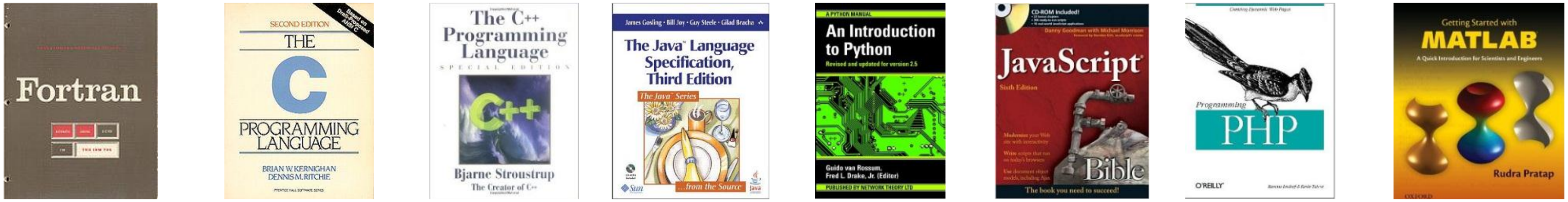
Multilingual Programming Made Easy

이병철

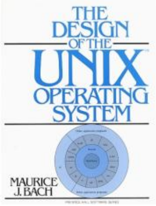
광주과학기술원

Evolving machines, programming languages, and systems

Faster and smaller machines used widely


Fortran
SECOND EDITION
THE C PROGRAMMING LANGUAGE
BRIAN W. KERNIGHAN DENNIS M. RITCHIE
The C++ Programming Language
SPECIAL EDITION
Bjarne Stroustrup
The Creator of C++
James Gosling · Bill Joy · Guy Steele · Gilad Bracha
The Java Language Specification, Third Edition
The Java Series
...from the Source
A PYTHON MANUAL
An Introduction to Python
Revised and updated for version 2.5
Guido van Rossum, Fred L. Drake, Jr. (Editor)
JavaScript
Sixth Edition
Bible
Danny Goodman with Michael Morrison
The book you need to succeed!
Programming PHP
O'REILLY
Getting Started with MATLAB
A Quick Introduction for Scientists and Engineers
Rudra Pratap
OXFORD

Innovative high level programming languages



OpenOffice.org™

mozilla Firefox

Apache Tomcat

android

Legacy libraries and systems

Evolving machines, programming languages, and systems

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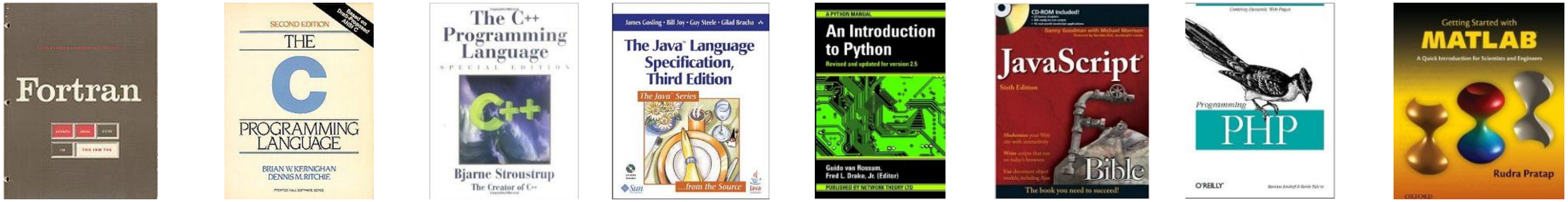
Portability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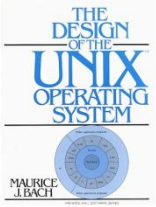

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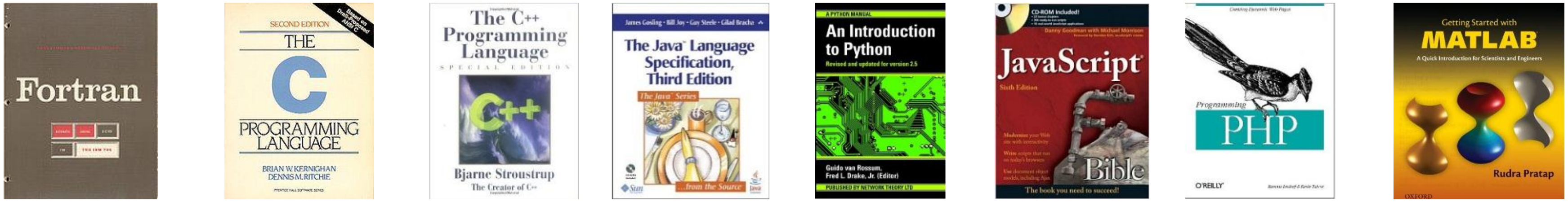
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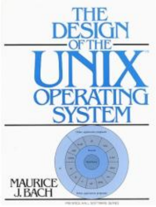
Complexity



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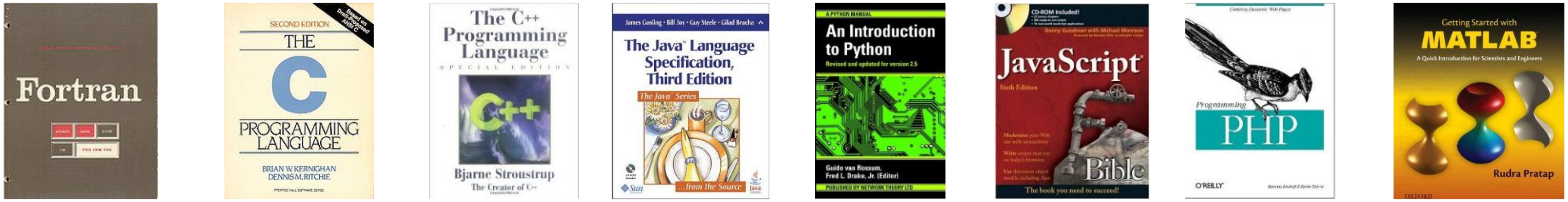
Heterogeneity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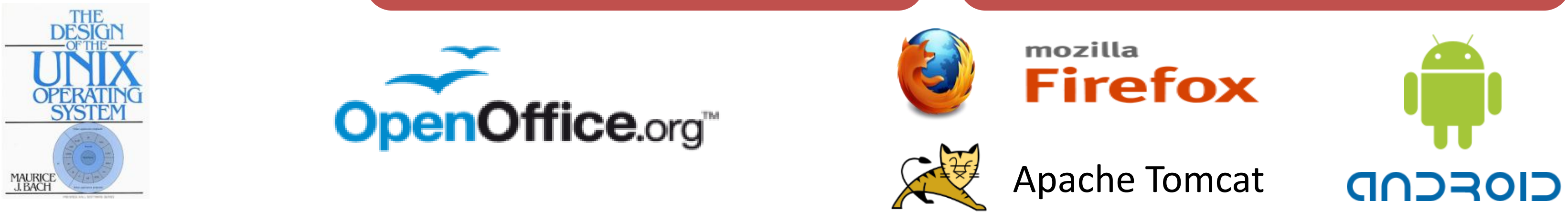
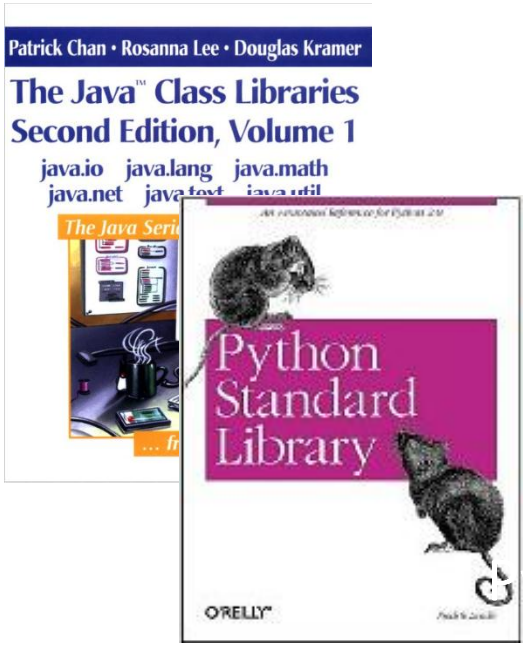
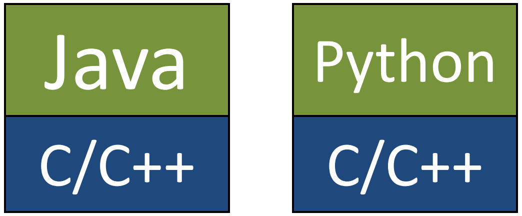


Legacy libraries and systems

Multilingual programs


Patrick Chan • Rosanna Lee • Douglas Kramer
The Java™ Class Libraries
Second Edition, Volume 1
java.io java.lang java.math
java.net
Python Standard Library
O'REILLY



Java

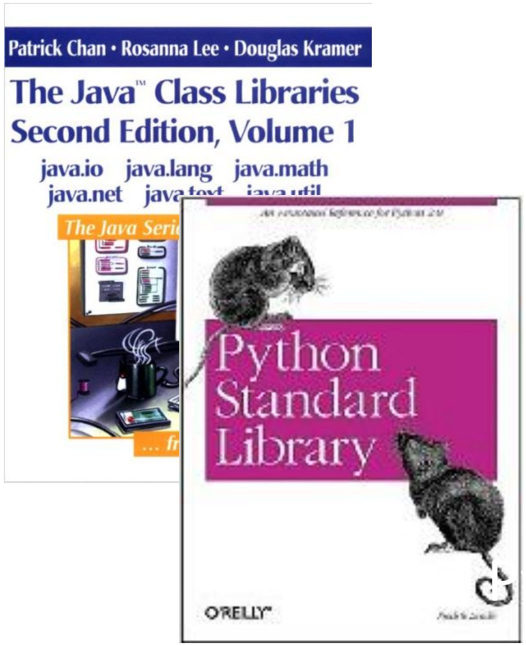
C/C++

Python

C/C++

Standard libraries

Multilingual programs



Patrick Chan • Rosanna Lee • Douglas Kramer

The Java™ Class Libraries Second Edition, Volume 1

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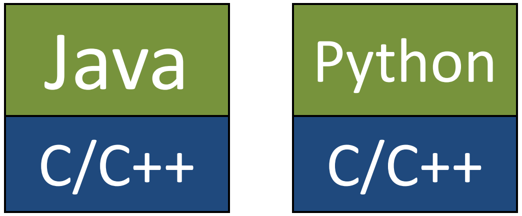
The Java Series

An essential reference for Python 2.0

Python Standard Library

O'REILLY®

Fredrik Lundh



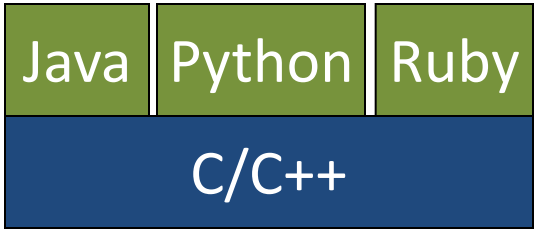
Java

C/C++

Python

C/C++

Standard libraries



Java

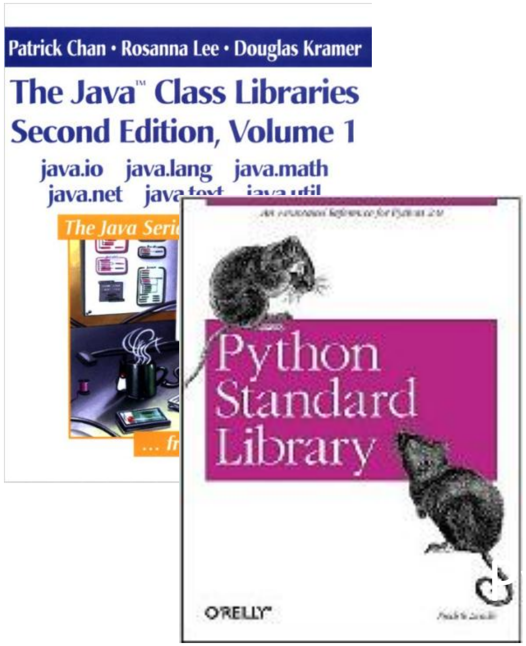
Python

Ruby

C/C++

Multilingual bindings

Multilingual programs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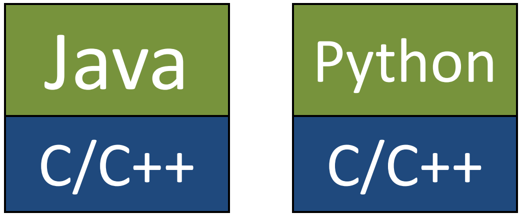
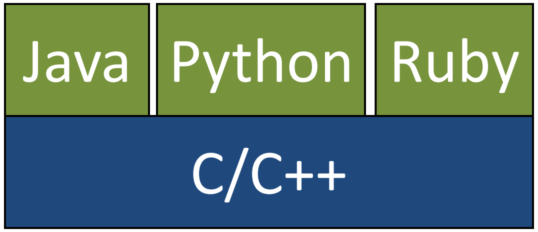

Java | Python
C/C++ | C/C++

Standard libraries


Java | Python | Ruby
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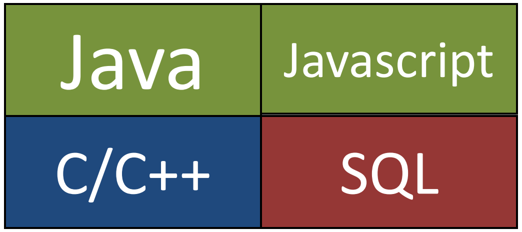
Multilingual bindings


Java | Javascript
C/C++ | SQL

Multilingual components

Active research groups in multilingual programming

	2005	2006	2007	2008	2009	2010	2011	2012
UNIVERSITY OF MARYLAND 1856	PLDI	ESOP	OOPSLA					
VE RI TAS HARVARD			OOPSLA		CCS	CCS	OOPSLA	PLDI
GIST THE UNIVERSITY OF TEXAS AT AUSTIN Microsoft Research IBM NEW YORK UNIVERSITY HARVEY MUDD COLLEGE			OOPSLA		OOPSLA	PLDI		ECOOP

PhD dissertation [Lee 2011]

Static analysis for Ocaml/C and JNI

Static and dynamic analysis for JNI

Composable analysis for language interfaces

Collaborators

GIST

Byeongcheol Lee

Microsoft Research

THE UNIVERSITY OF TEXAS AT AUSTIN

Kathryn S McKinley

IBM

Martin Hirzel

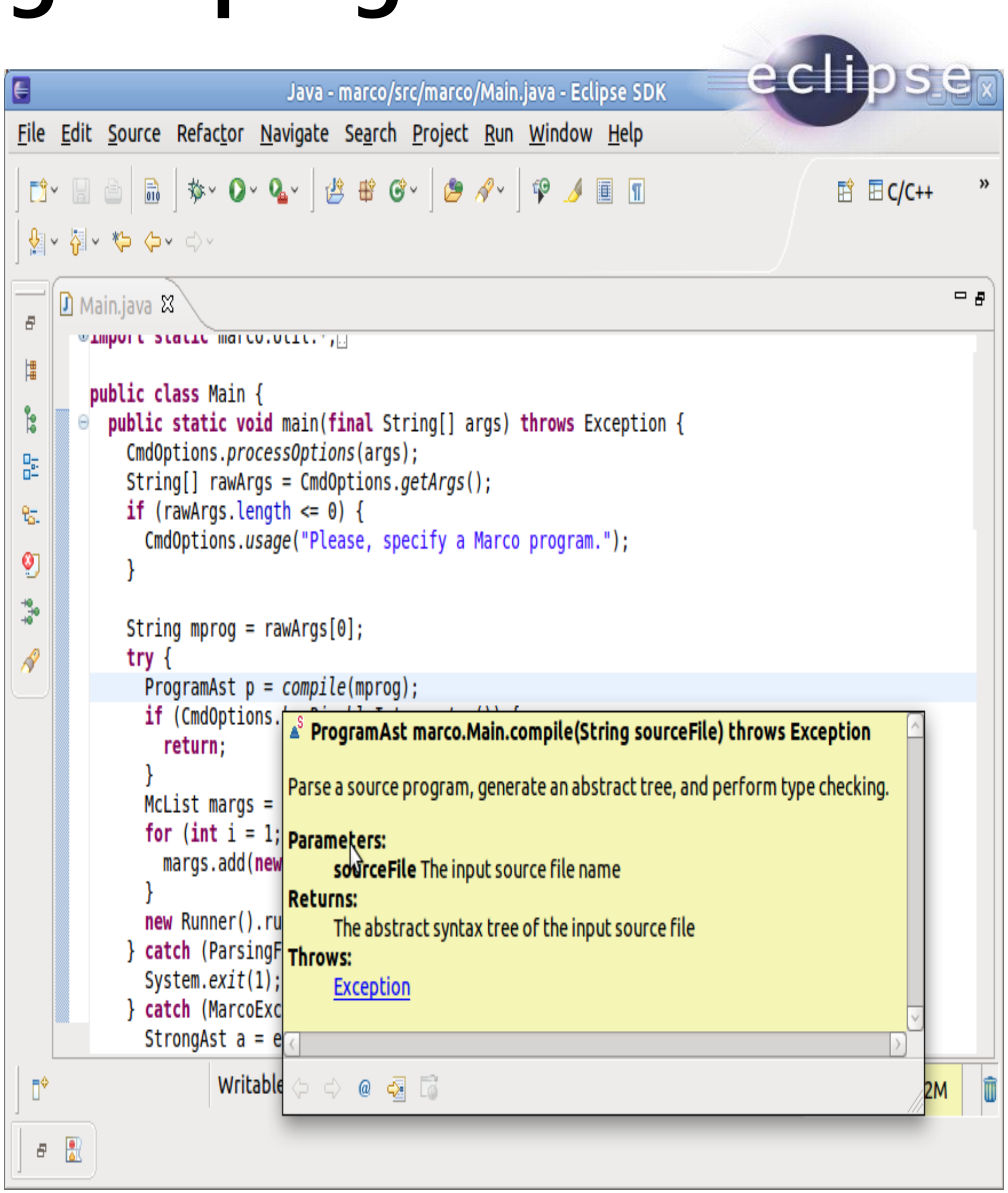
NEW YORK UNIVERSITY

Robert Grimm

HARVEY MUDD COLLEGE

Ben Wiedermann

Multilingual program



eclipse
Java - marco/src/marco/Main.java - Eclipse SDK
File Edit Source Refactor Navigate Search Project Run Window Help
C/C++
Main.java
Writable
2M

```
import static marco.util.*;

public class Main {
  public static void main(final String[] args) throws Exception {
    CmdOptions.processOptions(args);
    String[] rawArgs = CmdOptions.getArgs();
    if (rawArgs.length <= 0) {
      CmdOptions.usage("Please, specify a Marco program.");
    }

    String mprog = rawArgs[0];
    try {
      ProgramAst p = compile(mprog);
      if (CmdOptions.
        return;
      }
      McList margs =
      for (int i = 1;
        margs.add(new
      }
      new Runner().ru
    } catch (ParsingF
      System.exit(1);
    } catch (MarcoExc
      StrongAst a = e
```

ProgramAst marco.Main.compile(String sourceFile) throws Exception

Parse a source program, generate an abstract tree, and perform type checking.

Parameters:
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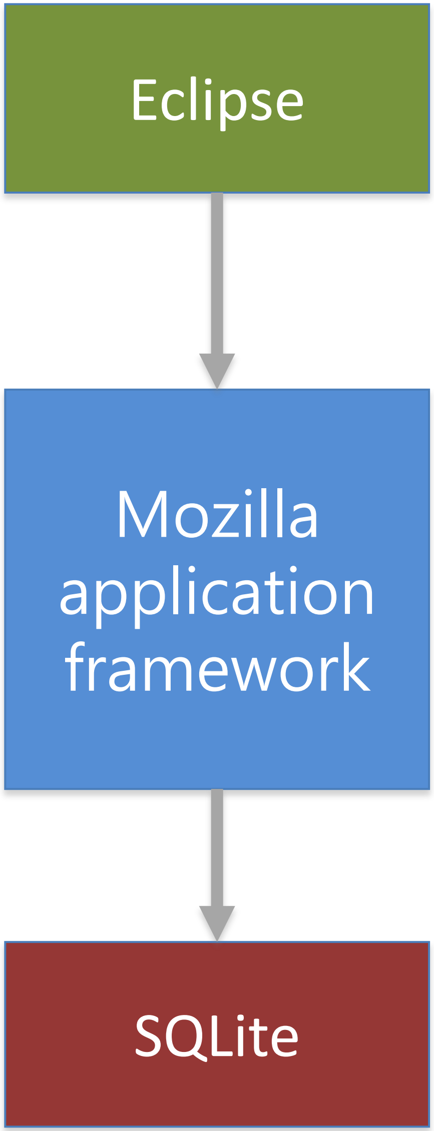
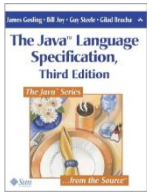
Returns:
  The abstract syntax tree of the input source file
Throws:
  Exception

Crossing language boundaries




James Gosling · Bill Joy · Guy Steele · Gilad Bracha
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The Java™ Series
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Sheng Liang
The Java™ Native Interface
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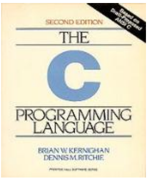

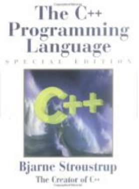

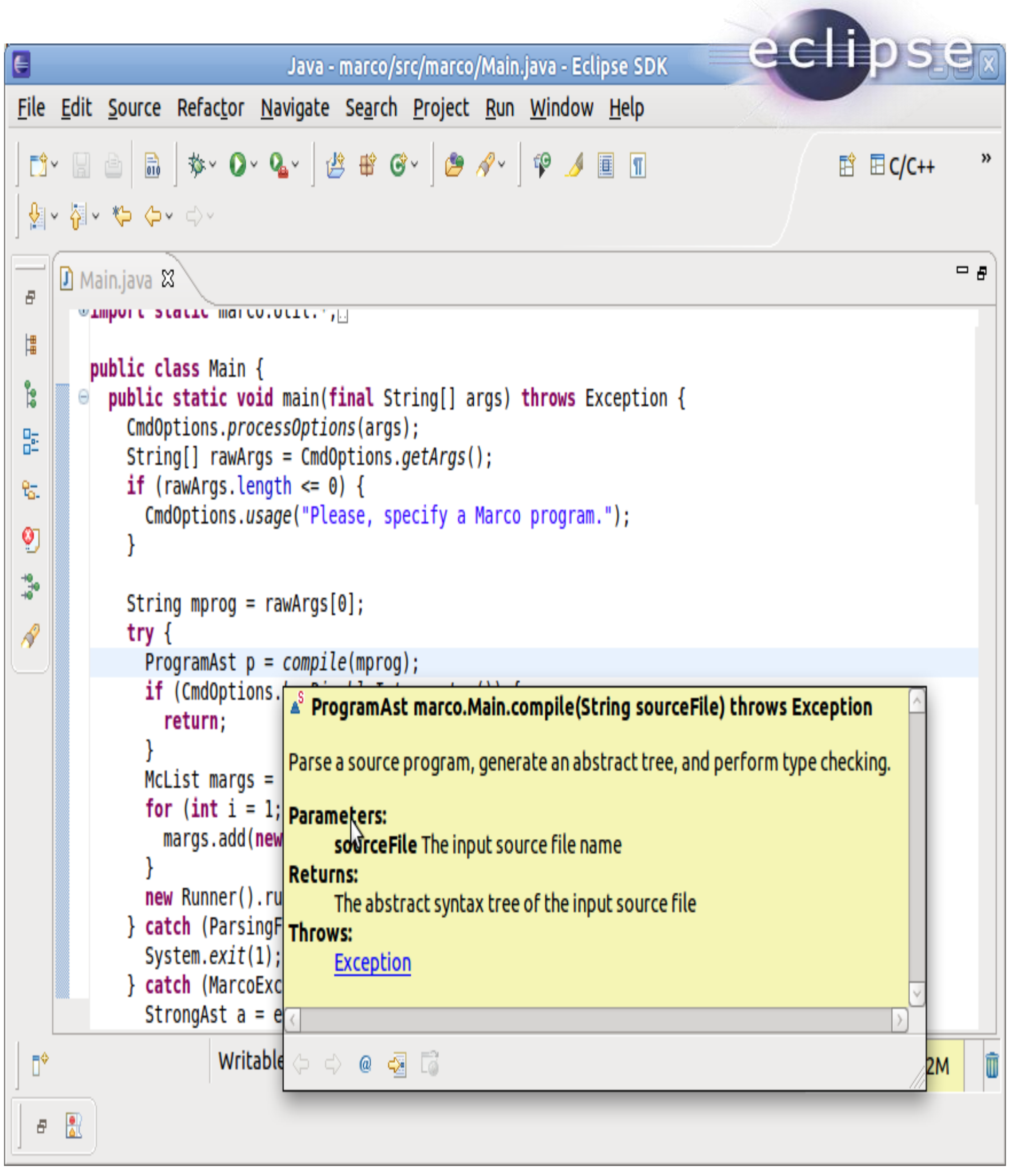
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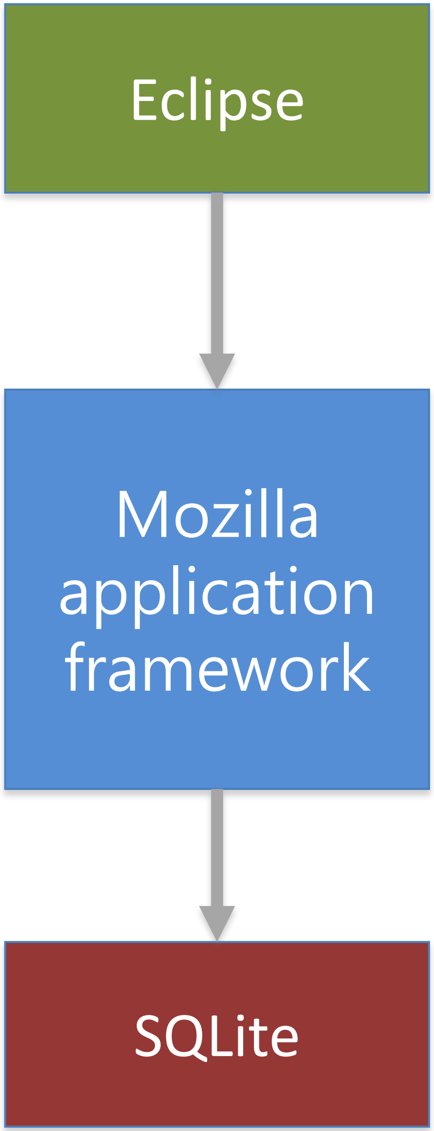

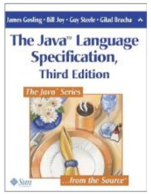
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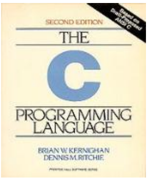

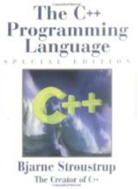

```
class Eclipse {
   native void show(String page);
}
void Java_Eclipse_show(JNIEnv* e,
     jobject jpage) {
   char *cpage =
            (*e)->GetStringUTFChars(e, jpage);
     Mozilla::show(cpage);
}
void Mozilla::show(string cpage) {
  sqlite3_run(
            “select title from bookmark”
            +  “where” + predicate(cpage)
  );  …}
```

Programming pitfalls

```
class Eclipse {
  native void show(String page);
}
```

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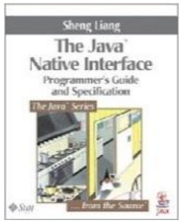

- Is it OK to call a JNI function here?
- Does “jpage” point to a Java string?
- Is “cpage” going to be released eventually?

Synthesizing dynamic FFI bug checker [PLDI’10]

Programming pitfalls

Is the SQL command syntactically correct?

Marco: safe, expressive macros for any language [ECOOP'12]

```
void Mozilla::show(string cpage) {
  sqlite3_run(
        “select title from bookmark”
        +  “where” + predicate(cpage)

  );  …}
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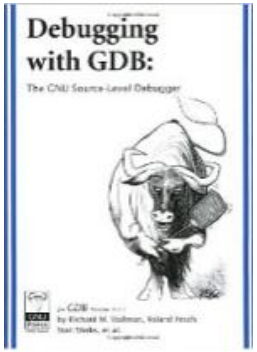
Programming pitfalls



How to debug this program across Java and C/C++?

Portable mixed-environment debuggers [PLDI'10]

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PhD Dissertation [Lee 2011]

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Sheng Liang
Python/C API Manual
PYTHON 2.6
Using SQLite
An Introduction to GCC
for the GNU Compilers gcc and g++
Brian Gough
eclipse
Debugging with GDB:
The GNU Source-Level Debugger

Classification and composition

Marco [ECOOP'12], Jinn [PLDI'10], and Blink [OOPSLA'09]

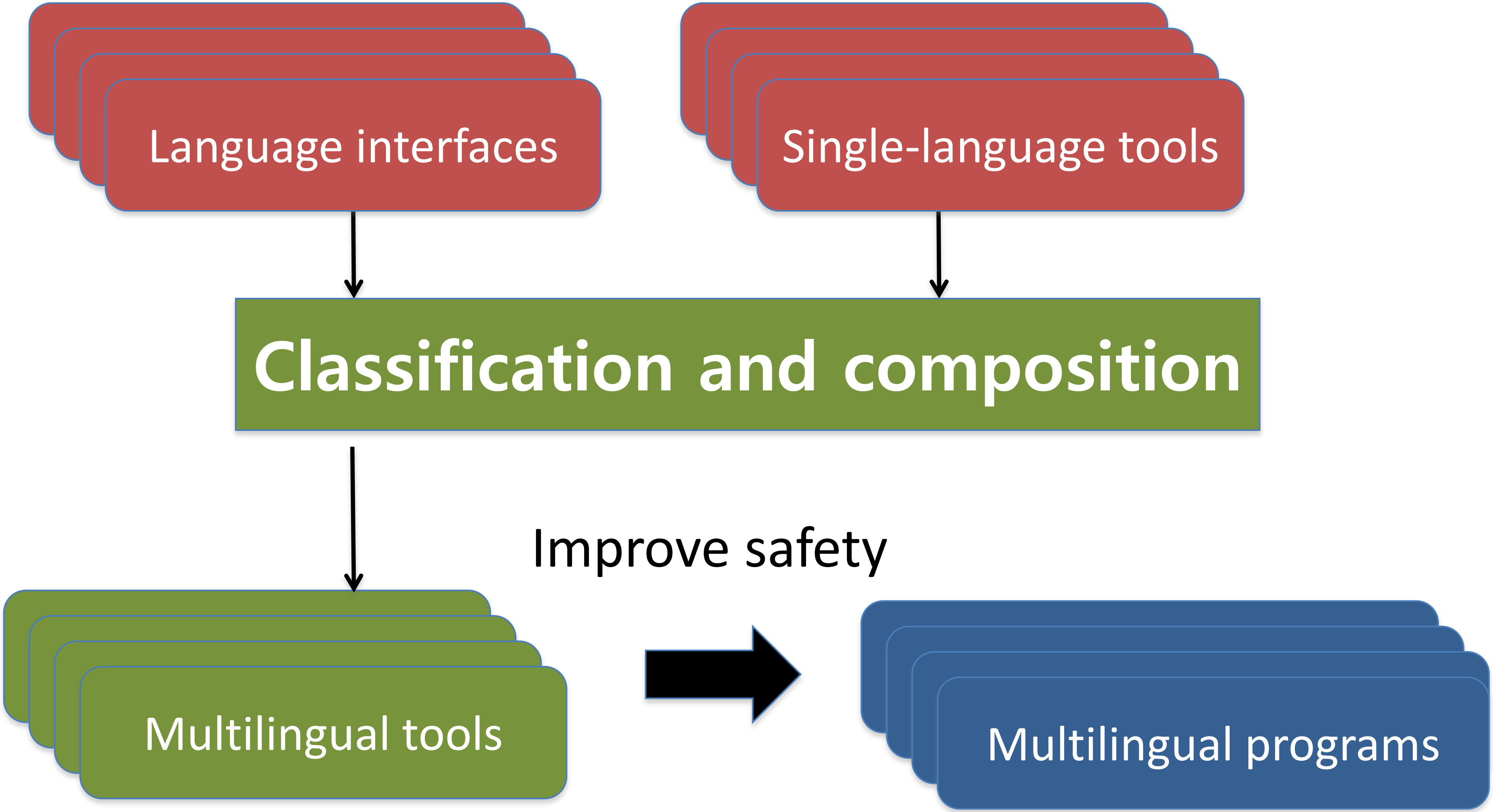
Improve safety

GNOME™

eclipse

SUBVERSION

PhD Dissertation [Lee 2011]



Language interfaces

Single-language tools

Classification and composition

Improve safety

Multilingual tools

Multilingual programs

Future work

- Correctness
  - Program analysis for resource management
  - Empirical studies on real-world bugs
  - Automatically explaining and fixing bugs
- Performance
  - Optimizing away cross-boundary overhead
  - Cooperative memory management for multiple runtime systems
  - Mapping multilingual program fragments to heterogeneous multi-core processors

Thank you

Questions?