Scripting Runtime Dynamic Analysis

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The Point

- What about ad-hoc and one-shot analyses?
- Need to lower the development cost
  - instrumentation cost
  - development effort
- Scripting languages offer an ideal platform for providing these things

Warning!!!

- I LOVE scripting languages
- SL put the fun back into programming
- Able to see exciting results quickly

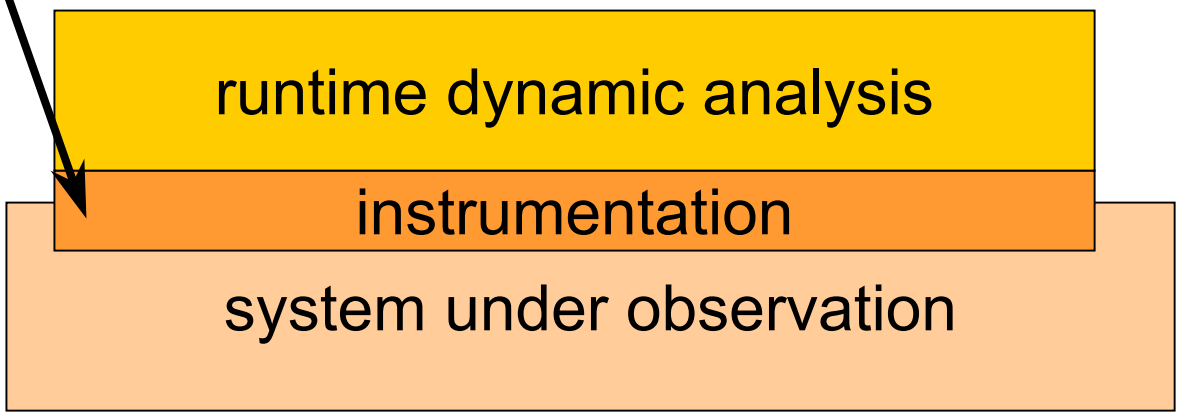
Scripting Languages

- Originally meant “shell scripts”
- Has evolved into programming that is
  - easy to use
  - less formal?
  - provides lots of built in functionality
- Perl, Tcl, Python, VB, PHP, …

RT Dynamic Analysis Needs:

frameworks
(tricky stuff!)

“old-fashioned”
programming



Instrumentation

- Always going to be “hard”?
- If done well, reusable
- An ideal arena for systems programming languages

Programming

- Many different needs
  - high execution speed
  - high robustness
  - low development effort
  - high ease of use
  - low entry barrier
- Scripting languages can often provide the last three

Scripting Has:

- Extensibility
  - can define new commands in the language through conventional programming
- GUI building
  - easy, flexible, and dynamic GUI capabilities
- Event handling
  - both system and user-defined events

DA Example in Tcl

```
proc mymalloc_begin {size} {
   global NumMallocs BytesMalloced AvgBlockSize CurrentAlloc
   incr NumMallocs
   incr BytesMalloced $size
   incr CurrentAlloc $size
   Setline $size red
   set AvgBlockSize [expr $BytesMalloced/$NumMallocs]
}
```

```
proc mymalloc_end {ptr size} {
   global MBlocks
   set MBlocks($ptr) $size
}
```

Tcl Continued

```
proc myfree_begin {ptr} {
   global NumFrees BytesFreed MBlocks CurrentAlloc
   incr NumFrees
   if {![info exists MBlocks($ptr)]} {
       puts stderr "Free error: block at [format "%x" $ptr] does not exist!“
      return  }
  if {$MBlocks($ptr) < 0} {
      puts stderr "Free error: block at [format "%x" $ptr] already freed!“
      return }
   incr BytesFreed $MBlocks($ptr)
   incr CurrentAlloc [expr -1 * $MBlocks($ptr)]
   Setline $MBlocks($ptr) green
   set MBlocks($ptr) [expr -1 * $MBlocks($ptr)]
}
```

Instrumentation Level

- Interface from excutable to Tcl is done in C
  - dynamic linker mods
  - wrapper generation from prototypes
  - future enhancements (data access,…)

Auto-generated Wrapper

```
void * mymalloc (size_t numbytes) {
  Tcl_Obj *cmdvector[3];
  void * retval;
  do_redirect = 0;
  cmdvector[0] = Tcl_NewStringObj("mymalloc_begin",-1);
  cmdvector[1] = Tcl_NewLongObj(numbytes);
  Tcl_EvalObjv(TclInterp,2,cmdvector,TCL_EVAL_GLOBAL);
  retval = malloc (numbytes);
  cmdvector[0] = Tcl_NewStringObj("mymalloc_end",-1);
  cmdvector[1] = Tcl_NewLongObj(retval);
  cmdvector[2] = Tcl_NewLongObj(numbytes);
  Tcl_EvalObjv(TclInterp,3,cmdvector,TCL_EVAL_GLOBAL);
  do_redirect = 1;
  return retval;
}
```

My Claims

- Scripting languages offer large code reuse base
  - avoid wheel reinvention
- Focus on language improves instrumentation interface design
  - what commands/events do I want to add?
  - what should their arguments be?
  - what options should they take?
  - when should control be transferred?

Scripting Needs:

- For dynamic analysis, some holes exist
- Event processing
  - event pattern triggers rather than just simple events
- Parsing
  - perhaps something like DCG's
- Logical inference capability
  - embed some minimal WAM?

Reasons for Failure

- Slow!
  - dynamic analysis is often compute intensive
- Error-prone?
  - weak or no typing can lead to surprising errors
- Too many choices
  - how to select a scripting language to use?

Reasons for Success

- Scripting languages provide an incredibly rich context for programming
- Ideal foundation for building prototypes and ad-hoc analyses
- Interfacing to a scripting languages forces good design of instrumentation interface