International Journal of Innovative Computing, Information and Control
Volume **1**, Number **4**, December **2005**
 ISSN 1349-4198
pp. **755–766**

DNA-BASED SEMANTIC MEMORY WITH LINEAR STRANDS

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Received January 2005; revised May 2005

Abstract. *In this work, a new DNA-based semantic model is proposed and described theoretically for implementing DNA-based semantic memories. This model, referred to as 'semantic model based on molecular computing' (SMC) has the structure of a graph formed by the set of all (attribute, attribute values) pairs contained in the set of represented objects, plus a tag node for each object. Each path in the network, from an initial object-representing tag node to a terminal node represents the object named on the tag. Input of a set of input strands will result in the formation of object-representing dsDNAs via parallel self-assembly, from encoded ssDNAs representing both attributes and attribute values (nodes), as directed by ssDNA splinting strands representing relations (edges) in the network. We believe that the DNA-based semantic memory is very suitable for knowledge representation memorized with DNA molecules.*
Keywords: Semantic networks, DNA computing, Knowledge representation

1. Introduction.

Semantic networks or nets are graphic notations for representing knowledge in patterns of interconnected nodes and edges. Computer implementations of semantic networks were first developed for artificial intelligence (AI) and machine translation, but earlier versions have long been used in philosophy, psychology, and linguistics. Human information processing often involves comparing concepts. There are various ways of assessing concept similarity, which vary depending on adopted models of knowledge representation. In featural representations, concepts are represented by sets of features. In Quillian's model of semantic memory [15], concepts are represented by the relationship name via links. Links are labeled by the name of the relationship and are assigned criteriality tags that attest to the importance of the link. In artificial computer implementations, criteriality tags are numerical values that represent the degree of association between concept pairs (i.e., how often the link is traversed), and the nature of the association.

In 1994, L. Adleman's [12] ground-breaking work demonstrated the way to use deoxyribonucleic acid (DNA) molecules for computational purposes. Such computation with DNA is, what is called, DNA computing or molecular computing. DNA computing has showed its potential by solving several mathematical problems, such as a graph and satisfiability problems [12, 18]. It appears, however, that current technology is not capable of the level of control of biomolecules that is required for large, complex computations [13]. One of the DNA's most attractive applications is a memory unit, using its advantages