(4, E), (4, D), (4, C), (3, B), (3, A), (3, G), (3, F), (3, E), (3, D), (3, C), (2, B), (2, A)

Measures and Time Signatures

A typical 5 minute piece of music may contain several thousand notes. If written in a sequence one after the other, it may be very hard for a player to keep track of where she is at a particular point of time. Keeping the performer's convenience in mind, music is divided into sets of notes called **measures or bars**. Measure boundaries are indicated in music by vertical lines across the staff. For example, in the above music, there are three measures, each containing exactly 4 notes.

Each measure in a piece of music must have the same duration, i.e. if you add the durations of the notes in each measure, it must come out to be the same. This duration of each measure is called the **time signature**. It is written right after the clef symbol. For example, the time signature of the above piece of music is 4/4 or 1. Thus the duration of each measure must be 1. You can verify this easily: each measure in the above music has 4 notes of $1/4^{\text{th}}$ duration. Hence the total duration of each measure is 1. The time signature is written only once in the entire sheet (as opposed to clefs which are drawn on every row). Also note that the time signature above could have been written 2/2 instead of 4/4: it makes no difference.² Common time signatures are 4/4 (called common time, also written c), 2/2 (called cut time, also written like the American cent symbol), 2/4, 3/2, $3/4$, $3/8$, $6/8$ and $3/16$.

The modifier-measure convention: As a rule, if a particular note is sharpened or flattened, then the sharp or flat is assumed implicitly on the note till the end of the measure, or until another modifier appears on the same note. This reduces the number of modifiers written on a sheet.

Chords, Multiple Staves and Key Signatures

Chords. Very often in music, a single pitch does not produce the desired sound. In such cases, we can superimpose sounds by playing several notes together. Such a set of notes played simultaneously is called a chord. Chords are typeset by writing the notes of the chord one over the other on the same staff. All notes in a chord must have the same duration.

² 2/2 and 4/4 are the same for the purpose of this homework. In actual music, the time signature also indicates the rhythm of the music. In that sense, 2/2 and 4/4 are different.

Multiple Staves. In many cases, music is meant to be played simultaneously by many musicians, or in the case of piano, by a single musician with two hands. In such cases, there are multiple sequences of notes that must be played simultaneously independent of each other. Such music is typeset by writing several staves one below the other, one for each instrument or hand. Note that even though the staves represent independent lines of music and may be written using different clefs, they always have the same time signature.

Key Signatures. In many pieces of music, the same set of notes is always sharpened or flattened. For example, if you look at Beethoven's Ode to Joy all C's and F's in it are sharpened. Rather than writing a # sign before every C and F in the music, this is noted on the staff, right after the clef symbol. This is called a key signature. A key signature is simply represented by an alphabet in the set [C, D, E, F, G, A, B] along with a modifier (this is called the key of the music). You don't have to worry about key signatures in this assignment, except to parse them accurately.

Here's an example of music for Piano taken from Beethoven's Ode to Joy showing chords, two staves and key signatures:

Two staves: the upper one is the right hand, lower one is the left hand

Key signature: All C's and F's are sharpened

Chord: Two notes played simultaneously

Rests

Sometimes in music we want to induce silence for a fixed duration of time. This is technically called a **rest**. A rest is like a note in that it has a duration. It means that the artist should stop playing for the specified duration of time. Rests are very common in music with multiple staves because not all instruments (or hands) are playing at all times. Here is the notation for rests of different durations:



Rests are counted as notes when totaling the duration of notes in a measure.