Simplified Model Equations for the music project

I. SIMPLIFIED MODEL EQUATIONS

We study N musical compositions ($i = 1, 2, \dots, N$) 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. For any musical composition i we do not consider t_{ij} at $j > M$.

Then we have the time steps for each musical composition i: $(0, t_1)$, (t_1, t_2), $\dots$, $(t_{(M-1)}, t_M)$. We emphasize that $t_M = T$.

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

Then we calculate the expectations of x, y, and z at the time step t_j as

$$\bar{x}_j(t_j) = \frac{1}{N}\sum_{i=1}^{N} x_i(t_{ij}); \qquad \bar{y}_j(t_j) = \frac{1}{N}\sum_{i=1}^{N} y_i(t_{ij}); \qquad \bar{z}_j(t_j) = \frac{1}{N}\sum_{i=1}^{N} z_i(t_{ij}), \tag{1}$$

where $j = 1, 2, \dots, M$.

We define the standard deviations $\sigma(x)$, $\sigma(y)$,and $\sigma(z)$ for x, y, and z, respectively, at the time step t_j as

$$\begin{aligned}
\sigma_j(x) &= \frac{1}{\sqrt{N}}\left[\sum_{i=1}^{N}\left(x_i(t_{ij}) - \bar{x}_j(t_j)\right)^2\right]^{1/2}; \quad \sigma_j(y) = \frac{1}{\sqrt{N}}\left[\sum_{i=1}^{N}\left(y_i(t_{ij}) - \bar{y}_j(t_j)\right)^2\right]^{1/2}; \\
\sigma_j(z) &= \frac{1}{\sqrt{N}}\left[\sum_{i=1}^{N}\left(z_i(t_{ij}) - \bar{z}_j(t_j)\right)^2\right]^{1/2},
\end{aligned} \tag{2}$$

where $j = 1, 2, \dots, M$.

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 the normal (Gaussian) distribution at the time step t_j with the probability density function for x, y, and z, respectively, defined as

$$\begin{aligned}
f(x_j) &= \frac{1}{\sqrt{2\pi\sigma_j^2(x)}}\exp\left[-\frac{\left(x_j(t_j) - \bar{x}_j(t_j)\right)^2}{2\sigma_j^2(x)}\right]; \quad f(y_j) = \frac{1}{\sqrt{2\pi\sigma_j^2(y)}}\exp\left[-\frac{\left(y_j(t_j) - \bar{y}_j(t_j)\right)^2}{2\sigma_j^2(y)}\right]; \\
f(z_j) &= \frac{1}{\sqrt{2\pi\sigma_j^2(z)}}\exp\left[-\frac{\left(z_j(t_j) - \bar{z}_j(t_j)\right)^2}{2\sigma_j^2(z)}\right],
\end{aligned} \tag{3}$$

where $j = 1, 2, \dots, M$.

In this theory we applied the central limit theorem, which states that under certain (fairly common) conditions, the sum of many random variables will have an approximately normal distribution.