

AUTOMUSICIANS: POLYPHONIC MUSIC COMPOSITION VIA GPT-4-POWERED MULTI-AGENT SYSTEM



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Overview

Background + motivation –Qixin

Method –Tianyi

Observation + Future work + Demo –Boning

Background: LLM Reasoning and Chain-of-Thought Prompting

Standard Prompting

Model Input

Q: Roger has 5 tennis balls. He buys 2 more cans of tennis balls. Each can has 3 tennis balls. How many tennis balls does he have now?

A: The answer is 11.

Q: The cafeteria had 23 apples. If they used 20 to make lunch and bought 6 more, how many apples do they have?

Model Output

A: The answer is 27. ❌

Chain-of-Thought Prompting

Model Input

Q: Roger has 5 tennis balls. He buys 2 more cans of tennis balls. Each can has 3 tennis balls. How many tennis balls does he have now?

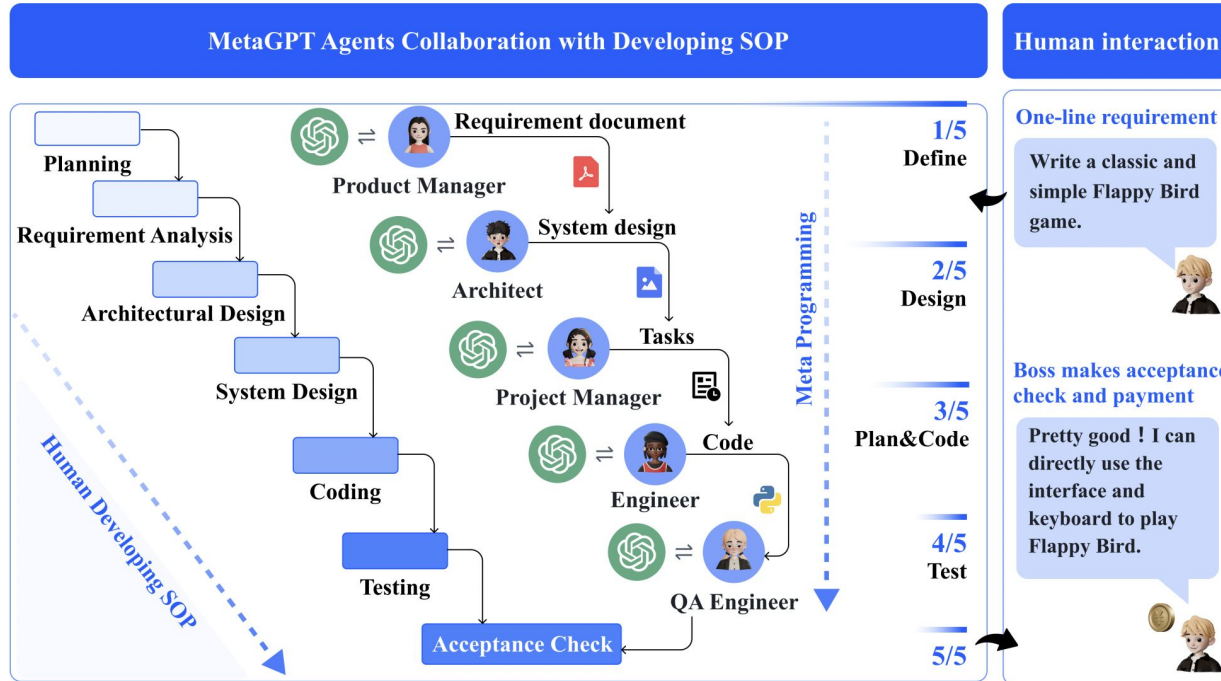
A: Roger started with 5 balls. 2 cans of 3 tennis balls each is 6 tennis balls. $5 + 6 = 11$. The answer is 11.

Q: The cafeteria had 23 apples. If they used 20 to make lunch and bought 6 more, how many apples do they have?

Model Output

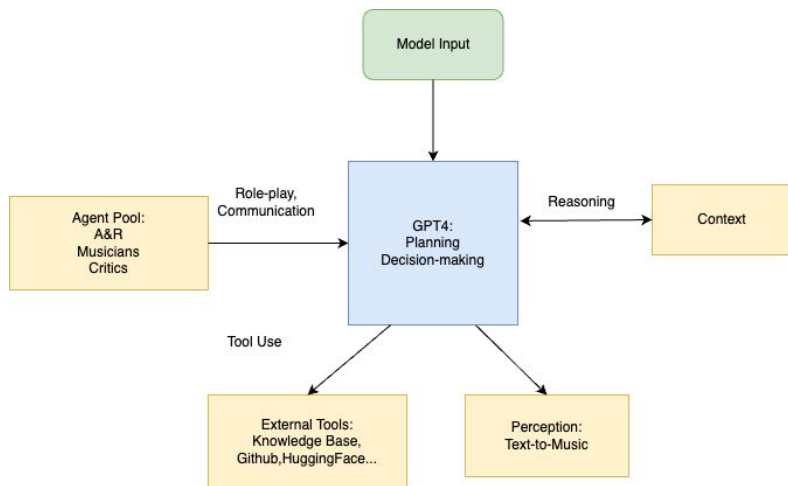
A: The cafeteria had 23 apples originally. They used 20 to make lunch. So they had $23 - 20 = 3$. They bought 6 more apples, so they have $3 + 6 = 9$. The answer is 9. ✅

Background: LLM as Agents:



Motivation

1. How well LLM(GPT-4) does in handling music-related tasks, such as music understanding and generation?
2. Can the musicality of GPT-4 be enhanced through CoT prompting and multi-agent collaboration?



Method: Chat chain between musician agents role-played by GPT-4

Method: text-to-music representation

```
<score lang="ABC">
X:1
T:The Legacy Jig
M:6/8
L:1/8
R:jig
K:G
GFG BAB | gfg gab | GFG BAB | d2A AFD |
GFG BAB | gfg gab | age edB | 1 dBA AFD :|2 dBA ABd |:
efe edB | dBA ABd | efe edB | gdB ABd |
efe edB | d2d def | gfe edB | 1 dBA ABd :|2 dBA AFD |]
</score>
```

The Legacy Jig

jig



ABC Notation:

Pros:

- Simplicity
- Similar to natural language
- Efficiency in Data Handling

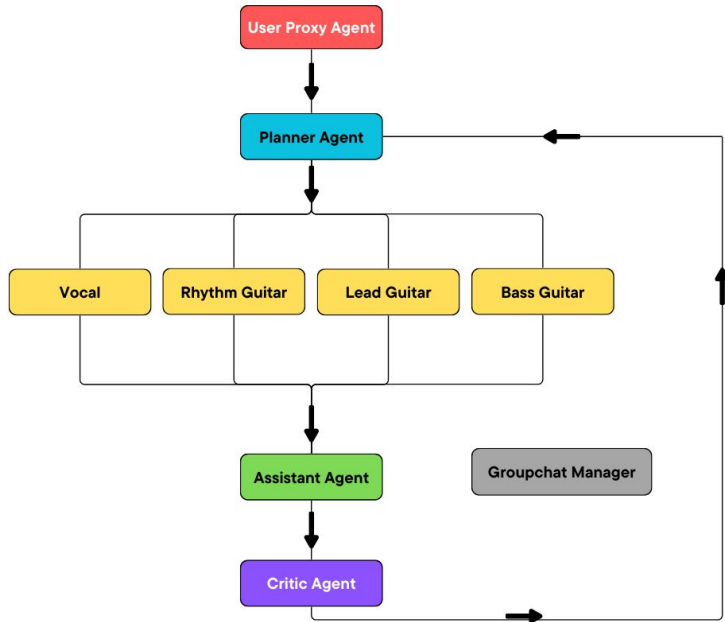
Cons

- Limitations in Expressiveness

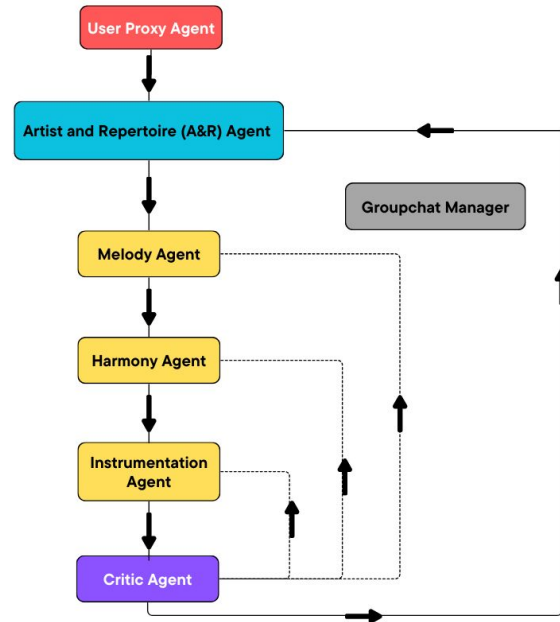


Method: Communication Protocols

Instrument Based:



Function Based:





Method: System Prompt Engineering

```
name="Vocal",  
llm_config=gpt4_config,  
system_message='''Vocal. Write only vocal part (one note at a time) following the plans.  
Vocal delivers the melody with emotion and clarity. Pay attention to vocal techniques like pitch, dynamics,  
and phrasing to enhance the expressiveness of the performance. Harmonize with the instrumental arrangements,  
and ensure that vocal delivery complements the overall composition of the song.  
Use a mix of note lengths such as eighth notes, sixteenth notes, dotted rhythms, and syncopation.  
Different parts of the song should have different vocal melodies, like chorus and verse.  
Don't repeat same note over and over again.  
Don't use scale.  
Pick MIDI program number for vocal  
Write everything in ABC notation.  
''',
```


Method: System Prompt Engineering

```
name="MeLodyAgent",
system_message="""
You are skillful musician, especially in melody.
You will compose a single-line melody based on the client's request and assigned tasks from the Creative Director.
You must output your work in ABC Notations.
Here is a template of a music piece in ABC notation,in this template:
X:1 is the reference number. You can increment this for each new tune.
T:Title is where you'll put the title of your tune.
C:Composer is where you'll put the composer's name.
M:4/4 sets the meter to 4/4 time, but you can change this as needed.
L:1/8 sets the default note length to eighth notes.
K:C sets the key to C Major. Change this to match your desired key.
The music notation follows, with |: and :| denoting the beginning and end of repeated sections.

'''
X:1
T:Title
C:Composer
M:4/4
L:1/8
K:C
|:GABc d2e2|f2d2 e4|g4 f2e2|d6 z2:|
|:c2A2 B2G2|A2F2 G4|E2c2 D2B,2|C6 z2:|

'''

You will output the melody following this template, but decide the time signature, key signature and the actual musical contents yourself.
After you receive the feedback from the reviewer agent, please modify your work according to the suggestions you were given.
""",
```



Method: Communication Example

User_proxy (to chat_manager):

Please compose a 32-bar Oriental-style music, use pentatonic scale



Method: Communication Example

AR (to chat_manager):

To create a 32-bar Oriental-style music using the pentatonic scale, let's break it down into subtasks for the Melody Agent, Harmony Agent, and Instrument Agent.

Melody Agent:

1. Compose a 32-bar melody in the pentatonic scale with an Oriental feel.
2. Incorporate common elements of Oriental music, such as pitch-bending or grace notes.
3. Provide a clear and memorable theme and variations throughout the melody.
4. Ensure the melody remains engaging and dynamic by using various note lengths and dynamics.

Harmony Agent:

1. Create a harmony using chords and progressions suitable for Oriental-style music.
2. Arrange the harmony to complement the melody and enhance the Oriental feel.
3. Consider the use of drones or sustained notes to provide a richer texture.
4. Use contrast in dynamics and rhythmic elements to maintain interest throughout the 32 bars.

Instrument Agent:

1. Select traditional Oriental instruments, such as the oud, qanun, duduk, ney, or darbuka.
2. Arrange the melody and harmony parts for the chosen instruments, utilizing their unique timbres.
3. Experiment with additional percussive elements, like finger cymbals or riq, to add depth and variety to the composition.
4. Focus on the balance and blend of instruments to highlight key sections of the music.



Method: Communication Example

MelodyAgent (to chat_manager):

Here's a 32-bar Oriental-style melody using a pentatonic scale. I have chosen 2/4 time signature and the key of C minor pentatonic for this melody. Keep in mind that this is just the melody, and can later be enhanced with harmony and instrumental accompaniment as mentioned in previous response.

...

X:1

T:Oriental Pentatonic Melody

C:Anonymous Composer

M:2/4

L:1/8

K:Cm

```
|:c2 cB |BG GA |AB BG |GA G2 |
c2 cB |BG GA |AB BG |1 GA Gz :|2 GA GB |
|:Ac Bc |dc BA |AB BG |GA GB |
Ac Bc |dc BA |AB BG |1 GA Gz :|2 GA G2 |
|:Ec Dc |BA ^GA |BG Ac |=GA GE |
Ec Dc |BA ^GA |BG Ac |GE G2 |
c2 cB |BG GA |AB BG |GA G2 |
c2 cB |BG GA |AB BG |GA G2 :|
...
```

Please review the generated melody and provide feedback if any modifications are required.



Method: Communication Example

CriticAgent (to chat_manager):

Thank you for the revised melody, Melody Agent. I appreciate your incorporation of the feedback. Here's my assessment:

1. **Melodic Structure:** The revised melody has an improved Oriental feel with the addition of grace notes, mordents, and a mix of both B-natural and B-flat. The theme has enough variety to keep the listener engaged throughout the piece.
2. **Rhythmic Complexity:** The use of triplets and syncopation adds to the rhythmic diversity in the revised version. These elements give the melody more character and emphasize the Oriental style.
3. **Originality and Creativity:** The melody demonstrates a good balance between maintaining the pentatonic scale structure and adding unexpected notes to create some tension and release. This results in a more unique and innovative composition.

Overall, the revised melody effectively achieves the goal of creating a 32-bar Oriental-style composition using the pentatonic scale. Great job on incorporating the feedback. Now we can move on to harmony and instrumentation.



Method: Communication Example

HarmonyAgent (to chat_manager):

Harmony Agent:

Here's a harmonization of the revised Oriental-style melody using chords and progressions suitable for Oriental-style music:

```
...
X:1
T:Oriental Pentatonic Melody with Harmony
C:Anonymous Composer
M:2/4
L:1/8
K:Cm
V:1
|:c2 c(3BcB|BG GA |AB B^A |GA G2 |
c2 c(3BcB|BG GA |A^B BG |1 GA Gz :|2 GA GB |
|:Ac Bc |dc BA |AB B^A |GA GB |
Ac Bc |dc ^GA |AB BG |1 GA Gz :|2 GA G2 |
|:Ec Dc |BA ^GA |BG Ac |=GA GE |
Ec Dc |BA ^GA |BG Ac |=B,=B G2 |
c2 c(3BcB|BG G^A |AB BG |^GB G2 |
c2 c(3BcB|BG G^A |AB BG |GA G2 :|
V:2
|:g,2 g, (3a=g^g |g,2 C2|c3 f, |=G,2 ^G,2 |
g,2 g, (3a=g^g |g,2 C2|c3 D |1 C4 :|2 C2 =CD |
|: _E2 F2 |F3 =E |E2 F=^F |_B2 =C2 |
_E2 F2 |F3 ^G, |G,2 ^=C3 |1 C4 :|2 _E2 F2 |
|:G,2 D,2 |G,3 ^=G, |G,2 D,2 |E,3 =G, |
G,2 D,2 |G,3 ^G, |G,2 E,2 |1 G,4 :|2 G,3 G, |
G,2 G, (3A=G^G |G,2 G^G |G,2 G,B, |^F,3 G,3 |
G,2 G, (3A=G^G |G,2 G^G |G,2 G,B, |G,3 G,2 :|
...
```

Please review the harmony and let me know if there are any changes needed or if it highlights the melody effectively.



Method: Communication Example

CriticAgent (to chat_manager):

Thank you, Harmony Agent, for providing a harmonization for the Oriental-style melody. Here's my feedback regarding the harmony and its different aspects:

1. Harmony and Counterpoint: The harmonization uses a range of chords, and their progressions are generally suitable for Oriental-style music. However, in bars 6, 14, and 22, the chords could use more distance from the melodic line to create more tension. Consider adjusting the chords in these bars to provide better contrast with the melody.

2. Rhythmic Complexity: The harmony incorporates a degree of rhythmic diversity, with held bass notes providing a solid foundation underneath the syncopated melody. Expanding this rhythmic variety in sections with faster melodic movement or ornamentation would add interest to the harmony.

3. Form and Structure: The harmonization follows the structure of the melody well and connects the sections smoothly. The chord progressions help build a sense of forward momentum, leading to the cadences at the end of each section.

Overall, while the harmony generally supports and highlights the melody effectively, making a few adjustments to the chord choices and extending the rhythmic diversity will help further refine the harmonization.



Method: Communication Example

Instrument Agent:

Here's the 32-bar Oriental-style melody with harmony, arranged for traditional Oriental instruments. The melody is played on the oud (MIDI program 24), the harmony is played by the qanun (MIDI program 105), and a subtle percussion line using darbuka (MIDI program 113) is added for rhythmic support.

...

X:1

T:Oriental Pentatonic Melody with Harmony and Instrumentation

C:Anonymous Composer

M:2/4

L:1/8

K:Cm

%%MIDI program 24

V:1 name="Oud" clef=treble

```
|:c2 c(3BcB|BG GA |AB B^A |GA G2 |
c2 c(3BcB|BG GA |A^B BG |1 GA Gz :|2 GA GB |
|:Ac Bc |dc BA |AB B^A |GA GB |
Ac Bc |dc ^GA |AB BG |1 GA Gz :|2 GA G2 |
|:Ec Dc |BA ^GA |BG Ac |=B,=B G2 |
Ec Dc |BA ^GA |BG Ac |=B,=B G2 |
c2 c(3BcB|BG G^A |AB BG |^GB G2 |
c2 c(3BcB|BG G^A |AB BG |GA G2 :|
```

%%MIDI program 105

V:2 name="Qanun" clef=treble

```
|:g,2 g,(3a=g^g |g,2 C2 |c=3 f, |=G,2 ^G,2 |
g,_b g,(3a=g^g |g,2 C2 |c==b ==D |1 C4 :|2 C2 =CD |
|:_E2 F2 |F3 =E |_E2 F^F |_B2 =_C2 |
_E2 F2 |F =^G,=^G, |_G,2 ^c3 |1 C4 :|2 _E2 F2 |
|:G,2 _D,2 |G,2 ^=G,2 |G,2 _D,2 |E,3 =G, |
G,2 _D,2 |G,2 ^=G,2 |G,2 E,2 |1 G,4 :|2 G,3 G, |
G,2 G,(3A=G^G |G,2 G^G |G,2 G,=B, |^F,3 G,3 |
G,_b G,(3A=G^G |G,2 G^G |G,2 G,=B, |G,3 G,2 :|
```

%%MIDI program 113

V:3 name="Darbuka" clef=percussion

```
|:z2z2|z2z2|z (^G2)|z2z2|
z2z2|z2z2|z (c2)|1z2z2:|2z2z (^A2)|
|:z2 (^A2)|z (_B2)|z (^G2)|z (^A2)|
```




Method: Communication Example

CriticAgent (to chat_manager):

Thank you, Instrument Agent, for providing the instrumental arrangement of the 32-bar Oriental-style melody with harmony. I appreciate your use of traditional Oriental instruments for this composition. Here's my feedback on the arrangement and chosen instruments:

1. Instrumentation and Timbre: The choice of oud for the melody, qanun for the harmony, and darbuka for rhythmic support is appropriate, as these are traditional Oriental instruments with unique timbres that contribute to the overall aesthetic. The subtle use of percussion provides rhythmical grounding without overpowering the other elements.

2. Balance and Blend: The arrangement ensures that the melodic and harmonic lines are well balanced, with the oud taking prominence, while the qanun supports and highlights the melody effectively. The darbuka percussion adds depth to the arrangement without detracting from the melodic and harmonic elements.

3. Dynamics: Although not explicitly notated in the ABC notation provided, I assume the dynamics will be varied throughout the arrangement. Ensure that there are dynamic contrasts and gradual changes in intensity, particularly during transitions between sections and moments of tension in the melody.

In summary, the instrumentation and arrangement effectively support the Oriental-style melody and harmonization, with an appropriate balance and blend of traditional instruments. Take note of the dynamics for the final performance. Overall, this is a successful rendition of the Oriental-style composition.



Observation

Pros

1. Interpret and analyze user request basically correctly: able to choose the most suitable instrument, keys, and time signatures
2. Have the basic feelings of desired styles
3. Applicable for a range of different genre and styles.



Observation

Problems

1. Harmony sometimes sound weird
2. Insufficient ability to control note range
3. Only satisfy the basic requirement without further instruction



Observation

Contrabass

The image shows a musical staff for Contrabass in 4/4 time. The staff is labeled 'Contrabass' on the left. The key signature has one flat (B-flat), and the time signature is 4/4. The notation consists of five measures, each containing four notes. The notes are positioned on the staff as follows: Measure 1: G4, F4, E4, D4; Measure 2: C4, B3, A3, G3; Measure 3: F3, E3, D3, C3; Measure 4: B2, A2, G2, F2; Measure 5: E2, D2, C2, B1. The notes in the third measure (D3, E3, F3, G3) are the highest notes in the piece, with D3 being the highest note overall.

Notes as high as **A5** for Contrabass



Observation

Problems

1. Harmony sometimes sound weird
2. Insufficient ability to control note range
3. Only satisfy the basic requirement without further instruction



Future work

1. Refine the prompt engineering to improve the performance and quality of generated content
2. Use of external tools — realize its own limit. Need backend processing to execute the codes
3. Fine tuning (GPT-3.5): collect and feed dataset of high quality ABC notation, reinforcement learning with human feedback.



Demo



32 bar-bach Chorale



A happy and joyful song “Allegro Adventure”



An oriental song with pentatonic scale



An electronic music “Neon Dreams”



A bach style Choir “Leuchtender Glaabe”



A thrill music “Lurking Fears”



A classical piano trio



Questions