Where Banks Can Use Smart Machines

Published: 8 January 2016

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Smart machines offer huge potential benefits to early adopters within financial services, even with regulators barring banks from some use cases. CIOs must proactively prioritize potential investments in smart machines and begin pilots in 2016.

Impact

- Most banks will invest in six main types of smart machines during the next few years, mandating that CIOs and other business leaders work together to determine how to exploit each.

Recommendations

CIOs:

- Develop and validate solid business use cases with customers.
- Use business capability modeling techniques to ensure organizational readiness prior to adoption. Use the results to foster collaboration and initiative synergy across the enterprise.
- Use strategic technology mapping techniques to assess the impact on three dynamics: customer experience, productivity and commercial value throughout the value chain.

Business leaders:

- Use scenario planning techniques to assess the impact of smart-machine use on the banking industry and your own bank, and plan accordingly.
- Ensure there is a common language among business leaders as to the role and impact of smart machines on the business.
- Plan to adjust corporate culture (including organizational development and HR practices) to reflect the impact of smart-machine usage on the workforce.
- Rethink enterprise risk management in light of the potential impact of investments in smart-machine technologies.
Analysis

This document was revised on 20 January 2016. The document you are viewing is the corrected version. For more information, see the Corrections page on gartner.com.

A technology can be described as "smart" if, given a human-generated model and a large amount of information to ingest, it learns on its own to classify various aspects of the content. In certain ways, their powers of observation exceed human capabilities. (We characterize the essence of smart machines' learning capabilities in "Smart Machines See Major Breakthroughs After Decades of Failure."¹) This smartness is primarily perceptual, in terms of classifying content such as images, faces, speech and bodies of text. Smart machines can find patterns in such data and extrapolate generalizations from those patterns (see Note 1).

CIOs in financial services must prepare for the direct impact of six broad categories of smart machines as well as the indirect impact of many others (see Figure 1). While CIOs need to recognize limitations that the current regulatory environment may impose, they also need to consider potential benefits beyond those limitations for themselves and the industry. Regulatory environments greatly lag, and innovative leaders need to think beyond the limitations they impose.² As in all industries, CIOs must expect technical and, critically, cultural difficulties when deploying solutions for the first time and when attempting to scale them throughout the organization and to their customers. Some resistance from human users and regulatory agencies is likely, such as potential bans on investment advice provided by machines. Although users are comfortable with a level of automation that makes work and life easier, they aren’t yet experienced in working as partners with — or as subordinates to — smart machines. CIOs and business leaders must include plans to adjust corporate culture, including organizational development and HR practices, to reflect the impact of smart-machine usage on the workforce.
Impact and Recommendations

Most banks will invest in the six main types of smart machines during the next few years, mandating that CIOs and other business leaders work together to determine how to exploit each.

During the next few years, financial institutions will address many use cases by investing in six specific types of smart machines:

- Smart vision systems
- Virtual customer assistants
- Virtual personal assistants
- Smart advisors
- Other natural-language processing technologies
- Smart campus infrastructure

We examine these in the six sections that follow. We've included additional examples to consider in the section titled Additional Sample Banking Industry Uses of Smart-Machine Technology.
All these types gain "smartness" from underlying deep neural network (DNN) technology. DNNs are typically combined with rule-based systems. They are the procedural engines that enable smart machines to appear to reason, within the constraints imposed by the programmer or subject matter expert. Rule-based systems are essential systems that are driven by both inputs from smart technologies and rules written by people.

1. Smart Vision Systems

Smart vision systems can identify objects, people, facial expressions and other attributes in a video stream. Instead of forwarding images to a rule-based system, they send descriptions of what they have found in their "visual field." That simplifies greatly the handling of video information and makes it easier to act on (see Note 2 for more detail on smart-vision-system technology).

Although most estimates suggest that 80% of smart vision systems will be used in vehicles through 2025, their capabilities will also make them valuable to banks and other financial institutions. CIOs should consider where and why their institutions might use, for example, facial recognition of employees, contractors and customers. Possible uses include:

- Authentication — for transactions
- Access — to buildings and specific floors and rooms
- Security — for public safety and surveillance in many locales, including ATMs
- Interpersonal recognition and virtual personal teller assistants — for example, advising tellers of a customer's identity without the customer having to do anything
- Smart campus infrastructure — adjusting HVAC based on the number and gender of people in the room

To exploit their use, CIOs must first address cultural issues, which vary from country to country. Cultural issues present greater problems in banking than in other industries, such as retailing. They may present barriers to collecting, processing and storing video information. For example, several years ago, banks connected their in-branch security cameras to risk management and credit decisioning engines to aid in decision making. This initiative failed because of a lack of cultural acceptance.

To cite specific usage examples:

- A bank of the U.S. southwest trialed a system a few years back using branch security cameras to track body language for prospective borrowers as a means of enhancing credit decisions. There was push-back from customers and fear on the part of the banks about invasion of privacy.
- In November 2014, Shanghai branches of Australia's 100% Genuine Imported Foods Chain Stores introduced a new way for customers to authorize payments: a scan of the capillary networks in their face and hands. To identify each customer, thermal imaging cameras at check-
out use a similar technique to facial recognition to measure the distance between data points on each individual’s facial capillary network.

- In similar initiatives, companies such as Capitec Bank in South Africa are already using biometrics to identify employees. A Canadian vendor, Nymi, is working with various financial services institutions to investigate the possibility of linking biometric processes to the blockchain to authorize bitcoin payments from a digital wallet. This could also be used to give individuals timed access to certain rooms and transport along specific paths, as well as monetize discrete activities.

CIOs may be able to use smart vision systems for space and interaction monitoring. For example, they could use them to monitor rooms, other physical resources, people and meetings. In some cases, CIOs will use derived physical social network analysis to supplement — or even replace — social network analysis performed on email and other electronic media. This analysis would answer questions such as "Who was speaking with whom in the meeting?" and "Did any new interaction patterns emerge?" In the right hands, this has the potential to improve collaboration and communication as well as optimize the use of physical resources. JPMorgan Chase, National Australia Bank and Citibank are among the institutions already doing this type of social analysis. However, organizations need to tread lightly to build trust with employees as they embark on these types of applications.

CIOs could also use smart vision systems to measure the attention people pay to media placed in public places, such as lobbies, waiting rooms and airports. They could use them to determine not only traffic, but attention gained, effectiveness and potential remediation. Wells Fargo has already pioneered the use of targeted digital marketing for ATMs based on location awareness and card identification. Adding smart vision systems to ATMs can result in additional benefits.

More examples can be found in Note 2.

**Recommendations:**

- Strive to find ways to overcome cultural objections to the use of smart camera systems.
- Assess how you can monetize the use of smart camera systems.

**2. Virtual Customer Assistants**

A virtual customer assistant (VCA) simulates a conversation to deliver information and can take action on behalf of a customer to perform transactions. VCAs can handle customer inquiries via natural-language dialogue in text or speech forms. They can empathize with the specific customer with whom they’re conversing, speed up transaction handling, improve customer satisfaction and reduce operating costs.

For example, in 2014 Diebold tested a teller avatar — a kinetic, interactive digital female that interacts with banking customers through a large video screen. The female avatar is part of a stylized ATM that dispenses cash and talks consumers through other transactions.
VCAs could also upsell financial services products if nonhuman agents were authorized to sell such products. Currently, although VCAs have the ability to provide directional input in the selling of financial services products, financial institutions would be breaking the law if they used VCAs to sell a product or even recommend that a customer buy it.  

More than 40 providers offer VCAs, which differ greatly from the interactive voice response units of the past. Sometimes they have a physical form, as in Xiaoi’s retail banking robots. The best VCAs:

- Engage in natural-language dialogue in text or speech
- Learn from interactions
- Offer suggestions tailored to the customer, but don’t recommend financial services products
- Sense customer emotions and act accordingly

*Recommendations:*

- Focus first on using VCAs for a limited set of processes, rather than for all your organization’s products and services.
- Explore the many ways in which you could use VCAs to help customers, including:
  - Integrating speech-to-text capabilities in existing customer-facing applications via Speaktoit’s APIs
  - Employing a rule-based system from a vendor such as Next IT or Yseop
  - Using a purpose-built package or cloud-based service from a VCA vendor, such as IPsoft or Creative Virtual
  - Using a general-purpose set of smart-machine services, as Go Moment does with IBM Watson’s Natural Language Dialogue service
  - Picking up a complete framework from the IBM Watson division
  - Selecting a specialist, such as CognitiveScale, that has already built the desired type of customer service application
  - Using a VCA embodied in a robot, such as Xiao’s
  - Pursue a business process outsourcer with experience in this particular domain

3. Virtual Personal Assistants

A virtual personal assistant (VPA) focuses mainly on a user-related information stream, learning and drawing inferences from it. It performs some of the functions of a human personal assistant. With the user’s permission, it:

- Observes user content and behavior
• Builds and maintains data models from which it draws inferences about people, content and contexts
• Predicts user needs
• Builds trust
• Makes proactive suggestions
• Acts autonomously on the user’s behalf — for example, doing automatic "housekeeping" to reduce the amount of low-value work the user has to do

The main corpus, or body of information, a VPA uses is what it has seen the user do and the context within which it’s done. Context includes interactions with others. In principle, the corpus is personal, not enterprise. VPAs will go under many names, including "smart agents," "digital personal financial assistants" and "digital payment advisors" (see "Smart Agents Will Drive the Switch From Technology-Literate People, to People-Literate Technology").

A VPA is not a VCA.

• Think of VCAs as replacements for call center operations. VCAs operate off an enterprise-rooted main corpus. The corpus contains the range of answers and requests for clarification it should provide to the customer in response to customer statements or questions. It also contains the specific processes it can address on behalf of the customer.
• Think of VPAs as alternatives for people with the job title "personal assistant."

(See also Note 3, Differentiating Between VCAs, VPAs and SAs.)

VPAs will proliferate, eventually replace apps and make proactive suggestions to customers, employees and others unaffiliated with your institution. We expect that people will have many of these assistants performing work for them, coaching and helping. These assistants will change the nature of work for people at all levels in financial services and other organizations. Here are some additional VPA examples:

• Meeting arrangers — to negotiate across participants to select the best time and location for a meeting. 9
• Virtual personal career counsellors — to advise individuals on opportunities and issues (jobs, training, performance).
• Virtual personal social advisor(s) — different ones for different social circles (work buddies, career buddies, hobby buddies, families and more).

**Blurring the Dividing Line**

We are beginning to see VCAs and VPAs overlapping a little, with some of the former acquiring some personal assistant attributes, learning and retaining knowledge of individual customers to tailor their interactions with them.
But make no mistake, the focus of the VCA is servicing the bank customer’s needs. The VPA flavoring makes the customer feel better about their bank, or so the thinking goes. IPsoft’s Amelia and Ally Bank’s in-app Ally Assist are two early examples.

**Regulatory Status**

We are uncertain as to regulatory guidance for entities outside the financial services industry that are building VPAs unaffiliated with any financial institution, and that will provide advice on investment products. There are behavioral bounds placed on media that provide financial advice. We do not know how the emergence of virtual personal financial assistants impact or are impacted by those regulatory behavioral boundaries.

Finally, bank machines will have to interact with customers’ VPAs (in the post-app world), so this is an opportunity for forward thinkers to exploit.

**Recommendations:**

- Decide how you can best exploit VPAs’ observations of user behavior, suggestions and autonomous actions.
- Anticipate the existence of many different types of VPA.

**4. Smart Advisors**

Smart advisors are similar to VPAs but don’t focus on observing and acting on behalf of users. They concentrate on a different corpus. Smart advisors:

- Ingest a collection of relevant material — all relevant training manuals, textbooks and case law in a particular domain
- Appear to "understand" that material — they extract the key concepts and relationships between the concepts, and can draw inferences from what they have ingested and the current needs of the user
- Provide the user with answers or recommendations — either proactively or reactively, using their "understanding"

CIOs could use smart advisors in many areas in financial services while remaining within the regulations that prohibit nonhuman agents from making purchase recommendations. For example, they could use a smart advisor to ingest all policy documents within the institution, as well as reference materials from government and industry organizations. This would enable the smart advisor to evaluate the information and advise the user on:

- The impact of proposed regulation changes in a particular country on the institution’s policies and procedures in that country. It could also advise on the impact of broader adoption.
- Conforming an internally generated business proposal for an external client with the client’s overall policies and external operating constraints.
Smart advisors can offer strategic advantage when the corpus they ingest is large, complex and changing. Using a smart advisor may not be advisable if the corpus doesn’t have those attributes.

Financial services institutions have shown much interest in smart advisors designed as wealth advisors. Such wealth advisors typically collect a large body of often-changing financial advice from internal and external sources, and offer tailored recommendations to those responsible for high-net-worth clients. It becomes the responsibility of the human relationship manager to decide which recommendations to pass on to a particular client (thus not running afoul of regulatory constraints).

We expect that smart advisors and VPAs will merge eventually, but not for a long time.

Some interesting smart advisors — such as one by CognitiveScale of Austin, Texas — help workers in extremely large organizations deal with the complexities of ERP packages. We believe similar simplifications are possible in the financial services industry. However, there is a big difference between internal and external use. CIOs must devise use cases with care.

**Recommendations:**

- Develop a multiyear strategic plan for smart advisors with proposed business cases, feasibility studies and vendor evaluations.
- Commit adequate time and resources to the long-term development of smart advisors (don’t expect quick success and returns), and prepare for a major shift in the way you do business.
- Invest in developing informatics talent for pilots.
- Pilot several smart advisors and assess the best fit for your use cases, including ease and cost of maintenance over the long term.

### 5. Other Natural-Language Processing Technologies

CIOs should decide between using smart advisors and other natural-language processing (NLP) technologies based on corpus size, complexity and rate of change. Other NLP technologies are usually lower cost, lower risk and less flexible than smart advisors in the long term. Many of the numerous NLP technologies have very positive use cases and benefits.

One large money center bank has used rule-based natural-language dialogue systems to greatly simplify access to many overlapping systems, some of which were redundant. Next IT designed a natural-language dialogue system to enhance the performance of the bank’s wealth advisors.

CIOs should also consider natural-language generation (NLG) tools. These tools combine NLP with machine learning and artificial intelligence (AI) to identify the most relevant insights and context in data (trends, relationships and correlation patterns). They automatically generate a narrative — tailored to the user’s context — to explain meaning or highlight key findings in data. Some financial services institutions have used NLG tools to enhance executive decision making, improve personalization for customer advice and communications, and for earnings reports.
For example, Narrative Science has developed a natural-language generation platform called Quill to allow companies to assemble more-useful reports from complex sets of information embedded in databases. The software uses AI to identify, prioritize and translate disparate information from databases into a written report. USAA, MasterCard, Markit and American Century Investments are using Quill to generate user-friendly reports. These reports can be directly used in customer interactions to enrich the experience and, for example, quickly produce internal and external reports to better prepare lending officers for meetings via more-consumable material. Three other key players in natural-language generation are Yseop, Arria and Automated Insights.

Two more (of many) NLP applications of potential interest to financial services CIOs:

- Advanced text analytics products from Brainspace.
- NLP-based, security-oriented communication monitoring technology from Digital Reasoning.

Recommendations:

- Engage outside experts to explore the ways in which other NLP technologies could impact your institution’s key initiatives.
- Develop relevant internal analytical skills as use cases become more obvious for your business priorities.

6. Smart Campus Infrastructure

Smart-machine technologies are leading to new ways to deliver building and other infrastructure services at lower cost. In many ways, this is the Internet of Things (IoT) story. Begin by collecting more data from your physical infrastructure. Apply various data-centered tools (rather than standardizing on a single hardware technology provider at the endpoints) to consolidate disparate inputs. Apply analytics to determine the clusters of signals that reliably predict problems. Employ rule-based systems to direct remediation on problems.

This is particularly important in the areas of HVAC systems, lighting, people monitoring, security and access control.

Subsequent academic research reports that smart-machine technologies (DNNs) superseded other analytics in their modeling and testing of temperature forecasting for building interiors — a key area for HVAC management and maintenance.

In the second generation, use smart-machine technologies (or buy systems that incorporate them) to identify patterns in the real-time data feeds that had never occurred to people but were surfaced by smart-machine technologies and found to be strongly correlated to significant consequences. Feed this new set of insights into the overall system.

Recommendations:

- Establish a specific set of smart-infrastructure goals with other business leaders in your institution.
- Create an "IoT" initiative aimed at exploiting smart machines to drive down infrastructure costs.
- Ensure someone is responsible and accountable for performance against those goals.

Additional Sample Banking Industry Uses of Smart-Machine Technology

Table 1 contains sample uses collected from material published by third parties. The entries are illustrative, not exhaustive. We have not evaluated the specific claims made by the entities that published the material, but we believe the examples can stimulate some additional creativity for our clients.
<table>
<thead>
<tr>
<th>Entity, Location, Status</th>
<th>Application</th>
<th>Additional Notes</th>
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<tbody>
<tr>
<td><strong>Smart Vision Systems</strong></td>
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<tr>
<td>BNZ New Zealand</td>
<td>Tapped advanced facial recognition to uncover consumers’ true financial feelings, encouraging people into branches for consultations with financial advisors</td>
<td>EmotionScan uses advanced emotion-recognition software to analyze facial expressions as participants listened to a series of scenarios designed around financial areas of interest: cash flow, budgeting, mortgages, retirement, financial security, financial control, debt, dependents, donations and savings. Helps customers understand how they feel about their money.</td>
</tr>
<tr>
<td>Bank of Chongqing China</td>
<td>Adopted a face-recognition system developed by Cloud Walk Technology</td>
<td>Facial recognition tightens up security vulnerabilities and better verifies customer information. The bank plans to construct an intelligent Internet finance platform, including a smartATM service, to provide more-convenient and safer financial services.</td>
</tr>
<tr>
<td>USAA U.S. Production (110,000) of 4.1 million members</td>
<td>Deployed voice and facial recognition with Daon, the software company</td>
<td>Offers facial recognition as an option for accessing its mobile app, which lets users check their balance, make deposits, view statements and reach customer service reps.</td>
</tr>
<tr>
<td>City banks U.K. Trialing as of October 2015</td>
<td>To implement Perceive software, developed by Socure, which uses biometric verification to detect fraud.</td>
<td>To reduce credit card fraud risk, the system asks customers to verify identifies by taking selfies on their mobile phones linked to their social media accounts. Once checked, the payment is either approved or a fraud alert issued.</td>
</tr>
<tr>
<td>Westpac New Zealand Production, early 2015</td>
<td>App allows customers to view financial information by pointing their smartphone camera at their bank card.</td>
<td>Optical character-recognition technology combined with a mobile app for new card activation to mitigate requirements for phone-based or branch processes.</td>
</tr>
<tr>
<td>CTBC Bank Taiwan Pilot, August 2015</td>
<td>Facial-recognition ATM</td>
<td>If successful, customers will be able to withdraw funds without the use of a card or PIN. Uses both facial recognition and finger-vein scanning (developed by Hitachi) to verify customer identity.</td>
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<tr>
<td><strong>Virtual Customer Assistants</strong></td>
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<tr>
<td>Mitsubishi UFJ Financial Group Japan Pilot, April 2015</td>
<td>A humanoid robot called Nao, developed by Aldebaran Robotics, a unit of SoftBank</td>
<td>The bank uses robots at its branches to greet customers and help them with inquiries. Can read emotions and speak 19 languages.</td>
</tr>
<tr>
<td>Commercial Bank of Dubai UAE Production since March 2014</td>
<td>“Ask Sara” portal with virtual assistant, Sara, powered by Creative Virtual’s V-Person technology</td>
<td>The virtual banking assistant provides website visitors 24/7 with personalized conversations, form completion and guidance, through interactions such as waving and tapping on the screen after a period of inactivity and, when used after hours, appearing in a darkened office.</td>
</tr>
<tr>
<td>Entity, Location, Status</td>
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</tbody>
</table>
| Widiba, Gruppo Montepaschi  
Italy  
Production since November 2014 | An intelligent virtual assistant, Widdy, using Artificial Solutions' Teneo platform | Provides 24/7 online banking process, such as new account opening and query resolution. In addition to chatting to the customer in a friendly, conversational style, Widdy also understands the context of a conversation. |

**Virtual Personal Assistants**

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<th>Additional Notes</th>
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| Ally Financial  
U.S.  
Production since June 2015 | A mobile personal assistant, Ally Assist, launched with the help of analytics firm Personetics | Ally Assist allows users to ask questions — by voice or text — and get contextualized answers. Also provides real-time insights into spending and transactions as well as offers predictions and feedback for budgeting and cash flow. Can also learn a customer’s behavior — e.g., will remind its customers to make a payment. |

**Smart Advisors**

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<th>Entity</th>
<th>Application</th>
<th>Additional Notes</th>
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</table>
| DBS Bank  
Singapore  
Moved to initial production, March 2015 | Using Watson to ensure relationship managers provide proper advice and experience for customers of its wealth management business | This collaboration between DBS and IBM is part of an ongoing journey by the bank to shape the future of banking. |

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<tr>
<th>Entity</th>
<th>Application</th>
<th>Additional Notes</th>
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</table>
| Standard Bank  
South Africa | Using Watson’s natural-language processing and machine-learning capabilities to gain insights from large amounts of structured and unstructured data | Using IBM Watson to speed handling of customer queries; also plans to help with customer identification, allowing staff to assess their needs and react more quickly. |

Note: Samples are recounted in reports by third parties and are meant to be illustrative rather than exhaustive.

Source: Gartner (January 2016)

**Caveat**

Smart machines will also have many indirect effects on the financial services industry, for which CIOs must prepare.

For one, the use of smart machines in areas outside financial services will have significant indirect effects within financial services. Driverless vehicles, for example, will affect the industry in many ways. People will rely on services similar to Uber, Lyft and Hailo that their VPAs will schedule for them. This will alter purchase, finance and insurance processes. Providers of transport services will buy or lease large fleets of driverless vehicles. This will cut the demand for personal loans and leases for vehicles. Accidents and injuries involving vehicles should plummet, as should damage to property caused by vehicles. This will change the risk curves for vehicles, and the economics and mechanics of auto-related insurance businesses.
Recommendation:

- Use scenario planning and similar methodologies to identify the potential indirect impacts of smart-machine technologies on the business activities of banks in segments relevant to you, and plan accordingly.

Gartner Recommended Reading

Some documents may not be available as part of your current Gartner subscription.

"Entering the Smart-Machine Age"

"Cool Vendors in Smart Machines, 2015"

Evidence

1 See "Entering the Smart-Machine Age" for a broader view of smart machines and their implications.

2 M. Raskino, G. Waller, "Digital to the Core: Remastering Leadership for Your Industry, Your Enterprise, and Yourself," Bibliomotion, 2015

3 This list is not meant to be exhaustive. There are other application categories that include smart-machine technology that banks might want to pursue now. One example is security tools that rely on DNNs to detect potential illegal activities or compliance violations (Digital Reasoning is one vendor of such tools). Furthermore, many application categories can intersect with one or more of the six specific types of smart machines listed in the main body of this note.

4 What they are able to recognize and describe depends on their training. They cannot describe everything that exists, only what they’re trained on. There are also limits to the number of discrete entities (visual patterns) they can recognize. One cannot, for instance, take the feeds from all Google Street View cameras and feed them into one DNN to train the system on everything seen by Google Street View cameras.

5 Perhaps the lead use case for smart vision systems in the banking industry is ATM cameras. These are getting more sophisticated, and the algorithms and analytics are providing better security for bank assets as well as protection for their customers — see here for more.

6 A smart vision system could not only identify the customer, but also use facial emotion detection (see, for example, Microsoft’s emotion detection tool). Windows Hello facial recognition in Windows 10 is a good example of potential wide-scale deployment of biometric facial recognition, which all CIOs will have to be getting to grips with soon.

7 This includes privacy and cultural attitudes to privacy. The same problems appear in retail video analytics where retailers are at pains to anonymize data.
There is no securities certification in place for smart machines. We do not know the regulatory conditions under which VCAs could provide financial advice. This limits, for now, initial VCA deployments to video teller, call center, ATM and branch holographics usage, and seems to rule out anything close to financial advice/sales. There’s a gray area between customer support and selling/advice. While clear in a human context, even something simple like product selection/optimization may be breaking the law as it stands today if a smart machine did it. Given the rate of change in financial services, no doubt this situation will change.

X.ai’s Amy is one of several examples — see "Cool Vendors in Smart Machines, 2015."

See EE Times, "Microsoft’s Big Data Analytics Tames Waste," recounting Microsoft’s experience tying together different campus infrastructure systems and using analytics to drive down operating costs. See also GreenBiz, "Inside the Killer App for Buildings and Energy Management."

Note 1 Smart-Machine Terms
It's valuable to distinguish between three different uses of the term "smart machines":

- **Smart-machine technologies** — The technologies that are essential to "smartness" and include such elements as deep neural networks (there may be other technologies that also exhibit smartness).

- **Smart-machine systems** — Primarily consist of smart-machine technologies. Examples include "smart vision systems" and "speech-to-text systems." (Not all vision systems or speech-to-text systems do contain "smart-machine technologies." Some contain large numbers of feature detection and other algorithms — these lack the ability to learn "on their own" given their dependence on specialized, human-created feature detector algorithms. Hence, they are not smart.)

- **Hybrid smart machines** — Consist of a mix of smart and "unsmart" technologies. For example, a driverless auto will contain several "perceptual" smart-machine systems (vision, speech to text and natural-language dialogue), but it will also contain very important yet unsmart rule engines, sensors and effectors.

Note 2 Smart-Vision-System Technology
Smart vision systems rely on deep neural networks (DNNs) to be able to identify visual features in their visual field without people having to write feature detector algorithms.

DNNs identify unique image features during (statistically based) training, during which a large number of images — potentially with additional biometrics — are fed into an empty DNN model created by a data scientist. As a result of training, the DNN is able to classify a large number of unique features, subfeatures and higher-level abstractions in the incoming vision stream, in such a way that it can identify them again in production. These image-processing capabilities have among the highest performance and lowest error rates of all smart-machine technologies.
In testing smart machines versus people on the same facial recognition task, smart-machine facial recognition systems can be more accurate than people. (Both people and machines make mistakes. Machines — assisted by people in worst-case conditions — are better than either alone but, in most applications, the boost in accuracy is not needed.)

Smart-vision-system growth will accelerate by 2020 and increase dramatically by 2022. The primary demand driver for the evolution of smart vision systems is the emergence of self-driving vehicles, expected to consume hundreds of millions of smart vision systems in the 2020s. The self-driving vehicle market will drive down the cost of the hardware at least a hundredfold — today, hardware for a camera-based smart vision system is over $1,000.

Note 3 Differentiating Between VCAs, VPAs and SAs
Virtual customer assistants (VCAs), virtual personal assistants (VPAs) and smart advisors (SAs) all overlap conceptually, but there’s one important difference: the body of knowledge (the corpus) the system is focused on.

- The primary corpus for VCAs is the bank’s content, processes, rules, policies and other content (such as marketing material) it chooses to expose to customers.
- The primary corpus for VPAs is the individual’s content, behavior, interactions and inferences regarding interests, intent and current context.
- The primary corpus for SAs is a deep, typically narrow, domain-specific body of specialized material, typically sourced from many domains such as open data, news feeds, social media, Wikipedia, books and articles.

One could imagine a universal agent with all three classes of capabilities. Today, you’re more likely to ride in a vehicle that can efficiently fly, drive down the highway and operate on the open seas than find a universal agent combining a VCA, VPA and SA.