

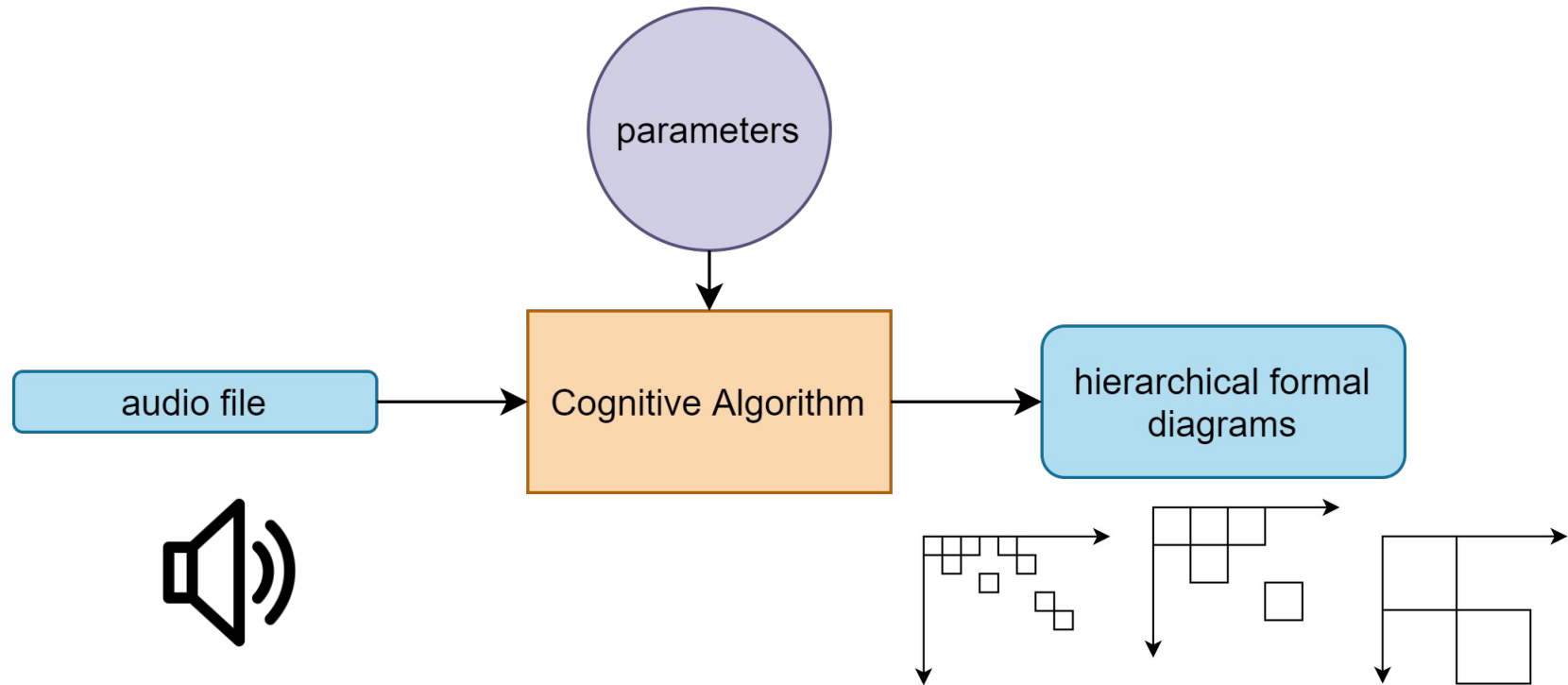
# Mutli-Scale Oracle and automated representation of formal diagrams based on the Cognitive Algorithm

TENOR 2021 - May 10th 2021

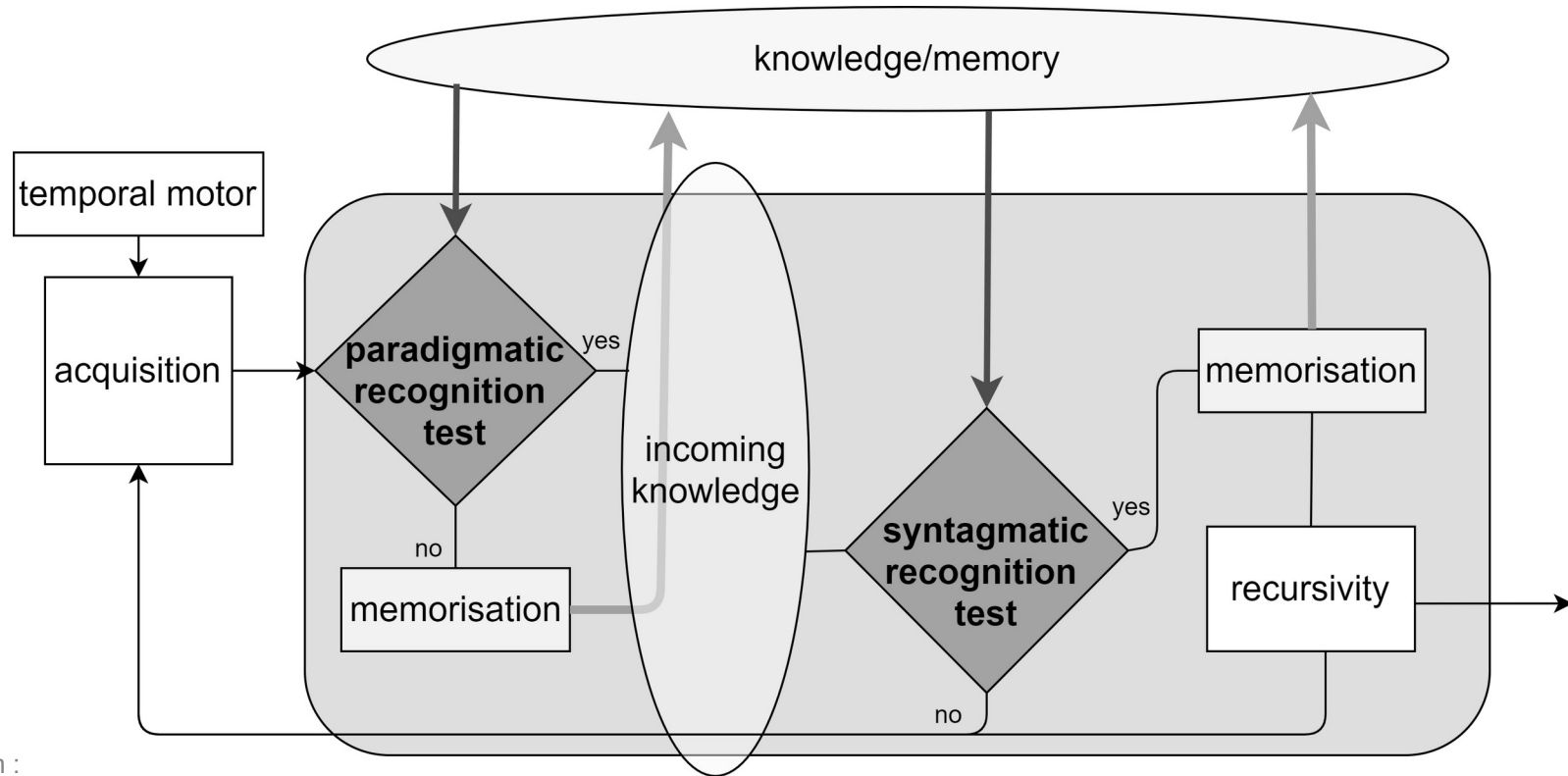
J. Calandra, J.-M. Chouvel, M. Desainte-Catherine



# Cognitive algorithm : main principle

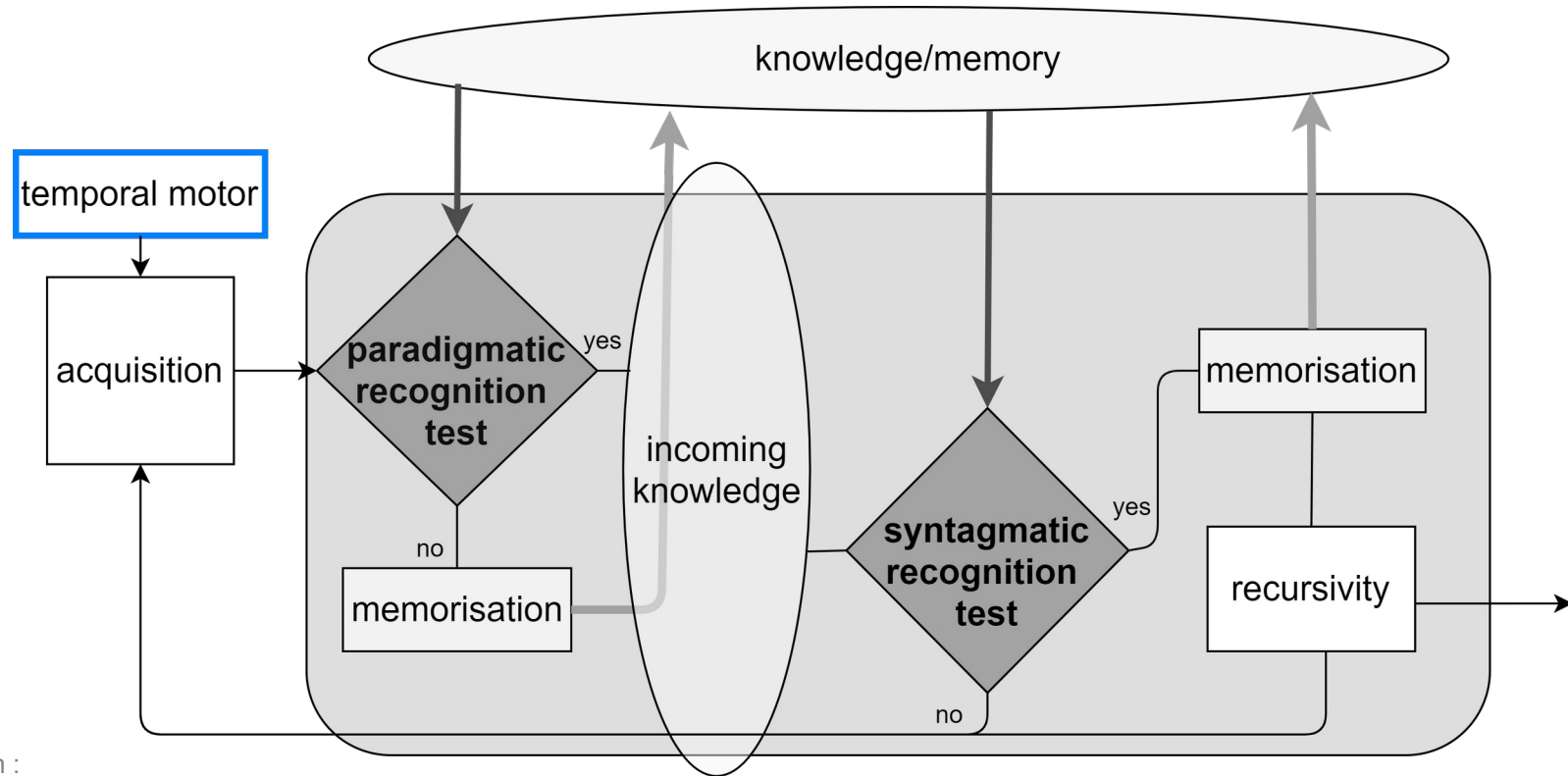


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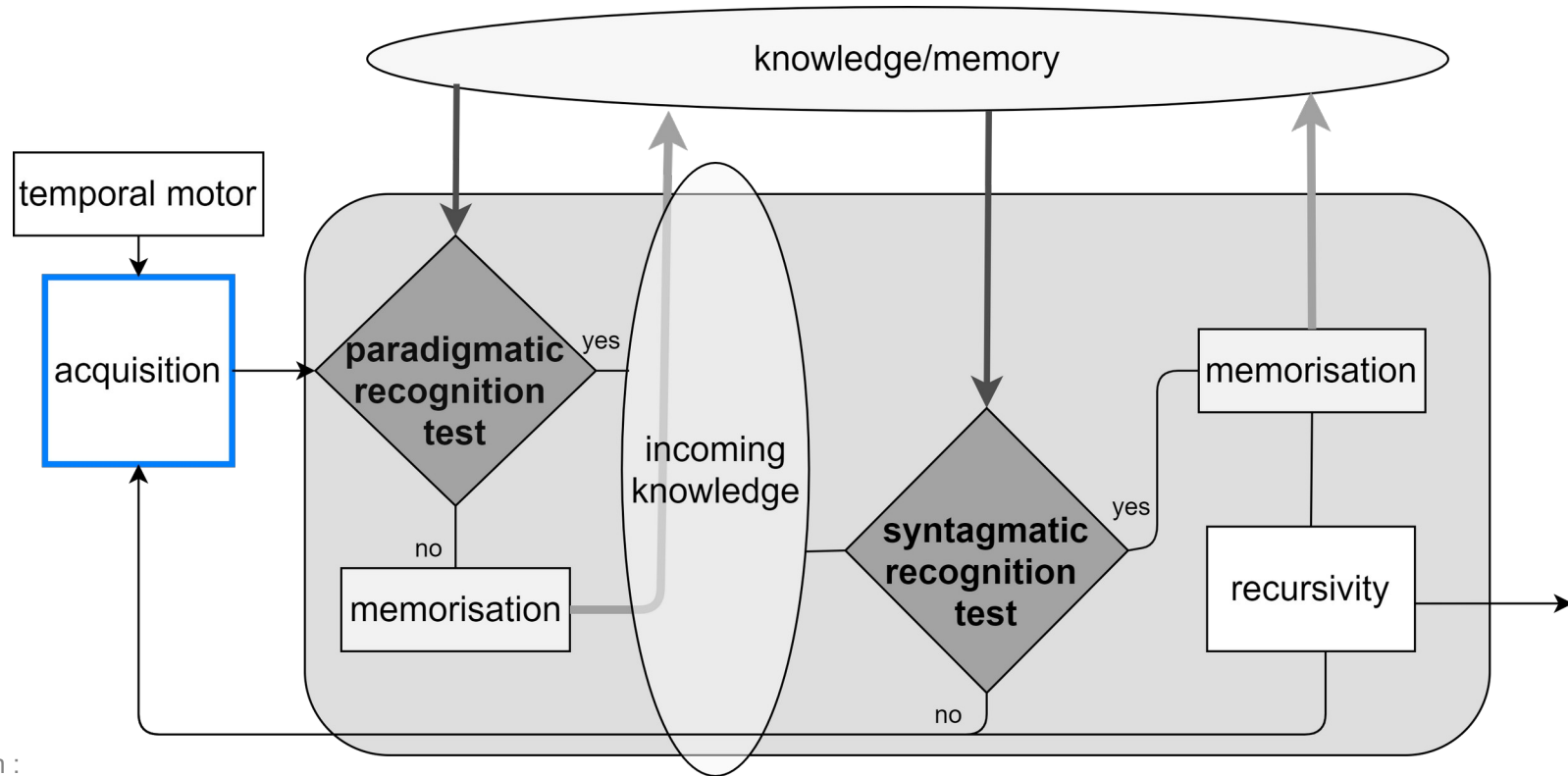
Complete version in :  
J-M. Chouvel, *Categories and representation in cognitive musical analysis*, Sonus, vol. 35, pp. 17–35, 2014.

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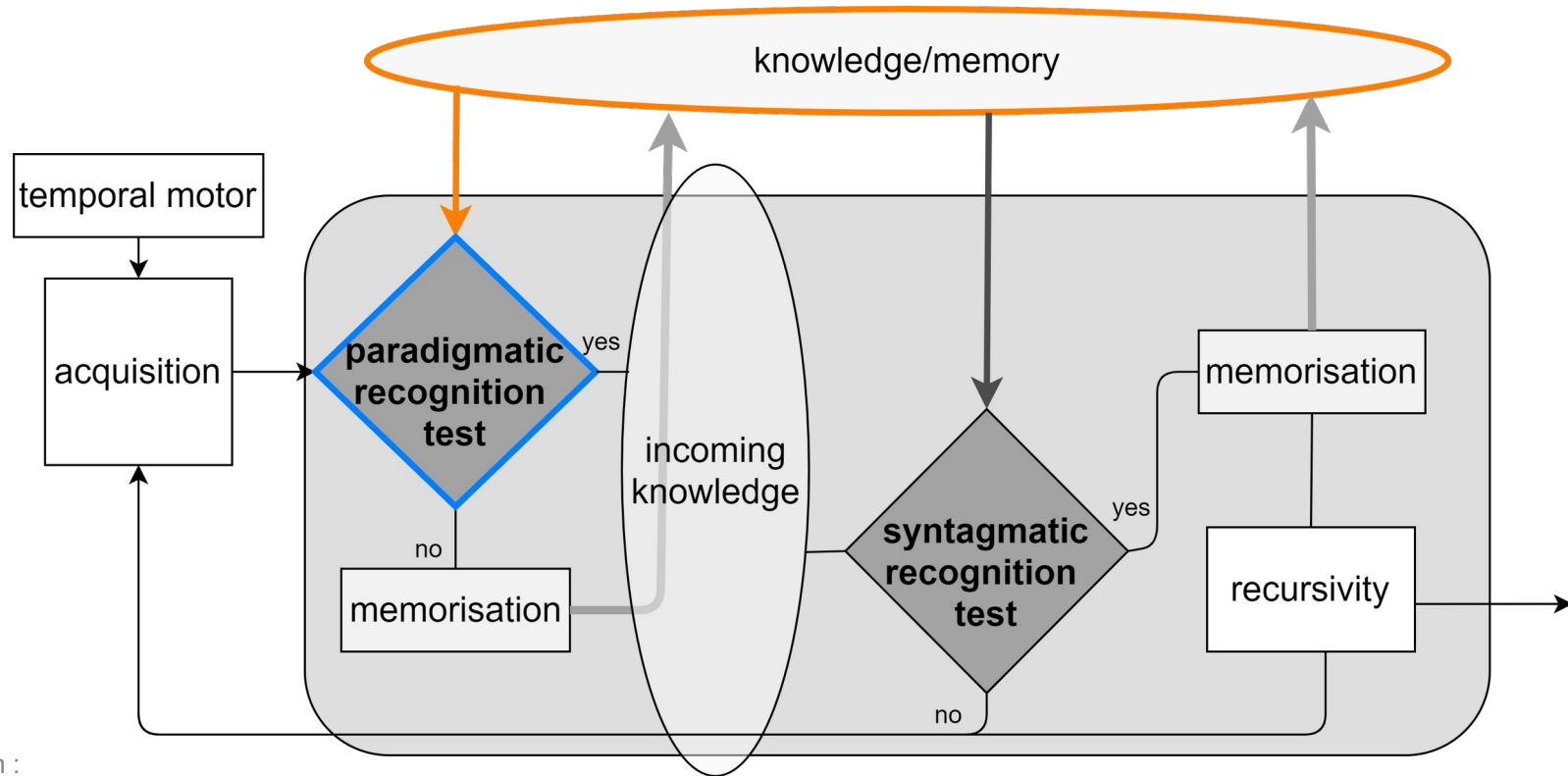
Complete version in :  
J-M. Chouvel, *Categories and representation in cognitive musical analysis*, Sonus, vol. 35, pp. 17–35, 2014.

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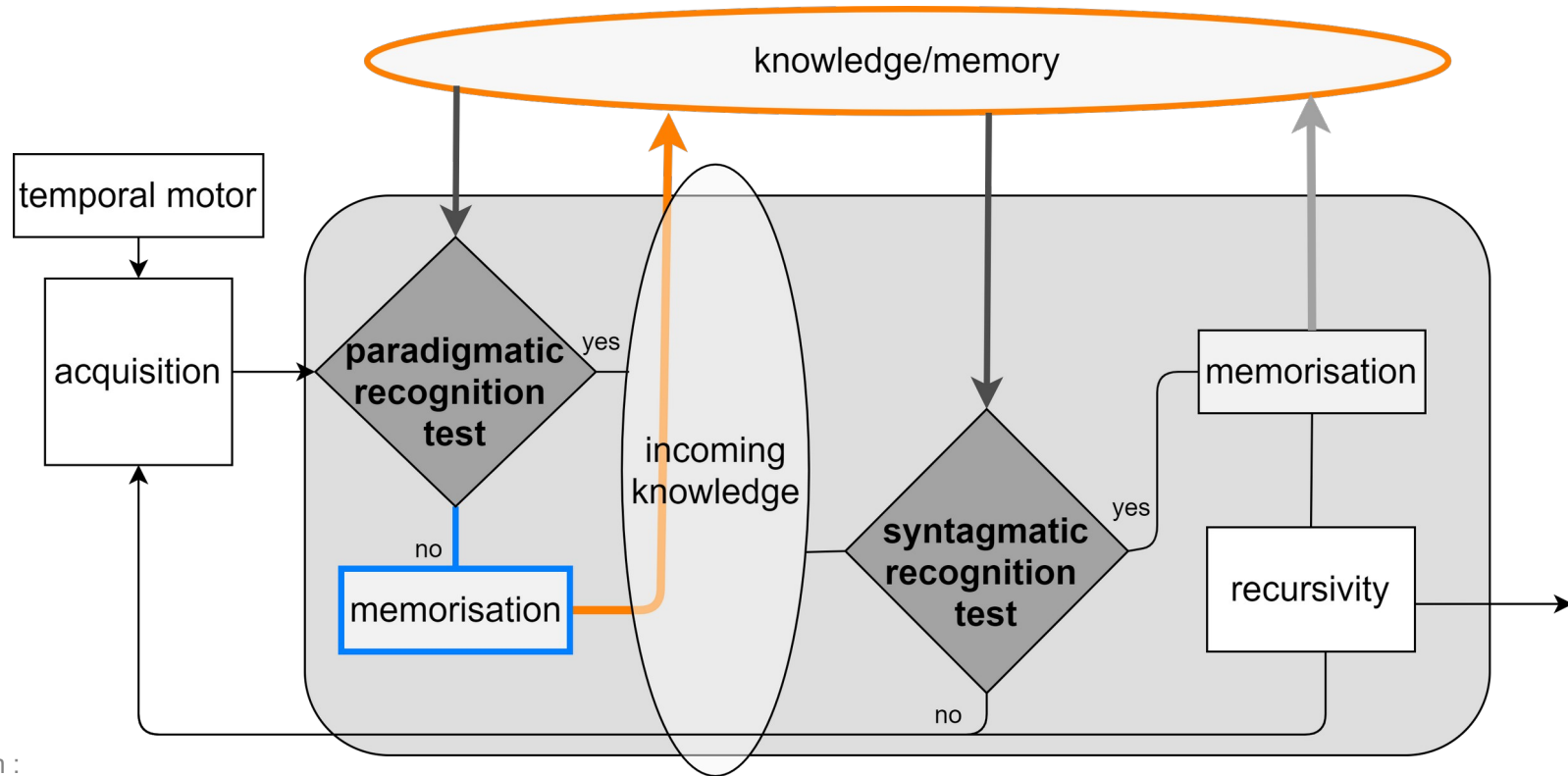
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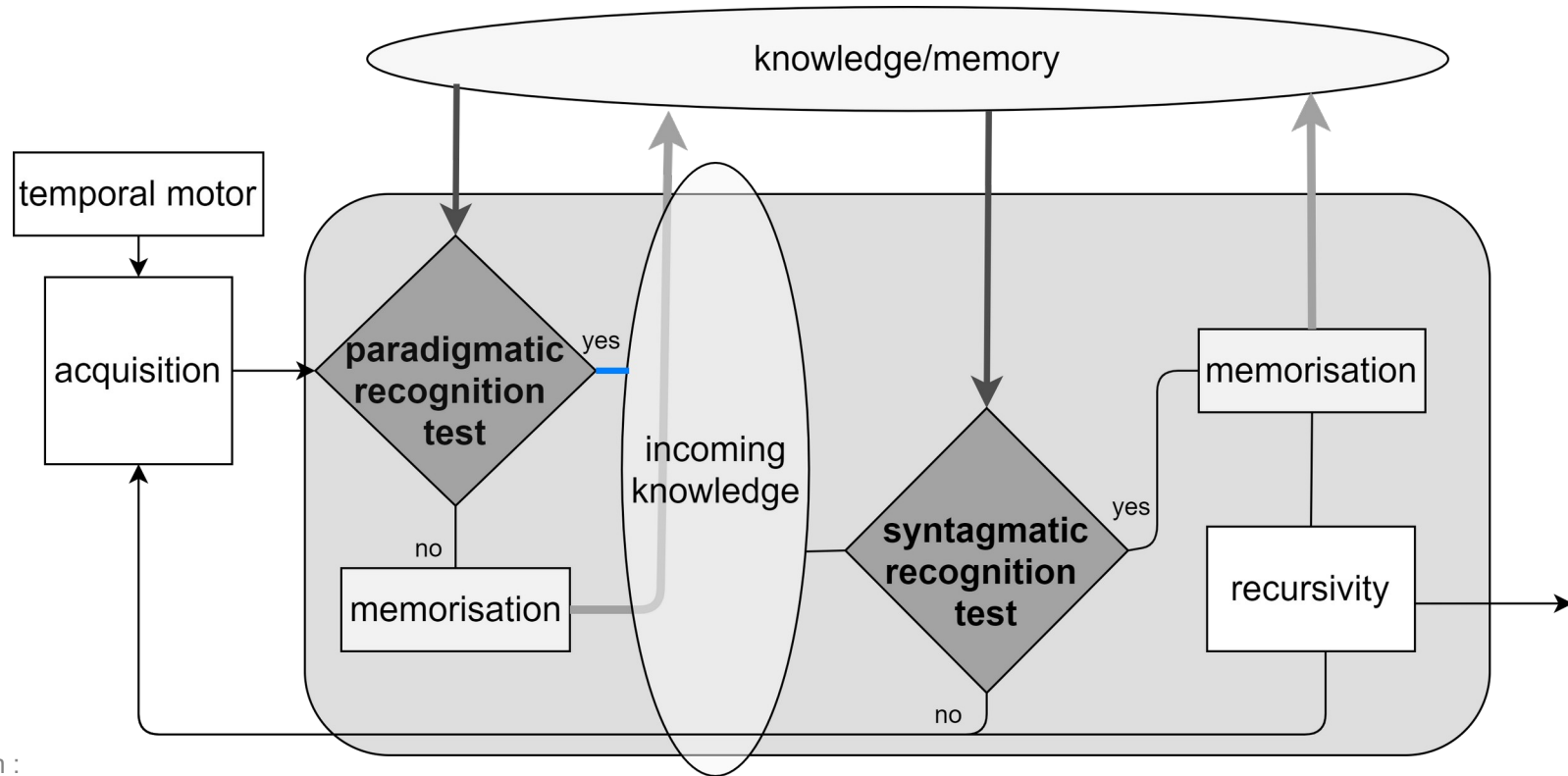
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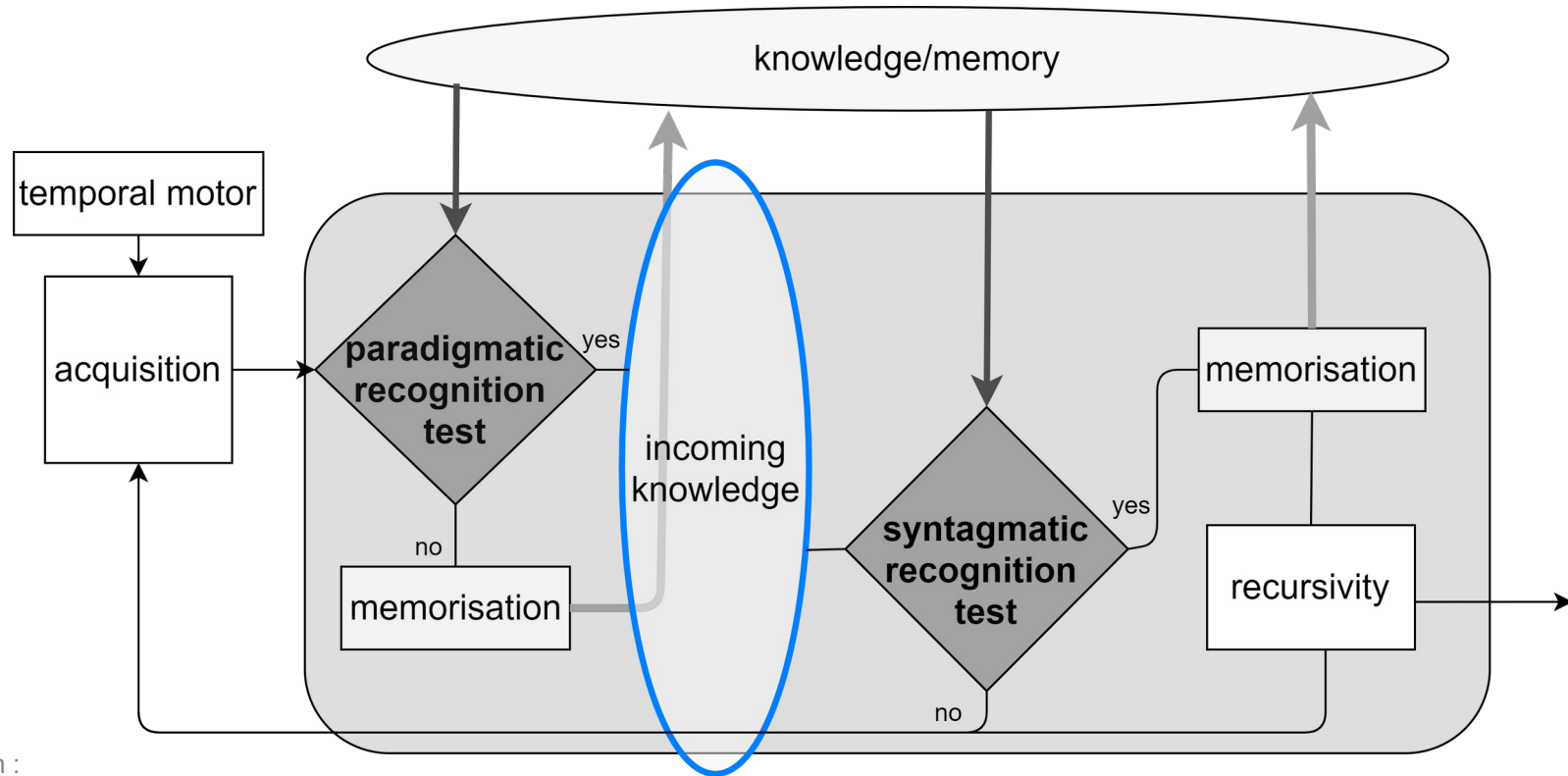
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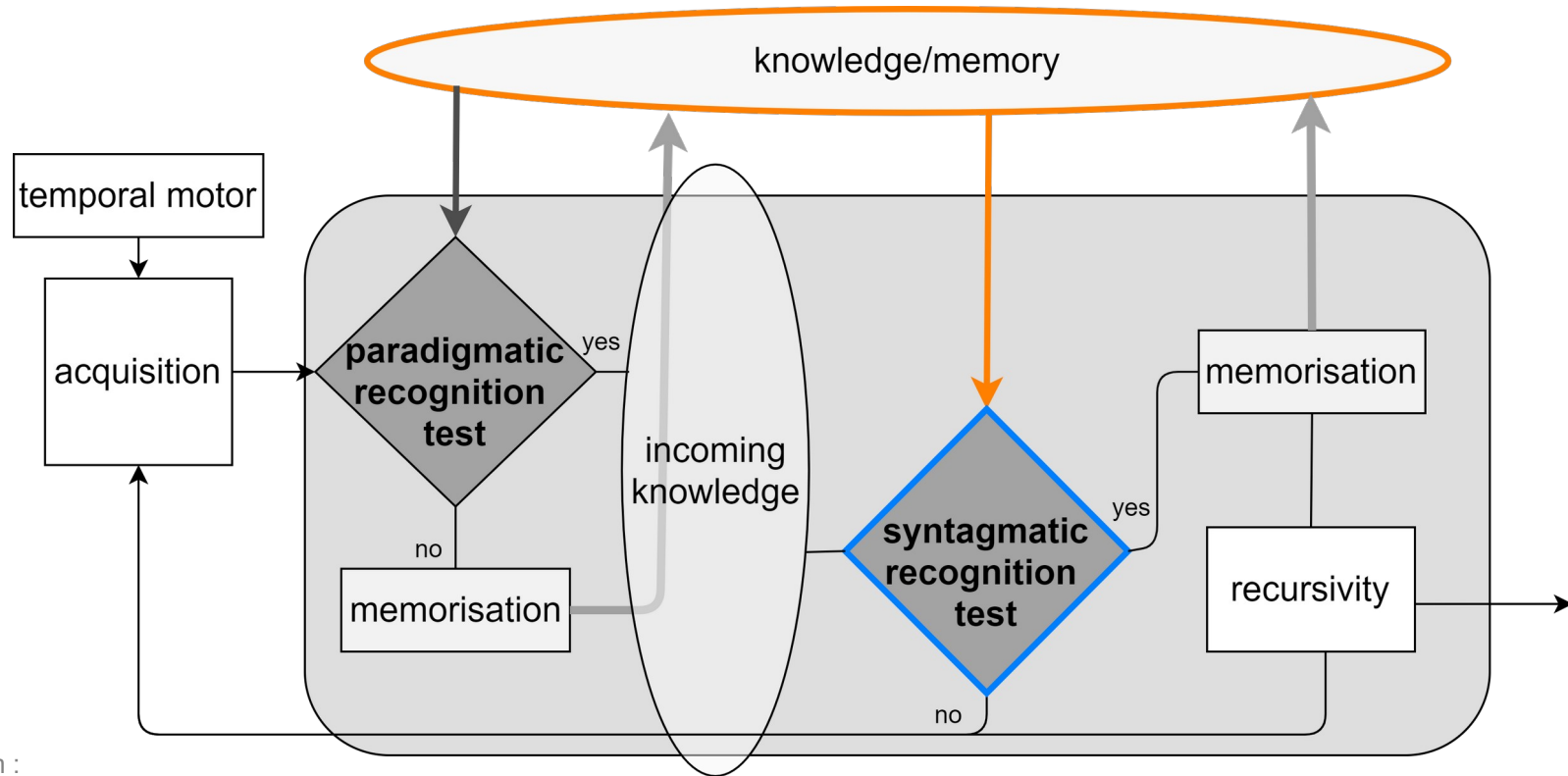
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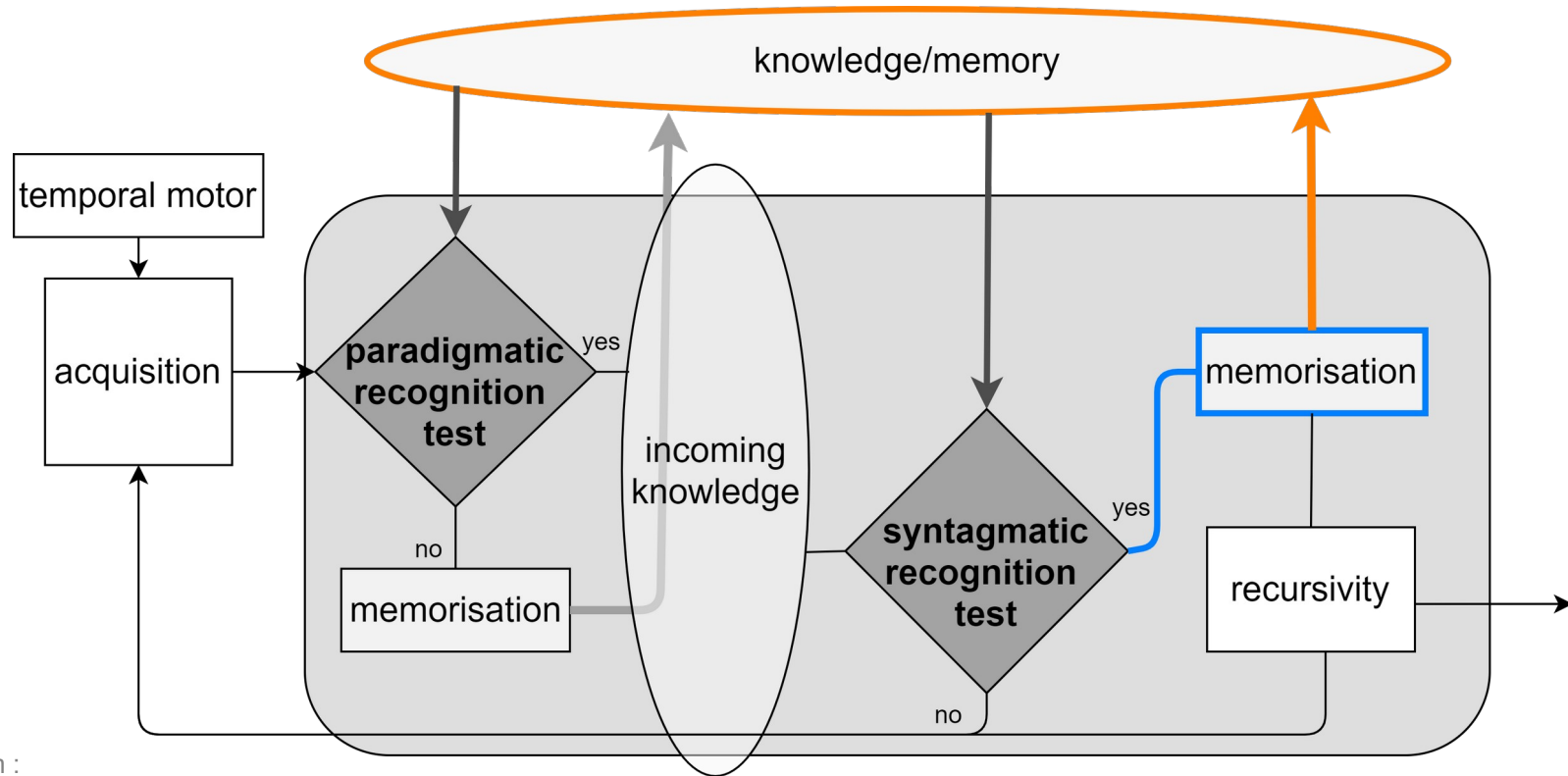
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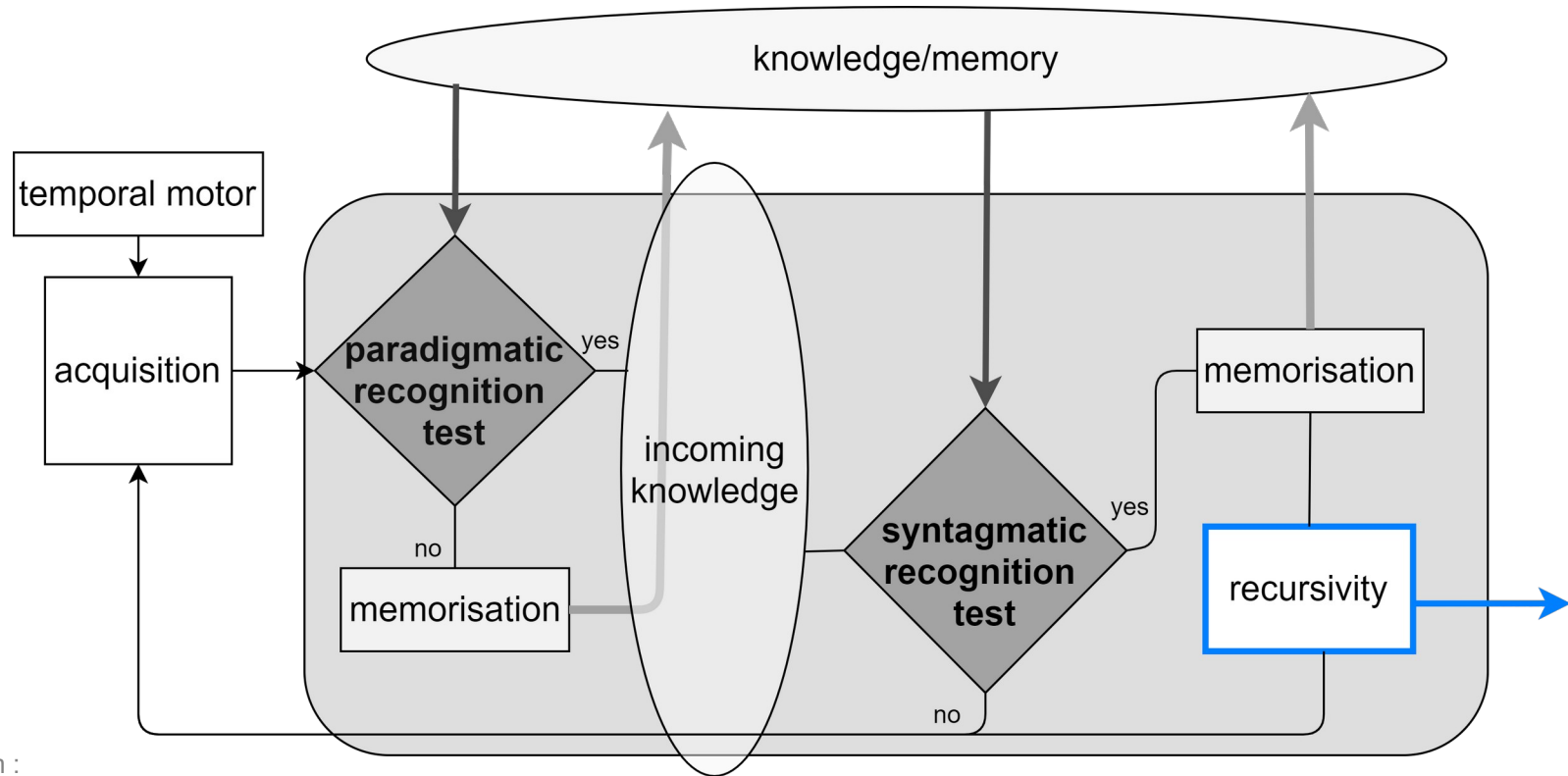
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J-M. Chouvel, *Categories and representation in cognitive musical analysis*, Sonus, vol. 35, pp. 17–35, 2014.

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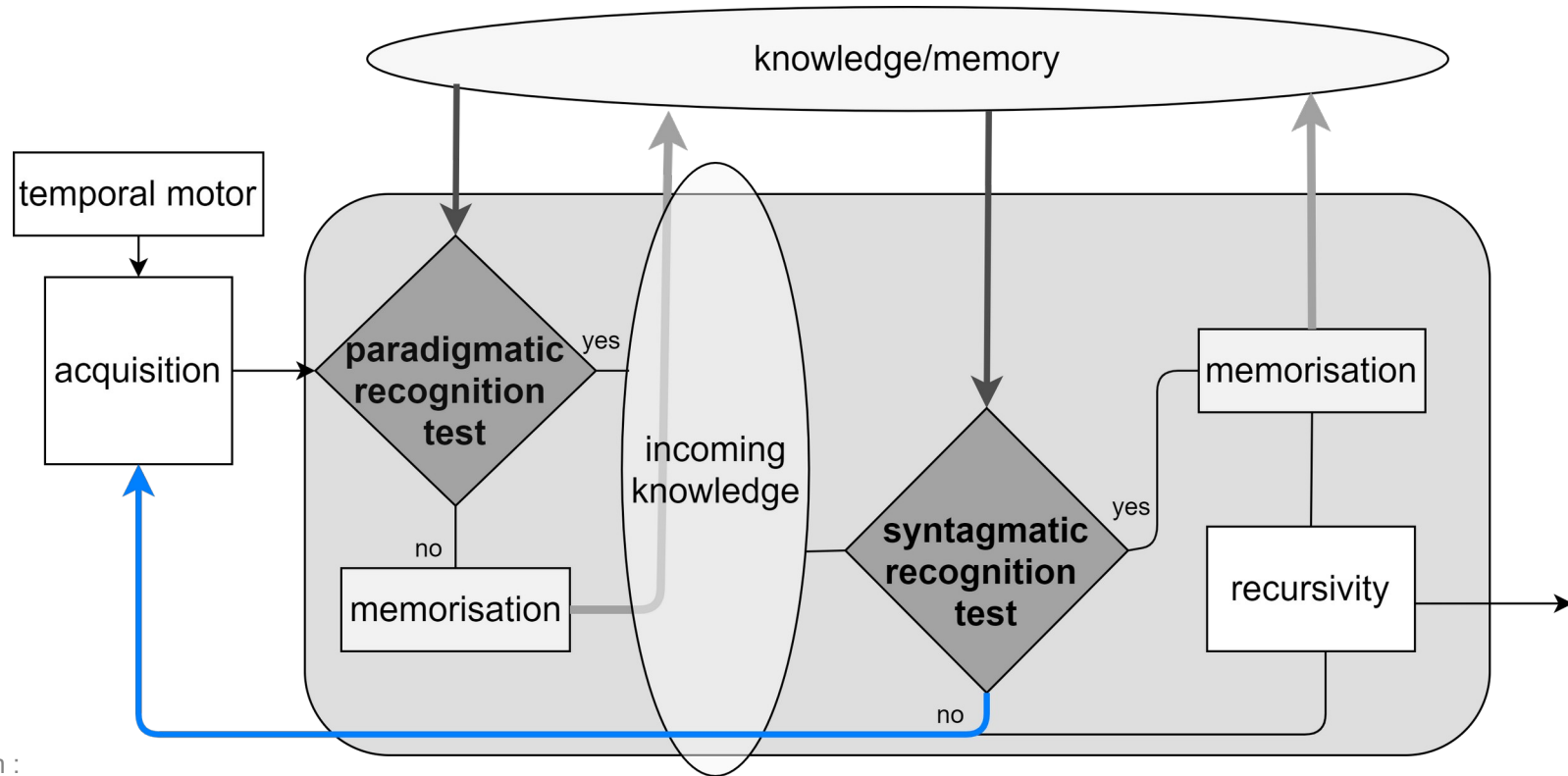
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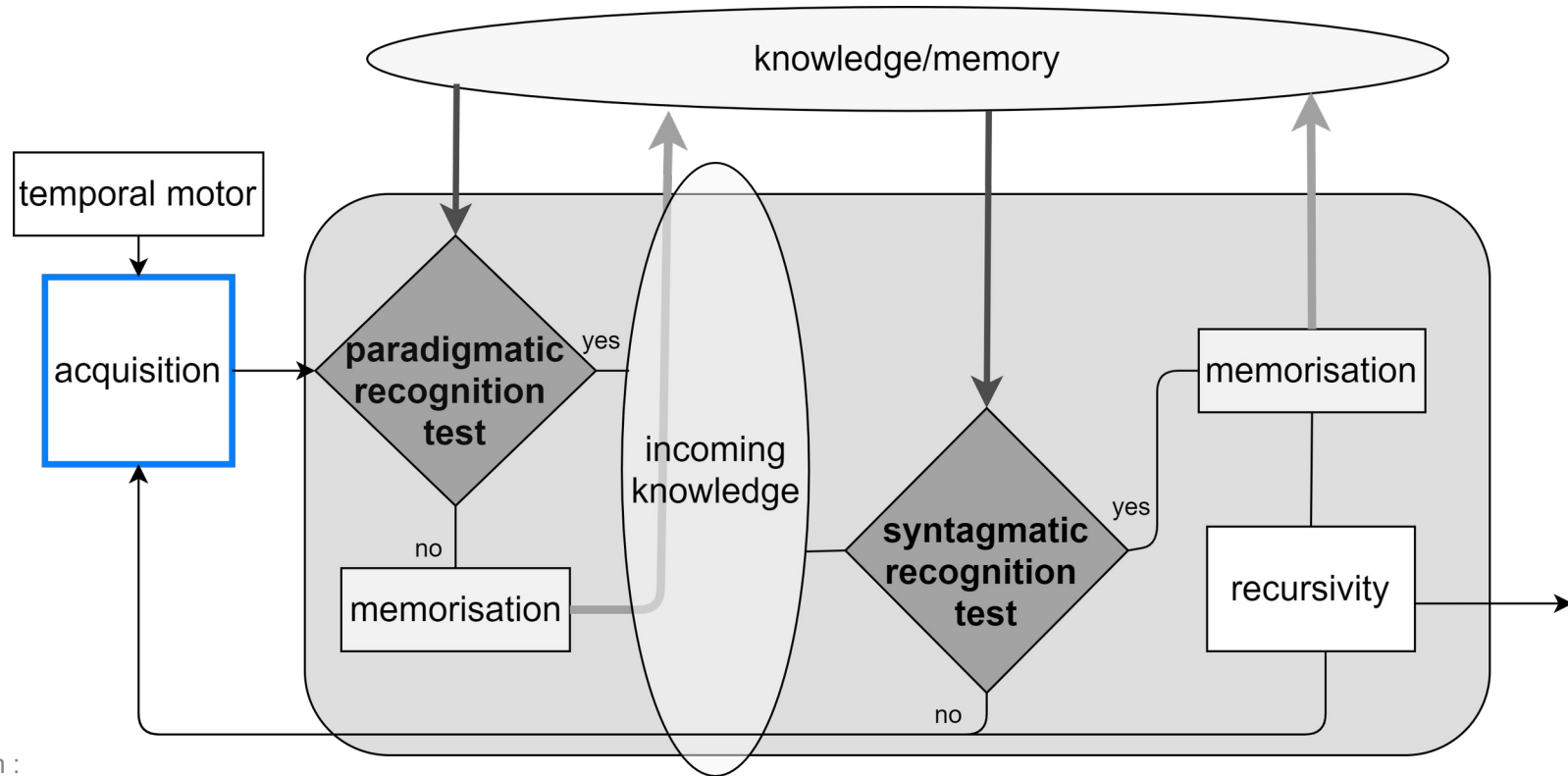
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Complete version in :  
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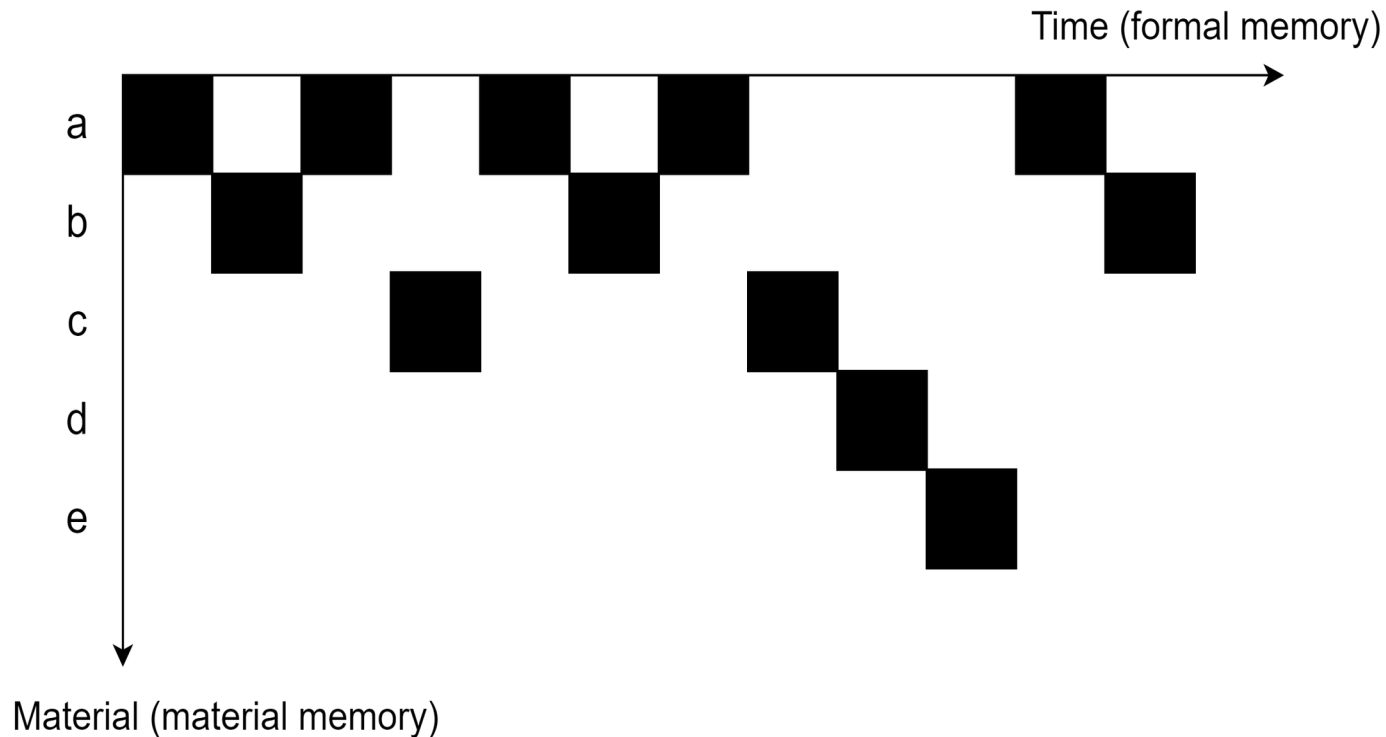
# Cognitive algorithm : main principle



Complete version in :  
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# Cognitive algorithm : objectives

Formal diagram of a piece of music associated with  
the sequence of encoded materials « abacabacdeab »



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Formal diagram of a piece of music associated with  
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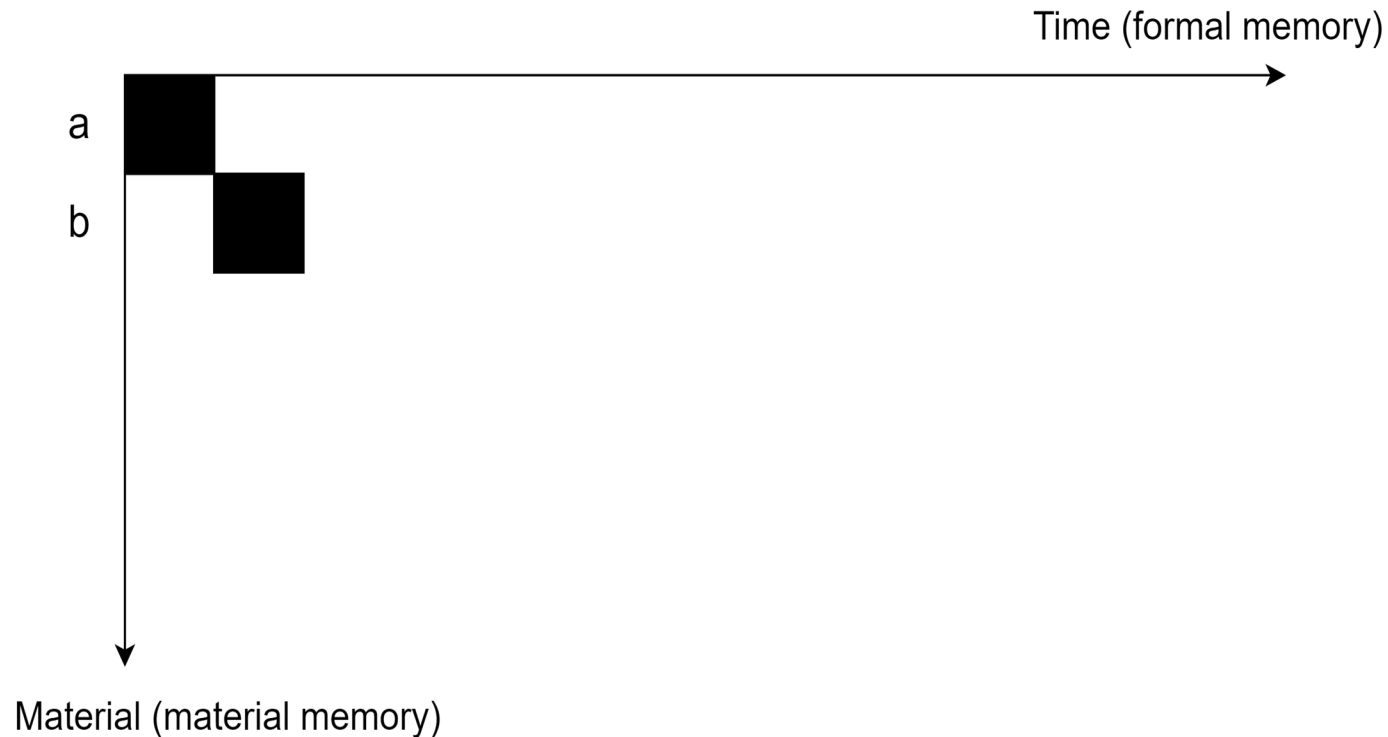
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Formal diagram of a piece of music associated with  
the sequence of encoded materials « abacabacdeab »



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Formal diagram of a piece of music associated with  
the sequence of encoded materials « abacabacdeab »



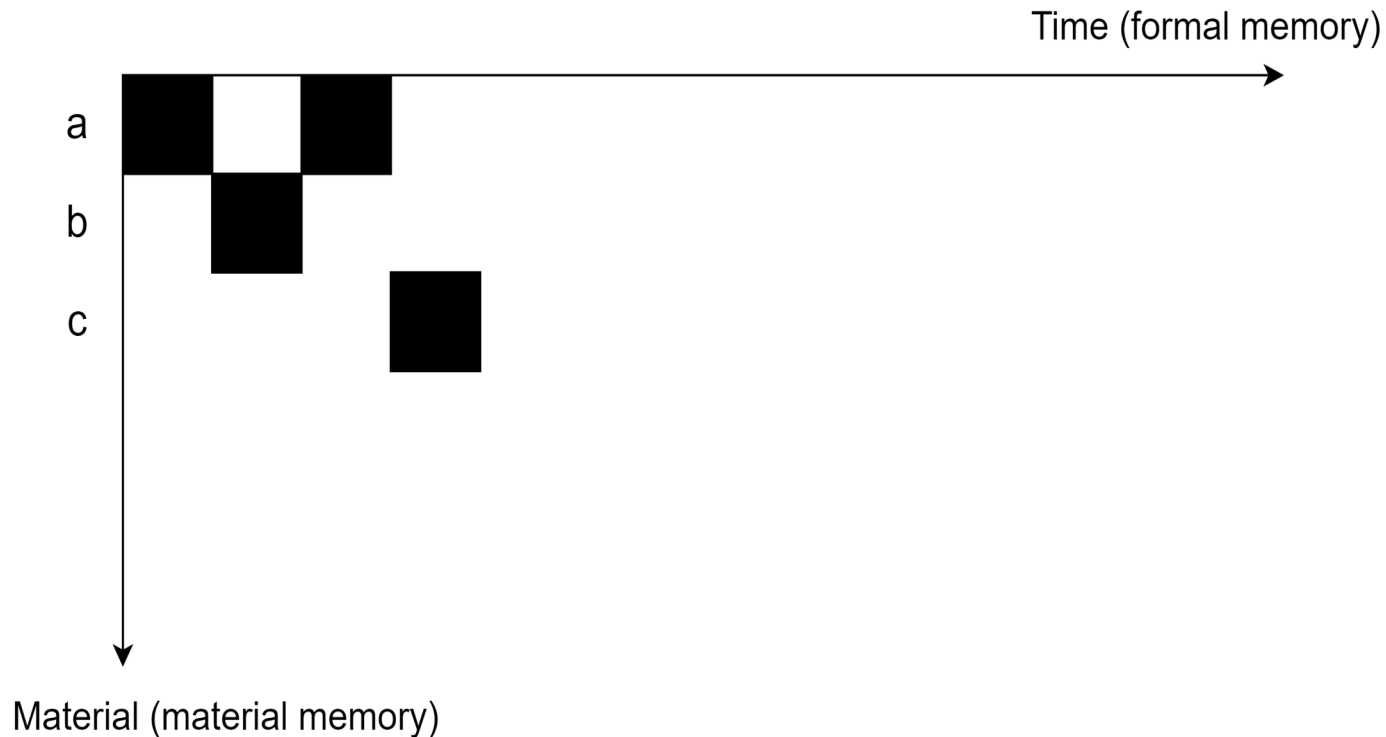
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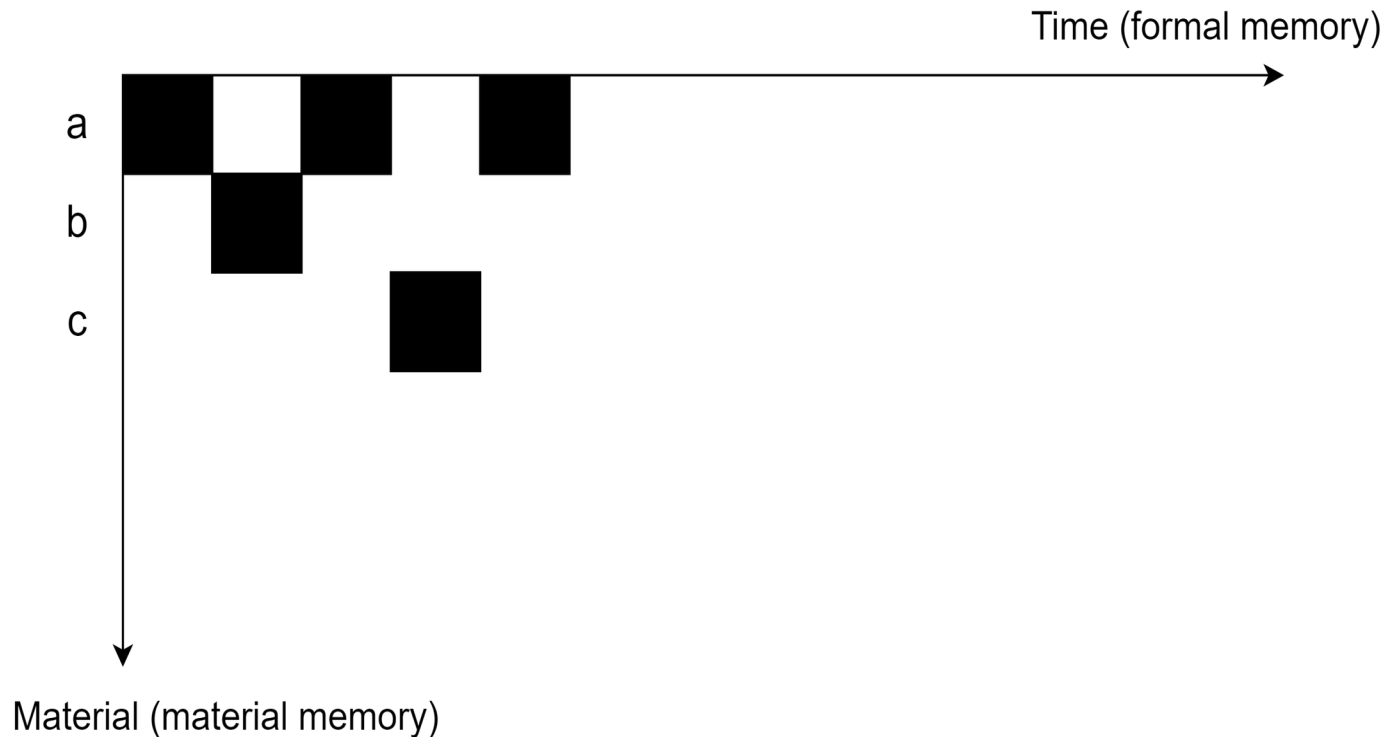
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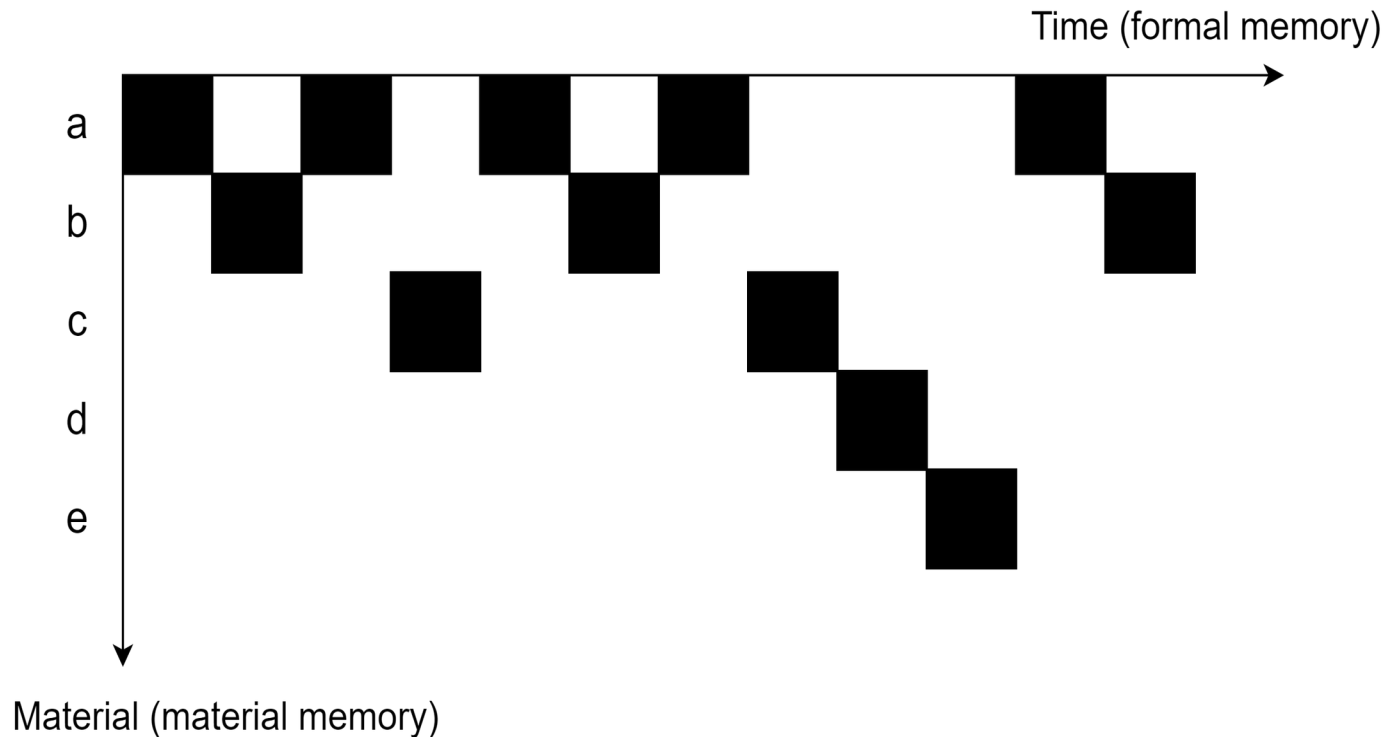
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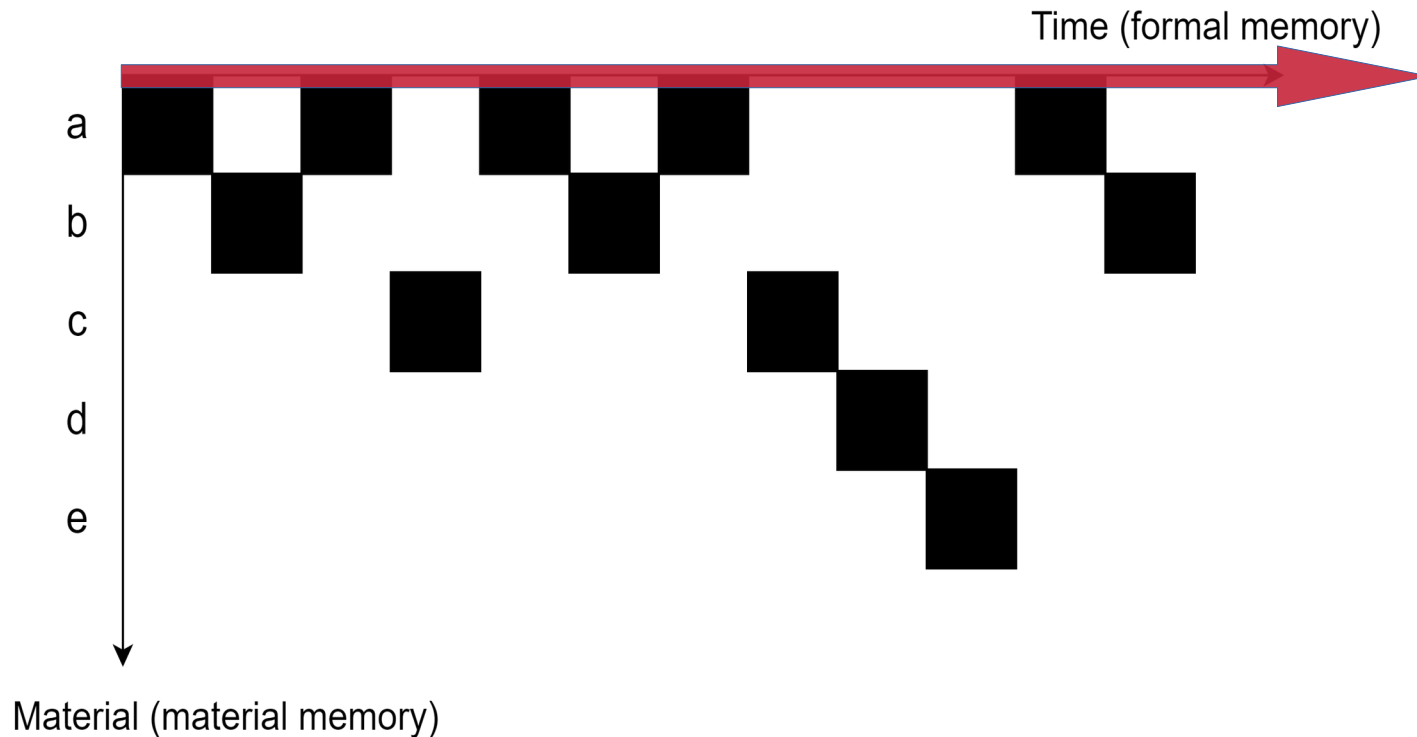
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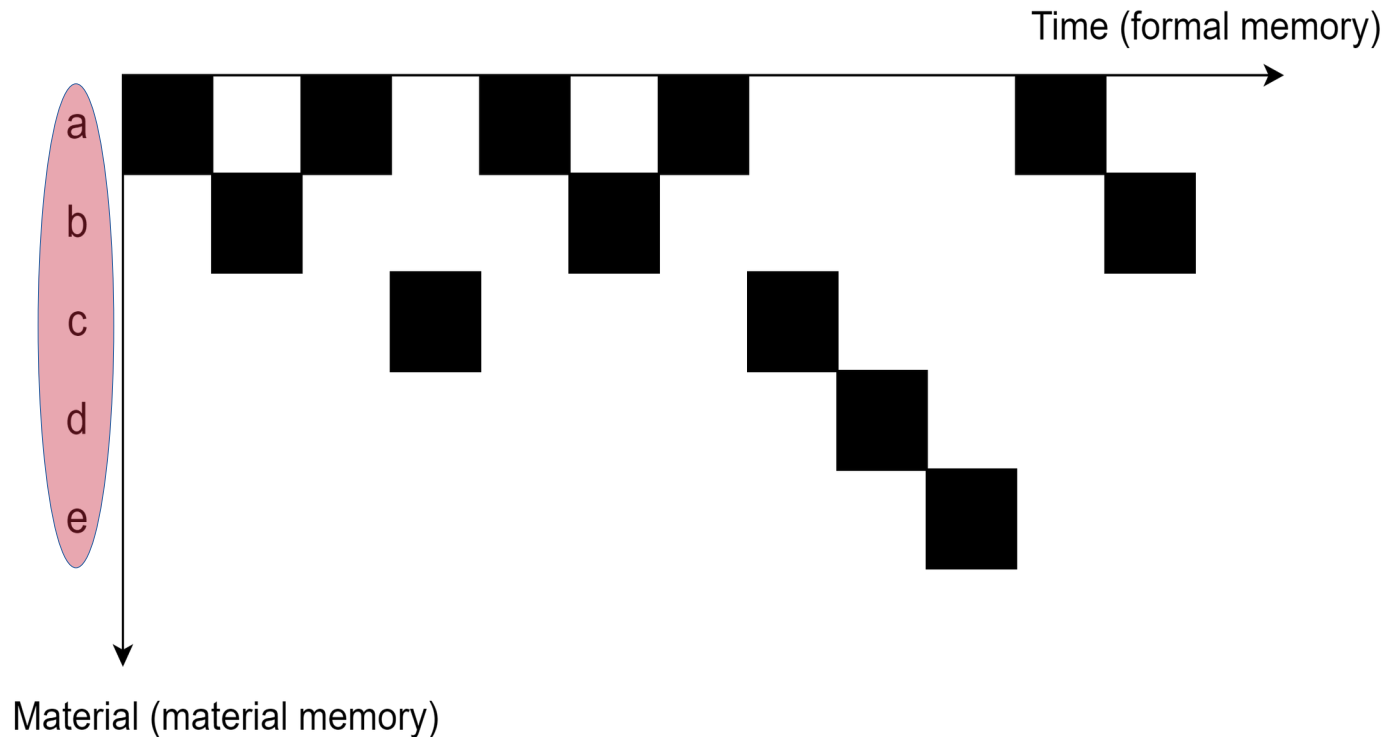
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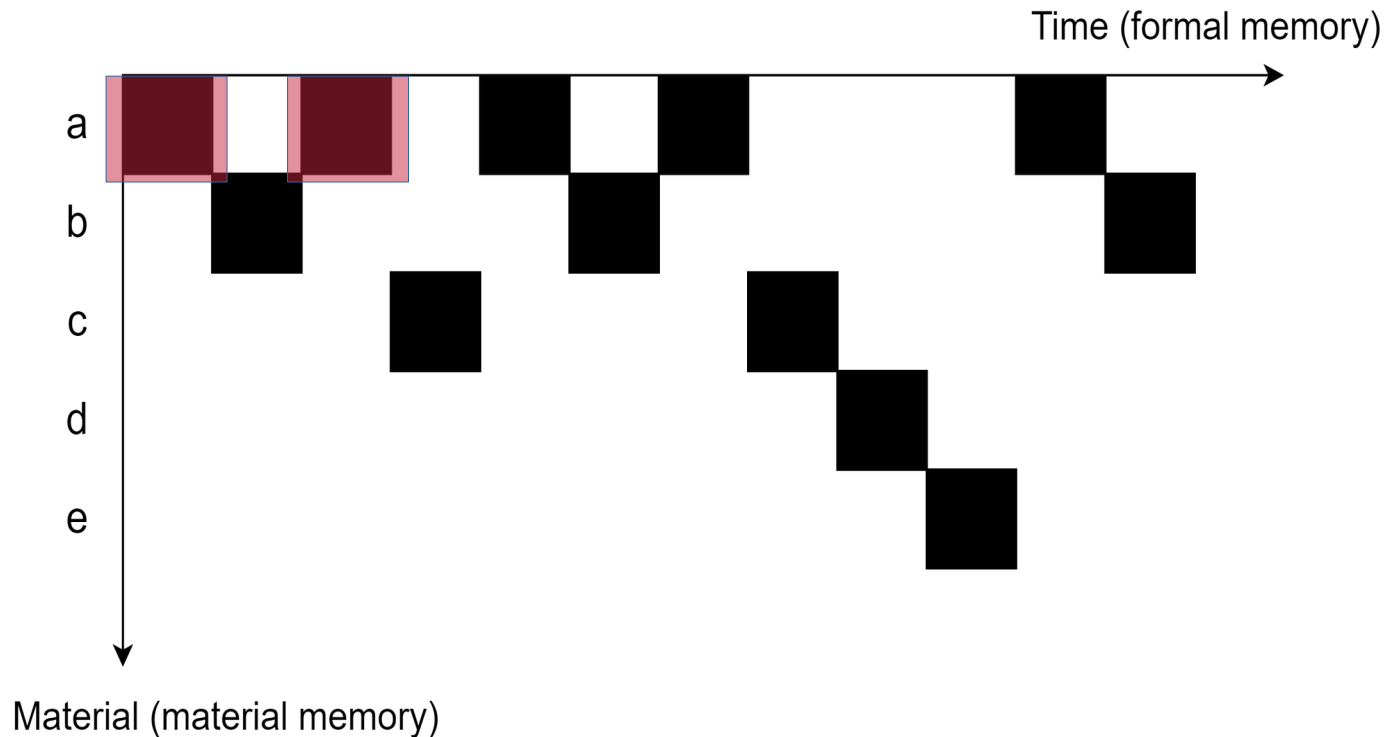
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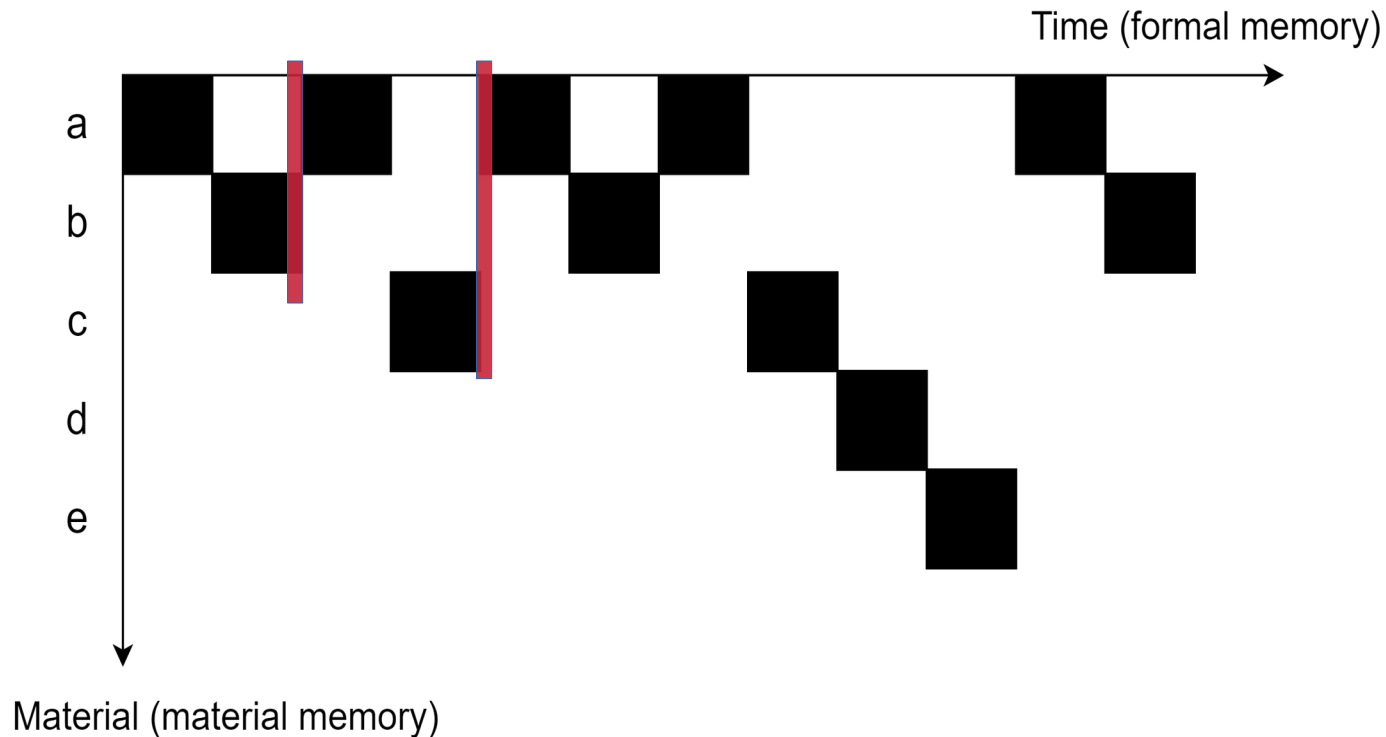
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Formal diagram of a piece of music associated with  
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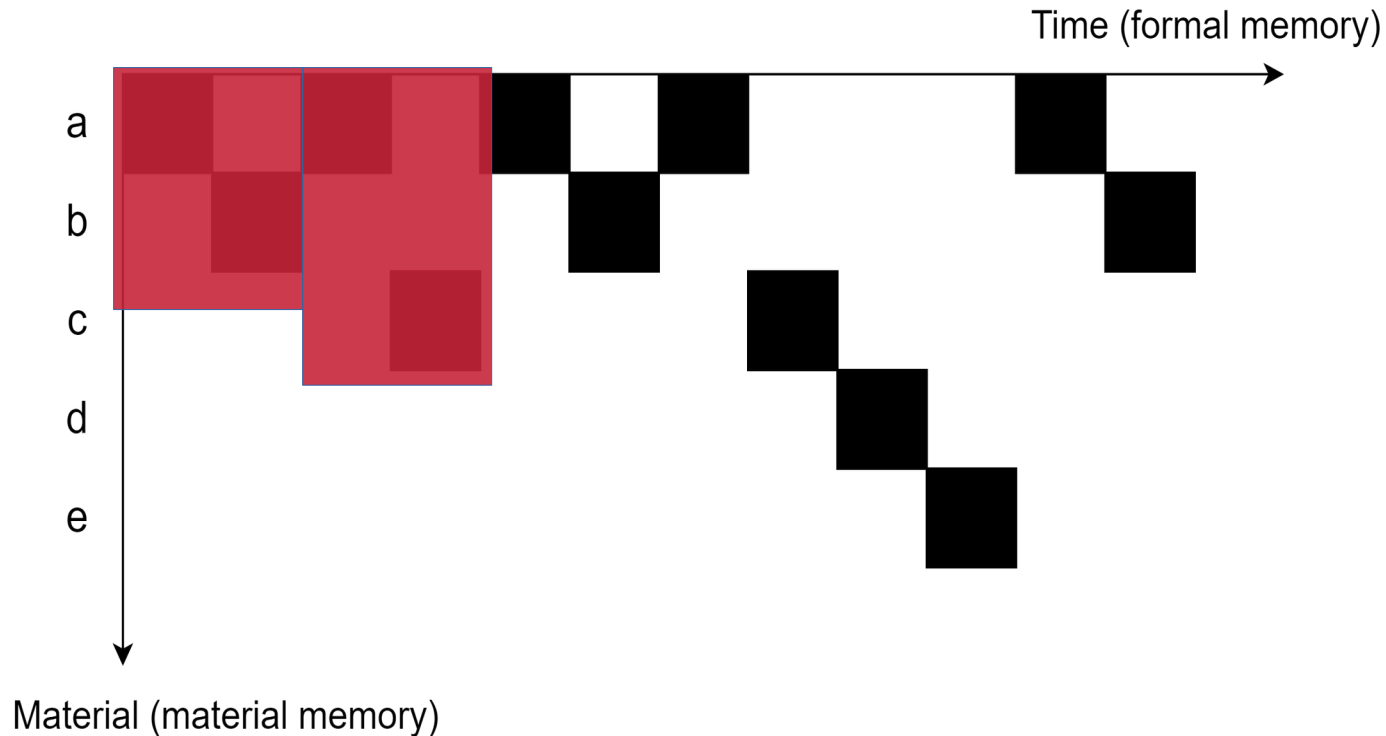
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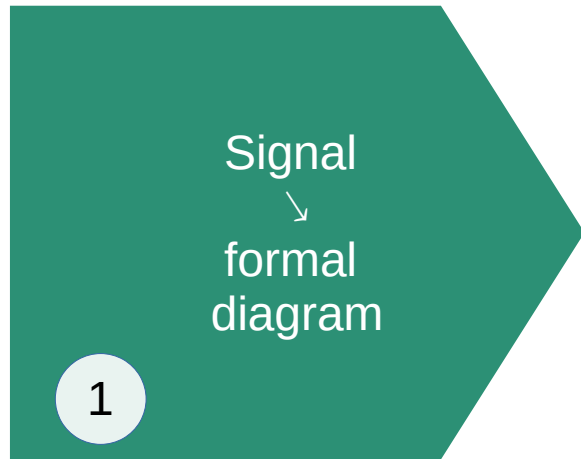
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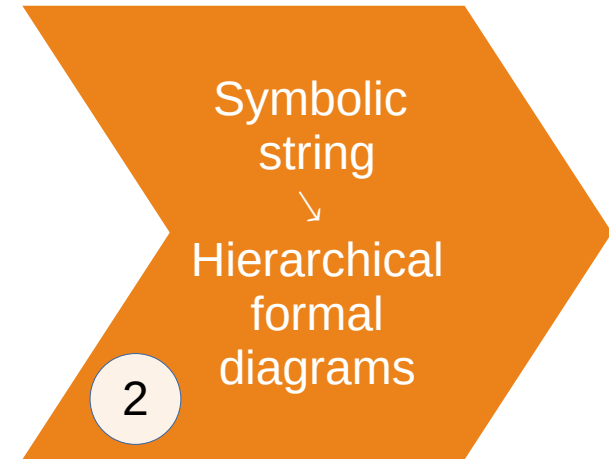
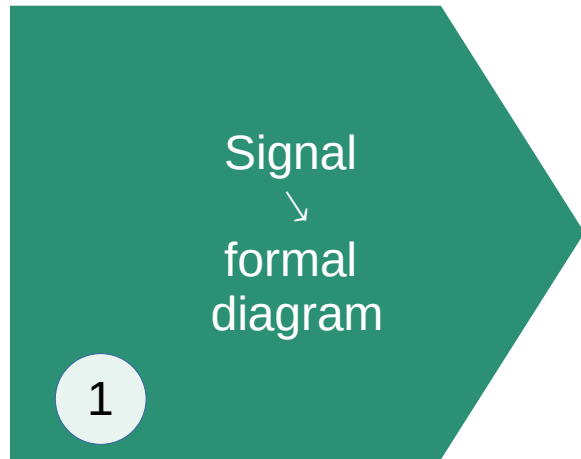


# Context and problematic

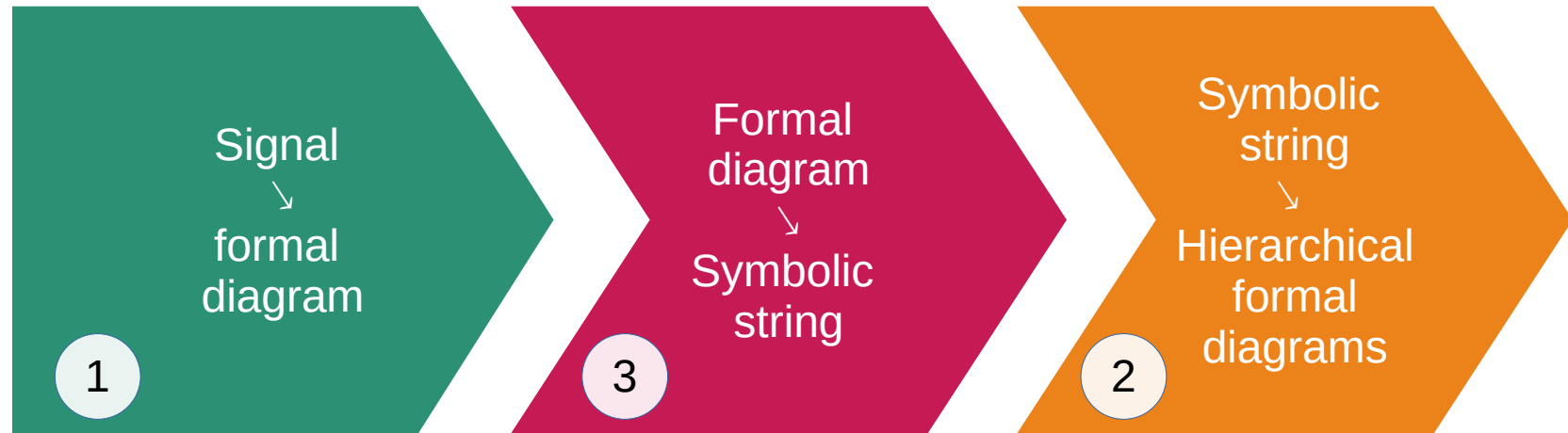
# From signal to hierarchical formal diagrams



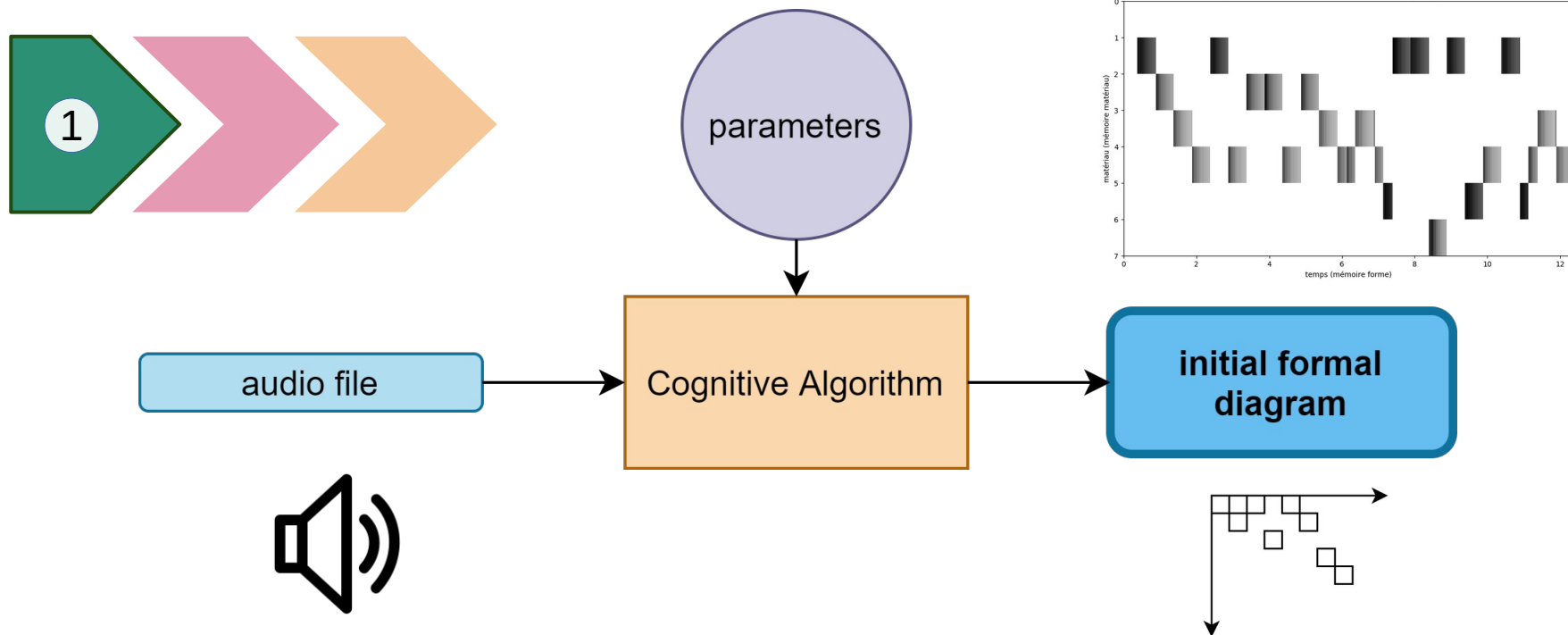
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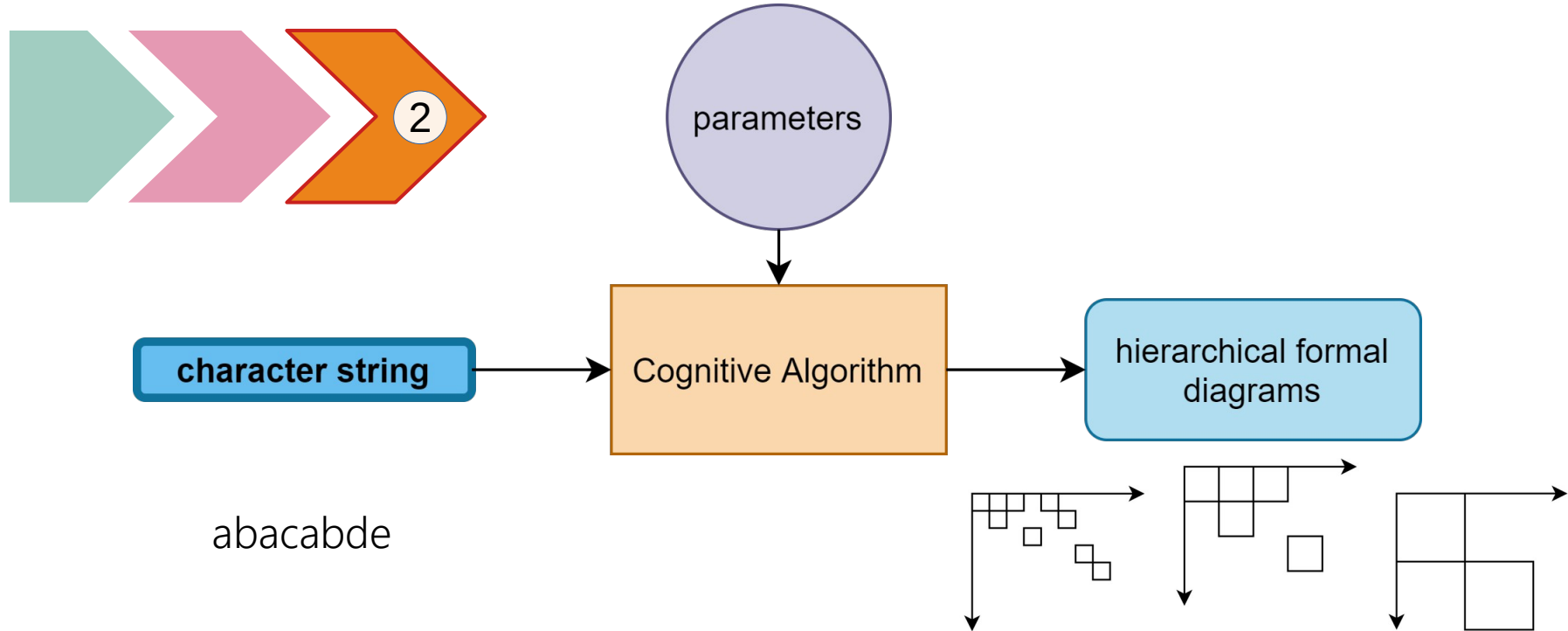


# From signal to one initial formal diagram



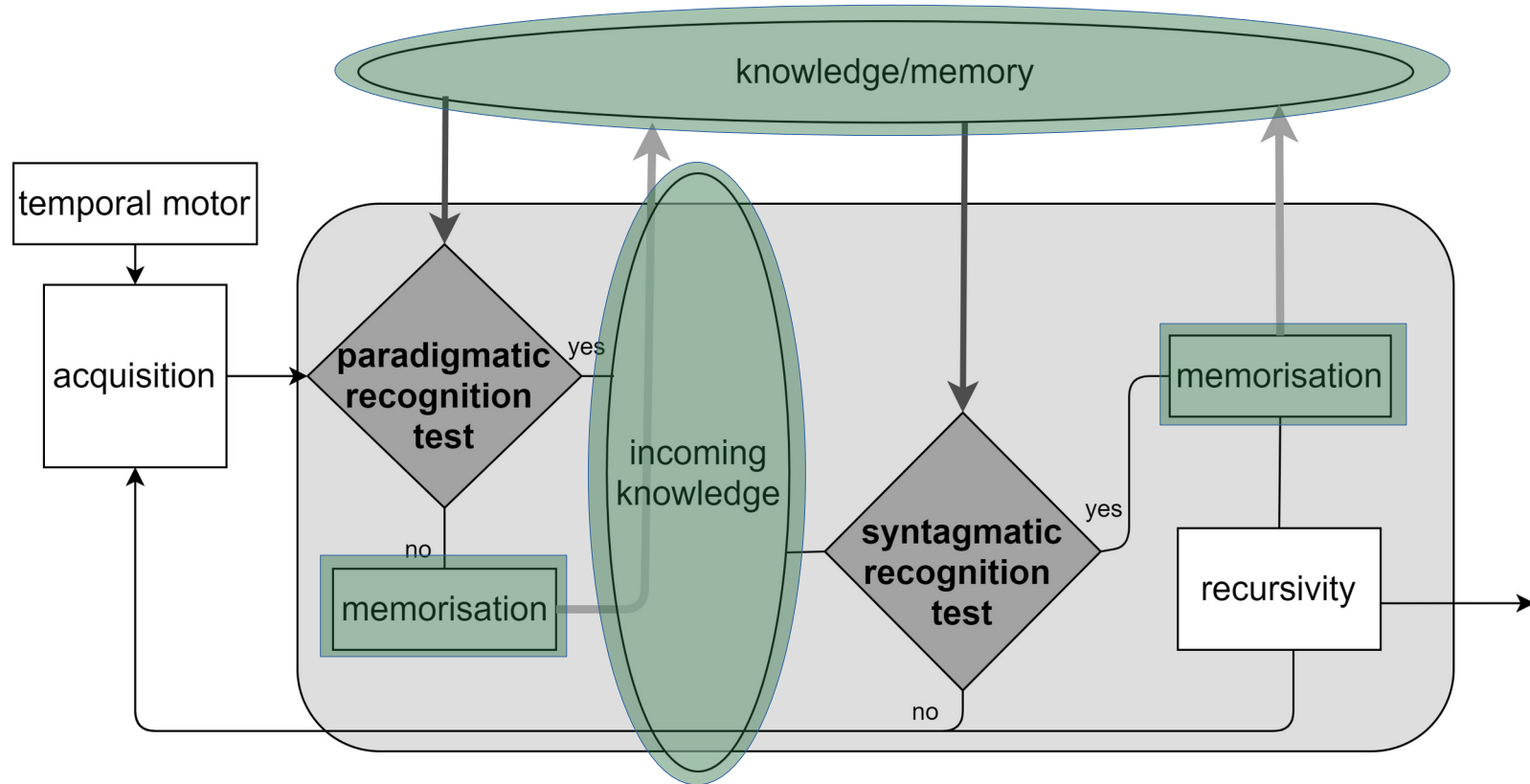
J. Calandra, J.-M. Chouvel, M. Desainte-Catherine, and al., *Génération automatique de diagrammes formels par un algorithme cognitif modulaire: étude préliminaire*, in Journées d'Informatique Musicales(JIM), Strasbourg, France, 2020.

# From symbols to hierarchical formal diagrams



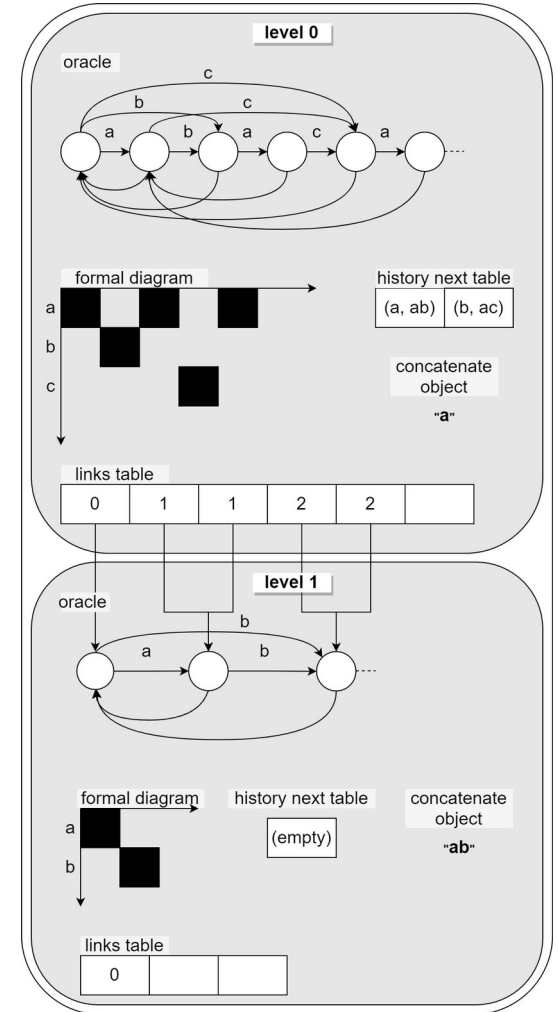
# The Multi-Scale Oracle

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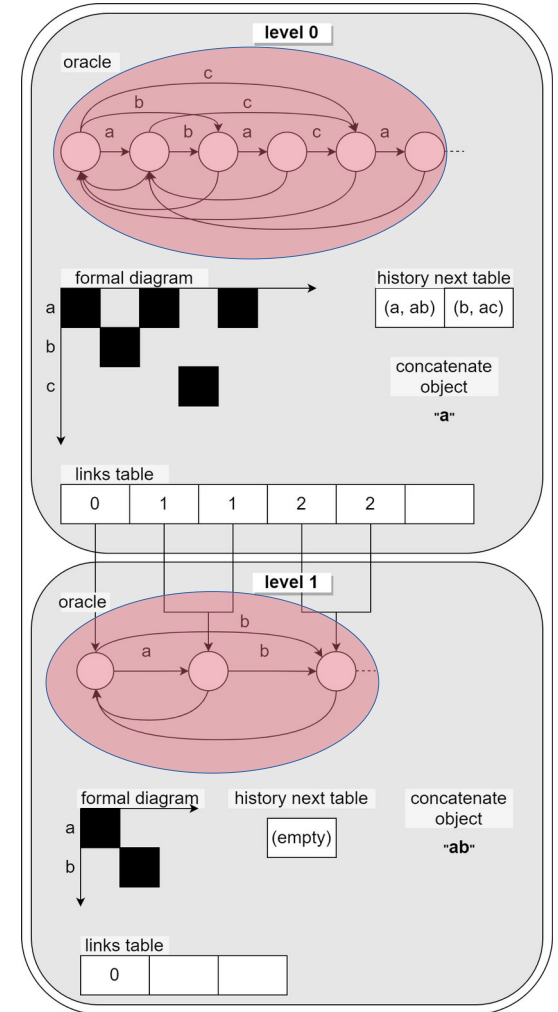
# The Multi-Scale Oracle

- For each level, 5 data structures:
  - Factor Oracle
  - Formal Diagram
  - History next table
  - Concatenate object
  - Links table



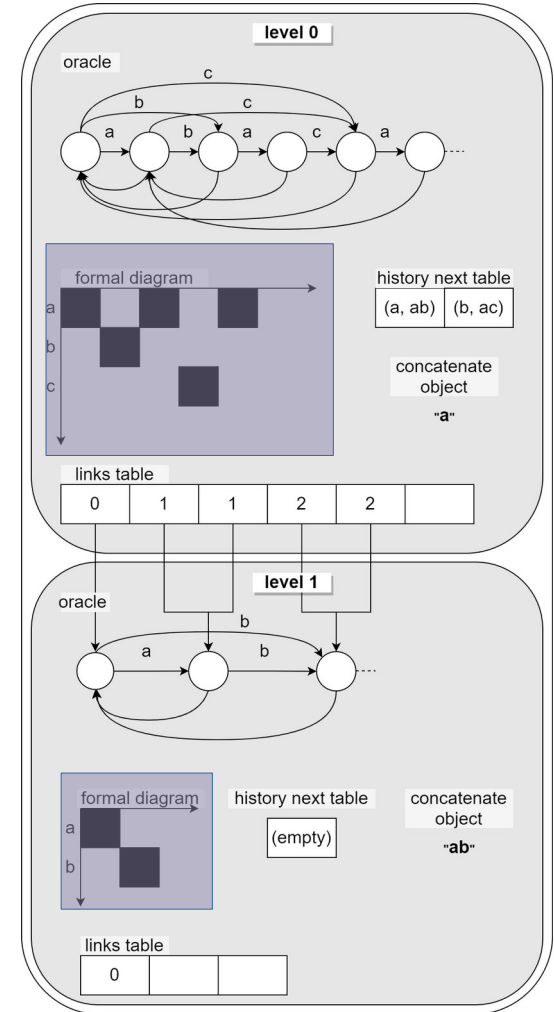
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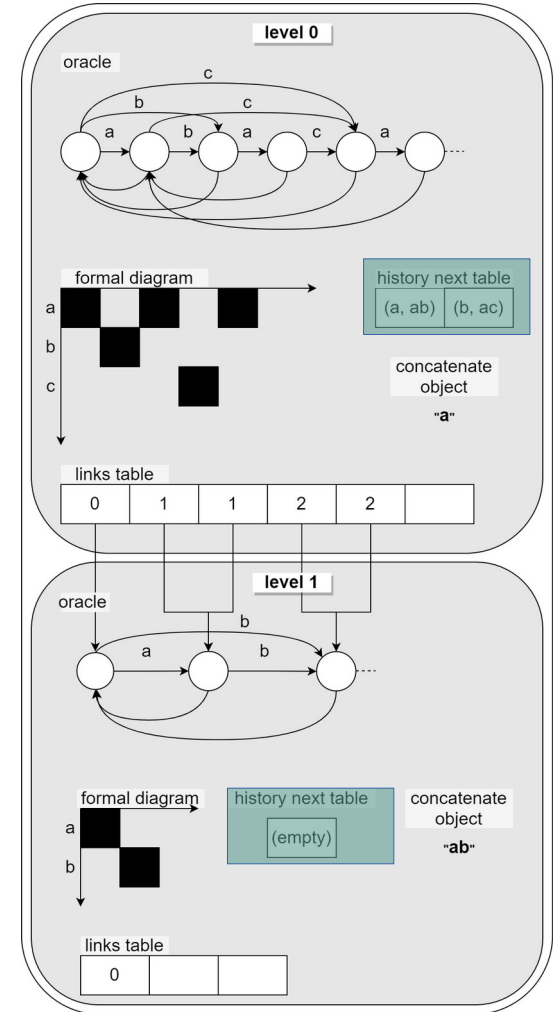
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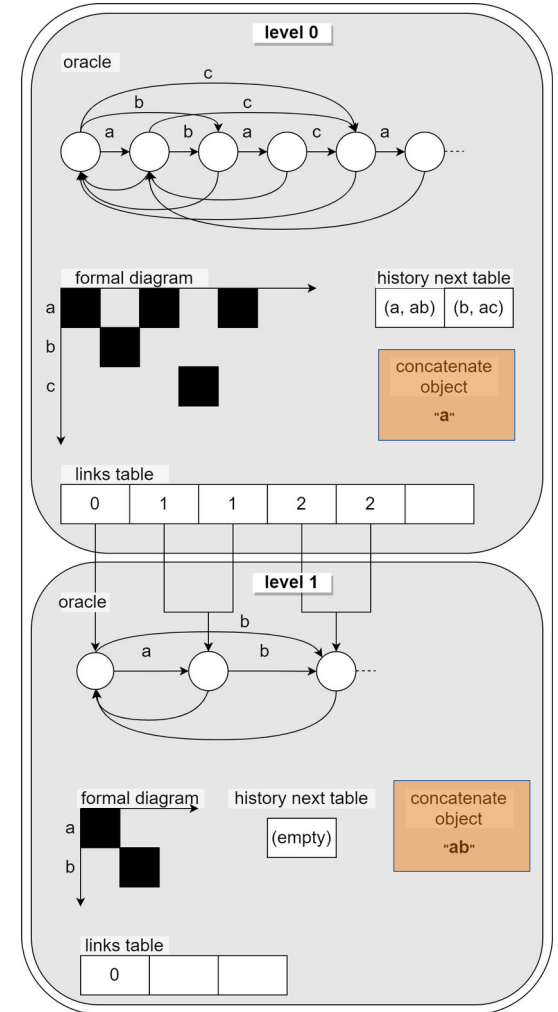
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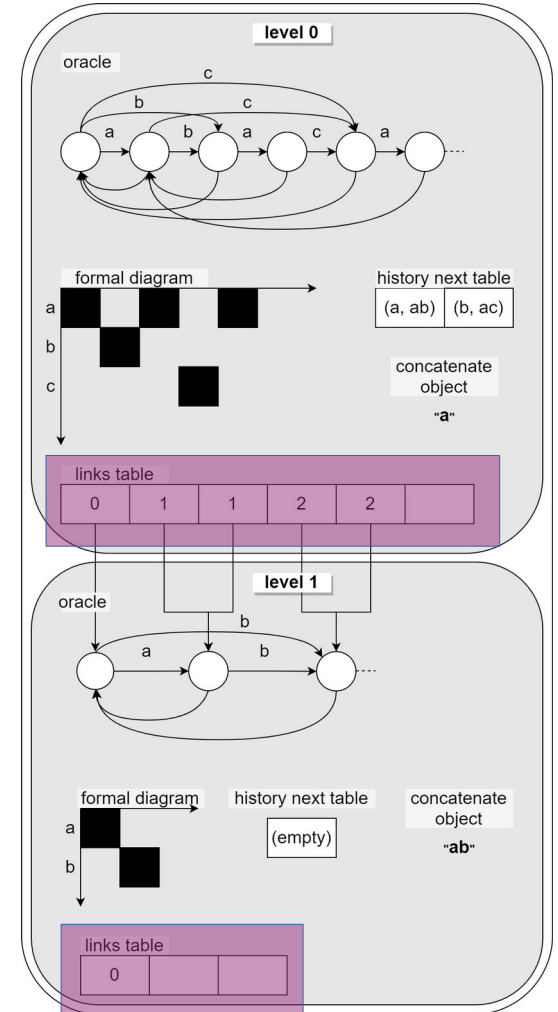
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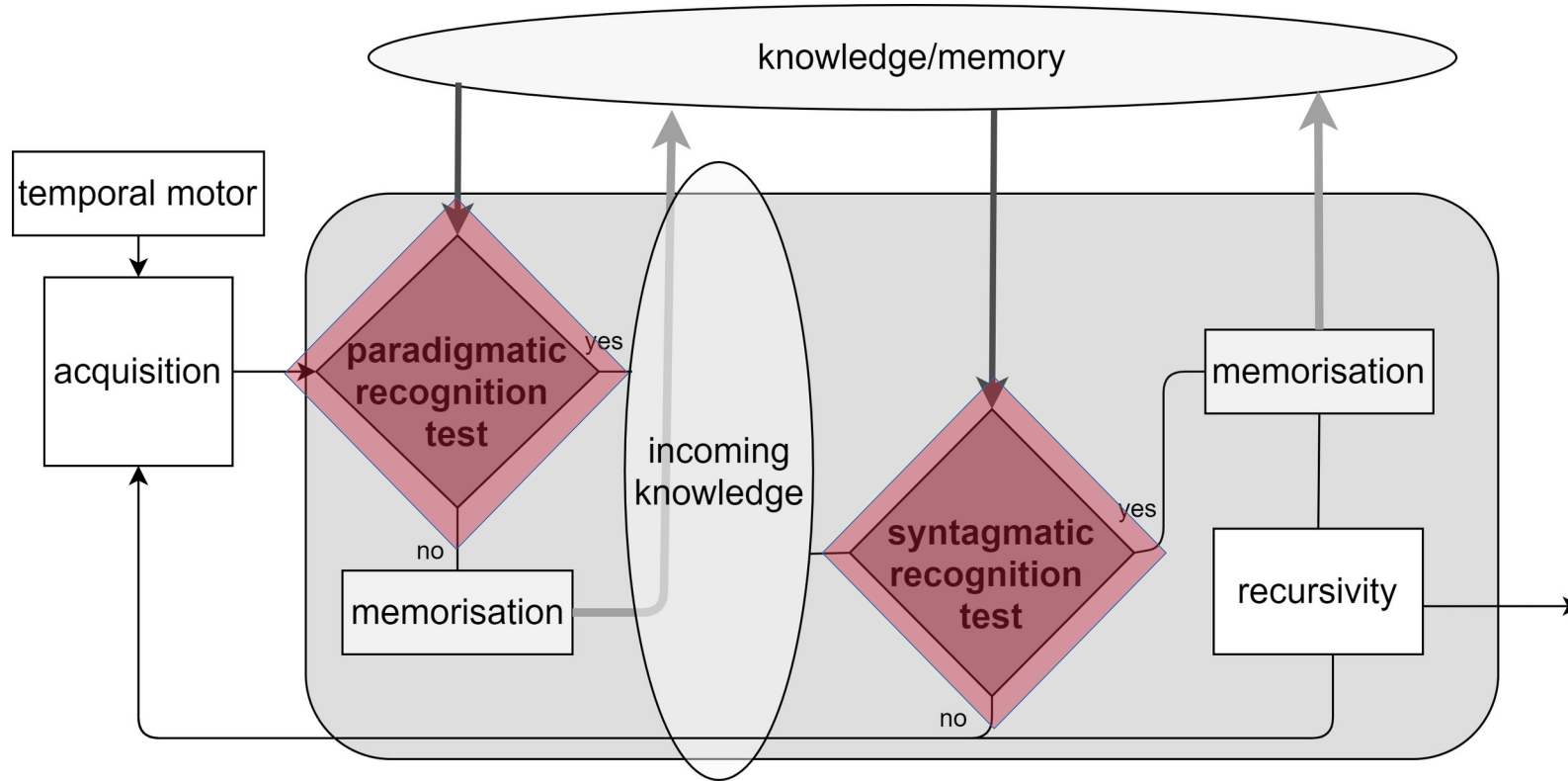
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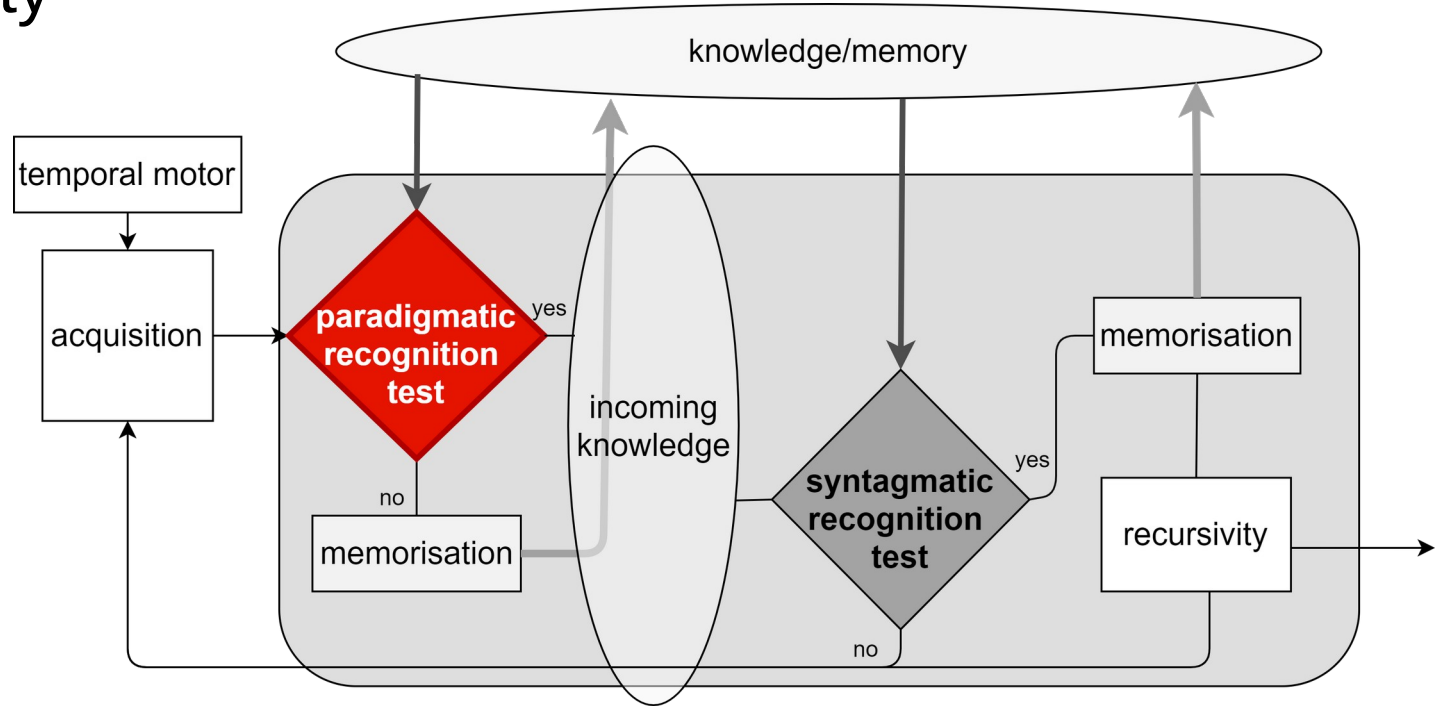
# Similarity and segmentation criteria

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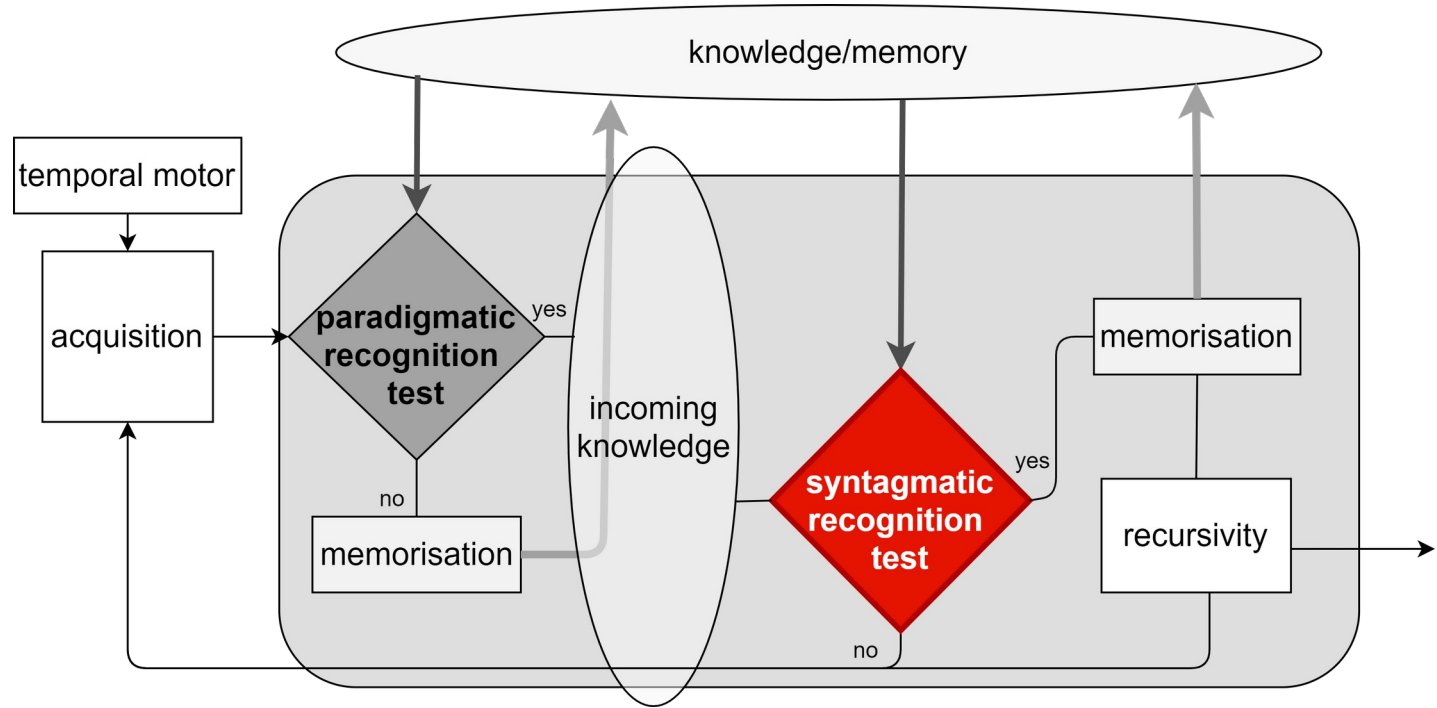
# Similarity criteria

- Strict equality



# Segmentation criteria

- 5 rules



# Segmentation criteria

- 5 rules :

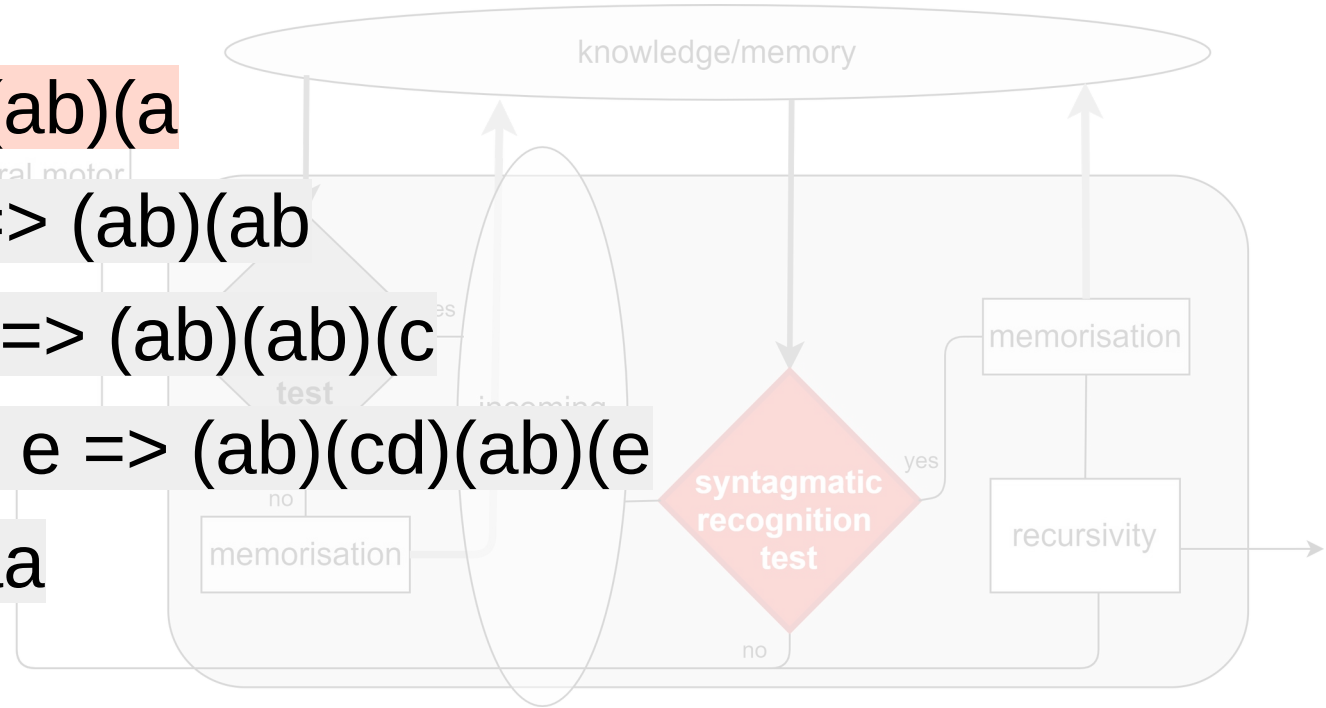
(ab + a => (ab)(a

(ab)(a + b => (ab)(ab

(ab)(ab + c => (ab)(ab)(c

(abcd)(ab + e => (ab)(cd)(ab)(e

(a + a => (aa



# Segmentation criteria

- 5 rules :

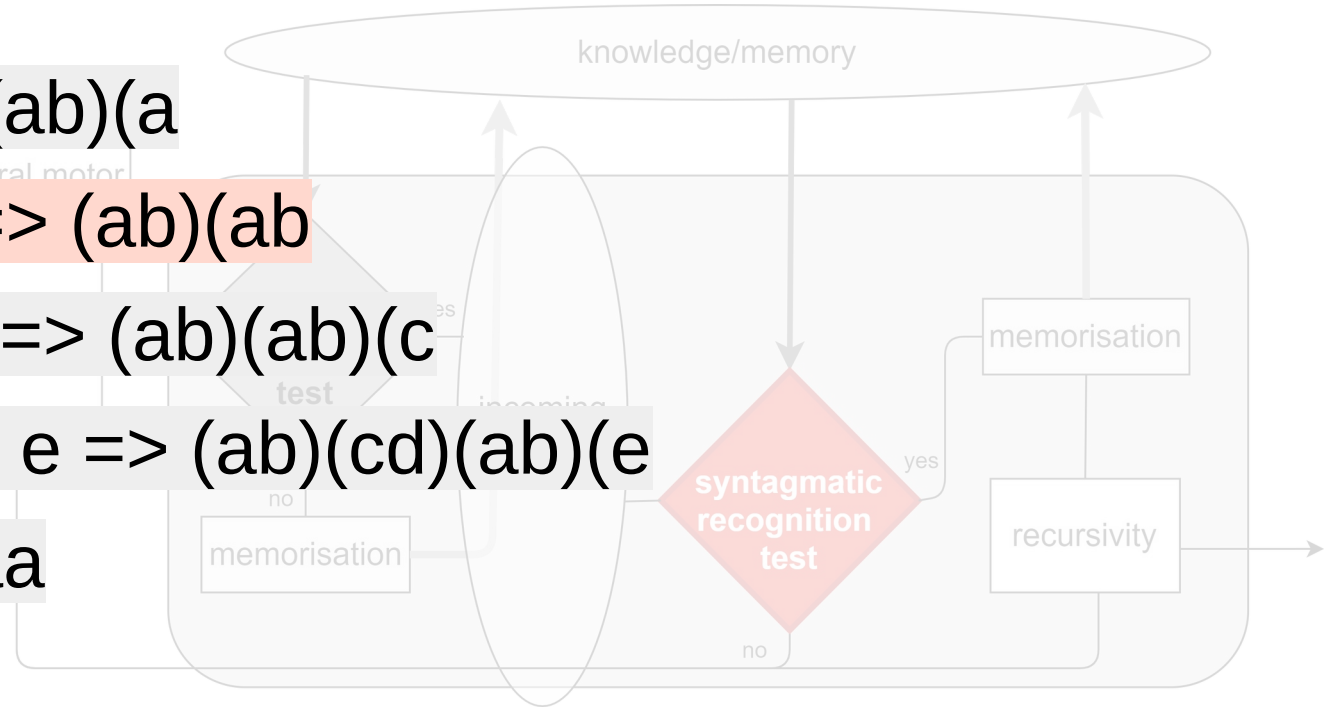
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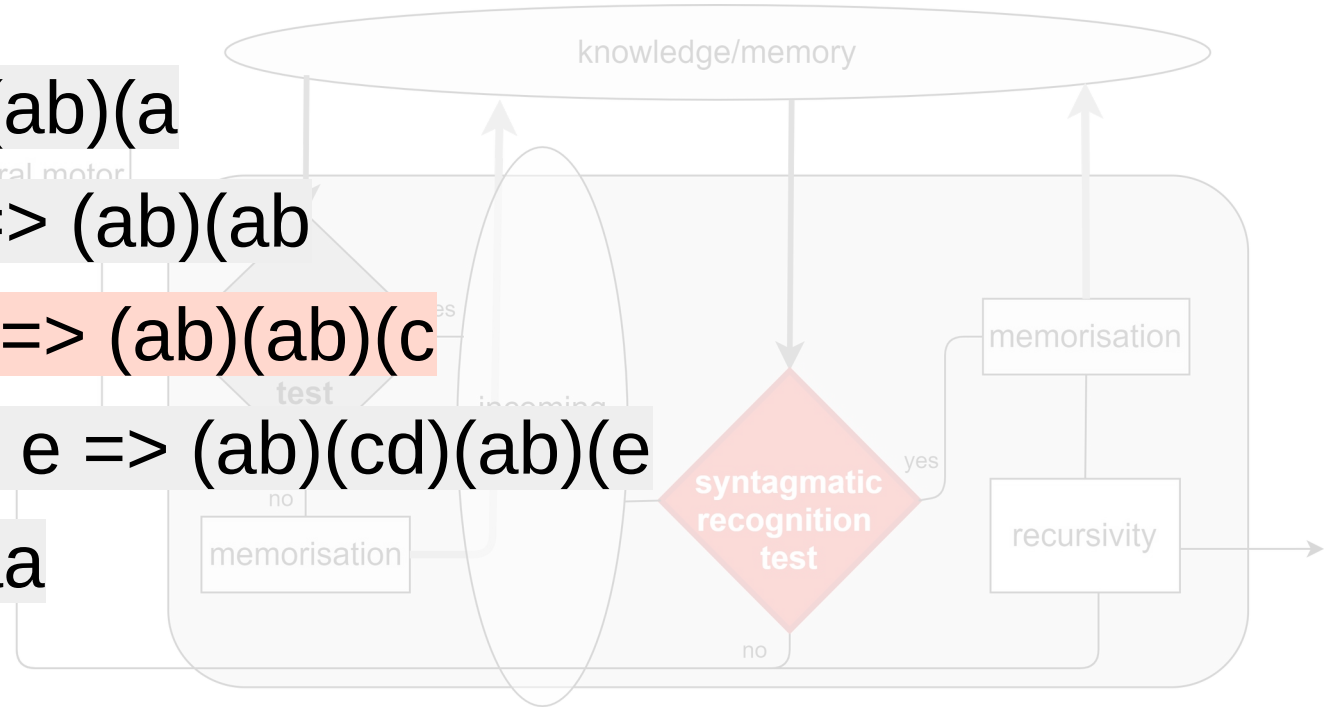
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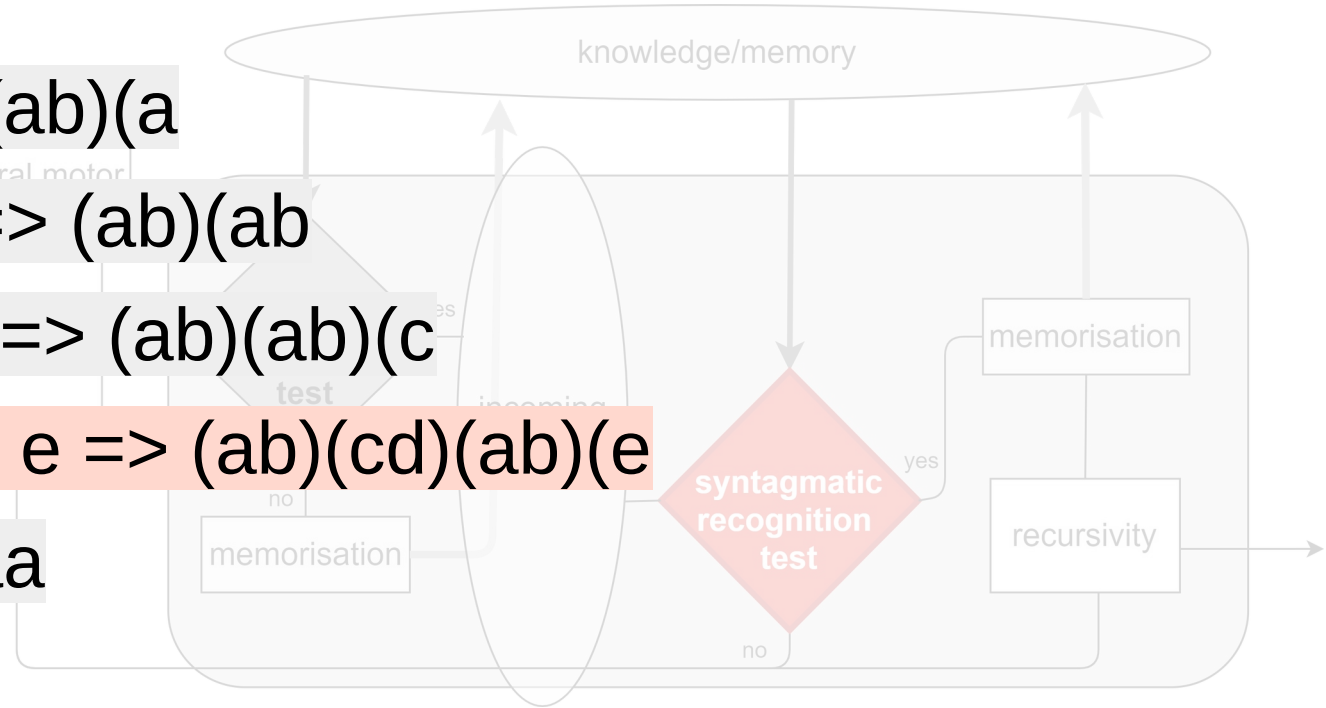
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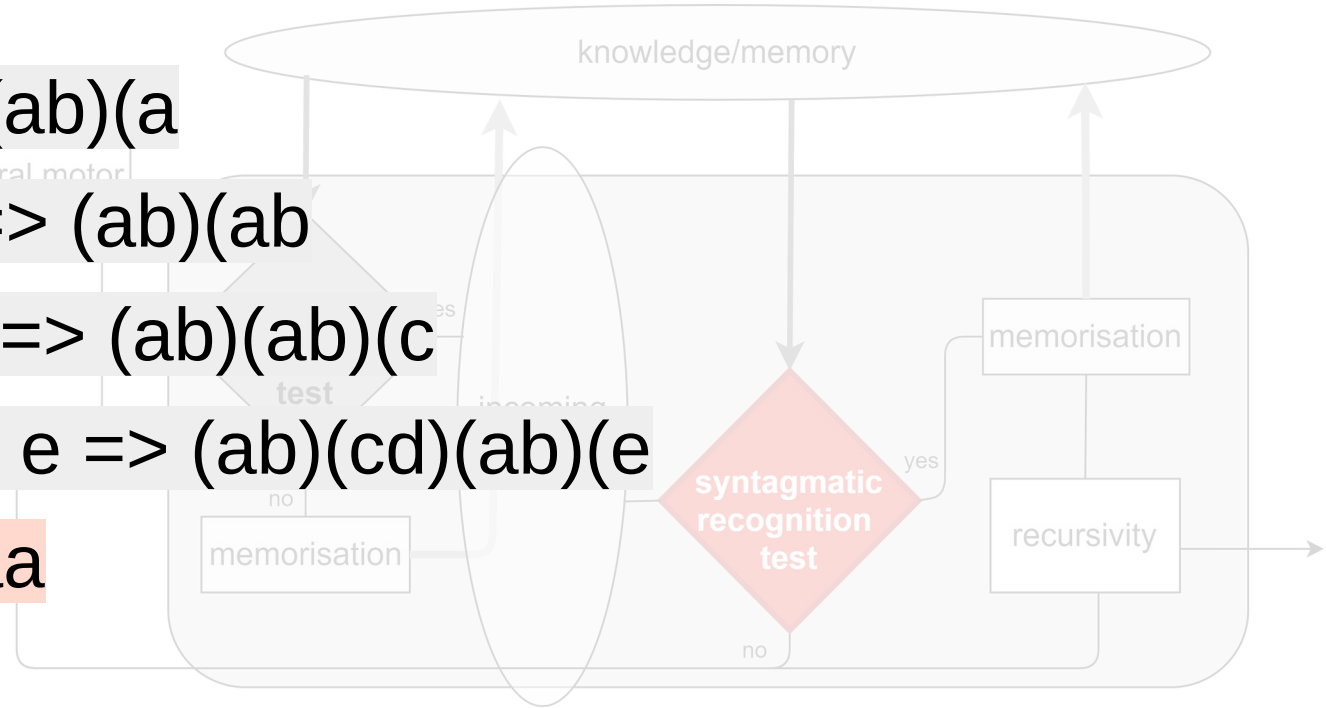
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# Applications

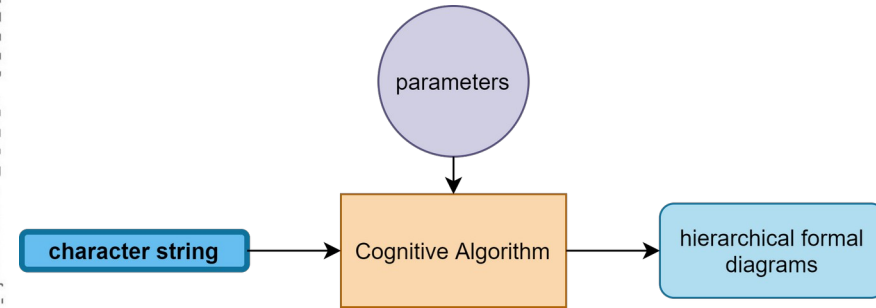
# Mozart K545, Rondo

5180) RONDO.  
Allegretto.

5181) 9

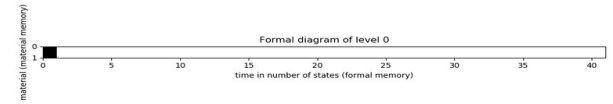
W. A. M. 545.

Rules 1, 2, 3, 4, and 5



→ abacabacdeabfgabachijklmhinopqabacsrsttu

# Mozart K545, Rondo



5180) RONDO.  
Allegretto.

5181) 9

W. A. M. 545.

W. A. M. 545.

The image displays two pages of musical notation for Mozart's Rondo K545. The notation is in G major, 3/4 time, and features a variety of musical symbols and dynamics. The first page (5180) includes a red-shaded section at the beginning. The second page (5181) continues the piece. The notation is arranged in two columns, with the first column on the left and the second column on the right. The notation includes various musical symbols such as notes, rests, and dynamic markings like 'p' (piano) and 'f' (forte). The piece is labeled 'RONDO. Allegretto.' and 'W. A. M. 545.'.

→ abacabacdeabfgabachijklmhinopqabacsrsttu

Rules 1, 2, 3, 4, and 5

# Mozart K545, Rondo

Formal diagram of level 0

| time in number of states (formal memory) | material (material memory) | memory type     |
|------------------------------------------|----------------------------|-----------------|
| 0                                        | 0                          | material memory |
| 0                                        | 2                          | material memory |
| 1                                        | 2                          | formal memory   |

1840) **RONDO.**  
*Allegretto.*

1841)

1842)

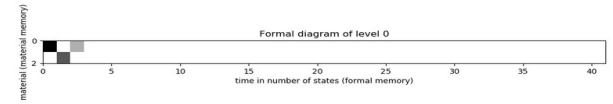
1843)

W. A. M. 545.

→ abacabacdeabfgabachijklmhinopgabacsrsttu

## Rules 1, 2, 3, 4, and 5

# Mozart K545, Rondo



5180) **RONDO.**  
Allegretto.

5181) 9

W. A. M. 545.

W. A. M. 545.

→ abacabacdeabfgabachijklmhinopqabacsrsttu

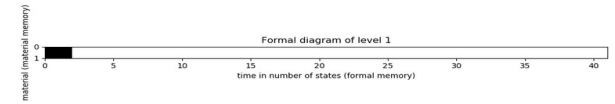
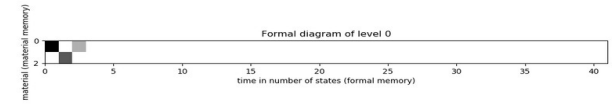
Rules 1, 2, 3, 4, and 5

# Mozart K545, Rondo

5180) **RONDO.**  
Allegretto.

5181) 9

W. A. M. 545.



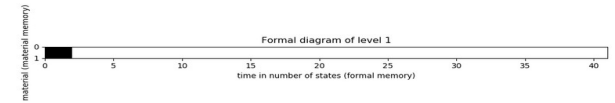
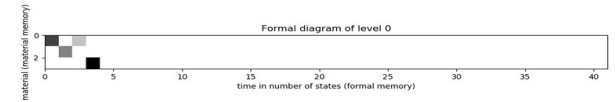
→ abacabacdeabfgabachijklmhinopqabacsrsttu

Rules 1, 2, 3, 4, and 5

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5180) **RONDO.**  
Allegretto.

W. A. M. 545.



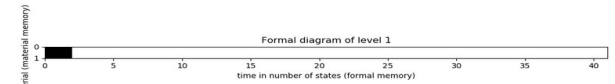
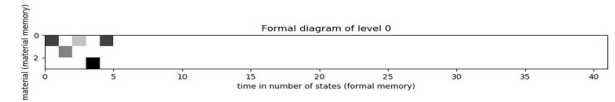
→ abacabacdeabfgabachijklmhinopqabacrsrsttu

Rules 1, 2, 3, 4, and 5

# Mozart K545, Rondo

5180) **RONDO.**  
Allegretto.

W. A. M. 545.



→ abacabacdeabfgabachijklmhinopqabacrsrsttu

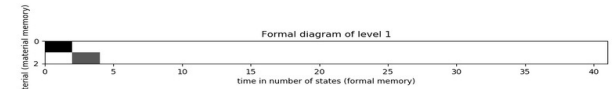
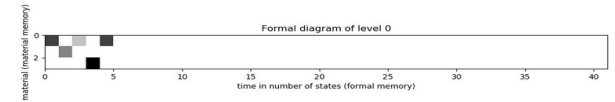
Rules 1, 2, 3, 4, and 5

# Mozart K545, Rondo

5180) **RONDO.**  
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5181) 9

W. A. M. 545.



→ abacabacdeabfgabachijklmhinopqabacsrsttu

Rules 1, 2, 3, 4, and 5

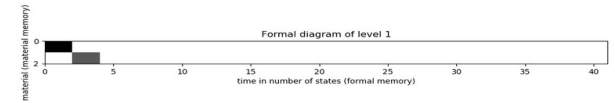
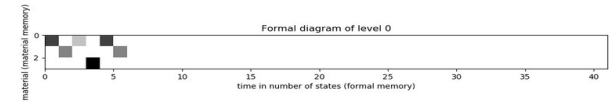
# Mozart K545, Rondo

(180) **RONDO.**  
*Allegretto.*

Musical score for a piano piece titled "Rondo, Allegretto" by W. A. M. 345. The score is in 2/4 time and consists of two systems of music. The first system contains measures 1 through 10, and the second system contains measures 11 through 20. The score is written for piano, with a key signature of one flat (B-flat). The tempo is marked "Allegretto." The score includes various musical notations such as notes, rests, and dynamic markings like "p" (piano) and "f" (forte). The score is divided into two systems, each with a red highlight on a specific measure. The first system has a red highlight on measure 10, and the second system has a red highlight on measure 20. The score is labeled "W. A. M. 345" at the bottom.

→ abacabacdeabfgabachijklmhinopgabacsrsttu

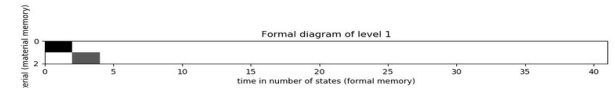
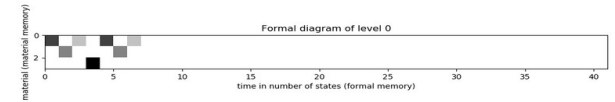
Rules 1, 2, 3, 4, and 5



# Mozart K545, Rondo

5 (180) **RONDO.**  
Allegretto.

W. A. M. 545.



→ abacabacdeabfgabachijklmhinopqabacrsrsttu

Rules 1, 2, 3, 4, and 5

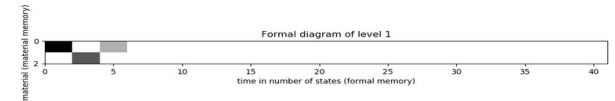
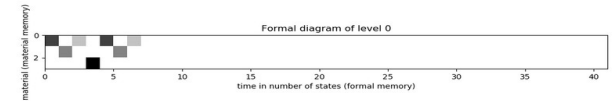
# Mozart K545, Rondo

**RONDO.**  
*Allegretto.*

W. A. M. 345.

→ abacabacdeabfgabachijklmhinopgabacsrsttu

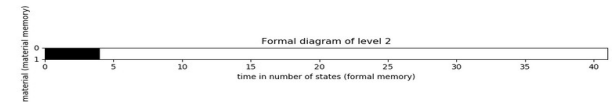
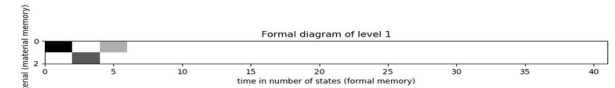
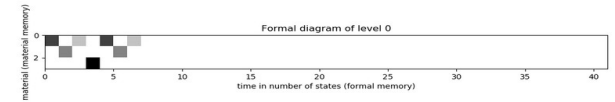
## Rules 1, 2, 3, 4, and 5



# Mozart K545, Rondo

5180) **RONDO.**  
Allegretto.

W. A. M. 545.



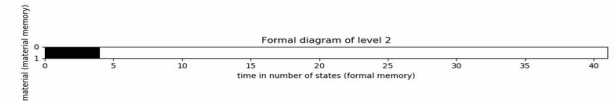
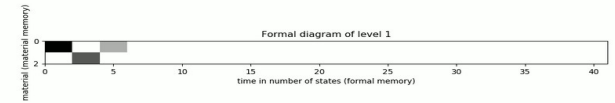
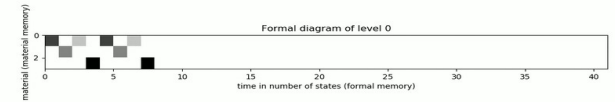
→ abacabacdeabfgabachijklmhinopqabacsrsttu

Rules 1, 2, 3, 4, and 5

# Mozart K545, Rondo

(180) **RONDO.**  
*Allegretto.*

W. A. M. 545.



→ abacabacdeabfgabachijklmhinopqabacsrsttu

Rules 1, 2, 3, 4, and 5

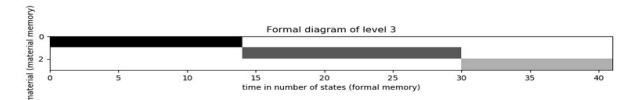
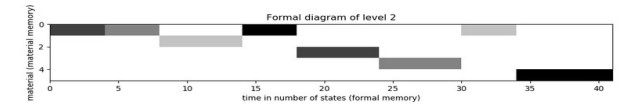
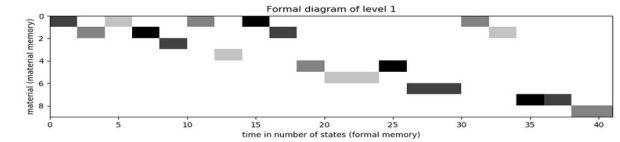
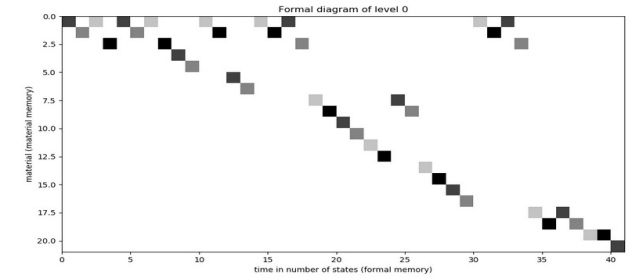
# Mozart K545, Rondo

5180) RONDO.  
Allegretto.

5181) 9

W. A. M. 545.

→ abacabacdeabfgabachijklmhinopqabacsrsttu



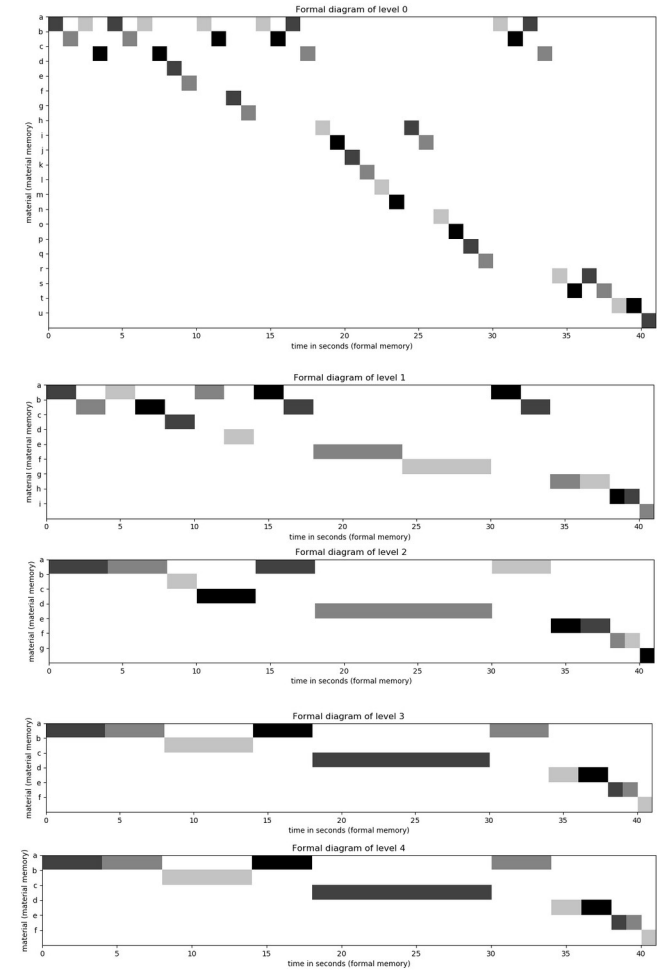
Rules 1, 2, 3, 4, and 5

# Mozart K545, Rondo

5180) **RONDO.**  
Allegretto.

5181) 9

W. A. M. 545.

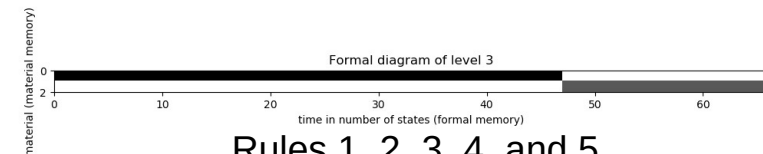
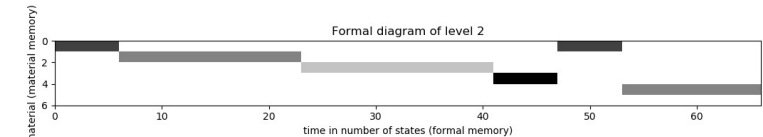
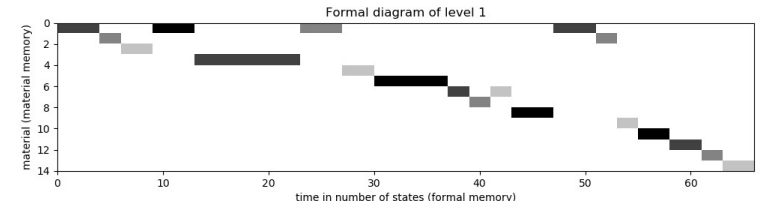
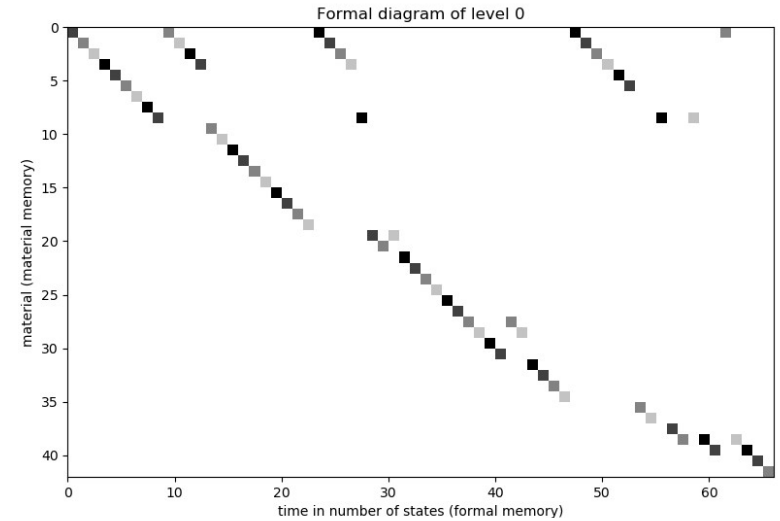


→ abacabacdeabfgabachijklmhinopqabacrsrsttu

Rules 1, 2, and 3

# Debussy's *Hommage à Rameau*

→ (1, 2, 3, 4, 5, 6, 7, 8, 9, 1, 2, 3, 4, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 1, 2, 3, 4, 9, 20, 21, 20, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 28, 29, 32, 33, 34, 35, 1, 2, 3, 4, 5, 6, 36, 37, 9, 38, 39, 9, 39, 40, 1, 39, 40, 41, 42)



Rules 1, 2, 3, 4, and 5

# Conclusion...

- Summary
- Ameliorations
- Representation
- Perspectives

