

# Improving driver's situation awareness

J. Brézillon, P. Brézillon and C.Tijus

Fourth International Workshop on Modeling and Reasoning in Context (MRC07)  
Including a Special Session on the Role of Contextualization in Human Tasks

Sixth International and Interdisciplinary Conference on Modeling and Using Context  
Roskilde University, Denmark, 20-24 August 2007



# Summary

- 1 Introduction
  - ACC Project
  - Main problem
  - Original Idea
- 2 Previous works
  - GADGET Project
  - Study of Young, 2006
  - Others projects
  - Interest of associating
  - Association of the two methods
  - Our assumptions
- 3 Tools
  - Contextual Graphs
  - Hidden Markov Models
- 4 Methodology
  - Drivers typology
  - Driving situation
  - Identify errors
- 5 Results
  - Drivers typology
  - Definition of our scenarios
  - Conclusion

# Summary

- 1 Introduction
  - ACC Project
  - Main problem
  - Original Idea
- 2 Previous works
  - GADGET Project
  - Study of Young, 2006
  - Others projects
  - Interest of associating
  - Association of the two methods
  - Our assumptions
- 3 Tools
  - Contextual Graphs
  - Hidden Markov Models
- 4 Methodology
  - Drivers typology
  - Driving situation
  - Identify errors
- 5 Results
  - Drivers typology
  - Definition of our scenarios
  - Conclusion

## 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

- 1 Introduction
  - ACC Project
  - Main problem
  - Original Idea
- 2 Previous works
  - GADGET Project
  - Study of Young, 2006
  - Others projects
  - Interest of associating
  - Association of the two methods
  - Our assumptions
- 3 Tools
  - Contextual Graphs
  - Hidden Markov Models
- 4 Methodology
  - Drivers typology
  - Driving situation
  - Identify errors
- 5 Results
  - Drivers typology
  - Definition of our scenarios
  - Conclusion

## 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

		Knowledge and Skills	Risk-Increasing Factors	Self- Assessment
Hierarchical Levels of Driver Behaviour	Goals for Life and Skills for Living	<b>Awareness about relation between personal tendencies and driving skills</b> <ul style="list-style-type: none"> <li>lifestyle/life situation</li> <li>peer group norms</li> <li>motives</li> <li>personal values</li> <li>...</li> </ul>	<b>Risky tendencies like</b> <ul style="list-style-type: none"> <li>acceptance of risks</li> <li>high level of sensation seeking</li> <li>complying to social pressure</li> <li>use of alcohol and drugs</li> <li>...</li> </ul>	<b>Awareness of</b> <ul style="list-style-type: none"> <li>impulse control</li> <li>risky tendencies</li> <li>dangerous motives</li> <li>risky habits</li> <li>...</li> </ul>
	Driving Goals and Context	<b>Awareness about</b> <ul style="list-style-type: none"> <li>effects of journey goals</li> <li>planning and choosing routes</li> <li>effects of social pressure by passengers inside the car</li> <li>...</li> </ul>	<b>Risks associated with</b> <ul style="list-style-type: none"> <li>physical condition (fitness, arousal, alcohol, etc.)</li> <li>purpose of driving</li> <li>driving environment (rural/urban/higway)</li> <li>social context and company</li> <li>...</li> </ul>	<b>Awareness of</b> <ul style="list-style-type: none"> <li>personal planning skills</li> <li>typical driving goals</li> <li>alternative transport modes</li> <li>...</li> </ul>
	Mastery of Traffic Situations	<b>Knowledge about</b> <ul style="list-style-type: none"> <li>traffic regulations</li> <li>traffic signs</li> <li>anticipation</li> <li>communication</li> <li>safety margins</li> <li>...</li> </ul>	<b>Risks associated with</b> <ul style="list-style-type: none"> <li>wrong expectations</li> <li>vulnerable road-users</li> <li>violations</li> <li>information overload</li> <li>unusual conditions</li> <li>inexperience</li> <li>...</li> </ul>	<b>Awareness of</b> <ul style="list-style-type: none"> <li>strong and weak points of manoeuvring skills</li> <li>subjective risk level</li> <li>subjective safety margins</li> <li>...</li> </ul>
	Vehicle Manoeuvring	<b>Skills concerning</b> <ul style="list-style-type: none"> <li>control of direction and position</li> <li>vehicle properties</li> <li>physical phenomena</li> <li>...</li> </ul>	<b>Risks associated with</b> <ul style="list-style-type: none"> <li>insufficient skills</li> <li>environmental conditions (weather, friction etc.)</li> <li>car condition (tyres, engine etc.)</li> <li>...</li> </ul>	<b>Awareness of</b> <ul style="list-style-type: none"> <li>strong and weak points of car control skills</li> <li>...</li> </ul>

		Knowledge and Skills	Risk-Increasing Factors	Self- Assessment
Hierarchical Levels of Driver Behaviour	Goals for Life and Skills for Living	<b>Awareness about relation between personal tendencies and driving skills</b> <ul style="list-style-type: none"> <li>lifestyle/life situation</li> <li>peer group norms</li> <li>motives</li> <li>personal values</li> <li>...</li> </ul>	<b>Risky tendencies like</b> <ul style="list-style-type: none"> <li>acceptance of risks</li> <li>high level of sensation seeking</li> <li>complying to social pressure</li> <li>use of alcohol and drugs</li> <li>...</li> </ul>	<b>Awareness of</b> <ul style="list-style-type: none"> <li>impulse control</li> <li>risky tendencies</li> <li>dangerous motives</li> <li>risky habits</li> <li>...</li> </ul>
	Driving Goals and Context	<b>Awareness about</b> <ul style="list-style-type: none"> <li>effects of journey goals</li> <li>planning and choosing routes</li> <li>effects of social pressure by passengers inside the car</li> <li>...</li> </ul>	<b>Risks associated with</b> <ul style="list-style-type: none"> <li>physical condition (fitness, arousal, alcohol, etc.)</li> <li>purpose of driving</li> <li>driving environment (rural/urban/highway)</li> <li>social context and company</li> <li>...</li> </ul>	<b>Awareness of</b> <ul style="list-style-type: none"> <li>personal planning skills</li> <li>typical driving goals</li> <li>alternative transport modes</li> <li>...</li> </ul>
	Mastery of Traffic Situations	<b>Knowledge about</b> <ul style="list-style-type: none"> <li>traffic regulations</li> <li>traffic signs</li> <li>anticipation</li> <li>communication</li> <li>safety margins</li> <li>...</li> </ul>	<b>Risks associated with</b> <ul style="list-style-type: none"> <li>wrong expectations</li> <li>vulnerable road-users</li> <li>violations</li> <li>information overload</li> <li>unusual conditions</li> <li>inexperience</li> <li>...</li> </ul>	<b>Awareness of</b> <ul style="list-style-type: none"> <li>strong and weak points of manoeuvring skills</li> <li>subjective risk level</li> <li>subjective safety margins</li> <li>...</li> </ul>
	Vehicle Manoeuvring	<b>Skills concerning</b> <ul style="list-style-type: none"> <li>control of direction and position</li> <li>vehicle properties</li> <li>physical phenomena</li> <li>...</li> </ul>	<b>Risks associated with</b> <ul style="list-style-type: none"> <li>insufficient skills</li> <li>environmental conditions (weather, friction etc.)</li> <li>car condition (tyres, engine etc.)</li> <li>...</li> </ul>	<b>Awareness of</b> <ul style="list-style-type: none"> <li>strong and weak points of car control skills</li> <li>...</li> </ul>

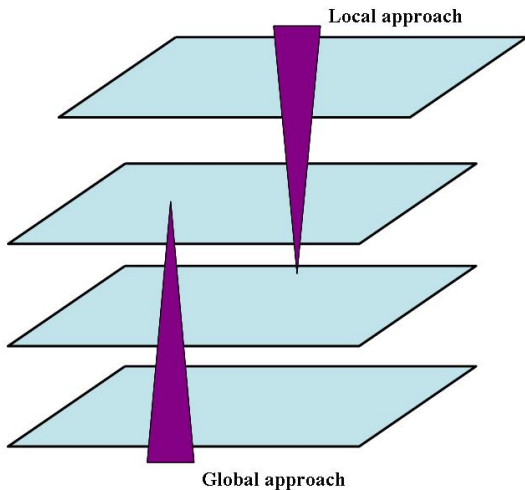
- Political
- ex: to be late
- Strategical
- ex: take the motorway

		Knowledge and Skills	Risk-Increasing Factors	Self- Assessment
Hierarchical Levels of Driver Behaviour	Goals for Life and Skills for Living	<b>Awareness about relation between personal tendencies and driving skills</b> <ul style="list-style-type: none"> <li>lifestyle/life situation</li> <li>peer group norms</li> <li>motives</li> <li>personal values</li> <li>...</li> </ul>	<b>Risky tendencies like</b> <ul style="list-style-type: none"> <li>acceptance of risks</li> <li>high level of sensation seeking</li> <li>complying to social pressure</li> <li>use of alcohol and drugs</li> <li>....</li> </ul>	<b>Awareness of</b> <ul style="list-style-type: none"> <li>impulse control</li> <li>risky tendencies</li> <li>dangerous motives</li> <li>risky habits</li> <li>....</li> </ul>
	Driving Goals and Context	<b>Awareness about</b> <ul style="list-style-type: none"> <li>effects of journey goals</li> <li>planning and choosing routes</li> <li>effects of social pressure by passengers inside the car</li> <li>....</li> </ul>	<b>Risks associated with</b> <ul style="list-style-type: none"> <li>physical condition (fitness, arousal, alcohol, etc.)</li> <li>purpose of driving</li> <li>driving environment (rural/urban/highway)</li> <li>social context and company</li> <li>....</li> </ul>	<b>Awareness of</b> <ul style="list-style-type: none"> <li>personal planning skills</li> <li>typical driving goals</li> <li>alternative transport modes</li> <li>....</li> </ul>
	Mastery of Traffic Situations	<b>Knowledge about</b> <ul style="list-style-type: none"> <li>traffic regulations</li> <li>traffic signs</li> <li>anticipation</li> <li>communication</li> <li>safety margins</li> <li>....</li> </ul>	<b>Risks associated with</b> <ul style="list-style-type: none"> <li>wrong expectations</li> <li>vulnerable road-users</li> <li>violations</li> <li>information overload</li> <li>unusual conditions</li> <li>inexperience</li> <li>....</li> </ul>	<b>Awareness of</b> <ul style="list-style-type: none"> <li>strong and weak points of manoeuvring skills</li> <li>subjective risk level</li> <li>subjective safety margins</li> <li>....</li> </ul>
	Vehicle Manoeuvring	<b>Skills concerning</b> <ul style="list-style-type: none"> <li>control of direction and position</li> <li>vehicle properties</li> <li>physical phenomena</li> <li>....</li> </ul>	<b>Risks associated with</b> <ul style="list-style-type: none"> <li>insufficient skills</li> <li>environmental conditions (weather, friction etc.)</li> <li>car condition (tyres, engine etc.)</li> <li>....</li> </ul>	<b>Awareness of</b> <ul style="list-style-type: none"> <li>strong and weak points of car control skills</li> <li>....</li> </ul>

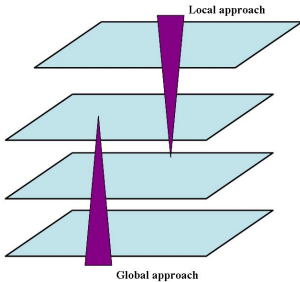
- Political
- ex: to be late
- Strategical
- ex: take the motorway
- Tactical
- ex: turn left

		Knowledge and Skills	Risk-Increasing Factors	Self- Assessment
Hierarchical Levels of Driver Behaviour	Goals for Life and Skills for Living	<b>Awareness about relation between personal tendencies and driving skills</b> <ul style="list-style-type: none"> <li>lifestyle/life situation</li> <li>peer group norms</li> <li>motives</li> <li>personal values</li> <li>...</li> </ul>	<b>Risky tendencies like</b> <ul style="list-style-type: none"> <li>acceptance of risks</li> <li>high level of sensation seeking</li> <li>complying to social pressure</li> <li>use of alcohol and drugs</li> <li>....</li> </ul>	<b>Awareness of</b> <ul style="list-style-type: none"> <li>impulse control</li> <li>risky tendencies</li> <li>dangerous motives</li> <li>risky habits</li> <li>....</li> </ul>
	Driving Goals and Context	<b>Awareness about</b> <ul style="list-style-type: none"> <li>effects of journey goals</li> <li>planning and choosing routes</li> <li>effects of social pressure by passengers inside the car</li> <li>....</li> </ul>	<b>Risks associated with</b> <ul style="list-style-type: none"> <li>physical condition (fitness, arousal, alcohol, etc.)</li> <li>purpose of driving</li> <li>driving environment (rural/urban/higway)</li> <li>social context and company</li> <li>....</li> </ul>	<b>Awareness of</b> <ul style="list-style-type: none"> <li>personal planning skills</li> <li>typical driving goals</li> <li>alternative transport modes</li> <li>....</li> </ul>
	Mastery of Traffic Situations	<b>Knowledge about</b> <ul style="list-style-type: none"> <li>traffic regulations</li> <li>traffic signs</li> <li>anticipation</li> <li>communication</li> <li>safety margins</li> <li>....</li> </ul>	<b>Risks associated with</b> <ul style="list-style-type: none"> <li>wrong expectations</li> <li>vulnerable road-users</li> <li>violations</li> <li>information overload</li> <li>unusual conditions</li> <li>inexperience</li> <li>....</li> </ul>	<b>Awareness of</b> <ul style="list-style-type: none"> <li>strong and weak points of manoeuvring skills</li> <li>subjective risk level</li> <li>subjective safety margins</li> <li>....</li> </ul>
	Vehicle Manoeuvring	<b>Skills concerning</b> <ul style="list-style-type: none"> <li>control of direction and position</li> <li>vehicle properties</li> <li>physical phenomena</li> <li>....</li> </ul>	<b>Risks associated with</b> <ul style="list-style-type: none"> <li>insufficient skills</li> <li>environmental conditions (weather, friction etc.)</li> <li>car condition (tyres, engine etc.)</li> <li>....</li> </ul>	<b>Awareness of</b> <ul style="list-style-type: none"> <li>strong and weak points of car control skills</li> <li>....</li> </ul>

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



- Political
- Strategical
- Tactical
- Operational



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 methods

# Summary

- 1 Introduction
  - ACC Project
  - Main problem
  - Original Idea
- 2 Previous works
  - GADGET Project
  - Study of Young, 2006
  - Others projects
  - Interest of associating
  - Association of the two methods
  - Our assumptions
- 3 **Tools**
  - **Contextual Graphs**
  - **Hidden Markov Models**
- 4 Methodology
  - Drivers typology
  - Driving situation
  - Identify errors
- 5 Results
  - Drivers typology
  - Definition of our scenarios
  - Conclusion

## Cognitive Sciences

- Contextual Graphs

## Machine Learning

- Hidden Markov Models

## Context definition

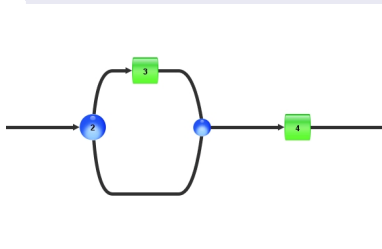
- (Brézillon and Pomerol): "that which constrains a focus without intervening in it explicitly"
- (1) context is relative to the focus,
- (2) as the focus evolves, its context evolves too
- 3) context is highly domain-dependent

## 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

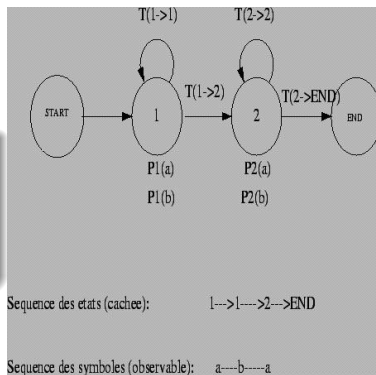
A3 : Give way to car on my right

NO

A4 : Priority crossing

## Hidden Markov Models

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



# Summary

- 1 Introduction
  - ACC Project
  - Main problem
  - Original Idea
- 2 Previous works
  - GADGET Project
  - Study of Young, 2006
  - Others projects
  - Interest of associating
  - Association of the two methods
  - Our assumptions
- 3 Tools
  - Contextual Graphs
  - Hidden Markov Models
- 4 **Methodology**
  - **Drivers typology**
  - **Driving situation**
  - **Identify errors**
- 5 Results
  - Drivers typology
  - Definition of our scenarios
  - Conclusion

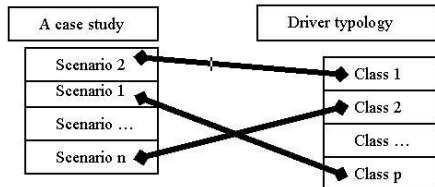
## First step

Make a typology by from a questionnaire

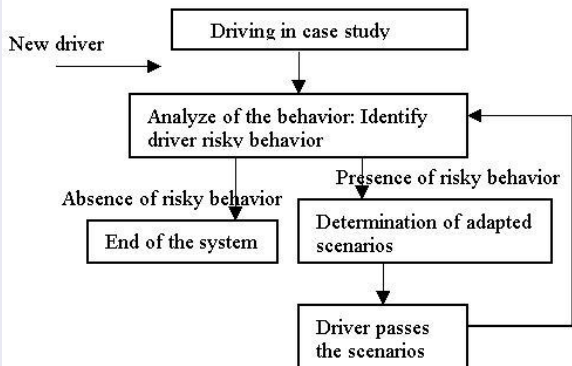


## Second step

Choose a driving situation



## The system architecture



## Started with GDE Matrix

- Completed
- Reorganized

## A questionnaire

- Questionnaire
- Make our typology thanks to the answers

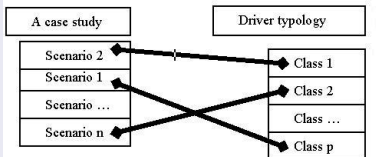
## Choose a driving situation

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



## Analyze of scenarios

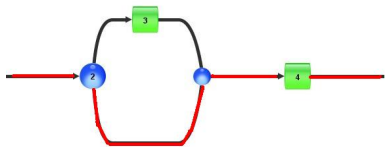
- Classify all these scenarios among our typology



By Machine learning

By HMM

By Cognitives Sciences



C2 : Is there a car on my right ?

YES

A3 : Give way to car on my right

NO

A4 : Priority crossing



# Summary

- 1 Introduction
  - ACC Project
  - Main problem
  - Original Idea
- 2 Previous works
  - GADGET Project
  - Study of Young, 2006
  - Others projects
  - Interest of associating
  - Association of the two methods
  - Our assumptions
- 3 Tools
  - Contextual Graphs
  - Hidden Markov Models
- 4 Methodology
  - Drivers typology
  - Driving situation
  - Identify errors
- 5 Results
  - Drivers typology
  - Definition of our scenarios
  - Conclusion

## Results

- Drivers typology
- Definition of all scenarios

## Started from GDE Matrix

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

	Knowledge and skills	Risk increasing factors	Self-evaluation
Skills for driving (general)	Knowledge about control over how life goals and personal tendencies affect driving behaviour - identify habits situation - aware group norms - motives - self-control, other characteristics - personal values	Risky tendencies - acceptance of risks - self-enhancement through driving - high level of sensation seeking - complying with social pressure - use of alcohol and drugs - phone, attitudes - towards society	Self-evaluation/awareness of - personal skills for impulse control - risky tendencies - safety-negative motives - personal risky habits
Driving goals and control (journey-related)	Knowledge and skills concerning - effects of journey goals on driving - planning and choosing routes - evaluation of required driving time - selection of social pressure inside the car - evaluation of necessity of the journey	Risk connected with - driver's condition (breast, DMC, etc.) - purpose of driving - driving measurement (translators) - social context and company - additional motives (competitive, etc.)	Self-evaluation/awareness of - personal driving skills - "time-driving" quest - special safety driving motives
History of traffic situations	Knowledge and skills concerning - traffic regulations - observation/selection of signals - anticipation of the development of situations - control ability performance - compensation - driving path - driving under difficult conditions - distance to adaptability margin - etc.	Risks caused by - wrong expectations - risk-increasing driving style (e.g. aggressive) - unsafe driving types - incorrect - vulnerable road-users - not obeying regulations - control ability performance - information overload - difficult conditions (weather, etc.) - insufficient automation - etc.	Self-evaluation/awareness of - driving and weak points - basic traffic skills - personal driving style - personal safety margin - wrong and weak points - the based situation - realistic self-evaluation - etc.
Vehicle manoeuvring	Knowledge and skills concerning - control of direction and position - tyre grip and friction - vehicle properties - physical phenomena	Risks connected with - insufficient automation - skills - variable speed adjustment - vehicle condition (weather, etc.) - etc.	Awareness of - driving and weak points of basic manoeuvring skills - wrong and weak points of skills for hazard situations - realistic self-evaluation - etc.

	Knowledge and skills	Risk increasing factors	Self-evaluation
Skills for driving (general)	Knowledge about control over how life goals and personal tendencies affect driving behaviour - identify habits situation - aware group norms - motives - self-control, other characteristics - personal values	Risky tendencies - acceptance of risks - self-enhancement through driving - high level of sensation seeking - complying with social pressure - use of alcohol and drugs - phone, attitudes - towards society	Self-evaluation/awareness of - personal skills for impulse control - risky tendencies - safety-negative motives - personal risky habits
Driving goals and control (journey-related)	Knowledge and skills concerning - effects of journey goals on driving - planning and choosing routes - evaluation of required driving time - selection of social pressure inside the car - evaluation of necessity of the journey	Risk connected with - driver's condition (breast, DMC, etc.) - purpose of driving - driving measurement (translators) - social context and company - additional motives (competitive, etc.)	Self-evaluation/awareness of - personal driving skills - typical driving goals - typical risky driving motives
History of traffic situations	Knowledge and skills concerning - traffic regulations - observation/selection of signals - anticipation of the development of situations - control ability performance - compensation - driving path - driving under difficult conditions - distance to adaptability margin - etc.	Risks caused by - wrong expectations - risk-increasing driving style (e.g. aggressive) - unsafe driving types - incorrect - vulnerable road-users - not obeying regulations - control ability performance - information overload - difficult conditions (weather, etc.) - insufficient automation - etc.	Self-evaluation/awareness of - driving and weak points - basic traffic skills - personal driving style - personal safety margin - wrong and weak points - the based situation - realistic self-evaluation - etc.
Vehicle manoeuvring	Knowledge and skills concerning - control of direction and position - tyre grip and friction - vehicle properties - physical phenomena	Risks connected with - insufficient automation - skills - variable speed adjustment - vehicle condition (weather, etc.) - etc.	Awareness of - driving and weak points of basic manoeuvring skills - wrong and weak points of skills for hazard situations - realistic self-evaluation - etc.

## Started from GDE Matrix

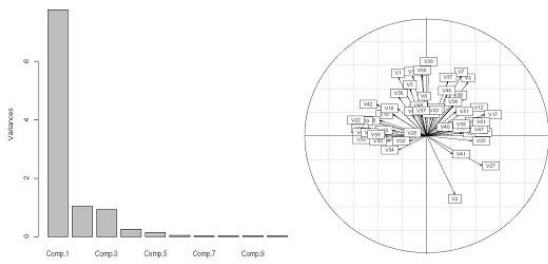
- Completed
  - Age,
  - Experience...
- Reorganised
  - Some repetitions
  - Reorganisation by type

	Knowledge and skills	Risks increasing factors	Self-evaluation		Knowledge and skills	Risks increasing factors	Self-evaluation
Goals for life and driving (overall)	Knowledge about/related over how life-goals and personal tendencies affect driving behaviour in specific situations (e.g. driving metrics) Characteristics other characteristics - personal values	Risky tendencies associated with self-enhancement through driving egoistic tendencies tendency to regulate negative emotions	Self-evaluation/ awareness of personal skills for regulation control egoistic tendencies tendency to regulate negative emotions	Goals for life and driving (overall)	Knowledge about/related over how life-goals and personal tendencies affect driving behaviour in specific situations (e.g. driving metrics) Characteristics other characteristics - personal values	Risky tendencies associated with self-enhancement through driving egoistic tendencies tendency to regulate negative emotions	Self-evaluation/ awareness of personal skills for regulation control egoistic tendencies tendency to regulate negative emotions
Driving peak and context (journey-related)	Knowledge and skills concerning effects of journey goals planning and requested routes evaluation of requested driving time effects of social pressure inside the car evaluation of necessity	Risks connected with driver's condition (stress, SAC, etc.) purpose of driving driving enjoyment (drive/relax) social context and company perceived time pressure, etc.	Self-evaluation/ awareness of personal planning skills type of driving goal perceived time pressure, etc.	Driving peak and context (journey-related)	Knowledge and skills concerning effects of journey goals planning and choosing routes evaluation of requested driving time effects of social pressure/pressure of necessity	Risks connected with driver's condition (stress, SAC, etc.) purpose of driving driving enjoyment (drive/relax) social context and company additional context and constraints (competitive, etc.)	Self-evaluation/ awareness of personal planning skills type of driving goal perceived time pressure, etc.
Mastery of traffic situations	Knowledge and skills concerning traffic regulations observation/selection of signals anticipation of the development of situations speed adjustment communication driving order etc.	Risks caused by wrong expectations regarding driving style (e.g. aggressive) vulnerable road-users unpredictable behaviour (drunkness, etc.) insufficient automation or skills	Self-evaluation/ awareness of strong and weak points of basic traffic skills egoistic tendencies personal safety margins strong and weak points of hazardous situations realistic self-evaluation	Mastery of traffic situations	Knowledge and skills concerning traffic regulations observation/selection of signals anticipation of the development of situations speed adjustment communication driving order etc.	Risks caused by wrong expectations regarding driving style (e.g. aggressive) vulnerable road-users not obeying regulations unpredictable behaviour communication breakdown difficult conditions driving order insufficient automation or skills	Self-evaluation/ awareness of strong and weak points of basic traffic skills egoistic tendencies personal safety margins strong and weak points for hazardous situations realistic self-evaluation
Vehicle manoeuvring	Knowledge and skills concerning control of direction and position tyre grip and friction vehicle properties physical phenomena	Risks connected with insufficient automation or skills predictable speed Approximate	Awareness of strong and weak points of basic manoeuvring skills speed and weak points Margins for hazard situations realistic self-evaluation	Vehicle manoeuvring	Knowledge and skills concerning control of direction and position variable speed tyre grip and friction vehicle properties physical phenomena	Risks connected with insufficient automation or skills unpredictable speed tyre grip and friction difficult conditions (low friction, etc.)	Awareness of strong and weak points of basic manoeuvring skills speed and weak points of skills for hazard situations realistic self-evaluation



## Results questionnaire

- Results among 419 participants
- Principal Component analysis



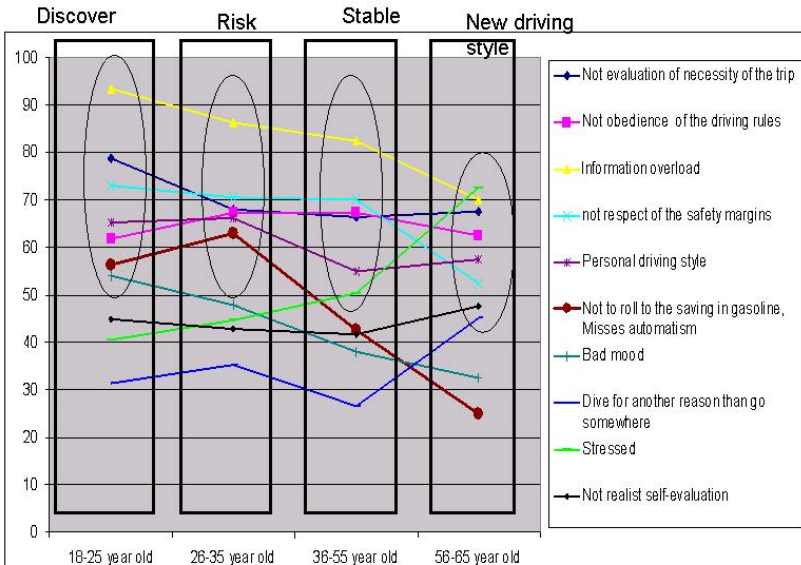
- Agglomerative methods
- 15 classes

## 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





## 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 instantiations
  - Integrity constraints
  - Inference rules

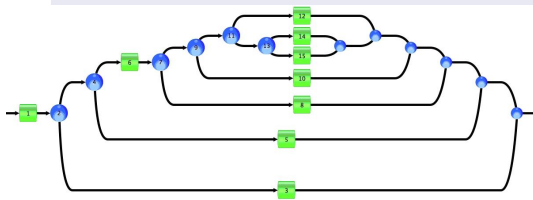
## Example

- Current focus = "Vehicle on the left-side road"
- Rule of normal behavior:  
IF "Vehicle" = "on my left"  
THEN I have priority
- Rule of integrity from relationships:  
IF "Vehicle" = "Police"  
THEN "Police" has priority  
IF "Vehicle" = "Priority"  
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 avoier 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