SICP in Emacs

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I recently began reading the notorious “Structure and Interpretation of Computer Programs” [1], a.k.a. the *Wizard book*. I’m only on the first chapter, but I can already see its value and why it gets recommended so much.

From Wikipedia:

> Structure and Interpretation of Computer Programs (SICP) is a computer science textbook by Massachusetts Institute of Technology professors Harold Abelson and Gerald Jay Sussman with Julie Sussman. [...] It teaches fundamental principles of computer programming, including recursion, abstraction, modularity, and programming language design and implementation. [...] The book describes computer science concepts using Scheme, a dialect of Lisp. It also uses a virtual register machine and assembler to implement Lisp interpreters and compilers.

In this post, I aim to showcase my workflow for studying the book using Emacs [2]. Also, I will provide any resources that helped me get going. To study SICP, we need two things: The book and a Scheme implementation for the examples and exercises.

1 Getting the book

Lucky for us, the book is freely distributed from MIT itself. It is available in HTML and PDF. But, there is also a third format option and it is the one we're going to choose: the Texinfo format.

> Texinfo uses a single source file to produce output in a number of formats, both online and printed (HTML, PDF, DVI, Info, DocBook, LaTeX, EPUB 3). This means that instead of writing different documents for online information and another for a printed manual, you need write only one document. [...] The Texinfo system is well-integrated with GNU Emacs.[1]

That last sentence is what's important here. `info` files are essentially manuals in plain text. Emacs has a built-in mode for rendering such documents. By using the `info` format, we can read SICP from inside Emacs.

1.1 Obtaining the `info` file

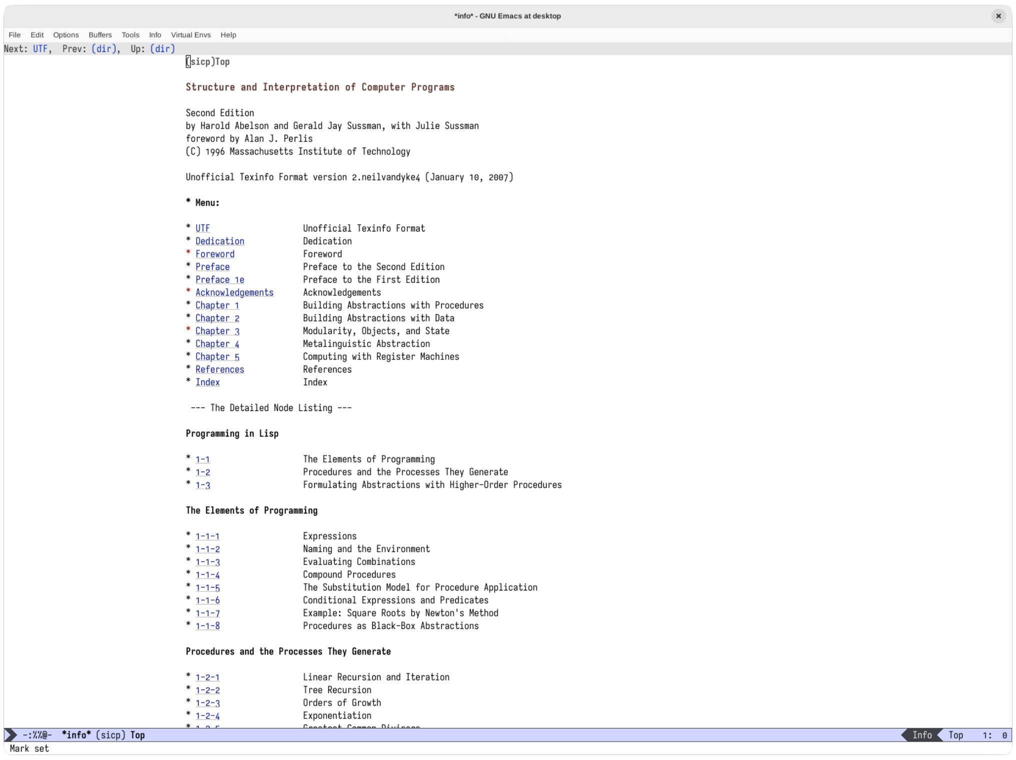
The `info` file can be retrieved in two methods:

1. By installing the `sicp` package[2]
2. By downloading the `info` file directly from neilvandyke.org and installing it.
   1. Download the `sicp.info.gz` file (link) in your home directory.
   2. Execute the following commands

```
$ sudo cp ~/sicp.info.gz /usr/local/share/info/
$ sudo chmod 644 /usr/local/share/info/sicp.info.gz
$ sudo install-info /usr/local/share/info/sicp.info.gz
↪ /usr/local/share/info/dir
```

Now SICP will be available through Emacs! To access it, you need to open Emacs, type `C-h i` to go to the `*info*` top directory, type `m` to search and type `sicp` to find the book. If everything went correctly, you should be greeted with something like this:

[1] From the official GNU site.
[2] Found in the MELPA repository.


info - GNU Emacs at desktop
File Edit Options Buffers Tools Info Virtual Envs Help

```
Next: UTF,  Prev: (dir),  Up: (dir)
(sicp)Top

Structure and Interpretation of Computer Programs

Second Edition
by Harold Abelson and Gerald Jay Sussman, with Julie Sussman
foreword by Alan J. Perlis
(C) 1996 Massachusetts Institute of Technology

Unofficial Texinfo Format version 2.neilvandyke4 (January 10, 2007)

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 --- The Detailed Node Listing ---

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The Elements of Programming

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Procedures and the Processes They Generate

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* 1-2-3                Orders of Growth
* 1-2-4                Exponentiation
-:%%@-  *info* (sicp) Top                                          Info  Top   1:  0
Mark set
```

Figure 1: SICP's table of contents in 'info' format, viewed from within Emacs

2 Setting up Scheme

SICP's examples and exercises are all implemented in Scheme. Scheme is a Lisp dialect with many implementations. ~~SICP uses the MIT-Scheme implementation~~ Turns out GNU/MIT-Scheme is **not** fully compatible with the code in SICP (source). Instead, we will use Racket. Racket offers the SICP collection, a Racket `#lang` that makes it fully compatible with the SICP code.

First, we need to install racket through our package manager. After that, the sicp collection can be downloaded like this:

```
$ raco pkg install sicp
```

That's it! Now, when we write a `.rkt` file that needs to be compatible with SICP all we need to do is add `#lang sicp` at the top of the file[3].

[3]when using the REPL, we need to first evaluate `(require sicp)` before evaluating anything else.

2.1 Racket in Emacs

Personally, I recommend racket-mode for working with Racket in Emacs. Another popular choice is geiser, but its `geiser-racket` module seems to be unmaintained[4].

To install `racket-mode` using elpaca, add the following to your config file:

```
(use-package racket-mode
  :elpaca t)
```

2.2 Racket in Org-Babel

In case you choose to go the literate programming route (as I have) using Org-Mode, you will need to enable support for racket in org-babel. To do this, use the emacs-ob-racket package. Add the following to your config:

```
(use-package ob-racket
  :elpaca (:type git :host github :repo "hasu/emacs-ob-racket"))
```

and then enable racket in your org-babel configuration.

```
(org-babel-do-load-languages
 'org-babel-load-languages
 '((emacs-lisp :tangle ./init.el . t)
   (C . t)
   (python . t)
   ...
   (racket . t)))
```

To be able to use the `sicp` package in org-babel code blocks, you need to add `:lang sicp` in the Org block, like so:

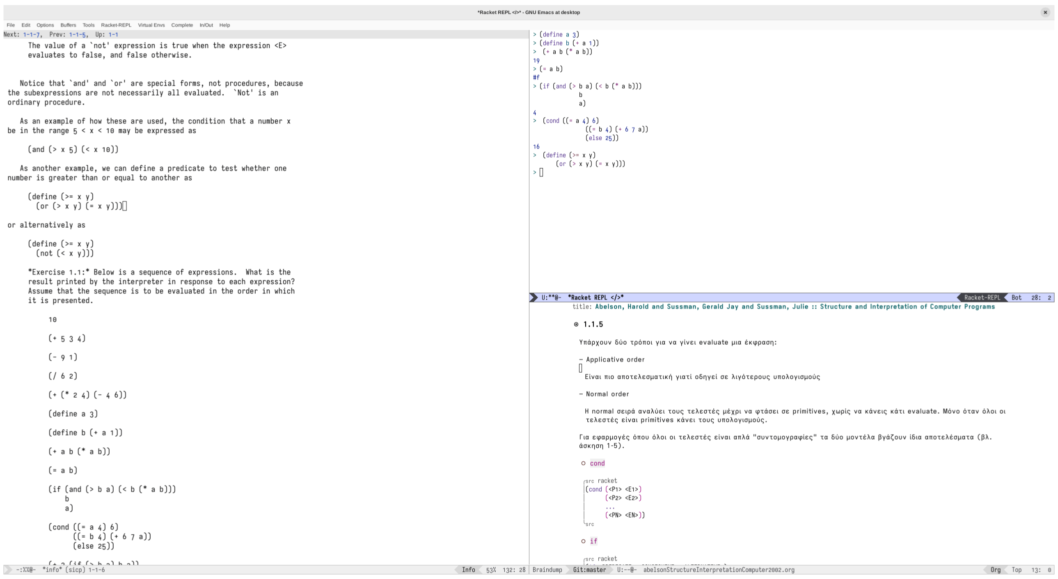
```
#+begin_src racket :lang sicp
"Hello World!"
#+end_src
```

Instead of adding that to every code block, you can add `#+property: header-args :lang sicp` to the start of your Org file. ~~This will be applied to *all* code blocks in the file, so make sure you include only racket code blocks~~ This can be mitigated by specifying that these header-args are to be applied only to racket blocks, like so: `#+property: header-args:racket :lang sicp`.

[4]According to this thread from the `geiser-users` mailing list.

3 Result

After all this work, now we can finally start reading SICP. My so-far workflow consists of the book in the left window, a racket REPL in the top-right corner and my Org-Roam notes in the bottom-right corner.


Racket REPL </> - GNU Emacs at desktop
File Edit Options Buffers Tools Racket-REPL Virtual Envs Complete In/Out Help

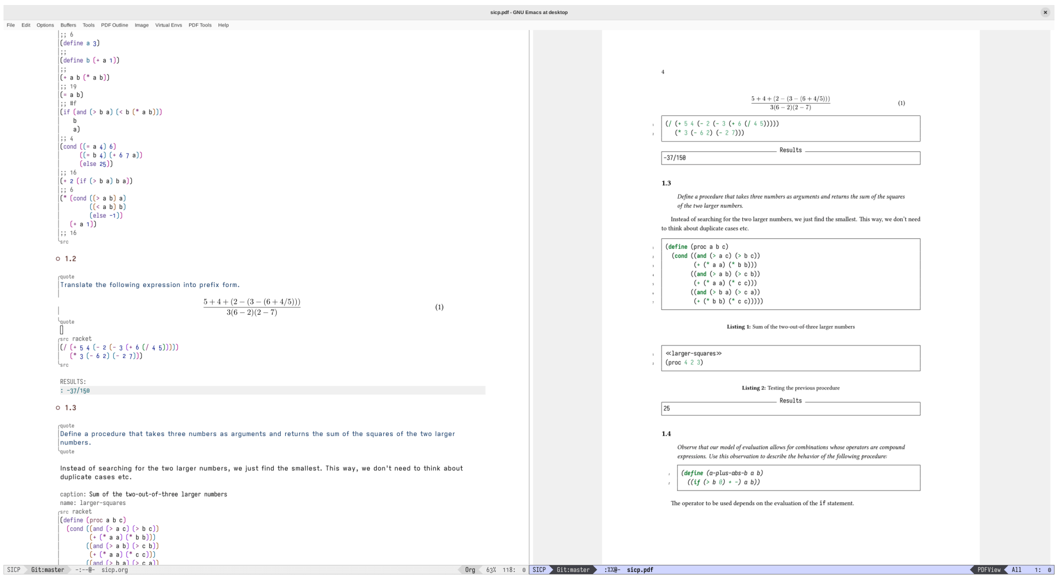
```
Next: 1-1-7,  Prev: 1-1-5,  Up: 1-1
     The value of a `not' expression is true when the expression <E>
     evaluates to false, and false otherwise.


   Notice that `and' and `or' are special forms, not procedures, because
 the subexpressions are not necessarily all evaluated.  `Not' is an
 ordinary procedure.

   As an example of how these are used, the condition that a number x
 be in the range 5 < x < 10 may be expressed as

     (and (> x 5) (< x 10))

   As another example, we can define a predicate to test whether one
 number is greater than or equal to another as

     (define (>= x y)
       (or (> x y) (= x y)))

 or alternatively as

     (define (>= x y)
       (not (< x y)))

     *Exercise 1.1:* Below is a sequence of expressions.  What is the
     result printed by the interpreter in response to each expression?
     Assume that the sequence is to be evaluated in the order in which
     it is presented.

          10

          (+ 5 3 4)

          (- 9 1)

          (/ 6 2)

          (+ (* 2 4) (- 4 6))

          (define a 3)

          (define b (+ a 1))

          (+ a b (* a b))

          (= a b)

          (if (and (> b a) (< b (* a b)))
              b
              a)

          (cond ((= a 4) 6)
                ((= b 4) (+ 6 7 a))
                (else 25))

 -:%%@-  *info* (sicp) 1-1-6                              Info  53%  132: 28
```

```
> (define a 3)
> (define b (+ a 1))
>  (+ a b (* a b))
19
> (= a b)
#f
> (if (and (> b a) (< b (* a b)))
             b
             a)
4
>  (cond ((= a 4) 6)
               ((= b 4) (+ 6 7 a))
               (else 25))
16
>  (define (>= x y)
       (or (> x y) (= x y)))
> 

 U:**@-  *Racket REPL </>*                              Racket-REPL  Bot  28:  2
```

```
         title: Abelson, Harold and Sussman, Gerald Jay and Sussman, Julie :: Structure and Interpretation of Computer Programs

         ⊙ 1.1.5

          Υπάρχουν δύο τρόποι για να γίνει evaluate μια έκφραση:

          - Applicative order

            Είναι πιο αποτελεσματική γιατί οδηγεί σε λιγότερους υπολογισμούς

          - Normal order

            Η normal σειρά αναλύει τους τελεστές μέχρι να φτάσει σε primitives, χωρίς να κάνεις κάτι evaluate. Μόνο όταν όλοι οι
            τελεστές είναι primitives κάνει τους υπολογισμούς.

          Για εφαρμογές όπου όλοι οι τελεστές είναι απλά "συντομογραφίες" τα δύο μοντέλα βγάζουν ίδια αποτελέσματα (βλ.
          άσκηση 1-5).

           ○ cond

            src racket
           (cond (<P1> <E1>)
                 (<P2> <E2>)
                 ...
                 (<PN> <EN>))
            src

           ○ if

            src racket

 Braindump  Git:master  U:--@-  abelsonStructureInterpretationComputer2002.org    Org  Top  13:  0
```

Figure 2: My SICP studying workflow

When it comes to the exercises, I use Org-Mode and Org-Babel to write the solutions in a literate programming style. The file is divided by chapter. Each exercise is included followed by its (hopefully correct) solution. (So far) I use a single `.org` file and export it to PDF. Also, all of the code blocks are exported to a `.rkt` file, with links to the corresponding position in the org file. All of these files can be found at this repo.


sicp.pdf - GNU Emacs at desktop
File Edit Options Buffers Tools PDF Outline Image Virtual Envs PDF Tools Help

```
;; 6
(define a 3)
;;
(define b (+ a 1))
;;
(+ a b (* a b))
;; 19
(= a b)
;; #f
(if (and (> b a) (< b (* a b)))
    b
    a)
;; 4
(cond ((= a 4) 6)
      ((= b 4) (+ 6 7 a))
      (else 25))
;; 16
(+ 2 (if (> b a) b a))
;; 6
(* (cond ((> a b) a)
         ((< a b) b)
         (else -1))
   (+ a 1))
;; 16
src

○ 1.2

quote
Translate the following expression into prefix form.
```

$$\frac{5+4+(2-(3-(6+4/5)))}{3(6-2)(2-7)} \qquad (1)$$

```
quote

src racket
(/ (+ 5 4 (- 2 (- 3 (+ 6 (/ 4 5)))))
   (* 3 (- 6 2) (- 2 7)))
src

RESULTS:
: -37/150

○ 1.3

quote
Define a procedure that takes three numbers as arguments and returns the sum of the squares of the two larger
numbers.
quote

Instead of searching for the two larger numbers, we just find the smallest. This way, we don't need to think about
duplicate cases etc.

caption: Sum of the two-out-of-three larger numbers
name: larger-squares
src racket
(define (proc a b c)
  (cond ((and (> a c) (> b c))
         (+ (* a a) (* b b)))
        ((and (> a b) (> c b))
         (+ (* a a) (* c c)))
        ((and (> b a) (> c a))
```

```
SICP  Git:master  -:--@-  sicp.org                Org  63%  118:  0
```

4

$$\frac{5+4+(2-(3-(6+4/5)))}{3(6-2)(2-7)} \qquad (1)$$

```
(/ (+ 5 4 (- 2 (- 3 (+ 6 (/ 4 5)))))
   (* 3 (- 6 2) (- 2 7)))
```

Results

```
-37/150
```

1.3

Define a procedure that takes three numbers as arguments and returns the sum of the squares of the two larger numbers.

Instead of searching for the two larger numbers, we just find the smallest. This way, we don't need to think about duplicate cases etc.

```
(define (proc a b c)
  (cond ((and (> a c) (> b c))
         (+ (* a a) (* b b)))
        ((and (> a b) (> c b))
         (+ (* a a) (* c c)))
        ((and (> b a) (> c a))
         (+ (* b b) (* c c)))))
```

Listing 1: Sum of the two-out-of-three larger numbers

```
<<larger-squares>>
(proc 4 2 3)
```

Listing 2: Testing the previous procedure

Results

```
25
```

1.4

Observe that our model of evaluation allows for combinations whose operators are compound expressions. Use this observation to describe the behavior of the following procedure:

```
(define (a-plus-abs-b a b)
  ((if (> b 0) + -) a b))
```

The operator to be used depends on the evaluation of the `if` statement.

```
SICP  Git:master  :%%@-  sicp.pdf                PDFView  All  1:  0
```

Figure 3: My SICP solutions in literate programming

4 Miscellaneous tips

- **Update 07/06/2023**: As u/jherrlin on Reddit pointed out, the fact that SICP is in text format gives us the ability to leverage Emacs' built-in bookmarks feature. When you arrive to the end of your study session, just type `C-x r m` and a bookmark will be placed on the current line. You can search your bookmarks with `C-x r b` or list them with `C-x r l`.

  My tip is to name the bookmark the same each time (e.g. `sicp`). That way, when you re-create it in a later position, the old bookmark is discarded automatically. Also, if you run Emacs in daemon mode, I suggest to run `M-x bookmark-save` after adding a bookmark, to make sure it has been saved.

References

[1] H. Abelson, G. J. Sussman, and J. Sussman, *Structure and Interpretation of Computer Programs* (Electrical Engineering and Computer Science Series), 2. ed., 7. [pr.] Cambridge, Mass.: MIT Press [u.a.], 2002, 657 pp., ISBN: 978-0-07-000484-9.

[2] R. M. Stallman, "EMACS the extensible, customizable self-documenting display editor," *ACM SIGPLAN Notices*, vol. 16, no. 6, pp. 147–156, Jun. 1981, ISSN: 0362-1340, 1558-1160. DOI: 10.1145/872730.806466. [Online]. Available: https://dl.acm.org/doi/10.1145/872730.806466.