Bug Injection in SATE VI

SATE VI Workshop - September 19, 2019 - MITRE, McLean VA

https://samate.nist.gov/SATE.html

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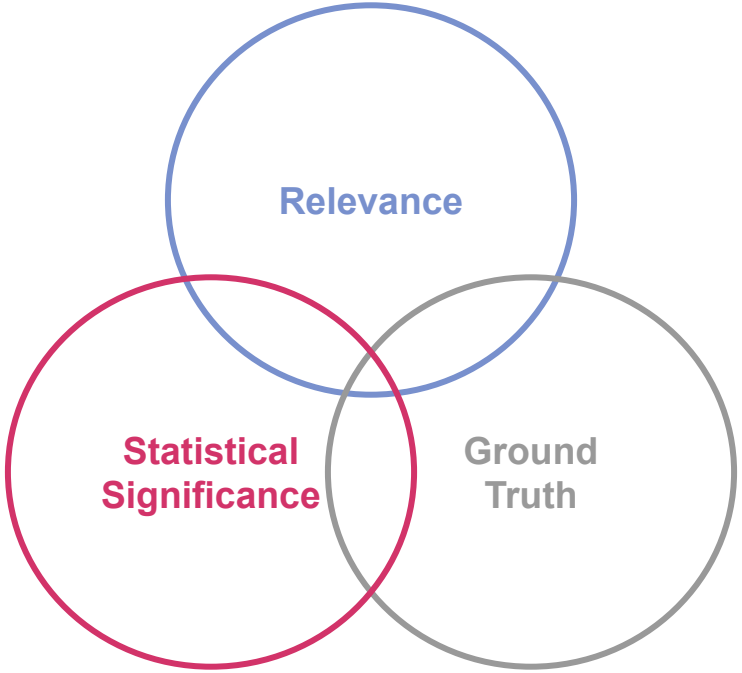
Why Bug Injection?



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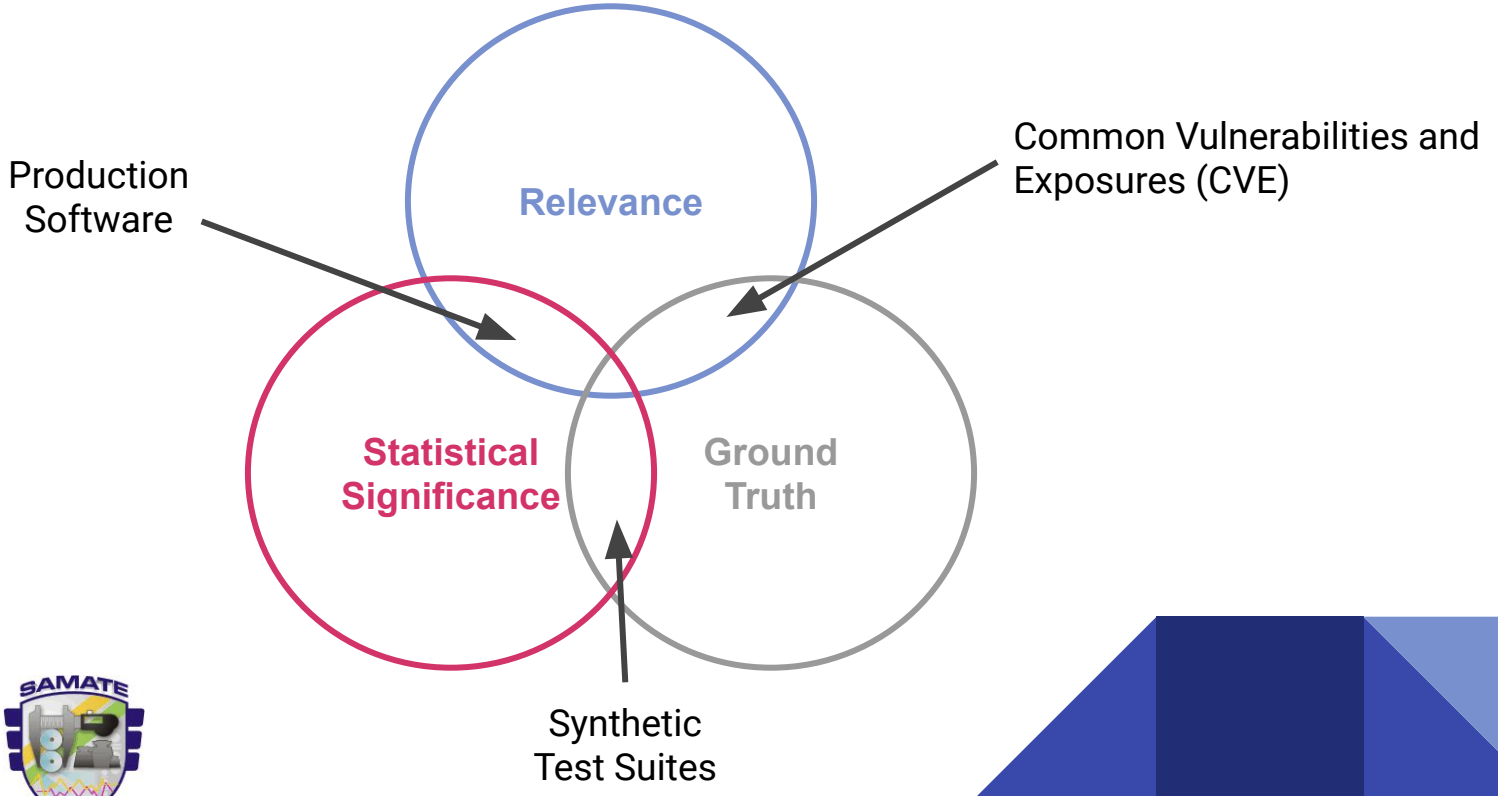
Why Bug Injection?



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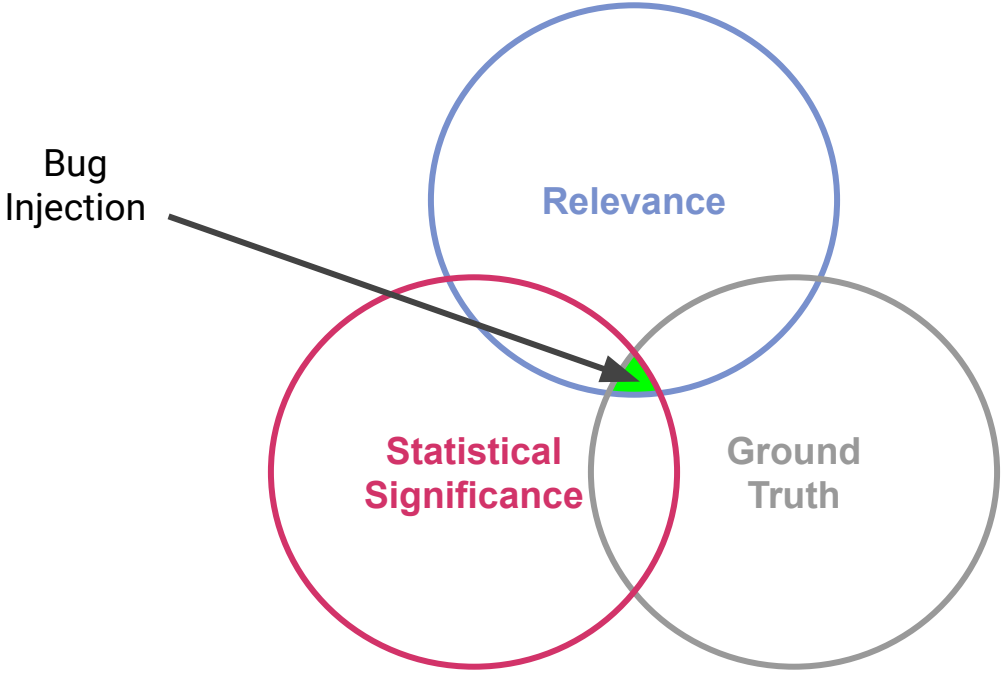
Why Bug Injection?



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Ways to “Get” Bugs

- Bug Injectors
- Manual & Semi-Automated Injection
- Specifically Developed Test Suites
- Existing Bugs
  - Discovered
  - Undiscovered

Bug Types in SATE VI

C: Undefined Behavior

- Pointers
- Buffers
- Initialization

Java: Code Injection

- Cross-Site Scripting (XSS)
- SQL Injection

▶️ High-Impact
▶️ Easy to Prove

Proof of Vulnerability (PoV)

Why?

- Proves Bug Matters
- Retrieve Bug Trace

How?

- Fuzzing
- Bug Tracker
- Manual

Bug Traces

- Based on PoVs
  - C: GDB / Valgrind / ASAN
  - Java: Flow

- Manual Analysis
  - Doc Review
  - Code Review

What Went Wrong?

Cheap but Hard Bugs

packet-arp.c

```
mac = tvb_get_ptr(tvb, tha_offset, 6) + spa_offset * 64;
```

- Almost Never Found by Tools

Asymmetrical Bug/Fix Pairs

SimplePageBean.java

```
String query = "";
query = "INSERT INTO FORUM_SATE (ID, TITLE, BODY) VALUES('" + uuid + "', '" + title + "', 'body')";
statement = connection.createStatement();
int i = statement.executeUpdate(query);
connection.commit();
```

Buggy

```
query = "INSERT INTO FORUM_SATE (ID, TITLE, BODY) VALUES(?, ?, ?)";
statement = connection.prepareStatement(query);
statement.setString(1, uuid);
statement.setString(2, title);
statement.setString(3, "body");

statement.executeUpdate();
connection.commit();
```

Fixed

Buggy Bugs

global.c

```
int sqlite3PendingByte = 0x40000000;
```

fts3_write.c

```
/* from input (./gt-harness.sh test BIN 4039 1) */
printf("from input 4039");
/* POTENTIAL FLAW */vfsList = malloc(sqlite3PendingByte * sizeof(int));
```

- Tainted Data Questionable
- Unintended Bug Type
- Implementation-dependent
- Unknown Sink

Buggy Fixes

global.c

```
int sqlite3PendingByte = 0x40000000;
```

fts3_write.c

```
/* from input (./gt-harness.sh test BIN 4039 1) */
printf("from input 4039");
if (sqlite3PendingByte < 2147483647 / sizeof(int)) {
  vfsList = malloc(sqlite3PendingByte * sizeof(int));
}
```

- Tainted Data Questionable
- Condition Always False

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Buggy Bugs

global.c

```
int sqlite3PendingByte = 0x40000000;
```

pragma.c

```
/* from input (./gt-harness.sh test BIN 9300 1) */
printf("from input 9300");
int buf[100];
if (sqlite3PendingByte > 99) {
    /* POTENTIAL FLAW */
    buf[sqlite3PendingByte] = 1;
}
```

Tainted Data Questionable

Condition Always True

Buggy Fixes

global.c

```
int sqlite3PendingByte = 0x40000000;
```

pragma.c

```
/* from input (./gt-harness.sh test BIN 9300 1) */
printf("from input 9300");
int buf[100];
if (sqlite3PendingByte < 100) {
    /* POTENTIAL FLAW */
    buf[sqlite3PendingByte] = 1;
}
```

Tainted Data Questionable

Condition Always False

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Buggy Fixes

global.c

```
int sqlite3PendingByte = 0x40000000;
```

fts3_tokenize_vtab.c

```
/* from input (./gt-harness.sh test BIN 378 4) */
printf("from input 378");
if (pInfo != NULL && sqlite3_temp_directory != NULL && sizeof(pInfo) > sqlite3PendingByte
            && sizeof(sqlite3_temp_directory) > sqlite3PendingByte) {
  memcpy(pInfo, sqlite3_temp_directory, sqlite3PendingByte);
}
```

- Tainted Data Questionable
- Condition Always False Due to Programming Error

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Sink Separation

date.c

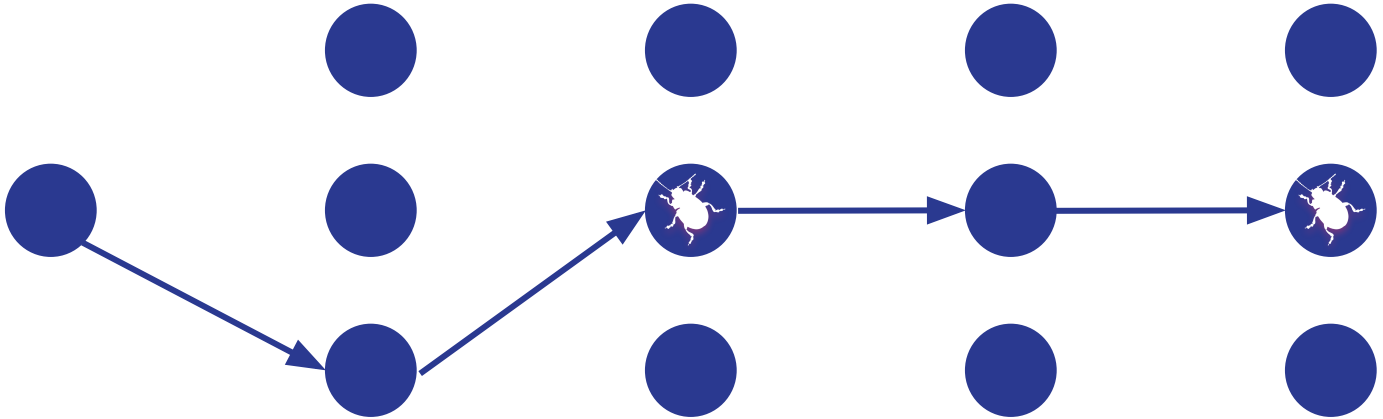
```
/* from input (./gt-harness.sh test BIN 9643 1) */
printf("from input 9643");
pRc = (int *)malloc(9*sizeof(int));
if (pRc != NULL) {
    int i;
    for (i = 0; i < 9; i+=1) {
        set_i(pRc, i);
        /* POTENTIAL FLAW */
        set_i(pRc, i + 1);
    }
}
```

insert.c

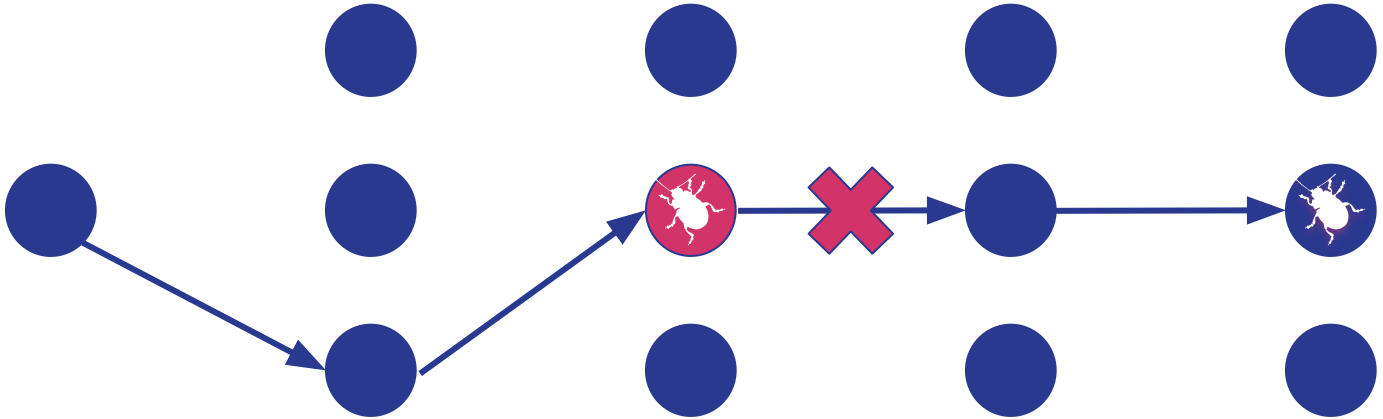
```
/* from input (./gt-harness.sh test BIN 8865 1) */
printf("from input 8865");
aiChng = (int *)malloc(9*sizeof(int));
if (aiChng != NULL) {
    int i;
    for (i = 0; i < 9; i+=1) {
        set_i(aiChng, i);
        /* POTENTIAL FLAW */
        set_i(aiChng, i + 1);
    }
}
```

```
void set_i(int *arr, int index) {
  arr[index] = 0;
}
```

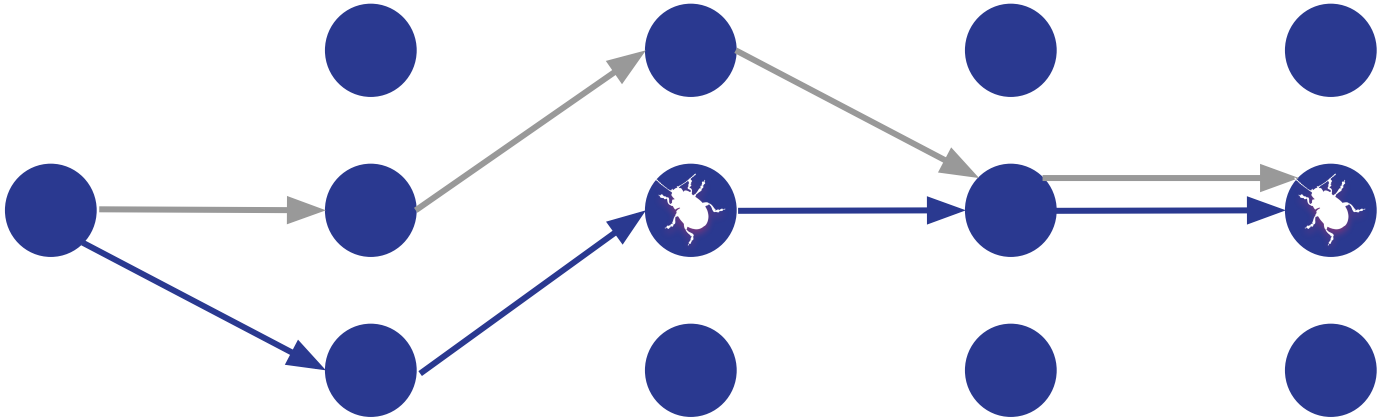
Shadowing



Shadowing



Shadowing



Take Away

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