Chapter 12: Systematic Development

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ECLiPSe ELearning Overview

Licence

Outline

Overview

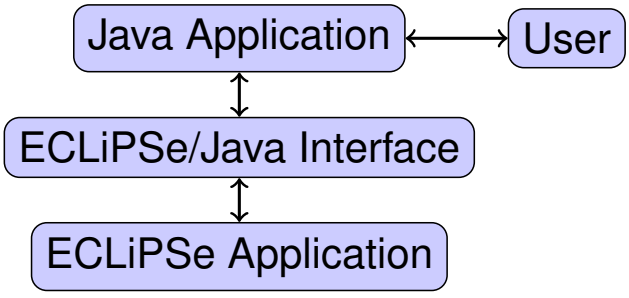
- How to develop large applications in ECLiPSe
- Software development issues for Prolog
- This is essential for large applications
  - But it may show benefits already for small programs
- This is not about problem solving, but the *boring bits* of application development

Disclaimer

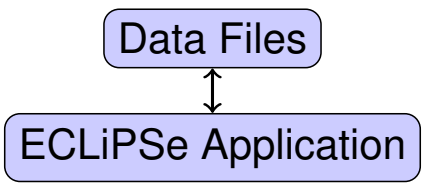
- This is not *holy writ*
  - But it works!
- This is a team issue
  - People working together must agree
  - Come up with a local style guide
- Consistency is not optional
  - Every shortcut must be paid for later on
- This is an appetizer only
  - The real story is in the tutorial Developing Applications with ECLiPSe (part of the ECLiPSe documentation)

Application Structure

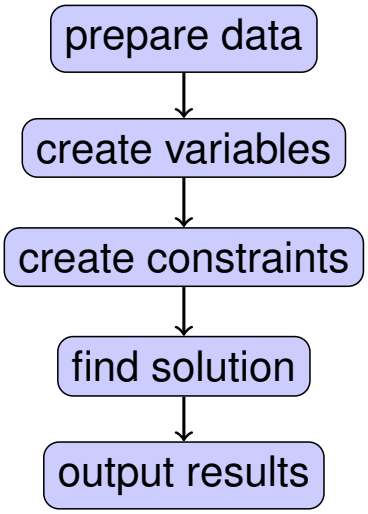
Full Application



Batch Application



LSCO Structure



Top-Down Design

- Design queries
- UML static class diagram (structure definitions)
- API document/test cases
- Top-level structure
- Data flow analysis
- Allocate functionality to modules
- Syntactic test cases
- Module expansion
  - Using programming concepts where possible
  - Incremental changes

Modules

- Grouping of predicates which are related
- Typically in a single file
- Defined external interfaces
  - Which predicates are exported
  - Mode declaration for arguments
  - Intended types for arguments
  - Documentation
- Helps avoid Spaghetti structure of program

Creating Documentation

- Your program can be documented in the same way as ECLiPSe library predicates
- Comment directives in source code
- Tools to extract comments and produce HTML documentation with hyper-links
- Quality depends on effort put into comments
- Every module interface should be documented

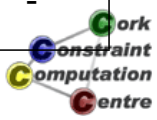
Example

```
:- comment(prepare_data/4,[
    summary:"creates the data structures
for the flow analysis",
    amode:prepare_data(+,+,+,-),
    args:[
"Dir":"directory for report output",
"Type":"the type of report to be generated",
"Summary":"a summary term",
"Nodes":"a nodes data structure"],
    desc:html("
This routine creates the data
structures for the flow analysis.
...
```


```
    see_also:[hop/3]
])
```


External Data Representation

Property	Argument	Data File	Term File	Facts	EXDR
Multiple runs	++	+	+	-	+
Debugging	-	+	+	++	-
Test generation effort	-	+	+	+	-
Java I/O Effort	-	+	-	-	+
ECLiPSe I/O Effort	++	+	++	++	++
Memory	++	-	-	–	-
Develoment Effort	+	-	+	+	-



Internal Data Representation

- Named structures
  - Define & document properly
- Lists
  - Do not use for fixed number of elements
- Hash tables, e.g. lib(hash)
  - Efficient
  - Extensible
  - Multiple keys possible
- Vectors & arrays
  - Requires that keys are integers (tuples)
- Multi-representation
  - Depending on key use one of multiple representations

Internal Representation Comparison

	Named Structures	Lists	Hash Tables	Vectors Arrays	Multi-representation
hold disparate data	++	–	–	–	–
access specific info	+	–	+	+	+
add new entries	–	+	++	–	–
do loops	+	++	-	++	++
sort entries	–	++	-	-	++
index calculations	-	–	–	++	+

Getting it to work

- Early testing `lib(test_util)`
  - Define what a piece of code should do by example
  - May help to define behaviour
- Stubs
- Line coverage `lib(coverage)`
  - Check that tests cover code base
- Heeding warnings of compiler, `lib(lint)`
  - Eliminate all causes of warnings
  - Singleton warnings typically hide more serious problems
- Small, incremental changes
  - Matter of style
  - Works for most people

Programming Concepts

- Many programming tasks are similar
  - Finding the right information
  - Putting things together in the right sequence
- We don't need the fastest program, but the easiest to maintain
  - Squeezing the last 10% improvement normally does not pay
- Avoid unnecessary inefficiency
  - `lib(profile)`, `lib(port_profiler)`

List of concepts

- Alternatives
- Iteration (list, terms, arrays)
- Transformation
- Filtering
- Combine
- Minimum/Best and rest
- Sum
- Merge
- Group
- Lookup
- Cartesian
- Ordered pairs

Example: Cartesian

```
:-mode cartesian(+,+,-).
cartesian(L,K,Res):-
        (foreach(X,L),
         fromto([],In,Out,Res),
         param(K) do
            (foreach(Y,K),
             fromto(In,In1,[pair(X,Y)|In1],Out),
             param(X) do
                true
            )
        ).
```

Input/Output

- Section on DCG use
  - Grammars for parsing and generating text formats
- XML parser in ECLiPSe
  - `lib(xml)`
- EXDR format to avoid quoting/escaping problems
- Tip:
  - Generate hyper-linked HTML/SVG output to present data/results as development aid

If it doesn't work

- Understand what happens
  - Which program point should be reached with which information?
  - Why do we not reach this point?
  - Which data is wrong/missing?
- Do not trace through program!
- Debugging is like solving puzzles
  - Pick up clues
  - Deduce what is going on
  - Do not simulate program behaviour!

Correctness and Performance

- Testing
- Profiling
- Code Reviews
  - Makes sure things are up to a certain standard
  - Don't expect reviewer to find bugs
- Things to watch out for
  - Unwanted choice points
  - Open streams
  - Modified global state
  - Delayed goals

Did I mention testing?

- Single most important/neglected activity
- Re-test directly after every change
  - Identifies faulty modification
  - Avoids lengthy debugging session after making 100s of changes
- Independent verification
  - Check results by hand (?)
  - By other program (??)
  - Use constraint solver as checker

Style Guide

- Rules that should be satisfied by finished program
- Things may be relaxed during prototyping
- Often, choice among valid alternatives is made arbitrarily, so that a consistent way is defined
- If you don't like it, change it!
  - But: better a bad rule than no rule at all!

Style Guide Examples

- There is one directory containing all code and its documentation (using sub-directories).
- Filenames are of form `[a-z][a-z_]+` with extension `.ecl`.
- One file per module, one module per file.
- Each module is documented with comment directives.
- ...
- Don't use `','/2` to make tuples.
- Don't use lists to make tuples.
- Avoid `append/3` where possible, use accumulators instead.

Layout rules

- How to format ECLiPSe programs
- Pretty-printer format
- Eases
  - Exchange of programs
  - Code reviews
  - Bug fixes
  - Avoids extra reformatting work

Core Predicates List

- Alphabetical predicate index lists 2940 entries
  - You can't possibly learn all of them
  - Do you really want to know what `set_typed_pool_constraints/3` does?
- List of Prolog predicates you need to know
  - 69 entries, more manageable
- Ignores all solver libraries
- If you don't know what an entry does, find out about it
  - what does `write_exdr/2` do?
- If you use something not on the list, start to wonder...

Other Sources

- Developing Applications with ECLiPSe
  - H. Simonis
  - `http://www.eclipse-clp.org`
- Constraint Logic Programming Using ECLiPSe
  - K. Apt, M. Wallace
  - Cambridge University Press
- The Craft of Prolog
  - R.O'Keefe, MIT Press

Conclusions

- Large scale applications can be built with ECLiPSe
- Software engineering is not that different for Prolog
- Many tasks are similar regardless of solver used
- Correctness of program is useful even for research work