# A Study of Music Production Algorithms Under BP Neural Networks: A Cross-Disciplinary Culture in Context

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Abstract: With the development of artificial intelligence in recent years, the application of AI technology in music production has become a new research field. In this field, using a series of networks such as neural networks to make music is a key research direction. In recent years, many related technologies have emerged and been applied. In this process, the relevant theories of traditional music composition provide a reference and basis for the implementation of algorithms in music production, while the neural network algorithm technology also has an impact on traditional theories in music production methods, production processes and other aspects. Combining the existing BP neural network algorithm, summarize the relevant content of music production through relevant experiments, and promote the development of music production and other related algorithms.

Keywords: BP Neural Network; Music Production; Algorithm

### 1. INTRODUCTION

In today's society, music, as an art genre, is increasingly needed in daily life. However, due to individual differences, each category has its own standards and requirements. In addition, the production has had a strong professional ability since the beginning, which stipulates that the original creator has a deep understanding of the song. It is with this high threshold that it is basically impossible for the layman to create comfortable personnel. However, with the development of AI technology and BP neural network, scientists realized that people can use computers to make something. This may be a completely different way from house writing. The people who make this method need not have strong theoretical knowledge, but can make satisfactory works based on electronic computers.

### 2. RELEVANT RESEARCH

#### 2.1 Overview of BP Algorithm

BP algorithm is still a classic neural network optimization algorithm, which is the development trend in single-layer neural network. Because of the limitation of single-layer neural network. Overseas experts and scholars use back-propagation to adjust the weight value of the multi-layer Internet, and the system software continues to improve according to the sample until it reaches the limit of deviation (Lakhani & Sundaram, 2017). As shown in Figure 1 below.



Figure 1: BP Neural Network Algorithm Model

The main idea of BP algorithm is to divide the training process into two stages: In the first stage (the whole process of forward propagation), the given input information content is solved layer by layer according to the input layer and the hidden layer, and the specific output value of each unit is calculated. In the second stage (the whole process of back propagation), after the output layer cannot get the expected output value, the difference value of the specific output and the expected output is calculated recursively according to each layer, and the weight value is adjusted according to the difference value. The average number of errors is defined as the objective function. The formula is as follows:

$$E_k = \frac{1}{2} \sum_{j=1}^m (d_{jk} - y_{jk})^2 \tag{1}$$

M is the number of output layer nodes, d jk is the expected output of the jth node of the k-th sample, and y jk is the specific output of the jth node of the k-th sample.

The total error of s sample is defined as follows:

$$E = \frac{1}{2S} \sum_{k=1}^{S} E_k \tag{2}$$

In that way, the network teaching problem is equivalent to the optimization problem of the past: mine  $(\omega)$ 

Adjust the weight so that the total error e is small. The formula of adjustment weight is calculated as follows

$$w_{ij}(t+1) = w_{ij}(t) + \Delta w = w_{ij}(t) - \eta \cdot \frac{\partial E}{\partial w_{ij}}, \eta > 0 \quad (3)$$

In the above formula is the process; T is the number of repetitions. Above should be a brief introduction of BP algorithm. The basic theory of the algorithm is to use the steepest descent method in nonlinear programming to make the weight change along the negative gradient of the error function, and reduce the mean square error of the specific output and expected output of the Internet to the minimum. In addition, its step size is generally obtained from the experience accumulated by the actual effect of the algorithm (Li et al., 2022).

#### 2.2 Development of BP Neural Network Algorithm

Increase the momentum moment term, that is, accumulate part of the previous weight and threshold adjustment amount with this weight adjustment amount, integrate the previous adjustment work experience, and have damping effect on the gradient direction adjustment at that time. When the error slope has large wavy lines, the momentum moment term improves the convergence speed of the algorithm based on reducing the vibration amplitude(Sihan, 2021). The actual formula is as follows:

$$w_{ij} = \eta_1 \times \left(-\frac{\partial E}{\partial w_{ij}}\right) + \alpha \bigtriangleup w_{ij} \tag{4}$$

$$v_{ij} = \eta_1 \times \left(-\frac{\partial E}{\partial w_{ij}}\right) + \alpha \bigtriangleup v_{ij} \tag{5}$$

The momentum factor a is generally 0.1-0.8. Under the term of moment of momentum, the elastic gradient reduction method is enhanced to further avoid the bad performance of the neural network caused by the large change of gradient value in the gradient adjustment link. The weight adjustment of the elastic gradient is adjusted according to the weight value, the updated value t of the threshold value and the gradient. The correlation between the upgrade value and the weight adjustment amount is:

$$\Delta w(t) = \begin{cases} -\Delta t \ \frac{\partial E(t)}{\partial w} > 0 \\ +\Delta t \ \frac{\partial E(t)}{\partial w} > 0 \\ 0 \ \frac{\partial E(t)}{\partial w} = 0 \end{cases}$$
(6)

BP algorithm is a kind of network marketing knowledge based on deviation reflection. The learning rate indicates the process of network teaching, which seriously harms the convergence speed of the Internet. The learning rate will slow down after an hour, but too much learning rate may cause vibration and diffusion. To maintain the convergence speed and system stability, adjust the learning and training rate according to the exercise (Lai et al., 2023). The physical model of learning and training rate is shown below.

$$\eta(k) = e^{-\lambda}\eta(k-1) \tag{7}$$

 $0.0001 \le 0.001$ , with the increase of practice frequency, the learning rate is getting smaller and smaller. However, in network training, if the deviation of the Internet decreases after the weight value system is reinstalled, it is necessary to expand the learning rate, so that the Internet has a large step function learning feedback, which is also a conditional limitation, that is, the training conclusion becomes better.

#### 2.3 Relevant Research on Music Production Theory

2.3.1 Basic Attributes of Music Theory

In physics, sound is produced by the vibration of phonology (Huang, 2020). In nature, our auditory system senses a lot of sounds, but not all sounds are raw materials. The sound used is selected by many people in the long-term practice process, which is used to form a certain system to produce the brand image of Gongle and express love. According to the difference in the vibration state of the pronunciation body, the sound can be roughly divided into musical sound and noise. There is regular vibration in the pronunciation, and the sound with clear voice quotient is called musical sound. The sound with irregular vibration of the sounder and unclear pitch is called noise. In that way, the key is music, and noise is an integral part of the expression, such as drums, gongs, triangle iron, sand and other traditional instruments, and the sound produced is all noise. If noise is better used in the room, it can make the music look more beautiful. In nature, people hear a lot of sounds, but not all sounds of nature have been applied (Pedersoli, 2019). In the long-term development process, many people have chosen some voices to express their feelings and their lives, and this kind of voice has developed. At the same time, with the passage of time, the selected voice gradually forms a management system, which is used to express thoughts and feelings. There are four characteristics of sound: how much, how high, how long, and how good it is. They are embodied in pitch, pitch, positive value, and sound quality. They are also called essential attributes (Preparedness & Rescue) Therefore, in the production process abroad, an octave is divided into 12 equal parts.

### 2.3.2 Production Characteristics of Music

Music is the aesthetics of sound, and it should be an art genre with sound as its main expression (Liu, 2018). Every Beijing capital is permeated with artists' writing ideas and design inspiration. The sounds that compose the will are planned and regular, including the sense of rhythm, rhythm, palace tune, harmony, resonance point and other factors, as well as the manufacturing characteristics of pitch, length, voice and so on. As shown in Figure 2.



Figure 2: Music Elements

(1) Pitch: The intonation refers to the number of tones. It is determined by the vibration frequency of the voice in a certain time. The higher the vibration frequency, the higher the sound, and the lower the vibration frequency, the lower the sound (Liu, 2022). Each tone in the sound management system has a beep sound level. The basic sound level is divided into basic sound level and variable basic sound level. The basic sound level is named by seven Latin letters C, d, e, f, g, a and b, and its sound names are do, re, mi, fa, sol, la and si. The basic sound pressure level that increases and decreases is called the transition sound pressure level. The sounds in the sound system are called sound strings according to the order of sound from far to near, from low to high, or from high to low (Balaji & Sigler, 2018). The names of the basic sound level are repeated in the sound column, and the same is true for the 52 white keys in the piano. The sound names c, d, e, f, g, a, and b are repeatedly used in the circulation system. As a result, many different pitches and sounds of the same name will be produced in the sound column. In order to distinguish different sounds, the sound column is divided into many groups, namely the sound column group. The central Cl of the electronic organ is called the central

C, which is composed of C to b (including the black key) and can be divided into groups by numbers and letters in English. Two homonyms of adjacent groups form an octave. For example, Cl and C2 form an octave. The sound pressure level keeps going round and round because the sounds that make up octaves seem very similar. In linguistics, the ratio of the number of octaves to the number of the two basic sound levels located in adjacent groups is 1:2, which is absolutely compatible in phonological theory (Meng, 2021).

(2) Length: The length of sound is the duration of sound, also known as the length of "duration value" (Pardo et al., 2019) The longer the sound body vibrates, the longer the sound will be. The less the vibration time is, the less the sound will be. In the basic theory, the sound duration is standardized. It is not only necessary to record the length of each sound inside, but also the length of no sound. This time is calculated on the basis of w "beat". There is no specific definition of the time of one beat, and the average is about one beat per second. All playing must have the same beat length. If you don't do this, you will be in a mess. In basic theory, playing music symbols indicates the length of a sound (Liu & Ge, 2022). A fulltone music symbol is 4 beats. A quarter note is two beats. A quarter note is a beat. The octave of one is half beat. A 16 minute note is a quarter beat. A 32 minute note is an eighth beat. Therefore, like the meaning of the name, a four-quarter note is divided into two parts by the length of a fulltone musical symbol. Why is the rhythm separated by half of the proportion? This may be related to human beings.

(3) Volume: Sound refers to the level of sound. That is determined by the vibration amplitude of pronunciation theory. The more the amplitude, the higher the sound, and the smaller the amplitude, the weaker the sound.

(4) Timbre: Sound quality is the color of sound (Miranda et al., 2018). It depends on the quality, appearance, vibration method, pronunciation method, the number of double tones and the compression strength of double tones. We can correctly judge the "color" of sound. Single yellow pipe and horn play music symbols with the same pitch (basically working frequency), which can clearly distinguish which one is multi-pipe and which one is horn, and will not be confused. The main reason is that the sound quality is different. It can be said that the sound quality is determined by the sound doubling spectrum and the wave shape of the sound. Because most of the wave patterns of sound are not just sinusoidal waves, but rather complex waves. The analysis shows that the complex wave pattern can be converted into a series of sine waves, which have the weight calculation, bit, multiple and f4 which are integral to the frequency, and its amplitude

has a specific proportion. The type ratio gives each traditional instrument a unique "color" sound quality. If there is no harmonic component, the simple pitch square wave signal is insensitive. Therefore, the working frequency band of the traditional instrument sound is not only the working frequency band of the basic signal frequency, but also contains the higher harmonics of the traditional instrument sound, and must have higher overtones. The sound quality of the instrument is also very loud.

(5) Interval: Interval refers to the pitch association between two tones (Lostanlen et al., 2019). The number of tones contained in an interval is called the myopic degree of the interval. The staff includes each line and interval, which is called multiple. The line and line frame of the staff, or the interval composed of the middle and the middle, is called once; The interval formed by the adjacent line and the middle is called the second. By analogy, in other words, the total number of the lines and the middle of the interval included in the staff is called multiple. This is also the characteristics of the hazard. Among them, pitch, length and sound are local features, and the features we can capture in a continuous sound period are surface features. The sense of rhythm and the tone of the palace are the overall characteristics. Only when we look at the overall situation and experience the overall situation, can we know the characteristics. Like the grammatical characteristics of grammar, they belong to the deep eave sign.

### 3. CONTROL MODULE OF BP NEURAL NETWORK LEARNING

The purpose of applying neural network manufacturing is to use a series of training data sets written by people to learn neural network. After learning the characteristics of the test set comprehensively, neural network can derive things with the same characteristics (Nomura & Fukumoto, 2018).

# 3.1 BP Neural Network - Music Production

In order to make use of neural network, we must first clarify what is input and what is export (Park, 2021). You will find that the data information is actually arranged in chronological order. Each time period has two data information space vectors: pitch and length. Apply the original input vector to obtain the output vector indicating the characteristic information (pitch and time length) of the first tone of the exercise, and then input the previous and subsequent information including the dependency information of the first tone into the Internet as a new input vector to obtain the output vector indicating the characteristic information of the second tone of the exercise. In that way, the Internet goes back and forth until it obtains the output vector indicating the characteristic information of the final sound of the exercise. You will find that this is a process of a recursive algorithm. That is, get the first sound, get the second sound from the first sound, get the third sound from the second sound, etc(Khan et al., 2020). As shown in Figure 3 below



Figure 3: Data Vector Input Process

In the central nervous system, the space vector x (t) of time division t and the output y) t-1 of time division t-1 jointly constitute the Internet input of time division t. For the k th export source, the output of time t is as follows:

$$y_k(t) = f_k(net_k(t-1)) \tag{8}$$

The steps of BP neural network production are as follows:

Set the test sample set as TP1, TP2 and TPN. Where p=1, 2, the expected value and the Internet derived value are calculated as follows:

$$W = \frac{1}{p} \sum_{p} E_{p} \tag{9}$$

$$E_P = \frac{1}{2} \sum_{l} (T_{pl} - O_{pl})$$
(10)

Weight w in music production\_ Ij The conditions that should be met are:

$$w_{ji}(k+1) = w_{ji}(k) + \eta \delta_j O_i \tag{11}$$

$$\delta_j = f(net_j) \sum_l w_{lj} \,\delta_l = O_j (1 - O_j) \sum_l w_{lj} \,\delta_l \tag{12}$$

When the root mean square error and e value meet the practical application conditions, the optimal BP neural network construction is created.

3.2 Generation of Music Production Algorithm

BP neural network is a process of unsupervised learning by compressing and decompressing characteristic data, and it is also a model of unsupervised learning of data (De Prisco et al., 2020). The data does not specify the advantages and disadvantages, so it is suitable for nonmonitoring. The variational automatic encoder is an upgraded version of the automatic encoder. The structure is similar to that of automatic encoder. The principle is to add some restrictions in the coding process. This solution principle is similar to the whole process of the exploration of music arrangement. In a sense, arrangement is the whole process of coexistence of creation and standards. Moreover, the VAE system is better in line with it. In the process of practice, VAE has been able to be well used for the statistical analysis and formation of multi-part pitch dynamics and instrument data. Especially in classical style and jazz music. Mozart's works can also be interpreted as jazz music design style. Form new matching methods. At present, the variational automatic encoder is one of the best ways to form specific content. It can form various forms of data, especially a process in the work of multi-part forming. However, if the data is multimode fiber, VAE cannot provide the established system. It is impossible to infer potential variables of discrete values. Therefore, this is also an important culprit that hampers its development. For example, in the processing of major and minor, the trend of various tones in minor scale is different. Especially when it is extended to more than 24 tones, the processing method of VAE becomes more and more difficult. Therefore, some basic ideas at this stage are to design the VAE LSTM method. This way can avoid some problems (Overinde, 2020).

## 4. APPLICATION OF BP NEURAL NETWORK TO MUSIC PRODUCTION ALGORITHM

The BP neural network system architecture is suitable for the data model of coding sequence, such as predicting and analyzing the next English word in natural language understanding, or possibly the next note in the formation process. The neural network is used to complete the maker and discriminator to form the clock frequency continuous data conforming to midi standardization. The standard initial function formula is used for practice to form continuous coding sequence data, and d is used to distinguish the formation data from the original data. The creator has created four groups of data indicating the length of the note, the working frequency of the note, and the output power length of the note. 4.1 Input and Output Structure of Network During Music Production

In order to effectively practice the Internet, analyze and number midi data, design and type appropriate data structures. Each input node includes the following data:

(1) Pitch value: In the production process, the pitch is generally a scalar value, which brings an ambiguous definition to the Internet and can distinguish the bass and the bass. Generally, part of the rhythm is located in the relatively high sound area, the central wide area is used for placement and rotation, and the bottom tone is generally located at the bottom.

(2) Tone level bitmap: The color bitmap represents the result obtained by mapping the pitch scale value of the current stage to the chromatic scale bitmap, which is used to show the effect of harmony and rotation. For network teaching, the definition of sound pressure level can make the neural network accurately distinguish the difference between the same attribute and the rotation on each pitch, that is, the absolute position correlation in the sound pressure level. The halftone bitmap includes 12 halftones. The projected bit value is 1, and the rest are 0. In the process of repeatedly cycling the system along the note axis, according to the bit-bybit or actual operation of the pitch bitmap obtained at the current stage and above, we can finally obtain the pitch distribution of all the notes in the current time step in the chromatic scale, and select and rotate through the bitmap data.

(3) Rhythm bitmap: The data structure of speed is essentially the binary representation of the area within the subtitle, expressed as t Assume that the time sign at this stage is 4/4 (the quarter note is one beat, and each subtitle has four beats), and each duration process corresponds to the sixteenth note. Each row corresponds to one data. The number of binary digits indicates the precision of quantitative analysis. Take 16 minutes as the minimum quantitative analysis enterprise. Therefore, each subtitle has 16 time steps and each rhythm has 4 time steps. If you want to select enterprises within 32 minutes as the precision of quantitative analysis, you can use data structure with large binary digits. In addition, the scale value corresponding to the number above all walks of life indicates that there is a difference between the positive and negative beats or the high and low beats in the sense of rhythm. The number of beats located in the positive or strong beats is 0, and the number of weak or reverse beats is 1. BP neural network itself must measure the midi data information, so the posture is on a certain time scale. However, in the network design scheme, the input data information will be automatically quantified, analyzed and converted, so the unmeasured fragments can also be accepted.

4.2 Music Production Strategy of BP Network Algorithm

In the process of compiling BP Internet optimization algorithm, the selection of fitness function is one of the important conditions to measure whether the ideal conclusion can be reached at last. For the software of the neural network model writing system, the fitness function formula is divided into two types:

(1) Stipulate the fitness function formula of the evolved music, and stipulate that plastic arts should be carried out for each music produced according to people's own understanding of objective reality

Further comment on correctly guiding the evolution of music. The problem with applying IGA is that it takes a long time to comment, which becomes the weakness of the fitness function.

(2) Formulate evolution rules to evaluate music.

This fitness function formula is not carried out by people. Before carrying out genetic operation, we should first design various standards that systematically code and express sufficient professional knowledge, and then evaluate the music produced by crossing or genetic variation on this basis. The rules are determined by the factors of music. The general fitness function is to obtain the fitness value of each song according to the difference of each song of these factors and the defined weight. Such factors are mainly shown in Figure 4:



Figure 4: Adaptation Factors of Music

1 Large spacing: Because the chromosome is a random event when it is reset, there is likely to be a large spacing between the continuous notes, which obviously does not meet the needs of the music. In that case, the fitness function formula must solve these problems. The user can specify the main interval in the middle of the note. When the interval exceeds the specified maximum value, the fitness penalty value will allow the excess part to be weighted.

2 Pattern matching: In the operation of the optimization algorithm, the matching algorithm does not appear in the middle of several notes, but only in the middle of the segments. Adding the fitness function formula to the matching algorithm can be explained psychologically. The audience can not only identify when appreciating, but also expect similar ways to happen inside. In addition, the development trend of the Chinese theme can also be linked by overlapping parts of the structure.

(3) Notes in the beat position: In a section, the first beat and the second beat are the two most surprising beats in this subtitle. When the first strong beat and the next strong beat are chords or notes, positive weight is given; If there are minor scale notes instead of chords, or there are no minor scale notes, the weight is negative.

(4) Long note: The user can specify long note in his eyes. The importance of long notes in music is to maintain stability. Therefore, there are some long notes in the music, which looks more natural. The weight of the long note can be set to match the weight of the saved note of the harmony note; The weight of the minor scale notes, notes and dissonant tones with theout concordance is negative.

(5) Speed: users can use it as the speed of music development according to certain specifications. The optimization algorithm can evaluate the speed of music by adding notes and notes to each continuous subtitle, and can measure "slow", "medium speed", fast and accurately.

4.4 Basic Operation of Music Production Under BP Neural Network

In the algorithm compilation of the neural network, after selecting the original species, carry out cross operation on the numbered music to control the actual operation of gene mutation.

(1) Crossover operation: one-point crossover and two-point crossover are commonly used algorithms for arranging crossover algorithms. After the crossover operation, the sex chromosome with higher fitness was selected as the next species.

(2) Mutation operation: In the system, the function of gene mutation algorithm is to find the deficiency of the music and make it evolve to a more energetic, relaxed and happy direction. As shown in Figure 5.



Figure 5: Method of Mutation Operation

1) Variation of a single note: select a note at will and replace it with the newly generated note, or replace it with a slightly lower or stronger note.

2 Exchange: arbitrarily select two wonderful segments with the same total number of notes and exchange their parts.

3 Change sequence: select any segment and change its note encoding sequence.

4 Ascending arrangement: select any segment to sort its notes in ascending order, and the notes maintain the origin.

5 Sort in descending order: in the same order, just change the ascending order to the descending order.

6 Reassign the duration of notes: select a segment at will, change the time series analysis of notes continuously, and maintain the order of notes unchanged.

7 Copy: copy the wonderful segment so that it coincides with any selected segment.

(8) Merge repetitive notes: Combine random continuous notes of the same pitch into notes of the same length on all chromosomes. In the copy and crossover process, the same note produced by arranging gene mutations and separating notes will feel simple and low, and combining repeated notes can avoid such things.

### 5. EXPERIMENTAL VERIFICATION OF MUSIC PRODUCTION

#### 5.1 Verification Process of Music Production

The whole certification process is shown in Figure 6 below. The process is as follows: (1) The user of the system software listens to the class and recognizes the music similar to the type of production, so as to improve the sensitivity when distinguishing the music. The characteristics of the music produced by this system are the types of children's rhymes with good rhythm and lively and lovely. Therefore, a certain number of children's rhymes should be selected first to carry out the audition class. (2) The system software first formed 200 chromosomes (individuals) according to the basic theory. Considering the pressure of customers, 20 of them were randomly selected as individuals participating in the evolution. (3) The user will evaluate this wonderful piece one by one according to his own cognitive ability, and select the most ideal music as the evaluation standard. (4) The system software carries out the actual operation of music evolution based on user feedback, and randomly selects 10 from 200 new chromosomes.



Figure 6: Production Process after Music Production

The user evaluation page is shown in Figure 6 below. Users evaluate 10 wonderful clips in such an interactive interface. After the user clicks the play button, the system starts to play the song, and the watch needle displays the playing video part of the song. After listening, users score each song according to their personal feelings, and get five integer values of - 2 to+2. Refer to evaluation Table 1 for its standards.

Table 1: Music Standard Evaluation Table			
<b>Evaluation Value</b>	Standard		
+2	The Music is Very Good		
+1	The Music is Very Good		
0	Music is Average		
-1	The Music is not Very Good		
-2	The Music is Particularly Unpleasant		

After evaluating 10 songs, users selected the ones they thought were better as the evaluation criteria for the next generation of music evolution.

If nothing is better than the standard, the original music will be used as the evaluation standard. If the user's score is positive, this dyeing experience will be imported to the next generation with 4 times the total number. When the evaluation is negative or zero, the chromosome will not be selected by the next generation. Chromosomes below 200 come from any source breeding pool.

#### 5.2 Experimental Results of Music Production

In order to verify the effectiveness of the algorithm, three people were selected to carry out the evaluation test of the system. They write happy music in the current system according to their subjective cognition. During each evolution, it is necessary to select a song from the evolution conclusion randomly for evaluation. After five evolutions, select five songs to evaluate the five people in common. Each section needs to give a category from 1 to 10. The user's evaluation values of the five songs are shown in Table 2. The average evaluation is getting higher and higher. This shows that although the evaluators themselves have individual differences, with the development trend of the algorithm, the bridge created by the system gradually conforms to the appreciation habit of most people.

Table 2: User Scoring Table						
Fragment -	Evaluation Value			Average		
	User 1	User 2	User 3	Value		
1	3	5	2	3.3		
2	2	4	4	3.3		
3	4	5	3	4		
4	4	4	6	4.6		
5	3	4	3	3.3		

Table 2:	User	Scoring	; Table

After the above experiments, it is proved that the three people have a high evaluation of BP neural network music production, and their personal evaluation is somewhat different, but the overall evaluation is above medium, and the music produced by BP neural network algorithm shows a certain recognition.

### 6. CONCLUSION

The compilation of algorithm is a relatively novel research direction in the scientific field. Neural network has a strong self-learning ability and has a driving role in people's independent innovation. With the participation of BP neural network, the whole process of music production has become simple, not only at the level of rhythm and song lyrics, but also at the level

of harmony, timbre, volume, and pitch, which will be developed in the future, with the support of multidisciplinary integration, Manufacturing will show more diversified ways.

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