Static Analysis, Dynamic Analysis and Symbolic Execution Techniques Applied to Security

Introduction & Case Study

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Overview

Background

Static Analysis

  Case 1: Detect PDF Malware

Program Analyzer

A program that takes other programs as input and decides whether or not they have a certain **property**[1].

Static Analysis

- ▶ Analysis of programs without executing
- ▶ Reason for non-trivial properties

Dynamic Analysis

- ▶ Analysis of programs by actual executing
- ▶ Common testing methods for a desire property

Symbolic Execution

- ▶ Analysis of programs by executing with **symbolic** inputs
- ▶ Determine what inputs cause each part of a program to execute

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[1]Anders Møller and Michael I. Schwartzbach. *Static Program Analysis*.
Department of Computer Science, Aarhus University. 2018.

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No Free Lunch
Limitations of Program Analysis

> *Program testing can be used to show the presence of bugs, but never to show their absence.*[2]

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[3] Henry Gordon Rice. "Classes of recursive enumerable sets and their decision problems". In: *Transactions of the American Mathematical Society* 74.2 (1953), pp. 358–366.

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Rice's theorem[3]

All interesting questions about the behavior (*i.e. non-trivial properties*) of programs (written in Turing-complete programming languages) are **undecidable**.

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SAFE-PDF[4]: Detect Malicious Javascript in PDFs

PLAS 2019 / Oracle / University of Sydney

JavaScript programs embedded in PDFs implement some **advanced** features:

1. control embedded multimedia objects
2. interact with the file system or network

However, it may be utilized for **malicious** intentions.

[4]Alexander Jordan, François Gauthier, Behnaz Hassanshahi, et al. "Unacceptable Behavior: Robust PDF Malware Detection Using Abstract Interpretation". In: *Proceedings of the 14th ACM SIGSAC Workshop on Programming Languages and Analysis for Security*. 2019, pp. 19–30.

Code

```python
 1  while not q.empty():
 2      p = q.get()
 3      p_list = os.listdir(p)
 4      for i in p_list:
 5          temp_p = os.path.join(p, i)
 6          if os.path.isdir(temp_p):
 7              q.put(temp_p)
 8              continue
 9          # do something
10          print(temp_p)
```