Some contributions for theme 3 (in distributed computing) at LIX/Cosynus

Eric Goubault

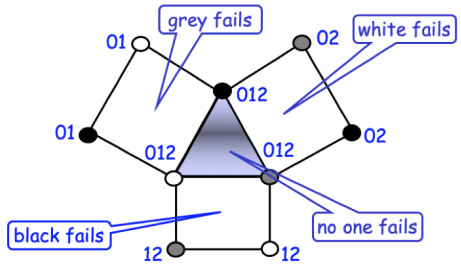
LIX/Cosynus, Ecole Polytechnique

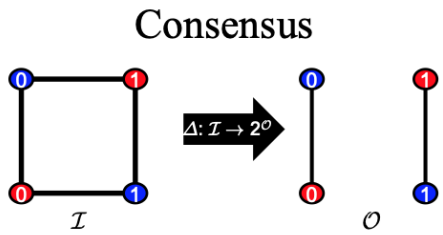
Workshop IP-Paris, 26th January 2021

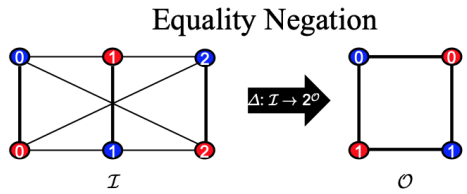
INSTITUT POLYTECHNIQUE DE PARIS

Semantics of concurrency and distributed systems

- Interest in semantic models, in particular geometric ones (now a larger community on "Applied Algebraic Topology", applications to systems biology [blue brain], robotics [topological complexity], hybrid systems, concurrent systems, distributed systems, data classification [persistent homology], type theory/proof theory [HoTT], rewriting systems [Squier like theorems] etc.)
- Main thrust concerning distributed systems: obstructions to task solvability on some (fault-tolerant) distributed architectures (e.g. consensus and FLP'85), complexity for solving tasks (e.g. number of communication rounds needed to solve a task) etc. with geometrical methods [à la Herlihy/Rajsbaum, and with directed topological methods as well]







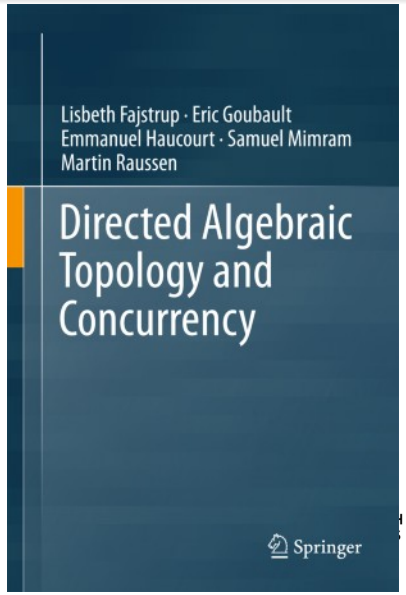
- Want to go towards distributed control (some ideas in e.g. Eric Goubault, Michael Farber, Aurélien Sagnier: Directed topological complexity. J. Appl. Comput. Topol. 4(1): 11-27 (2020))

Context and directions

- Obvious links with Bernadette Charron-Bost (LIX), Petr Kuznetsov (LTCI)... Thomas Nowak (LRI)... Pierre Fraignaud (LIAFA), Michel Raynal (Rennes)... Hagit Attiya (Technion), Yoram Moses (Technion), Maurice Herlihy (Brown), Sergio Rajsbaum (UNAM) etc.
- Link with theme 5 (foundations of CS - semantics), theme 2 (Trust - verification), theme 4 (Robotics/embedded systems - verification, distributed control)
- E.g. theme 5, from the old days:
  Originated in V. Pratt's POPL 1990 paper, my Ph.D. thesis (1995) and Lisbeth Fajstrup, Martin Raussen, Eric Goubault: Algebraic topology and concurrency. MFPS 1998, then Theor. Comput. Sci. 357(1-3): 241-278 (2006)

  Eric Goubault: Geometry and concurrency: a user's guide. Math. Struct. Comput. Sci. 10(4): 411-425 (2000)

See our book: Lisbeth Fajstrup, Eric Goubault, Emmanuel Haucourt, Samuel Mimram, Martin Raussen: Directed Algebraic Topology and Concurrency. Springer 2016, ISBN 978-3-319-15397-1, pp. 1-167



Some results and directions

- Link to distributed computing: e.g. concurrent objects and their correctness:

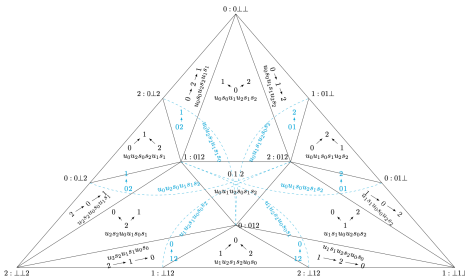
  Éric Goubault, Jérémy Ledent, Samuel Mimram: Concurrent Specifications Beyond Linearizability. OPODIS 2018: 28:1-28:16

  Éric Goubault, Jérémy Ledent, Samuel Mimram: Brief Announcement: On the Impossibility of Detecting Concurrency. DISC 2018: 50:1-50:4

- Link to e.g. fault-tolerant tasks:

  Éric Goubault, Marijana Lazic, Jérémy Ledent, Sergio Rajsbaum: Wait-Free Solvability of Equality Negation Tasks. DISC 2019: 21:1-21:16

  Éric Goubault, Samuel Mimram, Christine Tasson: Geometric and combinatorial views on asynchronous computability. Distributed Comput. 31(4): 289-316 (2018)



  Eric Goubault, Samuel Mimram, Christine Tasson: From Geometric Semantics to Asynchronous Computability. DISC 2015: 436-451

  Eric Goubault, Samuel Mimram, Christine Tasson: Iterated Chromatic Subdivisions are Collapsible. Appl. Categorical Struct. 23(6): 777-818 (2015)

- Link to (dynamic / epistemic) logics:

  Hans van Ditmarsch, Eric Goubault, Jérémy Ledent, Sergio Rajsbaum: Knowledge and simplicial complexes. CoRR abs/2002.08863 (2020)
  Éric Goubault, Marijana Lazic, Jérémy Ledent, Sergio Rajsbaum: A Dynamic Epistemic Logic Analysis of the Equality Negation Task. DaLí 2019

  Éric Goubault, Jérémy Ledent, Sergio Rajsbaum: A Simplicial Complex Model for Dynamic Epistemic Logic to study Distributed Task Computability. GandALF 2018: 73-87

INSTITUT POLYTECHNIQUE DE PARIS