# TOPDRIM: Topology Driven Methods for Complex Systems

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STREP — 3 years
www.topdrim.eu

The Consortium

- **University of Camerino**
  - Stefano Mancini & Emanuela Merelli
- **University of Southern Denmark**
  - Christian Reidys
- **University of Amsterdam**
  - Peter Sloot
- **Open University**
  - Jeffrey Johnson
- **ISI Foundation**
  - Francesco Vaccarino & Mario Rasetti
- **Aix-Marseille University**
  - Marco Pettini
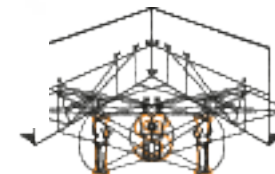
Motivation

Can we understand dynamics of multi-level complex systems in terms of its underlying topology?

Our approach is to develop new mathematical and computational formalisms that account for topological effects.

For example: we will (dis-)entangle novel RNA and RNA interaction structures
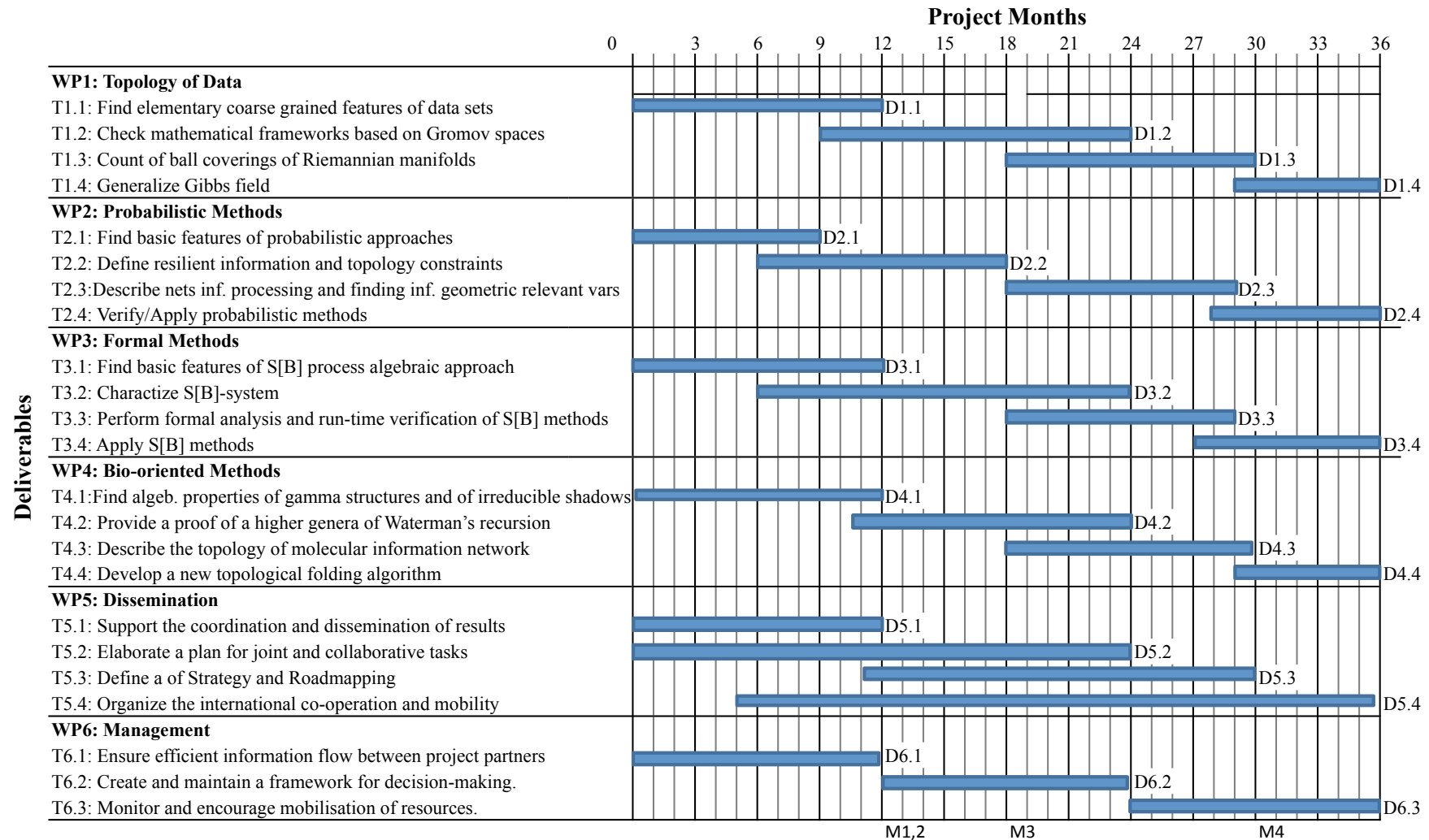
The scenario

Big Data – from reductionist to holistic approach

- – Topology of data

- – Topology-driven probabilistic methods

- – Topology-driven formal methods

- – Topology-driven bio-oriented methods

- – Topology-driven multi-level properties for models of complex systems

The integrated approach
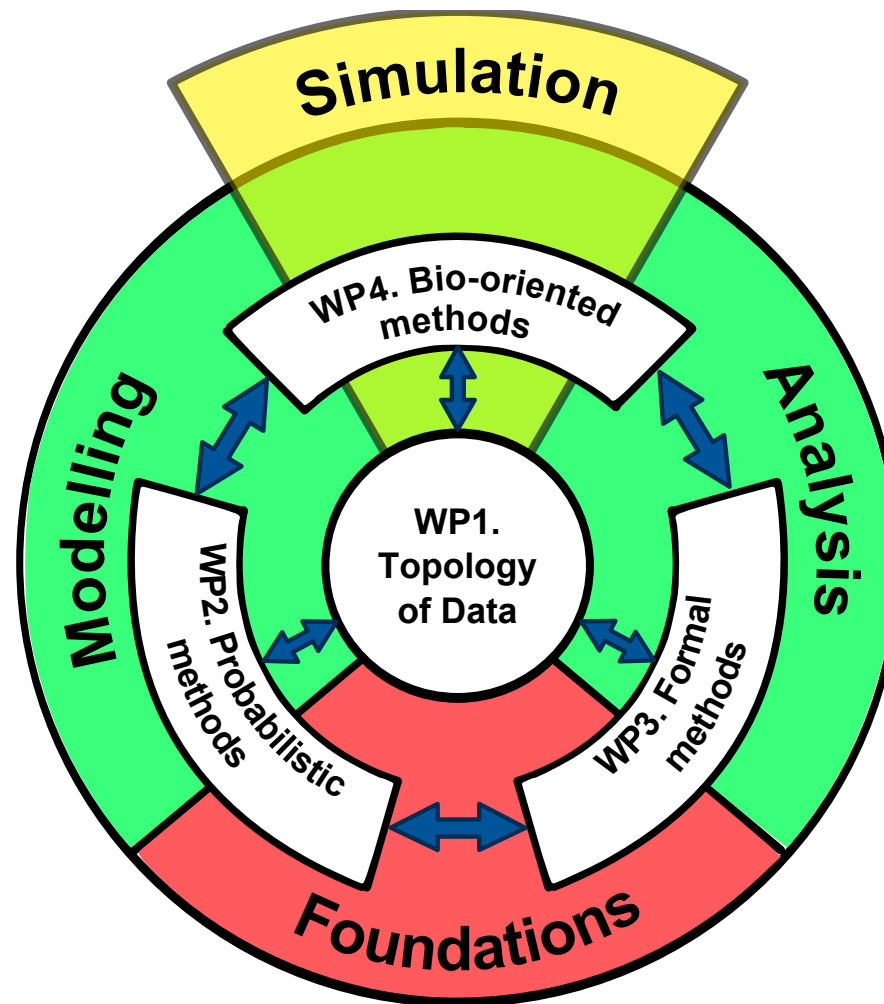
Temporal dependencies

Overlap in Partners - 1

- ## With Sophocles
  - Partner UvA is also in TOPDRIM (coordinated by Emanuela Merelli).
  - Both projects rely a.o. on background knowledge from UvA (theory of Information processing in complex systems).
  - In TOPDRIM this theory will be further developed by UvA in the context of topology and information geometry (TOPDRIM WP2). This will be mainly an theoretical study.
  - In SOPHOCLES this background knowledge will be combined by UvA, WUT and UNIGE with other background knowledge
    - from partner WUT on coupled networks,
    - from UNIGE and UvA on MML and CxA.
    - but also from the literature, e.g. the work of Jim Crutchfield on excess entropy
  - This combined theory will then be studied both theoretically and computationally in the context of emergence of scales and tipping points.
    - Specifically, in Sophocles WP2 the merging of background knowledge into a theory of Information Processing in Hierarchical Multilevel Systems is performed in task 2.1, the analysis in terms of tipping points and emergence of scales is carried out in task 2.2 and 2.3 respectively, whereas the numerical validation is performed in WP3, task 3.4.
  - People working on both projects at UvA will be disjoint.

Overlap in Partners - 2

- ## With Multiplex
  - Partner ISI is also in MULTIPLEX (coordinated by Guido Cardarelli).
  - In the presentation page of Institute (Sec. 2.2 Individual Participants) the first three people (Rasetti, Vespignani, Cattuto) have been inserted to describe the scientific management of the ISI Foundation (of which three are, respectively, President, Director scientific and Deputy Scientific Director) and give an idea of the trends of scientific and cultural institution.
  - Among the three, only Rasetti, who is the scientist in charge for the node ISI TOPDRIM (and he certainly will not be paid from project funds), will participate actively seeking TOPDRIM. It is obvious that the scientific profile of the three also serves to define also the high scientific level of the Foundation.
  - Finally, those who attend as a researcher affiliated with ISI TOPDRIM you will have to be placed in a family of other researchers ISI (sixty) working in the fields of research that substantially reflect ideas, methods, skills, tastes of these three persons and other leaders of research groups. Among these, only a part - working in fields closely related to those of the project - the project will participate in an active, entering it, with others surely there will be some time the cross fertilization process, it can only be a value added for the project, but in any case does not anticipate any conflict or overlap interference with other projects.

Data

Criticism: The proposal does not specify clearly, with a possible exception of WP4, which data is going to be used for testing the developed tools.

Asnswer: On pag.19 of DoW we added specific references to data repositories
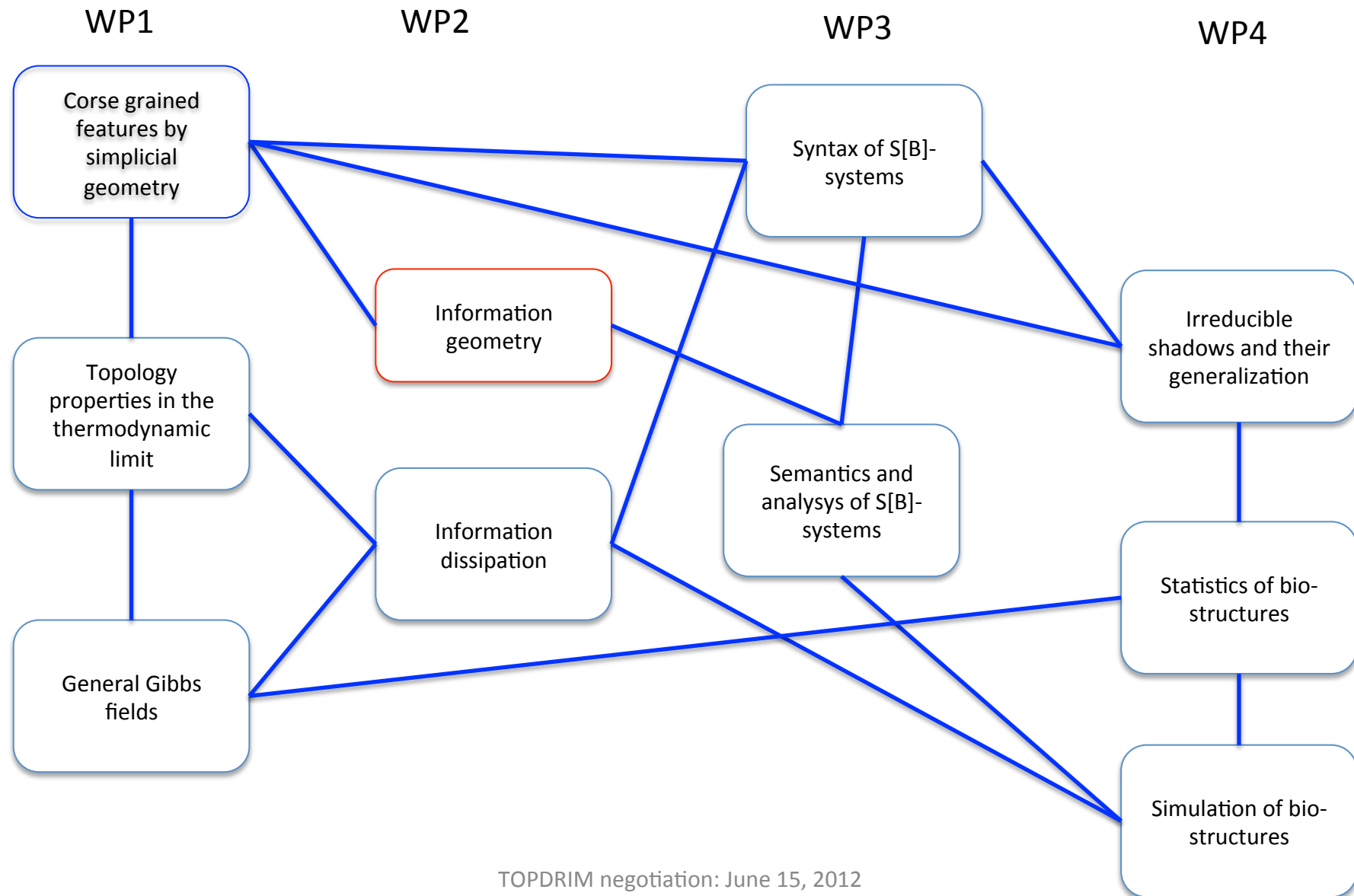
Algebraic topology community

Criticism: There is insufficient involvement of the algebraic topology community.

Answer: Francesco Vaccarino and Christian Reidys work on algebraic topology with many active collaborations with leading scientists in this field

Integration

Criticism: The level of integration of work of the various partners is not described fully convincingly

Answer

WP1   WP2   WP3   WP4

- Corse grained features by simplicial geometry
- Topology properties in the thermodynamic limit
- General Gibbs fields
- Information geometry
- Information dissipation
- Syntax of S[B]-systems
- Semantics and analysys of S[B]-systems
- Irreducible shadows and their generalization
- Statistics of bio-structures
- Simulation of bio-structures

TOPDRIM negotiation: June 15, 2012

Exploitation

Criticism: "Though one of the proposal's objectives is to develop algorithms. No concrete measures for making software available to the community are proposed"

Answer: We rephrase in WP4 the description of the objective to be reached with task T4.4.: Design a new topological folding algorithm.

This algorithm will published in a journal.