UMass Boston Computer Science

CS450 High Level Languages (section 2)

Compound Data Definitions

Monday, September 23, 2024

Logistics

- HW 2 in
  - ~~due: Mon 9/23 12pm (noon) EST~~
  - Files should not start `big-bang` loop automatically!
- HW 3 out
  - due: Mon 9/30 12pm noon EST
  - Add key handler

STYLE notes: Overcommenting

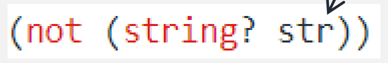
"The proper use of comments is to compensate for our failure to express ourself in code. Note that I used the word failure. I meant it. **Comments are always failures**."
– **Robert C. Martin,** Clean Code: A Handbook of Agile Software Craftsmanship

"Redundant comments are just places to collect lies and misinformation."
– **Robert C. Martin,** Clean Code: A Handbook of Agile Software Craftsmanship

"Don't Use a Comment When You Can Use a Function or a Variable"
– **Robert C. Martin,** Clean Code: A Handbook of Agile Software Craftsmanship

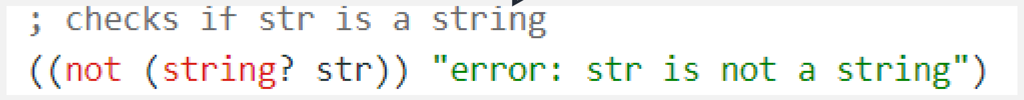
- Use comments to explain code if needed, BUT …
  - … the best code needs no comments
- Redundant comments makes code harder to read
  - More comments ≠ "better"
- (Also, don't submit commented-out code!)

(not a great variable name)



```
(not (string? str))
```

Terrible comment



```
; checks if str is a string
((not (string? str)) "error: str is not a string")
```

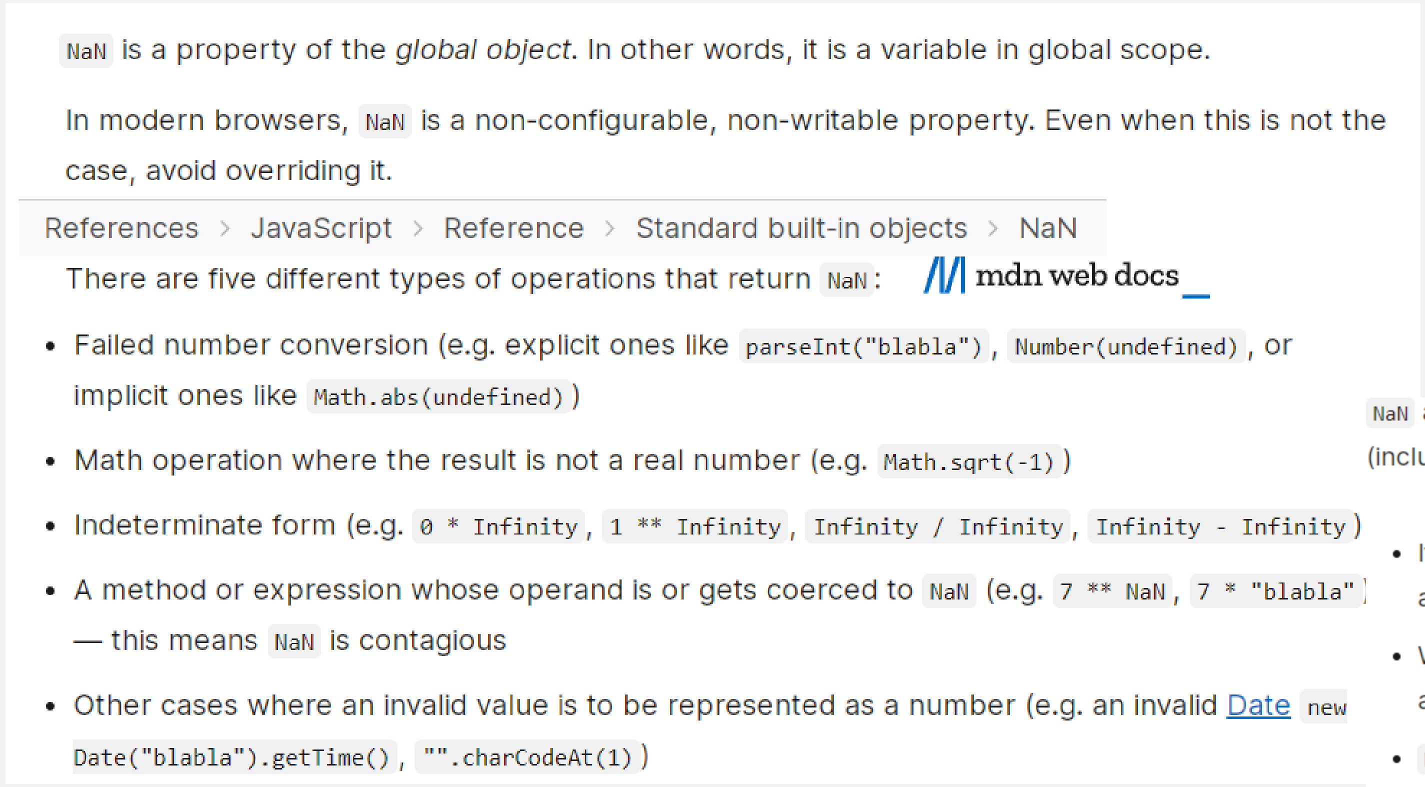
Last Time

Kinds of Data Definitions

- Basic data
  - E.g., **numbers, strings,** etc
- Intervals
  - Data that is from a **range of values,** e.g., [0, 100)
- Enumerations
  - Data that is **one of a list of possible values**, e.g., “green”, “red”, “yellow”
- Itemizations
  - Data value that can be from a **list of possible other data definitions**
  - E.g., **either** a **string** or **number** (Generalizes enumerations)

Itemization Caveats

```
;; A MaybeInt is one of:
(define NaN "Not a Number")
;; or, Integer
;; Interp: represents a number with a possible error case
```



`NaN` is a property of the *global object*. In other words, it is a variable in global scope.

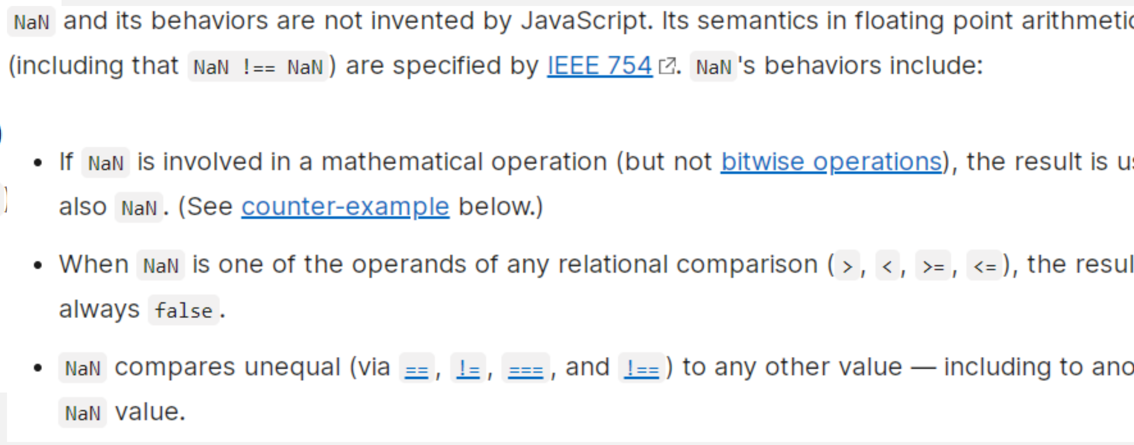
In modern browsers, `NaN` is a non-configurable, non-writable property. Even when this is not the case, avoid overriding it.

References › JavaScript › Reference › Standard built-in objects › NaN

mdn web docs

There are five different types of operations that return `NaN`:

- Failed number conversion (e.g. explicit ones like `parseInt("blabla")`, `Number(undefined)`, or implicit ones like `Math.abs(undefined)`)
- Math operation where the result is not a real number (e.g. `Math.sqrt(-1)`)
- Indeterminate form (e.g. `0 * Infinity`, `1 ** Infinity`, `Infinity / Infinity`, `Infinity - Infinity`)
- A method or expression whose operand is or gets coerced to `NaN` (e.g. `7 ** NaN`, `7 * "blabla"`) — this means `NaN` is contagious
- Other cases where an invalid value is to be represented as a number (e.g. an invalid Date `new Date("blabla").getTime()`, `"".charCodeAt(1)`)



`NaN` and its behaviors are not invented by JavaScript. Its semantics in floating point arithmetic (including that `NaN !== NaN`) are specified by IEEE 754. `NaN`'s behaviors include:

- If `NaN` is involved in a mathematical operation (but not bitwise operations), the result is u also `NaN`. (See counter-example below.)
- When `NaN` is one of the operands of any relational comparison (`>`, `<`, `>=`, `<=`), the resul always `false`.
- `NaN` compares unequal (via `==`, `!=`, `===`, and `!==`) to any other value — including to ano `NaN` value.

Itemization Caveats

OR **modify the data def!**
More common cases should go first!

```
;; A MaybeInt is one of:
(define NaN "Not a Number")
;; or, Integer
;; Interp: represents a number with a possible error case
```

```
(define (NaN? x)
  (string=? x "Not a Number"))
```

```
;; better predicate for MaybeInt
(define (MaybeInt? x)
  (or (integer? x)
      (and (string? x) (NaN? x))))
```

```
;; WRONG predicate for MaybeInt
#;(define (MaybeInt? x)
  (or (NaN? x)
      (integer? x)))
```

```
> (MaybeInt? 1)
string=?: contract violation
expected: string?
given: 1
```

```
;; OK predicate for MaybeInt
(define (MaybeInt? x)
  (or (and (string? x) (NaN? x))
      (integer? x)))
```

```
; WRONG TEMPLATE for MaybeInt
#;(define (maybeint-fn x)
  (cond
    [(NaN? x) ....]
    [(integer? x) ....]))
```

```
; OK TEMPLATE for MaybeInt
(define (maybeint-fn x)
  (cond
    [(string? x) ....]
    [(integer? x) ....]))
```

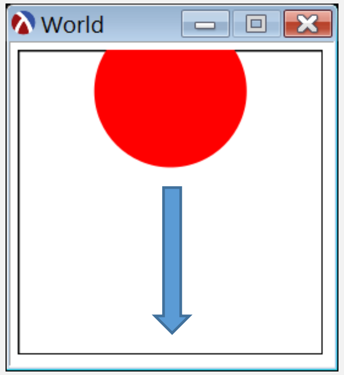
```
;; better TEMPLATE
(define (maybeint-fn x)
  (cond
    [(integer? x) ....]
    [else ....]))
```

Inside the function, **we only need to distinguish between valid input cases**

Last Time

Falling Ball Example

```
;; A WorldState is a Non-negative Integer
;; Interp: Represents the y Coordinate of the center of a
;;         ball in a `big-bang` animation.
```



What if the **ball can also move side-to-side?**

`WorldState` would need <u>two</u> pieces of data: the `x` *and* `y` coordinates

```
;; A WorldState is an Integer ...
;; ... and another Integer???
```

We need a way to create **compound data** i.e., **a new data definition that <u>combines</u> values from other data defs**

Last Time

Kinds of Data Definitions

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- Itemizations
  - Data value that can be from a **list of possible other data definitions**
  - E.g., either a string or number (Generalizes enumerations)
- Compound Data
  - Data that is a **combination of values from other data definitions**

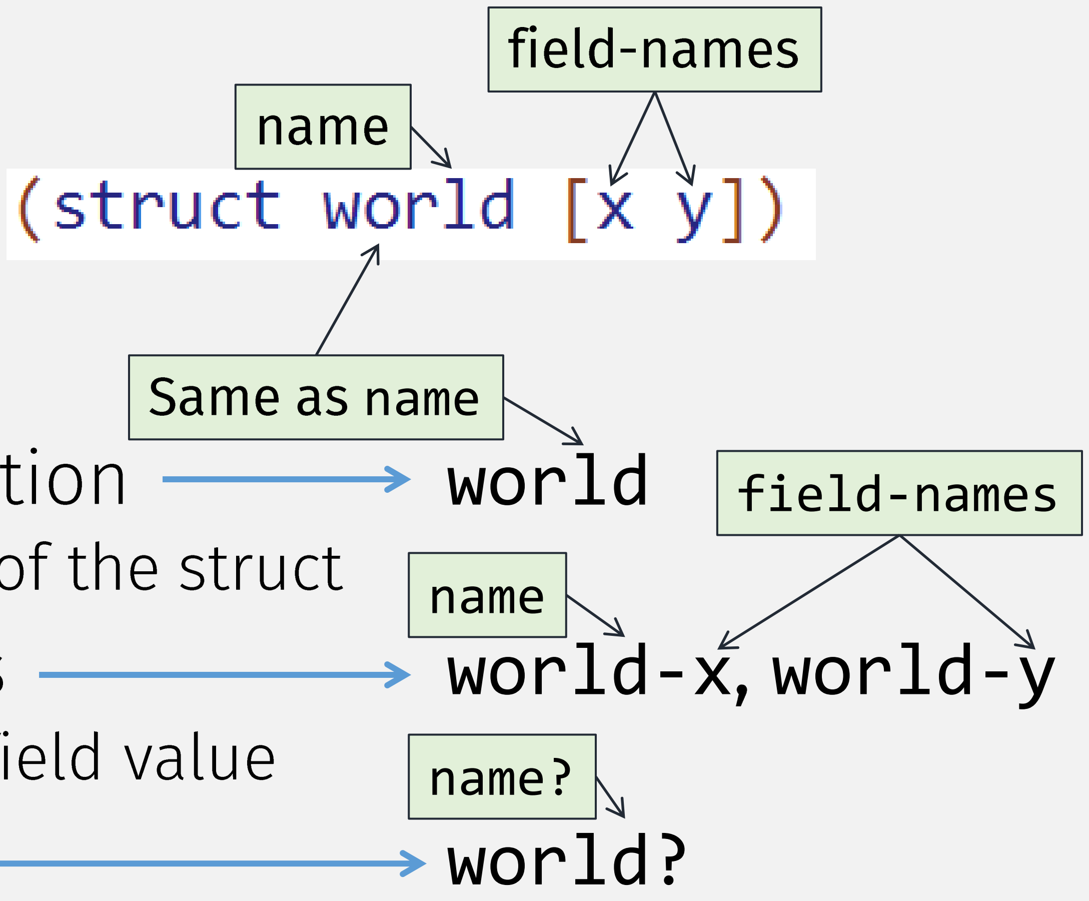
today

Falling Ball Example

a struct definition enables creating a new kind of **compound data**

```
;; A WorldState is a (make-world [x : Int] [y : Int]):
;; where
;; - x is ball center x coordinate in animation
;; - y is ball center y coordinate
(struct world [x y])
(define/contract (make-world x y)
  (-> integer? integer?)
  (world x y))
;; ...
```

Parts of a **`struct`** definition



```
(struct world [x y])
```

(Implicitly) defines:

- A **constructor** function → `world`
  - Creates instances of the struct
- **Accessor** functions → `world-x`, `world-y`
  - Get an instance's field value
- A **predicate** → `world?`
  - Returns true for struct instances

Falling Ball Example

```
;; A WorldState is a (make-world [x : Int] [y : Int]):
;; where
;; - x is ball center x coordinate in animation
;; - y is ball center y coordinate
(struct world [x y])
(define/contract (make-world x y)
  (-> integer? integer?)
  (world x y)
;; ...
```

a struct definition enables creating a new kind of **compound data**

Checked constructor

Unchecked constructor

```
(define INIT-WORLDSTATE (make-world 0 0))
```

Instances of the struct are values of that kind of data

Last Time

Function Design Recipe

1. **Name**

2. **Signature** – types of the function input(s) and output

3. **Description** – explain (in English prose) the function behavior

4. **Examples** – show (using `rackunit`) the function behavior

5. **Code** – implement the rest of the function (arithmetic)

6. **Tests** – check (using `rackunit`) the function behavior

Last Time

Function Design Recipe

1. **Name**

2. **Signature** – types of the function input(s) and output

3. **Description** – explain (in English prose) the function behavior

4. **Examples** – show (using `rackunit`) the function behavior

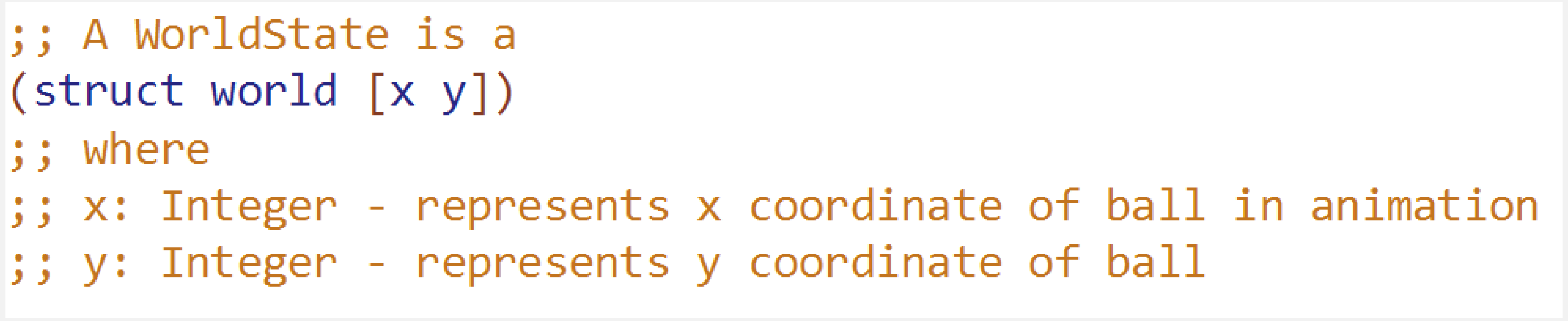
5. **Template** – sketch out the function structure (using input's Data Definition)

6. **Code** – implement the rest of the function (arithmetic)

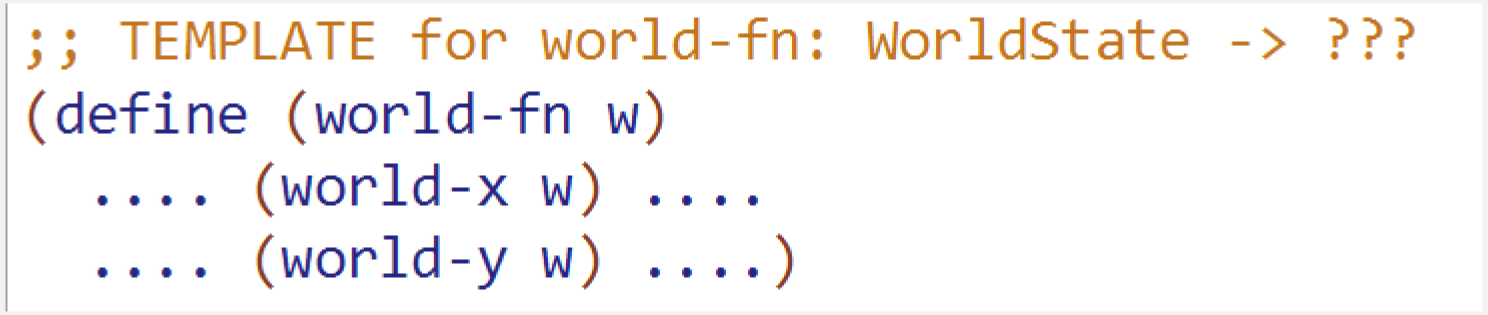
7. **Tests** – check (using `rackunit`) the function behavior

Template for Compound data

- A **function that consumes compound data** must
  - **<u>extract</u> the individual pieces,** using accessors
  - **<u>combine</u> them,** with arithmetic



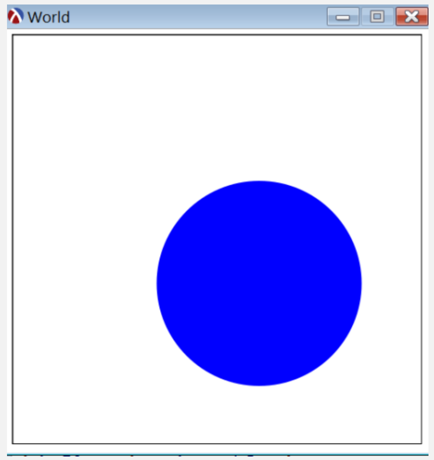
```
;; A WorldState is a
(struct world [x y])
;; where
;; x: Integer - represents x coordinate of ball in animation
;; y: Integer - represents y coordinate of ball
```



```
;; TEMPLATE for world-fn: WorldState -> ???
(define (world-fn w)
  .... (world-x w) ....
  .... (world-y w) ....)
```

In-class exercise: more **`big-bang`** practice

- Create a `big-bang` program with a "ball"
- Design `WorldState` so it can move in both x and y directions
- Add mouse handler that sets ball location to mouse location
  - (No `on-tick` fn needed)



Submitting

1. File: `in-class-09-23-<Lastname>-<Firstname>.rkt`
2. Join the in-class team: `cs450f24/teams/in-class`
3. Commit to repo: `cs450f24/in-class-09-23`
   - (May need to `merge/pull + rebase` if someone `push`es before you)