Regulatory approaches to managing artificial intelligence systems in autonomous vehicles in Australia

REGULATORY APPROACHES TO MANAGING ARTIFICIAL INTELLIGENCE SYSTEMS IN AUTONOMOUS VEHICLES IN AUSTRALIA

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ABSTRACT

This article explores the emergence of Automated Vehicles in Australia. It will investigate the legal and regulatory terrain. International and domestic approaches are examined to determine potential responses. The regulatory issues emerge partly due to the varied nature of artificial intelligence systems and processes that enable Automated Vehicles to function. The variations may be due to the chosen domain model, software development processes, or the development of biases that may occur during code development for the underlying AI system. Such variation can create difficulties in the application of road rules, safety requirements, and the legal and regulatory requirements. They may give rise to significant issues relating to driver classification and licensing for Automated Vehicles, due to the varied levels of control and involvement in the driving process. For this reason, legislative reform at specific jurisdictional levels is suggested together with clearer international standards as a pathway to ensure the safe and effective integration of autonomous vehicles into society.

KEYWORDS: Artificial Intelligence, Autonomous Vehicles, Regulation, Licensing, Software Bias

Contents

I. INTRODUCTION

Technology allowing the development of Automated Vehicles (AVs) is becoming widespread. However, the regulation of these vehicles varies between jurisdictions, with some developing more evolved approaches than others. There is much to be learned from exploring comparative regulatory approaches, as these may inform more consistent worldwide responses to the legal and regulatory issues raised by AVs. In this article, the authors initially explore variations in AV development and analyse comparative material before referring more specifically to the regulatory and legal approaches in one common law jurisdiction – Australia. This approach is undertaken in order to consider and explore whether and to what extent global regulatory approaches are possible or desirable. The position of jurisdictions such as the United States, the United Kingdom, China, Canada, Germany, New Zealand, Spain, Singapore, France, and European Union, are also considered. This supports a broad consideration of the very specific legislation applicable in each jurisdiction and a comparative approach promotes guidance about what the policy reform that will be required in each jurisdiction is. The authors conclude that domestic jurisdictional arrangements supported by a consideration of international approaches will enable the variation in legal and regulatory responses that will be required to support AV development.

The regulatory and legal terrain surrounding AVs in Australia is difficult to navigate. At present, a patchwork of laws exists in Australia around AVs and the underlying artificial intelligence (AI) systems and processes that support the operation of such vehicles. International jurisdictions are also moving towards the regulation of AVs and like Australia have varying degrees of regulatory coverage of autonomous vehicles. Some of the issues in creating a legal and regulatory framework can be linked to the need to adequately address safety issues, and ascertain the application of the *Australian Road Rules*. The technology operating the AV can lead to software, bias, and domain modelling concerns. Additionally, the variations in AI technology and 'support' that arises in vehicle operation needs to be considered. Also important are questions relating to the AV driver's role and subsequently the licensing model that they operate under. Reaching a resolution on these matters leads to a clearer approach for a national framework to be developed.

II. ARTIFICIAL INTELLIGENCE AND AUTOMATED VEHICLES

The development of AVs has taken place alongside advances in AI. In terms of motor vehicles, rather than AVs, simple and more complex AI systems have supported a range of arrangements that can make it easier for humans to safely operate and use vehicles. Such arrangements include an early focus on parking support and navigation and more sophisticated AI support that can assist to address human driver fatigue (for example, using facial tracking software). AV developments can however be considered along a broader continuum that assumes that human control of a vehicle will be limited. These limitations can be understood in the context of 'levels' of operation and, in terms of the activity and scope of the AI systems and processes used. FIGURE 1 and the discussion below explore the levels adopted by the SAE International Standard J3016 and domestic and international projects involving AVs.

There is no widely accepted definition of AI.[1] Historically, Alan Turing proposed the Turing Test as a replacement for the question 'Can machines think?'[2] The approach by Turing has received mixed responses. On the one hand, it initiated the concept of AI with the 'Turing Test' being the culmination of a successful AI system. On the other hand, it has been regarded as inappropriate. These positions are impacted by other factors such as behaviourism, operational definitions of intelligence, other mind problems, consciousness, and also the requisite conditions for 'intelligence-granting.'[3]

As a result, a number of different definitions are used to formulate an approach in this article. In order to understand the operation of AI, it is helpful to initially consider how to define intelligence as derived from the human condition and capturing problem solving capabilities that are derived from particular skills and knowledge, 'Intelligence is integrated with various cognitive functions such as; language, attention, planning, memory, perception…'[4] Based on this understanding of intelligence, AI attempts to mirror the human mind but it is not entirely identical to the human mind, according to Pei Wang:

> 'Therefore, here the key issue is *where* the two are similar or even the same. …every working definition of AI corresponds to an abstraction of the human mind that describes the mind from a certain point of view, or at a certain level of abstraction, under the belief that it is what intelligence is really about. This abstraction guides the construction of a computer

[1] Pei Wang, 'On Defining Artificial Intelligence' (2019) 10(2) *Journal of Artificial General Intelligence* 1, 1.
[2] Alan Turing, 'Computing Machinery and Intelligence' (1950) 59(236) *Mind* 433, 433–460.
[3] Ayse Pinar Saygin, Ilyas Cicekli, and Varol Akman, 'Turing test: 50 years later' (2000) 10(4) *Minds and Machines* 463, 463.
[4] Jahanzaib Shabbir and Tarique Anwer, 'Artificial Intelligence and its Role in Near Future' (2015) 14(8) *Journal Of Latex Class Files* 1, 1.

> system that is similar to a human mind in that sense, while neglecting other aspects of the human mind as irrelevant or secondary.'[5]

Jahanzaib Shabbir and Tarique Anwer, in contrast, suggest that AI is a system which originates with a range of knowledge and skills that are initially derived from data inputs that aim in so far as technologically possible to mimic the human mind. It then develops the system in a linear fashion to meet its environmental context. [6] In the context of AVs, what is important is the manner in which the AI program responds to complex and changing external stimuli and the current laws which operate on Australian roads.

AVs are suggested as a safer, more economically viable means of transport when compared to other options in the marketplace.[7] Legally defining AVs is complicated, and Australia does not have a single definition enshrined in legislation or established in case law. For this reason, the definition from the *National Transport Commission* is adopted in this paper. That is, an AV is a vehicle which contains an 'automated driving system' that performs all dynamic driving tasks whilst observing the external environment, with some to no human driver input.[8] Dynamic driving tasks, as described by the United States Society of Automation Engineers International, are 'real-time operational and tactical functions required to operate a vehicle in on-road traffic.'[9] Automated driving systems use a combination of software and hardware to allow them to dynamically perform both operational and tactical driving functions when operating in traffic in one of the following modes: conditional, high and full automation.[10] The hardware and software required for a vehicle seeking to operate autonomously depends upon whether it was manufactured as an

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[5] Wang (n 1) 8.

[6] Shabbir and Anwer (n 4) 2.

[7] See generally, National Transport Commission Australia, *Clarifying Control of Automated Vehicles* (Policy Paper, April 2017) <https://www.ntc.gov.au/sites/default/files/assets/files/Discussion-Paper-Clarifying-control-of-automated-vehicles.pdf>.

[8] National Transport Commission, *Automated Vehicle Program Approach,* (Report, October 2019) [1.8] <https://www.ntc.gov.au/sites/default/files/assets/files/NTC%20Automated%20Vehicle%20Reform%20Program%20Approach%20%28October%202019%29%20-%20Public%20version.pdf>; Society of Automation Engineers International, *Surface Vehicle Recommended Practice – Taxonomy and Definitions for Terms Relating to Driving Automation Systems for On-Road Motor Vehicles* (Report J3016, June 2018) [3.7]-[3.13].

[9] Society of Automation Engineers International, *Surface Vehicle Recommended Practice – Taxonomy and Definitions for Terms Relating to Driving Automation Systems for On-Road Motor Vehicles* (n 8) [3.13]; National Transport Commission, *Automated Vehicle Program Approach* (n 8) 9; see also, Tania Leiman, 'Law and tech collide: foreseeability, reasonableness and advanced driver assistance systems' (2020) *Policy and Society an Interdisciplinary Journal of Policy Research* 1, 2.

[10] National Transport Commission Australia, *Changing Driving Laws To Support Automated Vehicles* (Policy paper, May 2018) [1.5].

AV such as the Google Waymo,[11] or whether it is created from an existing non-AV.[12]

The technology utilised in an AV can determine the level of automation. Hardware to assist the vehicle's operation could include electronically activated brakes, steering, an interface device for software control of the electronic functions of the car,[13] real-time location and hazard identification equipment including sensors and cameras, and on-board computers.[14] The software systems could include global navigation satellite systems for mapping, vehicle localisation, object and hazard identification,[15] and cloud computing systems for real-time information storage and processing.[16] The accepted levels of automation are classified by the Society of Automation Engineers International and this classification has been adopted as a general standard by the National Highway Traffic Safety Administration in the United States,[17] the National Transport Commission in Australia, European Road Transport Research Advisory Council, United Kingdom's Department for Transport, and the Government of Ontario, Canada.[18]

Such levels are relevant in determining legal and regulatory responses and as discussed further in this paper may lead to arrangements that lack clarity, particularly where an AV may potentially have some minor characteristics relevant to a higher level of automation. The levels described are the minimum degree of automation for each level; meaning the extent of automation at each level could increase.[19] The six levels range from level zero to level five and are detailed in FIGURE 1 below. Though not exhaustive, FIGURE 1 indicates the growing range of projects and the

[11] See eg Waymo, *Waymo Safety Report – On the Road to Fully Self-Driving* (Report, 2018) <https://storage.googleapis.com/sdc-prod/v1/safety-report/Safety%20Report%202018.pdf>.

[12] See generally, in relation to systems and vehicles, Jesse Levinson, Jake Askeland, Jan Becker, Jennifer Dolson, David Held, Soeren Kammel, J. Zico Kolter, Dirk Langer, Oliver Pink, Vaughan Pratt, Michael Sokolsky, Ganymed Stanek, David Stavens, Alex Teichman, Moritz Werling, and Sebastian Thrun 'Towards Fully Autonomous Driving: Systems and Algorithms' (2011) *2011 IEEE Intelligent Vehicles Symposium (IV)* 163.

[13] Ibid 163.

[14] Ibid 163-164.

[15] Ibid 163-165.

[16] Sharon Poctver and Luka Jankovic, 'The Google Car: Driving Towards a Better Future?' (2014) 10(1) *Journal of Business Case Studies* 7, 8.

[17] Kanwaldeep Kaur and Giselle Rampersad, 'Trust in driverless cars: investigating key factors influencing the adoption of driverless cars' (2018) 48 *Journal of Engineering and Technology Management* 87, 87.

[18] Araz Taeihagh and Hazel Si Min Lim, 'Governing Autonomous Vehicles: Emerging Responses for Safety, Liability, Privacy, Cybersecurity, and Industry Risks' (2019) 39(1) *Transport Reviews* 103, 106.

[19] Society of Automation Engineers International, *Surface Vehicle Recommended Practice – Taxonomy and Definitions for Terms Relating to Driving Automation Systems for On-Road Motor Vehicles* (n 8) [4].

more recent trend towards a growth in the application and regulation of AI technology in this area. The use of levels and the patchwork framework of legislation is discussed further in the next section.

FIGURE 1: Levels adopted from SAE International Standard J3016[20]			
Level and Automation Level[21]	*DESCRIPTION*	*PROJECT AND YEARS (Significant Developments) International*	*PROJECT AND YEARS (Significant Developments) Domestic*
Level 0 No Substantive Driver Assistance	The vehicle has no automation and is entirely controlled by the driver. This level can include cruise control; however, the driver must monitor the environment and safely operate the car.[22]	For example: Honda Accord 2005 model that has cruise control.[23]	Not Applicable – no significant additional legislation dealing with AV issues at this level (NA).
Level 1 Driver Assistance	The driver is still required to maintain full control and be aware of surroundings, but the car has some supportive automated features such as cruise control, parallel parking and lane keeping assistance technology. Therefore, the driver cedes a small amount of control to the automated system.	Currently available conventional vehicles that have the aforementioned features.	NA.
Level 2 Partial Automation	This level has partial automation where it includes features such as vehicular control over speed via cruise control and steering under certain conditions.[24] Level two incorporates level one features, but has the ability to perform both at the same time.[25] The driver is still	*Tesla model S Autopilot* (2016) The first AV fatality in 2016.[27]	NA.

[20] Society of Automotive Engineers International 2018, *SAE J3016 Levels of Driving Automation* <https://www.sae.org/binaries/content/gallery/cm/articles/press-releases/2018/12/j3016-levels-of-automation-image.png>.

[21] National Transport Commission, *Automated Vehicle Program Approach* (n 8) 8 <https://www.ntc.gov.au/sites/default/files/assets/files/NTC%20Automated%20Vehicle%20Reform%20Program%20Approach%20%28October%202019%29%20-%20Public%20version.pdf>.

[22] Letter from National Highway Traffic Safety Administration to Chris Urmson (Web Page Letter, 4 February 2016) <https://isearch.nhtsa.gov/files/Google%20--%20compiled%20response%20to%2012%20Nov%20%2015%20interp%20request%20--%204%20Feb%2016%20final.htm>.

[23] Kyle Hyatt and Chris Paukert, 'Self-driving cars: a level-by-level explainer of autonomous vehicles', *Cnet.com* (Web Page, 29 March 2018) <https://www.cnet.com/roadshow/news/self-driving-car-guide-autonomous-explanation/>.

[24] Infrastructure Partnerships Australia, *Automated Vehicles Do We Know Which Road To Take?* (Report 2017) 31 <https://infrastructure.org.au/wp-content/uploads/2017/09/AV-paper-FINAL.pdf>.

[25] Ibid.

[27] Danny Yadron and Dan Tynan, 'Tesla Driver Dies in First Fatal Crash While Using Autopilot Mode', *The Guardian* (Web Page, 1 July 2016) <https://www.theguardian.com/technology/2016/jun/30/tesla-autopilot-death-self-driving-car-elon-musk>; See also, National Transportation Safety Board,

	responsible for monitoring the environment and supervising the car when required.[26]	*General Motor's 2017/18 Super Cruise Cadillac CT6*[28] *Audi A8* (2018)* *The Audi A8 2018 was originally level 3, however, due to regulatory issues, the 'traffic jam pilot' system Audi created is not being implemented until these issues are resolved, leaving the model at level 2.[29]	
Level 3 ***Conditional Automation***	At this level, the vehicle can perform all driving tasks, however, it includes the car being able to partially monitor the driving environment.[30] The driver does not need to continuously monitor the driving environment as the vehicle is able to do so for defined periods.[31] However, driver interaction is still required in circumstances unfamiliar to the driverless system, or where it requests driver intervention.[32]	None currently available for consumer purchase.	**SA** *Flinders Express (FLEX)* (2018). FLEX will shuttle people between a nearby train station and Flinders University in South Australia and will

Collision Between a Car operating With Automated Vehicle Control Systems and a Tractor-Semitrailer Truck Near Williston, Florida (Accident Report NTSB/HAR-17/02 PB2017-102600, 7 May 2016).

26 Ibid.

28 Evan Ackerman, 'Cadillac Adds Level 2 Highway Autonomy with Super Cruise', *IEEE Spectrum* (Web Page, 17 April 2017) <https://spectrum.ieee.org/cars-that-think/transportation/self-driving/cadillac-adds-level-2-highway-autonomy-with-super-cruise>; Kevin Kelly, 'Cadillac Super Cruise Sets the Standard for Hands-Free Highway Driving', *Cadillac* (Web Page, 10 April 2017) <https://media.cadillac.com/media/us/en/cadillac/news.detail.html/content/Pages/news/us/en/2017/apr/0410-supercruise.html>.

29 Chris Paukert, 'Why the Audi A8 won't get Level 3 partial automation in the US', *Cnet* (Web Page, 14 May 2018) <https://www.cnet.com/roadshow/news/2019-audi-a8-level-3-traffic-jam-pilot-self-driving-automation-not-for-us/>; Joey Capparella, '2019 Audi A8 Won't Offer Hands-Off Autonomous Tech in the U.S.', *Car and Driver* (Web Page, 14 May 2018) <https://www.caranddriver.com/news/a20652322/2019-audi-a8-wont-offer-hands-off-autonomous-tech-in-the-us/>.

30 United States Department of Transportation, 'Automated Vehicles for Safety', *National Highway Traffic Safety Administration* (Web Page) <https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety#topic-road-self-driving>; Society of Automation Engineers International, *Surface Vehicle Information Report – Taxonomy and Definitions for Terms Relating to Driving Automation Systems for On-Road Motor Vehicles* (Report J3016, January 2014) [3] <https://www.sae.org/standards/content/j3016_201806/>. See generally in relation level 3, David Large, Emily Shaw and Gary Burnett, 'Towards Future Driver Training Analysing Human Behaviour in Level 3 Automated Cars' (2020) *Ergonomics and Human Factors* (forthcoming) <https://nottingham-repository.worktribe.com/output/3811742/towards-future-driver-training-analysing-human-behaviour-in-level-3-automated-cars>.

31 National Transport Commission Australia, *Changing Driving Laws To Support Automated Vehicles* (n 10) 9.

32 Society of Automation Engineers International, *Surface Vehicle Recommended Practice – Taxonomy and Definitions for Terms Relating to Driving Automation Systems for On-Road Motor Vehicles* (n 8), 22; Infrastructure Partnerships Australia (n 24) 31.

			expand this route to a nearby hospital.[33]
Level 4 ***High Automation***	Level four automation is where the car is nearing full automation in normal driving conditions and performs all necessary safety functions and monitors the environmental conditions for the trip's entirety.[34] Vehicles perform all the driving-related operations without any input from the driver, who essentially becomes a passenger.[35] However, where the environmental conditions are unknown to the AV or extreme weather occurs, the user is still required to interact with the car.[36] Google's Waymo car claims to be at this level, with further developments being made to make it fully automated under level five.[37]	*Google Car 'Waymo'* (2018).[38] The Waymo car uses a combination of hardware and software systems including cameras, radar sensors, laser range finders and Global Positioning Systems, which aim to provide real-time environmental information.[39] *Robot Taxi* (2017-2018). Operating in Japan.[40] *Jaguar Land Rover.* *Volkswagen e-Golfe* (expected 2020).[41]	**SA** *Volvo XC90* (2015).[42] *'Olli'* & *'Matilda'* 2019.[43] These AVs will provide transport passengers to a beach in SA. *Aurrigo* (2019). Trial run from retirement village.[44] **NSW** *Smart Shuttle 'Navya'* (2017). Initial phase testing began in 2017, with the three-

[33] Casey Briggs, 'Fastest Driverless Vehicle to Hit Australian Roads Unveiled in Adelaide', *ABC News* (Web Page, 19 June 2018) <https://thenewdaily.com.au/news/state/sa/2018/06/19/fastest-driverless-vehicle-adelaide/>.

[34] Letter from National Highway Traffic Safety Administration to Chris Urmson (n 22); Tracy Hresko Pearl, 'Fast & Furious: The Misregulation of Driverless Cars' (2017) 73(1) *New York University Annual Survey of American Law* 19, 28-29.

[35] Infrastructure Partnerships Australia (n 24) 31.

[36] Ibid.

[37] CB Information Services, '46 Corporations Working on Autonomous Vehicles' *cbinsights.com* (Web Page, 4 September 2018) <https://www.cbinsights.com/research/autonomous-driverless-vehicles-corporations-list/>.

[38] Waymo (n 11).

[39] Poctver and Jankovic (n 16) 8.

[40] Fumio Shimpo, 'The Principal Japanese AI and Robot Strategy and Research Toward Establishing Basic Principles' in Woodrow Barfield (ed), *Research Handbook on the Law of Artificial Intelligence* (Edward Elgar Publishing Ltd, 2019) 114, 133.

[41] 'Volkswagen tests highly-automated driving in Hamburg', *Volkswagen* (Web Page, 3 April 2019) <https://www.volkswagenag.com/en/news/2019/04/volkswagen-tests-highly-automated-driving-in-hamburg.html>.

[42] Department of Transport and Planning, 'Volvo Rolls Into Adelaide for Driverless Car Trials', *Government of South Australia,* (Web Page) <https://dpti.sa.gov.au/m/news?a=179468>.

[43] Asha Barbaschow, 'South Australia kicks off six month driverless shuttle trial', *ZDNet* (Web Page, 18 January 2019) <https://www.zdnet.com/article/south-australia-kicks-off-six-month-driverless-shuttle-trial/>; 'Matilda' smart transit hub makes Australian debut at world's first integrated driverless technology trial', *A Sage Group Company* (Web Page, 17 January 2019) <https://www.sageautomation.com/news/pages/matilda-smart-transit-hub-makes-australian-debut-at-worlds-first-integrated-driverless-technology-trial>.

[44] 'Autonomous vehicle trial', *Regional Development Australia* (Web Page) <https://rdahc.com.au/projects/autonomous-vehicle-trial/>.

			phase testing to be completed by 2019.[45] **NT** *Easy Mile EZ10 Shuttle Bus* (2016)[46] **WA** *RAC Intellibus* (2016)[47] **QLD** *Easy Mile EZ10* (2019)[48] *Ipswich Connected Vehicle Pilot* (2019)[49] *'CHAD'* (2018-2023) Pilot testing vehicle, one at level 4 that will be used to ascertain interactions between it, the road, road users, vehicles.[50] **TAS** *Navya Autonom Shuttle* (2019).[51] **VIC**

[45] 'NSW Smart Shuttle', *NSW Government* (Web Page) <https://www.transport.nsw.gov.au/projects/programs/smart-innovation-centre/projects-0/nsw-automated-shuttle-trial>; Barbaschow (n 43).

[46] 'New Era of Modern Travel to Hit Waterfront', *Northern Territory Government Newsroom* (Media Release, 15 December 2016) <http://newsroom.nt.gov.au/mediaRelease/22676>.

[47] 'Trial Stages', *RAC* (Web Page) <https://rac.com.au/about-rac/advocating-change/initiatives/automated-vehicle-program/intellibus/trial-stages>.

[48] 'RACQ Smart Shuttle', *RACQ* (Web Page) <https://www.racq.com.au/racqsmartshuttle>.

[49] 'Ipswich Connected Vehicle Pilot', *Queensland Government* (Web Page) <https://www.qld.gov.au/transport/projects/cavi/ipswich-connected-vehicle-pilot>; Queensland Government, 'Cooperative and Automated Vehicle Initiative CAVI' (Media Release, 24 January 2019) <https://www.tmr.qld.gov.au/About-us/News-and-media/News-and-media-frequently-asked-questions/Cooperative-and-Automated-Vehicle-Initiative-CAVI>; 'Contact CAVI', *Queensland Government* (Web Page) <https://www.qld.gov.au/transport/projects/cavi/cavi-team>; 'Trials', *Austroads* (Web Page) <https://austroads.com.au/drivers-and-vehicles/future-vehicles-and-technology/trials>.

[50] 'Trials', *Austroads* (n 49); 'Cavi Components', *Queensland Government* (Web Page) <https://www.qld.gov.au/transport/projects/cavi/cavi-components#chad>.

[51] 'Leading the way in new technology', *Royal Automobile Club of Tasmania* (Web Page) <https://www.ract.com.au/community/related-articles/leading-the-way-in-new-technology>.

			Bosch Trials (2018)[52] *Autonobus* (2017)[53] **ACT** *CanDrive* (2018)[54]
Level 5 Full Automation	Full automation requires no interaction from a driver and does not require environmental monitoring by the user making the steering wheel and driver seat redundant.[55] This level is still unavailable but serves as the goal for AV manufacturers.[56]	There are currently no models available for consumer purchase. The closest developments include: *Stanford Cart Rover (1983).* The Stanford University developed a robotic cart that utilised a computer program to navigate and avoid objects.[57] *DARPA challenge (2004).* The United States' Defence Advanced Research Projects Agency challenge required teams to build an AV capable of navigating itself over 142 miles in normal driving conditions, whilst following road rules and avoiding stationary and moving objects.[58] None of the vehicles successfully completed the challenge however.	

[52] VicRoads, 'Grants, trials and partnerships', *Victoria State Government* (Web Page) <https://www.vicroads.vic.gov.au/safety-and-road-rules/vehicle-safety/automated-and-connected-vehicles/grants-trials-and-partnerships>; Minister for Transport Infrastructure, 'First automated vehicle to hit the road, *Premier of Victoria* (Web Page, 21 January 2019) <https://www.premier.vic.gov.au/first-automated-vehicle-to-hit-the-road/>.
[53] 'Autonobus', *La Trobe University* (Web Page, 3 December 2019) <https://www.latrobe.edu.au/technology-infusion/autonobus>; VicRoads, 'Grants, trials and partnerships' (n 52).
[54] *Candrive – Automated Vehicle Trial* (Report, June 2018) <https://www.business.act.gov.au/__data/assets/pdf_file/0020/1224344/CanDrive-Report-June18.pdf>; ACT Government, 'Candrive - automated vehicle trial' (Web Page) <https://www.business.act.gov.au/resources_and_networks/candrive-automated-vehicle-trial>.
[55] Infrastructure Partnerships Australia (n 24) 31; National Transport Commission Australia, *Changing Driving Laws To Support Automated Vehicles* (n 10) [1.5].
[56] Pearl (n 34) 29; Letter from National Highway Traffic Safety Administration to Chris Urmson (n 22).
[57] Hans Moravec, 'The Stanford Cart and the CMU Rover', (1983) 71(7) *IEEE* 872, 872.
[58] Defence Advanced Research Projects Agency, 'Grand Challenge 2004 Final Report' (Report VA 22203-1714, 30 July 2004) 2; See generally Daniel Fagnant and Kara Kockelman, 'Preparing a Nation For Autonomous Vehicles: Opportunities, Barriers and Policy Recommendations' (2015) 77 *Transport Research Part A* 167, [1.1].

III. DEVELOPMENTS IN AV REGULATION

Currently, legislation concerning the testing of AVs has been implemented in several countries including countries in the European Union,[59] the United States[60] and Australia.[61] However, legislation surrounding liability for incidents concerning AVs has yet to be finalised. The Society of Automation Engineers International guidelines have been considered in the development of autonomous driving legislation in Germany and the United States.[62] FIGURE 2 explores the legislative environment which

[59] In the European context the *Vienna Convention on Road Traffic* 1986 has been updated to accommodate the emergence of level 3 vehicles. Article 8, '(which previously required 'every driver to control his vehicle at all times'), now permits the use of automated vehicles, provided a driver is always present and the system can be overridden by the driver.' See Clayton UTZ, *Driving Into the Future: Regulating Driverless Vehicles in Australia* (Report, 2016) 8 <https://www.claytonutz.com/articledocuments/178/Clayton-Utz-Driving-into-the-future-regulating-driverless-vehicles-2016.pdf.aspx?Embed=Y>.

[60] In the United States Washington, DC Bills 2012 DC B19-0931; 2018 DC B22-0901 regulate autonomous vehicles and exclude all cars and other assistive technology which are not installed to actively control the car without a human operator present. The legislation allows for operation on a public road provided there remains a driver's seat with controls that include a manual override feature and provided the standard traffic laws are complied with. Manufacturers are not deemed responsible for a vehicle retrofitted by a third party unless the defect existed prior to the conversion, such conversions must be vehicles post 2009. See 'Autonomous Vehicles Self-Driving Vehicles Enacted Legislation', *National Conference of State Legislatures* (Web Page, 19 March 2019) <www.ncsl.org/research/transportation/autonomous-vehicles-self-driving-vehicles-enacted-legislation.aspx> for an overview of current legislation of autonomous vehicles in the United States; See also, Bella Skuthorp and Juliana Jorissen, 'Artificial Intelligence - Are We Ready?' (2017) 29(5) *Australian Construction Law Bulletin* (newsletter) 52, 5 which discusses Safely Ensuring Lives Future Deployment and Research In Vehicle Evolution (SELF DRIVE) Act 2017 (US) 30 HR 3338, 115th Congress (7 September 2017).

[61] A significant amount of legislation is being passed in Australia in relation to autonomous vehicles. For example, *Motor Vehicles (Trials of Automotive Technologies) Amendment Act 2016* (SA), *Transport Legislation Amendment (Automated Vehicle Trials and Innovation) Act 2017* (NSW) and *Road Safety Amendment (Automated Vehicles) Bill 2017* (Vic). Australia has also created guidelines for autonomous vehicles, National Transport Commission, *Guidelines for Trials of Automated Vehicles in Australia* (Report, May 2017) <https://www.ntc.gov.au/Media/Reports/(00F4B0A0-55E9-17E7-BF15-D70F4725A938).pdf>.

[62] Backer and Mckenzie International, *Global Driverless Vehicles Survey 2018*, (Survey, 2018) 87 <https://www.bakermckenzie.com/-/media/files/insight/publications/2018/03/global-driverless-vehicle-survey-2018/mm_global_driverlessvehiclesurvey2018_mar2018.pdf>; See generally, Krzysztof Czarnecki, *Operational World Model Ontology for Automated Driving Systems Part 2: Road Users, Animals, Other Obstacles, and Environmental Conditions* (Report, 21 July 2018 Waterloo Intelligent Systems Engineering (WISE) Lab University of Waterloo).

currently exists in Australia whilst FIGURE 3 details international developments. Though differences arise, some similarities are evident in terms of achieving a safe operating environment for continuing development and the need for careful and paced integration of AVs into existing transport networks. As regulation increases and the use of AVs becomes more widespread, it seems likely that domestic regulation will become more specific and follow the examples provided in international jurisdictions, which regulate AVs under a separate raft of legislation. It is important to have legislation domestically that is uniform; the authors suggest model legislation should be proposed by the Commonwealth of Australia to be adopted by all six states and two territories.

FIGURE 2: Australian Legislative AV Developments		
LOCATION	*TITLE*	*YEAR*
VICTORIA	*Road Safety (Automated Vehicles) Regulations 2018* (Vic) amends the *Road Safety Act 1986* (Vic) Pt 3A – Automated Vehicles	2018 Amendment
SOUTH AUSTRALIA	*Motor Vehicles Act 1959* (SA), Pt 4A – Trials of Automotive Technologies. *Motor Vehicles (Trials of Automotive Technologies) Amendment Act 2016* (SA)	2016 Amendment
NEW SOUTH WALES	*Transport Legislation Amendment (Automated Vehicle Trials and Innovation) Act 2017* Amends the following legislation*:* ● *Road Transport Act 2013* (NSW) Pt 5.6 Automated Vehicle Trials. ● *Road Transport Administration Act 1988*	2017 Amendment
QUEENSLAND	State Government issued permit required.[63]	
NORTHERN TERRITORY	There is no new legislation for testing of AVs, however, the exemption provisions under the *Motor Vehicles Act 1949* (NT) and the *Traffic Act 1987* (NT) enable the testing of AVs .[64]	N/A
TASMANIA	There is no legislation for AV testing at present, though exemption provisions under the *Road Rules 2019* (TAS) may be used.[65]	N/A
WESTERN AUSTRALIA	State Government issued permit required.[66]	
AUSTRALIAN CAPITAL TERRITORY	*Road Transport (Safety and Traffic Management) (Autonomous Vehicle Trials) Amendment Bill 2016* (ACT)	2016
COMMONWEALTH	There are no Federal level requirements, hence the difference between the State and Territory approaches.	N/A

[63] Queensland Government, 'Automated Vehicle Trial Application Checklist', *Business Queensland* (Web Page, 18 July 2019) <https://www.business.qld.gov.au/industries/transport/trialling-automated-vehicle/application-checklist>.

[64] *Motor Vehicles Act 1949* (NT) s 8A; *Traffic Act 1987* (NT) s 43B.

[65] *Road Rules 2019* (TAS) s 376.

[66] 'Automated Vehicles', *Department of Transport* (Web Page, 2020) <https://www.transport.wa.gov.au/projects/automated-vehicles.asp>.

FIGURE 3: International Regulation of AVs	
COUNTRY	*LAW*
United States[67]	There is a complicated hierarchy of legislation in the United States. At a federal level there has been an unsuccessful approach to regulating AVs under the *Self Drive Act H.R. 3388* (House passed).[68] The *AV START Act* is the corresponding bill to the *Self Drive Act H.R. 3388*. Unfortunately this act did not pass the Senate.[69] The *National Highway Traffic Safety Administration* can grant exemptions for the use of AVs in the United States.[70] This agency is empowered to do so under the *National Traffic and Motor Vehicle Safety Act of 1966 (Vehicle Safety Act)* and enforces the *Federal Motor Vehicle Safety Standards (Safety Standards).*[71] For an exhaustive list of a state by state approach to legislation and executive orders for AVs and other regulation see the National Conference of State Legislatures.[72] *Examples of State legislature* ● Nevada: AB 51 (Nev 2011) codified in *Nevada Revised Statutes,* NV Rev Stat § 482A (2014). ● California: SB 1298 (Cal 2012) codified in *California Vehicle Code 2012*, Cal Veh Code § 38750 (2012).[73] ● Florida: HB 1207 (Fla 2012) codified in *Florida Statutes,* Fla Stat Ch 316 (2014).[74] ● New Jersey: *New Jersey Advanced Autonomous Vehicle Task Force*, AJR 164, 218th Congress (2018).[75] ● Utah: *Distracted Driver Amendments*, HB 101 (2020).[76] ● Louisiana: *Motor Vehicles and Traffic Regulation*, 32 La Rev Stat Ann § 1 (2019).

[67] ‘Autonomous Vehicles – Self-Driving Vehicles Enacted Legislation’, *National Conference of State Legislatures* (n 60).

[68] Self Drive Act, HR 3388, 115th Congress (2017-2018); Andrew Hawkins, ‘Congress takes another stab at passing self-driving car legislation’, *The Verge* (Web Page, 28 July 2019) <https://www.theverge.com/2019/7/28/8931726/congress-self-driving-car-bill-redo-2019>; ‘House Passes Bipartisan Legislation Paving the Way for Self-Driving Cars on America’s Roads’, *E&C Republicans* (Web Page) <https://republicans-energycommerce.house.gov/selfdrive/>.

[69] Makena Kelly, ‘Congress Wants The Self-Driving Car Industry’s Help To Draft A New AV Bill’, *The Verge* (Web Page, 31 July 2019) <https://www.theverge.com/2019/7/31/20748582/congress-self-driving-cars-bill-energy-commerce-senate-regulation>; AV START Act, S.1885, 115th Congress (2017-2018) <https://www.congress.gov/bill/115th-congress/senate-bill/1885>.

[70] National Highway Traffic Safety Administration, ‘NHTSA Grants Nuro Exemption Petition for Low-Speed Driverless Vehicle’ (Media Release, 6 February 2020) <https://www.nhtsa.gov/press-releases/nuro-exemption-low-speed-driverless-vehicle>; Brent Skorup and Jennifer Huddleston, NHTSA-2019-0017 to NHTSA, *Safety Exemptions and the Regulatory Approach to Autonomous Vehicles* (20 May 2019) <https://www.mercatus.org/system/files/skorup_and_huddleston_-_pic_-_nhtsa_nuro_hav_exemption_-_v1.pdf>.

[71] William Malley, ‘Overview of NHTSA’s Federal Automated Vehicle Policy’, *Perkinscoie* (Web Page, October 2016) <https://www.perkinscoie.com/en/news-insights/overview-of-nhtsa-s-federal-automated-vehicles-policy.html>.

[72] ‘Autonomous Vehicles – Self-Driving Vehicles Enacted Legislation’, *National Conference of State Legislatures* (n 60).

[73] Kieran Tranter, ‘The Challenges of Autonomous Motor Vehicles for Queensland Road and Criminal Laws’ (2016) 16(2) *Queensland University of Technology Law Review* 59, 78 <https://research-repository.griffith.edu.au/bitstream/handle/10072/99495/TranterPUB1465.pdf?sequence=1>.

[74] Ibid.

[75] ‘AJR 164’, *Openstates* (Web Page, 2018-2019) <https://openstates.org/nj/bills/218/AJR164/>.

[76] ‘Utah HB101: Distracted Driver Amendments’, *Track Bill* (Web Page) <https://trackbill.com/bill/utah-house-bill-101-distracted-driver-amendments/1814429/>.

France	*LOI n° 2019-1428 du 24 décembre 2019 d'orientation des mobilités* [Mobility Orientation Law 2019] (France) JO, 26 December 2019. *LOI Pacte n°2019-486 du 22 May 2019 "Pacte" (plan d'action pour la croissance et la transformation des entreprises)* [Action plan for business growth and transformation 2019] (France) JO, 11 April 2019.[77]
Germany	*Straßenverkehrsgesetz* [Road Traffic Act] (Germany) 17 August 2017, FLG I, 2017, 3202. [78]
New Zealand	*Land Transport Act 1998* (NZ).[79]
Canada	No uniform law currently exists at a federal level, however, a patchwork of legislation can be utilised to allow for AVs, the most relevant include: *Motor Vehicle Safety Act,* SC 1993, c 16*; Motor Vehicle Transport Act,* RSC 1985, c 29 (3rd Supp.) *Motor Vehicle Safety Regulations*, CRC, C 1038. *Provinces that allow for some regulation of AVs:* ● Ontario: *O. Reg. 306/15: Pilot Project - Automated Vehicles* under *Highway Traffic Act,* RSO 1990, c H8. ● Quebec: *Highway Safety Code,* RLRQ 2018, C-24.2.[80]
Spain	*Real Decreto 2822/1998, de 23 de diciembre, por el que se aprueba el Reglamento General de Vehículos* [General Vehicle Regulation] (Spain). *Spanish Directorate General of Traffic (DGT) Instruction 15/V-113 of November 13th 2015* (Spain).
Singapore	*Road Traffic Act 2004* (Singapore, cap 276, 2004 rev ed).[81]
United Kingdom	*Automated and Electric Vehicles Act 2018* (UK).

[77] 'France', *Bird and Bird* (Web Page) <https://www.twobirds.com/en/in-focus/shareholders-directive/france?fbclid=IwAR1wzU0xdArcpebE-yB2OkEsR2MaKa0pMo3PIWt8fSVnvAjLie_N2OtWk5>; Lawrence Freeman et al, 'At a Glance: Autonomous Vehicles', *Bird & Bird* (Web Page, March 2019) <https://www.twobirds.com/en/news/articles/2019/global/at-a-glance-autonomous-vehicles>; 'PACTE, le plan d'action pour la croissance et la transformation des entreprises', Gouvernement (Web Page, 12 avril 2019) <https://www.gouvernement.fr/action/pacte-le-plan-d-action-pour-la-croissance-et-la-transformation-des-entreprises>; 'PACTE, the Action Plan for Business Growth and Transformation', *French Government* (Web Page) <https://www.gouvernement.fr/en/pacte-the-action-plan-for-business-growth-and-transformation>; 'Consequences of France's New PACTE Law (Action Plan for Business Growth and Transformation) on Corporate Governance', *Hugheshubbard* (Web Page, 1 August 2019) <https://www.hugheshubbard.com/news/consequences-of-the-french-pacte-act-action-plan-for-growth-and-transformation-of-companies-on-the-corporate-governance-management-of-companies-based-on-their-interests-and-potentially-their-raison-detre-1?fbclid=IwAR2FM22nJ57pO2mJXrRk_gkyL7b20Ir7i7ZdGgnip46vARqrbGbmObywD8w>.

[78] Lawrence Freeman et al, 'At a Glance: Autonomous Vehicles' (n 77); Bundesministerium der Justiz und für Verbraucherschutz, 'Road Traffic Act (Straßenverkehrsgesetz)' (Web Page, 2020) <http://www.gesetze-im-internet.de/englisch_stvg/index.html>.

[79] 'Current Regulatory Settings for Autonomous Vehicles', *Ministry of Transport* (Web Page, 19 December 2019) <https://www.transport.govt.nz/multi-modal/technology/specific-transport-technologies/road-vehicle/autonomous-vehicles/regulatory-settings-for-autonomous-vehicles/>.

[80] Léonie Gagné, 'Autonomous cars in Quebec: the legal uncertainty is clarified at last' (Web Page, 20 April 2018) <https://www.lavery.ca/en/publications/our-publications/3083-.html?page=1&BulletinId=0&MotCle=&profilId=0&dateMinimal=1900-01-01&SecteurId=0-0&affaireInter=0#05>.

[81] Taeihagh and Lim (n 18) 109-110.

China	*智能网联汽车道路测试管理规范（试行）* [Intelligent Connected Vehicle Road Test Management Specification (Trial)] (People's Republic of China) Order No. 66, 2018.[82] ● Shanghai: 上海市智能网联汽车道路测试管理办法 (试行) [Administrative Measures for Road Testing of Intelligent Connected Cars in Shanghai (Trial)] (Shanghai Jingxin Norm), Order No. 3, 22 February 2018.[83]

[82] 'Code for the Management of Road Testing of Intelligent Connected Vehicles (Trials)', *Ministry of Industry and Information Technology of People's Republic of China* (Web Page) <http://www.miit.gov.cn/n1146285/n1146352/n3054355/n3057585/n3057590/c6127095/content.html?from=timeline&isappinstalled=0>.
[83] 'Measures for the Management of Shanghai Intelligent Connected Vehicle Road Test (Trial)', *Shanghai Municipal Commission of Economic Informatisation* (Web Page, 3 April 2018) <http://www.sheitc.sh.gov.cn/cyfz/676771.htm>.

IV. REGULATING AVs – SAFETY AS THE PRIORITY

Legislative reform is currently needed as Australia is governed by a patchwork of law which aims to primarily regulate trials of AVs that are or will be in operation in the coming years. As a consequence, the widespread private use of AVs has generally not been considered. Once trials are successfully completed, it seems probable that environmental and other concerns (among which may be social distancing issues in mass transit arrangements occurring because of the advent of COVID19) will drive a transformation of the current vehicle marketplace to being autonomous friendly.[84] The emergence of this new marketplace requires sufficient regulation around privately owned and operated AVs. In this regard, a number of important issues arise in terms of AV functions and a potential legal and regulatory framework. Such issues relate to how adequate safety is maintained for the operators and passengers of the vehicle, the applicability of current road rules to AVs (addressing domain modelling, selective bias and other programming issues), the human driver's role in facilitating the operation of the AV, the standards required and whether an independent body governing licensing and safety is also required. Discussion relating to such issues place safety as the primary consideration in both creating operating systems and developing legislation in relation to AVs.

[84] Jim Erickson, 'Maximizing the Environmental Benefits of Autonomous Vehicles', *Michigan News* (Web Page) <https://news.umich.edu/maximizing-the-environmental-benefits-of-autonomous-vehicles/>; see also in relation to some other views in relation to the environmental impact not all are positive however, most suggest that when electric engines are used in tandem net positive effects for the environment are achieved: Larry Alton, 'How Self-Driving Cars Could Impact the Environment', *Blue and Green Tomorrow* (Web Page, 25 May 2018) <https://blueandgreentomorrow.com/environment/self-driving-cars-could-impact-environment/>; Justin Worland, 'Self-Driving Cars Could Help Save the Environment – Or Ruin It. It Depends on Us', *Time* (Web Page, 8 September 2016) <https://time.com/4476614/self-driving-cars-environment/>; Carolyn Beeler, 'Driverless cars could either be 'scary' or great for the environment', *The World* (Web Page, 18 April 2017) <https://www.pri.org/stories/2017-04-18/driverless-cars-could-either-be-scary-or-great-environment>.

A. Addressing AV Safety

Safety is a primary consideration in the development of AVs, and must be sufficiently addressed before widespread use can occur.[85] It is important to remember that current road deaths are predominantly caused by human (driver) error.[86] Tracy Pearl suggests that removing the human involvement in driving vehicles will lead to a decrease in crashes as AI does not suffer from distractions or fatigue.[87] AVs have the ability to make faster decisions, allowing potential crashes to be predicted, and more frequently avoided.

But this does not preclude the possibility of accidents.[88] Even with the small number of current AVs, accidents have occurred. It could be argued that these are based on design flaws in the technology that underpins the operation of the AV and the software designer could not account for the situation under a rules-based approach or through machine learning. For example, in 2016, a Google Car (modified Lexus SUV) sideswiped a bus in California (the human engineer in the vehicle assumed the city bus would slow enabling the AV to merge).[89] In the same year, Tesla's AV driver died due to his reliance on Tesla Model S autopilot system which failed. The Model S was a Level 2 AV (See FIGURE 1).This system failure resulted in a truck that was coloured white, being seen as the sky and led to the Tesla vehicle crashing into the truck.[90] Another accident occurred in 2018, when the 2016 Chevy Bolt EV being tested by General Motors and its Cruise subsidiary (in self-driving mode) collided with a motorcyclist,

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[85] National Highway Traffic Safety Administration and US Department of Transportation, 'Federal Automated Vehicles Policy: Accelerating the Next Revolution In Roadway Safety' (Policy, September 2016) 5 <https://www.transportation.gov/AV/federal-automated-vehicles-policy-september-2016>.

[86] Taeihagh and Lim (n 18).

[87] Pearl (n 34), 35-36, 38; United States Department of Transportation (n 30); Dimitris Milakis, Bart van Arem and Bert van Wee, 'Policy And Society Related Implications of Automated Driving: A Review of Literature and Directions for Future Research' (2017) 21(4) *Journal of Intelligent Transportation Systems Technology Planning and Operations* 324, 337, 339.

[88] Jeremy Levy, 'No Need to Reinvent the Wheel: Why Existing Liability Law Does Not Need to be Pre-emptively Altered to Cope with the Debut of the Driverless Car' (2016) 9(2) *Business, Entrepreneurship, and the Law* 355, 365; Bryant Walker Smith, 'Automated Driving and Product Liability' (2017) 1 *Michigan State Law Review* 1, 2; Pearl (n 34) 35-36, 39; United States Department of Transportation (n 30); Milakis et al (n 87), 339.

[89] Cary Silverman, Phil Goldberg, Jonathan Wilson, and Sarah Goggans, Shook, Hardy & Bacon L.L.P, 'Torts of the Future: Autonomous Vehicles Addressing the Liability and Regulatory Implications of Emerging Technologies' (US Chamber Institute For Legal Reform, May 2018) 7.

[90] Ibid.

resulting in significant injuries.[91] In 2018 a pedestrian in Arizona pushing a bicycle was hit and killed at night, by an autonomous Uber 2017 Volvo test vehicle. The cameras on the car revealed that both the pedestrian and operator's conduct contributed to the incident, with the operator at fault as he was distracted and had disabled the autonomous braking system.[92] Although Uber settled the claim with the victim's family, it has been reported that in an open letter, the Attorney for Yavapai County indicated that under the circumstances, criminal liability could not be established.[93]

Tania Leiman suggests that it may be difficult for the community at large to accept that the decision-making of machines is at times as impaired as that of humans and cannot be ever made totally 'perfect' or 'reliable' and that mistakes will continue to be made despite technological advances.[94] AVs remove many of the traditional errors that human drivers make. Operators of AVs are still prone to poor decision-making (though this is contingent upon the level of autonomy of the AV). However, AVs also introduce issues around programming and prioritisation which leads to the need to consider the operation of the current Road Rules and whether the rules are flexible enough to accommodate these problems, or whether new Road Rules need to be drawn up, that are broader and more specific to problems when using AVs.

B. Applicability of Current Road Rules to AVs

The applicability of the current Australian Road Rules to AVs is contingent upon ensuring that AI systems can appropriately model these rules. In turn this leads to the operation of open texture[95] generating challenges around minimising accidents and increasing operator and occupant safety.[96] The decision-making capacity of the AI system (provided by AV manufacturers) needs clear parameters in terms of what

[91] Ibid 7-9.
[92] Ibid 9-10.
[93] See: David Meyer, 'Uber Cleared Over Arizona Pedestrian's Self-Driving Car Death', *Fortune* (Web Page, 6 March 2019) <http://fortune.com/2019/03/06/uber-cleared-arizona-self-driving-death/>. See also, 'Uber 'not criminally liable' for self-driving death', *BBC News* (Web Page, 06 March 2019) <https://www.bbc.com/news/technology-47468391>.
[94] Leiman (n 9) 15.
[95] See generally, Ruth Kannai, Uri Schild, and John Zeleznikow, 'Modeling the evolution of legal discretion. An artificial intelligence approach' (2007) 20(4) *Ratio Juris* 530, 530-558.
[96] AI systems have particular difficulty with several rules, these include; r 54: 'How to give a stop signal', r 219: 'Lights not to be used to dazzle other road users rule', r 103: 'Load limit signs' and r 294: 'Keeping control of a vehicle being towed'. For further see National Transport Commission Australia, *Changing Driving Laws To Support Automated Vehicles* (n 10) 28.

is categorised as its base knowledge and what is learnt through experience on Australian roads. Information considered relevant by the AI system must be based on strict safety laws and any other standard practices programmed into the operating system that are unable to be overwritten by users users.[97] AV AI manufacturers will be responsible for determining who will be prioritised and saved in the event of an accident or collision where a number of different parties are threatened. A choice would need to be made, for example, between the occupants of the vehicle, another vehicle, or pedestrians or other bystanders. This creates a series of ethical dilemmas as to what discriminating factors will be classed as relevant in AI decision-making.[98] When considering vehicle safety and the appropriateness of the Australian Road Rules, these are relevant considerations and require appropriate carefully crafted Autonomous Vehicle Road Rules that address pitfalls under the current rules that do not address these AI software issues. In order to ascertain how to address these issues, it is important to look at domain modelling, software development bias, and then whether these issues are able to be eliminated as safety issues in the AI system.

1. Domain Modelling

When developing systems based on AI, how the domain should be modelled must be considered. Three strategies are available to software system developers: rule-based reasoning, case-based reasoning or machine learning. Rule-based (prescriptive) reasoning is the application of a pre-defined set of rules (or patterns) to an algorithm.[99] Early AI used rule-based reasoning. In the legal domain, systems such as TAXMAN[100] and the British Nationality Act[101] as a logical program encoded legislation as

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[97] Tshilidzi Marwala, 'Rational Choice and Artificial Intelligence' (2017) *University of Johannesburg*, 2 <https://arxiv.org/ftp/arxiv/papers/1703/1703.10098.pdf>.

[98] See generally, Osonde Osoba and William Welser, *An Intelligence in Our Image The Risks of Bias and Errors in Artificial Intelligence* (Research Report, 2017); See also, Kirsten Lloyd, 'Bias Amplification in Artificial Intelligence Systems' (Conference Paper, AAAI FSS-18: Artificial Intelligence in Government and Public Sector, 20 Sep 2018); See also Jeffrey Gurney, 'Crashing Into The Unknown: An Examination Of Crash-optimization Algorithms Through The Two Lanes Of Ethics And Law' (2016) 79 *Albany Law Review* 183.

[99] John Zeleznikow, 'Can Artificial Intelligence and Online Dispute Resolution Enhance Efficiency in the Courts' (2017) 8(2) *International Journal for Court Administration* 30, 36; Abhishek Mishra, *Machine Learning in the AWS Cloud: Add Intelligence to Applications with Amazon SageMaker and Amazon Rekognition* (John Wiley & Sons, 2019) 4.

[100] Thorne McCarty, 'Reflections on TAXMAN: An experiment in artificial intelligence and legal reasoning' (1976) 90 *Harvard Law Review* 837.

[101] Marek Sergot, Fariba Sadri, R. Kowalski, Franke Kriwacek, Peter Hammond, and H Cory, 'The British Nationality Act as a logic program' (1986) 29(5) *Communications of the ACM* 370-386.

AI rules. Case-based reasoning requires an analysis of previous experiences to ascertain the solution to a new problem.[102] Machine learning involves algorithms that learn through experience/data collection which in turn enables it to quickly and more accurately predict results.[103] The *National Highway Commission* in Australia has released a consultation paper on AV safety.[104] It discusses utilising both a rule-based and machine learning approach, which allows the AV systems to make an assessment of the safest route.[105] Other issues arise as to who determines whether the AI system operates under each of these strategies or whether a combination of these approaches is required.[106]

Ethical issues must clearly be addressed when building AI systems.[107] Under a machine learning approach for example, the classic trolley problem raises the question of the conditions under which an individual would deflect a large projectile — a runaway trolley — from hitting a larger group of persons to a smaller one.[108] The trolley problem requires that you: 'Imagine that you are driving a trolley. You have gone around a bend and see five men on the tracks your trolley is running on ahead of you. You put on your brakes, but they fail. You have just enough time to divert your trolley onto a track leading off to the right. However, there is a man on this track. If you divert the trolley you will kill him. If you do not turn the trolley the five men on the current track will die'.[109] Judith

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[102] Zeleznikow (n 99) 36.

[103] Harsha Vishnukumar, Bjorn Butting, Christian Muller and Ing Eric Sax, 'Machine Learning and Deep Neural Network – Artificial Intelligence Core for Lab and Real-World Test and Validation for ADAS and Autonomous Vehicles' (Conference Paper, Intelligent Systems Conference, 7-8 September 2017) 715; Mishra (n 99) 4-6; Zeleznikow (n 99) 36.

[104] National Highway Commission (Cth), *In-Service Safety for Automated Vehicles July 2019 – Consultation Regulation Impact Statement*, (Consultation Paper, July 2019) <https://www.ntc.gov.au/sites/default/files/assets/files/NTC%20Consultation%20RIS%20-%20In-service%20safety%20for%20automated%20vehicles.pdf>.

[105] Ibid [6.9.2].

[106] See generally, John Zeleznikow and Dan Hunter, *Building Intelligent Legal Information Systems: Representation and Reasoning in Law* (Kluwer Law and Taxation Publishers, 1994) for a detailed discussion of the use of Artificial Intelligence reasoning strategies in law; Andrew Stranieri and John Zeleznikow, *Knowledge discovery from legal databases* (Springer Science and Business Media, 2006).

[107] See eg John Zeleznikow, 'Don't Fear Robo-Justice. Algorithms Could Help More People Access Legal Advice', *The Conversation* (Web Page, 23 October 2017) <https://theconversation.com/dont-fear-robo-justice-algorithms-could-help-more-people-access-legal-advice-85395> for further discussion on bias.

[108] Judith Jarvis Thomson, 'The Trolley Problem' (1985) 94(6) *Yale Law Journal* 1395, 1395.

[109] Nachshon Goltz, John Zeleznikow and Tracey Dowdeswell, 'From the Tree of Knowledge and the Golem of Prague to Kosher Autonomous Cars: The Ethics of Artificial Intelligence Through Jewish Eyes' (2020) 9(1) *Oxford Journal of Law and Religion* 132, 132-156.

Thompson asks, 'Is it morally permissible for you to turn the trolley?'.[110] Ascertaining how an AI system is programmed to deal with these ethically challenging situations and the discriminating factors for the AI's decision-making is integral to facilitating the safety of the AV. It raises concerns around the bias of software programmers or the machine learning of the AI or how the past experience being used is coded. Each of these options emerge as important considerations.

2. *Software Development, Bias and Impacts on Safety*

Selective bias is an issue inherent in programming a raft of information into an AI system and originates with the software development team that works for AV manufacturers.[111] Bias can be described as a person's prejudice, conscious or subconsciously held values or beliefs.[112] It entails the identification and determination of the factors by the software developers that are to be used by the AI system in its decision-making and the degree to which the factors are prioritised (which inherently reflects the software developer team's opinions). Bias is a serious constraint on the widespread adoption of AVs and is likely to affect vehicle safety. The Trolley problem demonstrates ethical dilemmas that can be confronted by the AI system operating in the AV. The software programmer's own bias[113] may, for example, dictate that younger people should have priority in preserving life when opposed to older people, which in turn would drive AI decision-making and lead the AI system to protect the younger group (should this be an available criterion for decision-making). Alternatively, this bias could be learnt by the AI in the course of its AV operation and the same outcome could result. Ignacio Cofone suggests that as the rate of AI adoption by the community increases, whether it will always operate for society's benefit is debatable, and deception may well arise.[114] This is a critical concern for software developers who are attempting to model complex road rules in the AI system[115]. Legislation needs to accommodate the bias component of the technology driving artificially intelligent

[110] Ibid.

[111] Banu Aysolmaz, Nancy Dau and Deniz Iren, 'Preventing Algorithmic Bias in the Development of Algorithmic Decision-Making Systems: A Delphi Study' (Proceedings of the 53rd Hawaii International Conference on System Sciences, 2020) 5267-5276.

[112] Ayanna Howard and Jason Borenstein, 'The Ugly Truth About Ourselves and Our Robot Creations: The Problem of Bias and Social Inequity' (2017) 24(5) *Science and Engineering Ethics* 1521, 1522; See also, Martin Cunneen, Martin Mullins & Finbarr Murphy, 'Autonomous Vehicles and Embedded Artificial Intelligence: The Challenges of Framing Machine Driving Decisions' (2019) 33(8) *Applied Artificial Intelligence* 706, 716.

[113] Cunneen et al (n 112) 722.

[114] Ignacio Cofone, 'Servers and Waiters: What Matters in the Law of A.I.' (2018) 21(2) *Stanford Technology Law Review* 167, 181-182.

[115] We are in no way suggesting that these complex road rules should be directly coded into AI rules.

vehicles so that the self-learning programs are not corrupted by prioritising bad data. If a cloud-based learning model was adopted by manufacturers (which increases the performance of machine learning by enhancing situation accuracy, though competitors would need to share data and knowledge) then base controls need to be factored into AVs' operating systems. Therefore the bare minimum requirements need to be clearly set out by parliament. Additionally, the proposed legislation in this area must be flexible and able to adapt to a changing the AV environment. To this effect, legislation at the federal level in the United States has already been considered around bias issues arising from AI.[116] .These Acts included the *Algorithmic Accountability Act of 2019*, H.R.2231, 116th Congress (2019-2020) and *Algorithmic Accountability Act of 2019*, S. 1108, 116th Congress (2019-2020).[117]

When developing AI systems, there is a high risk of unpredictability emerging when these are designed in a human like fashion and have the ability to maintain their own autonomy.[118] Processes governing an AI system can result in new algorithms arising which in turn lead to different ways to accomplish tasks that could not be explained by the original programmers who created the base code.[119] As a result, a risk assessment needs to be undertaken in a controlled environment by programmers when implementing AI systems in relation to the emergence of this problem. [120] It is important to ensure consumers are adequately notified about any program vulnerabilities in relation to the unpredictable nature of the AI system and the result of adverse AI behaviour – the only option when this occurs is to have the AI system deactivated.[121] For example, 'a humanoid robot with an underlying developed A.I. system could pretend to care for our interests while caring for the commercial interests of other people. The social role that the A.I. agent is perceived to be performing may be different from the social role that it is actually performing.'[122] Adoption of a safety assurance system would facilitate better regulatory oversight of

[116] See 'Regulation of Artificial Intelligence: The Americas and the Caribbean', *Library of Congress* (Web page, 2020) ['United States'] <https://www.loc.gov/law/help/artificial-intelligence/americas.php#us>. The article says that United States lawmakers and regulators have mainly pursued AI in the area of autonomous or self- driving vehicles. In the 115th Congress (2017-2019), thirty-nine bills were introduced that had the phrase "artificial intelligence" in the text of the bill. Four of these bills were enacted into law.
[117] Mark MacCarthy, 'An Examination of the Algorithmic Accountability Act of 2019' (Discussion Paper, Transatlantic Working Group, Georgetown University, 24 October 2019) <https://www.ivir.nl/publicaties/download/Algorithmic_Accountability_Oct_2019.pdf>.
[118] Eduardo Magrani, 'New perspectives on ethics and the laws of artificial intelligence' (2019) 8(3) *Internet Policy Review Journal on Internet Regulation* 1, 5.
[119] Ibid.
[120] Ibid.
[121] Ibid.
[122] Cofone (n 114) 181.

AV safety performance to ensure that it can appropriately perform its function.[123] Dealing with this type of ethical issue will always be debated.[124]

In general, international legislative developments are not aligned with advances in AI AV technology. Legislation needs to accommodate the potential inherent bias component of the technology driving intelligent AVs so that self-learning programs are not corrupted by or prioritise bad data. The authors are not suggesting that all AI systems used in developing AVs are biased. Rather, it is suggested that there is a potential bias, if such possibilities are not appropriately addressed. If a cloud-based learning model was adopted by manufacturers (which is likely as such an approach increases machine learning by situation accuracy) then base controls need to be factored into the AV's operating systems. A bare minimum needs to be declared by parliament and regulated by an independent body. Additionally, the proposed legislation in this area must be flexible and able to adapt to a changing AV environment.

Because programmer bias always exists, we cannot conclusively eliminate high levels of bias or deception. The fictional text in Isaac Asimov's story, *Runaround*[125] contained laws that were created to govern robots so that humans are protected. These laws prioritised the avoidance of human harm, that robots need to obey human commands except where it would result in other humans being injured, and lastly that a robot (with an embedded AI system) would be able to protect itself only when the first two laws are satisfied.[126] Reforms in the legal area must be similar, but more specific to the circumstances that are faced by the AI in AV systems.[127]

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[123] National Transport Commission Australia, *Changing Driving Laws To Support Automated Vehicles* (n 10) 10.

[124] Howard and Borenstein (n 112) 1529; A 'Moral Machine Experiment' that conducted an online survey to assess the views of different countries, cultures (etc) in terms of harming a person/animal/object over another's life. See Edmond Awad, Sohan Dsouza, Richard Kim, Jonathan Schulz, Joseph Henrich, Azim Shariff, Jean-François Bonnefon and Iyad Rahwan, 'The Moral Machine experiment' (2018) 563 *Nature* 59.

[125] Isaac Asimov, 'Runaround' (1942) 29(1) *Astounding Science Fiction* 94-103.

[126] See Mark Robert Anderson, 'After 75 years, Isaac Asimov's Three Laws of Robotics need updating' *Conversation* (Web Page, 17 March 2017) <https://theconversation.com/after-75-years-isaac-asimovs-three-laws-of-robotics-need-updating-74501>; Isaac Asimov*, Runaround, in I, ROBOT 41, 53* (Gnome Press, 1st ed, 1950) cited in Jack M. Balkin, '2016 Sidley Austin Distinguished Lecture on Big Data Law and Policy: The Three Laws of Robotics in the Age of Big Data' (2017) 78 *Ohio State Law Journal* 1217, 1217; Uri Schild and John Zeleznikow, 'The three laws of robotics revisited' (2008) 4(3/4) *International Journal of Intelligent Systems Technologies and Applications* 254-270. See also, Ramesh Subramanian, 'Emergent AI, Social Robots and the Law: Security, Privacy and Policy Issues' (2017) 26(3) *Journal of International Technology and Information Management* 81, 97.

[127] See generally, Schild and Zeleznikow (n 126) 254-270.

C. What Is The Role Of A Driver Of An AV?

After addressing the software issues surrounding the AI system in an AV, it is important to consider the role of a driver (also referred to as an operator) in the use of AVs. Australian legislation requires the driver to be a 'person.' This legislative regime would not recognise the role of a driver being taken over by an AI software system (a non-person). The involvement of a 'person' in a fully autonomous vehicle is less likely to act as that of a driver and she/he is more likely to only initially operate the vehicle by highlighting the starting of the vehicle, the input of destination and likely a potential vehicle kill switch . It is unlikely that any other tasks need to be performed (although an option to do so may still be provided). Thus, the current legislative regime that is in force does not adequately recognise the underlying AI system as equivalent to a person driving an automobile, (even though the AI system would be taking over many of the stereotypical driving functions and would but for the 'person' description in the legislation for all intents and purposes be the driver of the vehicle). Nor does the legislation address the reduced function of a human who can drive (but does not do so) and likely only makes the afore-mentioned decisions in relation to the operation of the vehicle.[128]

Legislation that is in force at the time of the writing of this paper places the driver as fully responsible for the operation of the AV, rather than the AI system itself, or the developer of the AI software . The transfer in reliance upon the decision-making of the AI system as opposed to a fully accountable operator (such as a driver) is expected to occur when the private use of AVs with fully road-tested systems are in operation on Australian roads. Until this time responsibility for any accidents (even in the event of AI system failure) falls upon the driver. It is useful to consider what actions that Australian Courts have classified as 'driving'. In *Tink v Francis* [1983] 2 VR 17, Young CJ said:

> The question whether a person in given circumstances is driving the car will often turn on the extent and degree to which the person was relying on the use of the driver's controls … The ordinary meaning to be attached to the word 'drives' when applied to a motor car should, I think, embrace the notion of some control of the propulsive force which, if operating, will cause the car to move.[129]

[128] See: *Road Transport Act 2013 No* 18 (ACT) s 4; *Road Transport (Road Rules) Regulation 2017* (ACT) ss 16, 17, 19, 297; *Road Rules* 2014 (NSW) ss 16, 19; *Motor Vehicles Act* 1949 (NT) s 5; *Transport Operations (Road Use Management – Road Rules) Regulation 2009* (QLD) ss 16-19; *Road Traffic Act 1961* (SA) s 5; *Road Rules 2019* (TAS) ss 16, 19; *Road Safety Act 1986* (VIC), s 3; Clayton Utz (n 594) 11-12.

[129] Quoted in Tranter (n 73) 59, 65-67. See specifically 65 fn 46 in which the following cases are provided as support for this notion, *R v Murray* (1986) 4 MVR 331; *Mason v*

This is the dominant position under Australian law. There is also a common law duty to operate a vehicle with reasonable care as per *Cook v Cook* (1986) 162 CLR 376 and *Imbree v McNeilly* (2008) 236 CLR 510. Tania Leiman suggests that 'This standard of care focuses on what can reasonably be expected of the human driver and their act of driving, not on the performance capabilities of the vehicle they were driving or the technology they were using.'[130] Difficulties in attributing liability arise due to the lack of clarity in relation to whether AI would be regarded as being in control of driving the AV.[131] Driver responsibility must be considered in line with an AV's functions, and whether a driver can be overridden by an AI system and effectively locked out from taking an alternative action.[132]

The case law position is further enshrined in regulation. Generally under Australian legislation a driver is regarded as a person who drives the vehicle.[133] In order to be considered a driver of the vehicle, the person driving must be in control of the vehicle they are operating.[134] It is possible that (unless legislation is amended to clarify the issue) once propulsion of the AV is solely operated by the AI system as opposed to the 'driver', the lack of control would likely pass the driving responsibility onto the AI system itself. What it would mean for a non-human AI system to be "responsible" is of course another question.

This creates another hurdle in applying the Australian Road Rules in the long term, as they are written solely for human vehicle operators. Subsequent changes to the legislation will define the way in which levels 4 and 5 for an AV are introduced in Australia. When an accident occurs involving an AV within levels 3-5, the way a driver has been defined under Australian case law and legislation may assist in facilitating the resolution of any disputes, for example, phrasing driving by reference to the vehicle's movement, classing AV accidents as a collision and including definitions

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Dickason (2006) 47 MVR 30; *Cooley v Lowe* [1984] Tas R 107; *Robinson v R* (1991) 14 MVR 381; *Allan v Quinlan, Ex parte Allan* [1987] 1 Qd R 213.

[130] Leiman (n 9) 9-10.

[131] Ibid 2.

[132] Ibid 7.

[133] See: *Road Transport Act 2013 No* 18 (ACT) s 4; Road *Transport (Road Rules) Regulation 2017* (ACT) ss 16, 17, 19, 297; *Road Rules* 2014 (NSW) ss 16, 19; *Motor Vehicles Act* 1949 (NT) s 5; *Transport Operations (Road Use Management – Road Rules) Regulation 2009* (QLD) s16, 19; *Road Traffic Act 1961* (SA) s 5; *Road Rules 2019* (TAS) ss 16, 19; *Road Safety Act 1986* (VIC) s 3.

[134] See: *Road Transport Act 2013 No* 18 (ACT) s 4; *Road Transport (Road Rules) Regulation 2017* (ACT) s 297; *Road Rules* 2014 (NSW) s 297, dictionary; *Motor Vehicles Act* 1949 (NT) s 5; *Transport Operations (Road Use Management – Road Rules) Regulation 2009* (QLD) s 297, sch 5; *Road Traffic Act 1961* (SA) s 5; *Road Rules 2019* (TAS) sch 5, s 297; *Road Safety Act 1986* (VIC), s 3; *Road Traffic (Administration) Act 2008* (WA) s 4.

around ''running out of control' or 'defect''.[135] Clarifying these areas would facilitate a clearer introduction of the legalities of using AVs in Australia.

AVs presently on the market include the level 2 Tesla S and the level 3 Uber model. Both still require a traditional driver.[136] Current driving laws can be consistently applied until level 3 which starts to place higher levels of responsibility on the AI system operating the AV. Level 4 vehicles require minimal operator input, and at level 5 there is no need for any input by the AV operator. AVs at level 5, allow for drivers to have the capacity to undertake other tasks whilst driving. Such flexibility would be in breach of current law if the operator is classed as a driver as discussed above. Where the AV requires little to no input from the driver, a driver would be able to undertake other tasks potentially including mobile phone use.[137] Therefore, the operator remains the driver of the vehicle, which leads to questions arising around the standards of licensing that should be adopted in order to regulate the operators of AVs.

D. What Standard Of Licensing Should Be Required For The Safe Driving Of An AV?

The authors of this article suggest that the standard Australian model for licensing non-AVs is not currently appropriate for AVs. Australia proactively regulated the first vehicles that were used on its roads and developed frameworks to both register and licence vehicles and drivers.[138] Current driving rules and licencing requirements were developed to enable safer driving on Australian roads in the current context, where drivers are assumed to have full control of their automobile.[139] For AVs classified as levels 4 or 5, there is a suggestion that laws to restrict the occupant's behaviour around drink driving, speeding and new licensing regimes are unnecessary as the operator will not need to have control over such vehicles.[140]

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[135] Mark Brady, Kylie Burns, Tania Leiman and Kieran Tranter, 'Automated vehicles and Australian personal injury compensation schemes' (2017) 24 *Torts Law Journal* 32, 46.
[136] See generally, National Transportation Safety Board, *Preliminary Report Highway* (Report HWY18MH010, 18 March 2018).
[137] CB Information Services (n 37).
[138] Mark Brady, 'Is Australian Law Adaptable to Automated Vehicles?' (2019) 5(1) *Griffith Journal of Law & Human Dignity* 35, 46 <https://griffithlawjournal.org/index.php/gjlhd/article/view/1057>.
[139] *Road Safety Act 1986* (Vic); *Road Transport (Safety and Traffic Management) Act 1999* (ACT); *Road Transport Act 2013* (NSW); *Transport Operations (Road Use Management) Act 1995* (QLD); *Traffic Act 2018* (NT); *Road Traffic Code 2000* (WA).
[140] Brady et al (n 135) 35, 47.

Instead a separate scheme which provides for licensing of AVs should be created. There are unique safety concerns for AVs and as a result this new class of licence would need to address the need for further training (in addition to that required for the granting of a standard driving licence). Such training would enable the management of the risk of AV hacking. Privacy and safety must be protected, and advanced emergency vehicle takeover needs to be possible to mitigate accidents, especially in the case that the AI system is making an irrational response towards protecting the safety of the AV's occupants. Hacking and system confusion of the AI system in the AV is a legitimate concern, particularly given that it has already affected Tesla vehicles.[141]

It is suggested that the operator of an AV be required to be sufficiently proficient in managing the specific model that they operate, understand how to stop hacking of the AI system, and be capable of initiating code that would prevent the hacking of the vehicle software. Another important limb to licensing would need to ensure that an advanced driving licence course is undertaken that deals specifically with the relevant AV model and the operator being able to override the AI system and regain control of the AV when necessary. Even now in Victoria, the AV trials must be supervised, and the supervisor is required to obtain an ADS licence permit.[142] It would be logical to expand this approach so that the average driver of an AV would have sufficient skills to deal with any situation which could arise.

It is important to ensure that the licensing regime still requires drivers to have a standard level of alertness (for example not be under the influence of any substances which could impact their reaction times when a dangerous incident arises). The operator needs to be appropriately licenced given the need for interaction with the AV and needs to monitor the driving environment.[143] When operating an AV below level 4, drivers must maintain the standard level of alertness[144] as those driving regular vehicles

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[141] Catalin Cimpanu, 'Tesla Car Hacked At Pwn2Own Contest' (Web Page, 23 March 2019) <https://www.zdnet.com/article/tesla-car-hacked-at-pwn2own-contest/>; Davey Winder, 'Hackers Made Tesla Cars Autonomously Accelerate Up To 85 In A 35 Zone' Forbes (Web Page, 19 February 2020) <https://www.forbes.com/sites/daveywinder/2020/02/19/hackers-made-tesla-cars-autonomously-accelerate-up-to-85-in-a-35-zone/#7e227a4d7245>.

[142] *Road Safety Act 1986* (Vic) pt 3A.

[143] National Transport Commission Australia, *Changing Driving Laws To Support Automated Vehicles* (n 10) [6.2].

[144] See generally Jonas Gouraud, Arnaud Delorme and Bruno Berberian, 'Autopilot, Mind Wandering, and the Out of the Loop Performance Problem' (2017) 11(541) *Frontier Neuroscience* 1, 1-9; See generally, Simon Wood, *Flight Crew Reliance on Automation* (Report CAA PAPER 2004/10, December 2004) for a discussion on effects on automation on pilot distractibility and mind wandering.

and avoid potential distractions. [145] For AVs at levels four and five, it will be important to establish an independent body which deals with AV licensing.

VI. CONCLUSION

Whilst there has been significant global development behind the AI software and engineering hardware supporting AVs, legislation to regulate AVs has developed slowly. The purpose of proposing and developing legislation is to promote and facilitate the safe use and testing of AVs. However, an ad hoc approach in this area will not be sufficient to address the many issues that are raised by AV vehicles and there are realistic concerns that existing frameworks are insufficient to both regulate and support innovation in the AV area. As Leiman has suggested, 'The law has been used historically as a policy lever to pursue social goods such as safety, penalise the taking of unacceptable risks and either encourage or stifle emerging technological innovations.'[146]

In Australia, model legislation at a national level is required to unify the disparate frameworks of legislation and guidelines or permits that exist across all states and territories. In the short term, States and territories should provide, (rather than trying to place AV regulation under existing motor vehicle law), a separate and clear approach to specific legislation that will allow for both AV testing and the use of AVs for public transport and private purposes.

The international context is complex and varied with the approach to AVs operating at some points under specific legislation and in others under existing motor vehicle legislation. Reference in this article has been made to the approaches taken in a multitude of jurisdictions including the United States, France, Germany, New Zealand, Canada, Spain, Singapore, United Kingdom and China. Of course, this list is not exhaustive, however, approaches in other jurisdictions suggest proactive legislative responses are required in respect of an industry that will emerge rapidly once the testing companies are satisfied that the AI systems operating AVs sufficiently meet required performance standards. These standards must ensure that AVs function with less risk than non-automated motor vehicles that are currently used in Australia.

If inadequate mechanisms are put in place to manage AVs then safety could be compromised, – particularity once trials end and AVs become more available on the public market. Currently, the leading cause of road

[145] CB Information Services (n 372); Pearl (n 34), 8-9.
[146] Leiman (n 9) 1-2.

deaths is human error – the effects of fatigue and distraction upon human drivers and operators would be significantly reduced with the full automation of AVs. However, the risk of accidents cannot be completely eliminated regardless of the operating system employed in the AV. Accidents caused by AVs have already occurred. Programming and task prioritisation by the underlying AI system requires high flexibility and a fast error detection rate if future accidents are to be proactively avoided. The degree to which this can be achieved is not only contingent on the level of automation of software employed but the very way that the software is developed by the programmers who design the systems and the manufacturers who produce the AVs. The decision-making capacity of AI systems needs to be refined and able to adeptly implement Australian road laws. Necessary information will have to be provided to the AI system whilst capacity must be available for the system itself to learn from each interaction with stimuli in its operating environment. A rational decision-making model will need to be built into any AI system that supports the AV, but it must operate ethically, with a high level of public awareness and based upon non- discrimination factors. Issues that come to the fore with the introduction of an AV on roads include domain modelling and selective bias. Domain modelling should follow an integrated rule-based and machine learning approach and ethical issues need to be adequately addressed (for example, consider the trolley problem addressed above). Selective bias is inherent in any system and originates with the original design team that creates the AI. This bias could also extend to the AI system itself learning from its environment and creating rules that only it only follows (superseding initial programming). Controlled environments need to be used with continuous testing in order to satisfactorily address this problem. In this area, rather than in respect of specific jurisdictional regulatory arrangements, there is scope for international standards and frameworks that can inform more jurisdiction specific responses.

Consumers need to be informed about any detrimental situations that could arise through the technology failing to operate adequately. Any legislation that is put in place at the national level needs to account for technological issues that arise solely from the implementation of higher levels of automation in the AV. Future standards of licencing for AVs may require adjustment as the user will become an operator, rather than the standard driver of the vehicle. It is suggested that a new scheme needs to be implemented that creates a new class of license that would require the driver/operator to undergo further training, and would explore the issues of privacy, safety and hacking. This new approach would still require the driver to have alertness, meaning they could not be inebriated by any substances that could affect their operating role. AI AV developments are expanding rapidly as advances in software are achieved. The advances in technology come with risks that safety could be compromised if inadequate mechanisms are put in place to manage the domain modelling approach and the biases inherent in the programming.

The authors suggest the development of specific a AV law in Australia is required. Other jurisdictions are already implementing systems in their legislation to address some of the concerns discussed in this paper. It is vital that Australia too navigates the terrain and follows suit and that some common international approaches are considered. [147]

[147] The regulatory position in Australia (as well as other jurisdictions) is further explored by the authors in, 'Navigating A New Terrain: Developing Autonomous Vehicle Liability Pathways In Australia In Light Of International Experience' (2021) *Australian Law Journal,* forthcoming.