A Comparative Analysis of the Usability of Stack Overflow Code Snippets Across Languages

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Previous

Characteristics of Answers
Nasehi et al. 2012

Programming Knowledge & Age
Morrison and Murphy-Hill 2013

Developer Q&A Habits
Wang et al. 2013

Now

Previous

Usability: i.e. Execution Behaviour of Snippets

Characteristics of Answers
Nasehi et al. 2012

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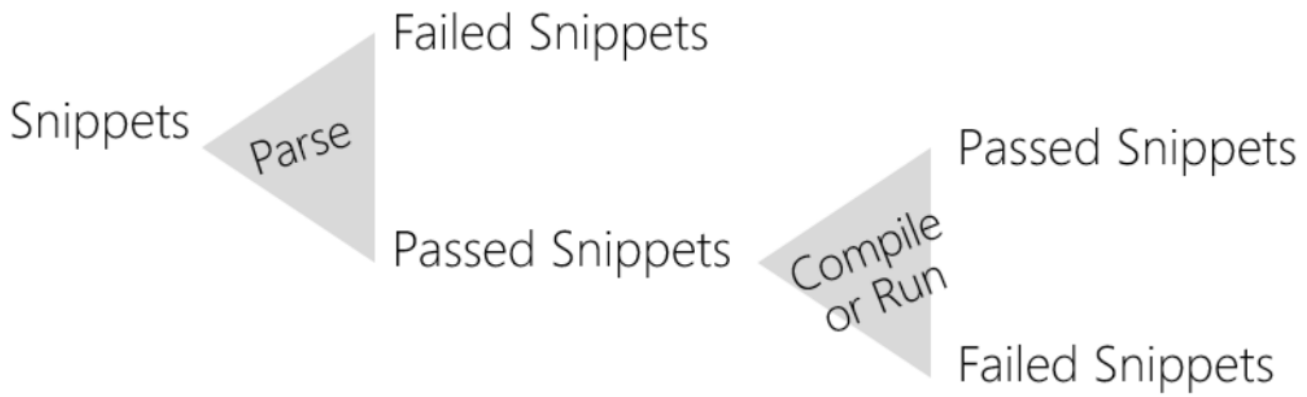
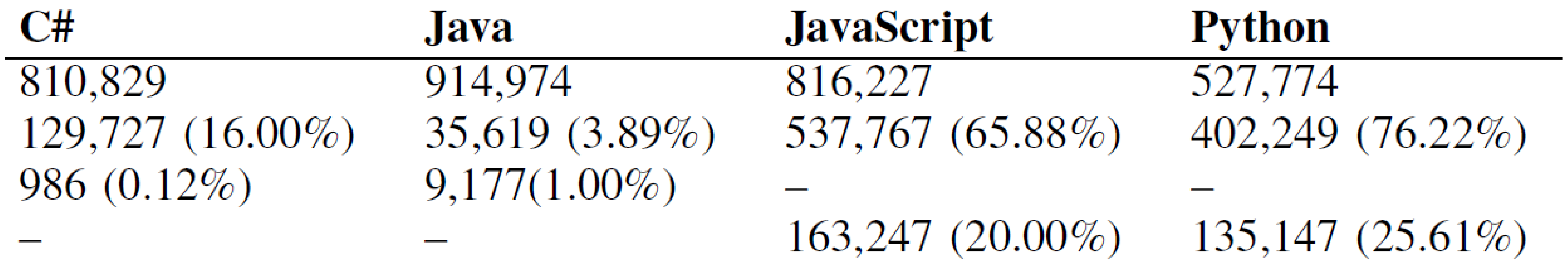
Extracted Snippets from Accepted Answers

Static Languages	
Java	914,974
C#	810,829
Dynamic Languages	
Python	527,774
JavaScript	816,227



Results



	C#	Java	JavaScript	Python
Total	810,829	914,974	816,227	527,774
Parsable	129,727 (16.00%)	35,619 (3.89%)	537,767 (65.88%)	402,249 (76.22%)
Compilable	986 (0.12%)	9,177(1.00%)	–	–
Runnable	–	–	163,247 (20.00%)	135,147 (25.61%)

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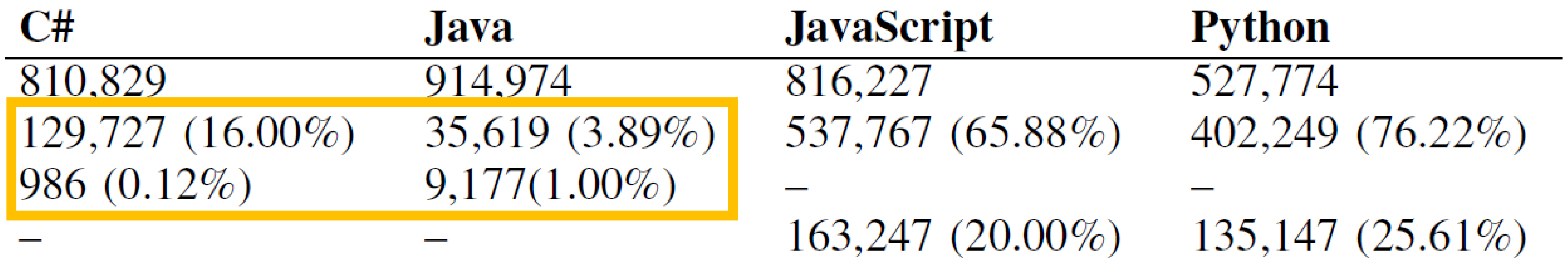

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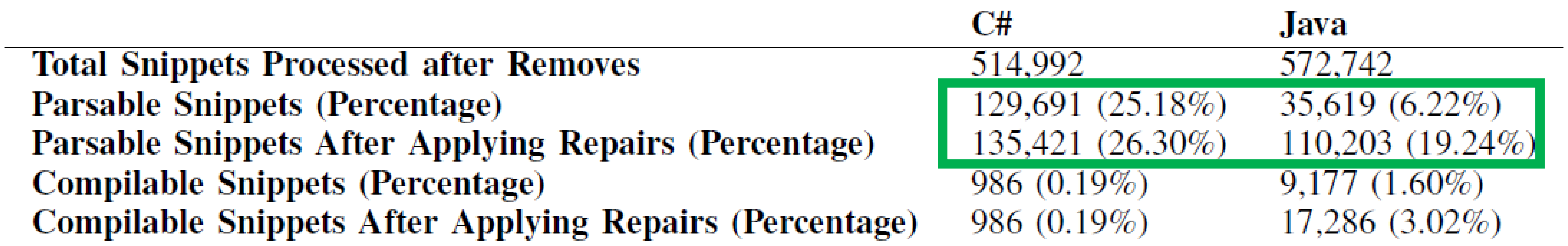
- Removed single word snippets
+ Added heuristic repairs:
+ semi-colons against each statement
+ class structure (for Java only)

Results



	C#	Java
Total Snippets Processed after Removes	514,992	572,742
Parsable Snippets (Percentage)	129,691 (25.18%)	35,619 (6.22%)
Parsable Snippets After Applying Repairs (Percentage)	135,421 (26.30%)	110,203 (19.24%)
Compilable Snippets (Percentage)	986 (0.19%)	9,177 (1.60%)
Compilable Snippets After Applying Repairs (Percentage)	986 (0.19%)	17,286 (3.02%)

Overarching Goal?

Generate programs from smaller existing programs with minimal effort in your IDE.

Easy to search
Easy to integrate the code

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SOF
GitHub
SourceForge

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Program Synthesis by Recombination and Learning

What is Program Synthesis?

Compiler v Synthesizer

Same goals:

Given a source program (the specification), generate a target program.

Find a program P that meets the specification φ(i/p, P)

Approach:

1. Generate AST of the program.
2. Rewrite the nodes/cluster of nodes in the AST in to the statements of the target language, until entire program is in the target language.

Ras Bodik Lecture:
http://www.cs.berkeley.edu/~bodik/cs294/fa12/Screencasts/L1/L1.html

The Difference?

Begin from a specification of source program
Rewrite the rules into language of desired program
The rewrite rules can be non-deterministic
There can be many sequences for a specification
Also does not stop if program cannot be lowered
Backtrack and analyze the program in other ways & generate sequence

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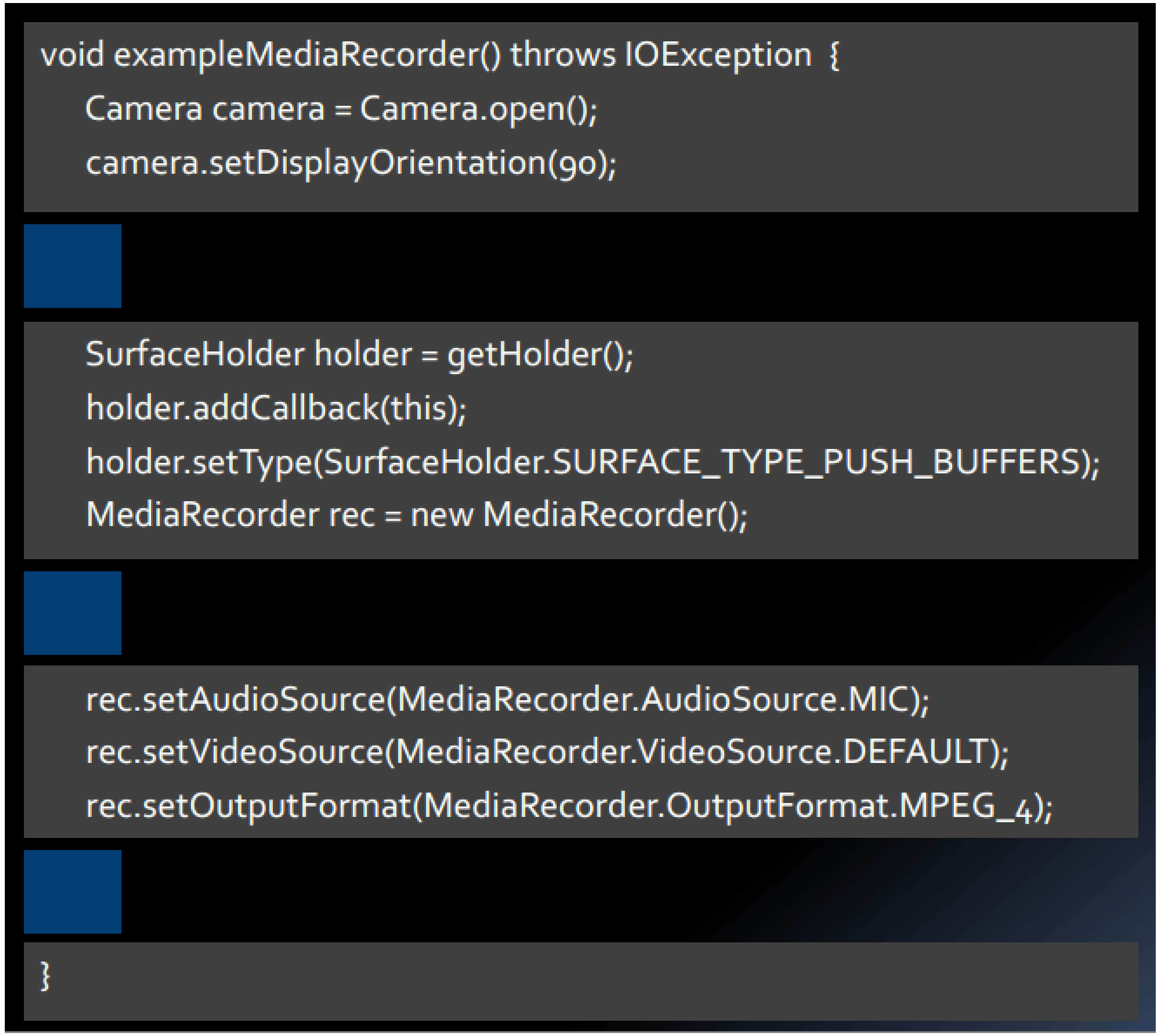
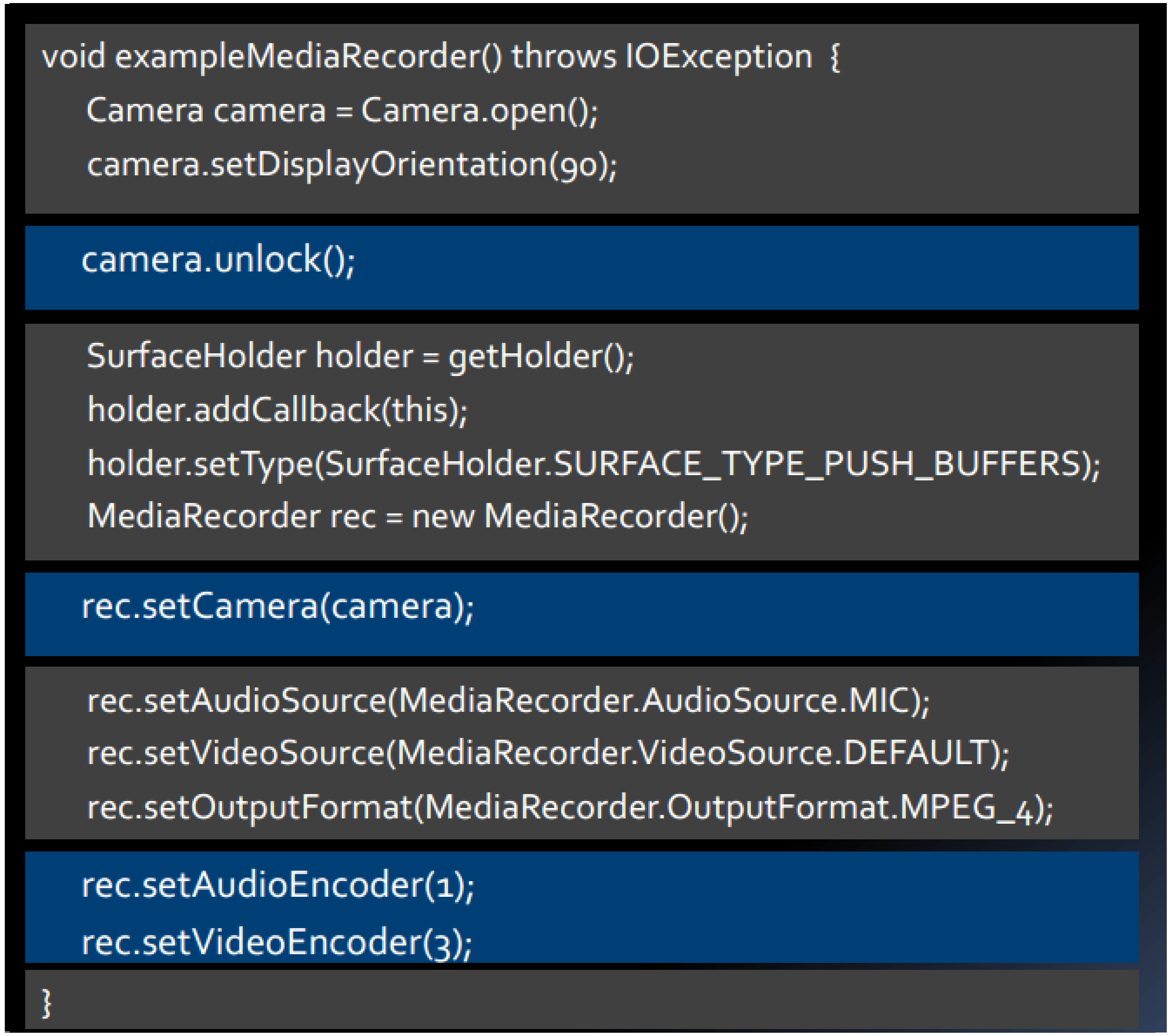
Code Completion with Statistical Language Models *Raychev et al. 2014*



```
void exampleMediaRecorder() throws IOException {
    Camera camera = Camera.open();
    camera.setDisplayOrientation(90);

    SurfaceHolder holder = getHolder();
    holder.addCallback(this);
    holder.setType(SurfaceHolder.SURFACE_TYPE_PUSH_BUFFERS);
    MediaRecorder rec = new MediaRecorder();

    rec.setAudioSource(MediaRecorder.AudioSource.MIC);
    rec.setVideoSource(MediaRecorder.VideoSource.DEFAULT);
    rec.setOutputFormat(MediaRecorder.OutputFormat.MPEG_4);

}
```

Martin Vechev Lecture:
http://www.srl.inf.ethz.ch/workshop2014/eth-vechev.pdf

Code Completion with Statistical Language Models *Raychev et al. 2014*



```
void exampleMediaRecorder() throws IOException {
    Camera camera = Camera.open();
    camera.setDisplayOrientation(90);

    camera.unlock();

    SurfaceHolder holder = getHolder();
    holder.addCallback(this);
    holder.setType(SurfaceHolder.SURFACE_TYPE_PUSH_BUFFERS);
    MediaRecorder rec = new MediaRecorder();

    rec.setCamera(camera);

    rec.setAudioSource(MediaRecorder.AudioSource.MIC);
    rec.setVideoSource(MediaRecorder.VideoSource.DEFAULT);
    rec.setOutputFormat(MediaRecorder.OutputFormat.MPEG_4);

    rec.setAudioEncoder(1);
    rec.setVideoEncoder(3);
}
```

Martin Vechev Lecture:
http://www.srl.inf.ethz.ch/workshop2014/eth-vechev.pdf

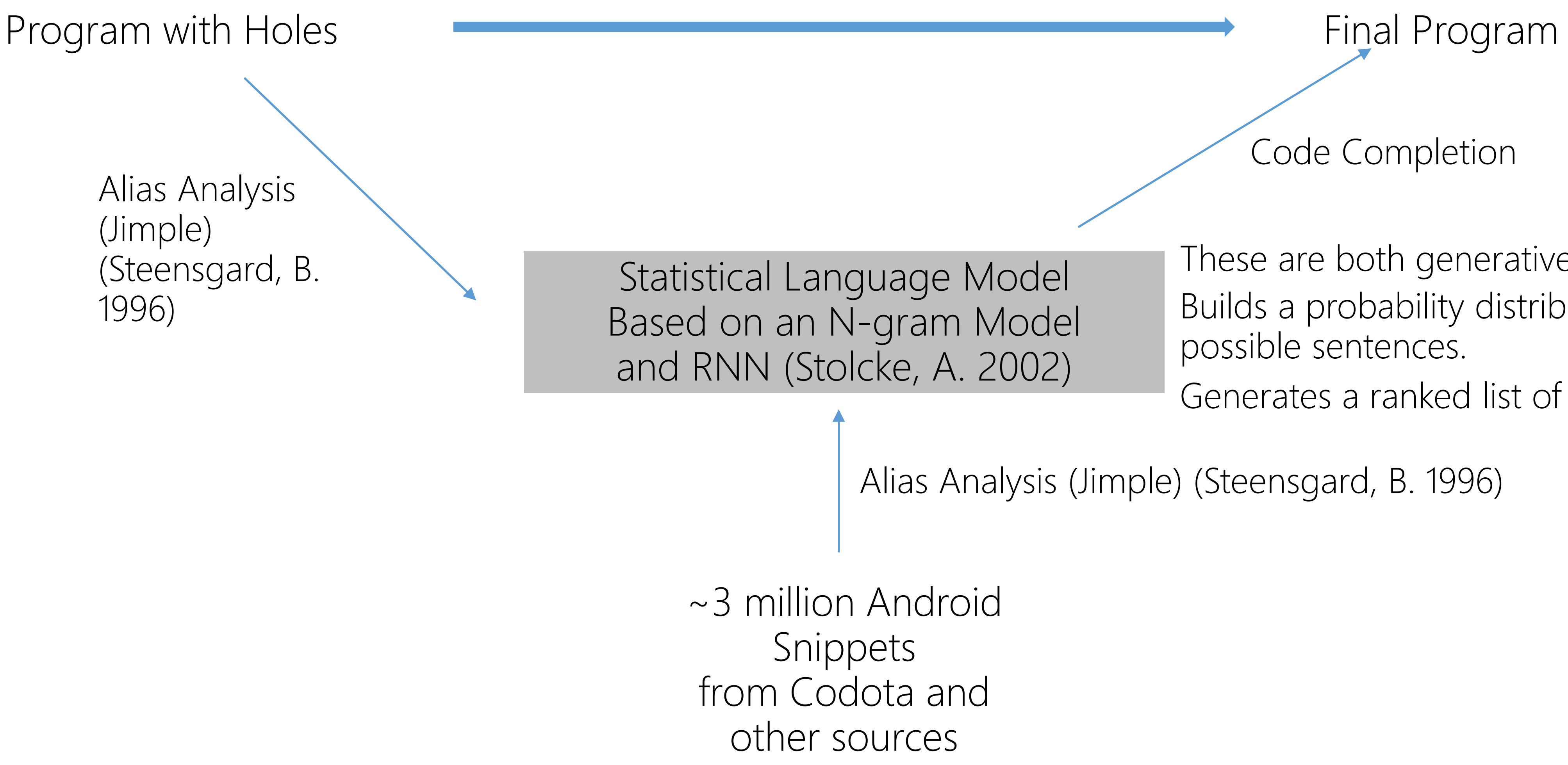
Code Completion with Statistical Language Models *Raychev et al. 2014*

```
----------------------------------------
----------------------------------------
----------------------------------------
?{params}// H1
----------------------------------------
----------------------------------------
----------------------------------------
----------------------------------------
?{params}// H2
----------------------------------------
```

$$\longrightarrow$$

```
----------------------------------------
----------------------------------------
----------------------------------------
----------------------------------------
----------------------------------------
----------------------------------------
----------------------------------------
----------------------------------------
----------------------------------------
----------------------------------------
```

Code Completion with Statistical Language Models *Raychev et al. 2014*

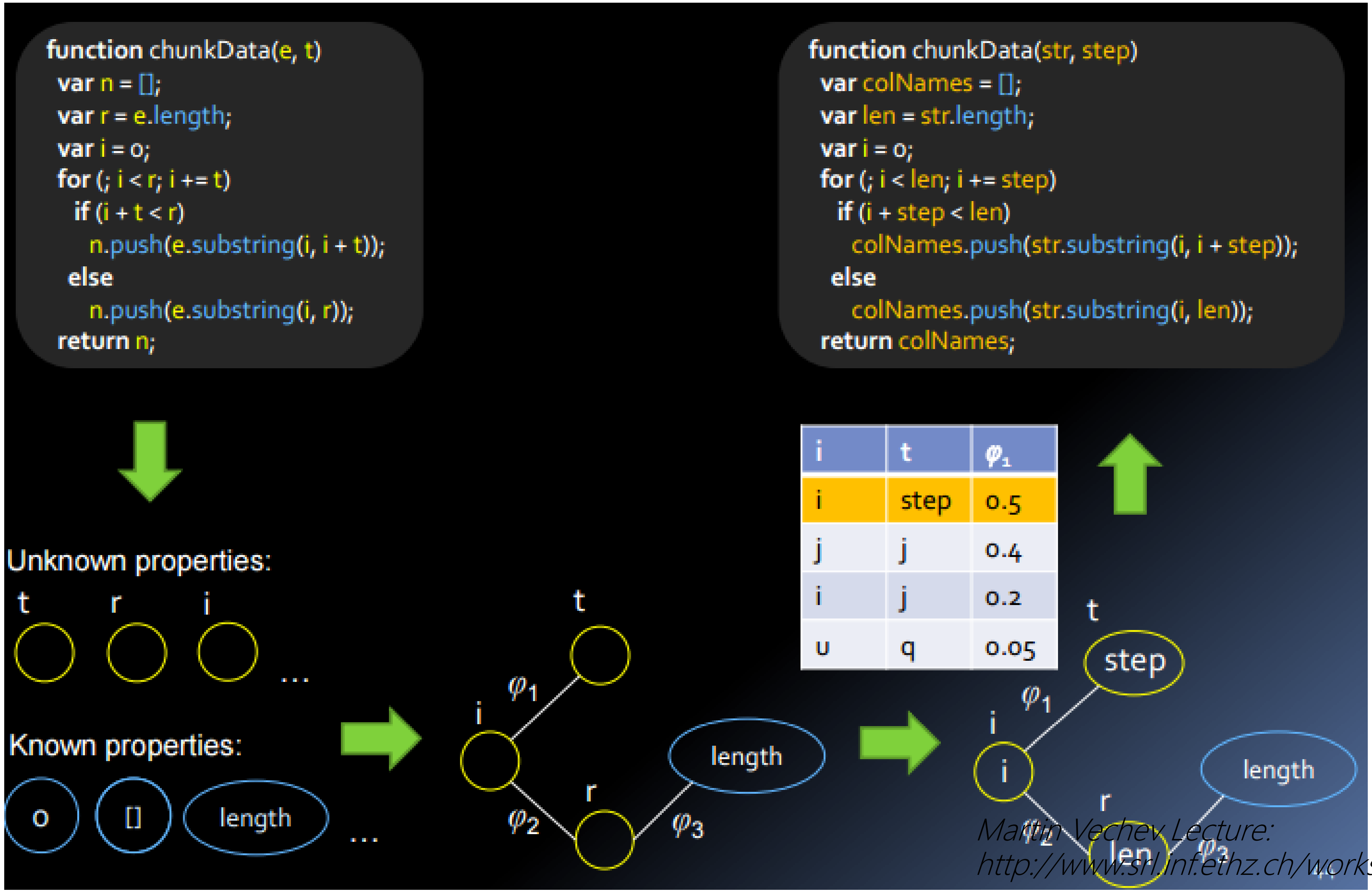

Program with Holes
Final Program
Alias Analysis (Jimple) (Steensgard, B. 1996)
Code Completion
Statistical Language Model Based on an N-gram Model and RNN (Stolcke, A. 2002)
Alias Analysis (Jimple) (Steensgard, B. 1996)
~3 million Android Snippets from Codota and other sources

These are both generative models.

Builds a probability distribution over all possible sentences.

Generates a ranked list of candidate.

JSNice: Raychev et al. – Predicting Program Properties from "Big Code"



```
function chunkData(e, t)
  var n = [];
  var r = e.length;
  var i = 0;
  for (; i < r; i += t)
    if (i + t < r)
      n.push(e.substring(i, i + t));
    else
      n.push(e.substring(i, r));
  return n;
```

```
function chunkData(str, step)
  var colNames = [];
  var len = str.length;
  var i = 0;
  for (; i < len; i += step)
    if (i + step < len)
      colNames.push(str.substring(i, i + step));
    else
      colNames.push(str.substring(i, len));
  return colNames;
```

i	t	φ_1
i	step	0.5
j	j	0.4
i	j	0.2
u	q	0.05

Martin Vechev Lecture: http://www.srl.inf.ethz.ch/workshop2014/eth-vechev.pdf

Our Long Distance Goal:

Synthesize code into your IDE from Stack Overflow

Realities:

1. Not All Answers are meant to be synthesized.
E.g.   "What is the difference between a C# Reference and a Pointer?"
Strategy: Identify and reject some classes of questions from consideration.

2. Answers split in the form of code chunks, with explanations in between.
Strategy: Try to combine those code snippets, using help from explanations, other SOF snippets, open source projects.

Refined Goal:

To make SOF Code usable.

Thank you!