

# FPV Week 1: Implications, Assertions and Conditions



## Exercises

- There will be tutorial exercises every week
- In non-programming weeks, there will be quizzes to be solved during tutorials
- In programming weeks, there will be homework
- All exercises will be managed on Artemis  
[artemis.ase.in.tum.de](https://artemis.ase.in.tum.de)
- Programming exercises will be graded automatically, with secret tests
- This means you see your results already before the deadline ("What you see is what you get")

- Successful participation ( $\geq 70\%$ ) in quizzes and programming tasks will lead to a bonus of 0.3 in the final exam, provided that you passed the exam.
- Programming homework and quizzes are to be submitted individually.
- Discussing solutions before the end of the week is considered plagiarism.
- Plagiarism will not be tolerated and will (at the very least) lead to exclusion from the bonus system

# Material

The screenshot shows a GitHub repository page for 'Funky-Punky / FPV\_SoSe23\_Fr-14-16'. The repository is public and has 1 branch (main) and 0 tags. The commit history shows three commits: 'Funky-Punky Update .gitignore' (1e0ab34, 37 minutes ago, 3 commits), '.gitignore' (Update .gitignore, 37 minutes ago), and 'README.md' (Create README.md, 38 minutes ago). The README.md file is displayed with the following content:

Materialien für das FPV Tutorium von Jonas im SoSe23 Freitag von 14 bis 16 Uhr

Hier ist der Zulip Stream: [https://zulip.in.tum.de/#narrow/stream/1643-FPV\\_Fr-14-16](https://zulip.in.tum.de/#narrow/stream/1643-FPV_Fr-14-16)

The right sidebar contains the 'About' section with the text 'No description, website, or topics provided.' and the 'Releases' section with the text 'No releases published' and a link to 'Create a new release'. The 'Packages' section also shows 'No packages published' and a link to 'Publish your first package'.

[https://github.com/Funky-Punky/FPV\\_SoSe23\\_Fr-14-16](https://github.com/Funky-Punky/FPV_SoSe23_Fr-14-16)

# Quiz

$$\neg(a \Rightarrow b)$$

$$\equiv \neg(a \wedge b)$$

$$\equiv a \wedge \neg b$$

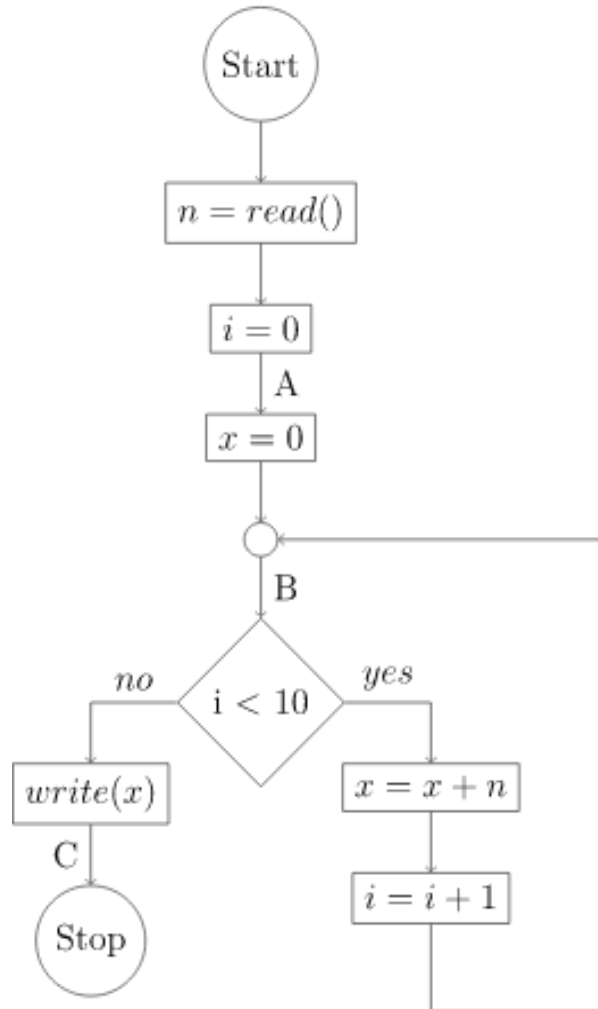
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# Week 01 Tutorial 01 Recap: Implications

1.  $x = 1 \implies 0 < x$  ✓
2.  $x < 6 \implies x = 3$  ✗
3.  $x > 0 \implies x \geq 0$  ✓
4.  $x = -2 \implies x < -1 \vee x > 1$  ✓
5.  $x = 0 \vee x = 7 \implies 4 \neq x$  ✓
6.  $x = 1 \implies x \leq 3 \wedge y > 0$  ✗
7.  $x < 8 \wedge y = x \implies y \neq 12$  ✓
8.  $x = 1, \vee y = 1 \implies x > 0$  ✗
9.  $x \neq 5 \implies \text{false}$  ✗
10.  $\text{true} \implies x \neq y$  ✗
11.  $\text{false} \implies x = 1$  ✓
12.  $x \geq 1 \implies 2x + 3 = 5$  ✗
13.  $A \wedge x = y \implies A$  ✓
14.  $B \implies A \vee B$  ✓
15.  $A \implies (B \implies A)$  ✓
16.  $(A \implies B) \implies A$  ✗

A	B	$A \implies B$
0	0	1
0	1	1
1	0	0
1	1	1

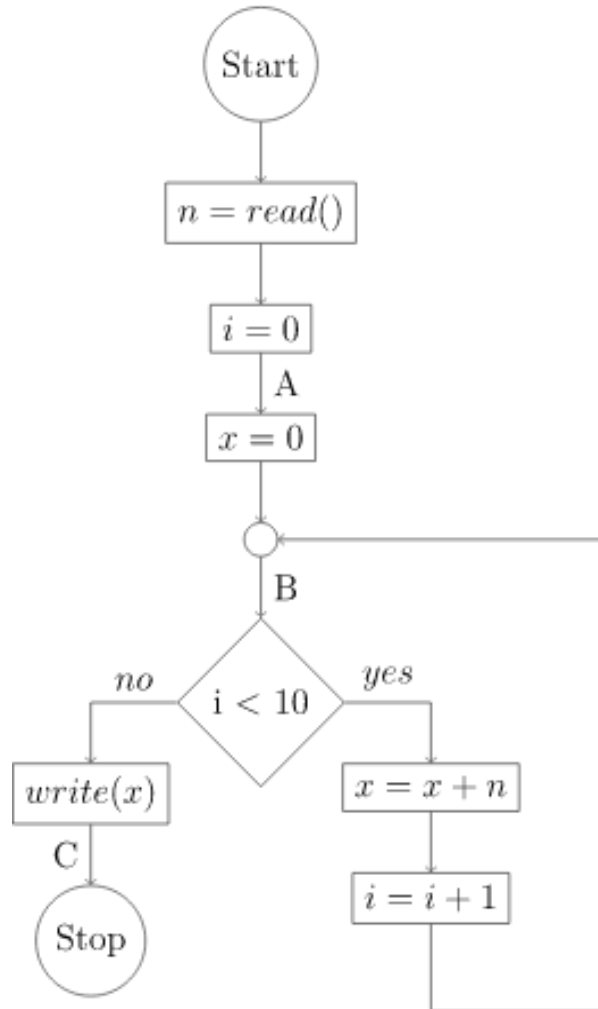
## Week 01 Tutorial 02 Assertions



1. Which of the following assertions hold at point **A**?

- ☒ a)  $i \geq 0$  ✓
- ☐ b)  $x = 0$  ✗
- ☐ c)  $i \leq 10 \wedge x \neq 0$  ✗
- ☒ d)  $\text{true}$  ✓
- ☒ e)  $i = 0$  ✓
- ☐ f)  $x = i$  ✗

## Week 01 Tutorial 02 Assertions



2. Which of the following assertions hold at point *B*?

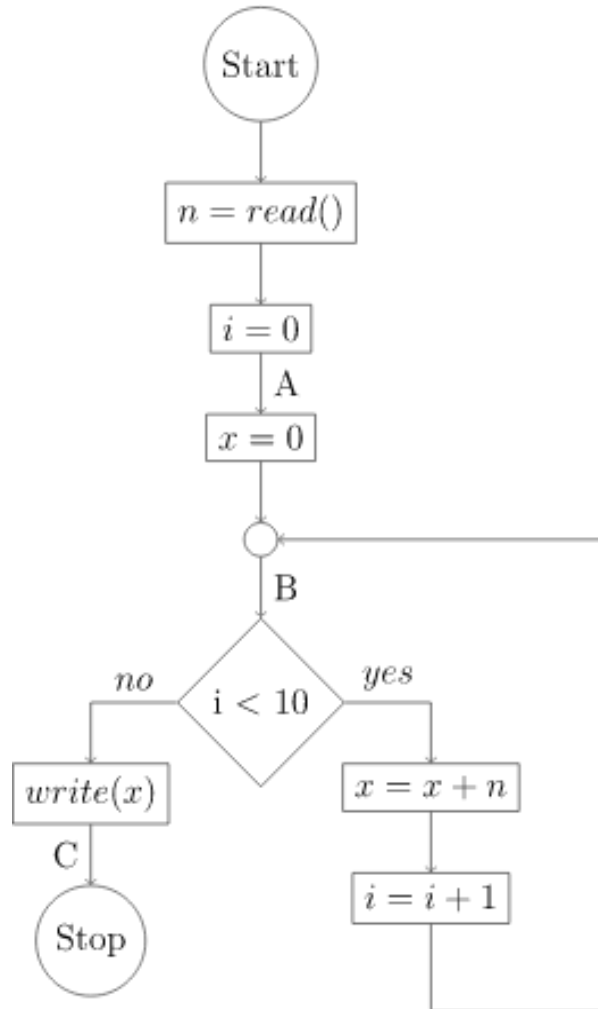
- a)  $x = 0 \wedge i = 0$  ✗
- b)  $x = i$  ✗
- c)  $i < x$  ✗
- d)  $0 \leq i \leq 10$  ✓
- e)  $i \geq 0 \wedge x \geq 0$  ✗
- f)  $n = 1 \implies x = i$  ✓

~~$F \implies D$~~

~~$D \implies F$~~



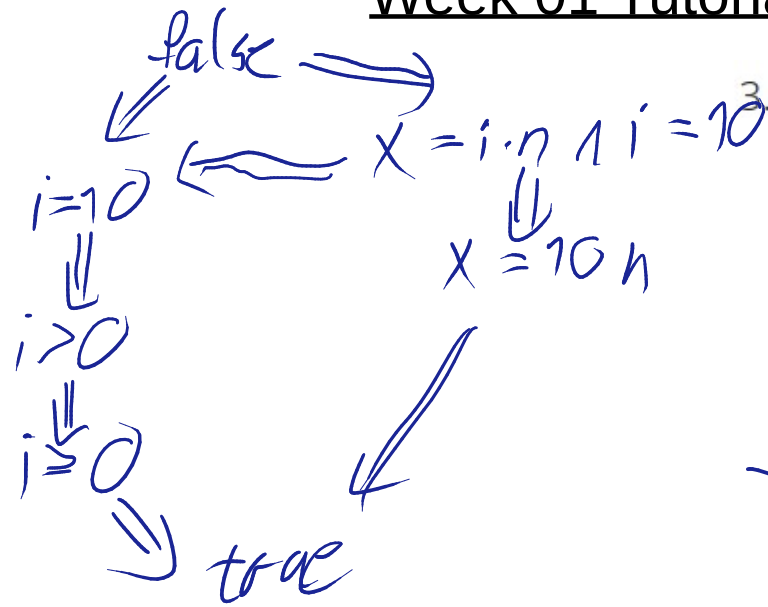
## Week 01 Tutorial 02 Assertions



3. Which of the following assertions hold at point *C*?

- a)  $i \geq 0$  ✓
- b)  $i = 10$  ✓
- c)  $i > 0$  ✓
- d)  ~~$x \neq n$~~  ✗
- e)  $x = 10n$  ✓
- f)  $x = i * n \wedge i = 10$  ✓

## Week 01 Tutorial 03 The Strong and the Weak



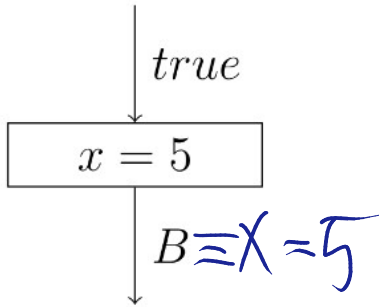
3. Which of the following assertions hold at point *C*?

- ☐ a)  $i \geq 0$
- ☐ b)  $i = 10$
- ☐ c)  $i > 0$
- ☒ d)  $x = i \cdot n$
- ☐ e)  $x = 10n$
- ☐ f)  $x = i \cdot n \wedge i = 10$

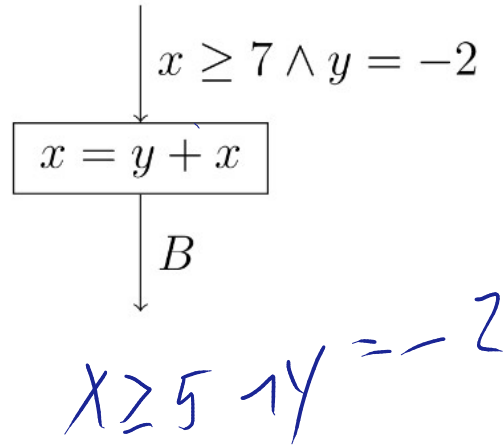
1. When annotating the control flow graph, can you say that one of the given assertions is "better" than the others?
2. Can you arrange the given assertions in a meaningful order?
3. How can you define a *stronger than* relation formally?
4. How do **true** and **false** fit in and what is their meaning as an assertion?
5. What are the strongest assertions that still hold at *A*, *B* and *C*?

# Week 01 Tutorial 04 Strongest Postconditions

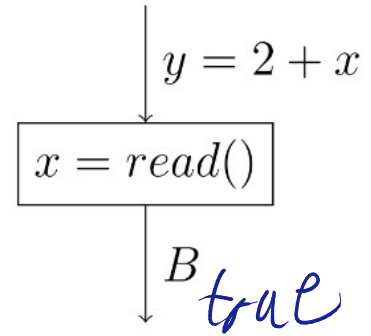
1.



3.

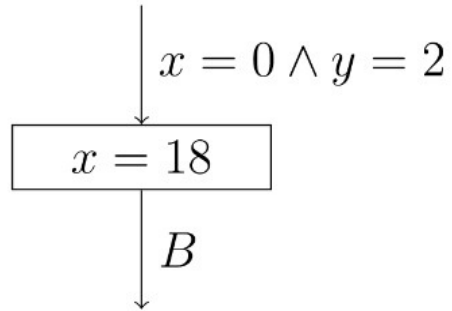


5.



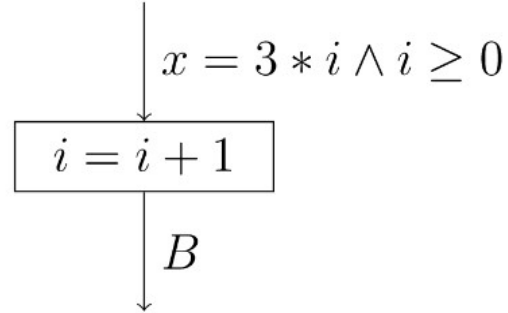
# Week 01 Tutorial 04 Strongest Postconditions

2.



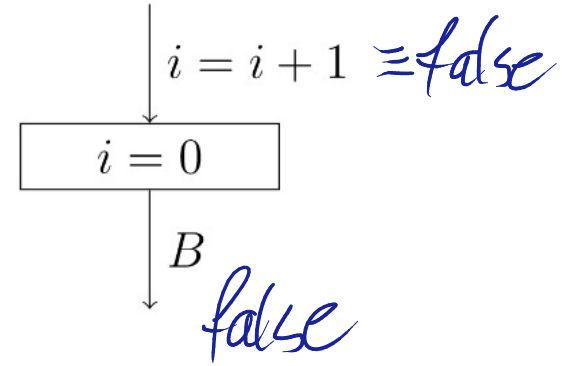
$$x = 18$$
$$y = 2$$

4.



$$x = 3(i-1) \wedge i \geq 1$$

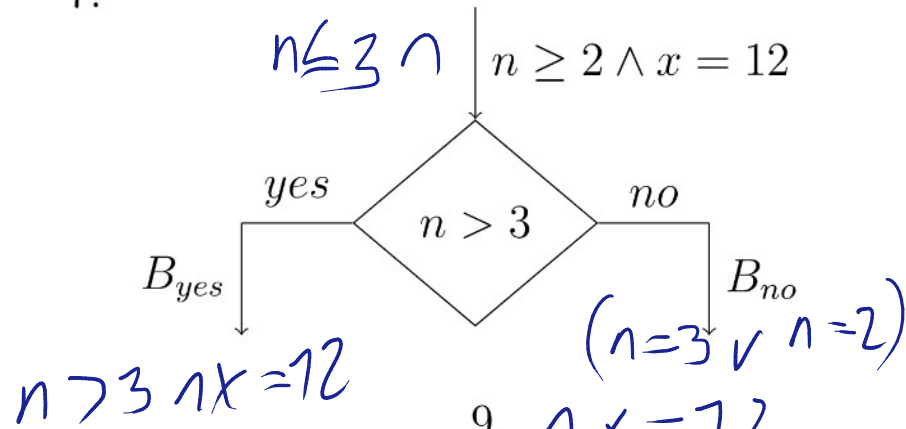
6.



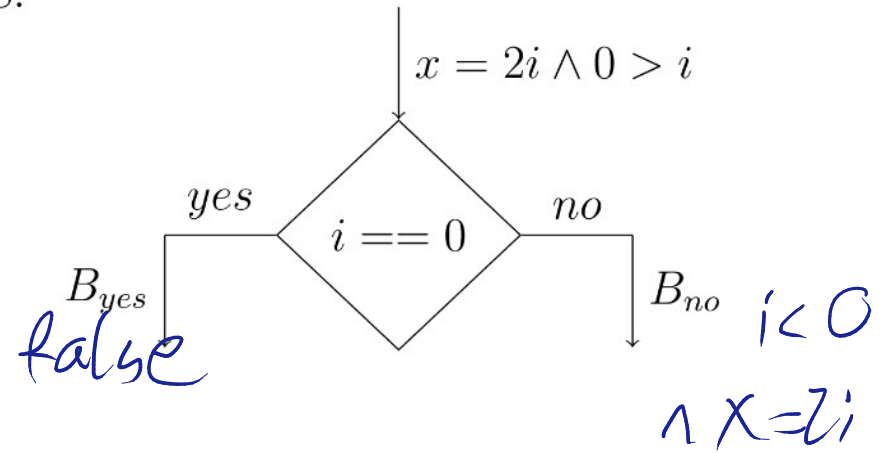
*false*

# Week 01 Tutorial 04 Strongest Postconditions

7.



8.



9.

