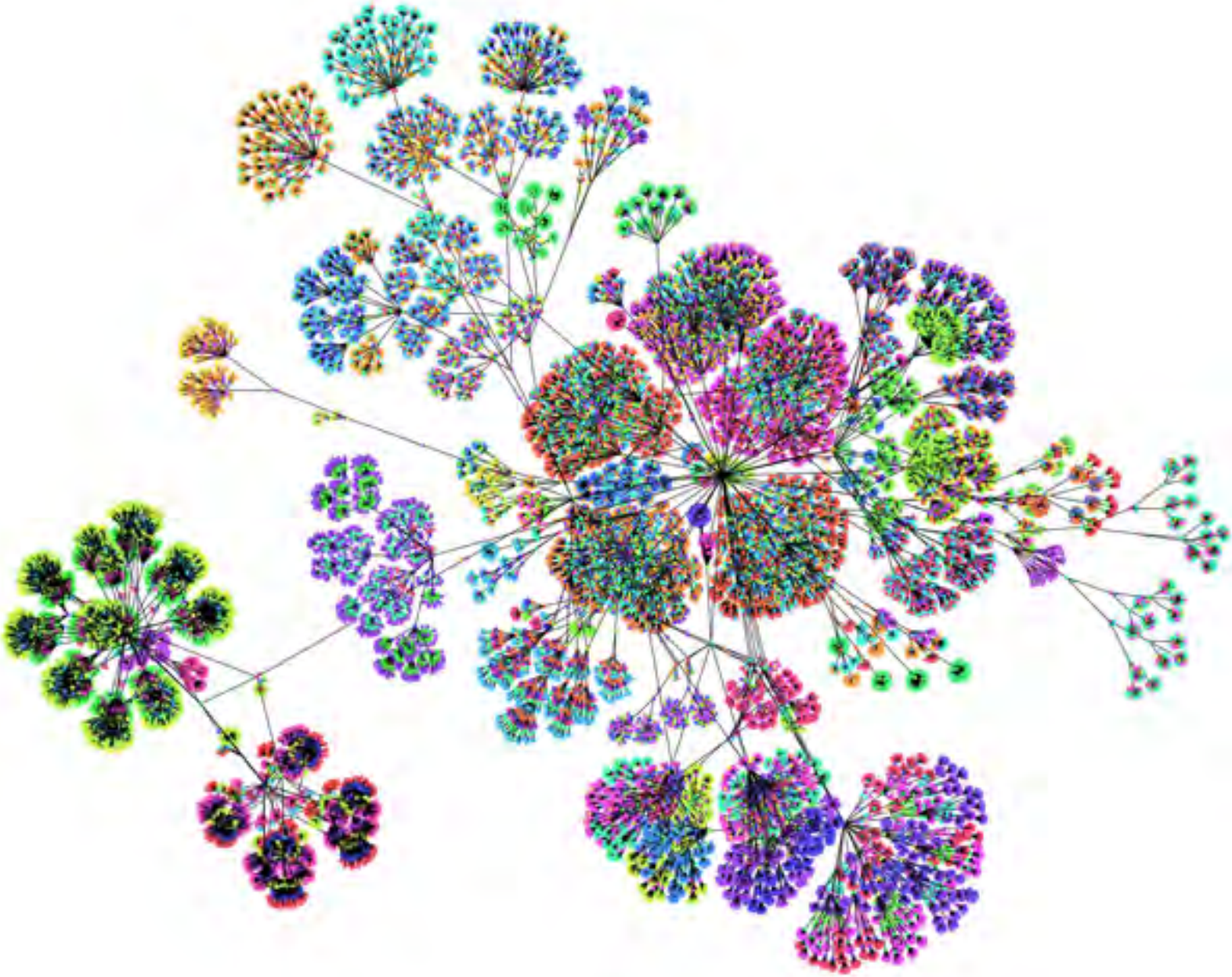
State Space Explosion: Facing the Challenge

OUrsi

Jeroen Keiren (@jkeiren)
Open University of the Netherlands

30 Juni 2015

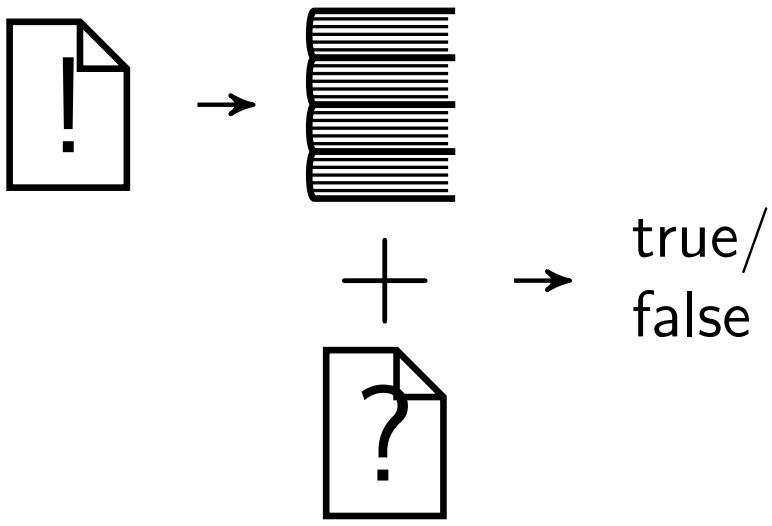


My Background

Research Topics

- Software verification
  - Model Checking
  - Fixed point logics (μ-calculus, PBES, LFP)
  - Two-player games for verification (parity games)
  - Applications

General Methodology



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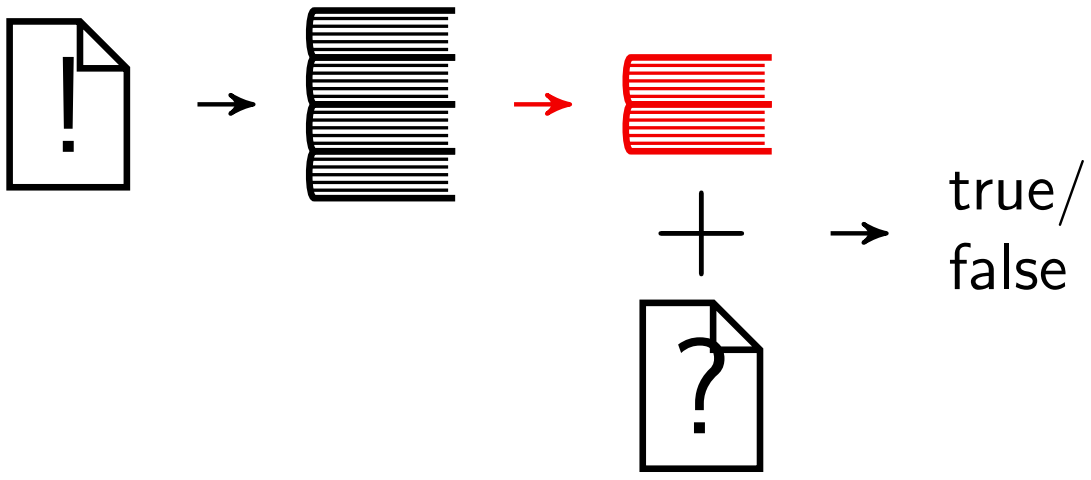

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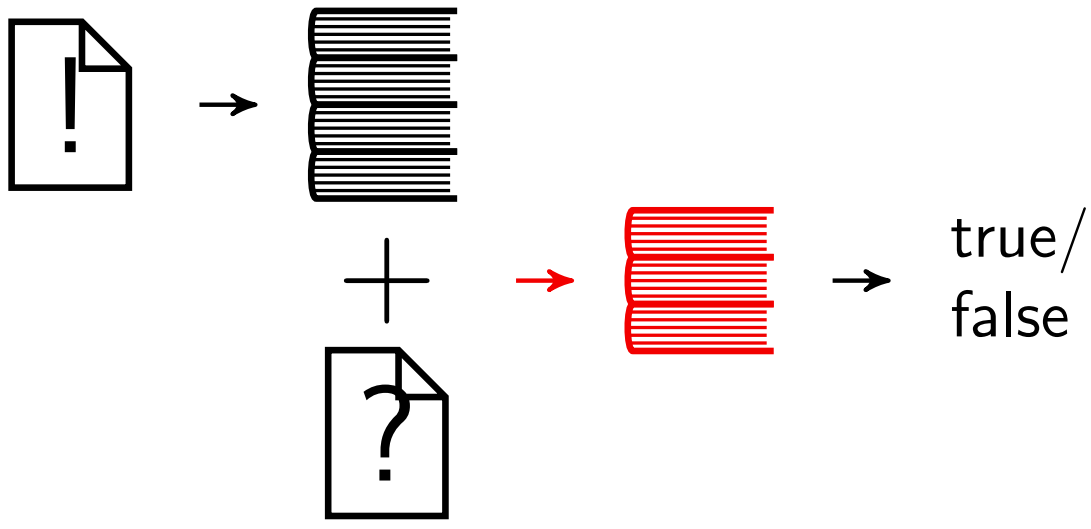

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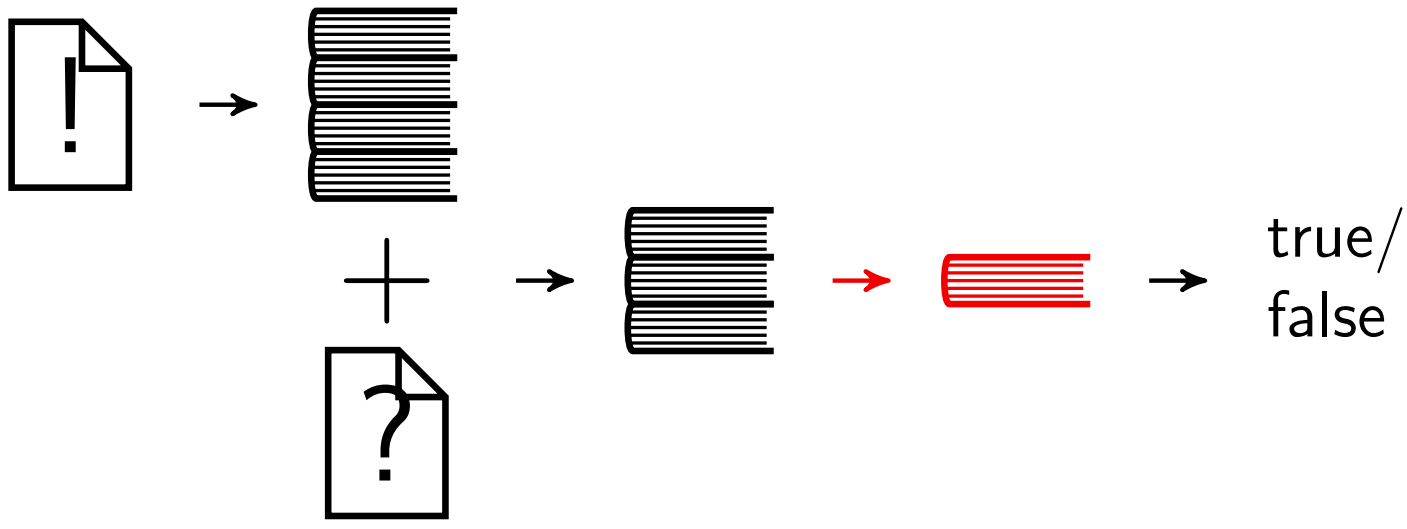

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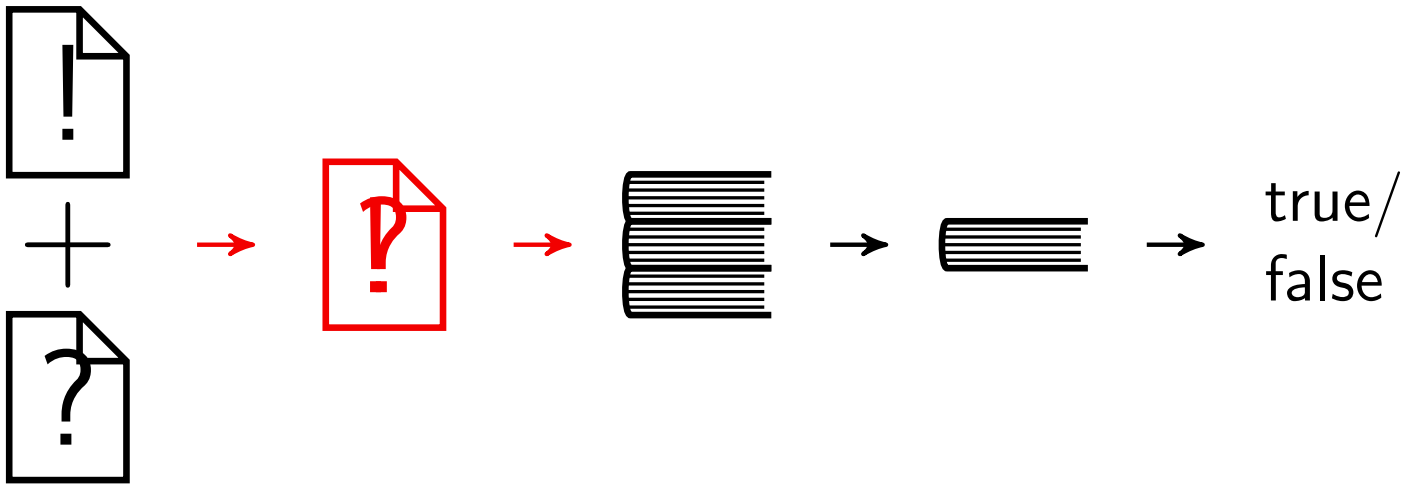

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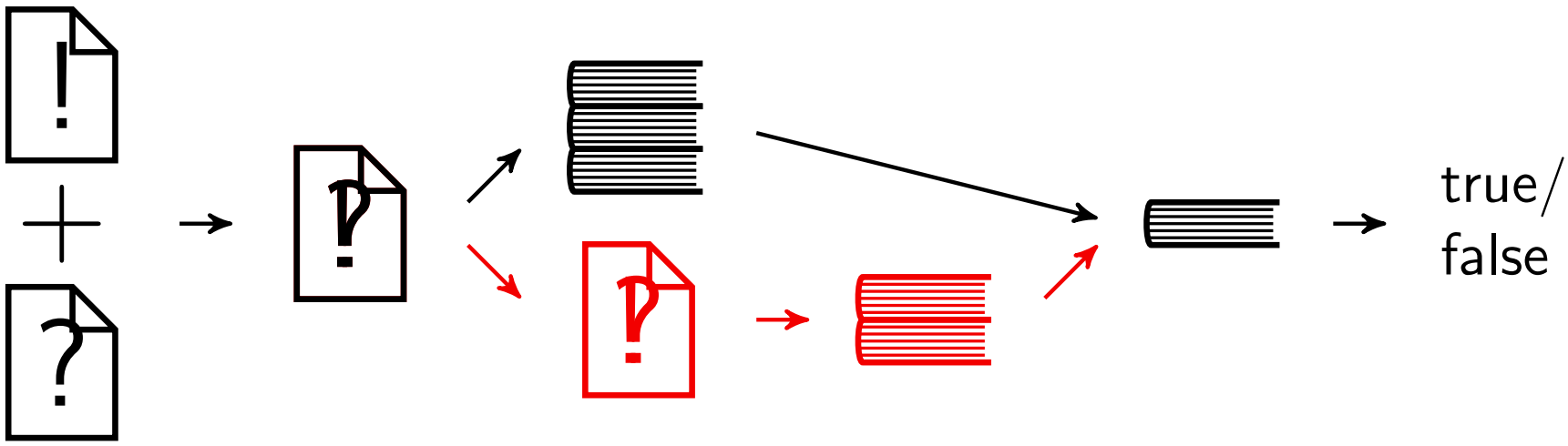
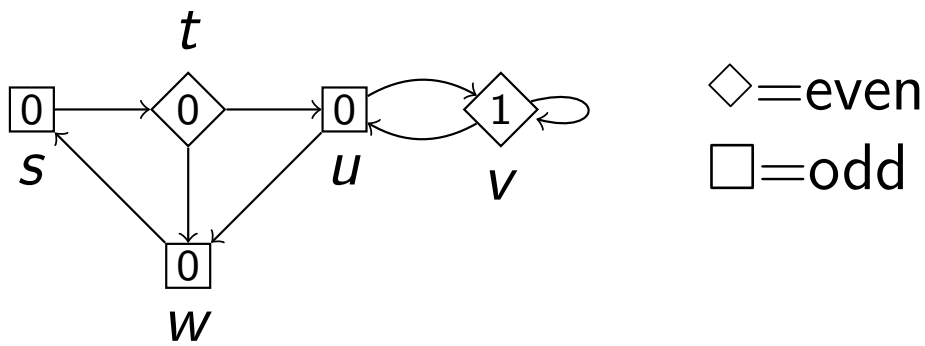


Where are parity games used?

- Model Checking
- Equivalence Checking
- Satisfiability/Validity of modal logic
- Synthesis

Parity Games

V	A set of vertices.
$\rightarrow \subseteq V \times V$	An edge relation.
$\Omega : V \rightarrow \mathbb{N}$	A priority mapping.
$\diamondsuit, \square$	Two players (even, odd).
$(V_\diamondsuit, V_\square)$	A partition of V.



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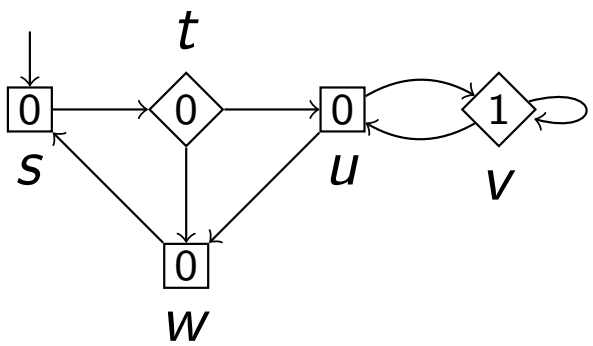

$\diamondsuit$=even

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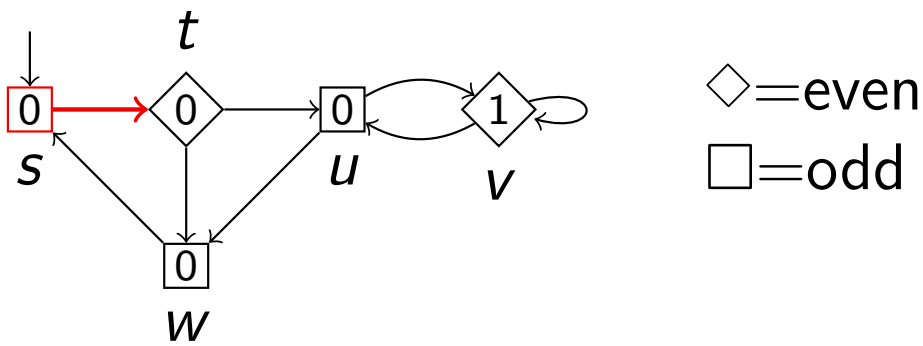

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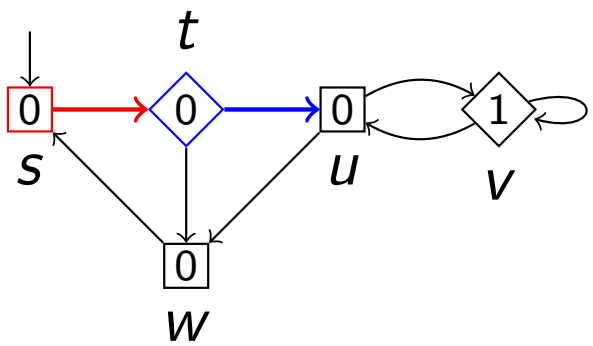

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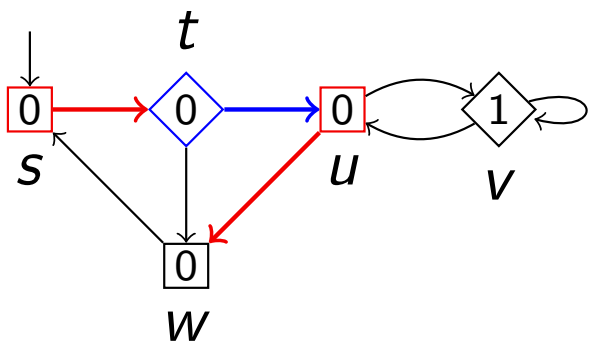

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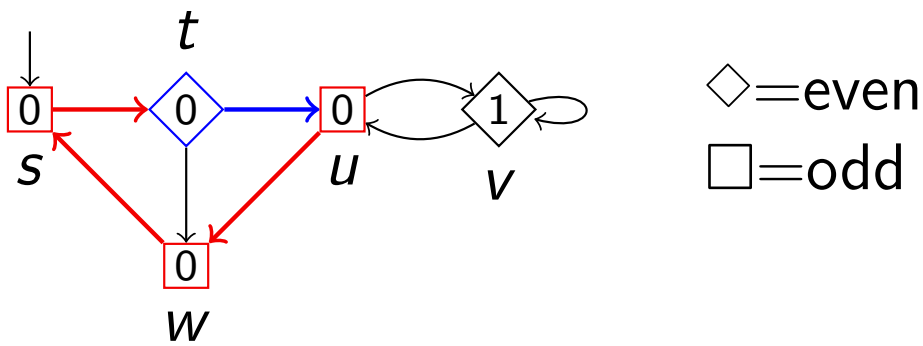

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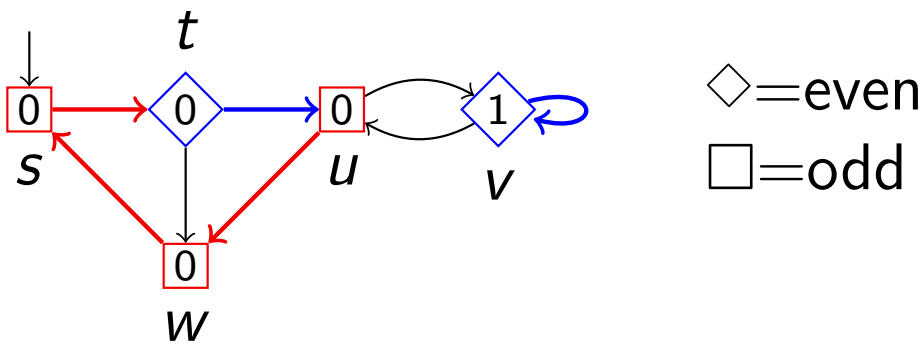

- Winner?

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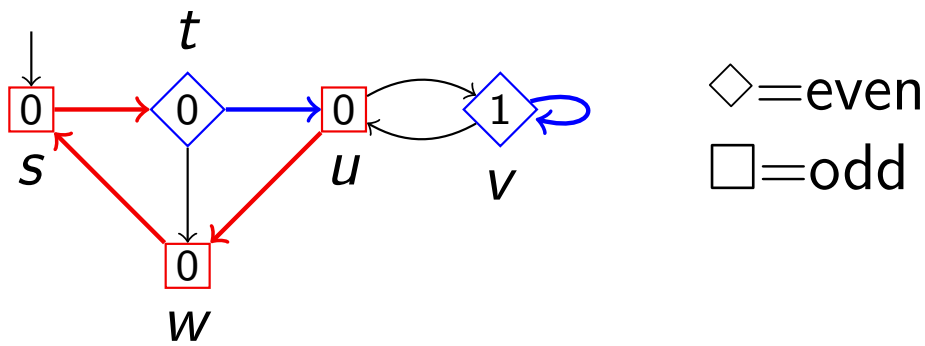

- Winner?
- Optimal strategies?

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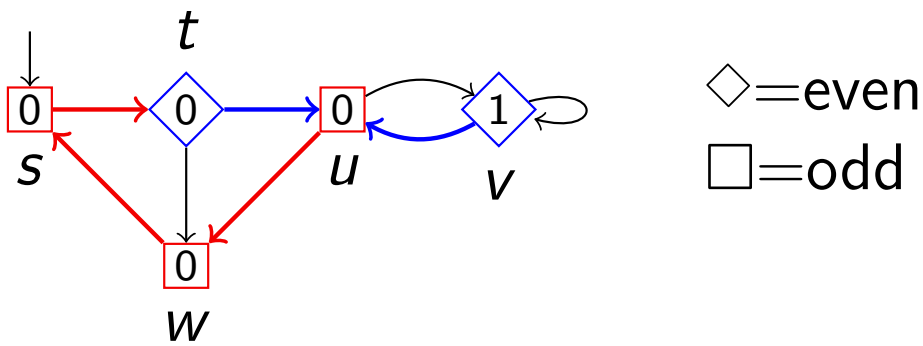

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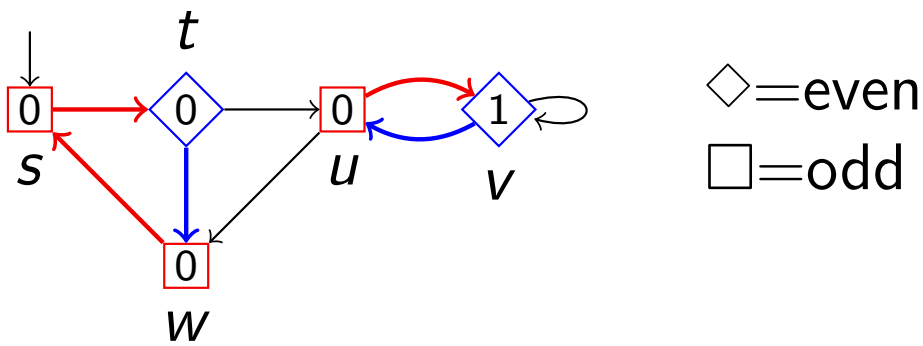


- Winner?
- Optimal strategies?

Winning Parity Games

Memoryless determinacy

- Partition $(W_\Diamond, W_\Box)$ of V
- Player $\bigcirc$ has memoryless winning strategy from $W_\bigcirc$, for $\bigcirc \in \{\Diamond, \Box\}$

Solving Parity Games

Solving a parity game:

- Determine partition $(W_{\diamond}, W_{\Box})$

Complexity:

- Problem is in $UP \cap \text{co-}UP$ (also $NP \cap \text{co} - NP$)
- Is it in P?

Solving Parity Games

Solving a parity game:

- Determine partition $(W_{\diamond}, W_{\Box})$

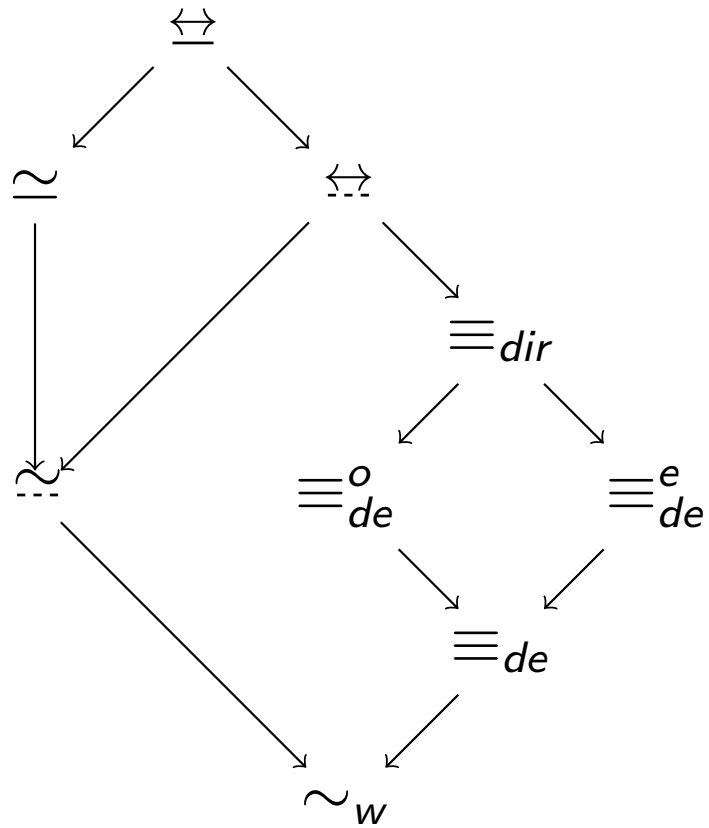
Complexity:

- Problem is in $UP \cap \text{co-}UP$ (also $NP \cap \text{co} - NP$)
- Is it in P? Open!

Reducing Parity Games

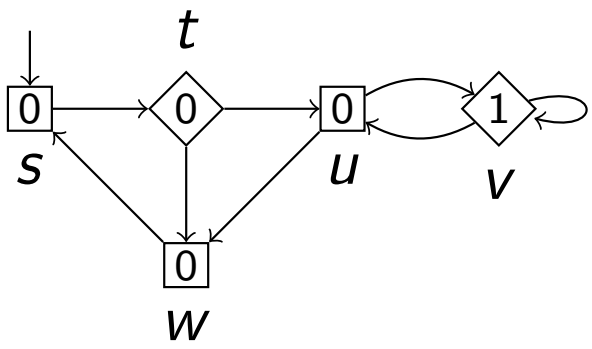
Idea

Define equivalences that preserve winner



Reducing Parity Games

Example: Governed Stuttering Bisimulation



◇=even

□=odd

Reducing Parity Games

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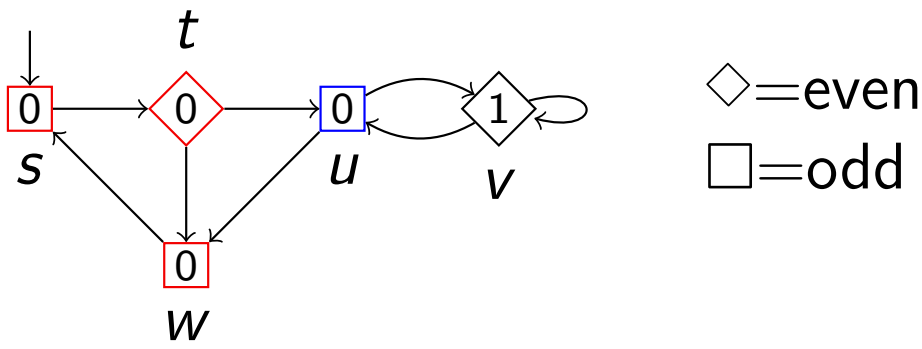

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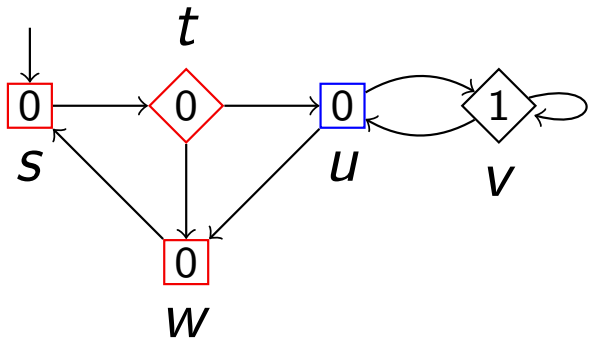

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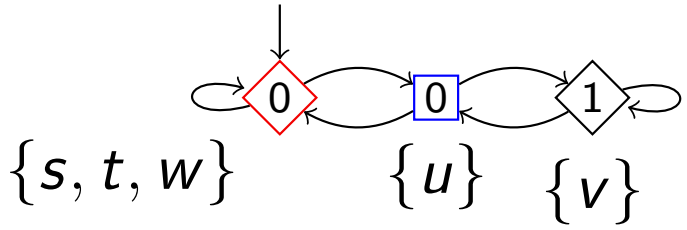

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Application

IEEE 11073-20601

Session setup for communication between personal health devices

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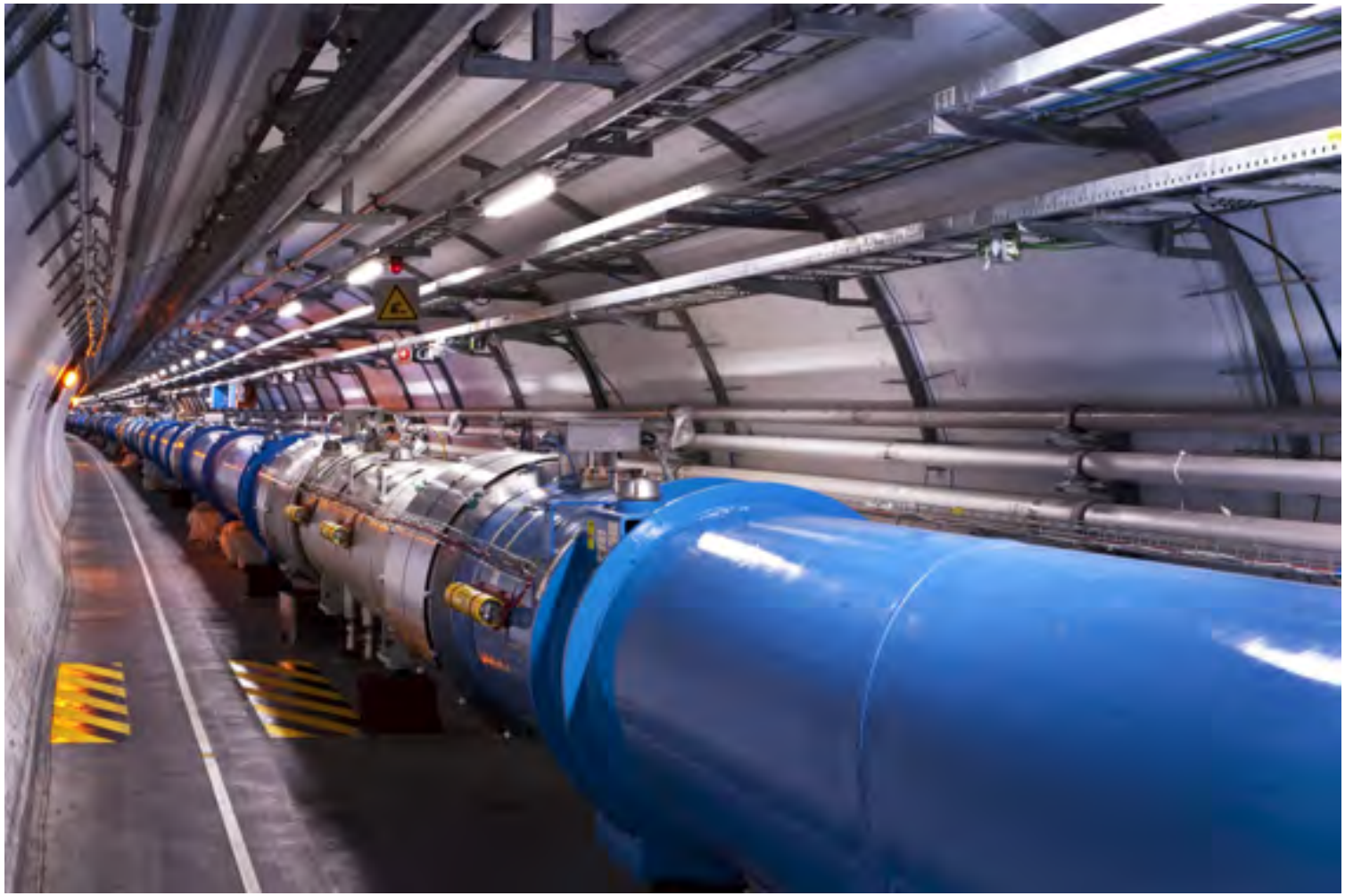
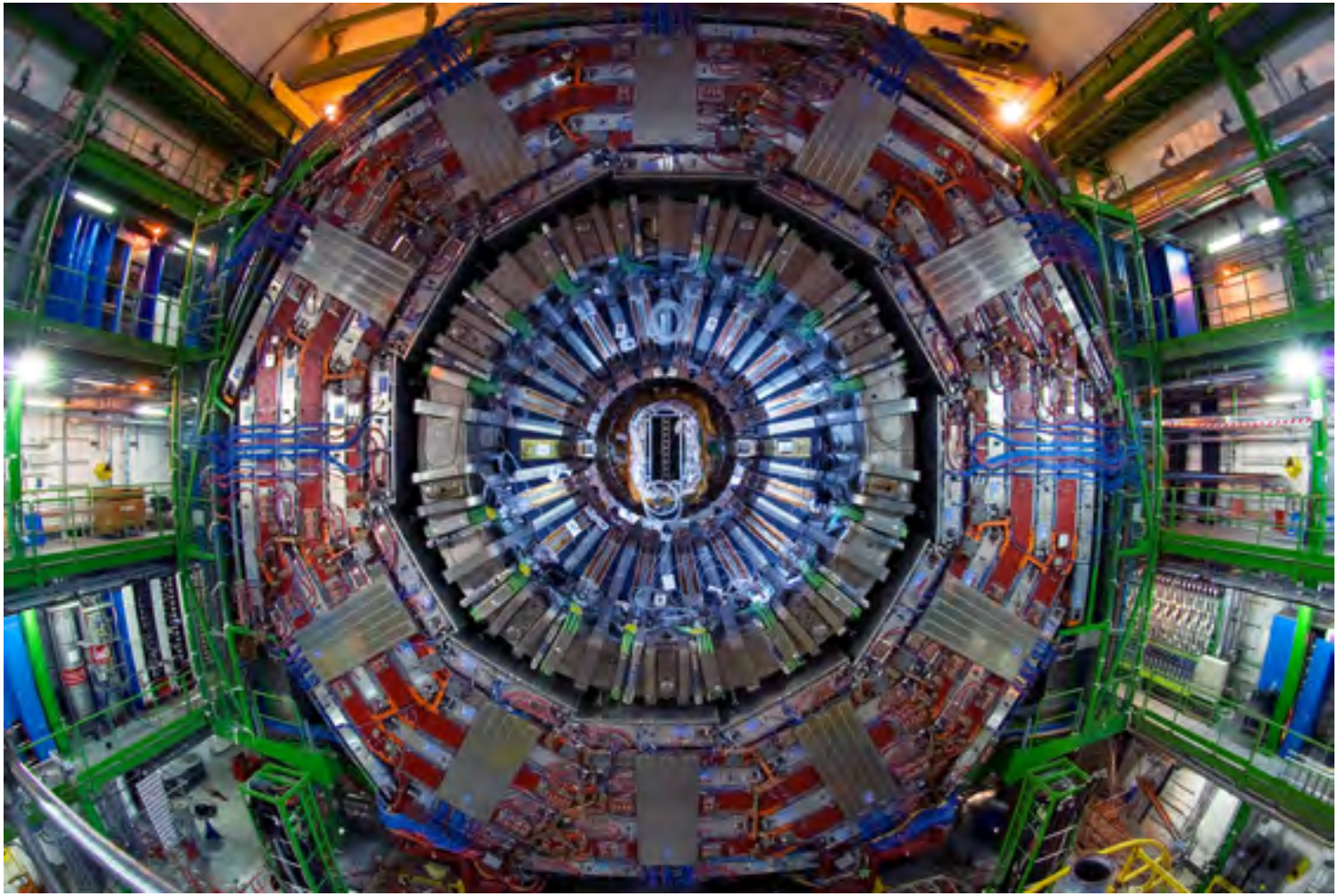
CERN's LHC



source: CERN

CERN's LHC

CMS Detector



source: CERN

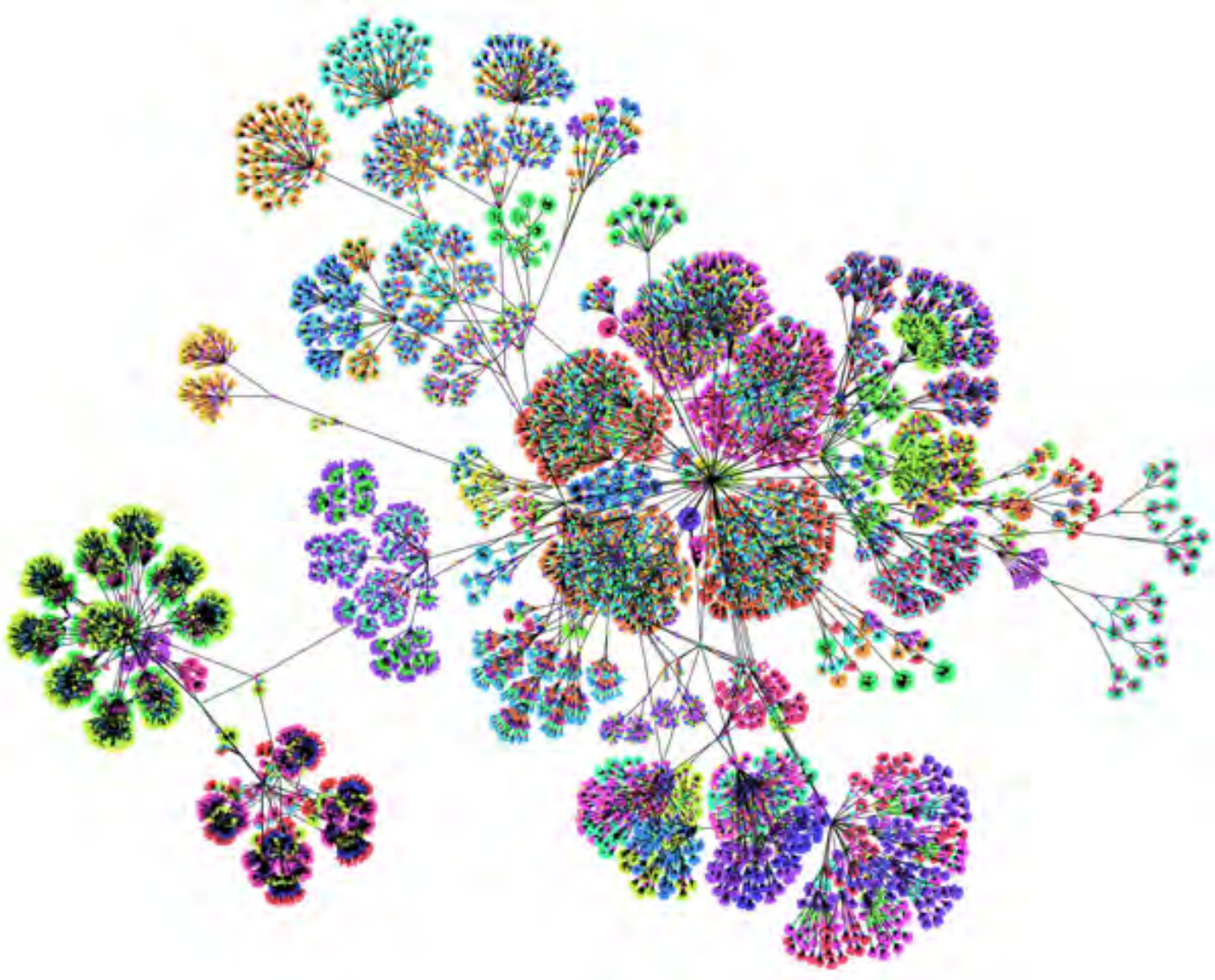
CERN's LHC

CMS Control System

source: CERN

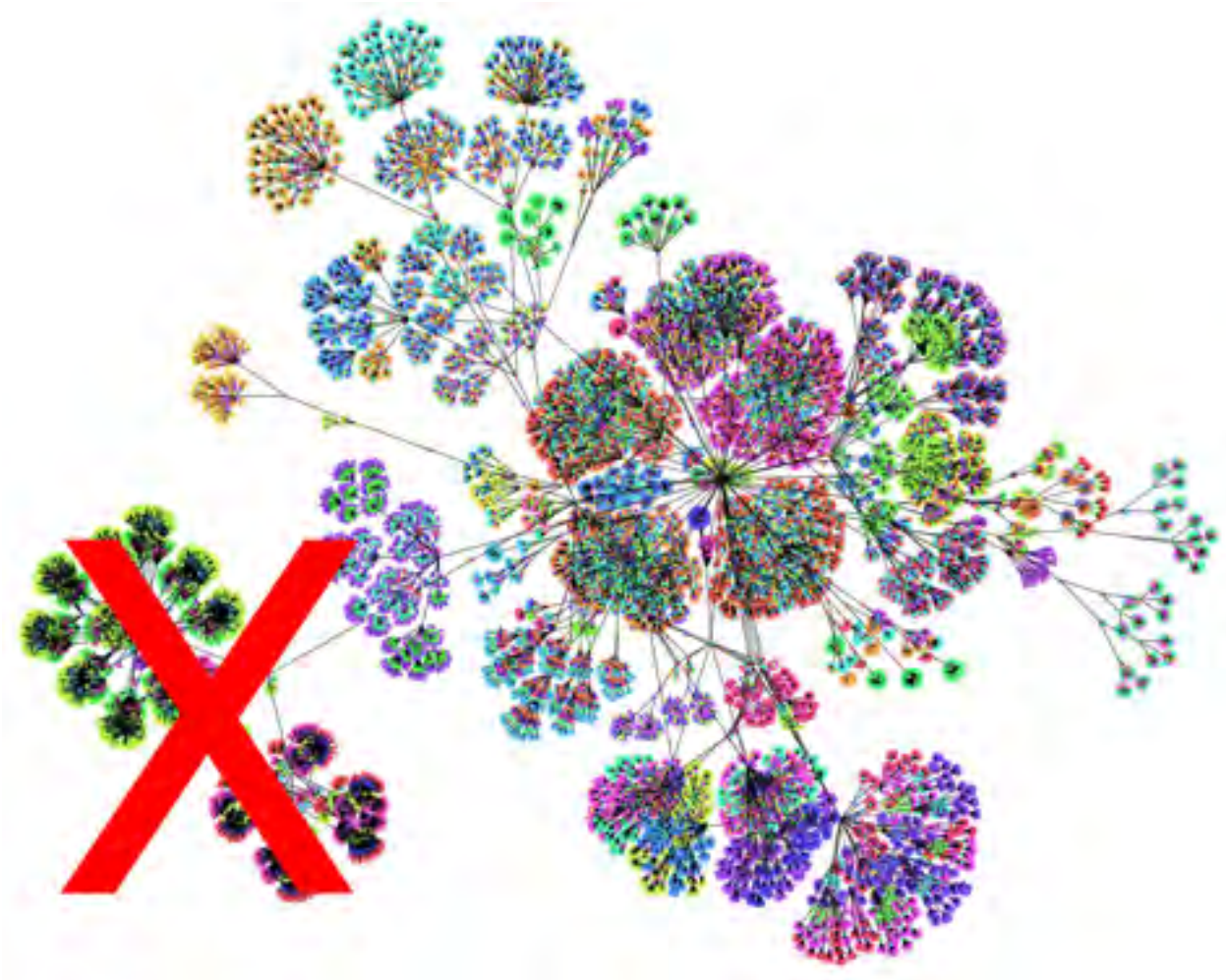
CERN's LHC

Control System Structure

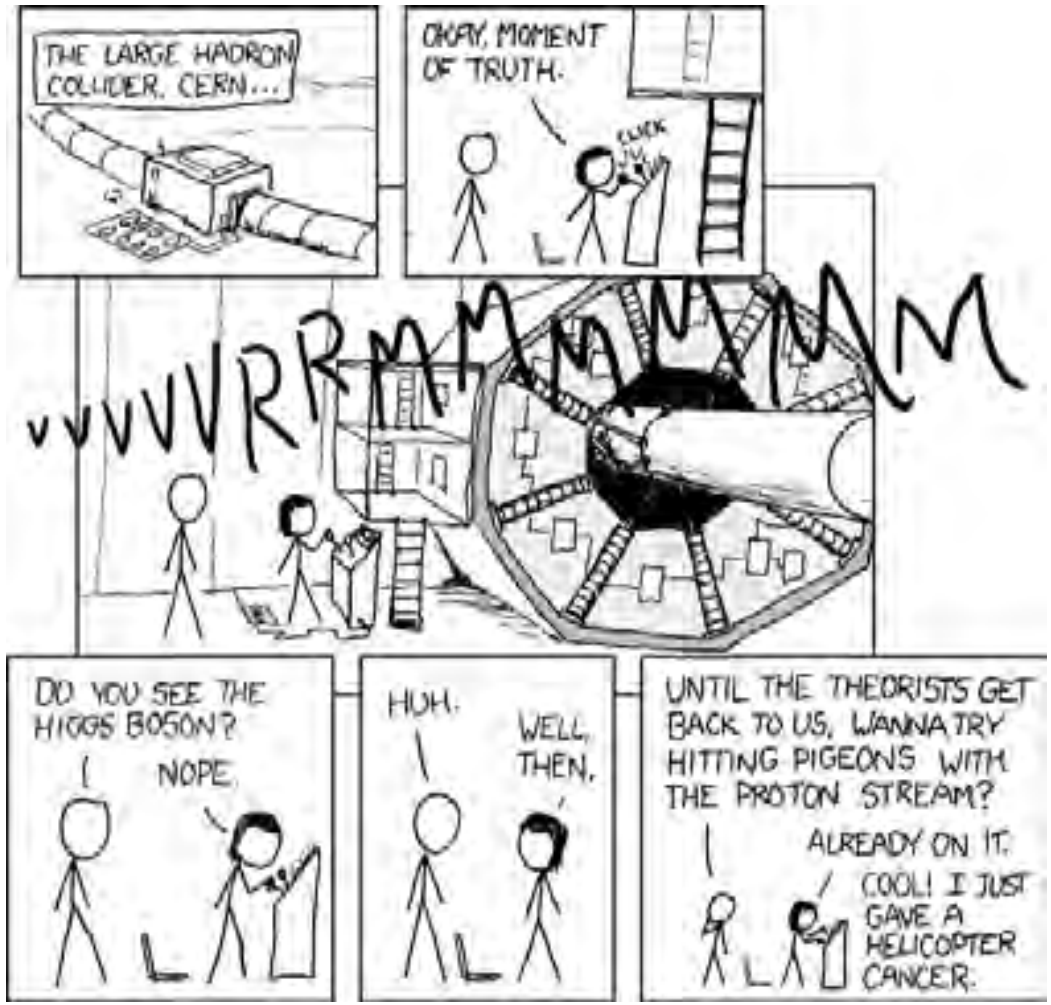


CERN's LHC

Unresponsive subsystems



Thank you



source: http://xkcd.com/401