Robots in Real Estate

How artificial intelligence will shape the way consumers search for real estate

Todd Carpenter, National Association of REALTORS®

Contents

On forward thinking

It's certainly possible that none of this will happen. Artificial intelligence (AI) may never reach its potential. Machine learning might be yet another overhyped buzzword. Robots may never evolve beyond those automated vacuum cleaners that scare pets and choke on power cords.

"Any sufficiently advanced technology is indistinguishable from magic."

Arthur C. Clarke

This is a look into the future and requires some measure of imagination.

Famed science fiction writer Arthur C. Clarke is credited for three adages that are known as Clarke's three laws:

1. When a distinguished but elderly scientist states that something is possible, he is almost certainly right. When he states that something is impossible, he is very probably wrong.

2. The only way of discovering the limits of the possible is to venture a little way past them into the impossible.

3. Any sufficiently advanced technology is indistinguishable from magic.

Clark's most widely known character is HAL 9000, the robot antagonist in his fictional Space Odyssey series. HAL (**H**euristically programmed **AL**gorithmic computer) is sentient, meaning "he" possesses artificial intelligence with the ability to learn. While most science fiction depictions of robots take a more humanoid form (like C-3PO in Star Wars), HAL lives inside a spaceship's embedded computer. He controls the systems of the spacecraft and generally interacts with the crew through human dialog and a series of camera lenses located all over the ship.

2001: A Space Odyssey, the first film depicting HAL 9000, was released in 1968. At the time, an omnipresent robot with artificial intelligence seemed like pure fantasy. But in the not-so-distant future, similar robots will be in the pockets of home buyers and will probably take the lead in helping them find their next home. This report explores how this may happen.

Real estate search today

According to the National Association of REALTORS® 2016 Profile of Homebuyers and Sellers, 95 percent of all recent buyers are using the internet at some point during the home search process. Of the home buyers who used the internet to search for a home, 51 percent found the home that they ultimately bought online.

EXHIBIT 3-9   **WHERE BUYER FOUND THE HOME THEY PURCHASED, 2001-2016**
(Percentage Distribution)

	2001	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Internet	8%	11%	15%	24%	24%	29%	32%	36%	37%	40%	42%	43%	43%	44%	51%
Real estate agent	48	41	38	36	36	34	34	36	38	35	34	33	33	33	34
Yard sign/open house sign	15	16	16	15	15	14	15	12	11	11	10	9	9	9	8
Friend, relative or neighbor	8	7	7	7	8	8	7	6	6	6	6	6	6	6	4
Home builder or their agent	3	7	7	7	8	8	7	5	4	5	5	5	5	6	2
Directly from sellers/Knew the sellers	4	4	5	3	3	3	2	2	2	2	2	2	3	2	1
Print newspaper advertisement	7	7	5	5	5	3	3	2	2	2	1	1	1	1	1
Home book or magazine	2	1	2	1	1	1	1	*	*	*	*	*	*	*	*
Other	5	6	4	*	*	*	*	*	*	*	*	1	*	*	*

* Less than 1 percent

Less than a decade ago, consumers most commonly cited the real estate agent for helping them find the home they ultimately purchased.

While many were concerned that the internet would eventually disintermediate the real estate agent, the opposite has occurred. Agents are more widely used today than in the infancy of the internet era. This is largely due to the industry's proactive approach to transitioning from data gatekeepers to data shepherds. Today, the lion's share of online real estate listings are a product of organized real estate. Agents, brokers and Multiple Listing Services (MLSs) all work together to provide property descriptions, pictures, comparable sales and other property records that give consumers online access to rich detail about a property and its surrounding neighborhoods.

This information is distributed to national real estate portals, including public-facing MLSs and brokerage and agent websites. Through a myriad of data agreements, brokers have significant influence over how their listings are publicly displayed on these sites.

EXHIBIT 8-1 FSBO AND AGENT-ASSISTED SALES, 1981–2016
(Percentage Distribution)

AGENT-ASSISTED   ALL FSBO (FOR-SALE-BY-OWNER)   OTHER
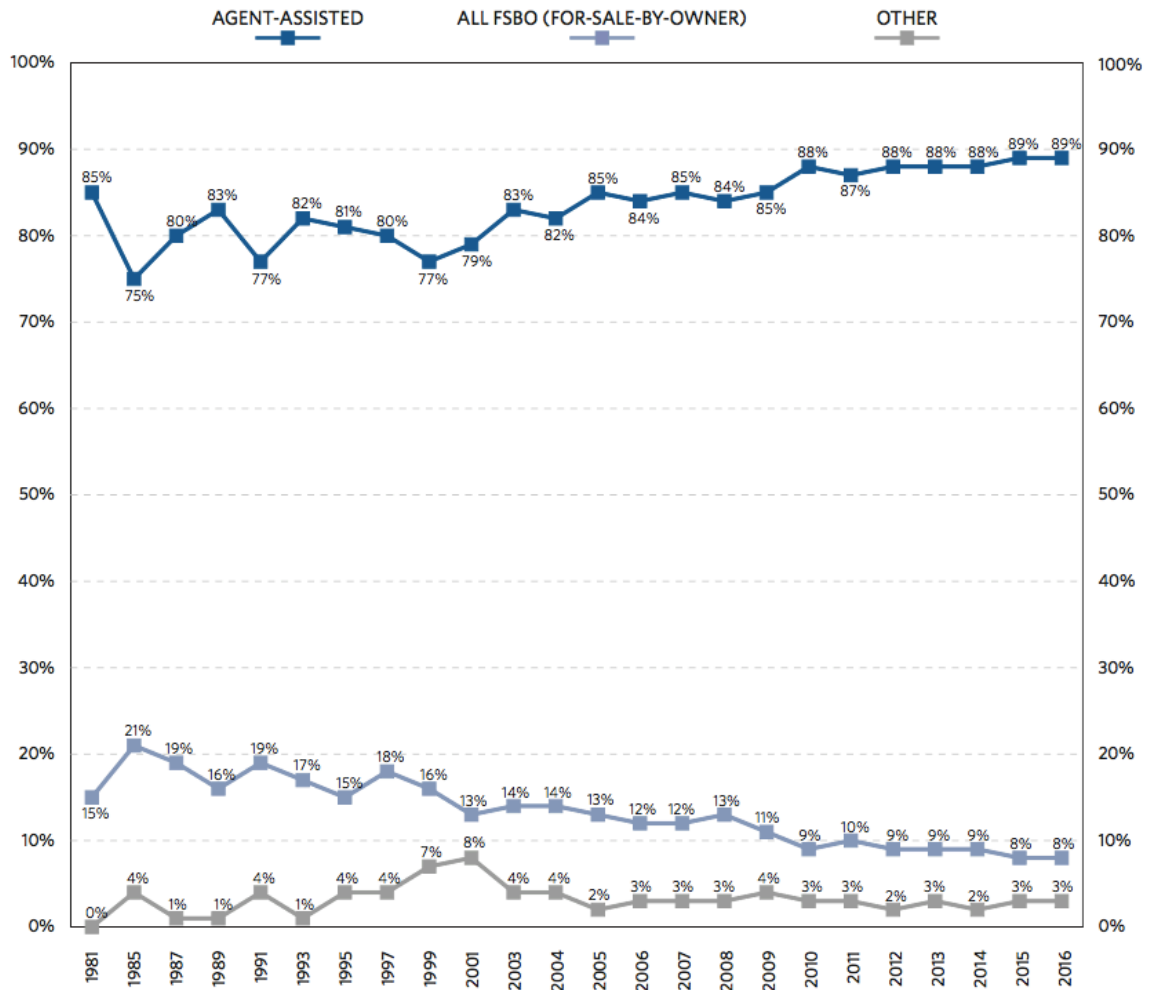
There are a growing number of listings that are provided outside the oversight of organized real estate. This includes For Sale By Owner (FSBO) sites, general classified listings sites, and social media. These listings are generally less used by home buyers in the real estate search as they are commonly out of date, incorrect, or possibly even fraudulent. Sifting through these suspect listings often requires more time and patience than it's worth. However, consumers will often turn to these sites when they can't find their ideal home through traditional real estate sites.

Organized real estate's work to create a great online environment for real estate search has led consumers to perceive the internet as a valuable tool. REALTORS® have remained essential to consumers in the search process by providing great online content and assuring the accuracy of this data.

Future players in search

A number of factors are primed to change the way consumers search for real estate:

Big Data

There is an exponential increase in the amount of data that will be collected about real estate and about the people buying and selling real estate.

Smart Homes

Internet of things devices already allow for the collection of rich data about the home itself.

Connected Communities

Citywide sensors will gather data about an area that was once the exclusive domain of a local expert.

Open Data

National, state and local governments continue to push more data into the public domain.

Blockchain

This new way of managing data will bring even more certainty to property records.

Mobile

The processors in today's mobile devices are quickly catching up to desktop-class computers.

Machine Learning

Artificial intelligence begins when a computer can process the unexpected.

Big data

Big data is a term for data sets that are so complex that the traditional approach to manage and analyze them proves inadequate. It's basically a moving target. Big data eventually becomes regular old data, with even bigger data becoming the new standard.

Big Data in Real Estate

The first time a group of real estate agents got together in one room and started trading stories about the buyers and sellers they represented, that was big data. The first time a board of brokers put information about all the active listings in a community onto index cards, and then filed them appropriately in a drawer so that all members could go in to the board's office and search through them, that was big data. The first time an MLS book was created, the first time the listings were put in a computer database, the first time county property records were mixed in with the listings, that was all big data at the time.

Today, there is far more property data available than ever before. But again, it's about to become much, much bigger.

Data sets that will affect the real estate industry include smart-home data, connected community data, social media, consumer spending data, data about crime, businesses, environment, noise, and air quality.

More importantly, there are massive data sets that have yet to be effectively tapped concerning buyer activities and motivations. This includes information about where the buyer travels, eats out, shops, and works. How often the buyer walks, takes public transit, or drives a car. What sort of political persuasion they tend toward, what kinds of news they read, what types of values they exhibit.

In most situations, collecting this data would be considered a massive invasion of privacy, but robots will change that.

Smart homes

The term "smart home" is not new. In the past, it generally described a home with timers and remote controls to automate certain systems in the house. These systems could tell the thermostat to raise the temperature at a certain time or to turn on a porch light in the evening.

The concept of a smart home significantly changed with the introduction of the Nest learning thermostat. This internet-connected device could not only be programed to change temperatures at certain times, it also had the ability to learn. During the initial setup process, the thermostat documents the use of the homeowner so that it can understand when to adjust the thermostat automatically.

As voice recognition continues to improve, the user interface for such devices will largely leverage human speech

This is a very basic example of embedded systems that learn from their owners. Soon, homes will feature a network of these devices that will learn to control everything from the temperature of the water heater to position of the window shades, all based on the ongoing preference of the owners.

These systems will be able to recognize homeowners. They will intuitively unlock the door as the owner approaches and adjust the air conditioning based on who is in the home.

As voice recognition continues to improve, the user interface for such devices will largely leverage human speech. These interactions are in early stages today using devices like Amazon's Echo to turn on the lights or request information about the weather outside.

Much like HAL 9000, these systems will eventually integrate to the point where they become an omnipresent robot that interacts with the homeowner through a series of sensors, web enabled devices, and a simple voice dialog.

Connected communities

Just as homes are becoming smarter, entire communities are following suit. Urban planners are tapping big data to attempt to solve issues like predicting rat infestations, scheduling mass transit, mitigating urban flooding, improving environmental quality, and hundreds of other problems faced by municipalities.

One of the leading examples is a project called the Array of Things in Chicago, IL.

From their website,

"The Array of Things (AoT) is an urban sensing project, a network of interactive, modular sensor boxes that will be installed around Chicago to collect real-time data on the city's environment, infrastructure, and activity for research and public use. AoT will essentially serve as a 'fitness tracker' for the city, measuring factors that impact livability in Chicago such as climate, air quality and noise."

The Array of Things will essentially serve as a 'fitness tracker' for the city of Chicago

Chicago is currently installing hundreds of these sensors on light poles in the central business district of the city. While this is one of the most ambitious connected community projects to date, many cities across the US and around the world are experimenting with similar concepts.

Using this data, one could determine which streets are the best lit during a late-night walk home from the train station. They could help a relocating buyer determine which streets are busier or noisier than others. Which streets get the most wind in the winter. What areas smell bad in the summer. Which areas have the most allergens.

All of the data being collected by these sensors describes what it would feel like to be in any one particular place in the city and any time. Winter or summer. Day or night. This knowledge was once the exclusive domain of a local expert. Eventually, this will just be one more data set that gets crunched into the search for a home.

Open data

On January 20, 2009, newly elected President Barack Obama launched The Open Government Initiative with the intention of "creating an unprecedented level of openness in government." By March of the same year, the nation's first Federal Chief Information Officer, Vivek Kundra, announced the creation of data.gov. This was when the floodgates holding back government data were opened to the public.

Open data can most simply be described as free data. It's information that's available to anyone in the public domain. Open data often refers to data amassed by local, state and federal governments. Not only is the data free, but governments have committed to keeping the data up-to-date and making it easy to assimilate. Many large enterprises use open data every day. It's often accessed in the real estate industry.

One example of open data is the aforementioned Array of Things project in Chicago. All of the data collected by these sensors is freely available to the public. There are nearly two hundred thousand open data sets now in existence on data.gov. In the Chicago suburb of Evanston, IL, there are data sets that include shape files (boundary maps) for business and historic districts. There's even a geolocated database of every tree in the city.

The concept of open data is also heavily adopted in the science vertical. The Human Genome Project was built upon the principle "All human genomic sequence information should be freely available and in the public domain in order to encourage research and development and to maximize its benefit to society." These science-based data sets will eventually document things like consumer spending habits, child care and youth development.

While the real estate industry seeks to retain control over real estate listing data, the world around those listings, including both the property being marketed and the people who want to buy or sell it, is rapidly expanding. Furthermore, much of this data is widely available to the public.

Blockchain

NAR Chief Technology Officer Mark Lessing has written in great detail about blockchain technology. His papers are listed on the resources page at the end of this report. Mr. Lesswing notes four key architectural elements behind blockchains:

1. **Distributed Ledger** – Information is not centralized in a single database. It's maintained by multiple hosts that all agree promote the most accurate version. This makes the data in these systems far less susceptible to a catastrophic failure, as there is always a working version of the data somewhere else.

2. **Smart Contracts** – The digital execution of agreements using software can manipulate the data in these systems. This allows a high degree of conditional processes to be automated, simplifying data-based transactions.

3. **Immutable Information State** – Changes are permanent. New information (chain-links) can be added to the chain, but the old data always remains. This makes the technology great for showing a complete history of a data set.

4. **Transparency** – Information on public blockchains is visible to all users. The nature of blockchain is very open. This could be considered both a benefit or a detractor for existing shareholder's of data in the real estate industry.

Blockchain is beginning to be adopted by mortgage, title and local government verticals to handle issues related to chain of title, transactional data and even commission compensation.

Identity provider service TrustStamp uses blockchain to combine multiple references and is used to ensure the identity of a user. As the user presents sources, they are documented and preserved in a blockchain.

While the potential of this technology has yet to be fully realized, the biggest takeaway is that data sources will have even more certainty that the data sets they are providing are accurate and up-to-date.

Mobile

In September 2017, Apple announced three new smartphones. Most of the reporting around the event focused on the new iPhone X's dazzling screen and facial recognition features. However, it was the more mundane announcement that all three phones would include Apple's new A11 Bionic processor that will actually write the story about the future of smartphones.

As soon as smartphone processors are released to the public, they are inevitably tested and compared to other processors. Using a benchmarking tool called Geekbench 4, the A11 chip proved to be faster not only than other smartphone competitors but also than a base model Apple MacBook Pro. This means, for the first time ever, that the processor in the new iPhone is probably more powerful than the desktop or laptop computers used by the vast majority of homebuyers or sellers.

Even more importantly Apple integrated a custom GPU (Graphics Processing Unit) into these phones. GPUs are a different kind of processor. They were originally designed to process graphics in high speed to make gaming applications more immersive.

The A11 chip proved to be faster not only than other smartphone competitors, but also faster than a base model Apple MacBook Pro

Later, the scientific community found that these processors were ideally suited to process machine leaning calculations. Apple is leveraging machine learning in its new facial recognition security system, and released a new developer framework called Core ML to allow developers to take advantage of the the iPhone's new abilities to leverage machine learning.

Like other premium smartphones, the iPhone packs a healthy array of sensors, including a barometer, three-axis gyro, accelerometer, proximity sensor, ambient light sensor, multiple cameras, a microphone, and cellular enabled GPS.

The iPhone was introduced just over 10 years ago. In that time, smartphones have progressed to the point where their processing capabilities now rival desktop computers, have the ability to collect incredible amounts of data about their owners, and most importantly, now have the ability to learn. Consider the capabilities they may have in just another 10 years.

Machine learning

An excellent example of machine learning in real estate is the Automated Valuation Model (AVM). This is an algorithm that predicts the market value of a home. There are still cases where AVMs are wildly inaccurate, but they improve every year.

AVMs are very much like the work a licensed appraiser might perform. Once appraisers are given details about a property to be valued, they search through their existing database of recently sold homes. They look for similar properties with recent transfers of sale. Because no homes are exactly alike, or in the exact same location, or sold on the exact same day, the appraiser begins with the sales price, and then makes adjustments to values of each comparable home, then compares these values to the home being appraised. This is used to predict the value of the home.

To build an AVM, a data scientist collects data about home amenities from a historical database for similar homes in the area that recently sold, trains a computer program to learn about the impact of home amenities on sale price, then applies what it leaned to the home being valued.

In both cases, there is a process for collecting the data about the property, a process for identifying comparable homes in a historical database and another process for doing the math.

A combination of processes is otherwise known as Knowledge Discovery. Machine learning is just the computer program that we mentioned above that uses algorithms like the AVM to learn information from the data.

We use information from machine learning to make a prediction about a target variable based on historical data it has already collected. In the case of an AVM, the target variable is the value of the property.

We use information from machine learning to make a prediction about a target variable based on historical data it has already collected. In the case of an AVM, the target variable is the value of the property.

Real estate search of tomorrow

In the short term, the internet will continue to be the dominant resource that home buyers use to find the home they end up buying. But there is now a clear path for robots to impact this space.

Consider Siri, Apple's friendly virtual assistant. Today, Siri is great for setting reminders or texting your spouse while driving. It can draw upon the internet for some information, but the one factor that differentiates itself from similar products from Amazon, Microsoft, and Google is that Siri is embedded inside the phone's processor. It's designed to handle queries at the local level. While Siri's local processing power is not as robust as the cloud servers used to process queries from its competition, working locally presents one huge advantage: data privacy. As Siri's capabilities grow, it will be able process more and more highly personal data sets that it is collecting about its user. Because this data is not being shared with Apple, or anyone else, consumers are more willing for Siri to collect it.

Siri is ideally situated to become the robot that will discreetly manage the interaction between sensors measuring the land and sensors measuring the person.

Through constant companionship, Siri will begin to learn about its user. Siri already has the ability to track its user's location, listen for their voice, and measure ambient conditions in the environment around them. Siri can track its user's spending and reading habits. Siri knows its user's schedule and their exercise regimen. Siri will also tap into its user's third-party app activities. It will be able to figure out what kind of restaurants its user likes or read through their social media posts to understand interests and values and even begin to figure out personality types. Siri could determine things like architectural preference based on the pictures its user takes or the pictures of homes they like on Instagram or Pinterest. All of these abilities are based on hardware that exists in current smartphones and on data science that has already been established.

Because Siri is web-enabled, it can follow its user across several devices. Siri is a part of Apple's phones and their desktop computers. Siri has a presence as a wearable watch and can embed itself in the home through Apple TV and Apple HomeKit-connected products. Soon, Siri will become an omnipresent robot, with artificial intelligence, that's embedded into all of its user's systems, interacting using a myriad of sensors and through a simple voice dialog.

Siri can amass the ever-increasing big data being offered about a community where its user may be interested in buying a home. It is ideally situated to become the robot that will discreetly manage the interaction between the sensors measuring data about the land and the sensors measuring data about the person.

Because Siri is an unrelenting robot, it also has time to scour through multiple sources of data about real estate listings, including those that are ungoverned by organized real estate. Siri will learn from its user's activity on real estate apps like REALTOR.com® or comments on social media, then scour the internet looking for homes that it predicts its user will like.

At some point, Siri will know more about both the home buyer and the opportunities to buy than any agent could ever dream of. It will have the ability to be the local expert and the trusted resource about a community. Consumers won't need to spend time on real estate search sites, because Siri will be doing it for them.

Once a Siri finds a home that the home buyer is interested in, it will help connect them with an agent. By accessing its user's contacts, social media accounts, Yelp reviews and data from real estate web sites, Siri will be able to suggest highly rated agents that do business in the appropriate areas and are either directly connected or are a part of the user's larger network of contacts. Siri could then access the user's financial information and use it to find a mortgage provider that will best meet the user's needs.

EXHIBIT 7-1 **METHOD USED TO FIND REAL ESTATE AGENT, BY FIRST-TIME OR REPEAT SELLER**
(Percentage Distribution)

	All Sellers	First-time Seller	Repeat Seller
Referred by (or is) a friend, neighbor or relative	39%	46%	35%
Used agent previously to buy or sell a home	25	22	28
Personal contact by agent (telephone, email, etc.)	4	5	4
Referred by another real estate or broker	4	4	5
Website (without a specific reference)	4	4	4
Visited an open house and met agent	4	3	4
Saw contact information on For Sale/Open House sign	2	2	2
Referred through employer or relocation company	2	2	2
Direct mail (newsletter, flyer, postcard, etc.)	2	1	3
Walked into or called office and agent was on duty	1	2	1
Newspaper, Yellow pages or home book ad	1	1	1
Advertising specialty (calendar, magnet, etc.)	*	*	*
Crowdsourcing through social media/knew the person through social media	*	1	*
Saw the person's social media page without a connection	*	*	*
Other	10	7	11

Less than 1 percent

To date, the internet has had relatively little impact on how a consumer chooses their agent. Consumers credit their network of friends and family as the top resource in finding an agent. Their own past experience with an agent is the second-highest-rated resource. There has been a large effort by the real estate industry to make the internet a better resource here, but despite

the various profiles, recommendations, ratings and reviews that can be found online, consumers have continued to most value someone they know.

Because Siri will know who the user knows, and because Siri has time to search the public actions of all the people that user knows, it can recommend agents based on existing connections or tell the user which people in their network would be the best to ask. Robots have a far better chance to be players in this space than the internet.

How will robot searches impact the real estate industry

In the scenario predicted above, the average real estate agent would be relatively unimpacted. Agents have already ceded real estate search to the internet. If they've built a strong sphere of influence and have performed at a high level, robots would probably be more likely to drive business to them compared to the internet.

It's the portals, brokers, franchises and other lead-gen providing companies that would need to adjust more heavily.

Robots don't have to respect fair display. They're not obliged to rank properties in the same way an IDX vendor is required to.

Consumers will no longer have to visit internet search sites. Robots would do that for them. Robots don't have to respect fair display. They're not obliged to rank properties in the same way an IDX vendor is required to. Robots could care less if the broker has paid for a premium status on a portal. It won't matter if a property is featured, or sponsored, or presented at the top of the page, or the very bottom. Robots won't visit one site; they'll visits hundreds of sites. Robots have time to sort through all of that. Voice dialog and text/messenger chats will become the defacto user interface that sits above the noise.

The ability to translate languages, down to dialect will allow robots to connect local and global markets without the need for a translator. Smart devices from Google and Apple can already translate in near real time.

Robots won't fill out lead forms or pay attention to embedded advertising. Because robots will display real estate information to their users at the device level, the broker's relative control over how their listings are displayed will completely disappear. If a business model depends on generating, selling, distributing or buying internet leads, that model will have to adapt.

Siri isn't the only game in town

Google, Samsung, Tesla, Nvidia, Facebook, Amazon, IBM and Microsoft are also poised to be players in artificial intelligence, as are hundreds of startups that the average real estate veteran has probably never heard of. There are niche players specializing in fin-tech, automotive, conversational interactions, text analysis, internet of things, BI, CRM, commerce, and robotics.

In February of 2017, Ford invested $1 billion in Argo AI, a Pittsburgh-based company that specializes in autonomous driving technology. Google recently invested over $10 billion on a company called Algorithmia, which is essentially an app store for AI-related algorithms.

Google recently invested over $10 billion on a company called Algorithmia, which is essentially an app store for artificial intelligence-related algorithms.

Robots may one day have the technical ability to impact all jobs in today's economy, including the existing roles of real estate agents. Process jobs like mortgage underwriters & processors, title extractors and even appraisers could be impacted sooner rather than later. AI, combined with the certainty of transactions using blockchain, could fairly quickly eliminate many jobs related to the process of transferring and recording property title transactions.

The personal relationships and trust that real estate agents forge with consumers will be far more difficult for robots to replace. However, several companies have already begun to hire psychologists and counselors with computer science skills to make their robots more personable. For instance, MIT spin-off Affectiva is building facial recognition algorithms to determine the mood of the user.

Artificial intelligence is still a long way away from taking everyone's job, but all of the data sets listed in this report exist today. All of the basic science surrounding machine learning is in place to allow machines to process the unexpected. All of the computing hardware required for robots to learn exists today and is rapidly becoming available to mobile platforms. Robots will continue to impact the real estate industry at an increasing level. Organized real estate will need to adapt, as it did in the internet age, to assure that REALTORS® remain essential to consumers.

NAR's work concerning robots in real estate

The National Association of REALTORS® sees artificial intelligence as an emerging technology that demands attention. The organization has been tracking the affiliated technologies in the following ways:

Big Data, Smart Homes, Open Data, & Connected Communities - Big data in real estate has been a primary subject of research for NAR's R&D technology group, The Center for REALTOR® Technology (CRT). In 2015, CRT established an R&D lab to investigate smart-home/internet of things devices, renewable energy, urban agriculture and building materials. CRT is working with NGOs, vendors, national laboratories, universities and government agencies to help promote NAR as an agent for technology research and innovation.

Blockchain Technology - Mark Lesswing, NAR's CTO, has released two papers (see resources) to educate the real estate industry on this technology. In addition, several members of CRT engage with the blockchain community by participating in the Chicago Blockchain Real Estate Collective Meetup group. They also recently sponsored a Hyperledger Hackfest event in Chicago and are developing blockchain prototypes to handle residential and member data.

Machine Learning - NAR's Data Analytics Group stays apprised on machine learning through sponsorship and participation in the Chicago ML group on meetup.com. Aleksander Velkoski, a data scientist at NAR, is the co-founder of the group and a lead event organizer. In less than two years, this community has grown to over 1,200 members and is one of the 100 largest artificial intelligence Meetup groups in the world. Speakers at these events include AI and ML researchers from top academic institutions, including Northwestern University, University of Chicago, Toyota Technological Institute, and DePaul University.

NAR hosts machine learning, blockchain and big data meetups and networking events in the evenings at the organization's Chicago headquarters. Staffers report on these technologies to the association's Data Strategies Committee for member evaluation.

Resources

Author

Todd Carpenter - Managing Director, Data Analytics, National Association of REALTORS®

Contributors

Mark Lesswing - CTO, National Association of REALTORS®

Aleksander Velkoski - Data Scientist, National Association of REALTORS®

Joe Sullivan - User Experience Designer; Graphic Designer at CRT Labs

Dave Conroy - R&D Lab Engineer at CRT Labs

Bob Soron - Copy Editor, REALTOR® Magazine

Related Papers and Articles Sourced

Profile of Home Buyers and Sellers, National Association of REALTORS®.

https://www.nar.realtor/reports/highlights-from-the-profile-of-home-buyers-and-sellers

Blockchain in Real Estate Part 1 (Mark Lesswing, CTO, National Association of REALTORS®)

http://crt.blogs.realtor.org/files/2016/10/blockchain_in_real_estate_technical_difference2.pdf

Blockchain in Real Estate Part 2 (Mark Lesswing, CTO, National Association of REALTORS®)

http://crt.blogs.realtor.org/files/2016/10/blockchain_in_real_estate_applications1.pdf

iPhone 8 Is World's Fastest Phone (It's Not Even Close) - Tom's Guide

https://www.tomsguide.com/us/iphone-8-benchmarks-fastest-phone,review-4676.html

TED Talk by Affectiva Co-founder, Rana El Kaliouby

https://www.aigency.com/2016/12/affectiva/

Google's smarter, A.I.-powered translation system expands to more languages - Tech Crunch

https://techcrunch.com/2017/03/06/googles-smarter-a-i-powered-translation-system-expands-to-more-languages/

Related Links

CRT Labs Website - https://crtlabs.org

Chicago ML - https://www.meetup.com/Chicago-ML/

Chicago Blockchain Real Estate Collective - https://www.meetup.com/Chicago-Blockchain-Real-Estate-Collective/

Hyperledger Chicago - https://www.meetup.com/Hyperledger-Chicago/

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