The Fractal Nature of Human Music

At the very beginning of/first day's lecture for this course, I posed the question: What ***is*** human music? Is it "just" an aesthetically pleasing ***sequence*** of tones, with some kind of rhythm/beat to it? If so, precisely ***why*** is a rhythmic ***sequence*** of musical tones aesthetically pleasing to our ears? Or, is our human music just some kind of "***auditory cheesecake***"?

We have discussed ***some*** of the underlying aspects of human music over the course of the semester – that our music is "anthropocentric" in nature (since we humans are primarily interested in our own species – just as ***all*** creatures living on this planet are primarily interested in ***their*** own species) – and that the sequences of musical notes associated with human music, with its consonant {and dissonant} tonal combinations, our musical scale(s) with their associated frequency intervals between successive notes do indeed reflect (and are derived from) the integer-related $f_n = nf_1$ harmonic content of the ***human voice***, which, in turn arises from the 1-D mechanical vibrational nature of the eigen-modes of the human vocal chords. The musical instruments that we humans have developed over the millennia artistically mimic the human voice (some instruments to a greater degree than others…); the temporal aspects of human music anthropocentrically and artistically reflect our own internal ***human rhythms*** – *e.g*. heartbeat / pulse, breathing, running/walking, *etc*. via artistic use of the percussion family of musical instruments in our music…

However, the nature of human music goes even ***deeper*** than just these aspects…

Over ~ the past century or so, there has been a "quiet" (*i.e*. under-appreciated) revolution in our understanding of the nature of a wide range of physical phenomena in our universe. There currently exists an already lengthy and steadily-growing list of processes that exhibit non-trivial temporal correlations – *i.e*. that the instantaneous state of a system in the ***here-and-now*** is dependent on what happened in the ***past***, and whatever happened in the ***past*** will also indeed have an effect on the system in the ***future***. However, such dynamical processes are not ***purely*** deterministic, but instead have intrinsic "noise" fluctuations associated with them.

Some examples of physical systems exhibiting $1/f$ noise are numerous electrical components, from vacuum tubes, carbon-composition resistors, op-amps, thin films, to giant magneto-resistance sensors/transducers, as well as terrestrial weather patterns (*e.g*. rainfall, annual flooding of the Nile River, ocean surface temperatures…), astrophysical phenomena (*e.g*. sunspots, cosmic microwave background, *x*-ray emission from Seyfert galaxies (thought to contain super-massive black holes at their centers), the interplanetary magnetic field), the geophysical record of the earth, earthquakes, agriculture (*e.g*. fluctuations in annual crop yields), chemical reactions, phase transitions, radioactive decays, optical systems (*e.g*. photon counting, lasers), traffic flow, financial transactions, signals in ***myelinated*** nerves, heartbeat, EEG… as well as $1/f$ noise – long-range temporal correlations in human music – in pitch (frequency), amplitude (volume/loudness) as well as tempo/rhythm (phase)!