UNIVERSITATEA TEHNICĂ
DIN CLUJ-NAPOCA

SISTEME EXPERT

REGULI DE CIRCULATIE FORMALIZATE IN CLIPS

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GRUPA 30644

CUPRINS

1. Domeniul aplicatiei si limitele sale

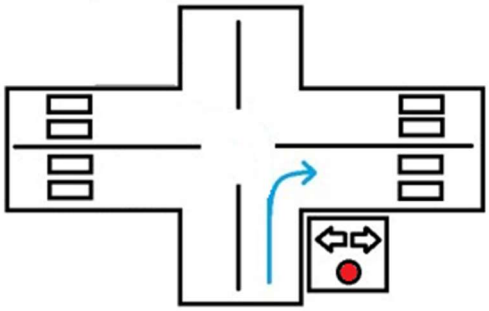
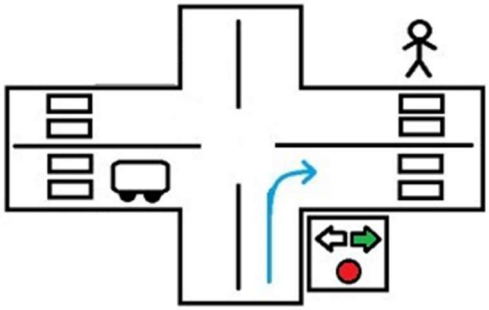
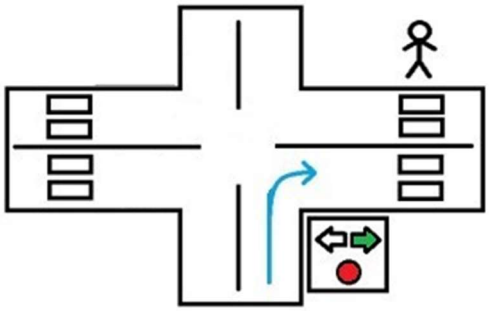
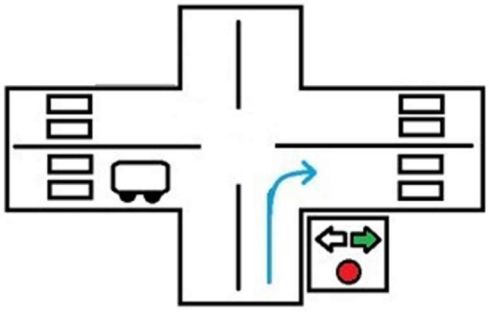
Aplicatia are la baza mai multe scenarii care pot fi intalnite in trafic de soferi in momentul in care acestia doresc sa efectueze manevra de viraj stanga/dreapta. Astfel, au fost create 4 scenarii posibile, fiecare avand un numar diferit de cazuri posibile (in total sunt 48 de cazuri).. Datele de mediu pot fi colectate folosind diversi senzori de imagine. Odata colectate, datele pot fi prelucrate astfel incat sa se stabileasca cu exactitate imprejurimile. Pe baza datelor colectate, dar si pe baza regulilor de circulatie prevazute in Codul Rutier, aplicatia va decide daca manevra de virare este permisa (ALLOWED) sau inverzisa (PROHIBITED).

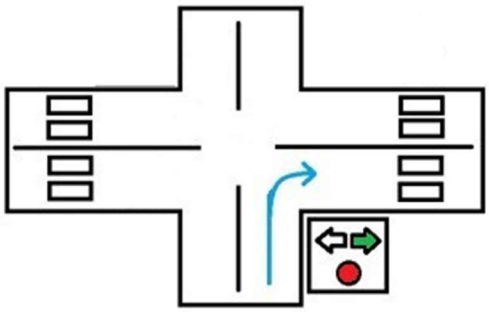
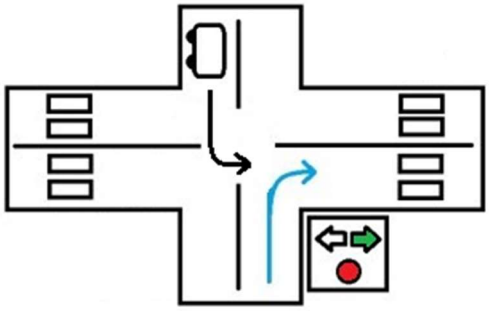
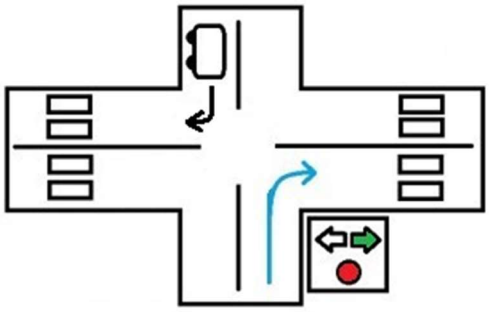
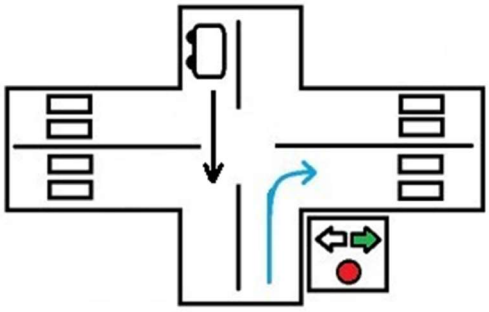
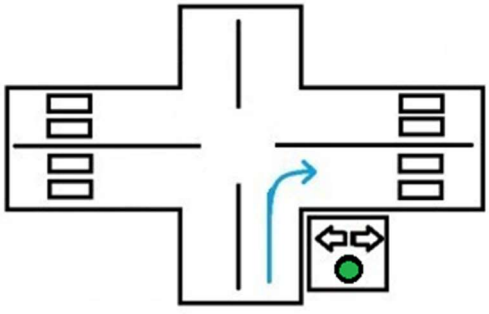
Aplicatia este alcatuita din 3 module mari:

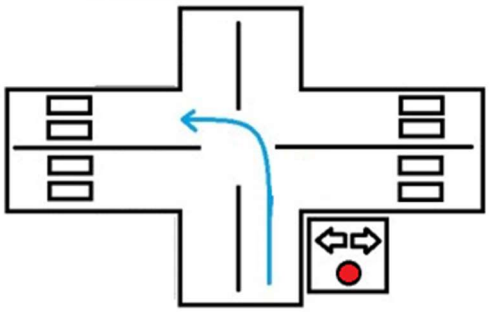
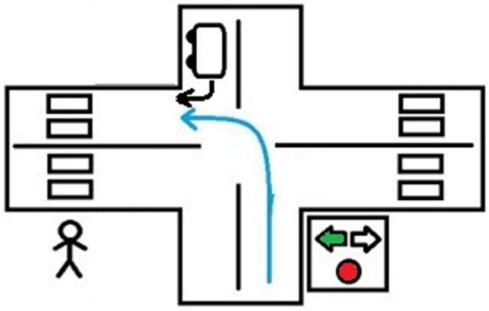
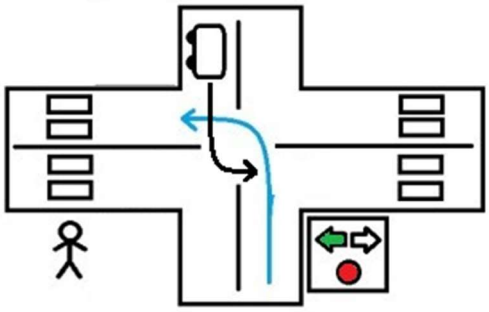
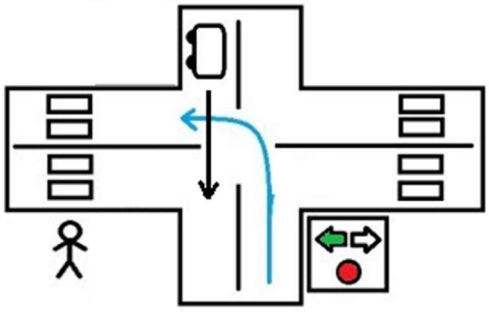
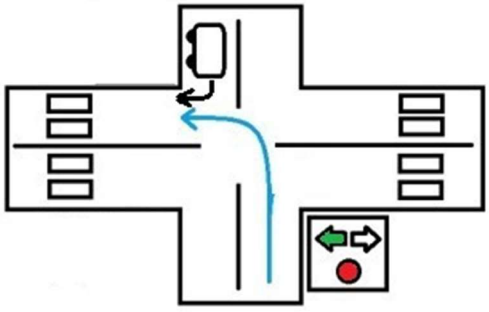
- **MAIN**
  - Se ocupa cu gestionarea celorlate doua module.
- **PERCEPT-MANAGER**
  - Se ocupa cu gestionarea perceptiilor citite de catre senzori (gestioneaza faptele).
  - Perceptiile vor fi scrise individual pentru fiecare moment de timp.
- **DRIVER-AGENT**
  - Se ocupa cu luarea de decizii pe baza perceptiilor (gestioneaza regulile).
  - Dupa prelucrarea faptelor pe baza regulilor, se va decide daca manevra este permisa sau nu.

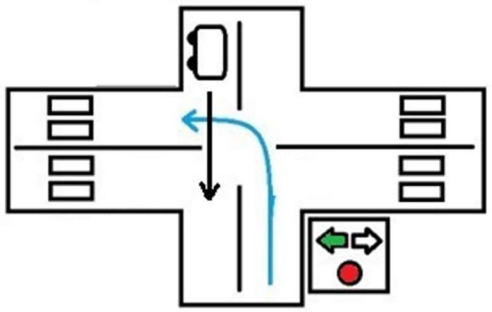
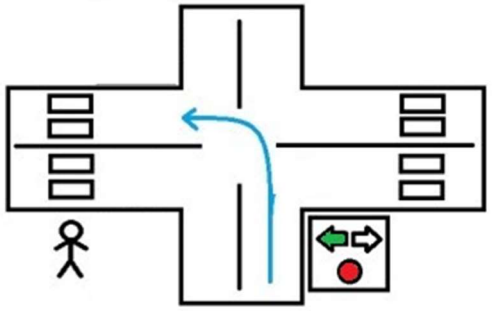
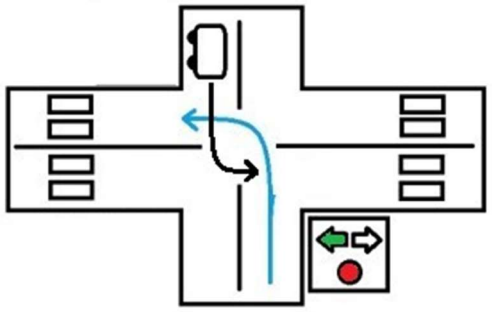
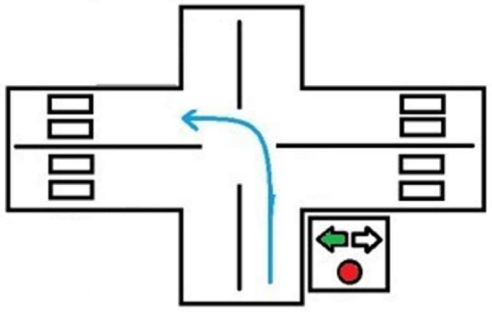
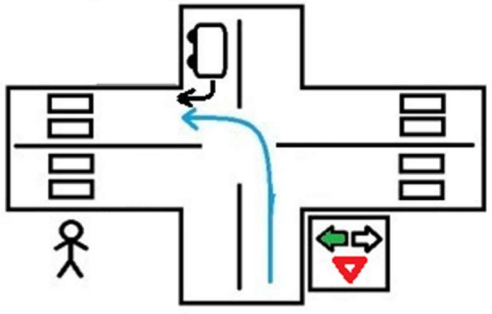
2. Scenarii propuse

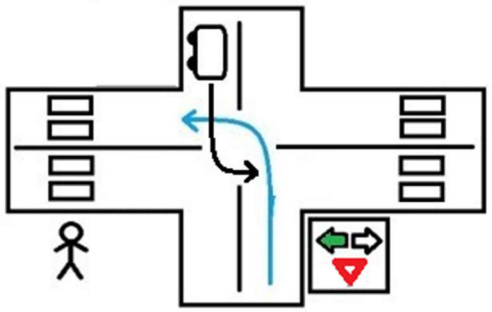
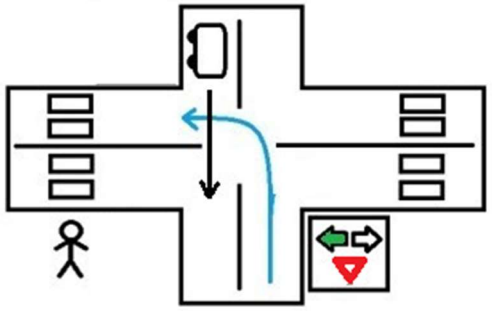
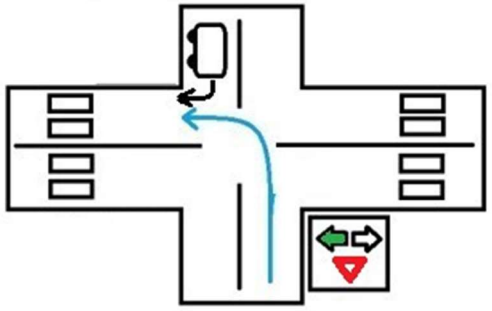
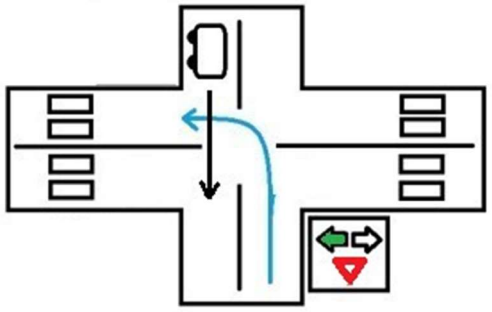
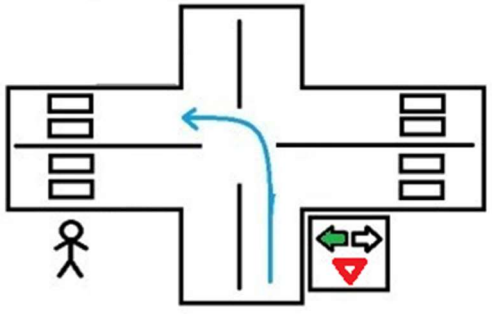
I. Intersectie cu semafor

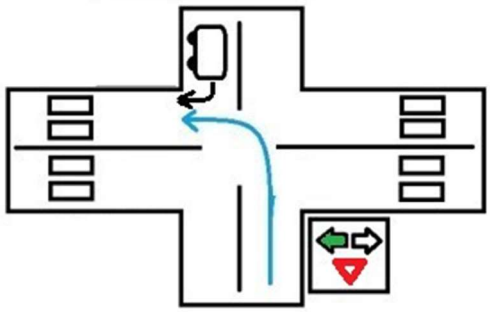
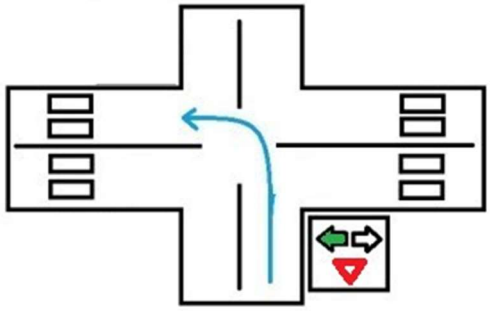
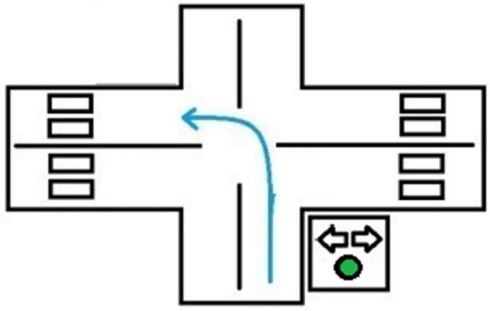
Viraj la dreapta cu semafor rosu	
Viraj la dreapta cu semafor rosu, sageata verde intermitent, masina care vine din partea stanga si pieton	
Viraj la dreapta cu semafor rosu, sageata verde intermitent si pieton	
Viraj la dreapta cu semafor rosu, sageata verde intermitent si masina care vine din partea stanga	

Viraj la dreapta cu semafor rosu si sageata verde intermitent	
Viraj la dreapta cu semafor rosu, sageata verde intermitent si masina care vine din contrasens vireaza stanga	
Viraj la dreapta cu semafor rosu, sageata verde intermitent si masina care vine din contrasens vireaza dreapta	
Viraj la dreapta cu semafor rosu, sageata verde intermitent si masina care vine din contrasens merge inainte	
Viraj la dreapta cu semafor verde	

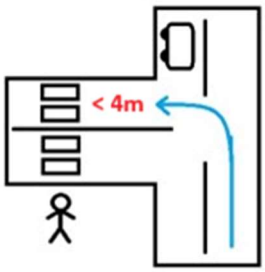
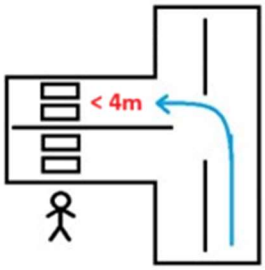
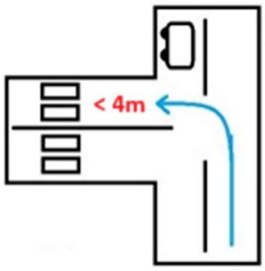
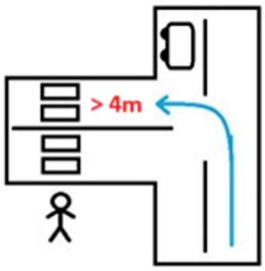
Viraj la stanga cu semafor rosu	
Viraj la stanga cu semafor rosu, sageata verde intermitent, pieton si masina care vine din contrasens vireaza dreapta	
Viraj la stanga cu semafor rosu, sageata verde intermitent, pieton si masina care vine din contrasens vireaza stanga	
Viraj la stanga cu semafor rosu, sageata verde intermitent, pieton si masina care vine din contrasens merge inainte	
Viraj la stanga cu semafor rosu, sageata verde intermitent si masina care vine din contrasens vireaza dreapta	

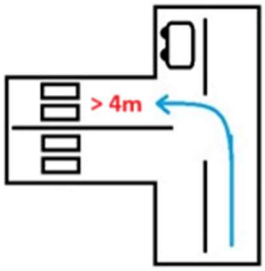
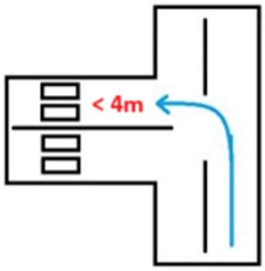
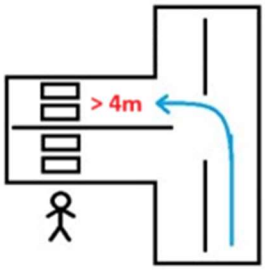
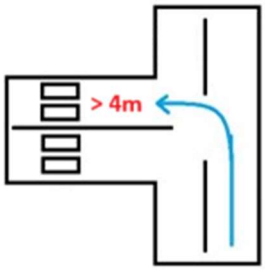
Viraj la stanga cu semafor rosu, sageata verde intermitent si masina care vine din contrasens merge inainte	
Viraj la stanga cu semafor rosu, sageata verde intermitent si pieton	
Viraj la stanga cu semafor rosu, sageata verde intermitent si masina care vine din contrasens vireaza stanga	
Viraj la stanga cu semafor rosu si sageata verde intermitent	
Viraj la stanga cu semafor rosu, cedeaza trecerea aditional, pieton si masina care vine din contrasens vireaza dreapta	

Viraj la stanga cu semafor rosu, cedeaza trecerea aditional, pieton si masina care vine din contrasens vireaza stanga	
Viraj la stanga cu semafor rosu, cedeaza trecerea aditional, pieton si masina care vine din contrasens merge inainte	
Viraj la stanga cu semafor rosu, cedeaza trecerea aditional si masina care vine din contrasens vireaza dreapta	
Viraj la stanga cu semafor rosu, cedeaza trecerea aditional si masina care vine din contrasens merge inainte	
Viraj la stanga cu semafor rosu, cedeaza trecerea aditional si pieton	

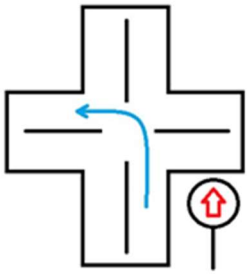
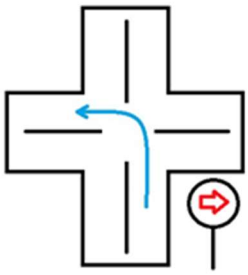
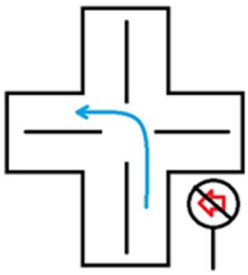
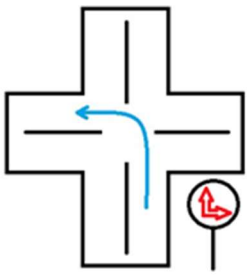
Viraj la stanga cu semafor rosu, cedeaza trecerea aditional si masina care vine din contrasens vireaza dreapta	
Viraj la stanga cu semafor rosu si cedeaza trecerea aditional	
Viraj la stanga cu semafor verde	

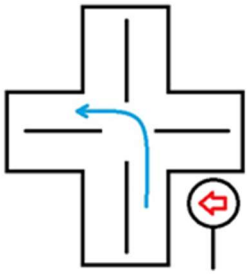
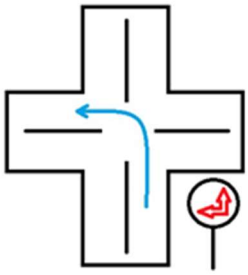
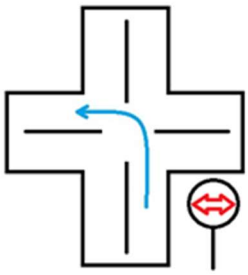
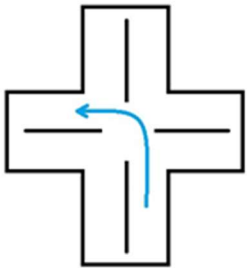
II. Trecere de pietoni dupa intersectie cu distanta pana la aceasta

Viraj la stanga cu pieton, masina care vine de pe contrasens si sub 4m intre trecere si intersectie	
Viraj la stanga cu pieton si sub 4m intre trecere si intersectie	
Viraj la stanga cu masina care vine de pe contrasens si sub 4m intre trecere si intersectie	
Viraj la stanga cu pieton, masina care vine de pe contrasens si peste 4m intre trecere si intersectie	

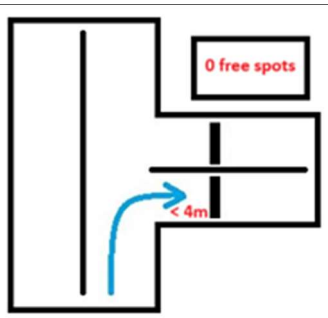
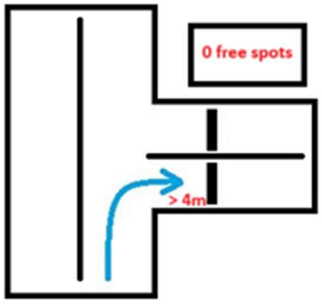
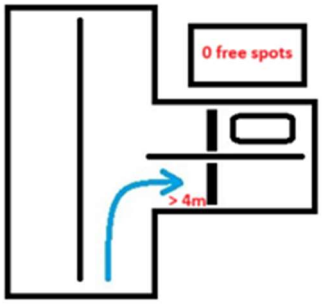
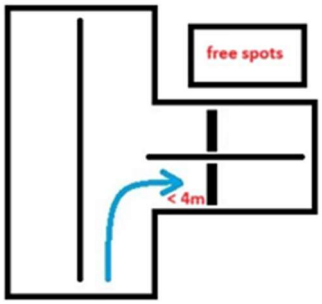
Viraj la stanga cu masina care vine de pe contrasens si peste 4m intre trecere si intersectie	
Viraj la stanga si sub 4m intre trecere si intersectie	
Viraj la stanga cu pieton si peste 4m intre trecere si intersectie	
Viraj la stanga si peste 4m intre trecere si intersectie	

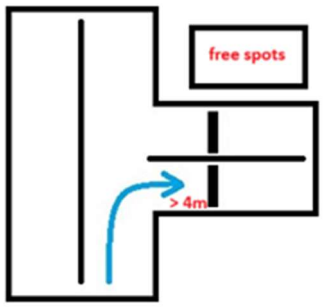
III. Intersectie cu indicator

Viraj la stanga cu indicator “obligatoriu inainte”	
Viraj la stanga cu indicator “obligatoriu la dreapta”	
Viraj la stanga cu indicator “interzis la stanga”	
Viraj la stanga cu indicator “obligatoriu inainte sau la dreapta”	

Viraj la stanga cu indicator “obligatoriu la stanga”	
Viraj la stanga cu indicator “obligatoriu inainte sau la stanga”	
Viraj la stanga cu indicator “obligatoriu la dreapta sau la stanga”	
Viraj la stanga fara indicator	

IV. Intrare in parcare cu numar limitat de locuri

Viraj la dreapta cu 0 locuri libere in parcare si sub 4m pana la primul obstacol	
Viraj la dreapta cu 0 locuri libere in parcare si peste 4m pana la primul obstacol	
Viraj la dreapta cu 0 locuri libere in parcare, peste 4m pana la primul obstacol, obsacolul este bariera si avem masina pe partea opusa a barierei	
Viraj la dreapta cu >0 locuri libere in parcare si sub 4m pana la primul obstacol	

Viraj la dreapta cu >0 locuri libere in parcare si peste 4m pana la primul obstacol	

3.Perceptii

- **Definirea scenariului**

(ag_percept (percept_pobj scenario1) (percept_pname isa) (percept_pval scenario))

- **Definirea evenimentului**

(ag_percept (percept_pobj event1) (percept_pname isa) (percept_pval event))

- **Definirea drumului**

(ag_percept (percept_pobj current_road) (percept_pname isa) (percept_pval road))

- **Definirea semaforului**

(ag_percept (percept_pobj my_semaphore) (percept_pname isa) (percept_pval semaphore))

- **Definirea masinii**

(ag_percept (percept_pobj my_car) (percept_pname isa) (percept_pval car))

- **Definirea sagetii aditionale semaforului**

(ag_percept (percept_pobj my_arrow) (percept_pname isa) (percept_pval arrow))

- **Definirea semnului de cedeaza trecerea aditional semaforului**

(ag_percept (percept_pobj additional_give_way) (percept_pname isa) (percept_pval sign))

- **Definirea trecerii de pietoni**

(ag_percept (percept_pobj left_crosswalk) (percept_pname isa) (percept_pval crosswalk))

- **Definirea pietonilor**

(ag_percept (percept_pobj right_pedestrian) (percept_pname isa) (percept_pval pedestrian))

- **Definirea semnului de circulatoe**

(ag_percept (percept_pobj mandatory_left_sign) (percept_pname isa) (percept_pval sign))

- **Definirea panoului de la intrarea in parcare**

(ag_percept (percept_pobj parking_screen) (percept_pname isa) (percept_pval info_screen))

- **Definirea amplasarii unui obiect in scena**

(ag_percept (percept_pobj my_car) (percept_pname partof) (percept_pval current_road))

- **Definirea culorii semaofrului**

(ag_percept (percept_pobj my_semaphore) (percept_pname color) (percept_pval red))

- **Definirea directiei de deplasare a masinii**

(ag_percept (percept_pobj my_car) (percept_pname direction) (percept_pval right))

- **Definirea directiei indicate de sageata**

(ag_percept (percept_pobj my_arrow) (percept_pname direction) (percept_pval right))

- **Definirea distantei dintre trecerea de pietoni si intersectie**

(ag_percept (percept_pobj left_crosswalk) (percept_pname distance_from_intersection)

(percept_pval more_than_four))

- **Definirea valorii indicate pe panoul de la intrarea din parcare**

(ag_percept (percept_pobj parking_screen) (percept_pname available_parking_spaces) (percept_pval zero))

- **Definirea obstacolului**

(ag_percept (percept_pobj first_obstacle) (percept_pname isa) (percept_pval obstacle))

- **Definirea tipului obstacolului**

(ag_percept (percept_pobj first_obstacle) (percept_pname type) (percept_pval barrier))

Obiectele pot fi detectate folosind senzori de imagine[1] iar distanta dintre obiecte poate fi calculata folosind senzori radar[2]**.** Imaginile detectate vor fi apoi prelucrate folosind algoritmi de prelucrare a imaginilor[3] [4] [5] [6] [7]**.**

Durata de obtinere a acestor perceptii poate varia intre 50ms si 10sec, in functie de calitatea imaginii, de complexitatea scenei, de algorimii folositi si de puterea de procesare.

4. Reguli

Pentru fiecare scenariu, regulile au fost scrise astfel sa cuprinda cat mai multe cazuri posibile. Astfel, folosind logica propozitionala s-a obtinut un numar redus de reguli, care au urmatoarele formule logice:

- **Scenariul 1, evenimentele 1-4:**

if { dreapta && rosu && [not (sageata) || (pieton && sageata) || (masina && sageata)] }

=> PROHIBITED

- **Scenariul 1, evenimentele 5-9:**

if { dreapta && [(rosu && sageata && not(pieton) && not(masina)) || verde] }

=> ALLOWED

- **Scenariul 1, evenimentele 10-16:**

if { stanga && rosu && [not (sageata) || (pieton && sageata) || (sageata && masina && (directie dreapta || directie inainte))] }

=> PROHIBITED

- **Scenariul 1, evenimentele 17-18:**

if { stanga && [(rosu && sageata && not(pieton) && masina && directie stanga) || ((rosu && sageata && not(pieton) && not(masina))] }

=> ALLOWED

- **Scenariul 1, evenimentele 19-24:**

if { stanga && verde && [(pieton && cedeaza) || (cedeaza && masina && (directie dreapta || directie inainte))] }

=> PROHIBITED

- **Scenariul 1, evenimentele 25-27:**

if { stanga && [(verde && cedeaza && not(pieton) && masina && directie stanga) || ((verde && cedeaza && not(pieton) && not(masina)) || (verde && not(cedeaza) && not(pieton) && not(masina))] }

=> ALLOWED

- **Scenariul 2, evenimentele 1-5:**

if { stanga && trecere && [(pieton && sub 4 m) || masina] }

=> PROHIBITED

- **Scenariul 2, evenimentele 6-8:**

if { stanga && trecere && [(not(pieton) && not(masina)) || (pieton && not(masina) && peste 4 m)] }

=> ALLOWED

- **Scenariul 3, evenimentele 1-4:**

if [stanga && (obligatoriu inainte || obligatoriu dreapta || interzis stanga || inainte/dreapta)]

=> PROHIBITED

- **Scenariul 3, evenimentele 5-8:**

if { stanga || [stanga && (obligatoriu stanga || obligatoriu inainte/stanga || obligatoriu stanga/dreapta)]}

=> ALLOWED

- **Scenariul 4, evenimentele 1-2:**

if (dreapta && 0 && not(bariera))

=> PROHIBITED

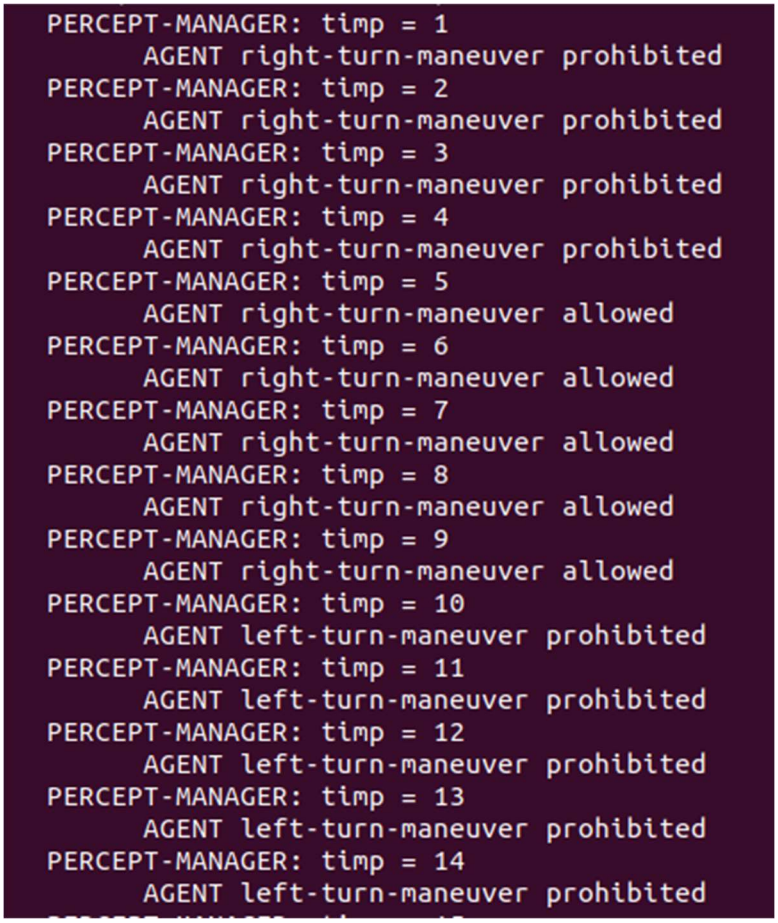
- **Scenariul 4, evenimentele 3-5:**

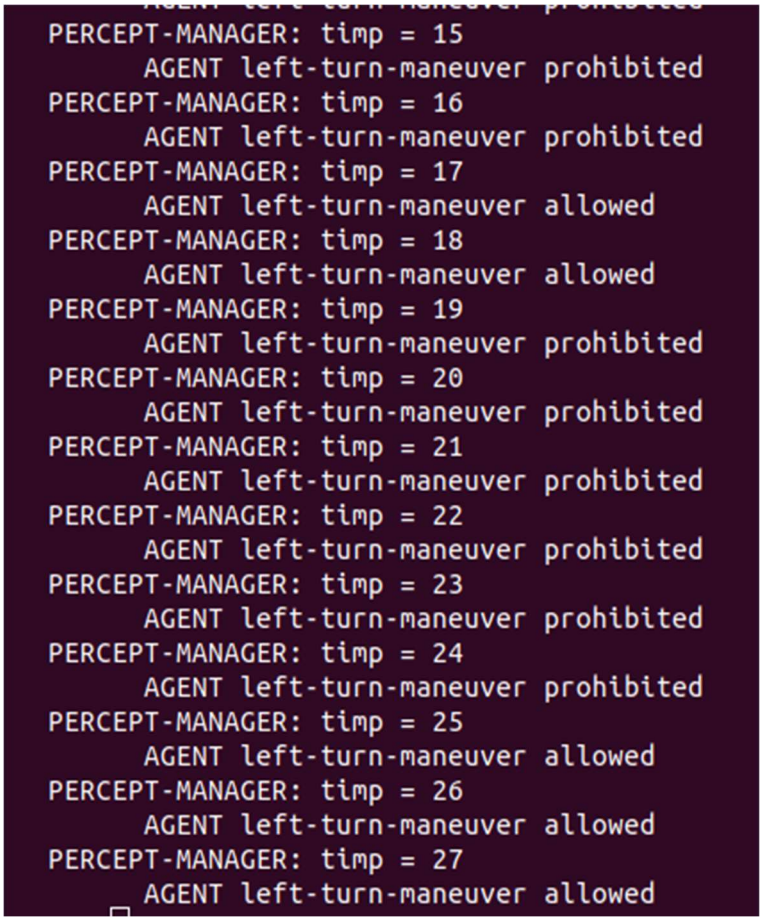
if [dreapta && (>0 || bariera)]

=> ALLOWED

5. Output program

Scenariul 1





Timpul 1: Viraj la dreapta cu semafor rosu

=> PROHIBITED

Timpul 2: Viraj la dreapta cu semafor rosu, sageata verde intermitent, masina care vine din partea stanga si pieton

=> PROHIBITED

Timpul 3: Viraj la dreapta cu semafor rosu, sageata verde intermitent si pieten

=> PROHIBITED

Timpul 4: Viraj la dreapta cu semafor rosu, sageata verde intermitent si masina care vine din partea stanga

=> PROHIBITED

Timpul 5: Viraj la dreapta cu semafor rosu si sageata verde intermitent

=> *ALLOWED*

Timpul 6: Viraj la dreapta cu semafor rosu, sageata verde intermitent si masina care vine din contrasens vireaza stanga

=> *ALLOWED*

Timpul 7: Viraj la dreapta cu semafor rosu, sageata verde intermitent si masina care vine din contrasens vireaza dreapta

=> *ALLOWED*

Timpul 8: Viraj la dreapta cu semafor rosu, sageata verde intermitent si masina care vine din contrasens merge inainte

=> *ALLOWED*

Timpul 9: Viraj la dreapta cu semafor verde

=> *ALLOWED*

Timpul 10: Viraj la stanga cu semafor rosu

=> PROHIBITED

Timpul 11: Viraj la stanga cu semafor rosu, sageata verde intermitent, pieton si masina care vine din contrasens vireaza dreapta

=> PROHIBITED

Timpul 12: Viraj la stanga cu semafor rosu, sageata verde intermitent, pieton si masina care vine din contrasens vireaza stanga

=> PROHIBITED

Timpul 13: Viraj la stanga cu semafor rosu, sageata verde intermitent, pieton si masina care vine din contrasens merge inainte

=> PROHIBITED

Timpul 14: Viraj la stanga cu semafor rosu, sageata verde intermitent si masina care vine din contrasens vireaza dreapta

=> PROHIBITED

Timpul 15: Viraj la stanga cu semafor rosu, sageata verde intermitent si masina care vine din contrasens merge inainte

=> PROHIBITED

Timpul 16: Viraj la stanga cu semafor rosu, sageata verde intermitent si pieton

=> PROHIBITED

Timpul 17: Viraj la stanga cu semafor rosu, sageata verde intermitent si masina care vine din contrasens vireaza stanga

=> *ALLOWED*

Timpul 18: Viraj la stanga cu semafor rosu si sageata verde intermitent

=> *ALLOWED*

Timpul 19: Viraj la stanga cu semafor rosu, cedeaza trecerea aditional, pieton si masina care vine din contrasens vireaza dreapta

=> PROHIBITED

Timpul 20: Viraj la stanga cu semafor rosu, cedeaza trecerea aditional, pieton si masina care vine din contrasens vireaza stanga

=> PROHIBITED

Timpul 21: Viraj la stanga cu semafor rosu, cedeaza trecerea aditional, pieton si masina care vine din contrasens merge inainte

=> PROHIBITED

Timpul 22: Viraj la stanga cu semafor rosu, cedeaza trecerea aditional si masina care vine din contrasens vireaza dreapta

=> PROHIBITED

Timpul 23: Viraj la stanga cu semafor rosu, cedeaza trecerea aditional si masina care vine din contrasens merge inainte

=> PROHIBITED

Timpul 24: Viraj la stanga cu semafor rosu, cedeaza trecerea aditional si pieton

=> PROHIBITED

Timpul 25: Viraj la stanga cu semafor rosu, cedeaza trecerea aditional si masina care vine din contrasens vireaza dreapta

=> *ALLOWED*

Timpul 26: Viraj la stanga cu semafor rosu si cedeaza trecerea additional

=> *ALLOWED*

Timpul 27: Viraj la stanga cu semafor verde

=> *ALLOWED*

Scenariul 2

```
PERCEPT-MANAGER: timp = 1
      AGENT left-turn-maneuver prohibited
PERCEPT-MANAGER: timp = 2
      AGENT left-turn-maneuver prohibited
PERCEPT-MANAGER: timp = 3
      AGENT left-turn-maneuver prohibited
PERCEPT-MANAGER: timp = 4
      AGENT left-turn-maneuver prohibited
PERCEPT-MANAGER: timp = 5
      AGENT left-turn-maneuver prohibited
PERCEPT-MANAGER: timp = 6
      AGENT left-turn-maneuver allowed
PERCEPT-MANAGER: timp = 7
      AGENT left-turn-maneuver allowed
PERCEPT-MANAGER: timp = 8
      AGENT left-turn-maneuver allowed
```

Timpul 1: Viraj la stanga cu pieton, masina care vine de pe contrasens si sub 4m intre trecere si intersectie

=> PROHIBITED

Timpul 2: Viraj la stanga cu pieton si sub 4m intre trecere si intersectie

=> PROHIBITED

Timpul 3: Viraj la stanga cu masina care vine de pe contrasens si sub 4m intre trecere si intersectie

=> PROHIBITED

Timpul 4: Viraj la stanga cu pieton, masina care vine de pe contrasens si peste 4m intre trecere si intersectie

=> PROHIBITED

Timpul 5: Viraj la stanga cu masina care vine de pe contrasens si peste 4m intre trecere si intersectie

=> PROHIBITED

Timpul 6: Viraj la stanga si sub 4m intre trecere si intersectie

=> *ALLOWED*

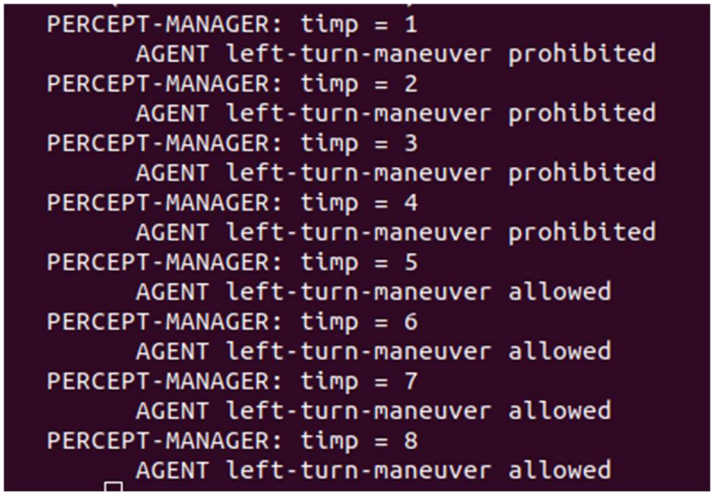
Timpul 7: Viraj la stanga cu pieton si peste 4m intre trecere si intersectie

=> *ALLOWED*

Timpul 8: Viraj la stanga si peste 4m intre trecere si intersectie

=> *ALLOWED*

Scenariul 3



Timpul 1: Viraj la stanga cu indicator “obligatoriu inainte”

=> PROHIBITED

Timpul 2: Viraj la stanga cu indicator “obligatoriu la dreapta”

=> PROHIBITED

Timpul 3: Viraj la stanga cu indicator “interzis la stanga”

=> PROHIBITED

Timpul 4: Viraj la stanga cu indicator “obligatoriu inainte sau la dreapta”

=> PROHIBITED

Timpul 5: Viraj la stanga cu indicator “obligatoriu la stanga”

=> *ALLOWED*

Timpul 6: Viraj la stanga cu indicator “obligatoriu inainte sau la stanga”

=> *ALLOWED*

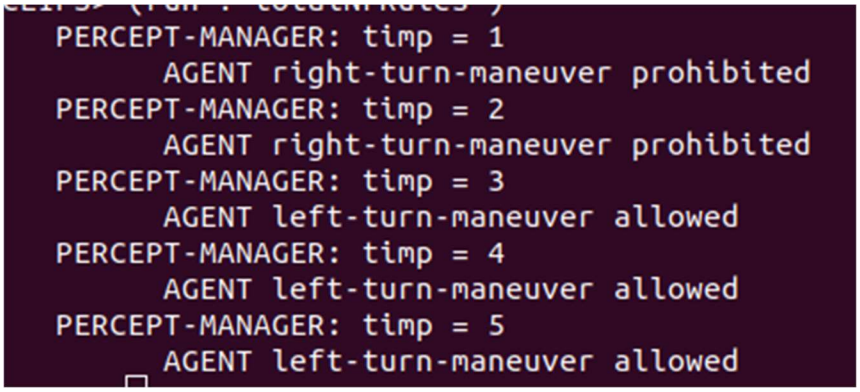
Timpul 7: Viraj la stanga cu indicator “obligatoriu la dreapta sau la stanga”

=> *ALLOWED*

Timpul 8: Viraj la stanga fara indicator

=> *ALLOWED*

Scenariul 4



Timpul 1: Viraj la dreapta cu 0 locuri libere in parcare si sub 4m pana la primul obstacol

=> PROHIBITED

Timpul 2: Viraj la dreapta cu 0 locuri libere in parcare si peste 4m pana la primul obstacol

=> PROHIBITED

Timpul 3: Viraj la dreapta cu 0 locuri libere in parcare, peste 4m pana la primul obstacol, obsacolul este bariera si avem masina pe partea opusa a barierei

=> *ALLOWED*

Timpul 4: Viraj la dreapta cu >0 locuri libere in parcare si sub 4m pana la primul obstacol

=> *ALLOWED*

Timpul 5: Viraj la dreapta cu >0 locuri libere in parcare si peste 4m pana la primul obstacol

=> *ALLOWED*

6. Rapoarte de performanta

$$\text{Average} = \frac{1}{N}\sum_{i=1}^{N}\text{Value}_i$$

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(\text{Value}_i - \text{Average})^2}$$

Scenariul 1:

Time\Nr.	1	2	3	4	5	Media	σ
T1	**0.00007510**	**0.000067949**	**0.000063180**	**0.000064134**	**0.000066041**	**0.00006788**	**0.00000428**
T2	**0.00008416**	**0.00010**	**0.000075101**	**0.000077009**	**0.000091075**	**0.00008529**	**0.00000641**
T3	**0.00007486**	**0.000067949**	**0.000066041**	**0.000065803**	**0.000067949**	**0.000068120**	**0.00000339**
T4	**0.000071048**	**0.000061035**	**0.000063180**	**0.000061988**	**0.000060081**	**0.000063266**	**0.00000409**
T5	**0.000062942**	**0.000057935**	**0.000058889**	**0.000056028**	**0.000054836**	**0.000058726**	**0.00000359**
T6	**0.000068902**	**0.000062942**	**0.000063896**	**0.000060081**	**0.000060081**	**0.000063980**	**0.00000329**
T7	**0.000064134**	**0.000066041**	**0.000061035**	**0.000059127**	**0.000055789**	**0.000061825**	**0.00000400**
T8	**0.000064134**	**0.000058889**	**0.000062942**	**0.000058889**	**0.000056982**	**0.000060367**	**0.00000269**
T9	**0.000050067**	**0.000044822**	**0.000046968**	**0.000042915**	**0.000043869**	**0.000045928**	**0.00000277**
T10	**0.000059127**	**0.000055789**	**0.000050067**	**0.000048875**	**0.000049114**	**0.000052594**	**0.00000405**
T11	**0.000087976**	**0.000077962**	**0.000074863**	**0.000077962**	**0.000077962**	**0.000079745**	**0.00000498**
T12	**0.000080823**	**0.000072002**	**0.000072956**	**0.000071048**	**0.000076055**	**0.000074977**	**0.00000329**

T13	**0.000077962**	**0.000073194**	**0.000071048**	**0.000030040**	**0.000070810**	**0.000064011**	**0.00001825**
T14	**0.000076055**	**0.000069856**	**0.0000 74863**	**0.000027894**	**0.000064849**	**0.000062104**	**0.00001819**
T15	**0.000074148**	**0.000067949**	**0.000068902**	**0.000025987**	**0.000065803**	**0.000060558**	**0.00001930**
T16	**0.000079870**	**0.000061035**	**0.000076055**	**0.000027894**	**0.000066995**	**0.000062370**	**0.00001800**
T17	**0.000074863**	**0.000028133**	**0.000073909**	**0.000028133**	**0.000061035**	**0.000053614**	**0.00001954**
T18	**0.000072002**	**0.000024080**	**0.000066041**	**0.000024080**	**0.000025987**	**0.000042838**	**0.00002268**
T19	**0.000087022**	**0.000030040**	**0.000079154**	**0.000043869**	**0.000030040**	**0.000052025**	**0.00002529**
T20	**0.000072956**	**0.000029087**	**0.000074863**	**0.000028133**	**0.000028133**	**0.000046834**	**0.00002064**
T21	**0.000081062**	**0.000028133**	**0.000076055**	**0.000029087**	**0.000030040**	**0.000048075**	**0.00002252**
T22	**0.000059843**	**0.000026941**	**0.000072002**	**0.000028133**	**0.000028848**	**0.000043553**	**0.00001660**
T23	**0.000057935**	**0.000028133**	**0.000066995**	**0.000025987**	**0.000026941**	**0.000041798**	**0.00001465**
T24	**0.000061988**	**0.000026941**	**0.000071048**	**0.000027179**	**0.000027894**	**0.000043810**	**0.00001464**
T25	**0.000061988**	**0.000025987**	**0.000061035**	**0.000026226**	**0.000026941**	**0.000044635**	**0.00001536**
T26	**0.000052928**	**0.000025033**	**0.000054836**	**0.000025033**	**0.000024795**	**0.000036325**	**0.00001256**
T27	**0.000041961**	**0.000019073**	**0.000042915**	**0.000020980**	**0.000018835**	**0.000028953**	**0.00001034**

Scenariul 2:

Time\Nr.	1	2	3	4	5	Media	σ
T1	**0.000092029**	**0.00012183**	**0.000092029**	**0.0000000010895**	**0.000092029**	**0.0000796**	**0.00004312**
T2	**0.000086069**	**0.000092983**	**0.000072002**	**0.0000801086425**	**0.000062942**	**0.000078020**	**0.00001065**
T3	**0.000065803**	**0.000082015**	**0.000071048**	**0.000081062**	**0.000069856**	**0.000074757**	**0.00000561**
T4	**0.000068902**	**0.000084877**	**0.000076055**	**0.000082969**	**0.000075101**	**0.000077981**	**0.00000511**
T5	**0.000061035**	**0.000072956**	**0.000064849**	**0.000073909**	**0.000066995**	**0.000067949**	**0.00000424**
T6	**0.000054121**	**0.000061988**	**0.000054121**	**0.000061988**	**0.000052928**	**0.000056829**	**0.00000305**
T7	**0.000057935**	**0.000069141**	**0.000056982**	**0.000070095**	**0.000059843**	**0.000062599**	**0.00000524**
T8	**0.000048875**	**0.000057220**	**0.000048875**	**0.000056982**	**0.000051975**	**0.000052985**	**0.00000307**

Scenariul 3:

Time\Nr	1	2	3	4	5	Media	σ
T1	**0.000071048**	**0.000066995**	**0.000068902**	**0.000068902**	**0.000077009**	**0.000070371**	**0.00000378**
T2	**0.000059843**	**0.000053882**	**0.000061035**	**0.000061035**	**0.000063896**	**0.000059938**	**0.00000315**
T3	**0.000055074**	**0.000049829**	**0.000054836**	**0.000054836**	**0.000068187**	**0.000056552**	**0.00000647**
T4	**0.000056028**	**0.000049829**	**0.000052928**	**0.000052928**	**0.0000600814**	**0.000054159**	**0.00000332**
T5	**0.000078916**	**0.000050067**	**0.000054836**	**0.000054836**	**0.000058174**	**0.000059566**	**0.00001169**
T6	**0.000059127**	**0.000049114**	**0.000053882**	**0.000053882**	**0.000059127**	**0.000054226**	**0.00000368**
T7	**0.000054121**	**0.000046968**	**0.000051975**	**0.000051975**	**0.000056982**	**0.000052204**	**0.00000371**
T8	**0.000049114**	**0.000044107**	**0.000049114**	**0.000049114**	**0.000051975**	**0.000048685**	**0.00000281**

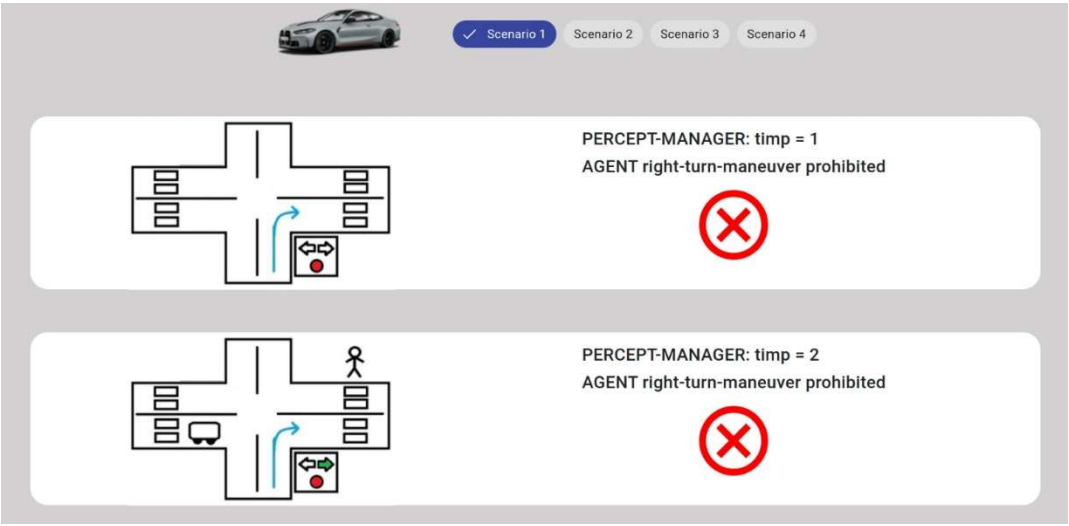
Scenariul 4:

Time\Nr	1	2	3	4	5	Media	σ
T1	**0.000092983**	**0.000077962**	**0.000082015**	**0.000099897**	**0.000085878**	**0.000087547**	**0.00000671**
T2	**0.000077009**	**0.00010204**	**0.000072956**	**0.000080108**	**0.000079857**	**0.000082794**	**0.00000889**
T3	**0.000083923**	**0.000076055**	**0.000077962**	**0.000090122**	**0.000080547**	**0.000081922**	**0.00000409**
T4	**0.000072956**	**0.000064849**	**0.000068187**	**0.000073909**	**0.000059898**	**0.000067560**	**0.000005284**
T5	**0.000071048**	**0.000058889**	**0.000060081**	**0.000074863**	**0.000060127**	**0.000065602**	**0.000005917**

7. Interfata Grafica

Pentru a oferi utilizatorului un mod mai prietenos de a folosi acest proiect, am creat o interfata grafica in angular care ii ofera acestuia posibilitatea de a alege scenariul dorit si rezultatul va fi afisat in mod sugestiv in pagina web.

Deoarece avem nevoie de rezultatele de la clips, am inclus un server care este scris in node, rolul acestuia fiind de a primi prin websocket un request de la frontend care continue scenariul selectat de utilizator, suprascrie fisierul headers.clp cu datele scenariului ales, executa comanda care porneste proiectul de clips, citeste datele din fisierul de output al proiectului de clips pe care le trimite inapoi spre frontend unde vor fi interpretate si mai apoi afisate utilizatorului. Comanda de Clips care va fi executata de catre serverul nodemon este **“clips -f “../VIRAJ/go””.** Pentru a executa aceasta comanda, Clips trebuie sa fie instalat global.



8. Instructiuni de rulare

Pentru a rula aceasta aplicatie e nevoie de urmatoarele librarii instalate global:

- Angular
- Nodemon
- Clips

Pentru a rula aplicatia se urmeaza pasii:

1. In folderul server se executa comanda **"nodemon index.js"** care va porni serverul de node

2. In folderul viraj-frontend se executa comanda **"ng serve"** prin care se porneste clientul de frontend

3. Intr-un browser se acceseaza adresa oferita in terminalul de la pasul 2. Programul de Clips nu trebuie pornit explicit, acesta va fi executat de serverul de node pornit anterior(pasul 1).

9. Concluzii si limitari

Proiectul dat reprezintă o abordare utilă și necesară în contextul tehnologiilor care vizează siguranța rutieră. Validarea manevrei de viraj a fost realizata tinand cont de urmatorii factori: semaforul, sagetă la semafor, cedează trecerea adițional, pietoni, mașini constrasens, treceri de pietoni și intersecții dirijate de indicatoare si intrarea intr-o parcare in functie de numarul de locuri disponibile.

In ceea ce tine despre dezvoltarile ulterioare ale acestui proiect, se numara:

- Includerea retelelor neuronale si a invatarii profunde
- Includerea unui circuit cu senzori care sa ofere date live
- Apelareea acestui proiect dintr-un alt proiect, de exemplu C.

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