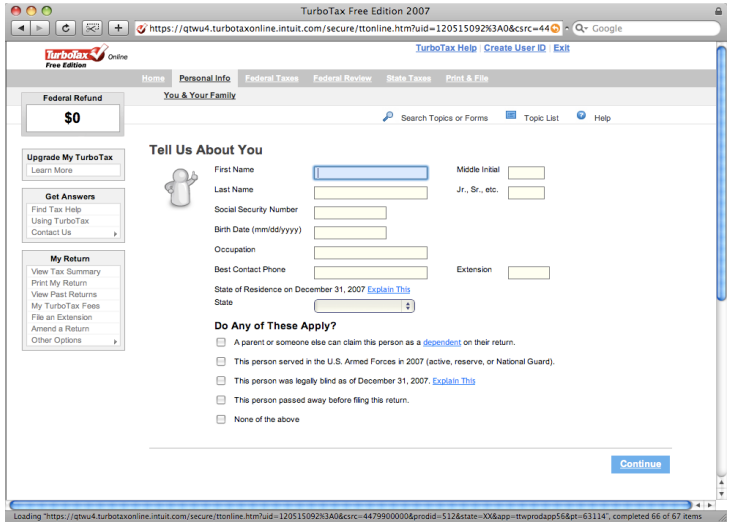
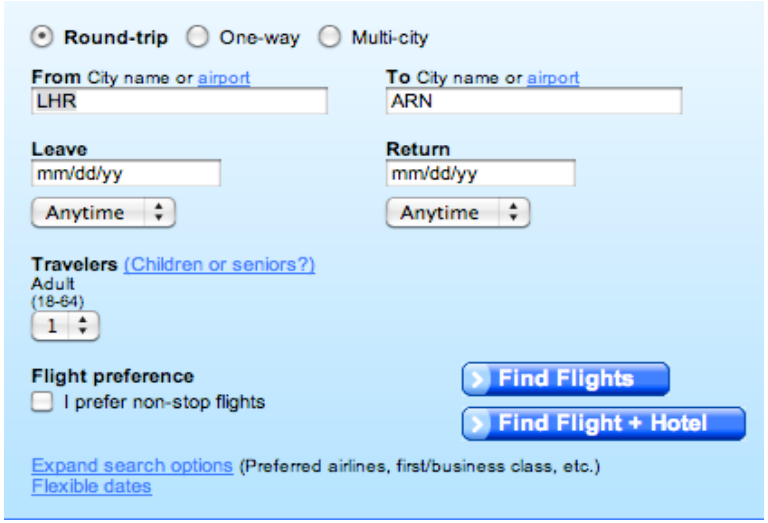
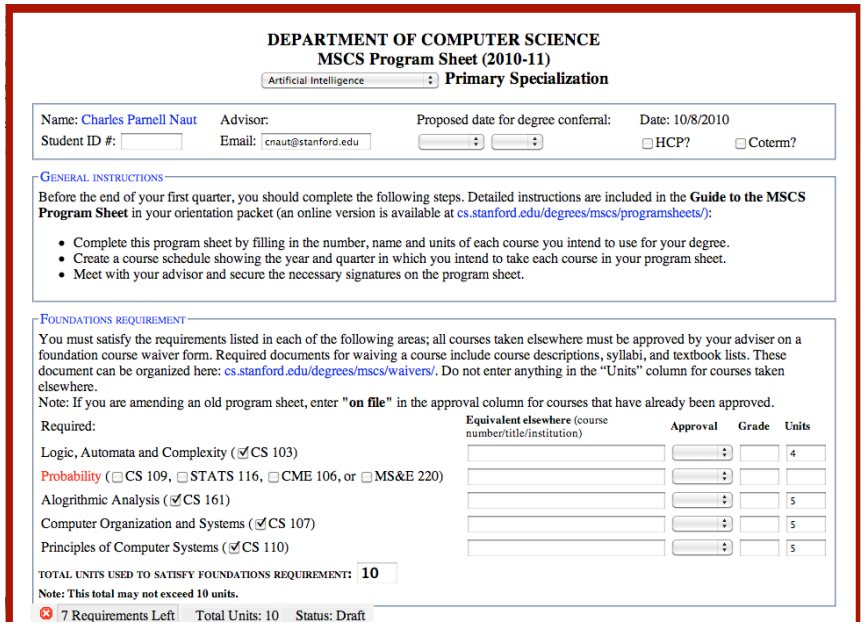
Logic Programming
Reactive Worksheets

Michael Genesereth
Computer Science Department
Stanford University

Worksheets







DEPARTMENT OF COMPUTER SCIENCE
MSCS Program Sheet (2010-11)
Artificial Intelligence **Primary Specialization**

Name: Charles Parnell Naut Advisor: Proposed date for degree conferral: Date: 10/8/2010
Student ID #: Email: cnaut@stanford.edu ☐ HCP? ☐ Coterm?

GENERAL INSTRUCTIONS

Before the end of your first quarter, you should complete the following steps. Detailed instructions are included in the **Guide to the MSCS Program Sheet** in your orientation packet (an online version is available at cs.stanford.edu/degrees/mscs/programsheets/):

- Complete this program sheet by filling in the number, name and units of each course you intend to use for your degree.
- Create a course schedule showing the year and quarter in which you intend to take each course in your program sheet.
- Meet with your advisor and secure the necessary signatures on the program sheet.

FOUNDATIONS REQUIREMENT

You must satisfy the requirements listed in each of the following areas; all courses taken elsewhere must be approved by your adviser on a foundation course waiver form. Required documents for waiving a course include course descriptions, syllabi, and textbook lists. These document can be organized here: cs.stanford.edu/degrees/mscs/waivers/. Do not enter anything in the "Units" column for courses taken elsewhere.
Note: If you are amending an old program sheet, enter **"on file"** in the approval column for courses that have already been approved.

Required:	Equivalent elsewhere (course number/title/institution)	Approval	Grade	Units
Logic, Automata and Complexity (☑ CS 103)				4
Probability (☐ CS 109, ☐ STATS 116, ☐ CME 106, or ☐ MS&E 220)				
Alogrithmic Analysis (☑ CS 161)				5
Computer Organization and Systems (☑ CS 107)				5
Principles of Computer Systems (☑ CS 110)				5

TOTAL UNITS USED TO SATISFY FOUNDATIONS REQUIREMENT: 10
Note: This total may not exceed 10 units.

7 Requirements Left Total Units: 10 Status: Draft

Characteristics

Meaningful Data Display

All data readily accessible

Tables, Charts, Graphs

Modifiability

What-you-see-is-what-you-get

Random access - data can be changed in any order

Constraint Checking

Completeness and Consistency

Problem alerting and Guidance in solving

Automatic Computation of Results

Consequences computed

Presentation automatically updated

Assignment - Academic Program Sheet

DEPARTMENT OF COMPUTER SCIENCE
MSCS Program Sheet (2010-11)
Artificial Intelligence **Primary Specialization**

Name: Charles Parnell Naut Advisor: Proposed date for degree conferral: Date: 10/8/2010
Student ID #: Email: cnaut@stanford.edu ☐ HCP? ☐ Coterm?

GENERAL INSTRUCTIONS

Before the end of your first quarter, you should complete the following steps. Detailed instructions are included in the **Guide to the MSCS Program Sheet** in your orientation packet (an online version is available at cs.stanford.edu/degrees/mscs/programsheets/):

- Complete this program sheet by filling in the number, name and units of each course you intend to use for your degree.
- Create a course schedule showing the year and quarter in which you intend to take each course in your program sheet.
- Meet with your advisor and secure the necessary signatures on the program sheet.

FOUNDATIONS REQUIREMENT

You must satisfy the requirements listed in each of the following areas; all courses taken elsewhere must be approved by your adviser on a foundation course waiver form. Required documents for waiving a course include course descriptions, syllabi, and textbook lists. These document can be organized here: cs.stanford.edu/degrees/mscs/waivers/. Do not enter anything in the "Units" column for courses taken elsewhere.
Note: If you are amending an old program sheet, enter "**on file**" in the approval column for courses that have already been approved.

Required:	**Equivalent elsewhere** (course number/title/institution)	**Approval**	**Grade**	**Units**
Logic, Automata and Complexity (☑ CS 103)				4
Probability (☐ CS 109, ☐ STATS 116, ☐ CME 106, or ☐ MS&E 220)				
Alogrithmic Analysis (☑ CS 161)				5
Computer Organization and Systems (☑ CS 107)				5
Principles of Computer Systems (☑ CS 110)				5

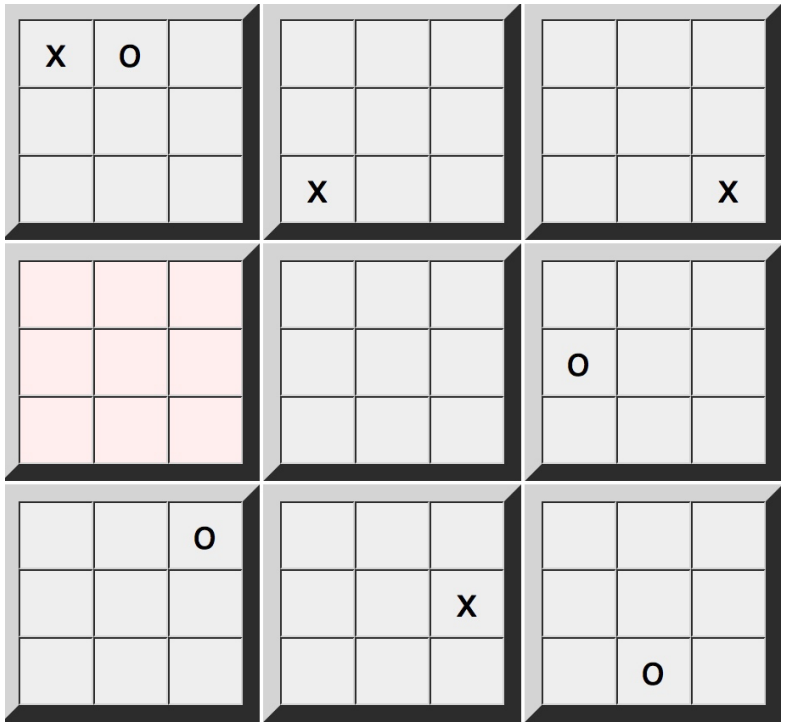
TOTAL UNITS USED TO SATISFY FOUNDATIONS REQUIREMENT: 10

Note: This total may not exceed 10 units.

7 Requirements Left Total Units: 10 Status: Draft

Demonstration

Assignment - Nineboard Tic Tac Toe



Demonstration

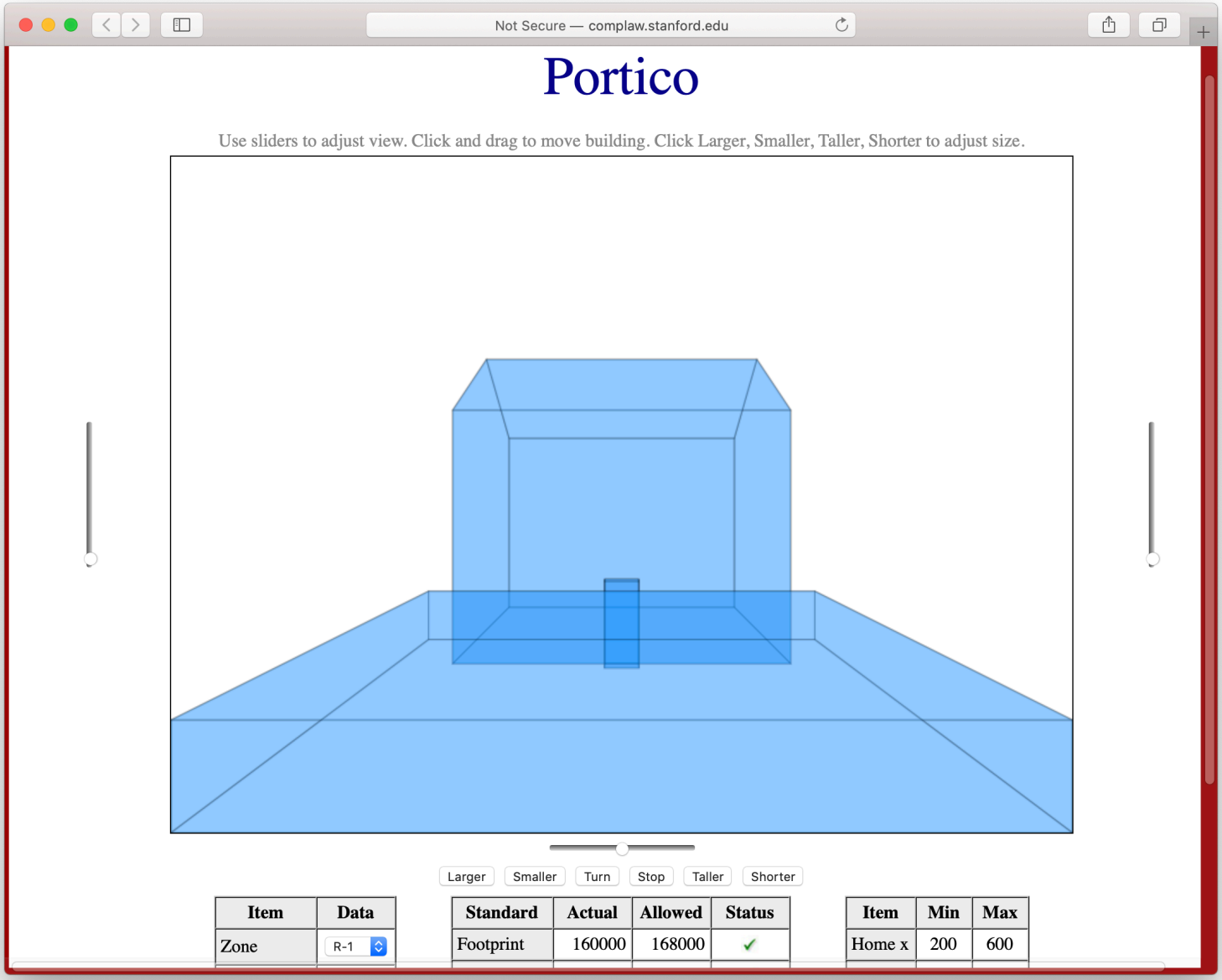
Example - Connect Four

Demonstration

Example - Solar System

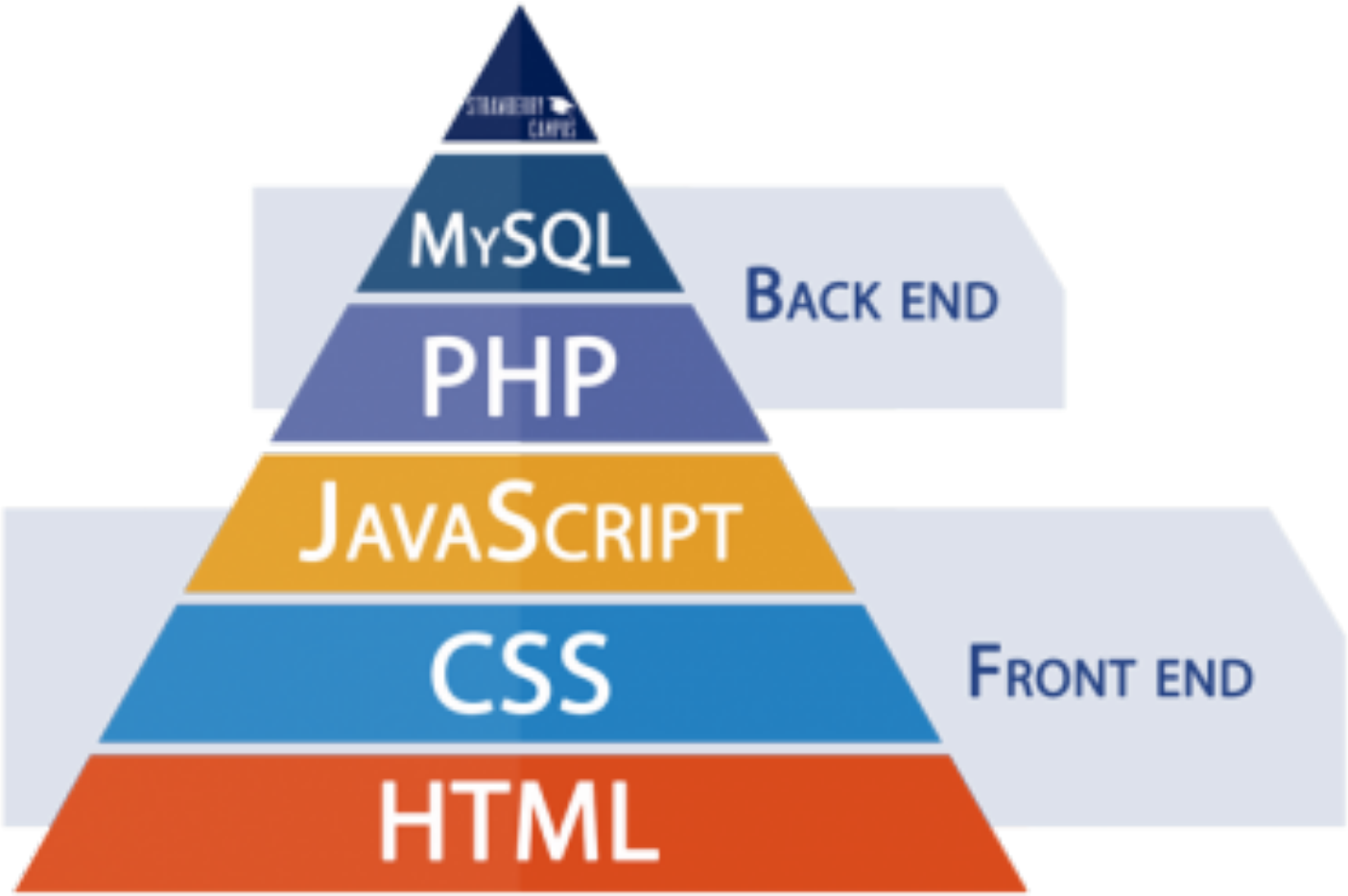
Demonstration

Assignment - Portico



Demonstration

Current Approach



The Big 5

Do you master them all?

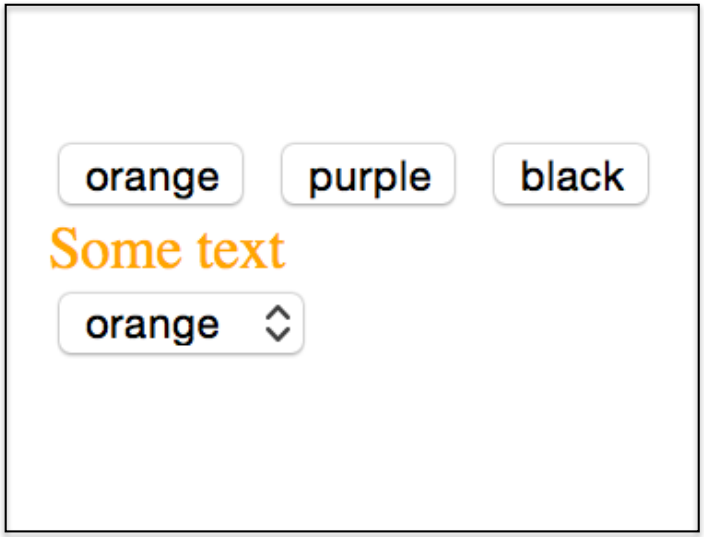
DIY Manifesto

Do It Yourself!

Worksheets :: Spreadsheets

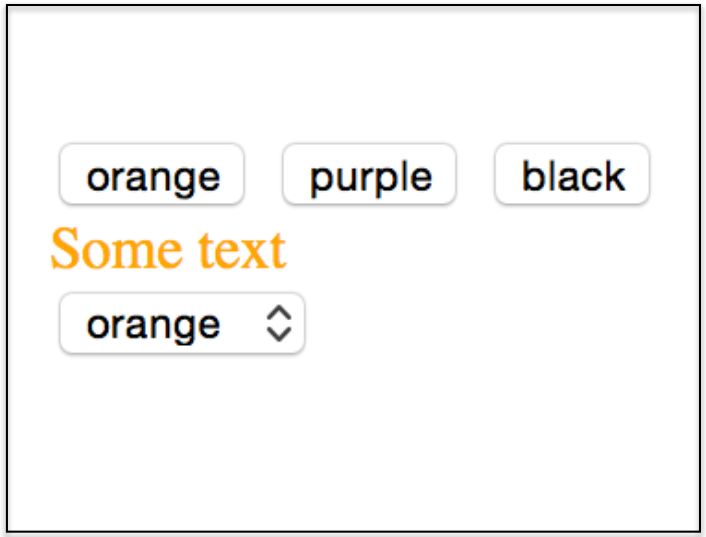
Web Pages

Webpage



Demonstration

HTML Representation




```
<html>
 <body>
    <input id='o' type='button' value='orange'/>
    <input id='p' type='button' value='purple'/>
    <input id='b' type='button' value='black'/>
    <p id='text' color='orange'>Some text.</p>
    <select id='s'>
      <option>orange</option>
      <option>purple</option>
      <option>black</option>
    </select>
 </body>
</html>
```

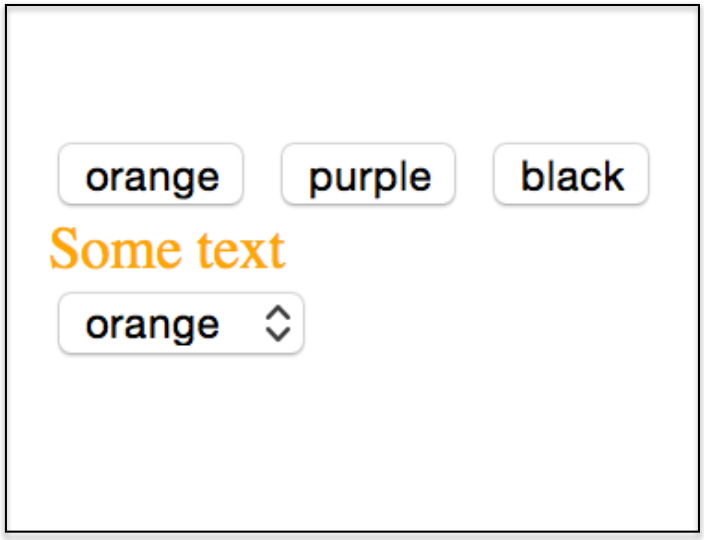
"Mirror" Semantics

Web browsers read HTML, create internal representation called the Document Object Model (DOM), and render page.

Dynamics

- User gestures change DOM
- Changes to DOM are reflected in visible web page

"Mirror" Dataset




```
value(o,orange)
value(p,purple)
value(b,black)
value(s,orange)

style(o,color,black)
style(p,color,black)
style(b,color,black)
style(text,color,orange)
style(s,color,black)
                ...
```

Our "Mirror" Semantics

Web browsers read HTML, create internal representation called the Document Object Model (DOM) and create dataset, and render page.

Dynamics

- User gestures translated to actions
- Actions change the dataset
- Changes to dataset reflected in DOM
- Changes to DOM are reflected in visible web page

Dataset Representation

DOM:

```
<center>
  <input id=‘mynode'
         type=‘text'
         value=‘hello'
         size=’30'
         style='color:black'/>
</center>
```

Dataset Representation

DOM:

```
<center>
  <input id=‘mynode'
         type=‘text'
         value=‘hello'
         size=’30'
         style='color:black'/>
</center>
```

Dataset:

```
value(mynode,hello)
attribute(mynode,size,30)
style(mynode,color,black)
```

Widget Predicates

`value(`*widget*`,`*value*`)` - true whenever the value associated with *widget* is *value*. The widget here may be a text field, selector, checkbox, radio button field, slider, and so forth.

`valuelist(`*widget*`, `*list*`)` - true whenever *list* contains the values associated with the multi-valued node *widget*. The widget in this case is typically a multi-valued selector or a checkbox field.

`options(`*selector*`,`*list*`)` - true whenever *list* contains the options for *selector*.

Node Predicates

`rows(`*table*`, `*list*`)` - true whenever *list* contains the rows of *table*.

`innerhtml(`*node*`,`*string*`)` - true whenever the innerHTML associated with *node* is *string*.

`attribute(`*node*`,`*property*`,`*value*`)` - true whenever the *property* attribute of *node* is *value*.

`style(`*node*`,`*property*`,`*value*`)` - true whenever the *property* style of *node* is *value*.

Actions

Gestures performed by the user:

- Making a selection from drop-down list
- Changing value of text field
- Clicking a button

Automatic Actions:

- Loading a page
- Clock tick

Example

DOM:

```
<input id='orange'
       type='button'
       value='orange'/>
```

-> user clicks

Action:

```
click(orange)
```

Example

DOM:

```
<select id='pagecolor'>
  <option>orange</option>
  <option>purple</option>  -> user selects
  <option>black</option>
</select>
```

Action:

```
select(pagecolor,purple)
```

Example

DOM:

```
<center>
  <input id='mynode'
         type='text'
         value='hello'  -> user enters "goodbye"
         size='30'
         style='color:black'/>
</center>
```

Action:

```
select(mynode,"goodbye")
```

Operations

`click(`*widget*`)`: This action occurs when the user clicks on *widget*.

`select(`*selector*`,`*value*`)`: This action occurs when the user enters or selects *value* as the value of *widget*.

`multiselect(`*multiselector*`,`*list*`)`: This action occurs when the user erases or deselects a value of *multiselector*. Here *list* is a list of selected values.

Operations

`click(`*widget*`)`: This action occurs when the user clicks on *widget*.

`select(`*selector*`,`*value*`)`: This action occurs when the user enters or selects *value* as the value of *widget*.

`multiselect(`*multiselector*`,`*list*`)`: This action occurs when the user erases or deselects a value of *multiselector*. Here *list* is a list of selected values.

`tick`: This action occurs periodically (when a page contains a timer and the timer is activated). By default, it happens once per second.

`load`: This occurs when a page is first loaded.

Buttons

orange | blue | purple | black

```
click(orange) :: style(page,color,orange)
click(blue) :: style(page,color,blue)
click(purple) :: style(page,color,purple)
click(black) :: style(page,color,black)
```

```
click(X) :: style(page,color,X)
```

Buttons

orange | blue | purple | black

```
click(orange) :: style(page,color,orange)
click(blue) :: style(page,color,blue)
click(purple) :: style(page,color,purple)
click(black) :: style(page,color,black)


click(X) :: style(page,color,X)
click(X) ::
 style(page,color,Y)==> ~style(page,color,Y)
```

Selectors


```
select(pagecolor,X) :: style(page,color,X)
```

Selectors

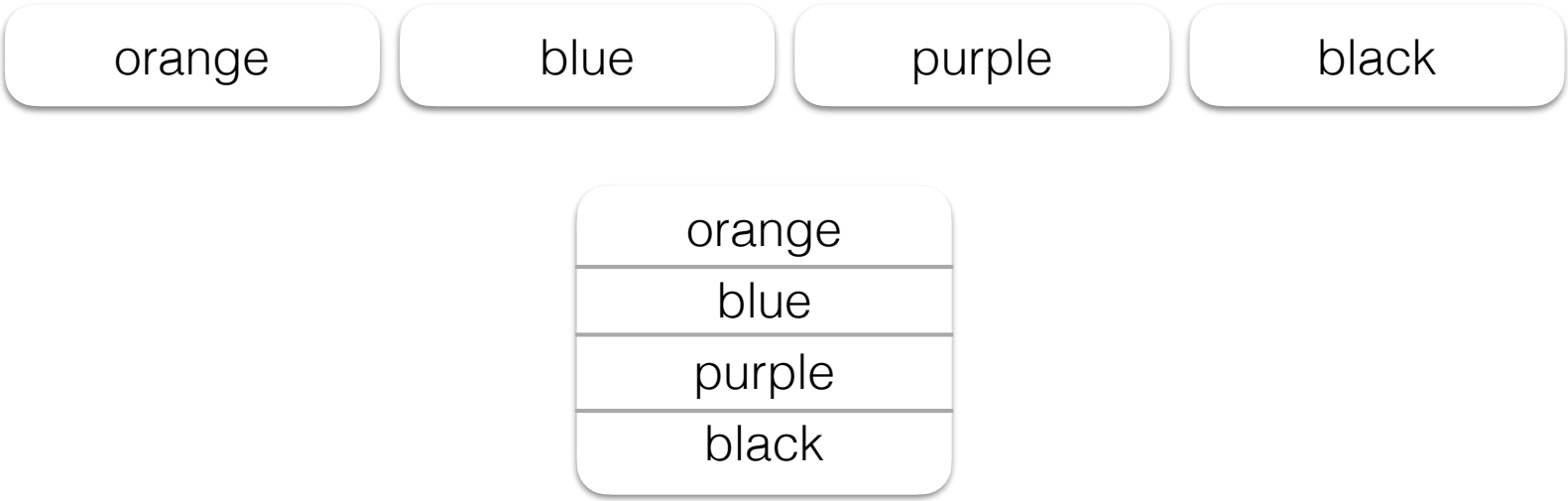

```
select(pagecolor,X) :: style(page,color,X)
select(pagecolor,X) ::
  style(page,color,Y) ==> ~style(page,color,Y)
```

Selectors


```
select(pagecolor,X) :: style(page,color,X)
select(pagecolor,X) ::
  style(page,color,Y) ==> ~style(page,color,Y)
```

```
select(pagecolor,X) :: value(pagecolor,X)
select(pagecolor,X) ::
  value(pagecolor,Y) ==> ~value(pagecolor,Y)
```

Interaction Between Buttons and Selectors

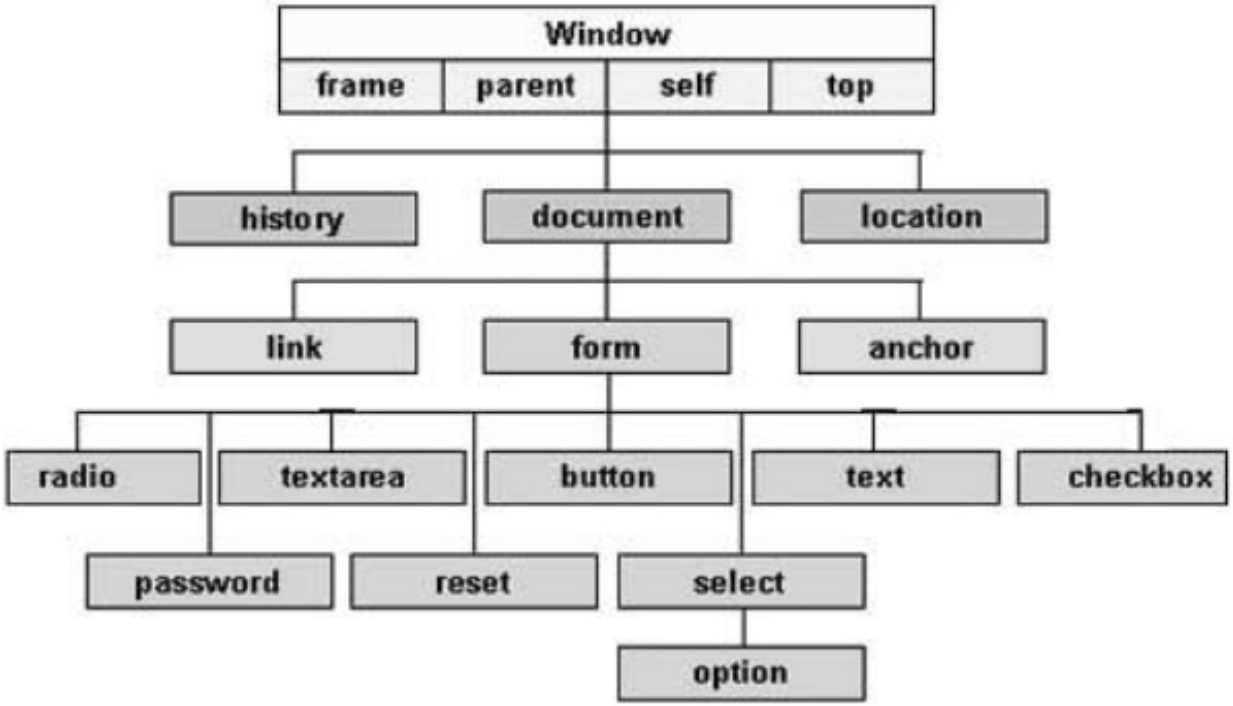



```
click(X) :: style(page,color,X)
click(X) ::
  style(page,color,Y) & distinct(X,Y)
  ==> ~style(page,color,Y)

click(X) :: value(pagecolor,X)
click(X) ::
  value(pagecolor,Y) ==> ~value(pagecolor,Y)
```

Representational Alternatives

Document Object Model (DOM)



NB: The DOM is a tree (not a graph).

Term Representation

Idea - Represent DOM as a term

```
<center>
  <input id=‘mynode'
         type=‘text'
         value=‘hello’
         size=’30'
         style=‘color:black'/>
</center>
```

```
node(center,
     [],
     [node(input,
           [[id,mynode],
            [type,text],
            ...,
            [style,stylenode([color,black])]])])
```

Analysis

Advantages

- Conceptually simple and appealing

Disadvantages

- Rules are messy
- Computational cost - Term update, DOM update

Full Dataset Representation

Idea

- represent *entire* DOM
- in dataset and view definitions
- use operator definitions to update dataset

```
<center>
  <input id='mynode'
         type='text'
         value='hello'
         size='30'
         style='color:black'/>
</center>
```

```
attribute(mynode,value,hello)
attribute(mynode,size,30)
style(mynode,color,black)
style(mynode,"font-family",courier)
style(mynode,"font-size",12px)
 ...
```

Analysis

Advantage - conceptually simple and flexible

"Mirror semantics"

state of DOM and dataset synchronized

changing either one changes the other

Possible to define some features as views

(but then must define DOM gestures as operators)

Disadvantages - computational cost and coverage

Entire DOM must be updated on each cycle

(less problematic if concentrate on nodes w/ ids)

Must ensure that the *entire* DOM is captured

Relevant Dataset Representation

Idea

- represent *relevant* portion of DOM as dataset
- use operator definitions to update dataset

Inertial / differential

- Anything not in the dataset closure remains same

Analysis

Disadvantages - *not* mirror semantics

- Things with no ids do not change
- Cannot create new nodes without update problems

Advantage - conceptually simple

- Focussed
- Deals nicely with *numerous* DOM features and updates
- Low computation cost

Authoring

Augmented HTML

Augmented HTML is plain HTML with augmentations that allow authors to use logic programs to control the *appearance* and the *behavior* of the web page.

Essentials:

- Representation of the state of the page as a dataset
- Values, attributes, styles via *relations*
- Behavior via *operation definitions*

Converting HTML Pages to Worksheets

Start with an HTML page.

(1) Add worksheets code.
(2) Initialize.
(3) Add identifiers and event handlers.
(4) Add Data and Rules.

Done.

file:///Users/mrg/Desktop/example.html

orange purple black

Some text

orange

Raw HTML

```
<html>
  <head>
  </head>
  <body>
    <input type=‘button’ value=‘orange’/>
    <input type=‘button’ value=‘purple’/>
    <input type=‘button’ value=‘black’/>
    <p color='orange'>Some text.</p>
    <select>
      <option>orange</option>
      <option>purple</option>
      <option>black</option>
    </select>
 </body>
</html>
```

Load Worksheets Code

```
<html>
  <head>
    <script type=‘text/javascript’
      src=‘http://epilog.stanford.edu/javascript/epilog.js'></script>
    <script type=‘text/javascript’
      src=‘http://worksheets.stanford.edu/javascript/worksheets.js'></script>
  </head>
  <body>
    <input type=‘button’ value=‘orange’/>
    <input type=‘button’ value=‘purple’/>
    <input type=‘button’ value=‘black’/>
    <p color='orange'>Some text.</p>
    <select>
      <option>orange</option>
      <option>purple</option>
      <option>black</option>
    </select>
 </body>
</html>
```

Initialize

```
<html>
  <head>
    <script type=‘text/javascript’
      src=‘http://epilog.stanford.edu/javascript/epilog.js'></script>
    <script type=‘text/javascript’
      src=‘http://worksheets.stanford.edu/javascript/worksheets.js'></script>
script>
  </head>
  <body onload=‘initialize()’>
    <input type=‘button’ value=‘orange’/>
    <input type=‘button’ value=‘purple’/>
    <input type=‘button’ value=‘black’/>
    <p color='orange'>Some text.</p>
    <select>
      <option>orange</option>
      <option>purple</option>
      <option>black</option>
    </select>
 </body>
</html>
```

Add Identifiers and Event Handlers

```
<html>
  <head>
    <script type=‘text/javascript’
      src=‘http://epilog.stanford.edu/javascript/epilog.js'></script>
    <script type=‘text/javascript’
      src=‘http://worksheets.stanford.edu/javascript/worksheets.js'></script>
script>
  </head>
  <body id=‘page’ onload=‘initialize()’>
    <input type=‘button’ value=‘orange’ id=‘orange’ onclick=‘handle(this)’/>
    <input type=‘button’ value=‘purple’ id=‘purple’ onclick=‘handle(this)’/>
    <input type=‘button’ value=‘black’ id=‘black’ onclick=‘handle(this)’/>
    <p id='orangetext'>Some text.</p>
    <select id=‘pagecolor’ onchange=‘handle(this)’>
      <option>orange</option>
      <option>purple</option>
      <option>black</option>
    </select>
 </body>
</html>
```

Add Data and Rules

```
<html>
  <head>
    <script type=‘text/javascript’
      src=‘http://epilog.stanford.edu/javascript/epilog.js'></script>
    <script type=‘text/javascript’
      src=‘http://minimal.stanford.edu/worksheets/javascript/worksheets.js'></
script>
  </head>
  <body id=‘page’ onload=‘initialize()’>
    <input type=‘button’ value=‘orange’ id=‘orange’ onclick=‘handle(this)’/>
    <input type=‘button’ value=‘purple’ id=‘purple’ onclick=‘handle(this)’/>
    <input type=‘button’ value=‘black’ id=‘black’ onclick=‘handle(this)’/>
    <p color='orange'>Some text.</p>
    <select id=‘pagecolor’ onchange=‘handle(this)’>
      <option>orange</option>
      <option>purple</option>
      <option>black</option>
    </select>
  </body>
  <textarea id=‘lambda’ style=‘display:none’></textarea>
  <textarea id=‘library’ style=‘display:none’>...</textarea>
</html>
```

Documentation

http://worksheets.stanford.edu/introduction/index.html