



University of Stuttgart
Institute of Industrial Automation
and Software Engineering

- **Automated Test Scenario Generation for Autonomous Driving from Real-World Traffic Accident Reports: Information Mining of Driving Behaviors and Events**

Sijia Chen

Electrical Engineering

Supervisor: Yuchen Xia



- **Motivation**
- **Basis**
- **Conception Design**
- **Implementation**
- **Evaluation and Verification**
- **Summary and Outlook**

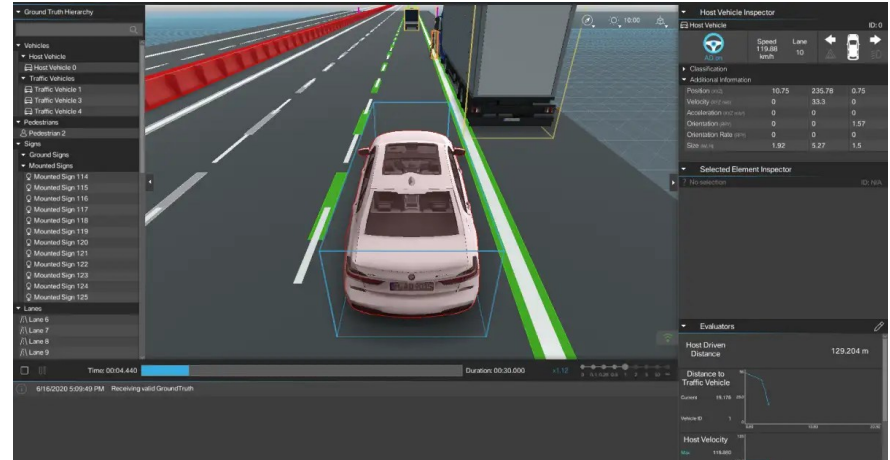


Motivation

Current Autonomous Driving Test Methods



[1]



[2]

Physical testing on public roads

- An engineer supervises the car
- Real-world experience

(!) traffic events are trivial

(!) limitation of time and physical space

Simulation Test

- Reproducible, no physical harm
- Not limited to time and physical space

(!) How **real** are the test cases?

(!) How **risky** are the test cases?

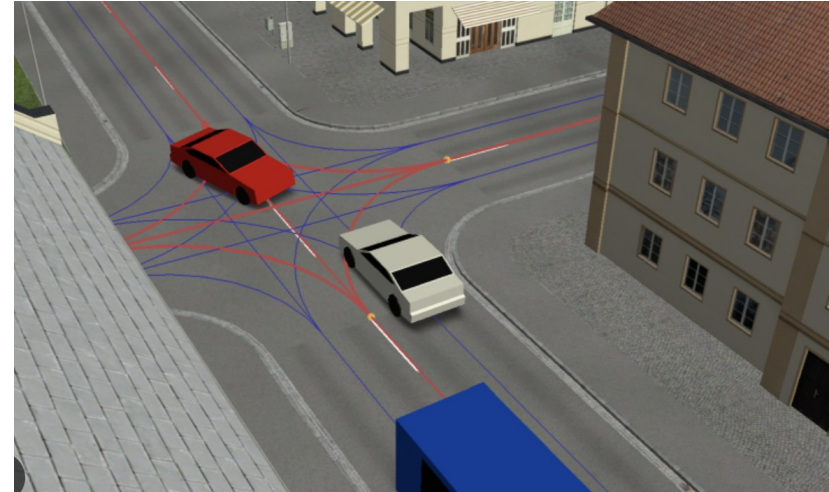
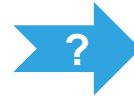
Initial ideas

Real and risky test cases?



[3]

Real Traffic Accident Reports



[4]

Simulation test case

The major problem



NMVCSS Case Viewer

Case Number: 2005-002-004

Case ID: 200500220042



Print Friendly Version of Case Download XML Source

Crash Overview - Summary

Case Number	4
Date	01/20/05
Day of Week	Friday
PMI Time of Crash	09:30
Crash Level KABC0U	A - Inappreciating injury

Case Summary

The crash occurred on a two lane undivided roadway with a posted speed limit of 40 MPH (30 MPH) and a -2.2% grade. There was an intersecting driveway to the right with a -13.2% grade. The weather was clear, the roadway dry and it was daylight at the time of this early morning weekday crash.

Vehicle 1, a 1996 Chevrolet Blazer, was traveling north on the two lane undivided roadway approaching the driveway. It should be noted that there was a large sign, small hill and telephone pole to this driver's right, which may have obscured the approach of Vehicle 2. Vehicle 2, a 2000 Toyota Corolla, was traveling west on the driveway approaching the main roadway. Vehicle 2 entered the main roadway and was struck in the left side by the front of Vehicle 1. Vehicle 2 was rotated counterclockwise off the left side of the roadway, over a small outcrop, into a private lawn and came to rest facing east. Vehicle 1 continued and came to rest in the southbound lane facing north.

The Chevrolet Blazer (Vehicle 1) was driven by a belted 50-year-old male who was transported, treated and released for a complaint of pain. Vehicle 1 was traveling north on the roadway and saw Vehicle 2 coming down the drive off to the right. He put on his brakes and steered right but hit Vehicle 2 on the left side. Vehicle 1 was towed due to damage.

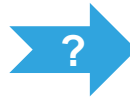
The Critical Precrash Event for Vehicle 1 was the encroachment of the other vehicle from a driveway. Intended path not known. The Critical Reason for the Critical Event was not coded to this vehicle. A possible contributing factor this crash may have been the sign, small hill and pole to this driver's right, which may have limited his sight of Vehicle 2's approach. No other associated factors were coded to the driver of the Blazer and he was not thought to be contributed to the crash.

The Toyota Corolla (Vehicle 2) was driven by a belted 25-year-old female who was transported, treated and hospitalized for 1 day due to a head injury. The driver of the Corolla stated that she had "blacked out" and did not recall the accident or the events preceding the accident. Vehicle 2 was towed due to damage.

The Critical Precrash Event for Vehicle 2 was to unknown travel direction. This was chosen due to no indication of turning left or right and the incapacitating threat of the driver. The Critical Reason for the Critical Event was the physical impairment of the ability to act of the driver. An associated factor coded to this driver was the use of prescription medications. She was taking two medications: a birth control pill and an antidepressant. They did not contribute to the crash.

Factor Summary

	Vehicle 1	Vehicle 2
Aggressive Behavior		
Alcohol		
Cargo Shift		
Cell Phone Use		
Deception		
Distraction		
Driver Fatigue		
Driver Inexperience		
Driver Performance		
Driver Physical		Present
Driver Stress/Emotion		Present
Drugs		
Roadway		
Speed/Distance		



```
<?xml version="1.0" encoding="UTF-8"?>
<OpenScenario>
  <FileHeader revMajor="1" revMinor="0" date="2020-03-20T12:00:00" description="CARLA:FollowLeadingVehicle" author="" />
  <ParameterDeclarations>
    <ParameterDeclaration name="LeadingSpeed" parameterType="double" value="2.0"/>
  </ParameterDeclarations>
  <CatalogLocations>
    <CatalogLocations>
      <RoadNetwork>
        <LogicFile filepath="Town01"/>
        <SceneGraphFile filepath="" />
      </RoadNetwork>
    </CatalogLocations>
  </OpenScenario>
  <Entities>
    <ScenarioObject name="hero">
      <Vehicle name="vehicle.lincoln.mkz_2017" vehicleCategory="car">
        <ParameterDeclarations>
          <Performance maxSpeed="69.444" maxAcceleration="200" maxDeceleration="10.0"/>
        </ParameterDeclarations>
        <BoundingBox>
          <Center x="1.5" y="0.0" z="0.0"/>
          <Dimensions width="2.1" length="4.5" height="1.8"/>
        </BoundingBox>
        <Axes>
          <FrontAxle maxSteering="0.5" wheelDiameter="0.6" trackWidth="1.8" positionX="3.1" positionZ="0.3"/>
          <RearAxle maxSteering="0.0" wheelDiameter="0.6" trackWidth="1.8" positionX="0.0" positionZ="0.3"/>
        </Axes>
        <Properties>
          <Property name="type" value="ego_vehicle"/>
          <Property name="color" value="0,0,255"/>
        </Properties>
      </Vehicle>
    </ScenarioObject>
    <ScenarioObject name="adversary">
      <Vehicle name="vehicle.tesla.model3" vehicleCategory="car">
        <ParameterDeclarations>
          <Performance maxSpeed="69.444" maxAcceleration="200" maxDeceleration="10.0"/>
        </ParameterDeclarations>
        <BoundingBox>
          <Center x="1.5" y="0.0" z="0.0"/>
          <Dimensions width="2.1" length="4.5" height="1.8"/>
        </BoundingBox>
        <Axes>
          <FrontAxle maxSteering="0.5" wheelDiameter="0.6" trackWidth="1.8" positionX="3.1" positionZ="0.3"/>
          <RearAxle maxSteering="0.0" wheelDiameter="0.6" trackWidth="1.8" positionX="0.0" positionZ="0.3"/>
        </Axes>
        <Properties>
          <Property name="type" value="simulation"/>
          <Property name="color" value="255,0,0"/>
        </Properties>
      </Vehicle>
    </ScenarioObject>
  </Entities>
  <Storyboards>
    <Storyboard>
      <Init>
        <Actions>
          <GlobalAction>
            <EnvironmentAction>
              <Environment name="Environment1">
                <TimeOfDay animation="False" date="2020-03-20T12:00:00"/>
                <Weather cloudState="free">

```

Real Traffic Accident Reports

- Unstructured data

Simulation Cases (OpenSCENARIO file)

- Store the structured information of a driving scenario



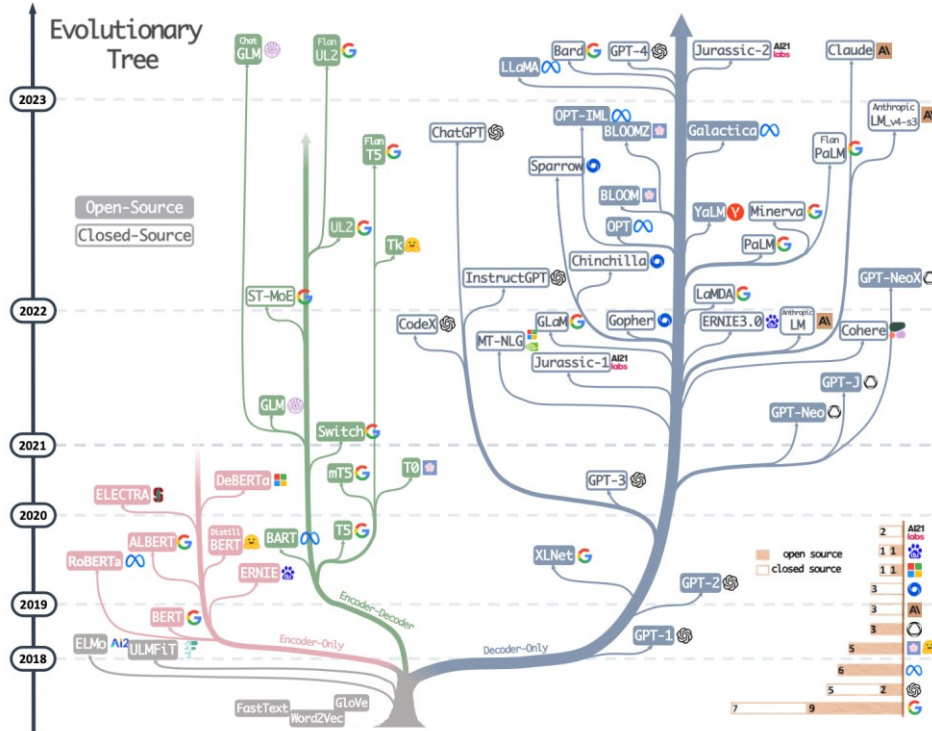
Natural Language Processing

- **Motivation**
- **Basis**
- **Conception Design**
- **Implementation**
- **Evaluation and Verification**
- **Summary and Outlook**



Basis

Large Language Models



[5]

Text interpretation


Solve a complex task

Answer a question

Generation capability

→ Generate test cases?


LLM fails



NMVCCS Case Viewer

Case Number: 2005-002-004

Case ID: 200502220042



Print Friendly Version of Case

Download XML Source

NMVCCS Case

Case Summary

Vehicle 1

Vehicle 2

Crash Overview

Case Number

Date

Day of Week

PMI Time of Crash

Crash Level KASBOU

Crash Overview - Summary

Case Summary

Factor Summary

Crash Overview

Case Number

Date

Day of Week

PMI Time of Crash

Crash Level KASBOU

Case Summary

The crash occurred on a two-lane undivided roadway with a posted speed limit of 48 MPH (30 MPH) and a 0.2% grade. There was an intersecting driveway to the right with a 13.2% grade. The weather was clear, the roadway or it was daylight at the time of this early morning weekday crash.

Vehicle 1, a 1998 Chevrolet Blazer, was traveling north on the two-lane undivided roadway approaching the driveway. It should be noted that there was a large sign, small hill and telephone pole to this driver's right, which may have obscured the approach of Vehicle 2. Vehicle 2, a 2000 Toyota Corolla, was traveling west on the driveway approaching the main roadway. Vehicle 2 entered the main roadway and was struck in the left side by the front of Vehicle 1. Vehicle 2 was rotated counterclockwise off the left side of the roadway, over a small cut, onto a private lawn and came to rest facing east. Vehicle 1 continued and came to rest in the southbound lane facing north.

The Chevrolet Blazer (Vehicle 1) was driven by a belted 50-year-old male who was transported, treated and released for a complaint of pain. Vehicle 1 was traveling north on the roadway and saw Vehicle 2 coming down the drive off to the right. He put on his brakes and steered right but hit Vehicle 2 on the left side. Vehicle 1 was slowed due to damage.

The Critical Pre-crash Event for Vehicle 1 was the encroachment of the other vehicle from a driveway, intended path not known. The Critical Reason for the Critical Event was not coded to this vehicle. A possible contributing factor this crash may have been the sign, small hill and pole to this driver's right, which may have limited his sight of Vehicle 2's approach. No other associated factors were coded to the driver of the Blazer and he was not thought to be contributed to the crash.

The Toyota Corolla (Vehicle 2) was driven by a belted 23-year-old female who was transported, treated and hospitalized for 1 day due to a head injury. The driver of the Corolla stated that she had "blacked out" and did not recall 1 accident or the events preceding the accident. Vehicle 2 was slowed due to damage.

The Critical Pre-crash Event for Vehicle 2 was to unknown travel direction. This was chosen due to no indication of turning left or right and the incapacitating illness of the driver. The Critical Reason for the Critical Event was the physical requirement of the ability to act of the driver. An associated factor coded to this driver was the use of prescription medications. She was taking two medications, a birth control pill and an antidepressant. They did not control the crash.

Factor Summary

Vehicle 1

Vehicle 2

Aggressive Behavior

Alcohol

Cargo Shift

Cell Phone Use

Distraction

Driver Fatigue

Driver Inexperience

Driver Performance

Driver Physical

Driver Stress/Emotion

Drugs

Runaway

Speed/Distance

Aggressive Behavior

Alcohol

Cargo Shift

Cell Phone Use

Distraction

Driver Fatigue

Driver Inexperience

Driver Performance

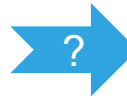
Driver Physical

Driver Stress/Emotion

Drugs

Runaway

Speed/Distance



ChatGPT

Creating a complete OpenSCENARIO file based on the detailed accident report you provided would be quite complex, as it requires a deep understanding of both the OpenSCENARIO XML schema and the specific details of the accident. However, I can provide you with a basic structure for an OpenSCENARIO XML file that you could expand upon. Here's a simplified example:

```
<?xml version="1.0" encoding="UTF-8"?>
<OpenSCENARIO xmlns="http://www.openscenario.org/schema/1.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema"
schema/1.0 OpenSCENARIO.xsd">
  <FileHeader revMajor="1" revMinor="0" description="Two-vehicle crash scenario" author="Your Name" />

  <ParameterDeclarations>
    <!-- Define any necessary parameters here -->
  </ParameterDeclarations>

  <Entities>
    <ScenarioObject name="V1">
      <Vehicle name="FordRanger1999" vehicleCategory="car">
        <!-- Vehicle V1 properties -->
      </Vehicle>
    </ScenarioObject>
    <ScenarioObject name="V2">
      <Vehicle name="Peterbilt379_1992" vehicleCategory="truck">
        <!-- Vehicle V2 properties -->
      </Vehicle>
    </ScenarioObject>
    <!-- Define the prized hog as a miscellaneous object -->
    <MiscObject name="PrizedHog" miscObjectCategory="animal" mass="130"/>
  </Entities>
</OpenSCENARIO>
```

Real Traffic Accident Reports

- (!) LLM fails in generating OpenSCENARIO files
- (!) Hallucination

Hypothesis

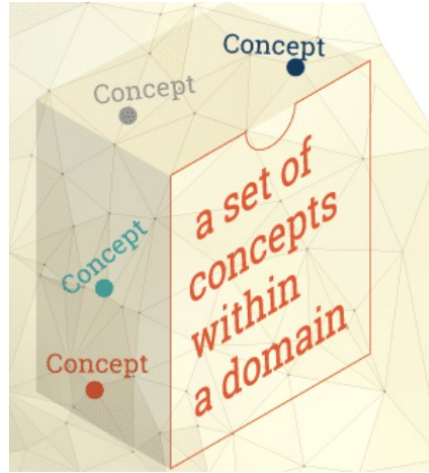
Add a new ingredient: Ontology



- Ontology provide more semantic information
- Reference to understand domain concepts and knowledge

Basis

Ontology



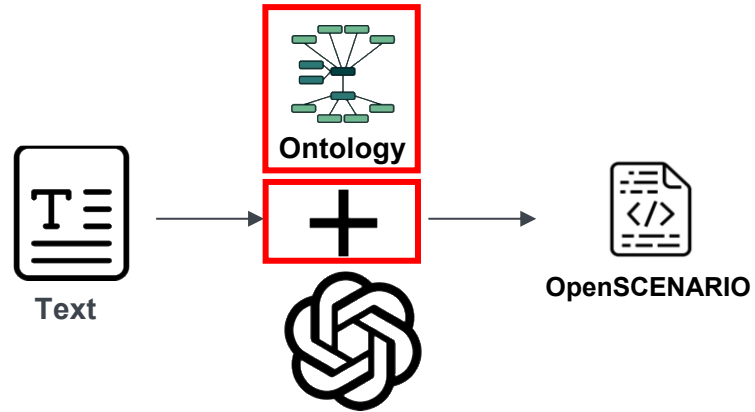
[6]

- concepts in a specific domain
- structured framework
- consistent understanding

- **Motivation**
- **Basis**
- **Conception Design**
- **Implementation**
- **Evaluation and Verification**
- **Summary and Outlook**



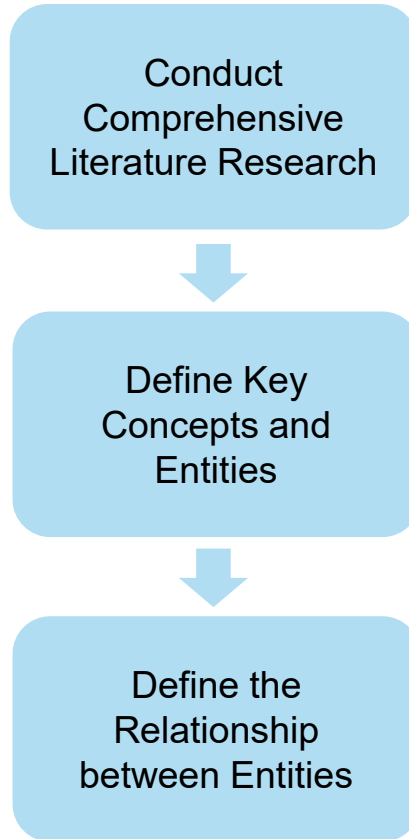
Conceptual Design



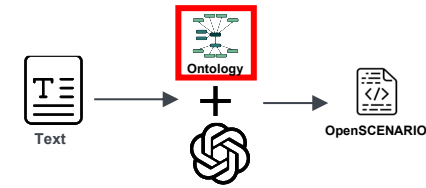
- (1) Design the ontology
- (2) Integration of ontology and LLM

Fundamental Ontology Creation

How to create the ontology?

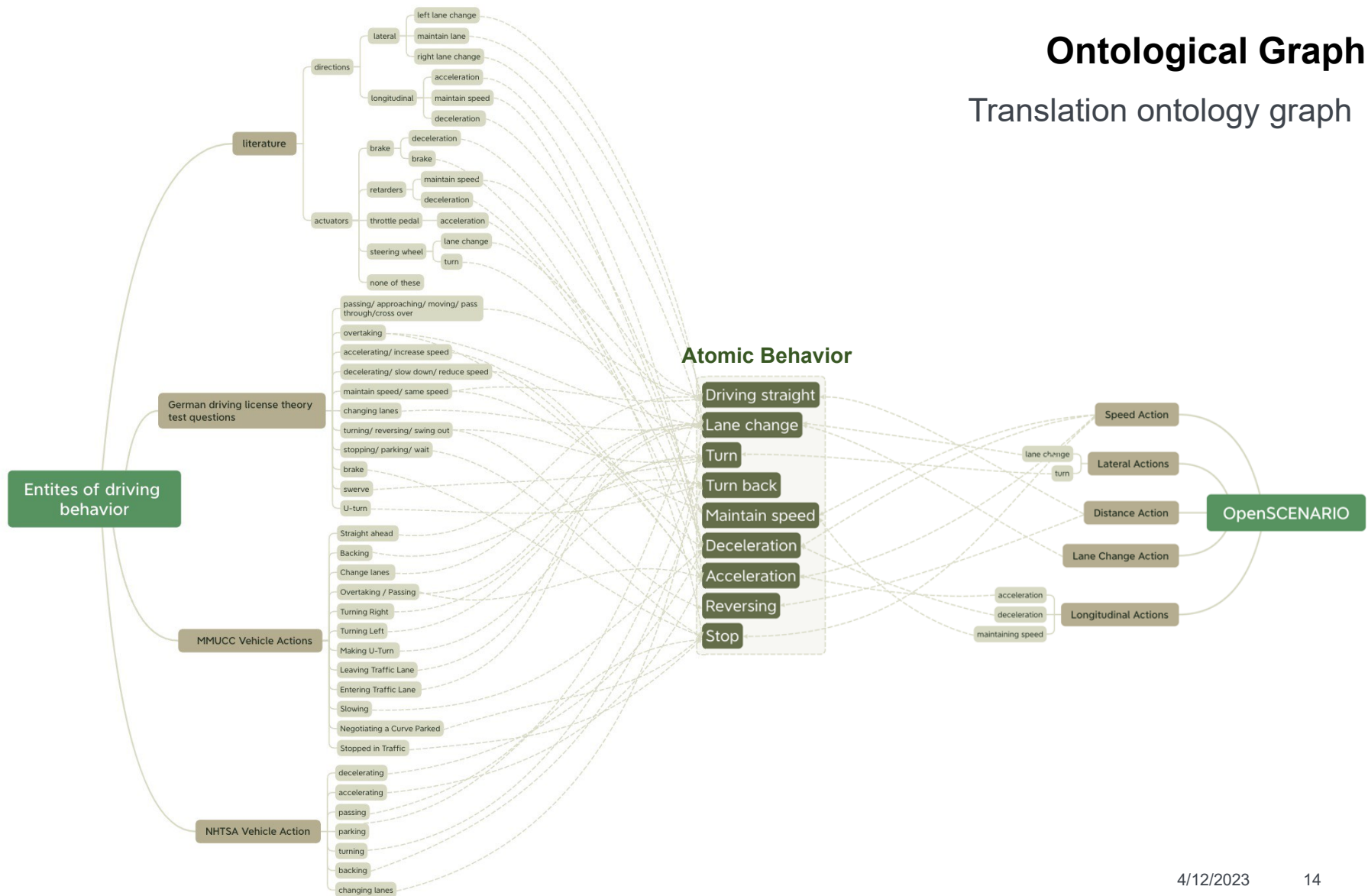


- **Google Scholar**
 - **Keywords:** “driver v driving”
“behavior v event v style v maneuver ”
“classification v detection v recognition”
 - **Literature Research:**
Academic papers
Guidance documents
Driving license test questions
- Basic Driving Behaviors**
- Driving straight
 - Lane change
 - Turn
 - Turn back
 - Stop
 - Reversing
 - Acceleration
 - Deceleration
 - Maintain speed

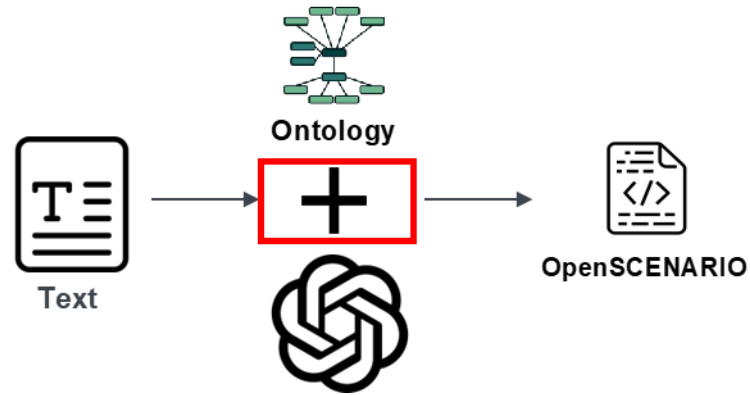


Ontological Graph

Translation ontology graph

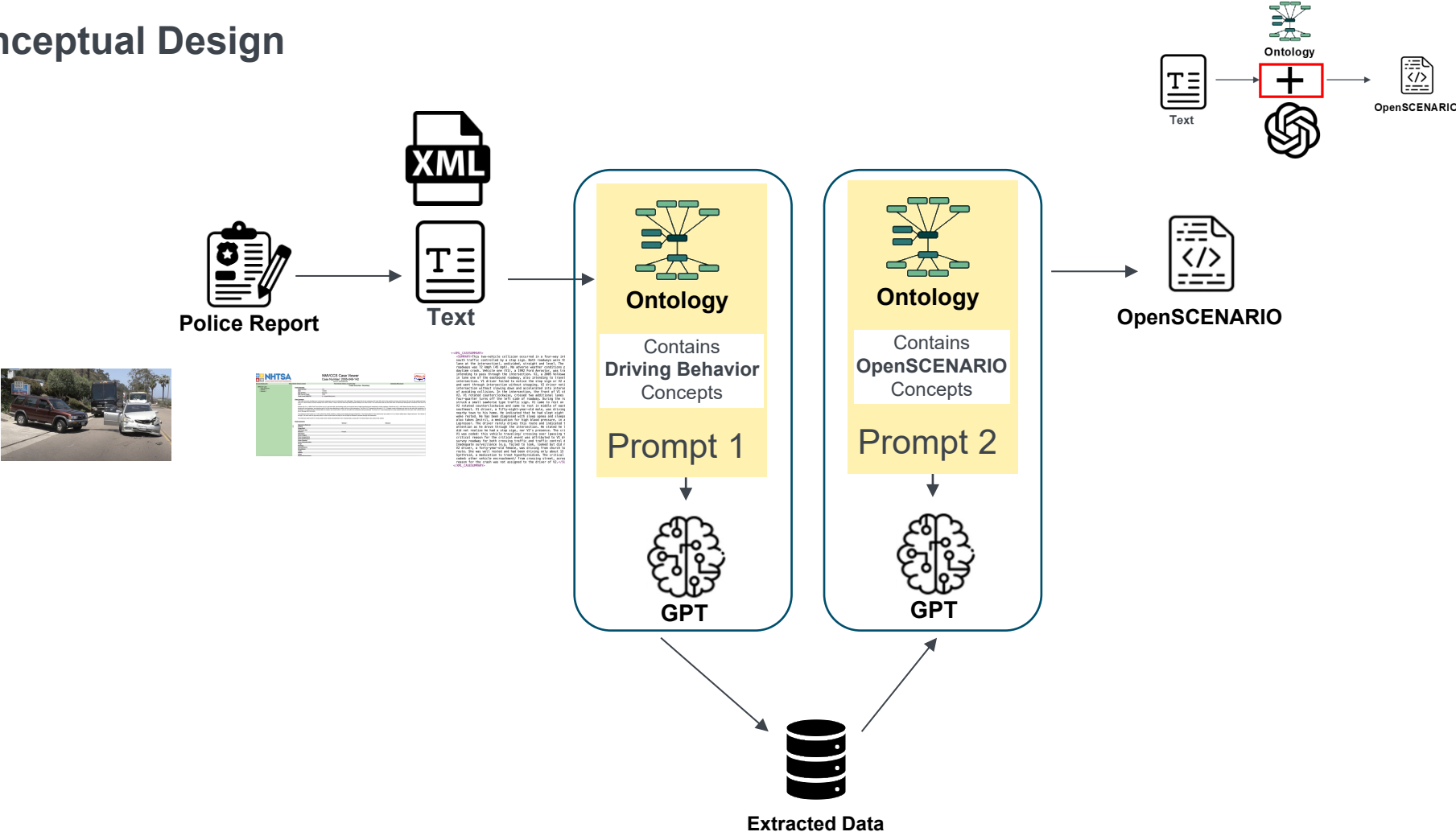


Conceptual Design



- (1) Design the ontology
- (2) Integration of ontology and LLM

Conceptual Design



- **Motivation**
- **Basis**
- **Conception Design**
- **Implementation**
- **Evaluation and Verification**
- **Summary and Outlook**



Implementation



NMVCCS (2005-2007)

Q New Search

Search performed with the following criteria:
Crash Criteria Number Vehicles<=2 AND Crash Criteria Number Vehicles>=2 AND Crash Criteria Crash Type=Intersecting Paths (Vehicle Damage) AND Crash Criteria Crash Criteria=A - Incapacitating injury

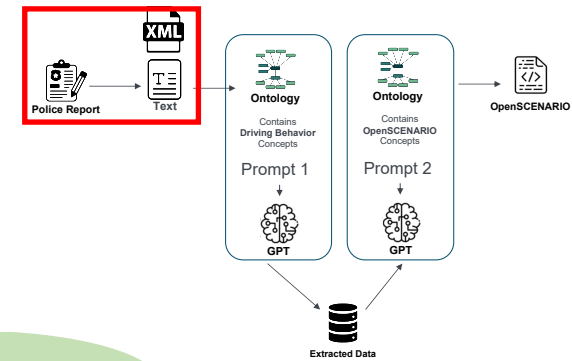
#	Case String	Vehicle Count	Severity	Case ID
1	2005-002-004	2	A - Incapacitating injury	2005002229042
2	2005-003-017	2	A - Incapacitating injury	2005003588301
3	2005-005-035	2	A - Incapacitating injury	2005005289462
4	2005-009-000	2	A - Incapacitating injury	2005009276021
5	2005-011-076	2	A - Incapacitating injury	2005011289063
6	2005-013-042	2		
7	2005-013-017			
8	2005-043-053			
9	2005-045-112			
10	2005-048-016			
11	2005-048-005			
12	2005-048-052			

XML Source

<XML_CASESUMMARY>

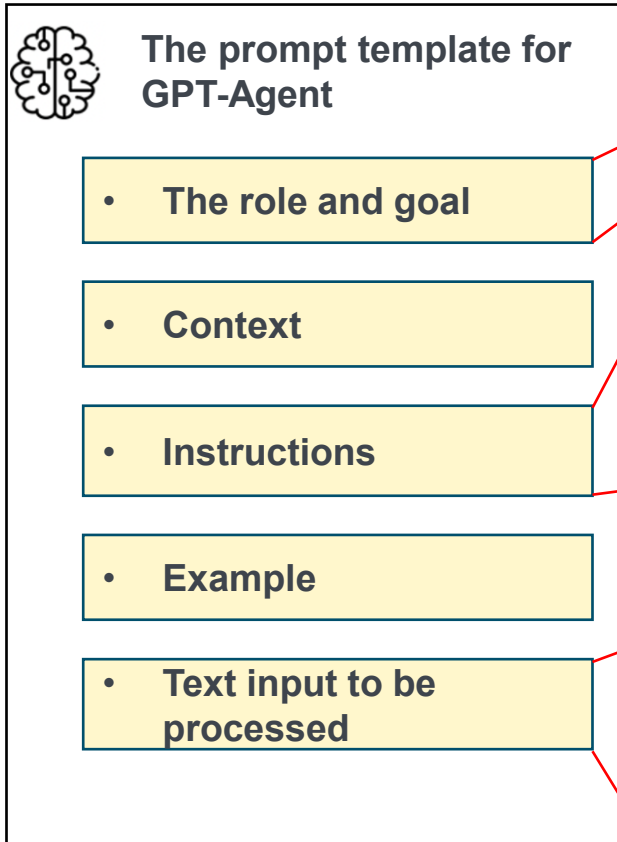
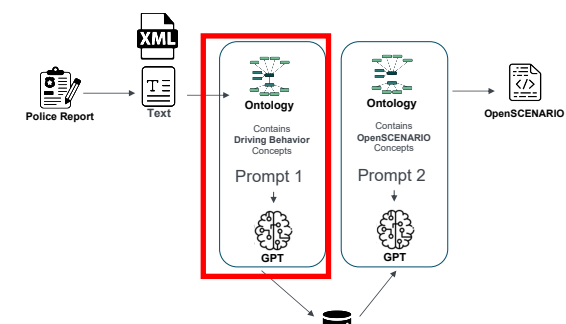
<SUMMARY>This two-vehicle collision occurred in a four-way intersection south traffic controlled by a stop sign. Both roadways were two-lane at the intersection, undivided, straight and level. The roadway was 72 kmph (45 mph). No adverse weather conditions present. Vehicle one (V1), a 1992 Ford Aerostar, was traveling south intending to pass through the intersection. V2, a 2005 Volkswagen in lane one of the eastbound roadway, also intending to travel intersection. V1 driver failed to notice the stop sign or V2 and went through intersection without stopping. V2 driver noticed intersection without slowing down and accelerated into intersection of avoiding collision. In the intersection, the front of V1 struck V2. V1 rotated counterclockwise, crossed two additional lanes four-quarter turns off the left side of roadway. During the collision struck a small sawhorse type traffic sign. V1 came to rest on V2 rotated counterclockwise and came to rest in middle of east southeast. V1 driver, a fifty-eight-year-old male, was driving nearby town to his home. He indicated that he had slept eight hours and was well rested. He has been diagnosed with sleep apnea and sleep apnea also takes Zestril, a medication for high blood pressure, in a Loproress. The driver rarely drives this route and indicated that attention as he drove through the intersection. He stated he did not realize he had a stop sign, nor V2's presence. The critical reason for the critical event was attributed to V1 driver survey roadway for both crossing traffic and traffic control. Inadequate surveillance (e.g. failed to look, looked but did not see V2 driver, a forty-year-old female, was driving from church to route. She was well rested and had been driving only about 15 minutes. Synthroid, a medication to treat hypothyroidism. The critical reason for the critical event was attributed to V1 driver survey roadway for both crossing traffic and traffic control. Inadequate surveillance (e.g. failed to look, looked but did not see V2 driver, a forty-year-old female, was driving from church to route. She was well rested and had been driving only about 15 minutes. Synthroid, a medication to treat hypothyroidism. The critical reason for the crash was not assigned to the driver of V2. </SUMMARY>

</XML_CASESUMMARY>



Implementation

Structured prompt



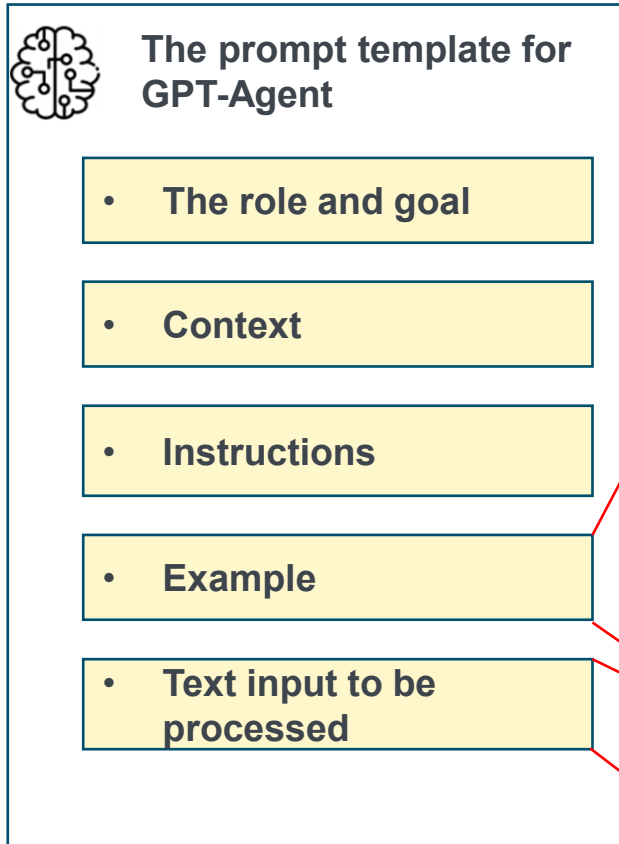
Prompt 1

```
Role and goal:
You are a data extractor to extract information from the input text. Your goal is to extract the process of the collision.
You should consider the provided context, instructions, and example.
Context:
The input data come from a crash report.
Instructions:
As information extractor, please read the crash report carefully and extract the following information:
The trajectory of each vehicle: initial location, collision location, stop location.
The behavior of each vehicle, match the driving behavior ONLY based on the given range: collision, driving straight, lane change,
turn, turn back, stop, reversing, acceleration, deceleration and maintain speed.
For extracting these behaviors, refer to the provided definitions of these behaviors:
Driving straight: The act of operating a vehicle in a straight line, maintaining a constant course in a single lane.
Lane change: The act of moving a vehicle from one lane to another on a multi-lane road, typically executed to overtake another
vehicle. At the end of the event, the vehicle should be in the neighboring lane.
Turn: The act of changing the direction of a vehicle by rotating its wheels, typically either to the left or to the right.
Turn back: The act of making a 180-degree turn to reverse the direction of travel.
Stop: The act of bringing a vehicle to a complete halt, usually by applying the brakes.
Reversing: The act of operating a vehicle in a direction opposite to its normal forward movement, often achieved by putting the
vehicle in reverse gear.
Acceleration: The act of increasing the speed of a vehicle by applying pressure to the accelerator.
Deceleration: The act of reducing the speed of a vehicle, usually by releasing the accelerator or applying the brakes.
Maintain speed: The act of keeping a vehicle moving at a constant speed, typically by using cruise control or consistent pressure
on the accelerator.
From the beginning until the two cars stop, the whole process is divided into 3 to 5 behaviors in chronological order.
Only use the input data that are given.
Only output the desired format.
Example:
Input: //
Output:
V1: name
trajectory: initial location, collision location, stop location.
behavior: behavior1, behavior2, behavior3...
V2: name
trajectory: initial location, collision location, stop location.
behavior: behavior1, behavior2, behavior3...

Input: {This two-vehicle collision occurred in a four-way intersection with north and south traffic controlled by a stop sign. Both
roadways were three-lane (with a left turn lane at the intersection), undivided, straight and level. The speed limit on both
roadways was 72 kmph (45 mph). No adverse weather conditions present at the time of this daytime crash. Vehicle one (V1), a 1992
Ford Aerostar, was traveling south in lane one intending to pass through the intersection. V2, a 2005 Volkswagen Touareg, was
traveling in lane one of the eastbound roadway, also intending to travel straight through the intersection. V1 driver failed to
notice the stop sign or V2 approaching from the right and went through intersection without stopping. V2 driver noticed V1
approaching intersection without slowing down and accelerated into intersection with the intention of avoiding collision. In the
intersection, the front of V1 struck the back left side of V2. V1 rotated counterclockwise, crossed two additional lanes of traffic
and rolled over four-quarter turns off the left side of roadway. During the rollover, the right side struck a small sawhorse type
traffic sign. V1 came to rest on the roadside facing north. V2 rotated counterclockwise and came to rest in middle of eastbound
traffic lanes facing southeast. V1 driver, a fifty-eight-year-old male, was driving from a toy show in a nearby town to his home.
He indicated that he had slept eight hours the night before and woke rested. He has been diagnosed with sleep apnea and sleeps with
a CPAP machine. He also takes Xestril, a medication for high blood pressure, in addition to Plomax and Lopressor. The driver rarely
drives this route and indicated that he was not paying attention as he drove through the intersection. He stated he looked straight
ahead and did not realize he had a stop sign, nor V2's presence. The critical precrash event for V1 was coded: this vehicle
traveling/ crossing over (passing through) intersection. The critical reason for the critical event was attributed to V1 driver
failing to adequately survey roadway for both crossing traffic and traffic control devices. This was coded as: Inadequate
surveillance (e.g. failed to look, looked but did not see) for this driver. V2 driver, a forty-year-old female, was driving from
church to home, a very familiar route. She was well rested and had been driving only about 15 minutes. She takes Synthroid, a
medication to treat hypothyroidism. The critical precrash event for V2 was coded: other vehicle encroachment/ from crossing street,
across path. The critical reason for the crash was not assigned to the driver of V2.}
Output:
```

Implementation

Structured prompt



Prompt 2

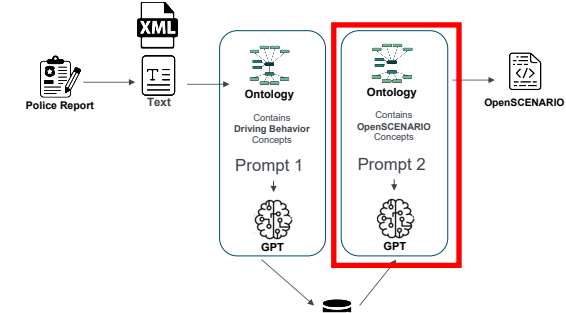
```
Role and goal:
You're an OpenSCENARIO XML file generator. Using the input data provided, your task is to produce a OpenSCENARIO XML scenario.

Context:
The given information are behaviors of vehicles. These behaviors describe how the vehicles act within the collision.

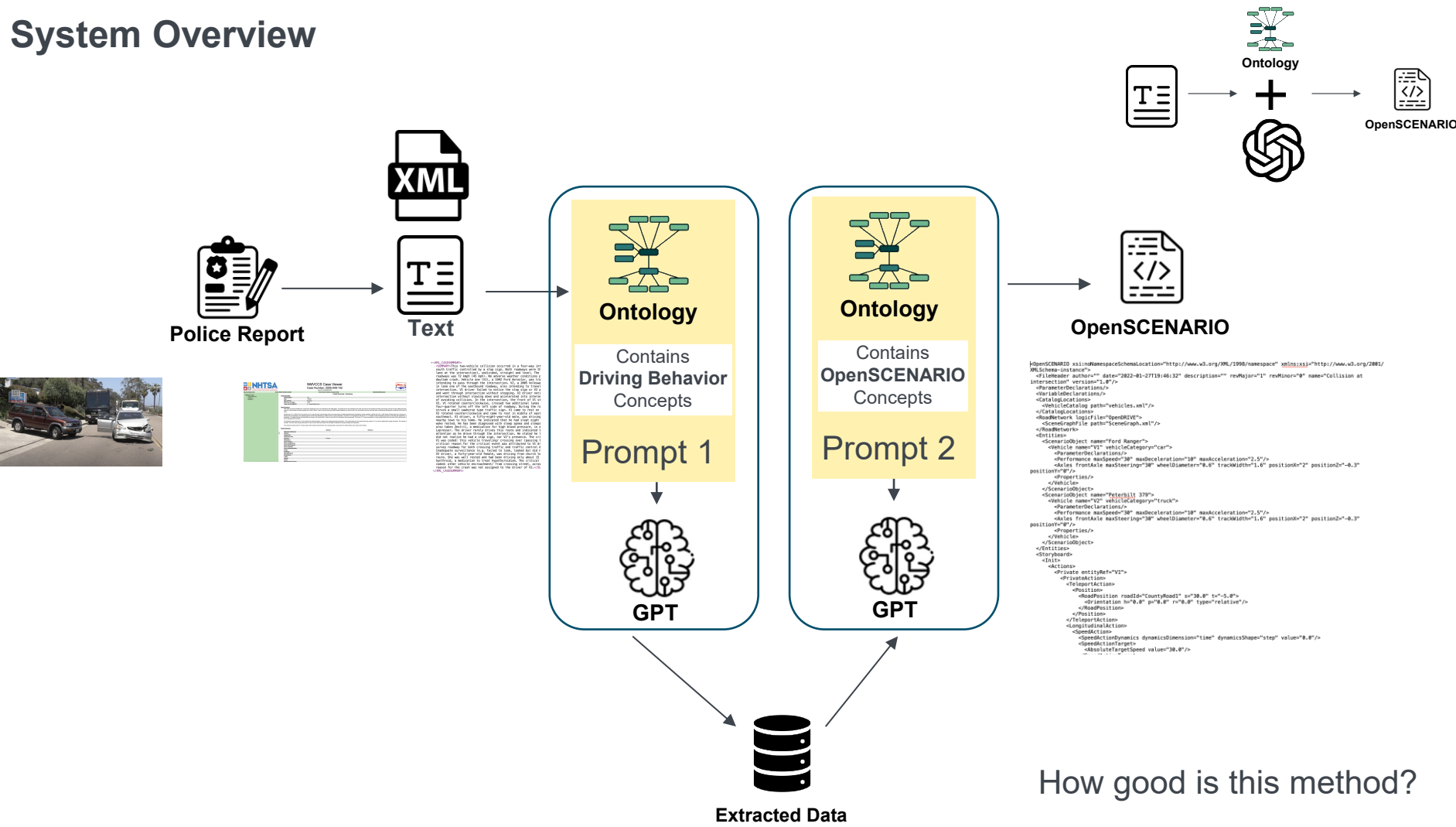
Instructions:
Create a COMPLETE OpenSCENARIO XML from the provided input.
The OpenSCENARIO file should include Fileheader, ParameterDeclaration, VariableDeclarations, CatalogLocations, RoadNetwork, Entities, and Storyboard.
Use the input data exclusively and in the order, they are provided.
Ensure that the storyboard is detailed and comprehensive, every behavior of a vehicle corresponds to an event.
You can make up any details not provided, such as distances, speeds, and trigger conditions.
use the Schema References: <Xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
<Xsd:import namespace="http://www.w3.org/XML/1998/namespace" schemaLocation="http://www.w3.org/2001/xml.xsd"/>

Example:
Input: V2 driving straight, V1 turn left, when relative distance falls below 20 m, V1 starts its left LaneChange action to the left.
Output:
<Event priority="overwrite" maximumExecutionCount="1" name="Turn left">
  <Action name="Lane Change">
    <PrivateAction>
      <LateralAction>
        <LaneChangeAction targetLaneOffset="0.0238800048828">
          <LaneChangeActionDynamics dynamicsDimension="distance" dynamicsShape="cubic" value="36.6430664063"/>
          <LaneChangeTarget>
            <AbsoluteTargetLane value="-3"/>
          </LaneChangeTarget>
        </LaneChangeAction>
      </LateralAction>
    </PrivateAction>
  </Action>
  <StartTrigger>
    <ConditionGroup>
      <Condition delay="0.0" conditionEdge="rising" name="Relative Distance">
        <ByEntityCondition>
          <TriggeringEntities triggeringEntitiesRule="any">
            <EntityRef entityRef="Vehicle 1"/>
          </TriggeringEntities>
          <EntityCondition>
            <RelativeDistanceCondition freespace="false" rule="lessThan" entityRef="Vehicle 2" value="20.0" relativeDistanceType="longitudinal"/>
          </EntityCondition>
        </ByEntityCondition>
      </Condition>
    </ConditionGroup>
  </StartTrigger>
</Event>

Input: {
  VV1: 1999 Dodge Intrepid
  Behavior: acceleration, collision, maintain speed, stop.
  V2: 1998 GMC Safari Minivan
  Behavior: stop, driving straight, collision, maintain speed, stop.
}
Output:
```



System Overview



How good is this method?

- **Motivation**
- **Basis**
- **Conception Design**
- **Implementation**
- **Verification**
- **Summary and Outlook**



Verification

Comparison of Ontology Integration in Behavior Identification

Information extraction with ontology	Information extraction without ontology
<p>V1: 1999 Ford Ranger Behavior: stop, driving straight, collision, stop</p> <p>V2: 1992 Peterbilt Conventional 379 tractor Behavior: driving straight, collision, stop</p>	<p>V1: 1999 Ford Ranger Behavior: traveling southbound, attempting to cross the intersection, impacted by V2, departed towards southeast of the intersection, impacted with a telephone guy wire.</p> <p>V2: 1992 Peterbilt Conventional 379 Behavior: traveling eastbound in the second lane, observed V1 stationary, impacted the right side of V1, departed the left side of the road, rested northeast of the intersection.</p>

- Concise, Structured
- Mapping to predefined ontology elements

Uncontrolled generation (non-deterministic)
Not compliant with OpenSCENARIO

→ Hallucination
→ Even though with more texts

Verification

10 traffic accident
reports

comparison	Required information elements	Information elements generated	correct generated elements	Generation Rate	Information Element Correctness
without ontology	30(for each)	6.3	2.4	0.21	0.08
with ontology	30(for each)	16.8	13.8	0.56	0.46

- **Motivation**
- **Basis**
- **Fundamental Ontology Creation**
- **Conception Design**
- **Implementation**
- **Evaluation and Verification**
- **Summary and Outlook**



Summary and Outlook

Summary:

- Combining ontology with LLMs enhance behavior identification from crash reports
- With ontology get a higher generation rate in OpenSCENARIO

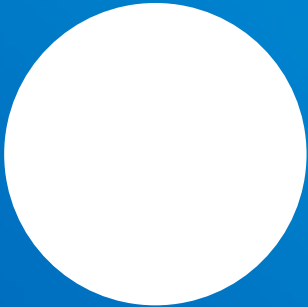
Outlook:

- Validation Test the file in simulation environment.
- Include more data sources to satisfy the required information by OpenSCENARIO files.
- Whether the model really "understand" the scenario (the model of dynamics)? Or mimic the pattern in text-data?



University of Stuttgart
Institut of Industrial Automation
and Software Engineering

Thank you!



Sijia Chen

e-mail st176741@stud.uni-stuttgart.de

phone +49 (0) 711 685-

fax +49 (0) 711 685-

University of Stuttgart

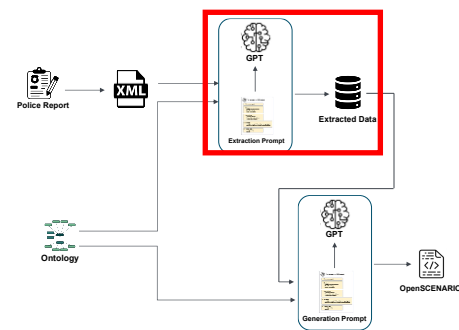


Quelle

- <https://www.gamearter.com/blog/bmw-autonomous-driving-development>
- <https://www.audi.com/en/innovation/future-technology/autonomous-driving/driverless-test-drives-in-china.html>
- <https://thelowdown.momentum.asia/the-emergence-of-large-language-models-llms/>
- <https://arxiv.org/pdf/1706.03762.pdf>
- <https://www.ontotext.com/knowledgehub/fundamentals/what-are-ontologies/>

Implementation

How system works?



Role and goal:

You are a data extractor to extract information from the input text. Your goal is to extract the process of the collision. You should consider the provided context, instructions, and example.

Context:

The input data come from a crash report.

Instructions:

As information extractor, please read the crash report carefully and extract the following information:

The trajectory of each vehicle: initial location, collision location, stop location.

The behavior of each vehicle, match the driving behavior ONLY based on the given range: collision, driving straight, turn, turn back, stop, reversing, acceleration, deceleration and maintain speed.

For extracting these behaviors, refer to the provided definitions of these behaviors:

Driving straight: The act of operating a vehicle in a straight line, maintaining a constant course in a single lane.

Lane change: The act of moving a vehicle from one lane to another on a multi-lane road, typically executed to overtake a vehicle. At the end of the event, the vehicle should be in the neighboring lane.

Turn: The act of changing the direction of a vehicle by rotating its wheels, typically either to the left or to the right.

Turn back: The act of making a 180-degree turn to reverse the direction of travel.

Stop: The act of bringing a vehicle to a complete halt, usually by applying the brakes.

Reversing: The act of operating a vehicle in a direction opposite to its normal forward movement, often achieved by vehicle in reverse gear.

Acceleration: The act of increasing the speed of a vehicle by applying pressure to the accelerator.

Deceleration: The act of reducing the speed of a vehicle, usually by releasing the accelerator or applying the brakes.

Maintain speed: The act of keeping a vehicle moving at a constant speed, typically by using cruise control or constant speed on the accelerator.

From the beginning until the two cars stop, the whole process is divided into 3 to 5 behaviors in chronological order.

Only use the input data that are given.

Only output the desired format.

Example:

Input: //

Output:

V1: name

trajectory: initial location, collision location, stop location.

behavior: behavior1, behavior2, behavior3...

V2: name

trajectory: initial location, collision location, stop location.

behavior: behavior1, behavior2, behavior3...

Input: {extracted_text}

Output:

```
<?xml version="1.0" encoding="UTF-8"?>
<OpenSCENARIO>
  <!--fileheader revMajor="1" revMinor="0" date="2020-03-20T12:00:00" description="CARLA:FollowLeadingVehicle" author=""/>
  <ParameterDeclarations>
    <!--XML_CASESUMMARY-->
    <SUMMARY>This two-vehicle collision occurred in a four-way intersection with north and south traffic controlled by a stop sign. Both roadways were three-lane (with a left turn lane at the intersection), undivided, straight and level. The speed limit on both roadways was 72 km/h (45 mph). No adverse weather conditions present at the time of this daytime crash. Vehicle one (V1), a 1992 Ford Aerostar, was traveling south in lane one intending to pass through the intersection. V2, a 2005 Volkswagen Touareg, was traveling in lane one of the eastbound roadway, also intending to travel straight through the intersection. V1 driver failed to notice the stop sign or V2 approaching from the right and went through intersection without stopping. V2 driver noticed V1 approaching intersection without slowing down and accelerated into intersection with the intention of avoiding collision. In the intersection, the front of V1 struck the back left side of V2. V1 rotated counterclockwise, crossed two additional lanes of traffic and rolled over four-quarter turns off the left side of roadway. During the rollover, the right side struck a small tree. V2 driver, a fifty-eight-year-old male, was driving from a toy show in a nearby town to his home. He indicated that he had slept eight hours the night before and woke rested. He had been diagnosed with clean arteries and a clean heart. He was wearing a seat belt.
  </SUMMARY>
  <XML_CASESUMMARY>
    <Properties>
      <Property name="type" value="simulation"/>
      <Property name="color" value="255,0,0"/>
    </Properties>
  </Vehicle>
  </ScenarioObject>
  </Entities>
  <Storyboard>
    <Init>
      <Actions>
        <GlobalAction>
          <EnvironmentAction>
            <Environment name="Environment1">
              <TimeOfDay animation="false" date="2020-03-20T12:00:00"/>
              <Weather cloudState="none">
                </Weather>
              </EnvironmentAction>
            </EnvironmentAction>
          </GlobalAction>
        </Actions>
      </Init>
    </Storyboard>
  </OpenSCENARIO>
```

Text-based accident

Extracted Data

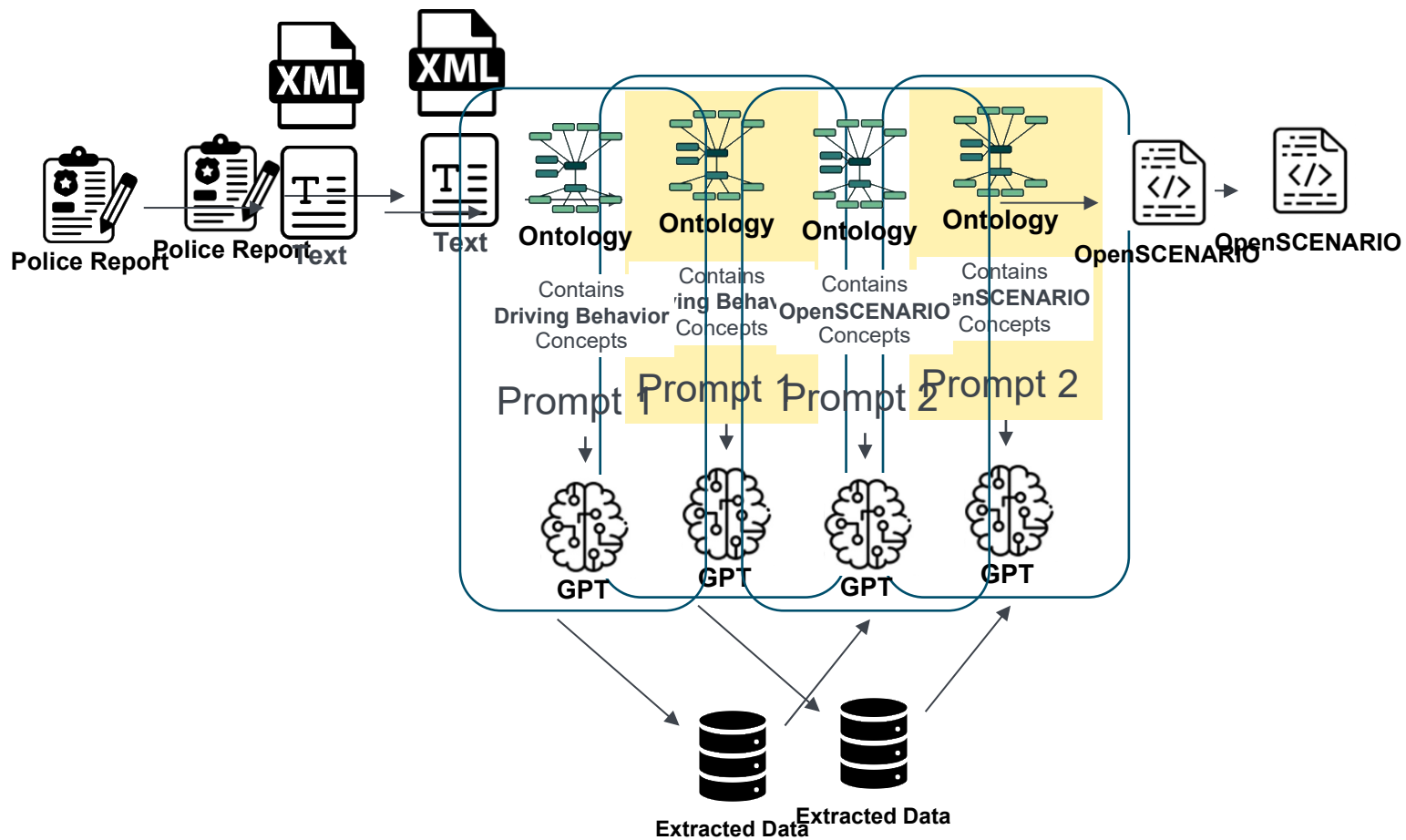
V1: 1999 Ford Expedition

behavior: driving straight, failed to stop at stop sign, collision, rolled over two quarter turns, stop.

V2: 2001 Dodge Ram 1500 truck

behavior: driving straight, collision, stop.

reason for the crash was not assigned to the driver of V2.



Conceptual XMLign

