

Exercise 4.48.

Extend the grammar given above to handle more complex sentences. For example, you could extend noun phrases and verb phrases to include adjectives and adverbs, or you could handle compound sentences.¹

Answer.

We can extend noun phrases to include adjectives:

```
(define adjectives '(adj old little lovely capacious))
```

and define a adjective noun phrase (e.g., “a little cat”) to be a adjective followed by a noun:

```
(define (parse-adjective-noun-phrase)
  (list 'adj
        (parse-word adjectives)
        (parse-word nouns)))
```

Now we can define a sentence to be a complex noun phrase followed by a verb phrase, where a complex noun phrase can be either a adjective noun phrase or a adjective noun phrase extended by a prepositional phrase:

```
(define (parse-sentence)
  (list 'sentence
        (parse-complex-noun-phrase)
        (parse-verb-phrase)))

(define (parse-complex-noun-phrase)
  (define (maybe-extend complex-noun-phrase)
    (amb complex-noun-phrase
          (maybe-extend (list 'complex-noun-phrase
                                complex-noun-phrase
                                (parse-prepositional-phrase))))))
  (maybe-extend (parse-noun-phrase)))

(define (parse-noun-phrase)
  (list 'noun-phrase
        (parse-word articles)
        (parse-adjective-noun-phrase)))

(define (parse-adjective-noun-phrase)
  (list 'adj-noun-phrase
        (parse-word adjectives)
        (parse-word nouns)))
```

We can now try the new parser and verify that it works for our simple test sentence:

```
;;; Amb-Eval input:
(parse '(the lovely cat eats))

;;; Starting a new problem
;;; Amb-Eval value:
(sentence
```

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1. This kind of grammar can become arbitrarily complex, but it is only a toy as far as real language understanding is concerned. Real natural-language understanding by computer requires an elaborate mixture of syntactic analysis and interpretation of meaning. On the other hand, even toy parsers can be useful in supporting flexible command languages for programs such as information-retrieval systems. Winston 1992 discusses computational approaches to real language understanding and also the applications of simple grammars to command languages.

```
(noun-phrase (article the)
              (adj-noun-phrase (adj lovely) (noun cat)))
(verb eats))
```