Identity Tracking of a Disease as a Causal Chain

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Life cycle of a disease

- An individual disease undergoes change after it has appeared
- It causes many disorders and symptoms
- It could cause other diseases as a result of evolution
- In some cases, some disorders might remain as *aftereffect* after the original disease has been cured
- Even if the disease would be cured completely, it could influence on the patient as *anamnesis* in the future
- The problem here is how such an evolution of a disease should be dealt with based on our disease ontology
Brief summary of “River flow model of diseases” presented at ICBO2011
   › A new definition of diseases
     • A causal chain of clinical disorders
   › A new explanation of causal chains

Identity tracking of an evolving disease
   › Causal links
   › Practical theory of identity [EKAWS 2010]
   › Identity of a causal chain of clinical disorders
A disease is a dependent continuant constituted of one or more causal chains of clinical disorders appearing in a human body and initiated by at least one disorder.

The main issue here is

> How is a causal chain of clinical disorders a continuant?
Informal account of our
“River flow model of diseases”

- A river is similar to a disease as a causal chain.
- After it has been born as a river (as a disease), it extends further (causes some disorders) to reach another lake or to the sea. While extending, it branches (the branching perhaps causes the appearance of another disorder or symptom).
- Finally, it may dry up because of climate change (cure).
- Thus, the life of a river corresponds well to the life of a disease. Thus – in concordance with OGMS – both a river and a disease are continuants.
What is a causal chain?

**Causal chain** = a chain of entities linked by causal relation. There can be a causal chain of disorders, causal chain of processes, causal chain of events, etc.

Note: What is *causality* is outside the scope of our research.

- **sequence of occurrents**
  1. **sequential occurrents**
     1. event sequence (accident=>ambulance arrival =>…)
  2. **concurrent occurrents**
     1. directly connected processes (piston=>shaft=>wheel=>car)
     2. state-mediated (clot growth=>decrease of cross-section=>..)
     3. pseudo-simultaneous (collision=>breakage=>…)

- A causal chain as a continuant is embedded in 2.2.
Causal chain of a disease

An accident happened

The size of a blood clot is growing.

Organ-a is dying.

The size of a blood vessel is reducing.

Amount of oxygen supplied is reducing.

Organ-b is dying.

An ambulance came.

The victim arrived at a hospital.

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Change in state and structure:

Disorder (Abnormal quality of an organ)

Disease as a continuant

Causal link
Identity tracking of a causal chain
Three kinds of causal links

Definition 4: Ongoing causal link
This is a link which shows that the causal flow from the cause to the effect is ongoing.

Definition 5: Historical causal link
This is a link which shows that the causal flow from the cause to the effect had been terminated.

Definition 6: Pseudo-simultaneous causal link
This is a link which shows only pseudo-simultaneous relation between cause and effect. It is used mainly for causal events which can be viewed as that they happened at the same time. E.g., collision => break
Causal links and nodes

- **Ongoing process**
  - **ongoing**

- **Past event**
  - **historical**

- **Event**
  - **pseudo-simultaneous**

- **Event or Ongoing process**
  - **Both happen almost at the same time**
Four kinds of causal chains

- **Definition 7: Strongly-connected causal chain**
  - Any causal chain all of whose causal links are ongoing causal links. That is, it is composed of only ongoing processes. A causal chain composed of one ongoing process is included as a special case.

- **Definition 8: Weakly-connected causal chain**
  - Any causal chain which includes at least one historical or pseudo-simultaneous causal link and at least one ongoing process.

- **Definition 9: Historical causal chain**
  - Any causal chain all of whose causal links are historical or pseudo-simultaneous causal links. That is, it is a causal chain composed only of terminated events.

- **Definition 10: Ongoing causal chain**
  - Any causal chain which has at least one ongoing process. It subsumes Strongly-connected and Weakly-connected causal chains.
Any individual causal chain is born as a single ongoing process, that is, as a strongly-connected causal chain.

When an intermediate disorder is terminated and becomes an event, it becomes a weakly-connected causal chain keeping its identity.

It never changes its identity as far as it has at least one ongoing disorder.

So, issues are:
- What identity can we use?
- when does it lose its identity?
Identity in practice

Practical Considerations on Identity for Instance Management in Ontological Investigation, Proc. of EKAW2010

- **Identity of objects**
  - Consideration on instance identity
    - 4 kinds of instance identities
      - Identity for Exactness (Numerical identity)
      - Identity for Essentiality (Personal identity)
      - Identity for Counting (differentiation from others)
      - Identity for Replacement (*I-Rep*)
  - *Identity* which an instance of the whole continues to be itself without becoming another thing while whose parts are being replaced independently of their kinds and number of the replaced parts.
From “ongoing” to “historical”

- When a causal chain becomes a historical causal chain, in which all the nodes become events, it becomes a new individual as a historical causal chain.

- An event is constituted of a process, and hence the event as a whole has a different identity from that of the process as its constituent.

- Then, the causal chain changes in terms of I-Rep.
Strongly-connected causal chain

Deficiency of insulin → Elevated level of glucose in the blood

Weakly-connected causal chain

Deficiency of insulin → Elevated level of glucose in the blood

Historical causal chain

Deficiency of insulin → Elevated level of glucose in the blood

Legend

- Disorder (ongoing)
- Disorder (terminated)
- Ongoing causal link
- Historical causal link
- Core causal chain (each color represents a disease)

Constituted by

Deficiency of insulin → Elevated level of glucose in the blood

Destroyed nerval tissue
Concluding remarks

- Disease as a causal chain of clinical disorders which is a continuant
- Identity of a disease as an evolving causal chain of clinical disorders
- We need *I-Rep* as its identity to enable us to track evolving diseases properly

Future work
- Harmonizing our definition with OGMS’s disposition
Thank you for your attention!

ご静聴有り難うございました！
Causal chain

- sequence of causally-connected occurrents
  1. that of events
     1. event sequence (accident=>ambulance arrival =>...)
  2. that of processes
     1. directly connected processes (piston=>shaft=>wheel=>car)
     2. state-mediated (clot growth=>decrease of cross-section=>..)
     3. pseudo-simultaneous (collision=>breakage=>...)

- sequence of causally-connected continuants embedded in 2.2 in such a way that each continuant constitutes its corresponding process
The life of a river

overflow
minimal flow
branches
might dry up
would reach another lake

reaches the sea
extends and changes its route, etc.