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Task 1: Test Case Design for Operator Misuse

1. Addressing the Mathematical Operations Problem
First Mathematical Operation:
$A=(A+B)\times B$
Second Mathematical Operation:
$C=A-5$

Objective
The objective is to detect any incorrect use of arithmetic operators in the program. There are three operators involved: addition (+), multiplication (*), and subtraction (-). Each operator could be incorrectly replaced by one of the other operators. Task 1 is intended to design test cases that distinguish the correct operator usage from incorrect operator implementations.

Alternative Constraints
The program $A=(A+B)\times B$ combined with $C=A-5$ can be affected by incorrect use of operators. There are 26 alternative constraints listed in the table below. It was generated by substituting each operator in the equations with different operators:

1. $C=(A-B)\times B-5$	10. $C=(A\times B)\times B\times 5$	19. $C=(A-B)+B+5$
2. $C=(A\times B)\times B-5$	11. $C=(A+B)+B+5$	20. $C=(A-B)+B\times 5$
3. $C=(A+B)+B-5$	12. $C=(A+B)+B\times 5$	21. $C=(A-B)-B+5$
4. $C=(A+B)-B-5$	13. $C=(A+B)-B+5$	22. $C=(A-B)-B\times 5$
5. $C=(A+B)\times B+5$	14. $C=(A+B)-B\times 5$	23. $C=(A\times B)+B+5$
6. $C=(A+B)\times B\times 5$	15. $C=(A-B)+B-5$	24. $C=(A\times B)+B\times 5$
7. $C=(A-B)\times B+5$	16. $C=(A-B)-B-5$	25. $C=(A\times B)-B+5$
8. $C=(A-B)\times B\times 5$	17. $C=(A\times B)+B-5$	26. $C=(A\times B)-B\times 5$
9. $C=(A\times B)\times B+5$	18. $C=(A\times B)-B-5$	

Justification for Test Cases
These test cases ensure that the program correctly implements the arithmetic operators. By comparing results with the 26 alternative constraints, discrepancies that show incorrect implementations can be identified.

Task 2: Test Case (A=10, B=0) analysis:

The test case (A=10, B=0) is unable to achieve the testing objective because when B=0, the program's original statement becomes A=(10+0)*0, which results in A=0, and subsequently C=A-5, which results in C=-5.

This specific test case is problematic because it leads to the original program outputting a unique result, C=-5, which cannot be obtained by any of the alternative constraints. However, this unique outcome occurs as a result of nullification through the multiplication by zero, thus hiding any possible incorrect use of arithmetic operators. Essentially, any incorrect operator would also result in A=0 and C=-5, thereby preventing the test from distinguishing between correct and incorrect operator usage.

In summary, the duplicate answer does not satisfy the constraints, which is that all expected outcomes for all alternatives should be different from the original statement for this testing objective. The use of B=0 does not reveal any operator misconduct, thereby not fulfilling the testing objective.

Task 3:

One concrete test case that can achieve the required testing objective is when A=3 and B=4. This test case is effective because its expected output (23) differs from all 26 alternative constraints. By ensuring that the outputs from the alternative constraints do not match the output from the original expression, this test case distinguishes correct operator usage from incorrect operators.

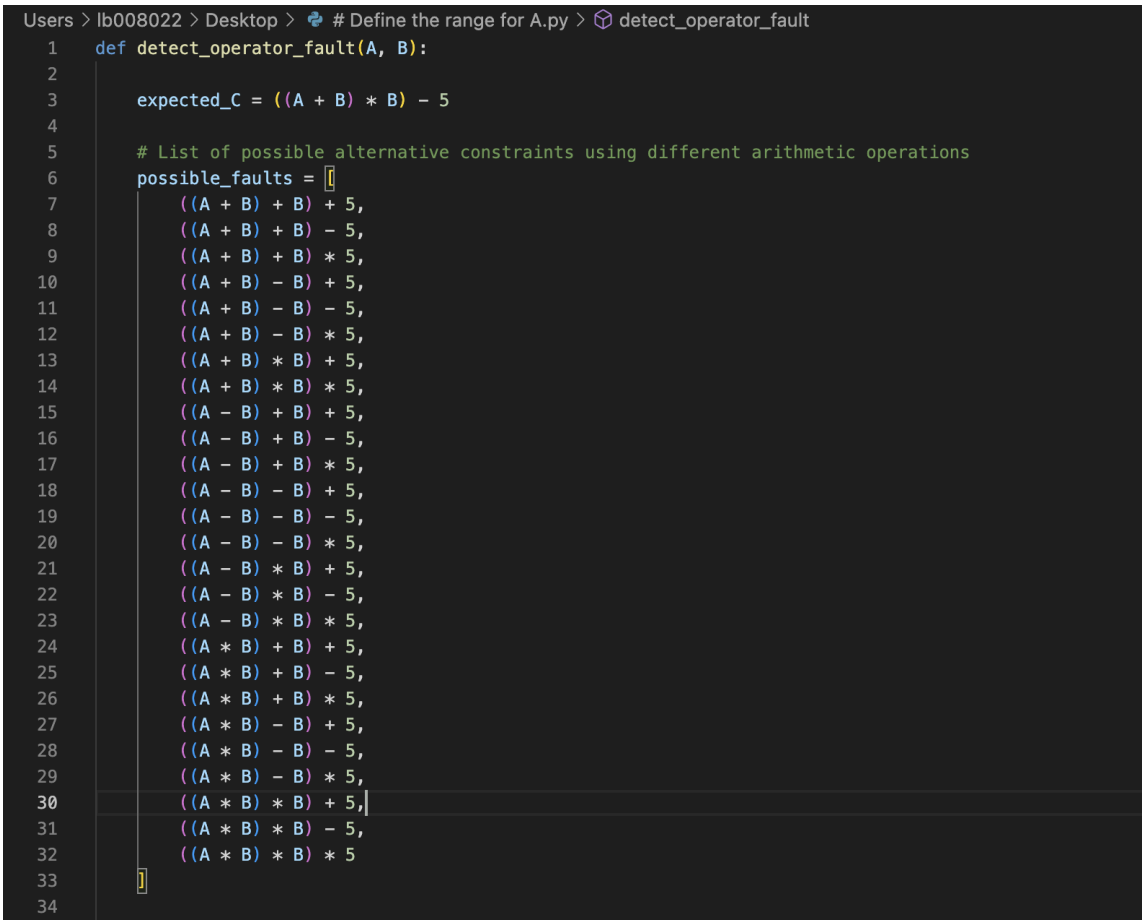
Statement	Output
Original: C=A−5	23
1. C=(A−B)×B−5	-9
2. C=(A×B)×B−5	43
3. C=(A+B)+B−5	6
4. C=(A+B)−B−5	-2
5. C=(A+B)×B+5	33
6. C=(A+B)×B×5	140

7. C=(A−B)×B+5	1
8. C=(A−B)×B×5	-20
9. C=(A×B)×B+5	53
10. C=(A×B)×B×5	240
11. C=(A+B)+B+5	16
12. C=(A+B)+B×5	27
13. C=(A+B)−B+5	8
14. C=(A+B)−B×5	-13
15. C=(A−B)+B−5	-2
16. C=(A−B)−B−5	-10
17. C =(A×B)+B−5	11
18. C=(A×B)−B−5	3
19. C=(A−B)+B+5	8
20. C=(A−B)+B×5	19
21. C=(A−B)−B+5	0
22. C=(A−B)−B×5	-21
23. C=(A×B)+B+5	21
24. C=(A×B)+B×5	32
25. C=(A×B)−B+5	13
26. C=(A×B)−B×5	-8

Task 4:

Language: Python
The code detects operator faults by calculating the expected result for the expression C=((A+B)×B)−5. It then tests various faulty operator combinations to check if they match the expected result. By iterating through a range of A values with

B=2, it identifies those where incorrect operators fail to reveal discrepancies, thus concealing faults in the program.



The output shown at the bottom of the image shows the values of A: [-8, -7, -4, -3, 0, 2, 6, 10]. These values cannot achieve the testing objective.