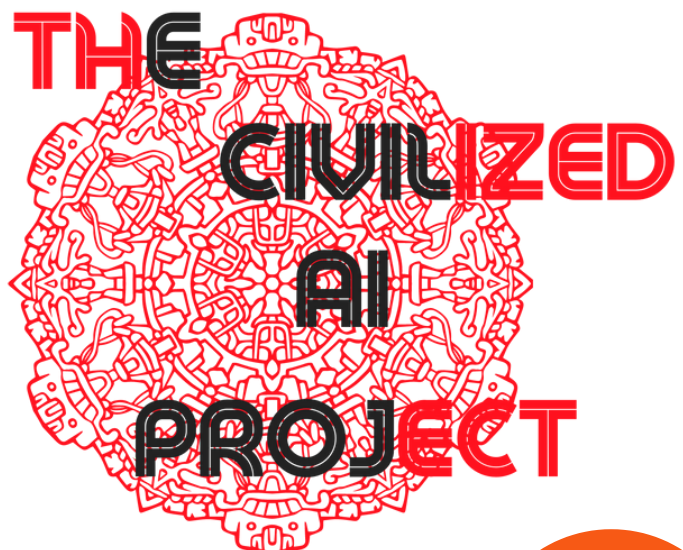


► **Policy Analysis**

# **AI and the Weaponization of Genetic Data**

**Dev Tejnani**



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# AI and the Weaponization of Genetic Data

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**Synopsis.** Policy Brief for the Civilized AI Project.

## 1 Introduction

In the year 2016, 2017, 2018 and 2019, genome editing was deemed to be regarded as a worldwide threat which marked a position in the annual Worldwide Threat assessment which was carried out by the United States of America Intelligence Community. Genome editing can be deemed to be regarded as one of the most promising developments which has been made in the field of biotechnology in recent years, however, it is also a huge threat. This threat was specifically cited by the US Intelligence and they deemed genome editing a threat to the US national security. It is imperative to understand what is meant by genome editing and why has the US regarding it as a national security threat.

“Genome editing”, means or deals with the tools and techniques that biotechnologists could use in order to change the genomes or edit the genomes, i.e. the DNA or the RNA of various plants, animals, and bacteria. There have been various technologies which have evolved over the years that have aided biotechnologists to edit genomes, however, the development of CRISPR in 2013, led to makeshift changes and changed the way the biotechnologists could edit genomes. It brought about significant development in the field of biotechnology, thereby improving the speed, cost, accuracy and efficiency of genome editing.<sup>1</sup>

CRISPR, or Clustered Regularly Interspersed Short Palindromic Repeats can be deemed to be regarded as an age-old mechanism which was used by biotechnologists. They basically used bacteria to remove viruses from their DNA. Various researchers came up with theories wherein they discovered that they could replicate this process if they created a synthetic RNA strand which could be matched with a target DNA sequence in a living organism’s genome. The researchers used this synthetic RNA strand which was also deemed to be regarded as a, “guide RNA” and attached this to an enzyme which could cut the DNA. After the guide RNA was able to locate the targeted DNA sequence, the enzymes which were to cut the DNA, could cut the genome at the very location where it was found. DNA could then be removed and a new DNA could

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<sup>1</sup> “How does Genome Editing Work?”- <https://www.genome.gov/about-genomics/policy-issues/Genome-Editint/How-genome-editing-works>.

be added to a living being. CRISPR can be deemed to be regarded as a powerful tool which has the ability to successfully edit genomes and it also has the capabilities to take on research on a broad range of plants and animals and at the same time it also has the capacity to take on research on humans.<sup>2</sup> It is imperative to understand that a large percentage of genome editing and the research pertaining to genome editing primarily focuses on aspects pertaining to the elimination of genetic diseases. However, with the advancements in technology and the development of tools like CRISPR, the alteration of pathogen's DNA has become possible and this means it could be more contagious and could spread like wildfire if left unattended by the researchers working on it. Furthermore, it is pertinent to note that the other potential uses of CRISPR include the various aspects pertaining to the formation of "killer mosquitoes and plagues that have the ability to wipe out staple crops, at the same time, it also the capabilities to develop a virus which could snip at an individual's DNA."<sup>3</sup>

However, the underlying question that arises here is whether genome editing really does deserve to be considered as a potential threat which could be deemed to be at par with nuclear weapons or cyber hacking. A number of members in the scientific community as also elucidated in the paper, enumerate upon how genome editing could be a dangerous invention. With advancements in the field of biotechnology, it is imperative to understand genome editing could destabilize the traditional risk equation in this field, however if it is used carefully then it cannot possibly pose a threat to the world, this however, does not mean that the misuse of genome editing and the advancements in the field of biotechnology is not a cause for concern. It is imperative to note that even if the technology pertaining to genome engineering of biological pathogens is used with utmost care and precision, it does not mean that such technology backed my sufficient research could be deemed to be regarded as something that can be converted into weapons or in simpler words, it is not necessary that such a technology could be easily weaponized. However, if a particular organization is striving to create a pathogen on purpose which is hazardous and could perhaps take innumerable lives, then under such circumstances if a country does not have enough resources to mitigate such a pathogen, then such a thing could be deemed to be regarded as the most dangerous creation of biotechnology.

## 2 Bio-warfare before Genome Editing

The advancements in technology and machine learning devices such as CRISPR have shown immense possibilities in the field of bio warfare, however, biological weapons have been the primary cause of concern of a lot of countries even before gene editing was developed or known. It is pertinent to note that the first time a biological pathogen was used as a means to attack and create a warfare weapon can be traced back to

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<sup>2</sup> "U.S. Scientists use CRISPR to Fix Genetic Disease in Human Embryos for the First Time."- <https://time.com/4882855/crispr-gene-editing-human-embryo/>

<sup>3</sup> "Top U.S. Intelligence Official Calls Gene Editing a WMD Threat- <https://www.technologyreview.com/2016/02/09/71575/top-us-intelligence-official-calls-gene-editing-a-wmd-threat>".

600 BC. It was during the 600 BC, when Solon, an Athenian statesman, used a pathogen to kill its enemies during the siege of Krissa. The statesmen poisoned the enemy water supplies. Another event which is pertinent to note, is when the Mongol Army during the siege of Caffa in 1346 AD, catapulted plague-infested corpses into the city, which also further led to the 14<sup>th</sup> Century Black Death Pandemic which claimed over two-thirds of Europe's population.

It is interesting to note that biological weapons were banned internationally by the 1925 Geneva Convention, however, the state bio warfare programs were still carried out in large numbers and at the same time, there was a huge increase in the number of cases, wherein countries resorted to the use of bioweapons and this took place during the second World War and the Cold War. However, in the year 1972, 103 nations signed and entered into the Biological Weapons Convention treaty when there was an uprise in the number of cases wherein biological weapons were used and countries found concrete evidence supporting their contentions with regards to the use of biological pathogens to kill enemies. The treaty enumerated specifically upon provisions which banned the creation and use of biological weaponry. It also aimed towards banning research activities pertaining to the formulation of defensive activities relating to the creation of biological arsenal, however defensive research activities were later made permissible. In fact, the Biological Weapons Convention (hereinafter referred to as the, "BWC") provides a condition which imposes a duty upon the signatories to submit information pertaining to the research that it carries out with regards to its biological research programs and this research needs to be submitted to the United Nations, and violations, if any, need to be reported to the UN Security Council, which may lead to an inspection, however, there is a catch here. The permanent members of the UN Security Council have the veto powers and they can veto the inspections. This just shows that there are no proper guidelines when it comes to the enforcement of an inspection over a particular country's biological research activities. Furthermore, the demarcation which separates the aspects of permissible defensive biological research from the offensive aspects is quite murky and at the same time it could be deemed to be regarded as a subject of controversy. It is pertinent to understand that the actual numbers with regards to the biological weapons produced by a particular country still remains unknown and a pathologist named Dr. Riedel was of the opinion that, "*the number of state-sponsored programs that have engaged in offensive biological weapons research, has increased significantly during the last 30 years.*"<sup>4</sup>

### 3 Multiple Uses

It can be said that biological warfare can be deemed to be regarded as a potential threat and it is going to remain a threat for a significant amount of time, however, genome editing technology on the other hand could hypothetically bring about

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<sup>4</sup> "Biological Warfare and bioterrorism: a historical Review, written by Stefan Riedel, MD, PhD, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1200679/>"

innumerable advancements and at the same time it could escalate things. Genome editing falls under the ambit of research and technology which can be deemed to be regarded as “dual use”- which means it has multiple uses and it also has the ability to create something phenomenal and at the same time it also has the ability to cause destruction. Genome editing can be deemed to be regarded as a technology which could open multiple avenues and it could enable a number of industries to flourish, however, the intention of the organizations making use of this genomic data will go a long way in determining whether the technology surrounding genomic data and genome editing would be a positive aspect or a negative aspect and ultimately the factor which determines whether an activity is positive or negative is the perspective of the individuals analysing it. A particular activity could be deemed to be regarded as a positive activity in the eyes of a few individuals, however it could pose as a negative activity to others.

It is imperative to note that genome editing could be used in order to make the world a better place to live in, for instance, genome editing could be used in order to curb the existence of disease-carrying mosquitoes or it could be used to make antibodies or medicines which could perhaps be developed in order to cure incurable diseases and this application or use of genomic data could be something which would be appreciated worldwide, however, certain cultures across the globe could perhaps consider this to be a sacrilegious practice and would probably strive to abolish it.

In order for the scientific community to accept that genome editing could be used for making the world a better place to live in, it is imperative for biotech scientists across the globe to come together and the scientific community together should find the key to the solution, by taking risks and indulging into discussions with regards to the research activities that it could carry out.

## 4 Genome Editing with Ease

A growing concern that arises here pertains to individuals who are not scientists. These individuals could take up dangerous research activities by themselves in the field of genome editing since there are a number of “do-it-yourself” (DIY) genome editing kits which are easily available on the market and these kits are priced relatively low, which could enable anyone, anywhere to edit the DNA<sup>5</sup> of an individual or of an organism using the CRISPR technology. However, what is unknown at present is whether these kits could be deemed to be regarded as a potential security threat or not and these threats could be evaluated based on two major criteria which are- the likelihood and the potential impact that such a kit may pose. Whether the “highest” or the “greatest” risks lie will entirely depend upon these two aspects or criteria.

If one takes risk as a factor when it comes to fathoming the likelihood of impact, the most known or predictable attacks could be made by the low-powered actors and this impact may not be quite significant and may perhaps be based on traditional

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<sup>5</sup> “Mail-Order CRISPR Kits Allow Absolutely Anyone to Hack DNA- <https://www.scientificamerican.com/article/mail-order-crispr-kits-allow-absolutely-anyone-to-hack-dna/>”

approaches, with the help of DNA pathogens that are already prevalent or existent and under such circumstances the risks could easily be characterised or assessed. DIY Genome editors could experiment on a large number of aspects and their research may be broad, however, it is quite unlikely that they would be able to produce a biological agent which could have the capacity to cause widespread havoc. However, what could actually be deemed to be regarded as a serious threat is when companies or organizations that have the power and the resources to carry out a sophisticated and technical analysis, put their resources into genome editing. A lot of biotech companies have the requisite resources and may also possess the technological competence that is required for a firm to excel in the field of bio warfare weapon manufacturing, however, it is pertinent to note that such resources are not easy to acquire at present, however, such a threat is still something that governments and countries need to assess and look out for.

## 5 Bioweapon Programs

A lot of countries are carrying out state-wise programs wherein they are striving towards creating a large-scale bioweapon armoury and this could be a huge threat, perhaps a double threat since there always arises the possibility of an accidental release of such technology which could then be misused by organizations or individuals in order to carry out their malicious activities. It is imperative to throw light upon the fact that the accidental release of such technological formulas has previously led to certain malicious activities being carried out by certain countries. In the year 1979, there was an accidental release of aerosolized anthrax by the Sverdlovsk (now Ekaterinburg) bioweapons production facility which is based in the Soviet Union. An air filter which was clogged was removed by the maintenance team, however, the same was not replaced and this caused a huge havoc. Somewhere around ninety-four people were affected by this accidental release of aerosolized anthrax and approximately sixty-four individuals out of the ninety-four died along with a number of livestock.<sup>6</sup> The Soviet Secret Police played an active role in covering up the tracks pertaining to the outbreak of the aerosolized anthrax, however, years later the Soviet Union Administration took responsibility and admitted the real cause of the outbreak. Similarly, a facility under the control of the US biodefense “failed to kill the anthrax that it allegedly sent out with the hope to carry out various lab trials, however, the facility in turn ended up sending a really devastating anthrax around the globe.” Luckily, no individual was infected by this deadly anthrax and in 2015, a government investigation<sup>7</sup> uncovered that over the course of the last ten years, “approximately 86 facilities situated in the United States and seven other

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<sup>6</sup> “The 1979 Anthrax Leak in Sverdlovsk-  
[https://www.pbs.org/wgbh/pages/front/shows/plague/sverdlovsk./](https://www.pbs.org/wgbh/pages/front/shows/plague/sverdlovsk/)”

<sup>7</sup> US Department of Defence Archives- “[https://www.defense.gov/Portals/1/features/2015/0615\\_lab-stats/Review-Committee-Report-Final.pdf](https://www.defense.gov/Portals/1/features/2015/0615_lab-stats/Review-Committee-Report-Final.pdf)”.



countries, in turn, received low concentrations of live anthrax and spore samples, which were assumed to have been completely deactivated.”<sup>8</sup>

These incidents fall nowhere in comparison to the activities carried out by Japan. In the 1930 and 40’s, Japan intentionally used biological weapons and approximately 30,000 people were killed in China by the biological weapons used by Japan and this incident took place during the period of the second World War. The Japanese wanted to perhaps only target a few villages based in China, however, the technology wasn’t quite advanced back then and the Japanese had no clue as to how to control the spread of the epidemic which it had caused. In fact, there are a number of reports which insinuate that as a result of the release made by the Japanese Army, a number of Japanese soldiers of the Japanese Army were themselves affected by the biological weapon that it had unleashed and were severely infected in the biological massacre caused by Japan in the year 1941.<sup>9</sup> Despite there being a ban imposed upon the production of biological weapons, a lot of countries are making use of the advancements and developments in the field of Artificial Intelligence and Machine Learning and are conducting research and manufacturing of genome based biological weapons. In fact, it is rumoured that the Soviets are making a complete use of AI in order to carry out research and are using tools that would answer key questions pertaining to the capabilities that a country needs to possess in order to make biological weapons. The BWC only prohibits offensive research, however, under the garb of a defensive program, an individual or an organization with the help of machine learning input genetic data into its system and carry out a full-fledged research and development program which would enable it to figure out what devices it could make in order to develop its biological weaponry. After carrying out the requisite research, a country solely needs to have the capacity to scale up the production levels quickly if it wishes to have an upper edge over other countries. It is rumoured that the Soviets have built “a set of state-based commercial infrastructure which would enable it to make vaccines” and it has been carrying out such activities on a daily basis, however they could very easily shift their resources from making vaccines to making weapons which could be used to stock up their bio weapon armoury. In fact, a lot of countries have been rumoured to carry out such secret operations and a lot of scientists and biotechnologists are of the opinion that countries do have the requisite powers to build something in order to accelerate its growth in the field of bio weapons, in fact this has been made possible due to the constant advancements in the field of Artificial Intelligence. CRISPR technology is one such example and it has proven to be highly effective and certain countries are very well making use of this technology along with its own research, however, a few countries have a fully prepared and properly set-out biological weapons program which it could use and unleash it into the real world, however, they need to first develop a way to turn their existing infrastructure towards a weapons program if they aspire to develop further in this field. However, what is

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<sup>8</sup> US Department of Defence Archives- “[https://www.defense.gov/Portals/1/features/2015/0615\\_lab-stats/Review-Committee-Report-Final.pdf](https://www.defense.gov/Portals/1/features/2015/0615_lab-stats/Review-Committee-Report-Final.pdf)”.

<sup>9</sup> “Biological Warfare and bioterrorism: A historical Review, written by Stefan Riedel, MD, PhD, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1200679/>”

pertinent to note here is that all these components would in fact be permissible under the provisions of the current international law regime.

## 6 Biological Weapons Convention

It can be said that the reality with regards to the fact that bioweapons can be used and developed is quite unsettling and raises innumerable questions with regards to the efficacy of the Biological Weapons Convention. The fact that there exists a ban on biologically generated weapons is something which is certainly the need of the hour, however, a number of countries are secretly working and carrying out research activities in this field since Machine learning and artificial intelligence has reached its zenith and with the help of these technologies, biotechnologists have been able to develop computer algorithms that improve with experience and research. These algorithms are specifically designed in order to help biotechnologists analyse huge sets of data pertaining to genomic sequencing. Machine learning algorithms have been proven to be useful when it comes to analysing large sets of genomic sequencing data. It is imperative to understand that supervised learning methods which specifically deal with gene identification requires biotechnologists to input labelled DNA sequences which enable them to identify the start and end locations pertaining to a particular gene. Furthermore, the algorithm is coded in a way which enables the model to identify and understand the general properties of the genes and it helps the scientists or the biotechnologists to understand the DNA sequencing patterns and the locations of the stop codons. After this, the model learns and understands properties which enables it to automatically analyse additional genes from the data sets which have been provided to it and therefore it resembles the genes in the training patterns that have been embedded into the system. The BWC does not prohibit all of these activities and research is very well allowed under the provisions of the BWC which certainly motivates organizations to take advantage of the loopholes which persist.

Furthermore, for deep learning algorithms to function in a proper and systematic manner, loss functions (which show how a prediction can be deemed to be regarded as accurate) and risk functions (which show the average loss incurred when the system is put to test) are taken into consideration within the model of the system to adjust for the false predictions that the algorithm may make. In fact, when data which is essential to carry out test runs is not available, unsupervised learning methods are adhered to and these methods could be used to discover genes of interest and also it would help a scientist in understanding other important information pertaining to a sequenced genome.

However, it is necessary to understand that the ban on biological weapons was somewhere down the line motivated by the ban which was imposed on chemical weapons, however, chemical weapons and biological weapons were traditionally dealt with together and the 1925 Geneva Protocol was one piece of document which banned the usage of both, however, the ban on Chemical Weapons was eventually dropped from the BWC after the original proposal for the BWC was submitted by the UK in the year 1969. It is therefore necessary to understand that biological weapons, if used in a proper



sense and if domestic laws in each country are developed regulating the acts of biotechnologists and the companies involved in the research pertaining to biological weapons, then biological weapons could be the next thing forward.

The secrecy surrounding the discoveries and the research of biological weapons programs has led countries to carry out their own research. Interestingly, before the World War I, the British started carrying out research in the field of bioweapons, subsequently the Germans became aware of this and they started funding their own research in the field of bioweapons, however, during the pendency of the war, the British stopped pursuing their research and this fact was unknown to the Germans and the Germans therefore went on researching and began making bioweapons under the garb of keeping its attempt to win over its competitors. By the time the Second World War started, Germany had no inventories of bioweapons left, however, its allies were of the opinion that Germany still possessed bioweapons and this led to the United States commissioning its Defence wing to begin research on bioweapons.

## 7 Conclusions

Genome editing could be deemed to be regarded as a “game changer” when it comes to bioweapons, however, it is something which could be deemed to be regarded as an enabling technology only for short to medium term and perhaps in the long term as well, however, there arises the risk of it being used for bio warfare, however, at present, the impact that it has on countries, makes it an innovation which is faster, cheaper and at the same time reliable and plus it somewhere brings back the traditional approach, but it is imperative to understand that with the advancements in artificial intelligence and machine learning, biotechnology is ought to evolve and so will bio warfare. Machine learning is something which is quite complex and algorithms could be made in a way which could change the way a particular data set is analysed. However, the method of machine learning that biotechnologists adhere to will depend on the nature and the characteristics of the data set that is available to them and at the same time it will also depend upon the aim and the purpose that biotechnologists have behind generating or developing such pathogens. For instance, it will become feasible for governments to test and alter specific sets of genes in their populations and imagine the government striving towards making an aerosolizing genome editor which could specifically knock out genes which are harmful for a population, however, it may also have its repercussions.