

The Ontology of Time and Process

Part V: Modelling Causation

Antony Galton

Department of Mathematics and Computer Science
University of Exeter, UK



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Causal Facts and Causal Laws

Causal facts are *particulars*:

A loud noise made me jump [on a particular occasion].

Causal laws are *generalities*:

Loud noises make me jump [at least under certain conditions].

How are causal facts related to causal laws? Is it

1. Causal laws are *summaries* of causal facts:
'Loud noises make me jump' is only true by virtue of a sufficient number of particular occasions on which a loud noise made me jump.
2. Causal facts are *explained* by causal laws:
'A loud noise made me jump' can only be true by virtue of the fact that there is some kind of general connection between loud noises and my jumpings.

The key philosophical question about causality is

- ▶ **What does it mean to say that something causes something else?**

I shall not attempt to answer this!

Instead, we shall look at the *structure of causal facts*, with particular reference to different types of causal relation and what they relate.

What kinds of things can be causes? A driver brakes suddenly, the road is icy, the car skids. What caused the car to skid?

- ▶ **An agent?** The driver
- ▶ **An object?** The ice on the road
- ▶ **A property?** The slipperiness of the road
- ▶ **A state?** The road's being slippery
- ▶ **An event?** The driver's braking
- ▶ **A fact?** The fact that the driver braked and the road was icy

What kind of things can be caused?

- ▶ **An event?** The car began to skid
- ▶ **A process?** The car skidded
- ▶ **A fact?** The fact that the car skidded
- ▶ **A property?** The car being out of control
- ▶ **An object?** A wreck by the roadside.

Mike Worboys and I proposed that there is a collection of *different* causal or causal-like relations, with different classes of relata:

- ▶ Antony Galton and Michael Worboys, [Processes and events in dynamic geo-networks](#). In M. A. Rodriguez *et al.*, *GeoSpatial Semantics: Proceedings of GeoS 2005*, Springer, 2005, pp. 45–59.

I developed some of these ideas further in:

- ▶ Antony Galton, [States, Processes and Events, and the Ontology of Causal Relations](#). In M. Donnelly and G. Guizzardi (editors), *Formal Ontology in Information Systems (Proceedings of FOIS 2012)*, IOS Press, 2012, pp. 279–292.

Eventualities

In this section, the term 'eventuality' is used as a general term to cover **states**, **processes**, and **events**.

These types of eventuality are distinguished as follows:

- ▶ States are **continuous** and **non-dynamic**.
- ▶ Processes are **continuous** and **dynamic**.
- ▶ Events are **non-continuous** and **dynamic**.

Causal relations between eventualities

We distinguish three different causal relations as follows:

- ▶ An event can **cause** another event.
- ▶ A process can **perpetuate** another process.
- ▶ A process or state can **maintain** another state.

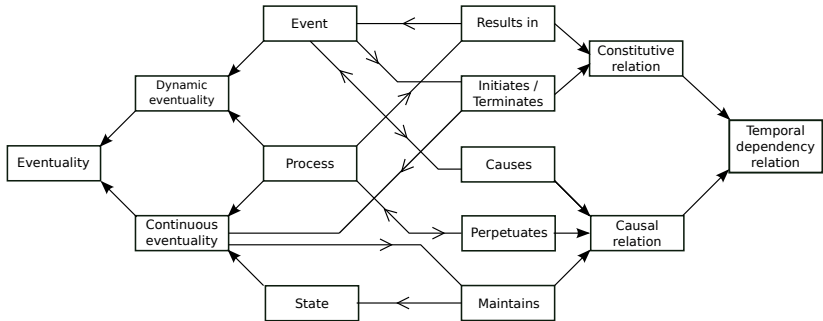
In addition we distinguish three causal-like **constitutive** temporal dependency relations:

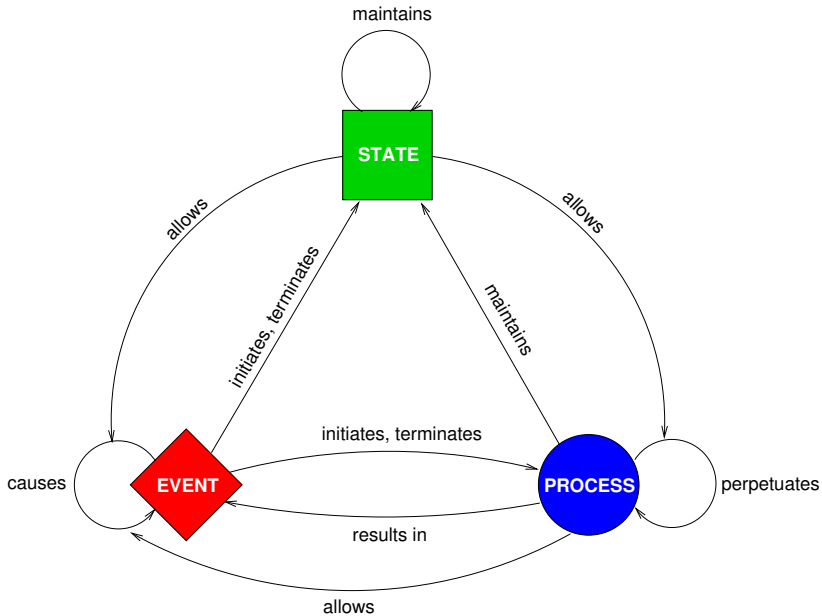
- ▶ A process can **result in** an event.
- ▶ An event can **initiate** or **terminate** a process or state.

Finally, we have a 'meta-relation' by which a process or state can **allow** a causation, and a state can allow a perpetuation.

**N.B. All these relations apply to particulars, not to types.
They feature in casual facts, not causal laws.**

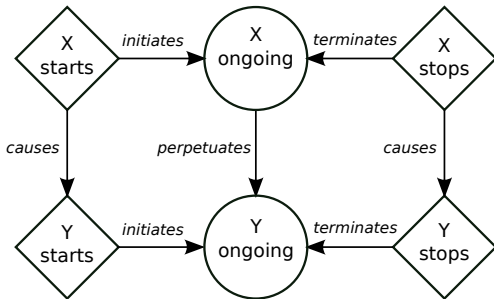
Taxonomy of Eventualities and Causal Relations





Perpetuation Pattern 1

The initiation of process X causes the initiation of process Y. The continuation of Y is then perpetuated by the continuation of X. The termination of X causes the termination of Y.



Example.

A box moves across the floor because someone pushes it.

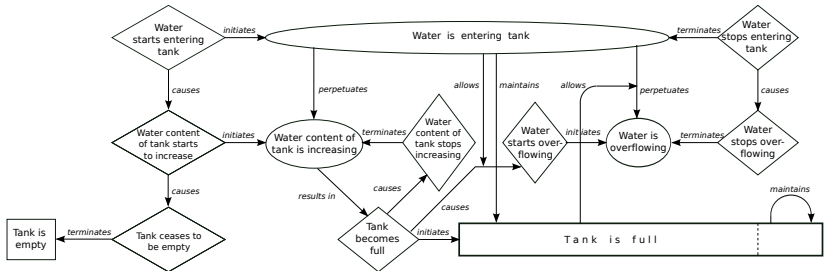
Temporal dependency patterns

I have compiled a catalogue of commonly occurring **temporal dependency patterns** similar to Perpetuation Pattern 1.

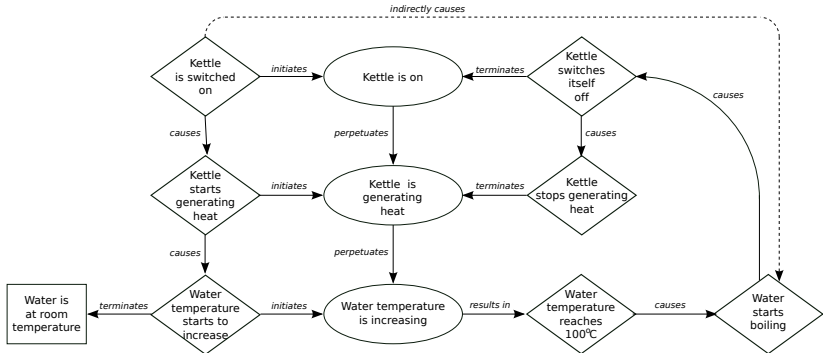
Instead of enumerating them here, I will show a number of case studies which feature some of them.

The cases studies will be presented by means of **temporal dependency diagrams**.

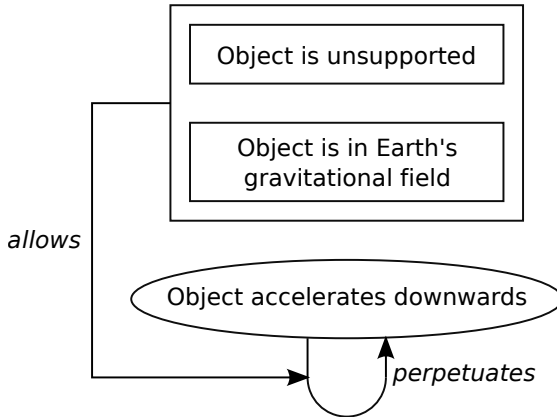
Case Study 1: The Water Tank



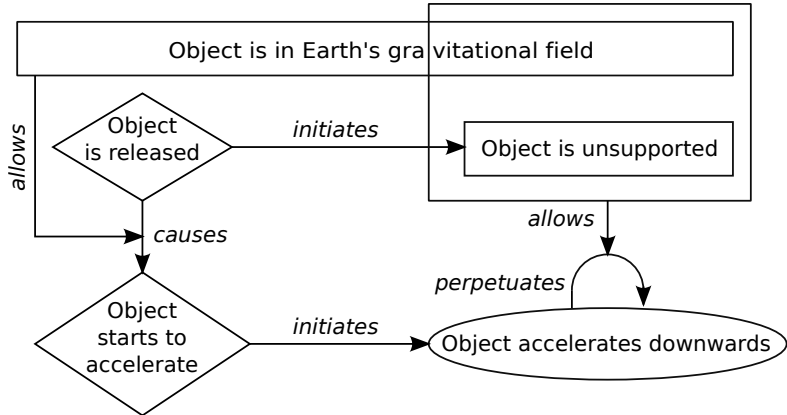
Case Study 2: A Kettle of Water is Boiled



Case Study 3: Unsupported object in a gravitational field



Case Study 4: An object is dropped from a height



Case Study 5: A ball is thrown up into the air

