Autonomous Vehicles: The Promise, Peril and Challenges

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The DARPA Urban Challenge: Requirements

- No pedestrians
- No bicyclists
- No traffic lights
- No sensor/actuator failures
- No CPU failures
- No connectivity
 V2V and V2I disallowed
- No cost concerns

- No bad weather conditions
- No night-time operation
- No heavy traffic
- GPS always available
 Military-grade GPS is ok
- High-resolution maps
- Max speed of 30 mph (no highways)









Challenges



The "Uncertainties of the Road World" Challenge

Dealing with the uncertainties of an unconstrained road-world operating environment

- Highways, urban, suburban, ex-urban and rural roads
- Accidents, Emergency Vehicles
- School zones, kids, the elderly, strollers, wheelchairs, jaywalkers and absent-minded crossing
- · Weather conditions
- · Road conditions
- · Lighting conditions
- Construction zones
- Wild life

Uncertainty to the power of *n*, where *n* is large.

 \rightarrow Is the list of scenarios even finite?



Other Challenges

- The Non-Cooperation Challenge
- The Fault-Tolerance Challenge
- The Cyber-Physical Security Challenge
- The "Co-Existence with Human Drivers" Challenge
- The Perception Challenge
 — minimizing false positives and false negatives
- Legal and Regulatory Challenges
- The "Customizability to Different Countries & Driving Cultures" Challenge
- The Ethics Challenge
- The "Knowledge Encoding" Challenge
- The "Human Expectation and Comfort" Challenge
- The "Dealing with Pranksters" Challenge

Human Intelligence ?	
 Super Intelligence The Vision system Human eye: very high resolution with depth info, iris/aperture control, focus The (Re)cognition system Near-instant detection and identification of objects and organisms Learn from a few examples (Unreasonable?) reasoning power Logical reasoning, generalization and specialization Spatial and temporal intelligence Intuition and experience Adaptability (to new vehicles, cultures, rules) Coordinated sensing & actuation 	 Fundamental Weaknesses Distractability Dozing off, conversations, diversion of interest, intoxication Imperfect sensing Drivers with poor vision, age impairments, Eyes at the front only Non-ideal reasoning Incorrect understanding of vehicle dynamics Poor multitasking Overconfidence Instincts and intuition can be wrong at critical moments Poor reflexes due to age or health
exchanges, game theory	Carnegie Mellon University

Turing, Where Art Thou?





















Connected Automation	
 Connectivity: uses V2X (i.e. V2V, V2I,) Sees farther Sees around corners Inexpensive 'sensor' Sends alerts to distracted humans Will not be present everywhere for a very long time Automation: uses vehicle sensors Pays attention all the time Reacts faster than humans Local sensors can be blinded, occluded or be wrong. Expensive sensors and processing. 	
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