Symbolic Verification via Program Transformation

Henrich Lauko

Masaryk University

Brno, Czech Republic

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Outline of the Talk

1. Introspection to my diploma thesis
2. Designing a better approach

Problem Introduction

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Solution: symbolic representation of data and computation

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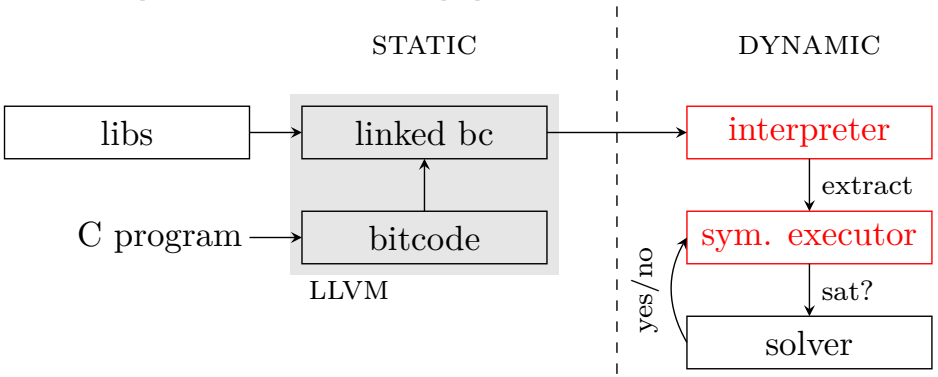

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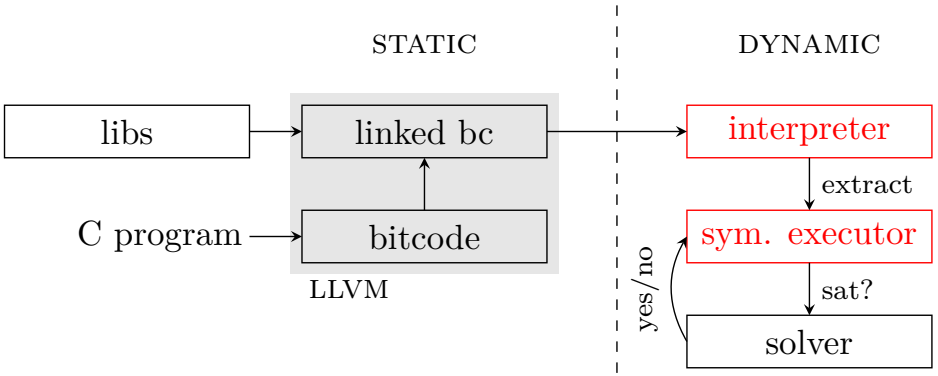

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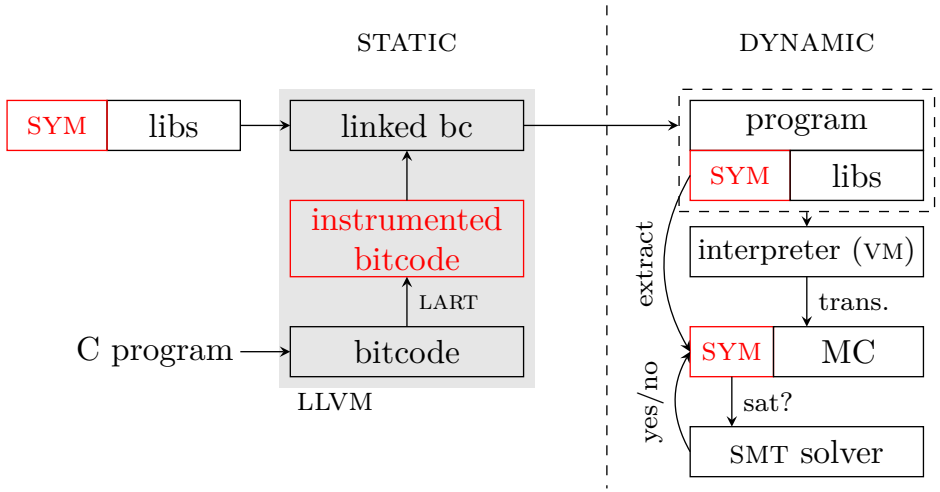

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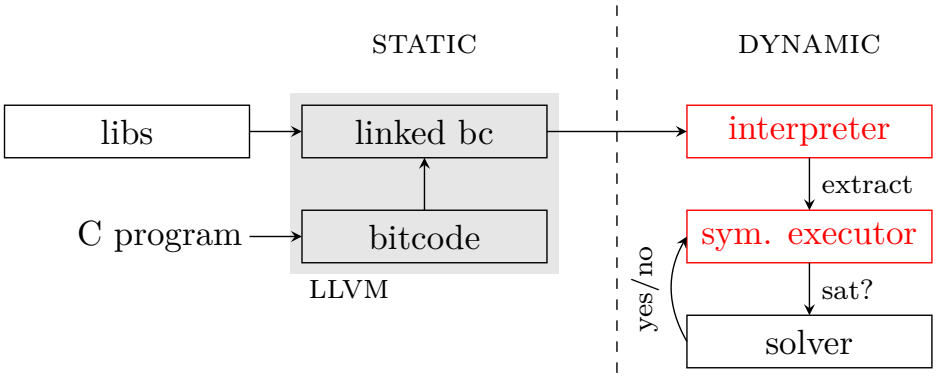

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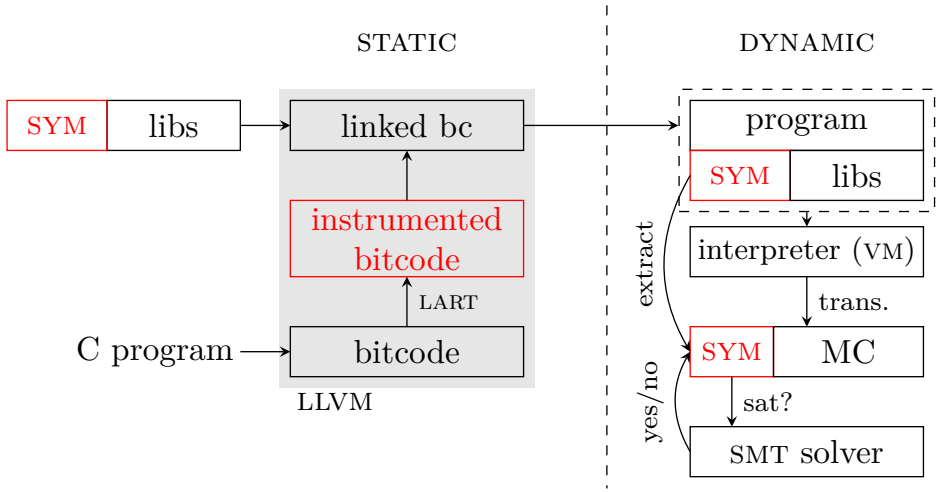

- compilation approach does not complicate an interpreter

Transformation of a Program

Let **x** be marked as symbolic:

```
bool foo(int x) {
  int n  = factorial(7);
  bool y = x + n;
  return y;
}
```

```
SymInt foo(SymInt x) {
  int n = factorial(7);
  SymInt y = sym_add(x, lift(n));
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```

- transform instructions, types, functions
- preserve concrete computation
- lift concrete values

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State After My Diploma Thesis:

- functional prototype
- each value needs to know whether it is concrete or symbolic

Analyzing Drawbacks and Designing a Better Approach

Aggregate Types and Arrays

Problem: types needs to be either concrete or symbolic

```
int arr[ 3 ] = { 1, 2, 3 };
arr[ 1 ] = input();
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- similar problem with aggregates, recursive structures
- aggregates requires shape analysis

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Solution: use discriminated union type

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Improve:

- use bits of concrete value, do not change anything!

Size of Symbolic Values

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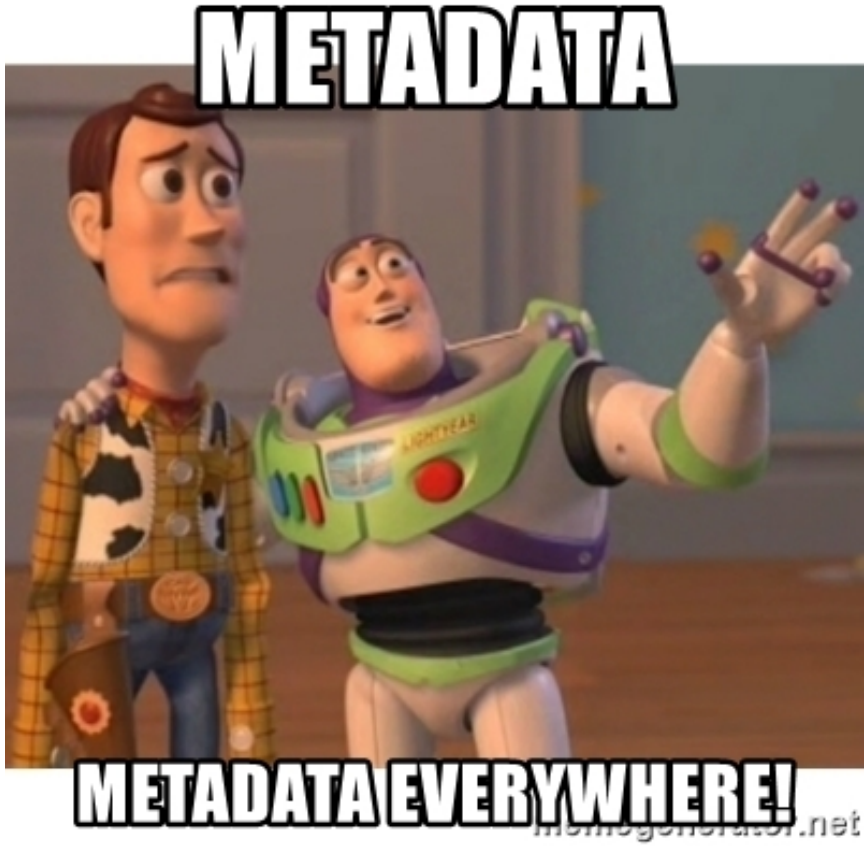
Solution: use metadata to store the symbolic value (thanks to Adam)

- if the value is tainted pick symbolic value from the metadata



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After transformation:

```
int y = lifter_add(x, 10);
```

- `y` gets taint if `x` is tainted

Values Lifter

- lifter decides to do either concrete or symbolic operation

```
int lifter_add(int a, int b) {
    if (!is_tainted(a) && !is_tainted(b))
        return a + b;
    else if (!is_tainted(a))
        a = lift(a);
    else if (!is_tainted(b))
        b = lift(b);
    return sym_add(a, b); // tainted value
}
```

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Problem: we need to create a clone of function for each possible combination of concrete and symbolic arguments

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Solution: solved by union types

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Thanks for attention