# Machine Learning Security Survey

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Abstract—Machine learning has experienced a significant growth in usage over the past few decades. Due to its data-centric approach in modeling, machine learning has seen use in a variety of subfields in computer science. In particular, researchers have been interested in incorporating machine learning into the domain of cybersecurity, utilizing it from the perspective of an adversary or ally. Researchers have also been concerned with the security state of current machine learning models. This survey paper provides a comprehensive overview of the state of machine learning, its application in various aspects of cybersecurity, securing machine learning systems, and future research directions being explored.

Index Terms—Neural networks, security, classification

## I. Introduction

With the increasing widespread adoption of machine learning technology, its usage is being observed in a variety of different fields. Some notable examples include image recognition, voice assistant technologies, email spam filters, and search engines. Much of its recent popularity can be attributed to the availability of frameworks such as tensorflow, allowing people of almost any background to quickly draft a machine learning application.

However, one growing concern tied to the ubiquity of machine learning is its accessibility to adversaries. Based on the assessment of current and prior research, there are a number of vulnerabilities in current machine learning models which can be exploited with little knowledge of a system's domain. In addition, attackers have been able to leverage machine learning technology to assist the deployment of cyberattacks. Enterprise machine learning applications may often contain large datasets of important information, becoming a potential candidate of a targeted attack. This paper will survey the domain of cybersecurity with regard to machine learning. This topic will explore the fundamentals of machine learning, current vulnerabilities in machine learning systems, machine

learning technology from the perspective of adversaries, and future research directions.

## II. OVERVIEW

This section will introduce the fundamentals of machine learning. Additionally, there will be a discussion about the key terms used by members of the community.

## A. Machine Learning Basics

Traditionally, when software developers are tasked with solving a problem, they use a combination of rules and logic to find a solution. The basic routine consists of finding appropriate input values, creating the logic and rules to process the input, and producing the appropriate output. The traditional approach to software development allows for fine-tuned control of program behavior to achieve the solution. However, this approach does not scale with the complexity of additional rules and/or possible solutions. An example is image classification, where the logic needed to compare images is complex. This becomes a bigger concern when new classifications need to be derived with new image data. Machine learning flips the traditional programming paradigm on its head, by taking a series of solutions as input, and letting the machine develop the rules by detecting patterns in the solutions. The result is a neural network, the mathematical model capable of making decisions on newly supplied data. This approach relies on large sets of well-defined data, and has the flexibility for being used in many different applications.

Briefly mentioned earlier, a common use case for machine learning is *classification*, where a dataset is categorized into different groups based on one or more *features*. A *feature* is defined as some measurable property or characteristic being observed in a dataset. There are several types of classifications, including *binary classification*, *multi-class classification*, & *multi-label classification*. *Binary classification* categorizes data based on whether a feature is present or not, resulting in

an outcome of true or false. *Multi-class classification* categorizes data into different groups, where each data instance is assigned according to its feature. *Multi-label classification* categorizes data into different groups, where each data instance is assigned according to its expression of on or more features.

Training is the process of teaching a machine learning model to detect patterns in datasets. There are two types of training mechanisms, supervised training and unsupervised training. Supervised training requires each data instance to have one or more labels, defining which category or feature it expresses. In contrast, unsupervised training omits the need for labels, and the machine learning model will categorize datasets on its own.

TODO: Talk about supervised vs. unsupervised training & validation

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Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, ac, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

## B. Units

- Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) English units may be used as secondary units (in parentheses). An exception would be the use of English units as identifiers in trade, such as "3.5-inch disk drive".
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$$a + b = \gamma \tag{1}$$

Be sure that the symbols in your equation have been defined before or immediately following the equation. Use "(1)", not "Eq. (1)" or "equation (1)", except at the beginning of a sentence: "Equation (1) is . . ."

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## E. Some Common Mistakes

- The word "data" is plural, not singular.
- The subscript for the permeability of vacuum  $\mu_0$ , and other common scientific constants, is zero with subscript formatting, not a lowercase letter "o".
- In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
- A graph within a graph is an "inset", not an "insert".
   The word alternatively is preferred to the word "alternately" (unless you really mean something that alternates).
- Do not use the word "essentially" to mean "approximately" or "effectively".
- In your paper title, if the words "that uses" can accurately replace the word "using", capitalize the "u"; if not, keep using lower-cased.
- Be aware of the different meanings of the homophones "affect" and "effect", "complement" and "compliment", "discreet" and "discrete", "principal" and "principle".
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- The abbreviation "i.e." means "that is", and the abbreviation "e.g." means "for example".

An excellent style manual for science writers is [7].

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a) Positioning Figures and Tables: Place figures and tables at the top and bottom of columns. Avoid placing them in the middle of columns. Large figures and tables may span across both columns. Figure captions should be below the figures; table heads should appear above the tables. Insert figures and tables after they are cited in the text. Use the abbreviation "Fig. 1", even at the beginning of a sentence.

TABLE I
TABLE TYPE STYLES

Table	Table Column Head		
Head	Table column subhead	Subhead	Subhead
copy	More table copy <sup>a</sup>		

<sup>a</sup>Sample of a Table footnote.

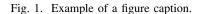


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## REFERENCES

Please number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use "Ref. [3]" or "reference [3]" except at the beginning of a sentence: "Reference [3] was the first ..."

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Unless there are six authors or more give all authors' names; do not use "et al.". Papers that have not been published, even if they have been submitted for publication, should be cited as "unpublished" [4]. Papers that have been accepted for publication should be cited as "in press" [5]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

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