FOLL-E: open source education tool to stimulate logical reasoning

FOSDEM 2025

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Whoami

- Simon Vandevelde
- Post-doctoral researcher @KUL (campus De Nayer)
- Research in knowledge-based AI
- Penchant for CompSci education
  - 5yrs programming teacher for children as student job
  - Dojo lead of CoderDojo Meise

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$\rightarrow$ This work is part of my research (sort of, I guess)

FOLL-E

First-**O**rder **L**ogic **L**earning **E**nvironment

→ Goal: Teach FOL to 8-13 year olds

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$\rightarrow$ Goal: Teach FOL to 8-13 year olds

$\forall x : Human(x) \Rightarrow Animal(x).$
$\forall x : Animal(x) \Rightarrow Mortal(x).$

Why teach FOL?

- Important foundation of maths, philosophy, compsci, ...
- Computational thinking
- A pillar of Artificial Intelligence!
- Sharpens reasoning skills, critical thinking

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> If a card shows an even number on one face, then its opposite face is blue.

Solution: 8 and red

Difficulties

- FOL by itself does not do *anything*
- Steep learning curve
- Scary mathematical symbols ($\forall \in \Rightarrow \Leftrightarrow \mathbb{R} \ldots$) to haunt your nightmares
- Not "fun": no animation, sound, graphics, ...

$\rightarrow$ can we build a better learning environment?

Difficulties

```
vocabulary V {
    type Country := {B, F, G, N, L}
    type Color := {Blue, Red, Yellow}
    borders: Country * Country -> Bool
    color_of: Country -> Color
}

theory T:V {
    color_of(B) = Red.
    !c1, c2 in Country: borders(c1, c2) => color_of(c1) ~= color_of(c2).
}

structure S:V {
    borders := {(B, F), (F, G), (B, G), (B, N), (B, L), (L, G), (L, F)}.
}

procedure main() {
    pretty_print(model_expand(T, S))
}
```

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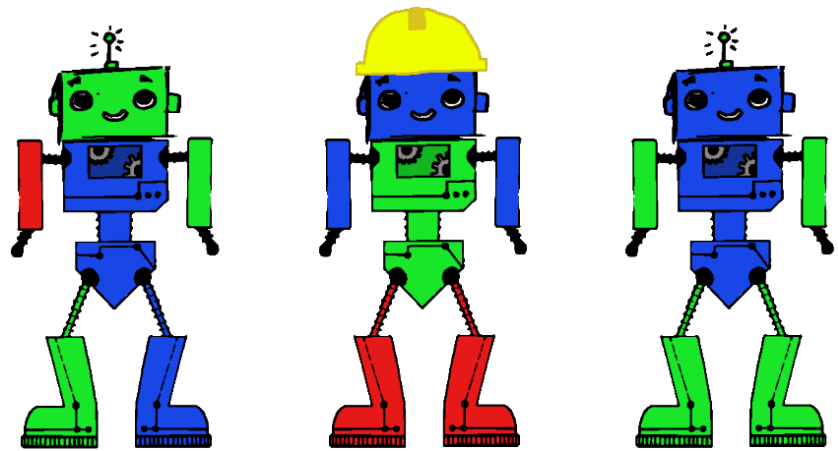
→ But: what application domain?

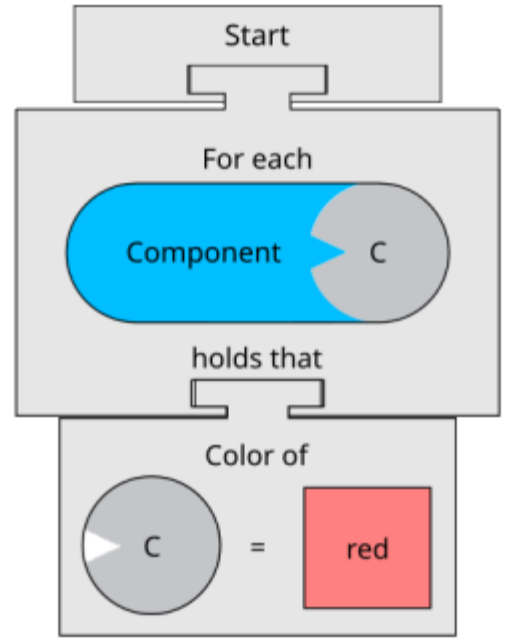
Application domain

- Robot designs
- Fun, cartoony, colorful!
- Each component may have different color (RGB)
- Optional helmet



FOL notation

- Blocks-based
- "Pegs-and-slot": syntax-free
- Fully generic, can cover all of FOL!



Blocks expressing that all components are red.

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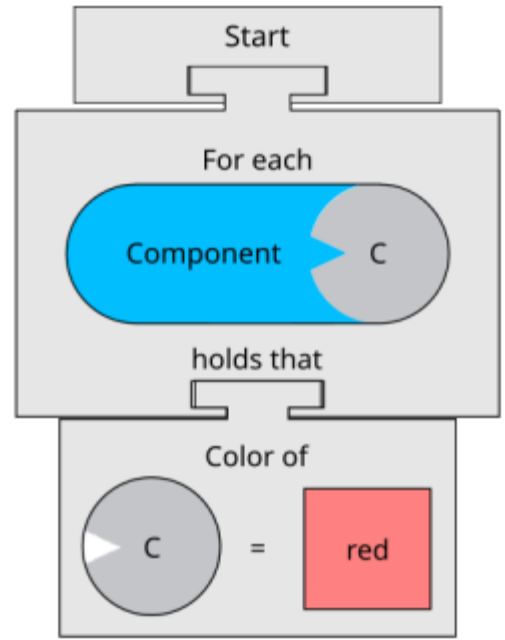
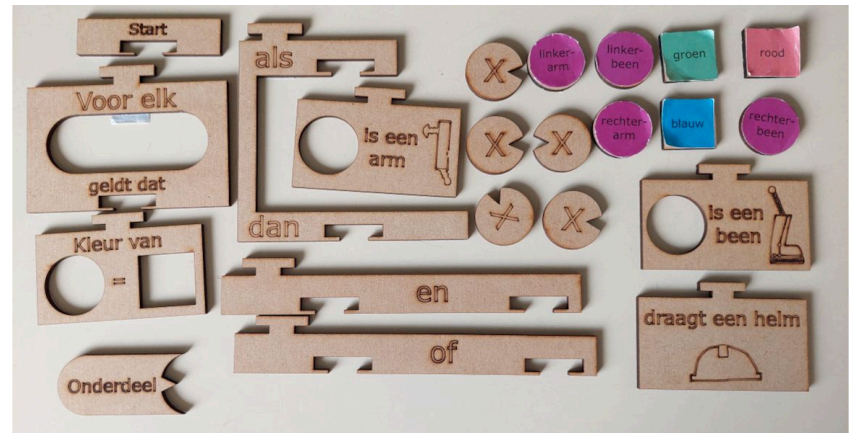
→ using mouse does not stimulate collaboration



Blocks expressing that all components are red.

FOL notation

- Laser-cut into physical blocks
- Engraved with intended meaning
- Tangible, puzzle-like
- Engaging and inviting



Task

- Shown 7 robots:
  - three "good"
  - three "bad"
  - one showing effect
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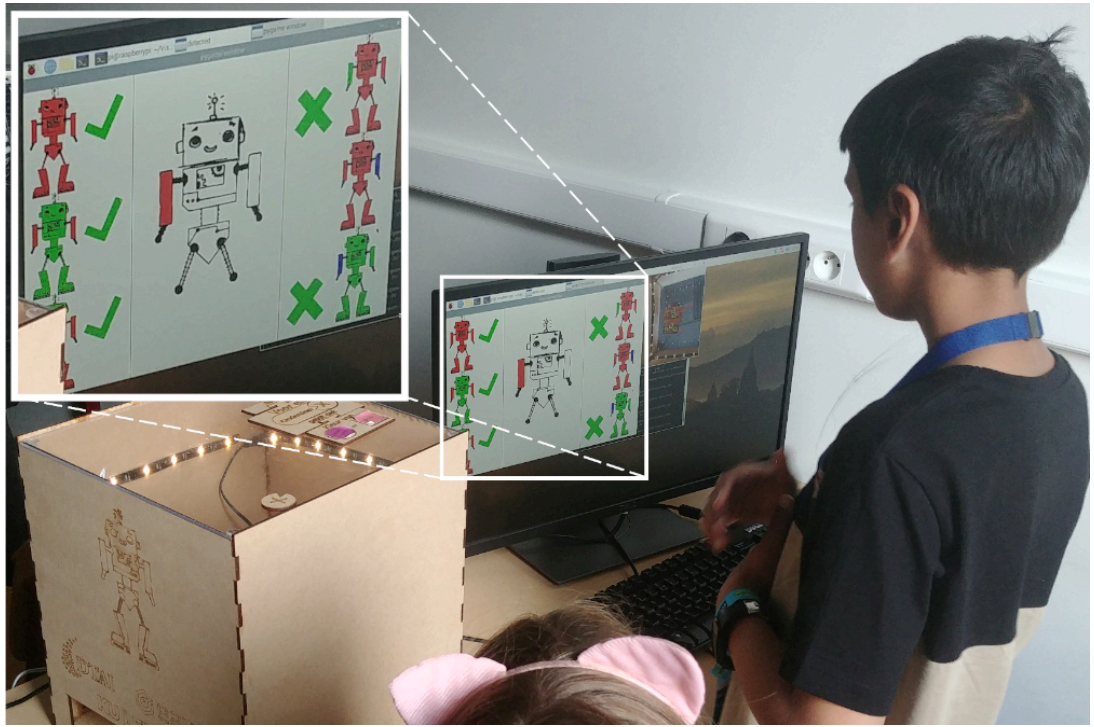
Examples:

- The left leg is blue
- If the robot wears a helmet, it has a green arm
- Every component that is an arm or a leg must be colored green

Task

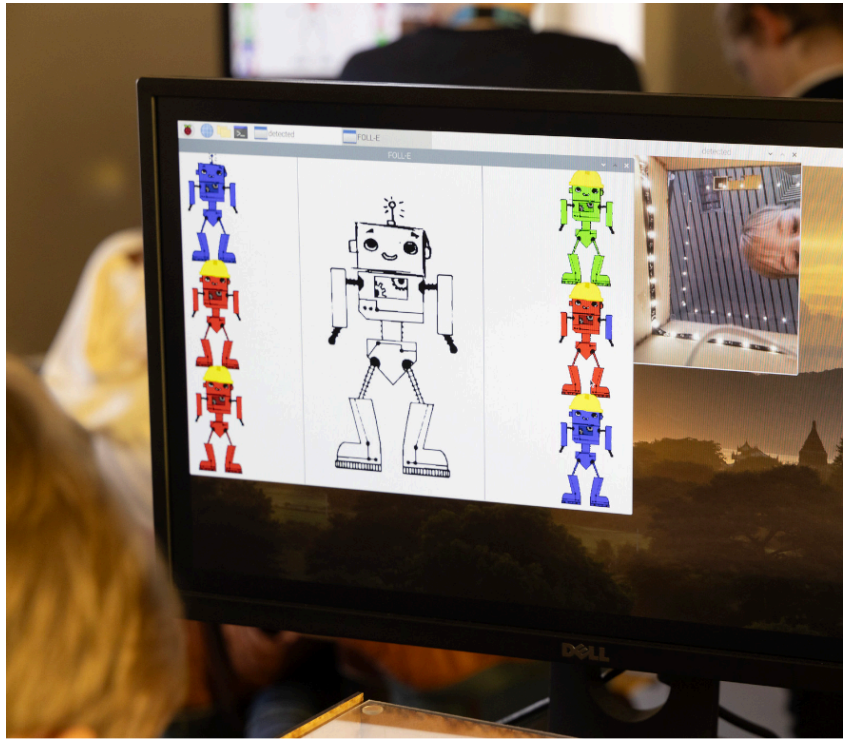


Using checkmarks and crosses, FOLL-E shows the effect of the rule.

Components

FOLL-E comes in a box containing:

- Raspberry pi 3B+
- Raspicam
- LED backlight
- Set of blocks
  - Annotated using AruCo markers



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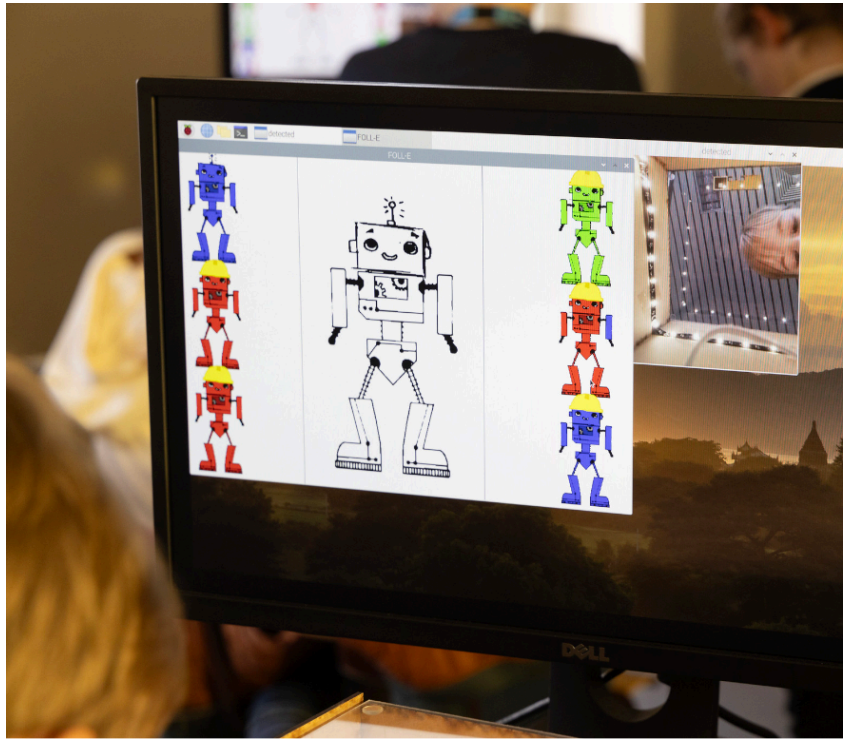
All you need is an HDMI monitor!



Application

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- Whenever a full statement is detected, it is evaluated
- Result is shown using checkmarks and crosses

Fully Open Source!

- https://FOLL-E.com
- https://gitlab.com/Vadevesi/foll-e
- Source code (GPLv3)
- Everything ready to laser cut!
  - Boxes
  - Blocks
- TODO: step-by-step guide on how to build it. (But pretty straightforward!)

→ we are setting up a program allowing schools to loan out boxes for a day

Thank you!

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- https://FOLL-E.com

Video if time

Another video if more time