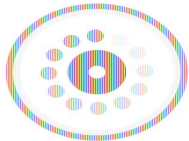RoME 2024

Exploiting modular game representation for GR(1) synthesis

Hernán Gabriel Gagliardi

PhD Advisor: Sebastian Uchitel
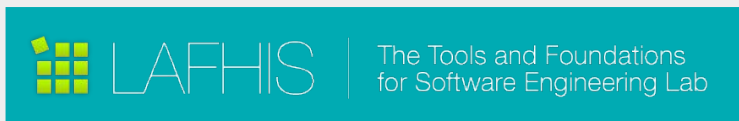
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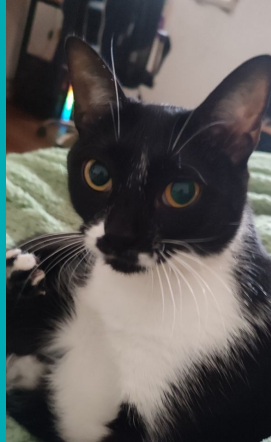
DEPARTAMENTO
DE COMPUTACION
Facultad de Ciencias Exactas y Naturales - UBA

First .. introducing myself

Currently ..

- **PhD student** in Computer Science at UBA (LaFHIS).

- Teaching assistant at **Operating Systems**.

Introducing my cat room partners

I live in Buenos Aires with Betún, Clementina, Rita and Santos.

Clementina because ..

Clementina was also the name of the first computer in my faculty and in my country.

Research interests

- **Formal specification languages**
- **Controller synthesis techniques** applied to adaptive systems.

Previous and ongoing projects:

- Improve existing heuristics for *on-the-fly controller synthesis* in non-blocking control problems. (MSc Thesis).
- Studying equivalence and translation between state-based and event-based control problems.
- Working on **dynamic-update problem for GR(1) contextual missions** (L'Aquila collaboration)
- Extending the on-the-fly synthesis controller algorithm for GR(1) control problem. (Work in progress)

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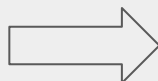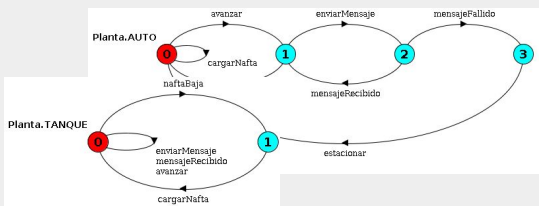
⟹ **Exploding modular representation**

Exploding modular representation

GR(1) Control problem - Background

Input

- *Event-based* environment-system with LTS's

representation with **modular approach**.
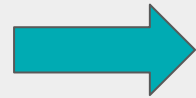
- **GR(1)** control problem Goal.

$$\varphi = \bigwedge_{i=1}^{m} \square \diamond J_i^1 \rightarrow \bigwedge_{j=1}^{n} \square \diamond J_j^2$$

Exploding modular representation
GR(1) Control problem - Background

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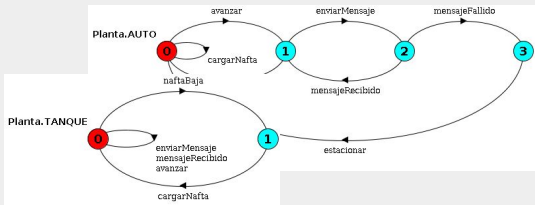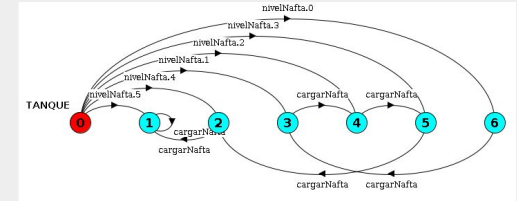representation with **modular approach**.
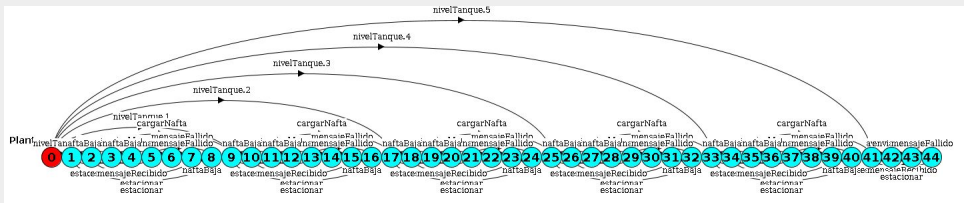- **GR(1)** control problem Goal.

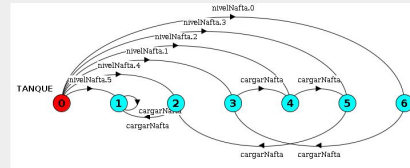$$\varphi = \bigwedge_{i=1}^{m} \square \lozenge J_i^1 \rightarrow \bigwedge_{j=1}^{n} \square \lozenge J_j^2$$

Synthesis

Output

Correct-by-construction controller
guaranteeing goal objective *(if exists strategy)*.

Exploding modular representation
State-explosion problem
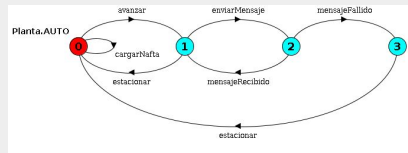
We want to avoid **state-explosion problem** of Monolithic approach.

Exploding modular representation
Compositional approach

Key idea: *Compose and reduce input processes.*

Exploding modular representation
Compositional approach

Key idea: Compose and reduce input processes **with effective techniques** and **without sacrificing synthesis correctness**.

Exploding modular representation
Compositional approach

Key idea: *Compose and reduce input processes **with effective techniques** and **without sacrificing synthesis correctness***.

¿Which techniques are these?

Exploding modular representation
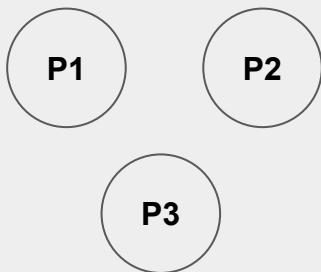Compositional approach - **Local synthesis**

Key idea: Solve the synthesis problem for a subset of processes.

Exploding modular representation

Compositional approach - **Local synthesis**

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Exploding modular representation

Compositional approach - **Local synthesis**

Key idea: Solve the synthesis problem for a subset of processes.

Input:

Output

P1 **P2**

P3

Local
Synthesis

C12

P3

$$\varphi = \bigwedge_{i=1}^{m} \square \Diamond J_i^1 \rightarrow \bigwedge_{j=1}^{n} \square \Diamond J_j^2$$
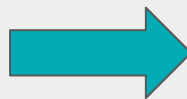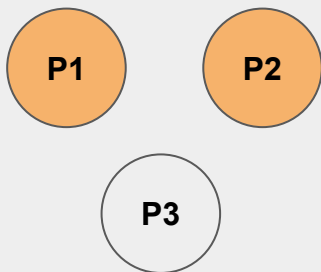
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Exploding modular representation

Compositional approach - **Reducing states by local-events equivalence**

Key idea: Combine similar processes and reduce the composition using local-event based equivalence.

Exploding modular representation

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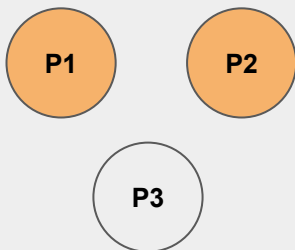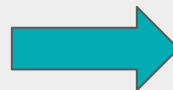
Input:

Output

$$\varphi = \bigwedge_{i=1}^{m} \square \diamond J_i^1 \rightarrow \bigwedge_{j=1}^{n} \square \diamond J_j^2$$

Equivalence reduction

$$\varphi = \bigwedge_{i=1}^{m} \square \diamond J_i^1 \rightarrow \bigwedge_{j=1}^{n} \square \diamond J_j^2$$

RoME 2024

Summary and ongoing work

- We are designing a general framework to exploit modular representation.

- We expect this approach lead us to solve bigger controller synthesis instances.

- Finishing implementation and formal demonstration about correctness.

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Questions?

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