

The Mathematical Order Structure of Subjective Time

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As one interacts with the environment, the order of perception of objects and events are important. When you confront an object it's the knowledge that materializes. The knowledge that there is a pen, a paper and a desk in front of you is discovered instantly. Damasio (1999) hypothesizes that each materialized knowledge is the content of each pulse-like generation of consciousness. Studies suggests neural synchrony to play a role in temporal processing and consciousness (Meck et al., 2014). We may therefore look at temporal processing as that which engenders a sense of self in the act of knowing (an inner sense). The logical or mathematical view of the role of subjective time or time processing is hence the process of order structuring, the property that mathematicians refer to as weak and strict partial order defined by reflexive, irreflexive, antisymmetric and transitive properties. The next perception grows out of the previous moment and so on ... resulting in a timeline view of the chain. This is strict partial ordering. But this has the shortcoming that a moment in time is not relatable to itself. It has irreflexive property. A timeline view is therefore not sufficient to represent the time process. Partial ordering with the reflexive property is called weak partial ordering. This extends the one-dimensional timeline into a multi-dimensional timescape. The parts of the timescape represents markings of perceptions at moments in time. These are like Damasio's pulses of consciousness. The order structure is a system of self-regulatory transformations. A direct relationship of mental structures and mathematical structures was discovered by Piaget and Dieudonne (Piaget, 1970). This paper will present a mathematical description of "what time does for perception?"

Keywords: synchrony; modelling; children; adult; sec-mins; mins-hours.

References

Damasio, A. (1999). *The Feeling of What Happens*. New York: Harcourt, Brace & Co.

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Structure (Piaget, 1970)

- (eg. system of whole numbers)
- It has governing laws. (eg. additive laws; associativity, commutative, transitivity and closure)
- Totality
The laws applies to the whole system. (eg. additive laws applies to $\forall a \in +Z$)
- Transform
The laws are laws of transformations. (eg. $2 + 2 = 4$)
- Self-regulating
Transformation does not to go outside the system. (eg. $2 + 3 = 5 \in +Z$)

A structure may be relatable with another structure. In most structures there are laws that don't satisfy. (eg. division law $\frac{1}{2} = 0.5 \notin +Z$)

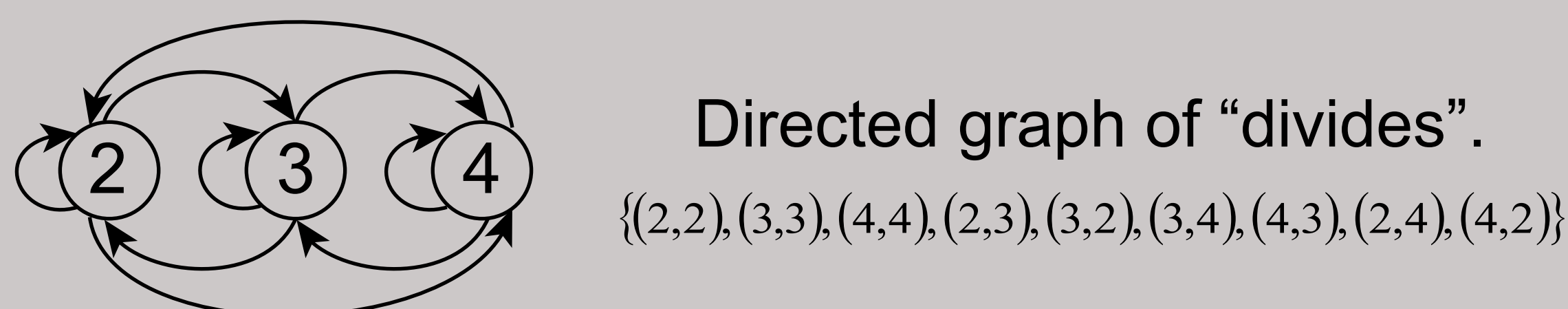
A Relation is represented as an ordered pair (a, b) .

Relation properties: reflexivity, symmetry & transitivity.

The relation "divides" satisfies reflexive property. $(2,2)$

The relation "divides" satisfies symmetric property. $(2,3)$ & $(3,2)$

The relation "divides" satisfies transitive property. $(2,4)$ & $(4,2)$



The relation "larger" is - irreflexive, $(2,2)$ $(3,3)$ $(4,4)$

- antisymmetric $(2,3)$ $(3,2)$
 - transitive. $(3,4)$ $(4,3)$
 $(2,4)$ & $(4,2)$

This structure is **Strict Partial Order**.

The relation "larger or equal" is

- reflexive, $(2,2)$ $(3,3)$ $(4,4)$
 This structure is **Weak Partial Order**.

S_i is the **direct cover** of S_j

$$(S_i, S_j) \quad \neg(S_j, S_i)$$

S_j is not the **direct cover** of S_i

S_k is not the **direct cover** of S_j

$$(S_j, S_k) \quad \neg(S_k, S_j)$$

S_j is the **direct cover** of S_k

The ordered pair of perceptions follow antisymmetry.

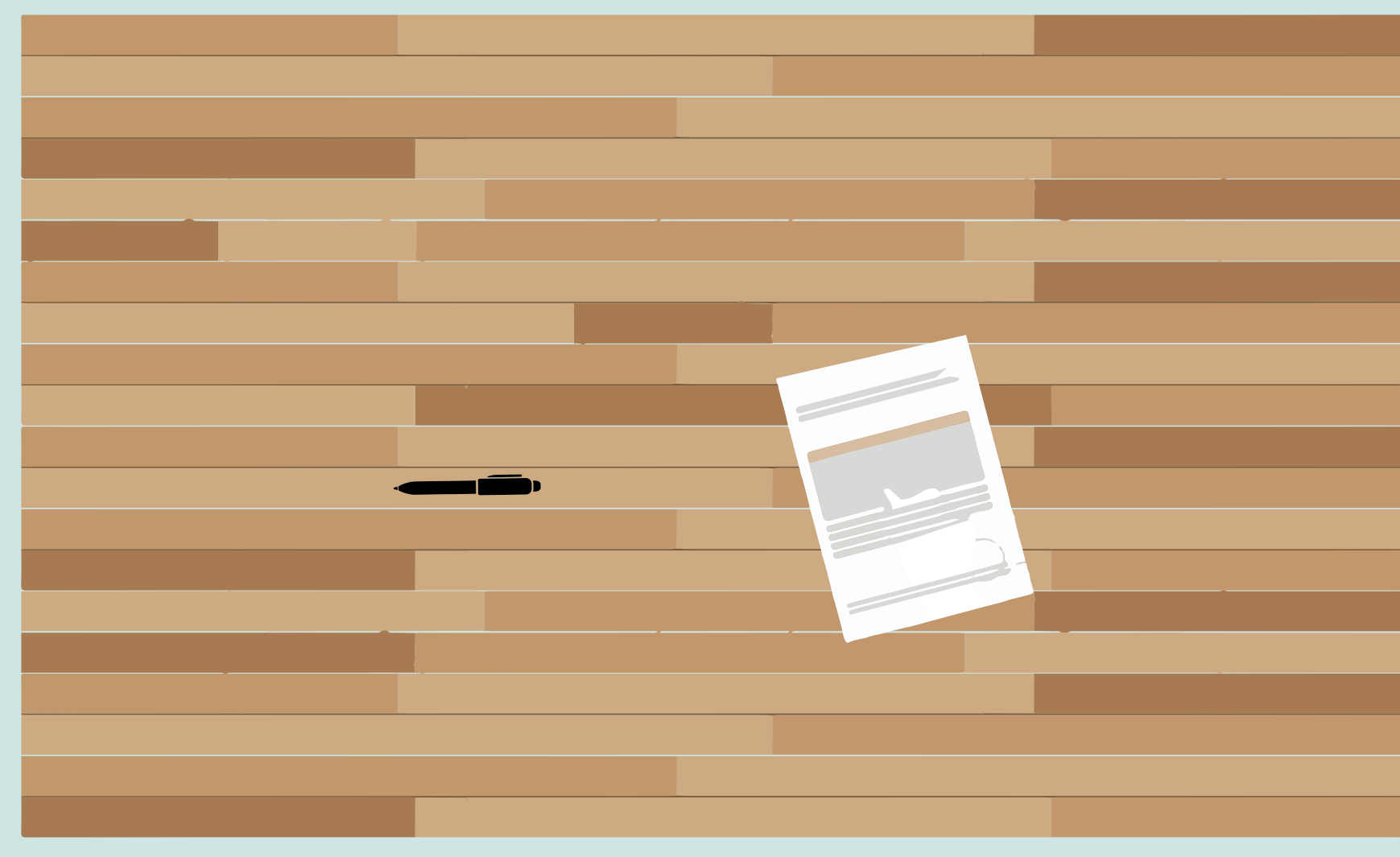
S_i is the **cover** of S_k

$$(S_i, S_j) \quad (S_j, S_k) \quad (S_i, S_k)$$

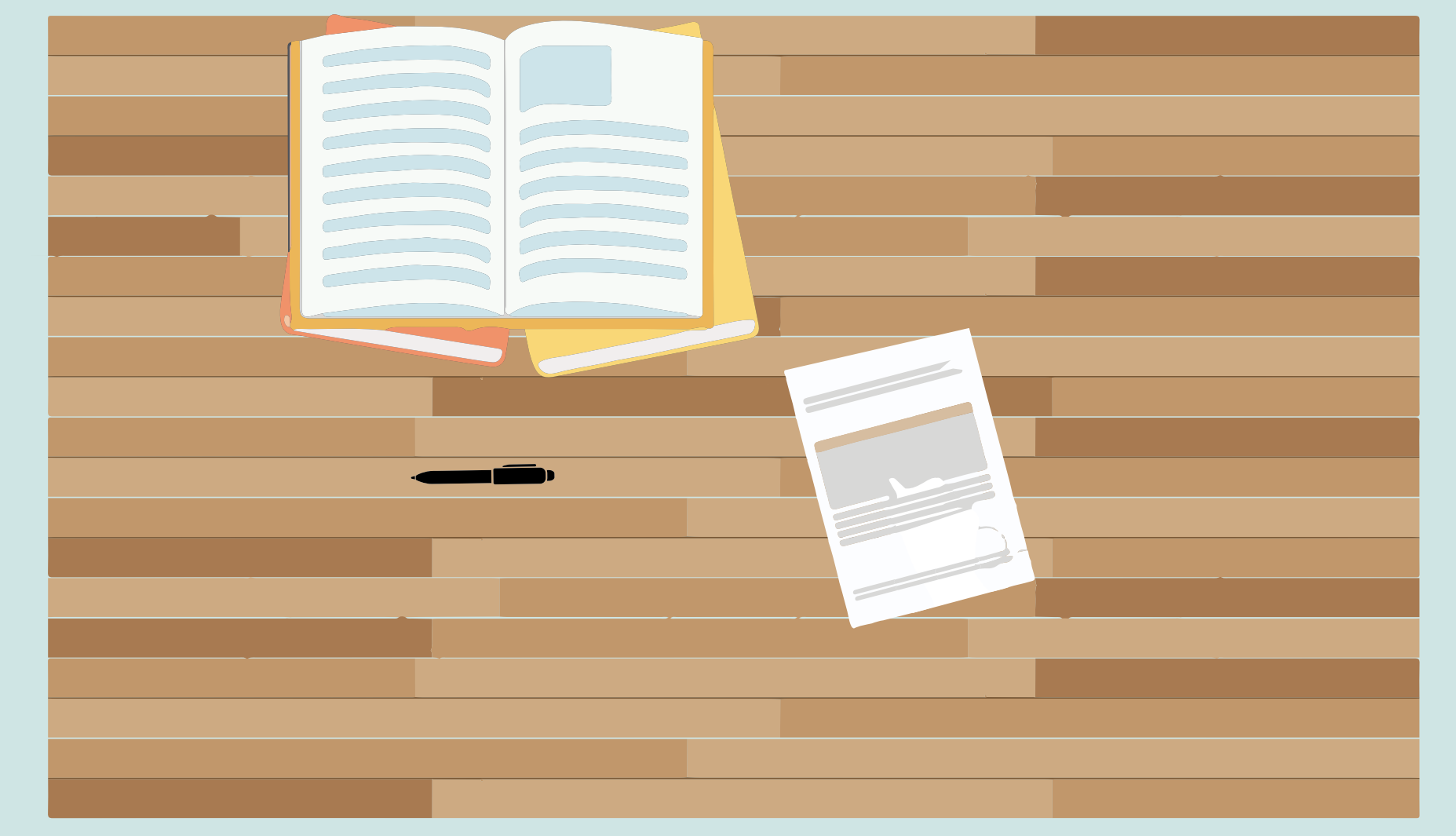
S_j is **between** S_i and S_k

The ordered pair of perceptions follow transitive relation.

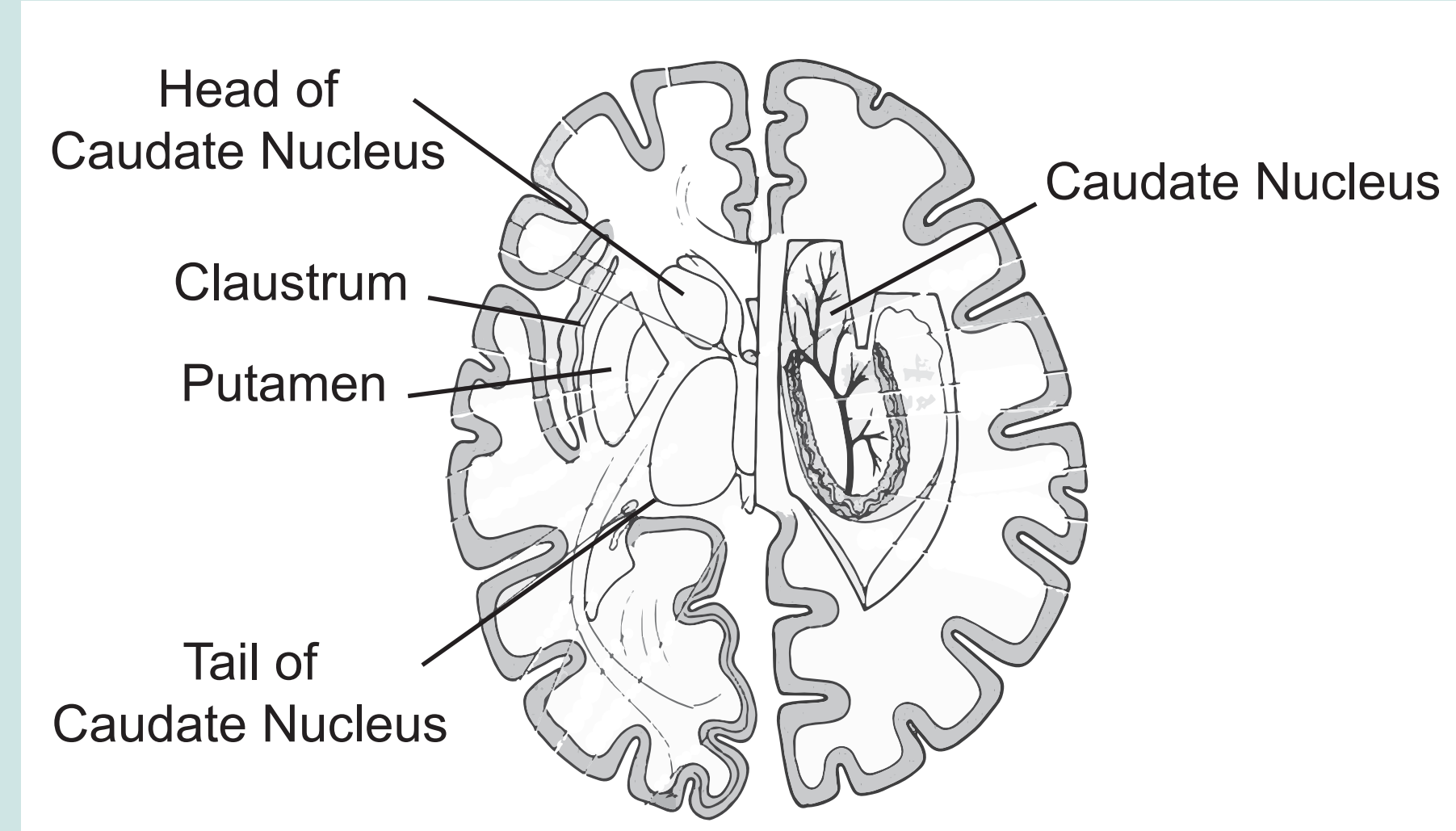
Knowledge that a pen, paper and desk are in front are discovered instantly.



Timeline View is Insufficient to Represent Subjective Time



Studies suggest neural synchrony to play a role in temporal processing and consciousness (Meck et al., 2014).



Claustrum and striatum are highlighted to play a role in neural synchrony.

The pen is *attended to briefly* and then *attention is switched back* to paper and so on ...

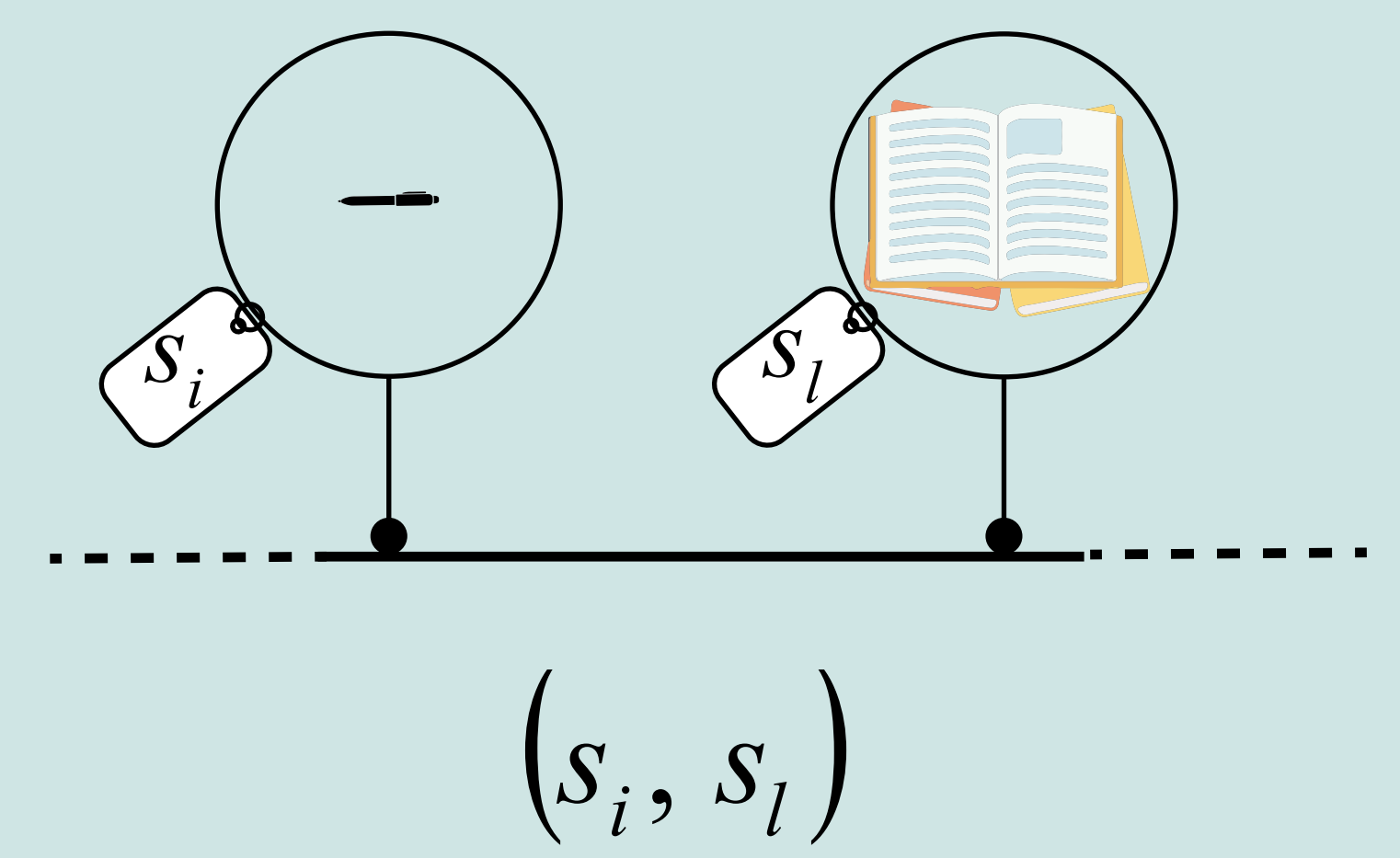


Perception is the representation in sensibility that is marked at a moment in time.



Damasio (1999) hypothesizes that each materialized knowledge is the content of each pulse-like generation of consciousness

There are discontinuities in experience and therefore **Persistence in Time**

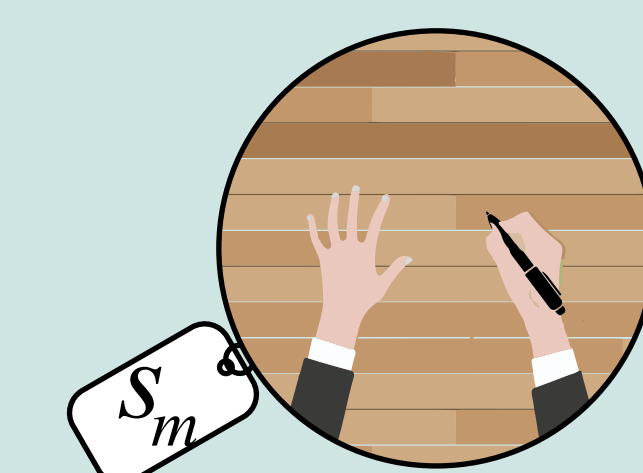


Kinetics of the two timelines

$$(S_j, S_k) \quad (S_k, S_l)$$

are not in the manifold of time.

The "something" shared between the two timelines is writing.

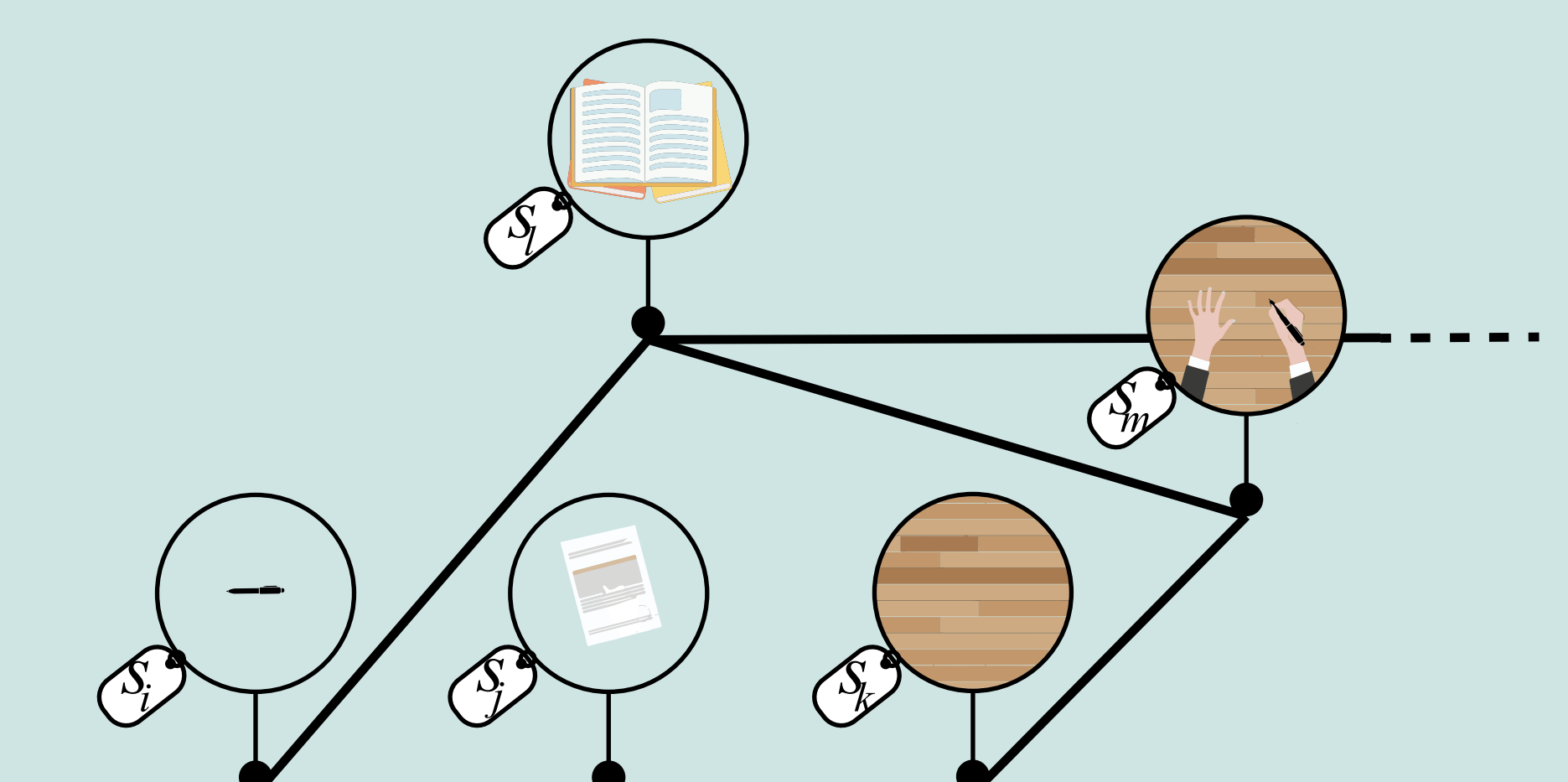


Therefore,

$$(S_l, S_m) \text{ shared writing with } (S_k, S_m)$$

Because the two timelines are separate, this means (S_m, S_m)

And the two timelines intersect.



S_m is the **join** of S_l and S_k

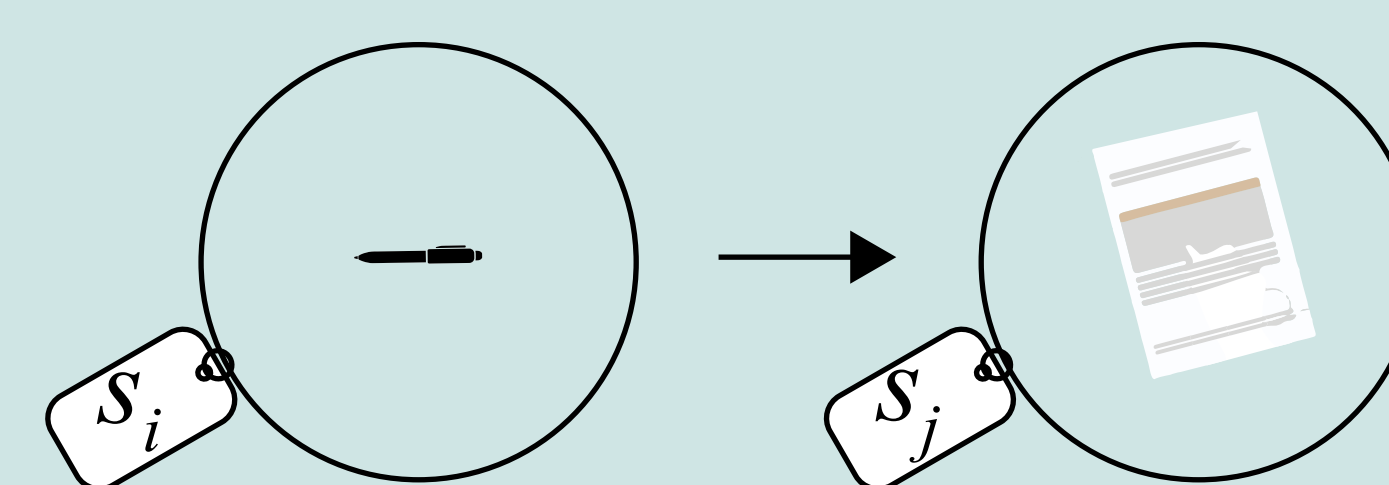
The structure is a weak partial order.

This is **Timescape View**.

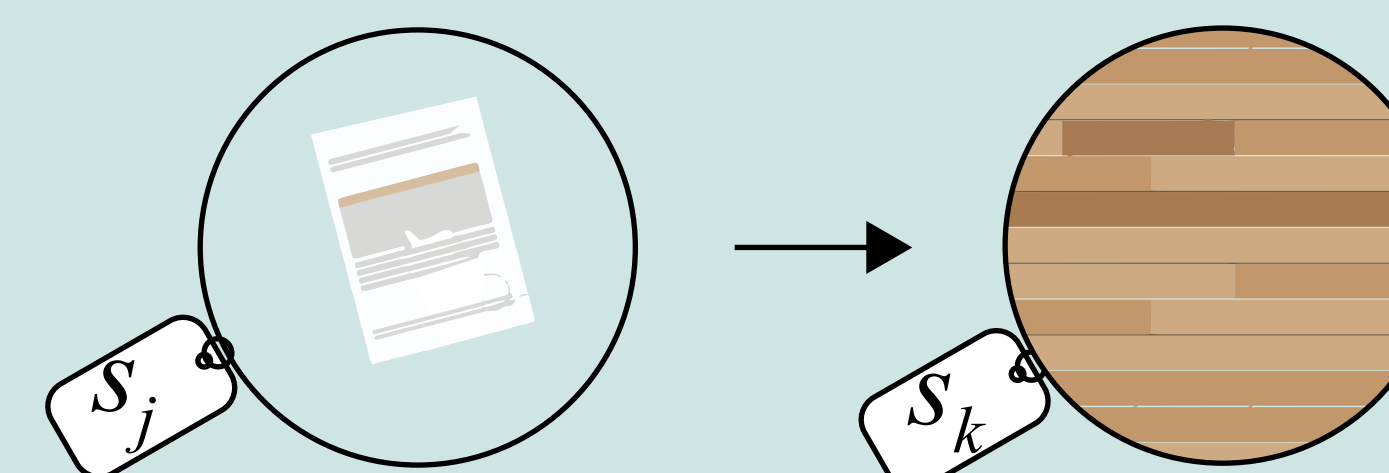
Succession in Time

We experience Nature in terms of changes

For our example perception of the paper follows the perception of the pen.



And similarly,



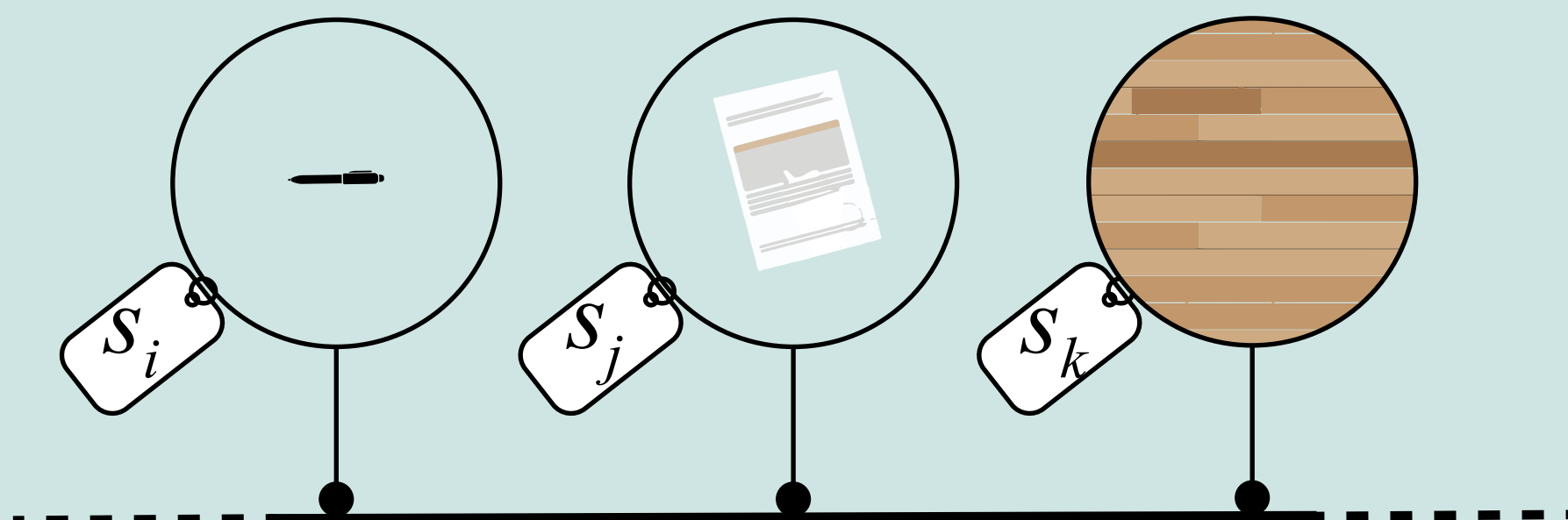
Coexistence in Time

The common factor among these is writing.



Perception of the pen, paper and desk at successive moment in time and coexisting in time.

The structure is strict partial order.



This is **Timeline View**.

Summary:

- Perceptions at moments in time for parts of a timeline.
- But the timeline view is insufficient to represent subjective time.
- The multi-dimensional timescape view represents subjective time.
- Mathematically timescape is a weak partial order structure.
- The order structure is a system of self-regulatory transformations.
- The concept of timescape is congruent with massive parallelism of brain activity.