



## Generating language bindings for C/C++ libraries

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# What and why ?

SWIG is an interface compiler that connects programs written in C and C++ with scripting languages such as Perl, Python, Ruby, and Tcl.

- Building more powerful C/C++ programs
- Make C libraries 'object oriented'
- Rapid prototyping and debugging
- Systems integration
- Construction of scripting language extension modules

# About SWIG

- Homepage: <http://www.swig.org>
- `# zypper in swig`
- History
  - Initially started in July, 1995 at Los Alamos National Laboratory.
  - First alpha release: February, 1996.
  - Latest release: April 7, 2008. SWIG-1.3.35
- Active development
  - 3-4 releases per year

# Supported languages

Allegro Common Lisp



CLisp

CFFI (Common Lisp)



(guile)



python™



Octave



Ruby

*A Programmer's Best Friend*

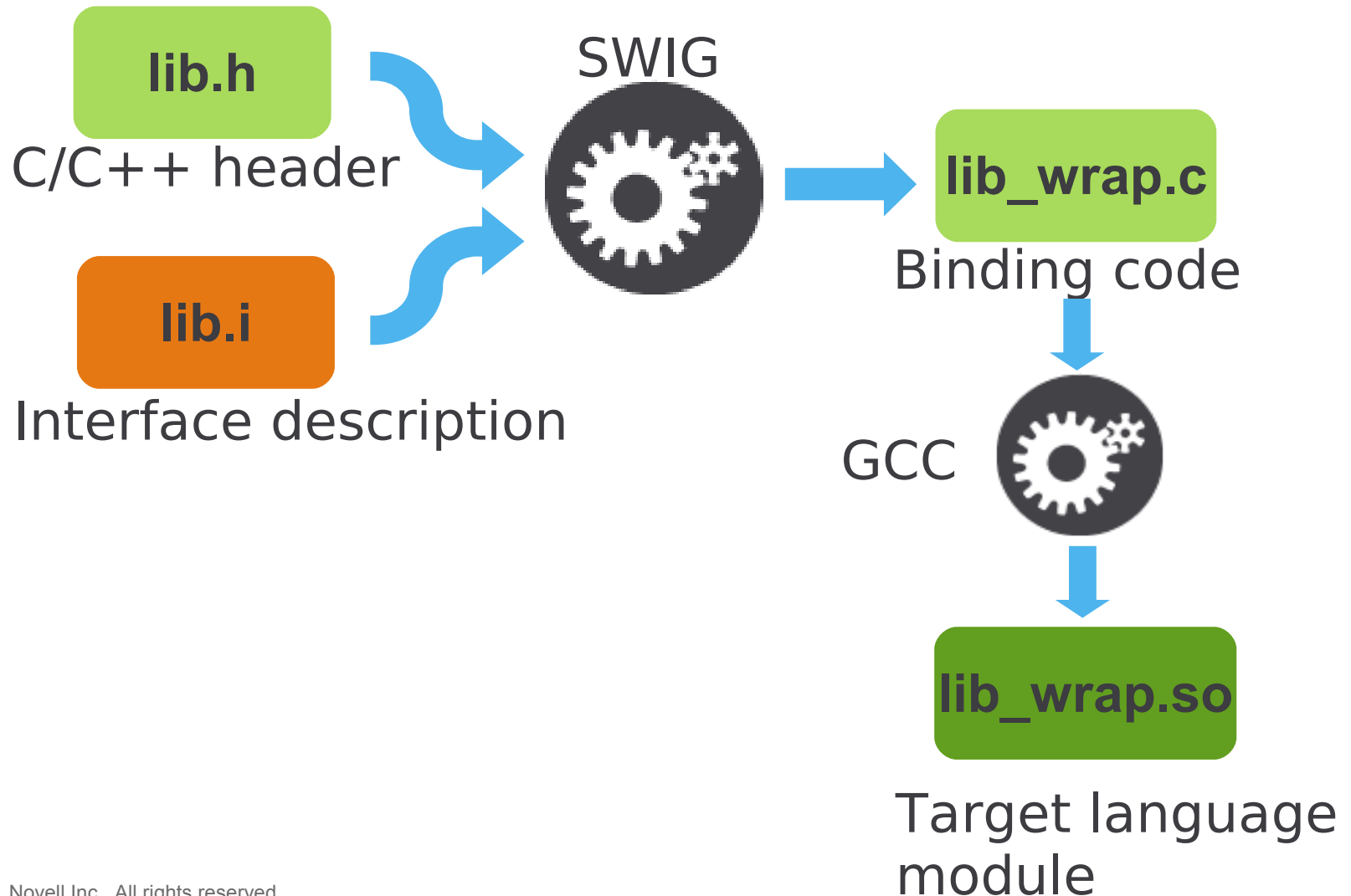


Chicken  
(Scheme)

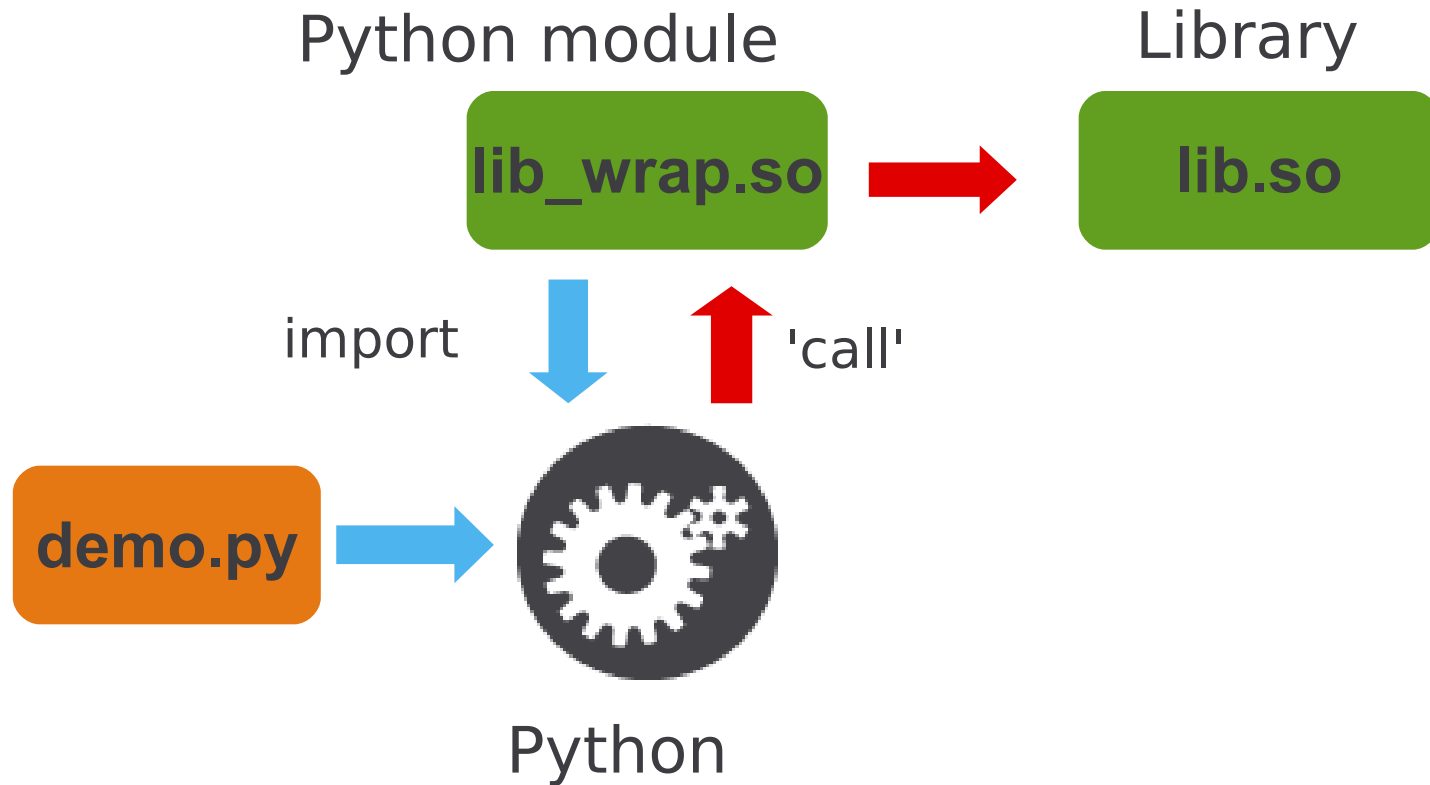
MzScheme



# How SWIG works



# How SWIG works (cont.)



# Using SWIG

# Example interface description

```
# Trivial example
%module example
%{
#include "satsolver/solver.h"
%}

#include satsolver/solver.h
```



# Running SWIG

- Generating

```
swig -ruby -I/usr/include example.i
```

- Compiling

```
gcc -fPIC -I /usr/lib64/ruby/1.8/x86_64-linux -c example_wrap.c
```

- Linking

```
gcc -shared example_wrap.o -lsatsolver -o example.so
```

- Running

```
irb
```

```
irb(main):001:0> require "example"
```

```
=> true
```

```
irb(main):002:0> s = Example::Solver.new
```

```
=> #<Example::Solver:0x7ffd300d4de8>
```

# Structure of interface descriptions

# Trivial example	Comment
%module example	Namespace
{	
#include "satsolver/solver.h"	C/C++ code
}	
%include satsolver/solver.h	Declarations

- C syntax, no C compiler
- Only minimal syntax checking

# What does SWIG do for you ?

- Namespace
- Constants
- Type conversion
  - For simple types (int, float, char \*, enum)
- Wraps complex types
  - Pointers to structs and classes
- Exposes functions
- Memory management
  - Constructors, destructors

# Example (Python)

(taken from libyui-bindings)

## YaST2/yui/YUI.h

```
class YUI
{
...
    static YWidgetFactory *
    widgetFactory();
...
}
```

## demo.py

```
import yui
factory = yui.YUI.widgetFactory()
dialog = factory.createPopupDialog()
vbox = factory.createVBox( dialog )
factory.createLabel( vbox, "Hello,
World!" )
```

## yui.i

```
%module yui
%{
#include "YaST2/yui/YUI.h"
%}
#include YUI.h
```

# Now how does it look like in ...

## Ruby

```
require 'yui'  
  
factory = Yui::YUI::widget_factory  
dialog = factory.create_popup_dialog  
vbox = factory.create_vbox dialog  
factory.create_label vbox, "Hello, World!"
```

## Perl

```
use yui;  
  
my $factory = yui::YUI::widgetFactory;  
my $dialog = $factory->createPopupDialog;  
my $vbox = $factory->createVBox( $dialog );  
$factory->createLabel( $vbox, "Hello, World!" );
```

# Things to watch out for

- Function names (target language conventions)

```
factory.create_popup_dialog
```

```
$factory->createPopupDialog;
```

- Comparing objects

SWIG *wraps* pointers to structs/classes, resulting in target languages objects (Python: `PyObject*`, Ruby: `VALUE`)

'a == b' compares `PyObject*` (resp. `VALUE`), not the wrapped C++ object pointer

- Object ownership

No explicit 'free' in e.g. Ruby and Python

# Controlling the bindings

# Exposure

- Swig recognizes C/C++ declarations

'struct' or 'class'

functions

- Hiding elements

```
%ignore solver::nouupdate;
```

```
%include "satsolver/solver.h"
```

- Hiding everything

```
typedef struct solver {} Solver;
```

```
%extend Solver {
```

```
...
```



# Memory management

- Complex types (struct/class) as pointers
- SWIG runs constructor ('malloc (sizeof struct)')
- Might not be useful

```
%nodefault solver;
```

- Explicit constructor/destructor

```
%extend Solver {  
    Solver( Pool *pool, Repo *installed = NULL )  
    { return solver_create( pool, installed ); }  
    ~Solver( )  
    { solver_free( $self ); }  
}
```

# Making C object-oriented

- Swig maps function calls 1:1, Ok for C++, bad for C

```
void solver_solve(Solver *solv, Queue *job);
```

(Ruby)

```
solver = Solver.new
```

```
solver_solve solver, job # Bad
```

```
solver.solve job # Good
```

- The power of %extend

```
%extend Solver {  
  int solve( Queue *job )  
  {  
    solver_solve( $self, job);  
    return $self->problems.count == 0;  
  }  
}
```

# Multiple target languages

- .i files are generic
- The target language is a SWIG runtime parameter

```
swig -ruby bindings.i
```

- Use `#if defined(SWIG<lang>)`

```
#if defined (SWIGRUBY)
```

```
...
```

```
#endif
```

# Useful commands

- Renaming

```
%rename("to_s") asString();  
%rename("name=") set_name(const char *name);  
%rename("empty?") empty();
```

- Aliasing

```
%alias get "[]";
```

- Constants

```
%constant int Script = C_CONSTANT;
```

- Defines

```
%define YUILogComponent "bindings"  
%enddef  
  
%define %macro(PARAMETER)
```

...

# Type conversions

- SWIG has default conversions for most types
- Look at the SWIG 'library'

```
/usr/share/swig/<version>
```

```
%include "carray.i"
```

- Typemaps

```
#if defined(SWIGRUBY)
    %typemap(in) (int bflag) {
        $1 = RTEST( $input );
    }
    %typemap(out) int problems_found
        "$result = ($1 != 0) ? Qtrue : Qfalse;";
    %rename("problems?") problems_found();
#endif
```

# Target specifics

- Bypassing SWIG type conversion
- Use target-specific types

Ruby: VALUE

Python: PyObject \*

- Example

```
%rename( "attr?" ) attr_exists( VALUE attrname );  
VALUE attr_exists( VALUE attrname )  
{  
  ...  
}
```

# Generating Documentation

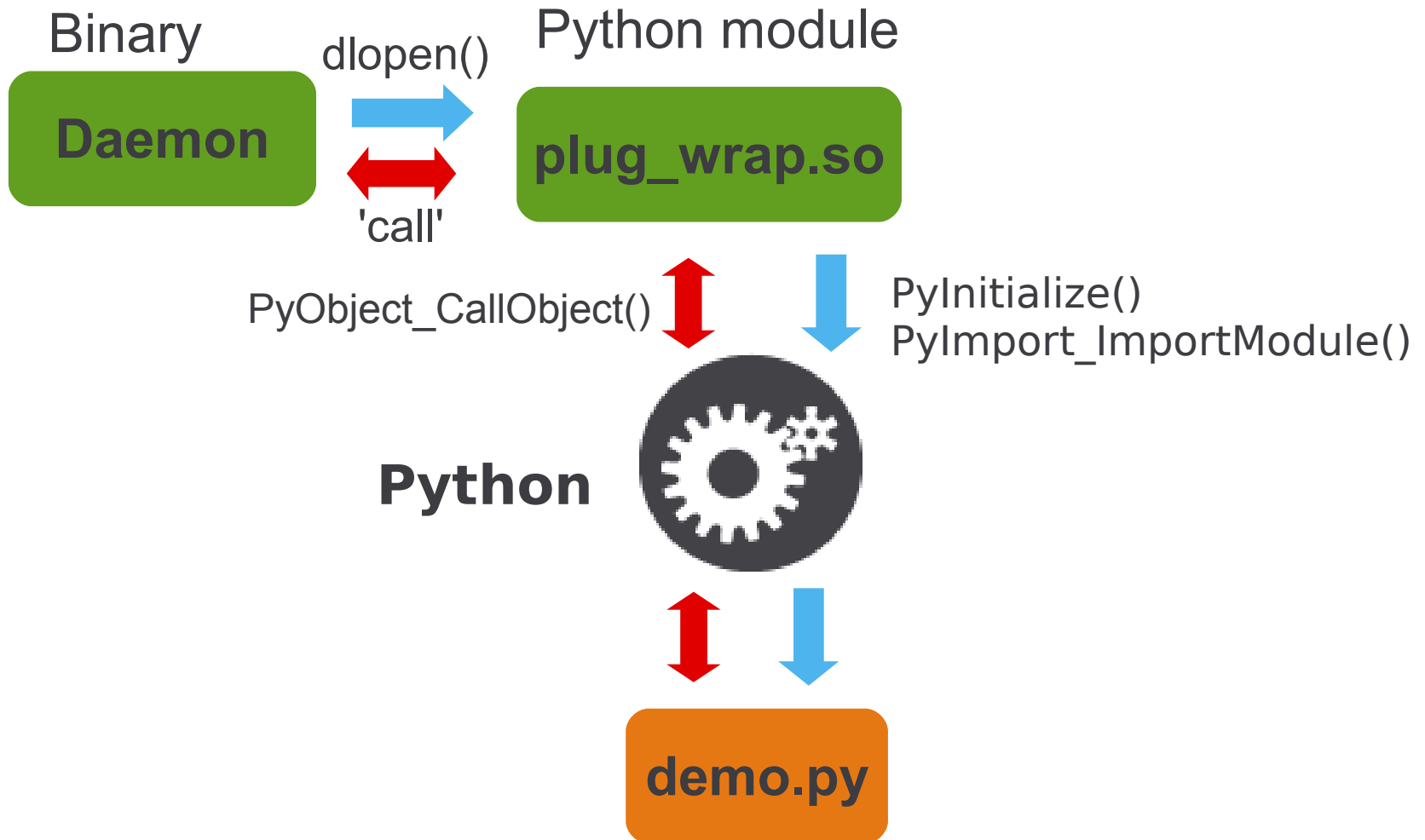
- SWIG can generate target-specific documentation  
e.g. rdoc for Ruby, pydoc for Python
- Enable with `%feature("autodoc", "1");`
- Converts C-style comments in .i files
- Needs fixing ...

The background of the slide is a solid blue color with a pattern of diagonal lines in various shades of blue, creating a sense of motion or depth. The lines are more densely packed on the right side and become more sparse towards the left.

Inversion of control



# Inversion of control



# Wrap up / Lessons learned

- SWIG is a tool, use it wisely
- Take the (script language) programmers view  
How should it look in Python/Ruby/Perl/... ?
- Tweak the bindings, not the target language
- Look at other SWIG code
- SWIG is very well documented  
But not without bugs ...
- Memory ownership is tricky

# Links for inspiration

- C++ Library

libyui-bindings (YaST user interface)

<http://svn.opensuse.org/svn/yast/trunk/libyui-bindings>

- C Library

Sat-solver (package dependency resolver)

<http://svn.opensuse.org/svn/zypp/trunk/sat-solver/bindings>

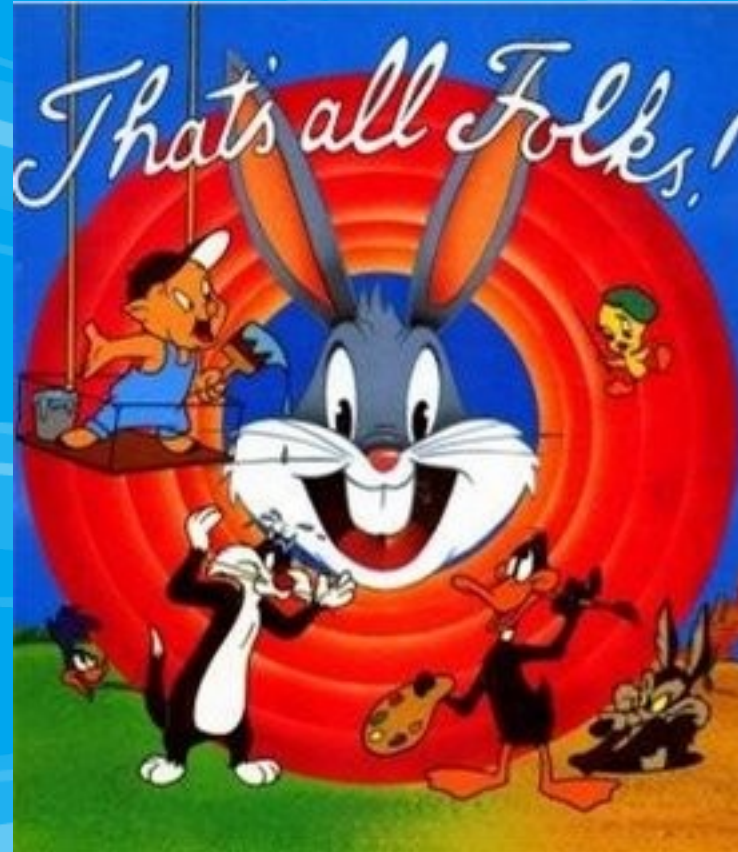
openwsman (Web Services for Management protocol)

<http://www.openwsman.org/trac/browser/openwsman/trunk/bindings>

- Inversion of control

cmpi-bindings (CIM Provider interface)

<http://omc.svn.sourceforge.net/viewvc/omc/cmpi-bindings>



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