Artificial Intelligence Analysis Applications

A Technology Primer

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TYPE	CHARACTERISTICS	RISK FACTORS
Platform Control and Information Support	Detectability Speed Precision	Vulnerable Clandestine Dual-use
DOMAIN	**COUNTRY**	
Cyber	United States	

- Artificial intelligence (AI) applications have the potential to significantly impact the strategic situational awareness (strategic SA) mission in two key areas—operations and analysis. While autonomous operations of platforms, sensors, and cyber strategic SA collection assets have their own sets of risks and benefits, which this project addresses in other primers, this primer focuses on the AI applications that enhance the strategic SA mission through improving analysis.
- AI analysis applications can enhance the strategic SA mission by employing data mining, data fusion methods, front-line analysis, and predictive analytics.
- Each of these methods of enhancing strategic SA has synergies with one another that build on each other and further enhance strategic SA. Taken together, these capabilities can unlock and increase the significant potential for *speed, precision,* and *persistence* inherent in the emerging strategic SA "ecosystem" without sacrificing *vantage* or *undetectability*. The *resilience/reliability* of these capabilities is dependent on both the resiliency of the collection platform or method and the reliability of the algorithms underlying the AI application.
- The potential for AI analysis tools to provide *predictive* and *preemptive* strategic SA could *enable actions* that undermine strategic stability. The *clandestine*, *vulnerable,* and *dual-use* nature of AI analysis applications could further undermine strategic stability by increasing the chance of misperception, miscalculation, and inadvertent escalation.

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Introduction

Political, military, and corporate leaders from around the world continue to highlight the significance of artificial intelligence (AI). After Canada became the first country to release its AI strategy in 2017, 18 countries have

followed suit in some capacity—nine have fully funded strategies, and nine have produced guiding documents.[1] The United States recently joined this group with the president signing an executive order that details a coordinated federal strategy regarding AI.[2] Despite substantial discussion and attention to the topic, there is no universal agreement on the definition of "artificial intelligence"; however, commentators broadly agree that AI is the scientific field concerned with algorithms and that it consists of several sub-disciplines. Since AI has applications for an incredibly large and diverse amount of commercial, military, and intelligence missions, some researchers have narrowed their analysis of AI by categorizing it as an enabling technology and comparing it to the steam engine or electricity.[3]

Thinking about AI as an enabling technology is especially useful for assessing AI's ability to enhance strategic situational awareness (strategic SA) missions and for understanding how enhanced strategic SA might affect strategic stability. At its core, the strategic SA mission requires collecting information and making sense of it. AI applications have the potential to significantly impact both of these key strategic SA mission components. In terms of collecting information, AI autonomy applications, such as autonomously operated platforms and sensors, are reshaping the nature and effectiveness of technical strategic SA collection tools. Meanwhile, AI applications for all-source data fusion, front-line analysis, and predictive analytics promise the potential to unlock new insights and effectively enhance strategic SA. While autonomous operations of platforms, sensors, and cyber SA collection assets have their own sets of risks and benefits, this primer focuses on the AI applications that enhance the strategic SA mission through improving analysis.

Due to the rapidly changing nature of the field, the meaning of the blanket term "artificial intelligence" is constantly evolving. Broadly speaking, AI is a field of study that encompasses several disciplines including machine learning, automated reasoning, natural language processing, knowledge representation, computer vision, and robotics.[4]

Much of AI's impact on strategic SA occurs through advances in a subset of machine learning known as "deep learning," Broadly speaking, any AI software application is comprised of a set of rules known as an algorithm. The software subsequently "runs" or employs the algorithm to process data. Advances in AI technology have moved beyond hardcoded "frozen" software to produce AI programs that can engage in deep learning with Artificial Neural Networks (ANNs) loosely inspired by mammalian neural networks.[5] Frozen software is limited by human knowledge. For example, although the IBM computer Deep Blue defeated chess master Gary Kasparov in a 1997 match, the IBM computer's software was hardcoded, and thus its victory occurred through "brute force." Today, AI research focuses on deep learning and the ability to learn and evolve without the constraints of human knowledge. Deep learning is a type of machine learning that employs "deep" neural networks. These

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[1] Tim Dutton, Brent Barron, and Gaga Boskovic, *Building an AI World: Report on National and Regional AI Strategies* (Toronto: Canadian Institute for Advanced Research, 2018), https://www.cifar.ca/docs/default-source/ai-society/buildinganaiworld_eng.pdf?sfvrsn=fb18d129_4.

[2] Darrell M. West, "Assessing Trump's artificial intelligence executive order", *Brookings Institution*, February 2019, https://www.brookings.edu/blog/techtank/2019/02/12/assessing-trumps-artificial-intelligence-executive-order/.

[3] Michael Horowitz, Artificial Intelligence, International Competition, and the Balance of Power," *Texas National Security Review* 1, issue 3 (May 2018): 36-57.

[4] Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach* (Upper Saddle River, New Jersey: Pearson Education Inc., 2010), 2-3.

[5] Robert Warren, "Artificial Intelligence and the Military," *RAND Corporation*, September 7, 2017, www.rand.org/blog/2017/09/artificial-intelligence-and-the-military.html.

networks have many hidden layers that operate between the input and output layers of the network.[6] They are a series of connections among artificial "neurons" that learn by adjusting the strength of the connections between the artificial neurons to "optimize the paths through the network to achieve a certain output."[7]

Figure 1.0 What Are the Disciplines Involved in AI?[8]

Discipline	Ability of a computer to...
Natural language processing (NLP)	Communicate successfully.
Knowledge representation	Store what it knows and hears.
Automated reasoning	Use stored information to answer questions and draw new conclusions.
Machine learning	Adapt to new circumstances and detect and extrapolate patterns.
Computer vision	Perceive objects.
Robotics	Manipulate objects and move about.

Source: Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach.

State of Play

The AI revolution is fully underway.[9] Although AI has been in development for decades, investment has skyrocketed since 2010.[10] Many analysts project the effects of the revolution on society to echo those that dramatically shaped society during the first and second industrial revolutions.[11] Due to the data-centric nature of AI, access to large volumes of data will be critical to AI advancement and advantage. Nations with access to computing resources, human capital, and access to large amounts of data are the most likely to thrive in the new AI-dominated age.[12]

Currently the United States and China lead the world in AI research; however, there are many other global actors investing in various areas of the AI field. In the United States, both private and public organizations

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[6] Paul Scharre and Michael C. Horowitz, *Artificial Intelligence: What Every Policymaker Needs to Know* (Washington, DC: Center for a New American Security, 2018), https://s3.amazonaws.com/files.cnas.org/documents/CNAS_AI_FINAL-v2.pdf?mtime=20180619100112.

[7] Ibid.

[8] Russell and Norvig, *Artificial Intelligence: A Modern Apporach,* 2-3.

[9] Ibid.

[10] Andrew P. Hunter, Lindsey R. Sheppard, Robert Karlén, and Leonardo Balieiro, *Artificial Intelligence And National Security: The Importance Of The AI Ecosystem* (Washington, DC: Center for Strategic and International Studies, 2018), https://csis-prod.s3.amazonaws.com/s3fs-public/publication/181102_AI_interior.pdf?6jofgIIR0rJ2qFc3.TCg8jQ8p.Mpc81X.

[11] Klaus Schwab, "The Fourth Industrial Revolution: what it means, how to respond," *World Economic Forum*, January 14, 2016, https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/.

[12] Scharre and Horowitz, *Artificial Intelligence: What Every Policymaker Needs to Know*.

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continue to develop AI analysis applications that could enhance strategic SA. For example, U.S. hedge fund Bridgewater Associates has publicly touted its development of an AI-enabled "coach," which essentially uses algorithms and predictive analytics to guide its analysts through decisions.[13] The U.S. Defense Department's research branch, the Defense Advanced Research Projects Agency (DARPA), has pledged to invest two billion dollars over the next five years to programs advancing AI.[14] In China, the Xi government has publicly prioritized investment in AI with the aim of Chinese global leadership in the field by 2030. The Chinese government has demonstrated its early advances in AI-enabled facial recognition technology through the domestic surveillance missions of its internal security services.[15] China's unique combination of critical resources, state-controlled businesses, weak civil liberties, and leadership focused on AI applications indicate that the nation will remain a leader in AI going forward. China is not alone among world powers in its quest to be a global leader in AI. Russian president Vladimir Putin prominently stated that dominating the AI sphere is a key to ruling the world.[16] While Putin's intentions for AI analysis applications are not as clear, the Russian military is heavily investing in AI applications for autonomous vehicles, claiming that thirty percent of its military force will be remotely controlled by 2030.[17] However, Russia's ability to actually meet its AI goals and become a global leader is questionable due to its own economic and financial limitations. While these three nuclear-armed powers continue to invest in AI applications, the building blocks of AI-enabled technologies—computing power, human capital, and large amounts of data—may offer an opportunity for traditionally weaker states with comparative advantages in these areas to increase their power on the world stage.

Despite the scramble for leadership in AI and the significant progress made in many applications of the technology, including image and speech recognition,[18] AI still has many limitations. AI analysis applications remain most effective at solving context-specific problems and have had very limited success in transferring that ability across fields.[19] Many leaders in the field share a quiet skepticism regarding AI's ability to continue

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[13] Rob Copeland and Bradley Hope, "The World's Largest Hedge Fund Is Building an Algorithmic Model From its Employees' Brains," *Wall Street Journal*, December 22, 2016, https://www.wsj.com/articles/the-worlds-largest-hedge-fund-is-building-an-algorithmic-model-of-its-founders-brain-1482423694.

[14] Drew Harwell, "Defense Department pledges billions toward artificial intelligence research," *Washington Post*, September 7, 2018, https://www.washingtonpost.com/technology/2018/09/07/defense-department-pledges-billions-toward-artificial-intelligence-research/?utm_term=.6d524affec1f.

[15] Louise Lucas and Emily Feng, "Inside China's surveillance state," *Financial Times*, July 20, 2018, https://www.ft.com/content/2182eebe-8a17-11e8-bf9e-8771d5404543.

[16] "'Whoever leads in AI will rule the world': Putin to Russian children on Knowledge Day," *Russia Today*, September 1, 2017, https://www.rt.com/news/401731-ai-rule-world-putin/.

[17] Tom Simonite, "For Superpowers, Artificial Intelligence Fuels New Global Arms Race," *Wired*, September 8, 2017, https://www.wired.com/story/for-superpowers-artificial-intelligence-fuels-new-global-arms-race/.

[18] Andrew P. Hunter, Lindsey R. Sheppard, Robert Karlén, and Leonardo Balieiro, "Artificial Intelligence And National Security: The Importance Of The AI Ecosystem," *Center for Strategic and International Studies*, November 2018, https://csis-prod.s3.amazonaws.com/s3fs-public/publication/181102_AI_interior.pdf?6jofgIIR0rJ2qFc3.TCg8jQ8p.Mpc81X.

[19] Andrew P. Hunter, Lindsey R. Sheppard, Robert Karlén, and Leonardo Balieiro, "Artificial Intelligence And National Security: The Importance Of The AI Ecosystem," *Center for Strategic and International Studies*, November 2018, https://csis-prod.s3.amazonaws.com/s3fs-public/publication/181102_AI_interior.pdf?6jofgIIR0rJ2qFc3.TCg8jQ8p.Mpc81X.

developing and believe that at some point, the field will hit a wall that cannot be breached with the current understanding of AI.[20] These experts contend that AI deep learning systems are not as sophisticated as they seem because they require large volumes of data for training but can't transfer what they learn to new contexts. Today's AI is what is known as "narrow AI" or AI that is concerned with one specific task but can't complete tasks beyond its specific field.[21] For example, a program that might understand how to pick up a cup needs to learn how to pick up a bottle—it can't simply extrapolate the knowledge it used to pick up the cup and apply it to a new situation.[22] Even without transferability issues, AI analysis applications have their own specific limitations and challenges when it comes to strategic SA. For example, J. Peter Scoblic highlights the dangers of spurious correlations, algorithms that reflect the bias of their programmers, and the "glut of data" that effectively decreases the signal-to-noise ratio.[23] While these issues represent problems to overcome, global actors are already using these AI analysis tools to enhance their strategic SA, and this usage appears only likely to increase in the future. Predicting the future progress of AI is difficult, but even if the basic science hits a hypothetical "wall," there are still numerous applications for existing AI, including in the strategic SA sphere.

Improvements for Strategic SA

AI applications can enhance the strategic SA mission by employing data mining, data fusion methods, front-line analysis, and predictive analytics. While each of these AI applications can enhance strategic SA, they can also be applied to situational awareness at other levels. Each of these methods of enhancing strategic SA also has synergies with one another that build on each other, as well as the non-AI capabilities of human analysts, and further enhance strategic SA. Taken together, these capabilities can unlock and increase the significant potential for *speed*[24]*, precision,* and *persistence* inherent in the emerging strategic SA "ecosystem," all without sacrificing *vantage* or *undetectability*. The *resilience/reliability* of these capabilities will be dependent on both the resiliency of the collection platform or method and that of the underlying algorithms.

Data Mining[25]

AI data mining applications can provide states with a new form of information that can be used to enhance the strategic SA mission. For example, the vast amounts of open-source and near open-source data available through traditional media sources, social media, and the growing Internet of Things (IoT) can provide new indicators relevant to strategic-level SA. In addition to providing a qualitatively new stream of strategic SA, this

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20 Jason Pontin, "Greedy, Brittle, Opaque, And Shallow: The Downsides To Deep Learning," *Wired*, February 2, 2018, https://www.wired.com/story/greedy-brittle-opaque-and-shallow-the-downsides-to-deep-learning/.

21 "What is Narrow, General and Super Artificial Intelligence," *TechTalks,* May 12, 2017, https://bdtechtalks.com/2017/05/12/what-is-narrow-general-and-super-artificial-intelligence/.

22 Jason Pontin, "Greedy, Brittle, Opaque, And Shallow: The Downsides To Deep Learning," *Wired*, February 2, 2018, https://www.wired.com/story/greedy-brittle-opaque-and-shallow-the-downsides-to-deep-learning/.

23 J. Peter Scoblic, "Beacon and Warning: Sherman Kent, Scientific Hubris, and the CIA's Office of National Estimates," *Texas National Security Review* 1, issue 4 (August 2018), https://tnsr.org/2018/08/beacon-and-warning-sherman-kent-scientific-hubris-and-the-cias-office-of-national-estimates/.

24 To learn how this project defines the italicized terms, please visit the *On the Radar* website glossary, https://ontheradar.csis.org/glossary.

25 While this capability probably fits more neatly into the category of AI enabled collection of strategic SA, we have included it in this primer because it is closely related to the other capabilities described in this primer.

capability represents an improvement in *precision*—the level of detail and quality of the information collected. Collecting large amounts of this open-source information quickly and cheaply enough to be useful for strategic SA is a resource challenge for traditional processes; however, advances in AI data mining applications can make this task efficiently achievable, an improvement in *speed*. This collection method extends the *vantage*, or range, from which states can collect strategic SA and this method is not particularly *detectable*.

Data Fusion

AI data fusion applications can rapidly integrate data from a variety of sources and provide new insights relevant to strategic SA. The modern SA ecosystem features an ever-growing and diversifying suite of sensors, each collecting different types of valuable data. Fusing this data can provide insights that were previously unknowable—an improvement in *precision*—without increasing the risk to any deployed collection assets—an improvement in *vantage*.[26] Despite these advantages, fusing diverse data from a myriad of different sources is expensive, time-consuming, and not always even possible when done by human operators and analysts. Using AI applications for this task not only reduces time and labor costs—improving *speed* by shortening the time required to detect adversary activity and respond to it—but it can also provide new insights that humans might miss. For example, the U.S. Air Force's "Data to Decision" program is using machines to shift thinking "to focus on the object in question" and look for "all data available" that may be relevant, including from "unstructured, open and national sources."[27]

Front-Line Analysis

AI pattern recognition applications can sift through the massive amounts of video, imagery, signal intercepts, and other technical intelligence collected by strategic SA assets and flag items of interest for intelligence analysts. While the technical collection capabilities exist to increase the *speed, precision,* and *persistence* of the strategic SA collected, the capability to make use of this strategic SA is limited by reliance on human analysts. By employing AI applications to conduct the initial "front-line analysis," human analysts can make use of the large data sets assembled by modern technical collection capabilities and potentially provide more accurate, timely, and enduring warning of strategic threats. Using front-line analysis could potentially allow for overarching trends, patterns, and anomalies to be extracted from a previously incoherent set of data, thereby producing insights that might have been previously glossed over at a more expedient rate. For example, the U.S. Department of Defense Project Maven uses this technique to identify objects in the massive amounts of video

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[26] Former U.S. National Geospatial-Intelligence Agency director Letitia Long pointed out that "[. . .] the targets and objects we seek to discover have weak signatures, that we cannot discover with any single intelligence domain. If we remain in our own INTs [intelligence stovepipes], these objects may always remain hidden, and when adversaries learn that they can hide their activities from us, they will become more adept at doing so." See Jan Sather, "The Tools of Intelligence Analysis Are Getting Smarter," *Stratfor - Worldview*, October 6, 2017, https://worldview.stratfor.com/article/tools-intelligence-analysis-are-getting-smarter.

[27] Patrick Tucker, "'Wouldn't It Be Great If We Could Shoot Someone in the Face at 200 Kilometers?'" *Defense One*, February 12, 2018, https://www.defenseone.com/technology/2018/02/us-air-forces-next-ai-project-about-kick-high-gear/145888/.

collected by small drones so that human analysts can focus their time on addressing anomalies.[28] Other examples of front-line analysis applications include language translation and even simple summaries of news events.[29]

Predictive Analytics

AI predictive analytics applications can be used by analysts to generate new hypotheses about adversary behavior and potential threats--improving *speed, precision,* and *persistence* without sacrificing *vantage*. Rather than an analyst training an AI analysis program to recognize certain patterns, as in front-line data analysis, in this case, the predictive analytics application ingests large amounts of data and suggests new patterns to the analyst. These applications promise the ability to discover previously unknown but strategically relevant anomalies through AI detection of new signatures by combing large amounts of data.[30]This could provide decisionmakers with a more accurate and timelier early warning because these insights would equip analysts with new indicators of strategic threats. These insights could also potentially assist analysts in tracking the locations of an adversary's strategic assets, even if those assets were mobile. Combining these tools could yield powerful results for strategic SA. For example, Predata is a private U.S. company that attempts to "parse open-source data and generate quantitative indicators of risk" by developing "machine-learning algorithms that [can] not only describe current security, political and financial trends, but [can] predict them as well."[31]

Impact on Strategic Stability

As an enabling technology, AI provides mechanisms for human analysts to better operationalize the full capabilities of the twenty-first century SA ecosystem. While this means that AI analysis applications can significantly enhance strategic SA, they also have the potential to dramatically impact strategic stability.[32] Improvements in *speed* and *precision* can strengthen stability by providing decisionmakers more time and clarity to make choices. However, the potential for AI analysis tools to provide *predictive* and *preemptive* strategic SA could *enable actions dual-use* nature of AI analysis applications could further undermine strategic stability by increasing the chance of misperception, miscalculation, and inadvertent escalation.

" As an enabling technology, AI provides mechanisms for human analysts to better operationalize the full capabilities of the twenty-first century SA ecosystem."

AI analysis applications are not inherently intrusive or destructive, though it is possible that they could take advantage of data collected by platforms that have these characteristics. Information garnered from the employment of AI analysis applications is vulnerable to countermeasures against, or failures of, both its collection platforms and the algorithms underlying

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[28] Marcus Geisberger, " The Pentagon's New Artificial Intelligence Is Already Hunting Terrorists," Defense One, December 21, 2017, https://www.defenseone.com/technology/2017/12/pentagons-new-artificial-intelligence-already-hunting-terrorists/144742/.

[29] Chris Baraniuk, "Would you care if this feature had been written by a robot?" *BBC*, January 30, 2018, https://www.bbc.com/news/business-42858174.

[30] Scharre and Horowitz, *Artificial Intelligence: What Every Policymaker Needs to Know*.

[31] "Our Team," *Predata.com*, https://www.predata.com/team/.

[32] Strategic stability is understood as the lack of incentive to use nuclear weapons (crisis stability) and the lack of incentives to build up a nuclear arsenal (arms race stability).

each application. While actors cannot keep the general existence of AI analysis applications secret, actors must ensure the security and integrity of both the data and the algorithms underlying each AI analysis application. Actors must keep the specifics of the algorithms clandestine to prevent manipulation of the algorithms by an adversary intent on disrupting the flow of strategic SA. Even without specific knowledge of the underlying algorithms, open-source research raises questions about the reliability of AI analysis applications to cope with unforeseen challenges or direct countermeasures. Understanding context is often an area where these sorts of applications struggle to perform properly. For example, one algorithm in testing grossly overestimated the number of anti-access/area-denial (A2/AD) batteries in North Korea because it lacked the cultural understanding that North Korean burial sites can look very similar to A2/AD batteries when viewed from overhead.[33] Furthermore, some researchers have demonstrated that even sophisticated algorithms can be tricked into misclassifying objects that would be easily recognizable to a human, raising the possibility that countries could design "AI camouflage" that would fool AI applications but not necessarily a human analyst.[34]

AI analysis applications provide strategic SA that is potentially *predictive*, *preemptive,* and *action-enabling.* In the most extreme case, the potential for the AI analysis applications described previously to enable rapid, precise, persistent, and undetectable strategic SA at range promises decisionmakers the ability to act preemptively against an adversary's strategic assets. In another example, this type of *predictive*, *preemptive,* and *action-enabling* strategic SA could allow a country to significantly improve its missile defense capabilities. In the short term, these actions could undermine crisis stability by enabling a potentially disabling first strike, and, in the long term, these actions could undermine arms race stability by encouraging the adversary to adjust their strategic force structure and posture to assure their second-strike capability. The fact that decisionmakers and analysts must make decisions based on information provided by AI analysis processes that may appear opaque or inexplicable to a human observer further increases the chance for miscalculation.

Even if AI analysis applications do not fully deliver this level of strategic SA about adversary assets and actions, perceptions about strategic SA capabilities like these can undermine strategic stability due to their *clandestine* nature. Since the specifics of these tools must remain secret, both actors involved may overestimate the effectiveness of the strategic SA provided by these AI analysis applications. In the short term, this lack of firm knowledge about an adversary's capabilities can lead to miscalculation or misperception and undermine crisis stability. In the long term, fears of an adversary's unknown capabilities can lead to changes in strategic force structure and posture, potentially undermining arms race stability.

Finally, AI analysis applications can negatively impact strategic stability because they are inherently *dual-use*. These tools are *dual-use* in two ways. First, they can provide situational awareness that is useful for both conventional, and nuclear missions. The conventional/nuclear *dual-use* nature of these capabilities could increase the chances of misperception and inadvertent escalation in a crisis. For example, the United States' use of anomaly detection algorithms to determine the locations of Chinese conventional mobile missile assets could cause the Chinese to feel less secure in their second-strike capability if those same algorithms could also plausibly be applied to locating Chinese mobile nuclear assets. Second, these tools are also *dual-use* because the underlying technology can be used in non-military contexts. Furthermore, the military/civilian *dual-use* nature will increase the number of actors capable of acquiring AI analysis capabilities, further complicating strategic stability dynamics.

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[33] This example was provided to the authors by CSIS imagery analysis expert Joseph S. Bermudez Jr.

[34] Alex Hern, "Shotgun shell: Google's AI thinks this turtle is a rifle," *Guardian*, November 3, 2017, https://www.theguardian.com/technology/2017/nov/03/googles-ai-turtle-rifle-mit-research-artificial-intelligence.

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