Teaching Formal Methods for 10 Years: Reflections on Theories, Tools, Materials, and Communities

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Motivation

The Role of Formal Methods in Computer Science Education[1]

... every computer scientist needs to know Formal Methods [4], since the skills and knowledge acquired ... provide the indispensable solid foundation that forms the backbone of CS practice.

Impressions from teaching FMs for 10 years in Brazil

- Theories
- Tools
- Materials
- Communities

[1] Link to the paper

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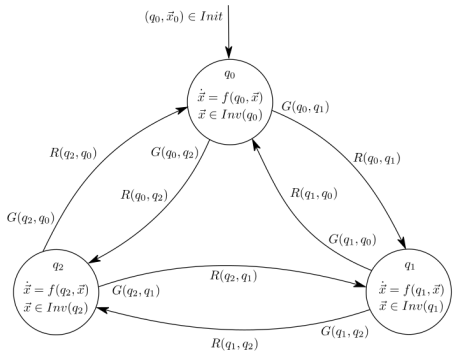
A reinterpretation of SE with rigour



Formal Model

enables

Animation	**Verification**	**Translation**	**Visualisation**
Random	Testing	Other models	View x Model
User guided	Manual proof	Code generation	
	Mechanised proof		
	Model checking		

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Teaching experience

Focus: a broad overview as depicted before
(conversely, a module with a focus on proof development using Coq)

Period: from 2014–nowadays

Level: undergraduate students

Grouped into three distinct phases

- Phase 1: teaching with Z and CSP#
- Phase 2: teaching with Event-B and CSP_M
- Phase 3: teaching with B

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General information

	Phase 1	Phase 2	Phase 3
Period	2014–2015	2015–2017	2017–now
Institution	UPE (BR)	UPE (BR)	UFPE (BR)
Course	Comp. Engineering	Comp. Engineering	Comp. Engineering Comp. Science Inf. Systems
Level	Undergraduate	Undergraduate	Undergraduate
Module	Formal Methods	Formal Methods	Critical Systems
Curriculum	Mandatory	Mandatory	Optional
Prerequisites	SW Analysis and Design	SW Analysis and Design	SW Engineering

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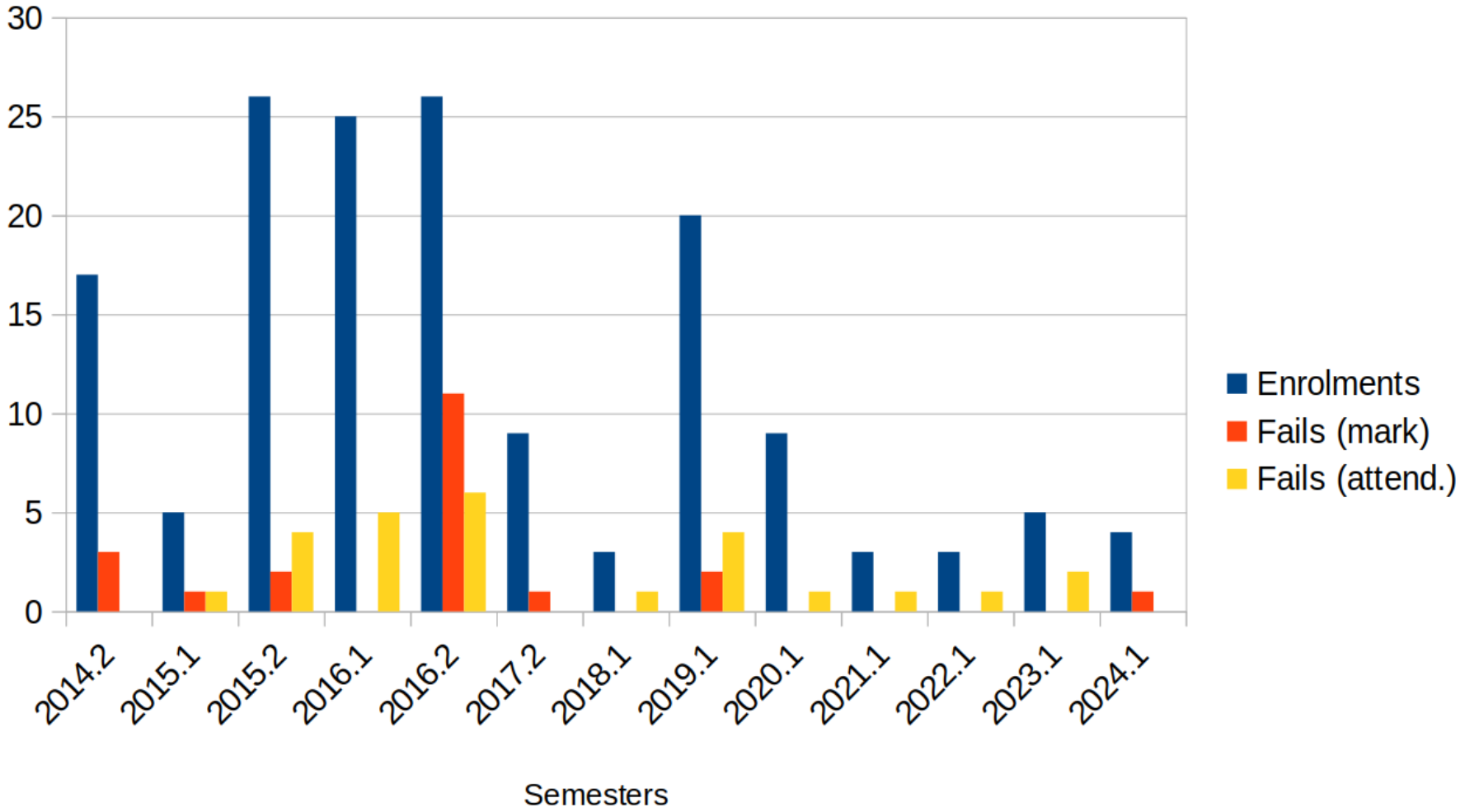
Enrolments and fails



Phase 1 = 2014.2 .. 2015.1
Phase 2 = 2015.2 .. 2016.2
Phase 3 = 2017.2 .. 2024.1

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Teaching and assessment dynamics

	Phase 1	Phase 2	Phase 3
Delivery mode	In person	In person	In person (mostly)
Methodology	Traditional	Traditional	Flipped classroom
Teaching	Classroom Lab. sessions Seminars	Classroom Lab. sessions Seminars	Lab. sessions
Assessment	Project (2 parts) Written exams (2)	Project (2 parts) Written exams (2)	Project (3 parts) Exam at the lab.
Marking	Manual	Manual	Manual

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Phase 1: from 2014 to 2015

	Phase 1
Approach	Fragmented overview
Theories	Z CSP#
Tools	CZT Z-Eves PAT
Materials	Book by Woodcock & Davies Tools documentation
Communities	Scarce
Impressions	- Loose connection - Tools (Z) - Scarce community - Shallow seminars

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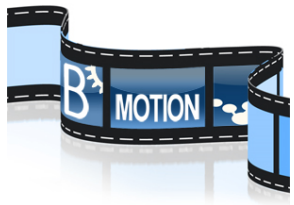
Phase 2: from 2015 to 2017

	Phase 2
Approach	Fragmented overview
Theories	Event-B CSP_M
Tools	Rodin ProB BMotion Studio FDR3
Materials	Tools documentation Book by Roscoe
Communities	Scarce
Impressions	- Loose connection + Tools (Event-B) - Scarce community - Shallow seminars



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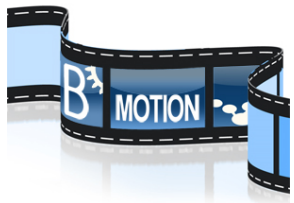
Phase 3: from 2017 to nowadays

	Phase 3
Approach	Unified overview
Theories	B
Tools	Atelier B ProB BMotionWeb
Materials	MOOC of B Tools documentation
Communities	Scarce
Impressions	+ Integrated applications of FMs + Tools (B) - Scarce community



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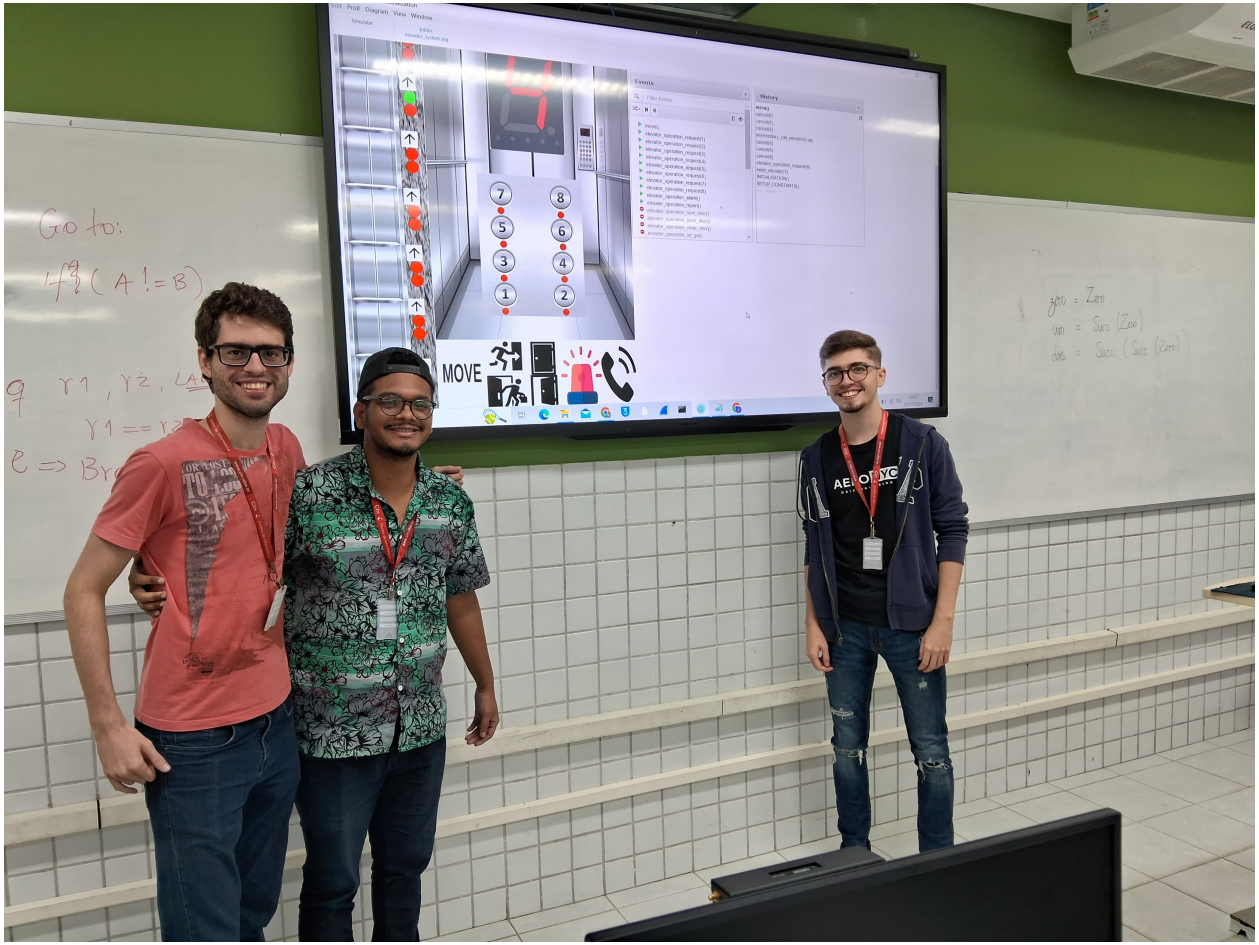
Phase 3: from 2017 to nowadays



Project presented in 2024.1: revisiting the lift example

Module's website:

sites.google.com/a/cin.ufpe.br/if721

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Summary of our thoughts

Curriculum

- Thinking about correctness is crucial
- Should be an integral part of CS education
- Start the discussion early (e.g., Discrete Mathematics, Logic)

Module's scope

- First, a mandatory module "Formal Methods" (unified overview)
- Then, optional modules (focus on specific techniques)

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Summary of our thoughts

Theories, tools, materials, and communities

- First, be more practical than theoretical
- Then, get into the underlying details and theories
- Choose appropriate languages (materials and communities)
- Choose appropriate tools (documentation and user-friendliness)

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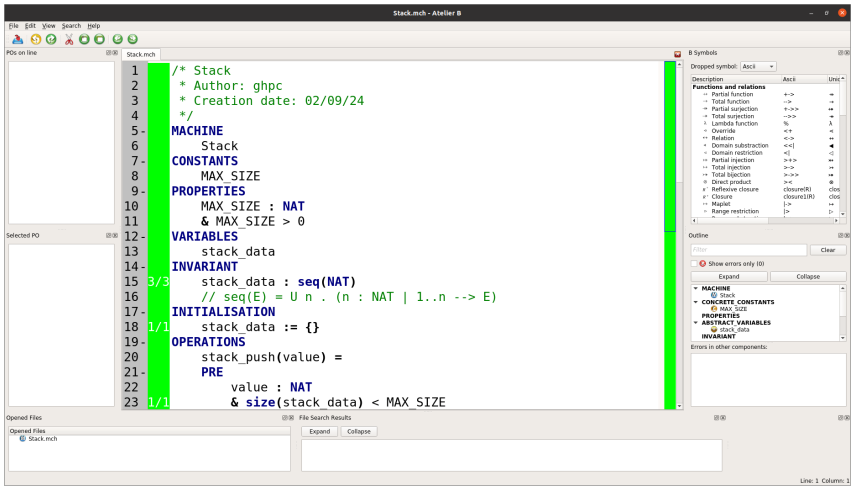
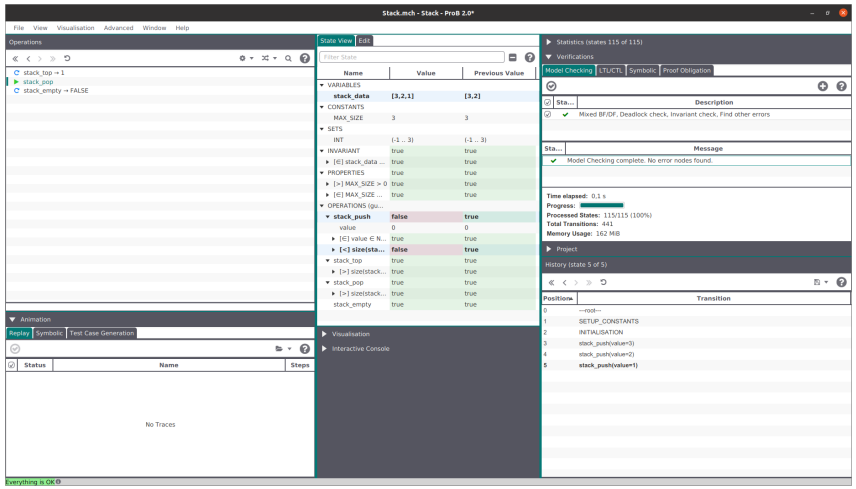
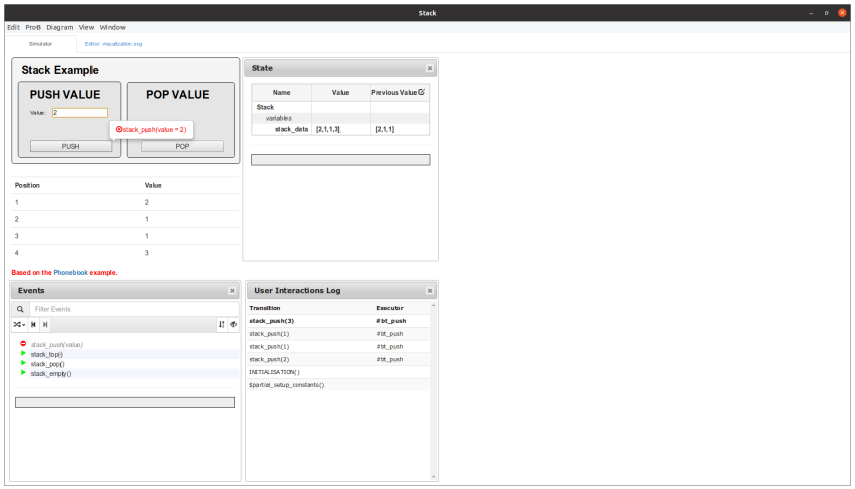
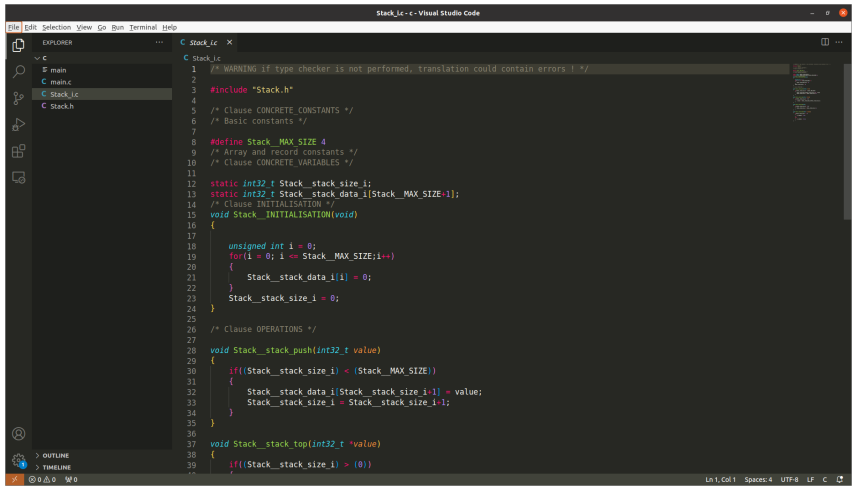
Demonstration @ FM Teaching Expo









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