



Informational Granules in Interactive Granular Computing[†]

Andrzej Skowron

Systems Research Institute, Polish Academy of Sciences, 01-447 Warsaw, Poland; skowron@mimuw.edu.pl

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Abstract: Informational granules are crucial objects in Interactive Granular Computing (IGrC). They are making it possible to link abstract objects and physical (not mathematical) objects in processes related to perceiving situations in the real world. The discussed IGrC computing model based on so-called complex granules is not purely abstract. Informational granules are responsible for the realization of the interaction between complex granules and the environment. The control of c-granules is responsible for the transformation of the current configuration of informational granules into the new one. The role of informational granules in perceiving the real world using c-granules is discussed.

Keywords: interactive granular computing; complex granule; informational granule; control of complex granule

We propose that the IGrC model is used as the basis on which the synthesis and analysis of intelligent systems dealing with complex phenomena should be grounded. The development of IGrC is still in progress, and can be witnessed in [1–7]. For more studies on IGrC, the readers are referred to <https://dblp.org/pid/s/AndrzejSkowron.html>, (accessed on 30 July 2023).

Let us start with some basic assumptions concerning IGrC. In the case of IGrC, contrary to Granular Computing (GrC) (see, e.g., [8,9]), which operates on abstract (mathematical) objects called granules or information granules only, we deal with complex granules (c-granules) comprising abstract objects, physical objects, as well as objects linking abstract and physical objects. States of c-granules are represented by networks of informational granules (ic-granules) linking abstract and physical objects. The extension of granules to c-granules allows us, in particular, to model the perception processes of objects (situations) in the real physical world. In IGrC, computations are performed on c-granules. Any c-granule may interact with another one from its currently perceived configuration. The control of c-granules transforms the current configuration of ic-granules into a new one, according to a rule selected by the control from the available set of rules. The decisions made in the rules specify the transformations that occur in the configuration of ic-granules. After selecting the rule, the control of the c-granule sends the specification of the transformation pointed to by the decision of the rule to the implementational module. This module, by implementing the transformation specification in the physical world, realizes the physical semantics of this transformation. Informational granules are crucial objects in IGrC, making it possible to link abstract objects and physical (not mathematical) objects. Hence, the discussed computing model is not purely abstract. Informational granules are responsible for the realization of interactions between c-granules and other c-granules in the environment.

The selected properties of the perceived objects and their interactions are encoded in the abstract part (informational layer) of c-granules, with the help of a c-granule control mechanism. The control uses this perceived information to achieve the goals of the c-granule. In particular, on the basis of special skills, represented by a reasoning mechanism embedded in the control, the currently perceived configuration of the c-granule can be modified into a new one. More compound c-granules (e.g., societies of c-granules) may comprise parts of some other c-granules, forming networks of c-granules.



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Contrary to mathematical logic, where relational structures, as well as sets of formulas and satisfiability relations expressing their properties, are treated as ‘given’, in IGrC, all these entities should be discovered; the process of discovering is realized often by using hierarchical learning to perceive data in interaction with the real world, which may change rapidly in an unpredictable way. Intelligent systems should be open to adapt the currently used strategies in order to make the right decisions. For instance, models for intelligent systems should be such that the perceived situation state, as well as the transition relation should be adopted according to the perceived changes in data. These issues are important to consider in the context of complex systems, complex phenomena, or complex processes, as they cannot be captured solely in the realm of classical mathematical modeling [10].

Intelligent systems dealing with complex phenomena should be continuously open to interaction with the physical world (including patients, experts, sensors, actuators, wearable devices, and physical objects used in telehealth and telemedicine). From this perspective, IGrC can be treated as the basis for data governance and processes, can thus be used for discovering (inducing) relevant computational building blocks that can help in perceiving the current situation (e.g., for inducing the relevant classifiers), and make the system able to make suitable (right) and feasible decisions (see the opinion by Professor Leslie Valiant at <http://people.seas.harvard.edu/~valiant/research>, accessed on 30 July 2023).

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