DZone

THE DZONE GUIDE TO

Artificial Intelligence

Machine Learning & Predictive Analytics

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DEAR READER,

Although AI isn't new as a concept, it's still very much in its infancy, and for the first time, as a society, we're beginning to shift towards an AI-first realm. With endless possibilities and so much unchartered territory to explore, it's no wonder that the race for AI supremacy is on. For driven industry professionals of all fields, AI presents an exciting challenge to develop new technologies, set industry standards, and create new processes and workflows, as well as propose new use cases that will enhance the state of human-AI relationships as we know them.

While some are willing to charge full force ahead at any cost, others, like Elon Musk, are concerned that this national AI dominance competition could result in unimaginable conflicts and a tech crisis that we're not equipped to face just yet. Projections aside, there are still a number of very elemental questions that need answering. What exactly is AI? What isn't it? Two seemingly simple questions that have yet to be satisfactorily addressed. As with any emerging field, it's difficult to set the tone and agree on a consensus or set direction. As AI undergoes major shifts, it reshapes our world, as well as our human experience, and as a result our understanding of AI is being challenged every single day.

As it stands, AI should be used as an extension of humans, and implemented so as to foster contextually personalized symbiotic human-AI experiences. In other words, AI should be developed in a manner that is complementary to humans, whether it's designed with the intent to assist or substitute. And, contrary to popular belief, AI isn't designed to replace humans at all, but rather to replace the menial tasks performed by humans. As a result, our AI-powered society will open the door to new jobs and career paths, allowing man to unlock greater possibilities and reach new developmental heights. In short, AI will augment our human experience.

Moreover, as we move forward with AI developments, maintaining the current open and democratized mindset that large organizations like Open AI and Google promote will be critical to addressing the ethical considerations involved with these integrative technologies. When it comes to AI, there are more questions than there are answers, and in this guide, you'll find a balanced take on the technical aspect of AI-first technologies along with fresh perspectives, new ideas, and interesting experiences related to AI. We hope that these stories inspire you and that these findings allow you to redefine your definition of AI, as well as empower you with knowledge that you can implement in your AI-powered developments and experiments.

With this collaborative spirit in mind, we also hope that this guide motivates you and your team to push forward and share your own experiences, so that we can all work together towards building ethically responsible technologies that improve and enhance our lives.

BY CHARLES-ANTOINE RICHARD

DZONE ZONE LEADER, AND MARKETING DIRECTOR, **ARCBEES**

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Executive Summary

BY MATT WERNER
PUBLICATIONS COORDINATOR, DZONE

In the past few years, Artificial Intelligence and Machine Learning technologies have both become more prevalent and feasible than ever before. Open source frameworks like TensorFlow helped get developers excited about their own applications, and after years of experimenting with recommendation engines and predictive analytics, some major organizations like Facebook and Google are trying to break new ground while others, like Tesla, warn of the possibility for harm. There's also been worry that using AI to automate tasks and jobs could cause significant harm to hundreds of people. But, how are developers approaching these new tools and ideas, and why are they interested? To find out, we asked 463 DZone readers to share their motivations for exploring AI, as well as the challenges they face.

WHY AI?

DATA Developers using AI primarily use it for prediction (47%), classification (35%), automation (30%), and detection (28%). Organizations are trying to achieve predictive analytics (74%), task automation (50%), and customer recommendation engines (36%).

IMPLICATIONS Those who are using AI for personal use are working on features that they may have seen in other places, such as a recommendation section on an eCommerce site or streaming service that suggests items to buy based on previous user behavior. Most organizations, on the other hand, are mostly focused on predictive analytics, which can help detect fraudulent behavior, reduce risk, and optimize messaging and design to attract customers.

RECOMMENDATIONS Experimenting with AI frameworks and libraries to mimic features in other applications is a great way to get started with the technology. Developers looking for fruitful careers in the space would also benefit by looking at "big picture" applications, such as predictive analytics, that organizations as a whole are interested in.

LIBRARIES AND FRAMEWORKS

DATA The most popular languages for developing AI apps are Java (41%), Python (40%), and R (16%). TensorFlow is the most popular framework at 25%, SparkMLLib at 16%, and Amazon ML at 10%.

IMPLICATIONS Thanks to familiarity with the language and popular tools like Deeplearning4j and OpenNLP, Java is the most popular language for developing AI apps. Python is close behind for similar reasons: it's a general-purpose language with several easily available data science tools, such as NumPy. TensorFlow quickly took the lead as the most popular framework due to its versatility and functionality, which has created a large community that continues to improve upon it.

RECOMMENDATIONS A good way to reduce the amount of time it takes to become familiar with AI and ML development is to start with general purpose languages developers are familiar with. Open source tools like OpenNLP and SparkMLLib have been built for developing these kinds of apps, so monetary cost is not a factor either. Developers, especially those working with Java and Python, can greatly benefit from exploring the communities and tools that currently exist to start building their own projects and sharing their successes and struggles with the community as it grows.

WHAT'S KEEPING AI DOWN?

DATA Organizations that are not pursuing AI do so due to the lack of apparent benefit (60%), developer experience (38%), cost (35%), and time (28%).

IMPLICATIONS While factors regarding investment into AI are contributing factors to why organizations aren't interested in pursuing AI, the perceived lack of benefit to the organization is the greatest factor. This suggests either a lack of education around the benefits of AI or that the potential gains do not outweigh potential losses at this point.

RECOMMENDATIONS Developers who are playing with AI technologies in their spare time have the ability to create change in their organizations from the bottom-up. Showing managers AI-based projects that simplify business processes could have a significant impact on the bottom line, as well as educating managers on how developers can get started through open source tools tied to existing languages, as explained above. Encouraging other developers to play with these libraries and frameworks either on company or their spare time is a good way to overcome the experience and cost objections, since these tools don't cost money. As developers learn more about the subject, it may be more profitable for organizations to actively invest in AI and incorporate it into their applications.

Key Research Findings

BY G. RYAN SPAIN
PRODUCTION COORDINATOR, DZONE

463 software professionals completed DZone's 2017 AI/Machine Learning survey. Respondent demographics are as follows:

- 36% of respondents identify as developers or engineers, 17% identify as developer team leads, and 13% identify as software architects.
- The average respondent has 13 years of experience as an IT professional. 52% of respondents have 10 years of experience or more; 19% have 20 years or more.
- 33% of respondents work at companies headquartered in Europe; 36% work in companies headquartered in North America.
- 17% of respondents work at organizations with more than 10,000 employees; 25% work at organizations between 1,000 and 10,000 employees; and 23% work at organizations between 100 and 1,000 employees.
- 75% develop web applications or services; 46% develop enterprise business apps; and 28% develop native mobile applications.

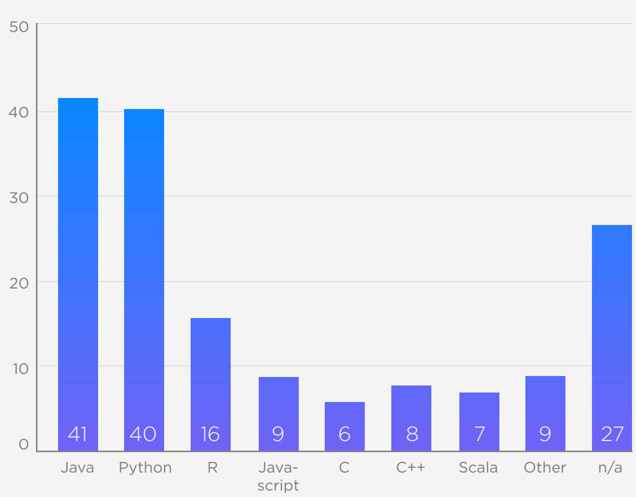
EXPERIENCE

40% of respondents say they have used AI or machine learning in personal projects, 23% say they have used one of these in their organization, and 45% of respondents say they have not used AI or machine learning at all; however, responses to later questions indicate that some respondents may have experimented with machine learning tools or concepts while not considering themselves as using AI or machine learning in their development. For example, only 34% of respondents selected "not applicable" when asked what algorithms they have used for machine learning. 61% of respondents at an organization interested or actively invested in machine learning (59% of total respondents) said their organization is training developers to pursue AI.

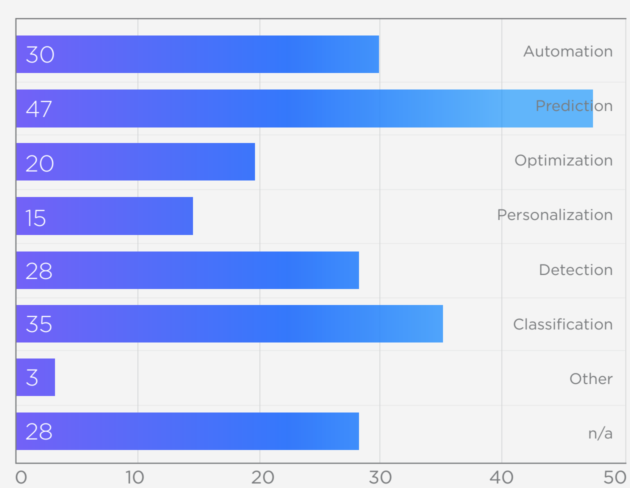
TOOLS OF THE TRADE

One of the most interesting survey findings is about the languages respondents have used for AI/ML. 41% of respondents said they have used Java for AI or machine learning, while 40% said they have used Python. Of the

Which languages do you use for machine learning development?



For what purposes are you using machine learning?



Java users, 73% said that Java is the primary language they use at work, considerably higher than the 54% among all respondents. But among respondents who said they have used AI or machine learning at their organization, Python usage increased to 68%. R was a distant third, with 16% saying they have used R for AI/ML. As far as libraries and frameworks go, TensorFlow was the most popular with 25% of responses; 16% of respondents said they have used Spark MLlib. For machine learning APIs, Google Prediction beat out Watson 17% to 12%. 21% of respondents said they have used an AI/machine learning library not listed in our survey, and 18% said they have used an API not listed, indicating the fragmentation of a still-new tooling landscape.

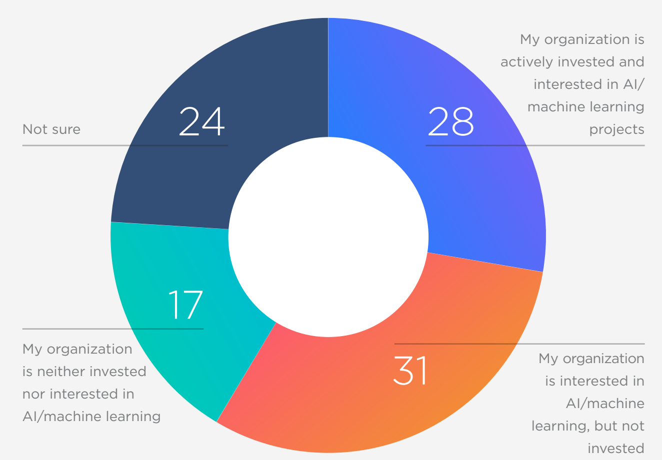
USE CASES AND METHODS

When asked what purposes they are using AI/machine learning from, almost half (47%) of respondents said they were using it for prediction. Other popular use cases were classification (35%), automation (30%), and detection (28%). 74% of respondents who said their organization was interested and/or invested in ML said that predictive analytics was their main use case, followed by automating tasks (50%). Customer recommendations were less sought after at 36%. The most popular type of machine learning among respondents was supervised learning (47%), while unsupervised learning (21%) and reinforcement learning (12%) didn't see as much use. The most commonly used algorithms/machine learning methods were neural networks (39%), decision trees (37%), and linear regression (30%).

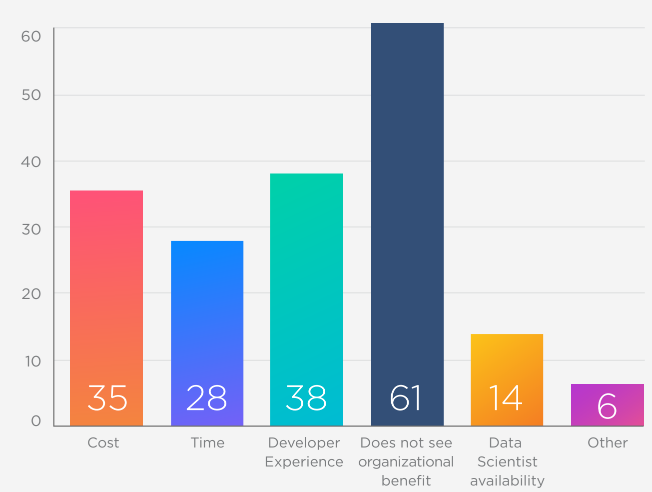
INTEREST AND CHALLENGES

While interest in machine learning is certainly present, it still has a long way to go before it is ubiquitous. Of respondents who have never used AI or machine learning, 54% said there is no current business use case for it, and 40% say they or their organization lacks knowledge on the subject. Respondents who have no personal interest in AI/ML (28%) cite lack of time (48%), ML development experience (40%), and practical benefit (28%) as the major reasons they aren't interested. 17% of respondents say their organization has no interest in AI or machine learning, and 24% aren't sure if their organization has any interest. Among those whose organizations are not interested, factors preventing interest included not seeing organizational benefit (60%), cost (38%), and time (28%). For those who said their organization is interested or invested in AI/machine learning, common challenges organizations face for adoption and use include lack of data scientists (43%), attaining real-time performance in production (40%), developer training (36%), and limited access to usable data (32%). Organization size did have an impact on responses; for example, 64% of respondents who said their organization is actively invested in AI or machine learning said they work at companies with over 1,000 employees, and 81% said they work in companies with over 100 employees.

Is your organization currently invested or interested in AI or machine learning?



What issues prevent your organization from being interested in AI/machine learning?



TensorFlow for Real-World Applications

BY **TIM SPANN**

SOLUTIONS ENGINEER, **HORTONWORKS** AND DZONE ZONE LEADER

QUICK VIEW

01 TensorFlow and deep learning are now something corporations must embrace and begin using.

02 The coming flood of audio, video, and image data and their applications are key to new business and continued success.

03 Images can be versioned by using image tags — this can include both the artifact version and other base image attributes, like the Java version, if you need to deploy in various permutations.

I have spoken to thought leaders at a number of large corporations that span across multiple industries such as medical, utilities, communications, transportation, retail, and entertainment. They were all thinking about what they can and should do with deep learning and artificial intelligence. They are all driven by what they've seen in well-publicized projects from well-regarded software leaders like Facebook, Alphabet, Amazon, IBM, Apple, and Microsoft. They are starting to build out GPU-based environments to run at scale. I have been recommending that they all add these GPU-rich servers to their existing Hadoop clusters so that they can take advantage of the existing production-level infrastructure in place. Though TensorFlow is certainly not the only option, it's the first that is mentioned by everyone I speak to. The question they always ask is, "How do I use GPUs and TensorFlow against my existing Hadoop data lake and leverage the data and processing power already in my data centers and cloud environments?" They want to know how to train, how to classify at scale, and how to set up deep learning pipelines while utilizing their existing data lakes and big data infrastructure.

So why TensorFlow? TensorFlow is a well-known open source library for deep learning developed by Google. It is now in version 1.3 and runs on a large number of platforms used by business, from mobile, to desktop, to embedded devices, to cars, to specialized workstations, to distributed clusters of corporate servers in the cloud and on premise. This ubiquity, openness, and large community have pushed TensorFlow into the enterprise for solving real-world applications such as analyzing images, generating data, natural language processing, intelligent chatbots, robotics, and more.

For corporations of all types and sizes, the use cases that fit well with TensorFlow include:

- Speech recognition
- Image recognition
- Object tagging videos
- Self-driving cars
- Sentiment analysis
- Detection of flaws
- Text summarization
- Mobile image and video processing
- Air, land, and sea drones

For corporate developers, TensorFlow allows for development in familiar languages like Java, Python, C, and Go. TensorFlow is also running on Android phones, allowing for deep learning models to be utilized in mobile contexts, marrying it with the myriad of sensors of modern smart phones.

Corporations that have already adopted Big Data have the use cases, available languages, data, team members, and projects to learn and start from.

The first step is to identify one of the use cases that fits your company. For a company that has a large number of physical assets that require maintenance, a good use case is to detect potential issues and flaws before they become a problem. This is an easy-to-understand use case, potentially saving large sums of money and improving efficiency and safety.

The second step is to develop a plan for a basic pilot project. You will need to acquire a few pieces of hardware and a team with a data engineer and someone familiar with Linux and basic device experience.

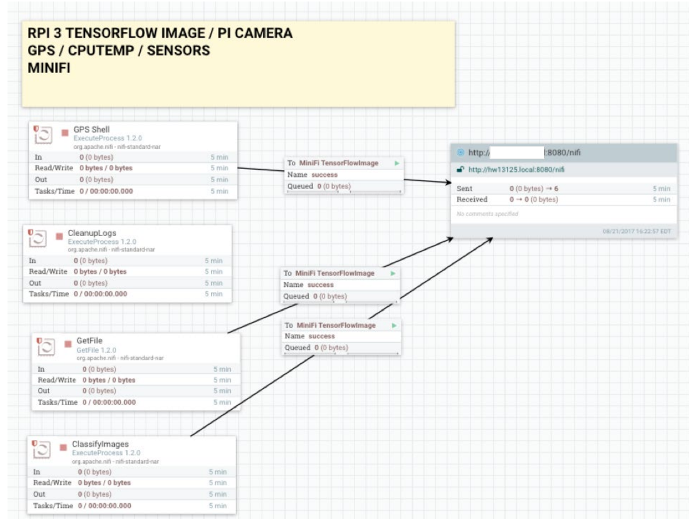
This pilot team can easily start with an affordable Raspberry Pi Camera and a Raspberry Pi board, assuming the camera meets their resolution requirements. They will need to acquire the hardware, build a Raspberry Pi OS image, and install a number of open source libraries. This process is well-documented here.

The first test of this project would be to send images from the camera on regular intervals, analyzed with image recognition, and the resulting data and images sent via Apache MiniFi to cloud servers for additional predictive analytics and learning. The combination of MiniFi and TensorFlow is flexible enough that the classification of images via an existing model can be done directly on the device. This example is documented here at Hortonworks and utilizes OpenCV, TensorFlow, Python, MiniFi, and NiFi.

After obtaining the images and Tensorflow results, you can now move onto the next step, which is to train your models to understand your dataset. The team will need to capture good state images in different conditions for each piece of equipment utilized in the pilot. I recommend capturing these images at different times of year and at different angles. I also recommend using Apache NiFi to ingest these training images, shrink them to a standard size, and convert them to black and white, unless color has special meaning for your devices. This can be accomplished utilizing the built-in NiFi processors: ListFiles, ResizeImage, and a Python script utilizing OpenCV or scikit-image.

The team will also need to obtain images of known damaged, faulty, flawed, or anomalous equipment. Once you have these, you can build and train your custom models. You should test these on a large YARN cluster equipped with GPUs. For TensorFlow to utilize GPUs, you will need to install the tensorflow-gpu version as well as libraries needed by your GPU. For NVidia, this means you will need to install and configure CUDA. You may need to invest in a number of decent GPUs for initial training. Training can be run on in-house infrastructure or by utilizing one of the available clouds that offer GPUs. This is the step that is most intensive, and depending on the size of the images and the number of data elements and precision needed, this step could take hours, days, or weeks; so schedule time for this. This may also need to run a few times due to mistakes or to tweak parameters or data.

Once you have these updated models, they can be deployed to your remote devices to run against. The remote devices do not need the processing power of the servers that are doing the training. There are certainly cases where new multi-core GPU devices available could be utilized to handle faster processing and more cameras. This would require analyzing the environment, cost of equipment, requirements for timing, and other factors related to your specific use case. If this is for a vehicle, drone, or a robot, investing in better equipment will be worth it. Don't put starter hardware in an expensive vehicle and assume it will work great. You may also need to invest in industrial versions of these devices to work in environments that have higher temperature ranges, longer running times, vibrations, or other more difficult conditions.



One of the reasons I recommend this use case is that the majority of the work is already complete. There are well-documented examples of this available at DZone for you to start with. The tools necessary to ingest, process, transform, train, and store are the same you will start with.

TensorFlow and Apache NiFi are clustered and can scale to huge number of real-time concurrent streams. This gives you a production-ready supported environment to run these millions of streaming deep learning operations. Also, by running TensorFlow directly at the edge points, you can scale easily as you add new devices and points to your network. You can also easily shift single devices, groups of devices, or all your devices to processing remotely without changing your system, flows, or patterns. A mixed environment where TensorFlow lives at the edges, at various collection hubs, and in data centers make sense. For certain use cases, such as training, you may want to invest in temporary cloud resources that are GPU-heavy to decrease training times. Google, Amazon, and Microsoft offer good GPU resources on-demand for these transient use cases. Google, being the initial creator of TensorFlow, has some really good experience in running TensorFlow and some interesting hardware to run it on.

I highly recommend utilizing Apache NiFi, Apache MiniFi, TensorFlow, OpenCV, Python, and Spark as part of your Artificial Intelligence knowledge stream. You will be utilizing powerful, well-regarded open source tools with healthy communities that will continuously improve. These projects gain features, performance and examples at a staggering pace. It's time for your organization to join the community by first utilizing these tools and then contributing back.

Tim Spann is a Big Data Solution Engineer. He helps educate and disseminate performant open source solutions for Big Data initiatives to customers and the community. With over 15 years of experience in various technical leadership, architecture, sales engineering, and development roles, he is well-experienced in all facets of Big Data, cloud, IoT, and microservices. As part of his community efforts, he also runs the Future of Data Meetup in Princeton.

Data Integration and Machine Learning for Deeper Customer Insights

BY **BOB HAYES**
PRESIDENT, **BUSINESS OVER BROADWAY**

QUICK VIEW

01 The goal of analytics is to "find patterns" in data. These patterns take the form of statistical relationships among the variables in your data.

02 The key to discovering new insights is to connect the dots across your individual data silos.

03 Data scientists are limited by their ability to manually sift through the data to find meaningful insights.

04 Data scientists rely on the power of machine learning to quickly and accurately uncover the patterns—the relationships among variables—in their data.

In this Big Data world, a major goal for businesses is to maximize the value of all their customer data. In this article, I will argue why businesses need to integrate their data silos to build better models and how machine learning can help them uncover those insights.

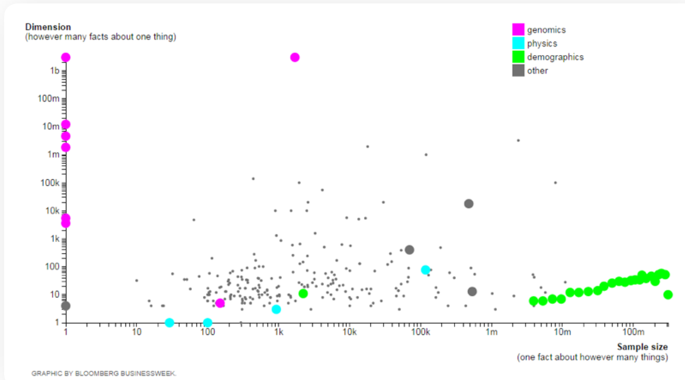
THE VALUE OF DATA IS INSIGHT

The goal of analytics is to "find patterns" in data. These patterns take the form of statistical relationships among the variables in your data. For example, marketing executives want to know which marketing pieces improve customer buying behavior. The marketing executives then use these patterns—statistical relationships—to build predictive models that help them identify which marketing piece has the greatest lift on customer loyalty.

Our ability to find patterns in data is limited by the number of variables to which we have access. So, when you analyze data from a single data set, the breadth of your insights is restricted by the variables housed in that data set. If your data are restricted to, say, attitudinal metrics from customer surveys, you have no way of getting insights about how customer attitude impacts customer loyalty behavior. Your inability to link customers' attitudes with their behaviors simply prevents any conclusions you can make about how satisfaction with the customer experience drives customer loyalty behaviors.

TWO DIMENSIONS OF YOUR DATA

You can describe the size of data sets along two dimensions: 1) the sample size (number of entities in the data set) and 2) the number of variables (number of facts about each entity). Figure 1 includes a good illustration of different data sets and how they fall along these two size-related dimensions (you can see an interactive graphic version here).



For data sets in the upper left quadrant of Figure 1, we know a lot of facts about a few people. Data sets about the human genome are good examples of these types of data sets. For data sets in the lower right quadrant, we know a few facts about a lot of people (e.g. the U.S. Census). Data silos in business are good examples of these types of data sets.

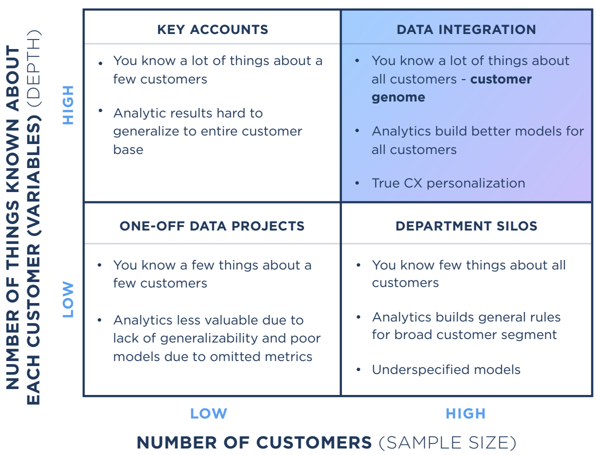
Mapping and understanding all the genes of humans allows for deep personalization in healthcare through focused drug treatments (i.e. pharmacogenomics) and risk assessment of genetic disorders (e.g. genetic counseling, genetic testing). The human genome project allows healthcare professionals to look beyond the "one size fits all" approach to a more tailored approach of addressing the healthcare needs of a particular patient.

THE NEED FOR INTEGRATING DATA SILOS

In business, most customer data are housed in separate data silos. While each data silo contains important pieces of information about your customers, if you don't connect those pieces across those different data silos, you're only seeing parts of the entire customer puzzle.

Check out this TED talk by Tim Berners-Lee on open data that illustrates the value of merging/mashing disparate data sources together. Only by merging different data sources together can new discoveries be made—discoveries that are simply not possible if you analyze individual data silos alone.

Data Integration:
Your Customer Genome Project



Siloed data sets prevent business leaders from gaining a complete understanding of their customers. In this scenario, analytics can only be conducted within one data silo at a time, restricting the set of information (i.e. variables) that can be used to describe a given phenomenon; your analytic models are likely underspecified (not using the complete set of useful predictors), thereby decreasing your model's predictive power/increasing your model's error. The bottom line is that you are not able to make the best prediction about your customers because you don't have all the necessary information about them.

The integration of these disparate customer data silos helps your analytics team to identify the interrelationships among the different pieces of customer information, including their purchasing behavior, values, interests, attitudes about your brand, interactions with your brand, and more. Integrating information/facts about your customers allows you to gain an understanding about how all the variables work together (i.e. are related to each other), driving deeper customer insight about why customers churn, recommend you, and buy more from you.

The Bottom Line: the total, integrated, unified data set is greater than the sum of its data silo parts. The key to discovering new insights is to connect the dots across your data silos.

MACHINE LEARNING

After the data have been integrated, the next step involves analyzing the entire set of variables. However, with the integration of many data silos, including CRM systems, public data (e.g. weather), and inventory data, there is an explosion of possible analyses that you can run on the combined data set. For example, with 100 variables in your database, you would need to test around 5000 unique pairs of relationships to determine which variables are related to each other. The number of tests grows exponentially when you examine unique combinations of three or more variables, resulting in millions of tests that have to be conducted.

Because these integrated data sets are so large, both with respect to the number of records (i.e. customers) and variables in them, data scientists are simply unable to efficiently sift through the sheer volume of data. Instead, to identify key variables and create predictive models, data scientists rely on the power of machine learning to quickly and accurately uncover the patterns—the relationships among variables—in their data.

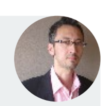
Rather than relying on the human efforts of a single data scientist, companies can now apply machine learning. Machine learning uses statistics and math to allow computers to find hidden patterns (i.e. make predictions) among variables without being explicitly programmed where to look. Iterative in nature, machine learning algorithms continually learn from data. The more data they ingest, the better they get at finding connections among the variables to generate algorithms that efficiently define how the underlying business process works.

In our case, we are interested in understanding the drivers behind customer loyalty behaviors. Based on math, statistics, and probability, algorithms find connections among variables that help optimize important organizational outcomes—in this case, customer loyalty. These algorithms can then be used to make predictions about a specific customer or customer group, providing insights to improve marketing, sales, and service functions that will increase business growth.

The Bottom Line: the application of machine learning to uncover insights is an automated, efficient way to find the important connections among your variables.

SUMMARY

The value of your data is only as good as the insights you are able to extract from it. These insights are represented by relationships among variables in your data set. Sticking to a single data set (silo) as the sole data source limits the ability to uncover important insights about any phenomenon you study. In business, the practice of data science to find useful patterns in data relies on integrating data silos, allowing access to all the variables you have about your customers. In turn, businesses can leverage machine learning to quickly surface the insights from the integrated data sets, allowing them to create more accurate models about their customers. With machine learning advancements, the relationships people pursue (and uncover) are limited only by their imagination.



Bob E. Hayes (Business Over Broadway) holds a PhD in industrial-organizational psychology. He is a scientist, blogger and author (TCE: Total Customer Experience, Beyond the Ultimate Question and Measuring Customer Satisfaction and Loyalty). He likes to solve problems through the application of the scientific method and uses data and analytics to help make decisions that are based on fact, not hyperbole. He conducts research in the area of big data, data science, and customer feedback (e.g. identifying best practices in CX/Customer Success programs, reporting methods, and loyalty measurement), and helps companies improve how they use their customer data through proper integration and analysis.

Discover "Unknown Unknowns" with AI Analytics and Anomaly Detection

Tracking hundreds of thousands of metrics can easily become overwhelming. Traditional monitoring tools like BI dashboards, only show a subset or aggregation of your data, so you may be looking at the wrong thing, or missing significant details. Static thresholds can set off alert storms, forcing you to spend way too much time searching for the root cause. Meanwhile, an important business service could be performing poorly, or worse, be down!

Yet if you track everything, you can detect anything. AI can accurately and automatically zero-in on anomalies from time series data – even for millions of individual metrics, finding even the issues you didn't know to look for. But building your own AI solution for time series anomaly detection can tie up experienced data scientists and developers for years.

Anodot's AI analytics brings your team their most important business insights, automatically learning the normal behavior of your time series metrics, and alerting on abnormal behavior. By continuously analyzing all of your business data, Anodot detects the business incidents that matter, and identifies why they are happening by correlating across multiple data sources to give you critical insights.

AI analytics frees your data scientists from building an AI solution from scratch, and unburdens your analysts from trying to manually spot critical anomalies while your business is moving forward, often at breakneck speed. AI analytics can eliminate business insight latency, and give your business the vital information to turn your time series data into a competitive advantage.

Explore the Ultimate Guide to Building an Anomaly Detection System.

WRITTEN BY IRA COHEN

CHIEF DATA SCIENTIST AND CO-FOUNDER, **ANODOT**

AI-Powered NLP: The Evolution of Machine Intelligence from Machine Learning

QUICK VIEW

01 Classical machine learning techniques are used for text mining to accomplish sentiment analysis, topic modelling, TF–IDF, NER, etc.

02 With the advent of deep learning techniques, MI objectives like automated real-time question-answering, emotional connotation, fighting spam, machine translation, summarization, and information extraction are achieved.

03 Word embeddings, recurrent neural networks, and long short-term memory (LSTM) are used for content creation in author's style.

BY **TUHIN CHATTOPADHYAY, PH.D.**
BUSINESS ANALYTICS EVANGELIST

This article will illustrate the transition of the NLP landscape from a machine learning paradigm to the realm of machine intelligence and walk the readers through a few critical applications along with their underlying algorithms. Nav Gill's blog on the stages of AI and their role in NLP presents a good overview of the subject. A number of research papers have also been published to explain how to take traditional ML algorithms to the next level. Traditionally, classical machine learning techniques like support vector machines (SVM), neural networks, naïve Bayes, Bayesian networks, Latent Dirichlet Allocation (LDA), etc. are used for text mining to accomplish sentiment analysis, topic modelling, TF–IDF, NER, etc.

However, with the advent of open-source APIs like TensorFlow, Stanford's CoreNLP suite, Berkeley AI Research's (BAIR) Caffe, Theano, Torch, Microsoft's Cognitive Toolkit (CNTK), and licenced APIs like api.ai, IBM's Watson Conversation, Amazon Lex, Microsoft's Cognitive Services APIs for speech (Translator Speech API, Speaker Recognition API, etc.), and language (Linguistic Analysis API, Translator Text API etc.), classical text mining algorithms have evolved into deep learning NLP architectures like recurrent and recursive neural networks. Google Cloud, through its Natural Language API (REST), offers sentiment analysis, entity analysis, entity sentiment analysis, syntactic analysis, and content classification. Before diving further into the underlying deep learning algorithms, let's take a look at some of the interesting applications that AI contributes to the field of NLP.

To start with the craziest news, artificial intelligence is writing the sixth book of *A Song of Ice and Fire*. Software engineer Zack Thoutt is using a recurrent neural network to help wrap up George R. R. Martin's epic saga. Emma, created by Professor Aleksandr Marchenko, is an AI bot for checking plagiarism that amalgamates NLP, machine learning, and stylometry. It helps in defining the authorship of write-up by studying the way people write. Android Oreo has the ability to recognize text as an address, email ID, phone number, URL, etc. and take the intended action intelligently. The smart text selection feature uses AI to recognize commonly copied words as a URL or business name. IBM Watson Developer Cloud's Tone Analyzer is capable of extracting the tone of any documents like tweets, online reviews, email messages, interviews, etc. The analysis output is a dashboard with visualizations of the presence of multiple emotions (anger, disgust, fear, joy, sadness), language style (analytical, confident, tentative), and social tendencies (openness, conscientiousness, extraversion, agreeableness, emotional range). The tool also provides sentence level analysis to identify the specific components of emotions, language style, and social tendencies embedded in each sentence.

ZeroFox is leveraging AI on NLP to bust Twitter's spam bot problem and protect social and digital platforms for enterprises. Google Brain is conducting extensive research on understanding natural language, and came up with unique solutions like autocomplete suggestions, autocomplete for doodles, and automatically answered e-mails, as well as the RankBrain algorithm to transform Google search. Google's Neural Machine Translation reduces translation errors by an average of 60% compared to Google's older phrase-based system. Quora conducted a Kaggle competition to detect duplicate questions where the modellers reach 90% accuracy. Last but not least, seamless question-answering is accomplished through a number of artificially intelligent natural language processors like Amazon's Alexa Voice Service (AVS), Lex, and Polly, along with api.ai, archie.ai, etc. that can be embedded in devices like Echo and leveraged for virtual assistance through chatbots.

"While the focus of ML is natural language understanding (NLU), MI is geared up for natural language generation (NLG) that involves text planning, sentence planning, and text realization."

Thus, the shift in gears from machine learning to machine intelligence is achieved through automated real-time question-answering, emotional analysis, spam prevention, machine translation, summarization, and information extraction. While the focus of ML is natural language understanding (NLU), MI is geared up for natural language generation (NLG) that involves text planning, sentence planning, and text realization. Conventionally, Markov chains are used for text generation through the prediction of the next word from the current word. A classic example of a Markov chain is available at SubredditSimulator.

However, with the advent of deep learning models, a number of experiments were conducted through embedded words and recurrent neural networks to generate text that can keep the style of the author intact. The same research organization, Indigo Research, published a blog recently that demonstrates the application of long short-term memory (LSTM) in generating the text through "memories" of a priori information. A number of research and development initiatives are currently going on the artificial natural language processing to match the human processing of language and eventually improve it.

The Stanford Question Answering Dataset (SQuAD) is one such initiative, with 100,000+ question-answer pairs on 5222300+ articles which were also shared in a Kaggle competition. Dynamic Co-attention Network (DCN), which combines a co-attention encoder with a dynamic pointing decoder, gained prominence as the highest performer (Exact Match 78.7 and F1 85.6) in SQuAD and in automatically answering questions about documents. Other applications of deep learning algorithms that generate machine intelligence in the NLP space include bidirectional long short-term memory (biLSTM) models for non-factoid answer selection, convolutional neural networks (CNNs) for sentence classification, recurrent neural networks for word alignment models, word embeddings for speech recognition, and recursive deep models for semantic compositionality. Yoav Goldberg's magnum opus and all the dedicated courses [Stanford, Oxford, and Cambridge] on the application of deep learning on NLP further bear testimony to the paradigm shift from ML to MI in the NLP space.

With the evolution of human civilization, technological advancements continue to complement the increasing demands of human life. Thus, the progression from machine learning to machine intelligence is completely in harmony with the direction and pace of the development of the human race. A few months ago, Nav Gill's blog on the stages of AI and their role in NLP observed that we have reached the stage of machine intelligence, and the next stage is machine consciousness. Of late, AI has created a lot of hype by some who see it as the greatest risk to civilization. However, like any technology, AI can do more good for society than harm — when used correctly. Instead of the predicted cause of the apocalypse, AI may turn out to be the salvation of civilization with a bouquet of benefits, from early cancer detection to better farming.

Tuhin Chattopadhyay is a business analytics and data science thought leader. He was awarded Analytics and Insight Leader of the Year in 2017 by KamiKaze B2B Media and was featured in India's Top 10 Data Scientists 2016 by Analytics India Magazine. Tuhin spent the first ten years of his career in teaching business statistics, research, and analytics at a number of reputed schools. Currently, Tuhin works as Associate Director at The Nielsen Company and is responsible for providing a full suite of analytics consultancy services to meet the evolving needs of the industry. Interested readers may browse his website for a full profile.

Changing Attitudes and Approaches Towards Privacy, AI, and IoT

QUICK VIEW

01 In the last couple of years there has been a big shift in the approach toward privacy, especially in the eyes of users.

02 Big Data, IoT, and AI technologies have all contributed to the widespread collection and use of personal information.

03 The privacy debate is at a crossroads, where the public, the authorities, and big companies must decide which direction the industry will turn.

BY **IRA PASTERNAK**
PRODUCT MANAGER, **NEURA INC.**

Privacy differs from culture to culture, and changes along with technological advancements and sociopolitical events. Privacy today is a very fluid subject—a result of major changes that took place in the last five or so years.

The big bang of privacy awareness happened in June 2013, when the Snowden leaks came to light. The public was exposed to surveillance methods executed by the governments of the world, and privacy became a hot topic. Meanwhile, data collection continued, and by 2015, almost 90 percent of the data gathered by organizations was collected within only two years. Compare this with only 10 percent of data being collected before 2013. People started to realize that a person could be analyzed according to online behavior, and a complete profile of social parameters like social openness, extraversion, agreeableness, and neuroticism could be created from just ten likes on Facebook.

Google Chief Economist Hal Varian wrote in 2014, "There is no putting the genie back in the bottle. Widespread sensors, databases, and computational power will result in less privacy in today's sense, but will also result in less harm due to the establishment of social norms and regulations about how to deal with privacy issues."

In 2015, at the height of The Privacy Paradox, the general belief was that privacy would soon reach a tipping point with regulatory crackdowns on big companies and public demand for better protection. By late 2016, it was clear that the European Union was set to approve the new General Data Protection Regulation.

Privacy views continued to evolve in 2016. A survey of American consumers showed a drastic change in public opinion from only one year earlier. Ninety-one percent of respondents strongly agreed that users had lost control of how their data was collected and used. When asked again whether collecting data in exchange for improved services was okay, 47 percent approved, while only 32 percent thought it wasn't acceptable—a drop of 39 percent in just one year. The feelings of powerlessness for "losing control of their data" changed to a more businesslike approach; users were willing to cooperate with the data collection in exchange for better services.

This shift continues with the realization that users are willing to exchange their data for personalized services and rewards. A survey conducted by Microsoft found that 82 percent of participants were ready to share activity data, and 79 percent were willing to share their private profile data, like gender, in exchange for better services. This correlated with the change in the willingness to purchase adaptive products. Fifty-six percent stated they were more likely to buy products that were adapting to their personal lives, rather than non-adaptive products.

This correlates with the first real commercial use of an AI service to personalize user apps and IoT devices to match users' physical world personas, preferences, and needs. As users have seen the value of personalized experience, they have relaxed their grip on accessing their personalized data. It should be noted, this is not the same thing as more targeted advertising. When users think they are allowing access to their data or relevant notifications and products that anticipate their needs, and receive advertising instead, they are disappointed, annoyed, and in some cases, hostile. In other words, if the user feels they've been deceived, they are less likely to trust that brand and possibly other AI-enhanced apps and products in the near future.

As companies plan to integrate AI into their apps and IoT devices, they must be aware of the changes in privacy cultural norms and newly enacted laws. Prior to 2017, the most common reply regarding private data collection was, "you don't have to be afraid if you don't have anything to hide." In 2017, we realized the power lies not in the secrets one might have, but in understanding one's daily routines and behaviors. We have moved beyond the issue of individuals being tracked for the sake of ads. It has become a story of tracking for the sake of building social-psychological profiles and executing micro-campaigns, so users will act the way you want them to in the real world.

Two important privacy-related acts of 2017 were the removal of restrictions on data trading in the US and stricter regulation on data trading in the EU. Companies will need to know both to navigate privacy regulations in the global economy.

The most obvious, basic difference between the two approaches is that the European law includes the right to be forgotten, while the American law doesn't. The European model says there should be strict regulations, followed by heavy penalties to the disobedient, to protect the end user from data collectors. The American model is more of a free market approach where everything is for sale, and in the end, the market will create the balance that is needed. It's no coincidence that Europe, with its historical understanding of the dangers of going without privacy protection, has privacy laws that are much stricter than in the US. Juxtaposed with both approaches is the Chinese/Russian model, which says the state is the owner of the data, not the companies or the citizens.

And yet, despite of all their fears and worries, most of the participants are not afraid to use the technology, and have more than four devices connected to the internet. For example, 90 percent of young American adults use social media on a daily basis, and online shopping has never been better—almost 80 percent of Americans are making one purchase per month. It seems that on one hand, users are aware of the risks and problems the technology presents today, and on the other hand, most are heavy consumers of that technology.

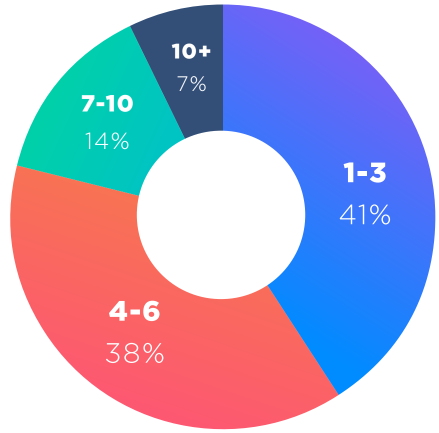


Fig 1. The number of devices I own that connect to the internet (incl. computers, phones, fitness trackers, internet-connected cars, appliances, Wi-Fi routers, cable boxes, etc).

The average person uses various digital services and technologies that provide a lot of data to whomever collects it. Since most of the services by themselves are not harmful, or at least don't mean any harm, there should be no problem, right?

Well, not exactly.

Today's massive data collection has brought us to a place where our privacy is at risk. It is dependent on a partnership between organizations and consumers to ensure cultural and legal privacy standards are met.

Since there is so much at stake, companies need to take a stand regarding their approach toward privacy. The right solution is a model of transparency and collaboration with the users. This model assumes that private data should be owned by the users, and anyone who wishes to approach the users' private data should ask their permission and explain why the data is needed. This way we provide transparency and understanding of the data sharing to all sides. This is particularly important when collecting data that will learn a user's persona and predict their needs or actions. AI holds great potential for user awareness and personalized experience that result in increased engagement and reduced churn. However, technology innovators must understand the benefits of AI can only be realized if users are willing, possibly even enthusiastic participants. It's up to organizations collecting and utilizing user data to follow culture norms and legal requirements. Only then will AI-enhanced apps and products reach their full potential.

Ira Pasternak heads product management at Neura Inc., the leading provider of AI for apps and IoT devices. With a strong background in mobile user experience and consumer behavior, Ira focuses on turning raw sensory data from mobile and IoT into real-world user aware insights that fuel intuitive digital experiences in mHealth, Smart Cars, Connected Homes, and more. Ira is passionate about the psychology behind human interface with technology and the way it shapes our day-to-day life.

ROBOFFICE

AI/ML may be a newer, growing technology, but one day you might find that it is your greatest ally in the office. There have been plenty of robots in movies, TV, and literature that warn us about the dangers of AI, but not nearly as many to demonstrate how AI can help create value for your applications and organizations. Here, DZone presents the Rob-office to walk through the most popular use cases for AI technology with our readers, and what they're used for.

DETECTION

28% of respondents use AI/ML for detection.
Detecting anomalies can be incredibly strenuous on humans trying to keep track of more data than they can handle, but an AI application can identify anomalies in data and alert a customer if something is the out of the ordinary, such as when a credit card is used to buy something in China without buying a plane ticket first.

OPTIMIZATION

20% of respondents use AI/ML for optimization.
AI applications built to optimize are trying to achieve a task or goal the best it can in the least amount of time. Based on what the AI observes, it will try to identify and replicate whatever actions have been taken that lead to the best responses. For example, a Roomba will try to map your floor and learn how to vacuum it in the most efficient way possible.

PERSONALIZATION

15% of users use AI/ML for personalization.
AI/ML can help to personalize UX by learning from a user's past behavior and tailoring the app to improve their experience. A common example is Netflix's suggested titles to stream, which are based on titles you have rated positively and what you've watched recently.

PREDICTION

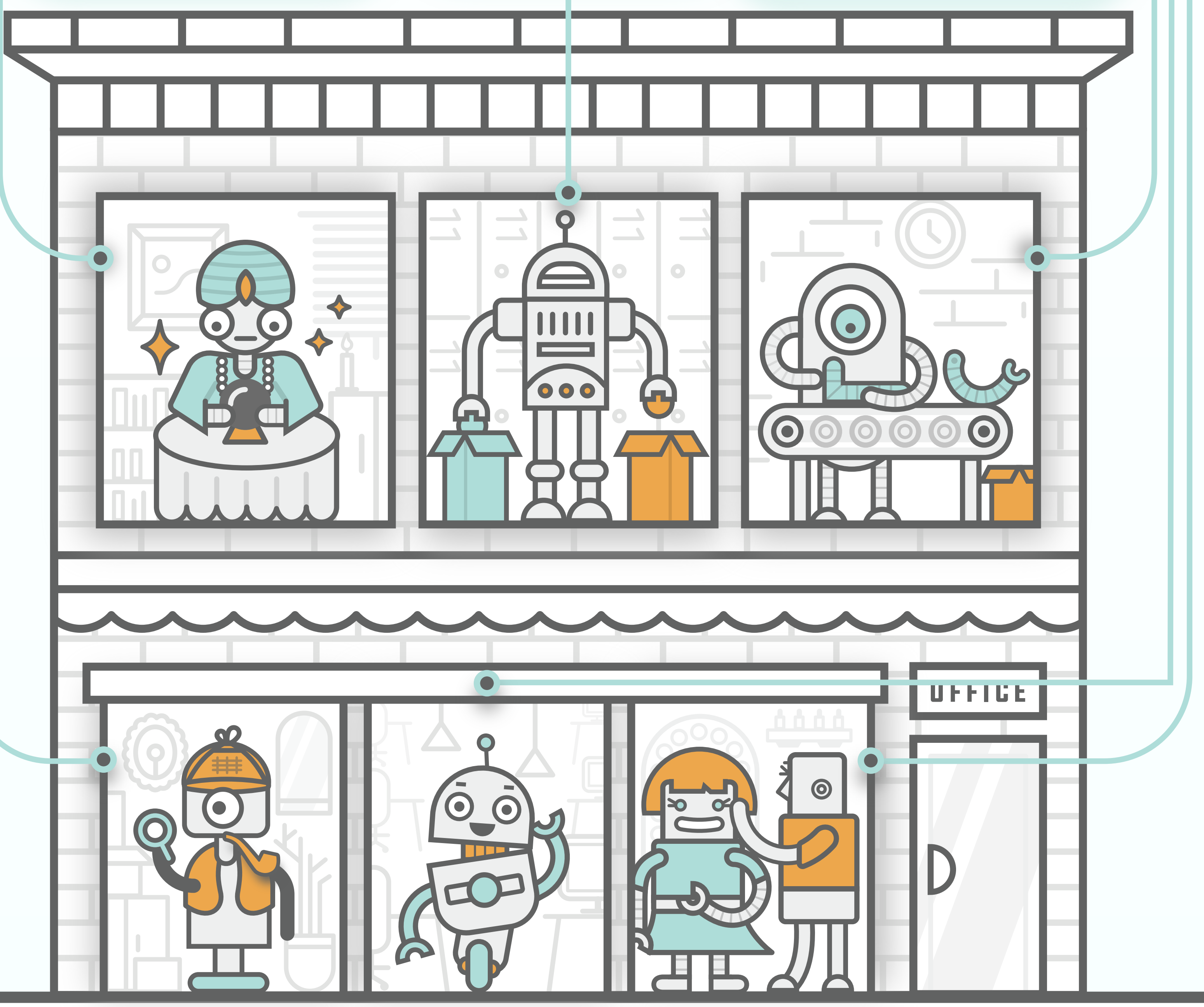
47% of respondents use AI/ML for prediction.
Prediction engines aim to extrapolate likely future results based an existing learning set of data. Prediction engines are useful for setting goals, analyzing application performance metrics, and detecting anomalies. For example, a predictive engine may be able to forecast how a stock's price may change.

CLASSIFICATION

35% of readers use AI/ML for classification.
Classification applications can be very useful to sort different variables into different categories. Rather than manually analyzing responses to a piece of news, an AI application can search for keywords or phrases and recognize which comments are positive or negative.

AUTOMATION

30% of DZone members use AI/ML for automation.
Using AI to automate tasks is a common goal for individuals and organizations. If a simple, repeatable task can be automated by an AI application, it can save tremendous amounts of time and money.



Find out how companies are using AI to increase app engagement by over **900%**

(That's right, we said 900%)

NEURA

The Evolution of AI Products

There are many smart products around us, but not all of them were created equal. There are different categories of AI that smart products can fit into:

- Automated products are the simplest and can be programed to operate at a specific time.
- Connected products are devices that you can control them remotely – like switching a light bulb at home from the office.
- Smart products can detect user activity – like an AC that detects when someone arrived home and starts cooling.
- User-aware products - The ultimate phase in product IQ. They understand who the users are and react to each one personally.

In order for a product to be user-aware it needs to know two things:

1. Who its users are – persona, habits, connections, visited places, etc.
2. What the users are doing – Have they just arrived home? Are they at the gym?

Combining who the users are and what they're doing enables user aware products to address user needs like never before.

Think about a smart home that knows that a user is returning from a run and cools the house a bit more. Or, a car audio system that knows its driver is alone on the way to the office and that under these conditions likes listening to podcasts.

And, it's not just IoT devices – it can be a coupon app that knows that Sheila is an avid runner and will show her discounts for running gear when she's at the mall, or a medication adherence app that reminds each user to take their meds personally when they're about to go to sleep.

These aren't visions for the future of AI, with the add-on SDK we've developed at Neura, any company can integrate AI into their product, instantly.

Welcome to the next phase of AI.

WRITTEN BY DROR BREN

PRODUCT MARKETING MANAGER, **NEURA**

Reinforcement Learning for the Enterprise

BY **SIBANJAN DAS**
BUSINESS ANALYTICS AND DATA SCIENCE CONSULTANT AND DZONE ZONE LEADER

QUICK VIEW

01 Reinforcement Learning is a first step towards general artificial intelligence that can survive in a variety of environments instead of being tied to certain rules or models.

02 Reinforcement Learning finds extensive application in scenarios where human interference is involved and cannot be solved by current age rule-based automation and traditional machine learning algorithms.

03 Identify various open source reinforcement learning libraries and get started designing solutions for your enterprise's problems.

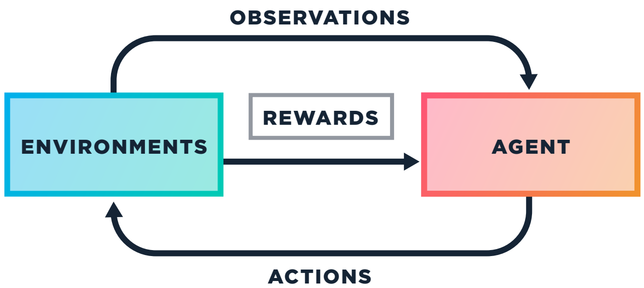
Humanity has a unique ability to adapt to dynamic environments and learn from their surroundings and failures. It is something that machines lack, and that is where artificial intelligence seeks to correct this deficiency. However, traditional supervised machine learning techniques require a lot of proper historical data to learn patterns and then act based on them. Reinforcement learning is an upcoming AI technique which goes beyond traditional supervised learning to learn and improve performance based on the actions and feedback received from a machine's surroundings, like the way humans learn. Reinforcement learning is the first step towards artificial intelligence that can survive in a variety of environments, instead of being tied to certain rules or models. It is an important and exciting area for enterprises to explore when they want their systems to operate without expert supervision. Let's take a deep dive into what reinforcement learning encompasses, followed by some of its applications in various industries.

SO, WHAT CONSTITUTES REINFORCEMENT LEARNING?

Let's think of the payroll staff whom we all have in our organizations. The compensation and benefits (C&B) team comes up with different rewards and recognition programs every year to award employees for various achievements. These achievements are always laid down in line with an organization's business goals. With the desire to win these prizes and excel in their careers, employees try to maximize their potential and give their best performance. They might not receive the award at their first attempt. However, their manager provides feedback on what they need to improve to succeed. They learn from these mistakes and try to improve their performance next year. This helps an organization reach its goals by maximizing the potential of its employees. This is how reinforcement learning works. In technical terms, we can consider the employees as agents, C&B as rewards, and the organization as the environment. So, reinforcement learning is a process where the agent interacts with the environments to learn and receive the maximum possible rewards. Thus, they achieve their objective by taking the best possible action. The agents are not told what steps to take. Instead, they discover the actions that yield maximum results.

There are five elements associated with reinforcement learning:

1. **An agent** is an intelligent program that is the primary component and decision maker in the reinforcement learning environment.
2. **The environment** is the surrounding area, which has a goal for the agent to perform.
3. **An internal state**, which is maintained by an agent to learn the environment.
4. **Actions**, which are the tasks carried out by the agent in an environment.
5. **Rewards**, which are used to train the agents.



FUNDAMENTALS OF THE LEARNING APPROACH

I have just started learning about Artificial Intelligence. One way for me to learn is to pick up a machine learning algorithm from the Internet, choose some data sets, and keep applying the algorithm to the data. With this approach, I might succeed in creating some good models. However, most of the time, I might not get the expected result. This formal way to learn is the exploitation learning method, and it is not the optimal way to learn. Another way to learn is the exploration mode, where I start searching different algorithms and choose the algorithm that suits my data set. However, this might not work out, either, so I have to find a proper balance between the two ways to learn and create the best model. This is known as an exploration-exploitation trade off, and forms the rationale behind the reinforcement learning method. Ideally, we should optimize the trade-off between exploration and exploitation learning methods by defining a good policy for learning.

This brings us to the mathematical framework known as **Markov Decision Processes** which are used to model decision using states, actions and rewards. It consists of:

S – Set of states
A – Set of actions
R – Reward functions
P – Policy
V – Value

So, in a Markov Decision Process (MDP), an agent (decision maker) is in some state (S). The agent has to take action (A) to transit to a new state (S). Based on this response, the agent receives a reward (R). This reward can be of positive or negative value (V). The goal to gain maximum rewards is defined in the policy (P). Thus, the task of the agent is to get the best rewards by choosing the correct policy.

So, reinforcement learning is a process where the agent interacts with the environments to learn and receive the maximum possible rewards.

Q-LEARNING

MDP forms the basic gist of Q-Learning, one of the methods of Reinforcement Learning. It is a strategy that finds the optimal action selection policy for any MDP. It minimizes behavior of a system through trial and error. Q-Learning updates its policy (state-action mapping) based on a reward.

A simple representation of Q-learning algorithm is as follows:

STEP 1: Initialize the state-action matrix (Q-Matrix), which defines the possible actions in each state. The rows of matrix Q represent the current state of the agent, and the columns represent the possible actions leading to the next state as shown in the figure below:

$$\begin{array}{ccc} & & \text{ACTION} \\ & & \begin{array}{cccc} 0 & 1 & 2 & 3 \end{array} \\ \text{STATE} \quad Q = & \begin{array}{c} 0 \\ 1 \\ 2 \\ 3 \end{array} & \begin{bmatrix} -1 & -1 & 0 & -1 \\ -1 & 0 & -1 & 100 \\ 0 & -1 & -1 & 100 \\ -1 & -1 & 0 & -1 \end{bmatrix} \end{array}$$

***Note**: The -1 represents no direct link between the nodes. For example, the agent cannot traverse from state 0 to state 3.*

STEP 2: Initialize the state-action matrix (Q-Matrix) to zero or the minimum value.

STEP 3: For each episode:

- Choose one possible action.
- Perform action.
- Measure Reward.
- Repeat STEP 2 (a to c) until it finds the action that yields maximum Q value.
- Update Q value.

STEP 4: Repeat until the goal state has been reached.

GETTING STARTED WITH REINFORCEMENT LEARNING

Luckily, we need not code the algorithms ourselves. Various AI communities have done this challenging work, thanks to the ever-growing technocrats and organizations who are making our days easier. The only thing we need to do is to think of the problem that exists in our enterprises, map it to a possible reinforcement learning solution, and implement the model.

- **Keras-RL** implements state-of-the art deep reinforcement learning algorithms and integrates with the deep learning library Keras. Due to this integration, it can work either with Theano or Tensorflow and can be used in either a CPU or GPU machines. It is implemented in Python Deep Q-learning (DQN), Double DQN (removes the bias from the max operator in Q-learning), DDPG, Continuous DQN, and CEM.

- **PyBrain** is another Python-based Reinforcement Learning, Artificial intelligence, and neural network package that implements standard RL algorithms like Q-Learning and more advanced ones such as Neural Fitted Q-iteration. It also includes some black-box policy optimization methods (e.g. CMA-ES, genetic algorithms, etc.).
- **OpenAI Gym** is a toolkit that provides a simple interface to a growing collection of reinforcement learning tasks. You can use it with Python, as well as other languages in the future.
- **TeachingBox** is a Java-based reinforcement learning framework. It provides a classy and convenient toolbox for easy experimentation with different reinforcement algorithms. It has embedded techniques to relieve the robot developer from programming sophisticated robot behaviors.

Ideally, we should optimize the trade-off between exploration and exploitation learning methods by defining a good policy for learning.

POSSIBLE USE CASES FOR ENTERPRISES

Reinforcement learning finds extensive applications in those scenarios where human interference is involved, and cannot be solved by rule-based automation and traditional machine learning algorithms. This includes robotic process automation, packing of materials, self-navigating cars, strategic decisions, and much more.

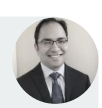
Reinforcement learning finds extensive applications in those scenarios where human interference is involved, and cannot be solved by rule-based automation and traditional machine learning algorithms.

1. **Manufacturing**
   Reinforcement learning can be used to power up the brains of industrial robots to learn by themselves. One of the notable examples in the recent past is an industrial robot developed by a Japanese company, Faunc, that learned a new job overnight. This industrial robot used reinforcement learning to figure out on how to pick up objects from containers with high precision overnight. It recorded its every move and found the right path to identify and select the objects.

2. **Digital Marketing**
   Enterprises can deploy reinforcement learning models to show advertisements to a user based on his activities. The model can learn the best ad based on user behavior and show the best advertisement at the appropriate time in a proper personalized format. This can take ad personalization to the next level that guarantees maximum returns.

3. **Chatbots**
   Reinforcement learning can make dialogue more engaging. Instead of general rules or chatbots with supervised learning, reinforcement learning can select sentences that can take a conversation to the next level for collecting long term rewards.

4. **Finance**
   Reinforcement learning has immense applications in stock trading. It can be used to evaluate trading strategies that can maximize the value of financial portfolios.



Sibanjan Das is a Business Analytics and Data Science consultant. He has over seven years of experience in the IT industry working on ERP systems, implementing predictive analytics solutions in business systems, and the Internet of Things. Sibanjan holds a Master of IT degree with a major in Business Analytics from Singapore Management University. Connect with him at his Twiiter handle @sibanjandas to follow the latest news in Data Science, Big Data, and AI.

Diving Deeper

INTO ARTIFICIAL INTELLIGENCE

TOP #ARTIFICIALINTELLIGENCE TWITTER ACCOUNTS

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 @karpathy

 @AndrewYNg

 @adampaulcoates

 @mgualtieri

 @soumithchintala

 @demishassabis

 @DrAndyPardoe

 @bobehayes

 @SpirosMargaris

ARTIFICIAL INTELLIGENCE-RELATED ZONES

AI dzone.com/ai
The Artificial Intelligence (AI) Zone features all aspects of AI pertaining to Machine Learning, Natural Language Processing, and Cognitive Computing. The AI Zone goes beyond the buzz and provides practical applications of chatbots, deep learning, knowledge engineering, and neural networks.

IoT dzone.com/iot
The Internet of Things (IoT) Zone features all aspects of this multifaceted technology movement. Here you'll find information related to IoT, including Machine to Machine (M2M), real-time data, fog computing, haptics, open distributed computing, and other hot topics. The IoT Zone goes beyond home automation to include wearables, business-oriented technology, and more.

Big Data dzone.com/bigdata
The Big Data/Analytics Zone is a prime resource and community for Big Data professionals of all types. We're on top of all the best tips and news for Hadoop, R, and data visualization technologies. Not only that, but we also give you advice from data science experts on how to understand and present that data.

TOP ARTIFICIAL INTELLIGENCE REFCARDZ

Recommendations Using Redis
In this Refcard, learn to develop a simple recommendation system with Redis, based on user-indicated interests and collaborative filtering. Use data structures to easily create your system, learn how to use commands, and optimize your system for real-time recommendations in production.

Machine Learning
Covers machine learning for predictive analytics, explains setting up training and testing data, and offers machine learning model snippets.

R Essentials
R has become a widely popular language because of its varying data structures, which can be more intuitive than data storage in other languages; its built-in statistical and graphical functions; and its large collection of useful plugins that can enhance the language's abilities in many different ways.

TOP ARTIFICIAL INTELLIGENCE PODCASTS

Linear Digressions
lineardigressions.com
Covering a variety of topics related to data science and machine learning, this podcast features two experts who make the most complicated AI concepts accessible.

The O'Reilly Bots Podcast
oreilly.com/topics/oreilly-bots-podcast
This assortment of podcasts discusses the most recent advances that are revolutionizing how we interact with conversational robots.

Concerning AI
concerning.ai
If you're interested in the more philosophical, ethical aspect of artificial intelligence, this podcast is for you. Concerning AI will inspire you to think deeply about what AI means for the future of society.

TOP ARTIFICIAL INTELLIGENCE RESOURCES

Best Practices for Machine Learning Engineering
by Martin Zinkevich
Learn how you can use machine learning to your benefit — even if you just have a basic working knowledge. Get a better understanding of machine learning terminology and consider the process of machine learning through three key phases.

Intro to AI
by Ansaf Salleb-Aouissi
In this free introductory course, learn the fundamentals of artificial intelligence, building intelligent agents, solving real AI problems with Python, and more.

Video Lectures on Machine Learning
This wide assortment of machine learning videos will teach you everything you need to know about machine learning, from Bayesian learning to supervised learning to clustering and more.

How to Manage Crowdsourcing at Scale with Machine Learning

Anyone who has used crowdsourcing systems like mTurk and Crowdflower has had the experience of getting results that aren't quite right. Whatever the reason, improving and assuring the quality of microservice output can be a challenge. We've implemented a machine learning model to successfully scale crowdsourced tasks without losing results quality.

WHY USE MACHINE LEARNING FOR SOFTWARE TESTING?

Manually checking output defeats the purpose of leveraging microservices, especially at the scale that we use it. By feeding every piece of work through our machine learning algorithms, we can avoid many of the issues associated with leveraging microservices efficiently.

DETECTING BAD WORK FROM INPUT PATTERNS

By running every test result against our algorithms, we can catch sloppy work based on input patterns. We can catch suspicious job execution behavior by analyzing mouse movements and clicks, the time it takes to execute the task, and other factors.

A CONSTANTLY GROWING TRAINING DATA SET

Almost every task executed with our platform becomes training data for our machine learning mode, meaning that our algorithm is constantly being refined and improved. It goes through tagging and sorting process to ensure that it's labelled correctly, then feeds into our algorithms to further refine our results.

REAL-TIME QUALITY CONFIRMATION

We want to give users results fast, whether they're running tests on Saturday at 2am or first thing Monday morning. Machine learning management allows us to provide a consistent bar for results quality at any moment, at any scale.

Incorporating machine learning into our crowdtesting model helps us stabilize the quality of our test results. As a result, we can more confidently integrate microservices into our development workflow.

WRITTEN BY RUSS SMITH

CTO AND CO-FOUNDER, **RAINFOREST QA**

PARTNER SPOTLIGHT

Rainforest QA

rainforest

Like Automation but Good: Machine Efficiency with Human Context.

CATEGORY	NEW RELEASES	OPEN SOURCE
AI-Powered QA Platform	Continuous	No

CASE STUDY

Guru is a knowledge management solution that helps teams capture, share and access knowledge easily. Their development team manages their own QA testing. In order to keep their team small as their product, Guru integrated Rainforest QA into its development workflow, encouraging their engineers to write tests from their code editor.

The Rainforest machine learning algorithm confirms all test results, allowing Guru to have confidence in the quality of their test results. By leveraging Rainforest, Guru has scaled their developer-driven quality process rather than hiring a dedicated QA manager. As a result, they have recovered 100+ hours of developer time from testing each month without sacrificing product quality.

Read their story here.

STRENGTHS

- Enables teams to take a streamlined, data-driven approach to QA testing
- Increases confidence in release quality with machine-learning verified test results
- Integrates testing into development workflow
- Provides clear, comprehensive test results for faster issue resolution

NOTABLE CUSTOMERS

- Adobe
- Oracle
- BleacherReport
- StubHub
- TrendKite

WEBSITE rainforestqa.com **TWITTER** @rainforestqa **BLOG** rainforestqa.com/blog

Learning Neural Networks Using Java Libraries

BY **DANIELA KOLAROVA**
SYSTEM ARCHITECT, **DXC TECHNOLOGY**

QUICK VIEW

01 Learn about the evolution of neural networks

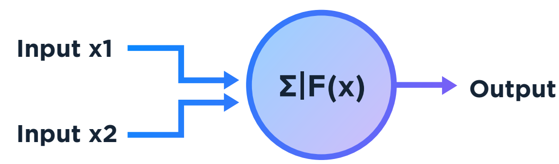
02 A short guide to implement of Neural Networks from scratch

03 A summary of popular Java Neural Network libraries

As developers, we are used to thinking in terms of commands or functions. A program is composed of tasks, and each task is defined using some programming constructs. Neural networks differ from this programming approach in the sense that they add the notion of automatic task improvement, or the capability to learn and improve similarly to the way the brain does. In other words, they try to learn new activities without task-specific programming.

Instead of providing a tutorial on writing a neural network from scratch, this tutorial will be about neural nets incorporating Java code. The evolution of neural nets starts from McCulloch and Pitt's neuron, enhancing it with Hebb's findings, implementing the Rosenblatt's perceptron, and showing why it can't solve the XOR problem. We will implement the solution to the XOR problem by connecting neurons, producing a Multilayer Perceptron, and making it learn by applying backpropagation. After being able to demonstrate a neural network implementation, a training algorithm, and a test, we will try to implement it using some open-source Java ML frameworks dedicated to deep learning: Neuroph, Encog, and Deeplearning4j.

The early model of an artificial neuron was introduced by the neurophysiologist Warren McCulloch and logician Walter Pitts in 1943. Their paper, entitled, "A Logical Calculus Immanent in Nervous Activity," is commonly regarded as the inception of the study of neural networks. The McCulloch-Pitts neuron worked by inputting either a 1 or 0 for each of the inputs, where 1 represented true and 0 represented false. They assigned a binary threshold activation to the neuron to calculate the neuron's output.



The threshold was given a real value, say 1, which would allow for a 0 or 1 output if the threshold was met or exceeded. Thus, in order to represent the AND function, we set the threshold at 2.0 and come up with the following table:

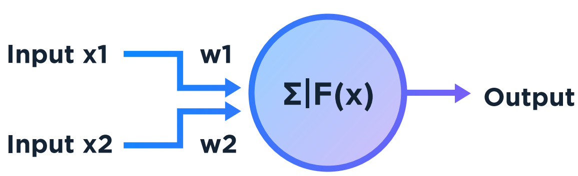
AND	T	F
T	T	F
F	F	F

This approach could also be applied for the OR function if we switch the threshold value to 1. So far, we have classic linearly separable data as shown in the tables, as we can divide the data using a straight line. However, the McCulloch-Pitts neuron had some serious limitations. In particular, it could solve neither the "exclusive or" function (XOR), nor the "exclusive nor" function (XNOR), which seem to be not linearly separable. The next revolution was introduced by Donald Hebb, well-known for his theory on Hebbian learning. In his 1949 book, The *Organization of Behavior*, he states:

"When an axon of cell A is near enough to excite a cell B and repeatedly or persistently takes part in firing it, some growth process or metabolic change takes place in one or both cells such that A's efficiency, as one of the cells firing B, is increased."

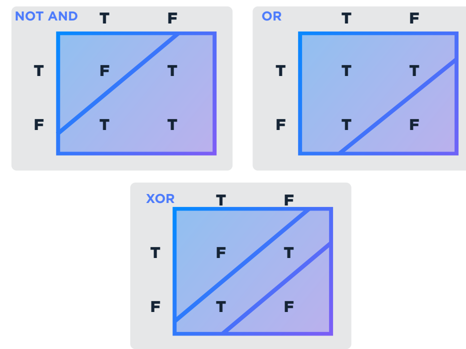
In other words, when one neuron repeatedly assists in firing another, the axon/connection of the first neuron develops synaptic knobs or enlarges them if they already exist in contact with the second neuron. Hebb was not only proposing that when two neurons fire together the connection between the neurons is strengthened — which is known as the weight assigned to the connections between neurons — but also that this activity is one of the fundamental operations necessary for learning and memory. The McCulloch-Pitts neuron had to be altered to assign weight to each of the inputs. Thus, an input of 1 may be given more or less weight, relative to the total threshold sum.

Later, in 1962, the perceptron was defined and described by Frank Rosenblatt in his book, *Principles of Neurodynamics*. This was a model of a neuron that could learn in the Hebbean sense through the weighting of inputs and that laid the foundation for the later development of neural networks. Learning in the sense of the perceptron meant initializing the perceptron with random weights and repeatedly checking the answer after the activation was correct or there was an error. If it was incorrect, the network could learn from its mistake and adjust its weights.

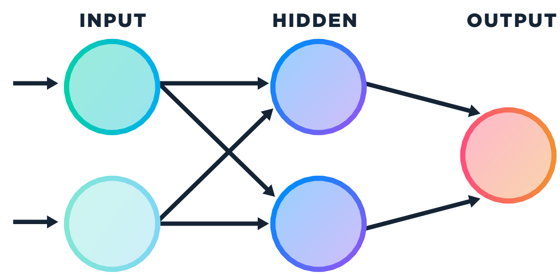


Despite the many changes made to the original McCulloch-Pitts neuron, the perceptron was still limited to solving certain functions. In 1969, Minsky co-authored with Seymour Papert, Perceptrons: An Introduction to Computational Geometry, which attacked the limitations of the perceptron. They showed that the perceptron could only solve linearly separable functions and had not solved the limitations at that point. As a result, very little research was done in the area until the 1980s. What would come to resolve many of these difficulties was the creation of neural networks. These networks connected the inputs of artificial neurons with the outputs of other artificial neurons. As a result, the networks were able to solve more difficult problems, but they grew considerably more complex. Let's consider again the XOR problem that wasn't solved by the perceptron. If we carefully observe the truth tables, we can see that XOR turns to be equivalent to OR and NOT AND functions representable by single neurons.

Let's take a look at the truth tables again:



We can combine the two neurons representing NOT AND and OR and build a neural net for solving the XOR problem similar to the net presented below:



The diagram represents a multiplayer perception, which has one input layer, one hidden layer, and an output layer. The connections between the neurons have associated weights not shown in the picture. Similar to the single perception, each processing unit has a summing and activation component. It looks pretty simple but we also need a training algorithm in order to be able to adjust the weights of the various layers and make it learn. With the simple perception, we could easily evaluate how to change the weights according to the error. Training a multilayered perception implies calculation of the overall error of the network.

In 1986, Geoffrey Hinton, David Rumelhart, and Ronald Williams published a paper, "Learning Representations by Backpropagating Errors", which describes a new learning procedure, backpropagation. The procedure repeatedly adjusts the weights of the connections in the network so as to minimize a measure of difference between the actual output vector of the net and the desired output vector. As a result of the weight adjustments, internal hidden units — which are not part of the input or output — are used to represent important features, and the regularities of the tasks are captured by the interaction of these units.

It's time to code a multilayered perceptron able to learn the XOR function using Java. We need to create a few classes, like a neuron interface named ProcessingUnit, Connection class, a few more activation functions, and a neural net with a layer that is able to learn. The interfaces and classes can be found in a project located in my GitHub repository.

The McCulloch-Pitts neuron worked by inputting either a 1 or 0 for each of the inputs, where 1 represented true and 0 represented false.

The NeuralNet class is responsible for the construction and initialization of the layers. It also provides functionality for training and evaluation of the activation results. If you run the NeuralNet class solving the classical XOR problem, it will activate, evaluate the result, apply backpropagation, and print the training results.

If you take a detailed look at the code, you will notice that it is not very flexible in terms of reusability. It would be better if we divide the NeuralNet structure from the training part to be able to apply various learning algorithms on various neural net structures. Furthermore, if we want to experiment more with deep learning structures and various activation functions, we will have to change the data structures because for now, there is only one hidden layer defined. The backpropagation calculations have to be carefully tested in isolation in order to be sure we haven't introduced any bugs. Once we are finished with all the refactoring, we will have to start to think about the performance of deep neural nets. What I am trying to say is that if we have a real problem to solve, we need to take a look at the existing neural nets libraries. Implementing a neural net from scratch helps to understand the details of the paradigm, but one would have to put a lot of effort if a real-life solution has to be implemented from scratch. For this review, I have selected only pure Java neural net libraries. All of them are open-source, though Deeplearning4j is commercially supported. All of them are documented very well with lots of examples. Deeplearning4j has also CUDA support. A comprehensive list of deep learning software for various languages is available on Wikipedia, as well.

Examples using this library are also included in the GitHub repository with the XOR NeuralNet. It is obvious that there will be less code written using one of these libraries compared to the Java code needed for our example. Neuroph provides an API for datasets that allows for easier training data initialization, learning rules hierarchy, neural net serialization/persistence, and deserialization, and is equipped with a GUI. Encog is an advanced machine learning framework that supports a variety of advanced algorithms, as well as support classes to normalize and process data. However, its main strength lies in its neural network algorithms. Encog contains classes to create a wide variety of networks, as well as support classes to normalize and process data for these neural networks. Deeplearning4j is a very powerful library that supports several algorithms, including distributed parallel versions that integrate with Apache Hadoop and Spark. It is definitely the right choice for experienced developers and software architects. A XOR example is provided as part of the library packages.

With the simple perception, we could easily evaluate how to change the weights according to the error.

Using one of the many libraries available, developers are encouraged to start experimenting with various parameters and make their neural nets learn. This article demonstrated a very simple example with a few neurons and backpropagation. However, many of the artificial neural networks in use today still stem from the early advances of the McCulloch-Pitts neuron and the Rosenblatt perceptron. It is important to understand the roots of the neurons as building blocks of modern deep neural nets and to experiment with the ready-to-use neurons, layers, activation functions, and learning algorithms in the libraries.

Daniela Kolarova is a senior application architect at DXC Technology with more than 13 years experience with Java. She has worked on many international projects using Core Java, Java EE, and Spring. Because of her interests in AI she worked on scientific projects at the Bulgarian Academy of Sciences and the University. She also writes article on DZone, scientific publications, and has spoken at AI and Java conferences.

Practical Uses of AI

BY **SARAH DAVIS** - CONTENT COORDINARTOR, **DZONE**

Too often regarded as a buzzword, artificial intelligence (AI) is a rapidly growing field that shows no signs of slowing down. According to the Bank of America Corporation, the AI-based analytics market should be valued at $70 billion by 2020. It's hard to tell exactly what the future will look like – there are many pros and cons to weigh out – but one thing is for sure: AI is well on its way to being a major part of the future.

SECURITY

Machine learning models are being developed that can accurately predict files that contain malware in order to help both prevent and predict security breaches. For example, Deep Instinct is applying AI and deep learning technology to detect threat attacks.

PUBLIC SAFETY

Natural language processing and machine learning are being used to collect and analyze data from 911 calls, social media, gunshot sensors, and more to create heat maps of where crimes are likely to occur.

EDUCATION

IBM's Teacher Advisor, based on Watson, allows math teachers to create personalized lesson plans for individual students. Another platform developed by IBM Watson is Jill, an automated teaching assistant robot that responds to student inquiries for large online courses and that could improve student retention rates.

PERSONALIZATION AND RECOMMENDATIONS

We've been seeing companies deploy marketing personalization through AI for year, with sites like Amazon suggesting recommended purchases after a user clicks on an item. This is advancing rapidly, though, and many AI systems are using location data to determine things like when to give users push notifications and what coupons to send.

ACCESSIBILITY

AI provides a great opportunity for wheelchair users and people with autism, to name a few. For example, Autimood is an AI application that helps children with autism better understand human emotions in a way that's both helpful and fun. Additionally, Robotic Adaption to Humans Adapting to Robots (RADHAR) uses computer vision algorithms to make navigating environments in a wheelchair easier.

HEALTHCARE

AI has huge potential in the healthcare industry since it can analyze big data much more quickly than human doctors can. It can assist in preventing, screening, treating, and monitoring diseases. For example, a computer-assisted diagnosis can predict breast cancer in women a year before their official diagnosis.

ENERGY AND THE ENVIRONMENT

MIT researchers have developed a machine learning system that uses predictive analytics to pick the best location for wind farms. Additionally, IBM researchers are using machine learning to analyze pollution data and make predictions about air quality. AI is also being used to analyze forest data to predict and stop deforestation before it starts.

CONVENIENCE

AI programs use algorithms and machine learning to make general life easier for consumers. For instance, machine learning systems can analyze photos to suggest the best restaurant, apps can give personalized financial advice, and household robots can read people's facial expressions and provide the best possible interaction.

How Will AI Impact Your BI

We should be living in an information utopia. Ever more powerful and affordable technology means you can gather data out of nearly any process, from overheating train brakes to citizen comments about the quality of service at their local airport, and share it widely and near-instantly.

With relatively little effort, a company or agency can amass petabytes of data – more information than the entire human race had collected until the 20th century. And information-collecting is vital, because in an increasingly competitive economy, companies need to take advantage of every possible insight in order to grow their business and stay ahead of competitors.

The problem is that having so much data can be overwhelming to manage. Organizing enormous volumes of data, searching them for patterns and relevant insights, and reporting those findings in a timely and useful way takes data science expertise and programming horsepower your organization may have trouble finding (or paying for). OpenText Magellan can help.

With relatively little effort, a company or agency can amass petabytes of data – **more information than the entire human race had collected until the 20TH century**.

Magellan is a flexible, pre-integrated AI-powered analytics platform that combines open source machine learning with advanced analytics, enterprise-grade BI, and capabilities to acquire, merge, manage and analyze Big Data and Big Content stored in your Enterprise Information Management (EIM) systems. What this means in real-world terms is that you can make decisions and take actions with the help of Magellan with greater speed and scale than you could unassisted.

WRITTEN BY STANNIE HOLT
MARKETING CONTENT WRITER, **OPENTEXT**

PARTNER SPOTLIGHT

OpenText Magellan

opentext™

The power of AI in a pre-configured platform that augments decision making and accelerates your business

CATEGORY
An AI-powered analytics platform that combines open source machine learning with advanced analytics

NEW RELEASES
Continuous

OPEN SOURCE
Yes

STRENGTHS

- A cohesive platform with pre-built components: Bundling technologies for advanced analytics, machine learning, data modeling and preparation, and enterprise-grade BI into a single infrastructure
- Built on an open foundation: Magellan lets you take advantage of the flexibility, extensibility, and diversity of an open product stack while maintaining full ownership of your data and algorithms.
- Designed to drive autonomy: Magellan empowers IT to empower non-technical users—with a self-service interface enabling business analysts to apply sophisticated algorithms and act on the insights they find.
- Infused with unstructured data analytics: Magellan includes powerful natural language processing capabilities for Big Content like concept identification, categorization, entity extraction, and sentiment analysis.

CASE STUDY
OpenText Magellan combines open source machine learning with advanced analytics, enterprise-grade BI, and capabilities to acquire, merge, manage and analyze Big Data and Big Content stored in your Enterprise Information Management systems.

The result is a flexible, cognitive software platform built on Apache Spark that dramatically reduces the time, effort and expertise required for integrating these varied technologies – to leverage the benefits and realize the value of advanced analytics for decision making and task automation across your EIM applications.

WEBSITE opentext.com **TWITTER** @OpenText **BLOG** bit.ly/2zAvtiY

Executive Insights on Artificial Intelligence And All of its Variants

BY **TOM SMITH**

RESEARCH ANALYST, **DZONE**

QUICK VIEW

01 Like Big Data and IoT, implementing a successful artificial intelligence strategy depends on identifying the business problem you are trying to solve.

02 Companies in any industry benefit from AI by making smarter, more informed decisions by collecting, measuring, and analyzing data.

03 People and companies are beginning to use AI and all of its variations to solve real business problems, seeing a tremendous impact on the bottom line.

To gather insights on the state of artificial intelligence (AI), and all its variants, machine learning (ML), deep learning (DL), natural language processing (NLP), predictive analytics, and neural networks, we spoke with 22 executives who are familiar with AI.

GAURAV BANGA CEO, CTO, AND DR. VINAY SRIDHARA, BALBIX

ABHINAV SHARMA DIGITAL SERVICING GROUP LEAD, BARCLAYCARD US

PEDRO ARELLANO VP PRODUCT STRATEGY, BIRST

MATT JACKSON VP AND NATIONAL GENERAL MANAGER, BLUEMETAL

MARK HAMMOND CEO, BONSAI

ASHOK REDDY GENERAL MANAGER, MAINFRAME, CA TECHNOLOGIES

SUNDEEP SANGHAVI CO-FOUNDER AND CEO, DATARPM, A PROGRESS COMPANY

ELI DAVID CO-FOUNDER AND CHIEF TECHNOLOGY OFFICER, DEEP INSTINCT

ALI DIN GM AND CMO, AND **MARK MILLAR**, DIRECTOR OF RESEARCH AND DEVELOPMENT, DINCLOUD

SASTRY MALLADI CTO, FOGHORN SYSTEMS

FLAVIO VILLANUSTRE VP TECHNOLOGY LEXISNEXIS RISK SOLUTIONS, HPCC SYSTEMS

ROB HIGH CTO WATSON, IBM

JAN VAN HOECKE CTO, IMANAGE

ELDAR SADIKOV CEO AND CO-FOUNDER, JETLORE

AMIT VIJ CEO AND CO-FOUNDER, KINETICA

TED DUNNING PHD., CHIEF APPLICATION ARCHITECT, MAPR

BOB FRIDAY CTO AND CO-FOUNDER, MIST

JEFF AARON VP OF MARKETING, MIST

SRI RAMANATHAN GROUP VP AI BOTS AND MOBILE, ORACLE

SCOTT PARKER SENIOR PRODUCT MARKETING MANAGER, SINEQUA

MICHAEL O'CONNELL CHIEF ANALYTICS OFFICER, TIBCO

KEY FINDINGS

01 The key to having a successful AI business strategy is to **know what business problem you are trying to solve**. Having the necessary data, having the right tools, and having the wherewithal to keep your models up-to-date are important once you've identified specifically what you want to accomplish.

Start by looking at your most tedious and time-consuming processes. Identify where you have the greatest risk exposure for failing to fulfill compliance issues as well as the most valuable assets you want to protect.

Once you've identified the business problem you are trying to solve, you can begin to determine the data, tools, and skillsets you will need. The right tool, technology, and type of AI depends on what you are trying to accomplish.

02 Companies benefit from AI **by making smarter, more informed decisions, in any industry**, by collecting, measuring, and analyzing data to prevent fraud, reduce risk, improve productivity and efficiency, accelerate time to market and mean time to resolution, and improve accuracy and customer experience (CX).

Unlike before, companies can now afford the time and money to look at the data to make an informed decision. You cannot do this unless you have a culture to collect, measure, and value data. Achieving this data focus is a huge benefit event without AI since a lot of businesses will continue to operate on gut feel rather than data. They view data as a threat versus an opportunity, and ultimately these businesses will not survive.

Employee engagement and CX can be improved in every vertical industry, and every piece of software can benefit. AI can replicate day-to-day processes with a greater level of accuracy than any human, without downtime. This will have a significant impact on the productivity, efficiency, margins, and the risk profile of every company pushing savings and revenue gains to the bottom line.

Companies will be able to get to market faster and cheaper, with greater customer satisfaction and retention.

03 The biggest change in AI in the near-term has been the fact that **people and companies are beginning to use it, and all of its variations, to solve real business problems**. Tools and libraries have improved. The cloud is enabling companies to handle data at scale necessary for AI, machine learning (ML), deep learning (DL), natural language processing (NLP), and recurring neural networks. In addition, more investment is being made in AI initiatives as companies see the dramatic impact it can have on the bottom line.

We've moved from machine learning to deep learning. We see more AI/ML libraries that are more mature and scalable. We see larger neural networks that are deeper and able to handle more data, resulting in more knowledge and greater accuracy.

Today the cloud is a commodity, and it's possible that this will happen to AI as well, except faster, as consumers adopt autonomous cars and manufacturers put hundreds of millions of dollars on their bottom lines. AI improves quality of life for individuals, making things simpler and easier while improving the quality of life of workers and making companies significantly more profitable.

04 The technical solutions mentioned most frequently with AI initiatives are: **TensorFlow, Python, Spark, and Google.ai.** Spark, Python, and R are mentioned most frequently as the languages being used to perform data science while Google, IBM Watson, and Microsoft Azure are providing plenty of tools for developers to work on AI projects via API access.

05 The **real-world problems being solved with AI are diverse and wide-reaching**, with the most frequently mentioned verticals being finance, manufacturing, logistics, retail, and oil and gas. The most frequently mentioned solutions were cybersecurity, fraud prevention, efficiency improvement, and CX.

AI helps show what's secure, what's not, and every attack vector. It identifies security gaps automatically freeing up security operations to focus on more strategic issues while making security simpler and more effective.

A large-scale manufacturer milling aircraft parts used to take days to make the parts with frequent manual recalibrations of the machine. Intelligent behavior has increased efficiency of the operators, reduced time to mill a part, and reduced the deviations in parts. AI automation provides greater support for the operators and adds significant value to the bottom line.

06 The most common issues preventing companies from realizing the benefits of AI are a **lack of understanding, expertise, trust, or data**.

There's fear of emerging technology and lack of vision. Companies don't know where to start, they are not able to see how AI can improve their business. They need to start with a simple proof of concept with measurable and actionable results.

Tremendous skillsets are required. There's a shortage of talent and massive competition for those with the skills. Most companies are struggling to get the expertise they need for the application of deep learning. Companies also have a hard time wrangling all of their data, which may be stored in multiple places.

Brownfield equipment owners can be very uncomfortable with anyone interfering with their very expensive and precise equipment. Luckily, you don't need to touch their equipment to execute a proof of concept. Once a client becomes comfortable with what AI can accomplish, they are open to automation. Once end users see the data is more accurate than their experience, they begin to trust the data and trust AI to improve the efficiency and reliability of their equipment.

07 **The greatest opportunities for the implementation of AI are ubiquitous** – it's just a matter of which industries adopt and implement it the quickest. All prospects have the same level of opportunity with AI. How can businesses identify jobs that require a lot of repetitive work and start automating them?

There are opportunities in every industry. We see the greatest opportunities in financial services, healthcare, and manufacturing. In manufacturing and industrial IoT, ML is used to predict failures so companies can take action before the failure, reduce downtime, and improve efficiency.

There are several well-known fraud controls. Companies can know what's on the network, who's on the network, what devices they are accessing the network with, what apps they are running, whether or not those devices are secure and have the latest security updates and patches. This is very complex in a large organization, and AI can handle these challenges quickly and easily.

08 The greatest concerns about AI today are the **hype and issues around privacy and security**. The hype has created unrealistic expectations. Most of the technology is still green. People are getting too excited. There's a real possibility that vendors may lose credibility due to unrealistic expectations. Some vendors latch on to "hot" terms and make it difficult for potential clients to distinguish between what's hype and what's real.

As AI grows in acceptance, privacy and data security come into play, since companies like Amazon and Google hoard data. Who decides the rules that apply to a car when it's approaching a pedestrian? We're not spending enough time thinking about the legal implications for the consumer regarding cyberattacks and the security of personally identifiable information (PII). We'll likely see more malware families and variants that are based on AI tools and capabilities.

09 To be proficient in AI technologies, developers **need to know math**. They should be willing and able to look at the data, understand it, and be suspicious of it. You need to know math, algebra, statistics, and calculus for algorithms; however, the skill level required is falling as more tools become available. Depending on the areas in which you want to specialize, there are plenty of open source community tools, and the theoretical basics are available on sites like Coursera.

Tom Smith is a Research Analyst at DZone who excels at gathering insights from analytics—both quantitative and qualitative—to drive business results. His passion is sharing information of value to help people succeed. In his spare time, you can find him either eating at Chipotle or working out at the gym.

Solutions Directory

This directory contains artificial intelligence and machine learning software, platforms, libraries, and frameworks, as well as many other tools to assist your application security. It provides free trial data and product category information gathered from vendor websites and project pages. Solutions are selected for inclusion based on several impartial criteria, including solution maturity, technical innovativeness, relevance, and data availability.

COMPANY	PRODUCT	CATEGORY	FREE TRIAL	WEBSITE
Accord.NET	Accord.NET	.NET machine learning framework	Open source	accord-framework.net
AirFusion	AirFusion	AI-powered infrastructure monitoring	N/A	airfusion.com
Alpine Data	Alpine Chorus 6	Data science, ETL, predictive analytics, execution workflow design and management	Demo available by request	alpinedata.com/product
Alteryx	Alteryx Designer	ETL, predictive analytics, spatial analytics, automated workflows, reporting, and visualization	Available by request	alteryx.com/products/alteryx-designer
Amazon Web Services	Amazon Machine Learning	Machine learning algorithms-as-a-service, ETL, data visualization, modeling and management APIs, batch and realtime predictive analytics	Free tier available	aws.amazon.com/machine-learning
Anodot	Anodot	Real time analytics and AI-based anomaly detection	Demo available by request	anodot.com/product
Apache Foundation	MADlib	Big data machine learning w/SQL	Open source	madlib.incubator.apache.org
Apache Foundation	Mahout	Machine learning and data mining on Hadoop	Open source	mahout.apache.org/
Apache Foundation	Singa	Machine learning library creation	Open source	singa.incubator.apache.org/en
Apache Foundation	Spark Mlib	Machine learning library for Apache Spark	Open source	spark.apache.org/mllib
Apache Foundation	OpenNLP	Machine learning toolkit for natural language processing	Open source	opennlp.apache.org
Apache Foundation	Lucene	Text search engine library	Open source	lucene.apache.org/core

COMPANY	PRODUCT	CATEGORY	FREE TRIAL	WEBSITE
Apache Foundation	Solr	Information retrieval library	Open source	lucene.apache.org/solr
Apache Foundation	UIMA	Unstructured data processing system	Open source	uima.apache.org
Apache Foundation	Joshua	Statistical machine translation toolkit	Open source	incubator.apache.org/projects/joshua.html
Apache Foundation	PredictionIO	Machine learning server	Open source	predictionio.incubator.apache.org
API.ai	API.ai	Chatbot development platform	Free solution	api.ai
Artificial Solutions	Teneo Platform	NLI platform for chatbots	Demo available by request	artificial-solutions.com/teneo
BigML	BigML	Predictive analytics server and development platform	Free tier available	bigml.com
Caffe2	Caffe2	Deep learning framework	Open source	caffe2.ai
Chainer	Chainer	Neural network framework	Open source	chainer.org
Cisco	MindMeld	NLP voice recognition and chatbot software	Available by request	mindmeld.com
CLiPS Research Center	Pattern	Python web mining, NLP, machine learning	Open source	clips.uantwerpen.be/pattern
Cloudera	Cloudera Enterprise Data Hub	Predictive analytics, analytic database, and Hadoop distribution	Available by request	cloudera.com/products/enterprise-data-hub.html
DataRobot	DataRobot	Machine learning model-building platform	Demo available by request	datarobot.com/product
EngineRoom.io	ORAC Platform	AI and deep learning platform	Available by request	engineroom.io
Gluru	Gluru AI	AI support system	Demo available by request	gluru.co
Google	TensorFlow	Machine learning library	Open source	tensorflow.org
Grakn Labs	GRAKN.AI	Hyper-relational database for AI	Open source	grakn.ai
Grok	Grok	AI-based incident prevention	14 days	grokstream.com
H2O	H2O	Open source prediction engine on Hadoop and Spark	Open source	h2o.ai
Heaton Research	Encog	Machine learning framework	Open source	heatonresearch.com/encog

COMPANY	PRODUCT	CATEGORY	FREE TRIAL	WEBSITE
IBM	Watson	Artificial intelligence development platform	30 day free trial	ibm.com/watson
Infosys	Nia	Artificial intelligence collection and analysis platform	Available by request	infosys.com/nia
Intel Nervana	Intel Nervana Graph	Framework development library	Open source	intelnervana.com/intel-nervana-graph
JavaML	Java-ML	Various machine learning algorithms for Java	Open source	java-ml.sourceforge.net
Kaldi	Kaldi	Speech recognition toolkit for C++	Open source	kaldi-asr.org
Kasisto	KAI	AI platform for chatbots	N/A	kasisto.com/kai
Keras	Keras	Deep learning library for Python	Open source	keras.io
Marvin	Marvin	JavaScript callback AI	Open source	github.com/retrohacker/marvin
MatConvNet	MatConvNet	Convolutional neural networks for MATLAB	Open source	vlfeat.org/matconvnet
Meya.ai	Meya Bot Studio	Web-based IDE for chatbots	7 days	meya.ai
Micro Focus	IDOL	Machine learning, enterprise search, and analytics platform	Available by request	software.microfocus.com/en-us/software/information-data-analytics-idol
Microsoft	Cortana Intelligence Suite	Predictive analytics and machine learning development platform	Free Azure account available	azure.microsoft.com/en-us/services/machine-learning
Microsoft	CNTK (Cognitive Toolkit)	Deep learning toolkit	Open source	github.com/Microsoft/CNTK
Microsoft	Azure ML Studio	Visual data science workflow app	Free tier available	studio.azureml.net
Microsoft	Distributed Machine Learning Toolkit	Machine learning toolkit	Open source	dmtk.io
mlpack	mlpack 2	Machine learning library for C++	Open source	mlpack.org
MXNet	MXNet	Deep learning library	Open source	mxnet.io
Natural Language Toolkit	Natural Language Tookit	Natural language processing platform for Python	Open source	nltk.org
Neura	Neura	AI-powered user retention platform	90 days	theneura.com
Neuroph	Neuroph	Neural network framework for Java	Open source	neuroph.sourceforge.net
OpenNN	OpenNN	Neural network library	Open source	opennn.net
Oryx	Oryx 2	Lambda architecture layers for building machine learning apps	Open source	oryx.io

COMPANY	PRODUCT	CATEGORY	FREE TRIAL	WEBSITE
Progress Software	DataRPM	Cognitive predictive maintenance for industrial IoT	Demo available by request	datarpm.com/platform
Rainbird	Rainbird	Cognitive reasoning platform	N/A	rainbird.ai
RainforestQA	RainforestQA Web App Testing	AI-powered web testing platform	Demo available by request	rainforestqa.com/product/web-app-testing
RapidMiner	RapidMiner Studio	Predictive analytics workflow and model builder	Available by request	rapidminer.com/products/studio
RapidMiner	RapidMiner Radoop	Predictive analytics on Hadoop and Spark with R and Python support	Available by request	rapidminer.com/products/radoop
Salesforce	Einstein	CRM automation and predictive analytics	N/A	salesforce.com/products/einstein/overview
Samsung	Veles	Distributed machine learning platform	Open source	github.com/Samsung/veles
Scikit Learn	Scikit Learn	Machine learning libraries for Python	Open source	scikit-learn.org/stable
Shogun	Shogun	Predictive analytics	Open source	shogun-toolbox.org
Skymind	Deeplearning4j	Deep learning software for Java and Scala	Open source	deeplearning4j.org
Skytree	Skytree	ML model builder and predictive analytics	Available by request	skytree.net
spaCy	spaCy	Python natural language processing platform	Open source	spacy.io
Stanford University	Stanford CoreNLP	Natural language processing toolkit	Open source	stanfordnlp.github.io/CoreNLP
Torch	Torch	Machine learning framework for use with GPUs	Open source	torch.ch
Umass Amherst	MALLET	Java library for NLP and machine learning	Open source	mallet.cs.umass.edu
University of Montreal	Theano	Deep learning library for Python	Open source	deeplearning.net/software/theano/
University of Waikato	Weka	Machine learning and data mining for Java	Open source	cs.waikato.ac.nz/ml/weka
University of Waikato	Massive Online Analysis	Data stream mining, machine learning	Open source	moa.cms.waikato.ac.nz
Unravel	Unravel	Predictive analytics and machine learning performance monitoring	Available by request	unraveldata.com/product
Wipro	HOLMES	AI development platform	N/A	wipro.com/holmes
Wit.ai	Wit.ai	Natural language interface for apps	Open source	wit.ai

GLOSSARY

ALGORITHMS (CLUSTERING, CLASSIFICATION, REGRESSION, AND RECOMMENDATION)
A set of rules or instructions given to an AI, neural network, or other machine to help it learn on its own.

ARTIFICIAL INTELLIGENCE
A machine's ability to make decisions and perform tasks that simulate human intelligence and behavior.

ARTIFICIAL NEURAL NETWORK (ANN)
A learning model created to act like a human brain that solves tasks that are too difficult for traditional computer systems to solve.

CHATBOTS
A chat robot (chatbot for short) that is designed to simulate a conversation with human users by communicating through text chats, voice commands, or both. They are a commonly used interface for computer programs that include AI capabilities.

CLASSIFICATION
Classification algorithms let machines assign a category to a data point based on training data.

CLUSTERING
Clustering algorithms let machines group data points or items into groups with similar characteristics.

COGNITIVE COMPUTING
A computerized model that mimics the way the human brain thinks. It involves self-learning through the use of data mining, natural language processing, and pattern recognition.

CONVOLUTIONAL NEURAL NETWORK (CNN)
A type of neural networks that identifies and makes sense of images

DATA MINING
The examination of data sets to discover and 'mine' patterns from that data that can be of further use.

DATA SCIENCE
A field of study that combines statistics, computer science, and models to analyze sets of structured or unstructured data.

DECISION TREE
A tree and branch-based model used to map decisions and their possible consequences, similar to a flow chart.

DEEP LEARNING
The ability for machines to autonomously mimic human thought patterns through artificial neural networks composed of cascading layers of information.

FLUENT
A condition that can change over time.

MACHINE LEARNING
A facet of AI that focuses on algorithms, allowing machines to learn and change without being programmed when exposed to new data.

MACHINE PERCEPTION
The ability for a system to receive and interpret data from the outside world similarly to how humans use their senses. This is typically done with attached hardware, such as sensors.

NATURAL LANGUAGE PROCESSING
The ability for a program to recognize human communication as it is meant to be understood.

RECOMMENDATION
Recommendation algorithms help machines suggest a choice based on its commonality with historical data.

RECURRENT NEURAL NETWORK (RNN)
A type of neural network that makes sense of sequential information and recognizes patterns, and creates outputs based on those calculations

REGRESSION
Regression algorithms help machines predict future outcomes or items in a continuous data set by solving for the pattern of past inputs, as in linear regression in statistics.

SUPERVISED LEARNING
A type of Machine Learning in which output datasets train the machine to generate the desired algorithms like a teacher supervising a student; more common than unsupervised learning

SWARM BEHAVIOR
From the perspective of the mathematical modeler, it is an emergent behavior arising from simple rules that are followed by individuals and does not involve any central coordination.

UNSUPERVISED LEARNING
A type of machine learning algorithm used to draw inferences from datasets consisting of input data without labeled responses. The most common unsupervised learning method is cluster analysis.