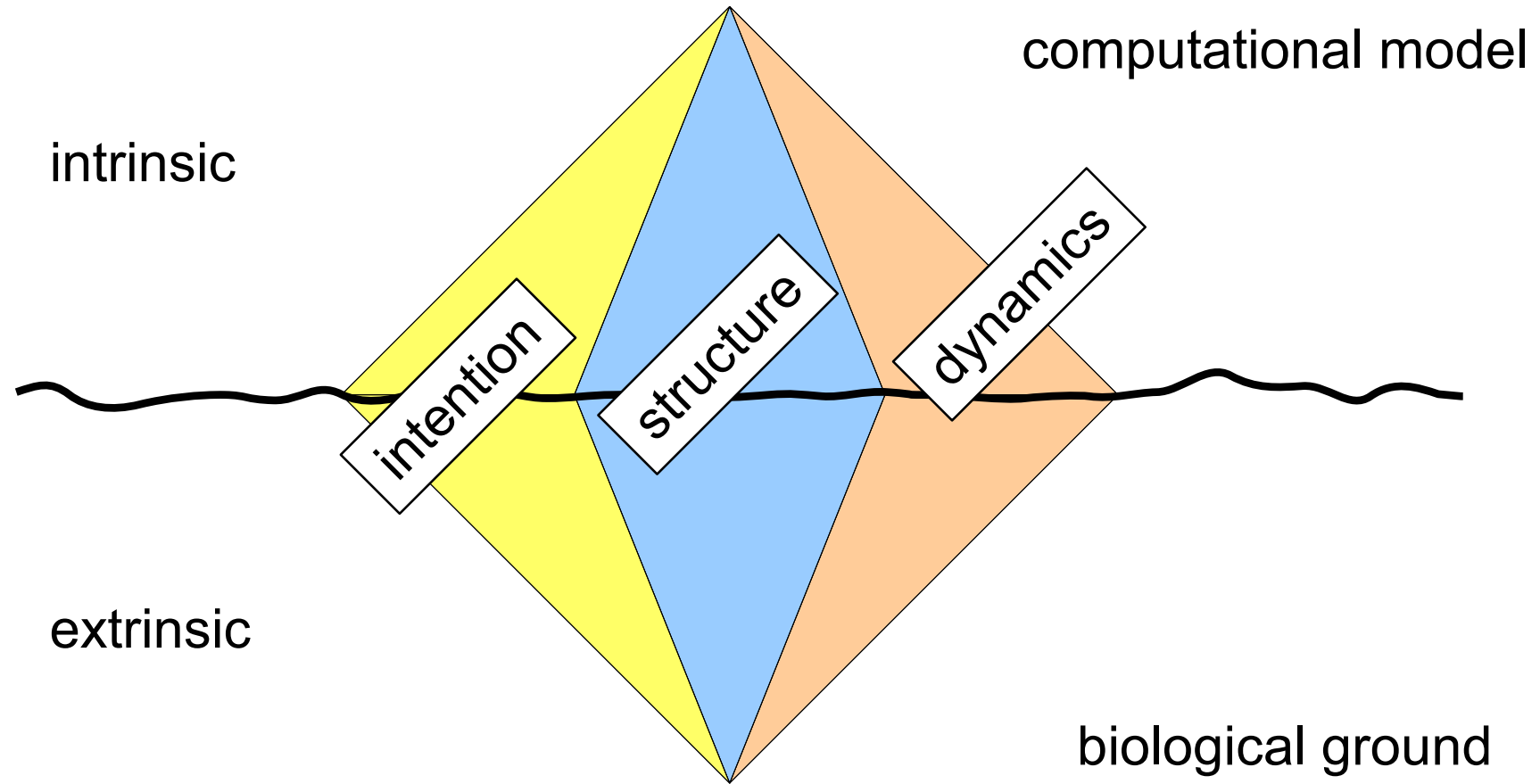


# Terminology for the Description of Dynamics

Christian Knüpper

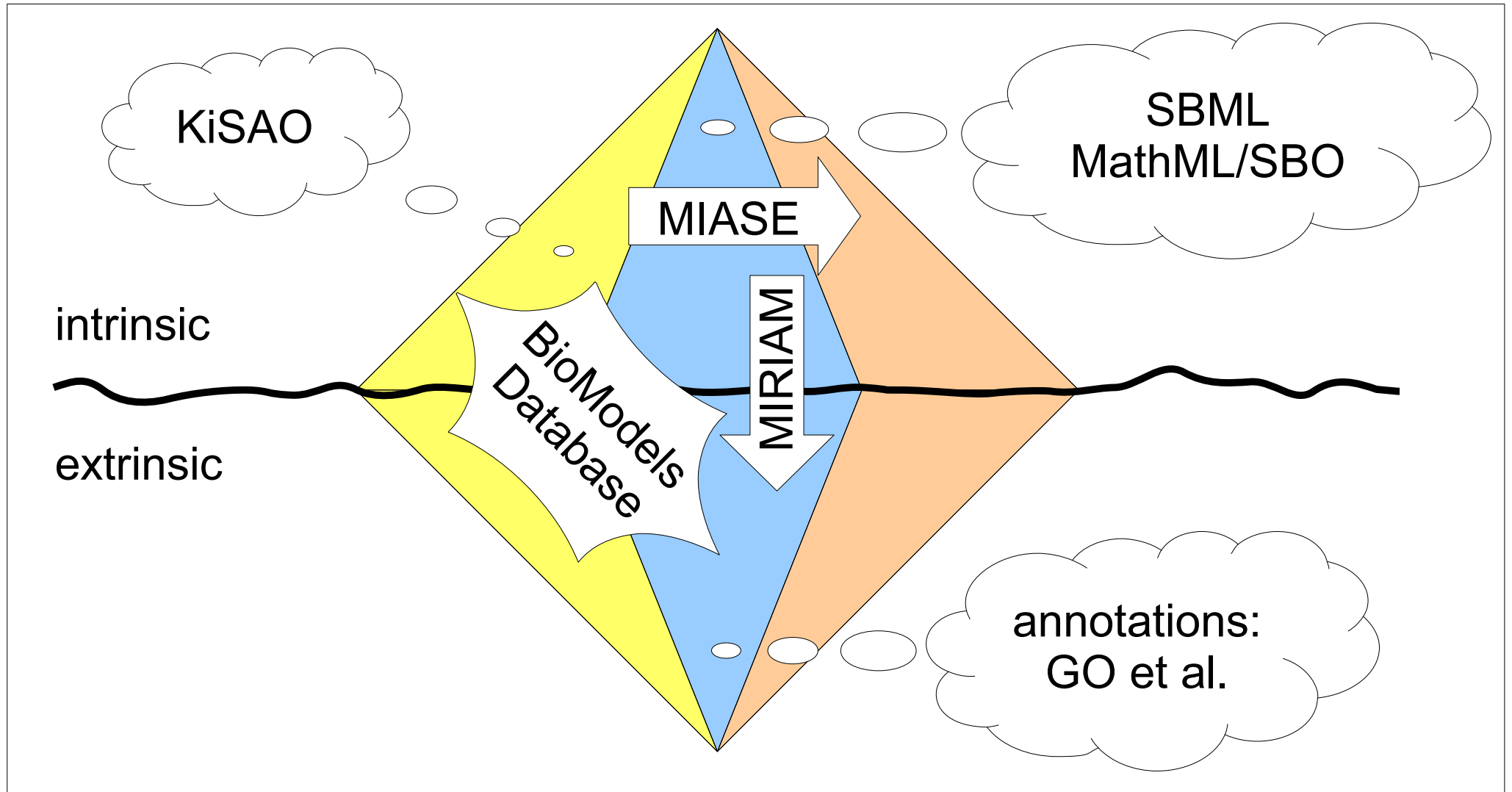
# Motivation



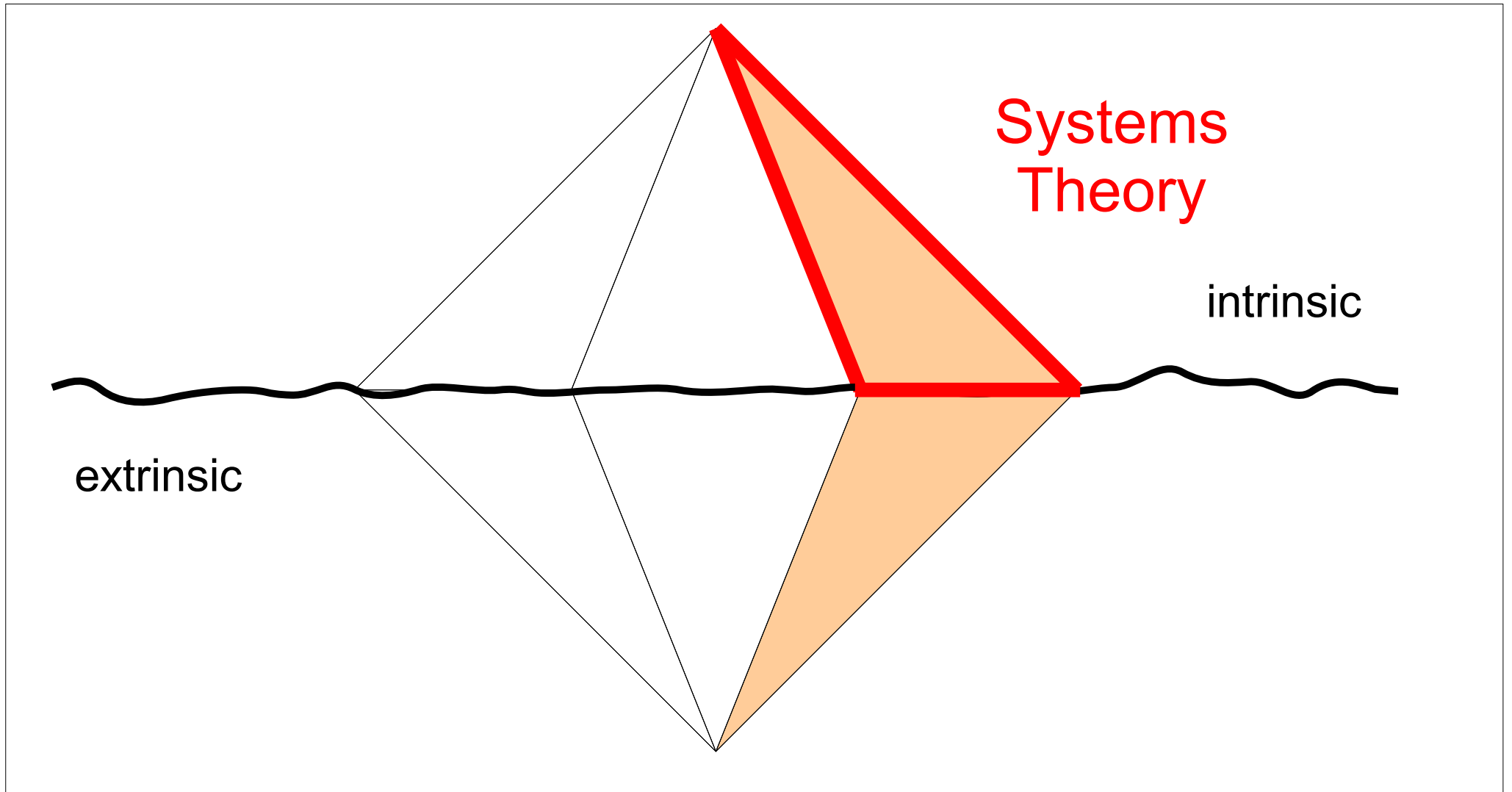
## Computer-Aided Collaborative Modelling



# Where we are



# Language for Dynamics



# Vocabulary for Dynamics

The screenshot displays the teddy Protégé 3.3.1 interface. The title bar reads "teddy Protégé 3.3.1 (file:\D:\home\tral\teddy\ontology\teddy.pprj, OWL)". The menu bar includes File, Edit, Project, OWL, Code, Tools, Window, TG'VizTab, and Help. Below the menu bar is a toolbar with various icons. The main workspace is divided into two panes: "SUBCLASS EXPLORER" on the left and "CLASS EDITOR" on the right. The "SUBCLASS EXPLORER" pane shows an "Asserted Hierarchy" for the project "teddy". The hierarchy starts with "owl:Thing" and includes "rdfs:Class", "rdf:Property", and "Teddy Entity". Under "Teddy Entity", there are several categories: "Characteristic" (with sub-classes like Curve Characteristic, Bifurcation, Period, \_obsolete Characteristic, Magnitude, Inflexion Point, Amplitude), "Functionality" (with sub-classes like Feedback, Feedforward, Switch, Integrator, \_obsolete Functionality), and "Behaviour". The "CLASS EDITOR" pane is currently editing the class "Behaviour". It shows the "Internal name" as "TEDDY\_0000083" and the "DisplayName" as "Behaviour". The "Definition" field contains the text: "A ``Behaviour'' is a change in the state of a dynamical system with respect to some aspect of the environment."



# TEDDY – an Ontology

- terms:
  - ID TEDDY\_XXXXXXXX
  - display name
  - definition
  - synonyms
  - references
- relations



# Aspects of Dynamics

1. Behaviour
2. Characteristic
3. Functionality



# Behaviour

- qualitative behaviour:

Steady State, Oscillation

- long-term behaviour:

Stable Limit Cycle

Stable Fixed Point

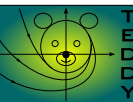
- perturbation behaviour:

Bistable Behaviour



# Characteristic

- changes in qualitative behaviour:  
Bifurcation, Hopf Bifurcation
- characteristics of states:  
High Magnitude
- characteristics of oscillations:  
Period



# Functionality

- dynamical role of network motifs:

Positive Feedback

- indented function of a model (part):

Integrator



# Current State

- Protégé, OWL
- last release: rel-2007-09-03, 130 terms
- `teddyontology.sourceforge.net`:
  - CVS, tracker, file releases, discussion list
- OWLdoc
- ChangeLog

`www.ebi.ac.uk/compneur-srv/teddy/`



# Annotation Example

If there exists a **Positive Feedback** (TEDDY\_0000035), the cascade will show a **Bistable Behaviour** (TEDDY\_0000110) with two different **Steady State** (TEDDY\_0000011) – one with **Low Magnitude** (TEDDY\_0000118) and one with **High Magnitude** (TEDDY\_0000117). On the other hand, if the cascade has a **Negative Feedback** (TEDDY\_0000034), the system is able to **Sustained Oscillation** (TEDDY\_0000062) because there exists a **Stable Limit Cycle** (TEDDY\_0000114). Between this two modes of dynamical behaviour a **Saddle-Node Homoclinic Bifurcation** (TEDDY\_0000119) occurs.



# Open Issues

- definitions
- coverage (bifurcation, functionality)
- precise definitions for relations
- OWL 1.1
- proposal to Relation Ontology (OBO)

contributions from community



# What Next?

- annotation of models with dynamics  
BioModels Database
- layer for simulations:  
MIASE, ...ML + KiSAO
- layer for observation and analysis:  
MI..., DyML + TEDDY
- integration of all descriptions



# BONUS TRACK



# Bifurcation Relations

## Hopf Bifurcation

hasSubPart Stable Spiral

hasSuperPart Unstable Spiral

## Supercritical Hopf Bifurcation

hasSuperPart Stable Limit Cycle

## Degenerate Hopf Bifurcation

hasOnPart Center



# Functionality Relations

Oscillation

dependsOn Negative Feedback

Bistable Behaviour

dependsOn Positive Feedback



# Characterising Relations

Steady State

hasCharacteristic High Magnitude

High Magnitude

hasValue 300nM

(Instance Level!)

