61A Lecture 25

Friday, October 31

Announcements

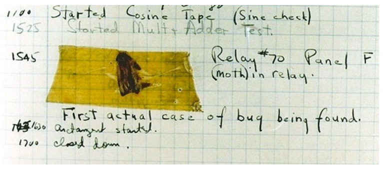
- Guerrilla Section 5 on Saturday 11/1
  - Vanguard section 12-2pm in 271 Soda (max 45 people)
  - Main section 2:30-4:30pm in 271 Soda (everyone is welcome)
  - Topics: Scheme and Functional Programming
- Homework 7 due Wednesday 11/5 @ 11:59pm
- Project 1 composition revisions due Wednesday 11/5 @ 11:59pm
  - Make changes to your project based on the **composition** feedback you received
  - Earn back any points you lost on **project 1 composition**
- Quiz 2 released Wednesday 11/5 & due Thursday 11/6 @ 11:59pm
  - Open note, open interpreter, closed classmates, closed Internet

Exceptions

Today's Topic: Handling Errors

Sometimes, computer programs behave in non-standard ways

- A function receives an argument value of an improper type
- Some resource (such as a file) is not available
- A network connection is lost in the middle of data transmission



1100 Started Cosine Tape (Sine check)
1525 Started Multi Adder Test.
1545 Relay #70 Panel F (moth) in relay.
First actual case of bug being found.
1630 antangent started.
1700 closed down.

Grace Hopper's Notebook, 1947, Moth found in a Mark II Computer

Exceptions

A built-in mechanism in a programming language to declare and respond to exceptional conditions

Python raises an exception whenever an error occurs.

Exceptions can be handled by the program, preventing the interpreter from halting.

Unhandled exceptions will cause Python to halt execution and print a stack trace.

Mastering exceptions:

Exceptions are objects! They have classes with constructors.

They enable non-local continuations of control:

If f calls g and g calls h, exceptions can shift control from h to f without waiting for g to return.

(Exception handling tends to be slow.)

Raising Exceptions

Assert Statements

Assert statements raise an exception of type AssertionError

```
assert <expression>, <string>
```

Assertions are designed to be used liberally. They can be ignored to increase efficiency by running Python with the "-O" flag; "O" stands for optimized

```
python3 -O
```

Whether assertions are enabled is governed by a bool `__debug__`

(Demo)

Raise Statements

Exceptions are raised with a raise statement

```
raise <expression>
```

<expression> must evaluate to a subclass of BaseException or an instance of one

Exceptions are constructed like any other object. E.g., TypeError('Bad argument!')

TypeError -- A function was passed the wrong number/type of argument

NameError -- A name wasn't found

KeyError -- A key wasn't found in a dictionary

RuntimeError -- Catch-all for troubles during interpretation

(Demo)

Try Statements

Try Statements

Try statements handle exceptions

```
try:
    <try suite>
except <exception class> as <name>:
    <except suite>
...
```

Execution rule:

The <try suite> is executed first

If, during the course of executing the <try suite>,
an exception is raised that is not handled otherwise, and

If the class of the exception inherits from <exception class>, then

The <except suite> is executed, with <name> bound to the exception

Handling Exceptions

Exception handling can prevent a program from terminating

```
>>> try:
        x = 1/0
    except ZeroDivisionError as e:
        print('handling a', type(e))
        x = 0

handling a <class 'ZeroDivisionError'>
>>> x
0
```

Multiple try statements: Control jumps to the except suite of the most recent
try statement that handles that type of exception

(Demo)

WWPD: What Would Python Do?

How will the Python interpreter respond?

```
def invert(x):
    inverse = 1/x  # Raises a ZeroDivisionError if x is 0
    print('Never printed if x is 0')
    return inverse

def invert_safe(x):
    try:
        return invert(x)
    except ZeroDivisionError as e:
        return str(e)

>>> invert_safe(1/0)
>>> try:
...     invert_safe(0)
... except ZeroDivisionError as e:
...     print('Handled!')
>>> inverrrrt_safe(1/0)
```

Interpreters

Reading Scheme Lists

A Scheme list is written as elements in parentheses:

```
(<element_0> <element_1> ... <element_n>)
```

A Scheme list

Each <element> can be a combination or primitive

```
(+ (* 3 (+ (* 2 4) (+ 3 5))) (+ (- 10 7) 6))
```

The task of parsing a language involves coercing a string representation of an expression
to the expression itself

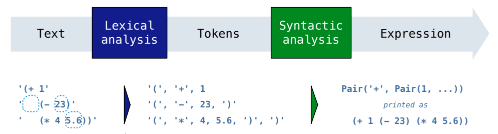
Parsers must validate that expressions are well-formed

(Demo)
http://composingprograms.com/projects/scalc/scheme_reader.py.html

Parsing

Parsing

A Parser takes text and returns an expression



- Iterative process
- Checks for malformed tokens
- Determines types of tokens
- Processes one line at a time

- Tree-recursive process
- Balances parentheses
- Returns tree structure
- Processes multiple lines

Recursive Syntactic Analysis

A predictive recursive descent parser inspects only k tokens to decide how to proceed, for some fixed k

Can English be parsed via predictive recursive descent?

sentence subject

The horse ~~raced~~ past the barn fell.

ridden

(that was)

Syntactic Analysis

Syntactic analysis identifies the hierarchical structure of an expression, which may be nested

Each call to scheme_read consumes the input tokens for exactly one expression

```
'(', '+', 1, '(', '-', 23, ')', '(', '*', 4, 5.6, ')', ')'
```

Base case: symbols and numbers

Recursive call: scheme_read sub-expressions and combine them

(Demo)