



Introduction to Software Verification

Vincent Penelle

<vpennelle@u-bordeaux.fr>

LaBRI, Université de Bordeaux

September 17, 2018

— *Models and Properties* —

Example of abstract models

Give examples:

- Finite Automata.
- Turing Machine.
- Pushdown Automata.
- Counter Systems.
- Vector Addition Systems

Interesting Properties

Explain and put examples:

- Reachability.
- Model-checking.
- Liveness.
- Fairness.
- etc.

Reachability

Input: A graph \mathcal{G} and two vertices x, y .

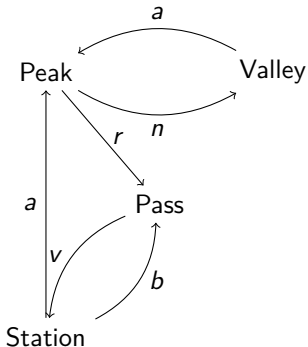
Output: If there exists a path between x and y .

Reachability

Input: A graph \mathcal{G} and two vertices x, y .

Output: If there exists a path between x and y .

Example: Is it possible to go from the valley to the station?

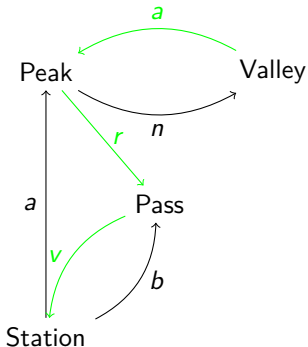


Reachability

Input: A graph \mathcal{G} and two vertices x, y .

Output: If there exists a path between x and y .

Example: Is it possible to go from the valley to the station? **Yes.**



Model-checking

Input: A graph \mathcal{G} and a logic formula ϕ .

Output: If $\mathcal{G} \models \phi$.

- First Order: $x \xrightarrow{a} y, \exists x, \forall x$
- First Order with reachability: $x \xrightarrow{*} y$
- Monadic Second Order: $x \in X, \exists X, \forall X$

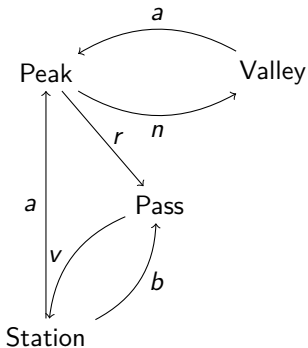
Model-checking

Input: A graph \mathcal{G} and a logic formula ϕ .

Output: If $\mathcal{G} \models \phi$.

Example: Is it possible to leave the valley without taking any ski lift?

$$\phi = \exists x, (\text{Valley} \xrightarrow{v} x \vee \text{Valley} \xrightarrow{n} x \vee \text{Valley} \xrightarrow{r} x) \wedge x \neq \text{Valley}$$



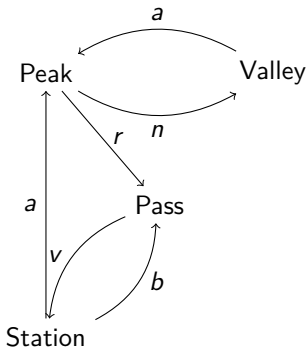
Model-checking

Input: A graph \mathcal{G} and a logic formula ϕ .

Output: If $\mathcal{G} \models \phi$.

Example: Is it possible to leave the valley without taking any ski lift? **No.**

$$\phi = \exists x, (\text{Valley} \xrightarrow{v} x \vee \text{Valley} \xrightarrow{n} x \vee \text{Valley} \xrightarrow{r} x) \wedge x \neq \text{Valley}$$



Nothing bad happens (bad states not accessible).

Liveness (concurrent programs)

Something good eventually happens. What to show ?