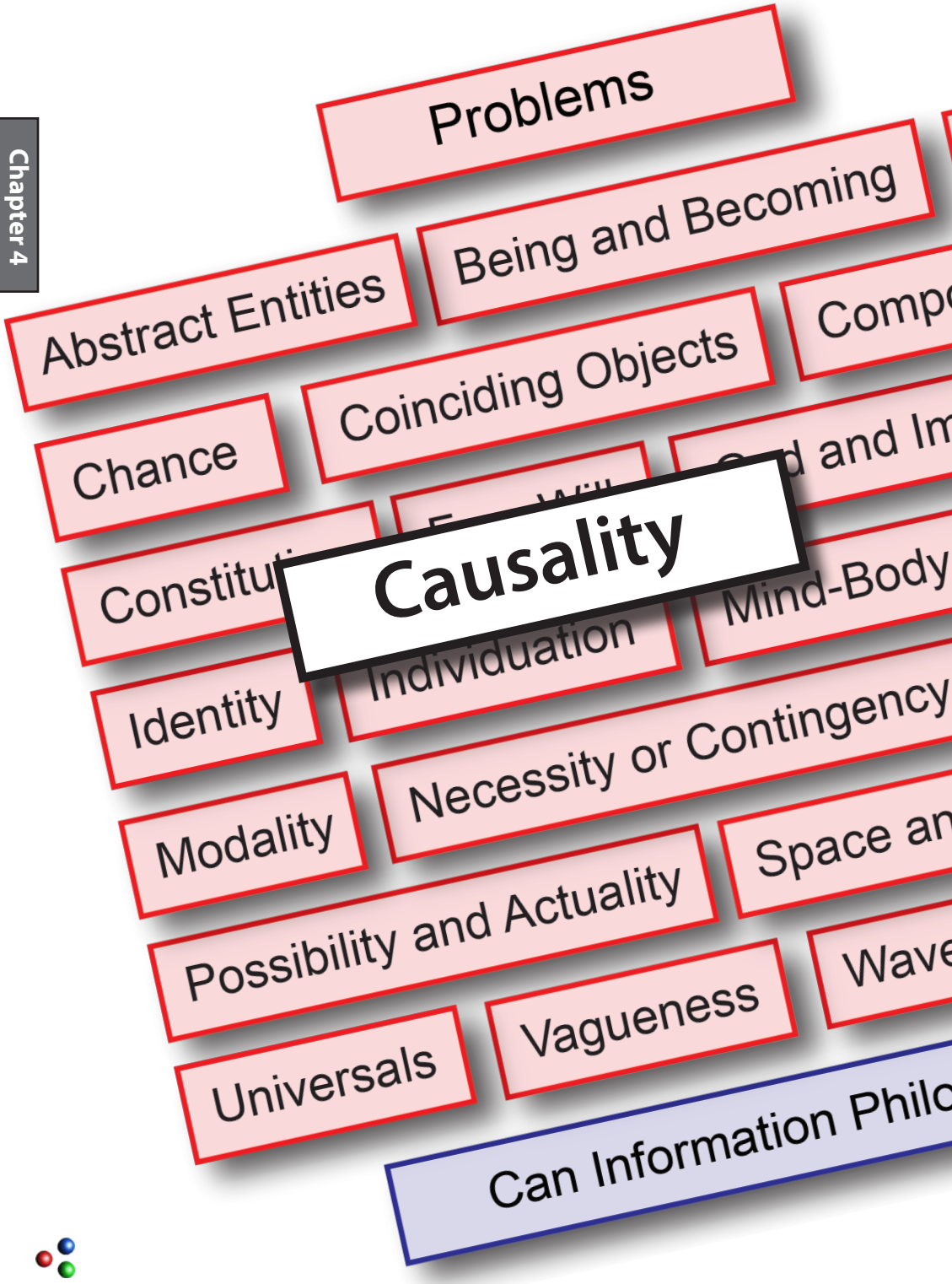
Problems
Abstract Entities
Being and Becoming
Chance
Coinciding Objects
Causality
Identity
Individuation
Mind-Body
Modality
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Possibility and Actuality
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Can Information Philo

Causality

Belief in causality is deeply held by many philosophers and scientists. Many say it is the basis for all thought and knowledge of the external world.

The core idea of causality is closely related to the idea of determinism. But we can have a "soft" causality without strict determinism. and an adequate or statistical determinism that accommodates *indeterminism*.

And we will see that the departure from strict causality needed to negate determinism is very slight compared to the miraculous ideas associated with the "*causa sui*" (self-caused cause) of the ancients, which most modern thinkers find unintelligible (with the exception of aome theists who accept the idea of miracles).

Despite David Hume's critical attack on the logical necessity of causes, which should have made us all skeptics about the logical necessity for causality, many philosophers embrace strict causal determinism strongly. Some even identify causality with the very possibility of logic and reason.

Few commentators note Hume's view that we all have an unshakable natural belief in causality, despite the impossibility of a logical proof of causality or successful attack on his skepticism.

Bertrand Russell thought a logical proof excessive,

> "The law of causation, according to which later events can theoretically be predicted by means of earlier events, has often been held to be *a priori*, a necessity of thought, a category without which science would not be possible. These claims seem to me excessive." [1]

Now the assumption of deterministic causation underlies most successful scientific theories, with the critical exception of quantum mechanics. Some major objections to the causal determinism implied by Newtonian laws of motion are

1 Russell. (1914) *Our Knowledge of the External World*, p.232

This chapter on the web - metaphysicist.com/problems/causality

- The complete predictability of future events is possible in principle (Laplace's Demon).
- There is only one possible future, even if unpredictable.
- The laws of motion are time reversible.
- Given enough time, all positions and motions will recur.

Information philosophy shows that all these objections can be removed by admitting a modest form of indeterminism into the world, at the microscopic level of quantum mechanics.[2]

The core idea of indeterminism is an event without a cause. Quantum mechanics does not go so far as to say that events have absolutely no causal connection with the events (the distribution of matter and motions) of the immediate past. What it does do is introduce events with a statistical cause. And quantum mechanics makes extremely accurate predictions of the probabilities for the different random outcomes.

So we can have an adequate or statistical causality without strict determinism, which otherwise implies complete predictability of events and only one possible future.

What Counts as a Cause?

For the ancients, a cause was an explanation (*aition*) or a story (*logos*) about how an event came about. For every event there is a cause, they argued. Aristotle famously argued in his *Metaphysics* that there are generally causal chains which he classified as material and formal, efficient and final.

Aristotle's material cause is simply the matter in an object. The formal cause is the *arrangement* of the matter, its "form" or shape. That these are distinct became the basis for metaphysical controversies between the Stoics and the Skeptics. For example, in the puzzle of the Statue and the Clay, the clay is Aristotle's material cause, the shape is Aristotle's formal cause.

Aristotle's efficient cause was the agent who initiates the change, for example, the sculptor of the statue. His final cause was the goal or purpose, the telos or end, in this example, the desire to have a statue.

2 Doyle (2016) *Great Problems*, ch.25, Microscopic Irreversibility

In his *Physics* and *Metaphysics,* Aristotle also said there were "accidents" caused by "chance (τυχή)." In his *Physics*, he clearly reckoned chance among the causes. Aristotle considered adding chance as a fifth cause - an uncaused or self-caused cause - that happens when two causal chains come together by accident (συμβεβεκός). He noted that the early physicists found no place for chance among the causes.

In his *Metaphysics*, Aristotle makes the case for chance and uncaused causes (*causa sui*) and in the Nicomachean Ethics he shows our actions can be voluntary and "up to us" so that we can be morally responsible.

> "Nor is there any definite cause for an accident, but only chance (τυχόν), namely an indefinite (ἀόριστον) cause." [3]

Without such indefinite (uncaused) causes, everything would happen by necessity.

> "It is obvious that there are principles and causes which are generable and destructible apart from the actual processes of generation and destruction; for if this is not true, everything will be of necessity: that is, if there must necessarily be some cause, other than accidental, of that which is generated and destroyed. Will this be, or not? Yes, if this happens; otherwise not." [4]

Some determinist philosophers have claimed that Aristotle's "accident" as the convergence of two causal chains is quite compatible with determinism, but Aristotle himself is unequivocal in opposing strict necessity. Accidents are a consequence of chance.

Aristotle rejected the necessity of determinism in his statement on chance. Unfortunately, his description of chance as "obscure" (ἄδηλος) to human reason led centuries of philosophers to deny the existence of chance:

> "Causes from which chance results might happen are indeterminate; hence chance is obscure to human calculation and is a cause by accident."[5]

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3 Aristotle , *Metaphysics*, Book V, 1025a25

4 *Ibid*., Book VI, 1027a29

5 *Ibid*., Book XI, 1065a33

While it was Aristotle who first discussed the metaphysics of causality, it was Immanuel Kant in his "Copernican revolution" who called causality the "*crux metaphysicorum*."[6] David Hume had famously attacked metaphysics...

> "If we take in our hand any volume; of divinity or school metaphysics, for instance; let us ask, Does it contain any abstract reasoning concerning quantity or number? No. Does it contain any experimental reasoning concerning matter of fact and existence? No. Commit it then to the flames: for it can contain nothing but sophistry and illusion." [7]

Here Hume is distinguishing logical and mathematical reasoning, relations between ideas, in which the results can be known *a priori*, from experimental evidence concerning matters of fact, which can only be known *a posteriori,* after the fact itself. In modern discussions, this is called "Hume's fork," the distinction between *analytic* and *synthetic* knowledge, between logical truths and empirical facts, between the necessary and the contingent.

Information philosophy has established that nothing in the material world is necessary, no cause is logically pre-determined, because the *creation* of new information always involves indeterminism, the source of new possibilities in the universe. Necessity and apodeictic truth are concepts applicable only in math and logic.

An example of an event that is not strictly caused is one that depends on chance, like the flip of a coin. If the outcome is only probable, not certain, then the event can be said to have been caused by the coin flip, but the head or tails result itself was not pre-determined. Some events are at least partially caused by prior (uncaused) events, so they are not completely determined by prior events in a causal chain back to a primal first cause. The Aristotelian chain (ἄλυσις) has been broken by the uncaused cause. Uncaused events start new causal chains. Aristotle himself called these events "fresh starts," "new beginnings," or archai (ἀρχαί).

We can describe most events as "adequately determined" because the contributions of chance tend to cancel out when they

6 Kant (1783) *Prolegomena to Any Future Metaphysics*, §29
7 Hume (1748) *Enquiry Concerning Human Understanding* (last paragraph)

are averaged over large numbers of individual contributing causes. Thus microscopic randomness at the quantum level is normally averaged over, unless specific amplification mechanisms bring quantum indeterminism to the macroscopic level. Even in a world that contains quantum uncertainty, the behavior of most objects is determined to an extraordinary degree. Newton's laws of motion are deterministic to the limits of observational error for large objects.

The presence of quantum uncertainty leads philosophers to call the world "indeterministic." But indeterminism is seriously misleading when most events are overwhelmingly "adequately determined." No events are pre-determined in the Laplacian or theological senses.

It was Hume's approach defining causality that famously awakened Immanuel Kant from his "dogmatic slumbers." Kant said

> "My object is to persuade all those who think Metaphysics worth studying, that it is absolutely necessary to pause a moment, and, neglecting all that has been done, to propose first the preliminary question, 'Whether such a thing as metaphysics be at all possible?'...
>
> "Since the Essays of Locke and Leibniz, or rather since the origin of metaphysics so far as we know its history, nothing has ever happened which was more decisive to its fate than the attack made upon it by David Hume... Hume started from a single but important concept in Metaphysics, viz., that of Cause and Effect. He challenges reason, which pretends to have given birth to this idea from herself, to answer him by what right she thinks anything to be so constituted, that if that thing be posited, something else also must necessarily be posited; for this is the meaning of the concept of cause. He demonstrated irrefutably that it was perfectly impossible for reason to think a priori and by means of concepts a combination involving necessity." [8]

Kant's "synthetic a priori" project hoped to show that necessity, which is "analytic" (true by logic and reason alone), is a "concept of the understanding" that can apply to experience - the realm of empirical evidence and synthetic knowledge. Kant's stumbling block was his failure in the *Critiques of Reason* to distinguish deductive reasoning from inductive reasoning.

8 Kant, *Prolegomena*, (Introduction)

The Problem of Induction

Hume had described causality as merely the constant conjunction of cause and effect. But no number of such conjunctions establishes with certainty that the next appearance of the cause will necessarily produce the same effect. Even the sun may not rise tomorrow.

This is the problem of induction. Whereas deduction can establish the truth of a logical conclusion given the premises, induction at best is an accumulation of evidence in favor of a causal relation.

Francis Bacon described "genuine Induction" as the new method of science. Opposing his new idea to what he thought Aristotle's approach had been in his *Organon* (as misinterpreted by the medieval Scholastics), Bacon proposed that science builds up knowledge by the accumulation of data (information), which is of course correct.

This is simply the empirical method of collecting piece by piece the (statistical) evidence to support a theory. The "problem of induction" arises when we ask whether this form of reasoning can lead to apodeictic or "metaphysical" certainty about knowledge, as the Scholastics thought. Thomas Aquinas especially thought that certain knowledge can be built upon first principles, axioms, and deductive or logical reasoning. This certain knowledge does indeed exist, within a system of thought such as logic or mathematics. But it can prove nothing about the natural material world.

Bacon understood logical deduction, but like some protoempiricists among the Scholastics (notably John Duns Scotus and William of Occam), Bacon argued in his *Novum Organum* that knowledge of nature comes from studying nature, not from logical *a priori* reasoning in the ivory tower.

Bacon likely did not believe certainty can result from inductive reasoning, but his great contribution was to see that (empirical) knowledge gives us power over nature, by discovering what he called the form of nature, the real causes underlying events.

It was of course David Hume who pointed out the lack of certainty or logical necessity in the method of inferring causality from observations of the regular succession of "causes and effects." His great

paradigm of scientific thinking, Isaac Newton, had championed induction as the source of his ideas. This is as if Newton's laws of motion were simply there in the data from Tycho Brahe's extensive observations and Johannes Kepler's elliptical orbits. "*Hypotheses non fingo*," Newton famously said, denying the laws were his own ideas. Although since Newton it is a commonplace that the gravitational influence ("action at a distance") of the Sun causes the Earth and other planets to move around their orbits, Hume's skepticism led him to question whether we could really know, with certainty, anything about causality, when all we ever see in our inductive evidence is the regular succession of events.

Thus it was Hume who gave us the "problem of induction" that has bothered philosophers for centuries, spilling a great deal of philosophical ink. Hume's skepticism told him induction could never yield a logical proof. But Hume's mitigated skepticism saw a great deal of practical value gained by inferring a general rule from multiple occurrences, on the basis of what he saw as the uniformity of nature. It is reasonable to assume that what we have seen repeatedly in the past is likely to continue in the future.

So how is it that philosophers and scientists should establish causal relations between events? It turns out that it is neither logical deduction nor empirical induction alone, but rather by what Charles Sanders Peirce called "abduction," to complete his triad.

Induction and the Scientific Method

Abduction is the creative formation of new hypotheses, one step in what some philosophers of science in the twentieth describe as the scientific method - the hypothetico-deductive-observational method. It can be described more simply as the combination of theories and experiments. Observations are very often the spur to theory formation, as the old inductive method emphasized. A scientist forms a hypothesis about possible causes for what is observed. Although the hypothesis is an immaterial idea, pure information, the abduction of a hypothesis creates new information in the universe, albeit in the minds of the scientists. By contrast, an experiment is a material and energetic interaction with the world that produces new information structures to be compared with theoretical predictions.

Experiments are Baconian accumulations of data that can never logically "prove" a theory (or hypothesis). But confirmation of any theory consists entirely of finding that the statistical outcomes of experiments match the theory's predictions, within reasonable experimental "error bars." The best confirmation of any scientific theory is when it predicts a phenomenon never before seen, such that when an experiment probes nature, that phenomenon is found to exist. These "surprising" results of great theories shows the extent to which science is not a mere "economic summary of the facts," as claimed by Ernst Mach, who was a primary exponent of logical positivism in science.

In his early years, Albert Einstein thought himself a positivist disciple of Mach. He limited his theories to observable facts. Special relativity grew from the fact that absolute motions are not observable. But later when he realized the source of his greatest works were his own mental inventions, he changed his views. Although a great believer in determinism, Einstein argued for "free creations of the human mind." [9] Here is Einstein in 1936,

> "We now realize, with special clarity, how much in error are those theorists who believe that theory comes inductively from experience. Even the great Newton could not free himself from this error ("Hypotheses non fingo")...
>
> "There is no inductive method which could lead to the fundamental concepts of physics. Failure to understand this fact constituted the basic philosophical error of so many investigators of the nineteenth century. It was probably the reason why the molecular theory and Maxwell's theory were able to establish themselves only at a relatively late date. Logical thinking is necessarily deductive; it is based upon hypothetical concepts and axioms. How can we expect to choose the latter so that we might hope for a confirmation of the consequences derived from them?
>
> "The most satisfactory situation is evidently to be found in cases where the new fundamental hypotheses are suggested by the world of experience itself. The hypothesis of the non-existence of perpetual motion as a basis for thermodynamics affords such an example of a fundamental hypothesis suggested by experience; the same holds for Galileo's principle of inertia. In the same

9 Einstein. (1936), 'Physics and Reality,' p.291

> category, moreover, we find the fundamental hypotheses of the theory of relativity, which theory has led to an unexpected expansion and broadening of the field theory, and to the superseding of the foundations of classical mechanics." [10]

And here, Einstein wrote in his 1949 autobiography about what may be the greatest of all the causal laws of nature...

> "I have learned something else from the theory of gravitation: No ever so inclusive collection of empirical facts can ever lead to the setting up of such complicated equations. A theory can be tested by experience, but there is no way from experience to the setting up of a theory. Equations of such complexity as are the equations of the gravitational field can be found only through the discovery of a logically simple mathematical condition which determines the equations completely or [at least] almost completely." [11]

We can conclude that causality is not something that can be understood deductively as Kant's synthetic *a priori*, nor is explained as Hume's inductive constant conjunction of cause and effect.

Induction corresponds to the gathering of large numbers of observations or experiments, which today are seen as the statistical basis for accepting a scientific theory.

Deduction is an *a priori* tool that allows predictions to be derived logically and mathematically from the theory.

Deduction and induction are supplemented today with abduction, which is the free invention of theories or hypotheses to be tested against the results of experiments. Freely created theories, new information in the universe, are then seen to generate predictions about alternative possibilities and probabilities.

Experimental tests provide the statistical evidence that either confirms or denies those predictions.

Theories are probabilities. Experiments are statistics.

Causality and various causal laws are simply theories, as is determinism.

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10 Einstein. (1936), 'Physics and Reality,' pp. 301, 307

11 Einstein (1949), 'Autobiographical Notes,' p.89