A Query Language in Scheme

Mark Boady

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Overview

- Lambda Calculus - Review of Question 3.39 Posted to website.
- Query Languages - Review of Query Language from SICP
- Metacircular Evaluator - Lab Introduction
Query Languages

- Query Languages Present a different method of writing programs.
- For most languages
  - We give a set of instructions and ask they be executed
- For a query language
  - We give a set of information and ask a question
- Terminology
  - Database: Our set of known information
  - Query: A question we want answered
- Note: Similar but not exactly like Database Programming (SQL)
Example

- A data base in scheme (From SICP 4.4.1)
  - (job (Bitdiddle Ben) (computer wizard))
  - (job (Hacker Alyssa P) (computer programmer))
  - (job (Fect Cy D) (computer programmer))
  - (job (Tweakit Lem E) (computer technician))
  - (can-do-job (computer wizard) (computer programmer))

- A simple query
  - (job ?x (computer programmer))

- Find all the people who have the job computer programmer.
  - Fill in the blank ?x

;;; Query results:
(job (Hacker Alyssa P) (computer programmer))
(job (Fect Cy D) (computer programmer))
Queries

- To start the SICP Query Interpreter

  (load "ch4-query.scm")
  ;;This is with the Lab 3 files
  (initialize-data-base microshaft-data-base)
  (query-driver-loop)

- We can use multiple variables

  (job ?x ?y)

  - This would just list everyone’s job

- We can also repeat variables

  (supervisor ?x ?x)

  - This would give us all the people who are their own supervisor.
Partial Matches

- This will find any person whose job starts with the word computer
  
  (job ?x (computer . ?type))

- This will not find someone with the job (computer programmer trainee)
  
  (job ?x (computer ?type))
We can use “and” and “or” to make more complex queries

I want to know the address of all the computer programmers
(\text{and} (\text{job} \ ?\text{person} (\text{computer programmer}))
  (\text{address} \ ?\text{person} \ ?\text{where})))

I want to know all the people who have either Ben or Alyssa as their supervisor
(\text{or} (\text{supervisor} \ ?x (\text{Bitdiddle Ben}))
  (\text{supervisor} \ ?x (\text{Hacker Alyssa P})))
Compound Queries

- The not command can be used to negate a statement
- I want to know all the people supervised by Ben who are not computer programmers
  (and (supervisor ?x (Bitdiddle Ben))
   (not (job ?x (computer programmer))))
- lisp-value can be used if we need to compare values
- I want to know everyone who makes more than 30,000
  (and (salary ?person ?amount)
   (lisp-value > ?amount 30000))
Adding New Rules

- We can add new rules to the query data base
- Two people are the same
  \[\text{(rule (same ?x ?x))}\]
- Two people live near each other if they are from the same town but not the same person
  \[\text{(rule (lives-near ?person-1 ?person-2)}\]
  \[\text{(and (address ?person-1 (?town . ?rest-1)))}\]
  \[\text{(address ?person-2 (?town . ?rest-2))}\]
  \[\text{(not (same ?person-1 ?person-2))})\]
- Now we can ask who lives near Ben
  \[\text{(lives-near ?x (Bitdiddle Ben))}\]
Programming with Logic

- Note: The single quote after mydb will be broken in the pdf (smart-quotes)

(load "ch4-query.scm")
(define mydb '(
  (rule (append-to-form () ?y ?y))
  (rule (append-to-form (?u . ?v) ?y (?u . ?z))
    (append-to-form ?v ?y ?z))
))
(initialize-data-base mydb)
(query-driver-loop)
(append-to-form (a b) (c d) ?z)

- For this version of append, the return value is placed in ?z
- In most query languages, we need to give a variable to place the solution
What is the list generated by appending these two lists
(append-to-form (a b c) (d e f) ?z)

What is the list that append to make a specific final list
(append-to-form (a b) ?y (a b c d))

What are all the possible lists that merge to a target list
(append-to-form ?x ?y (a b c d))
MetaCircular Evaluator

- A Scheme Interpreter written in Scheme
- Why?
  - Teaching!
  - Extending the Language or Adding Syntax
  - Debuggers
- Jikes RVM
  - A Java Research Virtual Machine Written in Java
  - The RVM runs on top of the JVM
  - Used For Research in:
    - Garbage Collection
    - Dynamic Parallelization
    - Machine Learning for Dynamic Compilation
    - Dynamic Typing
Running the mcEval

Here is an example of how to load and run code

(load "ch4-mceval.scm")
(define the-global-environment (setup-environment))
(driver-loop)
(+ 4 5)

Primatives

- We want to reuse base functionality
  - car,cdr,cons, null?, +, -, =, *, etc

We want to reimplement higher order functions

- Anything that can be built from the primary functions
- We would need to rewrite reverse