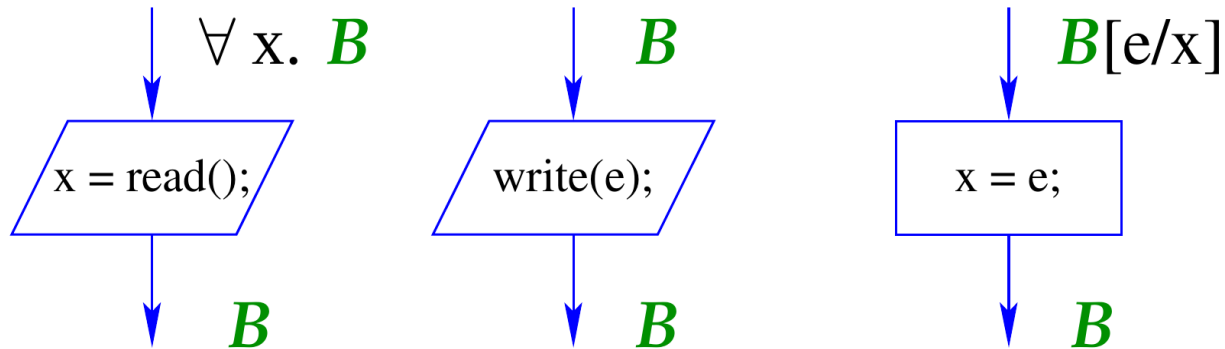


# Week 3: Loop Invariants



# Week 03 Tutorial 01 — MiniJava 2.0



# Week 03 Tutorial 01 — MiniJava 2.0

1. **rand**  $x$ :

Assigns a random value to variable  $x$ ,

2.  $x = \text{either } e_0, \dots, e_k$ :

Assigns one of the values of the expressions  $e_0, \dots, e_k$  to variable  $x$  non-deterministically,

3.  $x = e \text{ in } a, b$ :

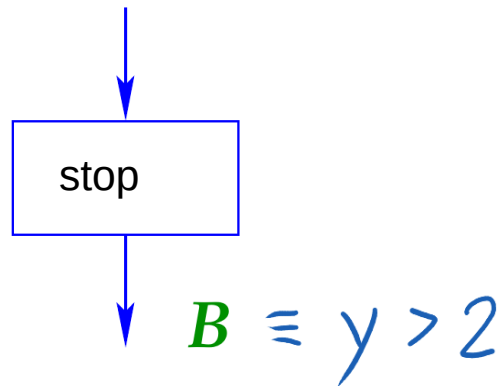
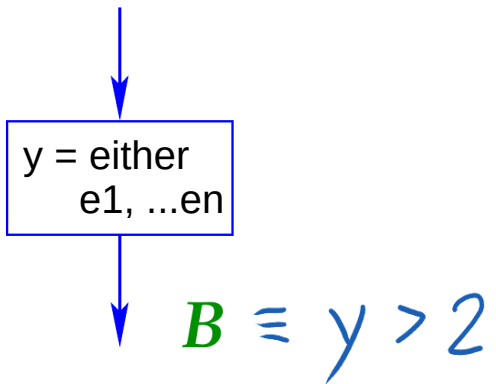
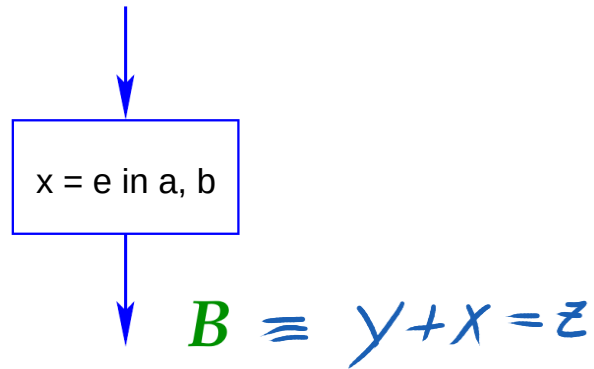
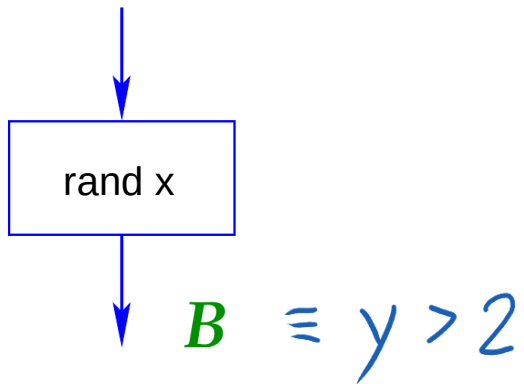
Assigns the value **1** to variable  $x$ , if the value of expression  $e$  is in the range  $[a, b]$  and **0** if  $e$  is not in the range or the range is empty ( $a > b$ ),

4. **stop**:

Immediately stops the program.

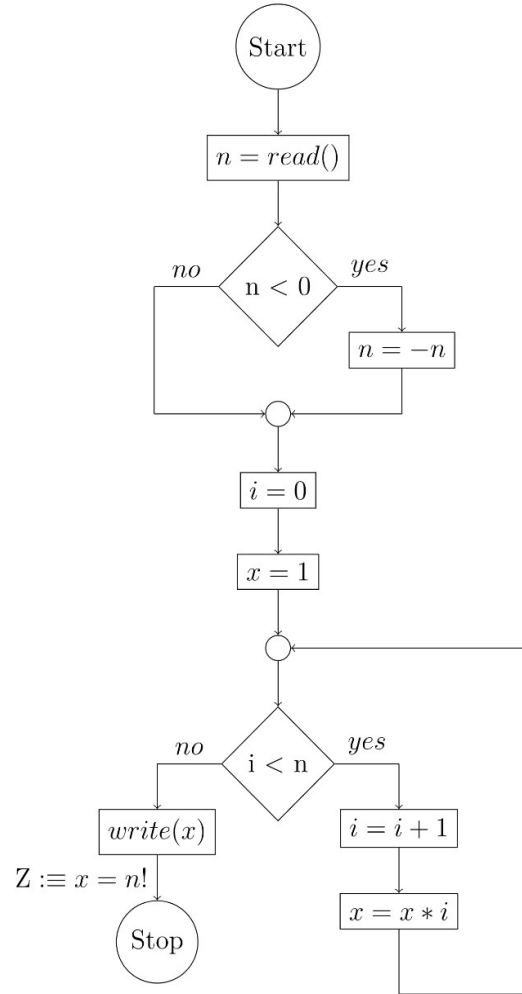
Define the weakest precondition operator  $\mathbf{WP}[\![\dots]\!](B)$  for each of these statements.

# Week 03 Tutorial 01 — MiniJava 2.0



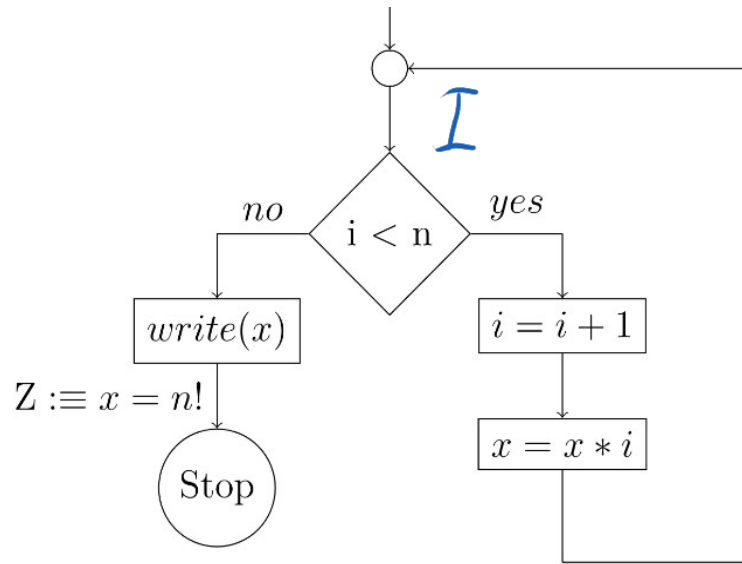
# Week 03 Tutorial 02 — Loop Invariants

1. Discuss the problem that arises when computing weakest preconditions to prove  $Z$ .
2. How can you use weakest preconditions to prove  $Z$  anyway?



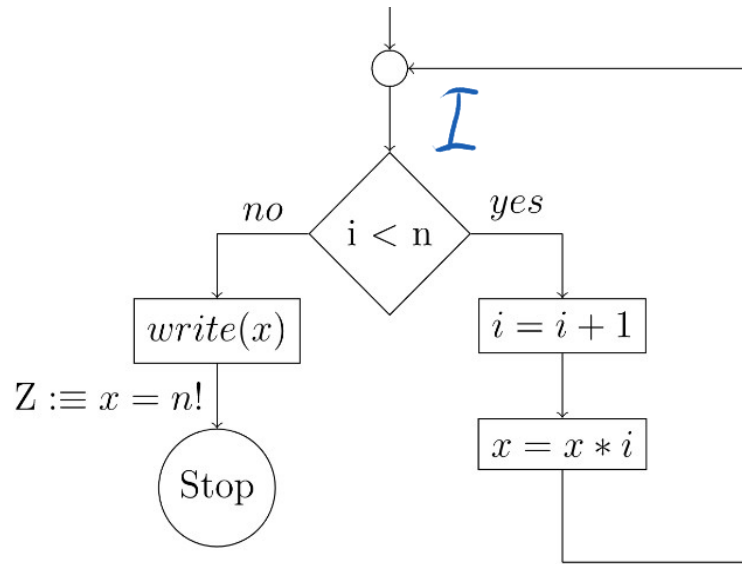
# Week 03 Tutorial 02 — Loop Invariants

$$I \equiv x \geq 0$$



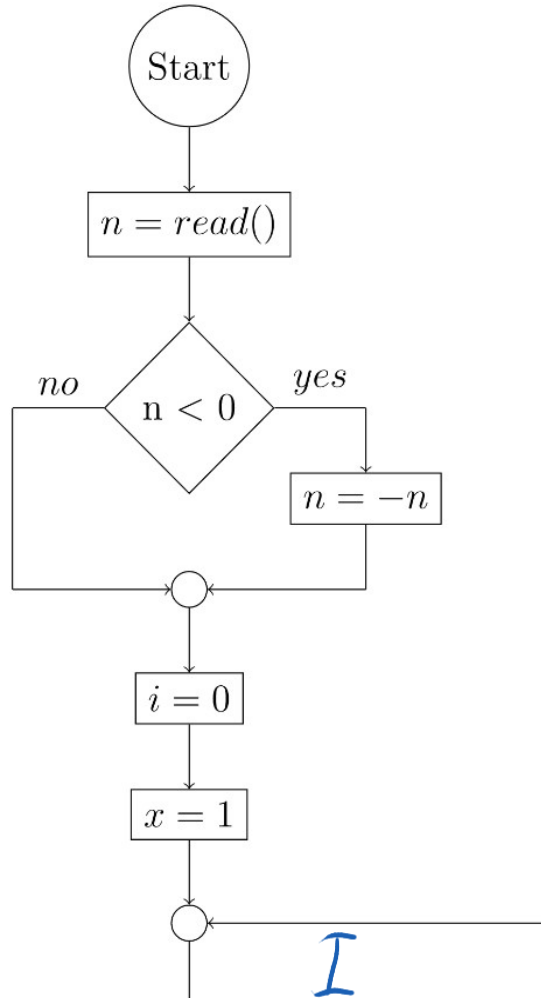
# Week 03 Tutorial 02 — Loop Invariants

$$I \equiv i=0 \wedge x=1 \wedge n=0$$



# Week 03 Tutorial 02 — Loop Invariants

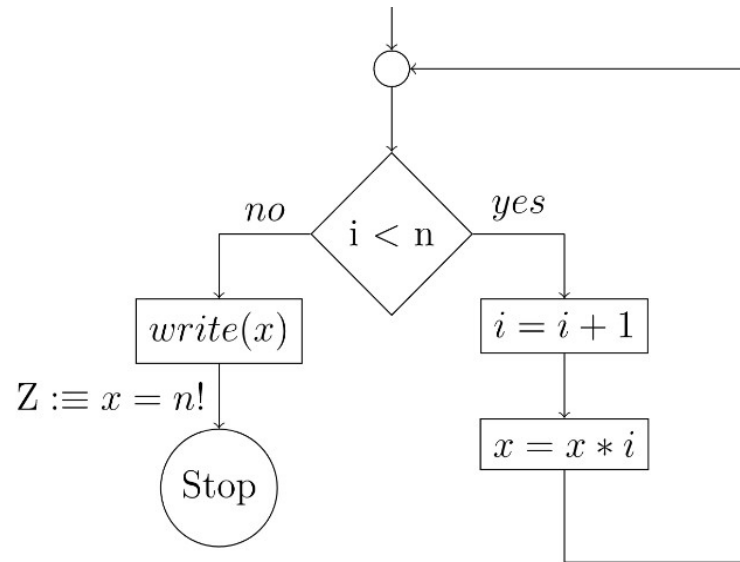
$$I \triangleq i = 0 \wedge x = 1 \wedge n = 0$$



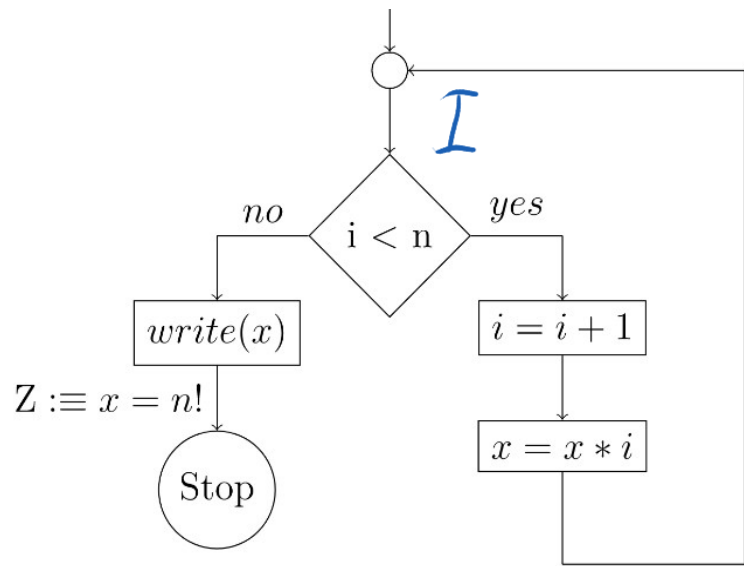


# Week 03 Tutorial 02 — Loop Invariants

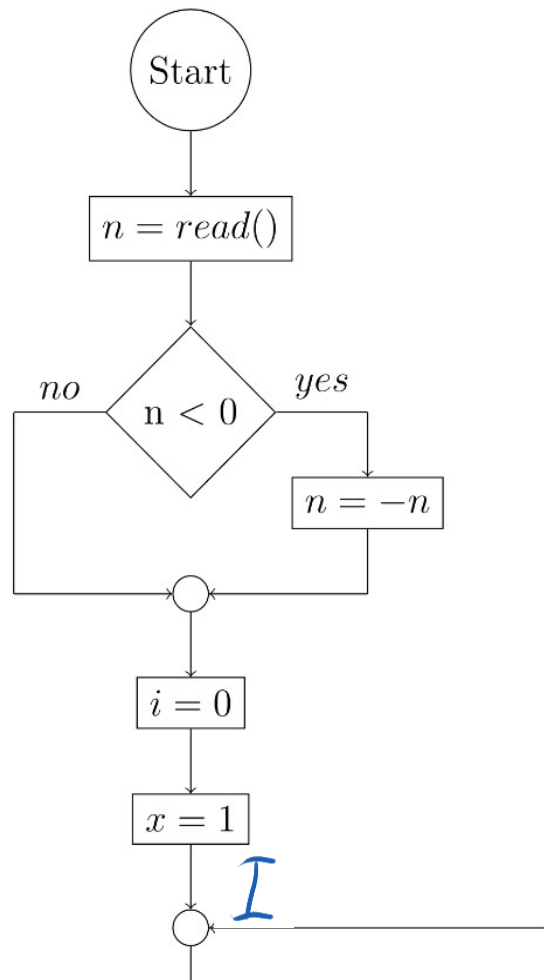
- a) How has a useful loop invariant be related to  $Z$ ?
- b) What happens if the loop invariant is chosen too strong?
- c) What happens if the loop invariant is chosen too weak?



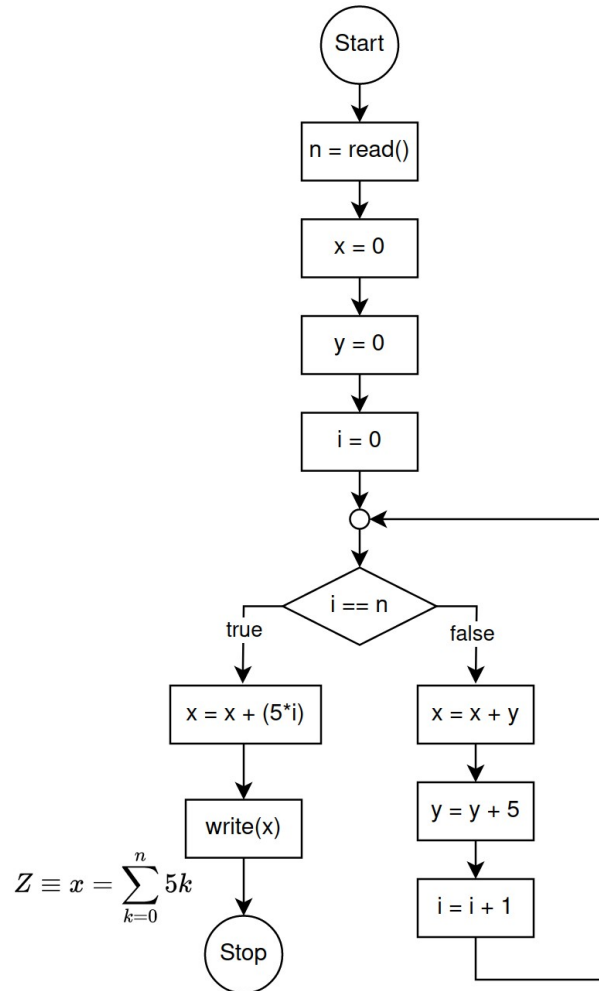
# Week 03 Tutorial 02 — Loop Invariants



# Week 03 Tutorial 02 — Loop Invariants



## Week 03 Task 3: Why is this not on Artemis?



## Week 03 Task 3: Why is this not on Artemis?

