3rd UCAAT User Conference on Advanced Automated Testing

ETSI World Class Standards

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Fuzz Testing of Web Browsers

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H.T.B.™ Hungarian Testing Board

Outline

- **Principles** of random testing
- **Pros** & **Cons** of fuzzing
- **How to** fuzz a browser?
- **Evaluation** of a real life framework

Principles of Fuzz Testing

- **Idea**: Stress testing the target with deformed inputs
- Expected bugs (primarily):
  - **Implementation** mistakes
  - Non-semantic issues
- **Automated** testing

Possible Issue Types

- **Stability** issues
  - Crashes
  - Memory corruptions
  - Hangs
- **Semantic** issues
  - Assertion failures
  - Output mismatch with an oracle

Pros & Cons

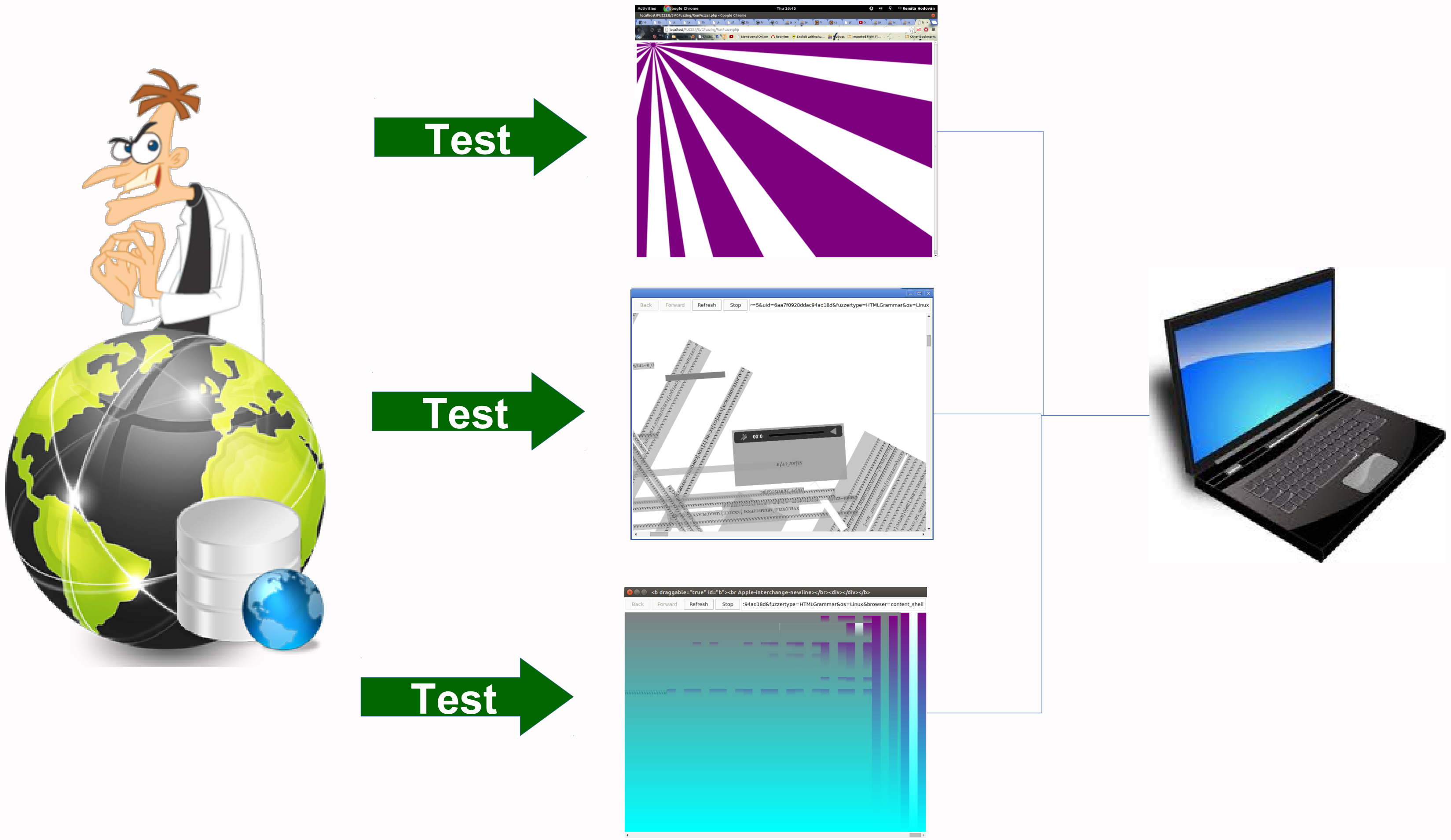
- **Pros**
  - It works! :-)
  - Fast and cheap
  - No need for source code
  - Portable
- **Cons**
  - Smart fuzzing can be challenging

How to Fuzz a Browser?

What do You Need ?

- Evil test generator algorithm
- Transfer mechanism
- Monitoring framework

Browser Fuzzing Framework



Variations for Generators

- **Random** noise
- **Mutation** based
- **Generation** based
- Combination of the above

First Steps ...

- Tests with **random** character **sequences**
- **Pros:**
  - Fast and easy to implement
- **Cons:**
  - Mostly fails on the first checks
  - Not able to find complex errors
- Found bug in WebKit (Apple Safari)
  - `&#6198&#656`

Mutation Based Approaches

- **Idea:** the most error-prone tests are the **almost good** ones
- Let's mess up existing tests!
- **Pros:**
  - Still easy to implement
  - Much more effective than purely random
- **Cons:**
  - The variety of possible tests depends on the initial test set

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Mutation Based Approaches

- **Ingredients:**
  - Existing test cases
  - Parser for the tests
  - Test domain (in)competence

Mutation Based Approaches

- Replace tokens with random contents:

```
<applet code="good.class"></applet>
```

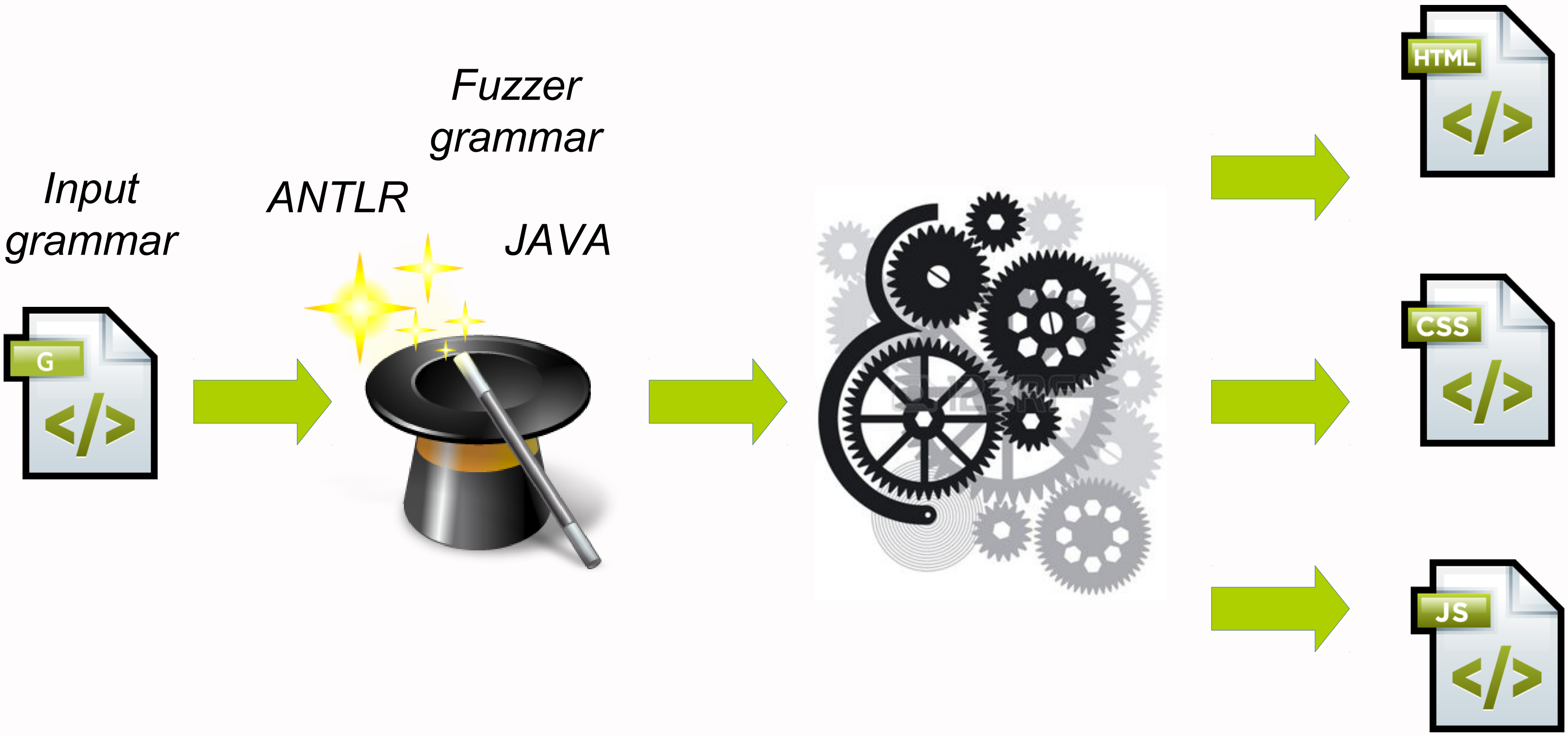
```
<applet code="foo.bar"></applet>
```

(Google Chrome issue)

Generation Based Approach

- **Ingredients:**
  - Model/grammar describing the input format
    - E.g., in BNF format
  - Automatism that processes the description and generates a fuzzer
    - ANTLR

Generation Based Approach



Generation Based Approach

- **Pros:**
  - Not bound to any input test set
  - Easier to extend
  - Increased coverage

- **Cons:**
  - Needs much more preliminary work

How to Obtain the Input Grammar?

- Make your hands dirty! **Write it** yourself!
- Extract it from **standards**
  - E.g., from XSD or IDL definitions
  - They can be processed automatically
- Extract from existing **test cases**
  - Uncover undocumented features
- **Combine** all of them

Further Challenges

- Grammars can only describe syntactic requirements but **not semantic ones.** E.g.,:
  - Variable matching
  - Using functions with “correct” parameter list
  - Building valid relations between XML nodes
- **Solution:**
  - Adding semantic information manually
    - E.g., using symbol tables

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Generation Based Approach

```
function f_0(){
    for(var v_0 in [10]){
        try {
            for(var v_1 in [10])
                return;
        } finally {}
    }
}
for(var v_2 in f_0()) {}
```

(JavaScriptCore issue)

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Fuzzinator

Features

- Supported languages
  - HTML
  - SVG
  - MathML
  - CSS
  - JavaScript
  - Combinations of the above
- Applied techniques
  - Mutation
  - Generation
- Grammar sources
  - Hand-written
  - Extracted from XSD, IDL, web standards
- Advanced features
  - ID matching, self adapting weights

Results in Numbers

Engine	Number of bugs
Google Chrome	274
Apple Safari	257
Jerryscript (JS engine)	96

Questions?