



Business guide to artificial intelligence

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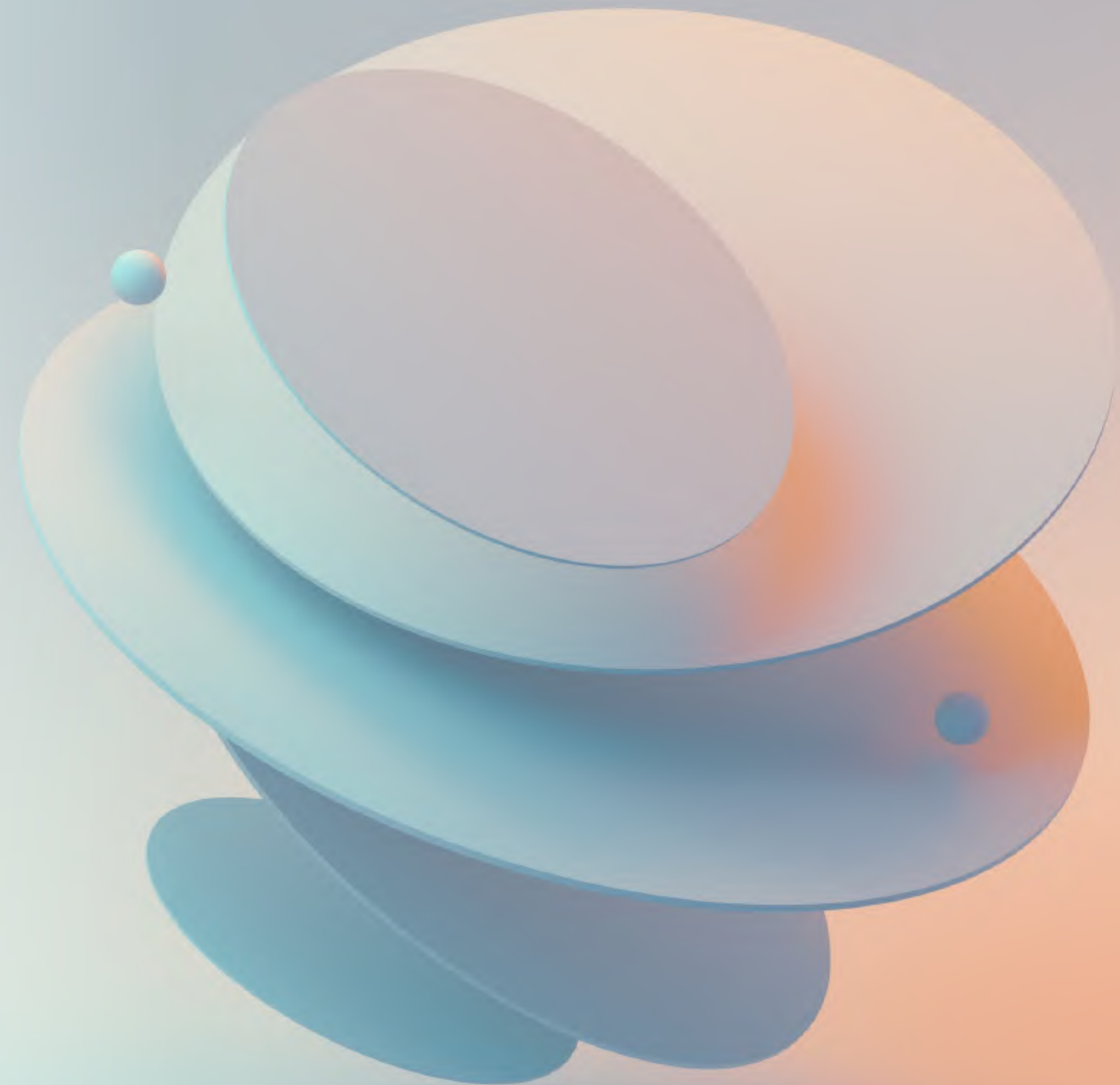
06. The future of AI in the enterprise

Artificial intelligence (AI) is gaining popularity around the world. The global AI market [was valued at \\$93.5 billion in 2021](#) and is estimated to grow at a CAGR of 38.1% from 2022 to 2030.

COVID-19 is one of the main factors accelerating AI adoption. According to RELX Emerging Tech Executive Report, [68% of the respondents](#) increased their spending on AI technologies due to the pandemic, with 48% investing in AI solutions that they had not used before.

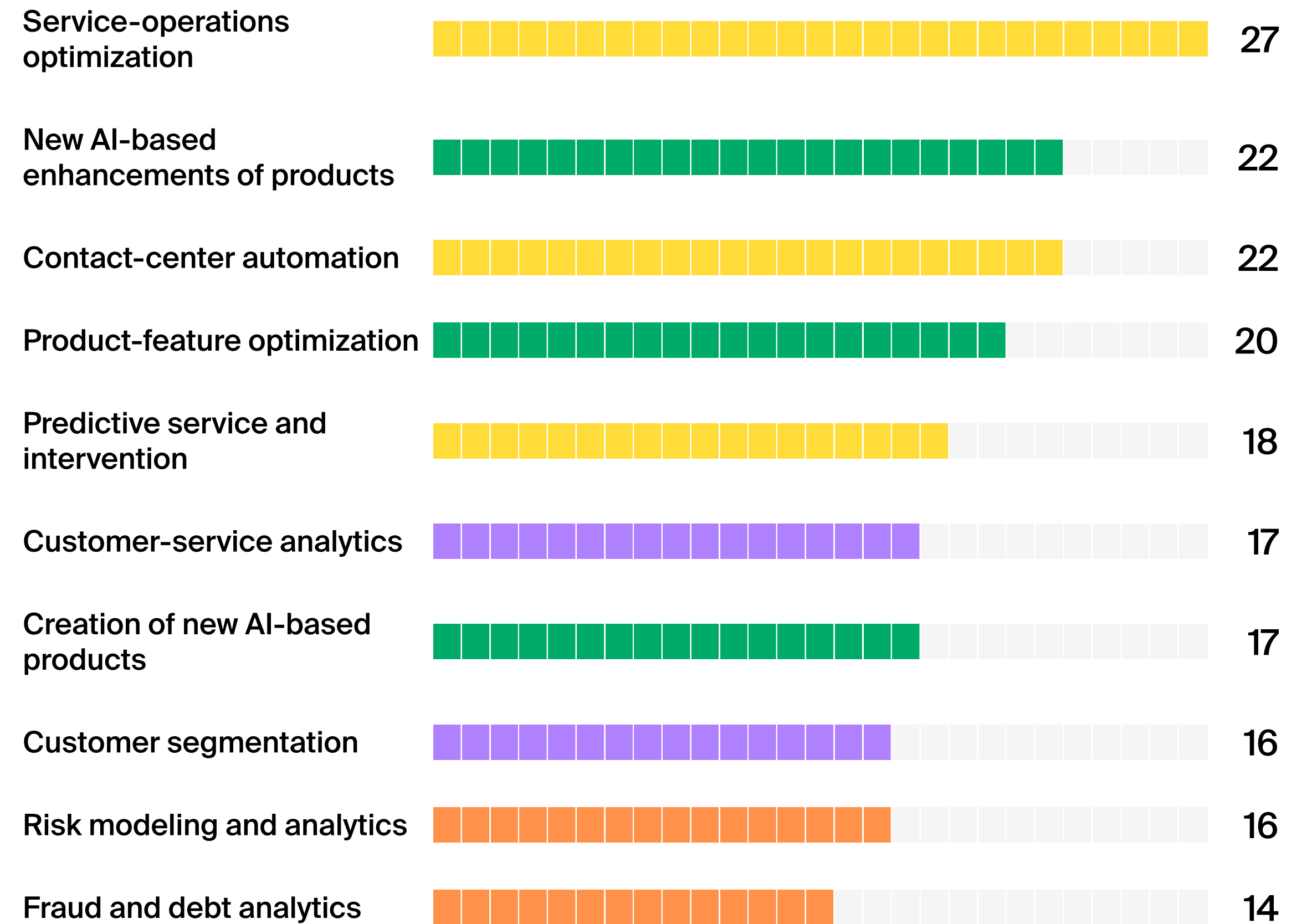
AI is no longer a prerogative of large corporations. Nowadays, it is a must to succeed and gain competitive advantage, and it is accessible to organizations of all sizes. Forbes published recent statistics on AI adoption, showing that [29% of the surveyed](#) small and medium-size enterprises are already benefiting from artificial intelligence. This number is still less than the 45% adoption rate among large organizations (over 1,000 employees), but it demonstrates that smaller firms are entering the market as well.

Another optimistic survey comes from Accenture. It shows that some industries are expecting to [boost their revenue by 30%](#) over the course of four years thanks to AI adoption.



What is AI exactly, and how can it bring value to business?

McKinsey's [The State of AI in 2021 Report](#) revealed that 57% of the participating organizations adopted AI in at least one of their functions. This number is up from 45% in 2020. AI adoption is the highest for Service and operations optimization function, closely followed by Product enhancement and Contact center optimization.



■ Service operations
 ■ Product and/or service development
 ■ Marketing and sales
 ■ Risk

Most commonly adopted AI use cases in 2021 (% of respondents)

Artificial intelligence: definition and types

Artificial intelligence (AI) is a wide-ranging branch of computer science and engineering concerned with building smart machines capable of performing tasks that typically require human intelligence.

Experts tend to divide AI into two types:

Narrow Artificial Intelligence (NAI): applications that outperform humans in some narrowly defined tasks, such as distinguishing malicious tumors in mammograms.

General Artificial Intelligence (GAI): applications that attempt to mirror human intelligence by applying their skills to function in different contexts. Theory of mind and self-aware AI systems belong to this category.

AI subsets

Machine learning and deep learning are two of the most prominent [AI subsets](#).

AI Teaching machines to think like humans

ML Teaching machines to get better w/o programming

DL Using multi-layered networks for ML

Machine learning

This technique involves training algorithms on labeled data, such as images of puppies and bagels. While basic AI systems often rely on if-then rules defined by human engineers, ML solutions alter themselves when faced with new information. They improve their accuracy with time.



Properly trained machine learning algorithms can correctly identify objects of a particular class in training data – in this case, photographs of pastry, cleaning supplies, and animals

Machine learning can be further divided into three main types:

Supervised learning: depends on labeled data to find patterns and make intelligent predictions. This ML type is best suited for classification tasks – for example, predicting house prices based on the square footage of a house, number of bedrooms, availability of a garden, etc.

Unsupervised learning: these models are exposed to unlabelled data, meaning engineers leave it up to smart algorithms to structure information and spot trends. Unsupervised models are used in clustering tasks like identifying customer segments in CRM data.

Reinforcement learning: such algorithms do not simply guess outputs based on the received data. Instead, they interact with the environment to find the best way to solve a problem, learn from mistakes, and get rewards when delivering accurate results. Some practical examples of deep learning include stock trading bots and computer applications that summarize long texts.

Deep learning

This type of machine learning uses neural networks with multiple hidden layers to extract additional insights from the input data and deliver more accurate predictions. To be considered "deep", an algorithm must contain at least three layers. While deep neural networks may use labeled data for training, they can also learn by themselves.

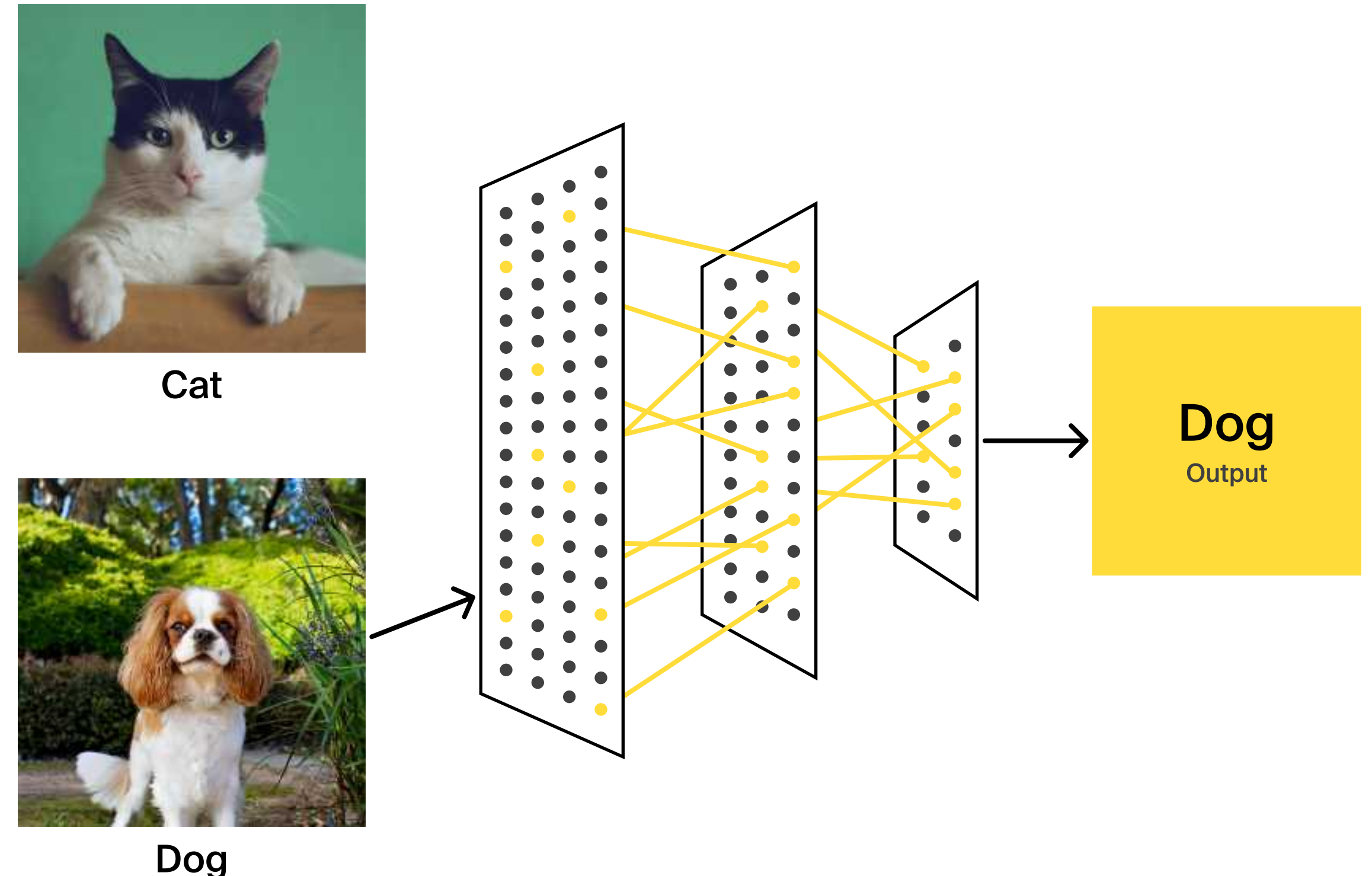
Deep learning has two main applications:

Natural language processing:

allows computers to process human language and understand its meaning. It is used to translate text from one language to another, respond to verbal commands, etc.

Computer vision:

enables systems to interpret information from digital images and react to it with action or recommendations. [Computer vision has many applications](#), such as medical image analysis and predictive maintenance solutions.



Neural networks pass information through several artificial neuron layers, assigning weights to input data. That's how algorithms access the probability or improbability of an event.

Examples of what AI can do for business*

01. Automate workflows

AI-powered systems confidently take over some repetitive and time-consuming jobs on the factory floor, in the office, and at call centers. Some experts claim AI could soon take [30 million jobs](#) in the US.

Since 2019, Amazon has been using packaging robots that box up 700 orders per hour. Another example comes from Humana, a leading US healthcare insurance company that automates 60% of its call center activities using voice assistants and AI-driven robotic process automation (RPA) technology.

02. Uncover insights in data

The insights obtained from raw, unstructured data help businesses improve equipment uptime, reduce energy consumption, and optimize throughput.

A couple of years ago, Google turned to deep neural networks to manage a cooling plant at one of its data centers. The moonshot project began as a recommendation engine that would come up with random suggestions to help human engineers optimize energy use. Google let the algorithms make the cooling plant tweaks on its own and registered a whopping 40% reduction in the facility's energy use.

03. Enhance security

While we saw two years' worth of digital transformation in the first two months of the COVID-19 pandemic, cyberattacks targeting businesses of all shapes and sizes grew by 273% during the same period.

As an alternative to passwords and PINs, enterprises may restrict access to corporate devices and applications using biometric authentication systems. Facial and voice recognition features steadily infiltrate corporate messengers, including WhatsApp for Business. AI algorithms could also analyze network traffic and alert security managers when malicious activity is detected.

*As the technology matures, some exciting AI use cases begin to emerge, so this list is by no means exhaustive.

Still, these applications could be the starting point of your company's artificial intelligence journey

Examples of what AI can do for business*

04. Improve user experience

Besides answering customer questions at the help desk and helping users navigate online catalogs, AI systems can dive deeper into social and purchase history data to come up with relevant product suggestions. Additionally, [AI can recognize emotions](#) and interact with users accordingly.

Walmart heavily relies on AI-powered cameras to improve shopper experience. These cameras can do many things. Here are a few interesting examples: monitoring inventory levels and timely restocking items that customers buy the most, overseeing fruits and identifying the ones that started to bruise, and notifying employees when more cash registers need to be operating to avoid the formation of long queues. With all the benefits AI brings, the supermarket chain respects customer privacy and does not place any cameras in front of pharmacies.

05. Enable content personalization

By processing real-time and historical customer data, AI algorithms can tailor content delivery to better match the needs of an individual client, improving conversion rates and a company's bottom line. That's how product recommendation engines, AI chatbots, and targeted marketing campaigns work.

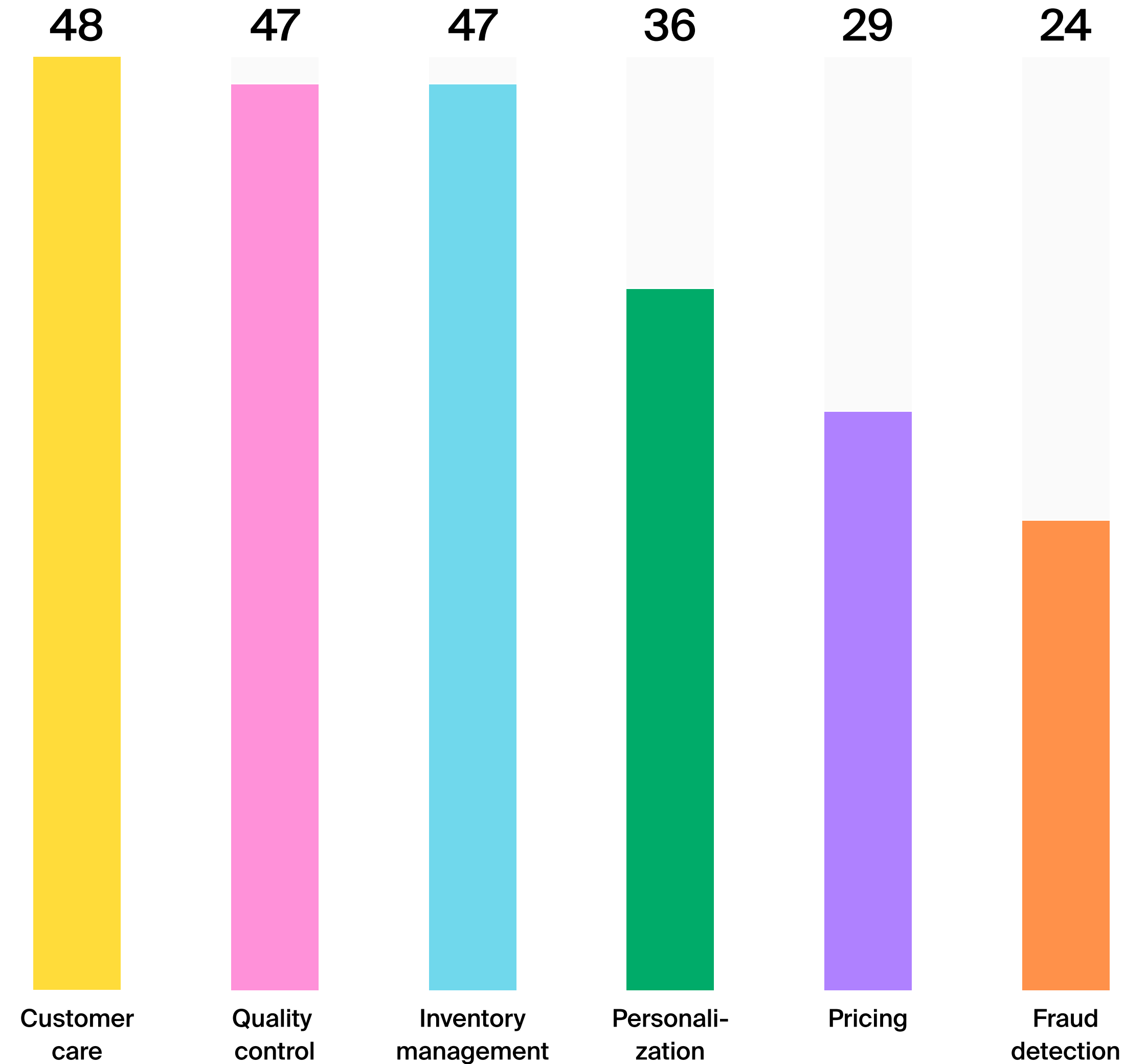
For example, Netflix is using an AI-based recommendation engine, which offers personalized movie suggestions to viewers. These recommendations account for 80% of movies and TV shows people stream on Netflix.

Key AI applications by industry



AI applications in the retail sector

The global AI in retail market [is expected to reach \\$23,426 million by 2026](#), rising from \$2,938 million in 2021. According to Statista, the consumer goods and retail sectors have been using AI for various purposes.



Top AI applications in retail (%)

AI applications in the retail sector

01. Sparking consumer interest through personalization

Personalized promotions: AI offers plenty of information on every individual buyer, such as their meal preferences, food allergies, and motives behind their purchases. Using this information, retailers can craft customized promotions to attract buyers and increase sales.

Woolworth in Australia uses AI to customize its marketing emails considering not only consumers' taste but also their past shopping behavior. For example, the chain can predict which items every shopper is likely to run out of based on their previous purchases and highlights them during checkout.

In-store navigation: customers can use AI technology to navigate around large stores and find the desired aisle or product.

The Mall of America houses over 520 stores and 60 restaurants. To relieve its customers, it deploys location-based AI chatbots, which operate through Facebook or a mobile app and assist customers in finding products and services.

03. Improving inventory management

Grocery store robots can alleviate the burden off store employees' shoulders by taking up a large portion of inventory management tasks. Robots can help tackle inventory-related problems, such as preventing out-of-stocks, incorrect labeling, and pricing. Additionally, they can cope with the increasing demand for deliveries.

02. Reducing theft

Shoplifting: [computer vision](#) can help store security managers identify theft attempts. The system records suspicious activities and notifies security personnel.

Thanks to this technology, Sainsbury's stopped almost [6,000 theft attempts](#) between September 2019 and March 2020.

Sweethearting: computer vision systems use ceiling-mounted video cameras to "watch" cashiers and detect sweethearting events, like covering barcodes and stacking items on top of each other.

The US-based supermarket chain Piggly Wiggly reported a loss of almost \$10,000 per month due to checkout shrinkage at one of its locations. After installing ScanItAll and retraining cashiers, shrinkage [costs declined to \\$1,000](#).

California-based Fellow Robots developed an autonomous retail robot, which can scan your store shelves as high as 2.4 m above the floor daily, taking high-definition pictures of products and their prices. Machine learning algorithms examine these pictures, searching for misplaced products and price discrepancies.

AI applications in the retail sector

04. Improving social distancing

As social distancing is here to stay, supermarkets are looking for ways to control the number of people indoors. In-store customer tracking technology can prevent overcrowding inside grocery stores.

A German supermarket company, Aldi, is using AI through an automated traffic light system, which controls people flow to its stores. When the number of shoppers in a particular location is below a pre-defined threshold, the light is green, and the door is open for others to come in. After the threshold is reached, the light turns red and the door closes.



05. Modernizing the checkout process

Smart shopping carts: AI-enabled shopping carts can take over some of the actions that register employees normally perform.

For example, Caper AI produced a shopping cart that uses artificial intelligence to instantly recognize items and measure their weight (if relevant). The cart contains a built-in navigation and product location system, helping customers to traverse the store. Caper AI has already partnered with the US-based Kroger and Foodcellar & Co, and Canadian Sobeys Inc.

AI-powered cameras: computer vision-powered cameras monitor which products every shopper picks to charge the total amount off their credit card immediately after they leave the store. Additionally, they can spot people who need assistance and communicate this to store employees.

Ireland-based Everseen developed a visual platform where AI watches videos of customers performing self-checkout in real time. The program can identify errors and correct users immediately. For instance, if a customer encounters an item that doesn't scan properly at the self-checkout AI kiosk, Everseen's system will register this incident and notify one of the employees to assist the troubled client. Kroger began deploying this system at its stores in 2020.

AI applications in education

What the COVID-19 pandemic and the subsequent lockdowns have shown is how ill-prepared the higher education system was for the challenge. Although [97% of universities and colleges](#) have eventually switched to online or blended learning, their journeys weren't smooth – 63% of students say the quality of instructions has worsened.

Now schools across the globe are rushing their digital transformation initiatives, adopting educational technology to make physical and remote learning more efficient and personalized, possibly without spending a fortune on digitizing their operations. Whether your educational institution is planning to continue operating online, return to the classrooms, or adopt a mixed approach, there are benefits that you can gain from deploying AI. The AI in education market size [surpassed \\$1.8 billion in 2021](#), and it could be growing at a CAGR of 36% from 2022 to 2030.



AI applications in education

01. Enabling smart campus and smart dorm solutions

By tapping into AI, colleges and universities can prevent unauthorized access to campus and studying facilities. They can use AI-powered CCTV cameras, biometric technology, and facial recognition to keep unauthorized people off campus, so that a student can get in a dorm only if they have their fingerprints or facial features scanned.

Besides increased safety, [AI contributes to climate change management](#) and can help educational organizations reduce energy costs. For this, a powerful combination of IoT and artificial intelligence, such as AI-powered smart lighting systems and self-learning thermostats, can be used.

The University of Arizona harnessed AI and sensors to turn its facilities to a smart campus. Their AI analytics is using parking lot occupancy data to deliver a color-coded representation of parking spaces, giving residents the chance to plan their travel. Energy sensors are reporting on how much electricity the buildings are using and how much energy is coming from solar installations. This enables facilities' staff to identify wasteful behavior and configure new energy sources as needed. The university is also using AI to manage its stadium. Smart algorithms conduct visual sentiment analysis to make sure the stadium itself does not offer any distractions during games.

02. Managing student lifecycle

AI can help professors by analyzing tests, assignments, classroom participation notes, and other data to build a unique student profile and identify what captures the student's attention and what causes struggles. Additionally, this technology can help the administrative staff by automating on-campus communications.

Georgia State University has implemented a chatbot to help newly admitted students prepare for enrollment. The chatbot answers questions about financial aid and housing and helps freshmen register for classes. During the first month of adoption, this chatbot exchanged about 50,000 texts, and less than 1% of students had to be routed to the university staff for further clarifications.

03. Ensuring universal access to education

International students or students with special needs benefit from AI as well. Translation tools, for instance, can accurately translate a lecture into a student's native language. Voice recognition and speech-to-text software can transcribe lectures, enabling students with concentration problems to listen to lecture parts several times.

[Presentation Translator](#) is a free PowerPoint plugin that creates and displays subtitles in real time as the lecturer is speaking. This is helpful for students who could not physically attend the lecture or who are still learning the language and cannot catch on to everything by listening.

AI applications in education

04. Facilitating skill-oriented learning

AI-powered chatbots, interactive mobile apps, and virtual assistants can help students master hard and soft skills, like mastering a foreign language, diagnosing a patient, or leveling up their communication and problem-solving abilities. For instance, students who are embarrassed to speak a foreign language can tame their anxiety by conversing with AI-powered chatbots.

One great example of a language learning app is [Duolingo](#). This chatbot understands your current language level and learning abilities, so it gives different responses to the same query posed by two students. This chatbot can help you learn 23 languages. Another example is [Mondly](#). This voice-based bot helps you quickly improve your functional speaking skills. It will converse on topics covering common activities, such as going out for dinner. Mondly offers over 30 languages.

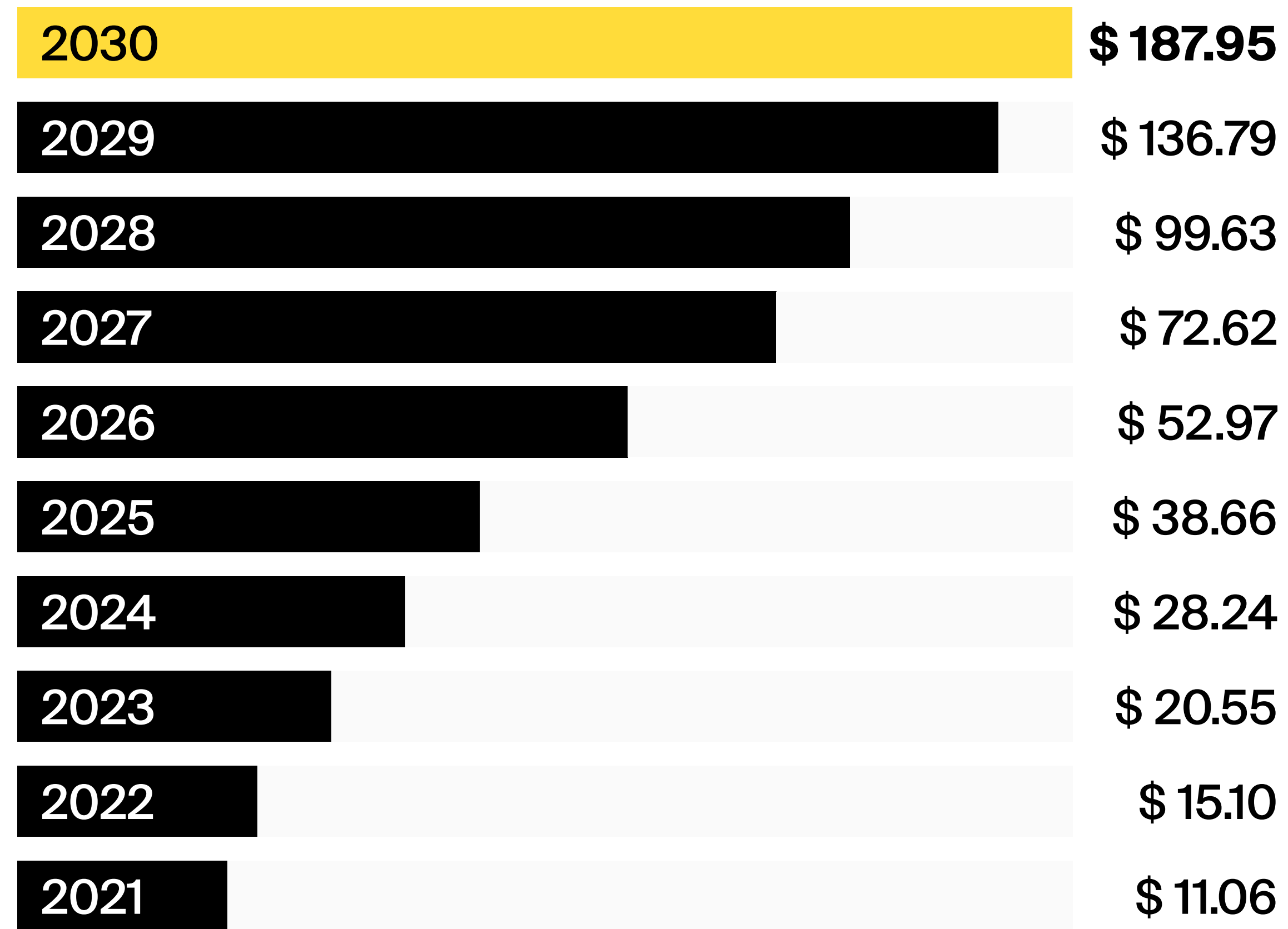
05. Improving student mental health

Universities can promote the use of tech like AI-driven chatbots to expand their mental health care to the students who are reluctant to turn to in-person services. Mental health apps relying on cognitive behavioral therapy have proven effective in alleviating anxiety, depression, and stress levels. Such apps can also analyze data from a mobile phone's built-in sensors or wearables to reveal changes in students' behavior patterns and provide tips on how to prevent their health from worsening.

One example of such software is [Woebot](#). Originally developed for young adults, the bot uses cognitive behavioral therapy techniques while talking to users. Besides therapeutic sessions, the bot can carry daily casual conversations with students and monitor their mood changes on a weekly basis. Stanford University tested Woebot with 70 students aged 18-28. During a two-week experiment, the participants had 20 sessions with the bot. At the end of the experiment, most of the students reported feeling better.

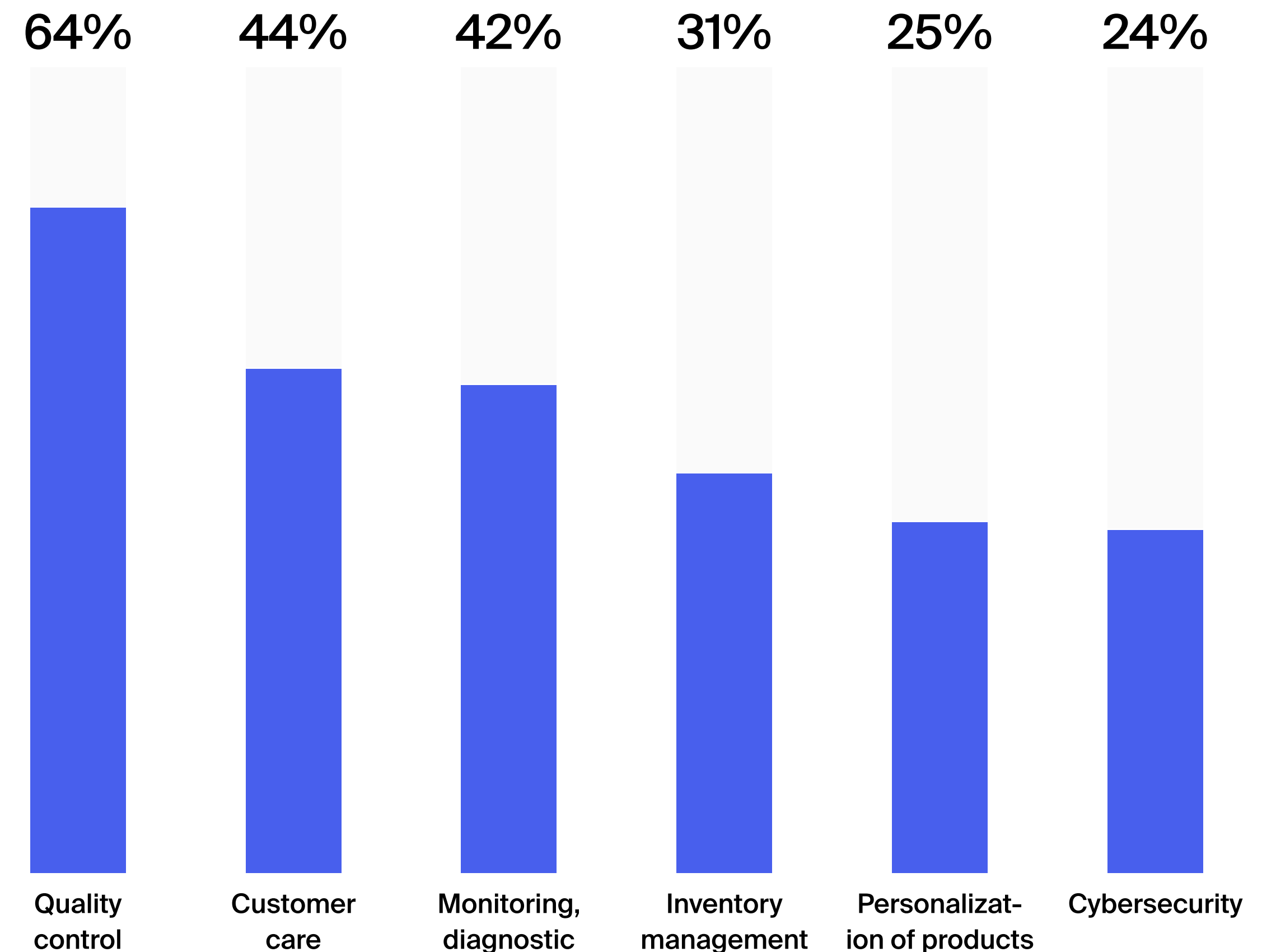
AI applications in healthcare

The global artificial intelligence market in healthcare [was valued at \\$11.06 billion in 2021](#) and is expected to hit \$187.95 by 2030.



Artificial intelligence in healthcare market size, 2021 to 2030 (USD billion)

According to [Statista](#), the most common usage of AI in the pharmaceutical sector is quality control. Now AI presents more diverse opportunities to capitalize on in 2022 and beyond.



AI use cases in the pharma and healthcare industry as of 2020

AI applications in healthcare

01. Speeding up drug development

A study published in Biostatistics reveals that [only 13.8%](#) of drug development programs actually lead to approval. Pharma and biotechnology companies are benefiting from AI to cut costs and increase the drug development success rate.

A biotechnology firm, Cyclica, partnered with Bayer to create an AI-powered technology that scans small-molecule drugs against different proteins and visualizes how they interact. This helps understand the side effects of different components during drug development and reuse existing drugs for new purposes.

Another aspect of drug development is finding participants for clinical trials, which has been a challenge for pharma. Research shows that [86% of clinical trials](#) fail to recruit enough patients.

AI can help in this regard. For example, [Deep 6](#) employs AI to analyze different types of clinical data, such as doctors' notes, medical images, and blood test results. Based on its analysis, the tool creates multi-dimensional patients' profiles, which clinicians use to find suitable candidates. In another instance, Antidote, a clinical trial and patient recruitment company, uses natural language processing to analyze surveys filled by prospective patients and suggest clinical trials that these people are eligible for.

02. Improving medical diagnosis

AI has many applications in radiology. It can detect fractures that are hidden from the human eye, reduce brain tumor classification time to [three minutes](#), identify women at risk of developing breast cancer by analyzing past mammogram scans, and detect neurological abnormality, such as Alzheimer's and Parkinson's at its early stage, allowing patients to make care arrangements while they still can.

One example of AI helping to spot Alzheimer's comes from Stevens Institute of Technology. The researchers developed a natural language processing tool based on convolutional neural networks and trained it using text composed by both healthy and affected individuals. The tool recognized early signs of Alzheimer's in elderly patients solely based on their speech pattern with a [95% accuracy](#).

03. Making sense of clinical data

AI can analyze patient data coming from EHRs, wearable devices, public records, research studies, etc. It can deliver insights that help predict appointment no-shows and hospital readmissions. On a wider spectrum, this technology can help manage population health by spotting disease outbreaks and identifying public health trends. Moreover, AI can facilitate medical research and assist in identifying new treatments.

For example, Massachusetts-based GNS Healthcare uses AI to discover new cancer therapies. The data analytics company uses Reverse Engineering and Forward Simulation technology to turn patient data into computer models. Such models can unveil diagnostic markers that help discover personalized cancer treatments.



AI applications in healthcare

04. Ensuring drug adherence

Medication adherence is very important in drug development trials. If patients don't follow the rules precisely, they can corrupt the results. AI enables clinicians to monitor patient adherence remotely without relying on the patients themselves to confirm they took the right dosage. Additionally, AI algorithms can continuously work on optimizing drug dosages for different patients.

New-York-based AiCure built an image recognition-powered mobile app, which videotapes patients when swallowing their pills. The embedded image recognition system verifies if the right person took the right drug.

Another interesting invention that ensures drug adherence is a smart medication dispenser. This automated device organizes and delivers medication with a touch of a button. It can maintain a strict schedule of pill intake and has additional features, such as communications with caregivers or facial recognition capabilities.

One example is [MedaCube](#) by PharmAdva. The device protects seniors from overdosing by releasing the right medication dosage at the right time. It also alerts caregivers about any missed doses.

05. Enhancing cybersecurity

According to the HIPAA Healthcare Data Breach Report, cyberattacks are frequent in the healthcare sector. The report revealed that most ransomware attacks involved data theft before encryption. April 2021 alone sustained [62 data breaches](#) in the healthcare sector. Seven of them resulted in compromising over 100.000 medical records each.

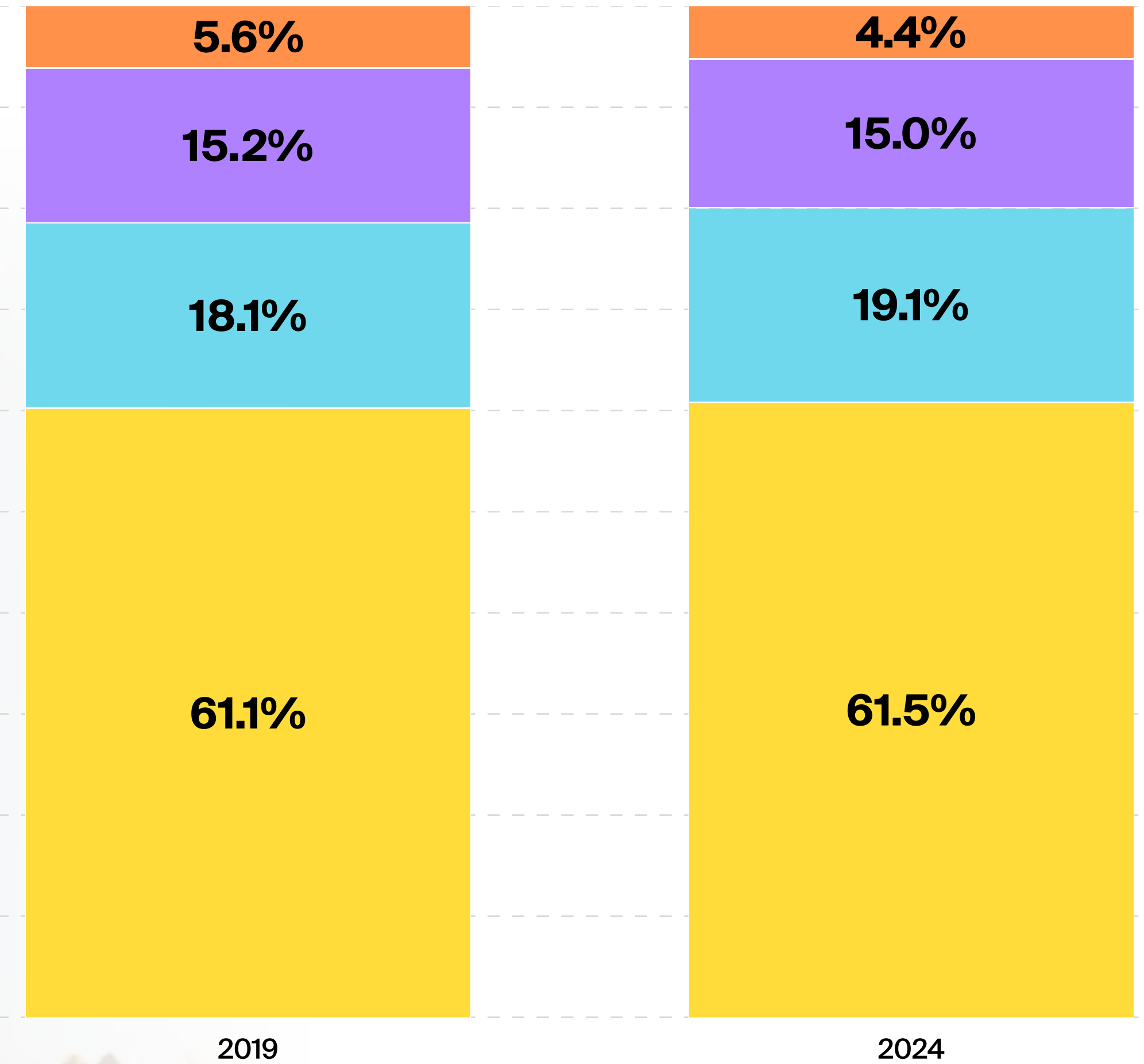
Organizations can use AI to calculate risk scores for different online transactions in real-time and respond to events based on their scores. For example, during a login event, the system will grant access to a low-risk process and block a high-risk process or challenge it for multi-factor authentication. This technology can also monitor data access and sharing to identify any changes in patterns, which could indicate an intrusion.

For example, IBM's Watson is an AI-based cloud service that can accelerate routine security assessments, quickly process the organization's historical cybercrime data, and provide insightful recommendations to its IT staff.

Healthcare organizations are already using artificial intelligence. For instance, Boston Children's Hospital deployed AI to stay one step ahead of the potential attackers and identify anomalous behavior like hundreds of doctors trying to access a patient's record at the same time, as it's happening in compromised IT systems.

AI applications in agriculture

The global AI in agriculture market [was valued at \\$1.08 billion back in 2021](#), and it is expected to amount to \$1.67 billion by 2028, growing at a CAGR of 6.5%. According to Statista, the main focus of AI in agriculture is field farming.



Field farming Livestock farming Indoor farming Others

Share of global AI in agriculture market by farming type

AI applications in agriculture

01. Protecting crops

Pest attack prediction. AI analyzes satellite or drone imagery, uncovering patterns in pest activity and watching new incoming data to notice pre-attack signs. With this data at hand, farmworkers can prevent attacks without affecting crop health or using pesticides.

For example, an early pest warning system by [Wadhvani AI](#) is widely used in India for cotton crop protection. The technology uses ML to identify pests taken from pest traps and offer detailed spray recommendations to farmers to prevent infestation before it gets out of control. Additionally, Wadhvani AI researchers created an algorithm that can identify pests' location within the cotton field.

Crop health monitoring. It is enabled by soil and plant sensors, as well as multispectral images sourced from satellites or drones. By using this data, AI predicts diseases in crops.

[VineView](#) is an example of an app used for monitoring crop health on vineyards. VineView teamed up with Grape Growers of Ontario to help oversee Niagara Region vineyards. They use aerial-based sensors and cloud-enabled image processing tools, which can detect diseases and determine vineyard vigor.

02. Sowing

Analyzing drone-supplied imagery, AI can help farm workers identify places best suited for sowing particular crops based on geographical characteristics of the field, chemical composition of the soil, or any other parameter.

One example of AI-powered sowing tools is [eAgronom](#). It can determine how much of each crop the farm needs to sow in a greenhouse per week, when the crops should be planted in the field, etc. With the help of such tools, farmers can reduce herbicide and fertilizer consumption by 25-35% and increase yield by 3-4%.

03. Harvesting

By comparing current field footage to how this crop looked at this point in the growing cycle during the previous season, AI can accurately predict when the crop will be ready for harvest. And as soon as harvesting time comes, robots can start removing crops from the field.

[Harvest CROO](#), for instance, offers a robotic harvesting solution to pick strawberries that minimizes waste, enhances food safety, and reduces CO2 emissions by 96% compared to traditional harvesting methods.

AI applications in agriculture

04. Cleaning and grooming animals

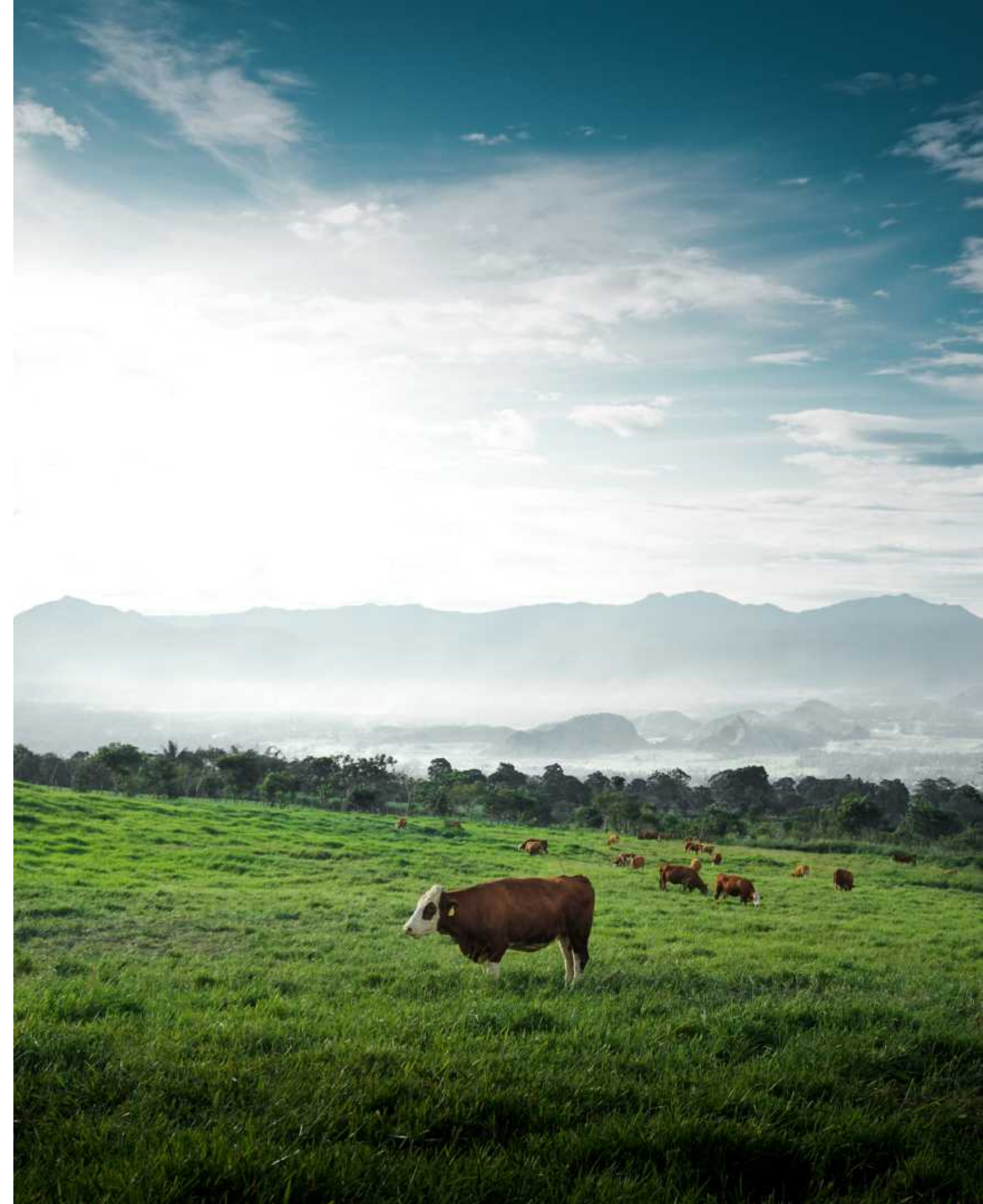
Using technology, such as livestock sensors and image processing, AI can help select and schedule grooming and cleaning procedures, so that farms don't waste resources on excessive maintenance or badly affect livestock health in case of insufficient grooming and cleaning. AI can also improve barn hygiene.

By using cleaning workflow automation solutions in tandem with milking and feeding robots, an Icelandic farm owned by the [Hallgrímsson brothers](#) saw a 30% increase in milk outputs and slashed their vet costs by four times.

05. Breeding

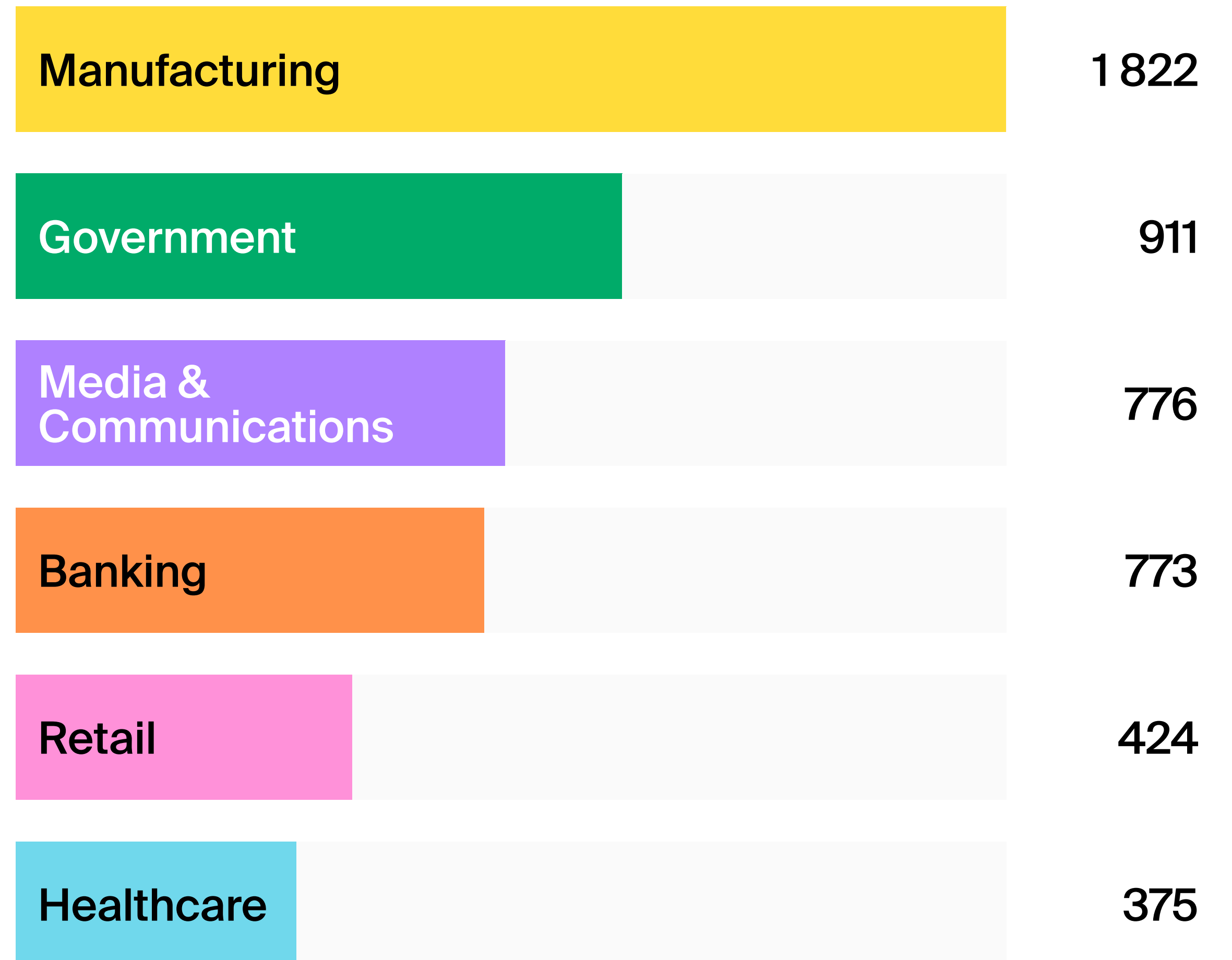
AI-powered tools that focus on smart breeding can identify livestock's reproductive quality and help with fertility management. This technology can also assist in breeding aimed at product quality improvement. If a farm tries to breed a new variety of cows to achieve better milk or meat quality, AI can crunch the data on relevant meat/milk parameters and reproductive qualities of available animals to suggest a 'smart breeding recipe.'

One such tool is Fertile-Eyez by [Verility](#). It offers real-time data on animal reproduction by assessing ovulation samples and analyzing semen for the three major quality indicators: morphology, motility, and concentration. Conventionally, equipment performing this task is large, expensive, and requires effort from farm staff. Fertile-Eyez is a cheaper option, which does not need any specialized training.



AI applications in manufacturing

The global AI in manufacturing market [was valued at \\$1,482 million in 2021](#) and it's expected to hit almost \$18 million by 2028, growing at a CAGR of 51.5%. According to Deloitte, the manufacturing sector surpasses other industries in data generation. Since AI shines at analyzing large amounts of data, it's only natural for the manufacturing industry to adopt this technology.



Petabytes of data created by different industries annually

AI applications in manufacturing

01. Enabling predictive maintenance

Equipment flaws can cause delays and disturbances on production lines, and increase expenses. One minute of downtime [can cost large factories as much as \\$20,000](#). AI-driven predictive maintenance solutions can analyze equipment's performance data, detect anomalies, and predict when the machines will need maintenance before malfunctions occur, disrupting the production process.

General Motors relies on AI to minimize downtime on its production lines. The firm mounted cameras on its assembly robots and trained artificial intelligence algorithms to analyze the incoming data and spot anomalies. In a pilot test, the company deployed this solution on 7,000 robots and [identified 72 instances of malfunctioning](#) before they resulted in an unplanned outage.

02. Forecasting demand

Artificial intelligence can aggregate and analyze data on behavioral patterns, geographics, and weather forecasts to identify products that will be in demand this season. This approach empowers manufacturers to focus on items that will actually sell and minimize expenses associated with products that will probably gather dust on the shelves.

Danone relies on AI to foresee variability in demand and tweak its production plan accordingly. This method helped the company [decrease its lost sales by 30%](#).

03. Supporting generative design

Generative design is an AI-powered application that mimics a human engineer's approach to designing products. Engineers feed this program with various parameters, such as materials to be used and the final product size, and the algorithm generates many design options. This approach enables manufacturers to consider hundreds of alternative designs of one item. AI can further test and filter the resulting designs to determine what works best.

Nissan car manufacturer experimented with deploying artificial intelligence to generate vehicle designs. The company reported that their solution put forward some innovative designs. They were not perfect and too raw to be used as a reference for a car, but it was a good start.



AI applications in manufacturing

04. Building digital twins

To build a digital twin, manufacturers need to aggregate data from sensors attached to actual physical items and project it onto their virtual twins. This way, the virtual item reflects the state of its real-world counterpart. Companies can use digital twins not only to mirror products but also to recreate manufacturing processes and experiment with adaptations.

For example, Unilever used Microsoft Azure to set up digital twins of its eight factories. Embedded AI algorithms observed the production lines and suggested improvements. For instance, one digital twin predicted the correct order of processes on a shampoo production line to get the optimal batch time. Moreover, this technology helped Unilever [reduce the number of production-related alerts by 90%](#), which was a great relief for production line operators.

05. Inspecting product quality

Manufacturers rely on in-line product inspections to make sure the quality is up to the standards. This is a time-consuming process, which can be delegated to artificial intelligence. AI-driven solutions can monitor the production process in real time and detect flaws at early manufacturing stages, enabling engineers to adjust processes and equipment accordingly.

A large food processing organization produces 270,000 eggs per hour, which makes it challenging for human operators to monitor the process and remove all the damaged eggs. The company wanted to experiment with an AI-based quality control system. They trained the system to spot flaws, such as leakage, holes, and cracking in eggshells. After training, it took the system [merely 40 milliseconds](#) to identify any of the classified defects.

7 major AI implementation challenges

Although corporate spending on artificial intelligence [topped \\$50 billion in 2020](#), just 11% of companies that enhanced their workflows with AI [have already seen](#) a significant return on their investments.

Deloitte recently conducted [a survey](#) to evaluate how different organizations worldwide employ or plan to use AI. This survey revealed that AI costs are still among the most prominent obstacles to widespread AI adoption.



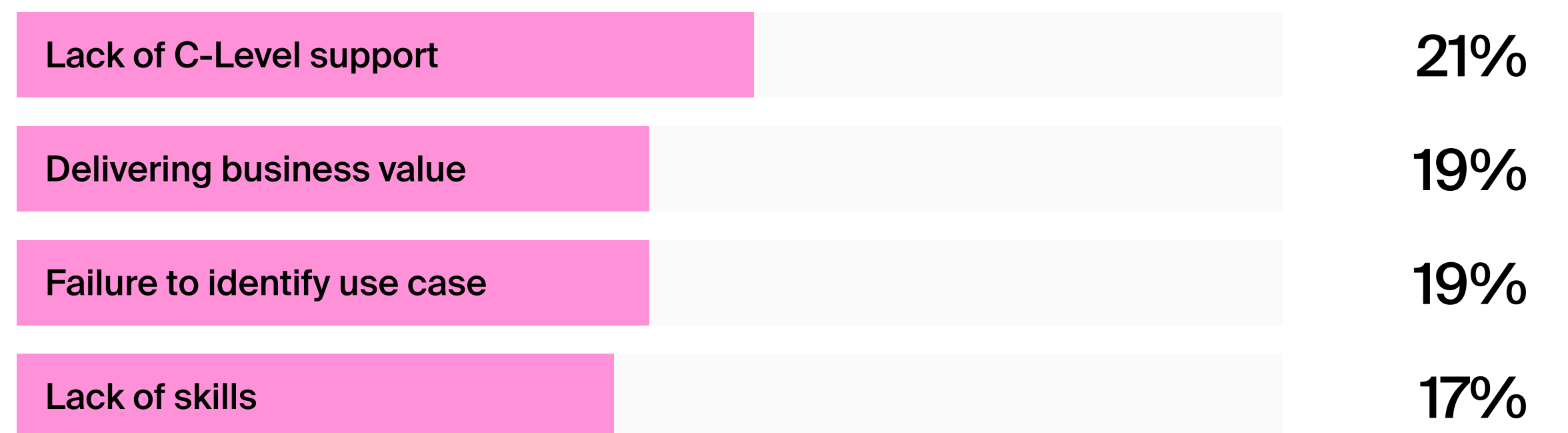
OPERATIONAL



TECHNOLOGICAL



ORGANIZATIONAL



Top AI development and implementation challenges (%)

7 major AI implementation challenges

01. Implementation costs

Although it's hard to estimate the cost of creating and implementing an AI application without diving into the project's details, one may easily spend [\\$50 thousand](#) on a basic system. We will elaborate on this topic in the AI costs section.

02. Hitting technology roadblocks

Poor architecture choices. Making accurate predictions is not the only thing to expect from an AI system. In multi-tenant applications (think AlaaS solutions serving thousands of users), performance, scalability, and effortless management are equally important.

Inaccurate/insufficient training data. Research shows that [96% of companies face data training issues](#) in AI-related projects.

Lack of explainability. [Explainable artificial intelligence \(XAI\)](#) is a concept that revolves around providing enough data to clarify how AI systems come to their decisions. Powered by white-box algorithms, XAI-compliant solutions deliver results that can be interpreted by both developers and subject matter experts. Compared to black-box models like neural networks and complicated ensembles, however, white-box AI models may lack accuracy and predictive capacity, which somewhat undermines the whole notion of artificial intelligence.

03. Replicating lab results in real-life situations

Tech giants can produce AI algorithms that achieve staggering results. For example, in 2017, Oxford and Google DeepMind scientists developed a deep neural network that reads people's lips with 93% accuracy (compared to just 52% scored by humans). However, other companies with fewer capabilities often fail to replicate such success outside the laboratory walls.

04. Getting AI bias under control

Bias occurs when AI algorithms produce results that are systematically prejudiced due to erroneous assumptions in the machine learning process. [Bias in AI](#) can take many forms – from racial bias and gender prejudice to recruiting inequity and age discrimination. For example, a facial recognition system deployed by US law enforcement agencies [is more likely to identify](#) a non-white person as a criminal.

7 major AI implementation challenges

05. Scaling AI

While most companies currently rely on third-party vendors to build smart systems and put them to work, forward-thinking CIOs and IT leaders must ensure their pilot projects help transfer knowledge from external DevOps, MLOps, and DataOps specialists. This way, enterprises could upscale their in-house capabilities before moving AI prototypes into production.

06. Overestimating AI's power

AI algorithms need human knowledge to eventually make accurate predictions. DHL uses a computer vision system to determine whether shipping pallets can be stacked together and optimize space in cargo planes. Gina Chung, VP of Innovation at DHL, says the AI solution performed poorly in its early days. Once the system started learning from human experts who had years of experience detecting non-stackable pallets, the results improved dramatically.

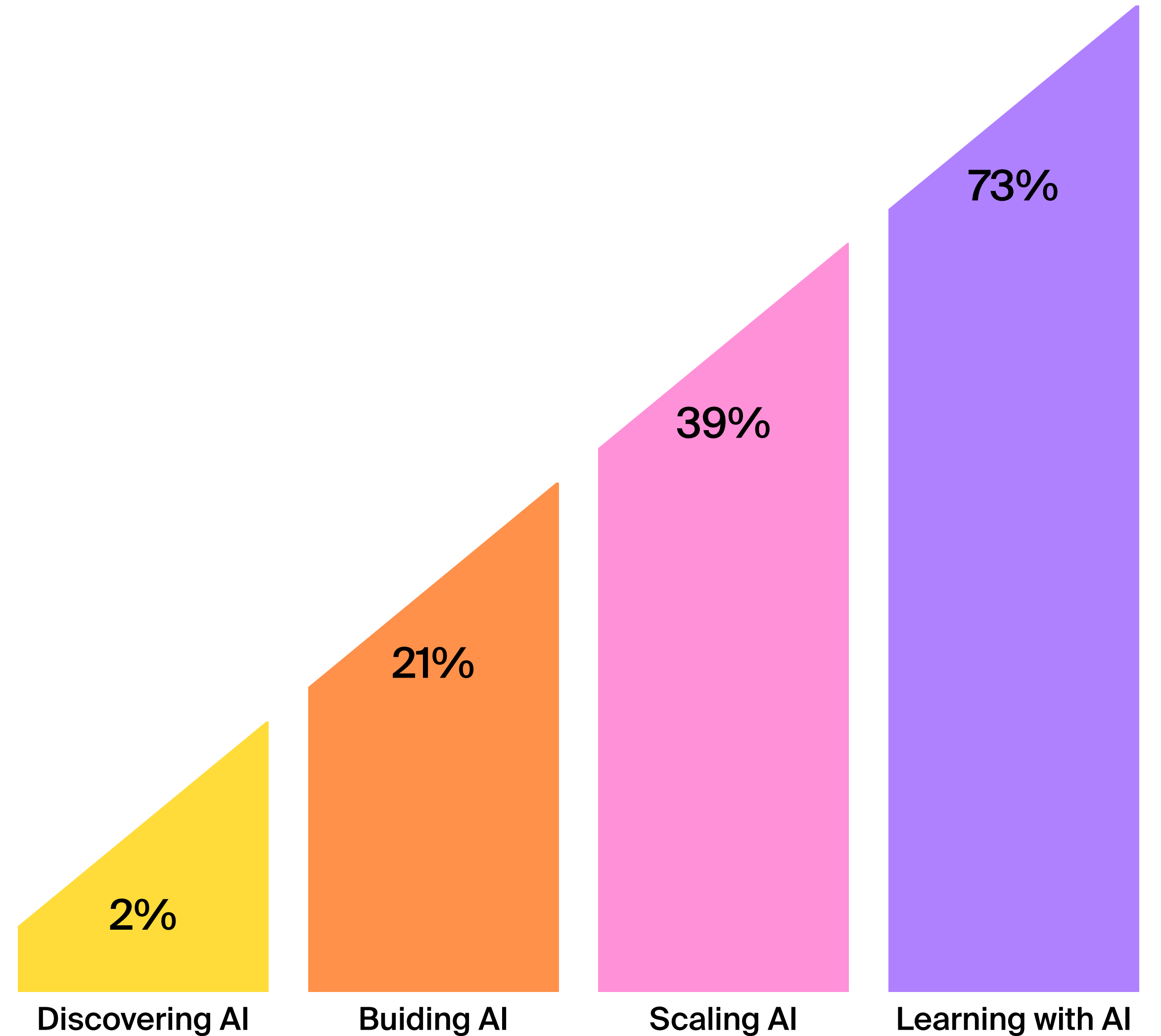
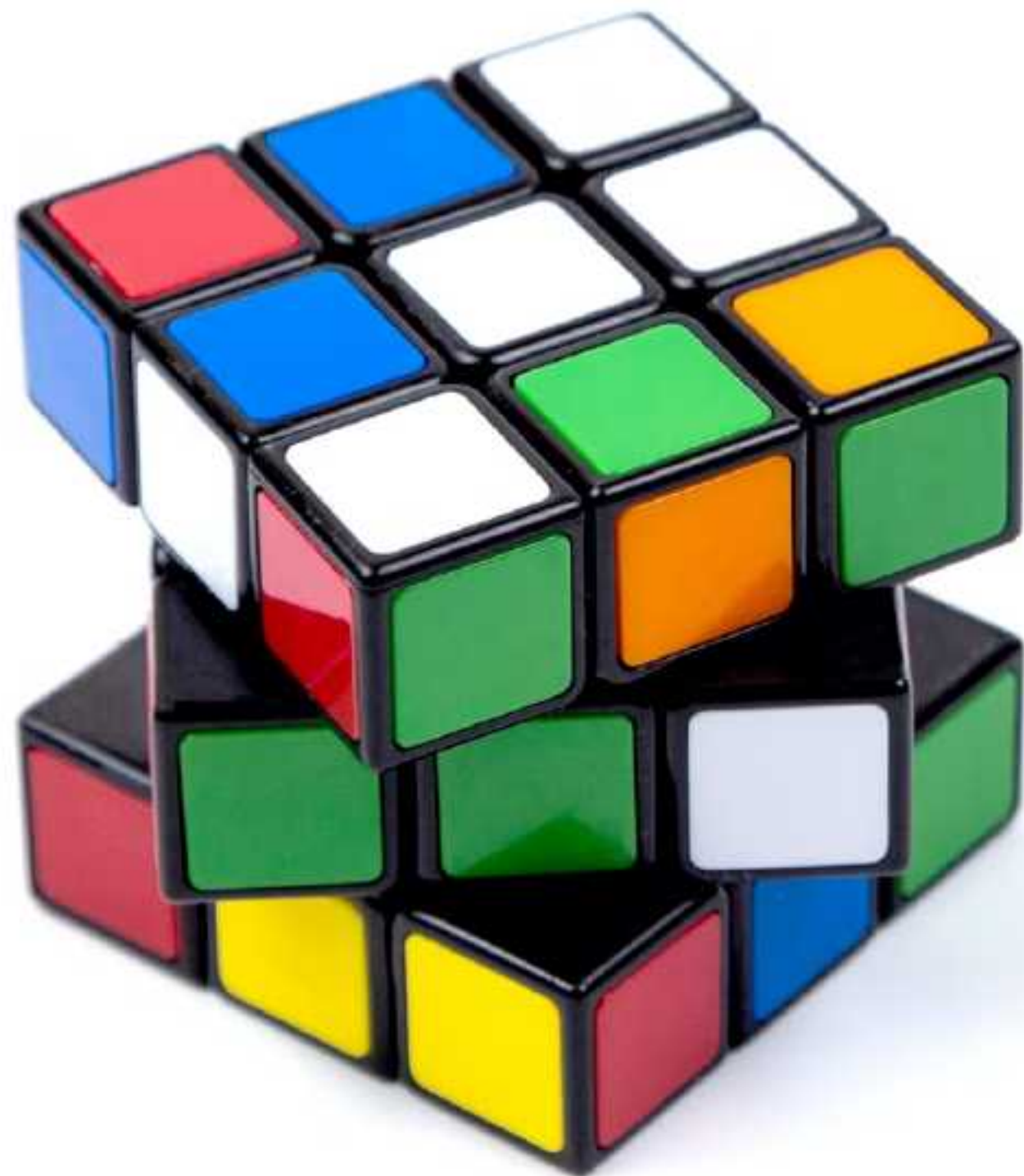
07. Dealing with ethical issues

Ethical issues include moral implications which mainly revolve around companies' intent to replace human workers with highly productive, always-on robots. But while some industries [register persistent changes](#) in their workforce size due to artificial intelligence implementation, it turns out AI will actually create 3% more jobs than it's going to kill.



AI implementation path

As the graph below demonstrates, your chances of achieving the desired return on AI investment increase as you build and scale your system. However, there are a few things that you can do at the very beginning to avoid costly mistakes in the later stages.



Discovering AI Building AI Scaling AI Learning with AI

Chances of achieving ROI increase with every AI development and implementation step

AI implementation path

On the organizational level

- Commit to a vision of becoming a data-driven organization. Identify the current processes that will need adjustment and be ready to implement the change. Communicate your ideas to the employees.
- Ensure that you have the key stakeholders' support to avoid misunderstandings at later stages of the project.
- Prepare to recruit new talent, including data scientists and developers, or collaborate with a trusted tech partner.
- Commit to training your existing employees. Allocate time and budget for this purpose.

On the data level

- Decide on data storage options, whether it's in the cloud or on premises. The on-premises approach gives you control over access and security. But the cloud is cheaper, offers recovery plans, and facilitates expansion.
- Make sure your infrastructure is scalable and can follow along with the unavoidable growth of data volumes.
- Set up strong data governance practices, define the desired level of data quality and accuracy, and determine how the incoming data will be filtered.
- Define data ownership and appoint owners of different datasets. These people will be accountable for data quality, completeness, etc.

On the managerial level

- Address an AI vendor with the relevant portfolio and expertise.
- Work with a skilled business analyst to determine which of your processes and IT systems could benefit from AI.
- Consider how ethical issues might prevent you from using AI to the fullest.
- Create a proof of concept to test the solution feasibility and work around technology-related AI pitfalls.
- Select the optimum technology stack. Utilize a combination of custom-made, open-source, and off-the-shelf components (e.g., plug-and-play facial recognition engines, API-driven voice assistants, and cloud-based services supporting the creation and training of AI algorithms) to develop a vendor-agnostic solution.
- Devise a detailed AI project implementation map covering solution development, integration, and scaling, as well as employee onboarding.
- Together with your vendor, start building your system while ensuring continuous knowledge sharing.
- Appoint subject matter experts to fine-tune AI algorithms.
- Do not raise your hopes high. It takes time, patience, and lots of data to build AI solutions capable of enhancing or taking over critical tasks.
- Treat AI implementation as a work in progress. Once you put AI to work, you may not get perfect results right from the onset; as your AI system consumes new information under the supervision of human specialists, it will deliver more accurate predictions and become more autonomous.



How much does it cost to develop and deploy AI solutions?

The honest answer would be “it depends”, as the price of developing, implementing, and maintaining custom artificial intelligence systems is driven by a number of factors and can only be evaluated on a case-by-case basis.

Below we present the top five factors affecting AI development costs, and five examples from the ITRex portfolio that will give you a better idea of AI cost estimations.

Top 5 factors influencing AI costs

01. Software type

AI is an umbrella term that refers to any device or application that makes decisions based on the information it consumes, thus mimicking human intelligence. Voice assistants that understand questions uttered in natural language, security cameras recognizing people in live video footage, and expert systems that spot cancerous tumors in CT scans can all be described as artificial intelligence. However, their complexity, performance requirements, and, subsequently, costs vary greatly.

02. Intelligence level

Most business AI solutions can be described as narrow AI, meaning they're only programmed to perform a particular task – for example, recognize text in PDF files and convert them into editable documents. To classify as truly intelligent, AI algorithms should be able to uncover patterns in data with little to no human intervention, assess the probability or improbability of an event, justify their assumptions, continuously process new data, and learn from it.

03. Input data quality

AI can ingest both structured data, which is properly organized and stored in relational database management systems (RDBMs), and unstructured data like emails, images, and videos, which are typically bulk-uploaded to data lakes. As far as AI cost is concerned, it is cheaper to work with structured data – especially if there is a substantial quantity of information to boost your algorithms' accuracy. In case of unstructured data, AI experts have to go the extra mile to organize and label it, while software engineers need to set up the complete infrastructure ensuring continuous data flow between the components of the system.

04. Algorithm accuracy

Higher accuracy and reliability of AI predictions directly affect the project's lifespan and increases development cost. Also, AI algorithms will continue to absorb new data as they work alongside human specialists, which may carry additional training and maintenance expenses.

05. System complexity

When discussing the cost of AI, we consider the price of creating proper software, with a cloud-driven back end, ETL/streaming tools, APIs supporting integration with internal and external systems, and some kind of interface, be it a cloud dashboard, mobile app, or voice assistant.



5 projects

**from ITrex portfolio to give you
a hint of AI implementation prices**

AI-powered MRI image enhancement

A Florida-based healthcare company specializing in medical imaging had an idea to improve MRI scan quality purely through software with no hardware-related changes. MRI machines differ in their scan quality depending on the magnetic power; 3 Tesla MRI has a stronger magnet and produces better images than 0.2/0.3 Tesla MRI. Subsequently, 3 Tesla MRIs are more expensive.

This company employed ITrex to develop AI-powered software that would upgrade 0.2/0.3 Tesla scans to the level of 3 Tesla. To achieve this, our team prepared datasets of different scans and built a machine learning algorithm that compares lower quality scans to the 3 Tesla, identifies the differences, and elevates 0.2/0.3 Tesla scans to the quality of 3 Tesla.

The proof of concept for such a project is estimated at approximately

\$15 thousand



AI-driven art generator

A renowned visual artist turned to ITRex to create an AI solution that would generate new paintings based on his works and the works of other artists who inspire him. The client was looking to build a minimum viable product (MVP) version of the system over the course of several weeks to present it at an exhibition.

For the MVP version, we suggested using the Instagram-like 1000 x 1000 image resolution and deploying the AI solution locally, leaving an option to port the system to the cloud in the future.

Depending on the type of training data (e.g., abstract vs. figurative art), image resolution (HD vs. low-resolution output images), and deployment approach, the cost of building an MVP version of an artificial intelligence system like this could reach

\$19-34 thousand



Intelligent recommendation engine

A technopreneur was looking to add AI capabilities to a B2C platform connecting users with local service providers. Our client's idea revolved around replacing cumbersome search filters with advanced machine learning algorithms that would analyze input text and come up with a list of service providers that match a user's query.

In addition to providing personalized recommendations based on user inquiries, the solution comes along with a fully managed cloud infrastructure for training, deploying, and hosting ML models. The system's back end would be written in Python, while user data would be securely stored in the cloud (Amazon S3).

The development, testing, and deployment of a similar artificial intelligence platform (MVP) would cost you anything between

\$20-35 thousand



AI-based telemedicine solution

A healthcare technology company approached ITRex to upgrade an existing telehealth system with video recording capabilities, which is implemented in multiple hospitals across the USA. The new version of the system would allow healthcare providers to apply facial recognition and natural language processing technologies to analyze videos filmed during consultations and potentially improve doctor-patient interactions.

For the pilot version of the telemedicine system, the client selected the speech-to-text functionality only, with no user-facing components expected to ship. The solution conducts linguistic analysis of video recordings to detect possible changes in the communication style that could shed light on patients' well-being and help physicians come up with better treatment plans.

A basic version of a video/speech analysis AI platform may cost

\$36-56 thousand



Machine learning solution for checkout-free shopping

A Milan-based startup reached out to ITrex to develop an AI-powered solution that would turn brick-and-mortar stores checkout free without redesigning them. The solution is expected to track shoppers' movements and detect the items they take from the shelves using ceiling-mounted cameras.

Our team helped the client take their ML model training to the next level. This cooperation included building a visualization system for the data used by the machine learning model to recognize shoppers' actions. ITrex also facilitated sensor data and video management. As a result, the client's technology attracted investors, which led to its acquisition by a San Francisco-based retail company.

This project would cost you

\$60-70 thousand



The future of AI in the enterprise

The ultimate goal of deploying AI in any business is to create an end-to-end data ecosystem where every process and every workflow can be enhanced or automated with the help of data and intelligent algorithms.

A **data ecosystem** is a set of interconnected business applications, analytics tools, and IT infrastructure solutions that help aggregate, cleanse, store, process, and visualize information produced by a company's units and technology systems and perform actions automatically. AI-based data ecosystems may rely solely on internal data (i.e., closed ecosystems) or augment corporate data with insights from other companies and third-party services (i.e., strategic partnerships).

Together with artificial intelligence, the modern data ecosystems are a significant improvement over traditional BI and analytics tools:

By applying machine learning algorithms and deep neural networks to both structured and unstructured data, companies gain an opportunity to identify recurring patterns, envision scenarios that might impact their operations, automate time-consuming tasks, and empower IT systems to make business-critical decisions autonomously.

By granting access to the insights drawn from corporate data to every employee regardless of their technical background, businesses manage to reduce bottlenecks in their workflows and help workers make better-informed decisions based on machine-driven recommendations.



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**Are you planning to deploy AI
in your enterprise but not feeling
confident about how to proceed?**

Get in touch! Whether you have a fully developed concept or just an abstract idea of what you want to achieve, our experts are excited to discuss it with you.