Improving driver's situation awareness

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Summary

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Presentation of the paper

- Main problem
- Original idea

Problem

Driving training is supervised by a driving instructor
Consequently, a novice driver

- do not learn how to contextualize procedures into effective practices
- do not see the danger of driving situations

Our aim

Improve driver's Situation Awareness

by simulation

Study in litterature

Most of the studies are modeling the driver in a uncompleted way:

- about driver's cognition (stress, tiredness...)
- about driver's actions (brake, accelerator...)

Our idea

- Model the driver in a more global way
- By associating local methods (cognitives sciences) and global methods (machine learning)

Summary

Previous works

- GADGET Project
- Study of Young et. al, 2006
- Others projects
- Previous works with association of the two methods
  - Interest of associating

GADGET Project

European project (2003) which aims to :

- assess traffic safety measures on driver behavior
- analyze the influence of in-car safety devices,
- analyze various road environments, education, training programs
- analyze safety campaigns, legal measures

Main result

- GDE Matrix

Hierarchical Levels of Driver Behaviour		Knowledge and Skills	Risk-Increasing Factors	Self- Assessment
	Goals for Life and Skills for Living	**Awareness about relation between personal tendencies and driving skills** • lifestyle/life situation • peer group norms • motives • personal values • …	**Risky tendencies like** • acceptance of risks • high level of sensation seeking • complying to social pressure • use of alcohol and drugs • …	**Awareness of** • impulse control • risky tendencies • dangerous motives • risky habits • …
	Driving Goals and Context	**Awareness about** • effects of journey goals • planning and choosing routes • effects of social pressure by passengers inside the car • …	**Risks associated with** • physical condition (fitness, arousal, alcohol, etc.) • purpose of driving • driving environment (rural/urban/higway) • social context and company • …	**Awareness of** • personal planning skills • typical driving goals • alternative transport modes • …
	Mastery of Traffic Situations	**Knowledge about** • traffic regulations • traffic signs • anticipation • communication • safety margins • …	**Risks associated with** • wrong expectations • vulnerable road-users • violations • information overload • unusual conditions • inexperience • …	**Awareness of** • strong and weak points of manoeuvring skills • subjective risk level • subjective safety margins • …
	Vehicle Manoeuvring	**Skills concerning** • control of direction and position • vehicle properties • physical phenomena • …	**Risks associated with** • insufficient skills • environmental conditions (weather, friction etc.) • car condition (tyres, engine etc.) • …	**Awareness of** • strong and weak points of car control skills • …

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- Political
- ex: to be late
- Strategical
- ex: take the motorway

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- ex: take the motorway
- Tactical
- ex: turn left

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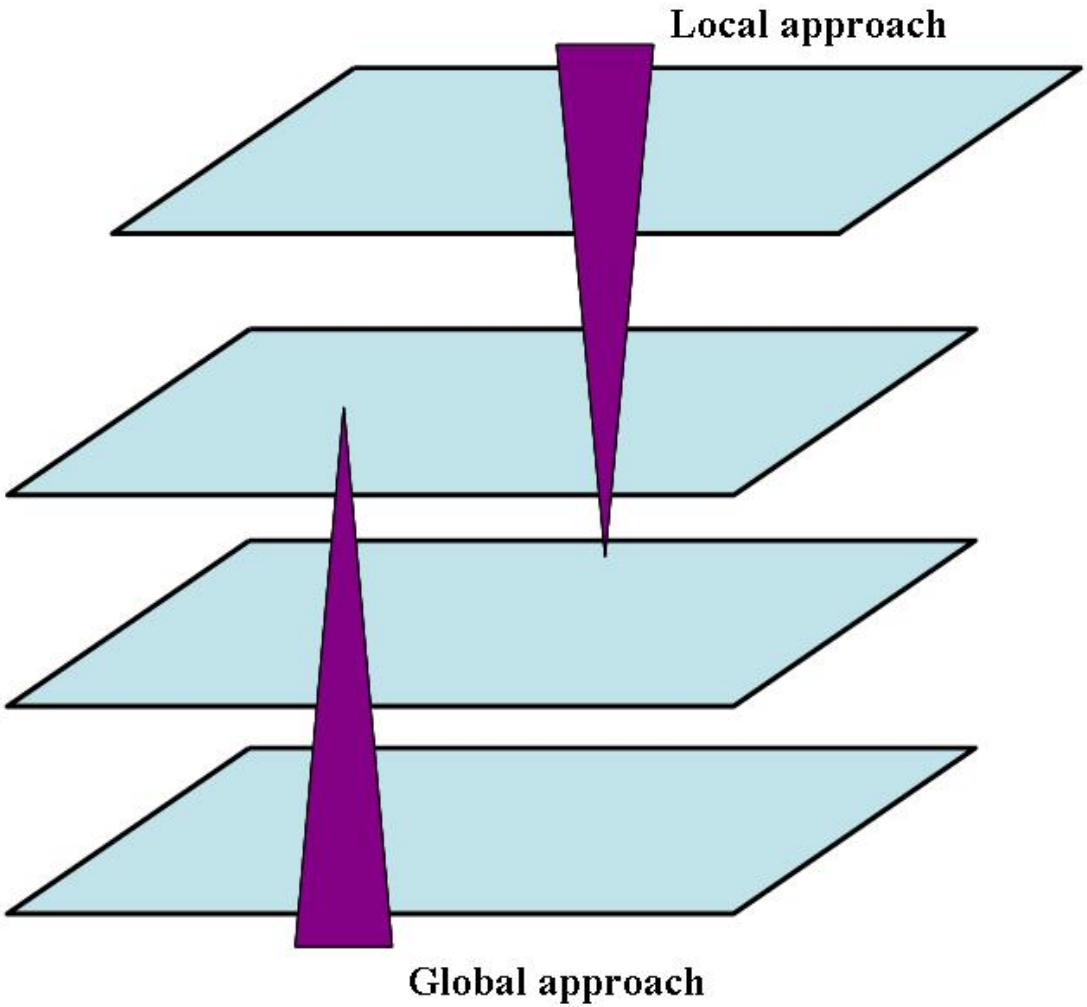
- Political
- ex: to be late
- Strategical
- ex: take the motorway
- Tactical
- ex: turn left
- Operational
- ex: move the wheel



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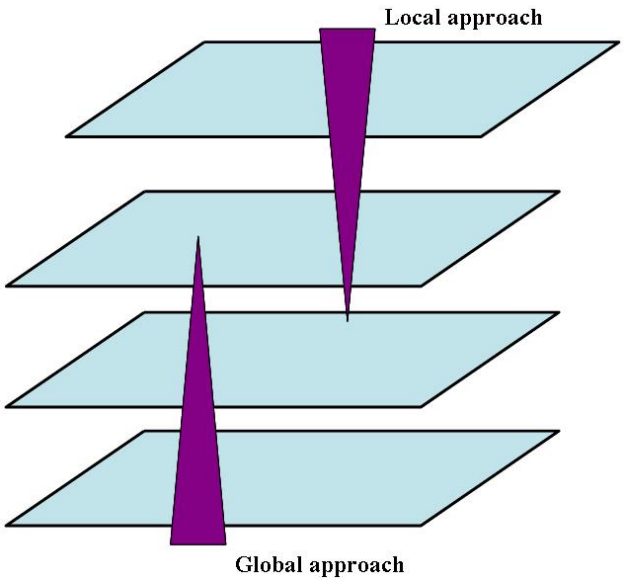


Main negative point is that there is no use of Context

- a element conditions lower levels
- abstraction thanks to context

Formation of firemen in two ways:

- Only good hierachical decisions
- Only bad hierachical decisions

Result

Second group has better results:
It is better to learn from others' errors

EU projects:

- HUMANIST
- ADVANCED
- TRAINER

Limits of the two methods :

Machine learning

- Analyze poor data
- Results are not interesting

Cognitives sciences

- Analyze hight-level data
- Incomplet results

Previous works

- Oliver (2000) :
  - Recognition and Prediction of driver's actions

    Limited results, prediction 1s before action
  - Complex models : HMM, Coupled HMM, Hierarchical HMM
- Dapzol (2005) :
  - Classification of sequences of driver's actions

    Interesting results
  - Model : HMM

First assumption

Improve driver Situation awareness = Minimize his driving's errors

Second assumption

A driver model by associating global and local mehods

Summary

Cognitive Sciences

- Contextual Graphs

Machine Learning

- Hidden Markov Models

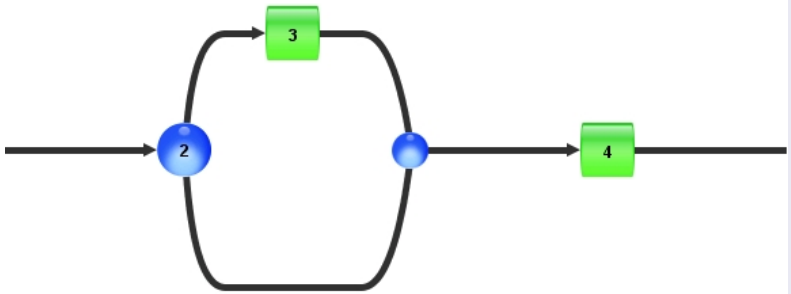
Context definition

- (Brézillon and Pomerol): "that which constrains a focus without intervening in it explicitly"
- (1) context is relative to the focus,
- (2) as the focus evolves, its context evolves too
- 3) context is highly domain-dependent

Contextual Graphs

- Contextual Graphs are a context-based formalism for representing knowledge and reasoning in a uniform way
- This formalism allows to represent the different ways in which the driving task can be realized
- A given driving situation represents the several possible scenarios for this "situation solving"
- A path in this graph represents a driver's behavior in the driving situation, taking into account the different contexts considered by the user during the situation solving

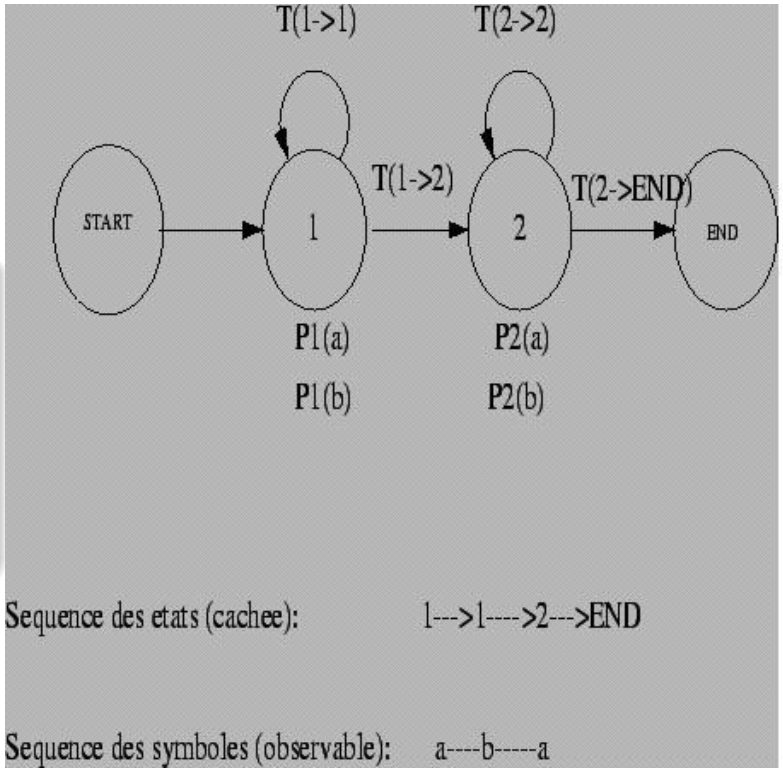
Example of Contextual Graphs



C2 : Is there a car on my right ?
YES
A3 : Give way to car on my right
NO
A4 : Prioritary crossing

Hidden Markov Models

- Popular models for sequences analysis
- First use in speech recognition



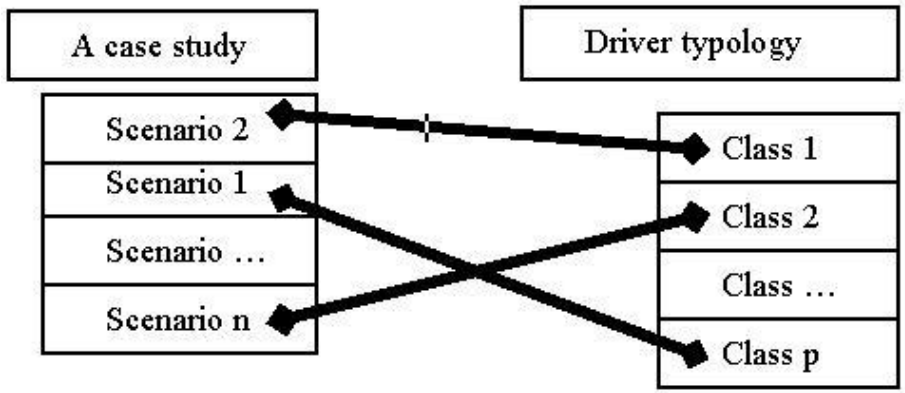
Summary

First step

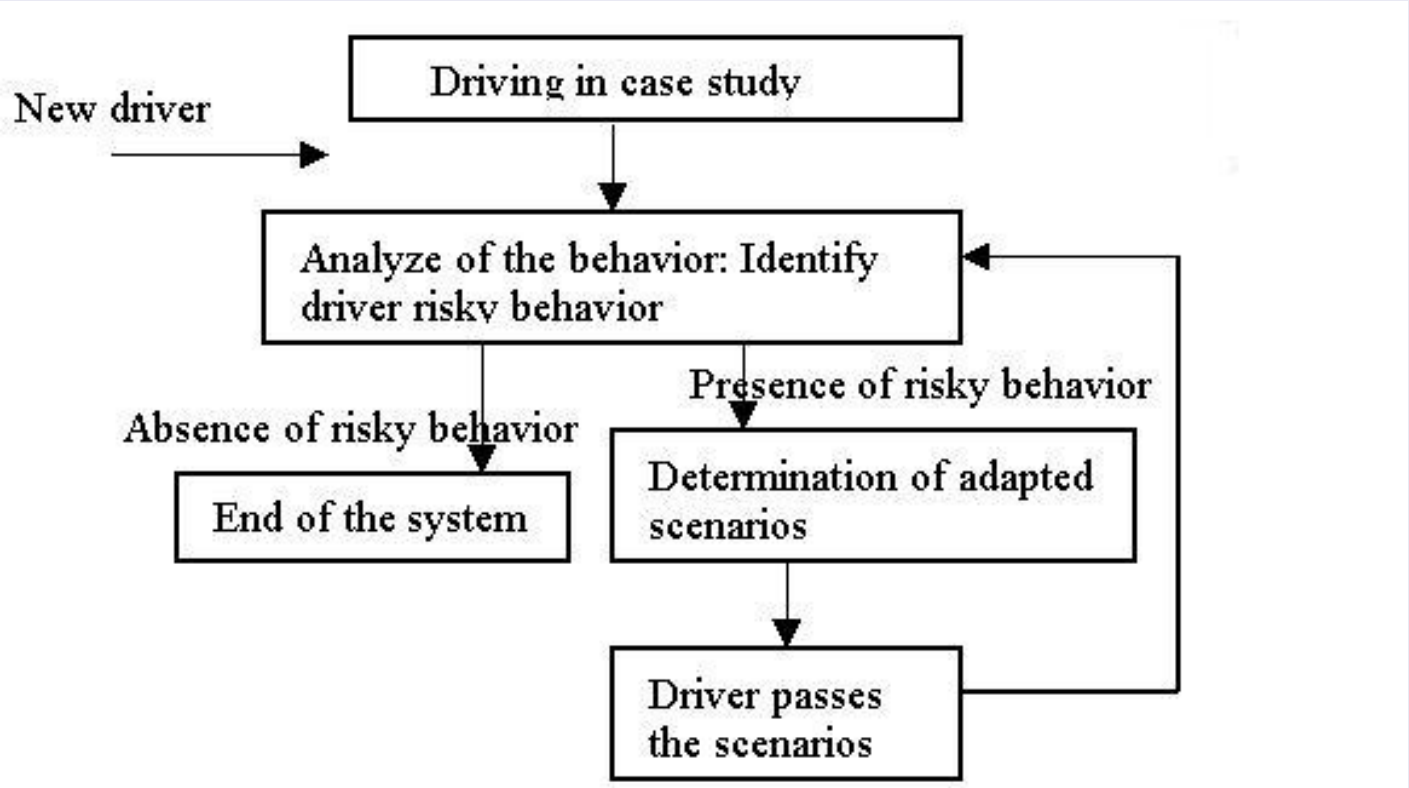
Make a typology by from a questionnaire

Second step

Choose a driving situation



The system architecture



Started with GDE Matrix

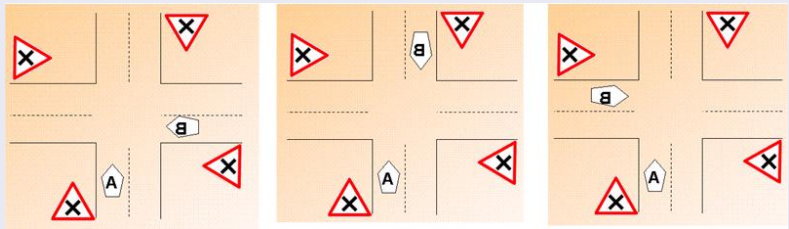
- Completed
- Reorganized

A questionnaire

- Questionnaire
- Make our typology thanks to the answers

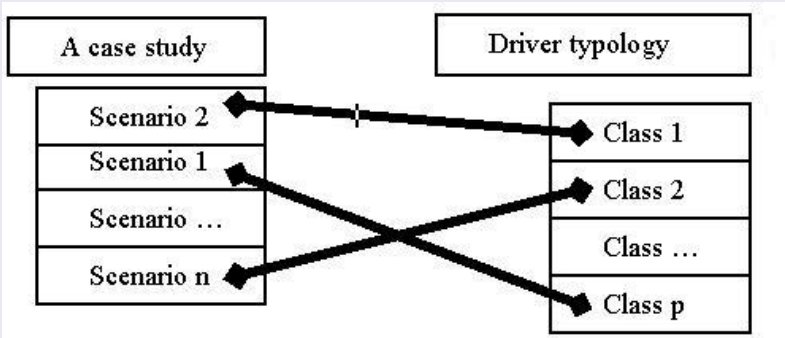
Choose a driving situation

- Crossroad without priority
- Analyze all possible scenarios
- Thanks to our defintion of context



Analyze of scenarios

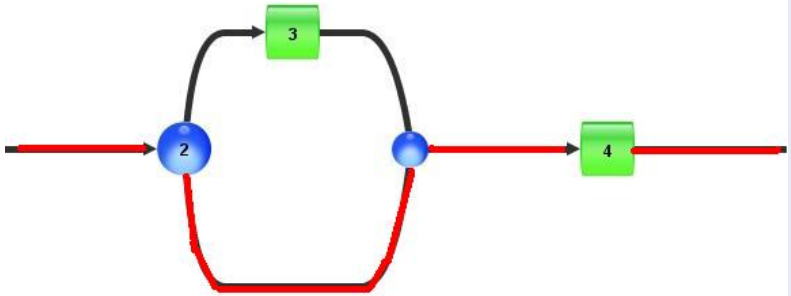
- Classify all these scenarios among our typology



By Machine learning

By HMM

By Cognitives Sciences



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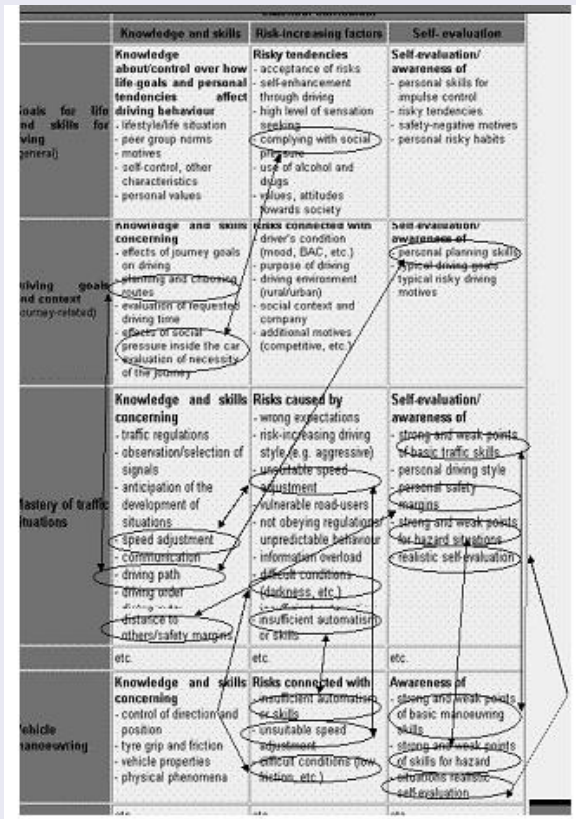
Summary

Results

- Drivers typology
- Definition of all scenarios

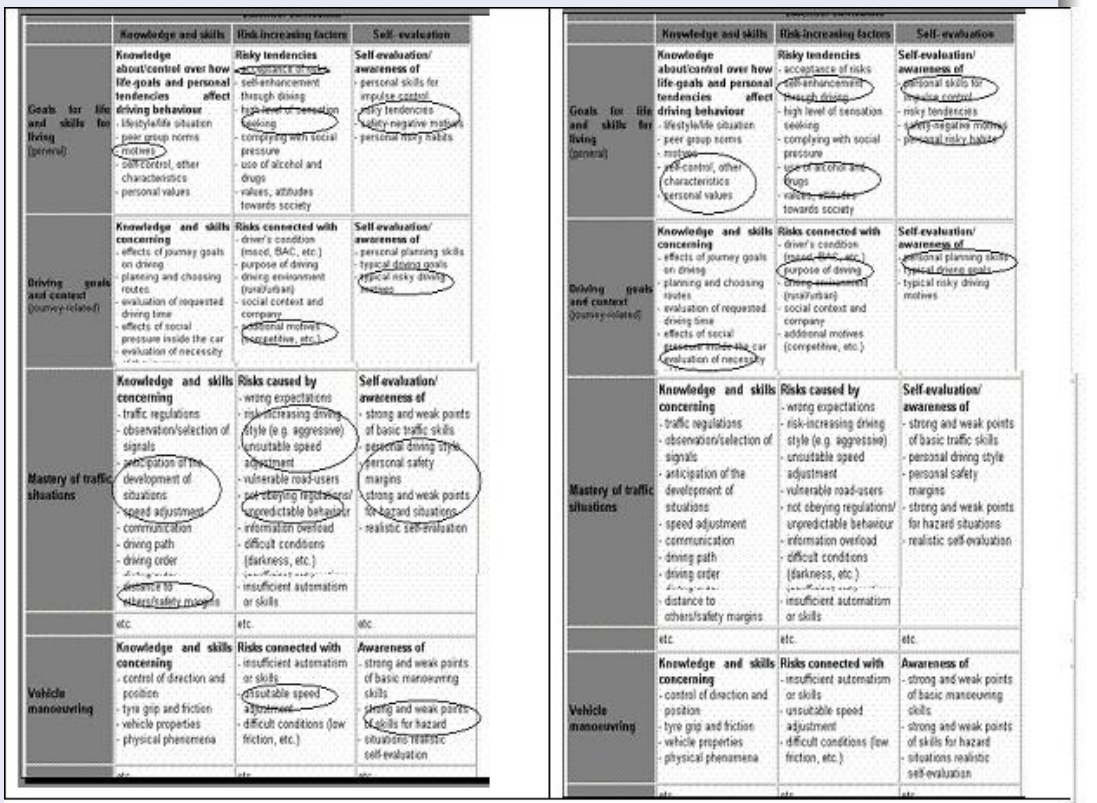
Started from GDE Matrix

- Completed
  - Age, Experience...
- Reorganised
  - Some repetitions

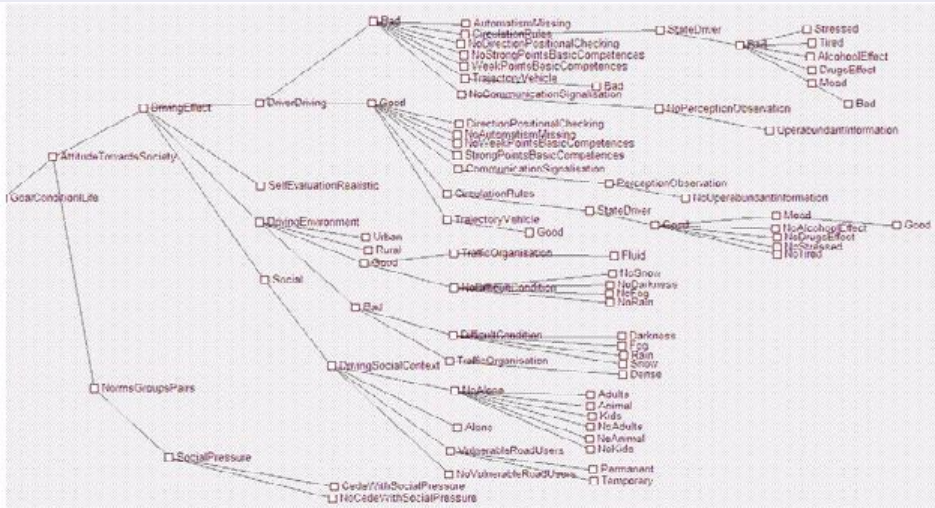


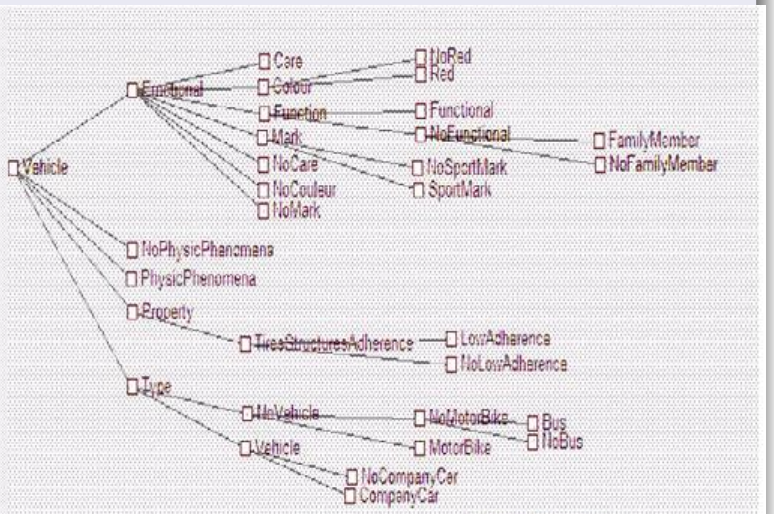
Started from GDE Matrix

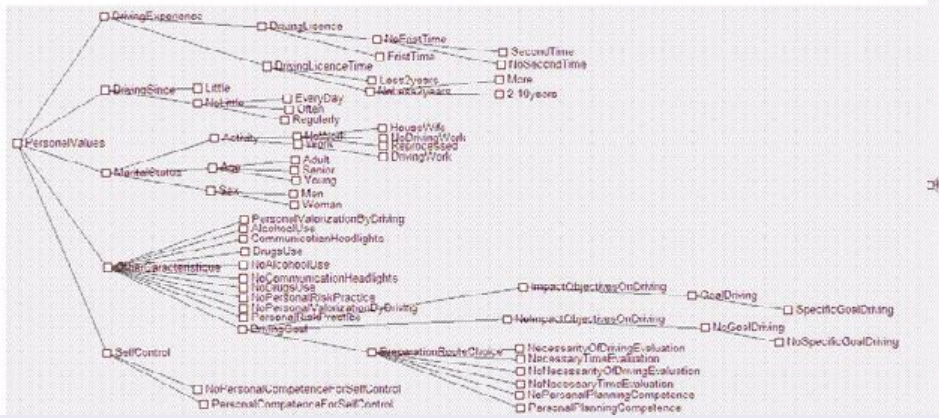
- Completed
  - Age, Experience...
- Reorganised
  - Some repetitions
  - Reorganisation by type

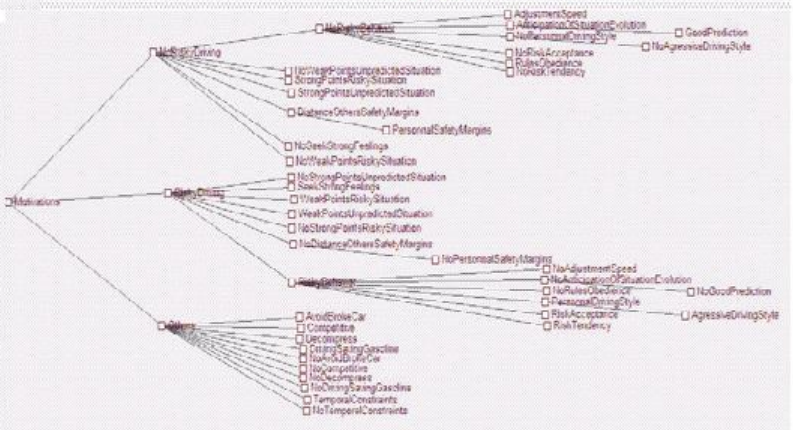


Our Tree Representation of Context Awareness for Drivers' behavior: TR-CAD



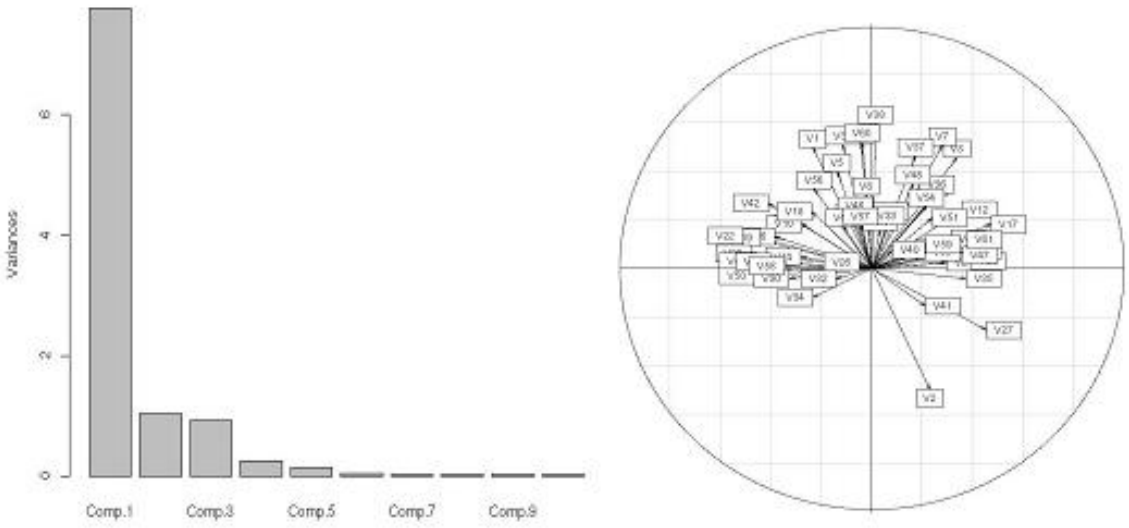






Results questionnaire

- Results among 419 participants
- Principal Component analysis



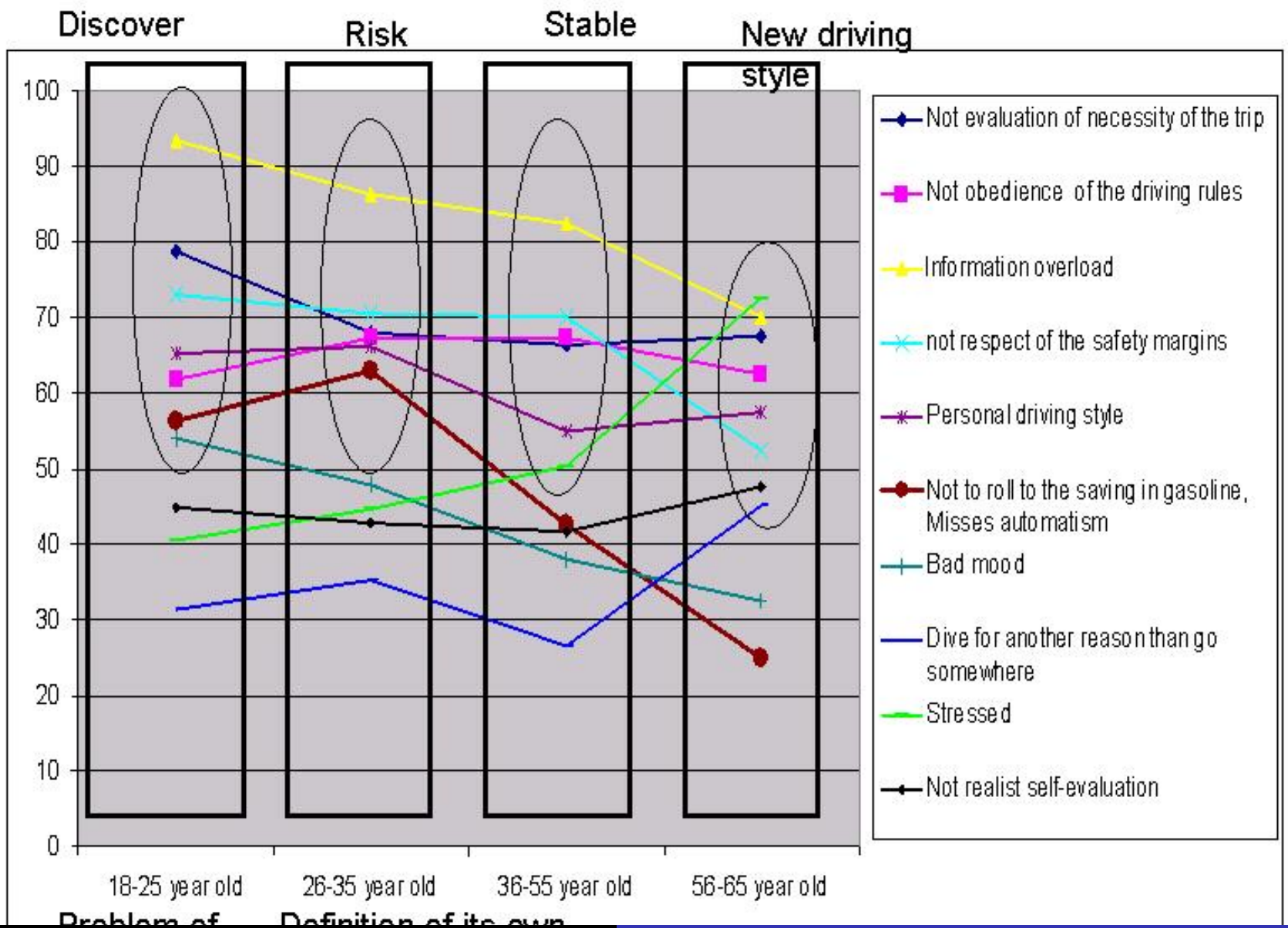
- Agglomerative methods
- 15 classes

15 classes

- Specific to one-class variables
- Risky variables
- 15 class represents 15 risky behaviors

Evolution of drivers' behaviors

- A first classification of the classes by age
- Evolution in driving errors according to the age


Discover
Risk
Stable
New driving style
100
90
80
70
60
50
40
30
20
10
0
18-25 year old
26-35 year old
36-55 year old
56-65 year old
Not evaluation of necessity of the trip
Not obedience of the driving rules
Information overload
not respect of the safety margins
Personal driving style
Not to roll to the saving in gasoline, Misses automatism
Bad mood
Dive for another reason than go somewhere
Stressed
Not realist self-evaluation

How we use context ?

- A unique situation
- Several dressing define by contextual elements

Contextual elements

- Physical elements: Environment, Nature of the ground
- Technical elements
  Type of crossroad structure simple, particular
  Type of way (for each arm)
  Road information
- Moment elements: Day, Season, Weather
- Driving elements: Vehicles, Traffic, Visibility
- Human elements: Physical aspects, Cognitive aspects, Journey

Context represents the situation dressing

- Focus: Entering a crossroad
  Context: A general description of the situation: "The crossroad is in a city"
- Focus: Entering a crossroad in a city
  External knowledge: "Type of field"
  Contextual knowledge: "Type of store"
  Proceduralized context: "Shop at the right corner = baker"
  Contextual elements whose the value is need to specify the situation

Procedure

- A dressing defines thanks to contextual elements
- Several instanciations
  - Integrity constraints
  - Inference rules

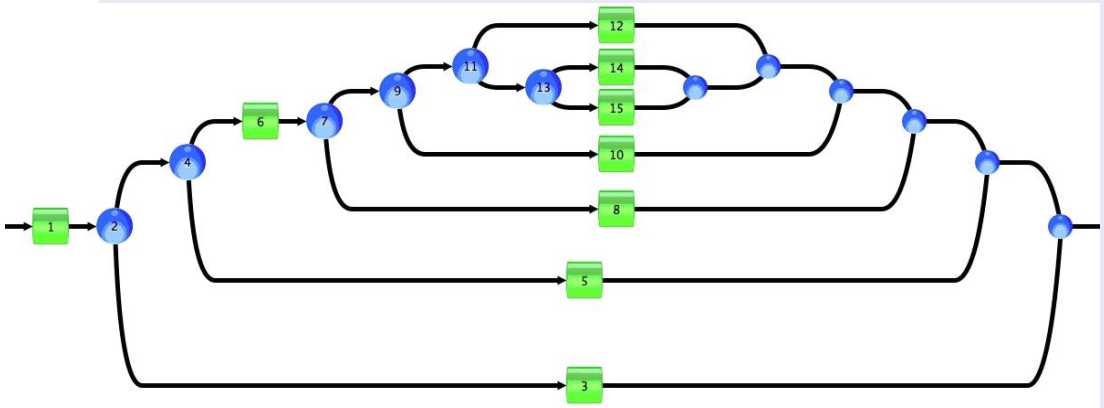
Example

- Current focus = "Vehicle on the left-side road"
- Rule of normal behavior:
  IF "Vehicle" = "on my left"
  THEN I have priority
- Rue of integrity from relationships:
  IF "Vehicle" = "Police"
  THEN "Police" has priority
  IF "Vehicle"= "Prioritary"
  THEN I must let it enter first the crossroad

See Poster session "Context modeling : Context as a dressing of a focus" for more details

Contextual Graphs

Make Contextual Graphs to identify his behavior



1 : Detect a crossroad
2 : Is a car coming on the right?
Yes 4 : Has the other car priority?
No 6 : Keep the same behavior et and be careful
7 : Is the other car coming on my road?
Yes 9 : Can I avoir the other car?
Yes 11 : Is it sufficient to break?
Yes 12 : Brake to reduce speed
No 13 : Can I overtake the other car on the left?
Yes 14 : Try to limit the consequences
No 15 : Brake strongly
No 10 : Try to limit the consequences
No 8 : Keep the same behavior
Yes 5 : Let the other acr going ahead
No 3 : Keep the same behavior

What is made ?

- Drivers typology
- Definition of scenarios
- We show that the type of reasoning depends essentially on the way in which context is modelled
- In our way, we introduce naturally a model of a standard behavior of drivers and in the same manner the model of practices

What next ?

- Machine learning part (currently work on it)
- Experimentation