

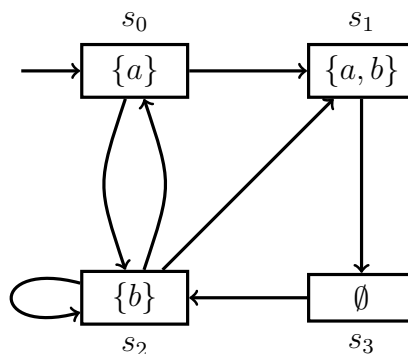
## Model Checking – Exercise sheet 9

### Exercise 9.1

Let  $a = a_2a_1a_0$ ,  $b = b_2b_1b_0$ , and  $c = c_3c_2c_1c_0$  be 3-bit, 3-bit, and 4-bit unsigned integers, respectively.

- (a) Draw a BDD that represents  $a + b = c$ . Write down your variable ordering.
- (b) Draw a BDD that represents  $a = 2 \cdot b$ . The BDD should contain every possible value of  $b$  such that  $2 \cdot b$  is representable using 3 bits. The variable ordering of  $a$  and  $b$  must be the same as in (a).
- (c) Use the BDDs from (a) and (b) to construct a BDD that represents  $3 \cdot b = c$ .
- (d) Use the BDD from (c) to construct a BDD that represents  $c \bmod 3 = 0$ .

### Exercise 9.2



For the given transition system,

- (a) Construct a BDD representing the transition system.
- (b) Using the BDD from (a), construct the BDD representing
  - (i)  $Img(\phi)$  where  $Img(\phi)$  is the set of successors of states which satisfy the formula  $\phi$ .
  - (ii)  $Pre(a)$  where  $Pre(\phi)$  is the set of predecessors of states which satisfy  $\phi$ .

### Exercise 9.3

For a given transition system as a BDD  $T$  and a set of states as a BDD  $S$ , give an algorithm to compute the set of all reachable states from  $S$ . Also, Give an algorithm to compute the shortest path between two given states  $s_1$  and  $s_2$  using  $T$ .