

QUANTUM
CODING

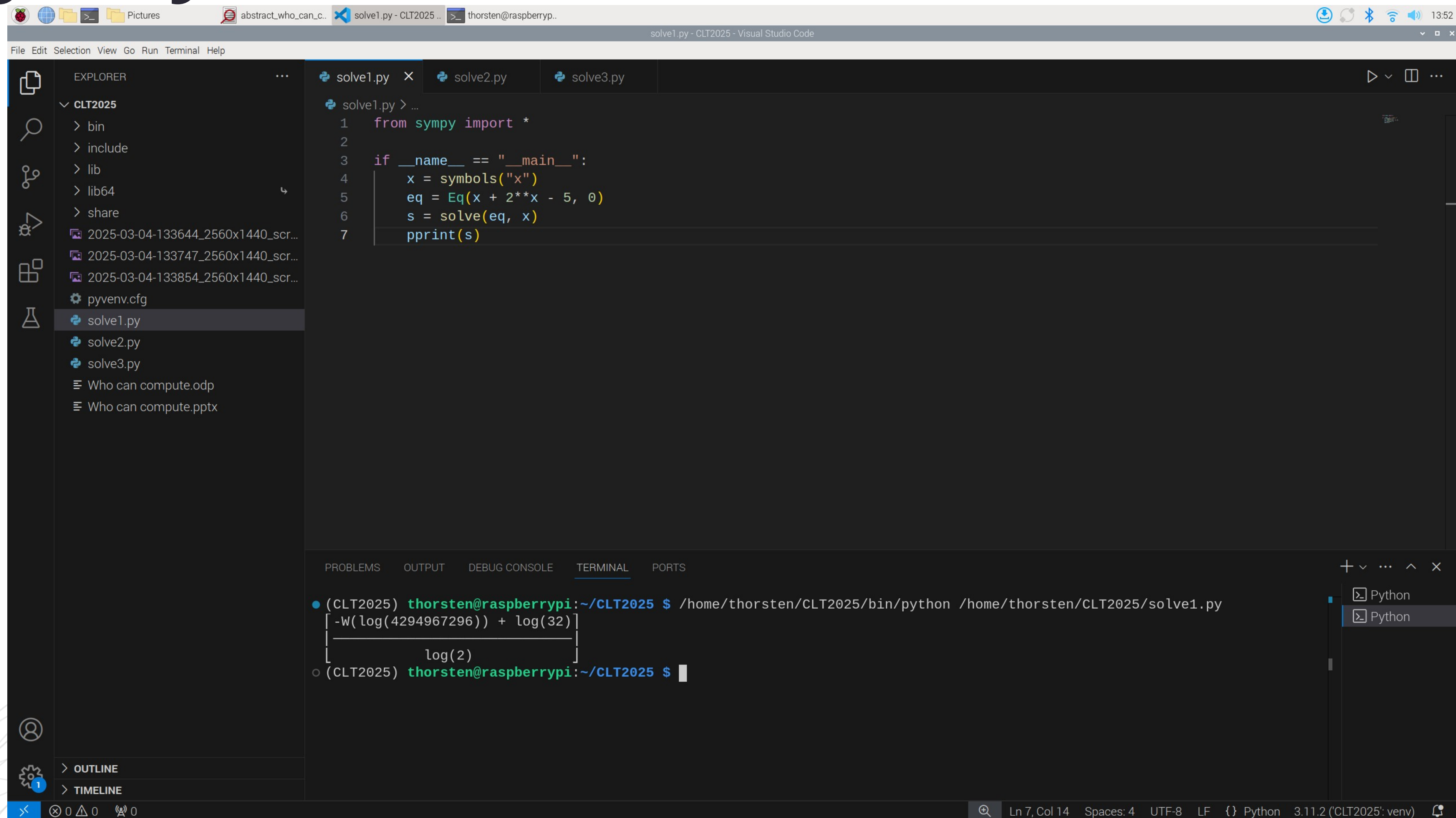
Who can compute?

Thorsten Roland
Khaled Saifullah

Contents

- 1 - Tasks to do
- 2 - SymPy
- 3 - Mathematica
- 4 - ChatGPT
- 5 - Deepseek
- 6 - Conclusion

2. SymPy — Task 1



```
File Edit Selection View Go Run Terminal Help
EXPLORER
CLT2025
  bin
  include
  lib
  lib64
  share
  2025-03-04-133644_2560x1440_scr...
  2025-03-04-133747_2560x1440_scr...
  2025-03-04-133854_2560x1440_scr...
  pyvenv.cfg
  solve1.py
  solve2.py
  solve3.py
  Who can compute.odp
  Who can compute.pptx

solve1.py
1 from sympy import *
2
3 if __name__ == "__main__":
4     x = symbols("x")
5     eq = Eq(x + 2**x - 5, 0)
6     s = solve(eq, x)
7     pprint(s)

TERMINAL
• (CLT2025) thorsten@raspberrypi:~/CLT2025 $ /home/thorsten/CLT2025/bin/python /home/thorsten/CLT2025/solve1.py
[-W(log(4294967296)) + log(32)]
[-----]
[          log(2)          ]
○ (CLT2025) thorsten@raspberrypi:~/CLT2025 $
```

2. SymPy — Task 2

The image shows a Visual Studio Code editor window. The top bar indicates the file being edited is 'solve2.py' in the 'CLT2025' workspace. The Explorer sidebar on the left shows a file tree for 'CLT2025' with folders 'bin', 'include', 'lib', 'lib64', and 'share', and files '2025-03-04-133644_2560x1440_scr...', '2025-03-04-133747_2560x1440_scr...', '2025-03-04-133854_2560x1440_scr...', 'pyvenv.cfg', 'solve1.py', 'solve2.py' (selected), 'solve3.py', 'Who can compute.odp', and 'Who can compute.pptx'. The main editor area shows the content of 'solve2.py':

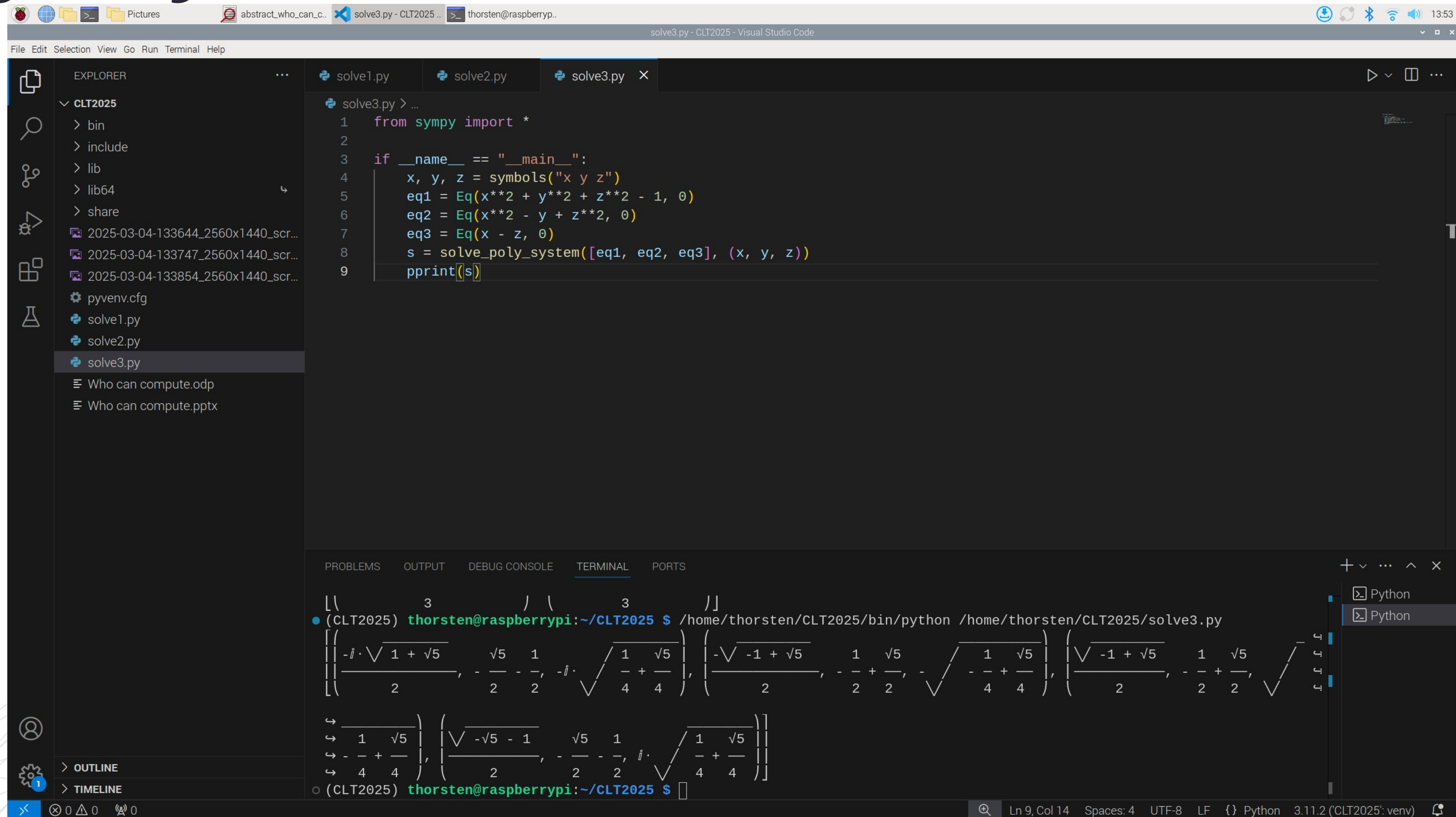
```
solve2.py > ...
1  from sympy import *
2
3  if __name__ == "__main__":
4      a, b, c = symbols("a b c")
5      eq1 = Eq(a*b, 100)
6      eq2 = Eq(b*c, 200)
7      eq3 = Eq(c*a, 300)
8      s = solve_poly_system([eq1, eq2, eq3], (a, b, c))
9      pprint(s)
```

The bottom panel shows the 'TERMINAL' tab with the following output:

```
(CLT2025) thorsten@raspberrypi:~/CLT2025 $ /home/thorsten/CLT2025/bin/python /home/thorsten/CLT2025/solve1.py
[-W(log(4294967296)) + log(32)]
[-----]
[log(2)]
(CLT2025) thorsten@raspberrypi:~/CLT2025 $ /home/thorsten/CLT2025/bin/python /home/thorsten/CLT2025/solve2.py
[[[-10*sqrt(6), -5*sqrt(6), 10*sqrt(6)], [10*sqrt(6), 5*sqrt(6), -10*sqrt(6)]]]
(CLT2025) thorsten@raspberrypi:~/CLT2025 $
```

The status bar at the bottom indicates the current position is 'Ln 9, Col 14', with 'Spaces: 4', 'UTF-8', 'LF', and 'Python 3.11.2 (CLT2025: venv)'.

2. SymPy — Task 3



```
File Edit Selection View Go Run Terminal Help
EXPLORER
CLT2025
  bin
  include
  lib
  lib64
  share
  2025-03-04-133644_2560x1440_scr...
  2025-03-04-133747_2560x1440_scr...
  2025-03-04-133854_2560x1440_scr...
  pyvenv.cfg
  solve1.py
  solve2.py
  solve3.py
  Who can compute.odp
  Who can compute.pptx
  OUTLINE
  TIMELINE
  PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
  solve3.py > ...
  1 from sympy import *
  2
  3 if __name__ == "__main__":
  4     x, y, z = symbols("x y z")
  5     eq1 = Eq(x**2 + y**2 + z**2 - 1, 0)
  6     eq2 = Eq(x**2 - y + z**2, 0)
  7     eq3 = Eq(x - z, 0)
  8     s = solve_poly_system([eq1, eq2, eq3], (x, y, z))
  9     pprint(s)
```

Terminal output:

```
(CLT2025) thorsten@raspberrypi:~/CLT2025 $ /home/thorsten/CLT2025/bin/python /home/thorsten/CLT2025/solve3.py
```

$$\left[\left(\frac{-i \cdot \sqrt{1 + \sqrt{5}}}{2}, -\frac{\sqrt{5}}{2} - \frac{1}{2}, -i \cdot \sqrt{\frac{1}{4} + \frac{\sqrt{5}}{4}} \right), \left(\frac{-\sqrt{-1 + \sqrt{5}}}{2}, -\frac{1}{2} + \frac{\sqrt{5}}{2}, -\sqrt{-\frac{1}{4} + \frac{\sqrt{5}}{4}} \right), \left(\frac{\sqrt{-1 + \sqrt{5}}}{2}, -\frac{1}{2} + \frac{\sqrt{5}}{2}, \sqrt{-\frac{1}{4} + \frac{\sqrt{5}}{4}} \right), \left(\frac{1}{4} + \frac{\sqrt{5}}{4}, \frac{\sqrt{-\sqrt{5} - 1}}{2}, -\frac{\sqrt{5}}{2} - \frac{1}{2}, i \cdot \sqrt{\frac{1}{4} + \frac{\sqrt{5}}{4}} \right) \right]$$

(CLT2025) thorsten@raspberrypi:~/CLT2025 \$

3. Mathematica — Tasks 1 to 4

The screenshot shows the Wolfram Mathematica notebook interface. The title bar indicates the file is 'tasks_mathematica.nb'. The menu bar includes File, Edit, Insert, Format, Cell, Graphics, Evaluation, Palettes, Window, and Help. The toolbar shows various icons for evaluation, cell style, and insertion. The notebook content displays the following:

In[7]:= `Solve[x + 2^x == 5, x]`

Out[7]= $\left\{ \left\{ x \rightarrow \frac{5 \log(2) - \text{ProductLog}[32 \log(2)]}{\log(2)} \right\} \right\}$

In[8]:= `Solve[{a * b == 100, b * c == 200, c * a == 300}, {a, b, c}]`

Out[8]= $\left\{ \left\{ a \rightarrow -5 \sqrt{6}, b \rightarrow -10 \sqrt{\frac{2}{3}}, c \rightarrow -10 \sqrt{6} \right\}, \left\{ a \rightarrow 5 \sqrt{6}, b \rightarrow 10 \sqrt{\frac{2}{3}}, c \rightarrow 10 \sqrt{6} \right\} \right\}$

In[9]:= `Solve[{x^2 + y^2 + z^2 - 1 == 0, x^2 - y + z^2 == 0, x - z == 0}, {x, y, z}]`

Out[9]= $\left\{ \left\{ x \rightarrow -\frac{1}{2} \sqrt{-1 + \sqrt{5}}, y \rightarrow \frac{1}{2} (-1 + \sqrt{5}), z \rightarrow -\frac{1}{2} \sqrt{-1 + \sqrt{5}} \right\}, \left\{ x \rightarrow \frac{1}{2} \sqrt{-1 + \sqrt{5}}, y \rightarrow \frac{1}{2} (-1 + \sqrt{5}), z \rightarrow \frac{1}{2} \sqrt{-1 + \sqrt{5}} \right\}, \left\{ x \rightarrow -\frac{1}{2} i \sqrt{1 + \sqrt{5}}, y \rightarrow \frac{1}{2} (-1 - \sqrt{5}), z \rightarrow -\frac{1}{2} i \sqrt{1 + \sqrt{5}} \right\}, \left\{ x \rightarrow \frac{1}{2} i \sqrt{1 + \sqrt{5}}, y \rightarrow \frac{1}{2} (-1 - \sqrt{5}), z \rightarrow \frac{1}{2} i \sqrt{1 + \sqrt{5}} \right\} \right\}$

In[6]:= `Prove that 3^n + 7^n - 2 is divisible by 4 for all natural n >= 0.`

4. ChatGPT — Task 1

I need the solution of these problems. What I need:

1. State the problem
2. step-by-step solution with brief explanation.
3. No numerical solution. Analytical or exact (implicit or explicit) solutions using appropriate functions.
4. The problem statement and the solution should be one after another when I say "Next" exclusively.

4. ChatGPT — Task 1

Problem 1:

Solve for x in the equation:

$$x + 2^x = 5$$

Solution:

We need to solve the equation:

$$x + 2^x = 5.$$

Step 1: Consider rewriting the equation

Rearrange it to express 2^x :

$$2^x = 5 - x.$$

Step 2: Consider analytical solutions

This equation involves both a linear term (x) and an exponential term (2^x), which suggests that an explicit algebraic solution is not possible. Instead, we express the solution using the **Lambert function** $W(x)$, which satisfies the equation:

$$ye^y = x \Rightarrow y = W(x).$$

We rewrite the equation in a Lambert function-friendly form:

$$2^x = 5 - x.$$

Taking the natural logarithm on both sides:

$$x \ln 2 = \ln(5 - x).$$

Rearrange:

$$e^{x \ln 2} = 5 - x.$$

4. ChatGPT — Task 1

Rewrite as:

$$xe^{x \ln 2} = (5e^{x \ln 2} - xe^{x \ln 2}).$$

Define $y = x \ln 2$, so we have:

$$ye^y = \ln 2 \cdot 5e^y - ye^y.$$

This form suggests the solution involves the Lambert function:

$$x = -W(-(5 \ln 2)e^{-5 \ln 2}) / \ln 2.$$

Thus, the solution is expressed as:

$$x = -\frac{W(-(5 \ln 2)e^{-5 \ln 2})}{\ln 2}.$$

This is the exact analytical solution using the Lambert function.

4. ChatGPT — Task 2

Problem 2:

Solve for a, b, c given the equations:

$$ab = 100, \quad bc = 200, \quad ca = 300.$$

Solution:

We have the system of equations:

$$ab = 100, \quad bc = 200, \quad ca = 300.$$

Step 1: Multiply all three equations

Multiplying all three equations together:

$$(ab) \cdot (bc) \cdot (ca) = (100) \cdot (200) \cdot (300).$$

Rewriting,

$$a^2b^2c^2 = 100 \times 200 \times 300.$$

Taking the square root on both sides:

$$\downarrow$$
$$abc = \sqrt{100 \times 200 \times 300}.$$

4. ChatGPT — Task 2

$$abc = \sqrt{6,000,000}.$$

$$abc = 100\sqrt{6}.$$

Step 2: Express Variables in Terms of One Another

From the given equations:

$$b = \frac{100}{a}, \quad c = \frac{200}{b}, \quad a = \frac{300}{c}.$$

Substituting $b = \frac{100}{a}$ into $c = \frac{200}{b}$:

$$c = \frac{200}{\frac{100}{a}} = \frac{200a}{100} = 2a.$$

Now, substitute $c = 2a$ into $a = \frac{300}{c}$:

$$a = \frac{300}{2a}.$$

Multiplying by a :

$$a^2 = 150.$$

$$a = \pm\sqrt{150} = \pm 5\sqrt{6}.$$

4. ChatGPT — Task 2

Step 3: Solve for b and c

Using $b = \frac{100}{a}$:

$$b = \frac{100}{\pm 5\sqrt{6}} = \pm \frac{20}{\sqrt{6}} = \pm \frac{20\sqrt{6}}{6} = \pm \frac{10\sqrt{6}}{3}.$$

Using $c = 2a$:

$$c = \pm 10\sqrt{6}.$$

Final Answer:

$$a = \pm 5\sqrt{6}, \quad b = \pm \frac{10\sqrt{6}}{3}, \quad c = \pm 10\sqrt{6}.$$

4. ChatGPT — Task 3

Problem 3:

Compute the solutions $(x, y, z) \in \mathbb{C}^3$ for the system of equations:

$$x^2 + y^2 + z^2 - 1 = 0,$$

$$x^2 - y + z^2 = 0,$$

$$x - z = 0.$$

Solution:

Step 1: Substitute $x = z$ into the equations

From the third equation:

$$x = z.$$

4. ChatGPT — Task 3

Substituting this into the first and second equations:

$$x^2 + y^2 + x^2 - 1 = 0.$$

$$x^2 - y + x^2 = 0.$$

Step 2: Solve for y

From the second equation:

$$x^2 - y + x^2 = 0 \Rightarrow 2x^2 = y.$$

Substituting this into the first equation:

$$x^2 + (2x^2)^2 + x^2 - 1 = 0.$$

$$x^2 + 4x^4 + x^2 - 1 = 0.$$

$$2x^2 + 4x^4 - 1 = 0.$$

4. ChatGPT — Task 3

Step 3: Solve for x

Rearrange the equation:

$$4x^4 + 2x^2 - 1 = 0.$$

Introduce $u = x^2$, so the equation becomes:

$$4u^2 + 2u - 1 = 0.$$

Solve using the quadratic formula where $A = 4$, $B = 2$, $C = -1$:

$$u = \frac{-2 \pm \sqrt{2^2 - 4(4)(-1)}}{2(4)}.$$

$$u = \frac{-2 \pm \sqrt{4 + 16}}{8}.$$

$$u = \frac{-2 \pm \sqrt{20}}{8}.$$

4. ChatGPT — Task 3

$$u = \frac{-2 \pm \sqrt{20}}{8}.$$

$$u = \frac{-2 \pm 2\sqrt{5}}{8}.$$

$$u = \frac{-1 \pm \sqrt{5}}{4}.$$

Since $u = x^2$ must be non-negative, we take the positive root:

$$x^2 = \frac{-1 + \sqrt{5}}{4}.$$

$$x = \pm \sqrt{\frac{-1 + \sqrt{5}}{4}}.$$

4. ChatGPT — Task 3

Step 4: Solve for y and z

Using $y = 2x^2$:

$$y = 2 \times \frac{-1 + \sqrt{5}}{4} = \frac{-2 + 2\sqrt{5}}{4} = \frac{-1 + \sqrt{5}}{2}.$$

Using $z = x$, we get:

$$z = \pm \sqrt{\frac{-1 + \sqrt{5}}{4}}.$$

Final Answer:

The solutions are:

$$\left(\pm \sqrt{\frac{-1 + \sqrt{5}}{4}}, \frac{-1 + \sqrt{5}}{2}, \pm \sqrt{\frac{-1 + \sqrt{5}}{4}} \right).$$

4. ChatGPT — Task 4

Problem 4:

Prove that $7^n + 3^n - 2$ is divisible by 4 for all $n \in \mathbb{N}_0$.

Solution:

We need to show that:

$$7^n + 3^n - 2 \equiv 0 \pmod{4}, \quad \text{for all } n \in \mathbb{N}_0.$$

Step 1: Consider Base Case $n = 0$

Since $\mathbb{N}_0 = \{0, 1, 2, \dots\}$, we start with $n = 0$:

$$7^0 + 3^0 - 2 = 1 + 1 - 2 = 0.$$

Clearly, 0 is divisible by 4. So, the base case holds.

4. ChatGPT — Task 4

We now compute 7^n and 3^n modulo 4 for small values of n .

- **Modulo 4 behavior of 7^n :**

Since $7 \equiv 3 \pmod{4}$, we see that:

$$7^n \equiv 3^n \pmod{4}.$$

- **Modulo 4 behavior of 3^n :**

- $3^1 \equiv 3 \pmod{4}$,
- $3^2 \equiv 9 \equiv 1 \pmod{4}$,
- $3^3 \equiv 27 \equiv 3 \pmod{4}$,
- $3^4 \equiv 81 \equiv 1 \pmod{4}$.

The sequence alternates:

- If n is **odd**, $3^n \equiv 3 \pmod{4}$.
- If n is **even**, $3^n \equiv 1 \pmod{4}$.

Thus, since $7^n \equiv 3^n \pmod{4}$, we have:

- If n is **odd**, $7^n \equiv 3^n \equiv 3 \pmod{4}$.



4. ChatGPT — Task 4

- If n is odd, $7^n \equiv 3^n \equiv 3 \pmod{4}$.
- If n is even, $7^n \equiv 3^n \equiv 1 \pmod{4}$.

Step 3: Compute $7^n + 3^n - 2 \pmod{4}$

Now, compute:

$$7^n + 3^n - 2 \pmod{4}.$$

- If n is odd:

$$7^n + 3^n - 2 \equiv 3 + 3 - 2 = 4 \equiv 0 \pmod{4}.$$

- If n is even:

$$7^n + 3^n - 2 \equiv 1 + 1 - 2 = 0 \pmod{4}.$$

4. ChatGPT — Task 4

Step 4: Conclusion by Induction

From the base case ($n = 0$) and pattern analysis, we see that:

$$7^n + 3^n - 2 \equiv 0 \pmod{4}, \quad \forall n \in \mathbb{N}_0.$$

Thus, $7^n + 3^n - 2$ is always divisible by 4 for all non-negative integers n .

This completes the proof. ✓

5. Deepseek — Task 1

Problem 1: Solve for x : $x + 2^x = 5$.

Solution:

Rewrite the equation as $2^x = 5 - x$. By substituting $y = 5 - x$, we transform it into $y \cdot 2^y = 32$.

Applying the Lambert W function W , the solution is:

$$x = 5 - \frac{W(32 \ln 2)}{\ln 2}.$$

5. Deepseek — Task 2

Problem 2: Solve for a, b, c : $ab = 100, bc = 200, ca = 300$.

Solution:

Multiply all three equations: $(abc)^2 = 6 \times 10^6 \Rightarrow abc = \pm 1000\sqrt{6}$. Solving for each variable:

$$a = \frac{abc}{bc} = \pm 5\sqrt{6}, \quad b = \frac{abc}{ca} = \pm \frac{10\sqrt{6}}{3}, \quad c = \frac{abc}{ab} = \pm 10\sqrt{6}.$$

The solutions are $(a, b, c) = \left(5\sqrt{6}, \frac{10\sqrt{6}}{3}, 10\sqrt{6}\right)$ or $\left(-5\sqrt{6}, -\frac{10\sqrt{6}}{3}, -10\sqrt{6}\right)$.

5. Deepseek — Task 3

Problem 3: Compute the solutions $(x, y, z) \in \mathbb{C}^3$ for:

$$\begin{cases} x^2 + y^2 + z^2 - 1 = 0, \\ x^2 - y + z^2 = 0, \\ x - z = 0. \end{cases}$$

Solution:

From $x = z$, substitute into the first two equations:

1. $2x^2 + y^2 = 1,$

2. $2x^2 - y = 0 \Rightarrow y = 2x^2.$

Substitute $y = 2x^2$ into $2x^2 + (2x^2)^2 = 1$, yielding $4x^4 + 2x^2 - 1 = 0$. Let $u = x^2$:

$$4u^2 + 2u - 1 = 0 \Rightarrow u = \frac{-1 \pm \sqrt{5}}{4}.$$

Thus, $x = \pm \frac{1}{2} \sqrt{\sqrt{5} - 1}$ or $x = \pm \frac{i}{2} \sqrt{\sqrt{5} + 1}$. Corresponding y :

$$y = \frac{-1 \pm \sqrt{5}}{2}.$$

5. Deepseek — Task 3

Solutions:

$$\left(\pm \frac{1}{2} \sqrt{\sqrt{5}-1}, \frac{-1+\sqrt{5}}{2}, \pm \frac{1}{2} \sqrt{\sqrt{5}-1} \right),$$

$$\left(\pm \frac{i}{2} \sqrt{\sqrt{5}+1}, \frac{-1-\sqrt{5}}{2}, \pm \frac{i}{2} \sqrt{\sqrt{5}+1} \right).$$

5. Deepseek — Task 4

Problem 4: Prove $7^n + 3^n - 2$ is divisible by 4 for all $n \in \mathbb{N}_0$.

Proof:

Using modular arithmetic:

- $7 \equiv -1 \pmod{4} \Rightarrow 7^n \equiv (-1)^n \pmod{4},$
- $3 \equiv -1 \pmod{4} \Rightarrow 3^n \equiv (-1)^n \pmod{4}.$

Thus,

$$7^n + 3^n \equiv (-1)^n + (-1)^n = 2(-1)^n \pmod{4}.$$

Subtracting 2:

- If n is even: $2(1) - 2 = 0 \pmod{4},$
- If n is odd: $2(-1) - 2 = -4 \equiv 0 \pmod{4}.$

Hence, $7^n + 3^n - 2 \equiv 0 \pmod{4}$ for all n .

6. Conclusion

01

SymPy

Could solve the first three exercises, but not the fourth

02

Mathematica

Could solve the first three exercises, but not the fourth

03

ChatGPT

Could solve all exercises, but in the third task the complex solutions are missing (Prompt engineering necessary)

04

Deepseek

Could solve all four exercises correctly

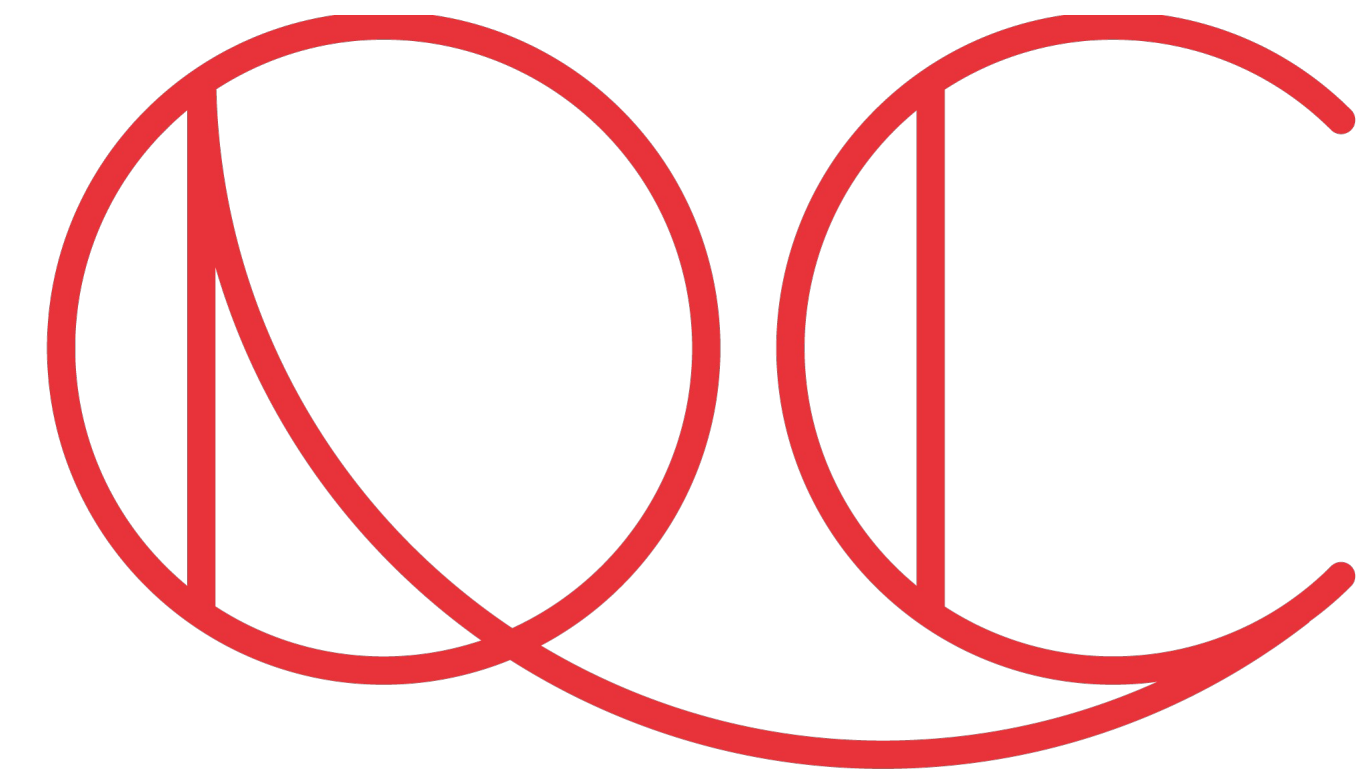
CONTACT

Thorsten Roland

Phone: 09131-4011955

Mobile: 0179-9750811

E-Mail: info@quantum-coding.de



**QUANTUM
CODING**