

JavaScript: Introduction, Types

Computer Science and Engineering ■ College of Engineering ■ The Ohio State University

Lecture 22

History

- ❑ Developed by Netscape
 - “LiveScript”, then renamed JavaScript
 - *Nothing* to do with Java!
- ❑ Motivation: client-side execution in browser
 - Interpreted
- ❑ Standardized by ECMA (“ECMAScript”)
 - Big update v6 in 2015, ie ES6 (aka ES2015)
 - Now annual updates, every June
 - After ES6, named with year (eg ES2024)
- ❑ Has become popular outside of browsers
 - Node.js
- ❑ Translation target for other languages:
 - Syntax: CoffeeScript
 - Static types: Dart (Google), TypeScript (MS)

Client-Side Execution: Request/Response

```
GET /news/index.php HTTP/1.1  
Host: www.osu.edu  
User-Agent: Mozilla/5.0 (X11; Ubuntu;...etc
```



Request



```
<!DOCTYPE html>  
<html lang="en">  
  <head><title>My Page</title>  
  <meta charset="utf-8" />  
  ...
```

Client-Side Execution: HTML Response

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <title>Something Short and Sweet</title>
    <meta charset="utf-8" />
  </head>
  <body>
    <p>
      Hello <a href="planet.html">World</a>!
    <br />
    
    </p>
  </body>
</html>
```



Client-Side Execution: Code in Response

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <title>Something Short and Sweet</title>
    <meta charset="utf-8" />
    <script>
      window.alert("Annoying!");
    </script>
  </head>
  <body>
    <p>
      Hello <a href="planet.html">World</a>!
      <br />
      
    </p>
  </body>
</html>
```



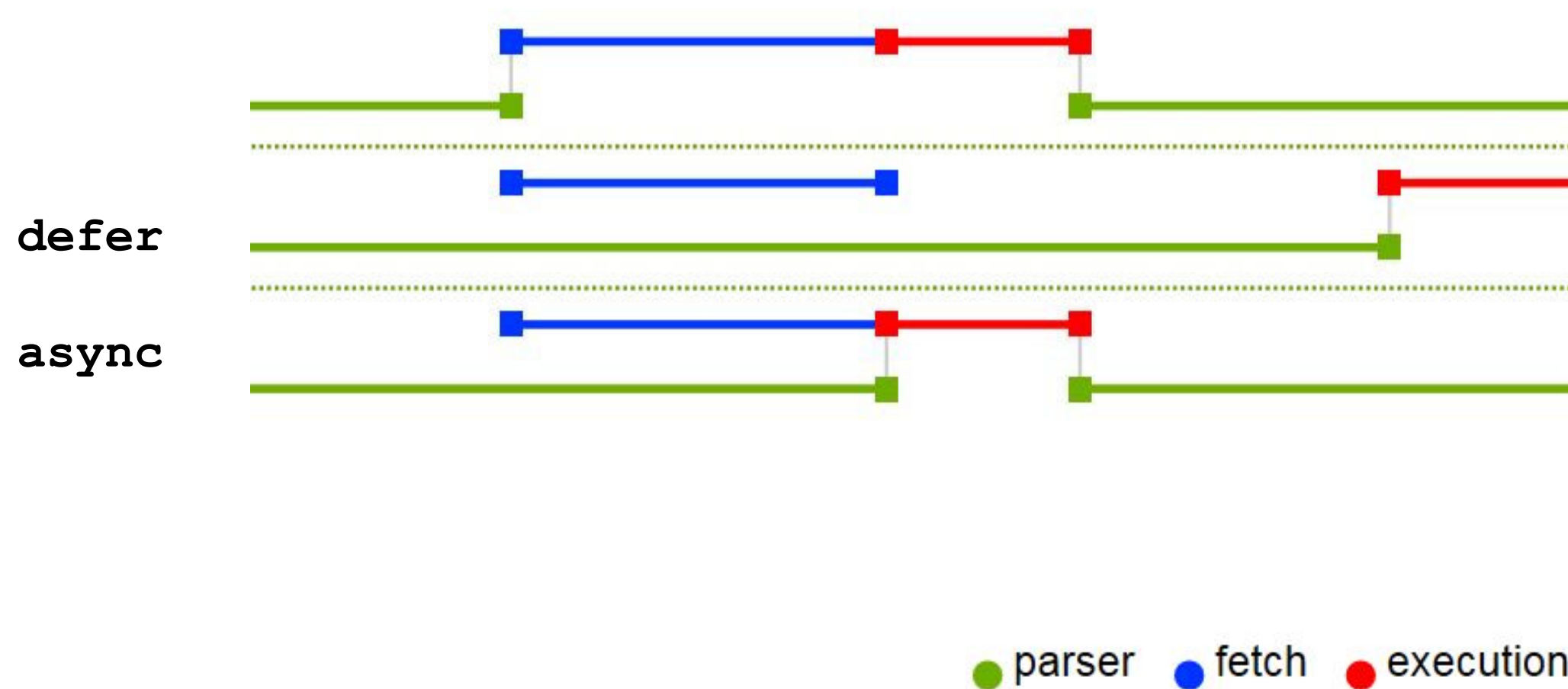
Including Scripts

- Head: executed *before* body displays
 - Script (source) can be explicitly included

```
<script>  
    console.info("hi");  
    ...  
</script>
```
 - Script can be linked in from external file

```
<script src="MyProgram.js"></script>
```
 - Recall: linking to CSS
- Inline: executed as body is displayed
- Browser blocks while downloading
 - Common advice: put scripts at *end of body*
 - Modern advice: use `<script src="..." async>`

Async/defer Downloading



Some Objects Provided Implicitly

- ❑ Some objects are created implicitly by the execution environment (browser)
- ❑ Document object (`document`)
 - `document.writeln()` puts output in body
- ❑ Window object (`window`)
 - Refers to browser's display window
 - Alert method pops up a dialogue
`window.alert("Say \"cheese\"!\");`
 - Prompt method pops up a dialogue
`name = window.prompt("Enter name");`

Demo with Popups

- ❑ See: codepen.io/cse3901/pen/BYqqPb
 - Alert window
 - Prompt window
 - Console output (info, warn, error)
- ❑ Notice:
 - HTML body is empty
 - Settings > Auto-update preview (Off)

Familiar (Java) Minor Syntax

- Statement separator `;`
 - Wrinkle: `;`'s are optional!
 - Implicitly automatically inserted
 - But clearer and safer to include explicitly
- Statement blocks `{...}`
- Parentheses in expressions `(...)`
- Comments `//` and `/*...*/`

Familiar (Java) Operators

□ Arithmetic (numbers are floats)

- + - * / %

- Wrinkles:

 - No diff in / between ints and floats!

 - % works on floats!

□ Relational

- < > <= >=

- == !=

- Wrinkle: === !==

□ Logical

- && || !

Familiar (Java) Statements

□ Assignment

- `=`
- `+= -= *= /= %=`
- `++ --` (pre and post)

□ Conditionals

- `if (...), if (...) ... else`
- `switch (c)`
 `case 'a': ... case 'b': ... default;`

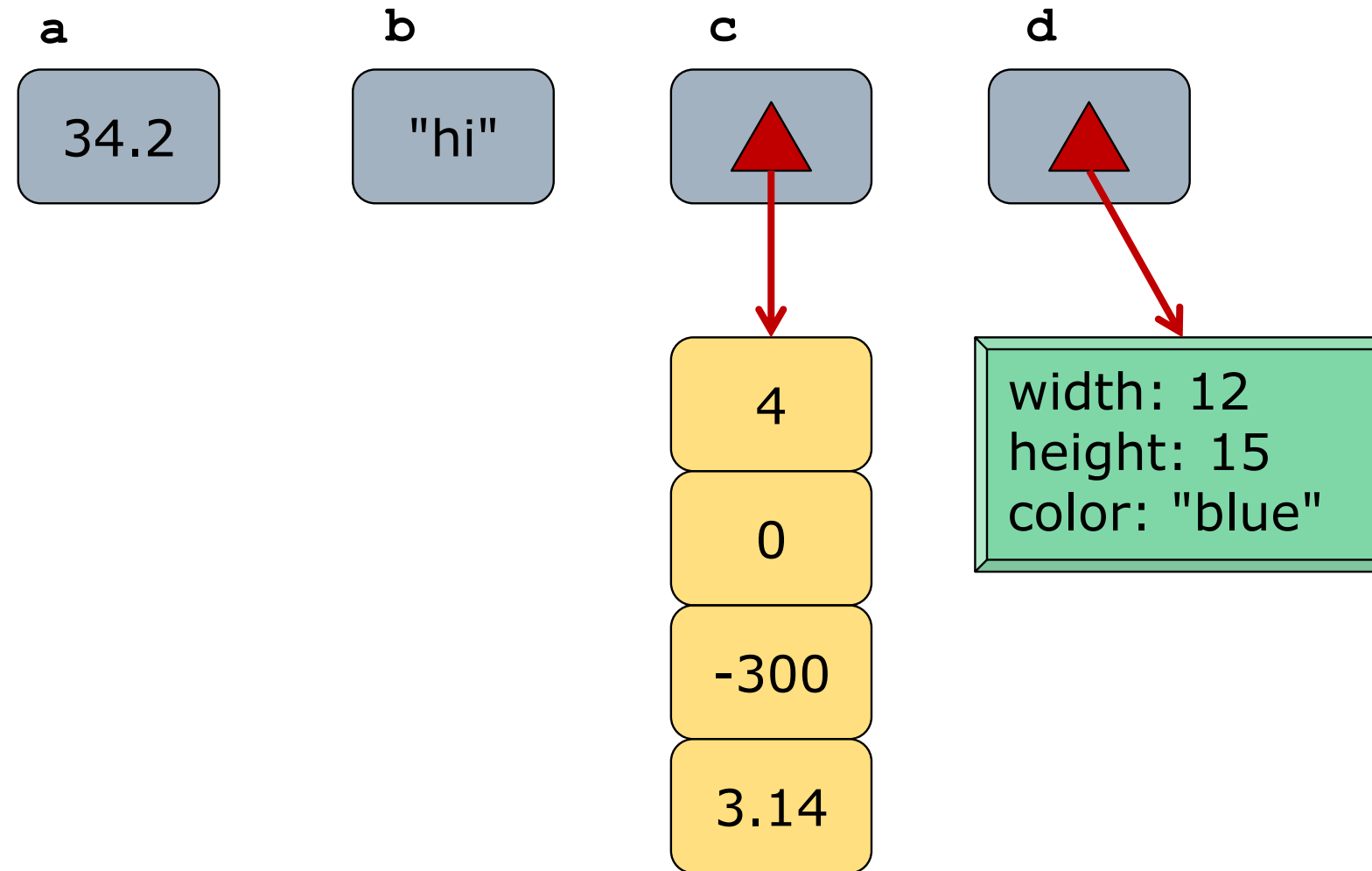
□ Iteration

- `while (...), do...while(...)`
- `for (...;...;...)`
- `break, continue`

Primitive vs Reference Types

- Distinction is similar to Java
- A variable is a “slot” in memory
- A variable can be *primitive*
 - The slot holds the value itself
 - Boolean, number, **string**, null, undefined
 - Since ECMAScript 2015 (ES6): symbols
- A variable can be a *reference*
 - The slot holds a pointer to the value
 - Arrays and objects (including functions!)

Primitive vs Reference Types: Picture



Primitives: Checking Equality

```
let a = 5;
```

```
let b = 5;
```

```
let c = 7;
```

```
if (a == b) ... //=> true, equal slots
```

```
if (a == c) ... //=> false
```

```
let x = "hello";
```

```
let y = "hello";
```

```
if (x == y) ... //=> true! cf. Java
```

Primitives: Assignment is Copy

```
let a = 5;
```

```
let b = a; // copy contents of slot
```

```
b++;
```

```
if (a == 5) ... // => true, a unchanged
```

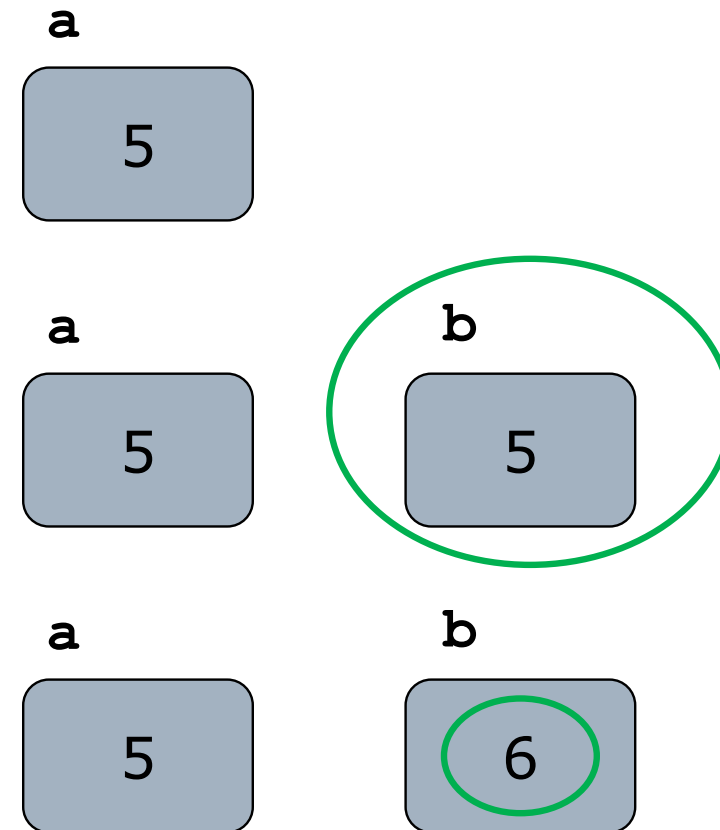

Assignment is Copy (of Slot)

```
let a = 5;
```

```
let b = a;
```

```
b++;
```

```
if (a == 5) ...
```



Primitives: Argument Passing

```
function inc (param) {  
    param++;  
}
```

```
let a = 5;  
inc(a) ; // copy contents of slot  
if (a == 5)... //=> true
```

References: Equality/Assignment

```
let a = {x: 1, y: 4}; // a new object
```

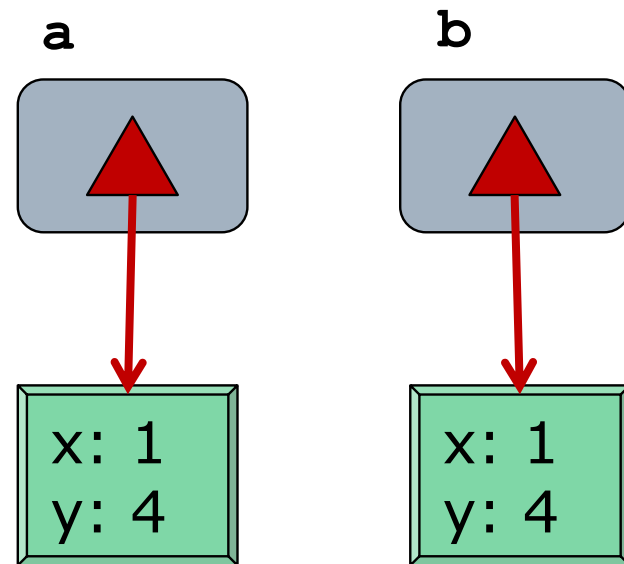
```
let b = {x: 1, y: 4}; // a new object
```

```
if (a == b)... //=> false
```

```
a = b; // copy contents of slot
```

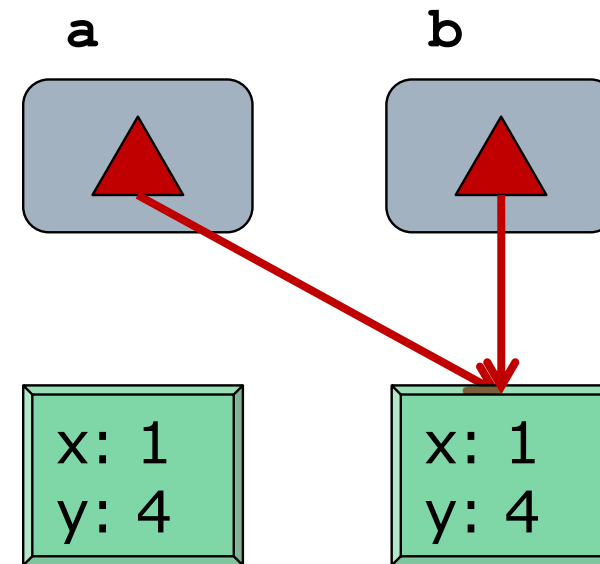
```
if (a == b)... //=> true
```

Assignment is (Still a) Copy (of Slot)



`a != b`

`a = b;`



`a == b`

References: Argument Passing

```
function inc (param) {  
    param.x++;  
}
```

```
let a = {x: 1, y: 4};  
inc(a); // copy contents of slot  
if (a.x == 2) ... //=> ??
```

References: Argument Passing (3)

```
function inc (param) {  
    param = {x: 2, y: 7};  
}
```

```
let a = {x: 1, y: 4};  
inc(a); // copy contents of slot  
if (a.x == 2) ... //=> ??
```

Wrinkle: == vs ===

- Recall + operator in Java
 - Concatenation between strings
 - Addition between numbers
 - `3 + "4"` also works! Results in `"34"`
- Similarly, JavaScript `==` (`!=`) tries to make types match
 - `3 == "3"` is true!
- To prevent implicit type conversion, use `===` (`!==`)
 - `3 === "3"` is false
- More on type conversion later...

Demo: Iteration

- ❑ See: codepen.io/cse3901/pen/Jpmejp
- ❑ Table generated by Javascript
 - Prompt for initial value
 - Calculate interest series
 - Print out a row of table for each year

Static vs Dynamic Types

□ Static: known at compile time

- *e.g.*, C, C++, Java, Ada

```
int x
```

```
char[] a
```

```
FluffyCloud t
```

```
void* d
```

□ Dynamic: known only at run time

- *e.g.*, Python, PHP, Ruby, JavaScript

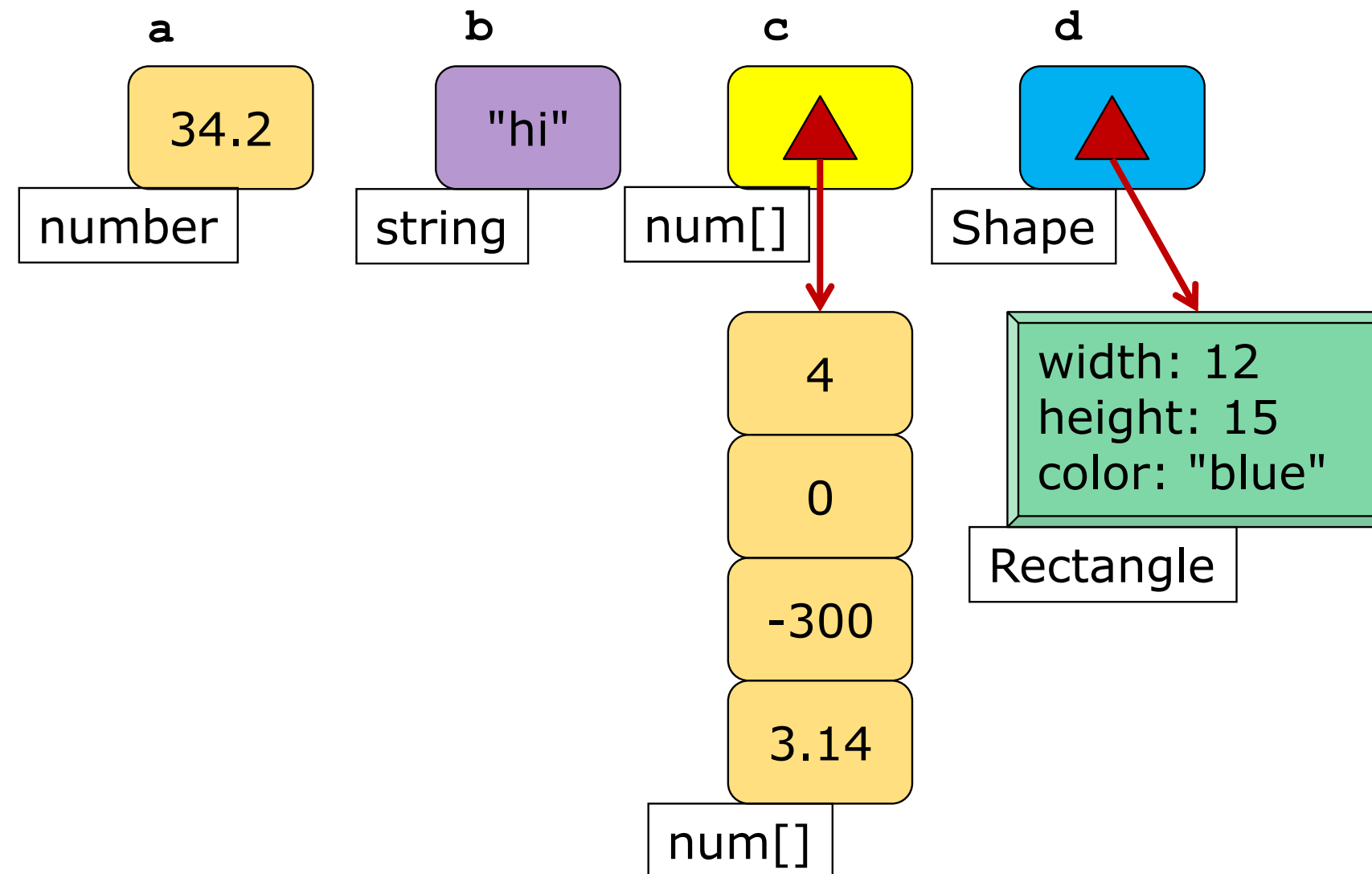
```
let x
```

```
let a
```

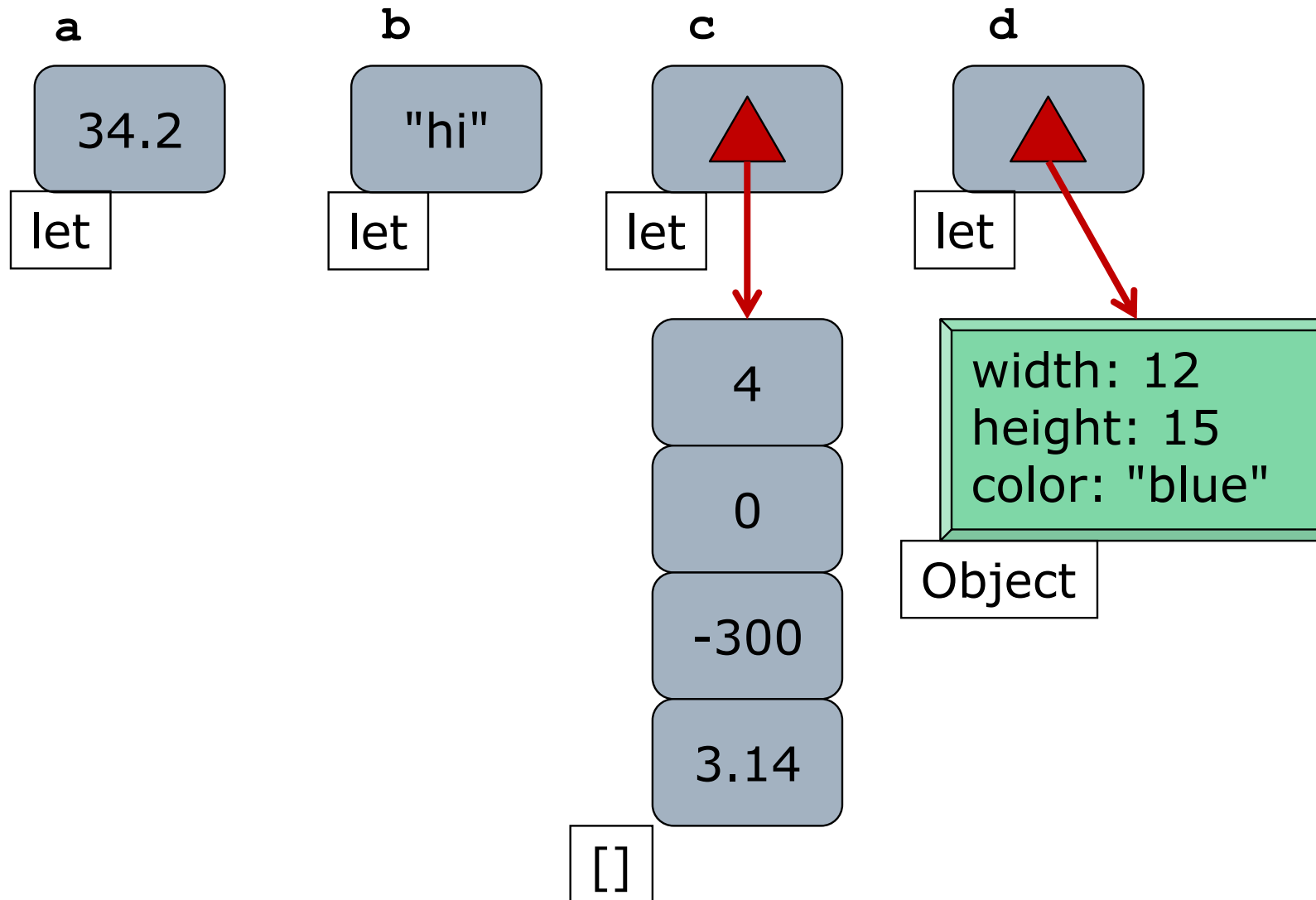
```
let t
```

```
let d
```

Static Types



Dynamic Types



Function Signatures

□ Statically typed

```
String parse(char[] s, int i) {... return e;}  
out = parse(t, x);
```

- Parameter types (*i.e.* s and i) are declared
- Return type (*i.e.* of parse) is declared
- The *compiler* checks conformance of
 - (Declared) types of arguments (t, x)
 - (Declared) type of return expression (e)
 - (Declared) type of expression *using* parse (out)

□ Dynamically typed

```
function parse(s, i) { ... }  
out = parse(t, x)
```

- You are on your own!

Changing Types at Run-time

Static Types

```
//a is undefined  
String a;  
    //a is null string  
a = "hi";  
    //compile-time err  
a = "hi";  
a = 3;  
    //compile-time err  
a.push();  
    //compile-time err
```

Dynamic Types

```
//a is undeclared  
let a;  
    //a is undefined  
a = "hi";  
    //load-time error  
a = "hi";  
a = 3;  
    //a is a number  
a.push();  
    //run-time error
```

Resources

- ❑ MDN (Mozilla Developer Network)
 - developer.mozilla.org/docs/JavaScript
- ❑ codepen.io, jsfiddle.net
 - HTML, CSS, Javascript → result
- ❑ REPL
 - With Node.js installed, at the console:
\$ **node**
 - In a browser: repl.it/languages/javascript
 - ❑ Update: free repl.it plan no longer useful
- ❑ Class web site (under Resources)
 - Style guides (Airbnb, Google)
 - Books, available online
 - ❑ *JavaScript: The Definitive Guide* (Flanagan)
 - ❑ *Eloquent JavaScript* (Haverbeke)

Summary: Introduction, Types

- Executes at client-side, in browser
 - Interpreted (not compiled)
- Basic syntax: operators, statements
- Objects: document, window...
- Types
 - Primitives: boolean, number, string, null, undefined
 - References: arrays, objects (& functions)
- Working with primitives and references
 - Checking equality
 - Assignment
 - Parameter passing
- Dynamic types (vs static types)