In this exercise we will see that there are programs that have an infinite reachability graph but there exists a finite precise abstract reachability graph.

In the lecture we defined the precise abstract reachability graph as follows.

**Definition** (precise abstract reachability graph) A precise abstract reachability graph is a pair \((AC, T)\) such that \(AC\) is a set of abstract configurations such that

- for each abstract configuration \((\ell, \{\varphi\})\) for which \(\varphi \neq \text{false}\) and there exists \((\ell, st, \ell') \in \Delta\), there is an abstract configuration \((\ell', \{\varphi'\})\) such that \(sp(\{\varphi\}, st) = \{\varphi'\}\) and \(((\ell, \{\varphi\}), st, (\ell', \{\varphi'\})) \in T\)

- \((\ell_{\text{init}}, \{\varphi_{\text{pre}}\}) \in AC\), and

- there is a path from \((\ell_{\text{init}}, \{\varphi_{\text{pre}}\})\) to each abstract configuration \((\ell, \{\varphi\})\).

**Exercise 1: Precise Abstract Reachability Graph** 2 Points

Consider the control flow graph depicted on the right, that was constructed for the the program \(P = (V, \mu, T)\) with \(V = \{x, y\}\), \(\mu(x) = \mu(y) = \mathbb{Z}\) whose code is shown on the left.

```plaintext
1 while (x % 2 == 0) {
2    havoc y;
3    assume y >= 0;
4    x := x + y;
5 }
```

Draw the precise abstract reachability graph for this control-flow graph and the precondition \(x \geq 0\).

In the lecture it was said that the precise abstract reachability graph is unique. This is not true. For example in this exercise you could chose \((\ell_2, \{x \geq 0 \land x \% 2 = 0\})\) or \((\ell_2, \{x \% 2 = 0 \land x \geq 0\})\) (or even both!) as successors of the initial abstract configuration. For solving this exercise it is necessary to choose the formulas that define sets of states wisely.