CLEAN – UNIQUENESS TYPING

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Why?

- Efficient Space Management
- Interfacing with Non-functional Operations

Clean Language

Clean is a practical applicable general-purpose lazy pure functional programming language suited for the development of reald world applications.[1]

Haskell	Clean	Remarks
(a -> b) -> [a] -> [b]	(a -> b) [a] -> [b]	higher-order function
f . g	f o g	function composition
-5	~5	unary minus
[x | x <- [1..10] , isOdd x]	[x \\ x <- [1..10] | isOdd x]	list comprehension
x:xs	[x:xs]	cons operator

http://en.wikipedia.org/wiki/Clean_(programming_language)

[1] Rinus Plasmeijer, Marko van Eekelen, John van Groningen [2011]. Language report Version 2.2.

Features

- Strictness analyzer

```
[ 1,3..9 ]    // a lazy list
[! 1,3..9 ]   // a head strict list
[! 1,3..9 !]  // a strict list (head and spine)
[# 1,3..9 ]   // a head strict list, unboxed
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- Dynamics

Sparkle

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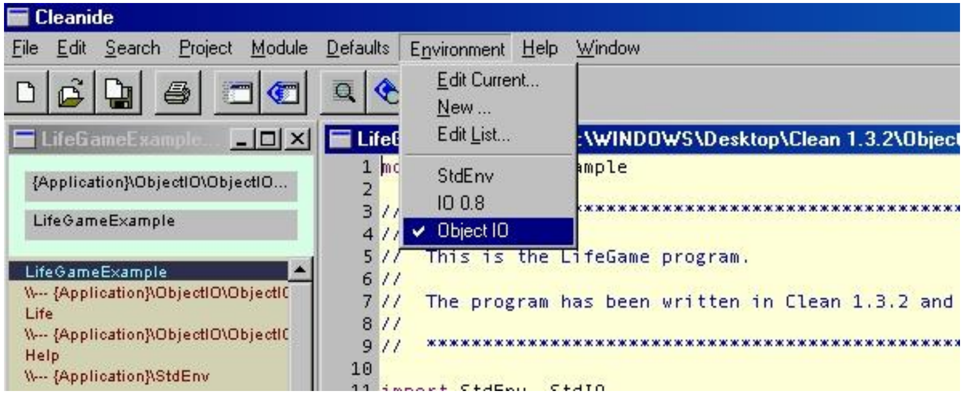
- Absurd
- AbsurdEquality
- Apply
- Assume
- Case
- ChooseCase
- Compare
- Exact
- Generalize
- Induction
- Injective
- Introduce
- MoveQuantors
- Reduce
- Reflexive
- Rewrite
- Split
- Symmetric
- Transitive
- Undo
- …

Clean Platform


Cleanide
File Edit Search Project Module Defaults Environment Help Window
Edit Current...
New...
Edit List...
StdEnv
IO 0.8
✓ Object IO
LifeGameExample
LifeG
:\WINDOWS\Desktop\Clean 1.3.2\Object

{Application}\ObjectIO\ObjectIO...

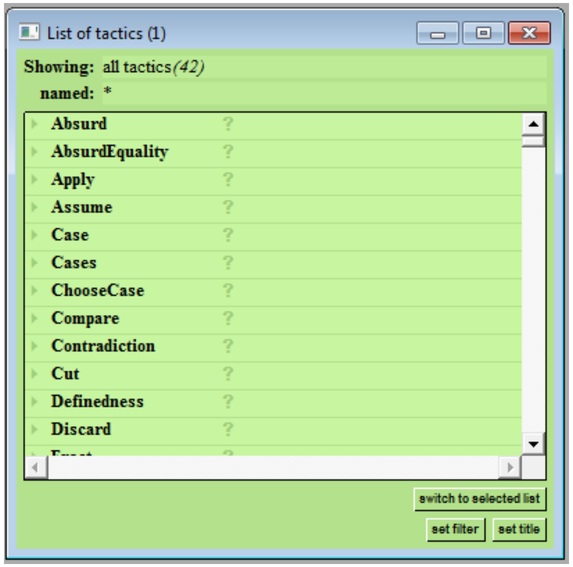
LifeGameExample

LifeGameExample
--- {Application}\ObjectIO\ObjectIO
Life
--- {Application}\ObjectIO\ObjectIO
Help
--- {Application}\StdEnv

```
mo              ample

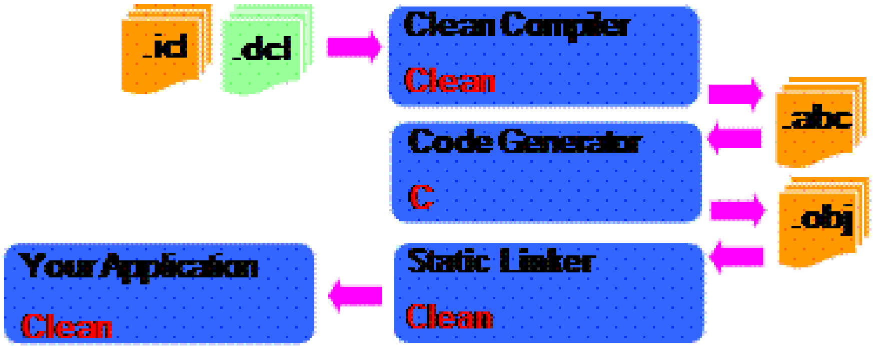
//              ************************************
//
//  This is the LifeGame program.
//
//  The program has been written in Clean 1.3.2 and
//
//  ************************************************

import StdEnv, StdIO
```



Showing: all tactics *(42)*
named: *

- Absurd ?
- AbsurdEquality ?
- Apply ?
- Assume ?
- Case ?
- Cases ?
- ChooseCase ?
- Compare ?
- Contradiction ?
- Cut ?
- Definedness ?
- Discard ?



Uniqueness Typing: Intuition

“The type of a value is given a ‘unique’ attribute if that value is used at most once. On such ‘unique’ values update operations may be safely implemented in-place since their uniqueness guarantees that their value is no longer required by the program.” [2]

[2] Dana G. Harrington [2001]. A type system for destructive updates in declarative programming languages.

Uniqueness Typing: Definition

A uniqueness type is a pair $S = \langle\sigma, A\rangle$, where σ is a conventional type and A is a uniqueness attribute. The underlying conventional type σ is denoted $|S|$. (Also a more convenient notation is using superscripts).

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```
fwritec :: Char *File -> *File
```

Why?

Adding uniqueness information provides a solution to two problems in implementations of functional languages.[3]

[3] Erik Barendsen and Sjaak Smesters [1993]. Conventional and Uniqueness Typing in Graph Rewrite Systems.

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- Efficient space management
- Interfacing with non functional operations

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Efficient Space Management

- Memory cells of `m` could be reused

```
let
  l = [1..10]
  m = map (*2) l
in
  m
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Efficient Space Management

- Memory cells of `m` could be reused

```
let
  l = [1..10]
  m = map (*2) l
in
  m
```

- Memory cells of `m` can not be reused

```
let
  l = [1..10]
  m = map (*2) l
in
  (l,m)
```

Interfacing with Non-functional Operations

```
// C example
int foo( FILE *file ) {
  int a = fgetc(file );  // Read a character from ’file’
  int b = fgetc(file );
  return a + b;
}
```

Interfacing with Non-functional Operations

```
// Clean example
fgetc :: *File → (Char, *File)


foo :: *File → (Char, *File)
foo file0 = let (a, file1) = fgetc file0
                (b, file2) = fgetc file1
            in  (a + b, file2)
```