



Rapid Development of An Assembler Using Python

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About Me

- Software Process Engineer in Qualcomm Israel
- Started using Python around 1998
- Use Python wherever I can
 - Currently around 90%+ of my code is in Python
- Written from small scripts to a linker and a source level GUI debugger
- Little activity in Python + OSS development
 - Also wxPython, PLY, ...



Background I

- It all started from Conway's Law:
In every organization there will always be one person who knows what is going on. That person must be fired.
- Luckily for me, I wasn't that person
- However I found out that there is a team writing code for a home grown micro processor in *machine code*
- Promised to deliver them an assembler in two days
 - Only way my boss would let me do it



Background II

- Did manage to pull it through
 - However I cheated :)
- This talk will teach you how to cheat as well



Main Idea

- Lexer?
 - We don't need no stinkin' lexer
- Parser?
 - We don't need no stinkin' parser
- The Python interpreter will do all the parsing for us
 - Users actually write Python code
 - We'll `execfile` to execute the code



User Code Example

```
MEM1 = 0x200  
add(r0, r2, r3)  
sub(r2, r4, r4)  
load(r2, MEM1)  
label('L1')  
move(r2, r7)  
jmp(L1)
```



The Big Picture

- Each command is composed of four instruction code bits and twelve data bits
- Labels are just location in memory
- We will use inheritance for similar commands
- Set execution environment before calling `execfile`
- All commands will be stored in a list called `PROGRAM`



Main Class

```
class ASM:
    '''Base ASM instruction'''
    def __init__(self):
        self.file, self.line = here()
        PROGRAM.append(self)

    def genbits(self):
        '''Generate bits, 'code' and '_genbits'
           will be defined in each derived class
        '''
        return (self.code << INST_SHIFT) |
               self._genbits()
```




ALU Operation

```
class ALU3(ASM):  
    '''ALU instruction with 3 operands'''  
    def __init__(self, src1, src2, dest):  
        ASM.__init__(self)  
        self.src1 = src1  
        self.src2 = src2  
        self.dest = dest  
  
    def _genbits(self):  
        return (self.src1 << SLOT1_SHIFT) | \  
                (self.src2 << SLOT2_SHIFT) | \  
                (self.dest << SLOT3_SHIFT)
```



Finally A “real” Instruction

```
class add(ALU3):  
    '''`add' instruction'''  
    code = 0
```

```
class sub(ALU3):  
    '''`sub' instruction'''  
    code = 1
```



Handling Labels

```
def label(name):  
    '''Setting a label'''  
    ENV[name] = len(PROGRAM)
```



Setting Up the Environment

```
# Add registers
for i in range(8):
    ENV["r%d" % i] = i

# Add operators
for op in (add, sub, move, load, store, label,
           jmp):
    ENV[op.__name__] = op
```



Parsing

```
execfile(infile, ENV, {})
```



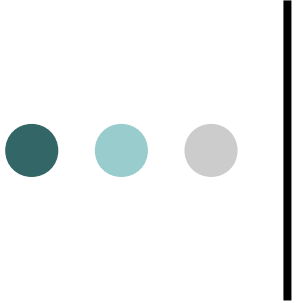
Generating Output (binary)

```
a = array("H") # Unsigned short array
for cmd in PROGRAM:
    a.append(cmd.genbits())
open(outfile, "wb").write(a.tostring())
```



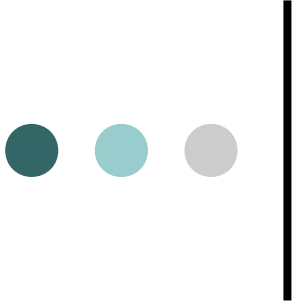
Debug Information

- Use Python's Exception mechanism to catch errors
- If we get a `SyntaxError` we can use `e.filename` and `e.lineno`
- For other exception we need to work a bit harder
- During coding we store line information in each instruction using `inspect` module
- Debug file is “`filename:line`” for each address



Summary – The Good

- Can spit out an assembler very fast
- Supported assembler has a very strong macro system
 - All of Python
- Cross platform
 - Check out for that byte order though
- Easy to extend
 - Took few hours to implement new commands in version 0.2



Summary – The Bad

- Users find syntax unusual
- Only Python syntax is supported
- Labels are not “Natural”
 - You define it as string but use it as a variable
- Code can not be divided to modules
 - Can't separate compilation and linkage
- Code is position dependent



Resources

- Article in UnixReview
 - <http://tinyurl.com/d62f3>
- inspect module
 - <http://docs.python.org/lib/module-inspect.html>
- execfile
 - <http://www.python.org/doc/2.4.2/lib/built-in-funcs.html>

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