Prolog’s Educational Potential

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Overview, Towards making Computational and Logical Thinking through Prolog and its successors a core subject in the educational curriculum and beyond

- Where we are vs. where we want (need?) to be
- Short and long term aims.
- Agreements, achievements; and remaining doubts on the main questions:
  - Why teach Prolog?
  - When?
  - How?
  - With what support? Sample tools.
  - To whom should we teach Prolog?
  - At what level?
- Sample Projects
- To-Do List
We've given the world a language like no other, pregnant with all kinds of under-explored, badly needed possibilities, e.g.:

- Universalizing reliable reasoning capabilities
- Providing actors and decision makers with substantiating tools (Examples: Logical English for Logical Law, Logical judges - Bob Kowalski [10], Viviana Mascardi [12])
- Replacing (e.g. through default reasoning- Gopal Gupta [8]) or at least complementing ML-based AIs with more sustainable, sound reasoning [15, 21]

Yet curricula around the world has not caught up with the need to teach Prolog properly, despite Prolog’s successful (although sometimes hidden) presence throughout the world. **LP IS UNDER-REPRESENTED!**
More human resources are needed! LP is *under-inclusive*, following old, still influential policies

Inclusiveness is paramount to our growth: We are a relatively small niche of people (typically white, élite, able-bodied, straight, cisgender, male people from the Global North- unrepresentative of Humanity at large --this is the case also in AI, in STEM).

**Origin:** *officially adopted elitist views of Education* (e. g. Horace Mann’s as “equalizer of men” - but not all: only white, Anglo, Christian-, and certainly not women [13])

**Result:** a persisting, individualistic style of teaching, no chance for conversations on ethics, no social aims => just a factory of élite professionals as tools [7]

*Truly inclusive policies that can achieve parity [17] would, in addition, provide us with the human resources we need.*

Photo: A typical ICLP demographic composition (from ICLP’12, Budapest [16]).
A Foolproof Way out?: LET’s MAKE SPACE

Because when given space, people take it.

E.g.

- “The Four Hidden Figures of the Space Race” (operation Apollo) were black [3]!
- In the ‘70’s, 75% of students in the still spacy new career of CS at its inception in Argentina were women! [18]

(clearly disproving the myth of “natural “ disinclination: it took proactive chasing-away for élites to replace the “other” when these new fields became desirable)

Y las mujeres, dónde están? Fundacion Sadosky [18].
How? Introduce children/youngsters to logic and a more human-friendly computer language

“Prolog Bus” (French community initiative, documented by Bob Kowalski)

Short Term (summer of 2022):

- online introductions to human-friendly, logic-based computer programming for students (JUST HOW YOUNG?) Aiming well!

and teachers:

  - emphasizing the declarative reading of logic programs- JUST HOW DECLARATIVE?
  - compatible with curricula employing ASP or other LP varieties

- Identification of position paper themes
Teaching Achieved:

- May 21- June 5: *Prolog for AI Thinking*, - Eric Fung (University)
- June: *Intro to Prolog and its KR & AI uses* - Gopal Gupta (High School or College, 17 year olds, 200 registrants, approx. 100 completed)
- October: *Prolog through solving Detective Mysteries*

Laura Cecchi (Elementary School: 8-10 year olds, 56 registrants, 16 facilitators, 4 inexperienced schoolteachers)
**Why teach Prolog?**

Reliable thinking, logic, computing :- Prolog

- It helps teach everything else
- It teaches how to reason soundly
- It can fill the need to make AI (and CS in general) explainable, transparent, accountable, sustainable.

**When?**

- Before imperative languages [1, 4]
- ASAP (before gender role mandates have gelled)
**How to teach Prolog?**

**Most common anchors:**

- Through what students already know, e.g.:
  - Mathematical problem solving
  - As a KB language

**Perhaps more effective:**

- **Familiarity & Concepts first:**
  - Use Prolog-written aids to teaching other subjects (logic, grammar, taxonomy…)
  - Read and use ready-made packages
  - Through active, engaging fun, e.g. games and puzzles
  - Through human language concepts
A neglected approach to use what is known: human language concepts! (→ syntactic sugar)

Example: through tiny NL grammar fragments
noun → [godess].
pronoun → [who].

... sentence → subj, pred.

predicate → verb.

CONCEPTS:

Constant = goddess

(Linguistic) variable= “who”

Rewrite rules, notation

Term = derivation tree sentence(subj(pronoun... )

Strategy= top-down, bottom-up, L-to R,...

(Existential) quantification= elicited by “Who”

Reversibility= generate or recognize

Modularity= change the lexicon etc.
Leads to Syntactic Sugared, more friendly support for learning, e.g. Logical English (Bob Kowalski, [10])

(https://logicalenglish.logicalcontracts.com/p/sister.pl)

the templates are:

*a person* is sister of *a person*.
*a person* is female.
the parents of *a person* are *a mother* and *a father*.

the knowledge base sister includes:

a person X is sister of a person Y if X is female
and the parents of X are a mother and a father
and the parents of Y are the mother and the father
and X is different from Y.

?- show prolog.
Examples History Solutions
en("the target language is: prolog.

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scenario alice is:
the parents of alice are mary and john.
the parents of harry are mary and john.
alice is female.

query sister is:
which person is sister of which other person.

Query sister with alice: *a person* is sister of *a person*
Answer: alice is sister of harry
true

?- answer sister with alice.
CLEARER AIM: Website of Prolog education (or Computational Thinking Education through Prolog) with resources that educators can use or adapt, classified by age & stage, regularly updated

Packaged Materials for specific audiences:
- Paradigms of Computation teaching materials
- (adaptable) syllabus as pedagogically adequate orderings of:
  - Prolog programming concepts vs.
  - Prolog-related or Computational skills
- Games that help teach
- Killer apps to help convince advocates of the need to introduce Prolog into curricula

Pointers:
- existing Prolog teaching sites and courses
- systems and environments: browser vs. server based, privacy issues, infrastructure needed, medium for text, tools for automating the teaching
Sample Materials for different levels

**Elementary Level**: Students as Detectives must discover who committed a robbery, from feeding clues received in successive stages to Prolog as their helper (Laura Cecchi)

**Elementary and High School**: Syllabus and sample implementation w/ games such as Populate a geometry world from declarative descriptions (Jose Morales, Salvador Abreu); Games such as “avoid landing on a mine using logic clues” (Michael Genesereth) Teaching arithmetic through Prolog (Jean Rohmer, [14])

**University Level**: covering AI and CS students, non CS students, comparative language courses

**All levels (incl. informal) + Advocates**: grammar that generates input to Dall-e (Paul Tarau); grammar that generates solutions to quantifiable ecological and social problems, using Doughnut Economics as a compass (Veronica Dahl, [5]) ; CLP rendition: Salvador Abreu
Grupo de Investigación en Lenguajes e Inteligencia Artificial
Laura Cecchi, Universidad Nacional del Comahue - Argentina

Prologue   XML   Derivation tree
1 involved(ana).     
2 involved(juan).    
3 involved(alicia).  
4 wears(ana, glasses). 
5 wears(pedro, glasses). 
6 wears(juan, glasses). 
7 likes(ana, dance).  
8 likes(ana, fish). 
9 likes(jose, swim). 
10 likes(juan, dance). 
11 likes(juan, watchTV).

http://www.programmierkurs-java.de/blocklyprolog/
A syllabus and interactive course for young students (Jose Morales, Salvador Abreu)

- A simple syllabus and example implementation to guide students in learning to program by way of Prolog.

- Interactive course (based on browser-side Ciao Playground and LPdoc)
  - Structured as basic (encoding knowledge as facts, asking simple and complex queries, rules as shorthands) and advanced topics (introduce compound terms and recursion)

- Some requirements:
  - Assumes (relies on!) no previous experience with programming languages and no knowledge of computer architecture.
  - Use a subset of standard Prolog, we do not want to rely on advanced features (e.g. tabling, constraints, ...)
  - Provide "practical" examples for every concept
  - This could mean young children (around 10yo) or students of non-technical topics, for instance in the humanities.

EXAMPLE TASK (above): “Amend the facts so that the figure on the right looks like the figure on the left.”
Grammar that generates input to Dall-e 2 (Paul Tarau)

Front end to Dall-e 2, which generates
NL descriptions of scenes in a given
domain that can then be fed to Dall-e to
create realistic images of the scenes

Input:
Photo of a cat playing on the golden moon
With a trumpet
Research-promoting games: Eco-social Solutions (Dahl [5])
Research-promoting games: Eco-social Solutions

How to get from where we are to where we want to be:

- Enter numeric assessments of (one or various) eco or social problem, e.g.
  status = 35 billion tons/year of Co2, goal = 0 emissions

- Enter possible reducing actions, e.g.
  prohibit_nonessential_plastics = -2

  + side effects, e.g. would create unemployment of X & health gains of Y

- Run & analyse resulting combinations of solutions.
Successful Projects → greater LP presence (<->?)
Greater human presence in LP

- **Yuanlin Zhang**: huge grant for a project that uses logic as a layer before using R as the programming language, in high school. He is translating his ASP materials from another project (LP Based Integration of Science and Computing for middle school students) into Prolog.
- **Laura Cecchi** has interested the Provincial Council of Neuquén in letting her try out her Intro for Kids Prolog project at elementary schools.
- **Theresa Swift** has lined up resources in the form of a network of high school teachers willing to try out any of our proposals.
- **Laurent Cervoni** and **Laure Bourgeois** will offer two Hackathons for students (in Schools of Engineering and universities, end of 2022/ early 2023).
To grow through inclusion: A WORD OF CAUTION, LEARNED FROM HISTORY

Beware of backlash (cf. that of the ‘80s, which succeeded, with much media and institutional help to institute a “geek culture” hostile to the “other”, in capturing even those computational spaces where women were majority)

HOW TO INVITE THOSE GROUPS CHASED AWAY BACK IN? Given role modeling is crucial,

THE KEY QUESTION: How can the people running the show share their power with diversities, esp. in leading roles?

- How can we structurally transform STEM Education altogether? [17, 7]
- How can achieving this lead to a much stronger representation of reasoning & LP?

INFAMOUS MEDIA CAMPAIGN INCLUDED ADS LIKE:
To-Do List: JOIN US!

- **ALLIES:** Team up with adequate other initiatives, e.g. UNESCO's initiatives for Computational Thinking in Education; find representatives per country
- **Entice decision-makers to add Prolog to existing curricular programs:**
  - Enlist teachers through great ready made little programs
  - Enlist decision-makers by showing them clearly superior Prolog renditions of powerful examples, compared with other languages
- **Help introduce greater role in ACM’s curricular recommendations**
- **Advertise**
- **Make space proactively, wherever we can:**
  help detect and deactivate biases encoded in language [11, 20], help introduce fairer laws [19], help universalize encouragement & role modeling, help deconstruct negative stereotyping, protest exclusion, help achieve parity in representation, …

COLLECTIVELY: Join or initiate collective action (e.g. UNESCO's [17] to convert our spaces into fully representative of, and welcoming to, all. Help fill in gaps in data [7] and build equity into both data collection and algorithms [7, 21,22].

Every bit helps!
Most importantly:

CREATE SOME GLOBAL ENTITY to Make Computational and Logical Thinking through Prolog and its successors a core subject in the educational curriculum and beyond
Thanks galore to our fantastic Prolog Education Team:

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A Few References


References (cont.)