



CLAWS
2025



Computational Logics: What and Why



— Carlos Areces - UNC, CONICET, GTIIT —
October 18, 2025 - China

Welcome to CLAWS 2025!

Let me start by welcoming all of you to:

CLAWS 2025

1st Computational Logic and Applications Winter School @ GTIIT

This is **amazing**.

We had more than 100 people joining the school in one week!

How it happened ...

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Now seriously, we started talking and we got excited about organizing a school on CL, and perhaps inviting some more people over.

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WE NEED YOU!



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Then Santiago.

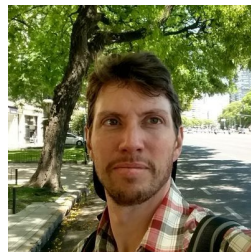


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Then Diego and Naza.

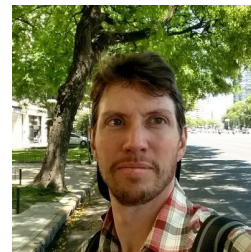


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They were **easy targets**.

Invited Guests



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Trabajo de hormiga

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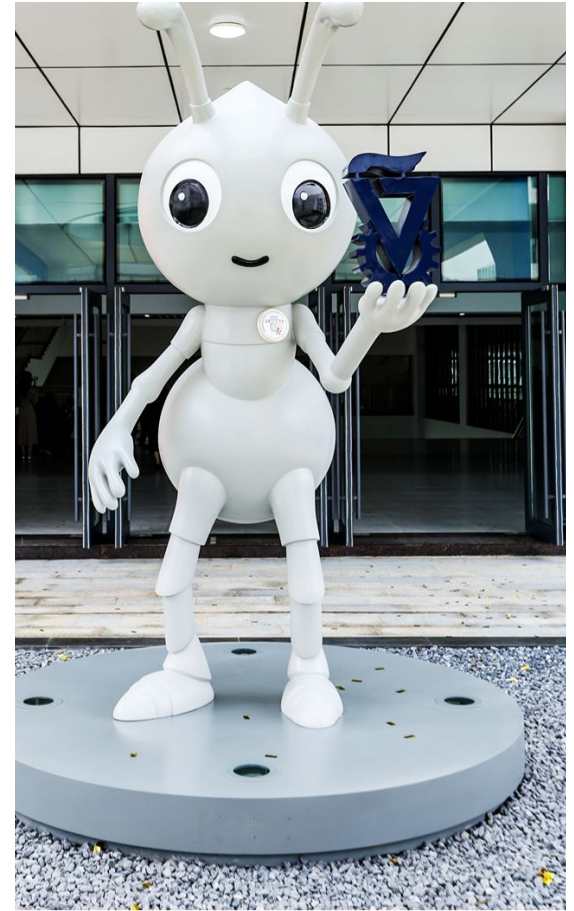
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Which means that it was done **patiently**, **little by little**, and with the **help of many**.

And I think it fits very well with the **spirit of GTIIT**.



Logic and Computer Science and Computational Logic

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Logic is the tool we (CS) use to model, describe and analyse computational systems.



Logic in Computer Science

Over the past 50 years there has been an extensive and growing interaction between Logic and Computer Science.

Indeed, I would say that Logic has been **more effective in CS than in Math**.

- You **can** do **serious, deep, theoretical Math** without Logic,
- but you **can't** do **serious, deep, theoretical CS** without Logic.

Impact of Logic in CS

Logic has a deep impact in different areas of CS, including:

- Programming Languages
- Database Systems
- Computational Complexity
- Computer Security and Cryptography
- Computer-Aided Verification
- Software Engineering
- Artificial Intelligence
- ...

It is easy to keep going, and going and going.

Example I: Logic and Databases

A **multi-billion-dollar** business.

- Logic lies at the core of modern database systems (SQL, QBE).
- Efficient query evaluation is based on relational algebra.
- Different modal logics are the backbone of query languages for semi-structured data: XPath for XML, DTD (Data Type Definition).



Example II: Logic and Computational Complexity

A **surprising and beautiful** connection:

- **complexity classes** (defined in terms of Turing machines, i.e., procedural systems) coincide exactly with
- **particular logics** (machine independent, and purely descriptive)

$$\text{NLOGSPACE} = \text{FO}(\text{TC})$$

$$\text{PTIME} = \text{FO}(\text{LFP})$$

$$\text{NP} = \text{SO} \exists$$

$$\text{PSPACE} = \text{SO}(\text{TC})$$

A two way bridge

Interestingly, CS also fuels Logic.

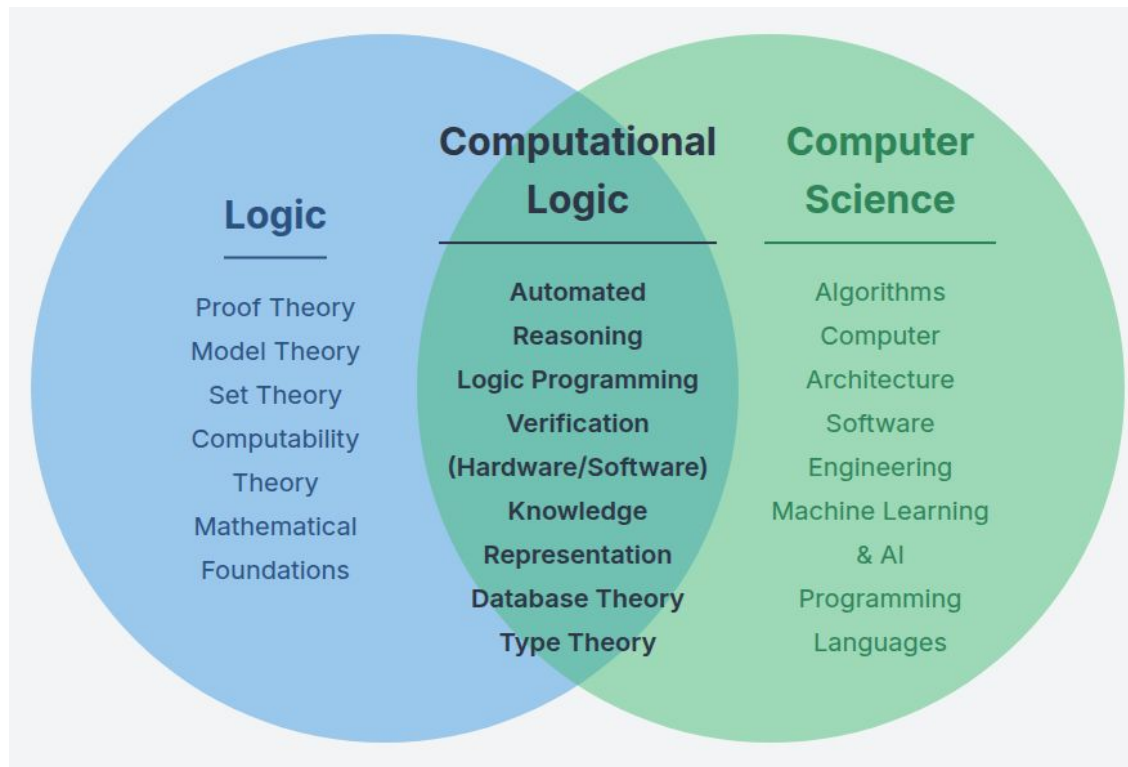
There are many examples of CS directly inspiring and contributing to Logic:

- **Finite-model theory:** study of logics on finite structures.
- **Logics directly motivated by CS applications:**
 - Fix-point logics for database querying,
 - Description logics for knowledge representation,
 - Authentication logics for security
- Completely **new notions of entailment:** e.g., non-monotonic logics for defeasible reasoning.

Computational Logic and what the future brings

Running out of time and still too many things to say...

In this school we will talk (a lot!) about **LogicS** (in many colors and flavors), and we will focus on their computational aspects.



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2. **Scalability**. Most inference tasks are hard (NP and above). How can we solve large instances? Can 1) help? Can 3)?
3. **Quantum Computing and Logic**. QC is coming. I think we still do not know how and what we can do with QC. Surely Logic will have a role to play (in both directions).

Thanks!

I want to end this introduction with my sincere thanks to everyone who is taking part of this idea:

- The people attending, for being here on a Saturday morning to do Logic!
- The lecturers for all the work they put in preparing their classes.
- Paulo and Eli for giving us the green light for this crazy project.
- **Felix CHEN** for solving one thousand and one issues and problems.
- GTIIT for being the home of CLAWS 2025.