POSSIBLE WORLDS

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By "a possible world" philosophers mean a total state of affairs in the conception of which no contradiction is involved. Our own world - the real world, the actual one - is just one of many possible worlds. Indeed, it is just one of infinitely many, since for any possible world containing say n atoms there is another logically possible world containing n+1 atoms, and so on *ad infinitum*. All possible worlds other than the actual world we inhabit are nonactual.

A world the conception of which does involve a contradiction is said to be an impossible world. An impossible world, of course, is a nonactual one. There are many possible worlds in which you, the reader, exist; the actual world is one of them. And there are possible worlds in which you do not exist; any such world is nonactual. But there are none in which you both do and do not exist; any such world is an impossible one.

The banality of possible worlds

Although the term "possible worlds" entered the philosophical lexicon only in the writings of Gottfried Leibniz (1646-1716), the fact is that we all think about them every day, though not usually under that description. The idea of worlds different from the actual one is totally commonplace. One wonders what the world would have been like if one had done something different from what one in fact did: if one had chosen a different partner or profession, for instance. One wonders what history would have been like if Hitler had won the war. Equally one ponders whether one should do this or that, or something else, where each of the possibilities would make a difference to how the world, or your little part of it, would then turn out. And one makes plans for the future hoping things will turn out one way though conscious of the fact that it may not.

The concept of possible worlds is implicit in all these ways of thinking. To imagine the past as having been different (even in the smallest respect) from the way it was, or the future (even in the smallest respect) as being different from what it will be, is to entertain the concept of different possible worlds branching out from the past (perhaps even from the beginning of the world), or from the present, or from the future.

Thus, there is nothing arcane about the notion of possible worlds, actual and nonactual alike. They feature in our dreams, our imaginings, our hopes and fears for the future, our regrets over past deeds and lost opportunities. We think about how the world *might* have been, and of how it *might* yet come to be.

They also feature in fiction, especially science-fiction novels and films in which we are invited in our imaginations to enter into worlds that often bear only the faintest resemblance to the real world that we in fact inhabit. Some are plausible. Some are not. And still others seem beyond the bounds of belief. Science-fiction stories involving time-travel, in particular, often challenge our sense of what is possible and what is not. Are such stories internally consistent or is there a contradiction involved somewhere? Is time travel possible? Is it possible to change the past? Or the future, for that matter?

Theoretical applications of the concept

The concept of worlds, possible and impossible, actual and nonactual, can play a valuable role in clarifying our thinking about many issues. Within Philosophy, the concept has been used to give us a better grasp on matters of Logic (leading eventually to the

development of temporal logics), Semantics, and issues in Philosophy of Religion, Philosophy of Science, Ethics, and Metaphysics. Some examples follow.

Possible worlds and logic

The aim of logic, as conceived by its founder, Aristotle (384-322 BCE), was to establish general principles for reasoning such that *if* we started from a set of true premises we could be guaranteed that we would finish with a true conclusion. These principles would ensure that the conclusion follows, as he put it, "of necessity" from the premises.

Leibniz's claimed that these principles about what follows of necessity (the principles of logic) *are true in all possible worlds*. This insight has enabled subsequent philosophers to give illuminating accounts of the whole field of logic.

In terms of possible worlds we can define many of the most basic concepts of logic as follows:

P implies Q	= def	There is no possible world in which P is true and Q false
P is consistent with Q	= def	There is a possible world in which both P and Q are true
P is inconsistent with Q	=def	There is no possible world in which both P and Q are true
P is a contradictory of Q	= def	There is no possible world in which both P and Q are true and no possible world in which both P and Q are false
P is a contrary of Q	= def	There is no possible world in which both P and Q are true but there is a possible world in which both P and Q are false
P is a subcontrary of Q	= def	There is no possible world in which both P and Q are false but there is a possible world in which both P and Q are true.
P is independent of Q	=def	There is a possible world in which both are true, a possible world in which both are false, a possible world in which P is true and Q is false, and a possible world in which P is false and Q is true.

Consider the propositions:
  (1)   The universe began more than 13 billion years ago.
  (2)   The universe began fewer than 3 billion years ago.
  (3)   The universe began at least 3 billion years ago.
  (4)   The universe began no more than 13 billion years ago.
A little thought will suffice to show
  •   that (1) *implies* (3)
  •   that (1) and (4) are *contradictories* and hence, by definition, are *inconsistent* (ditto for (2) and (3))
  •   that (1) and (2) are *contraries* (and hence, by definition, are *inconsistent*)
  •   that (3) and (4) are subcontraries (and hence, by definition, are *consistent*).
Moreover, we can define an argument as *valid* just when its premises imply its conclusion. Thus the simple two-premise argument
  (5)   Time began when the universe began.
  (6)   The universe began on Sunday 23 October 4004 B.C.

Therefore,
        (7)   Time began on Sunday 23 October 4004 B.C.
is *valid* since there is no possible world in which its premises are true and its conclusion false. (Note that it would be *sound* only if it was not only valid but also had true premises, i.e., premises that are not only true in some possible world but also true in the actual world.)

The concept of possible worlds also enables us to define some important properties of propositions. Clearly, each of the propositions (1) through (7) is true in some possible worlds (and hence *possibly true*) and false in some others (and hence *possibly false*). Propositions having the property of being possibly true and possibly false have been described, ever since Aristotle, as *contingent*. By way of contrast, propositions such as
        (8)   Not both P and not-P [the so-called Law of Non-contradiction]
        (9)   2 + 2 = 4 [a truth of mathematics]
        (10)   If a thing is red then it is coloured [a definitional or analytic truth]
are described as *non-contingent*, these all being instances of so-called *necessary truths* (propositions that are true in all possible worlds) while their contradictories
        (11)   Both P and not-P
        (12)   It is not the case that 2 + 2 = 4
        (13)   Some red things have no colour
are instances of *necessarily false* or *self-contradictory* propositions (not true in any possible worlds).

The properties of being necessarily true, necessarily false, or contingent are said to be *modal* properties. Aristotle sketched the foundations of a modal logic in which these properties play a vital role. Medieval logicians appealed to their logical intuitions to elaborate on Aristotle's findings. In 1918, C. I. Lewis developed axiomatic systems for various modal logics. In 1959, Saul Kripke provided some of these with a widely accepted semantic underpinning in what is called *possible world semantics* and, about the same time, Arthur Prior extended modal logics in the form of *temporal logics* (sometimes known as *tense* logics).

Possible worlds and science

The aim of science is to determine which of many possible worlds is actual. Its method is to progressively eliminate from further consideration all those that experience and reason show to be inconsistent with what we already know (or have compelling evidence for believing) to be true of the actual world.

That, in a nutshell, is how Sir Karl Popper (1902-1994), and his followers such as the Sir Peter Medawar (1915-1987), view science. On their account, a scientist has an idea of a *possible* world, i.e., a way the world might be, and then tests it experimentally to see whether the *actual* world conforms with it. If it withstands the tests, it is accepted provisionally as the best account available to date. But if not, the scientist--if endowed with an open mind and intellectual integrity--will reject it as having been ruled out by experience of how the actual world works.

Consider propositions (1) through (7) again. All are contingent, i.e., true in some possible worlds and false in others. But which, if any, is *actually* true?

Although Bishop Ussher (1581-1656) believed he had God's word, as revealed in the *Bible*, as his authority for claiming (6) to be true (that the universe began in 4004 B.C.) only a few die-hard biblical creationists would nowadays agree. Edwin Hubble (1884-1933) turned to science for an answer and calculated an age of about 2 billion years based

on observations of the rate of expansion of the universe. That was in 1929. In 1947 George Gamow (1904-1968), with new evidence in hand, gave an estimate of 2 to 3 billion years. And current estimates, based on evidence produced by the Hubble Space Telescope among other things, are that the Big Bang began about 13.7 billion years ago, thereby asserting the truth of proposition (1), and thereby implying the falsity of its contradictory (4) and the falsity of its contraries, (2) and (6).

Arguably, it is through a succession of such episodes of conjecture and refutation that the Big Bang theory of current physical cosmology has replaced Ussher's. We have come, through experiment, to realise that the possible worlds that Ussher, Hubble, and Gamow conceived are *non-actual* ones.

These advances were prompted by observation-based experiments. But not all experiments are observational ones. Some are made in "the laboratory of the mind", by conducting pure "thought experiments". The history of science, and of physics in particular, is replete with such cases. Notable examples range from Galileo's thought experiment refuting Aristotle's belief that heavier objects fall faster than lighter ones to Erwin Shrodinger's "Cat" critique of certain interpretations of quantum mechanics. And they include Einstein's thought-experiment in which he, at age 16, conceived of himself chasing a light-wave--a thought experiment that led him to formulate a new conception of time and space.

Possible worlds in the Philosophy of Time

Thought experiments can help us get clear about how the concept of time relates to other concepts.

Is time-travel possible?

It is not just science-fiction writers who entertain the idea of travelling back in time. Some physicists do, too, on the grounds that certain concepts of travelling through time are consistent with both general relativity and quantum theory.

Yet some thinkers have rejected the notion outright. Many argued that time-travel would make it possible for a person to go back in time, kill their own paternal grandfather while he was still a child, and thereby ensure that they themselves were never born. Hence the so-called grandfather paradox.

But where lies the contradiction? Not in supposing that the laws of nature (of genetics, in particular) would thereby be violated. For there is nothing contradictory involved in that part of the story. The paradox lies elsewhere.

It is tempting to think of travelling through time as akin to travelling through space to visit a place one hasn't been to before. This fosters the idea of visiting a place in the past, even though one hasn't been there before, and of leaving one's mark by changing things once one gets there. But this is where real paradoxes arise. For it is a logical truth--true in all possible worlds--that the past was what it was. It follows that you can't go back to a previous time, unless you had already been there. You can travel to the past only if you already *were* in the past. It follows, too, that you can't *change* the past from what it was by killing your grandfather, for example, if the fact is that he wasn't killed. There is no possible world in which either can occur.

Some tellers of time-travel tales have been astute enough to avoid any paradox. Robert A. Heinlein is a case in point. His novel *Time Enough for Love* depicts a world that is self-consistent and hence possible.

Must time have begun with the Big Bang?

Most physicists, following Stephen Hawking (b. 1942), would answer "Yes" on the grounds that the Big Bang model *defines* time that way. The argument is that since physicists can only define time in terms of its observational consequences, and events occurring "prior to" the Big Bang would have no such consequences, the concept of time prior to the Big Bang "makes no sense."

But this is conceptually confusing. It would seem to make proposition
      (5)   Time began when the universe began
true "by definition" and hence a necessary truth. Yet (5) is clearly contingent. We can easily, and without contradiction, conceive of worlds in which the Big Bang was preceded by phases of expansion and contraction. That is to say, there is no contradiction involved in the supposition that the Oscillatory Universe model is true. Or the Steady State model for that matter. In fact, both models entail that neither the universe nor time had any beginning at all.

So what has gone wrong? There has been a failure to distinguish between *operational definitions* of time (definitions couched in terms if the operations by which time is measured) and the concept of time itself. The concept of time itself has a scope that is not restricted by any particular scientific theory or to any method of measurement used by that theory. Arguably, its ties with other concepts are more a matter of philosophical analysis than of empirical inquiry.

Could time pass without events occurring?

It is obvious enough that a series of events (changes in objects or states of affairs) cannot occur without the passage of time. How about the converse? Could time pass if nothing was changing?

Few philosophers entertained this possibility until Sydney Shoemaker (b. 1931) argued for it. He told a possible worlds parable about a world with three parts, A, B, and C each of which undergoes periodic "local freezes" of, say, one year's duration--periods during which nothing whatever occurs--such that the freezes for all three parts coincide at regular intervals. The inhabitants of each part, he argues, could even have observational evidence for the freezes occurring in the other parts, have evidence from inhabitants of other parts that their part also undergoes periodic freezes, and calculate the times when all the freezes occur at the same time.

It won't do to object that none of the inhabitants could, during the concurrent freezes, observe or measure the passage of time. That would be to appeal to the operational definition of time whose tenability is in question. It won't do to invoke Occam's Razor and say that it is much simpler to suppose that the supposedly concurrent freezes never occur. The principle of parsimony is not a logical one. Nor will it do to object that his scenario affords no causal mechanism by which the freezes of any of the three parts could come to an end. For the issue is not whether his possible-worlds scenario is physically possible. It has to do only with whether it is logically possible.

Unless a strictly logical contradiction can be found in the Shoemaker scenario, we have no option other than to allow the possibility of time passing in the absence of anything whatever occurring.