The Ontology of Time and Process Part IV: Some Alternative Approaches

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ISAO 2016 Bozen-Bolzano, Italy 27 June – 1 July 2016 The 'Waterfall' Model: Processes as Continuant-like

Antony Galton and Riichiro Mizoguchi, 'The Water Falls but the Waterfall does not Fall', *Applied Ontology*, 4(2):71–107, 2009.

In this section, "process" is used in a narrower sense (comparable to that of DOLCE) and not the broader BFO sense of any continuant with temporal proper parts. (Thus, flying is a process, a flight is an event.)

Key observation:

A process can undergo change

EXAMPLES:

- The music is getting louder
- The rain is getting heavier
- The flow is getting faster

In order for processes to undergo change, we require that

- 1. Processes have qualities with respect to which change can take place.
- 2. The qualities of processes must apply to them at instants of time.
- 3. The qualities must be able to take different values at different instants.

Such qualities could include:

- The speed and direction of a flying process
- The loudness of a singing process
- The rate of a cooling process

Processes as Continuant-like

EVENT: A flight from London to New York

This is a temporally extended entity with proper temporal parts. Its properties, such as duration, average speed, and total distance covered, belong timelessly to the event as a whole and cannot meaningfully be said to change.

PROCESS: The flying of an aircraft

This exists at each moment during the flight, its properties such as speed and direction being evaluable at each moment and possibly taking different values at different moments.

Processes as Occurrent-like

Event is to Process as Thing is to Stuff:

- A wooden table is made of wood
- A flight is "made of" flying

How can we reconcile the continuant-like and occurrent-like aspects of processes?

The "Waterfall" solution postulates a "moving window":

- A process with temporal grain-size δt may be thought of as occupying a little "temporal window" (t − ½δt, t + ½) existing as a whole (continuant-like) on the "specious present" centred at t.
- This window moves forward through time, retaining its identity but possibly changing its properties as it does so.

Just as a quantum wave packet partakes of the character of both a wave and a particle, the process window partakes of the character of both an occurrent and a continuant.

Four categories of physical phenomena, according to the "Waterfall" view:



(From Galton & Mizoguchi, Applied Ontology, 2009)

- In "Waterfall" terminology:
 - An object enacts its outer processes, and is sustained by its inner processes.
 - The categories of object and process are mutually dependent.
 - A process is dependent on the objects which enact it.
 An object is dependent on the processes which sustain it.

Example:

I have to exist for my eating, singing, walking, laughing to occur. My respiration, digestion, blood circulation, metabolism have to occur for me to exist.



(From Galton & Mizoguchi, Applied Ontology, 2009)

Processes as Patterns

A different view of processes is suggested by the following quotation:

"Processes are repeatable behaviors whose occurrences cause continuants to undergo changes. It is important to distinguish between processes and process occurrences. Processes are neither endurants (continuants) nor perdurants (occurrents), since they do not change and they do not have temporal parts. Process occurrences are perdurants—they may have temporal parts (i.e., sub-occurrences such as changing the coffee filter while making coffee), and they have beginning and end timepoints."

A. Özgövde and M. Grüninger, 'Foundational process relations in bio-ontologies', FOIS 2010

Walking as a pattern of activity

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(From http://blog.ocad.ca/wordpress/gdes1b26-fw2010-19/category/3-2-project-two/)

Concrete realisations of process patterns

The walking pattern is realised concretely in particular occurrences.

Any one such occurrence may be redescribed in multiple ways, for example:

Mary walked. Mary walked for twenty minutes. Mary walked a mile. Mary walked to work. Mary walked along this path.

In general these sentences will apply to *different* sets of realisations of walking.

Experiential vs Historical Realisations

A concrete realisation of a process pattern presents different appearances according as it is described from the Experiential or Historical viewpoints:

Historical viewpoint presents the process realisation as a *fait* accompli, over an interval: an event:

Mary walked

(for 20 mins/a mile/to work/along this path/...)

Experiential viewpoint presents the process realisation as something existing in the here and now, at a moment: a state:

Mary is walking (for 20 mins/a mile/to work/along this path/...)

Spatial and Temporal Patterns

A temporal pattern is *a way of filling time* just as a spatial pattern is *a way of filling space*.

We can distinguish between open patterns and closed patterns.

Open and Closed Spatial Patterns I

Open: A Wallpaper Pattern



Closed: A Dress Pattern



Open and Closed Spatial Patterns II

Open: A tessellation of regular hexagons



Closed: A tessellation of regular pentagons



Open and Closed Patterns

- Open patterns can be extended indefinitely while still being a realisation of the same pattern.
 - Any particular instance of an open pattern necessarily has a boundary, but the form of the boundary is imposed from outside and not specified by the pattern itself.
- Closed patterns are finite, necessarily bounded arrangements of components.
 - The boundary of an instance of a closed pattern is specified, implicitly or explicitly, as an intrinsic part of the pattern itself.

Pattern and Repetition

Both open and closed patterns admit the notion of **repetition**. But what is repeated is different in the two cases:

- Open pattern: The repetition is *internal* to the pattern. The wallpaper pattern itself consists of an indefinite number of repetitions of some basic motif, and the spatial arrangement of these repetitions is specified as part of the pattern.
- Closed pattern: Any repetition is *external* to the pattern. The dress pattern specifies one unit, of which there may be indefinitely many repetitions, but the spatial arrangement of these (i.e., many dresses of the same pattern) is arbitrary and no part of the dress pattern itself.

The repeating motif of an open pattern may itself be specified as a closed pattern.

Open and Closed Temporal Patterns

Just as there are open and closed spatial patterns, so also there are open and closed temporal patterns.

We can call these open processes and closed processes.

References:

- Antony Galton, 'Experience and History: Processes and their Relation to Events', *Journal of Logic and Computation*, 2008.
- Antony Galton, 'Outline of a Formal Theory of Processes and Events, and Why GIScience Needs One', *Proceedings of COSIT* 2015.

Open Processes

- Open processes are open-ended activities which can in principle be continued in the same way indefinitely.
- Actual realisations of an open process are typically bounded, but the process itself does not specify how any of its realisations should be bounded.
 - The open process walking does not specify when an instance of walking ends. The end of an instance of walking is imposed by external factors, e.g., destination reached, too tired to continue, insurmountable obstacle.
- Examples of open processes:
 - ► Human: eating, reading, knitting, driving, sleeping
 - Non-human: flowing, rotting, photosynthesis, the beating of a heart, coastal erosion, nuclear fusion.

Closed Processes

- Closed processes are finite routines for which the start and end points are specified as part of the process itself and not imposed arbitrarily from outside.
- Once completed, a realisation of a process cannot continue, although another realisation of the same process could begin.
- Examples of closed processes:
 - Human: making a pot of tea, booking a theatre ticket, checking in for a flight, filling in a form, erecting a greenhouse.
 - Non-human: cell division, volcanic eruption, maturation of an organism, hatching of an egg, a single heartbeat, a supernova explosion.

Open patterns and homogeneity

In the limit, as the size of the repeating motif tends to zero, an indefinite repetition becomes homogeneous.

- Spatial example: A limiting case of wallpaper patterns is a uniform expanse of one particular colour. Concrete realisations of this pattern are patches of that colour; they can be of any size or shape, and can in principle be extended indefinitely.
- Temporal examples: rolling (of a ball), rotation (of the earth), sliding, gliding, humming, buzzing, warming, cooling These are strictly homogeneous processes.

Homogeneity and granularity

In many cases, instead of absolute homogeneity, we have homogeneity relative to the spatial or temporal granularity at which a pattern is observed or described.

Spatial example: Seen from a distance, a tessellation of red and blue squares appears as a uniform expanse of purple.







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- Spatial example: Seen from a distance, a tessellation of red and blue squares appears as a uniform expanse of purple.
- Temporal example: The humming of a radiator, on closer examination, consists of a repeated cycle of back-and-forth vibrations.

The simplest kind of closed pattern

The simplest kind of closed pattern is just a "chunk" of some open pattern.

- Spatial case: Delineate a region of space and fill it with a realisation of an open pattern.
 - Example: A chessboard is a square area filled with 64 squares' worth of the open pattern tessellation of alternating black and white squares
- Temporal case: Delineate a region of time and fill it with a realisation of an open process.
 - Walk 2 km—a chunk of walking in which the distance covered is 2 km.

Walk for an hour-an hour's worth of walking

Complex Closed Patterns

Complex closed patterns can be built up as "assemblies" of simpler ones. (This can be applied recursively to any desired depth.)

Consider the closed process specified by the following sequence of instructions:

Repeat four times: Walk in a straight line for one kilometer and then turn 90° clockwise.

It is the process of walking once round the perimeter of a square kilometer. It is built up as follows:

- Walking and turning are open processes.
- ► *Walk a kilometer* and *Turn 90*° are simple closed processes specified as chunks of open process.
- ► Walk round the perimeter of a 1km square is a complex closed process specified as an assembly of simple ones.

Open patterns from closed: Repetition

An open pattern can be specified as an open-ended repetition of some closed pattern.

Spatial example: A wallpaper pattern is an open-ended repetition in space of a basic motif. The repeating motif is itself a closed pattern.







Open patterns from closed: Repetition

An open pattern can be specified as an open-ended repetition of some closed pattern.

- Spatial example: A wallpaper pattern is an open-ended repetition in space of a basic motif. The repeating motif is itself a closed pattern.
- Temporal example: "Keep walking round the square". This is an instruction to enact an open process specified as an open-ended repetition of the closed process "Walk once round the square".

Fragment of an ontology: Processes as patterns of activity



Experiential realisations of processes

The easy case. Experiential realisations of open processes. What is Mary doing?

She's walking.

That is, Mary's current state of motion is a state of walking. It is a state because it characterises the current state of affairs — not because it is static! (It is a **dynamic state**.)

If you see someone walking, you see them in a particular state which you can identify as walking (i.e., the state of their being engaged in a walking process) on the basis of what you see.

Experiential realisations of processes (continued)

The hard case. Experiential realisations of closed processes. What is Mary doing? She's walking a mile.

Is there such a thing as a state of walking a mile?

If you see someone walking, you cannot identify that they are in the process of walking a mile solely on the basis of what you see.

By virtue of what can a person be said to be in the process of walking a mile? This is the problem of **the semantics of the progressive aspect**.

David Dowty (1979), Word Meaning and Montague Grammar Antony Galton (1984), The Logic of Aspect 1984.