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Harmonic Scale Transformations

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Abstract

My artwork derives from a project to delineate the transformations certain types of harmonic musical scales undergo as the sizes of their generating intervals vary over the space of the octave.

Keywords

computer graphics, music theory

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Harmonic Scale Transformations

John H. Chalmers

My artwork derives from a project to delineate the transformations certain types of harmonic musical scales undergo as the sizes of their generating intervals vary over the space of the octave. For example, the C Major scale of Western music consists of three major triads on the first (C), fourth (F) and fifth (G) degrees and minor triads on E, A, and in some tunings also D. In conventional theory, this scale is written as C D E F G A B c or 0 200 400 500 700 900 1100 1200 cents , but in my program, it is defined as 0 2D-1200 M 1200-D D M-D D+M 1200, where M is the size of the third, D the fifth. If one keeps D at 700 cents and lets M get smaller, this scale transforms first into a Neutral scale (0 200 350 500 700 850 1050 1200 cents, very similar to those used in Near Eastern music, and then into the Natural Minor scale C D Eb F G Ab Bb c (0 200 300 500 700 800 1000 1200 cents).

One can treat all other scales composed of major and minor triads similarly while letting the D and M values vary freely within the octave. My art consists of plotting various functions defined on these scales in the D x M plane. Once the database of transformed scales is made, the computer then calculates various functions at every pair of D and M values and plots the results in color. The colors are chosen by the computer from a pre-selected palette so that inversionally related transformations are the same color.

My program is written in TrueBasic and comprises around 30,000 lines of code, most of which are devoted to scale definitions. For each scale analyzed, about a dozen functions of the intervals are computed and plotted or tabulated. For more information about this study, you are more than welcome to contact me at jhchalmers@ucsd.edu.

Figure 1: The Major scale.

This is one of the simpler plots generated by my program. The major scale is expressed as described above. The D axis is horizontal and the M vertical and both run from 0 to 1200 cents. The familiar piano tuning lies near the middle of blue field that is next to the red one in the lower half of the diagram. The colored fields correspond to the 32 melodic transformations that the major scale undergoes as the values of D and M vary.

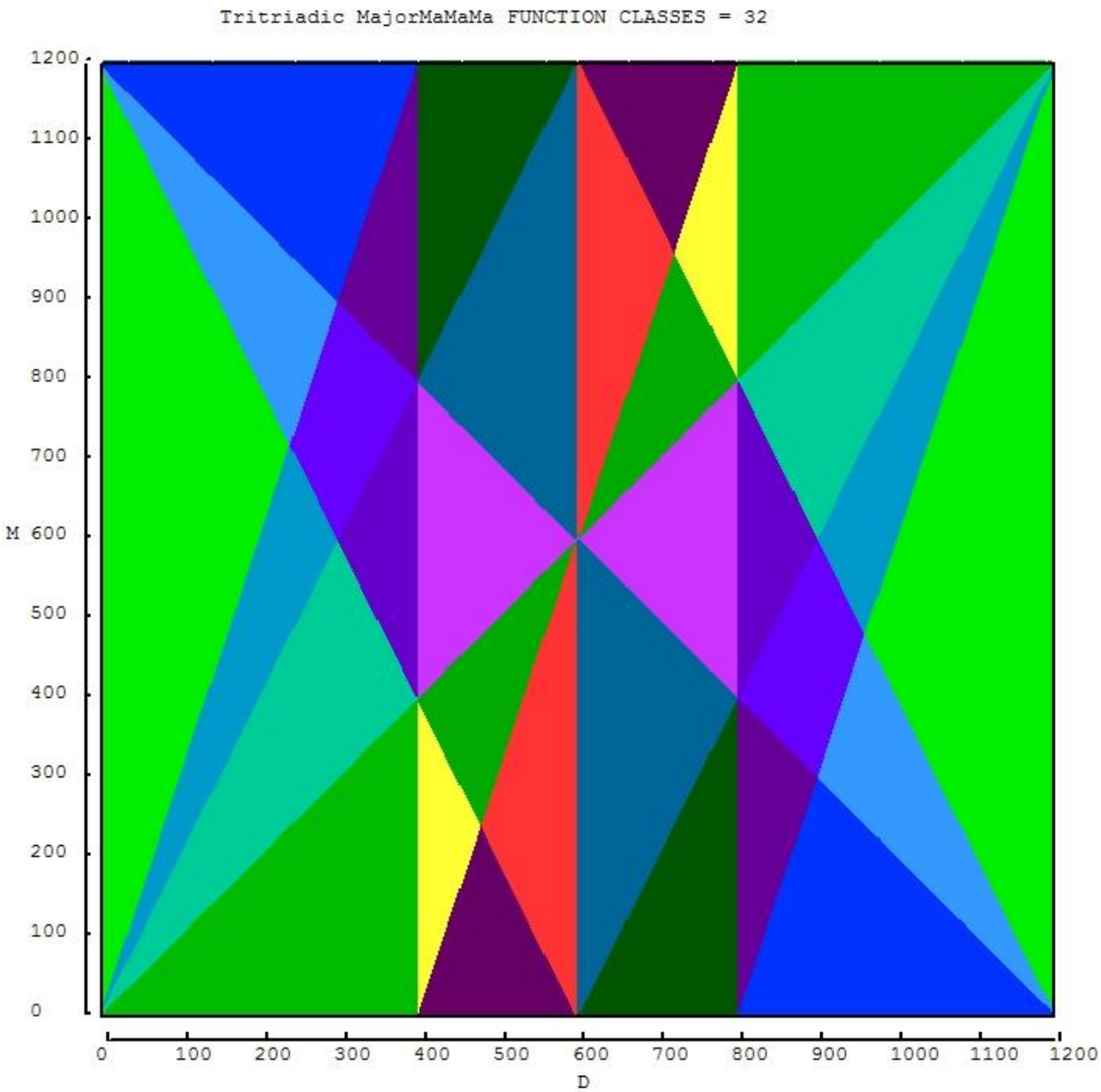
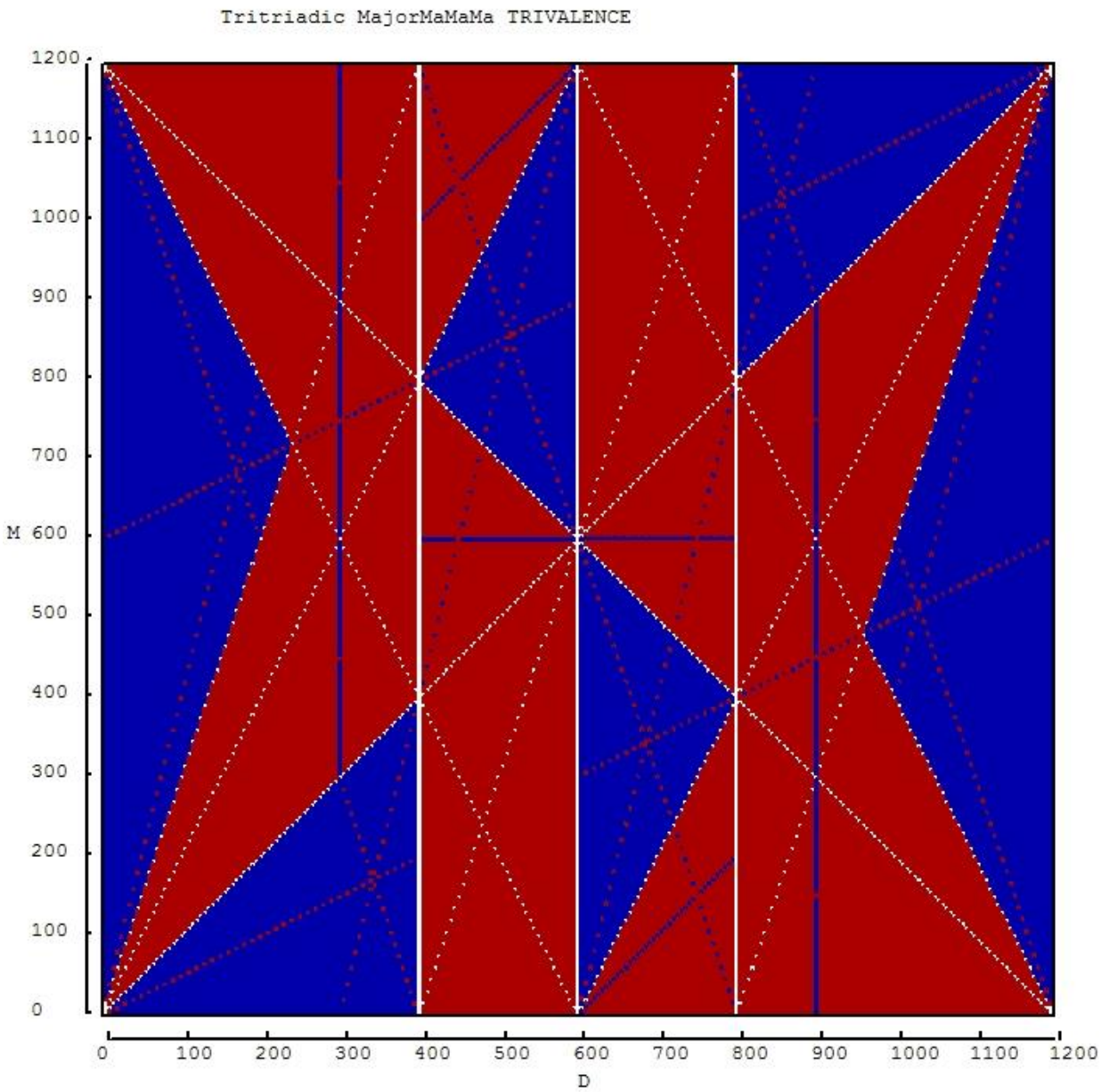
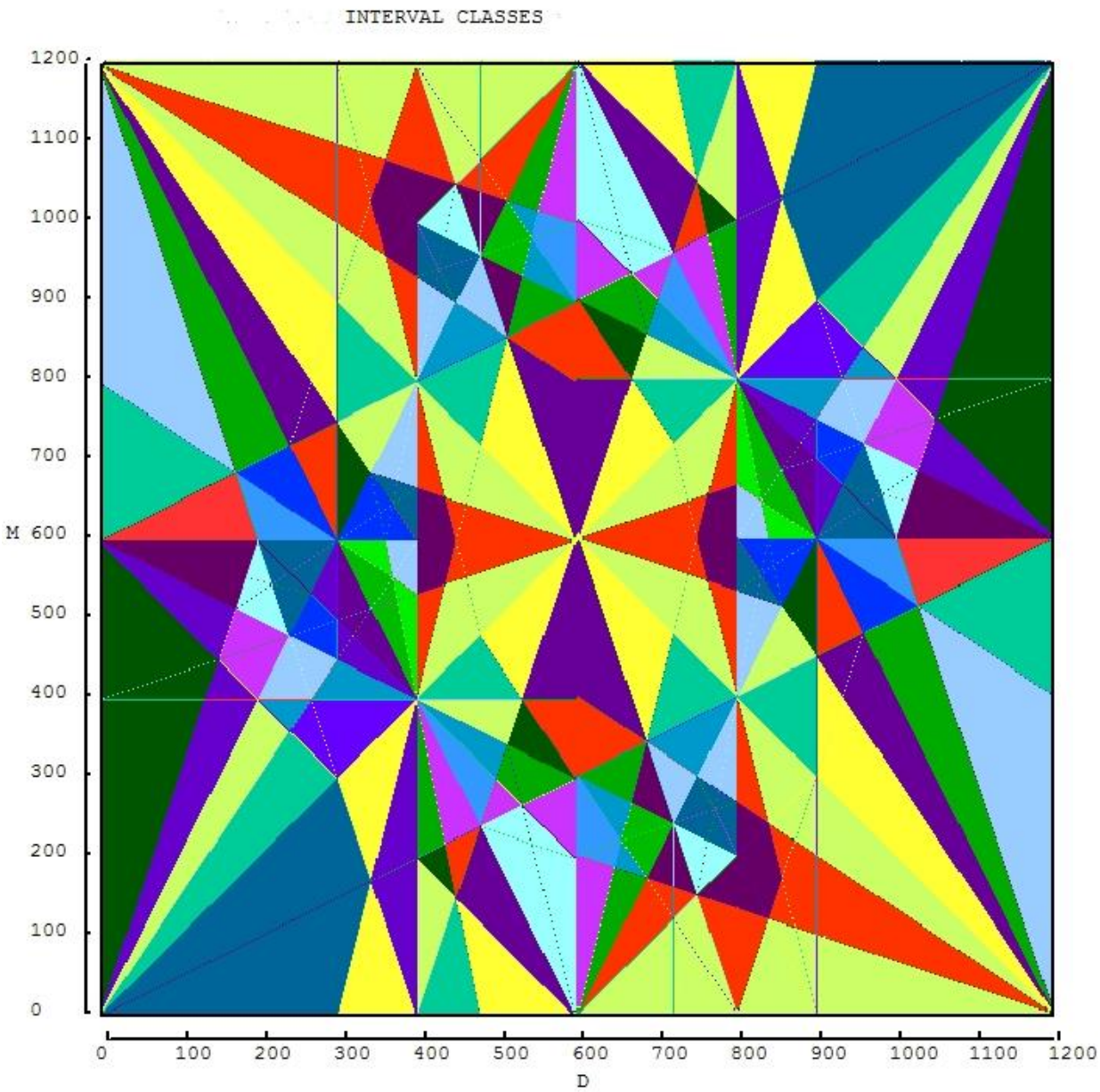


Figure 2: Trivalence of the Major Scale



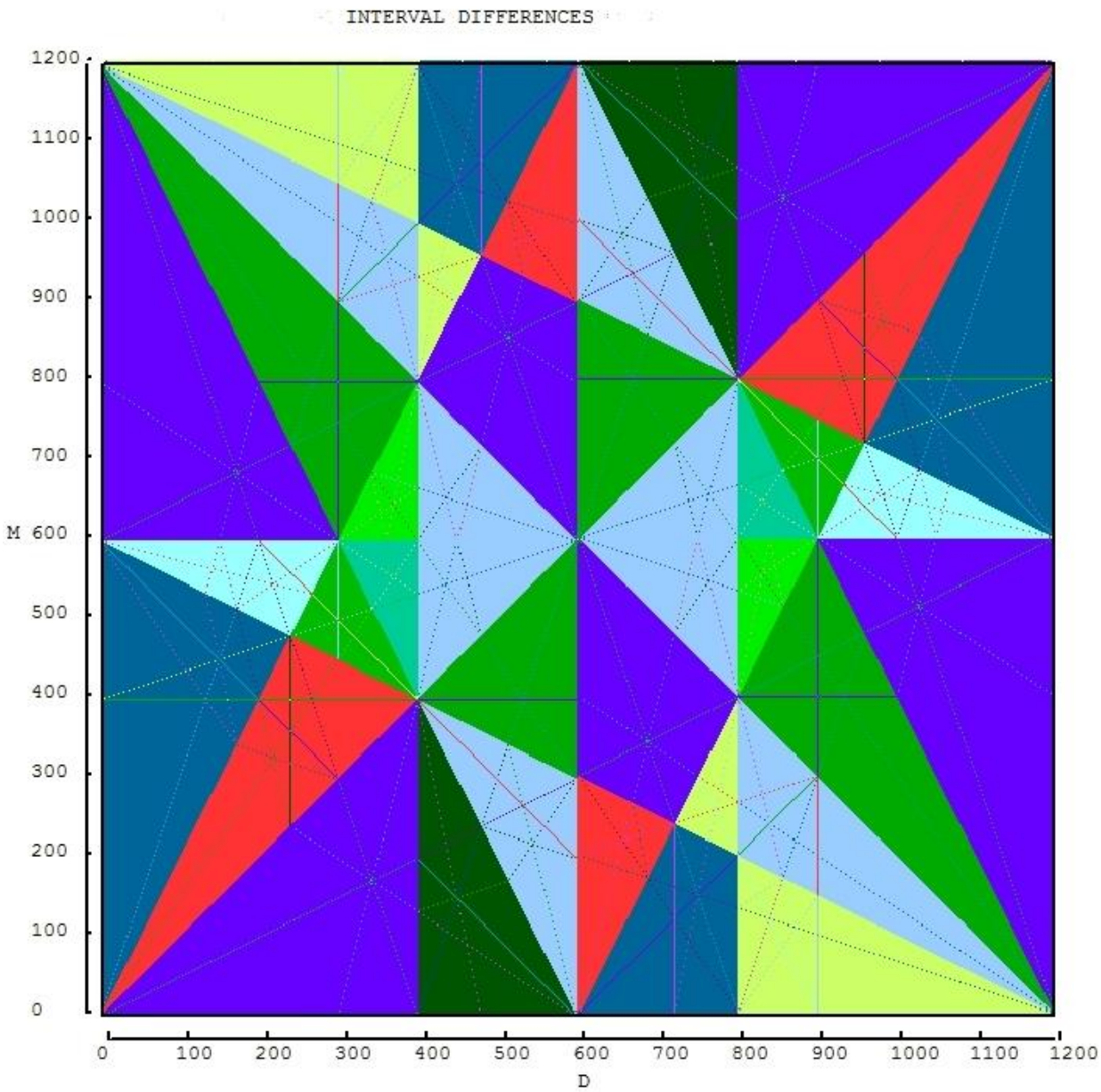
In this visually striking plot, the blue regions are those in which the transformed scale as defined above has three values for each interval class. That means that there are three sizes of 2nds, three sizes of 3rds, etc. for each of the interval classes. Furthermore, the blue regions correspond to the regions in the first plot where the triads of the transformed scale have constant melodic structures---two thirds (a major and a minor), two fourths, etc. The red zones are transformed tunings without this melodic constancy and presumably would be less useful in composition. This plot is at lower resolution to better show the fine structure and has the coordinates added.

Figure 3: Interval Classes of the Harmonic Minor Scale



This is one of my most popular plots. The Harmonic Minor is a Natural Minor scale in which the seventh degree is raised to a semitone from the tonic. In my functional notation it is 0 2D D-M 1200-D D 1200-M D+M 1200 cents. This plot expresses the number of intervals of different sizes as a function of D and M.

Figure 4: Interval Differences of the Harmonic Minor Scale



This plot depicts the number of differences between the intervals at each point in the D x M space.