COL:750/7250

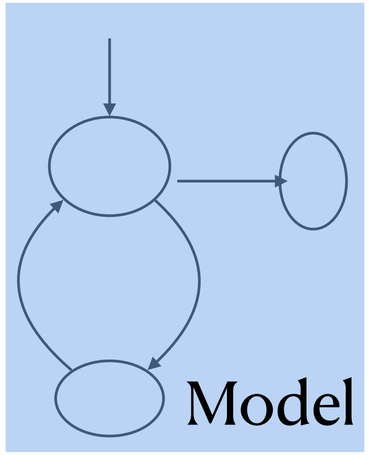
Foundations of Automatic Verification

Instructor: Priyanka Golia

Course Webpage

https://priyanka-golia.github.io/teaching/COL-750-COL7250/index.html

Does Code Satisfy Requirements ?

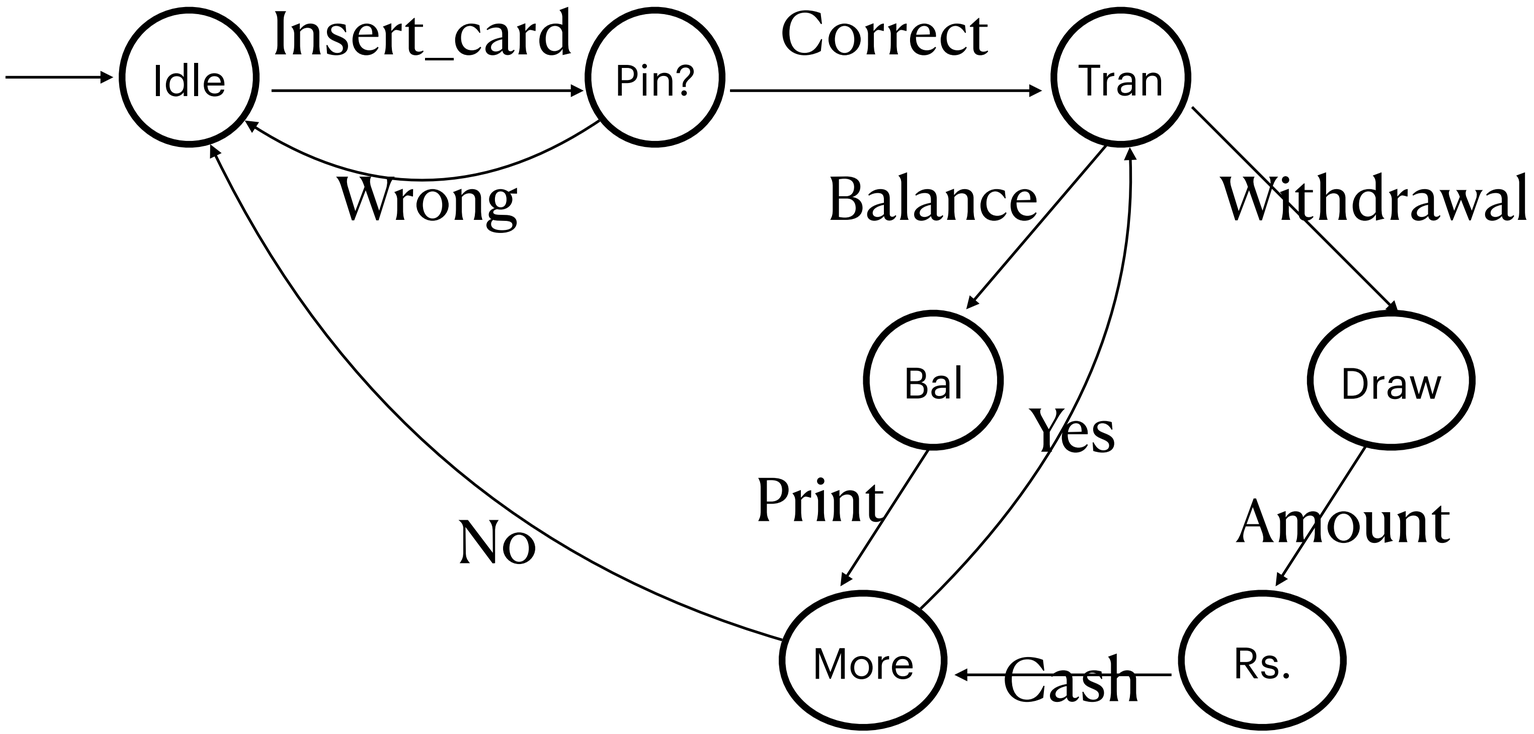


Does Model Satisfy Logical formulation: LTL/CTL Formula ?

Model Checking

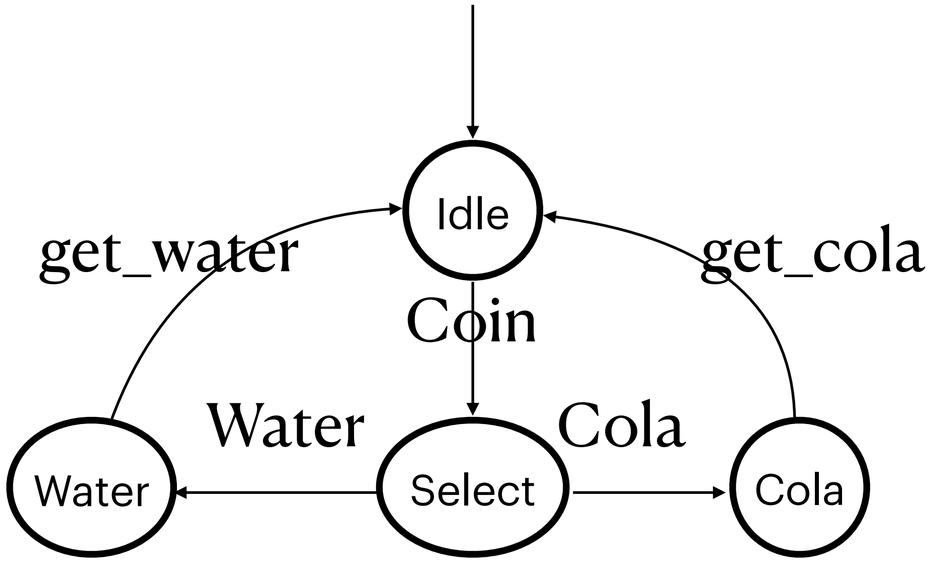
Modeling code behavior

How to model ATM behavior?



Modeling code behavior

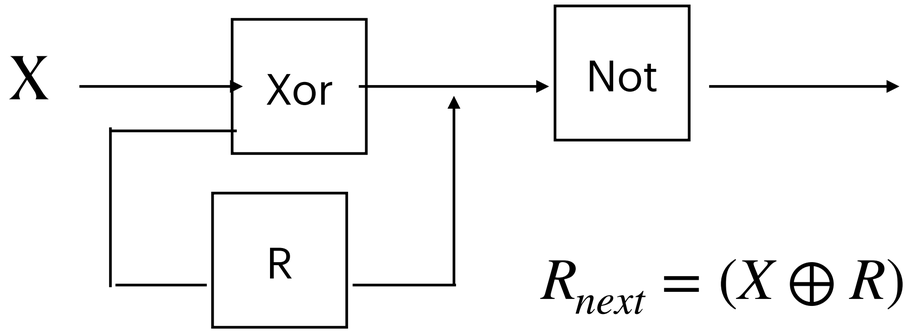
How to model a vending machine behavior?

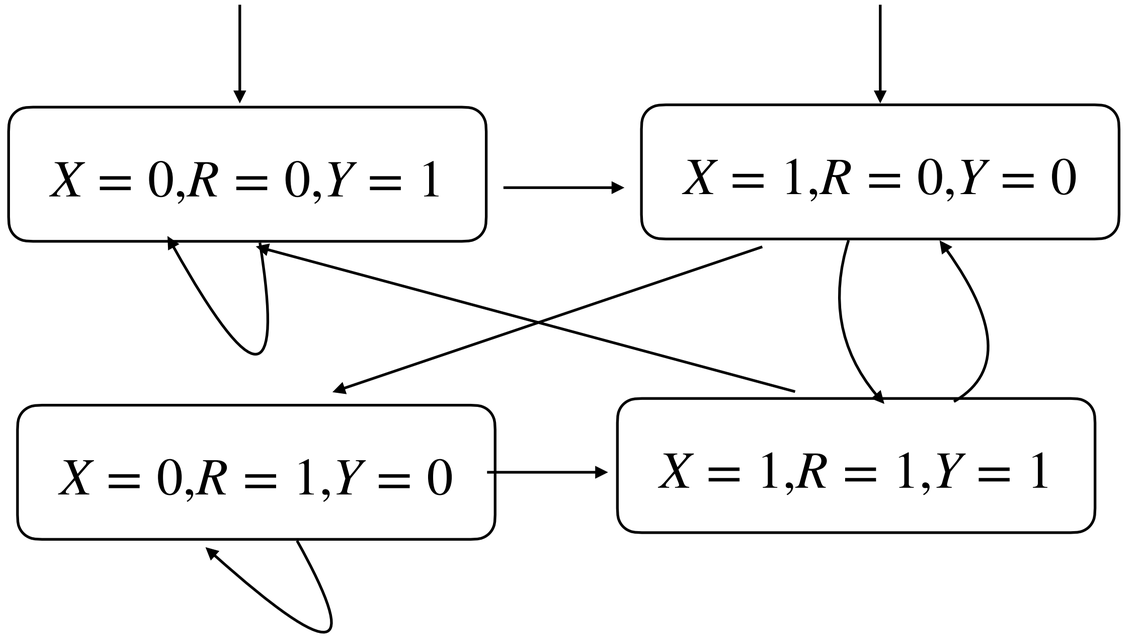


Transition systems: states, actions, transitions

Modeling code behavior

Hardware $Y = \neg(X \oplus R)$

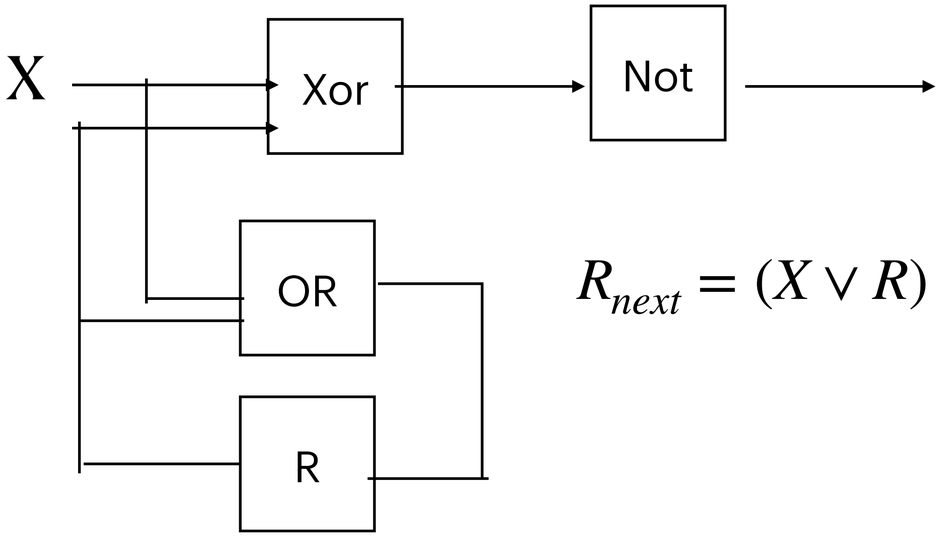




X	1	1	0	1	1	1
R	0	1	0	0	1	0
Y	0	1	1	0	1	0

Modeling code behavior

Hardware $Y = \neg(X \oplus R)$



$R_{next} = (X \vee R)$

Register

X	1	1	0	1	0	1
R	0	1	1	1	1	1
Y	0	1	0	1	0	1

$X = 0, R = 0, Y = 1$

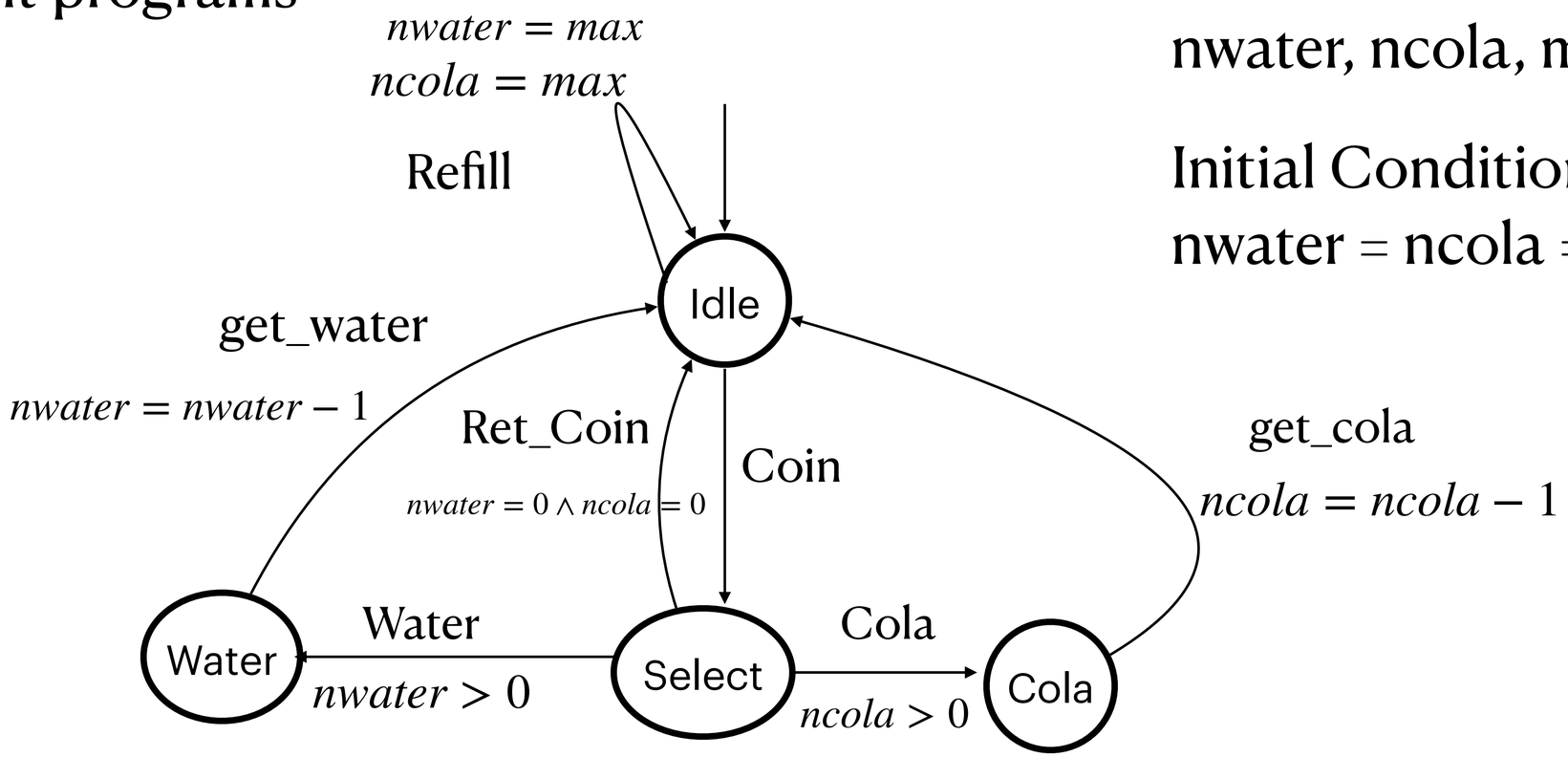
$X = 1, R = 0, Y = 0$

$X = 0, R = 1, Y = 0$

$X = 1, R = 1, Y = 1$

Modeling code behavior

Data-dependent programs



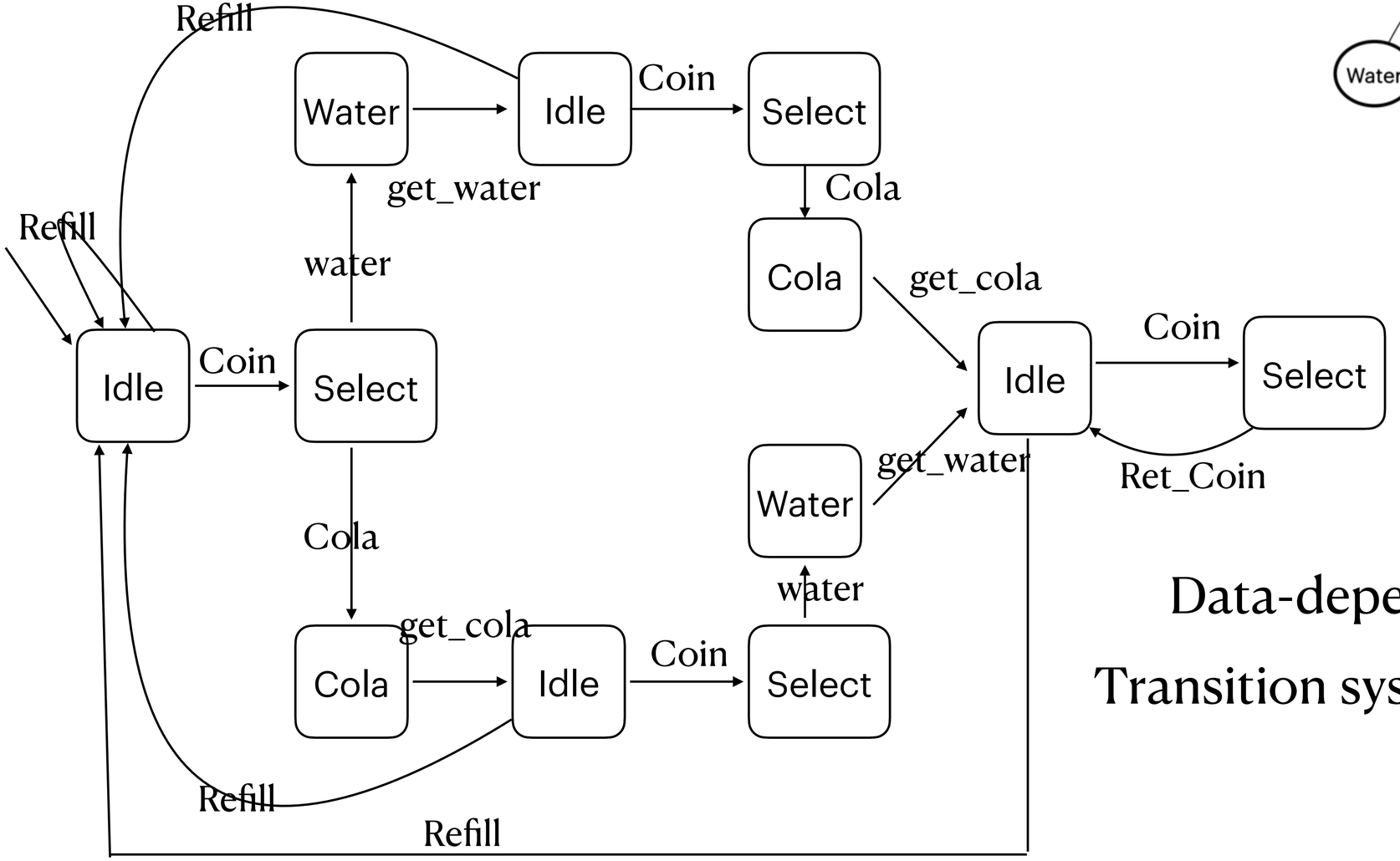
Program Graph

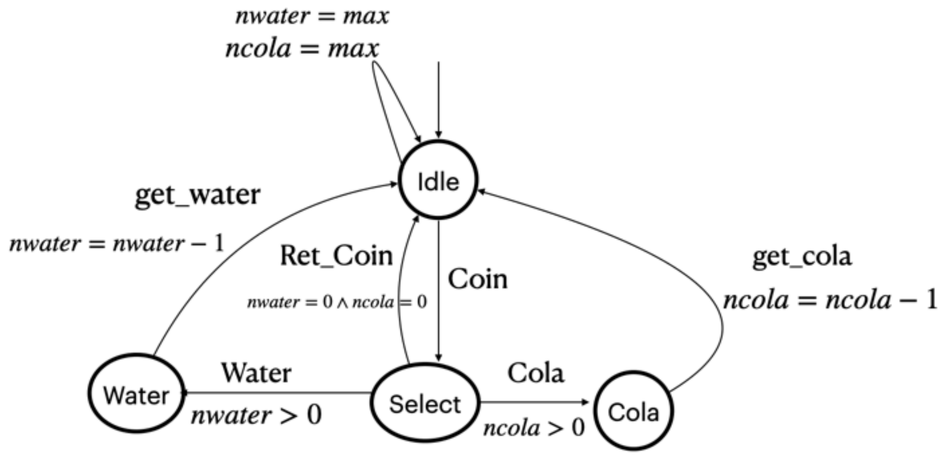
Variables:
nwater, ncola, max

Initial Condition:
nwater = ncola = max

Modeling code behavior

Data-dependent programs





Program Graph

Data-dependent programs

Transition system corresponding to Max=1

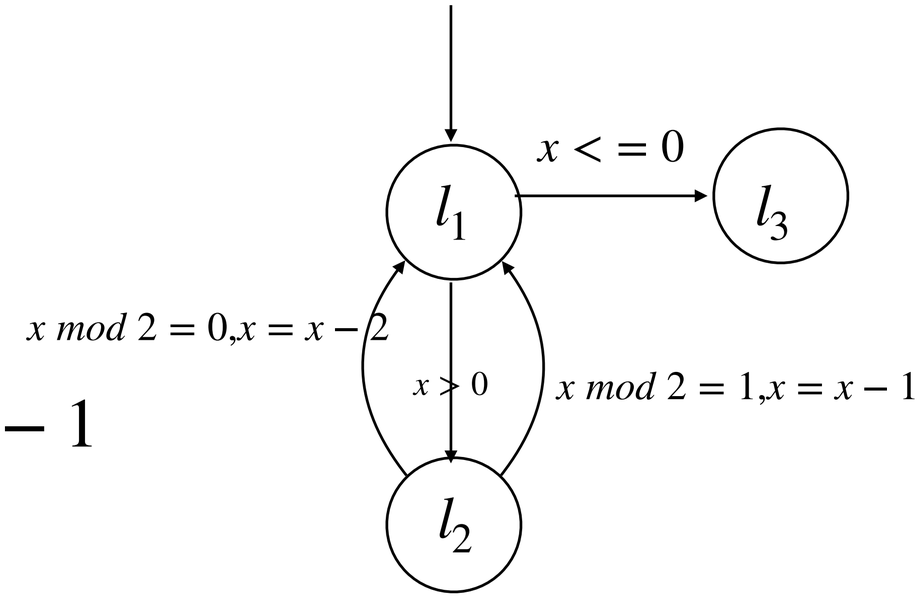
Modeling code behavior

Data-dependent programs

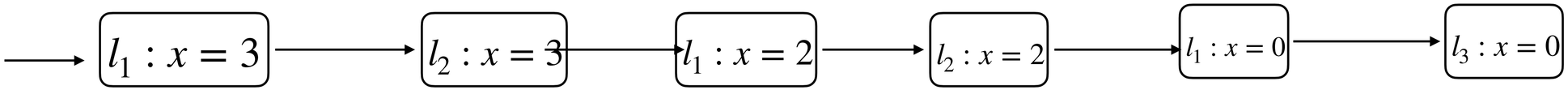
l_1: while $(x > 0)$

l_2 : $If(x \ mod \ 2 == 0)$ then $x = x - 2$, else $x = x - 1$

l_3 : …

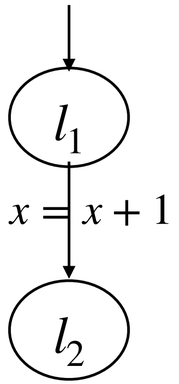


Transition system with initial condition $x = 3$



Modeling Concurrent Systems

Independent

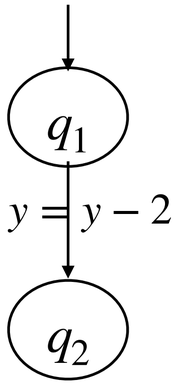


..
X: X+1
...

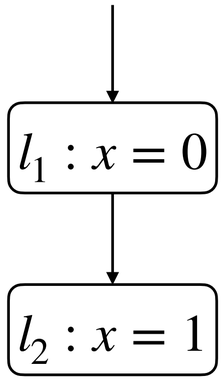
Shared variables

..
Y: Y-2
...

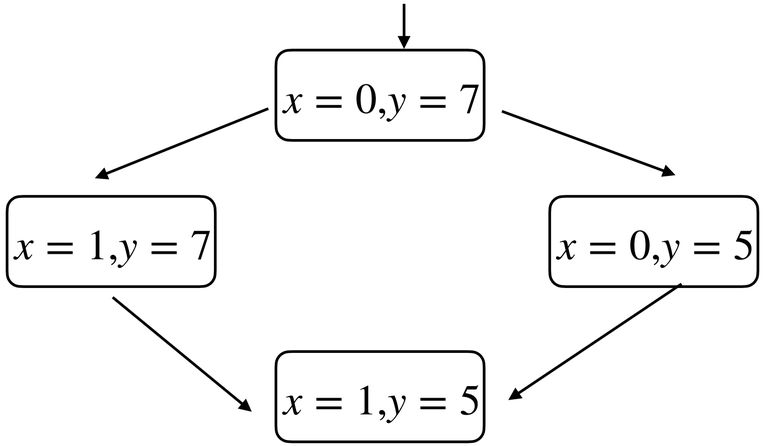
Shared actions



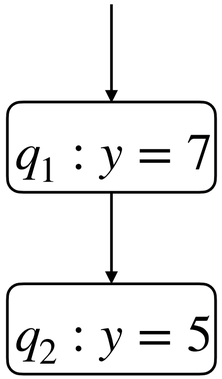
What is the transition system for the joint behaviour?



Initially x = 0

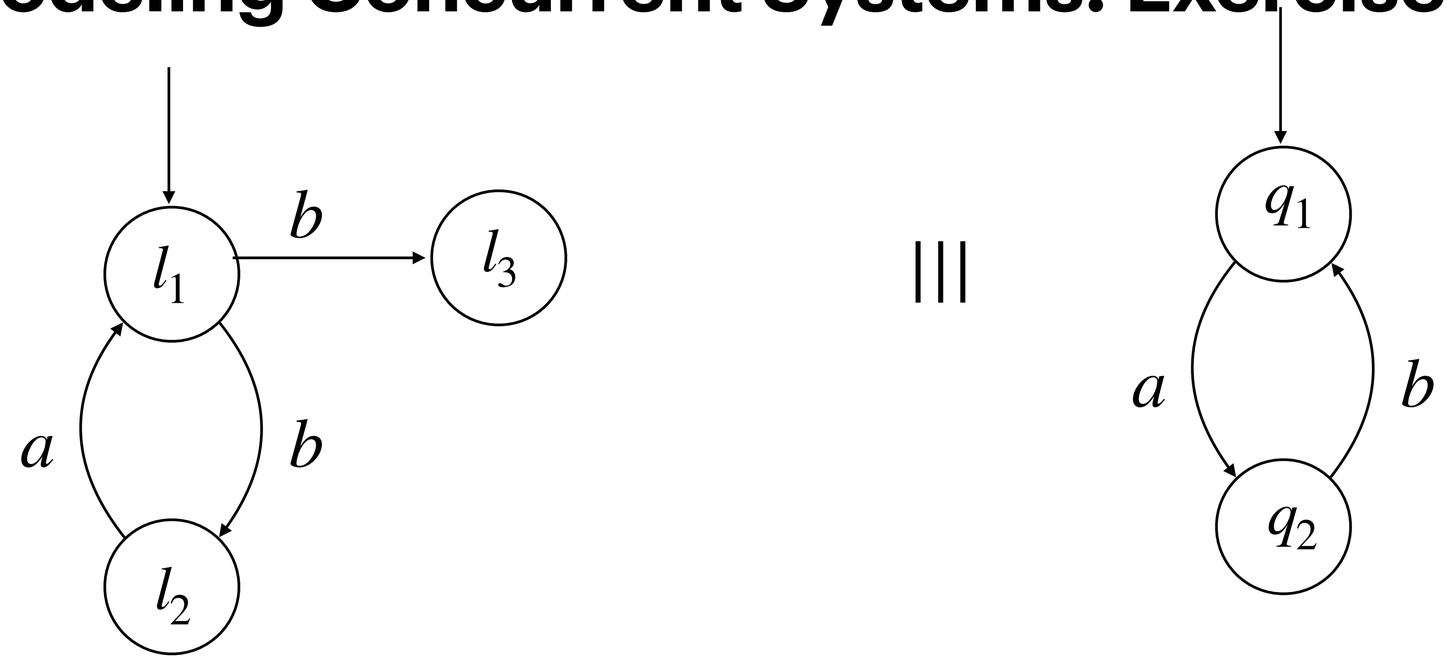


$TS_1 \;|||\; TS_2$



Initially y = 5

Modeling Concurrent Systems: Exercise



Modeling Concurrent Systems

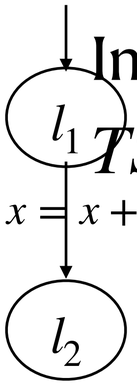
Independent

Shared variables

Shared actions

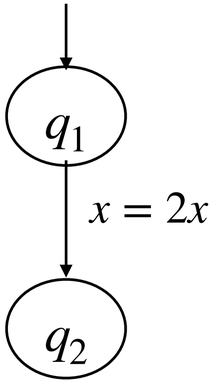
Interleaving:

$TS_1 \;|||\; TS_2 \;|||\; T_3 \ldots$

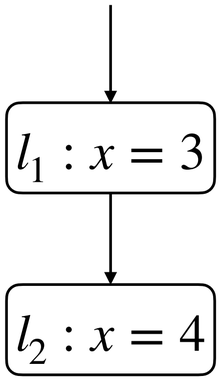


X: X+1
…

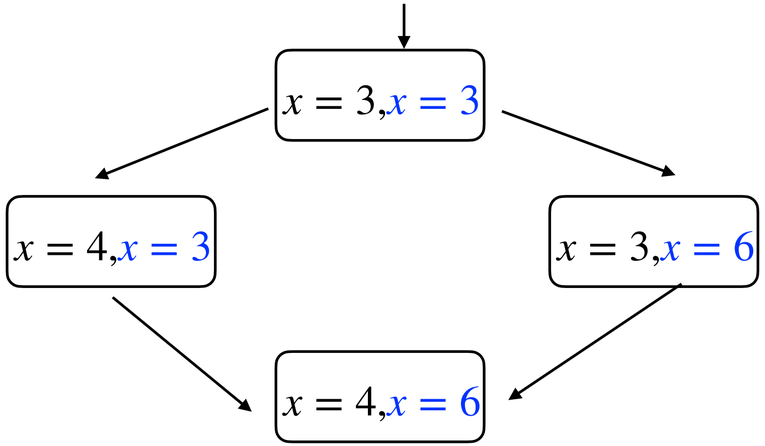
..
x: 2x
…



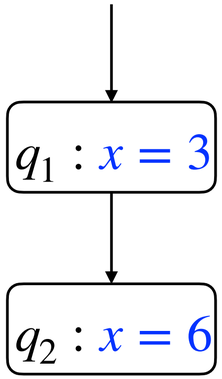
What is the transition system for the joint behaviour?



Initially x =3

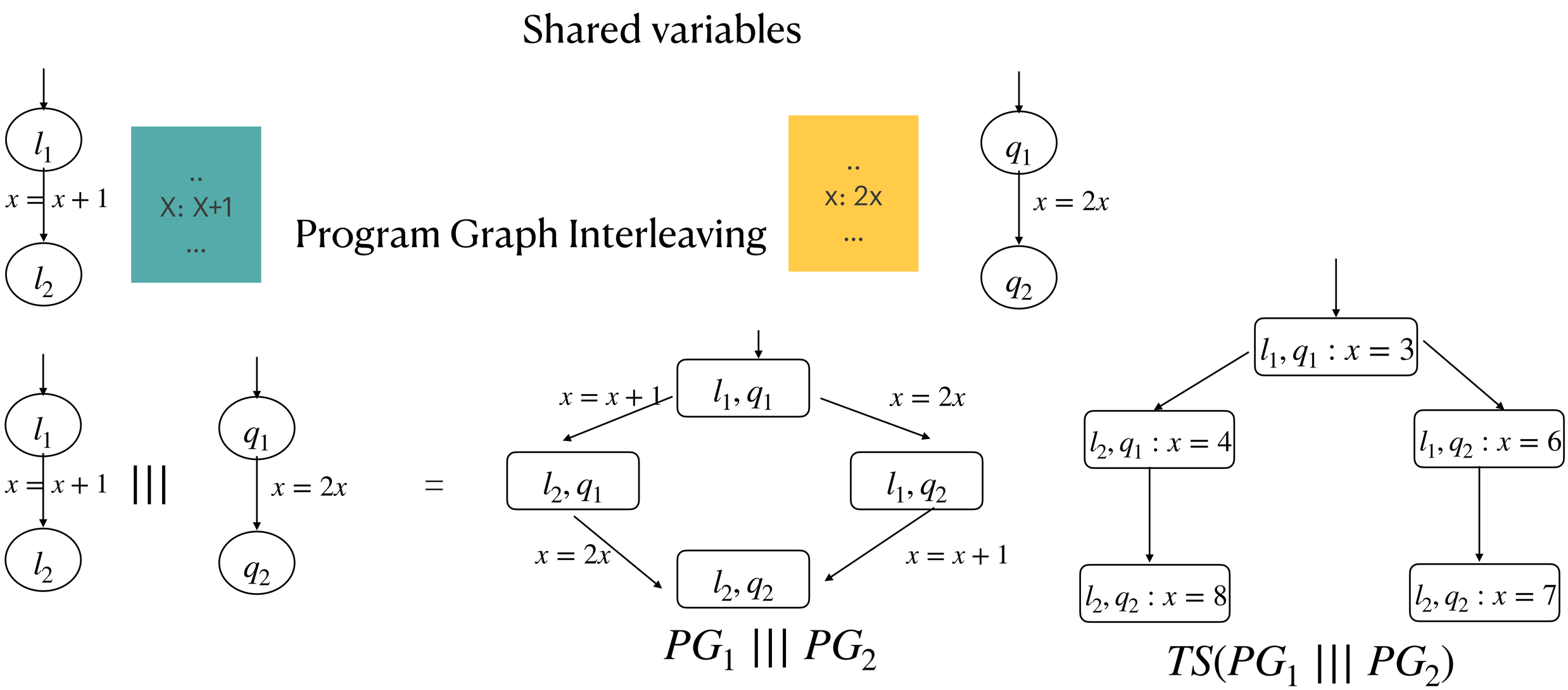


$TS_1 \;|||\; TS_2$



Initially x = 3

Modeling Concurrent Systems

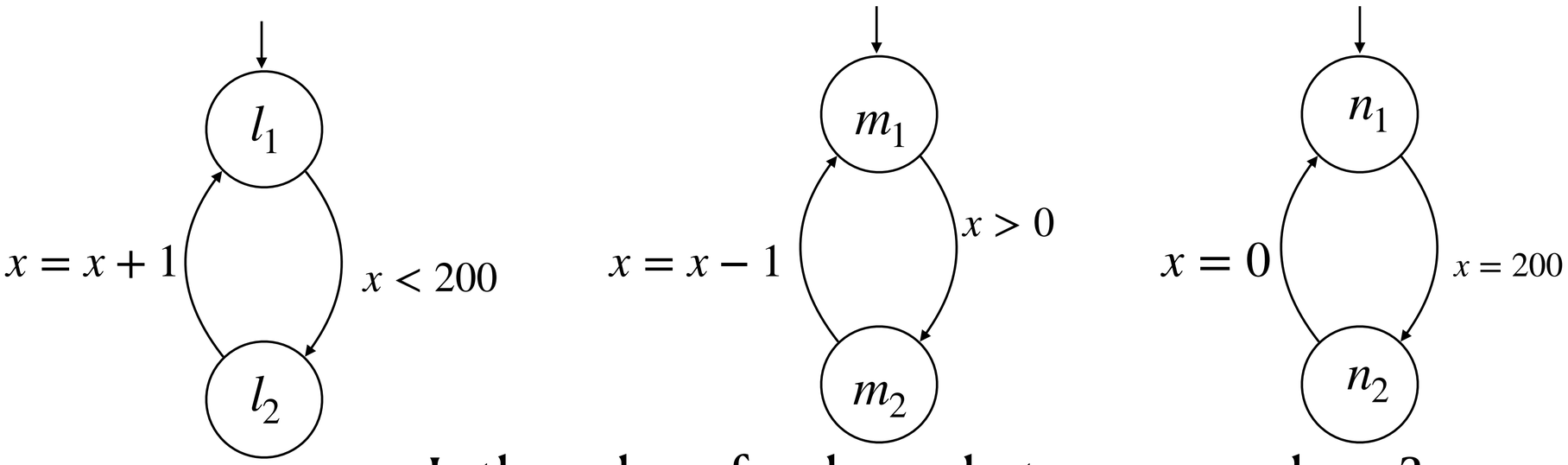


Modeling Concurrent Systems

While (X <200)
{x = x+1}

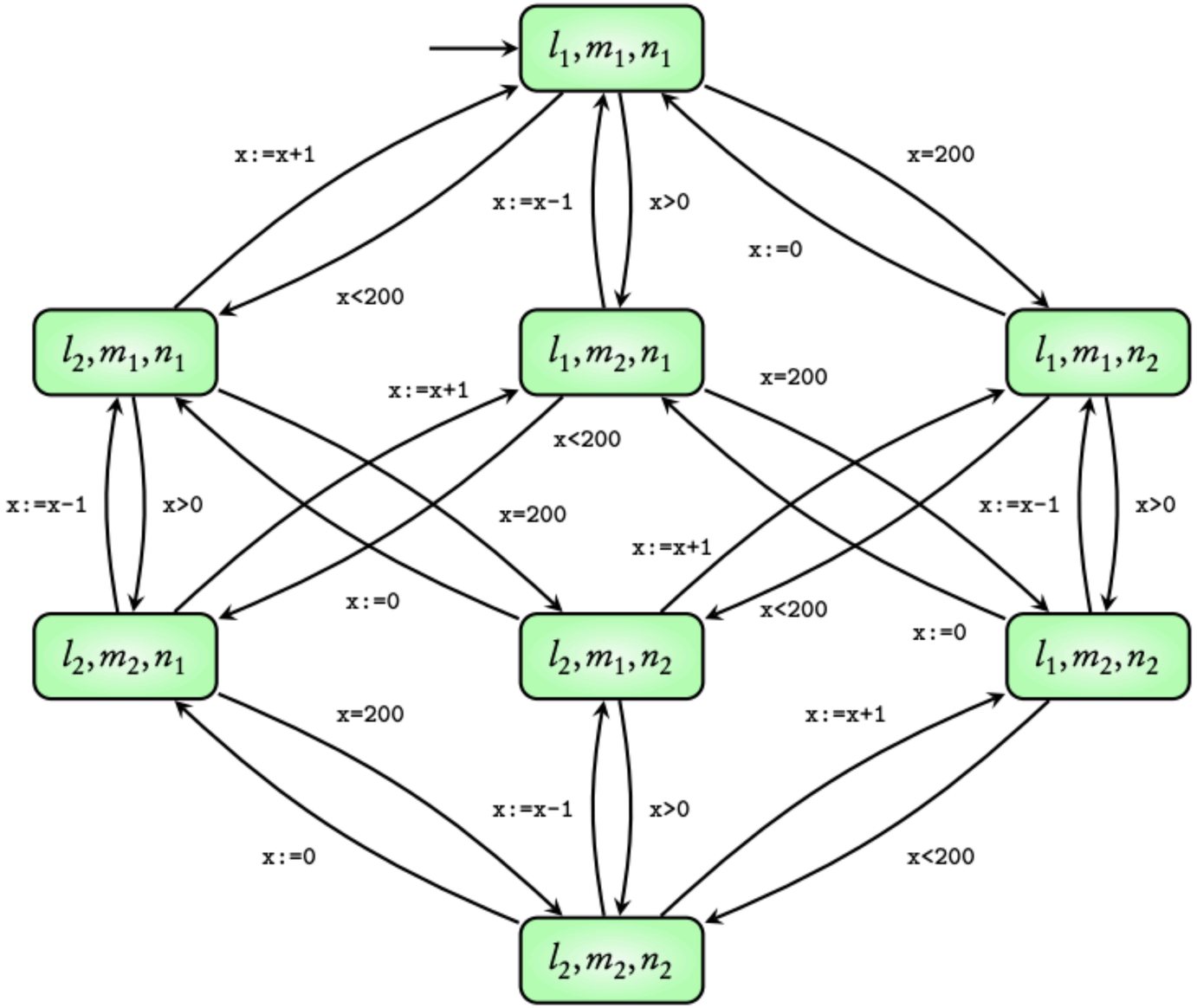
While (X >0)
{x = x-1}

While (X = 200)
{x = 0}

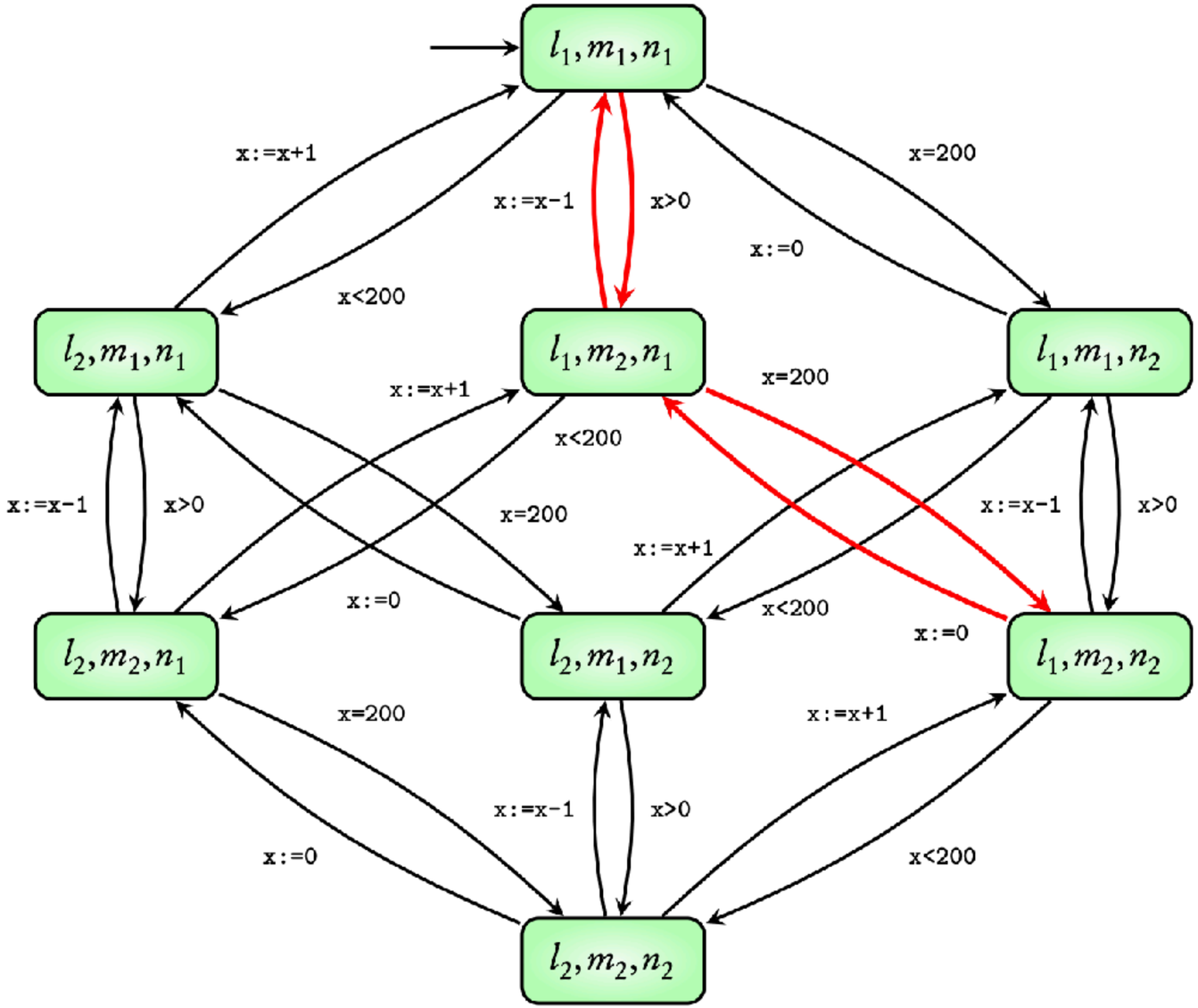


Is the value of x always between 0 and 200?

Modeling Concurrent Systems



Modeling Concurrent Systems



Is the value of x always between 0 and 200? No!!!

Modeling Concurrent Systems

Shared variables — Mutual exclusion

Mutual Exclusion: No two processes can access the resource (variables, printers, ..) simultaneously

How do we model the protocol for mutual exclusion?

Exercise!!

Modeling Concurrent Systems

Independent

Book-keeping system in a supermarket

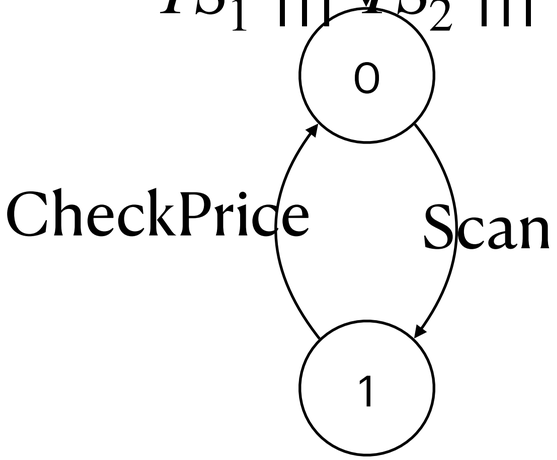
Shared variables

Shared actions

Interleaving:

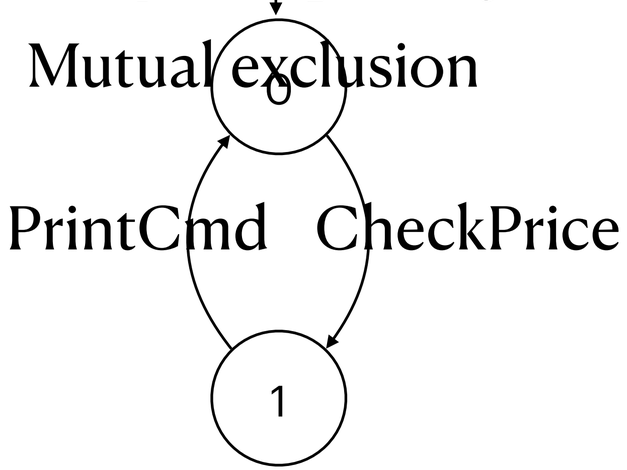
$TS_1 \mid\mid\mid TS_2 \mid\mid\mid T_3 \ldots$

$TS(PG_1 \mid\mid\mid PG_2 \mid\mid\mid PG_3 \ldots)$

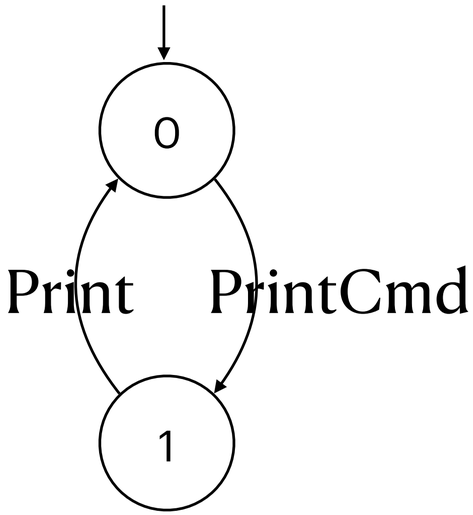


Bar Code Reading (BCR)

Mutual exclusion



Booking Program (BP)

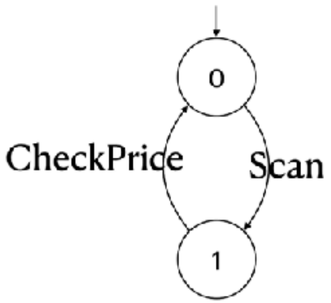


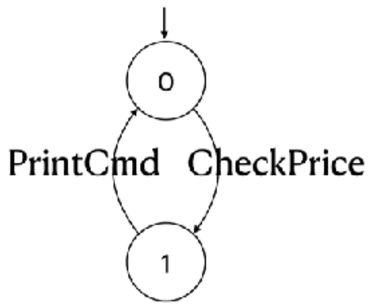
Printer

check_price, print_cmd: Shared actions (also called handshaking actions)

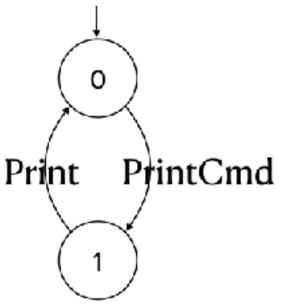
Modeling Concurrent Systems

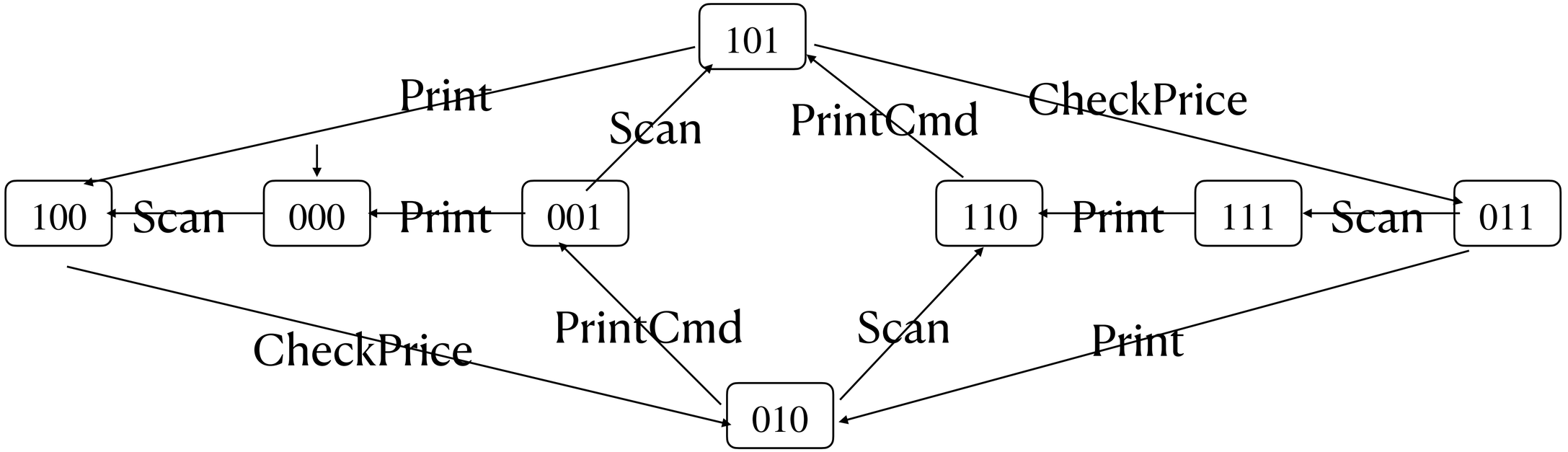
Book-keeping system in a supermarket





Shared actions



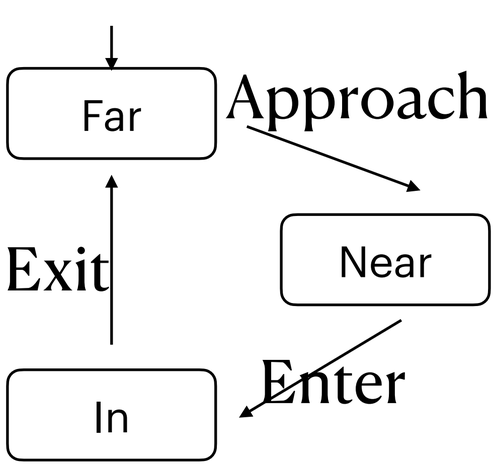


$$BCR \;||\; BP \;||\; P$$

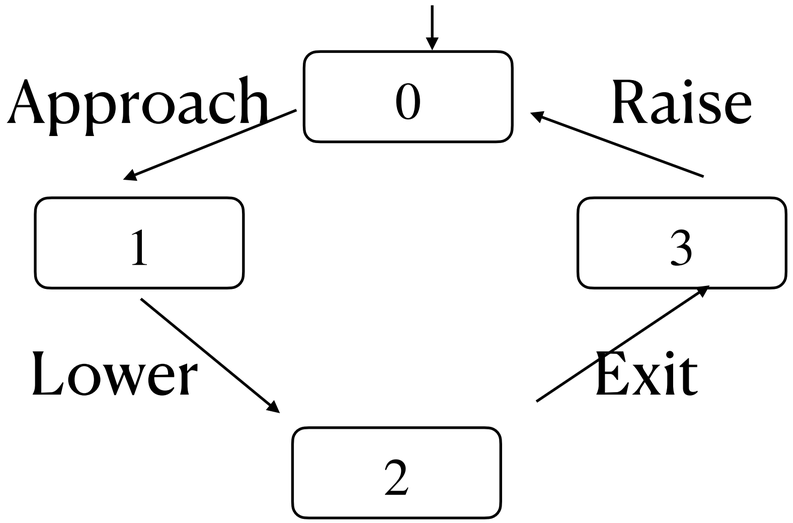
Modeling Concurrent Systems

Shared actions

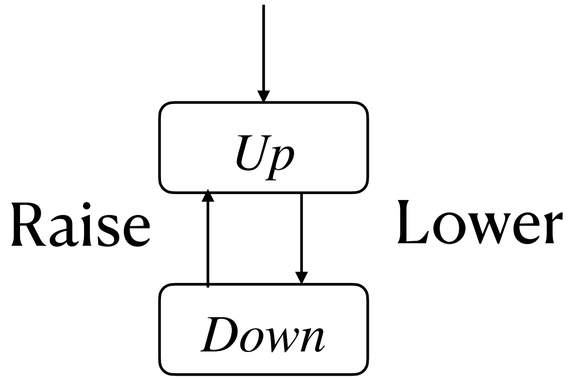
Train Crossing: Automatic Gate Closing



Train



Controller



Gate

Modeling Concurrent Systems

Independent

Interleaving:

$TS_1 \;|||\; TS_2 \;|||\; T_3 \ldots$

Shared variables

Mutual exclusion

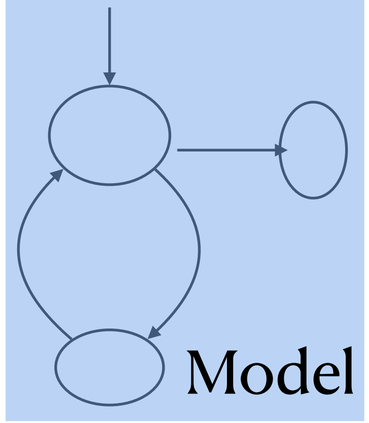
$TS(PG_1 \;|||\; PG_2 \;|||\; PG_3 \ldots)$

Shared actions

Handshake:

$TS_1 \;||\; TS_2 \;||\; T_3 \ldots$

Does Code Satisfy Requirements ?



Does Model Satisfy Logical formulation: LTL/CTL Formula ?

Model Checking

Model-checker will automatically check if system satisfies requirements

NuSMV : New Symbolic Model Verifier https://nusmv.fbk.eu/