Contents

Chapter 1

Appendices Structure

Appendix A: Extraneous Information. Extraneous information for the interested reader, such as additional state space diagrams and rewrite rules.

Appendix B: Source Code. All of the rewrite rules we implemented in GROOVE as part of the implemented model[1]. There is also a link to download the GROOVE implementation grammar we implemented in this paper.

Appendix C: User Guide A User Manual for readers wishing to try out our implementation on GROOVE[2], including rule documentation and a simple procedure for producing simulations.

[1] Since our implementation in GROOVE is directly executable, it takes the place of any source code we would have incorporated within this paper.

[2] More information on GROOVE, as well as download links, can be found here: https://groove.ewi.utwente.nl/

Appendix A

Extraneous Information

A.1 Simulation Results From *Section 6.1*

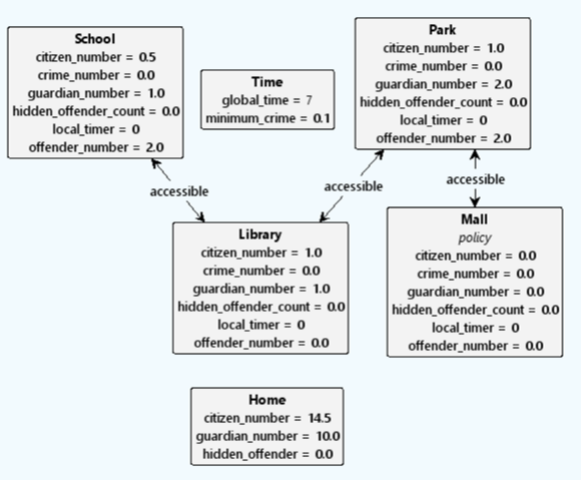


Figure A.1: State at time 7.

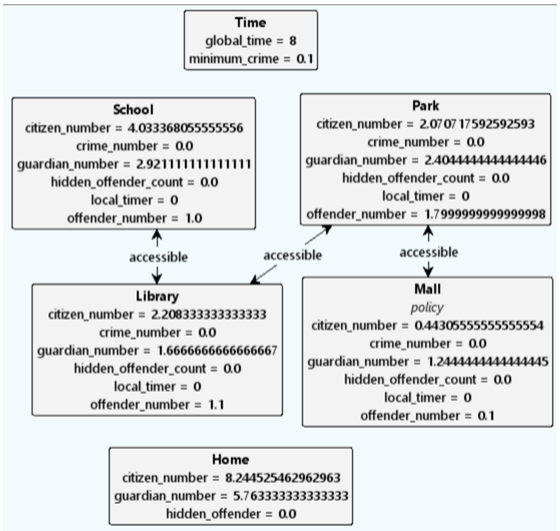


Figure A.2: State at time 8.

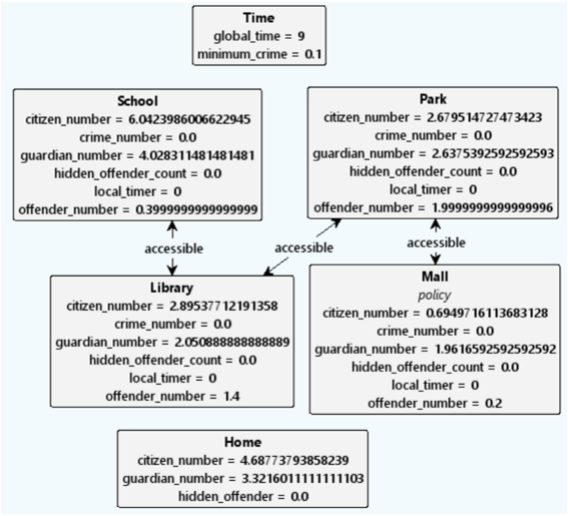


Figure A.3: State at time 9.

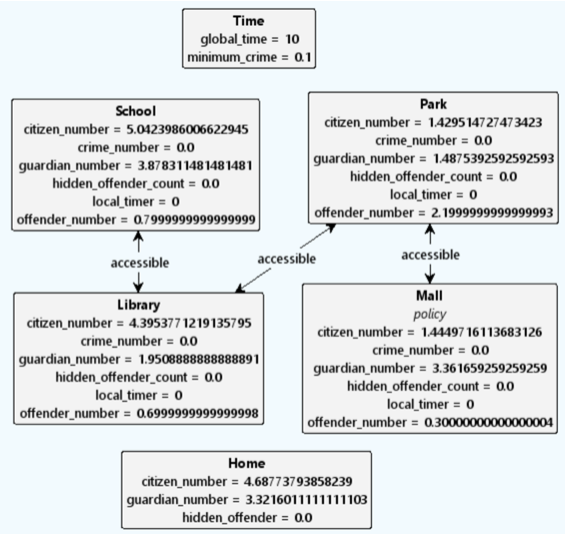


Figure A.4: State at time 10.

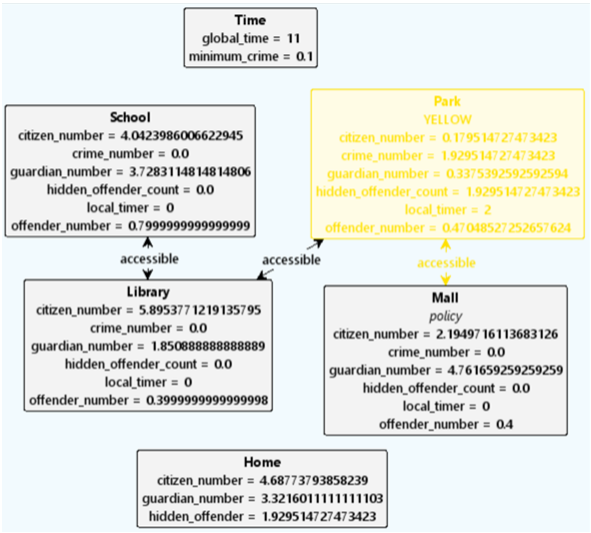


Figure A.5: State at time 11.

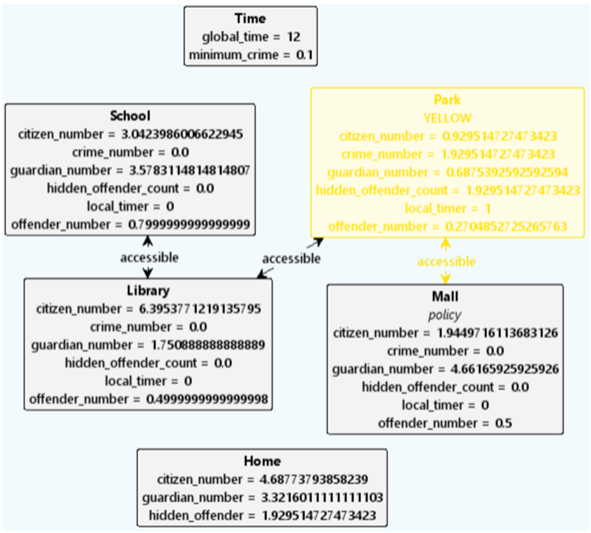


Figure A.6: State at time 12.

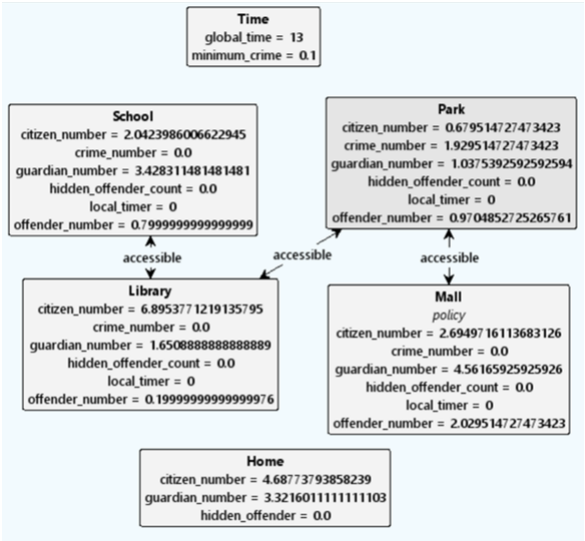


Figure A.7: State at time 13.

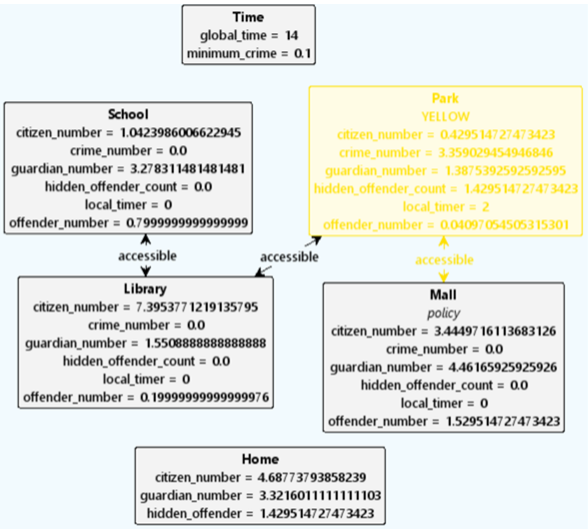


Figure A.8: State at time 14.

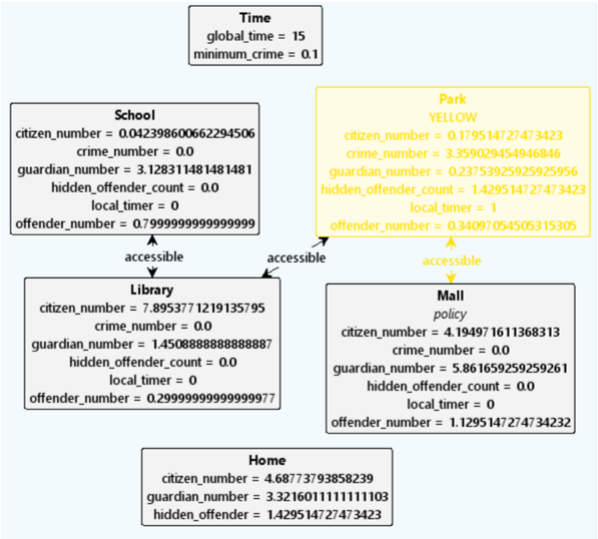


Figure A.9: State at time 15.

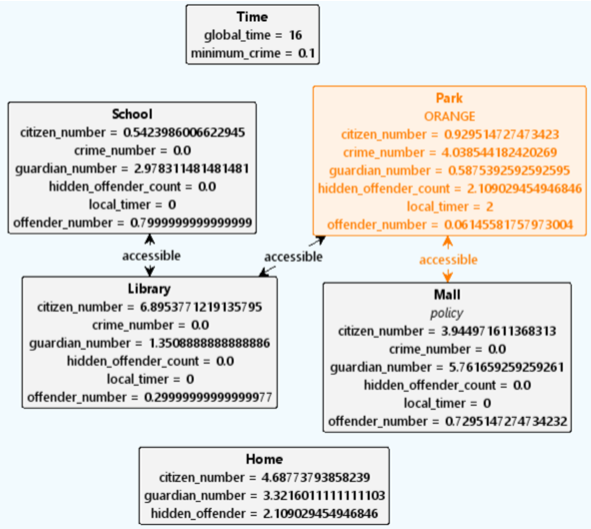


Figure A.10: State at time 16.

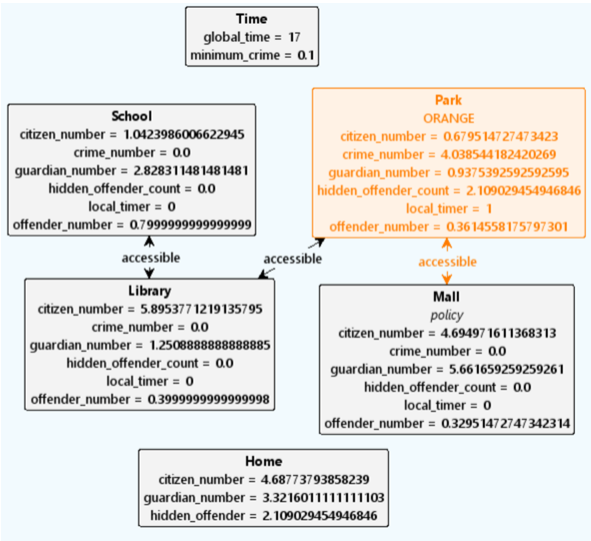


Figure A.11: State at time 17.

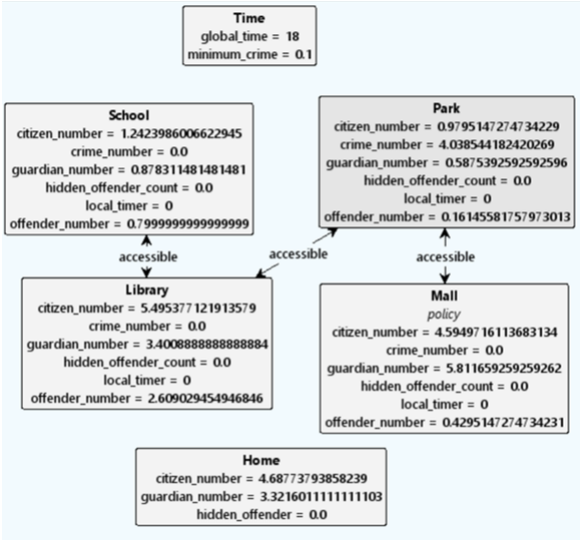


Figure A.12: State at time 18.

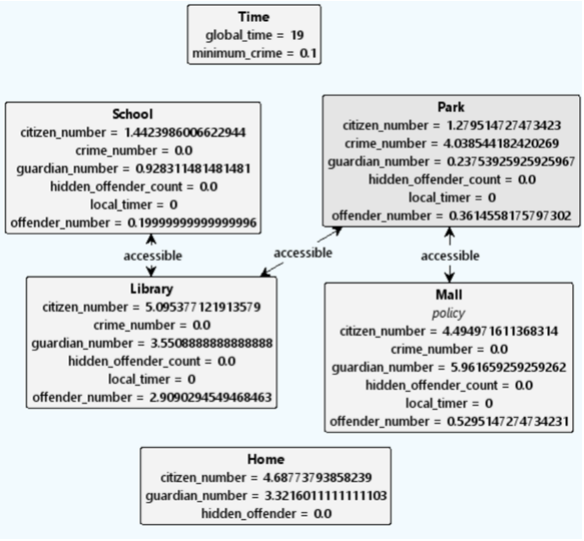


Figure A.13: State at time 19.

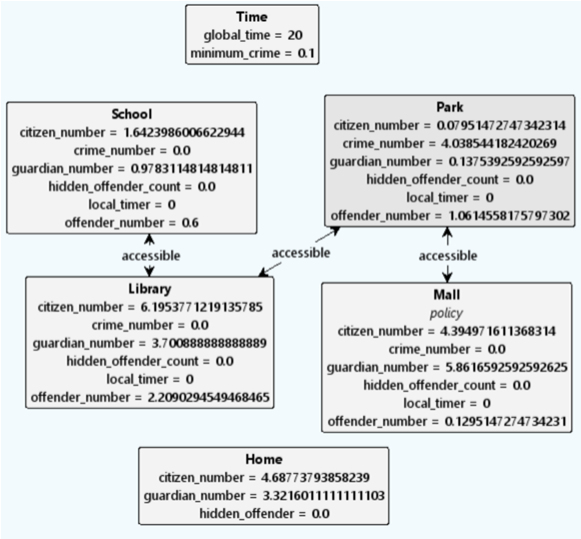


Figure A.14: State at time 20.

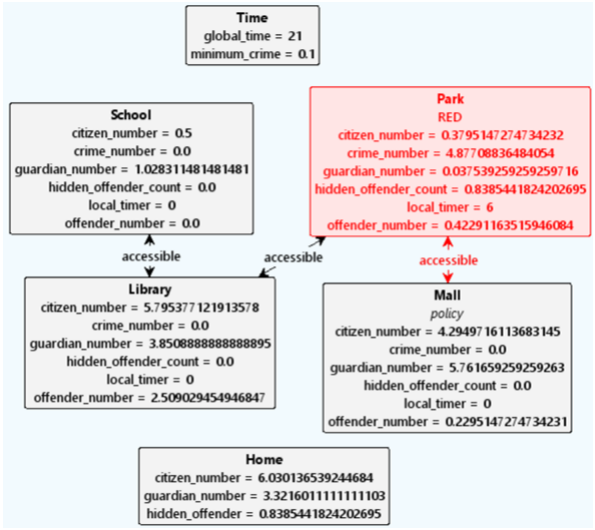


Figure A.15: State at time 21.

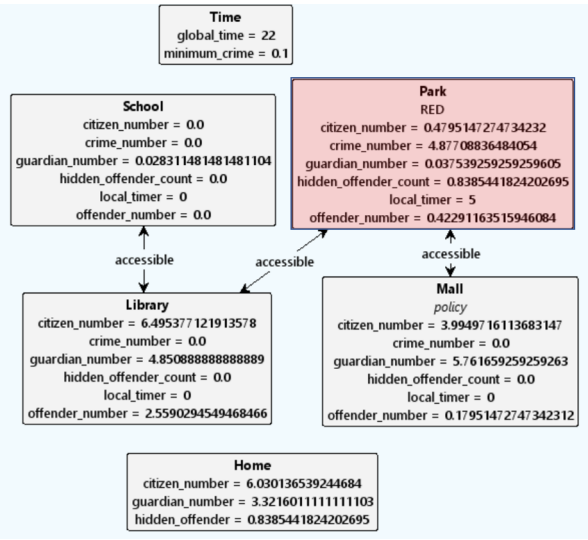


Figure A.16: State at time 22.

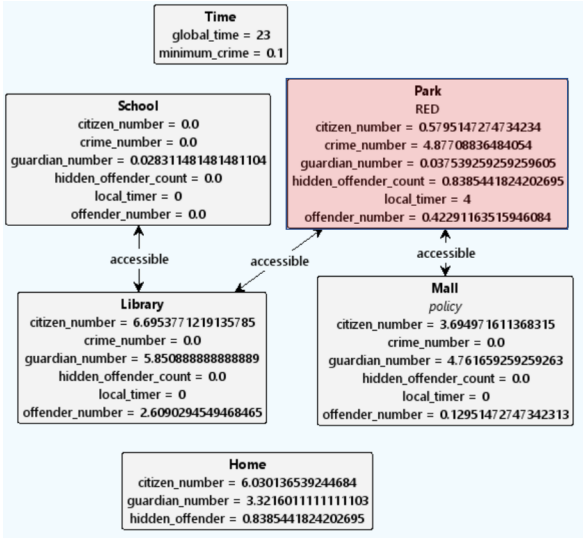


Figure A.17: State at time 23.

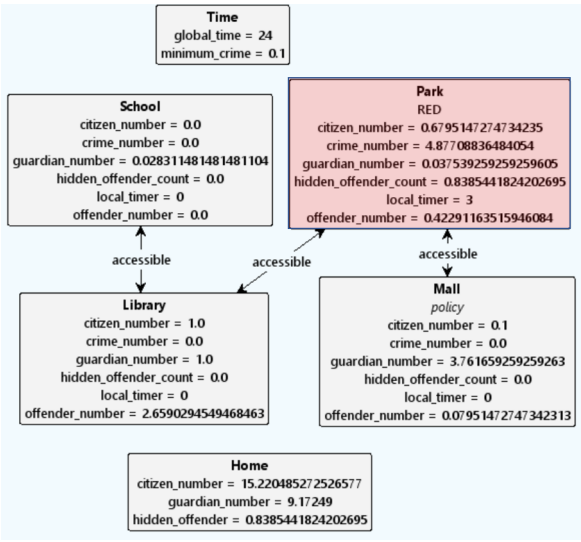


Figure A.18: State at time 24.

Note: after timestep 24, there is actually a state at time 0. However, this is only because the *newDay* rewrite rule sets the time of the day to 0 instead of 1. In our simulation, we just incremented the time once more when at the implicit state at time 0.

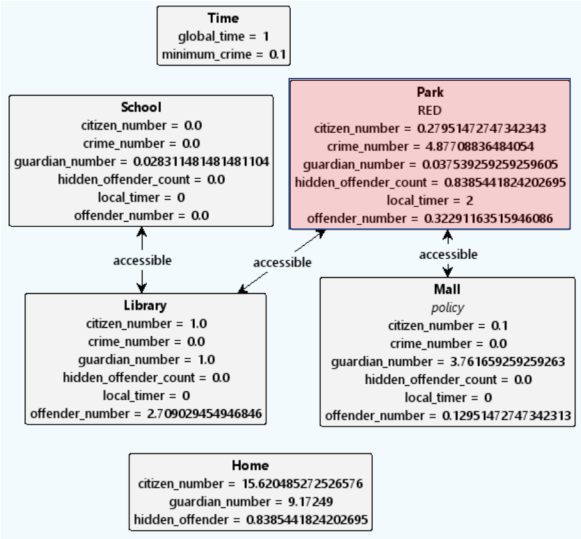


Figure A.19: State at time 1

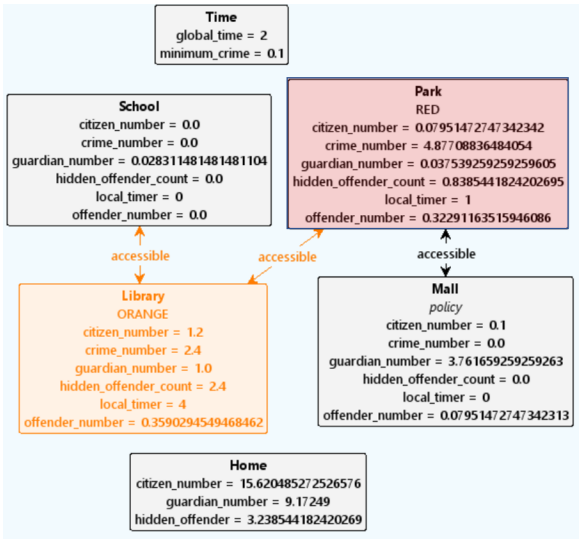


Figure A.20: State at time 2.

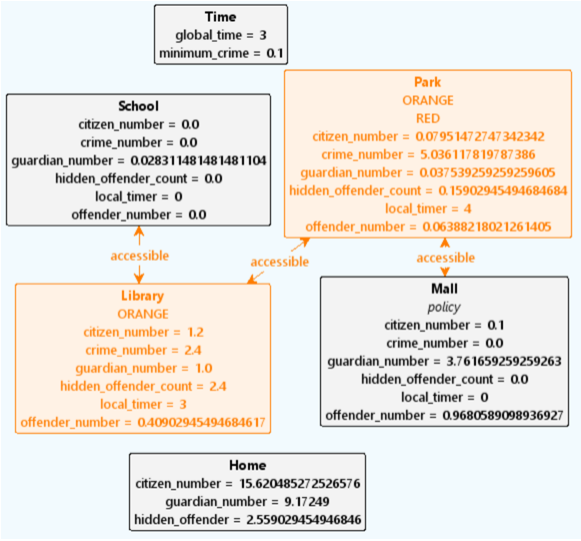


Figure A.21: State at time 3.

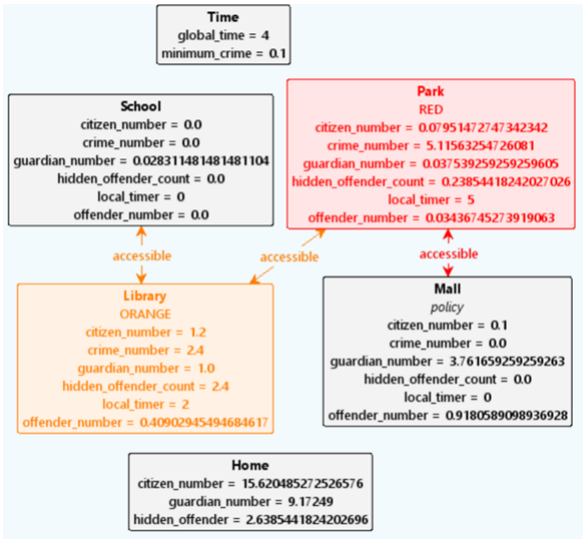


Figure A.22: State at time 4.

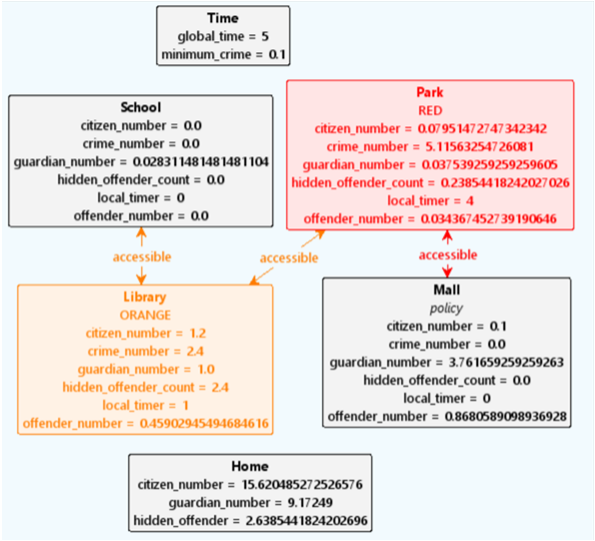


Figure A.23: State at time 5.

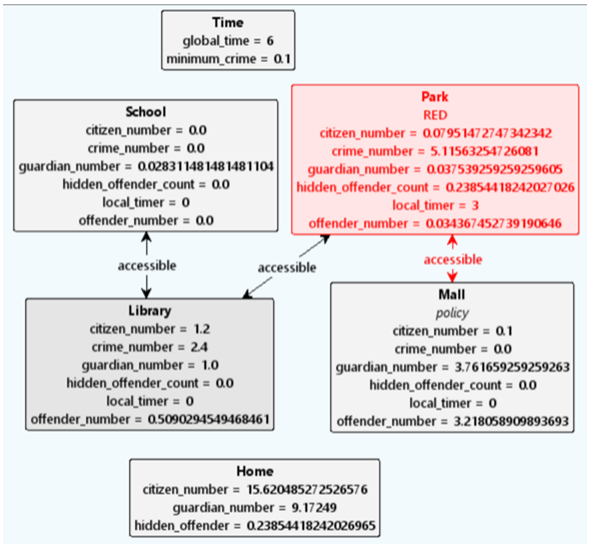


Figure A.24: State at time 6.

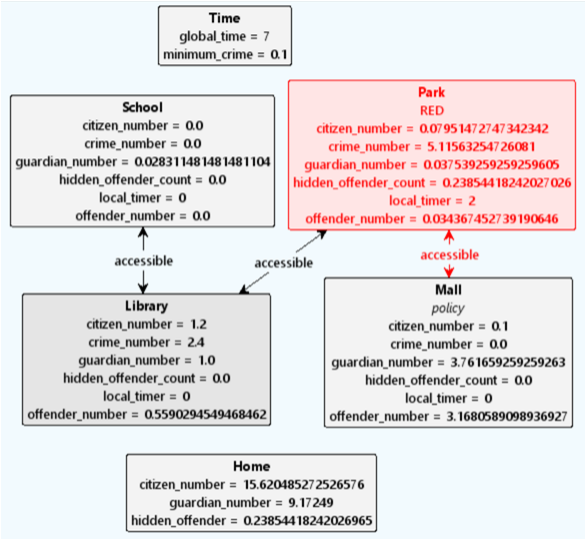


Figure A.25: State at time 7 after one day's cycle.

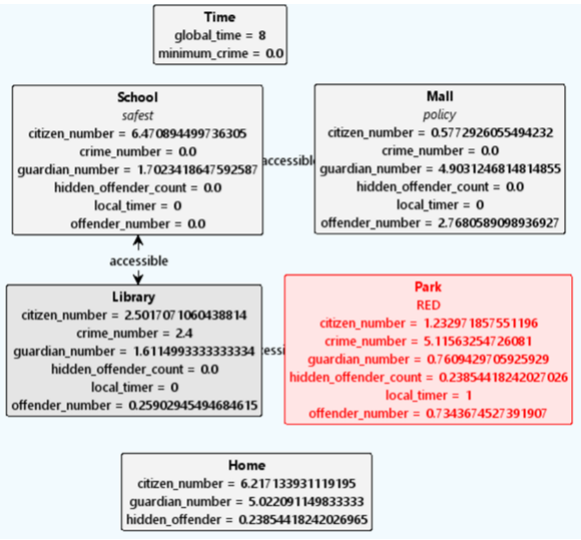


Figure A.26: State at time 8 after one day's cycle.

Appendix B

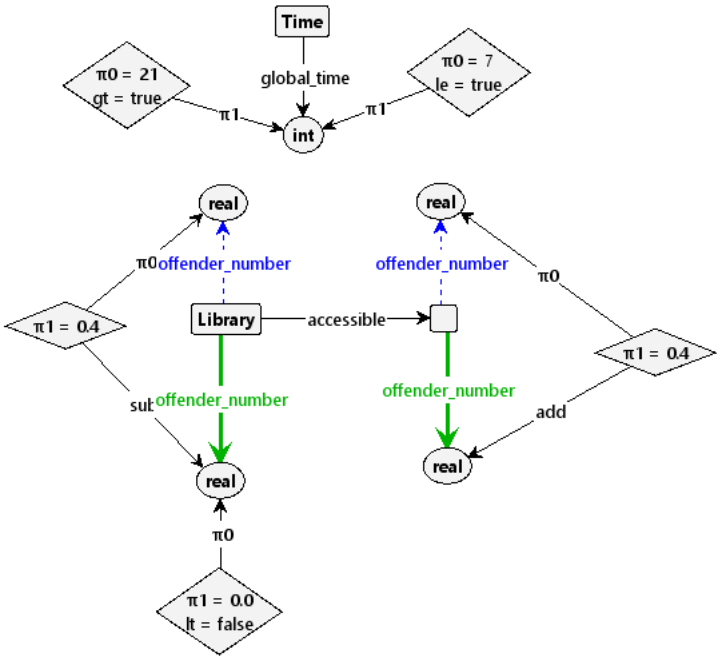
Source Code

B.1 GitHub Repository

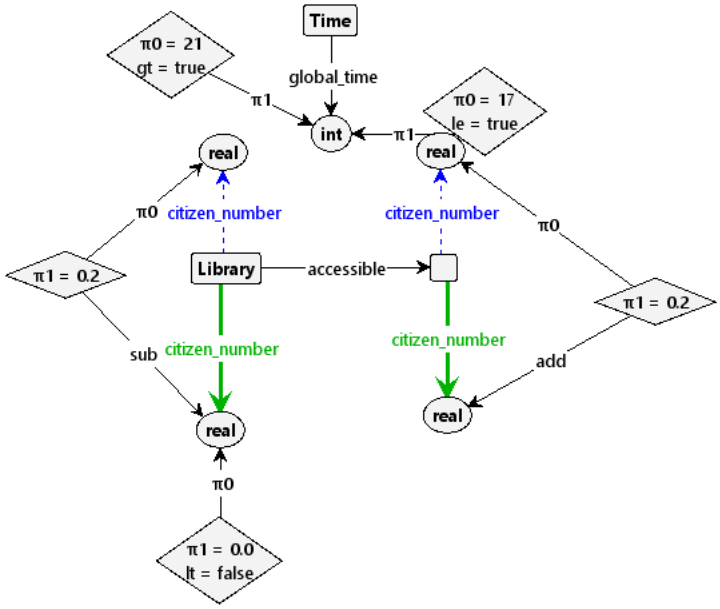
https://github.com/SAHussaini/Implementation.git

B.2 Rewrite Rules: Priority 0

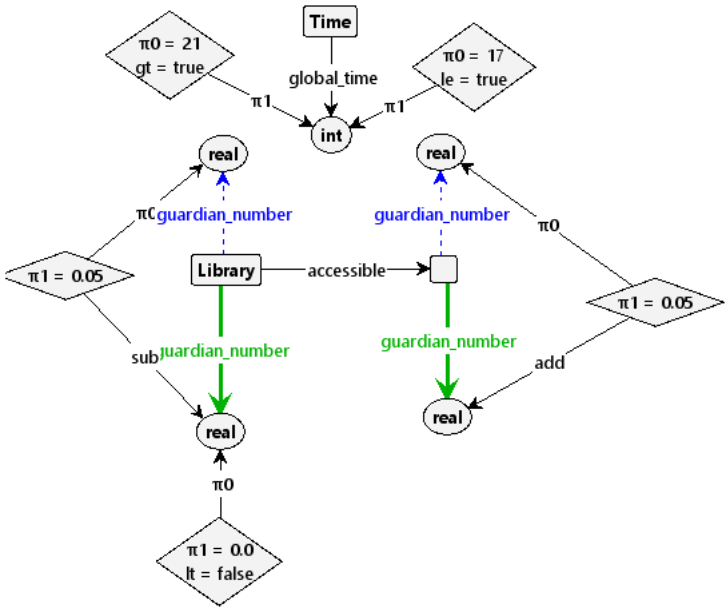
Rule 0-1



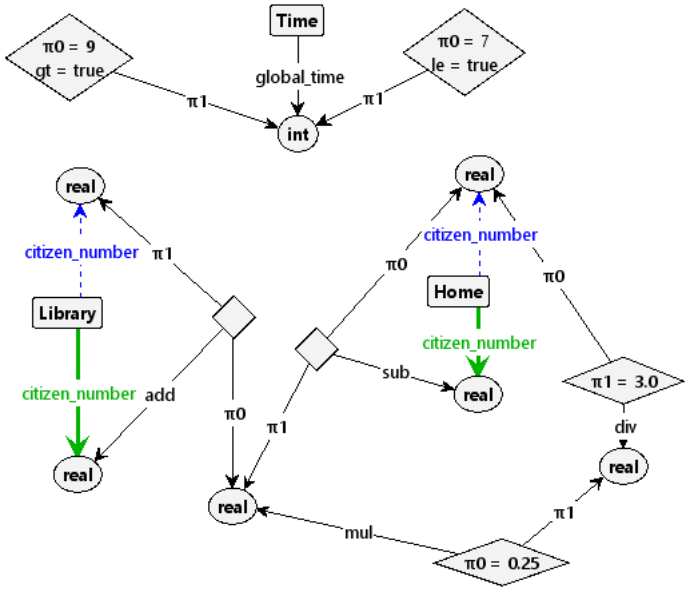
Rule 0-2



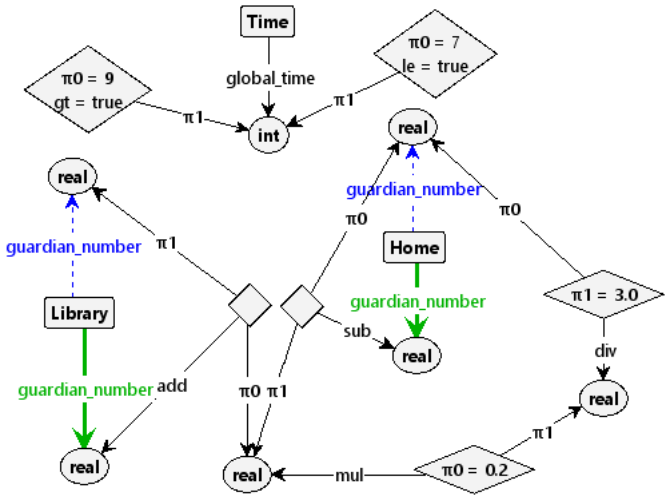
Rule 0-3



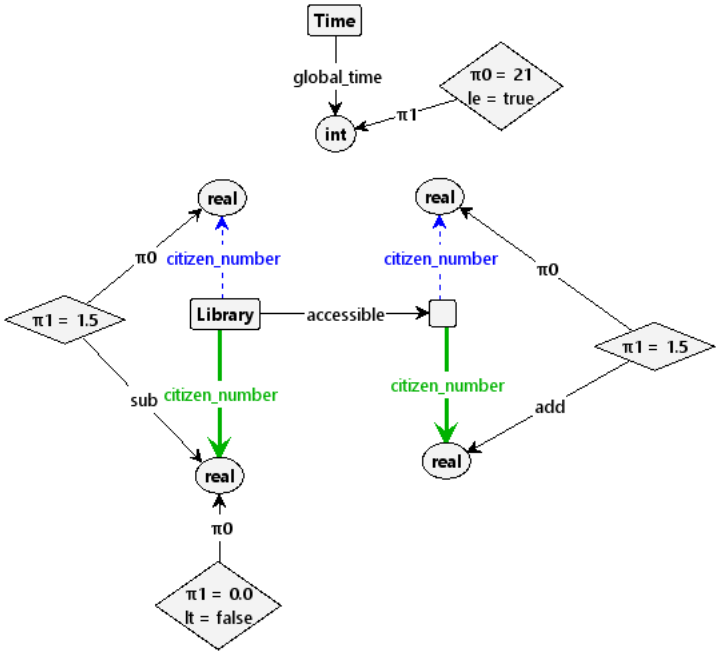
Rule 0-4



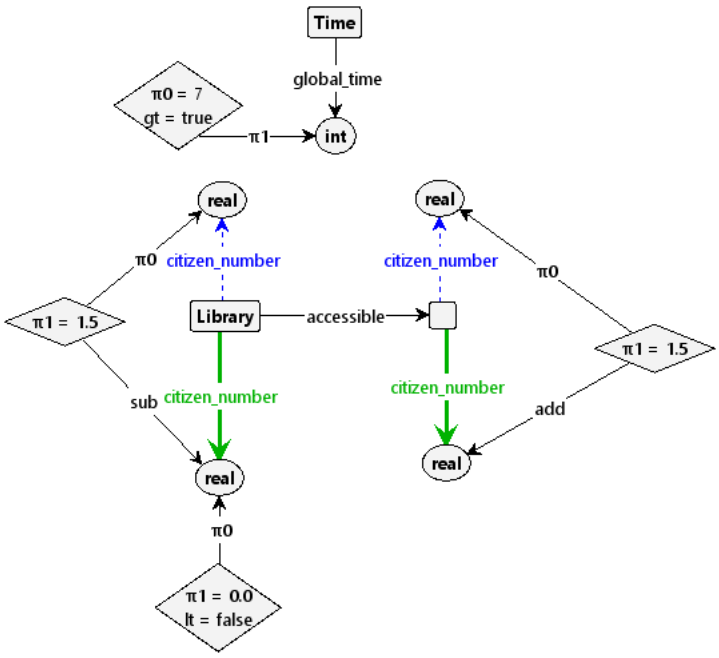
Rule 0-5



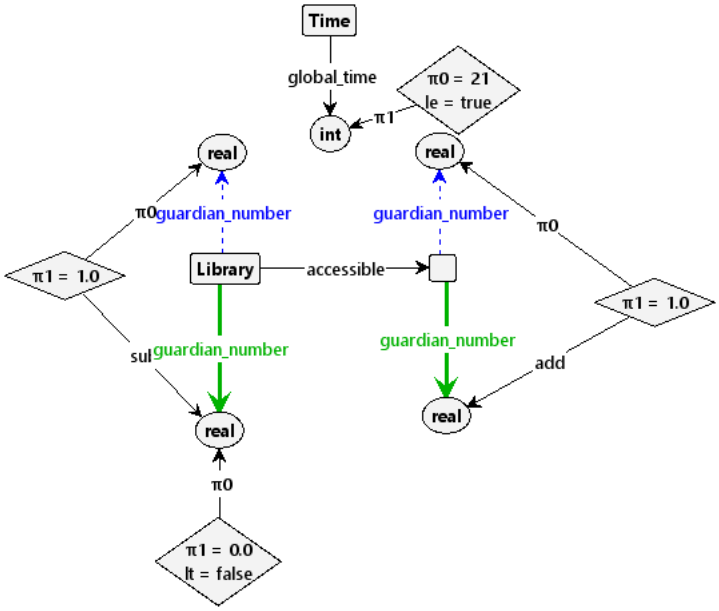
Rule 0-6



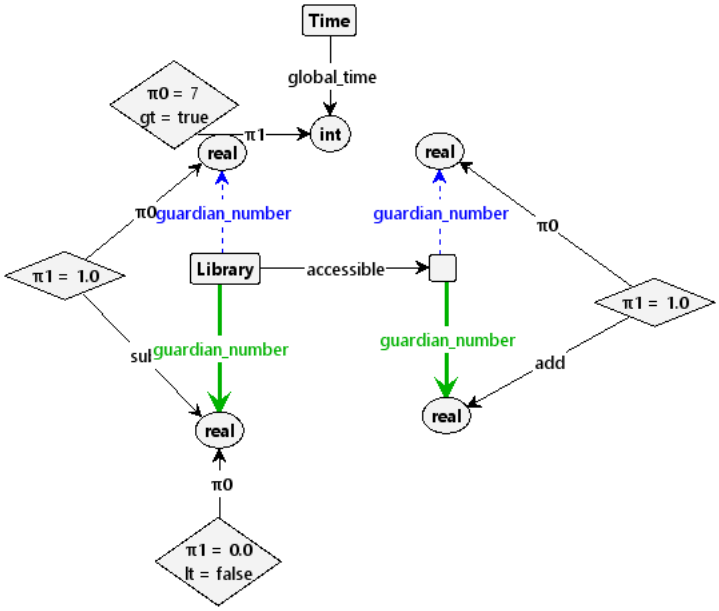
Rule 0-7



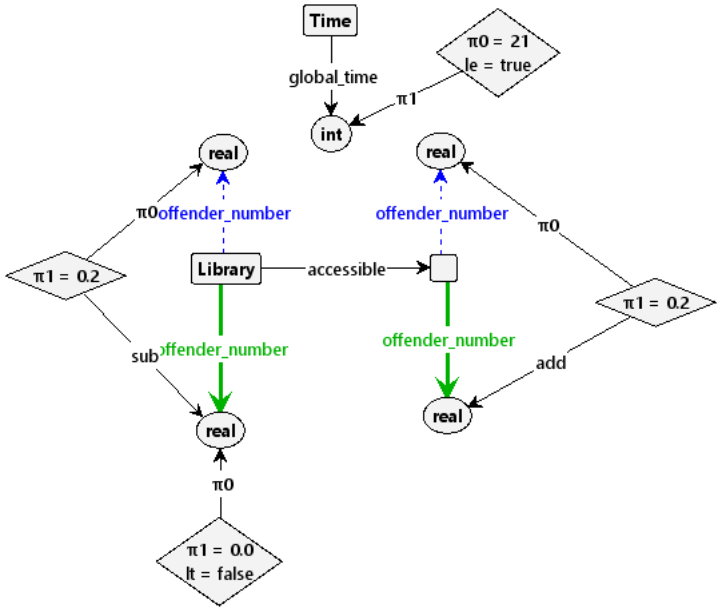
Rule 0-8



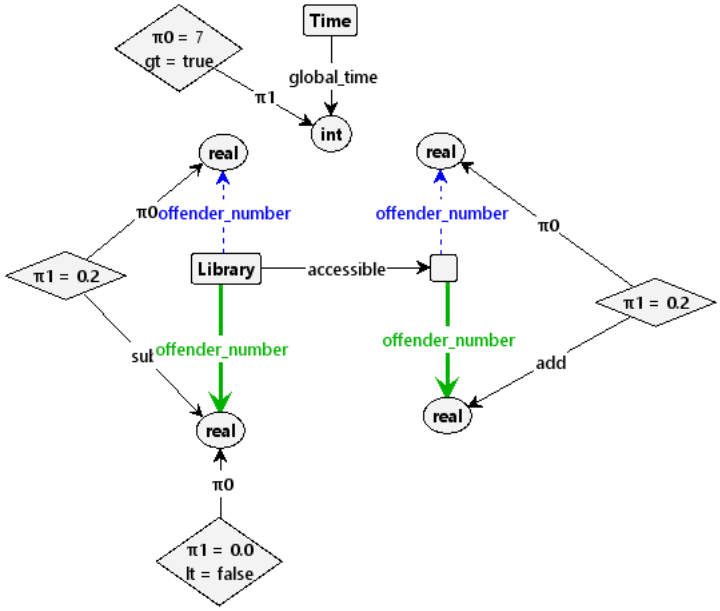
Rule 0-9



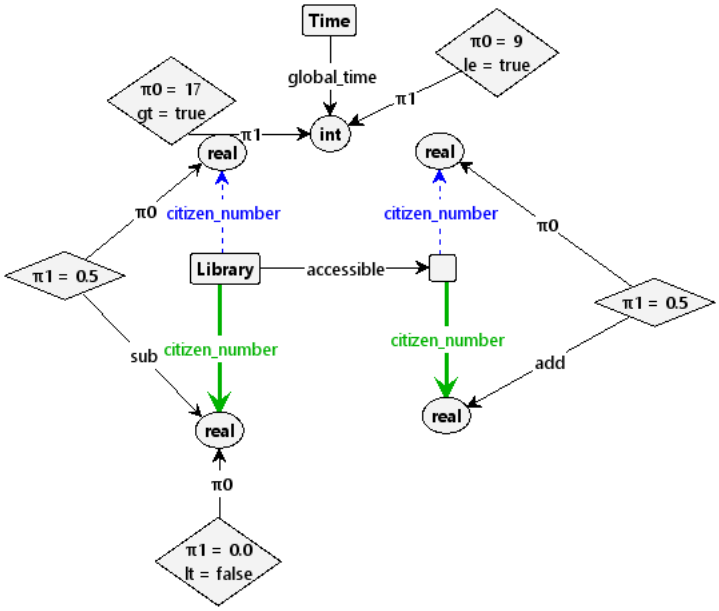
Rule 0-10



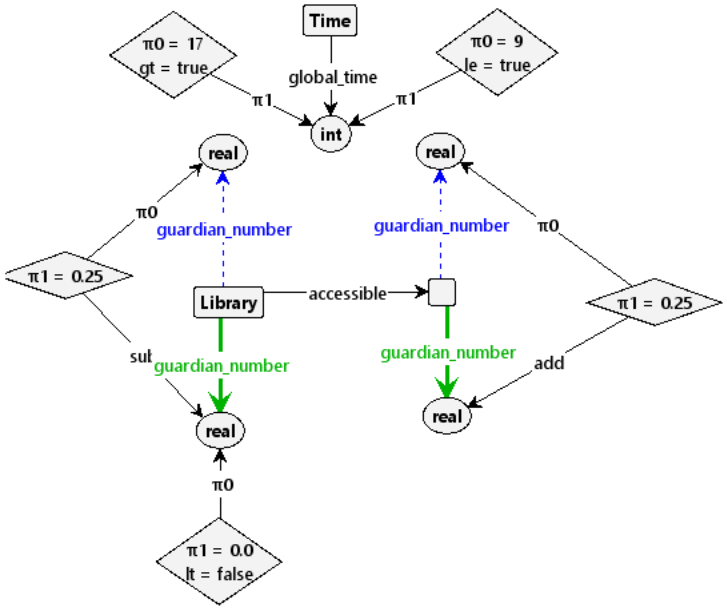
Rule 0-11



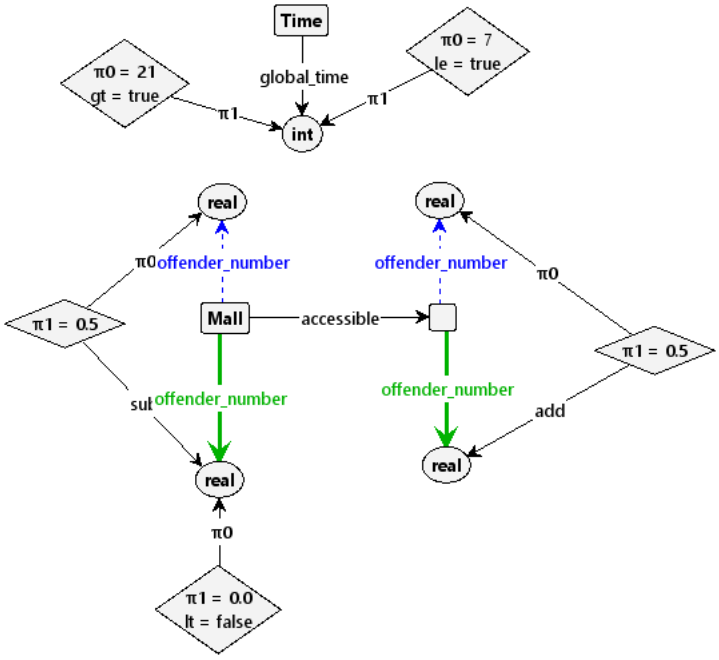
Rule 0-12



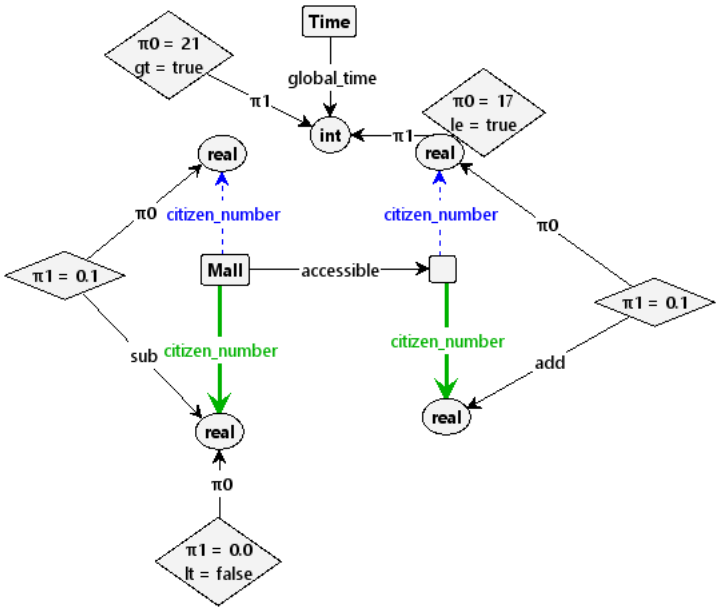
Rule 0-13



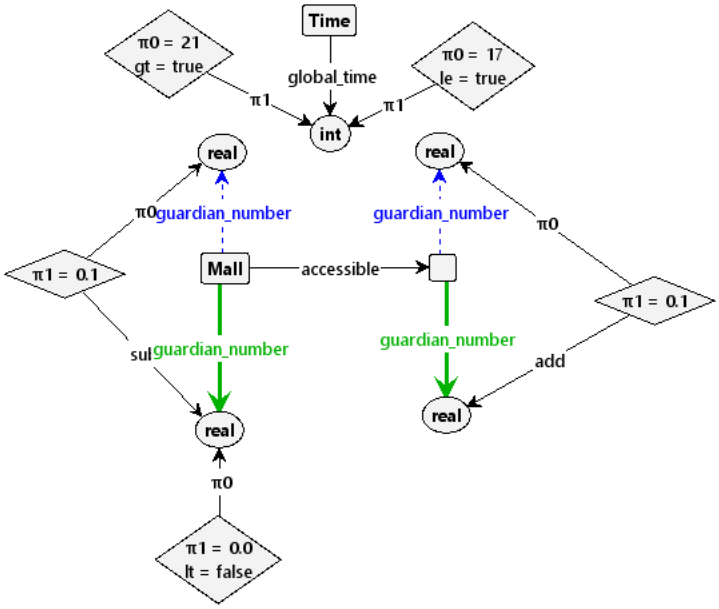
Rule 0-14



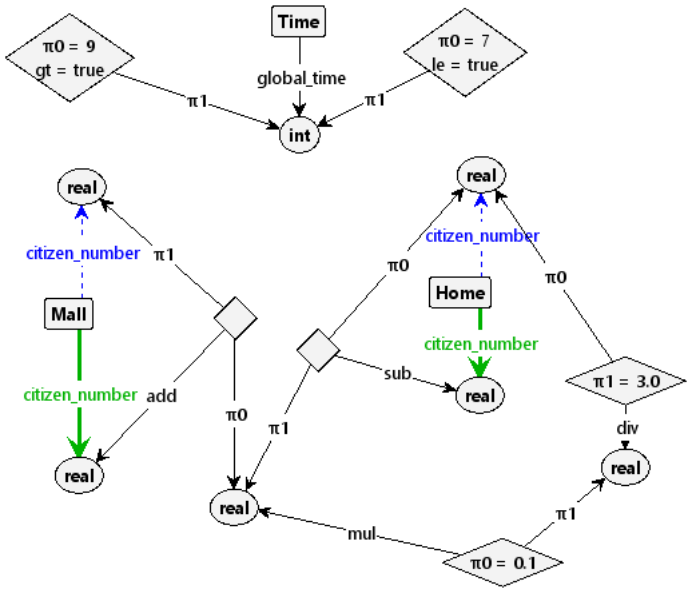
Rule 0-15



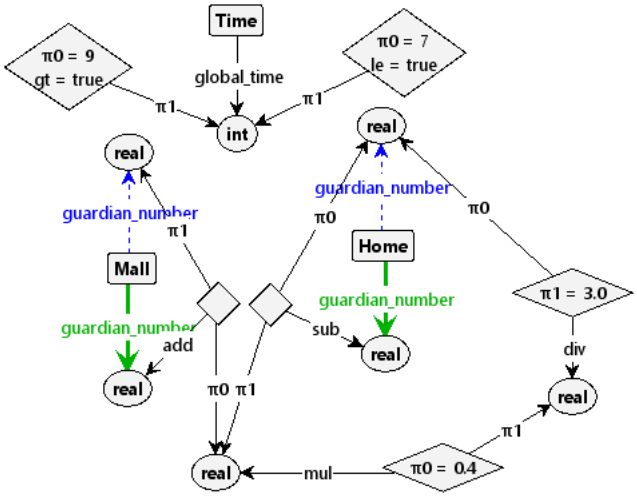
Rule 0-16



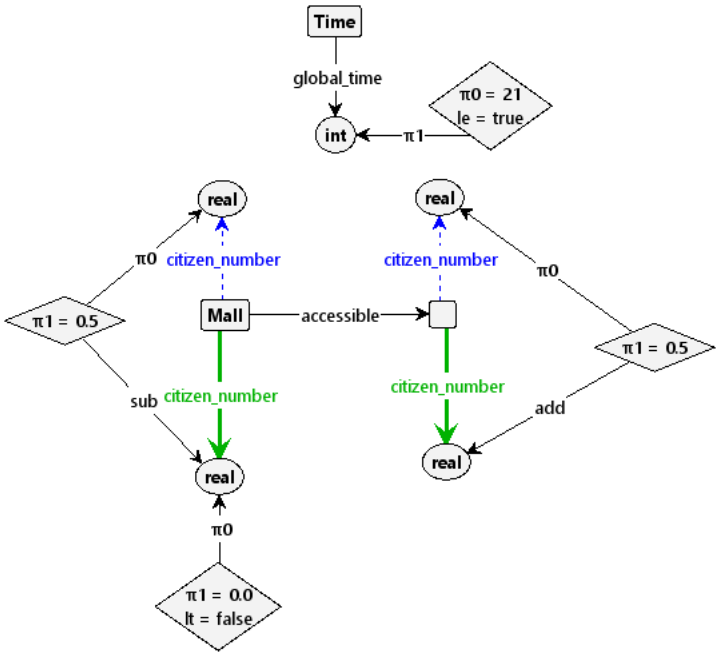
Rule 0-17



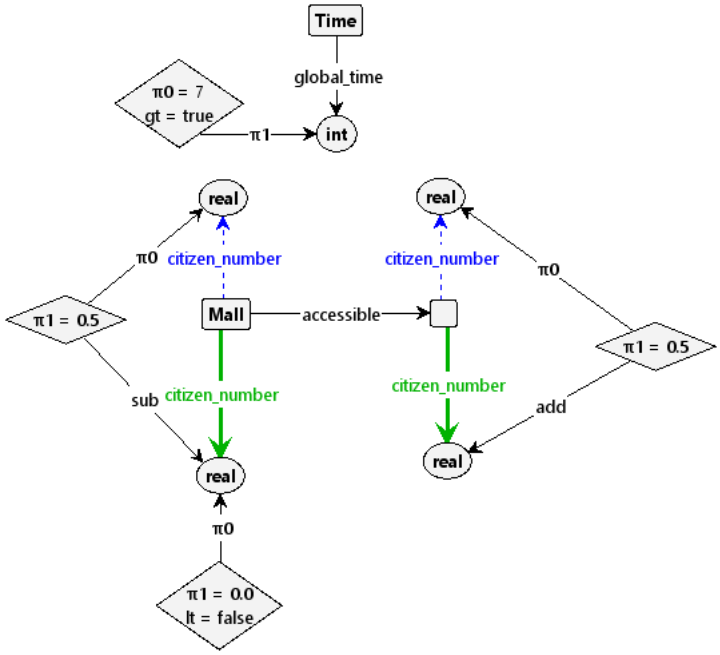
Rule 0-18



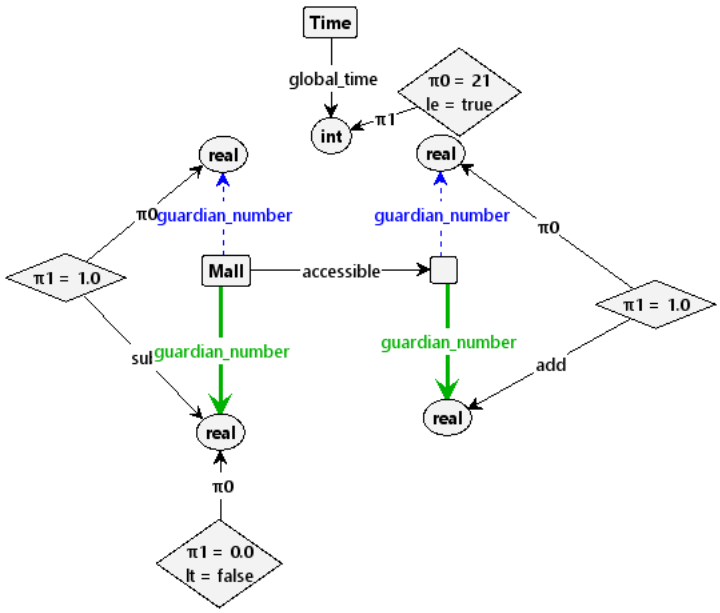
Rule 0-19



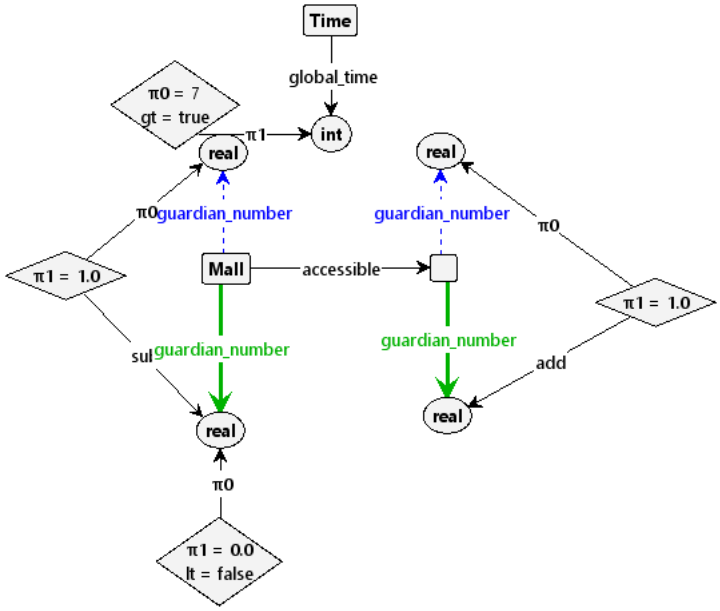
Rule 0-20



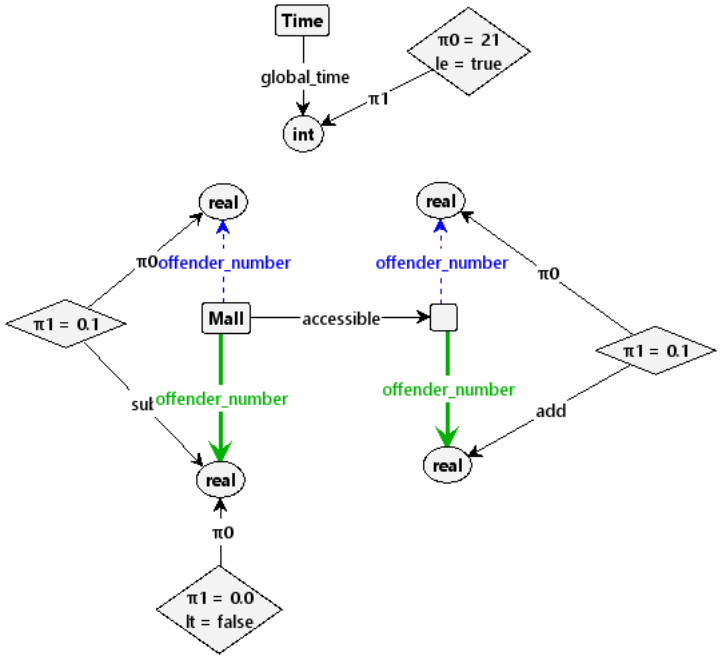
Rule 0-21



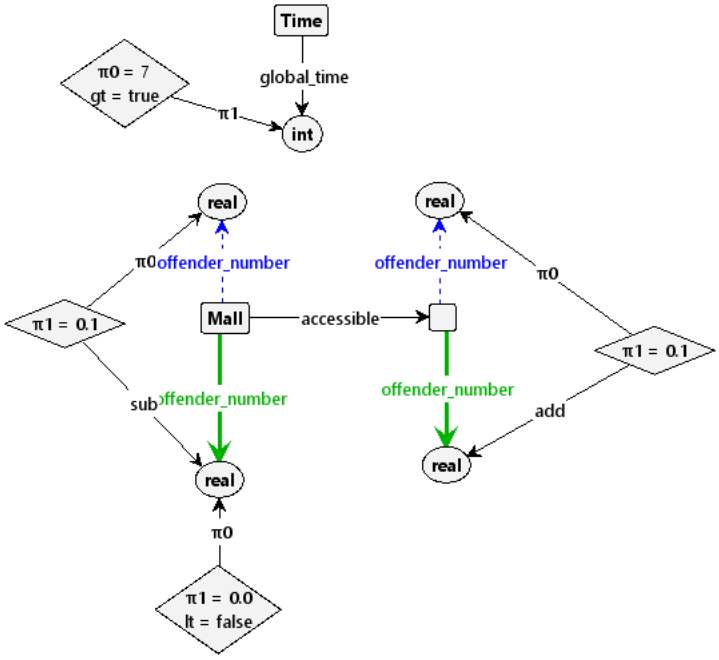
Rule 0-22



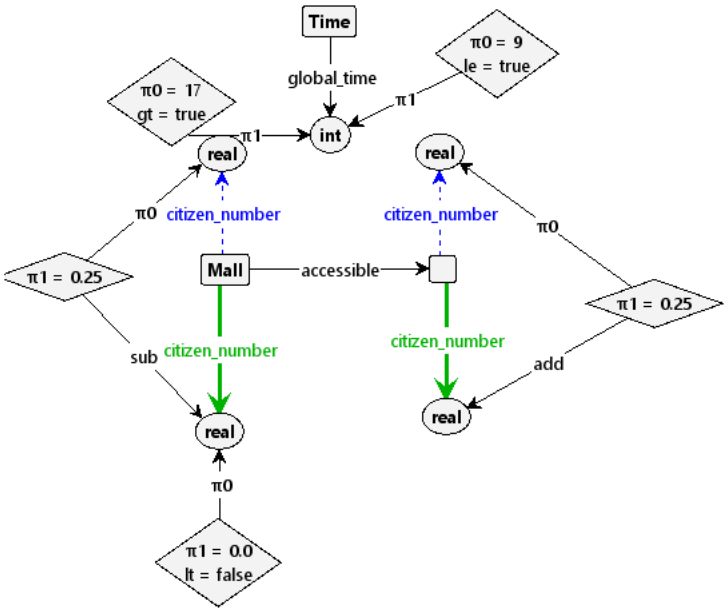
Rule 0-23



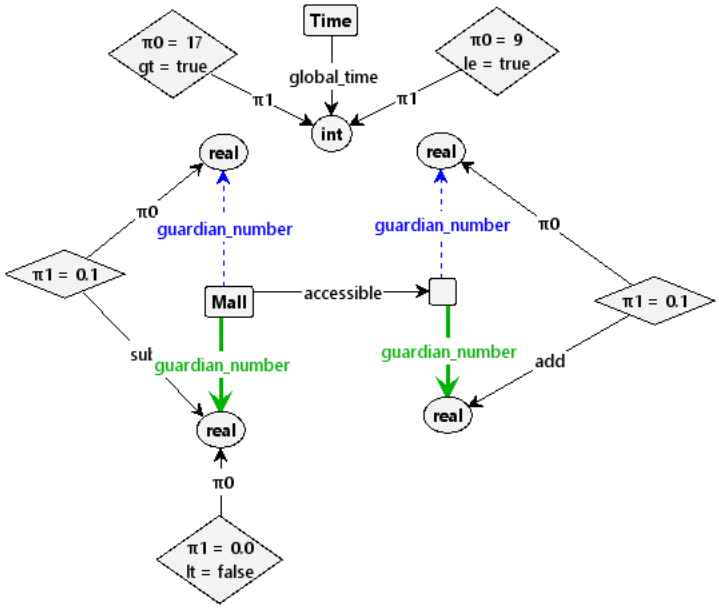
Rule 0-24



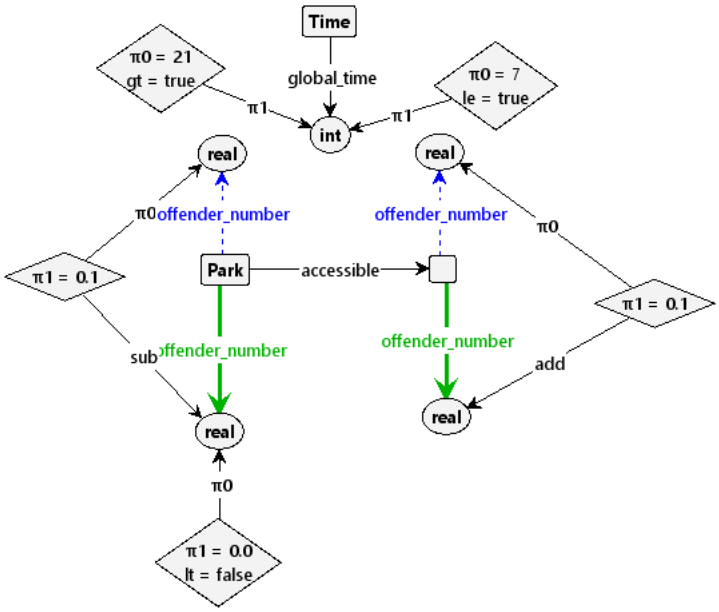
Rule 0-25



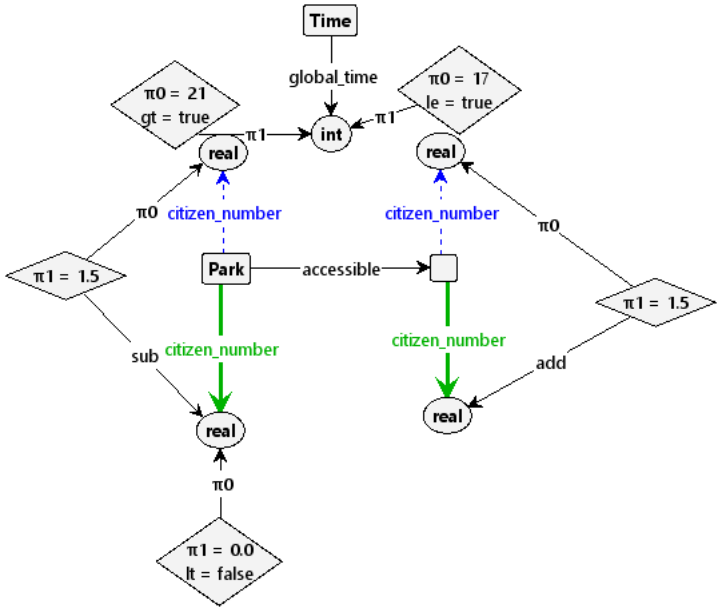
Rule 0-26



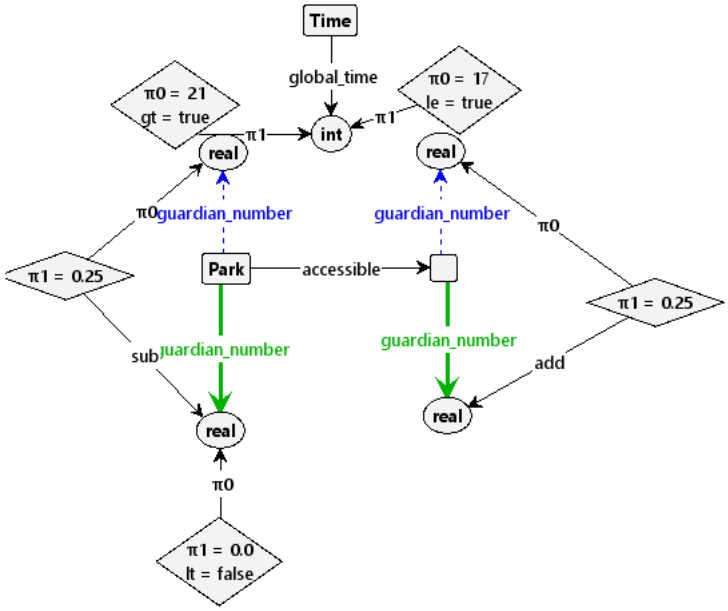
Rule 0-27



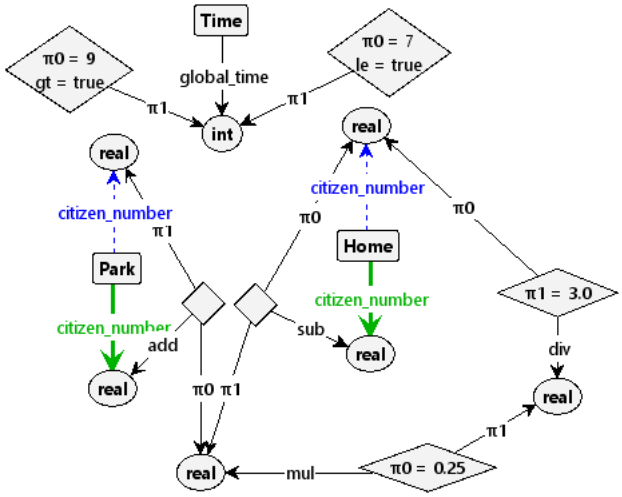
Rule 0-28



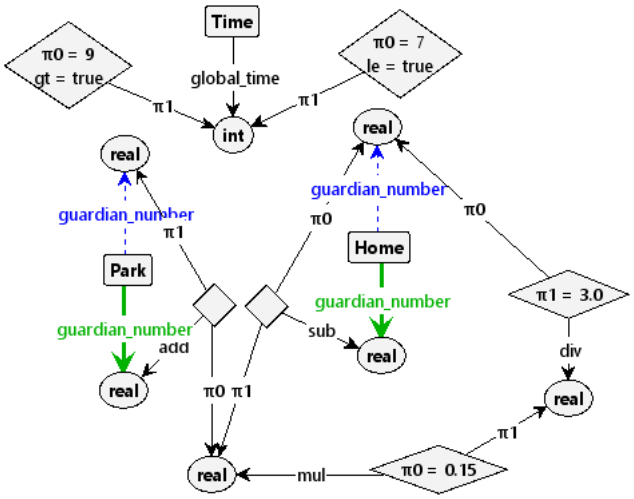
Rule 0-29



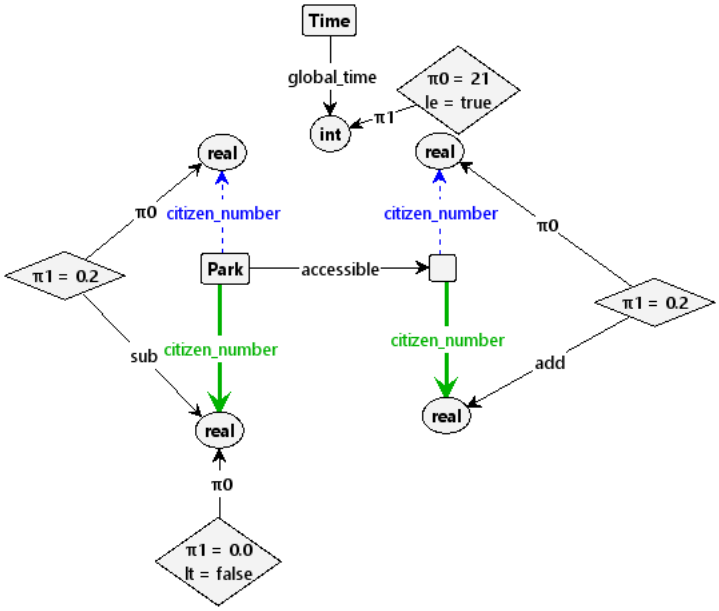
Rule 0-30



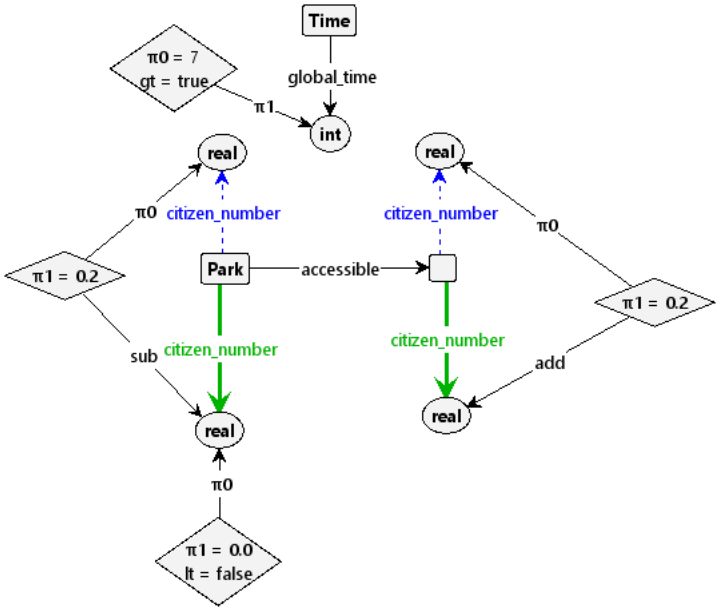
Rule 0-31



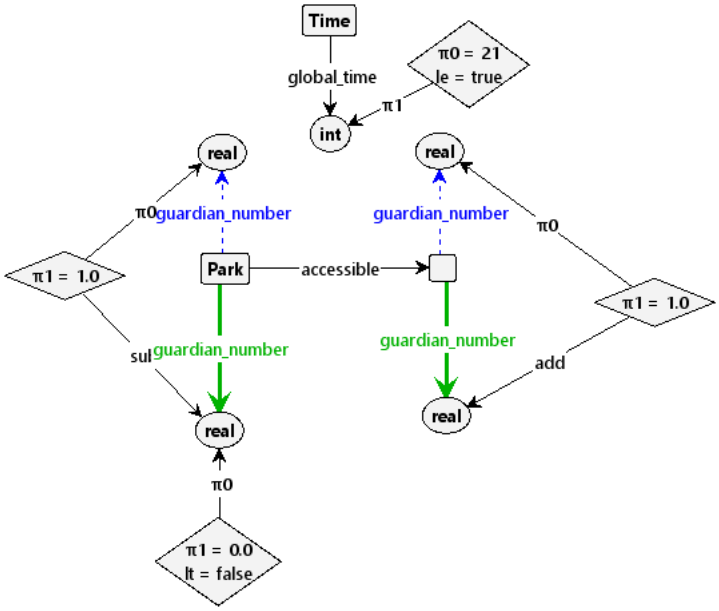
Rule 0-32



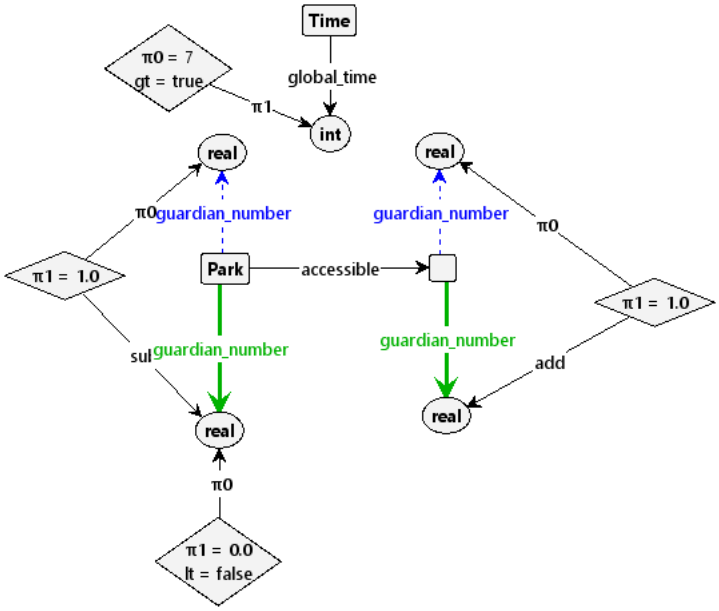
Rule 0-33



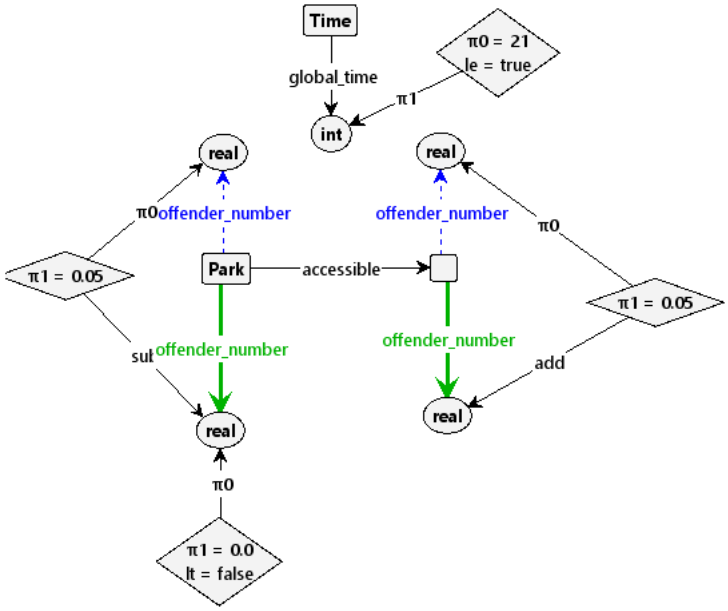
Rule 0-34



Rule 0-35



Rule 0-36



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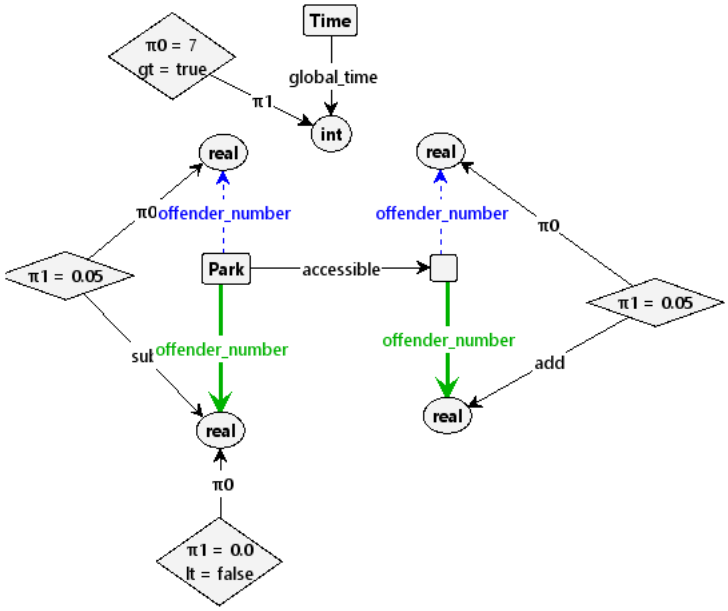
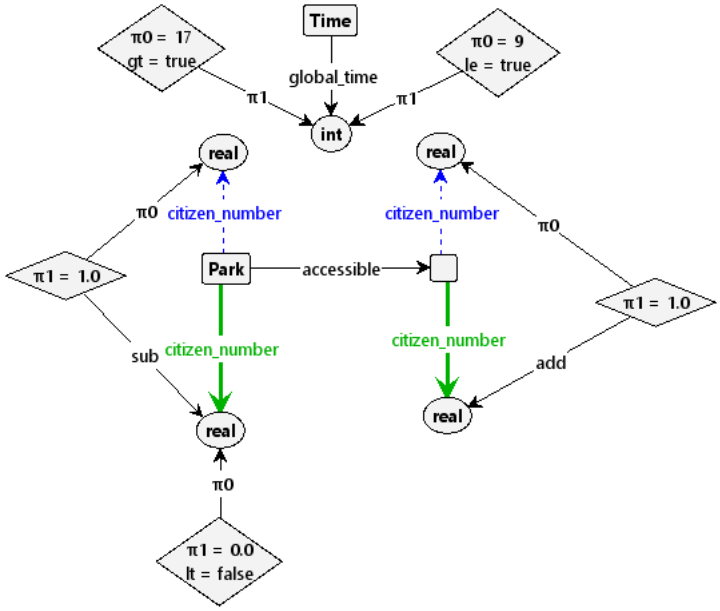
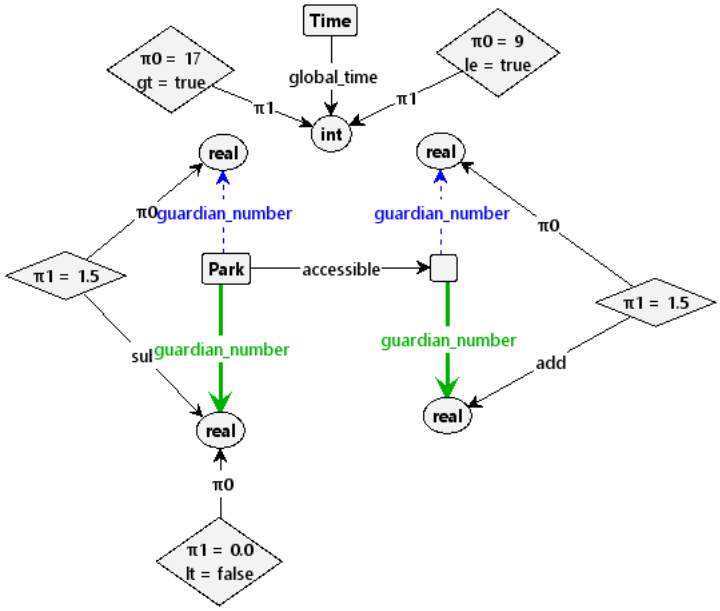


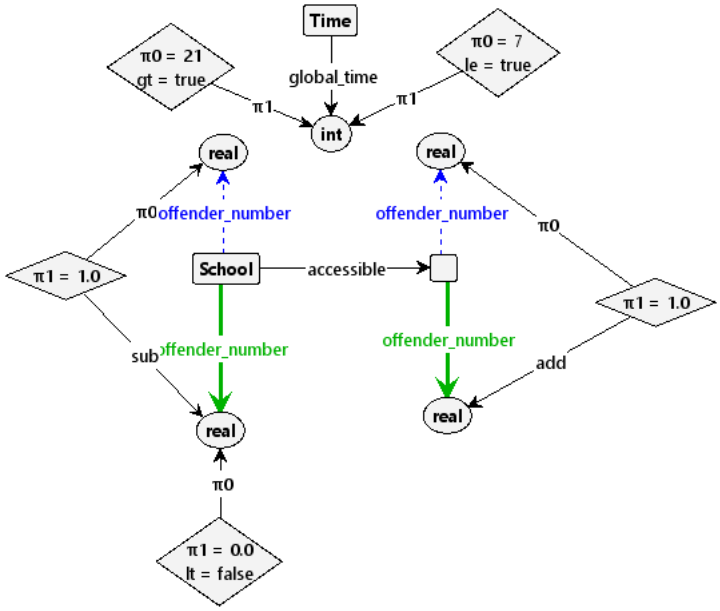
Rule 0-38



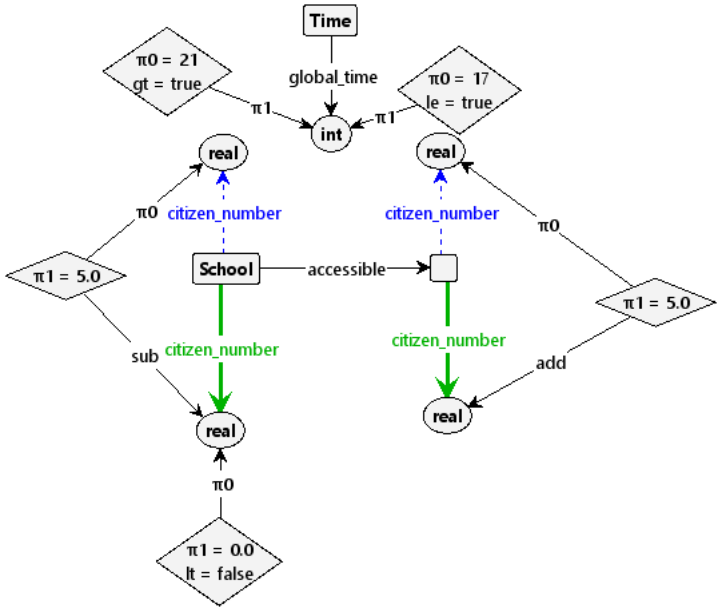
Rule 0-39



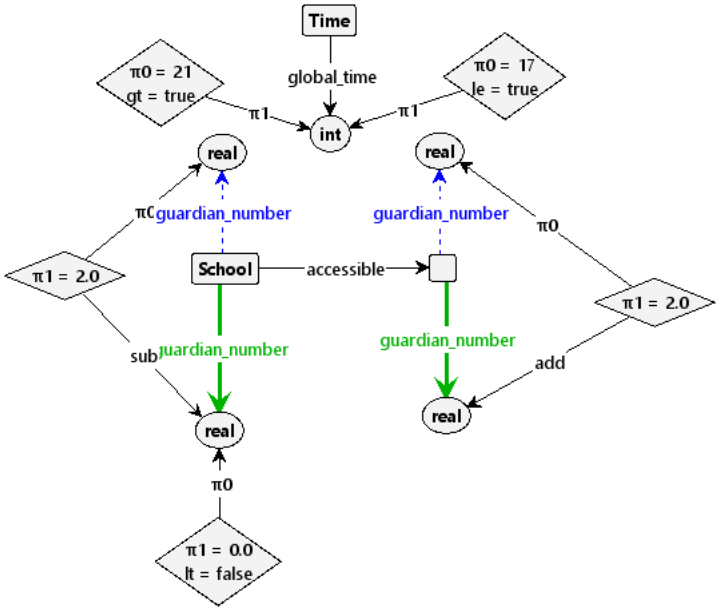
Rule 0-40



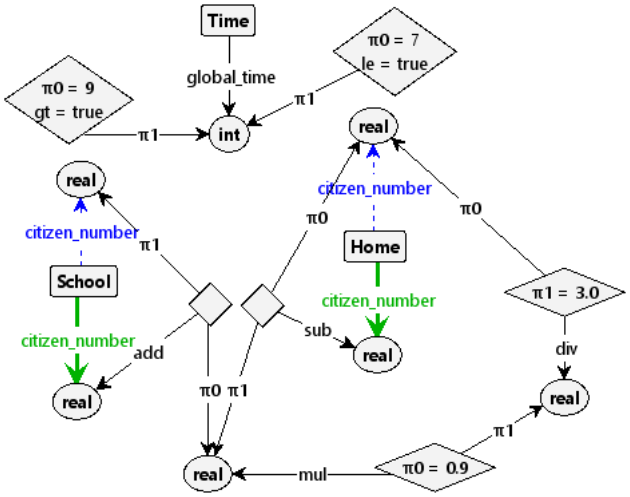
Rule 0-41



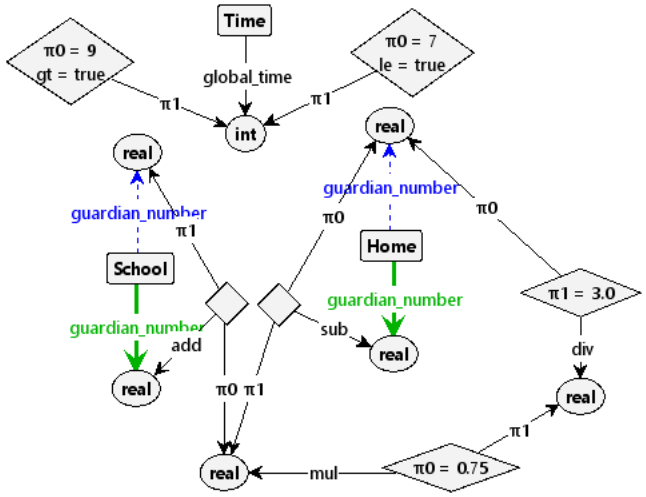
Rule 0-42



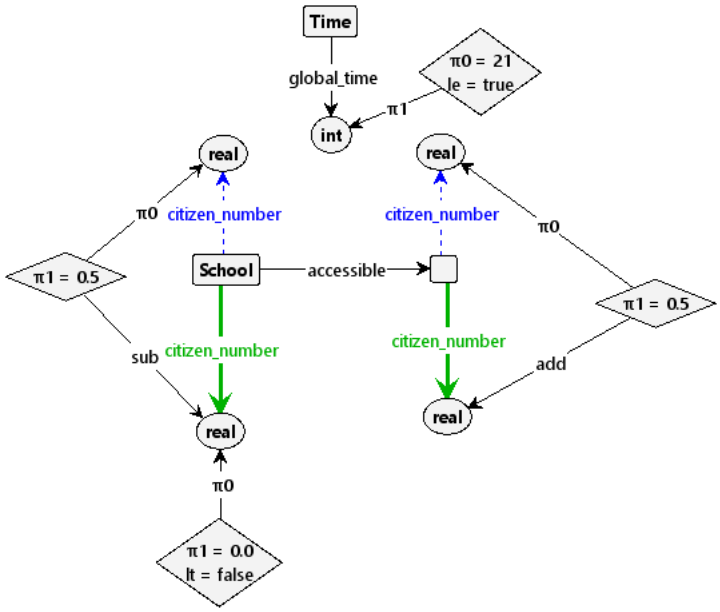
Rule 0-43



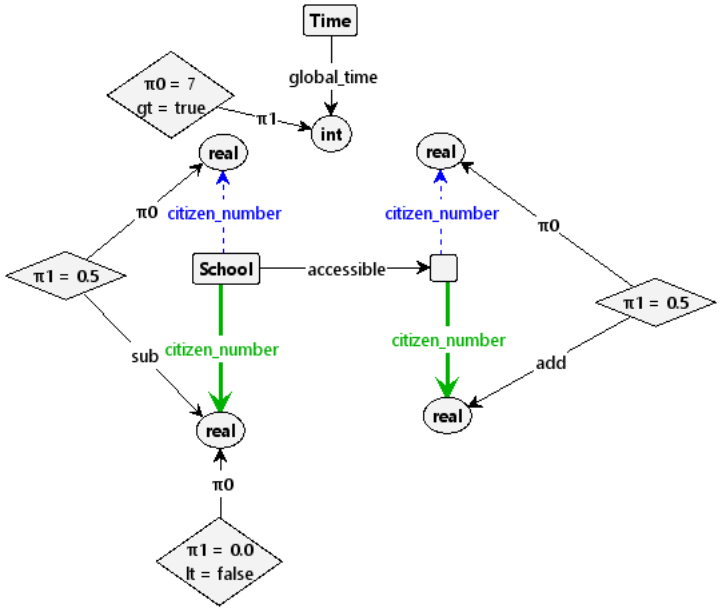
Rule 0-44



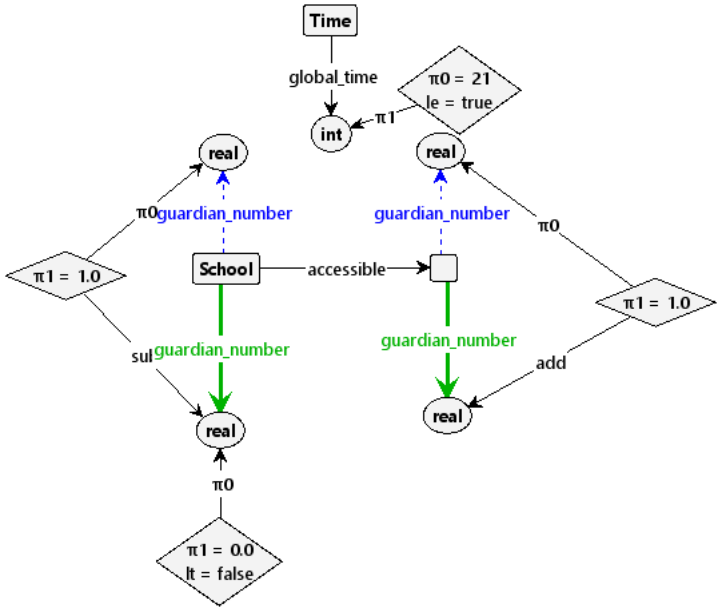
Rule 0-45



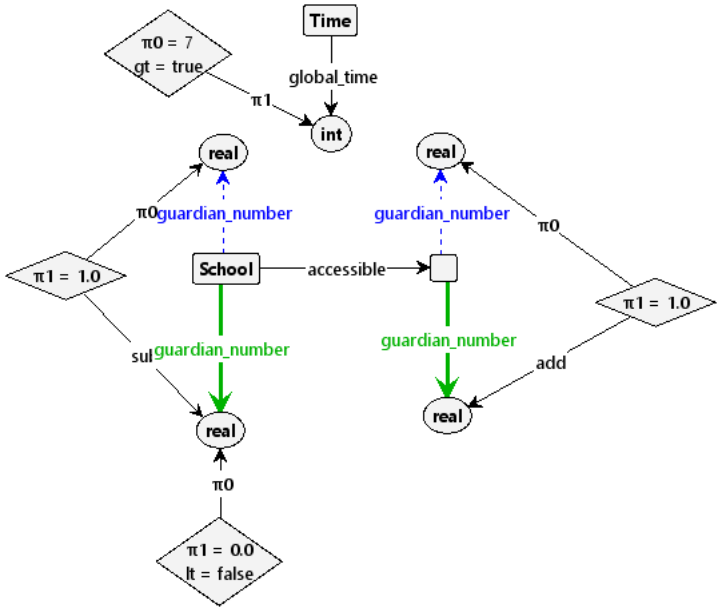
Rule 0-46



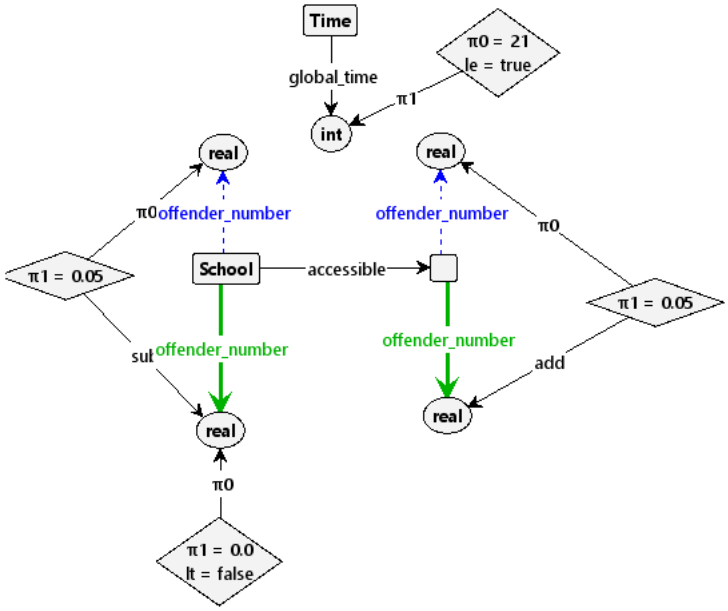
Rule 0-47



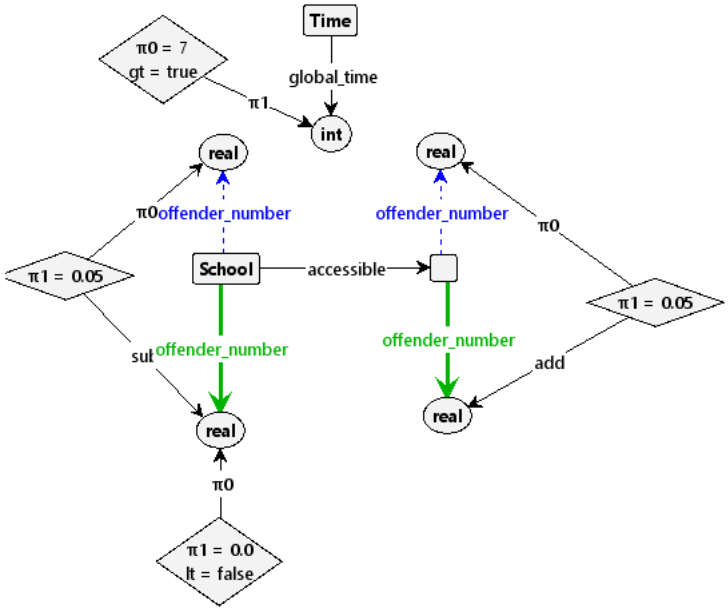
Rule 0-48



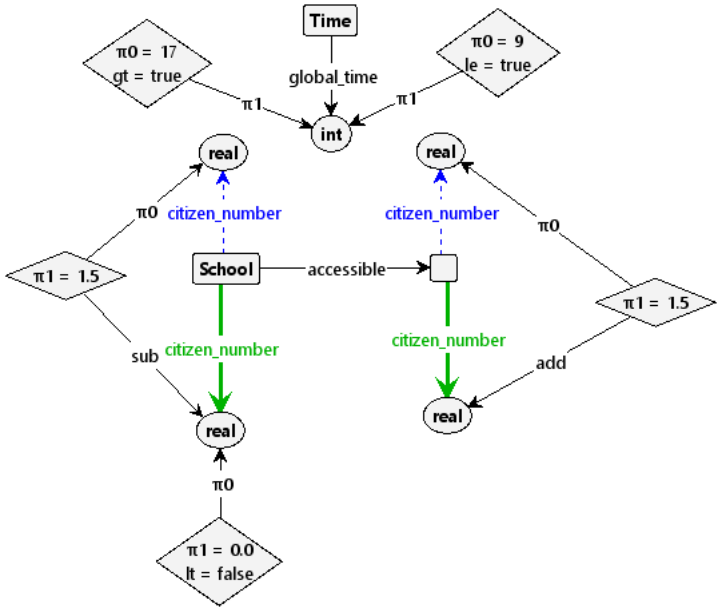
Rule 0-49



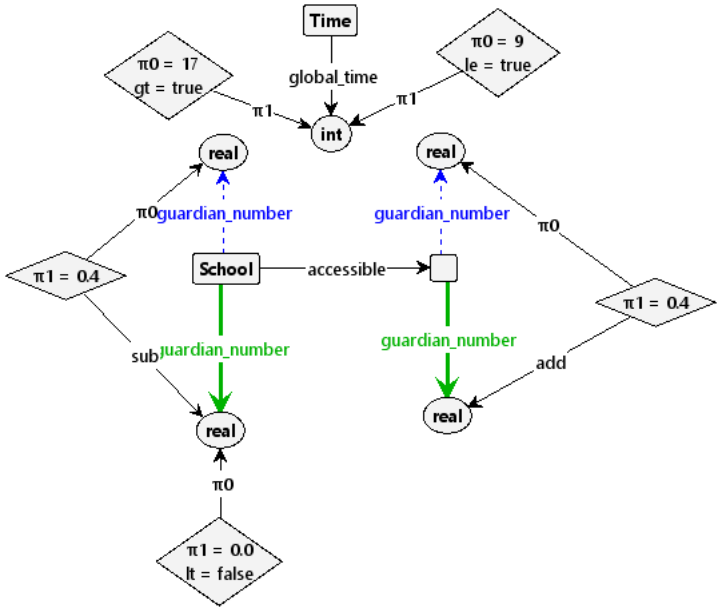
Rule 0-50



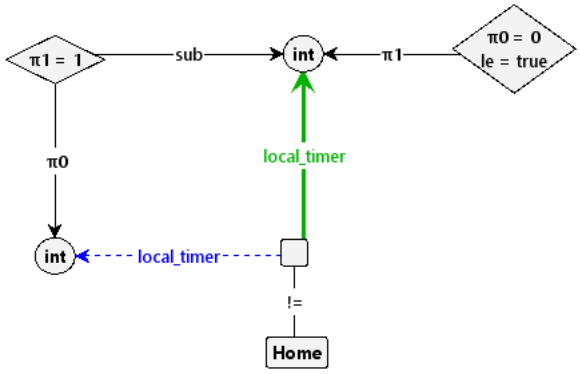
Rule 0-51



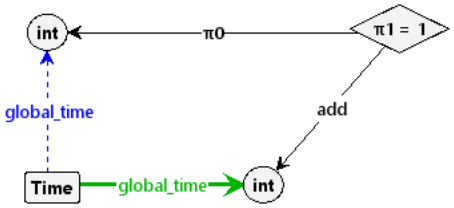
Rule 0-52



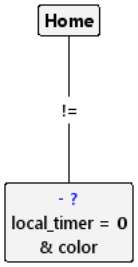
Rule 0-53



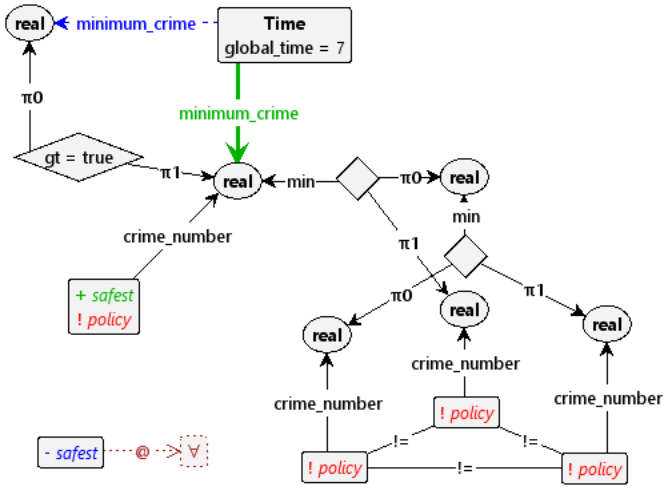
Rule 0-54



Rule 0-55

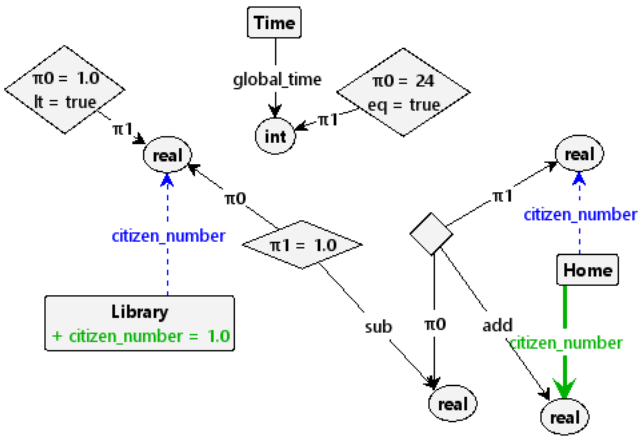


Rule 0-56

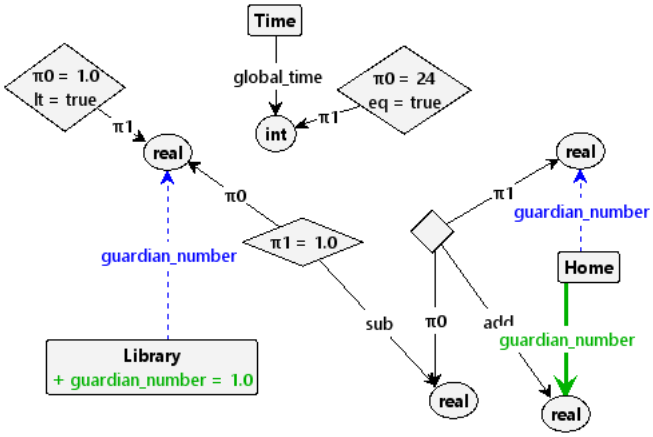


B.3 Rewrite Rules: Priority 1

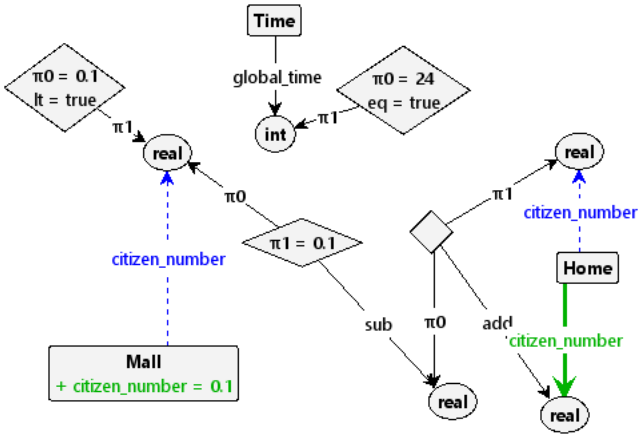
Rule 1-1



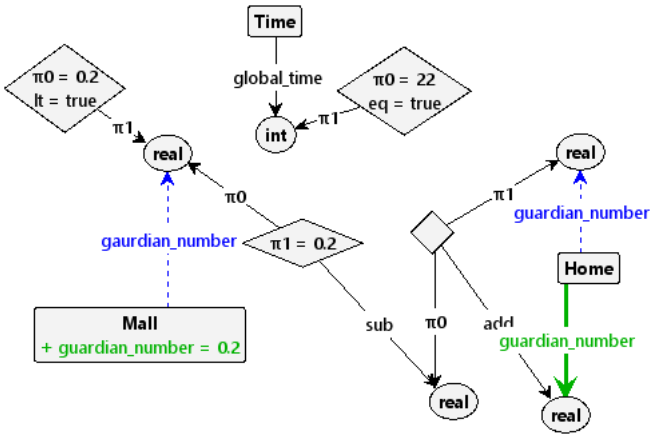
Rule 1-2



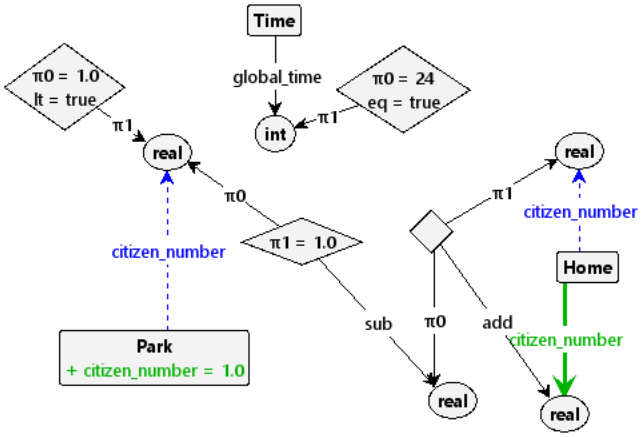
Rule 1-3



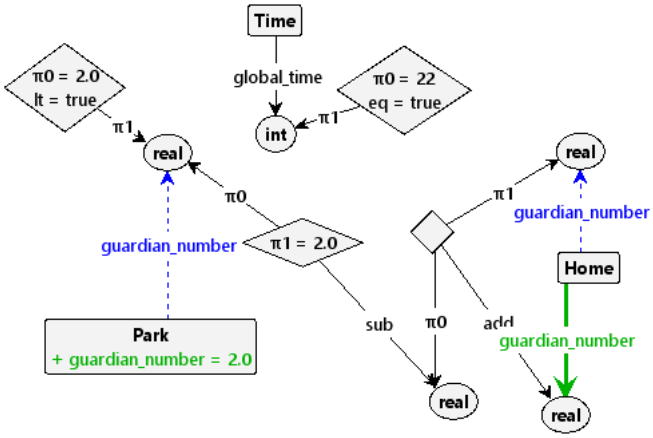
Rule 1-4



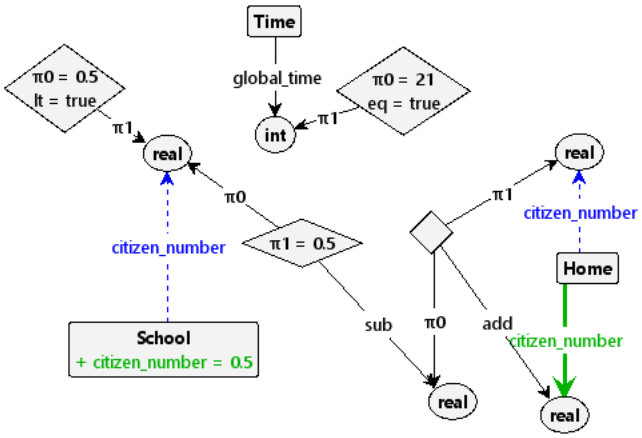
Rule 1-5



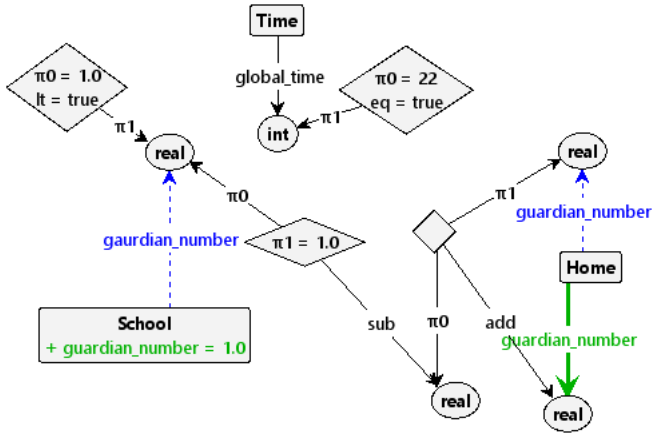
Rule 1-6



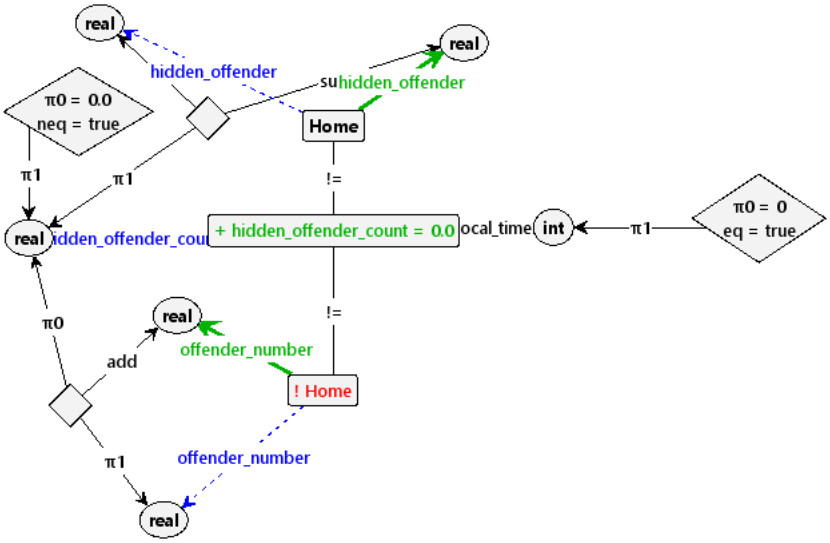
Rule 1-7



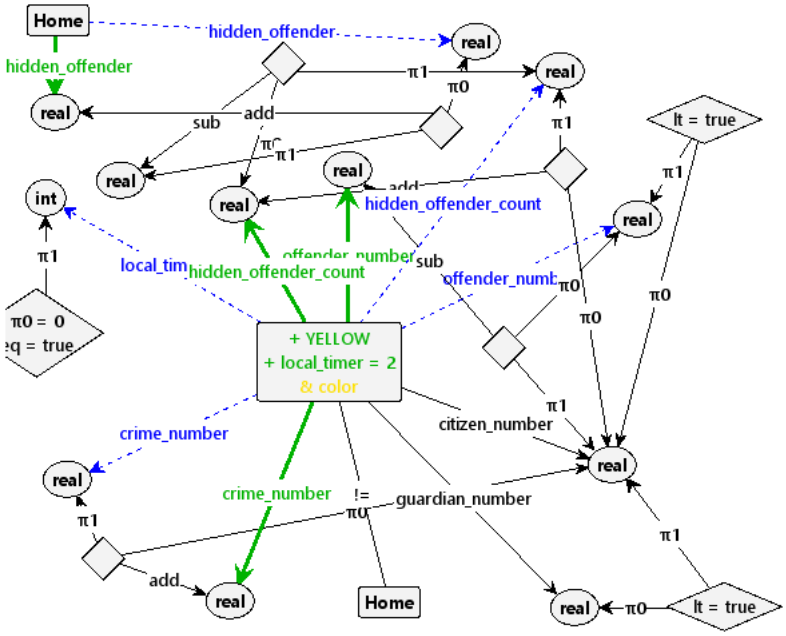
Rule 1-8



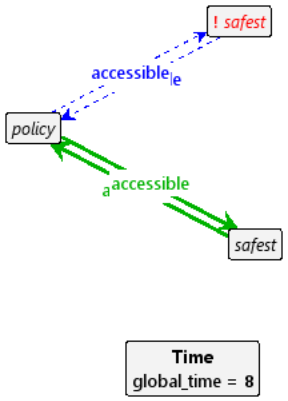
Rule 1-9



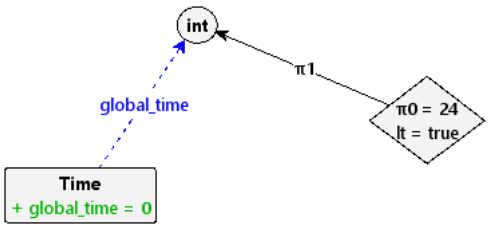
Rule 1-10



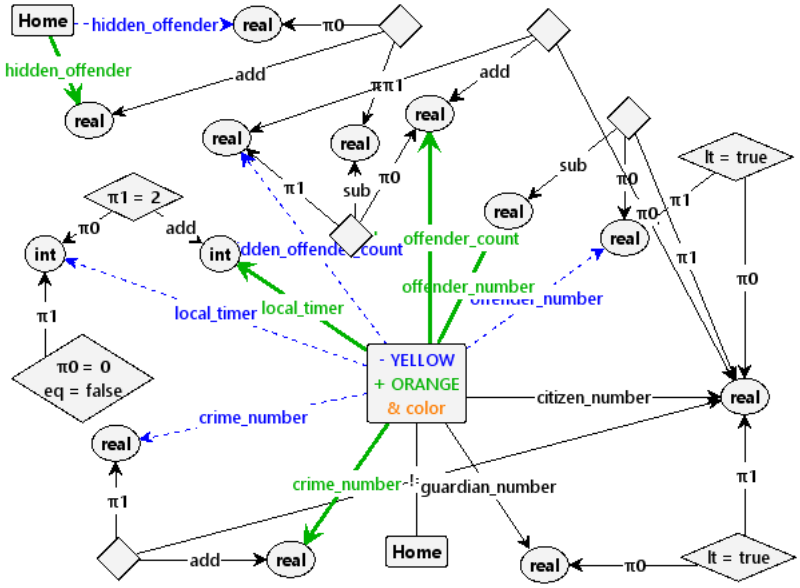
Rule 1-11



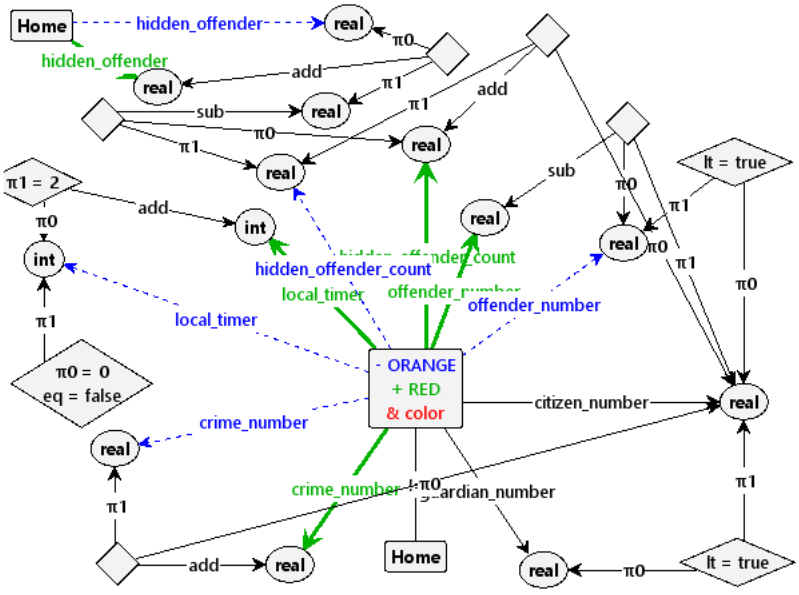
Rule 1-12



Rule 1-13



Rule 1-14



Appendix C

User Guide

In this appendix chapter, we will explain how the interested reader may make use of our implementation. This chapter will be divided into two parts: 'Rules' and 'Simulating in GROOVE'.

C.1 Rules

In this section, we will delineate the purpose and mechanisms for each of the implemented rewrite rules, found in *Appendix B: Source Code*, in the order in which they are listed.

C.1.1 Rule Structure

Before delineating the rules, it is important to understand the high-level view of the way the rewrite rules are structured. Below, we present such a high-level view.

Priority 0 Rules

- *Control Flow*
  - For Each Time Segment (Day [offender-exclusive], Mrn, Wrk, Eve, Ngh)
    - For Each Locality (Library, Mall, Park, School)
      - For Each Persons (citizen, guardian, offender) [0-1:0-52]
- *Crime Occurrence*
  - Under Post Crime
    - decrementLocalTime [0-53]
    - resetLocality [0-55]
  - *Policy Tests*
    - safestLocality [0-56]
  - *Other*
    - incrementTime [0-52]

Priority 1 Rules

- *Control Flow*
  - For Each Locality (Library, Mall, Park, School)
    - For Citizen and Guardian [1-1:1-8]
- *Crime Occurrence*
  - Under Incident Crime
    - firstCrimeOccurrence [1-10]
    - secondCrimeOccurrence [1-13]
    - thirdCrimeOccurrence [1-14]
  - Under Post Crime
    - decrementLocalCrime [1-9]
- *Policy Tests*
  - incrementPolicy [1-11]
- *Other*
  - newDay [1-12]

In the above listing, the rules are located in the inner most structure. For example, you would read the Priority 0 Control Flow section as:

Control Flow. For every time segment, for every locality, for every person type, there exists a control flow rule.

Additionally, you can change the rules by altering their modification values; you can even create your own time segments or new persons. Regardless of what you decide to do, the above structure serves as a mind map of how the implementation works.

C.1.2 Priority 0

Rule 0-1
Name: controlFlowLibraryDayHrOFN
Function: Manages the control flow for offenders at the **Library** during the day time.
Constraints:
Library.*offender_number*>= 0.4
21 >**Time**.*global_time*>= 7
Result: **Library**.*offender_number* decreases by 0.4 and another locality's *offender_number* increases by 0.4

Rule 0-2
Name: controlFlowLibraryEveHrCTZ
Function: Manages the control flow for citizens at the **Library** during the evening time.
Constraints:
Library.*citizen_number*>= 0.2
21 >**Time**.*global_time*>= 17
Result: **Library**.*citizen_number* decreases by 0.2 and another locality's *citizen_number* increases by 0.2

Rule 0-3

Name: controlFlowLibraryEveHrGRD

Function: Manages the control flow for guardians at the **Library** during the evening time.

Constraints:

Library.*guardian_number*>= 0.05

21 >**Time**.*global_time*>= 17

Result: **Library**.*guardian_number* decreases by 0.05 and another locality's *guardian_number* increases by 0.05

Rule 0-4

Name: controlFlowLibraryMrnHrCTZ

Function: Manages the control flow for citizens at the **Library** during the morning time.

Constraints:

9 >**Time**.*global_time*>= 7

Result: **Library**.*citizen_number* increases by $\frac{1}{12}$ of **House**.*citizen_number* and the **House**.*citizen_number* decreases by the same amount

Rule 0-5

Name: controlFlowLibraryMrnHrGRD

Function: Manages the control flow for guardians at the **Library** during the morning time.

Constraints:

9 >**Time**.*global_time*>= 7

Result: **Library**.*guardian_number* increases by $\frac{1}{15}$ of **House**.*guardian_number* and the **House**.*guardian_number* decreases by the same amount

Rule 0-6

Name: controlFlowLibraryNghHrCTZ1

Function: Manages the control flow for citizens at the **Library** during the first half of the night time.

Constraints:

Library.*citizen_number*>= 1.5

Time.*global_time*>= 21

Result: **Library**.*citizen_number* decreases by 1.5 and another locality's *citizen_number* increases by 1.5

Rule 0-7

Name: controlFlowLibraryNghHrCTZ2

Function: Manages the control flow for citizens at the **Library** during the second half of the night time.

Constraints:

Library.*citizen_number*>= 1.5

7 >**Time**.*global_time*

Result: **Library**.*citizen_number* decreases by 1.5 and another locality's *citizen_number* increases by 1.5

Rule 0-8

Name: controlFlowLibraryNghHrGRD1

Function: Manages the control flow for guardians at the **Library** during the first half of the night time.

Constraints:

Library.*citizen_number*>= 1.0

Time.*global_time*>= 21

Result: **Library**.*guardian_number* decreases by 1.0 and another locality's *guardian_number* increases by 1.0

Rule 0-9

Name: controlFlowLibraryNghHrGRD2

Function: Manages the control flow for guardians at the **Library** during the second half of the night time.

Constraints:

Library.*guardian_number*>= 1.0

7 >**Time**.*global_time*

Result: **Library**.*guardian_number* decreases by 1.0 and another locality's *guardian_number* increases by 1.0

Rule 0-10

Name: controlFlowLibraryNghHrOFN1

Function: Manages the control flow for offenders at the **Library** during the first half of the night time.

Constraints:

Library.*citizen_number*>= 0.2

Time.*global_time*>= 21

Result: **Library**.*offender_number* decreases by 0.2 and another locality's *offender_number* increases by 0.2

Rule 0-11

Name: controlFlowLibraryNghHrOFN2

Function: Manages the control flow for offenders at the **Library** during the second half of the night time.

Constraints:

Library.*offender_number*>= 0.2

7 >**Time**.*global_time*

Result: **Library**.*offender_number* decreases by 0.2 and another locality's *offender_number* increases by 0.2

Rule 0-12

Name: controlFlowLibraryWrkHrCTZ

Function: Manages the control flow for citizens at the **Library** during the working hours' time.

Constraints:

Library.*citizen_number*>= 0.5

17 >**Time**.*global_time*>= 9

Result: **Library**.*citizen_number* decreases by 0.5 and another locality's *citizen_number* increases by 0.5

Rule 0-13

Name: controlFlowLibraryWrkHrGRD

Function: Manages the control flow for guardians at the **Library** during the working hours' time.

Constraints:

Library.*guardian_number*>= 0.25

17 >**Time**.*global_time*>= 9

Result: **Library**.*guardian_number* decreases by 0.25 and another locality's *guardian_number* increases by 0.25

Rule 0-14

Name: controlFlowMallDayHrOFN

Function: Manages the control flow for offenders at the **Mall** during the day time.

Constraints:

Mall.*offender_number*>= 0.5

21 >**Time**.*global_time*>= 7

Result: **Mall**.*offender_number* decreases by 0.5 and another locality's *offender_number* increases by 0.5

Rule 0-15

Name: controlFlowMallEveHrCTZ

Function: Manages the control flow for citizens at the **Mall** during the evening time.

Constraints:

Mall.*citizen_number*>= 0.1

21 >**Time**.*global_time*>= 17

Result: **Mall**.*citizen_number* decreases by 0.1 and another locality's *citizen_number* increases by 0.1

Rule 0-16

Name: controlFlowMallEveHrGRD

Function: Manages the control flow for guardians at the **Mall** during the evening time.

Constraints:

Mall.*guardian_number*>= 0.1

21 >**Time**.*global_time*>= 17

Result: **Mall**.*guardian_number* decreases by 0.1 and another locality's *guardian_number* increases by 0.1

Rule 0-17

Name: controlFlowMallMrnHrCTZ

Function: Manages the control flow for citizens at the **Mall** during the morning time.

Constraints:

9 >**Time**.*global_time*>= 7

Result: **Mall**.*citizen_number* increases by $\frac{1}{30}$ of **House**.*citizen_number* and the **House**.*citizen_number* decreases by the same amount

Rule 0-18

Name: controlFlowMallMrnHrGRD

Function: Manages the control flow for guardians at the **Mall** during the morning time.

Constraints:

9 >**Time**.*global_time*>= 7

Result: **Mall**.*guardian_number* increases by $\frac{2}{15}$ of **House**.*guardian_number* and the **House**.*guardian_number* decreases by the same amount

Rule 0-19

Name: controlFlowMallNghHrCTZ1

Function: Manages the control flow for citizens at the **Mall** during the first half of the night time.

Constraints:

Mall.*citizen_number*>= 0.5

Time.*global_time*>= 21

Result: **Mall**.*citizen_number* decreases by 0.5 and another locality's *citizen_number* increases by 0.5

Rule 0-20

Name: controlFlowMallNghHrCTZ2

Function: Manages the control flow for citizens at the **Mall** during the second half of the night time.

Constraints:

Mall.*citizen_number*>= 0.5

7 >**Time**.*global_time*

Result: **Mall**.*citizen_number* decreases by 0.5 and another locality's *citizen_number* increases by 0.5

Rule 0-21

Name: controlFlowMallNghHrGRD1

Function: Manages the control flow for guardians at the **Mall** during the first half of the night time.

Constraints:

Mall.*citizen_number*>= 1.0

Time.*global_time*>= 21

Result: **Mall**.*guardian_number* decreases by 1.0 and another locality's *guardian_number* increases by 1.0

Rule 0-22

Name: controlFlowMallNghHrGRD2

Function: Manages the control flow for guardians at the **Mall** during the second half of the night time.

Constraints:

Mall.*guardian_number*>= 1.0

7 >**Time**.*global_time*

Result: **Mall**.*guardian_number* decreases by 1.0 and another locality's *guardian_number* increases by 1.0

Rule 0-23

Name: controlFlowMallNghHrOFN1

Function: Manages the control flow for offenders at the **Mall** during the first half of the night time.

Constraints:

Mall.*citizen_number*>= 0.1

Time.*global_time*>= 21

Result: **Mall**.*offender_number* decreases by 0.1 and another locality's *offender_number* increases by 0.1

Rule 0-24

Name: controlFlowMallNghHrOFN2

Function: Manages the control flow for offenders at the **Mall** during the second half of the night time.

Constraints:

Mall.*offender_number*>= 0.1

7 >**Time**.*global_time*

Result: **Mall**.*offender_number* decreases by 0.1 and another locality's *offender_number* increases by 0.1

Rule 0-25

Name: controlFlowMallWrkHrCTZ

Function: Manages the control flow for citizens at the **Mall** during the working hours' time.

Constraints:

Mall.*citizen_number*>= 0.25

17 >**Time**.*global_time*>= 9

Result: **Mall**.*citizen_number* decreases by 0.25 and another locality's *citizen_number* increases by 0.25

Rule 0-26

Name: controlFlowMallWrkHrGRD

Function: Manages the control flow for guardians at the **Mall** during the working hours' time.

Constraints:

Mall.*guardian_number*>= 0.1

17 >**Time**.*global_time*>= 9

Result: **Mall**.*guardian_number* decreases by 0.1 and another locality's *guardian_number* increases by 0.1

Rule 0-27

Name: controlFlowParkDayHrOFN

Function: Manages the control flow for offenders at the **Park** during the day time.

Constraints:

Park.*offender_number*>= 0.1

21 >**Time**.*global_time*>= 7

Result: **Park**.*offender_number* decreases by 0.1 and another locality's *offender_number* increases by 0.1

Rule 0-28

Name: controlFlowParkEveHrCTZ

Function: Manages the control flow for citizens at the **Park** during the evening time.

Constraints:

Park.*citizen_number*>= 1.5

21 >**Time**.*global_time*>= 17

Result: **Park**.*citizen_number* decreases by 1.5 and another locality's *citizen_number* increases by 1.5

Rule 0-29

Name: controlFlowParkEveHrGRD

Function: Manages the control flow for guardians at the **Park** during the evening time.

Constraints:

Park.*guardian_number*>= 0.2

21 >**Time**.*global_time*>= 17

Result: **Park**.*guardian_number* decreases by 0.25 and another locality's *guardian_number* increases by 0.25

Rule 0-30

Name: controlFlowParkMrnHrCTZ

Function: Manages the control flow for citizens at the **Park** during the morning time.

Constraints:

9 >**Time**.*global_time*>= 7

Result: **Park**.*citizen_number* increases by $\frac{1}{12}$ of **House**.*citizen_number* and the **House**.*citizen_number* decreases by the same amount

Rule 0-31

Name: controlFlowParkMrnHrGRD

Function: Manages the control flow for guardians at the **Park** during the morning time.

Constraints:

9 >**Time**.*global_time*>= 7

Result: **Park**.*guardian_number* increases by $\frac{1}{20}$ of **House**.*guardian_number* and the **House**.*guardian_number* decreases by the same amount

Rule 0-32

Name: controlFlowParkNghHrCTZ1

Function: Manages the control flow for citizens at the **Park** during the first half of the night time.

Constraints:

Park.*citizen_number*>= 0.2

Time.*global_time*>= 21

Result: **Park**.*citizen_number* decreases by 0.2 and another locality's *citizen_number* increases by 0.2

Rule 0-33

Name: controlFlowParkNghHrCTZ2

Function: Manages the control flow for citizens at the **Park** during the second half of the night time.

Constraints:

Park.*citizen_number*>= 0.2

7 >**Time**.*global_time*

Result: **Park**.*citizen_number* decreases by 0.2 and another locality's *citizen_number* increases by 0.2

Rule 0-34

Name: controlFlowParkNghHrGRD1

Function: Manages the control flow for guardians at the **Park** during the first half of the night time.

Constraints:

Park.*citizen_number*>= 1.0

Time.*global_time*>= 21

Result: **Park**.*guardian_number* decreases by 1.0 and another locality's *guardian_number* increases by 1.0

Rule 0-35

Name: controlFlowParkNghHrGRD2

Function: Manages the control flow for guardians at the **Park** during the second half of the night time.

Constraints:

Park.*guardian_number*>= 1.0

7 >**Time**.*global_time*

Result: **Park**.*guardian_number* decreases by 1.0 and another locality's *guardian_number* increases by 1.0

Rule 0-36

Name: controlFlowParkNghHrOFN1

Function: Manages the control flow for offenders at the **Park** during the first half of the night time.

Constraints:

Park.*citizen_number*>= 0.05

Time.*global_time*>= 21

Result: **Park**.*offender_number* decreases by 0.05 and another locality's *offender_number* increases by 0.05

Rule 0-37

Name: controlFlowParkNghHrOFN2

Function: Manages the control flow for offenders at the **Park** during the second half of the night time.

Constraints:

Park.*offender_number*>= 0.05

7 >**Time**.*global_time*

Result: **Park**.*offender_number* decreases by 0.05 and another locality's *offender_number* increases by 0.05

Rule 0-38

Name: controlFlowParkWrkHrCTZ

Function: Manages the control flow for citizens at the **Park** during the working hours' time.

Constraints:

Park.*citizen_number*>= 1.0

17 >**Time**.*global_time*>= 9

Result: **Park**.*citizen_number* decreases by 1.0 and another locality's *citizen_number* increases by 1.0

Rule 0-39

Name: controlFlowParkWrkHrGRD

Function: Manages the control flow for guardians at the **Park** during the working hours' time.

Constraints:

Park.*guardian_number*>= 1.5

17 >**Time**.*global_time*>= 9

Result: **Park**.*guardian_number* decreases by 1.5 and another locality's *guardian_number* increases

by 1.5

Rule 0-40

Name: controlFlowSchoolDayHrOFN

Function: Manages the control flow for offenders at the **School** during the day time.

Constraints:

School.*offender_number*>= 1.0

21 >**Time**.*global_time*>= 7

Result: **School**.*offender_number* decreases by 1.0 and another locality's *offender_number* increases by 1.0

Rule 0-41

Name: controlFlowSchoolEveHrCTZ

Function: Manages the control flow for citizens at the **School** during the evening time.

Constraints:

School.*citizen_number*>= 5.0

21 >**Time**.*global_time*>= 17

Result: **School**.*citizen_number* decreases by 5.0 and another locality's *citizen_number* increases by 5.0

Rule 0-42

Name: controlFlowSchoolEveHrGRD

Function: Manages the control flow for guardians at the **School** during the evening time.

Constraints:

School.*guardian_number*>= 2.0

21 >**Time**.*global_time*>= 17

Result: **School**.*guardian_number* decreases by 2.0 and another locality's *guardian_number* increases by 2.0

Rule 0-43

Name: controlFlowSchoolMrnHrCTZ

Function: Manages the control flow for citizens at the **School** during the morning time.

Constraints:

9 >**Time**.*global_time*>= 7

Result: **School**.*citizen_number* increases by $\frac{3}{10}$ of **House**.*citizen_number* and the **House**.*citizen_number* decreases by the same amount

Rule 0-44

Name: controlFlowSchoolMrnHrGRD

Function: Manages the control flow for guardians at the **School** during the morning time.

Constraints:

9 >**Time**.*global_time*>= 7

Result: **School**.*guardian_number* increases by $\frac{1}{4}$ of **House**.*guardian_number* and the **House**.*guardian_number* decreases by the same amount

Rule 0-45

Name: controlFlowSchoolNghHrCTZ1

Function: Manages the control flow for citizens at the **School** during the first half of the night time.

Constraints:

School.*citizen_number*>= 0.5

Time.*global_time*>= 21

Result: **School**.*citizen_number* decreases by 0.5 and another locality's *citizen_number* increases by 0.5

Rule 0-46

Name: controlFlowSchoolNghHrCTZ2

Function: Manages the control flow for citizens at the **School** during the second half of the night time.

Constraints:

School.*citizen_number*>= 0.5

7 >**Time**.*global_time*

Result: **School**.*citizen_number* decreases by 0.5 and another locality's *citizen_number* increases by 0.5

Rule 0-47

Name: controlFlowSchoolNghHrGRD1

Function: Manages the control flow for guardians at the **School** during the first half of the night time.

Constraints:

School.*citizen_number*>= 1.0

Time.*global_time*>= 21

Result: **School**.*guardian_number* decreases by 1.0 and another locality's *guardian_number* increases by 1.0

Rule 0-48

Name: controlFlowSchoolNghHrGRD2

Function: Manages the control flow for guardians at the **School** during the second half of the night time.

Constraints:

School.*guardian_number*>= 1.0

7 >**Time**.*global_time*

Result: **School**.*guardian_number* decreases by 1.0 and another locality's *guardian_number* increases by 1.0

Rule 0-49

Name: controlFlowSchoolNghHrOFN1

Function: Manages the control flow for offenders at the **School** during the first half of the night time.

Constraints:

School.*citizen_number*>= 0.05

Time.*global_time*>= 21

Result: **School**.*offender_number* decreases by 0.05 and another locality's *offender_number* increases by 0.05

Rule 0-50

Name: controlFlowSchoolNghHrOFN2

Function: Manages the control flow for offenders at the **School** during the second half of the night time.

Constraints:

School.*offender_number*>= 0.05

7 >**Time**.*global_time*

Result: **School**.*offender_number* decreases by 0.05 and another locality's *offender_number* increases by 0.05

Rule 0-51

Name: controlFlowSchoolWrkHrCTZ

Function: Manages the control flow for citizens at the **School** during the working hours' time.

Constraints:

School.*citizen_number*>= 1.5

17 >**Time**.*global_time*>= 9

Result: **School**.*citizen_number* decreases by 1.5 and another locality's *citizen_number* increases by 1.5

Rule 0-52

Name: controlFlowSchoolWrkHrGRD

Function: Manages the control flow for guardians at the **School** during the working hours' time.

Constraints:

School.*guardian_number*>= 0.4

17 >**Time**.*global_time*>= 9

Result: **School**.*guardian_number* decreases by 0.4 and another locality's *guardian_number* increases by 0.4

Rule 0-53

Name: decrementLocalTime

Function: Decrements the *local_timer* attribute of a host locality.

Constraints:

Locality.*local_timer*> 0

Result: The host locality's *local_timer* is decremented by 1

Rule 0-54

Name: incrementTime

Function: Increments the *global_time*

Constraints: N/A

Result: The **Time**.*global_time* is incremented by 1

Rule 0-55

Name: resetLocality

Function: Resets the colour of a host locality and also removes one label. *Constraints:*

Locality.*local_timer*= 0

The locality must have at least one label

Result: The host locality's colour is reset (to default) and one of its labels are removed

Rule 0-56

Name: safestLocality

Function: Determines the safest non-policy locality amongst three non-policy localities and declares it the safest (by means of a flag); the previous safest locality is stripped from its label.

Constraints:

Time.*global_time*= 7

The **Time**.*minimum_crime* must be greater than the newly found smallest *crime_number*.
Result: A new safest locality is declared (by means of a flag); the previous safest locality is stripped of its 'safest' flag. The **Time**.*minimum_crime* is set to the newly found smallest *crime_number*

C.1.3 Priority 1

Rule 1-1
Name: controlFlowLibraryHomeCTZ
Function: Moves any excess citizens at **Library** to **Home** *Constraints:*
Library.*citizen_number*> 1.0
Time.*global_time*= 24
Result: **Library**.*citizen_number* is set to 1.0; **House**.*citizen_number* increases by the number of surplus citizens at **Library**

Rule 1-2
Name: controlFlowLibraryHomeGRD
Function: Moves any excess guardians at **Library** to **Home** *Constraints:*
Library.*guardian_number*> 1.0
Time.*global_time*= 24
Result: **Library**.*guardian_number* is set to 1.0; **House**.*guardian_number* increases by the number of surplus citizens at **Library**

Rule 1-3
Name: controlFlowMallHomeCTZ
Function: Moves any excess citizens at **Mall** to **Home** *Constraints:*
Mall.*citizen_number*> 0.1
Time.*global_time*= 24
Result: **Mall**.*citizen_number* is set to 0.1; **House**.*citizen_number* increases by the number of surplus citizens at **Mall**

Rule 1-4
Name: controlFlowMallHomeGRD
Function: Moves any excess guardians at **Mall** to **Home** *Constraints:*
Mall.*guardian_number*> 0.2
Time.*global_time*= 22
Result: **Mall**.*guardian_number* is set to 0.2; **House**.*guardian_number* increases by the number of surplus citizens at **Mall**

Rule 1-5
Name: controlFlowParkHomeCTZ
Function: Moves any excess citizens at **Park** to **Home** *Constraints:*
Park.*citizen_number*> 1.0
Time.*global_time*= 24
Result: **Park**.*citizen_number* is set to 1.0; **House**.*citizen_number* increases by the number of surplus citizens at **Park**

Rule 1-6
Name: controlFlowParkHomeGRD
Function: Moves any excess guardians at **Park** to **Home** *Constraints:*

Park.*guardian_number*> 2.0

Time.*global_time*= 22

Result: **Park**.*guardian_number* is set to 2.0; **House**.*guardian_number* increases by the number of surplus citizens at **Park**

Rule 1-7

Name: controlFlowSchoolHomeCTZ

Function: Moves any excess citizens at **School** to **Home** *Constraints:*

School.*citizen_number*> 0.5

Time.*global_time*= 21

Result: **School**.*citizen_number* is set to 0.5; **House**.*citizen_number* increases by the number of surplus citizens at **School**

Rule 1-8

Name: controlFlowSchoolHomeGRD

Function: Moves any excess guardians at **School** to **Home** *Constraints:*

School.*guardian_number*> 1.0

Time.*global_time*= 22

Result: **School**.*guardian_number* is set to 1.0; **House**.*guardian_number* increases by the number of surplus citizens at **School**

Rule 1-9

Name: decrementLocalCrime

Function: Implements the logic concerning when a host locality's local timer reaches 0. *Constraints:*

Locality.*local_timer*= 0.0

Locality.*hidden_offender_count*! = 0

Result: Locality.*hidden_offender_count*= 0; **Home**.*hidden_offender* is subtracted by Locality.*hidden_offender_count* value prior to the 0.0 assignment; otherLocality.*hidden_offender_count* is increased by Locality.*hidden_offender_count* value prior to the 0.0 assignment.

Rule 1-10

Name: firstCrimeOccurrence

Function: Implements the logic concerning a host locality experiencing crime of severity level 'yellow' *Constraints:*

Locality.*guardian_number*<Locality.*citizen_number*

Locality.*citizen_number*<Locality.*offender_number*

Locality.*local_timer*= 0

Result: Locality.*offender_number* is subtracted by Locality.*citizen_number*; Locality.*hidden_offender_count* is incremented by Locality.*citizen_number*; Locality.*crime_number* is increased by Locality.*citizen_number*; Locality.$local_timerissetto2$; $Localityiscolouredyellowandassignedthe`YELLOW'flag$; ***Home***.$hidden\_offenderisincren$

Rule 1-11

Name: incrementPolicy

Function: Updates the current policy. Constraints:

Time.*global_time*= 8

Result: Policy node's accessibility with the previous safest locality is removed and a new accessibility is assigned with the current safest locality.

Rule 1-12

Name: newDay

Function: Implements the logic concerning when a new day is reached. Constraints:

***Time**.global_time*> 24

Result: ***Time**.global_time is set to* 0

Rule 1-13

Name: secondCrimeOccurrence

Function: Implements the logic concerning a host locality experiencing crime of severity level 'orange' Constraints:

Locality.guardian_number<*Locality.citizen_number*

Locality.citizen_number<*Locality.offender_number*

$Locality.local\_timer! = 0$

Result: Locality.offender_number is subtracted by Locality.citizen_number; Locality.hidden_offender_count is incremented by Locality.citizen_number; Locality.crime_number is increased by Locality.citizen_number; $Locality.local_timer is incremented by 2; Locality is coloured orange and assigned the 'ORANGE' flag (a previous 'YELLOW$

Rule 1-14

Name: thirdCrimeOccurrence

Function: Implements the logic concerning a host locality experiencing crime of severity level 'red' Constraints:

Locality.guardian_number<*Locality.citizen_number*

Locality.citizen_number<*Locality.offender_number*

$Locality.local\_timer! = 0$

Result: Locality.offender_number is subtracted by Locality.citizen_number; Locality.hidden_offender_count is incremented by Locality.citizen_number; Locality.crime_number is increased by Locality.citizen_number; $Locality.local_timer is incremented by 2; Locality is coloured orange and assigned the 'RED' flag (a previous 'ORANGE' flag$

C.2 Simulating in GROOVE

Assuming the user knows the basics of working with GROOVE[1]*, we present the following steps to begin constructing a simulation:*

1. *Select the LTS or 'State Panel' tab*
2. *Apply whichever control flow rules you would like from the list of applicable rules*
3. *Once you have applied the control flow rules of your choice, select (in this order):*
   (a) *The 'decrementLocalTime' (Rule 0-53) rule if applicable*
   (b) *The 'resetLocality' (Rule 0-55) rule if applicable*
   (c) *The 'safestLocality' (Rule 0-56) rule if applicable*
   (d) *The 'incrementTime' (Rule 0-54) rule*
4. *If, during any of the above, a higher priority rule (Rules 1-X) is applicable, call that rule*[2]*.*

Following the above steps is essentially the procedure for simulating a criminal domain using our implementation.

[1] If you do not, please check out the GROOVE demos to get a basic understanding of how to use GROOVE: https://groove.ewi.utwente.nl/demos

[2] GROOVE prevents lower priority rules from being executed if higher priority rules are applicable, so you will not be able to execute any other rules except the higher priority ones anyway