# LANGUAGE-AGNOSTIC INJECTION DETECTION

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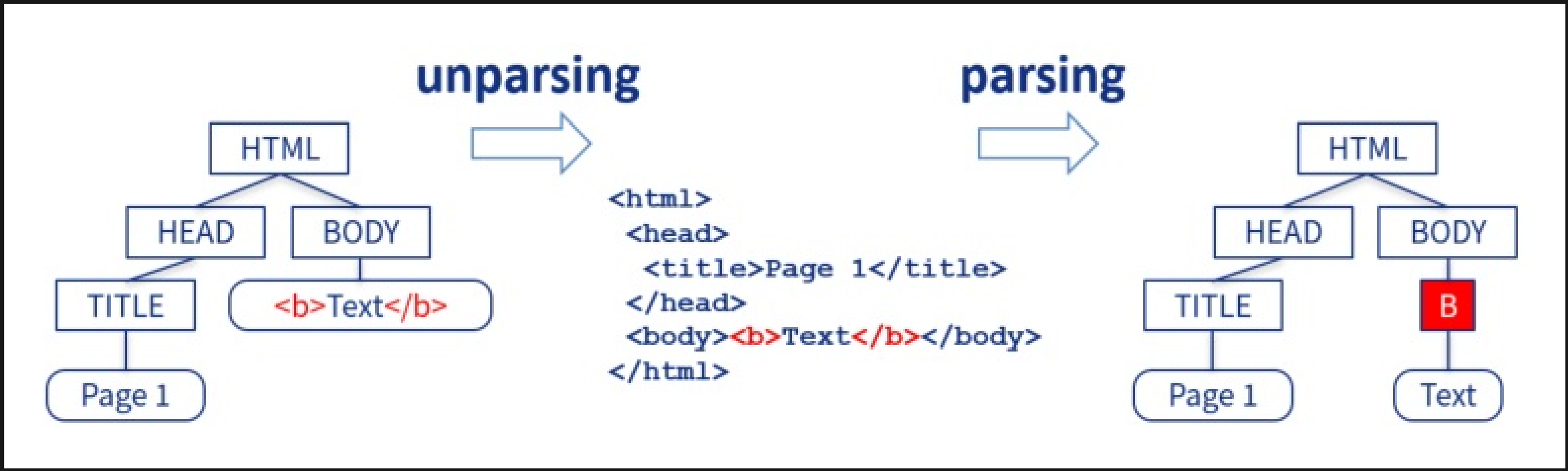
injections grow on trees




Software Engineering | RWTH AACHEN UNIVERSITY Fraunhofer IEM

# SHOTGUN UNPARSER

```c
if (recursive || print_dir_name)
{
if (!first)
        DIRED_PUTCHAR ('\n');
first = false;
DIRED_INDENT ();
PUSH_CURRENT_DIRED_POS (&subdired_obstack);
dired_pos += quote_name (stdout, realname ? realname : name
                        dirname_quoting_options, NULL);
PUSH_CURRENT_DIRED_POS (&subdired_obstack);
DIRED_FPUTS_LITERAL (":\n", stdout);
}
```

https://github.com/wertarbyte/coreutils/blob/master/src/ls.c

```sh
mkdir "1
1"
mkdir 2
ls | wc -l
```

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# RELATED WORK

- Language specific static and dynamic analysis: SQLi, XSS, ... are well known
- Language agnostic dynamic aka fuzzing: Parsers are known to be broken
- AUTOGRAM uses dynamic taint tracking: Grammar reconstruction from a given parser

Our contribution: Language agnostic detection of injections for textual languages

Awareness

Detection is never complete; Use a constructive approach like McHammerCoder to solve the injection problem.

# THE SOLUTION

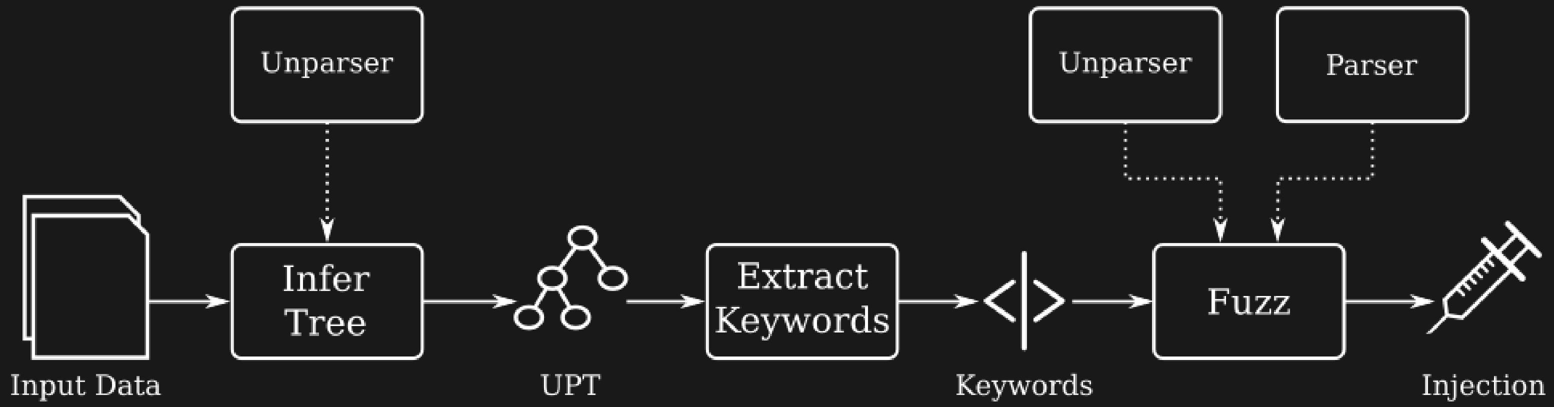
*Show, don't tell*

# PROBLEM SPACE

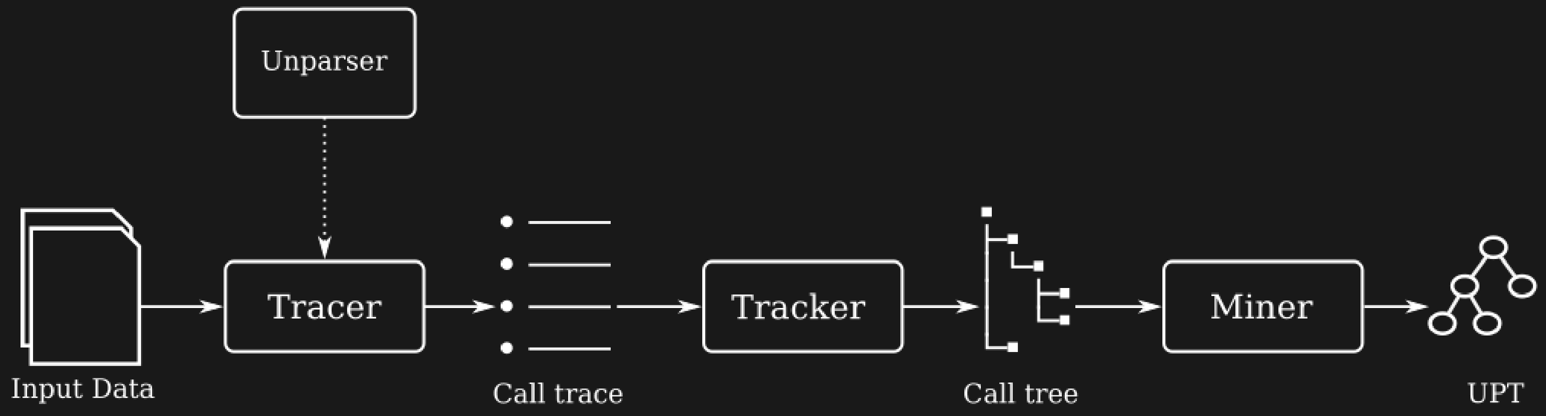
- Detecting unparsers
- **Identifying injections in a given unparser**
- Generate attacks
- Extract full grammar

# APPROACH OVERVIEW

- Guided fuzzing using language keyword information
- Keywords are extracted from unparse trees (UPTs)
- UPTs are inferred automatically using dynamic program analysis



# UPT INFERENCE



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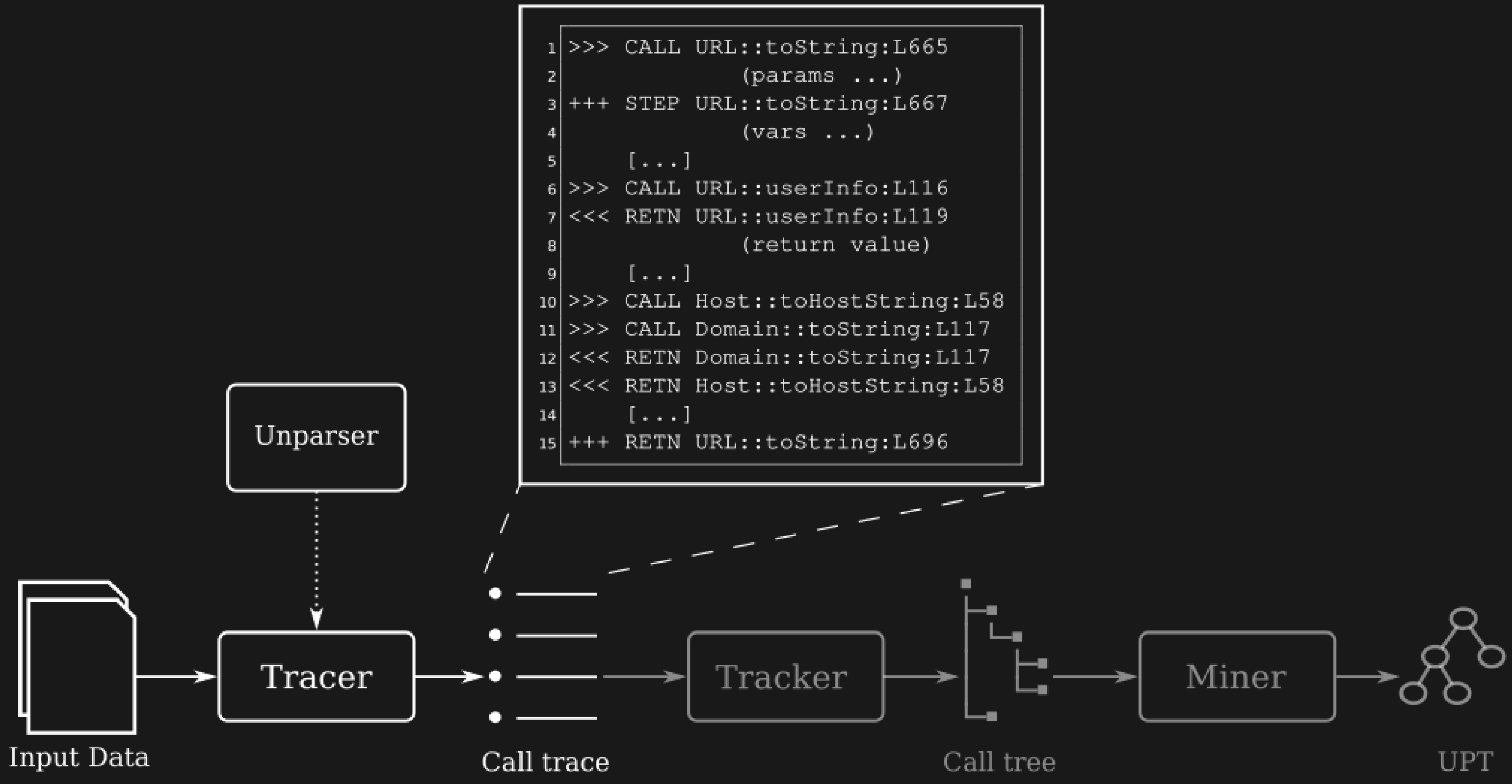

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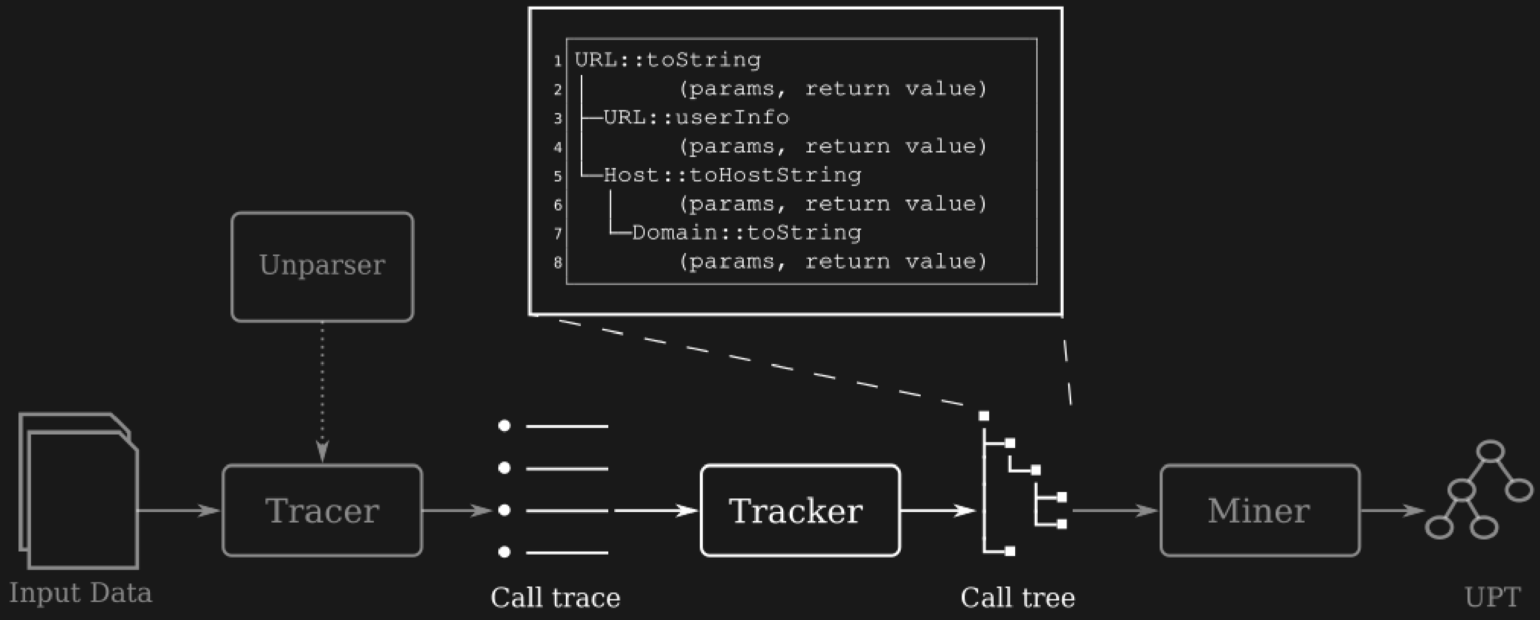

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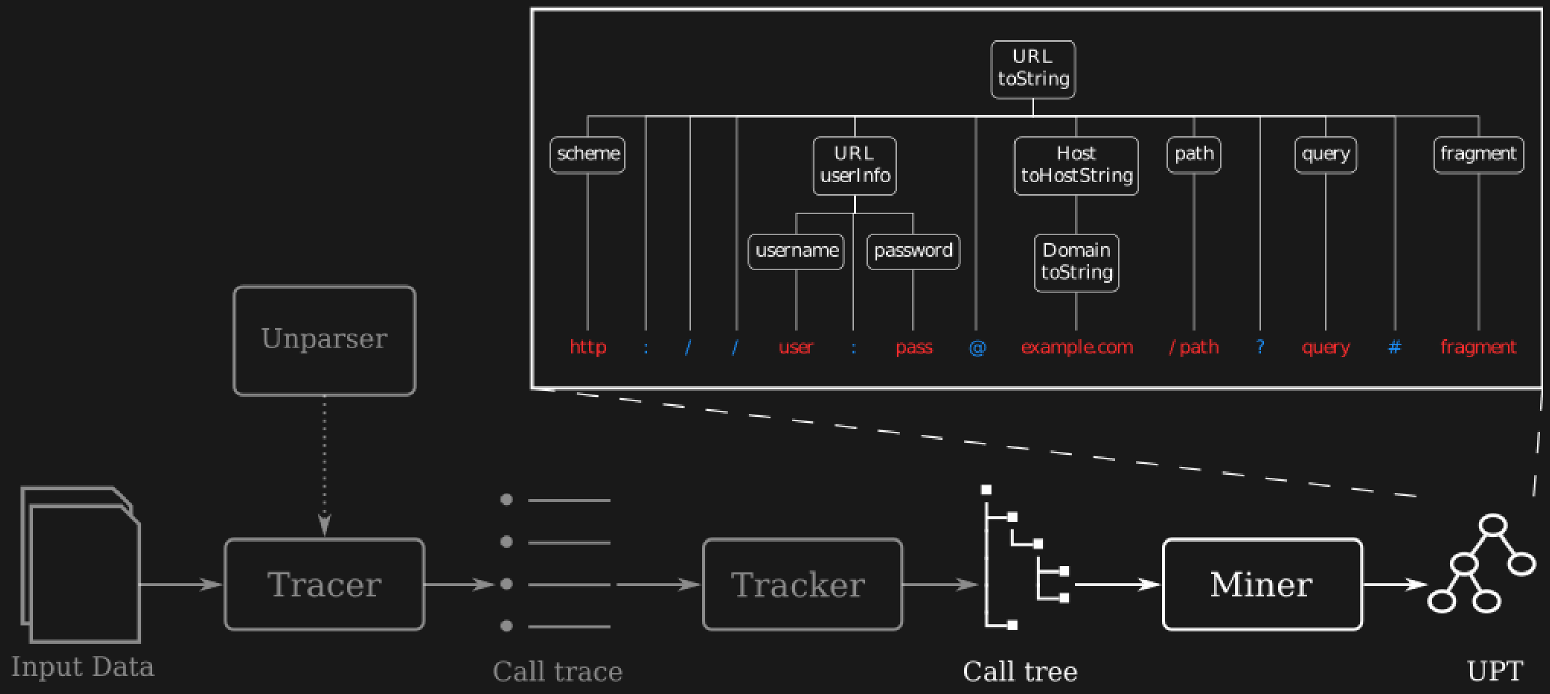
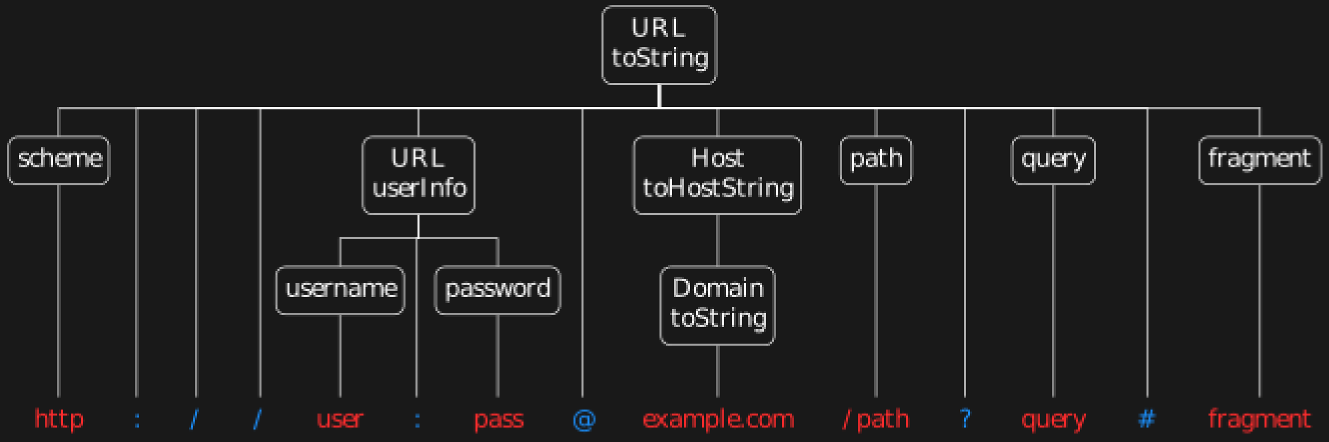


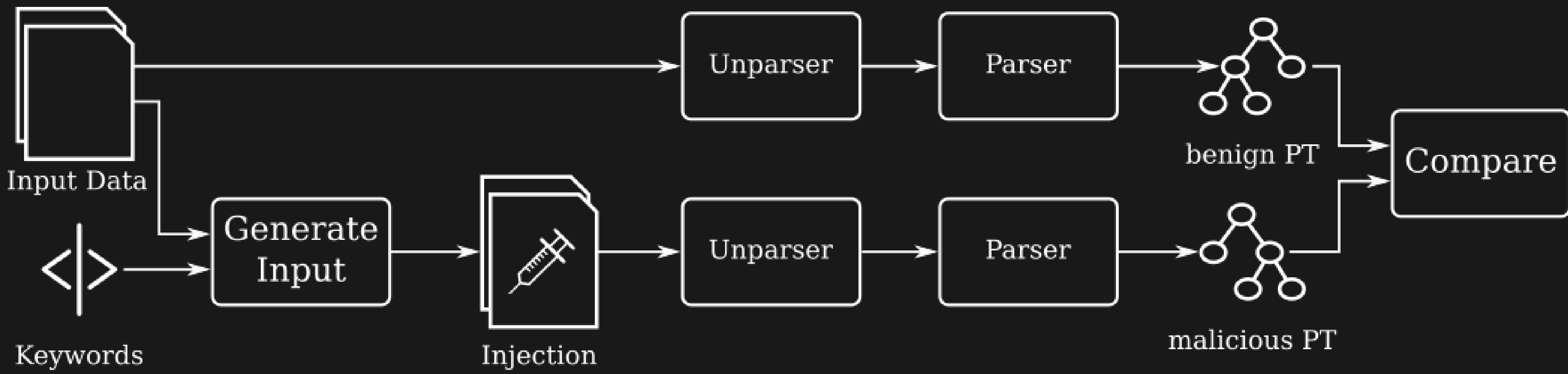
# UPTS AND KEYWORDS




- Keywords have no origin in any input
- They are created by the unparser
- Their location in the UPT shows where (structurally) they are valid in the language

# FUZZING

- generate targeted injection candidates based on keywords
  - example: "break out" of string-enclosing quotation marks
- evaluate injection success by comparing parse trees
  - run both original input and modified input through unparser-parser round-trip
  - compare structures of resulting parse trees
    - if the parse tree changed, an injection was found



# RESULTS

- Promising results in case studies
  - very accurate UPTs
  - found (implanted) injection vulnerabilities
  - structural keyword information can significantly improve fuzzing
  - caveat: not a quantitative evaluation
- Fuzzing automatically yields PoC exploits

# KEY OBSERVATIONS

- "Recursive descent unparsers" exist
  - common in ad-hoc implementations
- Difference to Taint Tracking:
  - leveraging **structural** information to identify keywords and their scope
- Requires structural variability in unparser outputs
  - poor UPTs in "template-based" unparsers
  - reduced to common taint tracking
  - better use a sample output for mutation fuzzing

# CONCLUSION

## Language-agnostic Injection Detection

- works for recursive descent unparsers
- use keywords from UPTs in fuzzing

## Awareness

- Creating output is not just writing an array of bytes
- Injections might exist in all your unparses

## Call to Action

Every programming language's core library deserves an (un)parser

# QUESTIONS?

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MARGOTUA code on GitHub