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Granular System Modeling: An Introduction

In the era of advanced methodologies and practices of system modeling, we are faced with ever growing challenges of building models of complex systems that are in full rapport with reality. These challenges are multifaceted. Human centricity becomes of paramount relevance in system modeling and because of this models need to be customized and easily interpretable. More and more visibly, experimental data and knowledge of varying quality being directly acquired from experts have to be efficiently utilized in the construction of models. The quality of data and ensuing quality of models has to be prudently quantified. There are ongoing and even exacerbated challenges to build intelligent systems, modeling multifaceted phenomena, and deliver efficient models that help users describe and understand systems and facilitate decision-making.

We have to become fully cognizant that processing and modeling has to be realized with the use of entities endowed with well-defined semantics, namely information granules. Human do not perceive reality and reason in terms of numbers but rather utilize more abstract constructs (information granules), which are helpful in setting up a certain cognitive perspective and ignore irrelevant details when dealing with the complexity of the systems.

In this talk, we introduce the key concepts of Granular Computing and demonstrate how this conceptual framework gives rise to human-centric system modeling and granular models. We discuss several representative formal setups used in describing and processing information granules including fuzzy sets, rough sets, and interval calculus. Key architectures of models dwell upon relationships among information granules. In particular, we elaborate on a principle of incompatibility in system modeling stressing a need for achieving a sound tradeoff between precision

and relevance of a model, which is of particular relevance when coping with systems of high complexity. We also demonstrate how information granularity and its optimization can be regarded as an important design asset to be exploited in system modeling. With this regard, two categories of models along with their granular augmentations are studied in detail, namely rule-based models and neural networks.

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