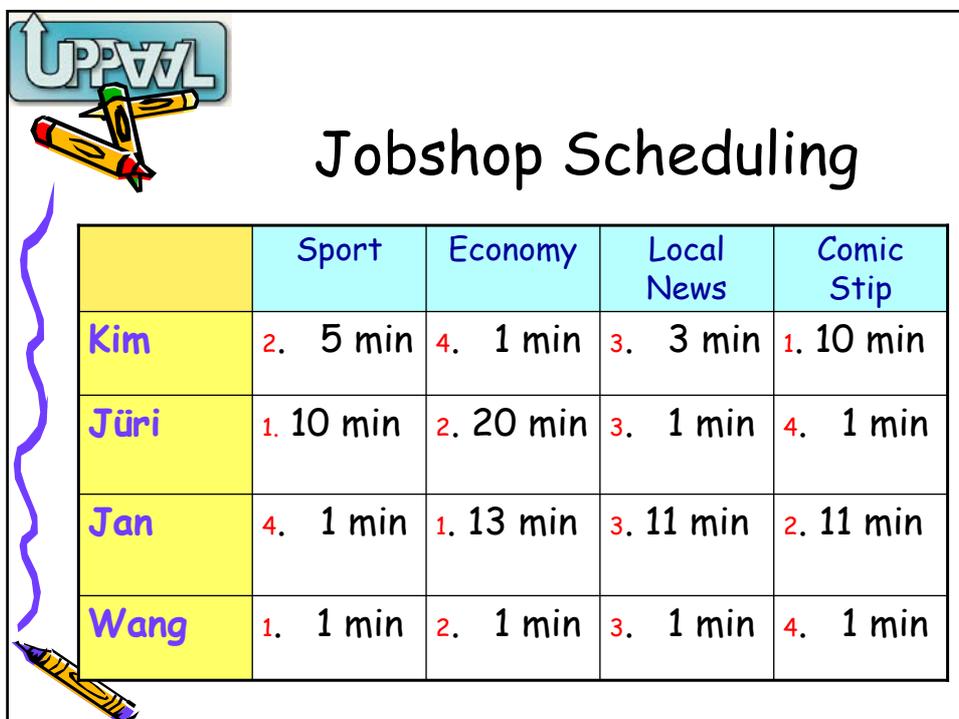


UPPAAL Tutorial

Examples & Exercises

Alexandre David
Paul Pettersson
RTSS'05



UPPAAL

Jobshop Scheduling

	Sport	Economy	Local News	Comic Strip
Kim	2. 5 min	4. 1 min	3. 3 min	1. 10 min
Jüri	1. 10 min	2. 20 min	3. 1 min	4. 1 min
Jan	4. 1 min	1. 13 min	3. 11 min	2. 11 min
Wang	1. 1 min	2. 1 min	3. 1 min	4. 1 min

UPPAAL

Rush Hour

Your CAR

EXIT

Objective:
Get your car out.

UPPAAL

Rush Hour - Car

Red

no==3,
i>=2

no==3,
i<2
BOARD[3][2+i]:=1,
i:=i+1

i:=0,
no:=no+1,
pos:=2

pos-1>0,
BOARD[3][pos-1]==0

pos+2<N+1,
BOARD[3][pos+2]==0

left?

right?

BOARD[3][pos-1]:=1,
BOARD[3][pos+2-1]:=0,
pos:=pos-1

BOARD[3][pos+2]:=1,
BOARD[3][pos]:=0,
pos:=pos+1

UPPAAL

Rush Hour - Hands



leftHand

```

x >= 2
x := 0
up!
x >= 2
left!
x := 0
right!
x := 0
x >= 2
down!

```

rightHand

```

x >= 6
x := 0
up!
x >= 6
left!
x := 0
right!
x := 0
x >= 6
down!

```

pos

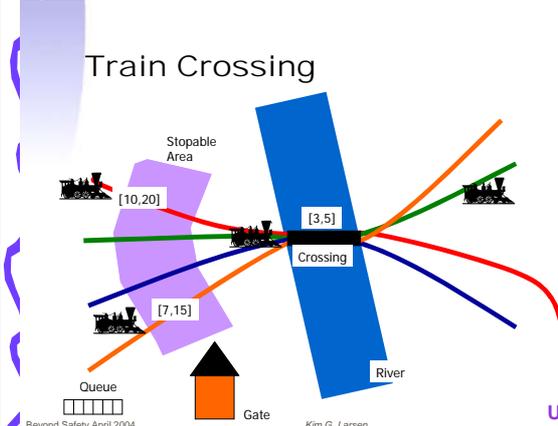
```

no = 3,
i = 2
BOARD[3][2+i] = 1,
i = i+1
pos = 2
left?
BOARD[3][pos-1] = 1,
BOARD[3][pos+2-1] = 0,
pos = pos-1
right?
BOARD[3][pos+2] = 1,
BOARD[3][pos] = 0,
pos = pos+1

```

UPPAAL

Train Crossing



Train1

```

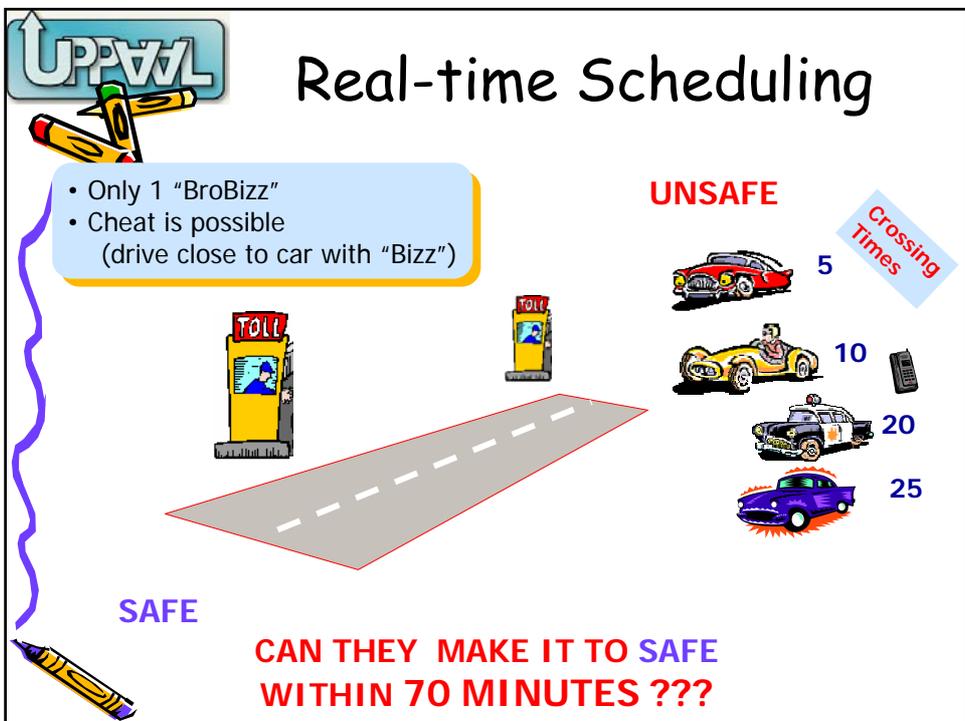
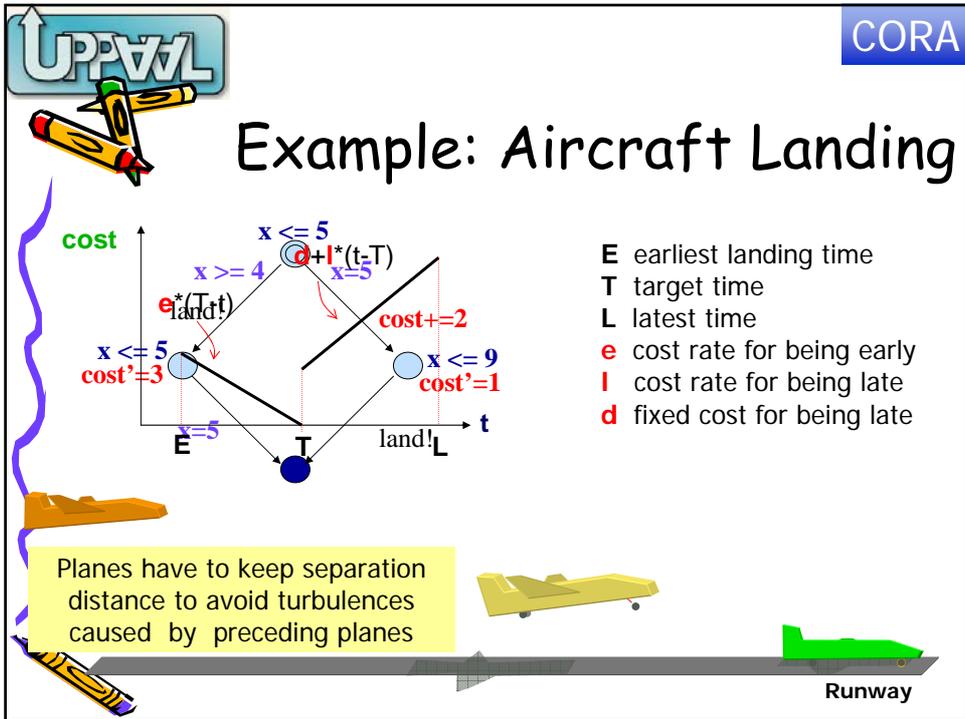
Safe
  |
  | appr!
  | el = 1,
  | x := 0
  |
  v
Appr
  |
  | x >= 10
  |
  v
Stop
  |
  | go?
  | el = 1
  |
  v
Start
  |
  | x <= 15
  | x := 0
  |
  | x >= 7
  |
  v
Cross
  |
  | x <= 5
  |
  | leave!
  | x >= 3
  |
  v
Safe

```

Beyond Safety April 2004
Kim G. Larsen

UCD

A [] Train1.Cross+Train2.Cross+Train3.Cross+Train4.Cross <= 1
Train1.Appr leadsto Train1.Cross



UPPAAL Real-time Scheduling

Solve Scheduling Problem using **UPPAAL**

UNSAFE

SAFE

The diagram illustrates a real-time scheduling problem. On the right, a road with two toll booths is shown. Four cars are approaching from the right, each with a different fuel cost: a red car (5), a yellow car (10), a black car (20), and a purple car (25). The road is labeled 'SAFE' in blue and 'UNSAFE' in red. On the left, a state transition graph for UPPAAL is shown. It consists of several components: a main graph with states C1, C2, C3, and C4; a 'Pass' sub-graph; and various transitions labeled with actions like 'take!', 'release!', and 'y := 0'. The graph shows a sequence of states and transitions, with some states being 'unsafe' and others 'safe'. The 'Pass' sub-graph shows a sequence of states 'free', 'one', and 'two' with transitions 'take?' and 'release?'.

UPPAAL Cost Optimal Scheduling **CORA**

Cost-Rates
Fuel consumed per time-unit

UNSAFE

SAFE

The diagram illustrates a cost-optimal scheduling problem. On the right, a road with two toll booths is shown. Four cars are approaching from the right, each with a different fuel cost: a red car (5), a yellow car (10), a black car (20), and a purple car (25). The road is labeled 'SAFE' in blue and 'UNSAFE' in red. On the left, a state transition graph for UPPAAL is shown. It consists of several components: a main graph with states C1, C2, C3, and C4; a 'Pass' sub-graph; and various transitions labeled with actions like 'take!', 'release!', and 'y := 0'. The graph shows a sequence of states and transitions, with some states being 'unsafe' and others 'safe'. The 'Pass' sub-graph shows a sequence of states 'free', 'one', and 'two' with transitions 'take?' and 'release?'. A blue box at the bottom states: "OPTIMAL PLAN HAS ACCUMULATED COST=550 and TOTAL TIME=105!".