GNU Aris

a web application for students

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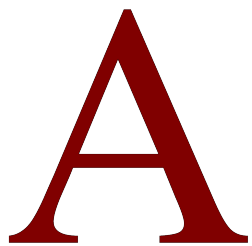
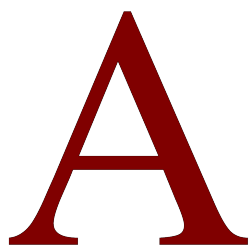


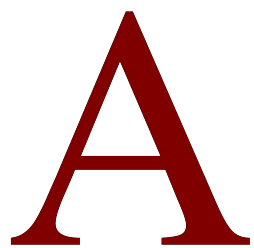
Abstract

We report on recent improvements to the free logic education software tool GNU Aris, including the latest features added during the Google Summer of Code 2023 project. We focused on making GNU Aris a web application to enable almost all users to use it as a standalone offline web application written in a combination of HTML, JavaScript, and WebAssembly. We used the Qt Quick framework with Emscripten to compile the application to WebAssembly. In the report we summarize the user feedback of university students given during a course on logic.



Why yet another software in teaching logic?

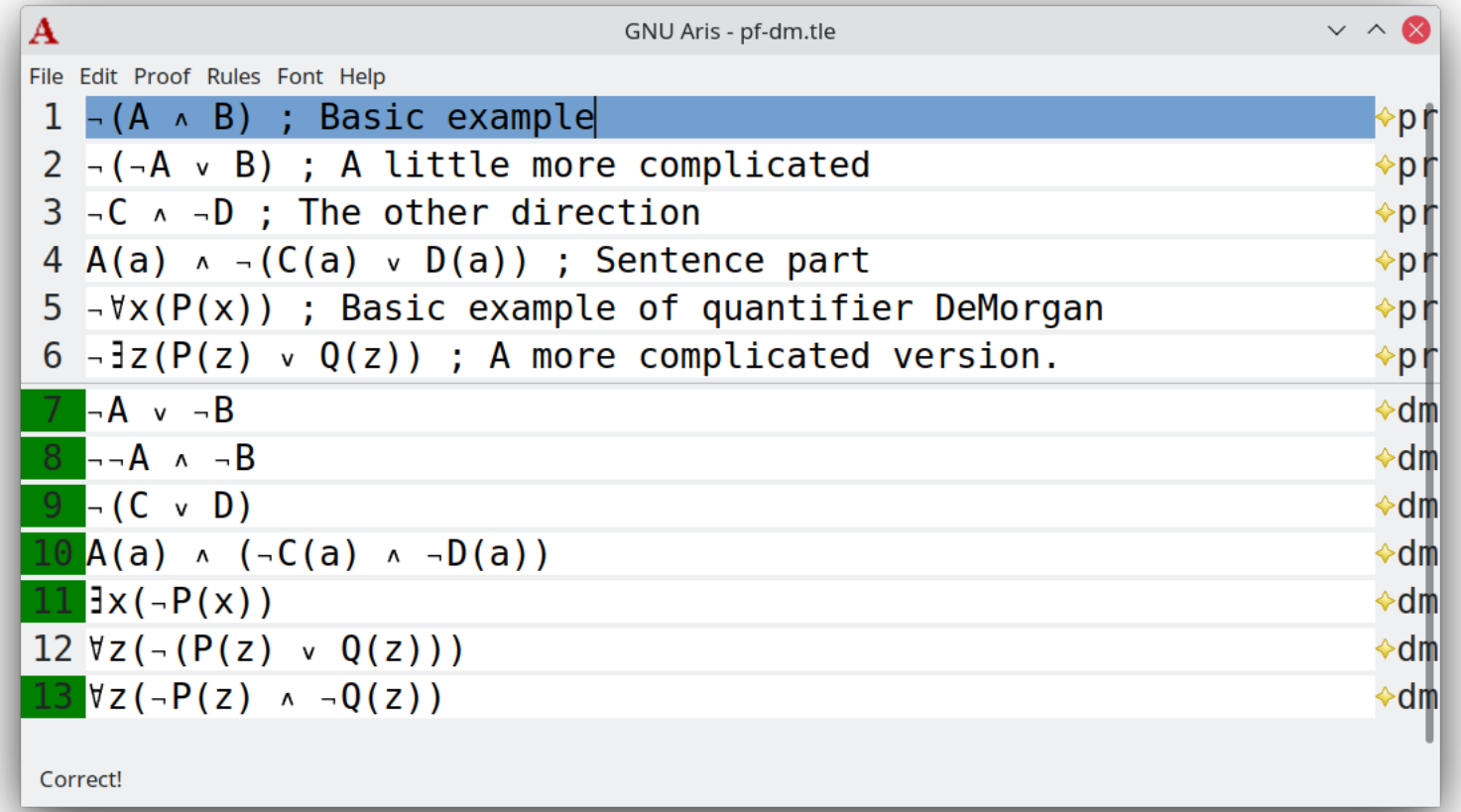
- In fact, it's not new, it exists since 2011 (programmed by Ian Dunn, until 2014).
- The well-known software (Coq, Isabelle, LEAN, etc.) are too complex, too big, too difficult, etc., for prospective mathematics teachers.
- It is usually enough to show just a taste of formal logic for most audience, during introductory courses.
- Aris seems a good balance between acceptable syntax for beginners and rich enough to demonstrate both propositional logic and first order logic.



What is missing from the original version?

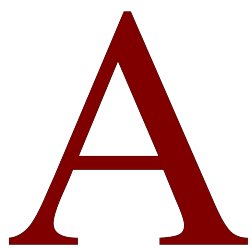
- Difficult installation (there are bundles, but they may be outdated, and only for certain platforms).
- Exotic shortcuts for logic operations and symbols (maybe unsupported on some national keyboards).
- Only English is supported.
- Import/export may be difficult because of its own XML format.
- Random crashes on certain inputs.

GNU Aris 2.2, GTK interface (original)



The Google Summer of Code 2023 project

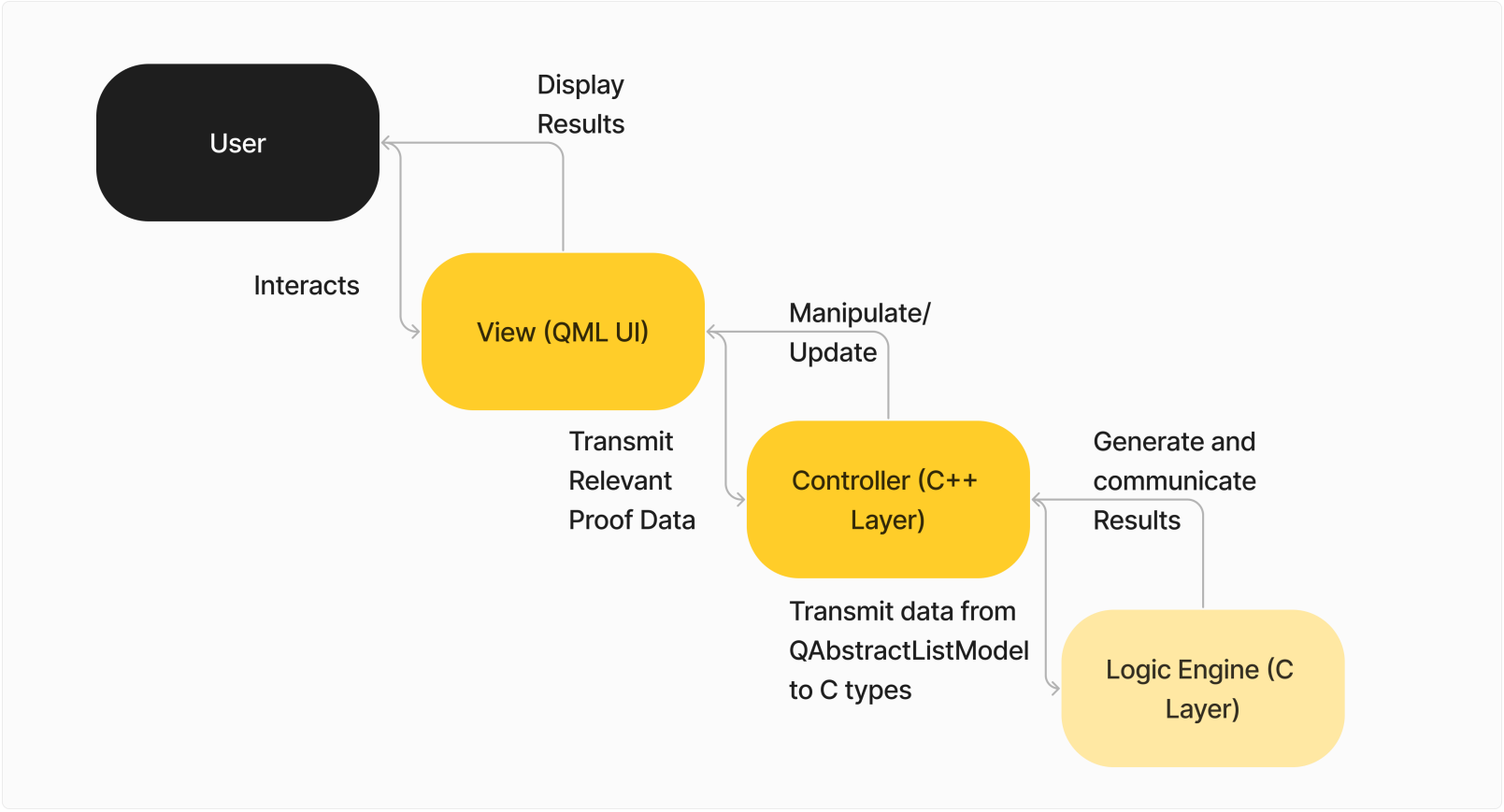
- 3 months of active work (S. A.).
- Supported by 3 mentors
  (Z. K., Andreas Ebetshuber and Alexander Thaller).
- Work plan:
  1. Create a Qt interface (transparently).
  2. Compile GNU Aris as a HTML/WebAssembly application.
  3. Polish the interface.
  4. Publish the new version.
  5. Get user feedback, fix issues.

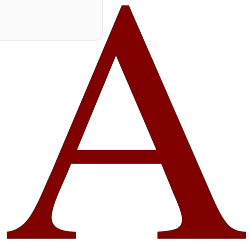


The Google Summer of Code 2023 project

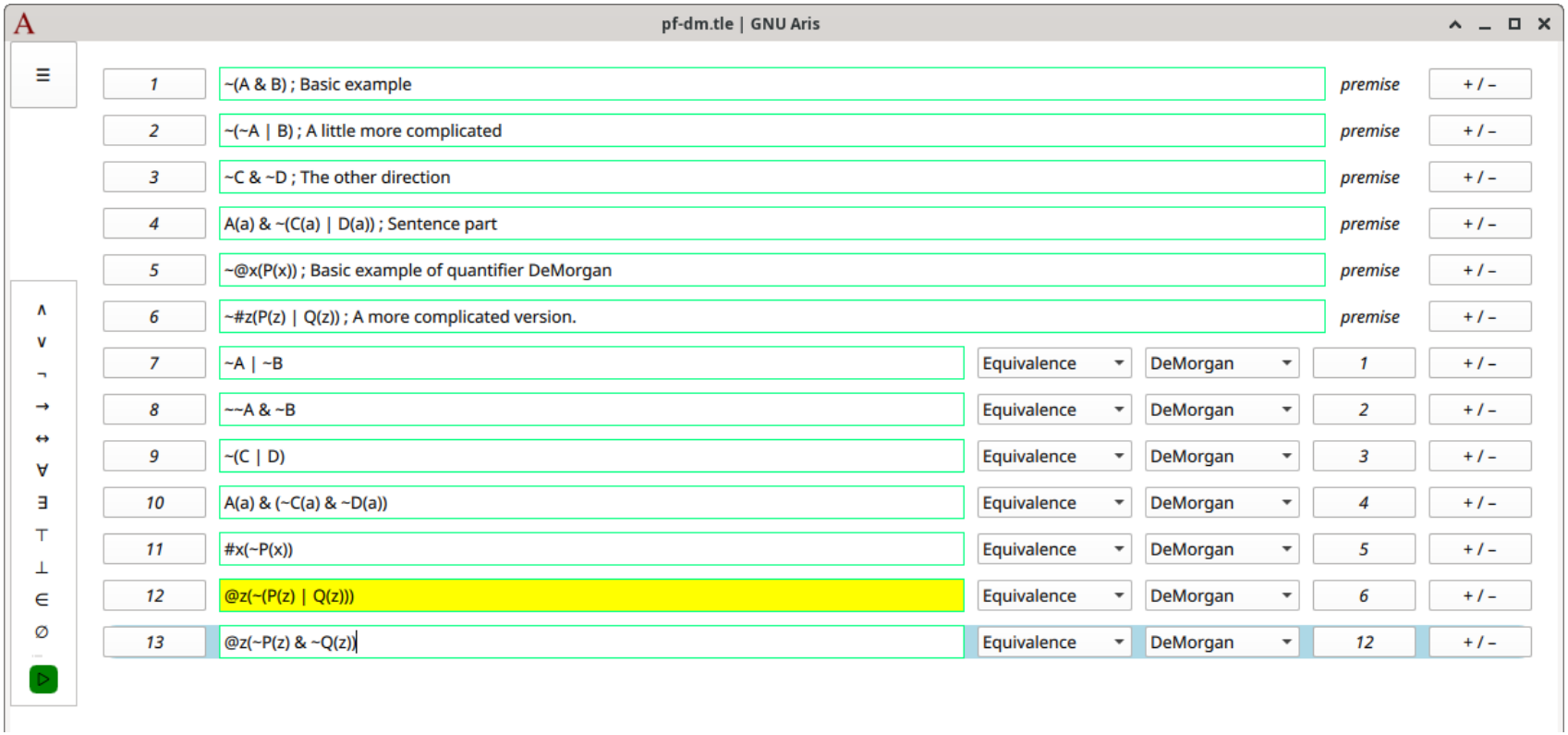
S. A.

Preparations for the Qt interface





Qt native interface



Web interface

https://matek.hu/kovzol/aris/

Feedback: A course in logic

For prospective mathematics teachers

- October 2023 – January 2024
- 30 students (some with bachelor degree, some without)
- Discussed topics: propositional logic, first order logic
- Two examples:
  1. Puzzles from Smullyan's "The Lady or the Tiger?"
  2. Category theory

A puzzle from Smullyan's "The Lady or the Tiger?"

5. Der fünfte Versuch

Es gelten dieselben Regeln, und die Schilder lauteten so:

I	II
Zumindest in einem Raum ist eine Dame	Im andern Raum ist eine Dame

Wie sollte der Gefangene sich entscheiden?

A puzzle from Smullyan's "The Lady or the Tiger?"

THE LADY OR THE TIGER?

5 • The Fifth Trial

The same rules apply, and here are the signs:

I	II
AT LEAST ONE ROOM CONTAINS A LADY	THE OTHER ROOM CONTAINS A LADY

A puzzle from Smullyan's "The Lady or the Tiger?"

THE SECOND DAY

"Yesterday was a fiasco," said the king to his minister. "All three prisoners solved their puzzles! Well, we have five trials coming up today, and I think I'll make them a little tougher."

"Excellent idea!" said the minister.

Well, in each of the trials of this day, the king explained that in the lefthand room (Room I), if a lady is in it, then the sign on the door is true, but if a tiger is in it, the sign is false. In the righthand room (Room II), the situation is the opposite: a lady in the room means the sign on the door is false, and a tiger in the room means the sign is true. Again, it is possible that both rooms contain ladies or both rooms contain tigers, or that one room contains a lady and the other a tiger.

A puzzle from Smullyan's "The Lady or the Tiger?"

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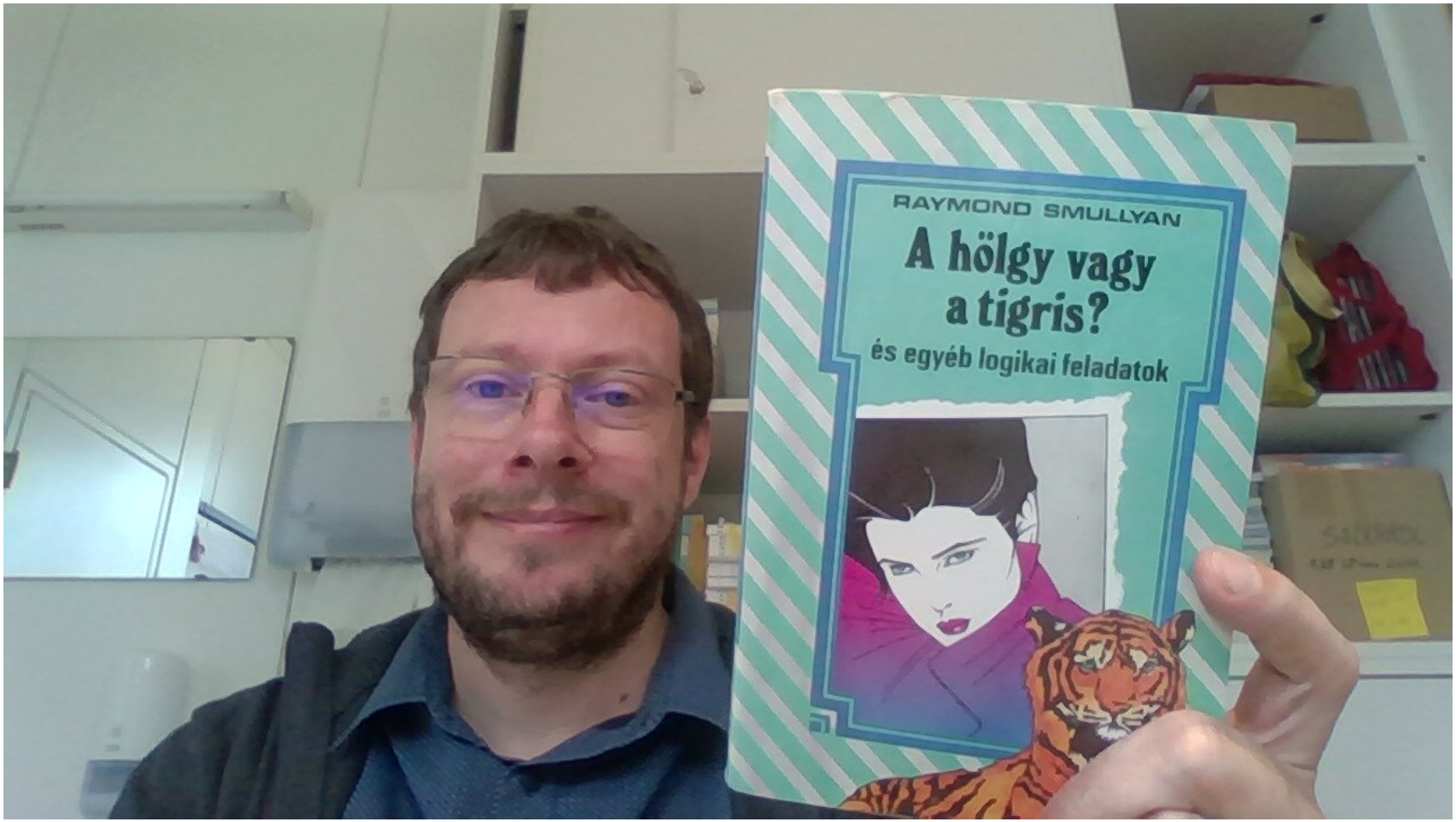
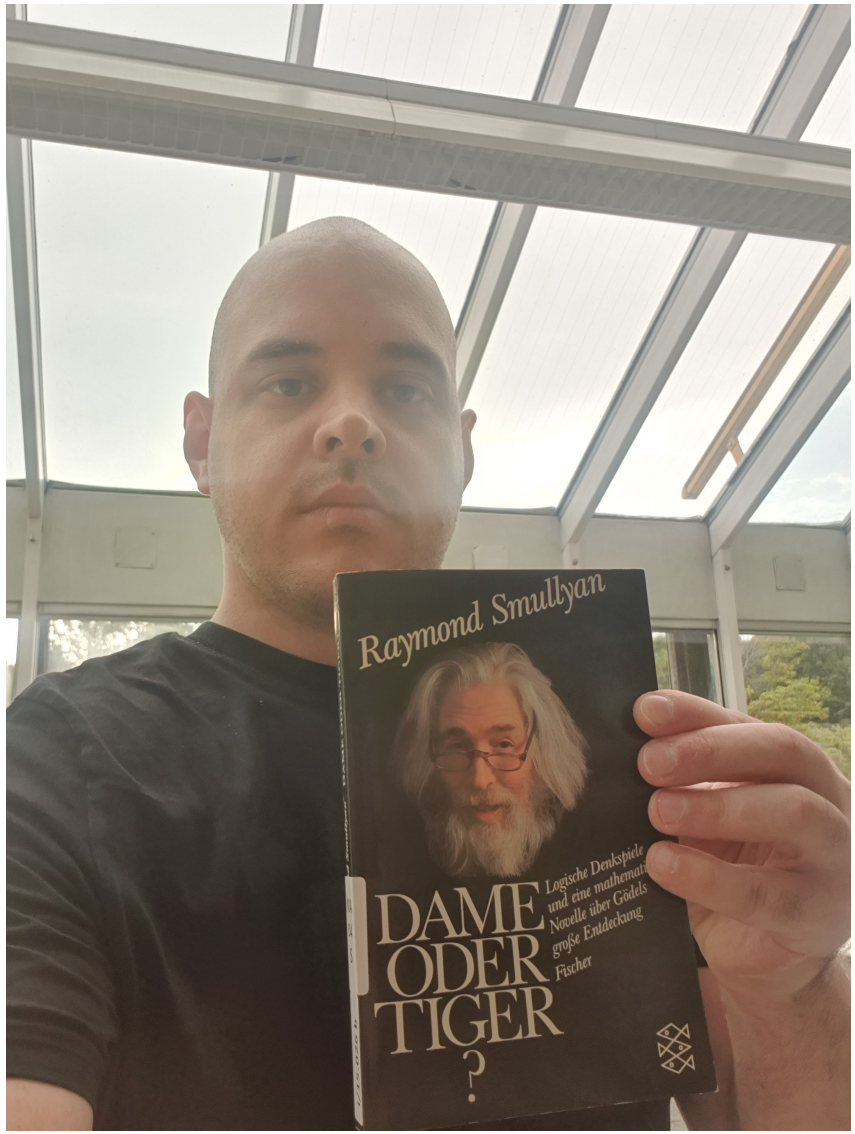


A puzzle from Smullyan's "The Lady or the Tiger?"



A puzzle from Smullyan's "The Lady or the Tiger?"

Solution in the web version of GNU Aris

A puzzle from Smullyan's "The Lady or the Tiger?"

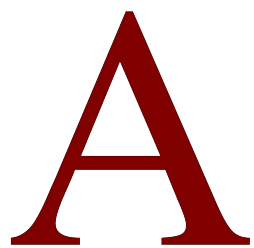
Solution in the web version of GNU Aris

26	L2→⊥ ;; The assumption of a lady being in room 2 leads to a contradiction.	*subproof*			5	+ / –
27	¬L2∨⊥	Equivalence	Implication		26	+ / –
28	¬L2 ;; There is no lady in room 2. Therefore, a tiger is in room 2.	Boolean	Identity		27	+ / –
29	(¬L2→S2)∧(S2→¬L2)	Equivalence	Equivalence		2	+ / –
30	¬L2→S2	Inference	Simplificatic		29	+ / –
31	S2	Inference	Modus Pone	30	28	+ / –
32	(S2→L1)∧(L1→S2)	Equivalence	Equivalence		4	+ / –
33	S2→L1	Inference	Simplificatic		32	+ / –
34	L1 ;; The lady is in room 1.	Inference	Modus Pone	33	31	+ / –
35	(L1→S1)∧(S1→L1)	Equivalence	Equivalence		1	+ / –
36	L1→S1	Inference	Simplificatic		35	+ / –
37	S1	Inference	Modus Pone	36	34	+ / –
38	(S1→(L1∨L2))∧((L1∨L2)→S1)	Equivalence	Equivalence		3	+ / –
39	S1→(L1∨L2)	Inference	Simplificatic		38	+ / –
40	L1∨L2	Inference	Modus Pone	39	37	+ / –
41	L1∧¬L2 ;; The prisoner should pick room 1, where the lady is. Room 2 contains a tiger.	Inference	Conjunction	34	28	+ / –

An exercise from category theory, LaTeX export

On left and right identity elements of a commutative binary operation

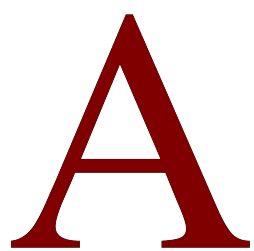
1.	$\forall a \forall b (o(a,b) = o(b,a))$		
2.	$\exists e \forall a (o(a,e) = a)$		
3.	$\forall a (o(a,e\_) = a)$	`ei`	(2)
4.	$o(x,e\_) = o(e\_,x)$	`ui`	(1)
5.	$o(x,e\_) = x$	`ui`	(3)
6.	$o(e\_,x) = x$	`fv`	(4,5)
7.	$\forall a (o(e\_,a) = a)$	`ug`	(6)
8.	$\exists f \forall a (o(f,a) = a)$	`eg`	(7)



Feedback: A course in logic

Feature requests by the students

- More comprehensible and detailed error messages.
- Automatic updates on the feedback for the correctness of statements after changing faulty inputs.
- A feature to zoom for smaller device displays.
- An option to change the user language.
- An option to highlight, copy and paste inputs.
- An option to change the type of input between premise and conclusion after inserting a new line.
- An operator for exclusive disjunction.
- An option to use the rule of interference for a proof by contrapositive.



THANK YOU!

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