

Programming Proverbs

- 17. “Never assume the computer assumes anything.”
- Henry F. Ledgard, “Programming Proverbs: Principles of Good Programming with Numerous Examples to Improve Programming Style and Proficiency”, (Hayden Computer Programming Series), Hayden Book Company, 1st edition, ISBN-13: 978-0810455221, December 1975.

PGE and libtool

- examine the file `pge/c/Makefile.am`
 - notice the rule starting with the text
 - `libpgeif.la`: this rule generates the library `libpgeif.la` using a variant of the command given on the previous slides

PGE and libtool

```
swig -outdir . -o pgeif_wrap.cxx -c++ -python $(top_srcdir)/i/pgeif.i
$(LIBTOOL) --tag=CC --mode=compile g++ -g -c pgeif_wrap.cxx \
  -I/usr/include/python$(PYTHON_VERSION) -o pgeif_wrap.lo
gm2 -c -g -I$(SRC_PATH_PIM) -fcpp -fmakelist \
  -I$(top_srcdir)/m2 $(top_srcdir)/m2/pgeif.mod
gm2 -c -g -I$(SRC_PATH_PIM) -fcpp -fmakeinit -fshared \
  -I$(top_srcdir) $(top_srcdir)/m2/pgeif.mod
$(LIBTOOL) --tag=CC $(AM_LIBTOOLFLAGS) $(LIBTOOLFLAGS) \
  --mode=compile gcc -c $(CFLAGS_FOR_TARGET) $(LIBCFLAGS) \
  $(libgm2_la_M2FLAGS) $(srcdir)/pgeif.c -o pgeif.lo
$(LIBTOOL) --tag=CC --mode=compile g++ -g -c _m2_pgeif.cpp -o _m2_pgeif.lo
$(LIBTOOL) --tag=CC --mode=link gcc -g _m2_pgeif.lo $(MY_DEPS) \
  pgeif_wrap.lo \
  -L$(GM2LIBDIR)/lib64 \
  -rpath `pwd` -liso -lgcc -lstdc++ -lpth -lc -lm -o libpgeif.la
cp .libs/libpgeif.so ../_pgeif.so
cp pgeif.py ../pgeif.py
```

More complex example

- passing data from Python into C, C++, Modula-2 shared library
 - can pass `int`, `float`, `double` and `enums` easily enough
- strings are also reasonably well supported
- how do we pass aggregate data types between Python and C/C++?
 - how do we return aggregate from C/C++ into Python?

Aggregate data types

- an aggregate data type is a data type which contains different sub types
 - for example a struct containing an int and a char field

```
typedef struct aggregate_t {  
    int field1;  
    char field2;  
} aggregate;
```

Passing aggregate data types from Python into C/C++

- fortunately binary strings of data can be passed between Python and C/C++ using swig
- we can build a sequence of bytes using the Python `struct` module
 - the `struct` module uses a `printf` formatting structure to pack and unpack binary data

Why do we need to pass aggregate data types from C/C++ to Python?

- consider, `pge`, the shared library module generate events which might be:
 - a draw frame event
 - a collision event
 - a timer event

- the draw frame event
 - contains a list of polygons and circles and their position and colour which need to be rendered to represent the world
 - this is a dynamic list of objects containing many different data types

Why do we need to pass aggregate data types from C/C++ to Python?

- a collision event
 - contains the time of collision, position of the collision
 - and the object `ids` in collision
- this will be a fixed aggregate structure of known length
- the timer event will have a time field (`double`) and the timer `id` (`integer`) as well as a few other fields
 - this is also fixed in length and represented in C as a `struct`

Passing aggregate data from C, C++, Modula-2 into Python

- we can use the string passing mechanism to pass bytes
 - the `.i` file needs extra information to say which functions return binary data **and also that the shared library can set the length**

`pge/i/pgeif.i`

```
...
#include cstring.i
%cstring_output_allocate_size(char **s, int *slen, );

%{
extern "C" void get_cbuf (char **s, int *slen);
extern "C" void get_ebuf (char **s, int *slen);
extern "C" void get_fbuf (char **s, int *slen);
...
}
```

Passing aggregate data from C, C++, Modula-2 into Python

- notice that a Python string is created in the shared library and passed back to the Python caller
- also notice that `get_cbuf` is a function!
 - returning a string
- the `swig` information
- ```
%include cstring.i
%cstring_output_allocate_size(char **s, int *slen,);
```
- indicates these types and name match a return string allocated in the shared library

# Passing aggregate data from C, C++, Modula-2 into Python



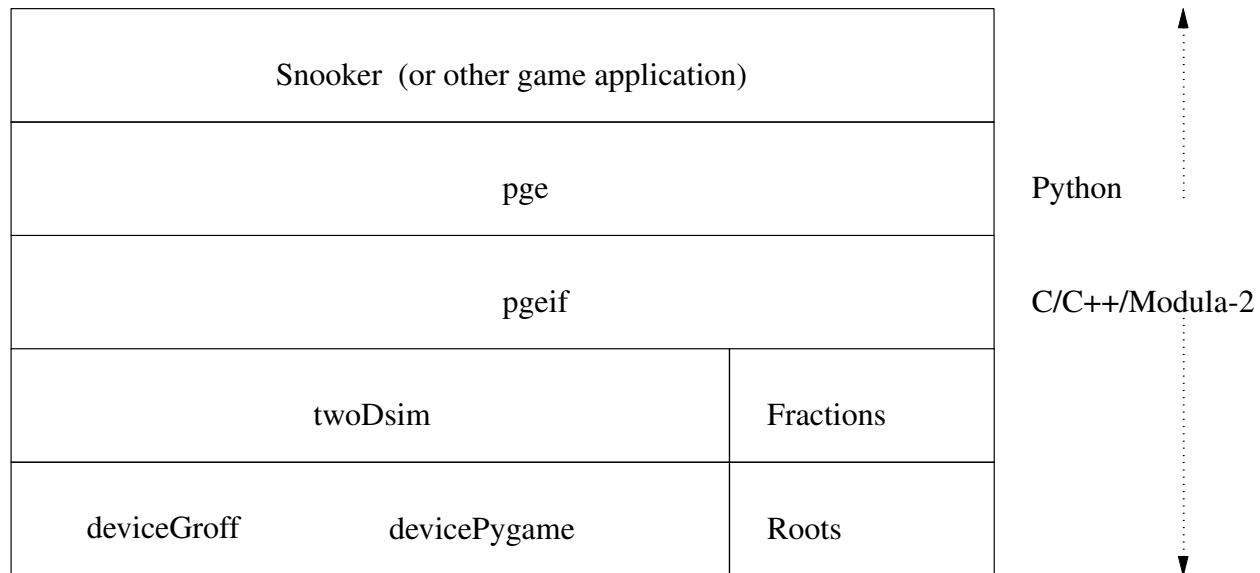
[pge/python/pge.py](#)

```
def runbatch (t):
 if t < 0.0:
 t = 30.0
 _debugf ("runbatch (%f)\n", t)
 pgeif.check_objects ()
 cData = pgeif.get_cbuf ()
 fData = pgeif.get_fbuf ()
 _draw_frame (cData, len (cData), fData, len (fData))
 pgeif.empty_fbuffer ()
 pgeif.empty_cbuffer ()
```

# Passing aggregate data from C, C++, Modula-2 into Python

- `swig` has many mechanisms to allow binary strings of data to be retrieved
  - above is the safest - as it contains the `length`

# PGE structure



# Passing aggregate data from C, C++, Modula-2 into Python

- examine the function `_draw_frame` which calls the function

[pge/python/pge.py](#)

```

_pyg_draw_frame - draws a frame on the pygame display.

def _pyg_draw_frame (cdata, clength, fdata, flength):
 global nextFrame, call, _record
```

# Passing aggregate data from C, C++, Modula-2 into Python

[pge/python/pge.py](#)

```
if _record:
 _begin_record_frame (cdata, clength, fdata, flength)
elif flength > 0:
 _draw_background ()
f = _myfile (cdata + fdata)
while f.left () >= 3:
 header = struct.unpack ("3s", f.read (3))[0]
 header = header[:2]
 if call.has_key (header):
 f = call[header] (f)
 else:
 print "not understood header =", header
 sys.exit (1)
```

# Passing aggregate data from C, C++, Modula-2 into Python



[pge/python/pge.py](#)

```
if flength > 0:
 _draw_foreground ()
if _record:
 _end_record_frame ()
if flength > 0:
 _doFlipBuffer () # flipping the buffer for an empty frame looks ugly
nextFrame += 1
_debugf ("moving onto frame %d\n", nextFrame)
```



## Inside the shared library

- it creates the byte string containing aggregate data

## Inside the shared library

pge/c/buffers.c

```
/*
 * buffers - wrap the event buffer contents into a binary string.
 */

extern void deviceIf_getFrameBuffer (void **start,
 int *length, int *used);

void get_fbuf (void **start, unsigned int *used)
{
 int length;
 #if !defined (DEBUGGING)
 printf ("calling deviceIf_getFrameBuffer\n");
 #endif
 deviceIf_getFrameBuffer (start, &length, used);
}
```

## Inside the shared library

- examine the file `pge/c/deviceIf.c`
  - follow the functions: `deviceIf_emptyFbuffer`, `deviceIf_useBuffer` and `deviceIf_finish`
  
- notice the use of the module `MemStream`
  - read the documentation of `MemStream` (<http://nongnu.org/gm2/gm2-libs-isomemstream.html>)
  
- `MemStream` allows the caller to use file operations to maintain a byte string which is contiguous and held in memory

## Conclusion and `pgeif.i`

- the full API describing the C interface is described in `pge/i/pgeif.i`
  - examine this file and see how a `circle`, `colour` and `box` are created
- now read the file `pge/python/pge.py` and see how a call to `box` and `colour` is mapped into the `pgeif.i` calls