

## **Large-size Message Construction for ETI Typing Static Relations**

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In proposals for languages for cosmic intercourse, e.g. LINCOS (Freudenthal<sup>1</sup>) and LCI<sup>+</sup> (Ollongren<sup>2</sup>), knowledge representation is an essential topic. In the design of LCI<sup>+</sup>, a basic idea is to use for this purpose ‘stories’ (linear codings of texts in a terrestrial language) as a platform, supported by illustrative pictograms, represented as bitmaps. In the texts reference can be made to (sub)area’s of these maps and the selected objects can be provided with names and properties, concrete and abstract. In this manner objects occurring in text and illustration are provided with types.

In the paper on LCI<sup>+</sup> static relations between objects in ‘stories’ are briefly discussed, but a thorough type-theoretical foundation is missing. The present contribution fills the gap. It is also a part of on-going research into the application of type theory to more general kinds of relations occurring in ‘stories’ in large-size messages for extraterrestrial intelligent recipients (ETI). Such extensions are important as they can be used by ETI in the process of interpretation.

A simple calculus of constructions (CC) is used for the formal representation of static relations between classes of objects – considered to be abstract types. In CC the type ‘universe’, which contains everything, is assumed to exist. The universe is assumed to have *ab initio* just a few unstructured ‘residents’, e.g. the natural numbers 1 and 2 and the successor function, identifiers (to be used for identifying objects), the Booleans ‘true’ and ‘false’, and the logical connectives together with the ‘if’ functions. All of these are assumptions. If necessary for a particular application, others can be added.

By definition, the universe can be enriched with new residents: the natural numbers using a (recursive) definition, lists of objects. Classes of objects are entered by defining structural details, using constructors, thus providing them with types. Relations between classes of objects are also types, residing in the universe as well. Finally, the universe is extended with functions and functions over functions – so generally functions of higher order. In this manner a simple system with high expressive power is obtained.

By way of example, a sound foundation is provided for the concept ‘family’ (of humans) and relations in families, briefly mentioned in the article on LCI<sup>+</sup>. This is achieved first by abstracting from the underlying ‘story’ and linguistic aspects of the natural language used, and then by applying concepts of the calculus of constructions.

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References

1. H. Freudenthal 1960, *LINCOS*, Design of a Language for Cosmic Intercourse, Part I, North Holland.
2. A. Ollongren, *Large-size Message Construction for ETI*, paper read at the 49th IAF International Astronautical Congress in Melbourne, IAA.9.2 SETI II: Interdisciplinary Connections, September 29, 1998