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essentialism where the essences of substances are
given by their chemical composition. Thus, for
Putnam, the fact that water = H₂O is true in all
possible worlds in which water exists, and hence
is a necessary truth about water (and so modal
reasoning, in this case, demonstrates the ‘truth’ of
scientific realism).

Modal logic has thus resurrected the mediae-
val notion that there are de re necessities (neces-
sary properties of things). This represents
something of a revival of metaphysics, especially
Aristotelianism, in contemporary analytic phi-
osophy, and runs counter to the Enlightenment
document – typified by Hume’s philosophy – that
necessity is ‘all in the mind’. However, the idea of
possible worlds may have other, less metaphysical,
uses. For if we accept that the idea of a world is
never simply a logical notion but always a cultural
and a historical one, then one way of conceiving
the conceptual terrain of global culture is to see it
as grounded in a set of interlinking possible worlds –
some of which are ‘accessible’ from worlds
geoigraphically and/or culturally adjacent to them,
some of which are not.

If the epistemology of global culture is
conceived as requiring a cultural-ontological
mapping of the interrelations between possible
worlds, then the problems involved in understand-
ing the architectonics of global knowledge can be
stated somewhat differently: is there a possible
cultural world ‘without logic’? When conceived
anthropologically the answer is probably ‘yes’. But
can there be a reflexive theoretical understanding
of world-knowledge without an organizing logic? If
we equate an understanding of world-knowledge
with its conceptual mapping, then we must
concede that some organizing logic is necessary.
Thus logic, as a normative standard for thinking
about thinking, may retain its status as a cognitive
necessity in global contexts – even though we may
be forced to accept that the topos of conceptual
encounter, wrought by the global flow and
counter-flow of ideas between accessible cultural
worlds, will, in time, give rise to new logics.

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The Religious Roots of Mathematics

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Keywords Buddhist logic, Jaina logic, logic
and culture, mathematics, quantum logic

Present-day science relies upon mathematics.
And mathematics has always been closely
connected with religious beliefs in the West.
Thus, Plato, in his Republic, advocates the teaching
of mathematics for its beneficial effects on the
soul, and expressly not for its practical appli-
cations. (For Plato’s thought that ‘geometry will
draw the soul towards truth’, see Republic VII,
527, in Plato, 1996.) Likewise, Socrates’ demon-
stration of the slave boy’s intrinsic knowledge of
geometry was explicitly intended by Socrates to
prove the existence of the soul, and how its recol-
lections could be elicited by a philosopher acting

Proclus, the alleged source of the single vague
remark that gave rise to the strong rumours about
the existence of ‘Euclid’, explicitly asserts in his
commentary on the Elements that the real function
of mathematics is to turn the attention of the
student inward, towards his soul, and thus make
him realize universal oneness – hence most of the
propositions in the Elements are about equality of
apparently dissimilar things. (Proclus’ explana-
tion of the etymology of the word ‘mathematics’ as the
science of learning, or the science of the soul, is at
the end of his Prologue, part 1, in Proclus, 1970.)

These beliefs about mathematics were so
strong a force in Islamic rational theology that even
stauch opponents like al Ghazali allowed that
even God was bound by the laws of logic. This
concession was seized upon not only by al
Ghazali’s opponent Ibn Rushd (Averroes) but also
by the school-men who inherited his legacy, and
connection theory incorporate any necessary truths, the neither the axioms nor the theorems of a formal according to formal mathematics, even though completely divorced from the empirical. That is, from theorems to mathematical proof, regarded as of this belief in necessary truth has been shifted worlds, truth not binding on God). forever contingent (true in only some possible though any empirically based truth must remain valid in all possible worlds, truth that binds God), deduction) can incorporate necessary truth (truth that only metaphysical procedures (like logical western thought reached the peculiar conclusion that the empirical world had to be contingent to allow for the creation of the world by God – although they denied his belief in continuous creation, held also by the Dunsenmen, whom they labelled dunces, and subscribed instead to the belief in one-time creation.

It is against this theological background that western thought reached the peculiar conclusion that only metaphysical procedures (like logical deduction) can incorporate necessary truth (truth valid in all possible worlds, truth that binds God), though any empirically based truth must remain forever contingent (true in only some possible worlds, truth not binding on God).

In present-day (formal) mathematics, the locus of this belief in necessary truth has been shifted from theorems to mathematical proof, regarded as completely divorced from the empirical. That is, according to formal mathematics, even though neither the axioms nor the theorems of a formal theory incorporate any necessary truths, the connection between axioms and theorems does: that is, for a formal theory, there may be worlds in which its axioms are false, and worlds in which its theorems are true, but any world in which the axioms are true is a world in which the theorems are true.

This is also the belief underlying Popper’s criterion of refutability (falsifiability), which supposed that any number of experiments could not verify a theory (since this process was inductive, and probabilities are not ampliative), while a single experiment could refute a theory. The point here is not merely that the process of refutation is also inductive (as I have pointed out earlier), but that refutation is believed to refute the physical hypotheses underlying the physical theory, rather than the mathematics that connects the physical hypothesis to the empirical conclusion. If mathematical proof does not represent certain or necessary truth, and if it were to be accepted that mathematical proof is also fallible (even when correct), there is no basis for this belief, for our actual world may happen to be the world in which the physical hypotheses of the theory are true, but its conclusions are false.

The completely cultural nature of the belief that metaphysics is somehow superior to physics, that deduction incorporates certain or necessary truth, becomes crystal clear the moment one turns towards Buddhism or Jainism. Both use logics that are different from the logic culturally assumed in western thought. Therefore the inferences drawn using these logics will be different from the inferences drawn using two-valued logic, e.g. many proofs by contradiction would fail in Buddhist or Jana logic. (The Buddha’s use of the logic of four alternatives is in the Brahmajāla Sutta of the Dīgha Nikāya. The very readable English translation by Maurice Walshe is not so clear on this point, and neither is the older English translation by T.W. Rhys Davids.) An interesting (but not necessarily correct) interpretation of the Jain logic of Svaññavada is provided by J.B.S. Haldane’s ‘The Syadavada System of Predication’ (1957, for more detail see Raju, 2003).

But what decides the nature of logic to use? If decisions about logic are purely cultural, why should one use one logic rather than another? In any case, it is hard to understand how cultural decisions can be regarded as infallible! Both Buddhism and Jainism, like all other Indian schools of thought, incidentally, accept the empirically manifest (pratyaksa) as the first means of proof, while also accepting it as fallible. Therefore, if, on the other hand, decisions regarding logic are empirical (and based on beliefs about the nature of time), they are bound to be inductive, and fallible. In either case, deduction turns out to be more fallible than induction. The incorrect belief that deductive inference, divorced from the empirical, represents certain truth, provides an important example of how deep-seated cultural assumptions are woven into the content of present-day mathematics, scientific theories, and also the philosophy of mathematics and science. Indian mathematics, by contrast, permitted the use of empirical procedures, and aimed towards practical calculation rather than claims of a universal and necessary truth, however, it is, on that ground, deemed not to be mathematics at all. (In fact, curiously, it is deemed to be neither mathematics nor physics!)

These cultural assumptions also underlie present-day technology. For example, the above assumptions about the nature of logic are also built into the present-day theory of computation, and are incorporated in common computer chips. As shown by quantum computers, using the structured-time interpretation of quantum mechanics, an alternative technology of computation based on alternative logics, like Buddhist logic, is feasible. (For the structured-time interpretation of quantum mechanics, see Raju, 1993; for further amplification and formal proofs see Raju, 1994. ch. 6b.)
Logic of Knowledge

John Phillips

Logic One

At least provisionally, where logic is concerned, it will pay to be precise. In the philosophical sense logic concerns the rules according to which we use our understanding in thought and knowledge, insofar as we can think of these rules independently of their application to objects of knowledge and experience. Logic concerns the formal conditions for the use of understanding without concern for the matter of knowledge or for practical ends. It concerns not what can be known but how knowledge in the abstract is possible. The science of logic therefore deals with necessary rules of thought rather than contingent ones. Necessary rules are those without which knowledge would not be possible. Contingent rules would apply in the practice of particular kinds of knowledge (e.g. mathematics, ethics or social sciences). So traditionally logic concerns the necessary rules for all thinking in general.

References


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Logic emerges as a specific domain in western philosophy with Aristotle, whose concern was to identify connections and differences between all the domains of knowledge, establishing an analogical basis for the otherwise distinct fields of episteme (science), praxis (action) and poiesis (production). Aristotle inherited during his time as a member of Plato’s academy the sense of a quest for the unification of all branches of knowledge and thus for what we now refer to as Metaphysics, the name (meaning ‘after the physics’) that later editions give to Aristotle’s book on general philosophical questions. The Metaphysics examines the possibilities of thought thinking itself in abstraction and it offers a technical consideration of beings qua being, thus anticipating modern philosophy’s rediscovery of fundamental ontology, particularly in Martin Heidegger’s Being and Time, which takes Aristotle as its starting point. Furthermore, Aristotle’s contributions to the systematic development of a science of logic, in the Prior and the Posterior Analytics and the Topics, help to bring this project about by establishing the logical structure of knowledge and its conditions of possibility. The Prior Analytics, for instance, details the conditions according to which one can reason from