Formalisation of Traffic Rules with BDI-logic
“Does your car have any idea why my car pulled it over?”
What is BDI logic?

Syntactically,

it’s an abbreviation for **Beliefs**, **Desires**, and **Intentions** Logic.
What is BDI logic?

Syntactically,

it’s an abbreviation for **Beliefs**, **Desires**, and **Intentions Logic**.

Historically,

it comes from the domain of **philosophy of mind** — it models the **mental** faculty of an autonomous system.
What is BDI logic?

Syntactically,

it’s an abbreviation for Beliefs, Desires, and Intentions Logic.

Historically,

it comes from the domain of philosophy of mind — it models the mental faculty of an autonomous system.

Practically,

it is how we can make autonomous systems’ ‘thinking’ or ‘mind’ accountable.
How is BDI logic relevant for traffic rules?

Road-users shall avoid any behaviour likely ... to cause damage to public or private property.

— Vienna Convention on Road Traffic §Article 7
How is BDI logic relevant for traffic rules?

Road-users shall *avoid* any behaviour likely ... to cause damage to public or private property.

— Vienna Convention on Road Traffic §Article 7

Assume that we record data such as its current occupancy, other vehicles’ occupancies, and road boundaries ...
How is BDI logic relevant for traffic rules?

Road-users shall avoid any behaviour likely ... to cause damage to public or private property.

— Vienna Convention on Road Traffic §Article 7

Assume that we record data such as its current occupancy, other vehicles’ occupancies, and road boundaries ...

Can you formalise Article §7 with these data?
How is BDI logic relevant for traffic rules?

Road-users shall avoid any behaviour likely ... to cause damage to public or private property.

— Vienna Convention on Road Traffic §Article 7

Assume that we record data such as its current occupancy, other vehicles’ occupancies, and road boundaries ...

Can you formalise Article §7 with these data?

Probably

$$\forall t \ (\text{ego-occupancy}(t) \cap \text{road-boundaries}(t) = \emptyset)$$
How is BDI logic relevant for traffic rules?

Road-users shall avoid any behaviour likely ... to cause damage to public or private property.

— Vienna Convention on Road Traffic §Article 7

Assume that we record data such as its current occupancy, other vehicles’ occupancies, and road boundaries ... 

Can you formalise Article §7 with these data?

Probably

\[ \forall t \ (\text{ego-occupancy}(t) \cap \text{road-boundaries}(t) = \emptyset) \] ?

Not really,

because what the Article §7 actually means is that we should never plan an action which will cause collision
How is BDI logic relevant for traffic rules?

Road-users shall avoid any behaviour likely ... to cause damage to public or private property.

— Vienna Convention on Road Traffic §Article 7

A more faithful formalisation:

\[
A G \neg (\text{Int}_\text{ego} (\text{ego-occupancy} \cap \text{road-boundaries} \neq \emptyset))
\]

A direct translation from this formula

\[
A \forall t (AG \neg \text{Int}_\text{ego} \rightarrow \neg \text{occ}_\text{ego} \cap \text{road-boundaries})
\]

At all times (AG), ego vehicle never intends (¬Int\text{ego}) an action such that its occupancy intersects with road boundaries.
How is BDI logic relevant for traffic rules?

Road-users shall avoid any behaviour likely ... to cause damage to public or private property.

— Vienna Convention on Road Traffic §Article 7

A more faithful formalisation:

$$\text{AG} \neg \text{(Int ego (ego-occupancy} \cap \text{road-boundaries} \neq \emptyset))$$
How is BDI logic relevant for traffic rules?

Road-users shall avoid any behaviour likely ... to cause damage to public or private property.

— Vienna Convention on Road Traffic §Article 7

A more faithful formalisation:

$$\text{AG} \neg (\text{Int ego} (\text{ego-occupancy} \cap \text{road-boundaries} \neq \emptyset))$$

A direct translation from this formula

At all times (AG), ego vehicle never intends ($\neg \text{Int ego}$) an action such that its occupancy intersects with road boundaries.
What is this seminar about?

- Check my previous formalisation
  - don’t be afraid to say my formalisation is wrong
- Propose a correction
  - your correction should solve the issue
- Continue formalising traffic rules from Vienna Convention
  - not all but a subset of it
- There has been Isabelle formalisation of BDI logic
  - we can use it to check our syntax