Strafunski

Functional Strategy Combinators

http://www.cs.vu.nl/Strafunski/

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Objectives

Using FP for language processing applications, e.g.:

- Program analysis and reverse engineering
- Refactoring and re-engineering

Reuse external components for e.g.:

- Parsing
- Graph visualization

Employ generic traversal for

- Conciseness (focus on relevant data constructors)
- Robustness (isolate against data structure change)

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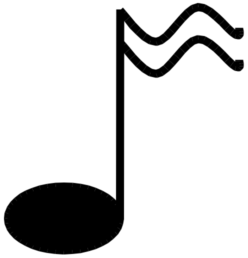
What is it?

Strafunski =

Strategies + functions



Strafunski =

- a Haskell-based bundle
- for generic programming, based on the concept of a functional strategy, and
- for language processing, using GLR

Strafunski =

combinator library + precompiler + parser generator

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Outline of this talk

- Concepts
- Design patterns
- Tools
- Applications

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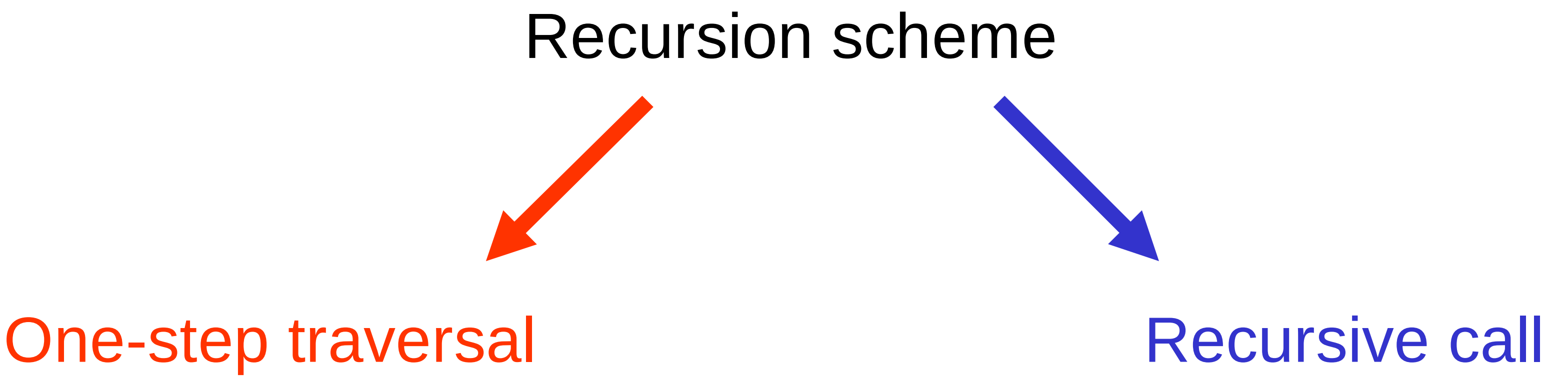
Traversal schemes




```
topdown s   = s `seq` (all (topdown s))
bottomup s  = (all (bottomup s)) `seq s
once_td s   = s `choice` (one (once_td s))
            ...
```

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What are functional strategies?

Characteristics:

- first-class, generic functions
- composed and updated in combinator style
- allow generic traversal into subterms
- mix type-specific and uniform behaviour

freely mix generic and type-specific behaviour

only uniform behaviour

functional strategy =/= parametric polymorphic function

functional strategy =/= polytypic function

composed from simple combinators

induction over sums-and-products

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What are functional strategies?

Example: increment all integers in a term

```
increment
    = apply (topdown (adhoc identity (+1)))
```

```
> :i increment
increment :: Term a => a -> a
> increment [0,1,2]
[1,2,3]
> increment (True,[0,1],Just 2)
(True,[1,2],Just 3)
```

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What is it good for?

Example:

- Haskell itself (30 datatypes, 100 constructors)
- Collect all type constructor names

```
refTypeNames :: Term a => a -> [HsName]
refTypeNames = runId . applyTU traversal
 where
  traversal = crush nodeAction
  nodeAction = adhocTU (constTU []) getName
  getName (HsTyCon (UnQual n)) = return [n]
  getName _                    = return []
```

- Mention two constructors only
- Works on any Haskell fragment / dialect

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vs. Scrap your boilerplate

Scope:

- Data.Generics: basic strategy combinators
- Strafunski: basic combinators + library + tools

Availability:

- Data.Generics: available in GHC version 6.2
- Strafunski: works with GHC and Hugs and NHC

Names:

- Data.Generics: Data, extM/Q, gmapM/Q,...
- Strafunski: Term, adhocTP/TU, allTP/TU,...

Future:

- Strafunski uses Data.Generics as basis (optionally)

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Library themes

- Traversal (full_td, once_td, stop_td, ...)
- Fixpoint (outermost, innermost, ...)
- Path (below, above,...)
- Name (freeNames,...)
- Keyhole (selectFocus, replaceFocus, deleteFocus)
- Metrics (typeMetric, predMetric, depthWith, ...)
- ...

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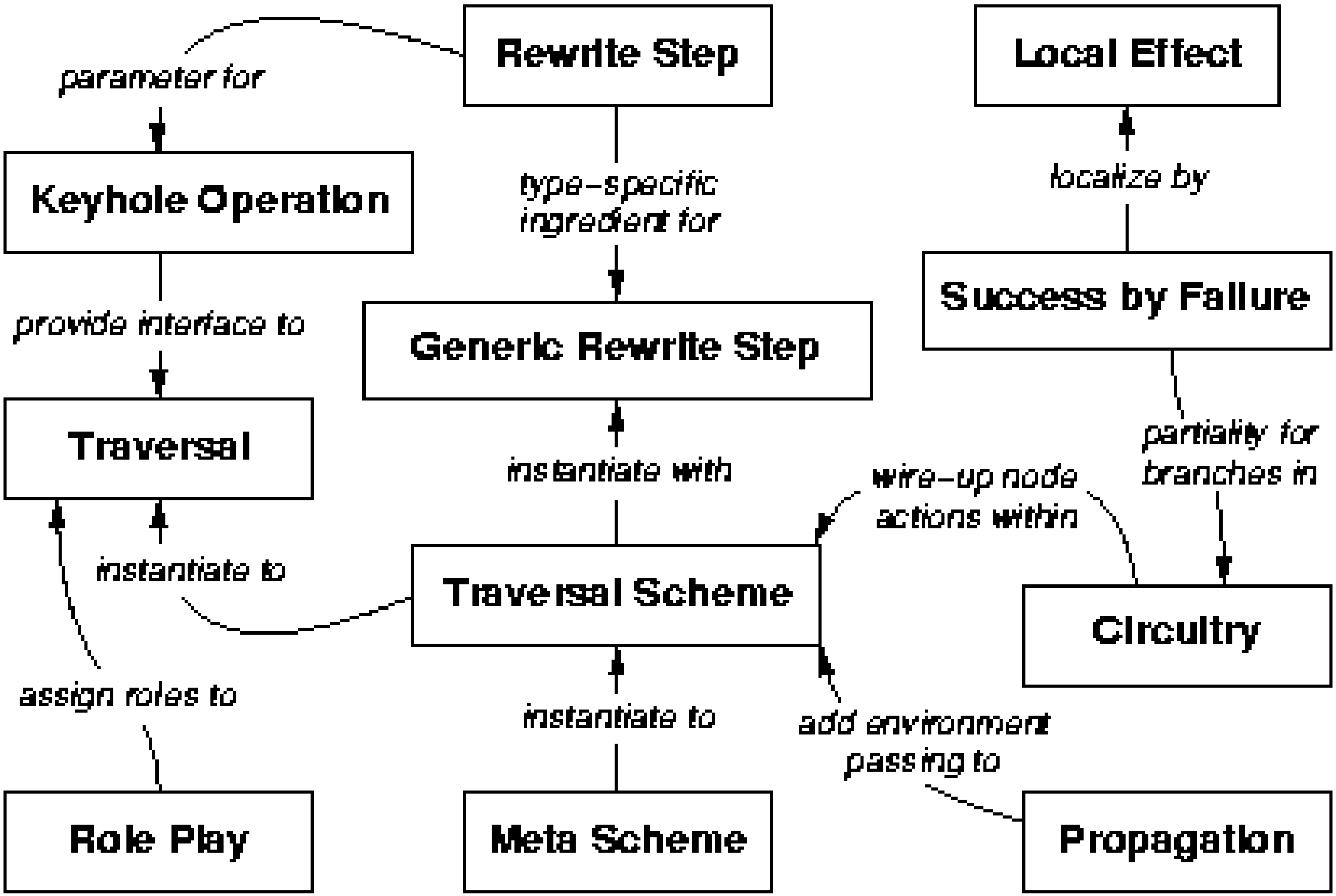
Design patterns



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Rewrite Step

Intent: Capture a single type-specific computation step

Motivation: By capturing type-specific computations and naming them, they can easily be reused in different contexts.

Schema:

```
step       :: T -> T'
step pat = rhs
step v     = ...
```

Sample code:

```
refTypes        :: HsType -> [HsName]
refTypes (HsTyCon (UnQual n)) = [n]
refTypes _     = [ ]
```

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Generic Rewrite Step

Intent: Lift type-specific rewrite steps to all types

Motivation: At some point in the synthesis of generic programs, type-specific steps must be made generic.

Schema:

```
generic = default `adhoc` step1 `adhoc` step2
```

Sample code:

```
anyTypes :: TU [HsName] Identity
anyTypes = constTU [ ]
           `adhocTU` (return . decTypes)
           `adhocTU` (return . refTypes)
```

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Traversal

Intent: Instantiate a traversal scheme with generic rewrite steps.

Motivation: You can construct your own traversal by instantiating a predefined traversal scheme e.g. from Strafunsk's library.

Schema:

```
instantiation = scheme arg1 ... argN
```

Sample code:

```
allTypes :: TU [HsName] Identity
allTypes = crush anyTypes
```

Using the predefined combinator:

```
crush :: (Monad m, Monoid u) => TU u m -> TU u m
```

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Keyhole Operation

Aka: Wrapper Worker

Intent: Do not expose strategy type to the top level.

Motivation: On the inside, you can work with the full power of strategies, while on the outside, all you see is a plain function without any trace of TP, TU, Term.

Schema:

```
wrapper fp1 ... fpN = ... apply worker ...
   where worker = ... `adhoc` ...
```

Sample code:

```
isFreshType :: HsName -> HsModule -> Bool
isFreshType n = runIdentity . applyTU worker
   where worker = allTypes `before` isNotElem
               isNotElem = not . (elem n)
```

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Generic Container

Intent: Use a strategy as a generic data container.

Motivation: Terms of different types sometimes need to be stored in the same container.

Sample code:

```
type GSet   = TU () Maybe
emptyGS     = failTU
fullGS      = constTU mempty
elemGS e s = maybe False (const True) (applyTU s e)
addGS e s  = modifyTU s e (return mempty)
rmGS e s    = modifyTU s t mzero

modifyTU f e = adhocTU f . modify (applyTU f) t
modify f x y   = \x' -> if x == x' then y else f x'
```

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What makes it work?

- no new language (cf. PolyP, GH, FISh)

- rely on Term class that captures extras
- instantiate for every algebraic datatype
- use precompiler (extended version of DrIFT)

- or add derive Data,Typeable to all your datatypes (with GHC 6.2).

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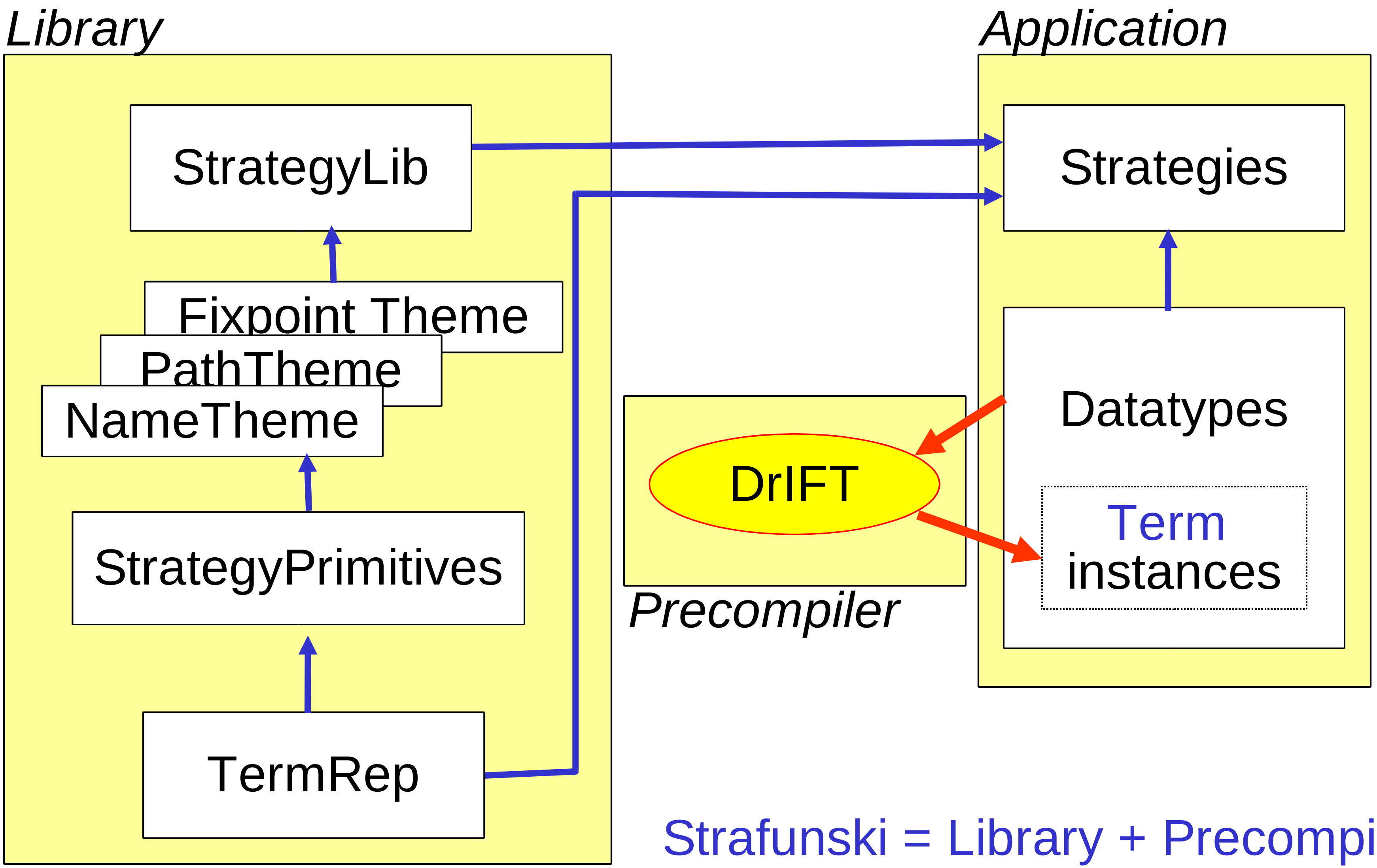
Architecture



Strafunski = Library + Precompiler

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Getting to terms

Source code:

- SDF to specify grammar
- SGLR to parse
- ATerms to exchange ASTs

Documents:

- DTD to specify document structure
- XML to exhange documents
- HaXML to read / write

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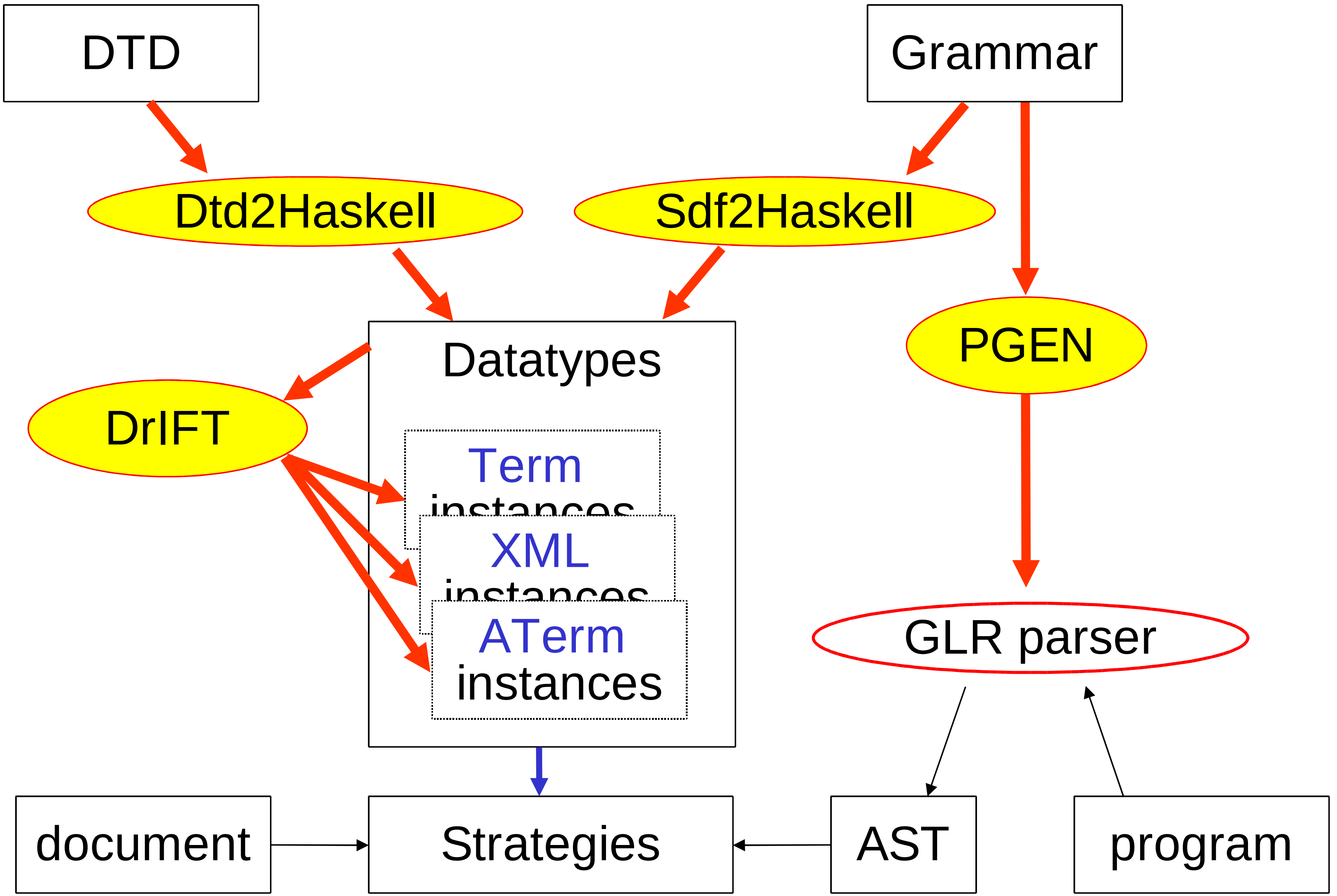
Getting to terms



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The bundle

Strafunski:

- StrategyLib
- ATermLib
- (DrIFT-Strafunski)
- Sdf2Haskell

Uses:

- Haskell compiler / interpreter (GHC / Hugs) and Haskell libraries
- parser & parse table generator (SGLR & PGEN)

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Applications

Java metrics and reverse engineering.

- SDF grammar for Java
- E.g. count conditionals, nesting depth, ...
- E.g. Extract conditional call graph

Java refactoring.

- E.g. *Extract Method* refactoring

Meta-lang = object-lang = Haskell.

- Use same parser as Haddock
- E.g. *do* elimination, *newtype* introduction

Cobol reverse engineering.

- SDF grammar for Cobol
- Extract *perform graph*

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Learn more

Principles:

Typed combinators for generic traversal (PADL 2002)

Applications:

A Strafunski application letter (PADL 2003)

Cook book:

Design patterns for functional strategic programming (RULE 2002)

Implementation:

Strategic polymorphism requires just two combinators! (IFL 2002)

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