Dynamic Patch Generation for Null Pointer Exceptions Using Metaprogramming

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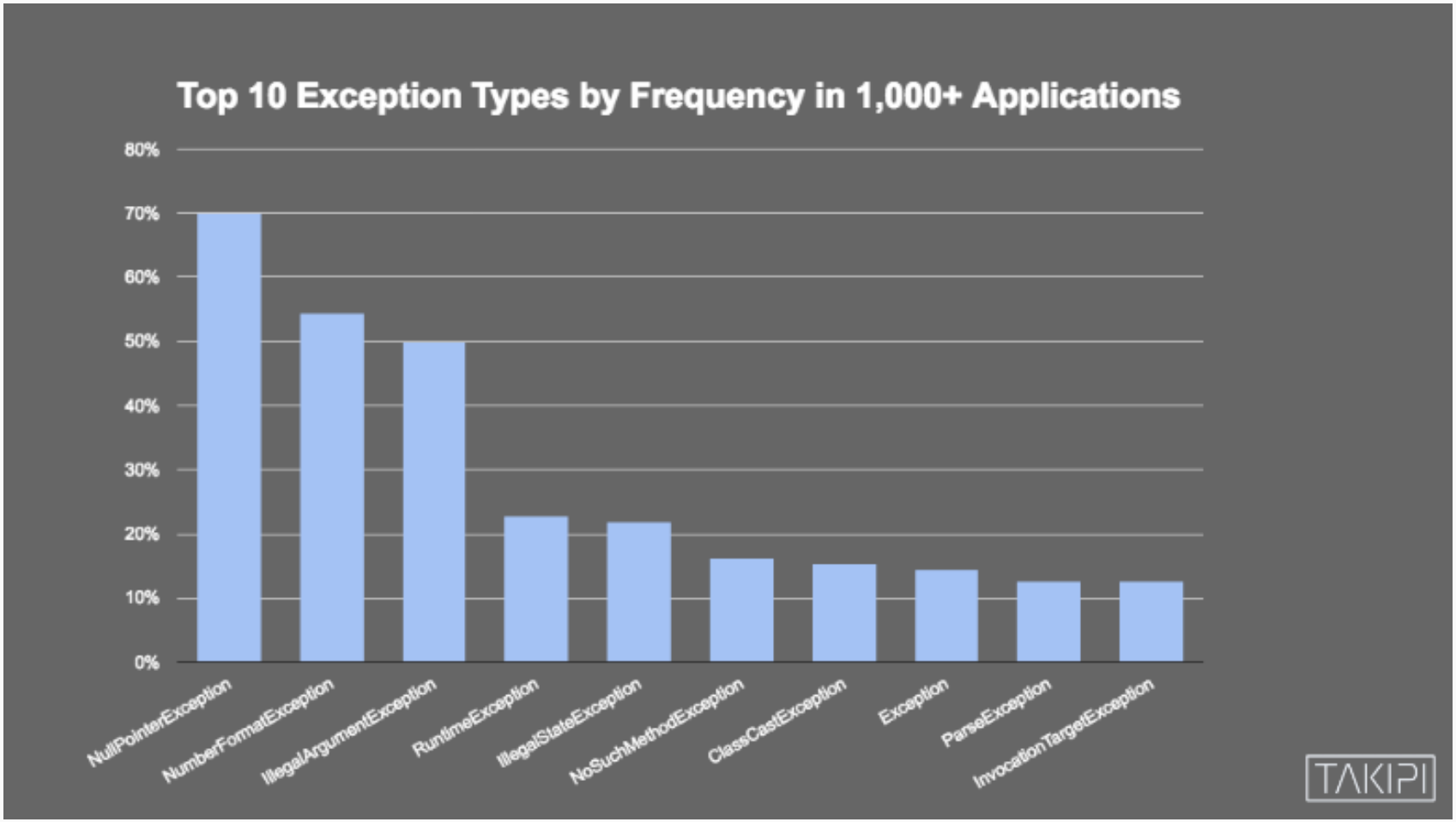
Motivation

Motivation

Why fixing Null Pointer Exception?



Test Based Automatic Repair Approach

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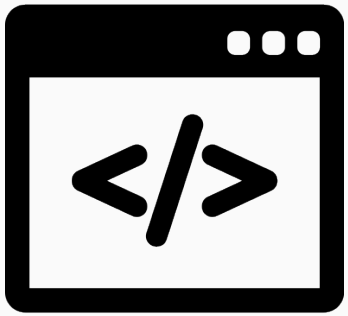
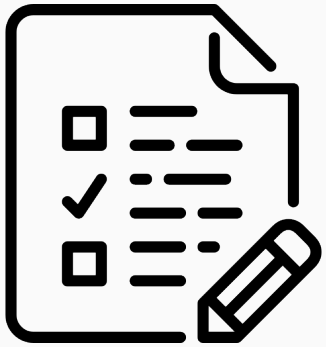


A buggy program



A test suite

A repair strategy

Automatic Program Repair: Patch Generation and Validation

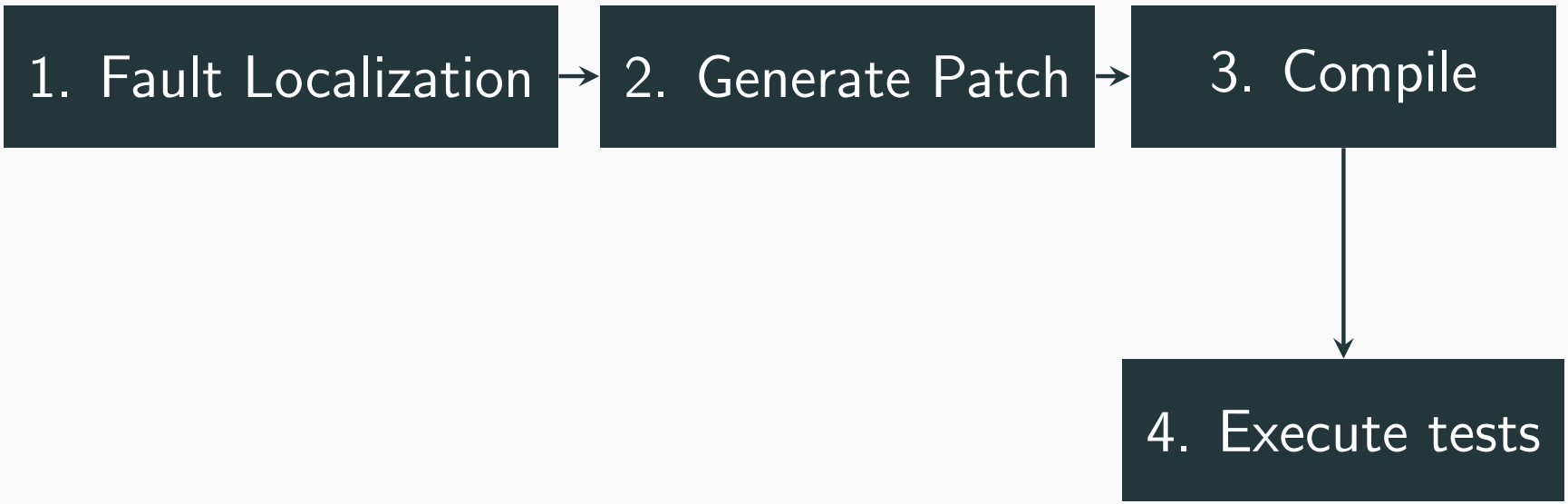
1. Fault Localization

Automatic Program Repair: Patch Generation and Validation

1. Fault Localization → 2. Generate Patch

Automatic Program Repair: Patch Generation and Validation

Automatic Program Repair: Patch Generation and Validation



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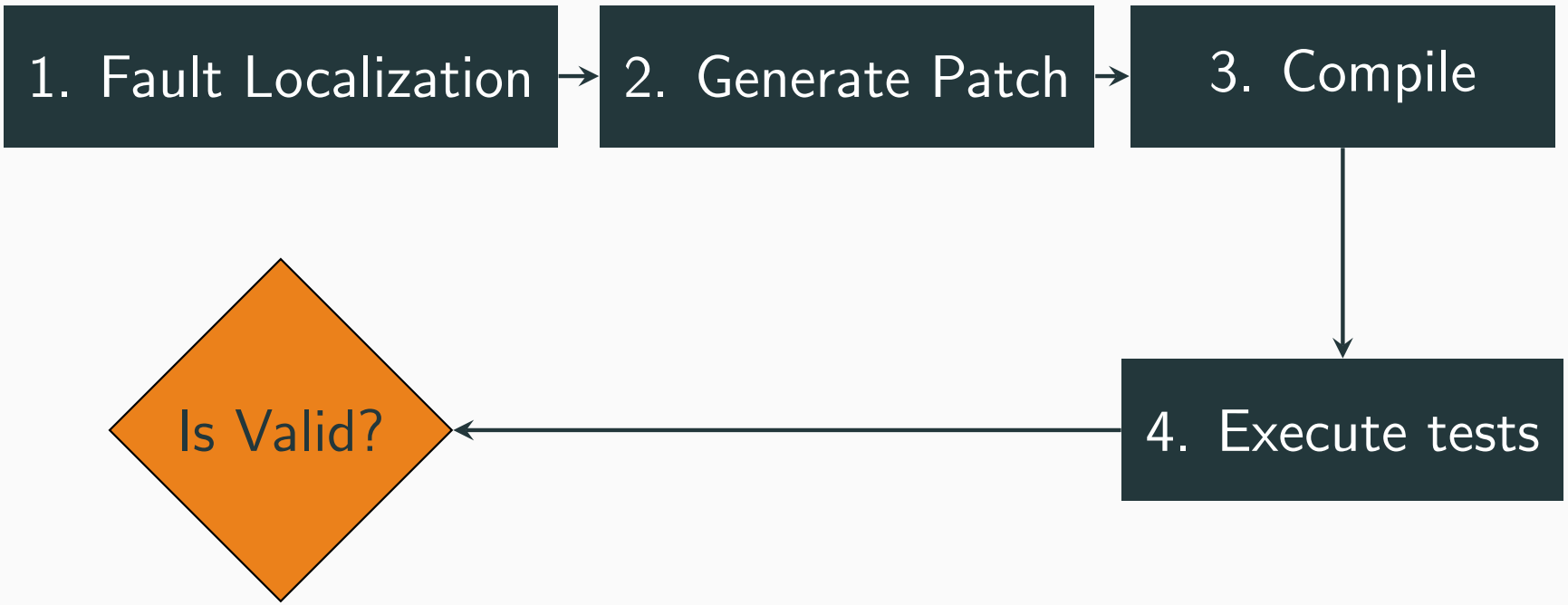

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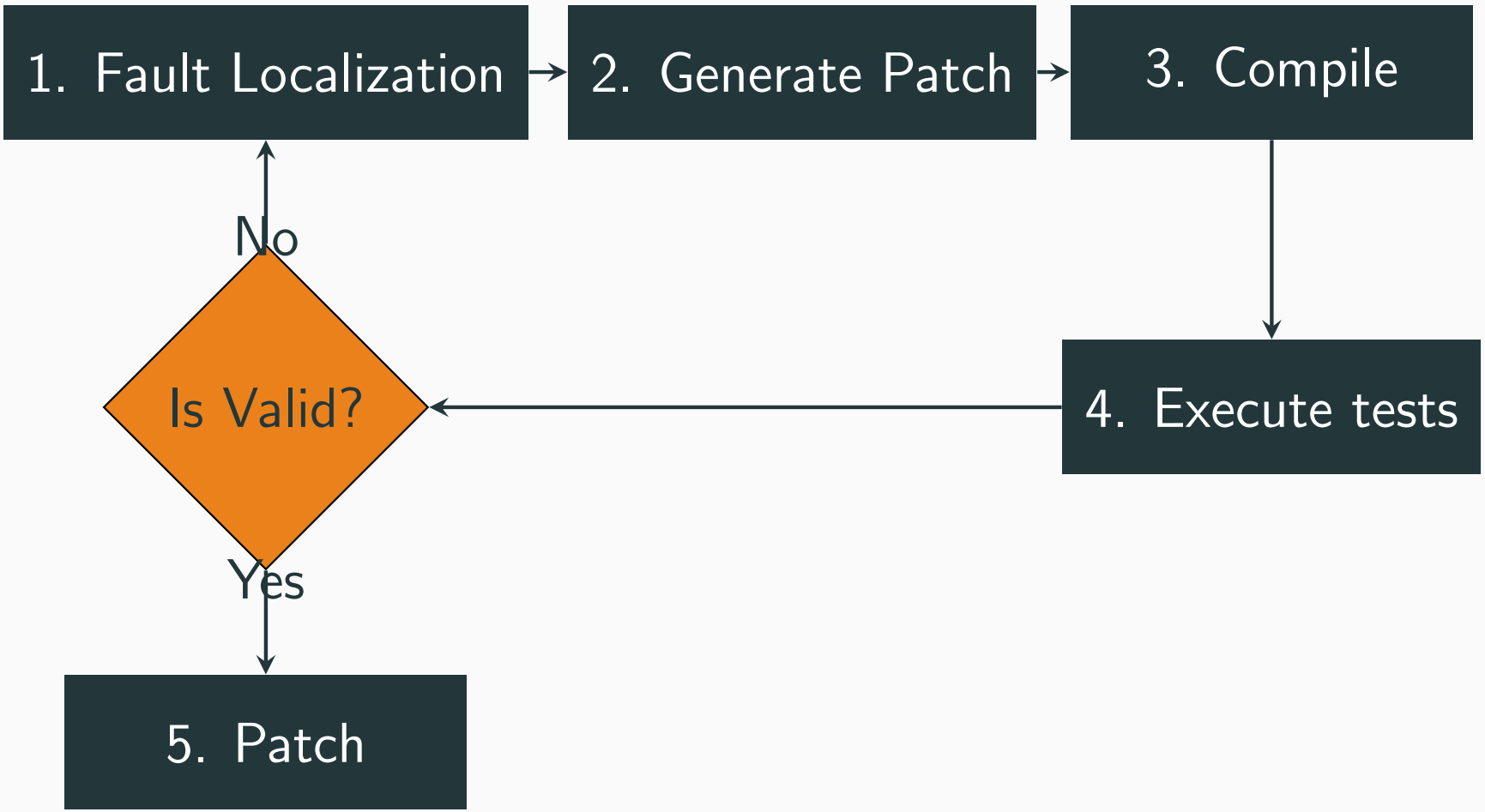
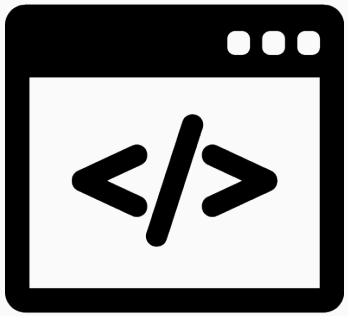


NPEfix

NPEfix



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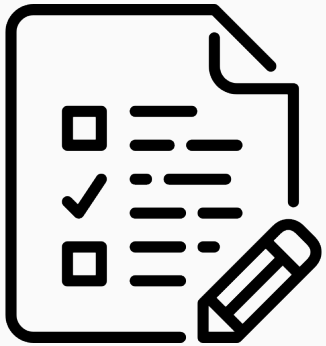


A test suite

A repair strategy

NPEfix: Repair Strategies

Replace the null expression

```
+ if (r == null) {
+    anotherVar.foo(p);
+ } else {
     r.foo(p);
+ }
```

```
+ if (r == null) {
+    new Foo().foo(p);
+ } else {
     r.foo(p);
+ }
```

NPEfix: Repair Strategies

Skip the null expression

```
+ if (r == null) {
+   return anotherVar;
+ }
  r.foo(p);
```

```
+ if (r == null) {
+   return new Bar();
+ }
  r.foo(p);
```

NPEfix Code Transformation

```
Object m(A p) {
    field.inv();
    return p;
}
```

NPEfix Code Transformation

```
Object m(A p) {
    try {
        call(field).inv()
        return p;
    } catch (SkipMethod e){
        if (returnVar) return getVar()
        if (returnNew)
            return createObject()
    }
}
```

NPEfix

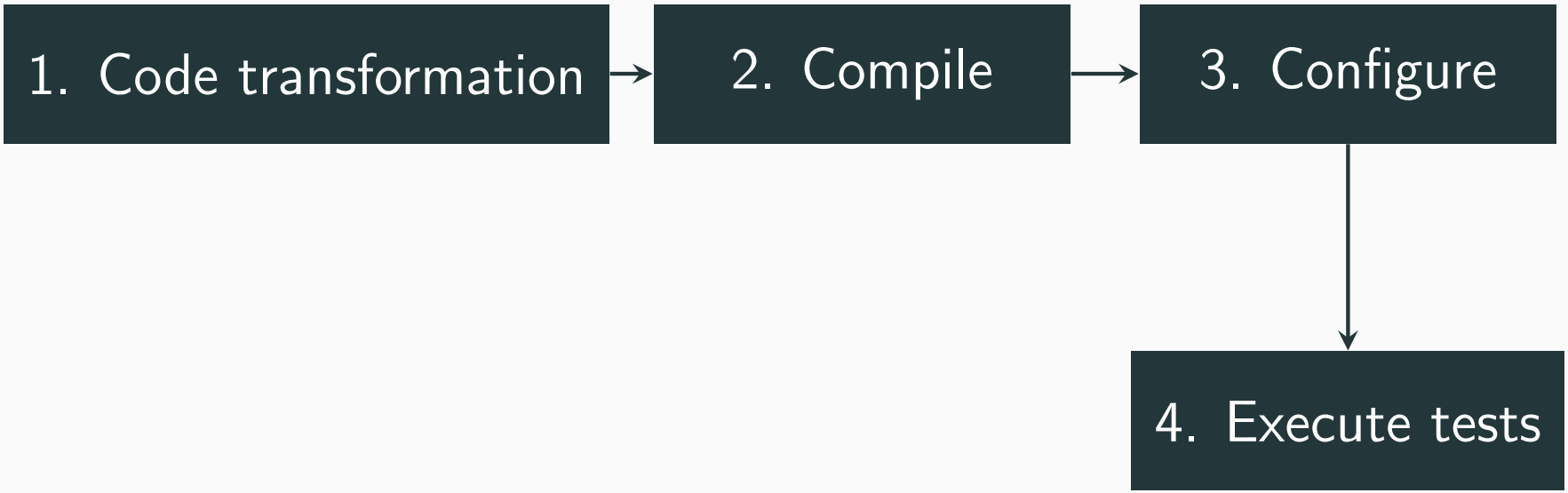
1. Code transformation

NPEfix

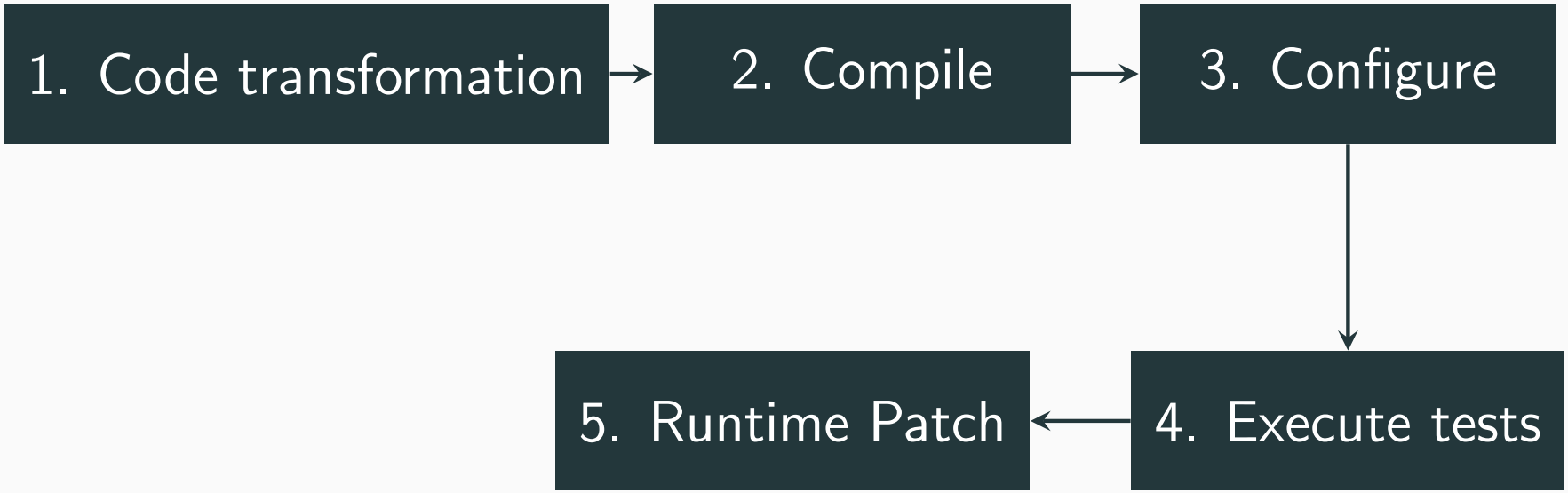
1. Code transformation → 2. Compile Metaprogram

NPEfix

NPEfix


1. Code transformation
2. Compile
3. Configure
4. Execute tests

NPEfix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2. Compile
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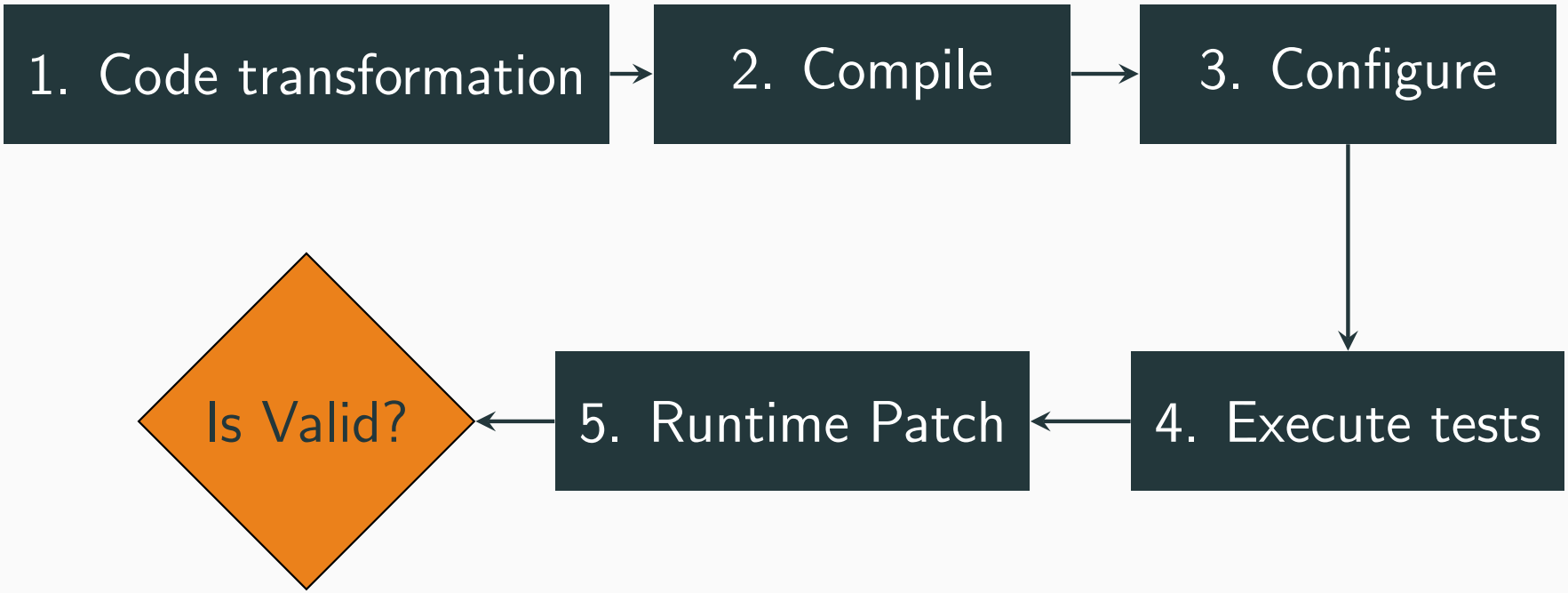
5. Runtime Patch

NPEfix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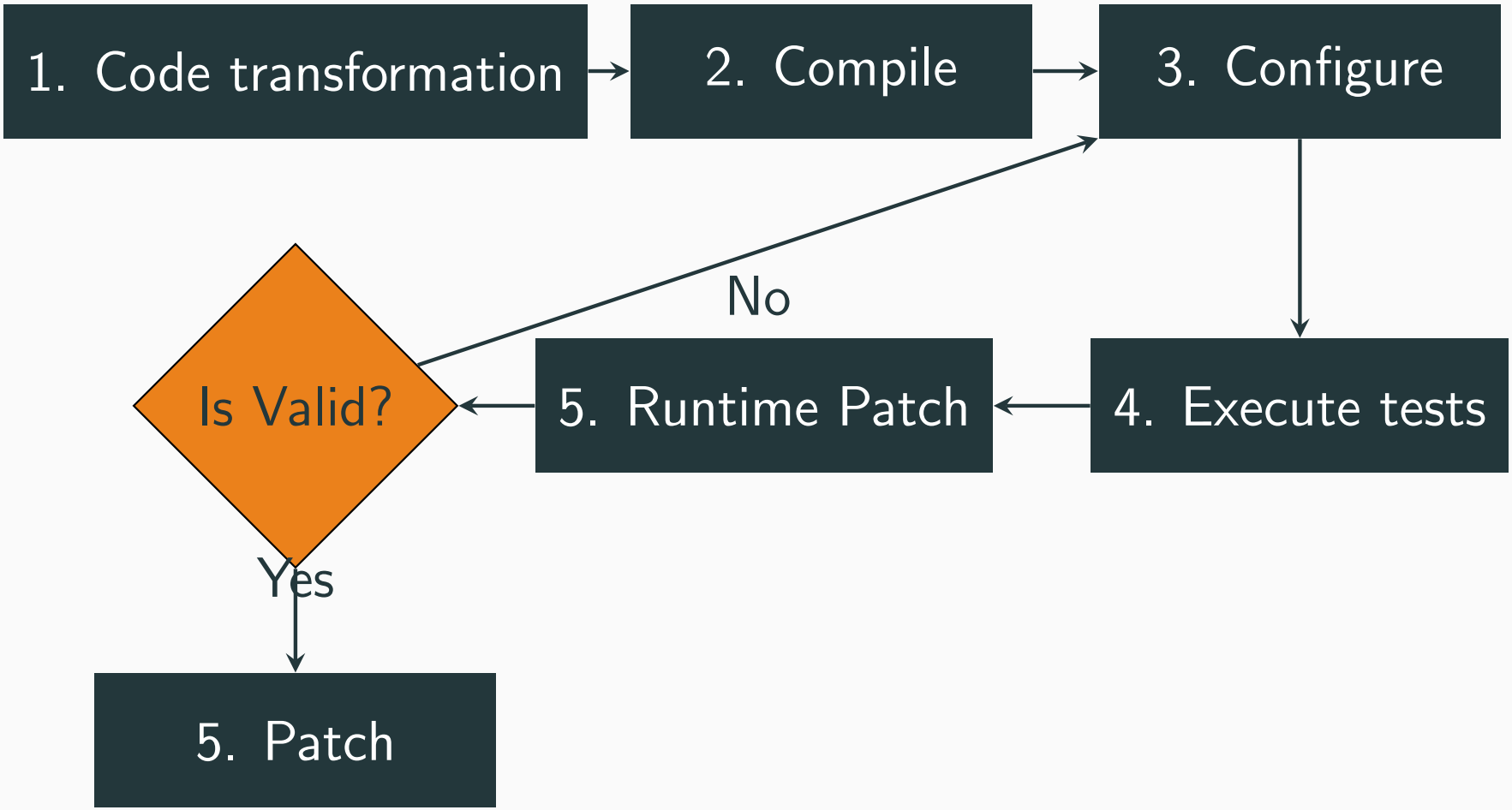
Is Valid?

NPEfix


1. Code transformation
2. Compile
3. Configure
4. Execute tests
5. Runtime Patch
Is Valid?
No
Yes
5. Patch

Patch Example

```
--- pdfbox/pdmodel/interactive/form/
    PDAcroForm.java
+++ pdfbox/pdmodel/interactive/form/
    PDAcroForm.java
@@ -250,2 +250,5 @@

+    if (fields == null) {
+        return retval; // reval is null
+    }
     for (int i = 0; i < fields.size() &&
         retval == null; i++)
```

Evaluation

Research Question

What is the impact of the meta programming approach compare to a template based approach on the number of patches?

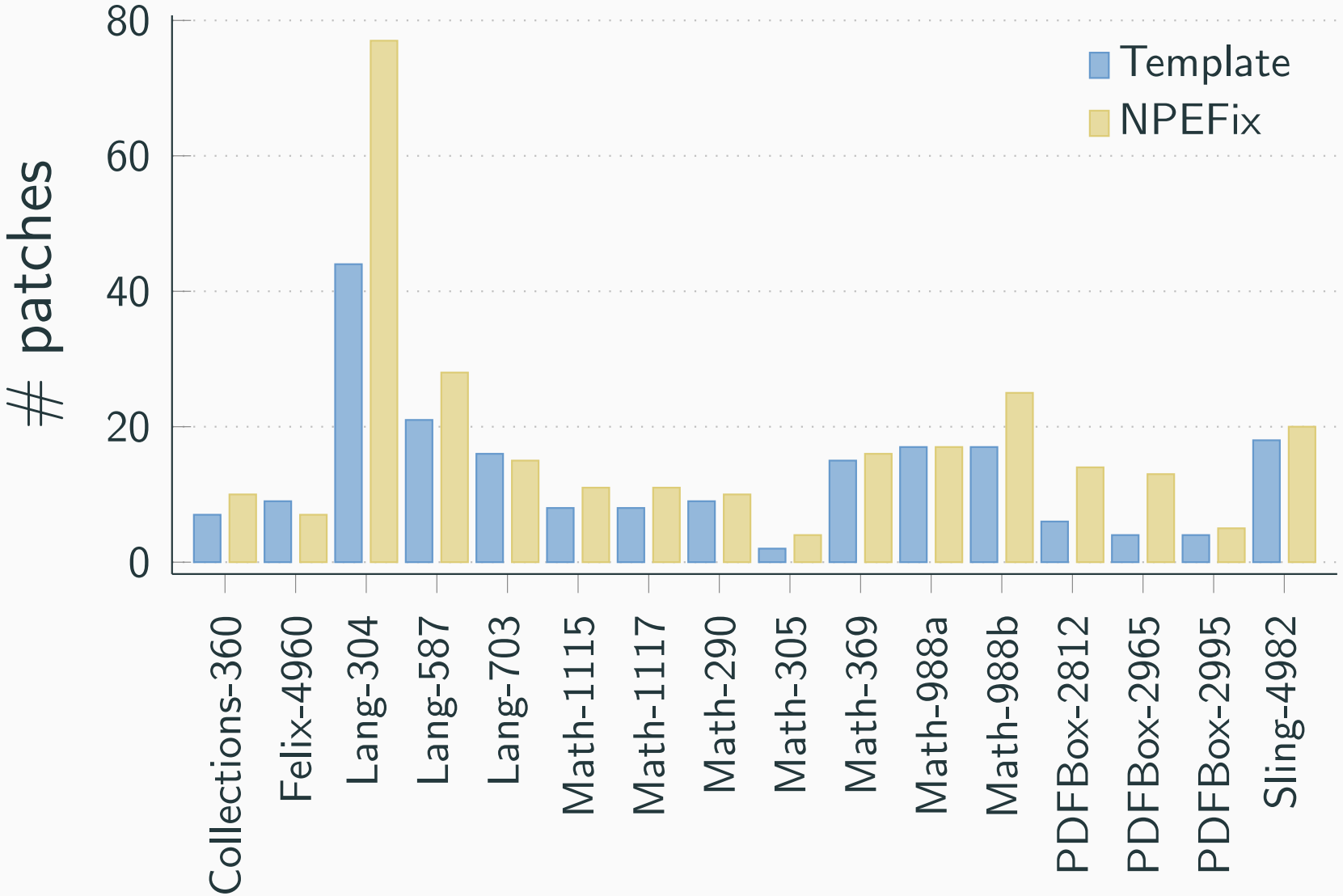
Evaluation Protocol

Compare metaprogramming to template based repair approach

16 real null dereference bugs

Collect the number of generated patches

The number of generated patches



Conclusion

Take way

It is possible to explore the embedded search space at runtime

Future work

Uses the metaprogramming approach for multi-points patches

`https://github.com/Spirals-Team/npefix`

Why do we use complex techniques when simple techniques work almost as well?