

How AI Will Change Software Development And Applications

by Diego Lo Giudice

October 13, 2016 | Updated: November 2, 2016

Why Read This Report

Artificial intelligence (AI) is back, and the tech industry's interest is stronger than ever. AI will have an important impact on the design and creation of software. Application development and delivery (AD&D) professionals need to understand the potential benefits AI will bring, not only to how they build software but also to the nature of the applications themselves. In parallel, AD&D pros should not ignore the challenges and risks that come with AI. This report is the first of a series that will examine the impact of AI on software development and separate myth from reality.

Key Takeaways

AI Will Improve, Accelerate, And Disrupt The Software Development Life Cycle

A combination of AI technologies like advanced machine learning, deep learning, natural language processing, and business rules will have an impact on all steps of the software development life cycle, helping developers build better software faster. AI will disrupt how developers build applications and the nature of the applications they build.

AI Will Enable Developers To Build Apps That Learn Like Humans

Machine learning and deep learning are the core AI technologies that developers should get familiar with to build applications that learn on their own. Devs will focus less on using coded rules to program applications to be smart and instead program algorithms or configure them to self-learn. Devs will integrate algorithms, compose, and source large data sets to train and test such apps.

Be Prepared For The Challenges And Risks

New AI-based systems will sit side by side with traditional programmed software for a long time to come. Integrating new with old — or even new with new — won't get any easier. Unrealistic expectations of AI techniques will strengthen the skeptics. Plan for integration skills, look for the right types of problems to solve, and set pragmatic expectations to avoid unattainable science fiction.

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Forrester surveyed 25 AD&D decision-makers at vendor, end user, and systems integrator companies and interviewed a further five vendors. Companies surveyed and interviewed included Assist, Blueprint Software, CA Technologies, Cognizant, Conformiq, CSI, EPAM Systems, Google, Hewlett Packard Enterprise, IBM Global Business Services, Infostretch, L&T Infotech, Microsoft, NIIT Technologies, Orange Applications for Business, Qentelli, SAP, Syntel, TCS, TestPlant, Tricentis, and Wipro.

Related Research Documents

[Artificial Intelligence Can Finally Unleash Your Business Applications' Creativity](#)

[Cognitive Engagement: A New Force Of Creative Destruction](#)

[The Quest For Speed-Plus-Quality Drives Agile And DevOps Tool Selection](#)

Developers: Watch Out For AI-Based Disruptions Ahead

For decades, computer scientists have been trying to use AI programming techniques and algorithms to transfer human-level knowledge, business rules and policies, and decision-making to computers. Although fancier than traditional programming, the AI techniques were largely used to manually enhance the system's knowledge base — which was always limited. Limited domain knowledge proved a poor substitute for human expertise; AI systems were only as good as the “intelligence” programmed by the human engineer.

The new AI approach is to build systems that learn by themselves, becoming experts that model and abstract rules from the data fed to them. Such systems deal with complexity with increasing precision, adapt to the unknown, and expand their capabilities beyond their original programming. Traditional natural language processing (NLP) techniques, rules-based reasoning, and knowledge representation are now being augmented with machine learning — particularly deep machine learning — to gradually strengthen AI. Early results are promising: New business apps are emerging in a variety of domains. The expanding basket of AI goodies will change developers' jobs — so AD&D pros need to know how to take advantage.

AI Makes Developers Smarter

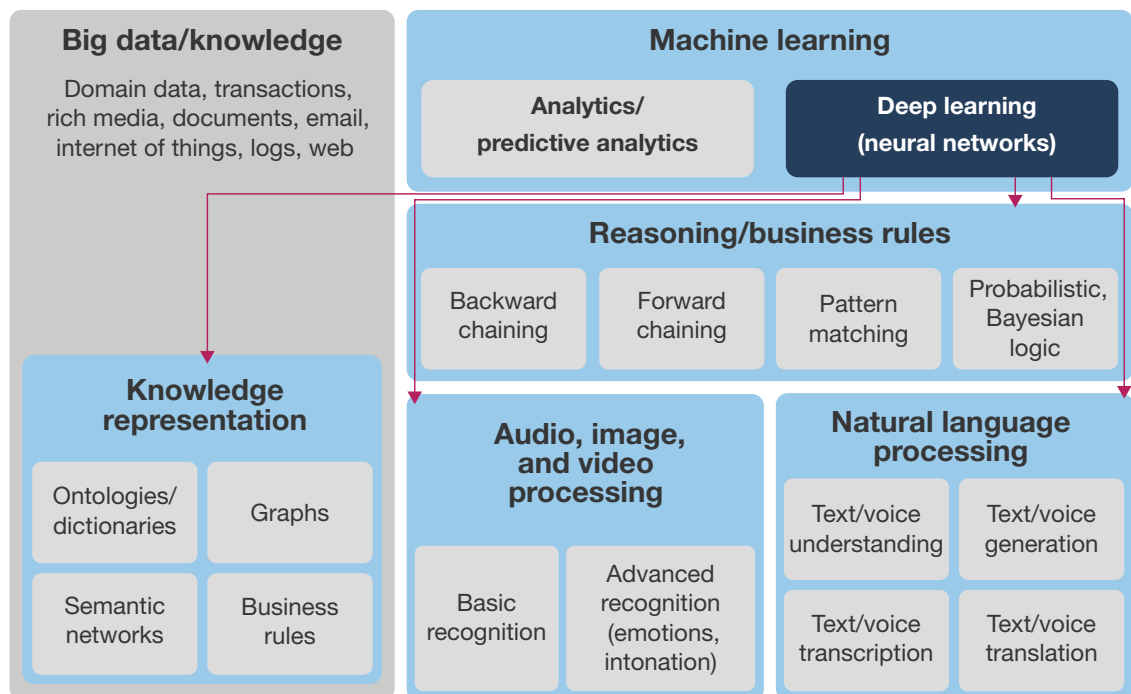
The AI technology landscape is full of old (weaker) and new (stronger) technologies (see Figure 1). Deep machine learning and neural networks are the basis for stronger AI; applying them to and combining them with existing weak AI technologies such as knowledge representation, NLP, reasoning engines, vision, and speech technologies will strengthen AI. Developers must first understand what these technologies are and what they can do differently and better with them, both in the software development life cycle (SDLC) and in new types of applications. We surveyed and spoke with 30 industry players to uncover the ideas they have coming from their research labs, their new products and services, and their experiments with clients. Imagine for a moment that AI will allow developers to:

- › **Quickly turn an idea into code.** Turning business ideas into working code is still a major source of problems, even as Agile, DevOps, and the latest requirements definition practices have improved the process. What if a dev team could just write its idea in natural language and the system understood the request and turned it into machine-executable code? While that's still science fiction, it's very reasonable for NLP and expert systems to suggest possible changes and where to apply them in the project. AI will enrich requirements models and test cases with more sophisticated text recognition, enabling better code generators.
- › **More precisely estimate user stories and timelines.** Precisely estimating the time to develop code from requirements is hard — if not impossible. To even get close to a reliable estimation, experts need a well-known context, with the same team using known technology. But a solution based on predictive machine learning and business rules will enable project leads to take the

huge amount of data collected over time from many projects — such as user story descriptions, decomposed activities related to a user story, historical team estimates, and historical actuals — and use correlations and statistics to come up with more precise estimates of effort and timeline.

- › **Quickly and confidently pinpoint production bugs and remedies.** DevOps teams spend huge amounts of time trying to figure out where and why operations bugs happen and who can quickly fix them. AI would enable them to use data on who wrote the code and what skills they had to intelligently search for devs with similar profiles who worked on similar projects and who have time available. Likewise, a team could use data generated during past project life cycles to predict what might go wrong in the current project as it unfolds and take steps to avoid problems.
- › **Automate decision-making on what to build and test next.** Code that implements incorrect or unused requirements causes lots of unnecessary regression testing. That in turn means time wasted in manual testing and building automation for features nobody uses — and wasted time and money for the operations team. A solution based on machine learning with business rules could leverage production data to show how the application is used and analyze the social sentiment around it. Data intelligence would help developers and testers prioritize their efforts based on business risk. AI would not only help spot high-risk areas but also automate the right tests to execute in the automated continuous delivery process.

FIGURE 1 Deep Learning Makes Other AI Stronger



AI Makes Applications Smarter

A new generation of apps that can speak, listen, sense, reason, think, act, and execute is hitting our mobile phones and desktops. The list of vendors pushing AI products, solutions, and technologies enabling these new apps is growing quickly. Solutions come in the form of embedded capabilities, point solutions, platforms, and deep learning (neural network) services (see Figure 2). AI will allow developers to build applications that offer:

- › **Straightforward human interaction.** We've created unnatural ways for humans to interact with computers. Developers spend time building apps with windows, data entry forms, pull-down menus, graphics, dashboards, and other graphical artifacts to make it "easy and efficient" for people to interact with them. AI will bring new and better options into play, enabling apps that see their users, write to them in natural language, hear and understand what they say, and respond to them through voice. Bots like Siri and Alexa are an early manifestation of this.¹
- › **Expert human interaction.** It's difficult and expensive to code policies and business rules using traditional programming languages like JavaScript, Ruby, Python, and C#. Weak AI offers the option of templating policies and business rules to build expert systems that focus on a specific business domain or problem area, support neophytes in their daily jobs or helping managers make better business decisions. While they have limits, they work for simple, confined problems. Rule-based reasoning, augmented with data and machine learning, will push such offerings further, opening more opportunities for expert advisors.
- › **Leverage "obvious" human capabilities.** Cl&T, a technology agency and Google service partner, is experimenting with clients to develop smart, focused business applications that leverage AI technologies. For example, it showed how vision recognition technology helped a Brazilian mining company looking to automate its inventory simplify the process by reading train car identifiers instead of retrofitting massive numbers of cars with RFID tags. Optical character recognition is increasingly using machine learning and neural networks and offers many opportunities to use machine vision much more accurately. Cl&T offers Google Cloud Vision API technology to help developers build these new types of applications.
- › **Software that learns on its own.** While traditional (weak) AI "works," it's limited, as devs must still program most of it. Software that learns autonomously to abstract new rules and new policies out of very large sets of data would enable devs to stop codifying rules and policies. Weak AI, using programming rather than learning, was never enough to cover all of the expert cases and heuristics needed to operate in a real business context. Deep learning with big data through neural networks is the most promising AI technology that will disrupt how developers build apps. The question will soon become: What will apps become once more unsupervised deep learning picks up?

How AI Will Change Software Development And Applications**FIGURE 2** A Broad Range Of AI-Based Products And Services Is Already Visible

Category	Sample vendors and products	Typical use cases
Embedded AI Expert assistants leverage AI technology embedded in platforms and solutions.	<ul style="list-style-type: none"> • Amazon: Alexa • Apple: Siri • Facebook: Messenger • Google: Google Assistant (and more) • Microsoft: Cortana • Salesforce: MetaMind (acquisition) 	<ul style="list-style-type: none"> • Personal assistants for search, simple inquiry, and growing as expert assistance (composed problems, not just search) • Available on mobile platforms, devices, the internet of things • Voice, image recognition, various levels of NLP sophistication • Bots, agents
AI point solutions Point solutions provide specialized capabilities for NLP, vision, speech, and reasoning.	<ul style="list-style-type: none"> • 24[7]: 24[7] • Admantx: Admantx • Affectiva: Affectiva • Assist: AssistDigital • Automated Insights: Wordsmith • Beyond Verbal: Beyond Verbal • Expert System: Cogito • HPE: Haven OnDemand • IBM: Watson Analytics, Explorer, Advisor • Narrative Science: Quill • Nuance: Dragon • Salesforce: MetaMind (acquisition) • Wise.io: Wise Support 	<ul style="list-style-type: none"> • Semantic text, facial/visual recognition, voice intonation, intelligent narratives • Various levels of NLP from brief text messaging, chat/conversational messaging, full complex text understanding • Machine learning, predictive analytics, text analytics/mining • Knowledge management and search • Expert advisors, reasoning tools • Customer service, support • APIs
AI platforms Platforms that offer various AI tech, including (deep) machine learning, as tools, APIs, or services to build solutions.	<ul style="list-style-type: none"> • CognitiveScale: Engage, Amplify • Digital Reasoning: Synthesys • Google: Google Cloud Machine Learning • IBM: Watson Developers, Watson Knowledge Studio • Intel: Saffron Natural Intelligence • IPsoft: Amelia, Apollo, IP Center • Microsoft: Cortana Intelligence Suite • Nuance: 360 platform • Salesforce: Einstein • Wipro: Holmes 	<ul style="list-style-type: none"> • APIs, cloud services, on-premises for developers to build AI solutions • Insights/advice building • Rule-based reasoning • Vertical domain advisors (e.g., fraud detection in banking, financial advisors, healthcare) • Cognitive services and bots
Deep learning Platforms, advanced projects, and algorithms for deep learning.	<ul style="list-style-type: none"> • Amazon: FireFly • Google: TensorFlow/DeepMind • LoopAI Labs: LoopAI • Numenta: Grok • Vicarious: Vicarious 	<ul style="list-style-type: none"> • Deep learning neural networks for categorization, clustering, search, image recognition, NLP, and more • Location pattern recognition • Brain neocortex simulation

AI Will Have Far-Reaching Effects On Software Development

Forrester expects artificial intelligence to affect software development in a number of ways — but at the same time, it will also affect the way developers and their business partners think about the applications and new solutions they can potentially build with AI. First, AI will increase the mastery of AD&D teams by transforming the SDLC by improving existing practices and development tools as well as adding totally new ones. And AI will not just improve apps as we know them today — it will also allow developers to begin to move beyond apps to deliver tomorrow's software experiences.

AI Will Increase The Mastery Of AD&D Teams

Just like any another business domain or process, software development, testing, and delivery will benefit from AI, making developers and development teams much smarter in how they plan, build, test, and deploy software. We recently spoke with 25 AD&D teams and found that they think that AI can boost software development and delivery in many ways, and the phases most ripe for near-term AI improvement are planning, development, and especially testing (see Figure 3 and see Figure 4). Developers will change their processes and the nature of apps themselves by (see Figure 5):

- › **Improving the overall SDLC.** There are lots of inefficiencies and waste in the way software is developed today. Agile and DevOps coupled with value stream management eliminate waste and focus on business value. At the same time, app architectures with loose coupling and microservices will only increase the number of moving parts to manage.² The complexity will go beyond what humans can manage and interpret. AI agents, bots, and embedded capabilities in tools will be key partners for development teams to address this.

Our survey respondents expect AI — in particular machine learning and predictive and deep learning — to seep into the overall life cycle. They see AI optimizing the process in four ways. First, AI will synthesize vast amounts of data to predict or prevent failures in project delivery. It will also produce more accurate project and program delivery timelines, especially for traditionally developed projects. AI will use intelligent agents to deliver project status updates in natural language. Finally, it will enable more complex improvements, like automatically diagnosing problems with software development practices.

- › **Accelerate delivery by applying AI in specific SDLC steps.** More in-depth use of AI will embed more intelligence capabilities in specific steps of the life cycle to yield unprecedented automation and quality at speed. While all SDLC steps benefit from accelerating work using automation and insights based on data analysis, the ideation and planning, testing, and deployment phases (including DevOps) will see more immediate benefits. Our respondents are prioritizing these phases and see testing in particular as the phase that will reap big benefits sooner.

How AI Will Change Software Development And Applications

AI can enhance testing in several ways. It can suggest a better strategy, automate test designs, predict the quality of outcomes based on type and test coverage, increase coverage while reducing test design and execution, and automate visual UI testing to improve problem detection through better object recognition. Last but not least, AI can also reduce the time to fix bugs in production by supporting root-cause analysis (see Figure 6).

- › **Disrupt the SDLC to build apps that are not apps any longer.** Ever since software was invented, devs have programmed what apps need to do in minute detail. Even weak AI has followed this approach, albeit making it somewhat easier through different programming styles.³ That will end soon. Code and algorithms won't manipulate and transform data as in the past; the (big) data will transform apps' behavior to autonomous thought and learning. More pervasive use of machine learning in general and deep learning in particular will permanently disrupt the SDLC.

While some developers will work on selecting what type of neural network or other algorithm to use, most will instead train neural networks (tweak the model) and test them. Devs will first create or collect the big data needed and tag it and train it in a "supervised" manner, as it will be long before unsupervised training occurs. They will then subset the data into training data and test data. These will be new tasks for delivery teams. Data analysts will partner more closely with developers, while fewer developers will develop and improve deep learning algorithms. Very focused and tailored use of deep learning is already a reality, but there is a long way to go before the disruption becomes significant and pervasive.⁴

FIGURE 3 AI Will Improve The Software Development Life Cycle, Starting With Testing

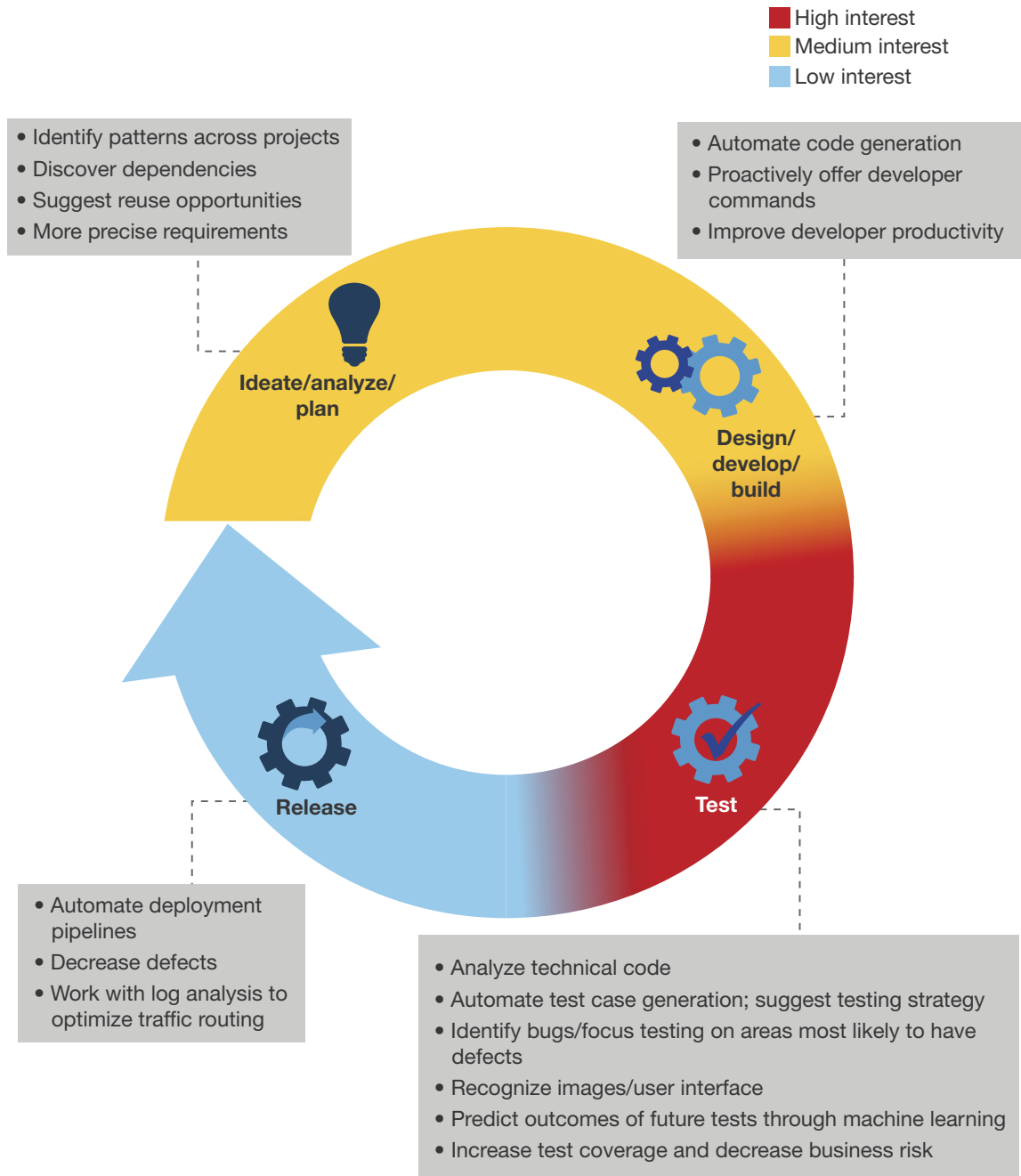


FIGURE 4 Improved Software Development Brings Direct Business Benefits

How AI improves software development	Business benefit
Increase automation	Deliver improved software faster
Use interactive natural language in interface	Improve customer experience
Predict customer churn	Retain customers, protect revenue
Manage huge amounts of data across life cycle	Gather good insights to improve development and delivery
Optimize resource allocation	Reduce costs
Automate decisions	Scale human decision-making
Improve analytics and diagnostics	Improve software quality
Increase developer productivity	Lower costs, increase value

FIGURE 5 AI Will Change The Way Developers Build Apps

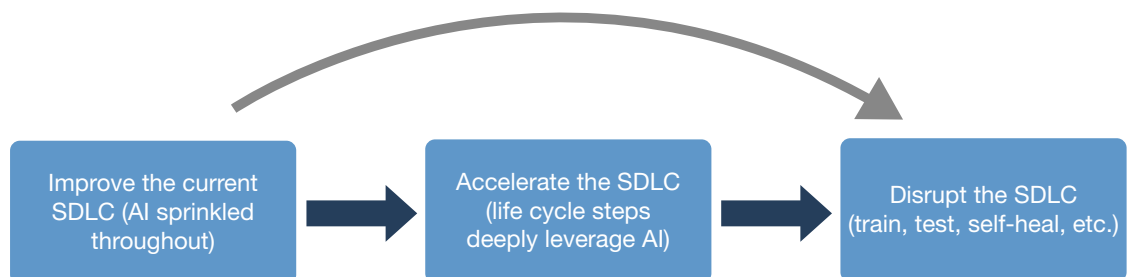


FIGURE 6 Zoom In On AI Improvements In Software Testing

Use case	Description	Results
Test strategy improvement	Use social data and production data to keep track of best and worst features used (or not used) to prioritize what to test, what to automate, and even what to build.	<ul style="list-style-type: none"> • Reduce test costs while increasing quality • Machine learning is mature enough to enable this use case today; some vendors are already experimenting with it
Optimization and automation of test case design	Combinatorial generation of all possible test cases generates a huge amount of them; AI can digest them in acceptable time frames and propose a minimum set of tests. Generate test cases directly from business requirements by having a deeper understanding of the system being tested.	<ul style="list-style-type: none"> • Reduce testing costs; focus testing on what is right, rather than testing more • Improve traceability from requirements to test cases to automation • Overall test cycle reduction • Leverage NLP and business rules capabilities
Automation and early prediction of quality	Use a description of quality practices and patterns to identify what might work and what might not and what improvements can be made to the team's activities. In some cases, suggest them; in others, make them automatically.	<ul style="list-style-type: none"> • Prevent poor quality from the beginning • Shift testing to the left • Automate continuous improvement
Automation of quality prescription	Support or even replace the human being in UI test automation through self-learning image pattern recognition. Detect and suggest updates of controls on the UI.	<ul style="list-style-type: none"> • Improve quality and fully automate UI testing by replacing human beings in repetitive, tedious manual testing. • AI visual testing system for optical recognition of images and characters
Waste elimination and optimization of testing work	Help testers keep track of test cases not executed in a given time frame, test cases not linked to requirements, untested requirements, and redundant and/or similar tests (duplications).	<ul style="list-style-type: none"> • Optimize testing costs and improve quality • Continuously improve testing work • Increase maintainability and relevance of test assets
Tough testing calls	Testing systems where a "failure" is not black and white. This need is growing with the IoT, where interfacing with the physical world makes it complicated to decide if a test actually should fail or not (e.g., self-driving cars, thermostats, manufacturing machines).	<ul style="list-style-type: none"> • Deal with complexity of testing in the internet of things • Human support when there's just too much data to analyze in a short time frame

AI Will Help Developers Make Better Apps — And Move Beyond Apps

Customer-obsessed organizations provide experiences that win, serve, and retain clients. AI will gradually be able to deliver unprecedented types of applications to those customers. Businesses will need imagination and experience to develop AI-enabled applications; they'll also need to adapt to a new world where developers no longer create an app for a specific outcome but can build software that can handle a range of outcomes and next steps. Caution is the order of the day; many respondents to Forrester's Q2 2016 Global State Of Artificial Intelligence Online Survey do not see a defined business case for AI investment (42%) and aren't clear on how their business can use AI (39%).⁵ AI clearly requires a test-and-learn approach, in line with how most firms are tackling digital disruption. Fifty-six percent of early implementers expect AI to help automate repetitive manual business processes.⁶ Enterprises need to adopt AI in small steps by getting the business, data scientists, and developers with AI expertise to experiment early on and in an agile way (see Figure 7). We expect such experiments to unfold in three overlapping stages:

- › **Make existing apps more conversational today and more fluent tomorrow.** Developers add some cool features to business applications with limited scope and within a confined domain like repetitive language or finite commands to improve customer engagement.⁷
- › **Improve reasoning, decision-making, speech, and understanding.** A smart combination of reasoning capabilities, ontologies, and data enriched by machine learning algorithms will give applications the ability to reason and deduct information by analogy.
- › **Develop apps that aren't apps any more.** Bots and intelligent agents will quickly take center stage in development; devs won't be programming them but rather teaching them.

FIGURE 7 AI Will Enable Developers To Build New Types Of Applications — Which Are No Longer Applications



AD&D Pros Must Face Up To The Risks, Challenges, And Costs

AI has a checkered history. Media hype alongside science fiction dystopias create anxiety for businesses considering investing in AI. But by no means will AI come close to replacing human intelligence in our lifetime. Rather, research and industry should focus on governing the evolution of AI, while working in the direction of developing a technology that helps and supports humans rather than replacing them or “taking over.” The principal challenges and risks companies face are:

- › **Inflated expectations.** AI can support customer contact centers with bots, NLP, and AI advisors suggesting customer engagement tactics. Financial services firms are piloting projects to use AI to scale and increase the quality of their contact centers. AI technology is here, but it's not yet perfect. For example, voice transcription is close to perfection — Baidu is the leader in precision voice understanding, with margins of error well below 5% — but understanding meaning, slang, dialects, or accents is not. Be aware of such limitations and look for the right type of problems to solve within a confined, well-defined domain. Set realistic expectations to avoid disappointment.
- › **Underestimated integration costs.** Any enterprise adopting AI will take on architecture and integration challenges to leverage AI services in its existing software landscape. Let's be clear: Integration won't get any easier, there won't be less of it, and it won't become cheaper. Glue code needs to be designed, developed, and maintained to link bot platforms or machine and deep learning algorithms with existing systems.⁸ Data flow from one algorithm to another needs to be programmed and managed. Solutions to these new problems will come, but in these early days sharpened integration skills are required to deal with AI integration efforts.
- › **Lack of big data or computing power.** Deep learning algorithms are generally available for simple scenarios; we train them on desktop graphics processing units (GPUs) and run them on our mobile devices. But training large, multilayer deep learning algorithms, especially for complex problems, requires huge data sets and significant computing power. Investing in more and more data will be a new item on CTOs' checklist. Stanford professor Andrew Ng, who is also Baidu's chief scientist, says that he gives researchers access to supercomputers in order to train neural networks. Google does the same. Is your firm willing to invest that kind of money in hardware or to run these types of projects through third-party cloud services?
- › **Uncertain AI testing regimes.** While AI will help improve the testing of existing applications, challenges remain about testing AI itself. How do we know that the AI application is giving the right recommendation? How will we know that the neural network is learning the right thing or when it has learned it?⁹ Some vendors are working on justification modules that show how a reasoning system reached certain conclusions, but a neural network often operates as a black box; even its developer is not sure exactly how it reaches a conclusion. Developing new testing practices and technologies to solve these issues will be high on AI developers' agenda. And until such challenges are addressed, companies will have to again temper their use of AI, making sure that they minimize the risks.

Recommendations

AI-Enabled Software Will Still Need Developers

Even as more AD&D professionals and their development shops apply AI techniques in the coming years, they will still have lots of traditional coding and integration work. Integration in particular will remain a relevant skill, even as AI transforms the SDLC. Creating AI-based applications and using AI to improve development processes will require various new skills and strong technology choices. Dev teams that want to ride the front edge of the AI wave will:

- › **Pair data scientist skills with AI technology skills.** It's not big data but very big data that AI systems need in order to become more useful and precise and take on more important tasks. Organizations need to set a data strategy to collect more business data than ever to feed their AI systems. A few select developers will need strong mathematical backgrounds to grasp the differences between the algorithms to cut down training time and have them converge faster to problem resolution. The collaboration of these two roles in development teams will be key.
- › **Apply data and insights to the development process.** You'll need data to underpin insight-driven decision-making across a continuous delivery pipeline, based on historical, current, and future data to provide prescriptive and predictive analysis through machine learning. With such a capability, developers will have a build triage to investigate and diagnose failing builds, pinpoint failure points, and provide advanced root-cause analysis. Testing will fully automate most repetitive tasks, with human intervention needed in exceptional situations.
- › **Combine weak and strong AI.** AI's output is best when it uses weak and strong technologies together. Neural nets can expedite data curation to feed a reasoning system or improve a natural language linguistic precision text or voice recognition. Weak AI helps improve, solve, and automate easy, repetitive tasks; strong AI makes the difference in solving harder problems at large scale. AI is getting stronger, but has a way to go; its strength depends on how fast deep learning will improve and augment weak AI. Look for vendors and platforms that augment weak AI products with stronger neural nets.

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Supplemental Material

Survey Methodology

Forrester's Q2 2016 Global State Of Artificial Intelligence Online Survey was fielded in May and June 2016. This online survey included 612 global respondents. For quality assurance, we screened respondents to ensure that they met certain standards in terms of job responsibilities and the size of their organization. The survey defined artificial intelligence for respondents as “a self-learning system that is able to interact with humans naturally, understands the environment, solve problems, and perform tasks that normally require human intelligence, qualities and abilities without the need to code instructions and rules.”

Companies Interviewed For This Report

We would like to thank the individuals from the following companies who generously gave their time during the research for this report.

How AI Will Change Software Development And Applications

Assist	L&T Infotech
Blueprint Software	Microsoft
CA Technologies	NIIT Technologies
Cognizant	Orange Applications for Business
Conformiq	Qentelli
CSI	SAP
EPAM Systems	Syntel
Google	TCS
Hewlett Packard Enterprise	TestPlant
Infostretch	Tricentis
IBM Global Business Services	Wipro

Endnotes

- ¹ Research at GoogleMany companies are betting on bots, chat-based software built to simulate human conversation and help consumers complete tasks. But while bots and the technologies that enable them are evolving rapidly, the customer experiences they offer today are often either poor or uneven. See the [“Bots Aren’t Ready To Be Bankers”](#) Forrester report.
- ² With increasing frequency, microservices are appearing in enterprises’ efforts to achieve better software architectures, especially among those operating at scale, such as eBay, Google, Netflix, and Walmart. “Better” in these efforts alternatively means faster software delivery, greater operational resilience and scalability, better solution maintainability, or all of the above. For AD&D pros, the question is how and where microservices might help improve software architecture. See the [“Microservices Have An Important Role In The Future Of Solution Architecture”](#) Forrester report.
- ³ Business rules engines allow one to represent rules as “if X, then Y, else Z” declarative statements, or in prologue logic language or LISP functional programming.
- ⁴ By 2021, AI within intelligent agents will evolve significantly beyond today’s relatively simple machine learning and NLP. Emerging applications will feature improved self-learning and more complex scenarios. As basic agents gain consumer adoption, next-generation AI will not power intelligent agents until 2020 or beyond. See the [“The Top Emerging Technologies To Watch: 2017 To 2021”](#) Forrester report.
- ⁵ Source: Forrester’s Q2 2016 Global State Of Artificial Intelligence Online Survey.
- ⁶ Source: Forrester’s Q2 2016 Global State Of Artificial Intelligence Online Survey.
- ⁷ Cognitive systems are creeping into commercial relevance beginning with high-end customer engagement applications in financial services, healthcare, and retail and will become ubiquitous in mainstream scenarios and the internet of things within five years. See the [“Cognitive Engagement: A New Force Of Creative Destruction”](#) Forrester report.
- ⁸ Source: D. Sculley, Gary Holt, Daniel Golovin, Eugene Davydov, Todd Phillips, Dietmar Ebner, Vinay Chaudhary, and Michael Young, “Machine Learning: The High Interest Credit Card of Technical Debt,” Research at Google, 2014 (<http://research.google.com/pubs/pub43146.html>).

How AI Will Change Software Development And Applications

⁹ There are two distinct phases in building an application based on a neural network. The first phase is training, during which developers identify a subset of big data and use it for training purposes. Once the algorithm starts yielding the expected results, developers proceed to the second phase, which is the testing phase. This test uses a separate set of big data for testing. However, for more complex AI systems that use multiple components or neural networks, providing advisory through reasoning is much harder to test; in some cases, no one knows how to test it. Better testing might be possible via deconvolutional neural networks, a new method that allows developers to visualize what a neural network is learning at each neural layer and what features it is extracting.

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