Using STPA thinking to help convert natural language into finite automaton

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2013.03.28

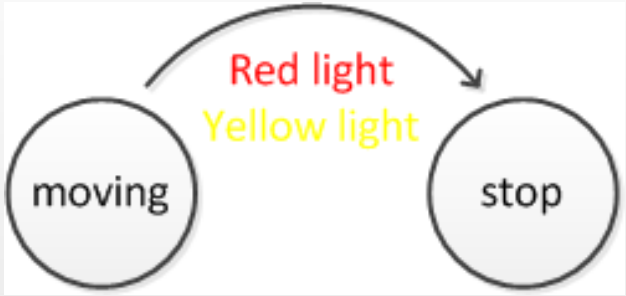
agenda

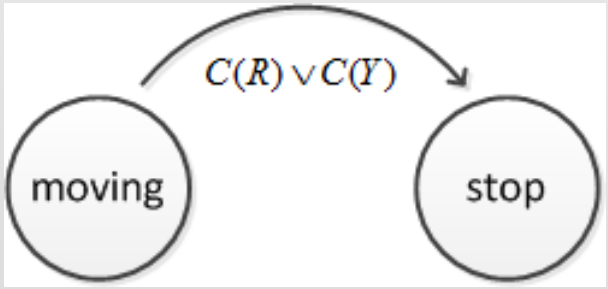
- Background
- Method
- Example

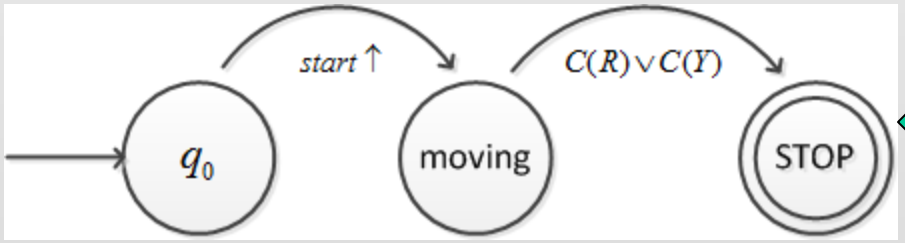
Background

When the lights are red or yellow,

the traffic must stop



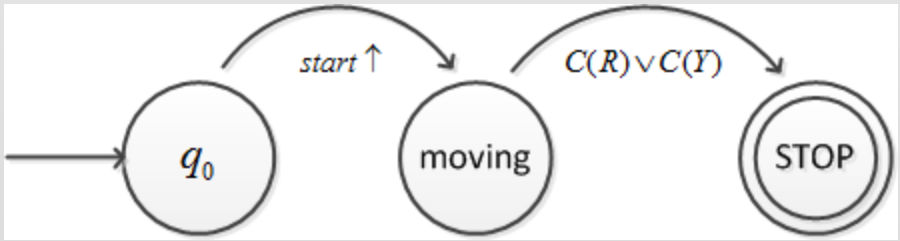




Background

$A\ finite\ automaton\ is\ a\ 5-tuple\ (Q,\sum,\delta,q_0,F),\ where$

1. Q is a finite set called the states,
2. $\sum$ is a finite set called the alpbabet,
3. $\delta: Q\times\sum\rightarrow Q$ is the transition function
4. $q_0\in Q\ is\ the\ start\ state,\ and$
5. $F\subseteq Q\ is\ the\ set\ of\ accept\ states$



Background

express

When the lights are red or yellow,

the traffic must stop

when drivers see the light are red or yellow,

the traffic must stop

Close eyes

the traffic must stop

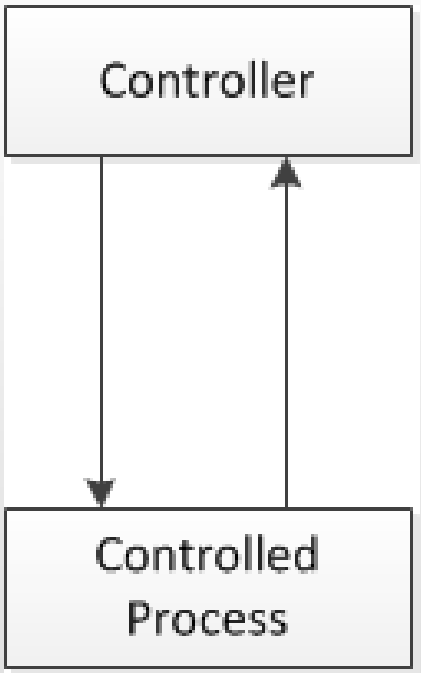
when the lights are not green

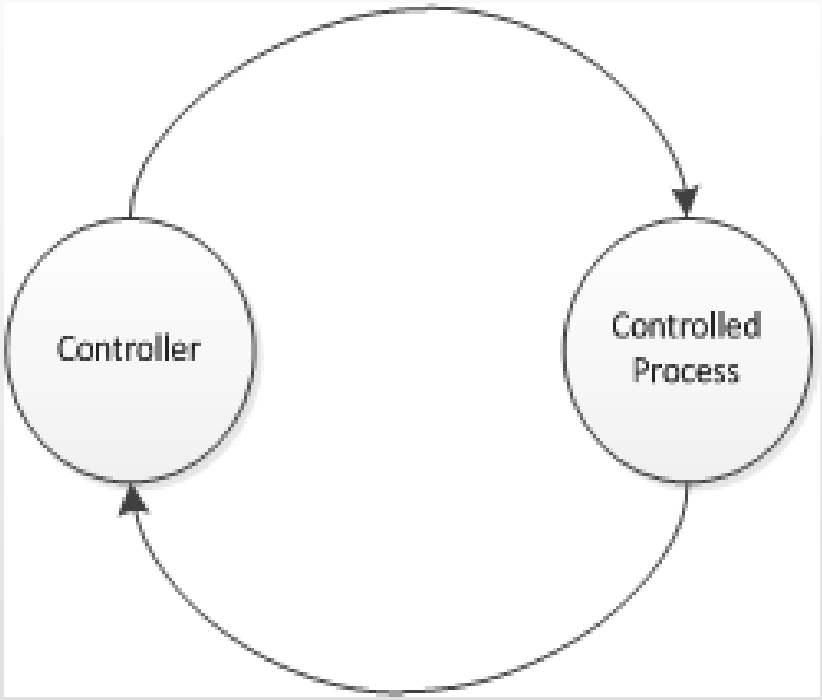
Four color lights

Method

- Step 1:Structuring the expression of natural language
- Step 2:Identifying potentially situation
- Step 3:Constructing a automaton

Step 1


Controller
Controlled Process


Controller
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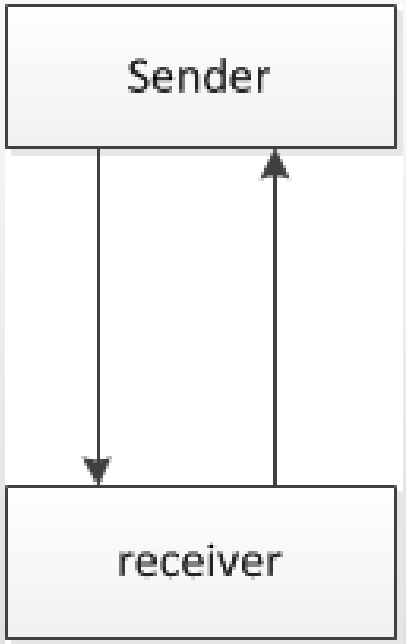

Sender
receiver

Step 1

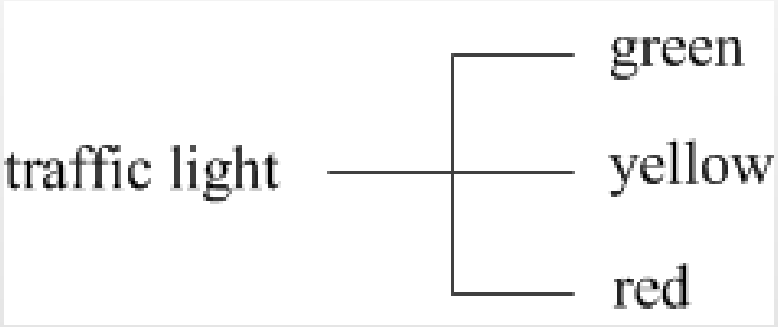
When the lights are red or yellow, the traffic must stop before the stop line

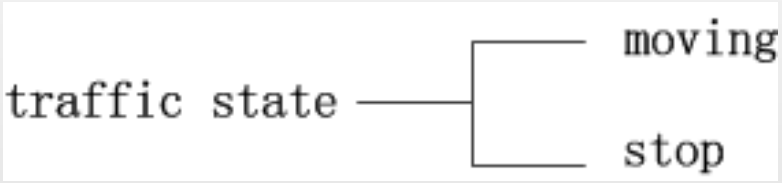
sender constraint receiver action context

- **Sender: seders of signal or information**
- **Receiver: receivers of signal or information.**
- **Constraint: the signal or information send by sender. It is constrain the behavior of receiver.**
- **Context: the environmental state which have to obey.**
- **Action: The behavior of receiver.**

Step 2a:determining the states

5-tuple(Q,∑,δ,q_0,F)

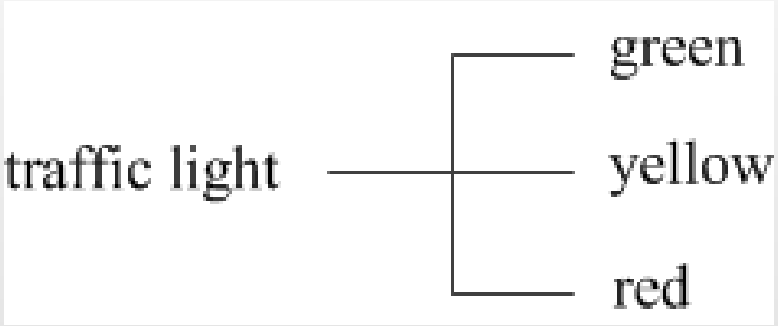




variable **states**

Step 2b:detemining the alphabet

5-tuple(Q,∑,δ,q_0,F)



Function Position P(t)

True: if the traffic stop before the stop line

False: if the traffic stop after the stop line

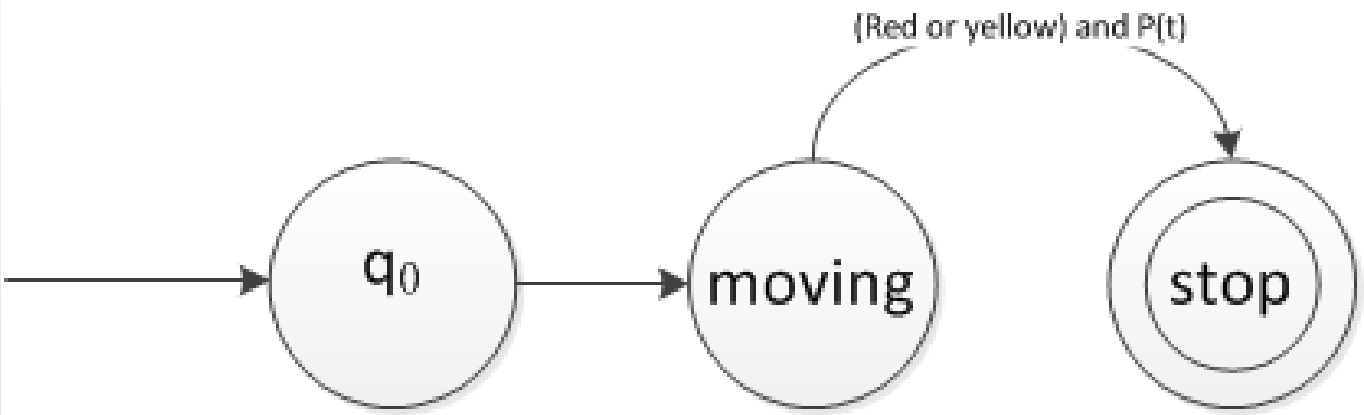
Step 2c:detemining transition function

5-tuple(Q,∑,δ,q_0,F)

	red	yellow	green
stop	T	T	F
moving	–	–	–

	moving	stop
stop	–	–
moving	–	red or yellow

Step 3: determining start and accepts states, draw an automaton



Example: describe

- 1.A toy train has a crossing with a traffic lights.
- 2.The train is moving at first.
- 3.When arrive on the crossing, the traffic light is green, the train keep moving to the end.
- 4.When a train arrive on the crossing and the traffic light is yellow, the train must slow down. If a part of the train pass the crossing before the light turn to red, the train keep moving, otherwise the train must stop.
- 5. the train will move again when the traffic light is green.

Example: list all the information

- Sender: traffic light.
- Receiver: train.
- Constraint: red,yellow,green.
- Context: the train parts weather pass the crossing.
- Action: moving, keep moving, stop, slow down.

Example: list process mode and context function

traffic state	moving
	keep moving
	stop
	slow down

traffic light	red
	yellow
	green

function PASS P(t)	
True iff	some part of the train have passed the crossing before red light
False iff	none part of the train have passed the crossing before red light

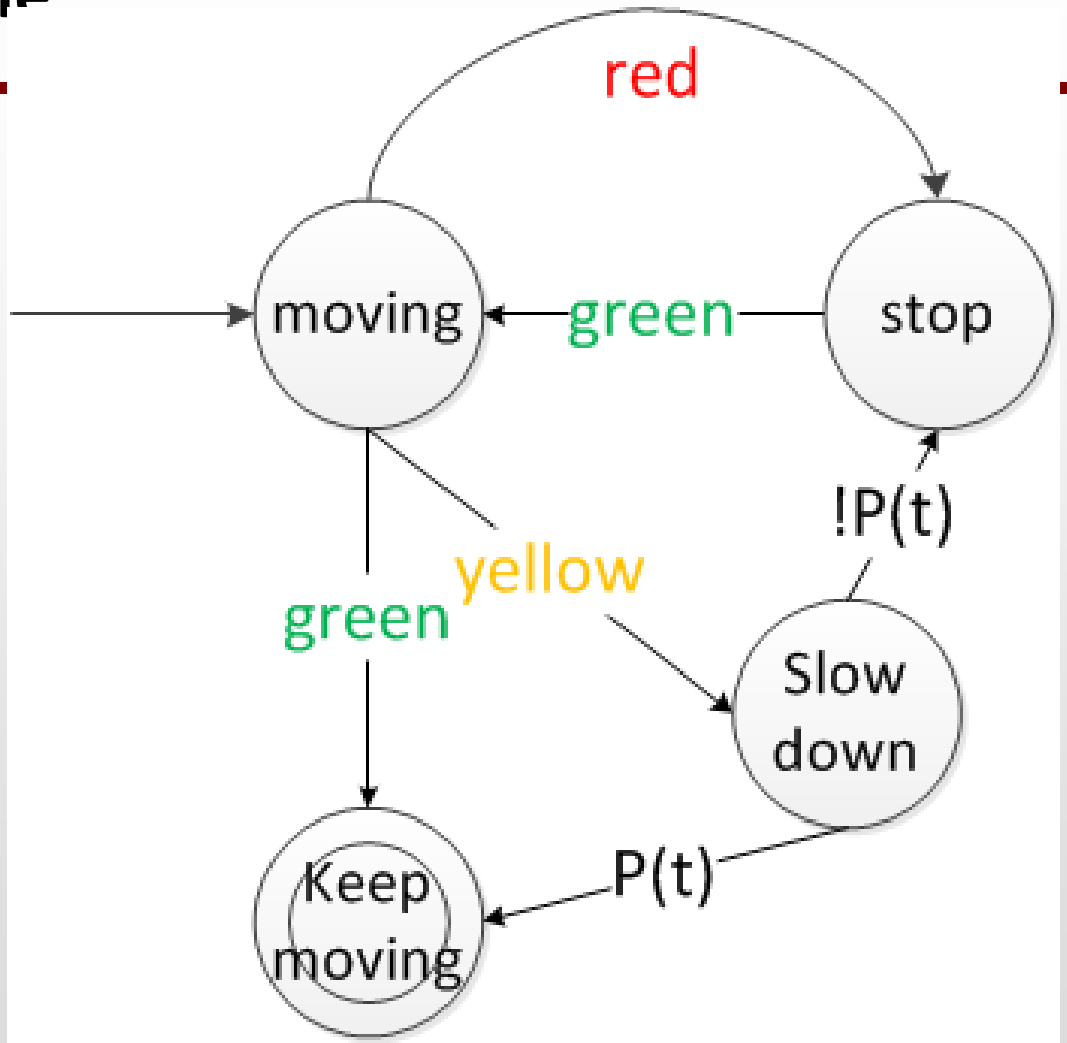
Example: table

	red	yellow	green
Stop	T	!P(t)	F
Moving	F	F	T
keep moving	F	P(t)	T
slow down	F	T	F

Example: table

	stop	moving	keep moving	slow down
stop	-	green	-	-
moving	red	-	green	yellow
keep moving	-	-	-	-
slow down	!P(t)	-	P(t)	-

example


red
moving
green
stop
!P(t)
yellow
green
Slow
down
Keep
moving
P(t)

Thanks

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