TEDDY – A Terminology for the Description of the Dynamics of Bio-Models

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Abstract

The purpose of models used in Systems Biology and Synthetic Biology is to simulate the dynamical behaviour of the biological system under examination. There are several efforts to enable computer support in bio-modelling and to increase the interchangeability of bio-models: for instance, SBML [2] is a computer-understandable format for models, BioModels Database [6] is a curated repository of published models, SBO (Systems Biology Ontology) [5] provides terms for the description of the model's structure, and bioinformatics databases and ontologies can be used to identify model components. However, the actual outcome of the models - their dynamical behaviour - is currently described exclusively in free text. At the moment there are no means to formalise and standardise the description of the model's dynamics. The lack of appropriate resources hamper the exchange of simulation results, the classification and evaluation of models based on their behaviour, and at the end the ability of computers to support the whole modelling process [4]. For these reasons, we started the development of a terminology for the description of the dynamics of bio-models called TEDDY.

Case Study

We use a modified version of model “BIOMD0000000010 - Khodolenko2000_MAPK_feedback” from BioModels Database [1] to demonstrate the annotation of dynamical behaviour by means of TEDDY.

The corresponding publication [3] discusses the dynamic properties of the MAPK cascade dependent on the feedback loop (dashed line in Fig. 1) from Nicolas Le Novère. Model storage, exchange and integration.

The bifurcation parameter $m$ decides the kind and strength of the feedback: For $m < 0$ the feedback is positive, whereas for $m > 0$ the feedback is negative. The bifurcation occurs at some critical value $m = m_c > 0$.

Three Vocabularies

TEDDY comprises three main branches to describe the dynamics of a modelled system:

- **Behaviour (TEDDY_0000083)**
  - terms for the actual (temporal) dynamical behaviour, e.g. Oscillation (TEDDY_0000006)
  - terms for the long term (asymptotic) behaviour, e.g. Limit Cycle (TEDDY_0000051)
  - terms for the behaviour with respect to perturbations, e.g. Bistable Behaviour (TEDDY_0000010)

- **Characteristic (TEDDY_0000002)**
  - terms to further characterise behaviours, e.g. Period (TEDDY_0000067)
  - terms for the dependency of behaviours from parameters, e.g. Bifurcation (TEDDY_0000053)

- **Functionality (TEDDY_0000003)**
  - terms for network motifs playing a specific dynamical role, e.g. Positive Feedback (TEDDY_0000035)
  - terms for the function that a (part of a) model is intended to play, e.g. Integrator (TEDDY_0000079)

References


