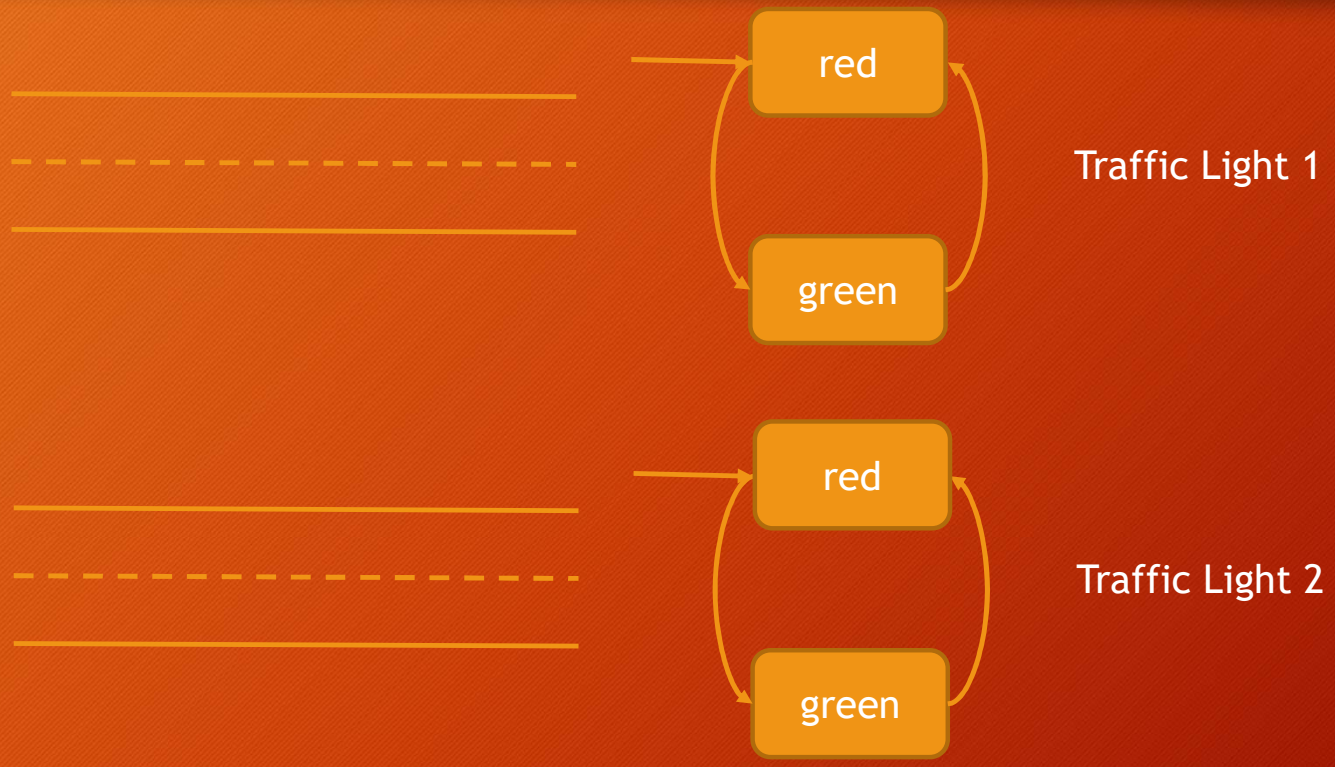
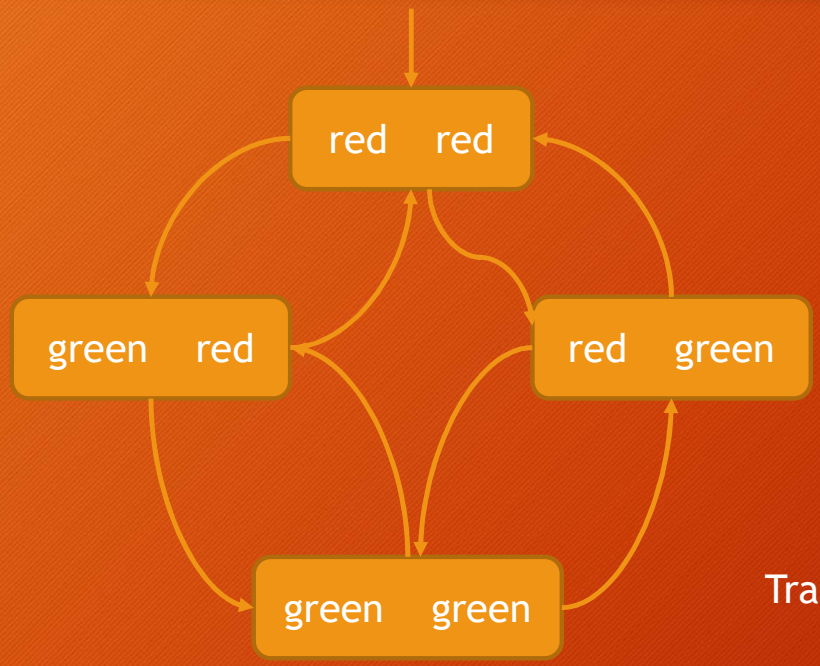
# SE2003
# Formal Methods in Software Engineering

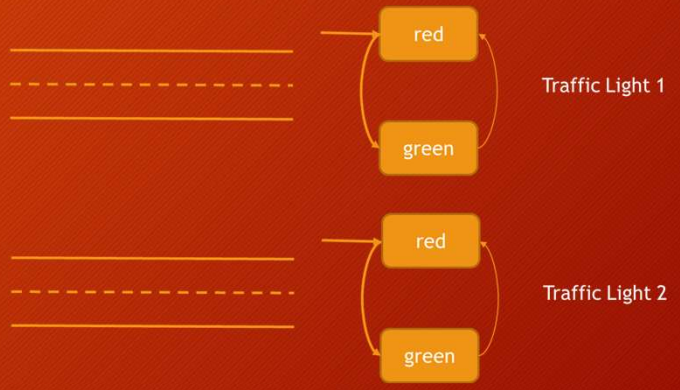
Spring-2024

# Modeling Concurrent Systems



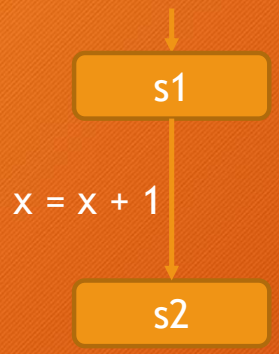
# Modelling Concurrent Systems



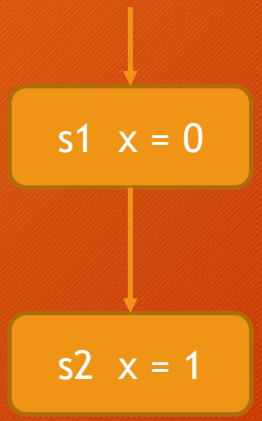

Traffic Light 1 ||| Traffic Light 2

# Modelling concurrent Systems

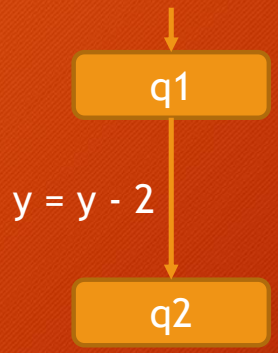



PG1

x = x + 1
...

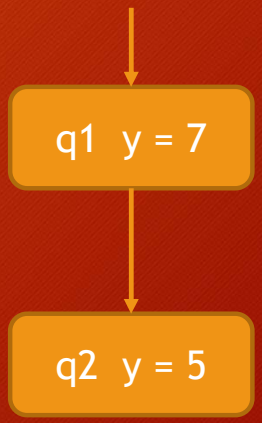



TS1
Initial value
x = 0



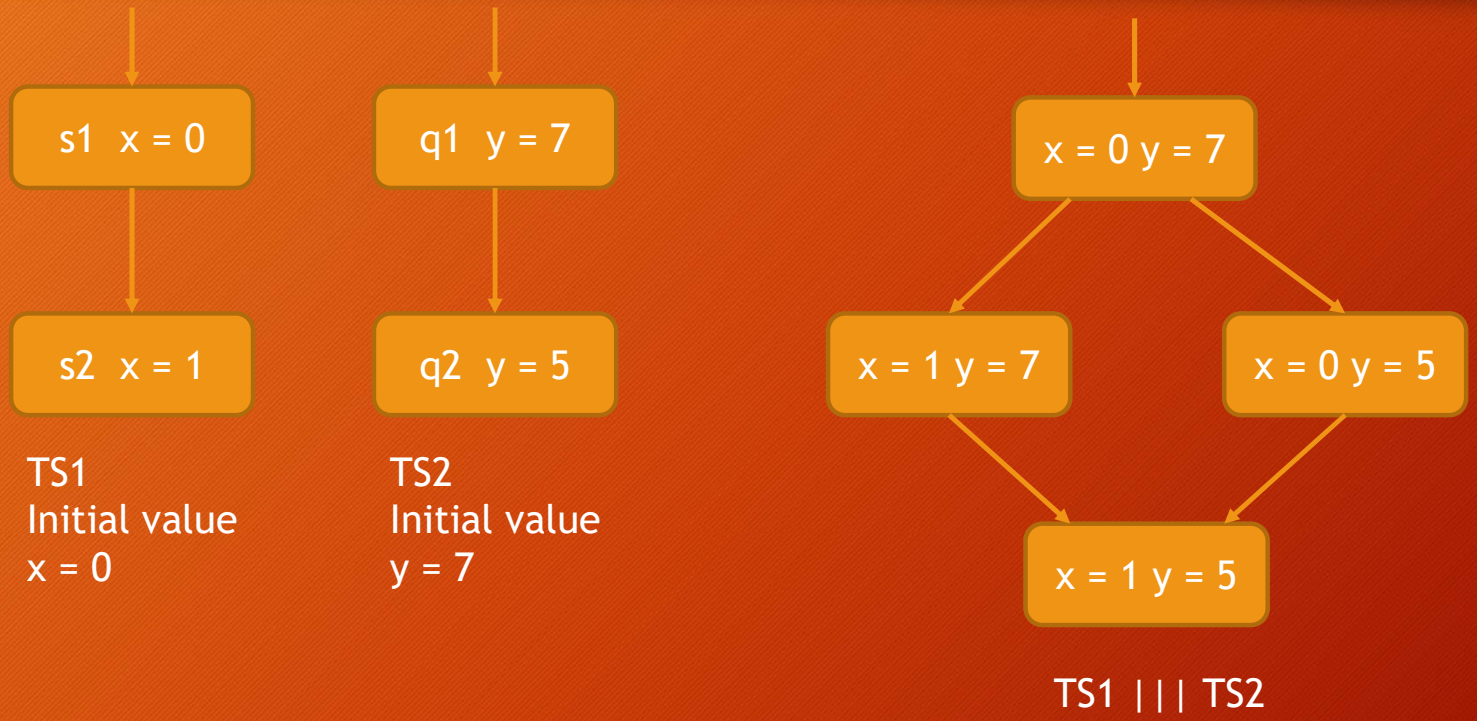

PG2

y = y - 2
...




TS2
Initial value
y = 7

# Modelling concurrent Systems

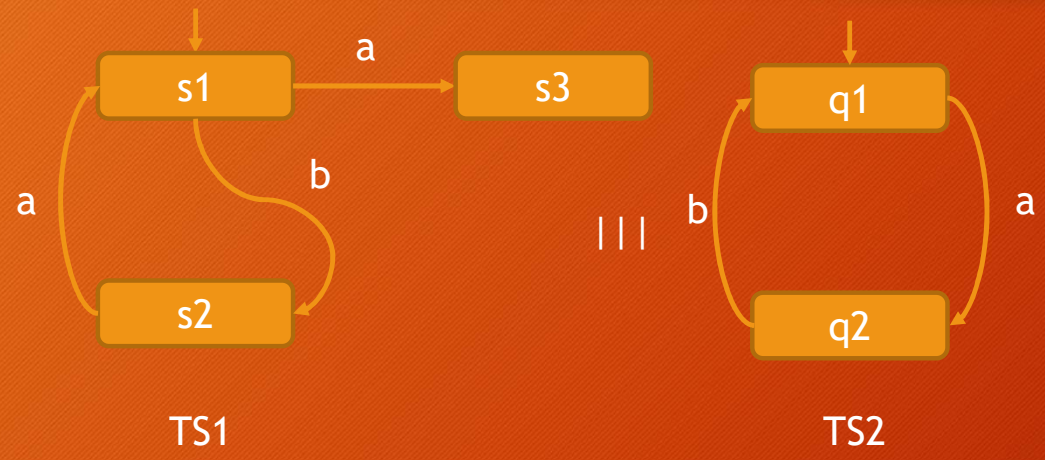



TS1
Initial value
x = 0

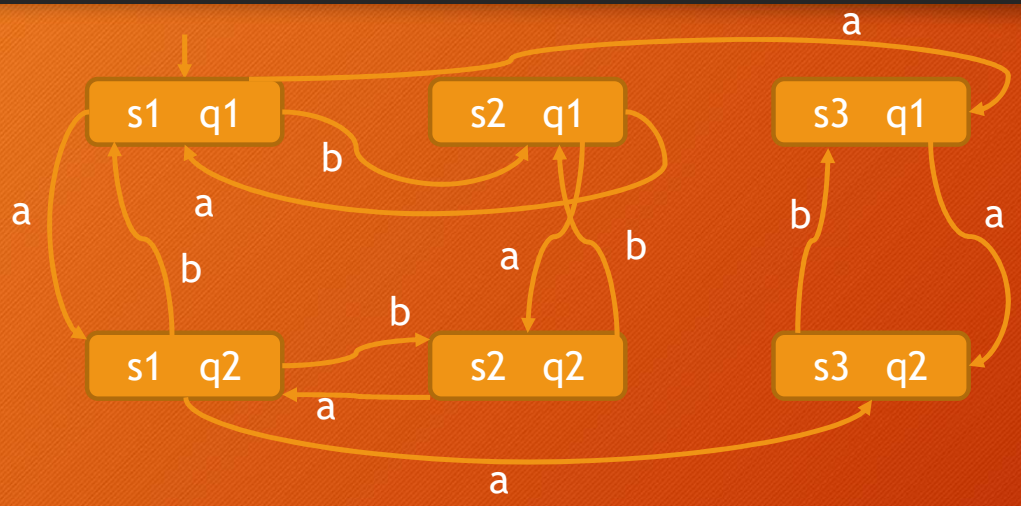
TS2
Initial value
y = 7

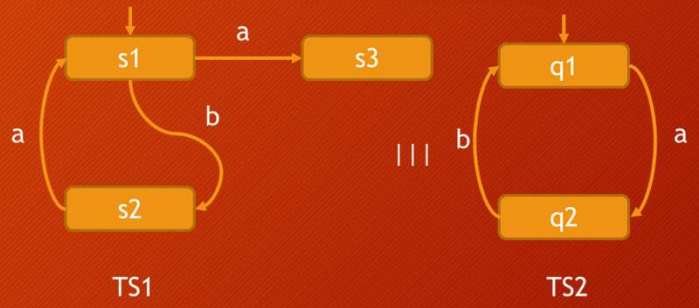
TS1 ||| TS2

# Modelling concurrent Systems

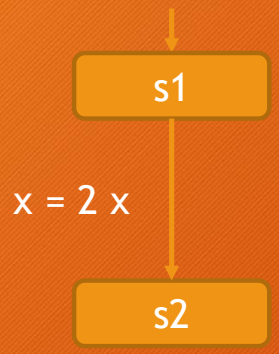


# Modelling Concurrent Systems



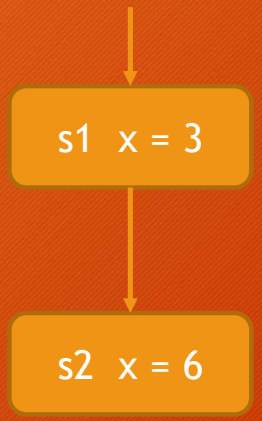



# Modelling concurrent Systems

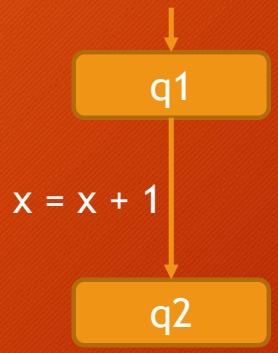



PG1

x = 2 x

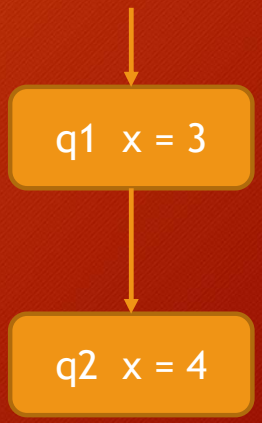



TS1
Initial value
x = 3



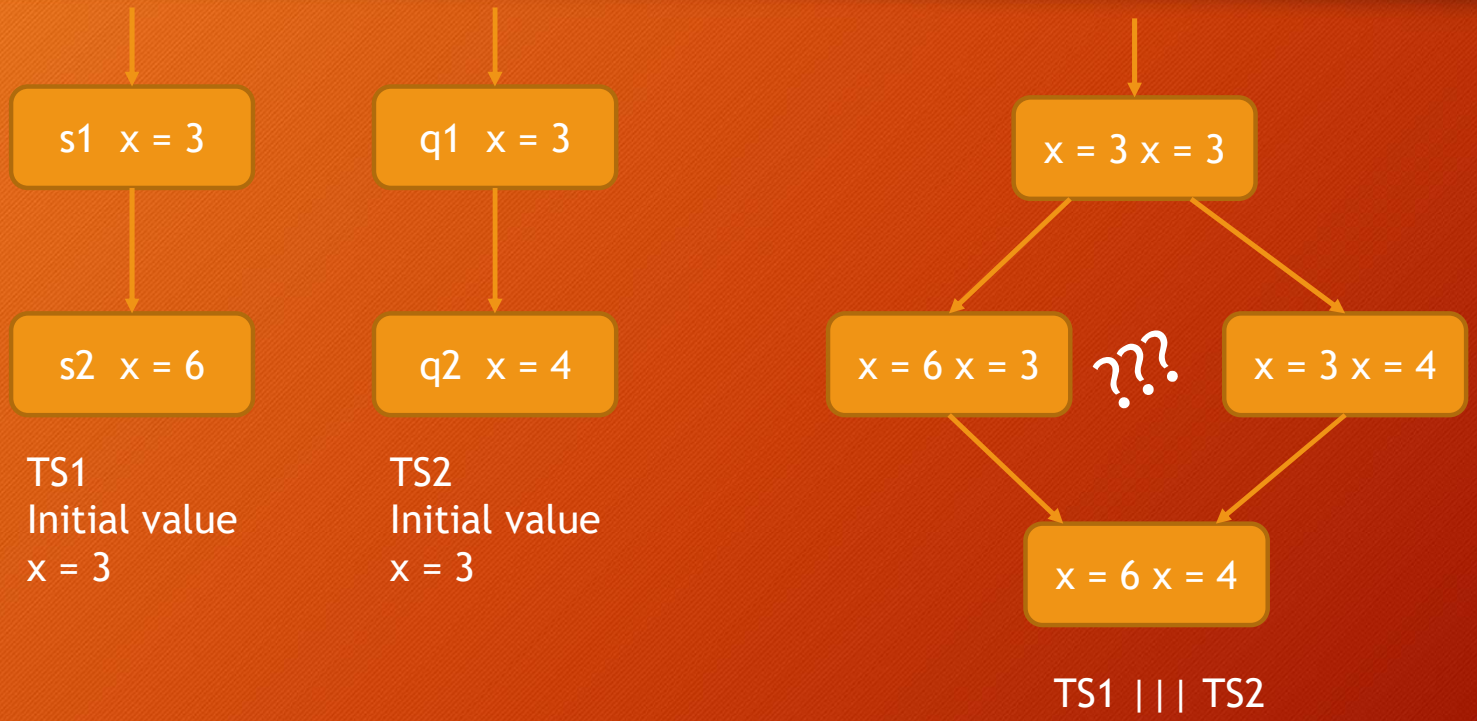

PG2

x = x + 1

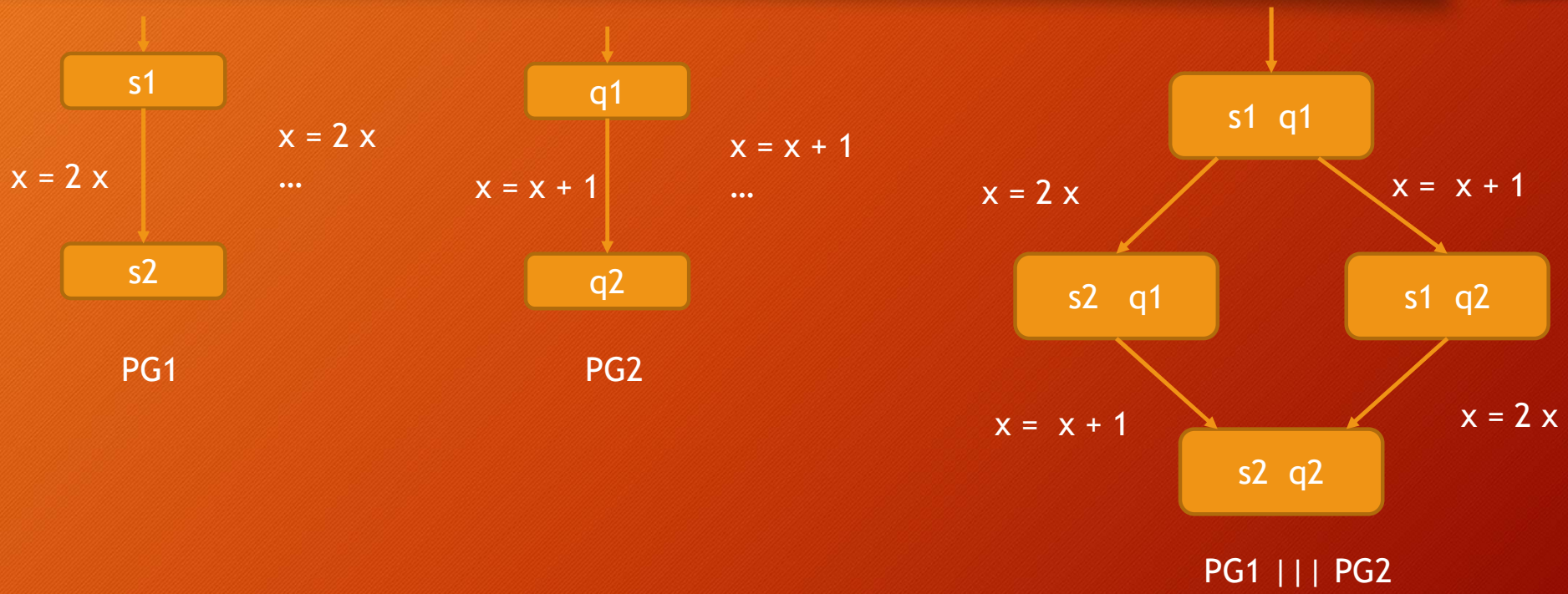



TS2
Initial value
x = 3

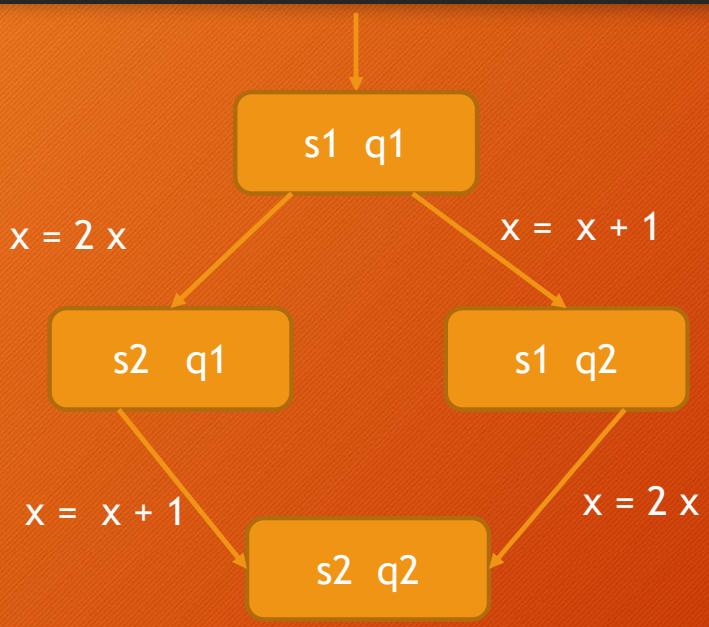
# Modelling concurrent Systems



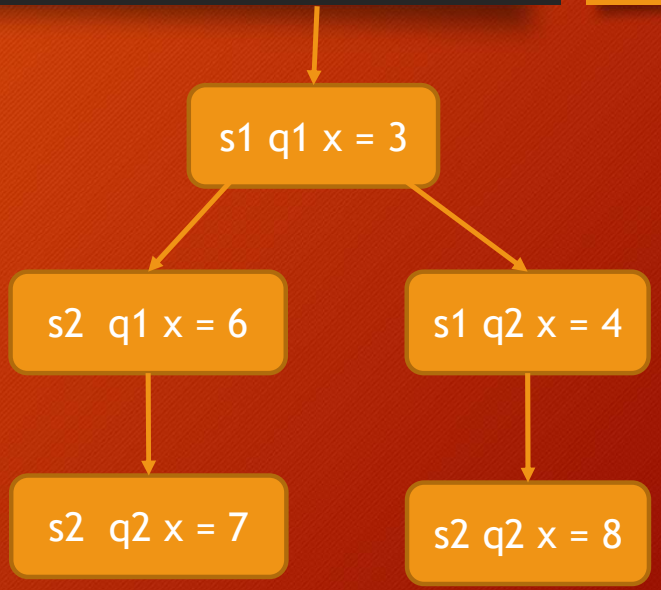
# Modelling Concurrent Systems



# Modelling Concurrent Systems




PG1 ||| PG2




TS( PG1 ||| PG2 )

# Modelling Concurrent Systems

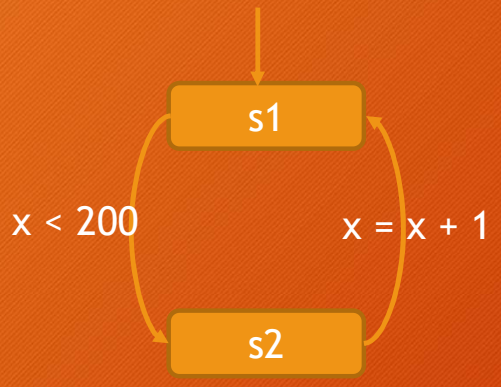
| while x < 200 | while x > 0 | while x == 200 |
| --- | --- | --- |
| x = x + 1 | x = x - 1 | x = 0 |

Is the value of x always between 0 and 200?

# Modelling Concurrent Systems

while x < 200

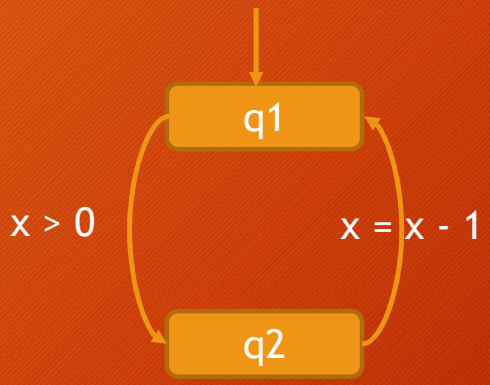
x = x + 1




PG1

while x > 0

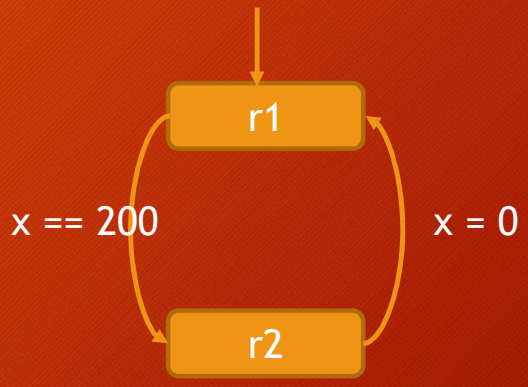
x = x - 1




PG2

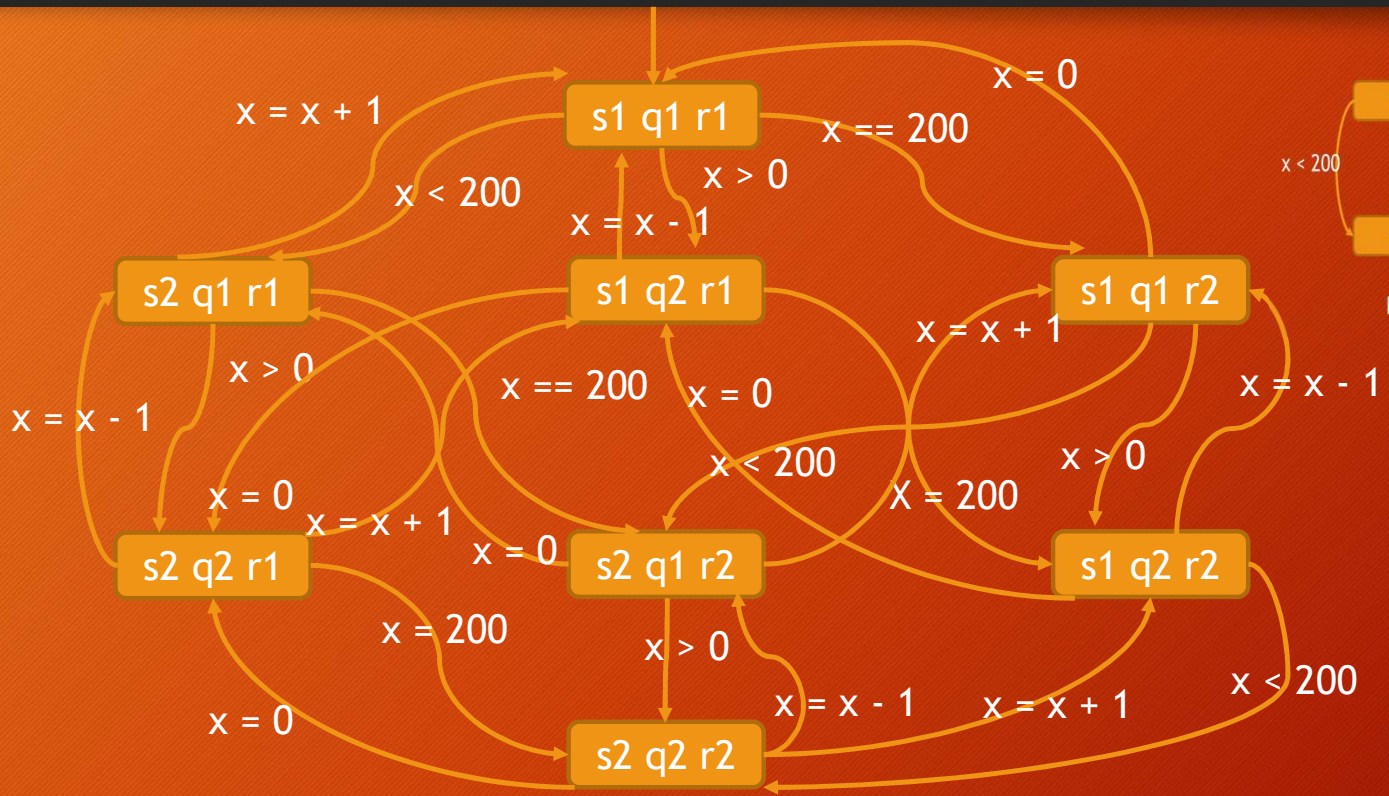
while x == 200

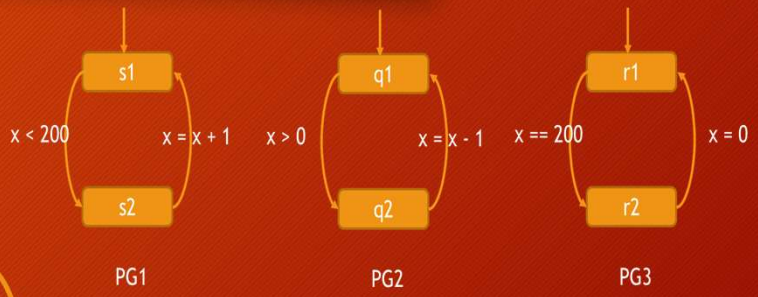
x = 0



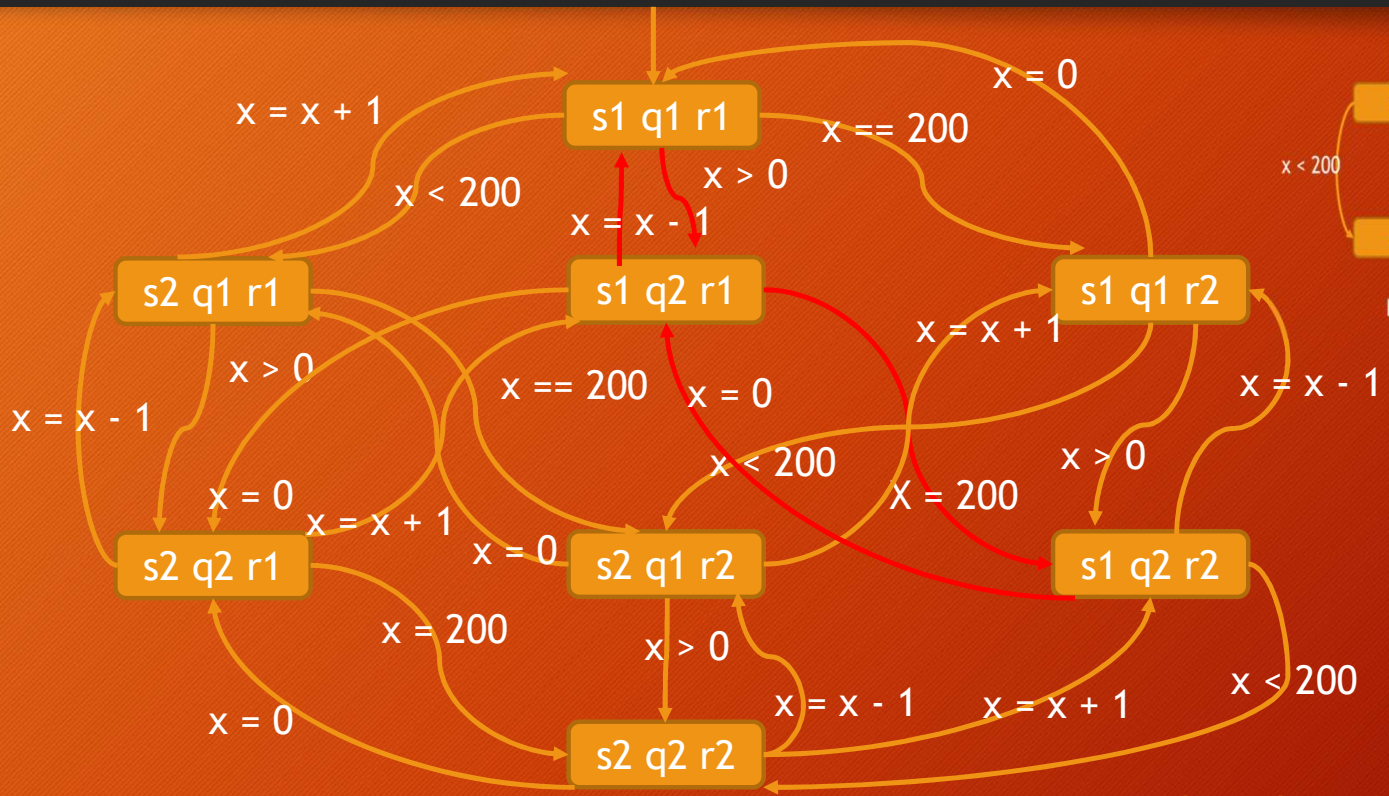

PG3

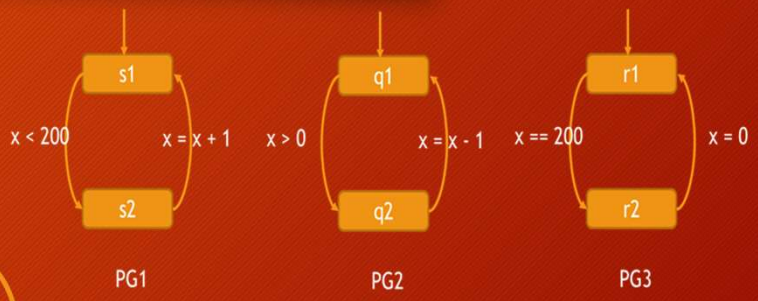
# Modelling Concurrent Systems



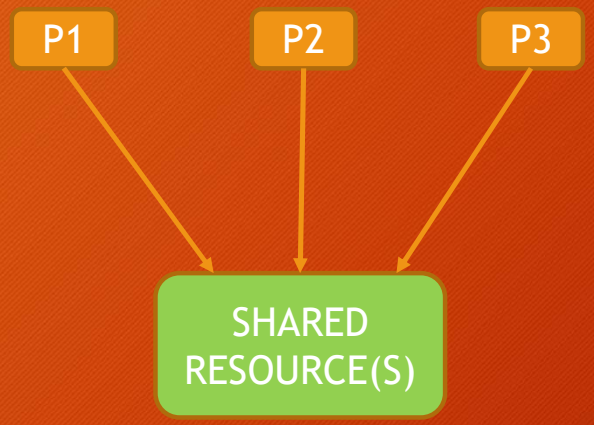
# Modelling Concurrent Systems




Is the value of x always between 0 and 200? **NO**

# Mutual Exclusion




No two programs can access the resources simultaneously.

How?

# Modelling Concurrent Systems

loop forever

.

. **noncritical actions**

.

request

critical section

release

.

. **noncritical actions**

.

end loop

P1


loop forever

.

. **noncritical actions**

.

request

critical section

release

.

. **noncritical actions**

.

end loop

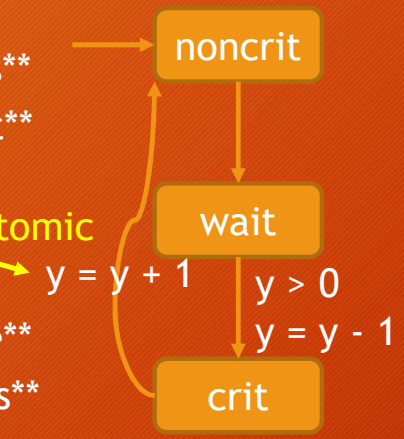
P2

# Modelling Concurrent Systems

loop forever
.
. **noncritical actions**
.
. **request**
.
(if y > 0) y = y - 1
critical section
y = y + 1
.
. **release**
.
. **noncritical actions**
.
.
end loop

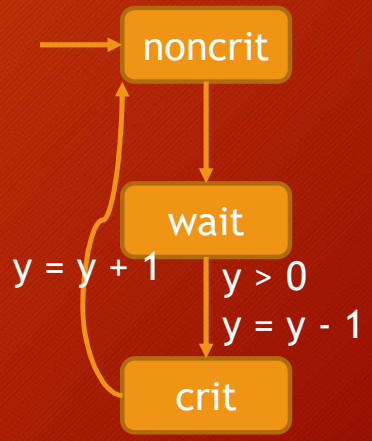
P1

inline/atomic

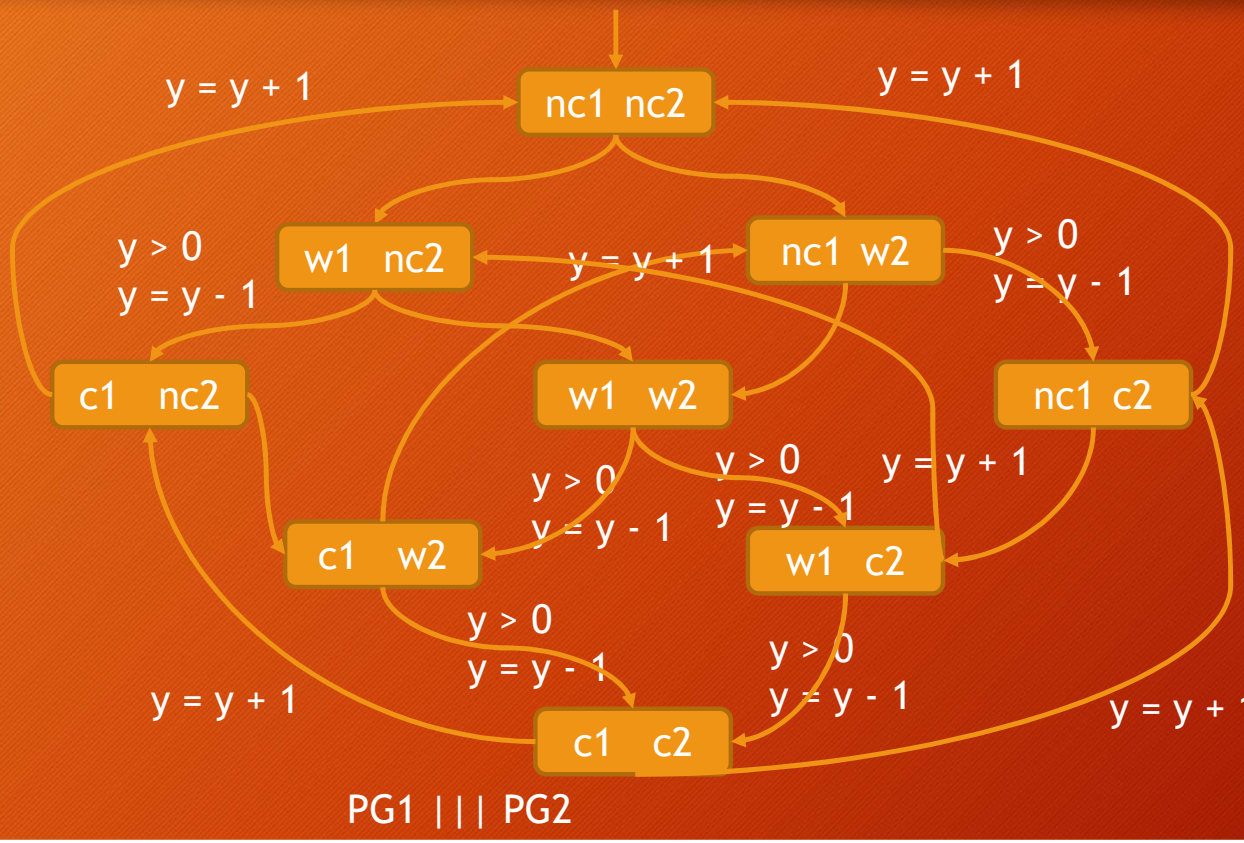


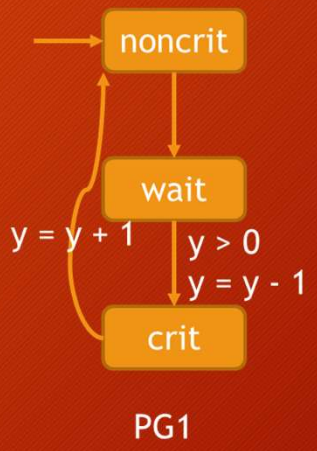

loop forever
.
. **noncritical actions**
.
. **request**
.
(if y > 0) y = y - 1
critical section
y = y + 1
.
. **release**
.
. **noncritical actions**
.
.
end loop

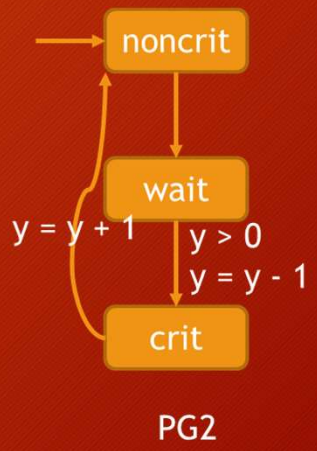
P2



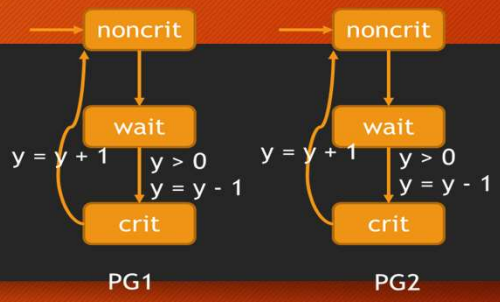
# Modelling Concurrent Systems

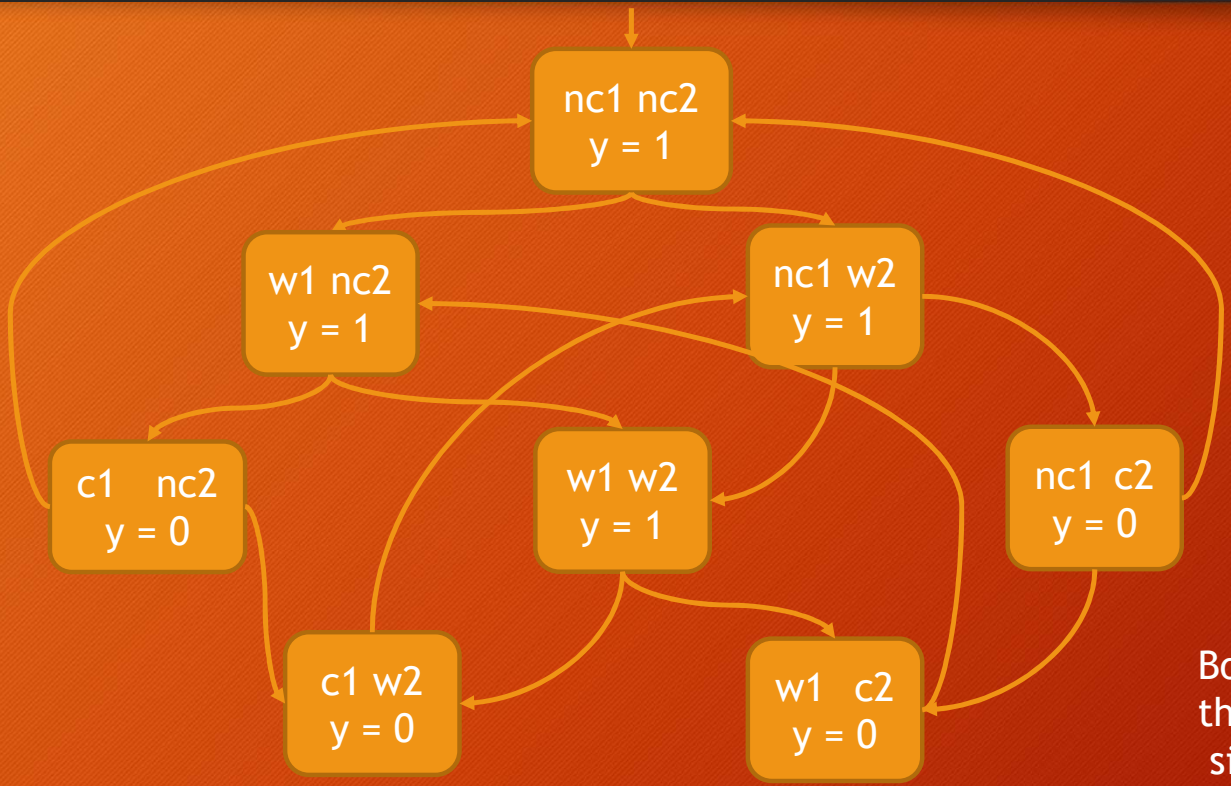


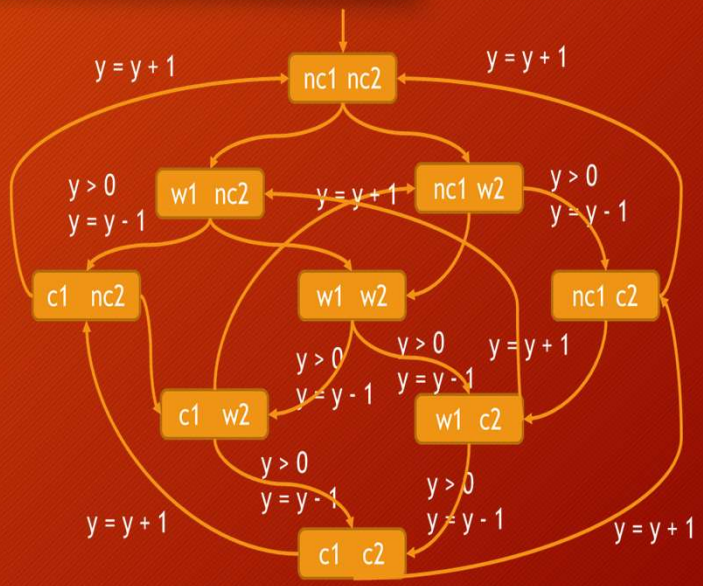



# Modelling Concurrent Systems




TS(PG1 ||| PG2)




Both process can not be in the critical section simultaneously.