

## Quantitative Verification – Exercise sheet 3

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### Exercise 3.1

Compute the set of reachable states in the TA shown in figure 1.

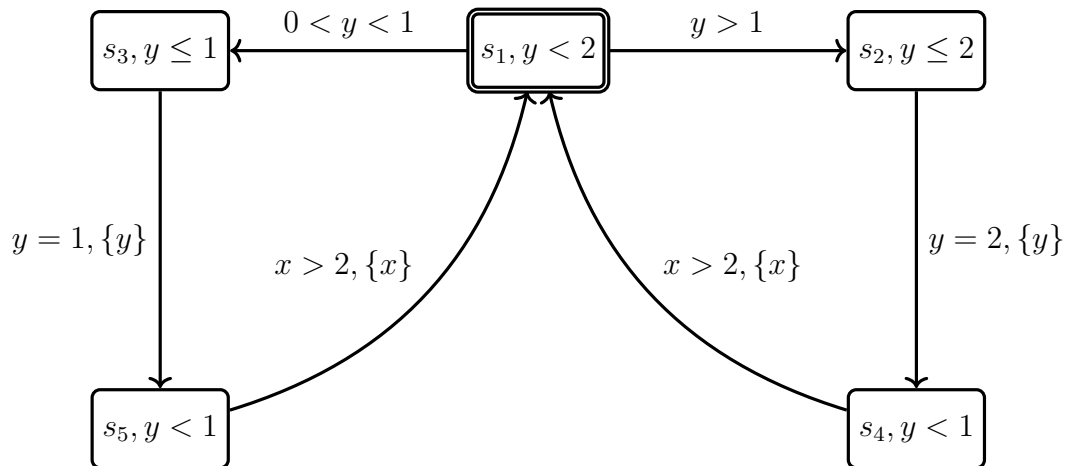


Figure 1:  $\mathcal{A}_1$

### Exercise 3.2

Draw the region automaton for the TA shown in figure 2.

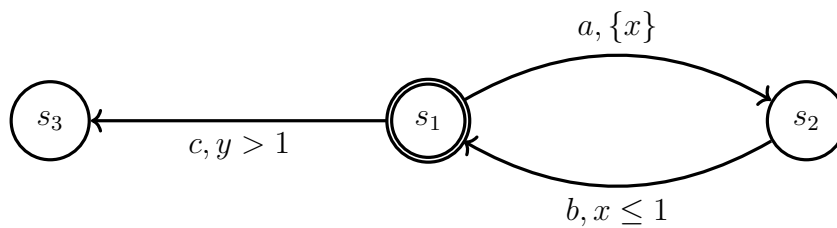


Figure 2:  $\mathcal{A}_2$

### Exercise 3.3

Draw the zone automaton for the TA shown in figure 3.

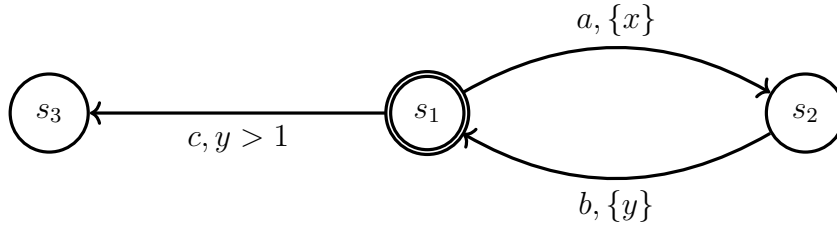


Figure 3:  $\mathcal{A}_3$

**Solution 3.1**

Set of reachable states =  $\{s_1, s_2, s_3, s_4, s_5\}$

**Solution 3.2**

- We have  $C_x = C_y = 1$ . Hence, we have the following regions

- |                          |                              |
|--------------------------|------------------------------|
| 1. $x = y = 0$           | 10. $x > 1, y = 0$           |
| 2. $x = y \in (0, 1)$    | 11. $x > 1, y \in (0, 1)$    |
| 3. $x = y = 1$           | 12. $x > 1, y = 1$           |
| 4. $x = 0, y \in (0, 1)$ | 13. $x = 0, y > 1$           |
| 5. $x = 0, y = 1$        | 14. $x \in (0, 1), y > 1$    |
| 6. $x \in (0, 1), y = 0$ | 15. $x = 1, y > 1$           |
| 7. $x = 1, y = 0$        | 16. $x > 1, y > 1$           |
| 8. $x \in (0, 1), y = 1$ | 17. $x > y, x, y \in (0, 1)$ |
| 9. $x = 1, y \in (0, 1)$ | 18. $x < y, x, y \in (0, 1)$ |

The region automaton is showed in figure 4. Delay transitions are dashed, transitive delay transitions and delay self-loops on states with regions 11, 14, 16, 17 and 18 are omitted for readability.

**Solution 3.3**

The zone automaton is showed in figure .

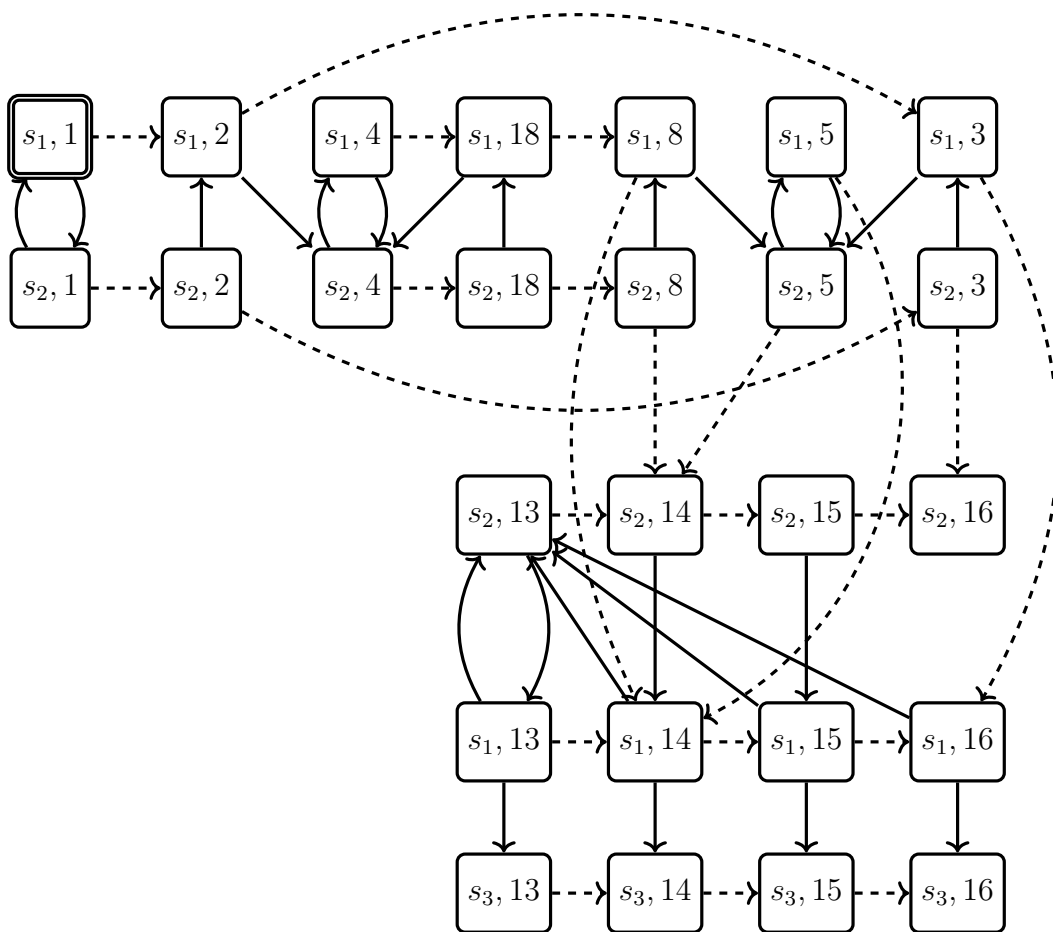


Figure 4: Region automaton

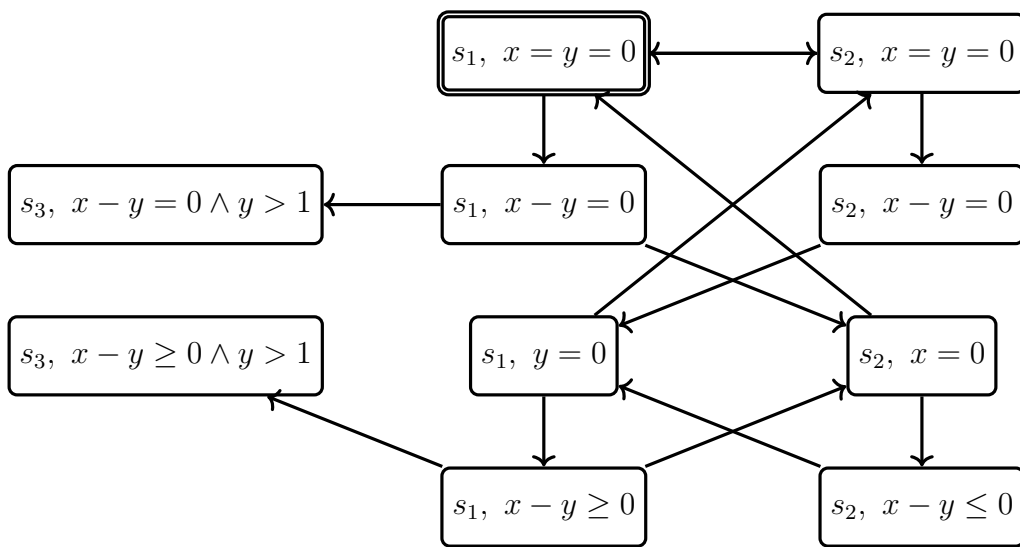


Figure 5: Zone automaton