Defining Your Own Functions in Common Lisp

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   For example, if one argument value is an integer and the other a floating-point number, the returned result will be a floating-point number. But if both argument values are integers, then the result will be an integer.

   If either argument value isn't a number, a type-mismatch error will be reported ***when the call*** (+ n x) ***is executed***.

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   In Java, the only characters that are allowed in the names of variables / parameters, and functions are letters, digits, _, and $. But Lisp also allows many other characters, including + - * / % ^ ! ? > < = [ ] { }.

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- The call (f 3 4) returns the ***integer*** 7, as the values of the parameters n and x are integers.

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For any integer $k \geq 0$, a new Common Lisp function that takes k arguments can be defined as follows:

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The QUOTE Special Operator

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- Evaluation of **(F X)** passes the *value of the variable denoted by* **X** as argument to a call of F.

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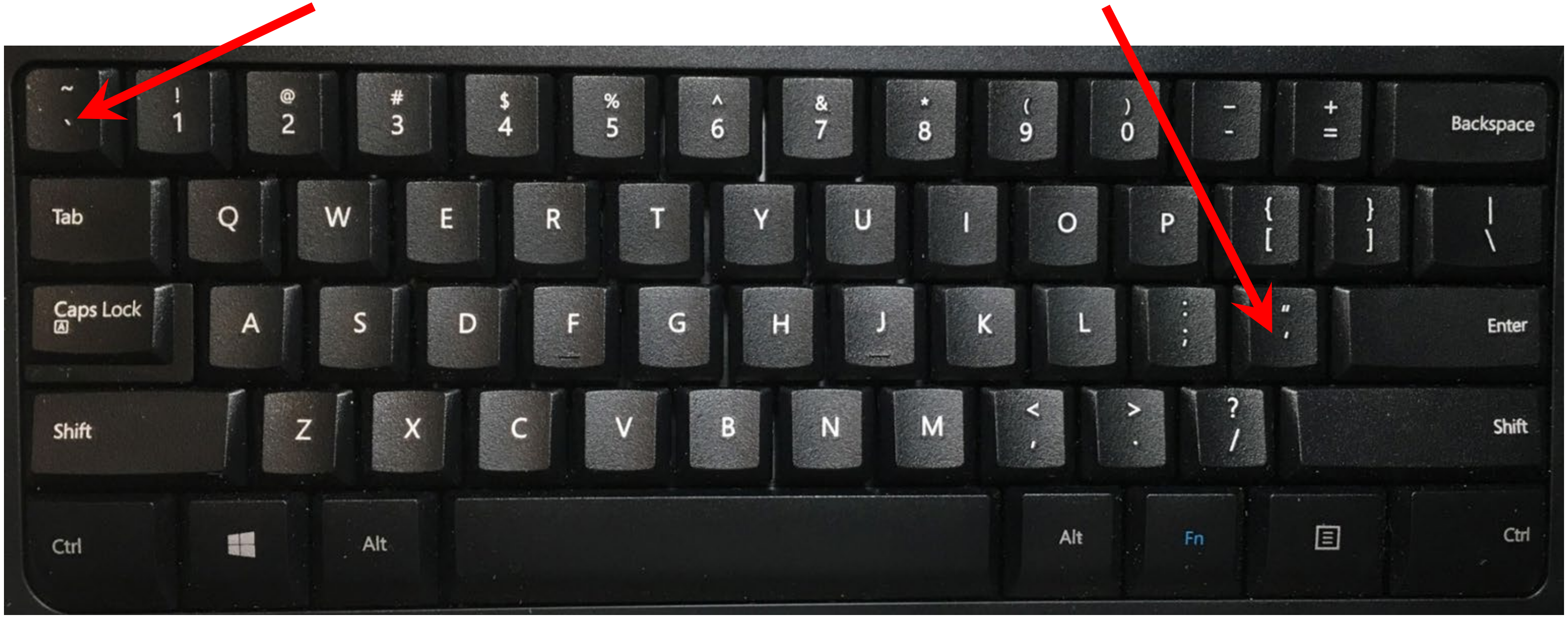
~ ` ! 1 @ 2 # 3 $ 4 % 5 ^ 6 & 7 * 8 (9) 0 _ - + = Backspace
Tab Q W E R T Y U I O P { [}] | \
Caps Lock A S D F G H J K L : ; " ' Enter
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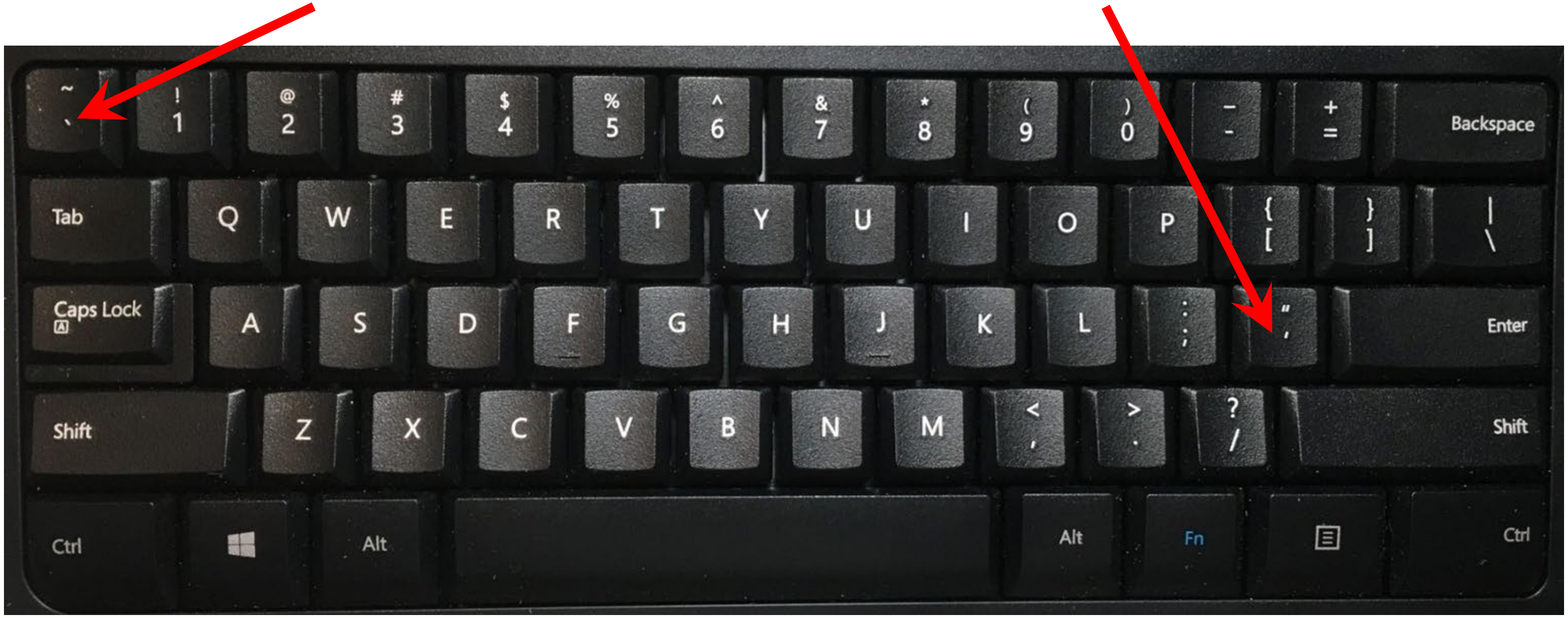

- ` can do things ' can't. It's useful for writing macros, but you won't need to use ` in this course.

Built-in
Common Lisp Functions
for Taking Lists Apart:
CAR/FIRST and CDR/REST

Notation: For S-expressions e and e', we write $e \Rightarrow e'$ to mean that e evaluates to e'.

Examples:

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Examples: `(+ 4 5) ⇒`   `(SQRT (+ 4 5.0)) ⇒`

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  (**CAR** *e*) ⇒ the *first* element of that list L.

Examples:
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(CAR '(DOG CAT (AT (3 +)))) ⇒ DOG
(CAR '(DOG)) ⇒ DOG
(CAR '((AT (3 +)) DOG CAT)) ⇒ (AT (3 +))
```

- If *e* ⇒ a nonempty list L, then:
  (**CDR** *e*) ⇒ the list obtained from L
  by *omitting* its first element.

Examples:

Notation: For S-expressions *e* and *e'*, we write

e ⇒ *e'* to mean that *e* evaluates to *e'*.

Examples: (+ 4 5) ⇒ **9** (SQRT (+ 4 5.0)) ⇒ **3.0**

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(CDR '(DOG)) ⇒
(CDR '((AT (3 +)) DOG CAT)) ⇒
(CDR (CAR '((A B C) D E))) ⇒
(CAR (CDR '((A B C) D E))) ⇒
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(CDR '((AT (3 +)) DOG CAT)) ⇒
(CDR (CAR '((A B C) D E))) ⇒
(CAR (CDR '((A B C) D E))) ⇒
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Examples:
```
(CDR '(DOG CAT (AT (3 +)))) ⇒ (CAT (AT (3 +)))
(CDR '(DOG)) ⇒ NIL
(CDR '((AT (3 +)) DOG CAT)) ⇒
(CDR (CAR '((A B C) D E))) ⇒
(CAR (CDR '((A B C) D E))) ⇒
```

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(CAR (CDR '((A B C) D E))) ⇒
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Examples: (+ 4 5) ⇒ **9** (SQRT (+ 4 5.0)) ⇒ **3.0**
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(CDR '((AT (3 +)) DOG CAT)) ⇒ (DOG CAT)
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- (CAR NIL) ⇒ NIL and (CDR NIL) ⇒ NIL.
  This is illogical, but sometimes convenient!
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- If *e* ⇒ an atom other than NIL, then evaluation of (CAR *e*) or (CDR *e*) will produce an ***error***!

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  E.g.: We get an ***error*** if (CAR (+ 3 4)), (CDR (+ 3 4)), (CAR (CAR '(A B))), or (CDR (CAR '(A B))) is evaluated!

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  Example: (CDR '(DOG CAT (AT (3 +)))) ⇒ (CAT (AT (3 +)))
- (CAR NIL) ⇒ NIL and (CDR NIL) ⇒ NIL.
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What happens if (CDR '(+ 3 4)) is evaluated?

A. (CAR '(+ 3 4)) ⇒ + (CDR '(+ 3 4)) ⇒ (3 4)

- If *e* ⇒ a nonempty list L, then:
  (CAR *e*) ⇒ the ***first*** element of that list L.

- If *e* ⇒ a nonempty list L, then:
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Alternative Names for CAR and CDR

- **FIRST** is another name for **CAR** in Common Lisp.
- **REST** is another name for **CDR** in Common Lisp.

- If *e* ⇒ a nonempty list L, then:
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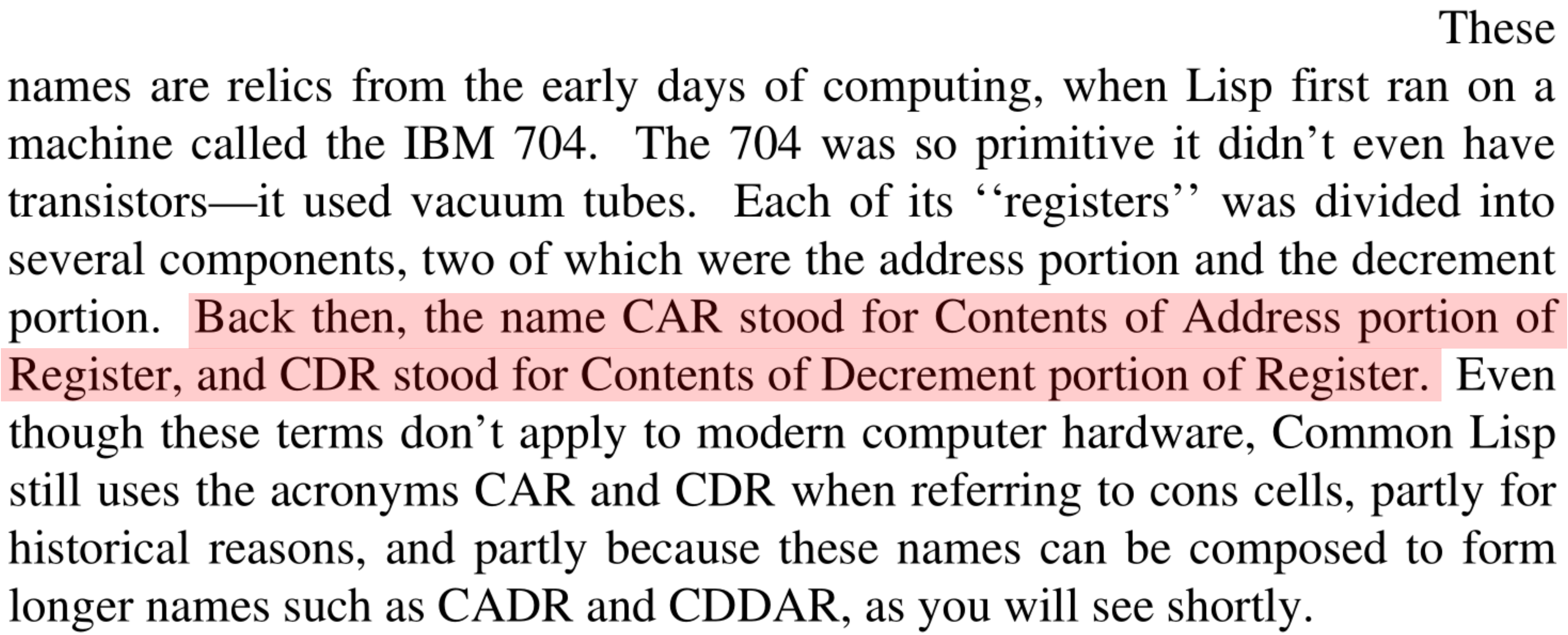
Alternative Names for CAR and CDR

- **FIRST** is another name for **CAR** in Common Lisp.
- **REST** is another name for **CDR** in Common Lisp.

Thus: (FIRST *e*) = (CAR *e*)   (REST *e*) = (CDR *e*)

The names FIRST and REST have the advantage of being descriptive, but "CAR" and "CDR" provide the basis for the C…R function names we will consider later.

The following remarks regarding the origin of the names **CAR** and **CDR** are from pp. 42 – 3 of Touretzky:



These names are relics from the early days of computing, when Lisp first ran on a machine called the IBM 704. The 704 was so primitive it didn't even have transistors—it used vacuum tubes. Each of its ''registers'' was divided into several components, two of which were the address portion and the decrement portion. Back then, the name CAR stood for Contents of Address portion of Register, and CDR stood for Contents of Decrement portion of Register. Even though these terms don't apply to modern computer hardware, Common Lisp still uses the acronyms CAR and CDR when referring to cons cells, partly for historical reasons, and partly because these names can be composed to form longer names such as CADR and CDDAR, as you will see shortly.