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"Name That Tune" – Writing Music with SAS®

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ABSTRACT

Writing music with SAS® is a simple process. Including a snippet of "music" in a program is a great way to signal completion of processing. It's also fun! This paper illustrates a method for translating music into SAS® code using the CALL SOUND routine.

BACKGROUND

All musical notes are based on two primary parameters:

- Frequency
- Duration

The CALL SOUND routine generates a sound with a specific frequency and duration using the following syntax:

- CALL SOUND(frequency,duration);
- Required arguments:
  - frequency – specifies the sound frequency in terms of cycles per second. The frequency must be at least 20 and no greater than 20,000.
  - duration – specifies the sound duration in milliseconds. The default is -1.

Example:

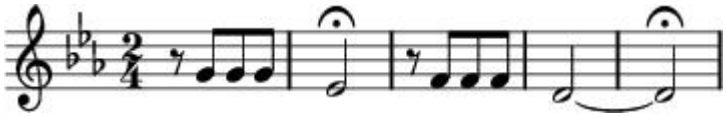
- The following statement will play "middle C" for 2 seconds:

```
data _null_;
  call sound(261.63,2000);
run;
```

Refer to Exhibit 1 for the frequencies for nine octaves of notes.

EXAMPLE

The Symphony No. 5 in C minor by Ludwig van Beethoven, Op. 67 is one of the best-known compositions in classical music. It begins with a distinctive four-note "short-short-short-long" motif twice:



In the first measure, the G note is played three times, followed by E flat in the second measure. In the third measure, the F note is played three times followed by D which is sustained for two measures. Translating these notes to the CALL SOUND routine is a straight forward look-up from the table in Exhibit 1, recalling that middle C (which is highlighted in the table) is 261.63 Hz. After entering the frequency value for each note, enter values for duration, keeping in mind that musical note and rest values are not absolutely defined, but are proportional in duration to all other note and rest values. The whole note is the reference value, and the other notes are named in comparison; i.e., a half note is half the length of a whole note.

In the five measures above, we have the following sequence of notes:

- Three G **eighth** notes
- E flat **half** note, with a pause accent symbol above it
- Three F **eighth** notes
- D **half** note, sustained for two measures with a pause

For this piece of music we will define note durations as follows:

Note	Milliseconds
Whole	1000
Half	500
Eighth	125
Sixteenth	62.5

Using this table as a starting point, and by applying some "artistic license", we make duration assignments as follows:

- Three G **eighth** notes: 125 millisecond duration for each
- E flat **half** note, with a pause accent symbol above it: Typically 500 milliseconds, but we will extend it to 1200 milliseconds based on the "pause" notation.
- Three F **eighth** notes: 125 millisecond duration for each
- D **half** note, sustained for two measures with a pause: Typically 500 milliseconds, but we will extend to a total of 1600 milliseconds based on the "pause" notation.

Here's what the SAS® statements look like:

```
* Beethoven:  Symphony No.5 in C Minor ;
data _null_;
   call sound(392, 125);
   call sound(392, 125);
   call sound(392, 125);
   call sound(311.13, 1200);

   call sound(349.23, 125);
   call sound(349.23, 125);
   call sound(349.23, 125);
   call sound(293.66, 1600);
run;
```

See Exhibit 2 for more examples.

CONCLUSION

This brief introduction to a simple coding technique is intended to encourage SAS programmers to have a little fun. You don't need to know how to read music to experiment with adding some "tone" to your programs. Just use your ear and tweak the code until it sounds right. Give it a try!

REFERENCES

Suits, B. H. "Frequencies for equal-tempered scale, A_4 =440 Hz." Available at http://www.phy.mtu.edu/~suits/notefreqs.html.

CONTACT INFORMATION

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Exhibit 1

Table of Musical Notes and Frequencies

Note	Frequency (Hz)	Note	Frequency (Hz)	Note	Frequency (Hz)
C_0	16.35	C_3	130.81	C_6	1046.50
$C^{\#}_0/D^{b}_0$	17.32	$C^{\#}_3/D^{b}_3$	138.59	$C^{\#}_6/D^{b}_6$	1108.30
D_0	18.35	D_3	146.83	D_6	1174.66
$D^{\#}_0/E^{b}_0$	19.45	$D^{\#}_3/E^{b}_3$	155.56	$D^{\#}_6/E^{b}_6$	1244.51
E_0	20.60	E_3	164.81	E_6	1318.51
F_0	21.83	F_3	174.61	F_6	1396.91
$F^{\#}_0/G^{b}_0$	23.12	$F^{\#}_3/G^{b}_3$	185.00	$F^{\#}_6/G^{b}_6$	1479.98
G_0	24.50	G_3	196.00	G_6	1567.98
$G^{\#}_0/A^{b}_0$	25.96	$G^{\#}_3/A^{b}_3$	207.65	$G^{\#}_6/A^{b}_6$	1661.22
A_0	27.50	A_3	220.00	A_6	1760.00
$A^{\#}_0/B^{b}_0$	29.14	$A^{\#}_3/B^{b}_3$	233.08	$A^{\#}_6/B^{b}_6$	1864.66
B_0	30.87	B_3	246.94	B_6	1975.53
C_1	32.70	C_4	261.63	C_7	2093.00
$C^{\#}_1/D^{b}_1$	34.65	$C^{\#}_4/D^{b}_4$	277.18	$C^{\#}_7/D^{b}_7$	2217.46
D_1	36.71	D_4	293.66	D_7	2349.32
$D^{\#}_1/E^{b}_1$	38.89	$D^{\#}_4/E^{b}_4$	311.13	$D^{\#}_7/E^{b}_7$	2489.02
E_1	41.20	E_4	329.63	E_7	2637.02
F_1	43.65	F_4	349.23	F_7	2793.83
$F^{\#}_1/G^{b}_1$	46.25	$F^{\#}_4/G^{b}_4$	369.99	$F^{\#}_7/G^{b}_7$	2959.96
G_1	49.00	G_4	392.00	G_7	3135.96
$G^{\#}_1/A^{b}_1$	51.91	$G^{\#}_4/A^{b}_4$	415.30	$G^{\#}_7/A^{b}_7$	3322.44
A_1	55.00	A_4	440.00	A_7	3520.00
$A^{\#}_1/B^{b}_1$	58.27	$A^{\#}_4/B^{b}_4$	466.16	$A^{\#}_7/B^{b}_7$	3729.31
B_1	61.74	B_4	493.88	B_7	3951.07
C_2	65.41	C_5	523.25	C_8	4186.01
$C^{\#}_2/D^{b}_2$	69.30	$C^{\#}_5/D^{b}_5$	554.37	$C^{\#}_8/D^{b}_8$	4434.92
D_2	73.42	D_5	587.33	D_8	4698.63
$D^{\#}_2/E^{b}_2$	77.78	$D^{\#}_5/E^{b}_5$	622.25	$D^{\#}_8/E^{b}_8$	4978.03
E_2	82.41	E_5	659.25	E_8	5274.04
F_2	87.31	F_5	698.46	F_8	5587.65
$F^{\#}_2/F^{b}_2$	92.50	$F^{\#}_5/G^{b}_5$	739.99	$F^{\#}_8/G^{b}_8$	5919.91
G_2	98.00	G_5	783.99	G_8	6271.93
$G^{\#}_2/A^{b}_2$	103.83	$G^{\#}_5/A^{b}_5$	830.61	$G^{\#}_8/A^{b}_8$	6644.88
A_2	110.00	A_5	880.00	A_8	7040.00
$A^{\#}_2/B^{b}_2$	116.54	$A^{\#}_5/B^{b}_5$	932.33	$A^{\#}_8/B^{b}_8$	7458.62
B_2	123.47	B_5	987.77	B_8	7902.13

Exhibit 2

Examples

Note: A simple method for inserting a rest (i.e., an interval of “silence) into a piece of music is to select a very high or low frequency that the human ear cannot hear, as you can see in several of the examples below.

```
* Deep Purple:  Smoke on the Water ;
data _null_;
   call sound(196, 300);
   call sound(233.08, 300);
   call sound(261.63, 600);

   call sound(196, 300);
   call sound(233.08, 300);
   call sound(277.18, 150);
   call sound(261.63, 600);

   call sound(196, 300);
   call sound(233.08, 300);
   call sound(261.63, 600);
   call sound(233.08, 300);
   call sound(196, 900);
run;


* George Thorogood:  Bad To the Bone ;
data _null_;
   call sound(440, 100);
   call sound(440, 100);
   call sound(587.33, 100);
   call sound(440, 100);
   call sound(523.25, 100);
   call sound(440, 800);

   call sound(440, 100);
   call sound(440, 100);
   call sound(587.33, 100);
   call sound(440, 100);
   call sound(523.25, 100);
   call sound(440, 800);

   call sound(440, 100);
   call sound(440, 100);
   call sound(587.33, 100);
   call sound(440, 100);
   call sound(523.25, 100);
   call sound(440, 800);
run;
```

```
* Cream:  Sunshine of Your Love ;
data _null_;
   call sound(587.33, 150);
   call sound(587.33, 150);
   call sound(523.25, 150);
   call sound(587.46, 300);

   call sound(440, 300);
   call sound(415.30, 300);
   call sound(392, 300);

   call sound(587.33, 150);
   call sound(698.46, 500);
   call sound(587.33, 300);
run;


* Queen:  We Will Rock You ;
data _null_;
   call sound(392, 400);
   call sound(369.99, 400);
   call sound(329.63, 400);
   call sound(293.96, 400);
   call sound(329.63, 200);
   call sound(329.63, 200);
   * pause - note you cannot hear ;
   call sound(16.35, 1200);


   call sound(392, 400);
   call sound(369.99, 400);
   call sound(329.63, 400);
   call sound(293.96, 400);
   call sound(329.63, 200);
   call sound(329.63, 200);
   call sound(16.35, 1200);


   call sound(392, 400);
   call sound(369.99, 400);
   call sound(329.63, 400);
   call sound(293.96, 400);
   call sound(329.63, 200);
   call sound(329.63, 200);
run;


* Shania Twain:  Man! I Feel Like a Woman! ;
data _null_;
   call sound(440, 200);
   call sound(440, 400);
   call sound(440, 150);
   call sound(369.99, 300);
   call sound(329.63, 200);
   call sound(440, 200);
   call sound(440, 300);
run;
```

```
* AC/DC:  Highway To Hell ;
data _null_;
   call sound(440, 200);
   call sound(440, 200);
   call sound(440, 600);

   call sound(369.9, 200);
   call sound(369.2, 200);
   call sound(392, 400);

   call sound(369.9, 200);
   call sound(369.2, 200);
   call sound(392, 400);

   call sound(369.9, 200);
   call sound(369.2, 200);
   call sound(392, 400);

   call sound(369.9, 200);
   call sound(440, 200);
   call sound(440, 600);
run;


* Beatles:  She Loves You ;
data _null_;
   call sound(587.33, 100);
   call sound(659.25, 200);
   call sound(783.99, 200);
   call sound(783.99, 400);
   call sound(739.99, 300);
   call sound(659.25, 400);
   * pause - note you cannot hear ;
   call sound(16.35, 15);

   call sound(587.33, 100);
   call sound(659.25, 200);
   call sound(783.99, 200);
   call sound(783.99, 400);
   call sound(739.99, 300);
   call sound(659.25, 400);
   * pause - note you cannot hear ;
   call sound(16.35, 15);

   call sound(587.33, 100);
   call sound(659.25, 200);
   call sound(783.99, 200);
   call sound(783.99, 400);
   call sound(739.99, 400);
   call sound(659.25, 400);
   call sound(587.3, 1000);
run;
```

```
* Led Zeppelin:  Immigrant Song ;
data _null_;
   call sound(369.99, 100);
   call sound(369.99, 50);
   call sound(369.99, 50);
   call sound(739.99, 100);
   call sound(369.99, 100);
   call sound(369.99, 50);

   call sound(369.99, 100);
   call sound(369.99, 50);
   call sound(369.99, 50);
   call sound(739.99, 100);
   call sound(369.99, 100);
   call sound(369.99, 50);

   call sound(369.99, 100);
   call sound(369.99, 50);
   call sound(369.99, 50);
   call sound(739.99, 100);
   call sound(369.99, 100);
   call sound(369.99, 50);

   call sound(369.99, 100);
   call sound(369.99, 50);
   call sound(369.99, 50);
   call sound(739.99, 100);
   call sound(369.99, 100);
run;


* Led Zeppelin:  Stairway To Heaven ;
data _null_;
   call sound(880, 200);
   call sound(1046.56, 200);
   call sound(1318.51, 200);
   call sound(1760, 200);
   call sound(1975.53, 800);
   call sound(1975.53, 200);
   call sound(2093, 800);
   call sound(2093, 200);
   call sound(1479.98, 800);
   call sound(1396.91, 200);
   call sound(1318.51, 200);
   call sound(1046.56, 200);
   call sound(880, 400);
   call sound(1318.51, 200);
   call sound(1046.56, 200);
   call sound(880, 200);
   call sound(783.99, 200);
   call sound(880, 200);
   call sound(880, 1200);
run;
```