Model Equations for the music project

I. MODEL EQUATIONS

We study N musical compositions ($i = 1, 2, \ldots, N$) at the time intervals for each musical composition t: $0 \leq t_{ij} \leq T_i$.

Then we divide the maximal time interval with the maximal T_i into M small parts.

Then we have the time steps for each musical composition i: $(0, t_{i1})$, (t_{i1}, t_{i2}), $\ldots$, $(t_{i(M-1)}, t_{iM})$. We emphasize that $t_{iM} = T_i$.

We represent each ith musical composition as a trajectory is the three-dimensional space $\overrightarrow{r}_i = \overrightarrow{r}_i(t)$, which can be represented as $x_i = x_i(t)$, $y_i = y_i(t)$, $z_i = z_i(t)$. We assume $\overrightarrow{r}_i(t) = (x_i(t), y_i(t), z_i(t))$.

We assume that we have L characteristic properties of musical composition: C_l; where $l = 1, \ldots, L$.

In this case, each jth point in the ith trajectory, corresponding to the ith musical composition, can be represented as

$$x_i(t_{ij}) = \sum_{l=1}^{L} p_{ilx}(t_{ij}) C_l; \qquad y_i(t) = \sum_{l=1}^{L} p_{ily}(t_{ij}) C_l; \qquad z_i(t) = \sum_{l=1}^{L} p_{ilz}(t_{ij}) C_l, \tag{1}$$

where $j = 1, 2, \ldots, M$. The coefficients $0 \leq p_{ilx}(t_{ij}) \leq 1$, $0 \leq p_{ily}(t_{ij}) \leq 1$, $0 \leq p_{ilz}(t_{ij}) \leq 1$ represent the relative contribution of the characteristic property C_l into the components x, y, and z correspondingly for the musical composition i during the time intervals $(t_{i(j-1)}, t_{ij})$. The coefficients $0 \leq p_{ilx}(t_{ij}) \leq 1$, $0 \leq p_{ily}(t_{ij}) \leq 1$, $0 \leq p_{ilz}(t_{ij}) \leq 1$ have to be defined from the known N compositions.

In this case we generate the new generated musical composition R, represented by the following trajectory:

$$x_R(t_j) = \sum_{l=1}^{L} P_{Rlx}(t_{Rj}) C_l; \qquad y_R(t) = \sum_{l=1}^{L} P_{Rjy}(t_{Rj}) C_l; \qquad z_R(t) = \sum_{l=1}^{L} P_{Rlz}(t_{Rj}) C_l, \tag{2}$$

where $P_{Rlx}(t_{Rj})$, $P_{Rly}(t_{Rj})$, $P_{Rlz}(t_{Rj})$ are the expectations of the coefficients $p_{ilx}(t_{ij})$, $p_{ily}(t_{ij})$, $p_{ilz}(t_{ij})$ for each characteristic property C_l during the time interval $(t_{R(j-1)}, t_{Rj})$, for x, y, and z components of the trajectory for the new generated musical composition R. The expectations $P_{Rlx}(t_{Rj})$, $P_{Rly}(t_{Rj})$, $P_{Rlz}(t_{Rj})$ are given by

$$P_{Rlx}(t_{Rj}) = \frac{\sum_{i=1}^{N} p_{ilx}(t_{ij})}{N}; \qquad P_{Rly}(t_{Rj}) = \frac{\sum_{i=1}^{N} p_{ily}(t_{ij})}{N}; \qquad P_{Rlz}(t_{Rj}) = \frac{\sum_{i=1}^{N} p_{ilz}(t_{ij})}{N}. \tag{3}$$

We can use the quantum computer in order to generate new musical compositions, represented by new random trajectories in the three-dimensional (x, y, z) space, by defining the new trajectories by random processes using Eq. (2) and assuming that $P_{Rlx}(t_{Rj})$, $P_{Rly}(t_{Rj})$, $P_{Rlz}(t_{Rj})$ are the probabilities that each characteristic property C_l can be represented in the time interval $(t_{R(j-1)}, t_{Rj})$, for x, y, and z components of the trajectory for the new generated musical composition R.