Exercise 5.9: For each of the LTL-formulas below, construct a Büchi automaton that accepts exactly those traces that satisfy the formula:

(1) $\Box\Diamond e \vee \Diamond\Box f$;
(2) $\Box\Diamond e \wedge \Box\Diamond f$;
(3) $\Box(e \rightarrow e \,\mathsf{U}\, f)$.

Exercise 5.10: Write an LTL-formula that exactly describes the set of traces that are accepted by the Büchi automaton shown in figure 5.9. Explain your answer. ■

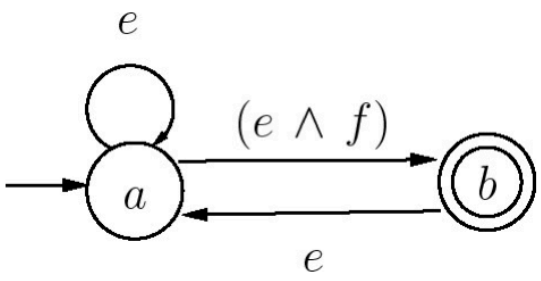

Figure 5.9: Exercise: From a Büchi Automaton to LTL

Exercise 5.15: Consider the LTL-formula $\phi = (e \,\mathsf{U}\, \bigcirc f) \vee \neg e$. First compute the closure $Sub(\phi)$. Then apply the tableau construction to build the generalized Büchi automaton M_ϕ. It suffices to construct only the reachable states. ■

Exercise 5.19: Consider a transition system with two variables x and y of type nat. Suppose the transitions of the system are described by the conditional statement

```
if ( x > y ) then x := x + 1 else y := x.
```

First, describe the transition region as a formula *Trans* over the variables x, y, x', and y'. Consider the region A given by the formula $1 \leq y \leq 5$. Compute the pre-image of the region A. ■