What "Lean-verified" means, and what it does not

READING LEVEL KIDS · EVERYONE · EXPERTS

Seven Lean demonstrations, each checked by Lean and leanchecker, and by a second kernel checker, nanoda, on a rebuild with Lean 4.35.0; not yet refereed.

Lean-checked 4 · computed 3 · open 1

What we actually checked: seven small Lean files showing which automatic check catches which trick that makes 2 + 2 = 5 look proved, where four files are proved in Lean as written, three are caught or refused by checks, and the book is not yet refereed.

CHECK IT YOURSELF

The check guide for this book · How to check a result yourself

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1. What "Lean-verified" means, and what it does not

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The strict referee

The question

If a computer program says a piece of maths is "checked", can you believe it? And can it be fooled into saying that 2 + 2 = 5?

My answer: you can believe what it checked, but you have to know what it checked. It can be fooled in five ways, and each one can be caught.

A referee who only checks the rules

Imagine a referee in a game. The referee is very, very strict. Every move has to follow the rulebook, and the referee never gets tired and never skips a step.

That is Lean. When Lean says "checked", it means every step followed the rules.

But a referee only checks that the rules were followed. A referee does not check that you are playing the game you said you were playing.

Trick 1: adding a rule

Suppose a player says, "New rule: 2 + 2 = 5!" and then uses that rule to win. The referee is fine with it, because the rule is written down. But Lean keeps a list, a bit like a scoreboard, of every extra rule a win depends on. If you read the list and see "2 + 2 = 5" at the top, you know the win is only fair if that rule is.

Trick 2: "I'll finish it later"

In Lean you can write a word, sorry, that means "I haven't done this step yet". Lean lets the game go on, but it prints a warning, and the word sorry shows up on the scoreboard too.

Trick 3: a clock with one number

Look at a clock. After 12 comes 1 again, so the numbers go round and round. Now imagine a clock with only one number on it, a 0. Whatever you add, you land on 0 again. On that clock, 2 + 2 is 0, and 5 is 0 too, so 2 + 2 = 5 is true!

Trick 3: a clock with one number

Lean checks it and says "yes, that is true". And it is true, on that clock. The referee did nothing wrong. The trick is that you thought we were talking about the numbers you count with. To catch this one, a person has to look at what kind of numbers the sentence is about.

Trick 4: changing what the plus sign does

Another way is to say, "In this game, a plus sign means add and then add one more." Now 2 + 2 is 5. Again the referee checks everything and says yes, because under that rule it is true. To catch it, you have to read the rules of the game, not only the score.

Trick 5: telling the referee to look away

This is the sneakiest one. Lean has a setting for experts who are fixing Lean itself. When it is on, the referee does not look at a claim at all. The claim goes straight into the book, and the scoreboard shows nothing wrong, because nothing was checked.

Trick 5: telling the referee to look away

To catch this, you ask a referee to go back through the whole book from the start. This time the referee looks at every claim, finds the one that was never checked, and says no.

The setting can even hide in a different file from the one with the maths in it. So a good checker looks in every file.

Even referees make mistakes

Referees are people, or in this case programs, and programs can have bugs. In July 2026 someone found a bug in Lean's referee, and the Lean team fixed it the same day. This is why people also write a second referee, in a different language, by different people. If two referees agree, that is more convincing than one. It still is not a promise.

Try it yourself

All the tricks are small files. You can download every one from the book's demos folder, and the check guide says what you should see for each one. Go check yourself.

Where to go next

- What if the referee itself has a bug? See Kernel bugs, and why a second checker helps.
- What are the five tricks, in real Lean output? See Five ways to get 2 + 2 = 5 past a build.

Experts: the files and checks are here: check guide.

Yesterday, today, tomorrow

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Yesterday: People built a computer program called Lean that works like a very strict referee for maths. You show it a claim and the steps that prove it, and it checks every step against the rules.

Today: I tried five ways to get Lean to say "2 + 2 = 5", and wrote down what Lean really printed each time. Then I wrote down how each trick gets caught.

Tomorrow: Anyone can run the same tricks on their own computer and watch what happens. If you find a new trick, I would like to hear about it.

We hope it helps others find more results and keeps their curiosity going. We'd love to collaborate with anyone.

Have an idea or a question? We'd love to hear it! Share it with a parent or guardian, and they can email it to us at hello@gocheckyourself.org.

Each result on its own page

- Demo 1: the honest file, $2 + 2 = 4$
- Demo 2: the added axiom, $2 + 2 = 5$ from a declared axiom
- Demo 3: the unfinished proof, $2 + 2 = 5$ by a placeholder
- Demo 4: the one-number system, $2 + 2 = 5$ below 1
- Demo 5: the different plus sign, $2 + 2 = 5$
- Demo 6: the faulty definition, 1 is prime
- Demo 7: the kernel-check-off file, False stored unchecked
- Open question: A second-kernel run with lean4lean

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