Using Python for CGI programming

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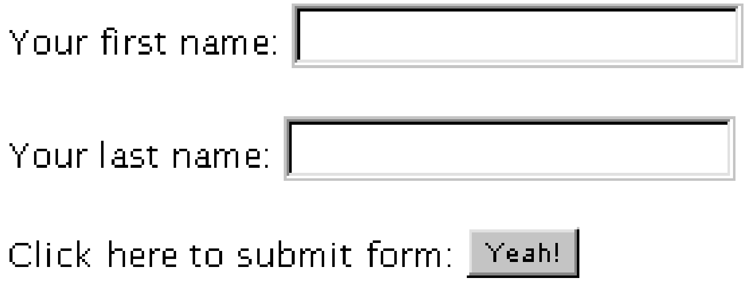
Python CGI programming

Outline

- HTML forms
- Basic CGI usage
- Setting up a debugging framework
- Security
- Handling persistent data
- Locking
- Sessions
- Cookies
- File upload
- Generating HTML
- Performance

A typical HTML form



```
<form method="POST" action="http://host.com/cgi-bin/test.py">
   <p>Your first name: <input type="text" name="firstname">
   <p>Your last name: <input type="text" name="lastname">
   <p>Click here to submit form: <input type="submit" value="Yeah!">
   <input type="hidden" name="session" value="1f9a2">
</form>
```

A typical CGI script

```
#!/usr/local/bin/python
import cgi

def main():
    print "Content-type: text/html\n"
    form = cgi.FieldStorage()          # parse query
    if form.has_key("firstname") and form["firstname"].value != "":
        print "<h1>Hello", form["firstname"].value, "</h1>"
    else:
        print "<h1>Error! Please enter first name.</h1>"

main()
```

CGI script structure

- Check form fields
  - use cgi.FieldStorage class to parse query
    - takes care of decoding, handles GET and POST
    - "foo=ab+cd%21ef&bar=spam" -->
      {'foo': 'ab cd!ef', 'bar': 'spam'} # (well, actually, ...)
- Perform action
  - this is up to you!
  - database interfaces available
- Generate HTTP + HTML output
  - print statements are simplest
  - template solutions available

Structure refinement

```
form = cgi.FieldStorage()
if not form:
    ...display blank form...
elif ...valid form...:
    ...perform action, display results (or next form)...
else:
    ...display error message (maybe repeating form)...
```

FieldStorage details

- Behaves like a dictionary:
  - .keys(), .has_key()   # but not others!
  - dictionary-like object ("mapping")
- Items
  - values are MiniFieldStorage instances
    - .value gives field value!
  - if multiple values: *list* of MiniFieldStorage instances
    - if type(...) == types.ListType: ...
  - may also be FieldStorage instances
    - used for file upload (test .file attribute)

Other CGI niceties

- cgi.escape(s)
  - translate "<", "&", ">" to "&lt;", "&amp;", "&gt"
- cgi.parse_qs(string, keep_blank_values=0)
  - parse query string to dictionary {"foo": ["bar"], ...}
- cgi.parse([file], ...)
  - ditto, takes query string from default locations
- urllib.quote(s), urllib.unquote(s)
  - convert between "~" and "%7e" (etc.)
- urllib.urlencode(dict)
  - convert dictionary {"foo": "bar", ...} to query string "foo=bar&..." # note asymmetry with parse_qs() above

Dealing with bugs

- Things go wrong, you get a traceback...
- By default, tracebacks usually go to the server's error_log file...
- Printing a traceback to stdout is tricky
  - could happen before "Content-type" is printed
  - could happen in the middle of HTML markup
  - could contain markup itself
- What's needed is a...

Debugging framework

```
import cgi

def main():
    print "Content-type: text/html\n" # Do this first
    try:
        import worker      # module that does the real work
    except:
        print "<!-- --><hr><h1>Oops.  An error occurred.</h1>"
        cgi.print_exception() # Prints traceback, safely

main()
```

Security notes

- Watch out when passing fields to the shell
  - e.g. os.popen("finger %s" % form["user"].value)
  - what if the value is "; cat /etc/passwd" ...
- Solutions:
  - Quote:
    - user = pipes.quote(form["user"].value)
  - Refuse:
    - if not re.match(r"^\w+$", user): ...error...
  - Sanitize:
    - user = re.sub(r"\W", "", form["user"].value)

Using persistent data

- Store/update data:
  - In plain files (simplest)
    - FAQ wizard uses this
  - In a (g)dbm file (better performance)
    - string keys, string values
  - In a "shelf" (stores objects)
    - avoids parsing/unparsing the values
  - In a real database (if you must)
    - 3rd party database extensions available
    - not my field of expertise

Plain files

```
key = ...username, or session key, or whatever...
try:
    f = open(key, "r")
    data = f.read()                    # read previous data
    f.close()
except IOError:
    data = ""                          # no file yet: provide initial data
data = update(data, form)              # do whatever must be done
f = open(key, "w")
f.write(data)                          # write new data
f.close()
# (could delete the file instead if updated data is empty)
```

(G)DBM files

```
# better performance if there are many records

import gdbm
key = ...username, or session key, or whatever...
db = gdbm.open("DATABASE", "w")         # open for reading+writing
if db.has_key(key):
    data = db[key]                      # read previous data
else:
    data = ""                           # provide initial data
data = update(data, form)
db[key] = data                          # write new data
db.close()
```

Shelves

```
# a shelf is a (g)dbm files that stores pickled Python objects

import shelve
class UserData: ...
key = ...username, or session key, or whatever...
db = shelve.open("DATABASE", "w")          # open for reading+writing
if db.has_key(key):
    data = db[key]            # an object!
else:
    data = UserData(key)      # create a new instance
data.update(form)
db[key] = data
db.close()
```

Locking

- (G)DBM files and shelves are not protected against concurrent updates!
- Multiple readers, single writer usually OK
  - simplest approach: only lock when writing
- Good filesystem-based locking is *hard*
  - no cross-platform solutions
  - unpleasant facts of life:
    - processes sometimes die without unlocking
    - processes sometimes take longer than expected
    - NFS semantics

A simple lock solution

```
import os, time

class Lock:

    def __init__(self, filename):
        self.filename = filename
        self.locked = 0

    def lock(self):
        assert not self.locked
        while 1:
        try:
              os.mkdir(self.filename)
              self.locked = 1
              return          # or break
        except os.error, err:
              time.sleep(1)

    def unlock(self):
        assert self.locked
        self.locked = 0
        os.rmdir(self.filename)

    # auto-unlock when lock object is deleted
    def __del__(self):
        if self.locked:
            self.unlock()


# for a big production with timeouts,
# see the Mailman source code (LockFile.py);
# it works on all Unixes and supports NFS;
# but not on Windows,
# and the code is very complex...
```

Sessions

- How to correlate requests from same user?
  - Assign session key on first contact
  - Incorporate session key in form or in URL
  - In form: use hidden input field:
    - <input type="hidden" name="session" value="1f9a2">
  - In URL:
    - http://myhost.com/cgi-bin/myprog.py/1f9a2
    - passed in environment (os.environ[...]):
      - PATH_INFO=/1f9a2
      - PATH_TRANSLATED=<rootdir>/1f9a2

Cookies

- How to correlate *sessions* from the same user?
  - Store "cookie" in browser
    - controversial, but useful
  - Module: Cookie.py (Tim O'Malley)
    - writes "Set-Cookie" headers
    - parses HTTP_COOKIE environment variable
  - Note: using cookies affects our debug framework
    - cookies must be printed as part of HTTP headers
    - cheapest solution:
      - move printing of blank line into worker module
      - (and into exception handler of debug framework)

Cookie example

```
import os, cgi, Cookie

c = Cookie.Cookie()
try:
    c.load(os.environ["HTTP_COOKIE"])
except KeyError:
    pass

form = cgi.FieldStorage()
try:
    user = form["user"].value
except KeyError:
    try:
        user = c["user"].value
    except KeyError:
        user = "nobody"

c["user"] = user

print c

print """
<form action="/cgi-bin/test.py"
      method="get">
<input type="text" name="user"
      value="%s">
</form>
""" % cgi.escape(user)

# debug: show the cookie header we wrote
print "<pre>"
print cgi.escape(str(c))
print "</pre>"
```

File upload example

```
import cgi
form = cgi.FieldStorage()
if not form:
    print """
    <form action="/cgi-bin/test.py" method="POST" enctype="multipart/form-data">
    <input type="file" name="filename">
    <input type="submit">
    </form>
    """
elif form.has_key("filename"):
    item = form["filename"]
    if item.file:
        data = item.file.read()          # read contents of file
        print cgi.escape(data)           # rather dumb action
```

Generating HTML

- HTMLgen (Robin Friedrich)

  http://starship.python.net/crew/friedrich/HTMLgen/html/main.html

```
>>> print H(1, "Chapter One")
<H1>Chapter One</H1>
>>> print A("http://www.python.org/", "Home page")
<A HREF="http://www.python.org/">Home page</A>
>>> # etc. (tables, forms, the works)
```

- HTMLcreate (Laurence Tratt)

  http://www.spods.dcs.kcl.ac.uk/~laurie/comp/python/htmlcreate/

  - not accessible at this time

CGI performance

- **What causes slow response?**
  - One process per CGI invocation
    - process creation (fork+exec)
    - Python interpreter startup time
    - importing library modules (somewhat fixable)
  - Connecting to a database!
    - this can be the killer if you use a real database
  - Your code?
    - probably not the bottleneck!

Avoiding fork()

- Python in Apache (mod_pyapache)
  - problems: stability; internal design
  - advantage: CGI compatible
  - may work if CGI scripts are simple and trusted
  - doesn't avoid database connection delay
- Use Python as webserver
  - slow for static content (use different port)
  - advantage: total control; session state is easy
- FastCGI, HTTPDAPI etc.
- ZOPE

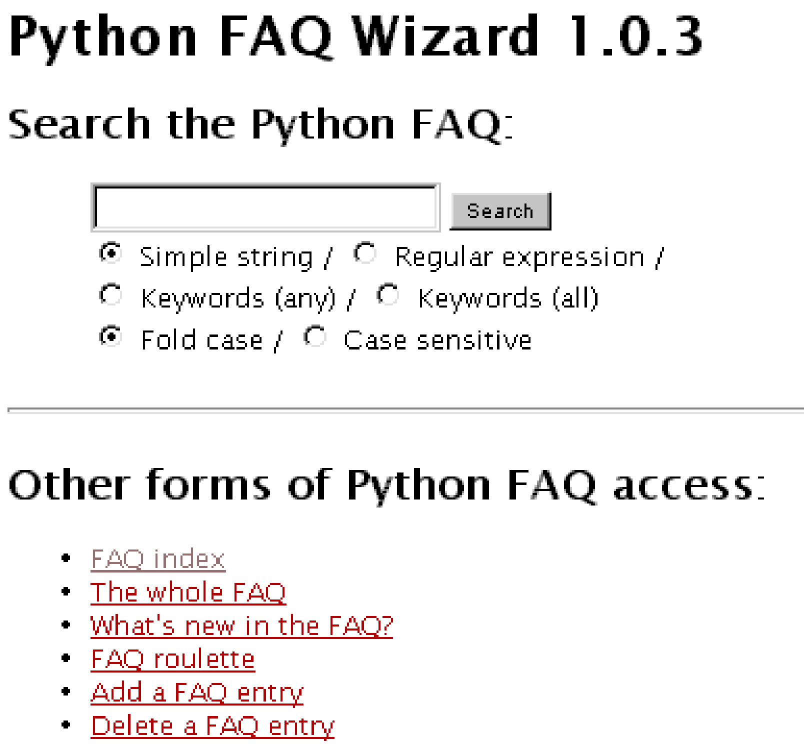
ZOPE

- Z Object Publishing Environment
  - http://www.zope.org
  - complete dynamic website management tool
    - written in cross-platform Python; Open Source
  - http://host/path/to/object?size=5&type=spam
    - calls path.to.object(size=5, type="spam")
  - DTML: templatized HTML (embedded Python code)
  - ZOBD (Z Object DataBase; stores Python objects)
    - transactionsm selective undo, etc.
  - etc., etc.

Case study

FAQ wizard

- Tools/faqwiz/faqwiz.py in Python distribution
- http://www.python.org /cgi-bin/faqw.py


Python FAQ Wizard 1.0.3

Search the Python FAQ:

[✓ Simple string] / Regular expression /
Keywords (any) / Keywords (all)
[✓ Fold case] / Case sensitive

Other forms of Python FAQ access:

- FAQ index
- The whole FAQ
- What's new in the FAQ?
- FAQ roulette
- Add a FAQ entry
- Delete a FAQ entry

faqw.py - bootstrap

```
import os, sys
try:
    FAQDIR = "/usr/people/guido/python/FAQ"
    SRCDIR = "/usr/people/guido/python/src/Tools/faqwiz"
    os.chdir(FAQDIR)
    sys.path.insert(0, SRCDIR)
    import faqwiz
except SystemExit, n:
    sys.exit(n)
except:
    t, v, tb = sys.exc_type, sys.exc_value, sys.exc_traceback
    print
    import cgi
    cgi.print_exception(t, v, tb)
```

faqwiz.py - main code

```
class FaqWizard:

    def __init__(self):
        self.ui = UserInput()
        self.dir = FaqDir()

    def do_home(self):
        self.prologue(T_HOME)
        emit(HOME)

    def do_search(self): ...
    def do_index(self): ...
    def do_roulette(self): ...
    def do_show(self): ...
    def do_edit(self): ...
    def do_review(self): ...
    def do_help(self): ...
    ...etc...
```

```
def go(self):
    print 'Content-type: text/html'
    req = self.ui.req or 'home'
    mname = 'do_%s' % req
    try:
        meth = getattr(self, mname)
    except AttributeError:
        self.error("Bad request type %s." % `req`)
    else:
        try:
            meth()
        except InvalidFile, exc:
            self.error("Invalid entry file name %s" % exc.file)
        except NoSuchFile, exc:
            self.error("No entry with file name %s" % exc.file)
        except NoSuchSection, exc:
            self.error("No section number %s" % exc.section)
    self.epilogue()
```

Example: do_roulette()

```
def do_roulette(self):
        import random
        files = self.dir.list()
        if not files:
            self.error("No entries.")
            return
        file = random.choice(files)
        self.prologue(T_ROULETTE)
        emit(ROULETTE)
        self.dir.show(file)
```

Persistency

- All data stored in files (faqNN.MMM.htp)
- Backed up by RCS files (RCS/faqNN.MMM.htp,v)
  - RCS logs and diffs viewable
- RCS commands invoked with os.system() or os.popen()
- search implemented by opening and reading each file
- NO LOCKING!
  - infrequent updates expected
    - in practice, one person makes most updates :-)
  - one historic case of two users adding an entry to the same section at the same time; one got an error back
  - not generally recommended

faqconf.py, faqcust.py

- faqconf.py defines *named string constants* for every bit of output generated by faqwiz.py
  - designed for customization (e.g. i18n)
  - so you can customize your own faq wizard
  - e.g. OWNEREMAIL = "guido@python.org"
  - this includes the list of sections in your faq :-(
- faqcust.py defines *overrides* for faqconf.py
  - so you don't need to edit faqwiz.py
    - to make it easier to upgrade to newer faqwiz version

Webchecker

- Tools/webchecker/webchecker.py in Python distribution
- Not a CGI application but a web *client* application
  - while still pages to do:
    - request page via http
    - parse html, collecting links
  - pages once requested won't be requested again
  - links outside original tree treated as leaves
    - existence checked but links not followed
  - reports on bad links
    - what the bad URL is
    - on which page(s) it is referenced
  - could extend for other reporting

Reference URLs

- Python websites
  - http://www.python.org (official site)
  - http://starship.python.net (community)
- Python web programming topic guide
  - http://www.python.org/topics/web/
- These slides on the web (soon)
  - http://www.python.org/doc/essays/ppt/sd99east.ppt

Reference books

- http://www.python.org/psa/bookstore/
- 1996
  - Programming Python (Lutz)
  - [Internet Programming with Python (Watters e.a.)]
- 1998
  - Python Pocket Reference (Lutz)
- 1999
  - Learning Python (Lutz, Ascher)
  - Python: Essential Reference (Beazley)
  - Quick Python Book (Harms, McDonald)
- Expected 1999/2000
  - Win 32, Tkinter, teach-yourself-in-24-hrs, annotated archives, ...