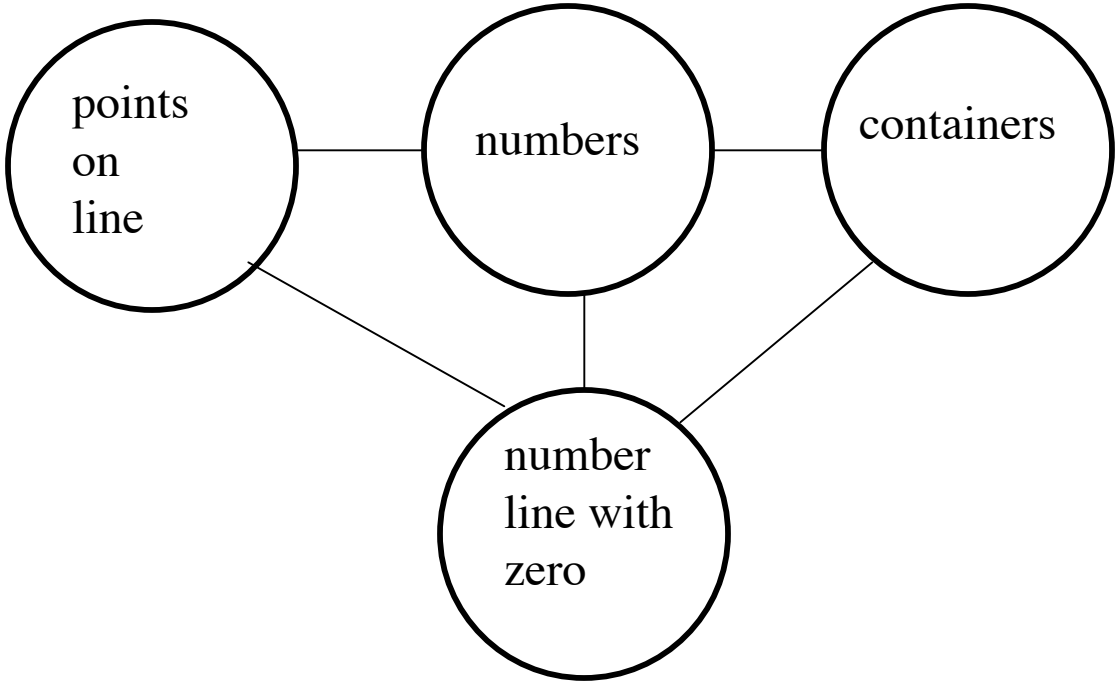
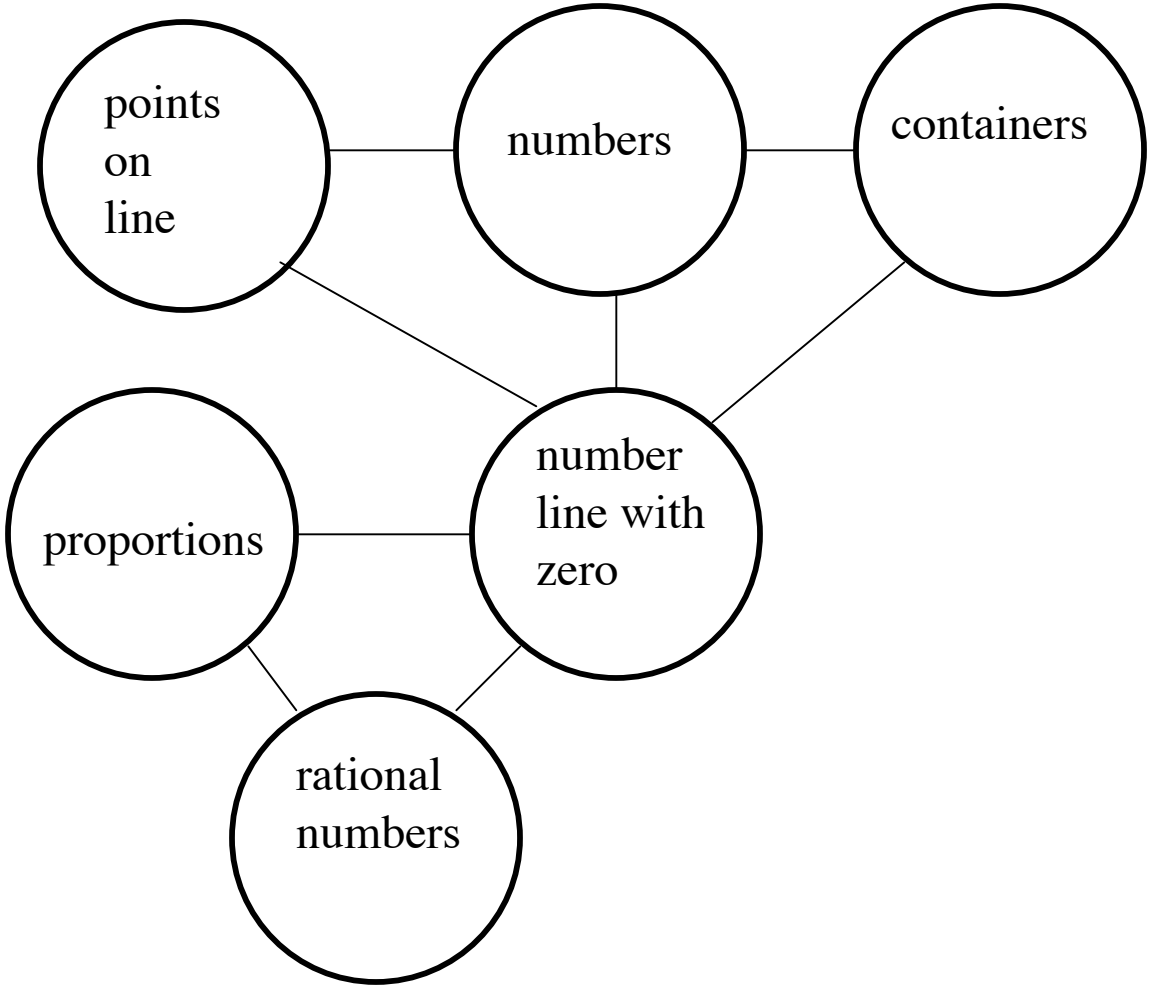
Metaphor and Conceptual Blending

Case of mathematics


points
on
line
numbers
containers
number
line with
zero


points
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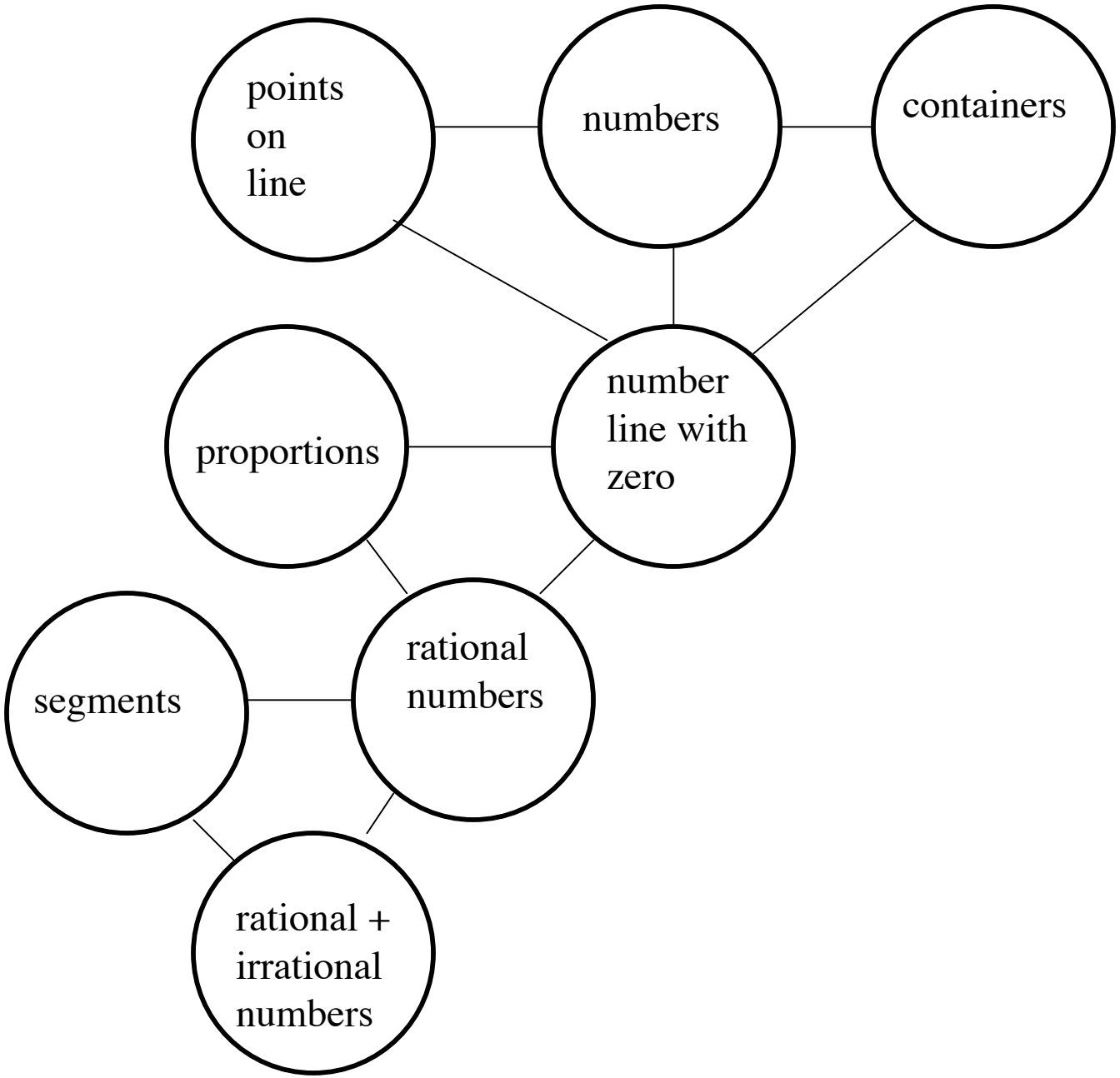
rational
numbers


points on line
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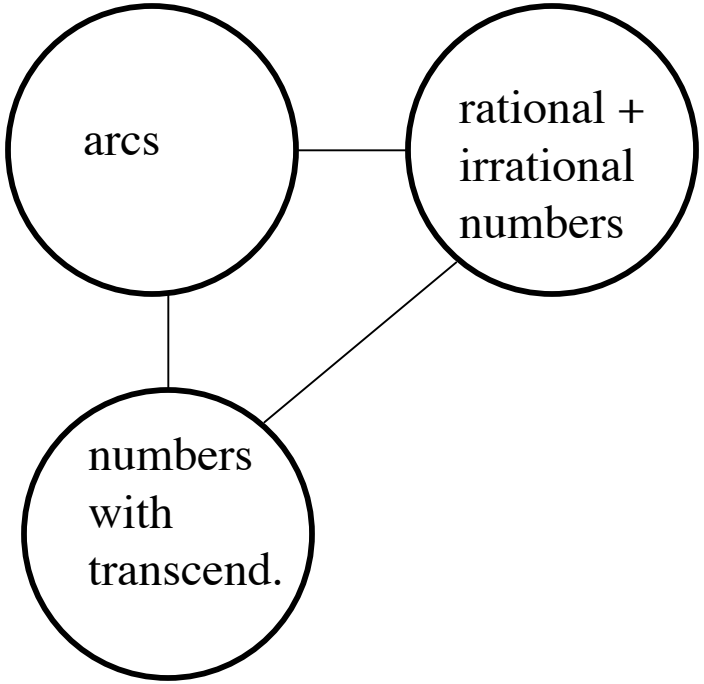
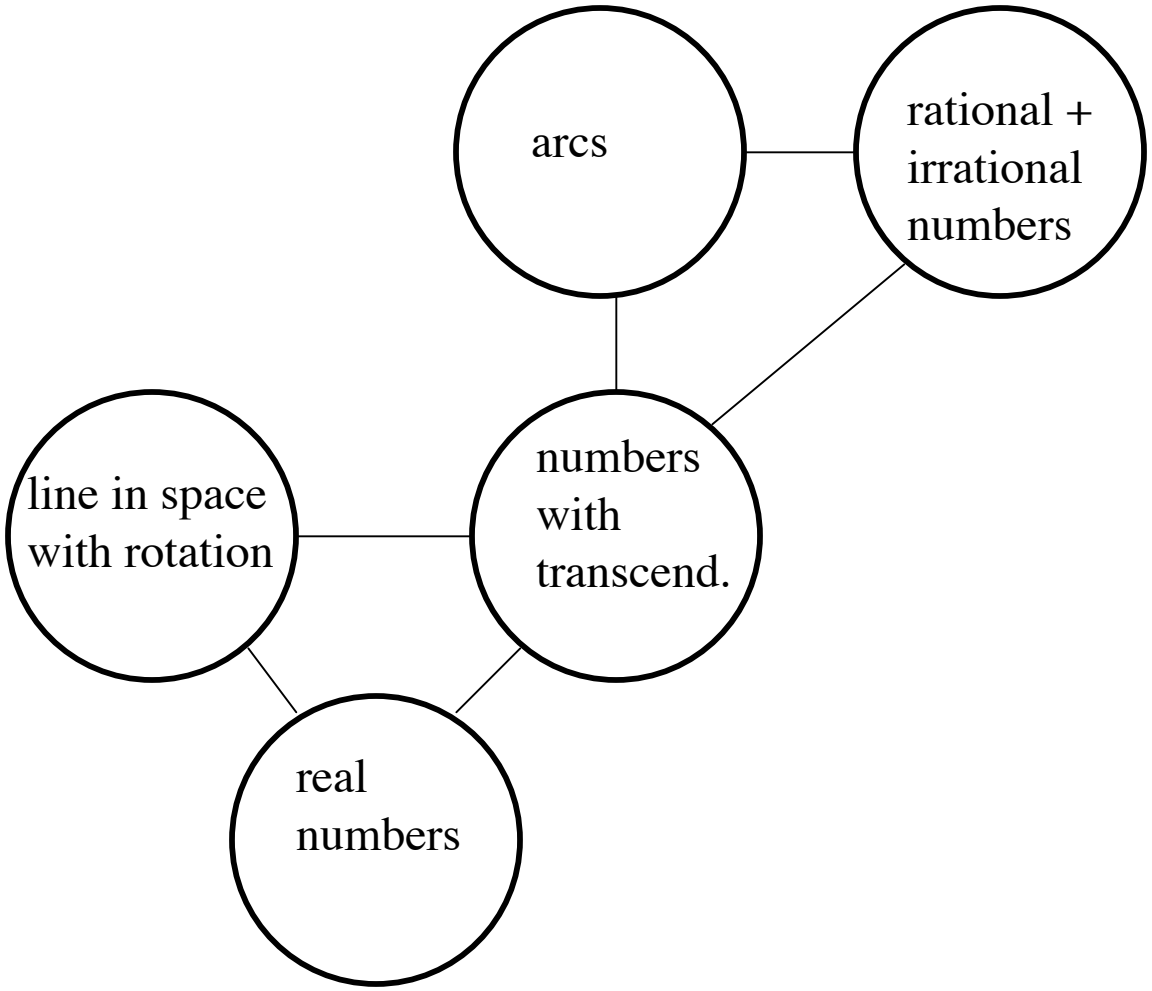
number line with zero
segments
rational numbers
rational + irrational numbers


arcs
rational +
irrational
numbers
numbers
with
transcend.


arcs
rational +
irrational
numbers
line in space
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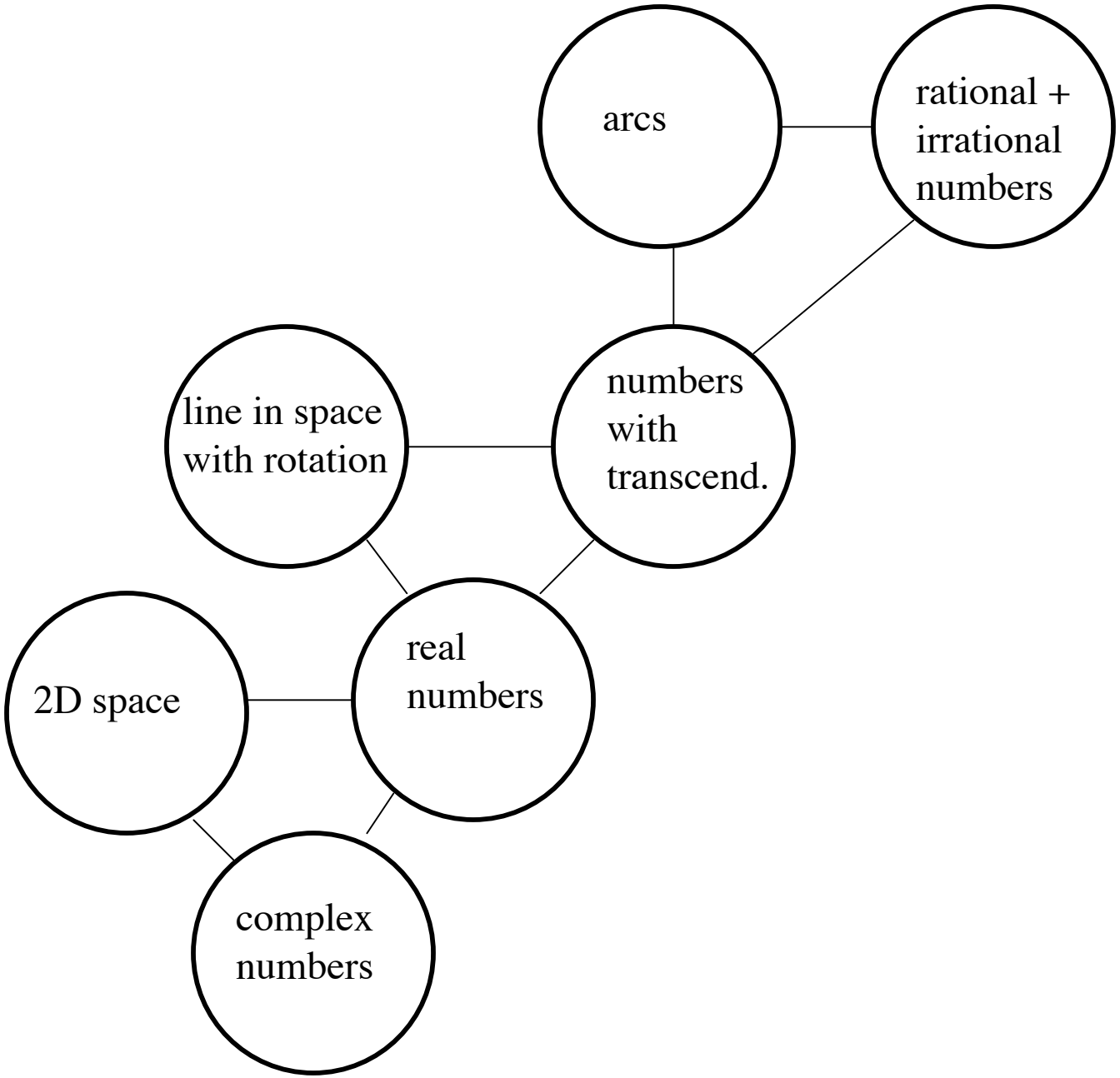
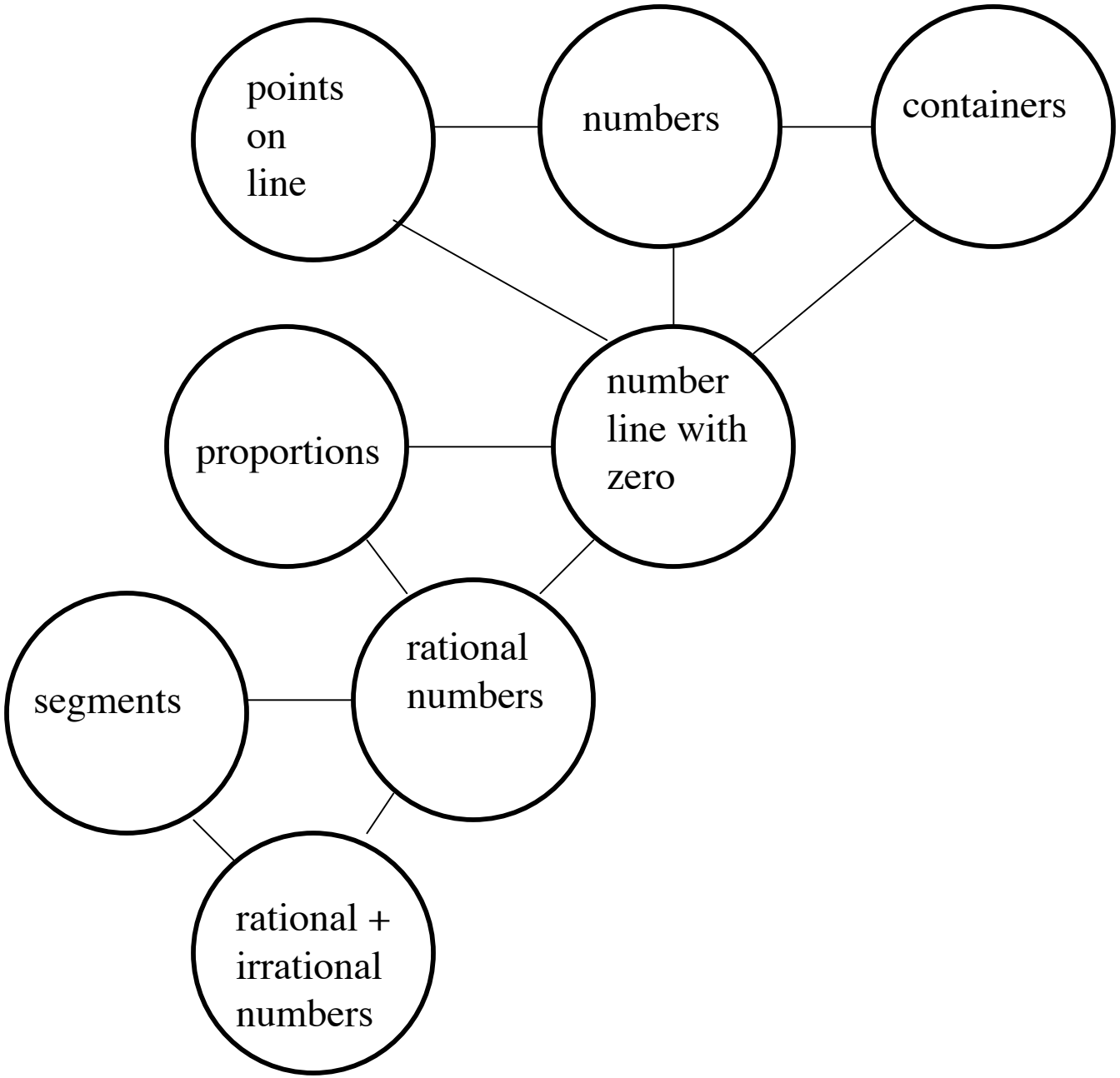
numbers
with
transcend.
real
numbers


arcs
rational + irrational numbers
line in space with rotation
numbers with transcend.
2D space
real numbers
complex numbers


points on line
numbers
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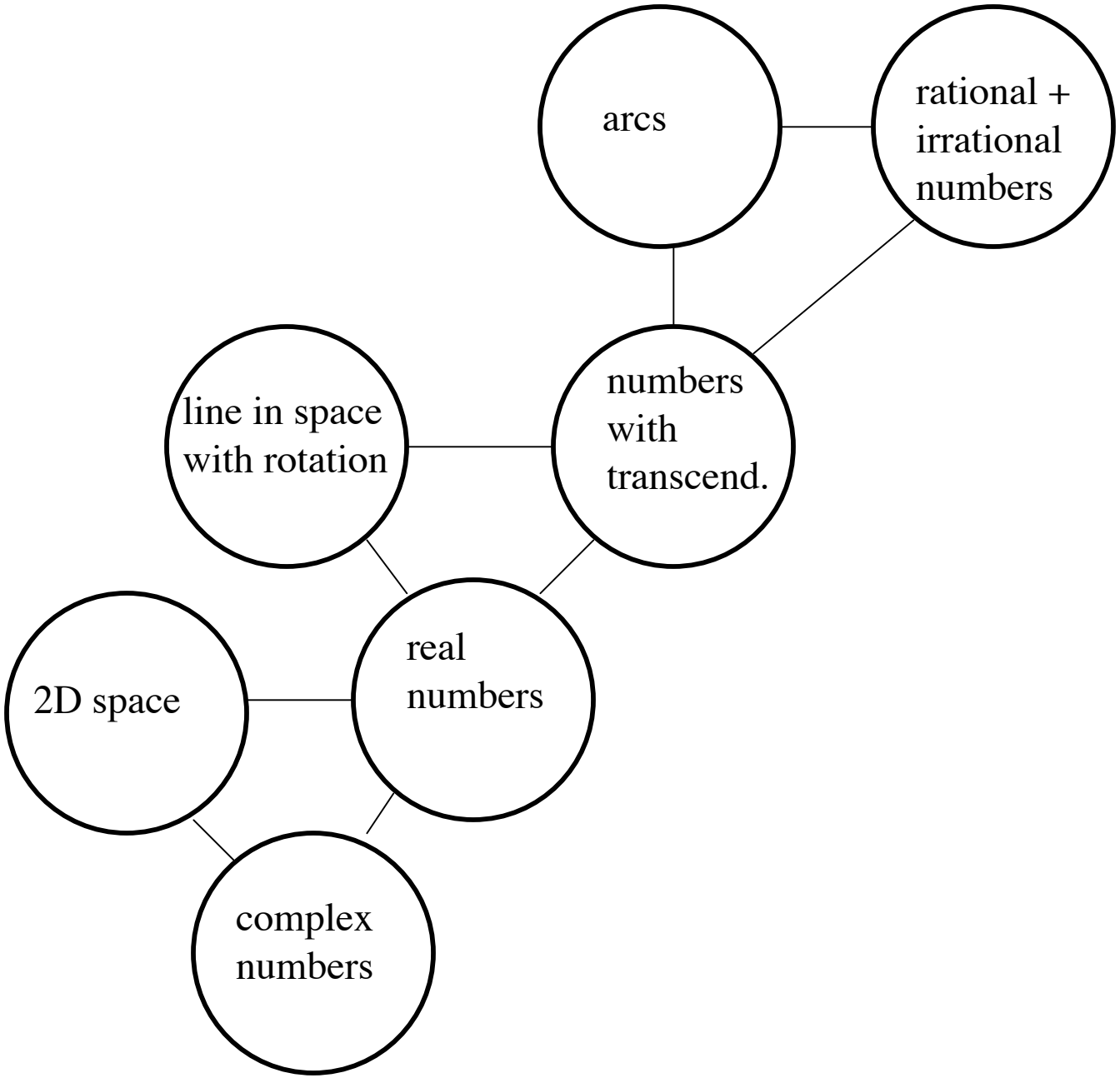
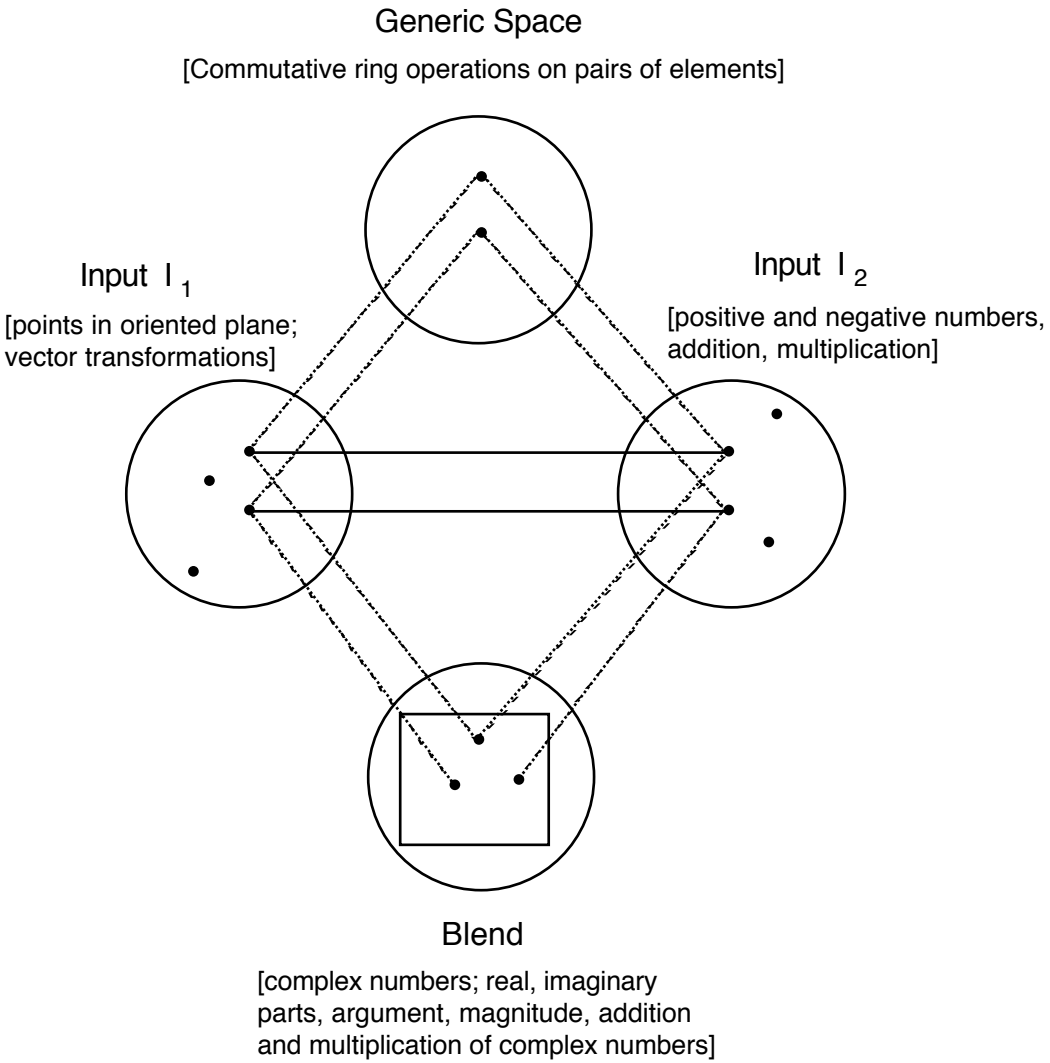
proportions
number line with zero
segments
rational numbers
rational + irrational numbers


arcs
rational + irrational numbers
line in space with rotation
numbers with transcend.
2D space
real numbers
complex numbers

The Invention of Complex Numbers



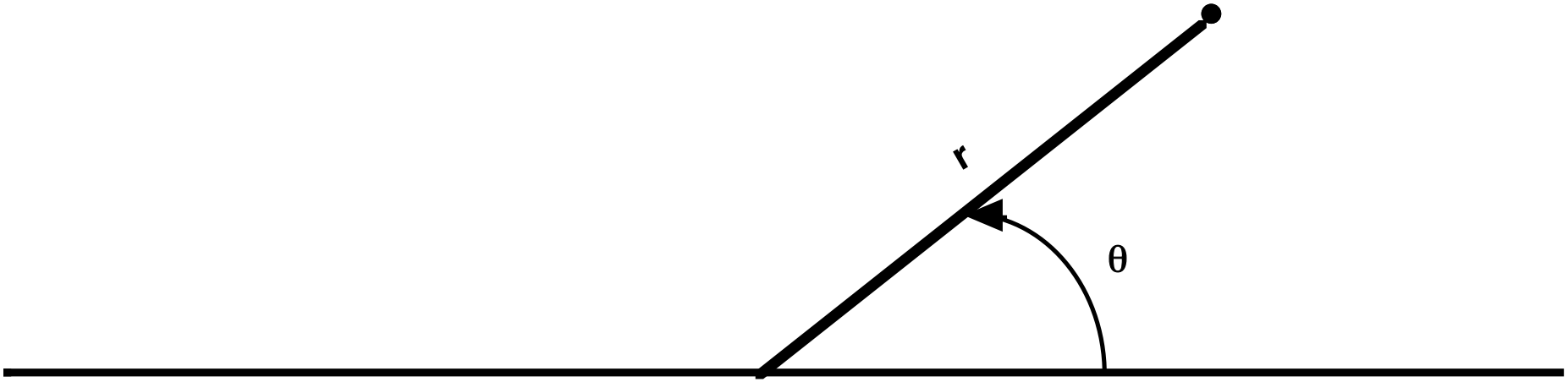
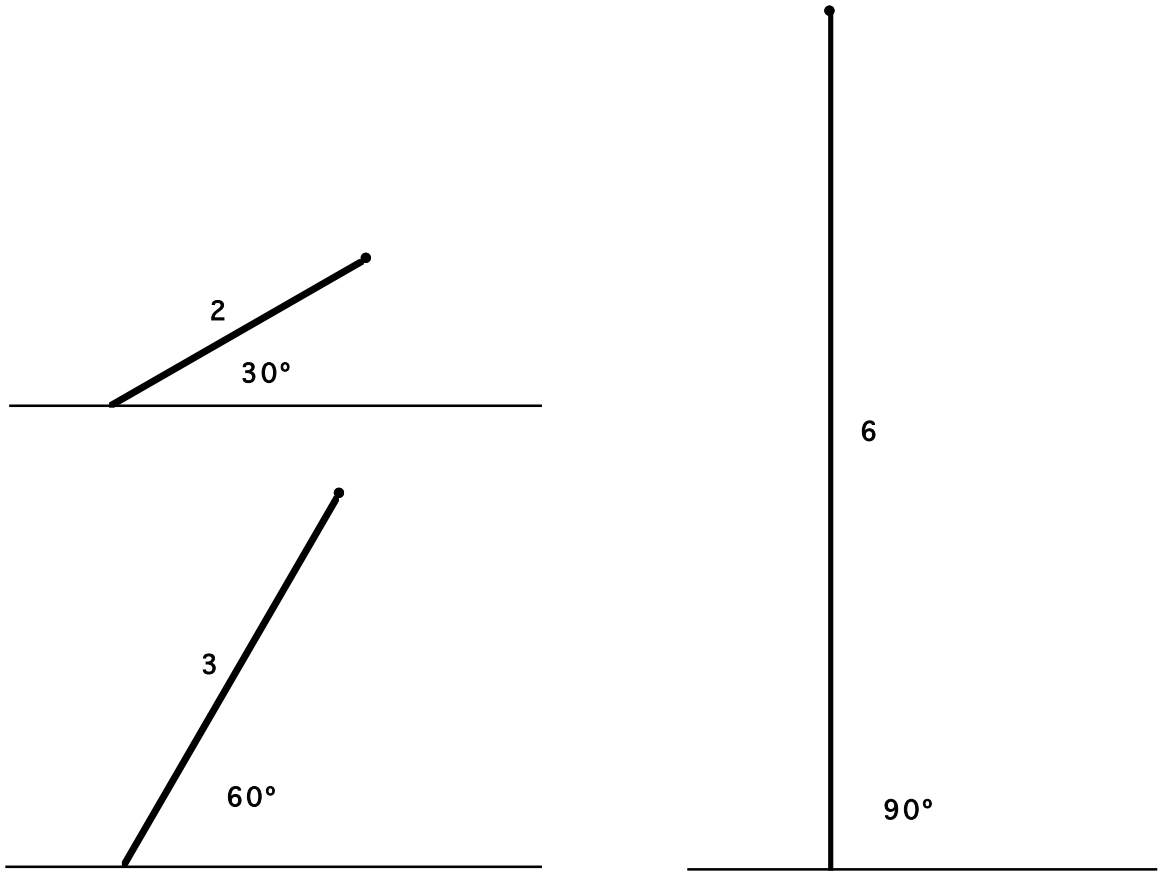


FIGURE 1 Complex number (**r**,**θ**)



multiplication of numbers (2,30°) and (3,60°) = (6,90°)

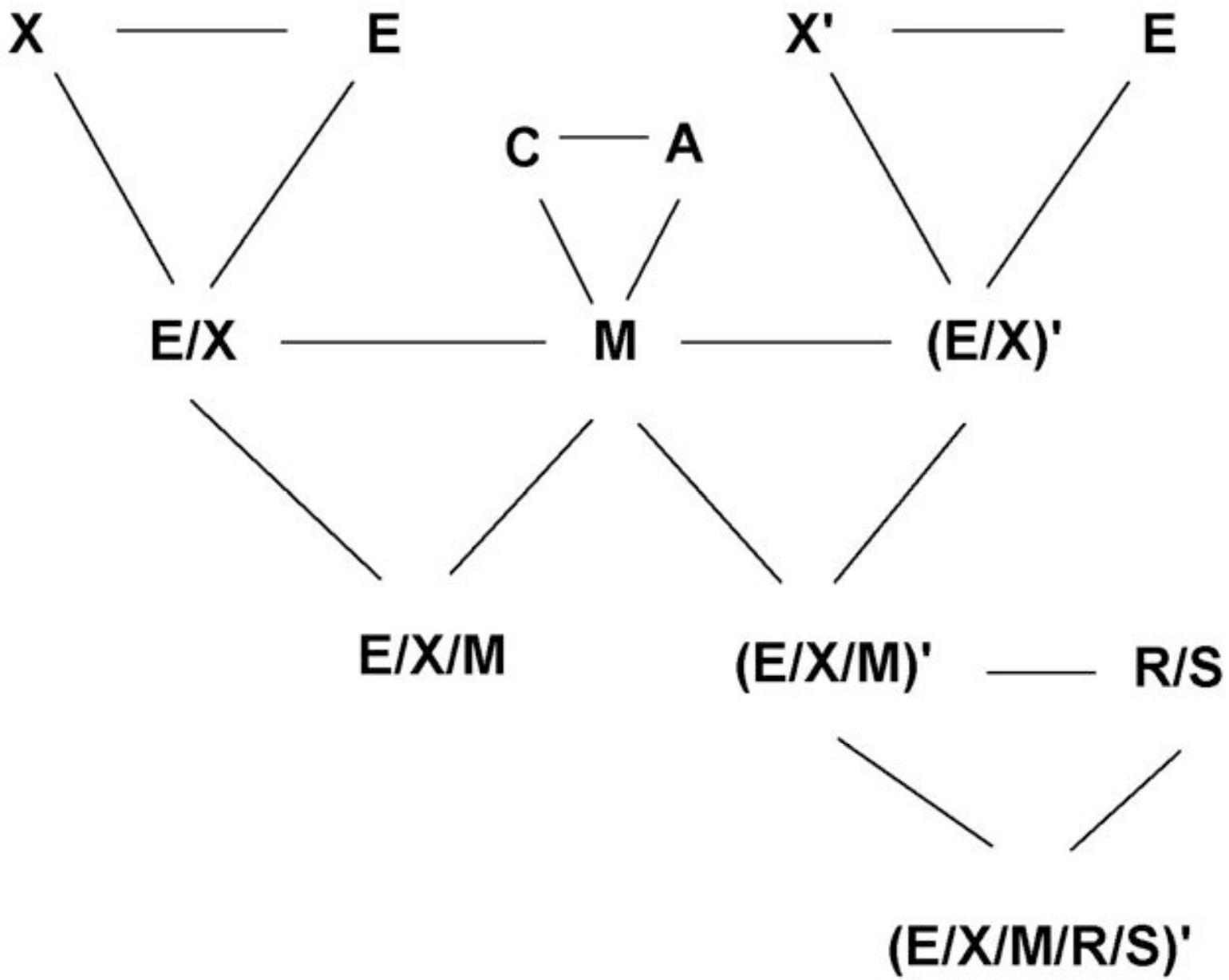
FIGURE 2

1) **new elements**: the blended mental space of complex numbers contains an infinity of numbers that were not in the original input mental space of real numbers. This is achieved by projecting points from the 2D-space into the blended space. The counterparts of the projected points are new "numbers." Because angles are projected from the 2D-space, numbers in the blended space now have "angles," a non-sensical notion in the original input mental space of real numbers. Angles (equivalently rotations) as features of numbers are new elements conceptually.

2) **emergent operations**: multiplication of numbers in the blended space includes the sum of their angles (equivalently the composition of their rotations). This is a completely emergent property of the blended mental space: in one of the inputs (the 2D space) there is no multiplication at all because you cannot multiply geometric points. In the other input (real numbers) there are no angles, and so multiplication cannot include any operation on angles. By the same token, square roots of number **n** in the blended space are obtained by taking the square root of the magnitudeof **n** and half of the angle of **n**. This is an emergent operation, impossible in either one of the inputs.

3) **compressions**: the mapping between points in one input and numbers in the other is compressed within the blended space into Uniqueness. This is fusion, the strongest possible form of compression: points are numbers and numbers are points.

If we only look at the blended space, its structure is remarkably simple, and can easily be taught to young children.


X
E
X'
E
C
A
E/X
M
(E/X)'
E/X/M
(E/X/M)'
R/S
(E/X/M/R/S)'

Why do we have a brain?

- the purpose of the brain is to produce adaptable and complex movements
- movement is the only way we have
  - of interacting with the world
  - of communicating (speech, gestures, writing)
- sensory, memory and cognitive processes have evolved to guide movement

TREES DO NOT NEED BRAINS,
BECAUSE THEY DO NOT HAVE MUSCLES

TIME IS MONEY

You're *wasting* my time.

This gadget will *save* you hours.

I don't have the time to *give* you.

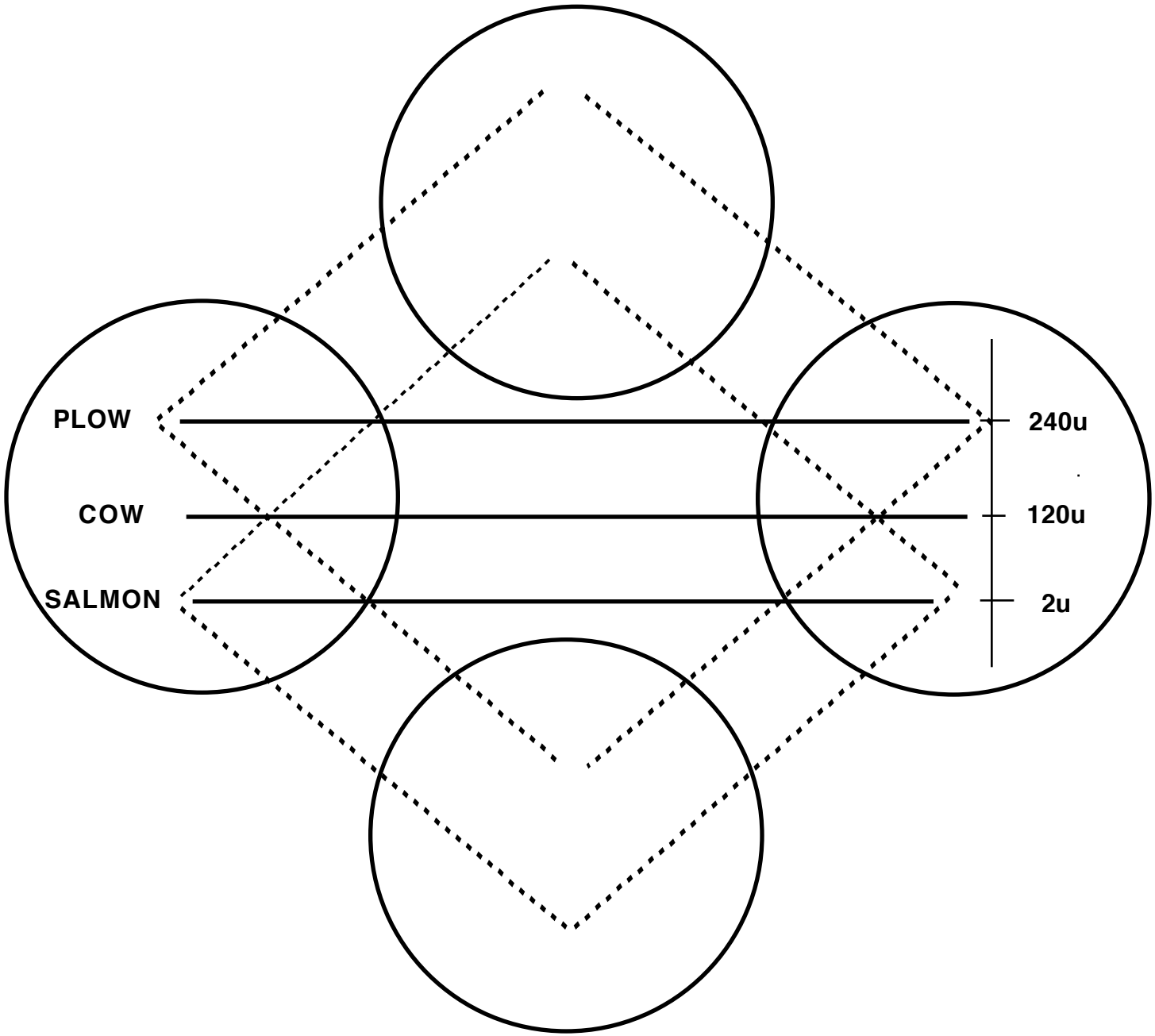
How do you *spend* your time these days?

That flat tire *cost* me an hour.

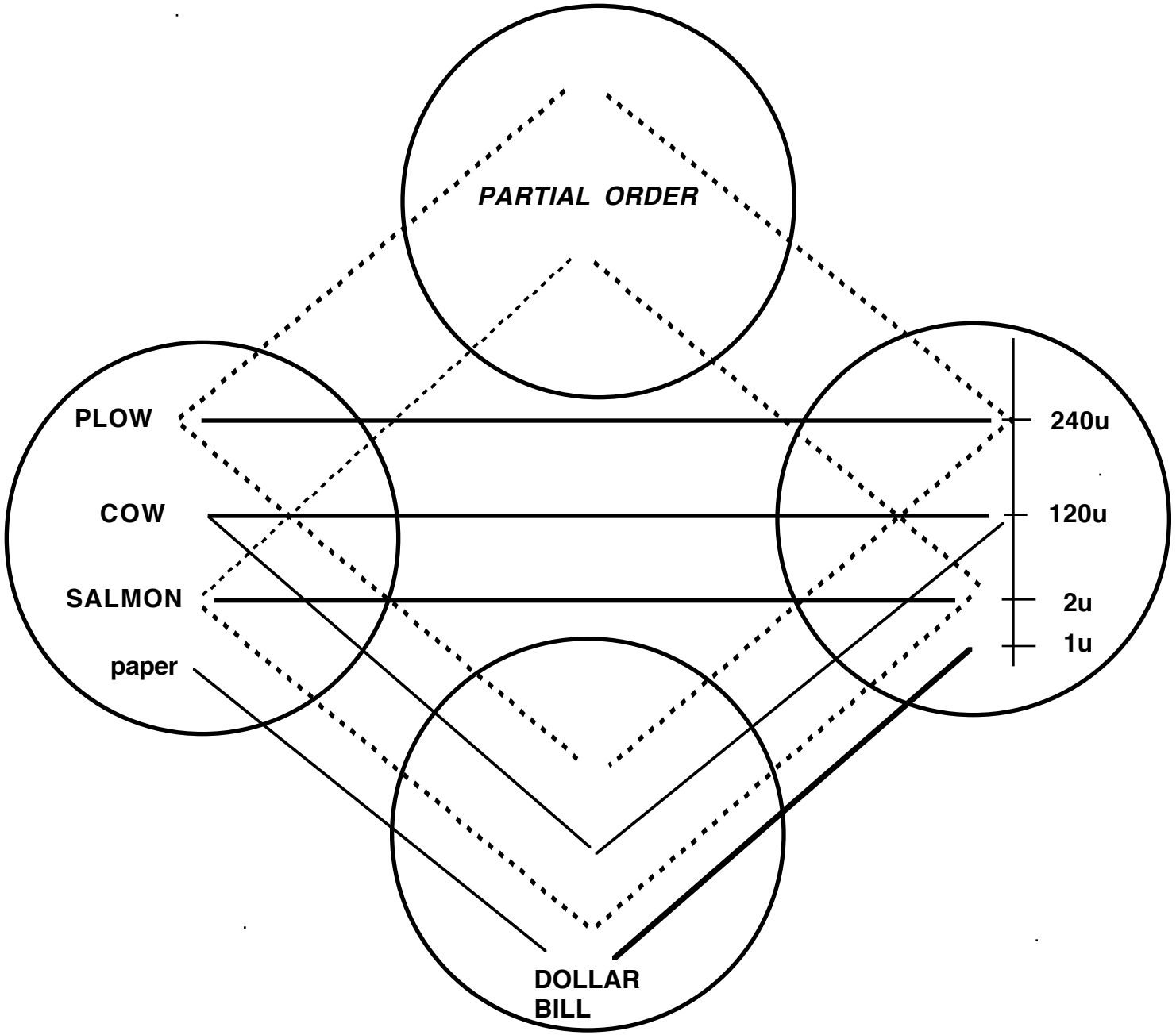
I've *invested* a lot of time in this project.

He's living on *borrowed* time.

(fisherman) 30 salmon = 1 piece of cloth = 10 chicken
(weaver)
(farmer) 2 cows = 1 plow


PLOW
COW
SALMON
240u
120u
2u


BANCO NACIONAL DE CUBA
T519520B
UN PESO
T519520B
1 PESO
UN PESO
UN PESO


PARTIAL ORDER
PLOW
COW
SALMON
paper
240u
120u
2u
1u
DOLLAR
BILL

Time

TIME is SPACE

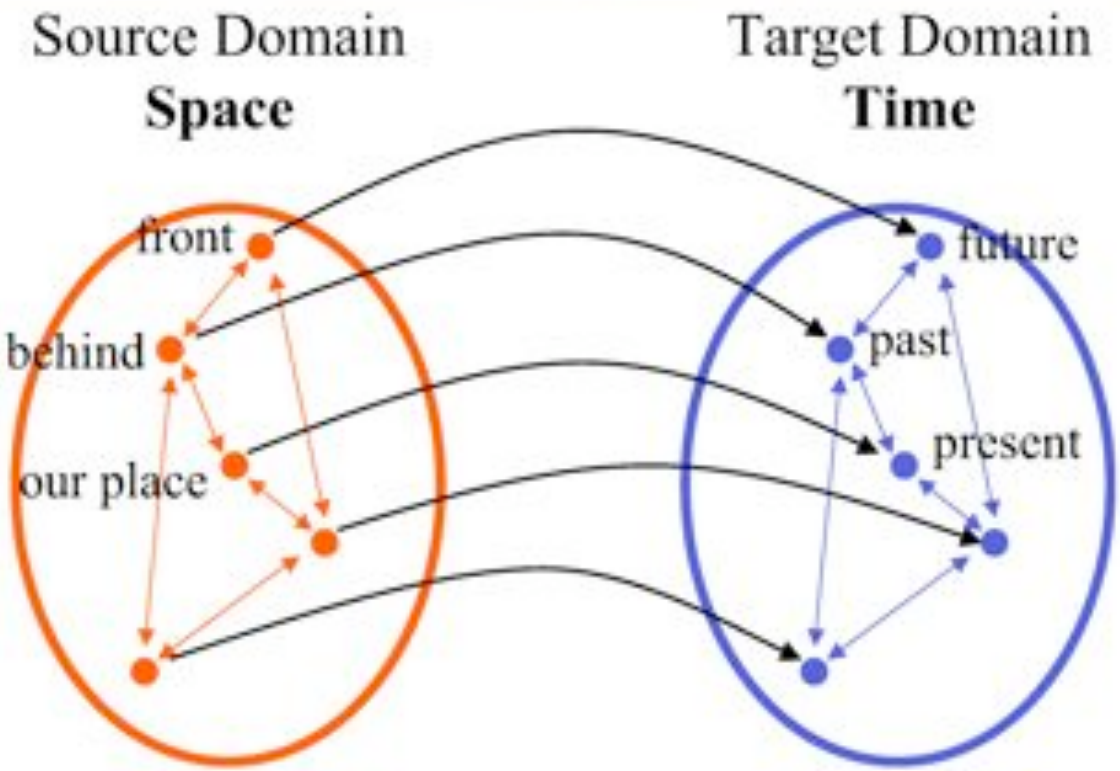
Christmas is not far away

We're getting close to Christmas

Time flies

etc.

Time As Unidimensional Space



1. Three hours went by, and then he had dinner.
2. *Three feet went by, and he was at the door.
3. Minutes are quick but hours are slow.
4. *Inches go by faster than feet.
5. Those three hours went by slowly for me, but the same three hours went by quickly for him.
6. For me, the hours were minutes but for her the minutes were hours.
7. At the end of the three hours, you will have solved the problem, but at the end of the same three hours, he will have solved it and five more.
8. Time came to a halt.
9. Sure, it's Friday afternoon, but Monday morning is already staring us in the face.
10. Next week was an eternity away.
11. For me, the three hours were forever, but for her, they did not exist.
12. It'll go by faster if you stop thinking about it.

E:

E is the input of Events.

Human beings are expert at parsing the world into events (selling shoes, solving math problems, dining) and objects.

This expertise includes understanding event shape, including ordering, and event type.

Event spaces can include subjective experience of those events.

A lecture is an event with many participants - the lecturer, the audience, the support staff - and each participant experiences the same event in a variety of different possible ways.

So the lecture can be painful for me, pleasant for you, difficult for the lecturer, easy for the technician, challenging for the interpreter.

X:

experienced motion through physical space

An important kind of event for human beings is motion through physical space from point A to point B, with corresponding objective and subjective experiences.

X, experienced motion through physical space,

is a subset of **E** (events)

Within **X**

- if we travel from A to B and then B to C, we know that the event of traveling from A to B is over before the event of traveling from A to C is over

Relative length corresponds to ordering of events:

AB is shorter than AC

event <AB> is over before event <AC>.

- In space **X**, the use of the notion of *fast* versus *slow* is not the one used in physics; it correlates with the duration of events.

, In English, we say that going from A to B is "*faster*" than going from A to C, even if our speed in the technical sense is the same. In **X**, the event of traversing the path is connected with the path.

E/X: blended space

E and **X** are blended to yield emergent structure

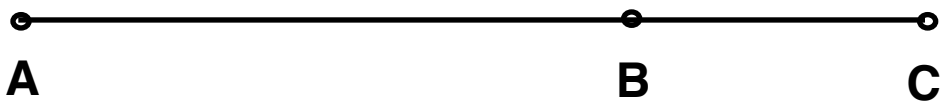
We can "*go through the lecture*" just as we can "*go through the park*" because in the blend, the event is motion from one point to another.

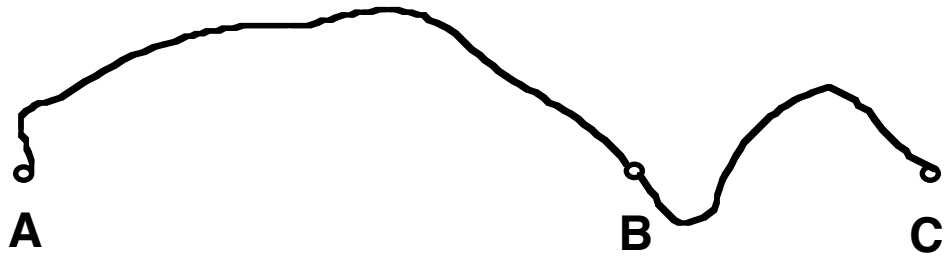
- In the blend **E/X**, any event has length and experienced motion (including speed, in the everyday sense of *fast* and *slow* rather than in the technical sense of physics).

- In **E/X**, the traveler of input X is fused with the experiencer of input E. The event in E is fused with the event of traversing the path in X and with the path in X. By this means, in the blend, an event becomes a path, and completing the event is traversing the path.

As we can say that *one stretch of road is faster than another* because the event of traveling the first is over before the event of traveling the other, just so, we can say that *one event is faster than another*.

In the blended space, an event is an origin and a destination. Two travelers may begin at the same origin and arrive at the same destination, yet they might traverse different paths, so the event can be **long** for one but **short** for the other, and can be **slow** for one and **fast** for the other.


A
B
C


A
B
C

Event of going from A to B is shared

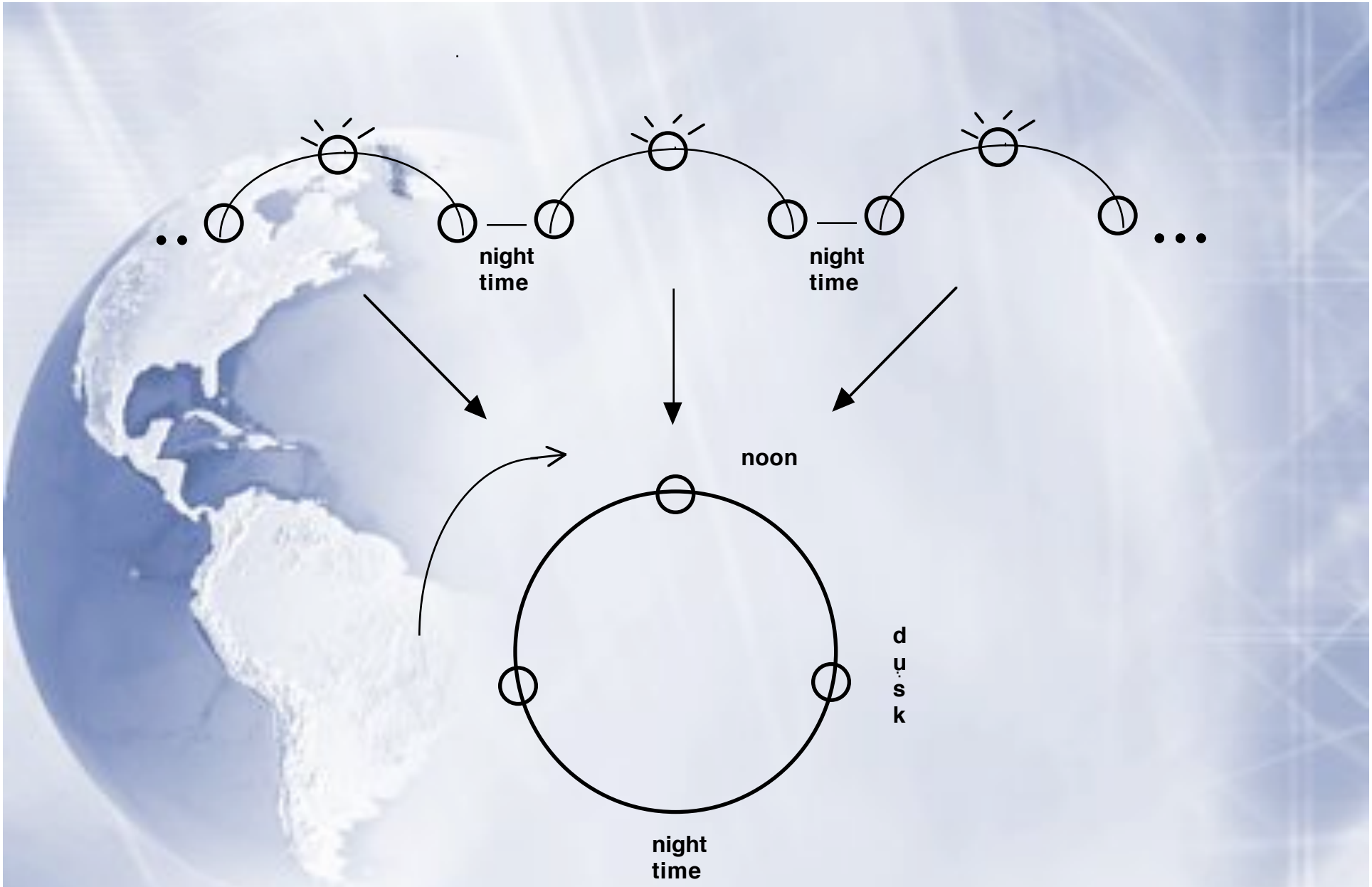
Event of going from A to B on path P is individual, which maps onto subjective (for duration)

M

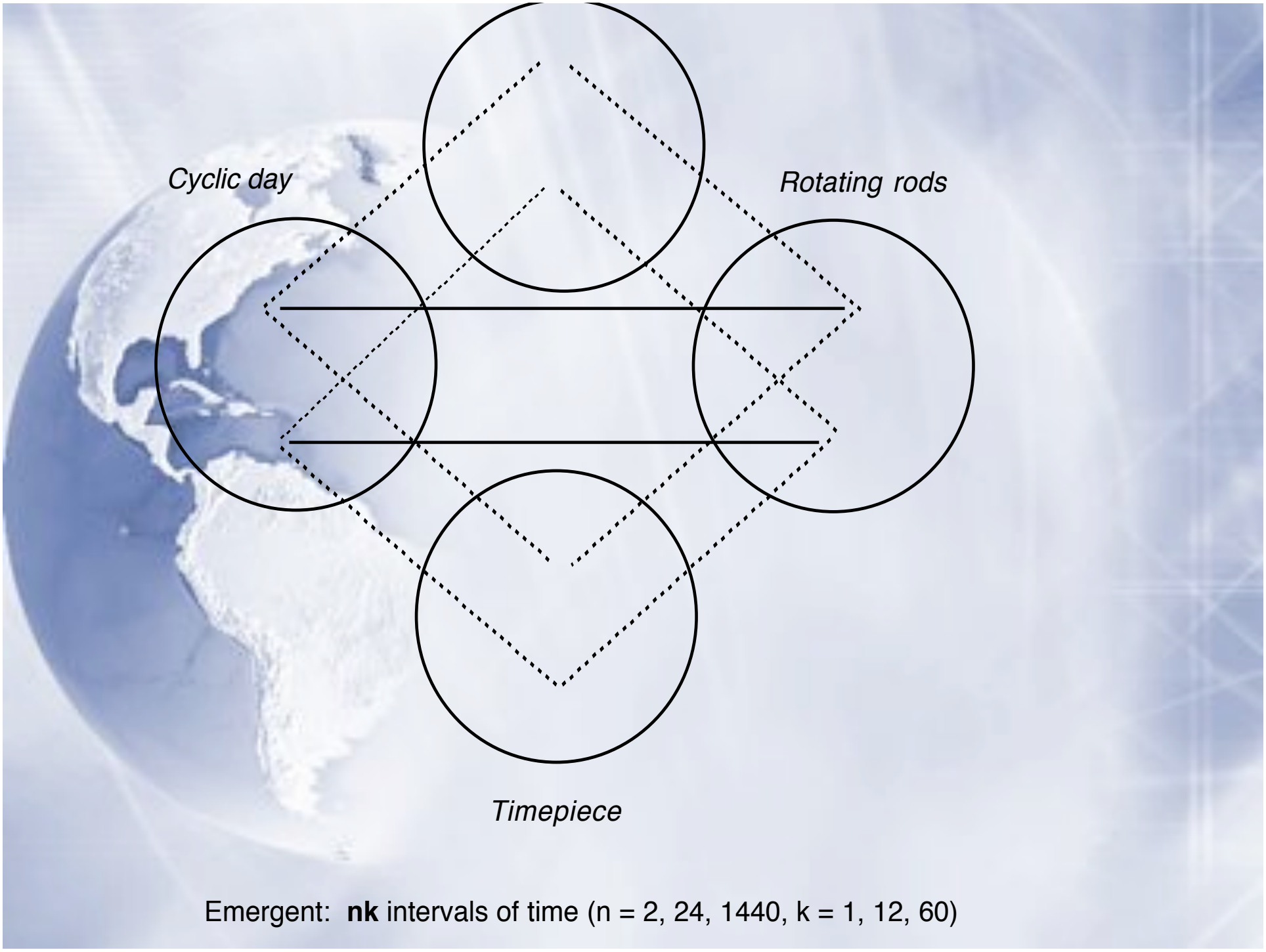
The socially (and technologically) constructed notion of shared universal events

M

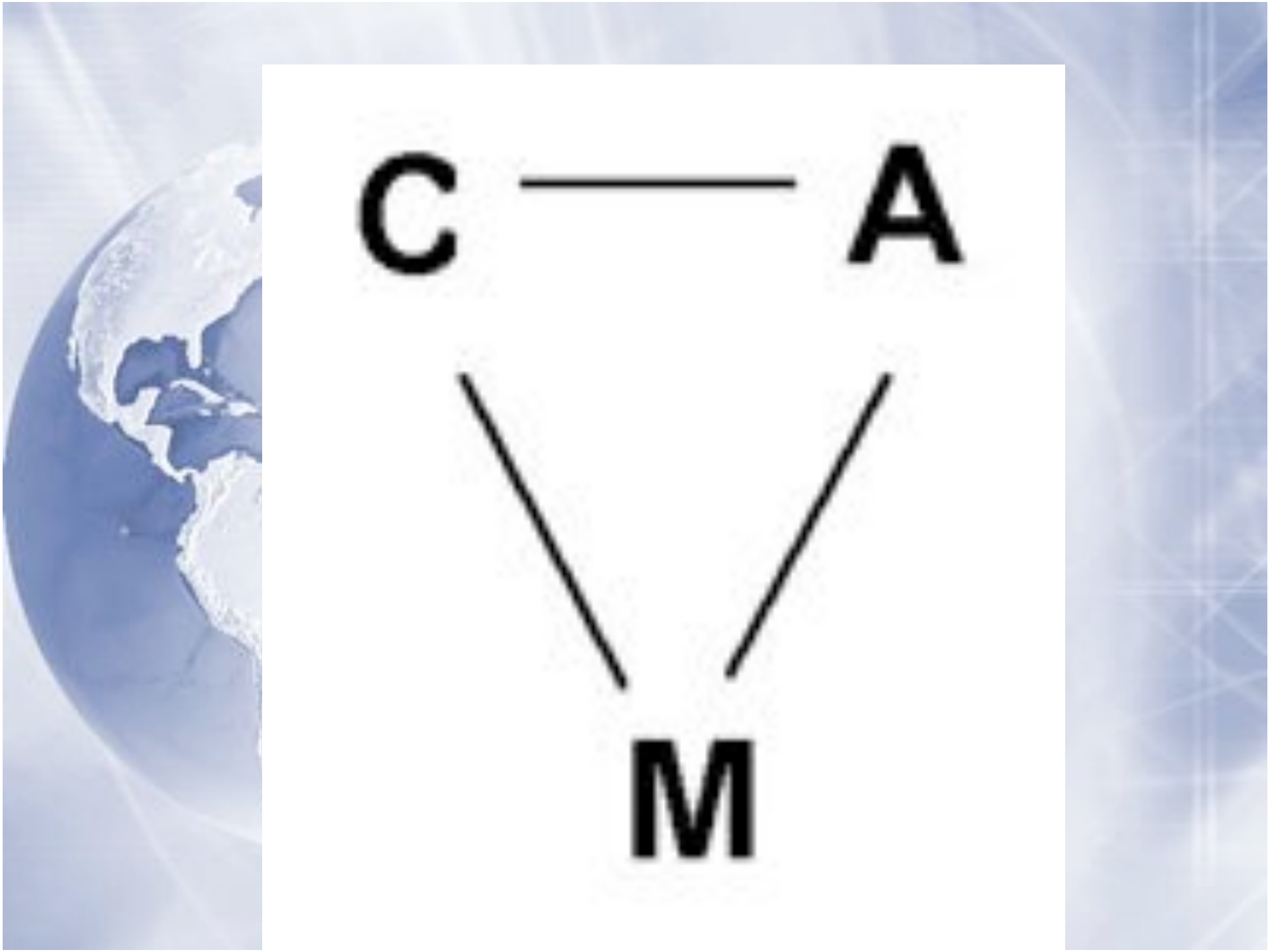
This is a blend built on the basis of standard normed, shared events such as *hand going around the clock*. It yields emergent structure of hours, minutes, etc., as explained in The Way We Think.



*the day runs its course, going through **the** day,*
when the day starts again



Emergent: **nk** intervals of time (n = 2, 24, 1440, k = 1, 12, 60)


C
A
M

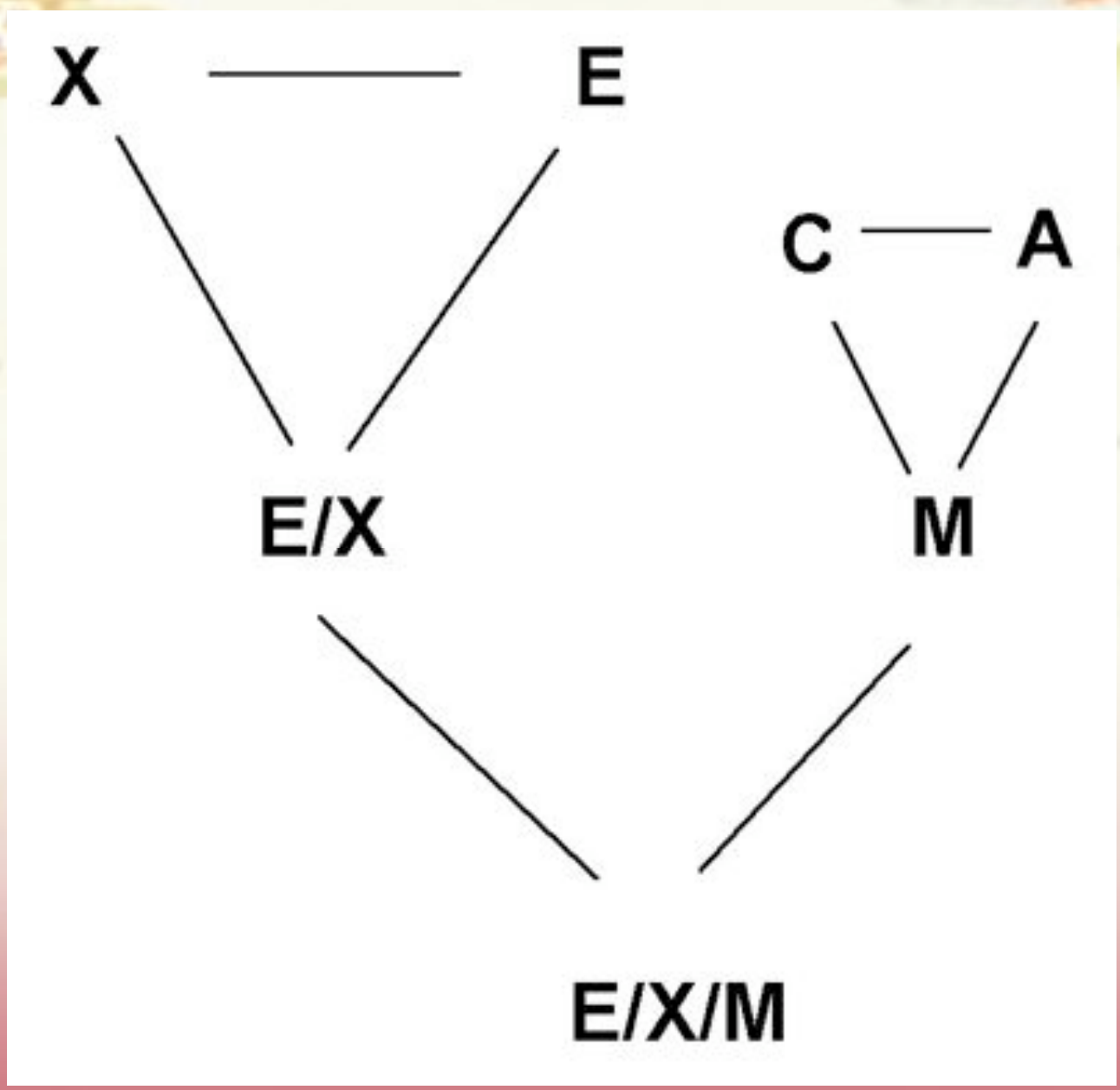
The crucial feature of these material timepieces is that they have, within tolerance, *matching onset and termination for the same constructed events* (minute, hour, day, . . .).

For purposes of the M network, we can compress various timepieces to

one ideal timepiece

because the particular onsets compress to the ideal onset and the particular terminations compress to the ideal termination.

The change from onset to termination defines, for example, an "hour." We conceive of everything in the universe as going through that hour. How do we in practice relate to this idealized universal event? The answer is, we relate to it because the compression guarantees that any local event involving motion of a tolerably accurate timepiece (watch, hourglass, sun) maps on consistently to the universal idealized event.


X
E
C
A
E/X
M
E/X/M

In that blended space, universal events in M become particular local events in E/X

You cannot go through the local event without going through the universal event that has the same beginning and end

In the emergent structure of the blended space, the universal event becomes a universal spatial length, and therefore a measure, analogous to yards, meters, and so on. This is why any event has a length - it is an hour long, a minute long, etc.

We can "*go through an hour*" just as we can “*go through a lecture*," and the hour can be painful just as the lecture can be painful

I went through the first hour much more quickly than the second hour

It's amazing how the eight-hour work day is longer on Monday than it is on Friday

Mapping between the events in **E/X** and the events in **M**:

When we blend them, we can preserve the topology of **M** or the topology of **E/X**

I went on too long; it was an hour and five minutes long

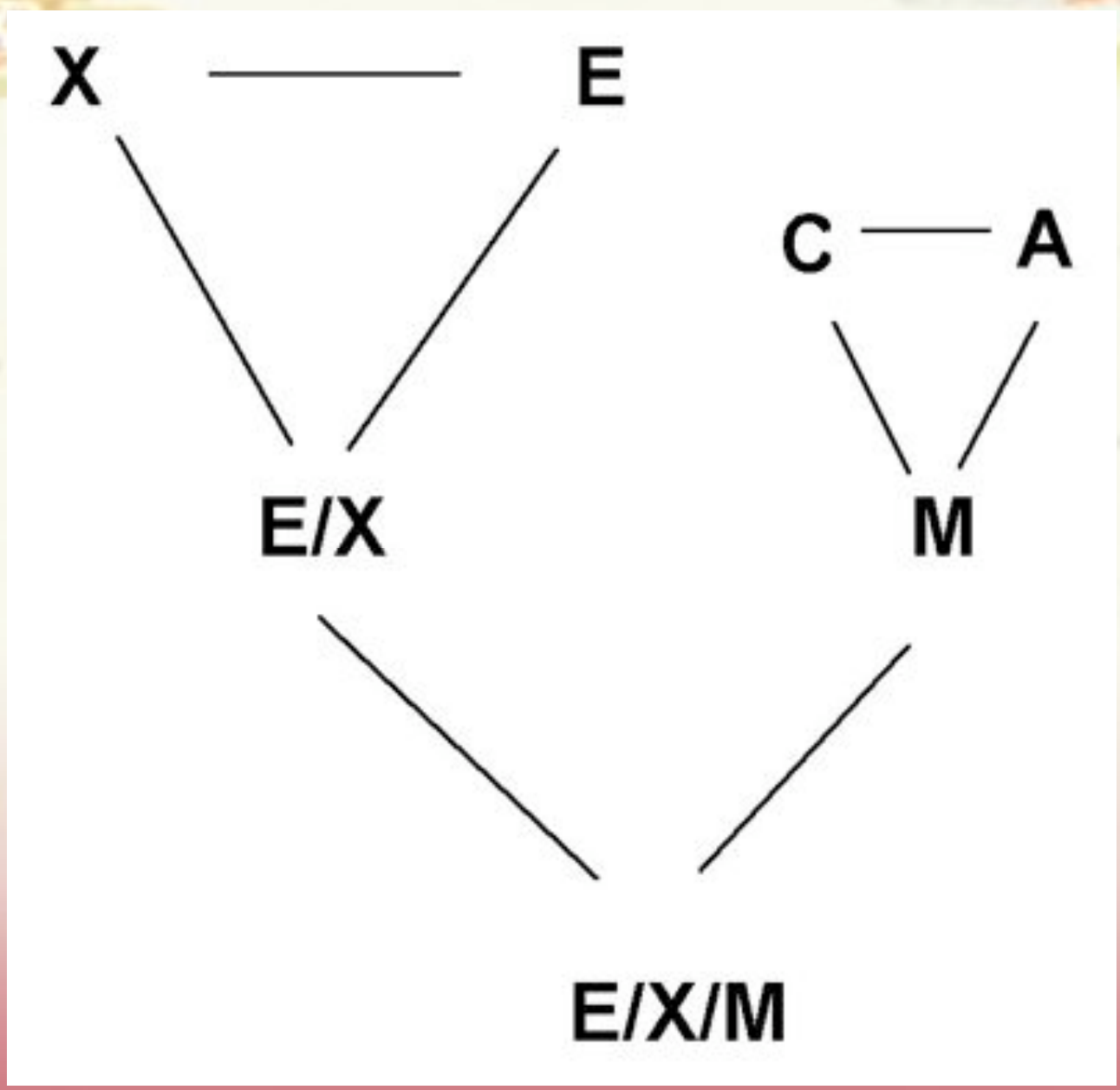
Centuries

E/X/M

Remember that visiting your parents goes faster for me than it does for you

E/X/M

Visiting your parents will take an hour


X
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E/X
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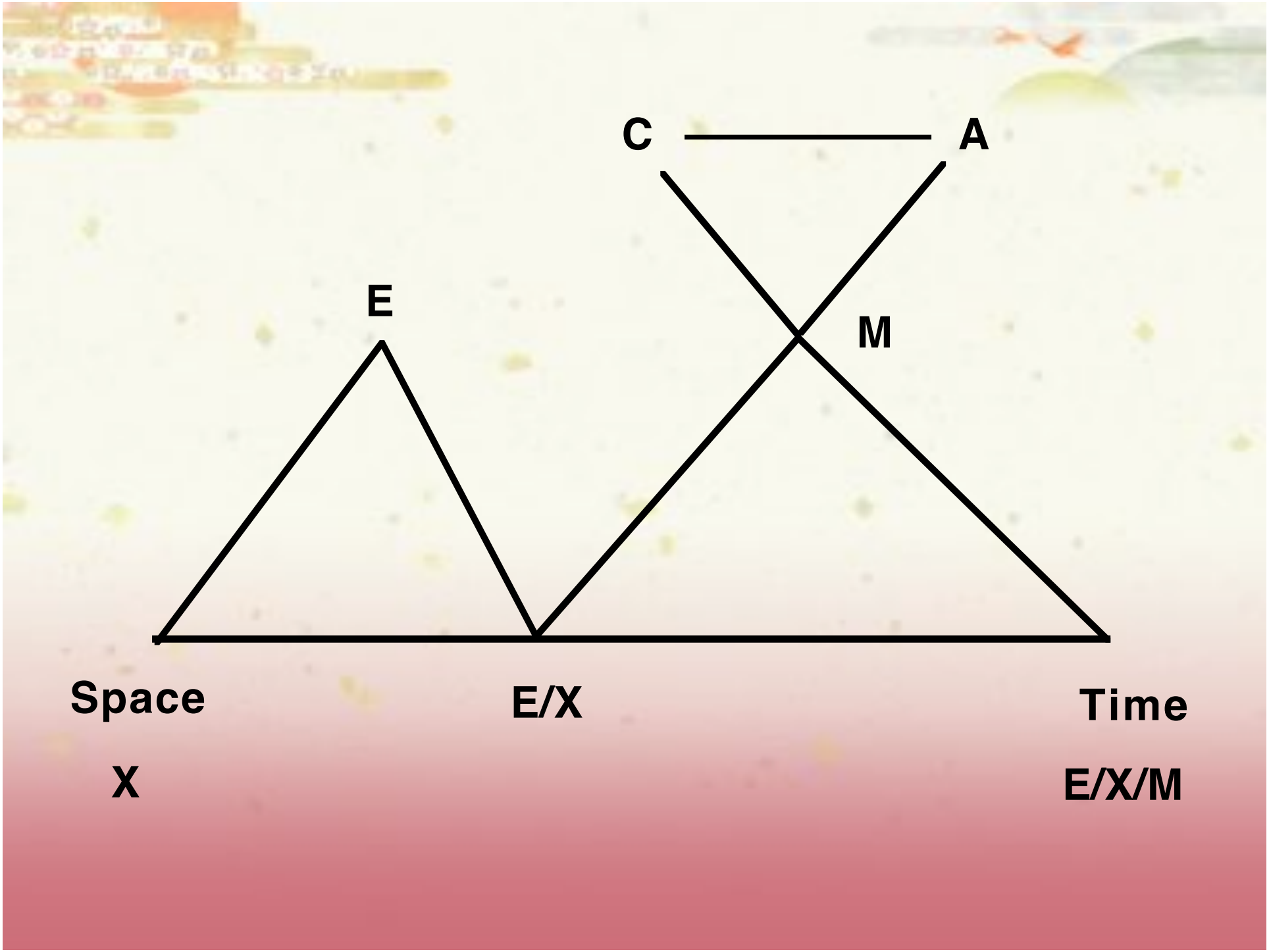
E/X/M


C
A
E
M
Space
E/X
Time
X
E/X/M

1. Three hours went by, and then he had dinner.
2. *Three feet went by, and he was at the door.
3. Minutes are quick but hours are slow.
4. *Inches go by faster than feet.
5. Those three hours went by slowly for me, but the same three hours went by quickly for him.
6. For me, the hours were minutes but for her the minutes were hours.
7. At the end of the three hours, you will have solved the problem, but at the end of the same three hours, he will have solved it and five more.
8. Time came to a halt.
9. Sure, it's Friday afternoon, but Monday morning is already staring us in the face.
10. Next week was an eternity away.
11. For me, the three hours were forever, but for her, they did not exist.
12. It'll go by faster if you stop thinking about it.

The old tollhouse went by.

The rough stretch of road went by.

The forest went by.

That stretch of road went by effortlessly.

The first five miles went by effortlessly.

X'

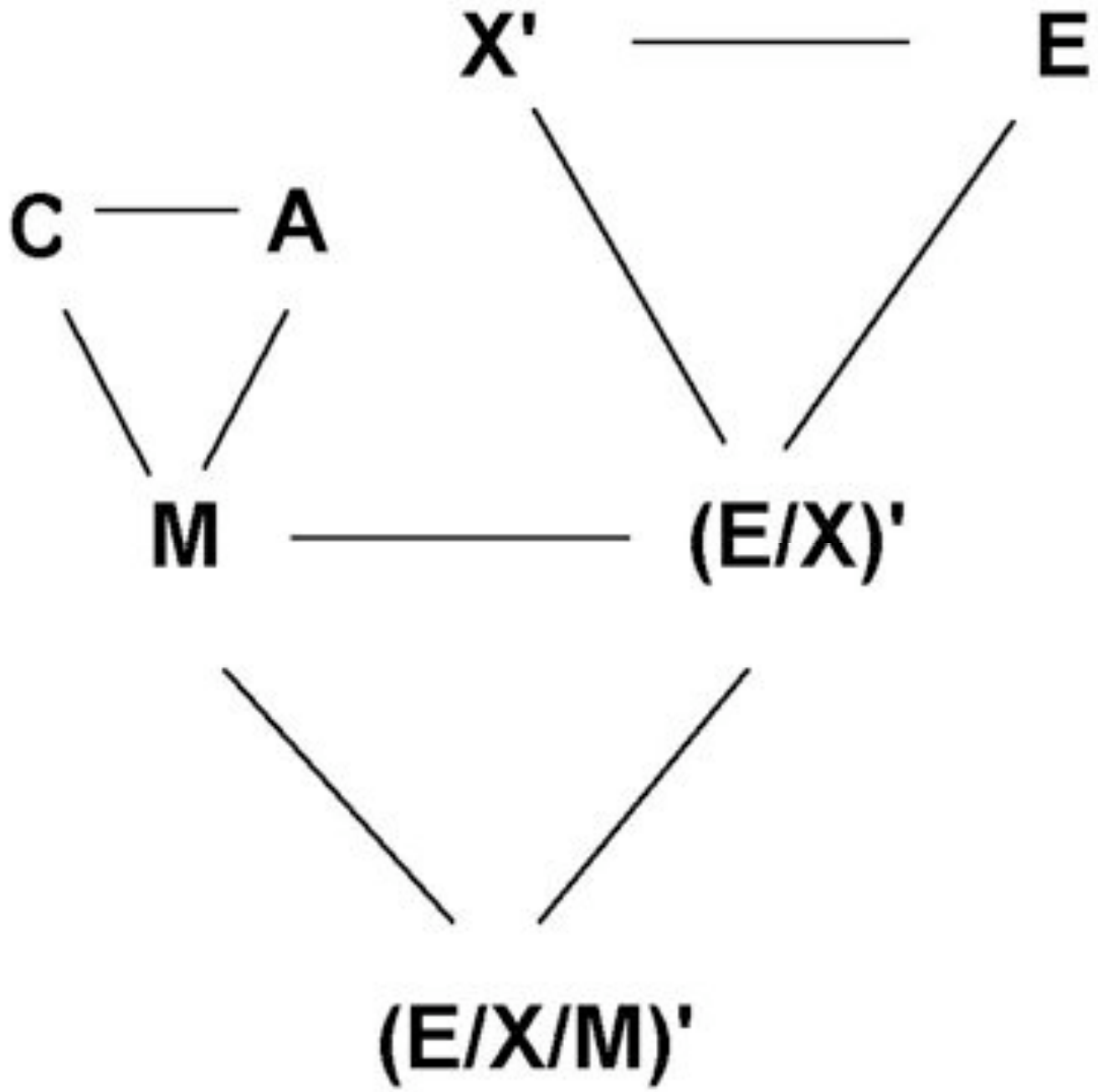
Motion of other objects through Physical Space

X has a dual where the EGO is stationary and the world moves (as for Micronesian navigators). This generates a dual blend. Crucially, adverbs expressing feeling are still relative to the EGO in the ego-moving dual **E/X/M**:

The two hours went by painfully, slowly, quickly, effortlessly.

= *It was painful, slow, effortless* for EGO *to move through the "two hours"*

as constructed in E/X/M, but expressed here in its dual.


X'
E
C
A
M
(E/X)'
(E/X/M)'

The years race past.
I die of despair.

In memory: distance is short
In E/P/M: distance is long (many years):
years must have travelled fast

1980 feels like yesterday.

The paradox is not really the "speed" of the years, it's the "objective" fact that there could be so much "objective" distance between points that seem so close. Then, the paradoxical great distance entails great speed of objects moving across it.

If I see objects passing by in succession and think they have speed **v**, I infer a certain distance **d** between them. But if it turns out that they were a lot farther from each other (**d** was much greater) then their speed has to be much greater than **v**.

Structure of **R/S**

Sure, it's Friday afternoon, but Monday morning is already staring us in the face.

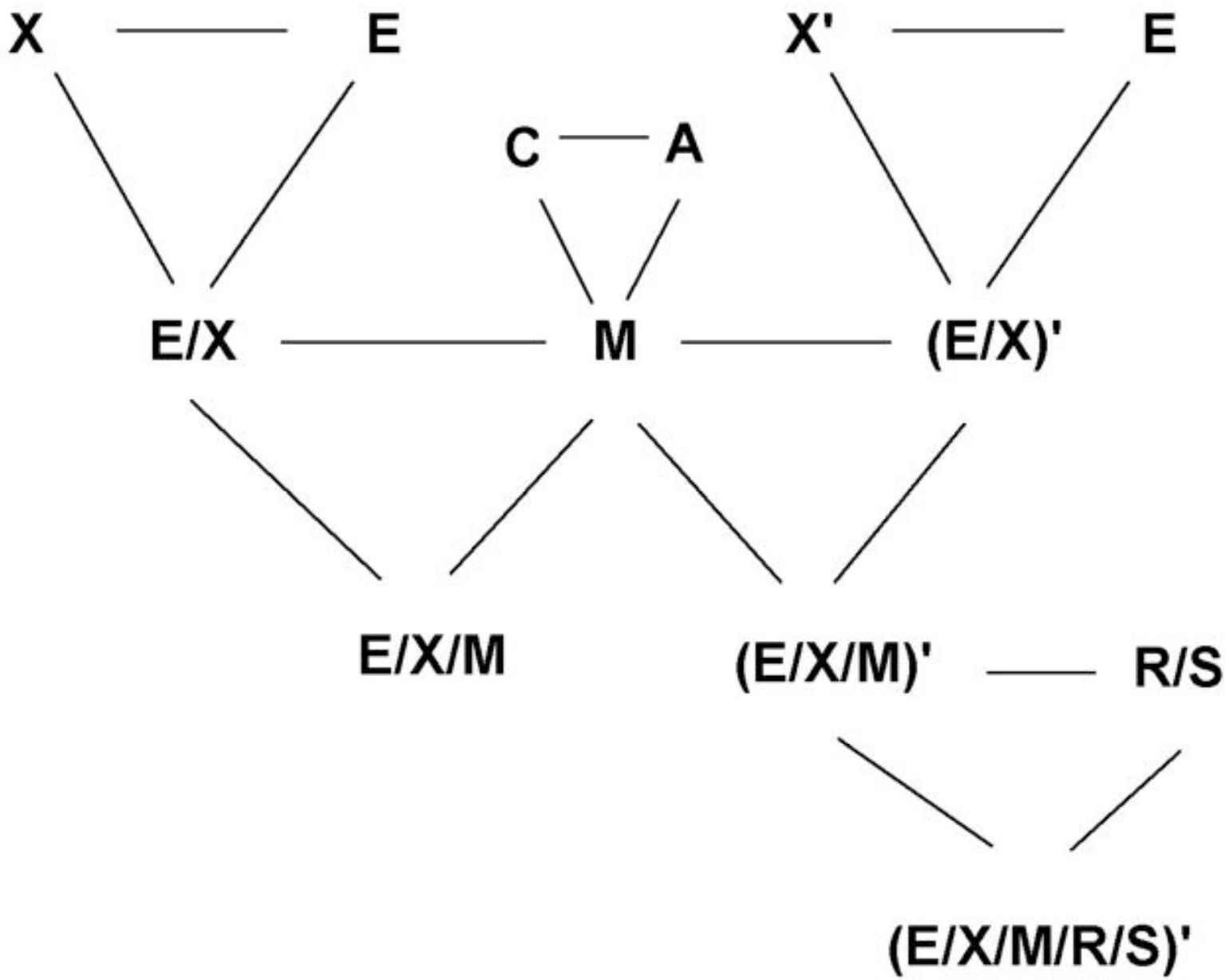
Next week was an eternity away.

For me, the three hours were forever, but for her, they did not exist.

Our wedding was just yesterday.

Where have all those years gone/disappeared?

What happened to all those years?


X
E
X'
E
C
A
E/X
M
(E/X)'
E/X/M
(E/X/M)'
R/S
(E/X/M/R/S)'

In the blend with objective time (i.e., shared universal events, such as hours, minutes, etc.), all egos are constrained to move at the same rate. If we project agency to that causal constraint, all egos are moved through the shared universal events at the same rate by an agent, in this case often referred to as "**Time**."

In this new blend, the emergent entity "**Time**" derives its **motion** from the network in which times move, but derives its **landmark** from the network in which Ego moves.

Time marches on

Time waits for no man

Never fear: time will carry us along

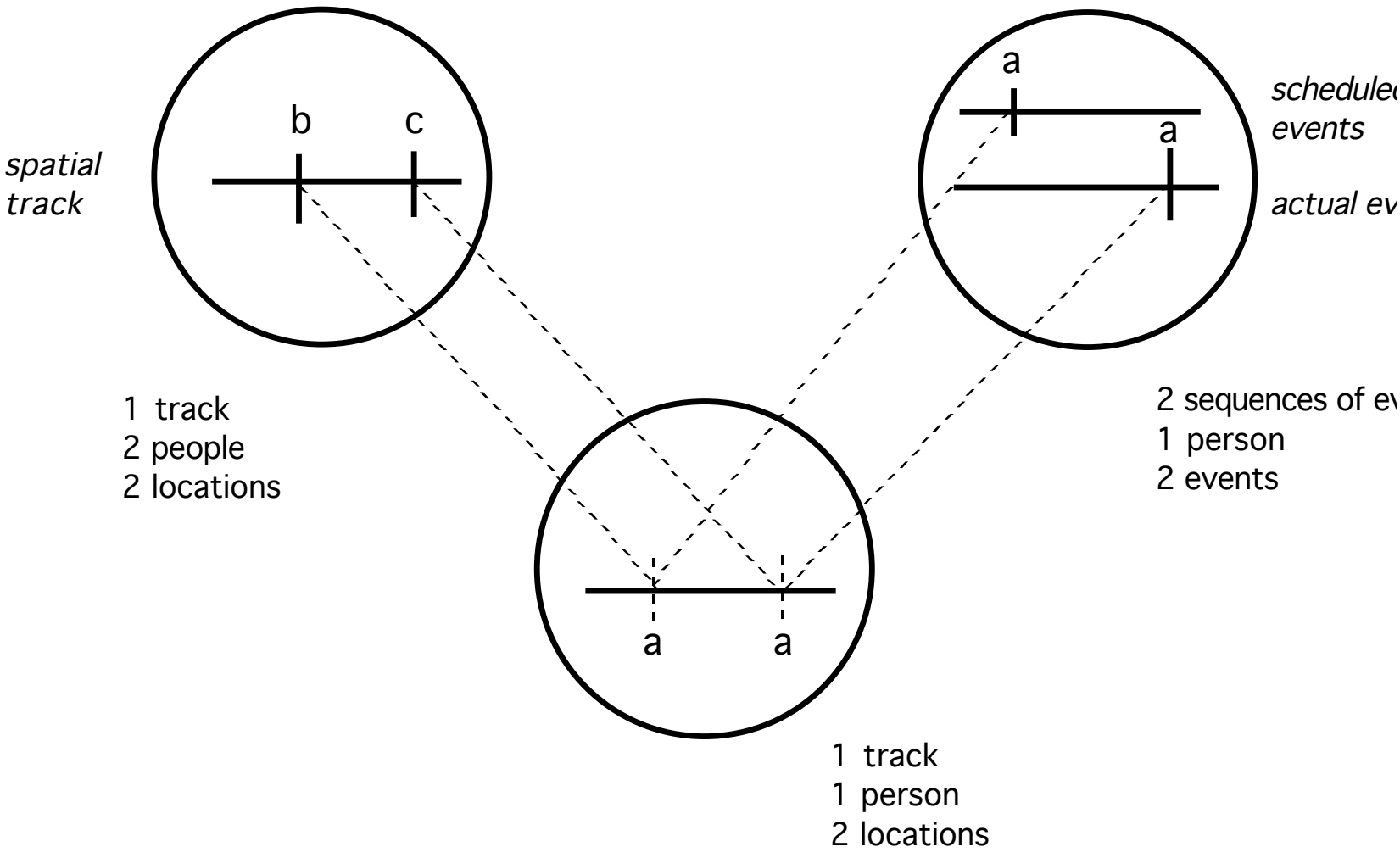
Come what come may
Time and the hour runs through the roughest day (Macbeth)

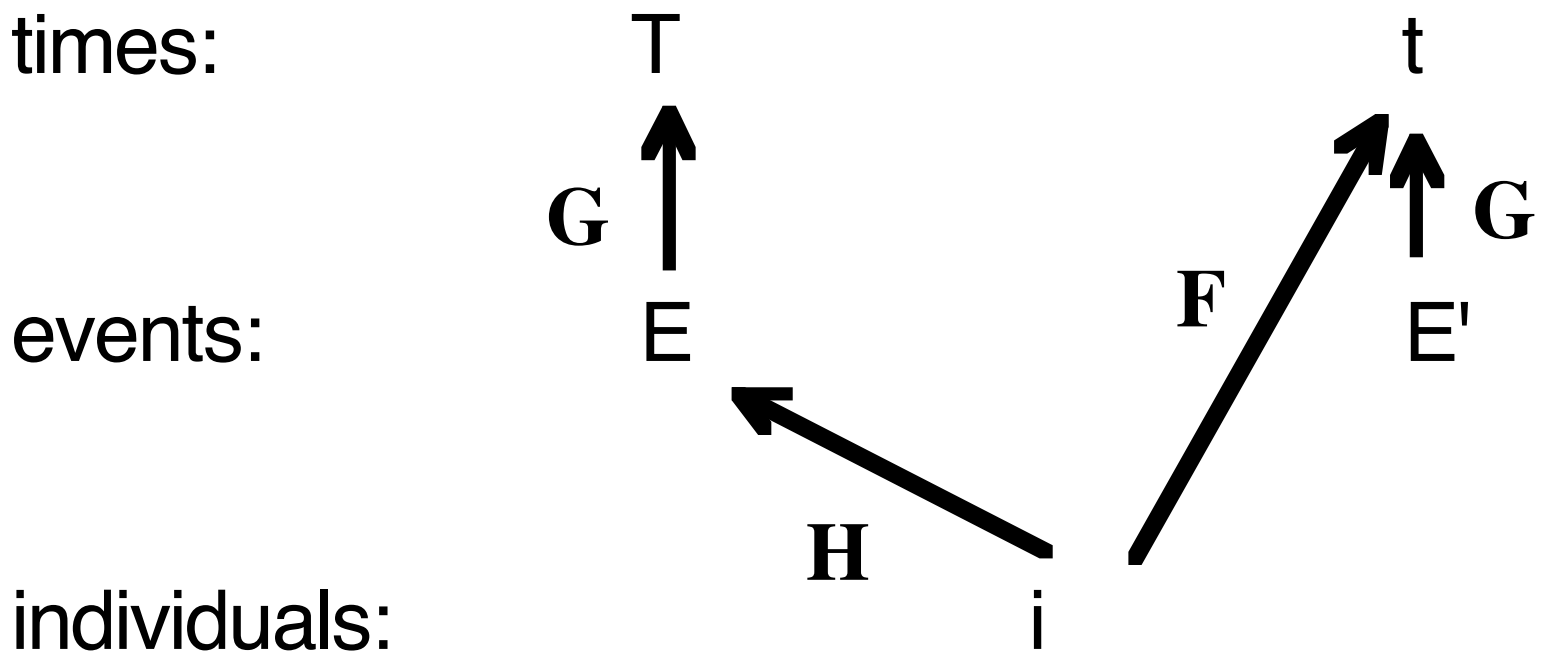
"Remarkable -- when I am sitting on a cushion on the floor, busy with scissors and glue pot, the time just vanishes. Before I know it the latticed rectangle of pale autumn sunlight has moved from the left wall across the floor to the other wall and Mrs. O'Carolan is calling me for supper. Perhaps time is flowing faster up there in the attic. Perhaps the accumulated mass of the past gathered there is pulling time out of the future faster, like a weight on a line. Or perhaps, more mundanely, it is only that I am getting older every year and that it is the accumulated weight of time behind me that is unreeling the years with ever-increasing speed. What a horrible thing it must be to grow older and find that ever-decreasing number of years hurrying you faster, faster toward your grave, as if time were impatient to be rid of you."

I am ahead of John

The event I am actually engaged in is earlier in the sequence of events than the event John is actually engaged in, or that on the schedule of events, my event comes before John's, as when my tennis match is at 7pm and John's is at 8pm.

I'm getting ahead of myself. [Contrast: I am ahead of schedule.]




times:
T
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events:
E
E'
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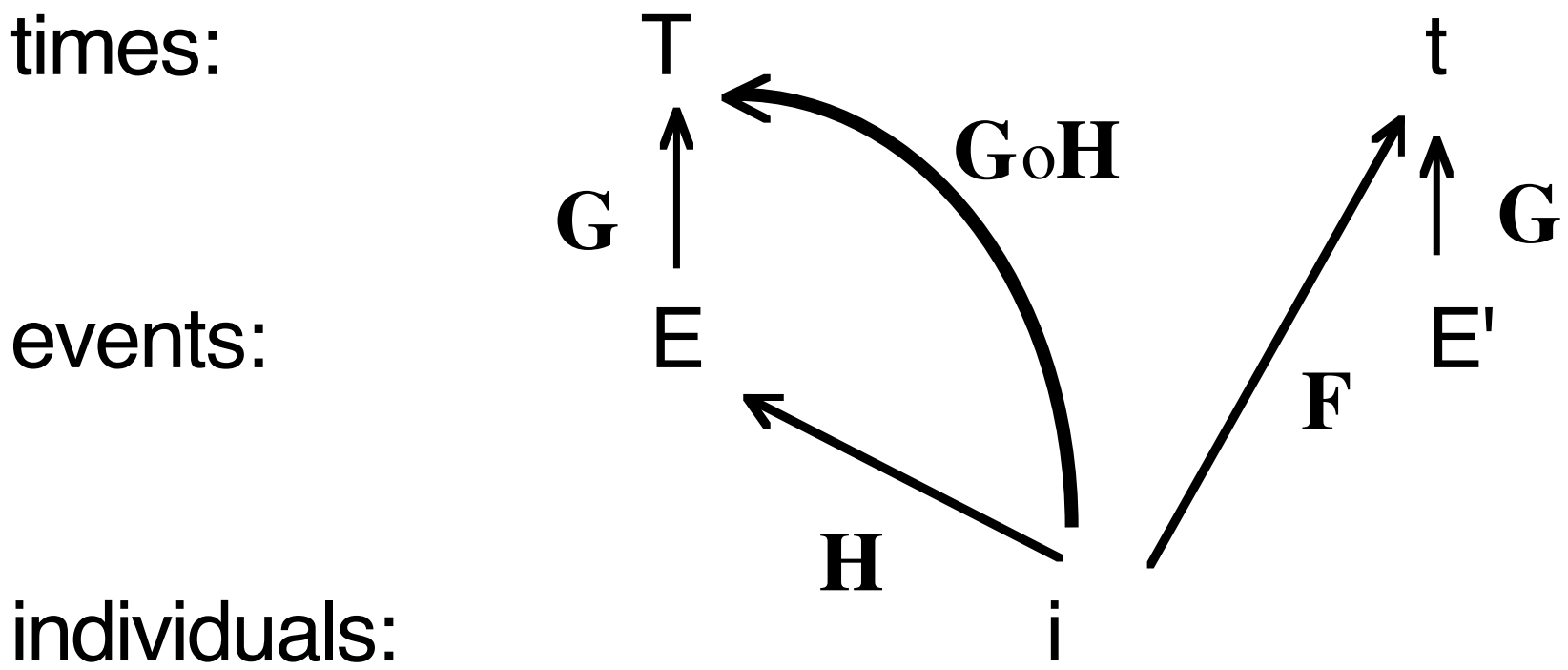
individuals:
i

She is ahead of her time

He's already in the 21st century
[said in 1984]

He's stuck in the nineties


times:
events:
individuals:
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E'
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H
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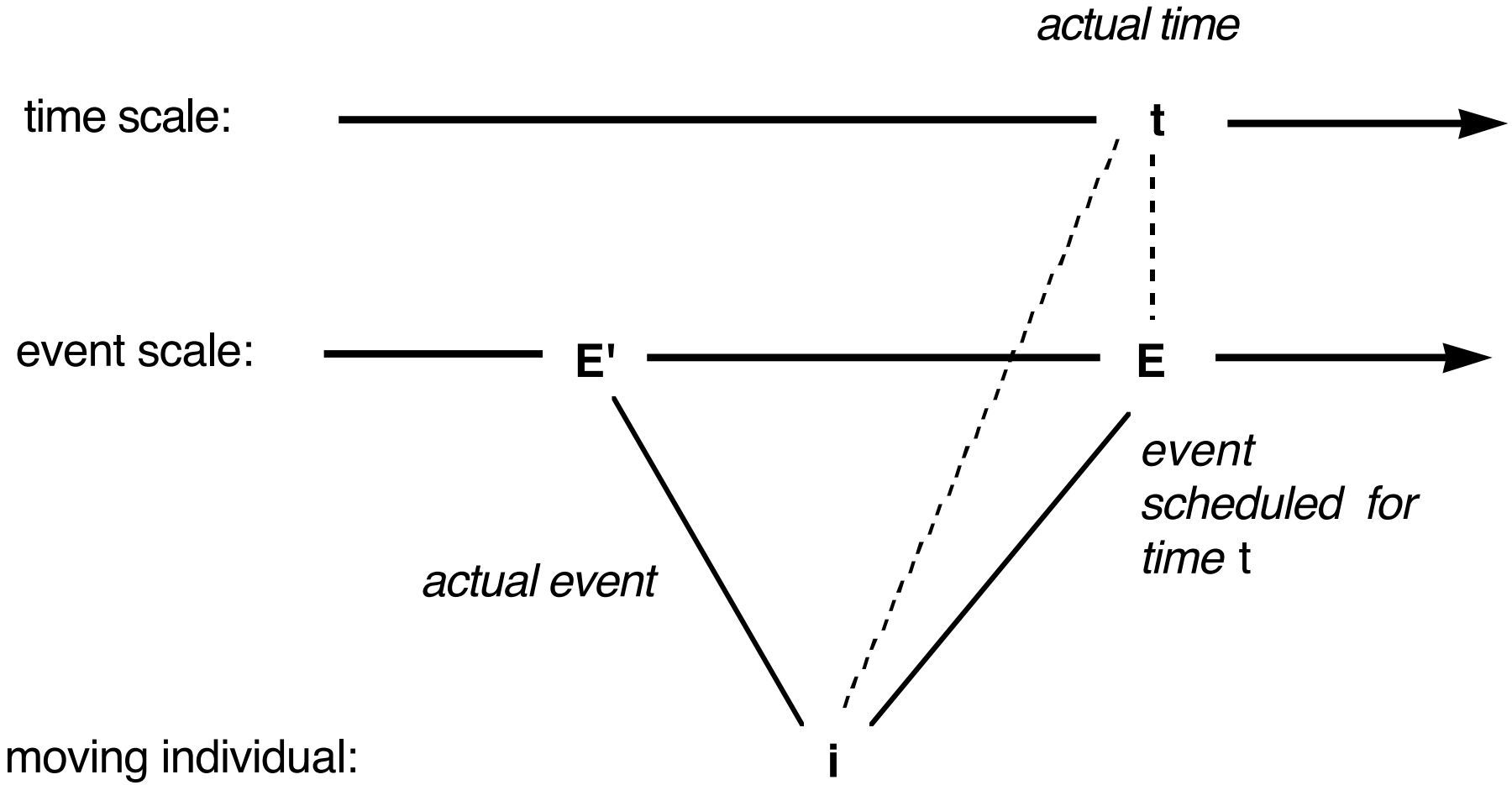
Keep up with the times

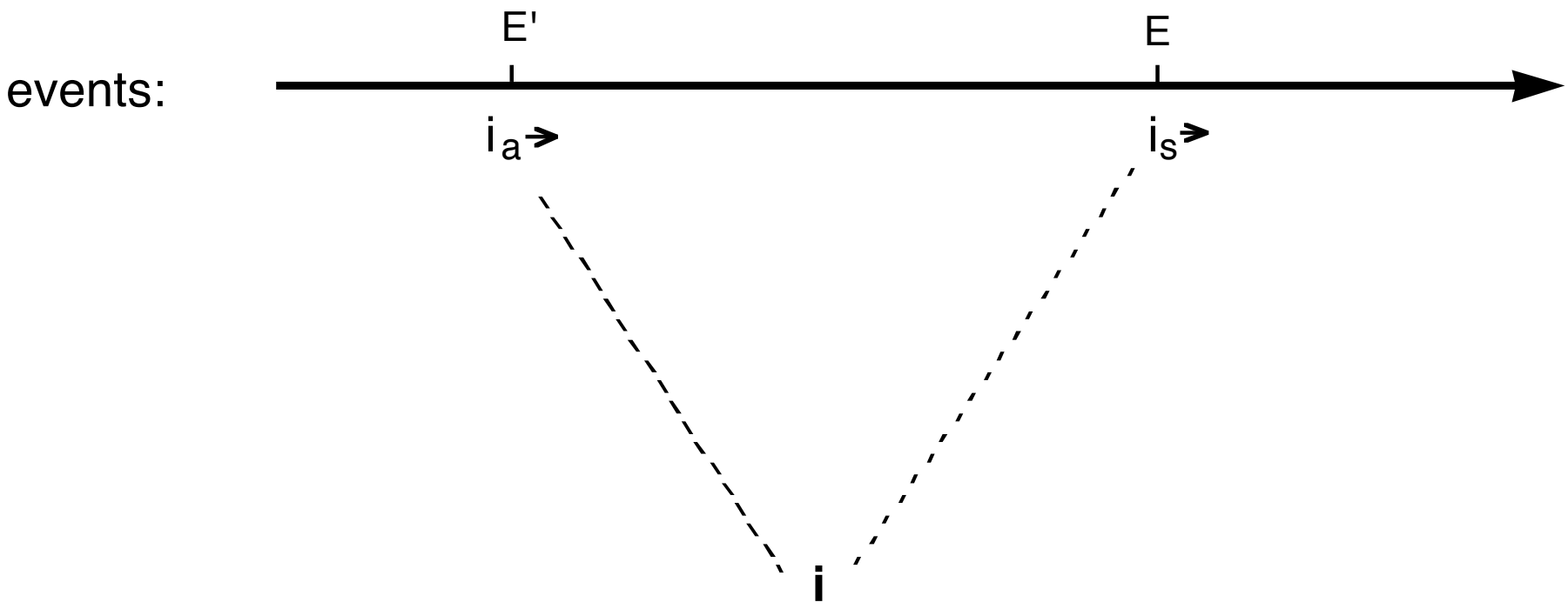
They've fallen behind

They're trying to catch up

The individual is moving on two correlated paths: the path of scheduled events, and the path of real times. This model is reflected by spatial vocabulary in language expressions like:

The queen went through all the events on her schedule and was exhausted when she reached the end of the day.


actual time
time scale:
t
event scale:
E'
E
event
scheduled for
time t
actual event
moving individual:
i


events:
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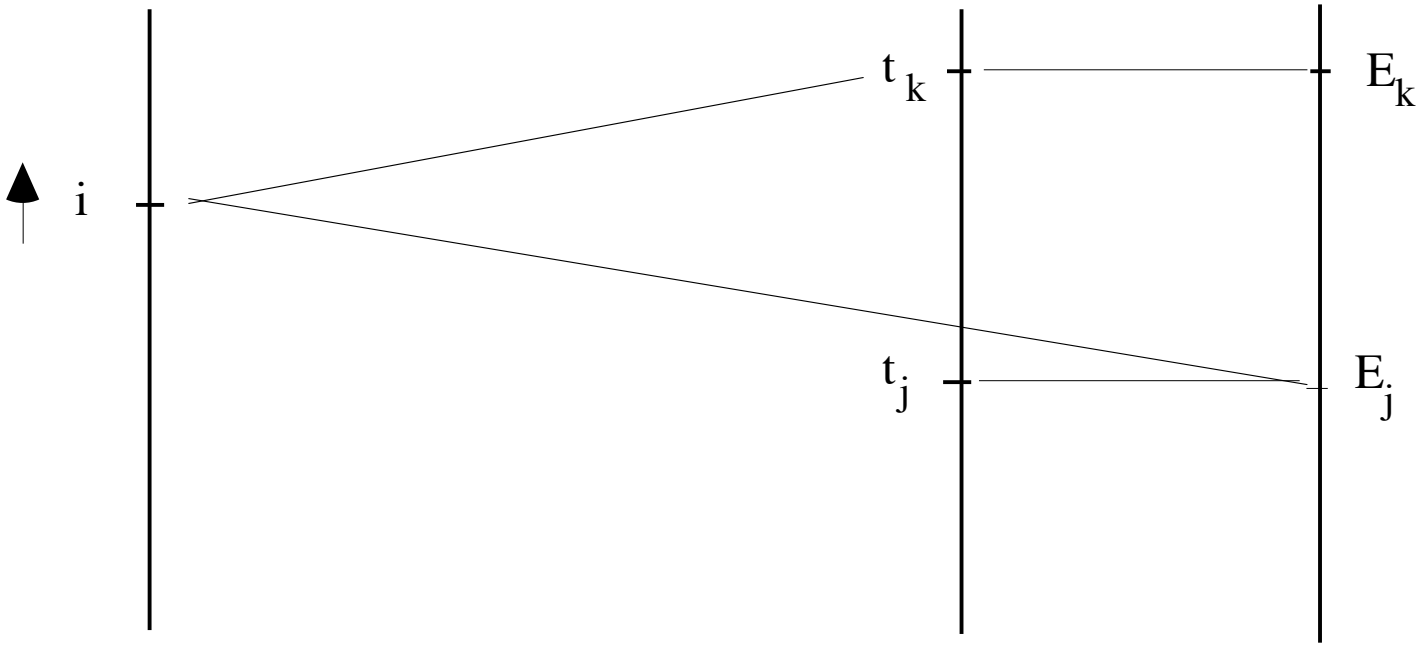
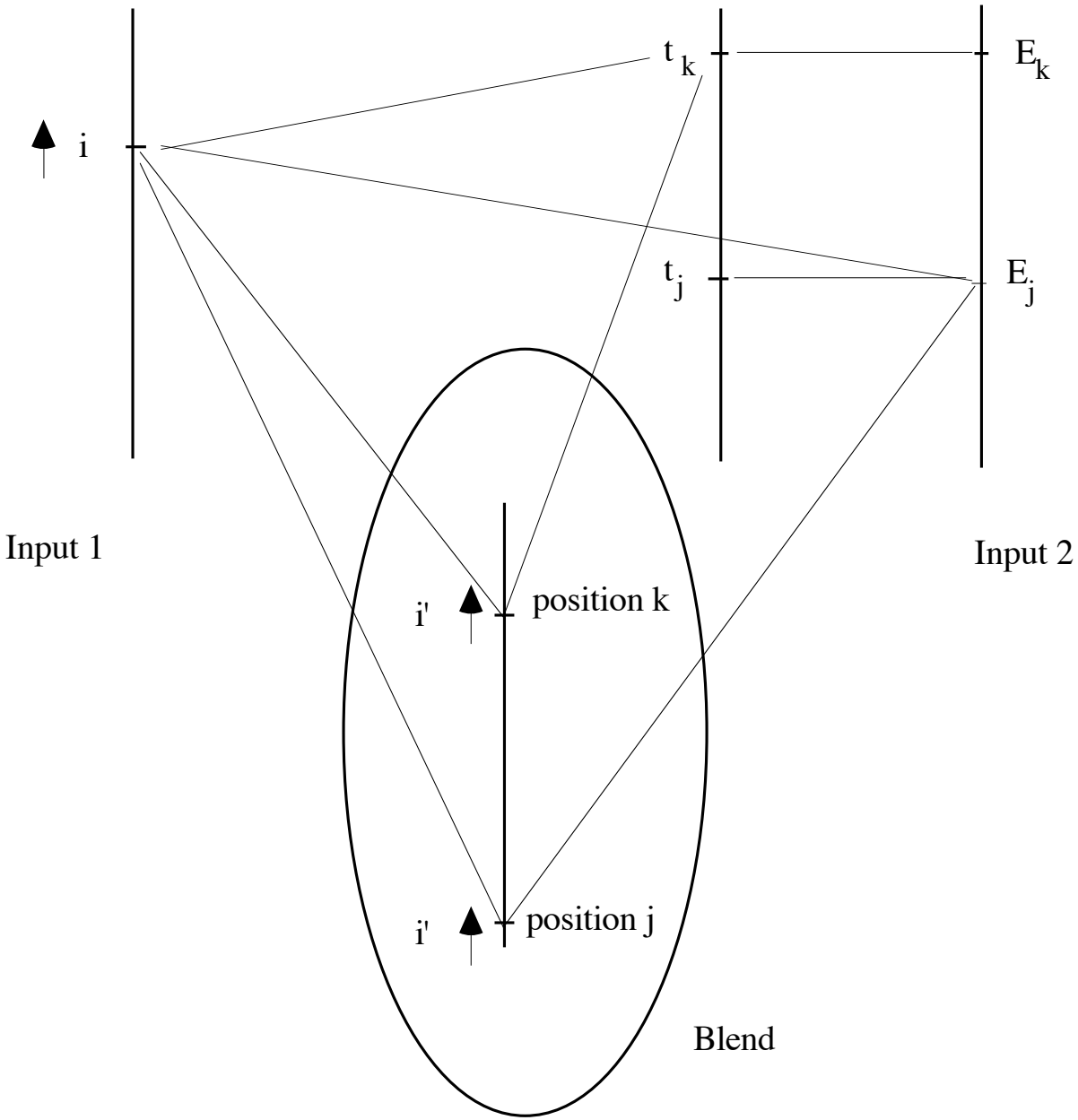
i_s
i


i
t k
E k
t j
E j
Input 1
I nput 2


t k
E k
i
t j
E j
Input 1
Input 2
i'
position k
i'
position j
Blend

Parallel to the 'blackboard' example, we also find:

I'm ahead of (or *behind*) *schedule*.

Schedule (the metaphorical trajectory) is linked to the trajector on the scale of events, and so the word *schedule* serves to identify this trajector in the Blend. In the Blend, the individual's position is compared to the 'schedule-trajector's' position. This projects back to Input 2, yielding the objective information regarding the events scheduled and the events actually engaged in.