Parsing Languages with mxTextTools

Building fast compilers in Python

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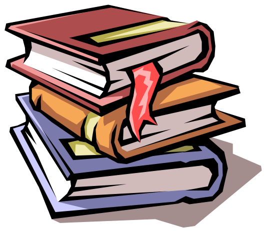
Speaker Introduction: Marc-André Lemburg

- CEO eGenix.com and Consultant
  - More than 20 years software development experience
  - Diploma in Mathematics
  - Expert in Python, Application Design, Web Technologies and Unicode
  - Python Core Developer
  - Python Software Foundation Board Member (2002-2004)
  - Contact: mal@egenix.com
- eGenix.com Software GmbH, Germany
  - Founded in 2000
  - Core business:
    - Consulting: helping companies write successful Python software
    - Product design: professional quality Python/Zope developer tools (mxODBC, mxDateTime, mxTextTools, etc.)
  - International customer base



Agenda

1. Introduction to mxTextTools
2. Parsing with the Tagging Engine
3. Compiling Languages with mxTextTools
4. Discussion

Introduction to mxTextTools

mxTextTools: Motivation

- Regular Expressions are sometimes nice…

  r′ \d\d\d\d-\d\d-\d\d′

  but often incomprehensible:

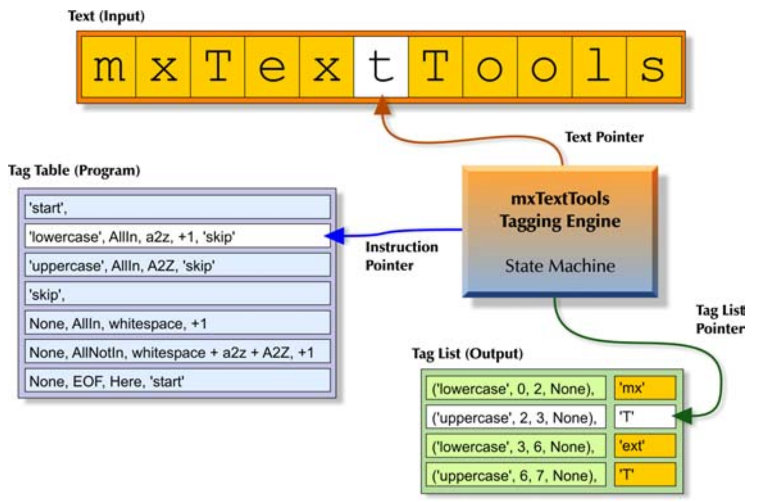
  ```
  (r′\s*([a-zA-Z_][-:.a-zA-Z_0-9]*)(\s*=\s*′
   r′(\'[^\']*\'|"[^"]*"|[]′
   r′[\-a-zA-Z0-9./,:;+*%?!&$\(\)_#=~\'"@]*))?′)
  ```

  (this parses an SGML attribute)

- Better use the good old iterative approach…

mxTextTools: Key Features

- Tagging Engine
- Search objects
- Helpers for string manipulation
- Helpers for Tagging Engine output
- Full Unicode support !


Text (Input)
m x T e x t T o o l s
Text Pointer
Tag Table (Program)
'start',
'lowercase', AllIn, a2z, +1, 'skip'
'uppercase', AllIn, A2Z, 'skip'
'skip',
None, AllIn, whitespace, +1
None, AllNotIn, whitespace + a2z + A2Z, +1
None, EOF, Here, 'start'
Instruction Pointer
mxTextTools Tagging Engine
State Machine
Tag List Pointer
Tag List (Output)
('lowercase', 0, 2, None), 'mx'
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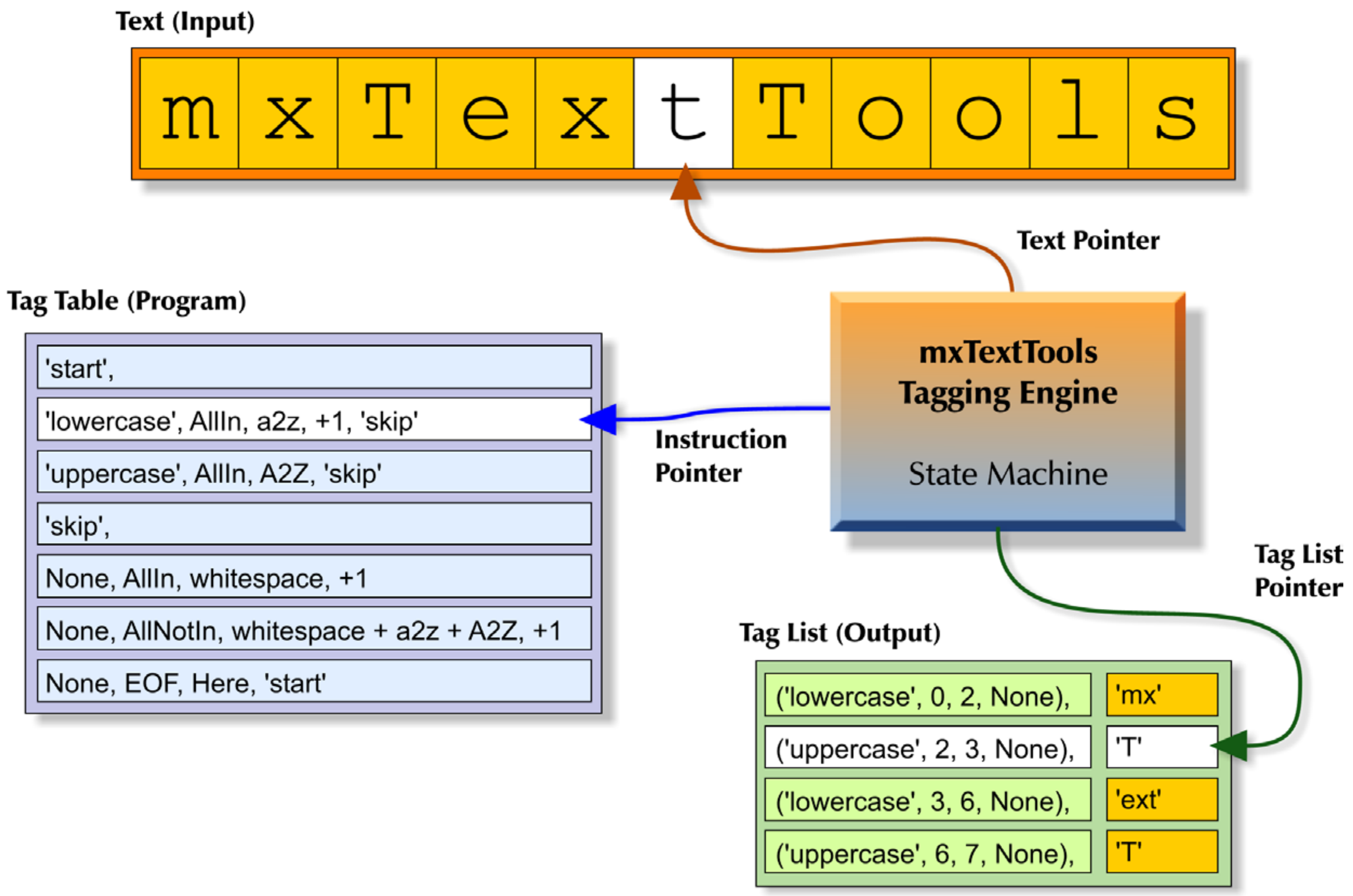
('lowercase', 3, 6, None), 'ext'
('uppercase', 6, 7, None), 'T'

Parsing with the Tagging Engine

Tagging Engine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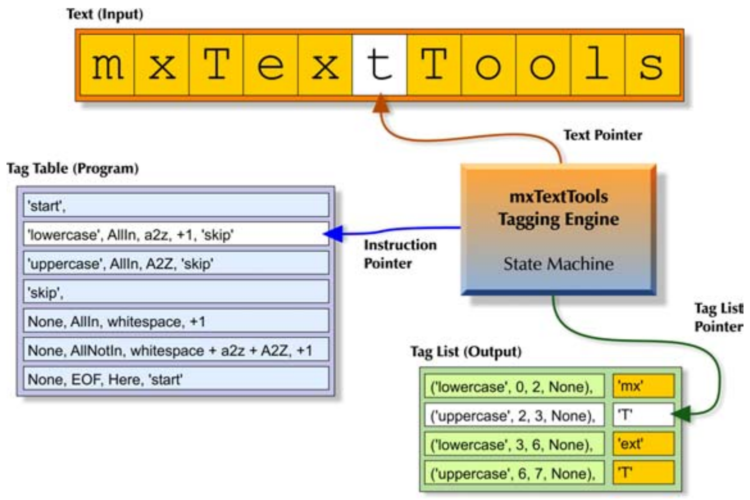
Tagging Engine: Key Features

- Works on slices (doesn't copy)
- Complete matching command set
- Callbacks to Python
- Arbitrary Tag Objects can be assigned to matching text slices
- Simple API
- JIT compiler
- Full Unicode support



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('lowercase', 3, 6, None),  'ext'
('uppercase', 6, 7, None),  'T'
```

...fast

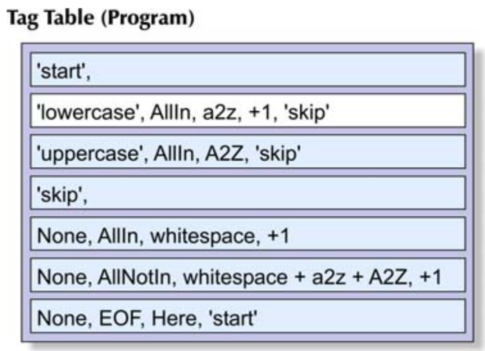
Tag Table Example: Mark text as lower/upper case

```
tag_table = (

    # Tag upper case and lower case text
    'start',
    ('lowercase', AllIn, a2z, +1, 'skip'),
    ('uppercase', AllIn, A2Z, 'skip'),

    # Skip all whitespace & non-letters
    'skip',
    (None, AllNotIn, a2z + A2Z, +1),

    # Check for EOF, otherwise continue
    (None, EOF, Here, 'start'),
)
```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```

Compiling Languages with mxTextTools

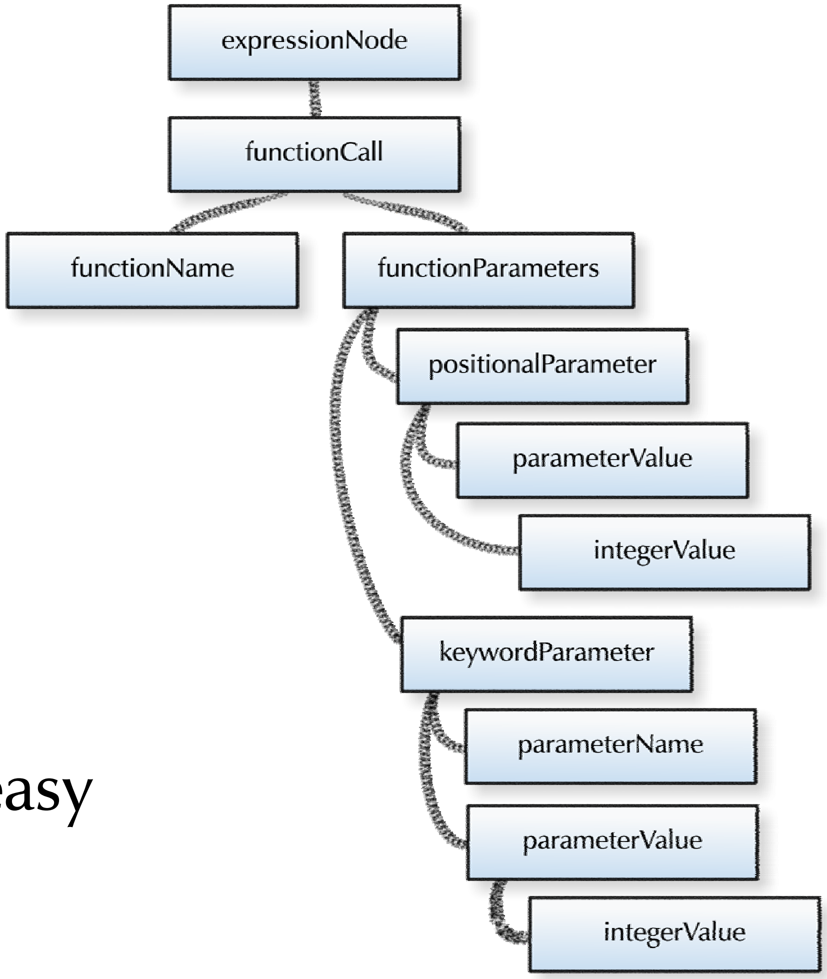
1. Introduction to mxTextTools
2. Parsing with the Tagging Engine
3. Compiling Languages with mxTextTools
4. Discussion

Compiling Languages: General Approach

- Tokenize the input
  - break the input text into logical syntax parts
- Parse the tokens
  - convert/group the tokens to syntax objects
  - group these syntax objects according to logic in a tree
- Manipulate the tree (e.g. to optimize it)
- Traverse the tree and generate a new representation
  - Use the generated representation for further processing

Compiling Languages: Abstract Syntax Trees (ASTs)

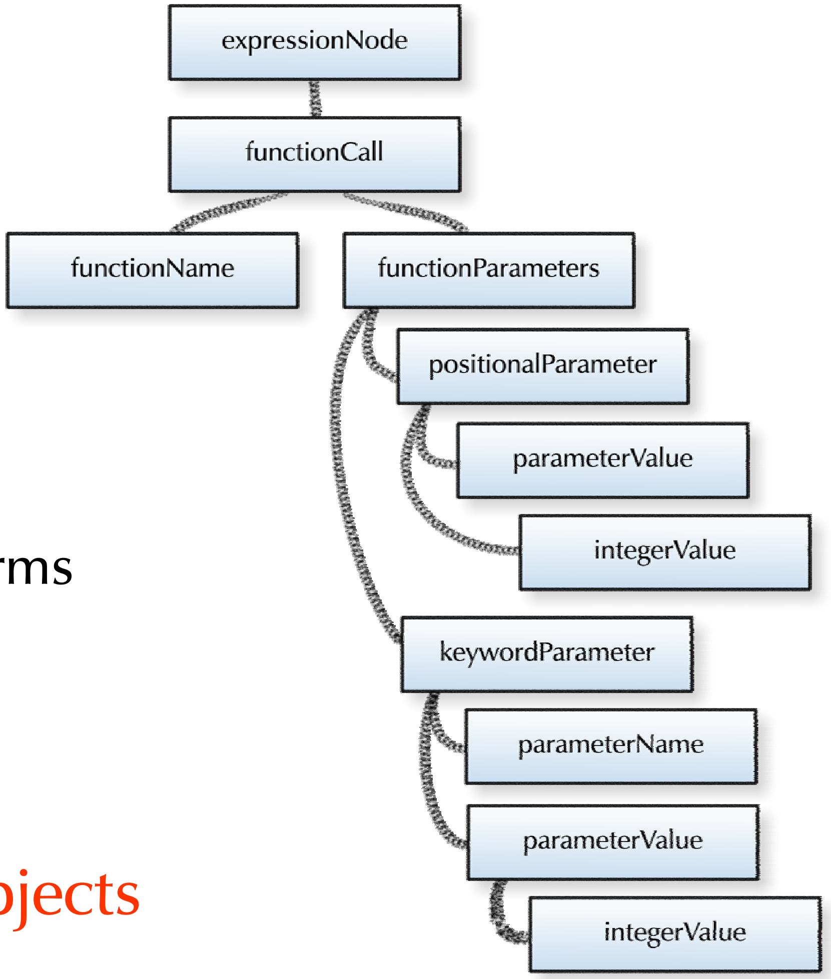
- Provide logical groupings of tokens as objects
- Use the Divide&Conquer approach
- Tree structure makes traversal easy



Compiling Languages: Abstract Syntax Trees (ASTs)

- Node objects contain the "knowledge" about the used syntax
  - have access to context
  - know how to parse tokens and extract their data/meaning
  - can convert the tokens to other forms (e.g. compile them)

- Idea: Use AST classes as Tag Objects



Compiling Languages: From Tag Lists to ASTs

- Recipe:

  1. instantiate the AST class for the first Tag List item (passing it a context object)

  2. pass the remaining Tag List to its .parse() method

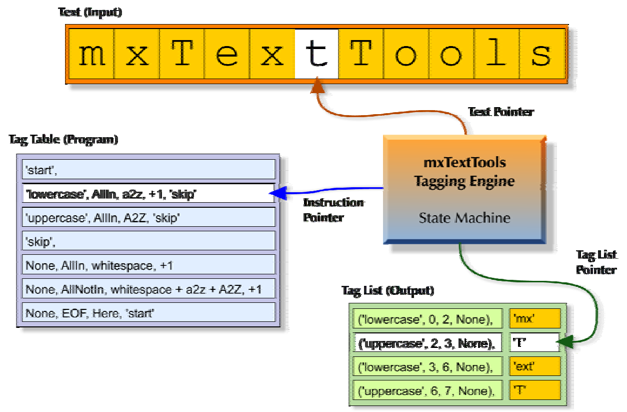
  3. if there are any Tag List items left, go to step 1.

Compiling Languages: From Tag Lists to ASTs

- Recipe:
  1. instantiate the AST class for the first Tag List item (passing it a context object)
  2. pass the remaining Tag List to its .parse() method
  3. if there are any Tag List items left, go to step 1.
- All the parsing logic is put into the hands of the AST objects
  – they can use context information
  – and generate additional information while parsing, e.g. type information

Parsing Languages with mxTextTools: Summary

- Define AST classes to represent the syntax elements
- Define the syntax representation using Tag Tables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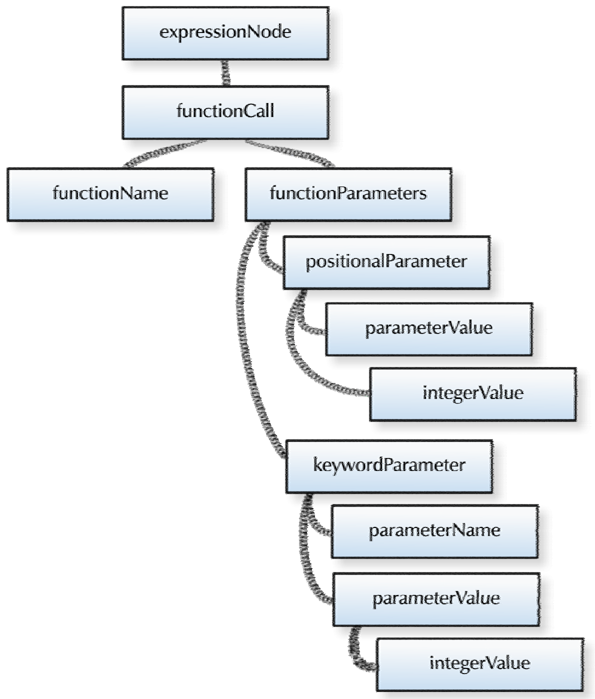
- Use the AST classes as Tag Objects

- Run the Tagging Engine on the input, creating a Tag List

Parsing Languages with mxTextTools: Summary

- Create an AST from the Tag List
- Traverse the AST
- Collect the compiled output



Discussion

Parsing Languages with mxTextTools: Questions ?

And finally...

Thank you for your time.

Contact

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Fax:	+49 211 3005250
Web:	http://www.egenix.com/

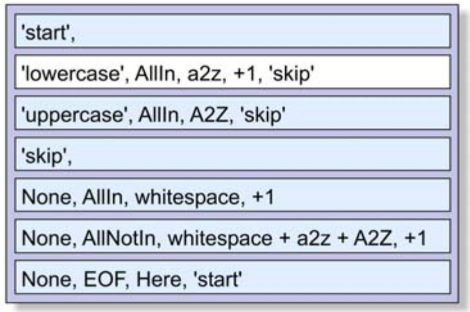
mxTextTools: Availability

- Python package with a highly portable C extension
- eGenix Open-Source Product
- Part of the eGenix mx Base Distribution
- Compiles on:
  - Windows
  - Linux
  - Mac OS X
  - FreeBSD
  - Solaris
  - many other Unix variants

Tagging Engine: Definitions

- Tag Table
  - List of tuples defining the matching program
  - Can be nested (e.g. via a Table command)
- Tag Object
  - Object associated with a matching text slice
  - Can be any Python object
- Tag List
  - List of tuples generated by the Tagging Engine
  - Defines the tags

Tag Table (Program)



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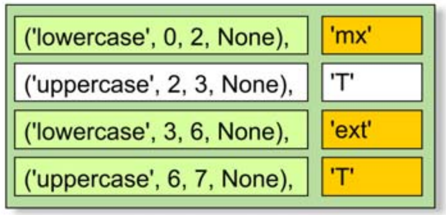
Tag List (Output)



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('lowercase', 0, 2, None),   'mx'
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```

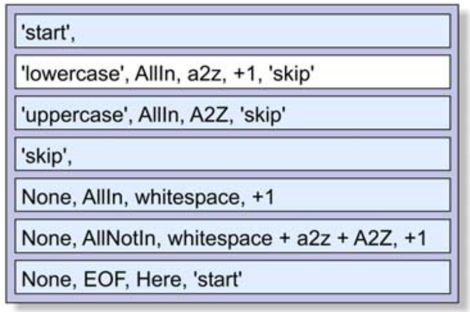
Tagging Engine Input: Tag Table

- Simple and standard item format:

  (tag_object, command, cmd_arg,
  jump_no_match, jump_match)

  with

Tag Table (Program)



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```

- *tag_object* .... object to be associated with the matched slice
- *command* .... command integer
- *cmd_arg* .... command argument
- *jump_no_match* .... jump if not matched (default: leave the table)
- *jump_match* .... jump if matched (default: +1)

Idea: "tag_object is tagged to matching text slice"

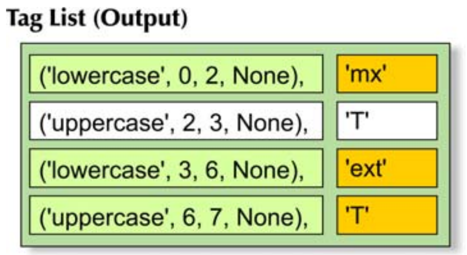
Tagging Engine Output: Tag List

- Simple and standard item format:

  (tag_object, slice_left, slice_right, sub_tag_list)

  with

- *tag_object* …………………. object associated with the slice
- *slice_left, slice_right* …….. slice indexes (text[left:right])
- *sub_tag_list* ………………. None or another Tag List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```

Idea: "tag_object is tagged to text[slice_left:slice-right]"

Tag List Example

```
text = "mxTextTools is an extension package for Python..."
```

```
tag_list =                                mx.TextTools.print_tags(text, tag_list)
    [('lowercase', 0, 2, None),               'lowercase' :  'mx' (0, 2)
     ('uppercase', 2, 3, None),               'uppercase' :  'T' (2, 3)
     ('lowercase', 3, 6, None),               'lowercase' :  'ext' (3, 6)
     ('uppercase', 6, 7, None),               'uppercase' :  'T' (6, 7)
     ('lowercase', 7, 11, None),              'lowercase' :  'ools' (7, 11)
     ('lowercase', 12, 14, None),             'lowercase' :  'is' (12, 14)
     ('lowercase', 15, 17, None),             'lowercase' :  'an' (15, 17)
     ('lowercase', 18, 27, None),             'lowercase' :  'extension' (18, 27)
     ('lowercase', 28, 35, None),             'lowercase' :  'package' (28, 35)
     ('lowercase', 36, 39, None),             'lowercase' :  'for' (36, 39)
     ('uppercase', 40, 41, None),             'uppercase' :  'P' (40, 41)
     ('lowercase', 41, 46, None)]             'lowercase' :  'ython' (41, 46)
```

Tag List Example

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tag_list =                              mx.TextTools.print_tags(text, tag_list)
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Tagging Commands

- Character and word matching
- Character set matching

- Jumps in text and Tag Table
- Recursive matching (using nested Tag Tables)
- Callbacks to Python (e.g. to do more complicated matching)
- String jump targets

Idea: “Highly optimized, with everything you need for parsing”