Institutionen för datavetenskap

Department of Computer and Information Science

Final Thesis

Correlational Analysis of Drivers Personality traits and Styles in a Distributed Simulated Driving Environment

By

Muhammad Hassan Abbas

Mati-ur-Rehman Khan

Thesis No: LiTH-IDA-EX-07/052-SE

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Titel
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Författare
Author

Mati-ur-Rehman Khan   and   Muhammad Hassan Abbas

Sammanfattning
Abstract

In this thesis report we conducted research study on driver's behavior in T-Intersections using simulated environment. This report describes and discusses correlation analysis of driver's personality traits and style while driving at T-Intersections.

The experiments were performed on multi user driving simulator under controlled settings, at Linköping University. A total of forty-eight people participated in the study and were divided into groups of four, all driving in the same simulated world.

During the experiments participants were asked to fill a series of well-known self-report questionnaires. We evaluated questionnaires to get the insight in driver's personality traits and driving style. The self-report questionnaires consist of Schwartz's configural model of 10 values types and NEO-five factor inventory. Also driver's behavior was studied with the help of questionnaires based on driver's behavior, style, conflict avoidance, time horizon and tolerance of uncertainty. Then these 10 Schwartz's values are correlated with the other questionnaires to give the detail insight of the driving habits and personality traits of the drivers.

Nyckelord
Keywords
Driver behavior, Driver style, T-Intersections, Self-report measures, Schwartz Value survey, NEO-FFI, Personality Traits

Dedication

In the name of Allah, the Most Gracious, the Most Merciful

Dedicated To our Parents

ix

Team Involved

Dr. Rego Granlund

Mati-ur-Rehman Khan

Muhammad Hassan Abbas

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ACKNOWLEDGEMENTS

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Abbreviations

GPS	Global Positioning System
ANOVA	Analysis of Variance
IVSS	Intelligent Vehicle Safety Systems
SIKA	Statens institut för kommunikations analys
LiU	Linkoping University
IDA	Department of Computer and Information Sciences
PET	Post Encroachment Time
TTC	Time to Collision
TET	Extended Time to Collision
TA	Time to Accident
GT	Gap Time
DTI	Distance to Intersection
NEO-FFI	NEO-Five Factor Inventory
DSQ	Driver Style Questionnaire
DBQ	Driver Behavior Questionnaire
DRP	Driver Risk Perception Questionnaire
OTS	On The Simulator Questionnaire
LCD	Liquid Crystal Display

Introduction

1. Introduction

The world population according to the U.S Census Bureau (http://www.census.gov/ipc/www/worldpop.html) is 6,605,046,992 and at the end of 2015 world population will be approximately 7,229,967,861. Due to this population increase the number of vehicles on the road is also growing in numbers, which leads to more traffic density and hence greater risk of accidents. Safety of the people is becoming more important and therefore more research and development is required in developing intelligent vehicle safety systems. These intelligent vehicle safety systems should be constructed on analyzed data, observations and statistics. So the study of driver's behavior on roads is an important step in understanding the causes of the accidents.

Statistics have shown that in 2005 a total of 1098 severe traffic accidents occurred in Sweden (SIKA 2006) and about half of them happened in intersections, so intersections are important in discovering the mistakes made by drivers and what countermeasures must be taken so that drivers avoid such mistakes. Hence study of driver's interaction with other drivers on intersection is very crucial in understanding the behavior of drivers in intersection and this study mainly focuses on the driver's interaction in intersection.

The intersection accidents are most commonly divided in to two categories that are cross path collisions and turning collisions. Cross path collisions are those collisions when two vehicles have been traveling on different roads and with crossing paths. These collisions made up 27% of all the accidents that occurs on the road. Whereas Turing collisions are those collisions when two vehicles have originally been traveling on the same road, in the opposite or same direction, and one or both vehicles have begun executing a turn. These collisions correspond to approximately 16% of all the traffic road accidents. And when these two categories are combined together they made up of 43% of all the road traffic accidents in Sweden.
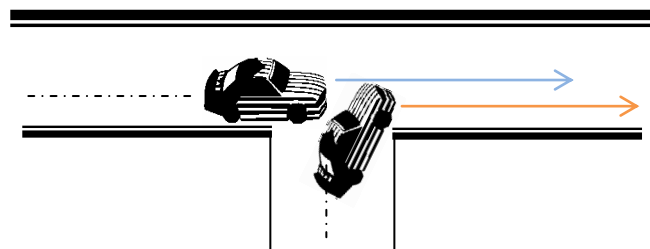
Figure 1: Crossing Path Collision
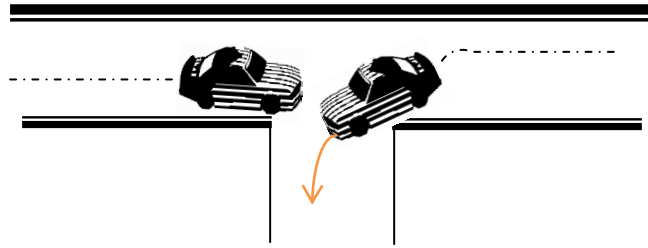
Figure 2: Turning Path Collision

From the statistical analysis of UK accident data it is found that 61% of all personal injury accidents occurred on intersections. In United States, the percentage of intersection accidents is 44% in reported accidents. Another study by Ragland and Zabyshny, 2003; Autoliv 2007 states that 50% of all pedestrian deaths and injuries are caused by intersections.

The study of statistical data and reports shows a large number of accidents are occurred on intersections, which drives us to perform experiments and make systems and methods to reduce or prevent the intersections accidents problems.

1.1.   **Objective**

The main idea is to study the behavior of drivers and how they behave when they come across intersections in real life. This study is performed by using a multi-user distributed driving simulator. In a simulated environment, we can observe the traffic safety rules easily and control the driver's environment without any risk of personal injuries and accidents. This study will perform a series of experiments by using drivers as subjects in the simulated driving environment. Each experiment consists of particular tasks and rules that should be followed by the drivers during the experiment. In between each experiment drivers were asked to fill out well-prepared and researched series of questionnaires, for providing information about the driver's behavior in daily life. A correlation analysis is performed with the gathered information from the questionnaires and drivers driving data. A statistical result will be prepared on the basis of correlation analysis to deduce some driving safety tips for intersection accidents.

2.   Literature Study

2.1.   **Simulator Research**

A traffic simulator can provide valuable information about driver behavior response in accident events that are simply too dangerous for any person to be exposed to. (Wedlin, 2004)

2.1.1. Types of Simulated Environments

There are two types of simulated environments, first one is moving based simulated environment and second one is fixed-based simulated environment. (Reed and Green, 1999)

2.1.1.1.   Moving Based Simulated Environment

A moving based simulator gives feedback from the steering wheel and the chair about how the car is moving in the simulated world.

2.1.1.2.   Fixed-Based Simulated Environment

This simulated environment gives no feedback from the steering wheel and the chair.

A validity study made by Reed and Green on fixed-based simulator and comparison with real world cars shows that fixed-based simulators has been found to be less precise than that of actual vehicles or moving-based simulators mainly due to the lack of motion queues.

Sideway steering precision was worse in the simulator as compared to a real car. However in Reed and Green study showed that participants were better at keeping a constant speed in the simulator as compared to real car. They claimed that it is most likely a result of the absence of wind and uneven roads.

The degree of importance of the simulator's validity can vary depending on the nature of study and ecological validity of the simulator. Advanced and expensive simulators may seem to be the best option but depending on the research question and the goal of study. One may be able to use a simpler simulator with less ecological validity and still get good results. More advance simulators should be used in those cases where the main focus is to get the realistic feeling of driving and that the ecological validity must be high. Whereas if the main focus is on the behaviors in a driving environment, then a less advance simulator might me suffice (Santos et al., 2005).

Reed and Green study shows us that fixed-based simulators are usable tools when it comes to study of human behavior in traffic, and they show a high absolute validity on

speed control but shows an overall low absolute validity. At the same time they show a high relative validity on the driving accuracy. A fixed-based simulator has generally low absolute validity and high relative validity.

Santos' et al. (2005) study on driving behavior using a simulator compared and evaluated a standardized visual performance test in three different environment's laboratory, simulator and instrumented vehicle. The goal of study was to assess the suitability for each test environment for testing the effects of In-Vehicle-Information-System on driving performance.

Simulator results couldn't be applied to the real world whereas they gave an enormous strength to the experimental design. A comparison between simulator and the instrumented vehicle with self report data indicated that the level of seriousness, of potential effect with respect to traffic safety, was lower in the simulator compared to the instrumented vehicle. Despite this the study provided a good first insight to the vehicle development industry for the improvement of assessing and designing for example safety systems.

A study made by Hancock and de Ridder (2003) on accident avoidance behavior in a controlled simulated environment, focus on the final seconds and milliseconds before a collision. There simulated environment was constructed so that drivers could be seated in two full vehicle simulators and interact within the same simulated world. That setup meant that they could create simulated situations that could evoke responses paralleling those observed in real world situations. In the experiment, a total of 45 participants were tested within the virtual world. Two ambiguous traffic situations were created for the driving participants, who crossed path with each other in the simulated world. Those situations were an intersection and a hill. In the intersections the two drivers met by approaching each other from an angle of 135 degrees. Objects blocked their views to keep both drivers from detecting each other early in the scenario, where as the hill scenario represented a wrong way conflict. Qualitative results were obtained through post experience questionnaires about the participant driving habits, simulated experience and their response to specific experimental events. Their study shows that situations with realistic avoidance response behavior can be created and replicated in a simulation environment. Hancock and de Ridder (2003) methodology is used in our research.

2.2. **Factors influencing safety**

People's behavior and performance is affected by several factors of daily life. In particular case of traffic safety, it is prohibited to drive a car after taking alcohol or other drugs. Jeffery Archer (2005) explains internal and external factors like stress, fatigue, social psychological factors such as attitudes, social cognition, biases and norms and

personality factors of daily life which can affect a person's behavior during driving. Swedish Road Authority (SRA, 1996) has also identified human functions that are critical for safe driving. SRA points out that stress, strain, tiredness, alcohol, medication as factors which can have a serious negative effect on driver performance. They also identified that inexperienced and incorrect attitudes of drivers can be potential problem areas with regard to safety. The factor's which can be important from research point of view and can be studied during simulated research involves drivers attitude and stress about the task and effect of this on the driving parameters.

2.2.1. Effect of Stress on driving behavior

According to Hennessy and Wiesenthal (1999) many traffic accidents occur due to stress or aggression in the driver's behavior. The reason of person's in stress may be due to the problems of job or home or time pressure. A stress condition during driving can make the person behavior aggressive on the road, as a result can be a cause of accident. Hennessy's and Wiesenthal (1999) research examine the difference between the stress and aggression state of driver's in high and low congestion conditions. The results of the study shows a high level of stress and aggression in the driver's in high congestion conditions. It is noticeable that time factor was main cause of stress in high and low congestion conditions, and aggression was the cause of stressful behavior in high congestion conditions.

Howard and Joint (1994) discuss the relation between stress and fatigue in driving. They say that long distance driving becomes the cause of fatigue for drivers whose minds are busy in thinking something else while they are driving. Those drivers are driving without awareness. This fatigue can cause stress in drivers, which is a result of concentration of mind in other things during driving. It is seen that when you are concentrating on other things during driving, distraction can occur easily. This distraction during the driving can be dangerous and hinders the driver's concentration during driving and cause accidents.

This study proves that stressful conditions can affect a persons driving behavior, yet this research is not opted to create stress less behavior.

2.2.2. Variations and traffic velocity

A connection between the variability of the vehicles speed and road safety is discussed by Solomon (1964). There is a deep connection between speed of the vehicles and traffic safety. Speed reduction helps to improve safety on roads. Solomon in his paper discusses relationship between crash risks and variability in speed i.e. sub-optimal interaction in present in traffic streams by different speeds of the vehicles.

Solomon study shows research of 10,000 crash reports in 35 sections of rural highways between 1955 and 1958. He shows that pre-crash speed of vehicle was determined by police, the driver himself or the witnesses of the crash sites. Solomon study involves the calculation of 290,000 vehicles speeds on each of the 35 sections of rural highways. He than calculated the mean speed for each of the 35 sections. While doing the comparison of the speed of the vehicle during the crash with means speed of particular road section Solomon found that crash-involvement rate was higher when vehicle drove faster or slower than the mean speed of the particular section. And the crash-involvement rate was rather low where mean speed is close to the vehicle speed.

The accidents occurring at mean speeds below average could be because of numbers of intersections and driveways on the crashes spots stated by Frith and Patterson (2001). Those points may be the reason for congestion on the roads. Solomon also states the same consideration, with reference to other places which also share the same point that intersections and other access points are reason for large number of accidents. So it is not correct to conclude that only high or low speed on highways can be a factor for accidents occurrence, also low speeds at intersection may also cause accidents to occur.

 In the Solomon's study results 46% of the totals are low-speed crashed, 51% were rear-end crashes and 38% were angle crashes. The accidents occurring at intersections and congestion conditions at rear-end. Driving with high speed are cause accidents to occur more frequently.

"The smaller the variation within the stream, the smoother and safer the traffic flow will be." (p. 6) said by Frith and Patterson (2001). A study about New Zealand in Frith and Patterson (2001) tells us that if the mean speed is lowered the variation in the traffic is decreased. This takes us to the conclusion that the reduction in speed variation takes us to the traffic safety. For decreasing the variability in the traffic velocity, we can make the slow moving drivers drive fast or fast moving drivers drive slow. Later case is the best option, as fast driving can lead to more accidents, so it is better to reduce there speed.

This shows that traffic velocity has significant role in the traffic safety. In simulated environment traffic velocity can be enforced easily with the help of simulation experiments, which is the reason of including range of traffic velocity in our experiments.

2.2.3. Violation of expectations

Anticipated behavior of other people is expectation. During communication it can be generalized or person specified. Expectancy violation theory can be used to examine effects of expectations. According to this theory, other people expect the communication behavior from others and violation of their expectations lead to a cognitive evaluative

process that results in either a positive or negative evaluation of the perceived outcome. Following are the factors that affect the outcome, according to the expectation violation theory: target characteristics, relationship characteristics and context features.

Theory of expectancy and Theory of expectancy violation provides support to study the behavior changes occur due to the changes in perceived and expected behavior. In order to study changes in behavior, differences in expectations are created by e.g. manipulation of instructions. Expectancy violation theory according to Bonito et al. (1999) "…*is concerned with the degree to which expectations frame behavior and the consequences of such framing on interaction and task outcomes*" (p. 231). Interpretation and evaluation of violation of expectations is a very important issue of expectancy violation theory. Positive or negative valence is assigned during the characterization of violations. Positive violation are socially valued behavior that exceeds the quality of anticipated actions, while on the other hand negative violations are relatively undesirable acts that fall short of expectations.

In 1976 Burgoon introduced the theory of expectation violation. It was at that time used at theory of non-verbal behavior. This theory is specific towards theory discourse and interaction and also considered as theory of communication processes. Burgoon and Le Poire, (1993) presented their study "*Affect of communication expectancies, actual communications, and expectancy disconfirmation on evaluations of communicator and their communication behavior*" and Bonito et al. (1999) presented "*The role of expectations in human-computer interaction*" both uses those theories in their studies. The study by burgoon and Le Poire shows changes in expectations due to different factors. Bonito et al. (1999) study shows support of expectancy violations theory's premises and predictions. The study by Bonito et al. (1999) shows the decision making tasks difference when people are interacting with the human partners or compute agents. Influence and perceptions of partners are affected by expectations and evaluations which are shown by correlation analysis of five different computer conditions.

In our experiments, drivers expectation are analyzed by providing them different instruction sets to see if it would create deviations of expectations, so to view a change in the driving behavior of the drivers.

2.3. Conflict Indicating Variables

A traffic conflict may result in a collision if the traffic participant would have continued with the same speed and direction. It is always desired to be able to predict the probable accident or collision by finding different factors involving the collision. Conflict indicator variables are set of those factors which can be used to identify the circumstances where an accident is about to be happen. For the analysis work, these

variables have lot of importance in order to draw useful outcomes. It is possible to get these details from the simulated environment with respect to the each participant and analyze his behavior. Conflict indicator's classification depends on its handling in a specific safety situation.

Conflict variables can be calculated using two types of method.

- Objective Methods
  These methods feature time distance and speed to calculate the severity of the safety situation.

- Subjective Methods
  These methods are dependent on human observation, who records the perceived risk at the moment of conflict. It is also possible to use a video observation from a fixed camera

To be able to get better result the combination of the mentioned methods may be used (Lu et al., 2001). The merging of these methods results an appropriate risk value.

The usefulness of these variables can be classified by evaluating the following three criteria (Svensson 1998):

1. *Indicators should complement accident data and be more frequent than accidents*

2. *Indicators have a statistical and causal relationship to accidents*

3. *Indicators have the characteristics of 'near-accidents' in a hierarchical scale that describes all severity levels of driver interaction with accidents at the highest level and very safe passages with a minimum of interaction at the lowest level.*

Some of the variables which are relevant for the current study are described as under.

2.3.1. Time to Collision (TTC)

In studies related to Traffic Conflicts Techniques, Time-To-Collision (TTC) has been considered to be a valuable measure for rating of traffic conflicts' severity and to differentiate between critical and normal behavior.

Hayward (1972) defined TTC as: "*The time required for two vehicles to collide if they continue at their present speed and on the same path*". TTC continue to be decrease if there is no change in speed and path. Disadvantages of TTC according to Archer are that it does not clarify the sternness of a traffic situation   and not a good measure for comparison.

2.3.2. Extended Time to Collision (TET, TIT)

Two alternative to proximal safety indicators have been proposed by Dutch researchers Minderhood and Bovy (2001) on the basis of general principles of the Time-to-Collision concept. These are Time Exposed TTC (TET) and Time Integrated TTC (TIT).For the period where TTC-event remains a chosen TTC-threshold TET is used to calculate the time of that period. On the other hand TIT referred to as Time Integrated TTC (TIT), is similar to the TET but it represents a measure of the integral of the TTC-profile during the time it is below the threshold.
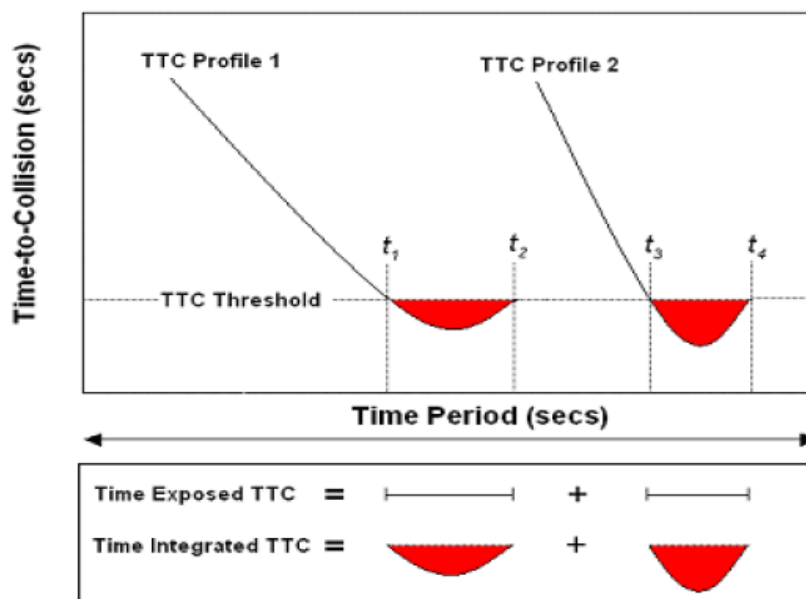
Figure 3: The Time Exposed and Time Integrated TTC proximal safety indicator measures proposed by Minderhoud and Bovy (2001)

2.3.3. Time to Accident (TA)

Time to Accident is a Safety indicator measure which based on a subjective estimation of speed and distance for conflicting road-users at a common conflict point. The Time-to-Accident measure is recorded only once at the time when evasive action is first taken by a conflicting road-user. TA-values are used in determination of the scale of conflict seriousness accordance with a threshold function (Archer 2005).

2.3.4. Post-Encroachment Time (PET)

Post-Encroachment Time (PET) is the further variation of TTC. PET is used to measure in situations where two road-users, not on a collision course, pass over a common spatial point or area with a temporal difference that is below a predetermined threshold (Archer 2005) (typically 1 to 1.5 seconds).

The main difference between PETs and TTCs is the absence of the collision course criterion i.e. even if no collision occur PET value can be calculated. PET's can be easily extracted using photometric analysis, video or simulated environment, than TTC as with TTC relative speed and distance data is required. It represents time difference between the passage of the "*offended*" and "*conflicted*" road-users over the area where collision may occur. This makes PET a useful objective and less resource-demanding in contrast of TTC's data extraction process. It is so as PET does not involve recalculations at each time-step during a conflict zone or safety warning zone (Archer 2005).

On the other hand the PET-concept is only useful in the case of transversal (i.e. crossing) trajectories in safety critical events. TTC- concept suits for events with similar trajectories. PET-measurement are done on a fixed projected point of collision, rather than one that changes with the dynamics of the safety critical events.

Small PET values indicate that two vehicles have a short distance to one another, whilst zero PET values indicate a collision between two vehicles. Thus PET is a measure of how nearly a collision has been avoided. These considerations led us to adopt PET as our measure of when an incident has or may have occurred, and thus we can draw conclusions about driving behavior in intersections.

2.3.5. Gap Time

If the road user continues with the same velocity and trajectory then the time lapse between the completion of an approaching by a turning road-user and the arrival time of a crossing road-user is known as Gap Time (GT).

The 'Gap Time' concept estimates the time of arrival at the potential point of conflict in spite of the actual time difference. It relies on a measure at the point when evasive action is first taken. While this accounts for the effect of braking by a secondary vehicle the elementary nature of the original PET concept is lost as resource demanding measures of both speed and distance are required during data extraction process (Archer 2005).

2.4. Self-report measures

2.4.1. Schwartz's Configural Model

Different questionnaires were obtained to gather information about the behavior, personality, religious beliefs of the participants. One of the most authentic and reliable questionnaire was of Schwartz value survey. It was used for correlation of the Schwartz value survey with other questionnaire values such as NEO Five Factor Inventory.

In 1990 Schwartz formulated a theory describing the universal content and structure of values (Schwartz Value Survey). He (1992, 1994) described a model that gives a detail

insight on the basis of empirical cross-cultural studies (Schwartz, 1992; Schwartz & Bilsky, 1987, 1990). Values were defined as desirable transsituational goals, varying in importance, that serve as guiding principles in the life of a person or social entity (Schwartz, 1994, p. 21) (Schwartz Value Survey).

Three universal requirements were thought to be at the root of values: needs of individuals as biological organisms, requisites of coordinating social interaction, and requirements for the functioning of society and the survival of groups. From these three basic goals, 10 motivational value types were derived; they are described in the table 1.

Value type	Symbol	Description
Self Direction	SD	Independent thoughts and actions; autonomy and independence.
Stimulation	ST	The organismic need for variety, excitement, novelty, and challenge.
Hedonism	HE	Pleasure or sensuous gratification for oneself.
Achievement	AC	Demonstrating competence to obtain social approval; the focus is social esteem.
Power	PO	Attainment of social status and prestige, and control or dominance over people and resources; the focus is social esteem.
Security	SE	Safety, harmony, and stability of society, of relationships, and of self.
Conformity	CO	Self-restraint in everyday interaction; restraint of actions, inclinations, and impulses likely to upset or harm others and violate social expectations or norms.
Tradition	TR	Respect, commitment, and acceptance of the customs and ideas that one's culture or religion imposes on the individual.
Benevolence	BE	Concern for the welfare of close others.
Universalism	UN	Understanding, appreciation, tolerance and protection of the welfare of all people and for nature.

Table 1: Value types and descriptions of the Schwartz value survey

In total there were 57 questions which are graded using a nine-point scale by rating each one according to the importance of the values as the guiding principle of the participant life. The "-1" rating stands for a value which highly oppose the beliefs and "7" as the most or of supreme important principle of life.
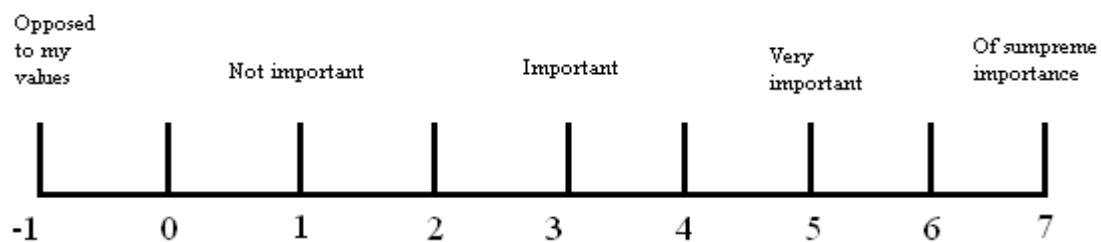
Figure 4: Grading scale used in the Schwartz value survey

Schwartz also identified the dynamic relations among them. For that purpose he analyzed data using Smallest Space Analysis that represents values as point in a multidimensional space where the distance shows their empirical relations. Figure 3 shows the generated model. Circular shape represents that boundaries are more seen as continuous than discrete and values which are more close to each other are compatible where as values opposite of one another are most in conflict.

Figure 5: Relational Value Model

2.4.2. NEO Five Factor Inventory (Neo-FFI)

NEO Five Factor Inventory is used to measure the personality traits. There are said to be Big Five model, these big five are the five domains of the adult personality. These are Extraversion, Agreeableness, Conscientiousness, Emotional stability and Openness (Costa and McCrae, 1992). This model is widely used to get the better understanding of the differences between the different subjects or individuals. NEO Five Factor Inventory is described in the table below.

Extraversion	Confidence and self-assuredness
Agreeableness	Willingness to get along with people who are different or have different opinions.
Conscientiousness	Punctuality and following through commitments.
Emotional stability	In control of emotions.
Openness	Intellectual curiosity and openness to experience.

Table 2: Neo-FFI description

In our questionnaire there are total of 60 questions, which are graded by the scale shown below in the table.

1. Strongly disagree	2. Disagree	3. Neither disagree nor agree	4. Agree	5. Strongly agree

Table 3: Scale for Neo-FFI questionnaire

Here in the scale "1" is the most negative value and "5" is the most positive value.

2.4.3. Questionnaires on conflict avoidance, time horizon and tolerance of uncertainty

In Smith's et al (2007) study several questionnaires were used to see the involved cooperation and decision making in micro worlds and cultural differences. These questionnaires are on conflict avoidance, time horizon and tolerance of uncertainty. These questionnaires used the same scale mentioned above in Table 2.

In conflict avoidance there are 23 questions in total, these questions assessed the person's ability to react to conflict. The tolerance of uncertainty instrument consists of 24 items that assessed the degree of comfort in decision making situation with incomplete information or in an unfamiliar situation. In time horizon there are 18 questions, these question assessed how far people plan in advance, the time frame of their goals, and how far ahead they look to justify their actions.

2.4.4. Questionnaire on Locus of control

Rotter (1966) developed Locus of control questionnaire, it consists of 13 questions. It measures locus of control of the participants or people that it is either internal or external. People with internal locus of control have a strong belief that their own actions determine their success in life where as on the other hand people with external locus of control believe that there is a hand of nature that control the larger degree of their actions and that their own behavior does not matter as much.

In locus of control there were two statements and participant has to select one of the two statements which he or she feels correct.

2.4.5. Driver Behavior Questionnaire (DBQ)

Driver Behavior Questionnaire was first developed at the University of Manchester, in United Kingdom. This questionnaire gives a detail insight of the driving habits of the driver during driving. There are three main types of driving behaviors, and all the questions in the questionnaire belong these three categories.

- Lapses – absentminded behaviors with consequences for the perpetrator while not threatening to other road users.

- Errors – Typically misjudgments and failures of observation that may be dangerous.

- Violations – Deliberate actions that break against norms and rules in traffic.

In Driver Behavior Questionnaire there were total of 24 questions and participants were required to indicate on a 5 point-scale (shown in Table 4) how often they indulged in the proposed behavior.

Hardly ever	Occasionally	Quite often	Frequently	Nearly all the time

Table 4: the driver behavior questionnaire Scale

2.4.6. Driver Style Questionnaire (DSQ)

Driver Style Questionnaire was also first designed in United Kingdom as a tool to judge the drivers style of driving. The questions in DSQ can relate to six different factors of driver style, these are described as under:

- Focus – The ability to drive cautiously and ignore distractions.

- Calmness – The ability to stay calm in dangerous and quick-paced situations.

- Social resistance – The driver's preference for being given advice about driving   abilities.

- Speed – Whether the driver drives fast and/or over the posted limit.

- Deviance – Whether the driver's behavior are inconsiderate and dangerous.

- Planning – Whether the driver tend to plan ahead before setting out for a trip.

These questionnaires was created in such a way that it includes questions about behavior related to accidents, decision-making styles and reactions to advice that other gives them.

2.5. **Data Analyzer Study**

The simulator was configured so that it collected the relevant data for this project. During the session all four simulator did record all real time data that was defined in the configuration.

To analyze the data we constructed a Java based analyzer program. The analyzer was based on the analyzer being developed by the previous group (Sanna, Natalia, Fredrik ,Patrik   2007)   which   was   working   on   this   project.

3. Research Questions

In this simulated research, we have tried to foresee the behavior of drivers while driving in a simulated environment. Behavioral analysis was based on pre-research questionnaires by Schwartz and Other researchers. We have chosen three hypotheses in relation to the aims and goals of this research.

The research question is the diversity in the drivers' behavior on the basis of their personal traits.

H0: Drivers with more desire of power and achievement has more aggressive and impatient nature while driving.

H1: Drivers with helping and caring traits are more focus towards smooth and careful driving to avoid accidents.

H2: Drivers which have high tolerance for uncertainty tends to have more self-control in uncertain situations.

To assess whether these hypotheses fit into one's personality and affect the driver's behavior, drivers were asked to fill out questionnaire during their driving sessions. The data from the questionnaires was collected from 48 persons. If the analysis with from the data support our hypothesis we can say it is true to some extent otherwise we negate   our   hypothesis.

4.   Method

The implementation of the project was conducted by the help of four multi-user driving simulators that were located at IDA at LiU. Each experimental session lasted for approximately two and a half hours. The participants also filled out several questionnaires. These were used to examine if certain personality types correlate with PET data. The total experimentation period lasted for two weeks. The subjects were from different parts of the world having different nationalities.

4.1.   Participants

A total of 48 participants were selected through posters put up all over IDA, Linkoping University. A valid driver's license was a requirement for participation. T2he participants were mostly students at the Linkoping University. The mean and standard deviation of the participants' age and driving experience in years is also calculated.

	Women	Men
Mean, age	23.28	26.85
Standard deviation, age	2.36	9.51
Mean, Driving experience	4.33	1.93
Standard deviation, experience	8.74	9.59

Table 5: The mean and standard deviation of participants' age

and driving experience in years

4.2.   Simulated scenario design study

The simulated scenario design study is based on the apparatus used and the mode of experimentation.

4.2.1.   Apparatus

There were four driving simulators installed at the Department of Computer and Information science at Linköping University. No driver was able to see the other driver.

Figure 6: The driving simulator at LiU/IDA.

Figure 7: One of the driving simulator stations.

4.2.2. The Simulator

There were four driving simulators installed and interconnected on a Local Area Network at the Department of Computer and Information science at Linkoping University. This driving simulator is able to extract and capture the driving patterns of the real and autonomous drivers.

It is upto the experimenter to decide the number of autonomous vehicles and can be generated easily. Driver's behavior and Driving Patterns, such as speed, acceleration,

lane position, distance to intersections and many more can be captured with the help of the scripting language.

The simulator application, the world design tool and the data processing tool was developed by the Dutch company STsim and the graphics engine was based on the Open Scene Graph high performance 3D open source graphics tool kit.

Three of the four simulators had 32" Samsung LCD screens and one had the smaller 19" Samsung LCD to display. The main application was equipped on a Dell machine which was used to control the driving environment.

The steering wheel that has force feedback, the pedals and gearbox were manufactured by Logitech and were the same for all four stations. The sound was also from Logitech and headphones for each of the driver to avoid mixing of noises.

4.2.3. The Simulated Environment

Our study involves simulated world and creation of scenarios very close to the reality. Reality involves that the driver feels comfortable with the environment, vehicles coordination and respecting the rules. The Sävenäs intersection (see figure 6) was reproduced in the driving simulator is an un-signalized T-intersection in the outer parts of Gothenburg. The reason behind selecting this intersection was due to the heavy traffic load on it causing road traffic accidents. Another major reason for selecting the Sävenäs intersection is that the buildings and vegetation around the intersection block the drivers' view earlier studied by Hancock and de Ritter (2003).

The road slopes around the actual Sävenäs intersection could not be implemented in the simulated world due to the limitations in the simulator. The other elements of the intersection were represented in a realistic manner.

Figure 8: The Sävenäs intersection

There were four different scenarios in our study, in which a driver was analyzed. There were total of four real and eight autonomous cars making a grand total of twelve cars in a single scenario. The driving speed was 50 km/h for the autonomous cars and the speed limit was the same for the real drivers. Scenarios were designed to find the changes in the behavior of the driver. The proposed scenarios were:

- Scenario A: World with the *Traffic Light* and *voice based command system (GPS).*

- Scenario B: World with the *Traffic Light* but without the GPS.

- Scenario C: World with the GPS but no *Traffic Light functionality*.

- Scenario D: No Traffic Light and GPS functionality.

	With Traffic Light	Without Traffic Light
With GPS	*A*	*B*
Without GPS	*C*	*D*

Table 6: Summary of Scenarios used for experimentation

The traffic light and the voice based command (GPS) system were implemented in order to help the drivers to meet at the intersection so that we can get more relevant data. The implementation was achieved using the scripting language provided by the simulator.

The first step involved the designing the simulated world using the simulation software (stRoadDesign by STSoftware) for simulated world designing. It was important to have T-intersections in our simulated world. All the scenarios were implemented on the same world shown as under:
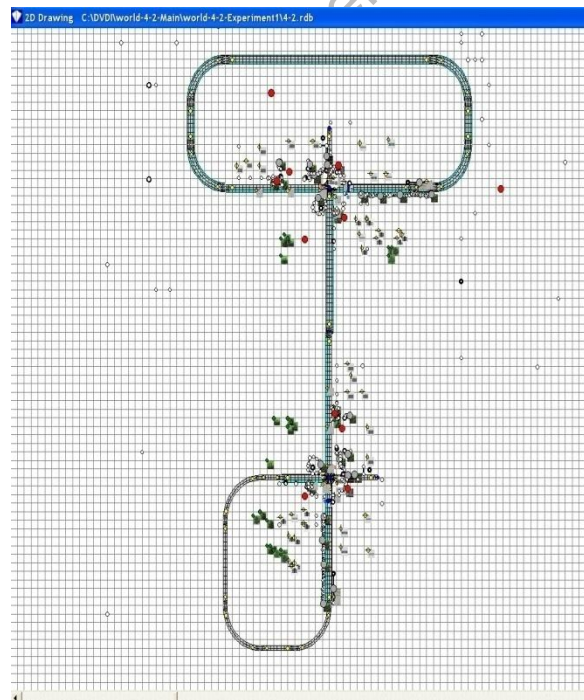
Figure 9: Grid view of the world used

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Figure 10: Simulated World for experimentation

Although the world was same for each scenario, STScenario scripting language was used to implement Traffic Light and the GPS.

Traffic light and GPS were introduced in the world to make it possible that driver intercept each other more frequently at the T-intersection. Traffic Light was controlled with respect to the position of vehicles. Along with the STRoad Design and STScenario, STControl is used to control the environment in the simulated world on each of the simulator.
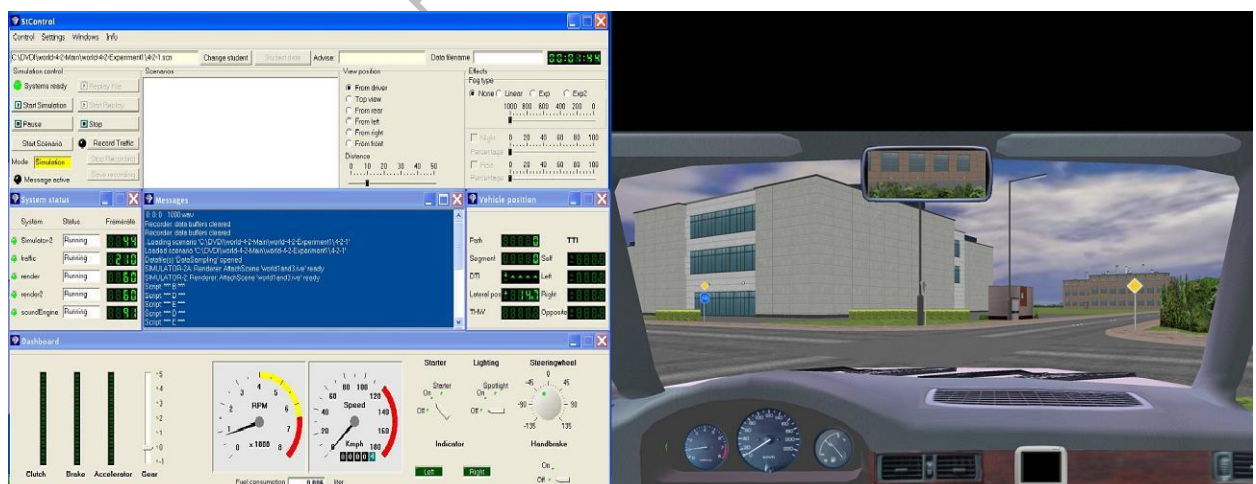
Figure 11: STControl for displaying the environment information

The order of scenario presentation was shuffled across all the 12 experimental groups. This was done to decrease the perplexing variable of driving the same session before another. Table 7 shows the order of the scenarios for each experimental group.

Experimental group	Scenarios Order
1	ABDC
2	BCDA
3	CDAB
4	DABC
5	ACBD
6	CBDA
7	BDAC
8	DACB
9	ADCB
10	DCBA
11	CBAD
12	BADC

Table 7: The order of scenarios

4.3. Tasks

In each session the participants were assigned a task to generate a purpose for their driving and to make them more eager to explore the world. The task was different in each of the four sessions. The drivers had to collect a number of signs (words) collectively forming a sentence. The sentence is a part of a song which were tokenized randomly.

Method

Sentences
Session A:
Meet you downstairs in the bar and heard
Your rolled up sleeves and your skull t-shirt.
Session B:
Hey baby, when we are together, doing things that we love.
Every time you're near I feel like I'm in heaven, feeling high.
Session C:
Every night in my dreams i see you, i feel you that is how I know you go on far across the distance and spaces between us.
Session D:
"I'm Alive"
When you call on me
When I hear you breathe.

Table 8: The sentences
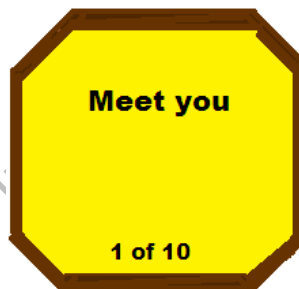
Figure 12: One of the signs

The signs were placed randomly in each of the world. The drivers had to drive through the world according to the requirements of the session and collect the signs. They had to pull off the road, giving way to other traffic, on the side walk to stop and write down each of the sign.

4.4. **Questionnaires**

Twelve different questionnaires were used to collect the participants' information, their subjective responses to questions concerning demographic variables, personality variables, value structure, risk attitudes and driving patterns (Reference: Section 2.4).

0	Personal Information
1	Demographic
2	Neo – FFI
3	Schwartz value survey part 1
4	Schwartz value survey part 2
5	Time Horizon
6	Tolerance for uncertainty
7	Conflict avoidance
8	Locus of control
9	Driver style
10	Driver behavior
11	Debriefing

Table 9: The fixed order of questionnaires

4.5. **Procedure**

A group of four participants were called upon on a single occasion. Four experimenters were there during the experiment sessions. The experimenters loaded the correct scenarios and helped the subjects in case of any problems. The experiments also monitored the subjects for careless driving.

The participants when arrived for the experimentation, they were asked to take a simulator. The set of printed instructions along with the consent form was given to all of the participants. One of the experimenters' read the instructions loud about the experiments and the sessions. The written instructions in English were also being provided to each of the participant. The participants were then asked to fill in the personal information questionnaire.

The participants had to start off with a practice session lasting 10 minutes so that they can get familiar with the driving environment. Experimenters helped each participant during the practice session so that they can drive properly. After the practice session the regular sessions were started along with a series of questionnaires to fill in.

4.5.1. The Cycles

The main experimental trial consisted of 4 sessions as described earlier in Table 6. Each cycle was followed by a series of questionnaires. The participants were given instructions about the upcoming sessions verbally by the experimenter. The participants had to listen to the instructions about the specific session using scripting within the session.

The participants were not allowed to talk between the sessions although they could ask the experimenter if they had any problems related to the sessions. A short coffee break was given after the second cycle. The length of the break varied between 15 to 25 minutes. The participants had to drive two more sessions after the coffee break. The total time of all the sessions was about 2 hours and 30 minutes. The participants were provided with a cinema ticket as thank you gift in the end.

4.5.2. Pilot Study

A pilot study was conducted with the first four participants before calling on other participants. There were a number of flaws identified in the time of the practice session and the instructions for driving the car. The errors were then fixed for the next experiments. As a result the practice session was prolonged for 10 minutes in total whereas the instructions for driving a car were provided in black and white.

4.6. Data Collection

The Data Analyzer was developed using Java in order to collect the relevant PET, speed, acceleration and lane position variables from the data collected. The chosen data from the sessions contained statistics from within 30 meters of the Sävenäs based intersections.

The PET was calculated if two vehicles were both within 30 meters of the centre point of the intersection at the same time. The PET algorithm worked only when one of the vehicles made a left turn, a right turn and when those vehicles had entered the intersection in different lanes. The predetermined threshold for calculating PET-values was set to 10 seconds i.e. we are not analyzing PET values above 10 seconds (Patrik 2007).

5. Analysis and Discussion

5.1. Correlation between Schwartz's Value Surveys and Questionnaires

Schwartz's Value Survey (Appendix C), consists of 57 human values that are formed into ten broader types. These reflect three universal human requirements: 1) biological needs, 2) needs for social coordination, and 3) need for group welfare and maintenance (Smith et al., 2006). During the experiments drivers were asked to fill Schwartz's value surveys, which will help us to have an insight view of personality traits. Other questionnaires related to the participant's personal driving behavior and style, were also used to collect information. Based on that qualitative data, a correlation analysis was performed between Schwartz's value survey and other questionnaire variables. Correlation is a measure of the strength of relationship between pair of variables. This section explains the results and analysis based on the correlation between Schwartz's value survey and Questionnaires.

In our thesis we are correlating Schwartz 10 motivational value types with NEO Five Factor Inventory, conflict avoidance, time horizon, tolerance of uncertainty, Locus of control, Driver Style and Driver Behavior. The ten different value types of the Schwartz's value survey are presented in X-axis. These values represent preference of values in life. The Y-axis denotes the correlation value from different questionnaires such as time horizon. Here is the regression parameter that shows different questionnaires with their respective peak values of the Schwartz's Model.

Scale / Measure	Questionnaire Type	B0	B1	SD B1	Phase Angle	Peak Value Type	r^2
conflict Avoidness	conflict Avoidness	-0.01359	0.231628	0.038423	289	CO	0.78
Impatient	DBQ	0.016447	0.216158	0.038818	188	AC	0.76
Hostile	DBQ	0.006	0.173	0.036	221	PO	0.70
Open	DSQ	-0.012	0.188462	0.040109	342	BE	0.69
Cautious	DSQ	-0.01771	0.211192	0.046364	293	BE	0.67
Tolerance for Uncertainty	Tolerance for Uncertainty	0.019639	0.257515	0.061208	77	SD	0.64
Authentic	OTS	-0.01923	0.241695	0.063166	294	CO	0.59
Frequency of behavior	DRP	-0.00138	0.142224	0.040514	218	PO	0.55
Obedient	DSQ	0.010352	0.18572	0.05965	55	UN	0.49
1 / Neuroticism	NEO-FFI	-0.001	0.166	0.055	242	SE	0.49
Openness	NEO-FFI	0.013618	0.157609	0.051372	105	ST	0.48
Difficulty	OTS	-0.01229	0.172446	0.062896	294	CO	0.43
Side View	OTS	0.013607	0.09237	0.040759	173	AC	0.34
Extraversion	NEO-FFI	0.009233	0.170733	0.077316	106	ST	0.33
E omission	DBQ	-0.00395	0.157877	0.076405	239	SE	0.30
Real	OTS	-0.02382	0.151837	0.076013	279	CO	0.29
E commission	DBQ	-0.01458	0.137625	0.071226	289	CO	0.27
Forgetful	DBQ	-0.0022	0.067182	0.0358	309	TR	0.26
Agreeableness	NEO-FFI	0.004293	0.148	0.08663	45	UN	0.23
Likelihood of Accident	DRP	0.010364	0.129779	0.083031	356	BE	0.20
Time Horizon	Time Horizon	0.000338	0.117097	0.079247	264	CO	0.18
Other	DBQ	-0.012	0.134773	0.096752	234	PO	0.16
Steering	OTS	-0.00479	0.08665	0.066585	165	AC	0.14
concienciouness	NEO-FFI	-0.00296	0.079771	0.063144	47	UN	0.14
Plan	DSQ	0.005605	0.053402	0.04537	47	UN	0.12
Front View	OTS	0.001568	0.110237	0.102025	31	UN	0.10
Gear	OTS	0.003083	0.055944	0.051804	252	SE	0.10
Likelihood of Citation	DRP	0.00616	0.057348	0.056105	8	BE	0.09
Clam	DSQ	0.024475	0.094403	0.106044	83	UN	0.07
Paddle	OTS	0.015395	0.054428	0.063785	123	ST	0.07
Rear View	OTS	0.007393	0.002856	0.052248	285	CO	0.00

Note: B_0 is the vertical offset of the sine wave. B_1 is the amplitude of the sine wave. Phase angle indicates the location of the ascending zero-intercept of the sine wave as measured in degrees from an arbitrary zero defined by the boundary between ST (stimulation) and HE (hedonism). Each of the 10 value types is assigned an arc length of 36°. * $p < .05$, ** $p < .01$ (Smith, Lindgren, Granlund 2005-2006).

Table 10: Correlation Analysis

In table 10, **Scale/ Measure** represent the Y-axis components that we correlate against Schwartz Values.   **B0** is the vertical offset of the model from the zero correlation baselines. If the data are well-behaved, its value is close to zero.   **B1** is the amplitude of the sine wave defined as the peak value of correlation in the best-fit model to the observed data. The statistical significance of this parameter determines the utility of the model as a predictor and descriptor of the data. **Phase angle** of the best-fit model defined as the distance in degrees from the left side of the correlogram to the zero intercept of the rising limb of the sine wave. The phase angle determines the location of the peak and is central to the interpretation of the patterns of correlation captured by the model. **Peak Value Type** represents the highest point of the Schwartz's value on the graph for the Y-axis measures in the correlation. The **R^2** value indicates that the model explains more than three-quarters of the variance (noise) in the observed data. (Smith, Lindgren, Granlund 2005-2006).

Here in this report we will only discuss those values of r^2 which are closer to 1, because when r^2 value is close to 1 we get a nearly a perfect sine wave, giving a result which fits the Schwartz's and other models.

5.1.1. Correlations between Schwartz's value and Conflict Avoidance

Here in this graph Schwartz's value is correlated with Conflict Avoidance. In the graph given below the peak value is Conformity=1 (CO) against the measure Conflict Avoidance. So Schwartz's value has a strong positive correlation with Conformity (CO) for the users which like to avoid conflicts in their life.
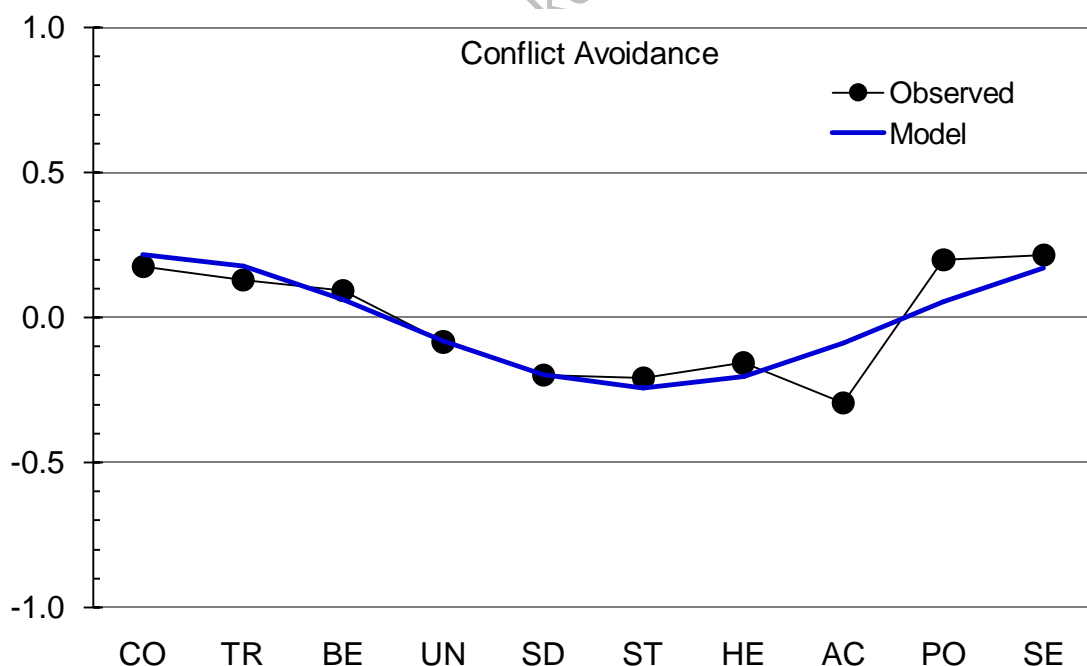
Figure 13: Correlation between Schwartz's Value Survey and Conflict Avoidance Value

This represents that people who are more conventional or follow their traditions are those people who like to avoid conflict in the way of life, they like to make such decisions or they spend their life in such a way that they prevent arguments or clashes. And also it has a negative correlation with Stimulation= -1 (ST), which suggests that people who don't like to face challenges are those people who like to avoid clashes or conflicts in their lives. This particular correlation gives a perfect picture of the behavior of the people who like to stay away from troubles or conflicts are usually good followers of tradition and they usually they don't like to face challenges in every day of their life.

5.1.2. Correlations between Schwartz's value and Impatient Value

In the figure 12, the impatient value from the driver's behavior questionnaire has a positive correlation with Achievement= 0.990 (AC) and a negative correlation with Benevolence= -0.990 (BE).
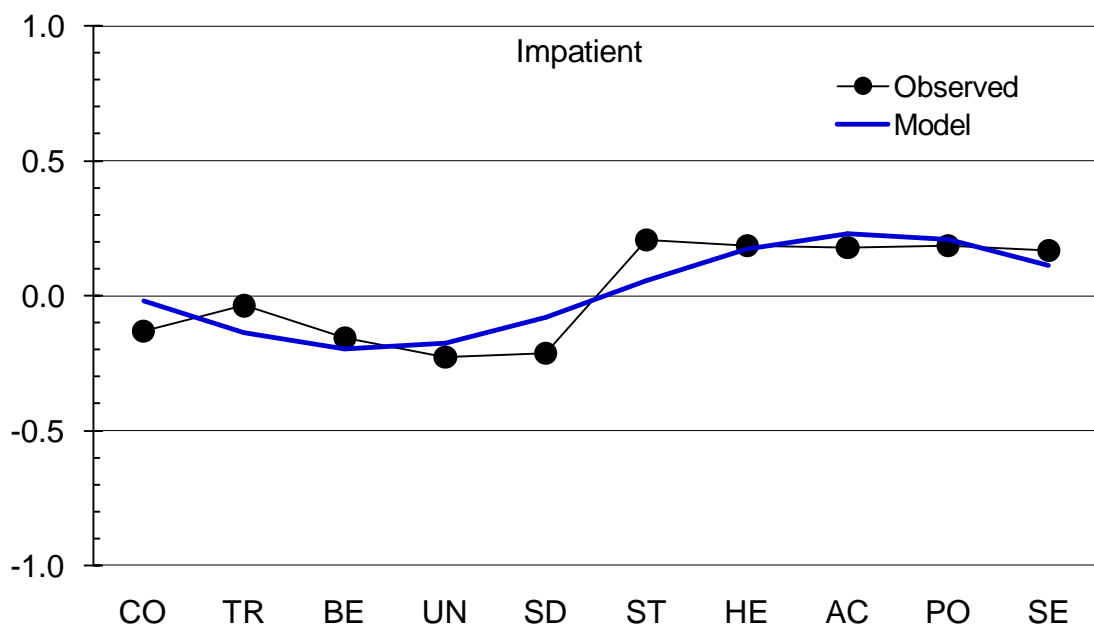
Figure 14: Correlation between Schwartz's Value Survey and Impatient Value

This positive correlation with achievement of impatient people shows that impatient people have more desire for accomplishment in life. People with these personality traits want to achievement things in fast or impatient way.

5.1.3. Correlations between Schwartz's value and Hostile Value

In the figure 13 below we have Hostile value from driver's behavior questionnaire has a positive correlation with Power= 0.997 (PO) and a negative correlation with Universalism= -0.997 (UN).
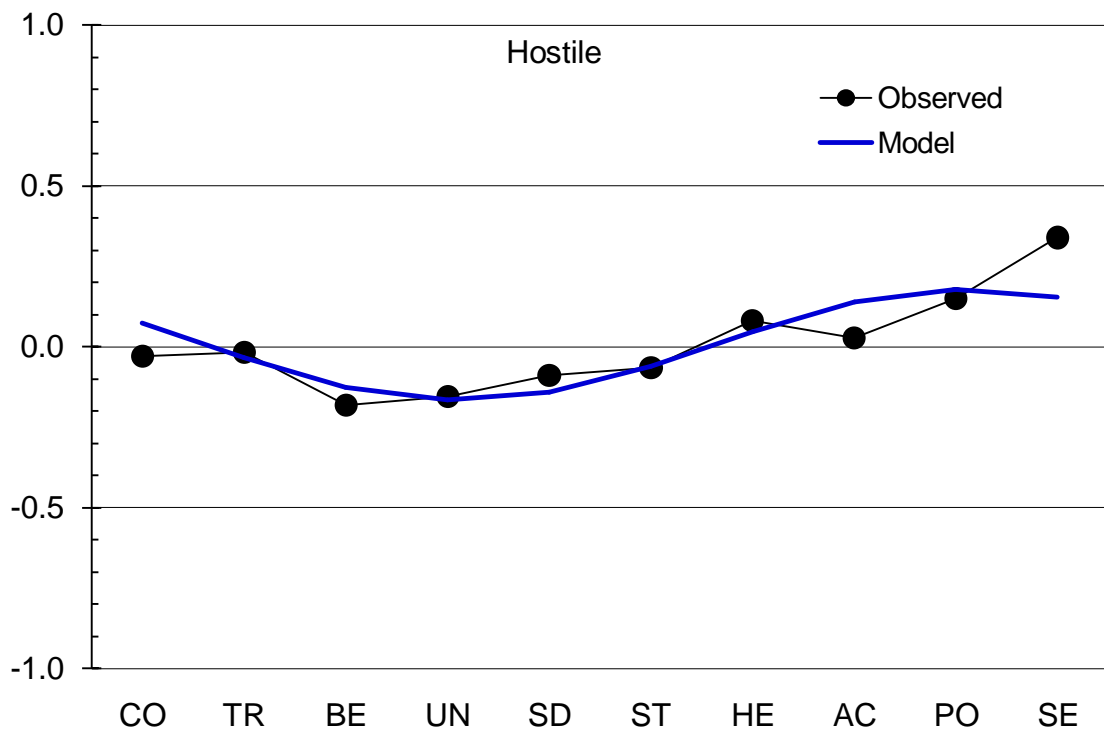
Figure 15: Correlation between Schwartz's Value Survey and Hostile Value

In daily life people who have desire for getting power are aggressive. To acquire the power people sometime leave all the understanding and care for others. Also this trait of hostility in human is opposite to the people which have an understanding and tolerance for other people. They only think about their own welfare and well-being. These results show obvious view of people which have desire for taking power and don't bother about other people.

5.1.4. Correlations between Schwartz's value and Open to suggestions

Here Benevolence= 0.952 (BE) has a strong positive correlation with Open which is a driver's style questionnaire value, stating that people who are more open to suggestions during driving are more benevolence. People, who value suggestions or comments while driving, are more into kindness or munificence.
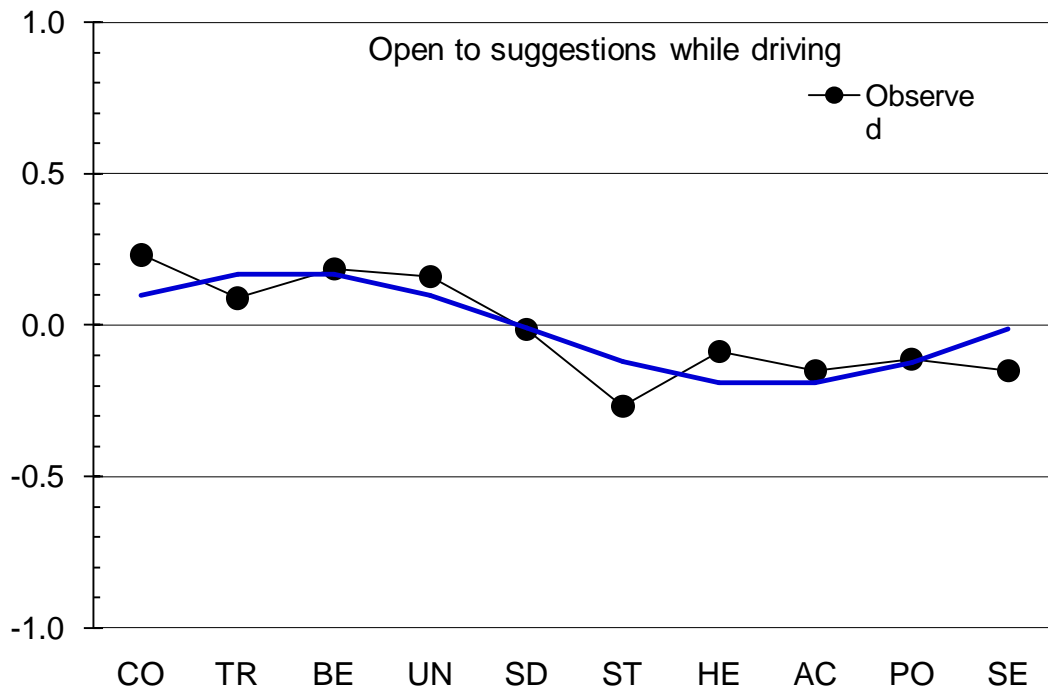
Figure 16: Correlation between Schwartz's Value Survey and Open to suggestion

So this driving habit or style gives an important insight of the driver's personality. Whereas it has negative correlation with Achievement= -0.952 (AC). This correlation suggests that, drivers who listen to other people advice or comments don't much believe in obtaining the social approval or getting the social esteem in their life.

5.1.5. Correlations between Schwartz's value and Cautious Value

We have Cautious value from driver's style questionnaire has a positive correlation with Conformity= 0.995 (CO) and a negative correlation with Stimulation= -0.995 (ST).
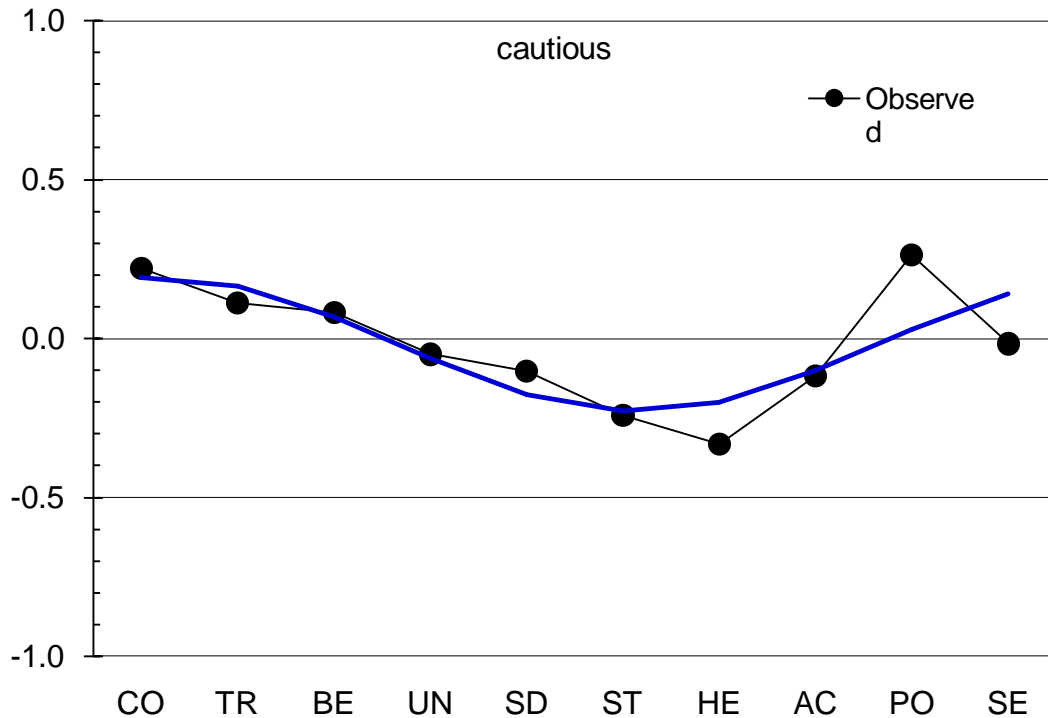
Figure 17: Correlation between Schwartz's Value Survey and Cautious Value

This result depicts very clearly aspects of life. We can see from an example like youngster try to follow their instinct when doing illegal car racing on public roads they don't bother about the norms, social values and traffic rules. This shows a negative correlation with cautiousness. If a person is cautious enough in daily matters of life, it is expected that he/she should follow the norms and traditions of society and restraint from doing things which can be annoying to other people.

5.1.6. Correlations between Schwartz's value and tolerance of Uncertainty

The graph shows the strong positive correlation between the Self direction= 0.996 (SD) and Tolerance for Uncertainty reflecting that, people who have more tolerance for uncertainty are more independent or they have high beliefs of self governing. People with self-determining attitude can do much better in decision making situation with incomplete information or in an unfamiliar situation. Inspection of Figure also reveals that it has a negative correlation with Power= -0.751 (PO) which means that people who don't want them self to be in unclear or ambiguous situations have less desire for social status and prestige.
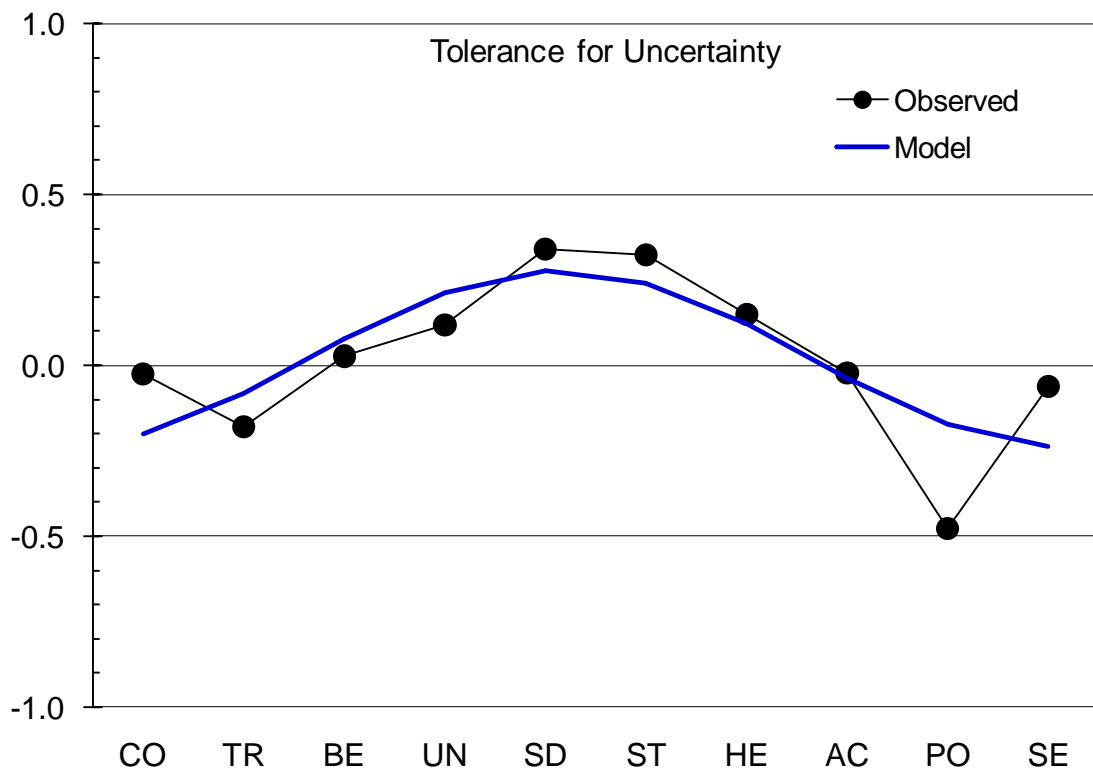
Figure 18: Correlation between Schwartz's Value Survey and Tolerance for Uncertainty

5.1.7. Correlations between Schwartz's value and Frequency of behavior

We have Frequency of behavior value from driving risk perception questionnaire which has a positive correlation with Power= 0.999 (PO) Schwartz's value and a negative correlation with Universalism= -0.999 (UN) Schwartz's value.
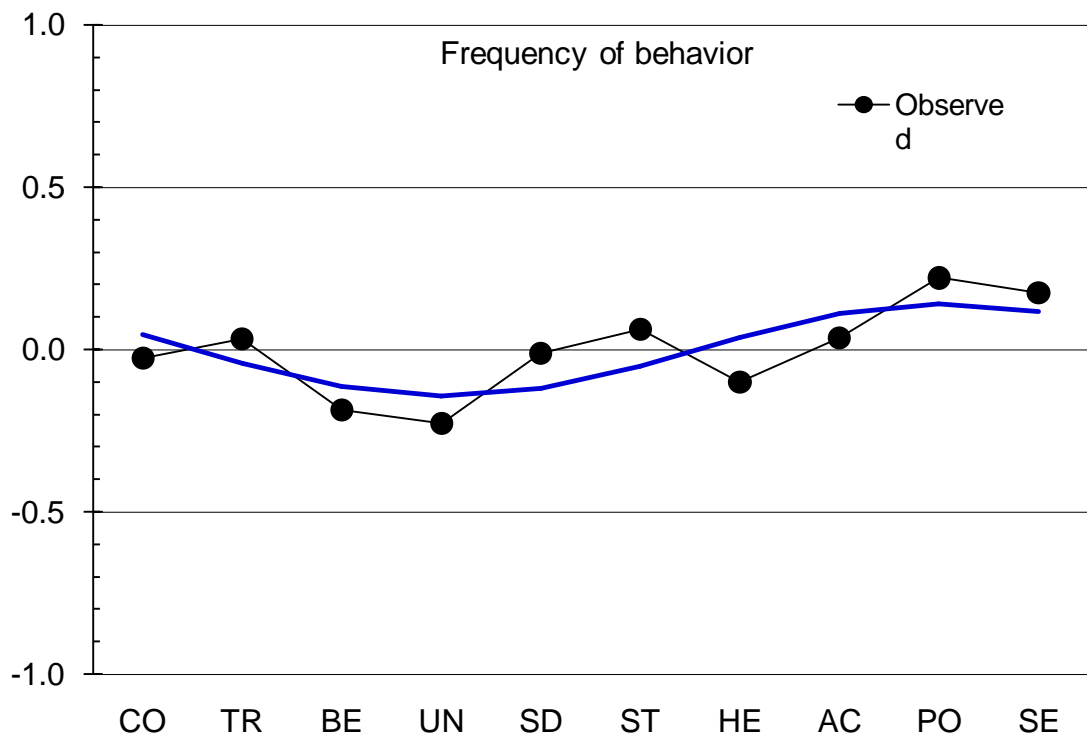
Figure 19: Correlation between Schwartz's Value Survey and frequency of behavior

This result shows that a person who has a tendency of gaining power in life will indulge into different things quite often. They have a high frequency of changing behavior. We can take an example a person who wishes to have power in life may over speed on road to be in the first position on every traffic signal. And the frequency of this behavior will be big. And a negative correlation with universalism shows no care for other people. We can say a person with these traits only focus on his own intentions.

5.1.8. Correlations between Schwartz's value and Obedient

Obedient value is taken from driver's style questionnaire, with Schwartz's value types it has a positive correlation with Universalism= 0.944 (UN) and a negative correlation with Power= -0.994 (PO).
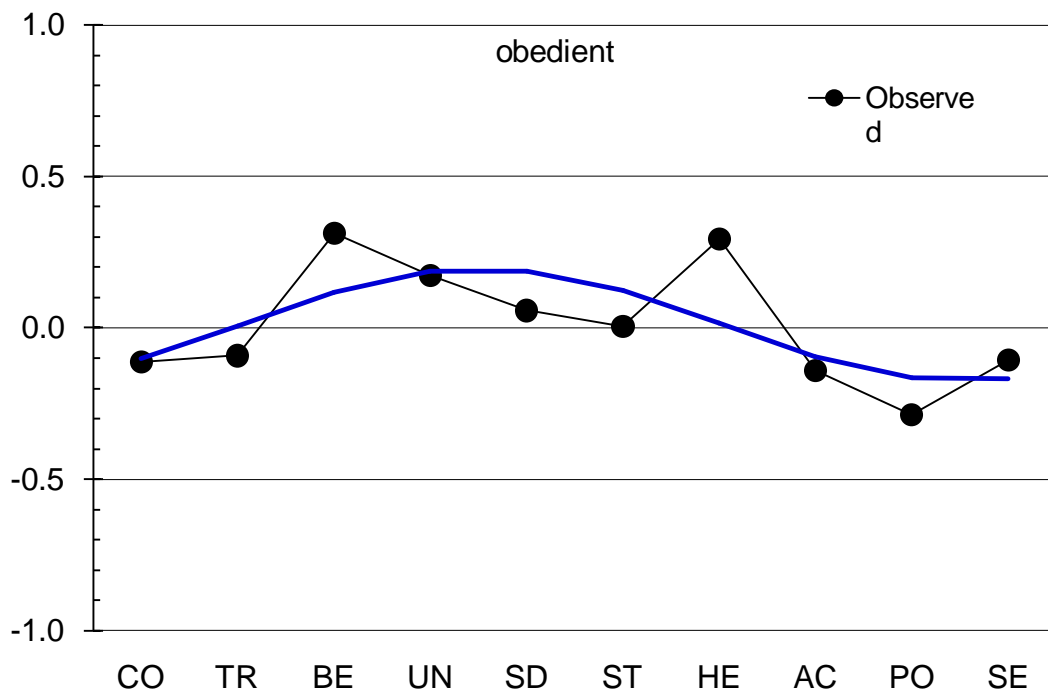
Figure 20: Correlation between Schwartz's Value Survey and Obedient value

Results show a fact that people who are obedient in parts of life are not keen of taking power. People tends to be obedient to the rules then to gain control over them. So for people who are obedient in life will drive safely as they will follow the rules and less accidents will occur.

5.2. **Post Encroachment Time (PET) Analysis**

This section presents the simulator data containing PET, Speed and Acceleration. There were a total of 244 PET meetings at an intersection in total within all the four sessions (mention fig). The data for PET values above 10 seconds is not being included in this analysis because they considered as a safe distance between the two cars. Here we will only discuss the results in a brief detail because our other group was working on this research study.

Analysis and Discussion
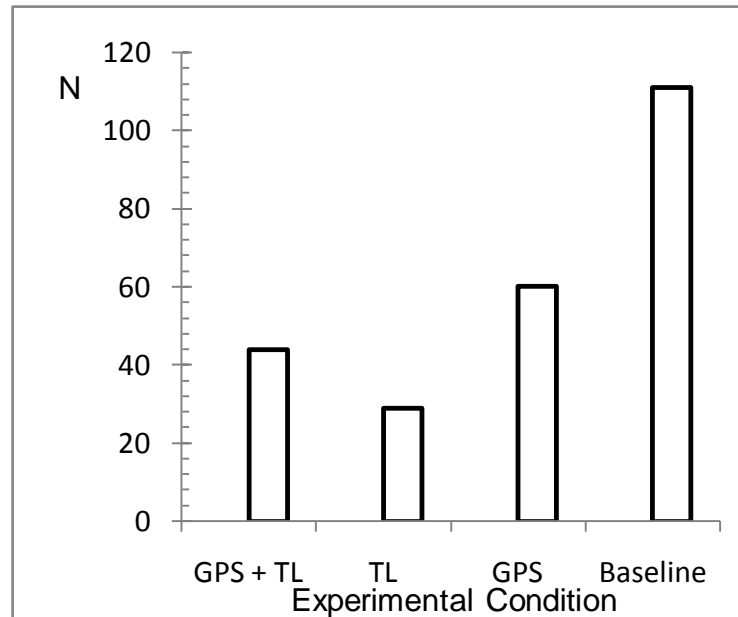
Figure 21: Total Number of PET Meetings in all four sessions

5.2.1. Results

1.   There is no indication in obtained data that the experimental manipulations influenced in the drivers PET.

2.   There are considerably more PET values than expected in Scenario B at 5 and 6 seconds, in Scenario C at 1 second, and in Scenario D at 3 seconds. In fact, in Scenario A and B, PET values were larger (times were longer, cars were further apart) than in Scenario C and D.

3.   There is no indication in obtained data that the experimental manipulations influenced the drivers' speed.

4.   There is no indication in obtained data that the experimental manipulations influenced the drivers' acceleration.

6. Conclusion

The main issue of this study has been to examine driving behavior in intersections. The results discussed in this report are derived from observations and experiments performed in the lab. Different people from different countries participated in our study and we do not claim that these results generalize to every individual from these countries. No claim is made that our participants are representative of the full diversity of their cultures. Indeed, our participants are largely drawn from a self-selected pool of university students pursuing advanced degrees. This analysis shows the existence of

Analysis and Discussion

relationship between different models and how these models can be correlated to identify several personality traits, driving habits and other important aspects of their lives.

According to our research question the diversity in the drivers' behavior is due to their personal traits. We mentioned three hypotheses. Our data and the correlation between the different models prove those hypotheses.

First hypothesis was drivers with more desire of power and achievement has more aggressive and impatient nature while driving. Our graph of Schwartz's value with Impatient Value (figure: 12) represents that impatient and intolerant people have strong desire for power and their focus is more of towards social esteem and this thing reflects in their driving. They are more aggressive in their driving. They like to do things which will get the attention of other people and that can be a risk for that person and for other people.

In our second hypotheses drivers with helping and caring traits are more focus towards smooth and careful driving to avoid accidents. The correlation between Schwartz's value and Cautious Value (Figure: 15) shows that people with more caring nature are usually more careful drivers and this nature helps them to avoid those things that can result in accidents.

In the third hypotheses we stated that drivers which have high tolerance for uncertainty tends to have more self-control in uncertain situations. From our correlation of Schwartz's value and tolerance for uncertainty, we see that people that have high value for tolerance for uncertainty do better in unclear situations and they are more self directed in such situations. But such type of people can create problems for other people who have low tolerance for uncertainty. So such type of people can do better driving for them self, but for others they can be dangerous in uncertain situations.

Our results of analyzed data are very positive. Correlation between the Schwartz's value and other questionnaires has provided some important insight in determining the driving behavior and driving style of the drivers. This information can be used to understand the instincts that human being follows in case of accidents or in uncertain situations and things that can create such situations and it can be used as an indicator of the driver's behavior.

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6.1. **Future Work**

There is still much to be done, we analyzed data without making the groups of people according to region or country. It will be a good idea to define several groups of people and then apply these correlations to get the different behavior of the drivers. It will also help to identifying similar pattern of driving styles or driving behavior that exists in people which are living in same region or country. So categorizing the people can give some extra information that can help in understanding the problems or personality traits of people. And similarly people can be divided into groups according to different age brackets, to see the different of driving behavior and styles that exists between them.

It will also be a good idea to individually assess each person and to do its correlation with different questionnaires to get the individual personality traits and driving behavior or styles, on the basis of the questionnaire data collected during the simulated experiments. It will help to generalize the result of each individual so that it can be compared with the cumulative result of all the people. It will enable us to confirm the results that we get from the analysis.

Also, the analysis of each person's PET values with their respective personality traits will provide us with detail insight in their driving behavior and style. Such study can reveal several new aspects of human behavior under different circumstances. It will be a very exciting work to perform the analysis between variation of driving style among different persons and their driving behavior.

Simulator-based research is growing day by day, more and more researches are done in these simulators and their usage is increasing as a tool to get the important behaviors of the human beings. That research might be implemented in the real world to compare the results.

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8. Appendix

8.1. **Appendix A**

Group Instructions for Running Experiments

Points to Remember

- Start all four simulators before the experiments.
- Check for the sound and the experiment to be run.

Introduction

(Read these out to the participants)

Hi,

Thank you for participating in our research study. You will need to help us for two hours and as a thank you gift we will provide you with a Cinema Ticket.

This study is about a project named IVSS (Intelligent Vehicle Safety System) which is mainly about analyzing the accidents occurring at intersections. We have Autoliv Research, SAAB, Volvo and Chalmers University as other partners in this research. This study will be performed using a car simulator.

The experiments are divided into 4 sessions each consisting of 10 mins time with a test session of about 3 minutes time in the start. In each of the session there will four participants and a total of 12 cars. In the test session you will be driving for around 10 mins in order to get familiar with the simulator's environment. In the other four sessions you may encounter either a GPS (Voice Command Based) system or traffic lights or both or none of them, which you will have to strictly follow with other road traffic signs (more details will be provided to you before each session). During all the sessions you need to look for a number of signs like below:

You will then note the text along with the number on these sign boards in the order to collect them. When these words are combined in the correct order they make a sentence. Please note that in order to read / write the word with the number on the sign board you have to stay off the road giving way to other traffic.

ALWAYS REMEMBER

- Never violate any road traffic signs until and unless instructed to do so.
- Never over speed until and unless instructed to do so.
- Never take a U-Turn in case you miss road signs.
- You are not allowed to talk with other drivers during the sessions.

- Always listen to the voice commands carefully.
- Always respect other drivers.

… Otherwise you may lose your cinema ticket.

You will also enjoy coffee breaks in between the sessions to get relax. We again thank you for participating in our study and helping us in completing our report.

Best of Luck to You!!! ☺

Extra Quick Driver's Guide

How to Start the car?

- Push the left red button once.
- Shift to gear one.
- Push the right left button for some seconds while you lover the pressure of the clutch and give gas.
- Be patient and try this for some times until you know how to start.
- The right red button is supposed to be pressed every time you start the car.
- The left red button is only pushed the first time, no more is required.

Try the stuff below while you drive in the Test Scenario

We want you to:

- Stop the car and start again.
- Give gas and use up to gear three.
- To try to go reverse. *(you may need to press the gear lever down)*
- Try the left and right indicators at the next intersection.
- Drive free and learn how to turn.
- Give more gas and use up to gear five.
- **Drive like a crazy person and drive everywhere ignore common sense.**

Consequence – Always Remember!!!

If you do not drive on the road according to traffic signs and laws the simulator may crash. The session must be done again. We stress that respond to common sense is serious.

8.2. **Appendix B**

Extra Quick Driver's Guide

How to Start the car?

- Push the left red button once.
- Shift to gear one.
- Push the right left button for some seconds while you lover the pressure of the clutch and give gas.
- Be patient and try this for some times until you know how to start.
- The right red button is supposed to be pressed every time you start the car.
- The left red button is only pushed the first time, no more is required.

Try the stuff below while you drive in the Test Scenario

We want you to:

- Stop the car and start again.
- Give gas and use up to gear three.
- To try to go reverse. *(you may need to press the gear lever down)*
- Try the left and right indicators at the next intersection.
- Drive free and learn how to turn.
- Give more gas and use up to gear five.
- **Drive like a crazy person and drive everywhere ignore common sense.**

Consequence – Always Remember!!!

If you do not drive on the road according to traffic signs and laws the simulator may crash. The session must be done again. We stress that respond to common sense is serious.

If you need any other guidance or help please feel free to contact us during the Experiment.

8.3. **Appendix C**

Thank you for participating in our research study. You will need to help us for two hours and as a thank you gift we will provide you with a Cinema Ticket.

This study is about a project named IVSS (Intelligent Vehicle Safety System) which is mainly about analyzing the accidents occurring at intersections. We have Autoliv Research, SAAB, Volvo and Chalmers University as other partners in this research. This study will be performed using a car simulator.

The experiments are divided into 4 sessions each consisting of 10 mins time with a test session of about 3 minutes time in the start. In each of the session there will four participants and a total of 12 cars. In the test session you will be driving for around 10 mins in order to get familiar with the simulator's environment. In the other four sessions you may encounter either a GPS (Voice Command Based) system or traffic lights or both or none of them, which you will have to strictly follow with other road traffic signs (more details will be provided to you before each session). During all the sessions you need to look for a number of signs like below:

You will then note the text along with the number on these sign boards in the order to collect them. When these words are combined in the correct order they make a sentence. Please note that in order to read / write the word with the number on the sign board you have to stay off the road giving way to other traffic.

<u>ALWAYS REMEMBER</u>

- Never violate any road traffic signs until and unless instructed to do so.
- Never over speed until and unless instructed to do so.
- Never take a U-Turn in case you miss road signs.
- You are not allowed to talk with other drivers during the sessions.
- Always listen to the voice commands carefully.
- Always respect other drivers.

… Otherwise you may lose your cinema ticket.

You will also enjoy coffee breaks in between the sessions to get relax. We again thank you for participating in our study and helping us in completing our report.

Best of Luck to You!!! ☺

Please fill in the following questionnaires which will be only used for the purpose of analysis in this project. Do read the instructions very carefully before filling out each of the questionnaires!!!

Personal Information

Name:		Date:
Age:	Email:	Simulator No.
Sex:	Telephone:	Group No.
What is your profession?		
Which year you got you drivers license?	Transmission of the car you drive: ○ Manual ○ Automatic	
How many miles do you driver per year? ○ 0 -500 ○ 501-1000 ○ 1001-1500 ○ Over 1500	Your Vision: ○ Drive without glasses/lens. ○ Driver with glasses/lens.	
Have you ever met a road traffic accident after you got your driver's license? ○ Yes, How? _____ ○ No		
How many days in a week you drive? ○ Everyday ○ 4 – 6 days ○ 1 – 3 days very frequently in a week		

Contacts:

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Questionnaire 1

Please Don't Turn the Page Until you are done with Experiment No. 1

Instructions

Carefully read all instructions before beginning. This questionnaire contains 60 statements. Read each statement carefully. For each statement fill in the circle with the response that best represents your opinion. Make sure that your answer is in the correct box.

Fill in **A** if you **strongly disagree** or the statement is definitely false.

Fill in **B** if you **disagree** or the statement is mostly false.

Fill in **C** if you are **neutral** on the statement, if you cannot decide, or if the statement is about equally true and false.

Fill in **D** if you **agree** or the statement is mostly true.

Fill in **E** if you **strongly agree** or the statement is definitely true.

Circle the letter in order to fill in only one response for each statement. Respond to all of the statements, making sure that you fill in the correct response. If you need to change an answer, make an "X" through the incorrect response and then fill in the correct response.

Enter your responses here.   Remember to enter responses ACROSS the rows.
A = Strongly Disagree, B = Disagree, C = Neutral, D = Agree, E = Strongly Agree

1	A	B	C	D	E	2	A	B	C	D	E	3	A	B	C	D	E	4	A	B	C	D	E	5	A	B	C	D	E
6	A	B	C	D	E	7	A	B	C	D	E	8	A	B	C	D	E	9	A	B	C	D	E	10	A	B	C	D	E
11	A	B	C	D	E	12	A	B	C	D	E	13	A	B	C	D	E	14	A	B	C	D	E	15	A	B	C	D	E
16	A	B	C	D	E	17	A	B	C	D	E	18	A	B	C	D	E	19	A	B	C	D	E	20	A	B	C	D	E
21	A	B	C	D	E	22	A	B	C	D	E	23	A	B	C	D	E	24	A	B	C	D	E	25	A	B	C	D	E
26	A	B	C	D	E	27	A	B	C	D	E	28	A	B	C	D	E	29	A	B	C	D	E	30	A	B	C	D	E
31	A	B	C	D	E	32	A	B	C	D	E	33	A	B	C	D	E	34	A	B	C	D	E	35	A	B	C	D	E
36	A	B	C	D	E	37	A	B	C	D	E	38	A	B	C	D	E	39	A	B	C	D	E	40	A	B	C	D	E
41	A	B	C	D	E	42	A	B	C	D	E	43	A	B	C	D	E	44	A	B	C	D	E	45	A	B	C	D	E
46	A	B	C	D	E	47	A	B	C	D	E	48	A	B	C	D	E	49	A	B	C	D	E	50	A	B	C	D	E
51	A	B	C	D	E	52	A	B	C	D	E	53	A	B	C	D	E	54	A	B	C	D	E	55	A	B	C	D	E
56	A	B	C	D	E	57	A	B	C	D	E	58	A	B	C	D	E	59	A	B	C	D	E	60	A	B	C	D	E

Have you responded to all of the statements?   ___ Yes   ___ No

Have you entered your reponses in the corect boxes?   ___ Yes   ___ No

Have your responded accurately and honestly?   ___ Yes   ___ No

1. I am not a worrier
2. I like to have a lot of people around me
3. I don't like to waste my time daydreaming
4. I try to be courteous to everyone I meet
5. I keep my belongings neat and clean

6. I often feel inferior to others

7. I laugh easily

8. Once I find the right way to do something, I stick to it

9. I often get into arguments with my family and co-workers

10. I'm pretty good about pacing myself so as to get things done on time

11. When I'm under a great deal of stress, sometimes I feel like I'm going to pieces

12. I don't consider myself especially "light-hearted"

13. I am intrigued by the patterns I find in art and nature

14. Some people think I'm selfish and egotistical

15. I am not a very methodical person

16. I rarely feel lonely or blue

17. I really enjoy talking to people

18. I believe letting students hear controversial speakers can only confuse and mislead them

19. I would rather cooperate with others than compete with them

20. I try to perform all the tasks assigned to me conscientiously

21. I often feel tense and jittery

22. I like to be where the action is

23. Poetry has little or no effect on me

24. I tend to be cynical and sceptical of others' intentions

25. I have a clear set of goals and work toward them in an orderly fashion

26. Sometimes I feel completely worthless

27. I usually prefer to do things alone

28. I often try new and foreign foods

29. I believe that most people will take advantage of you if you let them

30. I waste a lot of time before settling down to work

31. I rarely feel fearful or anxious

32. I often feel as if I'm bursting with energy

33. I seldom notice the moods of feelings that different environments produce

34. Most people I know like me

35. I work hard to accomplish my goals

36. I often get angry at the way people treat me
37. I am a cheerful, high-spirited person
38. I believe we should look to our religious authorities for decisions on moral issues
39. Some people think of me as cold and calculating
40. When I make a commitment, I can always be counted on to follow through

41. Too often, when thins go wrong, I get discouraged and feel like giving up
42. I am not a cheerful optimist
43. Sometimes when I am reading poetry or looking at a work of art, I feel a chill or wave of excitement
44. I'm hard-headed and tough-minded in my attitudes
45. Sometimes I'm not as dependable or reliable as I should be

46. I am seldom sad or depressed
47. My life is fast-paced
48. I have little interest in speculating on the nature of the universe or the human condition
49. I generally try to be thoughtful and considerate
50. I am a productive person who always gets the job done

51. I often feel hopeless and want someone else to solve my problems
52. I am a very active person
53. I have a lot of intellectual curiosity
54. If I don't like people, I let them know it
55. I never seem to be able to get organized

56. At times I have been so ashamed I just wanted to hide
57. I would rather go my own way than be a leader of others
58. I often enjoy playing with theories and abstract ideas
59. If necessary, I am willing to manipulate people to get what I want
60. I strive for excellence in everything I do

Questionnaire 2

Please Don't Turn the Page Until you are done with Experiment No. 1 and finished with Questionnair No. 1

VALUE SURVEY

In this questionnaire you are to ask yourself: "What values are important to ME as guiding principles in MY life, and what values are less important to me?" There are two lists of values on the following pages. These values come from different cultures. In the parentheses following each value is an explanation that may help you to understand its meaning.

Your task is to rate how important each value is for you <u>as a guiding principle in your life</u>. Use the rating scale below:

0--means the value is not at all important, it is not relevant as a guiding principle for you.

3--means the value is important.

6--means the value is very important.

The higher the number (0, 1, 2, 3, 4, 5, 6), the more important the value is as a guiding principle in YOUR life.

-1 is for rating any values opposed to the principles that guide you.

 7 is for rating a value of supreme importance as a guiding principle in your life; ***ordinarily there are no more than two such values.***

In the space before each value, write the number (-1,0,1,2,3,4,5,6,7) that indicates the importance of that value for you, personally. Try to distinguish as much as possible between the values by using all the numbers. You will, of course, need to use numbers more than once.

AS A GUIDING PRINCIPLE IN MY LIFE, this value is:

opposed to my values	not important			important			very important	of supreme importance
-1	0	1	2	3	4	5	6	7

Before you begin, read the values in List I, choose the one that is most important to you and rate its importance. Next, choose the value that is most opposed to your values and rate it -1. If there is no such value, choose the value least important to you and rate it 0 or 1, according to its importance. Then rate the rest of the values in List I.

VALUES LIST I

1 ____EQUALITY (equal opportunity for all)

2 ____INNER HARMONY (at peace with myself)

3 ____SOCIAL POWER (control over others, dominance)

4 ____PLEASURE (gratification of desires)

5 ____FREEDOM (freedom of action and thought)

6 ____A SPIRITUAL LIFE (emphasis on spiritual not material matters)

7 ____SENSE OF BELONGING (feeling that others care about me)

8 ____SOCIAL ORDER (stability of society)

9 ____AN EXCITING LIFE (stimulating experiences)

10___MEANING IN LIFE (a purpose in life)

AS A GUIDING PRINCIPLE IN MY LIFE, this value is:

opposed to my values	not important			important			very important	supreme of importance
-1	0	1	2	3	4	5	6	7

11____POLITENESS (courtesy, good manners)

12____WEALTH (material possessions, money)

13____ NATIONAL SECURITY (protection of my nation from enemies)

14____ SELF RESPECT (belief in one's own worth)

15____RECIPROCATION OF FAVORS (avoidance of indebtedness)

16____CREATIVITY (uniqueness, imagination)

17____A WORLD AT PEACE (free of war and conflict)

18____RESPECT FOR TRADITION (preservation of time-honored customs)

19____MATURE LOVE (deep emotional & spiritual intimacy)

20____SELF-DISCIPLINE (self-restraint, resistance to temptation)

21____PRIVACY (the right to have a private sphere)

22____FAMILY SECURITY (safety for loved ones)

23____SOCIAL RECOGNITION (respect, approval by others)

24____UNITY WITH NATURE (fitting into nature)

25____A VARIED LIFE (filled with challenge, novelty and change)

26____WISDOM (a mature understanding of life)

27____AUTHORITY (the right to lead or command)

28____TRUE FRIENDSHIP (close, supportive friends)

29____A WORLD OF BEAUTY (beauty of nature and the arts)

30____SOCIAL JUSTICE (correcting injustice, care for the weak)

Thank you for your time and effort!

Questionnaire 3

Please Don't Turn the Page Until you are done with Experiment No. 2

VALUE SURVEY - - VALUES LIST II

Now rate how important each of the following values is for you <u>as a guiding principle in YOUR life</u>. These values are phrased as ways of acting that may be more or less important for you. Once again, try to distinguish as much as possible between the values by using all the numbers.

Before you begin, read the values in List II, choose the one that is most important to you and rate its importance. Next, choose the value that is most opposed to your values, or--if there is no such value--choose the value least important to you, and rate it -1, 0, or 1, according to its importance. Then rate the rest of the values.

AS A GUIDING PRINCIPLE IN MY LIFE, this value is:

opposed to my values	not important			important			very important	supreme of importance
-1	0	1	2	3	4	5	6	7

31____ INDEPENDENT (self-reliant, self-sufficient)

32____ MODERATE (avoiding extremes of feeling & action)

33____ LOYAL (faithful to my friends, group)

34____ AMBITIOUS (hard-working, aspiring)

35____ BROADMINDED (tolerant of different ideas and beliefs)

36____ HUMBLE (modest, self-effacing)

37____DARING (seeking adventure, risk)

38____PROTECTING THE ENVIRONMENT (preserving nature)

39____INFLUENTIAL (having an impact on people and events)

40____HONORING OF PARENTS AND ELDERS (showing respect)

41____CHOOSING OWN GOALS (selecting own purposes)

42____HEALTHY (not being sick physically or mentally)

43____CAPABLE (competent, effective, efficient)

44____ACCEPTING MY PORTION IN LIFE (submitting to life's circumstances)

45____HONEST (genuine, sincere)

46____PRESERVING MY PUBLIC IMAGE (protecting my "face")

47____OBEDIENT (dutiful, meeting obligations)

48____INTELLIGENT (logical, thinking)

49____HELPFUL (working for the welfare of others)

50____ENJOYING LIFE (enjoying food, sex, leisure, etc.)

51____DEVOUT (holding to religious faith & belief)

52____RESPONSIBLE (dependable, reliable)

53____CURIOUS (interested in everything, exploring)

54____FORGIVING (willing to pardon others)

55____SUCCESSFUL (achieving goals)

56____CLEAN (neat, tidy)

57____SELF-INDULGENT (doing pleasant things)

Thank you for your time and effort!

Questionnaire 4

> ***Please Don't Turn the Page Until you are done with Experiment No. 2 and finished with Questionnair No. 3***

Time Horizon

Time Horizon refers to how far ahead people plan, the time frame of their goals, and how far ahead they look to justify their actions. Please answer the following questions in relation to your own experiences and opinions. There are no right or wrong answers. Answer the questions using the rating scale below. Circle the number that best matches your experience from the options to the right of each question.

Rating Scale:

Strongly disagree **A**	Disagree **B**	Neither Agree nor Disagree **C**	Agree **D**	Strongly Agree **E**

1. I prefer to take things as they come rather than planning ahead.	A B C D E
2. I like going on holidays with nothing planned in advance.	A B C D E
3. I like to have my weekends planned in advance.	A B C D E
4. I like to know exactly what I'm going to do next.	A B C D E
5. I like to plan ahead in detail rather than leaving things to chance.	A B C D E
6. I try to have my life and career clearly mapped out.	A B C D E
7. I have no problem in meeting deadlines.	A B C D E
8. My work is usually carefully planned and well organized.	A B C D E
9. I prefer situations where I do not have to decide immediately.	A B C D E
10. I often put off things that I should have done today until tomorrow.	A B C D E

11. I always know what will happen tomorrow.	A	B	C	D	E
12. I am quite certain of where I will be and what I will be doing a year from now.	A	B	C	D	E
13. I keep a shopping list and as soon as I notice that something is missing I add it to the list.	A	B	C	D	E
14. I consider it unnecessary to write shopping lists since I never know what I want until I get to the store anyway.	A	B	C	D	E
15. I often fantasize and make plans about future actions and events.	A	B	C	D	E
16. I consider it a waste of time to plan for the future since we cannot control much in our lives anyway.	A	B	C	D	E
17. I don't worry much about the future because other people will take care of things.	A	B	C	D	E
18. I live according to the expression carpe diem.	A	B	C	D	E

Thank you for your time and effort!

Questionnaire 5

> ***Please Don't Turn the Page Until you are done with Experiment No. 2 and finished with Questionnair No. 3 & 4***

Tolerance for Uncertainty

Tolerance for Uncertainty is related to comfort in making decisions with incomplete information and in unfamiliar situations. Please answer the following questions in relation to your experience when making decisions. There is no right or wrong answers. Answer the questions using the rating scale below. Circle the letter that best matches your experience from the options to the right of each question. Do not spend too much time on each question; usually your initial response is the best response.

Rating Scale:

Strongly disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
A	**B**	**C**	**D**	**E**

1. I prefer to take things as they come rather than plan everything in advance.	A	B	C	D	E
2. I always consider the consequences before I act.	A	B	C	D	E
3. I tend to give up easily when I don't clearly understand a situation.	A	B	C	D	E
4. Sudden changes make me feel upset.	A	B	C	D	E
5. When making a decision, I am deterred by the fear of making a mistake.	A	B	C	D	E
6. When uncertain, I act very cautiously until I have more information about the situation.	A	B	C	D	E
7. Facing uncertainty is a nerve-wracking experience	A	B	C	D	E
8. I get worried when a situation is uncertain	A	B	C	D	E

9. I find the prospect of change exciting and stimulating.	A	B	C	D	E
10. There is something exciting about not knowing what will happen.	A	B	C	D	E
11. The idea of taking a trip to a new country fascinates me.	A	B	C	D	E
12. I think you have to be flexible to work effectively.	A	B	C	D	E
13. Taking chances is part of life	A	B	C	D	E
14. When I feel uncertain about something, I try to rationally weigh up all the information I have.	A	B	C	D	E
15. Before making any changes, I need to think things over thoroughly.	A	B	C	D	E
16. A new experience is an occasion to learn something new.	A	B	C	D	E
17. I feel relieved when an ambiguous situation suddenly becomes clear	A	B	C	D	E
18. I enjoy finding new ways of working out problems.	A	B	C	D	E
19. When uncertain about what to do next, I tend to feel lost.	A	B	C	D	E
20. When a situation is unclear, it makes me feel angry.	A	B	C	D	E
21. Before I buy something, I have to view every sample I can find.	A	B	C	D	E
22. It is unpleasant for me to enter a situation without knowing what to expect from it.	A	B	C	D	E
23. I prefer things to be predictable and certain.	A	B	C	D	E
24. I feel uneasy when I am in the company of people whose behaviour I can't understand.	A	B	C	D	E

Thank you for your time and effort!

Questionnaire 6

Please Don't Turn the Page Until you are done with Experiment No. 3

Conflict Avoidance

Please answer the following questions in relation to your experience when interacting with others. There are no right or wrong answers. Answer the questions using the rating scale below. Circle the letter that best matches your experience from the options to the right of each question. Do not spend too much time on each question, usually your initial response is the best response.

Rating Scale:

Strongly disagree **A**	Disagree **B**	Neither Agree nor Disagree **C**	Agree **D**	Strongly Agree **E**

1.	When I am involved with other people, I am always afraid to make a fool of myself.	A	B	C	D	E
2.	It doesn't bother me if people make fun of or tease me.	A	B	C	D	E
3.	If I have said or done something wrong to anyone, I have a hard time seeing him/her again.	A	B	C	D	E
4.	I prefer work which I can perform alone, without being disturbed by others.	A	B	C	D	E
5.	I rather cooperate with others than compete.	A	B	C	D	E
6.	I can be malicious and sharp when it is needed.	A	B	C	D	E
7.	I hesitate to show my anger even if it is justified.	A	B	C	D	E
8.	If I don't like a person, I let him/her know.	A	B	C	D	E
9.	If someone starts a fight I am prepared to get even.	A	B	C	D	E
10.	I often get into arguments with my family and co-workers.	A	B	C	D	E

11.	If I know or suspect that someone is annoyed at me, I avoid that person	A	B	C	D	E
12.	I prefer to solve conflicts rather than letting them pass.	A	B	C	D	E
13.	If I think that someone has done something wrong I tell him/her.	A	B	C	D	E
14.	If I make a mistake, I will let others know about it.	A	B	C	D	E
15.	If I have done something wrong I want to hide from other people.	A	B	C	D	E
16.	When conflicts arise on the job I rather resolve than avoid them.	A	B	C	D	E
17.	I am more productive when opposing views are discussed rather than smoothed over.	A	B	C	D	E
18.	I like discussing various views with people on the job.	A	B	C	D	E
19.	I am more able to make good decisions about my job with conflict.	A	B	C	D	E
20.	I discourage others from speaking out their feelings and views.	A	B	C	D	E
21.	I seek harmony even at the expense of open discussion.	A	B	C	D	E
22.	I try to keep differences of opinion quiet.	A	B	C	D	E
23.	I try to keep my differences from being expressed.	A	B	C	D	E

Thank you for your time and effort!

Questionnaire 7

Please Don't Turn the Page Until you are done with Experiment No. 3 and finished with Questionnair No. 6

Driver Behavior Questionnaire (DBQ)

The questionnaire below requires you to judge the frequency of your own driving errors and violations. For each item you are asked to indicate *how often*, if at all, this kind of thing has happened to you. Base your judgements on what you remember of your own driving over the past year.

Please indicate your judgements by circling the response

	Never	Hardly Ever	Occasionally	Quite Often	Frequently	Nearly All The Time
Attempt to drive away from traffic lights in the wrong gear.	0	1	2	3	4	5
Become impatient with a slow driver in the fast lane and pass on the right.	0	1	2	3	4	5
Drive especially close to a car in front as a signal to the driver to go faster or get out of the way.	0	1	2	3	4	5
Attempt to pass someone that you hadn't noticed to be making a left turn.	0	1	2	3	4	5
Forget where you left your car in a parking lot.	0	1	2	3	4	5
Turned on one thing, such as your headlights, when you meant to switch on something else, such as the windshield wipers.	0	1	2	3	4	5
Realize that you have no clear recollection of the road along which you have just been traveling.	0	1	2	3	4	5
Cross an intersection knowing that the traffic lights have already changed from yellow to red.	0	1	2	3	4	5
Fail to notice that pedestrians are crossing when turning onto a side street from a main road.	0	1	2	3	4	5
Angered by another driver's behavior, you caught up to them with the intention of giving him/her "a piece of your mind."	0	1	2	3	4	5
Misread the signs and turn the wrong direction on a one-way street.	0	1	2	3	4	5
Disregard the speed limits late at night or early in the morning.	0	1	2	3	4	5
When turning right, nearly hit a bicyclist who is riding along side of you.	0	1	2	3	4	5
Attempting to turn onto a main road, you pay such close attention to traffic on the road you are entering that you nearly hit the car in front of you that is also waiting to turn.	0	1	2	3	4	5
Drive even though you realize you might be over the legal blood alcohol limit.	0	1	2	3	4	5
Have an aversion to a particular class of road user, and indicate your hostility by whatever means you can.	0	1	2	3	4	5
Underestimate the speed of an oncoming vehicle when attempting to pass a vehicle in your own lane.	0	1	2	3	4	5
Hit something when backing up that you had not previously seen.	0	1	2	3	4	5
Intending to drive to destination A, you 'wake up' to find yourself on a road to destination B, perhaps because destination B is a more common destination.	0	1	2	3	4	5
Get into the wrong lane approaching an intersection.	0	1	2	3	4	5
Miss "Yield" signs, and narrowly avoid colliding with traffic having the right of way.	0	1	2	3	4	5
Fail to check your rearview mirror before pulling out, changing lanes, etc.	0	1	2	3	4	5
Get involved in unofficial 'races' with other drivers.	0	1	2	3	4	5
Brake too quickly on a slippery road, or steer the wrong way into a skid	0	1	2	3	4	5

Questionnaire 8

***Please Don't Turn the Page Until you are
done with Experiment No. 3 and finished
with Questionnair No. 6 & 7***

Driver Style Questionnaire (DSQ)

The questionnaire below requires you to judge the frequency of your own driving errors and violations. For each item you are asked to indicate *how often*, if at all, this kind of thing has happened to you. Base your judgements on what you remember of your own driving over the past year.

Please indicate your judgements by circling the response

	Never	Hardly Ever	Occasionally	Quite Often	Frequently	Nearly All The Time
Sometimes when driving, things happen very quickly. Do you remain calm in such situations?	0	1	2	3	4	5
Do you plan long journeys in advance, including places to stop and rest?	0	1	2	3	4	5
Do you dislike people giving you advice about your driving?	0	1	2	3	4	5
Do you exceed the 70 mph speed limit on the expressway?	0	1	2	3	4	5
Do you ever drive through a traffic light after it has turned to red?	0	1	2	3	4	5
Do you exceed the speed limit on surface streets in urban areas?	0	1	2	3	4	5
Do you ignore passengers urging you to lower your speed?	0	1	2	3	4	5
Do you become flustered when faced with sudden dangers while driving?	0	1	2	3	4	5
How often do you set out on an unfamiliar trip without first looking at a map?	0	1	2	3	4	5
Are you happy to get advice from people about your driving?	0	1	2	3	4	5
Do you drive cautiously?	0	1	2	3	4	5
Do you find it easy to ignore distractions while driving?	0	1	2	3	4	5
Do you drive fast?	0	1	2	3	4	5
Do you pass other vehicles on the right, given the opportunity?	0	1	2	3	4	5
Is your driving affected by pressure from other motorists?	0	1	2	3	4	5

Thank you for your time and effort!

Questionnaire 9

Please Don't Turn the Page Until you are
done with Experiment No. 4

Locus of Control

Based on J.B. Rotter (1966) Generalized expectancies for internal versus external control of reinforcement, Psychological Monographs, 80, (1, Whole No. 609).

Instructions:

For each question, select the one statement that best describes how you feel.

1.
Many of the unhappy things in people's lives are partly due to bad luck.

People's misfortunes result from the mistakes they make.

2.
One of the major reasons why we have wars is because people don't take enough interest in politics.

There will always be wars, no matter how hard people try to prevent them.

3.
In the long run, people get the respect they deserve in this world.

Unfortunately, an individual's worth often passes unrecognized no matter how hard he tries.

4.
The idea that teachers are unfair to students is nonsense.

Most students don't realize the extent to which their grades are influenced by accidental happenings.

5.
Without the right breaks, one cannot be an effective leader.

Capable people who fail to become leaders have not taken advantage of their opportunities.

6.
No matter how hard you try, some people just don't like you.

People who can't get others to like them don't understand how to get along with others.

7.
I have often found that what is going to happen will happen.

Trusting to fate has never turned out as well for me as making a decision to take a definite course of action.

8.
In the case of the well prepared student, there is rarely, if ever, such a thing as an unfair test.

Many times exam questions tend to be so unrelated to course work that studying is really useless.

9.
Becoming a success is a matter of hard work; luck has little or nothing to do with it.

Getting a good job depends mainly on being in the right place at the right time.

10.
The average citizen can have an influence in government decisions.

This world is run by the few people in power, and there is not much the little guy can do about it.

11.
When I make plans, I am almost certain that I can make them work.

It is not always wise to plan too far ahead because many things turn out to be a matter of luck anyway.

12.
In my case, getting what I want has little or nothing to do with luck.

Many times we might just as well decide what to do by flipping a coin.

13.
What happens to me is my own doing.

Sometimes I feel that I don't have enough control over the direction my life is taking.

Thank you for your time and effort!

Questionnaire 10

> ***Please Don't Turn the Page Until you are done with Experiment No. 4 and finished with Questionnair No. 9***

Driving Risk Perception Questionnaire

Please rate the following behaviors by marking your answer along the appropriate scale. For each behavior, we ask that you rate it by: (1) how frequently you engage in that behavior; (2) How likely you think will be pulled over by the police and cited for doing the behavior; and (3) How likely you think you will be involved in an accident as a result of doing the behavior.

Driving 10-20 MPH over the speed limit

How often do you engage in this behavior?

Never 1   2   3   4   5   6   7 Most of the time
         Occasionally

How likely are you to get a ticket while doing this behavior?

Never 1   2   3   4   5   6   7 Most of the time
         Occasionally

How likely are you to get in an accident while doing this behavior?

Never 1   2   3   4   5   6   7 Most of the time
         Occasionally

Not yielding to a pedestrian

How often do you engage in this behavior?

Never 1   2   3   4   5   6   7 Most of the time
         Occasionally

How likely are you to get a ticket while doing this behavior?

Never 1   2   3   4   5   6   7 Most of the time
         Occasionally

How likely are you to get in an accident while doing this behavior?

Never 1   2   3   4   5   6   7 Most of the time
         Occasionally

Driving too fast for the road conditions

How often do you engage in this behavior?

Never 1   2   3   4   5   6   7 Most of the time
         Occasionally

How likely are you to get a ticket while doing this behavior?

Never 1   2   3   4   5   6   7 Most of the time
         Occasionally

How likely are you to get in an accident while doing this behavior?

Never 1   2   3   4   5   6   7 Most of the time
         Occasionally

Blood alcohol level slightly over the legal limit

How often do you engage in this behavior?

Never 1   2   3   4   5   6   7 Most of the time
         Occasionally

How likely are you to get a ticket while doing this behavior?

Never 1   2   3   4   5   6   7 Most of the time
         Occasionally

How likely are you to get in an accident while doing this behavior?

Never 1   2   3   4   5   6   7 Most of the time
         Occasionally

Driving without a seat belt

How often do you engage in this behavior?

Never 1 2 3 4 5 6 7 Most of the time
          Occasionally

How likely are you to get a ticket while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
          Occasionally

How likely are you to get in an accident while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
          Occasionally

Not yielding the right of way

How often do you engage in this behavior?

Never 1 2 3 4 5 6 7 Most of the time
          Occasionally

How likely are you to get a ticket while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
          Occasionally

How likely are you to get in an accident while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
          Occasionally

Driving more than 20 MPH over the speed limit

How often do you engage in this behavior?

Never 1 2 3 4 5 6 7 Most of the time
          Occasionally

How likely are you to get a ticket while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
          Occasionally

How likely are you to get in an accident while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
          Occasionally

Tailgating

How often do you engage in this behavior?

Never 1 2 3 4 5 6 7 Most of the time
          Occasionally

How likely are you to get a ticket while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
          Occasionally

How likely are you to get in an accident while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
          Occasionally

Driving with badly worn tires

How often do you engage in this behavior?

Never 1 2 3 4 5 6 7 Most of the time
          Occasionally

How likely are you to get a ticket while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
          Occasionally

How likely are you to get in an accident while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
          Occasionally

Not stopping at a red light

How often do you engage in this behavior?

Never 1 2 3 4 5 6 7 Most of the time
Occasionally

How likely are you to get a ticket while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
Occasionally

How likely are you to get in an accident while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
Occasionally

Performing an illegal U-turn

How often do you engage in this behavior?

Never 1 2 3 4 5 6 7 Most of the time
Occasionally

How likely are you to get a ticket while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
Occasionally

How likely are you to get in an accident while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
Occasionally

Turning with using a signal

How often do you engage in this behavior?

Never 1 2 3 4 5 6 7 Most of the time
Occasionally

How likely are you to get a ticket while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
Occasionally

How likely are you to get in an accident while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
Occasionally

Blood alcohol level 50% over the legal limit

How often do you engage in this behavior?

Never 1 2 3 4 5 6 7 Most of the time
Occasionally

How likely are you to get a ticket while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
Occasionally

How likely are you to get in an accident while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
Occasionally

Driving with under-inflated tires

How often do you engage in this behavior?

Never 1 2 3 4 5 6 7 Most of the time
Occasionally

How likely are you to get a ticket while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
Occasionally

How likely are you to get in an accident while doing this behavior?

Never 1 2 3 4 5 6 7 Most of the time
Occasionally

Passing where visibility is obscured

How often do you engage in this behavior?

1   2   3   4   5   6   7
Never   Occasionally   Most of the time

How likely are you to get a ticket while doing this behavior?

1   2   3   4   5   6   7
Never   Occasionally   Most of the time

How likely are you to get in an accident while doing this behavior?

1   2   3   4   5   6   7
Never   Occasionally   Most of the time

Not making a full stop at a stop sign

How often do you engage in this behavior?

1   2   3   4   5   6   7
Never   Occasionally   Most of the time

How likely are you to get a ticket while doing this behavior?

1   2   3   4   5   6   7
Never   Occasionally   Most of the time

How likely are you to get in an accident while doing this behavior?

1   2   3   4   5   6   7
Never   Occasionally   Most of the time

Note: Based upon a questionnaire developed by DeJoy (DeJoy, D.M, 1990, Gender differences in traffic accident risk perception. In *Proceedings of the Human Factors Society 34th Annual Meeting*, 1032-1036.)

Questionnaire 11

Please Don't Turn the Page Until you are done with Experiment No. 4 and finished with Questionnair No. 9 & 10

How authentic was the driving environment?

Mark an X accordingly.

Not Authentic -- Very Authentic

How were the traffic and the environment in the Simulated World?

Please mark an *X* accordingly.

	Bad Experience	Good Experience
Steering	--	
Gear	--	
Paddle	--	
Front View	--	
Side View	--	
Rear View	--	

How real was the driving environment?
Mark an X accordingly.

Not Real -- Very Real

If not then why?

How difficult was the driving environment?
Mark an X accordingly.

Not Difficult -- Very Difficult

Was there anything missing in the instructions? If yes then what?

Were there any other factors missing in the driving environment? If yes then please identify.

Were you able to identify the difference between the automatically driven cars and the real cars in the simulated driving world / environment?

- o   Yes
- o   No

If yes why and how?

If no then why not?

Thank you for your time and effort!

Driver's Data Collection Sheet

Experiment No.1 (*Please note in the order as you see the signs*)

1.   5.

2.   6.

3.   7.

4.   8.

Complete Sentence:

_____

_____

Experiment No.2 (*Please note in the order as you see the signs*)

1.   6.

2.   7.

3.   8.

4.   9.

5.   10.

Complete Sentence:

_____

Experiment No.3 (*Please note in the order as you see the signs*)

1.   6.

2.   7.

3.   8.

4.   9.

5.   10.

Complete Sentence:

_____

_____

Experiment No.4 (*Please note in the order as you see the signs*)

1.   4.

2.   5.

3.   6.

Complete Sentence:

_____

_____

_____

8.4. Appendix D

IMPORTANT WORKING SCRIPTS

```java
//Car.java Class file

import java.util.ArrayList;
import java.util.Iterator;
import java.io.*;
import java.text.*;
import java.math.BigDecimal;

class Car {

    ArrayList trail;
    ArrayList intersectionEvents;
    ArrayList meetings;
    Intersection[] intersections;

    String name;
    PrintStream p;
    PrintStream p1,p2;

    Car(float _length, float _width,String _name){

    this.name = _name;
// Contain the time xpos ypos and speed for this specific car.
    trail = new ArrayList();
// meetings contains times and data when two cars are in the same intersection at the same
time.
    meetings = new ArrayList();

// We only have 2 intersections inter0 x:0 y:340 and inter1 x:0 y:0
        intersections = new Intersection[2];

        intersections[0] = new Intersection((float)0.0 , (float)340.0);
        intersections[1] = new Intersection((float)0.0 , (float)0.0);

    }

    void loadTrail(Data data, int timeCol,int xCol,int yCol, int spdCol, int accCol, int lposCol, int
ttcCol, int pnCol, int dtiCol, int headCol)
{

        Float [] s;
        Iterator e = data.getMatrix().iterator();
        while (e.hasNext())
           {
```

```java
            Float [] trailDat;
            trailDat = new Float[10];

            s = (Float[])e.next();
            for (int i = 0;i < s.length;i++) {
                if (i == timeCol) trailDat[0] = s[i];

                if (i == xCol) trailDat[1] = s[i];
                if (i == yCol) trailDat[2] = s[i];
                if (i == spdCol) trailDat[3] = s[i];
                if (i == accCol) trailDat[4] = s[i];
                if (i == lposCol) trailDat[5] = s[i];
                if (i == ttcCol) trailDat[6] = s[i];
                if (i == pnCol) trailDat[7] = s[i];
                if (i == dtiCol) trailDat[8] = s[i];
                if (i == headCol) trailDat[9] = s[i];
                /* Add Acceleration, LatPos, TTC */
            }
        trail.add(trailDat);

        }

    }


String getTurnType(long p1, long p2){

        String turnType = "nada";

        Float[] s = (Float[])trail.get((int)p1);
        Float[] t = (Float[])trail.get((int)p2);

        int startAngle = Math.round((s[9] / (float)90.0)) % 4;
        int endAngle = Math.round((t[9] / (float)90.0)) % 4;

        if (endAngle - startAngle == -1) turnType = "rightturn";
        if (endAngle - startAngle == 1) turnType = "lefturn";
        if (endAngle == 3 && startAngle == 0) turnType = "rightturn";
        if (endAngle == 0 && startAngle == 3) turnType = "lefturn";

        if (endAngle == startAngle) turnType = "noturn";

        return turnType;
}

boolean inBox(float ix, float iy,float bx,float by,float length){

        if (Math.abs(ix - bx) > length) return false;
        if (Math.abs(iy - by) > length) return false;

        return true;
```

```
    }

    int getPos(long p, float ix,float iy,float dist){

        int pos = -1;

        Float[] s = (Float[])trail.get((int)p);

        float bx = s[1];
        float by = s[2];

        if (inBox(ix, iy - dist, bx,by, dist / 2)) pos = 0;
        if (inBox(ix + dist, iy, bx,by, dist / 2)) pos = 1;
        if (inBox(ix, iy + dist, bx,by, dist / 2)) pos = 2;
        if (inBox(ix - dist, iy, bx,by, dist / 2)) pos = 3;

        return pos;
    }

    float getTime(long p){

        Float[] s = (Float[])trail.get((int)p);

        return s[0];
    }

    void getIntersectionsDrivings(float range) { // range variable is not used

        if (trail.size() == 0){
            System.out.println("car data are not loaded");
            System.exit(0);
        }

        intersectionEvents = new ArrayList();

        long pos = 0;
        long x1 = 0;
        long x2 = 0;
        int inIntersection = -1;

        Float [] s;
        Iterator e = trail.iterator();
        while (e.hasNext())
          {
                s = (Float[])e.next();
// Check for this loop .. original 4 ..AHY
                for (int i = 0;i <2;i++){

                    boolean in = inBox(intersections[i].x,intersections[i].y,s[1],s[2],30);

                    if (in){
```

```
                    if (inIntersection == -1){
                            x1 = pos;
                            inIntersection = i;
                    }

              }
            if (!in){
                    if (inIntersection == i){
                        x2 = pos;

                        String turnType = this.getTurnType(x1,x2);

   int startPosition = getPos(x1,intersections[inIntersection].x,
intersections[inIntersection].y, (float)30.0);

int endPosition = getPos(x2,intersections[inIntersection].x,
intersections[inIntersection].y, (float)30.0);

  float startTime = getTime(x1);
  float endTime = getTime(x2);

  if (startPosition != -1) intersectionEvents.add(new
IntersectionEvents(inIntersection,turnType,startPosition,endPosition,x1,x2,startTime,endTime));

                        inIntersection = -1;
                    }
                }
            }
            pos += 1;
        }
  }

  private static String roundOff (String s)
  {
        if (s == null || s.trim().length() == 0 || "0.00".equalsIgnoreCase(s) ||
"0".equalsIgnoreCase(s) || "-0.00".equalsIgnoreCase(s) || "-00.0".equalsIgnoreCase(s) || "-
00.00".equalsIgnoreCase(s)|| "-0".equalsIgnoreCase(s)|| "-0.0".equalsIgnoreCase(s))
        {
                return "0.00";
        }
        double d = 0.00;
        int ind = s.indexOf('.');
        if (ind>0)
        {
                String dec = s.substring(ind);
                if (dec.length() == 1){
                        s = s.concat("00");
                        return s;
                }
                if (dec.length() == 2)
                {
```

```
                s = s.concat("0");
                return s;
        }
        if (dec.length() == 3)
        {
                return s;
        }
    }
    if (ind == -1)
    {
        return s.concat(".00");

    }
    try
    {
        d = Double.parseDouble(s);
        int decimalPlaces = 2;
        BigDecimal bd = new BigDecimal (d);
        bd = bd.setScale (decimalPlaces, BigDecimal.ROUND_HALF_UP);
        d = bd.doubleValue();
        return String.valueOf(d);
    }
    catch (java.lang.NumberFormatException nfe)
    {
        return s.substring(0,ind);

    }
}
void getMeetings(Car other){

    Iterator e = this.intersectionEvents.iterator();
    while (e.hasNext())
      {
        // s = one intersection event that we are observing
        // A intersection event is when a car is in a intersection.
        IntersectionEvents s = (IntersectionEvents)e.next();

        Iterator f = other.intersectionEvents.iterator();
        while (f.hasNext())
        {
            // t = the other car's intersection event
            IntersectionEvents t = (IntersectionEvents) f.next();

            boolean crossed = false;

            if ((s.startTime >= t.startTime) && (s.startTime <= t.endTime) &&
s.intersection == t.intersection)
                {
                crossed = true;
                // meetings contains times when two cars are in the same
intersection at the same time.
```

```
                                meetings.add(new Meeting(s,t,this,other,this.name));
                        }
                if ((s.endTime >= t.startTime) && (s.endTime <= t.endTime) && s.intersection
== t.intersection && crossed != true)
                        {
                                crossed = true;
                                meetings.add(new Meeting(s,t,this,other,this.name));
                        }
                if ((t.startTime >= s.startTime) && (t.startTime <= s.endTime) &&
s.intersection == t.intersection && crossed != true)
                        {
                                crossed = true;
                                        meetings.add(new Meeting(s,t,this,other,this.name));
                        }
                if ((t.endTime >= s.startTime) && (t.endTime <= s.endTime) &&
s.intersection == t.intersection && crossed != true)
                        {
                                crossed = true;
                                meetings.add(new Meeting(s,t,this,other,this.name));
                        }

                        }
                }

    }

    void printMeetings(){

        Iterator e = meetings.iterator();

        while (e.hasNext())
                {
                        Meeting m = (Meeting) e.next();
                        m.print();
                }

    }


    void dumpMeetings(){

        Iterator e = meetings.iterator();
        FileOutputStream out;
        FileOutputStream out1;
        FileOutputStream out2;
        int meetnumb = 0;


        while (e.hasNext())
                {
                String PETable;
```

```
                Meeting meeting = (Meeting) e.next();
                meetnumb++;
                //System.out.println("pet friendly"+meeting.PETfriendly);
                if (meeting.PETfriendly){
                        PETable = "YESPET";

                }else{
                        PETable = "NOPET";
                }

                try
                {
                        out = new FileOutputStream("c:/data/meetings/" + this.name +" "+ "S4" +"
"+" Meeting " + meetnumb + "_" + PETable + ".dat");
                        out1 = new FileOutputStream("c:/data/meetings/" + this.name +" "+ "S4"
+" "+ " DI " + meetnumb + "_" + PETable + ".dat");


                        out2 = new FileOutputStream("c:/data/pet/" + this.name + "_" +" "+ "S4"
+" "+ PETable + " "+ meetnumb + ".dat");
                        p2 = new PrintStream (out2);




                        p = new PrintStream( out );
                p1 = new PrintStream( out1 );

                }
                catch (Exception ex)
                {
                        System.err.println ("Error writing to file");
                }

                p.println ("t1              x1              y1              t2              x2
y2");
                p1.println("t1      mcar          acc           spd           lpos           dti
tcar");

        p2.println("MCar           TCar          PETVal          PETTotal");

                long pos1 = meeting.k1.x1;
                long pos2 = meeting.k2.x1;
                int chk = 0;
                while (pos1 < meeting.k1.x2 || pos2 < meeting.k2.x2){
                        String t1 = " ";
                        String t2 = " ";
                        String x1 = " ";
                        String y1 = " ";
                        String x2 = " ";
                        String y2 = " ";
```

```
String acc1 = " ";
String spd1 = " ";
String lpos1 = " ";
String dti1 = " ";

if (pos1 < meeting.k1.x2){
        Float[] g1 = (Float[])this.trail.get((int) pos1);
        t1 = g1[0].toString();
        x1 = g1[1].toString();
        y1 = g1[2].toString();
        chk = 0;
        if (g1[8] <5 && g1[8]>0){
        acc1 = g1[4].toString();
        spd1 = g1[3].toString();
        lpos1 = g1[5].toString();
        dti1 = g1[8].toString();
        chk = 1;
        }
}
if (pos2 < meeting.k2.x2){
        Float[] g2 = (Float[])meeting.other.trail.get((int) pos2);
        t2 = g2[0].toString();
        x2 = g2[1].toString();
        y2 = g2[2].toString();
        chk = 0;
        if (g2[8] <5 && g2[8]>0){
        acc1 = g2[4].toString();
        spd1 = g2[3].toString();
        lpos1 = g2[5].toString();
        dti1 = g2[8].toString();
        chk = 1;
        }
}
//if (meeting.PETfriendly){

//p2.println(this.name + " " + "P1" +" "+ meeting.other.name + " " +
meeting.petval + " " + meeting.pettot );
        //}
        p.println( roundOff(t1) + "              " + roundOff(x1) + "           " +
roundOff(y1) + "               " + roundOff(t2) + "             "+ roundOff(x2) + "           " +
roundOff(y2) );

        if(chk == 1)
        p1.println(roundOff(t1) + "                " + this.name +"                 "+
roundOff(acc1) + "              " + roundOff(spd1) + "          " + roundOff(lpos1) + "
    "+ roundOff(dti1)+ "              "+ meeting.other.name );


        pos1++;
        pos2++;
}
```

```
                p2.append(this.name + "              " + meeting.other.name + "            " +
meeting.petval + "              " + meeting.pettot );
                p.close();
                p1.close();
                p2.close();

                }


        }

    void getSpeeds(){

                System.out.println("Meeting speed for " + this.name);

                System.out.println("30:");

                Iterator e1 = this.meetings.iterator();
        while (e1.hasNext())
          {
                Meeting s1 = (Meeting)e1.next();

                s1.getSpeed30();
          }

                System.out.println("20:");

                Iterator e2 = this.meetings.iterator();
        while (e2.hasNext())
          {
                Meeting s2 = (Meeting)e2.next();

                //s2.getSpeed20();
          }

                System.out.println("10:");

                Iterator e3 = this.meetings.iterator();
        while (e3.hasNext())
          {
                Meeting s3 = (Meeting)e3.next();

                s3.getSpeed10();
          }

                System.out.println("5:");

                Iterator e4 = this.meetings.iterator();
        while (e4.hasNext())
          {
                Meeting s4 = (Meeting)e4.next();
```

```java
                    //s4.getSpeed5();
            }
    }

    void printintersectionEvents() {

    System.out.println("IntersectionEvents:");
    System.out.println("Car: " + this.name);

            System.out.print("number of detected intersections: ");
            System.out.println(intersectionEvents.size());

            IntersectionEvents s;
            Iterator e = intersectionEvents.iterator();
            while (e.hasNext())
                {
                    s = (IntersectionEvents)e.next();

                    System.out.print("intersection " + s.intersection + ", p1 " + s.x1 + ", p2 " + s.x2 +
", Svängtyp " + s.turnType + ", startPos " + s.startPos + ", endPos " +s.endPos + ",t1 " +
s.startTime + ",t2 " + s.endTime);

                    System.out.println();
                }
            System.out.println();
    }
    void printTrail() {

            System.out.println("storlek på trailen:");
            System.out.println(trail.size());

            Float [] s;
            Iterator e = trail.iterator();
            while (e.hasNext())
                {
                    s = (Float[])e.next();
                    for (int i = 0;i < s.length;i++) {
                        System.out.print(s[i]);
                        System.out.print(",");
                    }
                    System.out.println();
                }
    }
}
// PET Class
class PET {

    public static void main (String args[]) {

            Data mainTarget1Data = new Data("c:/data/Data-20070828-G12-S4-WD-C1-P45.dat");
```

```
Data mainTarget2Data = new Data("c:/data/Data-20070828-G12-S4-WD-C2-P46.dat");
Data mainTarget3Data = new Data("c:/data/Data-20070828-G12-S4-WD-C4-P47.dat");
Data mainTarget4Data = new Data("c:/data/Data-20070828-G12-S4-WD-C3-P48.dat");

Car [] MT = new Car[4];

// HumanCar
MT[0] = new Car((float)4.6, (float)1.75, "P45");
MT[0].loadTrail(mainTarget1Data,0,1,2,4,5,6,7,9,8,3);

MT[1] = new Car((float)4.6, (float)1.75, "P46");
MT[1].loadTrail(mainTarget2Data,0,1,2,4,5,6,7,9,8,3);

MT[2] = new Car((float)4.6, (float)1.75, "P47");
MT[2].loadTrail(mainTarget3Data,0,1,2,4,5,6,7,9,8,3);

MT[3] = new Car((float)4.6, (float)1.75, "P48");
MT[3].loadTrail(mainTarget4Data,0,1,2,4,5,6,7,9,8,3);

// AI-car
Car[] AIcars = new Car[8];

int AIbil = 1;

int ptr1 = 10;
for (int i = 0;i < 2;i++){

        AIbil++;

        AIcars[i] = new Car((float)4.6, (float)1.75, "AI-Car " + AIbil);

    AIcars[i].loadTrail(mainTarget1Data,0,ptr1,ptr1+1,ptr1+3,ptr1+4,ptr1+5,ptr1+6,ptr1+8,ptr
1+7, ptr1+2);
        ptr1 += 9;
}

int ptr2 = 10;
for (int i = 2;i < 4;i++){

        AIbil++;

        AIcars[i] = new Car((float)4.6, (float)1.75, "AI-Car " + AIbil);

    AIcars[i].loadTrail(mainTarget2Data,0,ptr2,ptr2+1,ptr2+3,ptr2+4,ptr2+5,ptr2+6,ptr2+8,ptr
2+7, ptr2+2);
        ptr2 += 9;
}

int ptr3 = 10;
for (int i = 4;i < 6;i++){
```

```
        AIbil++;

        AIcars[i] = new Car((float)4.6, (float)1.75, "AI-Car " + AIbil);

    AIcars[i].loadTrail(mainTarget3Data,0,ptr3,ptr3+1,ptr3+3,ptr3+4,ptr3+5,ptr3+6,ptr3+8,ptr
3+7,ptr3+2);
        ptr3 += 9;
    }

    int ptr4 = 10;
    for (int i = 6;i < 8;i++){

        AIbil++;

        AIcars[i] = new Car((float)4.6, (float)1.75, "AI-Car " + AIbil);

    AIcars[i].loadTrail(mainTarget4Data,0,ptr4,ptr4+1,ptr4+3,ptr4+4,ptr4+5,ptr4+6,ptr4+8,ptr
4+7, ptr4+2);
        ptr4 += 9;
    }

    // give garbagecollectorn somthing to do

    mainTarget1Data = null;
    mainTarget2Data = null;
    mainTarget3Data = null;
    mainTarget4Data = null;

    // Now it is 30 meter from intersection that is used
//4
    for (int i = 0;i < 4;i++) // Loop all Main Targets
    {
        // MT = MainTarget
        MT[i].getIntersectionsDrivings((float) 30.0);
    }
//24
    // Meetings between MainTarget And AICar
    for (int i = 0;i < 8;i++){ // Loop all AI Cars

        AIcars[i].getIntersectionsDrivings((float) 30.0);
//4
        for (int j = 0;j < 4;j++) // Loop all Main Targets
            {
            MT[j].getMeetings(AIcars[i]);
            }
        }

//4
//      Meetings between MainTarget And MainTarget
    for (int k = 0;k < 4;k++)
    {  //4
```

```
                for (int l = 0;l < 4;l++)
                {
                        if (k != l)
                                {
                                MT[k].getMeetings(MT[l]);
                                }
                }
        }

        MT[3].dumpMeetings();
        MT[1].dumpMeetings();
        MT[2].dumpMeetings();
        MT[0].dumpMeetings();


        MT[0].getSpeeds();
        MT[1].getSpeeds();
        MT[2].getSpeeds();
        MT[3].getSpeeds();

    }
}


// Data Class

import java.io.DataInputStream;
import java.io.FileInputStream;
import java.util.ArrayList;
import java.util.Iterator;
import java.util.StringTokenizer;

class Data {

    String[] titles;
    ArrayList dataRows;
    int columns;

    Data (String filename) {

        try
        {
            dataRows = new ArrayList();

            System.out.println("Loading data");

            FileInputStream fstream = new FileInputStream(filename);
            DataInputStream in = new DataInputStream(fstream);

            StringTokenizer rubr = new StringTokenizer(in.readLine());
            titles = new String [rubr.countTokens()];
```

```java
        int rubn = 0;
        while (rubr.hasMoreTokens ()){
            titles[rubn] = rubr.nextToken();
            rubn += 1;
        }

        in.readLine();

        while (in.available() != 0) {

            StringTokenizer st = new StringTokenizer (in.readLine());
            int colums = st.countTokens();
            Float [] dataRad;
            dataRad = new Float [st.countTokens()];

            int radn = 0;

              while (st.hasMoreTokens ()) {
                String str = st.nextToken();

                try { // dataRad = is a row in the logfile
                    dataRad[radn] = Float.valueOf(str.trim()).floatValue();
                    radn += 1;
                } catch (NumberFormatException nfe) {
                    System.out.println("NumberFormatException: " + nfe.getMessage());
                }
            }
            dataRows.add(dataRad);

        }

         in.close();
    }
      catch (Exception e)
    {
        System.out.println("File input error");
        System.exit(0);
    }

    System.out.println("Data loaded.");

}

void print() {

    Float [] s;
    Iterator e = dataRows.iterator();
    while (e.hasNext())
       {
            s = (Float[])e.next();
```

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```
            for (int i = 0;i < s.length;i++) {
               System.out.print(s[i]);
               System.out.print(",");
            }
            System.out.println();
         }
   }

   void print_titles() {
        for (int i = 0;i < titles.length;i++)
           {
                System.out.print(titles[i]);
                System.out.print(",");
           }
        System.out.println();
        System.out.println();
   }

   int rows() {
        return dataRows.size();
   }

   int cols() {
        return titles.length;
   }

   ArrayList getMatrix() {
        return dataRows;
   }
}

// Meeting Class

class Meeting{

        IntersectionEvents k1,k2;
        boolean PETfriendly;
        Car primary, other, tst;
        String thisName;
        double petval;
        int pettot=0;

        Meeting(IntersectionEvents _k1, IntersectionEvents _k2, Car _primary, Car _other,String
_thisName){

                this.k1 = _k1;
                this.k2 = _k2;
                other = _other;
                thisName = _thisName;
                primary = _primary;
```

```java
        PETfriendly = false;

        if (k1.turnType == "noturn" && k2.turnType == "leftturn"){
                if ( (k1.startPos != k2.startPos) ){
                        PETfriendly = true;
        //              System.out.println("in no and left");
                }
        }
        if (k1.turnType == "leftturn" && k2.turnType == "noturn"){
                if ( (k1.startPos != k2.startPos) ){
                        PETfriendly = true;
        //              System.out.println("in left and no");
                }
        }
        if (k1.turnType == "leftturn" && k2.turnType == "leftturn"){
                if ( (k1.startPos != k2.startPos) ){
                        PETfriendly = true;
        //              System.out.println("in left and left");
                }
        }
        if (k1.turnType == "noturn" && k2.turnType == "rightturn"){
                if ( (k1.startPos != k2.startPos) ){
                        PETfriendly = true;
                        //System.out.println("in no and right");
                }
        }
        if (k1.turnType == "rightturn" && k2.turnType == "noturn"){
                if ( (k1.startPos != k2.startPos) ){
                        PETfriendly = true;
                        //System.out.println("in right and no");
                }
        }
        if (k1.turnType == "rightturn" && k2.turnType == "rightturn"){
                if ( (k1.startPos != k2.startPos) ){
                        PETfriendly = true;
                        //System.out.println("in rigth and right");
                }
        }
        //System.out.println("in no");
        getPET();

}

void getPET(){

        float leastDistance = (float) 999999.0;
        long pos1 = 0;
        long pos2 = 0;
```

```
                        for (long p1 = k1.x1;p1 < k1.x2;p1++){
                                for (long p2 = k2.x1;p2 < k2.x2;p2++){

                                        Float[] s = (Float[]) primary.trail.get((int)p1);
                                        Float[] t = (Float[]) other.trail.get((int)p2);

                                        float x1 = s[1];
                                        float y1 = s[2];
                                        float x2 = t[1];
                                        float y2 = t[2];

                                        double dist = Math.sqrt((x2 - x1)*(x2 - x1) + (y2 - y1)*(y2 - y1));

                                        if (dist < leastDistance){
                                                leastDistance = (float)dist;
                                                pos1 = p1;
                                                pos2 = p2;
                                        }

                                }

                        }
// bajs = Junk
        if (/*primary.name == "bajs" && */this.PETfriendly){

                Float []a = (Float[])primary.trail.get((int)pos1);
                Float []b = (Float[])other.trail.get((int)pos2);


                System.out.println();
                System.out.println("Meeting: " + other.name);
                //System.out.println("t1 = " + a[0]);
                //System.out.println("t2 = " + b[0]);
                //System.out.println("x1 = " + a[1]);
                //System.out.println("y1 = " + a[2]);
                //System.out.println("x2 = " + b[1]);
                //System.out.println("y2 = " + b[2]);
                petval = Math.floor( (Math.abs(b[0] - a[0])));

                pettot = pettot + 1;
                System.out.println("PET Tot: " + pettot);
                System.out.println("PET = " + Math.abs(b[0] - a[0]));
                System.out.println("PET = " + (b[0] - a[0]));
        }

        }

        void getSpeed30(){

                Float[] ea = (Float[])primary.trail.get((int)k1.x1);
```

```
                System.out.println(ea[3]);
                System.out.println(ea[4]);
                System.out.println(ea[5]);
                System.out.println(ea[6]);
                System.out.println(ea[7]);
                System.out.println(ea[8]);
                System.out.println(ea[9]);
//              Add Acceleration, LatPos, TTC
        }

        void getSpeed20(){

                for (int p1 = (int)k1.x1;p1 < k1.x2;p1++){
                        Float[] ea = (Float[])primary.trail.get((int)p1);

                        if
(primary.inBox(primary.intersections[k1.intersection].x,primary.intersections[k1.intersection].y,ea
[1],ea[2],20)){
                                System.out.println("x = " + ea[1]);
                                System.out.println("y = " + ea[2]);
                                System.out.println(ea[3]);
                                System.out.println(ea[4]);
                                System.out.println(ea[5]);
                                System.out.println(ea[6]);
                                System.out.println(ea[7]);
                                System.out.println(ea[8]);
                                System.out.println(ea[9]);
                                // Add Acceleration, LatPos, TTC
                                return;
                        }
                }
        }

        void getSpeed10(){

                for (int p1 = (int)k1.x1;p1 < k1.x2;p1++){
                        Float[] ea = (Float[])primary.trail.get((int)p1);

                        if
(primary.inBox(primary.intersections[k1.intersection].x,primary.intersections[k1.intersection].y,ea
[1],ea[2],10)){
                                System.out.println("x = " + ea[1]);
                                System.out.println("y = " + ea[2]);
                                System.out.println(ea[3]);
                                System.out.println(ea[4]);
                                System.out.println(ea[5]);
                                System.out.println(ea[6]);
                                System.out.println(ea[7]);
                                System.out.println(ea[8]);
                                System.out.println(ea[9]);
//                              Add Acceleration, LatPos, TTC
```

```
                        return;
                    }
                }
        }

        void getSpeed5(){

                for (int p1 = (int)k1.x1;p1 < k1.x2;p1++){
                        Float[] ea = (Float[])primary.trail.get((int)p1);

                        if
(primary.inBox(primary.intersections[k1.intersection].x,primary.intersections[k1.intersection].y,ea
[1],ea[2],5)){
                                System.out.println("x = " + ea[1]);
                                System.out.println("y = " + ea[2]);
                                System.out.println(ea[3]);
                                System.out.println(ea[4]);
                                System.out.println(ea[5]);
                                System.out.println(ea[6]);
                                System.out.println(ea[7]);
                                System.out.println(ea[8]);
                                System.out.println(ea[9]);
//                               Add Acceleration, LatPos, TTC
                                return;
                        }
                }
        }

        void print(){

                System.out.println();
                System.out.println("Meeting!!!");
                System.out.println("mellan:");
                System.out.println(thisName);
                System.out.println(other.name);
                System.out.println(k1.startTime);
                System.out.println(k1.endTime);
                System.out.println(k2.startTime);
                System.out.println(k2.endTime);

                System.out.println("turntyp1: " + k1.turnType);
                System.out.println("turntyp2: " + k2.turnType);

                System.out.println("startpos1: " + k1.startPos);
                System.out.println("endpos1: " + k1.endPos);
                System.out.println("startpos2: " + k2.startPos);
                System.out.println("startpos2: " + k2.endPos);

        }
}
```