

# NARRATIVE ANALYSIS

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## Artificial Intelligence

July 2017



**Homeland  
Security**

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# NARRATIVE ANALYSIS RESEARCH PAPER

## Artificial Intelligence

### Executive Summary

Artificial Intelligence (AI) is an emerging risk that will affect critical infrastructure (CI) as it becomes common throughout the United States. The purpose of this research paper is to analyze the narratives about AI to understand the prominence of perceived key benefits and threats from AI adoption and the resulting implications for infrastructure security and resilience. Narratives are strongly held beliefs, and understanding them will help decision makers mitigate potential consequences before they become significant problems.

### Key Findings

- A majority of the overall conversation focuses on positive effects for business and society reflecting widespread acceptance and enthusiasm for AI adoption rather than ethical, security, or other concerns.
- Trends reveal increasing emphasis on advancing AI and concerns about the unemployment consequences, as well as declining focus on safety hazards and existing hurdles.
- Major tech companies (e.g., Google, Microsoft) have a significant and mostly positive presence, whereas government has a minimal and often negative presence.
- Four risks to get ahead of are mass job displacement, privacy concerns, lack of awareness of technological limitations, and safety and ethical shortcomings.

### Anticipated Benefits From Artificial Intelligence Driving Adoption

- **Improvement of Operations and Services in All Sectors:** AI is expected to enhance the functioning and efficiency of goods and services across all Sectors, but the Sectors most commonly mentioned in the narratives are Healthcare and Public Health, Transportation Systems, Financial Services, and the Government Facilities Subsector. At the same time, open-source collaboration in the private sector is furthering innovation to develop more advanced AI capabilities.
- **Efficiencies for Companies and Better Business Intelligence:** AI generates widespread benefits for business operations, such as automating tasks and enabling access to more information—including unprecedented capability to process that data—allowing for more accurate business intelligence and evidence-based decision making.

### Risks From Future Adoption and Implications for Critical Infrastructure Protection

- **Mass Unemployment:** As AI is integrated into every sector, job displacement will grow, potentially precipitating social unrest and security challenges, as well as a decline in tax revenue.
- **Vulnerability of Data Privacy:** AI adoption will enable the collection of a growing amount of personal data, from web traffic to facial and voice recognition data, which will be vulnerable to hacking. Public concern over the government's collection of this data could also lead to backlash over government use of AI, especially biometric technology, and inhibit security solutions.
- **Overestimation of AI Capabilities:** Increasing competition to get products to market might cause companies to overlook building robust security into AI technologies, and insecure products could be deployed in CI sectors. AI products may also have limitations, but if users are unaware of those limits, they might not exercise appropriate human oversight. That could lead to safety threats and service disruptions if technologies malfunction.

- **Susceptibility to Manipulation and Infliction of Harm:** Robots lack human and moral intelligence and might make harmful decisions on their own or be manipulated to make such decisions. Malicious actors and adversaries could co-opt AI products to launch cyber or physical attacks on infrastructure and could leverage open-source releases to develop their own AI capabilities or to infiltrate CI systems that also use open-source tools.

## Opportunities To Mitigate Risks

- **Plan for Resilience:** Use growing attention around job security to justify expanded public-private resiliency planning to mitigate mass unemployment and resulting consequences.
- **Advocate for Safeguards:** Encourage companies to improve protections against internal and external security breaches and to address data privacy and vulnerability gaps as part of their innovation and ethical research efforts.
- **Codify Best Practices:** Formulate and disseminate best practices for safe AI integration across sectors, acknowledging the technological limitations and the need for human oversight.
- **Advise on Regulation:** Highlight the role for government regulation in ensuring safe adoption of AI technology, using autonomous vehicle regulations as the example for other AI products.

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# I. SCOPE AND METHODOLOGY

## Scope

This analysis includes the online, open-source, U.S. discourse about Artificial Intelligence (AI)—defined expansively for this study as any technology explicitly discussed as a form of AI (e.g., machine learning, robotics, deep learning, neural networks)<sup>1</sup>—from November 2015 through October 2016.

## Objectives

- Surface the full range of narratives about AI and quantify their prominence—or Narrative Importance—in the discourse
- Detect and quantify the change in Narrative Importance over time
- Measure and assess government, private sector, and topical associations with positive and negative narratives
- Identify key insights and implications for risks, benefits, and effect on infrastructure protection

## Narrative Analysis Methodology

In support of this effort, OCIA, in partnership with Monitor 360, collected more than 20,000 narrative-rich articles from more than 4,000 different traditional media and blog sources. Machine learning and natural language processing algorithms analyzed these articles to identify, measure, and analyze narratives. Appendix B contains a non-exhaustive, illustrative list of 100 sources that span traditional media and blogs (selected according to source prominence). Interviews with select subject matter experts also validated findings.

## Key Metrics

- **Narrative:** strongly held conscious and subconscious beliefs, attitudes, and assumptions that humans rely on to make sense of their world.
- **Narrative Importance Score:** measures the share of impact a narrative captures relative to the overall landscape. It is calculated on a scale of 0 to 7 based on narrative volume and social engagement. The Importance Score is sometimes presented as a percentage to show the relative importance of each narrative.
- **Narrative Volume:** measures the number of articles or posts expressing a narrative, weighted by source rank.
- **Social Engagement:** measures the amount of social interaction—through shares, likes, and comments across social media platforms—with the posts and articles expressing a given narrative.
- **Trend Analysis:** measures the monthly change in Narrative Importance during the period of analysis.
- **Acceleration:** measures the rate of change in a narrative's Importance Score during 1 year.
- **Sentiment:** measures the underlying language used to express each narrative on a scale of most negative to most positive.
- **Entity Analysis:** measures percentage of posts in a narrative that mention a given entity, such as a company, government agency, university, or key topic (including name variations, abbreviations, and synonyms of each).

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<sup>1</sup> See Appendix A for a broader list of illustrative technologies and respective definitions.

## II. AI NARRATIVE LANDSCAPE OVERVIEW

### Majority of Narrative Conversation Is Favorable Toward AI Adoption

The two dominant narratives with the highest Importance Scores discuss the business efficiency and positive societal implications of AI. They are followed by several lower importance narratives that discuss threats to safety, the economy, and privacy rights, indicating that momentum around AI’s potential overshadows concerns about the technology. See table 1 for a list of narratives and their Importance Scores. These narratives are described in the voice of the subscriber, and do not necessarily reflect views put forth by OCIA about AI.

TABLE 1—IDENTIFIED NARRATIVES AND THEIR IMPORTANCE SCORES

NARRATIVE TITLE	IMPORTANCE SCORE (%)	ABRIDGED NARRATIVE DESCRIPTION IN THE VOICE OF THE SUBSCRIBER
Inspiring a Business Revolution	32	In today’s digital revolution, all businesses and employees must integrate AI and transform their operations, or otherwise risk survival. AI isn’t a choice, it’s a necessity.
Enhancing the Future	26	AI is changing every aspect of our society for the better. We must commit to reimagining the possible and champion a future of working side-by-side with machines and robots.
Innovating Together	11	We must keep pushing to develop AI to its fullest potential and further scientific discovery.
Threat to Humanity	10	Robots could kill mankind, and it is naive not to take the threat seriously. Companies must self-regulate to protect everyone; technology should help—not hurt—us.
Long Way to Go	8	While AI has vast potential, there are still many problems to solve. We need to critically analyze progress and limitations, and adjust expectations accordingly.
Fueling the Surveillance Machine	7	AI poses major threats to our privacy and civil liberties. We need to strictly regulate AI technology that enables biometric and other data collection that compromises our rights.
Taking Our Jobs	6	The mass application of AI technologies across industries will gradually enfeeble society, leaving us to deal with an unprecedented wave of structural unemployment.

■ Benefit-Focused

■ Threat-Focused

### Threat-Focused Narratives Are Easily Triggered and Could Spread Quickly

Lower impact threat narratives in the AI conversation make up a disproportionately high level of Social Engagement, since articles that play on fears often receive the most attention, suggesting that a marginal increase in volume could significantly increase the Narrative Importance. In contrast, the dominant narratives are characterized by high narrative volume, because they are often invoked in prolific coverage of new technology developments (figure 1).<sup>2</sup>

<sup>2</sup> Narrative Volume measures number of articles or posts weighted by source rank; Social Engagement measures amount of social interaction with a narrative (shares, likes, comments).

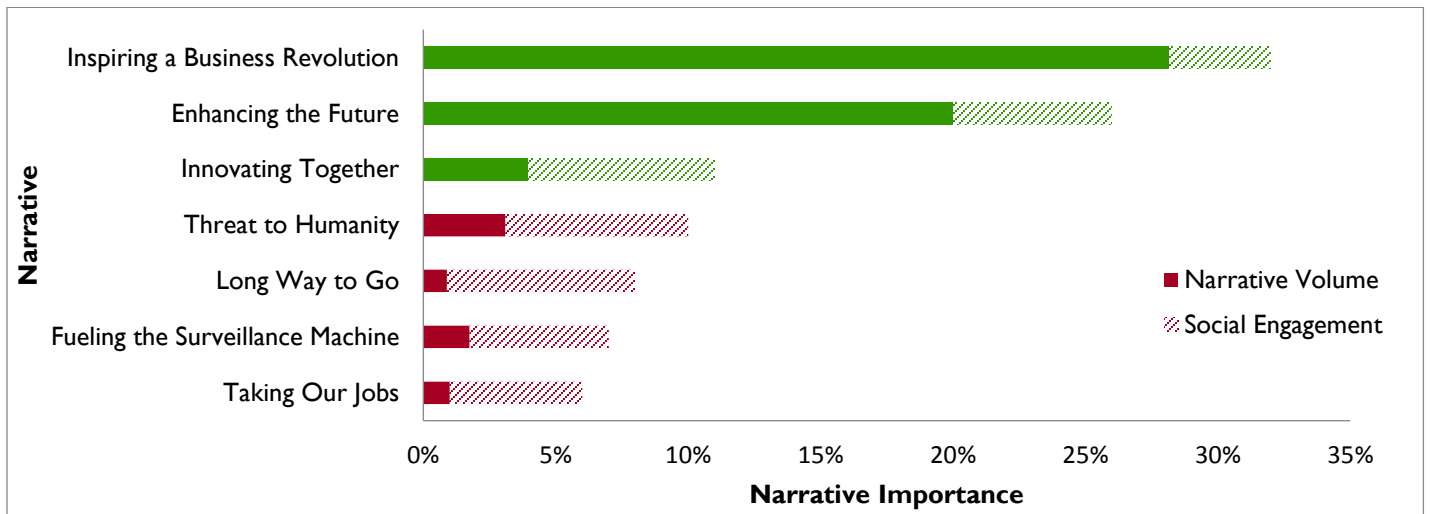


FIGURE 1—NARRATIVE VOLUME AND SOCIAL ENGAGEMENT FOR EACH NARRATIVE

■ Benefit-Focused      ■ Threat-Focused<sup>3</sup>

### Upward Trends Highlight Expanding Capabilities and Resulting Threats to Jobs

Innovating Together and Taking Our Jobs increased slightly between November 2015 and October 2016, suggesting that as awareness of more advanced applications of AI increases, concerns about unemployment are also increasing (figure 2).

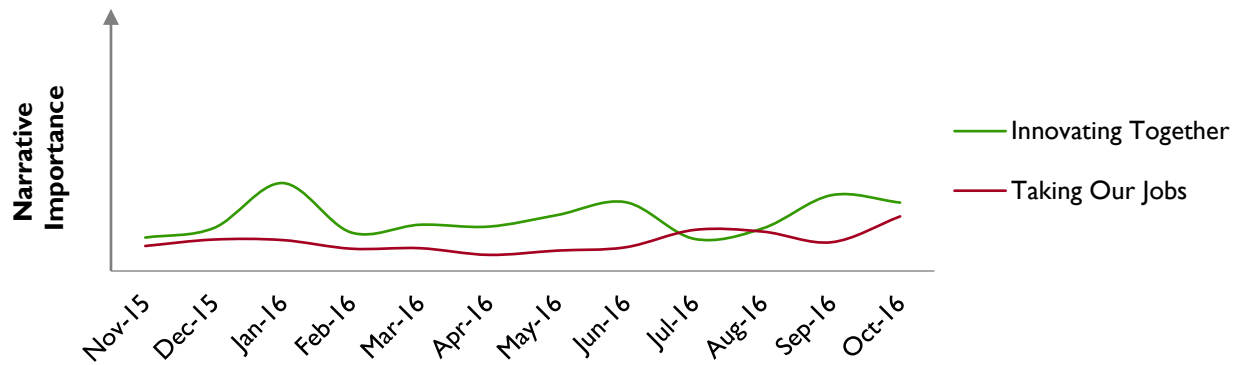


FIGURE 2—NARRATIVES WITH UPWARD TRENDING NARRATIVE IMPORTANCE

### Downward Trends Indicate Declining Concerns about Risks Posed by AI

Long Way to Go and Threat to Humanity decreased in prominence between November 2015 and October 2016, indicating that concerns about the limitations and public safety consequences are gradually declining as AI technologies advance and hit the market and the benefits are realized (figure 3).

<sup>3</sup> These colors will be used throughout the paper to signify benefit-focused and threat-focused narratives.



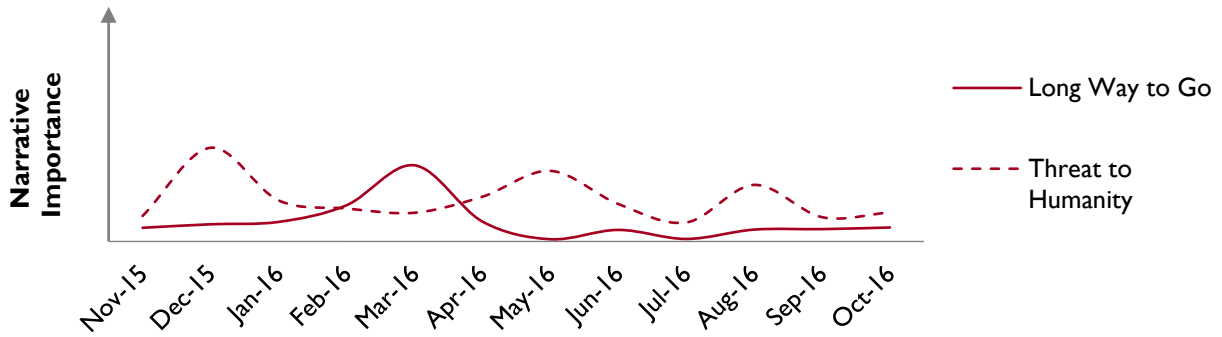


FIGURE 3—NARRATIVES WITH DOWNWARD TRENDING NARRATIVE IMPORTANCE

### Stable Narratives Suggest Overall Conversation Will Remain Positive

Enhancing the Future, Fueling the Surveillance Machine, and Inspiring a Business Revolution were stable in their prominence between November 2015 and October 2016 (figure 4).

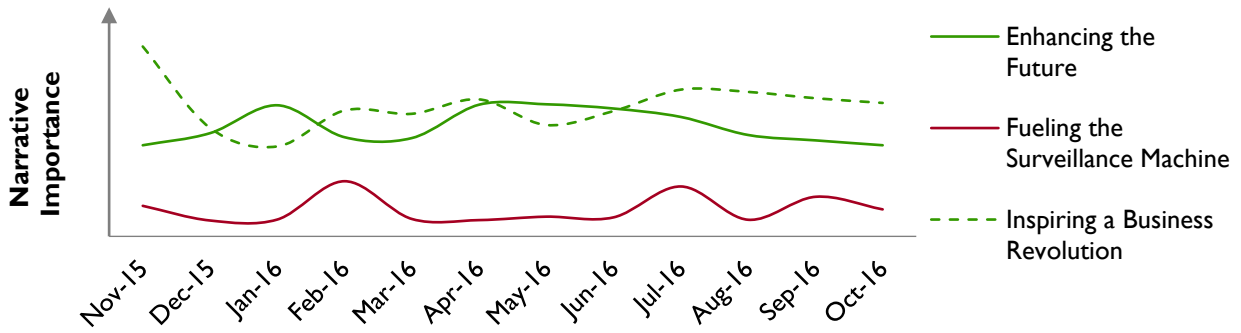


FIGURE 4—NARRATIVES WITH STABLE NARRATIVE IMPORTANCE

### III. NARRATIVE ASSESSMENTS: RISKS, BENEFITS, AND IMPLICATIONS FOR CRITICAL INFRASTRUCTURE

#### Organizing Narratives Based on Their Implications for Risk

It is useful to understand the relationship between a narrative’s acceleration and its degree of focus on threats or benefits. It can reveal distinct groupings of narratives that can inform which threats to get ahead of, as well as major benefits that are likely to drive adoption. In this Narrative Analysis, the narratives are divided into four groups: Accelerating, Benefit-Focused; Accelerating, Threat-Focused; Decelerating, Threat-Focused; and Decelerating, Benefit-Focused (see figure 5). Those labels will be placed in the top, right hand corner of Narrative Analysis for each narrative.

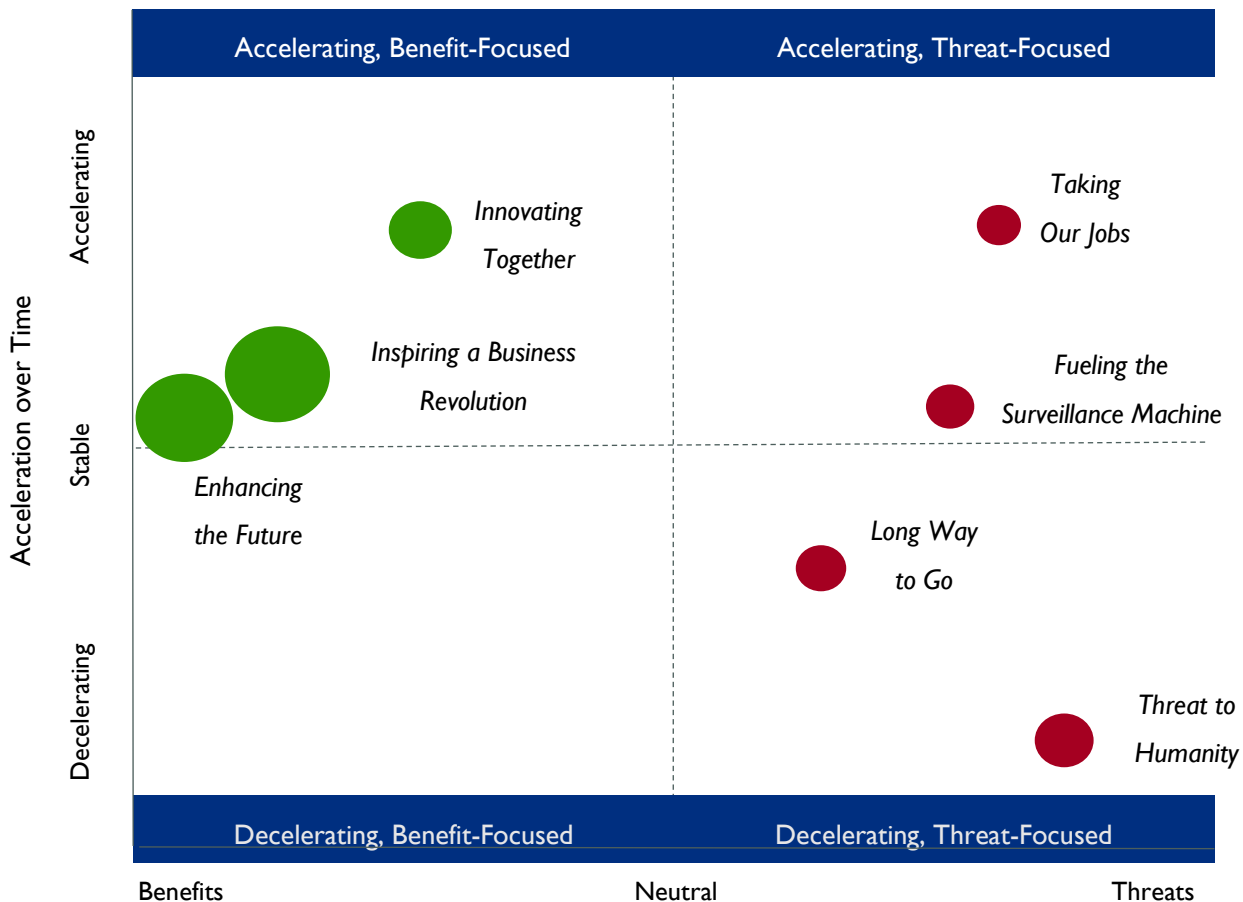


FIGURE 5—BALANCE OF BENEFITS VS. THREATS<sup>4</sup>

**Accelerating, Threat-Focused** narratives that explore the economic and social risks from AI adoption are increasing in prominence (Taking Our Jobs). This indicates that an imminent need might exist to mitigate and get ahead of these risks, because discussion may continue to grow in the future. Also, within this category is a more stable narrative (Fueling the Surveillance Machine) that is important to address since this concern is very likely to persist as AI adoption continues.

**Decelerating, Threat-Focused** narratives consider the technological limitations and safety risks of AI adoption and are decreasing in prominence (Long Way to Go, Threat to Humanity). Though they are declining, it is critical to understand these concerns and assess the risks they pose to security, because they might be overlooked in the public domain.

**Decelerating, Benefit-Focused** narratives are decreasing in prominence but focus on the benefits to society of AI adoption. No narratives fit into this category.

<sup>4</sup> Placement on x-axis is determined by assessment of narrative description and sentiment score. Placement on y-axis is based on narrative acceleration—the rate of change over time. Narrative markers are sized according to respective Narrative Importance Scores.

**Accelerating, Benefit-Focused** narratives discuss the advantages of AI for businesses, consumers, academia, and the government, and are increasing in prominence (Innovating Together, Inspiring a Business Revolution, Enhancing the Future).

Section IV is made up of assessments for each Narrative, including highlights of benefits and risks, and takeaways to inform outreach. Figures 6 through 12 show statistics and trends for each Narrative, including:

- **Narrative Importance (top left):** shows what portion of the overall discussion is made up by this Narrative, and shows the percentages of the Narrative Importance composed by Narrative Volume and Social Engagement.
- **Sentiment (top right):** shows whether the Narrative is positive or negative, and provides some context regarding the tone of the Narrative.
- **Industry, Academia, and Government (upper middle):** shows the most commonly mentioned private, academic, and government organizations in the overall discussion; whether those organizations are discussed positively or negatively, and provides the percentage of articles from the overall discussion mentioning the organization.
- **Key Sectors and Top Technologies (lower middle):** shows the most commonly mentioned Sectors and technologies in the overall discussion and provides the percentage of articles from the overall discussion mentioning the Sector or technology. It also shows whether the technologies are discussed positively or negatively.
- **Trend Analysis (bottom):** shows how the Narrative Importance of the Narrative changed from November 2015 through October 2016.

## a. Taking Our Jobs

The mass application of AI technologies across industries will gradually weaken society, leaving society to deal with an unprecedented wave of structural unemployment.

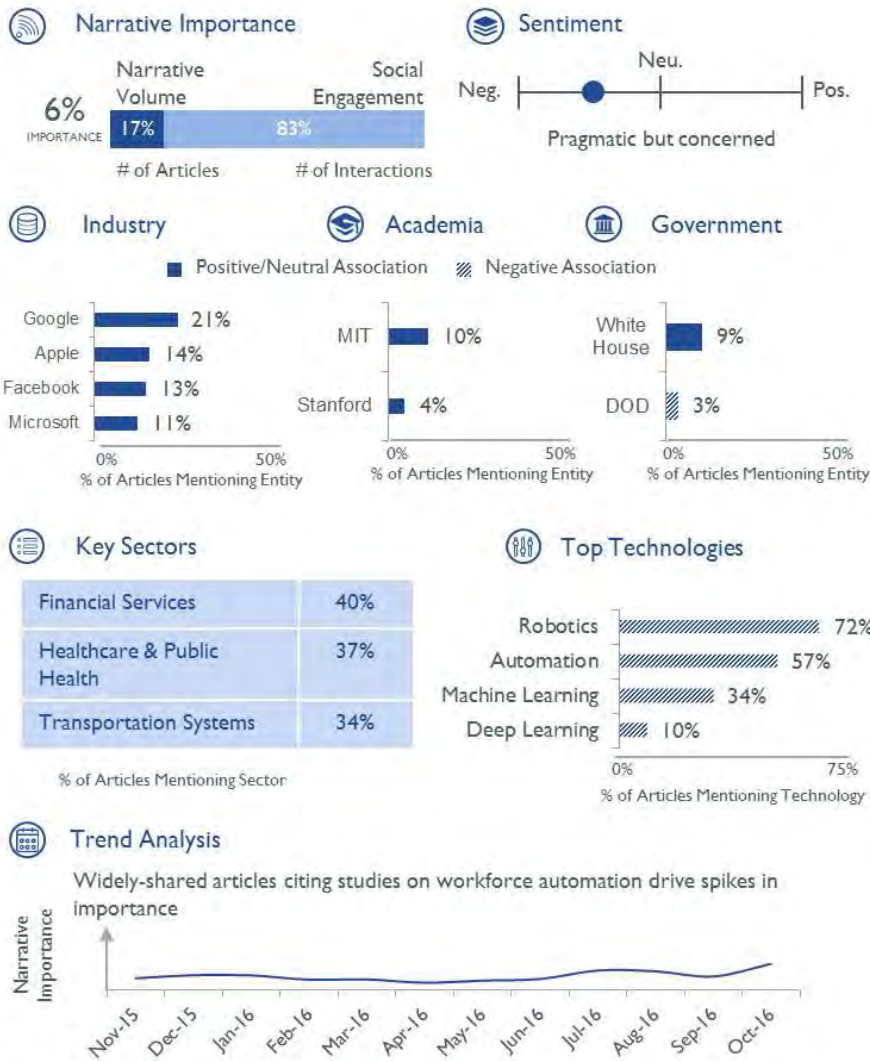
### Full Narrative Expression in the Voice of the Subscriber\*

Everyone talks about the end-of-humanity threat from robots, but fewer acknowledge the impending threat to jobs. Developments in automation and robotics are already replacing manufacturing and service jobs and will continue to disrupt employment as robots better mimic human judgment and decision-making. Robots will even eventually replace doctors, lawyers, and other white collar professionals. The mass application of AI technologies across industries will gradually enfeeble society, resulting in unprecedented structural unemployment. The government and companies must find ways to train people in new roles that leverage humans' emotional and moral comparative advantage. Additionally, society will need to rethink how it achieves meaning beyond a typical nine-to-five job, because automation will drastically alter the jobs needed in the future.

*\*These narratives do not necessarily reflect the views put forth by OCIA about AI.*

### ANALYTIC CHARACTERISTICS AND ASSOCIATIONS

### KEY INSIGHTS



### Risks, Implications, Opportunities

- **Risks:** Increasing job displacement across sectors because of automation.
- **Implications:** Mass unemployment could adversely affect tax revenue and the economy and lead to social unrest and security challenges.
- **Opportunities:** Growing attention to this issue could be used to justify greater public-private resiliency planning to mitigate the risk.

### Takeaways to Inform Outreach

- **Industry:** Discussion revolves around companies' products that will replace workers; but, rather than blame specific companies, it considers the shift inevitable.
- **Academia and Government:** Researchers, including from Massachusetts Institute of Technology and the White House, are credited for starting to develop solutions for retraining employees, whereas the Department of Defense (DOD) mentions concern about automating soldiers.
- **Specific Technologies:** Emphasis exists on robots replacing factory workers, followed by machine learning replacing service sector jobs (e.g., financial analysts).

FIGURE 6—STATISTICS AND TRENDS FOR THE NARRATIVE “TAKING OUR JOBS”

## b. Fueling the Surveillance Machine

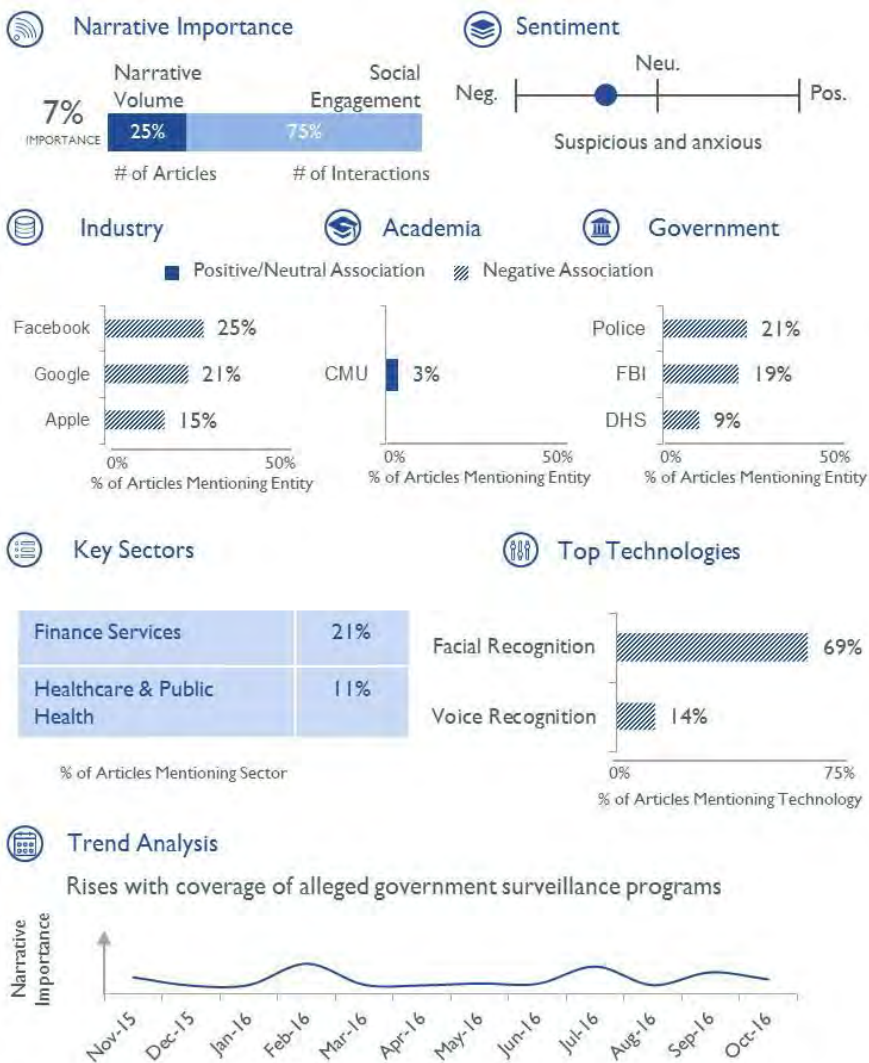
AI poses major threats to privacy and civil liberties. Society needs to strictly regulate AI technology that enables biometric and other data collection that compromises rights.

### Full Narrative Expression in the Voice of the Subscriber\*

The more data private companies and governments collect, the less anonymous—and autonomous—we are. AI enables them to gather more data than ever before, seriously threatening our privacy and civil liberties. Collection and use of biometric data is already happening without our consent. The government is taking thousands of iris scans for a database while companies are using biometrics to identify high value customers or potential shop lifters. AI-assisted surveillance technology allows anyone to take a picture and run it through a program overlaying it with location-sensitive data from our mobile phones. This could feed a vast database for unauthorized government surveillance, consumer research, and criminal enterprise. We need to strictly regulate and demand consent for data collection that compromises our rights—if not illegalize it entirely. Only then will we be safe.

\*These narratives do not necessarily reflect views put forth by OCIA about AI.

### ANALYTIC CHARACTERISTICS AND ASSOCIATIONS



### KEY INSIGHTS

#### Risks, Implications, Opportunities

- **Risks:** Growing amount of personal data collected is vulnerable to hacking.
- **Implications:** Public backlash over government use of facial recognition could inhibit implementation of biometric security solutions.
- **Opportunities:** Rising privacy and security concerns could be used as leverage to encourage companies to build safeguards against internal and external breaches.

#### Takeaways to Inform Outreach

- **Industry and Academia:** Facial recognition software that Facebook, Google, and Apple’s photo apps use fuels angst about the potential sale of that data, while Carnegie Mellon University is developing glasses to fool that software.
- **Government:** Local and national law enforcement is rebuked for its facial recognition databases that are deemed violations of privacy and racially discriminatory.
- **Specific Technologies:** Facial recognition dominates, including use for law enforcement, ATM access, and targeted marketing.

FIGURE 7—STATISTICS AND TRENDS FOR THE NARRATIVE “FUELING THE SURVEILLANCE MACHINE”

### c. Long Way to Go

Although AI has vast potential, many problems still to be solved. Society needs to critically analyze progress and limitations and adjust expectations accordingly.

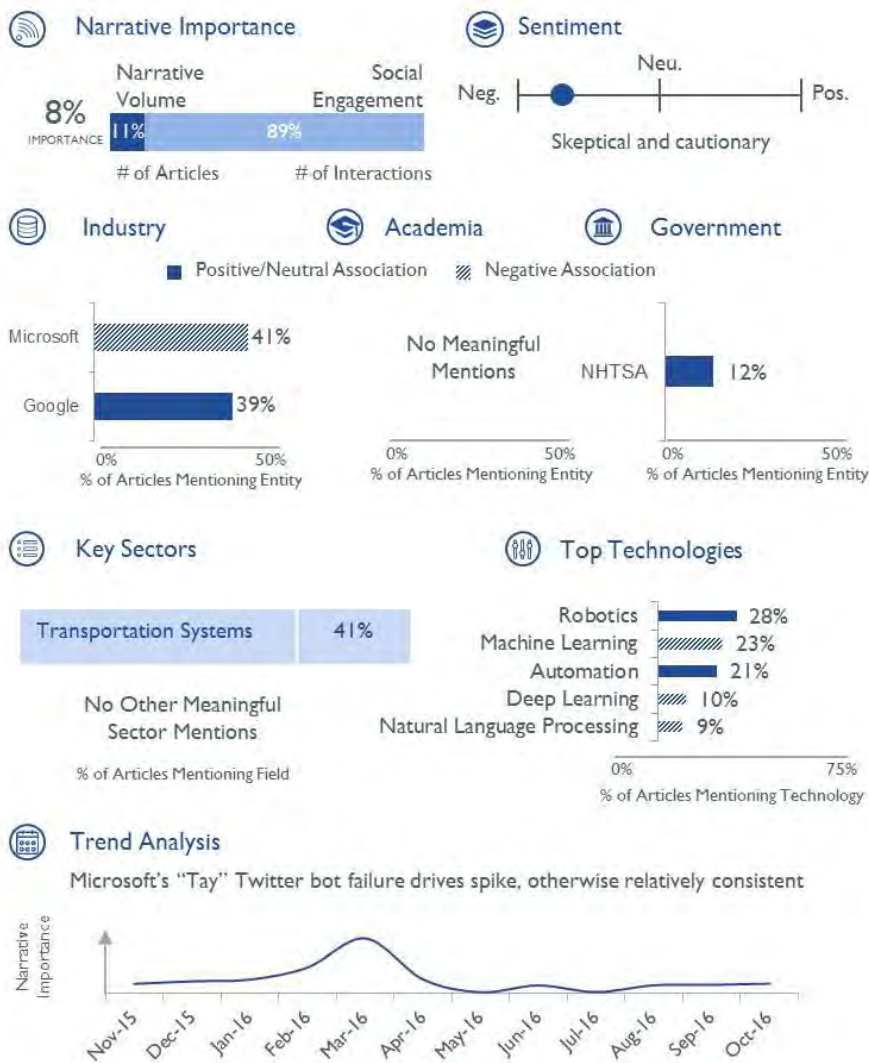
#### Full Narrative Expression in the Voice of the Subscriber\*

Projections of advances in the speed and capabilities of AI are overly optimistic. The vision of an imminent robotic ideal future discussed by the private sector, public, government, and even experts is misinformed; many problems still need to be solved. In some cases, the technology is fully developed, but the human training necessary to help the machines effectively “learn” their tasks lags. In others, AI is not as autonomous as people assume and requires significant human control and monitoring. Algorithms directing robots are designed to work under clearly defined conditions, but the real world is complex and unpredictable. AI technology has come far quickly, but we cannot oversimplify its trajectory. We must continue advancing development while also recognizing the limitations and critically analyzing the progress and realistic application of each technology.

*\*These narratives do not necessarily reflect views put forth by OCIA about AI.*

#### ANALYTIC CHARACTERISTICS AND ASSOCIATIONS

#### KEY INSIGHTS



#### Risks, Implications, Opportunities

- **Risks:** Unsafe or limited operability products might get to market, and the lack of user awareness of the limitations could cause safety or other hazards.
- **Implications:** Deployment of AI technologies that are not fully tested or monitored in CI sectors (e.g., Transportation Systems) could pose safety threats and service disruption.
- **Opportunities:** Critical role of government regulation in ensuring safe adoption of AI technology could be highlighted.

#### Takeaways to Inform Outreach

- **Industry:** Issues with Microsoft's "Tay" Twitter bot's offensive comments cast doubts about ethics in AI; Google's AI efforts are seen as nascent but high potential (e.g., driverless cars).
- **Government:** The National Highway Traffic Safety Administration associated with progress and challenges ahead in driverless car regulation, positively mentioned Google's AI for licensing as a legal driver.
- **Specific Technologies:** Criticism of machine learning's shortcomings; robotics and automation associated mostly with driverless vehicle achievements and hurdles

FIGURE 8—STATISTICS AND TRENDS FOR THE NARRATIVE “LONG WAY TO GO”

## d. Threat to Humanity

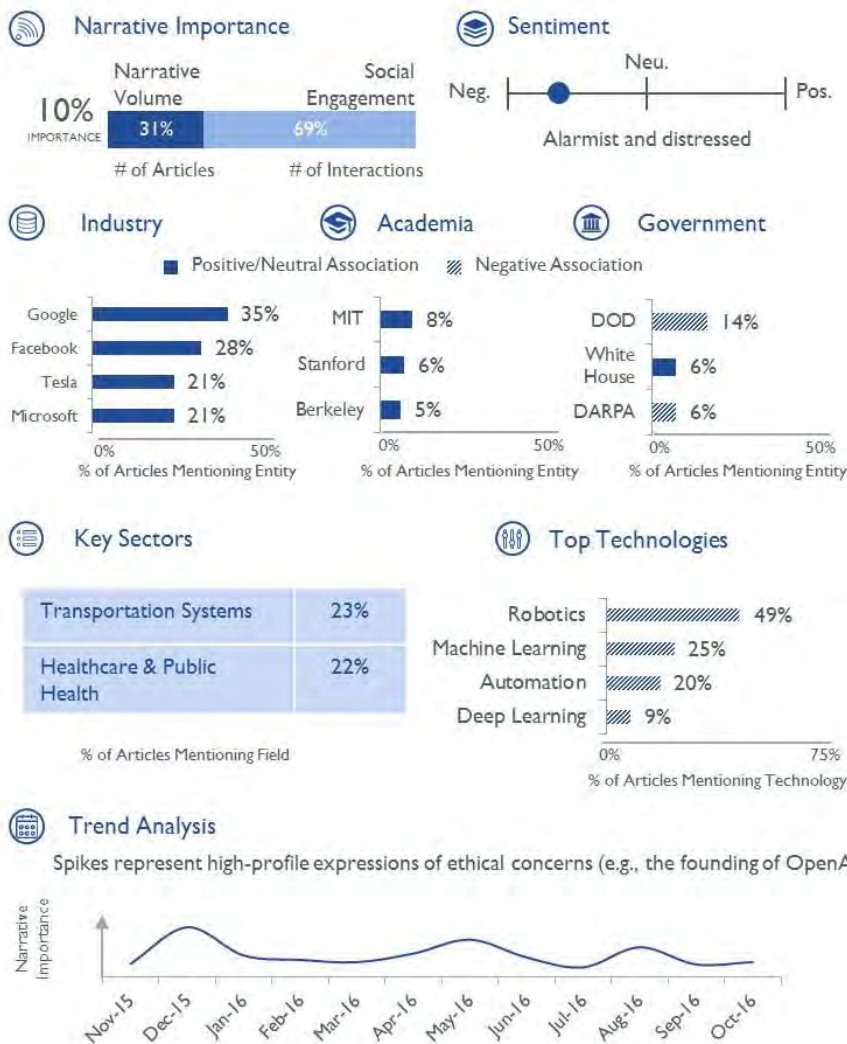
Robots could kill mankind, and it is naive not to take the threat seriously. Companies must self-regulate to protect everyone.

### Full Narrative Expression in the Voice of the Subscriber\*

Since the very conception of AI, people have worried it would surpass human control and intelligence. What was once an end-of-humanity science fiction tale is now closer than ever to reality? The full power of machine learning technologies is unknown, but the hype from some companies is blinding society from the real risks. Advances in AI are propelling robots to learn human values. But what prevents them from embodying the darker side of humanity and making harmful decisions? Robots could destroy mankind, and it is naive not to take the threat seriously. Companies must regulate their AI developments to ensure they are not too powerful or susceptible to manipulation. If they don't, we must halt their work all together. Humans must maintain control over machines. Technology should help—not hurt—us.

*\*These narratives do not necessarily reflect views put forth by OCIA about AI.*

### ANALYTIC CHARACTERISTICS AND ASSOCIATIONS



### KEY INSIGHTS

#### Risks, Implications, Opportunities

- **Risks:** Autonomous machines could make harmful decisions because of lack of human and moral intelligence, and are vulnerable to manipulation.
- **Implications:** Nefarious actors could co-opt AI to launch mass cyber or physical attacks on different sectors.
- **Opportunities:** AI ethical considerations could be ensured to be at the fore of decisions in private and public sectors.

#### Takeaways to Inform Outreach

- **Industry and Academia:** Referenced for collaboration to study AI ethics and safety, such as the Partnership on AI (which is made up of several major tech companies) and Elon Musk's OpenAI nonprofit (which works with university researchers).
- **Government:** DOD mentioned for concern about how it will deal with robotic warfare and arms race; White House report calls for ethically trained machines.
- **Specific Technologies:** Safety concerns about robots (e.g., vehicles) and ethical concerns about machine learning algorithms making healthcare decisions.

FIGURE 9—STATISTICS AND TRENDS FOR THE NARRATIVE “THREAT TO HUMANITY”

## e. Innovating Together

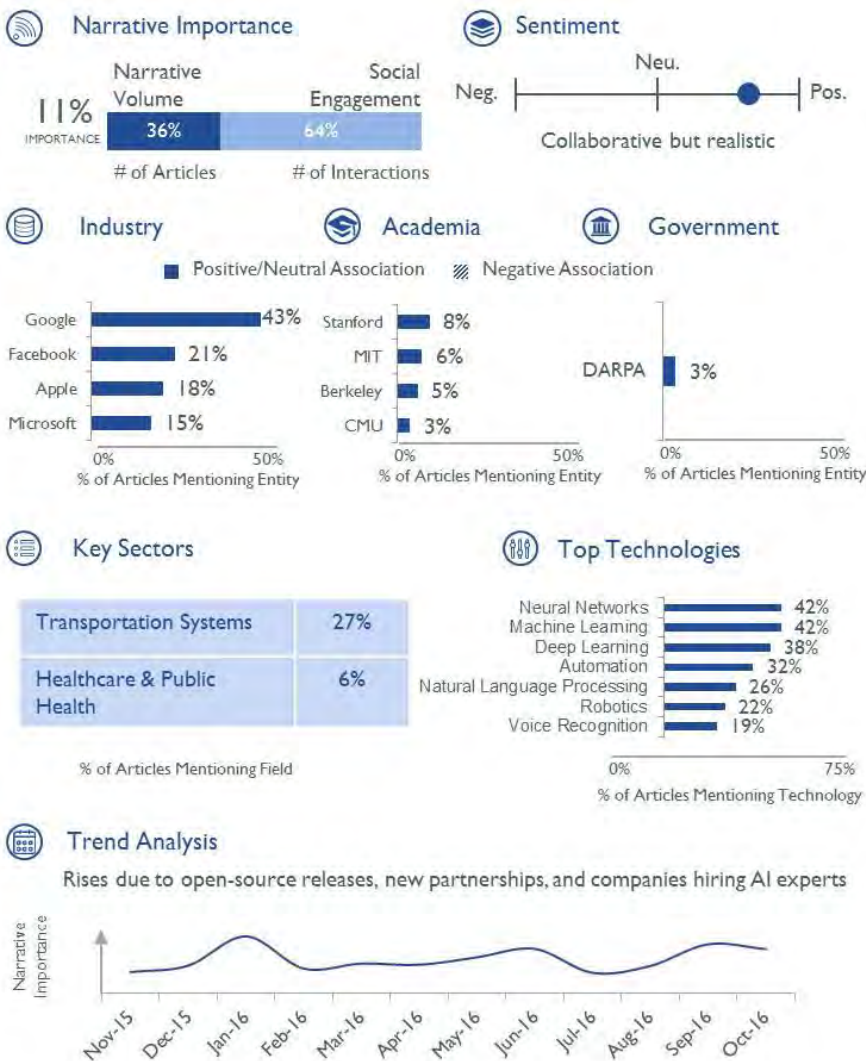
We must keep pushing to develop AI to its fullest potential and further scientific discovery.

### Full Narrative Expression in the Voice of the Subscriber\*

Relentless innovation allows us to expand the limits of what humanity can achieve. Given the unrealized potential, there are limitless opportunities to further scientific discovery by advancing AI. From raw neural networks to the latest in autonomous vehicle production, the best and brightest are working around the clock; but, no one person or company can fully develop AI on its own. By making information and new tools publicly available, tech companies are enhancing developers' and researchers' ability to expedite innovation and build new applications. It is essential to build on the progress we've made by continuing to work together to advance the field and reach the unknown promise inherent in AI.

*\*These narratives do not necessarily reflect views put forth by OCIA about AI.*

### ANALYTIC CHARACTERISTICS AND ASSOCIATIONS



### KEY INSIGHTS

#### Benefits, Risks, Implications, Opportunities

- **Benefits:** Open-source collaboration drives innovation across all fields, including government.
- **Risks:** Open-source releases might allow malicious actors to develop AI products.
- **Implications:** Adversaries could use these tools to target attacks or manipulate CI systems that also use open-source tools.
- **Opportunities:** Industry partnerships could collaborate on addressing security gaps and measures as part of innovations.

#### Takeaways to Inform Outreach

- **Industry and Academia:** Companies are recognized for collaborating on open-source releases, new AI hires, and university partnerships; Google is seen as the leader in open-source releases.
- **Government:** Minimal presence overall; Defense Advanced Research Projects Agency is noted for its efforts to discover the limits of machine learning.
- **Specific Technologies:** Focused on the next frontier of AI, such as developing artificial neural networks and bringing driverless cars to market.

FIGURE 10—STATISTICS AND TRENDS FOR THE NARRATIVE “INNOVATING TOGETHER”



## f. Inspiring a Business Revolution

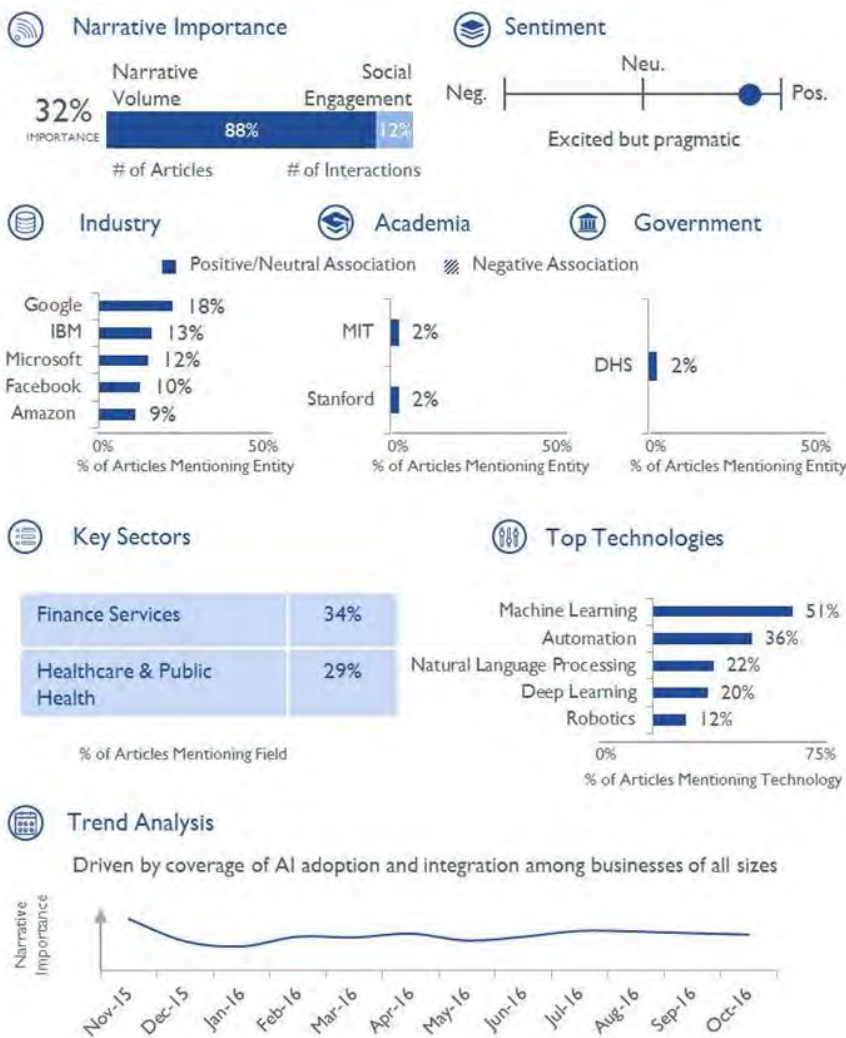
In today’s digital revolution, all businesses and employees must integrate AI and transform their operations or risk survival. AI isn’t a choice, it’s a necessity.

### Full Narrative Expression in the Voice of the Subscriber\*

Businesses used to be able to opt out of technology developments, but with today’s digital revolution, all business owners and employees will have to adopt AI or risk their survival. AI advancements have powerful benefits for business operations, such as automating workflows and enabling access to greater information. The unprecedented capacity to process big data allows companies to effectively translate information into better business intelligence and decisions. As a result, the private sector will be at the forefront of integrating machine and deep learning into every aspect of operations—transforming how companies make decisions, increase productivity, and create value. Whether a tech company in Silicon Valley or a family-run factory in Ohio, every business will have to embrace AI and rethink its operations, roles, and objectives to prepare for the future. AI is not a choice; it is a necessity.

*\*These narratives do not necessarily reflect views put forth by OCIA about AI.*

### ANALYTIC CHARACTERISTICS AND ASSOCIATIONS



### KEY INSIGHTS

#### Benefits, Risks, Implications, Opportunities

- **Benefits:** An AI-fueled fourth industrial revolution is expected to create efficiencies and drive economic growth.
- **Risks:** Automated business processes and less human oversight might lead to service interruptions if technologies fail.
- **Implications:** Reliance on AI and connectivity could lead to cyber attacks that disrupt deliveries of goods and services and have a ripple effect on the economy.
- **Opportunities:** Best practices on safe AI adoption and integration could be formulated.

#### Takeaways to Inform Outreach

- **Industry and Academia:** Tech companies are mentioned for their AI products, but the primary focus is on small and medium businesses’ adopting the technology.
- **Government:** Few mentions overall; some of DHS as a customer for facial recognition software contracts.
- **Specific Technologies:** Machine learning and automation are seen as increasing efficiency and profits without sacrificing quality across all sectors.

FIGURE 11— STATISTICS AND TRENDS FOR THE NARRATIVE “INSPIRING A BUSINESS REVOLUTION”

## g. Enhancing the Future

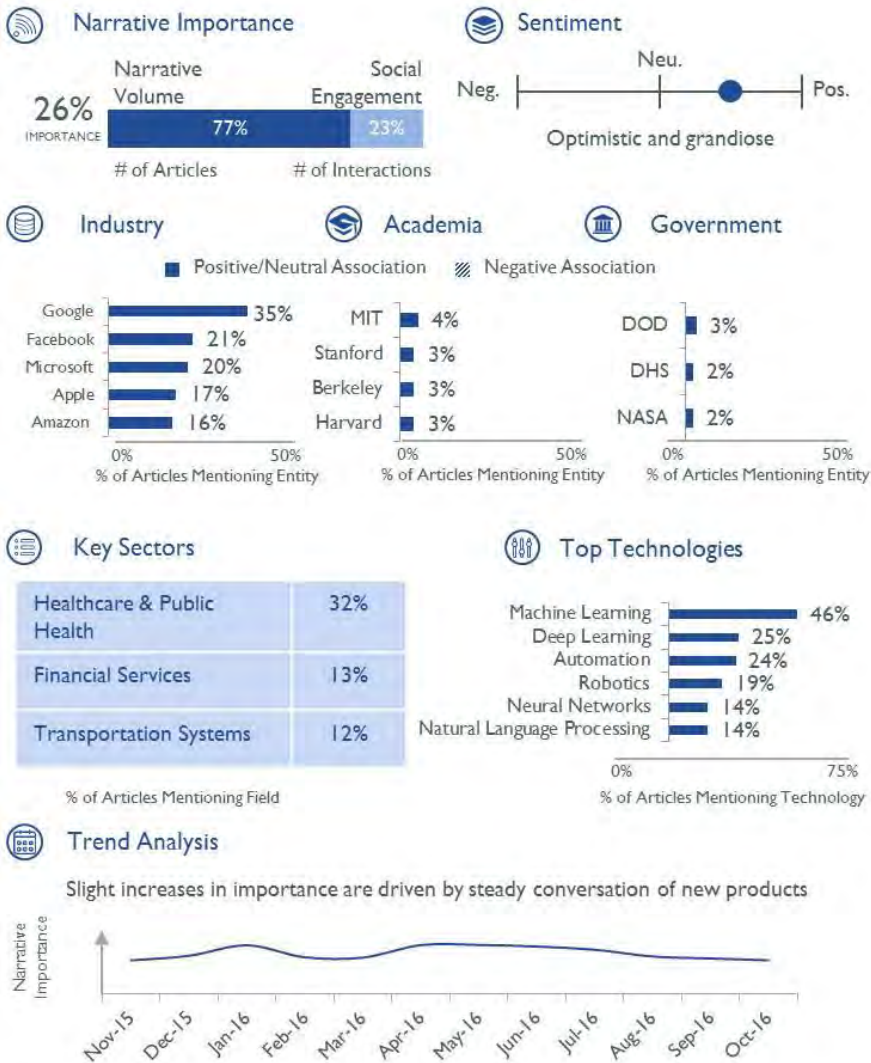
AI is changing every aspect of our society for the better. We must commit to reimagining the possible and champion a future of working side-by-side with machines and robots.

### Full Narrative Expression in the Voice of the Subscriber\*

Technology is changing the way we live, work, and interact. Computers are becoming more human-like, from bots that learn human speech patterns, to self-driving cars, to robots that “think” better than a child, to face and voice recognition that understands emotions more accurately than we do. We’re at the beginning of a new era in which humans and technology will co-evolve, with AI enhancing human capabilities and human creativity powering AI. AI technologies will change and improve every aspect of our lives. Doctors will diagnose cancer more reliably, educators will more effectively teach our children, and companies will change how people find and buy products. We must commit to reimagining the possible and champion a future of working side-by-side with machines and robots.

*\*These narratives do not necessarily reflect views put forth by OCIA about AI.*

### ANALYTIC CHARACTERISTICS AND ASSOCIATIONS



### KEY INSIGHTS

#### Benefits, Risks, Implications, Opportunities

- **Benefits:** Improvement of services and efficiency across Sectors (e.g., Healthcare and Public Health and Transportation Systems).
- **Risks:** Competition could lead companies to prioritize getting products to market over building in robust security.
- **Implications:** Insecure software could infiltrate CI sectors before threats are assessed.
- **Opportunities:** Autonomous vehicle regulations could be used as examples for other AI products.

#### Takeaways to Inform Outreach

- **Industry and Academia:** Companies’ specific AI developments mentioned, with Google seen as the leader; academia contributes through research partnerships.
- **Government:** Few mentions of DOD partnerships with companies; the DHS and National Aeronautics and Space Administration partnership for the AUDREY program for first responders.
- **Specific Technologies:** Diverse technologies—with machine learning dominating—noted for their effect on efficiency and ease of access to medical care, financial services, and transportation.

FIGURE 12—STATISTICS AND TRENDS FOR THE NARRATIVE “ENHANCING THE FUTURE”

## APPENDIX A: KEY TERMS AND ABBREVIATIONS

### Technologies Discussed in the Artificial Intelligence Dataset

The following list of technologies encompasses the most prominent technology types in the Artificial Intelligence Narrative Landscape dataset. It is not intended to be exhaustive. Many of these technologies overlap and leverage techniques from one another, thus the categorization is for organizational purposes only and is not mutually exclusive.

- **Artificial Intelligence:** Computer systems and machines capable of intelligent reasoning, decision making, and problem solving.<sup>5</sup>
- **Artificial Neural Networks:** Learning models based on the activity present in the brains of animals; these models are used for tasks that traditional algorithms are incapable of completing.<sup>6</sup>
- **Automation:** A category of any AI technology that does not require consistent input from a human to operate.<sup>7</sup>
- **Deep Learning:** A subcategory of machine learning that employs algorithms to analyze and model complex relationships among different datasets.<sup>8</sup>
- **Facial Recognition:** A type of technology that analyzes images of an individual's facial structure to identify that individual.<sup>9</sup>
- **Machine Learning:** A field focused on enabling machines to learn how to act and to adjust behavior on their own based on patterns of data, rather than relying on humans to program them.<sup>10</sup> Machine learning encompasses several other types of technology, such as but not limited to deep learning, reinforcement learning, supervised learning, computational learning, feature extraction, anomaly detection, and outlier detection.
- **Natural Language Processing:** A field focused on enabling machines to understand and derive meaning from natural human languages, primarily through text or speech recognition.<sup>11</sup>
- **Robotics:** An autonomous system that can complete tasks in the physical world by making sense of its environment and then fulfilling its programmed tasks.<sup>12</sup>
- **Voice Recognition:** A technology that converts vocal speech into computer text.<sup>13</sup>

### Entity Abbreviations

<b>MIT</b>	Massachusetts Institute of Technology
<b>Berkeley</b>	University of California, Berkeley
<b>DHS</b>	Department of Homeland Security
<b>DOD</b>	Department of Defense
<b>FBI</b>	Federal Bureau of Investigation

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<sup>5</sup> Forrest, C. (2015). "Mini-glossary: AI terms you should know." *Tech Republic*. <http://www.techrepublic.com/article/mini-glossary-ai-terms-you-should-know/>. Accessed February 1, 2017.

<sup>6</sup> Ibid.

<sup>7</sup> Ibid.

<sup>8</sup> Ibid.

<sup>9</sup> PC Mag (2017). "Definition of: Face Recognition." <http://www.pcmag.com/encyclopedia/term/42969/face-recognition>. Accessed February 1, 2017.

<sup>10</sup> Forrest, C. (2015). "Mini-glossary: AI terms you should know." *Tech Republic*. <http://www.techrepublic.com/article/mini-glossary-ai-terms-you-should-know/>. Accessed February 1, 2017.

<sup>11</sup> Ibid.

<sup>12</sup> Mataric, M. (2007). "The Robotics Primer." The MIT Press. Cambridge MA: MIT Press, 2007: p 2.

<sup>13</sup> PC Mag (2017). "Definition of: Voice Recognition." <http://www.pcmag.com/encyclopedia/term/54077/voice-recognition>. Accessed February 1, 2017.

## APPENDIX B: ILLUSTRATIVE SOURCES FROM THE NARRATIVE ANALYSIS PROCESS

The dataset includes more than 4,000 different traditional media and blog sources. Collectively these produced more than 20,000 narrative-rich articles that were analyzed. A non-exhaustive, illustrative list of 100 sources spanning traditional media and blogs (selected according to source prominence) is below. Interviews with select subject matter experts also validated findings.

TABLE 2—TOP 100 SOURCES

SAMPLE 1–34 SOURCES		SAMPLE 35–68 SOURCES		SAMPLE 69–100 SOURCES	
1	Washington Post	35	SiliconValley.com	69	The Vermilion
2	Time	36	Yahoo! Tech	70	The Utah Statesman
3	The New York Times	37	Yahoo! Health	71	The University of Tennessee
4	San Francisco Chronicle	38	The White House	72	Sensors WorldLink
5	Reuters	39	Spectrum Online	73	Seeking Alpha
6	New York Times	40	NPR	74	Security and Communication Networks
7	NBCNews.com	41	Mashable	75	SearchITChannel.com
8	MSNBC Newsweek	42	Harvard School of Public Health	76	Scientific American
9	MSNBC	43	Harvard Business Review	77	Risk Management Magazine
10	Los Angeles Times	44	Federal Trade Commission	78	RTTNews.com
11	Fortune	45	iPhone App Developer News	79	RCR Wireless News
12	FOXNews.com	46	iMF Direct	80	Power Electronics News
13	Christian Science Monitor	47	iDigitalTimes	81	Photonics Online
14	CNN Wire	48	Zolmax.com	82	PNAS
15	CNN Money	49	Women's Health Weekly	83	Oil and Gas Online
16	CNBC	50	Wolters Kluwer	84	NetworkWorld
17	CBS News	51	Wireless News	85	Network Computing
18	Boston Globe	52	West Tennessee Medical News	86	Motley Fool
19	Bloomberg	53	Wellesley News	87	Morningstar.com
20	ABC News	54	University of Texas in Austin	88	Medical Design Technology
21	Wired News	55	University Herald	89	MedImaging.net
22	TheStreet.com	56	United Nations	90	Macworld
23	FOXBusiness.com	57	US Telecom	91	Machine Design
24	Business Insider	58	UN Global Compact	92	Laboratory Network
25	Vocativ	59	UCLA News	93	Lab Medica
26	US News & World Report	60	UCF	94	Knowledge Management World
27	The New Republic Online	61	U.S. Department of Energy	95	Journal of the American Medical Association
28	Huffington Post	62	Tufts Daily: Tufts University	96	Defense Systems
29	Foreign Policy Magazine	63	Tubefilter News	97	Concurrency and Computation
30	ZDNet	64	Tribune's Newsday	98	Computer Applications in Engineering Education
31	Tech Republic	65	Travel & Leisure Close-Up	99	CNET News
32	TMC Net	66	Topnews Wires files	100	CIO Magazine
33	Software: Practice and Experience	67	This Week In		
34	Slate Magazine	68	The Vista		

### DHS POINT OF CONTACT

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For more information about OCIA, visit [www.dhs.gov/office-cyber-infrastructure-analysis](http://www.dhs.gov/office-cyber-infrastructure-analysis).

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