YEAH Hours: Enigma

11/6/18

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Objects

- Recall: arrays are ordered collections of things
- An object is an *unordered* collection of *"key-value pairs"*
    - "Key-value pair" is a fancy term for an idea you're already familiar with!
    - In a phonebook, each entry is a key-value pair. "Ryan Eberhardt" is a key and "(123) 456-7890" is a value
    - In the Explore Courses database, you might find a key-value pair for every class, where a key like "CS 106AJ" has the value "Programming Methodology in JavaScript"
- We will be talking much more about objects and how to use them in the next two weeks!

Creating objects

- Let's create an object to represent a point in space:

  ```
  let point = {x: 5, y: 10};
  ```

- This object now contains two entries (a.k.a two key-value pairs)
- We can get the contents of the object like this:

  ```
  console.log(point.x);
  console.log(point.y);
  ```

Creating objects v2

- Javascript also allows you to add onto objects at any time. That means you can also create an object by creating an empty one and then adding entries:

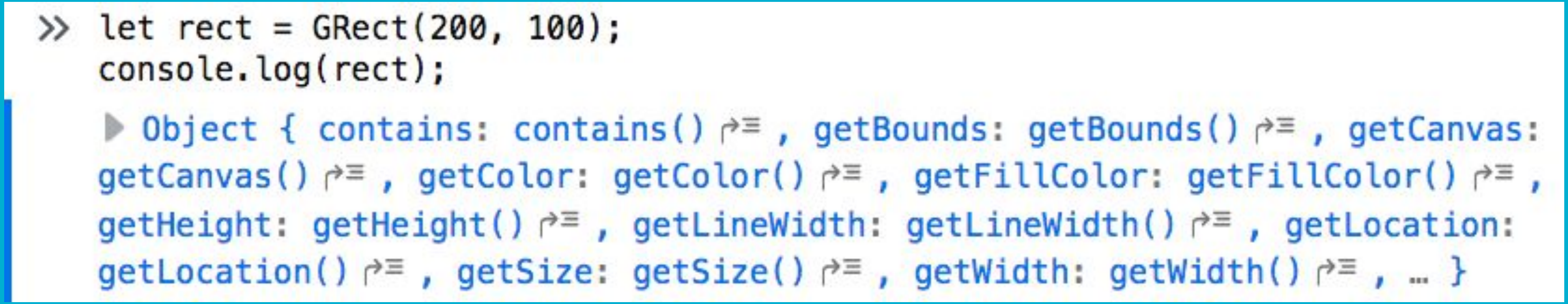
  ```
  let point = {};
  point.x = 5;
  point.y = 10;
  ```

- This produces an identical object to the previous slide. We can use it the same way:

  ```
  console.log(point.x);
  console.log(point.y);
  ```

Objects in Enigma

- As it turns out, nearly *everything* in JavaScript is an object!
  - When you do `console.log("Hello world".length);`, you are taking a string object and looking up the value for the `length` key
  - When you create a GRect, you are creating an object with keys like `getWidth`, `getHeight`, `setColor`, etc., and values that are functions



```
>> let rect = GRect(200, 100);
   console.log(rect);

   ▶ Object { contains: contains() ↱≡ , getBounds: getBounds() ↱≡ , getCanvas:
   getCanvas() ↱≡ , getColor: getColor() ↱≡ , getFillColor: getFillColor() ↱≡ ,
   getHeight: getHeight() ↱≡ , getLineWidth: getLineWidth() ↱≡ , getLocation:
   getLocation() ↱≡ , getSize: getSize() ↱≡ , getWidth: getWidth() ↱≡ , … }
```

Objects in Enigma

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        - As such, you can attach extra properties and functions to a GRect, just like we saw on the last slide! I'll explain this technique in a few slides :)

Objects in Enigma

- As it turns out, nearly *everything* in JavaScript is an object!
  - When you do `console.log("Hello world".length);`, you are taking a string object and looking up the value for the `length` key
  - When you create a GRect, you are creating an object with keys like `getWidth`, `getHeight`, `setColor`, etc., and values that are functions
  - As such, you can attach extra properties and functions to a GRect, just like we saw on the last slide! I'll explain this technique in a few slides :)
- This assignment will require you to manipulate many objects, so make sure you have some basic idea of what they are!

Enigma

Interactive demo: http://web.stanford.edu/class/cs106aj/assignments/assign5-milestones/

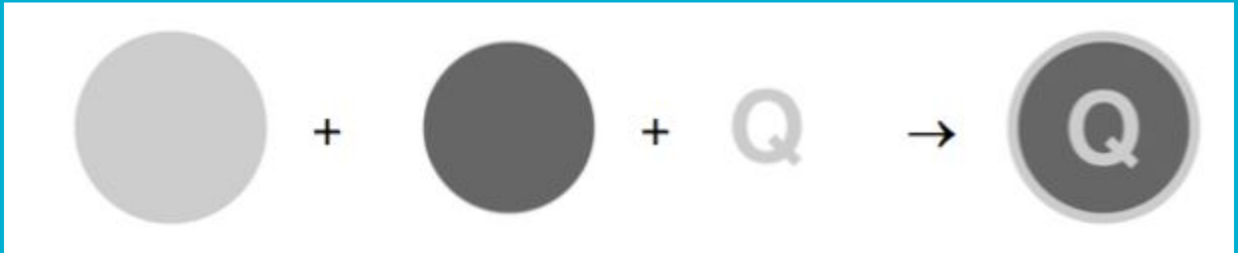
Enigma logistics

- Due next Friday (Nov 16)
- Partner assignment
- Broken into milestones
    - Follow along with the interactive demos: http://web.stanford.edu/class/cs106aj/assignments/assign5-milestones/

This assignment emulates a real (complicated) machine!

- We have several handouts about the workings of the machine:
  - Slides from lecture on cryptography
  - Theory of the Engima machine
  - Assignment handout
- The assignment handout is long, but worth paying attention to
- Make sure you understand what you're trying to do before starting to write code!

Milestone 1: Create the Keyboard



- Create a GCompound (with the reference point at the center) containing two GOvals and a GLabel
- Add the GCompound to the screen using coordinates from a KEY_LOCATIONS constant
    - From the handout:
      `KEY_LOCATIONS[ch.charCodeAt(0) - "A".charCodeAt(0)].x`

Milestone 2: Making keys interactive

- Problem: There are a lot of things on the screen that are supposed to do different things when I click them. If I write all the code in my click handler function, it's going to be really long and ugly!
- Solution: Event forwarding
    - Described in page 4 of handout, "Forwarding mouse events to graphical objects"
- Basic idea: Did the user click an object that is capable of handling clicks? If so, pass the event onto that object instead of handling it ourselves
    - Then, we'll modify all our GCompounds so that they know what to do when they are clicked on!

Milestone 2: Making keys interactive

- Simplified event listener:

```
function mousedownAction(e) {
    let target = gw.getElementAt(e.getX(), e.getY());
    if (target knows how to handle events) {
        Tell the target that the mouse pressed down on it
    }
}
gw.addEventListener("mousedown", mousedownAction);
```

Milestone 2: Making keys interactive

- How do we create a GCompound that's capable of handling clicks on itself?
    - Add a mousedownAction function to it!

-
  ```
  function makeKey(i) {
      let key = GCompound();
      let label = GLabel(figure out what goes here :) );
      // add the shapes/label to the GCompound

      key.mouseDownAction = function() {
          label.setColor(KEY_DOWN_COLOR);
          // more code added in later milestones
      };
      return key;
  }
  ```

Milestone 2: Making keys interactive

- Now, our main event listener can call this second listener:

```
function mousedownAction(e) {
    let target = gw.getElementAt(e.getX(), e.getY());
    if (target.mousedownAction !== undefined) {
        target.mousedownAction();
    }
}
gw.addEventListener("mousedown", mousedownAction);
```

Milestone 3: Creating the lamp panel

- Create a GCompound for each lamp, similar to what was done for keys
  - There are only two parts to the GCompound instead of 3
  - No need to attach mousedownAction or mouseupAction methods (because lamps don't respond to clicks)
  - However, **we do need to attach a `label` property** so that the GLabel can be accessed in the future

Milestone 3: Creating the lamp panel

```
function makeLamp(i) {
    let lamp = GCompound();
    let label = GLabel( figure out what goes here :) );
    // Do other stuff to make the lamp
    lamp.label = label;
    return lamp;
}
```

Milestone 4: Connect the keyboard to the lamp panel

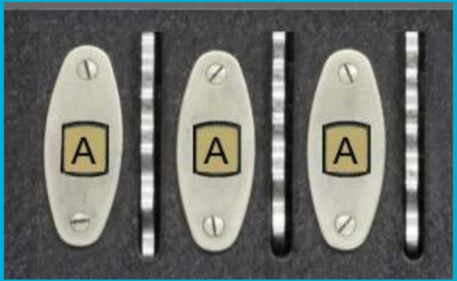
- When we press one of the keys, the corresponding lamp should illuminate
- In the `runEnigmaSimulation` (the main function), create an `enigma` object that contains an array of keys and an array of lamps
- Modify the main mousedownAction and mouseupAction functions to pass this object when dispatching events

```
function mousedownAction(e) {
    let target = gw.getElementAt(e.getX(), e.getY());
    if (target.mousedownAction !== undefined) {
    target.mousedownAction(enigma);
    }
}
```

Milestone 4: Connect the keyboard to the lamp panel

- When we press one of the keys, the corresponding lamp should illuminate
- In the `runEnigmaSimulation` (the main function), create an `enigma` object that contains an array of keys and an array of lamps
- Modify the main mousedownAction and mouseupAction functions to pass this object when dispatching events
- The key's mousedownAction function can now receive the array of lamps via the `enigma` parameter, and can change the color of the label attached to the appropriate lamp

Milestone 5: Add rotors in their default positions



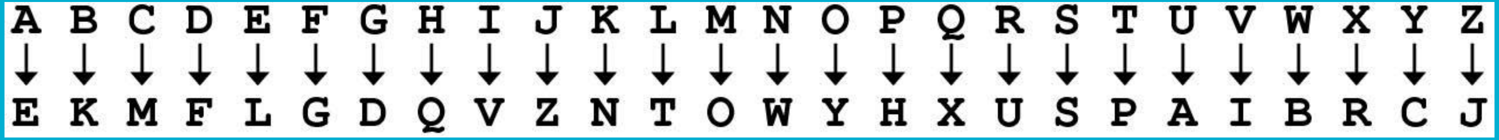
- Create a GCompound for each rotor; the handout details this
- Attach a string to each GCompound: `rotor.permutation = ROTOR_PERMUTATIONS[i];` (where `i` is the index of the rotor)
    - We don't do anything with this string at this stage, but later on, this string dictates a substitution cipher that this rotor implements. The handout explains this.

Milestone 6: Making rotors clickable

- When a rotor is clicked, it needs to advance to the next letter!
- When creating a rotor object, add an `offset` property indicating its current position (the default position, showing "A", is an offset of 0)
- Need to add a clickAction method to the rotor object, similar to the keys
- When the rotor's clickAction method is called by a main dispatcher clickAction function, it should increment `offset` and update the GLabel to show the next letter in the alphabet
    - Make sure the rotor wraps from Z back to A when we click it 27 times!

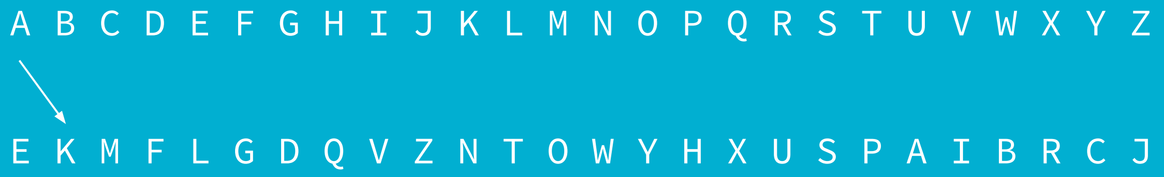
Milestone 7: Implement one stage in the encryption

- From milestone 5, each rotor should have a permutation string attached to it. The first rotor's permutation looks like this:
  EKMFLGDQVZNTOWYHXUSPAIBRCJ
- That string gives us this input-to-output mapping:



A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
E	K	M	F	L	G	D	Q	V	Z	N	T	O	W	Y	H	X	U	S	P	A	I	B	R	C	J

- However, if the rotor is in offset 1 (instead of offset 0), we should encrypt A like this:



A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

E K M F L G D Q V Z N T O W Y H X U S P A I B R C J

Milestone 7: Implement one stage in the encryption

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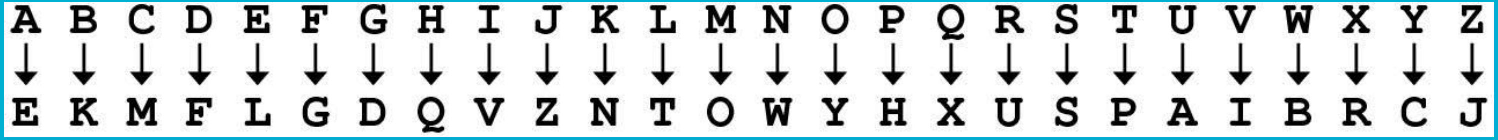
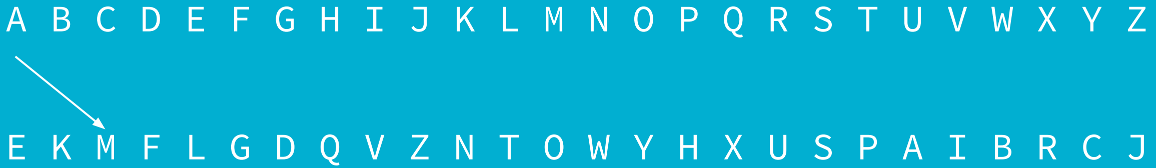


A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
E	K	M	F	L	G	D	Q	V	Z	N	T	O	W	Y	H	X	U	S	P	A	I	B	R	C	J

- If the rotor is in offset 2:



A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

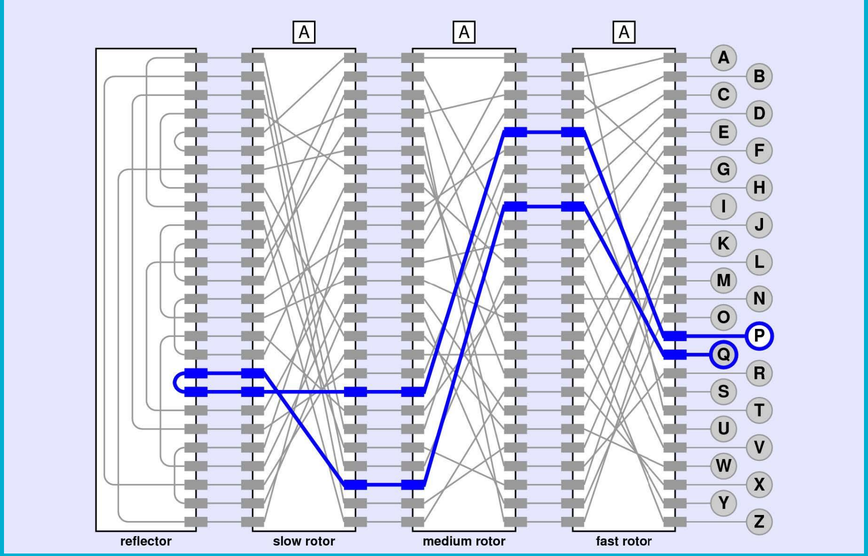
E K M F L G D Q V Z N T O W Y H X U S P A I B R C J

Milestone 7: Implement one stage in the encryption

- Your job is to implement an applyPermutation function that takes an index (in the alphabet), permutation string (like the one on the previous slide), and offset, and returns the index (in the alphabet) of the resulting character
- Then, use this function to illuminate the correct lamp when a key is pressed

Milestone 8: Implement the full encryption path

- After passing through all 3 rotors and the reflector, current flows *backwards* through the rotors:



Milestone 8: Implement the full encryption path

- You need to construct the *inverse* of a rotor's permutation string. This process is described fairly well in the handout
- Implement an invertKey function to return an inverted permutation string
    - Test it using console.log before you continue!!
    - If you call invertKey(invertKey(permutation)), you should get the same thing as the original permutation
- Then, update the key's event handler functions to call applyPermutation 7 times (once on each of the rotor permutations, then on the reflector permutations, then on the inverted rotor permutations in reverse order)

Milestone 9: Implement rotor advance on pressing a key

- Whenever a key is pressed, the fast rotor should be advanced BEFORE doing the encryption
- When the fast rotor rolls over from Z to A, the medium rotor should be incremented. When the medium rotor rolls over, the fast rotor should be incremented
- This milestone isn't long, but it will be challenging, because it ties together all the previous milestones, and any latent mistakes you made will be exposed here!