



Going under the hood of MontePy: A python API for MCNP input files

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Changing the World's Energy Future

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Going under the hood of MontePy

A python API for MCNP input files

Review of MCNP inputs

- Fortran & Punchcard
- Predates: XML, JSON, SGML
- Very specialized, and pointer based
- Cell example

```
123456 654321 -10.02 -1 2 3 4 imp:n=1.0 imp:p=0.5 fill = 10 ( 0 10.0 20.0)
```

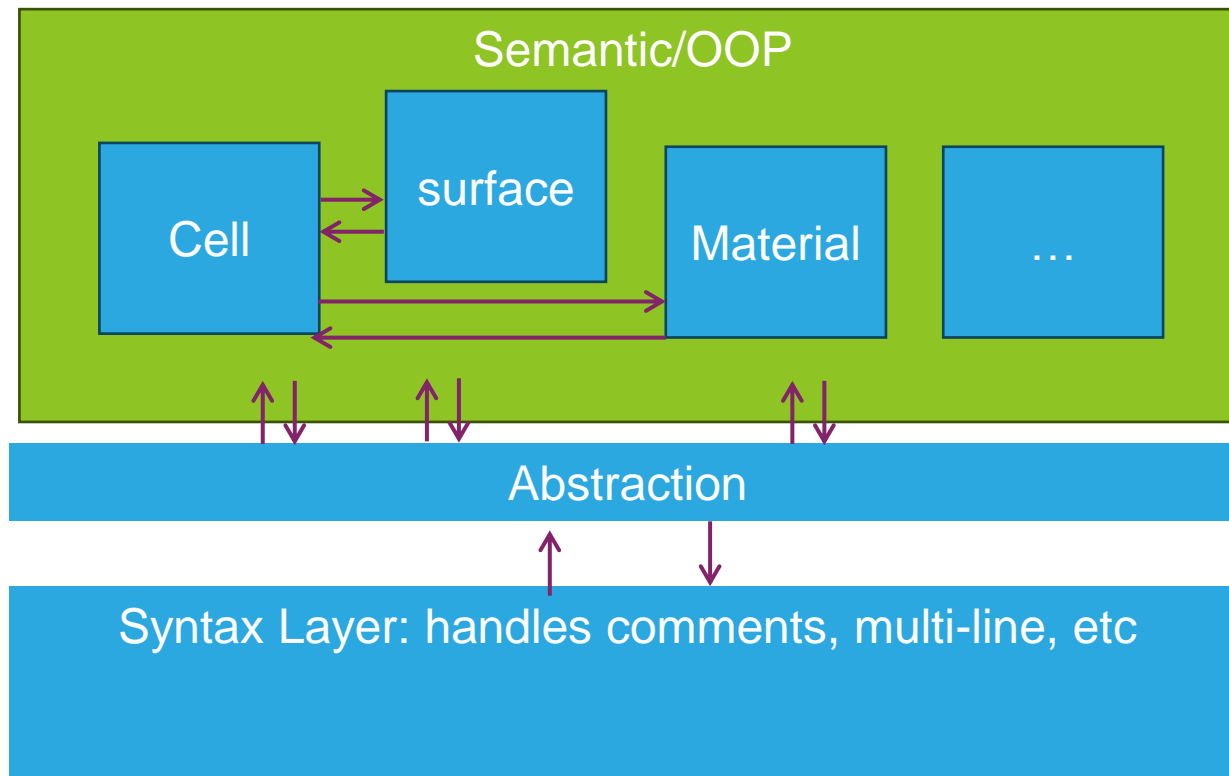
Cell #	mat num	density	geometry	parameters
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Problem

- Can't use standard library (e.g., `import json`)
- Updating pointers can be very tedious
- Finding objects by number is difficult

Solution: MontePy

- Object oriented interface



Very Naïve: Regular expressions

- MCNP is not a Regular language!

The screenshot shows a Stack Overflow page for a question titled "You can't parse [X]HTML with regex". The page is locked, with a message stating: "Locked. There are [disputes about this answer's content](#) being resolved at this time. It is not currently accepting new interactions." The question text reads: "You can't parse [X]HTML with regex. Because HTML can't be parsed by regex. Regex is not a tool that can be used to correctly parse HTML. As I have answered in HTML-and-regex questions here so many times before, the use of regex will not allow you to consume HTML. Regular expressions are a tool that is insufficiently sophisticated to understand the constructs employed by HTML. HTML is not a regular language and hence cannot be parsed by regular expressions. Regex queries are not equipped to break down HTML into its meaningful parts. so many times but it is not getting to me. Even enhanced irregular regular expressions as used by Perl are not up to the task of parsing HTML. You will never make me crack. HTML is a language of sufficient complexity that it cannot be parsed by regular expressions. Even Jon Skeet cannot parse HTML using regular expressions. Every time you attempt to parse HTML with regular expressions, the unholy child weeps the blood of virgins, and Russian hackers pwn your webapp. Parsing HTML with regex" (the text is partially cut off). The page has 4407 votes and a green checkmark icon. The left sidebar shows navigation links: Home, Questions, Tags, Users, Companies, LABS, Discussions, and COLLECTIVES.

<https://stackoverflow.com/a/1732454>

Naïve first attempt: fake parsing ($\leq 0.1.7$)

- Handle syntax
- Split on spaces

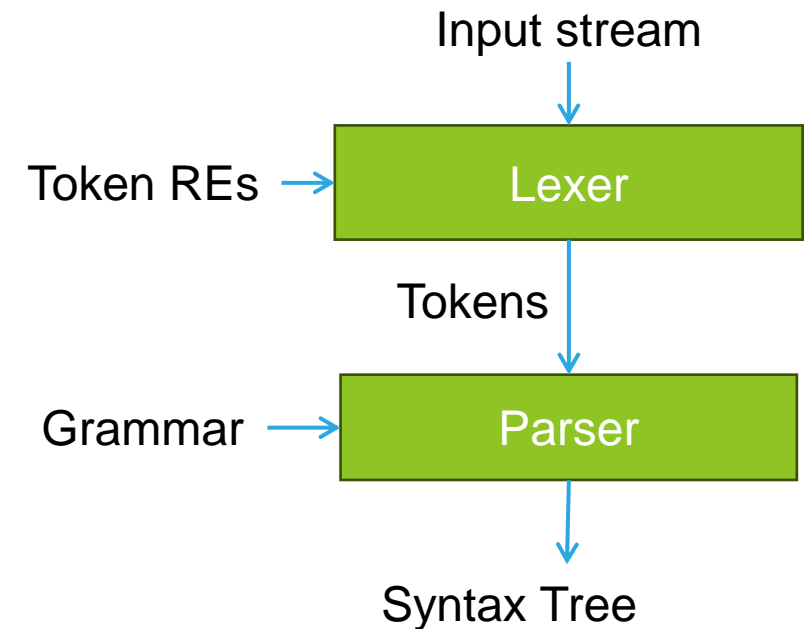
```
123456      654321  -10.02      -1  2  3  4
      imp:n = 1.0 imp:p 0.5
      fill = 10 ( 0 10.0 20.0)
```

```
["123456", "654321", "-10.02", "-1", "2", "3", "4",  
"imp:n", "=", "1.0", "imp:p", "0.5", "fill"...]
```

- Lots of formatting reconstruction headaches
- Users actually like their formatting?

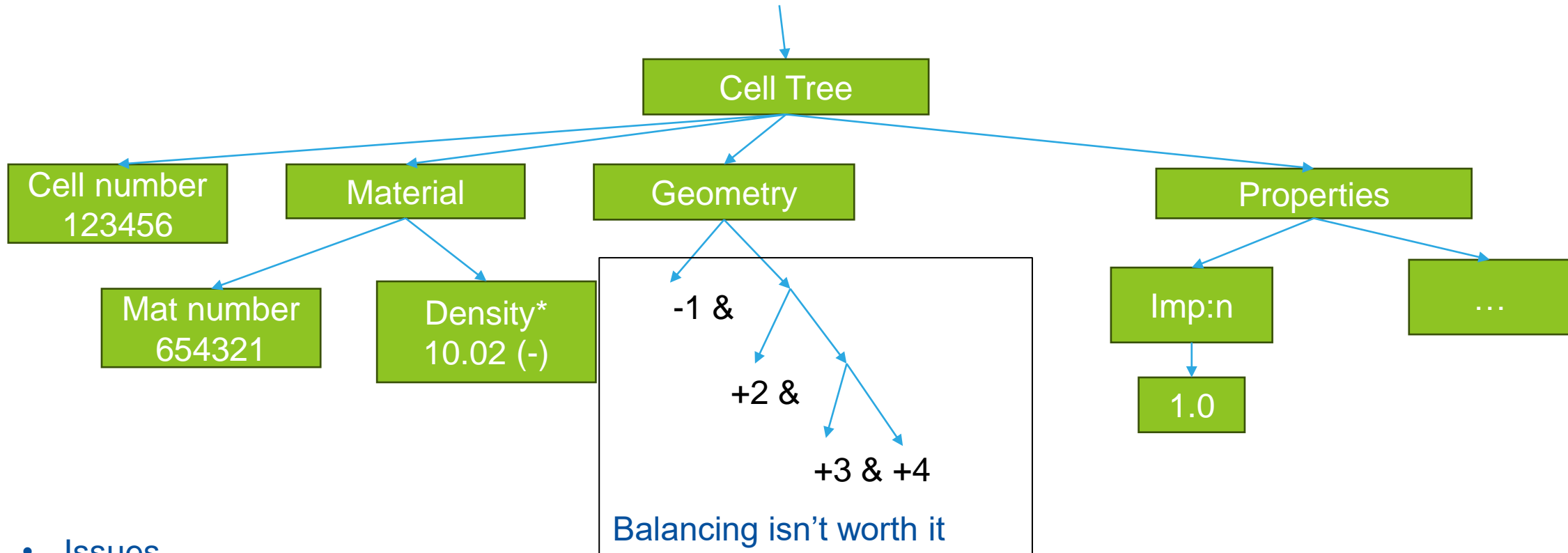
Finally doing it right: Lexers Parsers and syntax trees, oh my ($\geq 0.2.0$)

- Requires Context-free grammar
- Uses Lookahead left-to-right (LR) Parser (LALR(1))
- MCNP grammar is contextual
 - Break into context-free chunks
 - Build multiple lexers and parsers



Example Abstract Syntax Tree

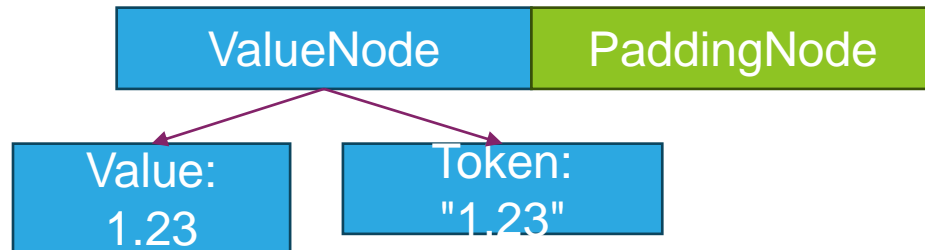
123456 654321 -10.02 -1 2 3 4 imp:n=1.0 imp:p 0.5 fill = 10 (0 10.0 20.0)



- Issues
 - Whitespace is an operator/ implicit operators
 - Users like formatting
 - Need “black”, not “python”

Concrete Syntax Trees

- Introduce padding
 - Whitespace + comments
- Glue to leaves



- Reverse Engineering formatting
 - `"10.02 "` \rightarrow `"10.03 "`, *not* `"10.021115 "`
 - `"6.1+23 $ hi"` \rightarrow `"1.0+01 $ hi"`

Everything is an Object, and every variable a pointer

- Objects point to each other
- When possible, properties of objects point to ValueNode
 - When reexported the ValueNode doesn't need to be updated in the syntax tree
 - Everything handled by a decorator to keep it DRY.

```
@make_prop_val_node("_number", int, validator=_number_validator)
def number(self):
    """
    The current cell number that will be written out to a new input.

    :rtype: int
    """
    pass

@make_prop_pointer("_material", (Material, type(None)), deletable=True)
def material(self):
    """
    The Material object for the cell.

    If the material is None this is considered to be voided.

    :rtype: Material
    """
    pass
```

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