Human-induced or natural?

Some philosophical considerations and concepts

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Stagesetting: Why philosophy?

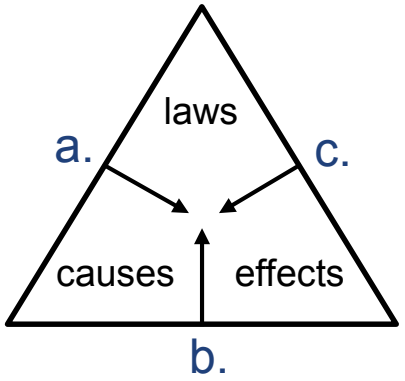
- Aim of philosophy: coordinating human experience
  - Getting loose ends together (coherent frame of reasoning)
  - Critical look at social, scientific … practices (adopting different perspectives)

- This relates to "human-induced" vs. "natural"
  - Inferences based on models, observations … which have legal and public implications
  - … so let's have a look at scientific reasoning and causation …

- The following is about starting a fruitful discourse,
  not about me being complete or providing solutions!

Scientific reasoning: types of inferences

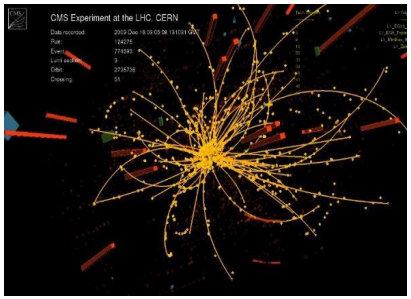
- Three sentences, three possible "inferences"
  1. All SWIS participants are in this room. (general rule/law)
  2. X is a SWIS participant. (individual observation; cause)
  3. X is in this room. (individual observation; effect)

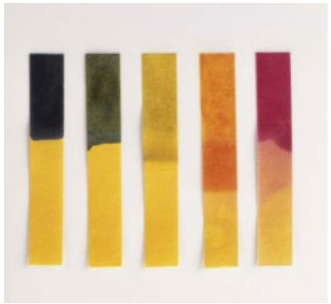


a. Deduction: from laws and causes to effect
   - 1 & 2, therefore 3 [logically valid]

b. Induction: from causes and effects to laws
   - 2 & 3, therefore 1 [valid only for finite cases]

c. Abduction ("inference to the best explanation"): from laws and effects to causes
   - 1 & 3, therefore 2 [not valid]
   - … in fact, we use this very often in science:
   - Leads to notion of explanation …





Predictions and explanations

"real test of model is to predict future data, not to explain past data"
(Geller et al. 2016: Why We Need a New Paradigm of Earthquake Occurrence)

- "Predictions" make claims about future, imply specific temporal relations
  - Opposite of "prediction" would be "retrodiction"
  - … but both might be "non-explanatory" (cf. tide tables, statistics-based models)
- "Explanations" answer why-questions, provide deeper understanding
  - No general implicit temporal relation between explanation and event
  - Understanding based on general rules/laws (cf. physics-based models)
  - Maybe there are different types of "explanations" (see below)
- Note on a further claim: science must be "prospectively testable"
  - Main concern is about "fudging"
  - NB: "testable" (and even "falsifiable") are very problematic notions

Types of explanation and types of causes

- Different types of explanations based on different types of causation
  - Causal explanations ["causal" in a narrow sense]
    - Based on efficient causation
    - … which is about physics (transfer of energy and momentum …)
    - Example: gravitation explaining the fall of an apple
  - Action explanations
    - Based on final causation
    - … which is about intentions/reasons/goals (usually of human actors)
    - Example: SWIS participance explaining whereabouts (cf. above)
    - … people are in this room (effect) *because* they are participants (reason or final cause)
  - Distinction very important in legal and ethical contexts
  - … and seems relevant for "human-induced" vs. "human-triggered" vs. "natural"

Sufficiency, necessity, and probability

- Formal character of causal relations (in terms of modal logic)
  - Sufficiency relation: if A, then B (if I take a shower, I get wet)
  - Necessity relation: if not A, then not B (if the apple had no mass, it would not have fallen down)
  - Again, difference seems relevant for "human-induced" vs. "human-triggered" vs. "natural"
- What do correlation coefficients (probabilities) represent?
  - Propensity: correlation coefficients represent intrinsic tendencies/dispositions of single cases
  - Frequentism: correlation coefficients represent relative frequencies of occurrences
  - Relates to distinction between physics- and statistics-based models
  - Open questions: relative frequencies of what? what is the reference class?
    - Factual past occurrences? Family of simulations/models?
    - Leads toward questions about independency of models and fudging issues!

"Paradigm shift": good news and a warning

There is a "need for a new paradigm" (Geller et al. 2016)

- Warning: Kuhn's "paradigm shifts" include "incommensurability"
  - No progress but untranslatability ?!
- Good news (pace Geller et al.):

"The failure to reach a consensus about the appropriateness, or lack thereof, of the CE model after **30 years of continuing debate reflects poorly on the earthquake science community**. It is comparable to what might have happened in a parallel universe in which the physics research community was still arguing about the existence or nonexistence of the 'ether' in 1917, 30 years after the Michelson-Morley experiment." (Geller et al. 2016, p.186)

  - In fact, it was quite similar in physics!

Summary: need for broad and common efforts

- I think it is important to discuss (clarify and distinguish) concepts such as prediction, explanation, cause/causation, probability, paradigm, uncertainty, robustness, fudging, laws, principles …
- … and that interdisciplinary efforts are particularly productive here to learn
  - … about the role of physics-based and statistics-based approaches
  - … about whether or what kind of "paradigm shift" is needed
  - … about sensible criteria to distinguish "human-induced" from "natural"
  - ...

Many thanks
for your kind attention!

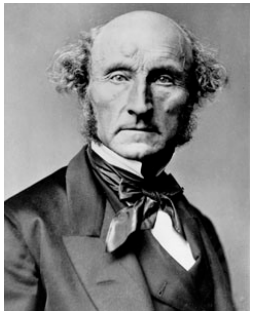
Finding and analysing causal relations

- Empirical finding: correlation between events of types A and B
  1. Causal interaction: A-events cause B-events
  2. Common cause: A- and B-events are both caused by C-events
  3. Accidental: no causal relation between A- and B-events
  - NB: 1 and 2 distinguishable by looking at possibility of information transport or invention

- How to figure out relevant parameters?
  - Important heuristics: Mills's methods (*A System of Logic*, 1843) including:

  - **Method of Agreement:**
    - Only one common antecedent shared by all instances where effect is observed
    - Conclusion: shared antecedent is the cause of the effect

  - **Method of Difference:**
    - Only one prior difference between cases where effect occurs and where is doesn't
    - Conclusion: antecendent which is present only in the case of the effect is the cause



J.S. Mill (1806-1873)

Important causal factors in human-induced earthquakes

- Some candidates:
  - Correlation mainshock-aftershock
  - Depth
  - Local history
  - (NB: waveform characteristics as bad candidates)

- Note that different models apply different preselection filters
  - E.g., ETAS doesn't consider foreshocks to be possible indicators,
  - … whereas earthquake nucleation theory does
    - NB: so-called experimenters' regress lurking: one must make sure to either agree on theory/model or on good experimental setup!

Uncertainty

- Types of uncertainty:
  - Suggestion a:
    - Inexactness
    - Ambiguity
    - Non-analyzability
    - underdetermination
  - Suggestion b:
    - event uncertainty
    - parameter uncertainty
    - model uncertainty (known and unknown model inadequacies)

Robustness

- Decreasing uncertainty …
  - … by slightly shifting parameter of a concrete model
  - … by investigating whole ensembles of models
    - models which are (ideally) based on different sets of parameters etc.
      - if models are closely related, then (alleged) robustness might be an artefact
  - NB: Robust processes vs. actual sequences

Finding and analysing causal relations