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Contending Frames

Evaluating Rhetorical Dynamics in AI

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Executive Summary

The narrative of an artificial intelligence "arms race" among the great powers has become shorthand to describe evolving dynamics in the field. Narratives about AI matter because they reflect and shape public perceptions of the technology. Policymakers will need to monitor these perceptions closely, as levels of public confidence in AI directly impact the scope for emerging technology policy. In this data brief, the second in our series examining rhetorical frames in AI, we compare four narrative frames that are prominent in public discourse: AI Competition, Killer Robots, Economic Gold Rush, and World Without Work. By searching more than seven million articles on LexisNexis over the 2012 to 2020 period, we find:

- The Competition frame predominates among the four frames under study, both in terms of raw counts and as a percentage of total articles that mention AI, with roughly as many occurrences in 2020 as the other three frames combined.

- While outlets that cater to niche foreign policy audiences, such as *Defense One* and *Foreign Affairs*, have become more diverse in terms of discourse around AI, outlets that cater to more general audiences appear to have converged around the Competition frame. This trend suggests that a hardening in foreign policy discourse around AI between 2012 and 2015 may have encouraged a perception of competition among general audiences. Media convergence around a competitive narrative could undermine efforts to bolster global AI standards-setting and collaboration around testing and safety.

- As a share of articles mentioning AI, the Killer Robots frame peaked in 2015. In that year, the Killer Robots frame was almost as prevalent as the Competition frame; today, it is the least common among the four frames under study. This suggests that early concerns about military use of AI may—for now—have become less salient.

- As a share of AI articles, the Economic Gold Rush frame peaked in 2018. Today, it is the second most common among all four frames under study. This frame peaked later than the other frames, suggesting that narratives focused on threat predominated early in the public discourse around AI and only more recently turned to potential opportunities. The Economic Gold Rush frame is often associated with Big Tech companies, which suggests this more

optimistic framing could have implications for efforts to regulate Big Tech.

- Political leaders and tech company CEOs are the individuals most commonly mentioned in articles that use the four frames. Prominent academics, authors, and computer scientists are less frequently mentioned. Whether this is a reflection of existing debates between political leaders and tech companies or an indicator of the politicization of AI is unclear, but an intriguing question for possible future research.

- More than 95 percent of articles, distributed among a range of sources, describe the activities of AI companies without using these frames, or any identifiable frame. For example, many articles are straightforward financial reporting. This suggests a majority of media coverage about AI may avoid commentary on the political implications of the technology. This finding also suggests that policymakers may have leeway to shape the public discourse around AI as the technology matures.

Contending Frames

In an earlier analysis, “Mainframes: A Provisional Analysis of Rhetorical Frames in AI,” we developed a novel methodology to capture occurrences of the “AI Competition” frame in popular media sources. In the Competition frame, AI development is described as a race between two or more actors.[1] We explored the use of the frame across more than 4,000 articles from three news outlets between 2012 and 2019.

Among our findings, we observed that since 2012, “a growing number of articles in the three news sources have included the Competition frame, but prevalence of the frame as a proportion of all AI articles peaked in 2015.”[2] We concluded that the frame’s peak in 2015 and subsequent decline as a proportion of all AI articles under study may indicate that reporting on AI had grown more diverse and sophisticated.

In this follow-up data brief, we compare the “AI Competition'' frame with other frames in public discussion of AI. After canvassing articles about AI across a wide range of outlets, we identified three additional rhetorical frames. We selected these frames to offer a diversity of perspectives on AI, emphasizing both national security and economic implications as well as positive and negative public sentiment.

In addition to the “AI Competition” frame, the three frames under study capture important dynamics in mass communications about AI. The “Killer Robots” frame describes a future in which lethal autonomous weapons select and engage targets without human supervision. This frame argues that lethal autonomous weapons present a threat to humanity and need to be controlled or banned. The “World Without Work” frame describes a future in which AI replaces, as opposed to augments, human labor. Just as machines displaced human manual labor during the Industrial Revolution, this frame claims that AI will replace human cognitive labor.[3] The “Economic Gold Rush” frame describes a future in which AI unleashes productivity and generates massive wealth for the global economy.

To compare occurrences of the four frames, we searched more than seven million articles on LexisNexis over the 2012 to 2020 period. We identified 125,567 articles that mentioned AI.[4] Among these, 3,207 (2.6 percent) talked about AI using one of the four frames.[5] Specifically, we recorded 1,702 occurrences of the “AI Competition” frame, 480 of the “Killer Robots” frame, 688 of the “World Without Work” frame, and 670 of the “Economic Gold Rush” frame. For each frame, we tracked its use

over time, the outlets and authors that employ it, and the individuals and organizations that are mentioned in association with it.

Identifying Rhetorical Frames

In our initial study of the AI Competition frame, we annotated a sample of 10,000 LexisNexis articles, following a carefully developed annotation framework. Drawing on this preliminary work, we developed queries for an analysis of rhetorical frames at scale across a large corpus of news media from LexisNexis. Specifically, we examined LexisNexis Metabase content published in English between 2012 and 2020 by national, newswire, or trade sources in the United States that LexisNexis categorized as "top international, national, and business news" or "top regional" outlets.[6] These criteria identified 7.9 million articles from 325 news sources.

Within this corpus, we searched for articles that included explicit mention of "artificial intelligence" or "AI" and captured occurrences of the Competition frame or three additional frames: "Killer Robots," "World Without Work," and "Economic Gold Rush."

AI Rhetorical Frames

As in our earlier analysis, the Competition frame describes AI development as a race between two or more actors, such as governments or companies. Invocations of the frame include the following:

- a military competition ("arms race")
- historical competition ("Cold War" or "Sputnik Moment")
- a territorial competition ("supremacy in Europe")
- a competition for resources ("battle for talent")
- any other type of competition ("two-man contest" or "AI rivalry")

We identified invocations of the frame by searching the corpus text for mentions of AI within a short distance (20 characters) of terms like these, in various forms: Sputnik, foreign adversary, arms race, battle, competition, conflict, rivalry, superiority, or strategic advantage.[7]

Economic Gold Rush	**“Cashing in on artificial intelligence”** “Companies are rushing to develop technologies incorporating such autonomous learning technology.... Other businesses have ideas about how to take advantage of the coming AI revolution.” *Nikkei Asia*
World Without Work	**“A Machine May Not Take Your Job, but One Could Become Your Boss”** “For decades, people have fearfully imagined armies of hyper-efficient robots invading offices and factories, gobbling up jobs once done by humans. But in all of the worry about the potential of artificial intelligence to replace rank-and-file workers, we may have overlooked the possibility it will replace the bosses, too.” *The New York Times*
Killer Robots	**"US general warns of out-of-control killer robots"** “America's second-highest ranking military officer, Gen. Paul Selva, advocated Tuesday for ‘keeping the ethical rules of war in place lest we unleash on humanity a set of robots that we don't know how to control.’” *CNN*
Competition	**“U.S. and China battle for technological supremacy”** “Escalating tensions between the U.S. and China are stoking the narrative of an all-out artificial intelligence arms race between the two countries.” *CBS News*

The “Killer Robots” frame describes a future in which lethal autonomous weapons or “fully autonomous weapons” select and engage targets without human supervision.[8] Killer robots, in this frame’s usage, are self-targeting, independent, and unsupervised. Some who employ this frame argue that lethal autonomous weapons present a threat to humanity and need to be controlled or banned. Others who use this frame contend that fully autonomous weapons lack the interpretive capacities and situational awareness necessary to comply with the laws of war.[9] Still others employing the frame argue that “killer robots” create an “accountability gap” and offend basic human dignity.[10]

We considered articles to invoke the frame if they included a mention of AI along with such terms as autonomous weapons, slaughterbots, international humanitarian law, laws of war, killer robots, human control, International Committee for Robot Arms Control, threat to humanity, Martens Clause, Convention on Certain Conventional Weapons, autonomy, DOD Directive 3000.09, or existential risk. We also included articles that mentioned "prohibition" or "ban" within a short distance of a reference to AI.[11]

The **"**World Without Work" frame describes a future in which AI replaces, as opposed to augments, human labor.[12] Some argue that AI will displace certain jobs and create new ones. Others claim that AI will help meet the challenge of declining birth rates and flagging productivity in countries such as Japan or China. Still others foresee a more ominous future where heavily populated countries suffer a "population curse" similar to nations that struggled from a surfeit of fossil fuels in the postwar period (the "resource curse").[13] The historian Yuval Noah Harari writes of a new "global useless class" where AI and biotech not only displace jobs but create new forms of inequality through the merger of machine learning and genetic engineering.[14] Unlike the Industrial Revolution, which had a "de-skilling" effect by opening up jobs and whole sectors to lower-skilled labor, the AI revolution could have the opposite effect: machines will make higher-skilled workers more productive and those with lower-skill jobs more vulnerable to automation.[15] The author Kai-Fu Lee argues that manual jobs involving higher levels of dexterity or those requiring "compassion and creativity" may be less at risk than other "repetition-rich white collar jobs."[16] According to many uses of this frame, surging productivity growth will not necessarily translate into shared prosperity or rising compensation.[17]

To find invocations of the World Without Work frame, we searched for articles that mentioned AI and included such phrases as global useless class, employment polarization, livelihoods, mass joblessness, fourth industrial revolution, winners and losers, or jobs eliminated. We also considered articles that mentioned the terms "displace" or "replace" within a short distance of a reference to the word "job."

The "Economic Gold Rush" frame describes a future in which AI unleashes productivity and generates massive wealth for the global economy.[18] Some uses of this frame tend to highlight upper-bound estimates of AI's potential to stimulate global growth without noting the lower-bound estimates, caveats, or historical trends. Other uses of this frame recognize the risks and argue that governments will need to invest in education and workforce training. This frame often analogizes AI to

electricity in its potential transformative effects on the global economy. The Economic Gold Rush frame tends to focus on absolute as opposed to relative gains and touts aggregate economic benefits as opposed to differential effects at the national and sub-national levels or across different sectors.

We counted articles as invoking the Economic Gold Rush frame if they mentioned AI alongside references to a productivity dividend, AI revolution, golden opportunity, labor productivity improvement, or similar concepts.

In the resulting corpus of frame-invoking articles, we assessed the prevalence of frames over time and across outlets. We also examined trends in references to individuals and organizations.[19]

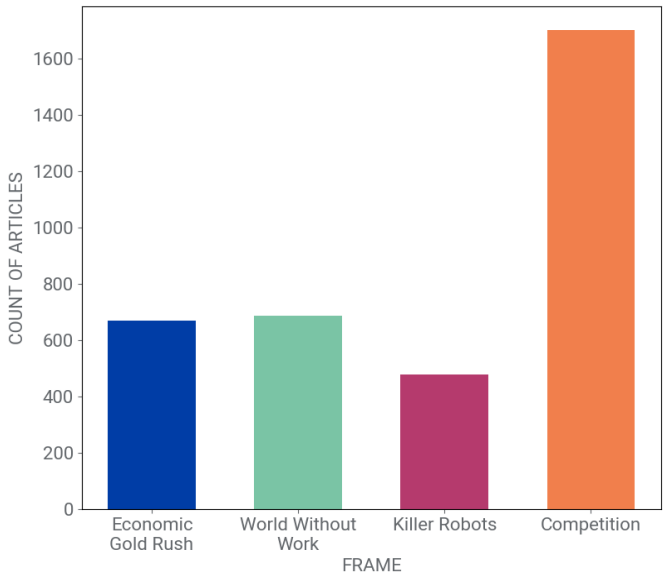
Findings

The Competition frame predominates among the four frames under study, both in terms of raw counts, as shown in Figure 1, and as a percentage of total articles that mention AI.

- For 2020, we recorded 728 occurrences of the Competition frame as compared to 337 occurrences for the Economic Gold Rush frame, 301 occurrences for the World Without Work frame, and 96 occurrences for the Killer Robots frame.

- In 2020, the Competition frame comprised 1.3 percent of AI articles that year, as compared to 0.2 percent for the Killer Robots frame, 0.5 percent for the World Without Work frame, and 0.6 percent for the Economic Gold Rush frame. The majority of remaining articles do not contain any identifiable frame. For example, many articles describe the activities of AI companies without any comment on AI.[20]

Figure 1. AI Competition Frame Occurred Most Frequently Among Contending Frames Between 2012-2020.



Source: LexisNexis, 2012-2020.

In our original analysis, which looked at outlets that cater to niche foreign policy audiences (e.g., *Defense One* and *Foreign Affairs*), we found a decline in the use of the Competition frame after 2015, suggesting that reporting on AI became more diverse among those publications. In this analysis, which includes a wider range of outlets, many of which cater to

more general audiences, the continued prevalence of the Competition frame suggests a convergence around this frame. Perhaps a hardening in foreign policy discourse around AI between 2012 and 2015 among niche audiences encouraged a perception of competition among a more widespread audience.

From 2012 to 2020, as a share of articles that reference AI, the Killer Robots and World Without Work frames declined. By contrast, the Competition and Economic Gold Rush frames increased, as seen in Figure 2. As a share of articles mentioning AI:

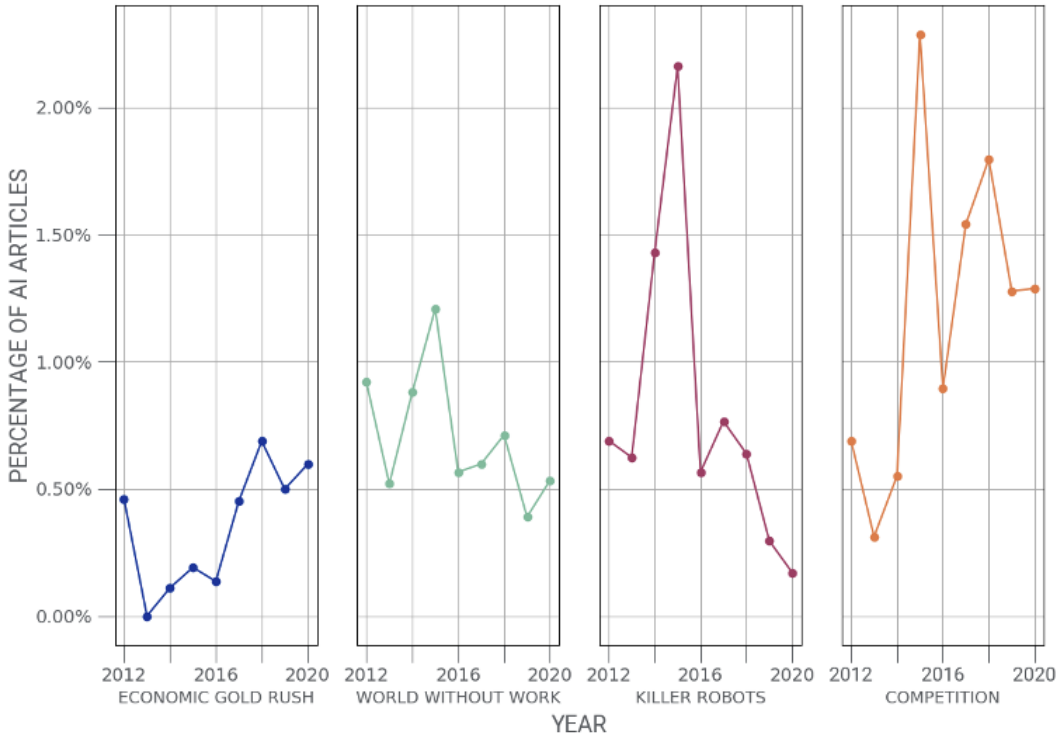
- The Killer Robots frame peaked in 2015. In that year, the Killer Robots frame was almost as prevalent as the Competition frame; today, it is the least common among the four frames under study. The peak in 2015 coincided with significant outreach and media activity by the Campaign to Stop Killer Robots.[21] The uptick in 2017 could be related to the short film "Slaughterbots," which debuted at a side event of the United Nations' Convention on Certain Conventional Weapons and went viral that year.[22] While the *Terminator* franchise has shaped the popular imagination on AI, the trend lines suggest that media reporting on AI has increasingly adopted other frames.

- The World Without Work frame peaked in 2015. At the time, it was the third most prominent frame after the Competition and Killer Robots frames.

- The AI Competition frame also peaked in 2015 and, after an initial decline, has leveled out through 2020. This finding is consistent with our initial study.

- The Economic Gold Rush frame peaked in 2018. Today, it is the second most common among all four frames under study. That this frame peaked later than the other frames is consistent with the theory that increasing commercialization of AI shapes public discourse around the technology. The growing prevalence of the Economic Gold Rush frame also suggests that frames centered on threat predominated early in the public discourse around AI, which only more recently turned to potential opportunities.

Figure 2. Frames Focused on AI Threats Declining while Frames Focused on AI Opportunities Increasing



Source: LexisNexis, 2012-2020.

Political leaders and tech company CEOs are the individuals most commonly mentioned in articles that use the four frames. Prominent academics, authors, and computer scientists are less frequently mentioned. In terms of specific people most frequently mentioned in an article's discussion of AI using one of the four frames:

- The political leaders most frequently mentioned in association with the frames are Donald Trump, Barack Obama, Xi Jinping, and Vladimir Putin.
- Jeff Bezos, Bill Gates, Elon Musk, Sundar Pichai, and Mark Zuckerberg are the most commonly cited tech company CEOs or former CEOs.
- Donald Trump is the individual most frequently cited in articles using the World Without Work and Competition frames. Elon Musk is the most commonly mentioned individual in articles using the Killer Robots frame.

- U.S. political leaders were frequently mentioned in articles that contained the World Without Work frame; the 10 most frequently cited individuals included two Republican leaders and five Democratic leaders.

As displayed in Table 1, companies, specifically AI companies, and U.S. government organizations are the organizations most commonly mentioned in articles that use the four frames.[23] Universities, non-profit organizations, international bodies, and foreign governments were less frequently mentioned. In terms of organizations mentioned in association with the four frames:

- Technology companies such as Amazon, Apple, Facebook, Google, and Microsoft are among the organizations mentioned most often in articles that use one of the four frames. AI companies like these appear in:
    - 32 percent of articles that contain the Killer Robots frame;
    - 26 percent of articles that contain the World Without Work frame;
    - 36 percent of articles that contain the Competition frame; and
    - 41 percent of articles that contain the Economic Gold Rush frame.
- Google is the top-mentioned organization in articles that contain the Competition and Killer Robots frames, while Amazon is the top-mentioned organization in articles that contain the World Without Work frame. The appearance of companies in articles invoking the Competition frame highlights that it describes both geopolitical and business competition.
- U.S. Government organizations (e.g., Department of Treasury, Congress) were the second most commonly mentioned organization type for the Killer Robots and World Without Work frames. Media organizations (e.g., *BBC*, *CNN*, *Business Insider*) were the second most common in articles using the Economic Gold Rush frame.
    - In terms of specific U.S. government organizations, the U.S. Department of Defense is mentioned the most often in articles associated with the Killer Robots frame, while

the United States Congress is mentioned the most often in articles associated with the World Without Work frame.

Table 1. AI Companies and U.S. Government Entities Are the Most Common Types of Organizations in Articles that Invoke a Frame.

Organization Type	Percentage of Organization Mentions by Frame			
	Economic Gold Rush	World Without Work	Killer Robots	Competition
AI Company	40.7%	26.0%	31.5%	35.9%
Company (not AI)	28.9%	20.0%	8.6%	19.7%
U.S. Government	7.0%	23.6%	25.0%	16.7%
Media	12.1%	12.2%	12.9%	12.0%
University	3.5%	4.9%	9.7%	5.5%
IGO	2.5%	5.6%	3.9%	2.3%
NGO	1.3%	2.7%	4.6%	2.1%
Foreign Government	1.0%	0.8%	0.9%	1.4%
Other	0.7%	1.9%	2.0%	2.2%

Source: LexisNexis, 2012-2020.[24]

The top news sources that contain a frame include PR Newswire (671), *Forbes* (450), *The New York Times* (312), *CNN* (249), *Seeking Alpha* (221), *Morningstar* (199), PRWeb (173), *TheStreet.com* (171), *CNN International* (82), Business Wire (80), *Investor's Business Daily* (65), *CQ Roll Call* (62), *U.S. News & World Report* (61), *Fox News* (59), *CIO* (50), *ZDNet* (48), *The Boston Globe* (45), *Wired* (44), *Politico* (42), *The Christian Science Monitor* (37), and *Slate* (28). Table 2 displays the number of times each frame was invoked by these sources.

The news outlets with the highest number of articles between 2012 and 2020 using the Killer Robots frame are *The New York Times* and *Forbes*. Those with the highest number of articles using the World Without Work frame are *Seeking Alpha* and *Forbes*. The outlets with the highest number of articles using the Competition and Economic Gold Rush frames are PR Newswire, *Forbes*, *Seeking Alpha*, and *Morningstar*.

Table 2. PR Newswire, Forbes, and The New York Times Publish the Most Articles that Invoke a Frame.

Media Source	Number of Times Frame Used by Source			
	Economic Gold Rush	World Without Work	Killer Robots	Competition
PR Newswire	208	56	27	380
Forbes	96	81	43	230
The New York Times	7	79	121	105
CNN	17	58	55	119
Seeking Alpha	80	107	2	32
Morningstar	66	18	4	111
PRWeb	52	14	8	99
TheStreet.com	37	13	12	109
CNN International	4	49	11	18
Business Wire	41	8	1	30
Investor's Business Daily	12	10	2	41
CQ Roll Call	7	13	22	20
US News & World Report	10	12	11	28
Fox News	3	29	4	23
CIO	9	6	4	31
ZDNet	7	3	4	34
The Boston Globe	2	14	12	17
Wired	3	4	15	22
Politico	0	7	3	32
The Christian Science Monitor	3	7	17	10
Slate	2	3	16	7

Source: LexisNexis, 2012-2020.

Concluding Observations

Rhetorical frames in AI serve as a barometer of public perceptions and provide insight into whether those perceptions are becoming more cooperative or competitive over time. To increase public trust in the technology, policymakers should monitor these narratives closely and take steps to respond to the concerns expressed in the evolving discourse on AI.

In the course of our research, we detected additional proto-frames worthy of study: the Eye in the Sky frame describes the use of AI for intelligence applications and surveillance technologies; the Speeding Bullet frame emphasizes the ability of AI to accelerate the pace of warfare, cyber operations and decision making; the Wolf in Sheep's Clothing frame reflects concerns about bias in the design, development and use of AI-enabled systems, including biased training data and concerns about automation bias in human-machine teams; and the House of Cards frame emphasizes the brittle nature of AI systems and their tendency to fail when encountering novel or complex environments for which they were not trained.

Future research could track these and other frames or explore sub-categories of the frames under study. For example, analysts could disaggregate the Competition frame into the categories of competitive dynamics between states and competition over talent in the private sector. By monitoring changes over time in the usage of rhetorical frames in niche and general audience sources, policymakers could more proactively shape the public discourse around AI and address legitimate concerns over safety, security, and reliability, thereby increasing public trust in the technology.

Authors

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Endnotes

[1] Andrew Imbrie, James Dunham, Rebecca Gelles, and Catherine Aiken, "Mainframes: A Provisional Analysis of Rhetorical Frames in AI" (Center for Security and Emerging Technology, August 2020), https://cset.georgetown.edu/research/mainframes-a-provisional-analysis-of-rhetorical-frames-in-ai/.

[2] Imbrie, Dunham, Gelles, and Aiken, "Mainframes: A Provisional Analysis of Rhetorical Frames in AI."

[3] Paul Scharre and Michael C. Horowitz, "Artificial Intelligence: What Every Policymaker Needs to Know" (Center for a New American Security, June 2018), 2, https://s3.us-east-1.amazonaws.com/files.cnas.org/documents/CNAS_AI_FINAL-v2.pdf.

[4] Articles were selected from LexisNexis if they fell into source rank one (top international, national, and business news sources) or two (top regional sources) and if they were included in the categories of Press Wire, National, or Trade. There were 285 sources identified that contained articles mentioning artificial intelligence. Of these, the top sources were PR Newswire (28 percent of AI articles), PRWeb (10 percent), *Morningstar* (8 percent), *TheStreet.com* (6 percent), *Forbes* (6 percent), *International Business Times* (5 percent), Business Wire (5 percent), *The New York Times* (3 percent), *Seeking Alpha* (2 percent), *Investor's Business Daily* (1 percent), and the *San Francisco Chronicle* (1 percent).

[5] While the percentage of articles mentioning AI that contain a frame may seem low, we sampled 250 articles from this set to evaluate what it contained and found only six articles that could be considered false negatives. The other articles generally fell into a frame not covered in this paper (see our discussion of further frames to consider); discussed AI in the context of advertisement for a company or product, where the only framing was that AI makes their product better; or made passing mention of AI as a feature in some product or issue that was being discussed but did not focus on it. There were also a small number of articles that were miscategorized as being about AI at all, which is one of the challenges of a keyword-based approach.

[6] The LexisNexis service includes a broad range of the print and electronic media content produced. However, there are some sources not covered in LexisNexis, including *The Wall Street Journal*, *The Washington Post*, *MIT Technology Review*, and *The Verge*. These sources were not included in our analysis. Patterns of frame use might differ between these excluded sources and those in our analysis, but we cannot enumerate the hypothetical universe of possible sources for an assessment of LexisNexis's coverage and the generalizability of our findings. We instead recommend some caution in their interpretation. Adding or removing sources from our analysis would affect its results. Similarly, we do not attempt to adjust for changes over time in the availability of sources in LexisNexis. We include in the analysis content from frame-invoking outlets that appear only in 2020, for instance, but our substantive conclusions are robust to this choice.

[7] All the patterns we matched against for this and other frames can be found with the replication code for this data brief at https://github.com/georgetown-cset/contending-frames.

[8] For examples of recent articles that include the frame, see Henry McDonald, "Ex-Google Worker Fears 'Killer Robots' Could Cause Mass Atrocities," *The Guardian*, September 15, 2019, https://www.theguardian.com/technology/2019/sep/15/ex-google-worker-fears-killer-robots-cause-mass-atrocities; Sono Motoyama, "Inside the United Nations' Effort to Regulate Autonomous Killer Robots," *The Verge*, August 27, 2018, https://www.theverge.com/2018/8/27/17786080/united-nations-un-autonomous-killer-robots-regulation-conference; Nita Bhalla, "Nations Dawdle on Agreeing Rules to Control 'Killer Robots' in Future Wars," Reuters, January 17, 2020, https://www.reuters.com/article/us-global-rights-killer-robots/nations-dawdle-on-agreeing-rules-to-control-killer-robots-in-future-wars-idUSKBN1ZG151; Kelsey Piper, "Death by Algorithm: The Age of Killer Robots is Closer than You Think," *Vox*, June 21, 2019, https://www.vox.com/2019/6/21/18691459/killer-robots-lethal-autonomous-weapons-ai-war; Zachary Fryer-Biggs, "Coming Soon to a Battlefield: Robots that Can Kill," *The Atlantic*, September 3, 2019, https://www.theatlantic.com/technology/archive/2019/09/killer-robots-and-new-era-machine-driven-warfare/597130/; Jonah M. Kessel, "Killer Robots Aren't Regulated. Yet.," *The New York Times*, December 13, 2019, https://www.nytimes.com/2019/12/13/technology/autonomous-weapons-video.html.

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[11] We did not include the term "terminator" as an indicator of the frame invocation because it produced too many false positives. Nonetheless, it appeared in 71 articles within the frame, and may thus be considered a relevant term.

[12] For examples, see Daniel Susskind, *A World Without Work: Technology, Autonomation, and How We Should Respond* (New York: Metropolitan Books, 2020); Carl Benedikt Frey, *The Technology Trap: Capital, Labor and Power in the Age of Automation* (Princeton: Princeton University Press, 2020); Alana Semuels, "Millions of Americans Have Lost Jobs in the Pandemic—and Robots and AI Are Replacing Them Faster Than Ever," TIME, August 6, 2020, https://time.com/5876604/machines-jobs-coronavirus/; Kevin Drum, "You Will Lose Your Job to a Robot—and Sooner Than You Think," *Mother Jones*, November/December 2017, https://www.motherjones.com/politics/2017/10/you-will-lose-your-job-to-a-robot-and-sooner-than-you-think/; Associated Press, "Over 30 Million U.S. Workers Will Lose Their Jobs Because of AI," *MarketWatch*, January 24, 2019, https://www.marketwatch.com/story/ai-is-set-to-replace-36-million-us-workers-2019-01-24; Jacob Douglas, "These American Workers Are the Most Afraid of AI Taking Their Jobs," *CNBC*, November 7, 2019, https://www.cnbc.com/2019/11/07/these-american-workers-are-the-most-afraid-of-ai-taking-their-jobs.html; Tom Simonite, "Will AI Take Your Job—or Make it Better?," *WIRED*, December 16, 2019, https://www.wired.com/story/will-ai-take-your-job-or-make-it-better/; Don Reisinger, "AI Expert Says Automation Could Replace 40% of Jobs in 15 Years," *Fortune*, January 10, 2019, https://fortune.com/2019/01/10/automation-replace-jobs/; "Will AI Destroy

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[17] See, for example, Zeninjor Enwemeka, "Robots Won't Take Away All Our Jobs, MIT Report Finds," WBUR, September 10, 2019, https://www.wbur.org/bostonomix/2019/09/10/mit-future-of-work-report.

[18] For examples of this frame, see: Frank Holmes, "AI Will Add $15 Trillion to the World Economy by 2030," *Forbes*, February 25, 2019, https://www.forbes.com/sites/greatspeculations/2019/02/25/ai-will-add-15-trillion-to-the-world-economy-by-2030/; "Sizing the Prize: PwC's Global Artificial Intelligence Study: Exploiting the AI Revolution," PwC, https://www.pwc.com/gx/en/issues/data-and-analytics/publications/artificial-intelligence-study.html; Bernhard Warner, "Artificial Intelligence Could Be a $14 Trillion Boon to the Global Economy—If It Can Overcome These Obstacles," *Fortune*, October 9, 2019, https://fortune.com/2019/10/09/artificial-intelligence-14-trillion-boon-only-if-overcome-one-thing/; Jacques Bughin, Jeongmin Seong, James Manyika, Michael Chui, and Raoul Joshi, "Notes from the AI Frontier: Modeling the Impact of AI on the World Economy," McKinsey, September 4, 2018, https://www.mckinsey.com/featured-insights/artificial-intelligence/notes-from-the-ai-frontier-modeling-the-impact-of-ai-on-the-world-economy#part1; Karen Hao, "If You're Thinking about Embracing AI: Just Jump In," *MIT Technology Review*, March 27, 2019, https://www.technologyreview.com/2019/03/27/136310/if-youre-thinking-about-embracing-ai-just-jump-in/; Vinod Mahanta, "AI Can Make an Impact Like Electricity: Andrew Ng," *The Economic Times*, August 26, 2017, https://economictimes.indiatimes.com/opinion/interviews/ai-can-make-an-impact-like-electricity-andrew-ng/articleshow/60227045.cms; Jibu Elias, "Andrew Ng on the Role of AI in Economic Transformation," *INDIAai*, September 12, 2020, https://indiaai.gov.in/article/andrew-ng-on-the-role-of-ai-in-economic-transformation; Erik Brynjolfsson, Xiang Hui, and Meng Liu, "Artificial Intelligence Can Transform the Economy," *The Washington Post*, September 18, 2018, https://www.washingtonpost.com/opinions/artificial-intelligence-can-transform-the-economy/2018/09/18/50c9c9c8-bab8-11e8-bdc0-90f81cc58c5d_story.html; "Bane or Boon: Artificial Intelligence and the Workforce," France Stratégie, June 12, 2018, https://www.strategie.gouv.fr/english-articles/bane-or-boon-artificial-intelligence-and-workforce; Charles Mizrahi, "The Economic Impact of AI Projected to Be over $14

Trillion," Banyan Hill, January 24, 2019, https://banyanhill.com/economic-impact-ai-14-trillion/.

[19] Our analysis of individual and organization mentions uses LexisNexis "semantic metadata," which identifies references to these entities in article text. We disambiguated the references manually and similarly canonicalized the names of publication sources where they varied. For our analysis of organizations, we categorized them by hand as companies, universities, (other) non-profit organizations, international bodies, U.S. government entities, or foreign governments. The frames are not mutually exclusive, but the overlap is low. Where overlap occurred, we counted as two separate frame invocations. For example, 40 frame-invoking articles overlapped between the Competition frame and the Economic Gold Rush frame. In this case, we counted the overlap articles as 40 Competition frame articles and 40 Economic Gold Rush articles.

[20] We focus here on the positive cases of frame invocation, but future research could explore the use of natural language processing tools to characterize mentions of AI in media more broadly.

[21] "Concern & Support at First Committee," Campaign to Stop Killer Robots, October 27, 2015, https://www.stopkillerrobots.org/2015/10/unga-report/.

[22] Motoyama, "Inside the United Nations' Effort to Regulate Autonomous Killer Robots."

[23] Organizations were considered AI companies if they were included in the list of AI companies compiled in Zachary Arnold, Rebecca Gelles, and Ilya Rahkovsky, "Identifying AI-Related Companies: A Conceptual Outline and Proof of Concept" (Center for Security and Emerging Technology, July 2020), cset.georgetown.edu/research/identifying-ai-related-companies/.

[24] Some entities mentioned in articles were identified as non-organizations and were not included in this analysis; for this reason, percentages will not sum to 100.