Automatic Music Accompanist

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Music Accompanist
Automatic Music Accompanist

Listen to performer

Think what to play

Accompany
Automatic Music Accompanist

Get Soloists Next Input

Determine What State the Performer is in

Generate Accompaniment
Automatic Music Accompanist

Get Soloists Next Input

Determine What State the Performer is in

Generate Accompaniment
Input
Automatic Music Accompanist

Get Soloists Next Input

Determine What State the Performer is in

Generate Accompaniment
Hidden Markov Models
Hidden Markov Models

- Hidden states
- Observation states

Diagram:

- States connected with arrows indicating transitions.
- States are labeled with notes from the whole tone scale.
- Octave and whole tone interval representation.

Legend:

- C
- C#
- D
- D#
- E
- F
- F#
- G
- G#
- A
- A#
- B
- C'
Hidden Markov Models

Hidden states

Observation states

Time: t-m, t-1, t, t+1, t+2, t+3, t+n

Ghost states

Normal states

Whole tone interval

Octave

Hidden States

Time \( t-m \) \( t-1 \) \( t \) \( t+1 \) \( t+2 \) \( t+3 \) \( t+n \)

Hidden states

Ghost states

Normal states

Music notation:

- \( \text{C major}\)
- \( \text{F major}\)
- \( \text{C minor}\)
- \( \text{F minor}\)
Hidden States

Correct

Ghost states

Normal states

Note missed

Ghost states

Normal states

Wrong note

Ghost states

Normal states

Extra note

Ghost states

Normal states
Hidden States

- Hidden states
- Ghost states
- Normal states

Time: t-m, t-1, t, t+1, t+2, t+3, t+n
Hidden States

- Time: t-m, t-1, t, t+1, t+2, t+3, t+n
- States:
  - Ghost states
  - Normal states

Algorithm window

Last sentence/phrase beginning

Next sentence/phrase beginning
Fast decoding algorithm

\[ q_{1:t} = \arg\max_{Q_{1:T}} P(Q_{1:T} \mid o_{1:T}, \lambda) = \arg\max_{Q_{1:T}} P(Q_{1:T}, o_{1:T} \mid \lambda) \]

\[ \lambda = (\pi, A, B) \]

\[ o_1 o_2 \ldots o_T \]
Fast decoding algorithm

\[
q_{1:t} = \arg\max_{Q_{1:T}} P(Q_{1:T} | o_{1:T}, \lambda) = \arg\max_{Q_{1:T}} P(Q_{1:T}, o_{1:T} | \lambda)
\]

\[
\delta_t(i) = \max_{q_{1:t-1}} P(q_{1:t-1}, q_t = S_i, o_{1:t} | \lambda)
\]

\[
\lambda = (\pi, A, B)
\]

\[
o_1 o_2 \ldots o_T
\]
Fast decoding algorithm

\[ \delta_t(i) = \max_{Q_{1:t-1}} Pr(Q_{1:t-1}, o_{1:t}, Q_t = S_i \mid \lambda) \]

\[ \delta_{t+1}(i) = \max_{Q_{1:t}} Pr(Q_{1:t}, o_{1:t+1}, Q_{t+1} = S_i \mid \lambda) \]

\[ \delta_{t+1}(i) = \max_{1 \leq j \leq N} (\delta_t(j) A_{ji} b_i(o_{t+1})) \]

\[ \lambda = (\pi, A, B) \]

\[ O_1 O_2 \cdots O_T \]

Complexity

\[ \delta_t(i), \delta_{t+1}(i) \]

\[ N \times N \]
Fast decoding algorithm

\[ \delta_t(i) = \max_{Q_{1:t-1}} Pr(Q_{1:t-1}, o_{1:t}, Q_t = S_i | \lambda) \]

\[ \delta_{t+1}(i) = \max_{Q_{1:t}} Pr(Q_{1:t}, o_{1:t+1}, Q_{t+1} = S_i | \lambda) \]

\[ \delta_{t+1}(i) = b_i(o_{t+1}) \max \{ \max_{j \in \text{nbh}(i)} [\delta_t(j) A_{ji}], \max_j [\delta_t(j) \mu] \} \]

Complexity

\[ \delta_t(i), \delta_{t+1}(i) \quad \text{W x N} \]
Automatic Music Accompanist

Get Soloists Next Input

Determine What State the Performer is in

Generate Accompaniment
Accompanist

1. What to play?
2. When to play?
3. How fast/slow?
4. How loud?
Accompanist

1. What to play?  
   Rule based match

2. When to play?  
   Dynamic volume changing

3. How fast/slow?  
   Beat tracking

4. How loud?  
   Dynamic volume changing
Program with GUI

MAIN SYSTEM
At System Start-Up
This is the main body of the program. This section repeats continuously with every new input from the soloist.

MANUAL CONTROLS (FOR DEBUGGING ONLY)
An accompanying software click is turned off by default. This can be changed here.

CURRENT STATE:
13 out of 15
You have reached:
Star
Most recent notes played:
G D E G
Have a try!

- Score
- Embellish
- Errors
- Temp changed
Thank you!