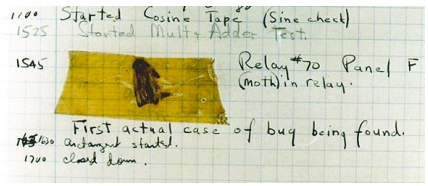
61A Lecture 26

Monday, October 29

Today's Topic: Handling Errors

Sometimes, computers don't do exactly what we expect

- A function receives unexpected argument types
- Some resource (such as a file) is not available
- A network connection is lost



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 a crash

Unhandled exceptions will cause Python to halt execution

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.

However, exception handling tends to be slow.

Assert Statements

Assert statements raise an exception of type AssertionError

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

Assertions are designed to be used liberally and then disabled in "production" systems. "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 an exception instance or class.

Exceptions are constructed like any other object; they are just instances of classes that inherit from BaseException.

`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

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):
    result = 1/x  # Raises a ZeroDivisionError if x is 0
    print('Never printed if x is 0')
    return result

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)
```

Reading Scheme Lists

A Scheme list is written as elements in parentheses:

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

A recursive Scheme list

Each <element> can be a combination or primitive.

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

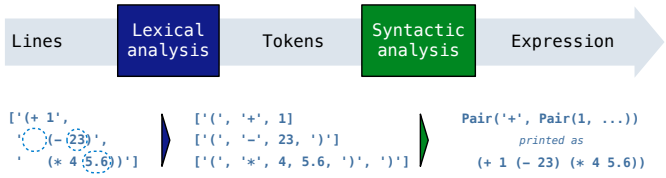
The task of *parsing* a language involves coercing a string representation of an expression to the expression itself.

Parsers must validate that expressions are well-formed.

Demo (http://inst.eecs.berkeley.edu/~cs61a/fa12/projects/scalc/scheme_reader.py.html)

Parsing

A Parser takes a sequence of lines 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.

(that was) ridden

You got Gardenpathed!

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, ')', ')'

Recursive call: scheme_read sub-expressions and combine them

Base case: symbols and numbers

Demo (http://inst.eecs.berkeley.edu/~cs61a/fa12/projects/scalc/scheme_reader.py.html)