It's Elementary, Dear Watson: Applying Logic Programming to Convergent System Management Tasks

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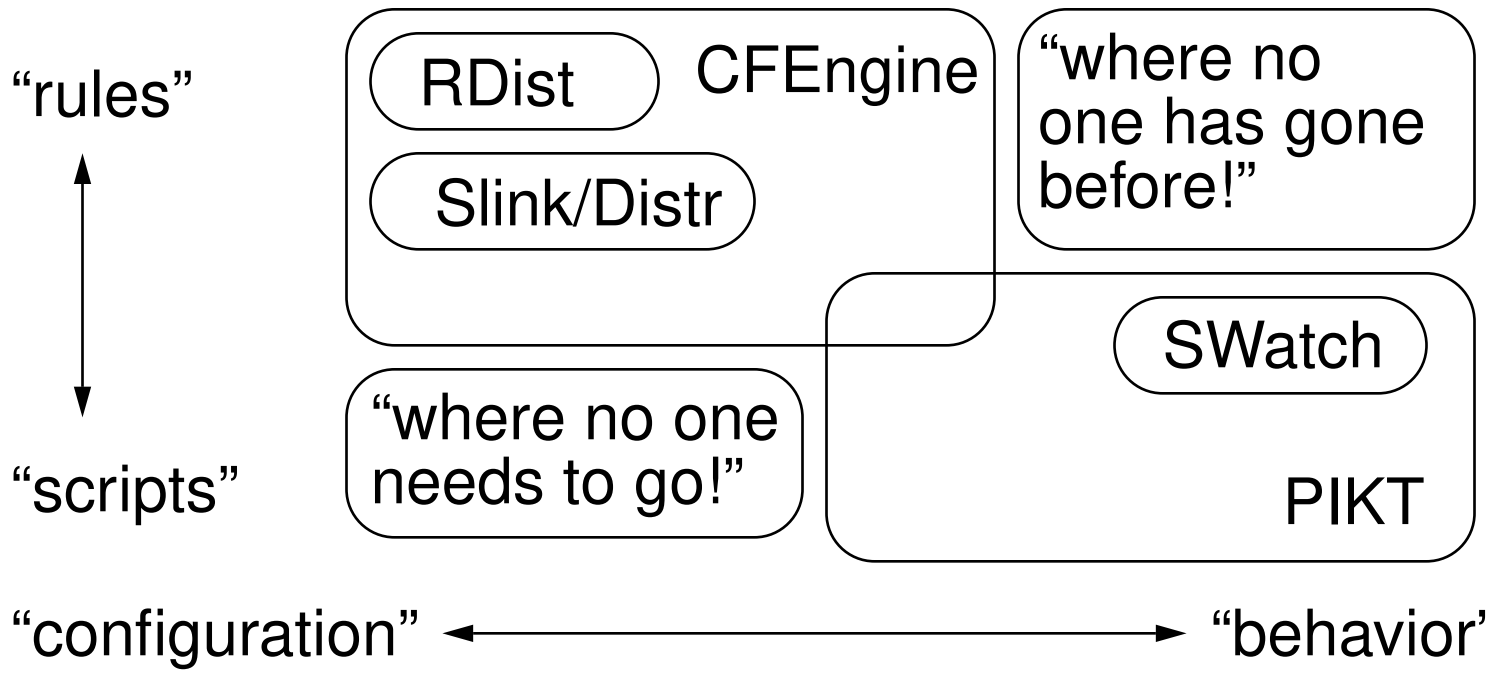
THE SYSTEM MANAGEMENT "LANDSCAPE"



“DISCLAIMER”

- *We love* CFEngine and PIKT.
  - Both do what they claim.
  - Both are optimal in execution time.
- But extending either one is difficult.
  - Is execution speed all-important?
  - Or is our time more valuable?

ELEMENTARY!

- CFEngine is “almost” Prolog (see paper).
- PIKT scripts “must do” what Prolog does.
- So try using a subset of Prolog.
- Gains:
  - Prolog programs “look more like policy”.
  - Loops and configuration changes are implicit.
- Losses:
  - Can’t explicitly control actions.
  - Lower runtime efficiency.

OUR EXPERIMENTAL PROTOTYPE

- SWI-Prolog on Solaris 7.
- Used builtins for manipulating files.
- Wrote extensions for manipulating system configuration, processes, etc.
- Wrote CFEngine-like configuration primitives (except for file distribution).
- Wrote PIKT-like output parsing primitives.
- Used these to pre-parse common command output formats (du, ps, quota, who, etc)

A USEFUL SUBSET OF PROLOG

- We don’t need the whole language.
- We only have one real goal: *system health.*
- Every script we write will be to *assure health.*

```
health:- /* same goal every time */
 passwd(Login,_,_,_,_,Home,_),
 du(Home,Usage),                    our
 Usage>20000,                       program
 email(Login,'you are a pig!',
  'oink!').
?- health,fail. /* check ALL cases */
```

IMPLICIT ACTIONS

- In a normal scripting language, this “program” would look like:

```
for each Login, Home pair,
  Usage = du(Home)
  if (Usage>20000)
    email(Login,'you are a pig!',
         'oink!')
```

- In Prolog, the underlined text was *implicit* and *inferred from context.*

IMPLICIT QUERIES AND TESTS

- **`passwd(Login,_,_,_,_,Home,_)`**
  sets **`Login`** and **`Home`** to *all valid pairs* in turn.
- **`passwd('couch',_,_,_,_,`**
  `'/home/couch',_)`
  is a *conditional test* that's true if the home directory of **`couch`** is **`/home/couch`**!

IMPLICIT EFFECTS

- **`owner('/etc/motd',Owner,Group)`**
  reads **`Owner`** and **`Group`**
- **`owner('/etc/motd',0,10)`**
  chown's **`/etc/motd`**

IMPLICIT CONVERGENCE

- **`copy('/Master/etc/motd','/etc/motd')`**
  copies *only if necessary.*
- **`link('/Master/etc/motd','/etc/motd')`**
  makes a link *only if necessary.*

CONTROVERSIAL CLAIMS

- Prolog can emulate the function of CFEngine through appropriate extensions.
- Prolog supports script genericity as in PIKT.
- See paper for details.

WHERE NO ONE HAS GONE BEFORE:

- Service-level declarations.
- Declarative rules for dynamic policies.

SERVICE-LEVEL DECLARATIONS

- Define generic high-level services, e.g., ftp.

```
health:- service(ftp), os(Os),
  config_path('inetd.conf',Os,Path),
  config_path('ftpd',Os,Ftpd),
  file_base_name(Ftpd,FBase),
  appendIfNoSuchLine(Path,
   [ftp,stream,tcp,nowait,root,
    Ftpd,Fbase]).
```

- Describe systems requiring service:

```
service(ftp):- hostname('fred').
service(ftp):- not os('solaris').
```

DECLARING DYNAMIC POLICY

- The lesson of COBOL:

  subtle: requires a Dilbert

  “natural language” policy ⇄ process “computer language”

  easy: any PHM can handle it.

- “The best we can do” is to code policies so that *once they’re coded and working, their meanings are obvious* (to PHM’s)!

POLICY TO PROCESS

- Policy:
  kill all Internet Explorer runaways that remain after the user has logged out.
- Prolog: “messy, but effective”

```
ps_f(User,Pid,_,_,_,_,_,Cmd),
match(Cmd,'iexplorer'),
not who(User,_,_,_),
kill(Pid,9).
```

PERFORMANCE

- If written well, Prolog executes as quickly as comparable Perl code.
- If written poorly, it can take thousands of times longer due to superfluous implicit loops.
- Example: the sequence

  ```
  passwd(_,_,_,_,_,Home,_),
  passwd(Login,_,_,_,_,Home,_)
  ```

  can take thousands of times longer than the second goal alone.

CONCLUSIONS

- Prolog is a “glue language” that allows coding of rules for both configuration management and behavior modification.
- But efficient coding is a *subtle art.*
- Prolog is an *assembly language* in which future configuration tools can be written.

THE FUTURE

- Preprocessor converts policy rules into Prolog.
- Syntax closer to usual scripting languages.
- Type checking and superfluous loop elimination.
- Example of proposed declarative syntax:

```
pid(Pid),Name=pidName(Pid),
match(Name,'iexplorer'),
User=pidUser(Pid),
not userTty(User),
kill(Pid,9).
```