Objects as Aggregates

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slides courtesy of Eric Roberts

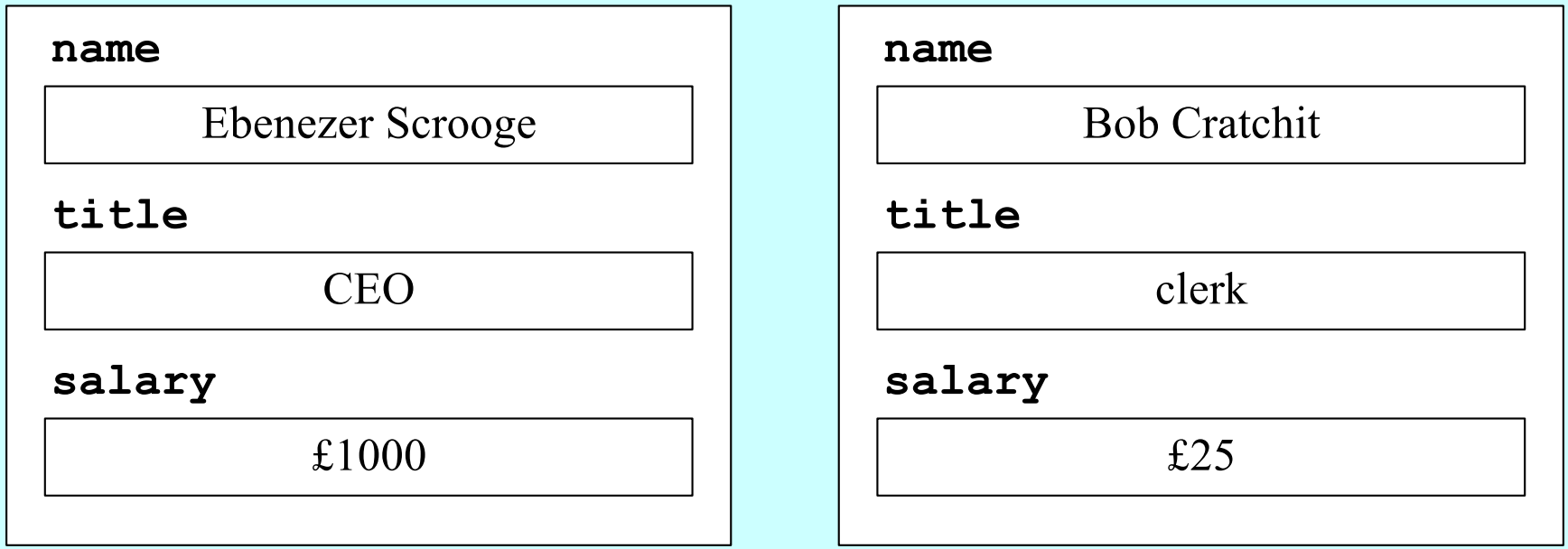
Objects in JavaScript

- JavaScript uses the word "object" in a frustratingly imprecise way.
- Unsurprisingly, the word "object" is used for the encapsulated data collections one finds in the object-oriented programming paradigm, as we'll will describe on Friday and next Monday.
- Unfortunately, JavaScript uses the same word to refer to any collection of individual data items. In other programming languages, this idea is often called a "structure," a "record," or an "aggregate." We will use "aggregate" when we want to restrict consideration to objects of this more primitive form.

Objects as Aggregates

- Even though modern programming practice tends to favor the object-oriented model, it is still important to understand the more traditional view of objects as data aggregates.
- Aggregates are used to represent situations in the real world in which several independent pieces of data are all part of a single unified structure. In contrast to an array, the data elements in an aggregate are often of different types and are identified by name rather than by a sequence number.
- The first example in the text imagines keeping track of the data for the employees of Scrooge and Marley, the company from Charles Dickens's *A Christmas Carol*. Each employee is identified by a name, a job title, and a salary. A diagram of the two employees at the company appears on the next slide.

Employees at Scrooge and Marley



Using JSON to Create Objects

- The easiest way to create new aggregates in JavaScript is to use ***JavaScript Object Notation*** or ***JSON***.
- In JSON, you specify an object simply by listing its contents as a sequence of name-value pairs. The name and the value are separated by a colon, the name-value pairs are separated by commas, and the entire list is enclosed in curly braces.
- The following declarations create variables named **`ceo`** and **`clerk`** for the employees diagrammed on the previous slide:

```
let ceo = {
   name: "Ebenezer Scrooge",
   title: "CEO",
   salary: 1000
};
```

```
let clerk = {
   name: "Bob Cratchit",
   title: "clerk",
   salary: 25
};
```

Selecting Fields from an Object

- Given an object, you can select an individual field by writing an expression denoting the object and then following it by a dot and the name of the field. For example, the expression **`ceo.name`** returns the string **`"Ebenezer Scrooge"`**; similarly, **`clerk.salary`** returns the number 25.
- Fields are assignable. For example, the statement

  ```
  clerk.salary *= 2;
  ```

  doubles poor Mr. Cratchit's salary.
- Fields selection can also be expressed using square brackets enclosing the name of the field expressed as a string, as in **`ceo["name"]`**. This style is necessary if the name of the field is not a simple identifier or, more likely, if the name is computed by the program.

Arrays of Objects

- Since arrays can contain values of any type, the elements of an array can be JavaScript objects. For example, the employees at Scrooge and Marley can be initialized like this:

```
let employees = [
   { name: "Ebenezer Scrooge", title: "CEO", salary: 1000 },
   { name: "Bob Cratchit", title: "clerk", salary: 25}
];
```

- The following function prints the payroll for the employee array supplied as an argument:

```
function printPayroll(employees) {
   for (let i = 0; i < employees.length; i++) {
      let emp = employees[i];
      console.log(emp.name + " (" + emp.title + ") £" +
                  emp.salary);
   }
}
```

Exercise: Hogwarts Student Data

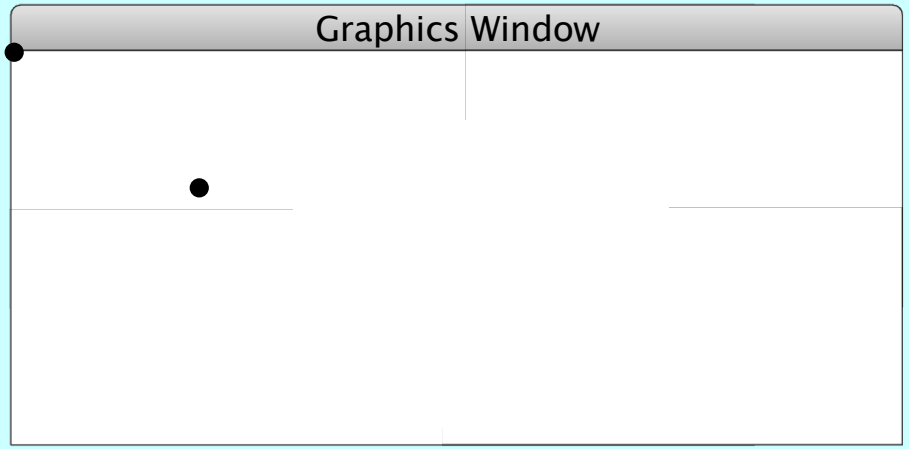
- How would you design an aggregate for keeping track of the following information about a student at Hogwarts:
  - The name of the student
  - The student's house
  - The student's year at Hogwarts
  - A flag indicating if the student has passed the O.W.L. exam
- How would you code this data for the following students:
  - Hermione Granger, Gryffindor, 5th year, passed O.W.L. exam
  - Luna Lovegood, Ravenclaw, 4th year, not yet passed O.W.L.
  - Vincent Crabbe, Slytherin, 5th year, failed O.W.L exam
- Just for fun, think about other data values that might be useful about a Hogwarts student and what types you would use to represent these values.

Representing Points as Aggregates

- One data aggregate that comes in handy in graphics captures the abstract notion of a ***point*** in two-dimensional space, which is composed of an *x* and a *y* component.
- Points can be created in JavaScript simply by writing their JSON notation, as in the following examples, which are shown along with their positions in the graphics window.

```
let p1 = { x: 0, y: 0 };

let p2 = { x: 90, y: 70 };
```



- The *x* and *y* components of `p1` can be selected as `p1.x` and `p1.y`, respectively.

Factory Functions

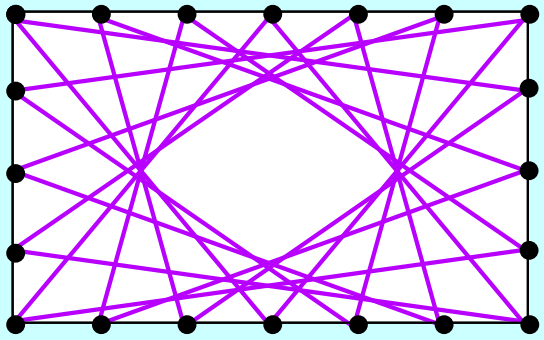
- Although JSON notation is compact and easy to read, it is often useful to define a function that creates a JavaScript object. Such functions are called ***factories*** and are written in the book using an uppercase initial letter.
- The following function creates a point-valued object for which the coordinate values default to the (0, 0) point at the origin:

```
function Point(x, y) {
    if (x === undefined) {
        x = 0;
        y = 0;
    }
    return { x: x, y: y };
}
```

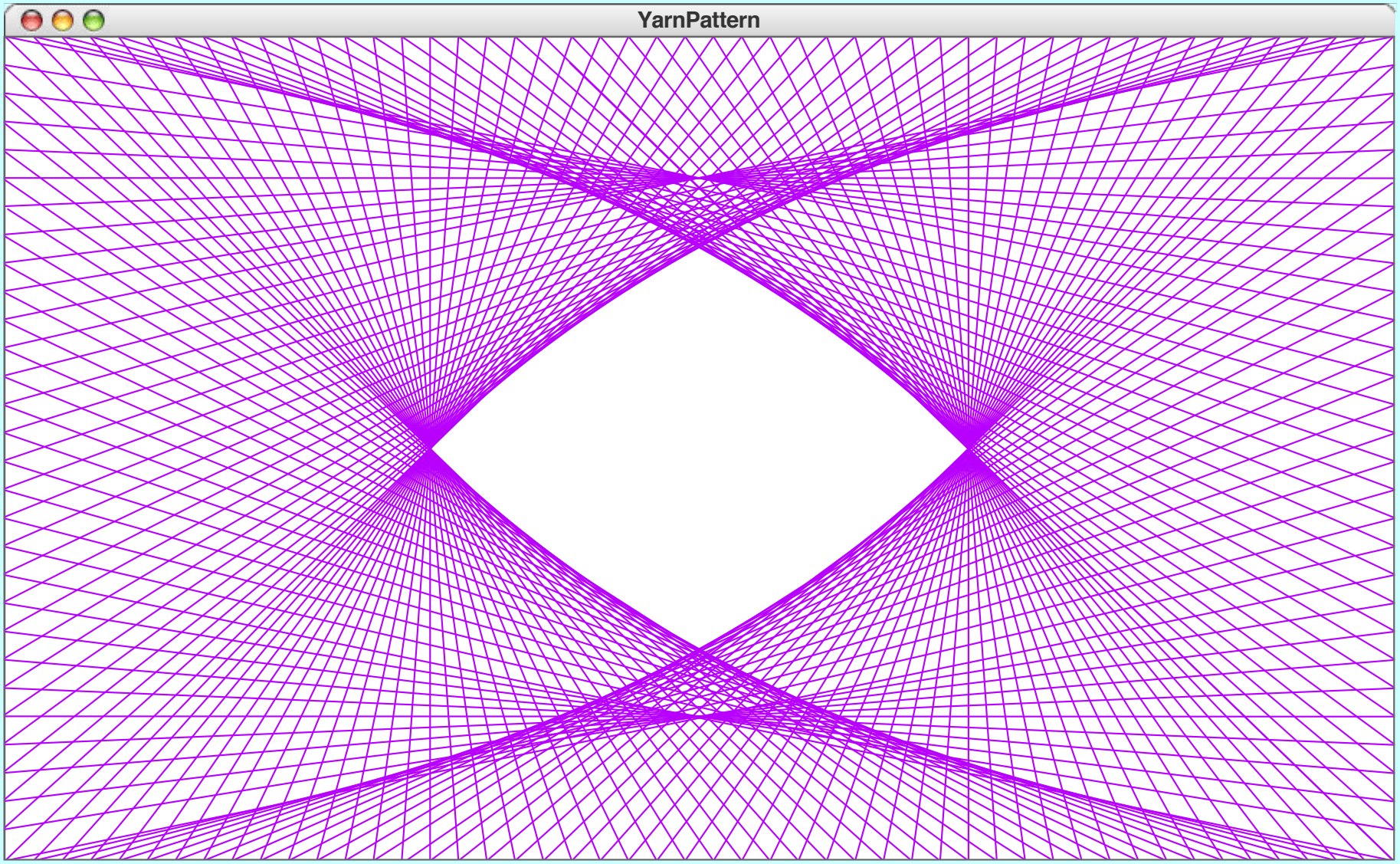
This **x** is a name. This **x** is a value.

Points and Graphics

- Points turn up often in graphical applications, particularly when you need to store the points in an array or an object.
- As an aesthetically pleasing illustration of the use of points and the possibility of creating dynamic pictures using nothing but straight lines, the text presents the program **`YarnPattern.js`**, which simulates the following process:
  - Place a set of pegs at regular intervals around a rectangular border.
  - Tie a piece of colored yarn around the peg in the upper left corner.
  - Loop that yarn around the peg a certain distance **`DELTA`** ahead.
  - Continue moving forward **`DELTA`** pegs until you close the loop.



A Larger Sample Run



The `YarnPattern` Program

```
/*
 * Creates a pattern that simulates winding a piece of yarn
 * around an array of pegs at the edges of the graphics window.
 */

function YarnPattern() {
   let gw = GWindow(GWINDOW_WIDTH, GWINDOW_HEIGHT);
   let pegs = createPegArray(GWINDOW_WIDTH, GWINDOW_HEIGHT,
                             N_ACROSS, N_DOWN);
   let thisPeg = 0;
   let nextPeg = -1;
   while (thisPeg !== 0 || nextPeg === -1) {
      nextPeg = (thisPeg + DELTA) % pegs.length;
      let p0 = pegs[thisPeg];
      let p1 = pegs[nextPeg];
      let line = GLine(p0.x, p0.y, p1.x, p1.y);
      line.setColor("Magenta");
      gw.add(line);
      thisPeg = nextPeg;
   }
}
```

The `YarnPattern` Program

```
/*
 * Creates an array of pegs around the perimeter of a rectangle
 * with the specified width and height.  The number of pegs in
 * each dimension is specified by nAcross and nDown.
 */

function createPegArray(width, height, nAcross, nDown) {
   let dx = width / nAcross;
   let dy = height / nDown;
   let pegs = [ ];
   for (let i = 0; i < nAcross; i++) {
      pegs.push(Point(i * dx, 0));
   }
   for (let i = 0; i < nDown; i++) {
      pegs.push(Point(nAcross * dx, i * dy));
   }
   for (let i = nAcross; i > 0; i--) {
      pegs.push(Point(i * dx, nDown * dy));
   }
   for (let i = nDown; i > 0; i--) {
      pegs.push(Point(0, i * dy));
   }
   return pegs;
}
```

The YarnPattern Program

```
/*
 * Creates a new Point object.  If this function is called with
 * no arguments, it creates a Point object at the origin.
 */

function Point(x, y) {
   if (x === undefined) {
      x = 0;
      y = 0;
   }
   return { x: x, y: y };
}

/* Constants */

const GWINDOW_WIDTH = 1000;
const GWINDOW_HEIGHT = 625;
const N_ACROSS = 80;
const N_DOWN = 50;
const DELTA = 113;
```

The End