

Discovery of Pyrser

Lionel "iopi" Auroux

Pyrser in few words

Plan

About parsing...

Motivations

Use case 1 : Parsing XML

Parsing is not enough, Type System!

Use case 2 : ToyLanguage4Typing

Conclusion

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Jeudi, 17/07/2014

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- A PEG parser tools in python 3 x
- Available on PYPI (pip install :P)
- Documented (sphinx): http://pythonhosted.org//pyrser/
- Tested (699 Unit Test)
- Will be use/Used by students each years (since 2013)
- Inspirated by codeworker (www.codeworker.org)
- Grammars as Classes, so inheritable
- Rules as methods, so overloadable
- Not so context-free (PEG)
- A Type system module (parsing is not enough)
- Still in development... 0.0.3 but completly functionnal (CNORM 4.0)

Plan



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About parsing...

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• Use case 1 : parsing XML

• Parsing is not enough, Type System!

• Use case 2 : ToyLanguage4Typing

Contribution/Conclusion



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Since 1970, goal evolves

- From 1 language compiler, 1 translation
 - To N entangled languages with N ad-hoc tools
 - i.e : Web Stack (HTML+PHP+JS)
 - i.e : C++/Doxygen
 - i.e : FramaC (C + ACSL)



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Emergence of Model Driven Engineering!

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Using Parsing/Generating technics mostly in case of MDE for :

- Defining DSLs for ad-hoc tools
 - Handle all the stuff
 - Generating many things (1-N files)
 - Extensibility and Customisation
 - Not really a compiler in classical terms...



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"Yacc is dead", M. Might, D. Darais, cs.PL 24/10/10 <arXiv :1010.5023>

We need

- WYSIWYG Parser
- Not WYSIWYGIYULR(k)—'what you see is what you get if you understand LR(k)
- Manage Ambiguous grammar
- For engineer not for computer scientist

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"Parsing Expression Grammars", B. Ford, 2004, 31st ACM SIGPLAN-SIGACT

PEG provides

- Prioritized choices
- Greedy rules
- Syntactic predicates
- Unlimited lookahead
- Backtracking

More easy and versatile than LR



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Old EPITA C++2C project

2003 KOOC : Kind Of Objective C

OO features on a superset of C \rightarrow need to give a grammar (C) to students!

Very short period (3 month) -> need quick prototyping



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Evolving since 2003

First version in PERL

From 2005 to 2012 in CODEWORKER (PEG)

Since 2013 in PYTHON



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A root of many projects

CNORM version 4 in Python with Pyrser

KOOC since 2013

Rathaxes...(MDE apply to driver development)



So Pyrser...

Provides Codeworker features to Python (PEG)

Choose of Python for readability and community

Describes grammar thru a 'BNF-like' description

No embedded language in the description (language agnostic or MVC)

Few abstractions to connect parser engine and scripting language (other language than Python)

Grammar composition

Dependency Injection

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Use case 1 : Parsing XML



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Let's apply it to an example : XML

We've got few abstractions

- Rules
- Nodes
- Hooks
- Directives

Use case 1 : Parsing XML



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Rules allow us to describe our grammar

5

6

7

10

11

12

13

```
define a non-terminal rule
          alternatives (lower priority than space)
          call a non-terminal
          terminal charater
"abc"
         terminal text
'a'..'z' terminal range
          define groups
Г٦
          classic repeater
some predicates:
          complement
          negative lookahead
          positive lookahead
-> A
          read all until A
```

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Some examples :

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```
// classic identifier
id = [['a'..'z'|'A'..'Z'|'_']['0'..'9'|'a'..'z'|'A'..'Z'|'_']*]

just_equal = ['=' !'='] // in C

all_but_eol = [ ~'\n' + ]
all_but_eol2 = [ ->'\n' ] // read the first |n equivalent to ''|n' + '\n'
```



Nodes and Hooks allow to interact with python

```
from pyrser import meta, grammar
    from pyrser.parsing import Node
4
    txtbnf = grammar.from_string("""
        plop = [ id:i #test_hook(_ , i)]
5
6
     111115
7
8
     # txtbnf is a CLASS
     Qmeta.hook(txtbnf)
10
     def test_hook(self, ast: Node, i: Node) -> bool:
11
         # ast
12
         # capture value and build a node
13
        ast.node = self.value(i) # capture value
14
        return True
15
     itxt = txtbnf()
16
     # rule 'plop' as entry point
17
    res = itxt.parse("cool", "plop")
```

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API is richer than this example!

Use case 1 : Parsing XML



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Finally, Directives have a global effect

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8

9

10

11

12 13

14

We could understand it with a little example :



New Directives could be user defined

Grammar are Classes, so inheritable and composable

Rules are overloadable

2

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6

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8

10

13

```
from pyrser.grammar import *
class GramA(Grammar):
    grammar = """ ... """
    entry = "entry_point"
class GramB(Grammar, GramA):
    grammar = """ ... """
    entry = "entry_point"
class GramC(Grammar):
    grammar = """ ... """
    entry = "entry_point"
    class GramC(Grammar):
    grammar = """ ... """
    entry = "entry_point"
    class GramD(Grammar, GramA, GramC):
    grammar = """ R = [GramA.R | GramC.Z] """
    entry = "GramA.entry_point"
```

Hooks are overloadable

Complete example with JSON in Tutorial I on http://pythonhosted.org//pyrser/

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Conclusion

Parsing is just the way to get an AST but is not enough

We need :

- A conveniance way to do AST visiting (tree transformation, generation)
- To check conformity of AST from a semantic



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Conclusion

Let's focus on conformity checks (AST visiting is trivial in python)

We need a Type System Module to do the job

Generals goals:

- Classic static typing: declarative or inference
- Versatility
- Extensibility

Remember goals for KOOC:

- Handle OO features: function overloads, kind of subtyping (inheritance is not really subtyping), covariant return types
- Handle C narrow (ugly) typing, implicit conversion, ...



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Conclusion

Difficult to mimic/use functionnal TS as is (with camlp4)

• How handle ugly things with a functionnal TS?

Need an expedient, an hybrid TS

- Provide a subset (or reinterpretation) of features found in functionnal language
- A toolbox to compose our semantic
- Usable outside pyrser (legacy parsing) Dependency Injection Again!



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Types? a set of syntactic constraints on language expressions.

- We could list them: declarative system
- We could deduce them thru uses : inference system

Our expedient :

- Easy type algebra : operators, statement are all functions
- Only have to find type of functions that use them...
- ...Deduce/Reduce from literals
- Deduce/Reduce from operators (polymorphic or not)
- Deduce/Reduce from statements (all is expression or not)
- Deduce/Reduce from declarations if present
- Polymorphic type (local or type reconstruction)
- Variadic functions are allowed (we want to type C)
- Choose between Implicit or Explicit conversion (no op if subtype)



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We provide few basic abstractions :

- Scope: universal container (block, namespace...)
- Signature : all things in a scope a identifiable
- Symbol : at the end all is symbol

And more complex abstractions:

- Var
 - Val: true, false, 12, "foobar"
 - Fun
 - Type: ADT meaning

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Conclusion

We just need to tag our AST with instances of these classes...

And to use generic strategies provide by the Inference submodule to :

- Type check and/or infer types
- Alter tree if TS need it
- And more...

Let see some examples with a Toy Language...



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ToyLanguage4Typing

Conclusion

TL4T is a language define just for Unit/Regression Test and for tutorials

Verv easy to understand

Follow some examples illustrate features of the TS

Complete example in Tutorial II & III on http://pythonhosted.org//pyrser/



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Implicit/Explict conversion and subtyping?

- We provide Type Operation to find if t2 is subtype of t1
- You could also say, implicitly convert t2 to t1 thru function f
- You could also say, prohibe convertion t2 to t1



```
from tests.grammar.t14t import *
    from pyrser.type_system import *
    test = TL4T()
    res = test.parse("""
         s = "toto" + 12:
     n m m \gamma
    res.type_node = Scope(is_namespace=False)
    res.type node.add(Type("string"))
    res.tvpe node.add(Tvpe("int"))
10
    res.type_node.add(Var("s", "string"))
11
    res.type_node.add(Fun("=", "string", ["string", "string"]))
12
    res.type_node.add(Fun("+", "string", ["string", "string"]))
13
    f = Fun("to_str", "string", ["int"])
14
    res.type_node.add(f)
15
    n = Notification(
16
        Severity.INFO,
17
         "implicit conversion of int to string"
18
19
    res.type node.addTranslator(Translator(f. n))
20
    res.type_node.addTranslatorInjector(createFunWithTranslator)
21
    res.infer type (res.diagnostic)
22
    print (res.to t14t())
```

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Will show us:

```
1 | s = "toto" + to_str(42);
```



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Selecting function overloads like in KOOC?

```
fun f(int, char) -> string;
fun f(int, int) -> double;

var a = f(12, 12); // here var a : double
var a = f(12, 'c'); // here var a : string
```

3



How type literals?

Val could have many types... C

```
int median(int, int);
...
int b = median('a', 'c');
```

Or Val could have unique fix types... F#

```
12s -> 12 as short
12 -> 12 as int
...
```

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We allow both...



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Variadic functions?

```
fun printf(string, ...) -> void;
...
var a = 12;
// here fun printf: (string, int, int) -> void
printf("%d + %d\n", 42, a);
```

We could always access in annoted AST to the define type and the instanciate type! Useful for polymorphic functions.

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• All presented features will be available in the next 0.0.3 Pyrser versions

Next type checked version of CNORM

- Deadlines (commit on PYPI) next student sessions (september 2014)
- A lot of features in the PIPE : cythonization, effective system, ...
- Migration to GITHUB
- 1 Lead dev + 3 contributors but need contributors...

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