

Date of publication xxxx 00, 0000, date of current version xxxx 00, 0000.

Digital Object Identifier 10.1109/ACCESS.2017.1000

# Novel Evasion Attacks against Adversarial Training Defense for Smart Grid Federated Learning

ATEF H. BONDOK<sup>1</sup>, MOHAMED MAHMOUD<sup>2</sup>, (Senior Member, IEEE), MAHMOUD M. BADR<sup>3</sup>, MOSTAFA M. FOUDA<sup>4, 5</sup>, (Senior Member, IEEE), MOHAMED ABDALLAH<sup>6</sup> and MAAZEN ALSABAAN<sup>7</sup>

<sup>1</sup>The Department of Electrical and Computer Engineering, Tennessee Tech. University, Cookeville, TN 38505, USA, and the Department of Electrical Engineering, Faculty of Engineering, Al-Azhar University, Cairo 11631, Egypt (e-mail: albondok42@ieee.org)

<sup>2</sup>The Department of Electrical and Computer Engineering, Tennessee Tech. University, Cookeville, TN 38505, USA (e-mail: mmahmoud@ieee.org)

<sup>3</sup>Department of Network and Computer Security, College of Engineering, SUNY Polytechnic Institute, Utica, NY, USA.

<sup>4</sup>Department of Electrical and Computer Engineering, College of Science and Engineering, Idaho State University, Pocatello, ID 83209, USA.

<sup>5</sup>Center for Advanced Energy Studies (CAES), Idaho Falls, ID 83403, USA.

<sup>6</sup>Mr. Abdallah is with Hamad Bin Khalifa University (HBKU), Al-Doha, Qatar. (e-mail: mabdallah@hbku.edu.qa).

<sup>7</sup>Department of Computer Engineering, College of Computer and Information Sciences, King Saud University, Riyadh 11451, Saudi Arabia.

Corresponding author: Mohamed Mahmoud (e-mail: mmahmoud@ieee.org).

**ABSTRACT** In the advanced metering infrastructure (AMI) of the smart grid, smart meters (SMs) are deployed to collect fine-grained electricity consumption data, enabling billing, load monitoring, and efficient energy management. However, some consumers engage in fraudulent behavior by hacking their meters, leading to either traditional electricity theft or more sophisticated evasion attacks (EAs). EAs aim to illegally reduce electricity bills while deceiving theft detection mechanisms. The current methods for identifying such attacks raise privacy concerns due to the need for access to consumers' detailed consumption data to train detection mechanisms. To address privacy concerns, federated learning (FL) is proposed as a collaborative training approach across multiple consumers. Adversarial training (AT) has shown promise in countering evasion threats on machine learning models. This paper, first, investigates the susceptibility of traditional electricity theft classifiers trained by FL to EAs for both independent and identically distributed (IID) and Non-IID consumption data. Then, it investigates the effectiveness of AT in securing the global electricity theft detector against EAs, assuming no misbehavior from the participant consumers in the FL process. After that, we introduce three novel attacks, namely *Distillation*, *No-Adversarial-Sample-Training*, and *False-Labeling*, which can be launched during the AT process to make the global model susceptible to evasion at inference time. Finally, extensive experiments are conducted to validate the severity of these proposed attacks. Our findings reveal that the AT can counter EAs effectively when the FL participants are honest, but it fails when they act maliciously and launch our attacks. This work lays the foundation for future endeavors in exploring additional countermeasures, in conjunction with AT, to bolster the security and resilience of FL machine learning models against adversarial attacks in the context of electricity theft detection.

**INDEX TERMS** Security, Evasion attacks, Federated learning, and Smart power grid.

## I. INTRODUCTION

The integration of communication and computing resources in the smart grid has brought about a significant transformation in traditional power delivery methods [1]. By employing various techniques to gather, process, and manage information, the smart grid has greatly improved the intelligence of power systems, leading to enhanced efficiency, reliability, sustainability, and cost-effectiveness [2]. A crucial element of the smart grid is the Advanced Metering Infrastructure

(AMI), which enables real-time monitoring of electricity consumption through communication between the electric utility (EU) and smart meters (SMs) installed at consumers' houses. This functionality enables dynamic billing, load monitoring, and grid management, granting greater control and optimization of the power systems [3].

Despite the numerous benefits associated with smart grids, they encounter various challenges, one of which revolves around the problem of electricity theft. This occurs when

# Evasion Line A Novel

**Yan Bai**



## **Evasion Line A Novel:**

## Enjoying the Beat of Phrase: An Emotional Symphony within **Evasion Line A Novel**

In some sort of used by displays and the ceaseless chatter of instantaneous transmission, the melodic beauty and emotional symphony produced by the written term often fade into the backdrop, eclipsed by the persistent sound and distractions that permeate our lives. But, set within the pages of **Evasion Line A Novel** a marvelous fictional treasure filled with fresh thoughts, lies an immersive symphony waiting to be embraced. Crafted by a masterful musician of language, that captivating masterpiece conducts readers on a mental trip, well unraveling the hidden songs and profound impact resonating within each carefully crafted phrase. Within the depths of this moving review, we can explore the book is main harmonies, analyze its enthralling publishing design, and surrender ourselves to the profound resonance that echoes in the depths of readers souls.

[http://www.pet-memorial-markers.com/About/scholarship/Download\\_PDFS/essential\\_dermatopathology.pdf](http://www.pet-memorial-markers.com/About/scholarship/Download_PDFS/essential_dermatopathology.pdf)

### **Table of Contents Evasion Line A Novel**

1. Understanding the eBook Evasion Line A Novel
  - The Rise of Digital Reading Evasion Line A Novel
  - Advantages of eBooks Over Traditional Books
2. Identifying Evasion Line A Novel
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Evasion Line A Novel
  - User-Friendly Interface
4. Exploring eBook Recommendations from Evasion Line A Novel
  - Personalized Recommendations
  - Evasion Line A Novel User Reviews and Ratings

- Evasion Line A Novel and Bestseller Lists
- 5. Accessing Evasion Line A Novel Free and Paid eBooks
  - Evasion Line A Novel Public Domain eBooks
  - Evasion Line A Novel eBook Subscription Services
  - Evasion Line A Novel Budget-Friendly Options
- 6. Navigating Evasion Line A Novel eBook Formats
  - ePub, PDF, MOBI, and More
  - Evasion Line A Novel Compatibility with Devices
  - Evasion Line A Novel Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Evasion Line A Novel
  - Highlighting and Note-Taking Evasion Line A Novel
  - Interactive Elements Evasion Line A Novel
- 8. Staying Engaged with Evasion Line A Novel
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Evasion Line A Novel
- 9. Balancing eBooks and Physical Books Evasion Line A Novel
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Evasion Line A Novel
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Evasion Line A Novel
  - Setting Reading Goals Evasion Line A Novel
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Evasion Line A Novel
  - Fact-Checking eBook Content of Evasion Line A Novel
  - Distinguishing Credible Sources

13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

### **Evasion Line A Novel Introduction**

In the digital age, access to information has become easier than ever before. The ability to download Evasion Line A Novel has revolutionized the way we consume written content. Whether you are a student looking for course material, an avid reader searching for your next favorite book, or a professional seeking research papers, the option to download Evasion Line A Novel has opened up a world of possibilities. Downloading Evasion Line A Novel provides numerous advantages over physical copies of books and documents. Firstly, it is incredibly convenient. Gone are the days of carrying around heavy textbooks or bulky folders filled with papers. With the click of a button, you can gain immediate access to valuable resources on any device. This convenience allows for efficient studying, researching, and reading on the go. Moreover, the cost-effective nature of downloading Evasion Line A Novel has democratized knowledge. Traditional books and academic journals can be expensive, making it difficult for individuals with limited financial resources to access information. By offering free PDF downloads, publishers and authors are enabling a wider audience to benefit from their work. This inclusivity promotes equal opportunities for learning and personal growth. There are numerous websites and platforms where individuals can download Evasion Line A Novel. These websites range from academic databases offering research papers and journals to online libraries with an expansive collection of books from various genres. Many authors and publishers also upload their work to specific websites, granting readers access to their content without any charge. These platforms not only provide access to existing literature but also serve as an excellent platform for undiscovered authors to share their work with the world. However, it is essential to be cautious while downloading Evasion Line A Novel. Some websites may offer pirated or illegally obtained copies of copyrighted material. Engaging in such activities not only violates copyright laws but also undermines the efforts of authors, publishers, and researchers. To ensure ethical downloading, it is advisable to utilize reputable websites that prioritize the legal distribution of content. When downloading Evasion Line A Novel, users should also consider the potential security risks associated with online platforms. Malicious actors may exploit vulnerabilities in unprotected websites to distribute malware or steal personal information. To protect themselves, individuals should ensure their devices have reliable antivirus software installed and validate the legitimacy of the websites they are downloading from.

In conclusion, the ability to download Evasion Line A Novel has transformed the way we access information. With the convenience, cost-effectiveness, and accessibility it offers, free PDF downloads have become a popular choice for students, researchers, and book lovers worldwide. However, it is crucial to engage in ethical downloading practices and prioritize personal security when utilizing online platforms. By doing so, individuals can make the most of the vast array of free PDF resources available and embark on a journey of continuous learning and intellectual growth.

### **FAQs About Evasion Line A Novel Books**

How do I know which eBook platform is the best for me? Finding the best eBook platform depends on your reading preferences and device compatibility. Research different platforms, read user reviews, and explore their features before making a choice. Are free eBooks of good quality? Yes, many reputable platforms offer high-quality free eBooks, including classics and public domain works. However, make sure to verify the source to ensure the eBook credibility. Can I read eBooks without an eReader? Absolutely! Most eBook platforms offer webbased readers or mobile apps that allow you to read eBooks on your computer, tablet, or smartphone. How do I avoid digital eye strain while reading eBooks? To prevent digital eye strain, take regular breaks, adjust the font size and background color, and ensure proper lighting while reading eBooks. What the advantage of interactive eBooks? Interactive eBooks incorporate multimedia elements, quizzes, and activities, enhancing the reader engagement and providing a more immersive learning experience. Evasion Line A Novel is one of the best book in our library for free trial. We provide copy of Evasion Line A Novel in digital format, so the resources that you find are reliable. There are also many Ebooks of related with Evasion Line A Novel. Where to download Evasion Line A Novel online for free? Are you looking for Evasion Line A Novel PDF? This is definitely going to save you time and cash in something you should think about. If you trying to find then search around for online. Without a doubt there are numerous these available and many of them have the freedom. However without doubt you receive whatever you purchase. An alternate way to get ideas is always to check another Evasion Line A Novel. This method for see exactly what may be included and adopt these ideas to your book. This site will almost certainly help you save time and effort, money and stress. If you are looking for free books then you really should consider finding to assist you try this. Several of Evasion Line A Novel are for sale to free while some are payable. If you arent sure if the books you would like to download works with for usage along with your computer, it is possible to download free trials. The free guides make it easy for someone to free access online library for download books to your device. You can get free download on free trial for lots of books categories. Our library is the biggest of these that have literally hundreds of thousands of different products categories represented. You will also see that there are specific sites catered to different product types or categories, brands or niches related with Evasion Line A Novel.

So depending on what exactly you are searching, you will be able to choose e books to suit your own need. Need to access completely for Campbell Biology Seventh Edition book? Access Ebook without any digging. And by having access to our ebook online or by storing it on your computer, you have convenient answers with Evasion Line A Novel To get started finding Evasion Line A Novel, you are right to find our website which has a comprehensive collection of books online. Our library is the biggest of these that have literally hundreds of thousands of different products represented. You will also see that there are specific sites catered to different categories or niches related with Evasion Line A Novel So depending on what exactly you are searching, you will be able to choose ebook to suit your own need. Thank you for reading Evasion Line A Novel. Maybe you have knowledge that, people have search numerous times for their favorite readings like this Evasion Line A Novel, but end up in harmful downloads. Rather than reading a good book with a cup of coffee in the afternoon, instead they juggled with some harmful bugs inside their laptop. Evasion Line A Novel is available in our book collection an online access to it is set as public so you can download it instantly. Our digital library spans in multiple locations, allowing you to get the most less latency time to download any of our books like this one. Merely said, Evasion Line A Novel is universally compatible with any devices to read.

### **Find Evasion Line A Novel :**

[essential dermatopathology](#)

[essays in the history of religions](#)

[escape from pretoria](#)

**escape teens who escaped the holocaust to freedom**

**essays and studies**

~~essay on the first amendment~~

*essays reflections*

[espa math practice test d](#)

**escape from willing house**

~~essay essentials with readings~~

~~essays on germanic religion~~

**essays on twentieth-century poets**

[espejo enterrado](#)

**essential estate planning pb 2001 w 2001 supplement**

**ess;german revolution 1848-49**

**Evasion Line A Novel :**

The Heavy Guitar Bible: A Rock Guitar Instruction Manual This book gives you everything you need to really be able to play your guitar like a professional. It's an easy method to learn your music theory and how to use ... The Heavy Guitar Bible - A Rock Guitar Manual This bestseller is now available with a CD! The complete book on the world of rock guitar, covering fretboard basics, chords, structure, and all rock styles, ... Heavy Guitar Bible Vol2 A Rock Guitar Manual Heavy Guitar Bible Vol2 A Rock Guitar Manual · Book overview. Book by Richard Daniels. The Heavy Guitar Bible: A Rock Guitar Instruction Manual The complete book on the world of rock guitar, covering fretboard basics, chords, structure, and all rock styles, with accompanying illustrations. GenresMusic. The Heavy Metal Guitar Bible The Heavy Metal Guitar Bible is a three-part series that teaches you the essential skills required to become a master Heavy Metal guitarist. Heavy Guitar Bible Rock by Richard Daniels The Heavy Guitar Bible: A Rock Guitar Instruction Manual by Richard Daniels and a great selection of related books, art and collectibles available now at ... The Heavy Guitar Bible: A Rock Guitar Manual (Guitar Educational). This bestseller is now available with a CD! The complete book on the world of rock guitar, covering fretboard basics, chords, The Heavy Guitar Bible [HL:2501149] A Rock Guitar Manual. This bestseller is now available with a CD! The complete book on the world of rock guitar, covering fretboard basics, chords, structure, ... The Heavy Guitar Bible by Richard Daniels, Paperback (Guitar Educational). The complete book on the world of rock guitar, covering fretboard basics, chords, structure, and all rock styles, with accompanying. Cherry Lane The Heavy Guitar Bible Book The Heavy Guitar Bible provides you with an incredibly resourceful book on the world of rock guitar, covering fretboard basics, chords, structure, ... Nelson functions and applications 11. Solutions manual Nelson functions and applications 11. Solutions manual Available at Education Resource Centre Education Resource Centre - 023 Winters College (510 NEL11 APP ... Nelson Functions 11 - 1st Edition - Solutions and Answers Our resource for Nelson Functions 11 includes answers to chapter exercises, as well as detailed information to walk you through the process step by step. With ... Nelson functions 11. Solutions manual - York University Nelson functions 11. Solutions manual Available at Education Resource Centre Education Resource Centre - 023 Winters College (510 NEL11 FUN SOL 2008) ... chapter 1 2-. -3-. +. -5. 4. Nelson Functions 11 Solutions Manual. 1-5. Page 6. d) This relation is a function because it passes the vertical line test: 13. a) Answers ... Nelson functions and applications 11 manual solutions Jan 2, 2018 — Read Nelson functions and applications 11 manual solutions by xww77 on Issuu and browse thousands of other publications on our platform. Functions 11, Student Edition - Answers & Solutions Nelson Functions 11 solutions assist all students, preparing them for success in Grade 12 and beyond. This textbook offers a wide variety of exercises, ... CHAPTER 8: - Discrete Functions Nelson Functions 11 Solutions Manual. 11. FV of each investment terms of a geometric sequence common ratio.  $(1+i)$  future value of annuities compound interest. Functions and Applications 11 Nov 16, 2012 — Functions

and Applications 11 Student Success Workbook: Success Workbook is specially designed to help struggling students be successful. It ... MCR3U Solutions to Questions from Nelson Functions ... Functions, Introduction to functions, function notation, evaluate functions, find inverse of functions, transformations of functions, ... MHF4U-Full-Solution-Manual-Small.pdf In these cases, one can use reasoning to determine if there is more than one value of the dependent variable paired with any value of the independent variable. Electrical Engineering Aptitude Test Questions and Answers May 29, 2019 — Prepare with these latest aptitude test sample questions and answers for electrical engineering job interviews and campus placements. Basic Electrical Engineering Aptitude Test This set of Basic Electrical Engineering Questions and Answers for Aptitude test focuses on Phasor Diagrams Drawn with rms Values Instead of Maximum Values. Electrical Aptitude Test The electrical aptitude test is conducted to find out your working knowledge of power flow, electrical functionality, and signals. Solving Electrical Circuits (2023) - Mechanical Aptitude Test These questions are designed to test your ability to apply basic electrical principles to real-world problems, and your performance on these questions can help ... Free Mechanical Aptitude Test Practice Questions and Answers Learn how to prepare for your mechanical aptitude test with free mechanical aptitude practice test questions, crucial information and tips to help you pass. Engineering Aptitude Test: Free Practice Questions (2023) Applying for a role in engineering? Prepare for engineering aptitude tests with 22 practice tests and 280 questions & answers written by experts. ENGINEERING Aptitude Test Questions & Answers ENGINEERING Aptitude Test Questions & Answers! Mechanical Comprehension & Electrical Aptitude Tests! ... 25 PSYCHOMETRIC TEST PRACTICE QUESTIONS ... Free Electrical IBEW Aptitude Test Practice: Prep Guide Free Electrical IBEW Aptitude Practice Test & Prep Guide by iPREP. Check out our free IBEW NJATC sample questions and ace your test. Electrical Engineering Questions and Answers Electrical Engineering questions and answers with explanations are provided for your competitive exams, placement interviews, and entrance tests.