How Duty of Care Defines Society's Top-Level Safety Requirement for Automated Vehicles

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How Safe is Safe Enough?

How do we answer this question?

- What form should the answer take?

How do we generate engineering requirements for AVs without an answer?

- No systematic way to do this
- What should be left to the discretion of engineers?

Society has an answer for "How Safe is Safe Enough?"

This answer comes from the legal system (at least in the United States)

- Translate legal requirements into engineering requirements

Common law gives weight to previous court decisions

- Both prior cases and statutes (laws) considered by judges

This gives the legal system a way to handle novel situations

- Find similar court cases by analogy
- Apply their reasoning to the current issue

How do we apply this to automated vehicles in advance of regulation?

- Consider an earlier example…

Early 1900s… Are cars allowed on roads and highways?

"Improved methods of locomotion are perfectly admissible, if any shall be discovered, and they cannot be excluded from the existing public roads, provided their use is consistent with the present methods. … When the highway is not restricted in its dedication to some particular mode of use, it is open to all suitable methods, and it cannot be assumed that these will be the same from age to age, or that new means of making the way useful must be excluded merely because their introduction may tend to the inconvenience or even to the injury of those who continue to use the road after the same manner as formerly. A highway established for the general benefit of passage and traffic must admit of new methods wherever it is found that the general benefit requires them."

"Almost any proper use of a highway may under some circumstances impede the use by another, and possibly render it dangerous."

Macomber v. Nichols 1876

(steam engine operator not responsible for frightening horse)

What did we do before traffic codes?

Translate concepts from other modes of transport

- In particular, the English “Rules of the Road”
- Road users owe each other a duty of care

Automobiles require “ordinary care”

- A common law concept that requires acting as a reasonable person
- Robust concept since it uses common understanding to clarify expectations

Further court cases crystallized the duty of care specific to automobiles

- Courts had worked out these principles by 1920
- The basic concept remains the same today

Duty of Care

California Jury Instructions

> "A person must use reasonable care in driving a vehicle. Drivers must keep a lookout for pedestrians, obstacles, and other vehicles. They must also control the speed and movement of their vehicles. The failure to use reasonable care in driving a vehicle is negligence."
>
> - CACI No. 700, Basic Standard of Care

Other states are similar, recognizing the lookout and control requirements

Traffic code interpreted relative to duty of care

Some traffic laws represent absolute duties and must be obeyed as written

- For instance, the need to stop at stop signs

The rest are relative duties and simply restate duty of care

- Interestingly, right of way is a relative duty, not an absolute duty:

> “Mrs. Watts' superior right to occupy and use that intersection over the right to such use by the defendant does not permit her to run the defendant down, where it is within her power by the use of proper care to give the defendant an opportunity to escape from the collision though the defendant should not have been in the intersection.”
>
> \- Watts v. Dallas Railway & Terminal Co.

Drivers must always be on the lookout and control their vehicles

Duty of Care: our top-level safety requirement

Automated vehicles shall maintain a strict duty of care to each road user.

This will make sure they are “consistent with present methods”

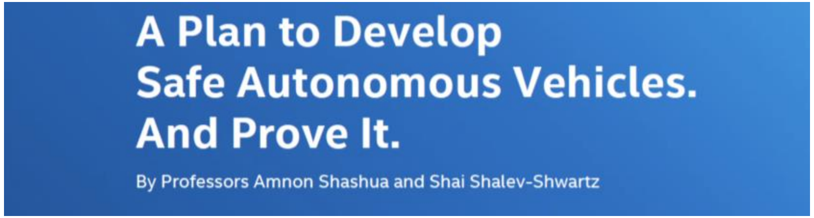
- Same standard society has evolved for human drivers

Using the same standard as human drivers doesn’t limit AVs to human safety levels

- AVs should be designed to meet the duty of care more reliably than humans
- AVs should be designed to respond more capably when others breach duty of care
- Failure to meet the duty of care is a defect subject to NHTSA recall authority

Duty of care idea underlies RSS

Mobileye's RSS identifies the need to formalize duty of care



However, the starting points are not the same as what courts have decided

- Duty of care is not an absolute guarantee of safety
- Turning it into an absolute guarantee impacts mobility
- AV design is not a blank slate and should fit current system

Is being legal enough, what about ethics?

Where is the trolley car?

A relevant ethical framework is social contractarianism

- This is a form of deontological ethics (which describe ethics in terms of duty)
- A social contract trades individual rights for civil rights

We have a social contract for driving with duty of care at its core

- Satisfying the social contract is the AV’s ethical duty
- Ethical and legal responsibilities coincide

When other road users violate duty of care

The automated vehicle needs to take a reasonable action

  Operate up to the physical limits of the car

Can it violate traffic code to avoid a collision? Yes, that’s reasonable.

  Invoke the necessity defense

Add one simple rule to the social contract:

  The AV may not violate the duty of care owed to one road user to resolve a conflict with another.

Trolley problem resolved!

Exceptional Driving Principles For Autonomous Vehicles

by Journal of Law and Mobility June 18, 2022

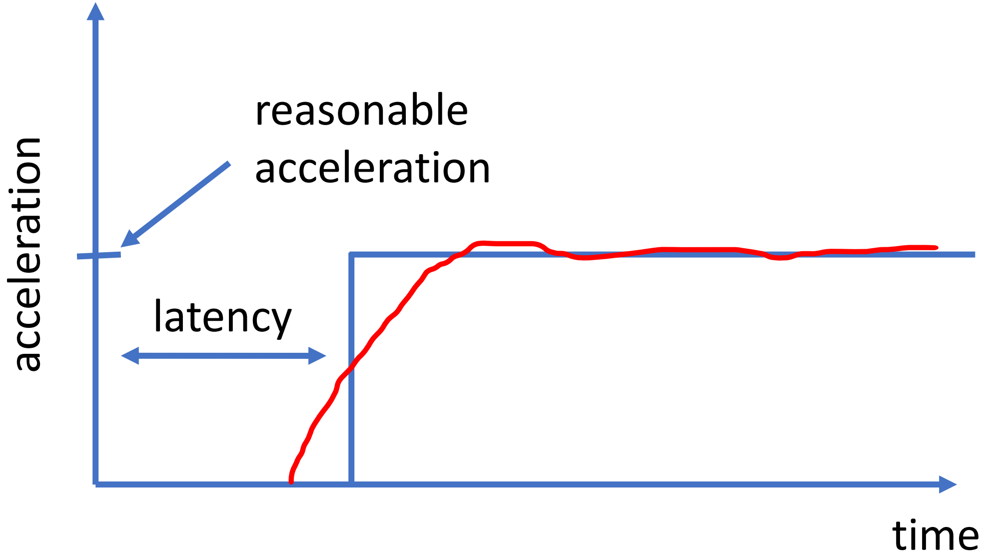
By: A. D’Amato, S. Dancel, J. Pilutti, L. Tellis, E. Frascaroli, AND J.C.Gerdes

So what is reasonable?

Engineers need to translate reasonableness into engineering requirements

- There is no one answer for this
- That's a feature, not a bug – we have to avoid unreasonable behavior

Model reasonable lookout and control behavior – bounded by physics and mobility



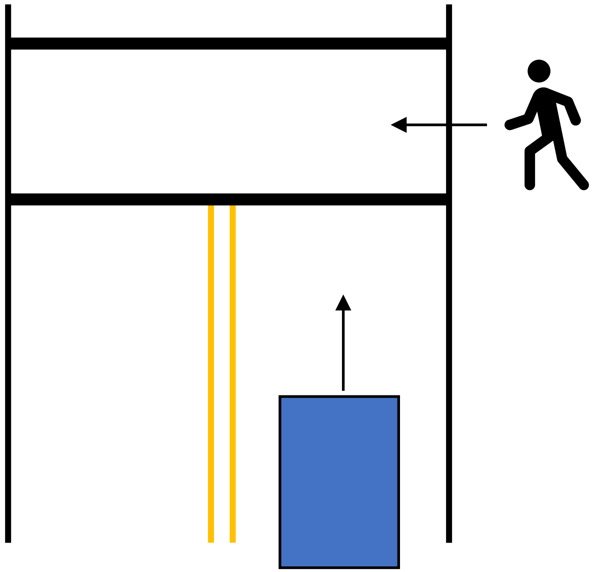
Example – Pedestrians

Reciprocal duties – pedestrians have right of way but also a duty of care

If required deceleration to stop is less than what our model describes as normal operation we should prepare to yield

If it is greater, the car represents an immediate hazard and we should expect the pedestrian to not enter the crosswalk

(Right to assume others follow the law)

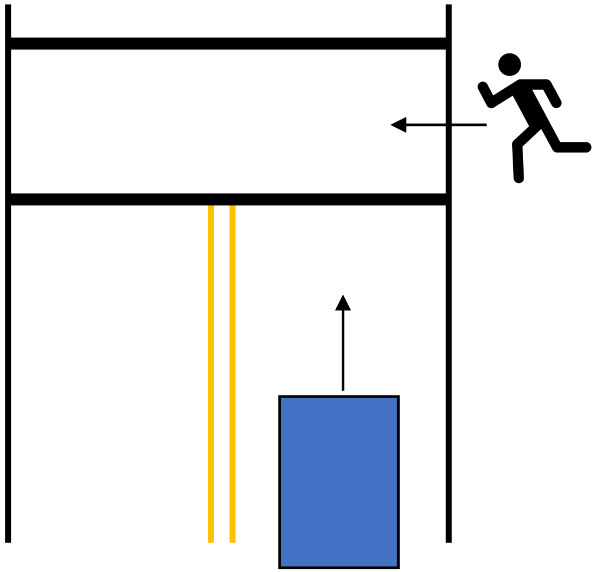


Example – Pedestrians

If the pedestrian and vehicle have mismatched ideas of reasonableness…

When we realize the pedestrian is continuing, we stop (duty of care requires this)

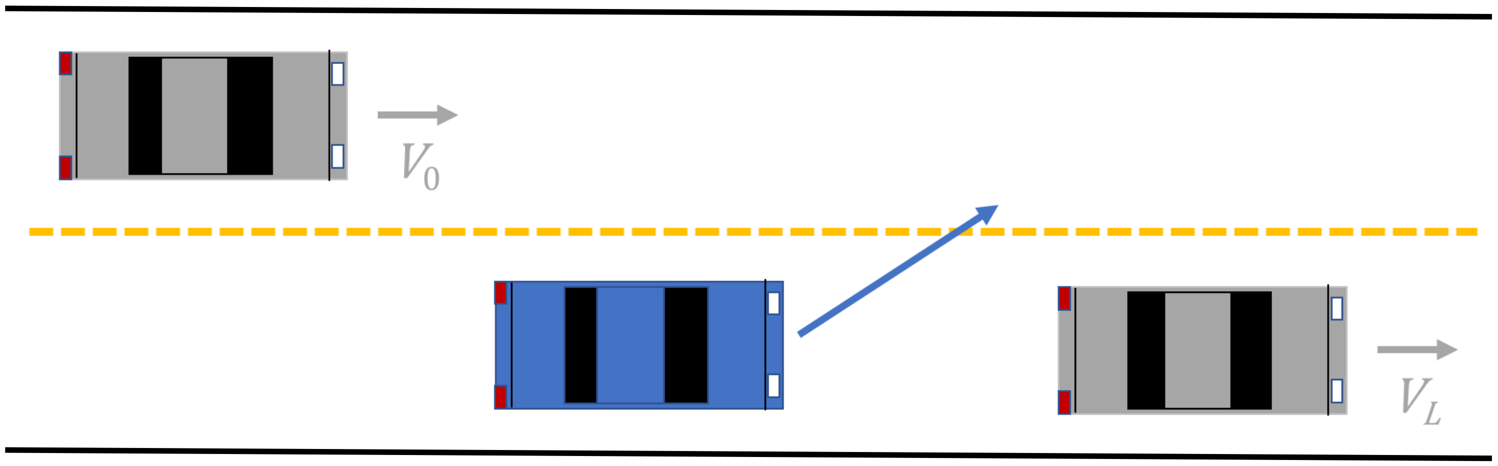
This will require using more than our reasonable acceleration, up to friction limits



Example – Lane change

Can change lanes if the vehicle in the target lane can respond reasonably

- Achieve safe distance by reasonable deceleration after reasonable latency
- Proposed UNECE 157 extension uses similar model



Conclusions

Society has determined how safe is safe enough

- In terms of the duty of care in the U.S. (a social contract, more generally)

We need to understand this determination

- To be safe enough
- To integrate with traffic and provide mobility
- In advance of regulation

For duty of care this involves determining what is reasonable

- Not a single answer (though could be standardized)
- Simple latency and deceleration model can answer many questions