JBMC: A Bounded Model Checking Tool for Verifying Java Bytecode

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AI for Code

Toolympics / SV-COMP 2019

JBMC

Java and JVM languages:

- Most widely used
- Established software development culture

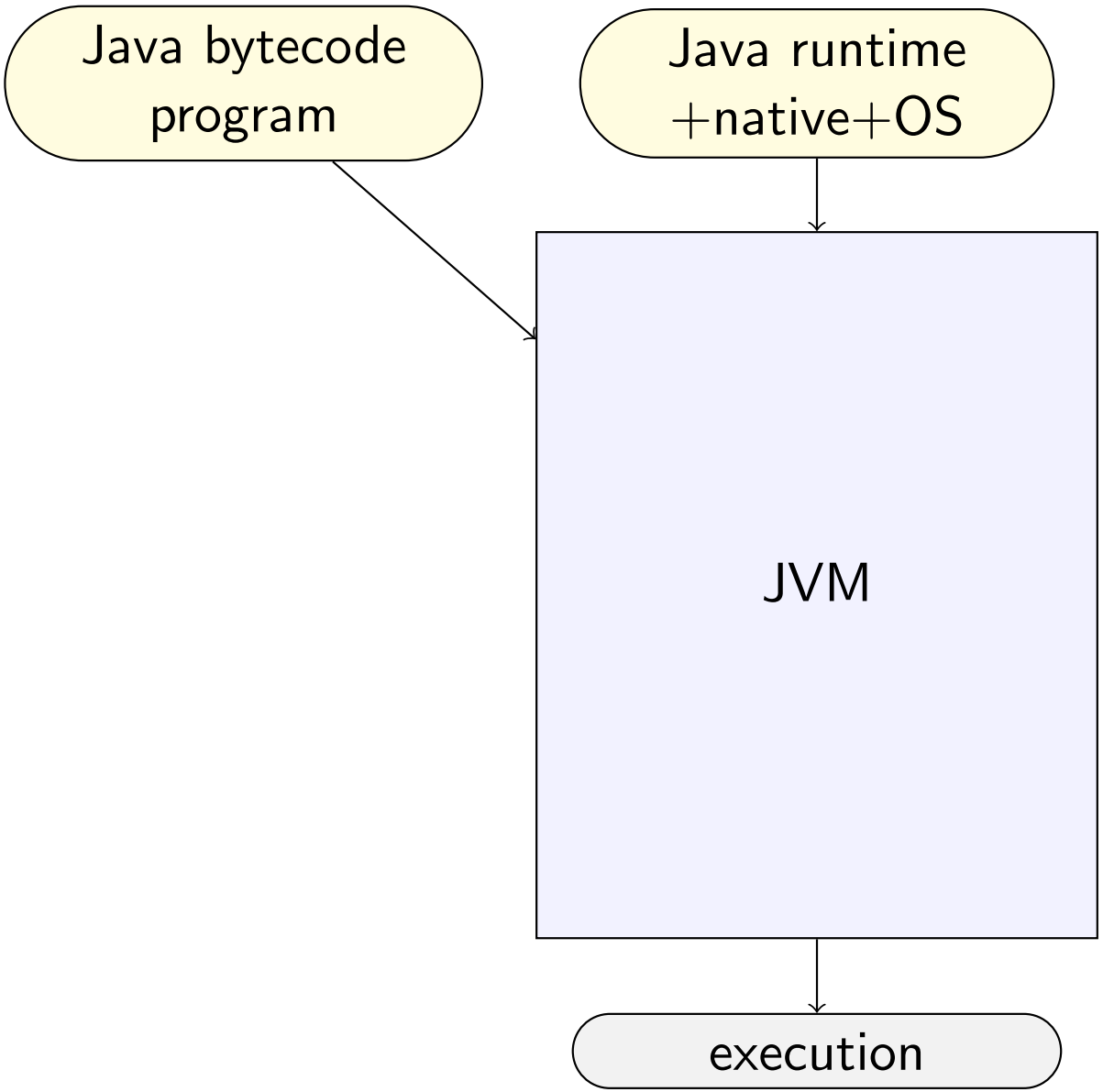
Only few model checking tools available:

- Symbolic JPF (Anand et al, TACAS'07)
- JayHorn (Kahsai et al, CAV'16)

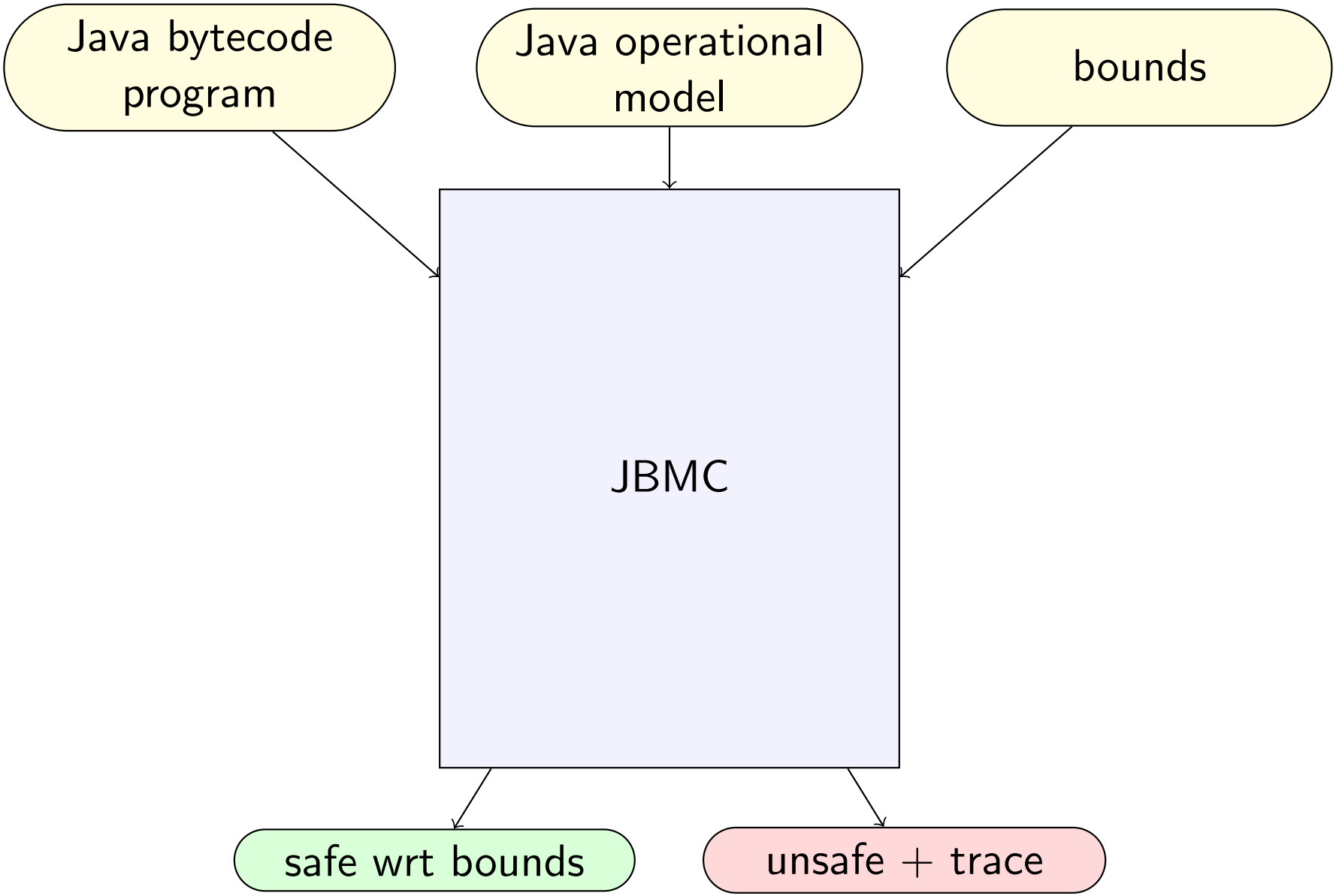
Many applications of BMC:

- Bug finding
- Program synthesis
- Test generation
- ...

JVM vs JBMC

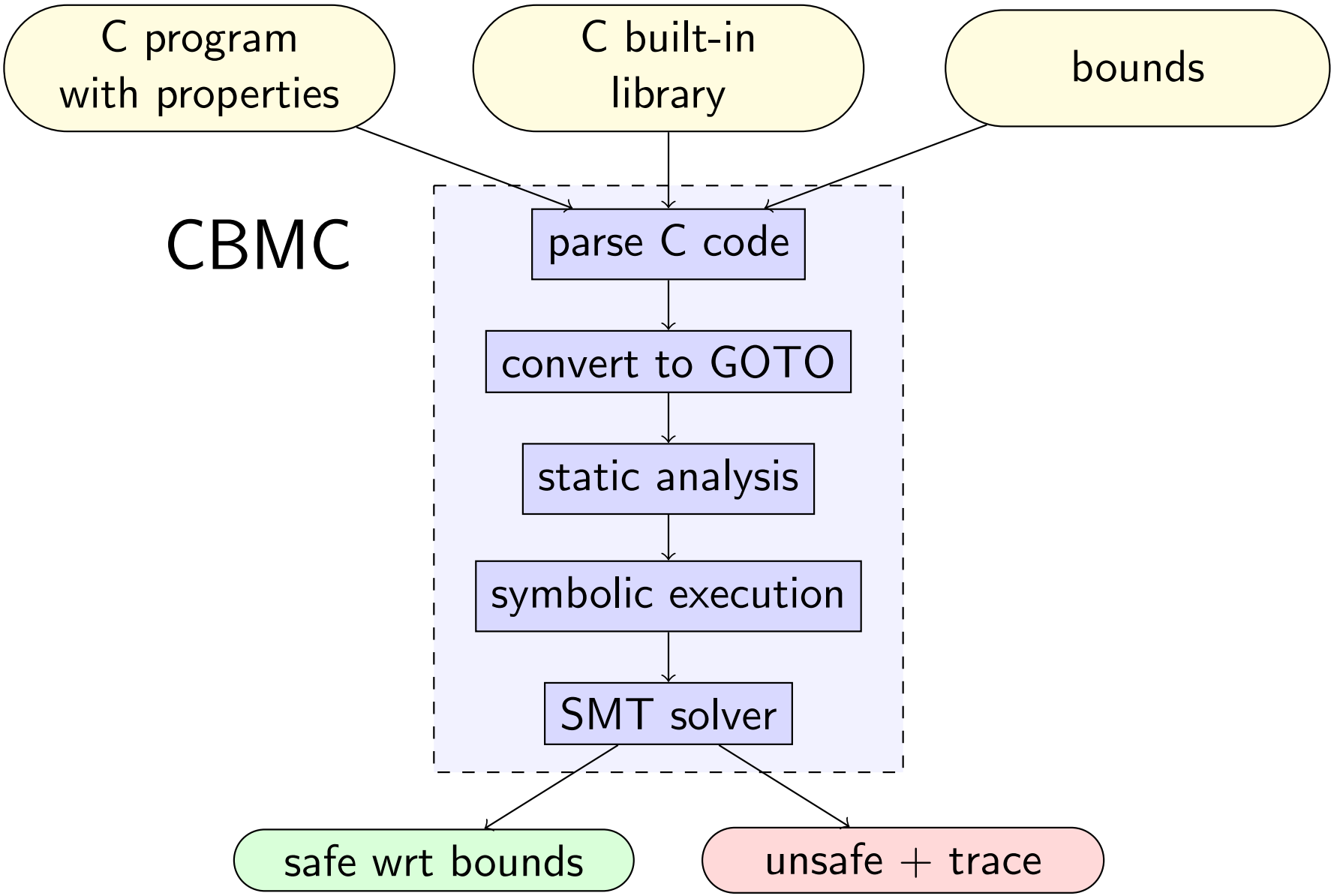

Java bytecode program
Java runtime +native+OS
JVM
execution

JVM vs JBMC


Java bytecode program
Java operational model
bounds
JBMC
safe wrt bounds
unsafe + trace

CBMC

Clarke, Kroening & Lerda, TACAS'04



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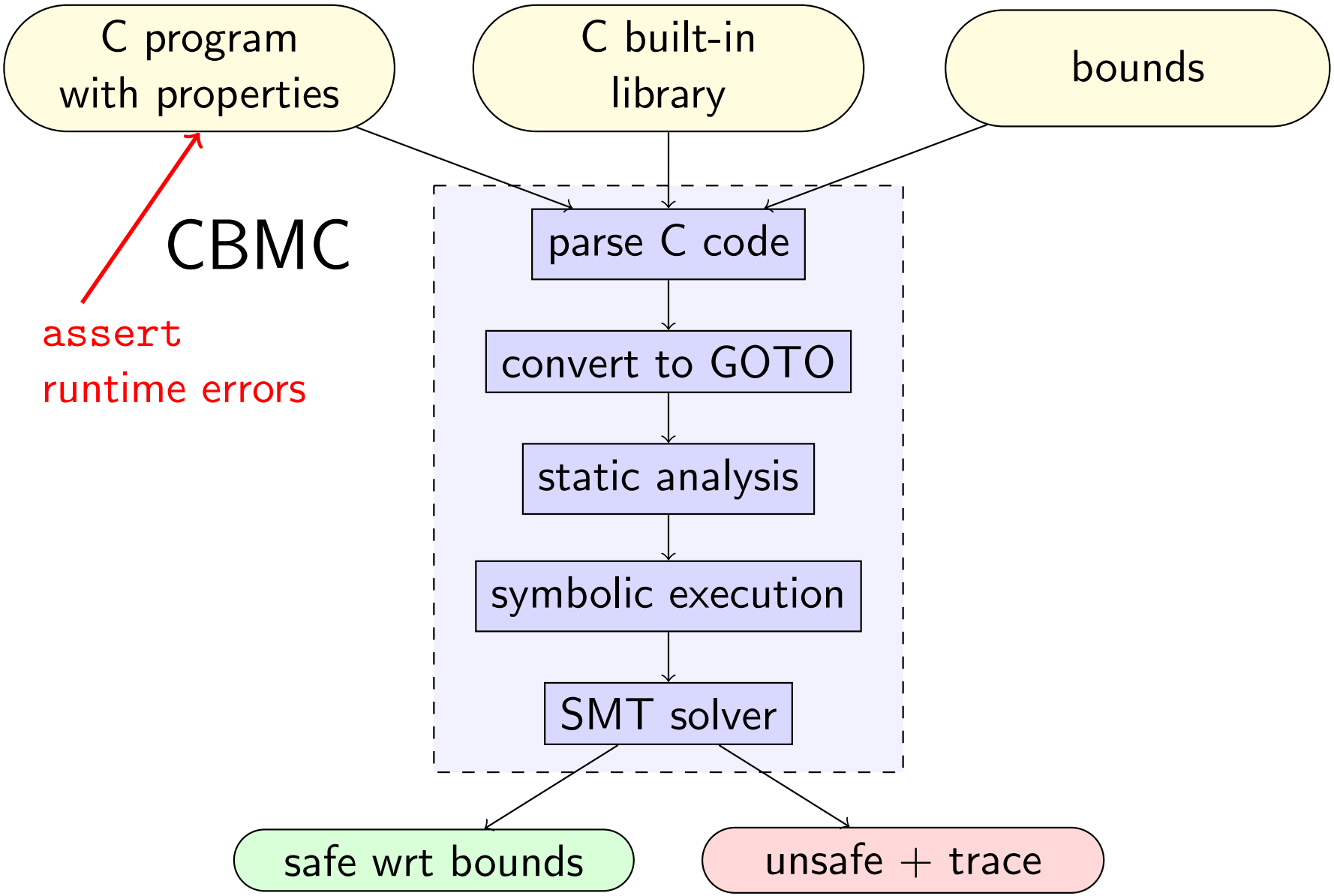

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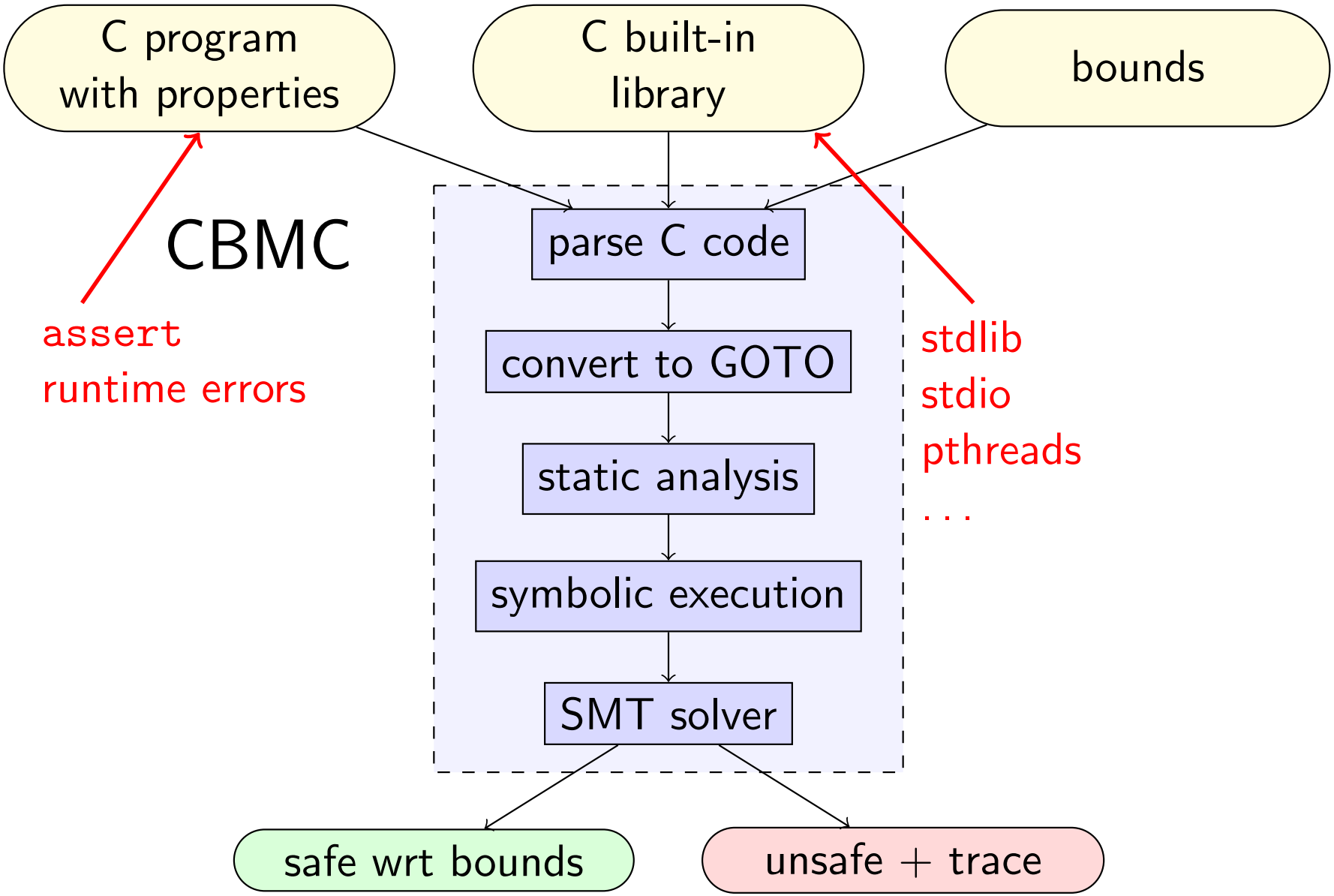

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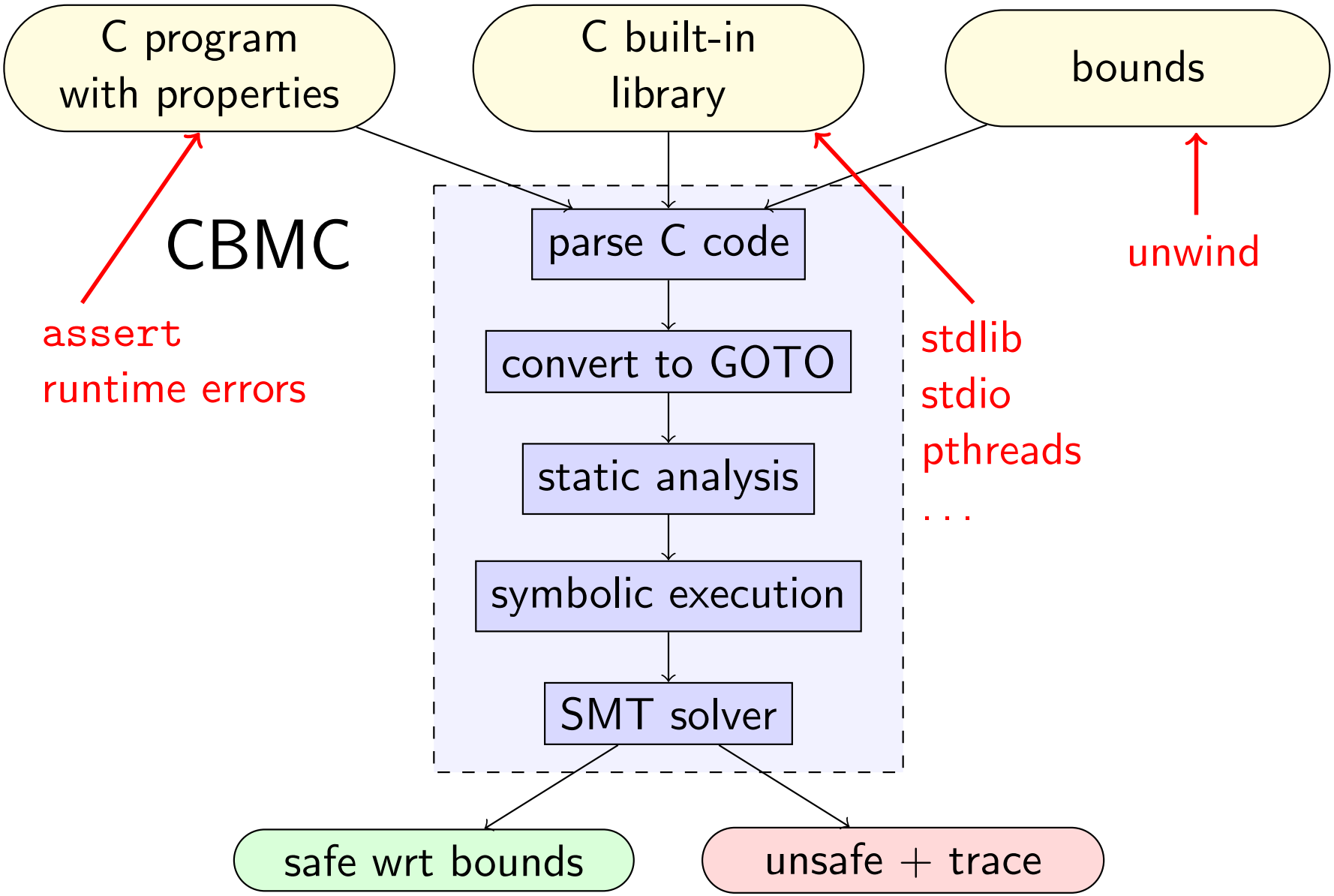

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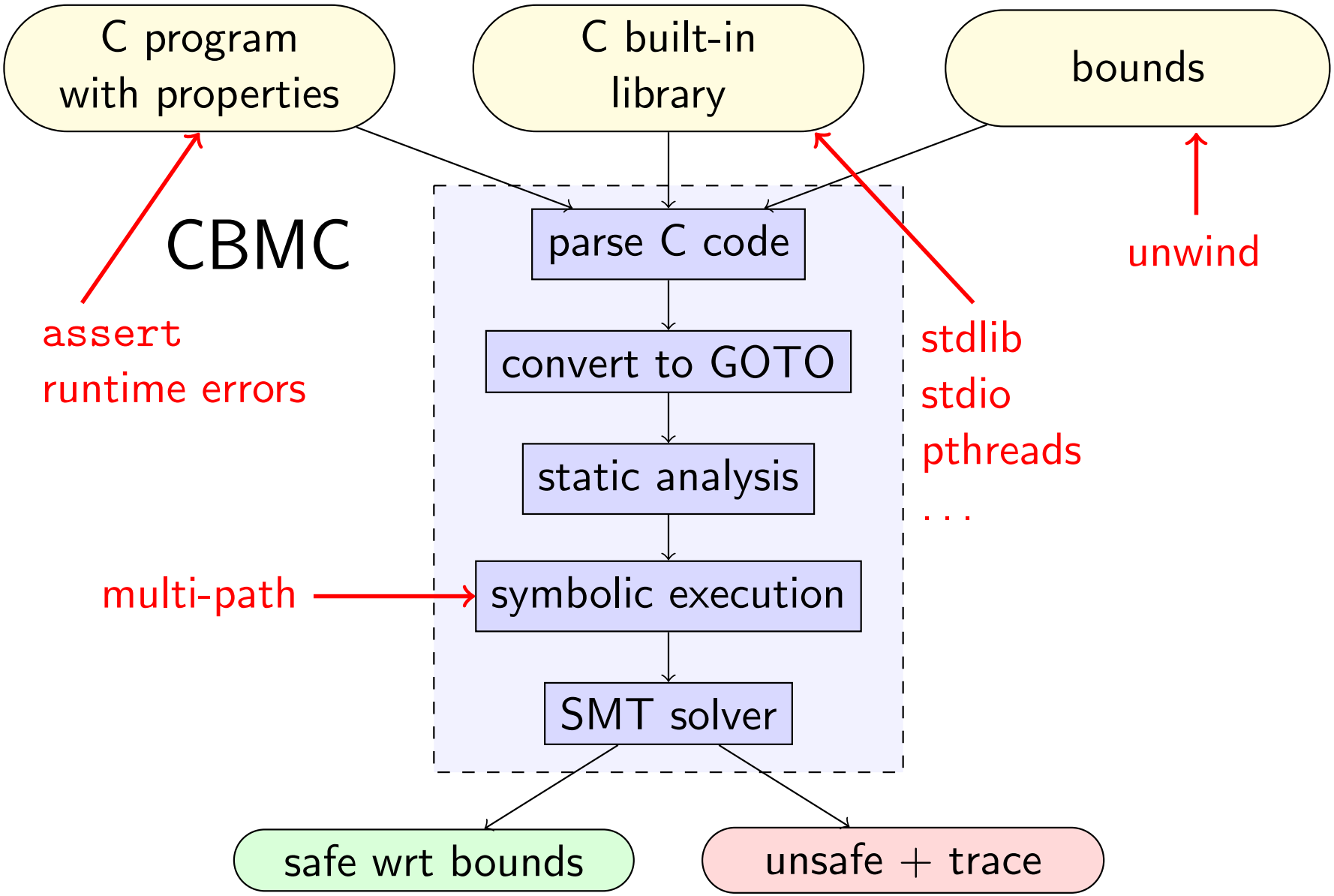

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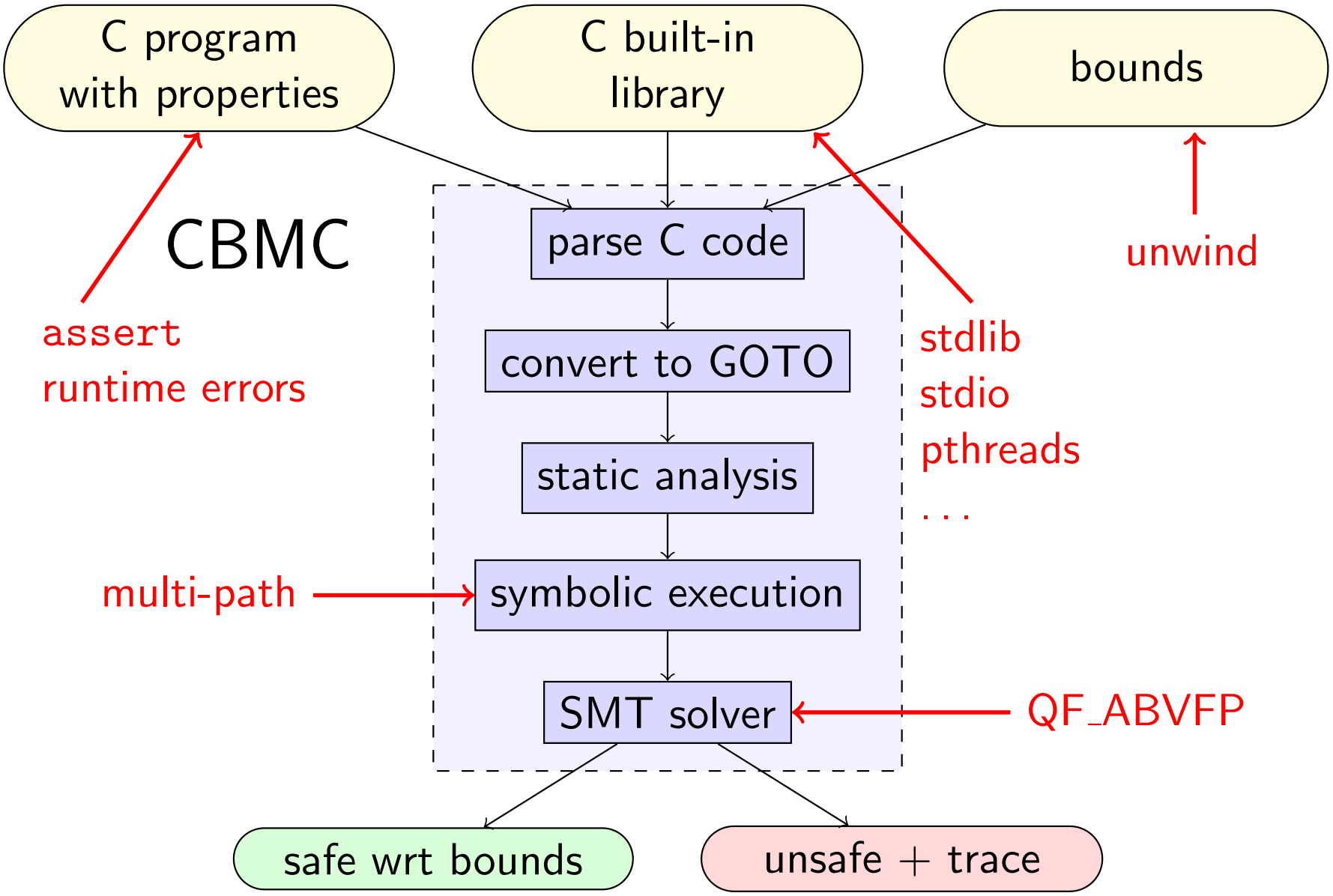
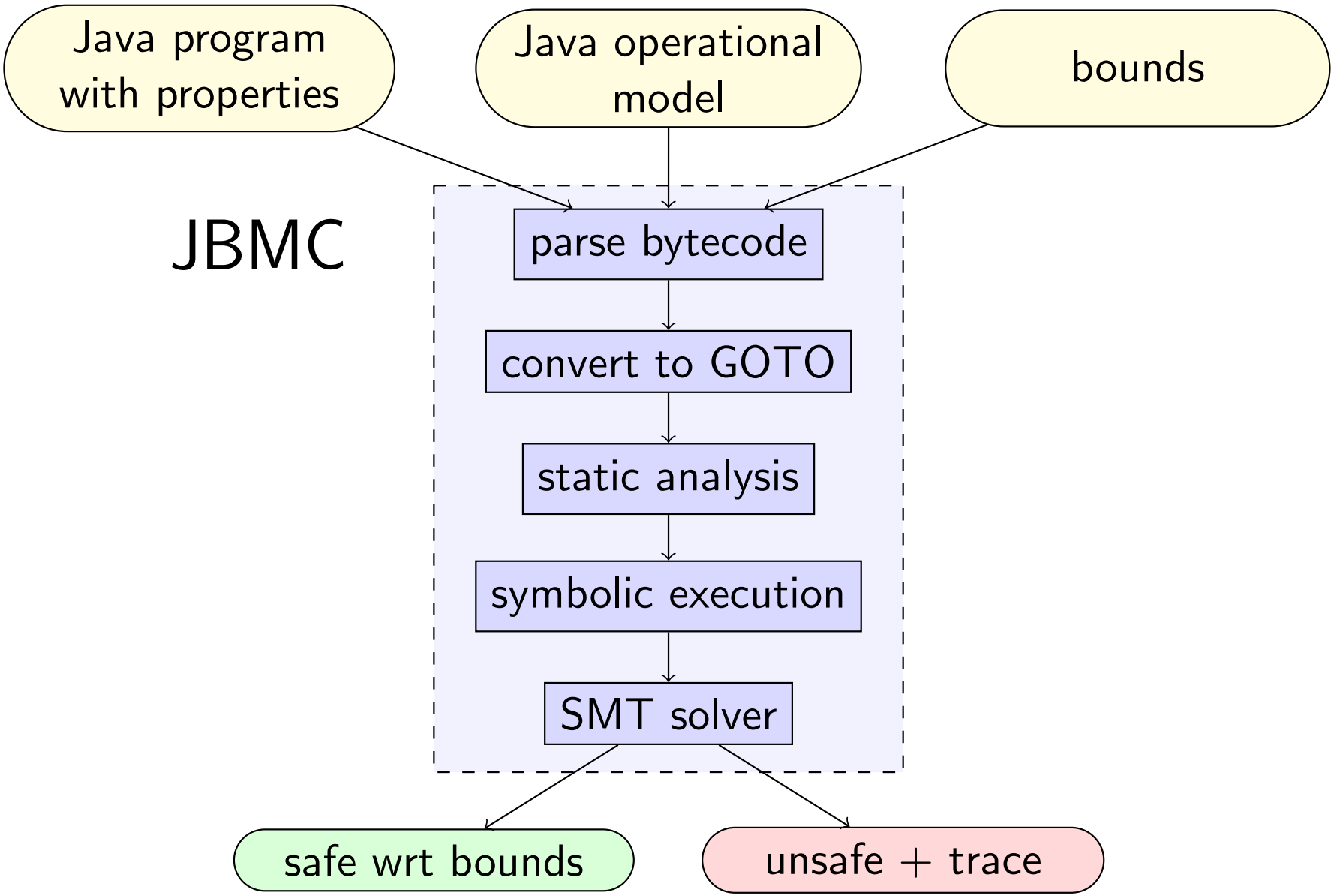


JBMC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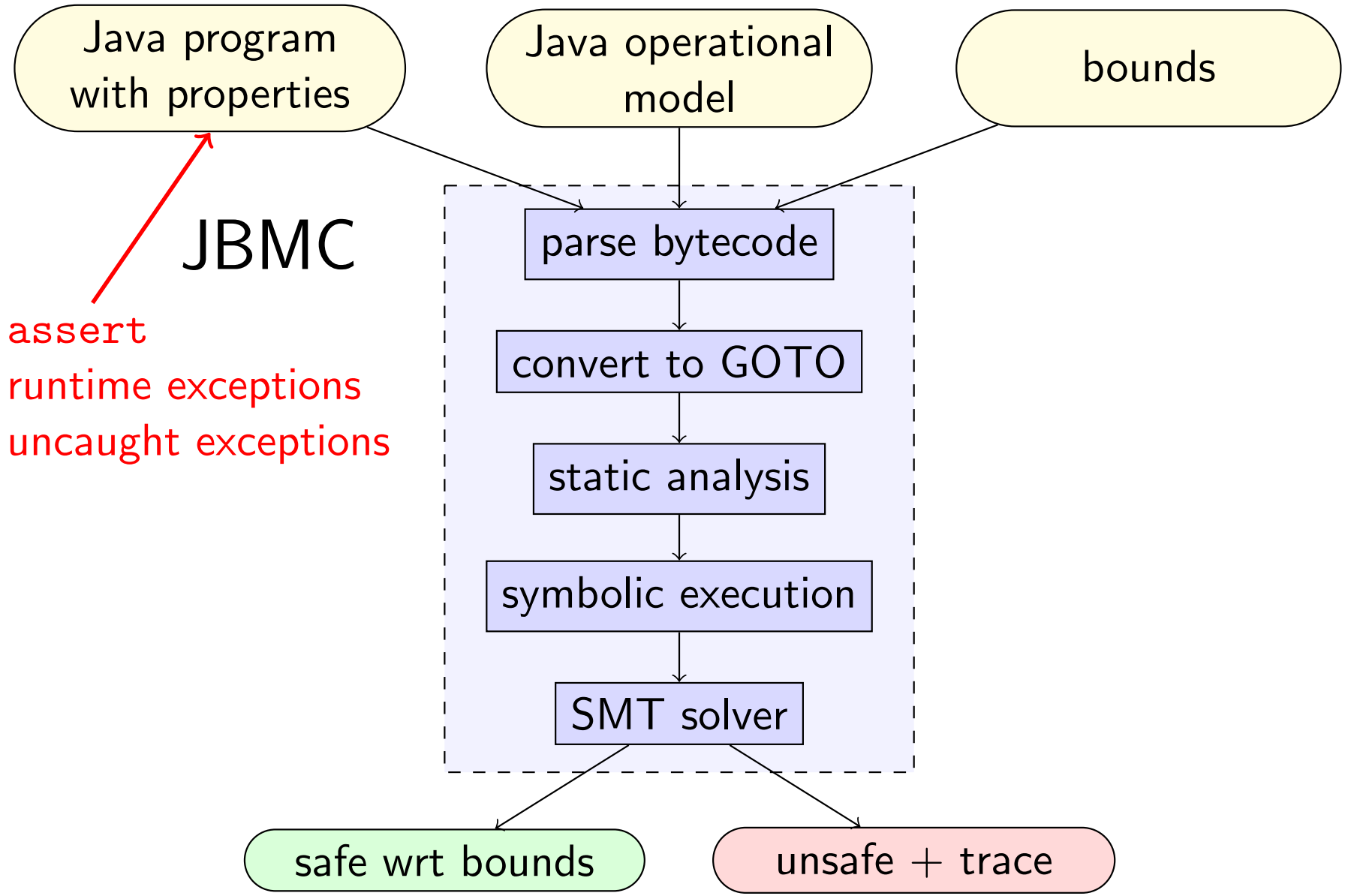
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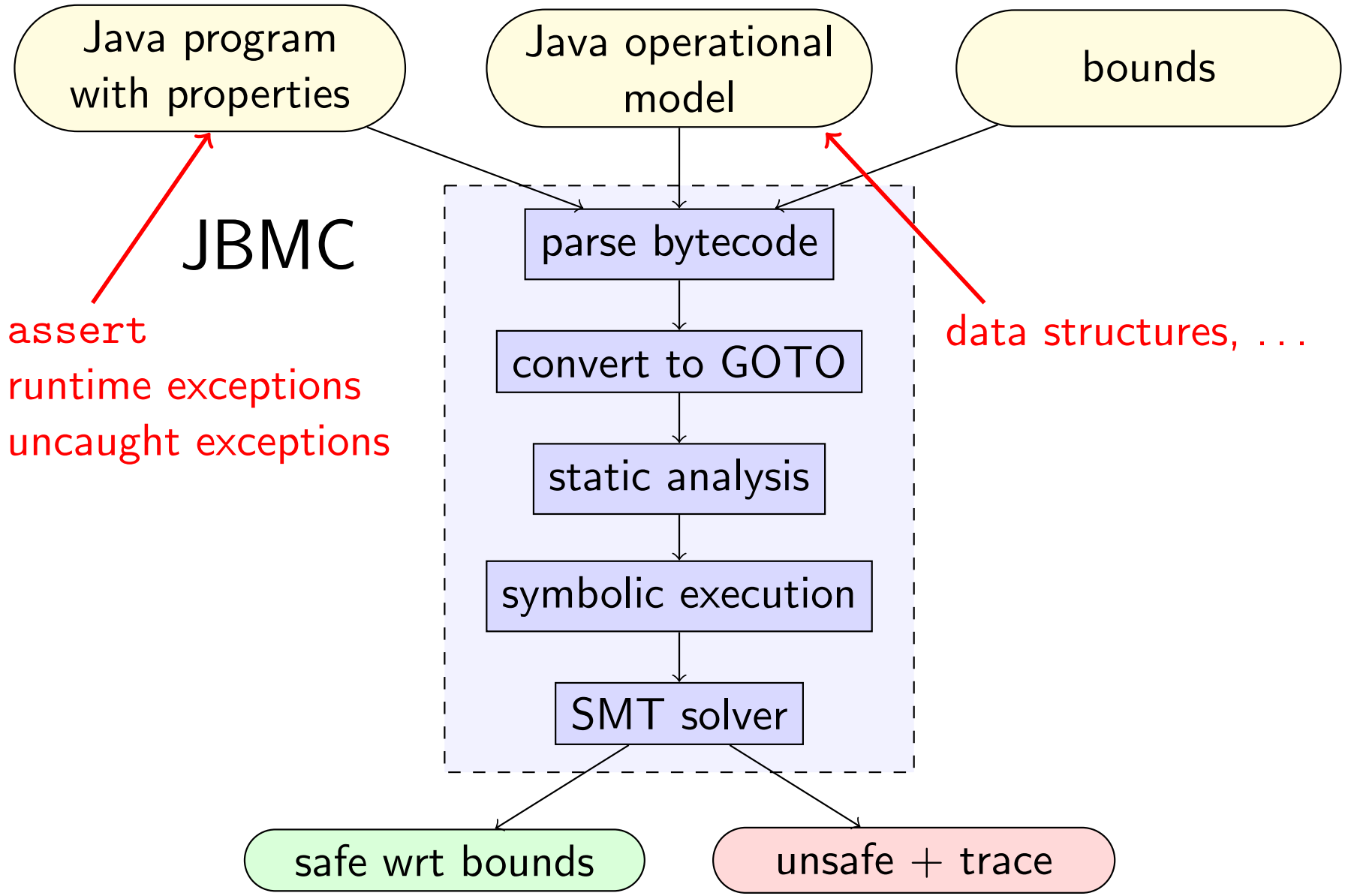
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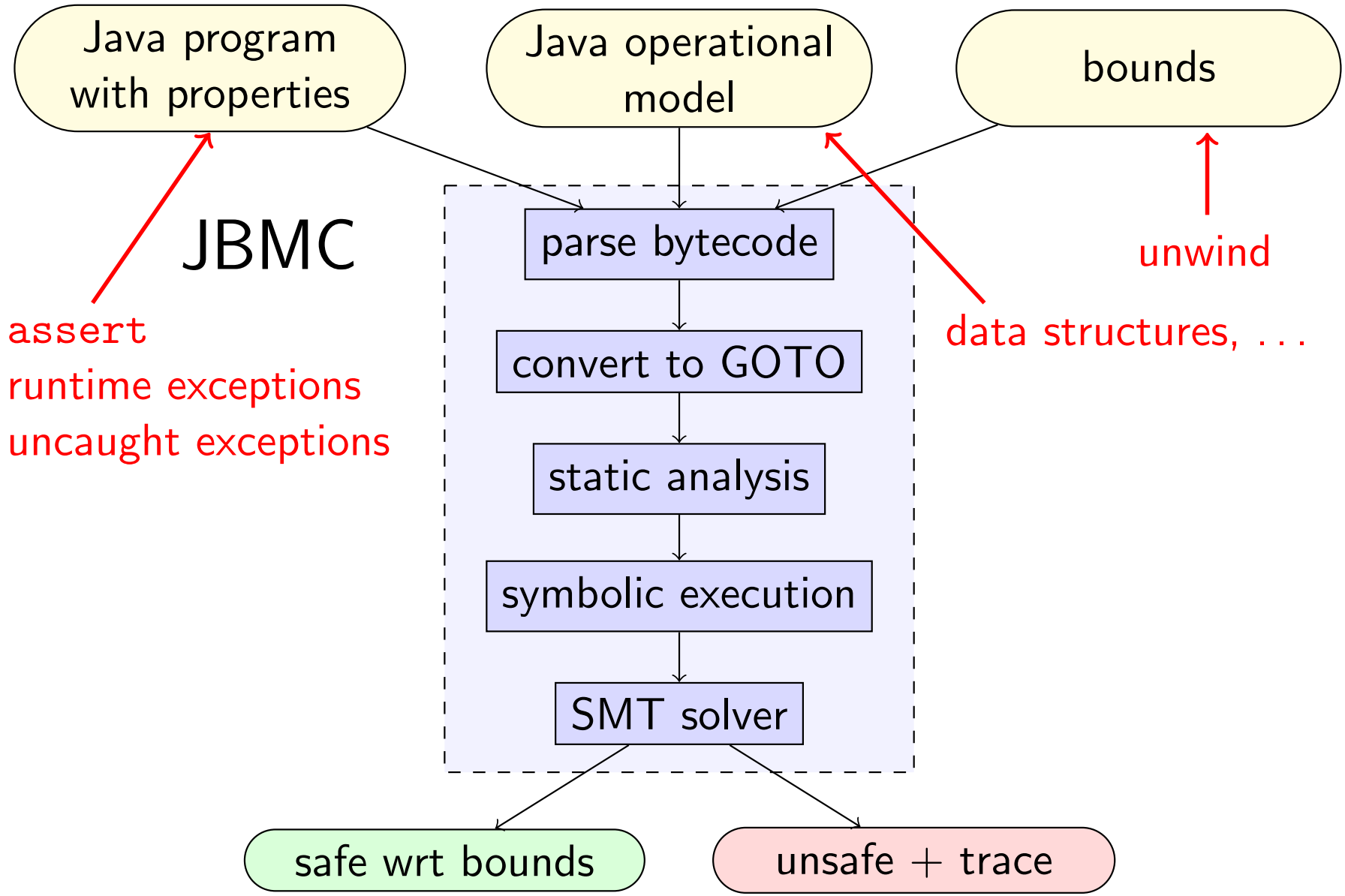
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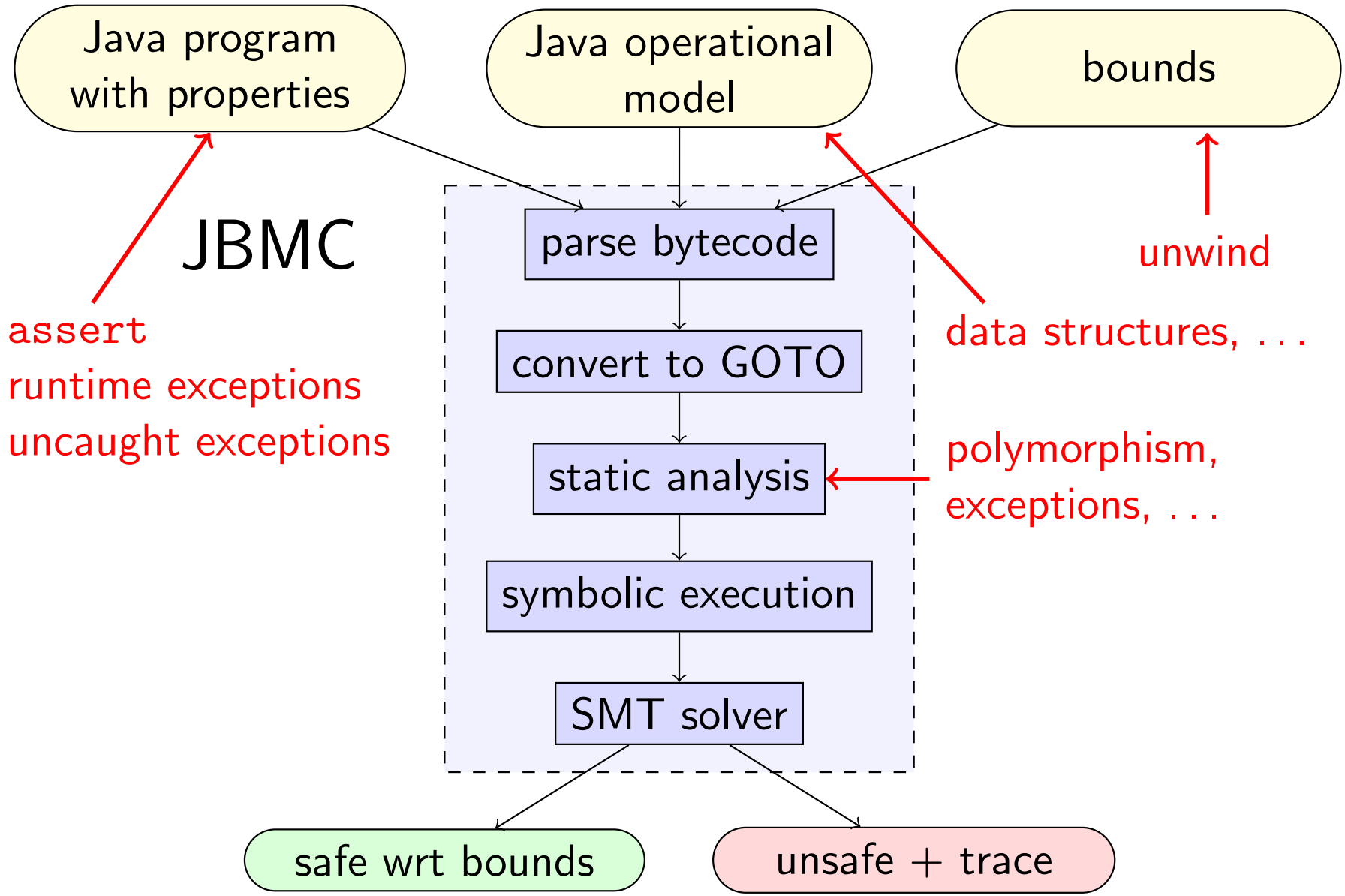
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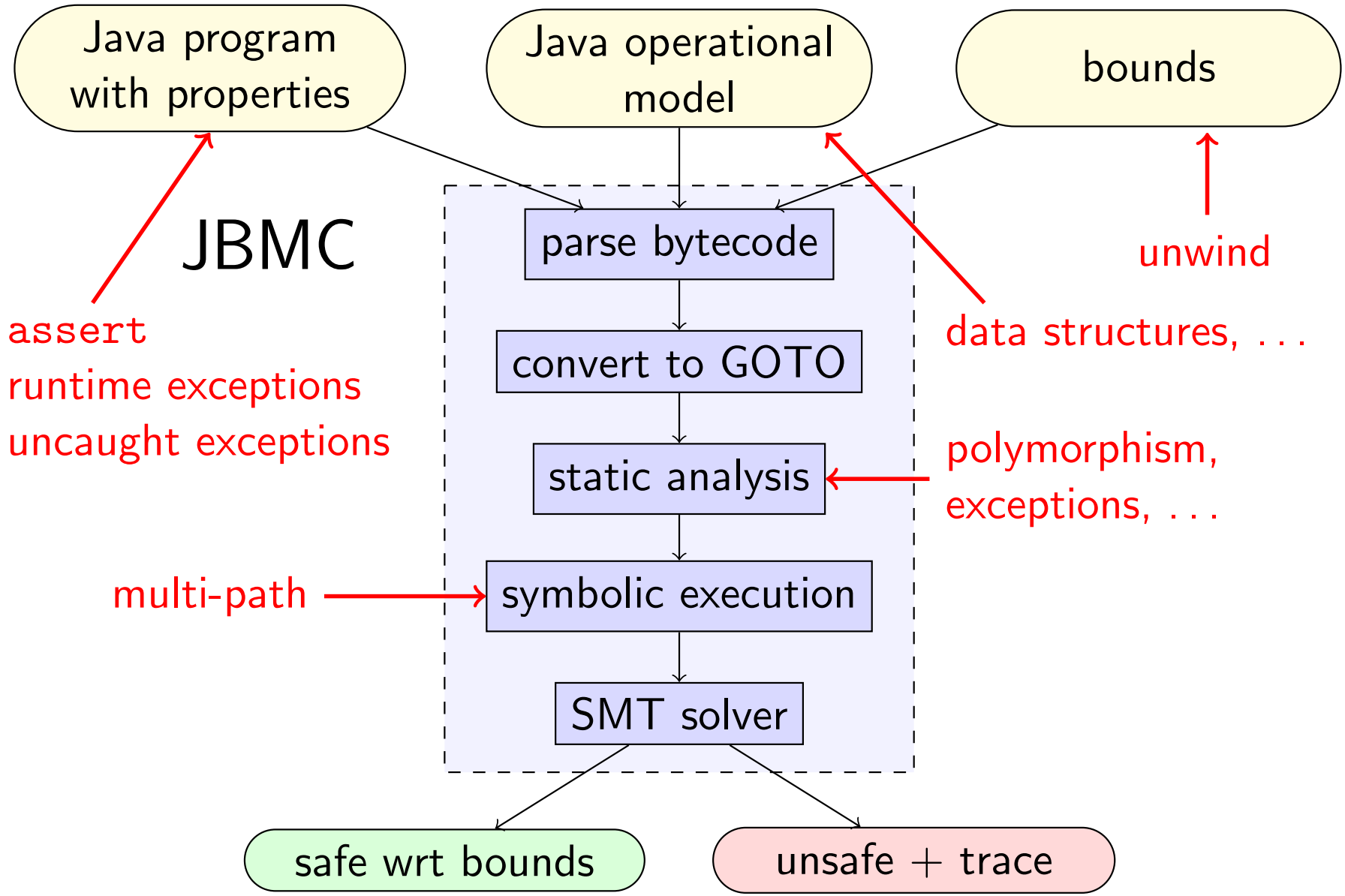
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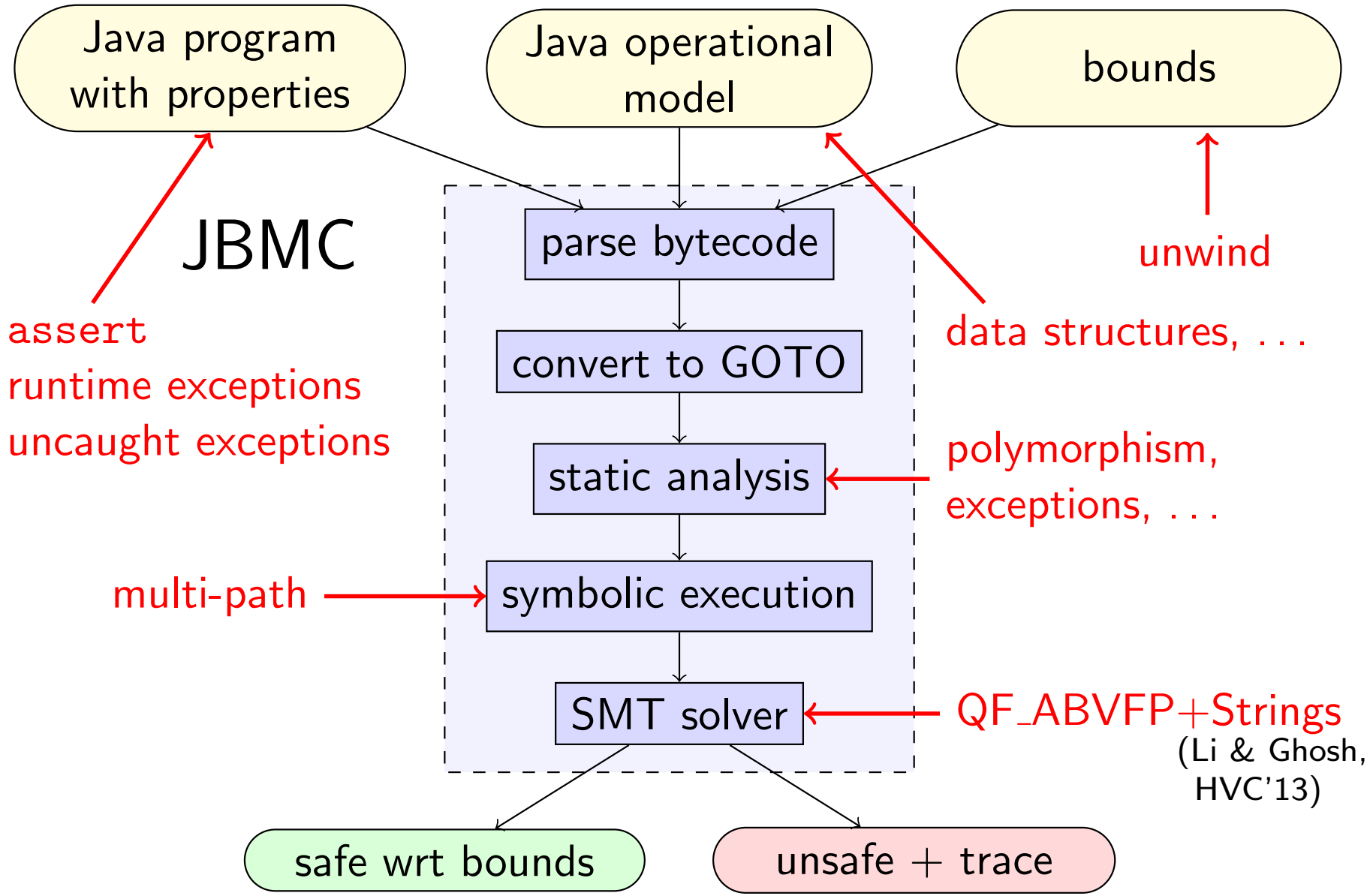
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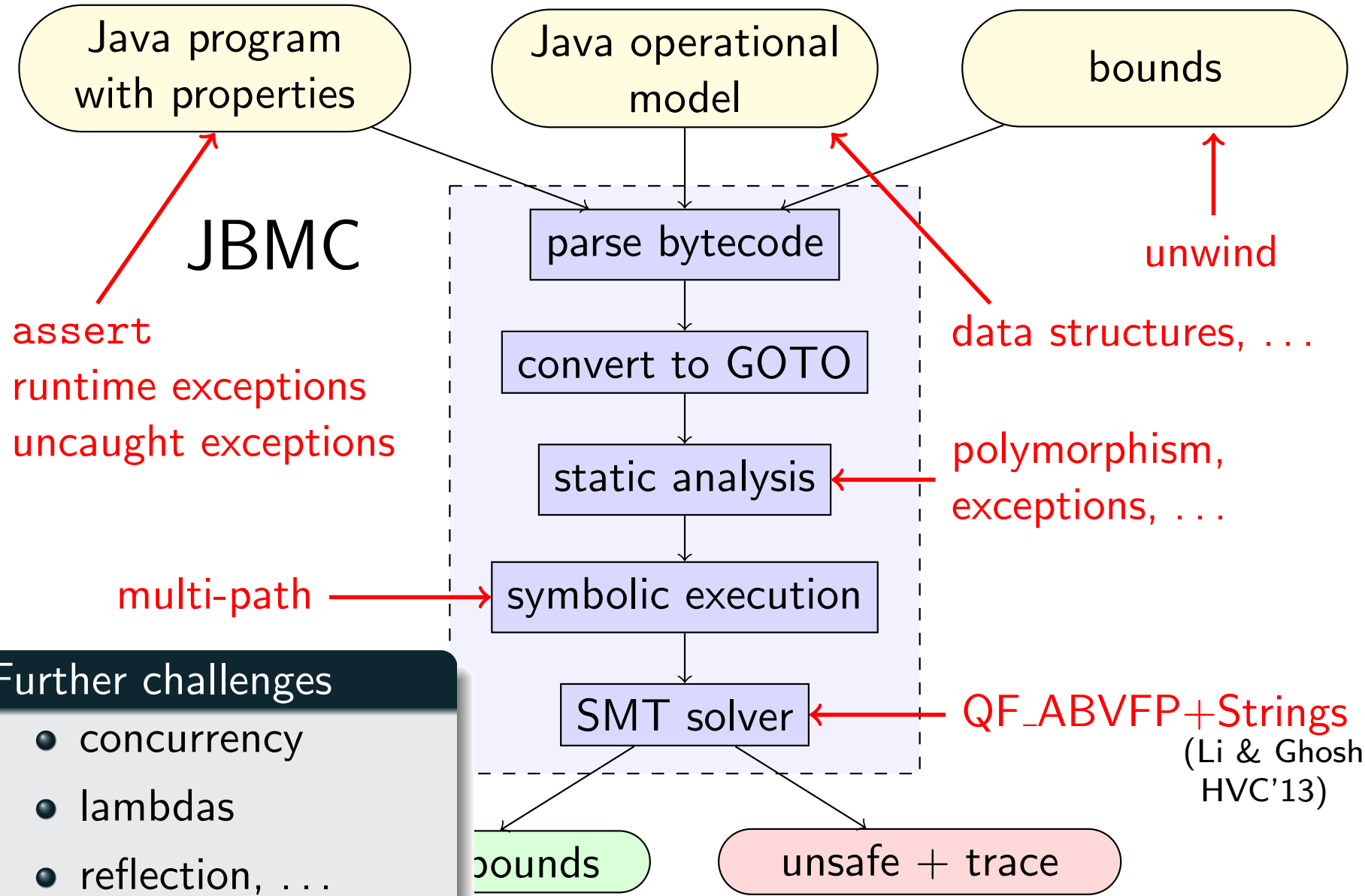
multi-path
QF_ABVFP+Strings
(Li & Ghosh, HVC'13)
safe wrt bounds
unsafe + trace

JBMC



Further challenges

- concurrency
- lambdas
- reflection, . . .

JBMC in Action

```
public class MyTranslator {
  static abstract class Translator {
    abstract String translate(String text);
    static Translator build(String language) {
      if("Chinese".equals(language))
        return new ChineseTranslator();
      return null;
    }
  }
  static class ChineseTranslator extends Translator {
    String translate(String text) {
      if(text.toLowerCase().contains("welcome to oxford"))
        return "欢迎来到牛津";
      return "I don't understand";
    }
  }
  public static void main(String[] args) {
    if(args.length < 2)
      return;
    Translator translator = Translator.build(args[0]);
    if(translator == null)
      return;
    String translatedText = translator.translate(args[1].trim());
    assert(!"欢迎来到牛津".equals(translatedText));
  }
}
```

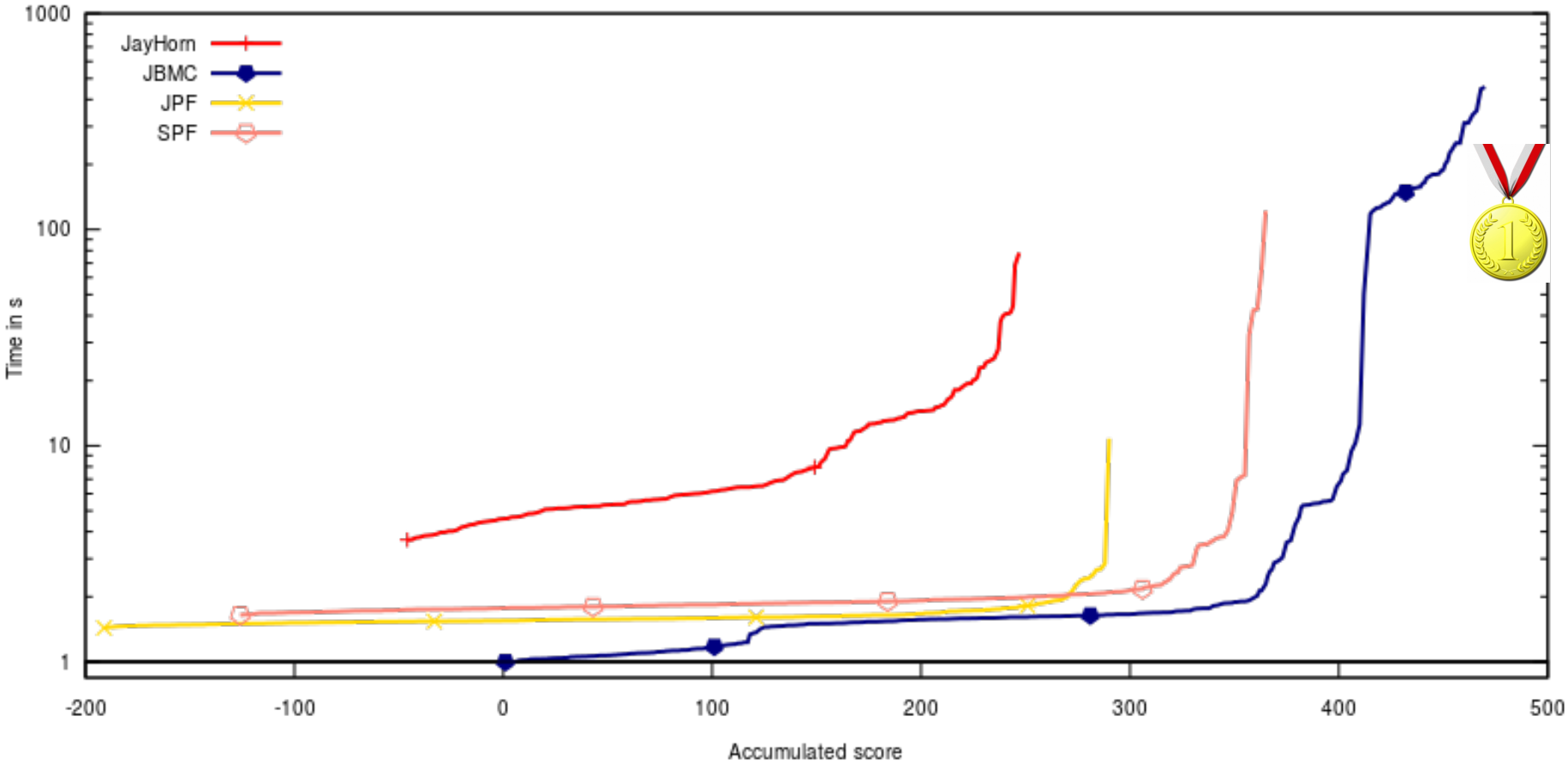
JBMC in Action

```
$ jbmc MyTranslator.class --classpath core-models.jar:. --trace
    --max-nondet-string-length 50

...
Runtime decision procedure: 0.786s
...
dynamic_object4={ 'C', 'h', 'i', 'n', 'e', 's', 'e' } // args[0].data
...
dynamic_object6={ '\u0010', '\u0017', 'w', 'e',
                  'w', 'E', 'L', 'C', 'O', 'M', 'E', ' ',
                  'T', 'o', ' ',
                  'o', 'x', 'f', 'o', 'r', 'D',
                  'x', 'x', 'x', 'x', 'x', 'x', 'x', 'x', 'x', 'x', 'x',
                  'x', ' ', ' ' }                    // args[1].data
...

Violated property:
  assertion at file MyTranslator.java line 31 function MyTranslator.main
```

SV-COMP 2019 Results



Strengths and Weaknesses

Good at

- Arithmetic, floating point arithmetic
- Strings

Limited/no support for

- Lambdas
- Concurrency
- Reflection
- JNI

What's next

JBMC:

- Concurrency support
- Witness output

SV-COMP 2020:

- Witness checker
- More and better benchmarks

Download JBMC and contribute!

`www.cprover.org/jbmc`