A Vision for Helping Developers Use APIs by Leveraging Temporal Patterns

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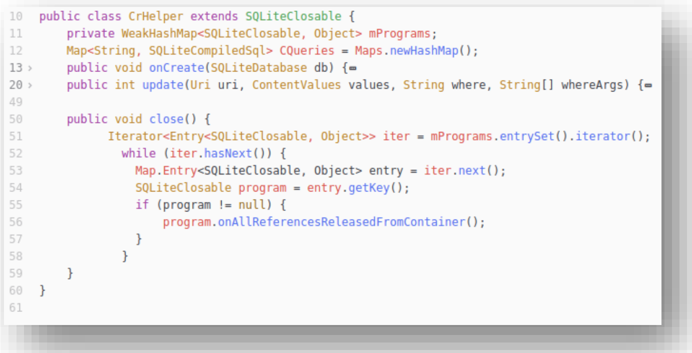
Université de Montréal

DIRO

geodes

IDEs are Awesome!



```java
public class CrHelper extends SQLiteClosable {
    private WeakHashMap<SQLiteClosable, Object> mPrograms;
    Map<String, SQLiteCompiledSql> CQueries = Maps.newHashMap();
    public void onCreate(SQLiteDatabase db) {…
    public int update(Uri uri, ContentValues values, String where, String[] whereArgs) {…

    public void close() {
          Iterator<Entry<SQLiteClosable, Object>> iter = mPrograms.entrySet().iterator();
            while (iter.hasNext()) {
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              if (program != null) {
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              }
            }
    }
}
```
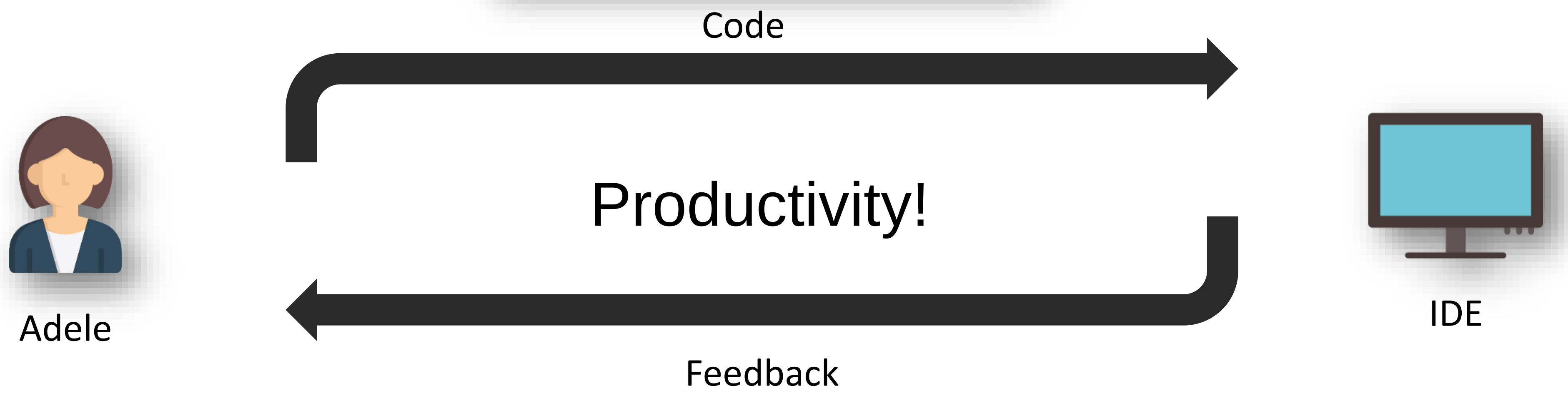
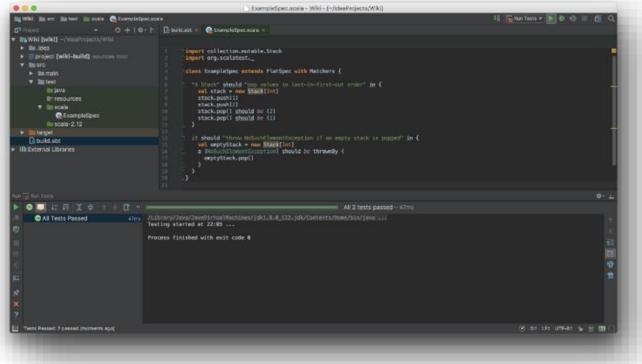





```scala
import collection.mutable.Stack
import org.scalatest._

class ExampleSpec extends FlatSpec with Matchers {

  "A Stack" should "pop values in last-in-first-out order" in {
    val stack = new Stack[Int]
    stack.push(1)
    stack.push(2)
    stack.pop() should be (2)
    stack.pop() should be (1)
  }

  it should "throw NoSuchElementException if an empty stack is popped" in {
    val emptyStack = new Stack[Int]
    a [NoSuchElementException] should be thrownBy {
      emptyStack.pop()
    }
  }
}
```

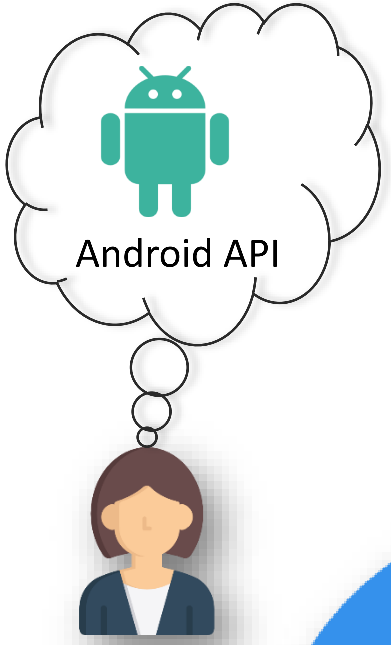
```
/Library/Java/JavaVirtualMachines/jdk1.8.0_112.jdk/Contents/Home/bin/java ...
Testing started at 22:05 ...

Process finished with exit code 0
```

Tests Passed: 2 passed (moments ago)

- Automatic code generation
- Organize imports
- “On the fly” compilation

Icon made by Freepik from www.flaticon.com

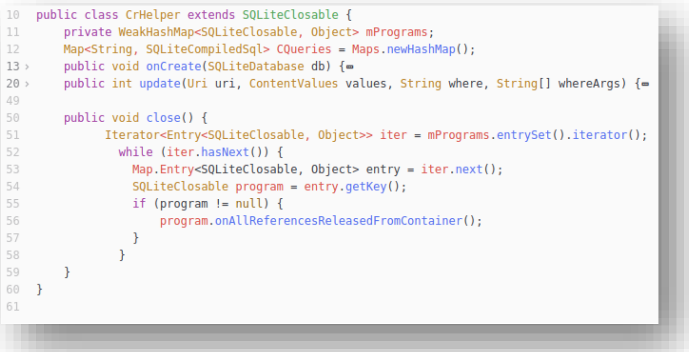
But not so much as it could be



Adele

Constraints

- Read and understand the documentation
- Look for example
- Seeking community support



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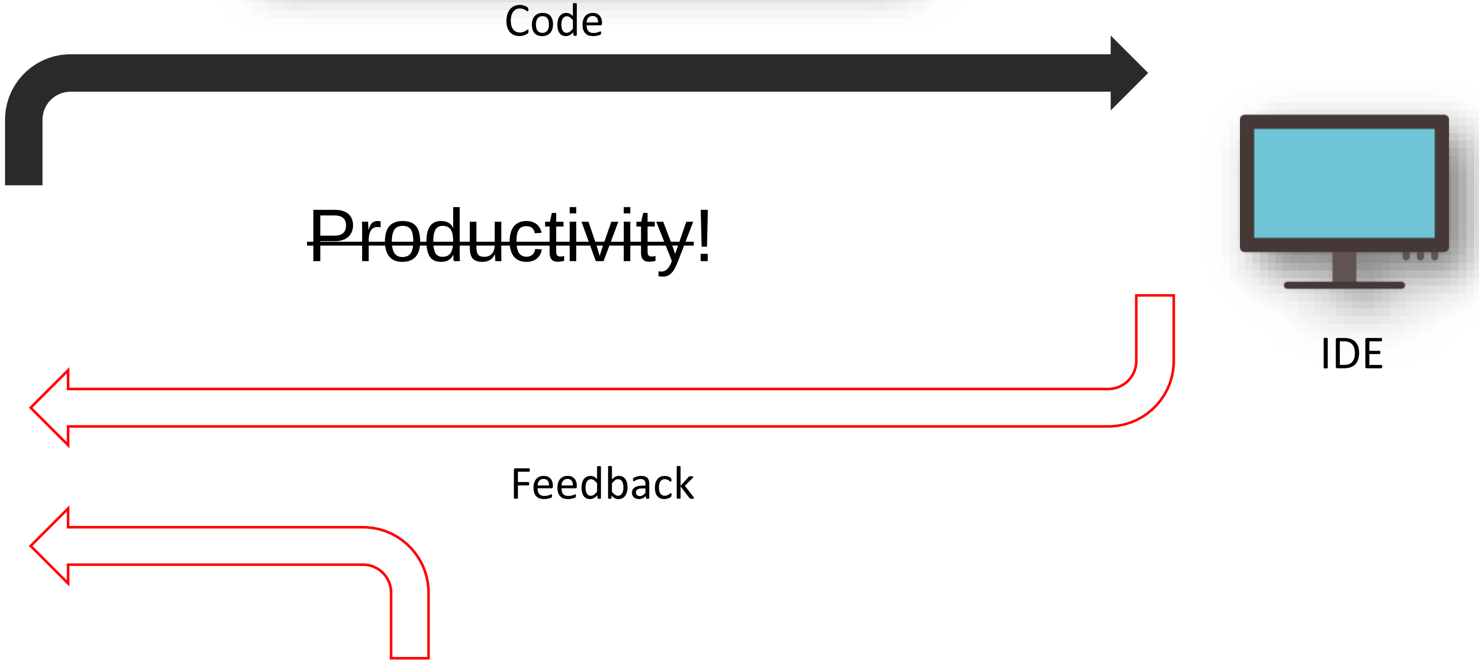
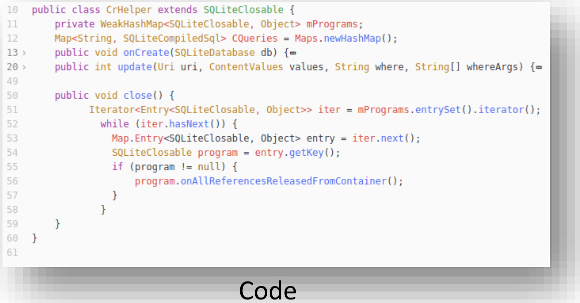


Feedback from other sources
(e.g., execution, bug reports)

Our Vision



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```

Code

Constraints

Adele

- Read and understand

Constraints

the documentation

k for example

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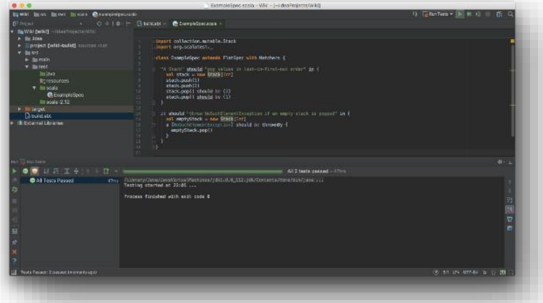
Productivity!

Safer Usage

Feedback



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  }
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```
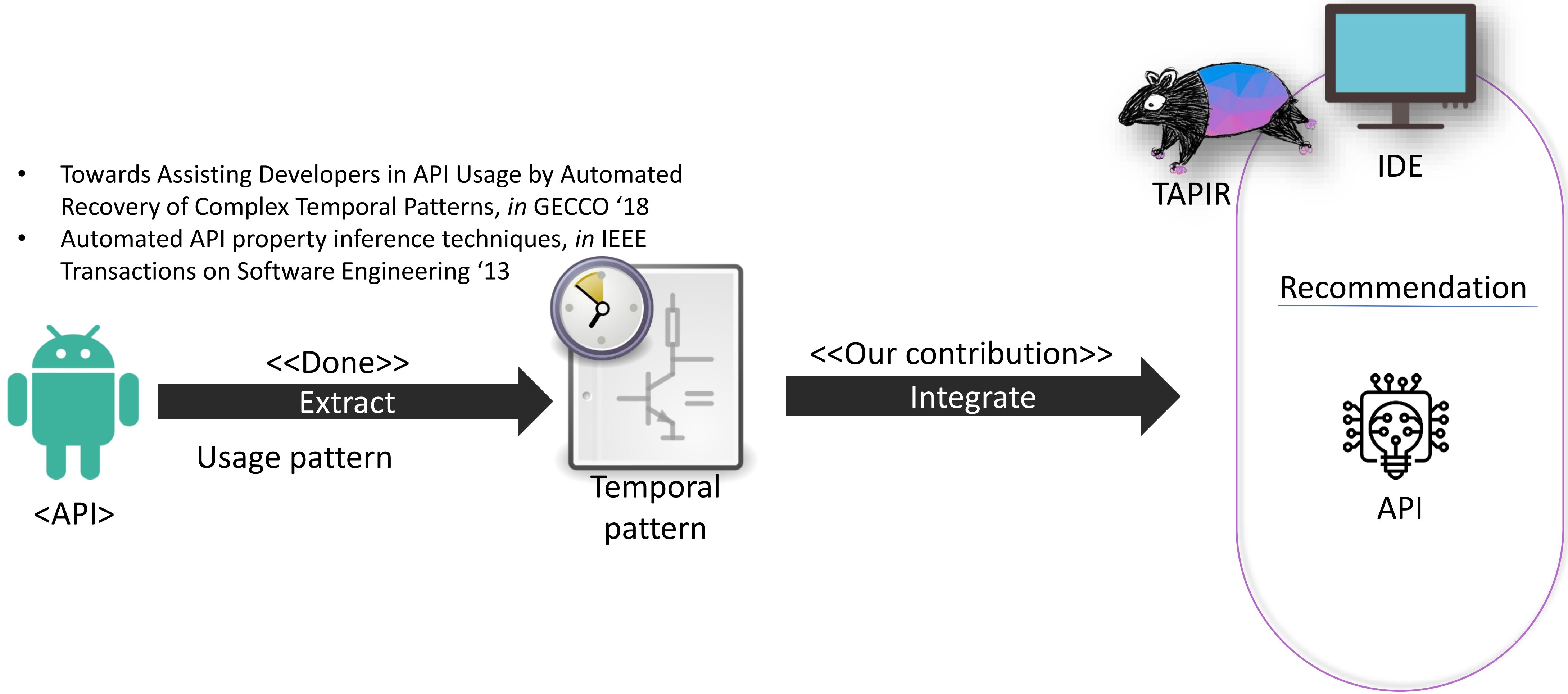

```
All 2 tests passed – 47ms
/Library/Java/JavaVirtualMachines/jdk1.8.0_112.jdk/Contents/Home/bin/java ...
Testing started at 22:05 ...

Process finished with exit code 0
```

IDE

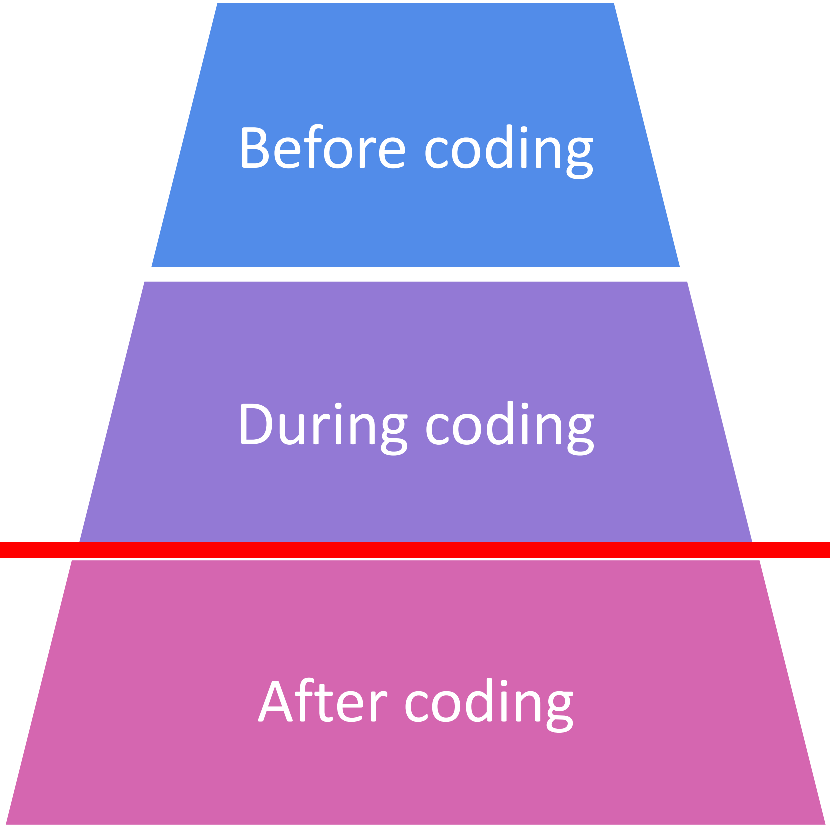
Knowledge about the API

Temporal API Recommender (TAPIR)

- Towards Assisting Developers in API Usage by Automated Recovery of Complex Temporal Patterns, *in* GECCO ‘18
- Automated API property inference techniques, *in* IEEE Transactions on Software Engineering ‘13



Recommendation



How much Tapir knows about Adele's **method**		Goal
Nothing yet	Before coding	Improve available documentation
Incomplete code	During coding	Instant contextual feedback
Everything	After coding	Conformity check

After coding a complete method

Strategy

Feedback about potential API misuse

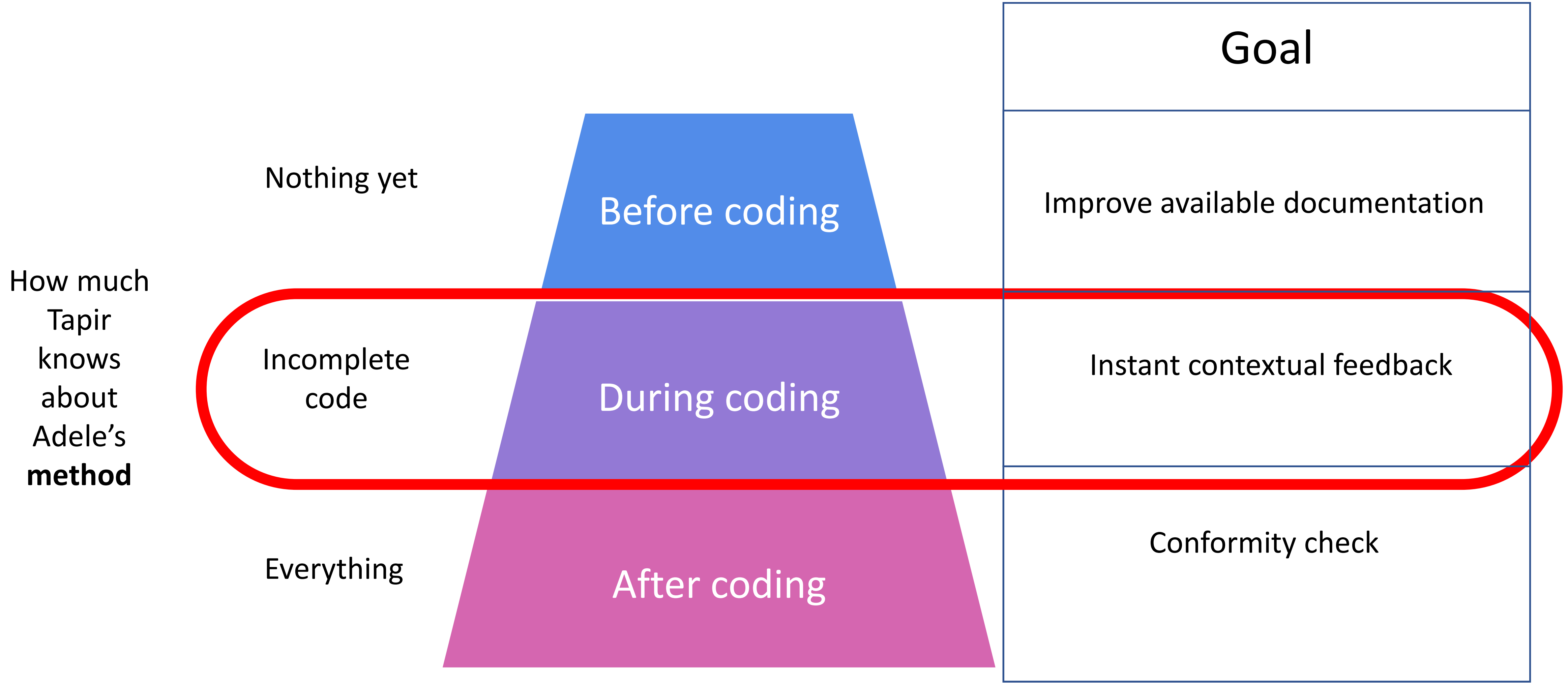
Challenges

- Does the **complete** client code conform to API patterns?
- What if **overall** client still **incomplete** and we don't have execution logs?

Current Approach

- Model check execution traces to find errors
- Model check pseudo-traces (static analysis) at compile time to produce warnings

Recommendation



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During coding a method

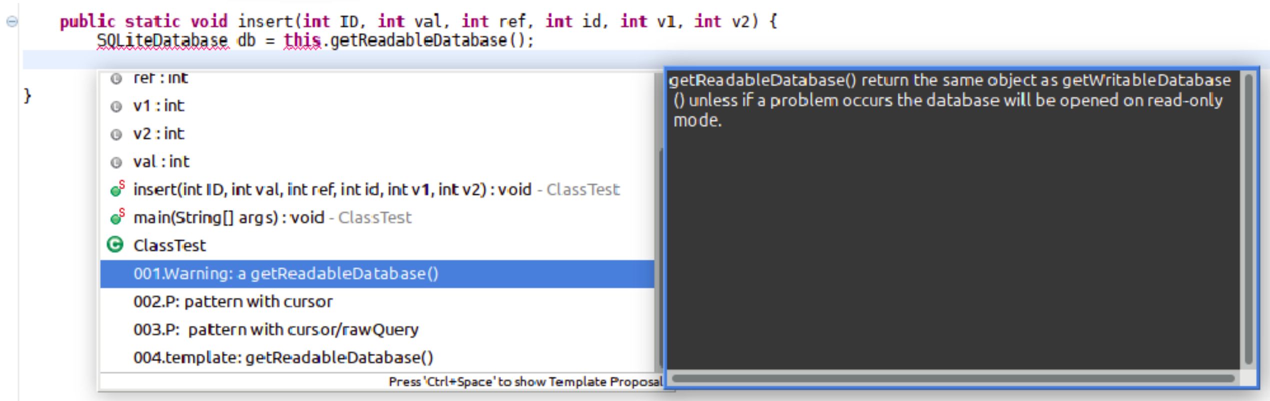
Strategy

- Generate contextual **help** (e.g., tell user that a pattern applies)
- Propose pattern-based code **auto-completion**

Challenges

- How do we check if a pattern **applies** to **incomplete** code?
- How to generate auto-completion recommendations?

Current Approach



```
public static void insert(int ID, int val, int ref, int id, int v1, int v2) {
    SQLiteDatabase db = this.getReadableDatabase();

}
```

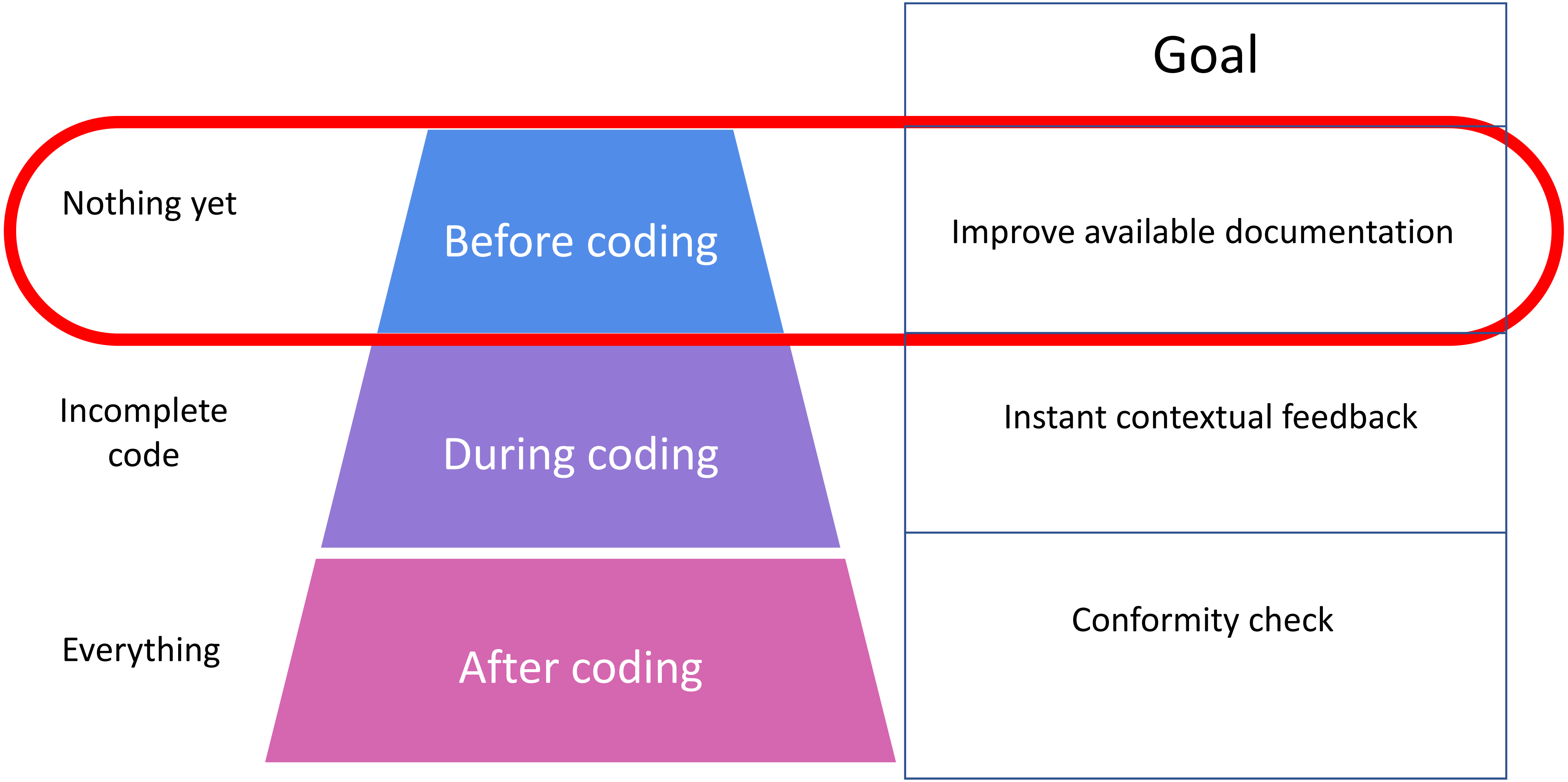
```
ref : int
v1 : int
v2 : int
val : int
insert(int ID, int val, int ref, int id, int v1, int v2) : void - ClassTest
main(String[] args) : void - ClassTest
ClassTest
001.Warning: a getReadableDatabase()
002.P: pattern with cursor
003.P:  pattern with cursor/rawQuery
004.template: getReadableDatabase()
Press 'Ctrl+Space' to show Template Proposal
```

getReadableDatabase() return the same object as getWritableDatabase () unless if a problem occurs the database will be opened on read-only mode.

[1] A. T. Nguyen, H. A. Nguyen, T. T. Nguyen and T. N. Nguyen, "GraPacc: A graph-based pattern-oriented, context-sensitive code completion tool," *2012 34th International Conference on Software Engineering (ICSE)*, Zurich, 2012,

Recommendation

How much Tapir knows about Adele's **method**



		Goal
Nothing yet	Before coding	Improve available documentation
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Before coding a method

Strategy

Improve existing **documentation** with API usage patterns

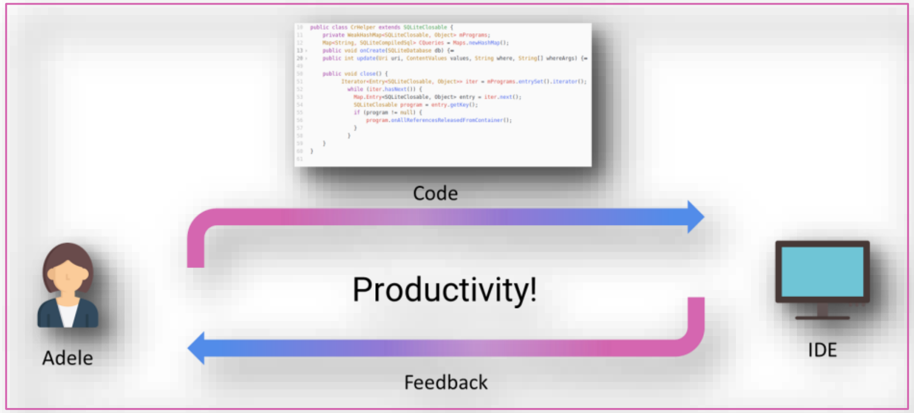
Challenges

- How to translate LTL to natural language?
- Can we visualize patterns for documentation?

Current Approach

- Based on LTL semantics
- Based on examples of pattern translations, e.g., using statistical machine translation
- Represent patterns by adapting Groums or CFGs

Summary



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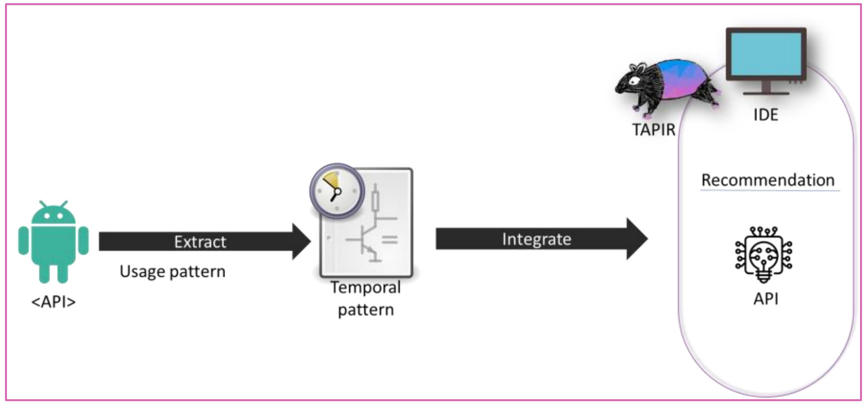

Recommendation Phase	Goal
Before coding	Documentation improvements
During coding	Instant contextual feedback
After coding	Conformity check

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Michalis Famelis @Mfamelis
Houari Sahraoui @sahraouh

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