An extract from EM paper #50: ***EM and the Foundations of AI***

A Classic Intelligence Test

The following problem illustrates one popular view of intelligence that has much in common with the logicist perspective as portrayed in Kirsh, 1991. It is drawn from a publication by Mensa, a society whose membership comprises people with a high "intelligence quotient".

> **The Captain of the darts team needs 72 to win. Before throwing a dart, he remarks that (coincidentally) 72 is the product of the ages of his three daughters. After throwing one dart, he remarks that (coincidentally) the score for the dart he has just thrown is the sum of the ages of his daughters. Fred, his opponent, observes at this point that he does not know the ages of the Captain's daughters. "I'll give you a clue", says the Captain. My eldest daughter is called Vanessa. "I see", says Fred. "Now I know their ages".**

The solution to this problem centres on the fact that factorisations of 72 into 3 factors are disambiguated by the sum of factors but for the pair of factorisations:

> 72 = 3 * 3 * 8 = 6 * 6 * 2.

By observing that he does not know the ages of the daughters, Fred discloses to the solver that one or other of these factorisations of 72 is the required one. (Note that, to make his observation, Fred does not need to know - as we as solvers do - that no other pair of factorisations of 72 into three yields the same sum, since he knows that the Captain has scored 14.) When he knows there is an *eldest* daughter, he knows that the ages of the daughters are 3, 3 and 8.

This puzzle illustrates several ingredients of logicism discussed in Kirsh. The problem is contrived around a mathematical model in the poser's mind. The casual and artificial way in which the abstract problem is placed in a real-world context echoes the modularity of 'inventing conceptualizations' and 'grounding concepts' presumed in logicism (Kirsh,1991). Embodiment plays a contrived role in the problem. The issue of psychological realism is not addressed. It is assumed that Fred exercises instantaneous - or at least very rapid - inference skills on-line, whilst "knowing the ages of the daughters" is an abstract concept, unconnected with being able to associate an age with a daughter who might turn up at the darts match. Nor is indexicality respected. In order to draw any inferences, a single Mensa-like persona must be imposed on the agents in the puzzle (the Captain and Fred) and on the poser and solver also.

The remarkable thing about problems of this nature is that the IQ-literate reader adopts the conventions of the problem poser so readily. Why should we regard problem-solving of this nature as intelligent? Perhaps because it involves being able to see through the contrived presentation to make ingenious abstract inferences, discounting the commonsense obstacles to deduction (cf. Naur's analysis of logical deduction in Sherlock Holmes stories (Naur,1995): "truth and logical inference in human affairs is a matter of the way in which these affairs are described").

To some degree, facility in making abstractions is a quality of intelligence. Some commonsense facts about the world must be taken for granted to make sense of the problem. For example, a game of darts takes place on such a timescale that the ages of the children are fixed for its duration. 14 is a legitimate score for one dart. Yet the puzzle is posed so artificially that it is almost a parody of intelligence.

A complementary mental skill is far less well-represented in logicism. This is the ability to transpose the problem imaginatively so as to disclose the implicit presumptions about the relationship between the abstract and the real-world elements. Imagination of this kind can subvert the intelligence test. A suspension of disbelief is needed in supposing that the Captain and Fred are mathematically adept and sober enough to factorise 72 in their heads whilst simultaneously taking turns at darts, or that Fred determines the ages of the children because of an inference rather than because he remembers Vanessa's age. In some contexts, especially where creativity or design are concerned, such questioning of the premises of a problem is essential, but it is out-of-place in the world of Mensa problems. The intended world model is closed and preconceived.

The Mensa problem is an example of the kind of challenge that might be addressed by an intelligence inference engine. It might not be easy to meet, as it involves some meta-level reasoning. This is illustrated by the fact that if Fred said he knew the ages of the daughters before he was told the name of the eldest, no inference could be drawn.

Though logicism is not primarily concerned with artificial tests of intelligence of this nature, it can be seen as construing intelligence in similar terms. It involves establishing a formal relationship between the world and a logical model similar to that between the mathematical model and the darts match scenario, such that intelligent behaviour can be viewed as if it were inference of the kind used in solving the intelligence test.

Empirical Modelling techniques address the broader view of intelligence that encompasses creativity and imagination. They are not particularly well-suited for exercises in inference masquerading as commonsense problems, but have direct relevance to real-life scenarios in which abstract explanations are sought.

References

1. D.Kirsh. Foundations of AI: the big issues. Artificial Intelligence, 47 : 3-30, 1991.
2. P.Naur. *Knowing and the Mystique of Logic and Rules.* Kluwer Academic Publishers, 1995.