LEARNING MADE EASY

2nd Edition

# Machine Learning

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Learn how machine learning algorithms are invaluable

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**John Paul Mueller**

**Luca Massaron**

Bestselling authors of the first edition

# Machine Learning

2nd Edition

**by John Paul Mueller and Luca Massaron**

for dummies®
A Wiley Brand

## Machine Learning For Dummies®, 2nd Edition

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# Introduction

The term *machine learning* has all sorts of meanings attached to it today, especially after Hollywood (and other movie studios) have gotten into the picture. Films such as *Ex Machina* have tantalized the imaginations of moviegoers the world over and made machine learning into all sorts of things that it really isn't. Of course, most of us have to live in the real world, where machine learning actually does perform an incredible array of tasks that have nothing to do with androids that can pass the Turing Test (fooling their makers into believing they're human). *Machine Learning For Dummies*, 2nd Edition gives you a view of machine learning in the real world and exposes you to the amazing feats you really can perform using this technology.

Even though the tasks that you perform using machine learning may seem a bit mundane when compared to the movie version, by the time you finish this book, you realize that these mundane tasks have the power to impact the lives of everyone on the planet in nearly every aspect of their daily lives. In short, machine learning is an incredible technology — just not in the way that some people have imagined.

This second edition of the book contains a significant number of changes, not the least of which is that it's using pure Python code for the examples now upon request from our readers. You can still download R versions of every example, which is actually better than before when only some of the examples were available in R. In addition, the book contains new topics, including an entire chapter that discusses machine learning ethics.

## About This Book

Machines and humans learn in entirely different ways, which is why the first part of this book is essential to your understanding of machine learning. Machines perform routine tasks at incredible speeds, but still require humans to do the actual thinking.

The second part of this book is about getting your system set up to use the various Python coding examples. The two setups work for desktop systems using Windows, Mac OS, or Linux, or mobile devices that have access to a Google Colab compatible browser.

TIP

If you're using R, you'll find a README file in the R download file that contains instructions for configuring your R Anaconda environment.

The third part of the book discusses math basics with regard to machine learning requirements. It prepares you to perform math tasks associated with algorithms used in machine learning to make either predictions or classifications from your data.

The fourth part of the book helps you discover what to do about data that isn't quite up to par. This part is also where you start learning about similarity and working with linear models. The most advanced chapter tells you how to work with ensembles of learners to perform tasks that might not otherwise be reasonable to complete.

The fifth part of the book is about practical application of machine learning techniques. You see how to do things like classify images, work with opinions and sentiments, and recommend products and movies.

The last part of the book contains helpful information to enhance your machine learning experience. This part of the book also contains a chapter specifically oriented toward ethical data use.

To make absorbing the concepts easy, this book uses the following conventions:

- Text that you're meant to type just as it appears in the book is in **bold**. The exception is when you're working through a step list: Because each step is bold, the text to type is not bold.
- Web addresses and programming code appear in `monofont`. If you're reading a digital version of this book on a device connected to the Internet, you can click or tap the web address to visit that website, like this: `https://www.dummies.com`.
- When you need to type command sequences, you see them separated by a special arrow, like this: File ➪ New File. In this example, you go to the File menu first and then select the New File entry on that menu.
- When you see words in *italics* as part of a typing sequence, you need to replace that value with something that works for you. For example, if you see "Type ***Your Name*** and press Enter," you need to replace *Your Name* with your actual name.

# Foolish Assumptions

This book is designed for novice and professional alike. You can either read this book from cover to cover or look up topics and treat the book as a reference guide. However, we've made some assumptions about your level of knowledge when we put the

book together. You should already know how to use your device and work with the operating system that supports it. You also know how to perform tasks like downloading files and installing applications. You can interact with Internet well enough to locate the resources you need to work with the book. You know how to work with archives, such as the `.zip` file format. Finally, a basic knowledge of math is helpful.

# Icons Used in This Book

As you read this book, you see icons in the margins that indicate material of interest. This section briefly describes each icon.


TIP

The tips in this book are time-saving techniques or pointers to resources that you should try so that you can get the maximum benefit from machine learning.


WARNING

You should avoid doing anything that's marked with a Warning icon. Otherwise, you might find that your application fails to work as expected, you get incorrect answers from seemingly bulletproof code, or (in the worst-case scenario) you lose data.


TECHNICAL STUFF

Whenever you see this icon, think advanced tip or technique. Skip these bits of information whenever you like.


REMEMBER

This text usually contains an essential process or a bit of information that you must know to perform machine learning tasks successfully.

# Beyond the Book

If you want to email us, please do! Make sure you send your book-specific requests to: `John@JohnMuellerBooks.com`. We want to ensure that your book experience is the best one possible. The blog entries at `http://blog.johnmuellerbooks.com/` contain a wealth of additional information about this book. You can check out John's website at `http://www.johnmuellerbooks.com/`. You can also access other cool materials:

- **Cheat Sheet:** A cheat sheet provides you with some special notes on things you can do with machine learning that not every other scientist knows. You can find the Cheat Sheet for this book at `www.dummies.com`. Type **Machine Learning For Dummies** in the Search box and click the Cheat Sheets option that appears.

- **Errata:** You can find errata by entering this book's title in the Search box at www.dummies.com, which takes you to this book's page. In addition to errata, check out the blog posts with answers to reader questions and demonstrations of useful book-related techniques at http://blog.johnmuellerbooks.com/.
- **Companion files:** The source code is available for download. All the book examples tell you precisely which example project to use. You can find these files at this book's page at www.dummies.com/go/machinelearningfd2e.

  We've also had trouble with the datasets used in the previous edition of this book. Sometimes the datasets change or might become unavailable. Given that you likely don't want to download a large dataset unless you're interested in that example, we've made the non-toy datasets (those available with a package) available at https://github.com/lmassaron/datasets. You don't actually need to download them, though; the example code will perform that task for you automatically when you run it.

# Where to Go from Here

Most people will want to start this book from the beginning, because it contains a good deal of information about how the real world view of machine learning differs from what movies might tell you. However, if you already have a first grounding in the reality of machine learning, you can always skip to the next part of the book.

Chapter 4 is where you want to go if you want to use a desktop setup, while Chapter 6 is helpful when you want to use a mobile device. Your preexisting setup may not work with the book's examples because you might have different versions of the various products. It's essential that you use the correct product versions to ensure success. Even if you choose to go with your own setup, consider reviewing Chapter 5 unless you're an expert Python coder already.

If you're already an expert with Python and know how machine learning works, you could always skip to Chapter 7. Starting at Chapter 7 will help you get into the examples quickly so that you spend less time with basics and more time with intermediate machine learning tasks. You can always go back and review the previous materials as needed.

# 1

# Introducing How Machines Learn

**IN THIS PART . . .**

Discovering how AI really works and what it can do for you

Considering what the term *big data* means

Understanding the role of statistics in machine learning

Defining where machine learning will take society in the future

IN THIS CHAPTER

- Seeing the dream; getting beyond the hype of artificial intelligence (AI)
- Comparing AI to machine learning
- Understanding the engineering portion of AI and machine learning
- Delineating where engineering ends and art begins

# Chapter 1
# Getting the Real Story about AI

*Artificial Intelligence (AI)*, the appearance of intelligence in machines, is a huge topic today, and it's getting bigger all the time thanks to the success of new technologies (see some current examples at `https://thinkml.ai/top-5-ai-achievements-of-2019/`). However, most people are looking for everyday applications, such as talking to their smartphone. Talking to your smartphone is both fun and helpful to find out things like the location of the best sushi restaurant in town or to discover how to get to the concert hall. As you talk to your smartphone, it learns more about the way you talk and makes fewer mistakes in understanding your requests. The capability of your smartphone to learn and interpret your particular way of speaking is an example of an AI, and part of the technology used to make it happen is *machine learning*, the use of various techniques to allow algorithms to work better based on experience.

You likely make limited use of machine learning and AI all over the place today without really thinking about it. For example, the capability to speak to devices and have them actually do what you intend is an example of machine learning at work. Likewise, recommender systems, such as those found on Amazon, help you make purchases based on criteria such as previous product purchases or products that complement a current choice. The use of both AI and machine learning will only increase with time.

In this chapter, you delve into AI and discover what it means from several perspectives, including how it affects you as a consumer and as a scientist or engineer. You also discover that AI doesn't equal machine learning, even though the media often confuse the two. Machine learning is definitely different from AI, even though the two are related.

# Moving beyond the Hype

As any technology becomes bigger, so does the hype, and AI certainly has a lot of hype surrounding it. For one thing, some people have decided to engage in fear mongering rather than science. Killer robots, such as those found in the film *The Terminator*, really aren't going to be the next big thing. Your first real experience with an android AI is more likely to be in the form a health care assistant (`https://www.robotics.org/blog-article.cfm/The-Future-of-Elder-Care-is-Service-Robots/262`) or possibly as a coworker (`https://www.computerworld.com/article/2990849/meet-the-virtual-woman-who-may-take-your-job.html`). The reality is that you interact with AI and machine learning in far more mundane ways already. Part of the reason you need to read this chapter is to get past the hype and discover what AI can do for you today.

REMEMBER

You may also have heard machine learning and AI used interchangeably. AI includes machine learning, but machine learning doesn't fully define AI. This chapter helps you understand the relationship between machine learning and AI so that you can better understand how this book helps you move into a technology that used to appear only within the confines of science fiction novels.

Machine learning and AI both have strong engineering components. That is, you can quantify both technologies precisely based on *theory* (substantiated and tested explanations) rather than simply *hypothesis* (a suggested explanation for a phenomenon). In addition, both have strong science components, through which people test concepts and create new ideas of how expressing the thought process might be possible. Finally, machine learning also has an artistic component, and this is where a talented scientist can excel. In some cases, AI and machine learning both seemingly defy logic, and only the true artist can make them work as expected.

### YES, FULLY AUTONOMOUS WEAPONS EXIST

Before people send us their latest dissertations about fully autonomous weapons, yes, some benighted souls are working on such technologies. You'll find some discussions of the ethics of AI in this book, but for the most part, the book focuses on positive, helpful uses of AI to aid humans, rather than kill them, because most AI research reflects these uses. You can find articles on the pros and cons of AI online, such as the Towards Data Science article at `https://towardsdatascience.com/advantages-and-disadvantages-of-artificial-intelligence-182a5ef6588c` and the *Emerj* article at `https://emerj.com/ai-sector-overviews/autonomous-weapons-in-the-military/`.

If you really must scare yourself, you can find all sorts of sites, such as `https://www.reachingcriticalwill.org/resources/fact-sheets/critical-issues/7972-fully-autonomous-weapons`, that discuss the issue of fully autonomous weapons in some depth. Sites such as Campaign to Stop Killer Robots (`https://www.stopkillerrobots.org/`) can also fill in some details for you. We do encourage you to sign the letter banning autonomous weapons at `https://futureoflife.org/open-letter-autonomous-weapons/` — there truly is no need for them.

However, it's important to remember that bans against space-based, chemical, and certain laser weapons all exist. Countries recognize that these weapons don't solve anything. Countries will also likely ban fully autonomous weapons simply because the citizenry won't stand for killer robots. The bottom line is that the focus of this book is on helping you understand machine learning in a positive light.

## Dreaming of Electric Sheep

*Androids* (a specialized kind of robot that looks and acts like a human, such as Data in *Star Trek: The Next Generation*) and some types of *humanoid robots* (a kind of robot that has human characteristics but is easily distinguished from a human, such as C-3PO in *Star Wars*) have become the poster children for AI (see the dancing robots at `https://www.youtube.com/watch?v=1TckiTBaWkw`). They present computers in a form that people can *anthropomorphize* (give human characteristics to, even though they aren't human). In fact, it's entirely possible that one day you won't be able to distinguish between human and artificial life with ease. Science fiction authors, such as Philip K. Dick, have long predicted such an occurrence, and it seems all too possible today. The story "Do Androids Dream of Electric Sheep?" discusses the whole concept of more real than real. The idea appears as part of the plot in the movie *Blade Runner* (`https://www.warnerbros.com/movies/blade-runner`). However, some uses of robots today are just plain fun, as in the

Robot Restaurant show at https://www.youtube.com/watch?v=l1vvTtz8hpg. The sections that follow help you understand how close technology currently gets to the ideals presented by science fiction authors and the movies.


TECHNICAL STUFF

The current state of the art is lifelike, but you can easily tell that you're talking to an android. Viewing videos online can help you understand that androids that are indistinguishable from humans are nowhere near any sort of reality today. Check out the Japanese robots at https://www.youtube.com/watch?v=LyyytwT-BMk and https://www.cnbc.com/2019/10/31/human-like-androids-have-entered-the-workplace-and-may-take-your-job.html. One of the more lifelike examples is Erica (https://www.youtube.com/watch?v=oRlwvLubFxg), who is set to appear in a science fiction film. Her story appears on *HuffPost* at https://www.huffpost.com/entry/erica-japanese-robot-science-fiction-film_n_5ef6523dc5b6acab284181c3. The point is, technology is just starting to get to the point where people may eventually be able to create lifelike robots and androids, but they don't exist today.

## Understanding the history of AI and machine learning

There is a reason, other than anthropomorphization, that humans see the ultimate AI as one that is contained within some type of android. Ever since the ancient Greeks, humans have discussed the possibility of placing a mind inside a mechanical body. One such myth is that of a mechanical man called Talos (http://www.ancient-wisdom.com/greekautomata.htm). The fact that the ancient Greeks had complex mechanical devices, only one of which still exists (read about the Antikythera mechanism at http://www.ancient-wisdom.com/antikythera.htm), makes it quite likely that their dreams were built on more than just fantasy. Throughout the centuries, people have discussed mechanical persons capable of thought (such as Rabbi Judah Loew's Golem, https://www.nytimes.com/2009/05/11/world/europe/11golem.html).

AI is built on the hypothesis that mechanizing thought is possible. During the first millennium, Greek, Indian, and Chinese philosophers all worked on ways to perform this task. As early as the seventeenth century, Gottfried Leibniz, Thomas Hobbes, and René Descartes discussed the potential for rationalizing all thought as simply math symbols. Of course, the complexity of the problem eluded them (and still eludes us today, despite the advances you read about in Part 3 of this book). The point is that the vision for AI has been around for an incredibly long time, but the implementation of AI is relatively new.

The true birth of AI as we know it today began with Alan Turing's publication of "Computing Machinery and Intelligence" in 1950 (https://www.csee.umbc.

edu/courses/471/papers/turing.pdf). In this paper, Turing explored the idea of how to determine whether machines can think. Of course, this paper led to the Imitation Game involving three players. Player A is a computer and Player B is a human. Each must convince Player C (a human who can't see either Player A or Player B) that they are human. If Player C can't determine who is human and who isn't on a consistent basis, the computer wins.

A continuing problem with AI is too much optimism. The problem that scientists are trying to solve with AI is incredibly complex. However, the early optimism of the 1950s and 1960s led scientists to believe that the world would produce intelligent machines in as little as 20 years. After all, machines were doing all sorts of amazing things, such as playing complex games. AI currently has its greatest success in areas such as logistics, data mining, and medical diagnosis.

## Exploring what machine learning can do for AI

Machine learning relies on algorithms to analyze huge datasets. Currently, machine learning can't provide the sort of AI that the movies present. Even the best algorithms can't think, feel, present any form of self-awareness, or exercise free will. What machine learning can do is perform predictive analytics far faster than any human can. As a result, machine learning can help humans work more efficiently. The current state of AI, then, is one of performing analysis, but humans must still consider the implications of that analysis — making the required moral and ethical decisions. The "Considering the Relationship between AI and Machine Learning" section of this chapter delves more deeply into precisely how machine learning contributes to AI as a whole. The essence of the matter is that machine learning provides just the learning part of AI, and that part is nowhere near ready to create an AI of the sort you see in films.

REMEMBER

The main point of confusion between learning and intelligence is that people assume that simply because a machine gets better at its job (learning) it's also aware (intelligence). Nothing supports this view of machine learning. The same phenomenon occurs when people assume that a computer is purposely causing problems for them. The computer can't assign emotions and therefore acts only upon the input provided and the instruction contained within an application to process that input. A true AI will eventually occur when computers can finally emulate the clever combination used by nature:

- **Genetics:** Slow learning from one generation to the next
- **Teaching:** Fast learning from organized sources
- **Exploration:** Spontaneous learning through media and interactions with others

## Considering the goals of machine learning

At present, AI is based on machine learning, and machine learning is essentially different from statistics. Yes, machine learning has a statistical basis, but it makes some different assumptions than statistics do because the goals are different. Table 1-1 lists some features to consider when comparing AI and machine learning to statistics.

**TABLE 1-1:** Comparing Machine Learning to Statistics

| Technique | Machine Learning | Statistics |
|---|---|---|
| Data handling | Works with big data in the form of networks and graphs; raw data from sensors or the web text is split into training and test data. | Models are used to create predictive power on small samples. |
| Data input | The data is sampled, randomized, and transformed to maximize accuracy scoring in the prediction of out-of-sample (or completely new) examples. | Parameters interpret real-world phenomena and provide a stress on magnitude. |
| Result | Probability is taken into account for comparing what could be the best guess or decision. | The output captures the variability and uncertainty of parameters. |
| Assumptions | The scientist learns from the data. | The scientist assumes a certain output and tries to prove it. |
| Distribution | The distribution is unknown or ignored before learning from data. | The scientist assumes a well-defined distribution. |
| Fitting | The scientist creates a best fit, but generalizable, model. | The result is fit to the present data distribution. |

## Defining machine learning limits based on hardware

Huge datasets require huge amounts of memory. Unfortunately, the requirements don't end there. When you have huge amounts of data and memory, you must also have processors with multiple cores and high speeds. One of the problems that scientists are striving to solve is how to use existing hardware more efficiently. In some cases, waiting for days to obtain a result to a machine learning problem simply isn't possible. The scientists who want to know the answer need it quickly, even if the result isn't quite right. With this in mind, investments in better hardware also require investments in better science. This book considers some of the following issues as part of making your machine learning experience better:

- **Obtaining a useful result:** As you work through the book, you discover that you need to obtain a useful result first, before you can refine it. In addition, sometimes tuning an algorithm goes too far and the result becomes quite fragile (and possibly useless outside a specific dataset).
- **Asking the right question:** Many people get frustrated in trying to obtain an answer from machine learning because they keep tuning their algorithm without asking a different question. To use hardware efficiently, sometimes you must step back and review the question you're asking. The question might be wrong, which means that even the best hardware will never find the answer.
- **Relying on intuition too heavily:** All machine learning questions begin as a hypothesis. A scientist uses intuition to create a starting point for discovering the answer to a question. Failure is more common than success when working through a machine learning experience. Your intuition adds the art to the machine learning experience, but sometimes intuition is wrong and you have to revisit your assumptions.


When you begin to realize the importance of environment to machine learning, you can also begin to understand the need for the right hardware and in the right balance to obtain a desired result. The current state-of-the-art systems actually rely on Graphical Processing Units (GPUs) to perform machine learning tasks. Relying on GPUs does speed the machine learning process considerably. A full discussion of using GPUs is outside the scope of this book, but you can read more about the topic at `https://devblogs.nvidia.com/parallelforall/bidmach-machine-learning-limit-gpus/` and `https://towardsdatascience.com/what-is-a-gpu-and-do-you-need-one-in-deep-learning-718b9597aa0d`.

# Overcoming AI Fantasies

As with many other technologies, AI and machine learning both have their fantasy or fad uses. For example, some people are using machine learning to create Picasso-like art from photos using products like NightCafé (`https://creator.nightcafe.studio/`), which supports people who really enjoy this art form. You can read all about using machine learning to create art at `https://www.washingtonpost.com/news/innovations/wp/2015/08/31/this-algorithm-can-create-a-new-van-gogh-or-picasso-in-just-an-hour/`. Of course, the problems with such use are many. For one thing, most people wouldn't really want a Picasso created in this manner except as a fad item (because no one had done it before). The point of art isn't in creating an interesting interpretation of a particular real-world representation, but rather in seeing how the artist interpreted it. The end of the article points out that the computer can only copy an

existing style at this stage — not create an entirely new style of its own. The following sections discuss AI and machine learning fantasies of various sorts.

## Discovering the fad uses of AI and machine learning

AI is entering an era of innovation that you used to read about only in science fiction. It can be hard to determine whether a particular AI use is real or simply the dream child of a determined scientist. For example, *The Six Million Dollar Man* (https://en.wikipedia.org/wiki/The_Six_Million_Dollar_Man) is a television series that looked fanciful at one time. When it was introduced, no one actually thought that we'd have real-world bionics at some point. However, Hugh Herr (https://www.smithsonianmag.com/innovation/future-robotic-legs-180953040/) and others (https://www.fiercebiotech.com/medtech/using-onboard-ai-to-power-quicker-more-complex-prosthetic-hands) have other ideas — bionic legs and arms really are possible now. Of course, they aren't available for everyone yet; the technology is only now becoming useful. Muddying the waters is *The Six Billion Dollar Man* movie, based partly on *The Six Million Dollar Man* television series (https://www.cinemablend.com/new/Mark-Wahlberg-Six-Billion-Dollar-Man-Just-Made-Big-Change-91947.html), which has suffered delays for various reasons (https://screenrant.com/mark-wahlberg-six-billion-dollar-man-delays-updates/). The fact is that AI and machine learning will both present opportunities to create some amazing technologies and that we're already at the stage of creating those technologies, but you still need to take what you hear with a huge grain of salt.

One of the more interesting uses of machine learning for entertainment purposes is the movie *B* (https://www.cinemablend.com/news/2548939/one-sci-fi-movie-will-be-able-to-film-during-the-pandemic-thanks-to-casting-an-ai-robot-as-its-lead), which stars an android named Erica. The inventors of Erica, Hiroshi Ishiguro and Kohei Ogawa, have spent a great deal of time trying to make her lifelike by trying to implement the human qualities of intent and desire (https://www.yoichimatsuyama.com/conversation-with-evolving-robotic-species-interview-with-hiroshi-ishiguro/). The result is something that encroaches on the uncanny valley (https://www.scientificamerican.com/article/why-uncanny-valley-human-look-alikes-put-us-on-edge/) in a new way. The plot of this movie will be on the same order as *Ex Machina* (https://www.indiewire.com/2020/06/ex-machina-real-robot-erica-science-fiction-movie-1234569484/).

REMEMBER

To make the future uses of AI and machine learning match the concepts that science fiction has presented over the years, real-world programmers, data scientists, and other stakeholders need to create tools. Nothing happens by magic, even though it may look like magic when you don't know what's happening behind the scenes. In order for the fad uses for AI and machine learning to become real-world uses, developers, data scientists, and others need to continue building real-world tools that may be hard to imagine at this point.

## Considering the true uses of AI and machine learning

You find AI and machine learning used in a great many applications today. The only problem is that the technology works so well that you don't know that it even exists. In fact, you might be surprised to find that many devices in your home already make use of both technologies. Both technologies definitely appear in your car and most especially in the workplace. In fact, the uses for both AI and machine learning number in the millions — all safely out of sight even when they're quite dramatic in nature. Here are just a few of the ways in which you might see AI used:

- **Fraud detection:** You get a call from your credit card company asking whether you made a particular purchase. The credit card company isn't being nosy; it's simply alerting you to the fact that someone else could be making a purchase using your card. The AI embedded within the credit card company's code detected an unfamiliar spending pattern and alerted someone to it.
- **Resource scheduling:** Many organizations need to schedule the use of resources efficiently. For example, a hospital may have to determine where to put a patient based on the patient's needs, availability of skilled experts, and the amount of time the doctor expects the patient to be in the hospital.
- **Complex analysis:** Humans often need help with complex analysis because there are literally too many factors to consider. For example, the same set of symptoms could indicate more than one problem. A doctor or other expert might need help making a diagnosis in a timely manner to save a patient's life.
- **Automation:** Any form of automation can benefit from the addition of AI to handle unexpected changes or events. A problem with some types of automation today is that an unexpected event, such as an object in the wrong place, can actually cause the automation to stop. Adding AI to the automation can allow the automation to handle unexpected events and continue as if nothing happened.
- **Customer service:** The customer service line you call today may not even have a human behind it. The automation is good enough to follow scripts and use various resources to handle the vast majority of your questions. With

good voice inflection (provided by AI as well), you may not even be able to tell that you're talking with a computer.

- **Safety systems:** Many of the safety systems found in machines of various sorts today rely on AI to take over the vehicle in a time of crisis. For example, many automatic braking systems rely on AI to stop the car based on all the inputs that a vehicle can provide, such as the direction of a skid.
- **Machine efficiency:** AI can help control a machine in such a manner as to obtain maximum efficiency. The AI controls the use of resources so that the system doesn't overshoot speed or other goals. Every ounce of power is used precisely as needed to provide the desired services.

This list doesn't even begin to scratch the surface. You can find AI used in many other ways. However, it's also useful to view uses of machine learning outside the normal realm that many consider the domain of AI. Here are a few uses for machine learning that you might not associate with an AI:

- **Access control:** In many cases, access control is a yes or no proposition. An employee smartcard grants access to a resource much in the same way that people have used keys for centuries. Some locks do offer the capability to set times and dates that access is allowed, but the coarse-grained control doesn't really answer every need. By using machine learning, you can determine whether an employee should gain access to a resource based on role and need. For example, an employee can gain access to a training room when the training reflects an employee role.
- **Animal protection:** The ocean might seem large enough to allow animals and ships to cohabitate without problem. Unfortunately, many animals get hit by ships each year. A machine learning algorithm could allow ships to avoid animals by learning the sounds and characteristics of both the animal and the ship.
- **Predicting wait times:** Most people don't like waiting when they have no idea of how long the wait will be. Machine learning allows an application to determine waiting times based on staffing levels, staffing load, complexity of the problems the staff is trying to solve, availability of resources, and so on.

## Being useful; being mundane

Even though the movies make it sound like AI is going to make a huge splash, and you do sometimes see some incredible uses for AI in real life, the fact of the matter is that most uses for AI are mundane, even boring. For example, a recent article