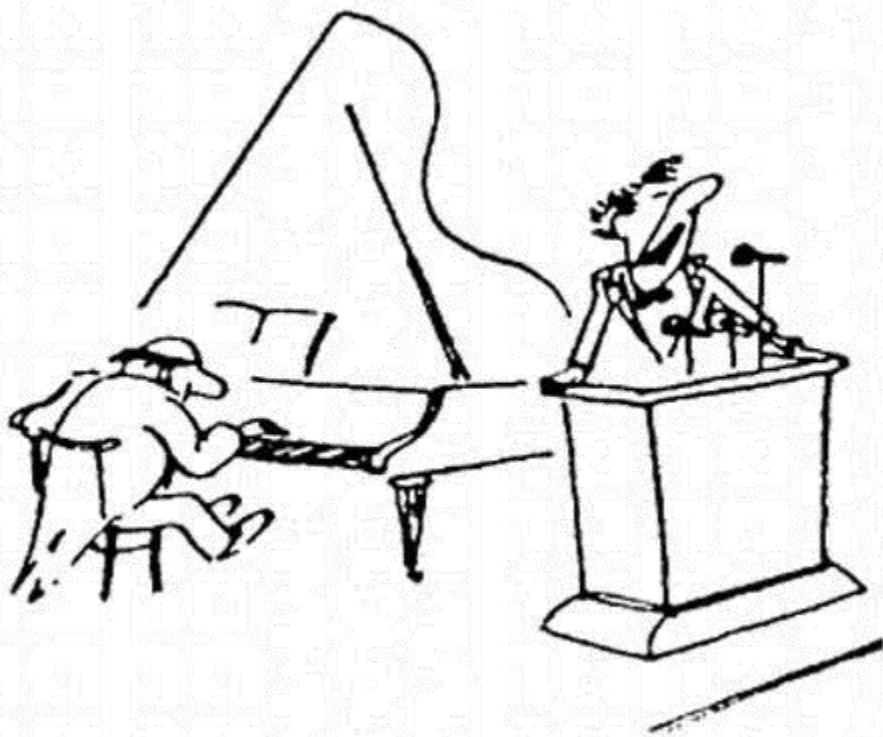


# Automatic Music Accompanist



Anyi Rao

# Music Accompanist



# Automatic Music Accompanist



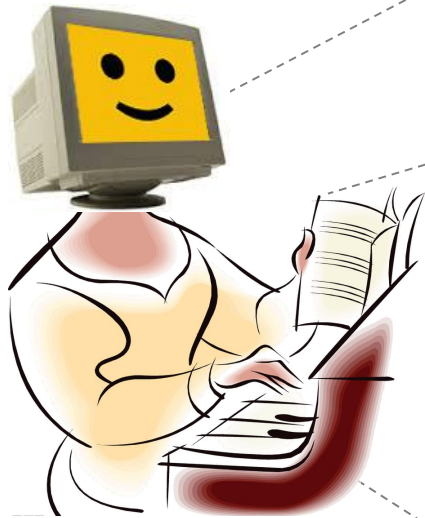
**Listen to performer**

**Think what to play**

**Accompany**



# Automatic Music Accompanist

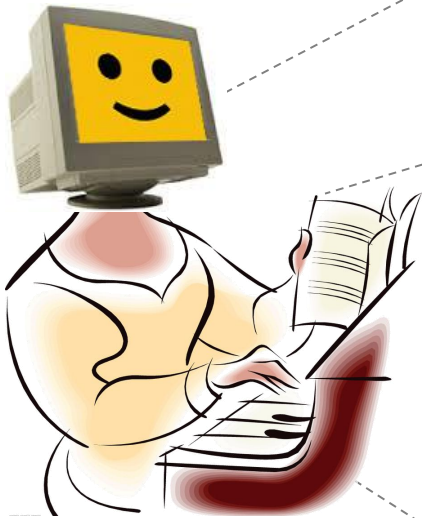


**Get Soloists Next Input**

**Determine What State the Performer is in**

**Generate Accompaniment**

# Automatic Music Accompanist



**Get Soloists Next Input**

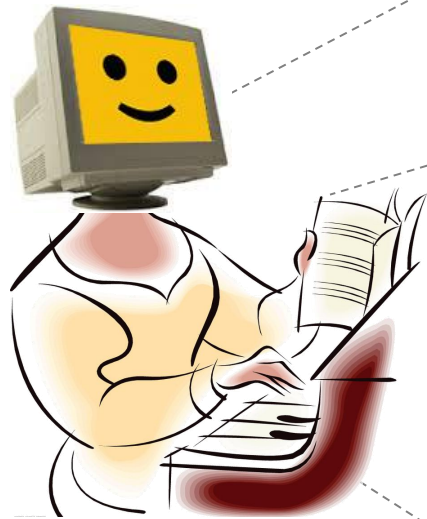
Determine What State the Performer is in

Generate Accompaniment

# Input



# Automatic Music Accompanist

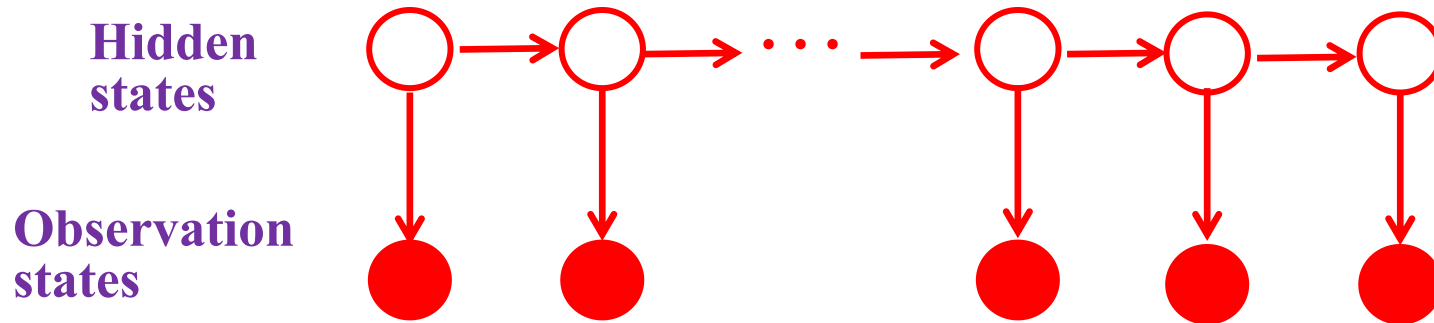


Get Soloists Next Input

**Determine What State the Performer is in**

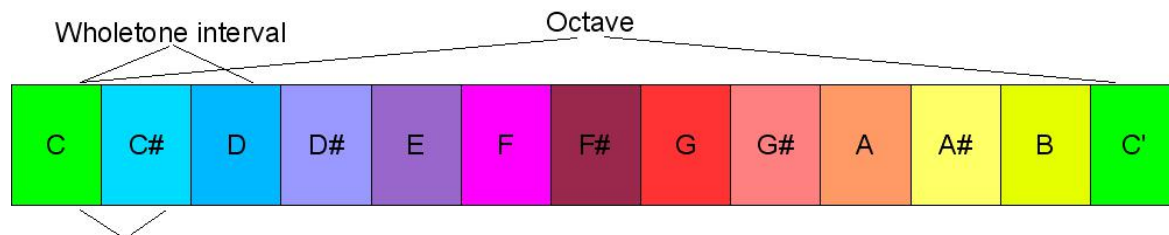
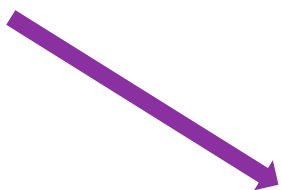
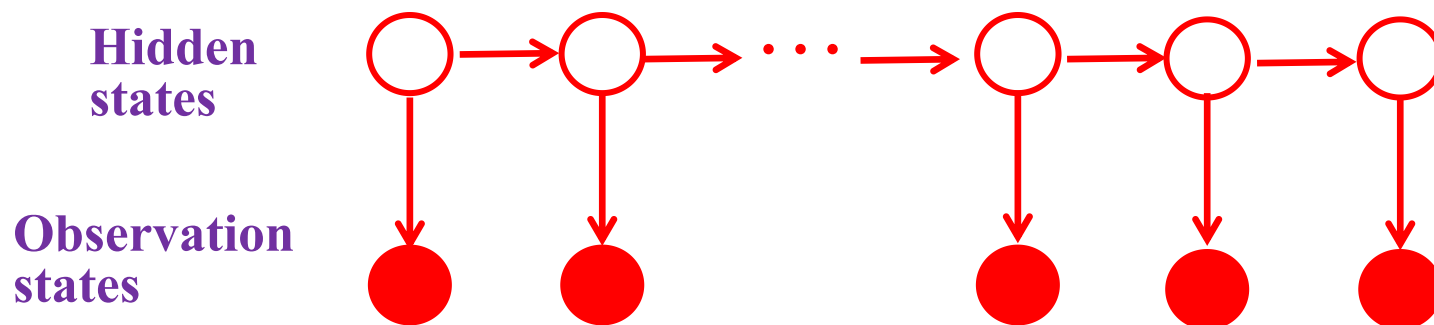
Generate Accompaniment

# Hidden Markov Models

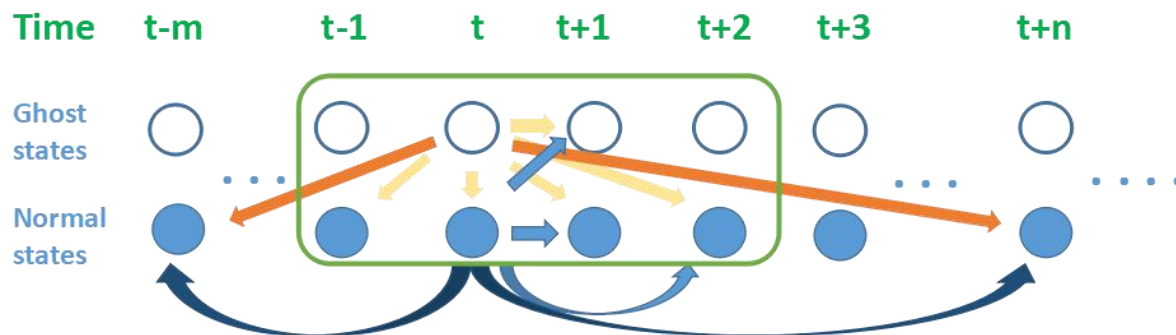




# Hidden Markov Models

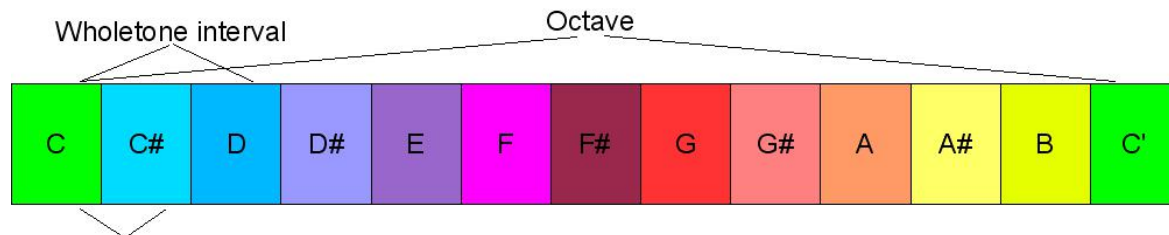
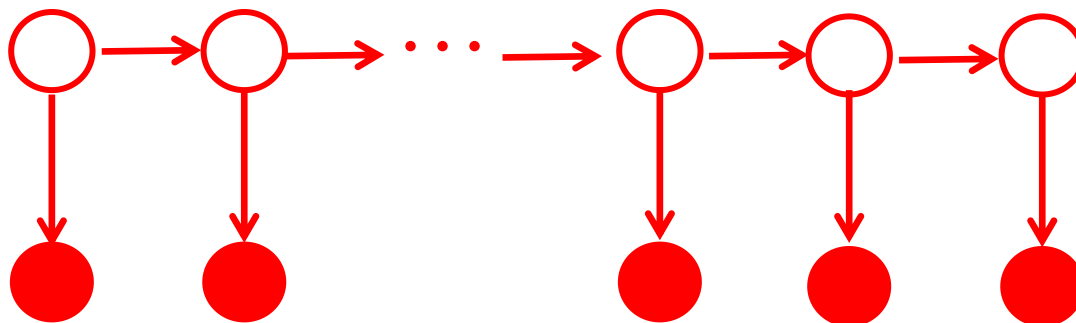


# Hidden Markov Models



Hidden states

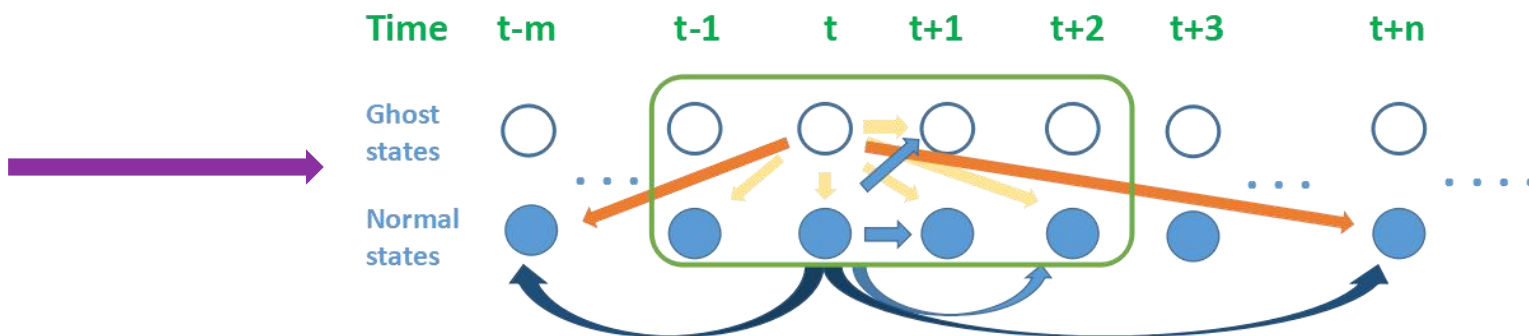
Observation states



# Hidden States



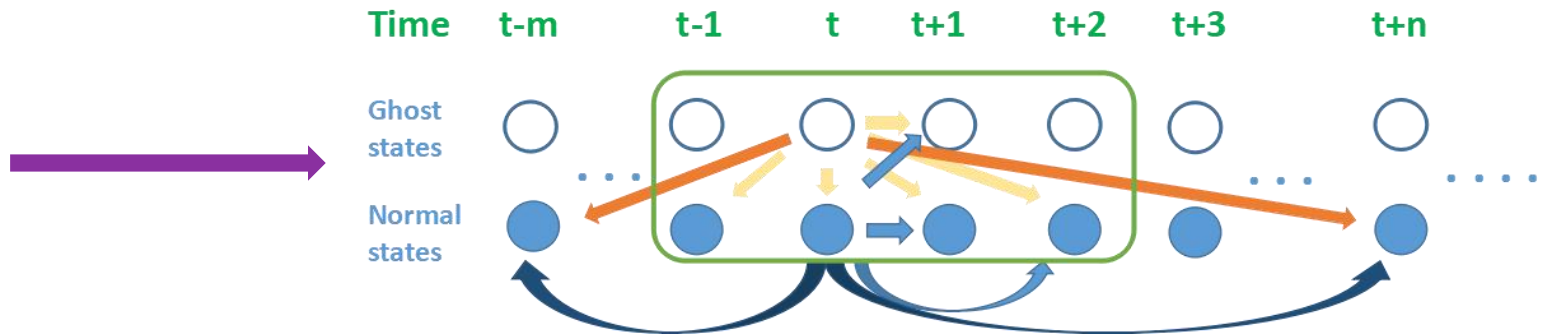
Hidden  
states



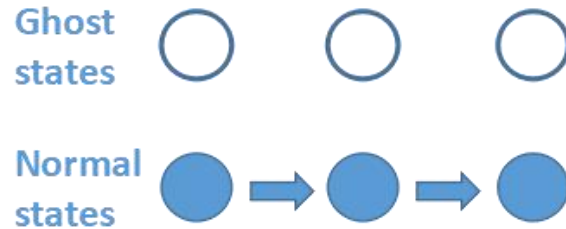
# Hidden States



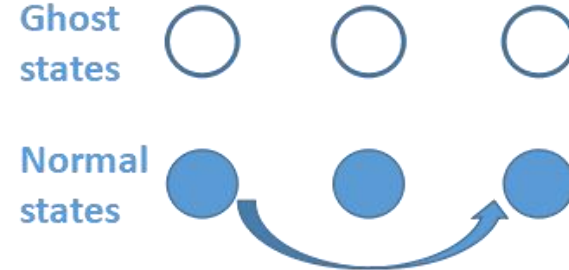
Hidden states



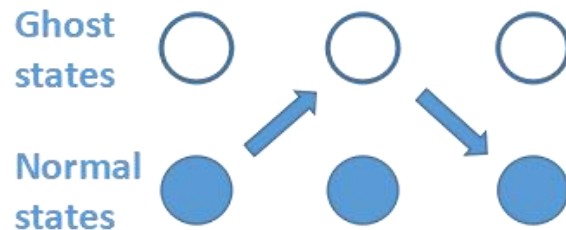
Correct



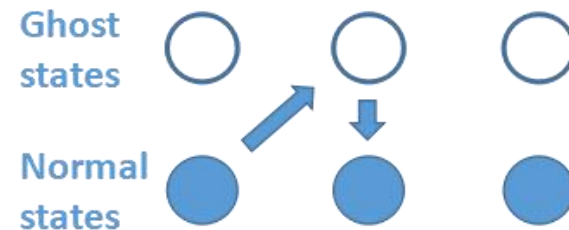
Note missed



Wrong note



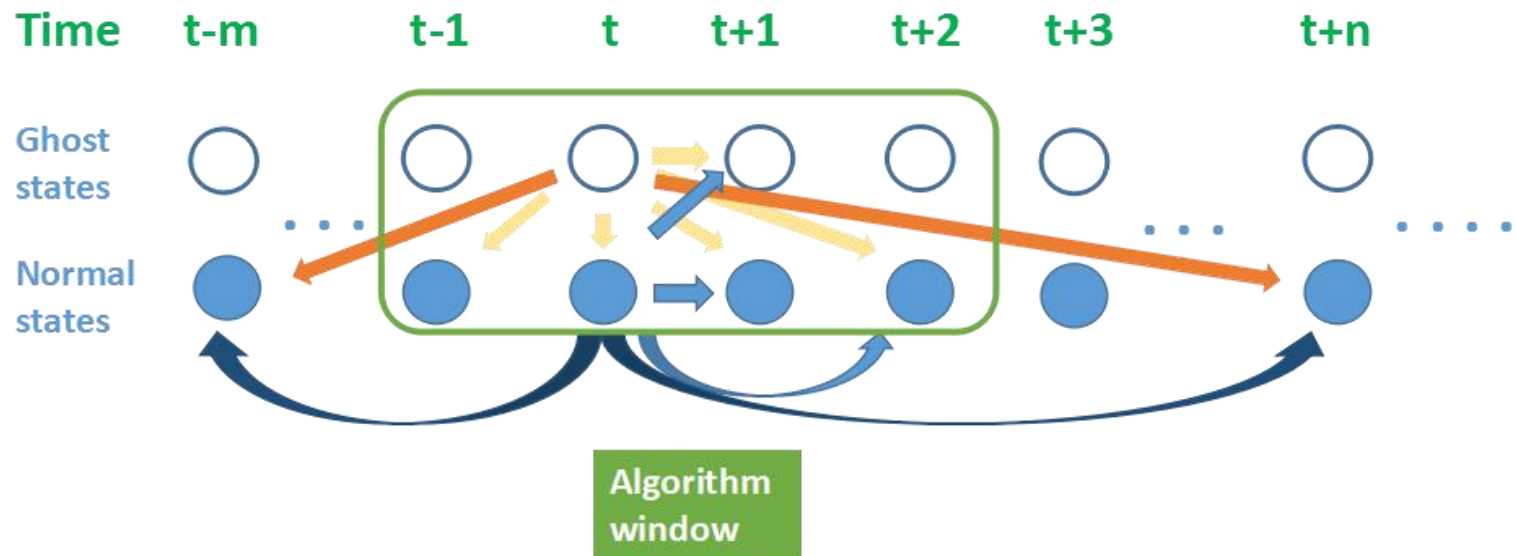
Extra note



# Hidden States



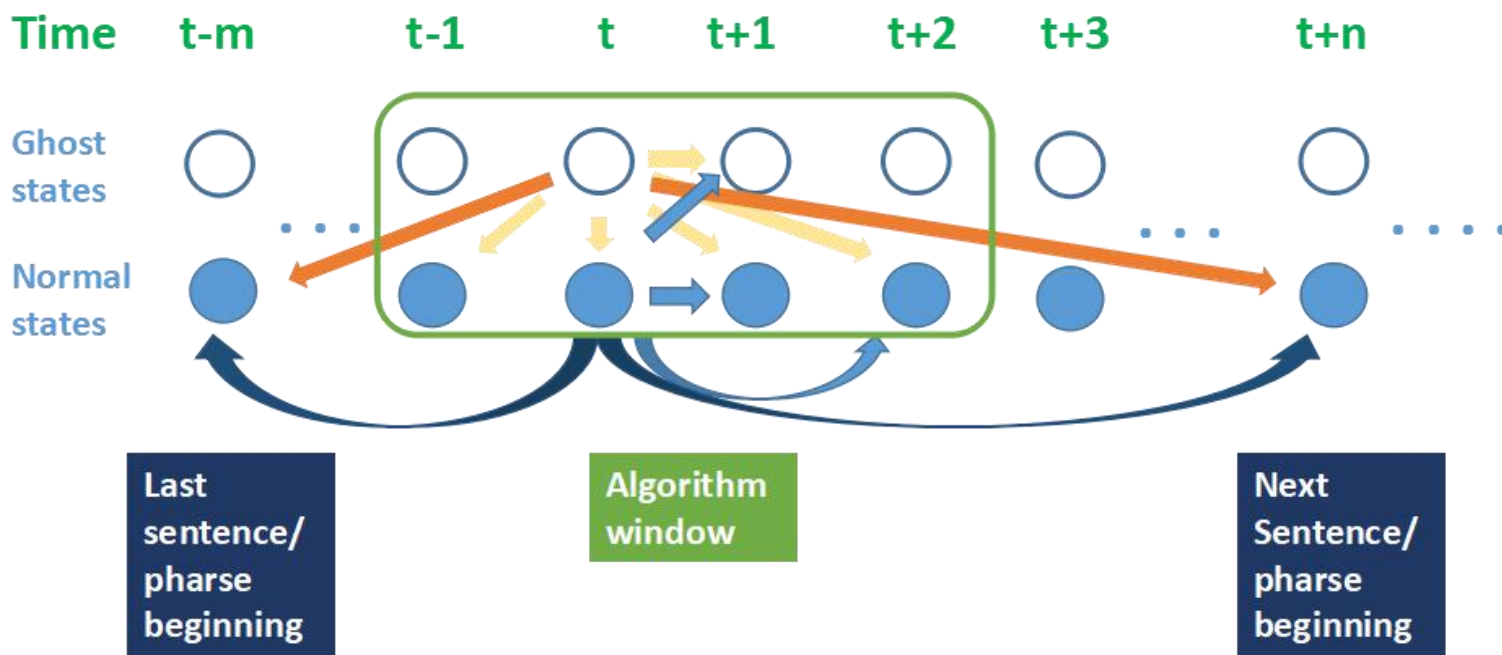
Hidden  
states



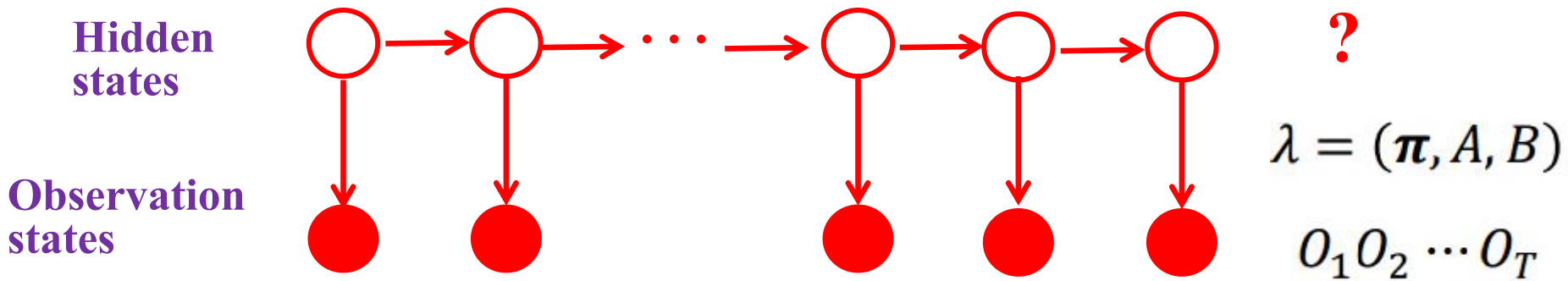
# Hidden States



Hidden  
states

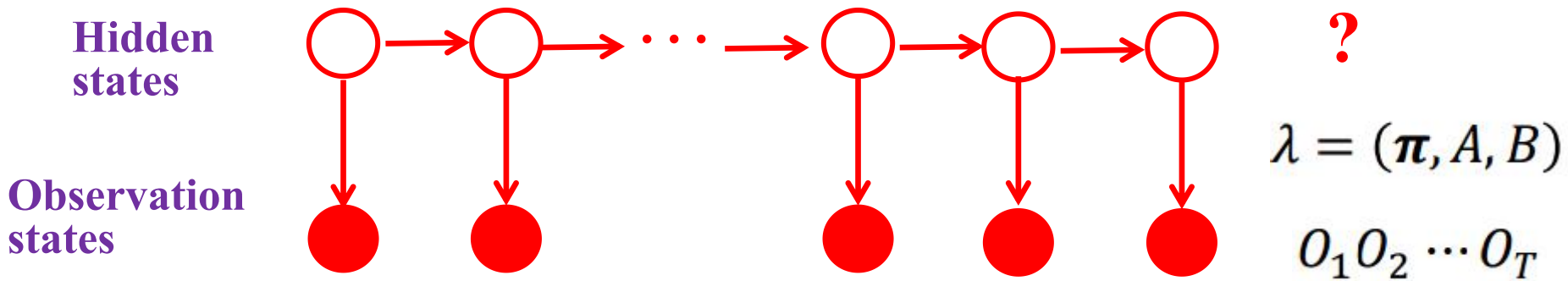


# Fast decoding algorithm



$$q_{1:t} = \underset{Q_{1:T}}{\operatorname{argmax}} P(Q_{1:T} | o_{1:T}, \lambda) = \underset{Q_{1:T}}{\operatorname{argmax}} P(Q_{1:T}, o_{1:T} | \lambda)$$

# Fast decoding algorithm

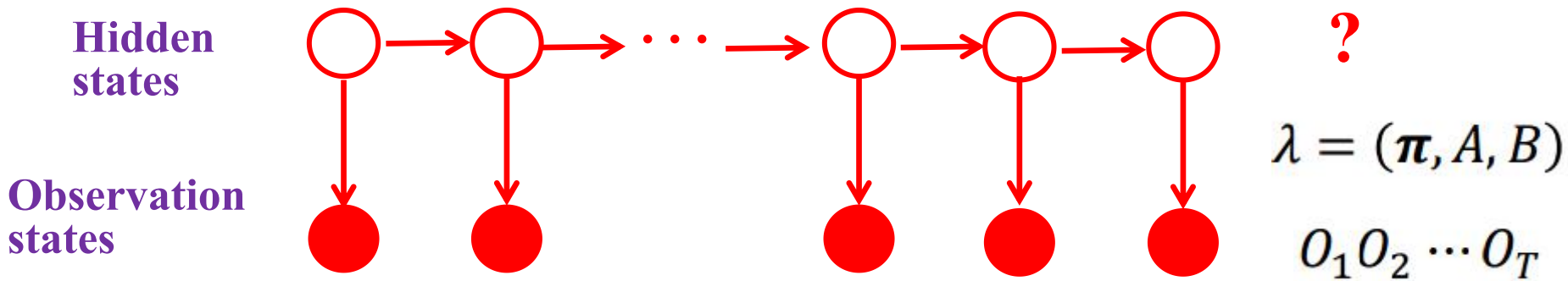


$$q_{1:t} = \operatorname{argmax}_{Q_{1:T}} P(Q_{1:T} | o_{1:T}, \lambda) = \operatorname{argmax}_{Q_{1:T}} P(Q_{1:T}, o_{1:T} | \lambda)$$

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



# Fast decoding algorithm



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

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

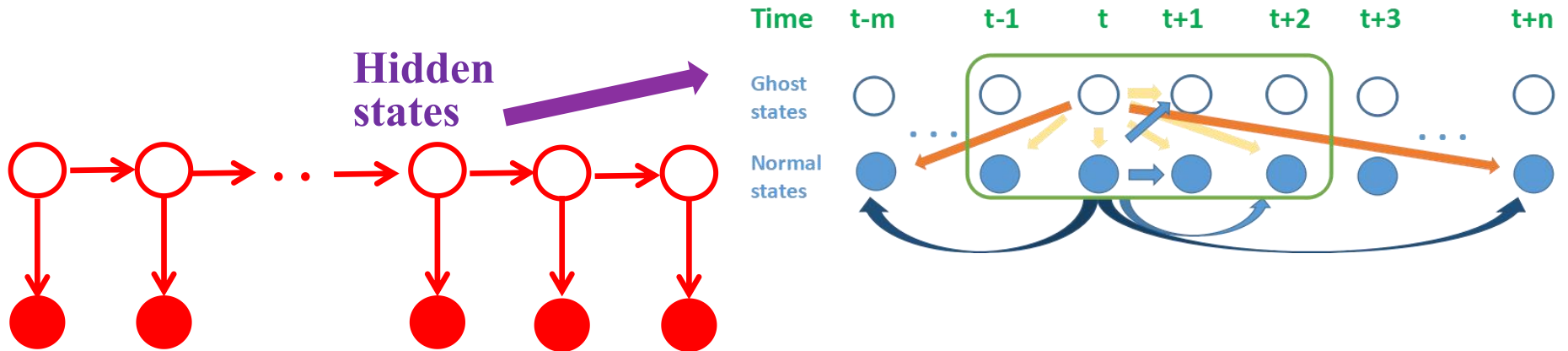
$$\delta_{t+1}(i) = \max_{1 \leq j \leq N} (\delta_t(j) A_{ji} b_i(o_{t+1}))$$

Complexity

$$\delta_t(i) \quad \delta_{t+1}(i)$$

$$\mathbf{N} \times \mathbf{N}$$

# Fast decoding algorithm



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

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

Complexity

$$\delta_t(i) \quad \delta_{t+1}(i)$$

$$\delta_{t+1}(i) = b_i(o_{t+1}) \max \left\{ \max_{j \in nbh(i)} [\delta_t(j) A_{ji}], \max_j [\delta_t(j) \mu] \right\} \mathbf{W} \mathbf{x} \mathbf{N}$$

# Automatic Music Accompanist



# Accompanist



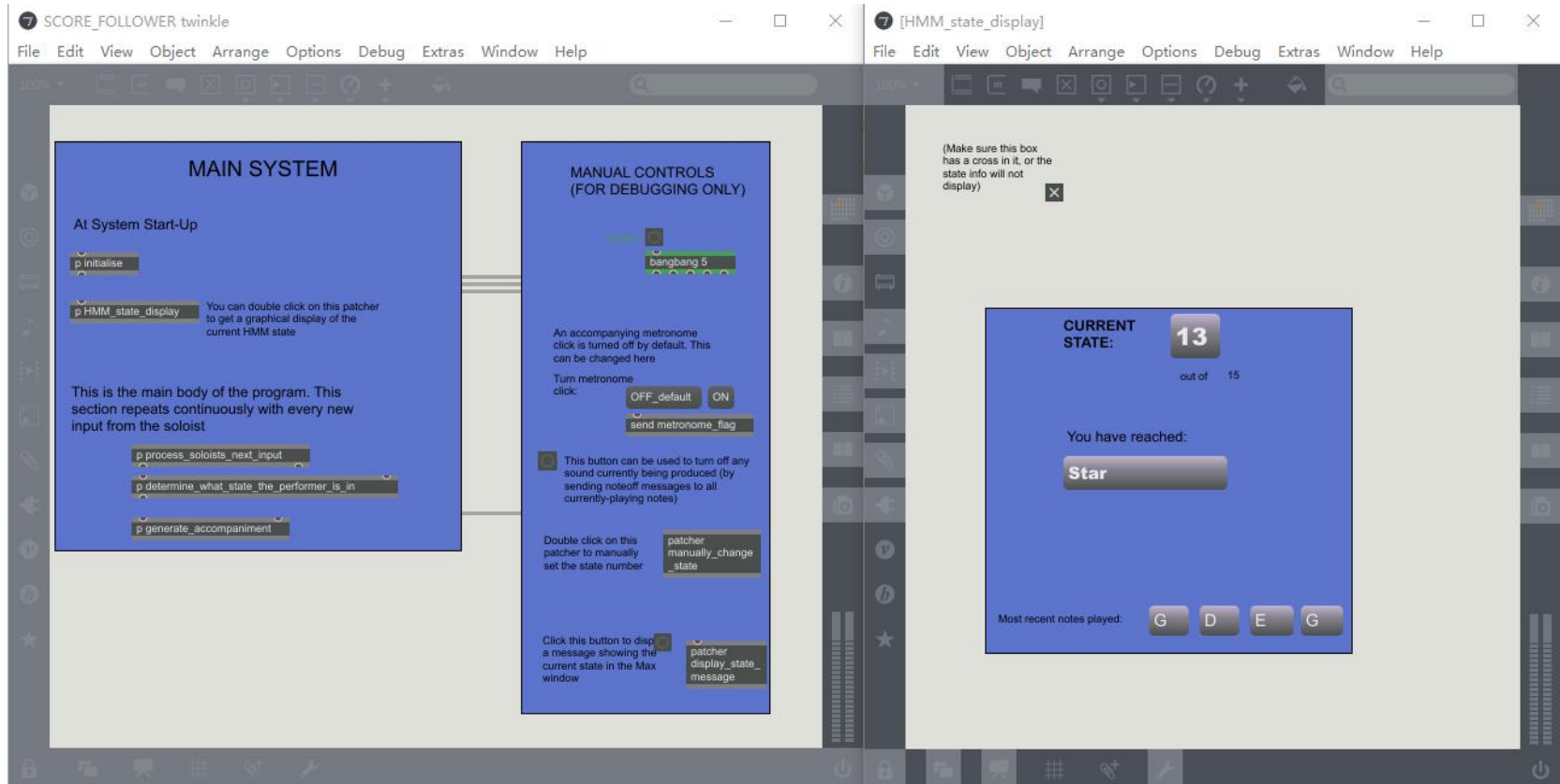
- 1 / What to play?
- 2 / When to play?
- 3 / How fast/slow?
- 4 / How loud?

# 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



# Have a try!



- Score



- Embellish



- Errors



- Temp changed





The University of Hong Kong

**Thank you!**