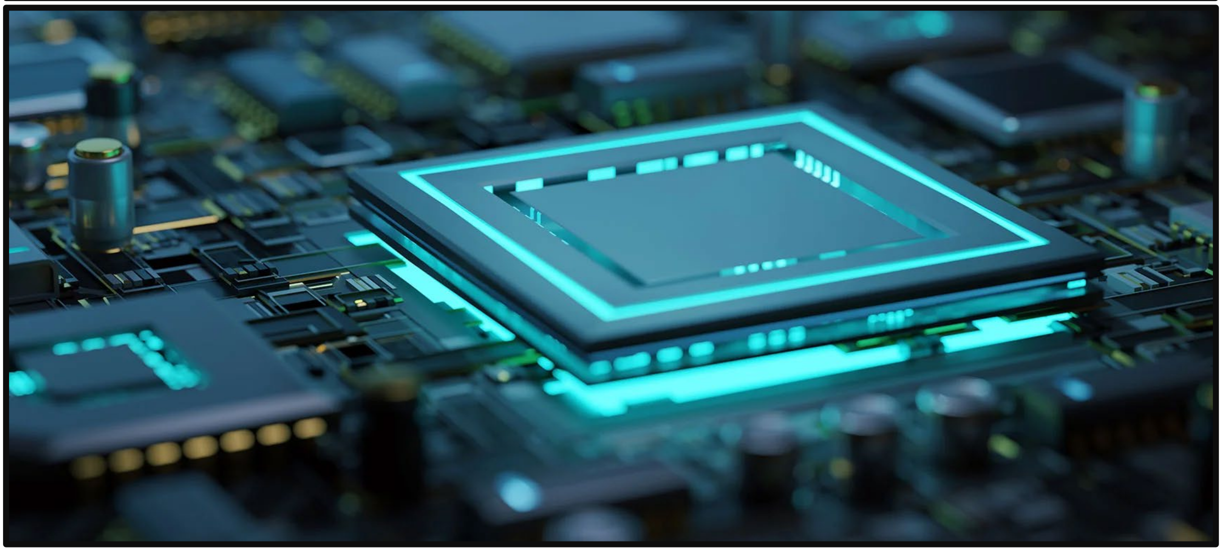
Science, Technology, and Global Security

PPOL 6100K, Spring 2023
Hong Kong University of Science and Technology



Date	**Class**	**PS**	**Exams**	**Team Project**	**Guest speaker**
07/02	Introduction: Science, Technology, and the Doomsday Risk				
14/02	Nuclear Weapons 1: Nuclear Fission Nuclear Weapons 2: Building the Bomb				
21/02	Nuclear Weapons 3: Nuclear Explosion Effects Nuclear Weapons 4: Nuclear Proliferation				
28/02	Bio 1: Biological and Chemical Weapons Bio 2: Risks and Ethics of Biotechnology	PS 1 due			King Chow
07/03	Bio 3: Dynamics of Infectious Disease				
14/03	Missile 1: Rocket Science: Principles of Ballistic Missiles	PS 2 due			
21/03	Missile 2: Ballistic Missile Defense			Group Project: Topics Selection	Li Bin
28/03	Digital 1: Semiconductors: The New Oil Digital 2: Quantum Technology	PS 3 due			
04/04	Arms Control 1: Nuclear Arms Control and Disarmament Arms Control 2: Cooperation in Nuclear Arms Control: From the Cold War to the U.S.-China Rivalry				Frank N. von Hippel
06/04 or 11/04			Midterm		
18/04	Digital 3: Cyberwarfare Technologies in the U.S.-China Relation				Tong Zhao
25/04	Digital 4: Machine Learning and Human-Level Artificial Intelligence Digital 5: Risks and Ethics of AI	PS 4 due			Dekai Wu
02/05	Team presentation				
09/05	Team presentation				

Course description

Advances in science and technology over the past century have created many unprecedented and still unresolved global security challenges for policy makers and the public. The invention of nuclear weapons during World War II led Einstein to conclude that "the unleashed power of the atom has changed everything save our modes of thinking." Security concerns and government-sponsored research programs later combined to shape the Cold War arms race between the United States and Soviet Union. Many military and technical innovations resulted; these include precision-guided intercontinental ballistic missiles, spy satellites, and global navigation satellite systems, but also the modern electronic computer and computer networks, which became the basis for the internet. Recent developments in biotechnology and digital communication and control raise the prospect of possible new kinds of warfare. Certain technologies, such as semiconductors or quantum computing, have become focal points of great power competition and are shaping major developments in geopolitics and international affairs.

This course will provide students with a basic technical understanding of some of the critical technologies that are relevant to national and global security and will equip them with the skills to better assess the challenge of developing effective policies to manage such technologies. Case studies will include nuclear weapons and their proliferation, delivery systems for weapons of mass destruction, biotechnology and biosecurity, cyberwarfare, semiconductors, quantum technologies, and human-level machine intelligence.

Contact

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Disclaimer

While most of the content is definitive, the schedule of this course might undergo minor modifications which will be communicated well in advance.
Some readings are already included and new one will be added soon.

Assignment and Breakdown of Grade

Problem sets are assigned on Tuesdays and are due for the next Tuesday, by the end of the day (00:00). They are graded over 100 points each. Outside of exceptional circumstances, late submissions are not accepted.

The midterm will be a 1:30 hours-long written test. More details will be given ahead of the exam.

The main deliverable for this course will be a final paper in the form of a policy memo that builds on a team project. In the team phase, groups of 3-4 students jointly develop the ideas and the overall scope for a comprehensive analysis on an issue related to this course, review the literature, and conduct basic research. Based on this original research, teams will write their final memos, where each individual student write one section of the memo exploring different dimensions of the topic. The overview will be presented by teams on May 2 and May 9, 2023. The final memos are due on May 19, 2023. More details will be given in due time. There is no final exam for this course.

Most readings and media required for this course are available online either directly or through HKUST library. Links are generally included below.

Breakdown of grade:

Problem sets: 30%
Midterm exam: 20%
Final memo: 30%
Team project presentation:10%
Attendance and participation:10%

Weekly Schedule and Readings

Date: 07/02

Introduction: Science, Technology, and the Doomsday Risk

Advances in science and technology have always played an important role in shaping the nature of warfare, but a fundamentally new dimension emerged with the invention of nuclear weapons in the 1940s and, as the nuclear arsenals expanded, the respective capability for nearly-instant global devastation. Since the end of the Cold War, many global security challenges have evolved. New technologies are now emerging that could again transform the conditions of global security. These developments can be disruptive (as with the invention of nuclear weapons) or gradual as with the increasing significance of autonomous weapons and artificial intelligence. Given their key roles for national security and power projection, these technologies have also become major focal points of great power competition and are shaping geopolitical developments. The dual-use nature of many relevant technologies further highlights the complexity of sound policy-making.

To set the stage for the topics and issues covered this semester, we will briefly explore the different types of security threats today, the perception and prioritization of relevant risks, current major geopolitical tensions related to technologies, and the resulting challenges for effective policy making.

Readings:

[Bulletin announcement coming soon]

7 views on how technology will shape geopolitics, World Economic Forum, April 2021, https://www.weforum.org/agenda/2021/04/seven-business-leaders-on-how-technology-will-shape-geopolitics/

Unit 1: Nuclear Weapons

Shortly after the discovery of nuclear fission in the late 1930s, it became clear that the process could, in principle, unfold in an explosive chain reaction and release large amounts of energy. At the time, it was unknown, however, just how hard it would be to make the fissile material (highly enriched uranium or plutonium) needed for a nuclear weapon. During World War II, the U.S. Manhattan project demonstrated the technical basis of large-scale fissile material production (including the feasibility of operating nuclear reactors) and led to the development and use of the first nuclear weapons in 1945. The Soviet Union demonstrated its nuclear capability in 1949, and military planners on both sides began to integrate these weapons into their war-fighting arsenals. The emerging arms race between the superpowers further escalated in scale with the invention of the hydrogen bomb, which would increase the yield of nuclear weapons several hundred-fold. The destructive effects of nuclear weapons remain unparalleled; they involve air blast, heat, and nuclear radiation.

Date: 14/02

Nuclear Fission

In this unit, we first briefly review basic knowledge on the structure of atoms. We then review the history of the scientific discovery of nuclear fission and other related breakthrough. Finally, we explore the principles of nuclear fission and the concept of a nuclear chain reaction.

Readings:

Henry Stimson (Secretary of War), *Memorandum Discussed with the President,* April 25, 1945, https://nsarchive2.gwu.edu/NSAEBB/NSAEBB162/3b.pdf

Jonathan Fetter-Vorm, Trinity: A Graphic History of the First Atomic Bomb, Hill and Wang, 2012. First 12 pages and then page 23 to 31.

Building The Bomb

This unit shows how the science of fission has been applied and weaponized to manufacture nuclear weapons. Key concepts such as critical mass are introduced. The production of fissile materials is then briefly reviewed. Finally, description on the basic principles and mechanisms of nuclear weapon designs is given.

Readings:

Jonathan Fetter-Vorm, Trinity: A Graphic History of the First Atomic Bomb, Hill and Wang, 2012. First 12 pages and then page 33-34.

Nuclear weapon design, Wikiwand.
https://www.wikiwand.com/en/Nuclear_weapon_design

Date: 21/02

Nuclear Explosion Effects

Throughout this class, we study the destructiveness of nuclear explosions, their impacts on human health and the possible consequences of a nuclear war. First, we derive the energy released through the fission of a critical mass. Then, a review of the various aspects of nuclear explosions and their effects is given. Finally, the lecture will give an overview of the possible dynamics of a nuclear war and of its humanitarian and ecological consequences.

Readings:

J. Robert Oppenheimer, Recollection of the Trinity Test ("Now I am become Death, the destroyer of worlds"), Television Broadcast, 1 min, 1965, http://www.youtube.com/watch?v=l8w3Y-dskeg

Alex Wellerstein, Tamara Patton, Moritz Kütt, Alex Glaser, and Jeff Snyder, Plan A, November 2017, www.youtube.com/watch?v=2jy3JU-ORpo

Victor Gilinsky, "What If Nuclear Weapons Are Used?," Bulletin of the Atomic Scientists, November 2016, https://thebulletin.org/2016/11/what-if-nuclear-weapons-are-used/

William Burr, "Cold War Estimates of Deaths in Nuclear Conflict," *Bulletin of the Atomic Scientists,* January 2023, https://thebulletin.org/2023/01/cold-war-estimates-of-deaths-in-nuclear-conflict/#post-heading

RETRO Report, "Nuclear Winter," The New York Times, April 4, 2016, Nuclear Winter - The New York Times (nytimes.com)

Nuclear Proliferation

Soon after the U.S. developed the first nuclear weapons in history, other major powers pursued their own nuclear programs. The non-proliferation regime was established to limit the spread of nuclear weapon technologies around the world. This class covers the historical perspective of nuclear proliferation since World War 2 until today. Since fissile materials production are the bottleneck of any attempts to develop nuclear weapons, this unit also covers technical and political aspects of this important part of a nuclear program. Finally, we review the dual use aspects of nuclear technologies and how this enables certain states to engage in clandestine nuclear military nuclear programs under the guise of peaceful program.

Readings:

Treaty on the non-proliferation of nuclear weapons, United Nations, 1968 (Effective 1970) https://www.un.org/disarmament/wmd/nuclear/npt/text

Harold A. Feiveson, Alexander Glaser, Zia Mian, and Frank von Hippel, "Production, Uses, and Stocks of Fissile Materials," Chapter 2 in *Unmaking the Bomb: A Fissile Material Approach to Nuclear Disarmament and Nonproliferation,* MIT Press, Cambridge, MA, 2014.

Scott Sagan, "Why Do States Build Nuclear Weapons? Three Models in Search of a Bomb," *International Security,* 21, Winter 1996/97, pp. 54–86. https://fsi9-prod.s3.us-west-1.amazonaws.com/s3fs-public/Why_Do_States_Build_Nuclear_Weapons.pdf

William J. Broad, David E. Sanger, and Troy Griggs, "The Nine Steps Required to Really Disarm North Korea," *New York Times,* June 11, 2018, https://www.nytimes.com/interactive/2018/06/11/world/asia/north-korea-nuclear-weapons-talks.html

Unit 2: Biological Weapons, Infectious Diseases, and Biotechnologies

Historical concerns over biological weapons were with state programs; this has now been supplemented by both the threat of terrorist use and, perhaps even more relevant, the extraordinary growth of biotechnology that places increasing potential power for dangerous biological modifications in the hands of the technically competent. Beyond the challenges of dealing with man-made pathogens, the Covid-19 pandemic has also shown us how vulnerable our societies are to zoonotic diseases. In this unit, we explore the fundamental principles of biological and chemical weapons and examine how dramatic advances in the life sciences affect policy options to address security risks and ethical issues associated with biotechnology. We will also work with simple models that describe the dynamics of infectious diseases and control options to mitigate an outbreak of such a disease.

Date: 28/02

Biological and Chemical Weapons

In this first session, we introduce the fundamental principles and effects of biological and chemical weapons. Since the 2001 anthrax-letter attacks (following 9/11), concerns over the possible development and use of biological weapons have shifted from state-sponsored programs to efforts that a non-state actor might be able to launch. Chemical weapons were primarily used during World War 1 on the battlefield by belligerent states and during World War II to harm civilians and commit genocide. Recent instances of chemical weapons use include states such as Iraq and Syria and terrorist groups. In this session, we review basic mechanisms of biological and chemical weapons, such as their effects on human organism and look at the historical policy approaches to manage them. We then examine how recent advances in biotechnology, especially the growing capabilities to sequence and synthesize DNA (including the DNA of pathogens) exacerbate these concerns.

Readings:

Jeanne Guillemin, "Introduction" and "Biological Agents and Disease Transmission," in *Biological Weapons: From the Invention of State-Sponsored Programs to Contemporary Bioterrorism,* Columbia University Press, 2006, pp. 1–39.

Organization for the Prohibition of Chemical Weapons, "What is a Chemical Weapon?", https://www.opcw.org/our-work/what-chemical-weapon#:~:text=A%20Chemical%20Weapon%20is%20a,the%20definition%20of%20chemical%20weapons.

Heidi Ledford, "CRISPR, The Disruptor," *Nature,* 522, June 4, 2015, pp. 20–24, https://www.nature.com/news/polopoly_fs/1.17673!/menu/main/topColumns/topLeftColumn/pdf/522020A.pdf

Sonia Ben Ouagrham-Gormley and Saskia Popescu, "The Dread and the Awe: CRISPR's Inventor Assesses Her Creation," *Bulletin of the Atomic Scientists,* March 8, 2018, https://thebulletin.org/2018/03/the-dread-and-the-awe-crisprs-inventor-assesses-her-creation/

Ali Nouri and Christopher F. Chyba, "Proliferation-resistant Biotechnology: An Approach to Improve Biological Security," *Nature Biotechnology,* 27 (3), 2009, pp. 234–236, https://www.nature.com/articles/nbt0309-234

Risks and Ethics of Biological Technology

The summary of this lecture will be available soon

Guest speaker: King Chow

Date: 07/03

Dynamics of Infectious Diseases

The effects of biological weapons can be greatly amplified if the disease caused by the agent is contagious and leads to an epidemic in the targeted population. In this session, we develop a simple mathematical model to describe the dynamics of infectious diseases ("SIR model") which enables us to assess the effects of a disease outbreak and the effectiveness of different control options. The COVID pandemic is taken as a case study and students will be asked to discuss the various COVID policies that different countries have implemented, including the recent policy change in China.

Readings:

Adam Kucharski, Chapters 1 and 2 in *The Rules of Contagion*, Basic Book, New York, 2020.

Saad-Roy et al. "Immune life history, vaccination, and the dynamics of SARS-CoV-2 over the next 5 years." *Science* 370, no. 6518 (2020): 811-818.
https://www.science.org/doi/10.1126/science.abd7343
SEE ALSO the companion online dynamic dashboard:
https://grenfelllab.shinyapps.io/sarscov2/

C. Jessica Metcalf and Justin Lessler, Opportunities and Challenges in Modeling Emerging Infectious Diseases, *Science,* 354 (6347), July 2017, pp. 149–152.

Benjamin Cowling, "The Impact of Ending 'Zero COVID' in China," *Nature,* January 2023.
https://www.nature.com/articles/d41591-023-00001-1

Smriti Mallapaty, "China COVID wave could kill one million people, models predict," *Nature,* December 2022. https://www.nature.com/articles/d41586-022-04502-w

Unit 3: Delivery Systems, Ballistic Missiles, and Missile Defenses

The importance of a delivery system for nuclear weapons has been recognized from the very beginning. In his famous 1939 letter to President Roosevelt, Einstein assumed that nuclear weapons would be powerful but gigantic and speculated that bombs would therefore have to be “carried by boat” and “might very well prove to be too heavy for transportation by air.” Nuclear warheads turned out much smaller, and delivery became possible not only by aircraft but also by ballistic missiles. The invention of the intercontinental ballistic missile equipped with guidance systems in the late 1950s and the development of de-facto invulnerable submarine-launched missiles critically shaped nuclear postures during the Cold War. The spread of missile technology continues to be a challenge for the nuclear nonproliferation regime. In this unit, we will review the basic phenomena and constraints underlying the delivery of warheads over intercontinental distances and the implications for nuclear strategy.

Date: 14/03

Rocket Science: Principles of Ballistic Missiles

The flight of a ballistic missile is uniquely determined by Newton's Laws of Motion, the presence of gravity, and the rocket equation. This lecture introduces the key concepts to determine the range of a ballistic missile and additional characteristics of a missile (such as payload and accuracy) that are relevant for its use as a delivery vehicle.

<u>Readings:</u>

Rocket Science: How Rockets Work – A Short and Basic Explanation:
https://www.youtube.com/watch?v=jI-HeXhsUIg&ab_channel=ScienceABC

What is an intercontinental ballistic missile:
https://www.youtube.com/watch?v=yB2JWd7AxFo&ab_channel=MilitaryTV

How hypersonic missiles work and the unique threats they pose – an aerospace engineer explains, *The Conversation*, https://theconversation.com/how-hypersonic-missiles-work-and-the-unique-threats-they-pose-an-aerospace-engineer-explains-180836

Date: 21/03

Ballistic Missile Defense

With the introduction of intercontinental ballistic missiles (armed with nuclear weapons) in the late 1950s, U.S. and Russian militaries immediately began to study the possibility of intercepting and destroying such an incoming missile or warhead before impact. Early concepts envisioned modifying existing surface-to-air missiles and equipping them with nuclear warheads that would detonate near the incoming weapon. More recent U.S. concepts rely on a hit-to-kill mechanism, which amounts to hitting a "one bullet with another bullet" in midair. All missile defense systems require radars (and often satellites) to acquire and track the incoming missile and the capability of the interceptor to maneuver. These are formidable technical challenges even when the adversary does not make an effort to defeat the defense system. There are a number of obvious countermeasures, however, and many of them are straightforward and inexpensive. They include warhead decoys, balloons (and warheads inside balloons), and radar-reflecting clouds of small wires ("chaff"). Despite these inherent difficulties and fundamental limits of missile defense systems, the United States has made extensive efforts to develop and deploy these systems. Ballistic missile defense is currently being advocated by its proponents as a viable response to North Korea's recent advances in missile and weapon capabilities. In this session, we will review the key concepts of ballistic missile defense, and examine the implications of these systems for strategic stability between the U.S. and China.

Readings:

Ballistic Missile Defense, Nuclear Threat Initiative.
https://www.youtube.com/watch?v=l4AJq4MqwwU&ab_channel=NuclearThreatInitiative

Li Bin, "China's Attitudes Toward Missile Defense And Its Limitation," *Bulletin of the Atomic Scientists,* 2018. (Available via HKUST library)

Guest Speaker: Li Bin

Group Project: Topic Selection

Unit 4: International Arms Control and Policy

How can we control, limit and perhaps eliminate existing nuclear arsenals? Since the beginning of the nuclear age, states have negotiated agreements to limit the dangers of nuclear war by placing limits on nuclear arsenals or even calling for the complete elimination of nuclear weapons. Bilateral arms control agreements between the United States and Russia have regulated, limited, reduced or even prohibited particular classes of weapons and remain a critical tool to support global security to the present day. In 2017, 122 non-nuclear weapon states agreed to a treaty for the prohibition of nuclear weapons ("The Ban Treaty"). The treaty, which entered into force on January 22, 2021, seeks the irreversible elimination of all nuclear weapons and establishes pathways for nuclear weapon states to join the treaty and verifiably dismantle their arsenals.

Date: 28/03

Arms Control and Disarmament

This lecture will discuss the state and future of bilateral and multilateral nuclear arms control, and the possible impact of the Ban Treaty on the future of disarmament politics.

Readings:

Timeline of US-Russia Nuclear Arms Control, 1949–2010, Council on Foreign Relations. https://www.cfr.org/timeline/us-russia-nuclear-arms-control

Daryl G. Kimball, "The Nuclear Ban Treaty: A Much-Needed Wake-up Call," *Arms Control Association,* November 2020. The Nuclear Ban Treaty: A Much-Needed Wake-Up Call | Arms Control Association

Andrew E. Kramer and Megan Specia, "What Is the I.N.F. Treaty and Why Does It Matter?," *The New York Times*, February 1, 2019. What Is the I.N.F. Treaty and Why Does It Matter? - The New York Times (nytimes.com)

Rose Gottemoeller. "Rethinking Nuclear Arms Control." The Washington Quarterly 43, no. 3 (2020): 139-159. (Available on HKUST library)

Cooperation in Nuclear Arms Control: From the Cold War to the U.S.-China Rivalry

The summary of this lecture will be available soon

Guest speaker: Frank N. von Hippel

Unit 5: Digital Technologies: From Semiconductors to Artificial Intelligence

The Digital Revolution starting in the middle of the 20th century has not only transformed our daily routine, but it has also revolutionized the ways states can project their power, make war, and defend against new threats. Many military-related technologies are now embedded in digital environment such as nuclear weapons and ballistic missiles which increases their level of control and automation but also render them more vulnerable to digital-based failures and cyber-attacks. Digital technologies are so ubiquitous that beyond states military toolkits, they are now pillars of our economy, information industry, communication tools or navigation systems. This has led states to leverage digital technologies to destabilize, influence, or infiltrate infrastructures and processes that are critical to the security of an adversary. Given their prominence in great power competition and in ensuring national security, knowledge, tools and resources necessary to develop, manufacture and control digital technologies have become new focal points of global geopolitical tensions. Major powers such China and the United States are competing for leadership in quantum computing, semiconductors or artificial intelligence and these tensions impact not only their relations but global affairs too. Finally, the advent of digital technologies, such as in Artificial Intelligence, pauses new interrogations and new risks for humankind as a whole.

Date: 04/04

Semiconductors: The New Oil

As oil and other fossil fuels were the fuel of technological revolutions from the 18th to the middle of the 20th century, semiconductors can be seen as the material fuel that underpins the digital world. Since their development in the late 50s, progress made on semiconductor technologies have directly impacted progresses in digital technologies. In recent decades the value chain of the semiconductor industry has expanded from the U.S. to many other countries, mostly in Western Europe and North-East Asia which has created interdependence in the development and manufacture of this crucial technology. However, competing powers such as the U.S. and China have recently enacted policies to reduce this interdependence in order to seek dominance in the sector. This class first reviews the technical aspects of semiconductors. In a second time, we map out the current network of the value chain and interdependence between countries in the semiconductor industry. Finally, the class explains the how current tensions between the U.S. and China are reflected in their policies to control this industry.

Readings:

The reading list will be available soon.

Quantum Technologies

The development of quantum physics in the 20th century has fundamentally changed the world. With the invention of the laser and the transistor, both straightforward applications of quantum theory, we have developed computers and the internet, which to a large extent shape today's society. We may now be on the brink of a second quantum revolution as we attempt to harness even more of the power of the quantum world. In 2012, the physics Nobel Prize was awarded to Serge Haroche and David Wineland "for ground-breaking experimental methods that enable measuring and manipulation of individual quantum systems." This work which took place in the 1980's has opened the path to new technological developments such as quantum computing, communication and sensors that could impact all sectors of society including national security. Significant hurdles need to be overcome, however, before large-scale impact can be achieved. In this session, we first explore the basics of quantum physics and introduce phenomena such as superposition, entanglement, the uncertainty principle, and decoherence that are central to the development of quantum technologies. We then cover briefly the current state-of-the-art technological development of new quantum technologies and discuss what could be their broader impact for society and policy.

Readings:

VIDEO, Talia Gershon, Quantum Computing Expert Explains One Concept in 5 Levels of Difficulty, WIRED (19 min). https://www.youtube.com/watch?v=OWJCfOvochA

Dylan Duan, "Quantum Technology: How It Works, Applications and Why The US and China Are Racing To Achieve Supremacy," *South China Morning Post, https://www.scmp.com/news/china/science/article/3161830/quantum-technology-how-it-works-applications-and-why-us-and*

Davide Castelvecchi, "Here's what the quantum internet has in store," *Nature*, 23 October 2018. https://www.nature.com/articles/d41586-018-07129-y

Daniel Garisto, "China Is Pulling Ahead in Global Quantum Race, New Studies Suggest," *Scientific American*, July 2021. https://www.scientificamerican.com/article/china-is-pulling-ahead-in-global-quantum-race-new-studies-suggest/

Michal Krelina, "Quantum Technology For Millitary Applications," *EPJ Quantum Technology*, 2021. https://epjquantumtechnology.springeropen.com/articles/10.1140/epjqt/s40507-021-00113-y

Date: 06/04 or 11/04

Midterm Exam

Date: 18/04

Cyberwarfare

The discovery in mid-2010 of "Stuxnet," a sophisticated computer worm developed by the United States and Israel to destroy uranium enrichment equipment in Iran brought into international focus the emerging strategic capabilities of cyberattacks, including the possibility of "kinetic" military action. In mid-2011, the White House released its own cyber-strategy, declaring that "when warranted, the United States will respond to hostile acts in cyberspace as we would to any other threat to our country." Many other countries are actively expanding their cyber capabilities. In this lecture, we will explore the fundamental elements of cyberwarfare, as far as they can be identified and anticipated today; consider the similarities and differences between cyberwarfare and "physical" warfare; and examine if and how traditional security concepts (including crisis stability, attribution, escalatory control, and minimization of collateral damage) and strategies apply to cyberwarfare.

Readings:

Fred Kaplan, "Could Something Like This Really Happen?," Chapter 1 in Dark Territory: The Secret History of Cyber War, New York 2016

David E. Sanger, "Left of Launch," Chapter 12 in The Perfect Weapon: War, Sabotage, and Fear in the Cyber Age, Crown, New York, 2018

Joseph Nye, "Deterrence and Dissuasion in Cyberspace," International Security, 41 (3), Winter 2016/2017. Deterrence and Dissuasion in Cyberspace | International Security | MIT Press

Technologies in the U.S.-China Relation

The summary of this lecture will be available soon

Guest speaker: Tong Zhao

Date: 25/04

Machine Learning and Human-Level Artificial Intelligence

Recent years have seen unprecedented progress in the field of machine learning, which gives computers the ability to learn from data. There are many (possible) applications of machine learning with applications that are (or could become) highly relevant for global security in both stabilizing and destabilizing ways. With regard to military applications, the pace of progress in machine learning has already led to an important debate about the possibility of autonomous weapons, which, once activated, would select and engage targets without further intervention by a human operator. Some experts consider this development inevitable; others consider it highly problematic and see autonomous weapons as violating principles of humanity. Looking further ahead, and currently in the realm of science fiction, there may be autonomous systems that match and eventually exceed human-level intelligence and achieve what some call "superintelligence." In this lecture, we first explore the fundamentals of machine learning and the security implications of these current and possible future developments in this area.

Readings:

Ben Buchanan and Taylor Miller, Machine Learning for Policymakers: What it Is and Why it Matters, Harvard Kennedy School, Cambridge, MA, June 2017. https://www.belfercenter.org/sites/default/files/files/publication/MachineLearningforPolicymakers.pdf

Grant Sanderson (3Blue1Brown), But What is a Neural Network?, 20 minutes, October 2017. https://www.youtube.com/watch?v=aircAruvnKk

E. Ackerman, "We Should Not Ban 'Killer Robots,' and Here's Why," IEEE Spectrum, July 29, 2015. https://spectrum.ieee.org/automaton/robotics/artificial-intelligence/we-should-not-ban-killer-robots

S. Russell, M. Tegmark, and T. Walsh, "Why We Really Should Ban Autonomous Weapons: A Response," IEEE Spectrum, August 3, 2015. https://spectrum.ieee.org/automaton/robotics/artificial-intelligence/why-we-really-should-ban-autonomous-weapons

Risks and Ethics of AI

The summary of this lecture will be available soon

Guest speaker: Wu Dekai

Date 02/05

Team Presentation 1

Date 09/05

Team Presentation 2