ADQL - PEG grammar

Progress status

IVOA Interoperability Meeting
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Remember!

Poster P919

ADASS XXXIII in Tucson

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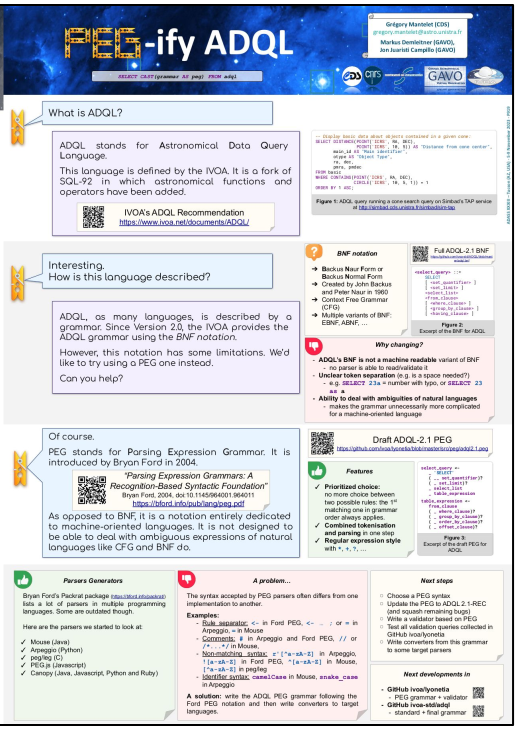

PEG-ify ADQL

`SELECT CAST(grammar AS peg) FROM adql`

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What is ADQL?

ADQL stands for Astronomical Data Query Language.

This language is defined by the IVOA. It is a fork of SQL-92 in which astronomical functions and operators have been added.

IVOA's ADQL Recommendation
https://www.ivoa.net/documents/ADQL/

```
-- Display basic data about objects contained in a given cone:
SELECT DISTANCE(POINT('ICRS', RA, DEC),
                POINT('ICRS', 10, 5)) AS "Distance from cone center",
       main_id AS "Main identifier",
       otype AS "Object Type",
       ra, dec,
       pmra, pmdec
FROM basic
WHERE CONTAINS(POINT('ICRS', RA, DEC),
               CIRCLE('ICRS', 10, 5, 1)) = 1
ORDER BY 1 ASC;
```

Figure 1: ADQL query running a cone search query on Simbad's TAP service at http://simbad.cds.unistra.fr/simbad/sim-tap

Interesting.
How is this language described?

ADQL, as many languages, is described by a grammar. Since Version 2.0, the IVOA provides the ADQL grammar using the *BNF notation*.

However, this notation has some limitations. We'd like to try using a PEG one instead.

Can you help?

BNF notation

- ➔ **B**ackus **N**aur **F**orm or **B**ackus **N**ormal **F**orm
- ➔ Created by John Backus and Peter Naur in 1960
- ➔ Context Free Grammar (CFG)
- ➔ Multiple variants of BNF: EBNF, ABNF, …

Full ADQL-2.1 BNF
https://github.com/ivoa-std/ADQL/blob/master/adql.bnf

```
<select_query> ::=
    SELECT
    [ <set_quantifier> ]
    [ <set_limit> ]
    <select_list>
    <from_clause>
    [ <where_clause> ]
    [ <group_by_clause> ]
    [ <having_clause> ]
```

Figure 2:
Excerpt of the BNF for ADQL

Why changing?

- **ADQL's BNF is not a machine readable** variant of BNF
  - no parser is able to read/validate it
- **Unclear token separation** (e.g. is a space needed?)
  - e.g. `SELECT 23a` = number with typo, or `SELECT 23 as a`
- **Ability to deal with ambiguities of natural languages**
  - makes the grammar unnecessarily more complicated for a machine-oriented language

Of course.

PEG stands for Parsing Expression Grammar. It is introduced by Bryan Ford in 2004.

"Parsing Expression Grammars: A Recognition-Based Syntactic Foundation"
Bryan Ford, 2004, doi:10.1145/964001.964011
https://bford.info/pub/lang/peg.pdf

As opposed to BNF, it is a notation entirely dedicated to machine-oriented languages. It is not designed to be able to deal with ambiguous expressions of natural languages like CFG and BNF do.

Draft ADQL-2.1 PEG
https://github.com/ivoa/lyonetia/blob/master/src/peg/adql2.1.peg

Features

- ✓ **Prioritized choice:** no more choice between two possible rules: the 1st matching one in grammar order always applies.
- ✓ **Combined tokenisation and parsing** in one step
- ✓ **Regular expression style** with `*`, `+`, `?`, …

```
select_query <-
   _ 'SELECT'
   ( __ set_quantifier)?
   ( _ set_limit)?
   _ select_list
   _ table_expression

table_expression <-
   from_clause
   ( _ where_clause)?
   ( _ group_by_clause)?
   ( _ order_by_clause)?
   ( _ offset_clause)?
```

Figure 3:
Excerpt of the draft PEG for ADQL

Parsers Generators

Bryan Ford's Packrat package (https://bford.info/packrat/) lists a lot of parsers in multiple programming languages. Some are outdated though.

Here are the parsers we started to look at:

- ✓ Mouse (Java)
- ✓ Arpeggio (Python)
- ✓ peg/leg (C)
- ✓ PEG.js (Javascript)
- ✓ Canopy (Java, Javascript, Python and Ruby)

A problem…

The syntax accepted by PEG parsers often differs from one implementation to another.

Examples:

- Rule separator: `<-` in Ford PEG, `<- … ;` or `=` in Arpeggio, `=` in Mouse
- Comments: `#` in Arpeggio and Ford PEG, `//` or `/*...*/` in Mouse,
- Non-matching syntax: `r'[^a-zA-Z]` in Arpeggio, `![a-zA-Z]` in Ford PEG, `^[a-zA-Z]` in Mouse, `[^a-zA-Z]` in peg/leg
- Identifier syntax: `camelCase` in Mouse, `snake_case` in Arpeggio

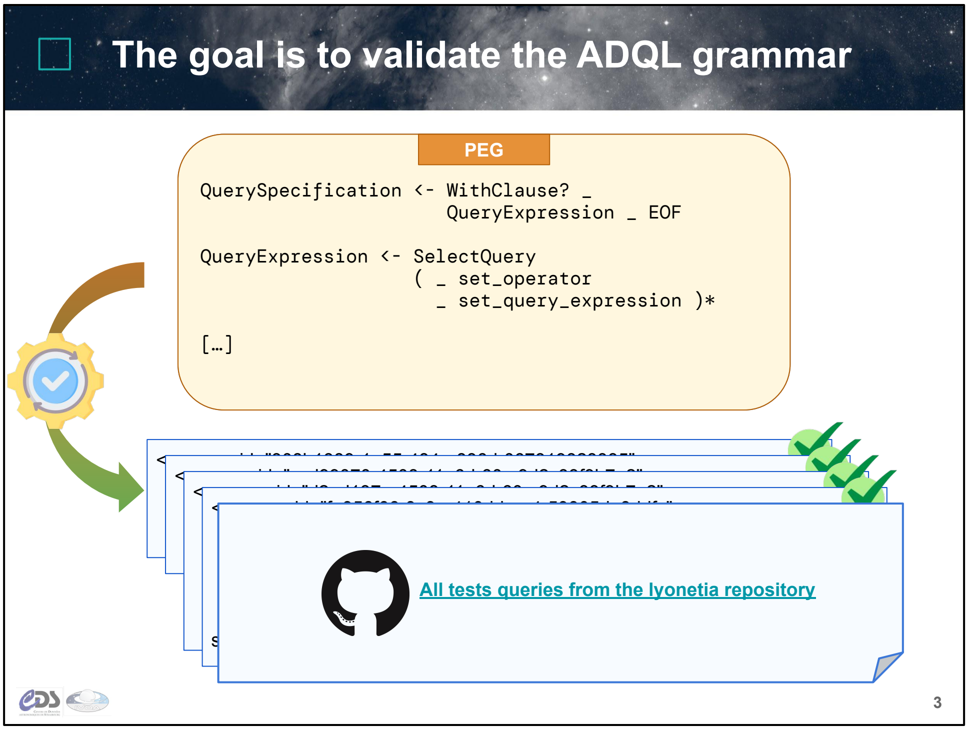
A solution: write the ADQL PEG grammar following the Ford PEG notation and then write converters to target languages.

Next steps

- ▫ Choose a PEG syntax
- ▫ Update the PEG to ADQL 2.1-REC (and squash remaining bugs)
- ▫ Write a validator based on PEG
- ▫ Test all validation queries collected in GitHub ivoa/lyonetia
- ▫ Write converters from this grammar to some target parsers

Next developments in

- **GitHub ivoa/lyonetia**
  - PEG grammar + validator
- **GitHub ivoa-std/adql**
  - standard + final grammar



The goal is to validate the ADQL grammar

PEG

```
QuerySpecification <- WithClause? _
                      QueryExpression _ EOF

QueryExpression <- SelectQuery
                   ( _ set_operator
                     _ set_query_expression )*

[…]
```

All tests queries from the lyonetia repository

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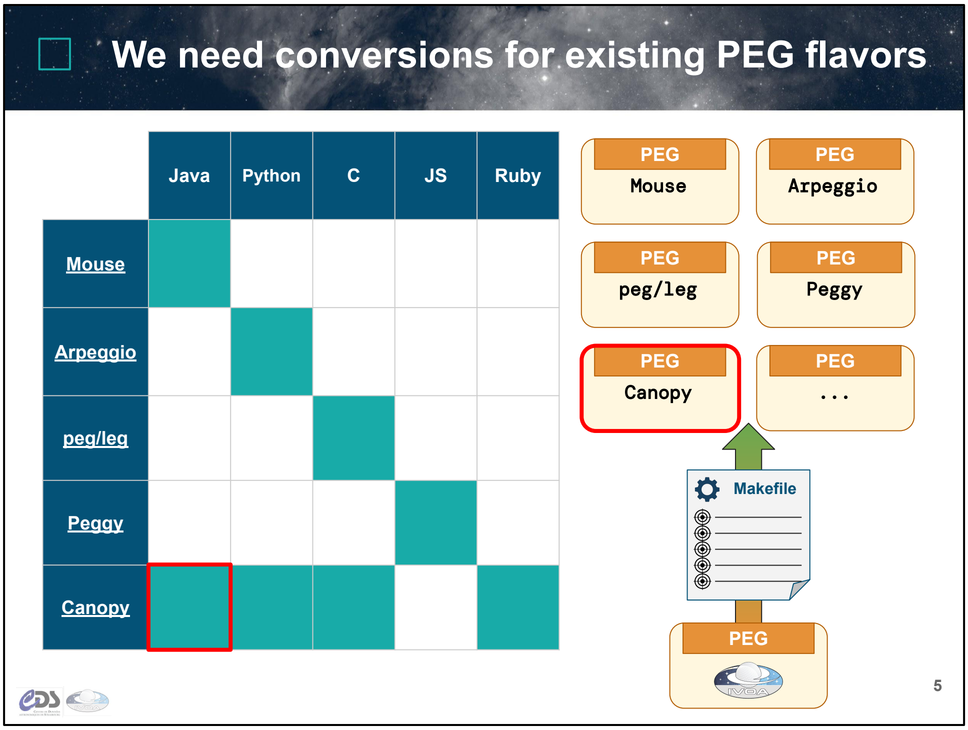
- In v2.0 and v2.1, the ADQL grammar is defined using a BNF.
- This BNF is actually not machine readable and cannot be used to validate the grammar.
- The idea is to use instead a PEG grammar, which is a kind of grammar well adapted to describe programmatic languages like SQL and so AQL,.
- Then, by running the PEG grammar against all test queries of the lyonetia repository, we can validate our language independently from existing ADQL parsers/implementations (e.g. DACHS, CADC's ADQL parser,

- VOLLT/ADQL-Lib).

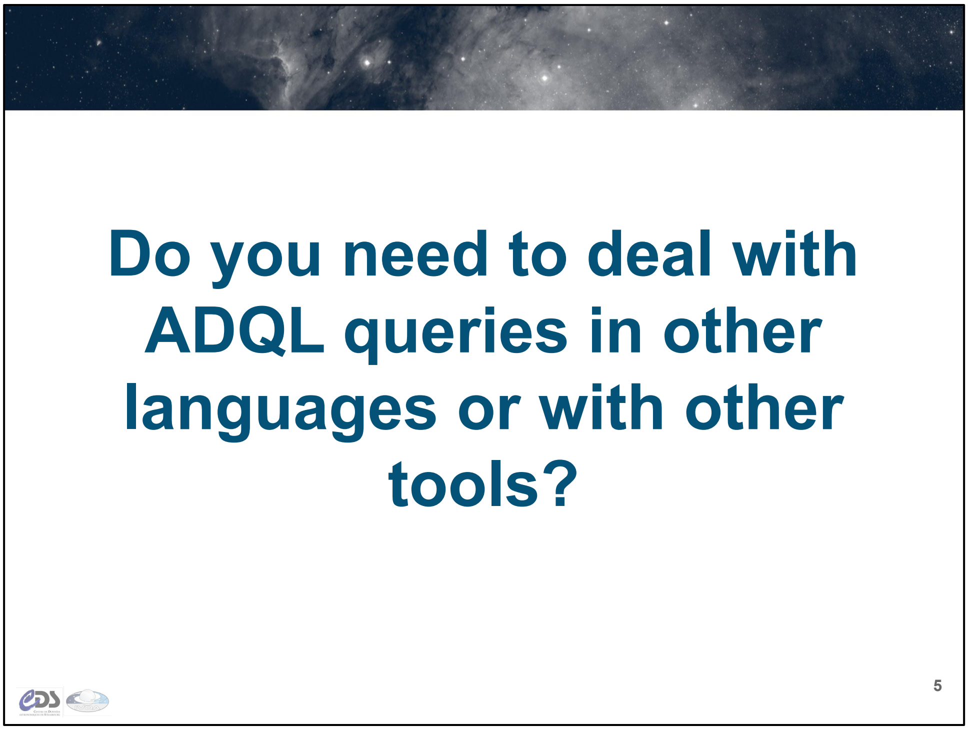


We need conversions for existing PEG flavors

	Java	Python	C	JS	Ruby
Mouse	🟩				
Arpeggio		🟩			
peg/leg			🟩		
Peggy				🟩	
Canopy	🟩	🟩	🟩		🟩

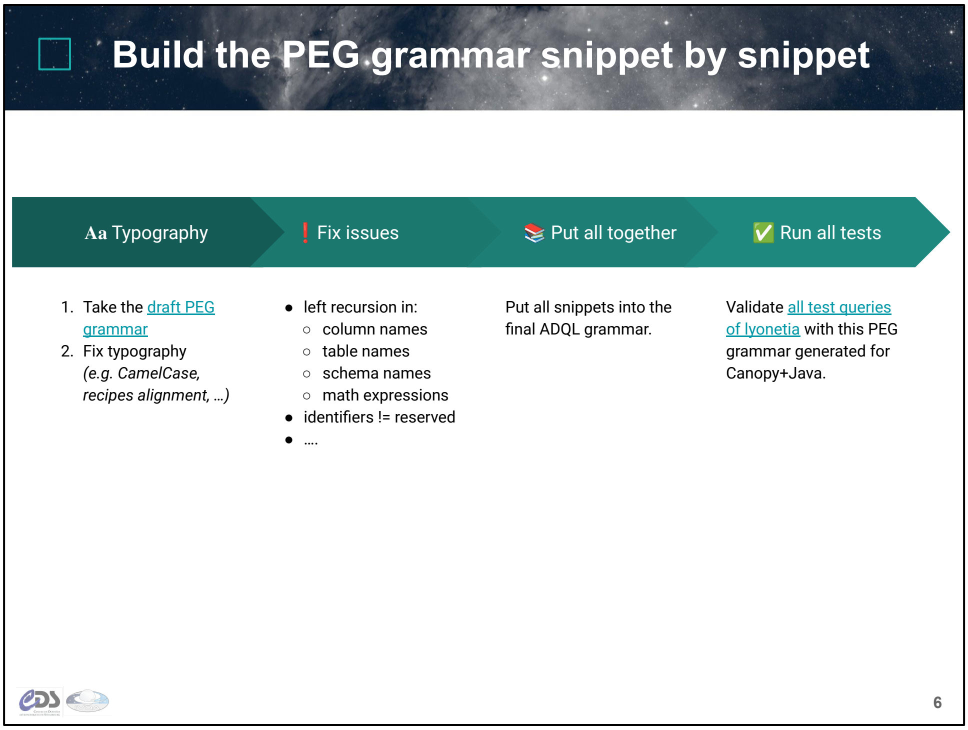
- There are many existing parser generators based on PEG. Here are the one that we have already explored:
  - Mouse (Java ; *quite outdated now*)
  - Arpeggio (Python)
  - peg/leg (C)
  - Peggy (Javascript)
  - Canopy (Java, Python, C and Ruby)
- Unfortunately, each tool uses its own variant of the PEG syntax.
- These variations are actually quite minor. That’s why we propose to write a script (currently a Makefile using the sed command) to convert our ADQL grammar expressed with the original Ford’s PEG syntax into a PEG grammar following the syntax of the target tool.
- To start the developments, I choose to focus first on Canopy for the Java language.

- Why Canopy? Because if we succeed to make the conversion right, we will already be able to generate a parser for 4 different programmatic languages.
- Why Java? Because it is the language I know the best and that I can start to see how to adapt my Java parser (VOLLT/ADQL-Lib) with the ADQL's PEG grammar.



Do you need to deal with ADQL queries in other languages or with other tools?

- Do you need another language/parser generator to be tested too?
  - If yes, don’t hesitate to tell me so that we can integrate it to the test cases.



Build the PEG grammar snippet by snippet

Aa Typography

1. Take the draft PEG grammar
2. Fix typography *(e.g. CamelCase, recipes alignment, …)*

❗ Fix issues

- left recursion in:
  - column names
  - table names
  - schema names
  - math expressions
- identifiers != reserved
- ….

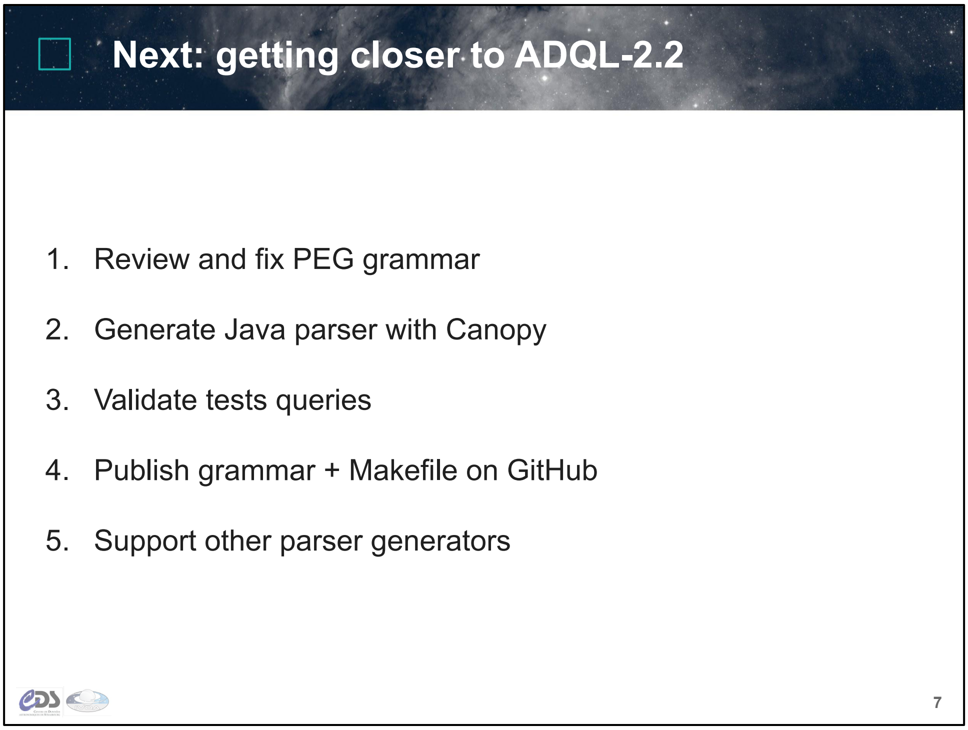
📚 Put all together

Put all snippets into the final ADQL grammar.

✅ Run all tests

Validate all test queries of lyonetia with this PEG grammar generated for Canopy+Java.

1. Use the draft PEG grammar on lyonetia from Jon Juaristi Campilio
2. Fix the format/typography to match the original Ford format
3. Check and adapt snippets each at a time to solve specific issues (e.g. left recursion for identifiers and expressions, identifier not equal to a reserved keyword)
4. Put all of them together
5. Run test queries with the final grammar



Next: getting closer to ADQL-2.2

1. Review and fix PEG grammar
2. Generate Java parser with Canopy
3. Validate tests queries
4. Publish grammar + Makefile on GitHub
5. Support other parser generators

1. Finish reviewing and fixing (when necessary) the PEG grammar
2. Generate parser with Canopy+Java
3. Validate all existing tests queries
4. Share this grammar and the Makefile on GitHub
5. Update the makefile to support all the other parser generators

thank you
PgUp
End
PgDn
hift