

Stochastic chains with memory of variable length

Ontology droplet

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Motivation - Example

Rhythmic sequence of the waltz:

... 1 2 1 1 2 1 1 2 1 1 2 1 1 2 ...

2 = strong beat

1 = weak beat

Motivation - Example

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- Algorithm to generate this sequence of symbols?

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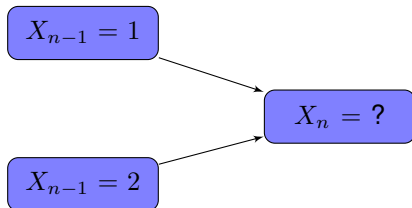
1 = weak beat

- Algorithm to generate this sequence of symbols?
- Given a sequence already generated, what is the next symbol?

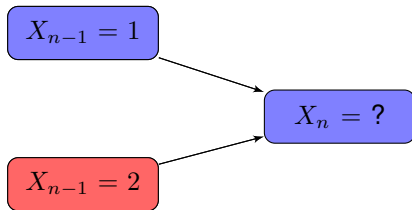
Motivation - Example

$$X_n = ?$$

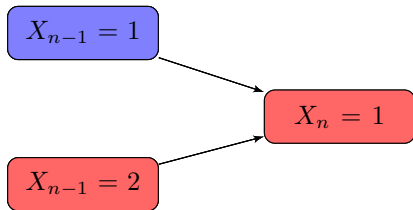
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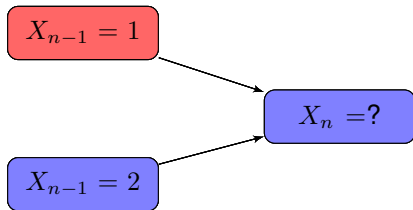
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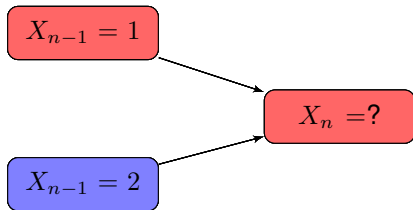
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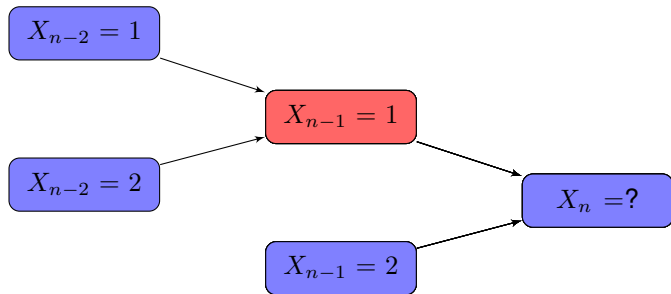
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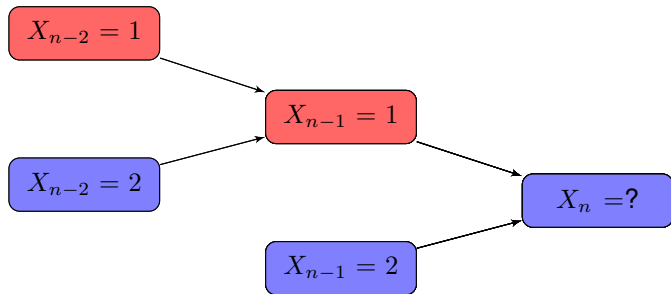
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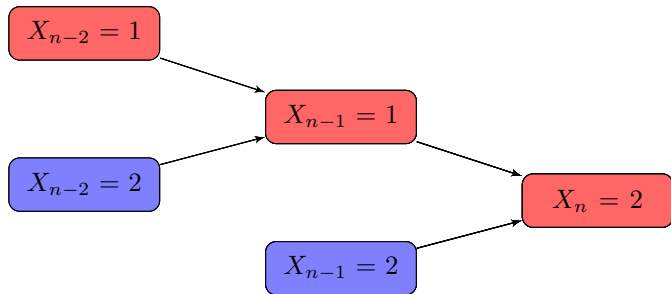
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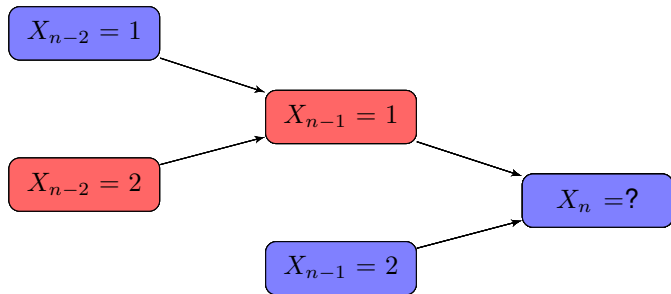
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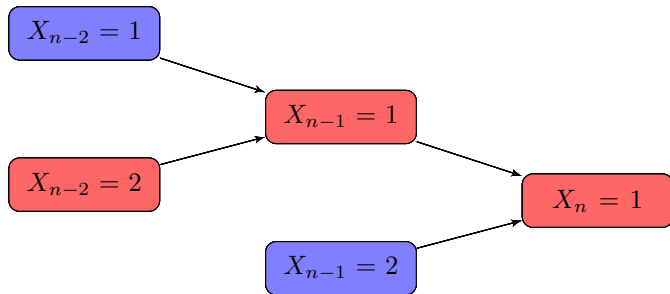
Motivation - Example



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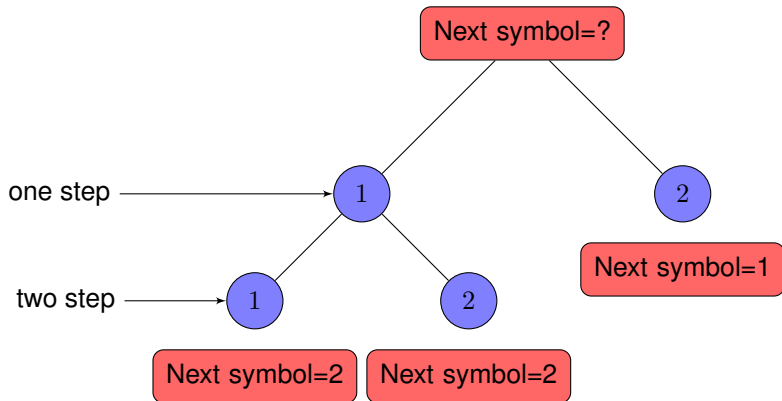


Motivation - Example



Observation: the number of look-back steps depends on the past.

Motivation - Example



This is a *tree*.

Motivation - Example

Waltz player by a human drummer.

A human drummer may erase weak beats from time to time.

... 1 2 0 1 2 1 1 2 1 0 2 1 1 2 ...

0 = silent unit.

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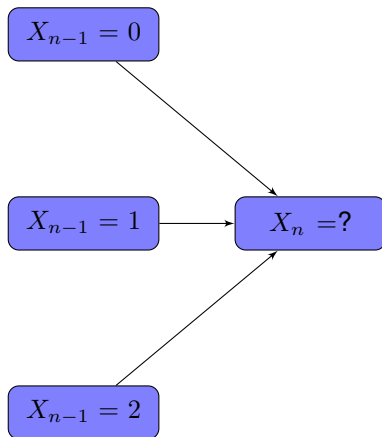
0 = silent unit.

Algorithm to generate the next symbol?

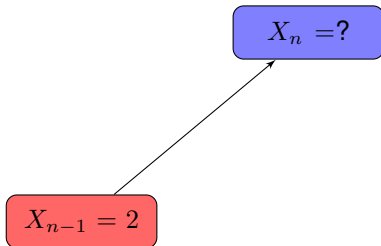
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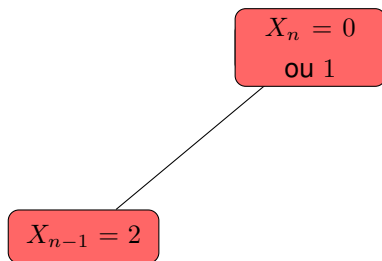
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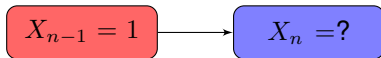
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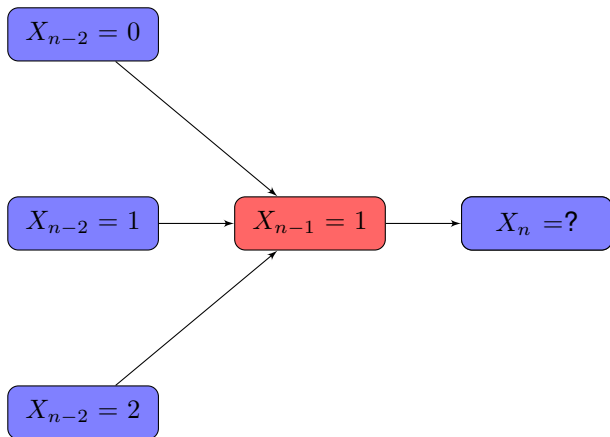
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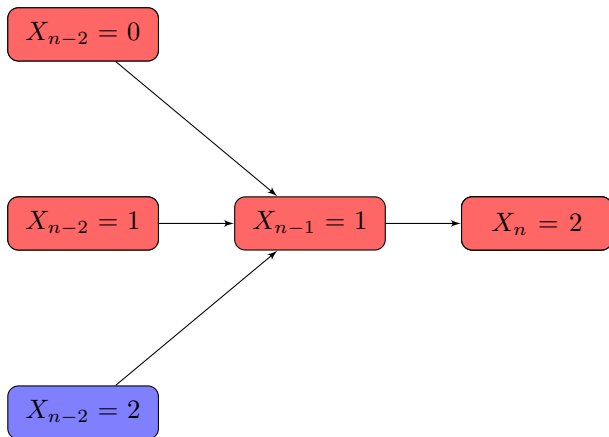
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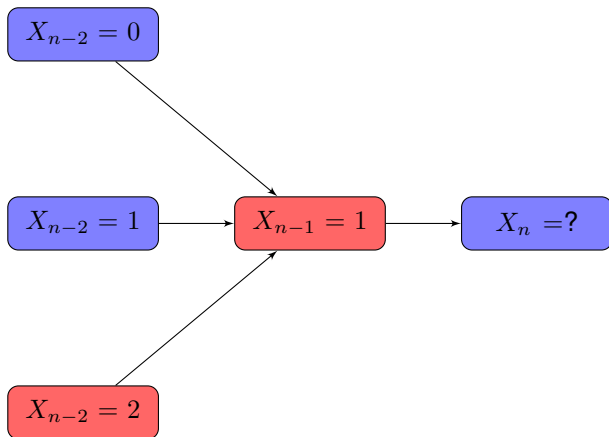
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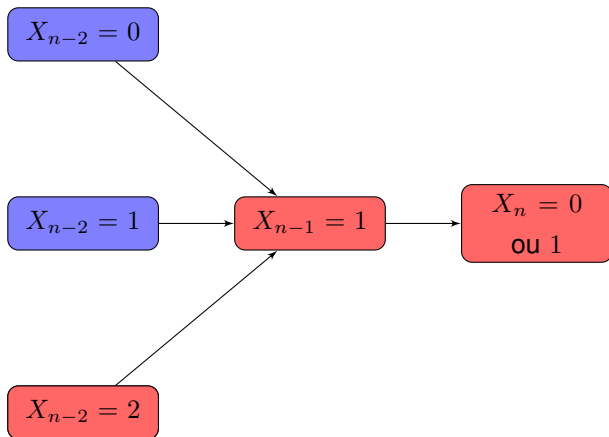
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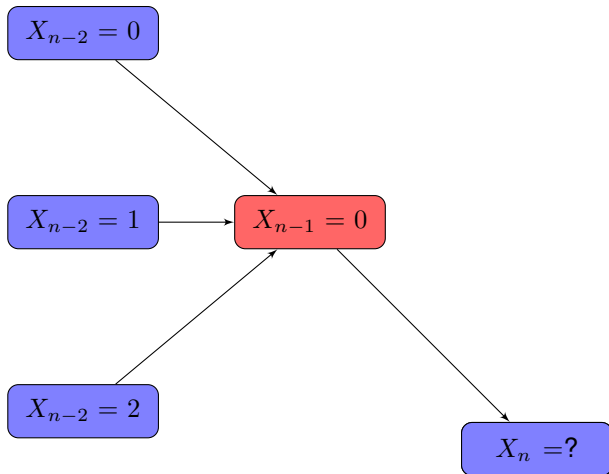


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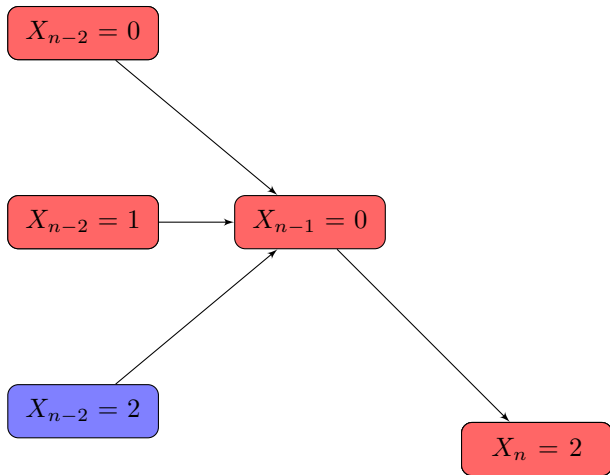
$$X_{n-1} = 0$$

$$X_n = ?$$

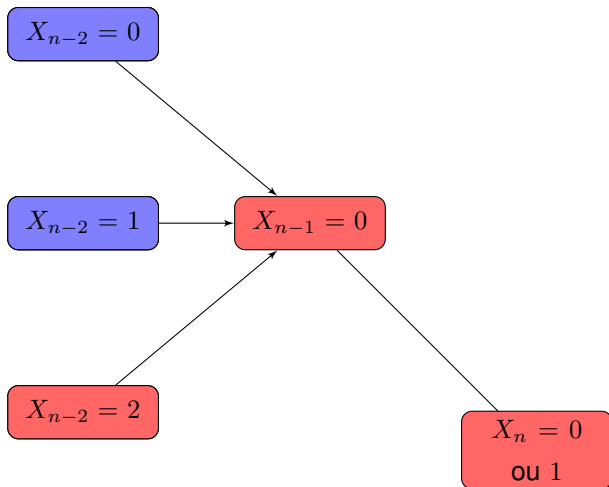
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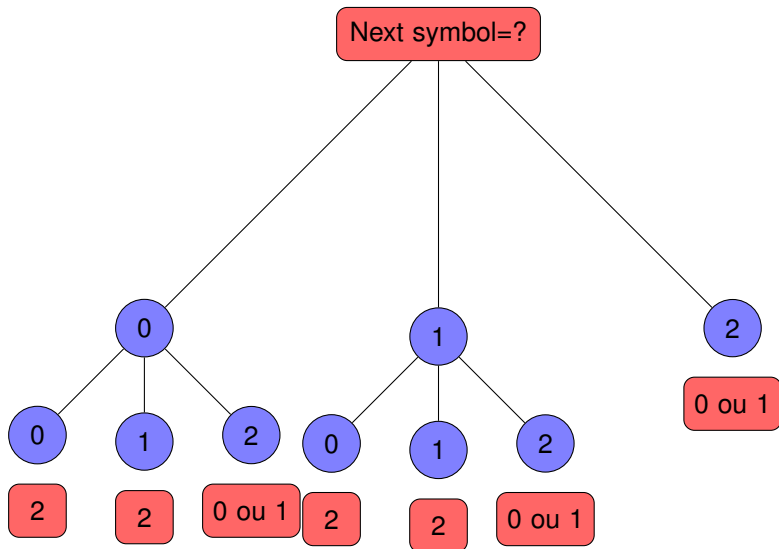
Motivation - Example



Motivation - Example



Motivation - Example - Probabilistic tree



Stochastic chains with memory of variable length

Generalizing, the sequence $\dots, X_1, X_2, \dots, X_{n-1}$ is a stochastic chain with memory of variable length if

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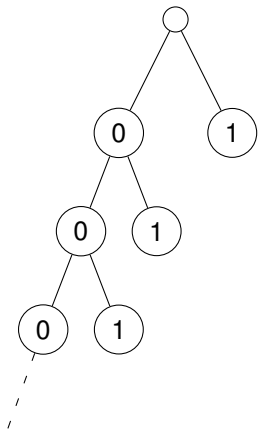
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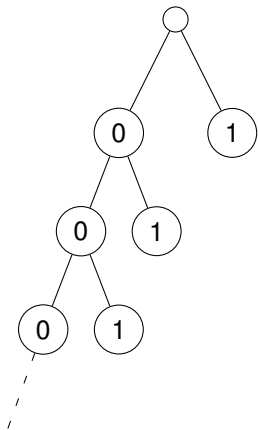
Context: part of the past needed to predict the next symbol.

Context tree: Tree of contexts together with associated probabilities.

Stochastic chains with memory of variable length - Renewal process

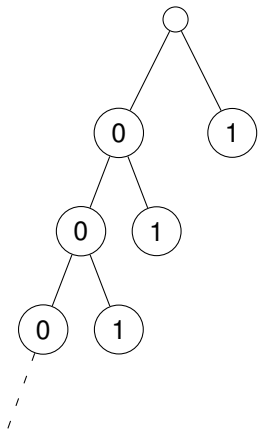


Stochastic chains with memory of variable length - Renewal process



Meaning of this chain?

Stochastic chains with memory of variable length - Renewal process



Meaning of this chain?

When a symbol 1 appears, the chain forgets the past.

Question

Do these chains appear in neurobiology?

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Spike Train: ... 0 0 1 0 0 1 0 0 0 1 0 1 0 1 1 ...

1 = spike in the time window

0 = no spike in the time window

time window length **10ms**

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Do these chains appear in neurobiology?



Spike Train: ... 0 0 1 0 0 1 0 0 0 1 0 1 0 1 1 ...

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time window length **10ms**

25% of the spike trains of neurons in the hippocampus, in S. Ribeiro data, fit this renewal process.

How do we know this?

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Using statistical model selection

(see up coming ontology droplet by Daniel Takahashi)