School of Informatics

Research Methods In Security, Privacy, and Trust
Detecting Ethereum Smart Contract Security Loopholes

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January 2022

Abstract

Date: Monday 17th January, 2022

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1 Introduction

Ethereum is a general-purpose Blockchain, providing a platform to run decentralized applications executing code called Smart Contracts. Smart Contracts mainly manage valuable digital assets, and thus securing them is a top priority. Yet, it is typical for any piece of code to have bugs. However, Smart Contract bug fixes on the fly are not feasible since blockchain is an immutable append-only data structure. Hence, detecting code bugs and vulnerabilities before deploying Smart Contracts is vital.

In recent years there have been several attempts to create practical vulnerability detection tools for Smart Contracts. This is a niche topic, and there are several schools of thought when it comes to detecting security loopholes. This literature review aims to probe associated studies, focusing on different methods of detecting Smart Contract vulnerabilities, comparing different approaches, and taxonomizing existing frameworks.

2 Methodology

In this literature review, we explore the most prominent research attempts towards creating an effective vulnerability detection tool for Ethereum Smart Contracts. The method used to filter relevant studies comprised both bottom-up and top-down strategies. Their combination significantly accelerated identifying adequate quality papers to include in this literature review.

During the bottom-up stage, we sought several papers related to frameworks that identify Smart Contract vulnerabilities. To achieve that, we employed trustworthy academic search engines such as *Google Scholar* and *IEEE Explorer*. We noticed that most of the retrieved writings had a joint primary related work, which guided us to discover this research topic's essence paper[1].

Subsequently, we aimed to find any derivative studies related to the paper we found in the previous phase. To do so, we used a graph representation tool[2] that links relevant papers. This mechanism allowed us to identify remarkable research articles rapidly. Afterward, we manually inspected the search results and included the most reliable in our under investigation list.

Namely, we collected forty-seven papers, but we only consider nineteen of them in this literature review. The selection criteria span the context of the studies and their research contribution. We measure their contribution according to their citations and release year. According to their publication year, studies are assigned a weight ranging from 1 to 4. Papers in the span of 2016-2017, 2018, 2019, 2020 receive 1, 2, 4, 8 points, respectively, for each citation they hold. Using this metric, we evaluate the studies shown in Table 2.

Study	Year	Cit.	Score	Ref.
Making Smart Contracts Smarter	2016	1445	1445	[1]
A Survey of Attacks on Ethereum Smart Contracts (SoK)	2017	1176	1176	[3]
Securify: Practical Security Analysis of Smart Contracts	2018	436	872	[4]
VerX: Safety Verification of Smart Contracts	2020	103	824	[5]
ZEUS: Analyzing Safety of Smart Contracts	2018	399	798	[6]
Finding The Greedy, Prodigal, and Suicidal Contracts at Scale	2018	357	714	[7]
SmartCheck: Static Analysis of Ethereum Smart Contracts	2018	291	582	[8]
Formal Verification of Smart Contracts	2016	525	525	[9]
ContractFuzzer:Fuzzing Smart Contracts for Vulnerability Detection	2018	233	466	[10]
Slither: A Static Analysis Framework For Smart	2019	109	436	[11]
MadMax:Surviving Out-of-Gas Conditions in Ethereum Smart Contracts	2018	213	426	[12]
Manticore: A User-Friendly Symbolic Execution Framework for Binaries and Smart Contracts	2019	91	364	[13]
teether:Gnawing at Ethereum to Automatically Exploit Smart Contracts	2018	173	345	[14]
Vandal:A Scalable Security Analysis Framework for Smart Contracts	2018	154	308	[15]
ReGuard: Finding Reentrancy Bugs in Smart Contracts	2018	122	244	[7]
Ethereum Smart Contracts: Vulnerabilities and their Classifications	2020	12	96	[16]
ETHPLOIT:From Fuzzing to Efficient Exploit Generation against Smart Contracts	2020	10	80	[17]
GasFuzzer: Fuzzing Ethereum Smart Contract Binaries to Expose Gas-Oriented Exception Security Vulnerabilities	2020	8	64	[18]
SoliAudit: Smart Contract Vulnerability Assessment Based on Machine Learning and Fuzz Testing	2019	13	52	[19]

Table 1: List of papers that are analyzed in this literature review, sorted by their score

3 Literature Review

3.1 Smart Contract Attack Surface

3.2 Static Analysis

3.3 Dynamic Analysis

3.4 Symbolic Execution

3.5 Fuzzing

3.6 The Machine Learning Approach

4 Summary & Conclusion

References

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