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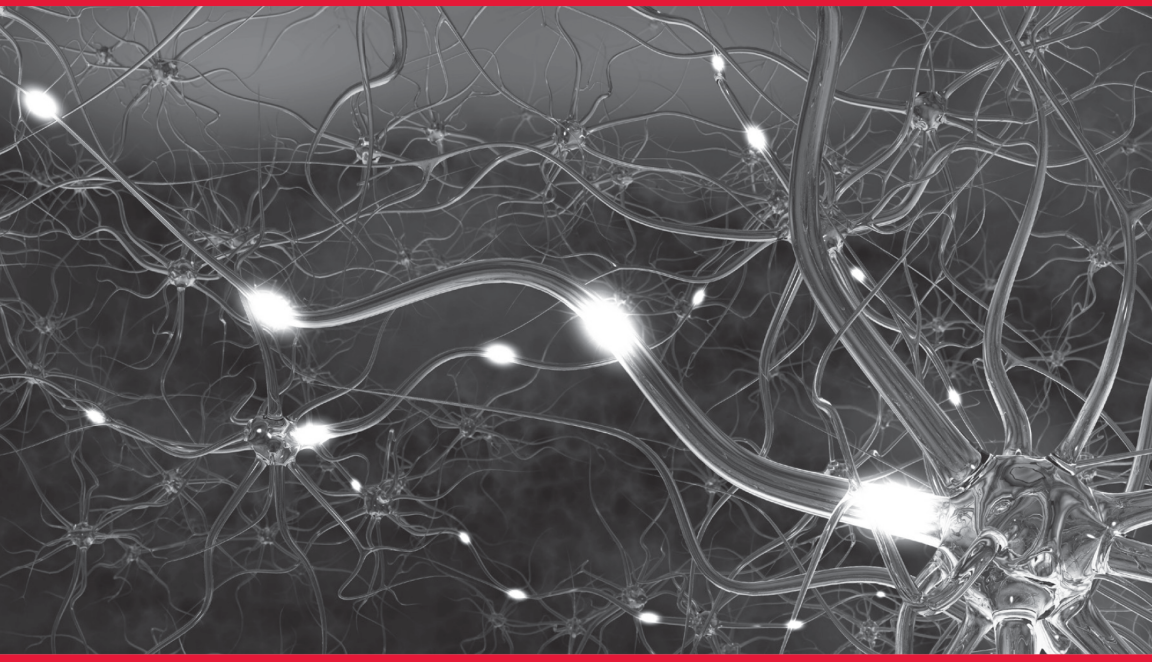

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by Jerry Overton

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CHAPTER 1

Introduction: A Simple Vision for Artificial Intelligence

Artificial intelligence (AI) is when a machine performs a task that human beings find interesting, useful, and difficult to do. The current wave of AI works by using computer models to simulate intelligent behavior. AI can drive economic growth by automating the workforce, improving efficiency, and becoming a source of product or service innovation.

The potential of AI varies by country depending on factors like the flow of information, communication infrastructure, regulatory frameworks, and public and private investment in the digital economy. The potential of AI varies by industry, depending on factors like the adoption rate of AI and the industry's investment in AI. Overall, however, AI has the potential to increase economic growth rates and boost profitability for much of the world's economy.

Every business needs an AI strategy to adapt and stay competitive. Getting access to AI technology is relatively straightforward. The difficult part is applying the technology to a specific business context. In this report, we introduce you to the simplest way to actively engage in applying AI. We help you put your organization on the path to a viable, effective use of AI. It covers ways to do the following:

- Determine where AI is useful in your organization
- Collect the data needed for AI

- Choose an AI strategy that produces useful results
- Scale up to make AI available wherever it is useful
- Check for bias and other ethical concerns

What Is AI?: A Working Definition of AI and Examples

Unfortunately, I have not found a universally accepted definition of AI. The best definition I can come up with does not get tangled in technical detail or make expansive promises, but lets us assess the role of AI in our organizations:

> AI is any program that does something that we would think of as intelligent in humans.

This definition is good enough to recognize when something is in the neighborhood of what most would consider as AI (even if we can't agree on an exact definition). But, more important, it's good enough to begin applying intelligent technology to the task of improving the businesses. Figure 1-1 shows the basic elements of AI and how concepts like AI, machine learning, and analytics all are connected.

Your AI potential is the difference between how smart your business is now and how smart it could be with properly applied intelligent technology. The simplest way to find your AI potential is to identify intelligence gaps in the business, build a portfolio of AI data stories to fill those gaps, and identify specific business value targets for each story.

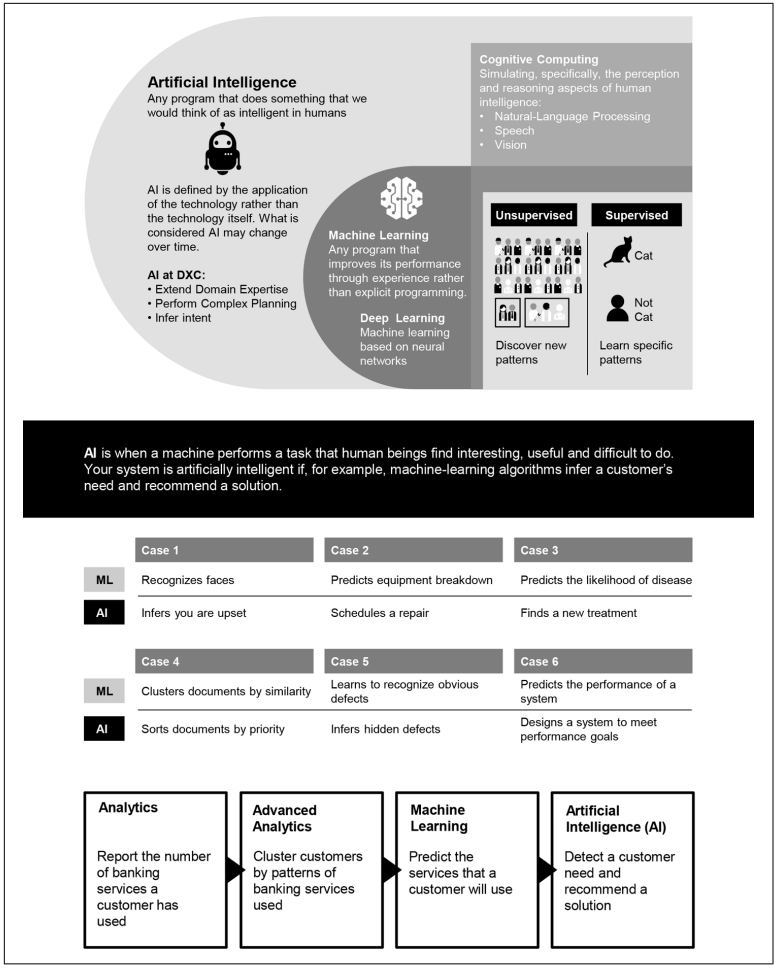


Figure 1-1. The role of AI and the relationships between terms like AI, machine learning, and analytics

CHAPTER 2

The Simplest Way to Find Your Artificial Intelligence Potential

Your business has areas that could improve significantly in cost reductions, efficacy, or new business ventures if you made better use of available information. Perhaps you could improve the way you monitor and predict failure. AI can help reduce cost, reduce waste, or even improve operational efficiency. Or, perhaps you could augment certain executive decisions. AI can help improve the allocation of your staff or increase the loyalty of your customers.

Whatever the potential, the simplest way to begin this discovery is to brainstorm on areas of the business with the largest intelligence gaps. Prioritize areas by their potential to improve the company. Then, begin filling the gaps with hypothetical AI data stories.

Tell Stories

An AI data story describes how AI could be applied in the company. Like any good story, it has a setting, a plot, and a resolution. AI—or more accurately, your application of AI—is the hero that resolves some important problem. In the same way that every hero needs a good villain, every good application of AI data needs a specific measurable business metric to improve.

Table 2-1 shows Act I of a three-act story of how AI might be applied to improve innovation in manufacturing. Act I begins by introducing the setting, presenting applied AI as the main character,

describing an unresolved state of affairs, and describing the desired final outcome.

Table 2-1. Opportunities for applying AI to the business

Act I: Set up the story	
The setting	Imagine if you could make smarter production design decisions that optimize the overall manufacturing process.
The hero	AI has the potential to decrease the time it takes manufacturers to discover and act on innovation by 50%. You stay relevant by finding good industrial design ideas and acting on them quickly.
The imbalance	Competition can come from anywhere, but good industrial design sets you apart. A study by the National Endowment for the Arts found that design-led manufacturers enjoy a 9% higher job growth rate than their peers.
The balance	Manufacturing simulation automates the search for new designs. Real-time production and supply chain planning lets you react quickly.
The solution	AI-based simulation of the manufacturing process (the digital twin) can use stochastic simulation to generate what-if scenarios that can help manufacturers avoid costly product quality issues while speeding time to market and increasing throughput.

Table 2-2 shows Act II of the data story. Act II moves the story forward starting from the unresolved state of affairs in Act I. Here, we describe the actions required to apply AI (the main character) in response to the story's setting.

Table 2-2. The detailed steps for applying AI to the business

Act II: Develop the action	
Story at the elevator-pitch level of detail	**Story at the presentation-level of detail**
Creating a digital twin starts with establishing new pipelines of manufacturing data. The next step is to take the manufacturing process and model it using rules.	We can use data pipelines to automate the collection of data, for example, from materials and design.
	The Internet of Things (IoT) adds another layer of insight. We can augment the manufacturing process with sensors and automatically generate data about operations, performance, and maintenance.
	When integrated with historical operations performance data, we now have what we need to support a digital twin.

Act II: Develop the action	
Story at the elevator-pitch level of detail	**Story at the presentation-level of detail**
With the digital-twin approach, we build stochastic simulations, or prescriptive models.	We use AI to discover rules that map from design to performance and add randomness to simulate risk.
	The prescriptive data from the simulations shows how new products will work.
	By analyzing simulation results, we can detect design flaws early. We can predict and minimize cost. We can also use this intelligence to build improved products in the future.
Turning point	Making good manufacturing design decisions keeps you lean. The McKinsey Global Institute found that 80% of manufacturing costs are affected by decisions made in the design phase.

Table 2-3 shows Act III of the data story. Act III ends the story by describing how the actions of Act II allowed application AI to overcome the central problem in the story.

Table 2-3. The results of applying AI to the business

Act III: Frame the resolution	
The crisis	We are far from putting all this data to good use. Research by McKinsey's Global Institute suggests that, as of 2016, manufacturers typically capture only 20–30% of the value of their data.
The solution	Analytics, advanced analytics, machine learning, and AI are how you capture that remaining 70–80%.
The climax	Manufacturing simulation automates the search for new designs. Real-time production and supply chain planning lets you react quickly.

Assuming that visuals and dialog will play a major role in telling the story, the script from Tables 2-1, 2-2, and 2-3 can be delivered as a 45-minute presentation. Telling a story is a natural and powerful way to communicate the potential value of AI. Stories tap into natural patterns underlying the way we think and communicate. Even though the subject of the story is technical, the listener does not need special training or technology to understand its message. A story ties together otherwise scattered pieces of information into a focused, clear, and engaging message.

Map the AI Journey

A solution to one story can be the setting for another. Stories share a dependency when one picks up where the other leaves off. Each individual data story can be linked, in dependency order, into a comprehensive story arc—an extended or continuing storyline. This extended storyline tells the big picture for how AI could transform your organization.

The AI data stories represent a portfolio of experiments that should drive your AI innovation program. Each data story can be distilled down to a simple hypothesis about what you think can be accomplished with the proper application of AI. Each hypothesis will eventually drive the development of individual projects.

Figure 2-1 demonstrates how you can evaluate your organization's AI needs as a minimal hypothesis. Each swim lane represents an area of the business that could improve with better use of information. Inside each swim lane are AI data stories that describe the needed improvements. The boxes at the bottom show the expected business impact of successfully implementing each story.

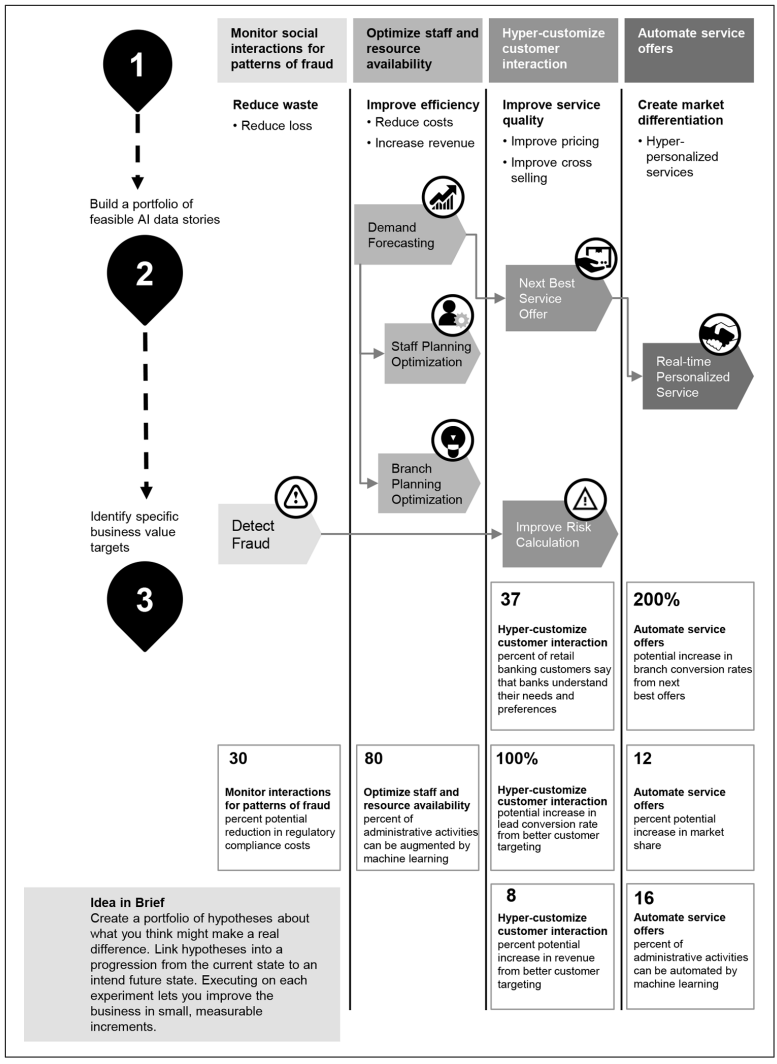


Figure 2-1. A banking example of the simplest way to find your AI potential

CHAPTER 3

The Simplest Way to Reach Your Artificial Intelligence Potential

It's difficult to talk about transformation because the word is both a process and a result. As a process, transformation applies to broad areas of your business, crossing organizational and divisional boundaries. The result, if the process is successful, will be a business that is more efficient, meets its clients' needs better, and can adapt flexibly to fast-changing conditions around it. An AI-based transformation of an energy services company, for example, could include completely new ways of trading energy commodities, matching supply to demand, managing the power grid, and forecasting demand.

Simple plans are easier to communicate and execute. The simplest way to transform your organization using AI and reach your AI potential is to adopt and repeatedly apply a simple metaphor, a simple execution model, and a simple team structure.

Think of AI as a Utility

A simple metaphor could treat AI as a utility. If AI is the new electricity, the best way to harness AI is to build an electrical utility. The applications of AI are varied and the technologies for implementing AI are many, but every good application performs the same basic functions:

- It accesses and collects data from various sources.
- It ingests the data, cleans it, and maps it to standard concepts.
- It automates the execution of algorithms.
- It generates insights and distributes them throughout the enterprise.

Figure 3-1 presents a visual metaphor of AI as a utility.

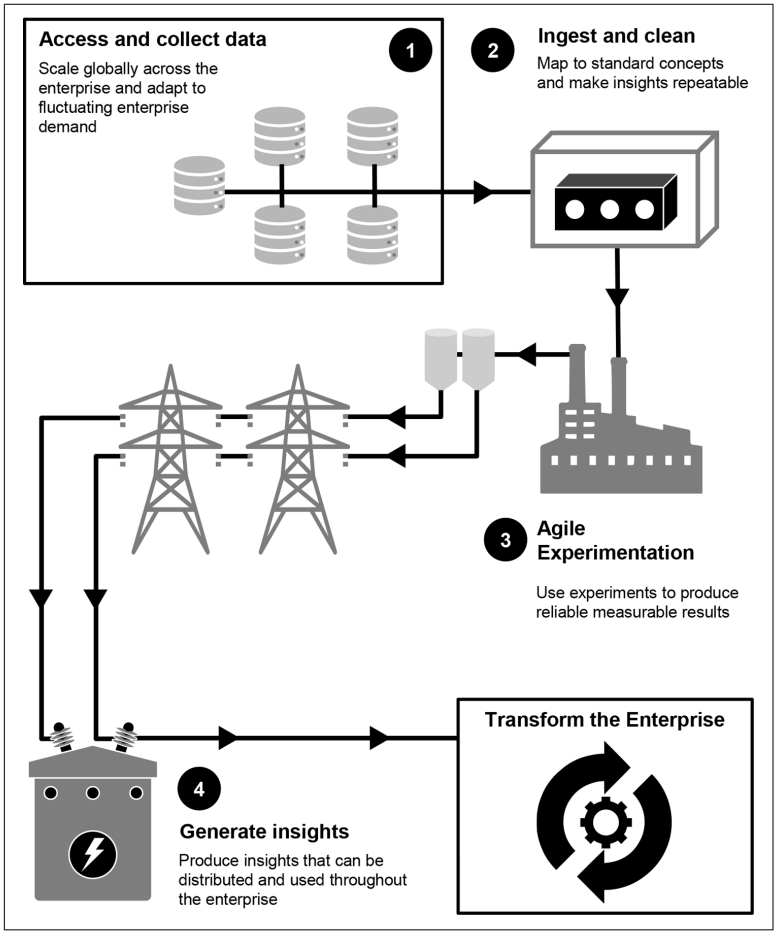


Figure 3-1. A simple way of thinking of AI is the metaphor of a utility

Scope Really, Really Small

An AI worth the trouble has to do a lot of things. It must be accessible to others in the organization. It must have a measurable impact on the business. It must respect and protect the data it uses. For an AI that can do all that, the simplest execution model is a microservice: a single-purpose executable exposed as an Application Programming Interface (API), an interface into a data source, and a small store of data.

A microservice lets you change the business in small chunks. For example, an AI that only spots potential quality defects in an automobile brake pad, for example, lets you focus just on improving a specific aspect of the manufacturing process, without requiring that you improve the entire system.

Microservices make data governance tractable. Although it might not be feasible to define data safety and security rules for all data within a manufacturing organization, it is certainly possible to define the rules for safely handling images of newly manufactured brake pads.

Microservices also make data gathering less intimidating. Even though the task of improving how an entire manufacturing company collects data can be daunting, the task of capturing images of brake pads and labeling them as defective or not is more doable than undertaking the task of examining the entire brake pad manufacturing process.

Figure 3-2 shows the questions to ask that help to identify the microservices of an AI initiative.

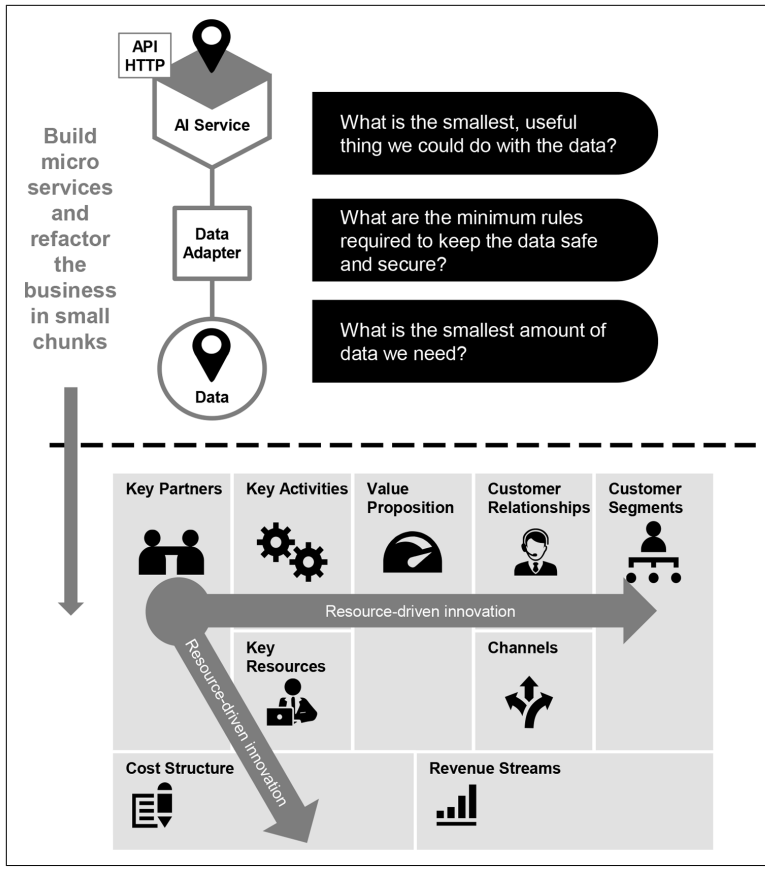


Figure 3-2. Set the scope really small and go after the smallest measurable change you can make to the business

Build an AI Squad

Finally, you need a team that can lead the transformation. This team must be technically savvy enough to build and operate an AI utility, organizationally savvy enough to coordinate efforts across multiple business units, and politically savvy enough to embed AI into existing business operations. The team should stay lean—as Jeff Bezos's popular slogan dictates, no bigger than what can be fed by two pizzas. The team should be supported by an executive sponsor, led by a digital innovator, and staffed with data scientists, engineers, and developers. The team should work side by side with both existing lines-of-business owners and core IT leaders.

Although the change itself can be complicated, the actions required to bring about that change can be relatively simple. The simplest way to reach your AI potential is to use agile teams to build AI microservices that run in AI utilities.

Figure 3-3 shows an example of a team built to lead AI transformation. The executive sponsor is the chief advocate for the team. Platform Engineering and Platform Support builds and operates the utility. The Digital General Manager from the AI team works closely with Lines of Business Leads. AI Team Project Leads work closely with Team Leads from the Lines of Business. The Project Lead and Platform Engineer work with IT Department Teams to embed AI into existing business operations.

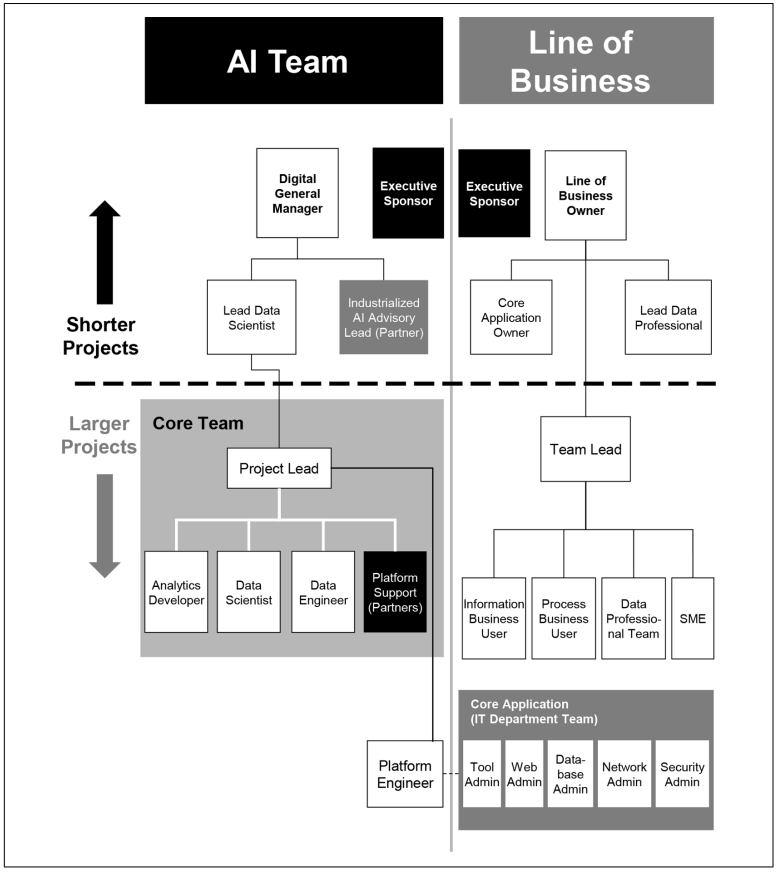


Figure 3-3. Execute with small AI teams

CHAPTER 4

The Simplest Way to Manage Data

At some point, IT staff realize that transferring data from one place to another can become complicated. A natural reaction to this problem is to write a script. Scripts are easy to write, and they start out easy to understand and manage. The problem with writing a script is that things change. The data, its purpose, the technology, the policies, and the people responsible all change over time. Eventually, the bulk of your time will be spent editing the script to keep it working when things change. So, the simplest way to manage data is to use standards and tools to build automated data pipelines that will make it easier to adapt to these inevitable changes.

The Data Pipeline

Make it standard practice to access remote data using web APIs. A standard interface makes it easy to adapt when the storage technology supporting the remote data source changes. Ideally, if data is accessed as a web service, you won't notice if the storage mechanism changes from, say, a mainframe to a relational database.

Use a standard tool to schedule, execute, and monitor data transfer. If all goes well, the scope of your AI efforts (and your data needs) will grow over time. The number of data sources will increase. The response times and update intervals of data sources will change depending on demand. Using a single, automated data ingestion tool makes it easier to keep up with data pipeline operations, discover when data ingestion jobs are failing, and take corrective action.

Run data cleaning and transformation code in a standard execution environment. If you're going to build an AI, you'll likely spend a lot of time cleaning and formatting training data. You'll need to write code that maps disparate data to a standard model—code that, for example, recognizes that "Zip Code," "Zip," and "Postal Code" all represent the same concept. You'll need to write code that imputes missing values, that joins the data, that reshapes the data, and that calculates new values. Running this code in a standard execution environment makes it easier to keep track of everything required to transform raw data into a usable source of machine-learning insight.

It's even better if the execution environment is *serverless*. Serverless execution automatically deploys code to servers. This means that you don't need to worry about managing the computing resources needed to execute the code. When the machines handle the compute infrastructure, you can spend more time writing and maintaining the code.

You must protect the data you collect. Even if the algorithm itself does not directly disclose sensitive information, its training might require sensitive information. Every tool used for the AI pipeline should include implicit controls for protecting sensitive data. This includes the ability to encrypt the data, control access at the user level, and log exactly who accessed the data and when.

Figure 4-1 shows how a modern data platform is integrated into the cloud.

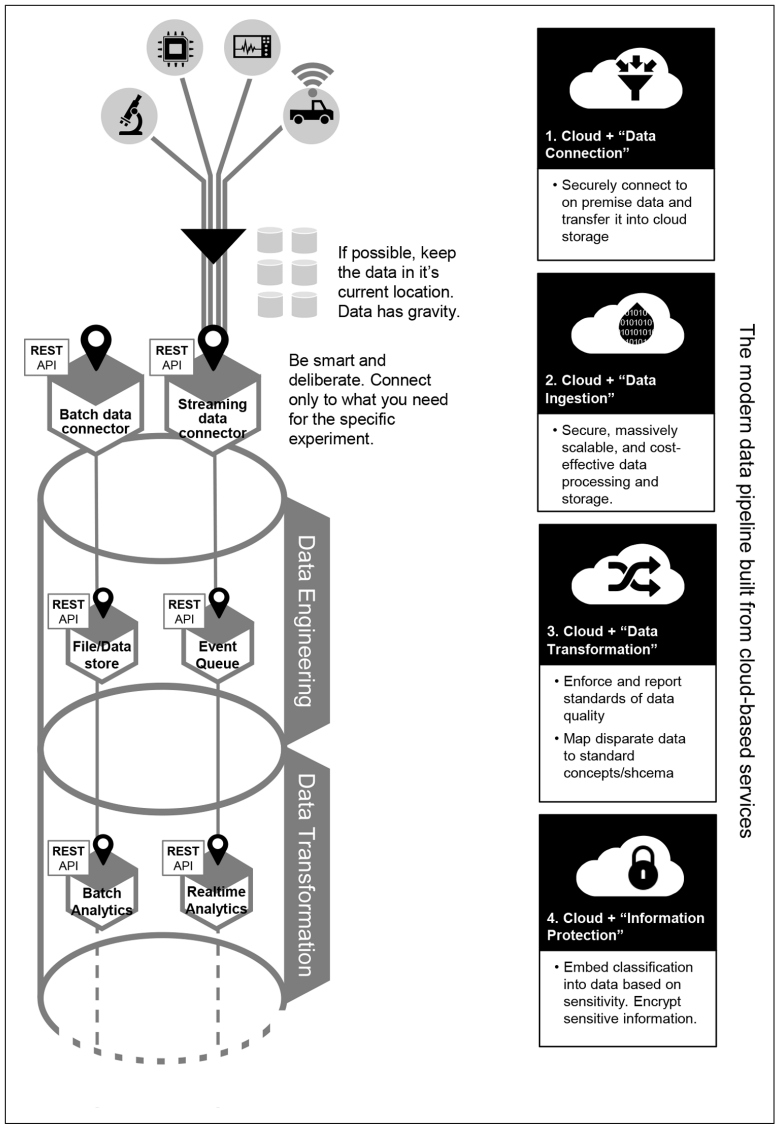


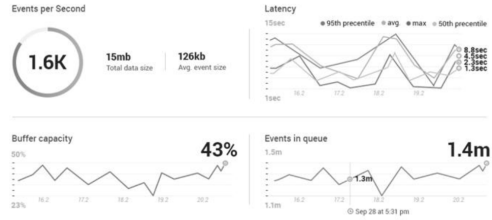
Figure 4-1. The modern data pipeline built from cloud-based services

What Good Data Looks Like

You must monitor the operation of the pipeline—this is usually done by the data engineer. Again, if all goes well, managing the data pipelines will become an important part of business operations. The data pipeline tools should include monitoring features that make managing pipeline operations as easy as possible. Monitor the pipeline for how often it runs, how many resources it consumes, and how much usable data it produces. Monitor the data to ensure that it has the required quality. What, exactly, defines quality in a dataset will depend on the task. The simplest way to monitor data quality is to compare the statistical distributions of the raw data attributes to expectations and ideals. For example, is the age of your population skewed toward youth or are customer transaction amounts suspiciously uniform?

Figure 4-2 shows data flowing down through an example pipeline.

Idea in Action: Monitor the data pipeline. Run statistical analysis of the uptime, data volume, and velocity for the pipeline. Prove that the pipeline is operational and delivers enough data to supply the enterprise with insight.



Idea in Action: Monitor the data. Run statistical analysis of the data variety and veracity. Prove that the data is fit for purpose.

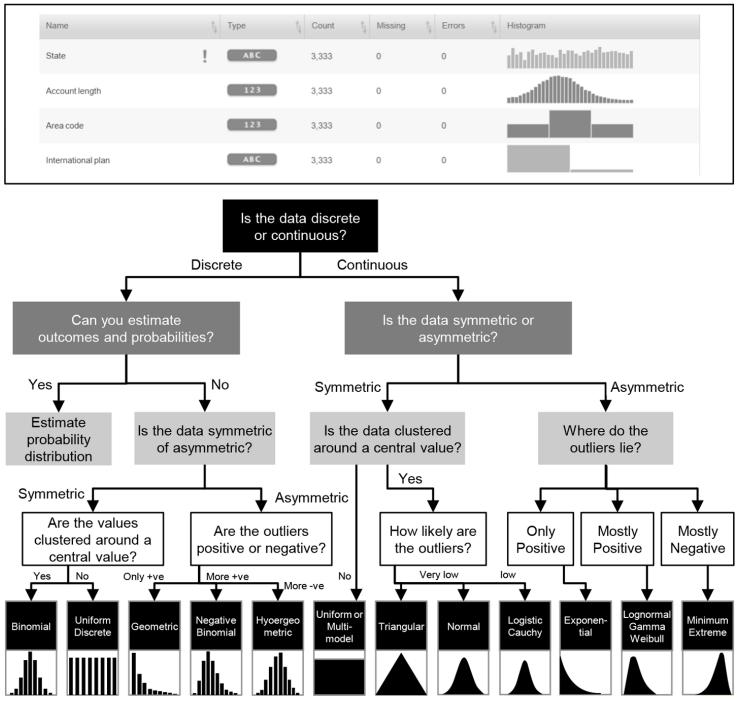


Figure 4-2. What good data (and data pipelines) look like

CHAPTER 5

The Simplest Way to Build an Artificial Intelligence

I will avoid the details of how to build a proof-of-concept from a particular algorithm. That kind of information is already abundant. If you do a web search on the kind of algorithm you want to tinker with and select a tool, you'll need only to follow the tutorial. Instead, we cover the more difficult-to-find best practices for building a process for running AI that has the best chance for a long life and widespread use.

Treat Your AI as an Experiment

The simplest way to build an AI application is to follow the scientific method: form a hypothesis; model the problem domain; build, train, and test the algorithm; predict the business impact; and monitor the results. Decide on the minimum functionality you need to deliver business value. Gather just enough data to model the business domain and run an experiment.

The simplest way to decide what to build is to choose the minimum set of technologies needed to tell the target AI data story. In every story, the AI application will need to assess input, make an inference, and emit a response. We can organize the universe of AI technologies based on the assess-infer-respond taxonomy and choose an appropriate technology from each category. To design an AI that helps customer service agents serve live wireless customers, you may choose speech recognition to monitor the call, predictive inference

to determine the customer's intent, and automation controls to adjust services to better serve the customer.

The periodic table in Figure 5-1 treats AI like the building blocks of an intelligent application. The focus is on the function of the AI rather than the technology. Building an intelligent application means selecting a set of building blocks that, together, can assess, infer, and respond. Assess elements characterize input from the external world. Infer elements generate new insight. Respond elements act on those insights.

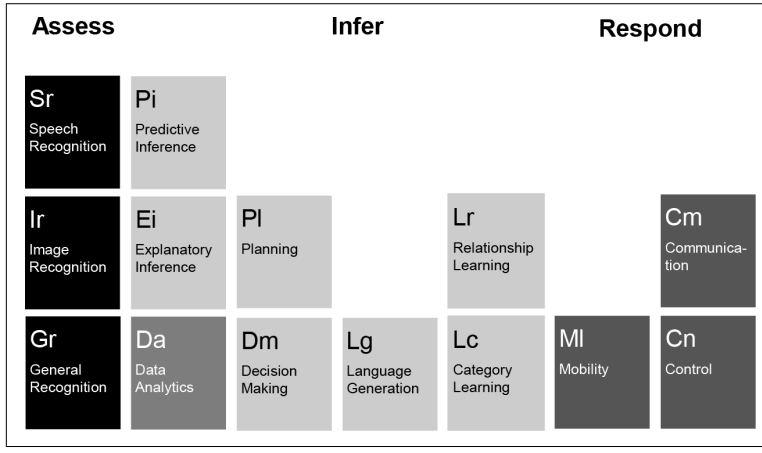


Figure 5-1. The periodic table of AI (image adapted and based on IBM's report "The Periodic Table of AI")

Did the Experiment Work?

If we decide that AI can help troubled wireless customers, we need to start with data on customer attributes and behavior—things like how many times customers called into the help desk or how many minutes they used last month. We then need an algorithm (like a *churn decision tree*) that produces an intelligent response. Finally, we need to monitor the results. Does using the AI have a measurable impact on customer satisfaction or churn?

Figure 5-2 shows the stages of the assess-infer-respond taxonomy for our sample wireless customer application.

Hypothesis: AI can predict customers most likely to churn and create a plan to intervene in the lifecycle.

Model a problem domain

State	Account length	Area code	International plan	Voice mail plan	Number vmail messages	Total day minutes	Total day calls	Total day charge
KS	128	415	No	Yes	25	265.1	110	45.07
OH	107	415	No	Yes	26	161.6	123	27.47
NJ	137	415	No	No	0	243.4	114	41.38
OH	84	408	Yes	No	0	299.4	71	50.9
OK	75	415	Yes	No	0	166.7	113	28.34
AL	118	510	Yes	No	0	223.4	98	37.98
MA	121	510	No	Yes	24	218.2	88	37.09
MO	147	415	Yes	No	0	157	79	26.69
LA	117	408	No	No	0	184.5	97	31.37
WV	141	415	Yes	Yes	37	258.6	84	43.96
IN	65	415	No	No	0	129.1	137	21.95

Build an algorithm

All models	Max. phi coefficient	ROC AUC
random decision forest, 1795-node, random candidate rati…	0.85293	0.93219
random decision forest, 577-node, random candidate ratio…	0.85290	0.92449
bootstrap decision forest, 747-node, 127-model, determini…	0.84812	0.94326
bootstrap decision forest, 1940-node, 118-model, determi…	0.84812	0.94228

Train and test an algorithm

ACTUAL VS. PREDICTED	False	True	ACTUAL	RECALL	F	Phi
False	568	4	572	99.30%	0.98	0.85
True	20	75	95	78.95%	0.86	0.85
PREDICTED	588	79	667	89.12% AVG. RECALL	0.92 AVG. F	0.85 AVG. Phi
PRECISION	96.60%	94.94%	95.77% AVG. PRECISION	96.40% ACCURACY		

Predict the business impact

100%	**Hyper-customize customer interaction** potential increase in lead conversion rate from better customer targeting	**8**	**Hyper-customize customer interaction** percent potential increase in revenue from better customer targeting	**12**	**Automate service offers** percent potential increase in market share

Figure 5-2. The simplest way to build an AI is to follow the scientific method

CHAPTER 6

The Simplest Way to Scale Artificial Intelligence

Scale is about making what you build as useful as possible to as many people as possible without drowning in complexity or expense. Scaling any kind of software system (including AI) isn't simple. However, there are things that you can do to make scaling AI as simple as possible. The simplest way to scale AI is to build and deploy utility services.

The AI Infrastructure

Utilities set standards that make technologies work together and ensure that everything is available through a common interface. Treat AI platforms as commodities. Design the AI applications so that platform components can be plugged into and swapped out of the existing legacy infrastructure. Choose technologies capable of running AI as widely available, reliable services.

Figure 6-1 shows the blueprints of an AI algorithm. These are the basic technical elements needed to deliver a functional, operational, and industrial AI.

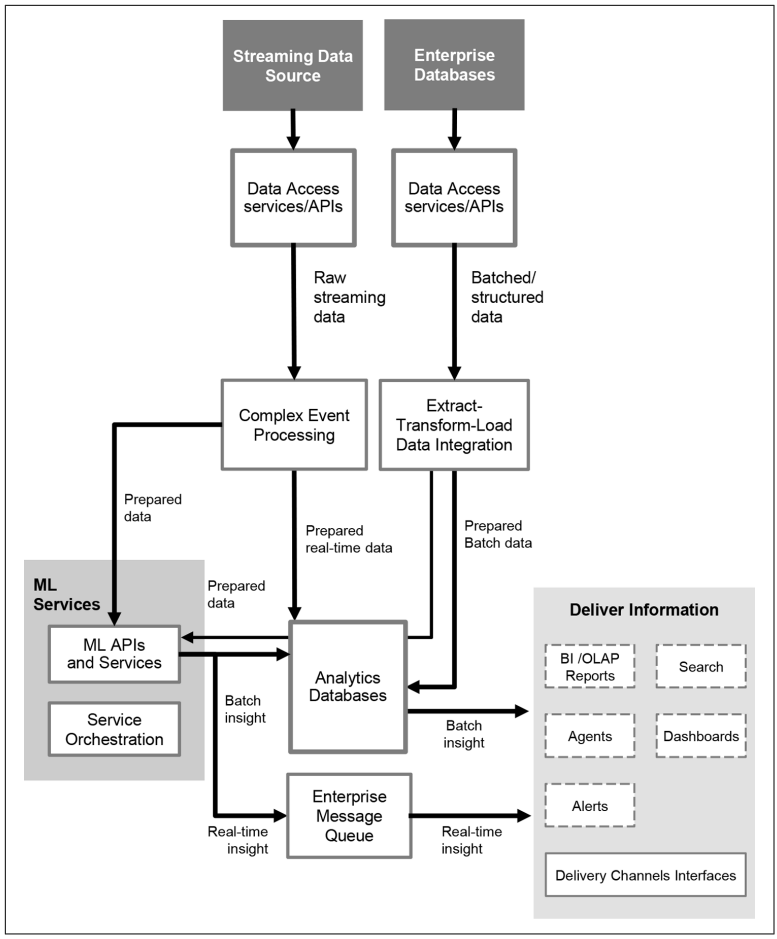


Figure 6-1. A blueprint for the AI utility

Utilities set standards for simplicity. Consistently choose the minimum viable algorithm you need to test out your hypothesis. Don't, for example, build *convolution neural networks* when *linear regression* will do. Pull in as little data as possible and map all of the data consumed to a standard domain model. Don't build a world-class data warehouse when a simple file store will do. However, do code up every component so that it will be available via a web API.

Is the AI Working?

The AI utility is a living, breathing entity. The simplest way to keep it going is to keep an eye on key statistics and generate early warnings when things go wrong. Understand whether the utility is running the algorithms that provide the utility services. The simplest way to monitor (and manage) these algorithms is to build, run, and monitor them as serverless functions. Going serverless means that you don't need to worry about the compute and storage infrastructure, and you can focus on the algorithms themselves. Keep an eye on whether they stay running, how often they run, and how many resources they consume (see Figure 6-2). Have an idea of what is normal and recognize when elements of the operation are performing too far outside the norm. Analyze the performance and prove that it actively supports the chosen portfolio of experiments.

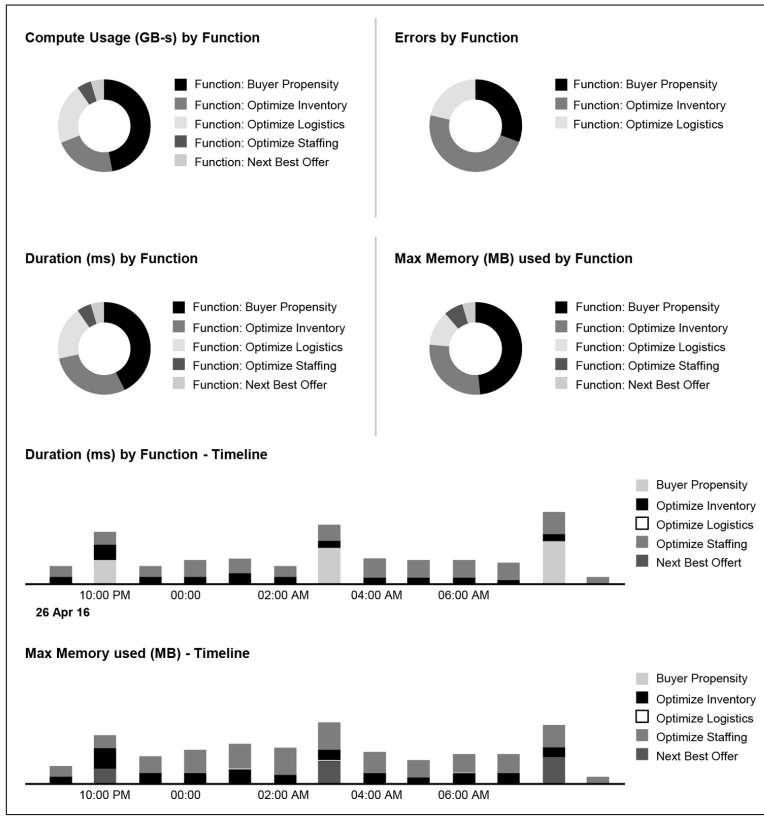


Figure 6-2. Dashboard that monitors the AI utility

CHAPTER 7

The Simplest Way to Keep Artificial Intelligence Ethical

I wrote an AI application designed to discover cohorts for patients. If you are diagnosed with an illness (especially a chronic illness), one of the best things that you can do to improve your long-term health is to actively manage your illness with other patients in a similar situation. Find people like you with a similar diagnosis and support each other. For patients who opt-in to such a program, AI can automatically find patient cohorts and help those with similar situations find one another.

I ran my model to find suitable partners for patients and checked the results of an early version, and I saw a huge red flag: the algorithm segregated people mostly by race and gender. Using AI Forensics, we caught the problem early and adjusted the algorithm's structure and training to prevent racial and gender bias.

Know Thine AI: Create a Profile of the AI Based on Its Recent Behavior

Bias, ethics, and fairness is a big risk factor in AI. The simplest way of protecting against this risk is to check the results. Part of a standard checklist for protecting against ethical violations with AI is to build AI forensics tools, use those tools to profile the algorithm, use the profile to anticipate behavior, and discuss the anticipated behavior with a diverse risk mitigation team (see Figure 7-1).

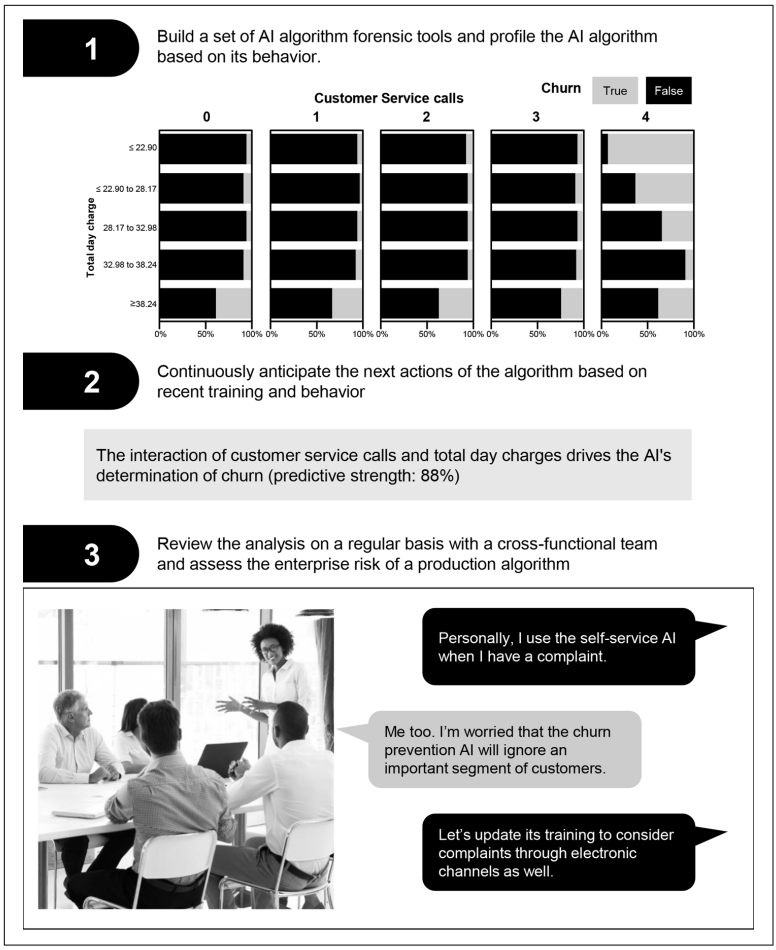


Figure 7-1. Performing AI forensics

AI forensics analyzes an AI model's tendencies based on its output. You need a good log of input and corresponding output. You also need tools that can discover the most influential factors in how the model makes decisions. Using the tools, you can build a profile: the decisions it makes, the factors that it considers, and the weight of each factor.

By building a profile, you gain insight into the model's behavior and tendencies. Profiling an algorithm doesn't sacrifice performance. It's not necessary to alter the function of the underlying algorithm. Nor

is it necessary for the inner workings of the underlying algorithm to be fully transparent and explainable.

Anticipate the AI's Behavior: Know What the AI Will Likely Do Next

Using the profile to anticipate the model's behavior is a statistically rooted exercise in which you calculate the most likely behavior, given both the profile and the production environment in which the final algorithm will operate. You know, for example, that customer service calls and total charges during the day is, by far, the strongest influencer for the customer churn model. But if there is a small but influential portion of customers who don't use the customer service phone line, the model will most likely ignore and alienate an important group of customers.

The final, and most important step in the AI-ethics checklist is to discuss the results of forensics with a diverse group of people. Bring together a group of people from all different backgrounds and job roles, present the results, and discuss the risks. Decide whether the risk is acceptable or whether changes need to be made before allowing the algorithm to continue in production.

Even when the algorithm is based on a single machine learning model, the complexity of analyzing its behavior, generating a profile, and anticipating behavior will likely be too high for human being to manage. Some of the most useful profiling and analysis tools will, themselves, be based on machine learning. It turns out that machine learning is one of the best ways to protect against the unintended consequences of machine learning.

Profiling is not just an upfront activity. You must update the profile on a regular basis. An AI based on a machine learning algorithm will acquire new behavior as it learns from new data. To remain ethical, your profile of the model must change as the model evolves.

We have a lot of experience dealing with intelligent beings—one another. Much of the basic common sense that we have developed for such dealings is applicable to machine learning. Observe the AI and understand it. Predict the most likely behavior and decide whether any risk is worth the benefit.

CHAPTER 8

Conclusion

A Reality Check on Artificial Intelligence

It's too early to worry about a sentient AI apocalypse. The reality is that we know very little about how the human brain works—which means we know even less about how to build a computer that works just like the human brain. For very specific tasks, AI tends to make rapid progress until it matches human-level performance; then, progress tends to slow down. Despite fears of an impending AI dystopia, the technology is still very limited compared to human intelligence.

AI has many useful applications, though. It can drive competitive advantage. Find an area of the business that you can make as smart as possible as quickly as possible. Identify the AI data stories that you think might make a real difference. Test your ideas using utilities and small experiments. Learn and adjust as you go.

The current wave of AI works by using computer models to simulate intelligent behavior. Machine learning algorithms are good at learning new behaviors but bad at identifying when those behaviors are harmful or don't make sense. Companies deploying AI will need a workforce trained to ensure that the technology remains both useful and safe.

AI adoption occurs fastest in digitized companies. The digital ideal is a company of people interacting with a core digital system. Most expect AI to automate the core system and eliminate people. But it's more realistic to think of most companies as networks of people

interacting with various, loosely connected digital systems. Realistically, AI helps connect disparate systems and improves the way we interact with both machines and one another. Rather than making people obsolete, I believe that AI will make the modern workplace smarter and more meaningful.

About the Author

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