Instructions

Please read these instructions very carefully!

a. This is a closed-book quiz. You should not refer to any notes in hard copy or online.
b. Every question is multiple choice, and may have more than one correct answer. In effect, then, the entire quiz is one long list of true/false questions, and your solution is a string of bits.
c. Every true/false response has an equal weighting in the grading of the quiz.
d. You will hand in only the final sheet. You may want to do the quiz on the main sheets, and then transfer your answers to the solution sheet afterwards. If you do so, bear in mind that it may take you more than a couple of minutes to do this, so plan your timing accordingly.

Good luck!

A Document Object Model and JavaScript

1. JavaScript that runs in the browser can access the current page via the document object model API. Which of the following actions can be performed through this API?
   a. Adding elements to the page
   b. Deleting elements from the page
   c. Modifying the rules in the page’s CSS stylesheet
   d. Replacing the HTML inside an element

   a, b and d. The CSS style rules cannot be modified, although you can change the style attributes of HTML elements.

2. The document object model (DOM) of a web page is a data structure that is constructed as the page is loaded. If no calls are made to the DOM API, might the DOM change?
   a. Yes, it changes incrementally as the page is loaded
   b. Yes, it can change as the user interacts with the page
   c. Yes, the server can push updates to the DOM
   d. No: the DOM is immutable

   a and b; the DOM includes things like keyboard focus, hence b.
3. Which of the following are good reasons for using object models (OMs) to define the document object model (DOM)?
   a. OMs are ideal for describing ordered sequences of elements, as found in a web page
   b. An OM shows the underlying structure of the DOM, and abstracts away API differences
   c. The DOM includes graph-like structure that is well captured by an OM
   d. The OM provides all the information you need to write code using the DOM.

   b and c.

4. JavaScript can appear at different places in a web page, and there are different opinions about where is best. Which of the following positions is reasonable?
   a. Small amounts of JavaScript can appear in the header section, because that is where scripts are typically placed
   b. JavaScript should appear throughout the page, so that it can be tightly integrated with the page elements
   c. Most of the JavaScript should appear or be called at the end of the page, so that the HTML loads first and the user can start reading the page before the JavaScript has loaded
   d. Any large segments of JavaScript should be contained in separate files, to encourage separation of concerns, and to allow caching

   Intended answers were a, c, and d. Putting JavaScript at the end is plausible, for the reason given, but we dropped this answer from the grading since the issue was not discussed in class.

5. It can be challenging to work with web technologies, since they tend to evolve quickly, have incompatible implementations and are often poorly defined. Which of the following are good ways to address this challenge?
   a. Warning users that your site is “optimized” for a particular browser
   b. Using libraries that sit between your code and the browser API
   c. Avoiding cutting edge features that are not yet widely deployed
   d. Checking that your artifacts pass standard validator tests

   b, c and d.

6. Look at the code in Example 1. It shows one way you might attach a JavaScript function click to a button, so that the function is called when the button is pressed. Which of the following statements is true about the code style evident in this fragment?
   a. Embedding large code fragments of JavaScript in HTML properties is bad, but embedded function calls like this is desirable because it improves performance, and ensures that the on-click functionality is available as soon as the HTML element is loaded
   b. This is bad, because the code fragment is executed in an unpredictable environment which may contain a different binding for the variable click
   c. This code is wrong because all properties of HTML elements are evaluated immediately, so the call to click will occur before the first press of the button
d. This code violates a basic tenet of unobtrusive JavaScript, which requires JavaScript and HTML code to be cleanly separated.

b and d.

The next few questions are about the code in Example 2. It shows a fragment of some JavaScript code that modifies a web page by inserting 'meta elements' at the top that reflect the structure of the page, so that when the mouse is hovered over one of these meta elements, the corresponding element in the web page is highlighted.

7. Why is the call to `event.stopPropagation` present?
   a. According to the DOM event model, when an event is targeted at an element, the listener associated with the element is fired. The event then propagates to other elements, and the listeners associated with them fire too. This call ensures that those other listeners don't fire.
   b. When an event occurs, it might cause other events. For example, the highlighting performed in the listener here modifies an element, so that might cause another listener to fire. This call prevents a chain reaction.
   c. Elements are arranged in a hierarchy, and events 'bubble up' the hierarchy unless propagation is stopped.
   d. To indicate that the event has been responded to, so that the same listener doesn't fire again.

   a and c; c just adds to a what the 'other elements' are.

8. Which features of this code strongly suggest that JavaScript has proper closures, and would not likely be found in a language without closures?
   a. The creation of two anonymous listener functions
   b. The reference to `elt` in the body of the first function expression
   c. The passing of functions as arguments to other functions
   d. The hiding of local variables with the `var` keyword

   b only; there are languages with anonymous functions (Python), functions as arguments (C), local variables (Pascal) that don't have proper closures.

9. What might go wrong if JavaScript had closures but did not have lexical scoping, and instead evaluated the body of a function in the environment of its application?
   a. When the mouse hovers over a meta element, the wrong corresponding element might be highlighted
   b. When the mouse hovers over a meta element, a JavaScript reference error may occur due to an unbound variable
   c. The function `make_meta` might never terminate
   d. The function `make_meta` might throw an exception when it encounters an unbound variable

   a, b and d.
B Object Model Notation

10. Which of the following might an object model be said to describe?
   a. A state invariant
   b. A collection of instances, or snapshots of a system’s state
   c. The main states of the application and the transitions between them
   d. A language, equivalent to a set of strings
   
   a and b.

11. What is the meaning of an ‘abstract set’ in object model notation?
   a. It represents a set of abstract objects
   b. It represents a set with an unbounded number of elements
   c. It represents a set every one of whose elements appears in a declared subset
   d. It represents a set that will not be implemented directly

   c only; d is an interpretation used only in specialized contexts (eg, when the OM is describing code).

12. What is the significance of the direction of a relation arrow in an object model?
   a. It indicates how the relation may be navigated
   b. It points from a parent (container) object to a child (contained) object
   c. It indicates in which class or database table the field will be represented
   d. It is a purely semantic notion, affecting how the relationship between two objects is interpreted

   d. This is fundamental to the power of OMs, and what makes it possible to transform an abstract OM
   into very different implementations.

13. Which of the following statements are true about good object modeling practice?
   a. Important entities (such as hosts in a communication system) should be included, but their
      names (such as IP addresses) should generally be omitted
   b. Collections such as sets, lists and tables should generally not be included
   c. It is helpful to introduce top level singletons to act as containers and a place to attach global
      properties, for example in a social network an object representing the network as a whole
   d. It is important to include as much detail as possible in an object model, such as the attributes
      of all objects

   b only.

The next few questions are about the object model shown in Example 3. It shows the essential structure
of a discussion group system.

Many of you made mistakes answering these questions. There are no tricks; they just depend on hav-
logical cases like this are important because they often represent tricky cases that the design has to accommodate, and are a common source of bugs. (Think about a mailing alias, for example, that contains a set of email addresses, and what has to happen when the last address is deleted.)

14. Which of the following statements about sets can be inferred from the object model?
   a. Every moderator is a member
   b. There are members that are not moderators
   c. There are moderators that are not members
   d. There are some moderated groups

   a only.

15. Which of the following statements about relations can be inferred from the object model?
   a. Every group has at least one member
   b. Every message is posted by at most one member
   c. Every message responds to a message
   d. A message cannot respond to itself

   a and b.

16. Which of the following statements about sets and relations can be inferred from the object model?
   a. Every group has at least one moderator
   b. A group that has a moderator must be a moderated group
   c. Every moderated group has at least one member
   d. The moderators of a group must be members of that group

   b and c.

17. Which of the following statements are consistent with the object model (even if they cannot be inferred from it)?
   a. There is only one group
   b. Every group is moderated
   c. Every moderator approves every message
   d. Every message was posted by a moderator

   all correct.

C JavaScript Language and Functional Programming
18. Which of the following correctly describes the effect of an assignment \( x = 3 \) in JavaScript?
   a. A binding for \( x \) is found, starting in the local environment, and moving upwards through its parent (prototype) environments, and is updated with the value 3; if no such binding is found, a binding of \( x \) to 3 in the top-level, global environment is created
   b. The value of \( x \) in the local environment is updated to be 3, unless no such binding exists, in which case a new binding is created
   c. If \( x \) is bound to the field \( f \) of an object \( y \), this will cause \( y.f \) to be updated also
   d. After this statement, the variable \( x \) and any other variables aliased to it will hold the value 3

   *a only. This is a reasonably precise description of what assignment in JS does. And yes, it's complicated!*

19. Which of the following is a correct statement about the `var` declaration in JavaScript?
   a. The `var` declaration can have no effect if it appears in dead code
   b. `var` declarations are not strictly necessary, since the same scoping effects can be achieved by declaring variables as extra function arguments
   c. A `var` declaration makes a variable local to a function, which means that the variable retains its value across invocations
   d. A `var` declaration in a function makes a variable private, so that it cannot be accessed outside the function

   *b and d.*

20. Which of the following is a true statement about JavaScript's type system?
   a. JavaScript lacks the static typing discipline of a language like Java
   b. In JavaScript, primitive objects carry their types at runtime, so that certain kinds of error can be prevented
   c. In JavaScript, compound objects carry their types at runtime, so that errors such as accessing non-existent fields can be prevented
   d. In JavaScript, variables carry their types at runtime, so that errors such as assigning a bad value to a variable can be prevented

   *a, b and c.*

21. Consider the code of Example 4. The JavaScript shown here is supposed to create four buttons, which when pressed will report which button has been pressed. Which of the following statements is true about this code?
   a. The dollar symbol is bound to an overloaded function that has a different effect depending on the type of the argument it is applied to.
   b. The code will not work correctly because the `div` element that is used for displaying output will not have been defined in the DOM when the JavaScript runs.
c. The code will not work correctly because the closures that are created in each iteration of the loop are all created in the same environment, so when they are executed they will all see the same value of i.

d. The code will not work correctly because the variable i is not bound in the listener functions.

\textit{a and c.}

The next few questions ask you to predict the output of the calls to \texttt{console.log} in Example 5.

\textit{These questions tested your understanding of constructors and prototyping in Javascript. The create function is Doug Crockford's constructor for making direct prototype links, which we discussed in lecture, and which appears in newer implementations of JS.}

22. True or false?
   a. The first log call prints 1
   b. The first log call prints undefined
   c. The second log call prints 1
   d. The second log call prints undefined

\textit{a and c.}

23. True or false?
   a. The third log call prints 1
   b. The third log call prints 3
   c. The third log call prints 4
   d. The third log call prints undefined

\textit{c.}

24. True or false?
   a. The fourth log call prints 1
   b. The fourth log call prints 3
   c. The fourth log call prints 4
   d. The fourth log call prints undefined

\textit{b.}

The next few questions are about the code of Example 6. It shows an abstract data type implemented in JavaScript to represent web colors.

25. Which of the following statements is true about this code?
   a. \texttt{Color} is similar to (but not the same as) a constructor in a class-based language
   b. \texttt{Color} should be called with the special JavaScript keyword \texttt{new}
   c. Two calls to \texttt{Color} will never return the same object
d. This code is intended to implement an immutable datatype

\[a, c \text{ and } d.\]

26. Ignoring their prototypes, how many properties do the objects returned by the Color function have?

a. 4 properties
b. 5 properties
c. 6 properties
d. 9 properties

\[b.\]

27. Suppose c continues to be bound to the same object. Which of the following is possible, and, if done, might cause a later call to c.checkRep to throw an exception?

a. Modifying the variables r, g, or b
b. Modifying the function bound to check
c. Modifying the red property of c
d. Modifying the checkRep property of c

d.

D Asynchronous Events

28. Which of the following statements is true of the JavaScript/browser concurrency model?

a. The JavaScript that runs on a web page has no real concurrency; all the code you write runs in a single thread
b. When an asynchronous request to a server is made, the JavaScript program making the call waits for a response before continuing
c. The tasks created by JavaScript events are executed sequentially, so you don't have to worry about them interrupting each other
d. An infinite loop in a JavaScript program is problematic because it will prevent control from returning to the user.

\[a, c \text{ and } d.\]

29. Which of the following statements is true about Ajax calls?

a. On the server side, an Ajax call is just like any other HTTP request, so no special mechanisms are needed beyond the ability to return JSON and XML as alternatives to HTML
b. An Ajax call is different from a regular HTTP request, because it always returns data, and never plain HTML
c. An Ajax call is different from a regular HTTP request, because it does not usually cause a page reload
d. Putting Ajax calls into a web page can make the back button less useful
The next few questions are about the code of Example 7. This is taken from an implementation of a client program that attempts to synchronize the time with a network clock.

30. If a call `getServerTime(f)` is made, where `f` is bound to a function, which of the following is true?
   a. The function `f` is always called before `getServerTime` returns
   b. The function `f` may be called before `getServerTime` returns
   c. The function `f` may be called after `getServerTime` returns
   d. The function `f` may not be called until after at least one call to `getClientTime`

   *c and d.*

31. Which of the following are true statements about the HTTP protocol?
   a. An HTTP protocol interaction usually consists of a single request followed by a single response
   b. An HTTP `GET` request is guaranteed not to have side effects
   c. An HTTP `PUT` request is supposed to be idempotent
   d. Within the HTTP protocol, one request should not have an effect on another

   *a, c and d.*

32. Which of the following are true statements about state in web applications?
   a. The HTTP protocol itself is stateless
   b. Session state can be stored on the server side
   c. Storing session state on the server side makes scaling harder
   d. Storing session state on the client side can be a source of privacy failures

   *all.*

33. In a web application that is intended to conform to the MVC pattern, which of the following statements about dependencies hold?
   a. The model should not depend on the controller
   b. The controller should not depend on the model
   c. The controller should not depend on the view, but it often does
   d. The view should not depend on the controller

   *a and c.*
34. Which of the following requests are not typically expressed by a simple combination of a ReSTful URI naming a resource and an HTTP verb?
   a. A request to display the contents of a record
   b. A request to delete a record
   c. A request to display a form for updating a record
   d. A request to submit form data to create a record
   c; this is the only one that isn’t a CRUD action.

F Relational Databases

35. Which of the following statements about normal forms is true?
   a. A database that is not in normal form will generally perform worse on read operations
   b. Normal form violations introduce redundancies into tables
   c. Schemas obtained by transforming object models tend to be in normal form
   d. Normalization of a database is often performed at runtime
   b and c.

36. Suppose an object model for a shopping cart has a one-many relation items from an entity Cart to an entity Item. Suppose the two entities are represented in the database as distinct tables of the same name. Which of the following statements is true?
   a. The relation items should result in a column defined in the table Item
   b. The relation items should result in a column defined in the table Cart
   c. The relation items will require an additional table to be defined
   d. The relation items will likely result in a foreign key declaration in Cart
   a only.
Examples Referred to in Questions

Ex. 1 Example for questions 6 and on

```html
<!DOCTYPE html>
<body>
  <button onclick="click()">Press me!</button>
</body>
</html>
```

Ex. 2 Example for questions 7 and on

```javascript
function make_meta(elt, meta_parent) {
  var meta_elt = make_matching_element(elt);
  var original_color = elt.style.backgroundColor;
  meta_elt.addEventListener("mouseover",
    function (event) {
      event.stopPropagation();
      elt.style.backgroundColor = "yellow";
    });
  meta_elt.addEventListener("mouseout",
    function () {
      elt.style.backgroundColor = original_color;
    });
  meta_parent.appendChild (meta_elt);
  return meta_elt;
}
```

Ex. 3 Example for questions 14 and on

```
<head>
  <script>
    $(function () {
      for (var i = 0; i <= 3; i += 1) {
        var bi = "<button>"; bi.text(i);
        $('body').append(bi);
        bi.click(function () {
          $('#log').text("Pressed " + i);});});}}
  </script>
</head>
<body>
  <div id=log></div>
</body>
```

Ex. 4 Example for questions 21 and on
Object.create = function (o) {
    var F = function () {};
    F.prototype = o;
    return new F();
}

a = {z: 1}
b = Object.create(a)
c = Object.create(b)
b.y = 2
console.log(b.z)
c.x = 3
console.log(c.z)
a.z = 4
console.log(b.z)
b.z = 3
console.log(b.z)

Ex. 5  Example for questions 22 and on

var Color = function (r, g, b) {
    var check = function (x) {if (x < 0 || x > 255) throw "rep inv error";}
    var rgb = [r, g, b];
    var color = {};
    color.checkRep = function () {rgb.map(check);}
    color.checkRep();
    color.red = function () {return r;}
    color.green = function () {return g;}
    color.blue = function () {return b;}
    color.toCSS = function () {return "rgb(" + rgb.join(",") + ");";
    return color;
}
c = Color(20,30,40);

Ex. 6  Example for questions 25 and on

var getServerTime = function (continuation) {
    var callback = function (response) {
        var response_received_time = getClientTime();
        var round_trip_time = response_received_time - response.request_time;
        console.log("Round trip time is " + round_trip_time + "ms");
        if (round_trip_time < tolerance) {
            measurement.valid = true;
            measurement.server_time = response.server_time;
            measurement.client_time = getClientTime();
        }
        continuation();
    }
    var params = {request_time: getClientTime()};
    $.getJSON("/get_time", params, callback);
};

Ex. 7  Example for questions 30 and on