# Domain-Specific Languages for Program Analysis

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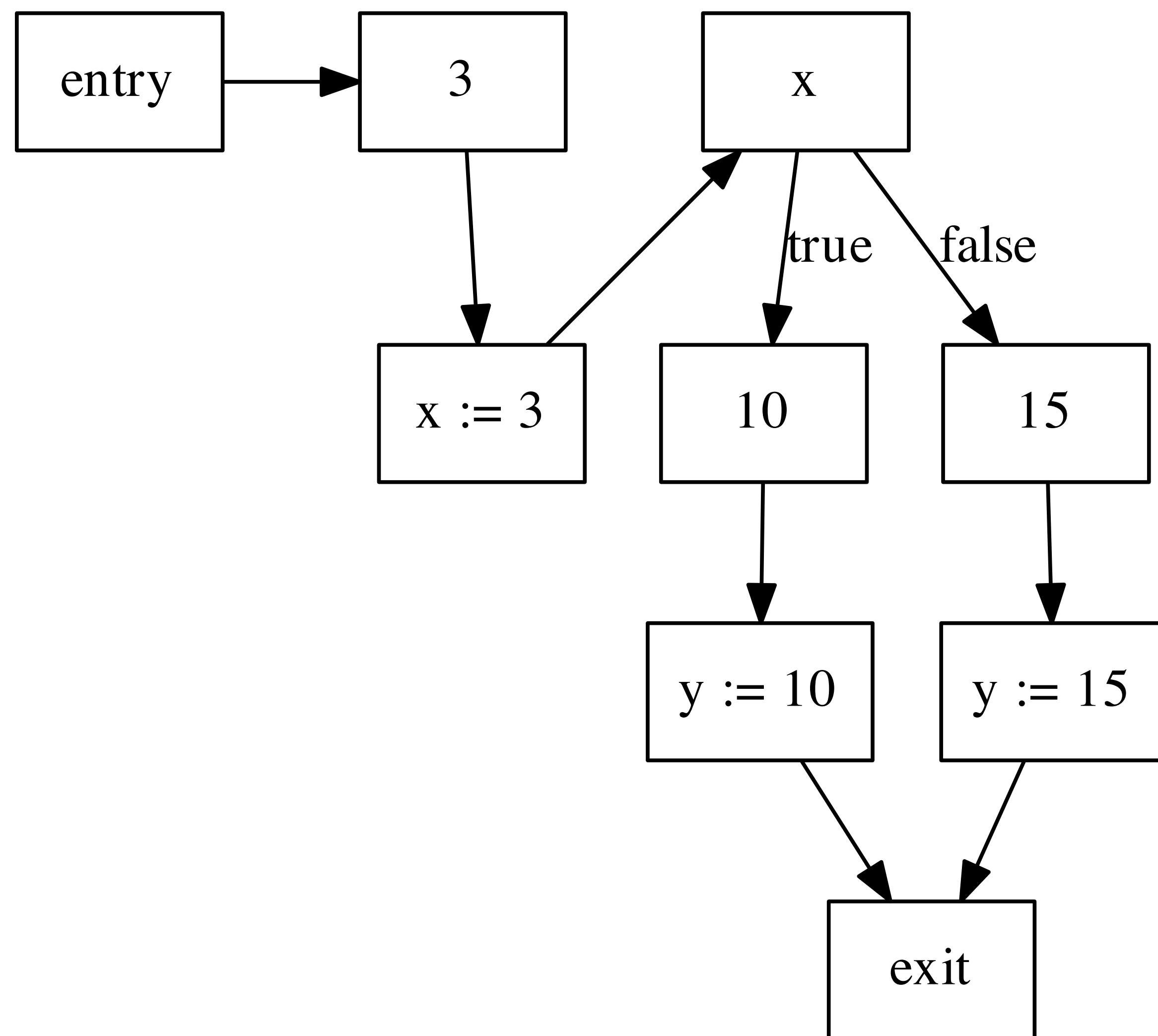
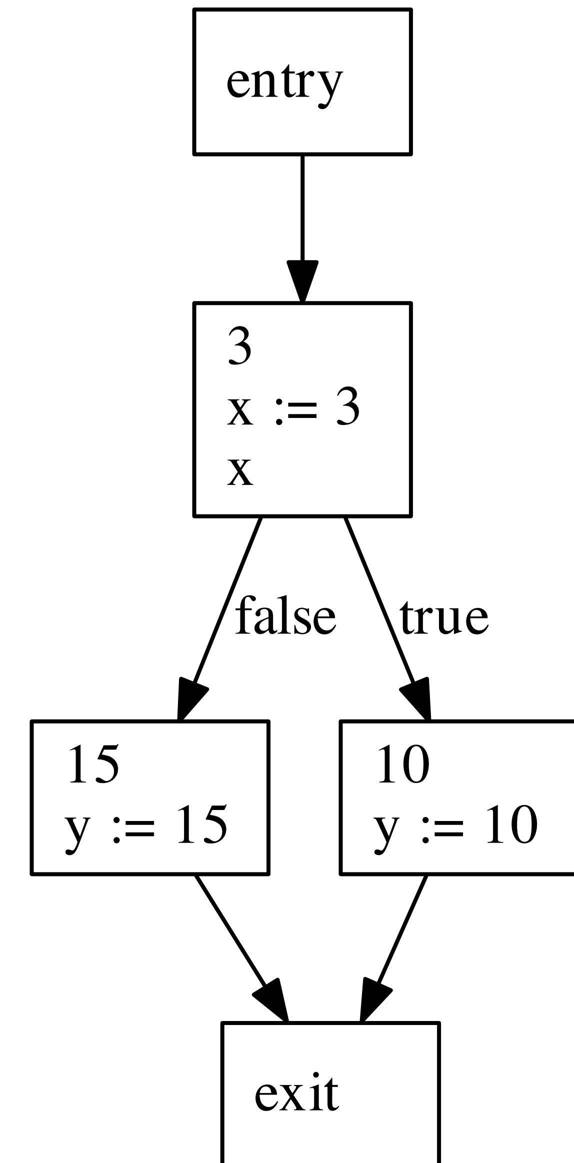
http://www.rascal-mpl.org

# Overview

- A Starting Example: DCFlow
- Other Early-Stage Ideas
  - Summary extraction from documentation
  - Trace processing
- Discussion

# Say you need a control flow graph…

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# Building control flow graph extractors

- First, define how to represent control flow graphs
- Then, pick a language — hopefully we can reuse the first part for different languages, but maybe not…
- Next, define the control flow rules, using your favorite language (such as Rascal, of course…)
- Finally, define something that uses the graph — this makes sure the data structure is rich enough to be useful as well…

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# What if we want to work with another language?

- *May* be able to reuse base CFG definition (but maybe not)
- Cannot reuse flow definition (unless CFG def is the same and features have identical semantics — the flow rules are specific to the features being defined)
- Cannot easily reuse analysis (since CFG definition and semantics differ)

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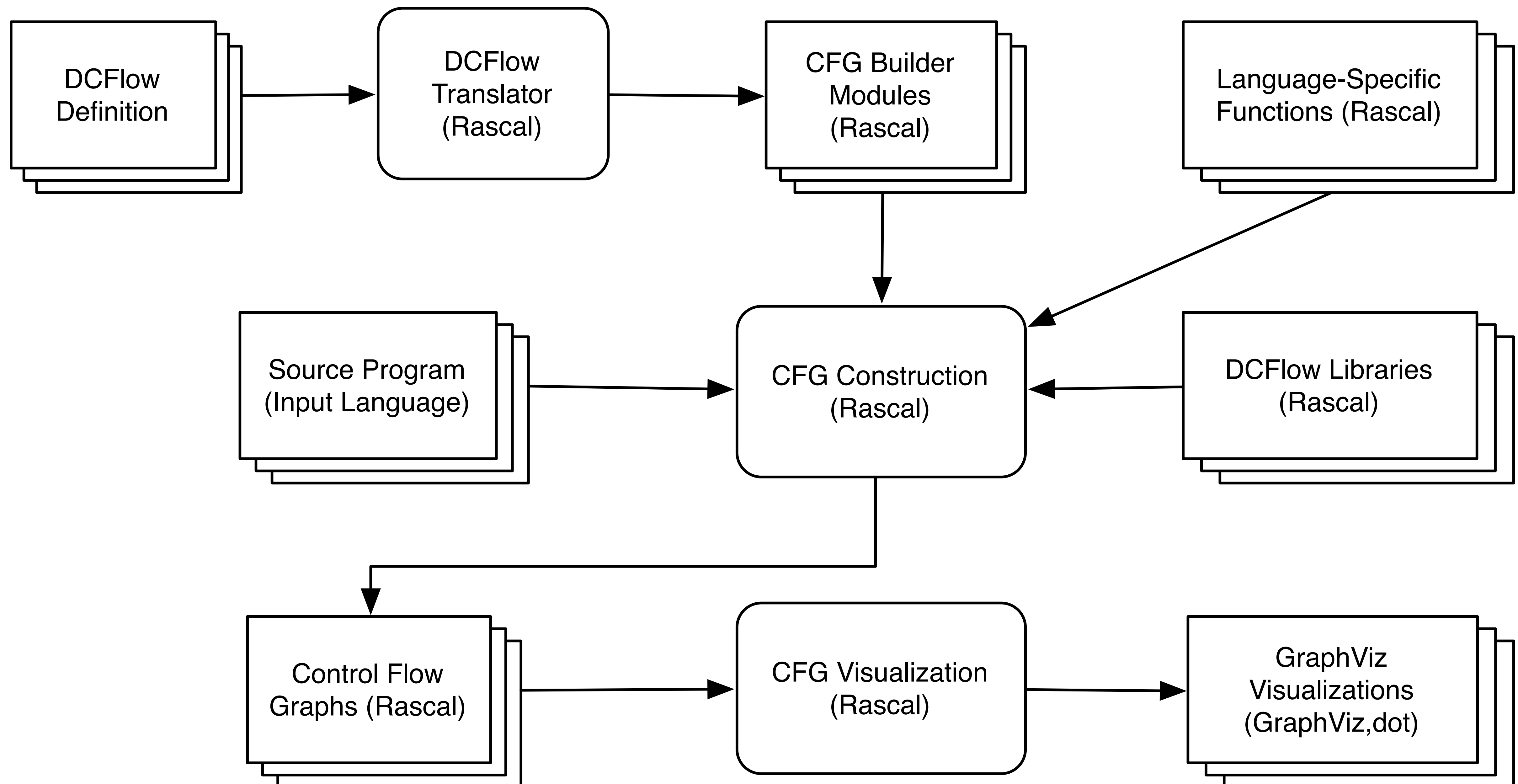
  So, we write the entire thing over again
  (and again, and again…)

# DCFlow: Declarative Control Flow

- Declarative DSL for defining control flow rules
- Generates Rascal code to build intraprocedural control flow graphs with reusable library of CFG concepts
- Provides basic visualization to allow graphs to be rendered in GraphViz dot
- Provides *ignore* mechanism to indicate which language constructs we are *not* trying to define
- IDE provides basic checking to aid user (with more coming)

# DCFlow Architecture



# Building up an example: plus

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- That's it!

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```
rule STATEMENT::whileStat = create(footer),
  ^exp -conditionTrue->  body -backedge-> exp,
   exp -conditionFalse-> $footer;
```

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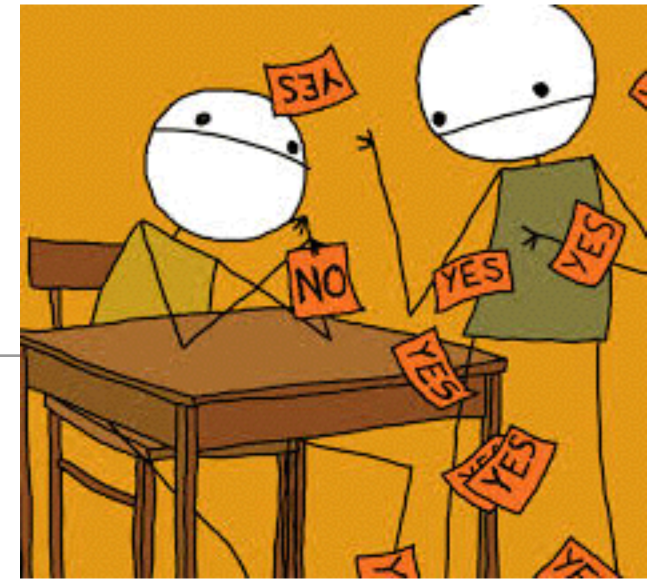
# Design Decisions




- Focus on abstract syntax trees (should *almost* work on Rascal concrete syntax, but there are some differences)
- Leverage reified types for generation and checking
- Try to ensure added features are general — don't want to add something just because PHP or Java needs it
- Make sure generated code is understandable — it should look close to what you would write yourself

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# How about for other domains?

- Idea 1: Program tracing
  - Internal DSL — goal is to build this as a library in Rascal
  - Allow filter functions to keep or discard events of interest
  - Use closures to support registration of handlers for specific events or event patterns
  - What we have now: rudimentary tracing for PHP programs using Rascal and xdebug (running over TCP sockets)

# How about for other domains?

- Idea 2: Summary extraction
  - Libraries make it harder to analyze code, we may not know what these libraries actually do
  - Extract function/procedure/method summaries from existing documentation — basic info such as signatures, types, maybe ability to attach more advanced info
  - No work on this yet, still deciding what makes sense — currently works for PHP by extracting very generic HTML representation and using Rascal to match over it

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# Related work

- "Extensible intraprocedural flow analysis at the abstract syntax tree level", Söderberg, Ekman, Hedin, Magnusson
  - Uses attribute grammars to represent control flow
  - Reference attributes represent edges
  - Collection attributes represent inverse relations (e.g., pred)
  - Higher-order attributes allow building new AST nodes (e.g., entry and exit)

# Related work

- Spoofax: NaBL, language for incremental type checking
- DHAL and variants for data flow analysis
- Related conceptually — use domain-specific languages for specific analysis-related tasks
- Direct language support: Rascal, TXL, Spoofax, ASF+SDF, etc

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# Discussion

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# Discussion: Some possible topics…

- What opportunities are there for creating DSLs for program analysis? Which parts of the process would be best for this?
- Which is best: internal or external? What circumstances drive this?
- Is this even a good idea? Why not just use Rascal (or something else, if you must…)

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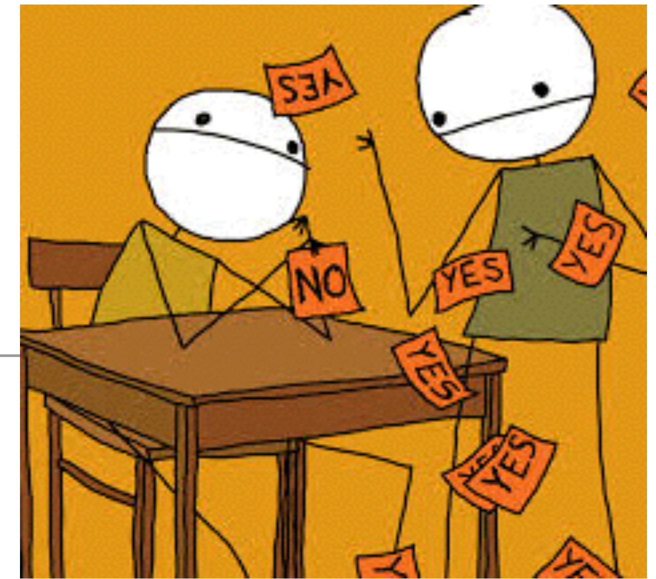
# Which design decisions are important?

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