JDUBIEL: A JAVA APPLET FOR PITCH-CLASS SET ANALYSIS

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ABSTRACT

Computer programs that facilitate analysis of atonal music are indispensable tools for music theorists. However, most of the programs currently available on the Web are limited to the derivation of T_n/T_nI types and interval vectors and basic twelve-tone operations and cannot handle rotational arrays of tone rows, transformational relations between pc-sets, and so on. By contrast, "JDubiel," written in Java, is platform-independent, easy to use, and ready for almost all analytical techniques employed in pc-set theory and transformational theory.

1. INTRODUCTION

Since pitch-class set analysis ("pc-set analysis" for short) involves a number of tedious, mechanical arithmetic calculations, it seems quite natural that many computer programs have been written to assist music theorists and composers.[1] Although Brinkman's programs[2] provide us with various useful functions, they utilize bit-map operations, which run faster with a trade-off of a lack of portability because of their reliance on hardware-specific features. Recent advances in microprocessors seem to make such an approach unnecessary. Castine[3] extended Brinkman's work and brought object-oriented features into his own program. His program, however, no longer runs on the latest platforms. The Humdrum Toolkit, developed by Huron[6], is perhaps the most versatile and comprehensive software package for music research. It requires, however, basic shell commands and seems to have a rather steep learning curve. "Macset," written by Kuuskankare, Castrén, and Laurson[7], seems to be a highly comprehensive program but is currently not available online. Other currently available programs include: Frans Absil[1], Jay Tomlin[14], Andreas Helmberger[5], Marcus Uneson[15]. Most of these are limited to the derivation of T_n/T_nI types, or classes of transpositionally or inversionally equivalent pc-sets, and interval contents of given pc-sets. Music theorists and composers today need some other

functions as well to apply analytical and compositional techniques developed by Forte[4], Lewin[8], Morris[10], and Rahn[11]. In short, we still need a computer program that is platform-independent, easy to use, and ready for all analytical techniques employed in current pitch-class set theory and transformational theory. For these reasons, I have developed "JDubiel."[2] Since the Internet is a common research tool among music theorists, JDubiel is written as a Java applet so that it is platform-independent and can easily be used on a Web browser by those theorists and composers who are unfamiliar with UNIX commands and shell programming.

2. THE MENU HIERARCHY OF JDUBIEL

Music theorists analyzing atonal compositions usually try to find properties of pc-sets, relations between pc-sets or tone rows, and so on repeatedly and switch back and forth between a program for analysis and a text editor a number of times. It seems, therefore, desirable for JDubiel to consist of separate, small windows each of which is dedicated to a family of similar functions.

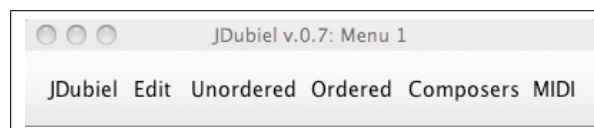When JDubiel is launched, the main menu window, as in Figure 1, shows up.

Figure 1. JDubiel Main Menu.

Pull-down menu "JDubiel" has submenus "About," "Acknowledgments," "Help," and "License" and pull-down menu "Edit" has the standard "Cut," "Copy," and "Paste." "MIDI" capabilities are not yet implemented. All the functionality for pc-set analysis is provided in the windows launched through submenus in "Unordered," "Ordered," and "Composers" pull-down menus. The menu hierarchy is shown in Table 1. Brief descriptions of functions available in those windows are given in Section 3.

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[1] Pc-set analysis employs analytical methods developed in pitch-class set theory. Pc-set theory is a powerful representation scheme that facilitates notational economy and taxonomies of pitch materials and very useful for finding properties of and relations between pc-sets. Rahn[11] is an excellent textbook on pc-set theory.

[2] JDubiel is available online at: `http://music.columbia.edu/~akira/JDubiel/`. JDubiel is named after Prof. Joseph Dubiel of Columbia University, with whom I was privileged to study pitch-class set theory. Joe generously granted me permission to use his name.

Main menu	Submenu 1	Submenu 2
Unordered	Properties	
	Relations	
n	Lists	
	Tables of T_n/T_nI Types	Trichords
		Tetrachords
		Pentachords
		Hexachords
		Septachords
		Octachords
		Nonachords
Ordered	Relations	
	Lists	
	Twelve-Tone Operations	
Composers	Stravinsky	
	Schoenberg	
	Webern	
	Berg	

Table 1. List of Pull-Down Menus.

3. THE FUNCTIONALITY OF JDUBIEL

3.1. "Unordered"

3.1.1. "Properties"

With a "Properties" window, one can find, as Figure 2 shows, various properties of a given pc-set. In this particular example, the window shows properties of C harmonic minor scale, {0,2,3,5,7,8,B}, as an unordered pc-set.[3] Every application for pc-set analysis currently available on the Web has similar capabilities.

Figure 2. Properties of the Harmonic Minor Scale.

3.1.2. "Relations"

In this window, one can find inclusion and transformational relations between any unordered pc-sets. For example, Fig-

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ure 4 shows that the pc-set in the third measure from Schoenberg's *Drei Klavierstücke* op.11/1 (see Figure 3)

Figure 3. Schoenberg's *Drei Klavierstücke* op.11/1.

{A,9,1,5,4}, 5-22, is a subset of D harmonic minor scale, that is, C harmonic minor scale {0,2,3,5,7,8,B} by T_2.[4]

Figure 4. Relations between Two Unordered PC-Sets.

3.1.3. "Lists"

Figure 5 shows invariants of {0,2,3,5,7,8,B}, that is, C harmonic minor scale, under T_1 through T_{11} and T_1I through $T_{11}I$.[5]

3.1.4. "Tables of T_n/T_nI Types"

One can copy and paste pc-sets and interval vectors listed in the Tables of T_n/T_nI Types windows of trichords, tetrachords, pentachords, hexachords, septachords, octachords, and nonachords to other windows (see Figure 6).

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[3]"0" is assigned to pitch-class C and base-12 is employed throughout this paper.

[4]Refer to Forte[4] for the list of the names of pc-sets such as 5-22.

[5]"Invariants" are the members of the subset of a pc-set that remain unchanged under transposition or inversion.

3.2. "Ordered"

In addition to the same functions as those provided by the "Unordered" family, "Ordered" ones offer those for rotations, retrograde forms, and matrices of sequences and operations dealing with P-, R-, I-, RI-, and IR-rotational arrays and four-part arrays of tone rows. Array-related functions are demonstrated in the following section.
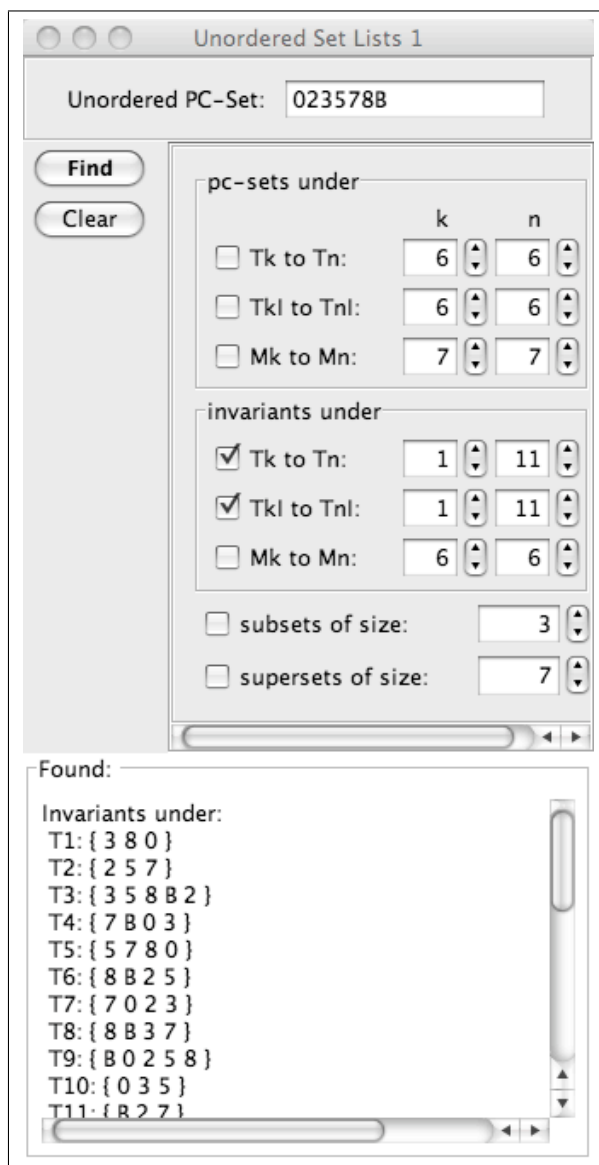
Figure 5. Invariants of a PC-Set under Transformations.

3.3. "Composers"

"Composers" menu consists of "Stravinsky," "Schoenberg," "Webern," and "Berg" windows, which store the complete

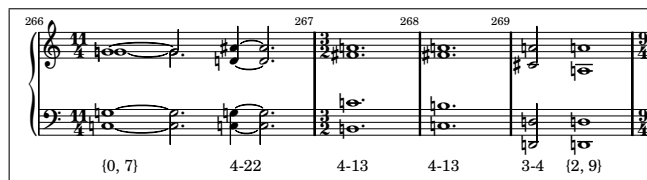**Figure 6**. List of T_n/T_nI Septachords.

Figure 7. The First Four Measures from "Libera me."

lists of the twelve-tone rows employed by these composers.[6] With these windows, one can perform analyses that are otherwise hard to be done. For example, although Spies[12] observes:

> The four-part simultaneities in the "Libera me" [from Stravinsky's *Requiem Canticles*] are as difficult (or impossible) to relate to the serial chart as the eight, seven, five, and four-factor whole-note chords in the "Postlude." (120)

With the aid of JDubiel, one can successfully identify the affiliations of most chords, pc-sets, hexachords, and series forms in Stravinsky's twelve-tone compositions. As Straus [13] points out, Stravinsky chose tone row $< 50B9A2138647 >$ for "Libera me" (see Figure 7). Figure 8 shows that pc-set 4-13, or $\{B,0,6,9\}$, in the second measure is derived from the second half of the tone row, that is, hexachord $< 138647 >$, by T_5 and the first half, $< 50B9A2 >$, by $T_{11}I$.

4. CONCLUSION

I have developed a new software tool that can handle most analytical techniques employed in pc-set theory. At the next development stage, because exhaustive data collection is crucial for pc-set analysis, JDubiel should allow theorists to do

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[6]I owe the list of those tone rows to London, von Hippel, Huron, Cartano, Kingery, Olsen, and Santelli[9].

faster data entry and some capabilities to incorporate staff notation such as those found in Macset[7] should be implemented.
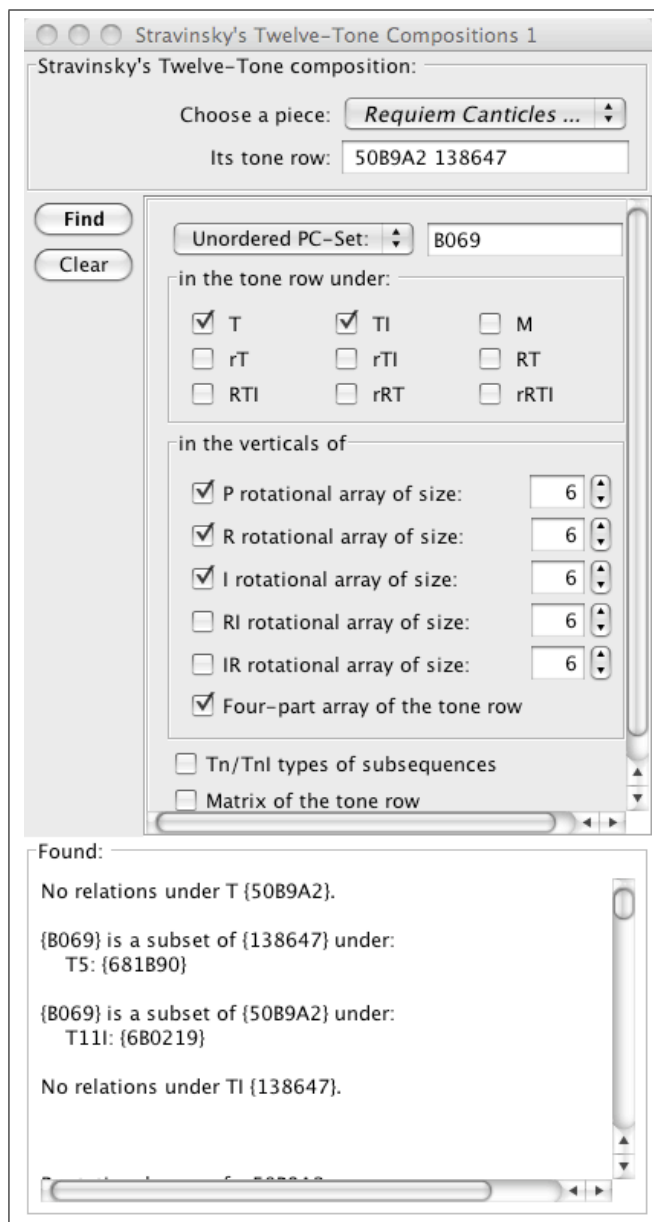

Figure 8. The Series Forms Used for "Libera me."

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