

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 ES2021)
- Has become popular outside of browsers
 - e.g. Node.js
- Translation target for other languages:
 - Syntax: CoffeeScript
 - Static types: Dart (Google), TypeScript (MS)

Client-Side Execution

```
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

```
<!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

```
<!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>
```



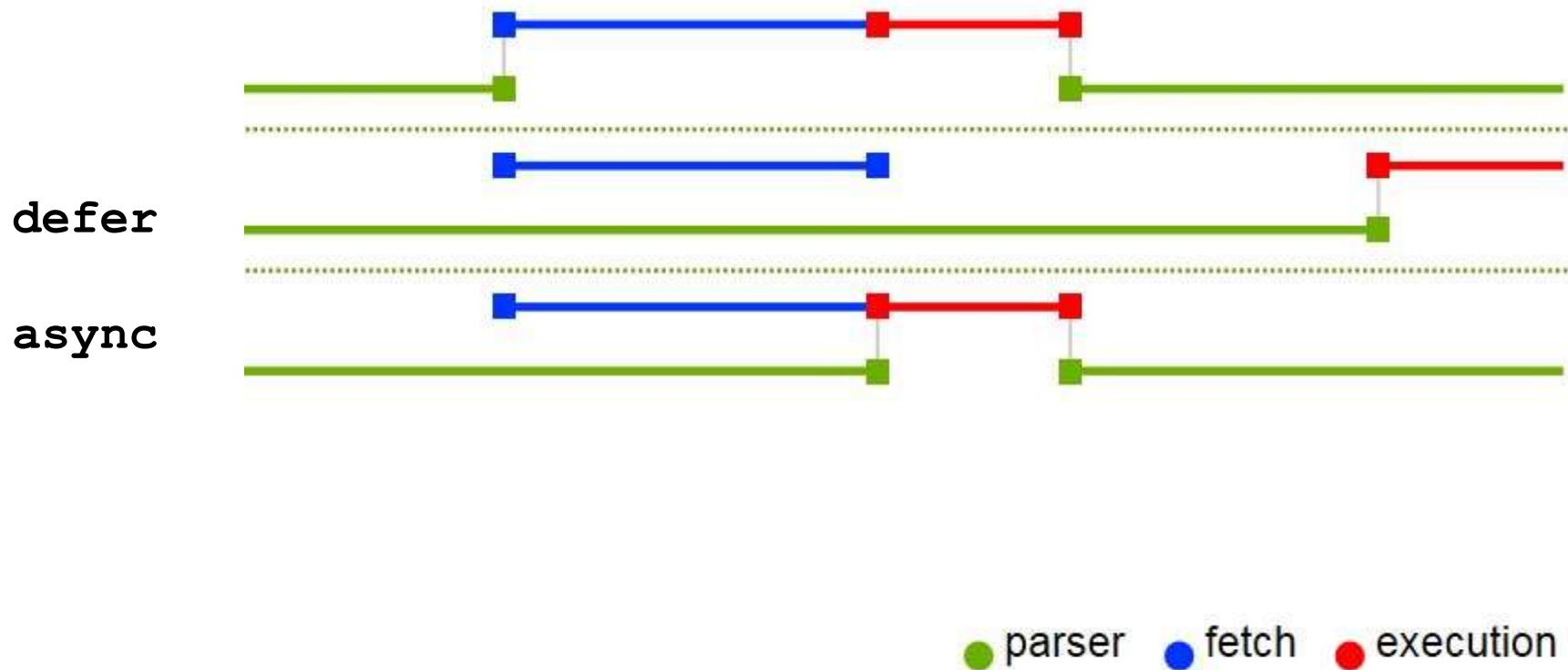
Including Scripts

- 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



Demo

- ❑ Simple “hello world” (page1.html)
 - HTML file containing JavaScript
 - Body is empty, script writes HTML output
 - Browser displays result
- ❑ Examining result with dev tools
 - Sources: see JavaScript program
 - ❑ Place breakpoints and reload
 - Console: see console output

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;`

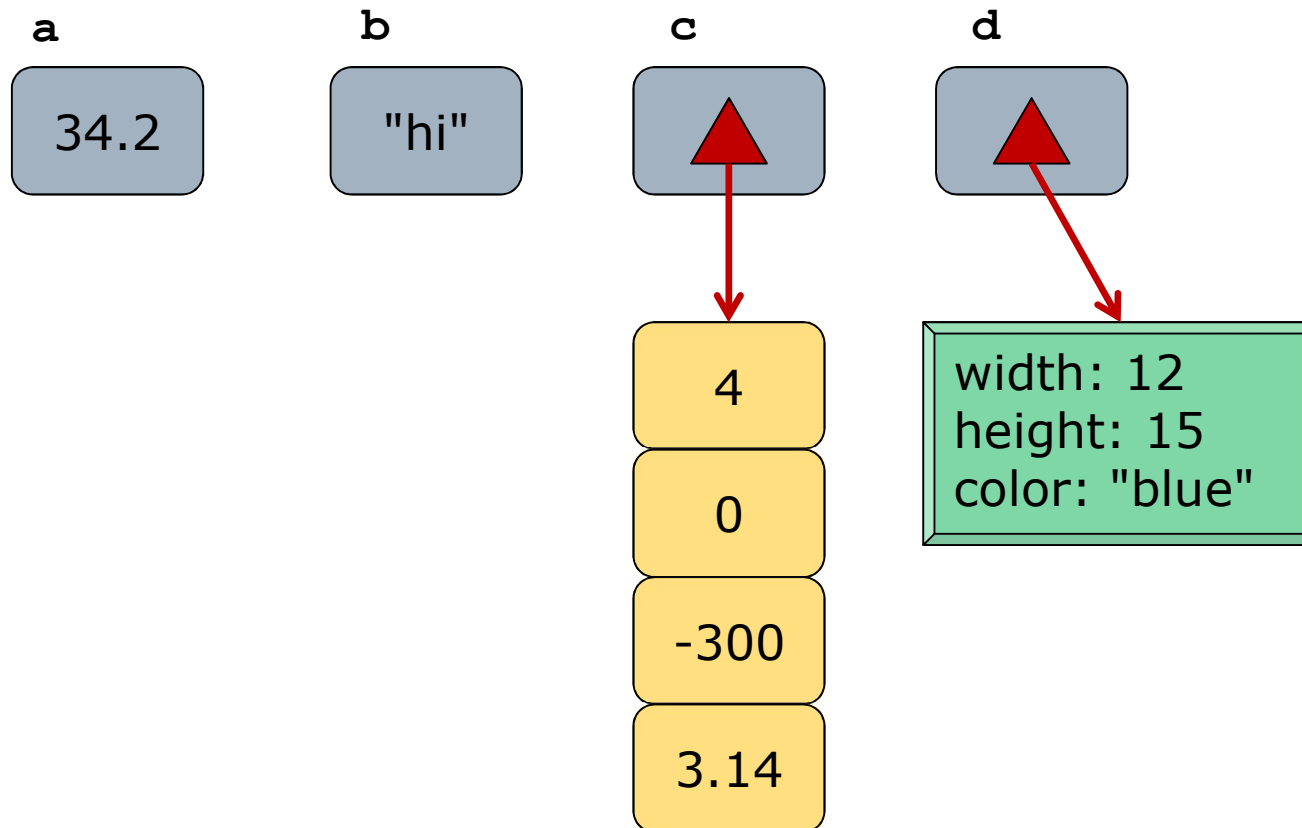
□ Iteration

- `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



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
```

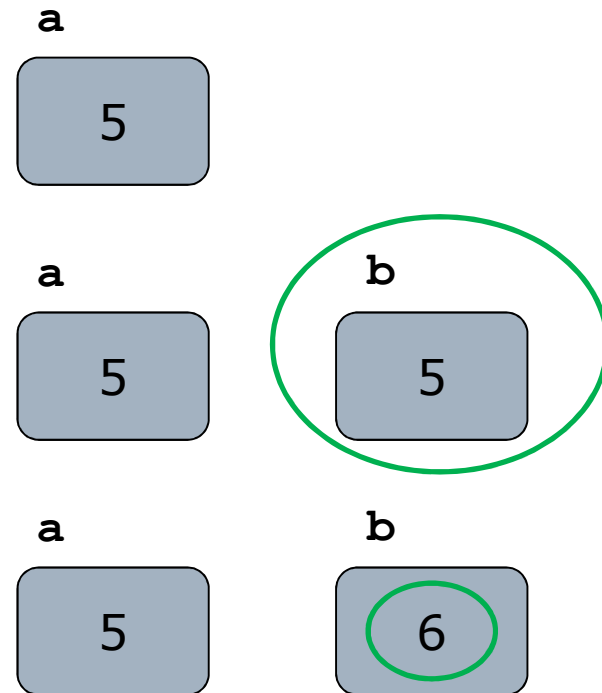
Assignment is Copy (of Slot)

```
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
```

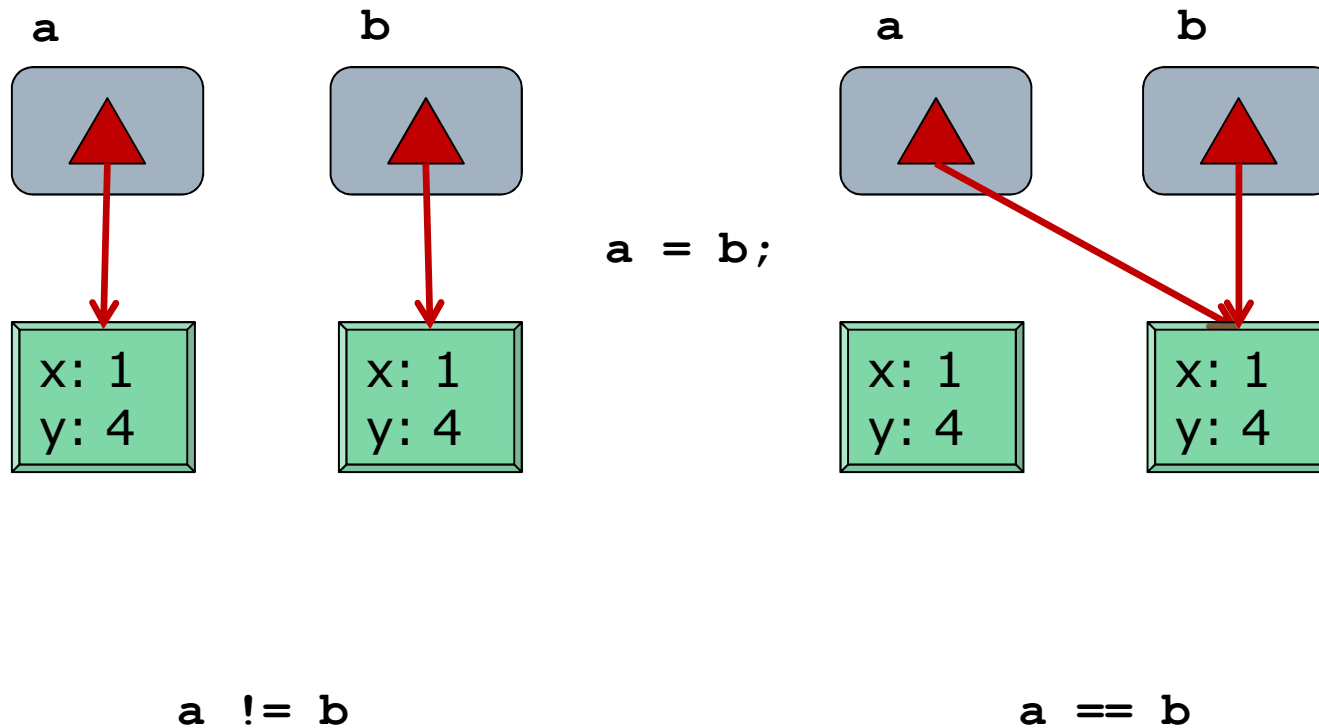
```
let b = {x:1, y:4}; // a new object
```

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

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

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

Assignment is Copy (of Slot)



References: Argument Passing

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

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

References: Argument Passing

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

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

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

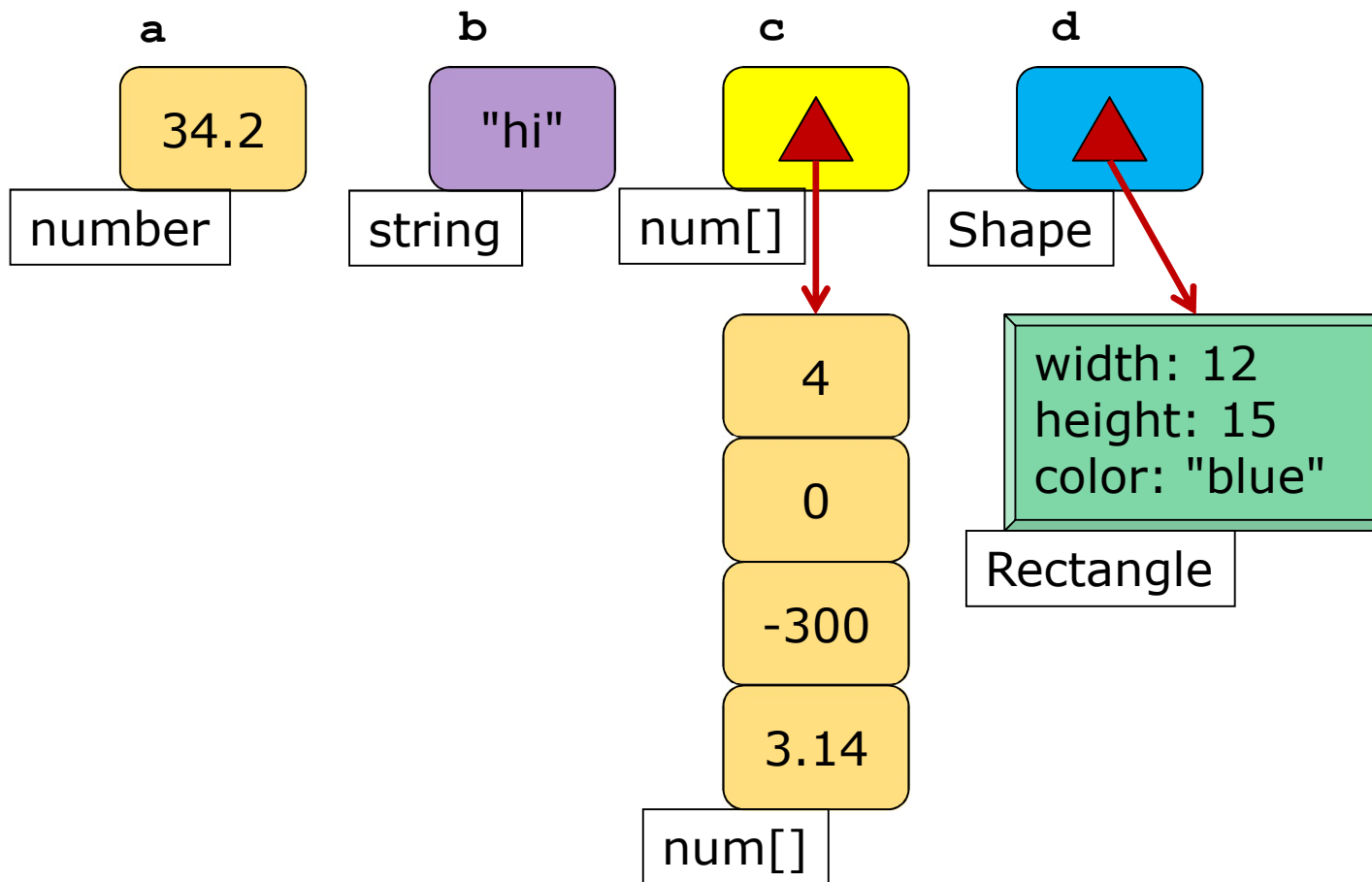
```
int x
char[] a
FluffyCloud t
void* d
```

□ Dynamic: known only at run time

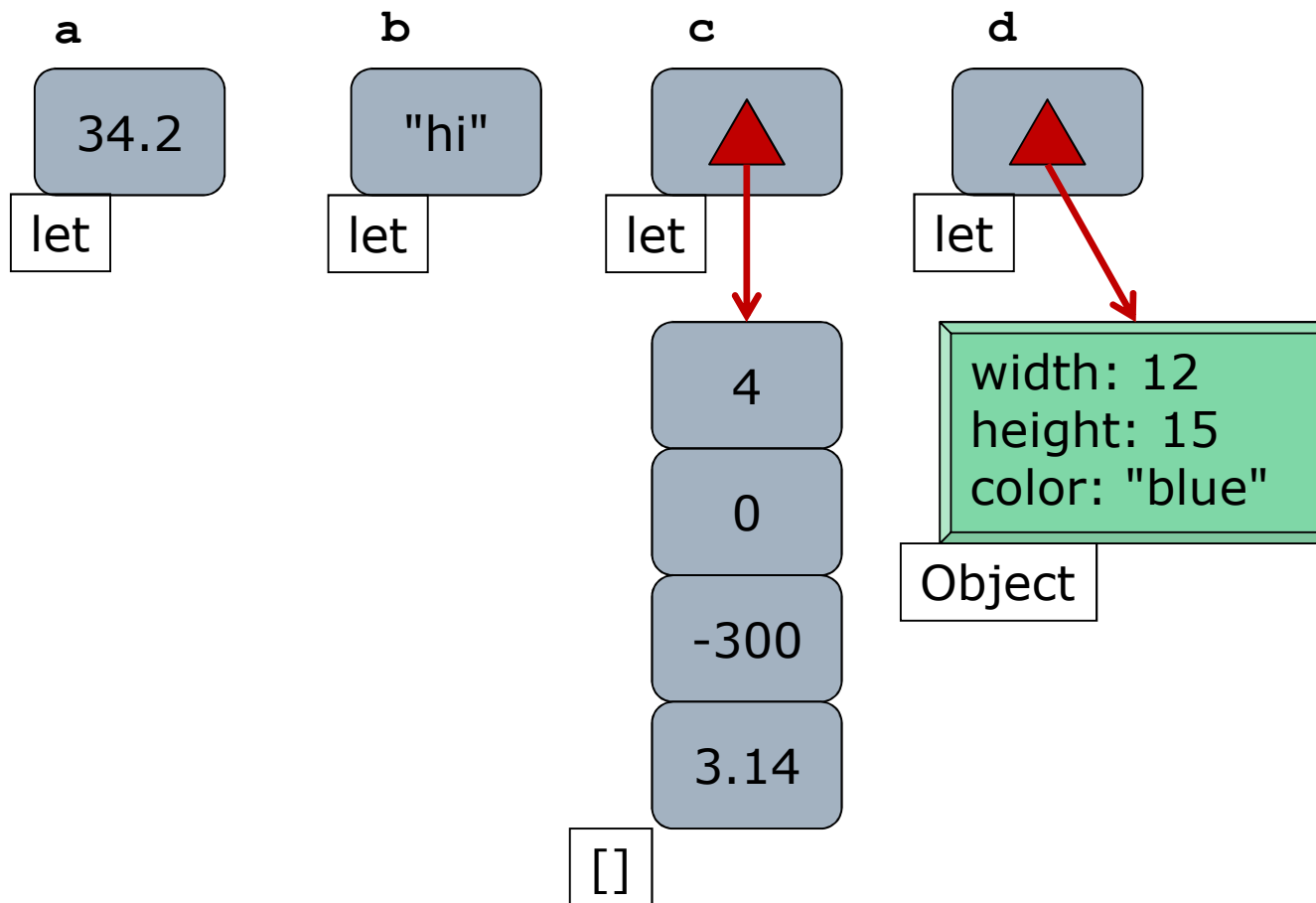
- *e.g.*, Python, PHP, Ruby, JavaScript

```
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
 - In VM, at console:
\$ **node**
 - In a browser: repl.it/languages/javascript
- ❑ Class web site (under Resources)
 - Style guides (Airbnb, Google)
 - Books, available online
 - ❑ *JavaScript: The Definitive Guide* (Flanagan)
 - ❑ *Eloquent JavaScript* (Haverbeke)

Summary

- ❑ 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)