Self-Driving Cars

It seems that everybody is talking about self-driving cars these days. These high-tech vehicles offer the potential to solve many of the world's transportation problems. Researchers and scientists suggest autonomous cars could reduce traffic congestion, air pollution, and accident rates. However, these benefits are not easily achieved; there are a host of challenges to overcome before driverless vehicles are a reality for the average person. We can certainly anticipate the complex technical challenges required to make autonomous vehicles safe. However, other types of challenges might surprise us. **What technical, ethical, and social challenges must be addressed before we can benefit from self-driving cars?**
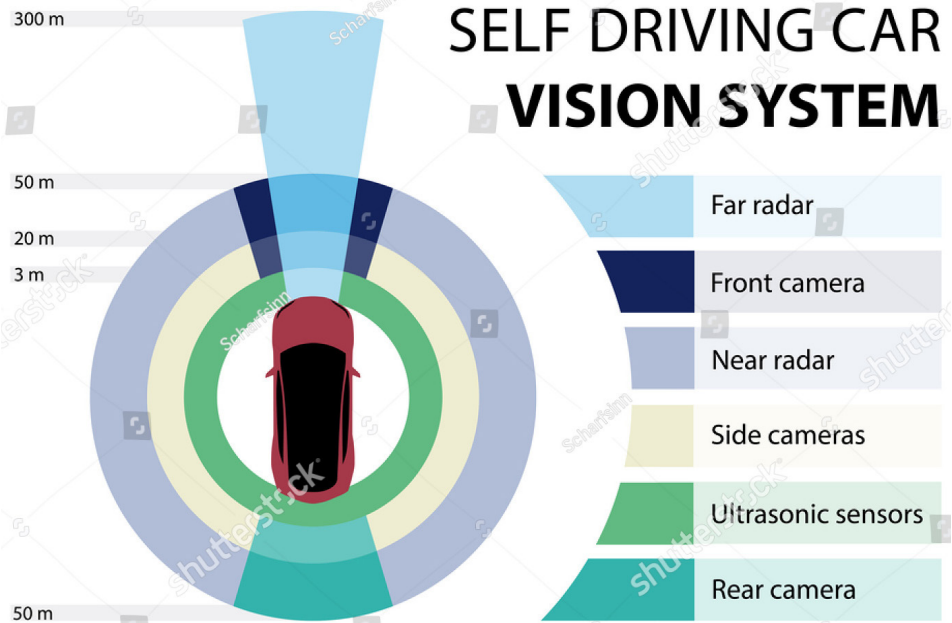
$d=25'$ High Alert!

$\sigma/\sqrt{n}$

In this chapter,
you will

- learn vocabulary related to self-driving cars;

- identify paraphrases and summaries;

- use techniques to paraphrase and summarize;

- express uncertainty in a variety or ways;

- write conditionally to express what might happen;

- identify causes and effects;

- write a summary and a cause and effect essay

GEARING UP

SELF DRIVING CAR VISION SYSTEM

300 m

50 m

20 m

3 m

50 m

- Far radar
- Front camera
- Near radar
- Side cameras
- Ultrasonic sensors
- Rear camera

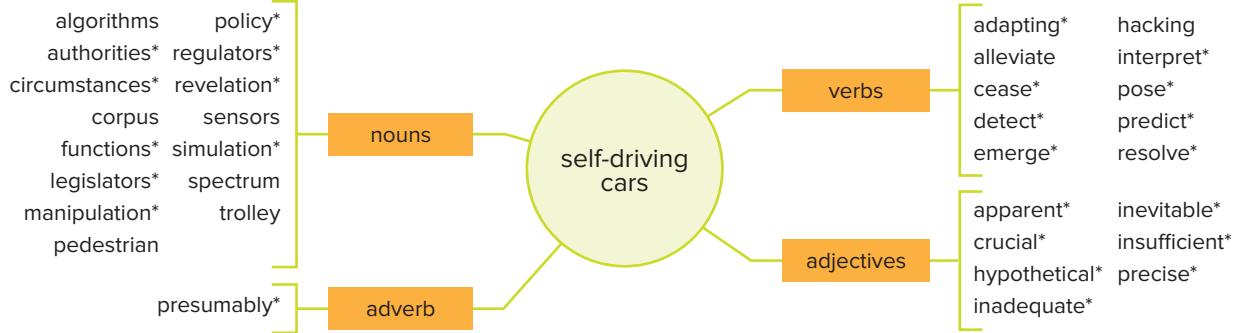**A.** Survey your class to determine attitudes about self-driving cars.

1 How many of you have driven in an autonomous car?

2 How many of you would like to ride in an autonomous car? Why or why not?

3 How many of you are worried about the possible dangers of riding in self-driving cars? Why or why not?

B. In the table below, list the reasons why some people might be excited, and others might be concerned about autonomous vehicles. Use a separate page if you need more space.

EXCITING POSSIBILITIES OF AUTONOMOUS VEHICLES	CONCERNS ABOUT AUTONOMOUS VEHICLES
• *High-tech cool factor*	• *Loss of control over driving*

Below are the key words you will practise in this chapter. Check the words you understand, then underline the words you use. Highlight the words you need to learn.

nouns
algorithms   policy*
authorities*   regulators*
circumstances*   revelation*
corpus   sensors
functions*   simulation*
legislators*   spectrum
manipulation*   trolley
pedestrian

adverb
presumably*

self-driving cars

verbs
adapting*   hacking
alleviate   interpret*
cease*   pose*
detect*   predict*
emerge*   resolve*

adjectives
apparent*   inevitable*
crucial*   insufficient*
hypothetical*   precise*
inadequate*

*Appears on the Academic Word List

READING 1

Moving Forward

The author of this article discusses progress in autonomous vehicle technology in many countries, giving readers an international perspective on self-driving cars.

VOCABULARY BUILD

Learning synonyms and developing an awareness of word forms (how words change when they are used as different parts of speech) will help you paraphrase and summarize successfully.

A. Review the introductory paragraph to this chapter (page 136) and list all the synonyms for self-driving cars used in that paragraph.

_____

_____

B. Working with a partner, complete the following table by changing the form of each word to match the part of speech in the column heading.

VERB	NOUN	ADJECTIVE	ADVERB
automate		*automatic / automated*	*automatically*
	benefit		
regulate			
		congested / congestive	
navigate			

C. Write definitions for the key words from Reading 1. Look up the ones you do not know. Then answer the questions that follow.

WORDS	DEFINITIONS	WORDS	DEFINITIONS
1 algorithms (n.)	*set of instructions to be followed in strict order in problem-solving operations, especially by computers*	**8** policy (n.)	
2 alleviate (v.)		**9** pose (v.)	
3 circumstances (n.)		**10** precise (adj.)	
4 crucial (adj.) to		**11** resolve (v.)	
5 hacking (v.)		**12** sensors (n.)	
6 inadequate (adj.)		**13** spectrum (n.)	
7 manipulation (n.)			

1 Which verb is a synonym of *cause*, and forms collocations with the nouns *problems* and *challenges*? _____

2 Which verb is a synonym of *find a solution to*, and collocates with the nouns *problems*, *concerns*, *conflicts*, and *disputes*? _____

3 Which verb is a synonym of *improve*, and collocates with the nouns *problems*, *situations*, and *suffering*? _____

4 What do these three verbs (answers 1, 2, and 3) reveal about Reading 1?

_____

5 Which adjective starts with a prefix that negates the root word? _____

6 Which noun refers to equipment that has human abilities? _____

7 Which word almost always follows the adjective *crucial*? _____

8 Which noun can have a negative connotation? _____

9 Which words might you associate with computer technology?

_____

Before You Read

A. For greater reading comprehension, consider the technology required by autonomous vehicles before reading this text. Working in a small group, answer the following questions.

1 Return to the infographic of the autonomous car in Gearing Up (page 137). List the kinds of technology shown in the infographic.

Far and near radar, _____

2 This technology allows self-driving cars to "see" what is around them. List the things that autonomous vehicles need to be aware of as they move.

_____

_____

3 Ultrasonic sensors are not the only technological features autonomous vehicles require. What in-car (or on-board) technology is needed to coordinate information from all the cars' sensors? What external technology is required?

_____

_____

4 As well as technology, what other controls or regulatory systems are needed to ensure autonomous vehicles are safe?

_____

_____

You now have an idea of the complexities related to self-driving vehicles. This will help you as you read the following report.

While You Read

B. The following headings were removed from this report and randomized. Read the headings and think about why some are in regular font and some are *italicized.* What is the difference between the two types of headings?

_____

- ~~Introduction~~
- *Public Acceptance*
- *Poor Highway Infrastructure*
- *Digital Hacking*
- *Reducing Air Pollution*
- Obstacles to Adoption and
- Utilization
- Benefits of Autonomous Vehicles
- *Bad Weather*
- *Alleviating Traffic Congestion*
- The Importance of Artificial Intelligence, High-Definition Maps, and Deep
- Learning to Autonomous Vehicles
- *Improving Highway Safety*
- *Inadequate Spectrum*
- Conclusion

C. As you read, insert the headings in the appropriate positions in the report. When you have finished, verify your heading placement with a classmate.

Moving Forward: Self-Driving Vehicles in China, Europe, Japan, Korea, and the United States

Introduction

Vehicles equipped with **sensors** and cameras navigate the streets of Mountain View, California; Austin, Texas; Kirkland, Washington; Dearborn, Michigan; Pittsburgh, Pennsylvania; Beijing, China; Wuhu, China; Gothenburg, Sweden; Rotterdam, 5 Netherlands; Suzu, Japan; Fujisawa, Japan; and Seoul, South Korea, among other places. Sophisticated on-board software integrates data from dozens of sources, analyzes this information in real time, and automatically guides the car using high-definition maps around possible dangers.

… The World Economic Forum estimates that the digital transformation of the 10 automotive industry will generate $67 billion in value for that sector and $3.1 trillion in societal benefits (Weinelt, 2016). That includes improvements from autonomous vehicles, connected travellers, and the transportation enterprise ecosystem as a whole.

This paper … argues that connected vehicles are likely to improve highway safety, **alleviate** traffic congestion, and reduce air pollution. However, to do that, designers 15 must overcome obstacles such as poor infrastructure, bad weather, **inadequate spectrum**, **hacking** threats, and public acceptance.

The technology to meet these barriers has advanced rapidly and is poised for commercial deployment. But to make progress, each country needs to address particular issues. There are budgetary, **policy**, legal, and regulatory concerns to **resolve**.

20 In China, for example, the key is to develop a national policy framework for autonomous vehicles. It has multiple ministries which are responsible for the supervision of automatic driving (some with overlapping jurisdictions) and there needs to be greater clarity regarding who regulates and how they regulate. In addition, the government needs to invest in highway infrastructure for autonomous vehicles, eliminate the 25 current national prohibition on road testing, and reduce restrictions on road map development so that car makers and software designers can devise the most accurate navigational guides.

In Europe, the challenge is strengthening the artificial intelligence capability that is **crucial** to autonomous vehicles. One of the reasons why large technology firms such as Google 30 in the United States and Baidu in China have moved into transportation is the opportunity to apply the processing insights and rapid learning capacity developed through search engine technology to a new sector. To be 35 competitive in driverless vehicles, European auto manufacturers such as Audi, BMW (in collaboration with Intel), Volkswagen, Daimler, Mercedes-Benz, and Volvo need people with strong artificial intelligence skills 40 and high-performance computing aptitude

because car manufacturing no longer is about physical design as much as it is about software development and real-time data analytics …

In Japan and Korea, governments and car manufacturers have
45 been cautious about autonomous vehicles. Firms such as Toyota, Honda, Nissan, Kia, and Hyundai are investing major resources. They are keeping track of what is happening in other countries and undertaking pilot projects. Yet they have to decide whether autonomous vehicles represent a high priority for them. If so, they
50 should invest resources in artificial intelligence, high-definition mapping, and data analytics, which are key to the future of this sector. Failure to do so means they will be left behind as the industry embraces autonomous vehicles in the coming years.

In the United States, the major difficulty is overcoming the regulatory fragmentation
55 caused by fifty states having differing preferences on licensing, car standards, regulation, and privacy protection. Right now, car manufacturers (such as Ford and General Motors) and software developers face conflicting rules and regulations in various states (G. Ivanov of Google, personal communication, June 21, 2016). This complicates innovation because makers want to build cars and trucks for a national
60 or international market. There also needs to be greater clarity in regard to legal liability and data protection, and legislation to penalize the malicious disruption of autonomous vehicles.

In each nation, government officials and business leaders have to resolve these matters because within a foreseeable period, the technology will have advanced to the point
65 where intelligent vehicles will spread into key niches such as ride-sharing, taxis, delivery truck, industrial applications, and transport for senior citizens and the disabled … It is important for leaders to provide reasonable guidance on how to commercialize advanced technologies in transportation.

_____

70 Autonomous vehicles involve the application of advanced technological capabilities to cars, trucks, and buses. These include automated vehicle guidance and braking, lane-changing systems, use of cameras and sensors for collision avoidance, artificial intelligence to analyze information in real time, and high-performance computing and deep learning systems to adapt to new **circumstances** through 3-D high-
75 definition maps …

Without sophisticated artificial intelligence models and high-definition maps to analyze information and the capacity to learn from changing circumstances, autonomous vehicles would be difficult to operate safely. They simply would not be able to handle the complex conditions that exist on roads and highways around the world **…**

80 _____

Many benefits are expected of autonomous vehicles. These include improving highway safety, alleviating traffic congestion, and reducing air pollution. Research studies have found there are major gains likely in each of these areas.

85 Highway deaths are a major problem around the world. In the United States, an estimated 35,000 people die in auto accidents each year, while in China, around 260,000 people die in vehicle accidents (Buckley, 2016; "Lessons," 2016). Japan experiences around 4000 highway deaths each year (Bloomberg, 2015).

Worldwide, according to the World Health Organization, 1.24 million people die 90 annually due to highway accidents (2010). It is estimated that traffic fatalities cost $260 billion each year and that accident injuries account for another $365 billion. This represents a total of $625 billion annually from highway fatalities and injuries (Morgan Stanley Research, 2014).

According to a RAND study, "39 percent of the crash fatalities in 2011 involved 95 alcohol use by one of the drivers" (Anderson et al., 2016, p. xiv). This is an area where autonomous vehicles almost certainly will produce major gains in terms of lives saved and injuries avoided …

Traffic congestion is a problem in virtually every large metropolitan area. In the United 100 States, for example, drivers spend an average of forty hours stuck in traffic, at an annual cost of $121 billion (U.S. DOT, 2015). For Moscow, Istanbul, Mexico City, or Rio de Janeiro, the wasted time is even higher. There, drivers can spend "more than a hundred hours a year in congested traffic" (Weinelt, 2016, p. 4) …

Once autonomous vehicles are phased in and represent a large part of the traffic, car- 105 mounted sensors will be able to operate in conjunction with an Intelligent Traffic System to optimize intersection traffic flow. Time intervals for green or red lights will be dynamic and vary in real time, depending on the amount of traffic flowing along certain streets. That will ease congestion by improving the efficiency of vehicular flows.

110 Automobiles are major contributors to poor quality air. According to a RAND study, "Autonomous vehicle (AV) technology can improve fuel economy, improving it by 4 to 10 percent by accelerating and decelerating more smoothly than a human driver" (Anderson et al., 2016, p. xvi). Since smog in industrial areas is linked to the number of vehicles, having more autonomous cars is likely to reduce air pollution. A 2016 115 research study estimated that "pollution levels inside cars at red lights or in traffic jams are up to 40 percent higher than when traffic is moving" (Schlossberg, para. 4).

A shared autonomous vehicle system (SAV) also offers benefits in terms of emissions and energy. Researchers at the University of Texas at Austin examined pollutants such as sulfur dioxide, carbon monoxide, oxides of nitrogen, volatile organic compounds, 120 greenhouse gas, and particulate matter with small diameters. Their findings show "beneficial energy use and emissions outcomes for all emissions [types] when shifting to a system of SAVs" (Fagnant & Kockelman, 2014, p. 9) …

There are several key challenges as intelligent cars emerge. This includes technical
125 challenges arising from bad weather and digital hacking threats as well as obstacles
that require institutional or societal action such as road infrastructure improvements,
spectrum allocation, and public acceptance. Each of these matters **poses** problems
for autonomous vehicles and their success in the marketplace.

130 Bad weather represents an area where driverless cars do not perform very well. Heavy
rain, large amounts of snow, or atmospheric smog obscure road signs and lane
markings, and therefore raise the risk of driving accidents. It is difficult in these kinds
of situations for autonomous vehicles to make good decisions. According to Rob Grant
of Lyft, autonomous cars "don't behave well in certain weather conditions or poor
135 road conditions" (personal communication, July 5, 2016) …

Security is an important consideration in this sector. There have been reports of
vehicles hacked and systems disrupted. Autonomous cars depend on vehicle-to-vehicle
(V2V) communications and vehicle-to-infrastructure (V2I) connections. It is crucial to
140 maintain security in each of these pathways as well as in the personal electronic
communications that passengers transmit via email, phone calls, texting, Internet
surfing, and location data (Greenberg, 2015).

Researchers Jonathan Petit and Steven Shladover outline a number of security threats
to connected cars. These include hacking, jamming, data theft, ghost vehicles, or
145 malicious actions such as using bright lights to blind cameras, radar interference,
or sensor **manipulation** (2015). … Manipulating this type of information puts passengers
at risk and can potentially lead to serious accidents …

Infrastructure problems plague many countries. In India, for example, highways and
150 roads represent a major challenge. Nearly 38 percent of the country's roads are
unpaved, compared to about 16 percent in China. For these reasons, the World
Economic Forum ranks India eighty-seventh in infrastructure in the world, well below
the number 6 ranking for Japan, 7 in Germany, 46 in China, 48 in Thailand, and 76 in
Brazil (Bhattacharaya, Bruce, & Mukherjee, 2014).

155 Poor highways pose challenges for autonomous vehicles. Cars need predictable
surfaces and clearly defined traffic lanes. In a cross-country pilot drive, Delphi
engineers found substantial variations in lane markings. According to Glen De Vos,
"the automated vehicle encountered some roadways with wide white stripes, while
others had narrow yellow markings. Some lane markings were new, others were
160 faded, and some were marked with raised bumps" (*Hands off: The future of self-
driving cars,* 2016, pp. 22-23).

To the extent that roads are poorly marked or engineered, it is hard for either semi-autonomous or fully autonomous vehicles to traverse those routes. The risk of accidents goes up and there is a grave danger that computerized **algorithms** will lead to
165 poor decisions. Unless addressed, this will limit the ability of autonomous vehicles to thrive …

Inadequate spectrum is a major barrier in many countries. Finding dedicated frequency ranges is key to supporting autonomous vehicles. They need specific bands that
170 perform well regardless of weather or traffic conditions. Autonomous vehicles and industrial applications need mid-range spectrum below 6 GHz due to the need to balance connection speed and radio link reliability. In a number of places, these frequencies are in high demand and it is difficult to guarantee the reliable service that autonomous vehicles require. A dropped phone call is annoying to consumers, but a
175 lost connection for a driverless car could be deadly.

American manufacturers generally support a dedicated short-range communication (DSRC) system. According to Sandy Lobenstein of Toyota, "DSRC is a two-way, short- to medium-range
180 wireless communication protocol that allows vehicles to communicate with each other to detect and avoid hazards. DSRC-equipped vehicles broadcast **precise** information—such as their location, speed, and acceleration—several times
185 per second over a range of a few hundred metres. Other vehicles outfitted with DSRC technology receive these "messages" and use them to compute the trajectory of each neighbouring vehicle, compare these with their own predicted
190 path, and determine if any of the neighbouring vehicles pose a collision threat" (*The Internet of cars,* 2015).
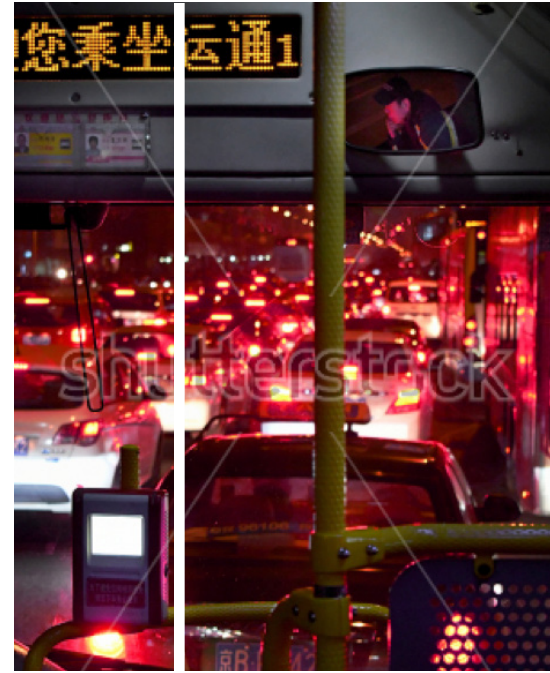

Ultimately, the public must feel comfortable with autonomous vehicles for this
195 market to develop. As with any emerging technologies, it takes a while for individuals to accept new models and different ways of navigating. Just as the shift from horses to cars and cars to mass transit was controversial, so too is the looming transition to autonomous vehicles.

According to an American public opinion survey undertaken at the University of
200 Michigan, many people still prefer traditional approaches to vehicle operations. When asked about their preferences, 46 percent of Americans said they prefer no self-driving vehicles, followed by 39 percent who like partial self-driving [semi-autonomous] and 16 percent who support complete self-driving [fully autonomous] cars (Schoettle & Sivak, 2016).

205 The same survey revealed that there were interesting variations in attitudes by gender and age. Men (19 percent) were more likely to prefer full self-driving vehicles compared to women (12 percent). Young people aged eighteen to twenty-nine years
210 old (19 percent) and those between thirty and forty-four (22 percent) were the most likely to want self-driving vehicles, compared to those sixty and older (only 10 percent support self-driving) and those forty-five to fifty-nine (12 percent) …

215 Chinese drivers appear more open to vehicular experimentation. A World Economic Forum survey found that "75 percent of Chinese say they are willing to ride in a self-driving car" (Spring, 2016; Hao, 2016) This view was echoed in a separate
220 survey undertaken by the Roland Berger consulting firm. It found that "96 percent of Chinese would consider an autonomous vehicle for almost all everyday driving, compared with 58 percent of Americans and Germans" (Girault, 2016). People in China do not have the same
225 positive emotional relationship with driving and their own cars, and therefore are more amenable to self-driving cars …

The technology underlying autonomous vehicles is well developed and poised for commercial deployment. Major automotive companies and software developers have
230 made considerable progress in navigation, collision avoidance, and street mapping.

But in each country, there are budgetary, policy, and regulatory issues that need to be addressed in order to gain the full benefits of autonomous vehicles … From an outside standpoint, work needs to be done to overcome obstacles such as poor infrastructure, bad weather, spectrum limitations, hacking, and public acceptance. If
235 car developers can overcome these barriers, there will be substantial advances for transportation and society.

There remain broader societal and ethical considerations, though, that must be considered as we move closer to commercialization. How should programmers build ethical choices into automated features and advanced algorithms? For example, if an
240 automated car is facing the outcome between hitting one child or a group of ten kids, how does it make that choice? What are the factors in the algorithm that would lead its system to veer one way or another? One can imagine a wide variety of ethical issues and software designers have to make choices regarding how to deal with them (Bonnefon, Shariff, & Rahwan, 2016). Learning how to navigate these complicated
245 issues is a major challenge facing the world.

(2405 words)

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After You Read

D. Working with a partner, answer the following questions to demonstrate your comprehension.

1 Why does the author start the report by referring to a) the countries where research on self-driving cars is being conducted, and b) the amount of money the autonomous car sector will generate globally?

2 What is the thesis of this report?

_____

_____

3 What are the major challenges the following countries and regions face concerning the adoption of self-driving cars?

China: _____

_____

Europe: _____

Japan and Korea: _____

_____

The United States: _____

_____

_____

4 What forms of technology support the development of autonomous vehicles?

_____

_____

_____

5 In the sections _Improving Highway Safety_, _Alleviating Traffic Congestion_, and _Reducing Air Pollution_, why does the author start by providing statistics?

_____

_____

_____

6 How will autonomous vehicles improve highway safety, alleviate traffic congestion, and reduce air pollution?

_____

_____

_____

_____

_____

_____

7 How could bad weather, digital hacking, and poor highway infrastructure pose problems for autonomous vehicles?

_____

_____

_____

8 How could inadequate Internet spectrum and public acceptance prevent the widespread use of self-driving cars?

_____

_____

_____

9 In one sentence, summarize the author's conclusion.

_____

_____

_____

10 In the final paragraph of the report, what new challenge does the author mention?

_____

_____

FOCUS ON READING

Identifying Paraphrases and Summaries

One of the ways the author of Reading 1 (Darrell West) presents information about self-driving cars is by integrating information and points from other authors and researchers. In some cases, West uses quotes or indirect speech (see Chapter 4, Focus on Writing, page 119, and Focus on Accuracy, page 120). In other cases, he paraphrases and summarizes information from other sources.

In paraphrases and summaries, writers use their own words to present others' ideas. For each instance, the writer must provide an in-text citation with a complete reference at the end of the text. (See Chapter 2, Academic Survival Skill, on page 57.)

What is the difference between paraphrasing and summarizing?

A paraphrase is approximately the same length as the original text; a summary is shorter than the original text. A formal summary is approximately one-third to one-quarter the length of the original text although this is not an absolute rule. For both paraphrases and summaries, it is important for writers to use their own words, not the words of the original author.

Why paraphrase and summarize?

Writers paraphrase and summarize other authors for many reasons:
• To build arguments for and against their thesis
• To give credit to the authors who first wrote about these ideas
• To avoid constant use of quotations
• To avoid plagiarism
• To demonstrate their extensive knowledge of the field
• To establish their writing as academic

In general, writers must paraphrase or summarize and provide a citation and reference for specific ideas and research outcomes.

A. Skim the in-text citations in Reading 1 and complete the following tasks.

1 Underline the in-text citations that refer to direct quotations of the original authors' words.

2 Highlight those that are paraphrases and summaries of original authors.

3 Does anything about these in-text citations surprise you?

_____

4 When you look at an in-text citation, can you tell if the author has paraphrased or summarized the original authors' views? Why or why not?

_____

B. Look at two of the original sources (shown below) that West integrated into his writing. For each, find the corresponding citation in Reading 1 and identify whether he paraphrased or summarized the sources.

Example 1:

> More than 35,200 people were killed in car crashes in this country last year, up 7.7 percent from 2014. People caused most of those accidents. Driverless cars could help reduce that toll substantially, but those vehicles are still years away.
>
> _____
> Lessons from the Tesla crash. (2016, July 11). *New York Times*. Retrieved from https://www.nytimes.com/2016/07/11/opinion/lessons-from-the-tesla-crash.html

Example 2:

> I was driving 70 mph on the edge of downtown St. Louis when the exploit began to take hold. Though I hadn't touched the dashboard, the vents in the Jeep Cherokee started blasting cold air at the maximum setting, chilling the sweat on my back through the in-seat climate control system. Next the radio switched to the local hip hop station ... at full volume. I spun the control knob left and hit the power button, [but nothing happened]. Then the windshield wipers turned on, and wiper fluid blurred the glass ...

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> The Jeep's strange behavior wasn't entirely unexpected. I'd come to St. Louis to be Charlie Miller and Chris Valasek's digital crash-test dummy, a willing subject on whom they could test the car-hacking research they'd been doing over the past year. The result of their work was a hacking technique ... that can target Jeep Cherokees and give the attacker wireless control, via the Internet, to any of thousands of vehicles. Their code is an automaker's nightmare: software that lets hackers send commands through the Jeep's entertainment system to its dashboard functions, steering, brakes, and transmission, all from a laptop that may be across the country. ...
>
> _____
> Greenberg, A. (2015, July 21). Hacker's remotely kill a Jeep on the highway—with me in it.
> *Wired*. Retrieved from https://www.wired.com/2015/07/hackers-remotely-kill-jeep-highway/

C. The following examples show how West integrates paraphrases and summaries into his writing. The notes illustrate the methods he uses. After, answer the questions.

PARAPHRASE OR SUMMARY	NOTES ON INTEGRATION
Researchers Jonathan Petit and Steven Shladover outline a number of security threats to connected cars. These include hacking, jamming, data theft, ghost vehicles, or malicious actions such as using bright lights to blind cameras, radar interference, or sensor manipulation (2015).	• Authors' names mentioned directly in the sentence • Use of verb *outline* • In-text citation at end (only year required as authors' names are in the text)
According to an American public opinion survey undertaken at the University of Michigan, many people still prefer traditional approaches to vehicle operations. When asked about their preferences, 46 percent of Americans said they prefer no self-driving vehicles, followed by 39 percent who like partial self-driving [semi-autonomous] and 16 percent who support complete self-driving [fully autonomous] cars (Schoettle & Sivak, 2016).	• Authors' names not mentioned directly in the sentence • No verb used to integrate summary • Only the in-text citation at the end attributes the information to the original authors.
Right now, car manufacturers (such as Ford and General Motors) and software developers face conflicting rules and regulations in various states (G. Ivanov of Google, personal communication, June 21, 2016).	• This is a summary from an interview the author did with G. Ivanov of Google. • The in-text citation is the only indication of this information. As there is no paper (or electronic) document, there is no matching reference in the References section.

① Select one page of Reading 1 and review each in-text citation to determine which paraphrases and summaries are integrated with a direct inclusion of the author's name and a corresponding verb, and which are not.

② When West integrates a paraphrase or summary with a direct inclusion of the author's name, which verbs and phrases does he use?

_____

_____

_____

_____

Academic
Survival Skill

Using Techniques to Paraphrase and Summarize

Transferring another author's words into your own is not always simple. Fortunately, there are techniques that can help you paraphrase and summarize. You can apply these techniques to this excerpt from the conclusion of Reading 1.

> The technology underlying autonomous vehicles is well developed and poised for commercial deployment. Major automotive companies and software developers have made considerable progress in navigation, collision avoidance, and street mapping.

First, it's essential to understand the meaning of the original text. If you don't understand the meaning of the original, take the time to reread it, and look up the meaning of words you don't know. Once you have a good understanding of the original text, there are several techniques you can use to arrive at your own wording, either in a paraphrase or a summary.

To start, cover up the original words and say or write what you understand them to mean. This is a step toward using your own words when paraphrasing. In addition, you can use the following techniques to paraphrase successfully.

❗ *Technical terms (like LiDAR), specific collocations (like artificial intelligence), or very common words (like "the") do not require synonyms.*

Paraphrasing

Using the first sentence of the excerpt as an example, here are some techniques you can use when paraphrasing.

USE SYNONYMS:	The equipment necessary for self-driving cars is established and ready for commercial use.	*A good start, but the sentence structure is too similar to the original. This technique by itself does not produce a successful paraphrase.*
CHANGE WORD FORMS:	The technological developments that underlie autonomous vehicles are at the point of commercialization.	*Good change in word forms, but the words and sentence structure are still too similar to the original. This technique by itself does not produce a successful paraphrase.*
CHANGE SENTENCE STRUCTURE:	As the technology underlying autonomous vehicles is well developed, they are now poised for commercial deployment.	*Good move to a new sentence structure, but the words are too similar to the original. This technique by itself does not produce a successful paraphrase.*
MOVE FROM ACTIVE TO PASSIVE:	The technology underlying autonomous vehicles has been well developed and is ready to be commercially deployed.	*Good move to passive voice, but the words are still too similar to the original. This technique by itself does not produce a successful paraphrase.*

These are all good techniques but on their own, none are sufficient to create a good paraphrase. A combination of methods yields the best results.

A. Which techniques were combined to create this paraphrase?

> The technological progress necessary for the commercialization of self-driving cars has been achieved.

_____

_____

It is also important to remember to introduce the paraphrase to give credit to the original author.

> West (2016) states that the technological progress necessary for the commercialization of self-driving cars has been achieved.

B. Paraphrasing one sentence at a time is a good way to analyze the different techniques, but you will probably want to paraphrase several sentences at once. In the following paraphrase, which techniques were used?

> West (2016) states that the technological progress necessary for the commercialization of self-driving cars has been achieved. Vehicle steering, accident prevention, and road mapping have all been significantly improved by the large car firms.

_____

_____

Summarizing

While paraphrasing is useful, it is more likely you will want to summarize large amounts of information into a few sentences that you can integrate in your writing. To write a summary, you first need to identify the main points of the original source.

C. In the excerpt below, underline the main points.

> The technology underlying autonomous vehicles is well developed and poised for commercial deployment. Major automotive companies and software developers have made considerable progress in navigation, collision avoidance, and street mapping.
>
> But in each country, there are budgetary, policy, and regulatory issues that need to be addressed in order to gain the full benefits of autonomous vehicles. Governments can accelerate or slow the movement toward self-driving vehicles by the manner in which they regulate. Addressing relevant issues and making sure regulatory rules are clear should be high priorities in all the countries considering autonomous vehicles …
>
> From an outside standpoint, work needs to be done to overcome obstacles such as poor infrastructure, bad weather, spectrum limitations, hacking, and public acceptance. If car developers can overcome these barriers, there will be substantial advances for transportation and society.

D. Once you have identified the main points, paraphrase them to create a summary.

_____

_____

_____

_____

E. Practise paraphrasing and summarizing. On a separate page, choose one of paragraphs 5, 6, or 7 from Reading 1 and work through the process presented in this section.

- Paraphrase the first sentence using each of the four paraphrasing techniques, then combine the techniques into the "perfect" paraphrase.
- Paraphrase the rest of the paragraph.
- Summarize the whole paragraph, reducing it to approximately one-third of its current length.
- Don't forget to include the author's name and the date of publication in an appropriate way.

WARM-UP ASSIGNMENT

Write a Summary

Your goal is to write a summary of the Introduction from Reading 1. You will use this summary in your Final Assignment.

A. Working on your own, underline the main points of the Introduction. Then compare what you have underlined with a classmate. Close your books and tell each other the main points. This will help ensure you understand the meaning of the original text.

B. Again working on your own, paraphrase the main points to create a summary that is approximately one-third the length of the original text. Combine techniques such as using synonyms, changing parts of speech, changing the sentence structure, and shifting from active to passive voice.

C. Be sure to cite the author and publication date either at the beginning or at the end. Finish with a complete reference to Reading 1. (To write an accurate reference, you will need to include page numbers. The introduction that you have just summarized is on pages 1–3 of West's original report.)

Refer to the Models Chapter (page xxx) to see an example of a summary and to learn more about how to write one.

> When you receive feedback from your instructor or your classmates on this Warm-Up Assignment, you will have information you can use to improve your writing on the Final Assignment.

Morality, Ethics of a Self-Driving Car

While there are many advantages to self-driving cars, we must think carefully about the consequences of decision-making algorithms that will allow autonomous vehicles to make value-based, life-changing decisions. Will the cars make better life and death decisions than human drivers?

VOCABULARY BUILD

A. In this reading, you will discover many expressions that refer to sudden movements by people or cars. Working with your class, on the board, draw a street with cars and a person walking along the sidewalk. Use a marker or eraser to demonstrate the movements these expressions describe:

- Veers sharply
- Swerves sharply
- Performs a sharp evasive manoeuvre
- Darts out / darts into the road / darts into the path of
- Hurtles toward

B. Key words from Reading 2 are in bold in the sentences in the first column of the table. Write the meaning of each of the key words in the second column.

KEY WORDS IN CONTEXT	MEANINGS OF KEY WORDS
❶ Autonomous vehicles will sense danger long before it would become **apparent** to a human driver and slow down or stop.	*noticeable or obvious*
❷ Self-driving cars can **detect** objects with 360-degree sensory data in daylight or at night.	
❸ Most automakers and experts expect some sort of standard to **emerge**—even if it's not entirely clear what it will be.	
❹ The moral issue for self-driving cars is represented by a **hypothetical** autonomous vehicle with malfunctioning brakes, hurtling toward a school bus.	
❺ A recent study found that respondents generally agreed that a car should, in the case of an **inevitable** crash, kill the fewest number of people possible.	
❻ "Shouldn't we treat everyone the same way?" he asked. "Ultimately, it's a societal decision," meaning it may have to be settled by **legislators**, courts, and **regulators**.	

KEY WORDS IN CONTEXT	MEANINGS OF KEY WORDS
7 A certain number of occupants will die if the car swerves; a number of **pedestrians** will die if it continues.	
8 It's difficult to know what objects a self-driving car will "see" and **predict** what those objects will do next and what the car's reaction should be.	
9 **Presumably** then, there could be a circumstance in which the responsibility for someone darting into the path of an autonomous vehicle at the last minute rests with that person.	
10 Through millions of computer **simulations** and data from real self-driving cars being tested, the cars themselves can begin to learn the "best" way to respond to a given situation.	
11 Automakers largely downplay the risks of "the **trolley** problem"—named for a no-win hypothetical situation in which a person witnessing a runaway **trolley** could allow it to hit several people or, by pulling a lever, divert it, killing someone else.	

Before You Read

The author asks readers to consider this terrible hypothetical situation: what would happen if, in an emergency situation, an autonomous car had to choose between hitting a pedestrian directly ahead or swerving to avoid the pedestrian and likely injuring the occupants of the car? What choice should the car make?

A. Working in a small group, discuss the following hypothetical situations. Take point-form notes in the final column to indicate your group's optimal solutions.

HYPOTHETICAL SITUATIONS	FIRST OPTION	SECOND OPTION	OPTIMAL OUTCOME
1 Pedestrian darts out in front of autonomous car	Car hits pedestrian	Car swerves and hits brick wall	
2 School bus swerves in front of autonomous car	Car hits school bus	Car veers sharply to avoid bus and crashes	
3 Small animal runs across a road	Car hits animal	Car performs an evasive manoeuvre and goes into a ditch	

B. Who should make decisions about the optimal outcomes in these hypothetical situations: legislators, regulators, researchers, or drivers? Discuss your thoughts with your class.

While You Read

C. This reading is a newspaper article. While you read, take notes on its organizational and text features.

D. One of the features of this article is the use of idiomatic language. As you read, write down the idioms you notice on a separate page. After, work with a classmate to define the idioms. Write your best definitions on the board to share with your class.

Morality, Ethics of a Self-Driving Car: Who Decides Who Lives, Dies?

Consider this hypothetical situation:

It's a bright, sunny day and you're alone in your [beautiful] new self-driving vehicle. You're sitting back, enjoying the view, moving along at the 70 km/h speed limit.

As you approach a rise in the road, heading south, a school bus appears, driving north,
5 one driven by a human, and it veers sharply toward you. There is no time to stop safely, and no time for you to take control of the car.

Does the car:

A. Swerve sharply into the trees, possibly killing you but possibly saving the bus
10 and its occupants?

B. Perform a sharp evasive manoeuvre around the bus and into the oncoming lane, possibly saving you, but sending the bus and its driver swerving into
15 the trees, killing her and some of the children on board?

C. Hit the bus, possibly killing you as well as the driver and kids on the bus?

In everyday driving, such no-win choices
20 may be exceedingly rare but, when they happen, what should a self-driving car— programmed in advance—do? Or in any situation—even a less **dire** one—where a moral snap judgment must be made?

dire (adj.): extremely serious or terrible

25 It's not just a theoretical question anymore, with predictions that in a few years, tens of thousands of **semi-autonomous vehicles** may be on the roads. Some $80 billion has been invested in the field. Tech companies are working feverishly on them, with Google-affiliated Waymo among those testing cars in Michigan, and mobility companies like Uber and Tesla racing to beat them. Detroit's automakers are placing a big bet
30 on them.

semi-autonomous vehicle (n.): vehicle that is controlled by computer algorithms, but can also be driven by a human

There's every reason for excitement: self-driving vehicles will ease commutes, returning lost time to workers; enhance mobility for seniors and those with physical challenges, and sharply reduce the more than 35,000 deaths on US highways each year.

But there are also a host of nagging questions to be sorted out as well, from what
35 happens to cab drivers to whether such vehicles will create sprawl.

And there is an existential question:

Who dies when the car is forced into a no-win situation?

"There will be crashes," said Van Lindberg, an attorney in the Dykema law firm's San Antonio office who specializes in autonomous vehicle issues. "Unusual things
40 will happen. Trees will fall. Animals, kids will dart out." Even as self-driving cars save thousands of lives, he said, "anyone who gets the short end of that stick is going to be pretty unhappy about it."

Whether the technology in self-driving cars is superhuman or not, there is evidence that people are worried about the choices self-driving cars will be programmed to take.

45 Last year, for instance, a Daimler executive set off a wave of criticism when he was quoted as saying its autonomous vehicles would prioritize the lives of its passengers over anyone outside the car. The company later insisted he'd been misquoted, since it would be illegal "to make a decision in favour of one person and against another."

Last month, Sebastian Thrun, who founded Google's self-driving car initiative, told
50 Bloomberg that the cars will be designed to avoid accidents, but that, "If it happens where there is a situation where a car couldn't escape, it'll go for the smaller thing."

But what if the smaller thing is a child?

How that question gets answered may be important to the development and
55 acceptance of self-driving cars.

Azim Shariff, an assistant professor of psychology and social behaviour at the University of California, Irvine, co-authored a study last year that found
60 that while respondents generally agreed that a car should, in the case of an **inevitable** crash, kill the fewest number of people possible regardless of whether they were passengers or people outside
65 of the car, they were less likely to buy any car "in which they and their family member would be sacrificed for the greater good."

Self-driving cars could save tens of thousands of lives each year, Shariff said. But
70 individual fears could slow down acceptance, leaving traditional cars and their human drivers on the road longer to battle it out with autonomous or semi-autonomous cars. Already, the American Automobile Association says three-quarters of US drivers are suspicious of self-driving vehicles.

"These ethical problems are not just theoretical," said Patrick Lin, director of
75 the Ethics and Emerging Sciences Group at California Polytechnic State University, who has worked with Ford, Tesla, and other autonomous vehicle makers on just such issues.

While he can't talk about specific discussions, Lin says some automakers "simply deny that ethics is a real problem, without realizing that they're making ethical
80 judgment calls all the time" in their development, determining what objects the car will "see," how it will **predict** what those objects will do next, and what the car's reaction should be.

The Trolley Problem

Automakers and suppliers largely downplay the risks of
what in philosophical circles is known as "the **trolley problem**"—named for a no-win **hypothetical** situation in which, in the original format, a person witnessing a runaway trolley could allow it to hit several people or, by pulling a lever, divert it, killing someone else.

In the circumstance of the self-driving car, it's often boiled down trolley to a hypothetical vehicle hurtling toward a crowded crosswalk with malfunctioning brakes: a certain number of occupants will die if the car swerves; a number of **pedestrians** will die if it continues. The car must be programmed to do one or the other.

Philosophical considerations aside, automakers argue it's all but bunk—it's so **contrived**.

"I don't remember when I took my driver's licence test that this was one of the questions," said Manuela Papadopol, director of business development and communications for Elektrobit, a leading automotive software maker and a subsidiary of German auto supplier Continental AG.

If anything, self-driving cars could almost eliminate such an occurrence. They will sense such a problem long before it would become **apparent** to a human driver and slow down or stop. Redundancies—for brakes, for sensors—will **detect** danger and react more appropriately.

"The cars will be smart—I don't think there's a problem there. There are just solutions," Papadopol said.

Alan Hall, Ford's spokesperson for autonomous vehicles, described the self-driving car's capabilities—being able to detect objects with 360-degree sensory data in daylight or at night—as "superhuman."

"The car sees you and is preparing different scenarios for how to respond," he said.

Lin said that, in general, many self-driving automakers believe the simple act of braking, of slowing to a stop, solves the trolley problem. But it doesn't, such as in a theoretical case where you're being tailgated by a speeding fuel tanker.

Some experts and analysts believe solving the trolley problem could be a simple matter of **regulators** or **legislators** deciding in advance what actions a self-driving car should take in a no-win situation. But others doubt that any set of rules can capture and adequately react to every such scenario.

The question doesn't need to be as dramatic as asking who dies in a crash, either. It could be as simple as deciding what to do about jaywalkers or where a car places itself in a lane next to a large vehicle to make its passengers feel secure or whether to run over a squirrel that darts into a road.

Chris Gerdes, who as director of the Center for Automotive Research at Stanford University has been working with Ford, Daimler, and others on the issue, said the question is ultimately not about deciding who dies. It's about how to keep no-win situations from happening in the first place and, when they do occur, setting up a system for deciding who is responsible.

For instance, he noted California law requires vehicles to yield the crosswalk to pedestrians but also says pedestrians have a duty not to suddenly enter a crosswalk
130 against the light. Michigan and many other states have similar statutes.

Presumably, then, there could be a circumstance in which the responsibility for someone darting into the path of an autonomous vehicle at the last minute rests with that person—just as it does under California law.

But that "forks off into some really interesting questions," Gerdes said, such as whether
135 the vehicle could potentially be programmed to react differently, say, for a child. "Shouldn't we treat everyone the same way?" he asked. "Ultimately, it's a societal decision," meaning it may have to be settled by legislators, courts, and regulators.

Researchers, automakers, academics, and others understand something else about self-driving cars and the risks they may still pose, namely that for all their promise
140 to reduce accidents, they can't eliminate them.

"It comes back to whether you want to find ways to program in specifics or program in desired outcomes," said Gerdes. "At the end of the day, you're still required to come up with what you want the desired outcomes to be, and the desired outcome cannot be to avoid any accidents all the time.

145 "It becomes a little uncomfortable sometimes to look at that."

The Hard Questions

Automakers will have to decide what the car "sees" and what it doesn't. Seeing everything around it—and processing it—could be a waste of limited processing power. Which means another set of ethical and moral questions.

150 Then there is the question of how self-driving cars could be taught to learn and respond to the tasks they are given—the stuff of science fiction that seems about to come true.

While self-driving cars can be programmed—told what to do when that school bus comes hurtling toward them—there are other options. Through millions of computer **simulations** and data from
155 real self-driving cars being tested, the cars themselves can begin to learn the "best" way to respond to a given situation.

For example, Waymo—Google's self-driving car arm—in a recent government filing said through trial and error in simulations, it's teaching its cars how to navigate a tricky left turn against a
160 flashing yellow arrow at a real intersection in Mesa, Arizona. The simulations—not the programmers—determine when it's best to inch into the intersection and when it's best to accelerate through it. And the cars learn how to mimic real driving.

Ultimately, through such testing, the cars themselves could potentially learn how
165 best to get from Point A to Point B, just by having programmed them to discern what "best" means—say the fastest, safest, most direct route. Through simulation and data shared with real-world conditions, the cars would "learn" and execute the request.

At the American Center for Mobility in Ypsilanti, Michigan, where a test ground is being completed for self-driving cars, CEO John Maddox said vehicles will be able to
170 put to the test what he calls "edge" cases that vehicles will have to deal with regularly—such as not confusing the darkness of a tunnel with a wall or accurately predicting whether a person is about to step off a curb or not.

The facility will also play a role, through that testing, of getting the public used to the idea of what self-driving cars can do, how they will operate, how they can be
175 far safer than vehicles operated by humans, even if some questions remain about their functioning.

Most automakers and experts expect some sort of standard to **emerge**—even if it's not entirely clear what it will be.

At SAE International—a global standard-making group—chief product officer Frank
180 Menchaca said reaching a perfect standard is a daunting, if not impossible, task, with so many fluid factors involved in any accident. Speed. Situation. Weather conditions. Mechanical performance.

Even with that standard, there may be no good answer to the question of who dies in a no-win situation, he said. Especially if it's to be judged by a human.

185 "As human beings, we have hundreds of thousands of years of moral, ethical, religious, and social behaviours programmed inside of us," he added. "It's very hard to replicate that."

(1981 words)

Spangler, T. (2017, November 25). Morality, ethics of a self-driving car. *Waterloo Region Record*, p. D8.

After You Read

E. Complete the following sentences to demonstrate your comprehension. When you have finished, discuss your answers with the class.

1. The author starts the article with the description of the hypothetical situation because _____

2. The author states that the benefits of self-driving cars include

   _____

   _____

3. According to the author, the essential question about self-driving cars is

   _____

4. The author establishes authority by _____

5. According to Van Lindberg, situations that could cause problems for autonomous cars include _____

   _____

6. To demonstrate people's concerns about the choices autonomous vehicles will make, the author _____

   _____

7. The author includes a fact from the American Automobile Association to demonstrate that members of _____

   _____

8 Patrick Lin believes that some automakers _____

_____

9 The trolley problem is a hypothetical situation in which an observer, seeing

a runaway trolley, _____

_____

10 Ultimately, while autonomous cars will reduce the number of accidents,

they can't _____

11 Frank Menchaca believes that _____

_____

_____

F. As a class, discuss the following question: If you had an autonomous vehicle waiting for you outside right now, would you use it to take a long trip? Why or why not?

FOCUS ON ACCURACY

Expressing Uncertainty

When we write about an evolving issue, like the development and adoption of self-driving cars, there will always be some uncertainty about the future. Writers can express this uncertainty in a variety of ways, for example, by strategically combining the use of modals (e.g. *could*, *should*, *may*) with other language elements. Here are some sentences from Readings 1 and 2 to analyze.

A. Read the sentences and underline the modals. When you finish, compare your answers with a classmate's.

1 A dropped phone call is annoying to consumers, but a lost connection for a driverless car <u>could</u> be deadly.

2 Addressing relevant issues and making sure regulatory rules are clear should be high priorities in all the countries considering autonomous vehicles.

3 How should programmers build ethical choices into automated features and advanced algorithms?

④ Self-driving cars could save tens of thousands of lives each year, Shariff said. But individual fears could slow down acceptance, leaving traditional cars and their human drivers on the road longer to battle it out with autonomous or semi-autonomous cars.

⑤ Automakers and suppliers largely downplay the risks of what in philosophical circles is known as "the trolley problem"—named for a no-win hypothetical situation in which, in the original format, a person witnessing a runaway trolley could allow it to hit several people or, by pulling a lever, divert it, killing someone else.

⑥ Some experts and analysts believe solving the trolley problem could be a simple matter of regulators or legislators deciding in advance what actions a self-driving car should take in a no-win situation.

⑦ The question doesn't need to be as dramatic as asking who dies in a crash, either. It could be as simple as deciding what to do about jaywalkers or where a car places itself in a lane next to a large vehicle to make its passengers feel secure or whether to run over a squirrel that darts into a road.

⑧ Presumably, then, there could be a circumstance in which the responsibility for someone darting into the path of an autonomous vehicle at the last-minute rests with that person—just as it does under California law.

⑨ Seeing everything around it—and processing it—could be a waste of limited processing power.

⑩ Then there is the question of how self-driving cars could be taught to learn and respond to the tasks they are given—the stuff of science fiction that seems about to come true.

⑪ Ultimately, through such testing, the cars themselves could potentially learn how best to get from Point A to Point B, just by having programmed them to discern what "best" means—say the fastest, safest, most direct route.

⑫ In everyday driving, such no-win choices may be exceedingly rare but, when they happen, what should a self-driving car—programmed in advance—do?

⑬ It's not just a theoretical question anymore, with predictions that in a few years, tens of thousands of semi-autonomous vehicles may be on the roads.

⑭ How that question gets answered may be important to the development and acceptance of self-driving cars.

B. Review the sentences in task A again, this time looking for evidence that the author is asking questions: either the sentence is a question, or it contains the word *question*. Put a star beside these sentences.

C. Review the following sentences from task A one more time, and circle specific words that suggest uncertainty. Write them next to the sentence numbers below. These words are often used to express an uncertainty.

Sentence 7   *whether* _____   Sentence 11 _____

Sentence 8 _____   Sentence 13 _____

Sentence 10 _____

D. Based on A, B, and C above, list three techniques that writers can use to express uncertainty.

• _____

• _____

• _____

E. Using these techniques and the topics listed below, write sentences that express uncertainty about the future of self-driving cars. After, share your best sentences with your class.

1 Development of a national policy framework for self-driving cars in China

_____

_____

2 Greater investment in highway infrastructure in China

_____

_____

3 Improved capability in artificial intelligence in Europe

_____

_____

4 More development in high-definition mapping and data analytics in Japan and Korea

_____

_____

MyBookshelf > My eLab > Exercises > Chapter 5 > Focus on Accuracy

FOCUS ON WRITING

Writing Conditionally

In addition to the techniques described in Focus on Accuracy (page 162) to express uncertainty, writers can use conditional sentences (and variations on conditional sentences) to show that what happens next depends on certain conditions.

Conditional sentences often start with *if* in a subordinate clause to express a cause and effect relationship (e.g., If A, then B). You may be familiar with the standard patterns of verb tense use in conditional sentences. These patterns are summarized in the next table.

CONDITIONAL SENTENCE PATTERNS	VERB FORM IN THE *IF*-CLAUSE	VERB FORM IN THE RESULT CLAUSE	EXAMPLE
❶ Present time, true condition	Present	Present	If I <u>see</u> a self-driving car on the road these days, I <u>am</u> surprised.
❷ Future time, true condition	Present	Future	If a self-driving car <u>has</u> an accident, the driver of the car <u>will be</u> angry.
❸ Present time, untrue condition	Simple past	*Would* + base form *Could* + base form *Might* + base form	If self-driving cars always <u>made</u> the best driving decisions, humans <u>would be</u> happy to buy them. If a self-driving car <u>were</u>* for sale, people <u>would buy</u> it.
❹ Past time, untrue condition	Past perfect	*Would have* + past participle *Could have* + past participle *Might have* + past participle	If the development of self-driving cars <u>had been</u> simple, automakers <u>would have succeeded</u> before now.

*The verb *be* in this pattern is irregular, with both singular and plural nouns followed by *were*.

As is common in advanced texts, the cause and effect relationships expressed in the conditional sentences in Readings 1 and 2 follow variations of these standard patterns. The authors strategically use verb tenses to express uncertain circumstances. You will analyze some conditional sentences from these two readings in the following tasks.

A. Read the sentences and underline the *if-clauses* and the *verbs* in the results clauses. When you finish, compare your answers with a classmate's.

❶ Yet they [the governments and automakers in Japan and Korea] have to decide whether autonomous vehicles represent a high priority for them. If [this is] so, they <u>should invest</u> resources in artificial intelligence, high-definition mapping, and data analytics, which are key to the future of this sector.

❷ If car developers can overcome these barriers, there will be substantial advances for transportation and society.

❸ For example, if an automated car is facing the outcome between hitting one child or a group of ten kids, how does it make that choice?

❹ Last month, Sebastian Thrun, who founded Google's self-driving car initiative, told Bloomberg that the cars will be designed to avoid accidents, but that "If it happens where there is a situation where a car couldn't escape, it'll go for the smaller thing."

❺ A certain number of occupants will die if the car swerves; a number of pedestrians will die if it continues.

❻ If anything [were to happen], self-driving cars could almost eliminate such an occurrence.

❼ "Even with that standard, there may be no good answer to the question of who dies in a no-win situation," he said. "Especially if it's to be judged by a human."

B. Review the sentences in task A again. In the first column of the table below, write the number of the sentence that follows the pattern (and pattern variations) described in the second column.

SENTENCE	CONDITIONAL PATTERN AND VARIATION
1	Pattern 1, using modal *should* in the results clause
	Pattern 3, no variation
	Pattern 1, using present continuous in the *if*-clause, and present (in question form) in the result clause
	Pattern 1 using modal *may* in the results clause; *if*-clause is in a separate sentence that is not correctly punctuated, causing a sentence fragment
	Pattern 2: *if*-clauses and results clauses are reversed
	Pattern 2, using modal *can* in the *if*-clause
	Pattern 2, using present in the *if*-clause and future in the result clause (no variation although the *where* phrases are confusing)

C. Review the sentences again and put a star beside the ones that are either questions or that contain the word *question*

D. Working with a partner, write conditional sentences (using either standard verb tense patterns or variations) about self-driving cars based on the topics below. You will use conditional sentences when you write your Final Assignment.

1 Simplified national-level regulations for self-driving cars in the United States

_____

_____

2 More national-level laws about data protection in the United States

_____

_____

3 Greater public acceptance of autonomous vehicles

_____

_____

4 More clarity about how self-driving cars will make decisions in no-win situations

_____

_____

E. When you have finished, share your best sentences with your class.

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The Social Life of Autonomous Cars

The author reports on observations made during a study based on video analysis of self-driving cars. The videos reveal that human drivers and autonomous vehicles don't always interpret traffic conditions in the same way.

VOCABULARY BUILD

A. Select the best words from the box to replace the bolded key words in the sentences.

> ~~adapting~~   authorities   cease   corpus   functions   insufficient
>
> interpret   revelation

1 These videos reveal some of the challenges of **modifying** _____*adapting*_____ autonomous cars to human social activity on the road.

2 Although the Google car edges forward, the motion is **inadequate**

_____ to signal an urgency to proceed.

3 We collected a **group** _____ of ninety-three video clips— totalling 10.5 hours—recorded in the US, the UK, Germany, France, Sweden, Hong Kong, Iceland, and Canada.

4 Human drivers also **infer** _____ other drivers' inaction.

5 Hours after the video appeared on YouTube, California **regulators**

_____ forced Uber to **stop** _____ testing until it had obtained proper permits.

6 Perhaps the most interesting **surprise** _____ comes from interactions between such cars and other drivers.

7 Cars such as the Tesla Model S and the Volvo XC90 now feature advanced

self-driving **abilities** _____, with tens of thousands of these vehicles on roads worldwide and more appearing every year.

Before You Read

When we think of autonomous cars, we envision a future where all cars are self-driving—where all vehicles will be programmed to understand when to stop or proceed, accelerate or decelerate, and maintain or change lanes. However, in reality, as we move toward this ideal future, human-driven cars will share the road for many decades with semi-autonomous and autonomous cars. Automakers and researchers anticipate that this transition phase will cause some challenges. Humans will not share the programmed understanding of self-driving cars, and the human drivers may not make predictable driving decisions.

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A. Working in a small group, consider the following driving situations. Take point-form notes on your thoughts about possible problems.

SITUATIONS	HUMAN-DRIVEN VEHICLES	AUTONOMOUS VEHICLES	POSSIBLE PROBLEMS
1. Three cars: In car 1, the human driver sees car 3 entering the highway up ahead. Car 2 (self-driving) needs to change lanes to make room for car 3.	In car 1, the human driver politely leaves space for car 2 (self-driving) to move into.	Car 2 (self-driving) doesn't interpret the car 1 human behaviour as an opportunity to change lanes	*Human driver will be frustrated by the lack of response from the autonomous car. If car 2 changes lanes after a hesitation, it might cut car 1 off.*
2. Three cars: Cars 1 and 2 are self-driving and waiting at a stoplight. They leave a big space between them for safety. In car 3, the human driver wants to move into the same lane as cars 1 and 2.	The human in car 3 sees a big space between cars 1 and 2.	Cars 1 and 2 continue to leave a big space between them.	
3. Two cars: Cars are waiting at a stop sign. Car 1 is a self-driving vehicle and should move through the intersection first. Car 2 is human driven.	The car 2 driver is waiting for car 1 to move through the intersection.	Car 1 is programmed to roll forward cautiously to signal intention to move through the intersection.	
4. Two cars: There is an accident on the road ahead. Car 1 (self-driving) slows down for safety.	The human driver in car 2 wants to move more quickly to pass the accident.	Car 1 proceeds slowly.	

B. When you have finished, discuss the possible problems your group identified with the class.

C. Do you believe that autonomous cars should be identified in some way so that human drivers can recognize them? Why? Discuss your answer with a partner.

While You Read

D. As you read, you will come across the three situations described above in task A and their outcomes. For each situation, write what actually happened.
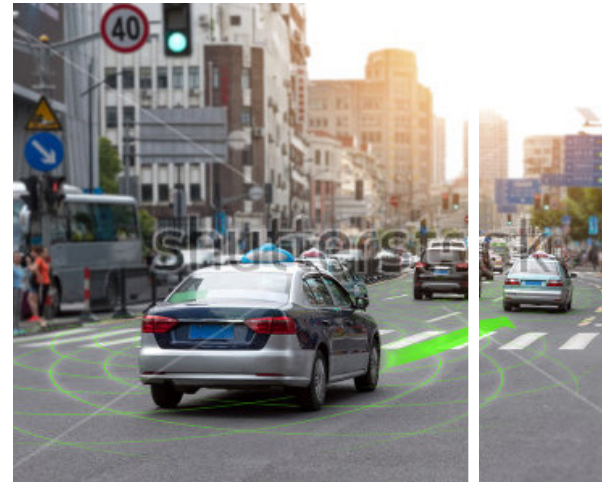
SITUATION	ACTUAL OUTCOME
1	

SITUATION	ACTUAL OUTCOME
2	
3	

The Social Life of Autonomous Cars

Until the day comes when all vehicles are fully autonomous, self-driving cars must be more than safe and efficient—they must also understand and interact naturally
5 *with human drivers.*

Cars such as the Tesla Model S and the Volvo XC90 now feature advanced self-driving **functions**, with tens of thousands of these vehicles on roads worldwide and
10 more appearing every year. In addition, Tesla and other companies like Delphi and Google are testing fully autonomous cars, which have travelled millions of miles on American roads.

15 We're in the midst of a global field test of autonomous driving technology, yet results from these tests are proprietary, with little publicly available data. Occasionally, flaws in the technology are exposed by videos taken by in-car **dashcams** and passengers' mobile phones and uploaded to social media sites like YouTube, prompting media discussion and sometimes controversy. For example, in December 2016, on the first
20 day of a trial launch of a fleet of Uber self-driving cars with human monitors in San Francisco, a motorist's dashcam captured one such car driving through a red light and narrowly missing a pedestrian. Hours after the video appeared on YouTube, California **authorities** forced Uber to **cease** testing until it had obtained proper permits (Rodriquez, 2016).

25 At Stockholm University, we've developed a new method that provides a quick, partial view of self-driving systems using public videos (Brown & Laurier, 2017). These videos reveal some of the challenges of **adapting** autonomous cars to human social activity on the road.

Repurposing Online Videos

30 YouTube is the world's largest **repository** of **third-party** videos. For our first study, we used a range of terms to search this repository for clips involving both semi-autonomous cars with driver-assistance functionality and fully autonomous test cars. We mostly excluded promotional videos and instead focused on reviews and travelogues, many of which contain long stretches of silent driving and commentaries
35 on system actions.

dashcam (n.): camera placed on the dashboard of a car to record what happens on the road ahead

repository (n.): space in which large quantities of things are stored

third-party (n., used as adj.): someone who is not one of the main two people involved

We collected a **corpus** of ninety-three video clips—totalling 10.5 hours—recorded in the US, the UK, Germany, France, Sweden, Hong Kong, Iceland, and Canada. The average length is nine minutes, with seven of the clips over thirty minutes. Most illustrate Tesla's driver-assistance
40 system, Autopilot, and three show similar systems in the Volvo XC90 and a Honda Civic. Nine videos, totalling eleven minutes, recorded Google's self-driving cars. In addition, a South by Southwest (SXSW) presentation on the Google project shows several interesting incidents.

The Social Road

45 We drew upon well-established linguistic and sociological methods that analyze unobtrusive video recordings of humans to better understand driving behaviour and some of the potential problems posed by autonomous vehicles. Perhaps the most interesting **revelation** comes from interactions between such cars and other drivers …

50 In the YouTube videos we collected, most of the time Autopilot drives without incident. Yet, due to its simple mechanics, Autopilot sometimes misunderstands other drivers' actions. While people can often discern other drivers' intentions as well as mood or character—aggressive, hesitant, selfish, unpredictable, and so on—based on changes (or the absence of changes) in their car's speed, direction, and so on, Autopilot lacks
55 this ability.

Consider, for example, this fairly common situation. On a divided highway with two lanes in each direction, a Tesla driver is in the right lane in heavy traffic. Ahead on his right he sees a pickup truck merging onto the highway from a connector road. The Tesla driver activates his left-turn signal, indicating his desire to move to the left
60 lane to make room for the truck. A driver in a silver car approaching from behind in the left lane sees the signal and stops accelerating, offering a space for the Tesla driver to enter. Autopilot, however, doesn't recognize this polite "gesture" and continues to maintain the Tesla's position. The silver car's driver, concluding that the Tesla driver has rejected the offer, starts accelerating again. Autopilot, determining the lane change
65 to still be safe, directs the Tesla to move over.

The action produced by the Tesla's robotic coordination might not "bother" another autonomous driving system, but the silver car's driver understandably perceives this as doubly rude: the Tesla driver first apparently rejects his offer and then cuts in front of him at the last second. The Tesla driver acknowledges this rudeness in the video:
70 "Well, we pulled in ahead of that guy and from what I saw it wasn't something he was exactly encouraging."

This example demonstrates that, even if autonomous cars can be safe and reliable, they fail to recognize the social nature of the road. Human drivers aren't always "in tune" with one another, but they're not just algorithmic agents—in most cases they
75 can detect the same kind of subtle cues that we exhibit in personal interactions.

Seeing a Gap as Just a Gap

In addition to not understanding what others on the road are doing, autonomous driving systems have trouble recognizing what their own actions might communicate to human drivers. In this example, a human driver crosses a four-lane highway and
80 then enters a left-turn lane just before an intersection, squeezing his red vehicle in the narrow space between two self-driving cars …

Yet, while the human driver might not show the best judgment, his behaviour is understandable. As drivers, we learn the importance of maintaining a safe distance behind the car ahead. This principle is likewise incorporated into autonomous driving systems. In this case, the second self-driving car slowly approaches the intersection and leaves a gap between itself and the first self-driving car. However, as the Tesla example shows, gaps in the road aren't just safe following distances—they can also be **interpreted** by other drivers as offers to enter the space. The human driver might have perceived the gap between the self-driving cars as such an offer.

The driver might also simply have tried to force his way in. People don't always drive sensibly or legally, especially in situations that can lead to anger or confusion such as in construction zones or heavy traffic. On busy roadways, some drivers will exploit any space they can find. In this case, the self-driving car approaching the intersection dealt with the human driver's action appropriately, slowing down and allowing the red vehicle to enter the space.

Sometimes It's Good to Be a Creep

Human drivers also interpret other drivers' *inaction.* This too can cause problems for autonomous driving systems … In this example, a Google self-driving car arrives at a four-way stop just before a driver in a white car on the cross street. Research on four-way stops underlines the importance of creeping into the intersection to let other drivers know that you're attentive to the situation and ready to take your turn. Although the Google car edges forward, the motion is **insufficient** to signal an urgency to proceed. The driver on the cross street interprets this as hesitation and accordingly moves into the intersection first. This causes the Google car to brake abruptly, much like a novice driver, which in turn causes the driver behind to also stop quickly to avoid a rear-end collision.

Our videos also show drivers, apparently annoyed by the Google car's slowness, **tailgating** the vehicle to "urge" it forward through intersections.

tailgating (v.): driving too close to the back of the car in front

Conclusion

My goal here isn't to critique the current generation of self-driving cars, which are still in the early stages of development. Rather, it's to point out that driving isn't just a mechanical operation but also a complex social activity. Until the day comes when all vehicles are fully autonomous, self-driving cars must be more than safe and efficient—they must also understand and interact naturally with human drivers. So long as most vehicles on the roadway continue to be operated by people, self-driving car designers must consider how their choices impact other drivers as well as their own vehicles' passengers. If not, the social road could get a lot bumpier.

(1300 words)

References

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Rodriguez, J. F. (2016, December 14). Video appears to show Uber self-driving car running red light in SF. *San Francisco Examiner.* Retrieved from www.sfexaminer.com/uber-self-driving-vehicle-appears-launch-red-light-first-day-sf

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After You Read

E. Indicate whether the following statements are true or false. For each false statement, write a true one on a separate page. Share your answers with the class.

STATEMENTS	TRUE	FALSE
1 There are many companies testing self-driving cars, and the results are easily accessible to the public.		
2 Sometimes people notice autonomous cars in test conditions and record the pilot test by dashcam.		
3 In a pilot test of Uber's self-driving cars, a dashcam (belonging to a human driver) recorded one of the autonomous vehicles nearly hitting a pedestrian.		
4 Authorities allowed Uber to continue with the pilot test.		
5 For this study, the author used ninety-three videos of autonomous and semi-autonomous cars uploaded to YouTube.		
6 The videos were recorded by drivers in other autonomous cars.		
7 Self-driving cars are very good at determining the mood of human drivers.		
8 Human drivers may interpret safe distances between autonomous cars as opportunities to move into a lane.		
9 Autonomous cars are programmed to be cautious at four-way stop intersections. Human drivers may misinterpret this caution.		
10 If human drivers knew that another car was autonomous, they would slow down and give the car plenty of room.		

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Exercises > Chapter 5 >
The Social Life of Autonomous Cars

F. With the class, discuss the following question: Do you believe that driving is a simple mechanical operation or a complex social activity?

FOCUS ON CRITICAL THINKING

Identifying Causes and Effects

Now that you have read the three texts in this chapter, you have a good understanding of the technological and regulatory challenges (from Reading 1), the moral issues (from Reading 2), and the complex social interactions (from Reading 3) related to self-driving cars. As you prepare to write your Final Assignment, it will be useful for you to think critically about what it will take for people to adopt self-driving cars.

A. Work in a small group to brainstorm conditions that would have to exist for self-driving cars to replace conventional cars. On a separate page and using the table below as a model, list those conditions in the first column. In the third column, brainstorm conditions that would lead to self-driving cars not being successful.

CONDITIONS ➜ (CAUSES)	POSITIVE EFFECT	CONDITIONS ➜ (CAUSES)	NEGATIVE EFFECT
• *Fuel prices rise.*	Self-driving cars (which should use less gas) replace conventional cars.	• *A new technology is developed that is more appealing than self-driving cars.*	Self-driving cars are not successful.

FINAL ASSIGNMENT

Write an Extended Cause and Effect Essay

A cause and effect essay explains how conditions (or causes) influence outcomes (or effects). Like many essays, a cause and effect essay starts with an introduction (that includes a thesis statement) and ends with a conclusion. The body of the essay presents the various causes and their possible effects. You worked as a group to brainstorm possible causes and effects in Focus on Critical Thinking. Now, work on your own to write a cause and effect essay that responds to this question:

> What technological, moral, and social variables (causes) will influence the adoption (effect) of self-driving cars?

A. Integrate the summary you wrote in the Warm-Up Assignment (page 154). Include paraphrases and summaries (as appropriate) from the three readings. Write accurate in-text citations and references to document which information comes from which source.

B. As you write, use modals and specific vocabulary to help you express uncertainty. Write conditional sentences (using both standard verb patterns and variations) to show how what happens next depends on certain conditions.

Refer to the Models Chapter (page xxx) to see an example of a cause and effect essay and to learn more about how to write one.

Critical Connections

Thinking critically about causes and effects can be a good way to generate new knowledge and deepen your understanding of issues. In this chapter, you carefully considered the causes that might affect the success of self-driving cars. Now apply this new way of thinking to other issues to gain new insights.

A. Work with a small group to identify the causes that will determine the success (or lack of success) of one or two of the following initiatives. For each initiative, replicate the table from Focus on Critical Thinking to record your ideas. When you have finished, share your ideas with your class.

Initiatives:
- Development of a global language such as Esperanto
- Widespread use of drones for agriculture
- Development of ultra-private smartphones
- Possibility of "smart" wind and solar power
- Development of a global curriculum
- Ability to print in 3-D using a material other than plastic
- Ability to transport vaccines without requiring cold storage
- Widespread adoption of instantaneous translation technology, making language learning obsolete