Ruby For Pentesters

Mike Tracy, Chris Rohlf, Eric Monti

Who

★ Mike Tracy

★ Chris Rohlf

★ Eric Monti

Agenda

- ★ Why Ruby
- ★ Scripted Pen-Testing
- ★ Reversing
- ★ Fuzzing
- ★ Integrating Ruby

Why Ruby

Why Ruby

- ★ **See a nail? Ruby is the Hammer**
  - Versatile
    - **Robust standard library**
    - **Extend existing classes to meet new needs**
    - **Hook existing libraries with Ruby/DL or FFI**
    - **Rubify anything by embedding Ruby**
  - Generally easy to write and understand
    - **Language structure lends itself to DSL creation**
  - IRB makes a great general-purpose console
    - **Blocks, mixins and monkey patching**

And We're Not Alone

★ **Lots of great security tools in Ruby**

- Metasploit
  - **Huge!**
- IdaRub
- Ronin

- More ...

- ... but why isn't this list longer?

Why Ruby

★Our approach to Ruby

- Use and extend what is already available to you
  - Monkey Patches
  - Luckily this isn't a Ruby conference
- Don't reinvent the wheel
  - Take tools and techniques that work and make them better
- JRuby!
- For example ...

Why Ruby

★ **RBKB - Ruby Black Bag**

- A ruby clone of the original Matasano Blackbag written in C
- Extensions to existing Ruby classes and general purpose pen-testing tools
- Great for pen testing and reversing
  - **Example: extending the String class**
    - "rubyisgreat".{xor, b64, d64, urlenc, urldec, hexdump, hexify, unhexify, blit, entropy, bgrep, crc32}

Scripted Pen-Testing

The Engagement

- Threat modeling / situational awareness
- Logistics challenges
- Everything is a webapp (even thick clients)
- Must find the bread and butter vulnerabilities
- More subtle vulnerabilities might take a back seat

A1 - Cross Site Scripting (XSS)
A2 - Injection Flaws
A3 - Malicious File Execution
A4 - Insecure Direct Object Reference
A5 - Cross Site Request Forgery (CSRF)
A6 - Information Leakage and Improper Error Handling
A7 - Broken Authentication and Session Management
A8 - Insecure Cryptographic Storage
A9 - Insecure Communications
A10 - Failure to Restrict URL Access

Tools You Know and Love

Burp Proxy	WebInspect
WebScarab	AppScan
Fiddler	Acunetix
Paros	Hailstorm
@Stake Proxy	Grendel-Scan
w3af	Sentinel

browser plug-ins

curl + sh

[sorry if I left you out]

Why Something New?

- Previous success using scrapers and fuzzers to test web applications
- Wanted fine-grained ability to manipulate any input (surgical fuzzing) in any part of the request and detect specific responses
  - Need a console for fuzz prototyping
  - Turn fuzz prototypes into automated scripts
  - Testing thick client apps that use HTTP for transport
  - Test custom form submissions
  - Smarter spidering
- Quickly move the test focus from the bread and butter to more difficult and devastating attacks

What Ruby Brings

- Transport
  - Curb
  - Net/HTTP
  - EventMachine
  - OpenSSL
- Parsing
  - Nokogiri
  - Hpricot
  - URI
- Encodings
  - Built-ins
  - Standard Library
  - Easy to mixin custom

[XPath searching an HTML DOM is incredibly useful]

```
module WWMD_Utf7
  def to_utf7
    self.scan(/./m).map { |b|
      "+" + [b.toutf16].pack("m").strip[0..2] + "-"
    }.join("")
  end
end

class String
  include WWMD_Utf7
end
```

WWMD Classes

- **Page:** all the heavy lifting
- **Scrape:** pull useful goo from pages
- **Spider:** find where everything is
- **Form*:** manipulate and submit HTML forms
  - and GET parameters and other things
- **UrlParse:** re-inventing the wheel
- **ViewState:** deserializer / serializer / fuzzer
- Lots of utilities for everyday tasks
  - Parse, cut and paste from and use burp/webscarab logs
  - FormFuzzer templates
  - URLlists / Fuzzlists
  - Convenience methods to make fuzzing web services easier

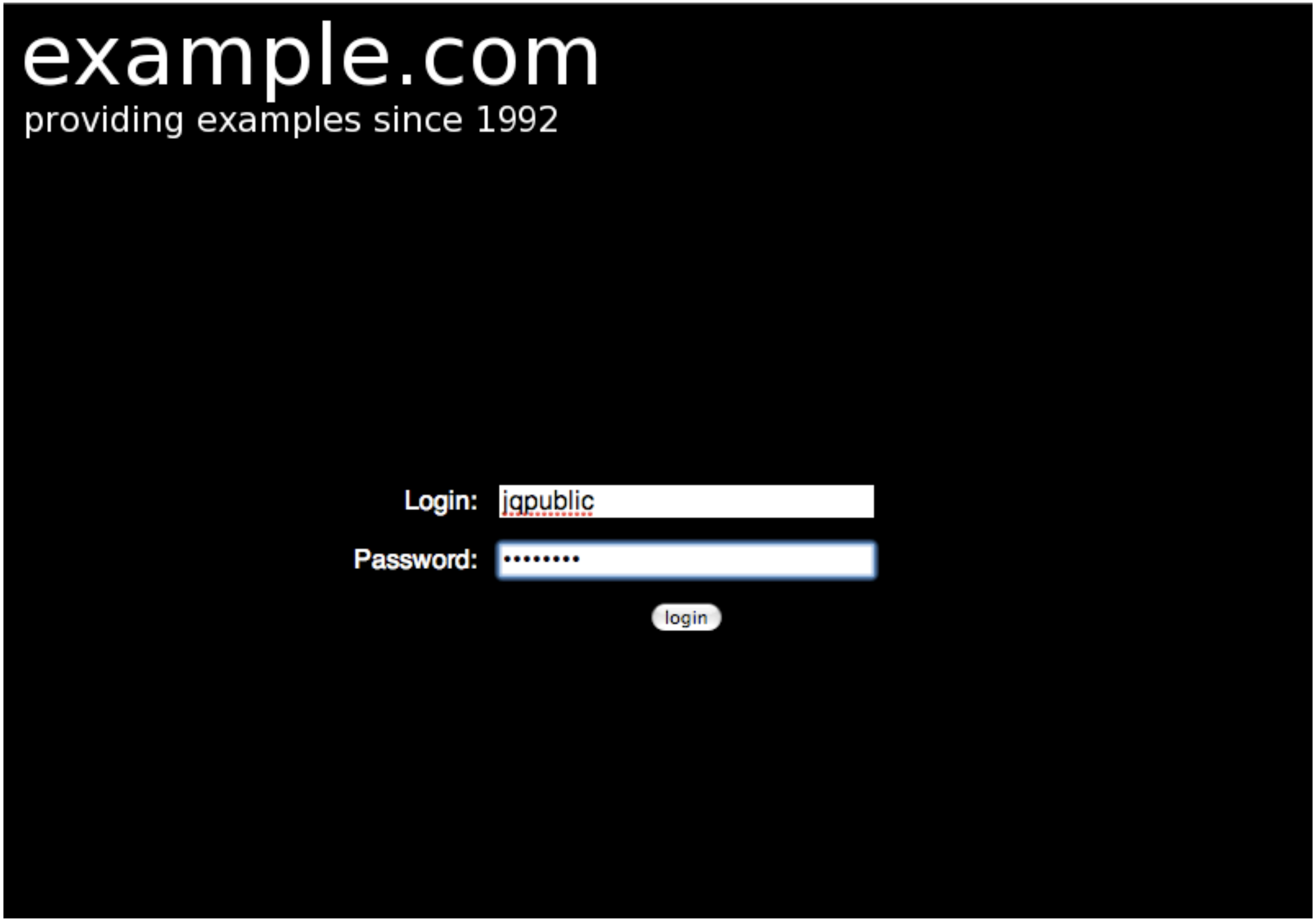
What Can I Do With It?

- A tool like scapy but for webapp pen-testing
- Integrate with the tools you already use
- Manipulate the entire request from a shell prompt
  - POST and GET parameters
  - headers, bodies and bespoke request types
- Easy shift between character encodings
- Focused customization of attack strings and wordlists
  - or fuzz using generators
- XPath searches of response bodies to create a smart fuzzer
- Instantaneous (almost) testing of exploits and concept proofs
- Trivial to automate spidering, scraping and exploit generation
- Find something new, mixin a method and it's yours forever

Walkthrough

And now... some code

welcome to example.com



example.com

providing examples since 1992

Login: jqpublic

Password: •••••••••

let’s figure out how to login

```
> wwmd
wwmd> OPTS = { :base_url => "http://www.example.com/example" }
=> {:base_url=>"http://www.example.com/example"}
wwmd> page = Page.new(OPTS)
=> ...
wwmd> page.get "http://www.example.com/example"
=> [200, 663]
wwmd> page.now
=> "http://www.example.com/example/login.php"
wwmd> form = page.get_form
=> [["username", nil], ["password", nil]]
wwmd> form.type
=> "post"
wwmd> form.action
=> "http://www.example.com/example/login_handler.php"
```

login method example

```
module WWMD
  class Page
    attr_reader :logged_in
    def login(url,uname,passwd)
      self.get(url)              ;# GET the login page
      form = self.get_form       ;# get the login form
                                 ;# did we actually get a form?
      return (self.logged_in = false) unless form
      form["username"] = uname   ;# set form username
      form["password"] = passwd ;# set form password
      self.submit(form)          ;# submit the form

      # naively check for password fields to see if we're still on login
page
      self.logged_in = (self.search("//input[@type='password']").size ==
0)
    end
  end
end
```

login method test

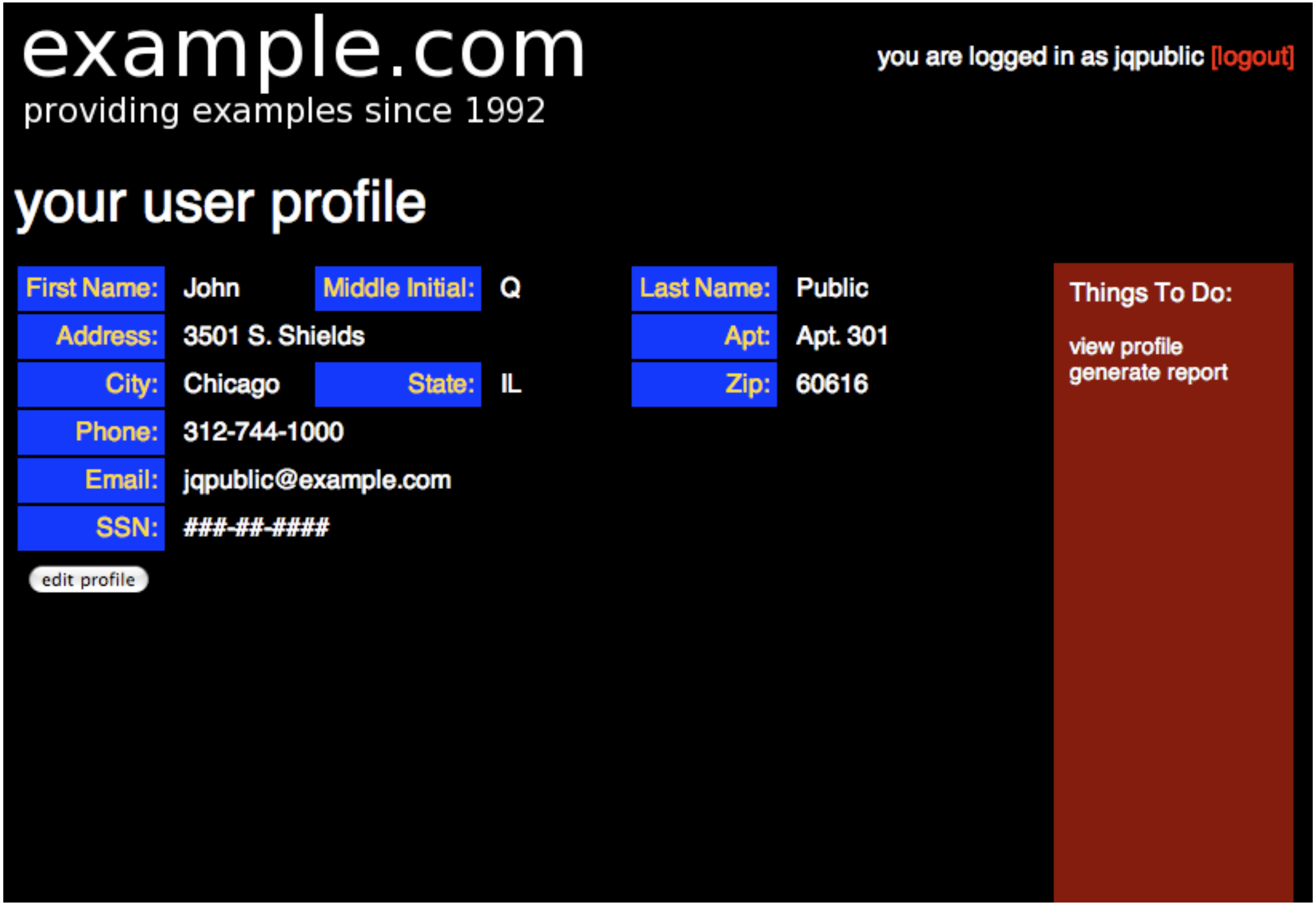
```
#!/usr/bin/env ruby
require 'wwmd'
require 'example_mixins'
include WWMD

opts = { :base_url => "http://www.example.com" }
page = Page.new(opts)
page.login((page.base_url + "/example"),"jqpublic","password")
raise "not logged in" unless  page.logged_in
puts page.search("//div[@class='loggedin']").first.text
```

```
>./login_test.rb

you are logged in as jqpublic [logout]
```

what's in here?



example.com

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you are logged in as jqpublic [logout]

your user profile

First Name:	John	Middle Initial:	Q	Last Name:	Public
Address:	3501 S. Shields			Apt:	Apt. 301
City:	Chicago	State:	IL	Zip:	60616
Phone:	312-744-1000				
Email:	jqpublic@example.com				
SSN:	###-##-####				

simple spider

```
#!/usr/bin/env ruby
require 'wwmd'
require 'example_mixins'
include WWMD

opts = { :base_url => "http://www.example.com" }
page = Page.new(opts)
spider = page.spider                          ;# use page's spider object
spider.set_ignore([ /logout/i, /login/i ])  ;# ignore login and logout
page.login((page.base_url + "/example"),"jqpublic","password")
raise "not logged in" unless  page.logged_in
while (url = spider.next)                     ;# shift from collected urls
  code,size = page.get(url)                   ;# get the shifted url
  page.summary                                ;# report on the page
end
```

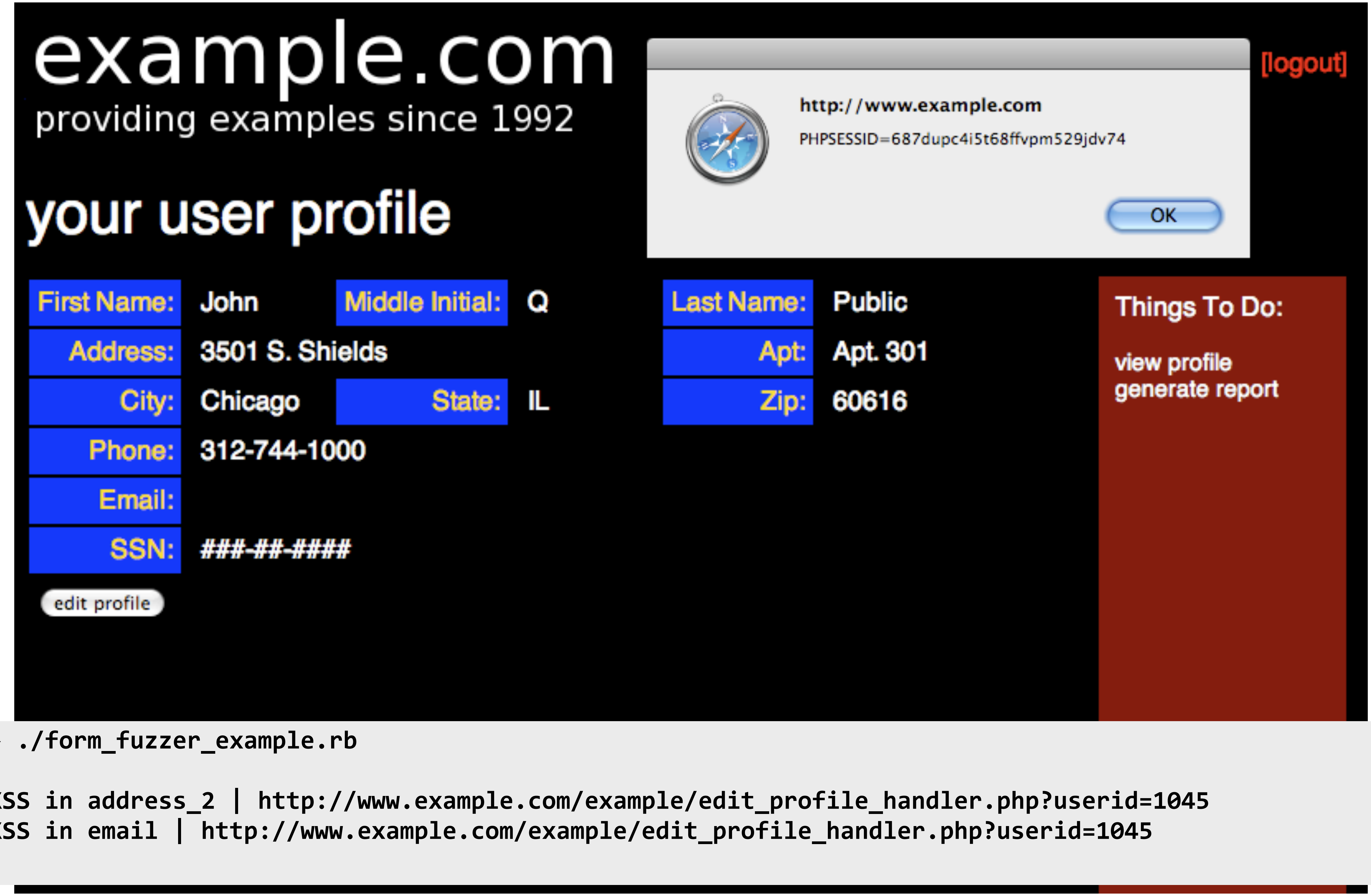
```
>./spider_example.rb

XXXX[LjfC] | 200 | OK | http://www.example.com/example/generate_report.php?userid=1045 | 818
XXXX[LjFC] | 200 | OK | http://www.example.com/example/edit_profile.php?userid=1045 | 2740
XXXX[ljfc] | 200 | OK | http://www.example.com/example/downloads/TEMP1053623.pdf?userid=1045
| 21741
XXXX[LjfC] | 200 | OK | http://www.example.com/example/edit_profile_handler.php?userid=1045 |
2039
```

simple xss fuzzer

```
...
fuzz = File.read("xss_fuzzlist.txt").split("\n")
while (url = spider.next)
  code,size = page.get(url)
  next unless (form = page.get_form)        ;# page has a form?
  oform = form.clone                        ;# copy the original form
  form.each do |k,v|                        ;# each key=value in the form
    fuzz.each do |f|                        ;# each entry in the fuzzlist
      form[k] = f                           ;# set value to our fuzz string
      r = Regexp.new(Regexp.escape(f),"i")  ;# create regexp to match
      page.submit(form)                     ;# submit the form
      form = oform.clone                    ;# reset the form
      next unless page.body_data.match(r)   ;# is our string reflected?
      puts "XSS in #{k} | #{form.action}"   ;# yes
    end
  end
  page.submit(oform)                        ;# leave things as we found
them
end
```

found some XSS



example.com

providing examples since 1992

your user profile

http://www.example.com

PHPSESSID=687dupc4i5t68ffvpm529jdv74

First Name:	John	Middle Initial:	Q	Last Name:	Public
Address:	3501 S. Shields			Apt:	Apt. 301
City:	Chicago	State:	IL	Zip:	60616
Phone:	312-744-1000				
Email:					
SSN:	###-##-####				

```
> ./form_fuzzer_example.rb

XSS in address_2 | http://www.example.com/example/edit_profile_handler.php?userid=1045
XSS in email | http://www.example.com/example/edit_profile_handler.php?userid=1045
```

viewstate example

```
wwmd> page = Page.new()
wwmd> vs = ViewState.new()
wwmd> page.get "http://www.example.com/vstest/test.html"
=> [200, 287]
wwmd> vs.debug = true
wwmd> page.get "http://www.example.com/vstest/test.html"
=> [200, 287]
wwmd> vs.deserialize(page.get_form['__VIEWSTATE'])
00000002 [0x0f] pair: next = string
00000003 [0x05] string: wwmd viewstate
00000013 [0x05] string: decoder
wwmd> puts vs.to_xml.pp
<ViewState version_string='ff01' version='/wE='>
  <VSPair>
    <VSString>wwmd viewstate</VSString>
    <VSString>decoder</VSString>
  </VSPair>
</ViewState>
```

viewstate example

```
#!/usr/bin/env ruby
require 'wwmd'
include WWMD

OPTS = { :base_url => "http://www.example.com/example" }
page = Page.new(OPTS)
vs = ViewState.new()
page.get(page.base_url + "/binary_serialized_test.html")
vs.deserialize(page.get_form["__VIEWSTATE"])
vs.to_xml.search("//VSBinarySerialized").each do |node|
  puts "====[ #{node.text.size}"
  puts node.text.b64d.hexdump
end
```

JRMI

★ **Java Remote Method Invocation**

- Translates:
  - **Transparent network serialization of objects between clients and servers**
- Been around 10+ years.
  - **But it crops up all over enterprise apps**
  - **We see this stuff *everywhere* by now**
- Examples:
  - **JMX rides on RMI**
  - **grep 'extends UnicastRemoteObject'**

JRMI

★ JRMI From Ruby - a primer

- Fire up JIRB and load RMI stub classes
  - **JRMI needs the client to have 'Stubs' for remote endpoints**
  - **This usually comes down to finding and pulling them in**

```
Dir["*.jar"].each {|jarfile| require jarfile }
```

- Get a RMI registry reference to walk remote endpoints

```
import java.rmi.Naming       # reads just like it does in Java
registry = Naming.lookup("//victimhost:1099")
registry.list.each do |remote_name|     # walk each remote endpoint
   remote = registry.lookup(remote_name)
   # walk its instance methods
   remote.java_class.declared_instance_methods.each do |meth|
      puts "#{meth.to_s}"     # produce a Java method prototype
   end
end
```

JRMI

★ JRMI - Remote Method Invocation cont...

- Next, don't be shocked to type things like
  - remote.getSystemConfiguration()
  - remote.getUserPassword('admin')
  - remote.executeCommand('/bin/pwn')
- We've beaten numerous enterprise Java apps using little more than 'jirb' and a jar file.
- ... and we didn't write a single line of Java

Reversing

Reversing

★ **Reverse Engineering**

- Having a dynamic language for reversing is a must
- Ruby excels in this role
  - **Many of the built-ins feel like they were made for reversing**
  - **What isn't built is easily added**

Reversing

- **Network Protocols**
  - You have to start somewhere
    - **Plugboards**
      - Blit, Plug, Telson
      - Using IRB to get inline
  - More advanced ...
    - **Protocol awareness**
      - Ruckus

Reversing

★ **Network Protocols**

- Blit
  - A simple OOB IPC mechanism for sending messages to blit enabled tools
- Plug
  - A reverse TCP proxy between one or more network connections
- Telson
  - Sets up a network connection and listens for messages from a blit client

Reversing

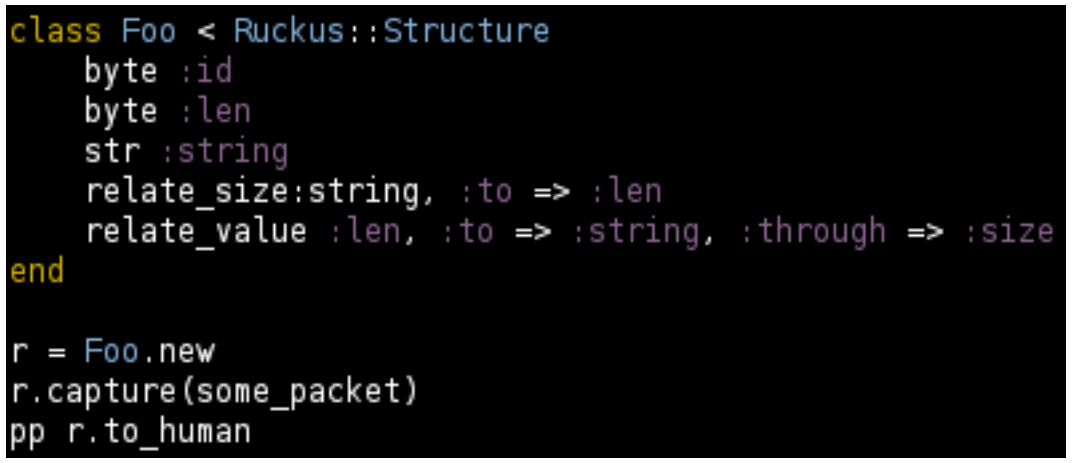
★ **Network Protocols**

- Reversing a proprietary network protocol
  - **We capture a TCP session and use Black Bag's cap2files to extract the messages using pcap**
  - **Now messages are in a ruby array**
  - **Lets try a replay attack with some modified fields**
    - Modify a length field in each payload at offset 5
      - pl_ary.each do |x| x[5] = rand(256); end
    - Connect to the target with Telson
      - telson -r 192.168.1.1:1234
    - Fire the first message with "blit" from IRB
      - pl_ary[0].blit

Reversing

★ **Network Protocols**

- Ruckus
  - **A DOM-Inspired Ruby Smart Fuzzer**
    - Declare structures like you’re writing C
    - Define network protocol headers
    - Built in mutators for fuzzing
    - No XML configuration files
    - Define your protocol in code



```
class Foo < Ruckus::Structure
    byte :id
    byte :len
    str :string
    relate_size:string, :to => :len
    relate_value :len, :to => :string, :through => :size
end

r = Foo.new
r.capture(some_packet)
pp r.to_human
```

Reversing

- **Network Protocols**
  - Ruckus
    - Capture a packet in IRB
    - Define your Ruckus structure on the fly
    - Inspect the packet
    - Modify the packet
    - Print the packet

```
puts r.to_human

Foo
   id = 49 (0x31)
   len = 48 (0x30)
   string =
%%
00000000  31 30 31 6c 6b 73 6a 64  6b 6c 73 61 6a 64  00 00  |101lksjdklsajd..|
00000010  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
00000020  00 00 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
%%
```

Reversing

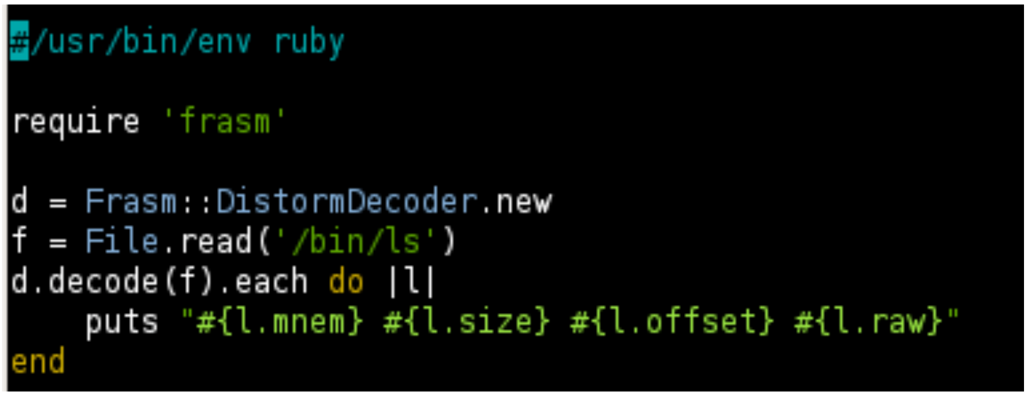
★ **Static analysis**

- Extracting embedded data using Black Bag
- Other useful things in Black Bag
  - **hexify, dedump, rstrings, bgrep ...**

Reversing

★ A Disassembler For Your Scripts

- Frasm
  - **Distorm wrapped with Ruby**
    - Distorm is a 32/64bit x86 disassembler C library written by Gil Dabah
    - Wrapped in a Ruby extension, and now we have frasm



```
#/usr/bin/env ruby

require 'frasm'

d = Frasm::DistormDecoder.new
f = File.read('/bin/ls')
d.decode(f).each do |l|
    puts "#{l.mnem} #{l.size} #{l.offset} #{l.raw}"
end
```

Reversing

★ **Static Analysis**

- Ruckus
    - We mentioned Ruckus earlier
    - It can be used for file formats too
    - Define structures like PE/ELF and parse up binaries just like network packets
    - Dump file format structures on the fly

Reversing

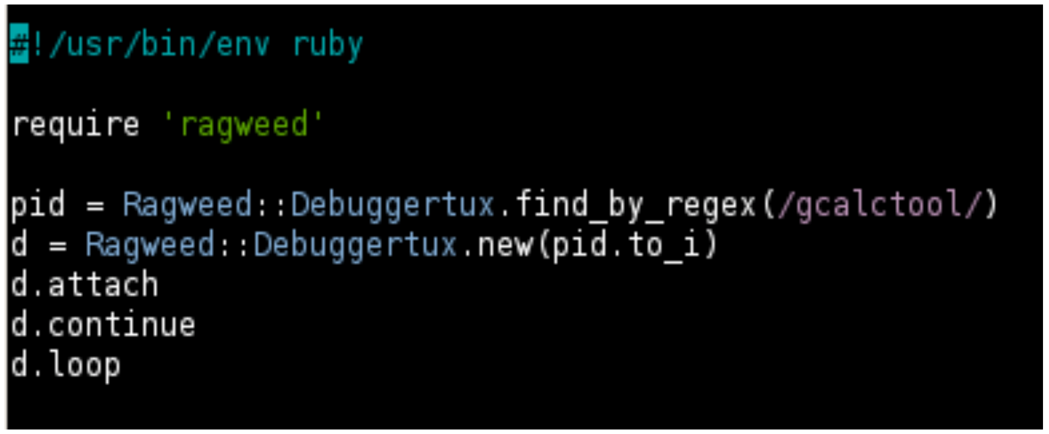
★ **Static Analysis**

- Ruckus Examples
  - **rElf**
    - Parse ELF structures with Ruckus
  - **ruPe**
    - Parse PE structures with Ruckus

Reversing

★ Dynamic Analysis

- Ragweed
  - PyDbg was our tool of choice, but we wanted something in Ruby
  - Support for Windows, OSX and Linux
  - Run Ruby blocks when breakpoints are hit
  - Write hit tracers in minutes
  - Example:



```
#!/usr/bin/env ruby

require 'ragweed'

pid = Ragweed::Debuggertux.find_by_regex(/gcalctool/)
d = Ragweed::Debuggertux.new(pid.to_i)
d.attach
d.continue
d.loop
```

Reversing

★ **Dynamic Java Analysis**

- Java Debugging Interface (JDI)
  - **"jdi_hook" drives JDI via JRuby**
    - Think kernel32 debugging API for the JVM
    - Next, think PyDBG for Java
- Why?
  - **JAD/JODE are an incomplete solution**
  - **Obfuscated Java code!**
  - **Have YOU used "jdb"?**

Demo:
Hit-tracing with “jdi_hook”

Reversing

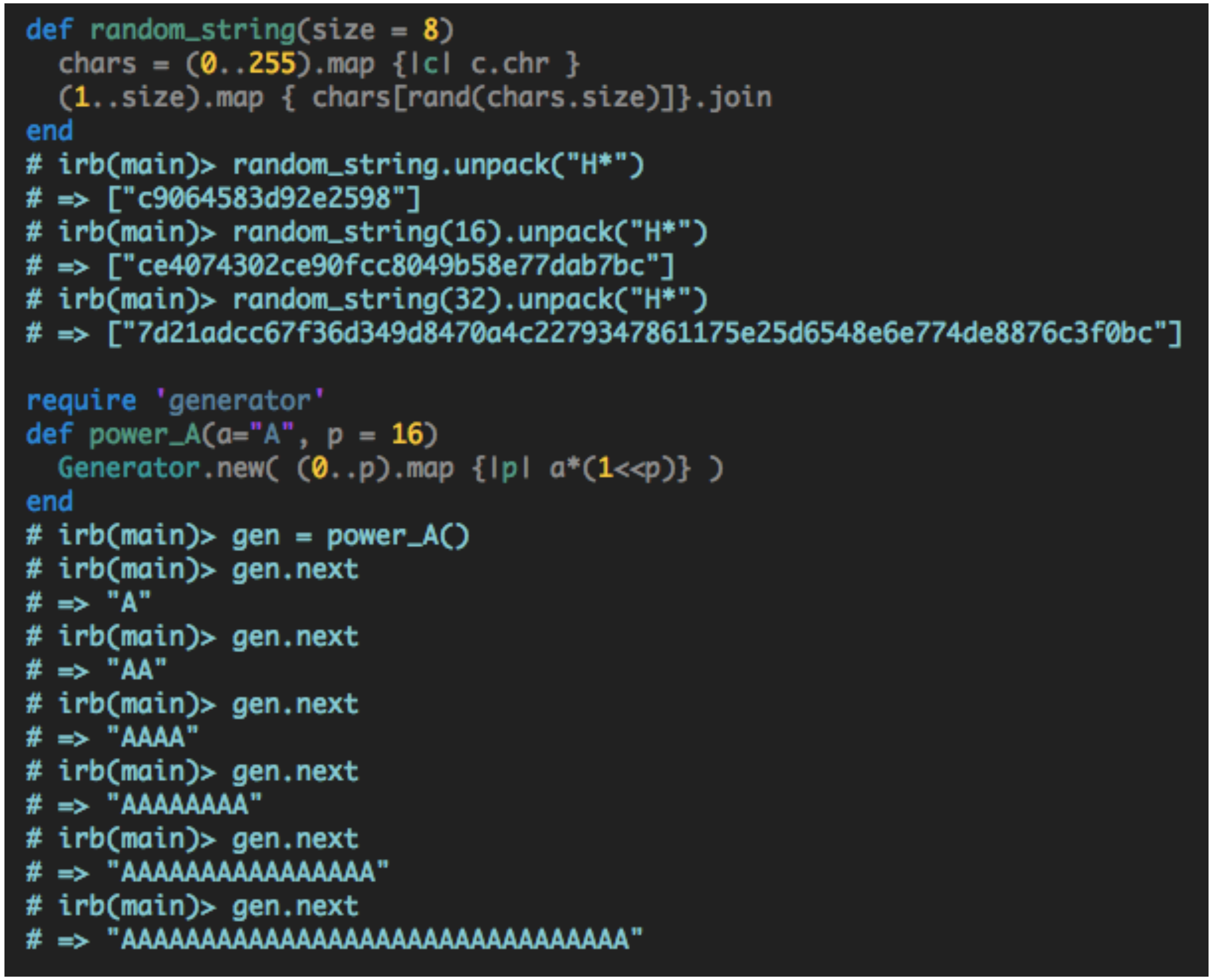
- ★ **JRuby for other dynamic Java tasks**
  - Use the target against itself
    - **Hook right into its proprietary network protocols**
    - **... and proprietary crypto algorithms?**
  - Bonus
    - **Divide and conquer the debugged target**
    - **"jirb" as your debuggee for class steering**

Fuzzing

Fuzzing

★ **Start Somewhere**

- Dumb fuzzers in Seconds



```
def random_string(size = 8)
  chars = (0..255).map {|c| c.chr }
  (1..size).map { chars[rand(chars.size)]}.join
end
# irb(main)> random_string.unpack("H*")
# => ["c9064583d92e2598"]
# irb(main)> random_string(16).unpack("H*")
# => ["ce4074302ce90fcc8049b58e77dab7bc"]
# irb(main)> random_string(32).unpack("H*")
# => ["7d21adcc67f36d349d8470a4c2279347861175e25d6548e6e774de8876c3f0bc"]

require 'generator'
def power_A(a="A", p = 16)
  Generator.new( (0..p).map {|p| a*(1<<p)} )
end
# irb(main)> gen = power_A()
# irb(main)> gen.next
# => "A"
# irb(main)> gen.next
# => "AA"
# irb(main)> gen.next
# => "AAAA"
# irb(main)> gen.next
# => "AAAAAAAA"
# irb(main)> gen.next
# => "AAAAAAAAAAAAAAAA"
# irb(main)> gen.next
# => "AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA"
```

Fuzzing

★ **Pretty Soon, Design Something Cleaner**

- DFuzz

```
strs = DFuzz::String.new()
while strs.next?
    target.send( strs.next )
end
```

  - Thanks Dino!

Fuzzing

- ★ **Intelligent Fuzzing: Structure Awareness**
  - Mutation based fuzzing
    - **Start with a structure (using ruckus)**

```
class DataField < Ruckus::Structure
   byte :id
   byte :len
   str :string
   relate_size :string, :to => :len
   relate_value :len, :to => :string, :through => :size
end
```

    - **Now lets fuzz the 'info' field**

```
dat = DataField.new
dat.id = 0xff
dat.len = 5
dat.string.value = Ruckus::Mutator::Str.new 'A', [Ruckus::Mutator::Multiplier]
dat.string.permute => "AA"
send(dat)
dat.string.permute => "AAAA"
send(dat)
dat.string.permute => "AAAAAAAA"
send(dat)
...
```

Fuzzing

★ **win32ole**

- ActiveX controls are historically ripe with bugs
- COM can be awkward to work with
- WIN32OLE is Ruby’s native COM API
- Plenty to work with for writing ActiveX and COM fuzzers

Fuzzing

★ **win32ole**

- We need something a bit more automated ...
- AxRub is our ActiveX Ruby fuzzer
  - **Uses win32ole to:**
    - Enumerate methods and arguments
    - Enumerate properties
  - **Uses Ruby to:**
    - Setup a fake web server
    - Serve up HTML with fuzzed ActiveX stuff

```
a = AxRub.new(clsid, 'blacklist.txt')
a.fuzz
```

  - **Just sit back and wait for the bugs**

Demo:
ActiveX fuzzing with “axrub”

Integrating Ruby

Integrating Ruby

★ **Your old tools suck. Give them Ruby!**

- Ruby Extensions
  - **Wrap C libraries and expose them in Ruby**
- JRuby
  - **Java classes are all just “there” in JRuby**
- Embedded Ruby and JRuby
  - **Ruby runtimes piggy-backing other apps**

Integrating Ruby

- ★ **qRub**
  - libnetfilter_queue C code with embedded Ruby
    - Was an existing tool called QueFuzz
      - It sucked, but had a lot of useful code
    - We ditched all the C fuzzing code and embedded Ruby instead
    - Easily intercept and modify packets
    - Drop into IRB for quick modifications
    - Hook into Ruby Black Bag
    - Reverse network protocols inline

Integrating Ruby

★ **LeafRub**

- Leaf is an extendable ELF analysis and disassembly tool written in C
- LeafRub is a Leaf plugin that embeds Ruby
  - **Analyze disassembly output using Ruby**
  - **Use Ruby extensions for different output**
    - There are gems for SQL, XML, HTML and just about anything else you want
  - **Write plugins to implement your ideas in half the time**

Integrating Ruby

★ Buby

- Portswigger BurpSuite is our 3rd-party web pesting tool of choice
  - **... but it needs more Ruby**

- Burp + JRuby = Buby
  - **Burp's API exposed fully to Ruby**

The end

★ Questions?