

1 Drivers behavior constrained by laws

2 Business Analysts need a Descriptive Model to know how drivers behave wrt HoS

ONBOARD DEVICES GENERATE LARGE VOLUMES OF DATA ABOUT DRIVERS ACTIVITY

Driver activity log

Driver	Date	Start	End	Duration	Activity
driver1	04/01/2017	9:25	9:29	0:04	Driving
driver1	04/01/2017	9:29	9:47	0:18	Pause
driver1	04/01/2017	9:47	9:50	0:03	Driving
driver1	04/01/2017	9:50	9:54	0:04	Other
driver1	04/01/2017	9:54	11:07	1:13	Pause
driver1	04/01/2017	11:07	15:22	4:15	Driving
driver1	04/01/2017	15:22	15:47	0:25	Pause
driver1	04/01/2017	15:47	15:50	0:03	Driving
driver1	04/01/2017	15:50	16:49	0:59	Pause
driver1	04/01/2017	16:49	21:11	4:22	Driving
driver1	04/01/2017	21:11	21:13	0:02	Other
driver1	04/01/2017	21:13	6:21	9:08	Pause

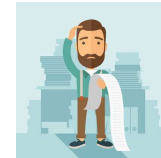


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We address the problem by HTN Plan and Goal Recognition

Descriptive model

Driver	Date	Start	End	Duration	Activity	day	driving period	sequence	event type
driver1	04/01/2017	9:25	9:29	0:04	Driving	ndd	splittd	cdds	elt
driver1	04/01/2017	9:29	9:47	0:18	Pause	ndd	splittd	cdds	B_T2
driver1	04/01/2017	9:47	9:50	0:03	Driving	ndd	splittd	cdds	elt
driver1	04/01/2017	9:50	9:54	0:04	Other	ndd	splittd	cdds	elt
driver1	04/01/2017	9:54	11:07	1:13	Pause	ndd	splittd	cdds	B_T3
driver1	04/01/2017	11:07	15:22	4:15	Driving	ndd	splittd	cdds	elt
driver1	04/01/2017	15:22	15:47	0:25	Pause	ndd	splittd	cdds	B_T2
driver1	04/01/2017	15:47	15:50	0:03	Driving	ndd	splittd	cdds	elt
driver1	04/01/2017	15:50	16:49	0:59	Pause	ndd	splittd	cdds	B_T3
driver1	04/01/2017	16:49	21:11	4:22	Driving	ndd	continuous	cdde	elt
driver1	04/01/2017	21:11	21:13	0:02	Other	ndd	continuous	cdde	elt
driver1	04/01/2017	21:13	6:21	9:08	Pause	ndd	continuous	cdde	rd_red



This is the starting point for a Business Analytics Cycle

- Conformance checking:
- Are my drivers compliant?
- Predictive analytics
- Is some driver close to illegality?
- Prescriptive analytics (recommend actions)
- How to avoid illegal deviations?

HoS regulation

DEFINES BASIC CONCEPTS LIKE BREAKS AND RESTS

BREAK	BREAK_T2	15min	< 30min
	BREAK_T3	30min	< 45min
	BREAK_T1	45min	< 3hrs

DEFINES LEGAL SEQUENCES IN TERMS OF DRIVING PERIODS

BASIC SEQUENCE	Composed of any combination of [DOPI] whenever P < 15mins
SPLITTED DRIVING PERIOD	Driving period splitted by two breaks : break_t2 and then another break_t3, with duration <= 4.5hours

HIERARCHICAL RELATIONSHIPS BETWEEN DRIVING PERIODS AT DIFFERENT TIME RESOLUTION

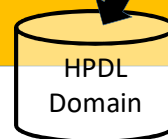
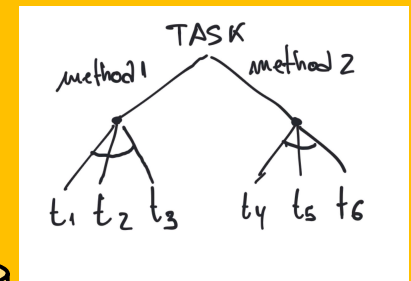
Weekly rest period	Weekly driving time				Weekly rest period
	Daily driving time		Daily rest period	Daily driving time	
Driving period	Break	Driving period	...	Driving period	...

Knowledge Engineering

HOS REGULATION FORMALIZED AS AN ATTRIBUTE GRAMMAR

```
elt: D {(elt.dt := D.dur; elt.rt:= 0)} |
P {(P.dur < 15mins)
(elt.dt := 0; elt.rt:= P.dur)} |
O {(elt.dt := elt.dt := 0)}
I {(elt.dt := elt.dt := 0)};
```

TRANSLATION INTO TEMPORAL HTNS



Meets modeling requirements

Temporal HTN extension

HTN features	Extended syntax (constraints, functions, et.)
PDDL 2.1	

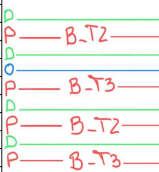
Legal event and sequence recognition

Temporal HTN Planner (SIADEX)

Recognize temporal subsequences and label them according to HoS terms.

TEMPORAL PLAN (Driver activity log)

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driver1	04/01/2017	9:25	9:29	0:04	Driving
driver1	04/01/2017	9:29	9:47	0:18	Pause
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driver1	04/01/2017	15:22	15:47	0:25	Pause
driver1	04/01/2017	15:47	15:50	0:03	Driving
driver1	04/01/2017	15:50	16:49	0:59	Pause
driver1	04/01/2017	16:49	21:11	4:22	Driving
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BASIC SEQ.

SPLITTED PERIOD

Goal recognition

Labeled plan translated into worksheet

Descriptive model

ORIGINAL EVENT LOG						LABELS			
Driver	Date	Start	End	Duration	Activity	day	driving period	sequence	event type
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driver1	04/01/2017	9:29	9:47	0:18	Pause	ndd	splittd	cdds	B_T2
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driver1	04/01/2017	15:47	15:50	0:03	Driving	ndd	splittd	cdds	elt
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